Zbornik 20. mednarodne multikonference INFORMACIJSKA DRUŽBA - IS 2017

Proceedings of the 20th International Multiconference

Slovenska konferenca o umetni inteligenci Slovenian Conference on Artificial Intelligence

Kognitivna znanost Cognitive Science

Odkrivanje znanja in podatkovna skladišča - SiKDD Data Mining and Data Warehouses - SiKDD

Kognitonika Cognitonics

Delavnica AS-IT-IC AS-IT-IC Workshop

Soočanje z demografskimi izzivi Facing demographic challenges

Sodelovanje, programska oprema in storitve v informacijski družbi Collaboration, Software and Services in Information Society

Robotika Robotics

Delavnica za elektronsko in mobilno zdravje ter pametna mest Workshop Electronic and Mobile Health and Smart Cities

Uredili / Edited by

Mitja Luštrek, Rok Piltaver, Matjaž Gams, Olga Markič, Toma Strle, Tine Kolenik, Urban Kordeš, Dunja Mladenić, Marko Grobelnik, Vladimir A. Fomichov, Olga S. Fomichova, Jernej Zupančič, Janez Malačič, Marjan Heričko, Andrej Gams, Aleš Ude, Aleš Tavčar

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9.–13. oktober 2017 / 9–13 October 2017 Ljubljana, Slovenia

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PREDGOVOR MULTIKONFERENCI INFORMACIJSKA DRUŽBA 2017

Multikonferenca Informacijska družba (<u>http://is.ijs.si</u>) je z **dvajseto** zaporedno prireditvijo osrednji srednjeevropski dogodek na področju informacijske družbe, računalništva in informatike. Letošnja prireditev je ponovno na več lokacijah, osrednji dogodki pa so na Institutu »Jožef Stefan«.

Informacijska družba, znanje in umetna inteligenca so spet na razpotju tako same zase kot glede vpliva na človeški razvoj. Se bo eksponentna rast elektronike po Moorovem zakonu nadaljevala ali stagnirala? Bo umetna inteligenca nadaljevala svoj neverjetni razvoj in premagovala ljudi na čedalje več področjih in s tem omogočila razcvet civilizacije, ali pa bo eksponentna rast prebivalstva zlasti v Afriki povzročila zadušitev rasti? Čedalje več pokazateljev kaže v oba ekstrema – da prehajamo v naslednje civilizacijsko obdobje, hkrati pa so planetarni konflikti sodobne družbe čedalje težje obvladljivi.

Letos smo v multikonferenco povezali dvanajst odličnih neodvisnih konferenc. Predstavljenih bo okoli 200 predstavitev, povzetkov in referatov v okviru samostojnih konferenc in delavnic. Prireditev bodo spremljale okrogle mize in razprave ter posebni dogodki, kot je svečana podelitev nagrad. Izbrani prispevki bodo izšli tudi v posebni številki revije Informatica, ki se ponaša s **40-letno** tradicijo odlične znanstvene revije. Odlične obletnice!

Multikonferenco Informacijska družba 2017 sestavljajo naslednje samostojne konference:

- Slovenska konferenca o umetni inteligenci
- Soočanje z demografskimi izzivi
- Kognitivna znanost
- Sodelovanje, programska oprema in storitve v informacijski družbi
- Izkopavanje znanja in podatkovna skladišča
- Vzgoja in izobraževanje v informacijski družbi
- Četrta študentska računalniška konferenca
- Delavnica »EM-zdravje«
- Peta mednarodna konferenca kognitonike
- Mednarodna konferenca za prenos tehnologij ITTC
- Delavnica »AS-IT-IC«
- Robotika

Soorganizatorji in podporniki konference so različne raziskovalne institucije in združenja, med njimi tudi ACM Slovenija, SLAIS, DKZ in druga slovenska nacionalna akademija, Inženirska akademija Slovenije (IAS). V imenu organizatorjev konference se zahvaljujemo združenjem in inštitucijam, še posebej pa udeležencem za njihove dragocene prispevke in priložnost, da z nami delijo svoje izkušnje o informacijski družbi. Zahvaljujemo se tudi recenzentom za njihovo pomoč pri recenziranju.

V 2017 bomo petič podelili nagrado za življenjske dosežke v čast Donalda Michija in Alana Turinga. Nagrado Michie-Turing za izjemen življenjski prispevek k razvoju in promociji informacijske družbe bo prejel prof. dr. Marjan Krisper. Priznanje za dosežek leta bo pripadlo prof. dr. Andreju Brodniku. Že šestič podeljujemo nagradi »informacijska limona« in »informacijska jagoda« za najbolj (ne)uspešne poteze v zvezi z informacijsko družbo. Limono je dobilo padanje slovenskih sredstev za akademsko znanost, tako da smo sedaj tretji najslabši po tem kriteriju v Evropi, jagodo pa »e-recept«. Čestitke nagrajencem!

Bojan Orel, predsednik programskega odbora Matjaž Gams, predsednik organizacijskega odbora

FOREWORD - INFORMATION SOCIETY 2017

In its **20th year**, the Information Society Multiconference (<u>http://is.ijs.si</u>) remains one of the leading conferences in Central Europe devoted to information society, computer science and informatics. In 2017 it is organized at various locations, with the main events at the Jožef Stefan Institute.

The pace of progress of information society, knowledge and artificial intelligence is speeding up, and it seems we are again at a turning point. Will the progress of electronics continue according to the Moore's law or will it start stagnating? Will AI continue to outperform humans at more and more activities and in this way enable the predicted unseen human progress, or will the growth of human population in particular in Africa cause global decline? Both extremes seem more and more likely – fantastic human progress and planetary decline caused by humans destroying our environment and each other.

The Multiconference is running in parallel sessions with 200 presentations of scientific papers at twelve conferences, round tables, workshops and award ceremonies. Selected papers will be published in the Informatica journal, which has **40 years** of tradition of excellent research publication. These are remarkable achievements.

The Information Society 2017 Multiconference consists of the following conferences:

- Slovenian Conference on Artificial Intelligence
- Facing Demographic Challenges
- Cognitive Science
- Collaboration, Software and Services in Information Society
- Data Mining and Data Warehouses
- Education in Information Society
- 4th Student Computer Science Research Conference
- Workshop Electronic and Mobile Health
- 5th International Conference on Cognitonics
- International Conference of Transfer of Technologies ITTC
- Workshop »AC-IT-IC«
- Robotics

The Multiconference is co-organized and supported by several major research institutions and societies, among them ACM Slovenia, i.e. the Slovenian chapter of the ACM, SLAIS, DKZ and the second national engineering academy, the Slovenian Engineering Academy. In the name of the conference organizers we thank all the societies and institutions, and particularly all the participants for their valuable contribution and their interest in this event, and the reviewers for their thorough reviews.

For the fifth year, the award for life-long outstanding contributions will be delivered in memory of Donald Michie and Alan Turing. The Michie-Turing award will be given to Prof. Marjan Krisper for his life-long outstanding contribution to the development and promotion of information society in our country. In addition, an award for current achievements will be given to Prof. Andrej Brodnik. The information lemon goes to national funding of the academic science, which degrades Slovenia to the third worst position in Europe. The information strawberry is awarded for the medical e-recipe project. Congratulations!

Bojan Orel, Programme Committee Chair Matjaž Gams, Organizing Committee Chair

KONFERENČNI ODBORI CONFERENCE COMMITTEES

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Invited lecture

AN UPDATE FROM THE AI & MUSIC FRONT

Gerhard Widmer Institute for Computational Perception Johannes Kepler University Linz (JKU), and Austrian Research Institute for Artificial Intelligence (OFAI), Vienna

Abstract

Much of current research in Artificial Intelligence and Music, and particularly in the field of Music Information Retrieval (MIR), focuses on algorithms that interpret musical signals and recognize musically relevant objects and patterns at various levels -- from notes to beats and rhythm, to melodic and harmonic patterns and higher-level segment structure --, with the goal of supporting novel applications in the digital music world. This presentation will give the audience a glimpse of what musically "intelligent" systems can currently do with music, and what this is good for. However, we will also find that while some of these capabilities are quite impressive, they are still far from (and do not require) a deeper "understanding" of music. An ongoing project will be presented that aims to take AI & music research a bit closer to the "essence" of music, going beyond surface features and focusing on the expressive aspects of music, and how these are communicated in music. This raises a number of new research challenges for the field of AI and Music (discussed in much more detail in [Widmer, 2016]). As a first step, we will look at recent work on computational models of expressive music performance, and will show some examples of the state of the art (including the result of a recent musical 'Turing test').

References

Widmer, G. (2016). Getting Closer to the Essence of Music: The Con Espressione Manifesto. ACM Transactions on Intelligent Systems and Technology 8(2), Article 19.

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Mitja Luštrek, Rok Piltaver, Matjaž Gams

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PREDGOVOR

V letu 2017 smo bili spet priča neverjetnim dosežkom umetne inteligence, ki na čedalje več področjih prekaša človeške sposobnosti. Velja omeniti poker Texas hold'em brez omejitev pri višini stav (ki je precej bolj kompleksen od že rešene različice z omejitvami) in strateško računalniško igro Dota 2, kjer so se do sedaj ljudje uspešno upirali programom umetne inteligence, sedaj pa je v igri ena na ena umetna inteligenca pokazala premoč. Podobno dobro rešuje tudi resnejše probleme, npr. prepoznavanje rakavih tkiv za zgodnjo diagnozo, kjer pa opažamo počasen prenos dosežkov iz raziskovalnih laboratorijev v prakso. Umetna inteligenca že sedaj ljudem pomaga na veliko področjih in celo rešuje življenja. Trendi kažejo, da bo naslednje leto še bolj koristna in prijazna. In naslednja leta še bolj.

Mnoge zanimive dosežke umetne inteligence lahko spoznamo tudi na Slovenski konferenci o umetni inteligenci (SKUI). Letos smo sprejeli 21 prispevkov, kar so trije več kot lani. Kot pretekla leta jih je največ z Instituta »Jožef Stefan«. Obžalujemo, da jih je manj kot lani prispevala Fakultete za računalništvo in informatiko, ki ima skupaj z Institutom vodilno vlogo pri raziskavah umetne inteligence v Sloveniji, pozdravljamo pa dva zelo kakovostna prispevka iz industrije. Upamo, da bo prispevkov iz industrije in nasploh izven Instituta prihodnja leta še več, saj je ključen cilj SKUI povezovanje vseh slovenskih raziskovalcev umetne inteligence, čeprav na konferenci niso nič manj dobrodošli tudi prispevki iz drugih držav.

SKUI je naslednica konference Inteligentni sistemi, ki je sestavni del multikonference Informacijska družba že od njenega začetka leta 1997. Letos tako skupaj s celotno multikonferenco praznuje 20. obletnico. Ker poleg tega Slovensko društvo za umetno inteligenco (SLAIS) – ki SKUI šteje za svojo konferenco – praznuje 25. obletnico, smo se odločili razširjene različice najboljših prispevkov povabiti v posebno številko revije Informatica o umetni inteligenci. Objava najboljših prispevkov z Informacijske družbe v Informatici je že dolga tradicija, ki pa jo bomo letos s posebno številko revije, kjer bomo objavili izbrane raziskave umetne inteligence v Sloveniji, še oplemenitili.

Mitja Luštrek, Rok Piltaver, Matjaž Gams

FOREWORD

2017 has brought many exciting achievements of artificial intelligence, which is proving superior to humans in increasingly many fields. Two examples are no-limit Texas hold'em poker (which is substantially more complex than the already solved limit version) and the computer strategy game Dota 2. In both cases, artificial intelligence has not been able to match the best humans so far, but this changed this year. Artificial intelligence is also solving more serious problems, such as the identification of cancerous tissue to enable early diagnosis; unfortunately, though, such achievements are not translated from research laboratories to practice as quickly as we may wish. However, artificial intelligence is already helping people in many fields and even saving lives. Trends indicate that it will be even more useful and friendly next year, and more so the years after that.

Slovenian Conference on Artificial Intelligence (SCAI) is a venue where one can learn about many achievements of artificial intelligence. 21 papers were accepted this year, which is three more than previous year. As in past years, most of them were from Jožef Stefan Institute. We regret that the Faculty of Computer and Information Science, which shares the leading role in artificial intelligence research in Slovenia with the Institute, contributed fewer papers this year; however, we are glad to have received two very high-quality papers from the industry. We hope for even more papers from the industry and other institutions outside the Institute in the following years, since a key objective of the conference is bringing together all Slovenian artificial intelligence researchers, although international papers are of course equally welcome.

SCAI is the successor of the Intelligent Systems conference, which has been a part of the Information Society multiconference since its establishment in 1997. The conference – together with the whole multiconference – thus celebrates its 20th anniversary this year. In addition, Slovenian Artificial Intelligence Society (SLAIS), which is the main supporter of SCAI, celebrates its 25th anniversary. Because of that, the extended versions of the best papers will be invited to a special issue of the Informatica journal on artificial intelligence. Publishing the best papers from the Information Society conference in the Informatica journal has a long tradition, but this year the best SCAI papers will find themselves in the company of other selected papers on the Slovenian research on artificial intelligence.

Mitja Luštrek, Rok Piltaver, Matjaž Gams

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ABSTRACT

In recent years, AI is facing incredibly fast progress. In this paper we review a couple of major new AI-related achievements and events. Among them, **IJCAI 2017** as the cover AI worldwide conference presented major scientific and industrial achievements along with several discussions and panels. Among them was AI superiority in the unlimited Texas hold'em poker and Dota 2. Both games were slightly limited, e.g. only 2 players instead of 10 in Dota 2, but the games itself included all major components such as bluffing with hidden cards or properties of dynamic strategic game with global and local decision making. Deep Neural Networks continue their excellence in **visual recognition tasks** and in real-life diagnostics, such as diagnosing which tissue contains malignant cancer cells, exceed best human experts in more and more diseases.

Among broader influence of AI on human future life, the **ban of autonomous weapons** was steadily promoted and as a result, the **asilomar principles** were defined for the first time. The principles present an attempt to provide guidelines for human-beneficial AI, the one that would prevent possibilities for AI to turn into humanharmful ways. The aim of the paper is to bring these issues to our society through presentation and discussions.

Keywords

Artificial intelligence, AI principles, Future of life institute

1. INTRODUCTION

The progress of artificial intelligence (AI) is fast and often surprisingly efficient even for AI professionals [5]. Each year there are scores of new achievements in academia, gaming, industry, and real life. There are also practical modifications of the way we live and work. For example, autonomous vehicles are improving constantly, they are introduced into more and more countries. In Europe, the goal to introduce similar legislation promoting the drones and autonomous vehicles alike by the EU Commissioner Violeta Bulc has not been successful vet, while several EU countries have modified their traffic laws accordingly and USA has recently changed its legislation to promote faster implementation of autonomous vehicle into real life. In Slovenia, where the Justice Minister Goran Klemenčič is intensively trying to modernize the legal system despite the resistance of mainly status-quo majority, the drones are prohibited to spam the space, but as it is becoming a European habit, the bureaucratic viewpoint prohibits the use of drones and autonomous vehicles also for scientific purposes. As a result, Slovenian researchers are developing drones and autonomous cars illegally, but luckily nobody charges them for that. This is just one example how the political and legal system is lagging behind the progress of artificial intelligence and ICT - information and communication technologies.

2. IJCAI 2017

The 26th International Joint Conference on Artificial Intelligence was held in Melbourne, Australia in August 2017 [6]. Melbourne is world's most liveable city for seventh year running and indeed it is safe, clean, not crowded, full of green nature and architectural wonders.



Figure 1: The growth of IJCAI papers in recent years.

The AI growth is indicated by the number of papers submitted to the IJCAI conference (Figure 1). In 2016 in New York there were 2.294 papers submitted while in 2017 in Melbourne, 2540 papers were reviewed. The growth was steady from 2009 on.



Figure 2: Papers per countries at IJCAI 2017.

Study of papers submitted per country (Figure 2) at IJCAI 2017 indicates that the majority of them was from China (37%), second EU (18%) and third US (18%).

On September 1, Vladimir Putin speaking with students warned that whoever cracks artificial intelligence will 'rule the world' [9]. Will that be China since it already submits the major bulk of AI papers? Or will it be USA since most of the awards were given to USA researchers?

It is not only the number of AI papers from China, the industry achievements are astonishing as well. One might not be as familiar with the Chinese solutions as with Google or Amazon AI systems, but Chinese systems are close to the top. For example, in 2017 China's Alibaba Group Holding Ltd introduced a cut-price voice assistant speaker, similar to Amazon.com Inc's "Echo". It is named "Tmall Genie" and costs \$73, significantly less than western counterparts by Amazon and Alphabet Inc's Google, which range around \$150. Similarly, Baidu, China's top search engine, recently launched a device based on its own Siri-like "Duer OS" system. Alibaba and China's top tech firms have ambitions to become world leaders in artificial intelligence as companies.

In terms of overall several scientific and practical achievements presented at IJCAI 2017, two games stood out as another example of AI beating the best human counterparts: unlimited Texas hold'em poker (10 on 160 possibilities) and Dota 2. Both games were slightly limited - in poker, there are only two players, and Dota 2 was also reduced to only two players instead of 10. Nevertheless, both games are most-played human games with award funds going into tens of millions. Both games are quite different from formal games like chess or Go. For example, poker included all major components of human bluffing interactions and hidden cards. Dota 2 was constructed in a way that fast computers had no advantage and the outcome of a game was dependent on strategic plans with global and local decision making, and adapting to the adversary. From Wikipedia: "Dota 2 is originally played in matches between two teams of five players, with each team occupying and defending their own separate base on the map. Each of the ten players independently controls a powerful character, known as a "hero", who all have unique abilities and differing styles of play. During a match, the player collects experience points and items for their heroes in order to successfully fight the opposing team's heroes, who are doing the same. A team wins by being the first to destroy a large structure located in the opposing team's base, called the "Ancient", which is guarded by defensive towers."

Regarding the methods, reinforcement learning and deep neural networks were somehow most common applied, however, the AI field was presented through over 10 major areas.

Deep Neural Networks continue their excellence in visual recognition tasks and in real-life diagnostics, such as diagnosing which tissue contains malignant cancer cells, exceed best human experts in more and more diseases. There are several tasks, e.g. recognition of faces from a picture where DNNs recognized hundreds of faces in seconds, a result no human can match. Figure 3 demonstrates the progress of DNNs in visual tasks: around 2015 the visual recognition in specific domains was comparable to humans. Now, it is surpassed humans quite significantly – again, in particular visual tests.

The effects of only visual superiority are astonishing on its own. For example, eye analyses enable detecting certain diseases like cancer or Alzheimer [3]. Furthermore, DNN studies of facial properties enable detecting sexual orientation, IQ, and political orientation. When shown five photos of each man, a recent system was able to correctly select the man's sexuality 91 per cent of the time, while humans were able to perform the same task with less than 70% accuracy [7]. This Stanford University study alone confirmed that homosexuality is very probably of genetic origin. The consequences of one single study can be profound. Will job applications be determined also by the DNN study of facial properties? Will dictatorship countries prosecuting homosexuality punish their citizens on the basis of their faces?



Figure 3: Error of DNNs on ImageNet through years.

There were several demonstrations and competitions at IJCAI 2017, including the traditional Angry birds competition. Most attractive, however, were soccer competitions with off-line Nao robots that were not trained or advised as a team, but performed on their own in a group proclaimed at the spot. Unfortunately, the local computing powers are at the level of a mobile phone, insufficient for good play. In Figure 4 one can see robots wondering around and searching for a ball. Still, they demonstrated some quite cunning properties, e.g. precise kicking the ball into the goal under the desired angle compared to the foot.



Figure 4: Soccer competition of independent individual Nao robots, dynamically assembled into teams at IJCAI 2017.

Next year will be of particular interest. ICML with 3500 attendees, IJCAI+ECAI with 2500, AAMAS with 700, ICCBR with 250 and SOCS with 50 attendees will be hosted at Stockholm in a 2-week event, July 2018. Wishful jokes are emerging that the critical mass of 6-7000 attendees will provide the critical mass to ignite the general intelligence or even superintelligence [2, 8, 10].

3. BAN OF AUTONOMOUS WEAPONS

Due to the vicinity of the Syrian conflict it is interesting to observe the level of sophistication of ICT solutions. ISIL, despite its technical inferiority, was the first to use slightly modified industrial drones to drop small bombs on the infantry. They also use remotely controlled weapons such as machineguns. However, the often used suicide industrial cars, fully loaded with explosives and shielded by attached armor plates, are still driven by vulnerable humans and not by remote controls on both sides.

None of these weapons falls into the category of fully autonomous weapons AI scientists propose to ban since they don't decide on its own when to fire.

There are two major reasons for the proposed ban:

• The fully autonomous weapons will likely make the war inhumane whereas humans – if war cannot be avoided – need

some rule of engagement to preserve some level of humanity and prevent too extreme human suffering.

• This is one of preconditions on the road to prevent superintelligence to go viral, malignant [2, 8, 10].

There is some reason for celebrating the first successes of the proban efforts – the movement is spreading through the social media since it started years ago by scientists like Toby Walsh or Stuart Russel and is currently coordinated by Mary Wareham. Slovenia is involved at national level where 4 societies (SLAIS for artificial intelligence, DKZ for cognitive science, Informatica for informatics, ACM Slovenia for computer science) assembled a letter and sent it to the UN and Slovenian government, while lately the Slovenian AI society SLAIS submitted a letter to the European national communities to join activities in this direction. Our initiative was also debated at the EurAI meeting at IJCAI 2017.

Second, Elon Mask and CEOs of 155 robotic companies assembled a letter, in which they write "Once developed, lethal autonomous weapons will permit armed conflict to be fought at a scale greater than ever, and at timescales faster than humans can comprehend. These can be weapons of terror, weapons that despots and terrorists use against innocent populations, and weapons hacked to behave in undesirable ways."

"We do not have long to act. Once this Pandora's box is opened, it will be hard to close."

On the other hand, the world superpowers are rapidly not only developing, but also applying autonomous weapons from drones to tanks or submarines. Some even argue that it is already too late to stop the autonomous weapons

Another example: the EU parliament accepted a new legislation giving artificial systems some rights of live beings. This is exactly one of the rules of the thumb not to do to avoid the potentially negative AI progress. So, why did the EU politicians accept such a law? It is not dangerous yet, but clearly worrisome.

4. The 23 ASILOMAR PRINCIPLES

The Future of Life Institute's [4] second conference on the future of artificial intelligence was organized in January 2017. The purpose of this paper is to present, in a rather original way as presented at the conference, the 23 asilomar AI principles [1] defined at the BAI 2017 conference, accompanied with the original discussions, the comments and analysis of the author of this paper.

The opinion of the community is pretty a shared one: "a major change is coming, over unknown timescales but across every segment of society, and the people playing a part in that transition have a huge responsibility and opportunity to shape it for the best."

The first task of the organizers was to compile a list of scores of opinions about what society should do to best manage AI in coming decades. From this list, the organizers distilled as much as they could into a core set of principles that expressed some level of consensus. The coordinating effort was dominating the event, resulting in a significantly revised version for use at the meeting. There, small breakout groups discussed subsets of the principles, giving detailed refinements and commentary on them. This process generated improved versions of the principles. Finally, they surveyed the full set of attendees to determine the level of support for each version of each principle.

After the consuming and meticulous process, a high level of consensus emerged around many of the statements during that final survey. The final list retained the principles if at least 90% of the attendees agreed on them. The 23 principles were grouped into research strategies, data rights and future issues including potential superintelligence, signed by those wishing to associate their name with the list. The principles will hopefully provide some guidelines as to how the power of AI can be used to improve everyone's lives in coming years.

At the web page of the event on the web pages of the Future of Life Institute [4], the following original presentations can be obtained with additional interviews on the consequent links

Artificial intelligence has already provided beneficial tools that are used every day by people around the world. Its continued development, guided by the following principles, will offer amazing opportunities to help and empower people in the decades and centuries ahead.

4.1 Research Issues

1) Research Goal: The goal of AI research should be to create not undirected intelligence, but beneficial intelligence.

2) **Research Funding:** Investments in AI should be accompanied by funding for research on ensuring its beneficial use, including thorny questions in computer science, economics, law, ethics, and social studies, such as:

- How can we make future AI systems highly robust, so that they do what we want without malfunctioning or getting hacked?
- How can we grow our prosperity through automation while maintaining people's resources and purpose?
- How can we update our legal systems to be more fair and efficient, to keep pace with AI, and to manage the risks associated with AI?
- What set of values should AI be aligned with, and what legal and ethical status should it have?

3) **Science-Policy Link:** There should be constructive and healthy exchange between AI researchers and policy-makers.

4) **Research Culture:** A culture of cooperation, trust, and transparency should be fostered among researchers and developers of AI.

5) **Race Avoidance:** Teams developing AI systems should actively cooperate to avoid corner-cutting on safety standards.

4.2 Ethics and Values

6) **Safety:** AI systems should be safe and secure throughout their operational lifetime, and verifiably so where applicable and feasible.

7) **Failure Transparency:** If an AI system causes harm, it should be possible to ascertain why.

8) **Judicial Transparency:** Any involvement by an autonomous system in judicial decision-making should provide a satisfactory explanation auditable by a competent human authority.

9) **Responsibility:** Designers and builders of advanced AI systems are stakeholders in the moral implications of their use, misuse, and actions, with a responsibility and opportunity to shape those implications.

10) **Value Alignment:** Highly autonomous AI systems should be designed so that their goals and behaviors can be assured to align with human values throughout their operation.

11) **Human Values:** AI systems should be designed and operated so as to be compatible with ideals of human dignity, rights, freedoms, and cultural diversity.

12) **Personal Privacy:** People should have the right to access, manage and control the data they generate, given AI systems' power to analyze and utilize that data.

13) **Liberty and Privacy:** The application of AI to personal data must not unreasonably curtail people's real or perceived liberty.

14) **Shared Benefit:** AI technologies should benefit and empower as many people as possible.

15) **Shared Prosperity:** The economic prosperity created by AI should be shared broadly, to benefit all of humanity.

16) **Human Control:** Humans should choose how and whether to delegate decisions to AI systems, to accomplish human-chosen objectives.

17) **Non-subversion:** The power conferred by control of highly advanced AI systems should respect and improve, rather than subvert, the social and civic processes on which the health of society depends.

18) **AI Arms Race:** An arms race in lethal autonomous weapons should be avoided.

4.3 Longer-term Issues

19) **Capability Caution:** There being no consensus, we should avoid strong assumptions regarding upper limits on future AI capabilities.

20) **Importance:** Advanced AI could represent a profound change in the history of life on Earth, and should be planned for and managed with commensurate care and resources.

21) **Risks:** Risks posed by AI systems, especially catastrophic or existential risks, must be subject to planning and mitigation efforts commensurate with their expected impact.

22) **Recursive Self-Improvement:** AI systems designed to recursively self-improve or self-replicate in a manner that could lead to rapidly increasing quality or quantity must be subject to strict safety and control measures.

23) **Common Good:** Superintelligence should only be developed in the service of widely shared ethical ideals, and for the benefit of all humanity rather than one state or organization.

5. CONCLUSION

The AI progress is already fascinating, and it speeds-up each consequent year. The rising awareness of AI-related changes in human society are appearing in scientific, academia and general public. Dozens of major reports have emerged from academia (e.g. the Stanford 100-year report), government (e.g. two major reports from the White House), industry (e.g. materials from the Partnership on AI), and the nonprofit sector (e.g. a major IEEE report). The paper will hopefully spur discussion and awareness about these issues also in our country where it is most important that the public, media and governance understand that the times are changing fast, that new approaches and methods are needed.

Scientific comprehensions about AI, its influence on everyday life, and future for the human civilization are stacking up. Scientists are able to provide some guidelines in which direction should we humans develop AI to avoid the dangers of the negative effects of the rising power of artificial intelligence. While AI often frightens general public, this author finds its fast progress a necessity to prevent degradation or self-destruction of human civilization. The potential dangers are real, not fictitious, primarily to a simple fact that any major power can be easily misused to cause harm to humans, and second, that there are some strong indications that civilizations tend to destroy themselves. By raising awareness, we increase the chances to ripe the positive aspects of the future mighty AI and avoid the negative ones.

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Comparison of Feature Ranking Approaches for Discovery of Rare Genetic Variants Related to Multiple Sclerosis

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ABSTRACT

In this work, we assess the quality of the ReliefF and Genie3 feature ranking algorithms on the task of discovering rare genetic variants related to multiple sclerosis using real world data. The data consists of a total of 183 patients with multiple sclerosis and healthy controls. We evaluate the rankings and check whether two different environments for data acquisition influence the data. The results show the that Genie3 algorithm produces better rankings. However, different environments for data acquisition have lesser influence on the ReliefF rankings.

Categories and Subject Descriptors

I.5.2 [Pattern Recognition]: Design Methodology

General Terms

Algorithms, Experimentation

Keywords

feature ranking, genetic variants, multiple sclerosis

1. INTRODUCTION

Feature ranking (FR) is an important task in machine learning, which can be formalized as follows. We are given a set of examples \boldsymbol{x} from the input domain $\mathcal{X} \subseteq \mathcal{X}_1 \times \mathcal{X}_2 \times \cdots \times \mathcal{X}_D$, where $D \ge 1$ is the number of descriptive attributes (features). We assume that the domain \mathcal{X}_i of the *i*-th feature x_i is either a subset of \mathbb{R} or an arbitrary finite set, i.e., domain \mathcal{X}_i and feature x_i are either numeric or nominal. Each example \boldsymbol{x} is associated with a target value $y(\boldsymbol{x})$ from the target domain \mathcal{Y} . Given a dataset $\mathscr{D} \subseteq \mathcal{X} \times \mathcal{Y}$, the goal of FR is to estimate how much each of the features influences the target, and then order the features with respect to the influences.

FR is a significant part of predictive modelling. The goal of predictive modelling is to learn a model able to predict the values of the target variable y, given a dataset \mathcal{D} . The two general types of predictive modelling are regression (when $\mathcal{Y} \subseteq \mathbb{R}$) and classification (otherwise). In our work we are concerned with classification. In classification, the values from \mathcal{Y} are usually referred to as classes.

There are three main reasons for FR with regards to predictive modeling. First, we may want to reduce the dimensionality of the input space, so that only the features that contain the most information about target are kept in the dataset. By doing this, we decrease the amount of memory/time needed to build a predictive model, while the performance of the model is not degraded.

Second, dimensionality reduction typically results in models that are easier to understand, which comes in handy when a machine learning expert works in collaboration with a domain expert.

Third, we can use FR as a guidance that reduces our search space which results in much lower costs of the subsequent experiments, for example, when we are trying to search for genetic markers that indicate the presence of a disease.

The last reason was the main motive for the experiments in this paper. Our goal is to establish a small subset of genetic variants that can be used to learn a predictive model that accurately distinguishes between sick and healthy patients. To this end we applied two FR algorithms to the real world problem of discovery of rare genetic variants that play a role in multiple sclerosis (MS) and evaluated their performance.

There is a plethora of FR methods. For their overview, see [8]. The result of applying a FR algorithm to a dataset, is a score $impo(x_i)$, which tells us how much information is contained in the feature x_i with regards to the target y. FR is then obtained by sorting the features with respect to their importance. In this work, we consider the ReliefF [6] and Genie3 [4] FR algorithms.

The rest of the paper is organized as follows. We describe the considered FR algorithms in Section 2. The description of the data and experimental design are presented in Section 3. We present the results in Section 4, and conclude in Section 5.

2. METHODS

In this section, the considered FR algorithms are described. The section starts with the description of the ReliefF algorithm followed by the description of Genie3.

2.1 ReliefF

The motivation behind the ReliefF algorithm is the following. Suppose the instances x^1 and x^2 are close to each other given some distance measure, but the difference of the corresponding values of a feature x_i is high. If x^1 and x^2 belong to different classes, we conclude that the change of the values of x_i is one of the reasons for the change of the target value. Hence, x_i has high relevance. However, if x^1 and x^2 are of the same class, then x_i is not relevant, since the high difference did not cause any change of the target value.

The ReliefF algorithm is an iterative procedure. As can be seen from its pseudocode (Alg. 1), the importances of the features are stored in the list of weights \boldsymbol{w} . At each of the m iterations, we randomly select an example $\boldsymbol{x} \in \mathcal{D}_{\text{TRAIN}}$ (line 3) and find its k nearest neighbors of the same class, i.e., *hits* (line 4), and its k nearest neighbours from each of the opposite classes, i.e., *misses* (line 6). The used distance on the descriptive space is the sum of component distances d_i that are defined as

$$d_i(\boldsymbol{x}^1, \boldsymbol{x}^2) = \begin{cases} \mathbf{1}[\boldsymbol{x}_i^1 \neq \boldsymbol{x}_i^2] & : \mathcal{X}_i \text{ nominal} \\ \frac{|\boldsymbol{x}_i^1 - \boldsymbol{x}_i^2|}{\max \boldsymbol{x}_i - \min \boldsymbol{x}_i} & : \mathcal{X}_i \text{ numeric} \end{cases}, \qquad (1)$$

At the end of each iteration, the feature importances are updated with the weighted average of the component distances between \boldsymbol{x} and its neighbors.

Algorithm 1 ReliefF($\mathscr{D}_{\text{TRAIN}}, m, k$) 1: $\boldsymbol{w} \leftarrow \text{zero list of length } D$ 2: for j = 1, 2, ..., m do $x \leftarrow \text{random example from } \mathscr{D}_{\text{TRAIN}}$ 3: $H_1, \ldots, H_k \leftarrow k$ nearest hits for \boldsymbol{x} 4: for all classes $c \neq x_y$ do 5: $M_{c,1}, \ldots, M_{c,k} \leftarrow k$ nearest misses for \boldsymbol{x} from c6: for i = 1, 2, ..., n do 7: $\begin{array}{l} \bigoplus \leftarrow \sum_{c \neq \boldsymbol{x}_y} \sum_{l=1}^{k} d_i \left(M_{c,l}, \boldsymbol{x} \right) / mk \\ \oplus \leftarrow \sum_{l=1}^{k} d_i \left(H_l, \boldsymbol{x} \right) / mk \\ \boldsymbol{w}[i] \leftarrow \boldsymbol{w}[i] + \oplus - \oplus \end{array}$ 8: 9: 10: 11: return w

2.2 Genie3

The Genie3 ranking is based on a forest of predictive clustering trees (PCTs) [1, 5] as the baseline classifiers. PCTs generalize decision trees and can be used for a variety of learning tasks, including clustering and different types of prediction. They are induced with the standard top-down induction of decision trees algorithm [2], which takes a set of examples $\mathcal{D}_{\text{TRAIN}}$ as input, and outputs a tree. The heuristic *h* that is used for selecting the tests in the tree nodes, is the reduction of variance caused by partitioning the instances in a node of the tree. By maximizing the variance reduction, the homogeneity of the instances in the subbranches is maximized: The algorithm is thus guided towards small trees with good predictive performance.

To achieve better predictive performance, one can induce more than one PCT and combine them into an ensemble classifier, called a forest of PCTs. The trees in the forest are not built on a dataset $\mathscr{D}_{\text{TRAIN}}$. Rather, different bootstrap replicates of $\mathscr{D}_{\text{TRAIN}}$ is constructed, for each tree. The prediction of the forest for a given instance \boldsymbol{x} is then typically the class that the majority of the trees voted for. The main motivation for Genie3 ranking is that splitting the current subset $E \subseteq \mathscr{D}_{\text{TRAIN}}$, according to a test in the node \mathscr{N} where an important feature appears, should result in high variance reduction $h(\mathscr{N})$. Greater emphasis is put on the features higher in the tree where |E| is larger. The Genie3 importance of the feature x_i is defined as

$$impo_{\text{GENIE3}}(x_i) = \frac{1}{|\mathcal{F}|} \sum_{\mathcal{T} \in \mathcal{F}} \sum_{\mathcal{N} \in \mathcal{T}(x_i)} |E(\mathcal{N})| h(\mathcal{N}), \quad (2)$$

where $\mathcal{T}(x_i)$ is the set of nodes of the tree \mathcal{T} where x_i is part of the test and $E(\mathcal{N})$ is the set of examples that come to the node \mathcal{N} .

3. EXPERIMENTAL DESIGN

In this section we present the data used in the experiments that were performed to i) find the locations in human DNA that influence the multiple sclerosis, and ii) check how much different environmental conditions in the data aggregation and processing step influences the results.

3.1 Data Description

Our data consist of 183 instances corresponding to patients. These are divided into three groups: 43 suffering from sporadic multiple sclerosis (SMS), 47 suffering from familial multiple sclerosis (FMS), and 93 being healthy (NoMS). The patients are described by 202487 numeric features which describe the presence of a genetic variant in patients' DNA, and the target variable which describes their diagnosis. The patient genomes were sequenced at the Clinical Institute of Medical Genetics at the University Medical Centre Ljubljana.

Based on the presence of genetic variants on the two strands of DNA, as compared to a reference genome (hg19), we can distinguish between three possible genotypes for every single locus: i) reference sequence on both strands, ii) presence of a genetic variant on one strand only, i.e., in heterozygous state, and iii) presence of a genetic variant on both strands, i.e., in homozygous state. These states are respectively assigned the values 0, 1 and 2. However, the data set contains some missing values, since the success of sequencing and genotyping at a particular locus varies among test subjects.

The feature value for the patients come from two different laboratories: the first and the second gave the results for 171 and 12 patients respectively. Since the different environments could introduce some bias, we prepared two versions of the dataset: one containing all patients and the other, containing only the patients from the first laboratory.

These two versions are used in the experiments where we try to tell apart the three groups of patients (NoMS, SMS and FMS). Following the suggestions of data providers, we also tried to tell apart only healthy and diseased patients. Here, we modify the target variable and merge SPS and FMS into one group (MS). The modified target can now take two different values: MS and NoMS.

3.2 Evaluation Methodology

To assess FR quality, one typically uses k-fold cross-validation (CV), where the data is divided into k parts (folds). At each of k iterations of the procedure, a ranking is constructed from the training set $\mathscr{D}_{\text{TRAIN}}$ which is an union of k-1 folds,

and then evaluated on the testing set $\mathscr{D}_{\text{TEST}}$, which is the remaining fold. At the end, the per-fold quality measures are aggregated to a single ranking quality score.

This procedure is appropriate if one wants to evaluate the quality of a FR algorithm and is not interested in the actual FR (different FRs correspond to different training folds). This is not the case in this study. On contrary, we are interested in the quality of one particular FR that is to be reported to the domain experts, so we slightly modified the standard evaluation procedure. Taking into account the specifics of the ReliefF and Genie3 FR algorithms, we adopted the following two approaches:

For ReliefF, we use k-fold CV, but we do not evaluate perfold FRs. Rather, we first average them into one single FR by sorting the features by their average per-fold importances. This average FR is then evaluated in the subsequent steps.

We use an analogous procedure for the Genie3 ranking. Note that the Genie3 importance (Eq. 2) is actually an average of importances for different trees in the forest. Moreover, each tree is built on different bootstrap replicate of the data which does not contain all known examples. This is why we simply run the algorithm on the whole dataset \mathscr{D} . The obtained ranking is then evaluated in the subsequent steps.

The remainder of the evaluation procedure is the same for both FR methods and is a variant of the one proposed by Slavkov [7]. Again, we use k-fold CV. At each iteration, we first build a predictive model on a training fold $\mathscr{D}_{\text{TRAIN}}$, considering only the *j* topmost features of the average ranking, for each value of $1 \leq j \leq D$, such that $j = 1 + \ell(\ell + 1)/2$ for some $\ell \in \mathbb{N}$ or j = D. Each of these models is then tested on the testing fold $\mathscr{D}_{\text{TEST}}$.

The result of cross-validation are confusion matrices M_j . The (c, d)-th entry of the matrix M_j tells how many patients from the class c were assigned the class d by the classifier that was built from the topmost j features in the ranking.

Let α_j denote the accuracy, computed from the matrix M_j . The points (j, α_j) form a *feature addition curve*. The motivation behind this approach is that for higher α_j 's, more relevant features are positioned at the beginning of the FR. Moreover, from the shape of the curve, we can deduce some qualitative characteristics of the FR. E.g., if the curve does not ascend in some part, that means only redundant or irrelevant features are placed in the corresponding part of the FR.

If we want to express the quality of a FR as a single number, we can compute the weighted average α of the accuracies α_j : $\alpha = (\sum_j w_j \alpha_j)/w$, where $w = \sum_j w_j$ and the weights w_j decrease with j, since the beginning of a FR is considered the most important. In our experiments, we choose $w_j = 1/j$, as suggested by Slavkov [7]. A good FR has a high α score.

To asses the influence of different sources of the data, i.e., two laboratories, we use the Jaccard similarity index. For a fixed size j of the set of topmost features, we compute the Jaccard similarity index

$$JSI_j = |B_j \cap F_j| / |B_j \cup F_j| \tag{3}$$

between the sets B_j and F_j that correspond to the rankings computed on a data from both laboratories (B_j) and the first laboratory (F_j) . Additionally, we also compute an approximation of the expected value \widehat{JSI}_j of the index between to random feature subsets: $\widehat{JSI}_j = j/(2D - j)$.

3.3 Algorithm Parametrisation

For the ReliefF algorithm, the default values of the parameters were used: the number of iterations was set to $m = |\mathscr{D}_{\text{TRAIN}}|$, and the number of neighbours was set to k = 10. To compute the Genie3 ranking, a forest of 1000 trees is grown. The random forest subspace size was set to 25% of the features.

Since the dataset is not too big, leave-one-out CV is used for obtaining the ReliefF ranking, as well as for evaluation of both average rankings. Here, the support vector machines with linear kernel were used as a classifier [3].

4. RESULTS AND DISCUSSION

To asses, which of the FRs found more promising genetic markers in human DNA that influence the MS, we compute the feature addition curves (Sec. 3.2). Fig. 1 shows the results for the first laboratory and binary target, but the graphs for the other three versions of the data are similar.

More specifically, in all four cases the ranking algorithms successfully discover important features, since the curves are ascending in the first part when relevant features are added to feature subsets. Later on, the irrelevant features prevail and the performance slowly decreases (see Fig. 1). Next, at the beginning, Genie3's curve is always clearly above the ReliefF's. Finally, the maximal accuracy of Genie3's ranking is always higher than ReliefF's, and is also achieved sooner.

As a consequence, the α scores of the Genie3 FRs are higher than those of ReliefF, as shown in Tab. 1. This table also shows that the data coming from both laboratories and having binary target, result both in the best FR among all Genie3 FRs, and in the worst FR among all ReliefF FRs.

Table 1: The α scores of the Genie3 and ReliefF rankings, for all versions of the data.

Laboratory	Target values	Genie3	ReliefF
Both	{MS, NoMS}	0.804	0.633
Both	{FMS, SMS, NoMS}	0.697	0.677
First	{MS, NoMS}	0.753	0.605
First	{FMS, SMS, NoMS}	0.745	0.711

We inspect the influence of different sources of data by computing the JSI (Eq. 3) between the sets of the topmost features of the FRs that base on data from both laboratories and from the first laboratory only. Fig. 2 shows that different sources notably influence the FRs. The fluctuations at the very beginning are expected, since every difference greatly influences the JSI values, when feature subsets are small.

After that, the curve of the ReliefF ranking stabilizes at approximately 0.8 which means that these rankings identify the same features as important. This does not hold in the case of Genie3 rankings. The corresponding sets of 10012



Figure 1: Feature addition curves for the rankings produced by the Genie3 and ReliefF algorithms, using data from the first laboratory only and considering a binary target (left: complete feature addition curves, right: feature addition curves for the first 4000 features). The numbers in the brackets correspond to the maximum accuracy and the number of features where it is first achieved.



Figure 2: Jaccard similarity of the topmost features of the rankings using the data from the first and both laboratories. The expected similarity corresponds to random ranking and serves as a baseline.

features still have $\widehat{JSI} < 0.2$, which means that different features are recognized as important. Therefore, the Genie3 ranking is more sensitive to changes in the data, since the 12 additional patients from the second laboratory notably changed the rankings. This finding also confirms the data providers' concerns about the influence of different environmental conditions on the data aggregation and processing.

5. CONCLUSIONS

We used the Genie3 and ReliefF algorithm to identify rare genetic variants related to multiple sclerosis. The feature addition curves reveal that the rankings produced by the Genie3 algorithm are better than those of ReliefF, but they are also more sensitive to changes in the data, as shown by low values of the JSI score.

However, since the Genie3 algorithm consistently outperformed ReliefF in terms of α scores, only the Genie3 rankings were reported to the domain experts. They further focused and analyzed a small subset of relevant features. They compared the top ranked features to results reported in the literature. In the small subset they found matches to genes that have been reported to be associated with MS. Given the positive matching, additional experimental validation of top ranked features can be performed in order to determine the existence of previously unconsidered causal relations.

We plan to run the algorithms on a new version of the data, processed using a new pipeline that takes into account the different environmental conditions. Since there is a taxonomic relation between the classes, we will also consider hierarchical classification as the baseline for FR.

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Modeling of Dynamical Systems: A Survey of Tools and a Case StudY

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ABSTRACT

Process-based modeling refers to an approach for automated construction of models of dynamical systems from knowledge and measurements. The underlying formalism allows for both explanatory representation of a dynamical systems in terms of principle system components, as well as their transformation into equations adequate for simulation. The process-based modeling approach, while successful in addressing a variety of modeling tasks, still struggles with meeting some user-interface criteria acceptable for a wider scope of users. In this paper, we review several state-of-the-art approaches and formalisms for (automated) modeling of dynamical systems, and compare them to the most recent implementation of the process-based modeling approach – ProBMoT (Process-based modeling tool).

Keywords

automated modeling, process-based modeling, dynamical systems, formalism, software

1. INTRODUCTION

Models of dynamical systems yield a mathematical representation of the nature laws that govern the behavior of the system at hand. Such models are employed to recreate or simulate the behavior of dynamical systems under diverse conditions.

The two principal elements of every approach to modeling dynamical systems are (1) structure identification and (2) parameter estimation. The former tackles the task of establishing a structure of a model in terms of equations, while the latter deals with approximation of the constant parameters and initial values of the variables in the model for a given structure. Typically, two approaches are being used for modeling dynamical systems: knowledge-driven (white-box) and data-driven (black-box) modeling. The former relates to a domain expert deriving a proper structure of a model by employing extensive knowledge about the system at hand. In turn, the model's parameters are estimated either by using measured data, or manually based on the expert's experience. The latter methodology refers to a trial-error principle: it uses measured data to search for a structure/parameters combination that best fits the observed behavior.

Process-based modeling (PBM) [1,2,3], refers to a grey-box approach, since it joins the knowledge- and data-driven modeling approaches and allows for automated modeling of dynamical systems. In particular, process-based modeling employs both domain-specific knowledge and data for simultaneously constructing the structure of the model and estimating its parameters. The resulting process-based model offers both highlevel explanatory representation of a dynamical systems in terms of its principle system components, as well as their transformation into a low-level formalism in terms of equations adequate for simulation of the system's behavior.

The latest implementation of the process-based modeling paradigm – ProBMoT [4,5] uses text-based, non-visual formalism, which

presents a challenge when it comes to visualizing the structure of the modeled system. While scientists can typically comprehend and relate to models formalized as equations, the (uncommon) highlevel PBM formalism is not always familiar to them. Currently, this makes ProBMoT usable for a narrow scope of domain experts. On the other hand, several state-of-the art grey-box modeling software such as: Prometheus [6], Eureqa [7], MATLAB [8], STELLA [9] and COPASI [10] have been used extensively for different modeling tasks in a variety of domains.

In order to widen ProBMoT's user base, in this paper we aim at identifying the main features and limitations of each of the aforementioned modeling software and compare them to ProBMoT. In particular, we attempt at modeling a two-cascaded water tanks system, a well-known system identification benchmark, with each of the six modeling tools and compare them in terms of their input and output according to several criteria. However, quantifying and describing a modeling software and its formalism, is not a trivial task. To this end, we propose five criteria according to which we survey the different modeling approaches:

(C1) *Generality:* the applicability of a software to a general problem (from all fields). In contrast, there are software applicable to problems from specific fields (molecular biology, finances, ecology, electronics, etc.).

(C2) *Parameter estimation:* capability of fitting the model's parameter values to data.

(C3) Automated modeling: ability to learn models with automated computational scientific discovery methods. Note that, here we can distinguish also between fully automatic and semi-automatic approaches. The former does not rely on prior knowledge about a domain and typically results in one model structure built from scratch. The latter refers to the ability to discover a set of explanatory models blending expert domain knowledge with computational discovery algorithms.

(C4) *Graphical representation*: ability to graphically represent the output models of the software.

(C5) *Comprehensibility:* whether the output of the software is comprehensible on first hand to the domain-expert user, without the need of background knowledge.

The rest of this paper is organized as follows. In the next section we outline the six state-of-the-art tools for modeling dynamical systems. Section 3 elaborates the design of the modeling experiment and presents the results, which in turn are discussed in Section 4. Finally, Section 5 concludes the paper.

2. BACKGROUND

In this section, we focus on six grey-box modeling software packages and their characteristics: ProBMoT, Prometheus, Eureqa, MATLAB, STELLA and COPASI.

ProBMoT [4,5] (Process-Based Modeling Tool) is the latest implementation of the process-based modeling paradigm. It is a software for construction, parameter estimation and simulation of process-based models.

The output of this software is a process-based model, represented with entities and processes. Entities relate to the actors of the observed system, defined with constants and variables. The processes, on the other hand, represent the interactions between the entities, referring to one or more ordinary/algebraic equation. Collating the equations from all the processes in the model, a system of ODEs can be attained.

To this end, ProBMoT takes as input a library of domain knowledge, a task specification and data.

The library is formalized by establishing templates of generic entities that appear in the generic processes. The templates can be organized into a hierarchical structure. The task specification limits the search space of candidate model structures by supplying constraints, specified as incomplete conceptual models as modeling presumptions. The library of domain-specific knowledge together with the task specification determine the space of models. The induction algorithm then searches through this space of candidate model structures, finding plausible model solutions and estimating the constant parameters of each candidate model structure to the input data.

Prometheus [6] is a software that supports interaction between the user and computational discovery algorithms. The formalism used in Prometheus specifies process models and background knowledge in terms of variables and processes that relate them. Each process express casual relations between its input and output variables through one or more differential equations.

The input for this software is a user-defined model, library of background knowledge consisted of generic processes, measured data and constraints specifying what can be revised. The output is a revised model-structure that best fits the measured data.

Prometheus is a predecessor to ProBMoT, and consequently their formalisms are comparable. Prometheus uses process models, which are analogous to ProBMoT's process-based models. Their definitions for processes as model's components are similar. The difference is that the variables in Prometheus are not encoded in an entity, but they are represented as a component.

Eureqa [7] uses symbolic regression [11] with genetic programming in order to infer equation-based structure of the system and its parameters solely from data, by minimizing the error using the implicit derivatives method. The state of the modeled system is declared with a target variable, its descriptors and their form in order to define the search space. Note that, the modelers have little-to-no control over the space of plausible structures. This means that, it is still a domain expert's task to infer the similarities between the resulting model and the real system structure.

MATLAB [8] supplies functions for performing system identification and parameter tuning of a user pre-defined model. Its formalism allows specifying quantitative models with instantaneous and differential equations. Note that, MATLAB does not support automated modeling, i.e., learning multiple structures. The models are defined as model objects, i.e. specialized data containers that encapsulate data and other model attributes. The dynamics of the system at hand are described with ODEs imported in a C MEX-file. With associating the model object to the C MEX-file, and employing functions for simulation and parameter estimation, on the output MATLAB obtains a completely defined model structure with all parameters tuned in accordance to data.

STELLA's [9] formalism relates to stocks, flows, convertors and connectors. Stocks represent variables, flows denote their changes over time (derivatives), converters encode the constant parameters, while connectors are used to attain a link between all of them. While the models are built using this formalism, the software produces finite difference equations that describe it. Note that, this formalism is comparable to the PBM. We can associate stocks with entities, and flows with processes. Similar to MATLAB, the input

to STELLA is a user-specified quantitative model and measured data. Similarly, STELLA also does not support automated modeling, therefore the output model structure is never learned. However, one can still simulate the complete model by invoking the simulator that can run the input user-defined model.

COPASI [10] is a software for simulation and analysis the dynamics of biochemical networks. It supports models in the SBML standard [12]. The models are defined with chemical reactions between molecular species. They can also include compartments, events, and other global variables that can help specify the dynamics of the system. Here, we can also draw an analogy between COPASI's and ProBMoT's formalisms. The species in COPASI correspond to ProBMoT's entities, while reactions are analogous to processes containing equations which describe the behavior of the system. However, in contrast to ProBMoT, COPASI does not perform automatic structure identification. The input to COPASI is user-defined model and measured data. The result is a complete model, with parameters tuned to best fit the data.

3. CASE STUDY

In order to better illustrate and evaluate the formalisms of the software described in the previous section, here we tackle the task of modeling a two-cascaded water tanks system [13]. The system is consisted of two cascaded water tanks with free outlets, fed by a pump. The governing equations for this system are depicted below (Eq. 1), where the states of the water levels of the two tanks are denoted with h_1 and h_2 , the latter (h_2) being the output. The voltage applied to the pump is u(t), while A_1 , A_2 , a_1 and a_2 denote the areas of the tanks and their effluent areas, while the applied voltage-to-flow conversion constant is denoted with k. The task is to model the response of the lower tank.



Equation 1. Two-cascaded water tanks system

ProBMoT - In order to model the water tanks system in ProBMoT, we first need to create a library of domain knowledge (Figure 1A), i.e. we need to formulate template entities and processes which in turn will be instantiated to specific entities and processes. The main actors in the system are two water tanks (with same properties) and a pump. In terms of template entities, this translates to one template entity Thank and a template entity Pump. The tanks are characterized with a variable h, representing the water level height, and a constant *outflow_c* which denotes the ration between the tanks areas (a/A). The dynamics that govern the system's behavior in terms of equations are encoded in template processes inflow, ValveTransmission, outflow. These correspond to the water inflow in the first tanks, the water flows between the two tanks, and the water outflow from the second tank, respectively. In terms of defining modeling constraints, we can outline the number of entities involved in the system and encode the plausible process alternatives. In turn, such a library together with the modeling constraints, can be induced to a specific model structure (Figure 1B-top) of the particular system, parameters of which are fitted using the measured data. Such a model can be then transformed into to a system of ODEs (Figure 1B-bottom) and simulated.



Figure 1. A) Library of background knowledge for a water tank system B) Process-based model of a particular watertank system (top); The same model transformed to ODEs (bottom)

Prometheus - In a similar fashion to ProBMoT, we define processes with equations in Prometheus as well. We have process *inflow*, *valvetransmition* and *outflow*. In this formalism, entity components are not present, but the variables represent a component themselves. Consequently, we have three variable components: h1, h2 (as observable), and v (as exogenous). We create a library of background knowledge, containing generic processes, where the equations instead of numbers have parameters, and with the measured data, we refine the model structure. We obtain the final defined model structure with estimated parameters. The models obtained in Prometheus (Figure 2) are highly comprehensible, since the software has visual representation for its models.

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Figure 2. Prometheus model of a particular water tank system

Eureqa - For the two-tank system, we define $\frac{dh^2}{dt}$ as the target variable. The form of the equation that describes our target should use h1, h2, $\frac{dh_1}{dt}$ and v as descriptive variables. During the search, we can visualize (Figure 3) the found equations, ranked on a complexity-error graph. If the error is not decreasing significantly, and the complexity is increasing, we can stop the search at any time. In the end, it results with a set of equations, from which we choose the most suitable one, obtaining a complete model for our water tanks system.

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	100	$D(t_1, t) = 0.33 \exp(t_1) = 0.16 \exp(0.0326 t_1 D(t_2, t)^2) = 0.0073 - 0.336 \exp(t_2)$
100		$D(h_{j_1}, i) = 0.23 \exp(h_j) + 0.089 \exp(D(h_{j_1}, i)^2) - 0.0008 + 0.229 \exp(h_j)$
	1.00	$D(n_{1}, t) = 1.000 \exp(0.0126(n_{1}) + 0.025 \exp(0.0100(n_{1}, 0)^{2}) + 0.010 - 0.025 \exp(n_{1}, 0)^{2})$
-	1.00	$2h[h_{11}, i] = 0.13 \exp(h_1] + 0.108 \exp(0.2824[h_{21}, i]^2] + 0.0321 - 0.223 \exp(h_1)$
10.		$D(h_2, l) = 0.13 \exp(h_1) + 0.137 \exp(D(h_2, l)^2 \exp(0.0141 h_2 + 0.00454 h_2)) - 0.0209 - 0.226 \mu$
		$D([n_{i_1}, i] = 1.81 \log((0.61881_i) + 0.138 \log((D([n_{i_1}, i]^2 \log((0.0181)h_i - 0.60488h_i))) - 0.0281 - 0.0281 - 0.00488h_i) = 0.0281 - 0.00488h_i = 0.0048h_i = 0.0$
40		$D(h_0, s) = 0.31 \operatorname{spr}(h_0) + 0.114 \operatorname{spr}(D(h_0, s) \operatorname{spr}(0.0141h_0 - 0.00444h_0)) - 0.020$
-		$\mathbf{fr}[n_1, 1] = 0.21 \exp\{(n_1] + 0.170 \exp\{[\sin(D(n_1, 1)]^2 \exp\{[0.0141, n_1] - 0.00074, n_1]\} - 0.0202 + 0.2$
11	1.000	$Dr(h_{ij}, i) = 0.224 \operatorname{super}(h_{ij}) - 0.274 Dr(h_{ij}, i)^2 + 0.0303 + 0.222 \operatorname{super}(h_{ij})$
- 10	8,000	$D(h_{0}, \eta) = 1.04 \exp(0.0196 n_{0}) + 0.000(h_{0}, \eta)^{2} = 0.0111 - 0.010 \exp(h_{0})$
	1.00	D(1), (A = 0.234 art(A) = 0.0177 = 0.23 art(A) = 0.034 D(A), (b)

Figure 3. Eurega model of a particular water tank system

MATLAB - We describe the dynamics of the two-tank system with writing the two differential equations that govern its behavior into a C MEX-file. First, we initialize all the parameters that we are going to use for modeling. Second, we write a function (*compute_dx*), which computes the state equations, i.e. the change in the water height level of the two tanks over time $(\frac{dh_1}{dt} \text{ and } \frac{dh_2}{dt},$ represented as dx[0] and dx[1] respectively). Next, we write a function (*compute_y*), which computes the output equation, in our case the response of the lower tank, i.e. y[0] = x[1]. In turn, with the *Identify non-linear grey box model* function in MATLAB, we associate a model object with the C MEX-file, resulting in a greybox model of the system at hand (Figure 4). We choose which of the parameters described we want to estimate, and with the function *Non-linear grey-box estimate* they are fitted to the data provided at input. The obtained model can then be simulated.

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Figure 4. Structure of a C MEX-file with and output equation and estimated parameters

STELLA - We model the particular system at hand with two stocks as the main actors of the system, representing the two water tanks. The change in their water height is indicated with three flows. *Flow* #1 represents the amount of water transferred from the upper to the lower tank: the outflow of the upper is an inflow for the lower tank. *Flow* #2 is the outflow from the lower tank and *Flow* #3 is inflow from the pump into the upper tank. The other components and parameters are represented with convertors. The model obtained in STELLA is graphically highly comprehensible. The drawback is that this software does not support automated parameter estimation.



Figure 5. STELLA model of a particular water tank system

COPASI - We compose our model with three compartments, species and reactions (Figure 6). The lower, the upper tank and the environment (in which the two tanks are in) represent different compartments themselves. Compartment Tankl has initial expression of the area of the upper tank (A1). Similarly, Tank2 has initial expression of the area of the lower tank (A2). In similar fashion to ProBMoT, where each entity has variables or constants, here each compartment contains species: Tank1 includes height h1, Tank2 holds height h2 and Environment contains the voltage u applied to the pump. Reactions in COPASI are analogous to ProBMoT's processes, and knowing the equations from (Eq.1), we define reaction *flow* (between *h1* and *h2*) reaction *inflow* (between u and h1) and reaction *outflow* (from h2). As an output, we obtain a model of differential equations with computed parameter values. COPASI is widely used in the field of biochemical networks and their dynamics. However, using COPASI outside of that fields, as the case in this paper, is not a trivial task.



Figure 6. COPASI model of a particular water tank system

4. **DISCUSSION**

Having the identified the key characteristics of each of the six modeling software, here we compare them based on the criteria defined in Section 1. Table 1 presents the results of the study.

 Table 1. Comparing the different modeling tools according the five different cirteria

	C1	C2	C3	C4	C5
ProBMoT	\checkmark	\checkmark	\checkmark	×	×
Prometheus	\checkmark	~	~	v	\checkmark
Eureqa	~	~	~	×	\checkmark
MATLAB	~	~	×	×	×
STELLA	~	×	×	\checkmark	\checkmark
COPASI	×	~	×	×	\checkmark

Based on the first criterion (*C1* - *generality*) all software except COPASI are general-purpose, meaning that systems from different fields can be easily modeled and simulated with them. COPASI is specific-purpose software, built around the logic of the biochemical networks and their dynamics. This means building every type of model in COPASI can be very challenging and ambitious.

According to the second criterion (C2 - *parameter estimation*), all tools except STELLA have integrated parameter estimation methods. In STELLA, the parameters are tuned manually.

In terms of *automated modeling* (C3), ProBMoT, Prometheus and Eureqa are capable of automated modeling. Eureqa is able to infer equation-based model from scratch using genetic programing. On the other hand, ProBMoT and Prometheus are able to find set of models with similar structure components and distinguish among them. Both of them relay on domain-specific modeling knowledge used in the process of induction of model structures.

In terms of *graphical representation* (*C4*), only STELLA and Prometheus have the ability to graphically visualize the models and their components, in the form of building blocks.

Finally, in terms of *comprehensibility* (C5), the high-level modeling formalisms used by ProBMoT and Prometheus results in not widely interpretable models. Still, both have the ability to transform the high-level formalism in equations, with additionally Prometheus having the ability to visualize the modeling components. While MATLAB is widely used for modeling tasks, its formalism still requires a low-level programing knowledge for one to be able to encode and decode the models. Regarding Eureqa, while the output models are contained of (differential) equations, the model structure doesn't necessarily correspond to the real system's structure. The obtained models in COPASI are comprehensible for experts in the field of biochemical networks. Finally, the models obtained from STELLA besides being offering graphical visualization the models can also be translated into equations. Either way, it is highly interpretable.

5. CONCLUSION

In this paper, we give an overview of a formalism for automated modeling of dynamical systems, named process-based modeling. It is not always easily interpretable, making it usable only for a narrow scope of domain experts. In order to improve that, we review several state-of-the art grey-box modeling tools, identifying their main features and limitations. As a case study, we model a two-water-tanks system with all the different tools and compare them in terms of their input and output according to five criteria.

The general conclusion of this paper is that ProBMoT, the latest software implementation of the PBM paradigm, while successful in tackling various modeling tasks, is usable for a very narrow scope of users mainly because of its uncommon high-level modeling language and the lack of graphical representation of the resulting models. We conjecture that establishing a Graphical User Interface (GUI) for it, will address its usability issues.

However, in order to create a GUI for ProBMoT, we first need to address the non-trivial and abstract problems of visually representing the hierarchical nature of the process-based models.

One answer could be presenting the components of the processbased models as building blocks, similar to the model components employed in STELLA or Prometheus. It would enable the user to make libraries and define tasks graphically and interactively.

Another feature that could be of good use for the GUI is tightly connected with the runtime process, the results and data visualization. Similarly to Eureqa, during the search, all found feasible models can be listed and ranked.

To conclude, with developing a self-explanatory visual representation of the process-based modeling formalism, comprehensible for domain-expert scientists, the PBM paradigm would become more approachable. With a universal visual representation, scientists from different fields would be able to transfer knowledge between them.

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Vpliv različnega prenosnega kanala pri referenčnih in testnih posnetkih na forenzično verifikacijo govorcev

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POVZETEK

V članku obravnavamo problematiko razpoznavanja oz. verifikacije govorcev v forenzične namene in vpliv različnih načinov zajemanja govornega signala na rezultate izvedenih analiz.

Izvedli smo poizkuse s pomočjo komercialnega sistema za samodejno razpoznavanje govorcev (SRG) in preučevali razlike v njegovi uspešnosti glede na različne kombinacije prenosnih kanalov pri zajemanju učnih oz. referenčnih in testnih posnetkov.

Podani so rezultati eksperimentov za slovenske govorce, ki smo jih simultano snemali preko petih različnih prenosnih kanalov in ob treh različnih načinih govorjenja: branje, spontani govor in dialog.

Ključne besede

Forenzične analize, razpoznavanje oz. verifikacija govorcev, prenosni kanali za zajemanje govora, govorna zbirka.

1. UVOD

Pri razpoznavanju oz. verifikaciji govorcev v forenzične namene imamo opravka s spornimi posnetki izgovarjav, ki predstavljajo dokazno gradivo in so posneti v »stvarnih pogojih« med samim izvajanjem kaznivih dejanj. V večini primerov govorni posnetki predstavljajo telefonske pogovore, pridobljene predvsem na dva načina: (i) anonimen klic, kadar je pričakovan ali kako drugače dostopen, (ii) prisluškovanje telefonskim pogovorom s strani policije. Pojem »stvarni pogoji« uporabljamo kot nasprotje »laboratorijskim pogojem«, ko ne moremo nadzirati, pričakovati ali predvidevati pogojev v katerih se bodo pridobili posamezni govorni posnetki. Celo več; obtoženec ponavadi ne želi korektno sodelovati in skuša ovirati ali preprečiti pridobitev kakršnihkoli zanj obremenilnih informacij.

Zaradi »stvarnih pogojev« pridobivanja posnetkov je govorni signal bolj spremenljiv oz. variabilen. Vire variabilnosti govornega signala lahko razvrstimo v naslednje kategorije [1]:

- svojske variabilnosti govornih signalov istega govorca: vrsta govora, staranje, časovni presledek med dvema posnetkoma, narečje, žargon, socialni status, čustveno stanje, uporaba omamnih sredstev itd.
- (ii) izsiljene oz. umetne variabilnosti govornih signalov istega govorca: »Lombardov« učinek, stres zaradi zunanjega vpliva, »cocktail-party« učinek itd.
- (iii) zunanja variabilnost odvisna od kanala: tip telefona ali mikrofona, fiksna/mobilna telefonija, komunikacijski kanal, pasovna širina, dinamični obseg oz. razpon, električni in akustični šum, odmev, popačenje itd.

Forenzični pogoji so doseženi, ko se dejavniki variabilnosti, ki predstavljajo t.i. »stvarne pogoje«, pojavljajo brez kakršnegakoli principa, pravila ali norme. Lahko so konstantni preko celotnega klica ali pa se hipoma pojavijo ali izginejo; na celoten proces vplivajo povsem nepredvidljivo.

2. METODE IDENTIFIKACIJE OZ. VERIFIKACIJE GOVORCEV

Različne metode identifikacije govorcev so lahko bolj ali manj subjektivne oz. objektivne. Tudi pri objektivnih metodah imamo opraviti z določenim vplivom človeka; npr. računalnik je sprogramiran, rezultati pa so interpretirani s strani eksperta. Najbolj subjektivna metoda identifikacije govorcev v forenzične namene je slušno-zaznavna metoda oz. slušna analiza. Nekoliko bolj objektivna je slušno-instrumentalna metoda. Med najbolj objektivne štejemo polavtomatske in avtomatske metode identifikacije govorcev.

Slušno-zaznavna metoda (angl. »aural-perceptual approach«) oz. slušna analiza (angl. »auditory analysis«) v osnovi temelji na pozornem poslušanju posnetkov s strani izkušenega fonetika, pri čemer se zaznane razlike v govoru uporabijo za ocenjevanje stopnje podobnosti med glasovi. Slušna analiza ima svoje omejitve in se pri običajni fonetični analizi uporablja predvsem za izluščenje zanimivih lastnosti in parametrov, ki jih nato podrobneje analiziramo s slušno-instrumentalno metodo [2, 3].

Slušno-instrumentalna metoda (angl. »auditory instrumental approach) vključuje meritve različnih parametrov, kot so npr. osnovna frekvenca (F0), hitrost govora, potek osnovnega tona, razne spektralne karakteristike govornega signala itd. Parametri se nato medsebojno primerjajo po srednjih ali povprečnih vrednostih in variancah. Pri računalniški akustični analizi (angl. »computerised acoustic analysis) dobimo numerične vrednosti različnih govornih parametrov s pomočjo posebne programske opreme. Pri tem je vloga eksperta še vedno zelo pomembna, saj se je potrebno odločiti, kateri govorni vzorci so dovolj dobre kvalitete za analizo. Poleg tega je potrebno izbrati oz. določiti primerljive dele govornih vzorcev, ki bodo analizirani, in ovrednotiti dobljene rezultate. Parametri pri akustično forenzični analizi večinoma izvirajo iz lingvistično-fonetičnih raziskav in so neposredno povezani s slišnimi fonetičnimi značilnostmi [4].

Polavtomatsko (angl. »forensic semiautomatic speaker recognition«) in avtomatsko (angl. »forensic automatic speaker recognition«) razpoznavanje govorcev v forenzične namene je uveljavljen termin za metode (pol)avtomatskega razpoznavanja govorcev, ki so prilagojene za uporabo v forenzične namene. Pri polavtomatskih metodah prihaja med preiskavo do interakcije eksperta in računalnika. Pri avtomatskem razpoznavanju govorcev pa se medsebojno primerjajo statistični modeli akustičnih parametrov glasov znanih govorcev (iz govorne baze) s statističnim modelom akustičnih parametrov nepoznane osebe, ki jo želimo identificirati (slika 1). Na podlagi te primerjave izračunamo kvantitativno oceno podobnosti med (od govorca odvisnimi) parametri glasu nepoznane osebe na posnetku in parametri obdolženca s čimer ocenimo prepričljivost dokaza. Pri avtomatskem razpoznavanju govorcev (slika 2) v forenzične namene je prepričljivost dokaza odvisna od relativne verjetnosti, da opazimo neke značilnosti nepoznanega glasu v statističnem modelu akustičnih parametrov obdolženca in v statističnih modelih glasov potencialne populacije.

Podatkovno vodena Bayesova metoda za avtomatsko razpoznavanja govorcev zahteva poleg preiskovanega posnetka (oz. sledi) uporabo še treh baz izgovarjav (slika 1): referenčno govorno bazo osumljenca (R), ki služi izdelavi statističnega modela njegovega glasu (pogoji snemanja morajo biti čim bolj podobni pogojem pri snemanju govorne baze populacije P), kontrolno govorno bazo osumljenca (C), ki služi ocenjevanju notranje variabilnosti glasu osumljenca (pogoji snemanja morajo biti čim bolj podobni pogojem snemanja preiskovanega posnetka) in govorno bazo potencialne populacije (P), ki vsebuje takšne posnetke glasov, da nobeden naključno izbran posnetek iz te baze ni izgovorjen s strani iste osebe, kot je preiskovani posnetek (oz. sled). Kakršno koli neujemanje govornih baz zaradi okoliščin pri prenosu govornega signala, vrste snemalne naprave, šuma, jezikoslovne vsebine in trajanja posnetkov lahko vpliva na zanesljivost dobljenih rezultatov [5].

Zadnje čase temeljijo sistemi za (pol)avtomatsko razpoznavanje govorcev v forenzične namene na oceni kvocienta verjetnosti (angl. »likelihood ratio«; LR) [6]. Razmerje verjetnosti (LR) je podano kot razmerje gostote verjetnosti porazdelitev razlik znotraj vzorcev osumljenca in porazdelitev razlik glede na vzorce populacije v točki E (dobimo jo s primerjavo preiskovanega posnetka in statističnega modela osumljenca) [5].

Metode razpoznavanja govorcev, ki temeljijo na tehnikah statističnega modeliranja, kot npr. Gaussov mešani model (angl. Gaussian Mixture Modell, GMM), imajo to dobro lastnost, da neposredno vrnejo verjetnost, ali posamezna izgovorjava lahko pripada statističnemu modelu govorca. Namesto GMM lahko za razpoznavanje govorcev uporabimo tudi prikrite Markovove modele ali nevronske mreže [5]. So pa te metode manj uporabne v forenzičnih postopkih, ker nam določene verjetnosti v praksi praviloma niso poznane in posledično ne moremo izračunati razmerja verjetnosti (LR), ki je najpogosteje uporabljan oz. edini sprejemljiv način podajanja rezultatov na sodiščih [6].

Avtomatski sistemi za razpoznavanje govorcev se ne smejo uporabljati samostojno pač pa le kot dopolnitev drugih metod; sicer obstaja možnost napačne identifikacije [7]. Rezultate različnih forenzičnih metod v praksi preučujemo povezano s čimer dobimo kombinirano oceno zanesljivosti dokaznega gradiva.



Slika 1. Shematski prikaz izračuna razmerja verjetnosti (LR) pri razpoznavanju govorcev.



Slika 2. Postopek avtomatskega razpoznavanja govorcev.
3. GOVORNA ZBIRKA

Glede na omejeno količino urejenih in tehnično primernih govornih posnetkov v slovenskem jeziku smo se odločili za izvedbo snemanja lastne govorne zbirke slovenskih govorcev.

Govorno zbirko smo posneli v laboratoriju. Posneli smo 25 moških slovensko govorečih oseb. Izbrali smo govorce različnih starosti, vse delovno aktivne, v starostni skupini od približno 25 do 65 let.

Večji del posnetkov so govorci hkrati govorili v dva namizna mikrofona (v oddaljenosti 15 do 30 cm od ust govorca), v prostoročni mikrofon VoIP telefona ter v GSM telefon in slušalko klasičnega analognega PSTN telefona. Na ta način smo isti govor posneli preko več sočasnih prenosnih kanalov, kar nam omogoča analize vplivov kanala na istem izvornem govornem signalu.

Govorci so pod nazorom operaterja snemanja govorili na tri načine: spontani govor, pogovor in branje.

Vsak način govora smo posneli v dolžini najmanj dveh minut. Vsako snemanje smo pričeli z branjem teksta nekega članka, pri čemer se je govorec lahko vsaj približno privadil na snemalne naprave. Po branju smo v pogovoru, ki smo ga snemali, govorca pripravili na ustrezno temo, ki mu je blizu. Pri tem je bil na posnetkih slišen tudi govor sogovornika, ki je vodil pogovor in snemanje. Na ta način smo skušali zagotoviti čim bolj naraven in sproščen način govora. V nadaljevanju smo posneli še spontani govor, ki je v obliki monologa o določeni temi trajal prav tako 2 minuti. Izkazalo se je, da govorcu močno olajšamo spontani govor v obliki monologa, če se le ta smiselno in tematsko navezuje na pričeti pogovor v prejšnjem delu snemanja, saj se ljudje praviloma počutijo nelagodno, ko morajo pred določeno osebo več časa nepripravljeni govoriti o poljubni temi.

Določeno težavo pri snemanju je predstavljala nesproščenost govorcev pri spontanem govoru. Izkazalo se je, da za določene ljudi predstavlja nelagodje, če jih na snemanje vnaprej ne pripravimo. Priprava je običajno obsegala obrazložitev postopka in namena snemanja. Nekateri govorci so želeli, da jim zagotovimo anonimnost oziroma zagotovilo, da posnetki ne bodo zlorabljeni ali javno objavljeni.

4. EKSPERIMENT

Meritev uspešnosti sistema za SRG [9] smo izvajali v več korakih: izbor posnetkov, generiranje modela ozadja, učenje sistema, testiranje in analiza rezultatov. Najprej smo izbrali dve skupini posnetkov. Prva skupina posnetkov je bila namenjena za generiranjem modela ozadja, druga skupina pa je bila razdeljena na podskupino za učenje in podskupino za testiranje sistema.

Pomembno je, da za **model ozadja** izberemo posnetke iz iste populacije, kot je zastopana v posnetkih za testiranje in učenje. Če so za model ozadja uporabljeni posnetki govorcev, ki hkrati govorijo tudi na posnetkih za testiranje in učenje, govorimo o testiranju v zaprtem podatkovnem setu. Model ozadja je pri vseh meritvah enak in je zgrajen iz dveh skupin posnetkov. Prva skupina vsebuje 66 posnetkov prek mikrofona, druga skupina pa 124 posnetkov prek mobilne telefonije. Za izgradnjo slovenskega modela ozadja smo morali zaradi omejene količine slovenskih govorijo iste osebe kot na posnetkih za učenje in testiranje. Obe skupini posnetkov za model ozadja sta bil sestavljeni iz posnetkov pogovora in spontanega govora. Skupini mikrofonskih posnetkov smo torej dodali še 30 posnetkov prek mobilne telefonije pa smo priložili 87 posnetkov pogovorov slovenskih moških. V teh posnetkih govori približno 10 različnih oseb, ki so posnete prek prisluhov v mobilnem telefonskem omrežju.

Učenje modelov govorcev je potekalo s posnetki, posnetimi preko vseh petih kanalov. Učenje s posnetki prek mikrofona, smo izvajali s posnetki prek obeh mikrofonov pri branju in spontanem govoru, torej skupno s štirimi posnetki za vsakega govorca. Sistem smo učili tudi s posnetki prek telefonije GSM, PSTN in VoIP za vseh izbranih 18 govorcev iz lastne govorne zbirke (branje in spontani govor).

Testiranje smo izvajali s posnetki iz lastne govorne zbirke prek vseh petih kanalov, ki so bili posneti pri pogovoru.

Za učenje smo uporabljali eno vrsto kanala, testiranje pa smo izvedli na podatkih posnetih prek istega in vseh preostalih kanalov. Tako smo lahko opazovali obnašanje sistema pri istem modelu ozadja, vendar pri različnih kanalih za učenje in testiranje. Na slikah 2, 3, 4 in 5 so prikazani rezultati štirih sklopov meritev uspešnosti sistema za SRG s posnetki za učenje modelov moških slovenskih govorcev, ki smo jih posneli prek štirih kanalov. DET krivulje uspešnosti sistema so na vseh grafih za mikrofonske posnetke obarvane rdeče, za PSTN posnetke črno, za GSM posnetke zeleno in za VoIP posnetke modro.



Slika 3. DET krivule učenja modelov z MIK posnetki.



Slika 4. DET krivulje učenja modelov z GSM posnetki.



Slika 5. DET krivulje učenja modelov z PSTN posnetki.



Slika 6. DET krivulje učenja modelov z VoIP posnetki.

5. REZULTATI

Iz rezultatov meritev uspešnosti sistema za SRG v mešanih okoliščinah lahko ugotovimo, da se sistem za SRG pričakovano najbolje obnaša s posnetki, pridobljenimi v istih razmerah tako za učenje kot testiranje.

FRR (angl. False Rejection Rate) je verjetnost, da sistem za SRG ne zazna govorca na posnetku, kjer je govorec prisoten. Govorimo o deležu napačno zavrnjenih govorcev.

FAR (angl. False Acceptance Rate) predstavlja verjetnost, da bo sistem za SRG napačno zaznal govorca, ki ni prisoten v posnetku, ki ga sistem analizira. Pri identifikaciji bo sistem identificiral govorca, ki ni prisoten v tesni množici, pri verifikaciji pa bo sistem napačno potrdil istovetnost neavtentičnega posnetka.

EER (angl. Equal Error Rate) predstavlja točko, kjer je verjetnost za napačno sprejetje in napačno zavrnitev enaka; torej je odločitev enaka naključnemu odločanju. Nižja kot je vrednost EER, boljši je sistem.

Pri učenju z mikrofonskimi posnetki (slika 3) dosega EER pod 5 % za mikrofonske testne posnetke. Obnašanje sistema s PSTN posnetki je nekoliko slabše, najslabše pa se sistem obnaša z GSM in VoIP posnetki, kjer je EER okoli 20 %.

Pri učenju s posnetki pridobljenimi preko mobilne telefonije GSM (slika 4) dosežemo EER okoli 10 % v primeru GSM tesnih posnetkov, nekaj nad 10 % v primeru PSTN posnetkov, 15 % v primeru uporabe mikrofona in nad 20 % pri uporabi testnih posnetkov preko VOIP.

V primeru učenja sistema za SRG s posnetki preko telefonije PSTN (slika 5) najboljši rezultat zasledimo pri testnih posnetkih, ki so posneti v enakih razmerah kot za učenje. Občutno slabše pa se sistem obnaša pri VoIP in mikrofonskih testnih posnetkih z EER okoli 20%. Testni posnetki preko GSM pa prinesejo napako EER blizu 40% .

Tudi v primeru učenja z VOIP posnetki (slika 6) so rezultati najboljši v primeru, ko so učni in testni posnetki pridobljeni na enak način. Opazimo pa lahko občutno poslabšanje napake pri posnetkih pridobljenih z mikrofonom in preko GSM telefonije z EER okoli 40%. Pri posnetkih pridobljenih s PSTN telefonijo znaša EER okoli 50%, kar pa je enakovredno naključnemu odločanju.

Iz vseh meritev v mešanih okoliščinah lahko ugotovimo, da se sistem za SRG pričakovano najbolje obnaša s posnetki, pridobljenimi v istih učnih in testnih razmerah. Vrednost EER za učne in testne posnetke pridobljene v enakih okoliščinah je razmeroma majhna, pod 5%, razen pri GSM, kjer je okoli 10%, pri čemer je pri VoIP celo pod 1%, tako da modra krivulja niti ni več vidna na grafu. To pripisujemo razmeroma majhni testni zbirki posnetkov. Gre namreč za testiranje v zaprtem podatkovnem setu.

6. ZAKLJUČEK

Prdstavili smo problematiko razpoznavanja oz. verifikacije govorcev v forenzične namene. Poudarek je bil na problematika pridobivanja posnetkov pod »stvarnimi pogoji«. V zvezi s tem smo proučevali vpliv različnih načinov zajemanja govornega signala na rezultate prepoznavanja SRG. Za potrebe eksperimenta je bila posneta posebna govorna zbirka slovenskih govorcev, ki jo je smiselno dograjevati z novimi glasovi.

Izkazalo se je, da so sistemi za SRG še vedno precej občutljivi na vplive prenosnega kanala. Največji izzivi so v primerih, ko izvajamo učenje sistema na podatkih, ki so pridobljeni preko ene vrste telefonije, testiranje sistema pa se izvaja na podatkih, ki so posneti preko druge vrste telefonije oziroma neposredno preko mikrofona. Izkazalo se je, da so rezultati v primerih mešanih pogojev znatno slabši od rezultatov pridobljenih v enakih pogojih.

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JSI Sound – platforma za enostavno klasifikacijo zvočnih posnetkov: Demonstracija na zvokih živali

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POVZETEK

Predstavljamo orodje JSI Sound, ki je namenjeno enostavni klasifikaciji zvočnih posnetkov. Implementirano je v okolju Orange, ki je odprtokodno orodje za strojno učenje in vizualizacijo podatkov za strokovnjake in začetnike. JSI Sound je bil razvit v skladu s paradigmo »strojno učenje kot storitev«, saj omogoča enostavno testiranje klasifikacijskih modelov na različnih bazah podatkov zvočnih posnetkov, v mislih imamo predvsem različne biozvoke. S tem je primeren tako za ljubitelje s področja bioakustike brez naprednega znanja s področja strojnega učenja, ki lahko JSI Sound uporabijo kot enostavno klasifikacijsko orodje, kot tudi za strokovnjake, ki ga lahko uporabijo za enostavno testiranje modelov kot prvi korak pri izdelavi specializiranih klasifikacijskih aplikacij. Vhodne podatke za JSI Sound predstavlja serija označenih posnetkov. Uporabnik v seriji korakov s pomočjo grafičnega vmesnika izbere način filtriranja, segmentacije in postopek določitev značilk. Na podlagi teh značilk orodje zgradi serijo klasifikacijskih modelov in jih testira. Tu predstavimo testiranje sistema na treh serijah podatkov – na brenčanju čmrljev ter oglašanju ptic in žab.

Ključne besede

Živalsko oglašanje, strojno učenje, Orange, klasifikacija

1. UVOD

Metode umetne inteligence in strojnega učenja so dolgo temeljile na analizah strogo strukturiranih podatkov, v novejšem času pa se vedno bolj ukvarjajo z direktnimi podatki iz realnega sveta, kot so video in avdio posnetki. V tem prispevku se osredotočimo na analizo in klasifikacijo zvokov, ki jih proizvajajo živali. Naloga je pomembna v zoologiji, denimo v študijah biotske raznolikosti. Čeprav je mnoge živalske vrste enostavno prepoznati na podlagi videza, to ni vedno možno - bodisi zaradi življenjskega sloga (mnoge ptice se denimo skrivajo v grmovju ali v trsju) bodisi zaradi tega, ker so si osebki več vrst tako podobni, da jih lahko ločimo šele ob podrobnem morfološkem pregledu - to pa zahteva, da osebek ujamemo. Klasičen primer so penice, skupina ptic, ki so si na videz precej podobne, se pa vsaka vrsta izrazito drugače oglaša, kar lahko uporabimo kot osnovo za prepoznavanje. Drug primer so netopirji - med letom ponoči je vizualno prepoznavanje izredno zahtevno ali celo nemogoče, lahko pa jih prepoznavamo na podlagi oglašanja - netopirji se oglašajo v ultrazvočnem območju, zvoke pa uporabljajo za eholokacijo in za sporazumevanje. Še en primer so žuželke na travniku, te proizvajajo različne vrste zvokov, kot so klici za sporazumevanje ali zvok brenčanja med letom. Slike 1-3 prikazujejo primere spektrogramov za oglašanje ptice, netopirja in čmrlja. Vidimo, da

so si izrazito različni med seboj, tako v časovni kot v frekvenčni domeni.



Slika 1: Spektrogram oglašanja ptice *Sylvia communis* (rjava penica). Iz spektrograma je razvidno izrazito strukturirano oglašanje, tako v časovni kot tudi v frekvenčni domeni.



Slika 2: Spektrogram klicev naključnega netopirja. Gre za kratke eholokacijske klice v ultrazvočnem območju.



Slika 3: Spektrogram brenčanja čmrlja *Bombus griseocollis*, delavka. Brenčanje je v časovni domeni precej neodvisno, v frekvenčni domeni pa je razvidna struktura osnovne frekvence in višje harmonskih frekvenc.

Problem klasifikacije živalskih vrst z metodami strojnega učenja na podlagi oglašanja ni nov – v literaturi zadnjih let najdemo primere za različne skupine živali in za različne pristope. Gradišek et al. [1] so uporabili kombinacijo metod strojnega učenja za prepoznavanje nestrukturiranega brenčanja čmrljev, kot najboljša metoda se je izkazal naključni gozd. Ganchev in Potamitis [2] sta se ukvarjala z oglašanjem žuželk (črički, škržati, prave cvrčalke), uporabila sta kombinacijo probabilističnih nevronskih mrež in gaussovskih modelov. Dosegla sta 90 % klasifikacijsko točnost na bazi 307 vrst. Stowell in Plumbey [3] sta uporabila nenadzorovano učenje za prepoznavanje ptic, različne metode za prepoznavanje ptic so preizkušali tudi Cheng et al. [4].

Kot smo videli na primerih spektrogramov, ima oglašanje vsake od skupin živali svoje posebnosti, zato se ni enostavno odločiti, na kakšen način bomo pristopili h klasifikacijskemu problemu kakšne značilke izbrati in katere algoritme uporabiti. Odločitev je še težja za strokovnjake s področja bioakustike, ki bi si želeli delujoče klasifikacijske aplikacije, nimajo pa obširnega znanja s področja strojnega učenja. Naša rešitev JSI Sound [5] izhaja iz paradigme »strojno učenje kot storitev«. Izdelali smo orodje, s katerim lahko uporabnik s pomočjo grafičnega vmesnika preizkusi različne pristope pri gradnji klasifikacijskih modelov. Po eni strani je to lahko že dovolj za enostavne klasifikacije, po drugi strani pa predstavlja dobro osnovo za gradnjo robustnih specializiranih aplikacij. Naše orodje se razlikuje od obstoječih rešitev, ki jih lahko razdelimo predvsem na orodja v obliki knjižnic ali modulov (npr. pyAudioAnalysis [6]) ter orodja z grafičnim vmesnikom (kot je denimo Audacity [7]). Primerjava nekaterih funkcij za vsako od orodij je prikazana v Tabeli 1.

Tabela 1: Primerjava funkcij treh različnih orodij za obdelavo zvoka

	Audacity	pyAudioAnalysis	JSI Sound
Spektrogram	da	da	da
Filtriranje	da	ne	da
Segmentacija	da (ročna)	da	da
Ekstrakcija značilk	ne	da	da
Klasifikacija	ne	da	da
GUI	da	ne	da

Orodje JSI sound je razvito v okolju Orange [8,9], s tem je prosto dostopno. V prispevku opišemo splošno delovanje metode, implementacijo v okolju Orange in rezultate testiranja na treh skupinah posnetkov živalskih zvokov.

2. METODA

Splošna metoda je prikazana na Sliki 4. Sestavljena je iz petih korakov: vnos zvočnih posnetkov, predprocesiranje, ekstrakcija značilk, gradnja modelov strojnega učenja ter evaluacija modelov.

Vhodne podatke predstavlja skupina označenih posnetkov, zaželeno je, da so bili vsi pridobljeni z enako opremo in z enako frekvenco vzorčenja. Predprocesiranje zajema uporabo filtrov za odstranitev šuma. Izberemo lahko med petimi filtri; FIR, Butterworth, Čebišev, Eliptični in Besselov filter. V tem koraku izvedemo tudi segmentacijo na posnetke izbrane dolžine. Uporabimo lahko fiksno ali drseče okno. Hkrati lahko zavržemo segmente, v katerih ni dovolj informacije. Za ekstrakcijo značilk uporabimo odprtokodne knjižnice, trenutno uporabljamo OpenSmile [10] in pyAudioAnalysis [6]. Te knjižnice podpirajo veliko število značilk (ki so rezultati kompleksnih matematičnih operacij na vhodnih posnetkih), tako v časovni kot tudi v frekvenčni domeni. Značilke temeljijo na operacijah, kot so mel-frekvenčni kepstralni koeficienti (MFCC), koeficientih percepcijskega linearnega napovedovanja (PLP) in koeficientih Chroma [10]. Ta pristop se je že izkazal koristnega pri analizi človeškega govora [11].



Slika 4: Shema metode, ki jo uporablja orodje JSI Sound

Na podlagi značilk Orange zgradi odločitvene modele, kot so naključni gozd, SVM, naivni Bayes in druge. Za evaluacijo posameznega modela se podatke razdeli na učno množico, na kateri se trenira modele, in na testno množico, na kateri se te modele nato testira. Pri tem JSI Sound skrbi, da so vsi segmenti, ki pripadajo istemu začetnemu posnetku, vedno ali v učni ali v testni množici. Poleg tega omogoča gradnjo modelov na nivoju posameznega segmenta ali pa na nivoju celotnega posnetka, z uporabo kombinacije napovedi za vsakega od segmentov posebej.

3. IMPLEMENTACIJA V OKOLJU ORANGE

Po namestitvi je vtičnik JSI Sound dostopen v klasičnem seznamu vtičnikov okolja Orange. Uporabnik naloži bazo posnetkov, nato s seznama izbere ustrezne filtre ter parametre za segmentacijo posnetkov (dolžina in prekrivanje okna). Zatem uporabnik izbere knjižnice za ekstrakcijo značilk.

V naslednjem koraku uporabnik s pomočjo orodij v okolju Orange gradi modele ter jih evalvira. Primer uporabe JSI Sound je prikazan na Sliki 5.



Slika 5: Primer uporabe orodja JSI Sound v okolju Orange. Vtičniki, ki so pobarvani modro, so bili razviti za JSI Sound, ostali so standardni vtičniki okolja Orange.

Po opisu implementacije in sheme uporabe lahko uporabnik vidi, da je orodje enostavno za uporabo, poleg tega pa mu omogoča hitro in natančno gradnjo klasifikacijskih modelov, katerih natančnost je primerljiva z rezultati prikazanimi v Tabeli 3.

4. EKSPERIMENTI

Orodje JSI Sound smo testirali na treh različnih skupinah živalskih zvokov, na posnetkih oglašanja slovenskih žab in ptic iz družine penic ter na posnetkih brenčanja čmrljev, gre za vrste iz zvezne države Kolorado v ZDA. Število razredov, posnetkov in segmentov za vsako od skupin prikazuje Tabela 2.

Tabela 2: Struktura podatkov za vsako od skupin živali

	Ptice	Žabe	Čmrlji
Št. razredov	6	13	9
Št. posnetkov	81	39	51
Št. segmentov	5536	4447	3854

Eksperiment je sestavljen iz treh korakov: strojnega učenja na nivoju segmentov, ekstrakcije značilk na nivoju posnetkov in strojnega učenja na nivoju posnetkov. Motivacija za ta pristop je dvojna: ker vemo, da posamezni segmenti istega posnetka pripadajo istemu razredu, nam kombinacija informacij o več segmentih lahko pove več kot le informacija o posameznem posnetku. Več metod strojnega učenja pa kombiniramo zato, ker lahko različne metode delujejo različno dobro na posameznih strukturah v podatkih.

Za strojno učenje na podlagi posnetkov smo uporabili sledeče metode: Logistična regresija (LR), Naivni Bayes (NB), metoda najbližjega soseda (kNN), naključni gozd (RandomForest, RF) in AdaBoost. Vhodni podatek za vsako od metod je vektor značilk za vsakega od segmentov, izhodni podatek pa so verjetnosti za vsakega od klasifikacijskih razredov.

V koraku ekstrakcije značilk na podlagi posnetkov združimo napovedi modelov iz predhodnega koraka, uporabimo maksimalno, minimalno in povprečno vrednost napovedi vsakega od modelov.

V koraku strojnega učenja na osnovi celotnih posnetkov na podlagi napovedi posameznih modelov na nivoju segmentov izdelamo meta-klasifikatorje. Te preverimo s desetkratnim prečnim preverjanjem na testni množici. Rezultati, v metriki ploščine pod krivuljo (area under curve, AUC), so predstavljeni v Tabeli 3.

Tabela 3: Klasifikacijski rezultati v metriki AUC z 10-kratnim prečnim preverjanjem za vsakega od modelov za vse tri skupine živali

	Ptice	Žabe	Čmrlji
LR	94	100	80
kNN	92	99	75
RF	94	100	81
NB	89	99	74
AdaBoost	85	93	67

Rezultati za ptice so odlični in bodo osnova za izdelavo namenske aplikacije. Visoka klasifikacijska točnost za žabe je verjetnost posledica majhnega števila posnetkov v vsakem od razredov, za izboljšanje zanesljivosti bo potrebnih več posnetkov. Rezultati za čmrlje so blizu tistim, ki smo jih dobili na bazi posnetkov slovenskih vrst [1].

5. ZAKLJUČEK

Predstavljamo orodje JSI Sound, ki je bilo razvito z namenom olajšati naloge s področja strojnega učenja za uporabnike, ki nimajo naprednih izkušenj s tega področja ali s področja obdelave zvočnih posnetkov. Orodje JSI Sound je implementirano v okolju Orange in vsebuje pet metod filtriranja, dve metodi segmentacije posnetkov ter dve obsežni knjižnici za določanje značilk, tako v časovni kot tudi v frekvenčni domeni. Vse te funkcije so dostopne kot vtičniki za Orange, do njih pa dostopamo prek grafičnega vmesnika.

Sistem smo testirali na treh setih posnetkov živalskih zvokov – na posnetkih brenčanja čmrljev ter oglašanju ptic iz družine penic ter žab. Rezultati klasifikacijskih modelov so podobni tistim, ki smo jih na istih ali podobnih setih dobili v prejšnjih študijah, kar kaže na primernost orodja JSI Sound za tovrstne naloge. V teku je raziskovanje primernosti metode za analizo drugih tipov zvokov, denimo za analizo govora in zvokov človeškega telesa, kot sta bitje srca in dihanje.

6. ZAHVALA

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Bat Classification using Deep Neural Network

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ABSTRACT

We present a deep neural network approach for bat species classification by echolocation and social calls. First the data is gathered on two separate locations using special high frequency ultrasound recorder. The data is then preprocessed in order to be usable in deep neural network architecture. Deep architecture used is discussed and experimental results for classification of two species are presented. The last part of the paper focuses on future work that could improve results.

General Terms

Algorithms, Design, Experimentation

Keywords

bats, deep neural network, convolutional neural networks, Pipistrellus pygmaeus, Barbastella barbastellus

1. INTRODUCTION

Bats are second largest order of mammals, representing 20% of all mammal species worldwide. Bats live in most of the world except extremely cold regions. There are 30 species of bats classified in Slovenia out of more than 1200 found around the world.

Bats in Slovenia are all insectivores - meaning they feed on insects. They are mostly active during the dusk and in general have poorly developed vision. For navigation and hunting however they use special organ that works similarly to sonar. They emit ultrasonic sounds, between 10 and 120 kHz and are precise enough to detect less than a 0.01 mm wide obstacle [1].

They live in colonies and also have ultrasonic social calls in order to communicate with each other. The sounds they produce differs from specie to specie and can be used for classification.

Bats perform vital ecological roles of pollinating flowers, they consume insect pests and their excrements (guano) are very good fertilizers. It is thus important for humans to do what they can to help them prosper. In this paper we focus on two species found in Slovenia, Barbastella barbatellus and Pipistrellus pygmaeus [Figure 1].

Modern ICT solutions nowadays allow us to better understand and study these animals by using automated systems. Since bats use such a unique form of communication they can be easily detected using sound compared to other methods (image), however sound data is full with noise and it might not be an easy task to differ

between two species of bats. Visual recognition can often be a difficult task when dealing with lowlight conditions, which are usually present when bats are normally active. On the other hand, classification based on bat calls is a more promising approach. Experts can classify most of Slovenian bat species based on the audio recordings. However, automatic classification methods are desired since they allow us to process large amounts of data from recording stations.

In last years deep neural networks (DNN) proved to perform very well in classification of real world signals such as sounds or images [2]. In this paper we present an advanced deep learning architecture that can be used for bat species classification based on sound.



Barbastella barbatellus

Pipistrellus pygmaeus

Figure 1: Two species of bats found in Slovenia that we try to classify.

2. Data

Data consist of two datasets from two different location Dolenja Vas; around 2000 recordings, 8 GB in size, and Kozina which contains 8.900 recordings and is 28 GB in size.

The data were recorded using a specialized high frequency recorder SM4BAT FS&ZC. Recorder has a recording range of 16 Hz to 150 kHz and recording frequency of 500 kHz. We used band pass filter between 10 kHz to 110 kHz in order to filter out most of the noise and to lower amount of empty recordings (in general bats do not produce noise that is lower than 15 kHz or higher than 100 kHz at the same time there are not many animals that produce sounds in such frequency range).

The recorder automatically records a sound, couple of seconds earlier and couple of seconds after certain frequency threshold is reached e.g. when sound over 15kHz is detected. The recording is then manually labeled by the expert, who normally looks at the spectrogram in order to determine number and species of bats in the recording. In total the dataset contains 22 different species. Majority of cases consists of one specie per recording although some contain multiple species. In some recordings expert was unable to determine exact specie so a specie family is used as a label. In total there are 37 labels in this dataset.

2.1 Data preprocessing

The information in wave form is concentrated in certain frequency components which are impossible to detect in wave form format that is why Furrier transform is performed to transform data into time-frequency representation – spectrogram. Spectrogram format also gives us a better look into frequency distribution in a signal (it is easier for human to interpret a visual information). The frequency resolution of spectrogram used was 256.

A representative spectrogram is shown in Figure 2. It is easy to distinguish 3 types of signals. Below 20 kHz there is noise, which can be discarded. At higher frequencies, there are two types of patterns. A social call, which spans over a higher range of frequencies, and an echolocation call, that is used for navigation.

3.1 Deep neural network

Artificial neural networks have existed since 1954 when Farley and Weasley first implemented a simple neural network on a computer. Because of the computation complexity they were not used widely until the late 2000's, when computers with new architectural design, initially optimized for graphic cards to allow parallelization, became capable enough to run several layers of neurons – a deep architecture. Architecture is considered deep if it contains at least 4 layers of neurons.

In 2012, AlexNet [3] architecture was proposed for image recognition. The network achieved more than a 10 % increase in accuracy compared to the second best method and made DNNs one of the most used ML methods today. The architecture uses convolutional layers to generalize input image and combine previously learned features into more complex high level features. By the rule of thumb, Convolutional Neural Networks (CNN) can be used and often perform good, especially when the task can be



Figure 2: Spectrogram of one recording. In the figure 3 distinct patterns emerge. Everything below 20 kHz is noise, in the range of 20kHz and 100 kHz there are two type of sounds, social calls and echolocation calls.

Due to the high sampling frequency (500kHz) of the recording device it is not possible to feed whole signal to the neural network. We split the recording using a sliding window of size 2048 samples. To reduce the size of the file we also removed frequencies below 15 kHz and above 80 kHz, which did not contain any relevant information for classification of the two bat species that we attempted to identify.

When dealing with natural signals such as sound or image, it is best to feed the neural networks with raw signal and allow for their abstraction power to generalize information out of the data. Spectrogram can be represented to the neural network as an image - that is why we do not attempt to manually extract any more features but feed the windows extracted to the network.

3. DEEP ARCHITECTURE

Deep neural networks are becoming increasingly popular in the last years. They perform especially well on natural signals and are dominant on the domains of image recognition, voice recognition and natural language recognition. In our experiments we tested several deep architectures that we present in the following sections. presented in such a way that a person can use their bare eyes to classify the objects. Since spectrograms are analyzed by humans by looking at them and discovering patterns in the time-frequency representation it is likely that CNN will perform better than other architectures on the same domain.

We loosely based our architecture on several state-of-the-art architectures [3,4,6] and fine tune it to achieve best results for bat domain. In our architecture we used 3 convolutional layers, each consisting of 34 filters sized 7x7, 5x6, and 3x3 on each consecutive layer. After the second and third layer, we use MaxPooling layer which uses filter size 2x4 and 2x2. Max pooling is used to reduce size of the image (data). Filter slides over the image and concatenates all values under the filter into one. Different approaches can be used e.g. average, min, or max [4].

After the fifth layer, 3 fully-connected layers follow. In order to reduce over-fitting, a small number of neurons is used 8, 4, and 2 on layers 6, 7, 8. We use rectified linear activation function (ReLU) [Figure 3] which in general gives best performance [5].



Figure 3: Rectifier Linear Function gives good performance and is extremely easy to calculate on GPU where float operations are computational expensive (example sigmoid)

In the last layer we use SoftMax regression for classification. The whole architecture is presented in Figure 4.

In order to speed up the learning, instead of using standard gradient descend (SGD) for adjusting neuron weights we use RMSProp [4] which supports batched learning - allows for parallelization, adjust gradient weight for each parameter separately and uses adaptive normalization with decay parameter β [Equation 1].

$$v = \beta v + (1 - \beta)(\Delta f)^{2}$$
$$\theta = \theta - \alpha \frac{\Delta f}{\sqrt{v} + \varepsilon}$$
Equation 1 RMSProp

Despite large amounts of data, we discovered our network was still over-fitting. In order to resolve this problem, we introduced dropout [6] in the last layer. During training phase, the dropout method will randomly remove connections from neurons in one layer making the layer temporarily sparsely connected. The removed connections will be shuffled after each iteration preventing co-adaptations of neurons during learning. In the testing phase the model is again fully connected (dropout only works during learning phase). We used dropout probability of 0.5.

4. EXPERIMENTS

Recordings in the dataset last multiple seconds and contain several calls from one or multiple bats. Because of the large sampling frequency, it is not possible to input the whole recording into a neural network so we use windows. The problem with windows is that they are not labeled separately but have the same label as the original recording. This presents a problem with windows that do not contain any bat call. In order to alleviate this problem, we only focused on distinguishing between two species of bats *Barbastella barbatellus* and *Pipistrellus pygmaeus*. They were chosen because they had better noise to data ratio.



Figure 4: Network Architecture, uses 3 convolutional layers, 2 MaxPooling and 3 fully connected layers in the end.

Despite large amount of data in total there are only 128 recordings of the selected species. We split the recordings into 793 half second

windows using sliding window technique. The amount of data available for training is extremely small for deep learning. Even worse is that a lot of windows from this data only contain noise and no bat calls.

We split the data 75% for training and 25% for testing and despite all achieved average 8% improvement compared to the majority class, which indicates that the networks were able to learn something from the data.

5. FUTURE WORK

Our initial experiments showed that deep neural networks have potential in bat classification based on sound. Currently the main problem is data segmentation and its labels. The one label per recording, which is then divided into multiple windows (with the same label) brings a lot of noise into the data. One solution would be to use whole recording as one instance of a class, but because of vast amount of data in one recording it is not currently feasible to do it. There are two solutions for this problem: have a better preprocessing and only learn on correctly labeled segments or introduce a new architecture of deep neural networks that can learn on unlabeled datasets.

For our next step we have implemented a segmentation method that uses power envelope to isolate bat calls from random noise or empty recordings as seen in Figure 5. Our initial tests show



Figure 5: Bat calls segmentation using power envelope promising results (around 2 times better precision over majority

class). However, it is likely that some of the time/sequential information is lost with this process.

In order to avoid this, the segmentation method can be used to first train the network to detect any bat sounds. When the network is proficient enough in the later task it can then be used to differentiate between different species. By dividing the problem into two sub problems the complexity/depth of the network can be lowered which allows for faster learning time and mitigates overfitting to an extent.

6. CONCLUSION

In this paper we presented problem of bat classification based on ultrasound recordings. We recorded an extensive database of bat recordings and presented a deep architecture used for species classification. In last part we presented initial results and proposed methods in future work to improve current model.

Despite the initial poor results, which we think are the result of noisy data, we have shown that deep neural networks can be used for animal sound classification – more precisely bats. We believe that with more data and better segmentation greater improvements in accuracy can be achieved. Additionally, semi-supervised learning can be used to train the model on vast amount of unlabeled data.

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Globoke nevronske mreže in matrična faktorizacija

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POVZETEK

Predlagana je nova inicializacija globokih nevronskih mrež, ki pred začetkom učenja nevronske mreže nastavi uteži in pristranske vrednosti tako, da usmeri nevronsko mrežo proti rešitvi, ki pri optimizaciji hitreje konvergira k lokalnemu minimumu. Predlagana inicializacija je od običajne inicializacije precej počasnejša, vendar lahko pri globokih nevronskih mrežah precej pohitri skupni čas učenja.

Ključne besede

Globoke nevronske mreže, klasifikacijska točnost, regresija, nenegativna matrična faktorizacija, analiza arhetipov, inicializacija uteži.

1. UVOD

Globoke nevronske mreže v zadnjih letih dosegajo precej dobre rezultate [6][7], vendar se z večanjem števila skritih nivojev pojavijo tudi nekatere težave, kot so izguba gradienta pri vzvratnem širjenju napake in čas, ki je potreben za učenje. Predlagana je nova metoda za nastavljanje začetnih uteži, ki temelji na inicializaciji s pomočjo matrične faktorizacije, kjer je cilj, da bi pospešili učenje in preprečili preveliko izgubo gradienta.

2. PREDLAGANA INICIALIZACIJA

Ideja za predlagano inicializacijo delno izhaja iz inicializacij uteži z algoritmi za nenadzorovano učenje, kjer poskušamo vsak nivo nevronske mreže naučiti čim bolj abstraktno predstavitev podatkov, iz katerih lahko nato lažje pravilno napovemo vrednosti na izhodu. Pri predlaganem algoritmu te abstraktne predstavitve podatkov izračunamo s pomočjo matrične faktorizacije.

Predpostavimo, da imamo globoko nevronsko mrežo z k skritimi nivoji, pri kateri bi se radi naučili preslikati matriko podatkov $X \in \mathbb{R}^{n \times m}$ v izhodne podatke $Y \in \mathbb{R}^{n \times h}$. Konstante n, m in hpredstavljajo število učnih primerkov, dimenzijo učnih podatkov in število nevronov na izhodu ciljne nevronske mreže. Originalno matriko X najprej faktoriziramo v pare $\{W_k \in \mathbb{R}^{n \times i}, H_k \in \mathbb{R}^{i \times m}\}$, kjer rank *i* predstavlja število nevronov ciljne nevronske mreže na skritem nivoju k. Število teh parov je zato enako številu nivojev v ciljni nevronski mreži. Dobljene matrike W v tem primeru predstavlja abstrakten povzetek originalne matrike oziroma aktivacije ciljne mreže na posameznem skritem nivoju. Matrik H za inicializacijo ne potrebujemo, zato jih lahko zavržemo.

Naslednji korak inicializacije je učenje k+1 enonivojskih mrež, kjer se vsaka od mrež nauči preslikavo iz ene predstavitve podatkov W_k v drugo predstavitev W_{k+1} . Posebnost so le prva enonivojska mreža, ki slika iz matrike $X v W_1$ in zadnja enonivojske mreža, ki slika iz W_k v matriko izhodnih podatkov Y. Za faktorizirane pare velja, da ni možno, da je dimenzija *i* večja od dimenzije *m* v matriki X oziroma velja $i_1, i_2, ..., i_k < m$. Igor Kononenko Univerza v Ljubljani, FRI Večna pot 113 Ljubljana igor.kononenko@fri.uni-lj.si

Slika 1 prikazuje predlagano inicializacijo za ciljno mrežo z dvema skritima nivojema. Prvi korak je faktorizacija matrike X vdve novi matriki W_1 in W_2 . Ko izračunamo abstraktno predstavitev podatkov za oba skrita nivoja, zgradimo tri enonivojske mreže, kjer prva mreža preslika originalno matriko Xv prvo zgoščeno vrednost W_1 , druga mreža slika iz W_2 , zadnja mreža pa iz W_2 v končno matriko Y.

Za učenje enonivojskih mrež lahko uporabimo različne funkcije napak z različnimi aktivacijskimi funkcijami. Pri učenju enonivojskih mrež, je pomemben tudi izbor števila iteracij (angl. epoch) in velikost učnega paketa (angl. batch), saj lahko pride do prevelikega prileganja, kar upočasni učenje ciljne mreže.



Slika 1. Izgradnja in učenje enonivojskih mrež ter njihovo združevanje v ciljno nevronsko mrežo.

Zadnji korak inicializacije je, da uteži teh enonivojskih mrež uporabimo za inicializacijo ciljne globoke nevronske mreže. Slika 1 prikazuje postopek, kjer enonivojske mreže združimo v ciljno mrežo, ki jo še dodatno učimo.

3. REZULTATI MNIST

Za testiranje inicializacije za klasifikacijske probleme je bila uporabljena podatkovna množica MNIST, ki vsebuje slike ročno napisanih številk. Slika 2 prikazuje hitrost učenja ciljne nevronske mreže inicializirane s predlagano inicializacijo. Razvidno je, da za globoko nevronsko mrežo učenje poteka precej hitreje kot inicializacija z naključno inicializacijo Xavier.

Pri nevronskih mrežah z manj kot 5 skritimi nivoji, je ta inicializacija največkrat nepotrebna, saj med učenjem ne prihaja do tako velikih izgub gradienta, kot je to pri globokih nevronskih mrežah.



Slika 2. Primerjava klasifikacijske točnosti med predlagano inicializacijo in naključno inicializacijo Xavier na globoki nevronski mreži z arhitekturo nivojev (400, 300, 200, 100, 70, 50, 40, 30, 20, 15, 13, 10) in sigmoidno aktivacijsko funkcijo.

Ker lahko pri enonivojskih nevronskih mrežah pride do prevelikega prileganja podatkom, kar slabo vpliva na klasifikacijsko točnost ciljne mreže, lahko že pri učenju teh mrež dodamo regularizacijo, ki nekoliko prepreči preveliko prileganje ciljne mreže. Slika 3 prikazuje vpliv različnih stopenj regularizacije L2 na točnost ciljne mreže.



Slika 3. Vpliv različnih stopenj regularizacije L2 enonivojskih mrež na klasifikacijsko točnost med učenjem ciljne nevronske mreže.

Iz stopenj regularizacije je razvidno, da lahko ob pravilni stopnji regularizacije enonivojskih mrež pospešimo hitrost učenja ciljne nevronske mreže. Če je regularizacija enonivojskih mrež prevelika, se te ne naučijo uporabne preslikave, kar zmanjša hitrost učenja ciljne mreže.

Pri izračunu zgoščene matrike podatkov lahko uporabimo več različnih metod za matrično faktorizacijo. Metode faktorizacije se med seboj precej razlikujejo. Slika 4 prikazuje vpliv različnih metod matrične faktorizacije na klasifikacijsko točnost ciljne nevronske mreže med učenjem. Uporabljeni so bili tipi NMF (nenegativne matrična faktorizacija), AA (analiza arhetipov) [1], SNMF (semi-nenegativna matrična faktorizacija), SVD (singularni razcep), PCA (analiza glavnih komponent) in FA (faktorska analiza). Za primerjavo je zraven dodana še inicializacija Xavier, ki se v tem primeru odreže precej slabše kot druge inicializacije. Pri napovedovanju se najbolje odreže algoritem AA, ki najhitreje doseže najboljšo klasifikacijsko točnost. Najslabša sta običajno algoritma PCA in NMF.



Slika 4. Primerjava vpliva različnih tipov matrične faktorizacije na hitrost učenja ciljne nevronske mreže.

Ena izmed najboljših postopkov za pohitritev učenja in preprečevanje nasičenosti aktivacijskih funkcij je uporaba funkcij, kot so ReLU ali katerokoli izmed mnogih variant te funkcije. Slika 5 primerja hitrost učenja med aktivacijsko funkcijo ReLU in sigmoidno aktivacijsko funkcijo.



Slika 5. Primerjava spreminjanje klasifikacijske točnosti pri uporabi aktivacijske funkcije ReLU in sigmoidne funkcije.

Izbor aktivacijske funkcije zelo vpliva na hitrost učenja, kar je povsem pričakovano. Pri uporabi sigmoidne funkcije se predlagana inicializacija obnese precej dobro, saj se že po 100 iteracijah nauči precej dobre inicializacije, med tem ko se pri inicializaciji Xavier klasifikacijska točnost ne povzpne nad 20%.

Pri uporabi funkcije ReLU z inicializacijo dosežemo hitrejše učenje, vendar kar je najbolj zanimivo, že pred začetkom učenja ciljne mreže dosega ta klasifikacijo nad 65%, med tem ko je točnost pri naključni inicializaciji pred začetkom učenja ciljne mreže 10%.

Inicializacija s pomočjo matrične faktorizacije je precej počasen postopek, saj večkrat faktoriziramo celotno matriko ter nato še učimo enonivojske mreže. Slika 6 prikazuje inicializacijo, kjer smo za faktorizacijo in učenje enonivojskih mrež uporabili le del učne množice.

Iz grafa je vidno, da lahko pri uporabi le dela učne množice za inicializacijo dobimo boljše rezultate kot pa pri uporabi celotne množice, pri tem pa precej pridobimo še na hitrosti pri matrični faktorizaciji in hitrosti učenja enonivojskih mrež.



Slika 6. Primerjava klasifikacijske točnosti med učenjem ciljne mreže v odvisnosti od odstotka uporabljenih podatkov pri inicializaciji.

4. **REZULTATI JESTER JOKES**

Inicializacija je bila testirana tudi za regresijski problem napovedovanja ocen šal, ki bi jih uporabniki dali šalam na spletni strani Jester.

Slika 7 prikazuje hitrost učenja pri uporabi različnih tipov matrične faktorizacije. Najboljša je bila ponovno faktorizacija AA, najslabša pa PCA, ki se sploh ni učila.



Slika 7. Primerjava vpliva različnih tipov matrične faktorizacije na hitrost učenja ciljne nevronske mreže.



Slika 8. Napaka MAE ciljne mreže pri uporabi različnih stopenj regularizacije L1 enonivojskih mrež.

Največja prednost predlagane inicializacije se je izkazala pri regularizaciji šal, saj je ciljna nevronska mreža pri šalah dosegla optimalno povprečno absolutno napako že po nekaj iteracijah, nato pa je prišlo do prevelikega prileganja. Slika 8 prikazuje MAE ciljne nevronske mreže pri različnih stopnjah regularizacije L1 enonivojskih nevronskih mrež.

Iz napake MAE vidimo, da lahko že s pravilno nastavljenimi utežmi, ki jih dobimo z regularizacijo uteži enonivojskih mrež dosežemo podoben efekt, kot če bi regularizacijo uporabili med učenjem ciljne nevronske mreže.

5. ČAS, POTREBEN ZA INICIALIZACIJO

Pri predlagani inicializaciji je potrebno najprej izvesti večje od število matričnih faktorizacij, ki odvisno časovne kompleksnosti potrebujejo precej časa. Ko končamo s faktorizacijo je potrebno še učenje enonivojskih mrež. V določenih primerih je za inicializacijo potrebno celo več časa kot pa za učenje ciljne nevronske mreže. Slika 9 primerja skupen čas, potreben za inicializacijo in učenje ciljne nevronske mreže, pri različnih odstotkih uporabljenih učnih podatkov za inicializacijo v odvisnosti od klasifikacijske točnosti ciljne mreže. Za primerjavo so bili uporabljeni podatki MNIST. Črtkana črta prikazuje čas, ki je potreben za inicializacijo in je odvisen od odstotka učne množice, uporabljene za inicializacijo. Pri uporabi le 30% podatkov se inicializacija izvede že po 150 sekundah, medtem ko inicializacija pri uporabi celotne množice potrebuje skoraj 500 sekund. Naključna inicializacija Xavier je na začetku boljša od predlagane inicializacije, saj že hitro po začetku učenja dosega 20% točnost, vendar je učenje precej počasno, zato jo druge nevronske mreže, ko so enkrat inicializirane hitro prehitijo po kriteriju klasifikacijske točnosti. Za merjenje časa je učenje nevronskih mrež potekalo z grafično kartico GTX 960M. Za faktorizacijo in učenje nevronskih mrež pa so bile uporabljene kniižnice sklearn, PvMF in Keras [2].



Slika 9. Primerjava časa, ki ga potrebuje predlagana inicializacija za izračun uteži v odvisnosti od klasifikacijske točnosti med učenjem.

Matriki W in H sta pred začetkom faktorizacije inicializirani naključno. Prav tako so naključno inicializirane uteži enonivojskih mrež. Zaradi naključne inicializacije so lahko rezultati med posameznimi testi nekoliko različni, zato so vsi grafi dobljeni kot povprečje treh poganjanj algoritma. Isto velja za graf časov, ki so sestavljeni kot povprečje treh testov.

6. ZAKLJUČEK

Predstavljena in testirana je inicializacija, kjer začetne vrednosti uteži izračunamo s pomočjo matrične faktorizacije. Metoda se dobro obnese pri podatkih, ki imajo precej veliko število atributov in za napovedovanje izhodnih vrednosti potrebujejo globoke nevronske mreže, saj se mreža že v začetku nauči nekatere abstraktne koncepte, ki obstajajo v podatkih.

7. PODOBNE INICIALIZACIJE

Skozi razvoj nevronskih mrež so te postajale vsakič bolj globoke, da bi se lahko naučile čim bolj zapletenih povezav med podatki. Pri globljih mrežah se pri naključni inicializaciji pojavi težava med učenjem, saj hitro prihaja do izgube gradientov. Ena izmed metod, ki pospeši učenje, je naključna inicializacija Xavier, ki uteži skalira, da se med učenjem aktivacijske funkcije ne nasičijo tako hitro. Druge možnosti za preprečevanje nasičenih funkcij so še Batch Normalization [3] in Self-Normalizing Neural Networks [8], kjer izhode nevronov normaliziramo med učenjem.

Predlagana inicializacija je najbolj podobna inicializacijama uteži, imenovanima Deep Autoencoder [4] ali Deep Belief Network [5], kjer je cilj, da mreži z nenadzorovanim učenjem nastavimo čim boljše uteži, ki nam bodo pomagale optimizaciji uteži. Prednost te inicializacije je ta, da lahko faktorizacijo in učenje enonivojskih mrež izvajamo paralelno, kar pa ni možno pri drugih dveh inicializacijah.

8. NADALJNE DELO

- Paralelizacija matrične faktorizacije in učenja enonivojskih mrež.
- Izračun matrike W_{k+1} s faktorizacijo matrike W_k namesto matrike X.
- Pretvorba inicializacije, ki bi delovala s konvolucijskimi nevronskimi mrežami.

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Optimiranje časa in porabe goriva v modelih človeške vožnje

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POVZETEK

Ko vozniki vozijo po cesti, optimirajo več kriterijev, npr. čas vožnje in porabo goriva. Toda teh kriterijev se navadno ne upošteva pri gradnji modelov človeške vožnje. Za namen sočasne optimizacije tako človeških vidikov vožnje kot kriterijev vožnje smo razvili Večkriterijski optimizacijski algoritem za iskanje strategij vožnje podobnih človeškim (ang. Multiobjective Optimization algorithm for discovering Human-like Driving Strategies, MOHDS). Algoritem vključuje modele človeške vožnje in optimira tri kriterije: čas vožnje, porabo goriva in podobnost s človeškimi vožnjami. MOHDS smo ovrednotili na treh cestah, ki so vključevale ovinke, naklone, druga vozila in avtocesto. Dobljene strategije vožnje smo primerjali s človeškimi strategijami vožnje. Rezultati kažejo, da MOHDS najde strategije vožnje, ki so z vidika kriterijev primerljive s človeškimi strategijami vožnje v večini obravnavanih scenarijev vožnje.

Ključne besede

večkriterijska optimizacija, človeške strategije vožnje, čas vožnje, poraba goriva

1. UVOD

Avtonomna vožnja vozil je zelo aktivno raziskovalno področje, na katerem deluje mnogo znanih podjetij, kot sta Google [11] in Toyota [9]. Veliko sistemov za pomoč voznikom, kot je npr. sistem za ohranjanje voznega pasu, je že vgrajenih v sodobna vozila. Poleg tega popolnoma avtonomna vozila že vozijo po javnih cestah [7].

Sistemi za avtonomno vožnjo se osredotočajo na zaznavanje okolice, kar vključuje druga vozila, pešce, obliko ceste, razne ovire na cesti itd. Toda dobljena vožnja lahko ne zadošča ostalim kriterijem vožnje, kot so čas vožnje, poraba goriva in posledično onesnaževanje okolja, udobje, podobnost s človeško vožnjo itd. Ti kriteriji vplivajo na sprejemljivost avtonomne vožnje s strani potnikov. Na primer, potniki ne želijo, da bi bila avtonomna vožnja preveč nenavadna, zelo različna od njihove vožnje ali pa slabša od človeške vožnje [12]. Jaka Sodnik Fakulteta za elektrotehniko Univerza v Ljubljani Tržaška cesta 25, 1000 Ljubljana NERVteh, raziskave in razvoj, d.o.o. Kidričeva ulica 118, 1236 Trzin

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Ta prispevek opisuje dvonivojski Večkriterijski optimizacijski algoritem za iskanje strategij vožnje podobnih človeškim (MOHDS), ki vključuje modele za oponašanje človeške vožnje ter optimira čas vožnje, porabo goriva in človeškost vožnje. Algoritem na spodnjem nivoju vključuje množico matematičnih modelov, ki oponašajo človeško vožnjo. Algoritem na zgornjem nivoju pa je večkriterijski optimizacijski algoritem, razvit na podlagi algoritmov Non-dominated Sorting Genetic Algorithm II (NSGA-II) [1] in Differential Evolution for Multiobjective Optimization (DEMO) [10], ki išče najboljše vrednosti parametrov za algoritem na spodnjem nivoju. Prispevek predstavi tudi okolje za simulacijo vožnje, s katerim smo vrednotili algoritem MOHDS.

Prispevek je nadalje organiziran kot sledi. Razdelek 2 opisuje sorodno delo na področju avtonomne vožnje. Okolje za simulacijo vožnje je predstavljeno v razdelku 3. Razdelek 4 opisuje algoritem MOHDS. Poskusi in rezultati so navedeni v razdelku 5. Prispevek zaključimo s povzetkom opravljenega dela in napovedjo nadaljnjega dela v razdelku 6.

2. SORODNO DELO

Človeške strategije vožnje lahko posnemamo z uporabo modelov človeške vožnje, pri čemer se obstoječi modeli osredotočajo na specifične aktivnosti vožnje, kot so sledenje vozilom, prosta vožnja, prehitevanje, sprememba pasu itd. Modeli za sledenje vozilom opisujejo aktivnost sledenja predhodnim vozilom na istem pasu. Ti modeli predpisujejo, da sledeče vozilo pospešuje oziroma zavira kot odziv na podatke iz okolice, pri čemer se modeli razlikujejo v upoštevanju teh podatkov. Na splošno lahko podatki vključujejo hitrost in pospešek vozila, relativno hitrost glede na predhodno vozilo, razdaljo do predhodnega vozila itd. [8, 14]. Modeli za prehitevanje na regionalni cesti in spremembo pasu na avtocesti opisujejo odločitveni proces za ustrezne aktivnosti vožnje. Spremembo pasu običajno modelirajo z modelom želje po spremembi pasu, modelom za sprejem vrzeli in modelom za izbiro vrzeli [13]. Prehitevanje modelirajo z modelom želje po prehitevanju in modelom za sprejem vrzeli [3]. Ti modeli

so organizirani zaporedno, tj. za spremembo pasu najprej preverijo željo po spremembi pasu, ob zadostni želji preverijo, ali je vrzel zadostna, ter če je zadostna vsaj ena vrzel, izberejo najustreznejšo vrzel. Podoben postopek je tudi pri prehitevanju, le da ne vključuje izbire vrzeli.

Modeli človeške vožnje posnemajo človeško obnašanje, pri čemer pa zanemarijo ostale kriterije, ki so tudi pomembni med vožnjo, kot so čas vožnje in poraba goriva. Razvitih je bilo več pristopov za optimiranje teh kriterijev, ki večinoma vključijo vse kriterije v eno kriterijsko funkcijo ali pa optimirajo samo porabo goriva, čas vožnje pa vključijo kot omejitev. Hellstrom in sod. [4] so razvili metodo dinamičnega programiranja, ki optimira uteženo vsoto kriterijev. Razvitih je bilo tudi več analitičnih metod za optimiranje utežene vsote kriterijev [6] oziroma le porabe goriva [5].

Obstoječe metode za iskanje strategij vožnje se osredotočajo bodisi na strategije vožnje podobne človeškim, bodisi na optimizacijo časa vožnje, porabe goriva in/ali ostalih kriterijev. Ta prispevek predstavlja algoritem, ki rešuje oba problema hkrati: modelira človeško vožnjo z modeli človeške vožnje ter uglašuje parametre teh modelov, pri čemer optimira čas vožnje, porabo goriva in podobnost s človeškimi vožnjami.

3. SIMULACIJA VOŽNJE

Simulacijsko okolje je namenjeno vrednotenju strategij vožnje in omogoča simulacijo vožnje po regionalni cesti in dvopasovni avtocesti. Cesta je razdeljena na odseke, pri čemer za vsak odsek določimo dolžino, omejitev hitrosti, polmer ovinka, naklon, smer vožnje pasov in možnost prehitevanja. Na cesti so lahko druga vozila, ki vozijo v smeri pasu ter ne prehitevajo. Tem vozilom določimo hitrost in razdaljo do predhodnih vozil.

Vozilo vodimo z ukrepi vodenja, ki vključujejo pospešek, kot vozila glede na smer ceste in prestavo. Prestava se spreminja glede na spodnjo in zgornjo mejo hitrosti motorja. Pri vožnji vozila upoštevamo tudi fizikalne omejitve vozila, s katerimi določimo največji pospešek, ki ga lahko vozilo doseže.

Simulacijo izvajamo v več korakih, dokler vožnja po celotni cesti ni končana. V vsakem koraku preverimo veljavnost vožnje, tj. vozilo se ne sme ustaviti, se ne sme zaleteti in ne sme kršiti omejitve hitrosti. Za celotno vožnjo izračunamo naslednje kriterije: čas vožnje, porabo goriva in podobnost s človeško vožnjo. Porabo goriva izračunamo na podlagi diagrama specifične porabe goriva. Podobnost s človeško vožnjo izračunamo na podlagi vnaprej pridobljenih podatkov o vožnjah voznikov. Ker pa želimo minimizirati vse kriterije, namesto podobnosti izračunamo različnost glede na človeško vožnjo. Za vsakega voznika izračunamo različnost s srednjim kvadratnim odklonom (ang. Root Mean Square Error, RMSE) in vrnemo RMSE voznika z najmanj različno vožnjo. Za ta izračun upoštevamo dva atributa: hitrost in odmik od sredine desnega voznega pasu. Pri tem izračunamo RMSE vsakega atributa in upoštevamo povprečje.

4. ALGORITEM ZA ISKANJE STRATEGIJ VOŽNJE PODOBNIH ČLOVEŠKIM

Ta razdelek opisuje Večkriterijski optimizacijski algoritem za iskanje strategij vožnje podobnih človeškim (MOHDS), ki sočasno oponaša človeško vožnjo in optimira čas vožnje, porabo goriva in različnost od človeške vožnje. MOHDS sestoji iz dveh nivojev. Na spodnjem nivoju je implementiranih več modelov človeške vožnje, ki vodijo vozilo v različnih aktivnostih vožnje. Vrednosti parametrov modelov na spodnjem nivoju iščemo z algoritmom na zgornjem nivoju, tj. večkriterijskim optimizacijskim algoritmom, ki minimizira čas vožnje, porabo goriva in različnost od človeških strategij vožnje. Začetna verzija algoritma je bila predstavljena v [2]. Ta verzija je sedaj nadgrajena z modeli za vožnjo po klancih in ovinkih, modeli za spreminjanje pasu ter s primerjavo s človeškimi strategijami vožnje oziroma optimizacijo glede na različnost od človeških strategij vožnje.

4.1 Algoritem na spodnjem nivoju

Algoritem na spodnjem nivoju vključuje množico matematičnih modelov, ki oponašajo človeško vožnjo in upravljajo vozilo pri naslednjih aktivnostih vožnje: (a) prosta vožnja, (b) sledenje vozilom, (c) zaviranje v sili, (d) prehitevanje in (e) sprememba pasu. Modeli za sledenje vozilom, prosto vožnjo in zaviranje v sili določajo pospešek vozila, medtem ko modeli za prehitevanje in spremembo pasu odločajo, kdaj vozilo spremeni vozni pas.

Model za sledenje vozilom temelji na modelu Gazis-Herman-Rothery (GHR) [8], ki določa pospešek vozila glede na hitrost vozila, razdaljo do predhodnega vozila in razliko hitrosti med vozilom in predhodnim vozilom. Ko je vozilo daleč od predhodnega vozila, uporabimo namesto modela za sledenje model za prosto vožnjo, ki vodi vozilo s konstantnim pospeškom, dokler ni dosežena ciljna hitrost. Ko je vozilo preblizu predhodnemu vozilu, uporabimo model za zaviranje v sili. Poleg zgornjih modelov uporabimo za določanje pospeška še naslednje omejitve. Pospešek se lahko zmanjša glede na omejitve vozila, kot je opisano v razdelku 3. Za vsak vozni pas ima vozilo določeno ciljno hitrost. Poleg tega se ciljna hitrost voznega pasu zmanjša, če je cestni odsek ovinek ali klanec, pri čemer je stopnja zmanjšanja ciljne hitrosti odvisna od ostrine ovinka in naklona odseka.

Prehitevanje na regionalni cesti je določeno z modeloma želje po prehitevanju in za sprejem vrzeli [3]. Model želje po spremembi pasu na podlagi ciljne hitrosti, razdalje do predhodnega vozila in hitrosti predhodnega vozila določi, kdaj vozilo želi prehiteti. Nato preverimo sprejemljivost prednje vrzeli na drugem pasu na podlagi hitrosti vozila, hitrosti predhodnega vozila na istem pasu in hitrosti predhodnega vozila na drugem pasu.

Sprememba pasu na avtocesti je določena z modelom želje po spremembi pasu in modelom za sprejem vrzeli [13]. Podobno kot pri prehitevanju tudi ta model želje po spremembi pasu na podlagi hitrosti vozila, razlike hitrosti glede na predhodno vozilo in razlike hitrosti glede na predhodno vozilo na drugem pasu določi, kdaj vozilo želi spremeniti vozni pas. Nato preverimo sprejemljivost prednje in zadnje vrzeli na drugem pasu glede na razlike hitrosti glede na predhodno vozilo in vozilo zadaj na drugem voznem pasu.

4.2 Algoritem na zgornjem nivoju

Algoritem na zgornjem nivoju je večkriterijski optimizacijski algoritem, razvit na podlagi algoritmov NSGA-II [1] in DEMO [10]. Algoritem išče najboljše vrednosti parametrov



Slika 1: Strategije vožnje v kriterijskem prostoru, najdene z algoritmom MOHDS: dva različna pogleda.

modelov na spodnjem nivoju, pri čemer minimizira čas vožnje, porabo goriva in različnost od človeških voženj. Za iskanje uporablja evolucijski pristop, ki množico rešitev izboljšuje skozi več generacij. Za ohranjanje konstantne velikosti populacije uporablja nedominirano razvrščanje in metriko nakopičenosti iz algoritma NSGA-II [1]. Rezultat optimizacije je množica nedominiranih rešitev. Za več podrobnosti glej [2].

5. POSKUSI IN REZULTATI

MOHDS smo vrednotili na treh cestah in rezultate primerjali s človeškimi vožnjami. Naslednji razdelki opisujejo testne scenarije in dobljene rezultate.

5.1 Opis poskusov

Vrednotenje algoritma MOHDS smo izvedli na naslednjih cestah: (a) Regionalna cesta dolžine 11.450 m, na kateri ni drugih vozil. Cesta vključuje različne omejitve hitrosti, tri stopnje ovinkov (od blagega do zelo ostrega) ter tri stopnje klancev navzgor in navzdol (od blagega do zelo strmega); (b) Dvopasovna regionalna cesta dolžine 9.000 m, po kateri vozijo tudi druga vozila. Cesta je brez ovinkov in klancev ter ima konstantno omejitev hitrosti. Vozila na desnem pasu spreminjajo hitrost, medtem ko imajo vozila na levem pasu, ki vozijo v nasprotno smer, konstantno hitrost. Razdalja med vozili na levem pasu je na začetku ceste krajša, nato pa daljša. Cesta se začne s polno sredinsko črto, na približno polovici ceste pa sredinska črta postane prekinjena; (c) Dvopasovna avtocesta dolžine 10.000 m, po kateri vozijo tudi druga vozila. Cesta je brez ovinkov in klancev ter ima konstantno omejitev hitrosti. Na celotni cesti je prekinjena sredinska črta. Vozila na desnem pasu spreminjajo hitrost, medtem ko imajo vozila na levem pasu, ki vozijo v isto smer, konstantno hitrost. Razdalja med vozili na levem pasu je na začetku ceste krajša, nato pa daljša.

Za vsako cesto smo pridobili podatke o človeških vožnjah 30 voznikov, pri čemer je vsak voznik prevozil vsako cesto dvakrat. Različnost od človeške vožnje smo nato izračunali za vsakega voznika posebej kot povprečje vseh voznikovih voženj, kot je opisano v razdelku 3. Različnost po hitrosti smo ocenjevali na prvi cesti in prvi polovici druge ceste, medtem ko smo različnost po odmiku od sredine desnega voznega pasu preverjali na drugi polovici druge ceste ter na tretji cesti. Vsako strategijo vožnje smo vrednotili na vseh treh cestah in pri iskanju strategij optimirali skupni čas vožnje, skupno porabo goriva in skupno različnost od človeške vožnje. Večkriterijsko optimizacijo smo izvajali skozi 200 generacij, pri čemer je bila velikost populacije 100 rešitev. Za ostale parametre algoritma MOHDS glej [2].

5.2 Rezultati

Strategije vožnje, pridobljene z algoritmom MOHDS, so prikazane na sliki 1. Rezultati kažejo, da MOHDS najde strategije vožnje z različnimi kompromisi med kriteriji, tj. časom vožnje, porabo goriva in različnostjo od človeške vožnje. Poleg tega se strategije vožnje, ki imajo bodisi najkraši čas vožnje bodisi najnižjo porabo goriva, najbolj razlikujejo od človeške vožnje.

Slika 2 prikazuje primerjavo človeških strategij in strategij algoritma MOHDS glede na čas vožnje in porabo goriva. Kljub temu, da smo optimirali skupni čas vožnje, skupno porabo goriva in skupno različnost od človeške vožnje za vse tri ceste, so na tej sliki prikazane delne vrednosti kriterijev za vsako cesto posebej. Posledično so lahko določene strategije slabe na posamezni cesti, a so vseeno nedominirane glede na skupne vrednosti kriterijev za vse tri ceste. Ti rezultati kažejo, da MOHDS najde strategije vožnje, ki so primerljive s človeškimi strategijami vožnje na prvi in tretji cesti. Poleg tega kažejo, da MOHDS uspešneje optimira porabo goriva, tj. najde strategije vožnje z nižjo porabo goriva v primerjavi z vozniki. Dodatna analiza strategij vožnje algoritma MO-HDS na drugi cesti je pokazala, da strategije prehitevajo bolj redko kot ljudje, kar onemogoča dodatno krajšanje časa vožnje.

6. ZAKLJUČEK

V prispevku smo predstavili dvonivojski Večkriterijski optimizacijski algoritem za iskanje strategij vožnje podobnih človeškim (MOHDS), ki sočasno optimira čas vožnje, porabo goriva in človeškost vožnje. Algoritem smo vrednotili z



Slika 2: Primerjava strategij vožnje algoritma MO-HDS in voznikov glede na čas vožnje in porabo goriva na (a) prvi, (b) drugi in (c) tretji cesti.

vožnjo po treh cestah, tj. prazni regionalni cesti, regionalni cesti z drugimi vozili in avtocesti z drugimi vozili. Dobljene strategije vožnje smo primerjali z vožnjami voznikov. Rezultati kažejo, da MOHDS najde strategije vožnje z različnimi kompromisi med kriteriji. Poleg tega MOHDS najde podobne strategije vožnje kot vozniki na prazni regionalni cesti in na avtocesti, medtem ko na regionalni cesti z ostalimi vozili najde počasnejše strategije vožnje. V bodoče bomo dodatno analizirali in izboljševali algoritem MOHDS predvsem za vođenje vozil po regionalni cesti, kjer vozijo tudi druga vozila in je prehitevanje dovoljeno.

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User-friendly Multi-objective Learning of Accurate and Comprehensible Hybrid-trees

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ABSTRACT

In data-mining applications, users must often choose between a comprehensible classifiers with low accuracy or a more accurate but incomprehensible classifier. A possible solution is to apply MOLHC algorithm, which finds the complete set of non-dominated hybrid-trees according to accuracy and comprehensibility. However, tools that would help the user select an appropriate hybrid-tree from the set are missing. Therefore, we present MOLHC implemented as an add-on for Orange data-mining suite. We implemented widgets for learning, evaluation and visualization of individual hybrid-trees and the set of non-dominated hybrid-trees. They comprise a user-friendly toolbox that enables users to efficiently execute the multi-objective data-mining process.

1. INTRODUCTION

There are two key criteria for selecting the classifier that will be deployed in a data-mining application: predictive performance and comprehensibility. The most appropriate measures of predictive performance (e.g. accuracy, area under the ROC curve, sensitivity, specificity) is used to select a subset of acceptable classifiers depending on the objectives of the application. However, acceptable predictive performance is often not enough. Comprehensibility is reported as decisive factor for classifier application in domains such as: medicine, credit scoring, churn prediction, and bioinformatics [2]. It is described as "the ability to understand the logic behind a prediction of the model" [4] or as "the ability to understand the output of induction algorithm" [3]. It is important because comprehensible classifiers enable explanation for classification of each instance, classifier validation, knowledge discovery and support classifier generalization improvement. Classification trees for example are often used in machine-learning applications because they are one of the most comprehensible classification models.

On the other hand, there are more complex classification

models such as support vector machines, artificial neural networks and ensembles (e.g. random forest, boosting and stacking algorithms) that achieve higher accuracy then classification trees in many domains but are not comprehensible, hence they are referred to as black-box classifiers. Users are therefore faced with a difficult decision: they can either choose a comprehensible classification tree with relatively low accuracy or an incomprehensible classifier with relatively high accuracy. In many cases none of the two options is sufficient.

The difficulty of learning accurate and comprehensible classifiers arises from the fact that the two objectives must be considered as equally important and that they are conflicting: increasing one often decreases the other. The solution is multi-objective learning. It is based on multi-objective optimization and therefore returns a set of non-dominated classifiers (not a single classifier). This enables the user to improve the decision on the accuracy-comprehensibility trade-off by deferring it: instead of taking an arbitrary decision about the relative importance of the learning objective before the execution of the learning algorithm (and having to rerun it with different settings to obtain a classifier with a different trade-off) user can now take a well informed decision by simply comparing the subset of all non-dominated classifiers returned by the multi-objective algorithm.

This paper focuses on a recently developed example of such algorithm named Multi-objective learning of hybrid classifiers (MOLHC) [7]. It finds the entire Pareto set of hybridtrees (according to accuracy and comprehensibility) by replacing sub-trees in the initial classification tree (given as an input) with black-box classifiers (also given as an input). The resulting hybrid-trees consist of regular leaves containing easily comprehensible rules and incomprehensible blackbox leaves enabling improved accuracy. MOLHC was shown to produce classifiers with accuracy-comprehensibility tradeoffs and offer insights into the data-mining task that are not available using traditional machine-learning algorithms as well as being fast and simple enough for applications in real-world problems [5].

After finding the entire Pareto front, the user has to select the best hybrid-tree, which was a cumbersome and time consuming task due to the lack of user-friendly tools to support it. Therefore, this paper presents a user-friendly implementation of the MOLHC algorithm and additional tools with a graphical user interface (GUI), which make learning, comparing and selecting the hybrid-trees and evaluating the results of learning efficient. The algorithm and the corresponding tools are implemented as an Orange add-on with three new Orange widgets shown in the Figure 1. The widgets are components in the visual programming environment called Orange Canvas [1]. Each widget offers a self contained data-mining functionality and a graphical user interface for setting its parameters and presenting its (main) results. A widget can be connected to other widgets by passing data from its output(s) to the input communication channel(s) of the other widgets, which enables visual programming of data-mining applications.



Figure 1: The list of developed Orange widgets.

The following sections describe the MOLHC related Orange widgets in the order in which they are typically applied during the data-mining process. Section 2 presents the MOLHC widget, which implements the MOLHC algorithm and visualizes the Pareto front of learned hybrid-trees. Section 3 presents the widget that visualizes the hybrid-tree chosen on the Pareto set and Section 4 presents the widget used for the evaluation of MOLHC results. Section 5 concludes the paper and discusses the ideas for future work.

2. MOLHC WIDGET

The MOLHC widget implements Multi-objective learning of classifiers (MOLHC) algorithm. The widget finds and visualizes the entire Pareto-optimal set of hybrid-trees according to accuracy and comprehensibility as shown in Figure 2. Comprehensibility is defined as the share of instances that fall into the regular (not black-box) leaves of the hybrid-tree - this measure was designed based on the results of survey on the comprehensibility of classification trees [8].

Pareto-front viewer, which is a part of the widget's GUI (the right part in Figure 2), supports comparison and selection of an appropriate hybrid-tree from the set of learned hybrid-trees and enables extracting insights about the data-mining domain as discussed in our previous work [6].

The MOLHC widget is compatible with the standard Orange widgets so they can be used together as explained below and illustrated in Figure 3. Its inputs are:

• Data: data set for training and testing.



Figure 2: MOLCH widget shows the Pareto front with 6 hybrid-trees (the chosen hybrid-tree is marked with an orange circle).

- Classification tree: the initial tree used by MOLCH.
- Black-box classifier: an (incomprehensible) classifier that has a higher accurate than the initial tree.



Figure 3: Connecting the MOLHC widget with the other widgets providing the required inputs (on the left) and accepting its output (on the right).

The output of the MOLHC widget is the hybrid-tree chosen by clicking on it in the Pareto-front viewer. The MOLHC widget offers the following options:

- Splitting options: splitting of the input data set into the training and testing set (used to estimate the accuracy and comprehensibility of the hybrid-trees on the Pareto-front) according to the set proportion or using all the data for both testing and training.
- Use local black-box classifier: use multiple black-box classifiers (each trained on the instances belonging to a specific leaf in the initial tree) instead of a single black-box classifier trained on all the training instances.
- Visualization options: zoom, selection and pan tool, change size or opacity of hybrid-tree symbols.



Figure 4: Evaluation widget with inputs.

3. HYBRID-TREE VIEWER

The hybrid-tree viewer widget visualizes a hybrid-tree (an example is shown in Figure 5) received as an input from the MOLHC widget. The visualization of a hybrid-tree is used to validate it or extract knowledge from it. In addition, a pair of hybrid-tree viewer widgets positioned side by side can be used to compare a pair of hybrid-trees according to their structure; comparing them according to the accuracy and comprehensibility is done with the Pareto-front viewer in the MOLHC widget.

The parameters of the Hybrid-tree viewer define the display options, which are similar as the ones available in the standard Orange tree viewer. In addition, the user can choose whether to use the train or the test data set to compute the statistical data shown in the tree nodes.

The hybrid-tree viewer widget provides two outputs that depends on which node of the hybrid-tree the user selected by clicking on it:

- Selected data: the subset of the data set instances that belong to the selected tree node.
- Selected black-box model: the black-box classifier if a black-box leaf is chosen.

4. MOLHC EVALUATION

The MOLHC evaluation widget compares the Pareto set of hybrid-trees (i.e. the output of the MOLHC widget) with the set of baseline solutions consisting of the initial classification tree and the black-box classifier. It is used to evaluate the results of multi-objective learning and to select the best algorithm for learning the black-box classifier (used as the input to the MOLHC widget/algorithm). The evaluation is based on the hyper-volume measure [9], which is often used to compare results of multi-objective optimization algorithms.

The MOLHC evaluation widget requires at least three inputs (an example is shown in Figure 4). They are the same as te inputs of the MOLHC widget, except that multiple blackbox classifiers can be provided for comparison.

The parameters of MOLHC evaluation widget are:

- The number of folds used for cross-validation.
- Train data proportion: the percentage of instances from the data set to be used as the training set, the rest of the instances are used as the testing set.
- Use local black-box classifier: use multiple black-box classifiers (one per leaf in the initial tree) instead of a single black-box classifier trained on all the training instances.

Figure 6 show an example of MOLHC evaluation. It is based on several measures for each provided black-box classifiers:

- Method: the name of the black-box classifier.
- BB accuracy: the accuracy of the black-box classifier.
- Tree accuracy: the accuracy of the initial tree.
- Baseline hypervolume: the hypervolume for the set of two baseline solutions (the initial tree and black-box classifier).
- MOLHC hypervolume: the hypervolume for the Pareto set of hybrid-trees learned by the MOLHC algorithm.
- Hypervolume difference: the difference between the MOLHC and the baseline hypervolume.

The results provided by the MOLHC evaluation widget are interpreted as follows. If the difference between the best BB accuracy and the tree accuracy is small, the user should consider using a regular classification tree instead of a blackbox classifier or a hybrid-tree. In general a higher BB accuracy means that the corresponding black-box classifier has a higher potential to increase the accuracy of the initial classification tree. However, the actual results of the MOLHC algorithm depends on the accuracy of the blackbox classifier in each leaf of the initial tree, therefore the best black-box classifier should be selected according to the MOLHC hypervolume. The overall success of the MOLHC algorithm is measured by the hypervolume difference - the higher the better. Finally, the user should select an appropriate hybrid-tree regardless of the hypervolume difference because it shows only the advantage of the MOLHC approach over the baseline algorithms, which depend on all the hybrid-trees in the Pareto set and is therefore not appropriate for the evaluation of a single hybrid-tree. To select a single hybrid-tree, the user should use Pareto front and hybrid-tree visualizer instead.

5. CONCLUSION

The paper presents an implementation of the MOLHC algorithm, which is a multi-objective learning algorithm that finds the complete set of non-dominated hybrid-trees according to accuracy and comprehensibility. The algorithm is most suitable for the data-mining applications where a



Figure 5: Hybrid-tree viewer widget: the black-box leaves are marked with black.

		MOLI	IC evaluation			- * 8
Info	Method	BB accuracy	Tree accuracy	Baseline hypervolume	MOLHC hypervolume	Hypervolume difference
366 instances in input data set	0 Random Forest	0.7351	0.6405	1.0143	1.0972	0.0829
Classification tree is on input. 4 black-box classifiers are on input.	1 Logistic Regression	0.7000	0.6405	1.0073	1.0890	0.0817
	2 Stochastic Gradient Descent	0.6811	0.6405	1.0035	1.0802	0.0767
Options	3 kNN	0.6703	0.6405	1.0013	1.0782	0.0768
Cross validation folds: 10						
Train data proportion: 50 🌲						
Use local black-box classifier						

Figure 6: MOLHC evaluation widget with calculated results.

regular classification tree is not accurate enough and blackbox classifier (with a higher accuracy) is not acceptable because it is not comprehensible. We implemented MOLHC as an add-on for Orange, which is a popular and user-friendly data-mining suite that offers visual programming and rich visualizations. We implemented three new Orange widgets for learning and visualizing the set of non-dominated hybridtrees, visualizing individual hybrid-trees and for evaluation of the MOLHC results. They comprise a user-friendly toolbox that enables users to efficiently execute the multi-ob jective data-mining process. Nevertheless, we are considering several improvement that could make the developed widgets more user friendly. We plan to improve the documentation in order to make our work more accessibly to a wider user base and reduce the learning curve. Another improvement would be to color similar hybrid-trees on the Pareto front according to Hammilton distance which would help the user when comparing them. Finally, an improvement of the Hybrid-tree visualizer widget would add an option to replace the sub-trees that have only black-box leaves with a single black-box leaf.

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Automatic Tennis Analysis with the use of Machine Learning and Multi-Objective Optimization

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ABSTRACT

Wearable devices for monitoring players' movements are heavily used in many sports. However, the existing commercial and research sports wearables are either not tennis-specific, or are worn on the wrist or in the racquet and thus offer too limited information. We therefore added tennis-specific information to a leading commercial device. Our solution is two-fold. Firstly, we developed a model for classifying shot types into forehand, backhand and serve. Secondly, we designed an algorithm based on multi-objective optimization to distinguish active play from the time in-between points. By combining both parts with the general movement information already provided by the device, we get a comprehensive set of metrics that are used by professional tennis players and coaches to objectively measure a player's performance and enable in-depth tactical analysis.

Categories and Subject Descriptors

I.2.6. Artificial Intelligence: Training

General Terms

Algorithms, Measurement, Experimentation

Keywords

Tennis; Wearable analytics; Shot detection; Optimization;

1. INTRODUCTION

The use of wearable sensors in sport is growing fast and can already be considered essential for success in some disciplines. In tennis the analytics started with computer vision and sensors for measuring shots. However, both of these approaches have limitations for professional use. The sensors worn on the playing wrist or built into the tennis racquets deliver information about the shots [6] or enable the analysis and modeling of different shot techniques [7]. However, the problem with this information is the lack of context (under what circumstances and where on the court did a specific shot occur), so it is not sufficiently actionable, i.e. cannot be used for tactical preparations or to significantly improve players' game. Video analysis offers better information, and there has been a lot of research on this topic [1, 5]. However, cheap solutions offer low accuracy, while better solutions are extremely expensive because they require advanced cameras with complex software for calibration. Additionally, they are bound to a specific court, so the information is not available whenever needed by the player or coach.

Due to these limitations, devices worn on the torso, and equipped with accelerometers, gyroscopes and GPS receivers are emerging as the new approach. These devices are perfect for determining Mitja Luštrek Jožef Stefan Institute Jamova cesta 39 1000 Ljubljana, Slovenia mitja.lustrek@ijs.si

the effort, distance covered, sprints analysis and much more. Here, the leading provider in the world is Catapult Sports, whose S5 product is currently used by the best tennis player in the world Andy Murray. Nevertheless, the problem with S5 is that it offers no tennis-specific metrics. That is why in our research we add tennis-specific information to the metrics already available in the Catapult S5 system, to produce a comprehensive solution that enables professional players to make better tactical preparations and to improve their game.

Our algorithm consists of two parts. In the first part, we detect when a tennis shot occurs and which type of shot it is. In the second part, we focus on detecting when the players actually play points (active play) and when they are in-between points. This allows us to determine the actual net playing time and real distance covered and also adds context to shots which enable complex analysis like "Is the player playing weaker shots, if the point is longer than 15 seconds?" With this solution the players and their coaches get a continuous comprehensive view of the player's game, both the physical and the tactical part of it.

2. DATA AQUISITION

To obtain sensor data we used the commercially available S5 device from Catapult. The position of the device was high on the player's back attached to a tight shirt. The device contains a 3D accelerometer (frequency 100 Hz), 3D gyroscope (frequency 100 Hz), 3D magnetometer (frequency 100 Hz) and GPS sensor, returning latitude and longitude (frequency 10 Hz).

We recorded 5 different professional tennis players for 6 hours in total. Due to the 100 Hz frequency, we obtained 2,172,363 data records. In this time, we recorded 1,373 shots. Each shot was labeled as a serve, forehand or backhand. As for detecting active play, we also manually labeled the beginning and end of each sequence of active play. Because we were interested in creating an algorithm for detecting shot types and active plays in actual matches, all the data were recorded during matches and none during predefined situations of practice sessions.

3. SHOT DETECTION

For every data point obtained from our device, we extracted a number of features used by the shot detection algorithm. We used supervised machine learning to train a model to detect shots. With this model we classified every data point and evaluated the shot detection.

3.1 Feature Extraction

To define informative features for shot detection, we visualized and examined the traces for the accelerometer and gyroscope. Since we saw that every shot is associated with body rotation, our main source for feature extraction was the gyroscope - more specifically angular speeds on axes 1 (Roll) and 3 (Yaw) - and not the accelerometer. Figure 1 shows a typical trace of the gyroscope and accelerometer for a backhand shot.



Figure 1: Gyroscope and accelerometer traces for backhand shot marked with the vertical line.

As our main feature, we calculated a feature called *Peak_strength* as follows:

- Calculate absolute sum of angular speeds on axes 1 and 3
- Raise it to the power 4, to emphasize higher values
- Apply Butterworth band-pass filter with high and low cutoff frequencies of 1.5 and 25 Hz.
- To get the final *Peak_strength* value, set the lower peak to zero when two peaks are too close (the distance was set by a domain expert to 1.3 s)

High *Peak_strength* values calculated in this way mark potential shots. Additionally, we calculated several other features. We set two different window sizes (0.8 s and 1.2 s) and calculated the average values, variances and standard deviations for each accelerometer and gyroscope axis. We added the sums of and differences between all pairs of gyroscope axis values and also between accelerometer axis values. We also calculated the speed of movement from the GPS coordinates. To illustrate its importance, Figure 2 shows how the combinations of *Peak_strength* and speed of movement separates shots and shot attempts (high *Peak_strength* values that are not shots).

3.2 Experimental Setup

We divided the evaluation in two parts. Firstly, we evaluated how well we can detect if a shot has occurred, and secondly, we tried to detect which type of shot was made.

For building the models, after empirical comparison of several algorithms, we chose the Random Forest (RF) [2] algorithm. Each RF consisted of 10 decision trees, the minimum number of samples required to split an internal node was 8, and the minimum number of samples required at a leaf node was 4.

We evaluated the models in two ways. Firstly, we performed 10fold cross validation using Stratified shuffle split [3]. This procedure ensured equal class distributions between training and test sets. Secondly, we used the leave-one-player-out approach (LOPO), where we used one player's data for testing and the data from the other players for training. This approach enables us to estimate the accuracy of the models for previously unseen players with different shot techniques.

When evaluating the models, we classified each data entry (10 ms) as a shot or no-shot, and the type of shot. With this approach almost all the data points were classified as no-shots, so calculating the classification accuracy would be useless. We therefore focused on the precision and recall.

3.3 Results

The results for detecting shots and shot types for the cross-validation and for the LOPO approach are presented in Tables 1 and 2.

	Cross-validation	LOPO
Precision	97.3%	97.3%
Recall	96.6%	96.5%

Table 1: Precision and recall for detecting tennis shots

	Cross-validation						
	Foreh.	Foreh. Backh. Serve All					
Precision	95.3%	94.3%	99.1%	96.2%			
Recall	91.4%	90.2%	99.3%	93.6%			
	LOPO						
	Foreh.	Backh.	Serve	All			
Precision	91.5%	93.6%	99.8%	95.0%			
Recall	90.5%	90.6%	98.2%	93.1%			

Table 2: Precision and recall for detecting types of tennis shots

As we can see, the precision and recall obtained with crossvalidation and LOPO are very similar. This means that the built models are relatively independent from the type of player or his technique or style of play.

The main sources of errors are fast unnatural body rotation movements and special events that occur during the play. An example from our data set is a player warming up doing very similar body movements as during shots, or a player throwing his racquet at the fence with the same body movement as when serving.

4. DETECTING ACTIVE PLAY

The algorithm for detecting active play during a tennis game could only be developed after we have detected the shots. The reason is that we want our algorithm not only to have a high classification accuracy, but also to include as many shots as possible in the detected active play. In other words, misdetection of active play is less undesirable when no shots are made. So due to having two objectives, the detection was formulated as a multiobjective optimization problem.

4.1 Feature Extraction

The main idea when detecting the starting (end ending) point of a sequence of active play (rally) was that at this point the difference between the activity before and after would be the largest.

We used accelerometer values because they better represent the players' movement then gyroscope values, which primarily spike when making shots. From these values, we calculated a modified variance that gives more emphasis to the largest variations in data traces:

var*
$$=rac{\sum_{i=1}^{N}(x_i-\overline{x})^4}{N}$$

So for each data point, we calculated three additional features based on var*: the back overall variance (BV), the forward overall variance (FV) and the difference between these two (DV = BV - FV). FV and BV are calculated as the sum of the var* for each of the three acceleration axes, on the sequences immediately before (BV) and after (FV) a potential beginning or end of a rally (the size of the sequences was subject to optimization).

To be able to truly detect the best point describing the beginning or end of each rally, we also calculated peaks on the DV feature. Calculating the peaks was done the same way as for the shot detection. The minimum distance between peaks was subject to the optimization.

4.2 **Problem Formulation**

For each data point we calculated the previously described features, and set a rule for detecting the beginning of a rally and a rule for detecting the end of a rally. A data point is marked as the beginning of a rally if it satisfies the following rule:

$$(DV > p1) \& ((BV < p3) || (FV < p4)).$$

A data point is marked as the end of the rally if it satisfies the following rule:

$$(-DV > p2) \& ((BV < p3) || (FV < p4)),$$

where parameters p1, p2, p3, p4 were determined through optimization. Both rules consist of two parts. The first part determines the threshold for the change in activity before and after a potential beginning or end of a rally. For the beginning of a rally, this difference is usually larger because a rally often starts explosively and ends gradually, so the thresholds p1 and p2 can be different. The second part is the same for both rules and serves to remove false detections due to the variation in intensity during the rally by specifying that the activity, either before or after the beginning or end of a rally, should be low.

So altogether we optimized six input parameters: sequence size, minimum distance between peaks, *p*1, *p*2, *p*3 and *p*4.

4.3 Experimental Setup

To optimize the two objectives – classification error and the number of shots not inside the detected rallies – we used the well-known evolutionary multi-objective optimization algorithm called NSGA-II [4]. The population size was set to 25, the stopping criterion was set to 10,000 solution evaluations, and the tournament selection was used.

4.4 Results

The final front of the optimization can be seen in Figure 3. We can see a typical result for a multi-objective optimization problem, a non-dominated front showing a tradeoff between objectives. We can also see a knee on the front labeled with a circle. In this solution six shots are missed, since they occurred without the surrounding intense activity which accompanied other shots. An example is a player hitting the ball out of court after the rally

finished. To include even such shots in the detected rallies, we would need to sacrifice a lot of classification accuracy.



Figure 3: The final front showing the best solutions based on the classification error and the number of shots outside of detected active play.

Since our objective was to accurately detect the duration of the rallies, we chose one solution from the middle of the front and for this solution, we calculated the distribution of the durations of the rallies. The comparison with the manually labeled rallies can be seen in Figure 4.



Figure 4: Comparing manually labeled (left) and automatically detected distributions for play durations.

We can clearly see the similarities between the distributions. The reason for the detected distribution having more very short rallies is that the algorithm detects even small starts of movement that we did not label as rallies because they were too short. For example, a server hitting the net with the first serve results in the returner making just a small movement.

By combining the classified shot types, detected active playing phases and locations from the GPS, we can calculate several useful metrics that help remove subjectivity from the game and allow for objective evaluation of different tactical approaches and training routines. An example of such a view can be seen in Figure 5, where we present the heat map of a player's position during active play and combine it with forehand and backhand shots as points of different color and size. We also included a dashed line that separates part of the court where more backhands are played from the one where more forehands were played. We can see that the player played more aggressively on the left side, thus his heat map is closer to the baseline. On the right side, a less aggressive approach allowed him to play more forehands and thus he dictated play by playing more often with his better shot.



Figure 5: Heat map of a player's position during active play combined with shot locations (blue = forehand, red = backhand) and their *Peak_strength* (size of points).

5. CONCLUSION

In this article we presented a two-part algorithm for analyzing wearable sensor data for professional tennis players. Firstly, we detected and classified different shot types, and secondly, we distinguished the active playing phases from the time in-between points. By combining the procedures, players can get a unique perspective on their game which enables objective analysis in the tactical and physical sense.

For the future, we plan to equip both players with the same type of sensor, and by measuring the time difference between their shots and by calculating the distance between them, we will be able to calculate the average speed of ball and thus additionally quantify the quality of each shot.

6. ACKNOWLEDGMENTS

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Anytime Benchmarking of Budget-Dependent Algorithms with the COCO Platform

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ABSTRACT

Anytime performance assessment of black-box optimization algorithms assumes that the performance of an algorithm at a specific time does not depend on the total budget of function evaluations at its disposal. It therefore should not be used for benchmarking budget-depending algorithms, i.e., algorithms whose performance depends on the total budget of function evaluations, such as some surrogate-assisted or hybrid algorithms. This paper presents an anytime benchmarking approach suited for budget-depending algorithms. The approach is illustrated on a budget-dependent variant of the Differential Evolution algorithm.

1. INTRODUCTION

In black-box optimization, the problem to be optimized cannot be explicitly written as a function of its input parameters (if an underlying function exists, it is unknown). This is often the case with real-world problems where solutions are evaluated using simulations. Without the possibility of exploiting the structure of the function, optimization algorithms resort to repeatedly sample its decision space and use previously evaluated solutions to steer the search towards promising regions. Since the evaluations of real-world problem functions are often more time-consuming than the internal computations of optimization algorithms, the running time, or *runtime*, of an algorithm is generally measured by counting the number of performed function evaluations. The goal of an algorithm in black-box optimization is thus to find satisfactory solutions to the given problem in as few function evaluations as possible.

When measuring the performance of an algorithm in the black-box setting, we are interested in the required runtime to reach a target value. Or rather, we wish to obtain all runtimes corresponding to increasingly difficult targets [3]. In problems with a single objective, the targets are usually defined as differences from the optimal function value, while in problems with multiple objectives, the targets are determined as differences from the optimal value of a multiobjective performance indicator.

The proportion of reached targets plotted against the runtimes in the sense of an empirical cumulative distribution function yields a *data profile* [7]—a graph showing the *anytime* performance of an algorithm, essentially mimicking the convergence graph (the plot of best found function or indicator values over time). In addition to being easy to interpret, the data profile has another important advantage—it can be used to represent algorithm performance aggregated over multiple runs on different problems of the same dimensionality (see Section 2 for more details). This considerably alleviates presentation and understanding of algorithm results on a large number of problems.

The underlying assumption in anytime performance assessment is that the performance of an algorithm at a specific runtime does not depend on the total budget of function evaluations. That is, performance of an algorithm at 1000 function evaluations is expected to be the same if the algorithm was run with a budget of 1000 or 100 000 function evaluations (everything else being equal). If this is not the case, data profiles should not be employed to infer performance of the same algorithm with a total budget different from the one used in the experiments.

Algorithms can depend on the total budget for different reasons. Consider for example surrogate-assisted approaches. They construct surrogate models of the optimization problem and combine actual function evaluations with evaluations on the models. While some algorithms work in a budget-independent way, e.g. [6], others save some true function evaluations for the end (just before the budget is exhausted), making them budget-dependent, e.g. [9]. Similarly, hybrid genetic algorithms that combine genetic algorithms with local search methods can reserve a number of final function evaluations to additionally improve the current best solutions [2]. Another example of budget-dependent algorithms are evolutionary algorithms that set any of their parameters based on the total budget [1].

To address this issue, we propose an approach for benchmarking budget-dependent algorithms that allows anytime performance assessment of their results. It is based on the anytime benchmarking from the Comparing Continuous Optimizers (COCO) platform [4]. The approach is demonstrated on a budget-dependent variant of Differential Evolution (DE) [8] ran on the bbob test suite [5].

In the following, we first present some background on anytime benchmarking with the COCO platform (Section 2). The new approach is described in Section 3 followed by a discussion on its time complexity. An illustration with the DE algorithm is shown in Section 4. Section 5 presents some concluding remarks.

2. ANYTIME BENCHMARKING IN COCO

COCO (https://github.com/numbbo/coco) is a platform that facilitates benchmarking of optimization algorithms by automatizing this procedure and providing data of previously run algorithms for comparison [4]. An important part of COCO's anytime benchmarking approach [3] is the presentation of algorithm results in the form of data profiles [7].

Consider a single run of algorithm \mathcal{A} on problem p. Given l increasingly difficult targets $\tau_1, \tau_2, \ldots, \tau_l$, it is easy to compute the corresponding runtimes $r_1^p, r_2^p, \ldots, r_l^p$ needed by algorithm \mathcal{A} to reach each of these targets. If the target τ_j was not reached, r_j^p is undefined. A data profile for algorithm \mathcal{A} is then constructed by plotting for each number of evaluations the proportion of targets reached by \mathcal{A} in a runtime equal to or smaller than the number of evaluations. In other words, a data profile is the empirical cumulative distribution function of the recorded runtimes $r_1^p, r_2^p, \ldots, r_l^p$.

Data profiles can be further exploited to show aggregated information over randomized repetitions of running algorithm \mathcal{A} on problem p. Instead of using repeated runs of \mathcal{A} on p(which is sensible only for stochastic algorithms), randomization in COCO is achieved by running the same algorithm \mathcal{A} on different instances of problem p (for example, translated versions of the same problem).

Consider k instances of the problem p, denoted here as $p(\theta_1)$, $p(\theta_2), \ldots, p(\theta_k)$. Like before, the runtime $r_j^{p(\theta_i)}$ at which algorithm \mathcal{A} achieves target τ_j on problem instance $p(\theta_i)$ can be easily calculated for each i and j and is undefined when the target has not been reached. In order to be able to compare algorithms of different success probabilities (for example an algorithm that always reaches difficult targets, but does this slowly, with an algorithm that sometimes reaches a target quickly while other times fails to reach it at all), we simulate restarts of each algorithm via a *bootstrapping procedure*. The N bootstrapped simulated runtimes $r_{j,1}, r_{j,2}, \ldots, r_{j,N}$ of the artificially restarted algorithm to reach a target τ_j are computed from the *recorded* runtimes $r_j^{p(\theta_i)}$ of algorithm \mathcal{A} (for a large N, e.g. N = 1000) as:

for $c \leftarrow 1, \ldots, N$ do	\triangleright Repeat N times
$r_{j,c} \leftarrow 0$	\triangleright Initialize runtime
loop	
$i \leftarrow \operatorname{random}(\{1, \ldots, k\})$	\triangleright Choose an instance
if $r_j^{p(\theta_i)}$ is defined then	\triangleright Successful
$r_{j,c} \leftarrow r_{j,c} + r_j^{p(\theta_i)}$	
break loop	
else	\triangleright Unsuccessful
$r_{j,c} \leftarrow r_{j,c} + r_{\max}^{p(\theta_i)}$	
end if	
end loop	
end for	
return $r_{j,1}, r_{j,2},, r_{j,N}$	

if at least one of the recorded runtimes is finite. Note that the total runtime of \mathcal{A} on $p(\theta_i)$, $r_{\max}^{p(\theta_i)}$, is added each time an unsuccessful trial is picked. Runtimes $r_{j,1}, r_{j,2}, \ldots, r_{j,N}$ are undefined for targets τ_j that were not reached in any of the problem instances. The resulting $N \cdot l$ runtimes (of which some undefined) are used to construct the data profile in an analogous way as before, but this time the y axis shows the proportion of targets reached out of $N \cdot l$ ones.

Finally, data profiles are also able to aggregate runtime results over problems of the same dimensionality that optimize a different function. Imagine a test suite consisting of m such problems with multiple instances. After bootstrapping is performed for each problem separately, there are $m \cdot N \cdot l$ function and target pairs and the same number of bootstrapped runtimes. The aggregated data profile for algorithm \mathcal{A} can thus be constructed by plotting for each number of evaluations the proportion of function and target pairs reached by \mathcal{A} in a runtime equal to or smaller than the number of evaluations.

It is important to note that runtimes are never aggregated over different dimensions since problem dimension is often used as an algorithm parameter. This also allows scalability studies. See [3] for more details on COCO's performance assessment procedure.

3. A BENCHMARKING APPROACH FOR BUDGET-DEPENDENT ALGORITHMS

The idea for benchmarking a budget-dependent algorithm \mathcal{A} is very simple: the algorithm is run with increasing budgets and the resulting runtimes are presented in a single data profile. This is achieved by means of an 'artificial' algorithm $\widetilde{\mathcal{A}}$ that works as follows.

Consider K increasing budgets b_1, b_2, \ldots, b_K and K budgetdependent algorithm variants $\mathcal{A}_{b_1}, \mathcal{A}_{b_2}, \ldots, \mathcal{A}_{b_K}$. The algorithm $\widetilde{\mathcal{A}}$ first works as algorithm \mathcal{A}_{b_1} for budgets $b \leq b_1$, then works as algorithm \mathcal{A}_{b_2} for budgets b, where $b_1 < b \leq b_2$, and so on, finishing by mimicking algorithm \mathcal{A}_{b_K} for budgets b, where $b_{K-1} < b \leq b_K$ (see also Figure 1). In an algorithmic notation (where x_i denotes the *i*th solution explored by the corresponding algorithm):

Although the first b_{j-1} evaluations of the algorithm \mathcal{A}_{b_j} are ignored by $\widetilde{\mathcal{A}}$, they need to be performed so that \mathcal{A}_{b_j} is in the correct state at evaluation $b_{j-1} + 1$, when it starts to be mimicked by algorithm $\widetilde{\mathcal{A}}$.

As shown with the red run in Figure 1, \mathcal{A}_{b_j} might not contribute to $\widetilde{\mathcal{A}}$ at all if the performance of \mathcal{A}_{b_i} is better for some $b_i < b_j$. On the other hand, if \mathcal{A}_{b_j} is significantly better than $\mathcal{A}_{b_{j-1}}$ (for example, the green vs. the yellow run), this causes a 'jump' in the performance of $\widetilde{\mathcal{A}}$. Note also that the best-so-far profile of $\widetilde{\mathcal{A}}$ does not necessarily follow the overall best-so-far profile of \mathcal{A}_{b_j} , but only its best-so-far profile after b_{j-1} function evaluations (notice the yellow and



Figure 1: An illustration of the 'artificial' algorithm $\tilde{\mathcal{A}}$ constructed from five runs of algorithm \mathcal{A} (\mathcal{A}_b means the algorithm was run with the budget of b function evaluations). Thin and thick lines show the actual and best-so-far performance for each run of \mathcal{A} , respectively.

black lines after 40 function evaluations).

Composing the performances of algorithm \mathcal{A} with different budgets into algorithm $\widetilde{\mathcal{A}}$ results in an estimation of the anytime performance of \mathcal{A} . The quality of the estimation depends on the number of budgets K—more budgets enable a better estimation, but make the procedure more time consuming.

One could run the budget-dependent variants of algorithm \mathcal{A} for every budget between 1 and b_K thus obtaining the best possible estimate. However, this would require

$$\sum_{j=1}^{b_K} j = \frac{b_K(b_K+1)}{2}$$

total evaluations. Diluting the budgets by taking only every Mth one does not help to significantly reduce the number of total evaluations. A more promising approach is that of using equidistant budgets in the logarithmic scale. For example, K such budgets between 1 and 10^M require

$$\sum_{j=0}^{MK} 10^{j/K} = \frac{10^{1/K+M} - 1}{10^{1/K} - 1}$$

total evaluations. Table 1 contains total evaluations for this case for some values of K and M. The actual number of evaluations is likely to be smaller than these numbers due to some consecutive (small) budgets being rounded to the same integer number.

4. EXAMPLE

We present a small example to demonstrate the proposed anytime benchmarking procedure on the COCO platform. The algorithm used in this example is a budget-dependent variant of Differential Evolution (DE) [8], a well-known evolutionary algorithm. While the original DE algorithm is Table 1: An upper bound of function evaluations required for benchmarking budget-dependent algorithms with K budgets between 1 and 10^M that are equidistant in the logarithmic scale, for some selected values of K and M.

$\int 10^{1/K+N}$	$\begin{bmatrix} I \\ -1 \end{bmatrix}$		M	
$10^{1/K}$	-1	3	4	5
	10	4.859	48.618	486.208
V	20	9.188	91.947	919.540
Λ	50	22.198	222.165	2.221.835
	100	43.889	439.270	4.393.094

Table 2: Population size of the budget-dependent DE computed for some selected values of budget multipliers m_{budg} and problem dimensions n.

$ 3\log^2(n,m,n) $		$m_{ m budg}$		
$[3 \log_{10}(n \cdot m_{\rm B})]$	udg/]	10	100	1000
	2	5	15	32
~	5	8	21	41
π	10	12	27	48
	20	15	32	55

budget-independent, a study shows that setting its parameters, especially population size, in connection to the total budget of evaluations can improve its results [1].

In the experiments we use the DE implementation from the scipy Python package (https://www.scipy.org/) with the following parameters:

- Initialization = Latin Hypercube sampling
- DE strategy = best/1/bin
- Population size = variable (see text)
- Weight F = random in the interval [0.5, 1)
- Crossover probability CR = 0.7
- No local optimization of the final solution
- Relative tolerance for convergence = 10^{-9}

This implementation computes the population size based on the problem dimension n (for a user-specified multiplier m_{pop} , the population size is calculated as $n \cdot m_{\text{pop}}$). This was bypassed in order to make population size budget-dependent. For a problem with n dimensions and a budget multiplier m_{budg} , the actual budget in COCO is computed as $n \cdot m_{\text{budg}}$ and the population size of DE is calculated as

$$|3\log_{10}^2(n \cdot m_{\rm budg})|$$
.

Table 2 gathers the values of this formula for selected budget multipliers m_{budg} and problem dimensions n.

The experiment consisted of running five instances of DE with budget multipliers from $\{10, 31, 100, 316, 1000\}$ and at the same time composing their performances into the anytime artificial algorithm called 'DE-anytime'. All algorithms were run on the 24 problems functions from the bbob test suite [5] with dimensions n in $\{2, 3, 5, 10, 20\}$. Each problem was instantiated 15 times. The results for dimension 10 are presented in Figure 2. In data profiles plots produced by



Figure 2: Data profiles for budget-dependent variants of DE run with budgets of $\{10, 31, 100, 316, 1000\} \cdot n$ number of evaluations and the 'artificial' algorithm constructed from these variants estimating anytime performance of DE. See text for further information.

COCO, the function evaluations are always divided by the problem dimension n and shown on a logarithmic scale.

The benchmark setting used in this example is COCO's *expensive setting*, in which the number of evaluations is limited to 1.000n and the 31 targets are defined in a relative way—according to the performance of a virtual algorithm denoted with 'best 2009' that is comprised of the best results achieved by 31 algorithms at the Black-box Optimization Benchmarking (BBOB) workshop in 2009. The targets are chosen from $[10^{-8}, \infty)$ such that the 'best 2009' algorithm just failed to reach them within the given budget of nm_{budg} evaluations, with 31 different values of m_{budg} chosen equidistantly in logarithmic scale between 0.5 and 50.

We are showing the results for dimension 10, since the differences among DE instances are best visible for this dimension. Note that the algorithms were stopped at the moment denoted by the large cross, but the data profiles increase also beyond that point due to bootstrapping (see Section 2).

From Figure 2 we can observe that DE variants with a budget of 10n and 31n evaluations achieve a very similar performance in the first 10n evaluations. Other DE variants are noticeably different from the first two and also among themselves, with those with lower budgets converging faster at the beginning of the run. This confirms the findings from [1] that better performance can be achieved by fitting the population size to the total budget.

The dark blue data profile corresponding to the 'DE-anytime' artificial algorithm follows the five underlying algorithms as expected. The accuracy of this estimate could be further improved if a higher number of different budgets was used.

5. CONCLUSIONS

We presented a novel approach for benchmarking budgetdependent algorithms that enables anytime performance assessment of their results. The approach demands repeated runs of an algorithm with increasing budgets. Depending on the number and size of these budgets, it can take a significant amount of time (it is quadratic in the maximal budget in the worst case). By using budgets that are equidistant in the logarithmic scale, the time complexity depends linearly on the maximal budget, making the approach more usable in practice. An example experiment showing how to use this approach in COCO will be available in COCO v2.2.

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Criteria for Co-existence of GM and Conventional Maize Production

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ABSTRACT

The criteria for co-existence of genetically-modified (GM) and conventional (non-GM) crops must reflect the best available scientific evidence on mixture between these two types of crops. Co-existence strategies based on fixed isolation distances are not in line with the EC guidelines on co-existence, which require criteria adaptable to local constraints. In this paper, we apply data mining for identification of co-existence criteria of maize production. We use classification trees to generate co-existence criteria for GM and conventional maize fields. The data used in this study were provided by ARVALIS and consisted of several surveys of outcrossing between pairs of maize fields. Based on the model structure, the most important co-existence criteria are flowering time lag, wind direction, presence of isolation rows and distance between the GM and conventional field. The coexistence criteria generated from the model for prediction of outcrossing were applied on an independent Spanish dataset. The results are meaningful and in accordance with literature and have high potential for application in the development of computer based co-existence decision support system.

Keywords

Genetically modified crops, GM maize, co-existence criteria, classification trees, random forests.

1. INTRODUCTION

Co-existence is concerned with the potential economic impact of the mixture of genetically modified (GM) and non-GM crops, the identification of workable management measures to minimize mixture, and the cost of these measures [5]. Coexistence applies only to approved GM crops that were considered to be safe prior to their commercial release and safety issues fell outside its remit [14]. EC regulation 1829/2003 (article 43) [6] provides guidelines to develop national or regional strategies and best practices to ensure co-existence. However, the selection of preventive co-existence criteria is the individual responsibility of each Member State.

The level of purity needed to ensure co-existence is defined by a tolerance threshold. The EU accepts an adventitious or technically unavoidable presence of authorized GM material in non-GM food and feed up to 0.9% and the main task of co-existence is to find out by which means the adventitious presence can be kept below the accepted threshold level. In particular, the prediction of adventitious presence of GM material in neighboring non GM fields is required in order i) to

assess the co-existence performance of applied management strategies in GM fields, and ii) to identify efficient crop management measures that enable the co-existence of GM and conventional crop production systems.

The identification of co-existence criteria is currently based on two approaches. The first uses a mechanistic matrix modeling approach that is based on a theoretical description of pollen dispersal, while data from field experiments are used for calibrations and validations of such models [1]. The second approach is based on empirical knowledge about co-existence, obtained mostly from observations and experiences from growing GM crops under real production conditions, where the performance of fixed co-existence measures is used and evaluated. Such an empirical model, called a global index, has been developed by [11].

In this study, we propose a third approach that employs techniques of data mining to real data about cross-pollination between GM and conventional crops grown under different crop management practices. Our goal is to identify co-existence criteria about the adventitious presence of GM maize in the conventional maize production, using the official threshold level of 0.9%, from the structure of the induced predictive models built from real data.

2. MATERIALS AND METHODS

2.1 Data

In this study, we used data provided by ARVALIS - Institut du végétal, France, and Institut de Recerca i Tecnologia Agroalimentàries (IRTA), Spain. The data provided by ARVALIS were used for construction of the data mining models and the Spanish data were used for validation of the induced coexistence criteria.

The data provided by ARVALIS were from surveys of outcrossing (gene flow from GM donor crop to recipient non-GM crop) between pairs of 88 maize fields in the Pau and Toulouse regions in the South – West of France, in the period from 2001-2007. Each field was described with the following variables: location of the fields, distances between donor and recipient fields, locations of sampling points, number of border rows, field size, sowing date, flowering date, flowering time-lag between donor and recipient fields, isolation distance between pairs of donor and recipient fields, prevailing wind direction from donor fields during the flowering period, and the percentage of outcrossing (outcrossing rate) in recipient fields using real-time quantification system-polymerase chain reaction.

The Spanish data were collected at harvesting time on 13 non-GM maize fields in 400 ha large maize crop area Pla de Foixà region (Girona), in Catalonia, Spain, in 2004, 2005 and 2006. During these years, the crop type, variety, sowing and flowering dates of maize fields were recorded, as well as meteorological data. At harvesting time, samples were collected on non-GM maize fields (7 fields in 2004, 4 fields in 2005 and 4 fields in 2006). The samples were analyzed by RTQ-PCR to evaluate the cross-pollination between GM and conventional maize [11]. The spatial distribution of crops in the selected region was described by maps generated from aerial photographs.



Figure 1: Example of the field-to-field map where the donor maize field is on the left and the recipient maize field is on the right side. Sampling points in the recipient maize field are indicated with lines.

2.2 Data mining methods

To find interactions between the attributes describing geographical, environmental and management parameters and outcrossing rates measured at sampled fields, we used data mining methods for induction of decision trees, which are ideally suited for analysis of complex ecological data. Decision trees predict the value of a dependent variable (target) from a set of independent variables (attributes). In our case, the dependent (target) variable is the outcrossing rate between a GM and a conventional maize in the field, which can have two values: 1 (below the threshold of 0.9% of adventitious presence) or 2 (above the threshold of 0.9% of adventitious presence). In this study, we used classification trees to develop predictive models for co-existence of GM maize production.

To evaluate the induced data mining models, we used two measures of performance or agreement of the discrepancy between measurements and predictions. We first calculated classifier's accuracy as the proportion of samples for which the category (below threshold vs. above threshold) was correctly predicted. We used 10-fold cross-validation as the most common and standard way of estimating the performance (accuracy) of a learning technique on unseen cases [15].

Data from real field studies describe the actual practices applied on the fields, where in the case of growing GM crops, incorporation of precautions for prevention of outcrossing of GM material to conventional fields is obligatory. Therefore, most often, these data are highly imbalanced, having a low number of outcrossing events. In our case, most of the samples (around 90%) were below the threshold of 0.9% of adventitious presence of GM material, while only around 10% were above this threshold. In cases like this, the accuracy is not the optimal performance metric for evaluation of the data mining models. Therefore, we used an additional performance metric - the Area Under the Receiver-Operator characteristic Curve (AUROC) [7], to more objectively evaluate the performance of the models. AUROC is defined for binary classification, where one of the classes is considered positive. A discrete classifier produces a pair of False Positives Rate (FPR: negatives incorrectly classified / total negatives) and True Positives Rate (TPR: positives correctly classified / total positives), which corresponds to a single point in the ROC space, while classifiers that return a probability value for the positive class correspond to an ROC curve. AUROC values of 0.7 and higher are considered to indicate a good fit to the data [7].

2.3 Data preprocessing

We used outcrossing grains as a unit of the outcrossing rate for all samples and surveys given in percentage of DNA [10].

From the original data described in section 2.1, we calculated the following attributes that we later used in the data mining analyses:

- Minimal distance from a sampling point to the donor field [m]
- Isolation distance (minimal distance between the donor and recipient field) [m]
- Presence of isolation rows [yes, no]
- Wind direction [0 upwind (from recipient field), 1 downwind (to recipient field)]
- Flowering time-lag [minimal (0-7 days), medium (8-14 days) and large (more than 15 days)]
- Common border length between donor and recipient field [m]
- Outcrossing rate [1 if < 0.9% GM grains, 2 if $\geq 0.9\%$ GM grains]

We discretized some of the initial attributes in order to obtain comprehensible and easily interpretable predictive models of outcrossing. The ranking and threshold values for *Flowering time-lag* attribute were selected according to expert knowledge about maize production, while the target variable *Outcrossing rate* was discretized according to the accepted European threshold (0.9 % grains).

To deal with the high imbalance in the data, we applied methods, such as up-sampling and down-sampling of the dataset, in order to create a more balanced dataset. However, the newly obtained balanced dataset did not improve the results, so we stayed with the original dataset.

The Spanish data had a different structure than the French dataset, so to use it for validation of the generated co-existence criteria, we standardized the data to achieve the same dataset structure as in the case of the ARVALIS dataset used for building data mining models (Section 3.1). First, we unified the units of the measurements on the fields. Then, we reorganized and calculated the data for pair-based comparisons of donor-recipient fields to create a setting similar to the setting in the ARVALIS experiments.

3. RESULTS

3.1 Data mining models

To generate classification trees, we used the algorithm J4.8, an implementation of the C4.5 algorithm within the WEKA suite [15].

The classification model constructed on training data (Fig. 2) correctly classified 94.31% of the instances, while the cross-validated model correctly classified 90.24% of the instances (Table 1). However, the accuracy is sensitive to imbalanced data and therefore, the model correctly classifies most of the instances belonging to class 1, but it misclassifies most of the instances belonging to class 2.

The most unbiased measure of the goodness of a model is its AUROC value. The AUROC values of the classification trees obtained on training data and with cross-validation are given in Table 1. The AUROC value of the classification tree obtained with cross-validation is (0.576). This value is very close to 0.5 (the diagonal y = x), which means that the predictive power of the classification tree obtained with cross-validation is not very high. The predictive power of the classification tree obtained on training data according to its AUROC value (0.850) is much higher and indicates good predictive power.

 Table 1: Accuracy and AUROC values for the J48 algorithm

 applied to the ARVALIS data.

	Accuracy	AUROC value
J48 on training data	94.31%	0.850
J48 10-fold cross- validation	90.24%	0.576

3.2 Co-existence criteria

The predictive power of the obtained classification tree (Fig. 2) is not very high due to the imbalanced data, therefore it cannot be used for making predictions about the outcrossing between GM and non-GM fields. However, its descriptive power is very relevant. The topmost part of the classification tree includes the attributes time-lag, wind direction, isolation distance and presence of isolation rows. Because of their dominant position in the model structure, they can be recognized as the ones which play the most important role in the cross-pollination process and as such they could present the most important criteria for co-existence of GM and conventional maize production.

Experts from ARVALIS and IRTA, as well as extensive literature [4,9,11,12,13] confirm the importance of the attributes captured in the model structure for the outcrossing process. Therefore, we focused on the parts of the model that correctly predicts outcrossing below 0.9% (leaves in the tree that provide most accurate predictions, presented by the number of examples that fall in a leaf and the number of incorrectly classified examples in Figure 2) and arranged our findings into a coherent and consistent list of co-existence criteria (Table 2).

In order to obtain robust and applicable co-existence criteria, we validated them on an independent dataset provided by IRTA, Spain.

The co-existence criteria (Table 2) derived from the classification tree generated from the French data, were confirmed by the Spanish data in 88.6% cases. Validation of the individual criterions (rules) has shown that the criterion 1 (time-lag) was confirmed in 90% of the cases, 76% of cases confirmed criterion 2 (combination of time-lag and wind direction), while criterion 4 was valid for 100% of the cases. None of the surveyed Spanish maize fields had protection rows, therefore, we were not able to validate criterion 3.

The validation of the outcrossing model (Figure 2) and the coexistence criteria, confirmed that there is a high potential for their application in the assessment process of co-existence issues.



Figure 2: Outcrossing model induced by J48 (values in the leaves: 1: outcrossing < 0.9% grains, 2: outcrossing $\ge 0.9\%$ grains).

 Table 2: Proposed co-existence criteria for GM and conventional maize production.

1.	If the flowering time-lag is ≥ 15 days, then the outcreasing rate in a recipient field is below 0.0%
	outcrossing rate in a recipient neid is below 0.9%.
2.	If the flowering time-lag is less than 15 days and if the prevailing wind direction during flowering period is from recipient to donor field, the outcrossing rate of a recipient field is below 0.9%.
3.	If the time-lag is less than 15 days and the wind direction during flowering period is from donor to recipient field, but the donor or the recipient field has an isolation or protection row, then the outcrossing rate in the recipient field is below 0.9%.
4.	If the time-lag is less than 15 days and wind direction during flowering days is from donor to recipient field, but there are no isolation nor protection rows and the distance between the donor and the recipient field is more than 50 m, then the outcrossing rate in the recipient field is below 0.9%.

4. CONCLUSIONS

Compared to most of the studies about maize cross-fertilization due to pollen flow, we used the opportunity to gain new knowledge about this phenomenon by applying data mining techniques to explore the information stored in datasets of real maize growing management. This allowed us to overpass some shortages of previous field experimental designs that were mostly oriented toward worst-case scenarios (e.g., small donor field placed in the center of large recipient field [2,3] or spatial arrangements and distribution of donor and recipient experimental fields that were too simplified compared to the real ones [8].

Data describing real field experiments that involve GM crops are in general very imbalanced, due to the fact that farmers are obliged to take measures to prevent or minimize the outcrossing from GM to conventional fields. In addition, field experiments about outcrossing rates show a fast decrease of outcrossing by a distance from donor field [13]. Because of these reasons, the datasets we used contained much larger number of sampling points with outcrossing below 0.9%, which resulted in a very imbalanced structure of the data.

To mitigate this problem we studied different performance measures to assess the goodness of the obtained models. These measures showed that the models are very precise in predicting the situations when outcrossing is less than 0.9%, but not that precise when predicting the situations when the outcrossing is above 0.9%. Therefore, we accepted a compromise to make a recommendation about the co-existence criteria that are taken from the structure of the predictive outcrossing model. However, the part of the model describing conditions, which lead to the outcrossing rate above 0.9% is not very reliable.

Our study made a significant progress about using data mining methods for identification of co-existence criteria. However, the imbalance of the data is a problem that needs to be addressed by applying data mining methods that are suited for analyzing that kind of data, such as cost-sensitive learning. Finally, in this study, we were focused on the pair-based effects of outcrossing between GM and non-GM fields. To assess the multi-field effects on the outcrossing rate at a selected recipient field, a different data mining setting should be created and other data mining methods can be exploited, such as methods for multitarget prediction and inductive logic programming. Furthermore, this study shows the ability of data mining methods to extract useful information about co-existence issues from data describing real and not experimental maize production settings. By that, data mining models for prediction of outcrossing under real crop production conditions could be successfully incorporated in a computer based co-existence decision support system.

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Knowledge Discovery from Complex Ecological Data: **Exploring Syrphidae Species in Agricultural Landscapes**

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ABSTRACT

Modelling structures and processes in ecosystems, such as biodiversity has always been a complex task. Most often, ecological empirical data are incomplete, inconsistent, imbalanced or very complex and a lot of effort should be put into preprocessing of such data in order to carry out meaningful analyses and modelling.

In this study, we are dealing with biological pest control in agricultural landscapes. The improvement of the natural regulation of organisms detrimental to agricultural production through biological pest control has the potential to reduce the use of pesticides and has a positive impact on crop production and environment. Our research focuses on auxiliary species of the family Syrphidae, which control Aphid pest species. In particular, our goal is to describe taxonomical and functional diversity of syrphid species to assess the potential performance of biological pest control in the studied area.

In this paper, we present the extensive process of data preprocessing for the purpose of modelling the taxonomic and functional aspects of syrphid species.

Keywords

Knowledge-discovery, data preprocessing, Syrphidae species, taxonomic and functional diversity, landscape structure, data mining.

1. INTRODUCTION

Knowledge discovery from ecological data is becoming an increasingly complex task. One reason for this is that ecosystems are very complex by themselves, representing networks of interactions and interdependencies among its elements and the environment, which are most often difficult to describe, explain or measure.

Empirical ecological data add another dimension to this complexity. Namely, we are often faced with empirical ecological data that are incomplete, inconsistent, containing outof-range values, collected at different temporal and spatial scales, dispersed in different databases, noisy and imbalanced [3]. Therefore, special attention should be paid on the preprocessing and quality check of ecological data in order to obtain meaningful results, which makes the data preprocessing a very central step in the knowledge discovery process [7].

In this study, we are dealing with the assessment of potential performance of biological pest control in agricultural fields in the Boigneville area (Central France). In particular, we are

exploring the biodiversity of the auxiliary species of the family Syrphidae (hoverflies), which are the major predators of Aphid pest species. The enhancement of biological pest control in agricultural fields helps reduce the use of pesticides and has an overall positive impact on crop production and quality of the environment.

Our goal is to analyse and model the taxonomic and functional diversity of syrphid species in order to estimate their potential performance of pest control in the studied area.

Quantifying and assessing the biological diversity of empirical data collected in the fields is a non-trivial task and involves calculations of different diversity measures, such as Hill numbers, Shannon's and Simpson's indexes, as well as quality checking and transformations of the available data in order to address the problem of modelling the taxonomic and functional diversity of species. In addition, the available empirical data did not contain sufficient information needed for these calculations and transformations. Therefore, we needed to extract additional data from several different datasets in order to cover all needed aspects of biodiversity.

These calculations, data transformation and collation, are a necessary step towards preparing a high quality dataset, which will enable us to obtain meaningful results and models. In this paper, we present the complex data preprocessing task that was carried out in order to explore and describe the taxonomic and functional diversity of syrphid species.

2. MATERIALS AND METHODS

2.1 Data

The empirical data were provided by ARVALIS, Institut du vegetal. Data come from Boigneville and were collected in 2009, 2010 and 2011. Samples of syrphid species were collected with five Malaise and eight cornet traps (Figure 1) on a weekly basis between March and November. Samples of caught insects have been determined to the species level and number of caught specimens per species was counted.

To describe the ecological functional traits of syrphid species in Boigneville, we obtained an additional and extensive database "Syrph The Net" [6]. It includes coded information on species' macrohabitats, microsites, traits, range and status. The database is updated annually it is used to analyse recorded species assemblages in relation to their habitat associations.



Figure 1: Malaise (a) and cornet (b) traps for sampling syrphid species

Data about landscape structure and crop properties were described from the original dataset for a 500 m and 1000 m radius around the traps (Figure 2). In delineated area, the surface of crops, natural vegetation (forests) and the length of linear corridors (tree lines, grass strips, grass pathways, hedges, roads) have been measured using GIS maps. Crop development stages were estimated for each crop in the studied area. Landscape description includes absolute and relative coverage of the surrounding soil with crops. The coverage is expressed through the percentage of groups of crops that share similar characteristics in response to Syrphids.



Figure 2: Area with 1000 m and 500 m radius around a sampling point for landscape and crop characterisation

We obtained climatic data from the French national meteorological station located in Boigneville. For the period

from 1.1.2008 to 31.12.2011, data about maximum, minimum, average temperature and cumulative rainfall have been collected at daily bases.

2.3 Data preprocessing

Taxonomic and functional diversity of caught syrphid species was described by the total number of species, referred to as species richness and evenness (indicating how abundance is distributed among the species). Indices that combine species richness and evenness into a single value are referred to as diversity indices.

Among the very large number of diversity indices, we decided to calculate the Hill diversity numbers (N0, N1, N2) because they are the easiest to interpret ecologically [4]. The three Hill numbers coincide with the three most important and known measures of diversity: S-number of species, H'-Shannon's index and λ -Simpson's index [3].

Shannon's index H' is calculated as: (S: number of species in the sample, $H' = n_i$: number of individuals of *i*-th

$$= -\sum_{i=1}^{S} \left[\left(\frac{n_i}{n} \right) \ln \left(\frac{n_i}{n} \right) \right]$$

species in the sample, n: number of all individuals in the sample). H' is 0 if there is only one species and its value increases then both the number of species and their evenness increase. For a given number of species, the value of a Shannon diversity index is maximized when all types are equally abundant.

Simpson's index is calculated as: $\lambda = \sum_{i=1}^{S} p_i^2$ (pi: proportional abundance of the i-th species $p_i = n_i/N$). Simpson's index varies from 0 to 1 and if the community consists of only one species, Simpson's index is 1 and there is no diversity.

The Hill numbers are given in units that represent the effective number, i.e., the number of species in a sample, where each species is weighted by its abundance (N0=>N1=>N2):

- N0 is the number of all species in a sample *i*: $N0 = n_i$;

- N1 is the number of abundant species and calculated from the Shannon's diversity index H': N1=e^H;

- N2 is the number of very abundant species and is based on Simpson's index λ : N2=1/ λ .

The distribution of abundance among the species is estimated by the evenness index. It is a ratio of observed to maximum diversity and it riches the highest values when the individuals are evenly distributed among species and it is independent of the number of species in the sample. Evenness is calculated as modified Hill number E5:

$$E5 = \frac{\left(\frac{1}{\lambda}\right) - 1}{e^{H'} - 1} = \frac{N2 - 1}{N1 - 1}$$

In addition, we calculated several measures that describe the landscape diversity. Among the most popular metrics used to quantify the landscape composition are the Shannon's index, which emphasizes the richness component of diversity, and Simpson's index, which emphasizes the evenness component [5]. The Shannon's index is therefore recommended for landscape management within an ecological framework. Simpson's index is more responsive to the dominant cover type and is used for specific situations where one cover type is prevailing. These diversity indices can be used to evaluate: i) Landscape richness, which is simply the number of land cover
types present within the landscape; ii) Landscape diversity, which evaluates both richness and evenness aspects of the landscape; iii) Landscape evenness, which normalizes for the effect of richness on the diversity index.

Thus, as with the biodiversity metrics, Hill numbers and Evenness index were used, where the number of species was replaced with the number of crops, while the number of individuals of each species with the land cover area (m^2) .

For each field the following soil properties have been described: soil texture class and content of clay, sand, coarse fragments, available water holding capacity, and bulk density. The data were acquired from dedicated soil database, established and maintained by ARVALIS.

Phenological development of syrphids (e.g., egg, larval, pupal, and total development times), crops (e.g., leaf unfolding, grass growing, flowering of plants, etc.) and natural vegetation depend on temperature conditions, which are described by degree-days.

Degree-days were calculated using simple logistic equation [1]:

$$DD = \frac{2 * \left[\beta_1 t - \frac{\beta_1 \ln(e^{\beta_3 t + \beta_2} + 1)}{\beta_3}\right]_0^{12}}{24} - MTT$$

According to the study of [2], the minimum daily average temperature of syrphid species is 6° C. For reliability reasons, we selected 5° C for the minimum temperature threshold in our study. Introduction of degree days enables objective comparisons of abundance and diversity dynamic between years and locations, because climatic and environmental conditions for the same calendar date vary between years, therefore calendar days cannot be used as a temporal reference point.

3. RESULTS

With regards to biological control, the abundance of predatory individuals (predators and parasitoids) might be far more relevant for performing pest control than their diversity. In particular, the results of the abundance of the syrphid species in the studied agricultural landscape of Boigneville, show that four syrphid species significantly dominated over other caught species. Comparisons between years show mostly no differences of the top most abundant species nor their relative abundance at a yearly level (Table 1).

 Table 1: Relative rank abundance of syrphid species on annual level (2009-2011)

Syrphid species	2009	2010	2011	2009-2011
	(%)	(%)	(%)	(%)
Sphaerophoria scripta	43.2	72.0	53.7	55.0
Episyrphus balteatus	22.6	3.6	4.4	10.5
Melanostoma mellinum	9.0	11.1	16.3	12.4
Eupeodes corollae	8.2	3.6	4.4	10.4
Other species	17.0	9.7	8.5	11.8

The prevailing dominance of these four syrphid species has been confirmed also at three week time period (Figure 3). This indicates very low variability of syrhid species at both inter and intra annual level, which further indicates stability of their living conditions, which means that landscape structure and applied crop management have not changed much in the studied period (2009-2011). Abundance is a strong indicator about the syrphid species, but it does not enable investigation of the correlation between taxonomic and functional diversity and landscape elements and crops.

The landscape structure of the studied area (radius of 500 and 1000 m) is very diverse and its diversity does not change over the studied period very much. Table 2 shows landscape diversity and evenness indices for a radius of 500 m around the traps.



Figure 3: Relative rank abundance of syrphid species for years 2009-2011 at three-week time steps (e.g., 09|w24-26 stands for week 24 to week 26 in year 2009)

Table	2:	Diversity	of	crops	in	the	area	within	500	m	of	the
traps												

Diversity indices	Year	
Number of crops (NO)	2009	15.3
	2010	14.0
	2011	13.2
Number of dominant crops (N1)	2009	7.5
	2010	8.4
	2011	7.2
Number of very abundant crops (N2)	2009	5.5
	2010	6.5
	2011	5.5
Evenness (E5)	2009	0.7
	2010	0.7
	2011	0.7

The prevailing number of crops is high and the value of evenness is relatively high as well. This indicates an even distribution of crops in the area. However, the prevailing crops are cereals, where winter wheat covers the largest areas. In addition to habitat variability, taxomomic (Table 3) and functional (Table 4) diversity of syrphid species appear to be high and relatively stable at the inter-annual level. Hill number 2 (N2) for taxonomic diversity shows that only the three species are very abundant, therefore the evenness values are rather low.

Table 3: Taxonomic diversity of syrphid species

Year	Abundance	NO	N1	N2	Evenness
2009	4844	57	4.89	3.18	0.560
2010	3748	48	3.68	2.61	0.599
2011	5469	56	4.26	2.97	0.604
Total	14061	84	4.56	2.98	0.558

Table 4: Functional diversity of syrphid species

Functional groups	NO	NI	N2	Evenness
Larvae: terrestrial	31	4.02	2.68	0.514
Larvae: herbal layer	19	3.53	2.49	0.552
Larvae: root zone	14	2.88	2.01	0.493
Overwinter hibernation (OH)	32	4.04	2.68	0.512
OH: above ground surface	9	2.61	1.97	0.610
OH: ground surface	22	3.12	2.25	0.555
OH: root zone	11	5.68	3.90	0.575
Larval food: living plants	6	1.98	1.60	0.558
Larval food: living animals	25	3.72	2.60	0.542
Adult food: nectar flowers	32	4.04	2.68	0.513
Adult food: pollen flowers	12	4.04	2.68	0.573

The analysis of functional diversity of syrphid species shows that larvae of 62% of caught species live in herbal layers and larvae of 81% of species feed on living animals. This indicates very high potential of syrphid species to perform biological pest control because most of syrphid species are feeding on living Aphids (aphidophagous), which are the major pest of cereal crops. The majority (68%) hibernate on the ground, while all adults feed on both nectar and pollen. Such obligatory dependence on nectar and pollen food indicates that the landscape and crop structure provides these required food sources.

Finally, after all the preprocessing of taxonomic, functional and environmental data, we got a dataset comprising seven groups of attributes describing: properties of the fields with sampling traps, taxonomic and functional descriptions of caught syrphid species, soil properties, descriptions of the landscape and crop properties, meteorological conditions with degree-days and descriptions of temporal components of the data collected. The final set of attributes contains in total 209 attributes (Table 5).

4. CONCLUSIONS

Preprocessing of data is a very important step in ecological modelling in general and data mining in particular, because the quality of input data affects the structure of the models and the quality of their predictions. In our study, we used all standard steps to ensure high quality of data, such as data cleaning, outlier detection, missing value treatment, etc.

 Table 5: Groups and number of attributes in the final dataset

Group of attributes	Number of attributes
Field description	13
Species description	7
Soil description	7
Landscape description	48
Meteorological conditions	7
Temporal component	4
Taxonomical aspect of species	84
Functional aspect of species	39

The majority of our work was focused on transformation and creation of new attributes in order to facilitate the knowledge discovery process about the potential contribution of syrphid species to biological control of Aphid pest species. In order to do this, we used extensive amounts of ecological knowledge about the description of taxonomic and functional properties of the study group of auxiliary species. The completeness and quality of the obtained (preprocessed) data were reviewed and confirmed by ecological experts.

We conclude that landscape and crop diversity support high taxonomic and functional diversity of syrphids. This is a very promising preliminary approximation, which indicates that we can expect to obtain interesting results from data mining models. Therefore, the next step is to apply various data mining methods on the preprocessed dataset in order to discover new knowledge about interactions between the environment (landscape structure, crop management, soil, climate) and taxonomic and functional diversity of syrphid species. The new knowledge will be used for enhancing the existing syrphid species to perform efficient biological pest control on growing crops.

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A Comparison of DEXi, AHP and ANP Decision Models for Evaluation of Tourist Farms

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ABSTRACT

This research covers a comparison between decision models created with the DEXi tool based on the DEX methodology, and the decision models made by Super Decision tool using Analytical hierarchical process (AHP) and Analytical network process (ANP) methodology, for analysing decisions, on a case study of tourist farms. Based on the performance of decision models, the most appropriate decision making methodology that maximally satisfied the evaluation criteria was DEX. Based on the empirical data, the best evaluated farm was Tourist farm IV from Logarska dolina, which achieved the best evaluation by all three decision models.

Keywords:

Decision support modelling, DEXi, Analytical hierarchical process, Analytical network process, touristic farm

1. INTRODUCTION

Decision making can be defined as a cognitive mind process, a human quality used to solve everyday situations. Some decisions may be felt as easy, others difficult and demanding. The development of the decision support system represents a new step towards optimisation and improvement of the whole decision making process [1].

Multi-criteria decision making is an approach where we make decisions on the basis of several criteria. This approach is necessary when intuitive decision making is not sufficient, either because of conflicts between criteria, or because of the differences between decision makers.

Tourist farms provide an important development potential for the inhabitants of the Slovenian countryside [2]. There are currently over 800 tourist farms in Slovenia and their number is growing rapidly. The increasing number of tourist farms brings many benefits for the regional development and local inhabitants such as prevention of emigration of young people from the countryside, preservation of the cultural landscape and the provision of social security for farming families with an additional source of income.

The problem that we deal with, relates to the selection of an appropriate modelling method for the case study of tourist farms and the criteria that they should fulfil in order to be chosen by users (tourists), for spending their holidays.

The goal of this article is to assess the decision models built with three different decision making methodologies, which is based on comparisons of their complexity, interdependency and consistency. The objective of these decision making models was also to help potential consumers to make decisions about which tourist farm to choose.

2. DATA DESCRIPTION

The study evaluates four tourist farms, whose locations are in different geographical regions of Slovenia: I - Izola, II - Pohorje, III - Ponikva, IV - Logarska dolina. In addition to the location of the selected tourist farms, it was also important that they provide the possibility of overnight stays. At this stage, 6 criteria and 17 sub-criteria were selected, (Table 1), and used in all decision models. The criteria were chosen personally bay the researcher, while the data for the evaluation of tourist farms were obtained through personal interviews of farm owners and guests, as well as survey questionnaires of potential guests. The data obtained through the interviews of the farm owners and guests have given numerical values, while the survey questionnaires of potential

Criteria	Location	Form of supplementary	Offer: complementary
		activity	activity
	-Where is it	-Stationary	-Food
	located	farm	-Drink
Sub-	-Accessibility	-Excursion	-Sport activities
criteria		farm	-Living space
			-Tourist farm
			Logo
	The		Host to quost
Cuitonia	1. 6	TT	most to guest
Criteria	surrounding of	Hospitality	rolationship
Criteria	the farm	Hospitality	relationship
Criteria	the farm -Flowers and	-Reception	relationship -Family
Criteria	-Flowers and greenery	-Reception -Events	relationship -Family arrangement
Sub-	-Flowers and greenery -Preserving the	-Reception -Events -Access to	relationship -Family arrangement -Cleanliness
Sub- criteria	-Flowers and greenery -Preserving the cultural	-Reception -Events -Access to information	relationship -Family arrangement -Cleanliness
Sub- criteria	surrounding of the farm -Flowers and greenery -Preserving the cultural landscape	-Reception -Events -Access to information for guests	relationship -Family arrangement -Cleanliness

guest resulted in descriptive data.

Table 1: Structure of data.

3. DECISION MODELS

Different methods such as Servqual and Dematal [5] can be used to measure the quality of tourist services. Some of them also enable work with inaccurate and incomplete data and use an interval account such as Mund, Promethee [5]. However, in this study we focused on the decision methods for construction of DEXi, AHP and ANP decision models.

3.1 DEXi

DEX is a multi-attribute methodology for decision making. The methodology is based on attributes with a finite set of qualitative values instead of attributes with numerical values [8]. The DEX methodology enables a construction of transparent and comprehensive models and it provides techniques for integration of attributes through aggregation rules in form of hierarchical decision trees.

DEXi is a software modelling tool, which is based on the DEX methodology and facilitates the development of qualitative Multi Attribute Decision Models (MADM) and enables an evaluation and what-if analysis of decision options [8]. DEXi is useful in cases where we do not have numerical data or ratings, but only qualitative ones [3]. In general, DEXi models are customised and do not have a complex structure, are insensitive to minor changes in input data and capable of resetting procedures [6].

In the DEXi modelling tool, the alternatives are described by initial attributes, which are then evaluated separately according to their values. The final evaluation of the alternatives is obtained by an aggregation process of input data (values of initial attributes Xi) using aggregation functions Fi. The output value of the topmost node in the decision tree (decision model) is used for selection of the most suitable alternative among all evaluated alternatives.

The DEXi model was applied to evaluate four tourist farms using data derived from interviews, as well as survey questionnaires. The tourist farms and their regulatory standards were precisely defined, in order to select attributes, which have been structured in the DEXi model. The goal of the model was to decompose the problem into smaller sub-problems, which were assessed individually using criteria determined by the decision maker: For example, the set of values for the attribute "Sport Activities" was: excellent; medium and poor. Through the process of hierarchical integration, using the utility functions obtained provided by the decision maker, the final assessment of the top-most attribute was determined. The outcome of the evaluation was an assessment of tourist farms.

3.2 Analytical hierarchical process (AHP)

AHP is an established and well-researched method of analysing a hierarchical decision-making processes based on mathematics and psychology [7]. The model was built in the Super Decision modelling tool [4] and consists of a general goal (selection of the best tourist farm), criteria and sub-criteria (Table1) and common options or alternatives (Tourist farm I, Tourist farm II, Tourist farm III and Tourist farm IV). The structure enables the possibility for taking into account the given elements at the selected level as well as all elements at lower levels. The criteria and their hierarchical structure are the same in the DEXi models as well as in AHP models, which provides the basis for comparisons of the models. The tourist farm is an alternative and therefore lies the highest in the hierarchy tree. They are determined by subordinate criteria, and further by lower subcriteria. The method converts the evaluation of tourist farms into numerical values that can be processed and compared for each criteria in the hierarchy. Mutual pairwise comparisons of alternatives (tourist farms) were performed in a hierarchical model based on the obtained data (surveys, interviews). A basic scale (i.e., the Saaty scale) from 1 to 9 was used, where each gives a specific preference [7]. The use of numerical weights allows for rational and consistent comparison of different or incompatible

elements with each other. The results in the AHP method are interpreted in three ways: i) 'Normals', where the results are presented in the form of priorities, where each one of the alternatives are summed and then each element is divided by the sum, ii) 'Ideals', where the values are obtained from 'Normals' by dividing each of its entries by the largest value in the column, so that the best alternative gets a priority of 1 and the others get proportion less than 1, and iii) 'Raw', whose values are read directly from the Limit Supermatrix.

3.3 Analytical Network Process (ANP)

The ANP is implemented in the software Super Decisions and has been applied to various problems both to deal with decisions and to illustrate the uses of the new theory. The ANP is a coupling of two parts. The first consists of a control hierarchy or network of criteria and subcriteria that control the interactions in the system under study. The second is a network of influences among the elements and clusters [7]. In the Super Decision modelling tool, the criteria were grouped into a network model, with clusters and with related criteria, and not in a hierarchical level. The method allows for interactions and feedbacks within the cluster, as well as between clusters, for example the alternatives of the decision in another cluster. This helps to make the basic computer operations and logical multiplication in different ranges as required by the model. The mutual pairwise comparisons were performed like in AHP model, base on the Saaty scale [7] from 1 to 9 meaning: 1) criteria are the same. 2) criteria is equivalent to another or has a moderate advantage over another. 3) criteria has a moderate advantage over other criteria. 4) criteria has a moderate to great advantage over another criteria, 5) criteria has a great advantage over another criteria, 6) criteria has a great advantage over other criteria, 7) criteria has a very great advantage over another criteria, 8) criteria has a very large to an extremely high advantage over another criteria and 9) criteria has an extremely high advantage over another criteria. Our research focuses on development of three ANP model applications: i) the simplest single model, which was built only in one layer and was the easiest to build, ii) the two-layers model, which divide the model into upper and lower levels, and iii) the complex three-layers model, which consists of several layers of sub-networks and is one of the most demanding models in the presented research. The input data, as well as the data from interviews and surveys used in the ANP model was excerpt from the previously presented AHP and DEXi models. However, due to the complexity of the ANP complex three-layers model, the criteria are further subdivided to create a more extensive model.

4. RESULTS WITH DISCUSSION

The aim of the research was to compare DEXi, AHP and ANP multi-criteria models, for an evaluation of tourist farms.

4.1 DEXi model

In DEXi modelling, the main focus is on the rationality and the regularity of the criteria. Based on the obtained data, a multicriteria model was developed that maximally met the given criteria. The best evaluated tourist farm (Figure 1) is from Logarska dolina (Tourist farm IV). The second best tourist farm was Tourist farm II, which achieved the same level of evaluation scores in almost all criteria as Tourist farm IV. Tourist farm II was evaluated worse only in the criterion "Complementary activities" (Figure 1). Tourist farm IV and Tourist farm II got the highest score in the criteria "The surrounding of the farm". However, in the criteria "Tourist Farm Logo" and "Where is it located" they did not receive the best estimates. Tourist farm III was evaluated well and it is potentially a good choice for tourists. The worst evaluated was Tourist farm I, although it was very well evaluated for the criteria "The surrounding of the farm". The Tourist farm I was inadequate due to poor estimates of the criteria "Complementary activities" and "Hospitality" (Figure 2).







Figure 2: Evaluated criteria in DEXi model for Tourist farm I and Tourist farm III.

4.2 AHP model

In AHP method, the development of decision-making model (identification of the decision problem, identification of the alternatives and determination of criteria) was similar as in DEXi. The difference in AHP is in the pairwise comparison of the criteria with respect to the goal and the pairwise comparison of the alternatives. The results of the AHP model (Figure 3), based on the Normals values show that the best evaluated tourist farm was from Logarska dolina (Tourist farm IV) which received 40%. Tourist farm II received 37%, Tourist farm I received 13 % and Tourist farm III received the lowest percentages 10%. Based on Ideals values (Figure 3), the results can be interpreted also in the way as: Tourist farm I is 33% as good as a Tourist farm IV, Tourist farm II is 92% as good as Tourist farm IV and Tourist farm III is 25% as good as Tourist farm IV.



Figure 3: Synthesized priorities for the alternatives in AHP model.

The criteria "Complementary activity" and "Location" contributed the highest values, while the least impact on the final results had criteria "Form of supplementary activity".

4.3 ANP model

Three different models have been developed with the ANP method in the Super Decision tool. According to the input data and the problems that were considered, we came to the conclusion (Table 2) that the outputs for all three applications of the ANP methods show that the Tourist farm IV from Logarska dolina was selected as the most appropriate one. The tourist farm IV received the highest percentage in the three layered model (40%), in the two layered model 38% and in single layered model 36%. The lowest percentage achieved Tourist farm III in the three layered model (10%) and 17% in both two layered and single layered model. The results in the simplest single layered model, showed that the greatest impact on the final results had criteria "Complementary activity" and "The surrounding of the farm", while the criteria "Location" heed the least influence on the results. In the two-layereds model, Tourist farm IV got the best assessment in all criteria. Tourist farm II received good assessment of the criteria "Host to guest relationship", "Form of supplementary activity", "Hospitality" and "Complementary activity". Tourist farm I received good assessment for the criteria "Location2 and "Form of supplementary activity". Tourist farm III was assessed with lower estimates, only a slightly higher rating according to the criteria "The surrounding of the farm". In the complex three-layereds model, Tourist farm IV achieved the best assessment in the criteria "Costs" and "Priority". Among all the criteria, three were selected that were assessed as most important and that had the greatest impact on the final results: "Where is it located", "Stationary farm" and "Cleanliness". By comparing results of all three ANP model applications, a deviation in the percentages was observed. The percentages of the three layered model were for Tourist farm IV and Tourist farm II evaluated higher and for Tourist farm III and Tourist farm I the percentages were evaluated lower in comparison with the percentages of the single and two layered models, where only a smaller deviation of the percentage occurred (Table 2). The three layered model contained in the upper level two new clusters, Strategic and Basic. Strategic served in the model for evaluating the Basic criteria using the rating model. The basic cluster consists of additional criteria: "Priority", "Cost" and "Risk". The new criteria contain lower levels, where the already known criteria and sub-criteria used in DEXi and AHP models are added (Table1). The criteria were grouped into i) Priority criteria: "Location" and "Hospitality", ii) Cost criteria: "Complementary activity" and "Form of supplementary activity" and iii) Risk criteria: "Host to guest relationship" and "The surrounding of the farm". The presented expansion of the three-layered model led to a deviation of the percentage (Table 2).

Table	2:	ANP	total	results.
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	ANP-Single layered model	ANP- Two layered model	ANP-Three layered model
Tourist farm I	21%	20%	15%
Tourist farm II	26%	25%	35%
Tourist farm III	17%	17%	10%
Tourist farm IV	36%	38%	40%

5. CONCLUSIONS

The goal of this study was comparison of the DEXi tool in the DEX methodology, and the Super Decision tool in the AHP and ANP methodology. The study presented three examples of decision models for evaluation of tourist farms, which in addition to the final results, also provided appropriate measures to improve the offers of the more poorly assessed alternatives. The objective of these decision making models used in the survey was also to help potential consumers to make decisions about the most appropriate tourist farms. The results of all models indicated that the Tourist farm IV located in Logarska dolina received the best evaluation results and represents the best provider of touristic activities in the farm. The applied methodologies were found to be very successful and effective. DEXi tool has proved a very simple model, which is not related to numerical values of input data. It is also easy to add additional criteria to a structured decision tree, despite the measurements of input data and integration functions. The modelling software indicates where model needs to be modified or corrected due to an additionally added criterion. AHP in the Super Decision tool also presents a simple and transparent way to build a model and represents a very good alternative to the DEXi model. However, in contrast to DEXi, it is bound to

numerical values. The ANP model build in the Super Decision tool proved to be more complicated. The application of the simple single network model and the two-layers model are comprehensive, and still sufficiently understandable, while the approach to build a complex three-layers model is much more complex. Despite the fact that, due to its size, the three-layers model gives us more precise results, its use is more difficult.

This led to the conclusion that in order to create a model with qualitative attributes, perform what-if analysis and include additional alternatives for evaluation (e.g., Tourist farm 5, Tourist farm 6., etc.), the most appropriate model was built in DEXi. The AHP model, which is based on numerical values of input data, can be more precise then the DEXi model, but on the other hand, determining one value in the comparison matrix in AHP, is much more difficult then determining it in DEXi models. Thus, if we want to use quantitative attributes without the evaluation of additional alternatives, the AHP methods could be applied. The application of the three-layers ANP model is non-transparent due to multiple layers and its construction is highly time-consuming. The use of a single or two-layer ANP model in the Super Decision toll can give sufficiently more precise results.

Each of the assessed decision modelling methods has its advantages and disadvantages. However, we have found that DEXi is the best modelling approach for the assessment of tourist farms, and that the Tourist farm IV located in Logarska dolina represents the best provider, which was not confirmed only by the DEXi model, but also by the models developed in Super Decision tool with AHP and ANP method.

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A State-Transition Decision Support Model for Medication Change of Parkinson's Disease Patients

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ABSTRACT

In this paper, we present a state-transition decision support model for medication change of patients with Parkinson's disease (PD), implemented with method DEX. Today, PD patients can be treated with three basic medications: levodopa, dopamine agonist, MAO-B inhibitors, and their combinations. We propose a model which, based on the current patient's symptoms (motor symptoms, mental problems, epidemiologic data and comorbidities), suggests how to change the medication treatment given the patient's current state. The model is based on expert's knowledge of neurologists and is composed of (1) a state-transition model that presents all possible medication changes, and (2) decision rules for triggering the changes, represented in terms of a qualitative rule-based multi-criteria model. The model assesses all states described by the state-transition model and proposes multiple different yet still correct possibilities for medication change.

Categories and Subject Descriptors

H.4.2 [Types of Systems]: Decision support.J.3 [Life and Medical Sciences]: Medical information systems.

General Terms

Algorithms, Management, Measurement, Design, Human Factors

Keywords

Parkinson's disease, medication change, decision model

1. INTRODUCTION

Parkinson's disease (PD) is a complicated, individual degenerative disorder of the central nervous system for which there is no cure. Hence it requires a long-term, interdisciplinary disease management including typical medicament treatment with levodopa (LD), dopamine agonist (DA), and enzymes (E), such as MAO-B inhibitor. Due to the different combinations of motor and mental symptoms from which PD patients suffer, in addition to existing comorbidities, the interchange of medications and their combinations is patient-specific [1]. In the framework of the EU Horizon 2020 project PD_manager (http://www.parkinson-manager.eu/) [2] we developed a decision support model, called the "How" model, for PD management which suggests how to change the medication treatment given patients' current state. The assessment is based on data that include patients' motor symptoms (dyskinesia intensity, dyskinesia duration, offs

duration), mental problems (impulsivity, cognition, hallucinations and paranoia), epidemiologic data (patient's age) and comorbidities (cardiovascular problems, hypertension and low blood pressure). The model is composed of (1) a state-transition model that presents the medication change among levodopa, dopamine agonist, MAO-B inhibitors and their combinations, and (2) decision rules for triggering the changes, represented in terms of a qualitative multi-criteria model. The latter has been developed using the DEX method [4], which integrates the qualitative multi-criteria decision modeling with rule-based expert systems.

2. MODEL DESIGN

The model development was performed with neurologists who work with PD patients. The process of decision analysis led to a design of a model composed of two key elements: (1) A statetransition model that represents all possible combinations of used medicaments and transitions between them, and (2) a multicriteria DEX model that provides decision rules for each transition.

2.1 A state-transition model

In the state-transition model the medication treatments (states) and transitions among them are represented in a form of a cube as presented in Figure 1. In Figure 1, each medication-treatment state is as a circle and each change of medication treatment is represented with a directed arc. Each state corresponds to the set of medications that constitute the current treatment. The set can be empty (the symbol O indicates no medication therapy), or can consist of any combination of DA, LD and E (Enzymes, such as MAO-B inhibitor). For example, the state DA+E means that the current medication treatment of the patient consists of dopamine agonist (DA) and MAO-B inhibitor. From this state there are three possible state changes depending on the combinations of patient's symptoms: add LD to the treatment (state denoted as LD+DA+E), remove DA from the current treatment (state E) or remove E and use only DA (state DA).

The absence of a directed arc between two states means that a particular change of medication treatment is not addressed in the model, either because it has been deliberately excluded (transitions from and to state O, which are out of scope of the PD_manager project), or is rarely or not at all used in practice. A

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reflexive arc means an increase/decrease of the medication (dosage or intake) [3].



Figure 1: A state-transition model for medication change among levodopa (L), dopamine agonist (DA), MAO-B inhibitors (E) and their combinations. Symbol O represents the state where the patient does not take medications.

2.2 DEX model

The transitions in the state-transition model (Figure 1) are triggered according to a multi-attribute model, which is responsible for interpreting patients' motor symptoms, mental problems, epidemiologic data and comorbidities, and aggregating them into an overall assessment of the potential medication changes of a given patient. The model is hierarchical and qualitative, developed using a qualitative multi-attribute modelling method DEX [4]. DEX models decompose the decision problem into smaller, less complex sub problems, which are represented by a hierarchy of attributes. Attributes from the decision alternatives are aggregated in order to obtain an overall the evaluation or recommendation. DEX belongs to the class of qualitative multi-criteria decision making methods: it uses qualitative (discrete) variables instead of quantitative (numerical) ones, and employs decision rules rather than numerical aggregation functions for the aggregation of attributes. The method DEX is supported by DEXi [5], freely available software that supports both the development of DEX models and their application for the evaluation and analysis of decision alternatives. DEX was chosen for modelling due to its previous successful usage for implementation of decision support models in health care [6][7].

Using DEX principles of model development, the state-transtion model from Figure 1 is mapped into a qualitative multi-attribute model presented in Figure 2. The model consists of basic and aggregated attributes given in a structure that identifies possible transitions in the state-transition diagram for a given patient [8]. The model combines 22 basic attributes including data about motor symptoms (rigidity, tremor, and bradykinesia), mental problems (impulsivity, cognition, hallucinations, paranoia), comorbidities (cardiovascular, low blood pressure, hypertension), and dyskinesia (offs duration, intensity, and duration). In addition, there is data about patient's age and activity, and data about the current therapy (which medications is the patient currently using, and whether or not the maximum dosages of DA and LD have been reached). The values of these attributes constitute model's inputs. Aggregation of the basic attributes leads to two sets of attributes. The first set is composed of six aggregated attributes: Dyskinesia, MotorSymptoms, CurrentTherapy, PersonalCharacteristics, Comorbidities and MentalProblems. The purpose of this set of attributes is to aggregate several specific symptoms into common indicators, which are used as inputs to the second set of aggregated attributes. For instance, Dyskinesia is a common indicator of patient's involuntary movements caused as a side effect of medications; it is determined by aggregating the basic attributes *offs duration*, dyskinesia intensity, and dyskinesia duration.

The second group of aggregated attributes forms a set of 15 submodels, which determine the transitions from one medication state to the other one as given in the state-transition diagram (Figure 1). Those submodels are the following:

- 1. **ChangeDAtoLD:** Change therapy from dopamine agonist to levodopa
- 2. **ChangeDAtoDA+LD:** Change therapy from dopamine agonist to dopamine agonist and levodopa
- 3. **ChangeDAtoDA+MAOI:** Change therapy from dopamine agonist to dopamine agonist and MAO-B inhibitors
- 4. **DecreaseDAdosage:** Decrease the dosage of dopamine agonist
- 5. **IncreaseDAdosage:** Increase the dosage of dopamine agonist
- 6. **ChangeLDtoLD+DA:** Change therapy from levodopa to levodopa and dopamine agonist
- 7. IncreaseLDdosage: Increase the dosage of levodopa
- 8. IncreaseLDintake: Increase the intake of levodopa
- 9. DecreaseLDintake: Decrease the intake of levodopa
- 10. DecreaseLDdosage: Decrease the dosage of levodopa
- 11. **ChangeDA+LDtoLD:** Change therapy from dopamine agonist and levodopa to levodopa
- 12. **ChangeMAOItoMAOI+DA:** Change therapy from MAO-B inhibitors to MAO-B inhibitors and dopamine agonist
- ChangeMAOItoMAOI+LD: Change therapy from MAO-B inhibitors to MAO-B inhibitors and levodopa
- 14. StopMAOI: Stop using MAO-B inhibitors
- 15. AddMAOI: Add MAO-B inhibitors to the current therapy.

At the top of each submodel, there is the *root* attribute which represents the overall assessment of medication change under consideration. For example, the submodel **ChangeDA+LDtoDA** estimates the change of medication from dopamine agonist and levodopa to dopamine agonist based on the information whether the patient already takes DA (*usingDA*) and LD (*usingLD*), if the patient has increased mental problems (*MentalProblems*) and/or cardiovascular problems (*cardiovascular*).

All submodels were obtained through expert modelling. In this case, decision-support models were developed in collaboration between the neurologists (experts) from and the decision analyst. The work proceeds in the form of a question-answer dialogue, led by the analyst, aimed at identifying the important indicators and decision rules used, implicitly or explicitly, by the expert when making decisions.

Attribute	Scale
ChangeDAtoLD	yes; no
-usingDA	yes; no
-MentalProblems	yes; no
-cardiovascular	yes; no
low blood pressure	yes; no
ChangeDAtoDA+LD	yes; no
-usingDA	ves; no
-maxDA	ves; no
-MotorSymptoms	ves; no
ChangeDAtoDA+MAOI	ves; no
-usinaDA	ves: no
-MotorSymptoms	ves: no
-cardiovascular	ves: no
DecreaseDAdosage	ves: no
-usinaDA	ves: no
-MentalProblems	ves: no
-cardiovascular	ves: no
low blood pressure	ves: no
IncreaseDAdosage	ves: no
-usingDA	ves: no
-maxDA	ves: no
-MotorSymptoms	ves: no
-offs duration	ves: no
-MentalProblems	ves: no
-cardiovascular	ves: no
-age	It65: 65-75: at75
activity	ves: no
Changel Dtol D+DA	ves: no
	ves: no
-MotorSymptoms	ves: no
-offs duration	ves: no
-MentalProblems	ves: no
age	lt65: 65-75: at75
IncreaseLDdosage	ves: no
usingLD	ves: no
-maxĽD	ves; no
-MotorSymptoms	yes; no
-MentalProblems	ves: no
-dvskinesia duration	ves: no
-dvskinesia intensitv	ves: no
offs duration	ves; no
DecreaseLDdosage	ves: no
-usingLD	ves: no
-MotorSymptoms	ves: no
-MentalProblems	ves: no
-dvskinesia intensitv	ves: no
-dvskinesia duration	ves: no
offs duration	ves: no
IncreaseLDintake	ves: no
usingLD	ves: no
-maxLD	ves: no
-MotorSymptoms	ves: no
-MentalProblems	ves: no
-dvskinesia intensitv	ves: no
-dvskinesia duration	ves: no
offs duration	ves: no
DecreaseLDintake	Ves: no
	ves: no
-MotorSymptoms	ves: no
-MentalProblems	yes: no
-dyskinesia intensity	yes, no
-dyskinesia duration	yes: no
	ves: no
0110 0010001	,00,110

ChangeDA+LDtoLD	yes; no
–usingDA	yes; no
-usingLD	yes; no
-MentalProblems	yes; no
cardiovascular	ves; no
ChangeMAOItoMAOI+DA	ves: no
	ves: no
-MotorSymptoms	ves: no
MontalProblems	yes, no
Change MA Olde MA OLd D	yes, no
	yes, no
usingiviAOI	yes, no
-motorSymptoms	yes; no
StopMAOI	yes; no
-usingMAOI	yes; no
–usingDA	yes; no
–Dyskinesia	yes; no
-MentalProblems	yes; no
hypertension	yes; no
AddMAOI	yes; no
-usingMAOI	ves: no
usingDA	ves: no
using D	ves: no
offs duration	yes, no
MotorSymptoms	yes, no
	yes, no
MotorSymptoms	yes, no
rigiaity	yes; no
Tremor	yes; no
-tremor at rest	yes; no
-action tremor	yes; no
└-postural tremor	yes; no
L bradykinesia	yes; no
MentalProblems	yes; no
-impulsivity	ves: no
-cognition	ves: no
Psychosis	ves: no
	ves: no
naranoia	yes, no
Comorbiditios	
	yes, no
	yes, no
hypertension	yes, no
Duckingerie	yes, no
Dyskinesia	yes, no
	yes; no
-dyskinesia intensity	yes; no
-dyskinesia duration	yes; no
PersonalCharacteristics	inactive; active
age	lt65; 65-75; gt75
⊢activity	yes; no
CurrentTherapy	max; yes; no
⊢usingMAOI	yes; no
⊢usingDA	yes; no
⊢usingLD	yes; no
⊢maxĎA	ves: no
maxLD	yes; no

Figure 2: Structure and value scales of the "How" medication change model

Figure 2 shows the value scales and structure of the model. It shows that most attributes in the model are binary, each taking one of the two corresponding values: yes or no. Coloured values indicate that the corresponding attribute is ordered from left-toright, so that the leftmost (red) value indicates a problematic, and the rightmost (green) a non-problematic patient's condition. The red/left values generally indicate a problem that should be addressed by medication change.

2.3 Decision rules

For each aggregate attribute in the DEX model, it is necessary to define the values of that attribute for all possible combinations of lower-level (input) attribute values. For example, the

IncreaseLDdosage aggregate attribute depends on seven lower level attributes that correspond to current patients' medication treatment and symptoms. These attributes are binary, so there are $2^7 = 128 \ 2^7 = 128$ possible combinations of their values. The DEXi software was used to represent, manage and define such combinations in the form of decision tables. All decision rules contained in the model are presented in a tabular form together with a verbal interpretation. Table 1 is an example of a decision table that defines the decision rules for the aggregated attribute ChangeDatoLD. The symbol '*' used in the decision tables denotes any value that can appear at that position. For instance, in connection with an attribute than can take the values "yes" and "no", the '*' stands for "yes or no".

According to the decision rules presented in Table 1, one may read that the change of medication treatment from DA to LD should happen only when the patient already takes DA (*usingDA*). The change may take place in in three different cases: the patient has mental problems, cardiovascular problems, or low blood pressure. Otherwise, the change to LD should not happen.

The whole model contains 21 other decision tables such as Table 1, corresponding to the remaining aggregate attributes in the model.

Table 1: Decision rules for submodel ChangeDatoLD

	usingDA	Mental- Problems	cardio- vascular	low blood pressure	Change- DAtoLD
1	yes	yes	*	*	yes
2	yes	*	yes	*	yes
3	yes	*	*	yes	yes
4	*	no	no	no	no
5	no	*	*	*	no

3. CONCLUSIONS AND FUTURE WORK

Using the DEX method, we developed a state-transition model and decision rules for medication change of PD patients. This approach assured that the model fulfils the following important characteristics: completeness (it provides outputs for any possible inputs), robustness (it works even if some input data is missing), consistency (the model is free of logical errors), transparency (the model is fully "open" for the inspection of contained decision rules), comprehensibility (the embedded decision rules are easy to understand and explain). The model assess all combinations of possible medication changes that arise from the state-transition model thus allowing interpretation of several different and yet correct scenarios for medication change for patients that suffer from PD.

The future work in the framework of the PD_manager project will be focused on model evaluation and implementation. We intend to verify and validate the model on (1) real-life examples of medication-change decisions, such as the Parkinson Progression Marker Initiative dataset [9], (2) on real case patient's scenarios, (3) and in comparison with neurologists from different EU countries. The model will be integrated in the PD_manager mhealth platform for Parkinson's disease management [2].

4. ACKNOWLEDGMENTS

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Designing a Personal Decision Support System for Congestive Heart Failure Management

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ABSTRACT

In this paper, we describe the design of the HeartMan Decision Support System (DSS). The DSS is aimed at helping patients suffering from congestive heart failure to better manage their disease. The support includes regular measurements of patients' physical and psychological state using a wristband and mobile device, and providing advice about physical exercise, nutrition, medication therapy, and environment management. In the paper, an overall architecture of the DSS is presented, followed by a more detailed description of the module for physical exercise management.

Categories and Subject Descriptors

H.4.2 [Types of Systems]: Decision support. J.3 [Life and Medical Sciences]: Medical information systems.

General Terms

Algorithms, Management, Measurement, Design, Human Factors

Keywords

Decision Support System, Personal Health System, Congestive Heart Failure, Physical Exercise, Decision Models

1. INTRODUCTION

Congestive heart failure (CHF) occurs when the heart is unable to pump sufficiently to maintain blood flow to meet the body's needs [1]. Symptoms include shortness of breath, excessive tiredness, and leg swelling. CHF is a common, chronic, costly, and potentially fatal condition [2]. In 2015 it affected about 40 million people globally. In developed countries, around 2% of adults have heart failure, increasing to 6-10% in age over 65.

HeartMan (http://heartman-project.eu/) is a research project funded by the European Union's Horizon 2020 research and innovation programme. The project aims to develop a personal health system to help CHF patients manage their disease. CHF patients have to take various medications, monitor their weight, exercise appropriately, watch what they eat and drink, and make other changes to their lifestyle. The HeartMan system will provide accurate advice on disease management adapted to each patient in a friendly and supportive fashion. The DSS follows the best medical practices [3] and is designed so that it never suggests anything that would harm the patient.

In this paper, we present the design of the HeartMan Decision Support System (DSS), which was finalised in June 2017 [3]. In section 2, we describe the overall functionality and architecture of the system, and define the roles of its modules that address (1) physiological measurements, (2) physical exercise, (3) nutrition, (4) medication, (5) environment management, and (6) management of calendars and plans. In section 3, we focus on the physical exercise module and present its most important components for (1) patients' physical capacity assessment, (2) weekly exercise planning, and (3) daily exercise management.

2. DESIGN OF THE HEARTMAN DSS

The HeartMan DSS aims at providing medical advice to CHF patients using predictive models, clinical care guidelines and expert knowledge. The purpose of a typical DSS is to passively present information to decision makers so that they can make maximally informed decisions. This DSS, however, is intended for patients who have limited medical knowledge and are consequently expected to follow guidelines with little discretion. Because of that, the DSS actively provides advice to patients, although it does offer choice where appropriate. In this way, it belongs to the category of cooperative DSS [4].



Figure 1: Overall architecture of the HeartMan DSS.

The overall architecture of the HeartMan DSS is shown in Figure 1. The system will use wrist-band sensors to monitor patient's physical activity, heart rate and some other physiological signs. In addition, it will receive data from additional devices, such as scales, smartphone and from the patient via the user interface of the mobile application. This will allow the system to identify the patient's current physical and psychological characteristics. This data will be combined with patient's health data to help them decide on disease control measures. The advice will be tailored to the patient's medical condition by adapting it to the patient's psychological profile (such as normal, poorly motivated, depressed, and anxious) and current health state. The advice will be shown at the mobile app. A web-based interface will be provided to the physician, too, who will be able to monitor the patient's health state and progress, and define or approve parameters that affect the advice given to the patient.

The core of the HeartMan DSS are modules that interpret patient's data and make recommendations. There are six main modules, which address the following aspects of health management:

- 1. *Physiological measurements*: CHF patients should perform various physiological measurements on a regular basis, such as measuring their weight, blood pressure, heart rate, etc. This raises the patients' awareness of their health, provides valuable information to their physicians, and provides inputs to the DSS. For this purpose, the DSS reminds the patient to regularly perform these measurements, provides the functionality to carry them out, and manage the collected data.
- 2. *Exercise*: Physical conditioning by exercise training reduces mortality and hospitalization, and improves exercise tolerance and health-related quality of life. For this purpose, the DSS provides a comprehensive exercise programme, which is detailed later in section 3.
- 3. *Nutrition*: CHF patients should maintain their body weight and take care of their diet, for instance, not eating too much salt or drinking too much fluid. The DSS assesses the patients' nutrition behavior, educates them through a quiz and provides advice towards a healthy diet.
- 4. *Medication*: Good adherence to medication therapy decreases mortality and morbidity, and improves well-being of CHF patients. For this purpose, the DSS reminds the patient to take medications and assesses the patient's adherence to the medication scheme. For each medication, the patient may obtain an explanation why the adherence is important.
- 5. *Environment management*: Environmental conditions, such as temperature and humidity, may affect the patient's feeling of health. Combining both, the patient's and environmental conditions, the DSS advises the patient how to change the environment to improve their health feeling.
- 6. *Calendars and plans*: Given all the DSS aspects (measurement, exercise, nutrition, medication and environment management) and many interactions between them, it is important to sensibly arrange all the activities and notifications, for instance not sending nutrition advice during exercise or suggesting physical exercise after taking diuretics. This DSS module thus coordinates the activities and arranges all the plans into one single calendar.

To date, all these modules have been designed in terms of their functionality, requirements, input data, processing, outputs, and distribution between the client (patient's mobile app) and the server (the DSS in "the cloud") [3].

3. PHYSICAL EXERCISE MODULE

The HeartMan DSS administers a comprehensive exercise programme. At the beginning, the DSS collects medical information and assesses patient's physical capacity in order to plan the difficulty level of the exercises. Then, the DSS provides a weekly set of endurance and resistance exercises, which increase in difficulty as the patient becomes fitter. The DSS also guides the patient during each exercise session: it checks whether the patient is ready to start, then provides instructions, and finally asks the patient to evaluate the exercise. The exercise module follows the guidelines provided in [5] with minor modifications to fit in a mobile application.

3.1 Physical Capacity Assessment

Prior to starting using the HeartMan DSS, the patients should perform a cardiopulmonary exercise (cycloergometry) test to assess their physical capacity. Alternatively, when using the system in a supervised, standardized setting, patients can perform a 6-minute walking test. On this basis, the *physical capacity* of each patient is assessed as "low" (less than 1 W/kg measured by cycloergometry or less than 300 m walked in 6 minutes) or "normal" (otherwise).

3.2 Weekly Exercise Planning

The DSS system provides the patient with a combined *endurance* and *resistance* exercise programme. Both types follow the same principle described with four parameters: *frequency* (times per week), *intensity*, *duration* and *type*. These parameters are combined with the physical capacity to make a *weekly exercise* plan for each patient. For instance, low-capacity patients start with very light 10-15-minute endurance exercises twice per week.

According to the patient's progress, these parameters may change with time. In the HeartMan DSS, the progress is prescribed by two models:

- *EnduranceFrequency*: a model for suggesting weekly frequency of endurance exercises;
- *EnduranceTime*: a model for suggesting weekly time boundaries of endurance exercises.

Both models are formulated using a qualitative multi-criteria decision analysis method DEX [6]. Here, we illustrate the approach describing the *EnduranceFrequency* model, whose structure is shown in Figure 2.

Attribute	Scale
EnduranceFrequency	2x; 3x; 4x; 5x
Normative	2x; 3x; 4x; 5x
Category	low; normal
Week	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 11; 12; 13; 14; 15; 16; 17; 18; 19; 20; 21; 22; 23; 24; more
-Current	2x; 3x; 4x; 5x
L Transition	decrease; stay; increase; automatic
MedicalAssessment	decrease; stay; increase; automatic
PatientsAssessment	decrease; stay; increase; automatic

Figure 2: Structure of the *EnduranceFrequency* model.

The *EnduranceFrequency* model is aimed at suggesting the *frequency of exercises* for the next week, based on the patient's physical capacity, week in the programme, current frequency, and the possible physician's and patient's suggestions for the change. In other words, the model takes into account both the normative

(as proposed by a general programme) and actual (as practiced by the patient) frequency, leveraging the patient's and physician's opinion about the suggestion for the subsequent week.

The overall recommendation, which is 2, 3, 4, or 5 times per week, is represented by the root attribute *EnduranceFrequency* (Figure 2). The recommendation depends on three sub-criteria:

- 1. *Normative*: Frequency as suggested according to the default programme. It depends on the patient's physical capacity ("low" or "normal" *Category*) and the current *Week*. The progression is defined by rules presented in Table 1.
- 2. *Current*: The frequency of exercises currently carried out by the patient; it can run ahead or behind the *Normative* plan. In order to make only small and gradual changes to the frequency, *Current* is compared to *Normative* and only a one-step change is suggested in each week.
- 3. Transition is an attribute that captures the patient's wish and the physician's opinion about changing the frequency. The possible values are "decrease", "same", "increase" or "automatic"; the latter is meant to suggest the frequency according to the normal plan, for instance, when neither the patient or physician have given any suggestion. The patient's and physician's suggestions are combined according to decision rules shown in Table 2. The first two rules say that whenever the patient or the physician suggest to decrease the frequency, it should indeed be decreased (the symbol '*' represents any possible value). Rules 3 and 4 suggest to keep the current frequency whenever one of the participants suggests so, unless the other participant suggests "decrease" Rules 5 and 6 define a similar reasoning for "increase". If both participants have no particular suggestions, the "automatic" transition according to the normal plan takes place.

Table 1: Decision table defining the Normative frequency.

	Category	Week	Normative
1	low	<=4	2x
2	low	5-12	3x
3	normal	<=6	3x
4	low	13-18	4x
5	normal	7–12	4x
6	low	>=19	5x
7	normal	>=13	5x

	MedicalAssessment	PatientsAssessment	Transition
1	decrease	*	decrease
2	*	decrease	decrease
3	stay	not decrease	stay
4	not decrease	stay	stay
5	increase	increase or automatic	increase
6	increase or automatic	cincrease	increase
7	automatic	automatic	automatic

3.3 Daily Exercise Management

Once a weekly plan has been established, the HeartMan DSS assists the patient in carrying out their daily exercises. This consists of four activities: (1) reminding the patient, (2) pre-

exercise checking, (3) exercise monitoring, and (4) post-exercise assessment.

3.3.1 Reminding the patient

Patients can choose the days when they want to exercise (e.g., every Tuesday, Thursday and Sunday). On these particular days, the patients are at some predefined morning time reminded about the daily exercise. Another reminder is issued if the exercise has not been completed before the given afternoon time.

3.3.2 Before the exercise

Before the start of each exercise session, the HeartMan DSS checks if all prior-exercise requirements are met, and advises the patients about safety. Figure 3 shows the decision model.





- 1. *Information requirements:* The blood pressure should have been measured during the day. If not, the patients are instructed to measure it. The pre-exercise heart rate is measured automatically by the wristband; the system makes sure that it is actually worn.
- 2. Medication requirements: Patients are asked to fill a check-list of frequently seen side effects based on their medication schemes and symptoms (e.g., dizziness and chest pain). On this basis the DSS checks for any possible restrictions due to medications or symptoms and suggests rescheduling the session if necessary. The physician or nurse are contacted if severe side effects are present. In the case of dizziness or chest pain, patients are instructed to rest until the symptoms are no longer present.
- 3. Physiological requirements: If all the requirements are met, patients can start with the exercise, otherwise they are instructed to repeat the measurements after five minutes of rest. If after re-checking the measurements are still not within safe limits, exercise is not allowed and patients are advised to contact their physician or heart failure nurse.

Again, a DEX [3, 6] model is employed for assembling and checking the medical conditions, which include medical intake, comorbidities and current physical condition of the patient. The structure and scales of the *PreExerciseRequirements* model are shown in Figure 4. All attributes are binary ("yes"/"no" or "not_met"/"met"). The values of the input attributes are

determined from patient data whenever the pre-exercise requirements are checked (normally once per day before making exercises). The subtrees of the model comprise four main groups of possible reasons against participating in the exercises:

- Blood coagulation: Whenever the patient takes anticoagulants and there are symptoms indicating a possible bleeding: rash, hemorrhages, or neurological symptoms.
- *Medication intake*: Whenever one of the following medications has been taken 2 hours or less before the exercise: beta blockers, ACE inhibitors, ARBs, diuretics, or loop diuretics.
- *Heart rate*: Whenever the patient takes Digitalis and his/her HR is less than 45 bpm.
- *Blood pressure*: Whenever there are risks of hypertension (taking ACE inhibitors or ARBs, and the patient has persistent low blood pressure or persistent cough) or problems regarding the systolic blood pressure (when the patient's systolic blood pressure is less than 105 and he/she recently took loop diuretics).

Attribute	Scale
PreExerciseRequirements	not_met; met
BloodCoagulationReasons	yes; no
-TakesAnticoagulats	yes; no
PossibleBleeding	yes; no
Rash	yes; no
Hemorrhages	yes; no
NeurologicalSymptoms	yes; no
MedicationIntakeReasons	yes; no
-Intake<2hours	yes; no
ExercisePreventionMedications	yes; no
-TakesBetaBlockers	yes; no
TakesACEInhibitors	yes; no
TakesARBs	yes; no
TakesDiuretics	yes; no
TakesLoopDiuretics	yes; no
HeartRateReasons	yes; no
-TakesDigitalis	yes; no
⊢HR<45	yes; no
BloodPressureReasons	yes; no
HypertensionReasons	yes; no
—TakesACEInhibitors	yes; no
-TakesARBs	yes; no
PersistentLowBloodPressure	yes; no
└─PersistentCough	yes; no
SystolicPressureReasons	yes; no
—TakesLoopDiuretics	yes; no
TookLoopDiuretics	yes; no
└─SYS<105	ves: no

Figure 4: Structure of the *PreExerciseRequirements* model.

3.3.3 During the exercise

If the exercise is allowed, a list of exercises is shown to the patient, who can then select the preferred exercise. After selecting the exercise, a detailed description (text or graphical) regarding the exercise is provided.

During the exercise, the heart rate and systolic blood pressure are continuously measured by the wristband. The patients are advised to stop the exercise in case of symptoms or measurements lying outside of prescribed safety margins. If the heart rate is within the safety limits, but too low or too high, the patent is advised to increase or decrease the intensity, respectively. The system also advises the patients about the exercise duration and is capable of recognizing a premature ending.

3.3.4 After the exercise

After completing the exercise, the patients can rate their feeling of intensity (very light, light, moderate, intense, very intense). Then the system assesses the exercise based on measurements recorded during the exercise. It checks if the exercise was prematurely finished and if the intensity was on average in the prescribed limits. The system takes into account this information when assessing the adherence to the exercise plan and the patient's improvement. Independent of this, the exercise is shown as completed and the weekly plan is updated.

4. CONCLUSION

This paper described the design of the HeartMan DSS that is concerned with "medical" interventions (i.e., interventions that try to improve the patients' physical condition as opposed to psychological). The DSS is based on clinical guidelines for the self-management of CHF, additional medical literature and expert knowledge from the project consortium. The DSS is designed in terms of process models (the order of actions and questions) and decision models (how to make some complex decisions – branching in the process models) for five main topics of CHF management: physiological measurements, exercise, nutrition, medication, and environment management.

The DSS is currently being integrated in the overall HeartMan platform. A comprehensive validation involving 120 CHF patients (of whom 40 are controls without the DSS) is planned for 2018.

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Continuous Blood Pressure Estimation from PPG Signal

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ABSTRACT

Given the importance of blood pressure (BP) as a direct indicator of hypertension, regular monitoring is encouraged in people and mandatory for such patients. We propose an approach where photoplethysmogram (PPG) is recorded using a wristband in a non-obtrusive way and subsequently BP is estimated continuously, using regression methods based solely on PPG signal features. The approach is validated using two distinct datasets, one from a hospital and the other collected during every-day activities. The best achieved mean absolute errors (MAE) in a Leave-one-subject-out experiment with personalization are as low as 11.87 ± 12.31 / 11.09 ± 9.99 for systolic BP and 5.64 ± 5.73 / 6.18 ± 4.85 for diastolic BP.

Keywords

Photoplethysmography, blood pressure, regression analysis, m-health

1. INTRODUCTION

According to the World Health Organization (WHO), cardiovascular diseases were the most common cause of death in 2015, responsible for almost 15 million deaths combined [1]. Hypertension is a common precursor of such diseases and can be easily detected with regular blood pressure (BP) measurements.

Given the importance of BP, people should actively monitor its changes. This is not trivial as the traditional "gold standard"BP measurement method involves an inflatable cuff, which should be correctly placed directly above the main artery in the upper arm area, at approximately heart height [9]. These requirements impose relatively strict movement restrictions on the patient and require substantial time commitment. Furthermore, when done by the patient himself, the process can cause stress, which in turn influences the BP values, so it is most commonly done by medical personnel. However, when BP is measured by medical personnel, this can again cause anxiety in the patient, commonly known as white coat syndrome.

Our work focuses on analyzing the photoplethysmogram (PPG) and then developing a robust non-obtrusive method for continuous BP estimation, which will be implemented and used in an m-health system, based on a wristband with a PPG sensor.

2. RELATED WORK

Photoplethysmography is a relatively simple and affordable technique, which is becoming increasingly popular in wearables for heart rate estimation. Exploring its applications, we can see that it is also becoming more widely used in BP estimation in one of two common approaches: 1.) BP estimation from two sensors (PPG + Electrocardiogram (ECG)) or 2.) BP estimation using PPG only.

PPG is based on illumination of the skin and measurement of changes in its light absorption. It requires a light source (typically a light-emitting diode – LED light) to illuminate the tissue (skin), and a photodetector (photodiode) to measure the amount of light either transmitted or reflected to the photodetector. Thus, PPG can be measured in either transmission or reflectance mode. With each cardiac cycle the heart pumps blood towards the periphery of the body, producing a periodic change in the amount of light that is absorbed or reflected from the skin, as the skin changes its tone based on the amount of blood in it [6].

The first approach suggests the use of two sensors, typically an ECG and a PPG sensor, in order to measure the time it takes for a single heart pulse to travel from the heart to a peripheral point in the body. This time is commonly known as pulse transit time (PTT) or pulse arrival time (PAT) and its correlation with BP changes is well established [2].

The more recent approach is focused on PPG signal only, however the relationship between PPG and BP is only postulated and not well established, unlike the relationship between PTT and BP. This approach is the least obtrusive by far and PPG sensors have recently become very common in most modern wristbands.

One of the earliest attempts at this approach was conducted by Teng et. al. [3] in 2003. The relationship between arterial blood pressure and certain features of the photoplethysmographic (PPG) signals was analyzed. Data was obtained from 15 young healthy subjects in a highly controlled laboratory environment, ensuring constant temperature, no movement and silence. The mean differences between the linear regression estimations and the measured BP were 0.21 mmHg for SBP and 0.02 mmHg for DBP. The corresponding standard deviations were 7.32 mmHg for SBP and 4.39 mmHg.

A paper was published in 2013 in which authors used data

from Multiparameter Intelligent Monitoring in Intensive Care (MIMIC) waveform database [4] to extract 21 time domain features and use them as an input vector for artificial neural networks (ANNs). The results are not quite as good as the linear regression model described earlier, however the data is obtained from a higher number and variety of patients in a less controlled environment, but was still measured in a hospital setting and an undisclosed subsample of all available data was taken. The results reached mean absolute difference between the estimation and the ground truth of less than 5 mmHg with standard deviation of less than 8 mmHg [5].

It is clear that the PPG only approach has potential, however a robust method that works well on a general case is yet to be developed.

3. METHODOLOGY

The workflow consists of two main parts, namely the signal pre-processing and machine learning part. In signal preprocessing, our PPG signal is cleaned of most noise and segmented into cycles, where one cycle corresponds to a single heart beat. Afterwards, features are extracted on per-cycle basis and fed into regression algorithms which build models that are further evaluated.

3.1 Signal pre-processing

When PPG is used in a wristband, the main problem comes from the contact between the sensor and the skin. During everyday activity, the patient moves his arm a lot, which in turn causes substantial movement artefacts in the signal. This is partially alleviated by the usage of green light, which is less prone to artefacts, however pre-processing is still required.

3.1.1 Cleaning based on established medical criteria

In first phase, both BP and PPG signal are roughly cleaned based on established medical criteria [8]. During this phase, parts of signals with systolic BP (SBP) > 280mmHg or diastolic BP (DBP) < 20mmHg or the difference between SBP and DBP < 20mmHg, are removed. This removes parts of signals for which the reference BP signal most likely contained an anomaly as such values indicate extreme medical condition and are not feasible in a common patient.

3.1.2 Peak and cycle detection

In order to do further cleaning and feature extraction, PPG cycle detection is mandatory. This is again not trivial, as substantial noise in the PPG signal poses a significant problem.

A slope sum function, which enhances the abrupt upslopes of pulses in the PPG signal is first created. Afterwards, a timevarying threshold for peak detection is applied [7]. After the peaks are detected, finding the cycle start-end indices is rather simple as the valleys between peaks must be found. An example of detected peaks and cycle locations is shown in Figure 1.

Once cycles are detected, they are used for further cleaning and feature extraction.



Figure 1: An example output of peak/cycle detection algorithm on PPG signal. Black asterisks correspond to a detected peak while red circles correspond to a detected cycle beginning.

3.1.3 Cleaning based on ideal templates

In the second cleaning phase, a sliding window of 30 seconds is taken and the mean of all cycles within this window is computed from the PPG signal. Presuming that the majority of cycles within a 30sec window are not morphologically altered, a good "ideal cycle template" is created. Each individual cycle is then compared to this ideal template and its quality is evaluated with three signal quality indices (SQIs). The most likely length of cycle L is always determined with autocorrelation analysis. The template is computed by always taking L samples of each cycle in the current window.

Signal quality indices are computed as follows. SQI1: First L samples of each cycle are taken, and each cycle is directly compared to the template using a correlation coefficient. SQI2: Each cycle is interpolated to length L and then the correlation coefficient is computed. SQI3: The distance between template and cycle is computed using dynamic time warping (DTW).

Finally thresholds for each SQI are determined and if more than half cycles in the given 30sec window are discarded, the whole window is considered too noisy and thus removed. Example of this cleaning is shown in Figure 2.

Once high quality signal is obtained, features can be extracted from each cycle.

3.2 Machine learning

In accordance with related work [5] several time domain features were computed and the set of features was further expanded with some from the frequency domain [8]. These are shown in Figure 3.

These features were extracted for each cycle and used in machine learning to derive a regression model for BP estimation.

4. EXPERIMENTS AND RESULTS

In an effort to make our method as general as possible, two datasets were considered for our experiment and all the data which had both PPG and BP signal were used.

4.1 Data

First is the publicly accessible MIMIC database set from which all the patients having both PPG and arterial BP



Figure 2: An example of the cleaning algorithm in the 2nd phase. Comparing the top (uncleaned) and bottom (cleaned) signal, we see that the obvious artefact period is discarded.



Figure 3: Time domain features which were used. Tc = cycle time, Ts = systolic rise time, Td = diastolic fall time, AAC = area above the curve and AUC = area under the curve for systolic and diastolic part of a cycle.

(ABP) signal were taken. This results in 50 anonymous patients, each having on average several hours of both signals available. The data was collected in a hospital environment, using the hospital equipment.

Second is a dataset collected at Jozef Stefan Institute (JSI) using the Empatica E4 wristband for PPG and an Omron cuff-based BP monitor for the ground truth BP, as is common in related work [3]. The collection procedure was conducted in accordance with recommended clinical protocol [9], ensuring correct placement of the cuff on upper arm with the sensor above the main artery and its location at approximately heart height. The subjects were in a sitting upright position during the measurements, thus following the protocol as best as possible. Ideally, arterial BP would be measured in the artery as ground truth, however due to invasive nature of the procedure, this is not feasible in an everyday life situation, so an upper arm cuff-based digital monitor was used as a good replacement. These devices are superior to wrist cuff-based monitors, as wrist devices are less accurate and extremely sensitive to body position.

In the first phase of data collection, 8 healthy subjects were considered, 5 male and 3 female. Each wore the wristband for several hours during every-day activities and measured their BP every 30min or more often. Finally, only parts of signals 3 minutes before and after the BP measurement were taken into consideration.

4.2 Experimental setup

Leave-one-subject-out experiment was conducted on each dataset, as it is the most suitable experiment to evaluate the generalization performance of the algorithms. Due to time and computational power restrictions, data was subsampled by taking 500 uniformly selected cycles.

During the initial attempt, a regression model was trained in each iteration on all subjects, except the left out. This yielded poor results, hinting at the fact, that most patients are unique in some way. This was confirmed by doing a cycle morphology analysis during which it was established that different subjects have different cycle shapes and that similar cycle shapes do not signify similar BP values. Thus, personalization of the trained models was considered.

In the second attempt, the regression models were again trained using all subjects except the left out, however they were further personalized using some data instances from the left out subject. The instances of the left out subject were first grouped by BP values and these groups were then sorted from lowest to highest BP. Afterwards, every n-thgroup (n = 2, 3, 4, 5, 6) of instances was taken from the testing data and used in training in order to personalize the model to the current patient. This ensures personalization with different BP values, as taking just a single group of instances gives little information, since the BP will be constant within this group. Given the fact that MIMIC data consists of roughly 5x the amount of patients compared to JSI collected data, the personalization data for it was multiplied 5 times, making it noticable within the large amount of training data from the remaining patients.



Figure 4: MAE for SBP and DBP for MIMIC dataset at different amounts of personalization.



Figure 5: MAE for SBP and DBP for JSI collected dataset at different amounts of personalization.

During both attempts, several regression algorithms were considered, as given in Figures 4 and 5. Mean Absolute Error (MAE) was used as a metric. All models were compared with a dummy regressor, which always predicted the mean BP value of the same combination of general and personalization data as the other models used to train themselves. Finally, the regressor with the lowest MAE was chosen.

For successful personalization, the user should measure his PPG continuously and also make a few periodic measurements of his BP using a reliable commercial device. This allows the model to personalize to the user, learning from a small sample of his labeled data, thus improving its predictive performance.

4.3 Results

Due to low variations in BP, the dummy regressor often performs relatively well, however for MIMIC data with more BP variation, some improvements have been made as shown in Figure 4. The JSI collected data has proven to be more problematic, as there are only a low amount of different BP values in this phase of collection.

The lowest error using MIMIC data was achieved by using the Random Forest regression algorithm, with the highest amount of personalization. The achieved errors were $11.87\pm$ 12.31 for SBP and 5.64 ± 5.73 for DBP.

Due to high amount of movement artefacts in JSI collected data, a lot of data was removed by the cleaning algorithm, leaving a very low amount of usable data with very low variations in BP. This further enhanced the performance of dummy regressor, while leaving little information for other algorithms. Best achieved errors of 11.09 ± 9.99 for SBP and 6.18 ± 4.85 for DBP are only slightly surpassing the mean predictions at maximum personalization, as shown in Figure 5.

5. CONCLUSION

We have developed a pipeline for BP estimation using PPG signal only and have evaluated its performance on two distinct datasets.

First part of the pipeline does signal pre-processing, removing most movement artefacts and detecting PPG cycles. The second part computes features on per-cycle basis and feeds them in regression algorithms. These were evaluated on hospital collected MIMIC database data as well as field collected data at JSI using a wristband. Due to low variations in subject's BP and high variation in their PPG, there is limited information about the correlation between the two, however promising results were obtained with best achieved mean absolute errors (MAE) in a Leave-one-subject-out experiment with personalization as low as $11.87 \pm 12.31 / 11.09 \pm 9.99$ for systolic BP and $5.64 \pm 5.73 / 6.18 \pm 4.85$ for diastolic BP.

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Recognizing Hand-Specific Activities with a Smartwatch Placed on Dominant or Non-dominant Wrist

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ABSTRACT

In this paper we analyze the use of accelerometer-equipped smartwatch to recognize hand-specific activities. We start with a large set of activities, and since many activities have a similar acceleration pattern, we gradually group semantically similar activities to find a tradeoff between the accuracy on one hand, and semantically understandable and useful activity groups on the other hand. Additionally, we compare the activity recognition in terms of the number of activities and accuracy when wearing a smartwatch on the dominant or non-dominant wrist. The preliminary results show that we can recognize up to seven groups of activities with the dominant, and up to five activity groups with the non-dominant wrist.

Categories and Subject Descriptors

D.3.3 [Human-centered computing]: Ubiquitous and mobile computing

Keywords

Activity recognition, wrist wearable, machine learning, accelerometers

1. INTRODUCTION

Activity recognition is an important module in person oriented intelligent systems, since most of the further reasoning or assistance to the user depends on the user's current or past activity. This dependency is highly significant in applications intended for the management of lifestyle and sports activities [6], as well as chronic diseases such as diabetes or chronic heart failure (CHF). In diabetes, the user needs to monitor two particular activities, the eating (which increases the blood glucose level) and exercise (which decreases the blood glucose) [1] and in CHF it is important to monitor the food intake (eating) as well as exercise in terms of its intensity and amount of rest [4].

Due to importance of activity recognition and availability of accelerometer equipped wearables it is not surprising that the research area is very popular and partially also very mature. The maturity of the area is shown in the amount of applications and wearable devices dedicated to activity monitoring available on the market [2, 3]. However, these applications and devices mostly recognize three activities (walking, running and rest), which is insufficient for applications in which e.g., eating or any other hand-oriented activities are important. In this paper we analyze and evaluate a possibility to use accelerometer equipped smartwatch to recognize a large set of hand-oriented activities. Since many activities have similar pattern we gradually group semantically similar activities into single activity group to find a tradeoff between accuracy and semantically understandable activity groups. Additionally, we compare the activity recognition in terms of number of activities and accuracy when wearing a smartwatch on dominant or non-dominant wrist.

The paper is structured as follows. Section 2 presents the related work on activity recognition, Section 3 introduces the dataset and methods for preprocessing and training the models. The evaluation results are present in Section 4 and Section 5 concludes the paper.

2. RELATED WORK

Pioneers in activity recognition research studied use of single or multiple accelerometers attached to different locations on the users body. Attal et al. [5] reviewed the research done until 2015 and proved that number of recognized activities increases with the number of sensors attached to the users body. Since using one or more dedicated accelerometers was perceived as unpractical, the researchers started using devices that most people already have or will have in the future, such as smartphones and wristbands.

Research on activity recognition with the smartphone mostly covers analysis of accelerometer signals without any knowledge of its orientation, thus recognizing only small fraction of activities (walking, running, rest, etc.) [11]. Martin et al. [10] was first to take varying orientation and location into consideration. Their approach requires use of all available smartphone sensors to estimate the location and normalize the orientation. In our recent research [8], we proposed a real-time method that normalizes the orientation, detects the location and afterward uses a location specific machinelearning model for activity recognition.

The research on activity recognition with wrist-worn devices has started with the accelerometer placed on a persons wrist [5]. Since this is the most comfortable placement of the sensor, the research became popular for recognizing sports activities [12] and common activities (sitting, standing, lying, walking, running) [7]. However, none of the research focused on recognizing hand-specific activities (e.g., eating, washing, hammering, etc.), which is the topic of this paper.

3. MATERIALS AND METHODS

3.1 Dataset

Dataset contains data of 11 volunteers equipped with two smartwatches with accelerometer and a heart rate sensor (one on each wrist), performing a predefined scenario. Average accelerometer sampling rate was 48.2 Hz (\pm 4.4) for the left hand and 51.3 Hz (\pm 14.2) for the right hand.

The scenario contained 39 different activities, but not all were performed by each volunteer. Figure 1 presents the distribution of data in terms of number of learning instances in the dataset and in terms of people performing the activity (see Section refpreprocess). We collected approximately two hours of data per person. We can observe that some activities were performed by one person only, which is insufficient for training the models and evaluating them using leave-onesubject-out approach. Omitting these activities left us with 30 activities, due to errors in data collection we also had to omit the mobile use, phone call, clapping, white board and rolling dice. This left us with 25 activities for further analysis.



Figure 1: Number of instances per activity (y axis)and number of people performing the activity (x axis)

3.2 Preprocessing

The goal of the preprocessing procedure is to combine the accelerometer and heart rate data received from the smart-watch into form suitable for further use with machine-learning algorithms (feature vectors).

The raw acceleration and heart rate data is first segmented into 2-second windows, each next overlapping by half of its size, from which we extract 90 acceleration features and 4 heart rate features. In brief, the raw acceleration data is first filtered (low-pass and band-pass) to remove noise and gravity. The data is then used for calculation of physical (e.g., velocity, kinetic energy, etc.), statistical features (e.g., the mean, variance, etc.) and features based on signal processing expert knowledge (e.g., number of peaks in a signal, etc.). The reader is referred to [8] for more details about the feature extraction. Once the features are extracted, they are used to form a feature vector to be used for machinelearning.

3.3 Method

Activity recognition is set as a classification task, performed in real-time. The feature vector formed during the feature extraction (Section 3.2) is feed into a classification machinelearning model trained to recognize the activities.

The collected dataset contains data labeled with 25 activities for each wrist. To design an accurate classifier, we had to solve two challenges: (i) the difference in movement of dominant and non-dominant hand during the same activity (e.g., drinking, eating, writing, etc.), and (ii) similar hand movement when performing different activities. We decided to develop two classification models, one for each wrist according to dominance to solve the first challenge. For the second challenge we analyzed the possibility to semantically group the activities, thus achieve higher recognition accuracy but still keep understandability of the recognized activity.

To select the machine-learning classification algorithm to be used for training the models, we have first evaluated the classification accuracy of five different machine-learning algorithms as implemented in Weka suite [9] (J48, SVM, JRip, Random Fores and Naïve Bayes) on the dataset with 25 activities. All experiments are done with Leave-One-Subject-Out approach (LOSO). As in our previous activity monitoring research, the Random Forest achieved the best results and was chosen for all further experiments.

Once the machine-learning algorithm was chosen we analyzed the possible grouping of the activities according to dominance. We started with the dominant hand, the grouping of which is presented in Figure 2. We start by gradually grouping the most similar activities together and evaluating the impact on accuracy. We first group the activities that seem the most similar. All upper hand movements used in face hygiene are grouped together, next are the eating activities, sports and activities similar to writing. The final three groups are the activities where the person plays games or the hand gesture is of low intensity. We also tried to group home chores into low and high intensity, which turned out less accurate then if grouping all home chores together. With this approach we divided all 25 activities into 7 groups or classes to be recognized when smartwatch is worn on dominant hand. Results of each iteration is presented in Section 4.

The same approach was used to group activities to be recognized by non-dominant hand (Figure 3). We grouped the sports activities, eating activities, all chores activities to-



6 7 8 9 10 11 12 13 Tennis Vollevball Sport Walking Eating with Eating Fating Eating apple Drinking Brushing teeth Cleaning surface Hammering Sawing Chore Using screwdriv Cooking Vacuuming Watering flowe Computer use Reading Writing Writing Drawing Rubik cube Origami Game Lego blocks Chess Washing face Washin Washing hand

Figure 2: Grouping of activities when smartwatch is worn on a dominant hand.

gether. The activities that were left were very similar in terms of non-dominant hand movement. We tried to distinguish between activities which are similar to writing and games activities, but this decreased the accuracy compared to grouping the two types of activities into single group (hand work). The last group of activities contains the washing activities. With this approach we divided all 25 activities into 5 groups or classes to be recognized when smartwatch is worn on non-dominant hand. The results of each iteration are presented in Section 4

Apart from evaluating the classification models for each wrist on dedicated grouping of activities, we have also evaluated the use of non-dominant hand activities grouping for training the dominant hand model and vice-versa (denoted as Cross). Both experiments were preformed in two ways:

- By using the machine-learning model trained for the specific wrist directly, namely Default approach (D)
- By smoothing the results using the majority classification in the 10-class sliding window, namely smoothing approach (S). The length of the window was selected arbitrarily.

The results are presented in Section 4.

4. EVALUATION

The goal of the evaluation was to analyze and compare the recognition of the activities according to the retrieved data from the smartwatch worn on the dominant or non-dominant wrist. Additionally, we wanted to evaluate and get an insight into type of activities that can be recognized in respect to the hand dominance. The evaluation was performed with Random Forest algorithm in leave-one-subject out (LOSO)

Figure 3: Grouping of activities when smartwatch is worn on a non-dominant hand.

manner on dataset presented in Section 3.1. The results are presented in Table 1.

First, we evaluated the use of acceleration and heart rate data retrieved from the smartwatch attached to the dominant wrist. We used the default approach (D) introduced in Section 3.3 to evaluate each grouping of the activities. The increase in accuracy while gradually decreasing the number of recognized classes from 25 to seven is presented in Figure 4. As expected the accuracy increased with each subsequent grouping and we have finally settled for seven classes (Dominant wrist (D)). If we apply smoothing (Dominant wrist (S)) we gain 3 percentage points in accuracy. Finally, we evaluated the recognition of seven classes with non-dominant wrist data, which returned poor accuracy of 58% when default (D) method was used and 63.7% when smoothing was applied (Figure 4 Cross: Non-dominant wrist (S)).

The same approach was used to define the classes to be recognized with non-dominant hand. We first used the default approach (D) on each grouping of the activities which resulted in five final classes. The process of grouping and respective accuracy is presented in Figure 4 (Non-dominant wrist (D)). When smoothing is applied (Non-dominant wrist (S)) we gain 4 percentage points in accuracy. Finally, we evaluated the recognition of five classes with dominant wrist data, which as expected returned higher accuracy then with seven classes (76% when default (D) method was used and 84% when smoothing was applied (Figure 4 Cross: Dominant wrist (S)).

Table 1: Evaluation of activity recognition. Themethods: D=default, S=smoothed.

Wrist (method)	Accuracy [%]	# classes
Dominant (D)	71	7
Dominant (S)	79	7
Cross: Non-dominant (D)	58	7
Cross: Non-dominant (S)	64	7
Non-Dominant (D)	70	5
Non-Dominant (S)	74	5
Cross: Dominant (D)	76	5
Cross: Dominant (S)	84	5



Figure 4: The grouping of activities and accuracy.

5. CONCLUSION

We presented a feasibility study of recognizing hand-specific activities using data retrieved from smartwatch on dominant or non-dominant wrist. We start with large set of hand-specific activities and gradually decrease the number of activities by semantically grouping them together. The preliminary results show that we can recognize larger set of activity groups if we use data from the smartwatch worn on dominant wrist (7 activity groups) then using data from the smartwatch worn on non-dominant wrist (5 activity groups).

Since these are only preliminary results, which gave us a feasibility insight, we will need to repeat the data collection procedure to collect more samples of already recorded activities as well as record additional activities (e.g., sport-specific, home-chores specific, etc.). To achieve higher accuracy, we will also need to perform feature selection procedure and analyze which features are relevant for the task. Finally, we will need to merge the dataset with other datasets that contain non-hand-specific activities and probably design more complex algorithm to achieve good results.

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R-R vs GSR – An inter-domain study for arousal recognition

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ABSTRACT

Arousal recognition is an important task in mobile health and human-computer interaction (HCI). In mobile health, it can contribute to timely detection and improved management of mental health, e.g., depression and bipolar disorders, and in HCI it can enhance user experience. However, which machine-learning (ML) methods and which input is most suitable for arousal recognition, are challenging and open research questions, which we analyze in this paper.

We present an inter-domain study for arousal recognition on six different datasets, recorded with twelve different hardware sensors from which we analyze galvanic skin response (GSR) data from GSR sensors and R-R data extracted from Electrocardiography (ECG) or blood volume pulse (BVP) sensors. The data belongs to 191 different subjects and sums up to 150 hours of labelled data. The six datasets are processed and translated into a common spectro-temporal space, and features are extracted and fed into ML algorithms to build models for arousal recognition. When one model is built for each dataset, it turns out that whether the R-R, GSR, or merged features yield the best results is domain (dataset) dependent. When all datasets are merged into one and used to train and evaluate the models, the R-R models slightly outperformed the GSR models.

Keywords

Arousal recognition; GSR; R-R; machine learning; health.

1. INTRODUCTION

The field of affective computing [1] has been introduced almost two decades ago and yet modeling affective states has remained a challenging task. Its importance is mainly reflected in the domain of human-computer interaction (HCI) and mobile health. In the HCI, it enables a more natural and emotionally intelligent interaction. In the mobile health, it contributes to the timely detection and management of emotional and mental disorders such as depression, bipolar disorders and posttraumatic stress disorder. For example, the cost of work-related depression in Europe, was estimated to ϵ 617 billion annually in 2013. The total was made up of costs resulting from absenteeism and presenteeism (ϵ 272 billion), loss of productivity (ϵ 242 billion), health care costs of ϵ 63 billion and social welfare costs in the form of disability benefit payments (ϵ 39 billion) [2].

Affective states are complex states that results in psychological and physiological changes that influence behaving and thinking [3]. These psycho-physiological changes can be captured by a wearable device equipped with GSR, ECG or BVP sensor. For example, the emotional state of fear usually initiates rapid heartbeat, rapid breathing, sweating, and muscle tension, which are physiological signs that can be captured using wearables. The affective states can be modeled using a discrete or a continuous approach. In the discrete approach, the affect (emotions) is represented as discrete and distinct state, i.e., anger, fear, sadness, happiness, boredom, disgust and neutral. In the continuous approach, the emotions are represented in 2D or 3D space of activeness, valance and dominance [3]. Unlike the discrete approach, this model does not suffer from vague definitions and fuzzy boundaries, and has been widely used in affective studies [4] [5] [6]. The use of the same annotating model allows for an inter-study analysis.

In this study we examine arousal recognition from GSR and heart-related physiological data, captured via: chest-worn ECG and GSR sensors, finger-worn BVP sensor, and wrist-worn GSR sensor and pulse oximeter (PPG) sensor. The data belongs to six publicly available datasets for affect recognition, in which there are 191 different subjects (70 females) and nearly 150 hours of arousal-labelled data.

All of this introduces the problem of inter-domain learning, to which ML techniques are sensitive. To overcome this problem, we use preprocessing techniques to translate the datasets into a common spectro-temporal space of R-R and GSR data. After the preprocessing, R-R and GSR features are extracted and are fed into ML algorithms to build models for arousal recognition. Finally, the results between different experimental setups are compared, i.e., models that use only R-R features, models that use donly GSR features and models that use both R-R and GSR features. This comparison is performed in a dataset-specific setup and merged setup where all datasets are merged in one. At the end, the experimental results are discussed and the study is concluded with remarks for further work.

RELATED WORK

Affect recognition is an established computer-science field, but many remaining challenges. Many studies confirmed that affect recognition can be performed using speech analysis [21], video analysis [8], or physiological sensors in combination with ML. The majority of the methods that use physiological signals use data from ECG, electroencephalogram (EEG), functional magnetic resonance imaging (fMRI), GSR, electrooculography (EOG) and/or BVP sensors.

In general, the methods based on EEG data outperform the methods based on other data [4] [5], probably due to the fact the EEG provides a more direct channel to one's mind. However, even though EEG achieves the best results, it is not applicable in normal everyday life. In contrast, affect recognition from R-R intervals or GSR data, is much more unobtrusive since this data can be extracted from ECG sensors, BVP sensors, PPG or GSR sensors, most of which can be found in a wrist device (e.g., Empatica [9] and Microsoft Band [10]). Regarding the typical ML

approaches for affect recognition, Iacoviello et al. have combined discrete wavelet transformation, principal component analysis and support vector machine (SVM) to build a hybrid classification framework using EEG [11]. Khezri et al. used EEG combined with GSR to recognize six basic emotions via K-nearest neighbors (KNN) classifiers [12]. Verma et al. [13] developed an ensemble approach using EEG, electromyography (EMG), ECG, GSR, and EOG. Mehmood and Lee used independent component analysis to extract emotional indicators from EEG, EMG, GSR, ECG, and (effective refractory period) ERP [14]. Mikuckas et al. [15] presented a HCI system for emotional state recognition that uses spectro-temporal analysis only on R-R signals. More specifically, they focused on recognizing stressful states by means of the heart rate variability (HRV) analysis.

However, a clear comparison between ML methods for affect recognition from unobtrusively captured sensor data (e.g., R-R vs. GSR data) has not been presented yet, since most of these studies focused on only one dataset and a combination of the sensor data, aiming towards the highest performance and disregarding the obtrusiveness of the system. In this work, we analyze which ML algorithms in combination with which data type (either R-R intervals or GSR) would yield best performance across six different datasets (domains) for arousal recognition.

2. DATA

The data belongs to six publicly available datasets for affect recognition: Ascertain, Deap, Driving workload dataset, Cognitive load dataset, Mahnob, and Amigos. Overall, nearly 150 hours of arousal-labelled data that belong to 191 subjects. Table 1 presents the number of subjects per dataset, the mean age, number of trials per subject, mean duration of each trial, duration of data per subject - in seconds, and overall duration.

					Duration per		
Dataset	Subjects	Females	Mean age	Trials	trial [s]	subject [min]	dataset [h]
Ascertain	58	21	31	36	80	48.0	46.4
DEAP	32	16	26.9	40	60	40.0	21.3
Driving	10	3	35.6	1	1800	30.0	5.0
Cognitive	21	0	28	2	2400	80.0	28.0
Mahnob	30	17	26	40	80	53.3	26.7
Amigos	40	13	28	16	86	22.9	15.3
Overall	191	70	29.25	135	884.0	251.3	142.7

The four datasets, Ascertain, Deap, Mahnob and Amigos, were already labelled with the subjective arousal level. One difference between these datasets was the arousal scale used for annotating. For example, the Ascertain dataset used 7-point arousal scale, whereas the Deap dataset used 9-point arousal scale (1 is very low, and 9 is very high). From the both scales, we split the labels in the middle, which is the same split used in the original studies. Similar step was performed for the Mahnob dataset. The two datasets, Driving workload and Cognitive load, did not contain labels for subjective arousal level. The Driving workload dataset was labelled with subjective ratings for a workload during driving session. For this dataset, we presume that increased workload corresponds to increased arousal. Thus, we used the workload ratings as an arousal ratings. The split for high arousal was put on 60%. Similarly, the cognitive load dataset was labelled for subjective stress level during stress inducing cognitive load tasks (mathematical equations). The subjective scale was from 0 to 4 (no stress, low, medium and high stress). We put the limit for high arousal on 2 (medium stress).

3. METHODS

3.1 Pre-processing and feature extraction

3.1.1 R-R data

The preprocessing is essential, since it allows merging of the six different datasets. For the heart-related data, it translates the physiological signals (ECG or BVP) to R-R intervals and performs temporal and spectral analysis. First, a peak detection algorithm is applied to detect the R-R peaks. Next, temporal analysis, i.e., calculating the time distance between the detected peaks, detects the R-R intervals. Once the R-R intervals are detected they can be analyzed as a time-series. First, each R-R signal is filtered using median filter. After the median filter, person specific winsorization is performed with the threshold parameter of 3 to remove outlier R-R intervals. From the filtered R-R signals, periodogram is calculated using the Lomb-Scargle algorithm [7]. The Lomb-Scargle algorithm is used for spectral analysis of unequally spaced data (as are the R-R intervals). Finally, the following HRV features were calculated from the time and spectral representation of the R-R signals: meanHR, meanRR, sdnn, sdsd, rmssd, pnn20, pnn50, sd1, sd2, sd1/sd2, lf, hf, lf/hf [29].

3.1.2 GSR data

To merge the GSR data, several problems were addressed. Each dataset is recorded with different GSR hardware, thus the data can be presented in different units and different scales. To address this problem, each GSR signal was converted to μ S (micro Siemens). Next, to address the inter-participant variability of the signal, person-specific min-max normalization was performed, i.e., each signal was scaled to [0, 1] using person specific winsorized minimum and maximum values. The winsorization parameter was set to 3. Finally, the GSR signal was filtered using lowpass filter with a cut-off frequency of 1HZ.

The filtered GSR signal was used to calculate the following GSR features: mean, standard deviation, 1st and 3rd quartile (25th and 75th percentile), quartile deviation, derivative of the signal, sum of the signal, number of responses in the signal, rate of responses in the signal, sum of the responses, sum of positive derivative, proportion of positive derivative, derivative of the tonic component of the signal, difference between the tonic component and the overall signal [21].

3.2 Machine learning

After the feature extraction, every data entry consists of 16 R-R features and 14 GSR features, which can be input for typical ML algorithms. Models were built using seven different ML algorithms: Random Forest, Support Vector Machine, Gradient Boosting Classifier, and AdaBoost Classifier, KNN Classifier, Gaussian Naive Bayes and Decision Tree Classifier. The algorithms were used as implemented in the Scikitlearn, the Python ML library [33]. For each algorithm, randomized search on hyper parameters was performed on the training data using 2-fold validation.

4. EXPERIMENTAL RESULTS

Two types of experiments were performed: dataset specific experiments, and experiments with merged datasets. The evaluation was performed using trial-specific 10-fold cross-validation, i.e., the data segments that belong to one trial (e.g.,

one affective stimuli), can either belong only to the training set or only to the test set, thus there was no overlapping between the training and test data.

4.1 Dataset specific

The results for the dataset specific experiments are presented in Table 2. The first column represents the ML algorithm, the second column represents the features used as input to the algorithm (R-R, GSR or Merged - M) and the rest of the columns represent the dataset which is used for training and evaluation using the trial-dependent 10-fold cross-validation. We report the mean accuracy \pm the standard evaluation for the 10 folds. For each dataset, the best performing model(s) is(are) marked with green. For example, on the Ascertain and the Driving workload dataset, the best performing algorithm is the SVM, on the Deap dataset the best performing algorithm is the RF, on the Cognitive Load and the Mahnob datasets the best performing is the NB, and on the Amigos dataset the best performing is the AdaBoost algorithm.

When we compare which input (R-R features, GSR features or Merged-M) provide better accuracy, on two datasets (the Asceratin and the Driving workload) the results are the same, on the Deap dataset, the R-R features provide better results, on the Cognitive Load dataset the highest accuracy is achieved both for the GSR and the Merged features, on the Mahnob dataset the GSR features provide best accuracy and on the Amigos dataset the Merged features.

4.2 Merged datasets

For these experiments, all datasets were merged into one, and the trial-dependent 10-fold cross-validation was used to evaluate the

ML models. The results are presented in Figure 2. The results show that the models that use the R-R intervals as input, consistently outperform the models that use GSR features as input.



5. CONCLUSION AND DISCUSSION

We presented an inter-domain study for arousal recognition on six different datasets, recorded with twelve different hardware sensors. We experimented with dataset specific models and models build on the overall (merged) data. We compared the results of seven different ML algorithms, using three different feature inputs (R-R, GSR or Merged – M features).

Algorithm	Features	Dataset						
Algorithm		Ascertain	Deap	D. Workload	Cog. Load	Mahnob	Amigos	
	R-R	0.655 ± 0.07	0.556 ± 0.03	0.785 ± 0.24	0.739 ± 0.13	0.580 ± 0.11	0.536 ± 0.06	
RF	GSR	0.638 ± 0.06	0.503 ± 0.04	0.780 ± 0.24	0.763 ± 0.12	0.611 ± 0.07	0.473 ± 0.11	
	М	0.653 ± 0.05	0.540 ± 0.04	0.785 ± 0.25	0.755 ± 0.13	0.611 ± 0.10	0.559 ± 0.10	
	R-R	0.664 ± 0.07	0.536 ± 0.05	0.795 ± 0.26	0.717 ± 0.21	0.623 ± 0.15	0.521 ± 0.24	
SVM	GSR	0.664 ± 0.07	0.525 ± 0.05	0.795 ± 0.26	0.712 ± 0.20	0.588 ± 0.10	0.470 ± 0.12	
	М	0.664 ± 0.07	0.513 ± 0.03	0.795 ± 0.26	0.691 ± 0.18	0.623 ± 0.15	0.506 ± 0.13	
	R-R	0.649 ± 0.07	0.554 ± 0.03	0.785 ± 0.20	0.736 ± 0.15	0.578 ± 0.11	0.543 ± 0.06	
GB	GSR	0.642 ± 0.05	0.500 ± 0.04	0.800 ± 0.21	0.743 ± 0.12	0.609 ± 0.08	0.527 ± 0.09	
	Μ	0.644 ± 0.05	0.533 ± 0.03	0.755 ± 0.23	0.761 ± 0.15	0.609 ± 0.11	0.542 ± 0.09	
	R-R	0.658 ± 0.06	0.532 ± 0.02	0.750 ± 0.23	0.718 ± 0.13	0.580 ± 0.09	0.531 ± 0.07	
AdaB	GSR	0.633 ± 0.05	0.485 ± 0.03	0.750 ± 0.22	0.740 ± 0.13	0.589 ± 0.08	0.514 ± 0.09	
	М	0.623 ± 0.05	0.526 ± 0.03	0.755 ± 0.22	0.766 ± 0.16	0.610 ± 0.08	0.560 ± 0.08	
	R-R	0.625 ± 0.05	0.509 ± 0.02	0.710 ± 0.19	0.715 ± 0.13	0.582 ± 0.07	0.509 ± 0.05	
KNN	GSR	0.590 ± 0.06	0.496 ± 0.04	0.795 ± 0.26	0.772 ± 0.09	0.605 ± 0.06	0.533 ± 0.08	
	М	0.600 ± 0.05	0.490 ± 0.02	0.750 ± 0.23	0.770 ± 0.13	0.601 ± 0.09	0.533 ± 0.06	
	R-R	0.654 ± 0.07	0.537 ± 0.04	0.735 ± 0.15	0.748 ± 0.15	0.574 ± 0.06	0.485 ± 0.09	
NB	GSR	0.602 ± 0.04	0.537 ± 0.05	0.540 ± 0.22	0.803 ± 0.09	0.624 ± 0.07	0.454 ± 0.10	
	Μ	0.591 ± 0.04	0.535 ± 0.06	0.665 ± 0.17	0.804 ± 0.12	0.592 ± 0.06	0.486 ± 0.09	
DT	R-R	0.664 ± 0.07	0.519 ± 0.05	0.685 ± 0.17	0.736 ± 0.15	0.597 ± 0.09	0.505 ± 0.06	
	GSR	0.640 ± 0.05	0.542 ± 0.05	0.765 ± 0.22	0.734 ± 0.08	0.583 ± 0.09	0.483 ± 0.11	
	M	0.650 ± 0.05	0.524 ± 0.04	0.615 ± 0.22	0.704 ± 0.09	0.581 ± 0.13	0.551 ± 0.09	

 Table 2. Dataset specific experimental results. Mean accuracy ± stdDev for trial-specific 10-fold cross validation. The best performing models per dataset are marked with green.

The results on the dataset specific setup showed that, out of the ML algorithms tested, none yields the best performance on all datasets. In addition to that, a clear conclusion cannot be made whether the R-R, GSR or the Merged features yield the best results – this is domain (dataset) dependent.

On the merged dataset experiments, the R-R models slightly outperformed the GSR models. This might be due to: (i) having more R-R features that GSR; (ii) having R-R features in frequency domain but no GSR features in frequency domain; (iii) the method for merging the data from the heart-related sensors providing more consistent features across datasets due to less noise in the ECG, BVP data.

In future, we plan to investigate intelligent combinations of ML models in order to gain accuracy. In addition to that, we plan to investigate more advanced techniques such as deep neural networks and transfer learning, which might be able to learn general models that will be able to generalize across different domains. Finally, once we find the best performing scenario, we will generalize the method for arousal recognition to method for valence recognition and method for discrete emotion recognition.

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Predicting Office's Ambient Parameters

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ABSTRACT

Bad environmental conditions in the office can negatively affect the workplace productivity. In the presented work we measure three ambient parameters - CO_2 , temperature and humidity - asses their quality and predict their likely future values. To do so, we first heuristically determine the state of the office (are the windows open, air conditioner active etc.) and then try to mathematically model the parameter's future behavior. Based on the current and predicted state of ambient parameters, we can send a recommendation on how to best improve them. Experimental evaluation shows that our models outperform the related work in terms of prediction accuracy.

Categories and Subject Descriptors

H.4 [Information Systems Applications]: Miscellaneous; D.2.8 [Software Engineering]: Metrics—complexity measures, performance measures

Keywords

CO₂, temperature, humidity, modeling, recommendations

1. INTRODUCTION

Good work environment is essential for keeping work productivity. In this paper, we are focusing on three office's ambient parameters: CO_2 , temperature and humidity. The quality of these parameters is often hard for humans to objectively detect, especially if they are changing slowly. However, it has been shown [4, 5] that when their quality drops below certain thresholds, the work productivity in the office is negatively affected.

In this paper we present an intelligent system that is able to measure these parameters and estimate their future values. In the case of CO_2 and temperature, a simple mathematical model is used for prediction, in the case of humidity a machine learning model is used instead. Furthermore, it is able to asses the quality of these parameters, simulate several possible actions that an user can take, and then recommend the one leading to the best working conditions. The system is meant to be used in offices without automatic ambient control and is a part of the larger "Fit4Work" project [2] that is focused on helping to raise the well-being of office workers. It requires no prior knowledge or manual input of office properties, yet it is able to adapt to them over time.

The ambient parameters were measured using the Netatmo commercial device [1]. The same device is expected to be used by the end users of the system, although it can be replaced with any similar device with the same functionality. This device has an indoor and an outdoor unit, both capable of measuring the CO_2 , temperature and humidity, and sending the data to a web server. For easier testing and validation of our method we also had sensors that monitor if the windows are opened and closed and an application where we manually labeled the number of people in the office, the air conditioner state, heater state and humidifier state. As for the time of writing this paper we collected roughly two years of data for three different offices in our department. Data is continuously sent to a web server, where it is analyzed as described in Section 2. If a recommendation is deemed necessary, it is sent to a mobile device via a push notification.

The paper was inspired by another work [3], and proposes a different solution to the same problem. The proposed solution makes heavier use of mathematical modeling and produces more accurate predictions about the ambient parameter's future values.

2. METHODOLOGY

The goals of this paper are three-fold. First, to predict the state of the office: are the windows open, is air conditioner turned on, etc. This not only allows us to predict the probable changes in the ambient parameters, but also to make sensible recommendations: no need to recommend opening of the windows if they are already open. Second, to predict the future behavior of the following three parameters - CO_2 , temperature and humidity. We are interested in predicting values up to 30 minutes in advance. Our data was measured every 10 minutes, so this corresponds to 3 data points. Behavior should be predicted for the current state and also for the cases where some office parameters changes. Finally, we use a combination of the previous two points to form recommendations to the user on actions that improve the work environment.

While the physical phenomena of temperature, humidity and CO_2 was already heavily studied in the past, the challenge we face here is in not knowing any attributes of the office where this system would be used: how big the office, how good the thermal insulation, the surface of the windows, etc. Using standard formulas for predicting the ambient parameters can therefore be infeasible, given how many unknowns they contain. In our approach we tried to simplify the models to simple versions with only a few unknowns. We use data recorded in the target office in the last two weeks (exact number of days may vary based on office usage) to estimate these unknowns, and then use them for real-time predictions in the following day.

2.1 Virtual sensors

Virtual sensors refer to values that are not directly measured. Instead, their value is derived from the measured data and then later used to help derive some other value. In our setting, there are five virtual sensors that affect the ambient parameters: the windows state, air conditioner state, heater state, humidifier state and number of people in the office.

"The number of people in the office" is calculated from raising CO_2 levels, and the humidifier state is tied to humidity data, so those two will be explored in the corresponding Sections 2.2 and 2.4. The remaining three can be determined with simple heuristics as described below.

2.1.1 Windows

Windows were modeled in a binary fashion: they are either open or they are closed. In a real office there might be many windows, some of them open, some closed, some perhaps half-open at any time; but lacking any knowledge about the window quantity or size, predicting their state more accurately is almost impossible.

An effect of opening the window is reflected on all three ambient parameters, but only in the case of CO_2 is the effect consistent. Whenever a window is opened, CO_2 falls drastically, whenever it is closed it starts to rise again. This allows us to make a simple heuristic: a.) if the CO_2 is falling faster then some threshold, window was opened; b.) if CO_2 keeps increasing, the window is closed; c.) if neither of those is happening, assume the last known state. Thresholds can be determined by looking at the data history and find such values that would generate predictions, where windows is opened/closed few times a day, as would realistically be the case.

This approach could be improved by correlating changes in CO_2 to those in temperature and humidity, but the described simple heuristic appeared to work well in practice.

2.1.2 Air conditioner

Again we assume binary outcome - the air conditioner is either on or off - additionally we assume that the temperature set on it is constant, or at least is changing infrequently. The distinguishing pattern of air conditioning is one of temperature inside decreasing while the temperature outside is higher then inside. Since the temperature naturally tries to equalize itself with its surroundings and since all other factors (people, computers, etc..) only serve to warm the office, it is reasonable to conclude that such a temperature drop was caused by the air conditioner. After a while of the air conditioner working, the temperature will converge to value that can be stored for later predictions. If the temperature starts rising again, the air conditioner is assumed to be turned off.

2.1.3 Heater

The same assumptions and methods are used here as with the air conditioner, except in reverse: the heater is on if the inside temperature rises significantly more then expected from the outside temperature, etc.

2.2 CO₂ predictions

We start by modeling CO_2 , as it the most "well-behaved" of the three ambient parameters, and we describe the process in depth. We later use a similar methodology for temperature modeling. Intuitively, CO_2 level inside the office is increasing linearly with respect to the number of people present, but at the same time it tries to equalize itself with the outside CO_2 level. The bigger the difference between outside and inside, the faster it moves from one side to another. If window is opened, the same happens, only to a significantly larger degree. This can be encapsulated in the following equation.

$$C_{n+1} = C_n + \alpha (C_{out} - C_n) + \beta p \tag{1}$$

 $C_n = CO_2$ inside at timestep n

 $C_{out} = CO_2$ outside

p = the number of people in the room

 α = the coefficient of diffusion speed (between 0 and 1) - small for closed windows, big for open ones

 $\beta =$ how much a single person raises CO_2 in a given time unit

Using all the labeled data, the α and β are mostly trivial to compute using linear regression. Using them results in an almost perfect match between the predicted and real values. In Figure 1 we plot a scenario where we know the initial CO₂ level and all future windows states and all future numbers of people, and we are able to predict CO₂ level two days in advance. This strongly signifies that the model captures the real-life behavior of CO₂, and it is only a matter of determining the correct coefficients.

Calculating the coefficients for a given office without the labeled data, however, is a challenging task as the above formula has 5 unknowns - α when windows are closed, α when windows are opened, window state, β and number of people p. Furthermore these coefficients can behave very similarly: CO₂ level in a room with many people and open window can be close to CO₂ level in a room with closed windows and few people. The first improvement is to combine the two variables β and p into one - γ , as we never need those two individually and are only interested in their product. This shortens the formula to:

$$C_{n+1} = C_n + \alpha (C_{out} - C_n) + \gamma \tag{2}$$

This formula can be rewritten in an analytical way (Equation 3) so it can predict an arbitrary time step instead of only steps of integer size (10 minutes). A simple explanation of this formula goes as follows - CO_2 always converges to a value L. The number of people in the office dictates this limit, while the value α dictates how fast we approach this limit. The inverse of this formula will also be useful and can be trivially computed using some basic algebra.

$$C_n = \begin{cases} \gamma^n, & \text{if } \alpha = 0\\ L + (C_0 - L)(1 - \alpha)^n, & \text{otherwise} \end{cases}$$
(3)

$$L = C_{out} + \frac{\gamma}{\alpha}$$

Determining the window state is described in Section 2.1.1. If we know the α value for the current window state, the γ value becomes the only unknown in the formula and can be determined with a simple linear regression, using last three data points. Since γ correlates with the number of people in the office, it must be recalculated for every prediction. The α value on the other hand is dependent on the office heat insulation level, office size and windows size, and is therefore a constant. We can therefore estimate the α value by trying different values on the past two weeks of data and then select the one that has the lowest error rate when predicting - this is possible since when predicting on the past data, we already know what CO₂ value will be reached.

2.3 Temperature predictions

We used the same base formula - Equation 3 - for the inside temperature prediction. This model however, has to be made more complex because of two factors.

First, the temperature does not converge towards the outside one, but goes towards some function of the outside temperature instead. For example, even if the outside temperature is below zero, the temperature in the office never went below 10 degrees, even without heating. There are several reasons for this behavior, including the heat of the building itself, and the fact that building is warming and cooling at different rates than the exterior when the external temperature changes. This is dealt by calculating a function from last two weeks of data that models the expected inside temperature as a linear function of the outside temperature. The calculation is made during rest days, when no one is in the office, reducing the noise in the data. This calculated value then replaces the value C_{out} in the Equation 3.

Second, we have to account for both air conditioning and heating. The detection of their state is described in Sections 2.1.2 and 2.1.3. In the same section it is also described how to collect the limiting temperature value these devices generate. If either device is on, the corresponding limiting value replaces L in Equation 3. Improvement of this rather simplistic modeling of the devices is subject to future work. A prediction example is plotted in Figure 2.

2.4 Humidity predictions

Humidity was not changing much in our data, and when it did, there was no obvious pattern. So instead of plugging the data into the same equation, we used a classical machine learning approach. The last few humidity and temperature measurements, together with the window state and estimated number of people (computed from γ in CO₂ model) are fed into a machine learning model, and a prediction for future humidity is given. Again the training of the model is made on the previous two weeks. If it turns out that the prediction underestimated the humidity in the office, the humidifier is determined to be active. If the classifier overestimates the humidity and humidifier was considered active, it is considered inactive from then on.

2.5 Recommendation system

Each ambient parameter has predefined quality ranges good, medium and bad. For example: "good" CO_2 is under 500 ppm, "bad" over 800 ppm and "medium" in between. The ideal case is to have all three parameters in the "good" quality range. This, however, is not always possible as improving one parameter may damage another - opening the window may improve the CO_2 , but it may reduce the temperature quality. The priority of the system is to have the minimum number of "bad" parameters. If all the parameters are "medium" or above, the maximum number of "good" parameters is prioritized.

A possible action is a change in one of the devices/windows that exist in office. In the current version, all the devices are assumed to be binary (air conditioner is either on or off, windows are opened or closed, etc.). The list of all possible actions is generated based on the current assumed state of the office. If the windows are assumed opened, "open the window" action will be omitted. Some hand-selected actions may appear in pairs, as they are commonly done simultaneously: turn on the air conditioner and close the windows for example. A default action "do nothing" is also included on the list.

Each action effect is simulated over the period of 30 minutes. The action that results in the best state after that time interval is selected. If the action has a higher score than the default action of doing nothing, it is recommended to the user.

While not fully implemented yet, there are two areas with possible improvements that are currently worked on. One is to try to make the recommendations more time-specific. Instead of "open the window", we could recommend "open the window for 7 minutes, then close again". This can be done by first determining all the relevant time frames - times where a parameter shifts from one quality range to another. All the possible actions can then be tested against every relevant time frame. Second is to predetermine which actions are even sensible, given the context. If the only problem is the temperature inside being too cold and it is also cold outside, then the sensible options are only to close the window or to turn on the heater. This is being implemented by an ontology that contains facts about some ambient parameters, configured in a way that is able to search for relevant actions given current state.



Figure 1: CO_2 prediction and ground truth, predicting values for the next two days, supposing that we have perfect information about the current and future office state.



Figure 2: Temperature prediction and ground truth. We predict what happens if no action is done, against what happens if window is opened. The prediction starts in the past so we can compare it to the actual measurements.

3. **RESULTS**

As results we list (Table 1) the mean absolute error when predicting a parameter 30 minutes in advance, during a three month period. The test are made to be comparable with those in paper by Frešer et al. [3]. We show that our predictions for CO_2 and temperature display lower error then the before-mentioned work. Their humidity measurements were better, probably because of better selection of features in their model.

 Table 1: Mean absolute error

Parameter	Our error	Error reported by Frešer [3]
CO_2 [ppm]	43	79
Temperature [°C]	0.36	0.50
Humidity [%]	1.2	0.74

4. CONCLUSIONS

In this work we model three ambient parameters in the office. For two of them, we show a simple mathematical model that predicts their future behavior. For those two we get more accurate predictions than those in the related work. This is probably a consequence of using a physically-inspired formula. For humidity we use a machine learning model that while showing promising results, still has room for improvement. We also predict the state of devices and windows in the office, although the accuracy of this prediction has not yet been directly tested. Furthermore we presented a recommendation system that we plan to test with multiple real offices in the future.

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Real-time Content Optimization in Digital Advertisement

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ABSTRACT

A key goal of advertising industry is to present the target audience with advertisements that induce most engagement. In digital advertising we are able to collect huge amounts of data on how different advertisements perform. This data can be used to optimize the content of such advertisements in real-time. The idea behind the optimization is essentially the same as in the multi-armed bandit problem. There are many optimization algorithms available for solving it, but they need to be modified for the specifics of digital advertising. In this study, we analyse real data from hundreds of advertising campaigns and present a methodology to asses the potential of advertisement content optimization. We compare the performance of different optimization algorithms and propose their modifications. We conclude that only a small part of the advertising campaigns can potentially benefit from content optimization. However, when there is room for improving the performance of an advertisement, the optimization algorithms coupled with the proposed modifications are able to exploit most of it.

Keywords

Digital advertising, optimization, multi-armed bandit, selection bias, exploration-exploitation trade-off, Thompson sampling, Upper confidence bounds algorithm

1. INTRODUCTION

In the advertising industry, there is a persistent aspiration to create and present to the target audience the most relevant advertisement, which would produce the highest number of *engagements* from the viewers. The most frequently measure of engagement, specific to the digital advertising, is the *click rate*. It measures how many views of a digital advertisement led to a user clicking on the advertisement and thus showing interest in the advertised product or service.

Given the complexity of the industry and the target population, it is difficult to predict which advertisement or variant of an advertisement would be more engaging. Fig. 1 shows an example of two variants of an advertisement. Digital advertising enables collecting large amounts of data that can be used to measure the performance of advertisements. Using an appropriate comparison methodology one can then decide which advertisement variant should be presented to the target audience. Some research regarding optimization of digital advertisements has been published [5, 7], however a lot remains hidden from the scientific literature due to confidentiality agreements in the advertising industry.

Advertisement content optimization can be done for long time spans – the decision on the content used in the advertisements for the next campaign is made based on the engagement rates in the previous campaign. On the other hand, optimization can also be done in real-time – the decision on the content is made when an advertisement is about to be shown on a web page or in a mobile application. In this



Figure 1: Which advertisement is more engaging?

paper, we are focusing on the latter approach. Our primary goal is to estimate the *potential* of the real-time content optimization, i.e. the differences in engagement rates among different variants of an advertisement. If there is some potential present, then the goal is to find the best algorithms that optimize the content of advertisements in real-time.

2. CHALLENGES IN ADVERTISEMENT CONTENT OPTIMIZATION

A digital advertising *campaign* usually consists of different *variants* of an advertisement, and generally multiple possible *media* (different web pages and mobile applications) where an advertisement is displayed. The variants of an advertisement can differ in many ways (e.g. text, graphics, colour). As the campaign progresses, one can track the num-



Figure 2: Sample time lapse of exposures (a) and success rates (b) for an advertisement campaign with two variants.

ber of *exposures* (i.e., how many times it was displayed to a viewer) and the number of engagements or successes (i.e., the number of clicks on the advertisement) of all variants on a time basis (we collected hourly data). Our hypothesis is that this data can be used to identify the better performing variants and adjust the amount of times they are displayed in their favour. In practice, this is not a trivial task. The number of successes is usually very low in comparison to the number of exposures, yielding near-zero probabilities of success. Additionally, the data is non-stationary as shown on an example campaign in Fig. 2: the volume of exposures and the probability of success is changing over time, because of hourly fluctuations in advertisement traffic, audience variability, and seasonal trends. Therefore, large amounts of data are needed to obtain reliable estimates of each variants' performance. Obtaining additional data is usually not feasible, since exposures cost money and there are limited funds available for a campaign. Another problem is that any optimization done during the campaign introduces a se*lection bias* [12] into the data – the variants chosen by the optimization algorithm have positively-skewed success rates. As a consequence, performance of certain variants can not be reliably estimated due to low number of exposures.

When optimizing the advertisement content, one has to carefully set the trade-off between the amount of exposures available to the optimization algorithm and the amount of exposures used for performance analysis. The more aggressive the optimization, the more biased (less reliable) are the estimates of the variants' performance. The balance of exposures across different variants must be such that the optimization algorithm will yield the highest possible number of engagements, while still allowing estimation of the performance gain with a reasonable accuracy. Another obstacle, caused by technical limitations, is that feedback on how variants perform is usually delayed (in our case by a few hours) and computed in batches (e.g., hourly). Therefore, the optimizing algorithm has to set the distribution of the exposures across different variants on a hourly basis and not for each exposure separately – this has a negative effect on the optimization potential of the algorithm.

3. EVALUATING THE PERFORMANCE

One approach for evaluating the performance of a digital advertisement content optimization algorithm is to compute its $lift L = \frac{S_o}{S_r} - 1$, where S_o is the number of successes achieved

by the optimization algorithm and S_r is the number of successes achieved by displaying the variants randomly according to the uniform distribution. We usually express lift in percentages. A positive lift means that using the optimization algorithm is better than choosing variants randomly, whereas a negative lift means that the optimization has a negative effect on the success rate. We estimate the *potential* of a campaign by computing the lift for the *oracle* algorithm, which is the optimal algorithm that always (in each hour) chooses the best performing variant. Of course, the oracle algorithm can only be used on the past data (not in real-time), when it already knows how variants performed.

To cope with the large variance of the success rates, we use one real campaign to generate several artificial campaigns by applying different amounts of smoothing to compute hourly success rates for each variant. Only the uniformly selected variants are used in creating the artificial campaigns to avoid selection bias affecting the success rates. Smoothing ranges from producing completely stationary data on one hand to highly volatile trends (no smoothing) on the other hand. From these campaigns we choose the best-case and the worstcase campaign according to its potential. This gives us the upper and lower limit for the true potential for different scenarios, which could be hidden in the real data. The artificial campaigns also enable us to perform an arbitrary number of runs of the optimisation algorithms in order to evaluate their performance. This would not be possible on real campaigns, since it is very expensive.

To understand the reliability of the measured lift, it is crucial to compute its confidence bounds. These can be computed using the Fieller's theorem [6] for the confidence interval of the ratio of two means. To avoid the selection bias, we split the exposures into two sets when running the campaign: the control set, where the variants are displayed at random, and the *optimization set*, where variants are displayed according to the decisions of the optimization algorithm. The control set is used to estimate the success rates of each variant and deduce the performance of the optimization algorithm. The control set is usually small (~ 10% of exposures), so the optimization algorithm has a big enough volume of exposures left to optimize. Low number of exposures in the control set has the disadvantage of confidence intervals being rather wide and the lower bound of the lift often being negative. We improve the estimation of the bounds and still keep the same

amount of exposures selected by the algorithm by introducing three-set sampling [12]. Here, we split the optimization set into a learning set and evaluation set. The control set is composed of the exposures with randomly-selected variants. The learning set is composed of the exposures that were selected by the optimization algorithm and are used by it for further selection. The evaluation set is composed of the exposures that were selected by the algorithm, but are not used by it for further selection – the optimization does not consider the exposures in the evaluation set when deciding which variant to chose next. Data from the control set and the evaluation set can then be used to produce unbiased estimates of the lift and its confidence bounds.

4. OPTIMIZATION ALGORITHMS AND THEIR IMPROVEMENTS

The optimization of advertisement variant selection can be treated as the *multi-armed bandit* problem [10]. This is a problem in which a gambler at a row of slot machines (onearmed bandits) has to decide which machines to play, how many times to play each machine and in which order to play them. Each machine provides a random reward from a probability distribution specific to that machine. The goal of the gambler is to maximize the sum of rewards earned through a sequence of plays. A plethora of algorithms dedicated to solving it exist [4], ranging from simple ones like the ϵ -greedy selection policy, to more intricate ones like the Thompson sampling (TS) [1], the upper confidence bound algorithm (UCB) [2], and its improvements [3]. Each optimization algorithm balances the exploration-exploitation trade-off using its parameters. They instruct the algorithm what will be the ratio between the number of exposures it will use to display the percievingly best variant (i.e., exploitation) and the number of exposures it will use to display the other variants to see if some other variant is potentially better (i.e., exploration).

By default, the aforementioned algorithms are not intended to cope with delayed feedback, batch updates, and nonstationary data. Therefore, we propose several enhancements to improve their performance on our use-case. A solution for the delayed feedback and batch updates is to simulate the immediate feedback for each variant selection based on the historical success rates. When the real feedback becomes available all of the simulated exposures are discarded and replaced by the real data.

Non-stationarity of the data is problematic because the algorithms have trouble adapting to trend changes. We deal with abrupt changes in trends by using the *Page-Hinkley test* [8] for detecting change-points in the success rate and the number of exposure displayed per time unit. If the test detects a change, we discard a portion of historical data to enable faster adaptation of the optimization algorithm to the new situation. Another approach that we propose is to perform periodic *forgetting* [10] of historical data based on some predefined condition like the total number of exposures or time elapsed since the last forgetting event. After the condition is met a forgetting event is triggered, which causes a part of the historical data to be discarded.

The above two approaches are suitable if there are a lot of abrupt changes in the trends. However, if the changes happen more gradually a more conservative approach to forgetting of historical data is needed. To deal with gradual changes in the trends we implement a *two-memory structure* [9] of the historical data. We keep track of exposures and successes in two separate data structures: a *long-term (persistent) memory* and *short-term (transient)* memory. The first holds almost all historical data and the latter holds only very recent data about each variant. A weighted sum of the two is then used to estimate the success rates of the variants and feed them into the optimization algorithm.

5. DATA AND EXPERIMENTS

We collected data from hundreds of advertising campaigns that used content optimization. The data includes the number of exposures and successes for each variant for each hour of each campaign. Exposures in each campaign were split in two groups, for 10% of the exposures a random advertisement variant was chosen from an uniform distribution (i.e., the control dataset), whereas for the remaining 90% of the exposures a hand-tuned optimization algorithm chose the variant.

From all the campaigns, we selected a representative sample of 38 campaigns for further analysis. The durations of the selected campaigns span from 3 days to 6 months and the number of exposures ranges between 10,000 and 10,000,000. There are 2 to 10 advertisement variants per campaign, with success rates ranging from 0.1% to 20% (median is 1.8%). The trend-change analysis shows there are 2 to 6 events per campaign that change the success rates of the variants, apart from the monthly, weekly, and daily seasonalities.

A preliminary analysis showed that 20 campaigns (out of 38) have at least some potential, so we used these to generate two sets of 200 artificial campaigns: a best-case and worstcase set. We created 10 artificial campaigns from each real campaign (hence 200 from 20) per set. The two artificial sets were then used to estimate the lower and upper bound of the real campaigns' potential and to measure the performance of the optimization algorithms. We tested three optimization algorithms: ε -greedy, Thompson sampling, and UCB1-Tuned. Each algorithm was run 10 times on each artificial campaign, producing 2000 runs per artificial set. Based on these 2000 runs per algorithm we comparatively analysed how many times each algorithm achieved lifts above 5%, 10%, and 20%. The simulations on artificial campaigns allocated 10% of exposures to the control set, 45% to the learning set, and 45% to the evaluation set.

6. RESULTS AND DISCUSSION

We observe that approximately half of the campaigns have no significant potential (Table 1): in the best case there is 45% of campaigns with lift below 5% and in the worst case there is 74% of such campaigns. A deeper analysis of the advertisement variants showed that there are considerable differences between the variants in some campaigns, whereas the variants are nearly identical in other campaigns, which reduces the amount of optimization potential.

In the initial experiments, we observed that ε -greedy is too aggressive for our non-stationary problem – it quickly fits to a single variant and requires a long time to switch to another. Therefore, we omit it from further experiments

Table 1: The theoretical potential in optimizing advertisement campaigns.

Ratio [%] of real campaigns with potential lift above:						
	$5\% \ \ 10\% \ \ 20\%$					
Worst case	26	18	8			
Best case	55	53	34			

Table 2: The performance of optimization algorithms. We present the lower and upper bounds based on the results from the worst-case and bestcase sets of artificial campaigns, respectively.

Ratio [%] of artificial campaigns with opt. lift above:						
	5%	10%	20%			
Thompson sampl.	25 - 39	17 - 27	11 - 16			
UCB1-Tuned	30 - 44	24 - 35	13 - 19			
Imp. Thompson sampl.	36 - 55	23 - 37	12 - 30			
Imp. UCB1-Tuned	34 - 59	27 - 35	14 - 30			

and focus on the other two algorithms instead. Comparison of the original Thompson sampling and UCB1-Tuned algorithms shows the latter is better (Table 2). When the two algorithms are improved with the techniques presented in Section 4, both Thompson sampling and UCB1-Tuned perform almost equally. The (improved) optimization algorithms exploit approximately 25% to 50% of the potential in an advertisement campaign. Note that exploiting 100% of the potential is not possible.

We omit the in-depth analysis of the proposed improvements of the optimization algorithms, and provide just a brief summary of the findings. We observed that simulated immediate feedback only slightly improves performance, that twomemory architecture is significantly beneficial, and that periodic forgetting (with two memories) is as good as trendchange detection with the Page-Hinkley statistical test. We have not measured which forgetting approach is more resistant to parameter over-fitting. When the algorithms are improved with the techniques mentioned above, the exploratory parameters of the optimization algorithms can be adjusted to make the algorithms more aggressive, since forgetting resets them frequently enough so they don't stick to the same variant for too long.

7. CONCLUSIONS

In this study, we propose a methodology for estimating the potential behind real-time optimization of digital advertisement content. We analysed hundreds of advertising campaigns provided by Celtra and developed a methodology for generating artificial campaigns that mimic real campaigns. We generated multiple benchmark sets of artificial campaigns and used them to empirically evaluate several optimization algorithms in combination with different improvements. The proposed modifications proved highly beneficial and provided us with ideas that may increase the performance of the optimization algorithms even further. Our main discovery is that optimization algorithms are able to exploit

the potential of an advertising campaign reasonably well. However, many campaigns have no potential at all - campaigns with no significant differences between variants do not benefit from optimization. In future work, we would like to identify what types of campaigns exhibit high potential. Discovering the characteristics that make a campaign suitable for optimization in the first place may significantly increase the value of digital content optimization in digital advertising. Additionally, more advanced algorithms, like dual-layer UCB or budget-limited UCB [11], could be used to further increase the benefit of optimization. Another possible improvement would be to find the optimal relative sizes of sets in the three-set sampling we used because large control and evaluation sets provide more data for the analysis, but inhibit the algorithms' learning rate and hence performance.

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PREDGOVOR

Na letošnji konferenci Kognitivna znanost sodelujejo avtorji/ice z različnih disciplinarnih področij, ki predstavljajo tako empirične rezultate svojih raziskav kot tudi teoretska raziskovanja. Osrednja tema konference je "Znanstveni pristopi k raziskovanju zavesti: premoščanje vrzeli in perspektiv". Vsak prispevek se vsaj posredno dotika ali namiguje na vprašanje zavesti in njenih vlog v najrazličnejših kontekstih raziskovanega znotraj kognitivne znanosti. Avtorji/ice so kritično razmišljali o vprašanju večih zavesti, se poglobljeno spraševali o resničnosti zavesti, o času in zavesti ter premišljevali o hipotezi bayesianskih možganov in njihove kognitivne penetrabilnosti. Poročali so o raziskovanju doživljanja prepričanj, preiskovali kvalije drugih zavesti skozi gledališko igro in preučevali vpliv opazovanja lastnega ustvarjanja znotraj vizualne umetnosti. Obravnavali so, kako različni vidiki kognicije oblikujejo bolečino, empirično preverjali motiviranost udeležencev v navidezni resničnosti za pomoč pri rehabilitaciji ter odkrivali povezave med gibanjem in kognicijo v zgodnjem otroštvu. Predstavljali so genetske algoritme in njihovo rabo v raziskovanju neveridičnega zaznavanja ter opozarjali na različne načine za stvarjenje družbeno koristne, nenevarne umetne inteligence. Raznolikost predstavljenih tem zaokrožujeta premislek o vključevanju nevroznanostvenih izsledkov v pravo ter metodološka analiza zamikov vidnih evociranih potencialov (VEP) pri elektroencefalografiji (EEG).

Upamo, da bo letošnja disciplinarno in metodološko bogata kognitivna konferenca odprla prostor za izmenjavo zanimivih misli in idej ter povezala znanstvenike/ice različnih disciplin, ki se ukvarjajo z vprašanji kognitivnih procesov.

Olga Markič Toma Strle Tine Kolenik

FOREWORD

2017 conference Cognitive Science boasts with authors from numerous disciplines presenting their empirical as well as theoretical work. This year's topic is "Scientific approaches in researching consciousness: building bridges above chiasms and between perspectives". Each contribution at least indirectly speaks of consciousness and its roles in various contexts of cognitive science. Authors critically contemplate the question of many consciousnesses, dig deep into whether consciousness is real or not, into time and consciousness, and assess the hypothesis on the Bayesian brain and cognitive penetrability. They survey their research on experiencing beliefs, on examining qualia of different minds through theatre performance and on the influence of self-observation on visual art creation. They discuss how cognition influences pain processing, they empirically test virtual reality users' motivation in relation to rehabilitation and they discover links between motion and cognition in early childhood. They present genetic algorithms and their use in researching non-veridical perception, and they bring attention to ways of making AI useful and safe. The thematic diversity of contributions is wrapped up with a reflection on using neuroscientific research in law practice and a methodological analysis of EEG visual evoked potential (VEP) acquisition delays.

We hope that this year's cognitive conference, being extremely diverse in disciplines and methodologies, will become a welcoming space for exchanging intriguing ideas and thoughts as well as for bringing together scientists from all the different areas exploring the questions of cognitive processes.

Olga Markič Toma Strle Tine Kolenik

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Povezave med telesnimi merami, gibalnimi spretnostmi in kognitivnimi sposobnostmi v zgodnjem otroštvu

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POVZETEK

V prispevku predstavimo zasnovo raziskave o vplivu rasti in splošnega telesnega razvoja na otrokove gibalne in kognitivne spretnosti. V raziskavi vzdolžno spremljamo otroke (N = 158) tipičnega slovenskega urbano-ruralnega okolja v razvoju od rojstva do zaključene prve osnovnošolske triade (starost 8 let) ter merimo njihove značilnosti in sposobnosti ter iščemo možne povezave med gibalnimi spretnostmi, telesnim in kognitivnim razvojem.

Ključne besede

Antropometrija, gibalne spretnosti, kognitivne sposobnosti, izvršilne funkcije, zgodnje otroštvo.

ABSTRACT

In the article we present the concept of research on the influence of growth and physical development on the child's motor and cognitive skills. In the survey, we longitudinally follow children (N = 158) of the typical Slovenian urban-rural environment from birth to the first elementary school triad (8 years of age). We measure their physical characteristics and abilities. We are looking for possible links between growth (anthropometrics measures), physical performance, and cognitive development.

Key words

Anthropometry, motor skills, cognitive abilities, executive functions, early childhood.

1. NAMEN RAZISKAVE

Namen raziskave je ugotoviti, ali so pri zdravih otrocih v zgodnjem otroštvu mere telesne rasti, gibalne spretnosti in kognitivne sposobnosti povezane in če so, kako so povezane med seboj. Izhajamo iz starodavne maksime *»Mens sana in corpore sano«* ("Zdrav duh v zdravem telesu") in predvidevamo, da otroci, ki tipično sledijo rastnim krivuljam, pridobijo podobno tipično tudi gibalne in kognitivne spretnosti. V raziskavi nas zanima, kaj se dogaja z otroki, ki so za rast večji in bolj razviti, kar se praviloma povezuje z boljšimi gibalnimi spretnostmi (povezano s samimi telesnimi dejavniki, ki povečajo npr. dolžino koraka, mišično moč, navor ipd.), vendar pa kognitivne spretnosti tega razvoja ne dohajajo vedno.

Določeni pokazatelji telesnega in gibalnega razvoja se povezujejo z znanimi zdravstvenimi tveganji [1, 2]. Veliki in hkrati neprimerno prehranjeni otroci, ki imajo pretežno sedeč način življenja, niso gibalno uspešni, hkrati pa raziskave tudi v Sloveniji kažejo, da tudi učno niso uspešni [3]. Tako veliki in telesno bolj razviti otroci, ki pa jih hkrati spremlja neustrezna prehrana in sedeč življenski slog, niso nujno tudi gibalno bolj razviti; Lovro Tacol, dipl. psih. (UN) MEi:CogSci program Univerza v Ljubljani 1000 Ljubljana +386 51 252 346 lovro.tacol@gmail.com

podobno verjetno velja za kognicijo. Hkrati sam učni uspeh ni nujno povezan s kognitivnimi sposobnostmi. Na kognitivni razvoj vpliva več dejavnikov, zato v raziskavi upoštevamo tudi sociodemografske dejavnike (socialno-ekonomski status – SES).

Predvidevamo, da sta glavna, med seboj sicer odvisna dejavnika, ki otrokom, ki so sicer v rasti v zgornjih percentilih, onemogočata doseganje v percentilih enako visokih gibalnih in kognitivnih sposobnostih, socioekonomski status družine in zasedenost (sedeč življenski slog). S pridobljenimi podatki želimo identificirati otroke, ki od tipičnega razvoja odstopajo ter ponuditi ustrezne intervencijske programe.

2. TEORETIČNO OZADJE

Raziskave, ki hkrati preučujejo um in telo – kognitivni in gibalni razvoj, se praviloma osredotočajo na populacije z določeno patologijo. Tako v literaturi zasledimo raziskave, ki preučujejo povezave med gibalnimi spretnostmi in kognitivnimi sposobnostmi ali pa različne intervence na omenjenih ravneh pri otrocih z Downovim sindromom [4], pri otrocih z mišično distrofijo [5], otrocih s cerebralno paralizo [6] ali otrocih z motnjo koordinacije [7]. Raziskav, ki bi iskale povezave med gibalnim in kognitivnim razvojem pri zdravih otrocih v obdobju, ki nas zanima, pa je malo. Van der Fels in drugi [8] so povzeli 21 študij, ki so preučevale otroke med 4. in 16. letom starosti in zabeležili srednje velike do močne korelacije med nekaterimi gibalnimi spretnostmi in kognitivnimi sposobnostmi. V zaključkih navajajo, da lahko pestri interventni programi, osredotočeni na gibanje, vzpodbujajo tako gibalne spretnosti kot tudi višje kognitivne funkcije pri prepubertetnih otrocih.

Gibalni in kognitivni razvoj sta neločljivo povezana. Razvoj otrokovih grobomotoričnih spretnosti sicer odseva rast in razvoj otrokovega telesa, vendar ne gre za enoznačno, linearno povezanost. Kako uspešen je sicer zdrav otrok v grobomotoričnih funkcijah je odsev koherentnega sodelovanja med njim in okoljem, ki določeno veščino spodbuja [9]. Pri razvojnih motnjah je pogosta povezava med kognitvnim in gibalnim razvojem oz. zaostankom, kar korelira tudi z mestom poškodbe. Mali možgani so danes prepoznani kot struktura, ki ni ključna le pri gibalnih pač pa tudi višjih miselnih procesih; podobno velja za striatum, ki je del omrežja, skupaj z dorzolateralnim predelom prefrontalne skorje [10].

Po drugi strani vemo, da telesni parametri določajo nekatere gibalne spretnosti. Višina, telesna masa, obseg pasu in velikost kožne gube so pokazali rahlo do srednjo obratno povezanost z gibalno koordinacijo. Biološka zrelost pa je bila statistično pozitivno pomembno povezana s posebnimi gibalnimi veščinami, npr. s poligonom nazaj. Grobomotorične spretnosti so korelirale tudi s koordinacijo in sposobnostjo fine manipulacije ter splošnim zdravstvenim stanjem (t. i. fitnes) [11].

Pri vplivih na razvoj moramo upoštevati tudi socialne, ekonomske in demografske posebnosti proučevane populacije. V raziskavi Gadžić idr. [12] sta imeli na merjene gibalne spretnosti in kognitivne sposobnosti statistično pomemben vpliv dve sociodemografski spremenljivki, in sicer bivanjsko okolje (urbano ali ruralno) ter očetova izobrazba. Osnovnošolci, živeči v urbanem okolju, so dosegali višje rezultate tako na testih gibalnih spretnosti kot tudi kognitivnih sposobnosti. Očetova izobrazba je na rezultate vplivala posredno, preko okolja, tako da so najvišje rezultate dosegali šolarji z višjo izobrazbo očetov, ki so živeli v mestih.

3. RAZISKOVALNI NAČRT

V raziskavo smo vključili vse otroke, rojene v letu 2009, vodene v primarni pediatrični ambulanti izbranega zdravstvenega doma (ruralno-urbano območje) pod vodstvom istega pediatra (T. B.). Otroci so bili redno spremljani in pregledani ob sistematičnih pregledih pri 1., 3., 6., 9., 12., 18., 36. in 60. mesecu starosti (od rojstva do vstopa v šolo). Na ta način smo pridobili antropometrične podatke, od katerih se bomo pri statistični analizi osredotočili na telesno višino in maso ter iz njih izračunan indeks telesne mase ter na podlagi tega izdelali njihove rastne krivulje (primerljivo z nacionalnim standardom). Otrok, ki imajo popoln zdravniški karton, brez manjkajočih podatkov, in ki so se torej uvrstili v nadaljnji del raziskave, je 158.

Trenutno so ti otroci v tretjem razredu osnovne šole. Da bi ohranili vzdolžen značaj raziskave, torej skozi čas merili iste posameznike, smo otroke poiskali na štirih osnovnih šolah v izbrani občini (3 manjše šole in ena večja s pripadajočima podružničnima šolama). Ker so otroci vključeni v reden, obvezen šolski program, so podatki o njihovih telesnih merah in gibalnih spretnostih (z zdravjem povezan fitnes in z gibalno učinkovitostjo povezan fitnes) že zbrani v t. i. športno-vzgojnem kartonu. Med poukom športne vzgoje je namreč na nacionalnem nivoju predviden vsakoletni preizkus otrokovih telesnih mer in gibalnih spretnosti, ki ga poznamo pod tem imenom, v zadnjem času uveljavljen tudi kot program SLOfit [13]. Podatke s kartona še pridobivamo. Zaradi interpretacije bomo podatke razvrstili v podkategorije (npr. spretnosti, vezane na lokomocijo, spretnosti, vezane na ravnotežje in stabilnost, spretnosti, vezane na ravnanje s predmeti).

V raziskavo smo se odločili vključiti še komponento kognitivnih sposobnosti otrok. Testiranje kognitivnih sposobnosti smo, za razliko od prejšnjih dveh, izvedli posebej, samo za tiste otroke, katerih starši so se za to svobodno odločili. Otrokom (N = 79) smo izven rednega pouka razdelili posebej oblikovane testne baterije, ki so jih oblikovali na Oddelku za psihologijo Filozofske fakultete Univerze v Ljubljani [14]. Testna baterija preizkuša delovni spomin in izvršilne funkcije (prepoznavanje besed, kognitivni nadzor, inhibicija). Reševanje testov je potekalo skupinsko, v skupinah do največ 20 otrok, po sprotnih navodilih testatorja (L. T.). Čas testiranja ni presegel 45 minut in za otroke ni predstavljal obremenitve, večje od običajne šolske dejavnosti.

Podatke bomo statistično obdelali s pomočjo orodij za statistično analizo (SPSS, R) in poiskali korelacije med izbranimi spremenljivkami. Pri tem bomo še posebej pozorni na povezave med različnimi gibalnimi spretnostmi in kognitivnimi sposobnostmi. Zanima nas, kako se določena izvršilna funkcija (npr. inhibicija neželenih dražljajev) zrcali v analogni gibalni spretnosti (npr. poligon nazaj) ter kako korelira z otrokovo rastjo (splošnim telesnim razvojem).

Diagram 1: Shema pridobivanja podatkov (raziskovalni načrt).



4. SKLEPI

Z raziskavo bomo poskusili opredeliti povezave med splošnim telesnim razvojem, gibalnimi spretnostmi in kognitvnimi sposobnostmi. Predvidevamo, da bomo uspeli identificirati socioekonomske dejavnike (SES), ki na te povezave najbolj vplivajo. S pridobljenimi podatki želimo prepoznati področja otrokovega razvoja, kjer bi usmerjena intervenca (npr. v gibalno dejavnost) spodbudila tudi specifično kognitivno in splošnozdravstveno korist.

Diagram 2: Preučevane interakcije, ki vplivajo na otrokovo splošno zdravje in razvoj.



5. ZAHVALA

Zahvaljujemo se ravnatelju in ravnateljicam osnovnih šol, ki so nam omogočili, da na njihovih šolah izvedemo testiranje kognitivnih sposobnosti, prav tako pa vsem otrokom in njihovim staršem, ki so nam s podpisanim soglasjem dovolili, da jih vključimo v raziskavo. Zahvaljujemo se tudi doc. dr. Gregorju Starcu s Fakultete za šport za pripravljenost na sodelovanje.

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ASILOMAR AI PRINCIPLES

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ABSTRACT

In this paper, asilomar AI principles are presented in the original form accompanied with additional analysis. The principles present an attempt to provide guidelines for human-beneficial AI, the one that would prevent possibilities for AI to turn into human-harmful ways. The principles were defined during the Future of Life Institute's second conference on the future of artificial intelligence in early 2017. The aim of the paper is to bring these issues to our society through presentation and discussions.

Keywords

Artificial intelligence, AI principles, Future of life institute

1. INTRODUCTION

The Future of Life Institute's [3] second conference on the future of artificial intelligence was organized in January 2017. The purpose of this paper is to present, in a rather original way, the 23 asilomar AI principles [1] defined at the BAI 2017 conference, accompanied with the original discussions, the comments and analysis of the author of this paper.

While not attending the conference, the author is well familiar with the studies of the artificial intelligence [4], superintelligence [2, 5, 6] and contributions of the Future of Life institute. The opinion of the community is pretty a shared one: "a major change is coming, over unknown timescales but across every segment of society, and the people playing a part in that transition have a huge responsibility and opportunity to shape it for the best."

AI is again experiencing the golden times after so many ups and downs, but this time the stakes are much higher and the probability to achieve major changes bigger than ever. The rising awareness of AI-related changes in human society are appearing in scientific, academia and general public. Dozens of major reports have emerged from academia (e.g. the Stanford 100-year report), government (e.g. two major reports from the White House), industry (e.g. materials from the Partnership on AI), and the nonprofit sector (e.g. a major IEEE report).

2. THE PROCCESS AND DISCUSSION OF THE ASILOMAR PRINCIPLES

The first task of the organizers was to compile a list of scores of opinions about what society should do to best manage AI in coming decades. From this list, the organizers distilled as much as they could into a core set of principles that expressed some level of consensus. The coordinating effort was dominating the event, resulting in a significantly revised version for use at the meeting. There, small breakout groups discussed subsets of the principles, giving detailed refinements and commentary on them. This process generated improved versions of the principles. Finally, they surveyed the full set of attendees to determine the level of support for each version of each principle.

After the consuming and meticulous process, a high level of consensus emerged around many of the statements during that final survey. The final list retained the principles if at least 90% of the attendees agreed on them. The 23 principles were grouped into research strategies, data rights and future issues including potential superintelligence, signed by those wishing to associate their name with the list. The principles will hopefully provide some guidelines as to how the power of AI can be used to improve everyone's lives in coming years.

At the web page of the event on the web pages of the Future of Life Institute [3], the following original presentations can be obtained with additional interviews on the consequent links. This original text of the asilomar principles, which is according to the opinion of this author the most important contribution of this paper, is accompanied with additional analyses and discussion. The overall intention of the author is to spread the ideas of the beneficial AI, which can be also seen as kind of directions for the advanced civilization, to the audience of the Slovenian cognitive conference and into Slovenian public. The final goal, of course, is to design a beneficial superintelligence, and not a malignant one.

3. THE 23 ASILOMAR AI PRINCIPLES

Artificial intelligence has already provided beneficial tools that are used every day by people around the world. Its continued development, guided by the following principles, will offer amazing opportunities to help and empower people in the decades and centuries ahead.

3.1 Research Issues

1) **Research Goal**: The goal of AI research should be to create not undirected intelligence, but beneficial intelligence.

This overall goal determines the motivation for asilomar principles: to research and implement beneficial AI and not "any" AI. In extreme: suppose a scientist develops a totally original, novel bomb that can destroy our world. Would it be smart to fund, support or even allow such a research? This principle says: No, nobody should research and implement such things. The reason is pretty simple: sooner or later somebody will discover something really dangerous and potentially lethal for the whole human civilization. But as in any situation there are always exceptions: What if someday a hostile alien civilization attacks our planet and we are not familiar with the lethal technology and consequently not able to defend?

2) **Research Funding:** Investments in AI should be accompanied by funding for research on ensuring its beneficial use, including thorny questions in computer science, economics, law, ethics, and social studies, such as:

- How can we make future AI systems highly robust, so that they do what we want without malfunctioning or getting hacked?
- How can we grow our prosperity through automation while maintaining people's resources and purpose?
- How can we update our legal systems to be more fair and efficient, to keep pace with AI, and to manage the risks associated with AI?
- What set of values should AI be aligned with, and what legal and ethical status should it have?

In short: funding policies should not consider only the scientific excellence and novelty, they should take into account also relevance, safety, benefits for individuals and society, and its relation to the real world including legislation. This is how normal research funding should look anyway, but this principle is a bit more specific regarding a couple of issues.

3) **Science-Policy Link:** There should be constructive and healthy exchange between AI researchers and policy-makers.

Another principle that is beneficial for all research and science. It is too often that the officially leading part of the human society (politicians, government officials) are quite ignorant of the scientific powers and potentials. That makes government much less efficient as it should be. However, it is not clear how this feed-back from the scientists actually facing problems and the officials should work since there is no direct influence on officials – they either decide on their own or follow instructions of the politicians. Unfortunately, it is just too common that science and politics are worlds apart.

4) **Research Culture:** A culture of cooperation, trust, and transparency should be fostered among researchers and developers of AI.

It is often the case that developers of the big companies are under direct instructions from the company leadership, pursuing their specific goals. These goals are often beneficial for individuals, for capital gains, and not the society. The principle promotes better cooperation which can be only positive for faster and more beneficial AI and research in general.

5) **Race Avoidance:** Teams developing AI systems should actively cooperate to avoid corner-cutting on safety standards.

The danger in the mind of the proposers is that under time pressure, things might get out of control, be it superintelligence, general AI or and other potentially very strong technology. Therefore, avoiding creating new not fully controlled AI systems under pressure should be of great concern.

3.2 Ethics and Values

6) **Safety:** AI systems should be safe and secure throughout their operational lifetime, and verifiably so where applicable and feasible.

This is an extension of the principle no. 5. Dealing with hazardous systems or materials or technologies is not only dangerous, but also highly regulated. However, software research has not been treated as potentially hazardous and that holds for AI as well. But AI has an incredible potential and some regulations or at least caution, even only self-caution is welcome.

7) **Failure Transparency:** If an AI system causes harm, it should be possible to ascertain why.

In most AI systems, even most non-transparent, it is possible to deduct what caused a particular event - at least to a point. If the designers of the system take care of the failure transparency, i.e. explanation what went wrong in a particular case, that would not

be only welcome, but more or less a necessity taking care of from the start of the design of the system.

8) **Judicial Transparency:** Any involvement by an autonomous system in judicial decision-making should provide a satisfactory explanation auditable by a competent human authority.

It is quite likely that the owners of the systems will shield themselves from any responsibility. Consider a case where an AI system is granted rights of a live being, e.g. a dog. The owner of a dog is responsible for the actions of the dog, and the dog itself takes negative consequences if, for example, a harm was done to another human. Basically, it would be a major error to give rights of live beings to the non-alive ones, so analogy with machines is a better option. A self-adapting car could become dangerous if hacked or under wrong influence, but whose error is that – of the hacker, the influence or the owner? All these issues should be resolved before actually using AI systems such as selfdriving cars, but at least in the opinion of this author, legislators should not get confused and should apply direct analogy with machines. A robot, however intelligent, is still a machine.

9) **Responsibility:** Designers and builders of advanced AI systems are stakeholders in the moral implications of their use, misuse, and actions, with a responsibility and opportunity to shape those implications.

The designers and builders often say that they are not responsible for the actual use, that the owners decide how the system will be used. Our history teaches us that there are many eager to earn money without hesitation even when other people are evidently harmed. The Stanford prison and Milgram experiment showed that people are rather senseless for the suffering of others when their gains are in question if they will not get prosecuted for that. Probably that indicates also something about the social orientation that all punishments are worthless. This, ninth principle says that designers should be responsible and that at least the research society, which is quite harsh to scientific fraud (and has to be), will not tolerate excuses from those designers that intentionally or not enable creation of harmful AI systems.

10) **Value Alignment:** Highly autonomous AI systems should be designed so that their goals and behaviors can be assured to align with human values throughout their operation.

Anca Dragan says that AI systems will optimize their systems to their own criteria if we are not careful to program them in the way that they will align their machine intelligence and values to human intelligence and values.

Italian Francesca Rossi similarly says that the AI systems should behave in a way that is aligned with human values. She points out that this principle is even more important when a human and an AI system cooperate. They can be a team only if they understand each other and have aligned values.

It is like in sports. Some individuals as if "read each other minds" and that is the most effective combination. In the case of principle 10 it is about sharing at least basic viewpoints. Note that the catch is in the AI system, fully or partially autonomous. For a washing machine, it is not relevant if the human and the machine have their values aligned, because there is no freedom of choice or action. But the autonomous system will by definition work on its own and the same values should be somehow shared.

The author of this paper does not believe that the case of autonomous car is relevant for value alignment. AI researchers often point out that an autonomous car should take care to hit a pole instead of a human or an old lady instead of a young child. Or drive into river instead of hitting a human (and drowning the owner). These examples all seem unreal, non-practical. Autonomous cars are ten times safer than normal drivers. So what if the car does not feel remorse when hitting a human if this is 10-times rarer than when human driving? There are many drunk and asocial or terroristic-oriented humans that do not care or even want to hit humans with a car.

11) **Human Values:** AI systems should be designed and operated so as to be compatible with ideals of human dignity, rights, freedoms, and cultural diversity.

This ideal is a wish, kind of social, promoting positive values into the AI systems. We humans would like that the AI systems will share positive human values with us. The rationale behind this seemingly naïve position is steel strong: when superintelligence will emerge, it should indeed better be positive to all other entities in the world, in particular to us, humans. The worst case is when one global intelligence emerges, with negative and harmful attitude towards humans, already combatting or quarreling with humans [2]. If we tend to design positive systems, it is far more likely that the superintelligence will also be of that kind.

12) **Personal Privacy:** People should have the right to access, manage and control the data they generate, given AI systems' power to analyze and utilize that data.

Guruduth Banavar insists that individuals should have the right to manage access to the data they generate. Already, the ICT (information, communication technologies) systems know far too much of us and torture us with ingenious ways of forced commercials we cannot avoid. The AI systems will be much more efficient in getting insights of individuals and institutions, personality traits, emotional make-up, lots of the things we learn when we meet each other. No doubt the web world is populated with systems getting from us individual information we do not like to share and those systems often declined services if we do not cooperate. Privacy loss is even now, without AI, insufficiently regulated and enforced.

13) **Liberty and Privacy:** The application of AI to personal data must not unreasonably curtail people's real or perceived liberty.

As mentioned, our liberty on the internet is already hampered and there is only limited AI functionality. There are even attempts to privatize the internet, which would make things far worse than today. The elites and the multinational corporations are forcing their money laundering schemata through their local interests not taking care that globally the web community and the human society suffer already.

To give a short example: when watching TV, there are lots of boring, loud and disturbing commercials. However, watching TV programs with time delay and skip or fast forward commercials, one can to a large extend eliminate them. But when using web services and mobile phones, several applications are free of charge only if they can pop up their commercials. A devil's deal! 14) Shared Benefit: AI technologies should benefit and empower

as many people as possible.

Another social nice thought, not strongly related just to AI. However, the actual applications and the relation to the superintelligence are a bit unclear. Yes, superintelligence should be positively oriented towards the humanity, towards each human and in particular towards to the human civilization. But nice wishes can result in negative effects. Raising kids with letting them do what they want turns out negative for the childen and the parents. Forcing superintelligence to be "smiling" all the time might cause some disturbance. On the other hand, elites already control the world to their own benefit and if they get hands on the AI to serve them, that is another undesired situation. In summary: a positive principle with many scenarios possible. 15) **Shared Prosperity:** The economic prosperity created by AI should be shared broadly, to benefit all of humanity.

Yoshua Bengio considers that one of the greatest dangers is that people either deal with AI in an irresponsible way or maliciously. The superintelligence might serve one owner or a group of owners to serve for their personal gain, which is nearly by definition against the interests of the majority. He, like many others, sees a more egalitarian society, throughout the world, as a recipe to reduce those dangers. In a society where there's a lot of violence, a lot of inequality, the risk of misusing AI or having people use it irresponsibly in general is much greater. Making AI beneficial for all is very central to the safety question."

Again, one should be careful. A total Unitarian society is probably bad for the civilization progress and as discovered recently by the author of this paper, might even lead to the fall of the human civilization.

16) **Human Control:** Humans should choose how and whether to delegate decisions to AI systems, to accomplish human-chosen objectives.

This is one of safe and generally agreed principles. Control should not be freely given to autonomous AI systems. Several AI researchers argue that when superintelligence emerges, it will soon be uncontrollable due to its superior intelligence. Others argue that one can always pull-off the plug and some companies like Google have already designed such safety buttons to prevent AI get loose.

17) **Non-subversion:** The power conferred by control of highly advanced AI systems should respect and improve, rather than subvert, the social and civic processes on which the health of society depends.

Another principle pinpointing the undesired progress of AI and superintelligence.

18) **AI Arms Race:** An arms race in lethal autonomous weapons should be avoided.

Stefano Ermon warns that lethal autonomous weapons could be extremely dangerous. He thinks that the technology has a huge potential, and even just with the capabilities we have today it's not hard to imagine how it could be used in very harmful ways. AI should not do harm to other humans. AI designers should not develop weapons or to start wars or create more deadly machines than what we already have.

Toby Walsh is one of the initiators of the movement to ban lethal autonomous weapons. He is warried that the AI arms race is happening amongst militaries around the world already and finds it very destabilizing. "It's going to upset the current world order when people get their hands on these sorts of technologies. It's actually stupid AI that they're going to be fielding in this arms race to begin with and that's actually quite worrying – that it's technologies that aren't going to be able to distinguish between combatants and civilians, and aren't able to act in accordance with international humanitarian law, and will be used by despots and terrorists and hacked to behave in ways that are completely undesirable. And that's something that's happening today. You have to see the recent segment on 60 Minutes to see the terrifying swarms of robot UAVs that the American military is now experimenting with."

Prof. Toby Walsh is one of the prominent AI researchers and was most active in 2017 IJCAI conference in Melbourne, Australia.

The movement to ban lethal autonomous weapons has spread worldwide and got support of the cognitive science society and the AI society in Slovenia. The discussion is going on in the U.N. If the information is correct, laser blinding of human soldiers is already prohibited.

On the other hand, the progress on AI and autonomous weapons is intensively going on in several armies, including autonomous ships, planes, tanks, drones and similar.

3.3 Longer-term Issues

19) **Capability Caution:** There being no consensus, we should avoid strong assumptions regarding upper limits on future AI capabilities.

Roman Yampolskiy, an author of another superintelligence book [6] says that in many areas of computer science, such as complexity or cryptography, the default assumption is that we deal with the worst case scenario. In a similar way, AI researchers, developers and the society should assume that AI will become maximally capable and prepare accordingly. No harm if we are wrong.

There is one issue that puzzles many AI researchers. There are famous intellectuals like Elon Musk, Bill Gates and Stephen Hawkins and including politicians like Putin that claim that the AI race to superintelligence is either on or is gaining great potentials already. Other like Toby Walsh or Facebook owner Zuckerman or Google chief developers or Kurzweil on the other hand claim that the dangers of superintelligence are nothing but a hype. Hard to depict which arguments prevail.

Dan Weld agrees with the principle no. 19, however, it concerns him because it's a distraction from what are likely to be "much bigger, more important, more near term, potentially devastating problems". He is much more worried about job loss and the need for some kind of guaranteed health-care, education and basic income than about Skynet; much more worried about some terrorist taking an AI system to kill people than about an AI system suddenly waking up and deciding that it should do that on its own." On the short term he is surely right.

20) **Importance:** Advanced AI could represent a profound change in the history of life on Earth, and should be planned for and managed with commensurate care and resources.

Kay Firth-Butterfield believes that AI will create profound change even before it is 'advanced' and thus we need to plan and manage growth of the technology. "As humans we are not good at long-term planning because our civil systems don't encourage it, however, this is an area in which we must develop our abilities to ensure a responsible and beneficial partnership between man and machine."

21) **Risks:** Risks posed by AI systems, especially catastrophic or existential risks, must be subject to planning and mitigation efforts commensurate with their expected impact.

Humans seem to be rather erratic in terms of development and use of novel systems. Not many systematic cate or regulation is thought in advance. However, for the potentially very powerful technologies such as creating black holes of superintelligence, much should be thought and regulated in advance. 22) **Recursive Self-Improvement:** AI systems designed to recursively self-improve or self-replicate in a manner that could lead to rapidly increasing quality or quantity must be subject to strict safety and control measures.

This is the core event Elon Musk sees as the superintelligence emergence. Already, many AI systems apply similar techniques, but this one is related to the general superintelligence at an initial stage, rapidly improving itself like the AI programs playing some game.

3) **Common Good:** Superintelligence should only be developed in the service of widely shared ethical ideals, and for the benefit of all humanity rather than one state or organization.

Similar to many principles, this one tries to promote positive values not only into the AI society, the superintelligence entities, but also into the human society. The last one is far-fetched for sure and such discussions in the technical AI community should be avoided.

4. CONCLUSION

While the paper practically copies the principles and the related information presented through the Future of life institute, it is important to spread the word around. The paper will hopefully spur discussion and awareness about these issues also in our country. The added discussions are here primarily to foster more attention.

The principles are not to be accepted as axioms or governmental laws, but rather as guidelines in which direction should we humans develop AI to avoid the dangers of the negative effects of the rising power of artificial intelligence. While AI often frightens general public, this author finds it a necessity to prevent degradation of human civilization. However, the potential dangers are real, not fictitious, primarily to a simple fact that any major power can be easily misused to cause harm to humans. By raising awareness, we increase the chances to ripe only the positive aspects of the future mighty AI.

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INFLUENCE OF SELF OBSERVATION IN THE PROCESS OF TWO-DIMENSIONAL CREATION IN VISUAL ARTS

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ABSTRACT

This paper presents a phenomenological case study of a fine artist and her process of self-observation in analog and digital media interaction. In the process of self-observation, the methodological questions emerged of how to explore the unconscious layers of subject's experiential nature, which also represent their source of inspiration without demolishing the creative practice. The results have shown an adverse effect of self-observation on the creative practice of an artist that draws attention to some problems of the empirical investigation in the field of art. In conclusion, contemporary scientific research needs to reconsider the issue of deepening self-awareness and the establishment of a state of mindfulness within investigations on the practice of art.

Keywords

Self-observation, phenomenology, experience, artistic process, mind wandering, awareness, creativity

1. OBSERVING THE SELF OBSERVATION PROCESS

This paper introduces a phenomenological case study of an academic painter which, through the first-person perspective, observes inner experience in interaction with analog and digital media during the creative process. The self-observation process gradually deepened self-awareness, influenced and changed the course of her painting process.

Based on the survey, there was no significant content found that explore the experiential role and the impact of self-observation of different levels of consciousness [11]. Related questions can be found in a broader context [5, 18] or in conjunction with other artistic disciplines [9] but there are only a few examples where research question is carried out and tested in collaboration with visual artists. Studies tend to focus on the object/subject of observation and ignore the methodological impact on the creative process.

Therefore, within the research process, which lasted from the inspirational phase to the initial phase of painting, a methodological question was raised: Whether or how self-observation and deepening the awareness are really compatible with the creative process?

The purpose of the contribution is therefore to illustrate the artist's experience within the self-observation process, its problematic points and the consequences that have arisen, in connection with the process of revealing her unconscious content.

2. PHENOMENOLOGICAL APPROACH

This research was constructing against the grain and delimiting itself from a prior hypothesis. The data of subjective experience was collected with the modified Descriptive Experience Sampling Method [6], by using a prototype of a mobile application that prompted the artist at random times to record her experience. After gathered samples, the experiences were "deepened" with the elicitation interview [14]. The purpose of this procedure was to get the most "pristine" structures of experience [8], the basic entities and patterns that form the individual's experience of the description, regardless of the meaning that she attributed to the experience [7].

3. OUTLINING THE EXPERIENTAL LANDSCAPE

The process of observation revealed a distinct dynamic between various *experiential states* and the experiencing *self-perception*. The dynamics of experiential process transpired between three *experiential states: sensory, emotional* and *mind wandering*. In correlation with the dynamics of experiential states, it was perceived that the experiential components that describe the perception of oneself, vary accordingly. The categories of *self-perception* were indirect descriptions of experience: *experiential space, sense of agency,* and *narrative perspective* [3].

With *experiential space* the artist defines where her attention is located during the creative process; it is either situated on the object of creation or it converts to thought processing. Based on the artist's descriptions, the "spaces" of attention were: *up there, here and now,* and *in between.*

Up there indicates the experience, which the artist describes as present in her "head". This is a "mental" phenomenon [22], which has no connection with the physical perception of this part of the body.

Here and now describes the experience where the artist experiences herself present in space and time in which she operates.

In between describes the experience where the artist is unable to define where the attention is, making the artist unaware of the experience in a specific moment.

The *sense of agency* contains reports of how the artist experiences her own causality [10, 12] working and happening. In the process, the artist experiences herself as the "agent" or things just happen to her and she is only an observer of events.

According to *self-perception*, the artist switches the position, or the perspective of description from first-person narration to second- or third-person narration, which implies that she is trying to distance herself from occurrences and sensations that are happening in and outside of her.

Mind wandering - defined as thought processing, was either taskoriented or task-unrelated [15, 13] in the creative process. Its subcategories were *reflective mind wandering* and *non-reflective mind wandering*, which means the artist can have a different metacognitive awareness of the current contents of thought [17]; an artist can either actively wander with her thoughts or only observe her mind wandering.

3.1 The relations and the dynamic between the categories

In the creative process, the relations and the dynamics between the categories were established automatically. According to the artist's reports, the experiences that were happening in the perception area here and now were always in correlation with the sub-category working. In this state, there was a certain coherence between the categories (emotional, sensory) which were confined to first-person narration. These reports were more explicit in comparison with the experience, which transpires in the place up there. The artist's experience of this »place« was always described from second- or third-person perspective.

There was another space between the up there and working in the here and now, that is the in-between category. This category represents the state of transition between the other two categories and connects with a second- or third-person point of view (the category: second or third person).

The dynamic runs among all experiential categories »relationally«, meaning that the change of a specific category affects the entire experiential process and thus the creative process as well.

3.2 Problematic points of observation

The specific properties of experiential categories, which were revealed as the problematic points of observation, had the ability to influence the experience of the exploration process itself and were presented along with every description of each experiential category.

The uniqueness and the complexity of the emotional experience primarily manifested in its multifaceted structure or in the parallel structure of the feelings; it was divided into two levels, that is to say, what is connected with the situation and what is connected with the content. The artist encountered some experiencing difficulties, e.g. the painting process induced the feelings of contentment, while at the same time she perceived the content of painting unpleasant.

The *sensory experience*, in the case of the artist, differentiates from the other categories because of its »vividness« or its intensity and the »presence« of this experience. The sensory experience was divided into two sub-categories; *the sensory experience with a physical component* (which mostly records unpleasant physical senses in connection with posture and body position when repeating specific movements) and the *sensory experience without a physical component*, which was recorded on a much smaller scale. Even though it seems like the latter plays a crucial role in the creative process, it is vital for the decisionmaking process and brings the feelings of joy and contempt. However, due to the momentary and very elusive nature of sensory experience, it is very difficult to track and observe this experience.

4. THE PROBLEMATIC POINTS OF OBSERVATION

The problematic points of specific categories had the power to influence the result of the observation process. Deepened awareness caused a reorganization of the dynamic processes, through which the amount of reflective mind wandering raised and consequentially also confirmed lowering the sensory perception [21] and higher amount of unpleasant emotional perceptions was detected. Due to increased mind wandering, the experience of the artist in the place here and now decreased and predominantly stayed in the area up there. Observation of mind wandering also encountered some problems due to its evasiveness, e.g., the problem of "fixating" the moment on a specific experiential moment, the elimination of the time component, and the transition between different forms of mind wandering takes place automatically, without awareness of the artist.

5. CONCLUSION AND FUTURE DIRECTION

The results of the study show that the self-observation and lowering mind wandering process, in this case, led to a creative block, namely to a negative influence on the artist's work, which is contradictive to some previous studies reports [13, 4]. This calls for consideration that the future studies should take the predispositions of the artist's practice and the phases of their creative process into account. Artists, as well as their creative processes, are different in sensitivity and difficulty of observation. Additionally, a caution with using contemplative techniques are needed because non-dual awareness does not always work in the favor of the individual, in fact, some studies show quite the opposite [2, 20]. The research supports the knowledge, that the balance between the conscious and unconscious states is needed for the creative process [16].

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Analysis of EEG visual evoked potential (VEP) acquisition delays

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ABSTRACT

EEG visual evoked potentials (VEP) are event related potentials (ERP), i.e., measured brain response, for visual events. In order to analyze ERPs, EEG acquired data must be supplemented with information indicating the time of stimulation events. This information may be detected by sensors or from event generation devices. Visual stimulation is most often carried out using computer monitors. The time of stimulation events is traditionally detected using monitor mounted lightness sensors. However lately, it is often obtained from visual stimulation software. In this work we tested the hypothesis that software event markers could be considered as an alternative to lightness sensor markers. We built a software application that acquires EEG data with both types of markers to measure the VEP acquisition delays and test the hypothesis. The results obtained on standard computer monitors show large discrepancy between information obtained from both marker types, not only the delay, which could eventually be compensated, but also the presence of jitter that may have a drastic influence on the analysis results. Even in the case of lightness sensors their careful positioning is required to correctly measure temporal characteristics of ERP responses.

Keywords

Electroencephalography (EEG), event related potentials (ERP), visual evoked potentials (VEP), delay, jitter

1. INTRODUCTION

Event related potentials (ERP) are measured brain responses that result from specific sensory, cognitive, or motor events[5]. Visual evoked potentials are a specific kind of ERPs that are limited to visual events. For a detailed explanation of evoked potentials, their physiological background and required acquisition system components see [1]. VEPs Peter Rogelj^{*} University of Primorska FAMNIT Glagoljaška 8, 6000 KOPER peter.rogelj@upr.si

are one of the primary tools for cognitive neuroscience research [3] and, lately, for brain computer interfaces (BCI) [9]. There are two types of VEP used, i.e., transient VEP (TVEP) corresponding to response to individual stimulus, and steady-state VEP (SSVEP) corresponding to repetitive stimulations. Analysis of the first one needs to be performed in the temporal domain and is sensitive to synchronization between the stimulus and EEG recording. Standard computer monitors are most often used for stimulus display and rarely other (typically flashtube) devices are used instead. Delays and jitter may have drastic influence on the analysis results. As the delay may be measured and compensated, there is no evident workaround for the jitter. In medical/neuroscience setups, the synchronization is typically performed by automatic EEG labeling using display mounted lightness sensors, for an examples of such a study see [8]. This kind of synchronization is rare in the BCI setups due to increased equipment cost. Today, many setups rely on expected low delay of computers and their peripherals [6, 7], and label the events in EEG data by visual event generating software.

In this work we analyze the delays in setups that display stimuli on computer monitors. We have implemented a VEP recording system with dedicated software for visual stimulation and simultaneous recording of EEG signals supplemented with different marker signals indicating system delays.

2. ACQUISITION OF EVENT-LABELED VEP DATA

To measure delays in VEP acquisition we built a system for VEP stimulation and recording capable of storing two additional marker signals to accurately label visual stimulation event timing. The first is a software marker signal that indicates when the software renders an image. In such moments the software marker's value is set to a value defined for the specific image in a predefined visual stimulation plan, else its value is zero. The second marker signal is a digital one, and indicates when images actually appear on the monitor. Is is acquired using two lightness sensors connected to an additional digital input channel of an EEG device. Each sensor influences one of the bits of in the digital signal value.

Our system consists of several hardware and software components. The hardware setup is shown in figure 1. The system uses EEG implementation from g.tec medical engineering consisting of two EEG amplifiers g.USBamp, toge-

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ther enabling 32 EEG channels, and g.TRIGbox with two lightness sensors.

We implemented our own software on a Linux operating system using g.USBamp C-API with special care for minimizing software delays during stimulation and data acquisition. Both tasks, stimulation and data acquisition were implemented in a single software component. All the data including the visual stimulation plan and all the images were preloaded, avoiding all unnecessary processing during the data acquisition. A single handler function served for accessing data from both EEG amplifiers including 32 channel EEG data and digital data from the lightness sensors, as well as the software marker signal set by a visual stimulation function. For displaying the images OpenCV function čv::imshow"was used. All the acquired data was written to a single binary file for each EEG recording session. After the acquisition the recorded data was analyzed in Matlab.

3. **RESULTS**

The experiment was performed using a HP Computer with an i7 processor, SSD disk and 16GB RAM, running a Linux operating system. Two different monitors were used, HP 1702 (A) and HP Z24i D7P53A4 (B), and for each of them four different lightness sensor placements labeled 1–4 were tested, altogether yielding eight cases, labeled from A1 to B4. Sensor placements are illustrated in figure 2.

In each of the recordings two images were periodically cycled, where the first one was all black and the other one was all white. Each image was shown for 200 milliseconds and the cycle repeated 500 times, such that 1000 image renderings took place in total in each of the recording cases. The signals were recorded using 512 Hz sample rate and analyzed according to delay between the markers. The software marker signal has a non-zero value only for samples when the image display function was called, i.e., value 1 for the transition from white to black (event E1), and value 2 for the transition from black to white (event E2). The sensor marker signal was coded as two bits of a digital signal, i.e., bit 1 for the top/left sensor and bit 2 for the bottom/right one, yielding values from 0 (black screen) to 3 (white screen). For the illustration of the marker signals see figure 3.

For each event, i.e., spike in the software marker signal, the consequent changes in the digital sensor signal were found and delays τ computed. The statistical distribution of delays was estimated for each of the cases and evaluated according to average delay ($\overline{\tau}$), maximal delay (τ_{max}), delay standard deviation (σ_{τ}), and maximal difference between response time of both sensors (Δ_{τ}). The results are listed in table 1. Delay distribution for case A1 is shown in figure 4(top). We can see that delay is not constant and jitter is present. The standard deviation of delay is roughly 6 samples or 12ms for monitor A and 10 samples or 20ms for monitor B. The difference between maximal and minimal delay can be up to 60 ms, which shows that our initial idea of compensating delay with calibration is not feasible.

Despite the sensors were in case A1 located as close together as possible, the maximal difference between their response was 3 samples or 6 ms. By positioning sensors further apart, the difference increases to up to 12 samples or 23.4 ms, which

Table 1: Statistical parameters of delay for two monitors (A and B) and four sensor placements (1-4). All results are given in number of samples at 512 Hz data acquisition.

	$\overline{ au}$	$ au_{max}$	$\sigma_{ au}$	Δ_{τ}
A1	22.28	48	6.53	3
A2	22.95	44	5.80	6
A3	22.49	44	6.18	12
A4	22.80	45	5.94	9
B1	27.20	54	10.54	3
B2	27.47	52	10.34	3
B3	26.27	60	10.20	5
B4	27.53	52	9.95	9

is more than the monitor refresh period (16.7 ms for a 60 Hz monitor refresh rate). In case of monitor B, this difference is closer to our expectations, up to 9 samples or 17.6 ms in case B4, exactly one monitor refresh cycle. A more detailed analysis shows that delay difference gets clustered into as many clusters as there are vertical segments of the monitor display being divided by the lightness sensors. Each of the clusters was up to 6 samples wide for monitor A and up to 3 samples wide for monitor B. The position of clusters roughly corresponds to the vertical portion of the monitor screen between the markers, and in most obvious cases A4 and B4 equals 8 to 9 samples; approximately one monitor refresh period. An example of delay difference distribution is shown in figure 5.

Detailed analysis of monitor A shows another phenomenon: different delay distributions for events E1 (white to black transition) and E2 (black to white transition), where E2 is on average 3ms faster than E1. Distributions for individual events are shown in 4(middle, bottom). This is phenomenon was less obvious for monitor B, where E1 is on average 1ms faster than E2.

4. DISCUSSION AND CONCLUSION

Our initial hypothesis was that software markers could be considered as an alternative to lightness sensor markers. Our results disprove such a hypothesis, because the delay between image rendering in software and actual image appearance on the computer monitor is not constant. The jitter cannot be compensated and this puts in question all setups that rely on software timing of events, not only for TVEP but also SSVEP analysis. Our results do not tell much about the source of the delay. Usually, the monitor refresh rate is expected to be the only factor responsible for the delay, as suggested by some of the EEG experiment setup guides [4]. In our results this cannot be the case, as 60 Hz refresh rate would reflect into at most 17 ms delay and not up to 47 ms measured in our tests. We hypothesize that delay also comes from software processing, graphic card rendering, monitor rendering and pixel response times. Due to using certified medical-grade EEG equipment, we can only expect that the delay of the lightness sensors and EEG amplifiers is small enough not to be considered. We have only tested LCD monitors and not CRT ones. As it has been reported that LCD monitors significantly increase the P100 latency compared to CRT monitors [2] one could speculate that this could be due to potentially higher delay of LCD monitors.



Figure 1: Hardware components of the VEP stimulation and recording system.



Figure 2: Lightness sensor placements. Two sensors were placed in four different configurations (1-4) in order to test the influence of sensor placement on the delay between their signals.



Figure 3: A section of marker signals. Spikes in the software signal correspond to moments when function for image display is called. Digital signal from lightness sensors is binary coded, each sensor contributing a single bit.

From the results of the delay difference between the lightness sensor signals we can conclude that positioning of the lightness sensors is important for TVEP analysis. Lightness sensors should be vertically positioned as close as possible to the center of the screen or the part with expected observer attention. If such positioning is not possible, the error cannot be corrected by changing the delay for the time proportional to the vertical screen displacement, because there are always two possible alternatives, with the delay difference of one monitor refresh period. The standard deviation of the clusters depends on the monitor. For monitor B it is estimated to equal one sample or 2 ms. This defines the highest possible accuracy of ERP studies.

Monitor selection turns out to be important. It influences the level of delay jitter, responsible for VEP analysis error in the case of software markers, and variation of sensor delay that limits the accuracy when using lightness sensors. In our case each of the monitors outperformed the other in one of the aspects. This suggests that with careful selection even better monitors could be found. We could only speculate how to get lower jitter, but evidently one of parameters influencing the lightness sensor marker accuracy is the monitor refresh rate. Higher is better. As the required monitor properties are similar to the ones sought by gamers, this may be a good starting point for the selection.

To conclude, the results of our work show that software markers are subjected to high visual stimulation delay and jitter when standard computer monitors are used. Consequently, such VEP recording system implementations should be avoided whenever possible, and used with extreme caution. Furthermore, even the lightness sensor markers should be used with a certain amount of care when stimulation is performed using computer monitors, especially to vertically



Figure 4: Delay distributions for case A1; for both events (top), event E1 (middle), and event E2 (bottom)



Figure 5: Distribution of delay difference between both lightness sensors for the B3 case. The distance between the clusters correspond the monitor refresh period.

align sensors with the expected center of attention.

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O fenomenologiji prepričanj, od Husserla do enaktivizma

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POVZETEK

Predstavljeni so nekateri koncepti in ideje v fenomenološki tradiciji, ki osvetlijo prvoosebni pogled na prepričanja. Husserlova ideja horizonta uvede prvoosebno obliko implicitnih prepričanj in zaznavnih procesov, ki so-določajo vsak naš doživeti trenutek. Pri horizontu je omenjena tudi pomembna vloga telesa kot kontekst za horizontna prepričanja. Utelešeno perspektivo poudari tudi Merleau-Ponty, ki argumentira, da telo daje našemu svetu pomen. Merleau-Ponty uvede tudi pojem intencionalnega loka, na podlagi katerega Dreyfus predstavi možnost učenja (ustvarjanja novih pomenov) brez reprezentacij. Na Merleau-Pontyju sloneč enaktivizem, kot ga uvedejo Varela, Thompson in Rosch, pomembnost utelešenja ponotranji. Na koncu je predstavljen še sodobni koncept opomenjanja avtorjev Di Paolo, De Jaegher in Rosch, katerega glavna značilnost je, da je telo to, kar določa norme na podlagi katerih naš svet pridobi pomen.

Ključne besede

fenomenologija, prepričanja, udejanjanje, enaktivizem, opomenjanje

1. UVOD

Prepričanje je po navadi definirano kot naravnanost »ko nekaj vzamemo za resnično«, pri čemer je ta »nekaj« izrazljivo kot propozicija. Prepričanja se tako opisujejo v obliki »S je prepričan, da P« (kjer je S subjekt, P pa propozicija), na primer: »S je prepričan, da ima naše osončje 8 planetov«. Velik del filozofske tradicije, od reprezentacionalizma preko dispozicionalizma in interpretacionalizma do funkcionalizma, razumejo prepričanja kot shranjena nekje v umu (reprezentirana), od kođer inspirirajo naše vedênje. Iz vedênja pa lahko retroaktivno sklepamo na prisotnost prepričanj. (Schwitzgebel, 2015)

Prispevek na kratko predstavi fenomenološko tradicijo, ki se ne naslanja na reprezentacije in ne ugotavlja, kateri organizmi se dovolj prepričljivo vedejo, da jim lahko pripišemo prepričanja. Fenomenologija se osredotoči na prvoosebno perspektivo tega, ko nekaj vzamemo za resnično. Velik delež bo posvečen konceptu horizonta Edmunda Husserla (1913), ki je le delček njegove obsežnejše teorije prepričanj. Horizontu bo dodan še poudarek na vlogi telesa Maurica Merleau-Pontyja (1996) in njegov koncept intencionalnega loka, ki ga Hubert Dreyfus (2002) uporabi za predstavitev možnosti učenja brez reprezentacij.

Utelešena perspektiva in odmik od reprezentacij sta ključnega pomena za enaktivizem oziroma teorijo udejanjenja, avtorjev Francisco J. Varela, Evan T. Thompson in Eleanor Rosch (1991). Znotraj enaktivizma je predstavljen koncept opomenjanja avtorjev Ezequiel Di Paolo, Marieke Rohde in Hanne De Jaegher (2010), katerega glavna značilnost je, da je telo to, kar določa norme na podlagi katerih naš svet pridobi pomen. Prepričanja nastopajo vedno pod tem imenom. Avtorji uporabljajo mnogo pojmov, ki jih je možno razumeti kot podvrste prepričanj ali kot prepričanjem sorodni fenomeni, kot na primer znanje (resnično, utemeljeno prepričanje), pričakovanje (prepričanje o tem, kaj bo v prihodnosti), pomen (prepričanje, kaj/kako neka stvar je) in učenje (»pridobivanje« novih veščin, znanj, prepričanj, pomenov).

2. HORIZONT

Husserl horizont opiše v mnogo kontekstih, eden izmed njih je kontekst doživljanja določenega predmeta. To izkustvo obdaja »temno zavesten horizont nedoločene resničnosti« (Husserl, 1913: 49) – obzorje možnih izkustev v prikazujočem se nam svetu v danem trenutku.

»Svojo pozornost lahko pustim potovati od ravno videne pisalne mize, na katero sem bil pozoren, preko ne-videne dele sobe za mojim hrbtom k verandi, na vrt, k otrokom in uti itd., k vsem objektom, za katere trenutno 'vem', kot tam in drugod v moji neposredno so-zavedani okolici bivajočim [...]« (ibid.)

Horizont je torej vso znanje (*Wissen*), ki spremlja dano izkustvo predmeta. Husserl še v isti povedi to znanje opredeli kot implicitno: »[...]– znanje, ki nima nič od pojmovnega mišljenja in se šele z naklonjenostjo pozornosti in tudi takrat le delno in po navadi zelo nepopolno preobrazi v jasno opazovanje.«

Druga oblika horizonta se pojavi pri Husserlovi analizi časovne zavesti. Gallagher in Zahavi (2007) povzemata Husserlovo argumentacijo, da doživljanje ni sestavljeno iz serije diskretnih izkustev, ki si sledijo eno za drugim. Za izkustvo časovne zveznosti se moramo v vsakem trenutku zavedati tudi trenutka pred njim in slutiti trenutek, ki mu sledi. A to zavedanje ne more biti enostavno spominjanje ali predstavljanje, ne more biti enostavno reprezentacija nekega preteklega ali bodočega trenutka v tem trenutku. Gallagher in Zahavi (2007) navajata primer doživljanja melodije. Ne slišim ene posamezne note, ki potem iz zavesti popolnoma izgine, na kar se pojavi izkustvo druge note, temveč »zavest ohrani občutek prve note, ko slišim drugo, slišanje, ki je obogateno s pričakovanjem naslednje note.« (Gallagher in Zahavi, 2007: 75) To še jasneje ponazorita s primerom slišanja zaporedja treh not C, D in E. Ko se zavemo note E, se hkrati tudi zavedamo predhodnih not D in C, a ne na enak način kot se zavedamo note E. Noti D in C sta pretekli, in doživeti kot toneči v preteklost. V vsakem trenutku imamo torej horizont tako preteklega trenutka, kot tudi pričakovanje prihajajočega.

Jeffrey Yoshimi (2009) horizont predstavi kot predznanje (*Vorwissen*) in pričakovanja povezana z doživljanjem danega predmeta:

»Ko gredo stvari kot pričakovano, naše trenutno izkustvo 'izpolni' (*erfüllen*) naša predhodna pričakovanja, in ti dve izkustvi prestaneta pasivno sintezo identifikacije. [...] Ko stvari ne gredo kot pričakovano, naše izkustvo 'razočara' (*enttäuschen*) naša predhodna pričakovanja (*Erwartungen*) [...] in posledično se zgodi le delna sinteza (še naprej se doživlja kot isti objekt, a razumljen je drugače).« (Yoshimi, 2009: 124)

Yoshimi (2009) izpostavi pet pomembnih lastnosti horizonta.

1. Horizontna pričakovanja so tiha, implicitna in ne vključujejo aktivnega mišljenja, premlevanja ali govorjenja. Ko dvignem roko, da bi potrkal na vrata, si po navadi ne mislim »pričakujem, da bodo vrata naredila leseni zvok«. Horizontna prepričanja so prej podobna »značajskemu odnosu med možnimi dejanji, zaznavami in stopnjami izpolnjevanja ali razočaranja.« (Yoshimi, 2009: 124) Na primeru trkanja vrat bi to pomenilo, da enostavno nisem presenečen, če vrata res naredijo lesen zvok, ko na njih potrkam, med tem ko me začudi, če ga ne.

2. Horiznotna pričakovanja niso diskretne enote in se ne nanašajo na enostavno ubesedljive možne dogodke, temveč ustrezajo zveznemu razponu možnosti. Zbirajo se v manevrske prostore (Spielräume), v katerih je znotraj danih omejitev možen širok diapazon pričakovanj (Yoshimi, 2009). Ko, na primer, sežem proti kamnu, sem odprt za razno razna s kamnom povezana izkustva. Ne pričakujem točno določene teže, le približek; ne pričakujem točno določene oblike in barve kamna na hrbtni strani, mnogo različnih oblik in barv ali barvnih kombinacij sive, črne, bele, rjave... lahko zadostijo moja pričakovanja. Presenečen bi bil le, če bi se moje izkustvo nahajalo povsem izven mojega obsega pričakovanj, če bi bil na primer lahek kot pero, ali kot kos lesa; ali če bi bil na hrbtni strani povsem raven in živo-modre barve.

3. Horizont je dinamičen, neprestano se posodablja na podlagi našega toka doživljanja (Yoshimi, 2009). Če, na primer, primem kamen in namesto hladnega, grobega in težkega občutka v roki, ki sem ga pričakoval, začutim manj hladen, gladek in lahek občutek, kot da bi bil to le kos plastike, se bodo moja horizontna pričakovanja v zvez s tem predmetom ustrezno posodobila in ne bom nenehno presenečen ob držanju tega predmeta. Če ga posledično vržem, pričakujem, da leti kot plastika, ne kot kamnina.

4. Horizontna pričakovanja so osnovana na informacijah o tipu stvari, ki jo doživljamo (Yoshimi, 2009). Ko doživljam določen kamen, so moja pričakovanja o tem kamnu osnovana na tem, kar vem o kamnih na sploh – o tipu »kamen«. Husserl da primer psa: »Ko vidimo psa, nemudoma pričakujemo njegove dodatne načine obnašanja: njegov tipičen način jedenja, igranja, tekanja, skakanja in tako naprej. Ni tako, da dejansko vidimo njegove zobe; a vemo v naprej kako bodo njegovi zobje izgledali – ne v njihovi individualni določenosti, temveč glede na tip, v kolikor smo že imeli pretekle redne izkušnje s 'podobnimi' živalmi, s 'psi', da imajo stvari, kot so 'zobe', tega tipa« (Dreyfus 1984: 19; citirajoč Husserl 1973: 331)

5. Horizontna pričakovanja so vpeta v kontekst možnih okoliščin, a predvsem so določena s telesom in gibanjem. Yoshimi poda primer z vrati:

»Kaj pričakujem v zvezi z vrati, ko z njimi stopim v interakcijo, je odvisno od tega, kako se gibljem: če se premaknem desno, pričakujem da se videz vrat spremeni na določen način; če se premaknem levo, pričakujem da se spremeni na drugačen način. Husserl včasih opiše 'predzačrtane' ali 'predizračunane' (*vorgezeichnet*) videze kot odvisne spremenljivke v odnosu do gibanja telesa (ki je neodvisna spremenljivka)«. (Yoshimi, 2009: 124)

Tudi od telesnega gibanja neodvisne okoliščine določajo horizontna prepričanja. Če vidim žogo, ki z neko hitrostjo leti proti vratom, imam s tem dogodkom povezana pričakovanja, na primer kakšen zvok bo naredil trk žoge ob vrata in to, da se bo žoga od vrat odbila. Povsem presenečen bi bil, če bi se namesto tega žoga razbila kot steklo.

3. UTELEŠENA PERSPEKTIVA

Husserl že malo namiguje na to, da igra telo oziroma naša utelešena perspektiva posebno vlogo v horizontu. Obsežne fenomenološke analize doživljanja telesa se loti Maurice Merleau-Ponty (1996), ki opiše telo iz dveh zornih kotov, kot objekt doživljanja in kot perspektiva doživljanja. V kontekstu analize telesa kot objekta doživljanja omeni dva pojma: telesna slika in telesna shema. Telesna slika je »sestavljena iz sistema izkustev, naravnanosti in prepričanj, kjer je objekt teh intencionalnih stanj lastno telo.« (Gallagher in Zahavi, 2007: 146) Merleau-Ponty (1996) telo opredeli kot zaznano drugače kot so zaznani siceršnji objekti. Drugi objekti se lahko oddaljijo in izginejo iz moje zaznave, med tem ko telo tega ne more, je trajno. Pri tem Merleau-Ponty (1996) doda, da telo za nas ni prisotno kot objekt v svetu, temveč kot naša perspektiva na svet (o tem več kasneje).

Telesno shemo Gallagher in Zahavi povzameta kot »naše predreflektivno in ne-obiektivizirajoče zavedanje telesa.« (Gallagher in Zahavi, 2007: 146) Ta karakterizacija so-doživljanja telesa v horizontu ne uvede nobenih novih idej ali razumevanj v sklopu že prej razdelanega pojmovanja horizonta. Lahko je enostavno del njega, kot je so-doživljanje sobe, ko sem osredotočen na pisalno mizo; ali kot so v horizontu pričakovanja na podlagi tipa »telo« ali »moje telo«. A Merlea-Ponty (1996) tudi tu doživljanje telesa predstavi kot doživeto drugače od drugih objektov. Na primeru pika komarja, ki ga ne rabimo iskati po lastnem telesu, temveč ga enostavno najdemo, izrazi: »Kar se tiče telesnega prostora, očitno obstaja védenje za kraj, ki ga je možno zreducirati na neke vrste so-obstoj s tem krajem, [...] čeprav ga ni možno izraziti z opisom ali nemo referenco geste.« (Merleau-Ponty, 1996: 121) Prostorskost telesa torej ne doživljamo enako kot prostorskosti sveta. Zavedanje, kje v prostoru je stikalo za luč, je približno, motorično se lahko osredotočimo nanj, in ga najdemo. Lastno peto pa najdemo brez iskanja, enostavno vemo, kje je.

Drugi zorni kot, na katerega je namigovala že telesna slika, obravnava telo kot izhodiščno točko naše zaznave, kot našo perspektivo na svet. Merleau-Ponty poudari pomembnost utelešene perspektive pri zaznavi že pri naslovu enega od poglavij v knjigi Fenomenologija zaznave: »teorija telesa je že teorija zaznave« (Merleau-Ponty, 1996: 235). Vsak pogled je pogled od nekod, pri čemer je ta medij in lokus zaznave telo. Kadarkoli se mi kaže nek predmet, se mi kaže iz perspektive mojega telesa, iz lastne perspektive (Merleau-Ponty, 1996; Gallagher in Zahavi, 2007). Telo torej (so)določa naš zaznavni svet in horizont, ki ga obdaja. A pomembnost telesa gre še globlje. Telo in njegove gibalne zmožnosti imajo moč ustvarjanja pomena (*Sinngebung*), na podlagi njih za nas svet pridobi pomen (Merleau-Ponty, 1996).

4. UČENJE BREZ REPREZENTACIJ

A kako natančneje svet pridobi pomen? Se to zgodi hipoma ali je proces dolgotrajnejši? Je ta postopek res popolnoma brez reprezentacij? Hubert Dreyfus (2002a) poda razlago učenja, ki se odmakne od (propozicionalnih) mentalnih reprezentacij. Pri tem se naslanja predvsem na Merleau-Pontyjev koncept intencionalnega loka (*intentional arc*), ki ga Merleau-Ponty (1996) označi kot to, kar poveže naše čute, inteligenco, gibalne zmožnosti ipd. v kognitivno ali zaznavno življenje z našo preteklostjo, prihodnostjo, fizično, ideološko in moralno situacijo. Dreyfus pri intencionalnem loku poudari predvsem, da »ko agent pridobiva veščine, se te veščine 'shranijo', ne kot reprezentacije v umu, temveč kot nagnjenost k odzivu na zahteve situacij v svetu.« (Dreyfus, 2002: 367)

Dreyfus (2002) svojo razlago ilustrira na primerih odraslega, ki pridobi neko veščino preko navodil, natančneje na primerih učenja vožnje avtomobila (motorična veščina) in učenja igranja šaha (intelektualna veščina). Učenje razdeli na pet stopenj, od začetnika na prvi stopnji do eksperta na peti stopnji, skozi katere se za učenca vzpostavi intencionalni lok. Prvi stopnja (novinec) še vključuje reprezentacije, pri primeru vožnje avtomobila: »prestavi v drugo prestavo, ko merilnik hitrosti kaže deset milj na uro.« (Dreyfus, 2002: 368) Vozniki začetniki vozijo in reagirajo počasi, saj se morajo neprestano spominjati (si priklicati reprezentacije) tovrstnih pravil. V nadaljnjih stopnjah Dreyfus (2002) predstavi počasen odmik od naslanjanja na propozicionalne reprezentacije. Navede primer, ko napredni začetnik poleg gledanja na merilnik hitrosti uporabi tudi zvoke motorja (ki jih ni mogoče dobro opisati z besedami) v pravilih za menjavo prestav. Pri tretji stopnji se učenje že naveže na čustva in oddalji od racionalnega premisleka. Spretno vedênje povzroča dober občutek, nespretno slab; učenec ne skuša delovati racionalno pravilno, temveč tako, da bo imel dober občutek. Pri četrti stopnji se izkušnje že asimilirajo na neteoretičen način: intuitivno vedênje zamenja premišljene odzive, »učenec enostavno vidi, kaj je treba doseči« (Dreyfus, 2002: 371). To se popolnoma ponotranji pri zadnji stopnji, ko ekspert deluje popolnoma intuitivno in brez premišljevanja. »Kar mora biti storjeno je preprosto storjeno.« (Dreyfus, 2002: 372)

Naučeno torej spreminja, kako doživljamo svet. Dreyfus (2002) z Merleau-Pontyjevo argumentacijo intencionalnega loka poudari, da naše izkušnje niso reprezentirane v umu in nato dodane trenutnemu izkustvu, ali kot piše Dreyfus: »kar učenec pridobi skozi izkušnje ni reprezentirano v umu, temveč je prezentirano učencu kot bolj in bolj razločna situacija« (Dreyfus, 2002: 373). Skozi učenje prevzamemo (ali ustvarimo) nova prepričanja, kdaj eksplicitna propozicionalna (v obliki navodil in napotkov) in kdaj eksplicitna nepropozicionalna (kot na primer zvok motorja) in jih ponotranjimo do te mere, da naš svet navdahnejo z novim pomenom (v smislu bolj razločnih situacij, ki zahtevajo bolj prefinjene odzive).

5. ENAKTIVIZEM

Bolj dosleden odmik od reprezentacij naredijo Varela, Thompson in Rosch (1991) na primeru zaznave barv. Avtorji so kritični do ideje, da:

» [...] barvne površine najdemo v vnaprej danem svetu, ki je neodvisen od naših zaznavnih in kognitivnih kapacitet. A kako naj opredelimo, kaj šteje za površino? Kako naj opredelimo njene robove, meje, teksturo in orientacijo, če ne v odnosu do nekega zaznavajočega, za katerega so ta razmejevanja relevantna?« (Varela, Thompson In Rosch, 1991: 166-167)

Z metaforo vprašanja o kuri in jajcu ta objektivistični pogled, da ima zunanji svet vnaprej dane lastnosti, ki jih um odkriva in reprezentira, imenujejo »pozicija kure«. Na drugo stran postavijo »pozicijo jajca«; idealizem – pogled, da um projicira svet, ki je le odsev (ali reprezentacija) strukture uma. Tema pozicijama postavijo naproti vmesno pot. Namesto pojmovanja kognicije kot raziskovalca zunanjega sveta ali kot projektorja notranjega sveta predlagajo kognicijo kot utelešeno dejavnost oziroma udejanjenje (*enaction*; Varela, Thompson In Rosch, 1991).

S pojmom utelešeno želijo poudariti, da je zaznavanje sveta pogojeno s »telesom in njegovimi zaznavno-gibalnimi zmožnostmi, [...] Te zmožnosti pa so zakoreninjene v širšem biološkem, psihološkem in kulturnem kontekstu« (Varela, Thompson in Rosch, 1991: 173; cf. Merleau-Pontyjev intencionalni lok). Z dejavnostjo pa poudarjajo neločljivo povezanost zaznave in gibanja. Iz ponavljajočih se zaznavnogibalnih vzorcev vzniknejo kognitivne strukture, ki spet omogočajo zaznavo in gibanje. Z udejanjenjem se torej osredotočimo na to:

»kako zaznavajoči usmerja svoja dejanja v dani situaciji. Ker pa se situacija nenehno spreminja z dejavnostjo zaznavajočega, referenčna točka za razumevanje zaznave ni več vnaprej dan, od zaznavajočega neodvisen svet, temveč zaznavno-gibalna struktura zaznavajočega.« (Varela, Thompson in Rosch, 1991: 173)

Udejanjenje poudari utelešenost kot horizont in kontekst za ustvarjanje pomena sveta, kot je to izpostavil že Merleau-Ponty (1996), na katerega se precej naslanjajo tudi Varela, Thompson In Rosch (1991). Ta pogled so ponotranjili tudi sodobnejši zagovorniki enaktivizma, kot na primer Di Paolo, Rohde in De Jaegher (2010) s konceptom opomenjanja (*sense-making*). Izhajajo iz argumenta, da interakcija med organizmom in okoljem za organizem (s ciljem samoohranitve oziroma ohranitve telesa, ohranitve »mene«) nosi pomembnost (*importance*), kar za organizem ustvari normativno perspektivno na svet (nekatere interakcije ali možnosti interakcije so bolj pomembne od drugih) z osrednjim vprašanjem »kaj to pomeni (zame)?«. Tako opredelijo definicijsko lastnost kognitivnega sistema kot ustvarjanje in cenjenje pomena – opomenjanje (Di Paolo, Rohde in De Jaegher, 2010).

Di Paolo, Rohde in De Jaegher (2010) pri tem poudarijo, da organizem ni samo pasiven prejemnik informacij iz okolja, ki si jih prevede v notranje reprezentacije, jih ovrednoti in nepomembne zavrže: »kognitivni sistemi nimajo v navadi dostopati do okolja, da bi si gradili točno sliko o njem« (Di Paolo, Rohde in De Jaegher, 2010: 39). Pomen ni lastnost okolja, ki jo organizem odkrije in/ali pridobi. Pomen je rezultat trajajočega dialoga med dinamiko okolja in utelešeno dejavnostjo organizma. To razliko osvetli citat Heinza von Foersterja:

»[...] 'tam zunaj' ni svetlobe in ni barve, so le elektromagnetni valovi; 'tam zunaj' ni zvoka in ni glasbe, so le periodične variacije v zračnem tlaku; 'tam zunaj' ni vročine in ni mraza, so le gibajoče se molekule z več ali manj kinetične energije, [...]« (von Foerster, 2003: 214)

6. ZAKLJUČEK

Fenomenologija torej naredi odmik od reprezentacij in behaviorizma. Husserlova ideja naravne naravnanosti opisuje naše prav vsakdanje prepričanje, da so objekti, ki jih doživljamo, enostavno tam zunaj, od nas neodvisno obstoječi. Husserlov koncept horizonta skriva prepričanja na obrobju našega doživljanja, kot védenje, kaj vse še zaobjema širši kontekst situacije, ki jo ta trenutek doživljamo (primer pisalne mize, sobe in otrok na vrtu). Horizont so prav tako pričakovanja povezana s predmetom, ki ga doživljamo (kakšen zgleda iz drugih zornih kotov, kakšne so njegove lastnosti, ki jih še ne moremo izkusiti). To prelije tudi v doživljanje časa, kjer se v doživljanju vsakega trenutka skriva tudi paslika prejšnjega in pričakovanje bodočega.

Kot posebno obliko horizonta smo se dotaknili Merleau-Pontyjeve analize telesa kot tega, kar oblikuje našo zaznavo (in posledično prepričanja). Pri tem smo izpostavili vlogo telesa pri ustvarjanju pomena v svetu – prepričanj, kakšen svet je. Naprej smo si pogledali Dreyfusovo idejo učenja brez reprezentacij, ki je osnovana na Merleau-Pontyjevem konceptu intencionalnega loka. Po Dreyfusu se učenje začne z reprezentacijami in eksplicitnimi prepričanji, ki se z vajo ponotranjijo in integrirajo v intencionalni lok oziroma kognitivno strukturo. Z združitvijo dosedanjih konceptov v idejo udejanjenja avtorjev Varela, Thompson In Rosch, pa smo lahko odpravili reprezentacije v celoti, saj bi z udejanjenjem prepričanja lahko argumentirali, da tudi eksplicitna, propozicionalna prepričanja niso reprezentirana, temveč udejanjena v dani situaciji.

Nazadnje smo se pomaknili globlje na področje enaktivizma, kjer smo spoznali koncept opomenjanja. Ko opomenjamo, udejanjamo svet, udejanjamo 'to, kako je', 'to, kar vzamemo za resnično'. S tako razlago lahko pojmujemo prepričanja v najširšem možnem smislu kot življenjski svet, ki ga udejanjamo. Če zdaj skušamo razlikovati med prepričanji in sorodnimi fenomeni, najdemo le zabrisane meje, ki jih moramo ponovno začrtati.

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The Use of Genetic Algorithms in Researching Non-Veridical Perception

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ABSTRACT

Synthetic approach to (cognitive) science - researching (cognitive) phenomena with computer and robot models - has been called upon by various field authorities, such as Froese, Ziemke and Harvey, to tackle the problem of opposing theories that have pestered Western philosophy for centuries, especially those of epistemic nature. One synthetic methodology can offer comparison of such theories under the mechanism of natural selection - genetic algorithm. Specifically, genetic algorithms can be deployed to research non-veridical perception, the viewpoint held by various paradigms (e.g., constructivism) that the world we experience is not a representation of the world out there. One such theory that boasts empirical proof is the interface theory of perception. However, genetic algorithms, although bearing an ecologically viable modeling platform in the form of natural selection, can be, due to yet undiscovered biological realities, largely manipulated with arbitrarily set parameters and methods to get biased results. What's more, GA-based research on nonveridical perception does not seem to include full computational, algorithmic and implementational materials. This begs a carefully set protocol for such research.

Keywords

genetic algorithms, non-veridical perception, methodology, natural selection, constructivism

1. INTRODUCTION

The use of genetic algorithms (GAs) as a methodology in cognitive science has always been tentative. Being generally used as an optimization technique [1], GAs seem to rely too much on most often than not arbitrarily and trivially set parameters [2] to be sufficiently rooted in biology, while at the same time mostly being useful when having fixed expectations in a limited set of phenomena. The rise and pervasiveness of artificial neural networks as a methodology for researching cognitive phenomena is partially a consequence of such limitations of GAs. The latter, however, innately possess the mechanism of natural selection, which can be exploited in researching what phenomena, under this specific mechanism, pass the test of adaptation and survival, especially when comparing different paradigms and theories. This notably holds true for phenomena which can hardly be researched analytically, i.e. through observation and experimentation, and therefore have to be subjected to synthetic approaches, i.e. by making computer and robot models [3]. Such phenomena have a certain epistemic impenetrability, which is why numerous established researchers [4][5] have already given research in AI "the rather privileged position of being able to help resolve

theoretical disputes which have plagued the Western philosophical tradition for decades if not centuries" [6, p. 6] through "understanding by building". One such theoretical dispute is whether perception (or cognition, for that matter) is veridical or not. The idea of non-veridical perception in cognitive science can be most notably traced to the paradigms of constructivism [7] and enactivism [8][9], while most recent successful attempts at putting it in the forefront of research can be attributed to the field of predictive coding [10]. The main commonality between these paradigms is the claim that we do not perceive and cannot know the world as it really is. Consequently, they deal with the connection and discrepancy between the external world and the subject's internal world, dynamics, experience and knowledge. Genetic algorithms can therefore serve as a way to determine what kind of perception performs viably under the pressures of natural selection.

2. GENETIC ALGORITHMS – A VIABLE METHODOLOGY?

Conceptually, GAs encompass all of the most general attributes of the Darwinistically-inclined natural selection and gene recombination with mutation. In practice, an individual organism is represented by one chromosome that is made of several genes, i.e. a string of bits, integers, characters, etc. A very basic Pythonic function that produces such an individual can be seen in the Image 1 below, as well as one potential output with arbitrarily set arguments in the Image 2.

def	individual(size, min,			max):				
	return	1 8	randint(min,	max)	for a	ĸ in	range(size)	1
Imag	ge 1)							
E a	5 4	11						

(Image 2: A randomly produced »chromosome« (list) with »genes« (integers) that constitutes an individual.)

By running such a function a number of times, a population is produced. The environmental pressures on the organisms is hidden in the fitness function. The fitness function represents a way to determine which organism fares best in the environment or milieu. Image 3 follows the examples from the Images 1 and 2 and shows a possible implicit milieu (hidden in an ideal individual) and the fitness function: def fitness(individual, milieu):
 return abs(sum(individual) - milieu)

(Image 3: The fitness function calculates the difference between an individual organism and the fitness required for them to survive. In such a case, the bigger the fitness score, the better the organism.)

[10, 10, 10, 10]

(Image 4: An implicit possible milieu, an ideal organism, with fitness score 40.)

Through genetic crossover and mutation, the population strives to adapt to the milieu by coming closer and closer to it (or rather, its fitness score). This can happen by taking a certain percentage of the best-performing organisms, pairing them together and creating an offspring that takes the first half of the chromosome from one parent and the second half of the chromosome from the second parent. The probability of a mutation of a random gene is also specified. For diversity, a certain probability of an »unfit« organism creeping into the selection can also be specified. Image 5 and 6 showcase a part of this process.

Parent 1:	[6,	5,	2,	1]
Parent 2:	[3,	2,	7,	9]
Offspring:	[6,	5,	7,	9]

(Image 5: Genetic crossover. The offspring has higher fitness than its parents in relation to the milieu in Image 4.)

(Image 6: A function declaration for the population evolution. It specifies the described probabilities. Argument »survive« specifies the probability of exact copies in the next generation.)

A shared woe of computer modelling in cognitive science is the inescapable problem of how to computationally represent some non-trivial real-life phenomena without making the model trivial through reduction. This woe is even bigger when the inevitable reduction is coupled with overtly reductionist paradigms. In the case of GAs, the main problem lies in paralleling real-world evolution to formal mechanisms of natural selection to a degree where no distinction is left – where a paradigm becomes the reality, which is something that has happened under symbolic and connectionist paradigms of cognitive science [6]. Such overreaching inductive practices should therefore be taken with caution.

However, GAs also face pragmatic obstacles which are more likely to be solved through good practices. The most problematic are GA's parameters of the evolutionary aspect, which are a critical part of GAs when used in researching cognitive phenomena. This especially holds true for crossover and mutation. Even before setting the probability (1 minus argument »survive« for crossover and »mutate« for mutation in Image 6), methods for crossover and mutation have to be set. This mostly encapsulates the numerous ways of a child organism to inherit its genes and the way the latter are subsequently mutated. Optimal results can be quickly gained by fine-tuning these two parameters even in more non-trivial problems. When researching phenomena related to biological realities, parameters have to be set to represent them. In complex and dynamic systems like cognitive phenomena, the facts themselves are still largely undiscovered [11][12]. This is why GAs are primarily used for applied optimization – the fine-tuning of given parameters makes sense for such usage. Research bias is

therefore almost ineliminatable. Research conduct protocol has to be set before specifying parameters. Ideally, parameters have to be set in advance through rigorous research of biological counterparts. In the case of GAs, research on quantitive aspects of evolutionary mechanisms and their manifestation in nature is needed. The protocol should deny researchers tweaking and subsequent running of GA-based models as well as ensure transparent reporting, similar to analytic research reporting computational, algorithmic and implementational material should always be fully disclosed. Synthetic research that deals with nonveridical perception seems to lack such transparency, which further obstructs research through repetition [13][14][15][16][17].

Questioning viability of using GAs for researching cognitive phenomena therefore seems to be warranted. Given their stochasticity, the settings should be ecological as much as possible. Where undiscovered biological properties are concerned, it remains unclear how to proceed in order to remain as unbiased as possible.

In researching non-veridical perception, additional difficulties arise – one has to be even more careful when delineating a paradigm and reality, as aligning with a constructivist paradigm while claiming certainties in the outside world that we can discover (e.g., Darwinistic evolutionary processes and their connection to cognition, especially when taken in a vaccuum) can be problematic. Remaining on the level of formalized mechanisms seems to be the proper way to explore non-veridical perception with GAs.

3. NON-VERIDICAL PERCEPTION

"Let us consider what happens in instrumental flight. The pilot is isolated from the outside world; all he can do is manipulate the instruments of the plane according to a certain path of change in their readings. When the pilot comes out of the plane, however, his wife and friends embrace him with Joy and tell him: 'What a wonderful landing you made; we were afraid, because of the heavy fog.' But the pilot answers in surprise: 'Flight? Landing? What do you mean? I did not fly or land; I only manipulated certain internal relations of the plane in order to obtain a particular sequence of readings in a set of instruments.'"

[18, p. 42]

The pilot in the quote is an analogy for an organism with nonveridical perception. The instruments are the world he experiences, perceives and acts in. It could be said they are his mental states in a non-dualistic manner. These instruments are completely different from the world outside of the plane, yet they still bear a certain (albeit unknown) correspondence to it. They ensure that the pilot (the organism) can operate and survive in the world. This is what is mostly meant by non-veridical perception, especially in paradigms that advocate for it [7][8]9][10][18]. To sum up: The experience we have of the world we are perceiving is not its faithful, isomorphic representation.

Despite this, the prevalent view of perception, especially human perception, seems to be the opposite [19][20]. The belief is that the function of perception is "that of generating a fully spatial virtual-reality replica of the external world in an internal representation" [21, p. 1]. Similarly, traditional Bayesianists advocate that perceptual estimates faithfully representing the truth are of greater utility than those that do not [22]. The two irreconcilable paradigms seem to fall into the previously mentioned category of theoretical disputes of Western philosophy as labeled by Froese. Each of them come from a different epistemic viewpoint, which would make a scientific comparison of the two an example of empirical epistemology. Aside from empirical phenomenology [23], artificial intelligence methods seem to be the only way to do such research. GAs provide a way to study the performance of organisms with either veridical or non-veridical perception and compare their faring under the pressures of natural selection. One of the few if not the only research that studies non-veridical perception with GAs is Hoffman et al.'s work [13][14][15][16][17] on Hoffman's interface theory of perception (ITP).

4. GENETIC ALGORITHMS IN THE INTERFACE THEORY OF PERCEPTION

ITP does not only propose that non-veridical perception is the more sensible of the two competing paradigms, but also tries to empirically answer two fundamental questions: 1) Do our perceptual apparatus have the necessary components to actually describe the objective truth and if so, do they do it?, and 2) If the perceptual apparatus for whatever reasons do not describe the objective world as it really is, what advantage does that kind of system have? Its main point is this: "The perceptions of an organism are a user interface between that organism and the objective world" [14, p. 7]. Hoffman et al. [13] use an analogy of a computer to describe non-veridical perception: "A desktop interface makes it easy to use the computer. To delete or copy files, for instance, one simply needs to drag icons around on the desktop. But a desktop interface does not make it easy to know the true structure of a computer - its transistors, circuits, voltages, magnetic fields, firmware and software. Indeed, it's in part by hiding this complex structure that the desktop makes it easier to use the computer" [Ibid, p. 28]. This analogy is very similar to Maturana's analogy of the pilot and his flight. Hoffman et al.'s user interface seems to have the exact same function as the plane's set of instruments. The most interesting part of the theory is therefore the empirical work, which seems to be a thoroughly novel achievement and therefore worth and needing of an overview.

This, however, presents an obstacle. Hoffman as the principal author of the theory has produced a number of papers where the GAs used for empirical work are referenced and conceptually described, but it seems that there is no complete report of computational, algorithmic and implementational data available for possible scrutiny, replication and further research. The GA used is based off of Mitchell's GA [24] that features Robby the Robot who has to learn how to effectively pick up soda cans in a grid space. Hoffman's Robby, however, is not surrounded by soda cans, but by a various amounts of water that range from 1 to 10. with extreme numbers giving the least amount of fitness point (bad for Robby) and the middle numbers giving the most (good for Robby). Furthermore, Robby does not see water at all - it sees either red or green. It then has to learn to assign red or green to different amounts of water in a way that brings him the most points. Through many generations, Robby devises a survival strategy that sees squares with high scoring profit as green and squares with low scoring profit as red, or vice versa. Robby's perceptions are in no way connected to the world out there, but only to his internal fitness dynamics. Compared, Mitchell's Robby needed 1000 generations to evolve a comparably effective strategy, while Hoffman's Robby only needed 500 generations [17].

The various papers by Hoffman do feature some information on the GA used. There is some description of DNA encoding, namely that it encodes the possible perceptual states, the number of water quantities and the colors; it also gives the number of genes for these encodings. The encoding of perceptual states is described. There is some information on crossover, i.e. that each pairing produces two children with randomly spliced parent genes, and each offspring has a version of it. Information on mutation is vague, only written as "A small amount of mutation is applied" [13, p. 26]. The population number is always set at 200, but there is no stated reason behind it (other than it may be a common GA population number in computer science).

As discussed before, a special attention should be paid to the stochastic parameters, which can be arbitrarily set; to the ways genes crossover and mutate; and to the definitions of fitness evaluation and DNA encoding. This is important as by fine-tuning, changing the methods of recombination and mutation, and adapting fitness and encoding, different outcomes are produced.

5. CONCLUSION

Viability of GAs as a biologically-rooted cognitive science research methodology seems to be a two-edged sword. On the one hand, their groundedness in mechanisms of evolution offers a great modelling platform that, at least formally, possesses a number of ecological structures (e.g., genetic recombination and mutation). On the other hand, given its stochasticity, a number of features ingrained in these structures depend on arbitrarily set numbers (e.g., various probabilities) and calibrations (e.g., the methods of doing crossover). Biological systems, be they related to evolution or cognitive phenomena, are still largely unexplored, which pushes the translation from biology to computer models beyond the usual reduction and into the realm of bias. This is especially true when researching non-veridical perception, given its epistemologically strenuous nature. However, aside from empirical phenomenology, synthetic research seems to be the only way of scientifically verifying various theories regarding nonveridicality of perception, which is echoed by notable field figures such as Froese, Ziemke and Harvey. ITP by Hoffman seems to be doing just that, as it is an empirically tested theory. Unfortunately, it does not fully address the issue of arbitrariness in GAs and their relation to biology in general and particularly the phenomenon at hand, neither does it offer full data on the GA conceived for proving the theory. In turn, this stifles scrutiny, replication and further research. This is why a protocol should be established when using GAs to research cognitive phenomena, especially nonveridical perception.

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What is it like to be a bat/man: consciousness and performance studies

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ABSTRACT

In this paper, I would like to underline some possibilities of engaging consciousness studies in theorizing acting as conscious process. It is a proposal of dialogue between the disciplines of theatre and neuroscience in order to re-think the understanding of the nature of actor's work.

Keywords

consciousness, acting performance, qualia, subjectivity

1. INTRODUCTION

"What is it like to be a bat?"

In the history of consciousness studies, this one is the most famous questions. First posed in 1950 and became famous in 1974 in American philosopher Thomas Nagel's paper in The Philosophical Review. [11]

Nagel said: "Consciousness is what makes the mind-body problem really intractable." but on the other hand "without consciousness mind-body problem would be much less interesting." [11, p. 435,436] "The most important and characteristic feature of conscious mental phenomena is very poorly understood." [11, p. 436]

Mystery stays alive even some twenty years later, when Daniel Dennett, also an American philosopher says: "With consciousness we are still in a terrible muddle. Consciousness stands alone today as a topic that often leaves even the most sophisticated thinkers tongue-tied and confused." [6, p. 22]

An Australian philosopher, David Chalmers said: "There is nothing we know about more directly than consciousness, but it is far from clear how to reconcile it with everything else we know." [4, p. 3]

Colin McGinn, the British philosopher: "You can look into your mind until you burst, and you will not discover neurons and synapses and all the rest; and you can stare at someone's brain from dawn till dusk and you will not perceive the consciousness that is so apparent to the person whose brain you are so rudely eyeballing." [10, p. 47]

We can go on with the problem, but by now it is evident that the phenomenon of consciousness is the hardest one, though it does not have to be protected from science. Rather comforting, as McGinn suggests, it has something (or everything) with brains. So, let us make this starting point - brain. We can agree that consciousness is locked in brain, but again, the very same McGinn raises the question can the mind be fully explained by the brain. Hardly; we do know a lot about the brain, but link between mind and brain still lies in mystery.

Catherine Malabou, the French philosopher, agrees that "discovery of the synapses and its functions was as revolutionary as the discovery of DNA" [9, p. 8] as it puts Jean-Pierre Changeux in 1979, but almost disappointed, Malabou asks what have we done knowing all that, and what should we do with our brain.

Maybe it is true that our intelligence is wrongly designed for understanding consciousness, as McGinn puts it. [10, p. xi]

Susan Blackmore asks how do we know that the way someone sees yellow paint would be the same for other. We don't. And that's what we mean by consciousness, a very private experience. "No one else can know what it is like. No one else can get it from you." [1, p. 9] Nagel calls it subjective character of experience and every subjective phenomenon is essentially connected with a single point of view. [11, p. 436,437]

2. CONSCIOUSNESS PROBLEM

Neuroscientists did not get far either when it comes to consciousness problem. Joseph LeDoux says that neuroscientists traditionally have avoided confronting that problem. But times have changed, discussions on subject are on rise, maybe overemphasized, and the major question for LeDoux is not how does consciousness come out of the brain, but rather how does our brain make us who we are. [8, p. 10]

For Antonio Damasio the problem of consciousness is a combination of two related problems; the problem of understanding how the brain engenders the mental patterns, "the images of an object"¹, and the problem of how, in parallel with first one, the brain engenders a sense of self in the act of knowing. [5, p. 23]

So, again, consciousness is a private moment, but it does not exclude *the other* and awareness of other. These two phenomenons are not mutually exclusive, but incessantly present and interfering, and we never make mistakes in assessing who is who. Or?

In the discussion on subjectivity we can introduce the term *qualia*. Although it is a philosophical term, everyone has it, that is, everyone has that private experience of what something *is like*. Blackmore gives an example: "the feel of the wind on your cheeks as you ride your bike" [1, p. 25] or as Damasio defines: "qualia are the simple sensory qualities to be found in the blueness of the sky or the tone of sound produced by cello..." [5, p. 23] He believes these qualities will be eventually explained neuro-biologically.

sensory modalities, e.g., a sound image, a tactile image, the image of a state of well-being". [5, p. 22]

¹ By *object* Damasio means "entities as diverse as a person, a place, a melody [...]" and by image "a mental pattern in any of the

On the other hand, Dennett does not believe in qualia at all. [6]

3. BAT/MAN PROBLEM

In terms subjectivity, let us go back with Nagel's question "How is it like to be a bat?". Nagel chooses bats because they are so different than humans; "their brain are designed to correlate the outgoing impulses with subsequent echoes, and the information thus acquired enables bats to make precise discriminations of distance, size, shape, motion, and texture comparable to those we make by vision. But bat sonar, though clearly a form of perception, is not similar in its operation to any sense that we possess, and there is no reason to suppose that it is subjectively like anything we can experience or imagine". [11, p. 438] Our own experience provides the basic material for our imagination, whose range is therefore limited. As Nagel illustrates, "it will not help to try to imagine that one has webbing on one's arms, which enables one to fly around at dusk and dawn catching insects in one's mouth: that one has very poor vision, and perceives the surrounding world by a system of reflected high-frequency sound signals; and that one spends the day hanging upside down by one's feet in an attic" [11, p. 439]. Such behaviour tells us only what it would be like to behave as a bat behaves. But that is not the question. Nagel wants to know what it is like for a bat to be a bat.

These (bat's) experiences also have a specific subjective character that it is, by all means, beyond our ability to conceive. After all, Nagel admits that he didn't have to go with this exotic bat case; the problem exists between two persons as well.

So, what does actor do? How he embodies someone else's realities and subjectivities. He does wear bat's costume to look like bat. He also can hang upside down all day in the attic, but inside him he experiences his own subjectivities. If in any case his performance stays within *act as if*, then the performance misses terms such as truth, real, natural... Actor does not describe. He experiences. He must be open for new, surprising solutions.

4. ACTING AND NEUROSCIENCE

Neuroscientist Antonio Damasio describes string of associations arising in the body first as emotion (as physiological state of the body) which is translated into feeling (as emotional state). Those strings create brain. Damasio uses term "somatic markers" [5] to describe how body-state become linked with our conscious responses to or interpretation of them. These markers become our repertory of emotional responses in guiding our choices of reactions to new situations. This hypothesis presents an intellect not as separate, but as aspects of a single organic process.

Actor in the costume of a bat reacts within his own somatic marker, not with somatic marker of a bat or some other person. If he trusts his own reactions, those surprising, new solutions, mentioned above, can occur. If he let his own arousal of emotion, performance will be truthful. Or, at least, he will allow himself to respond with varying degrees of habit of spontaneity.

In similar directions in defining mind, consciousness and cognition point Joseph LeDoux, who distinguishes between consciousness and cognition. "Consciousness can be thought of as the product of underlying cognitive processes" [8, p. 191] while mind is: "an integrated system that include, in the broadest possible terms, synaptic networks devoted to cognitive, emotional, and motivational functions. More important, it involves interactions

² The suggestion was made on the occasion of the Third International Conference "Dialogues between Theatre and Neuroscience" in Rome

between networks involved in different aspects of mental life. [8, p. 258]

Rhonda Blair, American scholar who is particularly looking at applications of cognitive science to the acting process suggests that in considering how brain structure and function are materially related to the nature of consciousness and self, we can move toward a more concrete sense how the actor works. [3, p. 170]

Referring to Marco De Marinis'es term of an *embodied theatrology*², Gabriele Sofia sees the concept of consciousness as a circular process between the human body and the environment. She proposes the hypothesis that consciousness is not a product of the brain but emerges from the relationship between one's own body and the environment. "Each time we 'perceive' the world, we are actually *acting* upon it, that is we are modifying the object that we intend to perceive. [...] then there is no pre-determined world that can be perceived 'as it is'." [12, p. 51]

If we agree on subjectivity or private experience as "the hard problem"³ how is it possible to integrate the study of one's own experience in the analysis of a performative event, asks De Marinis. In order to do that Sofia suggests that one would first have to analyse the sensorimotor mechanisms that subtend such an experience, which is primarily the 'performative' experience of the spectator. [12, p. 55] Consequently, spectator should not be left out from analyses of performative event, nor acting process as well.

5. CONCLUSION

Considering all above, in order to re-think and re-define some petrified "knowledges" of acting processes there is a vast unfilled spots that should be engaged in theatre and performance studies and it deserves further research. "Terrible muddle" [6] in defining consciousness is not any smaller in defining acting process. Can we discuss on acting phenomenon not knowing how consciousness works?

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Consciousness – one, two or many?

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ABSTRACT

Introductory papers on consciousness, whether within philosophy, psychology, or neuroscience, do not forget to point out that it is at once the most familiar and mysterious phenomenon. Indeed, we know it intimately, but it is extremely difficult to describe and explain it. It does not help matters that the words "consciousness" and "conscious" can mean different things and that this richness is also preserved in the scientific talk. This complex and multifaceted phenomenon - some even argue that we are dealing with many distinct phenomena - is a subject of interdisciplinary research, and it often seems that researchers talk past each other. This is most obvious in the interaction of empirical researchers and philosophers. In this paper, I will introduce some of the relevant notions of consciousness, explain to what aspect of consciousness refers the "hard problem" philosophers speak of and what importance it has for the research of consciousness in general.

Keywords

concepts of consciousness, mystery of consciousness, hard problem of consciousness

1. INTRODUCTION

In introductory papers and book introductions on consciousness, writers like to point out its mysteriousness. For example, Dennett in *Consciousness Explained* states: "Human consciousness is just about the last surviving mystery. ... [It] stands alone today as a topic that often leaves even the most sophisticated thinkers tongue-tied and confused." [1; p. 21–22] Similarly, Susan Schneider and Max Velmans in the "Introduction" to *The Blackwell Companion to Consciousness* point out: "...anything that we are aware of at a given moment forms part of our consciousness, making conscious experience at once the most familiar and most mysterious aspect of our lives." [2; p. 1]

But what is this consciousness that is at once so familiar and mysterious to us? The term "consciousness" is quite multifaceted and can mean different and quite diverse things. In everyday life we hear that an ill friend regained consciousness, that certain activists try to raise the political consciousness of the working class or warn about the dangers of consciousness-enhancing drugs. We enjoy reading a book in which the main character is at one point very conscious of the sound of the howling wind and very familiar with conscious efforts to give up some harmful habit.

The original meaning of the word "consciousness" was knowledge or awareness, either private or shared, but in the seventeenth century philosophers and other enlightened writers started to use the word specifically to refer to our inner awareness of our own mental states, such as thoughts, perceptions, sensations, feelings. As John Locke put it, "[c]onsciousness is the perception of what passes in a man's own mind." [3; p. 98] In our modern uses of the word both meanings are preserved in everyday talk as well as in theoretical writings.

For quite some time philosophers equated consciousness with mind, and the same is true of the early psychologists. For example, William James identified consciousness with the stream of thought [4]. But in the previous century researchers confirmed that not all mental states are conscious and that actually a lot of processing in perception, memory, action and learning is unconscious, automatic. One such flashy example is subliminal perception. John Kihlstrom named such states "cognitive unconscious" [5].

It also became clear that we are still conscious or aware of certain mental states although we do not deliberately focus on them and attend to their features (what the seventeenth century philosophers had in mind with consciousness as "inner perception" and what is today referred to as an introspective consciousness). For example, I can have a slight headache and do not pay much attention to it, but it is still present and it has a certain feel to it. There is something it is like for me to feel this particular pain, which is different from how intense toothache feels like, or how it feels like to see a clear blue sky. Philosophers refer to this kind of consciousness as phenomenal, qualitative and/or subjective consciousness. Another important aspect of consciousness that interests philosophers is its intentionality, namely its directedness to something.

Scientists are also interested in many aspects of consciousness. Beside the aforementioned study of the relation of conscious to unconscious processing in perception, memory, action and learning, they are interested in determining the function of consciousness, the neural correlates of consciousness, how information is disseminated within the human brain, what conscious experiences are and so on. For clinicians it is very important to be able to tell whether patients are conscious, and they start with the understanding of consciousness as the ability to respond appropriately to external stimulation, but the possibility of unconscious processing complicates things. Cognitive psychologists opt for a more comprehensive definition of consciousness as the awareness of oneself and one's surroundings, and the ability to respond to and to interact with the environment. Recently, scientists have also conducted research on emotional consciousness. Moreover, they are not only interested in human consciousness, but also in animal consciousness and consciousness of artificial intelligence.

To sum up, the terms "consciousness" and "conscious" are used in many different ways in everyday, but also in scientific, talk. The phenomenon itself is very complex, with many aspects, or maybe there are even many distinct, though closely related, phenomena that are grouped under one label. The study of consciousness is interdisciplinary, every discipline having its own special interests, terminology and investigative methods. Not surprisingly, this often results in scientists not understanding each other and actually talking past each other. This is particularly common in discussions between philosophers and other researchers, which mainly stems from the different approach to consciousness.

While psychologists, neuroscientists, biologists and computer scientists build on observations, on the collection and classification of data, and on the execution and interpretation of experiments, philosophers try to determine the overall picture, how all the empirical findings fit together, the research assumptions and paradigms along with its strength and plausibility, how the findings connect with previous ideas and research programs and where they could lead in the future, and what potential obstacles there are. The difference is especially obvious in their distinct approach to the mystery of consciousness and to the related hard problem of consciousness.

2. THE MANY CONCEPTS OF CONSCIOUSNESS

When an expression has multiple meanings, it is important that we always clearly specify which meaning we have in mind when we use it. If all researchers working on consciousness followed this rule, a lot of problems and difficulties would melt away.

First, we can talk about all organisms – human beings, animals, robots – being conscious, or we can ascribe consciousness to particular mental states or processes. This is a distinction between creature consciousness and state consciousness [6].

Within the creature consciousness we can further distinguish between intransitive and transitive consciousness [7]. A creature is transitively conscious when it is conscious of something, either by seeing, hearing, touching it, or by having a thought about it being present. Philosophers also speak of intentionality: being directed at an object, namely at the object of which the creature is conscious of. But more basic¹ is the intransitive notion where consciousness is treated as a non-relation property of a creature.

Under this rubric fall many senses mentioned in the previous section. In the most generic sense a creature is conscious or sentient if it is able to sense and respond to its environment. In a more demanding way, the ability as such does not suffice is not enough, and the creature must be actually exercising the ability. In this sense, a creature is conscious only if it is awake and alert, i.e. responsive to sensory stimulation. Accordingly, a creature asleep, anesthetized or in a coma is not conscious in this sense. In another, more demanding sense, a creature is conscious if it is aware not only of its surroundings, but also of its awareness. Consciousness is interpreted as a form of self-consciousness, where the requirement can be interpreted in various ways. The conceptual self-awareness might be required or just implicit selfawareness. Under this rubric falls Locke's previously mentioned notion. Yet another concept is the aforementioned phenomenal consciousness. A creature is conscious in this sense if there is "something that it is like" to be that creature, as Nagel phrased it somewhat awkwardly [10]. What is meant by this is simply that there is some subjective way that the world appears to a creature. for example, to a bat or a person or a cat. The main characteristic of this kind of consciousness is its perspectival subjectivity. Some authors also call it qualitative or subjective consciousness,

although it can also be argued that these three notions slightly differ.

Similarly, there are many concepts of state consciousness. A conscious mental state can be simply a state one is aware of being in [7]. In parallel with phenomenal consciousness, there are phenomenal states and closely related, often equated, qualitative and subjective states. These kind of states, primarily called qualitative states, have special qualitative or experiential properties, named "qualia" or "raw sensory feels." In general, what we try to capture here is how a given experience feels from the inside. For example, the visual experience of a ripe tomato is distinctly red, freshly roasted coffee beans have a distinct smell, and an intense toothache hurts in a particular way. The defining characteristic of phenomenal states, when being considered as distinct from the qualitative ones, is interconnectedness, how they all connect and form a continuous experience of a self, situated within a world of objects, ordered in time, space and tied with causality. And in the case of subjective states, beside their experiential feels, their subjectivity is also emphasized, the fact that it is quite plausible that this experience can be fully comprehended only from the first-person perspective.

Some philosophers, for instance Wilkes [11], argue, at least in part due to conceptual multiplicity, that the idea of consciousness is wrongheaded and should be eliminated. However, I agree with Van Gulick [12; p. 166] that the complex nature of conscious mentality can only be explained by a pluralistic diversity of concepts that capture all its many aspects. The plurality of concepts is, therefore, not a flaw, but a virtue as long as one clearly states which sense one has in mind and does not conflate one concept with another.

3. THE MYSTERY OF CONSCIOUSNESS AND THE NATURALISTIC WORLD VIEW

Concerning the mystery of consciousness, what puzzled and still puzzles the researchers is precisely its phenomenal aspect, the feel of conscious experiences. It is generally quite hard, often impossible, to describe a particular experience in a way that really conveys what it is like to someone who had never experienced it. For instance, how are we to explain to a blind person what the experience of seeing a crimson red patch feels like? The ineffability of conscious experience is closely associated with its subjectivity. It is argued that its particular feel can only be appreciated from within, i.e. from the first-person perspective. Moreover, it often seems totally arbitrary that an experience of a particular thing feels like it does. Why should freshly ground coffee beans produce in us the smell that they do? Alternatively, why should they produce any smell at all? And how do we know that the same stimuli produce the same experience in everyone? What if the phenomenal character of experience has nothing to do with what it represents and is just the intrinsic, i.e. non-relational, property that experience possesses independently of everything?

More generally, the special character of consciousness, its distinct nature makes it difficult to explain it in naturalistic terms, namely, to plausibly explain its link to the brain without resorting to miracles and ad hoc solutions. The link undoubtedly exists – changes in the brain can affect consciousness and certain brain damage can erase it permanently. The task is therefore to scientifically explain the link and the way in which consciousness arises from brain processes, and substantial progress has been made by adopting the functional and computational explanation of mental states and processes as well as of the conscious ones. Scientists only try to determine what causal role they play and in

¹ Some philosophers argue though that the transitive concept is the basic one, but they are in minority [8], [9].

what way a particular information processing is implemented in the brain.

Cognitive scientists therefore try to determine what consciousness does, what its function is. In order to achieve this, they can compare conscious and unconscious types of information processing and look for differences which would suggest what the role of consciousness is. One possibility are priming experiments, especially semantic ones (e.g. [13]), another is the study of disorders, especially caused by brain damage, which affect consciousness. Extensively studied disorders are blindshight [14] and unilateral spatial neglect [15].

These are just two of many avenues of research being pursued, which are proving quite successful. However, some philosophers complain that this does not contribute at all to a better understanding of phenomenal consciousness.

4. THE HARD PROBLEM OF CONSCIOUSNESS AND ITS RELEVANCE FOR THE STUDY OF CONSCIOUSNESS

The explanation of cognitive abilities and functions in terms of computational or neural mechanisms that can perform them does not help us to understand why conscious experiences accompany the performance of these mechanisms. The difficult question here is rather why and how conscious experience arises from a physical basis. To put the issue succinctly: it is not about what consciousness does, but how consciousness feels.

One philosopher who doubts that cognitive science, equipped with its computational and neural explanations, can explain phenomenal consciousness is David Chalmers [16, 17]. He termed this problem the hard problem and all the other problems concerning consciousness as the easy problems [16]. According to him, the latter are relatively easy because they seem directly susceptible to the standard methods of cognitive science, which is not the case with phenomenal consciousness because it resists the explanation in these terms and it is not clear how to approach it. Chalmers does not deny that phenomenal consciousness could have some function. It is even reasonable to assume that it does. But there is more to it than just the performance of functions and this "more" is the crux of the matter. To make his idea clearer, Chalmers enumerates some examples of easy problems, like providing explanation of the reportability of mental states, the ability of a system to access its own internal states, the integration of information by a cognitive system etc. [16; p. 4]

These issues are obviously not easy, scientists work hard on solving them, therefore many object to his division. To be fair, Chalmers himself points out that he does not underestimate their importance as well as difficulty and that he uses terms in a comparative sense. He just wants to emphasize a principled difference between the two kinds of problems, the first can be approached with the usual methods of cognitive science, but not the problem of phenomenal consciousness since what needs to be explained is not a function, but a subjective phenomenal quality that accompanies information processing. The problem is that we do not know what method to use. However, appearances matter, and it would have probably been better had he named the two problems differently, thus avoiding offending inadvertently scientists who work on the first kind of problems.

We have already encountered the complaint that researchers are not careful in distinguishing different senses of "consciousness," thus creating confusion. Chalmers rightly complains that often researchers start by stating the "hard problem" of consciousness, but then offer an explanation of another aspect of consciousness, such as reportability or introspective accessibility of information [17; p. 26]. Chalmers claims that these aspects of consciousness are psychological in nature as they play a causal or explanatory role of behavior exhibited by conscious creatures. To avoid conflation, he proposes to reserve the term "consciousness" for the phenomenal aspect and to call the other aspects "awareness." Awareness is thus "a state wherein we have access to some information, and can use that information in the control of behavior"² [17; p.28], and can be therefore explained in functional terms.

According to Chalmers, this terminology change is only a matter of convenience which does not make any real difference. However, the use of different words makes it easier to accept that we are not dealing with multiple aspects of one phenomenon, but with multiple phenomena. Indeed, Chalmers wrongly concludes from the grammatical difference that there is also an ontological difference. He views consciousness and awareness as two different phenomena, and considers the existing relation between the two. He concludes that consciousness is always accompanied by awareness, but awareness does not need to be always accompanied by consciousness. By positing two different phenomena, he can argue that due to its distinct nature consciousness in principle cannot be explained in the same way as awareness. However, he leaves out another plausible alternative, namely that we simply have two kinds of neural processing, which differ in such a way that one is also accompanied by the phenomenal feel, while the other is not, and that this difference can be functionally, or in some other scientifically acceptable way, explained. There is no reason to suppose that what he calls awareness and consciousness are two independent processes. The fact that awareness can be present without consciousness shows that awareness is a fundamental process, but consciousness could be just an extra characteristic of certain awareness processes, but not an independent process itself. But in this case, one cannot argue that solving "easy" problems will not help with the "hard" problem as Chalmers does.

5. CONCLUSION

To conclude, researches need to be careful and clearly state which aspect of consciousness they are investigating and not to unjustifiably claim that their findings also apply to other aspects of consciousness. Chalmers' claim that phenomenal consciousness cannot be explained in functional terms should be taken seriously, and the used methods should be carefully scrutinized. On the other hand, one should not despair. His argument is not definitive and there is a good chance that the functionalist explanation is possible. And even if it were not, it is a fair assumption that a better understanding of informationprocessing aspects of consciousness will help us to ascertain the limits of this kind of account and to look for new avenues of research.

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TEK ČASA

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POVZETEK

Kakšna je povezava med zunanjim, »fizikalnim«, objektivnim časom in notranjim, subjektivnim časom zavesti? V prispevku bom najprej prikazala značilnosti doživljanja časa, nato bom predstavila A-in B-teorijo časa in ontološke različice, ki so zaznamovale diskusije o filozofiji časa. Zaključila bom z optimističnim pogledom na raziskovanje, ki se odpira znotraj kognitivne znanosti.

Ključne besede

čas, doživljanje časa, A-zaporedje, B-zaporedje, tek časa

1. UVOD

»Kaj je torej čas? Če me nihče ne vpraša, vem; če pa ga hočem na vprašanje razložiti, ne vem.« [1: XI/14] Slavni citat iz Avguštinovih Izpovedi nas opozori, da se kljub temu, da smo vpeti v različne časovne okvirje, v katerih preživljamo svoj vsakdan, znajdemo v zadregi, ko bi morali o času povedati kaj več. Avguštin je nato nadaljeval. »Vendar si upam z gotovostjo trditi, da bi ne bilo preteklega časa, če bi nič ne prehajalo, da ne bi bilo prihodnjega časa, če ne bi nič prihajalo, in ne sedanjega časa, če ne bi bilo nič pričujoče.« [1: XI/14]

Uganka, s katero se spoprijemajo umetniki – pesniki, pisatelji, glasbeniki, filmarji, gledališčniki, znanstveniki – fiziki, biologi, psihologi, kognitivni znanstveniki, antropologi in filozofi se razpleta na zelo različne načine, odvisno od zornega kota in raziskovalnega vprašanja, na katerega se raziskovalec osredotoča. Kakšna je povezava med zunanjim, »fizikalnim«, objektivnim časom in notranjim, subjektivnim časom zavesti?

Aristotel je povezal čas s fizičnim gibanjem »število gibanja glede na prej in pozneje« [2: 219b2]. Tako pojmovanje časa je omogočilo merjenje, na primer kroženje nebesnih teles, nihanje različnih nihal. Kot ugotavlja Marko Uršič [3] se Aristotelovo opredelitev časa običajno razume kot filozofsko definicijo fizikalnega in/ali kozmološkega, »zunanjega« časa v nasprotju z »notranjim«, fenomenološkim časom zavesti, duše, o katerem govori Avguštin: »Kolikor je doslej jasno in očitno, je to, da niti prihodnost ne biva niti preteklost. Potemtakem pravzaprav ne moremo reči: trije časi so pretekli, sedanji in prihodnji. Natančneje bi se reklo takole: trije časi so - sedanjost glede na preteklost, sedanjost glede na sedanjost in sedanjost glede na prihodnost. Zakaj le v duši bivajo časi kot te vrste trojstvo, drugje jih ne vidim: sedanjost glede preteklosti je spomin, sedanjost glede sedanjosti je vpogled, sedanjost glede prihodnosti je pričakovanje.« [1: XI/20]. Vendar Uršič dodaja [3], da sam Aristotel ni postavil ostre ločnice med zunanjim in notranjim časom, saj na vprašanje »Ali bi čas bival, če ne bi bilo duše?« odgovarja: »Če v naravi ne šteje nič drugega kakor duša oziroma um duše, potem ni mogoče, da bi čas bival, ko ne bi bilo duše«[2: 223a23-25]. Tak pogled je blizu Uršičevemu panteističnemu stališču in morda lahko ponudi rešitev zagonetke, a sloni na za mnoge sodobne znanstvenike in filozofe vprašljivi

predpostavki »v naravi ne šteje nič drugega kakor duša oziroma um duše«. Kaj pa, če te predpostavke ne sprejmemo in izhajamo iz naturalističnega stališča? V prispevku bom najprej prikazala značilnosti doživljanja časa, nato bom predstavila A-in B-teorijo časa in ontološke različice, ki so zaznamovale diskusije o filozofiji časa. Zaključila bom z optimističnim pogledom na raziskovanje, ki se odpira znotraj kognitivne znanosti.

2. DOŽIVLJANJE ČASA

Ernst Pöppel (1978) [4] je navedel naslednje značilnosti kot temeljne značilnosti doživljanja časa:

- 1. trajanje
- 2. ne-simultanost
- 3. red
- 4. preteklost in sedanjosti
- 5. sprememba, vključujoč tek časa

Vsaka od teh značilnosti se na prvi pogled morda zdi očitna, a dejansko odpira nadaljnja vprašanja. Na primer, ko rečemo, da je prvi interval daljši od drugega, kaj je dejansko opisano kot kratko ali dolgo trajanje. Spomnimo se Avguštinovega citata - ne more biti preteklost, saj je ta nehala biti in kar ne biva, ne more imeti lastnosti v sedanjosti. Avguštin je našel odgovor glede na to, kaj merimo, ko merimo trajanje dogodka ali intervala časa, v pomnjenju. Iz tega je sklepal, da preteklost in prihodnost obstajata zgolj v duševnosti. Lahko se strinjamo, da je zaznava časovnega trajanja pomembno povezana s spominom, a iz tega mnogi ne bi izpeljali tako radikalnega sklepa kot Avguštin. Zdi se združljivo, da merimo interval, ki je neodvisen od naše duševnosti, toda to počnemo s pomočjo nekega psihološkega procesa. [4]. O posebni vrsti trajanja je govoril William James, ko je izraz »varljiva sedanjost« (angl. specious present) opredelil kot kratko trajanje, ki ga občutimo neposredno in neprekinjeno. To stalno zavedanje določenega trajanja varljive sedanjosti, ki gre od nekaj sekund do minute in kjer je vsebina zaznana tako, da ima en del prej in en del kasneje, je po njegovem prava intuicija časa. Kot ugotavlja LePoidevin, je Jamesova opredelitev dvoumna, saj jo je mogoče razumeti kot:

- 1. razpon v kratkoročnem spominu,
- 2. trajanje, ki je zaznano, ne kot trajanje ampak kot trenutno,
- 3. trajanje, ki je neposredno zaznano ne skozi posredovanje številnih drugih, morda vmesnih trenutnih zaznav,
- 4. trajanje, ki je zaznano kot sedanje in kot razširjeno v času.

Po njegovem mnenju je najbolj verjetno četrto razumevanje. Sedanjost izkustva je »varljiva«, saj naj bi se nanašala na interval in ne na netrajajoč trenutek, kar naj bi bilo v nasprotju z objektivno sedanjostjo. Čeprav ni uporabil istega izraza, pa je na podoben način o fenomenologiji časa razmišljal tudi Edmund Husserl, ki je, kot ugotavljata Andersen in Grush, poznal Jamesovo delo, predvsem pa so skupni predhodniki, ki so vplivali na oba [5]. V razpravi Predavanja k fenomenologiji notranjega zavedanja časa pravi takole: »Ko na primer zveni neka melodija, posamezni ton ne izgine popolnoma, ko preneha dražljaj [npr. zvok ob nihanju strune] oziroma z njim povzročeno živčno vzburjenje. Ko zazveni nov ton [v melodiji], tedaj prejšnji ne izgine brez sledi, sicer ne bi mogli opaziti medsebojnih razmerij med toni, ampak bi imeli vsak hip le en sam ton in eventualno v času med dvema tonoma pavzo, nikoli pa ne bi imeli predstave /Vorstellung/ neke melodije« [citirano po 3: 289] V obeh primerih gre za to, da zaznavamo nekaj razširjenega kot sedanjost.

Ta kratek prikaz seveda ne more izčrpati stališč in vprašanj, ki so jih odprli Avguštin, James in Husserl, v tem prispevku pa služi predvsem kot ilustracija, kako pomembno je razlikovati med »zaznavati sedanjost« in »zaznavati nekaj kot sedanjost«. [4] Prav to je bistvena razlika, kljub sicer mnogim podrobnostim, med tem kako zaznavamo predmete v prostorskih relacijah, na primer, blizu in daleč. Kajti ko zaznavamo preteklost, je ne zaznavamo kot preteklost, ampak kot sedanjost (preko spomina). Če sprejmemo Jamsov pristop z »varljivo sedanjostjo« ali Husserlovo tripartitni pogled o izkustvu časa, pa nam to spoznanje samo po sebi še ne more razložiti tega, da se naše doživljanje »kot sedanjosti« (as-of the present) stalno spreminja. Kot ugotavlja LePoidevin [4] sprememba v našem izkustvu ni isto kot izkustvo spremembe. Prav tek ali morda navidezen tek časa pa je tista značilnost, ki bi jo radi vsaj nekoliko podrobneje raziskali, predvsem z vidika ujemanja metafizičnih teorij zaznavanja časa, sodobnih fizikalnih teorij in prvoosebnega doživljanja časa.

3. METAFIZIČNE TEORIJE

3.1 A-zaporedje in B-zaporedje

Kako razumeti stavek »čas beži«, s katerim pogosto opišemo naše doživljanje časa. Tako takrat, ko se oziroma nazaj, na vse, kar smo preživeli in kar se odmika v preteklost, kot takrat, ko gledamo v prihodnost, ki se nam hitro bliža. Toda ali čas res »teče«? Angleški filozof z začetka prejšnjega stoletja John Ellis McTaggart [6, 7] je dokazoval, da nas pojmi, s katerimi opisujemo naše izkustvo časa, na primer tek časa, vodijo v protislovje. Ubral je podoben način dokazovanja (reductio ad absurdum) kot Zenon, ko je dokazoval, da nas na prvi pogled nevprašljiva resnica (npr. obstoj mnoštva), vodi v protislovje. Iz tega je nato sklepal, da je potrebno tako trditev zavrniti. McTaggert dokazuje, da je podobno z obstojem časa in da nas sprejemanje te trditve vodi v protislovje.

Pri dokazovanju, da je čas nerealen in zgolj velika iluzija, ki jo je proizvedel človeški razum, je uporabil dva različna načina za opisovanje časovne določenosti dogodka. Pri prvem, imenujemo ga A-zaporedje, dogodke časovno razvrščamo glede na njihov odnos do »zdaj« kot pretekle (včeraj, prejšnji teden, lani), sedanje (danes, letos) in prihodnje (jutri, naslednji teden, drugo leto). V primeru Bzaporedja pa ni odlikovanega »zdaj«, gre preprosto za urejeno zaporedje trenutkov ((t1, t2, t3, t4, t5, ...). Tako lahko rečemo, da se je dogodek v času t2 je zgodil pred dogodkom v t3 in po dogodku t1, ne moremo pa reči, da je dogodek v t2 pretekli dogodek ali prihodnji dogodek. Na primer, ko rečem (i) »Slovenska košarkarska reprezentanca je včeraj osvojila naslov evropskih prvakov« ali »Slovenska košarkarska reprezentanca je 17. 9. 2017 osvojila naslov evropskih prvakov«, sem isti dogodek opisala na dva različna načina . V prvem stavku je časovna določenost dogodka - »včeraj« odvisna od premikajočega se »zdaj«, v drugem pa je odvisna od »objektivnega« datuma. Zaporedji A in B urejata dogodke enako glede na časovno razdaljo in trajanje dogodkov, vendar je med njima pomembna razlika. A-zaporedje je dinamično,

B-zaporedje pa je statično. Ker se »zdaj« stalno premika, se spreminjajo tudi A-časi. Na primer, zmaga slovenske reprezentance se vse bolj odmika v preteklost. Kot ugotavlja Danilo Šuster: »V dinamičnem A-zaporedju dogodki in stvari nastajajo in minevajo. Gre za spremembo, ki so ji stvari in dogodki podvrženi zgolj s tem, da so »v času«. Včasih tek časa označujejo prav kot tezo o premikajočem se »zdaj-u«, tek časa je v nenehnem spreminjanju Ačasa, ki ga zaseda določena stvar ali dogodek v A-zaporedju.«[8] Po drugi strani pa dogodki v B-zaporedju svojega položaja v času ne spreminjajo, »so« v nekakšnem brezčasnem smislu. Odnosov med dogodki tu ne opredeljujemo glede na preteklost, sedanjost in prihodnost, gre za relacije, ki bi jih lahko primerjali z relacijami v prostoru. Na primer, na metrskem traku je oznaka »20 cm« pred oznako »30 cm« in za oznako »10 cm«. B-zaporedje tako uvaja pojmovanje časa, ki je blizu prostorskemu pojmovanju in s tem razumevanju časa v sodobnih fizikalnih teorijah [3]. (Več o razlikah in podobnostih v pojmovanju časa in prostora v naslednjem razdelku).



Slika 1: A- in B zaporedje

McTaggert je dokazoval, da so A-določila, t.j. biti pretekel, biti sedanji in biti prihodnji, protislovna, saj ni mogoče, da bi bil isti dogodek lahko obenem pretekli, sedanji in prihodnji, oziroma, da bi imel isti dogodek (Zmaga slovenske reprezentance na evropskem prvenstvu v košarki) vsa tri določila. Šuster v svojem članku opozarja, da enostaven ugovor realista glede časa, »da nič ne more hkrati posedovati nezdružljivih lastnosti, noben dogodek ni takrat, ko je sedanji tudi pretekel. Dogodki imajo te lastnosti zaporedoma. najprej so prihodnji, potem sedanji in nazadnje pretekli. Gre za zaporedje v času, v tem pa ni nobenega protislovja.« [8], ne omaje antirealista. Kot smo videli, za McTaggarta časovni odnosi med dogodki niso prvobitni, ampak jih analizira s pomočjo Azaporedja. Toda, trditev, da dogodek poseduje A-določila zapored, v času, predpostavlja obstoj časa, kar pa vodi v blodni krog. McTaggartov dokaz je sprožil diskusijo, katere prikaz bi presegel okvir tega prispevka [3, 8, 9, 10], njegova razdelitev na A in B zaporedje pa je zaznamovala razprave o filozofiji časa [11, 12].

3.2 Ontološke različice

A-zaporedje in B-zaporedje torej opisujeta isto zaporedje fizičnih dogodkov, vendar lahko A-zaporedju pripišemo A-določila, kot biti sedanji, n sekund pretekli ali n sekund prihodnji. V A-zaporedju ima tako vsak čas edinstveno A-določilo, ki ga umešča v edinstveno mesto znotraj zaporedja. Na ta način lahko čase uredimo v skladu z njihovimi A-določili. Vsak čas v A-zaporedju ima absolutno pozicijo. Časi v B-zaporedju so prav tako urejeni, toda njihova urejenost je določena z relacijami prej kot in kasneje kot, časi so torej urejeni glede na medsebojne relacije. Kot ugotavlja Simon Prosser [13], lahko vpeljemo še razlikovanje med A-teorijo in Bteorijo: po A-teoriji je realnost najbolje opisana z izrazi A zaporedja, B-teorija pa z izrazi B-zaporedja. V skladu z A-teorijo obstaja samo en čas, ki je dejansko (realno) prisoten. To je prvobitno, objektivno dejstvo, ki je od nas neodvisno. Toda, kateri čas je prisoten, se s tekom časa nenehno spreminja. V nasprotju s tem pa pri B-teoriji ni A-določil, nič nima objektivnega, Azaporednega mesta. Vsi časi imajo enak status. V skladu z B-teorijo tako ni teka časa, ni »gibanja« sedanjosti vzdolž časovne črte. [13: 3]

Kot smo videli, B teoretiki čas vzporejajo z dimenzijami prostora. Tako kot ni posebnih prostorskih lastnosti (npr. biti severno), ampak so zgolj prostorske relacije (biti severno od), tudi ni posebnih A-lastnosti. A-teoretiki pa vidijo bistvene razlike med prostorom in časom, saj tudi če sprejmemo, da ni pravih prostorskih lastnosti, obstajajo prave A-lastnosti. Za razliko od prostora za čas dejansko lahko rečemo, da mineva. Obstaja pa še en pomemben vidik, zaradi katerega se po mnenju A-teoretikov razlikujeta prostor in čas. Nekateri zagovarjajo stališče, da obstajaj zgolj sedanjost (presentism) – nujno je vedno resnično, da obstajajo zgolj sedanji objekti. [14] Preteklost je bila, a ni več, prihodnost bo prišla, a je še ni.

3 METAPHYSICS OF TIME



Slika 2: Tri metafizične teorije časa [15]

Na sliki je to stališče prikazano s štirimi puščicami, ki lažejo navzgor in konvencionalno predstavljajo smer prihodnosti. Predstavljajo dinamični vidik časovnega nastajanja in teka časa. Srednji diagram predstavlja stališče, po katerem je prihodnost razvejana struktura alternativnih možnosti (model drevesa, growing block view). Ta pogled se v veliki meri ujema z našim vsakdanjim pogledom, da obstaja nesimetrija med preteklostjo in prihodnostjo, ki je v prvem stališču ni. Tretje stališče, ki ga implicira B-teorija, pa je stališče večnosti (eternalism, the block universe). Glavna problema tega pristopa sta, kako razložiti intuicijo o nesimetriji med preteklostjo in prihodnostjo ter vprašanje zanikanja teka časa, ki se zdi v nasprotju z našim izkustvom. Pa vendar se tako Parmenidovsko stališče zdi najbolje podprto s sodobno fizikalno teorijo, predvsem Einsteinovo relativnostno teorijo. Ali je med izkustvom, doživljanjem časa in objektivnim, fizikalnim časom tak prepad, da ga ne moremo premostiti?

4. SKLEPNE MISLI

Razprava med A-teoretiki in B-teoretiki ter med zagovorniki različnih ontoloških stališč se nadaljuje. Oba tabora se lahko sklicujeta na prednosti, a morata hkrati odgovoriti na vprašanja, ki jih sproža njihov pristop. V prispevku sem na kratko predstavila osnovna stališča. A-teoretiki se pri iskanju podpore za svoje stališče pogosto sklicujejo na izkustvo in doživljanje časa. A kot pravi Prosser, je zelo čudno, da bi lahko filozofsko razpravo odločilo zgolį gledanje oziroma doživljanje [13: 23]. Kaj pa, če razlogi in argumenti, ki jih navajajo kritiki A-teorije, držijo? Če je na podlagi znanstvenih izsledkov in filozofskih argumentov najbolje podprta B-teorija in eternalistično stališče? V tem primeru je naloga tako filozofov kot kognitivnih znanstvenikov, da pokažejo, zakaj doživljamo tek časa, zakaj se zdi naša časovna zavest v opreki z izsledki fizike. Prosser meni, da obstajajo vidiki duševnega življenja, »kako je biti za nas« (fenomenalna zavest, Nagel, Chalmers), tako da se sprejemamo kot zavestni o teku časa. »Vsak, ki trdi, da mu izkustvo pripoveduje, da čas teče, sprejema, da je nekaj v karakterju naših duševnih življenj, kar nam to odkriva, karkoli je že lahko to »nekaj« [13: 26]. Sama menim, da je trenutno najbolj zanimivo področje raziskav, ki skuša povezati prvoosebno izkustvo z raziskavami v nevroznanosti. V zadnjem času smo priča raziskavam, ki kažejo, kako bi lahko sodelovanje med fenomenološkimi pristopi (npr. Husserlovim opisom časovne zavesti, retencije in protencije) in računskimi modeli nevronskih mrež osvetljevalo in dopolnjevalo oba, na videz nasprotna si pristopa. [16, 17, 18]

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Cognitive modulation of pain: how do cognition/mind influence pain processing?

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ABSTRACT

Pain is somatic perception with a strong cognitive component and arises from physiologic (e.g. nociception), psychic (e.g. sadness) or social/environmental factors (e.g. neglect). This multidimensional phenomenon helps with precise preservation of the homeostasis, stabile internal environment, and presents a precondition for survival. The information from and about the human's inner and outer world are accessible consciously and/or subconsciously. The final control is usually attributed to the brain. This fascinating organ is seen as a mysterious instrument that displays a remarkable intelligence and ability to adapt. This possibly understandable and sophisticated mechanism governs cognition and thought with neural and psychological underpinnings.

The studies of how cognition is realized in the brain enables researchers and professionals to explain the most complex thought processes. Psychical and physical modifications of mental processes operate at different stages of processing and can to some extent be observed or at least empirically probed. The scientific investigation by means of the methods of the natural and social sciences confirms the cognitive influence on perception of somatic sense (pain).

General Terms

Management, Measurement, Documentation, Human Factors, Theory.

Keywords

Cognition, Pain, Perception, Psychophysics, Psychocognition

1. INTRODUCTION

Somatosensation and its most ubiquitously appreciated and attention-seeking mode – pain – is challenging. The contemporary knowledge and science of pain, especially the humanistic kind, demands and allows the creative and unlimited brainstorming on all levels. The rules and doctrines have to be generally valued and person/individual oriented at the same time. The principles for elimination of confusion and the emphasis of the importance of cognitive determinants of somatic sensation (pain) are proposed.

2. PAIN

Pain is a multidimensional and multifunctional phenomenon. As a highly subjective perception, it is characterized by complex and often non-linear relationship between nociceptive input and pain perception. The study and management of this unpleasant symptom, syndrome or disease *per se* is demanding. The scientific and professional approaches range from the study of the peripheral structures, processes and mechanisms [1] to the last considerations

where brain processes are being considered in the analyses of human cognition [2].

Components of pain processes are sensory, perceptual and cognitive. Sensory processes take place peripherally and are measurable with physical instruments and metrics. Perceptual and cognitive processes are processed within the organism, without necessary reliance on physical metrics or instruments with predetermined protocols, and could be followed with more sophisticated devices [3-5].

The disciplines concerned with pain as a health problem are medicine, psychology, pharmacology and bio-technical disciplines. The treatment and management of pain requires more health care resources than the treatment of diabetes, heart diseases and cancer combined [6]. The mechanisms of pain management are based on the ways in which physical sciences process relatively simple or highly variable electrical impulses evoke sensation and manage them with the sophisticatedly evolved complex alternations of perception. The final goal of investigations is a steady development of universal trans-disciplinary tools for the effective and explanatory mechanism-based management.

3. FROM SENSATION TO COGNITION AND VICE VERSA

Physiological, psychical and environmental processes are usually explained as linear functions. Universal solutions for the explanation of those intertwined operations demand sophisticated instruments [5]. Contemporary knowledge is organised in a multidisciplinary way, but gaps are most effectively bridgeable through a trans-disciplinary approach [7-9]. Conscious organisation and processing of thought is scientifically approached by cognitive psychology, an integrative interaction of brain and mind [2].

Pain processing is in medicine and related disciplines acknowledged biologically (physiologically), although the generally accepted definition mention psychical factors too [10]. Their influence is better explained in Price's definition [11]. Recognition and evaluation of cognitive contents and processes remain undervalued and disregarded. The number of sensory informations per sec is 10⁹ bit, and 10² bit of them arrives to brain centres [12], where they elicit perceptions of senses (including pain). Perceptual experience is elicited by sensation, initiation of physiological processes by sensory stimuli (i.e. prick) and the process of accepting the environment. Perception, the process of attaining awareness of sensory information, happens simultaneously with sensation. We cognitively (consciously, mentally) interpret the sensory stimulus and understand sensory information (i.e. we are aware of it) [13].

Sensory processes in the appropriate centres integrate and interpret the arrived informations and turn them into appropriate responses [14; 15]. Neuromatrix serves as a treasure of basic patterns that could be changed and modified [16]. Recognition of received information is a function that categorises percept sense and serves as a diagnostic tool, which identifies factors that influence and burdens health status.

Modern scientific fields in neurology are devoted to investigation of neural mechanisms underlying the complex cognitive processes. It is well known that a variety of cognitive processes influences pain perception and biases nociceptive processing in the human brain [17-19] and the modulation of sensory information is an emerging field in pain (somatosensitivity) research [17; 18].

Cognition, referring to the mental process by which external or internal input is transformed, reduced, elaborated, stored, recovered, and used, has different and for physical metrics inaccessible underpinnings. Such an intellectual query demands and allows exclusively highly sophisticated approaches. It involves a variety of functions such as perception, attention, memory coding, retention, and recall, decision making, reasoning, problem-solving, imaging, planning and executing actions [20; 21].

The sensory, perceptual and cognitive information are additionally profoundly interconnected with unique individual psychical factors, e.g. emotional, which modulate anticipated experience [22]. Descending and afferent pathways, e.g., reciprocally influence the nociceptive input or elicited pain response. Cognitive psychology is thus the foundation on which all other social sciences stand, in the same way that physics is the foundation for the other physical sciences; neurological mechanisms are physiological [23], preserved in the neuromatrix [16].

Cognition and consciousness as well as the complex structure and functionality of the brain is intensively investigated and drives researchers toward exploring the mysteries of human thought. They are beyond the realms of human scientific understanding and reasoning [24]. The approach should exhibit universal solutions for similar queries. The neurodynamical processes are the basis of perception, cognition, and behavioural decision making, and is recorded with neurophysiological instruments [25; 26]. Psychophysical evaluation of sensory processes is accessible with psychophysical tests [27-29]. For the comprehensive understanding of human perception, new protocols are suggested [30; 31].

4. COGNITIVE MODULATION (PLASTICITY) OF PAIN

Pain sensation, perception and biased nociceptive processing are influenced by two aspects of cognitions: variety of cognitive processes [17] and cognitive content [32]. Cognitive processes characterize how individuals think about pain, whereas cognitive content establishes what individuals think or believe about their pain.

4.1 Cognitive processes

Cognitive processes involved in pain recognition and management are distraction, enhancement, suppression, dissociation, nonjudgment, acceptance, reappraisal, absorption and rumination [33]:

- distraction divides and diverts attention away from pain, to more pleasant perception,
- enhancement diverts attention to positive thoughts [34],
- suppression diverts thoughts by conscious suppression and captures a form of cognitive avoidance,

- dissociation and reappraisal either distance the person from the pain or make the pain more tolerable,
- nonjudgement include the experience, without unnecessary evaluation of characteristics as "good" or "bad",
- acceptance actively allows experience to solely be an experience, without a need for it to be different,
- absorption implies intense, hypervigilant intentional or unintentional focusing on pain and
- rumination signifies unintentional preoccupation with pain.

4.2 Cognitive content

Cognitive content involved in pain recognition and management include self-efficacy, catastrophizing, beliefs about pain, expectations:

- self-efficacy the belief that one can manage pain,
- catastrophizing focusing on negative aspects and consequences of pain and ruminating about negative beliefs,
- belief that pain represents a threat,
- expectations and
- predictions.

5. INVESTIGATION OF COGNITIVE PROCESSES AND CONTENT

Classical psychophysics relates physical stimulus energy to psychological sensation. The ideal psychophysical process is the function of a single variable and the perceived sensation is appreciated as the function of the intensity of the physical stimulus. Other factors that affect sensation are mostly neglected or considered as a nuisance or as context variables that should be eliminated to isolate the true psychophysical relation [5].

The explanation of many comprehensive issues, which emphasise multidimensional phenomena such as sensations (i.e. pain), should be grounded on the important cognitive determinants. Psychocognition (integration psychophysics) integrates separate functions, such as sensation of two or more variables, into a unitary perception. Variables may be sensory, perceptual, and cognitive. Because of many-variable forms, integration psychophysics can work entirely within the organism. The principles that govern the conceptions of psychophysics, are realistic, physical and necessarily rely on the physical metrics. Psychocognitive, on the other hand, typically lie at a stage beyond sensory processing, within the mental realm [2].

The contemporary neurophysiologic (electrophysiologic) and neuroimaging studies of neural mechanisms underlying more complex cognitive modulation indicate that modulations of pain are likely to share the general mechanisms and substrates of sensory processing. The pain modulatory systems complement, interact and overlap with general cognitive (mental) control systems [2; 16].

Neurology has many common points with neurophysiology and psychology shares many methods and instruments with psychophysics. Cognitive psychology integrates mechanisms and principles.

6. COGNITIVE APPROACH TO CHRONIC DISEASES

Chronic diseases are long-lasting and frequently exhausting conditions and can be often overloaded with an additional, for now incurable, health problem: pain. This unpleasant phenomenon arises as a symptom or sign, as an entity *per se* or complication [35]. Patient-oriented health care of patients with somatosensory disturbances, including pain, seems to increase costs related to improvement of common chronic conditions. But the determination

of a connective link/program leads to the development of increasingly sophisticated scientific methods for understanding the workings of the brain and the very nature of consciousness. The advanced techniques for monitoring the brain and psychical processes require the development of novel methods of theoretical analysis and interpretation tools. Our work is part of these endeavors.

Such comprehensive approach would be useful for:

- understanding the similarities and differences between existing and "cognitive" pain treatments,
- guiding the evaluation of patients with chronic pain,
- improving the management and
- giving clinicians greater flexibility for including new and improved interventions.

We continuously prove the efficacy of a trans-disciplinary approach to pain management. We are convinced that the gaps in visions and perspectives between scientific and professional areas and disciplines are artificially created. Our successful evidencebased everyday work and academic and professional clinical achievements are the basis for a new, trans-disciplinary, patientoriented approach, where cognitive factors will play a connective role.

Our studies and practices range from purely neurologic/ neurophysiologic or psychological, to psychophysically developed and psychocognitive [7; 30; 31; 36-42].

7. CONCLUSION

Cognition is the basis for the development of a conscious way to manage pain and other somatic sensations. Sensory informations are sets of processing steps that evolve from sensation to perception and beyond. The documentation and demonstration of influence and effectiveness is difficult. The approach is two-fold, physiologic with physics as the foundation for the other physical sciences and psychological with cognitive psychology as the foundation on which all other social sciences stand.

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Modeling the Model: the World Beyond the Immediate Sensorium

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ABSTRACT

The paper explored the hypothesis that there might be a certain type of probabilistically acquired embodied calculus that meditates our sensory perception. Our intention is to reflect upon some problems connected to modeling consciousness while weighing sensory and social perception against each other in the theater of action where Bayesian brain "plays us" while playing with itself.

Keywords

consciousness, modeling, Bayesian probability

1. INTRODUCTION

This paper is organized around the hypothesis that there might be a certain type of probabilistically acquired embodied calculus that meditates our sensory perception. That would imply that what we cognitively perceive and what we like to call "our reality" is already a model. We can literally "see" the model (without being aware of it) in such moments when "non-stimulus-driven inputs allow early neurons to respond even to stimuli which are inferred but not directly presented to the retina" [1, p. 1]. Our intention here is to reflect upon some problems connected to modeling consciousness while weighing sensory and social perception against each other in the theatre of action where Bayesian brain "plays us" while playing with itself. In the first part of the paper, which reflects upon some recent approaches to modeling consciousness, we pose a plethora of questions important for the chosen topic: - Should we favor mathematical abstraction and its "beauty" and use topological insights¹, or combine complex reality models with Bayesian ones, or give more emphasis on the development of bio-inspired models? How effective is the topological hypothesis in resolving still unresolved problems concerning our psychological activities, such as mind-wandering,

memory retrieval, consciousness and dreaming state? Maybe we should combine useful insights from different model-paradigms, but how? By optimizing the practice of already established models that proved their efficacy in experimental work, or from "above" from the explanatory unification paradigm and its claims about explanations contributing to our understanding of the world by embedding phenomena into general nomic patterns that we recognize in the world? To what extent our methodological choices connected to the controversy about the concept of the unification of knowledge help/limit our insights into the phenomena that we explain [4][5]. Are we (still) satisfied with bayesian calculation of epistemological «virtues» of unification [6]? Can we compare explanatory relevance [7] and constitutive relevance [8]? Is Elsasser's proposal to overcome reduction by the formalization of complexity through the undifferentiated heterogeneity of logical classes [9] still relevant? Are we "in the gird" of some sort of a "fearful symmetry"² because we are unable to get outside of the complex "reality" of the model?

2. A REALITY MODEL

Suppose it is impossible for us to be "outside" the texture of the dynamics and the dynamics of the texture in which we partake,

¹ See, for example Tozzi's paper "A Symmetric Approach Elucidates Multisensory Information Integration" in which he argues that the Borsuk-Ulam theorem is a general principle underlying nervous multisensory integration claiming that topological tools not only shed new light on questions concerning the functional architecture of mind and the nature of mental states, but also provide an empirically assessable methodology [2, p.1-14]. Another example could be recent research focusing on the link between neural network structure and its emergent function where the scientists attempt to describe such a link by "taking the direction of synaptic transmission into account, constructing graphs of a network that reflect the direction of information flow, and analyzing these directed graphs using algebraic topology" [3, p. 1-16].

² "Fearful symmetry" is a widely quoted, differently interpreted and for different reasons, and in different contexts used and misused syntagma. borrowed from the poetic/philosophical system of William Blake. The religious interpretation of the poem containing this syntagma should not be taken for granted. Mentioning «fearful symmetry» we refer to the first and the last symmetrically positioned quatren of the poem «The Tyger» composed of six stanzas. Contrary to the most of the already established interpretations of Blake's philosophical views, we strongly argument in favor of his methodological naturalism and we recognize the anticipatory value of Blake's functionalist insights into developmental potentials of the human brain as a sophisticated patternseeking instrument. The poem was published in 1795 in the Songs of Experience collection, as a counterpoint to the poem «The Lamb» published in the previous collection titled the Songs of Innocence. Blake was an admirer of Swedenborg's methodological naturalism but his position of Swedenborg's theological though oscillated from the satire in The Marriage of Heaven and Hell, across the phase of interest in Swedenborg's science and philosophy, to the phase of his criticism of The New Jerusalem Church. Blake also knew (an illustrated) the work of Darwin's grandfather - Erasmus Darwin - who formulated one of the first formal theories on evolution in Zoonomia, or, The Laws of Organic Life (1794-1796). Blake's disillusionment with Swedenborgian church already happened in the years when he wrote The Book of Experience, but this paper is not the right place to discuss in detail Blake's peculiar blend of spiritual naturalism, non-theism, simultaneous deism and anti-deism, and radical revolutionary ideas.

but what we can is to assume virtual outsiders' perspectives in order to assess the degree of the "reality" of the model that we cocreate by taking part in its dynamics. Suppose that the potential for *perspective-assuming* is already present in the first focusing of attention of a child in the pre-speech phase of its cognitive development, then it will be true - as Graziano & Kastner hypothetize - that awareness is best described as a perceptual model, not merely a cognitive or semantic proposition about ourselves that we can verbalize, but instead, a rich informational model that includes, among other computed properties, a spatial structure [10, p. 99]. Graziano & Kastner believe that their explanation of consciousness as a construct of the social perceptual machinery is contrary to the hypothesis that consciousness is an emergent property of the brain caused by neuronal complexity, and they have some serious concerns about the "rival" theory: first, they think that such as emergent property may lack adaptive value³, and second, they don't see how the complexity theory could give answers to vital questions on how consciousness emerges, and from what specific neuronal process. We are prone to think that a peculiar sort of dynamism of *reality*as-a-reality-model in which we partake, is a type of functional complexity that goes beyond both perceptually experiential and cognitively perceptual human scale. It is our intuition that the complexity of human reality as a reality-model should be (at least) the function of component complexity and system complexity. Here under system complexity we refer to the complexity resulting from the relationship between the functional processes like communication, concurrence and multi-instance which have their internal "component complexity". However, imagine for a moment the situation where what we experience as our realty turns to be a bio-emergent topological complexity. Biological development "takes advantage" of certain (physical or chemical) manifestations of mathematical possibilities usable for the dynamical development of a certain form; it adopts these possibilities and turns them to its own purpose. The opposite type of "getting an inspiration from" is not so rare in biology. In this context, for example, various models have been developed to

solve the problem of patterning of living organisms, starting in the 50s from Turing's "tiger stripe" theory, a brilliant idea that two kinds of reacting chemicals with different diffusibilities - two morphogens that work together as an "activator" and "inhibitor" could form a steady-state spatial pattern. Take into consideration the example of the cellular slime mold Dictyostelium discoideum as an organism interesting both for biologists and for physicists. This unicellular species was chosen as a model organism for biomedical research because it could be used for a model system for the study of cellular morphogenesis and the study of pattern formation. The synchronization mechanism of oscillatory production of cyclic adenosine 3'5'-monophosphate in Dictyostelium might be a universal feature that can explain synchronization in other organisms⁴. In their recent research, Tozzi and Peters hypothesize that brain functions are embedded in an imperceptible fourth spatial dimension and propose a method to empirically assess its presence. In order to achieve that, they use a concept from topology, the 4D space of a "hypersphere's torus" to understanding brain functions. The torus is undetectable by observers living in a 3D world and they compare it with a video game with biplanes in aerial combat: when a biplane flies off one edge of gaming display, it does not crash but rather it comes back from the opposite edge of the screen. Tozzi and Peters think that "our thoughts exhibit similar behavior, i.e. the unique ability to connect past, present and future events in a single, coherent picture as if we were allowed to watch the three screens of past-present-future 'glued' together in a mental kaleidoscope." [13, p. 189].

The idea that we cannot perceive un-modeled reality is highly disturbing in a philosophical sense, and the very thought that we do not "exist" outside of the "reality" (co)modeled for us and by us, makes us cognitively biased in favor of the interpretation of the superiority of the top-down, "perceptually cognitive" insight into what makes the conceptual stasis of a particular quale. In the text titled "Why cognitive penetration of our perceptual experience is the most plausible account?" Newen & Vetter claim that our perceptual experience is influenced by higher cognitive phenomena like beliefs, desires, concepts, templates, but they are not sure to what extent and how exactly. They claim that the weak impenetrability claim cannot account for (1) extensive structural feedback organization of the brain, (2) temporally very early feedback loops and (3) functional top-down processes modulating early visual processes by category-specific information. They admit that the strong impenetrability claim could incorporate these data by widening the "perceptual module" such that it includes rich but still internal processing in a very large perceptual module. They argue that this latter view leads to an implausible version of a module.

Contrary to them, in the second part of this paper, we argue that topological models – concretely the concept of 4D space of a "hypersphere's torus" proposed and experimentally used by Tozzi

³ It seems that emergent property of the brain caused by neuronal complexity may have adaptive value after all. See an adaptive network model of synchronization proposed by Assenza et al. [11]. The role of synchronization in nature, society and technology is valuable. However, real world systems change their interaction patterns in time. Assenza et al. analyzes synchronization features in networks in which structural and dynamical features co-evolve: "The feedback of the node dynamics on the interaction pattern is ruled by the competition of two mechanisms: homophily (reinforcing those interactions with other correlated units in the graph) and homeostasis (preserving the value of the input strength received by each unit). The competition between these two adaptive principles leads to the emergence of key structural properties observed in real world networks, such as modular and scalefree structures, together with a striking enhancement of local synchronization in systems with no global order" [Ibid, p. 1]. In such systems - "on one hand, local synchronization and consensus coexist with a lack of global order while, on the other hand, modularity and scale-free interaction patterns are core features of their backbone" [Ibid, p: 4]. Assenza's research team claims that their adaptive network model reproduces respectively at the mesoscopic and microscopic level, two universal properties of real networks. In addition to this, the two structural properties occur when the system displays a large degree of local synchronization in the absence of global dynamical order" [Ibid, p. 4]. This research team claims that in such way their findings are in agreement with either dynamical or structural features observed in real neural and social systems.

⁴ See "Modeling the model organism *Dictyostelium discoideum*" by Nagano: "Since the Belousov-Zhabotinskii reaction pattern, a wellknown non-linear phenomenon in chemistry, was observed during aggregation of *Dictyostelium* amoebae, *Dictyostelium* has been one of the major subjects of non-linear dynamics studies. Macroscopic theory, such as continuous cell density approximation, has been a common approach to studying pattern formation since the pioneering work of Turing. Recently, promising microscopic approaches, such as the cellular dynamics method, have emerged. They have shown that *Dictyostelium* is useful as a model system in biology". [12, p. 541-50]

& Peters for better understanding brain functions - could offer a very large "perceptual module" such that it includes rich but still internal processing. Because of our limited, three-dimensional perception, Tozzi & Peters' type of realism may not be readily accepted, but these authors offer a method to empirically assess the presence of the model of an imperceptible fourth spatial dimension of brain functionality. A four-dimensional brain, or a three-dimensional brain that operates in four dimensions? - it does not really matter as long as the model of "topological brain" could elucidate syntactic and semantic processing. Newen & Vetter offered a couple of other arguments against cognitive impenetrability hypothesis, and in that context they mentioned visual illusions (those that remain stable even if we are fully informed about the illusionary status of our experience) as the most striking evidence in favor of cognitive impenetrability. They agreed that such illusion allow us to discover construction principles of perception which remain active in everyday perception as well. They also agreed that construction principles revealed by stable illusions exist and that they remain active, but they disagreed that these construction principles can never be influenced by higher cognitive processes. They expressed one worry: "Why should we accept the generalization of exceptional cases of visual illusions to any case of everyday perceptual experience?" [14, p. 28] We find their argument based on the supposed exceptionality of visual illusion cases superficial and limited, because how then to explain the experimental statistics of the strange-face-in-the-mirror illusion which shows that some illusions are standardly effective (and typisized) only on healthy subjects, and less effective (and unstadardized) in patients diagnosed with some psychological problem or a psychiatric illness. We analyse findings of G. B. Caputo [15][16] related to the strange-face-in-the-mirror illusion as an example to prove that Newen & Vetter's second argument against cognitive impenetrability is not true [14]. Caputo's experiments show that in healthy, average observers gazing at one's own face in the mirror for a few minutes, at a low illumination level, produces the apparition of strange faces. All examined "normal" observers see distortions of their own faces which they describe roughly in 5 categories ranging from monsters, "archetypical" faces, faces of relatives and deceased, and animals. In one of Caputo's experiments, patients with depression were compared to healthy controls with respect to strange-face apparitions. Apparitions of strange faces in the mirror were much reduced in depression patients compared to healthy controls. Depression patients compared to healthy controls showed shorter duration of apparitions; minor number of strange faces; lower self-evaluation rating of apparition strength; lower self-evaluation rating of provoked emotion. While these decreases in the effect of the illusion in depression Caputo explained in psychiatric terms as a result of "deficits of facial expression and facial recognition of emotions, which are involved in the relationship between the patient (or the patient's ego) and his face image (or the patient's bodily self) that is reflected in the mirror". We could perhaps agree so far with Caputo, but the psychoanalytical, Jungian attempt at resolving the "mystery" about the way illusion functions in the "healthy" control group does not seem convincing enough - at least not scientifically. In the elaboration of this problem we develop different argumentation, backing up our hypothesis about the functionality of "filling in" the missing information by Bayesian modeling of sensory "reality" on some relatively recent experiments on visual processing in the human brain [1][17][18][19], and on some new theories of hippocampal

memory construction of the "world beyond the immediate sensorium" [20], as well as on a range of Bayesian models.

3. CONCLUSION

The overall theme of this paper is connected to some *neither-illusionary-nor-real* "circumstances" in the dynamics of "perceptual experience" and "perceptual cognition". In the concluding part we attempt to provide some argumentation for our belief that the degree of the modeled *neither-illusionary-nor-real* "circumstances" in the dynamism of that model opens the possibility to interpret one dynamic fuzzy set "level" interconnected to another dynamic fuzzy set "level" as more or less *convincing* and, at the same time, more or less *illusionary* on a scale that we use to *interpret* a degree of *human reality*. However, at the very end of this paper, the important question about what could be the best model for modeling a model – remains unanswered.

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Psihološki in fiziološki odzivi ob robotski vadbi v različnih pogojih navidezne resničnosti

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POVZETEK

Naš namen je bil ugotoviti, v kolikšni meri lahko prek fizioloških odzivov sklepamo na stopnjo motiviranosti in prisotnosti udeleženca za igranje računalniške igre, ki bi bila uporabna pri rehabilitaciji zgornjih okončin. Z znanjem o povezanosti fizioloških odzivov in psiholoških stanj bi rehabilitacijo lahko prilagajali tako, da bi bolnik pri njej vztrajal čim dlje. Fiziološki odzivi, ki smo jih merili, so bili srčni utrip, temperatura in prevodnost kože, zbrali pa smo tudi subjektivne ocene zanimivosti, težavnosti igre, vživetosti vanjo ter želje po nadaljevanju igranja. Srčni utrip se je med različnimi pogoji pomembno razlikoval. Najvišji je bil ob kognitivno in fizično zahtevnejših pogojih ter težjih nalogah, najnižji pa ob manj zahtevnih. Prevodnost kože je bila prav tako občutljiva na različne pogoje, vendar se je bila manj zanesljiva mera. Temperatura kože je bila na razlike med pogoji zelo malo občutljiva. Rezultati kažejo nizke korelacije med prevodnostjo kože in motiviranostjo za nadaljevanje igre ter med srčnim utripom in natančnostjo vožnje avtomobila. Na motiviranost za vztrajanje pri igri in občutek prisotnosti je pomembno vplival kognitivni napor, na natančnost vožnje pa poleg kognitivnega tudi fizični napor. Lahko zaključimo, da je pri izdelavi učinkovite računalniške igre za rehabilitacijo poleg ustreznega načrtovanja fizične vaje ključna tudi izbira primerne vsebine kognitivnih nalog.

Ključne besede

rehabilitacija, fiziološki odzivi, motivacija, prisotnost, računalniška igra

ABSTRACT

Our aim was to determine to what extent can the knowledge of the psychological responses help infer the level of motivation and the presence of a participant playing a computer game, which would be useful for rehabilitation of the upper limbs. Relying on the correlation between physiological and psychological states we can adjust rehabilitation so that the patient persists in doing the exercise as long as possible. The physiological responses we have measured were heart rate, skin temperature and conductivity. From the psychological responses we have assessed the point of interest and the difficulty of the game, participant involvement in the game and desire for its continuation. Heart rate was significantly different under different conditions. It was the highest under cognitively and physically more demanding conditions and when performing more difficult tasks and the lowest at less demanding ones. Skin conductivity was also sensitive to different conditions, but this was a less reliable measuring tool. Skin temperature had a very low sensitivity to changing conditions. I found low correlations between skin conductivity and motivation to continue playing the game and

between heart rate and accuracy of driving the car. The motivation for persisting and the sense of presence in the game were highly influenced by the cognitive effort. Accuracy of driving was influenced by both, cognitive and physical effort. When creating an efficient computer game for rehabilitation it is very important to plan appropriate physical exercise and cognitive tasks.

Keywords

rehabilitation, physiological responses, motivation, presence, computer game

1. UVOD

Bolniki lahko s pomočjo interaktivnih in intenzivnih vaj z robotom izboljšajo svoje gibalne sposobnosti. Treba pa je upoštevati, da v rehabilitaciji uporabniki niso vajeni takšne interakcije, imajo pa tudi slabše gibalne sposobnosti. Zato je za uspešno rehabilitacijo pomembno, da robot s svojim vedenjem čim bolj ustreza osebnosti in čustvenemu stanju človeka [3].

Mnogo raziskav za namene rehabilitacije preučuje povezanost fizioloških sprememb s čustvenimi stanji. Med najbolj pogostimi merami sta srčni utrip in prevodnost kože, sledita pa mu temperatura kože in dihanje. Raziskave v [4] in [5] so naredile obsežen pregled povezav čustev s fiziološkimi odzivi. Za anksioznost so npr. značilni povišan srčni utrip, nivo (SCL) in odziv (SCR) prevodnosti kože ter znižana temperatura na prstu. Za zabavo so bili v različnih raziskavah značilni zvišanje, znižanje ali pa nobena sprememba v srčnem utripu, zvišana ali znižana električna prevodnost kože (SCL in SCR) in zvišana temperatura na prstu [4]. Raziskave preučujejo tudi povezanost fizioloških odzivov s prisotnostjo oz. občutkom, da je del neke resničnosti (npr. navidezne resničnosti med gledanjem filmov, branjem knjig itd.). Rezultati npr. kažejo, da med odzivanjem v resničnem in navideznem okolju najbolje diferencira srčni utrip, ki v navideznem okolju visoko naraste, medtem ko je temperatura kože na spremembe okolja manj občutljiva, prevodnost kože pa ni kazala konsistentnih učinkov okolja [7].

Navidezna resničnost, vpeljana z igranjem računalniške igre, ki je interaktivna in posameznika stimulira prek več različnih čutnih kanalov, je lahko pomemben dejavnik motivacije v motorični rehabilitaciji [8]. Npr. ko bolniki postopoma nadgrajujejo svoje sposobnosti, je pomembno, da so gibalne naloge vse bolj zapletene oz. da zahtevajo vse več koordinacije različnih gibov. Tudi kognitivne naloge naj bi bile prilagojene stopnji kognitivnih sposobnosti, s čimer se izognemo dolgčasu in približamo zanosu. Dobro je tudi, da so igre zabavne, pri čemer pomagajo različni zvoki, vizualni učinki, in da vsebujejo rdečo nit (zgodbo), saj so bolniki tako bolj motivirani za igro [1]. Rehabilitacija negibljive okončine je lahko zelo naporna in če v njej ne vidimo vsaj malo smisla, toliko prej odnehamo. Vztrajanje v rehabilitacijski dejavnosti pa je ključnega pomena za izboljšanje gibalnih sposobnosti. Osebo lahko morda spodbudimo k vztrajanju, če ponavljajoči se rehabilitacijski aktivnosti (gibanju okončine) dodamo kognitivno nalogo, tako da posameznik med fizično vadbo osredotoča pozornost na nekaj drugega, s čimer se prekinja zaznana monotonost vadbe in zmanjša dolgčas. Uspešnost virtualnega okolja pa temelji tudi na tem, kako dobro lahko pri uporabniku vzbudi prisotnost – občutek, da je del tega okolja, ne pa resničnega, kjer je tudi njegovo telo [9]. Posameznik misli, čuti in se obnaša tako, kot da je v drugem svetu, in da so resnični tudi dogodki, ki se dogajajo.

Namen naše raziskave je bil preveriti, kako se pri udeležencu z dodajanjem različnih kognitivnih nalog k osnovni nalogi rehabilitacijske vadbe, tj. premikanju okončine, spremeni motiviranost za vadbo, prisotnost in subjektivna ocena težavnosti izvajanja vadbe. Poleg tega je bil namen tudi preveriti, kako se motiviranost za vadbo, prisotnost in subjektivna ocena težavnosti izvajanja vadbe razlikujejo pri različnih vrstah kognitivnih nalog. Merili smo tri fiziološke odzive – srčni utrip, prevodnost in temperaturo kože – ki so v raziskavah najpogosteje uporabljene fiziološke mere za preučevanje psiholoških stanj. Raziskave večinoma raziskujejo povezanost fizioloških odzivov in čustvenih stanj, vendar smo raje vključili koncepte motivacije (zanimivost, odločitev za ponovno igro), prisotnosti (vživetost) in težavnosti, ki dajo več informacij o tem, ali bi udeleženec še vztrajal ob določeni dejavnosti ali ne.

2. METODA

Raziskavo smo izvedli s 43 udeleženci (24 moškimi in 19 ženskami), starimi povprečno 25,2 let (SD = 4,4; min = 18, max = 35). Kot pripomočke smo uporabili enostavno obliko navidezne resničnosti, to je štiri variante dvodimenzionalne računalniške igre, v kateri so morali udeleženci čimbolj natančno voziti avto po cesti. Uporabili smo tudi vprašalnike za merjenje subjektivne zanimivosti igre, težavnosti igre, vživetosti v igro in željo po nadaljevanju igre. Za merjenje fizioloških odzivov smo uporabili merilnike srčnega utripa, prevodnosti in temperature kože, vgrajene v robotsko ročko.

Deli igre so se razlikovali po prisotnosti/odsotnosti kognitivnih nalog (tj., kognitivni obremenitvi) in visokem/nizkem uporu robotske ročke (tj., fizični obremenitvi). Uporabili smo 2 x 2 eksperimentalni načrt. V pogoju 1 kognitivnih nalog ni bilo (K–) in upor robotske roke (F–) je bil tako majhen, da osebi ni oteževal manevriranja avtomobila v računalniški igri. V pogoju 2 so bile prisotne kognitivne naloge (K+), fizično obremenitev pa je prav tako predstavljal le majhen upor robotske roke (F–). Pogoj 3 je vseboval kognitivne naloge (K+), upora robotske roke ni bilo, dodana pa je bila sila vztrajnosti (F+), zaradi katere je bilo težje manevrirati vožnjo avtomobila v računalniški igri. Pogoj 4 je bil brez kognitivnih nalog (K–) in brez upora robotske roke, z dodano silo vztrajnosti (F+).

Udeleženci so s premikanjem robotske ročke usmerjali vožnjo avtomobila. V križišču so se morali odločiti za eno od poti, in sicer glede na rešitev kognitivne naloge. Odločati so se morali med dvema odgovoroma in zaviti v smer, kjer je bil predvajan pravilni odgovor. V nalogah so iskali sopomenke (npr. parfum je "vonj" ali "dišava", reševali račune (npr. 7 * 9 - 22 = ,,30" ali "41") in zrcalili slike. Kognitivne naloge so morali udeleženci reševati čimbolj pravilno, hkrati pa čim bolj natančno voziti po zaviti cesti. Po vsaki odigrani igri so udeleženci izpolnili vprašalnik, v katerem nas je zanimalo, kako zanimiva in težka je bila igra, kako so se vživeli vanjo in ali bi jo igrali še enkrat.

Za analizo podatkov smo uporabili dvosmerno ANOVO za odvisne vzorce ali neparametrično Friedmanovo ANOVO z Wilcoxonovim post hoc testom. Za primerjavo nalog smo uporabili enosmerno ANOVO za odvisne vzorce s Sidakovim post hoc testom. Povezanost med psihološkimi in fiziološkimi odzivi smo opredelili s Pearsonovim koeficientom korelacije. Za ugotavljanje razlik v fiziologiji smo od vseh fizioloških odzivov v eksperimentalnih pogojih in kognitivnih nalogah odšteli odzive, izmerjene v stanju mirovanja.

3. REZULTATI

3.1 Primerjava različnih eksperimentalnih pogojev

3.1.1 Fiziološki odzivi v vseh štirih eksperimentalnih pogojih

Udeležencem smo, medtem ko so reševali kognitivne naloge in vozili avtomobil, merili različne fiziološke odzive. Rezultati so prikazani v Tabeli 1.

Tabela 1. Opisna statistika fizioloških mer (v primerjavi s stanjem mirovanja) v štirih pogojih (N = 39)

SD
7,66
1,63
7,80
1,35
6,25
1,28
8,20
1,57
711711711

Pogoji so se med seboj statistično pomembno razlikovali v srčnem utripu, $\chi^2(3) = 24,29$, p < ,001, v prevodnosti kože (SCR), $\chi^2(3) =$ 8,32, p = ,040, in temperaturi kože, $\chi^2(3) = 13,09$, p = ,004. Tabela 1 prikazuje rezultate Wilcoxonovega post hoc testa za preverjanje enakosti fizioloških odzivov med posameznima dvema pogojema (meja statistične pomembnosti je p = ,050 / 6 = ,008).

Tabela 2. Primerjava fizioloških odzivov v štirih pogojih (rezultati Wilcoxonovega post hoc testa in Cohenov d)

		1-2	1-3	1-4	2-3	2-4	3-4
srčni	Ζ	-1,91	-4,54	-0,78	-3,73	-0,29	-3,99
utrip	p	,056	< ,001	,435	< ,001	,769	< ,001
	d	-0,61	-1,50	-0,34	-0,88	0,30	1,24
SCR	Ζ	-2,97	-1,31	-0,41	-1,81	-2,76	-1,66
	p	,003	,190	,679	,070	,006	,097
	d	1,28	0,69	0,23	-0,65	-1,12	-0,48
	Ζ	-2,19	-2,57	-0,84	-0,54	-1,83	-2,70
Temp.	р	,028	,010	,933	,586	,068	,007
_	d	0,20	0,20	0,00	0,21	-0,16	-0,39

Pogoj 3 se je od vseh ostalih pogojev statistično pomembno razlikoval v srčnem utripu; pri vseh treh parnih primerjavah je šlo za velik učinek pogoja. Srčni utrip je bil torej najvišji v primeru, ko so udeleženci reševali kognitivne naloge, fizična obremenitev pa je bila višja (K+ F+), najnižji pa nasprotno ob najnižjih obremenitvah (K- F-). Pri parnem primerjanju ostalih pogojev sicer nismo našli statistično pomembnih razlik, ne smemo pa zanemariti majhne in srednjih velikosti učinka v teh primerjavah. Tudi parne primerjave prevodnosti kože (SCR) v različnih pogojih je pokazala na majhne, srednje ali velike velikosti učinka, vendar sta statistično pomembnost dosegli zgolj razliki med pogojema 1 in 2 ter pogojema 2 in 4. Vendar pa je bila za razliko od srčnega utripa prevodnost kože (SCR) najvišja ob kognitivno in fizično najlažjem pogoju, nižja pa v pogojih z višjimi obremenitvami (pogoja 2 in 3). V lažjih pogojih je temperatura kože udeležencem bolj naraščala kot pa v pogojih z višjimi obremenitvami. Vseeno pa med pogoji ni bilo statistično pomembnih razlik, razen med 3 in 4, ki sta se razlikovala po prisotnosti/odsotnosti kognitivnih nalog. Razlikovala sta se tudi v majhni velikosti učinka. Vpliv fizične obremenitve je bil majhen oz. ga sploh ni bilo, če primerjamo pogoj 1 s pogojem 4 (ki sta bila oba brez kognitivnih nalog, z različno fizično obremenitvijo).

3.1.2 Subjektivne ocene v vseh štirih pogojih

Tabela 3. Opisna statistika ocen zanimivosti (Z), vživetosti (V), nadaljevanja igre (N) in težavnosti (T) v pogojih (N = 43)

		М	SD		М	SD
Ζ		7,37	2,21		8,56	1,3
V	Pogoj 1	7,23	2,48	Pogoj 2	8,30	1,37
Ν	(K— F—)	6,65	2,64	(K+ F–)	7,74	1,94
Т		4,44	2,51		7,00	2,04
Ζ		8,21	1,61		7,67	2,09
V	Pogoj 3	8,40	1,68	Pogoj 4	7,51	1,98
Ν	(K+ F+)	7,58	2,17	(K— F+)	6,63	2,34
Т		7,12	2,00		5,86	2,14

Pogoji se statistično pomembno razlikujejo v zanimivosti, $\chi^2(3) = 33,31$, p < ,001, vživetosti, $\chi^2(3) = 13,63$, p = ,003, želji za nadaljevanje igranja, $\chi^2(3) = 23,34$, p < ,000 in težavnosti, $\chi^2(3) = 50,00$, p < ,001. Pregled Tabele 4 nam razkrije, da so med pogoji brez kognitivnih nalog in pogoji s kognitivnimi nalogami (1–2, 2–4, 1–3, 3–4) v večini primerov statistično pomembne razlike. Meja statistične pomembnosti je p = ,050 / 6 = ,008. Razlike se pojavljajo pri primerjanju pogoja vožnje brez nalog (pogoja 1 in 4) s pogojem vožnje z nalogami (pogoja 2 in 3) v primeru, ko je bila fizična obremenitev pri obeh tako enaka kot različna.

Tabela 4. Primerjava subjektivnih ocen med pogoji (rezultati Wilcoxonovega post hoc testa in Cohenov d)

		1-2	1-3	1-4	2-3	2-4	3-4
	Ζ	-4,44	-3,32	-1,73	-2,20	-3,36	-2,34
Ζ	р	< ,001	,001	,084	,028	,001	0,02
	d	-0,66	-0,43	-0,14	-0,24	0,51	0,29
	Ζ	-3,06	-3,25	-1,08	-0,86	-2,35	-2,45
V	р	,002	,001	,278	0,388	,019	0,01
	d	-0,49	-0,51	-0,09	0,07	0,43	0,48
	Ζ	-3,91	-2,86	-0,41	-0,93	-3,44	-2,85
Ν	р	< ,001	,004	,685	,351	,001	,001
	d	-0,47	-0,38	0,01	-0,08	0,52	0,42
	Ζ	-4,66	-4,61	-3,79	-0,09	-2,98	-3,25
Т	р	< ,001	< ,001	<,001	,931	,003	,001
	d	1,12	1,18	-0,61	0,06	-0,55	-0,61

Velikosti učinka v primerjavi pogojev 1 in 2 preko ocen zanimivosti, vživetosti, želje po nadaljevanju igre in težavnosti so

pokazale na srednje do velike razlike. Udeleženci so npr. težavnost pogojev s kognitivnimi nalogami ocenili kot izrazito višjo kot pa težavnost pogoja, kjer so samo vozili avtomobil. To pomeni, da ima prisotnost oz. odsotnost naloge pomembno vlogo pri dojemanju igre kot težje oz. lažje. Enako lahko rečemo za ostale tri vrste ocen, le da je bil učinek manjši kot pri težavnosti. Če primerjamo še drugi pogoj brez kognitivnih nalog, torej pogoj 4, s pogojem 3, kjer kognitivne naloge so (pri obeh pa je enaka fizična obremenitev), prav tako pridemo do podobnega zaključka, torej o pomembnem vplivu kognitivnih nalog, le da je velikost učinka tu manjša (od majhna do srednje velika). Vpliv fizične obremenitve ni tako pomemben kot vpliv naloge, saj primerjava pogojev z različnimi fizičnimi obremenitvami (npr. 1 in 4 ter 2 in 3) ne pokaže niti na majhen učinek.

3.1.3 Povezanost fizioloških parametrov, subjektivnih ocen in natančnosti vožnje pri različnih eksperimentalnih pogojih

V veliko primerih so bile korelacije zelo nizke, nekaj pa je bilo šibkih in srednje visokih. Npr. v pogoju 2 (K+ F-) je bila opaznejša korelacija med odklonom od poti in željo po nadaljevanju pogoja, r = .34, p = .024, enako tudi med odklonom od poti in zanimivostjo pogoja, r = .32, p = .036. To pomeni, da slabše kot so udeleženci izvajali gibalno vajo, bolj jim je bil pogoj zanimiv in bolj so si želeli, da bi nadaljevali z igranjem računalniške igre v pogoju, kjer so bile prisotne kognitivne naloge in manjša fizična obremenitev. Prevodnost kože (SCL) v pogoju 1 (K- F-) je srednje visoko korelirala s subjektivno oceno zanimivosti pogoja, r = .44, p = .005, in željo po nadaljevanju igre, r = .48, p = .002. Tudi v pogoju 2 je bila povezana z oceno zanimivosti, r = 42, p = 007. Povezave kažejo na to, da prevodnost kože (SCL) v določeni meri odraža motiviranost udeleženca pri igranju igre. Prav tako je bilo najti korelacije med srčnim utripom in natančnostjo vožnje – v pogoju 1, r = -57, p < -57,001, in pogoju 2, r = -45, p = 0.004. Srčni utrip se je torej povečal v primeru, ko so bili udeleženci manj natančni pri opravljanju svoje naloge in s tem verjetno tudi bolj anksiozni. Lahko zaključimo, da slabše kot so udeleženci izvajali gibalno vajo, bolj jim je bil pogoj zanimiv in bolj so si želeli, da bi nadaljevali z igranjem računalniške igre v pogoju, kjer so bile prisotne kognitivne naloge in manjša fizična obremenitev.

3.2 Primerjava tipov kognitivnih nalog, predvajanih v pogoju z nizko fizično obremenitvijo

3.2.1 Pravilnost odgovorov pri različnih tipih nalog

Udeleženci so statistično pomembno bolje reševali naloge sopomenk v primerjavi z ostalima dvema nalogama, sploh v primerjavi z računi. Pravilnost odgovorov je povezana s težavnostjo naloge, zato sklepamo, da so bile sopomenke najlažja, slike malo težja in računi najtežja naloga.

3.2.2 Fiziološki odzivi pri posameznih tipih nalog (relativno glede na stanje mirovanja)

Srčni utrip se je pri različnih vrstah kognitivnih nalog statistično pomembno razlikoval, F(1,78, 71,38) = 4,10, p = ,024. Najvišji je bil pri računih, nižji je bil pri zrcaljenju slik in najnižji pri sopomenkah. Rezultati za prevodnost in temperaturo kože ne kažejo statistično pomembnih razlik med nalogami.

3.2.3 Subjektivne ocene vseh tipov nalog

Račune so udeleženci zaznali kot statistično pomembno manj zanimive od ostalih dveh nalog, hkrati pa tudi težje. Vendarle pa zanimivost računov ni bila tako nizko ocenjena (povprečje točk je bilo nad 7 od 10 možnih), zato jo lahko obravnavamo kot zanimivo nalogo), prav tako sopomenke in slike. Naloge so bile v povprečju ocenjene visoko (nad 7 točk od 10 možnih) tudi glede vživetosti in želje po nadaljevanju igre.

3.2.4 Povezanost fizioloških parametrov, subjektivnih ocen, natančnosti vožnje in pravilnosti odgovorov pri različnih tipih kognitivnih nalog

Preverjali smo, ali obstaja povezava med fiziološkimi odzivi in na drugi strani zanimivostjo nalog, vživetostjo vanje, željo po nadaljevanju igre z določeno nalogo ter zaznano težavnostjo nalog. V večini nismo našli pomembnih povezav. Omeniti pa moramo dve korelaciji - med srčnim utripom in vživetostjo v reševanje nalog zrcaljenja slik, r = .35, p = .024, in srčnim utripom ter željo po nadaljevanju reševanja že omenjenih nalog, r = ,35, p = ,025. Z drugimi besedami, bolj kot so bili udeleženci motivirani in prisotni v igri, višji je bil srčni utrip. Tudi v primeru koreliranja fizioloških mer z natančnostjo pri vožnji in številom pravilnih odgovorov glede na nalogo večina korelacij ni bila pomembno visokih, razen korelacija med odklonom in srčnim utripom v primeru sopomenk, r = -54, p < 001, in računov, r = -54,40, p = .010. Korelaciji pomenita, da je udeležencem ob slabši vožnji bolj narastel srčni utrip. Najti je moč tudi srednje visoke korelacije med odklonom in vživetostjo v naloge sopomenk, r =,46, p = ,002, računov, r = ,45, p = ,002, in slik, r = ,34, p = ,047.

4. RAZPRAVA

V večini primerov pomembnih korelacij med različnimi merami fizioloških odzivov in motivacijo ter prisotnostjo ni. Izjema je prevodnost kože (SCL), ki je v dveh pogojih v manjši meri pozitivno korelirala z motiviranostjo udeleženca pri igranju igre. Kar nekaj raziskovalcev je našlo povezavo npr. med doživljanjem zabave in povišanjem prevodnosti kože (pregled v [4]), kar se sklada z našimi ugotovitvami, vendar pa jih je nekaj poročalo tudi o znižanju prevodnosti kože.

Več skladnosti z literaturo najdemo v analizi srčnega utripa. Ta je v dveh pogojih in dveh nalogah srednje visoko koreliral z natančnostjo vožnje (ob večjih odklonih vožnje od sredine poti je narastel). Udeleženci so bili ob slabši vožnji bolj vzburjeni. Z zvišanjem srčnega utripa se povezuje dvig vzburjenosti organizma [4]. Srčni utrip je srednje visoko koreliral tudi z vživetostjo in željo po nadaljnjem reševanju nalog zrcaljenja slik. Višji srčni utrip torej, kot kaže, ni povezan samo z anksioznostjo, ampak tudi z motivacijo in prisotnostjo v nalogi. Prav tako je višji utrip odražal višji kognitivni in fizični napor, nižji pa manj zahtevne pogoje. Udeleženci so imeli ob najtežji nalogi (računih) najvišji srčni utrip in ob najlažji (sopomenkah) najnižjega.

Bolj kot natančnosti vožnje so udeleženci morda pozornost posvečali nalogam, saj so subjektivne ocene nalog srednje visoko korelirale z vživetostjo pri kognitivnih nalogah. Slabše kot so udeleženci kontrolirali robotsko roko za krmiljenje avtomobila, večji je bil njihov občutek, da so del navidezne resničnosti (igre). Predvidevamo, da so se bolj vživeli v kognitivne naloge in s tem zanemarili vožnjo po sredini ceste. Vživetost v igro je sicer pokazatelj dobro pripravljene virtualne resničnosti in vztrajanja v rehabilitaciji [8], vendar pa ne smemo pozabiti, da je cilj rehabilitacije dvigniti gibalne sposobnosti na višji nivo. V nadaljnjih raziskavah predlagamo dovrševanje računalniške igre, bogatejše dražljaje ter preizkus še drugih kognitivnih nalog. Razmisliti bi bilo tudi treba, kako večkrat zapored zanesljivo in veljavno meriti motiviranost in prisotnost med meritvami. Za merjenje fizioloških odzivov predlagamo uporabo srčnega utripa, ki se je izkazal kot najbolj občutljiv na različne kognitivne naloge in pogoje, korelira pa tudi z motivacijo in prisotnostjo. Predlagamo tudi merjenje EKG-ja na gibalno manj aktivnih delih telesa in daljši časovni interval izvajanja posameznih nalog, da bi se spremembe temperature lahko bolj veljavno odrazile. Pomembno je, da v nadaljnjih raziskavah sodelujejo bolniki, ki potrebujejo rehabilitacijo. Ti bi verjetno bili bolj motivirani za (natančno) opravljanje gibalnih vaj kot pa zdravi.

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Semantic Implication of Traditional Values in Conscience of Modern Teenagers¹

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ABSTRACT

The article presents comparative analysis results pertaining to ingrained functionality demonstrated by Russian, Slovenian, and Slovak teenagers in explanation of the commandment *Love Thy Neighbor As Thyself*. In the present article, the authors do not detect any desemantization elements to the traditional Christian virtue and ask the question *What is going to happen to Europe, Russia, and world tomorrow*? They also hope that next generations aim at friendship and mutual understanding, and are ready to learn of each other, understand, and accept.

PREFACE

Let us define a discourse as the aggregate of actualized connections to reality and consider the process taking place inside its axiological component. As it is known, concepts of reality and values themselves are ephemeral. The things that were sacred for majority yesterday seem to be trivial today. To European civilization, the Christian commandments have remained the most durable for a long time despite the test of time, e.g. "the refugee crisis" that caused confusion within the EC.

The decision by Angela Merkel, a member of CDPG, to invite a million of refugees to the country did it shatter Europeans' confidence in consistency of traditional virtues? Certainly, the German Chancellor was pushed towards that act by necessity to solve economic, social, and political issues faced by the country. However, "invasion" instead of disciplined emigration in German tradition allows assuming that this decision was determined not only by the course of history that declared Germans guilty. Getting to the worldview structure [6], one can see that this decision, most probably, has originated from the worldview religious level (society consciousness), the level that is responsible for emotions and assessment of moral condition and actions of individuals or environment. Thence there is a wish to act in accordance with Christian nurture i.e. to help the destitute in defending the suffered, etc. Undoubtedly, such action the political leader to Europe -- which first passed a way of "God-deprivation" [2] that «does not exclude religious commitment; on the contrary, thanks to her, attitude towards gods for the first time becomes a religious experience» [2] -- seemed not only normal

but the only one possible. Responding to the German leader's call, the Europeans prepared for refugee admission: they provided meals, rendered medical care to diseased, brought warm clothes and food, vacated trains and buses for them... until the unavoidable culture clash happened. Regardless of what this crisis results in, the Europeans have faced a problem of "what's next?" What "old" and "new" inhabitants of the Old World may count upon? Is the commandment *Love thy neighbor*... still valid for contemporary efficient population?

The purpose of our research has been to detect evidence of desemantization of the commandment *Love thy neighbor as thyself* in Slavic languages and the native language speakers' perception.

The semantic-and-style method used for processing the questionnaire data includes statistical and comparative analyses.

The desemantization (Latin prefix *de*- means *removal*; Greek *sħmantikos* means *having significance*) is the process of losing the word meaning.

One of the monotheistic world's traditional values expressed by the phraseological unit *Love thy neighbor as thyself* (Leviticus, 19:18) its semantics is derived as a sum of component meanings.

As it is known, a personality is formed mostly by his/her family; moreover, a young person between ages of 10 and 13 -- when it comes time to have an independent opinion -- becomes a translator of values acknowledged by parents and closer family members and formed in school. The growing person "follows carefully everything that is disapproved or approved. ...actions on demand are approved, but in case the others dislike them, the person is made to correct his actions by observing the others" [5].

Neurophysiologic research results indicate that the human brain completes its development by age of 20-22, and only then, it is possible to speak of e.g. responsibility for the said words [3]. Answers to our questionnaire correlate to opinion by certain part of population of Russia, Slovenia, and Slovakia. These countries are Christian. Slovenia and Slovakia are populated with Catholics mostly, and Russia with Orthodox Christians, although most of the population is still unchurched. However, churched citizens may be considered virtually Christians in orthodox way.

The research was conducted for children and teenagers of 10-13 years old from three cities: Saint Petersburg, Russia; Košice, Slovakia; and Ljubljana, Slovenia. In total, 150 persons joined the study: 87 in Russia, 33 in Slovenia, and 30 in Slovakia.

The following questions were asked: Are you familiar with the commandment *Love thy neighbor as thyself*? How do you understand the word "*love*"? Whom can you call your neighbor? And more? In your opinion, can we call all the people on the planet the neighbors? Why do you think so? Whom would you like to exclude from "neighbors"? What can make a person be your neighbor? What in your consciousness prevents you from accepting a person as your neighbor? Who can help a person to overcome prejudice against *another*?

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FUNCTIONING OF PHRASEOLOGICAL UNIT LOVE THY NEIGHBOR AS THYSELF IN SLOVENIAN AND SLOVAK LANGUAGES

The question Are you familiar with the commandment "Love thy neighbor as thyself"? was answered No by a single Slovenian kid, which amounts to 3% of 33 respondents. All Slovak schoolchildren are familiar with the commandment. The question How do vou understand the word "love"? was answered variably and the most frequent answers by Slovenians are: as the word "dear" and the person I love, 27% each; there were also answers: become his/her friend and the one who I consider mine or respect, 18% each. There were interesting isolated answers that cannot be accounted for this study: the one who supports you, the one whom I think highly of. Slovaks' answers were vaguer, but still more definite: love, answered 27% schoolchildren; verb to love was used by another 40%. The above amounts to 67% of all answers. Answers God. Jesus loves us. love God amount to 17%. One interesting isolated answer is: to help each other.

The Russian verb *любить* / возлюбить (obsolete) / the same as <u>полюбить</u> [7] (to love) as well as corresponding Slovenian *ljubiti* / rad imeti and Slovak milovat' all have the same meanings: 1. Deep affection, strong gut feeling; 2. Deep disposition towards someone/something, self-sacrificing and sincere devotion; 3. Permanent strong addiction, enthusiasm for something; etc. Collins English Dictionary gives similar definitions: **to love**: 1. to have a great attachment to and affection for; 2. to have passionate desire, longing, and feelings for; 3. to like or desire (to do something) very much; etc.

Orthodox and Catholic theologists define love as something high-spirited and self-sacrificing. "The love that Christ brought into our world has another new and more spiritual meaning: it is the love as Jesus understood it, sacrificing one's life for neighbors" [8].

As we can see, understanding of the term by Slovenian and Slovak schoolchildren is very close to that describe in dictionaries. All shades of meaning that respondents mentioned in their answers may be found in First Epistle of Paul the Apostle to the Corinthians, Chapter 13 [9].

To the question *Who can you call your neighbor*? Slovenians named their family members and relatives (64% respondents), *friends* and *those who are close to me* (27% respondents); *everyone* (18%). Slovak schoolchildren rather repeated the same answers: *family* was chosen by large majority (73%); and *classmates* (23%). Some Slovaks mentioned God as their neighbor (13%), that Slovenians failed to do. Since the respondents mentioned several neighbors, total sum is over 100%; *friends* were mentioned in 10% answers.

To the question And more? Slovenians answered: acquaintances and friends, 27%; relatives, 18%; God, 18%; no answer, 31%. Slovak students added to neighbors: family, 27%; classmates, 33%; friends, 20%. 13% pollees consider God their neighbor. Among isolate answers, we can mention: those who I can trust / to whom I have deep friendly feelings / all classmates except for the Gypsies. Although some Slovaks' classmates are Gypsies who are treated negatively, probably due to some adults' disparagement, only Slovaks distinguish the special group of classmates. Slovenians speak of friends only.

The question *Can we call all the people on the* planet the neighbors? was answered Yes by 18% Slovenian respondents, No - by 54%; all kind ones by 3%. No answer was received from 26%. Slovak respondents slightly differ from their Slovenian colleagues. Their answers are: yes, because we belong to the same family, 33%; no, it's hard / no, because some of them are evil people / no, because they have their own families / no, because not all of them are my relatives or friends, 60%. 7% respondents have given no answer. As we can see, the most complicated component of the phraseological unit in question is not desemantized. It has absolutely the same meaning as in religious texts, without any semantic addition. Despite solitary rejection of other ethnic groups, Slovak respondents are more susceptible -- than Slovenians -to the idea of calling all people the neighbors.

The latter question and the following ones were introduced to clarify presence or absence of phraseological unit spiritual value desemantization and called for thinking over the idea contained in the commandment.

The question Why do you think so? was answered by Slovenian schoolchildren as follows: kindness connects us, 18%; for we all are the same, 18%; because some of the people are not good ones, 27%; because I don't know them, 18%; because we cannot trust everybody, 10%. Of isolated answers, one is interesting: all people are valuable. Slovak children answered: for we are all the same, 26%; because some of the people are not good ones, 10%; because I cannot embrace the whole planet / they are not my family / I don't know, 10% each; no answer, 50%.

The question Who would you like to exclude from "neighbors"? was answered by Slovenian schoolchildren in typical ways: thieves and villains, 27%; those who are against me because I don't know them / strangers / those who sins / those who doesn't like me / nobody, 3% each; there were also unexpected answers: relatives and friends, 18% each; no answer, 9%. Here are some single answers: Japanese, they are far away; Chinese. Slovak children have a different approach to the world: nobody, 23%. Single answers include: terrorists; some of the classmates; Gypsies. In their answers, Slovenian kids apparently tend to substitute concept of *neighbor* by *nearby*. Here we can again observe negative attitude to other ethnic groups: "bad ones" are Japanese and Chinese for Slovenians, and Gypsies – for Slovaks. Such answers are solitary.

Slovenians' answers to the question What should happen to make a person your neighbor? include: it is necessary to become friends, 36%; to do good, to trust, 9%; to know him/her better, 36%; we have to confide in each other, 6%. Here are some single answers: wonder; he should feel affection to me. Slovak students are sure that: he has to be tender/happy, 7%; he has to protect me / help me / play with me / take care of me / be close to me / to love me and to be a Christian, 13%. Kind, 43%; wellmannered, 10%; sweet, 17%; having a nice heart, 7%. Here are some single answers: merciful; with God in his heart. Note the "ought to" focus shift from the subject to the object: someone else ought to, not me.

Slovenians' answers to the question What in your consciousness prevents you from accepting a person as your neighbor? include: nothing, 27%; hostility, 18%; deception, 9%. There are some interesting isolated answers: temper; his malignity; that we cannot understand his malice; we see the world differently; ill acts; he is misbehaving; no answer, 18%. Slovak kids answered somewhat differently: I don't know, 10%; they are bad and proud, 17%. There are a lot of solitary answers, among those: he is a friend of someone I don't like / his behavior / he is *Gypsy / if he hates each another / he cheats / he has no* good heart / they are lazy / he's bad: he doesn't love me / he is unjust, greedy, criticizes other people. These are sincere answers by little persons who are sure that relationship concord is spoiled by external reasons only. Surely, this is result of children's perception of the world where the child is the center of his/her family, society, and the Earth. But how soon this naïve egocentrism will disappear from minds of adult people, parents, politicians?

The question Who can help a person to overcome prejudice against another? Slovenian respondents answered: relatives, 27%; God / friends, family, truth / has to know Him, 18% each. Among solitary answers: all together. Slovak respondents answered: angels, 17%; Mary, 10%; God, 60%; Jesus, 37%; senior priest, 7%; family, 10%; neighbor, 10%. Interesting isolated answers: has to know Him; truth.

Answers by Slovenian and Slovak students demonstrate no desemantization of the entire phraseological unit or its components. When discussing the commandment's essence, there is substitution of action subject for object. The Scripture says that your neighbor is not only the one who cares about you (Luke 10; 25-37), but also the one whom you should care about. The students' answers show that the former is more important than the latter. Schoolchildren are sure that to make humankind to feel like a monolithic society it is necessary for people to get closer, be friends, know each other better, do good to each other; but the other should also protect, help, play (that means "to be a friend"), care, be close, and love. Many pollees are not prevented from acceptance another for his/her neighbor at all, but it has to be a Christian. Some isolate answers indicate seedlings of nationalism.

FUNCTIONING OF PHRASEOLOGICAL UNIT "LOVE THY NEIGHBOR AS THYSELF" IN RUSSIAN LANGUAGE

Without a doubt, the "God-deprivation" process goes on with variable success. Science and modern technologies on the move greatly facilitate it. For example, our study has demonstrated that in Russian mega-metropolis, despite the introduction of mandatory school course "Basic principles of religious culture and secular ethics", over than half of the respondents are not familiar with the commandment in question, whereas in the provincial Slovak town all students know the commandment. In more educated Slovenia [11], where we questioned students from the capital city and provincials both, there was received only one negative answer to the question *Are you familiar with the commandment?*; but answers by other respondents (3 students of 6th grade) make clear that *Yes* answer does not always reflect the real situation. In some cases, the pollees know the commandment itself, but they never bothered about it.

Of Russian high-school students, 87 persons participated in the study: 59 fourth-graders and 28 fifth-graders. 57.5% Russian schoolchildren are not familiar with the commandment "Love thy neighbor as thyself", and 42.5% are familiar, accordingly.

For this reason we have divided the pollees' answers into YES-group (those who are familiar with the commandment) and NO-group (those who are not) to make assessment if the results demonstrated by secular-educated children differ from those by children brought up as a Christian.

First question, How do you understand the word "love"? In YES-group, the verb "love" was the most widely used and variably presented in 43% answers; respect; 17%; to accept the person, his/her point of view, etc., 14%; to be friends, 34%; family relations, treat as yourself, good fellowship, equal attitude to all people, 18% total. Single answers: commence listening.

In NO-group, the answers were as follows: answers including the name "love" amount to 52%; to catch fancy, friendship, 6% each. Single answers include: understand, get to know. Table 1: Answers to question How do you understand the word "love"? by YES-group and NO-group

Answers to the question Whom can you call your neighbor? by YES-group: family/ relatives, 63%. Friends, 37%; people of Russia / all of the people around / all people / all people are alike, 6%. Answers given by NO-group: relatives, 71%; friends, 17%; those who are spiritually close to me, 7%.

Answering first and second questions both, NO-group disregarded friendship. As opposed to those who are familiar with the commandment and indicate friends and friendship (37%), the pollees who answered *No* to the first question indicate friends only in 17% answers. In other cases results of two groups show little difference.

The question And more? was answered as follows: friends was again the most popular answer in YES-group with 37%, and in NO-group it amounts to 25%. The answers make clear that the students intuitively correctly divide neighbors into outer circle and inner circle. Relatives and acquaintances received 14% each. 5% answers mention animals and 8% pollees give no answer to this question. In NO-group leading answers are: relatives, 31%; nobody, 25%; classmates, 20%; everybody, 13%. Some of isolated answers include: teachers, coaches; those who are attached to me; God; those who are not against us; those who understands us.

Pay attention here to 13% answers containing word *everybody* in anticipation for the next question.

Answering to the question *Can we call all the people on the planet the neighbors?*: agreed to include *all the people,* 20%; *no,* 70%; *yes, but not all of them,* 3%; *yes and no,* 7%. The answer "yes and no" was accompanied with the following comments.

In YES-group, practically all the answers complement one another: *all of us are alike*, 51%; *we all trace origin from the same entity*, 27%; *all of us are people*, 10%; *we all live on the same planet*, 8%.

Isolated answers are also aligned: we have to help one another; we are a chain of acquaintances and everybody knows everybody; we can change the bad people; because we all live on the same planet. In NOgroup, the answers comprise: we are not acquainted, 45%; some people are ruthless/wicked, 14%; these answers pretty stay within traditional child-rearing practices. Interesting is the solitary answer: mercenaries, killers, collectors that witnesses that the kid is involved in modern society information realm and these widely discussed topics could not help but sticking in the kid's mind. All of us are different, 5%; scum of society / I don't like them, 4% each.

Neighbor category should exclude: *nobody*, 23%; the categories excluded most frequently are *scum* of society, 20%; *strangers*, 10%; *enemies*, 10%. 5% answers contain ambiguous information: *everybody except for... traitors / those who don't understand me / who treats be badly / everybody whom I don't love*, 7% each..

Most of the pollees understand that to make a person your neighbor it needs: to make friends with him/her (26%); to get to know another and to win confidence, 10% each; consensus / to get through hard times together / intercommunication, 8% each; confidence and to prove that I'm worthy of friendship, 7% each. However, there are some answers that shift the responsibility for getting closer entirely to other shoulders: to change the other's temper/behavior, 5%; he has to do something for me, 5%; he has to be liked by me / he has to become my own one / the person has to change, 7% each. Of singular answers worth mentioning: good deeds; equality; to make friends with me. Note that Russian schoolchildren's have given more answers where responsibility for actions is undertaken by respondent than Slovenians and Slovaks, yet it is obvious that here again subject to object relationship leave much to be desired.

Acceptance of another person is also hindered by: *uncertainty on positive attitude*, 19%; *nothing*, 7%; the same percentage *he's bad*, 7%; *stranger / mistrust / wariness*, 7% each; *lack of friendship*, 5%. Answers to this question reflect doubts and reflections over this issue or it may be brought up by discussion during a social science lesson. Children again, like Slovenians and Slovaks, lodge claims to another person: *he's bad / I don't know him / I don't trust him*, etc., but there are also signs of thinking: thus, *uncertainty of positive attitude* was mentioned by 19% respondents. Note that singular answer: *wider public*. It is hard to remain Christian-way tolerant in the atmosphere of total mistrust.

The question Who/what can help a person to overcome prejudice against another? shifted kids' minds to constructive stand. 29% answers indicate friendship, but responsibility is pinned entirely to the person-actor, 22%. 16% still bank on neighbor. 5% answers each describe fairly grown-up thinking: confidence, understanding, and psychology. Yet 3% answers reflect fatality in Russian way: nobody.

CONCLUSION

The conducted research allows for the following results:

- Neither of the polled groups has demonstrated desemantization of main idea of biblical commandment "Love thy neighbor as thyself";
- Slovenian, Slovak, and Russian schoolchildren understand words "love" and "neighbor" in full compliance with basic ideas of Catholic and Orthodox churches and secular society brought up within European civilization;
- Secular education with addition of course in "Basic principles of religious culture and secular ethics" allows thinking over essential questions of life without emasculating moral bearings.

We can be sure that next generations aim at friendship, mutual understanding, are ready to learn of each other, understand, and accept. Let us give them that chance!

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Problematičnost integracije nevroznanosti v pravne kontekste

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POVZETEK

V prispevku bom najprej predstavil porast vključevanja nevroznanosti v pravo (npr. uporabe nevroznanstvenih dokazov na sodišči) in na nekaterih primerih prikazal zaupanje, ki ga vzbujajo nevroznanstveni dokazi, razlage in opisi. Zagovarjal bom stališče, da moramo biti pri združevanju objektivistične in redukcionistično usmerjene nevroznanosti ter prava, ki temelji na vrednotah in odločitvah odločevalcev in javnosti, previdni. Namreč, nevroznanost v svojem raziskovanju pojavov, ki so relevantni za pravo (npr. osebnosti, volicije, samo-kontrole, odločanja, ipd.), in s svojim redukcionistično-mehanicističnim pogledom na človeško naravo spreminja naše intuicije in prepričanja o pojavih, ki jih raziskuje ter s tem vpliva prav na same naštete in sorodne pojave. To drži še posebej v kontekstu naraščajočega trenda integracije nevroznanosti v javno domeno. kot je pravo, ki nadalje spreminja naše intuicije in prepričanja o preučevanih pojavih in tako potencialno spreminja mišljenje ter delovanje ljudi. Pogled nevroznanosti na človeško naravo in integracija le tega v pravne kontekste tako vodita do krožnosti nevroprava, kjer nevroznanost in nevropravo pravzaprav vplivata na same (prihodnje) izsledke nevroznanosti. To pa pomeni, da nevroznanosti ne moremo jemati kot objektivne znanosti o človeški duševnosti in vedenju, na podlagi katere bo pravo končno lahko sklepalo pravilne in nepristrane odločitve.

Ključne besede

Moralna odgovornost, nevropravo, prepričanja, samo-kontrola, svobodovoljna dejavnost.

1. TREND INTEGRACIJE NEVROZNANOSTI V PRAVNE KONTEKSTE: OD NEVROZNANSTVENIH DOKAZOV DO ZAUPANJA V NEVROZNANOST

Uporaba dokazov in izsledkov nevroznanosti v kontekstu prava z namenom boljših in bolj "objektivnih" pravnih odločitev – npr. odločitev o zmanjšanju ali vrsti kazni obsojenih ali odločitev o bolj splošnih zadevah, ki se tičejo kazenske odgovornosti¹ – je v zadnjem desetletju in pol v močnem porastu. Na to kažejo mnoge sodobne analize uporabe nevrobioloških dokazov na sodiščih.

Analiza Farahanyjeve (2016) razkriva močan porast uporabe nevrobioloških dokazov na ameriških sodiščih med letoma 2005 in 2012. Farahanyjeva na primer ugotavlja, da je leta 2012 (250), v primerjavi z letom 2007, več kot dvakrat več pravnih mnenj navajalo nevrobiološke dokaze kot strategijo zagovora kriminalnih dejanj z namenom pokazati, da so možgani tisti, ki so obtoženega (vsaj delno) "prisilili" v dejanje X (Farahany, 2016) in tako le ta ni oz. je manj odgovoren za svoje kriminalno dejanje (glej npr. Church, 2012; Catley, 2016 za specifične primere).

Ne le, da odvetniki obtoženih kriminalnih dejanj uporabljajo nevroznanstvene dokaze v obliki slik raznih jasnih možganskih poškodb, ki jih poskušajo (tudi na podlagi pričevanj nevroznanstvenikov) uporabiti na primer za zmanjšanje trajanja kazni, ampak vedno bolj uporabljajo tudi funkcionalne dokaze (npr. pridobljene s FMR ali EEG tehnikami slikanja možganov). Le ti naj bi na primer kazali, da obsojeni z dozdevno "abnormalno" delujočimi možgani pač naj ne bili ali pa naj bi bili vsaj manj odgovorni za svoja dejanja.

Nadalje, nevroznanstveni dokazi niso uporabljeni le kot strategija zagovora obsojenih na najhujše zločine (kot je npr. umor ali posilstvo), ampak se vedno boj uporabljajo kot orodje za zagovor zločincev obsojenih ropov, prevar in preprodaje mamil. Farahanyjeva (2016) v svoji analizi ugotavlja, da je slednjih primerov približno 60 %. Čeprav je njena analiza omejena na ZDA, porast uporabe nevroznanstvenih dokazov na sodiščih ni omejena le nanje ali na države z anglosaksonskim oz. običajnim pravom (angl.: *Common law*), ki temelji na precedenčnih primerih in ki, vsaj v ZDA, v pravne odločitve bistveno vključuje porote, ampak je takšno porast zaslediti v mnogih evropskih in ne-evropskih državah (glej npr. Catley, 2016).

Porast vključevanja nevroznanosti v pravo pa je vidna tudi izven neposredne uporabe nevroznanstvenih dokazov in izsledkov na sodiščih. Vedno več pravnih odločevalcev (tako znanstvenikov kot pravnih ekspertov) se vključuje v diskusije in raziskovanje nevroloških osnov sodnih odločitev in pristranosti, ki jih spremljajo (na primer v diskusije o in raziskovanje mehanizmov presojanja in odločanja porot, sodnikov, prič, odločitev o pogojnih izpustih, ipd.). Prav tako so v porastu raziskave in diskusije o možnostih uporabe FMR ali EEG tehnik za detekcijo laži (v Indiji so bile slednje na primer že uporabljene; glej Church, 2012), o možnostih ustvarjanja direktnih možganskih intervencijskih terapij za zločince, ipd. Na skrajnem spektru

¹ Nevroznanstveni dokazi in izsledki so bili na primer že uporabljeni kot osnova za pravne odločitve, ki se nanašajo na bolj splošne zadeve, povezane z moralno odgovornostjo. V primeru Graham *versus* Florida leta 2012 je vrhovno sodišče ZDA tudi na podlagi nevroznanstvenih dokazov presodilo, da bo kategorično prepovedalo obsodbo mladoletnih oseb na dosmrtno kazen brez

možnosti pogojnega izpusta v primerih, ko ne gre za umor (iz Morse, 2015).

uporabe nevroznanosti v pravu je zaslediti trend diskusij in raziskav o t. i. nevro-osnovani predikciji (angl.: *neuro-based prediction*), katere namen je na podlagi podatkov o možganih storilcev kaznivih dejanj vnaprej predvideti potencialno možnost kriminalnih dejanj (za nedavno raziskavo glej Aharoni et al., 2013), tudi npr. v kontekstu odločitev o vrsti kazni, pogojnem izpustu, varščini, ipd. (Jones et al., 2013a). V tem kontekstu si ni težko zamisliti nekakšne distopične prihodnosti, kjer bi bila nevroznanost uporabljena kot orodje za kaznovanje "zločina misli", kot to lepo opiše Orwell v svojem distopičnem romanu *1984*.

Ne nazadnje se zdi, da nevroznanstveni dokazi in razlage v prejemnikih vzbujajo nekakšno posebno zaupanje, ki je po mojem mnenju delno odgovorno za hiter porast vključevanja nevroznanosti v pravne kontekste. Takšno posebno zaupanje je lepo vidno v nekaterih sodnih obravnavah in odločitvah porotnikov. Leta 2005 je bil Grady Nelson obtožen brutalnega umora svoje žene. Njegov odvetnik je zagovarjal zmanjšanje kazni na podlagi QEEG podatkov, ki naj bi kazali na relevantne abnormalnosti v delovanju njegovih možganov, ki naj bi bile – ne pa on sam² – odgovorne za njegovo kriminalno dejanje (primer je vzet iz Jones et al., 2013b). Pomenljivo sta v sodnem procesu dva od šestih porotnikov (vse skupaj jih je bilo v sodnem postopku udeleženih dvanajst), ki so glasovali proti smrtni kazni, naknadno poročala, da sta spremenila svoje prvotno mnenje zaradi QEEG dokazov (sprva sta bila za smrtno kazen; iz Jones et al., 2013b).³

Vedno boljše in natančnejše razumevanje delovanja možganov, hiter razvoj ne-invazivnih tehnik slikanja možganov in vedno večje zaupanje v objektivistično nevroznanost in njen redukcionistično-mehanicistični pogled na človeško duševnost skratka kaže, da bo nevroznanost v bližnji prihodnosti najverjetneje postala bistven sestavni del prava in njegovih praks, njene razlage duševnosti in vedenja pa čedalje bolj sprejete kot tiste prave, objektivne, najboljše, itd. – znotraj in izven prava.

2. POGLED NEVROZNANOSTI NA ČLOVEŠKO NARAVO IN KROŽNOSTI NEVROPRAVA

Vse do sedaj povedano pa nakazuje, da nevroznanost ni le na poti k temu, da postane neločljivo povezana s pravom, ampak počasi spreminja – in bo najverjetneje v prihodnje še močneje – naše intuicije, poglede in prepričanja na to, kaj pomeni biti oseba, kaj je in kako poteka odločanje, naš pogled na svobodovoljno dejavnost in odgovornost – koncepti, ki so za pravo bistvenega pomena. Kot to lepo izrazi Farah (2012): "Nevroznanost ponuja

alternativno perspektivo, iz katere lahko človeško vedenje razumemo tudi kot posledico fizičnih vzrokov. ... [U]porabe nevroznanosti ... bodo ponudile veliko opomnikov, da je naša duševnost v svojem izvoru in bistvu fizični mehanizem. S tem, ko nevroznanost ljudi postavlja v in kot del mehaničnega univerzuma, prevprašuje mnoge predpostavke o moralnosti in pojmu osebe. ... Sicer ne trdimo, 'Ni imel izbire, saj so ga prisilili zakoni fizike'. A vendar bo deterministični pogled, glede na to, da nevroznanost osebnosti, odločanja in nadzora impulzov začenja ponujati bolj podrobne razlage fizičnih procesov, ki vodijo do neodgovornega ali kriminalnega vedenja, vseeno najverjetneje močneje prevzel naše intuicije" (str. 585–586).

In čeprav je nevroznanstvena skupnost *relativno* skeptična do *trenutne* uporabe nevroznanosti na sodiščih in do *trenutnega* dosega nevroznanosti (vendar ne prihodnjega; glej npr. Jones et al., 2014), v splošnem sprejema prepričanje, da bo nevroznanost v bližnji prihodnosti pojasnila "dejansko" delovanje človeške duševnosti na bolj ali manj mehanicističen in redukcionističen način ter da bo priskrbela najboljšo (če že ne popolno) razlago človeškega vedenja (glej na primer Gazzaniga, 2008; Greene in Cohen, 2004; Jones et al., 2013a; 2013b; 2014, za takšen implicitno ali eksplicitno izražen pogled; vendar glej Bennett in Hacker 2003; Morse 2006; 2015; Strle 2013 za kritiko).

Ker pa je bilo že veliko zapisanega na temo kritike objektivističnih in/ali redukcionističnih razlag in metodoloških usmeritev nevroznanosti, se bom v preostanku prispevka zadržal pri stvari, ki je izpuščena iz večine diskusij nevroprava in širše.

Trdil bom, da vedno bolj popularen in sprejet objektivističen in redukcionističen pogled nevroznanosti na človeka (in na pojave, kot so oseba, odločanje, samo-kontrola, odgovornost, ipd.), ki ima, če sploh, zelo malo vpliva na lastno mišljenje in vedenje, pravzaprav spreminja naša dejanja (na slednje nakazujejo tudi raziskave, ki jih bom predstavil v nadaljevanju), prepričanja in intuicije o naštetih pojavih in tako vpliva na same pojave, ki naj bi jih nevroznanost raziskovala objektivno, ločeno od naših prepričanj, teorij in intuicij o teh pojavih: nenavadna krožnost nevroznanosti, ki je izpuščena iz večine diskusij o vključevanju le te v pravne kontekste.

Slednje drži posebej, če vzamemo v zakup porast vedno bolj sistematične integracije nevroznanosti in njenih predstav o duševnosti v javno domeno kot je pravo, ki še nadalje utrjuje in krepi nevroznanstven pogled na človeško naravo ter s tem nadalje spreminja same pojave, ki jih nevroznanost raziskuje dozdevno objektivno, ločeno od naših prepričanj, teorij in intuicij o teh pojavih.

Naj sedaj na kratko predstavim nekaj študij, ki kažejo, kako spreminjanje človeških prepričanj o zadevah, povezanih s človeško dejavnostjo (angl.: *agency*), kot je na primer samo-kontrola, v smer deterministične, mehanicistične in/ali redukcionistične koncepcije le teh, vpliva na samo mišljenje, delovanje in možganske procese, povezane s temi pojavi.

Seminalna raziskava Vohsa in Schoolerja (2008) na primer razkriva, da zmanjšanje prepričanj v svobodo volje zmanjšuje moralnost dejanj: vodi v povečanje dejanskega goljufanja udeležencev. Podobne študije nadalje kažejo, da je zmanjšanje prepričanj v svodobo volje povezano z zmanjšanjem pripravljenosti pomagati sočloveku in s povečano agresivnostjo (Baumeister, Masicampo in DeWall 2009); s povečano nagnjenostjo k impulzivnosti in asocialnosti (Rigoni et al., 2012), kar avtorji interpretirajo kot zmanjšanje samo-kontrole; Rigoni et

² Seveda je v kontekstu nevroprava pomembno, a povsem nereflektirano vprašanje, kdo sploh naj bi bil Grady Nelson, oz., kdo sploh je ta »jaz« oz. dejavnik (angl.: *agent*), ki naj bi bila entiteta, odgovorna za (svoja?) dejanja. S tem pa področje nevroprava – predvsem tisti del, ki ni kritičen do nevroznanosti – bolj ali manj sprejema predpostavko, da so možgani pravzaprav tisti bistven (če že ne edini) dejavnik, ki »upravlja« dejanja človeka in nad katerimi le ta pravzaprav nima prav veliko zavestnega nadzora in tako ni, vsaj ne v veliki meri, odgovoren za (lastna?) dejanja.

³ Številne študije prav tako kažejo, da nevroznanstveni dokazi in opisi dejanj na primer zmanjšujejo pripisovanje svobode volje in moralne odgovornosti (glej npr. Gurley in Marcus, 2008; Nahmias, Coates in Kvaran, 2007).

al. (2011) pa so celo pokazali, da zmanjšanje prepričanj v svobodo volje vpliva na možganske procese (zmanjšuje potencial pripravljenosti), ki so povezani s pripravo voljnih motoričnih dejanj. Implikacije takšnih in podobnih študij lepo izrazijo Rigoni et al. (2011): "Če povzamemo, ... to nakazuje, da ima morda abstraktni sistem prepričanj veliko bolj fundamentalen učinek kot bi pričakovala večina ljudi" (str. 617).

Podobno kažejo raziskave t. i. učinka izčrpanosti ega (angl.:: egodepletion effect), ki so močno relevantne za nevropravo, saj poskušajo razumeti mehanizme samo-kontrole. Učinek izčrpanosti ega naj bi kazal, da je moč volje (angl.: willpower) oziroma zmožnost samo-kontrole omejena (glej na primer Baumeister, 2002) na primer na način, da uporaba samo-kontrole za opravljanje mentalnih nalog vodi v slabše reševanje nadaljnjih mentalnih nalog oz. zmanjšuje nadaljnjo zmožnost samo-kontrole. Po drugi strani novejše raziskave jasno kažejo, da sta učinek izčrpanosti ega in tako samo-kontrola močno odvisni od implicitnih in eksplicitnih prepričanj ljudi o njiju. Savani in Job (2017) sta na primer pokazala, da je učinek izčrpanosti ega močno odvisen od kulturnih prepričanj ljudi o uporabi in naravi samokontrole. V svoji raziskavi sta pokazala, da Indijci - ki so v nasprotju z Američani v splošnem prepričani, da naprezanje volje vodi v povečanje (mentalne) energije (to je bil prvi rezultat njune študije) - izkazujejo ravno nasproten učinek od učinka izčrpanosti ega. Namreč, uporaba samo-kontrole Indijcev je, v nasprotju z Američani, izboljšala njihovo nadaljnje reševanje nalog, ki so prav tako zahtevale mentalni napor (takšen učinek so izkazali tudi Američani, ki so imeli podobna prepričanja o naravi samokontrole kot Indijci).

Omenjene raziskave skratka kažejo, da pojavi, kot so samokontrola, volicija, odločanje, svobodovoljna dejavnost, itd., ki so bistveni sestavni del prava, nikakor niso zgolj biološke narave (oz. jih ni možno razložiti zgolj z biološkimi in/ali nevrološkimi mehanizmi), ampak so pojavi, ki so neločljivo povezani in odvisni od naših konceptualizacij, opisov in prepričanj o njih. So nadalje pojavi, ki so neločljivo povezani s socialnostjo, v katero smo umeščeni in jo so-konstituiramo. To pa pomeni, da posameznikova prepričanja in koncepcije o teh pojavih pravzaprav so-konstituirajo same pojave, ki naj bi jih nevroznanost preučevala objektivno, ločeno od kulturnih in individualnih prepričanj, intuicij in teorij o njih. Posledično nevroznanost s svojimi objektivističnimi in redukcionističnimi metodološkimi usmeritvami in ustrezajočim pogledom na človeško naravo - ki ga, predvsem preko porasta integracije nevroznanosti v javno domeno, kot je pravo, vedno bolj sprejema tudi javnost – pravzaprav spreminja pojave, ki jih preučuje in tako potencialno vpliva na lastne (prihodnje) empirične izsledke.

Če misel izrazimo v jeziku Hackinga (1995), omenjeni pojavi, ki jih preučuje nevroznanost, izsledke o njih pa vedno bolj zvesto uporablja pravo, niso *naravne vrste* (kar bi si želela in kar predpostavlja nevroznanost), ampak *človeške vrste*, ki so bistveno odvisne od klasifikacij, opisov in človeških dejanj, ki se jih tičejo, ter socialnosti, v katero so umeščene, in ki kot take "lahko vplivajo same nase" (po Brinkmann, 2005). Kot je to provokativno izrazil Alasdair MacIntyre (1985; iz Brinkmann 2005): "Vodi je vseeno, kako jo imenujemo, a za človeške vrste je to [bistvena] razlika. Konec koncev, ... molekule ne berejo učbenikov kemije, med tem ko ljudje berejo knjige o psihologiji, ki vplivajo na njihovo samo-razumevanje" (Brinkmann 2005, str. 775) in treba je dodati, da tako tudi na njihove razmisleke in moralna dejanja. V tem smislu ne moremo trditi, da so objektivistične in redukcionistične razlage človeške narave, ki jih podaja nevroznanost, ustrezne ali zadostne, tako v kontekstu prava in izven.

3. ZAKLJUČEK

Če povzamem. Tem bolj nevroznanost sprejema in spodbuja mehanicistično-redukcionističen pogled na človeško naravo in bolj in bolj je le ta sprejet s strani javnost in pravnih odločevalcev – in tako nevroznanost postaja vedno bolj sistematično integrirana v pravne prakse in sisteme —, čedalje bolj mišljenje, možganski procesi in dejanja ljudi odražajo takšno koncepcijo človeške narave. S tem pa, ko bo (bi) opisani proces krožno napredoval in se razvijal, se bo (bi) vedno bolj zdelo, da ima nevroznanost prav v trditvi, da imamo v "resnici" zelo malo (če sploh) vpliva na lastno mišljenje in dejanja (manj, kot bi ga lahko imeli, če bi imeli drugačna prepričanja o človeški naravi) in da smo tako veliko manj (manj kot v "resnici", če bi imeli drugačna prepričanja o človeški naravi) ali pa sploh ne(?) odgovorni za lastna kriminalna ali običajna dejanja.

Če se strinjamo z opisanimi krožnostmi nevroznanosti in nevroprava, nevroznanosti ne moremo (več) jemati kot tiste prave objektivne znanosti o človeški duševnosti in vedenju, ki bo pravu končno prinesla tako dolgo iskani nespremenljivi "temeljni kamen modrosti", na podlagi katerega bo končno lahko sklepala pravilne in nepristrane odločitve. Pri združevanju objektivistične in redukcionistično usmerjene nevroznanosti ter prava, ki temelji na vrednotah in odločitvah pravnih odločevalcev in javnosti, moramo biti tako bolj previdni, kot trenutno nakazuje prikazani trend integracije nevroznanosti v pravne kontekste.

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Zavest in samozavedanje: iluzija ali realnost

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POVZETEK

Razpravljam o pojmovanju zavesti in samozavedanja (jaza) v zahodni filozofiji in v kognitivni znanosti. Ugotavljam spor med realizmom in antirealizmom glede zavesti in jaza, ki se je okrepil v kognitivni filozofiji in razvijam tezo o realnosti zavesti in jaza: človeška zavest in jaz realna le tedaj, če ljudje participirajo na »objektivnem duhu« skupnih situacij, kjer se razvijajo ustrezna skupna pričakovanja.

Ključne besede

zavest, samozavedanje, zavest kot realnost, zavest kot iluzija, skupna pričakovanja

Razprave o zavesti v psihologiji, filozofiji in kognitivni znanosti se skoraj vedno zapletejo v težko razrešljiv vozel nasprotujočih, celo paradoksnih trditev in domnev o tem, ali in kako je možno samozavedanje, ali to implicira obstoj samozavednega sebstva, ki obstaja kot posebno duševno ali mentalno bitje itd. Zavedanje samega sebe je nujna sestavina samospoznanja, to pa je že od antičnih časov temelj vse modrosti, saj nam že Delfsko svetišče narekuje "Spoznaj samega sebe". V evropski filozofiji je bilo to včasih povezano z vprašanjem obstoja (nesmrtne) duhovne duše, ki transcendira človeško snovno (telesno) bivanje. Vendar tudi potem, ko so zaradi kritike religije v razsvetljenjstvu takšne domneve vsaj v znanostih in v velikem delu filozofije postale nerelevantne, ostaja vprašanje, ali in kako obstaja kako samoovedeno sebstvo še vedno odprto. V neevropski filozofiji, predvsem v indijski filozofiji je to vprašanje zlasti pereče v budizmu in hinduizmu, posebno v sankhiji, jogi in vedanti. Zanimivo, da tovrstno spraševanje nikoli ni bilo kaj dosti pereče v kitajski filozofiji, še celo v kitajskem budizmu, npr. chanu ne. Zdi se, kot da Kitajci lahko "shajajo" tudi brez domnev o samoovedeni zavesti ali sebstvu, saj ne poznajo niti prave ustreznice za "sebstvo" (self) ali "jaz", še najbližje temu bi bili izrazi "ziran"(samo po sebi), "hsin" (srce, um) ali tudi "zihsing" (lastna narava), vendar običajno nastopajo v povsem drugačnih miselnih povezavah kot v zahodni ali indijski tradiciji.

V zahodni filozofiji je vsaj od Aristotela dalje znana teza o božanskem umu (duhu), ki po svoji naravi "misli samega sebe" (in zgolj sebe), medtem ko je bilo v Antiki človekovo samozavedanje bolj vprašljivo. Platon je v dialogu Harmides celo podvomil o tem, da lahko z miselno dojamemo samega sebe, vsaj če to dojamemo kot vedenje o svojem vedenju [1]. Avguštin je kot krščanski mislec, ki je visoko cenil samospraševanje posameznika, razvijal tezo o človeškem umu kot najvišji plati človeške duše, ki je sposoben samospoznanja na podlagi tega, da se zaveda samega sebe. Ta um je nematerialen in lahko biva sam zase, brez telesa. Auguštin je tudi predhodnik Descartesovega *cogita* "Mislim, torej

sem", torej da moje mišljenje implicira priznanje mojega obstoja [2]. Descartes in nato Locke sta temeljna avtorja glede miselnega samospoznanja v novoveški tradiciji. Za Descartesa je bilo preprosto evidentno nujno, da se zavedamo lastnega obstoja, če le kaj mislimo, tudi Locke je menil, da imamo nezmotljivo evidenco o lastnem obstoju, čim se česarkoli zavedamo ali o čem razmišljamo. To je povezano z njegovo tezo o tem, da preprosto neposredno zaznavamo lasten obstoj, tako kot neposredno zaznavamo čutne kvalitete zunanjih stvari ali lastna duševna stanja. Po tem pojmovanju je vsak jaz, ki se "kaže" človeku v njegovem samospoznanju, trden in samoidentičen čisto miselni subjekt in notranji opaovalec njegovih fizičnih in duševnih stanj. Strog kritik cogita, teze o nedvomnem zaznavanju lastnega sebe in o jazu kot subjektu doživljanja in mišljenja je David Hume. Za Huma sebstvo ni nič drugega kot sveženj medsebojno zvezanih različnih doživljajev oz. vtisov (zaznav in spominov na minule zaznave), vendar brez kakega "lastnika" te zbirke, tj. brez kakega trdnega in samoidentičnega jaza [3]. Zanimivo je, da je tudi Kant sprejel ta ergument, kajti tudi za Kanta nimamo nobene evidentne in nezmotljive zvesti o samem sebi in o svojem jazu. Svoje ideje o čistem jazu kot nujnem pogoju vsakega spoznanja je Kant dobil na podlagi zahtevnega sklepanja, ti. transcendentalne dedukcije o nujnih pogojih možnosti izkustva. Po tej "dedukciji" misel "jaz mislim" nujno spremlja vsako misel, pravzaprav vsako doživljanje posamične empirične zavesti, vendar ta kantovski kogito ni nobena miselna substanca, kot je bil za Descartesa, temveč zgolj "formalni" spremljevalec vseh vtisov in duševnih dogodkov, ki omogoča sintezo raznovrstnih predstav v enotnost empiričnega spoznanja (izkustva) [4].

Očitno gre za vprašanje odnosa med človekovo zmožnostjo za samozavedanje in posedovanjem predstave o samem sebi kot psihofizičnem akterju v snovnem in kulturnem svetu. Kasnejša filozofija, tako bolj idealistično spekulativna "nemška klasična filozofija" kot bolj empiristično naranana, fenomenološko ali eksistencialno ali analitično naravnana filozofija se je vsaka na svoj način lotevala tega problema. Na to so se navezovale nenehne raprave o naravi samozavedanja, npr. o tem, ali imamo neposredno ali intuitivno zavest o samih sebi, ki se je ne da zvesti na nič drugega, ali pa je nasprotno, vtis o tovrstni zavesti le nekakšna koristna iluzija, ki nam pomaga smiselno delovati v svetu kot enotni akterj in "igralci" v naših življenjskih igrah. (za kratek pregled teh razprav gl. [5] ali [6]).

Na podlagi teh razprav lahko sklepamo, da nam vsakdanje doživljanje samega sebe ponuja neko obliko samozavedanja, ki jo običajno miselno artikuliramo v prvo-osebnih mislih ali izjavah, kot je npr. »Sem tako in tako«, »Sem to in to«, »Sem ta in ta« itd. Vprašanje pa je, kaj to pomeni. Ena možnost je, da takšne misli in izjave morda merijo na neko zaznavanju podobno zavest o lastnem sebstvu, torej na sebstvo kot realni predmet doživljanja (izkustva). Druga možnost je, da samozavedanje primarno ne vsebuje nobenega nanašanja na samega sebe kot predmet zavesti, temveč je predrefleksivna zavest, ki se sicer lahko, ne pa nujno izrazi v prvo-osebnih miselnih in govornih gestah. Tretja možnost je, da samozavedanje predstavlja posebno obliko občutka posedovanja, namreč občutke posedovanja določenih fizičnih ali duševnih stanj kot »svojih lastnih«.

V vseh treh možnostih gre za nepojmovno, nepropozicionalno, vendar nezmotno in nedvomno nanašanje posameznika na samega sebe. V vseh primerih gre za teze o realnosti zavesti. Tem možnostim stoji nasproti pravo morje nasprotnih tolmačenj nanašanj posameznika na samega sebe, ki vsaka na svoj način zavračajo realni obstoj zavesti in jaza. Humovo zavračanje cogita je npr. klasični primer tovrstnega tolmačenja samonanašanja, prav tako »klasična« sta npr. Parfittova teorija o sebstvu kot domnevno enotnem mentalnem središču zavedanja in delovanja, pri čemer ima to domnevanje neko evolucijsko in družbeno podprto koristno vlogo v človekovem življenju, čeprav je dejansko iluzija [7] in Wittgensteinova teza o prvo-osebnem zavedanju samega sebe kot o gramatični iluziji, ki je sicer nujna v jezikovnih igrah, ki jih poznamo ljudje [8]. V sodobni kognitivni filozofiji je znan Dennettov poskus vsaj okvirnega pristopa k zavestnemu doživljanjau, tudi izrecno prvo-osebnemu doživljanju s tretjeosebnega stališča, namreč s pomočjo množice mikrodogodkov v človeških možganih, ki ustvarjajo vtis o enotni zavesti posameznika [9]. Za Dennetta je zavest je torej neke vrste virtualni uporabniški vmesnik za človeško (evolucijsko in kulturno) smiselno rabo svojih možganov. Dennett zlasti vneto zavrača predstavo o ti. kartezijanskem teatru, po kateri naj bi v možganih obstajalo neko središče, od koder »motrijo« to, kar se dogaja v telesu in izven njega.

Podobno kot Dennett razmišljajo še nekateri drugi kognitivni teoretiki, ki bi jim lahko rekli »antirealisti glede zavesti« (npr. S. Blackmore, T. Metzinger in M. Siderits). Po njihovem mnenju sta človekova zavest in še zlasti zavest o lastnem jazu neke vrste življenjsko koristni iluziji, ki nam jo posredujejo naši možgani zato, da čim uspešnejše preživimo v kompleksnem človeškem svetu. Susan Blackmore meni, da je ugotovitev o iluzornosti jaza sicer edina razumna, čeprav jo »zelo težko pripustimo v svoje osebno življenje, saj s seboj prinese korenito drugačen pristop na naše doživljanje in od nas zahteva sprijaznenje z dejstvom, da ni nikogar, ki bi ta izkustva imel« [5, str. 97–98].

Strinjam se z ugotovitvijo, da je takšno predstavo o zavesti in samozavedanju težko sprejeti, nisem pa prepričan, da je edina razumna, še zlasti, ker obstaja cela vrsta alternativnih pogledov, ki so vsaj na pogled enako »razumni«, zlasti tu merim na ti. nevrofenomenologijo, tj. poskus sinteze med fenomenološko metodo (prvo-osebnim pristopom) in nevroznanostjo (tretje-osebnim pristopom). Za nevrofenomenologe zavest je realnost, ne iluzija, čeprav je ta realnost sintetični učinek delovanja nevronov (predvsem v možganih, a ne le teh) [10].

Sam ponujam nekoliko drugačno gledanje na zavest in samozavedanje, a se omejujem le na kratek oris, ker za kaj več tu ni prostora. Podajam ga v obliki nekaj temeljnih domnev, iz katerih izhajam v svojih razmišljanjih o zavesti.

Moja *prva domneva* je, da vsako, še tako elementarno zavestno doživljanje in delovanje, predpostavlja, da *dani organizem ali splošneje, kognicijski sistem, zavzame svoj določen »zorni kot«*, s katerega zaznava svoje okolje, ga »razumeva« in v njemu deluje. Temu pravim »zavzemanje doživljajske perspektive« in sem o tem

že večkrat govoril in pisal (npr. [11], [12]). Te perspektive ne smemo izenačiti z zavestjo o svojem jazu, tudi ne z samozavedanjem ali kakim posebnim osebnim stališčem posameznika do svojega okolja, pač pa gre za to, da je specifični položaj, v katerem se nahaja kognicijski sistem, nekako pomenljiv za ta sistem in mu ta položaj nudi izhodišče za njegovo predelovanje informacij in njegovo delovanje v svojem okolju.

Moja *druga domneva* je, da so *tega sposobni tudi višje razviti živalski organizmi, v načelu pa tudi dovolj kompleksni umetni kognicijski sistemi*, npr. sistemi umetne inteligence. Vendar pa se strinjam z Nagelom, da način, kako se nek sistem znajde v svoji doživljajski perspektivi, ni docela opisljiv in dojemljiv s stališča brez tovrstne perspektive, npr. s povsem tretje-osebne perspektive naravoslovja.

Obenem privzemam še *tretjo domnevo*, namreč da je *možnost zavzemanja kake doživljajske perspektive temeljna sestavina narave same, pravim ji »dimenzija subjektivacije«. S tem mislim na nečelno možnost zavzemanja neke doživljajske perspektive za vsako realno bitje, ki deluje relativno samostojno in se ohranja ob pomoči svoje avtopoetske organizacije in svojih interakcij z okoljem.*

Moja četrta domneva je, da čim so ta bitja dovolj razvita, da so občutljiva na razliko med svojim obstojem in neobstojem, se pri njih že lahko razvije doživljajska perspektiva. Človeška zavest se mi s tega vidika kaže kot aktualizacija visoko razvitega potenciala za to, da se njegova občutljivost na svoj položaj (in način bivanja v njem) upodobi oz. izrazi v pomenljivih občutjih, mislih, hotenjih in dejanjih [13].

Važna se mi zdi še ena stvar, namreč prepletenost človekove zavesti in zlasti človekovega samozavedanja z intersubjektivno pomenljivim svetom med-človeškosti, namreč vpletenost ljudi v skupno deljene živkljenjske situacije. Šele tu namreč človeška zavest lahko izrabi in aktualizira svoje potenciale.

V nekaterih svojih prispevkih sem govoril o tem, da smo ljudje sposobni razumeti »objektivnega duha situacije«, pri čemer pod objektivnim duhom situacije razumem celoto skupnih pričakovanj glede vseh tistih vsebin govora, mišljenja in delovanja, ki so morda relevantne za kompetentno ravnanje v dani situaciji [14].

Moja peta domneva je, da v skupni situaciji tudi vsak sodelujoči posameznik razvije posebno skupnostno in situacijsko obarvano doživljajsko perspektivo, ki ni več le njegova, temveč se razširi v skupno doživljajsko perspektivo vseh sodelujočih v dani situaciji. Tedaj ne govorimo več le o sodelujočih jazih in o intersubjektivnosti, temveč o »nas« oz. o »mi«. V teh situacijah ljudje drug drugemu potrjujemo realnost lastnega doživljanja, mišljenja in stremljenja.

Moja šesta in končna domneva je, da se človeški jaz oz. sebstvo lahko razvije in ohrani le tedaj, če posameznik prostovoljno in odgovorno sprejema ustrezne anticipacije in zadolžitve, ki izhajajo iz različnih skupnih situacij in iz splošnejših oblik objektivnega duha (družbene institucije, narodi, kulture, države, danes morda tudi internetno globalizirane socialne mreže). Sklepam, da šele v tem primeru človekova zavest in človeški jaz vsaj v splošnem predstavljata neko mentalno realnost in ne le funkcionalno koristno iluzijo. Mentalna realnost pomeni dvoje: nedvomna prezentnost samega doživljaja za posameznika in takšna stopnja ustreznosti vsebine doživljaja objektivni (intersubjektivni in transubjektivni) realnosti, da se posameznik v svojem vsakdanjem in budnem ravnanju lahko zanese nanjo. Mentalna realnost zavesti in jaza torej pomeni nedvomno prezentnost doživljanja neke predmetne danosti za posameznika oz. nedvomno prezentnost doživljanja samega sebe pri posamezniku ter relativno zanesljivo nanašanje na vsebino zavedanja in na vsebino tega, kar si predstavlja sam o sebi v objektivni realnosti. Dejal sem, da gre pri zavesti (in jazu) »v splošnem« za neko mentalno realnost, kar pomeni, da so možni tudi posebni primeri, kjer temu, kar se nam javlja kot zavest in našim vtisom o samem sebi, ne gre ravno za zaupati. Takšni primeri so npr. sanje, drogiranost, razne ektaze itd. Tu tudi ne bi dalje razpravljal o še globljem vprašanju, koliko je morda naše zavedanje objektivne realnosti in naše samozavedanje iluziorno v kakem višjem, recimo »duhovnem« smislu, kar nam sugerirajo določene filozofije in religije.

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Odkrivanje znanja in podatkovna skladišča - SiKDD Data Mining and Data Warehouses - SiKDD

Uredila / Edited by

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PREDGOVOR

Tehnologije, ki se ukvarjajo s podatki so v devetdesetih letih močno napredovale. Iz prve faze, kjer je šlo predvsem za shranjevanje podatkov in kako do njih učinkovito dostopati, se je razvila industrija za izdelavo orodij za delo s podatkovnimi bazami, prišlo je do standardizacije procesov, povpraševalnih jezikov itd. Ko shranjevanje podatkov ni bil več poseben problem, se je pojavila potreba po bolj urejenih podatkovnih bazah, ki bi služile ne le transakcijskem procesiranju ampak tudi analitskim vpogledom v podatke – pojavilo se je t.i. skladiščenje podatkov (data warehousing), ki je postalo standarden del informacijskih sistemov v podjetjih. Paradigma OLAP (On-Line-Analytical-Processing) zahteva od uporabnika, da še vedno sam postavlja sistemu vprašanja in dobiva nanje odgovore in na vizualen način preverja in išče izstopajoče situacije. Ker seveda to ni vedno mogoče, se je pojavila potreba po avtomatski analizi podatkov oz. z drugimi besedami to, da sistem sam pove, kaj bi utegnilo biti zanimivo za uporabnika – to prinašajo tehnike odkrivanja znanja v podatkih (data mining), ki iz obstoječih podatkov skušajo pridobiti novo znanje in tako uporabniku nudijo novo razumevanje dogajanj zajetih v podatkih. Slovenska KDD konferenca pokriva vsebine, ki se ukvarjajo z analizo podatkov in odkrivanjem znanja v podatkih: pristope, orodja, probleme in rešitve.

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FOREWORD

Data driven technologies have significantly progressed after mid 90's. The first phases were mainly focused on storing and efficiently accessing the data, resulted in the development of industry tools for managing large databases, related standards, supporting querying languages, etc. After the initial period, when the data storage was not a primary problem anymore, the development progressed towards analytical functionalities on how to extract added value from the data; i.e., databases started supporting not only transactions but also analytical processing of the data. At this point, data warehousing with On-Line-Analytical-Processing entered as a usual part of a company's information system portfolio, requiring from the user to set well defined questions about the aggregated views to the data. Data Mining is a technology developed after year 2000, offering automatic data analysis trying to obtain new discoveries from the existing data and enabling a user new insights in the data. In this respect, the Slovenian KDD conference (SiKDD) covers a broad area including Statistical Data Analysis, Data, Text and Multimedia Mining, Semantic Technologies, Link Detection and Link Analysis, Social Network Analysis, Data Warehouses.

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ANOTATING DOCUMENTS WITH RELEVANT WIKIPEDIA CONCEPTS

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ABSTRACT

We describe an efficient approach for annotating a document with relevant concepts from the Wikipedia. A pagerank-based method is used to identify a coherent set of relevant concepts considering the input document as a whole. The proposed approach is suitable for parallel processing and can support any language for which a sufficiently large Wikipedia is available.

1 INTRODUCTION

Recent years have seen a growth in the use of semantic technologies. However, in many contexts we still deal with largely unstructured textual documents that lack explicit semantic information such as might be required for further processing with semantic technologies. This leads to the problem of semantic annotation or semantic enrichment as an important preparatory step before further processing of a document. Given a document and an ontology covering the domain of interest, the challenge is to identify concepts from that ontology that are relevant to the document or that are referred to by it, as well as to identify specific passages in the document where the concepts in question are mentioned.

A specific type of semantic annotation, known as *wikification*, involves using the Wikipedia as a source of possible semantic annotations [1][2]. In this setting, the Wikipedia is treated as a large and fairly general-purpose ontology: each page is thought of as representing a concept, while the relations between concepts are represented by internal hyperlinks between different Wikipedia pages, as well as by Wikipedia's category memberships and and cross-language links.

The advantage of this approach is that the Wikipedia is a freely available source of information, it covers a wide range of topics, has a rich internal structure, and each concept is associated with a semi-structured textual document (i.e. the contents of the corresponding Wikipedia article) which can be used to aid in the process of semantic annotation. Furthermore, the Wikipedia is available in a number of languages, with cross-language links being available to identify pages that refer to the same concept in different languages, thus making it easier to support multilingual and cross-lingual annotation.

The remainder of this paper is structured as follows. In Section 2, we present the pagerank-based approach to wikification used in our wikifier. In Section 3, we describe our implementation and present some experimental evaluaton. Section 4 contains conclusions and a discussion of possible future work.

2 PAGERANK-BASED WIKIFICATION

The task of wikifying an input document can be broken down into several closely interrelated subtasks: (1) identify phrases (or words) in the input document that refer to a Wikipedia concept; (2) determine which concept exactly a phrase refers to; (3) determine which concepts are relevant enough to the document as a whole that they should be included in the output of the system (i.e. presented to the user).

We follow the approach described by Zhang and Rettinger [1]. This approach makes use of the rich internal structure of hyperlinks between Wikipedia pages. A hyperlink can be thought of as consisting of a source page, a target page, and the *link text* (also known as the *anchor text*). If a source page contains a link with the anchor text a and the target page t, this is an indication that the phrase a might be a reference to (or representation of) the concept that corresponds to page t. Thus, if the input document that we're trying to wikify contains the phrase a, it might be the case that this occurrence of a in the input document also constitutes a *mention* of the concept t, and the concept t is a *candidate annotation* for this particular phrase.

2.1 Disambiguation

In the Wikipedia, there may be many different links with the same anchor text a, and they might not all be pointing to the same target page. For example, in the English-language Wikipedia, there are links with a = "Tesla" that variously point to pages about the inventor, the car manufacturer, the unit in physics, a band, a film, and several other concepts.

Thus, when such a phrase a occurs in an input document, there are several concepts that can be regarded as candidate annotations for that particular mention, and we have to determine which of them is actually relevant. This is the problem of *disambiguation*, similar to that of word sense disambiguation in natural language processing.

There are broadly two approaches to disambiguation, local and global. In the local approach, each mention is disambiguated independently of the others, while the global approach aims to treat the document as a whole and disambiguate all the mentions in it as a group. The intuition behind the global approach is that the document that we're annotating is about some topic, and the concepts that we use as annotation should be about that topic as well. If the document contains many mentions that include, as some of their candidate annotations, some car-related concepts, this makes it more likely that we should treat the mention of "Tesla" as a reference to Tesla the car manufacturer as opposed to e.g. a reference to Nikola Tesla or to Tesla the rock band.

2.2 The mention-concept graph

To implement the global disambiguation approach, our Wikifier begins by constructing a *mention-concept graph* for the input document. (Some authors, e.g. [2], refer to this as a mention-entity graph, but we prefer to use the term "mentionconcept graph" as some of the Wikipedia pages do not necessarily correspond to concepts that we usually think of as entities, and our wikifier does not by default try to exclude them.) This can be thought of as a bipartite graph in which the left set of vertices corresponds to mentions and the right set of vertices corresponds to concepts. A directed edge $a \rightarrow c$ exists if and only if the concept c is one of the candidate annotations for the mention a (i.e. if there exists in the Wikipedia a hyperlink with the anchor text *a* and the target *c*). A transition probability is also assigned to each such edge, $P(a \rightarrow c)$, defined as the ratio [number of hyperlinks, in the Wikipedia, having the anchor text a and the target c] / [number of hyperlinks, in the Wikipedia, having the anchor text a].

This graph is then augmented by edges between concepts, the idea being that an edge $c \rightarrow c'$ should be used to indicate that the concepts c and c' are "semantically related", in the sense that if one of them is relevant to a given input document, the other one is also more likely to be relevant to that document. Following [1], the internal link structure of the Wikipedia is used to calculate a measure of semantic relatedness. Informally, the idea is that if c and c' are closely related, then other Wikipedia pages that point to c are likely to also point to c' and vice versa. Let L_c be the set of Wikipedia pages that contain a hyperlink to c, and let N be the total number of concepts in the Wikipedia; then the semantic relatedness of c and c' can be defined as

$$SR(c, c') = 1 - [\log(\max\{|L_c|, |L_c'|\}) - \log|L_c \cap L_c'|] / [\log N - \log(\min\{|L_c|, |L_c'|\})].$$

In the graph, we add an edge of the form $c \rightarrow c'$ wherever the semantic relatedness SR(c, c') is > 0. The transition probability of this edge is defined as proportional to the semantic relatedness: $P(c \rightarrow c') = SR(c, c') / \sum_{c'} SR(c, c')$.

This graph is then used as the basis of calculating a vector of pagerank scores, one for each vertex. This is done using the usual iterative approach where in each iteration, each vertex distributes its pagerank score to its immediate successors in the graph, in proportion to the transition probabilities on its outgoing edges:

$$PR_{new}(u) = \tau PR_0(u) + (1 - \tau) \Sigma_v PR_{old}(v) P(v \to u).$$

The baseline distribution of pagerank, PR_0 , is used both to help the process converge and also to counterbalance the fact that in our graph there are no edges pointing into the mention vertices. In our case, $PR_0(u)$ is defined as 0 if u is a concept vertex; if u is a mention vertex, we use $PR_0(u) = z \cdot [number$ of Wikipedia pages containing the phrase u as the anchor-text of a hyperlink] / [number of Wikipedia pages containing the phrase u], where z is a normalization constant to ensure that $\Sigma_u PR_0(u) = 1$. We used $\tau = 0.1$ as the stabilization parameter.

The intuition behind this approach is that in each iteration

of the pagerank calculation process, the pagerank flows into a concept vertex c from mentions that are closely associated with the concept c and from other concepts that are semantically related to c. Thus after a few iterations, pagerank should tend to accumulate in a set of concepts that are closely semantically related to each other and that are strongly associated with words and phrases that appear in the input document, which is exactly what we want in the context of global disambiguation.

2.3 Using pagerank for disambiguation

Once the pagerank values of all the vertices in the graph have been calculated, we use the pagerank values of concepts to disambiguate the mentions. If there are edges from a mention a to several concepts c, we choose the concept with the highest pagerank as the one that is relevant to this particular mention a. We say that this concept is *supported* by the mention a. At the end of this process, concepts that are not supported by any mention are discarded as not being relevant to the input document.

The remaining concepts are then sorted in decreasing order of their pagerank. Let the *i*'th concept in this order be c_i and let its pagerank be PR_i , for i = 1, ..., n. Concepts with a very low pagerank value are less likely to be relevant, so it makes sense to apply a further filtering step at this point and discard concepts whose pagerank is below a user-specified threshold. However, where exactly this threshold should be depends on whether the user wants to prioritize precision or recall. Furthermore, the absolute values of pagerank can vary a lot from one document to another, e.g. depending on the length of the document, the number of mentions and candidate concepts, etc. Thus we apply the user-specified threshold in the following manner: given the user-specified threshold value $\theta \in [0, 1]$, we output the concepts c_1, \ldots, c_m , where *m* is the least integer such that $\sum_{i=1..m} PR_i^2 \ge \theta \sum_{i=1..n}$ PR_i^2 . In other words, we report as many top-ranking concepts as are needed to cover θ of the total sum of squared pageranks of all the concepts. We use $\theta = 0.8$ as a broadly reasonable default value, though the user can require a different threshold depending on their requirements.

For each reported concept, we also output a list of the mentions that support it.

2.4 Treatment of highly ambiguous mentions

Our wikifier supports various minor heuristics and refinements in an effort to improve the performance of the baseline approach described in the preceding sections.

As described above, anchor text of hyperlinks in the Wikipedia is used to identify mentions in an input document (i.e. words or phrases that may support an annotation). One downside of this approach is that some words or phrases occur as the anchor text of a very large number of hyperlinks in the Wikipedia and these links point to a large number of different Wikipedia pages. In other words, such a phrase is highly ambiguous; it is not only unlikely to be disambiguated correctly, but also introduces noise into the mention-concept graph by introducing a large number of concept vertices, the vast majority of which will be completely irrelevant to the input document. This also slows down the annotation process

by increasing the time to calculate the semantic relatedness between all pairs of candidate concepts.

We use several heuristics to deal with this problem. Suppose that a given mention a occurs, in the Wikipedia, as the anchor text of *n* hyperlinks pointing to *k* different target pages, and suppose that n_i of these links point to page c_i (for i = 1, ..., k). We can now define the entropy of the mention a as the amount of uncertainty regarding the link target given the fact that its anchor text is $a: H(a) = -\sum_{i=1..k} (n_i/n) \log(n_i/n)$. If this entropy is above a user-specified threshold (e.g. 3 bits), we completely ignore the mention as being too ambiguous to be of any use. For mentions that pass this heuristic, we sort the target pages in decreasing order of n_i and use only the top few of them (e.g. top 20) as candidates in our mentionconcept graph. A third heuristic is to ignore candidates for which n_i itself is below a certain threshold (e.g. $n_i < 2$), the idea being that if such a phrase occurs only once as the anchor text of a link pointing to that candidate, this may well turn out to be noise and is best disregarded.

Optionally, the Wikifier can also be configured to ignore certain types of concepts based on their Wikidata class membership. This can be useful to exclude from consideration Wikipedia pages that do not really correspond to what is usually thought of as entities (e.g. "List of..." pages).

Another heuristic that we have found useful in reducing the noise in the output annotations is to ignore any mention that consists entirely of stopwords and/or very common words (top 200 most frequent words in the Wikipedia for that particular language). For this as well as for other purposes the text processing is done in a case-sensitive fashion, which e.g. allows us to ignore spurious links with the link text "the" while processing those that refer to the band "The The".

2.5. Miscellaneous heuristics

Semantic relatedness. As mentioned above, the definition of semantic relatedness of two concepts, SR(c, c'), is based on the overlap between the sets L_c , $L_{c'}$ of immediate predecessors of these two concepts in the Wikipedia link graph. Optionally, our Wikifier can compute semantic relatedness using immediate successors or immediate neighbours (i.e. both predecessors and successors) instead of immediate predecessors. However, our preliminary experiments indicated that these changes do not lead to improvements in performance, so they are disabled by default.

Extensions to disambiguation. Our Wikifier also supports some optional extensions of the disambiguation process. As described above, the default behavior when disambiguating a mention is to simply choose the candidate annotation with the highest pagerank value. Alternatively, after any heuristics from section 2.4 have been applied, the remaining candidate concepts can be re-ranked using a different scoring function that takes other criteria besides pagerank into account. This is an opportunity to combine the global disambiguation approach with some local techniques. In general, a scoring function of the following type is supported:

$$score(c|a) = w_1 f(P(c|a)) PR(c) + w_2 S(c, d) + w_3 LS(c, a)$$

Here, *a* is the mention that we're trying to disambiguate, and c is the candidate concept that we're evaluating. P(c|a)is the probability that a hyperlink in the Wikipedia has c as its target conditioned on the fact that it has a as its anchor text. f(x) can be either 1 (the default), x, or log(x). PR(c) is the pagerank of c's vertex in the mention-concept graph. S(c,d) is the cosine similarity between the text of the input document d and of the Wikipedia page for the concept c. LS(c, a) is the cosine similarity between the context (e.g. previous and next 3 words) in which *a* appears in the input document d, and the contexts in which hyperlinks with the target c appear in the Wikipedia. Finally, w_1 , w_2 , w_3 are weight constants. However, our preliminary experiments haven't shown any improvements from the addition of these heuristics, so they are disabled by default ($f(x) = 1, w_2 = w_3$) = 0) to save computational time and memory (storing the link contexts needed for the efficient computation of LS has turned out to be particularly memory intensive).

3 IMPLEMENTATION AND EVALUATION

3.1. Implementation

Our implementation of the approach described in the preceding section is running as a web service and can be accessed at <u>http://wikifier.org</u>. The approach is suitable for parallel processing as annotating one document is independent of annotating other documents, and any shared data used by the annotation process (e.g. the Wikipedia link graph, and a trie-based data structure that indexes the anchor text of all the hyperlinks) need to be accessed only for reading and can thus easily be shared by an arbitrary number of worker threads. This allows for a highly efficient processing of a large number of documents.

Our implementation currently processes on average more than 500,000 requests per day (the total length of input documents averages about 1.2 GB per day), including all the documents from the JSI Newsfeed service [3]. The output is used among other things as a preprocessing step by the Event Registry system [4]. The wikifier currently supports all languages in which a Wikipedia with at least 1000 pages is available, amounting to a total of 134 languages. Admittedly, 1000 pages is much too small to achieve an adequate coverage; however, about 60 languages have a Wikipedia with at least 100,000 pages, which is already enough for many practical applications.

Annotations are returned in JSON format and can optionally include detailed information about support (which mentions support each annotation), alternative candidate annotations (concepts that were considered as candidates during the disambiguation process but were rejected in favour of some other more highly scored concept), and WikiData/DbPedia class membership of the proposed annotations. Thus, the caller can easily implement any desired class-based postprocessing.

3.2. Evaluation

One way to evaluate wikification is to compare the set of annotations with a manually annotated gold standard for the same document(s). Performance can then be measured using metrics from information retrieval, such as precision, recall, and the F_1 -measure, which is defined as the harmonic mean of precision and recall. We used a manually annotated set of 1393 news articles that was made available from the authors of the AIDA system and was originally used in their experiments [2]. This manually annotated dataset excludes, by design, any annotations that do not correspond to named entities. Since our wikifier does not by default distinguish between named entities and other Wikipedia concepts, we have explicitly excluded non-entity concepts (based on their class membership in the WikiData ontology) from the output of our Wikifier for the purposes of this experiment. In addition to our wikifier, we obtained annotations from the following systems: AIDA [2], Waikato Wikipedia Miner [6], Babelfy [7], Illinois [8], and DbPedia Spotlight [9].

	Gold	JSI	AIDA	Waikato	Babelfy	Illinois	Spotlight
Gold	1.000	0.593	0.723	0.372	0.323	0.476	0.279
JSI		1.000	0.625	0.527	0.431	0.489	0.363
AIDA			1.000	0.372	0.352	0.434	0.356
Waikato				1.000	0.481	0.564	0.474
Babelfy					1.000	0.434	0.356
Illinois						1.000	0.376
Spotlight							1.000

Table 1: F_1 measure of agreement between the various wikifiers and the gold standard.

Table 1 shows the agreement not only between each of the wikifiers and the gold standard, but also between each pair of wikifiers (the lower left triangle of the matrix is left empty as it would be just a copy of the upper right triangle, since the F_1 -measure is symmetric). As this experiment indicates, our wikifier ("JSI" in the table) performs slightly worse than AIDA but significantly better than the other wikifiers. Furthermore, it turns out that there is relatively little agreement between the different wikifiers, which indicates that wikification itself is in some sense a vaguely defined task where different people can have very different ideas about whether a particular Wikipedia concept is relevant to a particular input document (and should therefore be included as an annotation) or not, which types of Wikipedia concepts can be considered as annotations (e.g. only named entities or all concepts), etc. Possibly the level of agreement could be improved by fine-tuning the settings of the various wikifiers; in the experiment described above, default settings were used.

4 CONCLUSIONS AND FUTURE WORK

We have presented a practical and efficient approach to Wikification that requires no external data except the Wikipedia itself, that can deal with documents in any language for which the Wikipedia is available, and that is suitable for a high-performance, parallelized implementation.

The approach presented here could be improved along several directions. One significant weakness of the current approach concerns the treatment of minority languages. When dealing with a document in a certain language, we need hyperlinks whose anchor text is in the same language if we are to identify mentions in this input document. Thus, if the document is in a language for which the Wikipedia is not available at all, it cannot be wikified using this approach; and similarly, if the Wikipedia is available in this language but is small, with a small amount of text, low number of pages, and generally poor coverage, the performance of wikification based on this will be low. One idea to alleviate this problem would be to optionally allow a second stage of processing, in which Wikipedias in languages other than the language of the input document would also be used to identify mentions and provide candidate annotations. This might improve coverage especially of concepts that are referred to by the same words or phrases across multiple languages, as is the case with some types of named entities. For the purposes of pagerank-based disambiguation in this second stage, a large common link-graph would have to be constructed by merging the link-graphs of the Wikipedias for different languages. This can be done by using the cross-language links which are available in the WikiData ontology, providing information about when different pages in different languages refer to the same concept.

Another interesting directon for further work would be to try incorporating local disambiguation techniques as a way to augment the current global disambiguation approach. When evaluating whether a mention a in the input document refers to a particular concept c, the local approach would focus on comparing the context of a to either the text of the Wikipedia page for c, or to the context in which hyperlinks to c occur within the Wikipedia. Preliminary steps taken in this direction in Sec. 2.5 did not lead to improvements in performance, but this subject is worth exploring further. Instead of the bag-of-words representation of contexts, other vector representations of words could be used, e.g. word2vec [5].

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Impact of News Events on the Financial Markets

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ABSTRACT

In this work we investigate how news events can be used to predict the financial markets. Namely we built a time series model that includes features obtained from the news and investigated whether the changes in volume of traded shares can be predicted more accurately with this information. The time series model that was built is of an ARMA-GARCH type, because we wanted to account for any clustering of the volatility that is normal for the financial markets. The models were evaluated with the Akaike and Bayesian Information Criterion, while also being compared to the baseline model that did not include any features from the news. Overall our results show that there is an improvement in the model when the information from the news is used and hence show a promising avenue for future research work.

1. INTRODUCTION

The predictability of future movements of financial markets is a well researched area in the literature and offers many interesting theories. Financial institutions and investors have been using various sources of information in order to increase the accuracy of their predictions and consequently outperform others. There are several approaches to building the best predictive model, but in general we can divide them into two categories: technical analysis and fundamental analysis. On one side we have models that are based on the historical market data and believe that the past movements will repeat themselves. This is the so called technical analysis approach to modelling markets and believes that an experienced observer can detect the repetition of a pattern from a graph of market data. The effectiveness of this approach was tested by [9]. This approach however does not offer any reasons why market movements would repeat, and in order to incorporate more fundamental believes, a second approach named fundamental analysis was developed. These models use data that is available from multiple sources, which ranges from company's balance sheet data, financial market data like company's index, financial data about government activities to data about political or geographical circumstances presented in news.

From the variety of sources for fundamental data, we will focus on how news can be used in modelling financial markets. There have been various studies on this topic, which differ by the extent of the analysis of textual data describing news story. Initially research focused on the impact of frequency of news stories on the market movements (see [6] or [7]). In these papers authors found some correlation between increased number of published news stories and larger market movements. To extend this approach, researchers also analysed the content of the news stories, which led to determinDunja Mladenič Jožef Stefan International Postgraduate School and Artificial Intelligence Laboratory, Jožef Stefan Institute Jamova 39, 1000 Ljubljana, Slovenia dunja.mladenic@ijs.si

ing the sentiment of the news articles and consequently determining the impact on the market on the basis of whether it is positive (upward trend predicted) or vice versa (see [3] or [4]). Our approach is similar to the second one, but instead of determining sentiment for each news event, we use the effect that the past similar events had on the market as a proxy for the impact of the current event.

We define an event as a collection of news articles from different sources about the same story in the news. From this collection of articles we will be able to extract the topic, date, location, social score (how trending was this event on social media) and all of the entities involved in the event, which will add to the complexity of our dataset. One possible source of such dataset is a system called Event Registry (see [5]), which automatically extracts events from news articles. Using this type of data source is novel for this research area and hence serves as an additional contribution from this work.

In order to see the impact that these events had on the financial market, we looked at how the volume of traded shares changes on the days of the event. We obtained several features from the news events and checked whether they would allow us to improve the time series model for the volume change.

2. DATA

For the historical market data of the company, we collected the following values (prices): Open, High, Low, Close, Volume. In addition to the market values of a company we also used the value of the market volatility index VIX (closing price). Secondly with the use of the Event Registry system we obtained all of the news events relating to the company. The general description above was intentional as it can be applied to any publicly listed company, but for our specific example we will use data about investment bank Goldman Sachs (GS). In Figure 1 we present the dataset we will be modelling and predicting, where it can be seen that there are large spikes at certain time periods. Moreover the volume change graph demonstrates that we have clusters of periods with high volatility.

2.1 Data Description

Our dataset spanned from 2.12.2013 to 30.12.2016, which offered us 777 trading days on which we were able to collect historical market data. On the other hand the number of news events that occurred in that time period was significantly higher. When we singled out events using 50 as the relevance threshold we obtained 4336 events (details of how Event Registry calculates the weights of concepts in



Figure 1: Volume Dataset

the event are presented in [5]). For testing purposes we split our dataset into two parts, where we allocated 757 observations for training and testing, while we used the remaining 21 observations for the out of sample prediction.

For each event we also obtained related events to it. These related events are obtained by computing the TF-IDF weights on the concepts present in the event and then by using cosine similarity measure other events with similar concept weights are found (see [5]). These past similar events formed a crucial dataset, because we could link them to the market movements and deduce their impact.

2.2 Data preprocessing

In order to measure the impact of the event we will be considering the change in volume that occurs between the closing value of today and the day after the event. Specifically we will be analysing and predicting the value of

(Volume Change)_t
$$\equiv VC_t = \frac{V_{t+1} - V_t}{V_t},$$
 (1)

where V_t is the value of volume at time t. In this formulation we used future values, so that we can observe the impact an event has on future volume. It should be noted that this value is calculated in the same manner as that of the returns of shares, which we will also use in our analysis. The formula is identical except that we replace values of volume with those of closing price P_t . Hence we write

$$(\text{Returns})_t \equiv r_t = \frac{P_{t+1} - P_t}{P_t}.$$
 (2)

Changes in the volatility index VIX were calculated with the same formula. Additionally we also added rolling 5 and 10 day moving average of volume change to the feature set, so that we would have another measure of impact an event has on value. Hence the complete list of all of the features that were obtained from the stock market is:

- Returns
- Volume Change
- Open
- High
- Low
- Close
- Volume

- VIX Close
- VIX Change
- Rolling mean 5 days
- Rolling mean 10 days
- Rolling EMA 5 days
- Rolling EMA 10 days

In order to reduce noise in the dataset of events we selected only the most important ones. Namely we set a limit, which determined the lower boundary for the relevance of the events to the given company. Hence if an event was not relevant enough we discarded it. This naturally raises the issue of selecting the appropriate boundary for the relevance of the events and after testing several values we selected 89 out of 100. After this we were left with 424 events.

What should be noted here is that many events occurred on the days when the markets were closed (weekends, holidays), so they had to be linked with the next possible trading day that followed. Another issue was also that in many cases multiple events occurred on the same day and hence we were not able to isolate the effect of a single event, but rather looked at the average effect of all the events on a specific day. Therefore we are also relying on the fact that there are no duplicates in the our dataset.

3. METHODS

3.1 Predictions from Similar Events

In order to build our time series model, which uses data from news events, we examined the effects of past similar events on the market for each new event separately. This was done by first extracting the market information on the days of the similar events and combining them with the additional information about the event (social score, relevance to the company, correlation to current event, number of articles). On average each event had between 5-17 similar events from our dataset.

Illustration of this processes for an event E "Goldman Profit Rises 74% as Bond Trading Beats Estimates" with two similar events (SE) is represented in Figure 2. On the two days of the SE_1 and SE_2 we then collect all of the available stock market values for the company and index VIX. It should also be noted that the time difference between event and past similar events is not limited or predetermined. In this case we have events that are years apart.



Figure 2: Similar Events

Once the dataset of market impacts from past similar events was obtained an Ordinary Least Squares (OLS) model was fit to the dataset. In the Figure 2 this would be all of the market variables available at times t_{i-k} and t_{i-j} . This
dataset then allowed us to use data from the market and current event to form a prediction of what the future market movement could be. This procedure was done for both volume change and returns. Several choices of external regressors that were used in OLS were tested, where the main issue arose when there were fewer similar events than features to be fit. Namely we fitted two models, one with all of the market information available and one where only Returns, VIX Change and concept weight were used to predict Volume Change. Similarly two models were fit to predict Returns, where Volume Change, VIX Change and concept weights were used as features in the second one. In addition we also calculated the average of volume changes and returns from dates of similar events and used it as a feature. In order to take into account the correlation to the similar events we created an extra feature that represented the value of average of volume changes and returns multiplied by the normalized correlation (correlation/100). All together the following features were added to the model (all of which are predictions from similar events):

- Number of Events that day
- Returns (all regressors)
- Returns (selected regressors)
- Volume Change (all regressors)
- Volume Change (selected regressors)
- Average Returns
- Average Returns * Correlation
- Average Volume Change
- Average Volume Change * Correlation

With the OLS model trained on the dataset of similar events we were then able to predict the impact of the original event on the volume change. It should also be noted that the OLS model was selected in order to avoid over fitting an ARMA type model. The predictions that were obtained in this way were then used in the next step when we were building our regression model.

3.2 ARMA-GARCH MODEL

The main model in our analysis will be of the ARMA-GARCH type, because this formulation allows us to capture the effects of values from previous periods and account for clustering in volatility.

The ARMA model is in its general form specified as:

$$X_{t} = \mu_{t} + Z_{t},$$

$$\mu_{t} = \sum_{i=0}^{p} \alpha_{i} X_{t-i} + \sum_{j=1}^{q} \omega_{j} Z_{t-j} \qquad (3)$$

$$Z_{t} = \sigma \epsilon \Rightarrow Z \sim N(0, \sigma^{2})$$

where X_t is the target variable at time t, μ_t is the equation for the mean at time $t, \epsilon \sim N(0, 1)$ is an iid normally distributed noise term and σ is the variance at time t. The first step in modelling is to determine the best values for (p, q) according to the evaluation criteria.

The above model however assumes that the variance (σ) is constant. This assumption is dropped due to the clustering in the volume change (periods of high changes are followed by lower ones). This type of models are called Generalised Autoregressive Conditional Heteroskedasticity (GARCH) models ([2]) and have been shown across literature to improve the models (see [8]). They allow us to model $\sigma = \sigma_t$ by an additional non linear model. Namely general formulation of the problem is the following:

$$\sigma_t^2 = \beta_0 + \sum_{i=1}^r \beta_i Z_{t-i}^2 + \sum_{j=1}^s \gamma_j \sigma_{t-j}^2$$
(4)

So the current value of the variance also depends on the previous values of the variance. From this general formulation one has to determine the value of (r, s) that is most suitable for the model. Finally we can add external regressors (features) to the equations 3 as an additional sum term in the first line of the equation.

3.3 Evaluation Criteria

In order to asses which model was most suitable for the given dataset we have used a variety of different tests. In order to be able to assume that the time series is stationary we first ran Augmented Dicky Fuller test and KPSS test. In both cases the p-value was below and above the 5% threshold respectively. To differentiate between variety of different model we analysed the performance of each model by the Akaike information criterion (AIC) and Bayesian information criterion (BIC), which are the classical information criteria used across literature that also penalize model for high complexity ([1]). Finally in order to determine the significance of the features we will also build a model without the predictions from the similar news events. This will serve as our baseline model and the difference in performance will be then the main measure of how significant these features are.

4. **RESULTS**

• Rolling mean 10 days

Our first step in determining which features are significant for our analysis was running a t-test selection procedure for all regressors. From this analysis it was determined that only the following features were relevant for our model:

- VIX Close price Rolling EMA 5 days
 - Rolling EMA 10 days
- Rolling mean 5 days Prediction of Returns

Hence our first finding was that the predictions that we obtained from the similar events were significant, but instead of using the predicted volume changes, the predicted returns turned out to be more significant for our model.

With this set of regressors the best ARMA model was of order (2,2), so two lagged terms in both variables were included. This model preformed according to the evaluation criteria shown in the table 1. As mentioned before in order to capture clustering in the dataset we modelled the variance term even further with a GARCH type model. Again the same evaluation criteria were used and a grid search was preformed to find the best coefficients (r, s) for order of the model. This resulted in a GARCH (5,1) model, with the evaluation criteria presented in the same table 1. Comparison of results yields what improvements have been made by including the feature. This table also serves as a comparison to the baseline model. Since the AIC is merely a heuristic, differences between its values are important. So the predicted feature from similar events improves AIC value by 10.22, while the improvement of our final model is 32.69.

One way of interpreting this difference is also in terms of relative likelihood, which is defined as $exp((AIC_{min}-AIC_i)/2)$ for model *i*, where AIC_{min} represents the lowest AIC value from all models. Hence the baseline model is 7.97×10^{-8} times as probable as the best model to minimize the information loss, while the ARIMA(2,2) with feature is 1.06×10^{-5} times as probable. However we can see that due to additional complexity of our final model, BIC criterion is actually the highest for our chosen model. Hence an optimisation by the BIC criterion would result in a different model.

	AIC	BIC
Baseline	-925.57	-874.66
ARMA(2,2)	-935.35	-879.81
ARMA(2,2)- $GARCH(5,1)$	-958.26	-869.96

Table 1: Evaluation criteria train set

It should be noted that we have also tested the assumption about the distribution of the standardized residuals. So instead of using normal distribution we fitted the model with student t distribution with and without skew. Some minor improvements in AIC value were obtained, but not really significant. Hence we kept the distribution as normal.

Final test included out of sample predictions, where our best chosen model was ARMA(2,2)-GARCH(5,1). The time period for prediction was 1 month (December 2016) with 21 trading days. We also calculated errors when making these predictions, where our best model from above scored a value of 0.1344944 for Mean Absolute Error and 0.1565652 for Root Mean Squared Error. Figure 3 shows how the model predicted future values, where the middle line represent predictions for the mean value. Additionally the plot also included intervals of upper and lower 95 and 80 quantile range.



Figure 3: Out of Sample Forecast

5. CONCLUSION

In this paper we investigated one possible approach of determining the impact that news have on the financial markets. This is a growing research area since nowadays any model that wishes to capture market dynamics has to account for the effect of world events. In order to extend previous work in this area, we demonstrated how a more complex text data can be used to obtained relevant features for modelling changes in financial markets. Our data consisted of news events that were automatically extracted from the news articles. For each event we then collected past similar events and observed how the market reacted to those events. On the basis of these reactions we built various features vectors that helped us improve our model. Results show that when predicting change in volume, the predicted returns from similar events served as a useful feature. Additionally we tested the performance of our improved times series model on the out of sample dataset for the period of 1 month. Future work will be done in this direction, where we will look for further similarities between news events and possibly obtain new features that could be used for modelling financial markets.

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Challenges in media monitoring of worldwide news sources to support public health

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Abstract—Real-time global media monitoring is nowadays an essential resource to public health. Multilingual capabilities can enrich this potential allowing a worldwide overview based on online news sources, blog posts or social media. In this paper we propose research topics related with the exploration text mining tools used to provide real-time global media monitoring in the context of health. We aim to understand how media can contribute to a better overview of health related and well being matters. With it we shall also identify open research questions that motivate further technological development to better fit the needs, interests and workflow of public health professionals.

I. INTRODUCTION

Dealing with media (written online media in particular) has several issues, one of which is a lack of common publishing standards. Another issue is related to the global nature of the service: the mere fact of a system being universal, requires a system that can manage a variety of languages, possibly hundreds of them. This creates issues, as todays language technologies can deal only with words and sentences, highlighting the need to bridge the gap from simple textual representation towards semantic representation, where we would want to understand the semantic and conceptual aspect of the textual content and not just lexical (words and phrases) and syntactical (sentences).

Considerable research and commercial activity in the past period has led to a development of high performance online news monitoring systems and accompanying tools, methods and models. For example, a complete cross-lingual news processing pipeline consisting of the following components has achieved good results in both research and commercial usage scenarios: NewsFeed system [16] to monitor, gather an produce clear-texts of online (HTML) news articles; Sentiment Detection module [17]; Enrycher module for text annotation [7]; Wikifier for advanced text categorization [2]; Cross-lingual document linking [11]; Document clustering [1]; and Event Registry [9], an advanced news visualization and analysis tool. There is a relatively large offer of similar online news monitoring ("clipping") systems available, each of them with a distinctive set of features. Authors, however, are not aware, of a monitoring system that would implement a rich set of cross-lingual features as the online news processing pipeline mentioned above.

Category: H.4.0 Information Systems Applications: General reporting, statistical analysis, visualisation, networks



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Fig. 1. The contribution of text mining efforts based on online multi-lingual news to public health raises several research questions. In the image above shows an ER visualisation module representing a real-time stream of news that permits us to explore the range of some of those questions.

According to the ECDC (European Centre for Disease Prevention and Control), the objective of epidemic intelligence is to produce timely, validated and actionable intelligence on events related to communicable diseases or of unknown origin that are of interest for public health and health authorities [4]. A similar definition is provided also by the WHO [18]. Part of this effort is to gather unofficial, unstructured and unverified information about those events, that are then later verified and analyzed by Public Health experts. Several ICT solutions to support these efforts have emerged. Most notable solutions used by authorities are GPHIN [3] (Global Public Health Intelligence Network), developed and operated by the Canadian Government, MedISys [15], developed and operated by the Joint Research Centre of the European Commission and Healthmap.org, a system developed by Boston Children's Hospital receiving external funding.

All those systems are multi-lingual to some extent, i.e. they monitor news in more than one language. However, it seems they do not leverage the usefulness of cross-lingual approaches to increase the quality of detected health events. Also, they seem no to use Wikipedia, which is nowadays the biggest freely available knowledge base, to extract meaningful information from news articles.

In this paper we aim to identify research questions, related to features highlighted above (cross-linguality, wikification, among others), that can contribute to the appropriate software development serving the needs of Public Health professionals. Part of the work presented in it was developed in the context of the European Union research project MIDAS, under the program Horizon 2020.

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Keywords: Text mining, public health, news, media.

II. COLLECTING THE DATA

Online news media sources represent a reliable and structured near-real time stream of a heterogeneous, multilingual text documents that describe real-word events. A range of services offers the aggregation of both social media and online news, following the uptake of news publishing through the latter channel. Several media news aggregators provide web crawlers for information extraction and media monitoring aiming for newsworthy stories. In order to extract meaningful information for a particular application domain, automatic event detection mechanisms exist allowing us to measure the media impact of public health awareness rising campaigns, health related news coverage and bias across different outlets. Those also include sentiment detection and cross-lingual linking of documents applied to news sources. In the public health domain, these approaches have been used to detect disease outbreaks and other public health threats (e.g. monitoring of international social and sports events, anti-vaccination campaigns, among others).

Among the available news aggregator and analysis services that provide some level of access to online news streams we highlight the NewsFeed system (available at newsfeed.ijs.si). It is a real-time aggregated stream of semantically enriched news articles tracking over RSS-enabled global media sources worldwide. In particular, the online media monitoring system NewsFeed currently monitors around 900.000 RSS news feeds (800.000 web sites) and collects between 350.000 and 600.000 articles per day, assuming an article archive available since May 2008. Using the current API it is possible to get annotated articles since June 2013. Currently, about 50% of all articles are in English. All languages present in Wikipedia are included, but are covered in respect of quality, volume and extent of analysis performed [8] to differing degrees. For research purposes, authors where granted access to the NewsFeed system, available at newsfeed.ijs.si. The data is accessed through a HTTP API and the result is provided in XML format. Additional metadata can be obtained through the API: named entities, concepts, categories, mentioned places and similar [14]. Furthermore, this technology could be used for additional data annotation and analysis tailored to public health applications (e.g. the annotation with wikifier as later discussed in Section III).

The news monitoring software EventRegistry (ER) (available at www.eventregistry.org) feeds on Newsfeed, tracking over 100,000 global media sources in near-real-time, operating across 100 languages, and aggregating global media content in a semantically meaningful way. It collects over 300,000 news articles on average per day and arranges them into events, events are further connected into story-lines which enable tracking of evolving topics [9]. Since ER covers most of the global media reporting on any topic, it can be used also to track topics like health and well-being on different levels of resolution from small local issues, up to the higher level country issues and global trends.

III. AUTOMATIC ANNOTATION

The complexity of identification of entities makes the automatic multilingual text analysis a difficult task. Wikifier

(i) Language autodetected as English (en; #0). Show details...

Text	Anno	tations		
The role of <u>hepatitis virus infection</u> in <u>glucose homeostasis</u> is uncertain. We examined the associations between <u>hepatitis B virus</u> (HBV) or <u>hepatitis C virus</u>	PR	Annotation	Annotation (en)	
(<u>HCV</u>) <u>intection</u> and the development of <u>diabetes</u> in a cohort (N = 439,708) of asymptomatic participants in <u>health screening</u> examinations. In cross- sectional analyses, the multivariable adjusted odds ratio for prevalent	0.0312	Diabetes mellitus	Diabetes mellitus	<u>>></u>
diabetes comparing hepatitis B surface antigen (HBsAg) (+) to HBsAg (-)	0.0195	Hepatitis 👿 🖻	<u>Hepatitis</u>	>>
participants was 1.17 (95% Cl 1.06-1.31; P = 0.003). The corresponding odds	0.0170	Hepatitis B	Hepatitis B	>>
ratio comparing hepatitis C antibodies (HCV Ab) (+) to HCV Ab (-) participants was 1.43 (95% Cl 1.01-2.02, P = 0.043). In prospective analyses, the	0.0166	Hepatitis C w	Hepatitis C	<u>>></u>
multivariable-adjusted hazard ratio for incident diabetes comparing HBsAg (+	0.0149	HBsAg D	HBsAg	>>
) to HbsAg (-) participants was 1.23 (95% CI 1.08-1.41; P = 0.007). The number of incident cases of <u>diabetes</u> among <u>HCV</u> Ab (+) participants (10 cases) was the annula to reliable methods and the reliable between UC).	0.0134	Hepatitis C virus W D	<u>Hepatitis C</u> <u>virus</u>	<u>>></u>
infection and diabetes. In this large population at low risk of diabetes. HBV	0.0132	Odds ratio	Odds ratio	>>
and <u>HCV infections</u> were associated with <u>diabetes</u> prevalence and <u>HBV</u>	0.0131	Infection D	Infection	>>
infection with the risk of incident diabetes. Our studies add evidence	0.0127	Virus w D	Virus	>>
suggesting that <u>diabetes</u> is an additional <u>metabolic</u> complication of <u>HBV</u> and	0.0121	Antibody D	Antibody	>>
ncy infection.	0.0117	Hepatitis B	Hepatitis B	<u>>></u>

Fig. 2. The automatic annotation tool Wikifier used to enrich a WHO article on vaccination taken as an example. It is copied to the *Text* field and has several underlined words corresponding to the identified Wikipedia concepts. When hovering the emphD icon on disease name, we notice that this article is mostly about Yellow Fever, we see that yellow fever is a disease and we see that Kinshasa is a settlement. If we further explore the DBpedia entry the area, number of inhabitants, country and other information in available.

(available at wikifier.ijs.si) takes profit of Wikipedia, the biggest open, online and up-to-date knowledge repository on the internet, to annotate text and link it to relevant knowledge resources. Wikifier allows for annotating large quantities of free text in a very short time. The type of analysis provided permits us to identify trends (e.g. health related lifestyles) or ask questions like: *Provide me all texts (articles) that are about vaccination campaigns in Africa in cities with population of more than 2 million people.* Figure 2 shows the output of the automatic annotation of the abstract of a recent article on Cholera. The top ten concepts annotated include "Vibrio cholerae", "Fresh water" or "Bacteria".

By being constructed over the knowledge-base of Wikipedia, it is essential that Wikipedia coverage on health topics is of high quality which is itself an open question. It is also another open question of whether an extension of Wikipedia can capture all of the concepts covered by MeSH.

IV. FROM GLOBAL TO LOCAL MEDIA MONITORING

In the context of Public Health, a graphical dashboard can provide contribution to the real-time monitoring of the global health by allowing to a continuous observation of medical and well-being issues, limiting to the presentation of articles/items related to those topics (a possible health dashboard is available at [6]). Such a dashboard presents the incoming multi-lingual health related media content published somewhere in the world. That allows the health professional to have an overview of what is happening globally at any given moment in time (cf. [5]). This is a convenient way to observe global health monitoring by using the ER system introduced above in Section II. Its key feature is to be able to observe health issues across many languages and in temporal detail, over a variety of scales, which is what most other systems have difficulties [10]. The image in Figure 1 shows a snapshot of the dashboard with health related events on July 20th, 2017.

The event of the Zika outbreak is identified immediately after the collection of news articles that report about it. With

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Fig. 3. ER screenshot showing the event of "lead poisoning" in Nigeria on May 12, 2015. It includes date, location, categories, number of languages covered and social media (Twitter) count.



Fig. 4. ER screen-shot showing story-line developed after the event of "lead poisoning" in Nigeria on May 12, 2015. It describes below the event a timeline of related news.

it, the health professional can explore the evolution of the news publishers awareness of the epidemics in time by looking at the related news articles represented in a world map, as they were identified or updated during a selected period of time. ER can find articles and events related to a particular entity, topic, date, location or category, as well as measure their impact on social media (in particular, Twitter). Moreover, its crosslingual capabilities allow to consider events where the news appears only in e.g. Chinese or some unknown language where the news never came into English speaking space. This is of particular interest when considering the monitoring of rare diseases worldwide.

Another perspective is the micro view of a particular health related event happening somewhere in the world. The event of "lead poisoning" in Nigeria on May 12th, 2015, which went mostly unnoticed at a global level, is an example that can be explored through ER. With a simple query to the system, the health professional can extract all the reports related to that event, and check the event in the context of other related events. To illustrate this, the screen-shots in Figures 3 and 4 show the event itself and the story-line developed after the event, respectively.



Fig. 5. A temporal intensity visualisation in ER for the query 'Ebola virus disease' showing that the system could notice the outbreak of the epidemic before it was made public.



Fig. 6. ER screenshot showing a geographical spread visualisation module for the query 'Ebola virus disease'. Each mark shows the number of related news per location in the map.

V. HISTORICAL PERSPECTIVE

Another view relevant to any health related issue is a historical perspective based on an aggregation of a particular topic. The evolution of Ebola virus and reporting after 2014 until 2017 can be an example to be explored through ER. Querying ER for Ebola virus disease provides over 20,000 events related to Ebola appearing after 2014. The content (over 200,000 news articles) could be analysed through several visual modules: temporal intensity, geographical spread, topical spread, among others. The Figures 5 and 6 illustrate temporal (with the peak in October 2014) and geographical spread (West Africa and the US) of Ebola related events. We highlight that ER was able to notice the outbreak of the epidemics before it was made public. Though, the question was not asked then, i.e., the query wasn't done because it was not yet an identified issue and there was a lack of continuous attention. Though a complete attention of all such epidemic related topics could be a heavy burden to the system. This rises the research problem of predicting and alerting of high density events like this.

In ER the Zika outbreak event is identified immediately after the collection of the news articles that report about it. One can explore the evolution of the news publishers awareness of the epidemics in time by looking at the related news articles represented in a world map, as they were identified or updated during a selected period of time. ER can find articles and events related to a particular entity, topic, date, location or category, as well as measure their impact on social media (specifically, Twitter). This social media monitoring is complemented by TwitterObservatory (cf. [12]), leveraging in-house technology that uses data observation, enrichment and storage techniques for social media data presentation, search and analytics. Moreover, there have been several successful tests done to extract sentiment from news based on the sentiment of tweets associated with news [13]. The sentiment directly from news is still an open problem that shall be tackled.

VI. CONCLUSIONS AND FURTHER WORK

In this paper we discussed the potential of several text mining tools dedicated to explore worlwide multilingual news, focusing matters of interest to Public Health. Further research (exploring the potential of Newsfeed, Wikifier and ER) includes: (i) the correlation of high level concepts with low level features; (ii) the showcase of hierarchies (e.g. in some disease) and how they can be drilled down to variety of sub topics (e.g. different aspects of such a disease; (iii) the analysis of the impact of health related issues on society (e.g. Ebola news impact in adherence to insurance); (iv) the presence of PubMed/Medline in global news; and (v) the prediction of consequences of a health event. Other research directions consider the dynamics of Public Health/Healthcare institutions where activities happen affecting: (1) the decision makers that make choices based on the legislation and on the available in-house monitoring systems operated by their own data scientists, (2) those data scientists that explore the data and extract relevant information that contributes to evaluation of Public Health scenarios, and (3) the technical team that deploys and maintains the data infrastructure where data scientists are active. It could be very useful to have easy to handle data visualisation modules (like the ones offered by Kibana and shown in Figure 7) allowing decision-makers to choose with a few clicks the representation of data that makes sense to the problems they focus on. The data scientists could then manipulate the current workflows, maximising critical outputs, presenting data in a meaningful way whilst minimising resource required to drive data interrogation and presentation.

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Fig. 7. Kibana screenshot showing the different visualisation modules based on queries to elasticSearch composing an interactive dashboard. This is a puppet example from venzia.es to show the practical potential of this tool.

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Ontology-based translation memory maintenance

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ABSTRACT

In this paper, we explore the use of text mining techniques for translation memory maintenance. Language service providers often have large databases of translations, called translation memories, which have been in use for a long time leading to a slow population of the translation memory with other domains (i.e. adding financial content to a medical translation memory). To our best knowledge, no tools exist that would effectively separate the content of a translation memory according to different domains. Having the ability to extract individual domains from low-quality translation memories could mean a significant benefit to language service providers looking to utilize modern translation methods, such as machine translation and automated terminology management. In the first stage, we used OntoGen, a semi-automatic ontology building tool which uses text mining techniques, to separate the segments in the translation memory according to domains. In the second stage, we wanted to test whether we could use the domains defined in the previous stage to build classification models - effectively using them as class labels in place of the costly and time-consuming manual annotation of segments.

Keywords

translation memory, language service provider, ontology, OntoGen, text classification

1. INTRODUCTION

In the translation industry, language service providers (LSP) often offer a guarantee to their customers that they will never have to pay twice for the translation of the same text. In order to do so, they have come up with a way of saving and re-using past translations to reduce costs and offer discounts. Starting in the 1970s and 1980s, translation companies began using translation memories which are essentially databases of bilingual segment pairs (source text – target text) along with some metadata. Whenever a new document is received for translation, it is leveraged against the

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translation memory for "exact" and "fuzzy" matches and the results are used to calculate the final price of the translation. This technology really took off in the 1990s and today virtually every language service provider on the market uses some kind of a translation memory to store translations.

In theory, the translation memory concept involves the use of metadata to clearly mark the segments belonging to different domains and/or customers. However, metadata are often not added due to time pressure or other issues and the information about the domain or customer is lost. Without this information it is difficult to reuse the translation memories for machine translation and/or terminology management. Finally, the quality of a translation memory can also degrade over the years because segments may get accidentally stored in the wrong translation memory (the domain of the segments is not the same as the domain of the translation memory).

In this paper, we analyze one such translation memory used by the translation company Iolar to see whether we could use text mining techniques to extract domains and clean lowquality translation memories. We used OntoGen [4] topic ontology editor to separate the dataset into distinct domains and then used these domains for text classification in Weka [5].

Ontology learning is a well-researched area with researchers using various techniques, such as natural language processing([10]), machine learning ([13]) and information retrieval ([3]). The same can be said of using machine learning for text classification (for example, [11], [9] and [7]). On the other hand, research into using data mining techniques for translation memory maintainance is scarce with most authors focusing on spotting low-quality individual segments. Barbu [1] uses several machine learning algorithms to spot false segment pairs in translation memories, Sabet et al. [6] describes a system for unsupervised cleaning of translation memories without labeled training data based on a configurable and extensible set of filters, and Nahata et al. [8] defines a set of rules for a rule-based classifier which is in turn used to find low-quality segment pairs. A more recent topic that serves a similar purpose is quality estimation of machine translated segments. For example, Specia et al. [12] describe a system that tries to predict the quality of machine translated segments using machine learning.

2. DATA DESCRIPTION

The translation memory analyzed for this article has been in use for almost 15 years and contains parallel translation segments in English and Slovene. Initially, it was meant to store Marketing, Legal and Financial translations, but over the years various other domains have been stored in this translation memory. In addition to the three domains mentioned above, this translation memory also contains a large chunk of IT-related segments, such as user interface strings, user assistance texts and technical documentation of various IT devices (printers, scanners, monitors etc.). Given the content of these documents, we expect to see some overlap between domains – for example, a printer user manual will typically contain some legal information as well as some marketing-like language.

3. EXPERIMENTS

The most obvious way to go about this task would be to manually annotate a dataset from this translation memory and then use it to train a classifier. However, manual annotation is time consuming and costly, so we first utilize OntoGen [4], a semi-automatic and data-driven ontology editor focusing on editing of topic ontologies, and then use the resulting ontology topics for building a text classifier that could be used for other translation memories and documents.

3.1 Preprocessing

The first step involved extracting the segment pairs and filtering them. The Slovene segment parts were discarded because only one language is needed for this task. English was chosen because it is the source language in this translation memory. The TMX file contained 247,103 English-Slovene segment pairs. To cut down on the noise and remove the segments most difficult to classify, we decided to remove all segments with less than 8 words leaving us with 121,593 segments.

3.2 Ontology creation

The selected segments were saved in a Named Line-Documents format suitable for OntoGen. Given the size of the file, the processing in OntoGen was slow-going. We tried various approaches in OntoGen and finally settled on using k-means clustering (with k=10) functionality to generate various sets of segments corresponding to different keywords and then manually group them into meaningful domains based on our translation experience with this translation memory.

After experimenting with various ontology building techniques in OntoGen, the following topic ontology was constructed (followed by the number of documents in parentheses): IT (51,247) (subdivided into ITGeneral and User Interface), Marketing (11,567), Financial (12,987), Legal (42,163) (subdivided into Contracts, Tenders and IT Legal¹).

A graphical representation is shown in Figure 1.

3.3 Classification

In the final step we exported the domains from OntoGen, attached them to their corresponding segments and loaded

¹This group contains segments from privacy policies and license agreements of various software applications



Figure 1: Ontology visualization: 4 main domains are extracted (Financial, Marketing, IT, Legal) with two of them having additional subdomains

the data into Weka machine learning toolkit. We tested various machine learning classification algorithms (Naïve Bayes Multinomial, SVM, J48) to find which one gives the best results. 10-fold cross-validation was used for all experiments. We applied Weka's StringToWordVector filter and used a stoplist (300 most frequent words from the BNC [2] corpus) to filter out the most common words.

In the first phase, we have both topics and subtopics – where a subtopic existed, we glued the topic and subtopic together to get a distinct class. This means we had 7 distinct classes: ITUserInterface, ITITGeneral, Financial, Marketing, Legal-Contracts, LegalTenders, LegalITLegal.

In the second phase, we used only the main topics – meaning that 4 classes were used: IT, Financial, Marketing, Legal.

Because the original dataset was fairly large (more than 100.000 segments), we had to significantly reduce it in order to be able to complete the calculations in Weka in reasonable time. However, we couldn't just take the first n segments, because the different topics were not uniformly distributed across the dataset. Therefore, we took every 10th segment, leaving us with a dataset of about 10,000 segments.

Tables 1 and 2 contain information about the performance of the three classifiers mentioned in section 3.3. For a detailed analysis see section 4.2.

4. EVALUATION AND INTERPRETATION OF RESULTS

When one evaluates the results of the hierarchical clustering by OntoGen and classification, one should bear in mind that in many cases no clear boundaries between domains exist. This was to be expected on the one hand due to the short length of the documents, and on the other due to the seg-

Table 1: Classifier performance with 7 labels (accuracy of the ZeroR classifier for the majority class = 0.349)

	J48	SMO	NB Multinomial
Accuracy	0.511	0.495	0.583
Precision	0.507	0.483	0.581
Recall	0.511	0.495	0.583
F-measure	0.472	0.483	0.580

Table 2: Classifier performance with 4 labels (accuracy of the ZeroR classifier for the majority class = 0.406)

	J48	SMO	NB Multinomial
Accuracy	0.597	0.619	0.671
Precision	0.615	0.608	0.678
Recall	0.597	0.619	0.671
F-measure	0.576	0.610	0.673

ments that are very difficult to assign to a single domain, for example:

- The system must support operation of the HSM system and the archiving of files even if the file system operates in the Windows cluster.
- The latest Windows operating systems have a firewall built in.

The first sentence comes from a tender document, while the second one comes from an IT user manual. Even for a human annotator, this would be a difficult task and we would most likely see low levels of inter-annotator agreement.

4.1 Ontology creation

To evaluate the results of ontology creation in OntoGen, we extracted 50 random segments for all 7 topics/subtopics, manually annotated them and compared the results.

Overall, a precision of 0.81 is quite good considering that we are working with sentences which are difficult to classify. It is also important to not lose sight of the fact that there can be some overlap between the topics and that certain sentences cannot be adequately classified into any of the available topics. The overlap between the various topics causes a certain degree of ambiguity, but we believe that

Table 3: Manual evaluation of the ontology resultson 50 segments per domain

Topic	Precision
Financial	0.76
ITGeneral	0.80
ITUserInterface	0.86
LegalContracts	0.80
LegalITLegal	0.86
LegalTenders	0.78
Marketing	0.80
Average	0.81

the precision is high enough to use the topics extracted in OntoGen as class labels for building a classifier.

4.2 Classification

The results of the classification with 7 labels are not promising. The performance of all classifiers does exceed the majority class classifier significantly, but the accuracy is not high enough for production use (close to 60% for the best performing classifier). Looking at the confusion matrix in Figure 2, we can observe that the ITGeneral topic overlaps with quite a few other topics and is the largest culprit for the low performance. A significant part of the false positives originate in the ITGeneral topic for all topics apart from Financial and LegalContracts (class c and e in Figure 2). These two topics also have the highest precision (0.688 and 0.668, respectively).

((JIIIUSI	LOTI Ma	ILL'IX				
а	b	с	d	e	f	g	< classified as
236	258	10	24	13	39	25	a = ITUserInterface
197	2512	80	380	137	267	118	<pre>b = ITITGeneral</pre>
7	131	817	73	231	41	18	c = Financial
7	372	46	511	56	115	9	d = Marketing
9	187	183	52	1321	121	108	e = LegalContracts
9	401	43	150	152	447	38	<pre>f = LegalTenders</pre>
12	164	8	20	68	34	325	g = LegalITLegal

Figure 2: Confusion matrix of the Naïve Bayes Multinomial classifier - 7 labels

When we focus only on the main 4 labels, the results are better. Naïve Bayes Multinomial is again the best performing classifier with its accuracy reaching a little over 67%. Looking at the confusion matrix in Figure 3, it is evident that the first 3 labels perform significantly better than the last one. Indeed, the precision of Legal, IT and Financial is around 0.7, while that of Marketing is just a little over 0.4 (for detailed results see Table 4).

=== Confusion Matrix ===

а	b	с	d	< classified as
2482	838	261	271	a = Legal
566	3206	80	447	b = IT
268	126	852	72	c = Financial
163	336	50	567	d = Marketing

Figure 3: Confusion matrix of the Naïve Bayes Multinomial classifier - 4 labels

	Precision	Recall	F-measure
Legal	0.713	0.644	0.677
IT	0.711	0.746	0.728
Financial	0.685	0.646	0.665
Legal	0.418	0.508	0.459

Table 4: Detailed performance of the Naïve Bayes Multinomial classifier

The largest issue that we have not been able to overcome in this analysis is that a huge chunk of the segments in this dataset are IT related – this is especially true of the Marketing and certain Legal segments (e.g. terms of use, privacy statements or press releases or advertising material for IT devices) which means that it is often difficult to differentiate between a Legal/Marketing segment and a regular IT one. This issue is very clearly seen in the confusion matrix in Figure 3. In contrast, the Financial segments have no immediate relation to any IT content making them a much more distinct category.

5. CONCLUSION AND FUTURE WORK

This paper tries to determine whether text mining techniques can be used to facilitate translation memory maintenance in a language service provider environment. Given the fast-paced nature of work in the translation industry, it is only natural that the quality of translation memories reduce over time. Even if they are perfectly designed, noise will inevitably be introduced leading the reduced usefulness for other language applications.

At the outset, we had two questions: 1) whether OntoGen can be used to divide the content of a particular low-quality translation memory, and 2) whether the resulting topics can be used as labels to build a classifier for other translation memories and documents. The main reason was to find a shortcut for manual annotation which is costly and timeconsuming.

We successfully managed to build an ontology, but the boundaries between some topics were relatively vague. One reason for this is that we had to deal with sentences – as opposed to larger chunks of text – which are difficult to classify. The second issue was the fact that many of these topics were in fact inter-related and some of the segments could have easily been classified in more than one domain. In particular, the Legal, IT and Marketing domains are closely related, because a lot of Legal and Marketing segments originated in IT-related translation jobs. One could argue that the IT and Marketing domains could be combined into one category, since there is so much overlap, however from a strictly translator's point of view it makes sense to have separate categories, because different translation strategies are normally used for marketing (i.e. press releases) and general IT (i.e. user manuals, help articles) translation jobs.

The results of the ontology creation were promising with manual evaluation (see Table 3) showing that around 4 in 5 strings were assigned a correct label. However, the picture was much less clear when it came to building a classifier. It turned out that the full ontology was too complex for the classification algorithms used in this paper (see Section 4.2). When we used only the four main topics as labels, the results started approaching acceptable with an accuracy of 67% (compared to 0.406 as majority class). We would still ideally like to see the accuracy breaking the 75% or 80% barrier.

In the current state, the classifier is not accurate enough to be used in production. However, when there are reasonably clear boundaries between topics in OntoGen, the resulting labels can be successfully used – as evident by the performance of the Financial label. This is in itself a useful achievement, because there is currently no way to export just the finance-related segments from the translation memory. An obvious route to better classification performance would be to use just those topics that are clearly separated from the other parts of the dataset.

In terms of future work, we will explore text classification on manually annotated high quality translation memories. Finally, an interesting route would be to utilize domain terminology to enhance highly domain-specific terms assigning higher weight to terminological features.

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Audience Segmentation Based on Topic Profiles

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ABSTRACT

Audience segmentation is often applied on Web portals to gain insights into the audience, support targeted marketing and in general provide on-line recommendations to the users. We propose an approach to audience segmentation that is based on using machine learning on topic profiles of the visited content. Our preliminary experiments on a small sample of log-data show that the proposed approach is promising and the proposed combination of features capturing short term and long-term user interest gives better results than using only the short-term interests of the user.

1. INTRODUCTION

Large number of retuning users regularly visiting the same Web portals offer an opportunity to apply audience modeling considering descriptions of the visited content, different characteristics of the user and the user behavior. Instead of the usual audience segmentation based on user profiles that is also commonly adopted in recommendation systems [1], we propose an audience segmentation approach that is based on the topic profiles of the visited content. As the users potentially have interests in different topics we allow the same user to occur in several segments.

In this paper, we described the proposed approach and on a small sample of real-world log-data test the hypothesis that the proposed combination of features capturing the content of the recently visited pages and the properties of all the pages visited by the user improves the quality of the segmentation.

The rest of this paper is structured as follows. Section 2 describes the problem setting and the dataset used in the experiments. The proposed approach is described in Section 3 together with the description background knowledge that we have used for mapping form the space of users into the space of topic profiles. Section 4 gives the results of the preliminary experiments, while the conclusions are presented in Section 5.

2. PROBLEM SETTING AND DATA

High-quality Web portals that offer regularly updated content, such as market data, news articles or financial data, attract many loyal users [2]. Today, vendors offer user data

obtained by third-party cookies that cover a whole range of user properties including demographics, interest, geography. The problem that we are addressing is automatic audience segmentation where potentially vendor data on the users is available in addition to the usual Web log files and content of the visited pages. In addition we propose to use background knowledge in the form of pre-trained machine learning model that classifies Web pages into a predefined custom taxonomy. In this way, each Web page is based on its textual content assigned a ranked list of content topics of different granularity. For instance, the assigned topics may be Business, Business/Financial_Services/Medical_Billing, Business/News_and_Media, Society/Issues/Gun_Control.

The dataset that we have used to test the proposed approach was obtained from an international media company. Almost 3 000 Web pages were crawled from the company Web site. The anonymized user data was obtained for more than half a million users that have visited the Web site within one selected day. All the considered text is in English language.

We have pre-processed the data to remove references to Web pages that have limited textual content or un-standard formatting. The Web pages were processed in a standard way to extract the textual content, remove the standard English stop-words and represent each Web page as a bag-of-words (BoW) with TFIDF weight. In addition to the content, each page has metadata including a set of manually assigned content labels done by the editorial team. For instance, brexit, Europe, money, davos, jobs, London, markets. These content labels were historically used to annotate the users visiting the pages. Each user is thus described by a set of properties including demographics and the content labels of the pages visited over a longer period of time.

3. APPROACH DESCRIPTION

Audience segmentation is commonly based on grouping the users by their common interests and some other e.g., demographic properties and behavioral similarity. However, the same user may have several interests and exhibit different behavior depending on the current focus. This may result is grouping together the users that do not have much in common except that they share some (but not the same) interests with the third user. Thus we propose an approach to audience segmentation based on the similarity of the topics that the users are interested in. The idea is to view the problem through topics of the visited Web pages and based on that obtain segments of the users.

Architecture of the proposed approach is shown in Figure 1. The whole pipeline consists of several steps:

- 1. From the log file of the user visits we obtain a list of visited pages (URLs).
- 2. By using background knowledge in the form of machine learning model for classifying documents

into a predefined custom taxonomy, we assign a ranked list of topics to each URL.

- 3. For each URL we select one or a few topics with the highest rank and form a collection of URL Topic pairs.
- 4. Representation of the topics is based on a list of URLs that were assigned the topic and the list of UserIds of the users that visited the URLs.
- 5. Topic profiles are processed by a clustering algorithm to obtain segments of the users.



Figure 1. Architecture of the proposed approach to audience segmentation. The user visits of the Website and combined with the visited content and properties of the users to obtain segments of the users based on the topic clusters.

As topic profiles are built around the URLs that were assigned the topics using background knowledge, we separately keep a list of UserIds for each URL (obtained from the log file). When constructing features for each topic, we combine different data source:

- content of the Web pages visited by the users,
- properties of the visited pages,
- properties of the users, and
- information about the visits.

Background knowledge that we have used in the experiments is based on a subset of a large custom taxonomy [2]. The subset was defined by the domain expert from the company of the Web portal and consists of several hundred of topics.

We use DMOZ classifier with custom taxonomy to classify each Web page into a hierarchical content topic. Pages can be classified into topics on different levels of hierarchy, where lower levels give more specific classification. Upper levels also give context to the lower levels of classification. If we compare the following two topics that mention aerospace in their hierarchy:

- Science/Technology/Aerospace,
- Business/Aerospace_and_Defense/Aeronautical,

we can see that the first content topic is put into the context of Science and Technology, whereas the second is put into the context of Business and Aerospace and Defense. This approach gives us more information about the content topic.

In our experiments, content of the Web pages is obtained by crawling the Web portal. User data including properties of the visited pages is obtained from the Vendor data.

4. EVALUATION

Source

In the experimental evaluation we combine two sources of data: URLs from the log file and the user data from the user's history. The two features sets used for data representation correspond to these two data sources: bag-of-words from the Web page corresponding to the URL; the user interest in the form of a collection of content labels of the Web pages visited by the user over a longer period of time (see Table 1).

No. of

values

Table 1. Features used for audience segmentation.

Description

Wah naga	BoW - Words from the	
web page	Web pages	59929
User	Content Labels of the	
interest	visited Web pages	1268

To compare the influence of different feature sources on the obtained segmentation we use a cluster dispersity measure. Specifically, we measure the weighted average distance between the examples and their centroid normalized by the average distance to the global mean (i.e. center of the data). The formula is given below:

$$D = \frac{\sum_{i=1}^{k} \frac{n_i}{n} \sum_{j=1}^{n_i} \frac{1}{n_i} d(\mu_i, x_j)}{\frac{1}{n} \sum_{i=1}^{n} d(\mu_i, x_j)} = \frac{\sum_{i=1}^{k} \sum_{j=1}^{n_i} d(\mu_i, x_j)}{\sum_{i=1}^{n} d(\mu_i, x_j)}$$

D represents the dispersity, *d* is a distance measure (in our case cosine distance), n_i and μ_i are the size and centroid of the *i*-th cluster, x_j is the *j*-the example and μ is the global mean. Intuitively, examples in more compact clusters will lie closer to the centroid and so will contribute less to the dispersity than more disperse clusters.



Figure 2 Experimental results comparing relative mean centroid distances for the three data representations over different number of clusters (*k* ranging from 20 to 200).

The experiments on clustering topic profiles were performed on three different data representations. One that considers only content of the visited pages, one that considers only user interest and a combination of the two feature sets. We have applied k-means clustering, varying the value of parameter k(the number of clusters) form 20 to 200. As the results of the applied clustering method depends on the random seed for choosing the initial clusters, we have repeating the process five time for each value of k. Figure 2 shows the results of the experiments averaged over five runs.

We can see that the smallest distance of topic clustering is obtained when the data is represented only by user interests, which represents a long-term interest of the user on an aggregated level. This can be particularly attributed to the fact that the number of different content labels is much smaller than the number of different words from the page content. Combining user interest (capturing history of the user) and page content (of pages visited in the considered log file) gives better results than using only page content.

Looking at the topic clusters that we have obtained, we can see that the similar topics are clustered together (see Table 2). For instance, the topics such as Health/Addiction, Business/Chemicals/Wholesale_and_Distribution, Recreation/Drugs are in the same cluster.

Table 2. Illustrative example of some clusters obtained when generating 50 clusters using both feature sets. For a few selected clusters we show the topics that belong to the cluster.

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Business/Biotechnology_and_Pha	Recreation/Models	Home/Personal_Fin	Health/Addictions	Business/Financial_Service
rmaceuticals		ance		s/Venture_Capital/Regional
Health/Child Health	Science/Astronomy		Recreation/Drugs	Business/Transportation_an
Health/Clind_Health				d_Logistics/Bus
Health/Conditions and Diseases/			Business/Chemicals/W	Business/Transportation_an
Cancer			holesale_and_Distribut	d_Logistics/Rail
Cancer			ion	
Health/Conditions and Disasses/			Business/Food_and_R	Government/Agencies
Immuna Disorders			elated_Products/Bever	
Ininune_Disorders			ages	
ealth/Conditions_and_Diseases/In			Science/Biology/Bioin	Recreation/Autos/Makes_a
fectious_Diseases			formatics	nd_Models/Honda
Haalth/Dharmaay			Society/Issues/Gun_C	Science/Environment
Health/Filailliacy			ontrol	
				Science/Environment/Carb
				on_Cycle,

To obtain audience segments from the clustering of the topic profiles, we map the topic clusters onto a set of UserIds based on the user visits of the URLs that are classified to each of the topic in the cluster. In this way we obtain non mutually exclusive audience segments. The average number of users per segment is given in Table 3. From the table we can see

Table 3. Average size of the audience segments in relation to the granularity of the segmentation.

No. of segments	Average size	Median size
20	43592.35	589.5
50	17436.94	301
100	8718.47	229.5
200	4359.235	193

5. CONCLUSION

We have proposed an approach to audience segmentation based on topic profiles of the visited Web pages instead of the commonly used user profiles. The topic are obtained by classifying the visited Web pages into a custom taxonomy. The classification is performed automatically using a pretrained machine learning model. The topic profiles are formed from properties of the users visiting the Web page that are classified into the topic, and the content of the Web page.

Preliminary experiments on a small sample of log-data show that the proposed approach is promising, grouping together similar topics and based on that segmenting the audience into reasonably populated segments. Namely, one of the issues with audience segmentation when the users have multiple interests is that many users that are not similar to each other are assigned to the same segment, due to similarity with the other users form the same segment.

Larger scale experiments are needed in the future work to confirm the results and provide additional insights into the other properties of the users form the same segment, such as demographics, geography, job.

6. ACKNOWLEDGMENTS

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Building Client's Risk Profile Based on Call Detail Records

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ABSTRACT

Data collected from mobile phones can be used to uncover underlying social network dynamics and individual's behavioral patterns. Based on a Call Details Records dataset, we build a weighted, directed network and analyze it's properties. In addition to node-level network measures we extract an extensive consumption and mobility-based feature set. We show that extracted network and consumption features can be used to model individual's risk profile.

Keywords

Mobile Phone Network, CDR, Supervised learning

1. INTRODUCTION

The Call Detail Records (CDR) dataset is a relatively standard dataset obtained by mobile phone operators. One record in the CDR dataset corresponds to a communication event between two mobile phone users and includes time stamp, type of event (call, text), direction (in- or outgoing) etc. This data type reveals behavioral patterns that can be used to identify user's personality [2], spending habits [11] or socioeconomic level [5]. Here, we are interested in using the data to build each client's risk profile; in particular, we attempt to use this data to predict user defaults. To this end, we focus our analysis around whether the clients phone number was blocked at the end of month (indicating issues potentially related to the defaulting behavior), using this data to label clients as good or defaulted. The dataset used is completely anonymised.

Structure of the rest of the paper is as follows: Section 2 presents characteristics of the network built from the CDR, Section 3 describes feature extraction, Section 4 presents probability of default models and their evaluation and Section 5 concludes the paper.

2. NETWORK PROPERTIES

As the first step in analyzing the dataset and gaining an understanding of how the users operate we define the structure of the network. Here, we treat the mobile data set as a social network where each node is an individual and each edge represents a connection between them and another individual. Wherever possible, we use weighted, directed edges to preserve the strength of the connection between individuals [4]. Weights are assigned based on the frequency of outgoing communications between the source node and the target node. Where applicable, we use this metric to define the distance between two nodes as $w_{avg}/w_{i\rightarrow j}$ where w_{avg} is the average weight of all connections in the network and $w_{i \to i}$ is the weight of the connection between the source (i) and the target (j) [6]. Wherever it is not feasible to use a weighted edge scheme, we create an unweighted graph using a cutoff to define how many outgoing communications from one node to another constitutes a connection (ie we use the frequency to define whether a connection exists at all, and all connections are still directed but have equal weight) [5]. Using a low cutoff introduces a lot of noise into the system and is less representative of a true social network as many of the edges are too weak to accurately indicate a social connection between two individuals, but choosing too high of a cutoff restricts the network and discards potentially valuable data connecting nodes and communities together.

Using these methods, our data set translates to a network with a giant component comprising 99.14% of the it. Of course, the number of edges and size of the giant component decreases quickly when the unweighted cutoff scheme is used (Fig. 1). The size of the giant component decreases linearly with increases in the cutoff, while the decrease in the number of edges levels off as a power law with $\gamma \approx 0.75$. The degree distribution also changes slightly with the cutoff than without; in both cases the distribution has a fat tail that is well approximated by a power law, but the exponent increases with a larger cutoff. For the general case of the weighted edges with no cutoff, the power law tail has an exponent of $\gamma \approx$ -4.3 while with a high cutoff such as thirty the power law tail exhibits an exponent of $\gamma \approx -6$ (Fig. 2), both in general agreement with prior work on mobile network data [5, 7]. Similarly, the distribution of node strengths (defined as the sum of the weights of its adjacent edges) also exhibits a heavy tailed decay as expected [7].



Figure 1: (a) The size of the giant component G as it decreases linearly with higher cutoff criteria to form an edge between two nodes. (b) The total number of edges in the system decreases as a power law with $\gamma \approx 0.75$.



Figure 2: (a) The degree distribution for various cutoff criteria to create an edge between two nodes. As the cutoff increases, the peak of the distribution shifts left until it peaks at zero. (b) The same distributions on a log-log scale to highlight the power law tail of the distributions. Shown here are the two extreme cutoffs tested in order to highlight the increase in the gamma value for higher cutoffs.

Additionally, we study the distribution of some higher level node based measures such as reciprocity[14], which is surprisingly low. Without a cutoff only 38.65% of all links are reciprocated, while higher cutoffs increase the fraction of reciprocated links up to a maximum of only 41.57% when the cutoff is fifteen. We further measure the reciprocity using the weighted network scheme by defining the weighted reciprocity[12, 13] as $R_{ij} = |w_{ij} - w_{ji}|/(w_{ij} + w_{ji})$. Using this metric, the network shows an average weighted reciprocity of only .3235, further indicating the low reciprocity of the network.

Finally, we use node centrality to measure how the nodes position themselves in within the communication paths across the network (nodes with high centrality are most likely to connect communities and therefore are very important to the study of how risk patterns propagate across the network). For this purpose, we utilize the closeness centrality[1, 10, 3], a node level measurement that utilizes the shortest paths across the network to identify where nodes lie in the network structure. Specifically, it is a ranking of the distance from the node in question to every other node, defined as $C_C(i) = (N-1)(\sum_{i \neq j} d_{ij})^{-1}$ where C_C is the closeness centrality and d_{ij} is the length of the shortest path between nodes i and j (assuming a path exists). Unfortunately this measure only works on connected graphs, so to analyze the full unconnected graph, we also study the harmonic closeness centrality [9, 8], defined instead as $C_H(i) = \frac{1}{n-1} \sum_{j \neq i} \frac{1}{d_{ij}}$. As seen in Fig. 3, the closeness

centrality has a tightly grouped, high density of relatively high values. This implies a very well connected graph such that the shortest path between any two nodes is low. This can further be seen via the harmonic centrality, which also has a relatively low density of low scoring individuals even with the inclusion of nodes not within the giant component. This implies that even the nodes that are not connected to the giant component tend to form small, tightly connected communities of their own.

3. FEATURE EXTRACTION

After understanding the network dynamics, our aim was to build individual's behavioral patterns. For that reason we extracted from the CDR three types of behavior-related features: individual's consumption, social network and mobility. Some of the features were extracted for different time window (e.g. per day, per week, hour of day), separately for incoming and outgoing events and/or separately for event type (call, text). We also added another more technical category which relates to individual's position in the underlying network. Together, more than 6000 features were extracted. Each category is described in more detail below.

- 1. Consumption features: These features are related to individual's usage of the mobile phone. We extracted for each individual the number of all calls, number of all texts, total duration of calls, average duration of calls, average time between consecutive events.
- 2. Social network features: This type of feature focuses



Figure 3: Distribution of closeness and harmonic centrality scores across the network where higher scores indicate a more central position in the network. The closeness centrality only considers nodes in the giant component (and the distribution is therefore only calculated for those nodes). The harmonic centrality includes all nodes in the network.

on the number of contacts and reciprocated events: the number of unique contacts, the number of contacts with which individual exchanges on average at least 5 texts per week / 2 calls per week, the number of reciprocated call events, the median time between reciprocated call events, and the median time to answer text.

- 3. Mobility features: These features that are based on used BTS tower location and include the average daily radius of gyration, the average distance traveled per day of week, the popular cell towers that sum up to 90% of records, and the average number of unique cell towers used per week.
- 4. Node level network measures: These features all rely on the individuals location within the social network built off of their usage statistics. The details of these metrics are discussed in Section 2, and represent each nodes level of importance to the overall social network as well as how deeply embedded the individual is.

3.1 Geographic analysis

Geographic analysis was performed to help us with the specific goal of building individual's risk profile. Analyzing geographic features requires a definition of their location that considers that most people connect to many different cell towers over the course of a three month period. For our purposes, we use each user's top two most used cell towers. We assign an individual to both their most used and second most used towers to account for the likelihood that a user will spend large amounts of time both at their residence and their workplace. From there we analyze the number of people that exhibit default behavior for each tower or district and identify high risk geographic regions. Based on that analysis we calculated empirical probability of default for each cell tower. These probabilities were used as two additional features, one for each of the two most commonly used towers of each user.

4. MODELING

Our aim was to model probability of default for each client based on extracted phone usage patterns and node-level network measures. We present the results of fitting several linear regression models with varying parameters. Features that are described in previous sections were used for modeling, and all features were normalized to standard score (z-score). We divided our dataset into train- and test set in 70:30 ratio.

We started with a linear model (labeled as glm-6 in Figure 4) that was based only on six predictor variables: frequency (corresponds to the node's strength), duration (of user's call events; sum), degree, harmonic centrality and the two geographic (cell tower PD) variables. We chose with these features because we believed that they carry a lot stronger signals in contrast to the other 6048 features. The p-value is < 0.01 for all, except for duration, which has a p-value of 0.97. Overall this implies that network measures are good predictors for default behavior.

4.1 Principal Component Analysis

Further, when dealing with larger amount of features (6048) principal component analysis (PCA) was performed on the train set for feature space reduction. PCA is a method that decomposes the feature space into principal components (eigenvectors) and also provides information about how much variance in the data each component explains. Selection of a subset of PCA components reflects a trade-off between 1) model simplicity (we want to include a moderate number of features in our models) and 2) total variance explained by the component subset. All features were subjects to PCA, except for the 6 features that were used in glm-6 model described above. Those were added to models in their original (but standardized) form.

We ordered the obtained PCA components decreasingly by explained variance of the data. The first component explains 20% of the variance, the second 7%, the first ten components together 37%, first thirty together 42%, and first five hundred sum up to 66%. We then created two linear models based on reduced feature subsets: first, using 30 PCA components and second, using 500 components (*pca-30* and *pca-500* in Figure 4). Because many variables in *pca-500* have large p-values, we fitted another model that didn't include those variables with p-value ≥ 0.5 (*pval-05*).

4.2 Oversampling

Only about 0.25% of users in the underlying dataset exhibited default behavior, which makes the dataset very unbalanced. For that reason, we implemented a simple oversampling method on train set: we multiplied defaulted users (and their features) by 20. The model using this method, *oversampled-20*, is also presented in Figure 4. Surprisingly, the oversampled dataset not only does not improve performance, but can be seen to provide slightly worse results than the originally unbalanced dataset.

4.3 Evaluation

Model comparison is presented in Table 1. We can see that at 95%, the level recall is high, up to 0.91 for both models based on 500 PCA components. Precision is low for all models due to the unbalanced dataset, but even with that drawback, our models still perform far better than random models.

Model	random	glm-6	pca-30	pca-500	pval-05	oversampled-60
Recall	0.05	0.13	0.79	0.90	0.91	0.86
Precision	0.003	0.007	0.042	0.049	0.049	0.046

Table 1: Recall and precision at 95% level for each of the models presented in Figure 4.



Figure 4: This graph presents prediction results on test set of the fitted models. y-axis corresponds to the false negatives (clients, that we're labeled as *good* but really defaulted), while x-axis corresponds to false positives. Results are shown for probability thresholds 0 - 1 with step 0.01. *pca-500* (purple) is to great extent covered by *pval-05* (green) since both models provide very similar results.

5. CONCLUSION

This paper presents an analysis of a mobile phone data using a social network representation and various prediction models to understand default patterns. The analysis on the underlying network reveals a large giant component such that most nodes have at least some path to any other node in the network. Further, both the nodes within and without the giant component exhibit relatively high centrality scores; meaning that nodes are form tightly connected communities such that the path between nodes is generally quite short. Further, many nodes have a high degree and the degree distribution exhibits a heavy power law-like tail. Using many of these properties as features, we were able to make even more accurate predictive models of default.

Our model evaluation shows that there are many variables that carry weak signals about user behavioral patterns that have a strong predictive power when aggregated together. The unbalanced nature of the dataset makes the fitted models have a high recall but low precision, yet they strongly outperform the random model in both measures.

There is still a lot of space for improvement in the modeling including testing more complex oversampling methods, fitting additional models (SVM, LASSO, ANN), and including additional node-level network measures and community detection analysis.

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Connecting Professional Skill Demand with Supply

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ABSTRACT

Todays job market demand from the job seekers to continuously learn new skills. When applying for a job position one must have the required skill set. If the applicant is missing a skill it can be learned by attending a course. Finding the appropriate courses can be tedious but necessary work to be up-to-date with the job market demand. In this paper, we present a dashboard which connects the job market skill demand with the courses that give the required skill knowledge. We developed a pipeline for continuous crawling of job postings and courses which feeds the dashboard with the appropriate data. The dashboard allows searching by keywords and returns relevant job postings, courses and basic statistics relevant to the given search query.

General Terms

Job Market, Skill Set, Courses, Lectures, Design

Keywords

Information Retrieval, Data Mining, Analysis, Wikifier, VideoLectures.NET

1. INTRODUCTION

In todays job market the required skills are constantly evolving. This can be seen in more technical fields such as web development and data science where new tools and libraries are developed and available to the public with an increasing rate. This is visible in both research and industry sectors where a job position might require a previously unseen skill and the applicant needs to learn it to be qualified. Finding the courses that would give the skill knowledge can be tedious and does not guarantee its sufficiency.

To this end, we developed a dashboard which would connect the job market skill demand with the courses that give the required skill knowledge. We focused on job positions that require data science skills and courses that are provided by acknowledged course providers. Inna Novalija Jožef Stefan Institute Jamova cesta 39 1000 Ljubljana inna.novalija@ijs.si

Our contributions are a) creating a sizable data set of data science related job postings containing the job postings title, description, locations and other information, and b) developing a dashboard which for a given query shows relevant job postings as well as courses and lectures which give the appropriate skills. The dashboard is daily updated with new job postings showing the most recent changes. Basic statistics such as the most popular job locations and skills are also shown.

The remainder of the paper is structured as follows. In section 2 we present related work. Next, data acquisition is explained in section 3 followed by the presentation of the dashboard in section 4. Finally, we discuss and conclude our work in section 5.

2. RELATED WORK

There are multiple blogs that write about top skills needed for getting a job in data science. One such blog is [14] which lists both non-technical and technical skills a data scientist should have in the coming years. Another blog [15] lists the top data science skills and courses where they can be learned. A lot of these blogs are not up-to-date and not reflecting the current state.

A research report [11] writes about connecting supply and demand in Canada's youth labor market. They were interested in finding what skills young adults acquired during their education, how employers demand is conveyed to students and those who support them and how well are the acquired skills utilized on the job. They presented their results but did not develop an application that would help to narrow the gap between the skill demand and supply.

Another report [13] talks about the mismatch of the skills young adults get during their education and the skills the companies demand. They found that skills are a critical asset for individuals, businesses and societies and that many employers report difficulties in finding suitably skilled workers. Additionally, they find that a sizable qualification mismatch is one of the biggest problems.

The company Year Up [9] helps young adults get the appropriate skills and the needed work experience. They identify motivated individuals and companies that are prepared to help, send the individuals to learn new skills and afterwards apply the newfound skills at the companies, getting the critical work experience for their career. The work is done

manually which can be expensive and time consuming.

3. DATA ACQUISITION

Open job positions can be found using job search services. These services aggregate job postings by location, sector, applicant qualifications and skill set or type. One such service is Adzuna [6], a search engine for job ads which mostly covers English speaking countries. Another service is Trovit [7], a leading search engine for classified ads in Europe and Latin America. The service is available in 13 different languages and provides listings of jobs as well as cars, real estate and other products.

When applying for a job position the applicant requires to have a certain skill set. If the requirements are not fulfilled, he can enroll in courses to get the missing skills. Additionally, watching certain lectures can give a deeper understanding of a particular problem which can increase the probability of getting accepted for a job position. Video-Lectures.NET [8] is an award-winning free and open access educational video lectures repository. It contains videos of individual lectures as well as lectures given at renown conferences.

Crawling. Since we needed a continuous flow of data, we developed a pipeline for acquiring job postings, courses and lectures. This will allow us to provide the dashboard, presented in section 4, with the most recent data. For job postings we targeted the portals like Adzuna with an emphasis on positions in Data Science and for courses we targeted different course providers, including Coursera [2], providing courses from top universities, and Hackr.io [4], a service which finds the best online programming courses & tutorials. We also targeted VideoLectures.NET to acquire video lectures containing the Data Science tag. The tags are given manually by the VideoLectures team.

For data acquisition and enrichment, we collected data either using dedicated APIs, including Adzuna API [1] as well as custom web crawlers. The data was formatted to JSON to aid further processing and enrichment.

Enriching. The next step of data preprocessing is *wikification* - identifying and linking textual components to the corresponding Wikipedia pages [16]. This is done using Wikifier [10] which also supports cross and multi-linguality enabling extraction and annotation of relevant information from job postings, courses and video lectures in different languages. Wikification will allow us to search for job postings, courses and lectures in multiple languages.

Next, we use the Skill and Recruitment Ontology (SARO) [17] to extract Data Science skills from job postings. For each job posting we match the Wikipedia concepts with the skills found in SARO ontology and declare the matched concepts as Data Science skills. These skills are then added to the job posting profile.

Finally, to allow searching by locations and countries the job postings were further enriched by using GeoNames ontology [5] to include the latitude and longitude and the corresponding GeoNames ID and the location name. **Data Set Statistics.** The job postings data set contains almost 3.3M job postings acquired in the period of 18 months. Job postings were located for 144 different countries, the majority of them from Europe. Figure 1 shows the top fifteen countries with most found job postings. The UK dominates other countries with 906k job postings, followed by France with almost 539k.



Figure 1: Top fifteen countries with most found job postings. The greatest number of job postings were found for UK, followed by France and Germany.

There were 650 unique Data Science skills extracted from the data set. These include soft skills, such as leadership and management, knowledge of a particular domain, such as machine learning and artificial intelligence, and programming languages. Figure 2 show the most demanded skills in the data set.



Figure 2: Top fifteen most demanded skills. They are mostly comprised of high-level skills, such as "database" and "computer science", and programming languages.

The course data set contains over 63k course information including their title, description and course providers. The data set is comprised of over 8k courses available online and 55k offline courses. Figure 3 shows the distribution of online courses by course providers. The most courses were acquired from Coursera with above 4k, followed by Hackr.io at 2k.



Figure 3: The distribution of online courses by course providers. The most courses were acquired from Coursera, followed by Hackr.io.

Finally, we acquired a data set of over 20k lectures published on VideoLectures.NET. It contains information about the lectures available on the video repository including title and description and link to the lecture.

4. DASHBOARD

Our objective is to automatically connect Data Science skill demand with the provided courses. To this end, we developed a dashboard [3] which enables its users to search for their desired job position, find out what is the required skill set and which are the appropriate learning materials and courses to acquire the missing skills. Additionally, the dashboard shows the most demanded skills and hiring location for the given results. In this section, we present the content retrieval methodology and describe the different components of the dashboard.

Methodology. Here we present the methodology used for retrieving the demand and supply content. The content is retrieved by inserting a query text in the search input. The user may add additional query conditions by selecting the Data Science skills, locations, countries and a time interval in which the job postings were published. Upon submitting, the query is used to fetch the content that matches the conditions. While all query values are used for retrieving job postings, only the input text and skills are used for retrieving the courses and video lectures content. Since courses and video lectures are available online the location and time interval are irrelevant for retrieving the supply content. To retrieve the content we first need to set an appropriate index. The job posting data set is indexed by Wikipedia concepts, Data Science skills, locations, countries and published date while the course and lecture data sets are indexed only by Wikipedia concepts. The query text is sent through wikification to acquire Wikipedia concepts which are used for retrieving the relevant content. Next, additional query conditions are used to filter out the content. The remaining content is used to calculate the most demanded skills and hiring locations. Finally, the query results are returned and used to update the dashboard components. This process is developed using QMiner [12], a data analytics platform for

processing large-scale real-time streams containing structured and unstructured data.

Components. The dashboard is composed of different components. The largest component is a list of job postings. Each job posting is presented by its extracted information, including the Data Science skills extracted from the title and description. Figure 4 shows an example of a job posting in the list. Since Wikifier supports cross and multi-linguality the list consist of job postings written in different languages.

DATA SCIENTIST / BIG DATA ANALYST

Raona, Barcelona, Spain PUBLISHED ON AUGUST 28, 2017

machine learnin

DESCRIPTION

En Raona buscamos un Data Scientist creativo, con ganas de empezar proyectos nuevos e imaginar aplicaciones donde podamos aplicar machine learning en nuestro... Hace 2 días en trabajos

Figure 4: Example of a job posting returned by the query "machine learning". Even though the job posting is written in Spanish the methodology finds it relevant.

If the user does not have the required skill set it can be acquired by enrolling into courses shown in the course list. The list shows courses offered by different online course providers that are relevant to the users input query. Figure 5 shows the component containing the course list. Left and right arrows are used to navigate through the list where each course is presented by its name and a course provider.



Figure 5: A sample of recommended courses for the query "machine learning". Clicking on a course redirects the user to the course provider where he can enroll.

Additionally, the user can watch lectures to get a deeper understanding of a problem. Similar to courses the video lectures list show relevant content found on VideoLectures.NET. Clicking the lecture redirects the user to the video lecture homepage.

The dashboard also shows them most demanded skills and job posting timeline. The timeline shows how did the ratio between queried and all job postings change since the start of the year 2016. Additionally, this shows a trend of the skill demand in the queried job posting subset. Figure 6 shows the visualizations used to show the skill demand and timeline.



Figure 6: On the left the ten most demanded skills histogram, and on the right the number of job positions timeline, for the query "machine learning". Hovering over the histogram column shows the number of queried jobs demanding the skill.

Finally, a world map shows the most popular hiring locations extracted from the queried job postings. The locations are at first clustered where upon zooming the clusters divide and the individual locations are shown. Figure 7 show an example of clustered locations.



Figure 7: Top hundred hiring locations for the query "machine learning". The clusters show the number of locations it contains.

5. CONCLUSION AND FUTURE WORK

In this paper we present the methodology for automatically connecting skill demand and supply. We acquired a sizable job posting and course data set, developed a methodology for retrieving job postings, courses and lectures relevant to the user query and created a dashboard for showing the retrieved content.

In the future we wish to improve the data enriching process by handling skills that are not in the SARO ontology and add new features and improvements to the dashboard.

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Analyzing raw log files to find execution anomalies

A novel approach to analyzing text-based log files to find changes in the execution profile of complex IT systems

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ABSTRACT

Anomaly detection (a.k.a. outlier detection) is the identification of events that do not conform to an expected pattern in a dataset. When applied to monitoring modern, complex IT systems, it keeps track of a plethora of incoming data streams. This paper provides an approach that uses the lowest and most unstructured source of data related to an IT system - the raw system log files. Several versions and parametrizations of basic building blocks will be presented to show how different types of anomalies can be extracted from the data. Several experiments on synthetic as well as real-world data show effectiveness of the algorithm. Special care is taken to keep the model and the resulting alerts interpret-able - since detecting an error without a meaningful explanation about its details is of limited use to end user (the results need to be actionable).

Keywords

Anomaly detection, Outlier detection, Infrastructure monitoring

1. INTRODUCTION

Modern IT systems are getting increasingly complex and distributed. On-line monitoring of their health is becoming critical for their normal operation. The data that is being collected about these systems comes in diverse time series (numerical, categorical, text), potentially huge in volume and arriving with different latencies. For instance, complex systems often expose metrics about their performance such as number of served requests or size of internal data structures. One can also monitor systems performance indirectly Jan Rupnik Jozef Stefan Institute Jamova 39 Ljubljana, Slovenia jan.rupnik@ijs.si

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by inspecting CPU load, network load or database communication patterns. Quality assurance of input and output data can also be performed, such as the number and the size of the data records. Spotting unusual behavior of such systems is crucial and unhandled execution problems can lead to catastrophic results. The anomalies can be very different in nature, from abrupt changes that occur within a second to the gradual decay of performance that is only observable on a weekly or monthly scale.

Most of the research about anomaly detection has been concentrated on outlier detection in numerical time-series (e.g. financial time series like in [5], time series arising from infrastructure monitoring) and discrete-event sequences (e.g. fraud detection like in [4], cyber-security applications like in [3]). Data representation (the way of encoding the relevant information) is vital to the practical performance of an anomaly detection approach (does it capture relevant events or just insignificant variation).

However, all of these numeric data series have to be "prepared" in advance. A developer had to think ahead about the potential problems that can arise and expose appropriate measurements. When this data is available, it can clearly signal the problem to the operators. But what happens when a new type of outage occurs and no measure to detect it was put in place? In such case the infrastructure maintainers typically resort to inspection of *raw log files*. Writing a line of text to console or file output is often the only indication that something happened or has not happened when it should have. In our experience, all complex IT systems produce such files and they are still used to solve the hardest problems and errors.

The log files may be very unstructured in practice and may contain extremely diverse information. From errors, warnings, database calls and initialization steps, to casual counters and observations. The log lines themselves may be unstructured: their content might be unordered and they may contain text written in natural language (e.g. error messages). Even then, these bits of information may or may not be written in a easy-to-parse form (e.g. JSON format). The only thing that can be expected of each line is a *timestamp* a clear indication of time on the server, when this particular line was written to the log. Even if this data is missing from some lines, the sequential order of writing to file helps us narrow down the possible timestamp for each line. We can simply choose to re-use the last timestamp before that line.

Many algorithms and approaches to anomaly detection have been proposed in the literature. [1] provides an excellent overview of the field. New approaches are getting increasingly more sophisticated at dealing with multidimensional numeric data, discrete, sequential or even spatial data. The unstructured nature of raw log files makes the problem amendable to text-mining based approaches. This article presents work in that direction.

2. ANOMALY-DETECTION

End-users in charge of maintaining a large IT system will typically be concerned with two types of anomalies. Either they will want to avoid a sudden, critical degradation of performance, or they will want to know if the performance has been slowly degrading and attempt to prevent that.

Abrupt change - In this scenario, the system "falls of the cliff" - performance plummets and multiple parts of the system typically experience severe problems. Users will most often be notified of the problem via many channels. Hence, the raw log files are not the first place they will start looking at. However, if the cause of the problem cannot be determined or the exact timeline of events of the disaster cannot be established, the information from the log files will also be used as a part of the forensic analysis.

Gradual deterioration - IT systems that have been in production environment for a long time can experience gradual changes. These changes do not necessarily cause catastrophic failure overnight, but degrade the performance over a longer period of time. Such changes are very difficult to detect by the programmer as they are very subtle, e.g. they are only observable on the monthly scale. And often the only place where this can be detected is with a long term analysis based on the raw log files.

2.1 General pipeline

Algorithm 1 shows the general structure of a typical anomalydetection system that operates on a stream.

First, a data record is extracted from the incoming data. As stated before, the timestamp is always defined. The record can also incorporate recent past data (previous lines of log file) and contextual data (e.g. server overall status, holidays indicator).

In the second step a *score* is calculated that should reflect a record's anomalousness (non-normality, novelty). The simpler the score, the easier the subsequent steps are. Additionally, we prefer models and scoring functions that can easily be explained to the end user, since he is supposed to act on them. Lastly, the score should be constructed in such manner that the anomalous examples fall on one edge of the spectrum (e.g. the higher the score, the bigger the anomaly).





Figure 1: Text-processing anomaly pipeline

The score value is then used to decide if the incoming data record is an anomaly - either by comparing against some manually predefined static threshold or against a dynamic one, which uses historical score values to determine the threshold autonomously. Finally, in case of an anomaly, an alert is created that contains enough data to explain what was observed and why it was tagged as an anomaly.

Only when all of the above steps are done, we add the new data point to the model. We can store it internally in the model for some time, but we have no guarantee to be able to ever again access all the historical data (e.g. for retraining of the algorithm).

2.2 Defining normality

It is crucial for any anomaly-detection system to be able to tell what *normal* is, so that based on this notion it can say that something is *not normal*, i.e. anomalous. When available, domain knowledge and experience from human experts can be used to capture the appropriate aspect of normality in the data, which greatly improves the quality of the reported anomalies.

In general, however, the systems need the ability to autonomously define normality. This ability greatly depends on the scoring function and it is common practice to define it in a way that only the values on the border of observed values are indicators of an anomaly.

2.3 Detecting anomalies on raw log files

We will now present our approach to anomaly detection based on text processing techniques. The steps of the approach are given in Algorithm 2 and graphically presented in Figure 1.

The log parser processes a single line at the time and each

Algorithm 2 Log-file anomaly pipeline
while input data available do
read data from log file
parse data and extract BOW
insert into time windows
calculate distance in kNN
if score quantile above threshold then
create explanation using distance
report anomaly
end if
add record to model
end while

time emits a record with several features. In the second step we extract standard BOW (bag-of-words) feature vectors. There are several possible ways of how to extract features and how to weight each feature dimension. We chose to use a simple representation where we extract tags, such as server=x and process=mytask.tsk. We collect all these tags from the record and assign them weight 1. This means that individual lines can produce vectors of varying lengths, as they are not normalized. We could also normalize them or re-weight them using the TFIDF weighting scheme ([6]) to down-weight frequent tags.

To capture the wider context of each record, we aggregate a set of records within a time-window of predefined length and emit a combined record (simple normalized sum of all vectors) that represents that window. In the fourth step, we use the k-nearest-neighbor algorithm (kNN) to find which k windows from the past are the closest to current window. This unsupervised algorithm was chosen because it can handle skewed distributions very well.

The average distance of the k neighbors is used as an *anomaly* score: the further away an instance is to its nearest neighbor set, the more anomalous it is. The value of the parameter kis usually small, between 1 and 5. The best value depends on the data domain and should be determined by experimenting.

The absolute scale of the score may vary from problem to problem and also depends on the feature representation. For that reason we used a quantile based approach: we compare the anomaly score of a new instance with scores of recently observed data points (the size of the of recently observed data point set is controlled with a parameter learning window). If the score is higher than a large (example 0.999) fraction of scores (controlled by a parameter *nn_rate*), then we classify the instance as an anomaly. The quantile (1 nn_rate) directly controls the detection rate (0.001 corresponds to classifying 0.1% of instances as anomalies) under the assumption that the data distribution is stationary.

2.3.1 Tokenization

When tokenizing input tests we have several options. If we know that some common patterns exist on how the special entities are marked inside the text, we can extract them and create useful features for BOW step. For instance we can use message text directly to create BOW. Alternatively, we can just find identifiers of the origin of the message (e.g. process name, method name, class name, page name etc.)

Table 1: Synthetic Data - window $= 1 \min$

NN rate	Precision	Recall
0.003	0.06	1.00
0.001	0.15	0.66
0.0005	0.23	0.66

Table 2: Synthetic Data - window = 1 h

NN rate	Precision	Recall
0.05	0.07	0.66
0.03	0.14	0.66
0.01	0.33	0.33

and use these instead of whole texts.

2.3.2 Anomaly explanation

We construct the explanation for an individual alert by finding its nearest neighbor and subtracting one vector from the other and squaring each element of the resulting vector. Each dimension is thus attributed with an "anomalousness" score, and the highest scoring dimensions contributed the most to the distance to the nearest neighbor. The explanation to the user contains a sorted list of highest scoring dimensions (clipped to avoid information overload).

EXPERIMENTAL RESULTS 3. 3.1 **Evaluation**

In most real-world anomaly-detection cases we receive a dataset that is largely unlabelled. The labels we have usually denote some special catastrophic situations that users experienced and want to avoid in the future. The rest of the data can be assumed to be mostly "normal", but unknown anomalies may also remain in the dataset. The standard metrics to evaluate the performance of an anomaly detector are precision (#true anomalies / #predicted anomalies) and recall (#predicted true anomalies / #true anomalies). Low precision translates to a higher burden on the user that inspects the anomalies (each inspection has some cost) and low recall translates to missing many anomalies and increasing risk. If we suspect that the dataset is not labelled completely (unlabelled anomalies present) the precision might be estimated pessimistically and recall might be measured optimistically. In such cases manual inspection of false positives might lead to discovering new relevant types of anomalies present in the dataset.

3.2 Synthetic data

We generated log files by simulating parallel execution of several processes, each having a specific pattern of writing to log. We then manually inject 8 instances of anomalous entries, 2 per week, each pair occurring within one minute.

We use 10 days for the kNN learning window length, so there will be no anomalies in the first 10 days. For the length of the input-grouping window, we experimented with two settings: 1 minute and 1 hour. In the former setting we have 6 original anomalies, but in the later, we only have 3 since each pair of adjacent anomalies (they are 1 minute apart) gets collapsed into the same hour. We set the parameter k to 1 - thus making the explanation of the anomaly very simple.

Table 3: Web logs - an anomaly explanation example

	File	Val	Near	Contr	L
- [/shuttle/missions/sts-68/mission-sts-68.html	0.707	0	0.354	j.
Ì	/images/NASA-logosmall.gif	0	0.505	0.180	ĺ
- 1	/hthin/cdt main pl	0	0.416	0.122	1

Table 1 shows the results for windows of length 1 minute. When parameter nn_rate , which controls the sensitivity to outliers, was set to 0.03, it correctly detected all 6 manually inserted anomalies. Table 2 shows the results for windows of length 1 hour. This granularity of data is too coarse and hides certain anomalies that remain undetected.

3.3 Web-server logs

We analyzed browsing pattern logs from a production web server where the logs contained information on web-page and file requests. The specific feature of this web site is that it is almost completely static - there are almost no new pages being added to it, so the browsing patterns should be relatively constant. The dataset spanned a period of one month. We set the summarization window length to 5 minutes and the kNN comparison window length to 10 days. The parameter k was again set to 1 and the anomaly rate was set to 0.001. The parameters were hand-tuned.

When analyzing such data the anomalies that we are interested should capture both system failure (malfunctioning software, infrastructure failure) as well as malevolent behavior (denial-of-service attack (DoS), a hacker-induced scanning for exploits). In these cases the system should ideally produce anomalies with **strong dimensional outliers**.

We manually inspected anomalies where the strongest dimension contributed more than 30% of the total anomaly score. An example is shown in Table 3, where columns Valmeans value in current record, Near means value in the nearest record and Contr means contribution to the total distance. It turns out that these anomalies corresponded to the rare events when new content was added to the web page. No DoS or hacker attacks were detected in the observed time period. So the vector dimension for the file (mission - sts - 68.htm) was Val = 0.707. This file was not present in the nearest record (Near = 0) and this dimension contributed 0.354 of the total distance between this record and the nearest one.

4. CONCLUSIONS AND FUTURE WORK

We presented a novel combination of known approaches to anomaly detection using techniques developed in the field of text mining. Using these we were able to extract valuable information from raw textual log files that are normally only used for manual inspection and forensic analysis.

Our algorithm is based on processing log files, but many other sources of information can be used to extract anomalies in modern IT systems. Our long-term goal is to design what we call *Full-spectrum anomaly detection system* (FSADS) that will be able to import many different types of data streams, covering a wide range of aspects of an IT system (inputs, outputs, internal performance, database performance, network communications etc.). After each single source of data is analyzed and anomalies are extracted, the next step in FSADS will correlate them, determine critical signals (which anomalies have a high impact on system?), indicate possible root causes (what might have caused a particular anomaly?) and give predictions (what may follow after detecting a particular type of anomaly?).

The popularity of deep learning techniques ([7]) is also felt in the anomaly-detection field and we plan to study their application to multivariate analysis. Most often, autoencoders are used to create compact descriptions of the data and may also be used to highlight the dimensions with high reconstruction error. Another interesting approach is to use generative adversarial networks ([2]), where two neural networks are contesting in a zero-sum game: one network generates "normal" candidates and the other one discriminates between generated examples and true examples. We currently see two major challenges for broader use of deep neural networks in anomaly detection systems. The first one is the ability to explain the results to the end-user in an actionable way. The second one is processing of stream data and updating the model on-the-fly. Currently, existing and simpler techniques (e.g. kNN, clustering, statistical tests) provide much better support for these requirements. However, the linearity in describing the feature space is an issue that we would like to address in the future and deep neural networks present a promising approach.

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Usage of SVM for a Triggering Mechanism for Higgs Boson Detection

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ABSTRACT

Real-time classification of events in high energy physics is essential to deal with huge amounts of data, produced by protonproton collisions in ATLAS detector at Large Hadron Collider in CERN. With this work we have implemented a triggering mechanism method for saving relevant data, based on machine learning. In comparison with the state of the art machine learning methods (gradient boosting and deep neural networks) shortcomings of Support Vector Machines (SVM) have been compensated with extensive feature engineering. Method has been evaluated with special metrics (average median significance) suggested by the domain experts. Our method achieves significantly higher precision and 8% lower average median significance than the current state of the art method used at ATLAS detector (XGBoost).

Categories and Subject Descriptors

H.2.8 [Database Applications]: Data mining, scientific databases

General Terms

Algorithms, Measurement, Experimentation.

Keywords

Support Vector Machine, Gradient Boosting, Classification, High Energy Physics, Higgs Boson

1. INTRODUCTION

ATLAS and CMS experiments have announced discovery of the Higgs boson in 2012 [1]. Experiments have been conducted on Large Hadron Collider (LHC) in CERN in Geneva. The discovery has been succeeded by a Nobel Prize in Physics, awarded to François Englert and Peter Higgs. The existence of the particle, which gives mass to other elementary particles, has been predicted around 50 years ago [6][7][8].

Higgs boson decays almost instantly and can be observed only through its decay products. Initially the particle has been observed through $H \rightarrow \gamma\gamma$, $H \rightarrow Z^0Z^0$ and $H \rightarrow W^+W^-$ decays. These decays leave a signature that is relatively easy to interpret. The next steps required analysis of Higgs boson decay into fermion pairs: τ leptons or b quarks.

In this paper we focus on a special topology of $H \to \tau^+ \tau^-$ decay [9]. Due to similarities with other decays this particular decay is very difficult to classify. Distinguishing background (events that do not belong to the $H \to \tau^+ \tau^-$ decay) from signal (events that belong to Higgs boson decay) requires the use of state of the art machine learning methods.

In the past the task has often been solved with simple cut-off techniques based on statistical analysis, performed by expert users.

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Today advanced classification methods based on machine learning are used regularly.

State of the art methods for this type of problems include deep neural networks and gradient boosting [10][11][12]. Experiments at CERN prefer the usage of gradient boosting classifiers as they are able to evaluate large amounts of data (more than 20×10^6 events/s) [4].

The success of both methods is based on their intrinsic property of introducing non-linearity into the system. In our work we want to compare basic linear methods and Support Vector Machines (SVM) with different kernels to the state of the art models. Additionally, we want to enrich the data by intensive feature engineering.

The results of feature engineering can be used for further physical interpretation of relevant physical phenomena.

2. DATA

Dataset has been made public by the ATLAS collaboration for the Higgs Boson Machine Learning Challenge on Kaggle in 2014 [3]. It contains data from the ATLAS detector simulator (real labelled data would be impossible to obtain). The winning method from the challenge is being used in the ATLAS experiment today [4].



Figure 1. Distribution of signal (yellow) and background (green) according to most informative attribute DER mass MMC (mass of Higgs boson candidate) [5].

2.1 Data Description

Dataset consists of 250,000 instances. 85,667 represent signal, 164,333 represent background. Each instance consists of 32 attributes and 1 target variable. All the attributes are numerical (continuous), target variable is nominal (binary). 2 of the attributes

should not be used for classification purposes, as they represent id of the instance and probability of such an event happening in the experiment [4].

There are missing values in the data. 11 attributes could not always be measured due to characteristics of the detector. Distribution of the missing values is different for signal and for background.



Figure 1. Plot of 1st PCA component against the 3rd. Red dots represent signal instances, green dots represent background instances [5].

The signal is limited to the events representing only one possibility for $\tau^+\tau^-$ pair decay [4].

2.2 Data Understanding

The main task of our method is to separate the signal from the background, based on the ATLAS detector measurements. As vast amounts of data (a few terabytes/day) are generated within the process it is crucial that only the relevant events are detected and stored [4].

Exploratory analysis has shown (see Figure 1) that this task can not be successfully accomplished with simple cut-off techniques based on a single attribute. Figure 2 depicting PCA components plot is a bit more promising as parts of phase space can clearly be assigned to one of the classes.

Attributes are divided into 3 groups. First group contains 18 primary attributes (measured in the detector), second group contains 12 derived attributes (relevant physical phenomena calculated from primary attributes) and 2 metadata values (weight and event id). Detailed exploratory data analysis can be found in [5].

2.3 Data Preprocessing

ATLAS detector enables good precision of all measurements, therefore expected noise in the data is very small and it can not be further filtered. Missing values have been dealt with in two different ways. Firstly – we used "replacement with average" strategy to fill in the missing data and secondly, we generated additional binary features, representing missing attribute values.

SVM expects input data to be normalized, therefore the features have been normalized with average and standard deviation values set to 1. Data transformation has been handled with Pandas library in Python.

2.4 Feature Engineering

The main task of our work has consisted of extensive feature engineering, where non-linear combinations of features were introduced to overcome the shortcomings of linear SVM in comparison with gradient boosting or deep neural networks.

We have built new features from original attributes by transforming them with some common functions like e^x , x^2 , x^3 , \sqrt{x} and log(x). Additionally we have used k-means clustering to generate an additional attribute (cluster id). All the generated feature sets are shown in Table 1.

Table 1. Attribute s	ets used	for S	VM.
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Set	Description
1	Original feature set.
2	Added missing values.
3	Filtered missing values and all e^x derivatives.
4	Filtered missing values, e^x and all x^2 derivatives.
5	Filtered missing values, e^x , x^2 and all x^3 derivatives.
6	Filtered missing values, e^x , x^2 , x^3 and all \sqrt{x} derivatives.
7	Filtered missing values, e^x , x^2 , x^3 , \sqrt{x} and all $log(x)$ derivatives.
8	Selection of most relevant transformations by one attribute.
9	Unfiltered set of transformations by one attribute.
10	Unfiltered set of $x_i x_j$.
11	Set of attributes by one of HiggsML winners (Tim Salimans, DNN).
12	Unfiltered set of $x_i^2 + x_j^2$.
13	Unfiltered set of $e^{x_i^2 + x_j^2}$.
14	Unfiltered set of $\sqrt{x_i^2 + x_j^2}$.
15	Unfiltered set of $(1 + x_i x_j)^2$.
16	Filtered set of transformations by 1 and 2 attributes.
17	(8) with k-means cluster id.

Filtering of the features has been done manually, with a simple cutoff technique based on feature importance as obtained from linear SVM model.

3. MACHINE LEARNING METHODS USED

Baseline experiments have been carried out with simple cutoff techniques and linear methods like logistical regression and Naïve Bayes classifier. As state of the art methods we included gradient boosting and gradient boosting adjusted for the approximate median significant metrics (see Section 3.2) [11].

We are proposing to use SVM method [12]. Linear SVM can be used for feature selection with large number of attributes. It can discover most relevant features in a large feature set.

3.1 Brief Description of SVM

In our setting we are solving a binary classification problem. Let us assume, that the classes are linearly separable in our space. In general, there are many different hyper planes that can separate the two classes. Support vector machine (SVM) method is also called maximum margin classifier. There exists only one hyper plane that maximizes margin between the two classes [12].



Figure 2. Maximum margin of dividing hyper plane in SVM [5].

SVM classifier is derived from maximization of the margin, which can be translated into minimization of $||w||^2$ [5][12]. As we are dealing with data sets, where classes are not separable, we need to consider a soft margin method that would take into account classification error. SVM is therefore solving minimization problem of $||w||^2 + C \sum_{i=1}^n \xi_i$, where ξ_i is a classification error metrics and C is a parameter that controls the influence of ξ .

3.2 Brief Description of the Evaluation Criteria

Evaluation of the results is to be done with measures derived from confusion matrix (accuracy, precision, recall, F_1). The evaluation metrics (*approximate median* significance) is defined as

$$AMS = \sqrt{2\left(s+b+b_{reg}\right)\ln\left(1+\frac{s}{b+b_{reg}}\right)-2s}$$

s represents sum of event probabilities of true positives (signal), *b* represents sum of event probabilities of true negatives (background), b_{reg} is set to 10 and represents a pre-set regularization parameter. The metrics favorizes recall before precision. In real setting this algorithm is used as a triggering mechanism for saving relevant data. Probability for a positive example in the real data is only around $p \approx 2 \times 10^{-5}$, therefore we do not want to lose many of them.

4. EVALUATION

Experiments have been carried out in Python. Data loading and cleaning has been accomplished with Pandas library, implementation of SVM, scaling and other methods have been taken from scikit-learn package. Default parameters for SVM have been used.

On our system SVM learning phase took ~1 hour. For time optimization purposes normal evaluation with training and test set has been performed. Training set consisted of 225,000 and test set of 25,000 instances.

 Table 2. Evaluation of different attribute sets on SVM with linear kernel.

Attribute set	Prec.	Rec.	Acc.	F_1	AMS
1	0.665	0.548	0.749	0.600	1.999
3	0.748	0.655	0.805	0.698	2.526
4	0.748	0.654	0.805	0.698	2.528
5	0.740	0.657	0.802	0.696	2.478
6	0.743	0.683	0.809	0.712	2.547
7	0.734	0.690	0.807	0.711	2.516
8	0.732	0.670	0.802	0.700	2.482
10	0.744	0.705	0.815	0.724	2.582
11	0.694	0.584	0.768	0.634	2.201
12	0.744	0.705	0.815	0.724	2.583
13	0.744	0.709	0.816	0.726	2.581
14	0.744	0.705	0.815	0.724	2.583
15	0.744	0.710	0.816	0.726	2.578
16	0.740	0.684	0.809	0.711	2.553

Results from extensive feature engineering are shown in Table 2. Linar SVM performed similar to linear baseline methods (logistic regression, Naïve Bayes). AMS score was ~2.00. Best feature sets for linear SVM were (10), (12), (13) and (14). These feature sets include two-attribute transformations, e.g., $x_i x_j$. It is interesting to notice that filtered feature sets performed slightly worse. Extensive feature generation achieved almost 30% better AMS results (1.999 on basic feature set compared to 2.583).

Table 3. Evaluation of different methods and attribute sets compared to baseline and state-of-the-art methods.

Method and attribute set	Prec.	Rec.	Acc.	F ₁	AMS
simple window	0.560	0.824	0.716	0.667	1.579
log. reg. (1)	0.668	0.535	0.749	0.594	2.015
SVM-LIN (13)	0.744	0.709	0.816	0.726	2.581
GBC (8)	0.787	0.703	0.832	0.742	2.856
SVM-r (8)	0.791	0.718	0.837	0.752	2.940
opt. SVM-r (8)	0.907	0.446	0.793	0.598	3.451
XGBoost (1)	0.665	0.806	0.793	0.729	3.735

Table 3 contains results of baseline, state-of-the-art and the proposed SVM. Best feature sets for selected methods were chosen. Baseline methods are simple window (based on cut-off technique on candidate particle mass) and logistic regression. As state of the art methods we included: gradient boosting (GBC) and current state of the art (XGBoost, gradient boosting optimized for AMS).

Proposed methods are linear SVM, SVM with RBF kernel (SVMr) and optimized SVM with RBF kernel (opt. SVM-r).

Usage of kernels (RBF and polynomial kernels have been tested) improved AMS score for another ~15%. Because of the nature of SVM kernels in this setting 2-attribute transformations were less efficient than 1-attribute transformations. Selection of most relevant transformations by 1 attribute (set (8)) gave the best results. Method behaved better than gradient boosting classifier (GBC) on the same training set. However, methods were not optimized to maximize AMS score. The difference however suggests that the usage of SVM might be a promising way to proceed.

Finally we optimized SVM with RBF kernel for AMS score and compared it to XGBoost method, which implements gradient boosting, optimized for AMS. Optimization has been done based on threshold for SVM confidence score. Our method performs approximately ~8% worse than the state of the art. There is, however, a big difference with XGBoost. Our method yields higher precision than the other methods and still preserves very high AMS score. The proposed method also performs ~20% better than other SVM based methods reported in HiggsML Challenge [3].

5. CONCLUSION

In our work we have examined the potential of SVM for a triggering mechanism in high-energy physics domain. With extensive feature engineering we have also provided an interesting input for high energy physics experts, where most effective generated features could be analyzed through domain knowledge.

Our method achieves more than 200% better AMS score compared to cut-off techniques, based on statistical approach. Further, our methods achieves ~20% better AMS score than other SVM based methods reported by HiggsML Challenge competitors, but performs ~8% worse than current state of the art (XGBoost). There is however a significant difference between our method and state of the art. Although achieving comparable AMS score, our methods achieves much better precision. This might make SVM based methods valuable members of an ensemble method.

Beside adding SVM methods to ensembles and trying to improve state of the art, further work could be done with adapting the SVM optimization to AMS metrics. In our work features were selected based on weight-importance. Often different transformations of the same attributes have been selected. Features that could improve our models only by little have potentially been left out. This should be studied further. Optimization of SVM parameters should also be performed.

6. ACKNOWLEDGMENTS

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A methodology to evaluate the evolution of networks using topological data analysis

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Abstract—Networks are important representations in computer science to communicate structural aspects of a given system of interacting components. The evolution of a network has several topological properties that can provide us information on the network itself. In this paper, we present a methodology to compare the the topological characteristics of the evolution of a network, encoded into a (persistence) diagram that tracks the lifetimes of those features. This will enable us to classify the evolution of networks based on the distance between the diagrams that represent such network evolution. In that, we also consider complex vectors that bring a complementary perspective to the distance-based classification that is closer to the computational methods, aims to enhance the computational efficiency of those comparisons, and that is by itself a source of open research questions.

I. INTRODUCTION

A. Comparing the topology of the evolution of networks

Networks that change as a function of time - known as evolving networks - are a natural extensions of undirected graphs (i.e., standard (static) networks). Almost all real world networks evolve over time, either by adding or removing nodes or edges. The example of scientific collaboration analysis, such as in the example of Figure 1 shows such a network.

The analysis of the evolution of a network is a matter of interest transversal to many fields of knowledge, from social network analysis and scientific collaboration to computational biology. A standard example is the network dynamics of a social network such as Twitter should consider an evolution through time where new nodes come up as new members join, and new edges are created mirroring the new relationships between members that appear [1]. Often all of these processes occur simultaneously in social networks.

Collaborative networks are a prime example of evolving networks, where nodes represent authors and edges represent scientific collaborations. This is illustrated in Figure 1. It shows the plot of three phases of an instance in the scientific community in Slovenia [13] using ScienceAtlas, a web portal available at scienceatlas.ijs.si integrating data about 35272 researchers, 5716 projects, 82905 publications and 17190 video lectures. This too allows visualizing collaboration and competences of the researchers [14].



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Fig. 1. The evolving network ScienceAtlas of the collaborations in scientific works by Slovenian researchers, evolving over a 9-year period with 3-year leaps. Each node represents an author and each edge represents a collaboration. The nodes with degrees smaller than 20 are filtered out so that the networks are not too large to be visualized.



Fig. 2. An example of an evolving network based on an undirected graph that is growing over time by adding new edges and nodes at each step.

A biological network, on the other hand, is an approximate mathematical representation of connections found in ecological, evolutionary, and physiological research, among others. An example of a relevant application of such analysis of biological networks with respect to human diseases is network medicine. It considers networks in biological systems containing many components connected within complicated relationships but organized by simple principles [1].

In this paper, we focus on the comparison of the evolution of two (or more) given networks. Our approach considers topological data analysis (TDA), allowing us to encode the topological features of the corresponding evolving networks onto diagrams, and using standard methods to compute distances between them. In that, we can classify networks according to the distance between the topology of their evolution.

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The TDA approach to the study of networks is not itself new. It had several widespread applications from collaboration networks [3] to functional brain networks [15]. There are several ways of considering a height function in a network including: (i) considering weights in the edges of the network - weighted network - and then having the function built by threshold those weights [17]; (ii) measuring the distance from each node to each other by counting the minimal number of edges between them and then building the height function based on that distance [11]; among others. This permits us to use persistent homology over such height function. Another possibility is to consider the maximal cliques as the simplicial complexes (named *clique complexes*) that feed the persistence algorithm and proceed with the computation directly over that [5]. We used the latter approach to compute the persistence of the networks generated for the purpose of this paper.

B. Basic notions in persistent homology

Topology is a field of study in mathematics concerned in the quality aspects of an object. It focus on the properties that are preserved through deformations, twistings, and stretchings of the given continuous objects (e.g. linear maps) in multidimensional scenarios. Computational topology takes advantage of simplification methods (e.g. the triangulation of a space) to permit the computation of topological invariants. One of those computations is homology which evaluates the connectedness of, e.g., a network at different dimensions separately. Thus, homology is a natural choice when it comes to the study of the topology of a network. Now, if we consider a monotone function describing the time variable in, e.g., an evolving network, we can track its homology changes. This notion is known as persistent homology and is rooted in TDA, allowing for retrieving the essential topological features of an object [2]. Formally, persistent homology computes the topological features of a growing sequence of spaces $\emptyset = X_0 \subseteq X_1 \ldots \subseteq$ $X_n = X$, known as a *filtration* of the space X. $H_i(X)$ is the *i*th homology group of X, with an associated *i*-th Betti number of X, β_i , corresponding to the measure of connectedness in the *i*-th dimension (cf. [5]). Using the inclusion maps $X_j \rightarrow X_{j+1}$ we can identify copies of Z_2 in the homology groups $H_i(X_j)$ and $H_i(X_{i+1})$ of a filtration and track where the homology changes. We do that by recording when a new copy appears (i.e. "is born"), and when an existing copy persists or merges to an existing one (i.e. "dies"). That persistence of the topological feature is tracked by a lifetime bar (as shown in Figure 3) that can be equivalently represented by an ordered pair (x, y), where x is the birth time and y is the death time. The multiset of all such points exists in the plane subset defined by 0 < x < y that encodes the topology of a space and is known as *persistence diagram*. Several topological features can have the same lifetimes and therefore some of the points in the persistence diagram are repeated in the multiset. We refer to their amount as *multiplicity*. We consider the infinite points in the diagonal as points of the persistence diagram with null lifetime. The standard method to compare two persistence diagrams - called bottleneck distance - measures the cost of finding a correspondence between their points. It



Fig. 3. The computation of persistent homology on a simplicial complex changing in time [3]. The colors correspond to the topological features to which the lifetime is tracked in the persistence barcode below. The Betti numbers indicate the number of connected components β_0 in dimension zero, the number of holes in the network β_1 in dimension one, and the number of tunels and voids β_2 in dimension two.

identifies the closest matching elements of each persistence diagram and determines the global distance based on what is the biggest of those distances. The cost of taking a point $p = (p_1, p_2)$ to a point $q = (q_1, q_2)$ in R^2 is given by the L_{∞} norm $||p - q||_{\infty} = max|p_1 - q_1|, |p_2 - q_2|$. Then, the bottleneck distance between persistence diagrams X and Y is computed by taking the infimum over all such matchings, i.e., $d_B(X, Y) = \inf_{\eta} \sup_{x \in X} ||x - \eta(x)||_{\infty}$, where the infimum is taken over all bijections η from X to Y. Each point with multiplicity k in a multiset is interpreted as k individual points, and the bijection is interpreted between the resulting sets [4].

C. The motivation of EVOSOFT

Nowadays, software systems start to interconnect to provide new and innovative applications and services that drives new development opportunities in all domains. Therefore these software systems have gradually evolved into large scale complex systems and we lack models for their further management and evolution. One of the key aspects of such systems is the ability to model and predict their behaviour to achieve the required quality of operations to fulfill human expectations in all domains. In that, the project Evolving Software Systems: Analysis and Innovative Approaches for Smart Management (EVOSOFT) aims to understand how abstract software structures can be used to model global system properties (e.g. fault distributions). Understanding how to use software structure to model fault distributions can help us to improve system reliability. EVOSOFT observes software structure as networks with nodes representing various software functions that are interconnected to each other by function calls. In particular, a software graph structure considers nodes as program functions (e.g. classes in object oriented paradigm, functions or modules in functional programming) and edges as function calls or signals transferred in communication among these program functions. EVOSOFT aims to observe how large software systems evolve from version to version, and understand the relationship between the change in software structure during its evolution, and the change in software fault distributions across its structure. Previous empirical studies in [9], [10], [18] show that communication structures among the program functions significantly influence system fault distributions. This is what motivated us to further explore this relationship.



Fig. 4. The methodology diagram to encode and compare the topology of the evolution of two (or more) networks using TDA. It considers three phases: (i) the data, where we input the evolving network represented by an adjacency matrix; (ii) the topology, where a persistence diagram encodes the topological invariants of the network evolution; and (iii) the distance, held between persistence diagrams representing the topology of given evolving networks.



Fig. 5. The presented methodology applied to the comparison of the evolution of three networks sharing the same evolution as the network represented in Figure 2 but with differences in phase 2. Each evolving network is associated with one persistence diagram that encodes its topology. This permits us to visualize the relevant topological features of the evolution of the networks.

II. USE-CASE METHODOLOGY TO ENCODE AND COMPARE EVOLVING NETWORKS

The problem of tracking and comparing the evolution of networks can be very demanding and complex due to the combinatorial properties of networks. In the following section we shall describe the methodology diagram to encode a compare the topology of the evolution of networks (as illustrated in Figure 4). It considers persistent homology to encode the topological features of the evolution of a network using persistence diagrams. In that, we first provide the evolving network given by one Boolean adjacency matrix for each phase of network development. We then compute the persistent homology of the evolving network by feeding the concatenated matrices a suitable algorithm. It will encode the topology of each evolving network, representing it by one unique persistence diagram each. Finally, we measure the bottleneck distance between persistence diagrams to identify how close are the evolving networks to each other based on their topology.

To the purpose of this paper, we used the software library *Perseus* [16] to compute the homology of a the evolving network represented in Figure 2, given by the graph's Boolean adjacency matrix. The network is provided to *Perseus* as a list of cliques including the time of appearance. The output of that procedure is a persistence diagram that corresponds to the topological changes within the evolution of that network. The evolving network A on the left has four stages as illustrated in Figure 2. The evolving networks B and C are variations of the evolution of the end network in A with different phases at time t = 2, as represented in 5.

To compare the evolution of networks we consider the distance between the corresponding persistence diagrams, using the bottleneck distance. This permits a fast computation of the distance between the (persistence diagrams representing the) topology of two evolving networks. In the case of the persistence diagrams encoding the topology of evolving networks A, B and C represented in Figure 5, we get d(A, B) = 0 and d(B, C) = d(A, C) = 1. This discards the points with infinite persistence that are less relevant when considering dimension 1 diagrams. The computations were done using the TDA package available in R [7]. In this example we can explore the distance between several possible evolution of a network. In it, shows how TDA can contribute to better understand the behavior of a certain network.

III. THE EVOSOFT EXPERIMENTS

For the purpose of this research we will use the EVOSOFT motivation to generate networks that fit that scenario and allow us to compare the evolution of networks in that context. In these preliminary experiments we shall consider data representing the evolution of networks based on the empirical analysis of the evolution of complex software systems [8].

In these experiment we will generate networks with labeled nodes - not ordered pairs in \mathbb{R}^2 - and extract all maximal cliques from it. The maximal cliques serve us to construct clique complexes with which we are able to later on compute the topology of those networks. In these experiments we shall obtain the EVOSOFT evolving networks provided by their graph's Boolean adjacency matrix. Those matrices must be consistent with the evolution of the network in the sense that existing maximal cliques in phase *i* must maintain or enlarge in the phase *i* + 1 during the updates of a software version. The persistence diagrams computed by *Perseus* shall exhibit the encoded topology of evolving networks corresponding to different pieces of software.

The comparison between the topology of a pair of evolving networks given by the adjacency matrix is given by the bottleneck distance between the corresponding diagrams. That distance can be computed using the R library [7]. When considering other evolving networks we can calculate the pairwise distance between all of them and consider single linkage clustering based on this metric (as in earlier TDA applications to gene expression data as in [12]) to allow classification based on the topology of network evolution.

IV. COMPARISON THROUGH COMPLEX VECTORS

A possible algebraic representation of persistence diagrams is offered by complex polynomials. The method layed out in [6] can lead to avoid tedious and less meaningful computations of bottleneck distance, since far polynomials represent far persistence diagrams (the converse is known not to be true). A fast comparison of the coefficient vectors can reduce the size of the database to be classified by the bottleneck distance. We can then focus on close persistence diagrams for which we want to calculate precise measures. This should complement existing methods, rising the efficiency of computations for large evolving networks. Given a persistence diagram D described by its points $p_1 = (u_1, v_1), \ldots, p_s = (u_s, v_s)$ with multiplicities r_1, \ldots, r_s , respectively, the method considers complex numbers $z_1 = u_1 + iv_1, \ldots, z_s = u_s + iv_s$. This allows us to associate to D the complex polynomial $fD(t) = \prod_{j=1}^s (tz_j)^{r_j}$ where r_j is the multiplicity of the point p_j . It was shown in [6] that the first k coefficients are the ones carrying most of the relevant information and, therefore, the choice of a threshold k can reduce the computational complexity.

The unpublished 2-part algorithm by the authors of [6] permits us to input a persistence diagram in order to compute a complex vector out of it. Then the same algorithm compares two complex vectors corresponding to two persistence diagrams to output a float corresponding to the distance between those vectors. At the moment, this approach to convert persistence diagrams into complex vectors can be applied only when neglecting points with infinite persistence. In the running example we get the polynomial $p_A = (t - 1 - 3i)(t - 2 - 3i)(t - 2)$ $4i)(t-3-4i) = p_B$ and $p_C = (t-1-3i)(t-2-4i)^2$, not considering points of infinite persistence. We then develop the polynomials to identify their coefficients into a complex vector. The distance between the three complex vectors corresponds to a basic classification of the given evolving networks. This is not a dense case where we would need additional tools like complex vectors. Though, real life examples of evolving networks are appropriate cases of such needs due to their inherent complexity.

V. CONCLUSIONS AND FURTHER WORK

In this paper we have discussed the topological data analysis of evolving networks. In that we presented a method to encode the topology of the evolution of a given network through a persistence diagram, and its potential for a classification based on a chosen distance between diagrams. The inherent complexity of an evolving network demands for the data simplification methods to be available and appropriate to the nature of the considered object. In that, the TDA-based methodology in this paper can contribute to the analysis and interpretation of evolving networks and their behaviour. The experiments in real data are valuable to improve this method. In that, the collaborations with the earlier mentioned Slovenian Science Atlas would be welcome, allowing us to further explore the interpretation of the topology of the evolution of these collaborative networks and the distance between them. Further work includes the processing of EVOSOFT existing networks, as well as the interpretation of results in the context of that field of knowledge. It can provide new challenges specific to the available data and to its role and usage in the field. In particular, the interpretation of the persistent topological features captured in EVOSOFT experiments represents a relevant open problem that requires a deeper analysis based on the EVOSOFT expertise and the manipulation of the topological results. Lastly, the mathematical development of the complex vector method, that contributes to the study of evolving networks in general, is a rather computational method that is suitable to the application of compatible algorithms, allowing potential engineering applications. Moreover, it is itself a great source of open mathematical problems that we shall consider in further research (e.g. stability [5]).

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Improving mortality prediction for intensive care unit patients using text mining techniques

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ABSTRACT

Numerous severity assessment scores for estimation of in-hospital mortality in Intensive Care Unit (ICU) have been developed over the last 40 years. In this study, we predicted 1-month mortality in chronic kidney disease (CKD) patients using the open Medical Information Mart for Intensive Care III (MIMIC III) database. Additionally, we observed the improvement in predictive performance and interpretability of the baseline model used in ICUs to a more complex model using simple features such as unigrams or bigrams, as well as advanced features extracted from textual nursing notes. For the latter, MetaMap extraction tool was used to extract medical concepts based on the Unified Medical Language System (UMLS) terminology. We used a logistic regression based classifier, built using Simplified Acute Physiology Score II (SAPS II), age and gender, as a baseline model. The baseline model was then compared to regularized logistic regression based classifier built using simple and more complex additional features. The Area Under the ROC Curve (AUC) results for the baseline predictive performance improved from of 0.761 to 0.782 when frequency of unigrams and bigrams were used to build the model. In a similar scenario, where unigram and bigram frequency was replaced with Term Frequency-Inverse Document Frequency (TF-IDF) based feature values, AUC further increased to 0.786.

This paper represents an opportunity in extracting new knowledge in the form of unigrams, bigrams or concepts extracted from textual notes accompanied by regression coefficient values that can be interpreted as relations between the features and the outcome. The combination of both can provide added value in decision support systems in ICU departments, where data is collected in electronic medical records (EMRs) in real-time.

Categories and subject descriptors

H.2.6 [Information Systems]: Database Machines H.2.8 [Information Systems]: Database Applications

General Terms

Algorithms, Measurement, Documentation, Performance, Reliability, Experimentation.

Keywords

Text mining, ICU, database, machine learning, mortality prediction.

1. INTRODUCTION

Predicting the mortality of ICU patients is a complex and dynamic process. Critical illness severity assessment scores, such as Acute Physiology and Chronic Health Evaluation I-IV (APACHE), Sequential Organ Failure Assessment score (SOFA), Mortality Probability Model I-III (MPS), or Simplified Acute Physiology Score I-III (SAPS), help clinicians detect patient problems earlier, thus providing a better holistic treatment for patients and making patient care more cost-effective. The sheer number of different severity scores used is partly because of the quality of recorded data needed to calculate them. An example of such severity score is APACHE IV, which tends to have the best discriminative performance but the data needed to compute the score is complex and hospitals would need to develop a good enough high-quality database for analysis of risk stratification [1, 2].

The MIMIC III database [3], a free public-access intensive care unit repository, is widely used for predicting the mortality of ICU patients, where developers provided several severity scores for the database (e.g., OASIS, SAPS, SAPS II, SOFA), but also noted that for APACHE IV the coding of the diagnostic component is difficult and might lack accuracy [4]. Part of MIMIC III are free text nursing notes, which represent a good candidate source of information for mortality risk prediction, as they contain a detailed and regularlyupdated record of the interventions performed, medications administered, vital signs, and physical examination findings, all of which carry highly specific information about the patient's dynamic physiological state and eventual outcome [5]. Because such data is unstructured, our purpose is knowledge discovery where we observe the improvements in predictive performance and interpretability of predictive models based on additional features extracted from nursing notes collected in EMRs. More precisely, we aim to predict one month mortality in CKD (ICD 9 code 585.x) patients and compare the improvement of the baseline model performance by including simple features such as unigrams or bigrams as well as more advanced features extracted from text in the form of medical concepts using MetaMap [6] to define mapping between textual notes and UMLS terminology.

2. METHODS

The data were obtained from the MIMIC III database, version 1.3, to select 58,976 hospitalizations for 46,520 patients who stayed in critical care units of the Beth Israel Deaconess Medical Center in Boston between 2001 and 2012. The database included 26 linked tables, which can be merged mostly by patient or hospitalization identification numbers. Our focus were nursing notes (i.e., free text

notes from patients with CKD diagnosis), where we excluded hospitalization of patients that died within 24 hours of admission and nursing notes that were not fully updated, where duplication of data was likely. That left us with 10,867 nursing notes from 4,381 hospitalizations. The first nursing note was taken on average 7.8 hours after admission (85.2 % hospitalizations have at least two notes), second taken on average 14.7 hours after admission (38.1 % had at least 3 taken) and the third one was taken on average 17.5 hours after admission. A slight majority of hospitalized patients were male (59.4 %), with an average age of 65.6 (Standard Deviation (SD) 15.2)) and a 13.4 % mortality rate (death during or up to one month after the hospitalization was recorded).

Developers of the database also included source code for calculation of several severity scores (i.e., OASIS, SAPS, SAPS II and SOFA), and we selected SAPS II as the main feature in the baseline model, since it is used on daily bases in hospitals. The input features of our baseline model consisted of SAPS II score, age and gender.

Nursing notes were initially processed using traditional text extraction algorithms with stemming and removal of stop words, which produced 51,680 unique unigrams and 363,055 unique bigrams. Both frequency and TF-IDF tables were prepared. The text from the nursing notes was also processed using the MetaMap tool from the US National Library of Medicine. MetaMap identifies and normalizes biomedical terminology from the Unified Medical Language System (UMLS). Binary representations of Bags of Phrases (BOP) identified by MetaMap, and their UMLS (Concept Unique Identifiers) CUIs were used as features for the classifier. Space characters in phrases were replaced with underline character. Word sense disambiguation was used to distinguish similar words with same structure. In addition, phrases were marked with whether the associated concepts were found in a positive or negative context. To identify the polarity of phrases (negative or positive), the NegEx module [7] of MetaMap was enabled in order to identify the polarity of phrases (negative or positive). NegEx implements a simple algorithm that contains several regular expressions indicating negation, filters out sentences containing phrases that falsely appear to be negation phrases, and limits the scope of the negation phrases.

For better understanding, we provide a short example of MetaMapannotated phrases from part of the sentence "URINE MICROSCOPY" (Table 1).

 Table 1. Example of MetaMap-annotated phrases from part of the sentence "URINE MICROSCOPY"

Meta Candidates						
Score	Score Matched concept					
1000	1000 C0430397: Urine microscopy (Microscopic					
	urinalysis) [Laboratory Procedure]					
861	861 C0026018: Microscopy [Laboratory Procedure]					
789	789 C0205288: Microscopic [Qualitative Concept]					
694	694 C0042036: Urine [Body Substance]					
694	694 C0042037: Urine (In Urine) [Functional Concept]					
694	694 C2963137: Urine (Portion of urine) [Body					
Substance]						
Meta Mapping						
Score Matched concept						
1000	C0430397: Urine microscopy (Microscopic					
urinalysis) [Laboratory Procedure]						

The *meta candidates* are all discovered mappings that are ordered according to an evaluation metric described in [7], while *meta mappings* represent the selected phrases which finally represent

features in our model. Please note that several meta mappings may be found in a sentence. Parentheses contain the concept's preferred name while square brackets contain the concept's semantic type. One of our goals was interpretability and avoidance of over-fitting, therefore we restricted model building to regularized linear models, further we narrowed the selection to L1 regularization models or least absolute shrinkage and selection operator (lasso), which includes feature selection functionality which was needed due to high number of features in our datasets [8]. We expanded on the work of Marafino et al. [4], where they used the MIMIC II dataset and predicted mortality via stochastic gradient descent-based classifiers with TF-IDF on the extracted unigrams and bigrams for patients that died during the given ICU stay. All experiments were implemented in R language and environment for statistical computing [9] using glmnet package [10] to build and validate predictive models.

3. **RESULTS**

Results presented in this section were obtained from four scenarios where we compared different combinations of two types of extracted features (n-grams versus concepts) and two types of the extracted feature values (frequency vs. TF-IDF).

The baseline classifier with basic features (SAPS II score, age and gender) to predict mortality was used to evaluate the performance gain when more complex classifiers were built. Initially, we were interested in measuring the improvement of the baseline predictive performance by adding unigram and bigram features to SAPS II, age and gender of the patients. At the same time, we were observing the complexity of the predictive models by observing the number of features that were included in the models.

Second row in Table 2 presents the results when frequency of unigrams and bigrams were used to build the model. It can be seen that baseline predictive performance improved from the AUC of 0.761 to 0.782 when frequency information of unigrams and bigrams was used to build the model. With an improvement of more than 2% in AUC it is also important to note that in this scenario we obtained the simplest models in terms of interpretation with only 9 features on average. In a similar scenario where unigram and bigram frequency was replaced with TF-IDF based feature values resulted in further improvement with AUC of 0.786. In the next two experiments, we replaced unigrams and bigrams with UMLS concepts that were extracted from free text (nursing notes). Table 2 demonstrates further improvement of the classification performance as the AUC in case of TF-IDF increased to 0.789, while even further improvement with a mean AUC of 0.791 was measured in frequency based features experiment. Tables 3 and 4 provide more detailed overview of selected features along with the number of times a feature was included in a predictive model during 100 cross-validation runs. It can be seen that TF-IDF produced predictive models with a larger number of features and therefore represents a richer set of concepts that can be used to warn a medical expert of a potential threat to a patient. On the other hand, a complex model (in case of TF-IDF experiment, more than 35 features were used in a model on average) might represent a challenge for medical experts when interpretation of models is needed.

4. DISCUSSION AND CONCLUSIONS

In this paper, we observed the improvements in predictive performance and interpretability of predictive models based on new features extracted from nursing notes collected in EMRs. More precisely, we predicted one month mortality, at the end of 24-hours spent in the ICU, for CKD patients. The improvement of the
Table 2. Summary of predictive performance measures for different experiments using features extracted from nursing notes						
	AUC	Sensitivity	Specificity	PPV	NPV	Selected features
Baseline (SAPS II)	0.761	0.712	0.687	0.283	0.933	1.0
	[0.757-0.766]	[0.704-0.720]	[0.680-0.695]	[0.277-0.288]	[0.931-0.935]	[1.0-1.0]
Unigrams and	0.782	0.727	0.714	0.306	0.939	9.1
bigrams (frequency)	[0.778-0.786]	[0.721-0.734]	[0.707-0.722]	[0.300-0.313]	[0.937-0.940]	[6.6-11.6]
UMLS concept	0.791	0.736	0.716	0.310	0.941	17.6
mapping (frequency)	[0.787-0.795]	[0.728-0.745]	[0.708-0.724]	[0.304-0.316]	[0.939-0.943]	[14.8-20.5]
Unigrams and	0.786	0.733	0.712	0.306	0.940	25.1
bigrams (TF-IDF)	[0.782-0.790]	[0.725-0.740]	[0.704-0.720]	[0.300-0.313]	[0.938-0.941]	[21.7-28.6]
UMLS concept	0.789	0.747	0.700	0.302	0.942	35.5
mapping (TF-IDF)	[0.785-0.793]	[0.741-0.754]	[0.692-0.709]	[0.296-0.308]	[0.94-0.943]	[31.0-40.0]

Table 2 Comments of and Hoting a sufference of an according for different contractions for the sector of a ferrer state of the sector sector is a sector

baseline model (SAPS II, gender and age) in comparison to predictive models that included unigrams, bigrams as well as more advanced features extracted from text in the form of medical concepts using the MetaMap extraction tool was also observed.

The results show high level of predictive performance that can be compared to a similar study by Brabrand et al. [11] where it was shown that using clinical intuition of the admission staff produced comparable predictions in terms of AUC when identify patients at risk of dying. However, it has to be noted that Brabrand and colleagues did not focus on a specific group of patients.

Table 3. Frequency of specific features selected in the UMLS concept mapping (Frequency) experiment

concept mapping (1 requency) enperment		
Single_count_all_CKD_all_feat	Ν	
DNR_(DNRDo_not_resuscitate)_[Finding]	100	
Map_(Functional_Map)_[Conceptual_Entity]	100	
SAPSII	100	
Meeting_(Meetings)_[Health_Care_Activity]	98	
Coccyx_(Entire_coccyx)_[Body_Part_Organ_	02	
or_Organ_Component]	95	
PICC_line_(Peripherally_inserted_central_	86	
catheter_(physical_object))_[Medical_Device]		
Anuria_[Disease_or_Syndrome]	85	
CMO_(Chronic_multifocal_osteomyelitis)_	02	
[Disease_or_Syndrome]	82	
Family_[Family_Group]	70	
vascular_(Blood_Vessel)_[Body_Part_Organ_	51	
or_Organ_Component]	51	
Bilirubin_[Biologically_Active_	45	
SubstanceOrganic_Chemical]		
Prognosis_(Forecast_of_outcome)_	45	
[Health_Care_Activity]	45	
error_[Qualitative_Concept]	35	
Necrotic_(Necrosis)_	24	
[Organ_or_Tissue_Function]	54	
Pleural_effusion_(Pleural_effusion_fluid)_	20	
[Body_Substance]	28	
Poor_prognosis_(Prognosis_bad)_	28	
[Finding]	20	
Thick_[Qualitative_Concept]	28	
Hypotensive_[Pathologic_Function]	27	
dysfunction_(physiopathological)_	25	
[Functional_Concept]	23	
Brain_[Body_Part_Organ_or_	23	
Organ_Component]	25	

When providing the predictive models for healthcare experts to support their work in clinical practice, we should also pay attention

to interpretability of such models. As already noted in [12] in case of similar predictive performance on training set, the simplest models often also perform the best on the test set. Therefore, we should also take the complexity of models with similar performance into account. In case of our study, the complexity of the four proposed models ranges from 9 up to approximately 35 selected features. In case of both unigram and bigram based models, it would perhaps make sense to use the simpler model as it does not significantly differ in predictive performance at a significantly lower complexity of the simpler, frequency based model.

Table 4. Frequency of specific features selected in the UMLS concept mapping (TF-IDF) experiment

Single tfidf all CKD all feat	
DNR_(DNRDo_not_resuscitate)_[Finding]	100
Meeting (Meetings) [Health Care Activity]	100
SAPSII	100
CMO_(Chronic_multifocal_osteomyelitis)_	
[Disease_or_Syndrome]	98
PICC_line_(Peripherally_inserted_central_	
catheter_(physical_object))_[Medical_Device]	97
Family_[Family_Group]	96
Coccyx_(Entire_coccyx)_[Body_Part_Organ	
_or_Organ_Component]	88
Heels_(Heel)_[Body_Location_or_Region]	88
Pressors_[Pharmacologic_Substance]	83
Map_(Functional_Map)_[Conceptual_Entity]	74
Levophed_[Organic_ChemicalPharmacologic_	
Substance]	73
loosen_(Loosening)_[Functional_Concept]	70
neg_DNR_(DNRDo_not_resuscitate)_	
[Finding]	68
Worsening_(Worse)_[Qualitative_Concept]	68
error_[Qualitative_Concept]	67
dysfunction_(physiopathological)_[Functional_	
Concept]	64
Bilirubin_[Biologically_Active_SubstanceOrganic_	
Chemical]	62
Anasarca_[Pathologic_Function]	59
Coccyx_(Bone_structure_of_coccyx)_	
[Body_Part_Organ_or_Organ_Component]	51
Poor_prognosis_(Prognosis_bad)_[Finding]	50

From the most frequently selected features (Table 3 and 4) we can observe some very general concepts, like "do not resuscitate (DNR)" and high SAPS II score, indicating higher mortality. Also, family related concepts can be easily interpreted by a fact that physicians usually call family members to discuss the severity of the situation, especially when the situation is critical or life threatening. Additional features indicating higher mortality are concepts related to bones like "coccyx" and "heel", which could indicate specific problems related to calcification, frequently observed in CKD patients. Medical terms such as "peripherally inserted central catheter", "chronic multifocal osteomyelitis" and "use of pressors (pharmacologic_substance)" could be interpreted as signs of worsening health situation. We plan to investigate these conclusions in more detail in future work. It is also interesting to note that the UMLS frequency model's most selected variable was the medical term "Anuria (non-passage or less than 100 milliliters passage of urine a day)", which was not selected in the UMLS TF-IDF model.

Further development of our model will include extensions where a shorter (e.g., 6 or 12 hours) period would be used to provide "early warning" signal to healthcare experts working in the ICU. Additional features can be extracted from MIMIC-III that would further improve the predictive performance and possibly also the interpretability of the models.

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FOREWORD

Since October 2009, the biannual international scientific conference on Cognitonics ("Kognitonika" in Slovenian) is a part of the international scientific multiconference "Information Society" (Slovenia, Ljubljana, Jozef Stefan Institute).

The first objective of cognitonics, or the science about the human being in the digital world, is to explicate the distortions in the perception of the world caused by the peculiarities of information society and globalization. The second, principal objective of cognitonics is to cope with these distortions in different fields by means of elaborating systemic solutions for compensating the negative implications of the kind for the personality and society, in particular, for creating cognitive-cultural preconditions of the harmonic development of the personality in the information society and knowledge society and for ensuring the successful development of national cultures and national languages.

Cognitonics formulates a new, large-scale goal for the software industry and Web science: to develop a new generation of culture-oriented computer programs and online courses intended for supporting and developing positively-oriented creativity, emotional intelligence (EI), communication culture, social responsibility, the appreciation of the roots of the national cultures, the awareness of the integrity of the cultural space in the information and knowledge society and for supporting and developing symbolic information processing and linguistic skills, associative and reasoning abilities of children, adolescents, and university students.

From the standpoint of educational practice, cognitonics proposes an answer to the following question: what precious ideas and images accumulated by the mankind, at what age, and in what a way are to be inscribed into the world's conceptual picture of a person in order to harmonize his/her intellectual and spiritually-coloured emotional development and to contribute to the successful development of national cultures and national languages?

Being a relatively young scientific discipline, cognitonics both is of high social significance just now and has great prospects of the kind. It is due to the fact that it suggests new, deep and constructive ideas, new angles of look and original, effective solutions to a number of socially significant problems emerged in adjacent fields, including education. The examples of such solutions are as follows.

During last decade, big international companies, fulfilling the casting of the specialists for vacant positions, have been paying a high attention to the level of EI of the pretenders. Cognitonics suggested a highly effective system of teaching methods aimed at supporting and developing EI of the learners. This system includes, in particular, a many-staged method of early children's socialization in information and knowledge society and a method of developing creativity, figurative thinking, the skill of integrating information from numerous dispersed sources.

Cognitonics enriched psychology by means of introducing the notion of Thought-Producing Self and of suggesting the most deep today (on the world level) model of developing conscious control in the childhood: control of thought, emotions, and actions.

Art cognitonics - one of the most developed branches of cognitonics - makes a considerable contribution to cultural studies and theory of up-bringing. It develops a complex method of using the works of art for

positive development of the child's, adolescent's, and university student's personality. Art cognitonics suggests a new paradigm of delivering lectures on art.

The goal of the conference is to combine the efforts of the scholars from numerous scientific fields and educators in order to establish a new synergy aimed at ensuring the harmonic, well-balanced development of the personality, national cultures, and national languages in the modern information society and knowledge society and, as a consequence, to compensate a number of broadly observed negative distortions.

The Program Committee has accepted for the conference 16 long papers and one short paper from 16 countries of three parts of the world: Asia (PR China, Lebanon, India, Japan, Pakistan), Europe (Croatia, Cyprus, Finland, Italy, Macedonia, Poland, Russia, Slovenia, Sweden, United Kingdom), and North America (USA).

The editors would like to thank the authors of the papers for their contributions and the members of the Program Committee for their precious comments ensuring the high quality of the accepted papers and making the reading as well the editing of this volume a rewarding activity.

Vladimir A. Fomichov, Olga S. Fomichova

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Terror: The lack of ethos and the initiation into a distorted mythology

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ABSTRACT

The goal of this study is to question the myth of martyrdom that is publicly attributed to suicide terrorism attacks, by proposing that the root of this phenomenon is on the contrary the lack of mythology and ethos. Located in a society without recognizable rituals, unable to relate stories depicted in their minds with an alien environment, suicide attackers are initiated to the rituals of gangs and internet communication channels. The demythologized world of economics, combined with the constant flow of news of destruction and violence replaces the sanctification of the local landscape, an organic synergy of mythology that is no longer functional [1]. The new myth lacks connotations and becomes their distorted metaphor.

General Terms

Security

Keywords

Ethos, mythology, violence.

1. INTRODUCTION

In Ancient Greece Ethos primarily had the meaning of the usual place of residence to be developed later to the meaning of habit, custom and finally to character. The dual meaning of the word reflects a cause and effect semantic relation. The landscape and residence give birth to the customs that create the character that is inseparably rooted in its source. Ethos as a synthesis of environmental and internal physiognomies activate maturity and character development [2]. Ethos vitalities the process of self-actualization [3]. However, the moral and spiritual traditions of modern individual are separated from his/her life and the void come to fill economics, violence, destruction and alienation. This disorientation is reinforced by the separation of the individual from his/her meaningful mythological landscape resulting in moral and social decay [4].

It is common in modern age for cultures to try to identify themselves in the void between broken traditions and a mosaic of contemporary perceptions and in this new environment, together with other vital rites, the rite of passage is lost, since it follows the changes of the community values [5]. In the new demythologized world, a distorted version of rite passage is being processed. All this is magnified in the case of migrants that in addition to the unclear picture of a dehumanized world, that ignores their values and customs, they have to deal with the separation from a natural landscape and their "unconscious identity".

Separated from their familiar mythological, cultural and religious norms, adolescents but also adults that have migrated away from their landscape find themselves separated from their ethos. They sometimes mentally return in the comforting past, dream of their symbols and supernatural forces, they nurture obligations to the dead and experience feelings of anxiety and anger [6].

The virtual internet cosmos resembles rituals in metaphor as they are transformed in a psychological atmosphere that is monitored by the communication channels that use this distorted metaphor for the recruitment of suicide attackers. The rules of propaganda find their perfect medium: an audio-visual space, the messages of which can be reproduced innumerable times "for the deliberate and systematic pursuit of an individual or group to control the attitude of other individuals or groups by using any possible means of communication and purposefully provoking a desired for the source behaviour of the target" [7]. The suicide attacker is not experiencing the hero myth liberated, ready to contribute to the achievements in a useful life. Dissociated from his/her identity, he/she is initiated in a distorted scene of an altar full of as many victims as possible.

2. THE HOMELAND OF OUR SYMBOLS

As infinite as its mother nature, our psyche appears in fragments of a mosaic, the archetypal symbols, full of connotations, that are depicted in our collective unconscious [8]. Narrated in our myths, our dreams, literature, religions, folklore, the story of our psyche, from its source to its developed form, is carried forward, tied on the familiar chariot of our initiatory images. The wisdom of our mother land functions through metaphors that embroider the patterns in the paths of which, we follow the steps of our course in the world. And as small parts of a living organism we reflect the form of our unity with all our past generations. Supported by our enlarged icon, as individuals we are called to save our collective body [9].

Our stories are not merely shaped as the landscape that is our home, they participate in the existence of the landscape, as the sphere of nature and humans are not separated [10].

2.1 Living at the end of an era

The time when the individual was embodied in the cosmic reality, when all phenomena were for him/her the comprehensible "thou", has become today the alien, inexplicable "it" [11]. Economics, violence, destruction consist an "it" that disintegrates humans from their tradition and this dissociation is a synonym to isolation.

The lack of the spiritual support of a consistent mythology, rite and symbolism create a vast void that is difficult to fill. The mythological symbols cannot be technically created, even if modern individual will keep trying to mentally touch them, even in his/her dreams. Sealed in the distant shadows of the past, the imprisoned cosmic energy of our existence can cause neurotic incidents, as we remain fixed to the frozen images of our infancy, unable to follow the passages to our adulthood [12].

When the conscious and the unconscious are separated the psychology of the individual reaches the line that distinguishes a healthy condition from psychological pathology [13].

2.2 Rites and structure

The complexity of structure defines the complexity of life form. This axiom reflects the importance of structure in the line of evolution. From the innate, stereotyped functions to the open to imprinting mechanisms of human psyche that is embroidered by the culture of society, structure imports the development of our organizations. Rituals are the chariots that carry the imprinting of society to the accessible psyche of adolescents [14]. Rites in process reflect and are attracted by the archetypal myths of our distant shadow.

Hunger for structure is not weaker than the hunger for stimuli and recognition. We strive to structure our time with ritualistic interplay, aiming at the acceptance of our local environment. A historical, cultural and personal path leads us from the formal rituals to the semi-ritualistic interaction to the individual games [15].

2.3 The loss of the rites of passage

We are born adults and we remain adolescents lost in adolescent societies. Since early childhood we have access to all information. All is shallow and nothing goes deeper than our skin. Facebook is our Prometheus and we are offered the fire of its knowledge that has been transformed to information, even before we go to school. We do not remember ourselves in the memory-realization evoking moment of the rites of passage, we do not eavesdrop the rhythm of our nature, we pass by our rebirth [16]. Lertzman notes that the moments of transitional development should be emphasized by rites, creating a map that will help the individual not to lose his/her way on life's journey [17]. Van Gennep distinguished between physiological and social puberty [18].

An individual thrives in the context of the community. The community today is visible only to an astronaut fondly staring at the planet earth from his distant spacecraft. And our virtual community is as impersonal as the wire that kindly brings it to us. Today we are not only lost between lost communities. We are lost between a dying era and an era that is not yet born.

2.4 Without this dialogue homeostasis is unbalanced

The deep inner energy, painted in picture syllables and words, narrate our myths while in the contemporary. Outside world another alphabet is being developed. A harmonic dialogue between these two worlds is essential for the healthy development of the individual. Citizens that find themselves in alien environments find themselves unable to keep the balance between their inner truths and the outside realities. The natural homeostasis of their mythology dysfunctions. In defense, the individual can only choose the extreme ends.

3. LOST IN AN ALIEN LANDSCAPE OF AN ALIEN TIME

The loss of the collective identity is not caused during the lifetime of one generation. It can survive in generations to come, especially if it is as deeply rooted as religion that is dissipated in all levels of life and is facing a liberal secular society. After six centuries of scientific progress Islam stopped taking into account the collective energy of the community. Gender equality and sexual liberalization are areas where Islam and Western societies can't meet half way. Also, the Sharia law will challenge and will be challenged by democracy [19]. In addition, western Democracy and secularism in Europe is not free of values either [20]. It derives from a collective identity as strong and as deeply rooted. These factors differ according to the citizen's education, age, gender and income but the contradictions are very much present in the general public.

Of a vulnerable planet population, the most vulnerable are the ones who no longer live in a familiar region and are divided between a world that is lost and a world that is alien. They grieve and the cultural norms around them cannot help them deal with this grief. The loss of the sense of identity causes reactions rooted deeply in the unconscious and the results have negative names: guilt, thoughts of death, morbid thoughts and feelings of worthlessness, psychological dysfunction, hallucinations [21]. Eisenbruch invented a cultural bereavement interview in order to diagnose cultural bereavement and find ways of healing it [22]. But most of the cases of individuals lost in an alien landscape do not heal, on the contrary they are nurtured by the hatred that is constantly communicated through the Mass Media, that quite often validate rites, in contemporary form [23].

3.1 Gang prestige

A group that is organized, has a name and members that share a common criminal record is often the first small community that offers to the lost adolescent all that he/she needs: recognition, sense of belonging, support, personal relations, prestige. The gangs that welcome the individual who seeks to reaffirm his/her identity are usually affiliated with terrorists and function as a first stage of initiation towards the passage that will lead the counter-hero to the threshold of mass murder.

3.2 Games towards destruction

As substitutes to intimacy, games humans play fill the structured time until the final act that could lead to a miracle or death, or/and death. The more disturbed an individual is the harder he/she plays the game [24]. He/she will follow the game to its last drop falling into the dark waters of death and destruction. And the game has an organic truth: emotions are regulated.

3.3 Blue Whale

A recent example of a game that demonstrated the power of initiation, through the regulation of the emotions of an adolescent hungry for structure and games is the internet suicide game Blue Whale, that was mainly active in Russia, Kazakhstan and Kyrgyzstan but had also operated in Europe and other parts of the world. The game would begin with an initiator/Blue Whale curator explaining to the youth that once in the game there is no way out. The curator would guide the youth each time to a destructive act. The game ends with the youth committing suicide.

4. A VIRTUAL THRESHOLD LEADING TO THE ALTAR

The more distinctly a culture expects something in the future the more precise is the rite of passage that is exercised. In the same respect, a rite with a visible goal to be achieved in the future will create the right atmosphere by applying the right scenario to a metaphor. The virtual cosmos of internet resembles the ritual in metaphor, in the context of what Heim defines as "psychic framework" [25]. And the wrong people, using the right communication channels for the wrong reasons, create a distorted metaphor for the lost adolescent. A subjective reality, seen through the right lenses: mythology, culture, history, fear. Because terrorism is a psychological warfare and it needs the right tools. The distorted rite of passage can succeed only if it targets the most deeply rooted myths, fears and beliefs of the individual. Only then it touches the sphere of the collective consciousness. The computer screen starts its ritual. Radical Islamic motifs, songs, video recordings. The language orates: murders are "executions", criminals are "martyrs". The semantics create the right bonds. A whole virtual community is ready to witness this glorified rite of passage. You are being recruited, you belong somewhere [26]. While the channel of communication is transformed to a rite of passage, leading to the initiation of a murderer the rest of the world is watching the news, helpless in the streets of the western cities that have lost their safety. Is there a way out of this mess?

The Organization for Security and Cooperation in Europe (OSCE) and the United Nations try to raise international awareness of this dangerous tool of initiation to mass murder and to advise recommendations of action. Also, the same channels of communication could work backwards, showing the way back to the source that is spreading the propaganda. Young citizens are not trained to be able to recognize and nurture their abilities. They remain, fixated fossils, depicting some patterns of the past that are inexplicable to them.

The failure to reinforce the resistance of the audience by educating the public rests at a great extend to the fact that the same means, internet, websites, are not used for the cultivation of the opposite attitude. The media use the vocabulary the propaganda uses, thus adopting the desired concepts of the source. "Whoever learns the language of a nation secures himself from its evil" (Arab Prover) [27].

4.1 On the altar, he is not alone

In the hero myth, the hero is unable to find connotations to his/her adult world, unless he/she has managed to extricate himself/herself from the psyche and gain autonomy. The hero is aware, he is spontaneous, he can experience intimacy. The hero transcends all generalized classifications, he/she stands opposite the programming of the past and criticizes it, he is ready to be open and intimate. He/she must be liberated and deepen into the meaning of his/her consciousness, in order to live a useful life, contribute to society and achieve the feeling of self-distinction.

But the hero myth greatly differs from the initiation rite. For the hero strives to achieve his/her goal, he/she spears no efforts, he/she participates with all his/her will to accomplish his/her dreams. While the lost adolescent, the inflexible novice, ready for initiation and programming, is giving up all ambition, all hope and all desire and submits to the ordeal. He/she must be ready to die. He/she must be ready to kill. He/she must be ready to place on that altar as many victims as possible. The initiator said so.

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The Student-Self Oriented Learning Model as a Paradigm for Supporting and Developing Emotional Intelligence and Creativity

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ABSTRACT

Proceeding from broadly accepted role of emotional intelligence (EI) in professional and personal life, the paper suggests a new learning model (LM) called Student-Self Oriented LM (SSOLmodel). It is defined as the model being beneficial for selfcognition and self-construction through the prism of the acquired knowledge and life experience. A successful implementation of the SSOL-model is shortly described. It is the system of emotional-imaginative teaching (the EIT-system), developed by the authors in the 1990s and expanded in the 2000s. This system is underpinned by the authors' Theory of Dynamic Conceptual Mappings (the DCM-theory). The EIT-system includes an original method of developing figurative thinking and creativity at the lessons of second language (English for Russian children)., literature and poetry in English and Russian, symbolic language of painting, and communication culture. It is stated that this method may be used as an effective starting framework for education in knowledge society. The DCM-theory and the EITsystem became the starting point for developing the foundations of a new scientific discipline called cognitonics. The significance of its well developed branch - art cognitonics for helping the learners to answer the encountered moral questions is indicated.

General Terms

Human Factors, Languages, Theory

Keywords

Emotional intelligence, art cognitonics, creativity development, serendipity, intelligent tutoring system, early socialization of children, theory of dynamic conceptual mappings, system of emotional-imaginative teaching, cognitive engagement

1. INTRODUCTION

The progress of science and technology in the end of the 20^{th} – the beginning of the 21^{st} century, globalization process underpinned by the stormy expansion of the Internet have posed new demands to education. Likely, the most significant demand is the formation of the preconditions of mastering several professions during the life: for the most part of people, it is impossible in knowledge society (KS) to have only one profession during the life. The

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second most significant demand seems to be the ability to quickly generate new knowledge, the skill of integrating knowledge pieces obtained from numerous dispersed information sources, the ability of creative thinking while processing new knowledge and its connections with available knowledge.

The analysis of the literature shows that the scholars from many countries consider the problem of supporting and developing creativity of the learners as a highly acute problem. Until the 2000s, the majority of publications on creativity studied the peculiarities of intelligent activity of outstanding scientists, painters, writers, poets, etc. (see., e.g., [16]). This kind of creativity is often called in modern literature "big C creativity" (BCC), this term was introduced in [21].

However, the realities of information society transforming in many countries into KS caused the emergence of the term "little C creativity" (LCC) [2]. The birth of this term reflects the demand of everyday creative thinking. The two criteria of BCC are the originality and high significance for big groups of people. Creativity demonstrated by children usually is subjective, it is determined by their prior knowledge. An important characteristic of children's creativity is imagination.

The realities of KS demand to support and develop LCC in order to increase the proportion of the specialists possessing BCC. But it is not obvious how to achieve this global goal. The paper [20] analyses the results of a large scale study carried out in USA and focused on the evolution of average level of intelligence and creativity during two decades, since the early 1990s. The diapason of participants was from young children in kindergartens to 12th grade students and adults. The results of the study showed a steady decline of creative thinking from 1990 to 2008 among inhabitants of USA. This decline is especially considerable in kindergarten through third grade. Besides, the results of the study indicated that young children "are tending to grow up more narrow-minded, less intellectually curious, and less open to new experience" [20, p. 1]. Taking this into account, Kim [20] expressed the opinion that it is necessary to encourage creative thinking in preschool or before.

Parallelly with the term "creativity", the notion "emotional intelligence" (EI) belongs to the set of concepts most often used in scientific publications in the field of education. According to [1], EI is the other kind of smart. The studies carried out during two decades after the birth of this notion in 1995 [17] have shown

that EI is the crucial factor distinguishing star performers of various professional roles among all performers of these roles.

EI determines the manner of a person to manage behavior, deal with social complexities, and make decisions leading to positive results. EI is the unity of four core skills forming two primary competences: personal competence and social competence. According to [1], personal competence is composed by two skills: self-awareness and self-management. The first skill is the ability of a person to accurately perceive his/her emotions and stay away of them as they happen. self-management is the ability of a person to use awareness of his/her emotions for staying flexible and for positively directing his/her behaviour. Social competence is defined by Bradberry [1] as the ability of a person to understand other people's moods, behaviour, and motives for improving the quality of his /her relationships.

During the last two decades, the psychologists have discovered a huge role of well-developed EI in taking successful business decisions. That is why now the big companies throughout the world pay a very high attention to the state of EI while hiring, promoting, and increasing qualification of their employees [18].

promoting, and increasing qualification of their employees [18]. Since early 1990s, we have been looking for more effective principles of teaching and learning in comparison with the broadly used ones. The accumulated theoretical and practical experience shows that modern education as a whole underestimates the significance of basing on EI for making easier for the students grasping central ideas of theoretical materials to be learned.

The structure of this paper is as follows. Section 2 introduces a learning model (LM) aimed at supporting and developing EI and creativity. Section 3 considers two components of an original conceptual learning environment for studying second language (English for young Russian children). Section 4 gives a very short information about the System of Emotional-Imaginative Teaching (the EIT-system), being a successful implementation of the suggested LM. Section 5 interprets the EIT-system as a balanced approach to combined development of EI, reasoning skills, and creativity, outlines the significance of this approach for education in KS. Section 6 indicates the importance of art cognitonics and the methods of achieving cognitive engagement at the lessons of art for improving emotional well-being of the learners. Section 7 shows the broad prospects of using the developed educational methods.

2. STUDENT-SELF ORIENTED LEARNING MODEL

We believe that modern education may find the ways to effectively deal with numerous open problems as a result of accepting a new LM taking into account the significance of EI in professional and personal life.

The broadly accepted student oriented LM determines the activities launched by the goal to discover the world: acquisition of information, information processing, knowledge construction. The resulting activities are constructing a new text and constructing a new sense. Then the achieved cognitive-emotional state is as follows: a student is well-educated but not intellectually and spiritually mature.

Discovering the world is based on a brand-new culture on the basis of digital opportunities and ideology. Its essence is to catch up with new technologies (but not to find one's way and incorporate it into modern reality as a new vision). It is underpinned by the curiosity and strong aspiration to discover the digital world, on the one hand, and by the desire to emulate the grown-ups and become as smart and powerful as the grown-ups or even much smarter and much more powerful.

The concept of Self is based upon our images of ourselves. The Self develops as it interacts with the most important of environmental influences. Through this social interaction the Self defines itself as a social being, which influences, and is influenced by others [22].

Student-self oriented learning model (SSOL-model) is defined as the model being beneficial for self-cognition and self-construction through the prism of the acquired knowledge and life experience.

Natural language is the tool for constructing social reality [26]. The Self develops through the social interaction and co-creative work, because creative work suggests personal involvement and is underpinned with strong emotions (e.g., inspiration). The process is always emotionally coloured.

Under the framework of standard model, the process of knowledge acquisition often seems to the students to be first gloomy (no interest, no personal involvement), then pleasant and afterwards filled with never-ending delights. In case with the SSOL-model, the process of learning seems to the students to be pleasant and curious from the very beginning. Afterwards it is filled with never ending delight. The new model helps to exclude from the perception of educational process such characteristics as "gloomy". As a result, it arises the interaction with the environmental influences and causes cognitive engagement of the students.

This idea is intuitively clear to very many experienced lecturers. EI suggests Self, because Self is always emotionally coloured. One is never tired when the subject of the conversation (or lecture) touches his/her Self in a positive and curious way. You are never tired if we are speaking about you and want to know your life experience, you are in the centre of attention.

Strength of materials (or mechanics of materials) is known as one of most difficult disciplines for the university students – future engineers. However, 61 years ago one scientist found a thrilling way to introduce basic ideas of his discipline. This scientist is Charles Seim, he wrote the article "A Stress Analysis of a Strapless Evening Gown" in the year 1956. This article was published in the book "A Stress Analysis of a Strapless Evening Gown and Other Essays for a Scientific Age" (Robert A. Baker, 1969, 212 pages). The translation of this book under the title "The physicists are joking" became very popular in Russia in the 1970s.

The core of the proposed model consists of self-cognition, selfconstruction, and self-regulation of self-conscious emotions. Let's explicate these notions. Self-cognition is active transfiguration but not passive reflexion. Self is constructed through the interaction with the world (through the discovery of the world). The particular facets of the personality are improved as a result of new experience and as a result of processing the semantic trace left by a strong emotion caused by that new experience (it is the improvement of emotional experience). Self is always coloured by emotions. That is why this semantic trace deepens the emotional experience and, as a consequence, improves the emotional intelligence of the student [23].

Firstly, the realization of this new model leads to Student – Digital World balanced partnership. It means the spiritual maturity and cultural level of the student become equal to the outstanding breakthrough in digital technologies. Secondly, the realization of the new model leads to the improvement of serendipity and turns information into serendipitous information

(unexpected but desirable). Serendipity is the ability to make pleasant and unexpected discoveries entirely by chance [19]. It leads to much higher level of socialization and to much higher level of responsibility.

To sum up, the suggested model determines the humanistic filling of education in the digital world. The new model suggests:

- a conceptual learning environment instead of a memorization-based one (it means making emotionally coloured the concepts to be learned and, as a consequence, making much easier grasping these concepts);
- the methods of achieving cognitive engagement of the students;
- a system of self-oriented questions in the process of knowledge acquisition;
- the methods of encouraging the students to discover the world aimed at self-cognition and self-construction;
- a method of teaching the students how to process serendipitous information.

3. EXAMPLES: A CONCEPTUAL LEARNING ENVIRONMENT FOR STUDYING SECOND LANGUAGE

Example 1. The experience shows that it is very difficult for five six year old Russian students to understand why they should use in simple phrases different words "am", "is", "are" and how one should combine these words with the words "I", "you", "he", "she", "it", "we", "they". Our approach to this problem is as follows. Assume that a teacher knows that her young student Julia has a beautiful dress for theatre, a dress for kindergarten, and a dress for a bathroom. Julia agrees that she never doubts what dress to wear. Then the words "am", "is", "are" may be called the different dresses of the verb "to be" (children at this age have very vivid imagination). Besides, "am" may be called a dress for visiting the house where the word "I' lives, "are" - a dress for visiting the house where the words "you", "we", "they" live, and "is" - a dress for visiting the house where the words "he", "she", "it" live [5].

Example 2. In English grammar we have the Present Continuous Tense. We propose a new approach to explaining this Tense, the motive is that our many year experience has shown that this approach provides the possibility to minimize the number of errors. The peculiarity of this piece of grammar for Russian learners is the lack of similar tense in the grammar of Russian language. This tense is very important tense, because it reveals the emotional state of an interlocutor and emotionally colours the speech. It is possible to call it the Emotional Tense - the tense which reveals our emotions. For example, saying "Look, she is reading", we attract somebody's attention to something or somebody, because we are not indifferent to it. When we are talking and drinking in a cafe, we say: "I am readying an interesting book now", it means that we are carried away by the book (at least we are not indifferent towards it if we mention it while talking and drinking). We use this tense speaking about the weather, about changing situation, irritation ("You are always wearing my slippers"), to express admiration ("What a nice hat you are wearing!"), personal arrangements, etc.

This tense shows emotionally coloured attitude towards something, it doesn't just state the fact, doesn't denote something which is true in general. The personal involvement is high, the state of minute is obvious (when somebody scoops a precious, significant, or just a particular minute out of the river of time). Due to the usage of the proposed approach at lessons of English as a second language (SL), the Russian students begin to employ this tense eagerly while speaking. It makes the lessons of English grammar socially coloured and more interesting for the students. Besides, this method reveals the essence of the English character.

4. THE SYSTEM OF EMOTIONAL-IMAGINATIVE TEACHING AS A SUCCESSFUL IMPLEMENTATION OF THE SSOL-MODEL

In early 1990s we came to the conclusion that educational potential of young learners (5-6-7 years old) is much higher then it was broadly accepted to believe. The key to more effective realization of this potential should be the ways of establishing a correspondence between a piece of material to be studied and a certain *bright* fragment of the learner's conceptual picture of the world. We called such correspondences *dynamic conceptual mappings* [4]. That is why we started in early 1990s a study aimed at finding more effective ways of teaching and learning due to systemic basing on young learners' emotional experience accumulated, in particular, during the breakfasts and lunches, the walks in gardens and parks and along a river, while visiting school and theatres, plaving various games, sport activities, etc.

Step by step, we obtained several scientific and practical results of high social significance, and these results stood apart from the principal trends in education of the 1990s and early 2000s [15]. It was done due to our original Theory of Dynamic Conceptual Mappings (the DCM-theory) [4 - 7, 12] and our System of Emotional-Imaginative Teaching (the EIT-system), based on the DCM-theory. The EIT-system is aimed at systematic development of EI, reasoning skills, sound creativity, language skills, and communication culture at the lessons of language - mother tongue and SL, literature and poetry in two languages (on the example of Russian and English), symbolic languages of painting, sculpture, garden-park art, classic dance. We have accumulated the 27-yearlong successful experience of using the EIT-system in extra education in Moscow, Russia. Many aspects of the EIT-system are described in our papers published in the proceedings of the First -Fourth international conferences on cognitonics (see, in particular, [11, 13, 14]) and in the papers [3 - 10, 12].

Let's consider now such aspects of the EIT-system that concern basing on and developing EI and Self of the students.

Self is always creative, because it is a personal way of viewing the world, based on the world's conceptual picture of the beholder and his/her estimation of the events.

Example. The famous Russian poet Boris Pasternak gives the picture of the early spring, writing:

- Is it only dirt you notice
- Does the thaw not catch your glance?

We ask the students what makes Pasternak think that the thaw is beautiful. The answers of young students (7 years old) are as follows:

- The thaw is like a herd of dapple grey deer basking in the spring sun;
- It is like a surface of the moon dotted with craters;
- A table served for breakfast with blue cups and black ice tea with a piece of Sun.

This approach helps young students to understand and penetrate the very essence of beautiful poetical lines written by the great poet. Besides, it expands their way of viewing the world, makes the surrounding world much more colourful, and their way of viewing it much more creative. This approach helps them also to understand painting (and modern painting, in particular).

An acute educational problem is early socialization of children in KS. Let's illustrate the approach of the EIT-system to solving this problem.

Example. In the fairy-tale "Snow White" the Queen asks: "Looking-glass on the wall who is fairest of us all?". The students are asked whether it is a question in fact or she is sure that she is beautiful. The young students give the following explanations:

- If she wants to know as a researcher, she wouldn't be furious.
- She does it every morning simultaneously with having coffee or brushing her hair. It means that she is sure in the answer.
- She is selfish and she doesn't think about the good for the others, even the King. That is why she can't be beautiful. May be attractive, like Cinderella's sisters, but not beautiful.
- When the hunter promises to take Snow White into the woods, he doesn't promise to kill her. But the Queen is sure that he does. It is a cognitive trap: she doesn't expect anybody to protest, to disagree, to disobey her. It is one more prove that she is selfish and doesn't listen to anyone. It will mislead her.

Our educational results obtained in the 1990s due to the EITsystem were retrospectively interpreted during last decade as a significant contribution to *developmental psychology* and to *positive movement in psychology* [3, 10].

5. A BALANCED APPROACH TO COMBINED DEVELOPMENT OF EMOTIONAL INTELLIGENCE, REASONING SKILLS, AND CREATIVITY

Showing the diminishment of creativity level in USA during two last decades, Kim [20] indicated the necessity of starting the development of creativity in kindergartens. An important role in achieving this goal is to be played by calm, free, friendly atmosphere at lessons.

We believe that now, as a whole, cognitive potential of five-seven year olds is underestimated. The analysis shows that the DCMtheory and the EIT-system may be interpreted as an effective theoretical framework for starting education in KS.

The principal advantages of our approach to creating the preconditions of effectively starting education in KS are as follows. Young learners (five-seven years old) get accustomed to the beauty expressed in various ways. It is well known that it is highly important not only for the painters, sculpturers, poets, dress designers but also for mathematicians, physicists, designers of ships and airplanes to have a well developed feeling of harmony, feeling of beauty. That is why our approach is of high value as a starting mechanism for education in KS.

As a consequence of getting a developed figurative reasoning (due to several kinds of intellectual games, intellectual competition),

children get a developed creativity. Our approach to early creativity development excellently correlates with the opinion of



Figure 1. A scheme of a new look at combined development of emotional intelligence, reasoning skills, and creativity.

Piaget [24] about the significance of "reflective abstraction'. i.e., about the crucial role of processing and constructing knowledge in the course of mental actions performed on the perceived and imaginary objects and causing generation of new ideas.

As for early socialization, the young students became careful, tactful, thoughtful, they acquire the feeling of empathy and start appreciating the harmony in everything, including human relationships. It is important to do before the age of "teen", when children are ready to discuss and follow the social rules. In this case, beauty becomes the core of their system of values [3, 9, 10], and it helps a lot at the moment they are twelve and are going on thirteen – the transition age. Figure 1 illustrates a new look at combined development of EI, reasoning skills, and creativity.

The EIT-system includes the original methods of teaching to process serendipitous information. According to Kim [20], a very large scaled study carried out in USA showed that during last decade of the XXth century and first decade of the XXIst century children became less able to connect seemingly irrelevant things. That is why our methods of teaching how to process serendipitous information are very topical.

Well developed feeling of beauty creates for the student the preconditions of being successful at arts lessons. It is broadly accepted to believe that art education supports and develops creativity of young children and teenagers, develops emotional intelligence, improves emotional well-being, self-confidence, and

life skills of the students [25].

A fundamental significance of our approach for education in KS is determined also by the formulation of the cognitive precondition of the situation when it is possible to start systematic acquaintance of children with the computer. It is the realization of the Thought-Producing Self of the child [7, 8, 12].

6. ART COGNITONICS AND COGNITIVE ENGAGEMENT AT ARTS LESSONS

Art cognitonics (AC) [11] is one of the principal branches of cognitonics, or the science about the human being in the digital world [8 - 11, 13, 14]. The DCM-theory and the EIT-system belong to the constructive core of cognitonics. AC aims at tuning the EI of the young children and adolescents with the help of well-known works of art. The goal is to create a bright semantic trace in the world's conceptual picture of the learner corresponding to an idea explaining or illustrating a moral value, communicative situation, a situation of making a decision, cognitive process itself, the process of self-cognition and consideration, the seething cocktail of emotions, a way of viewing the world around, etc.

AC establishes the links between the objects, situation, processes, views of a person (a beholder) and the work of art that becomes a metaphor or a vivid illustration (vivid mental representation) of something the beholder is considering about. That is why the consciousness of the beholder receives a considerable impulse to developing the ability of establishing diverse analogies and consequently to finding a new look at a situation [11].

Example. For enriching the colour of their canvases, the impressionists made use of what is know as division of colour and optical blending. E.g., to represent a green meadow, they put little tabs of blue and yellow on the canvas which are supposed to be combined to form green in the eye of the beholder – a far more intense green than one taken straight from the artist's palette. That is why it is impossible to understand the idea of a picture standing close to the canvas. We have to step aside and look at it from a certain distance to enjoy it and to have the desired effect.

The same situation we have in every-day life. "Multiple debs, reflections" prevent us from grasping the sense of what is happening. As in case with impressionists' canvases, we have to have a look at the situation from a distance, and distance in this case is equal to time distance. We need some time to better understand what has happened, and this will help us to cope with the situation (see another examples in [11]).

The paper [9] contains an algorithm of resisting emotional attacks from social networks by means of transforming the negative emotions into the positive ones. This algorithm is based on the idea described immediately above.

Cognitive engagement (*CE*) is defined in [10, 14] as the process of highly motivated intellectual activity when the interest towards the subject under discussion is so strong that the students loose the track of time and, as a result, they are not tired. The students' interest determines the level of involvement. The emotional response is very close to inspiration, because they are making their own discoveries, and their mental efforts are appreciated. It helps to provide a conceptual learning environment instead of a memorization based one and enhances the motivation. CE is created mainly by the components called in [10, 14] *focused attention, positive effect, aesthetics, endurance, novelty, motivation.*

7. BROAD PROSPECTS OF USING THE DEVELOPED EDUCATIONAL METHODS

The EIT-system has been mainly realized at lessons of English as a SL for Russian-speaking children and at the lessons of poetry and literature in English, at lessons devoted to explaining the symbolic language of painting, the culture of communication, and the symbolic language of classical dance. These kinds of lessons are considered in numerous countries as highly appropriate for young children and teenagers. The carefully selected collection of texts used at lessons is provided by a number of classical, worldknown fairy-tales and novels, in particular, "Snow White", "Cinderella", "Sleeping Beauty", "Pinocchio", "Pollyanna", "The Life and Adventures of Santa Claus" by L. Frank Baum, "Alice in Wonder Land" by Lewis Carroll, "The Wind in the Willows" by Kenneth Grahame, "The Hundred and One Dalmatians" by Dodie Smith, etc. That is why the EIT-system may be used (after a certain adaptation requiring a small time) in English-speaking countries and in numerous countries where the English language is learned as a SL.

8. CONCLUSION

We believe that the proposed SSOL-model possess the properties enabling its usage as a paradigm for education in KS. The focus on the student's Self at the lessons means that the lessons are emotionally coloured, and this very much contributes to the success of the learning process.

Now there is at least one successful implementation of the SSOLmodel, and it is our EIT-system, tested during 27 years in Russia. The principal distinguishing features of the EIT-system are an effective, many-staged method of sustaining and developing creativity in young children and adolescents, supporting and developing EI, basing on EI for making much easier the grasping of the materials to be studied.

Our numerous publications in English describe many aspects of the EIT-system. The scholars from various countries do have the possibility to develop their original implementations of the SSOLmodel with respect to their mother tongue and national culture.

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The Methods of Cognitonics as the Basis for Designing Intelligent Tutoring Systems Developing Emotional Intelligence of the Learners

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ABSTRACT

The constructive core of cognitonics, or the science about the human being in the digital world, includes the system of the methods of emotional-imaginative teaching (the EIT-system). This system is aimed at systematic development of emotional intelligence (personal competence and social competence), reasoning skills, sound creativity, language skills, and communication culture at the lessons of language (mother tongue and second language), literature and poetry in two languages (on the example of Russian and English), symbolic languages of painting, sculpture, garden-park art, classic dance. The goal of this paper is revealing to the designers of intelligent tutoring systems (ITSs) the broad prospects of constructing a new generation of ITSs opened by the EIT-system. The principal peculiarities of the discussed new generation of ITSs are to be: (a) taking into account emotional intelligence of children as the basis for designing ITSs; (b) as a consequence, making much easier for children and adolescents the grasping of the pieces of theoretical materials to be learned; (c) for the majority of the systems belonging to this new class, contributing to early socialization of children.

General Terms

Design, Human Factors, Languages, Theory

Keywords

Emotional intelligence, social competence, cognitonics, creativity development, intelligent tutoring system, early socialization of children, theory of dynamic conceptual mappings, system of emotional-imaginative teaching, cognitive engagement

1. INTRODUCTION

During last decade, information society in many countries has been transforming into knowledge society (KS), or smart society. Its main distinguished features are effective knowledge processing, generation of new knowledge, establishing the links between remote knowledge fields, the possession by the specialists in various spheres of creating thinking and the ability of integrating information from numerous dispersed sources.

One of the terms being most popular in the sphere of education is smart learning (SmL). At the first sight, it may seem that SmL is a new stage of education satisfying the demands of KS. However, in Vladimir A. Fomichov School of Business Informatics Faculty of Business and Management, National Research University Higher School of Economics Kirpichnaya str. 33, 105187 Moscow Russia vfomichov@hse.ru

fact this term is interpreted in the scientific literature much more narrowly: as learning with broad use of mobile devices: tablet computers, androids, etc. This definition reflects the focus on technical means of learning. There are reasons to believe that the dominant part of the scholars don't notice the fundamental problem of perfecting, improving the principles of teaching and learning.

We suggest here a much broader definition of SmL, taking into account the significance of basing educational methods on emotional intelligence (EI) and of supporting and developing EI of the learners (see [11]). We believe that SmL is a collection of theoretical ideas and practical methods of teaching and learning developed by smart specialists in education theory, information and communication technologies, mathematics, humanities, arts, and many adjacent fields for creating cognitive-cultural and technical preconditions of up-bringing young generation being personally and professionally successful in smart society.

The analysis of scientific literature shows that a high proportion of elementary, middle, and high school students encounter considerable difficulties as concerns grasping the main ideas of the pieces of theory to be studied. Let's consider the main social consequences of this situation.

- 1. The US Public Health Service prepared in the year 2000 a report on children's mental health [20]. According to this report, approximately one fifth of children and adolescents experienced problems showing their need for mental health services. One of the main reasons for this need is the intellectual and emotional obstacles on the way of successful learning faced by the school students in conditions of too short time for relaxation and refreshing the brain as a consequence of many-hour interaction with the Internet, in particular, with computer games.
- 2. Rather often, the breaks of discipline at lessons encountered by the students in the process of grasping the materials to be learned cause the growth of aggressiveness towards the teachers and the classmates with higher grades. The breaks of discipline negatively influence the total learning result of the class. Besides, these breaks and the aggressiveness of some students towards the teacher prevent a considerable part of gifted persons with the abilities of good educator from choosing the profession of teacher for himself/herself.

- 3. The negative consequences of students' aggressive attitude towards their classmates may be very severe (posting in social networks false information about a classmate, false erotic pictures, etc.) and even tragic in cases of cyber bullying [21].
- 4. In many cases, the attacks of young hackers against socially important technical systems may be explained as a result of expressing the aggressiveness. The intelligent power of applied computer systems is being permanently increased. That is why the negative consequences of the hackers' attacks promise to be increasing too. Taking this dangerous tendency into account, and, besides, the aggressiveness of some students towards their classmates and the teachers, a socially very significant task is to find the ways of making easier for the students the grasping of the pieces of theory to be learned (there are reasons to believe that, very often, the experience of success in the process of learning eliminates the student's aggressiveness).

5. In KS, many countries encounter the problem of insufficiently developed social lifts. The following scientific fact says about the high significance of solving this problem: in different strata of people living in one country, various gifts are distributed approximately in the same way. That is why it would be important to have the situation when the adolescents from different social-economic strata possessing the gifts being crucial for a certain socially significant profession (a medicine, a lawyer, etc.) would enter a university for mastering this profession. Unfortunately, in many countries the real situation is quite opposite. E.g., it applies to UK. As it is shown in [16], the Organisation for Economic Co-operation and Development (OECD) describes the United Kingdom's troubling social mobility problems: more than 50% of youngsters will grow up to have the same salary as their father [18]. The Sutton Trust[19] shows that 53% of the UK's most influential people were independently educated, including 24% of university vicechancellors, 32% of Members of Parliament, 51% of medical consultants, 54% of top journalists, 70% of High Court judges when only 7% of the UK population are.

During last twenty years, the intelligent tutoring systems (ITSs) have been broadly used throughout the world for helping children and adolescents to grasp theoretical materials. The big subclasses of ITSs help to study (a) second language (SL), (b) mathematics. However, one has been able to find in the literature only separate examples of the systems oriented at developing the personality of the learners. In particular, the interactive multimedia courseware package CITRA is a tool for moral values education using traditional Malay oral narratives [17]. Two collaborative videogames described in [1, 2] not only develop mathematical and language skills of the eight – ten year old children in Mexico but also support and develop in Mexican children the skill of effective collaboration in a team, hence develop social competence.

Our paper [11] introduces a new learning model (LM) called Student-Self Oriented LM (SSOL-model). Its principal distinguished feature is basing on EI and developing EI of the learners. We believe that the SSOL-model may be interpreted as a paradigm for education in KS, i.e., as a paradigm of SmL in the expanded sense of this term. The SSOL-model has at least one successful implementation - the System of Emotional-Imaginative Teaching (the EIT-system), it belongs to the constructive core of cognitonics, or the science about the human being in the digital world (see [7-10]). The aim of this paper is revealing to the designers of ITSs the broad prospects of constructing a new generation of ITSs opened by cognitonics. More exactly, these prospects are opened by the EIT-system [3-10, 12-15] (see also next section). The principal peculiarities of the discussed new generation of ITSs are to be as follows: (a) taking into account EI of children as the basis for designing ITSs; (b) as a consequence, making much easier for children and adolescents the grasping of the pieces of theoretical materials to be learned; (c) for the majority of the systems belonging to this new class, contributing to early socialization of children.

The structure of this paper is as follows. Section 2 sets forth a rationale for creating the foundations of cognitonics. Section 3 sets forth a script (a collection of instructions) of designing an ITS contributing to the socialization of young children. The system is based on using the world known fairy-tale "Sleeping Beauty". Section 4 indicates the significance of using in the ITSs the vocabulary and images extracted from young children's speech. Section 5 outlines the possible directions of future research.

2. THE RATIONALE FOR FOUNDING A NEW SCIENTIFIC DISCIPLINE – COGNITONICS

In early 1990s we started a study aimed at finding more effective ways of teaching and learning due to systemic basing on young learners' personal experience, including emotional experience accumulated, in particular, during the breakfasts and lunches, the walks in gardens and parks and along a river, while visiting school and theatres, playing various games, sport activities, etc.

Our main motive was the feeling that educational potential of young learners (5 - 7 years old) is much higher than it was broadly accepted to believe. As a key to more effective realization of this potential, we saw the ways of establishing a correspondence between a piece of material to be studied and a certain fragment of the learner's conceptual picture of the world. We called such correspondences *dynamic conceptual mappings* [4].

In three - four years, we obtained several scientific and practical results of high social significance, and these results stood apart from the principal trends in education of the 1990s and early 2000s. It was done due to our original *Theory of Dynamic Conceptual Mappings (the DCM-theory)* [4-6, 14, 15] and due to the EIT-system, based on the DCM-theory.

The EIT-system is composed by (a) several complex methods combing teaching/learning with the development of the student's personality and (b) an original program of extra-scholastic humanitarian education covering 12 years of continuous studies, where the starting age is five $- \sin x$ – seven years. The system is aimed at systematic development of EI (personal competence and social competence), reasoning skills, sound creativity, language skills, and communication culture at the lessons of language (mother tongue and SL), literature and poetry in two languages (on the example of Russian and English), symbolic languages of painting, sculpture, garden-park art, classic dance. We do have accumulated the 27-year-long successful experience of using the EIT-system in extra-scholastic education in Moscow, Russia [3-6, 8, 12-15].

We mean here, first of all, the following four scientific and educational results that stood apart from the principal trends in education of the 1990s and early 2000s:

- 1. An original and effective method of supporting and developing figurative thinking of five-six-seven year old children was proposed. Its essence is teaching young students to decode and to compose metaphors. This method may be interpreted as the foundation of an original, many-staged method of developing creative thinking of young children and adolescents and realizing their Thought-Producing Self (the same mechanism does function in case of both foreign language and mother tongue) [3, 6, 7, 15].
- In the 1990s and 2000s, according to the generally accepted methods of learning SL by young children (five seven year old), young learners were taught short poems, songs, and the usage of fixed phrases in standard communication situations. They didn't generate speech from lexical units. Our original approach based on EI of children enabled us to teach young children to read complex texts in English (fairy-tales) with understanding and to generate speech while discussing various situations. The speech of children demonstrated the command of constructing sentences in SL (English) in Present Simple and Past Simple tenses and building questions in Present Simple [4-6, 12-14].
 A discovery: the consciousness of five-six-
- 3. year
 - year old children demands a very rich language for representing the emotions from the pictures of nature [6, 8].
- 4. One of the most precious distinguishing features of the EIT-system is no problem with discipline at lessons. This applies both to the lessons with five-six-year old and seventeen-year old students. This phenomenon is a consequence of highest cognitive engagement at lessons due to the basing on EI of the learners [10].

In early 2000s, we realized that it is possible and desirable to do much more for the development of the child's personality (reasoning skills and EI, including social competence) than it is broadly accepted to do throughout the world. This conclusion was drawn in the context of numerous observed negative implications of the Internet's stormy progress and the globalization process underpinned by it.

After thoroughly thinking over this situation, we came to the conclusion that it is necessary to create a new scientific discipline for combining the efforts of the scholars throughout the world for compensating negative implications for the personality development of the Internet's stormy expansion and for creating cognitive-cultural preconditions of successful personality's development. We suggested to call this new discipline "cognitonics" [7]. Later we interpreted cognitonics as the science about the human being in the digital world.

From the standpoint of educational practice, cognitonics proposes an answer to the following question: what precious ideas and images accumulated by the mankind, at what age, and in what a way are to be inscribed into the world's conceptual picture of a person in order to harmonize his/her intellectual and spirituallycoloured emotional development and to contribute to the successful development of national cultures and national languages?

Cognitonics formulates a new, large-scale goal for the software industry and Web science: to develop a new generation of cultureoriented computer programs and online courses (in the collaboration with educators, linguists, art historians, psychologists) - the computer programs and online courses intended for supporting and developing positively-oriented creativity, EI, the appreciation of the roots of the national cultures, the awareness of the integrity of the cultural space in the information and smart society, and for supporting and developing symbolic information processing and linguistic skills, associative and reasoning abilities of children and university students. In October 2009, 2011, 2013, 2015, four international scientific conferences on cognitonics (Cognit-2009 – Cognit-2015) took place under the framework of the international scientific multi-conferences "Information Society" (IS-2009, IS-2011, IS-2013, and IS-2015, Slovenia, Ljubljana, Jozef Stefan Institute). The access to the proceedings of the conferences Cognit-2009 – Cognit-2015 is open, see https://is.ijs.si/proceedings.php. A part of cognitonics-based scientific and practical results is presented in the Second Edition of the International Encyclopedia of Social and Behavioral Studies [3].

3. A SCRIPT OF AN INTELLIGENT TUTORING SYSTEM CONTRIBUTING TO EARLY SOCIALIZATION OF THE LEARNERS

The analysis shows that the methods of cognitonics open broad prospects for the development of a new generation of ITSs. Their principal distinguished features should be orientation at culture, at developing EI of the learners.

New, culture-oriented scripts under the framework of cognitonics may be divided into three main groups.

Group 1: Socialization-oriented scripts.

Group 2. Improvement of the language (mother tongue and SL) as a tool of thinking in order to oppose the phenomenon of poor language and, as a consequence, poor cognitive process, that is, an underdeveloped tool of constructing social reality.

Group 3. The scripts aimed at demonstrating the possibilities of expressing the same idea by means of different languages, for instance, by means of natural language and the language of painting. The goal is the development of the ability to see something extraordinary in an ordinary thing or situation, to find a new look at an object of interest and to make a discovery, to develop the ability of processing serendipitous information.

Let's consider a script of a culture-oriented ITS based on the idea of social conventions. The literary source of this script is the fairytale "Sleeping Beauty". The script is associated with two aims. The first aim is to explain how it is possible for the student to escape in the life the meeting with the 13th fairy. It means not to make a person act in a provocative way. The reason is that such kind of behaviour would make harm both to an initiator and to a person. In case of the considered fairy-tale, a fairy turned into a witch, because she could not cope with emotions and gave way to hatred. The second aim is to develop the Ecological Self of the student.

Instruction 1 for the designers.

Construct a dwelling (a hut, a castle, a palace, a cottage, etc.) appropriate for a King and a Queen and for the 13th fairy.

Put the dwelling into appropriate surrounding (garden, park, edge of the forest, etc.).

Choose the interior revealing the characters of the story.

Choose the time of the day, the season. Dress the characters up and choose some occupations for them.

Instruction 2.

According to the logic of Instruction 1, create a big album containing the photos of the characters in different situations. One part of the photos adequately illustrates the life of the personages. Another part falsely illustrates the actions of the personages (in such cases an action or situation contradicts the properties of the character).

Motivate the students to select the photos for the album of each character. The aim of this subsystem of the ITS is to develop the ability of the student to correctly associate the actions of a character with the essence of this character.

Instruction 3.

Create a subsystem motivating students to construct a dynamic picture showing the extensive preparations in the Kingdom for the Christening Party.

Step 1: The construction of a picture showing all kinds of the living beings (in particular, the carpenter, the animals, and the birds) in the Royal Park.

Step 2: Ask the student to select the living beings for active preparation for the Christening Party.

Step 3: For each considered living being, select one of four-five actions.

Example. It is possible that for the birds a student will select the action "sing the songs".

Instruction 4.

In general terms, the task is to realize the step explicating the essence of social responsibility. The details of this step are as follows.

The King should be sure that every guest has received the invitation and has accepted the invitation. In order to be sure, the King is to receive a confirmation from every guest that the guest has received and has accepted the invitation. The violation of the rule leads to misunderstanding. In our case, the 13th fairy didn't receive the invitation, though the King had sent an invitation, and regarded the lack of invitation as a mark of disrespect on his part.

Instruction 5. Explain to children how the violation of etiquette will mislead them. Preventing a violation of etiquette means not to make a person act in a provocative way. The reason is that such kind of behaviour would make harm both to an initiator and to a person. In case of the considered fairy-tale, the fairy turned into a witch, because she could not cope with emotions and gave way to hatred. Consider possible examples.

Example 1. One meets a classmate but doesn't greet him/her. It may lead to offense.

Example 2. One may take a pencil of a classmate without the permission. The classmate may become cross with him/her.

Example 3. One may eat a cake without expressing his/her gratitude to a classmate. The classmate may think that he/she is not polite.

Example 4. When he/she does something wrong and doesn't **5.** apologize, then the classmate may think that he/she is rude with him/her.

Example 5. When a classmate brings a mouse, though he/she knows that the girl is afraid of mice, it means that he/she is selfish, because he/she doesn't take into account the peculiarities of the girl.

Instruction 6. The essence of this step is to construct the chains revealing the behaviour of the character of the book who is thinking and acting in terms of public good.

Example 1. The 12^{th} fairy was attentive and ready to help, she made up the situation and tried to make not only the princess but the whole kingdom fall asleep. The motive of the fairy was not to make the princess lonely when she woke.

Example 2. The people of the kingdom were ready to help, and they brought their spindles to the square to make a fire. They were

ready to sacrifice the necessary things and not to have new clothes, because they would not have the spindles to spin.

Instruction 7.

Preliminary stage. Ask five-six-seven-year-old children being acquainted with the fairytale "Sleeping Beauty" to describe the preparations in the Kingdom to the birth of a princess. Construct a collection containing all proposed creatures and their actions of the kind.

Main stage. Ask children to select the creatures and their preparations to the birth of a princess.

4. CHILDREN'S SPEECH AS A SOURCE OF VOCABULARY AND IMAGES FOR THE DESIGNERS OF TUTORING SYSTEMS

The inner world's picture of young children is very different from the picture of adults. Young children have a vivid imagination, and they easily go from the reality into the world of fantasy. That is why it is very important for the designers of ITSs to use in the computer systems the vocabulary and images extracted from children's examples collected at the preliminary stage of developing a system.

We have collected, in particular, the following examples given by children:

Preparation of gifts

(1) The gardener prepares fountains and flower beds; (2) the carpenter makes the cradle shaped like (a) a swan, (b) dolphin which always rescues, (c) see-shell in which the princess will be like a pearl, (d) a flower which opens its petals at dawn; (3) the beasts prepare (a) milk taken from forest plants, (b) pick up glowworms; the birds sing songs; the kittens are purring a lullaby; the baby-squirrels have picked up nuts; the mother-dogs are knitting mittens; the mother-squirrels are sewing the dresses for the dolls of the princess.

Preparation in the palace

(1) The birds are bringing in the beaks the field flowers; (2) the chipmunks are bringing the baskets with drops of dew in order to water field flowers; (3) in the evening the star peeps through the curtain to light the room; (4) the little angel descends in order to fill the nursery with kind dreams and to kiss the princess good night.

5. POSSIBLE DIRECTIONS OF FUTURE STUDIES

The considered script allows us to get an initial impression about the possibilities of using the methods of emotional-imaginative teaching as the basis for developing ITSs of a new generation. This script may be compared with a single piece of a big, complicated mosaic picture to be created. The EIT-system provides original effective methods for designing ITSs solving the following tasks:

- developing imagination, creativity by means of teaching to decode metaphors and invent metaphors;
- contributing to early socialization of the learners on the example of etiquette as a social agreement (etiquette makes the behaviour of the humans predictable, it is very important for understanding

each other and in order not to heart the feelings of people);

- making thrilling the mastering of SL grammar (on the example of English);
- teaching the learners to integrate information dispersed in various sources and to establish timecausal relationships between the extracted facts;
- revealing cross-culture differences for avoiding misunderstanding during communication.

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To Fear or Not to Fear the TOR Communication System

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ABSTRACT

Whenever a user tries communicating with another recipient on the Internet, vibrant information is sent over different networks until the information is intercepted or normally reaches the recipient. Precarious information crisscrossing networks is usually encrypted. In order to conceal the sender's identity, different implementations have proven successful - one of which is the invention of anonymous communication systems. There are many anonymous communication systems developed but, the Onion Router (Tor) is the greatest organized anonymous communication system, which offers online anonymity and privacy. There are a vast number of obstacles in security that have to be considered when deploying Tor. This paper thoroughly investigates and presents these security issues in Tor.

Categories and Subject Descriptors

C.2: [Computer-Communication Networks]: Network Architecture and Design, Network Operations

General Terms

Security

Keywords

Tor, onion routing, design and non-design objectives, and security issues.

1. INTRODUCTION

Tor is a network of implicit channels that enables a user to connect to a manager with heightened confidentiality via the Internet [1]. Remote hosts can be introduced by using Tor from learning a user's location (IP address). The basic working of Tor is that it routes the outgoing connections from a client's computer via "onion routers". "To create a confidential structure passageway - with Tor, the software of the user/client increasingly makes a circuit of networks, which are encrypted on the net through the servers. The circuit, which is created, is then lengthened through one jump at a time and each server only knows from where the data is coming from and to whom will it be transferred to. None of the servers ever knows the complete path. For each jump, the client uses a set of encryption keys, which are separate, so that each jump should not be traced as these links are passing through [2]. When a circuit is constructed, different forms of data can be traded and different types of software (applications) can be utilized over the Tor network [3]. The use of traffic inquiry - to link the networks destination and source - cannot be done because in the circuit each server cannot see more than one hop, (neither by an adversary nor a malicious server).

To help protect everyday confidentiality by letting on the user to be anonymous, Tor acts as an excellent system for those who want to make outbound links that prohibit the use of certain protocols. Tor is one of the best services which provide anonymity online [4]. It routes data, packed into equally sized frames, along a (cryptographically) secured path called onion routers. The routing follows the principles of CSN (circuit-switched networks), from where the terminology is provided to Tor. Each router only knows the predecessor and successor. This is achieved by limiting the perspective of onion routers on a circuit, which in return gives a high level of anonymity. In every jump a "coating" of cryptography is removed or added which depends on the direction of flow. A client, who wants to connect to a remote server anonymously, uses Tor as a proxy. All the connections and messages go through Tor first, then to the server. Thus, the client is hidden by the server because the server believes that the connection is coming from Tor. The Tor system is made up of a network of relays. Each relay is a volunteer machine. The client picks three relays from the network to form a circuit: the entry node, the middle node, and the exit node. The client establishes a connection with the entry node, then using the entry node as a proxy, extends that connection to the middle node, and finally, extends the same connection to the exit node. Currently, there are more than 500, 000 users in Tor and more than 6,000 relay nodes [5].

At first sight, the anonymity of navigating through the Internet may be used mainly by people with malicious intentions. However, the analysis shows that the real situation is much more complex.

The relative technical easiness of recording the navigation routes of numerous Internet users creates the preconditions of getting to know and accumulating their interests of various kinds. This information may be used by malicious people (probably, acting with the help of intelligent robots) for inventing the ways of making attractive for certain categories of Internet users some actions (purchases, donations, etc.) resulting in a considerable damage for these users.

That is why the use of anonymous communication systems like TOR protects very many Internet users from the attacks of people with malicious intentions. As a consequence, the usage of TOR by normal people contributes to their harmonic existence in knowledge society, and this corresponds quite well to basic objectives of cognitonics [6].

The premise of anonymity provided by Tor relies on the three relays used by the client to be non-colluding. Moreover, the

identity of the three relays used by a client to connect to a server is hidden. If an adversary could somehow identify the three relays used by a client, this breaks some of the anonymity of the client as it reveals which three Tor relays the client chose, as after the Tor relays in the circuit have been identified, and the identity of the client is also leaked. Thus, de-anonymizing the three relays used by a client is the first step towards identifying which client is communicating with which server. This has a colossal tremble on Tor as the anonymity of any Tor user can be compromised [7].

This paper takes a deeper look at Tor, and highlights its security and other open issues. The remainder of the paper is organized as follows. Section 2 provides a background of Tor. The design and non-design goals are presented in section 3. Sections 4 and 5 provide the research and open issues in TOR. And section 6 concludes the paper.

2. BACKGROUND

The Onion Router (Tor), as depicted in Figure 1, is a circuitbased, low latency, overlay network which provides anonymity and privacy. It is the most deployed/available anonymous communication system in present era. Its users are in hundreds of thousands, e.g. military, intelligence agencies, journalists etc. and in more than 75 countries with over 6000, relays to provide online anonymity and privacy. The idea inside Tor is of "onion routing". David Goldschlag, Paul Syverson, Michael Reed developed it in the mid-1990s. It is funded by the U.S. Naval Research Laboratory.

For anonymous communication anonymity over computer/internet is provided by Onion Routing (OR). Messages are encrypted and then forwarded to nodes known as onion routers. A header is peeled and the instructions for routing to next router are performed. This process occurs in repetition. No initial node or intermediate nodes know where the message is being passed send or received [8]. There are three nodes/relays in Tor as depicted in Figure 1: entry node, middle node, and exit node. As a communication system, there are four basic components in Tor: sender, receiver, onion routers and directory servers.



Figure 1.TheTor architecture [9].

3. DESIGN GOALS/NON-GOALS OF TOR

The following are the design goals/non-goals of Tor:

Goals(Table 1):Anonymous systems are designed for low– latency. Tor defends against attackers from connecting as communication companions and its users from connecting to multiple communications.

Table 1. Design goals of Tor

Design	Developments	
Open/simple	Tor is open source; simple	
	protocol; with security	
	parameters paving the way	
	for its defense	
Accessibility on different	Tor is easily accessible on	
platforms	different platforms (e.g.,	
_	Windows, Linux, Mac, etc.)	
Design is deployed	Tor is deployed in the real	
	world and volunteers are	
	willingly making it possible	
Flexibility	Tor's flexible and well-	
	identified protocol makes it	
	a hotspot for future research	

Non-goals(Table 2): Tor's deployable and simple design left unsolved questions, which need to be addressed.

Work required in its design					
Protocol	As like Privoxy or				
	Anonymizer, Tor does not				
	provide protocol				
	normalization				
End-to-end attacks	Traffic confirmation or				
	end-to-end timing attack				
	requires attention in the				
	Tor community				
Steganography	Steganography is not				
	concealed in a Tor				
	network				
No peer-to-peer	A Tor network is non-				

peer-to-peer

Table 2: Non-design goals of Tor

4. RESEARCH AREAS IN TOR

The current areas of research in TOR include:

Security: A traffic confirmation attack [10] is possible when an attacker is controlling the relays on both ends of a Tor circuit and comparing traffic timing, volume, and other characteristics. This makes it possible to locate that the two relays are in on the same circuit. If the first (entry guard)and last relays (exit node) know the direction of the destination and the source in the circuit, then together they can de-anonymize it, which demolishes the security of the data as well as the IP of the server and the destination. More work need to be done to avoid these types of attacks so that security is guaranteed.

Confidentiality: Overall, Tor networks are susceptible to numerous attacks. A path selection attack is an example of one such broad category of attacks. In Tor, the initiators choose the nodes on the circuit so the last nodes cannot be combined. The length of the circuit is three by default. Because of this, latency is

kept to a minimum. This opens the door for connected attacks, which include congestion of the genuine Onion Routers to a point where they cannot require a fresh circuit to be built.

The Tor last nodes pose a risk to confidentiality, since anybody can offer to route a Tor node. An assailant would have full admittance of data which is being routed if the assailant occurs to route the last node in a circuit. While in MITM (Man in the middle attack) [11] the exit nodes can similarly transmit attack by mentioning back a false text for the site the originator wants to join.

Authentication: Each onion router keeps Transport Layer Security (TLS) connection with all other onion routers. Tor uses TLS cipher suites with ephemeral keys. All TLS connections use short-term ephemeral keys. Short-term ephemeral keys are Onion encryption keys. Every onion router issues a router self-key. Moreover, directory servers keep a long term, authority self-key (stored offline) and a medium term authority signing key (3–12 months). The Onion Proxy does not have any identity keys. Tor uses a number of nodes located around the Internet to protect users' privacy.

It is important that originator can guarantee that his/her communications with the many nodes is authenticated: if a malicious man-in-the-middle attack functioned or cooperated with one node to connect to the first node, then authentication is lost.

Performance: Many works have been done to improve the performance of Tor [12-13]. This led to improving the performance of Tor and moving it from a high latency to a low latency network. However, due to the constant processing of cryptographic modules, Tor is slow in performing these actions. For the improvement of Tor, more work needs to be done.

Anonymity: Tor is free of cost software for enabling online anonymity. This feature makes it viable for users to search and surf the Internet, making them untraceable (activity and location) by government agencies, corporations, or anyone else. However, more work is needed for improving anonymity (online) and defending against attacks.

Censorship resistance: Censorship circumvention systems such as Tor are highly vulnerable to network-level filtering. Because the traffic generated by these systems is disjoint from normal network traffic, it is easy to recognize and block; and once the censors identify network servers (e.g., Tor bridges) assisting in circumvention, they can locate all of their users. Due to this, Skype-morph [14] was introduced, but there is more work which is needed to avoid the blocking of Tor relays/bridges.

Scalability: Tor's insistence on deployability and simplicity of design has led to the adoption of a clique topology and semicentralized directory that made the network model completely visible to client knowledge. These properties cannot scale past a few hundred servers, but implementation experience will be useful to learn the relative importance of these bottlenecks.

Path selection/circuit creation: A Tor client initially contacts Directory Authorities to fetch the consensus. As a Tor client gathers information about existing relays, it tries to build circuit paths. The paths are created according to the following rules [15]:

• The guard node should be the first node.

- For the same path, routers should not be identical in a Tor family.
- Un-valid or non-running router/relays are not selected. If their configuration is proper, then it is allowed to be connected in network.

5. OPEN QUESTIONS IN TOR

The following is a list of open issues in Tor:

* The previously discussed issues are based on active and passive measurements (circuit latencies) as well as throughput estimations for improving the performance of anonymous communication channels provided by Tor. Work needs to be done on viable significance of new methods on security and anonymity of the system.

* The Circuit Clogging Attack [16] can be used to identify all the Tor relays used in a circuit; however, it is an open question to identify which of the relays are the entry, middle, and exit relays.

* There needs to be work done on the basis of onion proxies; i.e.,to prevent compromised onion proxies to send false information so that they can obtain high scores. Also needed is the maintenance of Tor performance when the mechanism for optimizing Tor node store and output mode reduces the choice of relay nodes.

* Current algorithms may be modified to optimize performance by improving classification of the bulk traffic and considering alternative strategies for distinguishing web from bulk connections. Additional approaches to rate-tuning are also of interest. For example, it may be possible to further improve web client performance using proportional fairness to schedule traffic on circuits.

* Reliable relay of information is very important for building paths with better performance; therefore, a Relay Recommendation System (RRS) is needed for Tor to offer reliable relay material with better performance for building paths, ease low-resource attacks, and enable operators to explore the compromises among anonymity and performance based on their needs.

* The importance of the Tor network, as an online tool, is to safeguard the confidentiality and to try to improve the performance of applications for interactive users. To do this, researchers proposed Personal Computer Transmission control Protocol or PC/TCP (IPsec over TCP for the circuit), a new transport mechanism for Tor anonymous communication that allows you to design circuits protected by IP sec [17] TCP connection. There are some areas for improvement in this very aspect.

* The use of the path length is the key factor of path selection to provide flexible and easily deployed tunable options for users. It is an open research to design more options utilizing more potential factors in Tor to provide fine-grained tunable functions.

* Simple strategies are used to improve the selection method for relays with high bandwidth and TCP advertised window sizes. Bandwidth is a key factor in Tor design and path selection. Anopen research question is to work on this inadequate balance in the load distribution to enhance Tor circuit and the efficiency of performance.

In (LASTor): A Low-Latency AS-Aware Tor Client, a technique is used by agreeing on a value of 0 for low-latency and 1 for highanonymity for parameter selection. An operator can select a suitable trade-off among anonymity and latency. An open research question that needs to be further investigated.

* The nodes which are under the same person/organization are called family nodes. There are many open research questions regarding family nodes: examining Tor family's influence, or Tor performance, availability and anonymity especially when family nodes are under attack.

Moreover, one needs to look deeper into Tor's family mechanism and discovering potential family misconfigurations in the Tor network.

6. CONCLUSION

Tor isfree software which empowers censorship resistance and provides online anonymity. In this paper, many research areas in Tor were analyzed and described:performance, security, anonymity, censorship resistance, scalability, and circuit creation/path selection. In recent years, Tor has become a research hotspot in the anonymous communication systems research community. Future work involves conducting a detailed study to compare Tor with other anonymous communication systems.

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Dilemmas Connected With Preservation of Contemporary Art

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ABSTRACT

Art is a reflection, testimony and testament of its time. Reevaluations that have taken place in the arts and in our daily life, tremendous dynamics, diversity, and availability of new technology and materials have given artists the tools and capabilities they have never had before. Art ceased to be an object hanging on the wall or standing on the pedestal; through the use of various disciplines, it became a piece engaging the viewer, absorbing, stimulating all their senses. If we want such complex art to survive, we must take proper care of its preservation. The paper presents the present standing of contemporary art, the role it plays, and why is it different form the traditional one. Considerations included issues related to the change in technique, technology and materials, affecting its durability and, consequently, the entire subject matter of care and conservation.

General Terms

Documentation, Performance, Design, Theory, Verification.

Keywords

Art, preservation and conservation of contemporary art, modern materials, theory and practice of conservation

1. INTRODUCTION

The times we live in are full of uncertainty, transitions in ideological, ethical formats, prevalence and common acceptance of post-truths, post-politics, populism, virtual reality taking on the actual one, the "liquid reality", as the Polish philosopher Zygmunt Bauman put it. What will remain of us? If there is something to remain, we should look after and take care of it now. This includes culture and art. Upbringing lacking constant contact with culture and art results not only in the terrible lack of taste in everyday life, but also in a narrow perception of the world, the lack of sensitivity, focus on material needs. Countries in which every child has contact with art (for example, playing an instrument) show a much higher rate of innovation and creativity, contributing to high development of individuals and the society as a whole. I believe that every person, regardless of the degree of education, social affiliation, or affluence, needs an aspect of life

capable of moving them into another dimensions, and art is here a great tool. Contemporary art has involved the audience to a greater degree, introducing a separate reality created by the artist; it requires interaction, it is founded in stimulation of all senses, to leave an impression, experience, memory. Contemporary works bond together, synthesize values of various disciplines: visual arts and theater (Tadeusz Kantor, Józef Szajna), stage design (Jerzy Grzegorzewski), provincial art (Władyslaw Hasior) and others. We experience synesthesia: a simultaneous perception of multisensory experiences, a perception of colors, sound, scent, space - in recent years taken up in neuroaesthetics research, inspired by the cognitive science.¹

Turning away from the needs of an individual and looking more globally and prospectively, it could be said that culture and art have always been the reflection, testament, and legacy of its age, usually drawing on the full potential of the times. On one hand, reassessments that have taken place in the arts, on the other our daily life, tremendous dynamics, diversity, availability of new technology and materials presented artists with tools and capabilities they have never had before. The effects of their use determine our times.

2. PRESERVATION OF CONTEMPORARY ART AS A CHALLENGE OF OUR TIME

Some reject contemporary art as overly hermetic, others say it so simple that "their kid would do it better". Many prophesy "the end of art", but it must be remembered that such a claim appeared already on the occasion of the first exhibition of impressionists, and then successively accompanied following genres of visual arts. And art continues to be, reflecting civilization, technological and social change. And it remains a major part of our cultural

¹ D. Folga-Januszewska, Synestezja jako proces. Jak dokumentować i rekonstruować doznania? (Synesthesia as a process. How to document and reconstruct emotions?), in: Sztuka w procesie/proces w sztuce. Ku nowej filozofii ochrony dziedzictwa kultury (Art in the process/ Process in art. Towards a new philosophy of the culture care), eds. I. Szmelter, Wydawca Akademii Sztuk Pięknych, Warsaw 2016.

heritage. It ceased to be just an object hanging on the wall or standing on the pedestal, that evoked emotion or aesthetic pleasure, it began to absorb and engage the viewer. Artists started to use materials and measures that were not considered artistic or simply were not there before (e.g. plastics, multimedia).



Figure 1. Old works of art are full of palimpsest, having its own history, painter unknown, *Saint Antonii*, XVI/XIX, photo M. Jadzińska.

Our ancestors are evaluated mostly by what they left behind. If we want the current and future generations to assess us and our times in terms of culture and art, we have to ensure their survival. Conservation of modern and contemporary art has become a real challenge of our times. The extreme variety of means of expression does not allow use of established rules. Cultural changes have generated new needs. New forms of art came into being, breaking away from the customary artistic disciplines in the sphere of ideas and their representation, as well as their technology, materials and their durability. A work of visual art could then be everything: an object, but also a concept, performance, space, smell, taste, process, and could be created with anything, including materials which were intentionally or accidentally unstable, low quality, used in an experimental way or with no actual knowledge of their properties.



Figure 2. Contemporary art could be everything (light, sound, material) involving a viewer, Carsen Höller, *Doubt* (2016), Pirelli Hangar Bicocca, Milan, photo M. Jadzińska.

3. MATERIAL BODY OF ART

This is of particular importance in the case of unconventional art or art made with materials that turn out to be less durable than traditional ones. Like plastics, known and used in every field of life for more than a hundred years, in art cause tremendous problems due to their impermanence, bad state of preservation, and terrible prospects for future.

3.1 Changing the technique and technology of works of art and its impact on sustainability

In traditional art throughout the ages the rules of materials, technique and technology were rationally and systematically improved, and artists' subordination to them ensured durability of their works. Since the end of the nineteenth century (and according to some researchers even earlier), the situation began to change, to change dramatically in the twentieth century. Knowledge of the technique and technology, durability and immutability of material in the twentieth century began to be recognized by artists as unnecessary burden that inhibited their creativity. Since the futurists non-durable materials got into use, without reflection of the future of works developed with them. This happened even before - in 1881. Degas made his Little Dancer of Fourteen Years of wax, gauze, silk and hair. Of course, such materials have been used in folk performances or, for example, in Spanish images of Madonna. However, beginning from the Cubist collage, artists adopted a program of inserting "scraps of everyday life", worn-out already at the time of being used by the artist. Such materials have had a dramatic effect on durability of the objects which already after leaving the studio exhibited signs of wear and tear, increasing over years due to improper conditions of storage, transport and exhibition.

3.2 Modern materials in art

One type of materials used in art and presenting greatest conservation problems are the already mentioned plastics. Today artists reach for plastics more and more eagerly. A large number of works made in whole or in part of plastics can be seen at every major exhibition of modern and contemporary art, such as Venice Biennial (2013), Documenta in Kassel (2012), international art shows in Basel. Objects involving plastics have been incorporated into major contemporary art collections (Tate Gallery, London), museums of art (MOMA in New York), or art and design (Victoria and Albert Museum, London, Pinakothek der Moderne, Munich), and private collections, where they constitute greater and greater share. Objects created from modern materials have also been present in public space. They have become a major part of our cultural heritage and a testament of social life over the last century. Artists appreciated diversity and application of plastics, such features as their plasticity, possibility to obtain a wide range of colors using different methods, transparency, and variety of forms - from foams and thin films, to plates of different thickness. They have used them as the main means of expression, as structural materials, but also in combination with traditional materials, such as wood, metal, plaster or stone. Often these combinations are destructive to objects (for example, a combination of plastic and metal).

Seemingly plastics are a durable and resistant material, however actually oftentimes they undergo ageing processes at a faster pace than the traditional ones. Moreover, we know much less about them, and free use of plastics by artists can only raise legitimate concerns about future of their works. Improper storage, transportation, and exhibition conditions, lack of knowledge and understanding of how these "young", and at the same time very sensitive materials are to be handled, contribute to the process of destruction. Many valuable objects of art and design have already disappeared and disintegrated.

4. PROTECTION AND CONSERVATION OF CONTEMPORARY ART

Works of new art require protection both in their material, conceptual layer, but also in terms of the creator's intention, context, function, form, space, place, time, history and creation process. Therefore, analyzes and queries preceding conservation activities are indispensable. The ephemerality of works of contemporary art and their processual nature require a different approach and careful archiving of works. Conservation of contemporary art is complex in nature.

4.1 Dilemmas related to the protection of works of contemporary art

In the old art conservation pertained to a material object of a particular stratigraphic structure, created according to established rules, from the best possible raw material, known or at least identifiable one. The assumption that works of art are stable comes from the Renaissance, along with a belief in the "original condition" of the object, despite the fact that the object over many centuries could have undergone radical and multiple changes.



Figure 3. The old art works' conservation and restoration pertained to a material object of a particular stratigraphic structure, created according to established rules, photo M. Jadzińska.

Today we are confronted with objects that we can call "complex". Complex art gives rise to many dilemmas. Some of them are technical in nature, but a lot of them must be considered in terms of ethics and philosophy. How should a work that is intended to self-destruct (objects from plants, ice and other ephemeral materials) be preserved? What about the authorship of an object made according to the artist's concept but not by the artist themselves? How can we preserve performance art, land art, art created using new, rapidly aging technology (time-based media) or materials that turn out to be dramatically unstable for future generations? How should we preserve "original" elements of a work when the artist mentions that at the next exhibition of a work, some or all of them (as is often the case with installation art) can be replaced? The current theory and practice of conservation mainly refers to the traditional arts.



Figure 4. Today we are confronted with objects that we can call "complex" art of works. Tadeusz Kantor, *Umarła klasa (Dead class)*, 1975/89, photo M. Jadzińska.

4.2 Paths for modern conservation and restoration

The complexity of contemporary art is a big challenge for conservators. Environment, assemblage, kinetic art, installations, performance arts, and video require separate conservation procedures. These works are often unconventional, they result from experimental artistic concepts, and their matter is made of non-durable materials or ready-made items. The protection of new art requires a broad recognition of the work in both material and conceptual terms, and determining its value. A modern approach must be adapted to the nature of the work and allow for preservation methods such as making replicas, reconstruction, emulation or re-enactment. Therefore, taking care of contemporary art calls for empowering the conservator to involve in recording, conserving, curating and ensuring integrity of works and their compatibility with the author's message.

Conservators, often thoroughly educated, with extensive experience, fluent in modern methods and technologies, try to prevent degradation of a monument (conservation) and restore its artistic and aesthetic value (restoration). They adhere to the established paradigms, impartially maintain the matter within the object, apply the rule of minimal intervention, refute replacement of original parts, and retain the postulate of reversibility of all treatments. In the case of modern visual arts, this is not always the goal. These unconventional, conceptual and physical hybrids make routine conservation practices irrelevant. They require thorough insight and interpretation based on holistic research using tools and instruments of chemistry, biology, microbiology, material science, history, history of art and culture, and other sciences and the humanities.

5. CONCLUSION

Culture and art, in times of globalization, conflicts, the sense of danger, the omnipresence of modern technology and the virtual world, appear as a value for us, and a trace of our times for future generations. Not indispensable, but necessary. As Jean-Paul Sartre said: "Art is indeed not the bread, but the wine of life," and wine and art must be properly taken care of.

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A Cognitonics Methodology for Artificial Persons

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ABSTRACT

Organisations (artificial persons) such as Facebook and Google, use organizational intelligence to offer social networking platforms for free, alongside for-profit business services for businesses who wish to influence the users of their networks. While many customer-influencing activities are essentially harmless, there are a few, such as the process of influencing a person's voting intentions during an election campaign, where the activity becomes a matter of concern for such disciplines as cognitonics. This paper will explore aspects of the organizational intelligence of Facebook over the years 2014-2017, where it developed tools in algorithmic artificial intelligence and applied them in electoral voting settings, and will propose a means of introducing a cognitonics methodology for organisations in the information society.

General Terms

Management, Measurement, Reliability, Experimentation, Security, Human Factors.

Keywords

Organisational intelligence, cognitonics, artificial person, information society, Chinese Room.

1. INTRODUCTION

Incorporated (embodied) Business Organisations are created by societal legal instruments: the owners of the business (shareholders) are declared, and the business organisation's rights and obligations as a person under the law are established. Consequentially, the business organisation is recognised as a person under the law: an artificial person. Shortly after incorporation, an artificial person develops its own organisational intelligence: its ability to comprehend and use knowledge that is relevant to its business purpose. Organisational intelligence[1]–[4] is the possession of an artificial person; is constructed from many contributory elements, procedural, algorithmic and human; and is creatively interpreted and used[5]–[7]. With organisational intelligence a personhood emerges[8]: artificial persons individuate, self-organise, and affect the world around them as they pursue their business interests and serve their customers.

Cognitonics [9] has been applied to areas of child development [10] and harmonic development of the personality [11]. Regarding cognitonics for organisations, there has been some work on how organisations can work to improve harmonic human development in education[12], and how a harmonic relationship

can be established between natural persons (humans) and artificial persons (organisations)[13]. This paper will explore the possibility of global ICT companies developing their own cognitonics methodology so that their business activities and products can be monitored in such a way as to allow any imbalances in societal development to be addressed, while at the same time protecting the company's own financial security.

We ask if it would be possible for artificial persons to adopt a cognitonics methodology, particularly in pursuit of three key goals of cognitonics[9]:

- 1. Resisting the preference for commercial values over human values,
- 2. Resisting the subordination of national cultures to globalization,
- 3. Recognition of the importance of emotional and spiritual values in the human condition.

We hope to show that it would be remiss for global ICT artificial persons not to adopt a cognitonics methodology.

2. A NEED FOR COGNITONICS IN SOCIAL NETWORKING BUSINESSES

We will look at the organisational intelligence of Facebook over the years from 2014 to 2017, as presented by Chief Executive Officer, Mark Zuckerberg, in his quarterly earnings call transcripts In his 2014 transcript Mark Zuckerberg described 3, 5 and 10 year plans for Facebook[14]:

- 1. Over the next three years, our main goals are around continuing to grow and serve our existing communities and businesses and help them reach their full potential;
- "Over the next five years, our goals are around taking our next generation of services, Instagram, Messenger, WhatsApp and Search and helping them connect billions of people and become important businesses in their own right."
- 3. For the next 10 years our focus is on driving the fundamental changes in the world that we need to achieve our mission, connecting the whole world, understanding a world with big leaps in AIs and developing the next generation of platforms, especially in computing.

In 2016, two elections that were surprising to general observers the Brexit vote of June 2016, and the US presidential elections of November 2016 - saw criticisms levelled at Facebook for its new Artificial Intelligence tool, Facebook for Politics, which allows real-time targeting of custom chosen audiences. The tool works by addressing each targeted custom audience member's psychological profiles to achieve a cognitive change in the person's voting intentions. A premium is attached to altering the voting intentions of users on social networks who have followers who they will then influence. In his 2017 Q2[15] results presentation meeting, Zuckerberg said, "Now you can put a creative message out there, and AI can help you figure out who will be most interested. A lot of the time you don't even need to target now because AI can do it more precisely and better than we can manually. This makes the ads that you see more relevant for you and more efficient for businesses. Those are just a few of the reasons why I'm optimistic about how AI is going to improve our core services over the next few years."

There are questions that have been raised regarding the ethics of allowing businesses to influence voters in national elections. Those questions become more difficult to explore when we are faced with the black-box algorithms of companies such as Facebook and Google who have business reasons for protecting their proprietary AI algorithms. At the same time, people need to be able to discursively unpick unacceptable practices of such tools. We will explore how to deal with such systems.

3. FACEBOOK AND CHINESE ROOMS

Searle's Chinese room Searle[16](p115) says:

"Imagine a native English speaker, let's say a man, who knows no Chinese locked in a room full of boxes of Chinese symbols (a data base) together with a book of instructions for manipulating the symbols (the program). Imagine that people outside the room send in other Chinese symbols which, unknown to the person in the room, are questions in Chinese (the input). And imagine that by following the instructions in the program the man in the room is able to pass out Chinese symbols which are correct answers to the questions (the output). The program enables the person in the room to pass the Turing Test for understanding Chinese, but he does not understand a word of Chinese."

In Searle's room, the key activity is in translating text with semantic integrity, and the person inside it is merely an operative. Searle's task was to show that no intelligence is encompassed in a computer program which employs algorithmic artificial intelligence to solve a language translation problem.



Figure 1: Translating by Following Rules and Using Signs

Searle argued that an embodied algorithmic artificial intelligence could not be considered a minded-entity. The concern here is with another type of room, one that has been prepared by organisational intelligence. We will focus on a Facebook tool which has been used to alter the voting intentions of customers to the room in democratic elections for the purposes of fulfilling a business model. Consider for a moment the political targeting tool that has been the source of speculation regarding the 2016 United States of America presidential election. The tool is provided by Facebook and requires high-level information with which it can work.

The stages of application of the tool involve:

1. A political campaign (artificial person) compiles an email list of voters which it would like to target - this is absorbed into Facebook as a "custom audience". The custom audience is delivered to Facebook along with any other information that the campaign may have on each individual voter, such as what their political habits are, what their real name is, their address, phone numbers, etc. This is the "intelligence" which the political campaign has already gathered on the people they wish to influence. The intelligence on each individual is merged with the knowledge that Facebook has accrued. This connection gives political operators access to some of the various forms of psychological knowledge that Facebook has of members within the Facebook universe. Custom audience members may be placed somewhere on the Openness-Conscientiousness-Extraversion-Agreeableness-Neuroticism (OCEAN) scale. Facebook will share task-specific access to its knowledge while endeavoring to keep other valuable information of the Facebook Universe from the political customer. This information, along with other AI tools can be used to identify such things as who are the political influencers in the custom audience, and to make recommendations for ad content (based on psychological profiling) that will have maximum impact on each custom audience member.

2. At the second stage, Influential contact is established with the custom audience members, in 2014 this was via a Facebook Exchange advertising tool (FBX), and since November 2016, a Dynamic Product Ads (DPA) interface tool. At this stage there is a real-time working together of the custom audience influence packages with the social networking activity of targeted customer audience members for the purposes of influencing each as agreed in the customer-sales agreement between Facebook and the political campaign. This work takes place over the time that is allocated to the campaign, and may take place over the whole election campaign, with reports being delivered to the business customer intermittently.

3. At the completion of the influencing period, a final report on the work that was done in the Facebook Universe along with evidence of change activity over the period of the campaign is presented. This information becomes part of the voter information which the campaign has amassed on the candidates which it has on their list. Although Facebook encrypts this data and does not maintain it after the duration of the commercial contract, the data passed to the political campaign, and consequently any person the political campaign shares the information with, could be used as the basis of further influential work in a related business area.

Our observation is that each of these stages describes a Searleian Chinese Room type of cognitive activity, and each may be a firm focus of philosophical inquiry. There are difficult philosophical and ethical issues to be explored, and all three stages involve a high degree of organisational intelligence (the intelligence of the artificial person), which is designed to be of the organisation, and for which no individual person is responsible. Wherever algorithmic artificial intelligence is used, it is scaffolded by the organisational intelligence. Organisational intelligence may be the most successful form of artificial intelligence that is operational in the world today, and we will adapt Searle's metaphor to view Facebook activities, with its voter product[17], in Cognitonics terms.

4. ARTIFICIAL PERSONS, CHINESE ROOMS AND COGNITONICS

The organisational intelligence that we have become concerned with is non-human, subtly-embodied, perfectly reasonable intelligence, applied for the benefit of various businesses, and may be very difficult to address except poetically. The difficulty of addressing this organisational intelligence aside, it is clearly more embedded within the real-world than algorithmic artificial intelligence is.

We explore how Facebook's organisational intelligence can strike the right balance between respecting people as voters, guaranteeing them the space to make up their own minds on election issues, and the company determination to support a business organisation or network that wants to influence the voting intentions of individuals on mass.

We also ask how, in the face of a large-scale error in human harmonic development, an organisation such as Facebook could humanely address the issue and seek to remedy any harm that may have been caused as a consequence of its business activity, organisational intelligence or corporate tools.

In the first instance, a philosophical basis for a methodology of cognitonics for an organisation Cogitonics might be:

- Information and communication technologies (ICTs) are being developed and deployed extremely quickly and have been penetrated pervasively, not only into every workspace, but also into every societal space and every family environment;
- 2. it is morally responsible and ethical for an artificial person to engage the power of modern ICT in order to promptly address any negative distortions in society that are ICT-induced, and to comprehensively disseminate effective methods to compensate for those distortions, wherever they appear: either in personality development or in the evolution of national cultures throughout the information society.

With a philosophical background in place, it would now be valuable to explore how work could be done. As a company such as Google (with its search engine) and Facebook with its dynamic advertising products, perform their functions while not allowing a casual user access to the details of the algorithms that are involved, they are effectively building advanced algorithmic tools which only allow input/output access, in the same way as Searle's Chinese Room does. Searle's Chinese Room paradox has a particular attraction in this regard. We will describe any hidden algorithm which performs a human-like function as one that is embedded in a Chinese-Style-Room.

It seems clear that some of the activities that take place in such rooms can be much more impactful than the task of translation that was envisaged by Searle. Consequently, we need to be able to look at some of the actions of the room from a Cognitonics perspective, while not causing an organisation any compromise of its proprietary technology.

Some fundamental questions for explorations of Chinese-Style-Rooms:

- 1. What is the Internet to companies such as Facebook? Is it a room? A workspace, only? Should companies working in human spaces be forced to observe norms and laws of human interactivity? That being said, how open should an organisation such as Facebook be regarding the operation of problematic Chinese-Style-Rooms?
- 2. Organisations have been designed to have limited financial liability they are now achieving limited cognitive liability. How can we personalize the activities of companies such as Facebook to ensure that liability for inappropriate business behavior is accepted? Regarding algorithms, how can we granularise algorithmic activity sufficiently so that we can explore the human dimensions of tools that manipulate the cognitive intensions of large numbers of mostly unsuspecting people who use Facebook for other purposes.
- 3. Although translating languages is interesting. Should some human activities (such as electoral voting) be offlimits to businesses who accrue profits from social networking activities in digital business environments? There is a larger question of what are the social networking activities where it is not appropriate to allow business activities to interfere with their development? If a discussion were to take place of questions such as this, how best could an appropriate discursive setting between a global company such as Facebook, its users and other societal stakeholders be facilitated? Would the stakeholders be represented by appropriately constructed artificial persons?
- 4. Who would be in the appropriately constructed artificial persons? And how could we ensure that it's organisational intelligence would be sufficient to the task in hand and powerful enough to be heeded? How could a global organisations legitimate business purposes be protected and encouraged alongside healthy human development?
- 5. How could we disentangle the relationships between governmental executives and busineses for the benefit of ordinary people? What human body could take on such a task of overseeing difficult discussions between business artificial persons and societal artificial persons? Would it be the United Nations? Or the Red Cross? Or would some other global body be required?

5. CONCLUSION

We have looked at the exciting period of artificial intelligence development in the organisation of Facebook over the period 2014 to 2017, and have found there to be relevant Cognitonics questions to be raised over the use of tools to alter voter intentions during election campaigns. As a consequence, we have explored how Cognitonics might offer a set of principles for an organisation to follow that would allow them to pursue their legitimate business interests while safeguarding the harmonic development of human beings and national cultures.

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Logical Characteristic of Analogy and its Classification

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ABSTRACT

Analogy has a distinct logical structure, which has been ignored. In this paper, analogy is reinterpreted as the synthesis of typical inference forms. By this analysis, three kinds of analogy are confirmed, and under these criteria several examples of analogy are classified into each category. Thus we can get broader understanding of the analogical thinking.

Keywords

Induction, deduction, logic, classification of analogy

1. INTRODUCTION: THE MEANING OF ANALOGY

The identity sign (=) is one of the greatest inventions in human intellectual history, because it reminds us of oneness of more than two seemingly different things. And the same evaluation can be applied to the sign of similarity (\approx). The concept of 'not the same but similar' expands itself beyond that of identity to almost everything in nature and society. The universe is overlapped by similarity.

Analogy is about everything, for everything has some similarity to other things, from certain points of view. So that analogy can be used as general method of thinking which can explain a lot of phenomena around us.

Analogy, as a way of thinking, is a logic based upon similarity, but it seems to have been thought to be illogical and unscientific; analogy is analogy, which is about two similar things, nothing more or less.It gives us impression something like an intuitional correspondence from one thing to the other things. And it gives us only a rough, and at best, a comparative understanding through similarity.

Nevertheless it is a logic and the synthesis of logics. In the background of analogy, two typical concepts of logical inference are structuralized about which no other studies had made clear explanations.

In this paper, I try to expand the logical characteristic of analogy, reasoning with inference rule, with simple figures. I suggest conceptual, structural character of analogy as the logic, which is shown in [3] by applying the basic concepts of the particular and the general, as well as deduction and induction, and classify it into three categories with their examples.

2. THE LOGIC OF ANALOGY

2.1 Logical characteristic of analogy

Logic is the character of the statement, which can be used to judge true or false. According to Kant, judgement is the inclusion of the particular in the general. It is movement from premise (X) to

conclusion (Y). The premise and the conclusion can be particular as well as general.

When the general is applied to the particular, it is called deduction. When the particular is included in the general, then it is induction. The statement is the linkage between the particular and the general, and we can build the inference table out of this linkage between two characteristics (Table 1).

Table 1. Inference table				
Y X	Particular	General		
Particular	analogy	induction		
General	deduction			

Analogy is, in a sense, the induction of one particular into the other particular. But it has the characteristic that it is necessarily mediated by the intervention of meta element.

The essential characteristic of induction is the probability of the premise-conclusion relation. And that of deduction is the necessity. Intrinsic problem of analogy is that this probability is necessitated. In other words, it is justified as the probability. It contains the possibility of error in the premise-conclusion relation, and it has the content which is probable, as much as the error is excluded. This is the possibility as well as the limitation, of the inference from the particular to the particular. Therefore, in the analogic possibility are concealed logical probability and necessity.

Analogy is the relevance of two entities as the whole and the parts. As the result, it has the significance of structuralism: the whole consists of the parts and the parts have its meaning in the whole. Similarity of the whole results in the correspondence of the parts. Therefore, in analogy, similarity is the necessary condition of correspondence, and correspondence is the sufficient condition of the similarity.

In analogy the total recognition precedes.Without the intuition of Knower (in Figure 1) that X (Known) and Y (Unknown) are similar¹, analogy does not begin. Total similarity relates to the generality of Knowledge. Basic principle of analogy is that specific similarity has the general commons. Here commons which mediate the similarity is called meta.



Figure 1. Knowledge structure related to analogy

¹The term 'whole' is always only comparative (I. Kant) [4].
2.2 Derivation of analogics²

As was shown by Kim[3], the logical process is drawn in Figure 2. $X \rightarrow A$ is inductive process, which has the movement from the particular to the general. And $A \rightarrow Y$ is the deductive process, which has the movement from the general to the particular. And finally, this process is concluded as $X \rightarrow Y$, which seems to show the movement from the particular to the particular.



Figure2. The logic triangle

These logic vectors in the triangle are written, as below.

$$X \xrightarrow{1} A \xrightarrow{2} Y = X \xrightarrow{3} Y$$

This logic triangle is derived by using the method of elimination. Here the two objects, X and Y, are basic starting points as the

known and the unknown. By mediation of the meta elements, the relation of the three is established.

X is the known and Y is the unknown. We add A to X and Y to make the logic triangle. Then there appear 6 relationships between these three elements (A: the general, X and Y: the particular). The arrows designate these relationships. As the result it produces 6 relations between the three points. Each has the premise and the conclusion. The starting point of the arrow is the logical premise, and the end point is the logical conclusion.

The movement 3 is possible, but the reverse direction $Y \rightarrow X$ cannot take place, because from the unknown to the known cannot be deducted or inducted.

Logic vector 1 is the abstraction $X \to A$, which is inductive.ais the deduction $A \to X$. 2 is the deduction $A \to Y$.b is the induction $Y \to A$, which is impossible because induction from the unknown cannot be imagined.

So finally there remains the flow of 1, 2 and 3, because a is meaningless in this flow from $X \rightarrow Y$, unless X and Y are known objects of comparison. We can have the logical relations as in the Figure 3. Here the analogy of the two objects, X and Y, is logically completed.



Figure 3. Logical possibilities

3. THE CLASSIFICATION OF ANALOGY AND ITS EXAMPLES

We cannot deduct (abstract) from the unknown, so that the direction of $X \rightarrow A \rightarrow Y$ is determined. And when we adapt logical character in comparing the two similar structures, three kinds of analogy appear. Let's call them analogy of the 1st kind, the 2nd kind, and the 3rd kind. Here we generalize the relationship of known – unknown in the 3rd kind, to that of base – target, so that Y can be redefined as known. As the result, Table 2 shows the classifications of three kinds of analogy and their characteristics. And in the figures below, the real line depicts the real movement, and the broken line depicts the metaphorical movement.

I try to confirm the logical structure of analogy described above, through several examples. These shows the proofs of general

existence of particulars which have the meta logic in the background. Here examples are classified according to the 3 kinds of analogics. All the examples of classified analogic objects are synthesized in Table 3.

Classification	X	Y	Characteristic
1 st kind	Known	Unknown	Discovery
2 nd kind	Known	Unknown	Adaptation
3 rd kind	Known	Known	Comparison

3.1 Analogy of the 1st kind (Heuristic discovery=creative adaptation)

Analogy of the 1st kind is heuristic.

The general principle constructed by induction process 1 is adapted to Y (process 2), to reach a new conclusion which results in a creative discovery or prospectas process 3: $X \rightarrow Y$ (Figure 4).

Here the unknown element is decided by the known fact.

The similarity of the two objects results in the similarity of structures, and the structure of the objects makes the correspondence of the elements possible.

This can be called heuristic, because it includes a creative problem solving.



Figure 4. Analogy of the 1st kind

The examples of the 1st kind are listed below³.

(1) Heuristic problem solving

Proportional correspondence of elements in the structure gives a solution for the unknown. Heuristic problem solving is the typical creative adaptation of analogical reasoning.

(2) Habitable zone in planetary systems

A planet far from us is the unknown world. But this terra incognita can be recognizable by expanding the facts and principles of the known, the earth.

Recently, we get many new information from astronomers, which show that similar physical or chemical conditions gives us the confidence there will be a possibility of life on the planets outside our solar system. Human being may be able to make a practical decision to send people to Mars, based upon the analogical conclusion that it is habitable.

(3) Concilience or interdisciplinary adaptation of theories

Economics and physics are similar in that they belong to applied mathematics and the principles of physics are often adapted to economic theories.

For example, price elasticity in economics resembles the elasticity laws in physics. Here price changes result in the change of demand

² I suggested new terminology "analogics" in [3] to emphasize the logical aspects of analogy, which has the composite logical characters in the background, as well as to evade the confusion when using "analogic", the adjective form of analogy.

³ Some of these examples are explained fully by Kim in [3].

or supply quantity, and the size of this change is called the price elasticity of demand or supply. This is similar to the principle of elasticity between force and the change of matter in physics. The two disciplines share mathematical rate of change as the meta principle.

This kind of interdisciplinary similarity also forms the base of the concept 'concilience'.

3.2 Analogy of the 2nd kind

(Adaptation=metaphorical interpretation)

Analogy of the 2nd kind is adaptive.

This kind has the characteristic of the 1stkind, but it has rather metaphoric interpretation than creative conclusion (Figure 5).

The 2^{nd} kind is different from the 1^{st} kind, in that it has little to do with the problem solving, but it widens and deepens our understanding of the unknown. Adaptability is the essence of both the 1^{st} kind and 2^{nd} kind, but the division line between them is whether they have creative finding or not.



Figure 5. Analogy of the 2nd kind

(1) Parables and fables

Parable explains the metaphysical religious truth, using the daily episodes. It has analogical reasoning between the truth and the story. It goes without saying that a parable with the story is easier and softer to understand than mathematics.

Buddhist "Poor woman's lamp" and Christian "Widow's mite" have the same structure and are summarized in a mathematical ratio, which emphasizes more devotion than donation.

Fables have structural similarity between animal world and the human society. The truth is given by the animal story with human wisdoms, which are experienced mainly in nature world. The goose with the golden egg, the sun and the northwind, the hare and the tortoise and the ant and the grasshopper are famous titles of Aesop's fables. Fables have the same effects as religious parables.

This parable and fables are has successive structure: heaven human world - animal world. And all these three worlds have the truth which is similar to each other. Religious truth is explained by human episode, and human world is paraphrased by animal words and deeds.

(2) Historical drama and contemporary politics

People have expressed their political opinions through metaphoric criticism for centuries. In many authoritarian states in the world, historical drama or films express metaphorically the reality of contemporary politics by showing the historical facts of ancient, medieval or modern eras, because the direct criticism of the government of the time is dangerous.

Here main figures of drama correspond to the contemporary politicians, and the flow and composition of the events in the past resemble the actual political structure in contemporary world. And the viewers of the drama guess their political situation.

It is often heard that history repeats itself. This proverb itself testifies the analogy of historic event in a new, modern version, in reality or in drama.

(3) Fractal analogy

A fractal is the structure which is similar in various levels of scale. This means that in spite of the differences of scale, there exists one structure, which shows similar patterns.

The same pattern exists beyond big or small. So small structure is adapted to the big one, this is adapted again to the bigger one.

3.3 Analogy of the 3rd kind

(Comparison=deductive confirmation

ofinductive principle)

Analogy of the 3^{rd} kind is comparative. This is different from the 1^{st} and 2^{nd} in that it is not the relation between the known and the unknown. It is the expansion of the Figure 2. Here Y is reinterpreted as known. Two facts are known and have a common principle, which is inductively confirmed.

This kind is mutual recognition of the two known objects. This is inductive inference to find a common principle or structure. This is aposteriori recognition that general principle is adaptable crossly to the other (Figure 6).

Therefore X and Y are compared, as the result to confirm their similarity under the principle A.

Here A in Figure6 is the relationship between objects of comparison and it means the basic concern of the observer. We can find one general in many particulars as below.



Figure 6. Analogy of 3rd kind

(1) Analogy in physics

Two physical phenomena have their own uniqueness.

Phenomena of different world are linked by the commonality of the flow in general. Material characteristics are different, but the meta principle of flow is applied generally.

Poiseuille's Law of water flow, and Ohm's Law of electric current can be analogized to each other ([2] Gust et al.).Flow and current are in general the same, regardless of their material particularity. (2) Golden ratio

The fraction below is called the golden ratio, which is found in many natural, artificial creations. This number symbolizes the beautiful, stable structure of those phenomena.

$$\frac{a+b}{a} = \frac{a}{b} = \phi \approx 1.618$$

Flower petals, seed heads, pinecones, tree branches, shells, spiral galaxies, hurricanes, fingers, animal bodies, DNA molecules⁴ are some examples.

How can φ of the shell be the same φ of the sunflower. How can the Fibonacci number be common to all these different phenomena? No one particular object can explain the others, because they are different. But by observing those objects we can abstract one definite number. This deepens our understanding of nature. This is the utility of the 3rd kind analogy, but the artificial adaptation of this ratio in art or construction, in pursuit of beauty and function, can be interpreted as the 1st kind.

(3) Exchange rate and turbulence

Hydrodynamic turbulence and foreign exchange market have the similar elements and structure, in spite of the specificity of energy and information [1], which are the elements of flow in each environment. Here information is metaphorically energy.

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<sup>4</sup>http://www.livescience.com/37704-phi-golden-ratio.html
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4. CONCLUSION: THE SIGNIFICANCE OF ANALOGICAL CLASSIFICATION

Analogy is a creative thinking with a strong logical structure. It is based upon the simple principle: everything is similar. This means again that analogy is a general method of thinking.

The fundamental task of analogy is; how a particular makes other particular possible, epistemologically. In other words, how can we find the significance or the meaning of a particular, in other particulars. So that analogy is quite important in itself beyond the logic or inferential process. It is a fundamental way of questioning and method of how we see the things.

The significance of analogy lies in that everything in the world is similar. We find ourselves in others. We are not different from others. From one fatherhood (meta theory) comes the brother and sister. Analogy means this brotherhood and sisterhood of things.

Similarity means not the same. A thing consists of the common of and the different from others. Everything exists as diversity, because it is not duplicated like clone, but it has something in common. Analogy is based upon this coexistence of diversity and commons. Analogy is a philosophy as well as a logic. This philosophy of analogy is universal, and so we face every day with the new similar things.And the logical structure of analogy, which was emphasized in this paper, signifies that the thinking of similarity is scientific.

The significance of analogical classification suggested in this paper

is as follows:

- 1. It confirms again the meaning of logical characteristic of analogy, which is suggested in [3].
- 2. The classification is based upon the logical structure, not by approximate sorting of facts,
- 3. By clarifying the distinction of analogy groups, the logical application of analogic function can be more effective.

More precise application of analogy based upon this classification will lead to scientific use of analogical thinking.

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Classification	Phenomena	X	Meta principle	Y
1 st kind	heuristic problem solving	known fact	Common problem structure	unknown fact
1 st kind	geological heuristics	e.g.) known elements of triangle	Common geological structure	e.g.) unknown elements of triangle
1 st kind	consilience	science e.g.) physics	interdisciplinary principle or common intellectual structure	science e.g.) economics
2 nd kind	parable	human episode	truth	religious lesson
2 nd kind	fable	animal society	similar situation of daily life	human society
2 nd kind	metaphor	Indirect expression	common semantic structure	reality
2 nd kind	fractal	small form	Common morphological structure	large form
2 nd kind	historical drama	past events, history	political, socialstructure	contemporary political situation
3 rd kind	physics	electricity	flow	water flow
3 rd kind	golden ratio	natural or social phenomena	$\phi \approx 1.618$	natural or social phenomena
3 rd kind	economic physics	turbulence	flow	exchange rate movement

 Table 3.Summary of analogy classification and the examples

Virtual Personal Psychosocial Counsellor

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ABSTRACT

Mental health issues deriving from stress are ever more present in the lives of many people. However, due to lack of knowledge, stigmatization and high price of counselling, people often do not seek professional help and problems remain unsolved. One possible solution is an affordable and discrete professional psychosocial support. This paper presents an attempt to provide help through a virtual assistant named OSVET, based on expert knowledge and artificial intelligence algorithms. The assistant is capable of online personal counselling for people with stress overload. The application consists of an initial stress level diagnosis, detection of users' typical mental errors, personalized professional counselling dialogue, appropriate tasks definition and psychoeducation. The application is human-friendly using natural language communication. We anticipate that such assistance will encourage more people in need to start solving their mental distress, since it will be easier to come up with appropriate professional personalized treatment. Finally, this approach will hopefully decrease the stigma of mental health care in society.

General Terms

Algorithms, Documentation, Performance, Design, Security, Human Factors.

Keywords

Virtual assistant, psychosocial help, cognitive behavioral therapy, artificial intelligence.

1. INTRODUCTION

Most humans experience some amount of stress during our lives, whether at work, relationship issues, fears and phobias, etc. While some of stress is not harmful, prolonged or intensive stress can cause harmful consequences. According to Krivec and Suklan [13], 94,8% of Slovenians have experienced a state where a psychosocial professional help would be needed. If distress is not treated properly and in time, it can cause serious psychological conditions and mental health disorders that can affect daily lives. However, many of those in need do not receive the deserved treatment. One of the main reasons for this is stigma. Researches [13, 28] revealed that nearly two-thirds of people who need mental health care never get it mainly because they are too embarrassed to make in-person contact with a psychotherapist incorporated into the medical system. According to Krivec and Suklan [13], 60,5% of the interviewees think that psychotherapeutic practice should be widely accessible in societal facilities and not incorporated into the medical system. Stigma also affects therapeutic process. Even if people find professional

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help, there is a big discrepancy between the initial state and the number of people who successfully finish therapy. Moreover, people may not seek help due to the inaccessibility, especially if they live in a remote, rural area, far from a therapist's office. Next, scheduling, money, physical challenge, conflicting relationships, or misconceptions may also keep people from seeking help [17]. Last but not least, searching for therapy outside the medical sector can be tricky due to a vast number of unprofessional counselors. Addis and Mahalik [1] showed that strategies based on problems as a normal part of one's life enable an easier approach in seeking help to resolve them. Online psychosocial help is one of such strategies.

1.1 Online psychosocial help

For decades, people live part of their lives virtually with increase in recent years since virtual worlds have reached the mainstream. In particular, younger people using their smartphones and tablets for all of their social interactions live a substantial part of their life effectively online. In relation to stress, for many people the Internet feels more private and helps them get past the barrier of stigma to seek help through e-therapy. In 2001, eighty percent of Internet users or about 93 million Americans, have searched for a health-related topic online [3]. There are several different online facilities regarding psychological help. They can be classified in the following categories:

- 1. *Virtual communities*: self-help groups on the internet, where the psychosocial topics are widely spread, e.g. AYAs or 7 Cups of Tea online support encourages members of the community to exchange emotional and informational support, coping with difficult emotions through expression [14], [31]. Tinyurl [27] is one of successful self-help platforms, encouraging people to seek for help at depression.
- E-therapy and adjunct services: counselling platforms, where a large net of counsellors perform different kind of therapies using virtual tools. Services are typically offered via email, real-time chat, and video conferencing with professional psychologists in place of or in addition to faceto-face meetings [16]. Examples of a good practice are [4], [24], [5] [21]. The formation of the International Society for Mental Health Online (ISMHO) was a milestone in the development of e-therapy [11].
- 3. *Computerized therapy virtual assistant*: In this case the computer is playing an active role in delivering the clinical content. There are several ways of computer activities:
 - a. *Self-Help*: The rules encapsulate clinical knowledge and are used to deliver targeted interventions. Adding more

and more decision points and pieces of personalized content, the computerized "self-help book" is getting thicker and more accurate. Eventually, each reader takes a unique path through the book based on their own idiosyncratic mental profile. This, in a nutshell, is one of the key ideas behind computerized therapy [19]. There are several such applications already developed, such as Mood Tracker – a mobile application that allows users to self-monitor, track and reference their emotional experiences; PTSD Coach - provides opportunities to find support and tools that can help users manage the stresses of daily life with PTSD; LearnPanicCBT - selftreatment for panic disorder that is based on Cognitive Behavioral Therapy (CBT) principles; Stress Check provides users with an overall stress score that illuminates their current level of stress; Cognitive Diary CBT Self-Help - helps to recognize thinking that interferes with achieving your goals in life and how to change that thinking.

- b. *Virtual reality therapies*: use computer demonstration of reality most often to perform virtual exposure therapy for different kinds of anxieties and phobias, e.g. fear of flying. Examples of such applications are: Virtually Better, Psious, VirtualRet, Mimerse [25].
- c. *Robots*: they are used as a human computer interaction such as Paro - a therapeutic robot in the form of a baby harp seal developed by The National Institute of Advanced Industrial Science and Technology in Japan to comfort dementia sufferers to increase their motivation, reduce stress of the patients and their caregivers and stimulates interaction between patients and caregivers [18].
- d. Avatars: they are based on communication between human and computer in natural language. ELIZA is one of the earliest and most well-known programs that attempted to act as a therapist and provide Rogerian psychotherapy. Because Rogerian psychotherapy primarily encourages clients to talk more rather than engaging in a discussion, ELIZA takes the users text and rephrases it, putting the focus back on the user and encouraging him/her to talk more rather than conversing. This approach works for some clients but quickly becomes frustrating and useless. It might be worth mentioning that the version of ELIZA, developed in our department, was among the most often visited in the world. The reason was found years later - it mixed replies from users online at the same time. Unfortunately, it was treated as non-privacy-preserving and eliminated as a consequence. Unlike ELIZA, a newer chat bot Ellie was able to talk about herself and generate a conversation rather than only rephrasing the responses it received. Ellie's aim was to treat people with depression and veterans with post-traumatic stress disorder (PTSD). The program recognizes facial expressions and analyzes audio and posture to formulate its response and adjust its tone. Nonetheless, Ellie was far from being able to provide the kind of understanding a human therapist could [15]. More recent applications are MoodKit [26] that helps the user identify and change unhealthy thoughts and chart the user's state of mind and Woebot [30] which uses CBT to reduce

depression. A virtual coach "Shelley" incorporates patient education materials and uses conversations to help the user make decisions and change behavior.

1.2 Efficacy and benefits of online psychosocial help

A growing body of research on online counseling has established the efficacy of online therapy with treatment outcomes being similar to traditional in-office settings [16]. Researches [2, 7, 9, 23, 29] showed that in the medium term, online psychotherapy yields same or even better results than conventional therapy. Cristina Botell and her colleagues [20] confirmed the efficacy of using virtual reality in psychotherapy. Client satisfaction surveys also tend to demonstrate a high level of client satisfaction with online counseling [8]. In a recent survey of over 400 clients of online therapists, more than 90% responded that working with a therapist on the Internet helped them [17].

Benefits of online psychosocial help:

- allows the patient to attend sessions at a higher rate than traditional sessions and reduces the number of missed appointments [10]
- good for clients located in areas under-served by traditional counselors (such as rural area) or for disabled that traditionally under-utilize clinical services [16], for clients who may have difficulty reaching appointments during normal business hours [6]
- therapy in person is more likely after using e-therapy Change [6] showed that 64% of the persons moved on from e-therapy to consult a therapist in person
- beneficial for young people, who are keen using computers or intelligent phones.
- cheaper and thus more affordability
- reduces social stigma
- anonymity encourages people to disclose their problems, emotions, thoughts or sensitive information. Patients admit that they feel less judged by the virtual therapist and more open to him/her, especially if they were told that (s)he was operated automatically rather than by a remote person [15]
- enhanced content: computerized therapy can incorporate more than text on a screen. The programs can be rich in multimedia content, with images, videos, animations, audio voiceovers, and interactive exercises. A well-designed treatment program can be a very compelling user experience.
- virtual reality is a protected environment for the patient, where one can deal with the feared situation in secrecy.

2. Virtual stress assistant OSVET

2.1 Scope

The scope of our solution, called "OSVET", is to help people in distress. It combines virtual community, e-therapies and avatars. It includes screening of the distress severity level, following by personalized self-help and psychoeducation. The human-computer interaction (HCI) is performed with communication in natural language, which gives the user a feeling as if she/he is interacting with a real human. In case of severe mental health issues, users are encouraged to proceed to e-therapy or seek in person therapy and appropriate contacts are provided to the user. With such an approach we believe stigma will be reduced and people in need will get a pleasant experience searching for help, which will further encourage them to increase care of their mental health.

2.2 Basic assumptions

- *Combination of several therapeutic techniques*: OSVET uses screening of the user state, psychoeducation, self-help, communication with virtual assistant using natural language and implements e-therapy if necessary.
- *Personalization*: based on the information provided by the user, OSVET provides personalized answers, instructions and assignments.
- User friendly HCI: besides conversation in natural language, user experience is enriched with information about the stress overload issues, cognitive distortions, exercises, etc.
- *Safety*: OSVET is based on the personalized psychoeducation, which is safe and positive in nature. When cognitive error is classified by OSVET, user is asked to confirm the assumption. If there is no confirmation, OSVET asks for the clarification before moving to further steps. If higher level of stress or more serious mental issue is detected, users are redirected to in person therapists. Last but not least, the content of the OSVET is designed by experts in the field of psychosocial counselling.
- *Cognitive behavioral therapy (CBT) approach:* OSVET is based on CBT approach. This approach was chosen because it is one of the leading therapeutic approaches to dealing with distress overload and anxiety disorders. Previous researches show that it is most suitable approach for algorithmic delivery style and for counselling with virtual assistant [19]. Kessler et al. [12] showed that online CBT is as effective as traditional "in-person" therapy for the treatment of depression.



2.3 OSVET architecture

Figure 1. OSVET architecture.

- Assessment: OSVET first makes a screening of distress level based on the simple questionnaire. If the level is low, it provides some encouraging statements, directs the user towards simple relaxation techniques and reassures the user that the mental state is normal. If the level of distress is extremely high, the user is directed to get help with in person therapist and suggests an adequate counsellor according to the detected problem. If there is medium distress level, virtual assistant continues with personalized conversation. There is also an option for the user to pass initial screening and continue directly to conversation with virtual assistant.

- Cognitive distortion identification: CBT typically focuses on a specific problem, helping the patient to identify, recognize and change disturbing thought patterns and feelings that are leading to negative or destructive beliefs and behaviors [22]. In OSVET we identify the following 12 common cognitive distortions from the users' problem description:
 - Mental Filter: dwelling on the negatives and ignoring the positives.
 - Disqualifying the Positive: insisting that the user's accomplishments or positive qualities don't count.
 - Overgeneralization: viewing a negative event as never ending pattern of defeat.
 - Catastrophizing: blowing things way out of proportion or shrinking their importance inappropriately.
 - Personalization: blaming oneself for something one was not responsible for, or blaming other people and overlooking ways that the user's own attitudes and behavior might contribute to a problem.
 - Fortune telling: arbitrarily predicting things will turn out badly.
 - Mind reading: the user assumes that people are reacting negatively to the user when there is no evidence for it.
 - Shoulds and Oughts: criticizing oneself or other people with "Shoulds" or "Shouldn'ts", "musts", "oughts", "have tos" and similar offenders.
 - Emotional Reasoning: reasoning from how one feels: "I feel like an idiot, so I really must be one." Or "I don't feel like doing this, so I will put it off."
 - Global labelling: identification with one's shortcomings. For example, instead of saying "I made a mistake", the user says "I am a jerk".
 - Low frustration tolerance: think one cannot (and shouldn't have to) tolerate situations and conditions that are found frustrating.

When a particular mental distortion is detected with the use of artificial intelligence algorithms, the user is asked to confirm the avatar's classification. If the user confirms it, (s)he is further guided to the appropriate personalized dialogue for the detected distortion. If the user does not confirm the way of thinking that avatar proposes, avatar asks the user to describe in detail the mental problem and the loop repeats.

- *Personalized dialogue with adequate assignments*: When the user's problem description is classified into one of the above cognitive distortion and confirmed by the user, one of the prepared scenarios, i.e. flexible sequences of dialogs is executed. It includes:
 - Psychoeducation: to educate users about the distorted way of thinking and representing the world is obviously of value.
 - Emotional support is given, i.e. inceptions which encourage the users to deal with his/her problem and gives him/her hope to find a solution.

- Guided self-help: OSVET guides users to think and analyze their way of thinking and mental representation. Several different therapeutic techniques are used such as paraphrasing, active listening, etc.
- Assignments: at the end of the conversation, assignments with instructions are presented to the user.
- Redirecting to adequate in person counsellor if necessary.

Data gathered throughout conversation are anonymously saved in databases and regularly checked by the experts. If there are signs of misdiagnosis or inappropriate further dialogue, experts correct it and thus OSVET is improving constantly.

3. OSVETS BENEFITS AND DISADVANTAGES

Main benefits of the OSVET online counselor are constant accessibility to all people in need, discreetness and safe, professional, personalized treatment, based on natural language communication. As such, OSVET reduces stigma and encourages people in distress to search for help, leading to better mental health in global society.

There are also some disadvantages of the OSVET solution: The rapport is limited since the therapist cannot see the user, and thus cannot interpret facial cues, voice tone and body language. It is questionable if emotional depth achieved through written words can be as deep as in person therapy. There is a particular risk of misdiagnosis. Even if safety is one of OSVETs main assumptions, there can still potentially be negative consequences when a system fails to understand emotions and incorrectly filter information during sensitive, high-stakes conversations. As such one should be aware of the fact that online counselling does not entirely substitute in person therapy.

4. CONCLUSION

OSVET is developed as an online psychosocial help solution for people in distress. The basic idea is derived from the fact that many people experience stress in their everyday life, but because of stigma they don't seek professional help. Besides, people are becoming more attuned to, and more dependent on technology in everyday living. It seems inevitable that counseling will be affected by the technology. Therefore, our goal was to develop a first stage of psychosocial help, which is accessible, professional and personalized, and user friendly. This innovation in psychosocial counselling is based on combination of artificial intelligence and distance technology with elements of traditional psychotherapeutic techniques, e.g. expert knowledge stored in the form of scenarios. The approach could be beneficial in several fields, for students and pupils under distress, career counselling, etc. If this kind of solution will gain on popularity, counselor education is likely to be affected significantly. Many challenges still lie ahead, including clinical, legal, technological, assessment and ethical issues, but we believe counselling solutions such as OSVET can be accepted as a useful clinical tool, if only appropriate monitoring and connection is established with real therapists. In time, such solutions will encourage more people to start to resolve their mental health issues and consequently

decreasing stigma and promoting mental health hygiene in global society.

5. ACKNOWLEDGMENTS

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Cognitive Computing Within the Evaluation Process

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ABSTRACT

The evaluation process is one of the key components of education and business in general, and therefore it is of utmost importance to determine the optimal evaluations system as well as its methods. The main research objectives of this paper are to determine how performance evaluation rating systems increase employee productivity and the quality of student knowledge (e.g., ECTS grading system in higher education). The research will also determine how process evaluations affect interpersonal relationships and whether or not they motivate or dehumanize employees and students. Finally we question the possible effects of using a machine, grading algorithm for the purpose of evaluation. As a conclusion we aim to determine how important emotional intelligence is, immanent to the human being.

General Terms

Measurement, Performance, Algorithm Security, Human Factors, Standardization, Legal Aspects, Verification.

Keywords

Evaluation, Emotional intelligence, Assessment, Measurement

1. INTRODUCTION

The term evaluation has many definitions and synonyms which provide a different point of view. In its simplest, general sense it refers to making a judgment about the amount, number, or value of something. The focus of the subject is the starting point at which the evaluation process is being created. If this starting point refers to some program, policy or project, the purpose of the evaluation is to explore the concept and direction, measure the effect and estimate the success and the efficiency of the program, policy or project in the question. In that sense, the question arises as to - what is leading the human civilization to the achievement of a certain goal. There are many answers but the final goal should be the advancement of humanity.

2. THE IMPORTANCE OF EVALUATION

Increasing the degree of globalization in the marketplace leads to increased competition and increased dynamics in companies and educational institutions. If these companies and institutions wish to remain competitive, investment that increases the quality of business processes, products, services and employee's efficiency as well as the one that increases the quality of knowledge acquisition in educational institutions, becomes crucial for further development. In this context, the prevailing way of observing and analyzing the progress and system features is evaluation.

Evaluation is a process that critically examines a program. It involves collecting and analyzing information about a program's activities, characteristics, and outcomes. Its purpose is to make judgments about a program, to improve its effectiveness, and/or to inform programming decisions [1].

Regardless of the application of the evaluation - from the evaluation of the pupils in the earliest school days up to the evaluation of the employees in a company - it gains its importance as an essential tool for recognizing the subject's current state, but also improving it.

3. VALORIZATION OF KNOWLEDGE

Valuing knowledge and skills has a significant impact on the individual. Apart from the fact that ratings often have a direct impact on the realization of some student rights like the right to student accommodation or scholarship, they also have a psychological impact. This is an inevitable element that is essential to education in general. The psychological impact of evaluation on students depends on its motivational profile, which consists of:

3.1 Three components of motivation

3.1.1 Perception of one's own ability

Student's assessment of their own abilities for successful learning and performing tasks.

3.1.2 Learning objectives

Goals that a student wants to achieve within educational activities, usually they can be divided into three categories:

3.1.2.1 Mastery / Skills development

The desire to understand and master the content and adopting new knowledge and skills.

3.1.2.2 Performance

Concern about getting the best ratings / results, the desire to be the best or one of the best in the group.

3.1.2.3 Avoidance

Attempting to meet the minimum requirements for passing a course with the least effort.

3.1.3 Other values

A combination of student interest in the courses, the perceived importance of the course and their perceived usefulness [2].

Depending on the motivational profile, the evaluation will have a different impact on the student. Generally speaking, it can be assumed that most students who believe that they are judged inferior to what they deserve or that their efforts, knowledge and skills are unfairly evaluated will lose the motivation for making an effort in their work and in acquiring new knowledge.

Besides the motivational factor, a very important psychological factor of student success is also self-confidence. Self-confidence is not a motivational perspective by itself. It is a judgment about capabilities for accomplishment of some goal, and, therefore, must be considered within a broader conceptualization of motivation that provides the goal context [3].

In order to reduce the differences in perception and misunderstanding, and raise the level of students' self-confidence for achieving success in learning, new "student-centered" educational trends are becoming prominent. Thus, Bloom's taxonomy, presented to help students strive to achieve sophisticated levels of understanding and abstraction, should be integrated into their overall educational experience.

4. COGNITIVE DOMAIN OF MEASURING KNOWLEDGE - FROM STUDENT PERSPECTIVES

Recently there seems to be an international change in education from a "teacher-oriented" to a "student-oriented" approach. One of such alternative models is recognizable in the Bologna system.

That model is focused on what the students are expected to be able to do at the end of the module. Such an approach, based on Bloom's taxonomy in the area of cognitive domains of learning, tries to define the necessary knowledge, which allows the professor to write the learning outcomes. Learning outcomes are statements of what a learner is expected to know, understand and/or be able to demonstrate after completion of a process of learning. The outcome-based approach has been increasingly adopted within credit frameworks and by national quality and qualifications authorities such as the QAA (Quality Assurance Agency for Higher Education) in the UK, the Australian, New Zealand and South African Qualification Authorities. The overall aim is to improve the efficiency and effectiveness of higher education in Europe [4].

Higher educational institutions provide online specification of the learning outcomes. In addition to describing what the students can show in terms of knowledge, skills and attitudes upon completion of a programme, the specification also gives examiners and students insight into the criteria that is applied to specific assessments. In that sense, students can know how much knowledge is needed for a certain number of ECTS credits, which in turn gives them an idea if they belong to the *Avoidance or Performance* type of motivational student profile. However, if they belong to a group of *Mastery / Skills Development* motivation profiles, learning outcomes could open up some new issues related to the content of knowledge. The question remains whether the traditional form of teaching can respond to such challenges, especially in the field of Informatics, where one can observe incredibly fast changes.

Based on the level of knowledge of Bloom's taxonomy, regarding the cognitive domain of the educational process, it is obvious that the processes of acquiring knowledge and skills as well as their evaluation are very complex and challenging. The task of the education system is to create an environment and structure of learning mode that will enable its participants to acquire constant and useful knowledge and skills that can be equated to a numerical value. However, the question is whether or not the professor will be able to take into account all the required standards, which the assessment itself requires, at any point in the decision making process. Or rather, can a professor conduct the evaluation process ethically while at the same time being mentally and emotionally independent of socially-conditioned standards? Following the above-mentioned issues, research was conducted through questionnaires at the Polytechnic of Rijeka and the University of Juraj Dobrila in Pula, Croatia.

5. RESULTS OF THE RESEARCH

The purpose of this research was to find out what students think about professors' objectivity and whether they believe that computer technology can achieve a higher level of objectivity? And finally, what percentage of students is willing to replace human beings with computer technology in some form of artificial intelligence, in order to achieve a greater degree of objectivity.

The survey was conducted by a questionnaire method that consisted of 10 statements related to the topic plus 2 questions related to gender and age of respondents. The study included 154 students from the fields of Information Science and Technology, Telematics, Entrepreneurship, Road Transport, and Occupational Safety. With concern to the gender of respondents, 56% students are male, 44% female. Regarding age, 77% of respondents belong to the age group of 18-25 years while the other 33% belong to the group older than 25 years.

For the first pronouncement in the survey, as the fundamental statement of this research, "When assessing, professors are always objective." 34% of students responded with the affirmative. In addition to that, 72% of respondents, believe that the professor's ability to successfully manage his/her own emotions in different circumstances, i.e. emotional intelligence of a professor, is a key factor that makes student assessment objective.



Figure 1. Emotional intelligence factor

Besides the emotional intelligence of a professor, 66% students also believe that objectivity can be influenced by some form of interaction between students and professors, in informal, out-ofclass activities.



Figure 2. Non-institutional factor

According to the survey results, it is evident that most students believe that professors are not objective when evaluating. Such an attitude is one of the factors of reduced motivation in students. As an alternative to the human beings' assessment, there are the opportunities offered by the development of digital technology. "A computer program or some form of artificial intelligence (AI) would be judged more accurately than a professor." - This is a statement on which the 36% of respondents show indecision. 26% of students agree and 38% of students disagree.

A computer program or some form of artificial intelligence (AI) would judge more accurately than a professor.



Figure 3. Knowledge measurement-challenges of digital technologies

Furthermore, 38% of respondents believe that computer-based assessment is acceptable, what is not a negligible number if we find that 22% of respondents are indecisive in this regard. Thus, 40% of respondents pleaded against such a choice.

Evaluation by computer technology would be



Figure 4. Knowledge measurement-acceptability of digital technologies

In order to determine if the students are ready for a different type of assessment and what it would look like if they are, the study introduced the following conditional statement: "To be able to change the grading system, the evaluation criteria would have to be determined:" -"According to a free/intuitive assessment" what 3% of students choose. -"According to knowledge levels (knowledge, understanding, application, analysis, synthesis, evaluation)." - 37% of students choose the standard educational framework, which uses Bloom's taxonomy to evaluate the cognitive levels. -"According to a precisely defined structure, which defines exactly which point refers to the information/result, without exception." - is the choice of 55% of students. And the other 5% of students that belong to the category of "Other proposals", mostly offer solutions that include human factors based of education system, for example: "I believe that the student's progress must be more appreciated than the ultimate amount of knowledge." Judging by the results of the last statement, standardization in the assessment is a fundamental factor that provides an insight into the results of educational success. However, regardless of the fact that the students participating in the research are participants of the Bologna system, and as such have a pretty measurable scoring system like the ECTS system, more than half of them (55%) believe it is necessary to try to achieve a higher degree of precision in the assessment in comparison to the existing one that uses Bloom's taxonomy to evaluate the cognitive levels. In that sense, it is obvious that social consciousness goes hand in hand with the development of technology, which ensures its accomplishments with its performance.

6. DATA VALUES - DIGITAL PERFORMANCE OF MEASUREMENT

Thanks to the development of digital technologies, it is possible to update student evaluation data within the database of educational institutions. Online learning is one of such examples where measurement takes place in a digital online environment. Expanding rapidly, with increasing numbers of providers offering services and more students choosing to participate, online learning becomes an excellent environment to enable tracking performance of digital measurement in both learning processes as well as in knowledge assessment. With that in consideration, standardization for evaluations in a digital online environment includes a wide range of data collection and analysis activities from formative evaluations that rely primarily on survey, interview, and observation data, to scientific experiments that compare outcomes between online and traditional settings. Institutions and professional bodies in many countries are addressing the challenge of how to make online learning a quality experience for students. An example of such an approach is development of Massive Open Online Courses (MOOCs) projects. Various EU-funded MOOC projects together with OpenupEd are working with the following definition: MOOCs are "online courses designed for large numbers of participants, that can be accessed by anyone anywhere as long as they have an internet connection, are open to everyone without entry qualifications, and offer a full/complete course experience online for free".[5] Thus, most top universities have started to offer some sort of MOOC platform, which applies new kinds of educational approaches that enable assessment of knowledge through written assignments, participation in online discussions essays, online quizzes, multiple choice questions to test understanding (formative) or as a test (summative), collaborative assignment work or debates, experiential activities such as role play simulation etc. The aforementioned approaches in online learning open a variety of new opportunities. MOOC generate massive amounts of data about learner behavior. This data can be used to understand cognitive growth and to improve instruction.[6] Furthermore, the creation of educational platforms for online learning opens up a wide range of possibilities in the field of cognitive computing. By generating data about learner behavior the system obtains data values that can be used for the development of an algorithm for artificial intelligence that can be used for educational purposes. Student engagement and effectiveness of incentives can be improved through software solutions that are implemented on such platforms. In addition, most technical universities collect data on MOOCs, while so far only few of the comprehensive universities, or the specialised or applied sciences institutions do so.[7] Though, only at the very beginnings of its existence, collecting data in digital form, within educational frameworks, provides new opportunities which bring adaptive learning to the next level.

7. CONCLUSION

Digital performance of measurement will certainly affect the change in the structure of education, methodology, evaluation, verification, intellectual property issues, security as well as all other legal aspects that are encompassed. The rapid development of digital technologies contributes to the perception of evaluation and the goals of education. Given that we still live in the time of traditional education, but we are largely consummating technological achievements that open up new opportunities, it seems important to put a fundamental question in the context of evaluation: What is real value? Regardless of cognitive computing and everything that comes with it, we need to create values by which we could achieve a social change. Both the professors in educational institutions and business leaders could increase the results by taking measures to enhance their standards of sustainability.

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Learning Processes for a Cognitive Democracy In Information Society

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ABSTRACT

In this paper we deal with *how* the processes of the Learning interact with the variable aspects of the democracies within the globalized world. Environmental catastrophes, cultural disasters, economic exasperations and social traumas became continuous and pervasive menaces, further emphasized by the political behaviors of the local /national governments. Such menaces distort even the very concept of Democracy, influencing in particular the behaviors of the young generations.

Vice versa, another idea of Democracy based on Relational Communitarian Learning Processes can be developed and differently practiced by various human societies as a *Cognitive Democracy*.

Such a *Cognitive Democracy* Idea is today urgent and extremely necessary, just to cope with the contradictions between techno-informational sciences and human societies, that strongly influence-without distinction-the weakest societies and all the young generations of the globalized world.

To realize such ideas we need a wide range of Learning Processes, modeled on different contexts and necessities and practiced through environmental friendly learning experiences.

On this premise it is possible to evolve the original concept of Democracy going beyond its binary (Individual/Society) socio-political field throughout ternary relationships (Individual/Society/Life Environment) experientially produced as a complex system at the same time aesthetic/ethic and concrete /informational, versus the trivialization and fragmentation of the Globalized World.

Some concrete practices of Learning Processes related to various socio-environmental political contexts can be taken into consideration and presented to discuss the proposals of this paper.

Key words

Globalization, Democracy, binary /ternary systems, learning experience, informational/real world

1. INTRODUCTION

.The idea of *Cognitive Democracy* was promoted by the French philosopher Edgard Morin at the end of the XX Century, as an adequate way to propagate the appropriate forms of effective participation by different contemporary societies in the scientific and political processes. This idea involves another challenging idea, which has been suggested by the French Philosopher Felix Guattary as a *Molecular Revolution*. Both these ideas, even if they have not been officially celebrated, inspired a lot of social manifestations, behaviors and projects, continuously in progress. All of these

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manifestations are strongly linked to very learning processes that are spontaneously practiced by different contexts and social groups, dedicated to political discussions, protests or very action-researches referred to their local or general problems. Yet the democratic governments, completely ignoring or underestimating these challenges, overpower them by authoritarian decisions, macro financial programs or trivial public projects and works. It seems true that between the spontaneous manifestations and official powers do not exist effective relationships and that, consequently, the processes of the Learning cannot interact with the variable aspects of the democracies within the globalized world. In particular, the contemporary environmental catastrophes, cultural destructions, economic exasperations and social traumas are further stressed by the political behaviors of local/national governments to distort even the very concept of Democracy and influence the social behaviors and young generations towards the self-defense of their identity.

2. A QUESTION REMAINS

If and how appropriate interactions can be realized despite this generalizable trend? The idea of democracy currently acknowledged is still referred to the traditional logic reasoning (the third excluded) the Game's theory (winner or losers) and the numeric representativeness of the voters during a pre-decided time when the Governmental projects have to be realized, often in spite of unpredictable events or changes of social mind. Within a so rigid framework (conceptual and practical) the cognitive processes cannot be harbored, the participative spontaneous processes in particular, and this is why :

- he classic idea of democracy continues to be related to classic logical reasoning, (the third excluded), the Game's theory (winners or losers) and to the numeric contraposition (majority/minority) of the voters during a predecided time when the Governmental projects are *mechanically realized*, often despite unpredictable events or change of social ideas.
- ithin a so rigid framework (conceptual and practical) the cognitive processes cannot be harbored, while the participative spontaneous phenomena remain defenseless, often interrupted and constantly attacked by the dominant powers.

In this situation, it is reasonable to wonder *whether* and *how* appropriate interactions between institutions, strong powers and legitimate social expectations can be achieved. This

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question cannot be answered but remains open to stimulate the evolution of the *very* concept of democracy. The current well-established idea of democracy corresponds to a rigid framework of relations where there is no place for unforeseeable events or for the change of voters' willing, for participatory processes, initiatives, new ideas, and even less for the spontaneous learning processes emerging from different social contexts. On the contrary the simplifications, the exasperate contrasts and the most trivial political and social behaviors. are welcome.

3. THE COGNITIVE DEMOCRACY

Another idea of Democracy based on Relational Communitarian Learning Processes can be developed and differently practiced by various human societies as Cognitive Democracy. Originally the idea of Cognitive Democracy was suggested by Edgard Morin [8] at the end of the XX century: "Cognitive democracy presupposes itself a reform of thought as science, since the sciences are extremely esoteric for the citizens. They give up understanding, they are sure they cannot understand, while the scientists say - you cannot understand-. So a profound ditch has been created even more serious why the most important political issues have a scientific and technical component that is reserved to experts". Morin's proposal was then addressed to educators and considered as a link between expert elites and people, whose participation in scientific advances could and should become more effective and democratic. This idea though hierarchically structured (from scientists to people) turned out useful for the dissemination and propagation of scientific knowledge.. But it harbored many other potentialities not only as a *democratization of the knowledge* but as a *different* democracy, constructible only throughout participative Learning processes. In those same years within the traditional democratic systems the contradictions and tensions among the political and governmental systems and their populations were growing. For these reasons, what we propose today is another evolutionary development of democracy, intended in a broader sense, as a Democracy of Learning and Creativity, practicable through spontaneous initiatives, autonomously encouraged by participants and supported by experts, but not hierarchically controllable. Starting from E. Morin's idea, we could approach the concept of democracy by using shared principles and diversified criteria, not standardized but tailored for many contexts and contemporary conditions.

3.1 Steps to a Cognitive Democracy

As we have just described, the E. Morin's. proposal did not change the management of scientific and technical knowledge but made them simply more propagable and easily understandable by the users. Today, we do not think that, given the exasperated separation between dominant powers and people, it is still possible to maintain the traditional style of current political practices, mainly based on binary relations .On the contrary, we believe that the Democracy can change only by reconstructing suitable ternary relationships among people, their contexts, and the Institutions who govern them. In other words these changes become possible only through different approaches based on the circularity of ternary relationships. For the contemporary conditions such kind of a Cognitive Democracy is today urgent and extremely necessary, just to cope with the political contradictions and the strong contrasts between human societies and driving forces (political, techno-informational, financial). These Forces strongly influence - without distinction- the weakest societies and all the young generations of the globalized world, by attacking the ternary relationships among individuals/society/life environment

that are the most threatened. Today it is true that some aspects of Morin's proposal have been successfully implemented. In fact we have conquered informational social communication and instant access to news e ideas, we have developed forms of political struggle and creative proposals, self-sustained by people, but once again all these forms of propagation and communication use linear dynamics with very limited results regarding the real advances in sociocultural activities of contemporary society. In this way the democracy, though widened, is practiced only at a mechanical-reduction level, without any chance of circularexperiential verification by the subjects involved and therefore without the emergence of learning processes. Furthermore the influence of the digital world on such contemporary conditions produces new exasperations on individuals and social behaviors, by worsening the spontaneous communications and exchanges (ideas, experiences, projects), which are all forced to follow linear dynamics far from any ecological circularity.

At the same time, the need to maintain the intrinsic prerogatives of creativity, common to all living systems, continuously stimulate the human societies to start new learning processes, often temporary, consequently fragile and easily controllable by the dominant powers. For all these reasons we think that considering democracy as a standard phenomenon that can be imposed indifferently on every society in the world is an epochal error with irreversible consequences on the social mentality where the existing tensions are often exasperate or increased.

Actually, to realize the multiple forms of Cognitive Democracy we need a wide range of Learning processes, tailored to different contexts and needs, and practiced through friendly learning experiences, which must remain constantly referable to well-identified and recognizable ecological ternary systems.

On these premises it is possible to evolve the current Democracy to go beyond its binary habits and refer it to ternary systems of relationships (i.e. Individual/Society/Life Environment) and experiential action-researches, socially produced as complex systems, aesthetic/ethic and concrete /informational at the same time, against the trivialization and fragmentation of the Globalized World.

4. THE MOLECULAR REVOLUTION

Felix Guattari , the French psychotherapist and philosopher who coined the word Molecular Revolution, inspired us a new approach to the complexity of nature and the idea of Learning, free from constraints and hierarchical systematizations of the thinking. The Molecular Revolution is a very impressive idea which suggests and involves many topics, problems and human realities since the bio-molecular nature, micro, autonomous, creative and interactive within the living world leads us to a variety of realities and contexts. In our opinion the Molecular Revolution can combine the dynamics of the living world with the dynamics of the evolutionary cognitive processes in a non-hierarchic way, homologous to the one used by individuals and groups to evolve their ideas, mature their desires and practice their creativity, according to the virtual-actual dynamics, quintessence of the all living world. The circular combination of molecular dynamics and learning experiential processes can produce and develop that necessary adequate knowledge (autonomous and selfproduced) to practice differentiated forms of democracy, all cognitive and equal, beyond the current democratic methods.. This combination can lead us towards new and various types of democratic participation, each adapted to the characteristics of the context in which it is formed. These eco-epistemological research and action- strategies welcome the philosophical thoughts of Gilles Deleuze and Felix Guattari, realizing the concrete translation of micro virtual and real dynamics, into a tangible social dynamic so often highlighted in their philosophical elaborations.¹This translation -from the micro level of the organisms to the political level of societies- constitutes a very evolutionary shift for the contemporary realities since it can mark, for the first time, the direct, capillary pervasion of the philosophy into the social contexts in a spontaneous and nonauthoritarian-deterministic way. In such a way it becomes possible to escape from the mechanical (cause /effect/ action/reaction) political, social, informational habits and reintroduce on the scenery of the world multiple and propagable versions of molecular revolution As a lot of study cases testify, our contemporary age already shows many micro- dynamics that, as new cyanobacteria in a global primordial soup, actually practice contemporary molecular revolutions, in counter tendency to the massive global attacks of the dominant forces on the planet. Hence we say that the new dynamic processes which could continuously rise from the exasperated human/ environmental contexts actually constitute a translation of the philosophical concepts virtual-actual into political dynamics tension-fact, and a base of further molecular revolutions.

5. MULTIPLICITY AND VARIETIES OF COGNITIVE DEMOCRACY

The theoretical and contextual reference points outlined above allow us to define the key elements to activate new forms of democracy based on ternary relationships Individual/ Society/Life environment (understood as a wider ecological context, as a very *landscape* where culture, economy, human solidarity, meet and interact throughout processes of participative learning). Therefore, to achieve appropriate levels of participatory democracy and adequate systems of Governance the following procedures become necessary and basic for every context :

- Re-discovering potential or latent ternary systems capable of harboring and supporting new learning dynamics
- Encouraging people involved in learning processes
- Inspiring new functional, aesthetic and attractive configurations that life environments can take
- Implementing and promoting true relational structures at any level, rooted in the contexts

A lot of potential Cognitive Democracies can come to light from different contexts and stimulate different forms of Governance where the participants become at the same time guarantors, promoters and administrators of the environment, guardians of its values and trustees of its Governance.

6. FIRST STEPS TO COGNITIVE DEMOCRACIES

Many action-research experiences are already in course in different places, from the post-industrial metropolitan realities (Cleveland, USA) to the contradictory megalopolis of post colonialist realities (Kibera/Nairobi, Kenia). In Europe many social experiences have taken shape just to answer the economical, urban and social crises in course and promote new levels of experiential processes. Some significant experiences in Italy can validate the strategic importance of this approach to urban, rural and territorial contexts. They are very interesting examples of potential Cognitive Democracies practicable at the urban, rural and territorial scale that can take roots in different contexts developing throughout the reconstitution of inter/ecosystemic relationships, stimulated or encouraged by appropriated ecological inputs.

7. EXPERIENCES IN ITALY

The daily struggles to contrast the degradation and environmental transformations provoked by natural catastrophes or authoritarian political decisions are usually impeded or ignored by the Public Authorities. For these reasons they could develop in terms of action- researches beyond the mere opposition or the alternative Projects or Planning. Most of these experiences brought to light new levels of adequate knowledge and concrete socioenvironmental perspectives. This phenomenon has been continuously testified by numerous spontaneous micro activities and territorial experiences. Such experiences, autonomously promoted by participants or encouraged by scientific-technical promoters, could further develop through unexpected ecological configurations of the ternary systems involved. Some significant examples in Italy can validate the strategic importance of the experience practiced on different life environments urban, rural and territorial.

7.1 The La Pica Garden and Kitchen gardens -Mirandola (Emilia Romagna Region, North Italy)



In this small town of Mirandola a No- Profit Association founded and realized the *La Pica Garden* and developed a *kitchen garden area* organized around the ancient town, destroyed by the 2012 strong earthquake.

These two experiences achieved interesting and integrated outcomes towards people, life environment and political government, playing a fundamental role towards the citizens in search of new reference points (aesthetic, cultural, social, economic) especially after the 2012 earthquake. Today the Garden is appreciated as a very stimulus to cultivate culture, agriculture and social consciousness, while the Kitchen Gardens became a fundamental encouragement for the renaissance of the devasted town. All of these initiatives, successfully carried out by their promoters and citizens, got a

¹Virtual-actual have to be translated into tension-fact.

What does it mean for us today practically, i.e. politically, to translate the relation virtual-actual in the one tension-fact? It means to disclose the productive nature of the relation virtual-actual, or, as Deleuze affirmed, to potentiate the nature of the virtual, which is the invention of the new. ...I would say – that the "dynamics of becoming as differentiation and creation" comes to be (Anne Sauvagnargues in *Le vocabulaire de Gilles Deleuze*, p. 22)

more intense and involving relationship towards the local public managers, just to transform these voluntary proposals into effective continuous popular participation in the public management. A very micro revolution, towards a concrete management of the Public Common Goods is in course at any level (solidarity income taxes and services, mutual interaction of social works and cultural initiatives). A very autonomous Governance is developing!

7.2 The "Asilo Filangieri", a new Urban Common-



The Asilo (Napoli, Campania Region, South Italy) is an ancient building originally dedicated to poor people. In coherence with the name of its founder Gaetano Filangieri (Naples 1752-1788) a noble enlightened jurist who dedicated his entire life to the political and social justice, the Asilo became property of the Naples Municipality, who recently acknowledged it as Urban Common Good. Thanks to the constitution of such an Urban Common Good the Building located in the centre of the ancient City within an impoverished but alive animated area - has been transformed into a complex socio-cultural structure, jointly promoted by spontaneous Groups and local Municipality. This structure is now self-managed by artists, artisans, actors, students and producers who develop a very interesting cultural policy towards the entire City of Naples. This Asilo (a former institute to welcome poor people) became a creative harbour able to revitalize the urban area and implement the civic participation in the cultural activities. The Asilo became also a key factor for a wider ranging action-research towards a micro urban ecology and self-governance.

7.3 The Landscape Cities in Tuscany

We would consider the Landscape City as a nucleus and a mover of the in-becoming Life Environments, the place where the multiple networks (natural, technological and informational) of the town are closely entwined around the environmental texture to form a very holistic configuration.

Such configuration equally involves the territory, the living spaces, the single persons and the social communities reciprocally linked and ecologically balanced. In this sense the Landscape City can emerge as an aesthetic catalyser of new projecting processes.

This phenomenon develops at the *real/local environmental dimension* but it is strongly connected to the unbounded informational *web environment* in a continuous reciprocal entanglement.

In other words, the Landscape/ City is nothing but a *very relationship* between a consolidated social trim –the traditional town- and a new organization of its environmental context to which the ancient town had been referred.

The very nursery of such relationship are the both territory and its natural aesthetic Configuration. We are speaking of a complex and multiple system of relationships where the Action-Research of Persons and Community play a fundamental role, just as reference point to their whole environmental contexts that include and harbour both the City and the Landscape. If in such condition they could be related each other and involved in reciprocal dynamics we could really think of a new entity able to harbour and foster an in becoming human /environmental context.

In Tuscany and in Italy in general, such realities (ranging from small villages or towns, to little parts of urban or metropolitan areas) are still alive and manifest throughout the habits, experiences and life styles of their citizens even if they often are overwhelmed by the impelling globalization.

Within such realities more and more communities improve their knowledge, experiences and projects that could open the ways to different configurations of Landscape City.

On this base we consider that multiple versions of Landscape City are possible and can be realized within such socioenvironmental conditions, according to various procedures, that can continuously take shape on each territorial reality throughout evolutionary participative processes.

7.4 The Landscape Contracts in Italy

Specific new agreements between social groups, environmental, economic managers, policy makers can be promoted and practiced on different life environmental contexts through shared landscape projects. The Landscape Contracts can be concretized through the choral construction of specific proposals, statutes, project activities which tailor specific modalities of Governance suitable for each environmental context (territorial, social, informational, cultural and so on). The very key actors of the Contracts are the groups of citizens who participate in the action-research as creative promoters and responsible partners of the Contract's Governance, who are organized as Landscape Contract's Presidia.

The Panaro (Emilia Romagna Region) and Simeto (Sicilia Region) River/Landscape Contracts have been developed by interdisciplinary staffs along with local groups, associations, Public Bodies (politicians and technicians), Schools, local Museums, and local entrepreneurs (tourism, culture , agriculture) through the following steps:

- Social perception of the Life Environment friendly learning approach among local groups, experts and staff -Informal meetings, survey promenades, some thematic synthesis;
- Self-reflection on the local River landscape shared evaluations, constitution of a common stock of information and aesthetic landscape evaluations;
- Social potentialities and actions- *ecological*, *cultural*, *scientific*, *educational*, *economic- have been recognized in their mutual relationship with specific territorial river areas and connected as a dynamic interactive network (creative hive);*
- Location of the network on the river territorylandscape valley;
- Constitution of River Landscape Presidium of citizens who become promoters and guarantors of the participative Governance of their territories and mover of the ecological ternary process of the Contracts

The proposal of the Contract is a new Pact between society and river sites, an agreement between official Bodies (Region, Province, Municipalities, local Groups, Technicians, public Managers) for a new way to manage the natural-social common heritage in evolutionary terms..

8. CONCLUSIONS

The examples described above show that every context can achieve its own Cognitive Democracy while specific modes of governance can actually be realized at different scales and levels.

All these dynamics constitute a multiplicity of articulated sets of initiatives, experiences, changes in the lifestyle of people and their reference societies, all involved in environmental changes of great strategic importance even if of small size.

As it happens in the case of all evolutionary processes, the turning point of cognitive democracy does not proceed linearly, but in a complex, circular and reticulated manner, with many different episodes, with different initiatives and cultural achievements, with successes and failures, with times and rhythms each time different and, above all, with the alternation of virtual-actual/ tension-fact dynamics that remains common to all experiences.

However, these processes are irreversible and can continue. The Cognitive Democracy is already alive and in becoming!

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Suicide attacks, mass media and data mining

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ABSTRACT

The aim of this study is to evaluate, examine and critically analyze two contradictory approaches and perspectives concerning terrorist suicide attacks. The first approach reflects the majority of theories, research and literature that are based on sociological explanations that portrait the suicide attacker as driven by his/her ideology. The second approach is based on a new field of research that studies the possibility of suicide attackers being mentally unstable, driven by their suicidal tendencies. In addition, this research examines the role of the media and how terrorist organizations exploit the fact that terrorist suicide attackers are presented by the media as rational individuals committing an altruistic suicide that is driven by their ideology. The conclusion of this study is that the factors that prompt an individual to commit suicide are not necessarily limited to one on each individual. Many factors often co-exist. Moreover, the role of the media plays a role on the rates of suicide attacks. The study suggests that a more systematic cross-disciplinary research and cross-national collaboration is needed in order to facilitate the design of a prevention program.

1. INTRODUCTION

There is a variety of reasons that explain the rationale behind a terrorist organization and its actions, but different factors and reasons might play a role for an individual to join in a such organization and proceed to act through suicide attack. This study's aim is to explore and examine different theories and explanations regarding an individual's decision to commit a suicide attack. As it is a phenomenon that rose the past years and left thousands of people dead and the public in fear, it is worth examining in detail in order to try and explain such behavior. Are the perpetrators acting on an ideological cause, or are they mentally unstable individuals with suicidal traits?

2. THE SOCIOLOGICAL EXPLANATIONS OF SUICIDE ATTACKS

2.1 Social explanations of suicide attacks

There are two main factors that influence an individual's decision on suicide attacking; the impact terrorist organizations and groups have on the individual, and the individual's social context. Most of the Islamic terrorist organizations and groups aim for a social change by firstly developing alternative principles of living, and secondly by introducing these alternative principles through practice, massages and codes that come in various forms and flow through networks and media. These terrorist organizations and groups are structuring their war on religion and perceived oppression, stating that the fight is for the threatened and oppressed Muslims but also God's will. Furthermore, Islamic terrorist organizations are spreading and exploiting the dissatisfaction and alienation of Muslims in order to get more recruits. This ideology and principles serve well these terrorist organizations, as the individuals involved, fight for God's (Allah's) will and Islam. Thus, they are not afraid of death and they are willing to die in their attacks for the greater purpose, making them an impossible enemy to intimidate or destroy [1].

There is a variety of motivations and factors linked to an individual's decision to participate in a terrorist suicide attack. One of them, is an individual with an authoritarian personality, associated with religious fundamentalism who is not able to express his/her authoritarian character in his/her social context. Joining a terrorist organization and proceeding with a suicide attack is perceived as the only way to prove his/her power [2]. Moreover, emotional distress and moral outrage associated with experiences of humiliation, not only of its own but as well as in the context of the individual's close circle, that can be either religious or ethnic circle are often factors that prompt the individual to act out of revenge for his/her people or for his/her own dignity [3]. An example of this case would be a TV interview in January 2005 of Saleh Jamil Kassar who was a captured Saudi Fighter that stated that seeing pictures of Muslim violations as well as Muslim women getting violated in TV and internet was what motivated him to join the terrorist group and try to carry out a suicide attack.

Nevertheless, in some cases there are possible motivations in terms of instrumental rationality. An individual that might be suffering by a status crisis, either a real loss of status or the fear of losing it, can chose to join a terrorist organization. Such individuals might believe that dying in a suicide attack is a better choice than losing their social status and staying marginalised. It might be based on an egoistic interest, trying to find solidarity as well as becoming a glorified martyr who will act and die in a heroic manner [4]. Thus, the individual leaves the social norms in the context of which he/she fears of losing his status and becomes a member in a group where he will gain prestige and glory, even if it comes to the price of his/her own life. The idea of having the image of loyalty, sacrifice and autonomy overcomes the price of death [5].

Moreover, in Durkheim's theory there are two explanations that could apply on this matter. One is the anomic suicide; anomie is the condition where social and also moral norms are confused, unclear or simply not present. Individuals in this concept, lack the sense of social regulation and have a feeling of marginalization from the societal norms, resulting in a selfcrisis and choosing suicide. In this case, individuals that feel like they have no place in their own society, turn up to a terrorist organization where the social norms no longer exist and this results in a suicide attack. Furthermore, the second explanation of Durkheim's theory that could apply, is altruistic suicide. In this case, individuals that give primary consideration to the interests and welfare of others but are not able to express it in their social context, choose to join a terrorist organization and "sacrifice" themselves through a suicide attack [6]. An example of a case would be the story of Teoria Hamori, a Palestinian woman who was captured right before she tried to commit a suicide attack. As she stated, she was very disappointed for her unsuccessful attack, her only purpose was to sacrifice herself for Palestine, her land and her people; her life would be the price for the Palestinian freedom.

As mentioned above, the main resource for all organizations that use suicide attacks as their main form of action is the availability of attackers. Their recruitment method involves socialization with all the important circles of society, such as, family, educational institutions, religious community, peer groups as well as mass media. Individuals might get involved in such an organization as a result of the strong bond they form in this circle. In this case, these individuals, in their search for companionship and solidarity, are joining terrorist organizations with no intention of committing a suicide attack. However, as the social bond becomes more intense they adopt the values, ideologies and goals of the group [7]. In the modern age, radicalization and the creation of these social bonds have become increasingly constructed through the internet instead of face-to-face communication. Thus, individuals that already have a strong fundamentalist view are able to find groups that share the same ideologies with them easily, through private networks. In addition, there are individuals that grew up in a social context where radical fundamentalism, extremism and suicides attacks are their social norms. These individuals are trained and recruited in an already Islamist radical environment and their life goal is to proceed with a suicide attack.

Another factor is the political beliefs an individual has and his/her oppositions to certain countries or Governments that can prompt the decision to suicide attack in order to protect his/her political positions [8]. Nevertheless, the factors that prompt an individual to commit suicide are not necessarily limited to one; many of the above factors often co-exist in the act of one suicide attacker. An example of that case would be the attack of Mohammad Sadique Khan who was the ringleader of the 2005 London attacks. As he stated, his motivation comes from his religion, Islam, the duty to serve Allah, the need to destroy the democratically elected governments of which Muslim people, or "brothers" as he calls them, suffer, and the need to sacrifice himself for the people he loves. As it can be seen in the above statement, there is a variety of factors that prompt the specific suicide attacker to act, radical religion beliefs, political oppositions, solidarity as well as the need to express heroism. Thus, for a better understanding of suicide attacks, all the above factors should be taken into consideration and every attack should be studied individually, rather than being generalized in a theory of one-fits-all.

3. THE MYTH OF MARTYRDOM AND THE PSYCHOLOGICAL EXPLANATIONS OF SUICIDE ATTACKS

3.1 Religion and suicide attackers

Many scholars come in contrast with the belief that suicide attackers cannot have suicidal tendencies, as a result of suicide being strictly forbidden in Islam. It is believed that Muslims have lower suicide rates as they are not willing to get humiliated and stigmatized in their community by disobeying Allah's "orders" [9]. The assumption that religion prevents suicide is not a solid argument. It might be true that religious affiliation is correlated with lower rates of suicide attempts in some clinical populations. However, in Islam where suicide is strictly forbidden by the Ou'ran, few Muslims will admit to have suicidal tendencies if questioned directly, whereas more Muslims would admit it if the questions are open-ended [10]. Findings show that taboos against suicide can result in suicides being underreported, and growing evidence show that suicides are largely underreported in Muslim countries [11]. An analysis that was conducted in 17 predominantly Islamic countries, reported that suicide rates including "hidden" suicides that are otherwise classified as "other violent death" (OVD) were as high as those in the United Kingdom and eight times higher than otherwise officially reported [12]. In addition, the idea of suicide attackers not being able to be suicidal based on religion is problematic, on the grounds that there is no evidence of all suicide attackers being Muslims or religious [13]. On the other hand, a result of suicide being strictly prohibited and a crime against God, Islamic individuals find suicide attacks as the only honourable form of suicide that will lead them to heaven. Thus, the belief is that for that very reason the majority of suicide attackers come from an Islamic background [14].

3.2 Psychopathology and terrorism

There is a remarkable consensus in the research literature field that there is no such thing as a terrorist's personality or psychopathology and that mental illness is not an important consideration when trying to understand terrorist attackers. Many research findings suggest that terrorists are "normal" people but who commit acts of terrorism. In addition, Ruby commented that terrorists are rational individuals that have unrealistic goals based on their extremist ideologies [15]. There is a large number of individuals that have common extremist ideologies regarding religion and nationalism. Terrorist groups might use this in their advantage by recruiting individuals that share these extremist ideologies, but that fails to explain why not all of them join.

3.3 Mental Illness and suicide attacking

A research conducted by using qualitative method and interviewing the family members and close associates of 26 female Chechen suicide bombers found that nearly all had lost close family members in bombings, landmines or air raids carried out by Russian forces in battle. Many of them had witnessed themselves the death or torture of their family. As their family members and friends stated, none of them had any significant personality disorder or symptoms of depression before the trauma, but all changed afterwards. More specifically, they all had dissociative symptoms which is a characteristic of posttraumatic stress disorder (PTSD). In addition, before they commit a suicide attack, 92% became socially isolated, 73% of them showed signs of depression and 23% became aggressive [16].

Furthermore, Ariel Merari conducted a controlled study of three groups. The first group that was interviewed was 15 "would-be" suicide terrorists, as they were arrested moments before their attack. The second interviewed group was 12 non-suicide terrorists and the last group was 14 terrorist organizers. None of the interviewed individuals had a diagnosis of psychosis or a history of hospitalization for mental health disorders. However, 53% of the "would-be" suicide terrorists showed symptoms of depression, such as, low energy, emotional constriction, distracted attention, melancholy, sadness, hopelessness and tearfulness. In addition, three of the "would-be" suicide terrorists displayed evidence of PTSD. On the other hand, only 8% of the organizers showed depressive tendencies and none of them showed evidence of PTSD. Findings also showed that 25% of the control group and 7% of the organizers group exhibited psychopathic tendencies, whereas none of the "would-be" suicide terrorists had exhibited these traits [28].

3.4 Recruitment

There is an assumption in research literature that recruiters successfully reject individuals who are mentally ill. However, Berko who interviewed Israeli terrorist prisoners argues, that recruiters are often told to "look for sad guys" [17]. The question arising is how do these recruiters spot out the mentally ill candidates? There is good evidence that soldiers are the ones that can spot and predict signs such as withdrawal, poverty of thought and lack of help-seeking the best in combat situations, thus terrorist recruitments might also have the same "ability" [18].

3.5 Impulsivity and suicide attacks

The notion arguing that suicide terrorists could not be suicidal as a result of the belief that suicide attack is a well-planned action, whereas suicide is impulsive is simply wrong [19]. While on some populations impulsive traits have been shown to increase the risk of suicide, especially in those who suffer from bipolar disorder and alcohol abuse, decades of research have shown that the majority of individuals who commit suicide do not act so impulsively and that in fact, have had suicidal thoughts and ideation for some time and made prior plans for these acts [20].

3.6 Murderous intend argument

The proposition that suicide terrorists could not be suicidal based on the belief that they have murderous intent represents a false dichotomy. Even if suicide terrorists have murderous intent, it does not mean that suicide intent can't be also part of the decision. They might be both homicidal and suicidal. Furthermore, depending on the culture in which the act occurs, the degree of homicidal intent might be lower or higher. At least in the initial phases, suicide attacks were less effective and took fewer victims in Afghanistan than in Iraq. This might be as a result of cultural taboos on killing innocents in Pashtun culture [21].

3.7 Familiar network and genetic factors

As researches show, suicide bombers in particular are known to act in familial pairs, such as, mother with son, father with daughter, as well as siblings. This raised the idea of suicide bombings being a result of socio-environmental factors and upbringing. However, the growing evidence of genetic factors in suicide, come to challenge the idea that suicide terrorists could not be suicidal, because suicide bombers most often act in familial pairs [22]. According to one study, in 15% of cases, identical twins share suicidal tendencies [23]. In addition, many other adoption studies evidently showed that individuals that were adopted were six times as likely to commit suicide as their biological relatives who committed suicide [24]. Thus, the fact that suicide bombers and attackers often act in familial pairs might be as a result of transmitted genetic suicidal traits [25].

4. TERRORISM AND THE MEDIA: A DANGEROUS SYMBIOSIS

4.1 The media-related goals and means of terrorists

Terrorism has as "target" the wider audience at which the violence is actually aimed. However, without the media's coverage, the terrorist acts would be arguably wasted, narrowing the impact to the direct victim(s) of the attacks [26]. In addition, the terrorist organisations are mainly interested in the wider audience, rather the direct victims and it could be argued that the reaction from the audience has the same importance as the acts themselves [27]. Moreover, terrorist organizations are carefully selecting the places that they will attack, in order to get the best media coverage and win the attention of national and foreign publics as well as the decision-makers in a government. An example would be the 9/11 attacks in the US, where not only a large number of media covered the story immediately but also it was documented by hundreds of people through videos and pictures [28]. However, the goals of terrorist organisations are not limited into gaining the attention of the masses. However, it is through the media that they aim to inform both foes and friends, regarding the motives behind terrorist deeds, explain their rationale behind their acts of violence and publicize their political causes as well as to motivate future recruiters [29].

4.2 Media's coverage of terrorism

Terrorism and terrorist incidents involve blood, tragedy, heroes, shocking footages, drama and the feeling of danger. For that very reason, media's coverage of terrorist-related stories provides a high pick of view ratings and profit which is very beneficial, as Media rely on views and the audience [30]. Another factor that makes terrorism such an attractive topic is that, in the modern television culture, violence has been a major and defining quality that public audience enjoy [31]. Moreover, what is problematic

regarding media's coverage of terrorism is not the actual act of covering terrorism, but rather the way the media cover terrorism. There is no doubt that terrorism should be reported, but the way the incidents are framed and the extent to which it is covered is also important. Media's coverage of terrorism is most often framed by enlarging stories, sensation-seeking, exaggerating the matter of who is to blame, repeating the same footage and images over and over again, separating physical and mental health consequences of disasters as well as creating new syndromes [32].

4.3 What is problematic about this symbiosis

The media may directly or indirectly serve the interests of terrorists by over-simplifying stories for the audience to the point that it has little to do with the actual events. By repeating the traumatising horrific scenes and stories it also serves the goals of the terrorists, which are to appear in the media as long and often as possible. Moreover, the media's obsession and bias of sensationalising certain aspects of terrorism related stories might contribute to the fact that terrorist organisations are using media as a tool for their own success. Creating an atmosphere and politics of fear and creating the necessary conditions for propaganda and recruitment following a terrorist attack is the ultimate contribution of media to terrorism.

In addition, the way media frame suicide attackers, is by portraying them as rational individuals that committed an altruistic suicide on their beliefs and ideologies. This idea and view has been adopted and shared by the broad audience that mass media have. One could argue that the way suicide attackers are framed and covered by the mass media contributes to the recruitment of future suicide attackers by creating copy-cats. In other words, individuals that will choose to mimic this kind of action and behaviour. As mentioned above, terrorist organizations arguably plan out their attacks in a rational and strategically way with having full awareness of the influence that media coverage has on society as well as government officials in almost all levels. Thus, recruiters and leaders have knowledge on the impact the media have on an individual's decision to participate in such an act and use it on their own benefit.

This can be seen and explained through the different approach media gives to mass-shootings, school-shootings and suicide attacks. All of the above-mentioned acts involve a perpetrator that kills a number of people and then proceeds to take his/her own life. However, the media will portray the gun-shooter as a mentally unstable individual that suffered depression and suicidal thought, whereas the terrorist suicide attacker as a rational individual that acted on ideologies and beliefs. Thus, mentally unstable individuals with suicidal tendencies and intrigued by the media's portrayal of suicide attackers, might choose to act in the context of terrorism in order to get the expected response by the media and be portrait in the same manner. Media's representation of terrorism and suicide attacks influence the public in such a degree that it is a major contributing factor in the recruitment of future suicide attackers.

5. CONCLUSION

The researches and literature in the field of suicide terrorism has been dominated by political and social theories. This might be a result of the political and social aspects of suicide terror being thought as more important, or at least more pertinent to counterterrorism than individual aspects. In addition, it might be also a result of information on what motivates an individual to engage in this behaviour being so difficult to obtain. Suicide attackers, after all, operate in secret, they are protected by clandestine groups, and many do not live to tell their stories. However, for scholars there might be an additional concern, which is that any inquire into the psychological or psychiatric aspects of suicide attacks will somehow marginalize or delegitimize the real political and social grievances that are thought to lie at the heart of the phenomenon.

Even though every case of an individual committing a suicide attack can differ as well as the rationale behind it, previous attacks, attackers' statements and evidence, suggest that the influence and impact terrorist organizations and groups have, as well as the individual's social context, can be the key to certain suicide attackers' decision on attacking. However, this new growing field of research comes to challenge the popular and traditional opinion, regarding the reasons behind suicide attacks, stating that the psychology of an individual and genetic traits are also important factors for one's actions. Thus, psychological explanations of suicide attacks should also be considered.

6. FUTURE DIRECTIONS

This emerging evidence and research that argues regarding suicidal ideation and behaviour, playing a role in a number of cases of suicide terrorism, should not be dismissed, even if that number is found to be significantly low. Just because suicidal ideation operates at some level in some cases does not mean that political and social factors do not also operate at other levels or that these levels are not equally important. What is needed, is a more systematic, cross-disciplinary research and cross-national collaboration regarding this phenomenon. Well organized and systematic databases have been beneficial for this field of research, for example the Suicide attack database. These databases can be mined for factual information regarding suicide attacks and incidents, such as, tactics and weapons used, the motivations of the groups or organizations promoting the attacks and where and when they occurred. However, they are not designed to provide insight information on the very personal motivation or the psychopathology and potential suicide tendencies of individuals who turn to suicide attacking. Knowing whether suicide attackers are suicidal is not simply an academic issue. The growing evidence that recruitment occurs among the bereaved, those with disabilities and even mental illness has clinical implications. It also has implications for prevention. If suicidal ideation, intent or planning plays any role in the decision for an individual to become a suicide attacker, even if such individuals might be the minority of suicide attackers in general, that finding could be used in order to possibly design a more proper prevention programme for such vulnerable individuals and possibly future recruits.

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Architectural Cognition Sociology

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ABSTRACT

The aim of this paper is to promote Architectural Sociology keeping cognition in focus. Firstly architecture, cognition and society are considered in their relationships. Secondly associations promoting cognition, its study and extensions of architectural cognitonics are discussed. This all is made in order to form a clear basis to understand architectural action in socio-psychological reality.

General Terms

Design, Experimentation, Human Factors, Management, Performance, Theory

Keywords

Architecture, Certainty, Information Society, Cognition, Cognitonics, Sociology

1. INTRODUCTION

Architecture manifests human creative potentials in culture [Alvar Aalto, 1963 in discussion]. These potentials are evidently cognitive and achieved by talent and education [37, 28]. In this sense Architectural Sociology [33, 5, 26, 27] is the most natural forum to discuss architectural cognition and its role in society. We have the following key questions:

Architecture, cognition, society and cognition

Cognition society, study, cognition sociology extended

Architecture and thinking have the same roots in ordination, which according to Aristotle is central content of thinking [38, p. 25]. Later Vitruv [37, p. 37] adopted the concept of ordination into the constituents of architecture. Cognition is a broader concept than thinking. The common point mentioned gives, however, a good start to discuss the problem. In practical life designers do not think thinking but just think [31]. In theory the notification of this has been emphasized [36]. It is also a commonplace to say that architecture is one of the so many targets of thinking and cognition, but how this happens is a new question. [22]

2. INTRODUCTION TO ARCHITECTURAL COGNITION SOCIOLOGY

2.1 Architectural Cognition

Architecture consists in its relation to cognition of ideas represented in its basic theory [37], like:

Ordination, disposition, harmony (and cognition)

Symmetry, decor, distribution (and cognition)

Architecture is subordinated to the idea of order analogical with cosmic order [42]. We are directed toward world (Brentano) and its architecture. In ideal form this relation is harmonic, but fight for harmony and peace is one possible and important extreme in our attitudes.

Our relation toward world is dually "symmetric", and a lot of similarities exist in supposed reality and mental representations due to the cosmic order [35, 14]. We are interpreting our environments and décor tells about the social content of targets. Finally architecture is distributed and this correspond the most accurate descriptions of it in mind.

Architecture has its cognitive modes discussed in literature [30, 40] Environmental Psychology is a study area discussing cognitive problems also in architecture [10]. More surprising is that cognition has its architecture [23, 24, 25].

Spatial architecture refers both to performances and products and the same holds for cognitive architectures, which have also their mental perfomances and products.

2.2 Cognition

Cognition is studied not only in philosophy but in cognitive psychology as well [41]. How to define it is a problem, but we define it in a relative unproblematic way to consist in relation to architecture of ideas:

Perception, memory, thinking (and architecture)

Abstraction, knowledge, information (and architecture)

Architectural perception does not differ from general one in principle, but in orientations [10]. The role of memory in architecture has been noted, but also problematized [29]. The word "reminescences" has been used in design speech [Aalto, 1968 in discussion] and art history to mean the use of loans from other buildings. Thinking is the key element of cognition in rationalistic architecture [31].

Abstraction [15] has its typical forms both in science but also in art [1, p. 71-]. Knowledge-based approach in architecture [9, 12] has brought architecture closer to KE (Knowledge-Engineering) and AI (Artificial Intelligence). Ideas like Information Society [18, 2] have catalyzed discussion in architecture and its communication [32, 40, 20].

Architects have discussed a lot how to guarantee multi-modal convenience in architecture and prohibit strong reflections or noise [1, p. 37-]. Information on the other hand is the same as the elimination of uncertainty, which has central task in all cognitive faculties above. - Rational skills are the first tools to discuss cognition, but rationality is only a sector in cognition. Covering discussion has to consider belief, knowledge, volition, desire, emotion and skills.

2.3 Societal Cognition

The form and content of human societies separates us from other animals. The secret behind this depends on cognitive potentials (Aristotle > rationem particeps). [28, p- 16-] Societal cognition has its forms, like:

Ecological, communal, technological (cognition)

Economic, cultural, civilization/ -civilized (cognition)

Ecological cognition renders it possible to survive in a world in a sustainable manner. Human world has evolved to be an Antropokosmos [7, p. 251-]. It consists of community societies [8] challenging the human mind to react to social needs and desires in renewing ways. This catalyzes technological evolution based on typical ways of cognition in the same way that architecture does as arche-technology [1].

Humans have developed fiscal ecology called economy, which has its characteristic ways of thinking in good and bad. In normal societal discussion the concept of thinking is most connected to cultural phenomena (above). In culture we may differentiate civilized forms or not of cognition. Crucial question in this evaluation is the dilemma between human or not human [1]. Today it is important to note recent transition toward Information Society [12, p. 20-], Electromediative [21] or "Smart Society"[3].

3. SOME SIGNIFICANT ASPECTS OF ARCHITECTURAL COGNITION SOCIOLOGY

3.1 Cognition Societies

The dispersions of our opinions concerning what is cognition force us to found cognition-associations or mini-societies to promote right ways of thinking [39]. Key ideas to note include:

(Cognition) ecology, community-networks, technology

(Cognition) economy, culture, civilization

Cognition is under constant processes of change. [38] Some ideas are born whereas other die or decade. The only way to fight for cognition promotion is to network locally and globally for professional assertion [39] (> CIAM, [4]). Cognition technology in the form of mnemonics has its long roots and can be connected today to ICT (Information and Communication Technology) [13].

Cognition has its own economy, which can be traced to the ideas of Occam and Mach [11, p. 18-]. In practical level we also know that cognitive tools are targets of exploding business (> Nokia, Microsoft, Apple). The ways how we manage cognition can be called cognition culture, which may reach its civilized forms or not. Today there are a lot of mal-uses of cognitive devices, like in cyber-war, cyber-crime, reckless confusions in digital education etc. Smart societies are from our point of view communo-technological ecosystems utilizing ICT [3].

3.2 Study

Cognition sociological problems can be studied first of all in Cognitonics [6]. From methodological point of view we may separate forms [26, 27], like:

Statistical, empirical, logical cognition-study

Comparative, qualitative, quantitative cognition-study

Statistics is a natural tool to run brain-study in the same way than behavioral approach in sociology. Brain and mind are, however, not identical research targets. Empirical study of mind is a problem and should be re-connected with the idea of internal experience or experiment (Hutcheson). In this sense we need reflective conception-logics and notification of modal and deontic logic. [16]

Cognition is naturally compared as related to variation of content (> Carnap, Hintikka > [17]). These problems can be studied in qualitative [19] or quantitative information theory [20] discussing the elimination of uncertainty in environmentally related action.

Logical study of cognition starts eg from the logic of perception. If some of the cognitive operations above (2.2) hold for target x, and hold for target y, then they hold for target x and y. If cognitive operations hold in the case of target x, then they hold for more general targets like x or y. They either hold or not for x. Then if I perceive a house and I perceive a sauna, (then) I perceive a house and a sauna. If I remember a red door, then I remember (a red or a green door) it is I remember a door. Cognitive operations are thus connected to Propositional (Boolean) Algebras to be represented in Set Theoretical tools in the so called Stone Space (created). [17] In the case of perception we have the situation of standard scientific experiment. It is however well known that in addition to perception experiments we may have remembering, thought, abstraction/ determination, knowledge acquisition and information gathering experiments as well. In fact for example perception experiment is also information gathering experiment per se in eliminating our uncertainty about the target. [20]

3.3 Cognition Sociology Extended

Architectural Cognition Sociology has its key target in society. The complex problem means that it is natural to enlarge the study to dimensions, like:

Sociality, society, state (and cognition)

Function, work, politics (and cognition)

The study of cognition starts from personality [24]. Personality is built, however, on collective achievements. [1, p. 92-93] Society is the primary growth environment for us. State however gives still mainly the rules for societies. In this sense it is natural to speak about Finnish or Scandinavian design and so on. The situation is however changing and we have lost Regional ideas [1] on the altar of not only International Style but also of Global often speculative forces.

Architecture refers only seldom to global problems of Mankind in war and peace. The normal level of thinking in architecture is functional. [39, 42, 4] In this sense we have to recognize sacral, public, work, free-time, private and profane tasks and challenges to be solved with our creative potentials (above). Work has its special status. Design is work and design for work is decisive because success in it catalyzes success in general [34]. In this sense politics and work politics have decisive role in directing human potentials to right targets. According to Aristotle the best politics in Politeia picks people to realize their own talents and skills achieved by education.

4. CONCLUSIONS

We have shown what Architectural Cognition Sociology is in its big picture. Society is the basic unit to consider interaction of architecture and societal activities. This concern can be deepened to personal aspects of cognition and toward global problem formulations. The main field of application of the theory lies on the side of Information, Electromediative and Smart Societies.

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Goals of Cognitonics in Formal ICT Education

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ABSTRACT

Cognitonics is a scientific discipline of the newer date developed with the aim of studying the human being in the digital world. The aim of this study is to evaluate the realization of Cognitonics' goals within IT subjects in Croatian primary education. The work will serve as a starting point for further research of the implementation of Cognitonics' goals within IT subjects in elementary education.

Categories and Subject Descriptors

K. Computing Milieux: K.3 Computers and education: K.3.0 General, K.3.1 Computer Uses in Education, K.3.2 Computer and Information Science Education.

General Terms

Management, Measurement, Documentation, Performance, Design, Reliability, Experimentation, Human Factors, Standardization, Theory.

Keywords

Cognitonics, ICT, ICT education.

1. INTRODUCTION

Cognitonics is a scientific discipline of the newer date developed with the aim of studying the human being in the digital world. It is based on research results that point to the gap between intellectual and spiritual development of individuals in a modern information society under the influence of rapid technological progress, ICT (Information and Communications Technology) development and globalization.

One of the goals of Cognitonics is to determine which are the optimal age and the cognitive preconditions that a person must possess for getting acquainted with ICT in order to reduce the gap that affects the integrity of human nature, i.e. the harmonious development of a person. Furthermore, the goal of Cognitonics is to create theoretical basis that will enable development of different systems within ICT. These systems must have a positive impact on development of individual's creativity, its sense of harmony and beauty, awareness of belonging to a particular national culture, a positive impact on the development of individual language skills, ethical behaviour, self-regulation and other values that represent some of the principles of Cognitonics. The application of these principles should be encouraged for the purpose of harmonious and complete, correct development of individuals.

The aim of this research is to evaluate the realization of Cognitonics' goals within IT subjects in Croatian primary

education and to point out the changes that should be made for quality and harmonious intellectual and spiritual development of an individual.

2. ICT in Education Systems

Today it is necessary to supply schools with multimedia equipment, connect them to the Internet, and train teachers to work with this technology. It can be done by encouraging schools to be more proactive, to accept new ideas and to adopt and implement the changing goals of society. By integrating ICT, the tools for work as well as educational contents are changed, i.e. the complete educational environment is changed. According to Bearden [1], the goal is to change traditional concept of classroom teaching, to integrate technology into education, and to create a space open to demands of society, with the aim of building a sense of belonging to society in order to achieve a smart, sustainable and inclusive growth of an individual. In the research conducted in Italy [1], the teacher's view is that the use of ICT within the education system affects the development of group work ability and represents a cognitive learning resource that enables development of more complex and richer thoughts among individuals.

Today, there are a number of educational contents in digital form. Teacher is the one to choose the form in accordance with educational needs of students and characteristics of educational content. Besides that, appropriately chosen technology and content can be a motivating factor for encouraging and maintaining interest in both teaching and learning.

The use of ICT in education has a number of advantages over the traditional way of education: accessibility, mobility, interactivity, lower price, distance learning, etc.

Additionally, digital learning materials can be easily updated and / or altered with new ones, which is essential in today's rapidly changing educational environment.

Many studies point to the benefit of using ICT as a teaching and learning tool within teaching. Using it, students are able to change the way they access information, collect them, analyze them, present them, etc. It also enables them to develop the skills of socialization, creativity and cooperation skills. In this way students show interest and satisfaction, and learning is transformed from static to dynamic situation.

3. Cognitonics and Emotional-Imaginative Teaching System

The traditional education system in Croatia was focused on content, not on an individual; on results, not on the process of acquiring knowledge and skills; on shaping an individual according to existing social patterns, not on creating conditions for development of his/her creative potential. The main goal of the education system should not be to absorb large amounts of different information, but to develop the logical and creative abilities of individuals as well as to develop their ability to change existing situations.

According to Fomichova and Fomichov [3], the main social function of education is reproduction of culture. Their approach to solving educational problems is in line with the constructivist theory which states that knowledge is not only transmitted by a teacher to a student but it is built into the mind of students during the process of active learning. That is why the educational process should be based, among other things, on the principles of Cognitonics. The goals of cultural enrichment, the development of cognitive mechanisms and intellectual and spiritual development of child must be jointly incorporated into contemporary educational processes in order to enhance the child's ability to properly process all information.

In the 1990s, Olga Fomichova created the Emotional-Imaginative Teaching System (EIT - system), which became one of the principal preconditions of developing in the 2000s (together with Vladimir Fomichov) the foundations of Cognitonics.

According to Fomichov and Fomichova [4], the aforementioned system aims at developing in individual: ability to process symbolic information; ability to observe and appreciate beauty in all its appearances, particularly in human activity; ability to understand others; understanding of so-called social agreement and social relationships; ability to have one's own point of view; sense of belonging to the generation as well as the understanding of those generations that were before and those that will develop later; and awareness of belonging to a particular national culture. In other words, this system aims to introduce a social, human component into education and can be perfectly integrated into goals of Cognitonics for the use of ICT.

Related to this, Micarelli and Pizziolo [5] mention the fact that today's younger generation under the influence of modern ICT is increasingly deprived of perceptual experiences arising from the social environment in which they live. They remain deprived of direct and spontaneous social relationships, and these are replaced by superficial, virtual interaction. Authors believe that traditional education systems are not able to close this trend, which suggests that certain changes are certainly needed to create new ways of teaching and learning. They argue that it is necessary to teach the children of a modern information communication age to discover and interact with their living environment and recognize themselves as the integral and active part of that environment. In other words, it is necessary to encourage a sense of belonging and social awareness and sensitivity. In addition, it is necessary to harmonize the impact of virtual and real-world environment, as well as to enable their merging to achieve an extended life environment. Micarelli, Pizziolo et al. [6] claim that the virtual environment seeks to replace the real world by imitating it, endangering the social component of individual life. One of the ways that authors [5] emphasize, as being successful in creating an individual's connection to their environment, is the pursuit of activities that allow friendly engagement, spontaneous conversations, social awareness, and real connectivity with their surroundings, all accompanied by a pleasant atmosphere. In this way, an individual can once again discover the possibility of respecting and associating with his/her own living environment.

The main driving force of each society of knowledge is a creative class that encourages development of: creativity, the desire to be useful to society, the ability of social co-operation and a deep sense of social responsibility.

Additionally, in order to develop intellectual and emotional spheres of students harmoniously, emotions need to be taken into account. In order to equally develop student's intellectual and emotional sphere in the classroom, it is necessary to take into account what incentives are needed for their development. There is, for example, thought about music or any other type of art that promotes the development of emotions. For art it can be said that it is representation of emotional experience which is achieved by experiencing a particular work of art. Besides emotions, there is a need to develop the ability of empathy, sympathy, and emotionality in students.

4. Cognitive Psychology and Informatics

Cognitive psychology was developed in Great Britain in the fifties and sixties of the 20th century under the influence of various disciplines (neuroscience, linguistics, anthropology, philosophy, etc.) including computer science. Technological development has influenced the way that human psyche began to be perceived, so the development of ICT has led to the use of IT terms in the sphere of psychology (for example, a sentence: the human brain has limited *capacity* for processing information). Besides that, cognitive psychology studies how human mind works using computer tools and methods. Cognitive psychology, as well as Cognitonics, studies how computers can be best used to help an individual in his/her work, with the aim of harmonious development of his/her emotional and rational sphere. On the other hand, psychological knowledge can be a very useful tool in developing ICT, which enables communication of the individual (user) with the mentioned technology. Psychological optimization will probably become one of the important factors in the development of user interfaces for computer systems that will stimulate the achievement of goals of Cognitonics as a newer scientific discipline.

5. Cognitonics and eLearning

Today's use of the online education environment is increasingly frequent.. In order to make the use of eLearning successful, it is necessary to offer to individual high quality of educational experience. In order to achieve this, it is necessary to have a wellmade training course adjustable to student needs and capabilities. This can be achieved with a well-developed system for evaluation of student achievement. With this system, a student can be provided with a more personalized learning experience.

Since it is, in today's information communication era, more and more common the use of eLearning, which is carried out within the various educational programs, it is necessary to, at all times, respect the goals of Cognitonics in order to achieve desired results in the development of individual (student). One of the items that must be taken into account when organizing and conducting eLearning is the culture and cultural heritage of the society within which such a form of learning is implemented [7]. In addition, there are many items in each individual participant of such programs that must be taken into account in order to meet the goals that are being set up by eLearning. Some of them are: the language in which the program is being conducted (level of knowledge of the language, the competence of its use), the necessary foreknowledge of the participant, his/her material status, religious orientation, cultural and social background, sense of beauty, etc. All these are important parts that need to be carefully considered during design of an eLearning program, so they could be indeed adapted to an individual enabling the

harmonious development of his/her intellectual and emotional sphere.

In accordance with this, Burdescu et al. [2] note that classification is one of the main algorithms that must be used when implementing eLearning. It provides the possibility of detecting potential groups of participants of similar characteristics and similar responses to the offered learning strategy. Furthermore, the authors believe that the use of classification: increases the learning ability of students; allows the grouping of students who are faced with a failure to help them improve their skills; identifies participants with low motivation, and similar. The aim of the use of classification is to increase the effectiveness of the online education process, which is one of the biggest challenges of the information society. For this purpose, the authors created a structure for the classification of the participants, based on their final grades. That has been achieved by using certain algorithms and procedures for classifying every student.

In order to improve the communication between professors and participants of eLearning program, new tools are developed, which contain intelligent data analysis techniques (for analysing the text itself and the feedback that students send). In addition, it is necessary to develop tools that will be able to analyze the cognitive development areas of students with the aim of enabling teachers to develop precise mental models of each student's abilities. Within regular education systems, teachers achieve that by a constant face-to-face interaction with students, which enables them to recognize both learning abilities and individual developmental abilities. It is much more difficult to achieve that online. The aim is to develop tools to monitor the activity of each individual student so that teachers can understand and analyze their behaviours and actions to improve their skills and experience while attending online education programs [8].

6. Research about implementation of goals of Cognitonics when introducing students into the spheres of ICT

The aim of the research is to determine the extent to which informatics teaching in elementary schools in the Republic of Croatia is conducted in accordance with the goals of Cognitonics. In other words, the aim is to analyze the existing situation by investigating how far the Cognitonic goals are being pursued during the introduction of an individual into the sphere of ICT. Research will also help to understand when the children are first encountered with formal IT education.

The research was conducted by an anonymous survey that was distributed online to the student (academic) population. It should be emphasized that this was a non-probabilistic sample of volunteers. A sample of this age group was selected because it is considered that respondents can reasonably, accountable and comprehensively approach reflection during filling in the questionnaire. In addition, the respondents were able to see, with a certain time lag, the situation in which they were in the first formal meetings with ICT.

For the purpose of the research, it was used a survey questionnaire with closed questions and with the obligation to answer each question. Survey respondents were voluntary and anonymous. The survey was distributed through the web site www.inovacije.eu, which aims to conduct online research. When analyzing the results of the survey, descriptive statistical data analysis was used.

With this survey and analysis of its results we want to gather data and explore whether and to what extent are the goals of Cognitonics represented in formal elementary informatics education in the Republic of Croatia. This will give a clear picture of the current situation regarding Cognitonics. This research has not yet been carried out in Croatia, and can be included under primary research with regard to the type of data being collected. Given the type of data being studied and considering the goals, this will be a theoretical descriptive statistical study.

6.1 Survey questions

1. Gender?

- 2. Year of birth?
- 3. Do you have daily access to the computer and the Internet?

4. For what purpose do you use the computer and the Internet most frequently?

- 5. How often do you use the computer and the Internet?
- 6. How old were you when you started using the computer?
- 7. How old were you when you started using the Internet?
- 8. Do you feel like a computer literate person?

9. When did you start with formal (organized) education in the field of information technology?

10. Have you been encouraged to use ICT for educational purposes during elementary school education?

11. Do you think that at the beginning of the organized (formal) attendance of IT education you have been introduced into its spheres so that ICT: has become a tool that has expanded / enriched your creative way of thinking; has became a tool that guided you / determined your way of thinking?

12. During the use of ICT that was available to you in your classes, professors supported / encouraged the development of your: personality; creativity; cognitive sphere; emotional sphere; awareness of national affiliation and national culture; language skills; communication skills; ability to cooperate; ability of independent thinking; ability to prepare for real situations; ability to make your own decisions; analytical abilities; learning abilities; ability to learn from mistakes; Did not encourage any development; I do not know.

13. At the beginning of your formal (organized) IT education was it accentuated to you what kind of behaviour is expected of you in the information environment, and what kind of behaviour is strictly forbidden?

14. Do you believe that the Internet, at the beginning of your formal education, has influenced your cultural identity (an identity that speaks to which culture you belong)?

15. Do you feel that during formal (organized) IT education you have been encouraged to appreciate traditional values (family, religion, awareness of national affiliation ...) regardless of the fact that Internet allows globalization?

16. Do you believe that the use of ICT generally encourages in you the acceptance of traditional or commercial values?

17. During your beginning of formal IT education, by using ICT you were encouraged to: develop awareness of the values of the national culture to which you belong; develop the need for globalization instead of belonging to a single national culture; I do not know.

18. When using ICT during the beginnings of your formal IT education it was stimulated your: spiritual development; intellectual development; equally intellectual and spiritual development; I do not know.

19. When using information technology for communication, do you pay attention to the grammatical accuracy of your language expression?

20. Each of us has its own value system in life. The use of ICT in formal education encouraged you to follow which value system subjects?

21. How do you react to any negative situation you face on the Internet?

22. How much are you affected by the information you are encountering on the Internet?

23. With other people you usually associate: virtual; live; equally virtual and live; I do not know.

24. Where do you feel better: in virtual reality, in real life, or equally?

25. Do you think there is a difference between "face to face" communication and communication by using ICT?

26. Do you feel that you belong to the social community within which you live?

27. Have you ever used ICT for any wrong purpose?

28. Do you think that using ICT encourages tolerance, dialogue, and respect for others?

29. Does the use of ICT affect you positively or negatively?

30. Were you, during the formal education, warned on the negative consequences of using ICT for the wrong purpose?

7. EXPLANATION OF RESULTS INSTEAD OF CONCLUSION

The results of the survey analysis show that there was an equal number of female (50.94%) and male (49.06%) respondents. The sample with which the analysis was made consisted of 53 examinees. The oldest respondent was born in 1969, the youngest in 1998, and it was a student (academic) population. All respondents (100.00%) have daily access to the computer and the Internet. As far as information literacy is concerned, most respondents (92.45%) are considered themselves literate. Two respondents (3.77%) did not know and two of them (3.77%) responded nor yes nor no. When stating what is the most common purpose of using computer and Internet, the majority of respondents placed communication (28.30%) and entertainment / gaming (20.75%) in the first place, which shows that it is a younger population. In the second place, most of the respondents put informing (30.19%) and fulfilment of faculty obligations (20.75%). In the third place, it was again the fulfilment of the faculty obligations (24.53%). On fourth place, the majority of respondents put equally learning and informing (20.75%). In the fifth place, most of the respondents put again learning (24.53%). Considering the population of the respondents, it would be expected that *learning* would be at a higher priority ranking place. At the second last place most of the respondents put the purchase (35.85%) and the work / fulfilment of the business obligations (24.53%). The same is the last place: purchase (41.51%) and work / fulfilment of the business obligations (30.19%). The last two places are again an obvious indicator that respondents who have completed the survey belong to the student population.

When answering how frequently are using the computer and the Internet most respondents (98.11%) responded several times a day, and only one respondent (1.89%) responded several times a week. More than half of the respondents started using computers between 6 and 10 years of life (50.94%), and the Internet between 11 and 14 (56.60%), which points to the need and importance of implementing Cognitonics' goals into ICT education already in elementary school. According to the answers to the previous question, most respondents (43.40%) started with formal IT education in higher grades of elementary school. Nonetheless, more than half of the respondents (54.72%) answered that during primary education they were not encouraged to use ICT for educational purposes. Positive side points out that almost half of the respondents (49.06%) said that at the beginning of their formal IT education, ICT became a tool that expanded / enriched their creative way of thinking. More than half of the respondents stated

that the professors used to support / encourage the development of their: communication skills (52.83%), co-operation skills (50.94%), self-reflection skills (52.83%) and learning abilities (50.94%) during the use of ICT in teaching. A little less than half of the respondents stated that the professors used to support / encourage the development of their creativity (49.06%), analytical skills (41.51%), and the ability to learn from mistakes (45.28%). What indicates insufficient presence of goals of Cognitonics in teaching is the statement of less than one third of respondents that during the use of ICT in teaching professors supported development of their cognitive sphere (24.53%), language skills (22.64%), ability to prepare for real situations (28.30 %) and the ability to make their own decisions (26.42%). It is worrying that 20.75% of respondents stated that there was not encouragement of any development in them. Likewise, only 16.98% of the respondents state that during the use of ICT in teaching, it was stimulated the development of their personality. The development of the emotional sphere (1.89%) and awareness of national affiliation and national culture (7.55%) are completely neglected.

It is interesting to note that the same number of respondents (43.40%) stated that they were accentuated, and were not accentuated at the beginning of their formal (organized) IT education what kind of behaviour is expected of them in the information environment, and what behaviour is strictly forbidden, while 13.21% of them do not know the answer to this question. As far as *cultural identity* is concerned, more than half of respondents (64.15%) stated that the Internet, at the beginning of their formal education, had no impact on their identity which tells them to which culture they belong to. Among the respondents, 43.40% stated that during formal ICT education they were not encouraged to value traditional values such as family, religion, previously mentioned nationality and similar, while 39.62% stated that they were encouraged. On the other hand, when they had to choose whether ICT use generally encouraged them to respect traditional or commercial values, 35.85% said it was commercial and only 1.89% said it was traditional values, while 30.19% of respondents considered that the representation of values is the same. Almost half of the respondents (49.06%) stated that during formal IT education they were encouraged to develop the need for globalization instead of belonging to a single national culture, 39.62% did not know, and only 11.32% stated that they were encouraged to develop awareness about the values of the national culture they belong to. More than half of the respondents (67.92%) stated that at the beginning of their formal IT education, it was stimulated their intellectual development, only one respondent (1.89%) stated spiritual development, and 22.64% stated the same amount of intellectual and spiritual development. In any case, it is too little to argue about how successful goals of Cognitonics are pursued during elementary school education. Interestingly, more than half of respondents (52.83%) stated that when using ICT for communication they pay attention to the grammatical accuracy of their language expression only when they consider it necessary, less than half of the respondents (45.28%) stated that they pay attention always, and only one of the respondents (1.89%) stated that he does not pay attention. Respondents stated that, during the use of ICT in formal education, they were stimulated to grow the feeling for the following elements of their value system in the following percentages: career 49.06%, friendship 41.51%, social responsibility 39.62%, decency 35.85%, tolerance to differences 35.85%, sincerity 30.19%, honesty 30.19%, family 20.75%, trust 18.87%, love 15.09%, religion 5.66%, and patriotism 3.77%. As

for the negative situations encountered over the Internet, most respondents (45.28%) stop and think before allowing the negative situation to affect them, 24.53% do not respond to negative situations, 20.75% respond to the first impression, 7.55% do not encounter situations that negatively affect them, and one respondent (1.89%) does not know. When respondents were asked to what extent they are affected with the information they encounter over the Internet, most of them (75.47%) stated that they are affected to the extent to which they feel that this information is accurate. 20.75% responded that they are not affected, one respondent (1.89%) answered that he is fully affected, and one respondent (1.89%) did not know. Less than half of the respondents (41.51%) believe that ICT use encourages them to tolerance, dialogue and respect for the other, 30.19% argued that this is not the case, and even 28.30% do not know.

Half of the respondents (50.94%) stated that they usually associate with other people *in person*, 45.28% of them communicate *equally virtual and live*, and only 3.77% communicate only *virtually*. Accordingly, 62.26% of respondents stated that they *feel better in real life*, 26.42% stated that they *feel equally good in virtual reality and in real life*, and 9.43% respondents responded that they *feel better in virtual reality*. Regardless, all respondents (100.00%) are aware that *there is a difference between "face to face" communication and communication using ICT*. More than half of the respondents (62.26%) stated that they feel *they belong to the social community they live in*, 24.53% feel *they do not belong* and 13.21% *do not know*.

It is worrying that almost half of the respondents (49.06%) stated that they used ICT for some wrong purposes. 39.62% responded that they were not, and 11.32% did not know. Probably this is the reason why 41.51% of the respondents believe that ICT affects them both positively or negatively, one third (32.08%) considers that it affects them positively, 20.75% stated neither positive nor negative, 3.77% stated it affects them negatively, while one respondent (1.89%) does not know. In the end, the respondents were asked if they were warned during formal education on the negative consequences of using ICT for the wrong purposes. 60.38% of the respondents stated yes, 2.53% stated no, and 15.09% did not remember.

In the next paper, we will deal with a more detailed analysis of the collected data and with making more conclusions related to them.

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Serendipity as a Design Principle for Social Media

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ABSTRACT

Personalization of content in social media fundamental to restrain information overload and satisfy Internet users. Yet, overpersonalization creates filter bubbles and strengthens echo chambers. Thus, it also restrains exposure to diversity of information. This represents a fundamental issue for media law and ethics which attempts to maintain pluralism in democratic societies. As a result, individuals reduce their informational empowerment and societies become more politically polarized. This short paper discusses the potentials of serendipity as an alternative design principle. Serendipity is indeed a complex phenomenon that can be considered as a capability of seeking and processing unexpected and valuable information. As a precondition, it requires novel and diverse information. As outcome, it causes cognitive diversity. Therefore, serendipity is able to encompass relevant phases of production and consumption of information, representing a positive freedom valuable from an epistemological, educational and even political perspective. The research exposes an emerging theoretical trade-off in information filtering between relevance and serendipity (or unexpected relevance) that might be tackled with serendipity-driven recommender systems and specific design choices.

General Terms

Algorithms, Design, Theory, Experimentation

Keywords

Filter bubbles, Personalization, Ethics, Serendipity

1. INTRODUCTION

Internet is very serendipitous. Every day Internet users can discover plenty of unexpected and valuable informationthat can change their current task, their own beliefs, or even their life. Hyperlinked digital environments are a fertile ground for serendipity [1]. Even social media, where users increasingly spend most of their online time, is a powerful source of coming across information serendipitously [2]. Of course, serendipity is often an implicit design goal. Yet, the Internet can be ever more serendipitous.In the past, in fact, any procedure to select information recognized and sought to solve in a beneficial manner the ideal tension between *relevance* - what a reader wants - and serendipity - what a reader may want (or "unknown relevance"). In the digital environment, this balance inevitably shifted from serendipity to relevance [3]. Actually, already back in 1997 it was warned "the end of serendipity" [4]. Theoretical basis for the necessity to defend randomness from processes for search and discovery have also been proposed [5]. In fact, aside from natural human proclivities such as selective exposure, confirmation bias and homophily, information discovery is actually limited by overpersonalization of online content, especially in social media.

Information filtering and design choices can indeed fuel filter bubbles and echo chambers, two sides of the same token. Generally, the first refers to the situation in which a user continue to see, listen and read what reinforces their opinions and interests. The latter refers to a group situation where information, ideas, and beliefs are uncritically spread and amplified, whereas dissenting views are ignored. The risks of this phenomenon have been well discussed [6, 7, 8]. In theory, it raises serious concerns both on the individual and collective levels. Individual, because these filters might reduce opportunities for users to self-determine, by reducing the exposure to alternative points of view and serendipitous discovery. The consequences may be various: from the limitation of personal creativity to a reduction in the ability to build productive social capital. Collective, because by fuelling political polarization, media pluralism may be weakened and make people more vulnerable to censorship and propaganda, or, better, to self-censorship and self-propaganda. Furthermore, another prominent risk is growing inequality. Indeed, a certain privileged group of users that have enough (digital) literacy would be able to reach a good balance between relevance and serendipity, and a larger group of users would risk to be exposed only to a minimum, qualitatively inferior range of information. In practice, the risks of over-personalization are very hard to prove. In fact, most research is often inconsistent and inconclusive because they are generally survey-based, and thus dependent on self-reporting, or based on a small or unsatisfactory sample. Also, in the light of the rapidly changing media landscape, many studies become quickly out-dated [8]. The question, then, is not whether filter bubbles and echo chambers exist because there is plenty of evidence of their existence. Instead, four key issues persist: to what extent filter bubbles and echo chambers are actually detrimental, to what extent are social media complicit in their growth, whether they should be the target of a policy focus and, eventually, what kind of intervention might be pursued.

This short paper presents the idea that the phenomenon of serendipity is able to encompass fundamental phases of production and consumption of information, and to re-balance the emerging trade-off between relevance and unknown relevance. Indeed, serendipity needs information diversity as a precondition to occur, and it also sustains "cognitive diversity" [9]. These, in fact, are fundamental media policy goals.

Before advocating serendipity as an alternative design principle for social media, the information filtering landscape it will be firstly analyzed to argue that over-personalization can become very detrimental and that social media are complicit and responsible for its risks. Secondly, the concept of information diversity from a media law and ethics perspective it will be briefly introduced to present the current debate. Finally, what is intended with serendipity, and why it is so valuable, will be defined. Besides, potential design choices for supporting serendipity in social media will be proposed.

2. INFORMATION FILTERING

By bridging the gap between demand and supply in an ocean of information, personalization performs a fundamental role of knowledge management by limiting information overload. Generally, it can be explicit and implicit; the first makes use of user requests, while the latter is mainly based on monitored user activity. Both forms of personalization have increased dramatically in the last years, though many websites have acted to make passive forms of personalization the fastest growing forms[3].Of course, its invisibility makes it dangerous because nobody decided consciously to enter into such an "informational bubble", whereas many others simply ignore that they are already living in it. In fact, users embrace and enjoy automatically generated personalized recommendations. For most of them, algorithms are not doing anything wrong cause they recommend impartially [10]. However, there is no objectivity in the realm of filtering and personalization. Indeed, algorithms are using supplied criteria to determine what is "relevant", though these biases are not generally recognized. Rather, users do not have much influence on the recommendation process, apart from providing implicit or explicit ratings for items, usually in the longterm use of the system. Many argue to design recommender systems from a user-centric perspective. A lack of transparency, interactivity and control, in fact, prevents users from comprehending why certain items are suggested and, as a result, creates a reduced trust in the system. Nevertheless, most of the users have no awareness, skills and motivations to opt-out - in particular due to the network effect - so they are "locked-in" in such over-personalized social media.

Even though social media becoming our being-in-the-world, interests of social media companies conflict with the opportunities that social networks entail. Their policies and profit-driven models negatively affect the externalities of personalization. Facebook, in particular, offers many ways for personalizing, whereas it does not provide any clear tools or afford ancestor "depersonalize". Newsfeed algorithm attempts to nudge users' comfort zone by satisfying their interests, homophilic attitudes and hedonism, without taking into serious consideration the importance of diversity, of the dynamicity of users' identities, and of personal discovery. Instead, information intermediaries might actually increase users' engagement, and thus the profit, by triggering unconscious addictive rituals. Techniques like gamification and "captology" (computers as persuasive technologies), a study at the intersection of computer science and psychology, are more and more widespread and exploited [11].

Furthermore, future advances in artificial intelligence, machine learning, and the semantic web have the potential to enable algorithms to make ever more sophisticated recommendations, while virtual reality, augmented reality and the Internet of things will definitely blur the distinction between online and offline. As Pedro Domingos [12] argues, tomorrow's cyberspace will be a vast parallel world that selects only the most promising information to try out in the real one and it will be like "a new, global subconscious, the collective id of the human race". These main trends are increasingly evident. Thus, it is becoming imperative to employ an ethical mediator in influencing media users and information intermediaries appropriately. Is it possible, then, to find a good balance between human and computer agency, and between individuals' and corporate rights? Is it also possible to ground a methodological framework based on an encompassing principle that is able to provide users with the necessary agency to autonomously and effectively deal with the first trade-off by balancing the latter?

3. INFORMATION DIVERSITY

Media pluralism is considered a fundamental goal of national and European media policies. Media policy, especially in Europe, has aimed mainly at organizing the supply-side of pluralism through various sources that focus on content diversity [13]. Internet, however, constituted a significant challenge to established media policies and the role of public service media. With large media providers no longer serving a gate keeping function, the diversity of individual exposure turned on the choices of users and algorithms. As a reaction to such new media environment, the notion of "diversity exposure "increasingly received attention as both a media policy objective and a challenge to the legitimacy of public service media [14]. Mere exposure of consumers to various sources and content, however, is not sufficient to ensure actual experience of media diversity. Therefore, a thorough analysis of media diversity in the digital age must also consider the cognitive and affective factors that drive Internet users, and ultimately actual "diversity experience". Of course, its normative evaluation is a lot more complex than the traditional policies. Yet, media law debates could employ a user-centric perspective and thereby extend beyond the assumption that supply diversity equals diversity experience[15]. From a theoretical perspective, in fact, all the models of democracy consider the consequences of filter bubbles problematic for particularly different reasons [16].

The main rationale of any policy proposal is that development of accurate beliefs requires diversity experience. It has been already argued, indeed, that in an age of user-driven pluralism, public service media could find new legitimacy in facilitating user experiences of diversity and creating encounters with challenging and, eventually, serendipitous content [13],so as to tackle filter bubbles [16].Arguments in support of serendipity as a design principle for media ethics will be now briefly introduced.

4. DESIGNING FOR SERENDIPITY

Serendipity plays a relevant and often undervalued role in our everyday life. It is the art of discovering new things by observing, and learning from unexpected situations. It can be defined as "an unexpected experience prompted by an individual's valuable interaction with ideas, information, objects, or phenomena" [17]. The ability to extract knowledge from an unexpected event covers all areas of human activity, including business, law, politics and, particularly, science. According to Robert K. Merton [1] serendipity is the "happy accident" inherent in scientific research, one of the main forces that has steered the progress of science. Indeed, its role in epistemology of science is well established [19]. Such discoveries can be perceived as accidentals but not necessarily unplanned or the result of fortuity. Contrary to vulgar interpretations, more often serendipity is the result of groundwork, observation, and knowledge. As Louis Pasteur once famously said [1]: "in the field of observation, chance favours only the prepared mind." Thus, serendipity is a capability [18].

Serendipity helps us to innovate and to be creative, leading us to the emergence of a theory, a law or perhaps simply revise an opinion. In fact, serendipity has been considered as a fundamental experience to maintain creativity in the computer era [20]. Also, it usually manifests among interdisciplinary scholars [19]. Being strictly related to abductive reasoning and the innovative learning theory of "connectivism" [21], it represents a powerful mode of tackling the challenges of the information era [22]. Hence, serendipity is a valuable experience also from an educational perspective [23]. Such pursuit can also be intended as a *positive freedom* against algorithmic power. In fact, designing for serendipity would imply a change in the asymmetric power to favour the agency of final users. Hence, it could also represent a fundamental political struggle. It has, indeed, the potential also to stimulate the *algorithmic imaginary* of users.

4.1 SERENDIPITY BY DESIGN

Programming for serendipity might sound like an oxymoron. It is, in fact, a subjective and unexpected phenomenon. Indeed, serendipity cannot be created on demand. Though, it can be cultivated by creating opportunities for it through the design of physical, digital, and learning environments [24]. Similarly to other analogous proposals to expose users to different media, such as "diversity by design" [14], "serendipity by design" is the idea that it is possible to mitigate the influence and improper bias of personalization by creating an architecture that gives people powerful incentives to seek and encounter alternative information and, ultimately, experience more serendipitous insights [25]. From a user-perspective, there are two main information behaviours for seeking, encounter and experience serendipity: non-purposive or passive and purposive or active [26]. These will be briefly analysed in the following sub-chapters.

4.2 SERENDIPITOUS FILTERING

The primary goal of recommender systems (RSs) is to provide personalized recommendations so as to improve the satisfaction of users. Many studies showed that RSs are moving beyond accuracy and embracing serendipity [27]. Indeed, when serendipitous encounters are successfully implemented by intersecting users' interests, it is possible to avoid predictable recommendations in collaborative filtering systems, and solve the over-specification problems in content-based systems while also helping users reveal their unexpected interests. Yet, most of the current recommender systems have been criticized for not sufficiently account for serendipity [28]. Studies also show that users are willing to sacrifice some amount of accuracy for improved serendipity in the algorithms filter performance [29]. Though, increasing serendipity might negatively impact accuracy. In some cases, RSs metrics such as novelty, diversity and serendipity can also be improved simultaneously, without any apparent trade-off. A question, therefore, arises: does accuracy as a major metric naturally leads to more profits for social media companies rather than serendipity-driven RSs? In other words, it seems that very accurate personalization increases the engagement of users in the short-run more than might occur with serendipity-driven RSs. Arguably, this is a theoretical trade-off that can emerge in knowledge management (see table 1).

Table 1. A Theoretical Trade-off in Recommender Systems.

PLATFORM	VALUES	EXPLICIT GOAL	LATENT GOAL	TENDENCY
Business Social Media	Relevance and Accuracy	Engagement (Short-term Gratification)	Profit	Determinism
Alternative Social Media	Diversity and Screndipity	Unexpected discoveries (Long-term Satisfaction)	Individual and Social fulfilment	Chance and Randomness

Currently, there is no consensus on the definition of serendipity in RSs [24]. The two core characteristics of serendipity embedded in RSs, however, are usually unexpectedness and usefulness[27]. Thus, serendipity also implicitly builds upon the concepts of diversity and unfamiliarity. This is certainly relevant in the context of media policy attempts to cultivate information diversity experience. Serendipity, in fact, can encompass all these metrics: a user is surprised by a novel, unexpected (thus mostly diverse) and useful information. Of course, optimizing current RSs for more serendipitous recommendations is not a trivial task.Programming for serendipity, however, is indeed possible. Notably, Campos and Figueiredo patented the "serendipity equations"[30] and codedan information retrieval software that reached the level of 52.7% of (pseudo)serendipitous suggestions [31]. Interestingly, they also offered a granular approach to the question of assessing serendipitous findings and encountering: by dividing user results into distinct categories, according to their possible outcomes. By opening space for similar granularity it is possible to expand and encompass a wide range of results that can be considered serendipitously valuable. In fact, under the general commitment to serendipity there are other concepts related to information seeking and encountering; for instance, opportunistic acquisition of information; pseudo-serendipity; micro-serendipity; accidental discovery of information, etc.. Designing for serendipity would indeed mean to aim to cultivate all of these indirectly, and directly serendipity par excellence.

4.3 SERENDIPITOUS ENVIRONMENT

Aside from non-purposive information behavior, it is possible to cultivate a serendipitous environment for active seeking [24, 32]. Firstly, it is possible to design several features that empower users, extract value meaningfully from their profiles, to illustrate connections, and to stimulate creative and serendipitous associations. For instance, the visualization design developed by Nagulendra and Vassileva [32] displays to users their filter bubbles, showing them which categories and friends are in their bubble and which ones are not, allowing them to control the algorithm by manipulating the visualization to escape the bubble, by adding or removing friends on a certain topic to the filters. The results are promising: 72 % of participants said that it was easy to find an interest which was not inside their filter bubble, so that they were able to "discover new interests that they didn't display otherwise in their behaviour." Also, other visualization tools have been developed to make users aware of their information diet, their potential narrowness of choice, in order to seek serendipity, including Bobble, Balancer, Scoopinion or EscapeYourBubble. Some of these plug-ins could be implemented by default in social media

Secondly, another fundamental possibility to cultivate a serendipitous environment would occur with *multiple filtering*. In fact, in mainstream media there is no possibility to have more than one filtering per profile. As Facebook chief Mark Zuckerberg remarks: "having two identities for yourself is an example of a lack of integrity". However, identity is dynamic, and one may want (and need) to seek different information at a different time with multiple filtering. Indeed, many factors, such as weather, mood or location, can influence user preferences for recommended items. Changing such design choice could increase user resiliency in seeking more serendipitous information by subtracting from the determined path offered by personalization.

Certainly, there is plenty of potential design choices to improve serendipity [25]. Also, the assessment of perceived serendipity is one the most problematic issue to focus on. Foremost, it is needed an objective theoretical and methodological framework to assess serendipity. Some measures have already been experimented [24, 26], and alternative ones can be framed [25]. Yet, many technical challenges persist, considering how it is hard to prospect a onesize-fits-all framework for all mainstream social media. This, however, represents the ideal purpose that the paper advocates.

5. CONCLUSIONS

Serendipity is a fundamental and profoundly valuable experience for individuals and information societies. On the one hand, designing for serendipity increases the diversity of information. On the other hand, educating for serendipity increases "cognitive diversity".Of course, more often, serendipity is an implicit goal for designers, though it can be explicated for its inherently positive value. In the case of social media, design for serendipity would meanto find a right balance between personalization and "serendipitous generalization", between determinism and chance. It is their dynamic relation that can actually sustain a healthier infosphere. Such design approach can indeed increase user resiliency and restrain information redundancy.

The pursuit of serendipity can also be interpreted as a technical attempt to maintain a sense of freedom and mystery that is available in less networked information environments. It might indeed become fundamental in the future to maintain the pleasing feelings that elevate accidental discoveries to sensations of serendipity. When a user is educated and treatedas an active-seeker of information, indeed, he/she will perceive his/her findings as triumphs of personal agency, intuition, and inspiration, and as a self-reinforcing expectation, it will increase his/her (perception of) freedom from algorithms. Such empowerment could also prevent users from the actual risks of persuasion.

Overall, serendipity can represent a design principle able to reinforce the protection of media pluralism in the new emerging social media landscape. To some extent, filter bubbles would probably persist but, eventually, users could burst them and autonomously seek and experience information diversity through the access to more potentially-serendipitous encounters.

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Evaluating a Reading Companion Service

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ABSTRACT

This paper presents a pilot case study using an empathymimicking companion robotic platform to support readinglearning for children in Brevard County, Florida. Literacy skills are vital for all; they are critical to communicate with others and to understand the world. Furthermore, they represent the strongest predictors of students' success in primary school. Motivation is an important factor influencing acquisition of reading ability. To remediate children with reading difficulties, we engaged pupils to learn reading by teaching a robot in a face-toface setting. Our innovative platform uses alphabet recognition and phonetic awareness skills, a method used by teachers in all elementary schools of the county. The children that were evaluated were in kindergarten grade, and came from economically disadvantaged families registered at elementary school. The research presented considers how such issues might be addressed by using robot-supported learning, and specifically empathy-mimicking robotic platforms.

General Terms

Design, Human Factors, Measurement, Experimentation

Keywords

Reading skills, Cognitonics approaches to learning, Robotic Companions.

1. INTRODUCTION

Research in the past two decades has greatly increased the knowledge concerning the beginnings of successful academic trajectories for children. Such work has established that young children's emerging understandings of numbers, letters, and sounds are important predictors of later academic achievement [1-4].

The ability to name the letters of the alphabet during preschool and kindergarten is a well-established predictor of children's later literacy skills [2], [5-6]. More specifically, reading abilities are predictors of long-term school attendance, and are required to break the cycle of intergenerational poverty [7-8].

Spoken words are made up of different individual sounds called phonemes which permit the distinguishing of one word from another. Literacy in elementary school is based on a phonemic awareness (PA) curriculum. From kindergarten to 2nd grade, children are trained to be phonemically aware, that is being able to isolate the sounds, manipulate the sounds, and blend and segmented the sounds into spoken and written words.

Having identified the importance of the children's future role in the nation's economy, schools in USA are exposing children at an early age to the fun of learning science, technology, engineering, and mathematics (STEM) [9].Before the arrival of computer technology into family homes, the most important pillars of education were reading, writing, and mathematics. The pervasiveness of computer systems has also modified learning activities in modern education. Students have witnessed the arrival of Intelligent Tutoring Systems (ITS), computer programs that are able to model learner's states in order to provide individual instruction. ITS consider the learner's knowledge level and progresses to personalize and adapt presentation of learning activities [10]. Several examples have proven the benefits of this kind of personalized education [11-13]. All these experiences are based on embodied conversational agents (ECA) trained with teachers' pedagogical practices.

Recently, more attention has been given to robots in education, for example to teach children a second language [14], to train them in storytelling [15], or to teach them about healthy food choices [16]. In such settings, the robot is used as an adult teacher, and the ensuing robot–child interactions are based on interactions between children and their teachers. However, in long-term interactions, children may treat the robot as a peer, not as a teacher. Moreover, peer interactions have been shown to have a positive effect on language development [17]. In addition, research conducted by [18] has found that "sociable robots, used as robot learning companions can provide the necessary social setting for language learning" [19-21].

STEM education programs are targeted for pre-K to 12th grade students; they are also oriented to make these fields more racially, socially, and gender diverse. From kindergarten to 2nd grade, children gain skills to learn to read; 3rd grade is expected to consolidate reading abilities; and the important shift of reading to learn occurs by 4th grade. Reading to learn is crucial in STEM careers as they require critical reading skills. In USA, of the total pupils in fourth grade hailing from low income families, 82% are not proficient in reading skills. Furthermore, 34% of children entering in kindergarten lack the basis language skills needed to learn how to read, 65% of children in 4th grade are reading below grade level, and 37% students graduate at or above reading

proficiency [22].Struggling children readerscome from African-American, Hispanic, and Native American populations[8].

1.1 Tutor Companion or Tutee Companion

The process of teaching is as follows: preparation, explanation, and feedback [23]. Teaching to learn is a well-known pedagogical mechanism which provides opportunity to learn by teaching. It involves a different beneficial cognitive process: the teacher-tutor needs to revise the information, establish material, and identify the basic structure. Moreover, research suggests that interaction with the tutee is key factor in tutor's learning [24]. Previous research suggests that children aim to interact with companions. In a learning game-based setting, 80% of children from ages 9 to 10 perceived Companions as friends [25]. This suggests that children are not looking for a hierarchical relationship with a Companion even in a learning setting. An empathetic relationship between children and companions is to be constructed [26]. We would like to propose and encourage an active role for children with respect to the robot to promote their spontaneous learning by teaching the robot as a peer.

The purpose of this study is to examine the interaction between children and robots to help improve reading abilities in children. The study, therefore, intends to use robots as a tutee in order to help improve children's reading skills. Empathy and social interaction are proposed as a support and mode of interaction, respectively, in improving learning amongst young children. Additionally, the study hypothesizes that interacting with a social robot would also motivate the child to learn.

2. RELATED WORK

Cognitonics aims to help people adapt to and use technology by improving cognitive mechanisms of human processing information and developing the emotional sphere of the personality [27-28]. This approach is particularly relevant in educational setting, see par example work of [29-30]. Robots have recently arrived in the camp of educational technology and they are quickly becoming the prominent agents in this field [31]. These are very promising technologies particularly for kids [32],[15]. They provide and maintain children's interests by allowing new modes of interaction and new opportunities of socialization. Empathetic robot tutors are transforming the classroom atmosphere and the ways that children are learning [33-34],[15].A good example is a robot that helps children with visuoconstructive deficits; kids that struggle with writing. The robot provides support even to children with poor handwriting and poor self-confidence [35]. Another example of social robots booming in educational setting is the Junior Robotics category in the World Robot Summit 2020 hosted by the Japan Ministry of Economy, Trade, and Industry and the New Energy and Industrial Technology DevelopmentOrganization. The Junior Robotics category will be a student competition in 2018. It aims to promote STEM learning and computing, preparing the kids to understand the human-robot interaction and how these artifacts will assist humans in their everyday life [36].

3. OVERALL RESEARCH PLAN

The idea of a robot reading Companion is based in several assumptions explained previously, and we developed a research plan which included the following hypothesis:

 H_{01} : Children's reading-learning experience is modified after the introduction a class with a robot

 $H_{\rm Al:}$ Children's reading–learning experience is not modified after the introduction a class with a robot

 H_{02} : Certain reading skills are more influenced than others after children's exposure to the robot

H_{A2}: Certain reading skills are not more influenced than others after children's exposure to the robot

H₀₃: Children progress through a "learning by teaching" method using a companion robot

H_{A3}: Children do not progress through a "learning by teaching" method using a companion robot

4. METHODOLOGY

We involved a kindergarten teacher in participatory design of our case study [37]. The following parameters were used to test the children: letter recognition, beginning sounds, and blending words. The teacher was also in charge of the evaluations of the children. The experiment was conducted during the summer break of an elementary school. Of the children attending this school, 91% are economically disadvantaged with a diverse population: 48.2% white, 34.8% African-American and 10.1% of Hispanic/Latino descent. The experiment was conducted in three sessions over a period of two weeks. The first two sessions were conducted with a gap of 2 days. The third session was conducted one week after the second session. The participants for the experiment were 6 students (5 boys, 1 girl) in the age bracket of 4-5 years, who were all attending the same elementary school.

4.1 Experimental set up

The children were told that the robot was fully autonomous and that it would respond to their inputs as a peer would. However, the Wizardof Oz technique was employed [38], in which the robot was remotely controlled from a laptop in a neighboring (control) room outside the line of sight of the children. The robot, named Ellie, was voiced by a young girl, aged 9. We had a control room with the Wizard and a child assistant and an experiment room with participants, the teacher and the robot when it intervenes. The apparatus for the experiment included a JD Humanoid robot, which is manufactured by EZ-Robot¹, a laptop, two mobile phones, and a microphone.

Figure 1 shows a view of the robot control interface.

¹http://www.ez-robot.com



Figure 1. Robot control interface view

The setup was such that the controller with the laptop and the young girl—located in a control room—could view the participants via the robot's camera and could hear the participants via an active mobile phone call from another phone in the participants' room. The young girl then responded to the participants' questions and inputs so as to simulate the robot autonomously responding to them.



Figure 2. The JD Humanoid robot used in the experiment

4.2 Experimental Procedure

The first session of the experiment was conducted in three phases. The two first phases took place between the teacher and the group of children the last phase was an individual meeting between each child and the robot. The teacher was present in the room with the participants when they interacted with Ellie to regulate the teaching process. The first phase consisted of the teacher testing the children's reading and speaking skills on the basis of three tests; letter recognition (LR), beginning sound (BG), and blending words (BW). The second phase consisted of the teacher teaching the children a predefined lesson that taught the abovementioned three skills. The children were then tested again on the same skills to evaluate the skill levels. The third phase consisted of the children interacting with the robot on a one-on-one basis. At the beginning, they have a minor social exchange: the robot engages the child in a personal conversation, asking them their name, etc. Once they had familiarized themselves with Ellie, the children then taught Ellie the same skills they had learnt in the class with the teacher in the second phase of the session. After the participants' interactive meetings with Ellie, they were tested once more on the same skills to evaluate any possible change in the skill levels. The second session of the experiment was conducted exactly in the same manner as the first, with only one difference being that the first phase of the test, which was the initial testing of the children's skills. The two other phases were conducted in the same manner with the same content in the testing, teaching, and robot interaction. The third session of the experiment was conducted a week from the first session and consisted solely of the teacher testing the participants with the same testing methodology as in the first and second sessions. This interaction was independent of the researchers or the robot.

5. RESULTS

Qualitative results in Figure 3 and Table 1 display the children's performance during the 2 days exposed to Ellie. We could observe a positive modification of their results after teaching Ellie (H1), (H3). It is also observed that some variables improved such as BS and particularly BW progress more than letter recognition (H2). This could be based on the fact that half of the children mastered LR with a maximum score before the test, and two of the children's scores regressed between the first and the second session. However, another child progressed, maintained his score and progressed further during the third session. The progression looks particularly significant in BW where all the children started with a low score.



Figure 3. Children's combined performance (weighted average) on both days

 Table 1. Combined results (weighted average) of children's performance

Testing	All Students: Both Days		
	LR	BS	BW
Post Teacher	2.91	2.16	0.66
Post Ellie	3.08	2.66	1.23

Concerning the global learning experience (H1), we observe a net progression in the results including over the time. This progression is not noteworthy for LR which is also the variable with higher score before the experiment. This progression is observable in Figure 4 and table 2



Figure 4. Children's performance on day 2

Testing	All Students: Day 1 vs. 3		
	LR	BS	BW
Pre Experiment	3.2	1.6	0.4
Post Experiment	3	3.2	2.4

Table 2. Results test performance pre post experiment

6. DISCUSSION

In this qualitative study, all participants had a very positive perception and reaction towards the empathetic robot named Ellie during and after our intervention. For example, the teacher informed us that in the classes following our visit, children requested to again meet and interact with Ellie. The children, too, provided a lot of inputs concerning the robot's appearance, such as the fact that they liked its small size. They also confirmed that it had the right look as a robot, and also mentioned that they probably preferred it to have human-like hands with fingers, rather than the pincers our robot had. They also suggested dressing it up in different clothing (see in Figure 2, Ellie's appearance without clothes).

Concerning the interaction with the robot, the children were amazed by Ellie calling them by their names and giving smart and empathetic responses, such as "yes, I would like you to teach me that", "hello! How are you? Did you enjoy your pizza?","Yes I would love it if you read me a story."

The teacher considered the robot to be a very good and effective tool for small children, and also did not expect such good results in such a short time. In addition, she confirmed that children were not distracted by the robot, and they were totally focusedon teach it. The children considered Ellie to be their peer, and look forward to seeing it again in their classes.

7. CONCLUSION

Our study was limited to only three variables of the skills considered in kindergarten teaching: letter recognition, blending words, and beginning sounds. The children displayed significant change in their progress in one of these variables. Results are influenced by the fact that our sample is small. The age of the children also limited the time they could spend in the sessions, as their concentration span does not last for a long duration of time. For the same reason, we did not conduct any surveys.

The children do not consider Ellie to be a teacher but as their peer.However, they perform better in all the evaluated skills LR, BS, and BW; particularly in the last one. Furthermore, results suggest all are skills retained over the time, however more research is needed to confirm this retention. As per the data collected, children learned better with Ellie than they did with the teacher, but more studies are required to confirm this result. Having said that, the global results suggest that the progress in performance of children was due to the use of the robot by the teacher, as a complementary learning tool.

8. FUTURE WORK

We expect to conduct the same experiment with a bigger sample of children composed with an equal number of boys and girls for further observation and to measure improvements.

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ABSTRACT

Stress-induced disorders have become more the norm than the exception in the last ten years, especially in children (ages 0 to 14) and young adults (ages 14 to 19). Lifestyle and economic factors have begun to provide a favourable environment for even the smallest genetic component to flower into a completely symptomatic disease. Even infants show higher rates of eczema which has a high mental health component. Are they absorbing stress from their care - givers, from their life in-utero or their own personality at its (current) state of development? Is it a combination of all of these? How does the digital way of thinking help these children and their families? How does one incorporate thorough examination and laboratory investigations, regular follow-ups and quality in-depth interviews into the quest for recover? How can we optimize health-interviews when working across continents through digital communication, as could be the case for specialized treatments? These questions are more powerful than their answers because in the digital age, answers change and evolve. The questions shift between "same-ness" and "new-ness" for improved results. The paper deals with these questions in case specific contexts. Archival data are taken from study of recovery in chronic diseases as part of a thesis in Medical Anthropology (University College London, 2011-12).

General Terms

Documentation, Human factors

Keywords

Recovery, Stages, Children, Digital Interviews, Health-care

1. INTRODUCTION

Children experience the world in mainly in terms of sensations, colours, feelings and sounds up to the age of 6. Following a time in transition, they begin to experience more analysis and morality from ages 7 up to 12 (or puberty). The post-puberty stage until the age of 18 (approx.) is the phase of communication, testing ones limits as a 'pre-adult' and shedding the now unnecessary dependence of child-dom. These stages are general guidelines based on the work of Freud, Carl Jung, Erik Erikson and Rudolf Steiner – these are subject to individual and clinical context.

When working with children in recovery from long-standing noncommunicable disorders, one observes that child perceives illness and recovery within these contexts. To facilitate an individualized and effective turning point, one is needed to step into the psychosocial-developmental stage of the child, evaluate his/her selfdialogue and then apply the appropriate medical guidelines. One wants the flash of insight arrive from within the child – this makes it more real, more permanent for him or her. It gives the child the flexibility to utilize it in a context-specific way through his/her stages of development, rather than as a 'black-or-white'-like compulsion.

2. DIGITAL COMMUNICATION AND RECOVERY IN CHILDREN

In the case of pre-verbal stages in a child, one relies on video conference facilities and history shared by the family or guardian. In post-verbal stages, one can utilize the understanding of psychosocial development via digital communication.

2.1. Ages 2.5 to 6 years or equivalent

This stage of growth can vary slightly or drastically, depending on the state of health of the child and medical history.

The best way to maximize therapeutic accuracy is to work with the imagination of the child through a series drawings regarding his/her illness, fears, perceived relationships, dreams and selfimage. This gives one access to the child's world of physical sensations even when connected through a two-dimensional computer screen.

The child, as early as in this stage, has the agency and insight to form new conclusions with respect to his/her suffering. New conclusions set the stage for fewer fears, improved compliance and regular follow-ups. Other happy side-effects can include deeper bonding with parents, guardians, teachers, siblings and peers.

2.2. Ages 6 to 12 or equivalent

These are the years of naturally developing moral agency in the child. If the natural moral convictions are at odds with strong moral values in the surroundings, there forms the beginning of conflicts with authority. This is emotionally painful for the child, even if he/she is not fully aware of this pain. The child has a biological urge to be loyal to the parents and the proverbial 'village' or community, but the inner pangs of morality are not in sync with his/her established trust. Most children ask unending "Why?" based questions at this stage – they are only beginning to process the nuances of decision-making. They are beginning to undergo pain for ethical benefits; for example, reporting a bully to the teacher or surrendering a favourite toy to another child.

At this stage, recovering children respond beautifully to letter writing combined with drawing. They may be more exposed to television and media now, and it is best to ask them to conjure their own scripted² cartoon series. The entire inner picture of

disease, conflict and resolution becomes evident – the child's mind reaches a peak of conflict in this storytelling process followed by stages of resolution as his/her consciousness resolves the various components of the plot. This can be sequential or unsequential – the objective is to reach a point of peace through the digital screen. In this way, the 'missing' empathetic physical presence of the doctor is slowly replaced by the child's own self-empathy. At the same time, the relationship with the illness is reframed.

2.3. Ages 12 to 19 or equivalent

Listen, listen, listen, listen – this is the phase of Whatsapp, Messenger, Snap Chat, Instagram, Facebook, Skype, cell-phones and video-games. The child is already plugged into technology; he or she is living in the parallel world of the internet (often within parental content settings!). In this stage, the young adult (also referred to as teen or tween in some circles) wants to emote, communicate, shut off, withdraw, shine, compete and experiment all at the same time. It is the natural urge of growth. At the same time, he or she *demands* unconditional approval from perceived authority, often the parent or guardian. It's an adventurous time for the family – the family is growing up too.

The digital screen turns into an even more dependable tool during these years. This is the time when the parents, siblings and sometimes even grand-parents need specialized counseling with respect to the recovery of the child. Technology becomes a way of reaching out even when extended family, cousins, parents or the doctor are in different cities. The modern grand-parent is more aware than the modern parent. This grandparent is in his/her own quest to keep up with technology, and to keep pace with the times. Therefore, they are more open to learning new strategies in helping – their stakes are higher.

Ingraining confidence in more nuanced use of technology for the senior citizens involved has deep and long-term benefits. It improves communication, confidence, trust and ownership of each family member towards the problems at hand. Grandparents often recognize, though they may not always openly acknowledge their part in the harmful conclusions in the parent. They can see these mechanisms working against the synchronicity of the situation, but don't always know how to rectify the same. The main coping mechanism then turns up in the form of guilt and difficult though well-intentioned advice.

The magic of technology is to work with the family as a unit, in addition to one-on-one interviews with the primary patient.

3. CONCLUSION

Solutions are everywhere. It is important to turn to qualitative data and in-depth interviews to effect deeper recovery with the help of the virtual and not-so-virtual world of technology. While one part of digital efficacy does lie in the virtual realm, the effects can be very very tangible.

4. ACKNOWLEDGMENTS

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2. Administrative staff : Shradhdha Cures (Centre for Chronic Diseases), Mumbai, for collation of archival data.

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Mobile Mental Health Support for Chinese University Students

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ABSTRACT

World Health Organization statistics shows that 29 percent of people worldwide suffer from mental health or psychological problems at some point in their life. The problem can be particularly acute for Chinese university students due to high expectations from family and the pressures of the academic environment. This paper analyses the need for different mental health support app functionality to facilitate self-help or encourage students to make use of traditional mental health support services. Results allow us to characterize student preferences in the design of our own prototype app and should support the design of more effective mental health support apps in the future.

General Terms

Human Factors

Keywords

Mental health support; university students; application prototype evaluation

1. INTRODUCTION

Around 29 percent of us will suffer from mental or psychological problems at some stage in our lives [1]. However, many victims of mental health problems are often unwilling or incapable of finding the support and guidance they need to most effectively overcome their difficulties. For many individuals, there is still a stigma attached to mental-health issues and private mental-health treatment can be expensive. This can be particularly problematic for university students who tend to have limited financial resources and pressure to obtain high levels of academic achievement [2]. While most universities have psychological consultation centers, resources tend to be limited and there is a need to make the best use of resources to support students and encourage them to utilize the services available.

The leverage of new technology is one way in which universities can make better use of available resources for psychological counseling and intervention. Research in this area is focused on online remote treatment, the use of virtual reality technology, intelligent hardware, wearable devices and different types of application to support traditional counselling services [3]. This paper looks at developing a methodology for designing mobile mental-health support apps for Chinese university students. Paul Craig Xi-an Jiaotong-Liverpool University Suzhou China p.craig@xjtlu.edu.cn

2. STATE OF THE ART

There have been a number of applications developed for mental health support in the past two decades. As early as 2001 Helen Christensen, at the Australian National University, developed mobile app called MoodGYM which was specifically designed to help adolescents cope with depression [4]. This development was initially a cause of considerable controversy among mental health specialists and attracted a great deal of criticism from detractors who felt that the automation of mental care support might be detrimental to users from a vulnerable group who could benefit from a more human-touch. These doubts were eventually overcome as initial results proved positive and the app has since been adopted by the Australian National Health Service. Now MoodGym has more than a hundred-thousand active users in Australia and is also used in over two-hundred other countries around the globe.

In another significant development, in 2007, the British National Health Service developed FearFighter, an online environment to support patients dealing with fear and anxiety. This included an APP called 'Beating The Blues for Depression' which dealt specifically with mental health support [5].

Other mental-health care apps of note include Biteback, Mycompass [6], Optimism and BellyBio [7]. The functionality of these apps can be roughly classified into categories such as; guidance, mental health tests, treatment follow-up, psychological consultation, and social assistance. And while a significant number of practitioners still express doubt over the overall effectiveness mental-health apps, it is increasingly more widely accepted that these apps will form an integral part of any larger mental health care solution that also includes more traditional methods such as one-on-one counselling and support groups. Indeed, a number of developed countries with progressive social care programs, such as Australia, Holland and the United Kingdom, have already incorporated online mental-health support into their national systems of health-care provision.

3. METHODOLOGY

In this paper, we present the results of a requirements analysis exercise aimed at determining what functionality is needing in an app for mental-health support. The app is designed for Chinese university students and our study focuses on the needs of this particular group of users as well as different types of user within this group as determined by gender, age, area of study, and type of degree. Results of a survey of our users allow us to develop a prototype mobile application that is further tested to gauge the users' overall impression of this type of app.

4. INITIAL SURVEY

The 60 subjects of our initial survey are Chinese university students from Xian Jiaotong-Liverpool University. 65 percent of the responders are male and 35 percent female. The subjects are aged between 18 to 26 and divided into two groups; age range 18-21 (70 percent) and age range 22-26 (30 percent). The art and business major students form 55 percent of our sample while science and technology major students form 45 percent. There are 47 undergraduate students (78.33 percent) and 13 postgraduate students (17.17 percent).

The main part of the questionnaire asks subjects to gauge the importance of the six mental-health care app functions we found to be the most common features of existing software. These are:

- Mental health self-evaluation tests. Users can use this function to test aspects of their mental health. This can give users an indication of their mental health status and tell them which forms of additional support might be most appropriate.
- 2) On-line consultation. This allows users to talk to consultants online before having a face-to-face consultation or in lieu of an online consultation if another course of treatment is thought more appropriate. This form of consultation can be more convenient and cost-effective than a traditional one-to-one consultation performed in person.
- 3) Communication and discussion. This can include chatrooms, forums and other media for facilitating communication between app users. Social interaction can help users benefit from shared knowledge, reduce feelings of isolation and help build a sense of community among users.
- Entertainment. This aims to stimulate the user and elevate their mood with music, positive videos, humor and puzzles.
- 5) **Events and activity postings.** This highlights realworld events and activities such as workshops or lectures on mental health.
- 6) **Professional tips.** Links to mental-health advice and resources.

5. RESULTS

The results of our survey indicated that the three most important functions for mental-health support apps are on-line consultation, professional tips and self-evaluation tests. Communication and event posting are also thought to be important but these where thought of as secondary features that shouldn't detract from the principle functions of the app. User preferences didn't change in any significant way for different types of user which suggests that the same general design can be used for different groups in different universities.

Figure 1 shows the online consultation page of our prototype app. Figure 2 shows self-evaluation, figure 3 shows the mental health tips and figure 4 shows events and activities.

Evaluation of the prototype app gave us further insight into how the tool might be used. For example, while features like event postings and communication where not considered as core functions of the app, the students thought they might be useful in encouraging first time users who may otherwise be inhibited by using the app. This type of discovery encourages us to consider the complete user experience in our design and think more about the process of a user progressing through different functions of the app as their requirements evolve.

Figure 1. Mental-Health Support App, online consultation.

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RECENT USERS		
View a		Carvai Sent

Figure 2. Mental-Health Support App, self-evaluation quizes.

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MYTHS AND FACTS ABOUT YOUR MOOD	
L'Ausic ainess Improves your mood.	
True	
E False	
	۰

Figure 3. Mental-Health Support App, mental-health tips.

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WHAT IS MENTAL HEALTH?

What Is Mental Health?

Mental health includes our emeriental, psychological, and social well-heing. It affects how we act. It also helps determine how we bandle stress, relate to others, and make choices. Moreal health is important at avery stage of life, from childbood and adolencence through adulthood.

ene of your file, if you experience mental health problems, yo could be affected. Many factors contribute to reveal health reoblems, suchaling

- Biological factors, such as genes or broke of
- Life experiences, such as manna or abase
 Turnity history of mental health publicity

Mental health problems are common but help is unallable. People with mental health problems can get beite

Figure 4. Mental-Health Support App, events and activities.



6. RESULTS

Looking at student preferences for mental-health support apps has allowed us to make informed decisions in the design of our own app by prioritizing on-line consultation, professional tips, and self-evaluation tests. Reaction the prototype was largely positive.

Another more general conclusion from this project is that automated support should complement rather than replace humaninteraction. Online consultation was a priority for our users and online consultation would, in many cases, lead to an actual meeting with a counselor or psychologist. The main benefit of our app would be to support the user up until this point.

Another important conclusion from our investigation is that mental health support apps require people to continue using the apps in order to record enough data for them to help with any diagnosis or help prescribe any sort of treatment. A study showed that 60 percent users stopped using the MoodGYM after they finished the first module [8]. If mental-health support apps are to be effective they need to encourage people keep using them. So apps need not only to include core functionality, but they also need to be usable, entertaining and reward progress in order to keep users interested.

7. ACKNOWLEDGMENTS

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Delavnica AS-IT-IC AS-IT-IC Workshop

Uredila / Edited by

Matjaž Gams, Jernej Zupančič

http://is.ijs.si

9. oktober 2017 / 9th October 2017 Ljubljana, Slovenia

PREDGOVOR

Projekt Avstrijsko-Slovenski inteligentni turistčno-informacijski center (AS-IT-IC) je bil sprejet na razpisu Programa sodelovanja Interreg V-A Slovenija-Avstrija v obdobju 2014-2020. Glavni rezultat projekta bo delujoča mreža ljudi s podpornimi orodji, kot so: virtualni asistent (ta bo omogočal komunikacijo z uporabnikom v naravnem jeziku ter integracijo z zunanjimi storitvami), komunikacijske storitve (rešitve, ki bodo omogočale komunikacijo med turisti, virtualnimi asistenti, ponudniki turističnih informacij in lokalnimi skupnosti), turistične vsebine, priporočilni sistem za načrtovanje izletov ter mreža turističnih ponudnikov in njihovih storitev.

Delavnica AS-IT-IC je organizirana v sklopu Multikonference Informacijska Družba. Delavnica naslavlja naslednje teme na področju turizma: raziskovalne aktivnosti, inženirske aplikacije in pogled na informacijsko komunikacijske rešitve z vidika ponudnikov turističnih informacij.

Matjaž Gams, Jernej Zupančič

FOREWORD

Austrian-Slovenian Intelligent Tourist-Information Center project (AS-IT-IC project) was approved in the Cooperation Programme Interreg V-A Slovenia-Austria in the period 2014-2020. The main project output will be the operational center with humans involved, having support of the following tools: Virtual assistant (providing automatic answering in natural language to the questions and performing services), Communication service (web-based solution that will enable conversation between the tourists, virtual assistants, tourist information officers and local communities), Information sources of tourism-oriented data, Recommender system for tour planning, Network of tourist services and services from local communities.

The AS-IT-IC Workshop is organized within the Multiconference Information Society. It covers research activities, engineering applications, as well as tourist-information providers view of the information-communication technologies solutions in the field of tourism.

Matjaž Gams, Jernej Zupančič

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ABSTRACT

In this paper we will present some of our systems and solutions that will allow local societies and municipalities to become well-suited in the modern world. By providing services such as:

- Live Television
- Interactive 3D Virtual Reality navigation
- Intelligent virtual assistant with natural language interface for municipalities, societies, tourists and tourism organizations
- Health-related solutions

Keywords

virtual assistant; streaming service; smart tourism; health-care system

1. INTRODUCTION

There are many challenges for societies to be known and keep their members informed about recent actions and events. Most of the time they need some instruments to deliver rich information in the most simple and user-friendly way. The best ways are classic newspapers delivered to members and interested people and accessible television shows or even a channel.

While having all content it is still complicated to deliver it to all curious individuals more so it is still a challenge to make it easy to understand and simple to get.

That is why research prototypes of Institute "Jožef Stefan" are coming to municipalities, retirees and other societies.

Figure 1: Ecosystem

To bring plain and straightforward services for people that need digestible information about municipality offers, touristic sightseeing destinations, accommodation and health.

Artificial intelligence as well as Information and Communication Technologies are getting better every day and the Department of Intelligent Systems is a part of this arduous process.

In addition to researching new ways of understanding information we are exploring ways of not only presenting but also maintaining information.

2. TELEVISION

By adopting our internet television solution any municipality could be enabled to broadcast their festivals, events, news and general information blocks live 24 hours per day with ease. This solution is prepared to be deployed without professional help nor special equipment since we already have a public web page with a handbook for setting up your own broadcasting server.

The simplest live streaming solution is well-suited for the most popular use-case - a PC with modern OS like Linux with GUI (tested on X and Wayland), macOS or Windows. It has a rich interface and is easy to use by inexperienced users (it is also well documented).



Figure 2: IJS TV interface

There's also a headless solution with an intuitive web interface (Figure 2). It is advised to deploy it with help of the specialist since it requires some special knowledge like Linux administrating and the Docker container system.

3. 3D ASISTENT

To provide effortless navigation in public locations like museums, parks or even government facilities our team prepared a virtual reality solution.



Figure 3: 3D Asistent VR

There are ways to access the virtual helper via special applications but there's an option where a web browser is sufficient.

This product can be used for helping to navigate facilities like: Hospitals - to help patients navigating in a maze of departments and rooms, Museums - to help visitors to get to desired masterpiece or historical item. Also it open possibility to have a virtual tour (with a chosen virtual guide) for people who cannot access the museum in person, Government facilities - to guide visitors to desired office, person before or during the visit,

It is also possible to enrich and combine 3D Assistant with other solutions like Television and our Text-to-Speech solution 'Govorec'.

4. ASISTENT



Figure 4: Asistent view

There are about 200 municipalities in Slovenia and every single one of them¹ already has it's own "Asistent" which helps the public to interact with their local government and guides tourists to desired destinations.

The system [2] has prepared answers for a variety of questions starting from simple ones like renting a bicycle to complex ones like getting a list of documents needed for a land use certificate.

The "Asistent" is made up by combining systems like:

- 1. Cloud-based service that offers API calls and has it's own web interface. It is built on MAS (multi-agent system) with several agents communicating in various environments depending on the intent of the user.
- 2. Administrative tools for maintaining databases and smaller services, it has it's own separate web interface.
- 3. A modern client-side application with a rich graphic interface that allows the end-user to have a meaningful conversation with multiple services and APIs in a comfortable and convenient way.
- 4. Mobile applications that are easy to download via appropriate mobile application store. Currently among supported mobile OSes there are iOS, Android, Black-Berry an Windows Phone.



Figure 5: e-Turist Explorer

5. TOURISM

Project "e-Tourist"² [1] is a service for planning itineraries in Slovenia. The project was founded in 2013 within the "Call for proposals for co-funding of projects developing e-services and mobile applications for public and private non-profit organizations" funded by the European Union and Slovenian Ministry of Education, Science and Sport.

It allows to plan trips within selected regions it also tailors the route to user's defined preferences like gastronomy trip or a hiking tour.

This project is an important step in developing Austrian-Slovenian Intelligent Tourist Information Center (AS-IT-IC) project. The project addresses the problem of not getting the desired information about natural and cultural heritage sites in the Slovenian-Austrian cross-border area in an integrated way.

6. HEALTH



Figure 6: IN LIFE smart watches

Most of the medical professionals understand that Artificial Intelligence is going to revolutionize the healthcare system.

¹http://projekt-asistent.si/meta-asistent ²http://turist.ijs.si In recent years the Institute "Jožef Stefan" was developing solutions and researching algorithms for identifying types and measuring levels of stress, detecting heart problems as well as several solutions fitted for elders. There are various modules that are already available for no price - some of them were developed or are still in development at our Department. The electronic health system has numerous components - First Aid assistant, information from the National Institute of Public Health, Self Care advice suggester, modules that work in collaboration with EkoSMART subprojects like "e-Health and Mobile Health", the Repository of Domains and Prototypes, Stress detectors and system for the care of elderly.

Here are the projects involved:

- 1. IN LIFE³: aims to prolong and support the independent living of seniors with cognitive impairment, through interoperable, open, personalized and seamless ICT solutions that support such everyday tasks as home activities, communication, health maintenance, travel, mobility, socialization tasks.
- 2. E-gibalec⁴: Smartphone game for children that will encourage them to do exercises, empowered with statistics for supervisors.
- 3. ASPO⁵: An online application for identifying and informing about sexually transmitted infections
- 4. Stress detector: Students project for identifying stress type and level via text web interface
- 5. EkoSmart, EMZ⁶: One of the important features of the program is the integration of the solutions in different areas into a common ecosystem. Too often the practice of introduction of smart cities shows limited focus on certain areas and lacks connection with others. One of the important objectives of the EkoSmart program is therefore the development of the platform with the same name (EkoSmart platform) which will allow easy integration of sector-specific solutions into a common ecosystem (featured in the program, as well as others) and will, as such, facilitate the identification and support of inter-sectoral value chains. This platform will be compatible with global solutions and will include concepts such as the Internet of Things (IoT). Within EMZ (e-Health and Mobile Health) we collect domain repositories and prototypes, so you can see who stores what data and what prototypes in Slovenia. We are developing an EMZ assistant here.

7. INTEGRATION WITH AS-IT-IC

To help the AS-IT-IC project to create a joint Austrian-Slovenian center. A network of services that help to navigate and deliver useful information will be necessary to collaborate with service providers and tourist offices, municipalities, tourists and citizens to enhance continuous cooperation between them. These projects are going to be part of the touristic ecosystem that is still developing.

³http://www.inlife-project.eu/

⁴https://www.e-gibalec.si/

⁵https://aspo.mf.uni-lj.si/static/ASPO_new/#/

⁶http://ekosmart.net/sl/ekosmart/

8. CONCLUSION

In this paper we presented different systems that are going to help societies, municipalities and organizations to become more visible in the modern world, become more accessible and transparent for interested parties and collaborate with each other. With help of Artificial Intelligence and Natural Language Processing societies could build modern information systems now with no need of special knowledge and deliver services for more customers in the nearest future.

9. ACKNOWLEDGMENTS

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Tourist Information Center Slovenj Gradec as a Part of the AS-IT-IC Interreg Project

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- 6. Developing of new tourist products.
- 7. Encouraging the development and regulation of tourist infrastructure facilities in the area of the founder's municipality.
- 8. Organizing and marketing public events.
- 9. Graphic design and editing of the web presence.
- 10. Providing tourist information.

2. AS-IT-IC PROJECT

2.1 About the Project

Austrian-Slovenian Intelligent Tourist Information Center $(AS-IT-IC)^1$ is a project that was accepted in the crossborder Cooperation Programme Interreg V-A Slovenia-Austria in the programme period 2014-2020. The project has two main goals:

- 1. To develop information and communication technology (ICT) tools to support a tourist when he or she wants to create a personalized itinerary for the visit of the Slovenian-Austrian cross-border area.
- 2. To create a sustainable community that will support the use and maintenance of the developed tools.

The project consortia comprises 5 partners from the Slovenian-Austrian cross-border area.

- 1. Jožef Stefan Institute,
- 2. Graz University of Technology, Institute for Software Technology,
- 3. SPOTUR Slovenj Gradec,
- 4. The Association of Municipalities of Slovenia, and
- 5. Graz Tourismus und Stadtmarketing GmbH.

ABSTRACT

We present the Tourist Information Center Slovenj Gradec and the organization within which it operates. Additionally we provide a short description of the Austrian-Slovenian Intelligent Tourist-Information Center (a project within the Cooperation Programme Interreg V-A Slovenia-Austria, period 2014-2020) and the role of the Tourist Information Center within the project. We also provide our view of Information and Communication Technologies impact on tourism and discuss the need for a nation/region-wide platform for services and tools for tourist services providers and tourists.

Keywords

tourism; information society; AS-IT-IC project

1. INTRODUCTION

SPOTUR Slovenj Gradec (Slovene: "Javni zavod za turizem, šport, mladinske in socialne programe SPOTUR Slovenj Gradec") is a public institution, established in 2009, with a view to carry out various tasks of public interest in the field of tourism, sports, youth, and social programs in the municipality of Slovenj Gradec. SPOTUR cooperates with several similar institutions in the area of Koroška as well as in the wider region and is an important operational partner in the Regional Development Agency for Koroška (which operates under the auspices of the Regional Development Agency).

1.1 SPOTUR Objectives

Objectives of the SPOTUR Public Institution in the field of tourism are the following:

- 1. Organized, constant and professional approach to the development of new integrated tourism programmes (excursions, weekend programs, holidays).
- 2. Coordination an cooperation with all tourist providers in the municipality.
- 3. Promotion and marketing of Slovenj Gradec as a tourist destination on the domestic and foreign markets.
- 4. Creating and ensuring the strategic development of tourism in the region.
- 5. Linking the public and entrepreneurial interests and services.

¹https://as-it-ic.ijs.si

2.2 Relation to the Project

The Tourist Information Center of Slovenj Gradec is a department within the Public Institution SPOTUR, which is the main office involved with the AS-IT-IC project. With the participation to the project we want to improve and update the quality of our tourist information services and cooperate with Austrian and Slovenian partners in building the next generation tourism-oriented ICT tools.

2.2.1 ICT Project Tools

Currently, a tourist cannot get the desired information about Slovenj Gradec in an integrated way from both the humans and Web services, much less from the joint Austrian-Slovenian services. Our tourist office provides local information in traditional ways through printed materials, brochures, web sites and social media, and face-to-face communication with tourists when they visit our office. According to the world-wide trend, the tourists increasingly obtain more information about sights and attractions on the Internet or through mobile applications. They do that either in advance, when planning their trip, or on the spot, when they find themselves in an unknown place with some time to spend and do not know what to do. In both cases they do not have the access to the human tourist information officer or the printed brochures - all available at the tourist information office. By relying on third party applications such as Google Search², Google Maps³ and TripAdvisor⁴, they find only the most popular places and spend a big part of their time searching and deciding on where to go. Consequently, tourists may miss locations they might be interested in and have less time for sight-seeing.

The lack of information and non-personalized trip planning is two-fold: first, tourists may visit the places that receive most publicity but skip the ones that they might really be interested in, and second, some interesting smaller tourist locations may get less visits, because they cannot afford the publicity of bigger attraction managers.

ICT tools that we help to develop will provide personalized recommendations to the tourist and allow him or her to communication with a human tourist information officer through the familiar chat-like interface.

The ICT tools will consist of Virtual assistant, Chat platform, and Tour planner.

- 1. Virtual assistant will provide automatic answering in natural language and will be an important addition to classic means of providing information, which nowadays exist in the Tourist Information Centers. Virtual assistant is available 24/7 and has the access to a vast knowledge of tourist attractions available on the Internet.
- 2. **Tour planner** will enable better planning of crossborder visits for the tourists - they will be able to discover less popular sites that would otherwise be missed, stay longer, and better satisfy their needs.

3. Chat platform will allow the tourists to communicate with the tourist information officer or the virtual assistant in the same familiar chat interface. This will provide a single access point to the information on sights in the Slovenian-Austrian cross-border area.

Within the scope of the project we will assist in building a modern interface to approach the tourists and the services for continuous availability of information. This is of great importance to us and every other tourist office. By participating in the project and the advantage to be the first to add new content to the project platform and use it we expect to increase the visibility of our tourist offer and thus increase the number of tourists who decide to visit our tourist destination.

2.2.2 Tourism Network

The most important goal of the project for us is to create a joint cross border Tourist Information Center - an ICT supported network of service providers and tourist offices, to enhance continuous cooperation that is practically nonexisting at the present time. In our opinion the cross-border tourist exchange, collaboration and transfer of expertise between providers is very important and can increase the visibility of the tourist attractions to a wider range of tourists. Of particular interest are the possibilities to cooperate with tourist offices from the neighboring Austria, since the diverse tourist offer from both countries nicely complement each other.

3. SLOVENJ GRADEC TOURIST OFFER

The wider area of Slovenj Gradec has a lot to offer. Slovenj Gradec is the cultural and economic centre of the Mislinja valley. With its number of inhabitants, it is a small town, but when you take its creative tradition and institutions into account, its importance extends over many borders. Numerous exhibitions in the art gallery and events (some of them under the aegis of the UN) have brought the town closer to its foreign neighbours - that is why in 1989 Slovenj Gradec got the distinguished title of the Peace Messenger City.

3.1 Town History

The historical image of Slovenj Gradec and its surrounding area stretches back to pre-historic times. This may be traced in the remains of Illyrian and Celtic settlement called Colatio. The medieval town was (like other oldest Slovene towns) founded in the 13th century. It has survived centuries of turmoil but the town folk (most often artisans and merchants), together with foreign and native masters and artists, have managed to care for the image of the town. The old town center has remained the focus of cultural and social life right up to the present day.

3.2 Cultural Heritage

Slovenj Gradec has always been and still remains rooted within its historical and cultural tradition. The most important artistic monuments in the town are to be found in the Gothic church of the Holy Spirit and in the church of St. Elizabeth; it is also interesting to examine the old town center which has been preserved in its original design. In the nearby surroundings, there are quite a few cultural and

²https://www.google.si

³https://maps.google.com

⁴https://www.tripadvisor.com

historical monuments, whose particular characteristics resonate in a wider cultural context. The most important are the church of St. George at Legen, the ruins of Vodriž castle, and the church of St. Pancras above the Stari trg (the Old Square). There are also some sites of ethnological interest that have been preserved. Among them we find many traditional Slovene hayracks (Slovene: "kozolci"), old peasant houses, chapels, and old watermills and sawmills.

3.3 Natural Heritage

Many diverse environments to be found around Uršlja gora and Pohorje offer the visitors peace and its simple charms, which are the reasons on why they are worth discovering. The town and surrounding area offer many different opportunities for recreation: skiing on Kope, horse riding, biking, gliding, and mountaineering, which make one appreciate the nearby natural sights.

4. ICT TECHNOLOGIES

Slovenj Gradec with its surrounding area offers a wide range of smaller, attractive products. The promotion of the tourist offer is mainly based on the printed materials, brochures, web sites⁵ and social media⁶. However, due to the small size of Slovenj Gradec and low budget, some attractions might remain undiscovered.

In the last years we have tried to involve some modern tools of promotion, such as virtual tour 7 on Google maps and mobile applications.

4.1 Virtual Tour

Virtual tour (Figure 1) includes the integration of 360deg spherical images of points-of-interest in the Slovenj Gradec area and a map with the locations of the chosen points. The application enables the user to interact with the spherical images, zoom-in/out, share the view or like it using the social media "Like" button. We provide 14 spherical images of churches, squares and tourist infrastructure.

4.2 Problems with ICT Tools

Due to the lack of professional support and resources the novel ICT products have been more or less a short terms solutions that didn't bring us many positive results, although the ICT tools are of great importance for successful promotion (as evident in [1]).

We see the same obstacles to innovative ICT supported solutions in other Tourist information centers and municipalities as well. Municipality is able to reserve some resources for an innovative ICT tool (web or mobile application or advanced interactive content), however, due to the lack of sustainable resources the tool is only developed to the prototype stage where it remains unchanged for years. Lacking the marketing power even great ideas go unnoticed by the general public for which the solution was intended. This goes hand in hand with the problem of discoverability - each organization hosts its web applications on its own web site that is usually not optimized for search engines.

gradec/virtualna-panorama

Slovenia lacks a common ICT platform (such as the one described in [2]) with tools and services that can be used by any tourist information provider or a provider of a tourist service. Some tourist-oriented points-of-interest such as sights, services, accommodation and activities are highlighted with a short description and a photo or a video on the main Slovenian tourist information site⁸ managed by the Slovenian Tourist Board. According to the website: "The Slovenian Tourist Board (STB) is a national tourist organisation responsible for planning and carrying out marketing policies in regard to Slovenia's comprehensive tourist offerings. Furthermore, this organisation is also entrusted with the task of developing Slovenian tourism."⁹. While STB does a great job at promoting the Slovenian tourism destinations at fairs and social media and provides a great entry point for a tourist that is yet to decide whether to visit Slovenia, it lacks a platform that would be useful for providers of services (high quality sights entries, access to reservation system, tools for innovative sights presentations, high availability access to potential customers over the Internet, a platform for establishing B2B contacts etc.) and the consumers (tour planners, live chat support, dynamic information providers etc.).

Each municipality deals with the same problem - there is no sustainable solution that would help in creating innovative ICT tools that would be of use for all municipalities at affordable cost. A tourism platform would have to be a cloud native ecosystem with:

- 1. Open application programming interfaces (APIs) that would enable the solution providers to develop useful services for tourist service provider and tourists.
- 2. Ready-to-use modules (provided as a service) with a pay-per-use subscription models that would enable tourist service providers a one-stop shop to useful services.
- 3. Tourist applications gallery that gives the access to the applications relevant for tourists, which integrate into the platform and use the platform databases and services.

5. CONCLUSION

We have presented the tourism oriented goals of the SPO-TUR public institution, our role in the AS-IT-IC project and our views of the ICT tools and services for tourism. We have also discussed the problems of smaller tourist pointsof-interest in promoting the attractions, obtaining the visitors and managing the destinations. To this end we proposed a larger-scale platform with built in services available to tourists and tourist service providers. We are convinced that the AS-IT-IC project is a step in the right direction of enabling such a platform.

With the participation in the AS-IT-IC project and with the help of well-known institutions we expect to lay the groundwork for good practice of a modern Tourist Information Center also for other Information centers in Slovenia

⁵http://www.spotur.si/

⁶https://www.facebook.com/spotursg/

⁷http://www.turizem-slovenjgradec.si/slovenj-

⁸https://www.slovenia.info/

 $^{^{9} \}rm https://www.slovenia.info/en/business/about-slovenian-tourist-board$



Figure 1: Web-application with 3D views of points-of-interest in the Slovenj Gradec area

and Austria, with whom we expect to build a fruitful and long term cooperation.

6. ACKNOWLEDGMENTS

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Nadgradnja Sistema e-Turist in Integracija s platformo AS-IT-IC

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POVZETEK

Slovenski turizem in turizem v sosednjih državah beleži v zadnjih letih rekordne številke. Slovenija se uvršča nad povprečje Evrope. V letu 2016 je bilo v Sloveniji za 9,9% več prihodkov in 8,1% več prenočitev glede na leto 2015. [1] Z večanjem števila turistov, se veča tudi število tistih turistov, kateri se ne udeležujejo organiziranih izletov. Taki turisti si po navadi v kratkem času ogledajo veliko število turističnih znamenitosti. Kljub dostopnim informacijam na spletu pa je planiranje poti in ogledov za povprečnega turista težak zalogaj.

Sistem Turist pripravi za turista program izleta, prilagojen njegovim željam. Turistu so ponujene turistične znamenitost iz izbranega območja, izriše pa se tudi pot ogleda turističnih znamenitosti na zemljevidu. Ponujeni so mu tudi pisni in govorni opisi, fotografije in ocene drugih uporabnikov, kateri so že obiskali te turistične znamenitosti.

Sistem smo nadgradili z dodatnimi tri tisoč turističnimi znamenitostmi na Slovenskem. Znamenitosti so bile avtomatsko dodane v bazo podatkov s pomočjo modula za avtomatsko dodajanje novih znamenitosti katerega bomo opisali v nadaljevanju.

Cilj dodajanja novih turističnih znamenitosti je povezava obstoječega informacijskega sistema Turist z novim naprednejšim informacijskim sistemom imenovanim AS-IT-IC.

1. UVOD

Turizem je ena izmed najpomembnejših in hitro rastočih panog slovenskega gospodarstva. Slovensko turistično gospodarstvo prispeva 13% BDP, neposredno ali posredno zaposluje 12% aktivne delovne populacije in predstavlja 40% izvoza storitev. Slovenija je mednarodno prepoznana kot »zelena, aktivna in »zdrava« turistična destinacija.

Slovenski turizem in turizem v sosednjih državah beleži v zadnjih letih rekordne številke. Slovenija se uvršča nad povprečje Evrope. V letu 2016 je bilo v Sloveniji za 9,9% več prihodkov in 8,1% več prenočitev glede na leto 2015. [1]



Slika 1: Povečevanje obiska turistov v Sloveniji za leto 2016[1]

Z večanje števila turistov, se povečuje tudi število posameznikov in manjših skupin, kateri se ne udeležujejo organiziranih izletov pod vodstvom strokovno usposobljenih turističnih vodičev in katere zanimajo tudi manj znane turistične znamenitosti. Ti turisti si po navadi sestavijo program ogleda sami, kar pa običajno ni lahka naloga, saj so na spletu podatki razdrobljeni in ne povezani med sabo.

Sistem Turist sestavlja spletna aplikacija v katero uporabnik vnese svoja zanimanja glede na lokacijo znamenitosti katere si želi ogledati, namen potovanja, čas za potovanje, ki ga ima na voljo, prevozno sredstvo s katerim potuje in čas katerega bo namenil za obrok, če tako želi. Na podlagi zbranih podatkov, program s pomočjo priporočilnega sistema organizira izlet prilagojen turistovim željam. V ta namen, sistem uporablja priporočilni sistem in metode za iskanje najkrajše poti z najzanimivejšimi znamenitostmi. Vsako znamenitost je mogoče tudi oceniti, kar priporočilni sistem upošteva pri načrtovanju poti v prihodnje. Del sistema Turist so tudi administrativne strani, ki turističnim delavcem omogočajo vnos novih turističnih znamenitosti in pregled ocen obiskovalcev ter obiska Slika 5.

Obstoječi sistem smo nadgradili z dodatnimi tri tisoč turističnimi znamenitostmi na Slovenskem. Znamenitosti so bile avtomatsko dodane v bazo podatkov s pomočjo modula za dodajanje novih znamenitosti katerega bomo opisali v nadaljevanju.

Cilj dodajanja novih turističnih znamenitosti je povezava obstoječega informacijskega sistema Turist z novim naprednejšim informacijskim sistemom imenovanim AS-IT-IC. Naloga informacijskega sistema AS-IT-IC je pomoč turistom pri načrtovanju njihovih čezmejnih obiskov, spodbujanje k odkrivanju manj znanih zanimivosti in omogočanje kvalitetnejših izpolnjevanj želja. V nadaljevanju bomo opisali arhitekturo Sistema Turist, vnos novih turističnih znamenitosti, povezavo med sistemom Turist in priporočilnim sistemom za načrtovanje poti glede na želje uporabnikov, kateri je del sistema AS-IT-IC.

2. PRIPOROČILNI SISTEM IN UPORABNIŠKI VMESNIK SISTEMA TURIST

2.1 Priporočilni sistem

Sistem deluje kot spletna storitev, uporabniki lahko dostopajo do sistema preko spletnih brskalnikov. Priporočilni sistem v dveh korakih sestavi program ogleda. V prvem delu za vsako znamenitost izračuna primernost za danega turista. V ta namen uporablja kombinacijo priporočanja na podlagi znanja in skupinskega filtriranja (collaborative filtering). Priporočanje na podlagi znanja primernost znamenitosti izračuna iz strokovnega mnenja o njeni pomembnosti in tega, katere znamenitosti so primerne za katere turiste na podlagi starosti, izobrazbe, narodnosti in finančnih sredstev turistov, ki jih ti lahko vnesejo v svoj profil. Če je profil na voljo, je prednost tega načina priporočanja, da deluje takoj – ne potrebuje nobenih predhodnih ocen znamenitosti ali turista. Skupinsko filtriranje pa primernost izračuna iz ocen, ki so jih znamenitosti dali drugi turisti, ki so v preteklosti izkazali podoben okus kot turist, za katerega se primernost računa.

V drugem koraku se znamenitosti na podlagi primernosti, ki jih izračuna priporočilni sistem, in njihovih zemljepisnih položajev uvrstijo na program ogleda. [2]

2.2 Uporabniški vmesnik

Načrtovanje ogleda (slika 2) se prične z izbiro regije katero si želimo ogledati. Če v regiji lahko obstaja več občin, te se nam prikažejo ob kliku na regijo. Uporabnik lahko na to izbere določene občine ali pa pusti izbrano celotno regijo. Trenutno pokriva sistem 13 regij v Sloveniji, preko administrativnega vmesnika pa je mogoče regije poljubno urejati ali dodajati. Potem, ko si uporabnik izbere regijo oz. kraj, si lahko po želji nastavi tudi čas kosila, pričetek izleta, čas katerega ima na voljo, število dni trajanja izleta in prevoz s katerim bo odšel na izlet. Ta je lahko peš ali pa z avtomobilom.



Slika2: Načrtovanje ogleda

Program ogleda (slika 3) je sestavljen iz znamenitosti in podznamenitosti. Ob kliku na znamenitost se nam na zemljevidu prikaže naslov znamenitosti in trajanje ogleda. Več o znamenitosti si lahko uporabnik ogleda s klikom na gumb "več" (slika 4). Tam je na voljo tudi govorni opis in slika znamenitosti.

Zemljevid ogleda (slika 3) prikazuje pot ogleda, Z različnimi barvami so prikazane znamenitosti na programu, znamenitosti ob poti, turistična infrastruktura (npr. informacijske točke) in ogledane znamenitosti.



Slika 3: Program in zemljevid ogleda

Blejska kremšnita



Kremna rezina iz listnatega testa, polnjena z vaniljevo kremo posebnost.



Slika 4: Ogled podrobnosti turistične znamenitosti

2.3 Administrativne spletne strani

Administrativne strani omogočajo uporabniku urejanje lokacij in urejanje turističnih znamenitosti.

Urejanje lokacij določita geografski položaj in okvirna velikost (polmer).

Urejanje znamenitosti med urejanjem znamenitosti se vnesejo opis s slikami in bogati metapodatki. Med metapodatke spadajo: naziv, naslov, vrsta, strokovna ocena, geografski položaj, odpiralni čas, čas ogleda, dostopnost za osebe z gibalnimi omejitvami, raznovrstna dodatna ponudba, podatki o starših in otrocih, ki sestavljajo hierarhijo podznamenitosti, ter podatek o

tem, ali znamenitost v resnici ni znamenitost, temveč del turistične infrastructure in podatek za kakšne profile turistov je znamenitost primerna.

3. POVEZAVA SISTEMOV TURIST IN AS-IT-IC

AS-IT-IC sistem je še v fazi razvoja, naloga sistema bo pomoč turistom pri načrtovanju njihovih čezmejnih obiskov, spodbujanje k odkrivanju manj znanih zanimivosti in omogočanje kvalitetnejšega izpolnjevanja želja kot obstoječi sistemi. Lokalne skupnosti bodo obiskovalcem učinkoviteje ponujale lokalne storitve in informacije, npr. organizator lahko vključi obisk obrtnika/umetnika glede na želje in tako poveča prodajo.

Glavna prednost sistema bo pogovor turista in sistema v naravnem jeziku npr. "Vse reke na dolenjskem".

Cilj povezave sistemov je, enostavno načrtovanje krajše in večdnevne poti, ki vključujejo obisk naravne in kulturne dediščine, z možnostjo primerne nastanitve. Pri načrtovanju večdnevne poti, zlasti pri čezmejnem območju, je običajno potrebno veliko truda za zbiranje informacij od začetne točke, nastanitve, do najboljših poti - informacije o ciljnih lokacijah so razpršene, opisi za mesta so na voljo v različnih jezikih, itd. Računalniški programi so dobri pri vključevanju in analiziranju velikih količin podatkov, filtriranju informacij ter računanju optimalnih rešitev. Zato je potrebno orodje, ki omogoča uporabniku, da hitro ustvari pot v skladu z željami in parametri.

3.1 Potrebne nadgradnje Sistema Turist

Za povezave sistemov bo potrebno razviti različne API ("Application Programming Interface") vmesnike za namensko programiranje. [4] API je namenjem naprednejšim uporabnikom ter razvijalcem in omogoča dostop do storitev sistema preko HTTP zahtevkov. Storitve bodo vračale tekstovne odgovore v formatu, kot je npr. JSON.

Do sedaj smo že razvili API za dodajanje novih znamenitosti v podatkovno bazo, kateri je opisan v nadeljevanju. Potrebno pa bo še razviti API za priporočanje znamenitosti, in gradnjo načrta poti.

3.2 API za vnos novih turističnih znamenitosti

V obdelavo smo dobili veliko količino podatkov o turističnih znamenitosth v Sloveniji, katere smo predhodno na strežnik zapisali v podatkovni obliki JSON. V ta namen smo razvili API preko katerega so nam bili podatki na voljo, ta nam je ob klicanju vračal objekt tipa JSON. JavaScript Object Notation ali JSON, [3] je odprtokodni format datoteke, ki uporablja človeško berljivo besedilo za prenos podatkovnih objektov, sestavljenih iz parov atributnih vrednosti in podatkovnih tipov matrike (ali katerekoli druge serijsko spremenljive vrednosti). To je zelo pogosta oblika podatkov, ki se uporablja za asinhronsko komunikacijo brskalnika / strežnika.



Slika 6: Delovanje JSON formata datoteke

Turistične znamenitosti so bile zapisane kot objekti, kateri so vsebovali trinajst atributov: ime atrakcije, povezava na spletno stran, naslov atrakcije, telefonska številka, spletna stran, oznake, tip atrakcije, opis, fotografija, ime regije, ime občine, gpsX in gpsY.

Znamenitosti je bilo sprva potrebno prebrati, jih filtrirati in grupirati po regijah. V drugem koraku smo podatke shranili v podatkovno strukturo in naprej v obstoječo podatkovno bazo sistema Turist (**slika 7**).



Slika 7: Potek vnosa novih znamenitosti v obstoječo podatkovno bazo

API funkcija za branje novih turističnih znamenitosti iz strežnika pošlje podatke o turistični znamenitosti v JSON obliki v obdelavo modulu za vnos novih znamenitosti.

Funkcija za filtriranje vstopnih podatkov omogoča kasnejšo lažjo obdelavo. Ker vsi atributni niso potrebni za vnos v obstoječo podatkovno bazo Sistema Turist, je najprej potrebno pobrisati nerelevantne attribute. Po tem sledi filtriranje znamenitosti, katere ne vsebujejo atributa občina. Na podlagi atributa naslov, je na to potrebno istancam določiti občino kateri pripadajo, tako da lahko kasneje instance grupiramo po regijah.

Funkcija za grupiranje po regijah nam omogoča natančen zapis v obstoječo podatkovno bazo, tako da lahko dodamo nove znamenitosti v že obstoječe regije, pravtako pa regije katere še niso zapisane v podatkovni bazi vpišemo na novo. Začetnim trem regijam Slovenska Istra, South Holland in Srce Slovenije smo dodali še enajst novih: Gorenjska, Goriška - Smaragdna pot, Jugovzhodna Slovenija, Koroška, Notranjsko - kraška, Obalno - kraška, Osrednjeslovenska, Podravska, Pomurska, Savinjska, in Zasavska.

Funkcija za zapis novih znamenitosti, se sprehodi po vseh prebranih turističnih znamentostih, katere smo predhodno obdelali (filtriranje, grupiranje, vpis novih regij) in jih sproti zapisuje v

obstoječo podatkovno bazo. Med obdelavo so instance shranjene v pomnilniku računalnika. Po končanem zapisovanju lahko s pomočjo administrativnih spletnih strain opisanih v razdelku 2.3 preverimo pravilnost in smiselnost podatkov, da med samim zapisovanjem ni prišlo do kakšnih napak.

S pomočjo API-ja za vnos novih turističnih znamenitosti smo tako število turističnih znamenitosti iz 300 povečali na skoraj 3000.

4. ZAKLJUČEK

V članku smo predstavili obstoječi sistem za načrtovanje izletov Turist in povezavo sistema z novim sistemom za pomoč turistom pri načrtovanju njihovih čezmejnih obiskov AS-IT-IC. Podrobneje je predstavljeno delovanje Sistema Turist, v nadeljevanju pa potrebne nadgradnje. Opisan je tudi API za vnos novih turističnih znamenitosti v obstoječo podatkovno bazo.

Zaradi velikega števila novih neobdelanih turističnih znamenitosti in morebitne kasnejše uporabe tudi v drugih sistemih je bilo nujno potrebno razviti API vmesnik za vnos novih turističnih znamenitosti.

Vmesnik nam omogoča vnos novih turističnih znamenitosti preko HTTP zahtevkov. Programerju tako ni potrebno podrobno poznati delovanja API-ja. Tako lahko API uporabimo v bodoče tudi za morebitne druge naloge.

V prihodnje je potrebno zaradi povezave sistemov razviti še API kateri bo nudil funkcije za priporočanje znamenitosti, in gradnjo načrta poti. API bo preko HTTP zahtevkov klican iz strain sistema AS-IT-IC.

5. LITERATURA

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Open Questions of Technology Usage in the Field of Tourism^{*}

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ABSTRACT

The focus of this paper is to identify and discuss requirements necessary for a tourism recommender that is capable to interact with customers naturally in order to identify their wishes and needs in order to plan for the best journey. For this purpose, we introduce a case study comprising a typical conversation between a customer planning a trip and the system. We further on use this case study when discussing available solutions in order to identify shortcomings. We summarize the findings and come up with open research questions to be tackled in order to provide methods and techniques needed when developing a recommendation system for tourists.

Keywords

intelligent recommendation systems; trip planning; requirements for tourist applications

1. INTRODUCTION

In the last years a lot of booking portals and other tourism applications have been arising, which people use regularly. Most of these applications provide specialized services and functionality but do hardly really cover interactions occurring for example in a travel agency when customers plan for their vacation. Hence, more sophisticated tourism applications are required that allow interactions with customers to identify needs and wishes for recommending traveling plans considering requirements like the available budget, the customer's interests, routes, and available dates. Such tourism systems need to provide and integrate chat functionality, booking systems, travel planning, and recommendation technology to identify the best match between the customer's requirements and available offers.

In order to come up with a general tourism application, we need to identify potential use case scenarios from which we identify the most general system requirements. In addition, we need to know potential competing systems and their shortcomings in fulfilling the obtained requirements. From the requirements, we also are able to extract new challenges that serve as foundation for research in order to come up with methods and techniques that allow to develop the indented general tourism application. One example of such an open issue necessary to be closed, corresponds to the question of how to deal with inconsistencies that naturally arise during a conversation when searching for the best customer solution. There might be wishes like always staying overnight in a five star hotel, which might be in contradiction with the available budget or the chosen route in cases of unavailability of requested hotels. Therefore, systems have to adapt constantly during a conversation which requires solving inconsistencies and also obtaining knowledge to further enhance future recommendation interactions with the same customer.

In this paper, we start describing a general use case for a tourism recommendation system that interacts with customers in the context of the AS-IT-IC project¹. This use case is further on used for identify shortcomings in available tourism systems considering planing a whole journey. In particular, we discuss TripAdvisor² and Google Trips³ in detail. Afterwards, we summarize the findings and identify research questions to be tackled in order to really come up with a general tourism recommendation system that is able to naturally interact with users in order to find the best traveling solution based on availability of resources and the customer's needs and wishes.

2. USE CASE

In the following use case, we discuss a typical scenario occurring during a recommendation session with a tourism application we have in mind. In this use case, we mainly focus on the interaction between an intelligent tourism recommender and ignore other means like human interventions into the process. The purpose of this use case is to identify requirements and needs for a tourism recommendation system to be developed.

^{*}Authors are listed in alphabetical order.

¹See https://as-it-ic.ijs.si/

²See https://www.tripadvisor.com

³See https://get.google.com/trips/

Use case 'Trip to Europe'. John is an American businessman who is interested in modern architecture and art, natural heritage, and ethnic culinary. For his next trip, he and his family would like to visit the central European region, specifically Graz. He wants a truly customized package of experiences, not a standard tourist package which he would be offered to him in a local tourist office. He can also use the internet search to obtain the information on his own. But John neither wants to a standard package nor search on his own. So he decided to use again an application which provides recommendations, based on his interests and previous visits, human-like, but fully automated, communication via a chat interface and an easy to use interface via his mobile devices.

Therefore he visits the application and chooses to log-in since he can use one of his many identification providers such as Google or Facebook. After log-in, he checks his previously specified preferences and the basic information about himself, like his age, gender, and his interests. Next, he clicks on a button to launch a new tourist session. Immediately, he is greeted by a virtual assistant, which asks him which places John would like to visit. The assistant takes into account the provided answer and John's interests and recommends him some natural and the cultural sights in the Slovenian-Austrian cross-border area.

The virtual assistant first asks John about the basic trip dates, like start date, duration, the number of travelers, travel radius and cause of the stay. After answering these questions, the assistant offers him several interesting sights in Graz like the Kunsthaus, the Eggenberg palace, and the Schlossberg. All these recommendations are based on his profile, which he defined, and his past trips. By accepting several sights, the system tries to find other fitting sights as well. Although John's travel radius is too small for some interesting sights in Ljubljana, the assistant offers him some of these because of his strong preferences to this sort of sight. The assistant included an offer of a car-rent as well for the travel from Graz to Ljubljana. John accepts this offering because he really likes the pictures and information, that the assistant provides to him. After selecting the sights, he wants to visit, the assistant starts to show him some possibilities to eat lunch and dinner during his visit. In his past travels, John prefers quite expensive restaurants, because on business trips he does not really care. The assistant shows him that kind of restaurants in Graz and Ljubljana, but he denies them because of the estimated costs. The system adapts to the new situation and shows him lower priced restaurants. John browses through the provided information of the restaurants and selects his preferred places. The last step is the selection of the hotel. The system knows that the hotel has to be family friendly and needs to be located next to the sights he wants to visit, because of the answers before. The system lowers also the price range of the hotels.

The assistant now finishes the session with calculating the optimal path for his travel and offers him the possibility to book all necessary hotels, attractions, transportation and sights in a convenient way. The travel information is now provided within the application and could be easily accessed from every device John uses.

3. **REQUIREMENTS**

The use case shows many features and requirements to an application which is important for a user experience we propose.

3.1 Natural Language Interface & Chat bot

A natural language interface is a great way to interact with a user in a more natural and interactive way. Therefore it is necessary to ensure that the system can process many kinds of information via a natural language interface. Talking to a virtual assistant enhances the user experience and allows new ways of helping the customer to achieve his goals. The technological challences lie in the problem that a conversation could involve many topics and domains which is not easy to cover (see also [1], [2], [3]). This level of complexitiy drops to some extent by narrowing the domain to the touristic sphere. Nevertheless stays the complexitiy on a very high level.

3.2 Recommendation

The task to recommend hotels, sights, etc. to customers is a very important task, because the time they want to invest in their trip planning seems decreases. There are also several stakeholders in this process of recommendation. Hotels want to sell their product, attractions want visitors, customers want a perfect vacation experience. Here it is necessary to find a balance between each of these interests.

The recommending strategies of the available platforms and applications did not consider the user's interests in the first place. There is no profile and not enough information available to ensure qualitative recommendations. The user could choose from several packages or has to plan the days on his own. There is no really customized and intuitive way to plan such trips. The process of trip planning has to become more humanized.

The approach, shown in the use case, by using the profile and past trips to recommend the customer also shows that this could lead to problems when the parameters for the trip are different to everything before. There the system has to adapt itself to the new situation and should be able to learn from this new kind of information. Maybe the change in behaviour is triggered by the weather, the fellow travelers, the purpose of the travel or other external factors. The system should detect this kind of changes, adapt for the specific session and ask the customer where the change of behaviour come from.

3.3 Trip & route optimization

The trip and route optimization is the next and last step in a trip planing procedure. The distribution of places should be evenly throughout the stay addressing the duration every sights need to consume. The route should be short, but scenic. The tourist needs enough time to visit the sight and should not feel like in a hurry.

4. AVAILABLE APPLICATIONS AND PLAT-FORMS

In the following section we discuss the main and established contendors in trip planning as well as new and arising platforms.

4.1 TripAdvisor

TripAdvisor is a platform, owned by the identically named American company, which provides information and recommendations of sights and hotels, as well as hotel booking features and more. It offers customers to share their experiences and opinions with a large user audience. Originally founded as an aggregator of professional reviews, found in newspapers, guidebooks, and magazines, it evolved into a user-generated content platform.



Figure 1: A trip view in TripAdvisor

The platform aggregates now all kind of information, like pictures, texts, ratings or tagging. It includes recommendation features to provide advices for traveling to a specific city.

It provides a feature to plan specific trips and book hotels and visits from the platform. After selecting a name for the trip, the destination and the date of the trip, the platform enables the user to select several sights and attractions. These places could be planned on days. A map of and routes between them is also provided.

The integrations to book hotels or reserve tables in restaurants exist but do not submit every needed information to the other portal which implies more hassle for the booking tourist.

4.2 Google Trips

Trips is a service by Google which provides similar features than TripAdvisor. It allows marking sights which should be visited during the trip. It also provides several predefined sights packages, which could be visited in a day or more. The ways between are already calculated and time approximated. Another way is to define your own custom day sightseeing. There you could select some sights and pin them to your route. After that, the application could add sights on the way to complete a full day. After saving the package it is available in the trip view.



Figure 2: A trip view in Google Trips

It works tightly together with the product Google Maps (see [4]) . The ratings, top comments, and some pictures are shown in the Trips app, along with phone number and website. There is no possibility to comment or rate there. If you want to comment or rate the sight, it is necessary to switch to the Maps App to do so.

The app works well with Gmail. Tickets and Reservations are extracted from Mails and put into a section of the trip view. There they could be easily accessed in one place during the actual trip. This integration improves the user experience, but shows the high level of data analysis and interconnection within the Google services.⁴

⁴See http://inbox.google.com

4.3 AS-IT-IC

The project AS-IT-IC will provide an application, which allows user to interact with human and virtual assistants to plan trips to Austria and Slovenia. The usage of chat bots enhances the possibilities of tourist centric applications in a great way. It allows a 24/7 coverage of user requests. The capabilities of chat bots are a bit restricted today but the field is subject to a rapid development. The recommendations will come from members of tourist offices and other involved people as well as virtual assistants. Aside from recommendations, the platform will support booking hotels and restaurants in a convenient and easy way.

The knowledge base of the platform stores hotels, sights and other points of interest. Aside of the typical information about a place, it stores also information about the estimated duration to visit it.

The trip is planned during a normal chat conversation. This planning could be done with a member of a tourist office or with the virtual assistant as conversation partner. After determining some basic information the platform shows several recommendations and possibilities to visit. After selecting the desired sights, hotels and eating spots the platform automatically calculates a convenient way through the points of interest.

	Trip Advisor	Google Trips	AS-IT- IC
Recommendations	+	+	+
Reviews	+	+	+
Rating	+	+	+
Manual planning	+	+	+
Auto planning	-	+	+
Preplanned packages	-	+	+
NLP & chat bots	-	-	+
Chat interface	-	-	+

 Table 1: Comparison of the platforms

5. DISCUSSION AND CONCUSION

The compared platforms show many possibilities and features which are useful for a good user experience. The following table (see Table 1) shows a quick overview of the supported functionalities of every platform.

Ratings, reviews and recommendations in any way are broadly used in this applications. There are differences between the level of integration and automation of these functionalities. Planning features are also differently implemented in the reviewed platforms. Trip Advisor lacks fully automatic planning.

As part of our research effort, natural language processing, chat bots and chat interfaces will be supported by the platform AS-IT-IC. It brings this technology in a new way to the field of tourism. That makes it unique to some extent throughout the reviewed products. However, in order to support the prototyping of such a product, several research challenges need to be addressed within the project. First, the fact that AS-IT-IC deals with local cross-boarder content, there is the risk of inconsistencies among the various data sources. Data is retrieved from local tourism offices, in at least two languages and these data sources are possibly enriched with timely information (local tourism events etc.). Considering the high granularity and large diversity of the collected data and the fact that NLP and chatbots introduce additional inconsistencies in terms of data obtained from interaction with the user, it is of uttermost importance to address these issues. That is, one of the crucial questions is to provide recommendation systems [5] that can handle such inconsistencies such that the user is seamlessly guided when planning his trips.

In this article we motivated the AS-IT-IC project and illustrated a use case in the field of tourism. Afterwards we briefly discussed the requirements wrt. natural language interfaces and chat bots. We listed the central features of two well-known products in this field and focused on the challenges in designing the features for natural language processing, chat bots and the chat interface. One of the major issues is the handling of inconsistent information. These kind of information arises due to the multi-language interface, the granularity of cross-boarder relevant data and the interaction with the user.

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Testing of Artificial Intelligence Applications *

A State of the Art Survey

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ABSTRACT

Verification and validation are procedures that are used together for checking that a product, service, or system meets requirements and specifications and that it fulfills its intended purpose. With the advent of artificial intelligenceenabled applications, there is an increased pressure to test such systems. In this article we present a survey on the state of the art in testing artificial intelligence applications. We present the general publication population in this area and discuss the open challenges and issues when it comes to verification and validation of artificial intelligence software.

Keywords

test, software test, verification, validation, adaptive systems, software evolution $% \left({{{\left({{{{\left({{{}_{{\rm{s}}}} \right)}} \right.}} \right)}_{\rm{software}}} \right)$

1. INTRODUCTION

Verification and validation is one of the most important activities carried out during system development to assure system quality. The purpose of verification is to assure that a system fulfills its specification, whereas validation deals with assuring that the system implements the functionality users are expecting. Hence, verification answers the question whether someone has built the system right, whereas validation deals with the question: "Have I developed the right system?". Testing (see e.g. Myers [6]) is one activity that can be used for both validation but also verification. Quoting Edsger W. Dijkstra "Testing shows the presence, not the absence of bugs" it is obvious that the purpose of testing is to find faults in the system but there is no guarantee to find all of them before deployment. Nevertheless, testing is inevitable for quality assurance, which cannot be superseded by formal proofs as said by Donald Knuth: "Beware of bugs in the above code; I have only proved it correct, not tried it.".

Unfortunately, testing as a necessary activity within the software engineering process has gained only little attention in

Artificial Intelligence (AI). It is often assumed that an implementation of an algorithm works as expected because of available correctness, termination, and completeness proofs. However, often systems fail because of underlying boundaries like memory limitations, or the used data structure, causing a system to crash. Unfortunately, such bugs are hardly considered during formal verification based on mathematical proofs. The necessity to deal with testing is further supported considering a most recent example. In Tom Simonite's Wired article, Even Artificial Neural Networks Can Have Exploitable 'Backdoors'¹, the author mentioned the case where a neural network can be trained to behave differently in identifying a traffic sign in cases with or without attaching a post-it note. Such behavior can have severe consequences in real life and thus testing AI systems is required.

In this paper, we focus on the current state of the art in testing AI applications. In particular, we are interested in finding out whether there are already testing approaches used in the context of AI applications and also to discuss future research directions and open challenges. The goal behind is to prepare for testing an application in the area of tourism recommendation systems where we are interested in finding the right testing technique to be applied before deployment in order to capture the most important bugs during development. This paper is organized as follows: First, we discuss the research design behind the survey including the tackled research questions, the analysis procedure and the study results. We further on discuss the obtained results and come up with open research questions. Finally, we conclude the paper.

2. RESEARCH DESIGN

Our objective is to capture the field of testing wrt. applications that exhibit intelligent behavior, i.e., a software that perceives its environment and takes actions to maximize its chance to achieve a specific goal. In this context, the software mimics cognitive functions such as learning or problem solving. By analyzing the exiting pool of publications, we provide a snapshot that further will be used to analyze trends or to identify gaps. Therefore, we identify the research questions first.

^{*}Authors are listed in alphabetical order.

 $^{^1 \}mathrm{See}$ https://www.wired.com/story/machine-learning-backdoors/

Research questions:

- RQ 1: What is the general publication population when it comes to testing AI-enabled applications? This research question aims to structure the publication pool on and around testing AI-enabled applications. In particular we are interested in the research type facets in this evolving field of research.
- RQ 2: What types of research contributions are in place regarding software testing of AI-enabled applications? This question deals with the addressed topics and major contributions (e.g., models, theories, frameworks, guidelines, etc.).
- RQ 3: Can we observe trends respectively are there significant open challenges and issues? The last question will investigate the focus point and strive to identify gaps in order to sketch possible future research on testing of AI-enabled applications.

In this study we collected data from two sources. First we carried out a query via Scopus^2 document search. Second we considered articles published in workshop series specifically dealing with realizing artificial intelligence synergies in software engineering [5, 4, 10, 9, 1].

Query construction: In a worksop we defined the keywords that we are interested in. Since we are interested in articles that investigate functional testing of of AI software we looked for the keywords 'test' or 'testing' and the keywords 'functional' or 'regression' or 'acceptance' and the keywords 'AI' or 'artificial intelligence' in the title or abstract. We performed an automated search that required us to filter the result. For example, we found a number of publications that are not in software engineering or computer science. We therefore cleaned the initial result by removing these publications and we removed duplicates.

Selection process: We classified the obtained papers as relevant or irrelevant to build the final set of publications for further investigation. We applied the criteria listed in Table 1.

2.1 Analysis and classification

On the final set of publications we carried out the analysis and classification. The classification has been carried out in two dimensions. We classified every selected publications according to the research type as proposed by Wieringa et

Table 2: Research type facets for our survey(Wieringa et al. [13]).

research type	description	
evaluation research	an implementation has been carried out, evaluation of implementation has been conducted, requires more than just one demonstrating case study	
solution proposal	a solution of the problem is proposed, benefits/applicability is demon- strated by example, this includes proposals complemented by a demon- strating case study, however, no dissemination plan is obvious	
philosophical paper	paper comes up with a new way of thinking or structuring a specific field, e.g., in the form of a taxonomy of con- ceptual framework, secondary studies like systematic literature reviews or systematic mapping studies	
opinion paper	captures a personal opinion, the work however, is not grounded in related work or research methodology	
experience paper	captures personal experiences and de- scribes how things are done in prac- tice	

al. [13]. Table 2 illustrates the proposed research types. In order to characterize how a specific research type contributes to the body of knowledge regarding the testing of AI-enabled applications we used contribution type facets as proposed by Shaw [8]. Table 3 lists the criteria for these specific facets.

3. STUDY RESULTS

In this section, we present and discuss the results of our study. In particular we address the research questions raised in the previous section.

3.1 RQ1: General publication population

To get an overview of the selected publications, we performed a categorization and defined the research type and the contribution type. Table 4 provides an integrated picture

Table 3: Contribution types for our survey ([8])

contribution type	description
	representation of observed
model	reality by concepts,
model	representation after
	conceptualization
theory	construction of a
theory	cause-effect relationship
	framework of method
framework	related to testing
	of AI-enabled systems
guideline	list of advices
loggong loonnod	number of outcomes from
lessons learned	obtained results
tool	a tool supporting testing of
1001	AI-enabled systems

²see www.scopus.com
Table 4: Integrated picture: type of research in the obtained result set (numbers in percent)

evaluation	solution	philosophical	opinion	experience
research	proposal	paper	paper	paper
11	50	31	4	4

Table 5: Integrated picture: type of research in the obtained result set (numbers in percent)

model	theo.	fw./ meth.	guidel.	less. lear.	adv.	tool
11	4	60	0	8	3	15

that shows the papers in the different categories. Regarding the research type facet, our analysis reveals that the majority of the contributions deal with solution proposals (50 percent) and philosophical papers (31 percent). Taking into account the fact, that most of the publications appeared in the last couple of years, the classification according to research types indicates a evolving research field. Only a minority (11 percent) of the research papers are classified as evaluation research.

Table 5 aggregates the contribution type facet and shows a similar tendency. From the 53 papers in the result set, almost 60 percent contribute frameworks or methods, followed by models (11 percent) and tools (15 percent).

3.2 RQ2: Research contributions

From the analysis using the basic classification schemas, we see a clear trend towards solution proposals and the majority of the proposed solutions considers frameworks or methods. A second trend is the appearance of philosophical papers. Regarding the solution proposals, approx. 19 percent (10 out of 53 papers) are classified as framework/methods, i.e., solution proposals without any evaluations beyond a demonstrating case study. In summary this indicates an emerging research field that is developing new approaches but the field yet lacks evaluated models and /or sound theories. Figure 1 illustrates a systematic map over research- and contribution types.

3.3 RQ3: Trends and open challenges

As outlined previously, the majority of the contributions address testing of AI-enabled software in terms of a framework or method at the level of a solution proposal. The first publications date back to 1991 and deal with testing of expert systems in the field of flight software [2] followed by the testing of AI-applications for satellite command and control [7] in 1996. In the recent past, the number of publications dealing with verification and validation of AI-application has risen. In [3] the authors present an analysis of the problems and lessons learned from the deployment of an artificial intelligence based financial application that was developed and commercialized later. Regarding the research to development interface, the authors state the difference between an experimental AI, with its quirks and oddities; and a development tool that must be a reliable and testable product. During this transition the authors encountered the problem of being able to confirm that the software, after optimizations and modifications, was functionally equivalent to



Figure 1: Systematic map over research- and contribution types.

the original software. They necessitated the development of repeatable 'intelligence tests' that could be automated to confirm that no functional changes occurred. Most notably, this article reports on lessons learned to smooth the transitions along the path from a research project to a commercially deployed artificial intelligence application. In [11] the authors describe their early experiences of using agile techniques while developing a solution to a specific, multiobjective real world problem called the United States Navy Sailors' Assignment Problem. Because the investigators are working in a research environment where the results produced at intermediate stages cause the requirements to continually change, an agile software development methodology was deemed most appropriate. Although the research team applied several agile practices, the paper emphasizes their experiences when performing test-first or test-driven development. Whereas the latter contribution focuses on testing within an agile process when developing an AI-research prototype, at the other end of the spectrum, publications deal with automated learning of the behavior of evolving functionality. For example, the authors of [12] show that model-based testing allows the creation of test cases from a model of the system under test. Often, such models are difficult to obtain, or even not available. Automata learning helps in inferring the model of a system by observing its behavior. Under some assumptions, for dealing with nondeterminism, input-enabledness and equivalence checking, the authors prove that the algorithm produces a model whose behavior is equivalent to the one under learning. To what extent this method is applicable to learn the behavior of AI-enabled applications is an open issue.

4. THREATS TO VALIDITY

As a literature study in an emerging research field, this study may suffer from potential incompleteness of the obtained results. Also the study may exhibit a general publication bias, i.e, positive results are more likely published than failed approaches. For example, to our best knowledge, the result set does not contain papers that report on failed attempts to testing of AI-enabled applications. We counteract this risk by providing the result set to other researchers³ and encourage them to continue this line of research. Among the major threats is also the threat regarding internal validity. Internal validity of the study could be biased by personal ratings of the authors. To counteract this risk we used supporting tools in cleaning, study selection and classification and in particular carried out this work in a peer setting.

5. DISCUSSION AND FUTURE WORK

In this article we analyzed the publication flora in the emerging field of testing AI-enabled applications and structured the general publication population in this field. We analyzed 53 contributions and conclude that the majority of the papers are solution proposals, i.e, proposed methods of frameworks that are illustrated in terms of a single case study. There is lack of evaluation results and to our best knowledge we cannot report on an article proposing a sound theory of testing AI-enabled applications. Although numerous applications appeared in the recent past, we lack papers that in particular deal with systematic testing of such applications. Most of the investigated articles address testing in a broader sense (namely verification and validation). Testing is about finding critical faults within the implemented software, such as mentioned in the introduction (memory limitations, data structures and configuration issues). In deploying AI-enabled applications, testing will become a necessity for professional software engineering of AI-applications. Research in this direction, in particular contributions dealing with conceptual and formal models, and sound theories alongside with evaluation research is thus highly desirable in setting up future research.

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Virtual Assistants for the Austrian-Slovenian Intelligent Tourist-Information Center

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ABSTRACT

We present a virtual assistant for the Austrian-Slovenian Intelligent Tourist-Information Center (AS-IT-IC - project within the Cooperation Programme Interreg V-A Slovenia-Austria, period 2014-2020) that can answer questions and hold a conversation on the topic of natural and cultural heritage sights. The prototype is currently integrated into the AS-IT-IC communication platform prototype and Slack application and communicates in Slovene language. During the AS-IT-IC project the virtual assistant will be expanded to other languages (English and German) and other communication platforms.

Keywords

virtual assistants; chatbots; chat platforms; tourism; natural language understanding; AS-IT-IC project

1. INTRODUCTION

Virtual assistants (VAs) or chatbots are software programs that can interact with the user through a vocal, textual or graphical user interface (or a combination of them) usually mimicking the way humans converse. Continuous advances in artificial intelligence technologies, particularly text processing and natural language understanding, have greatly increased the performance of VA systems. Easily accessible tools for creating such systems (examples are API.ai¹, Wit.ai², and Microsoft's bot framework³) together with the widespread adoption of chatting platforms and mobile electronic devices, have caused the number of VAs available to a user to increase significantly in the past few years.

1.1 Virtual Travel Assistants

Tourism is one of the industries where VAs can provide a significant added value as is evident by the increasing number of tourism or travel chatbots. Travel chatbots usually aim to enable:

¹https://api.ai

- 1. Quicker and smarter booking.
- 2. Quicker and more entertaining travel options and destinations searching process.
- 3. Personalized city tour guides.
- 4. At least partial automation of call centers and information offices.

Existing travel bots usually specialize in one aspect of travel and can be sorted into one of the following categories:

- 1. Customer service/info bots. Usually very limited assistants that offer information about a certain business where the user talks to the VA instead of consulting complicated FAQ pages. Examples include Ana⁴ and Julie⁵.
- 2. Travel options searching and booking bots. These assistants allow one to search and book a flight, hotel, drive or restaurant through a conversation. This is usually more time-consuming than using a graphical user interface (GUI) with well-known and established web forms. However, some search domains are easier to navigate using natural language, therefore with the advance of natural language understanding tools and their easier integration into conversation platforms the options for innovation will increase. Examples of such assistants are the Expedia Facebook Messenger Bot (hotel search) and the Skyscanner Facebook Messenger Bot (flight search).
- 3. *Human assisted bots.* Despite the advancements in natural language understanding research and the rising popularity of fully automated VAs the chatbot-only response is rarely of good quality. Until enough usage data is gathered and several conversational corner

 $^4 \rm https://connectmiles.copaair.com/en/web/guest/ask-ana <math display="inline">^5 \rm https://www.amtrak.com/about-julie-amtrak-virtual-travel-assistant$

²https://wit.ai

³https://dev.botframework.com

cases are addressed, the human-in-the-loop approach seems to be the most effective assistance. The user may communicate through a familiar chat interface with a VA and when the VA is not sure about the answer it forwards the question and the conversation history to a human operator, who continues the conversation with the user. Examples include Tradeshift Go, Pana⁶, Lola⁷, and Mezi⁸.

1.2 AS-IT-IC Project

Austrian-Slovenian Intelligent Tourist-Information Center (AS-IT-IC) project was accepted in the cross-border Cooperation Programme Interreg V-A Slovenia-Austria in the programme period 2014-2020.

Currently the only way to obtain relevant information about cultural and natural heritage sights is through user-unfriendly web search, less known information sites (usually managed on the government or local authority levels), and then plan the trip using itinerary planners such as Google Maps⁹ or more advanced tour planners such as e-Turist¹⁰ [1] and TripHobo¹¹. ICT tools will be built within the scope of the project that will enable integration of several solutions: tourism information search, tour itinerary planning, sight and tour recommendations, and live-chat with the tourist information providers (service providers and tourist offices, municipalities, tourists and citizens) in one place - the AS-IT-IC Platform.

2. AS-IT-IC PLATFORM

The goal of the AS-IT-IC project is to integrate and upgrade the existing tools to enable smart tourism. The existing components that will be integrated into the AS-IT-IC ecosystem include (Figure 1): Rocket.Chat - a chat platform, e-Turist - a tour planner, Asistent - a rule based question-answering and natural language understanding toolkit. The existing components will be upgraded with application programming interface (API) implementations that will enable the use of their functionalities through third party applications and will be customized for the AS-IT-IC project.



Figure 1: AS-IT-IC ecosystem components

Additionally, services that will enable the integration of existing components will be developed: integrations that can use the Asistent and e-Turist as a service, conversational logic and webhooks that will use a natural language understanding toolkit on the backend, and several microservices that will extend the functionality of Rocket.Chat for the purpose of the AS-IT-IC project. Dashboards that will enable access and modifications of the existing knowledge base will have to be added, together with an ecosystem-wide usermanagement service that will allow for a seamless transition between applications, and a content system that will enable the ground truth knowledge base (multilingual tourist information data) to be used by the various components.

3. AS-IT-IC VIRTUAL ASSISTANTS

The AS-IT-IC VA will provide the integration of several services and tools: Hubot - bot infrastructure for Rocket.Chat, Asistent, natural language understanding toolkit, content system and third party services that will be integrated through the specialized bots (Figure 2).



Figure 2: Example architecture for the AS-IT-IC specialized bot

3.1 AS-IT-IC VA Components

3.1.1 Hubot

Hubot¹² is an open source chatbot framework that has built in support for the Rocket.Chat client. It provides a standardized way to create chatbots on several conversational platforms by matching patterns from user input and producing a response by calling custom JavaScript code that in most instances calls an external api. For the AS-IT-IC project, Hubot provides a way to call APIs exposed by the AS-IT-IC Virtual assistant and correctly displaying the results in the Rocket.Chat client.

3.1.2 Asistent

Asistent¹³ - slovenian for assistant ([2]) is a rule-based virtual assistant framework developed at the Jožef Stefan Institute, Department of Intelligent Systems. It enables the embedding of a floating window on a website, within which questions can be asked and the reply is presented, additionally the background web-page is changed to a page relevant to the answer.

Asistent provides a rudimentary API for posting questions and receiving answers, which will be upgraded during the project. The API exposes the endpoint /ask which takes the question as a URL parameter and responds with a json

⁶https://pana.com

⁷https://www.lola.com/welcome

⁸https://mezi.com

⁹https://www.google.si/maps

¹⁰http://e-turist.si

¹¹https://www.triphobo.com

¹²https://hubot.github.com/

¹³http://projekt-asistent.si/info/

document that contains the answer and, optionally, the url of a web-page with relevant information to be displayed in the background. An example query to ask who is the mayor of Ljubljana with the question in Slovenian being "Kdo je župan?" is (after url encoding the question)

http://projekt-asistent.si/ljubljana

/ask?question=Kdo%20je%20%C5%BEupan%3F. The JSON response from the asistent service is:

```
{
```

Additionally, Asistent enables the information providers to enter a custom knowledge base for the Asistent in the form of a triple: (question, answer, web-page), where the question is presented in the form of a rule using keyword stems and logical operators.

3.1.3 Natural Language Understanding Toolkit

Natural language understanding (NLU) toolkit enables the parsing of entities, parameters and intents from a natural language text. In a way NLU transforms non-structured text into a structured text that can then be used by other programs and services to provide functionalities for the user. Currently available NLU toolkits include API.ai, Wit.ai, Microsoft bot framework, and Rasa NLU¹⁴. The AS-IT-IC VA solutions will be designed in such a way that they will be as much toolkit-agnostic as possible. This will enable higher sustainability of the project results and lower the damage in cases of unavailable external toolkit services.

3.1.4 Content System

AS-IT-IC project partners have access to multiple databases with information about sights in the cross-border area. However, each database is in its own format with its own special fields. In order to provide a unified data interface for all systems integrated into the AS-IT-IC ecosystem, a separate Content system will be developed.

The goal of the Content system will be the integration of various information sources about sights into a database that will be easily updateable from the information sources and enriched with the data from third party content providers from the Internet such as TripAdvisor, Google Places and relevant tourist information websites. The content system will therefore facilitate machine-human cooperation, where some of the information may be pulled from third party websites automatically and a human may be able to view, edit or add sight entries. The REST API based microservice layer will be responsible for providing all the relevant information about a sight. Since a microservice approach to implementation will be used, the Content system will be accessible by several AS-IT-IC ecosystem components. At the moment the integration modules are developed for obtaining the information about sights from the web and transforming the data into a database schema used by the e-Turist.

3.1.5 Third Party Services

The biggest advantage of a VA is the possibility to integrate some third party applications into the chat platform. This greatly extends the functionality of the chat platform, brings all the interaction into one place and enables a userfriendly natural text based conversation interface for controlling applications. Several third party services will be integrated into the AS-IT-IC VA, most notably: internal solutions (such as Asistent, e-Turist, full-text sights search) and outside services (such as Google places, Google maps, TripAdvisor, restaurant bookings, hotel bookings, event ticket purchase). Some of these services already provide an API that will facilitate access for the VA, for others, however, wrapper methods will be implemented, which will then be used by the AS-IT-IC VA.

3.2 VA Prototype

In order to test the AS-IT-IC VA concept, we have implemented a tourist VA that the tourist can use to ask questions about a specific sight, a group of sights in a specific area, a specific group of sights, and to hold a conversation about a sight (preserving context and taking into account the conversation history). Currently, the prototype is implemented for Slovenian language, since the used service for full-text search is indexed only over the Slovenian content.

The prototype architecture is very similar to the example architecture for the AS-IT-IC specialized bot (Figure 2). For the NLU toolkit we have chosen Api.ai, another third party service that we integrated into the prototype was full-text search over the sights, instead of the Content API we have accessed the sights database directly through the ORM (object relational mapping) layer, conversation data was managed by the Api.ai chatbot framework, as well as the bot API. Additionally, we have provided rich message templates for bot integration into the Slack communication platform and custom Hubot scripts for integrating into the Rocket.Chat client, which will form the basis for the AS-IT-IC platform. Rich messages are only partially supported by the Rocket.Chat platform for now. To overcome this shortcoming we will implement custom frontend modifications and API calls for Rocket.Chat, which will provide the required functionalities. Rich messages are already supported by Slack, which was the reason we provided such integration. We will strive to provide services in a chat platform-agnostic way, which will allow us to easily transfer the bots to other messaging platforms such as Facebook Messenger, Microsoft Cortana, Google Assistant, WeChat, Viber and others.

3.2.1 VA Modeling and Integration

The VA intelligence comprises NLU and a webhook part.

NLU part comprises model training, entity definitions, and context specifications. In order to train the model to adapt it to the tourism domain we had to come up with several possible inputs from the user, when he/she communicates with

¹⁴https://rasa.ai/products/rasa-nlu/

the VA. Each input was classified into one of the following categories: welcome, general sights query, sight query near specific place, sight query in the specific region, similar sight query near specific place, similar sight query in the specific region, adding the sight to "must see list", obtaining the path to sight, sight recommendation. Additionally we have added a few small talk categories, allowing for the VA to answer questions about itself - what does it do, who developed it, how old it is etc.

Entities enable the VA to label a word or a set of consequent words and categorize it. We have added the following entities: *attraction name*, *attraction type*, *place*, and *region*. When enough training examples are given the NLU is able to infer the category on its own.

The webbook integrates the logic of the VA transforming the intents and entities provided by the NLU toolkit to commands and method calls. Additionally, the webbook may use original input text from the user to call third party APIs. In the case of the VA prototype, we have devised different methods that correspond to the intent, determined by the NLU toolkit. The original input text is transformed to a query that was tested to yield better results and the transformed query is then sent to the sight description full-text search service. The obtained response is then transformed to a rich message representation which is forwarded to Api.ai, which in turn responds to the client in its own format.

3.2.2 VA Interaction

The VA prototype supports the following types of questions by a user:

- 1. Show me some rivers in the Dolenjska region.
- 2. List the castles near Kranj.
- 3. (After asking about a sight in previous question) Recommend me nearby sights.
- 4. (After asking about a sight in previous question) How do I get there?

All the answers are provided in text form, with additional formatting when providing the description of a sight - url link to the detailed description, category and a location of a sight, quick description, interactive buttons for quicker interaction. An example is shown in Figure 3.

4. CONCLUSION

The paper presents the architecture and functionalities of the virtual assistant for the AS-IT-IC platform and its integration into the AS-IT-IC ecosystem. Additionally, a prototype VA was presented, which has already been integrated into the AS-IT-IC conversational platform and enables the tourist to search a particular sight, a set of sights of particular type, or obtain relevant information about a sight.

Future work will include the addition of other languages, primarily English and German and more thorough integration with the Rocket.Chat platform. Additionally, several other specialized VAs will be added, the integration of which will



Figure 3: VA interface in the Slack client

be based on the presented prototype, and the AS-IT-IC VA will be implemented. It will provide a unique access point to all the specialized VAs. This will provide easy access to available bots and a seamless experience for tourists.

5. ACKNOWLEDGMENTS

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Soočanje z demografskimi izzivi Facing demographic challenges

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FOREWORD

It is the 10th annual conference "Facing demographic challenges" and it represents a milestone in our endeavor. Not only has a candidate for Slovenian president submitted a paper and will present it at the conference, there are also several technical and overview papers representing a major shift in Slovenian demographic efforts. At the beginning of our conference, the Slovenian birth rate was close to 1.2, and while in recent years stagnating below 1.6, the major orientation of public was that there is nothing wrong with it.

There is no proof, but a correlation with our initial efforts to bring the Slovenian birth rate at least to 1.8 (with sustainable 2.1). Again, there is no proof that our efforts changed the climate in Slovenia, but it is more or less becoming clear that

- Slovenia cannot withstand the so low birthrate for a long period of time without serious consequences
- The world is moving towards the sustainable birth rate overall, and the number of children is becoming stable in the last decade
- The influx of refugees has to be systematically taken care of by preventing mass exodus and continuing with a relatively small immigration
- The refugee crisis is just the visible top of the tantamount demographic challenges Europe is facing. The decades of negligence of the demographic matters are at least for a while becoming visible to the political leadership and the public.

At the conference, we constantly emphasized that among often misunderstood issues is the European "demographic winter". Governments, public opinions and media often fail to understand the importance of population in the domains of economics, politics and other components of societal and individual standard of living. Studies show that the demographic challenges are directly linked to education, work and employment, health care, financial problems, retirement and other important topics of everyday life.

The developed countries, in essence nearly all Europe, are in the last decades facing a variety of demographic challenges, among them very low fertility rates that do not enable sustainable development. The underdeveloped countries, in particular in Sub-Saharan Africa, on the other hand, still maintain very high fertility rates which threaten to cause overpopulation and extinction of animal and plant species. As a result, Europe and its population have been becoming less and less relevant in the world. To which end?

It is particularly indicative that many European political leaders despite clear data reject all scientific warnings and reject open dialogue with civil and scientific communities. Slovenia is no exception in these issues. However, the public opinion is slowly bur constantly changing towards accepting scientific demographic studies.

The "Facing Demographic Challenges" conference deals with all questions related to the demography and population development, in particular:

- fertility	- economic aspects
- mortality/health care	- anthropological aspects
- migrations	- sociological aspects
- population ageing	- historical aspects
- family	- population projections
- solidarity between generations	- mathematical/computational models
- gender relations	- demography of national minorities
- moral / ideological influences	- theological aspects
- (rural) planning in new demographical conditions	- reforms

We present our analyses and hypotheses in the top academic environment, openly presenting the worrisome future trends. Not only that, based on national, European and global studies, we also discuss various potential solutions and propose them to our leading politicians and political institutions.

It is not that everything has been discovered in the demographic studies, in particular in measures to raise the too-low fertility rate and to decrease the too-high ones. New scientific studies in particular in relation to artificial intelligence indicate that there might be rather simple and inexpensive solutions to solve the abovementioned problems. For example, extensive maternity leave, recently including also the male partners, seems to have no influence on fertility. Why is it getting even extended if other measures are cheaper and more effective?

We continue to pursuit an ambitious goal – to enlighten Slovenian and European leaders with demographic problems and knowledge to enable them to govern the society better. And now it is becoming clearer than ever that the voices of the demographic science should be carefully studied.

Janez Malačič and Matjaž Gams

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ALBANIA AND KOSOVO IN FRONT OF CHALLENGES OF SUSTAINABLE DEMOGRAPHIC DEVELOPMENT

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ABSTRACT:

One of the most important elements for a sustainable development are demographic trends and developments, therefore, as such need to be incorporated in comprehensive analyses trying to find the interaction between demographic tendencies and a sustainable development.

In order to have a sustainable development of places, regions or municipalities there is a need to have a demographic sustainability.

Main topic of this work is the trend, presepective and challenges of a population development of Albania and Kosovo in the first half of the XXI century and consequences deriving from such development.

Albania and Kosovo are characterized with a specific demographic development compare to other countries in the region including Europe. The end of XXth century had a negative i mpact in this aspect due to a socio – economic and political developments in Albania and Kosovo. This period is characterised with massive migritaions specially of a population capable to contribute to demographic increase which affected the decrease of natality, marriages and other irregularities in structural population and other demographic and socio economic structures.

In order to avoid and decrease consequences of a negative demographic developments it's important to focus in the preparation of authentic politicies for population and ensure a sustainable demographic development which is seen as key precondition for a sustainability in different spheres of life.

Key words: *Population projection, Albania, Kosovo, sustainable demographic development, age structure, socio-economic structure, migration, challenges etc.*

1. INTRODUCTION

The minimum overall objective of sustainable demographic development in each country should be to reach a stationary population model that implies that the next generation is at least the same as the existing one.

In this context, a sustainable demographic development can be achieved by: ensuring the replacement of the population through appropriate substitution models of natural populations; establish a sustainable pattern of migration; create a demographic balance in population structure by age and sex; create and secure sustainability between the economically active and the passive population; create and secure sustainability in the labor force contingent; raising and improving the educational structure of the population education for a sustainable development etc.

Albania and Kosovo are characterized by specific demographic development compare to other countries in the region as well as Europe in general due to the low level of economic development, industrialization, urbanization and the unfavorable economic structure of the extractive industry (especially Kosovo), the general political situation and so on. The last decade of the XXth century., in both states is characterized by negative developments in all spheres of life: economic, social and political, which was manifested with negative impacts also in the demographic sphere. In both states this is the period of massive emigration of the population (open population), especially of that replicable which was manifested by the decline in fertility rate and natural increase, the decline in marriages, disorders in other structures of the population As well as the other consequences that were also documented with the 2001 census (Albania) and 2011 in both states.

The crisis of the 90s of the last century was manifested by:

- in Albania with the reduction of the total population -8.6%, fertility decrease from 25.8 % (1989) to 11.8 % (2011) and natural increase from 18.6 % to 4.9 %, while
- in Kosovo with a decrease of the total population -9.1%, a decrease in fertility from 30.5 % (1988) to 19.2 % (2011) and natural increase from 24.9 % to 15.1 %, which in both cases were accompanied by disorders in many spheres such as marriages, divorces, changes in the

population structure by age with the reduction of the participation of the young age groups and increased participation of the elderly.

2. DYNAMICS IN THE GENERAL NUMBER OF POPULATION

After the Second World War with the improvement of socioeconomic and sanitary conditions, the total number of the population has been increasing steadily in both countries (until the beginning of the 21st century), although the emigration continued at different intensities throughout the period The peak was reached in the last 10 years of the 20th century when was estimated that 35-40% of the total population of Albania and Kosovo emigrated. As a result of mass emigrations and losses in the 1999 war (Kosovo):

- Albania's population for the first time in the period 1991-2001 is characterized by a tendency of decreasing the overall number, while the trend of decline continues to reach - 8.6% in 2011, while
- the population of Kosovo for the first time in the period 1991-2011 is characterized by a tendency of reducing the total population to -9.1%.

According to the forecasts on which the paper is based (1.2), Albania's population has been introduced into the depopulation process, which will continue to deepen from decades to decades (see tab.1), while the population of Kosovo will show a growth trend By 2034 but these trends will be much slower than during the second half of the 20th century. XX.



Graph 1. Dynamics in the total population in Albania and Kosovo 1948-2061

Kosovo in 2034 will have 1935630 inhabitants. Thus, for 23 years (2011-2034) the number of inhabitants will increase to 155,609 inhabitants or 8.1%. The year 2034 represents the turnaround year when Kosovo will begin to face depopulation as a demographic problem, which from decades to decades will continue to grow steadily with an annual average of: 2031-2041, -0.05%, 2041-2051, -0.33 and For the period 2051-2061, -0.62%.

Table 1. Movement of the total population of Albania and Kosovo: forecast 2011-2061

Year	Albania	Annual Kosovo average %		Annual average %	
2011	2907362	-	1780021	-	
2021	2863311	-0.15	1883805	0.58	
2031	2782312	-2.83	1931957	0.25	
2041	2640893	-5.08	1923175	-0.05	
2051	2461958	-6.77	1859447	-0.33	
2061	2293467	-6.84	1743470	-0.62	

After the XX century when the population of:

- Albania marked a population growth of 183.6% (1945-1989), the first half of the century. The first phase will be characterized by a depopulation of -12.6% (2011-2031), while the second phase (2031-2061) will be the phase of accelerated depopulation process with a negative growth of - 17.6%, while
- Kosovo recorded a population growth of 139.6% (1948-1991), the first half of the century. The first phase will be characterized by slower population growth of 8.5% (2011-2031), while the second phase (2031-2061) will be the stage of the depopulation process with a negative growth of -9.8%.

By the end of the century, the process of depopulation in Albania and Kosovo will be further deepened if does not occur unexpected positive or negative developments.

Since both Albania and Kosovo are lagging behind the EU countries in the socio-economic sphere, negative developments through migration (the case of 2014 and 2015) may further aggravate the situation in the demographic, economic, social spheres, etc. in both countries, especially in the case of Kosovo with a visa liberalization case.

3. STRUCTURE OF POPULATION BY MASS AND GENDER

The population structure by age and gender shows not only the demographic past but also the current and future trends of these developments (3).

The high rate of natural increase and the general population increase affected:

- in Albania the participation of the young population age group by the end of the 1960s. XX was about 40%, while over 30% was up to half of the 80s. As a result of mass emigrations of the 1990s, this share declined to close to 20% (2011).
- in Kosovo until the mid-1980s. XX to be characterized with more than 40% of the young age population. As a consequence of the conflicting situation of the 1990s, XX in 2011 this share decreased to below 30% and 27.8% respectively.

The trend of age structure deterioration by age is best confirmed by the fact of population growth by age group where:

 in Albania, the age group of 0-14 years in the period 2011-2061 will show a downward trend of -55.3% (more than halving), the age group of 15-64 years will also show a downward trend of -31.3%, while the only age group over 65 years will show an increase of 108% (2.1 times), while

in Kosovo, the age group 0-14 years in the period 2011-2061 will show a downward trend of -56.4% (rather than halving), the age group 15-64 years will be stable but with a tendency of falling -12%, While the age group over 65 years will show an increase of 311.2% (4.1 times) (4, 7).

The unfavorable demographic development in the future is also argued by other data. So

- in Albania, the old age group in the period 2011-2061 will increase to 346173 people (2.1 times), while the participation from 11% to 29.1%. In the same period, the younger age group will be reduced to -55.5%, while participation from 21.6% to 12.2%.
- in Kosovo, the old age group in the same period will increase to 382423 people (4 times), while participation from 6.9% to 29%. New age groups will reduce by 56.4% in the same period, while participation from 27.8% to 12.4%.

Leveling and participation among young and old age groups is expected to take place around 2022 in Albania and 2036 in Kosovo.



Graph 2. Participation of the age group in population of Albania and Kosovo 1971-2061

The aging index (the number of people over 65 years in 100 of the young 0-14 years) is the other indicator showing unfavorable demographic developments both in Albania and in Kosovo. Thus:

- in Albania, the aging index would show a growth trend from 51.1 in 2011 to 135 in 2031 to reach 240.1 in 2061.
 So until 2011, in Albania, an elderly person used to comeo 2 young aged, while in the year 2061, for one young person will come 2.4 elderly ones.
- in Kosovo in 2031 the aging index will be 68 to reach 234 (2061) from 24.8 in 2011. So, as in 2011, an elderly person came to 2.4 in the year 2061 in every 1 youngsters will come 2.3 elderly.

Other contingents of the population such as preschool children (0-6 years), primary education children (6-14

years), the fertile contingent of a population capable of work etc. will mark trends and unfavorable developments.

According to the UN categorization, in 2011 the Albanian population was in the initial phase of aging while the Kosovo population was on aging threshold, while at the end of the researching period the two states will enter into a deep process of demographic aging. These developments are unfavorable from both the demographic and socio-economic point of view.

4. POPULATION MIGRATIONS

Kosovo throughout the post-World War II period, while Albania since the 1990s have been characterized as emigrant countries. Given the current performance, but also thr expected one concerning economic development, employment opportunities in the country and the movement of natural growth, a migratory population movement with low intensity is to be expected for a while (5). It is estimated that 35-40% of the population in both countries have emigrated abroad, transforming migration into a very important element of (negative) demographic developments. In the 10 years period (2000-2010):

- from Albania to other European countries have emigrated between 40 and 45 thousand persons per year (6), while
- from Kosovo to other European countries have emigrated between 10 and 15 thousand (2) persons per year.

Forecasts show that Albania and Kosovo are not only in the past but also in the future expected to be migrant countries, while the negative balance of net migration will depend on overall developments. As a consequence of the decline of the population contingent in the age of emigration, in the mid-30s of the 21st century, it is assumed that the migrant population will decline.

Given the fact that both countries lag behind EU countries in the socio-economic sphere (as one of the main factors of migration is the difference in the level of economic development between the countries of origin and the host country), the situation regarding migration can also (as was the case of the end of 2014 and the beginning of 2015 when over 120 thousand people emigrated from Kosovo). Also, visa liberalization and the unification of Kosovo with the EU can spur a widening wave of emigration.

5. DEMOGRAPHIC CONSEQUENCES

Since the main source of population growth in both Albania and Kosovo in the past was the natural increase then data on the fertile, population contingent in the future is an important source to show the trends of the population movement of Albania and Kosovo in the future.

According to the forecasts, the female fertile contingent (15-49 years) will show a tendency of continuous decline. So in relation to 2011, in 2061 the female fertile contingent would be smaller:

 in Albania for 32,801 women, while participation will decrease from 50.9% (out of the total number of women) to 37.1%. Female fertile contingent during the period 2011-2061 will be reduced by -44.4%, while

 In Kosovo for 161574 women, while participation will decrease from 53.7% to 36.5%. The female fertile contingent during the 2011-2061 period will be reduced by -34.1%, which will undoubtedly be followed by lowering the fertility rate.

Numerous studies (3.8) show that the main potential of fertility bear the younger ages of female fertile contingent (20-29 years) by reducing the participation of the older age group in the birth rate. Forecasts for the new female fertile contingent are even more "gloomy" as in the period 2011-2061, it is estimated that this contingent will be reduced;

- in Albania for 114265 women, while participation from 15.1% (2011) to 9.3% (2061). Thus the new age group of female fertile contingent will be reduced to -52.4%, while
- in Kosovo for 61874 women, while participation from 16.9% (2011) to 10.2% (2061). Thus the new age group of the female fertile contingent will be reduced by -41.5%, which is also an argument for the declining trends of fertility during the given period.

Albania and Kosovo in 2011 had a total birth rate of 1.7 respectively 2.0 children per woman, meaning that NTL in both cases was below the average needed for a simple population resuscitation of about 2.3 children. Due to many factors such as the level of women's education, employment, family planning, postponement of marriages, migration, economic status, etc., the likelihood that low NTLs are very real at 1.4 children per woman in Albania (6) and 1.7 children per woman in Kosovo in 2031 (2).

6. CONSEQUENCES IN THE EDUCATION SYSTEM

Apart from the demographic sphere, many negative consequences from future demographic developments will also be manifested in the socio-economic sphere. The accelerated growth of the elderly population contingent - the demographic impoverishment and the reduction of the youth contingent will have negative implications in all spheres of life in Albania and Kosovo.

6.1. Reduction of the school population quota - according to population anticipation:

- in Albania in the period 2011-2061, the contingent of children in primary education (6-14 years) will be reduced in 2031 for 146007 whereas in 2061 for 256477 students so the participation of this contingent will be reduced by 15.5% (2011), to 10.9% (2031) and 8.5% (2061). Consequently, in the primary schools of Albania in relation to 2011, in 2031 there will be 4867, while in 2061 there are about 8549 fewer class groups (if average is 30 students per class group).
- in Kosovo 2011-2061, the contingent of children in primary education (6-14 years) in 2031 will be lower for 90531 while in 2061 for 181386 students so the participation of this contingent will be reduced by 17.6% (2011), to 11.5% (2031) and 7.5% (2061).

Consequently, in the primary schools of Kosovo in relation to 2011, in 2031 there will be about 3000 (3017), while in 2061 there will be about 6000 (6046) fewer class groups (if average is 30 students per class group).

The situation will not be even better with the middle school contingent (15-19 years). In relation to 2011, the population of the secondary school contingent will be reduced for:

- in Albania in 2031 it will be 130083, compared with 2061 for 179627 younger students compared to 2011. As a result, participation will decrease from 9.8% (2011) to 5.6% (2031) and 4.6% (2061). This means that in Albania in 2031 there will be 4336, while in 2061, 5988 class groups less than in 2011,
- in Kosovo in 2031 will be for 55076, while in 2061 for 98799 less students compared to 2011. Thus, participation will decrease from 10.1% (2011) to 6.4% (2031) and 4.5% (2061). This means that Kosovo in 2031 will have about 1800 (1835), while in 2061 about 3200 (3293) class groups less than in 2011 (if average is 30 students per class group).

Reduction of the education contingent will be followed by a reduction in the number of teachers the thing that will require planning in education for teachers which affects a reduced education enrollment quotas and the closure of many schools from which the most affected will be rural areas, a present process in many hilly and mountainous areas of Albania and Kosovo.

7. CONSEQUENCES IN ECONOMIC STRUCTURE

Reduction and aging of the labor contingency - the contingent of the active population (15-64 years) will mark a growth trend until the beginning of the second decade of XXI century in Albania while in Kosovo until the end of this decade (2028).

In Albania, the active population contingent will reduce participation from 67.4% (2011) to 63.0% (2031) and 58.7 in 2061, while in Kosovo in the first half this contingent will have growth tendencies from 65.3% (2011) To 67.7% (2031) while the second half will show a downward trend from 67.7% (2031) to 58.6% (2061).

At the same time, the participation of the old working contingent (over 50 years) will be increased in addition to the new labor contingency (15-49 years). In Albania, this contingent will increase participation from 24.9 (2011) to 35.7 (2061), while in Kosovo from 17.8 (2011) to 36.9 (2061).

The presented data show a significant deterioration of the situation regarding the structure of the labor contingent. From economic studies it is well-known that the older workforce: has difficulties to adapt to technical-technological advances, has lower productivity, is not innovative, etc

8. STRUCTURAL CONSEQUENCES BY AGES - DEMOGRAPHIC AGING

In the period 2011-2061 the only category that will have a continuous increase will be a group of ages over 65 years. In relation to 2011 these age -groups

- in 2031 in Albania, the age group over 65 would grow by 270834 persons (84.5%), which would almost duplicate, while by 2061 the increase would be even faster for 346173 (108.1%) or for more than 2 times. Participation of the age group over 65 in the general population will increase from 11% (2011) to 21.3% (2031) to reach 29.1% (2061), while
- in Kosovo over the same period, the age group over 65 will increase to 129482 (105.8%), which means that it will double, whereas by 2061 the increase will be very fast for 382423 (311.2%) or for more than 4 times. Participation of the age group over 65 in the general population will increase from 6.9% (2011) to 13.1% (2031) to reach 29.1% (2061) (9).

The very rapid growth trend will be especially among older age groups (over 75 years) within the old population which will increase participation in Albania from 37.1% (2011) to 41.3% (2031) and 48.1% (2061), while in Kosovo participation will increase from 33.6% (2011) to 38.9% (2031) and 49.9% (2061). So in both cases, the population of the older age group will consist half of the elderly population.

Demographic aging as a process is characterized by numerous negative consequences both in the demographic and socio-economic spheres.

9. CONCLUSION

The World Bank defines sustainable development as a development that involves the transition of an equal reserve or the greatest possible human, economic and social capital to the next generation. Based on this definition Albania and Kosovo are facing major challenges in sustainable development in general and sustainable demographic development in particular.

Based on the Population Projections in Albania and Kosovo Population Forecast 2011-2061 can conclude that more negative demographic processes with which Albania is facing since the beginning of this century, Kosovo will face years of 30s century XXI. This corresponds to the time when for the first time is Albania and Kosovo will face ;

- start the process of depopulation
- in the population structure by age the older age groups will dominate youths
- marks the beginning stage of decreasing active population contingent etc.

It will also process of depopulation will deepen, reducing the fertility rate, have negative developments in other contingencies of population: reducing the number of school age children, active population, growing older of work contingent etc. There are a number of socio- economic factors that will continue to favor the emigration of Kosovo's population, especially in the case of visa liberalization or merge into EU, such as low economic development, low level of economic activity, high rate of unemployment, the structure of unemployment, reduction of investment (global economic crisis), low living standard, low political stability

, large distinctions with EU countries , the prospect that EU offers etc.

In order to avoid and minimize the consequences of such an occurrence is not only required but also necessary to prepare policies so that the negative effects of these developments to be much smaller. There is no doubt that the processes and consequences arising from foreseen demographic trends, constitute a major challenge for the population, economic policies, educational, social, etc., of Albania and Kosovo towards sustainable development as imperative that the modern world requires harmonization between population, economy, environment etc.

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Vedenje uporabnikov zdravil brez recepta

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POVZETEK

Zdravila brez recepta predstavljajo pomemben del samozdravljenja; poleg učinkovitega delovanja lahko pacienti izkusijo tudi neželene učinke, možna so tudi medsebojna učinkovanja med zdravili. Zaradi tega je pomembno, da uporabniki zdravil pridobijo ustrezne informacije o zdravilih. Poleg informacij, ki jih pacientom posredujejo strokovnjaki s področja zdravja, so pomembni uradni pisni viri o zdravilih, predvsem navodilo za uporabo. Pomemben napotek pacientom je, da preberejo navodilo za uporabo zdravil. Za zagotavljanje učinkovitega in varnega zdravljenja je nujno razumevanje navodil, pa tudi njihovo upoštevanje. Pogosto uporabljena metoda v raziskavah o zdravju je conjoint analiza, ki pridobiva vedno večji pomen. Rezultati tudi z demografskega vidika kažejo, katerim atributom uporabniki zdravil pripisujejo večjo pomembnost. Preliminarni rezultati slovenske raziskave kažejo nakupno vedenje uporabnikov zdravil brez recepta za lajšanje simptomov virusnih obolenj in branje informacij iz navodil za uporabo zdravil, glede na spol, starost in izobrazbo. Analiza anketnih odgovorov je vključevala 86 respondentov. Delež respondentov, ki so zaradi virusnega obolenja zbolevali od enkrat do trikrat na leto, med respondenti, ki so odgovorili na vprašanje o pogostnosti zbolevanja, je znašal 78,9 %. Ta rezultat je skladen s 75,3 % respondentov, ki so zdravila brez recepta iz te terapevtske skupine kupovali do nekajkrat letno. Večkrat na mesec so zdravila brez recepta iz te terapevtske skupine večinoma kupovale osebe, starejše od 50 let. Čeprav je približno polovica respondentov označila, da prebere navodila za uporabo, še vedno preveč oseb ne prebere navodila za uporabo ob vsakem nakupu zdravila brez recepta, oziroma nekaj oseb sploh nikoli. Rezultati raziskave kažejo razlike v vedenju pri nakupu zdravil brez recepta in branju priloženih navodil, pri primerjavi oseb nad 50 let starosti z mlajšimi osebami in torej demografski vidik teh ugotovitev.

Ključne besede

Zdravila brez recepta, vedenje uporabnikov zdravil, conjoint metoda, atributi, demografski vidik.

ABSTRACT

OTC medicines represent an important part of self-medication; besides efficient acting, adverse events can be experienced by patients and also interactions with other medicines can occur. Thereby, it is important for the users of medicines to acquire adequate information on medicines. Besides information, given by health experts, also official written information sources are important, especially a patient information leaflet. Reading the patient information leaflet is an important direction for the patients. Comprehension of patient information leaflets and their consideration are essential for ensuring an efficient and safe treatment. A conjoint analysis is a frequently used method in researching about health and its meaning is increasing. Also from

a demographic point of view results show to which attributes an importance is ascribed by the users of medicines. Preliminary results of the Slovene study show the consumer behavior of the users of the OTC medicine related to viral infection and reading information from the patient information leaflets with a regard to gender, age and education. An analysis of questionnaire answers included 86 respondents. A share of respondents who acquired a viral infection once to three times a year, according to respondents who answered a question related to the frequency of disease, was 78,9 %. This result agreed with 75,3 % respondents who purchased OTC medicines belonging to this therapeutic group up to several times a year. A few times a month were medicines from this therapeutic group mostly purchased by the persons over 50 years of age. Although approximately a half of respondents marked to read patient information leaflets, there still have been too many persons who have not read the patient information leaflets at every OTC medicine purchase, and some responders even never. Research results show the behavior differences regarding a purchase of OTC medicines and reading the enclosed patient information leaflets by the persons aged over 50 years, compared to younger persons, and therefore a demographic aspect of these findings.

Keywords

OTC medicines, behavior of medicines' users, conjoint method, attributes, demographic aspect.

1. UVOD

Zdravila brez recepta za veliko oseb predstavljajo pomemben del zdravljenja. Za razliko od zdravil, ki se predpisujejo na recept, pri zdravilih brez recepta običajno ni prisotno obsežno informiranje uporabnikov. Pa vendar imajo zdravila brez recepta poleg terapevtskih učinkov tudi neželene učinke, pa tudi medsebojno lahko učinkujejo z zdravili na recept. Za zdravila brez recepta se osebe odločajo v okviru samozdravljenja in pri tem pogosto ne prejmejo dovolj informacij strokovnjakov. Zaradi tega je pomembno, da poleg nasveta v lekarni dobro preberejo navodilo za uporabo zdravila in navodila pri jemanju zdravil brez recepta tudi upoštevajo. Ker je promocija zdravil brez recepta namenjena tudi splošni, ne le strokovni javnosti, je nujno tudi pravilno razumevanje pisnih in drugih virov informacij o zdravilih brez recepta. Predstavnike splošne javnosti je treba tudi z vidika demografskih značilnosti dobro poučiti o vrsti ustreznih virov informacij o zdravilih in o upoštevanju navodil.

2. RAZISKOVANJE ZDRAVJA IN MEDIKAMENTOZNEGA ZDRAVLJENJA Z UPORABO CONJOINT ANALIZE

Med objavljenimi članki so prisotni tudi članki, ki obravnavajo analize različnih področij zdravja, tudi z demografskega vidika. Objavljen je bil sistematični pregled literature z rezultati raziskav, v katerih so uporabili conjoint analizo (1). Analizirali so 79 člankov z interpretacijo raziskav s področja zdravstvenega varstva, kjer so uporabili conjoint analizo. Avtorji so v nekajletnem obdobju od leta 2005 dalje opazili povečanje števila javnozdravstvenih raziskav, kjer so uporabili conjoint analizo. Pri izvedbi večine raziskav so vključili od 3 do 7 atributov, večinoma v dveh ali treh nivojih. Vzorec je največkrat zajel med 100 in 300 respondentov, v eni raziskavi le 13 respondentov. Pogosto se je med atributi pojavljala cena. Primerjavo med interpretacijo rezultatov posameznih raziskav otežujejo razlike med pristopi.

Avtorji raziskave (2) so izhajali iz izhodišča, da je malo znanega o stališčih in odločanju oseb o zdravilih; pri tem so se osredotočili na uporabo analgetikov pri osebah iz več mlajših starostnih segmentov. Pomen in avtonomnost odločanja pacientov o samozdravljenju sta v preteklem obdobju narasla. Farmakoepidemiološke raziskave so pokazale, da blagovna znamka oziroma lastniško ime zdravila in cena igrajo pomembno vlogo pri izbiri in uporabi zdravil brez recepta in zdravil na recept. Prav tako cena in blagovne znamke močno vplivajo na odločanje pacientov in zdravnikov ter na njihovo zaznavanje kakovosti zdravil. Raziskovalci so izbrali zdravila brez recepta za lajšanje bolečin (analgetike), ki sodijo k pogosteje uporabljenim zdravilom brez recepta. Razmeroma pogosto ta zdravila uporabljajo mlajše osebe, ki kažejo tudi veliko zanimanje za zdravje, posebej ženske in izobraženi moški. Pri raziskovanju so uporabili conjoint analizo, ki je koristna metoda pri raziskovanju preferenc potrošnikov. V tej raziskavi (2) so kot pomembne atribute izbrali blagovno znamko oziroma lastniško ime in ceno, čas nastopa delovanja zdravila, kraj nabave zdravila in vir informacij zdravil brez recepta. Rezultati raziskave so pokazali, da sta cena in lastniško ime najpomembnejša atributa pri izboru zdravila brez recepta v tej raziskavi. Respondenti so bile mlajše osebe, ki običajno kmalu sprejmejo inovacije in blagovne znamke. Glede na rezultate so oblikovali pet skupin, prva skupina je poudarek namenila učinkovitosti (hitremu nastopu delovanja), druga skupina respondentov je pomembnost pripisala predvsem nizki ceni, tretja skupina respondentov pa blagovni znamki oziroma lastniškemu imenu zdravila in sicer so prednost dajali proizvodu, ki je bil tržni vodja. Naslednja skupina respondentov pomembnost pripisovala možnosti posvetovanja s ie strokovnjakom s področja zdravstvenega varstva. Respondenti iz zadnje skupine so pomembnost pripisovali kombinaciji dobrega učinka, nizke cene in dostopnosti strokovnjaka za posredovanje informacij; to skupino so raziskovalci opredelili kot racionalne paciente in je predstavljala 27 % delež vseh respondentov. Skoraj polovica vseh respondentov je kot pomembno zaznavala ceno, medtem ko so pri drugih respondentih opazili druge preference.

Uporabniki zdravil zaznavajo tako koristnosti kot tveganja zdravil. Prisotna je interakcija med dvema psihološkima sistemoma, čustvi in razumom ter njunim skupnim vplivom na zaznavanje in sprejemanje tveganj (3). Posamezniki se lahko razlikujejo glede intenzivnosti njihovih afektivnih reakcij, kar kaže na pomembno vlogo individualnih razlik pri zaznavanju tveganja. Reakcija na tveganja lahko zajema čustva kot so strah in jeza. Kljub ključni vlogi čustev v mnogih teorijah vedenja potrošnikov so bila čustva redko razpoznana kot pomembna sestavina presoje in odločanja (4). Međtem ko nekatere teorije odločanje obravnavajo s kognitivnega vidika, pa Damasio (5) poudarja vlogo čustev in vedenje potrošnika razlaga tudi z nevrofiziološkimi mehanizmi. Conjoint analiza predstavlja pomembno tehniko, pri kateri se ugotavljajo stališča pacientov oziroma predstavnikov skupnosti o zdravstvenem varstvu (6). Conjoint analiza se je uspešno uporabila na raznih področjih zdravstvenega varstva in ima velik potencial kot metoda za odkrivanje preferenc pacientov.

2.1 Raziskava o vedenju uporabnikov zdravil brez recepta z demografskega vidika

Predstavljeni so rezultati pilotske raziskave (7), ki se je izvedla v Sloveniji. Na vprašanja iz spletne ankete je odgovarjalo 86 respondentov. V tem prispevku je navedenih le del rezultatov; predstavljeni so izsledki, ki zajemajo demografski vidik, z analizo posameznih odgovorov vedenja potrošnikov po spolu, starosti in stopnji izobrazbe.

Osnovna zasnova raziskave (7) sicer temelji na atributih, ki opisujejo koristnosti in tveganja zdravil; z nadaljnjo analizo rezultatov pilotske raziskave in predvidoma tudi na večjem vzorcu respondentov se pričakujejo rezultati z ugotovitvami o tem, katerim atributom respondenti pripisujejo večjo pomembnost.

Pri izvedbi pilotske raziskave (7) se je uporabila conjoint analiza, ki pridobiva naraščajoči pomen pri raziskovanju zdravstvenega varstva. Ta metoda za ugotavljanje preferenc in stališč pacientov se je razvila v psihologiji, uspešno pa se uporablja tudi v raziskavah tržišča in drugih vejah ekonomije ter se uveljavlja tudi na področju zdravstvenega varstva (6).

Pri izvedbi raziskave (7) so respondenti preko elektronske pošte prejeli sporočilo, s povezavo na anketo. Vključeni so bili respondenti obeh spolov, iz različnih starostnih skupin in z različno stopnjo izobrazbe; povezava na anketo je bila posredovana respondentom iz Slovenije, iz več geografskih področij. Vprašanja so zadevala zdravila za lajšanje simptomov virusnih obolenj, ki se izdajajo brez recepta.

V pilotskem delu raziskave (7) je bilo zajetih 86 respondentov, veljavnih je bilo 85 anketnih odgovorov, ki jih je podalo 68 (80,0 %) žensk in 17 (20,0 %) moških (Tabela 1). 34 (40,0 %) respondentov je imelo do 30 let, 18 (21,2 %) med 30 in 50 let in več kot 50 let je imelo 33 (38,8 %) respondentov. Glede na izobrazbo je imelo 12 (14,1 %) oseb srednješolsko, 40 (47,1 %) višjo ali visoko izobrazbo ter 33 (38,8 %) podiplomsko izobrazbo.

Tabela 1: Respondenti ankete po spolu, starosti in izobrazbi

Spol	Število	Starost	Število	Izo=	Število
	(delež	(leta)	(delež	brazba	(delež v
	v %)		v %)		%)
ženske	68	< 30 let	34	srednja	12
	(80,0 %)		(40,0 %)		(14,1 %)
moški	17	nad 30	18	višja ali	40
	(20,0 %)	let, do 50 let	(21,2 %)	visoka	(47,1 %)
		> 50 let	33	podi=	33
			(38,8 %)	plomska	(38,8 %)
Skupaj	85		85		85
	(100,0		(100,0		(100,0
	%)		%)		%)

2.1.1 Preliminarni rezultati slovenske raziskave o vedenju uporabnikov zdravil brez recepta z demografskega vidika

Na vprašanje, kako pogosto respondent zboli zaradi virusnega obolenja, je večina respondentov označila odgovor 'od enkrat do trikrat na leto' in sicer 60 oziroma 78,9 % respondentov glede na vse respondente, ki so odgovorili na to vprašanje (7). Na osnovi rezultatov ankete je razvidno, da je pogosteje kot trikrat na leto zaradi virusnega obolenja zbolevalo le nekaj oseb in sicer 2 ženski in en moški, 13 oseb pa zaradi teh obolenj ni zbolelo nikoli.

Eno izmed vprašanj se je nanašalo na pogostnost nakupa zdravil brez recepta v lekarni (7). 13, od tega 12 žensk je odgovorilo, da zdravila brez recepta v lekarni kupujejo večkrat na mesec. Enkrat na mesec je zdravila brez recepta v lekarni kupovalo 8 oseb, med njimi 6 žensk. Največ, to je 64 oziroma 75,3 % oseb je ta zdravila nabavilo do nekajkrat letno in sicer 50 žensk in 14 moških. Velika večina respondentov (12 oziroma 92,3 %), ki so kupovali zdravila brez recepta iz te terapevtske skupine večkrat na mesec, je sodila v starostno skupino nad 50 let. Vsi (13) respondenti, ki so kupovali zdravila brez recepta večkrat na mesec, so imeli podiplomsko izobrazbo.

Rezultati primerljive raziskave (2) so pokazali večjo pogostnost uporabe zdravil brez recepta in sicer nekajkrat (1-4-krat) na mesec pri 53,9 % respondentov, pri 16,0 % respondentov celo več kot štirikrat mesečno. Pri tej raziskavi so bili zajeti primerjalno mlajši starostni segmenti respondentov, obravnavani pa so bili analgetiki, ki se izdajajo brez recepta. S conjoint analizo so ugotovili, da respondenti največjo pomembnost pripisujejo blagovni znamki oziroma lastniškemu imenu zdravila ter ceni. Po relativni pomembnosti sledijo atributi o nastopu delovanja, kraju nakupa zdravila in viru informacij o zdravilu.

Navodila za uporabo zdravil brez recepta je prebralo 42 oseb (36 žensk in 6 moških), včasih je navodila za uporabo zdravil prebralo 38 oseb, navodila za uporabo pa skladno z odgovori respondentov ni prebralo 5 oseb (7). Izmed oseb, ki so prebrale navodilo za uporabo, jih je imela več kot polovica oziroma 22 (52,4 %) oseb več kot 50 let in malo manj kot polovica (18 oziroma 42,9 %) podiplomsko izobrazbo. Starostna struktura respondentov, ki so včasih prebrali navodilo za uporabo zdravil brez recepta je pokazala, da ima 20 respondentov do 30 let, 10 respondentov med 30 in 50 let ter 8 respondentov več kot 50 let.

2.1.1.1 Statistični izračuni preliminarnih rezultatov izvedene raziskave o vedenju uporabnikov zdravil brez recepta

Hi-kvadrat test ne kaže povezave med pogostnostjo kupovanja zdravil brez recepta v lekarni in spolom respondentov (7). Hikvadrat test tudi ne kaže povezave med pogostnostjo zbolevanja zaradi virusnih bolezni in spolom, starostjo ali izobrazbo. Prav tako ni povezave med branjem navodila za uporabo zdravil brez recepta in stopnjo izobrazbe.

Povezavo med branjem navodil za uporabo in starostjo s hikvadrat testom ugotovimo pri stopnji tveganja 0,05 (7).

Pri nekaterih spremenljivkah hi-kvadrat test zaradi premajhnega števila vrednosti ni dal veljavnih rezultatov.

3. RAZPRAVA

Iz rezultatov pilotske raziskave, izvedene v Sloveniji (7), je razvidno, da je večina (78,9 %) respondentov med tistimi, ki so odgovorili na to vprašanje, zaradi virusnega obolenje zbolevala od enkrat do trikrat na leto. Ti rezultati so skladni z rezultati o pogostnosti nakupa zdravil brez recepta iz te terapevtske skupine, namreč 75,3 % respondentov je ta zdravila kupovalo do nekajkrat letno.

Raziskovalci so v rezultatih primerljive študije (2) pokazali večjo pogostnost uporabe zdravil brez recepta, to je do 4-krat na mesec in sicer kar pri 53,9 % respondentov, 16,0 % respondentov pa je skladno z odgovori zdravila brez recepta za lajšanje bolečin uporabljalo celo več kot štirikrat mesečno. Rezultati zgoraj opisane raziskave (7) pa kažejo nakup zdravil brez recepta večkrat na mesec le pri 15.3 % respondentih. Delno razlike v rezultatih lahko pripišemo različnim starostnim segmentom respondentov in velikosti vzorca respondentov, pa tudi razlikam v indikacijah pri obeh skupinah zdravil. Medtem ko je raziskavi Halme s sodelavci (2) zajel tri starostne segmente od 18 do 20 let, 21 do 30 let in 31 do 50 let, odgovarjalo pa je 256 respondentov, pa je bilo v slovensko pilotsko raziskavo (7) zajetih 86 respondentov iz treh starostnih segmentov in sicer osebe, stare do 30 let, osebe med 30. in 50. letom starosti ter osebe, starejše od 50 let. V tej raziskavi so bila vključena zdravila brez recepta za zdravljenje virusnih obolenj, v primerljivi raziskavi (2) pa so bila zajeta zdravila brez recepta za zdravljenje bolečin, torej analgetiki. V slovenski pilotski raziskavi (7) se razpravlja o nakupu zdravil brez recepta, v primerljivi (2) raziskavi pa o uporabi zdravil brez recepta; pacient lahko nabavi zdravilo brez recepta za večkratno uporabo.

Med respondenti, ki so na osnovi slovenske raziskave (7) označili, da zdravila brez recepta za lajšanje virusnih obolenj kupujejo večkrat na mesec, jih je velika večina (92,3 %) sodila v starostno skupino nad 50 let, kar se povezuje z večjo zbolevnostjo oseb iz te starostne skupine. Vsi respondenti, ki so kupovali zdravila brez recepta iz te terapevtske skupine večkrat na mesec, so imeli podiplomsko izobrazbo. Primerjalno pogostejši nakup teh zdravil brez recepta se pripisuje boljšemu znanju oziroma več izkušnjam s samozdravljenjem.

Med vsemi respondenti, ki so odgovorili na vprašanje o branju navodil za uporabo zdravil brez recepta, je približno polovica oziroma 42 oseb, med njimi 36 žensk in 6 moških označilo, da navodila preberejo (7). Včasih je navodila za uporabo zdravil prebralo 38 respondentov, navodil za uporabo pa skladno z odgovori respondentov ni prebralo 5 oseb. Čeprav navodila za uporabo zdravil brez recepta prebere polovica oseb in je malo oseb, ki navodil ne preberejo, bi se moral zmanjšati delež oseb, ki navodil ne preberejo. Kljub izobraževanju o pomenu informacij v navodilu za učinkovito in varno uporabo zdravil je treba z izobraževanjem nadaljevati.

Izmed oseb, ki so prebrale navodilo za uporabo, jih je imela več kot polovica (22 oseb) več kot 50 let in 18 oziroma 42,9 % podiplomsko izobrazbo (7), torej osebe z večjim obsegom znanja in predvidoma z več izkušnjami s samozdravljenjem navodilom za uporabo pripisujejo večjo pomembnost.

Glede na statistično analizo s hi-kvadrat testom (7) se kaže povezava le med branjem navodila za uporabo in starostjo respondentov.

4. ZAKLJUČEK

Pomembno je preučevati vedenje uporabnikov zdravil brez recepta, tudi z demografskega vidika. Conjoint analiza je metoda, ki tudi na področju raziskovanja zdravja pridobiva pomen. S conjoint analizo anketnih odgovorov se lahko pridobijo rezultati o tem, katerim atributom uporabniki zdravil pripisujejo večjo pomembnost. Interpretacija rezultatov raziskav, kjer se uporabi conjoint analiza, lahko pripomore k poznavanju stališč in namer uporabnikov zdravil. Če uporabniki zdravil brez recepta ustrezno razumejo informacije, to pomembno prispeva k učinkovitemu in varnemu zdravljenju. V študijah so raziskovalci uporabili različne atribute in sicer lastniško ime, ceno, mesto nakupa zdravila, vir informacij, nastop delovanja, stališča do zdravila in druge. Predstavljeni preliminarni rezultati slovenske pilotske raziskave (7) kažejo nekatere vidike vedenja uporabnikov zdravil brez recepta glede na spol, starost in izobrazbo in sicer pogostnost kupovanja zdravil brez recepta in branje navodil za uporabo zdravil brez recepta, ki so eden najpomembnejših uradnih virov informacij o zdravilih. Podrobnejši rezultati bodo pokazali, kakšno pomembnost so respondenti pripisovali posameznim atributom, v prihodnosti predvidoma tudi na večjemu vzorcu respondentov. Z demografskega vidika bodo pomembni tudi rezultati predvidenega nadaljnjega raziskovanja, ki bodo zajemali ugotovitve o vedenju respondentov glede na spol in starost. Ti rezultati bodo pomenili izhodišča za komuniciranje o ustreznem informiranju o zdravilih brez recepta z različnimi skupinami respondentov.

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Where is elderly care in the Czech Republic heading? Historical and gender perspectives in relation to informal carers

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ABSTRACT

The issue of setting elderly care policies and changing them is mostly monitored in West European countries, with some exceptions. Therefore, this work focuses on the shift in the setting of elderly care policies in the Czech Republic as one of the postsocialist countries in the period from 1948 until now. I ask what the identified shift means with regard to gender in/equality as far as informal carers, who are mostly women (partners, daughters or daughters-in-law, or female neighbours and friends), are concerned.¹

General Terms

Human Factors

Keywords

Elderly care, welfare regimes, gender equality, Czech Republic.

1. INTRODUCTION

In the Czech Republic, more than 80% of elderly care is provided by relatives [1]. According to SHARE (2006-2007), the Czech Republic (except Poland) is a country with the highest share of informal care (care is provided by family and friends in case of occasional need in 97% of cases; it is 78.5% in case of everyday care) [2]. Only about one fifth of seniors who need everyday assistance are in residential care (within social or medical services).

The estimated number of informal carers is about 300 thousand people, out of which 80% are women at the age between 40 and 65 (i.e. mostly in the economically active age). 20% of informal carers leave the labour market due to taking care of seniors.

The number of people at the age of 65+ is demographically predicted to double in the next twenty years². It is estimated that 25-30% of them will be in poor health condition and will require long-term care.

2. METHODOLOGY

Leitner's typology [3] is used to analyse elderly care policies in CR. Leitner classifies familialistic and defamilializing³ welfare regimes in a greater detail (than Esping-Andersen), she determines criteria for their measurement (i.e. time right, direct and indirect transfers for caring, social rights giving individual pension rights) and distinguishes 4 ideal types of gender welfare regimes.⁴ A mixed-method approach was used in the analysis, combining several data sources (policy documents, administrative data, statistics, and secondary use of qualitative and quantitative data).

3. ANALYSIS

3.1 Communist Era (1948-1989)

After the communist coup-d'état in 1948, the aim of care policies was to free women from household care and to release female

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² In 2015, the population aged 65+ accounted for 18.3% of the population, i.e. 1.932 million inhabitants. [4]

³ *Familialistic welfare regime* (familialization) is connected to the male breadwinner/female homemaker ideology and is defined by the absence of public and market provision of services. *Defamilializing* welfare regime (de-familialization) aims at unburdening the family in its caring function (see the public provision of care and/or social services or the public subsidy of care provision through the market). This model of familialism enables gender equality in the field of family care.

⁴ *De-familialism* based on strong de-familialization due to the state or market provision of care services and weak familialization. Family carers are (partly) unburdened but the family's right to care is not guaranteed. The *explicit familialism* (strong de-familialization and weak familialization) strengthens the family in caring also for the elderly because it lacks of the provision of any alternative to family care. In the *implicit familialism* (weak both familialization and de-familialization) the family will be the primary caretaker, there are no alternatives at hand. This type relies implicitly upon the family when it comes to care issues. Within the *optional familialism* (both strong familialization and de-familialization) services as well as supportive care policies are provided. The caring family is strengthened but is also given the option to be (partly) unburdened from caring responsibilities.

workforce for extensive development of economy. Therefore, residential care (not home based care) both for children and seniors was supported mainly in the 50s. From the end of the 40s to the beginning of the 60s, there was a clear tendency to defamilialization of care for elderly (i.e. de-familialism).

In the following period, i.e. from the beginning of the 60s, there was a "shift towards the family". Family was redefined to coprovider of care. In mid-1960s, home care services were introduced, allowing seniors to stay in the family and delaying residential care until later. In mid-1970s, an optional "allowance for caring for a close person" was introduced. The person (a women in majority cases) taking care of a fragile senior who received this allowance did not have to work and the time spent providing care was included in the entitlement to pension as alternative insurance time.

3.2 Development after 1989 until 2016

After 1989, the change in the system of elderly care occurred with a broader social change, within which the basic principles of the system were redefined. Emphasis is placed more on home based care where family continues to play a crucial role.

When compared with the past, the method of supporting families in elderly care changed radically. In the beginning of the 90s, the character of the facultative allowance changed to claimed allowance, which reinforced the possibility of carers to receive this allowance when caring for a senior. However, this allowance continued to contribute to covering basic needs of carers, i.e. it did not make elderly care "financially equal" to the performance of a paid job.

After 1989, there is growing emphasis on the possibility of choosing a specific method of care by seniors. The approval and implementation of the Act on Social Services in 2006 represents a significant change as it stabilised the primary responsibility of family to care for dependants as well as personal responsibility of each (older) family member for their own well-being. The allowance is no longer provided to those who take care, but to those who are being taken care of and who can autonomously decide what type of care they will arrange, or "purchase" for themselves.

Even though the introduction of the allowance for care (instead of the allowance for caring for a close person) theoretically expands the care recipients' options, residential care is becoming factually unaffordable for many seniors due to the financial costs of (high)quality residential care (equalling a multiple or multiples of the senior's pension) and thus they have to rely on home based care. Moreover, not all the required home care services are accessible by clients (seniors) in some localities. Therefore, seniors have to rely either on direct provision of care by their relatives (most often children or their partners – in both cases mainly women), or on their direct financial assistance in case of residential care. Thus, the role of the family in the elderly care system does not grow less, but it increases. 5

In addition, some seniors (mainly those at lower levels of dependency) perceive this allowance as an "benefit in pension", which resulted in using the care by relatives (usually women) for free, as well as in the reduction in the use of home care services.

The analysis estimates (see Scheme 1) that from 1948 until the present, the shift from paternalism (typical of a totalitarian regime) to senior autonomy is connected with the shift from a specific form of defamilialism through implicit and explicit familialism again to implicit familialism in the elderly care policies. The situation of informal carers (usually women) has been insufficiently solved during the entire period – with regard to the possibility to receive the allowance, to the amount of the allowance and to the return on the labour market (after the elderly care ends and the carer is still in an economically active age).

What will the proposed (and currently government-approved) measure introducing a three-month leave to take care of a senior relative change in this trend? Is it even possible to establish more gender-equal / non-discriminatory elderly care?

3.3 Change Proposal (2017) – Shift to Optional Familialism?

The proposed change of a leave related to providing elderly care broadens the options for carers. The three-month "care leave" and the related allowance for care (in the amount of approx. 0.6 multiple of average salary/wage of the individual paid by sickness insurance) is to be provided with the employer's consent (!) under the condition that the carer is entitled to return to their original job (and the time of the provision of care is included in the entitlement to pension.) Even though this care leave is an expression of time rights as well as social rights, the consent of the employer might make carers "tributaries" of the employer and it might aggravate the situation of carers. The either/or situation, i.e. either care or work, might become even more critical for some carers (mostly women). On the other hand, introducing this type of leave with financial compensation might make even (some) men provide care more often.

4. CONCLUSION

Although communism flaunted the idea of the equality of the sexes, it was unable to eliminate the gendered nature of care for dependent family members, did not place any demands on men to provide care and did not create proactively any measures to reduce gender inequality in care provision. On the contrary, by neglecting this issue and postulating care as being women's nature and as unnatural for men and men unable to care, it reproduced and reinforced the stereotype of women's caring. During the entire period of socialism women were a reservoir of cheap labour force: whether it was initially completely unpaid care in women's own families (wives, daughters or daughters in law) or unpaid or

⁵ This measure indicating implicit familialism obviously devalues home based care in relation to a paid job (when the value of the highest provided allowance, i.e. CZK 13,200 net (from 1/8/2016) currently reaches 0.45 multiple (gross) of the average salary (2Q/2017 = 29,346/20,542)/i.e. 0.64 net of the average

salary in situation when the care for a completely dependent person is provided 24 hours, 7 days a week, 52 weeks a year (i.e. continuously throughout the whole year). The allowance for care in the amount of CZK 13,200 on average suffice for about 2 weeks of respite care in an elderly residence and less than 2 weekends in case of 24-hour assistance at home (at the price of CZK 150 per hour, it is 88 hours, i.e. 3.6 days).

only symbolically remunerated voluntary care 'for people from the neighbourhood'. In eldercare socialism not only prolonged and reinforced the gendered nature of care but due to the double burden placed on women it increased gender inequality in society as a result of care for dependent family members.

After 1989, the gendered nature of care was prolonged, including potential negative impacts on carers (women):

a) In case of fully (or heavily) dependent person, the negative effects of elderly care include (forced) economic inactivity due to the provision of care, higher possibility of subsequent unemployment or under-employment, a low level of income during the period of care and following this period, and also a lower assigned pension (when the low amount of financial remuneration of care contributes to feminisation of poverty as well as feminisation of poverty of women at older age).

b) In case of care for a partially dependent person, it is usually a double burden placed on women as they often have a paid job while providing care.

c) In both cases, long-term care for a senior may affect the physical and mental health of the individual when the burden of care is too high (year-round without any rest - free time to recover).

If the newly proposed measure is to lead to optional familialism, then it should not reduce expenses in the spatially and financially available residential care (or the cost of home care services) to prevent the reduction in options of care both for seniors and their relatives providing care (mostly women).

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6. ANNEX

Period/	Time	Social	Direct transfer for	Indirect	Formal care	Welfare regime***
Criteria	right	rights*	carers (cash benefits	transfer (tax		
		(pension)	- care allowance)	reduction)**		
1948-	NO	NO	NO	NO	Retirement	Defamilialization/
1960					homes	Defamilialism
					supported	
1960-	NO	NO	NO	NO	Home care	Tendency to familialization
1975					services	
-					introduced	
1976-	NO	YES	YES – but not	NO	Support for	Implicit familialism
1989-			claimed allowance		home care	
1994					services more	
					than for	
					retirement	
1007		1150			homes	
1995-	NO	YES	YES – claimed	NO	dtto	Explicit familialism
2005			allowance			
2006-	NO	YES	NO – allowance for	NO	Reduction in	Implicit familalism
2016			the person being		the support of	
			cared for		home care	
					services (mainly	
					2006-2007)	
Proposal	YES (3	YES	YES - allowance	NO		Tendency to optional
ın 2017	months)		trom sickness			familialism (?)
			insurance			

Scheme 1: Analyses of welfare regimes in relation to informal carers providing elderly care in the Czech Republic

* Social rights: This means the inclusion of the time when elderly care was provided and the "allowance for caring for a close person" or later "care allowance" was received [in case of caring for a person with a medium dependency (dependency level II) or heavy dependency (level III) or complete dependency (level IV)] as an alternative time of insurance in the years required for pension insurance.

** Usually this is a tax reduction for the "provider" of the family providing care.

*** I.e. (ideal) type(s) of elderly care policies (ideal types of familialism).

Otrokovo soočanje z izzivi ločitve

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POVZETEK

Zmanjšanj socialni pomen zakonske zveze in povečano število izvenzakonskih partnerskih odnosov, je značilnost moderne družbe. Prav tako je pogosto strmo število naraščanja razvez zakonske skupnosti, kar pa nedvomno ne prizadane samo partnerjev, ki se ločujejo, ampak tudi otroke, ki so največje žrtve ločitve. Namen prispevka je prestaviti obdobje pred, ob in po ločitvi, pri čemer se bomo posebej osredotočili na dejavnike, ki so povezani z otrokovim odzivom na ločitev ter v tem konteksu opisali, kako in na kakšen način se odraža stiska ob ločitvi po posameznih starostnih obdobjih.

1. DEJAVNIKI, KI VPLIVAJO NA OTROKOV ODZIV NA LOČITEV

Za vsakega otroka je razveza travma, vendar jo otroci na različnih razvojnih stopnjah različno razumejo in zato uporabljano različne strategije pri spoprijemanj s spremembami, ki posledično sledijo v njihovem življenju [1]. Kakšen bo otrokov odziv na ločitev in kako bo to vplivalo na njegov kasnejši razvoj, ni odvisno samo od tega, kakšen odnos bo otrok vzpostavil s staršem, s katerim bo živel po ločitvi, od odnosa z okoljem in od tega, kašne so bile razmere pred ločitvijo, ampak tudi od nekaterih drugih dejavnikov. Med te najpogosteje spadajo [2, 3]: temperamentne lastnosti (bolj impulzivni otroci so bolj dovzetni za neugodna dogajanja, večkrat so deležni kritike staršev, njihove jeze, agresije in anksioznosti. Otroci, ki so bili že pred razvezo v psihosocialnih stiskah, imajo po razvezi običajno dolgotrajnejše čustvene motnje, predvsem če so manj odporni in bolj ranljivi); razvojna raven oziroma zrelost otroka (v splošnem velja, da mlajši kot je otrok, bolj je odvisen od staršev in bolj je čustveno obremenjen. Starejšemu otroku se lažje razloži, kaj se dogaja.); otrokov spol (stereotipno dečki svoje vedenje eksternalizirajo, deklice pa internalizirajo), otrokove pretekle izkušnje in sam splet okoliščin, v katerih se ločitev odvija. Otrokov odziv bo drugačen, če bo imel v bližini vsaj eno osebo, ki mu ohranja občutek varnosti, babico, dedka, sestro, brata..., kot če takšne osebe nima [4].

2. OBDOBJE PRED LOČITVIJO

Običajno otroci opazijo že v zgodnjih stopnjah krhanja zakonske zveze, da se starša ne razumeta med seboj, se prepirata ali imata tihe tedne, opazijo očetovo pogosto odsotnost in morda vidijo, kako mama pogosto joče ali je v svojem svetu zaskrbljena. Četudi starša skušata probleme prikriti pred otroci, otroci občutijo hlad, ki se je naselil med njiju. Ker najverjetneje posledično dobijo od staršev manj pozornosti, jih začne skrbeti, da ne bi koga izgubili [5]. Obdobje nesoglasij in kriz med zakoncema pred razpadom je največkrat tudi obdobje nesoglasij med staršem in otrokom. Dlje kot traja tako mučno stanje med staršema in v družini, več je čustvenih šokov pri otrocih in več sledi v njegovi osebnosti [3]. Otrok v tem obdobju ne ve, kaj naj pričakuje. V njegovi glavi se poraja cel kup vprašanj, na katera ne dobi odgovorov. Začne verjeti, da on ni dovolj dober, da je z njim nekaj narobe, prevzema krivdo in jo skriva v notranjosti, saj ne dobi več toliko potrditev s strani staršev, ki ne posvečata dovolj časa njegovemu napredku in vzgoji. Še huje je, če starša otroka vpletata v medsebojne spore in celo pričakujeta, da bo on razsodnik, mirovnik, tolažnik ali ščit enemu proti drugemu. Otrok se v takem odnosu znajde kot lutka, s katero poskušata manipulirati, in se ne zavedata, da s tem pustita v otrokovi psihi trajne posledice [6]. Zbegani otroci čutijo, da jim grozi nevarnost in obenem nimajo nikjer trdne opore, zato se počutijo osamljene in prestrašene. Težko prenašajo, če je njihovim staršem hudo. Čim večja je povezanost s tistim, ki je odšel, tem močneje se otroci odzivajo na zapuščenost. Ko naenkrat manjka del staršev, nimajo več izbire, pri komu bodo iskali potrditev, dotike, pogovor, saj lahko iščejo samo pri tistem, ki je ostal. Zato mu največkrat skušajo v vsem ustreči in ga tako osrečiti. Skušajo celo nadomestiti očeta, ki je odšel [3]. Nekateri odvračajo pozornost od ločitve tako, da postanejo problematični, drugi zbolijo in poskušajo na tak način združiti starše v skupni skrbi za svoje zdravje. Lahko se zgodi, da so navzven otroci neprizadeti in neproblematični, takoimenovani pridni otroci, ki ne želijo staršem povzročati nobenih težav, saj se bojijo, da bodo izgubili še tisto lažno varnost, ki jo imajo. Obstajajo tudi otroci, ki se zatečejo v svet domišljije in fantazije, kjer močno verjamejo, da bosta starša spet nekega dne skupaj in bo družina zaživela lepše, celo idealne čase. Pogosto otroci to fantazijo ohranijo, tudi ko imajo starši že zveze z novimi partnerji [7].

3. OBDOBJE OB LOČITVI

Obdobje ločitve staršev je za vsakega otroka posebno težko obdobje ne glede na starost. Ljudje večkrat rečejo, da še dobro, da sta se ločila sedaj, ko so otroci še majhni, ker ne razumejo. Otroci v predšolskem obdobju morda res še ne znajo izraziti čustev z besedami, vendar vse čutijo in veliko razumejo. Veliko več, kot se jim pripisuje. In se kar doživijo v otroštvu, pride za njimi v adolescenci. Vsak doživlja posledice na svoj način in četudi gre številnim kar dobro navzven, notranje brazgotine vedno ostanejo. Celo otroci iz iste družine lahko čutijo povsem različne posledice.

Tomorijeva [8] meni, da je zgodnja očetova odsotnost pri dečkih nekoliko bolj odločilna kot pri deklicah. Fantje brez očetov naj bi težje navezujejo stike z dekleti. Pogostejše so tudi težave pri usmerjanju in obvladovanju njihove agresivnosti. Dečki, ki ne odraščajo ob ustreznem očetovem liku in imajo tudi sicer neustrezne pogoje za razvoj, težje ravijajo sposobnosti za smiseln samonadzor. Dekleta, ki so odraščala brez prisotnosti očeta, naj bi imela pri splošnem razvoju osebnosti manj težav kakor fantje. Najbolj ogroženo pa naj bi bilo njihovo zdravo oblikovanje spolne vloge. Dekleta ob svojem spolnem razvoju pogosteje in izraziteje doživljajo stisko, ki jo poskušajo razrešiti na različne načine, ali z umikom in izogibanjem vsem socialnim stikom ali z nesprejemljivim vedenjem, ki zbudi v njih močna občutja krivde in se okolje odziva nanj s kaznovanjem. Nekateri drugi avtorji [3,7] menijo, da so fantje bolj dojemljivi za negativne, predvsem kratkotrajne učinke ločitve. Dekleta so v predšolskem in osnovni šoli bolj uspešne, prilagoditveni problemi pa postanejo bolj očitni v obdobju adolescence, ki se kažejo predvsem v pogostejših konfliktih z materami, antisocialnem vedenju, nejevoljnosti, čustveni zmedi in izgubu samozavesti. Elium [9] temu dodaja, da ločitev staršev pogosto med očeti in hčerami naredi še večjo razdaljo, med materami in hčerkami pa se pojavi tekma za pozornost in naklonjenost.

Sporočilo, da se bosta starša ločila, je za otroka zelo travmatično, zato je zelo pomembno, kako mu bo preneseno. Vsekakor je pomembno tudi to, da starša otroku povesta takrat, ko sta za to trdno odločena in ne, ko o tem samo razmišljata. Strokovnjaki svetujejo, da naj bosta pri tem navzoča oba starša, ki pa naj med pogovorom z otrokom dasta na stran vse očitke, medsebojne zamere, jezo, obtoževanje in naj otroka ne zavajata, kajti laži ga lahko še dodatno zmedejo in spodkopljejo njegovo zaupanje vanje. Sporočilo o ločitvi mora biti oblikovano otrokovi starosti primerno in z izrazi, ki jih bo otrok razumel. Otrok mora prejeti temeljito sporočilo, ki mu pove, da ločitev ni povezana z njim, da ni nič kriv in da zaradi ločitve liubezen staršev do njega ne bo nič maniša. Pomembno je, da razume, da ni kriv za razhod, za nesrečo mame ali očeta. Čeprav se bo naravno spraševal, ali je tudi ljubezen do njega začasna in pogojena, je prav, da mu

starša zagotovita, da ga imata vedno in brezpogojno rada in se tako tudi obnašata, da bo z zgledom in dejanji to čutil. Ločitev od zakoncev ne sme biti ločitev od otroka [10].

Raziskave kažejo, da otroci zaradi ločitve staršev trpijo tako kratkoročne kot dolgoročne posledice. Ključne vplive na to, ali bo otrok nadalje, ko začetna stiska mine, v življenju lahko imel manj ali več težav, imata dva bistvena dejavnika ob ločitvi staršev: učinkovitost odnosa med materjo in očetom po ločitvi in zadovoljstvo otroka v reorganizirani (novi) družini [4]. Končen izid ni odvisen le od tega, kaj je otrok izgubil, temveč tudi od tega, kaj je v zameno dobil. Če po ločitvi otrok živi v urejeni družini, v kateri ni prepirov, in če se tudi ločena starša ne prepirata, potem so možnosti, da se bo boljše počutili, veliko večje [5]. Zagotovo lahko nasilni prepiri med staršema bolj škodijo kot dejanski razpad družine in selitev enega od staršev, zato pogosto otrok, ki si želi ločitve, v resnici želi in upa, da se bodo se zaradi psihičnih in/ali fizičnih grobosti končale njegove stiske, ki lahko trajajo že leta. Rad bi čutil ljubezen, pozornost in sprejemanje obeh staršev [11].

Obsežna raziskava v Britaniji [12], ki je pokazala, da ločitev pri otrocih močno vpliva na njihov občutek lastne vrednosti ter njihovo telesno in duševno zdravje, kaže, da je kljub nasilju, odhod enega od staršev šok. Tiste otroke, ki niso bili priča prepirov med starši, ločitev še bolj zbega. V družinah, v katerih so se nesporazumi med starši končali z ločitvijo, otroci ločitve niso bili pripravljeni sprejeti kot edine rešitve.

Na majhne otroke lahko vpliva že sprememba pohištva, še toliko bolj pa izginjanje enega od staršev. Predšolski otrok ne more realno oceniti dogajanja, odločitev, motivov in čustev svojih staršev, niti tega, kakšna je njegova vloga v tem dogajanju. V vsem je odvisen od svojih staršev in ima manjše zmožnosti za samostojno obvladovanje in reševanje nalog, težav, ovir, stresnih in problematičnih situacij [3, 7].

2. 1 Stiska ob ločitvi po posameznih obdobjih

Čeprav so otroci med seboj kljub enaki starosti zelo različni, pa veljajo nekatere skupne značilnosti, ki se kažejo pri doživljanju stresa ločitve: [3, 7]:

- od rojstva do drugega leta: za otroka je najbolj pomembno, da ima rutino, svoj dnevni ritem spanja, hranjenja, tolaženja in da je v varnem okolju pomirjen z ljudmi, ki jih pozna. Malčka zelo razburijo in vznemirijo spremembe in hitre ločitve. Pogosto že samo mamin odhod v službo in njegov prihod v vrtec doživlja zelo stresno in ker ne razume še pojma časa, kdaj se mama vrne, obenem pa ga je morda strah, če se sploh vrne, lahko zanj to predstavlja veliko stisko, kar se kaže kot naraščajoči nemir, jok ter spremembe prehranjevalnih ali spalnih navad. Otrok je pri tej starosti zelo občutljiv na ločitev. Zaradi tesnobe, ki jo čuti ob ločitvi, se lahko posledično umakne, postane pasiven ali gre v druge oblike vedenja, ki za otroka pred tem niso bile značilne.

- od drugega do petega leta: v tem obdobju je prav tako pomembna usklajeno vedenje staršev in njihova nega. Otrok začne razvijati svoje fizične spretnosti, govorne spretnosti in dolgoročni spomin, zato se že bolj zanaša na sebe. Znaki, da je otrok pri tej starosti pod stresom zaradi ločitve, so najpogosteje: nenehna skrb zaradi ločitve, razni tiki (mežikanje z očmi, jecljanje), regresija, (npr. sesanja prsta, mokrenja postelje), dobesedno so priklenjeni na starših, nočejo jih pustiti same, so jokavi in se pritožujejo, kažejo znamenja strahu, so nenavadno težavni in neubogljivi, hočejo spati v postelji svojih staršev, njihovo vedenje je agresivno, nenehno se prepirajo, pretepajo z brati, sestrami in prijatelji, zvečer nočejo v posteljo, so vase usmerjeni, težko jih je čustveno prebuditi, imajo pogoste izbruhe joka in jeze, med spanjem jih tlači mora, staršev nočejo pustiti samih, zato nočejo oditi v vrtec in imajo strah pred separacijo, imajo nerazložljive bolečine v želodcu, slabosti, glavobole, krivijo se za nastale težave, so pogosto tesnobni, sprašujejo o odsotnem staršu ... To se lahko odraža ne samo doma, ampak tudi v vrtcu, kjer preživlja veliko časa.

- od šestega do osmega leta: otrok čuti da je ljubljen, če se mu starša kakovostno posvečata. Pravičnost postane pomembna tema, saj otrok želi, da bi oba starša preživljala enako časa z njim. Pri tej starosti bo otroka že zanimalo, kdo je kriv za ločitev in lahko izraža upanje, da bi bila družina spet skupaj. Pomembno zanj bo, če bosta starša poskrbela, da bosta ločeno z njim preživela čim več časa skupaj, da bo na ta način doživljal čim manj stresa kot je možno glede na okoliščine in spremembe. Izraža lahko vsa čustva, od jeze, žalosti, strahu, agresije, razočaranja do obupa, obenem pa ima lahko težave tudi z vrstniki, s prijatelji in v poli. Nepredelana čustvena in psihična stiska se lahko začne odražati tudi v psihosomatskih simptomih (npr. boli želodec, glava, trebuh ...).

- od devetega do dvanajstega leta: v tem obdobju imajo otroci vedno več dejavnosti, ki niso povezane s starši. Pomembno jim je, da imajo jasno strukturiran urnik za preživljanje časa z vsakim staršem posebej. Lahko se zgodi, da že začne zavračati to, da bi preživel enako količino časa z vsakim od staršev, pogosto se postavi na eno ali drugo stran. Taki odzivi so povsem normalni in je dobro, če starši zaradi njih niso užaljeni, ampak razumejo, da se za tem lahko skriva čisto drugo sporočilo stiske, ki jo otroci čutijo. Možna je tudi zamenjava vlog, ko se otrok počuti dolžnega podpirati in skrbeti za čustveno prizadetega starša na račun lastnega čustvenega stanja. Razvojno in sistemsko gledano, to ni dobro za otroka, zato je prav, da starš išče podporo za svoje težave v drugi odrasli osebi in odvzame to breme otroku, obenem pa je sam podpora otroku, ki težje predeluje stiske in bolečine zapuščenosti, krivde ...

Najpogostejši pokazatelji stresa in stiske pa se pri tej starosti kažejo kot težave z vrstniki, osamljenost, depresivnost, jeza, učne in vedenjske težave, lahko motnje prehranjevanja ali hranjenja ter fizični simptomi v obliki glavobolov in bolečin v želodcu.

- od dvanajstega do petnajstega leta: v tem obdobju otroci potrebujejo čim več podpore in razumevanja staršev. Pogosto zavrnejo enako časovno delitev med oba starša in za ločitev krivijo enega ali oba. Občutek nadzora imajo tako, da zahtevajo, da živijo pri enem od staršev ali da stalno zamenjujejo kraj bivanja. Znaki, da so v težavah pa so: depresija, slaba volja, slab uspeh v šoli, zloraba alkohola, drugih drog ter motnje hranjenja, prezgodnja spolnost ali kronično uporniško obnašanje, ... četudi težave niso nujno povezane z ločitvijo, najstnik potrebuje pomoč.

- od petnajstega do osemnajstega leta: večino časa je namenjenega vzpostavljanju neodvisnosti ter družbenim in šolskim dejavnostim. V splošnem do težav staršev postanejo nestrpni in jih ne zanimajo več tako močno, a kljub temu potrebujejo podporo staršev. Čeprav si želijo, da bi bili njihovi starši srečni, imajo običajno zelo mešane občutke, če se ti srečujejo z drugimi partnerji. Lahko doživljajo, da bi bilo odobravanje drugega partnerja nelojalno do drugega starša. V veliko pomoč so redni pogovori staršev z otrokom o njegovih občutkih. Njihovi klici na pomoč se največkrat kažejo kot vedenjske in čustvene težave, depresija, slab učni uspeh, beg od doma, motnje hranjenja, zapletanje v težave s policijo, zapletanje v promiskuitetna vedenja, razne zasvojenosti ...

Longitudinalna študija, ki so jo strokovnjaki izvedli v Kanadi [13], v katero so vključili otroke ločenih staršev, je ocenjevala tesnobo otrok, hiperaktivnost, fizično agresijo, uporniško in prosocialno vedenje, in vse to vsaki dve leti, od vrtca pa vse do konca osnovne šole. Rezultati so pokazali, da so otroci, ki so doživeli razvezo staršev pred dopolnjenim šestim letom, pokazali razmeroma več vedenjskih motenj kot njihovi vrstniki, katerih starši so se ločili kasneje.

Povsem razumljivo je, da otrok na različne načine reagira, ko je v stiski. Kako dolgo bo trajala stiska, kakšne sledi bo pustila, pa je tako kot pri odraslih, tudi pri otrocih zelo odvisno od tega, če ima otrok koga ob sebi, na katerega se lahko opre oziroma nekoga, ob katerem mu je varno in mu lahko zaupa.

4. OBDOBJE PO LOČITVI

Potem, ko se starši dogovorijo glede skrbništva in osebnih stikov z otroki ter uredijo premoženjske stvari, se začne novo poglavje v njihovem življenju in v življenju njihovih otrok. Navaditi in prilagoditi se morajo na drugačen ritem in način življenja ter se spopasti s posledicami, ki jih je prinesla ločitev (npr. selitev, menjava delovnega mesta, vrtca, šole, prijateljev ...). Otroci se morajo prilagoditi na manj pogoste stike in vpletenost s tistim od staršev, ki ne živi skupaj z njim ter prilagoditi se na življenje s tistim, s katerim živi in je le-ta pogosto preobremenjen, razdražljiv in preobčutljiv. Pogosto zaradi vsega lahko postane družinsko življenje zelo kaotično in stresno [10].

Pomembno je, da se otroku pomaga v smeri zmanjševanja stresa. Starši to dosežejo tako, da se na otrokove skrbi odzivajo odprto in iskreno ter mu pomagajo čim bolj mirno preživeti stresno obdobje Ko otrok čustveno močno navzven reagira (joče, je razburjen, ga je strah) ob včasih navidezno pomembnih ali nepomembnih stvareh, je pomembno, da mu starši dajo vedeti, da spoštujejo njegove občutke in ga imajo radi ne glede na vse [3].

Ko otroka skrbi vse možno in postavlja vprašanje, je prav, da starši odgovarjajo iskreno in čim bolj z nevtralnimi čustvi, kolikor je le mogoče. Otrok mora dobiti določene informacije, da bo lažje pripravljen na spremembe, ki sledijo v življenju. Potrebno se je zavedati, da otrok ne potrebuje vseh podrobnosti, vedeti pa mora dovolj, da razume, da se partnerja ne ločujeta tudi od njega. Ob vsakem odhodu, se v otrokovi glavi začnejo porajati vprašanja, če nekdo odhaja za vedno, ali pride nazaj, zakaj ga je pustil samega, ali je tako slab, da ga nihče ne mara, kdo bo poskrbel zanj.... [7].

Kadar razvezani starši dobijo novega partnerja, se njihov otrok, ki najpogosteje še ni prebolel ločitve in še žaluje, je jezen ali poln strahov, znajde v situaciji, ki od njega zahteva veliko prilagajanja in nove čustvene viharje. V splošnem velja, da naj bi se mlajši otroci lažje navezali na nove partnerie svojih staršev kot starejši. Če pa imata starša številne nove zveze, to v otroku samo povečuje zmedo, strah in vedno znova odpira rano odhoda, zavrženosti in zapuščenosti. Kadar eden od staršev zahaja na zmenke, lahko drugi starš postane ljubosumen in užaljen in nezreli starši v takih primerih izkoristijo otroka za zbiranje informacij o novi zvezi in mu celo dajejo navodila, kako naj nagaja novemu partnerju in onemogoči zvezo [14]. Nemalokrat je problem tudi v novih vlogah, ki jih dobi otrok, ko ostane večino časa z enim od staršev (npr. postane tolažnik, čustveni partner mami, starš mlajšim bratom in sestram, ...) [15].

Nekaterim otrokom so njihovi novi oziroma krušni »starši« tudi všeč, drugi jih zavračajo in primerjajo s svojimi biološkimi starši. Ob tem pa doživljajo, da ta oseba poskuša nadomestiti odsotnega starša in da njegova navzočnost pomeni grožnjo ljubezni in spominu nanj. Takšni občutki so še posebej prisotni, če je zveza med otrokovimi biološkimi starši razpadla zaradi afere drugega starša s sedanjim partnerjem. Prav zato je pomembno, da ločeni partnerji razumejo in razmejijo, da je njih zapustil ali do so oni zapustili moža, ženo, od otrok pa odšel oče oziroma mama. Za otroka bo oče vedno ostal oče in mama vedno mama. Razvrednotiti očeta ali mamo, je zato za otroka katastrofalno [6, 11]. Z novo družino pa lahko otrok ali otroci dobijo novega brata ali sestro. Velikokrat prihod novega člana skupaj z maminim ali očetovim partnerjem v otroku prebudi občutek, da je njegov položaj ogrožen. Otroci, ki so postali člani iste družine tekmujejo med seboj za naklonjenost in pozornost različnih staršev. To največkrat prinaša zamere, ljubosumje in slabo voljo. Zgodi pa se lahko tudi, da imajo otroci svojega očima ali mačeho raje kot pa svojega pravega starša, sploh če je bil le ta nasilen ali zasvojen ali večino časa odsoten [3, 7].

5. ZAKLJUČEK

Ločitev je nedvomno med najbolj stresnimi dogodki v življenju, otroci pa predvsem zaradi razvojne zrelosti, odvisnosti od staršev ter občutka varnosti in zaupanja, ki se močno zamaje, nemočni in žrtve odločitev odraslih. Ne glede na vse, pomembno je, da večkrat slišijo in tudi čutijo prek dejanj, da oni niso krivi in da jih imata starša še vedno rada, predvsem pa, da četudi zapuščata drug drugega, to še ne pomeni, da z njimi prekinjata stike ali odhajata tudi od njih. Če bodo starši, širša in ožja okolica znali prisluhniti otrokovim stiskam, ki bodo na tak ali drugačen način prišle na dan, bo otrokovo sprejemanje in prilagajanje na spremembe manj stresno in bo prej lahko začel živeti novo življenje.

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BEGUNCI V SVETU OD KONCA HLADNE VOJNE DO DANES IN NJIHOV DEMOGRAFSKI POMEN

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POVZETEK

V zadnjih 25 letih absolutno in relativno število beguncev v svetu hitro narašča. Problem je težji v manj razvitem delu sveta. Sredi drugega stoletia pa ie desetletia 21. begunska problematika dobila razsežnosti in javno pozornost, kot jih v preteklosti še ni imela. Avtor besedila obravnava statistične in demografske vidike in pomen begunske problematike. Podatki, ki jih večinoma zbira VKBOZN, kažejo, da živimo v času, ko je približno vsak stoti Zemljan begunec. To je nedopustno visoka številka. Begunstvo je neenakomerno razdeljeno po svetu. V obravnavanem obdobju prizadeva predvsem Afriko in Azijo, čeprav noben del sveta ni povsem varen pred njim. Statistična in demografska dinamika pa hkrati kažeta, da človeštvo ne obvladuje begunske problematike. Zato se problematika zapleta in zaostruje še preden so nastopile hujše posledice klimatskih sprememb, ki utegnejo v prihodnosti pognati v beg ne samo več deset ampak več sto milijonov ljudi.

Ključne besede : begunci, prisilne migracije, ljudje na begu, regionalna porazdelitev različnih skupin beguncev.

1 UVOD

Problematika begunstva je stara kakor človeštvo, vendar imamo za največji del človeške zgodovine zelo malo dobrih podatkov o beguncih. Zelo okvirno lahko rečemo, da je bilo do polovice 20. stoletja o beguncih zelo veliko napisanega na literarni in poročevalski ravni, zelo malo pa na strokovni ali celo znanstveni ravni, pa tudi literarne obravnave so pogosteje slonele na mitih in legendah kot pa na statističnih osnovah, ki smo jih vajeni v modernem času.

Sredina 20. stoletja je bila prelomna za predvsem zaradi mednarodno begunstvo pravnega ureiania te problematike. Najpomembnejši sta bili pri tem ustanovitev Visokega komisariata OZN (v nadaljevanju VKBOZN ali v angleški verziji UNHCR) za begunce, 1. januarja 1951, in sprejem Konvencije o statusu beguncev, 28. 7. 1951, na posebni konferenci OZN. Sprejem konvencije so spodbudile razmere v Evropi po 2. svetovni vojni. Zato je urejala predvsem evropsko problematiko. Razširitev na svetovno raven je pomenil sprejem Protokola o varstvu beguncev v letu 1967, ki je odpravil omejitve, zaradi katerih so lahko zaprosili za status pretežno Evropejci in še ti zaradi dogodkov pred začetkom leta 1951 (UNHCR, 2002, 4-5). Kasneje je bilo sprejetih več drugih dokumentov na svetovni in regionalni ravni, vendar ostaja Konvencija še zmeraj temeljni in najpomembnejši dokument. Med novejšimi dokumenti omenimo tukaj le Deklaracijo Generalne skupščine OZN 0 beguncih in migrantih, ki so jo poimenovali po New York-u in sprejeli 19. 9. 2016 (UN, 2016).

VKBOZN ima mandat Generalne skupščine OZN za zaščito beguncev in za iskanje

rešitev v pogosto zelo zapletenih konkretnih političnih, humanitarnih in vojaških razmerah. Narava njegovega dela je nepolitična in humanitarna. V polovici stoletja po sprejemu Protokola o varstvu beguncev praksa varovanja beguncev kaže zelo počasen napredek. Število beguncev v svetu pa bolj ali manj stalno narašča tako v absolutnem kot relativnem smislu.

V tem besedilu se ni mogoče ukvarjati z vsemi zelo številnimi in izjemno kompleksnimi vidiki begunstva. Zato se bom omejil na obravnavo splošnih trendov begunstva po koncu hladne vojne ter na njegove statistične in demografske vidike. Zagovarjal bom tezo, da človeštvo ne obvladuje begunstva na primeren način, zato se problemi zaostrujejo, begunska problematika pa postaja vse težja, zapletena in kompleksna. Pri tem je še posebej pomembno dejstvo, da se begunska problematika v zadnjih letih vse bolj meša in povezuje z mednarodnimi ekonomskimi migracijami. Zato se v strokovnih in političnih krogih vse več govori o mešanih migracijah in o potrebi po managementu mešanih migracij na globalni in na regionalnih ravneh.

2. STATISTIČNI PODATKI O BEGUNCIH IN NJIHOVA ZANESLJIVOST

Statistično zbiranje podatkov zahteva v prvi vrsti opredelitev osnovne statistične kategorije, ki jo v obravnavanem primeru najdemo v 1. členu Konvencije. Ta begunca definira kot »osebo, ki je zunaj države, katere državljan je, ali v kateri je imela običajno prebivališče, ki se utemeljeno boji preganjanja zaradi rase, vere, narodne pripadnosti, pripadnosti določeni družbeni skupini ali določenemu političnemu prepričanju in ki zaradi takšnega strahu ne more ali noče uživati zaščite te države ali se vanjo vrniti« (UNHCR, 2002, 6). Ključna značilnost takšne definicije je njena meddržavna narava. Zajete so samo osebe, ki bežijo iz ene države v drugo. To pa pomeni, da je pojav meddržavni in je kot tak del širšega okvira zunanjih oziroma mednarodnih migracij. Po analogiji so notranje razseljene osebe del širše kategorije notranjih migracij.

Na mednarodni ravni je zadolžen za zbiranje podatkov o beguncih VKBOZN. Ta zbira podatke s pomočjo mreže svojih predstavništev in izpostav po državah sveta. Uporablja in preverja pa tudi vladne podatke različnih držav. Pri svojem delu je kljub težavni naravi statistike begunstva zelo napredoval. To najlepše dokazujejo Statistični letopisi VKBOZN. Zadnji, 15. po vrsti, je bil objavljen v septembru leta 2017 (UNHCR, 2017). Vse bolj pomembni in predvsem najbolj prenovljeni pa so podatki objavljeni na spletnih straneh VKBOZN. V tem besedilu bom uporabljal predvsem podatke VKBOZN.

V ožjem smislu so begunci osebe s priznanim statusom begunca. To je mednarodna kategorija, ki ji je že priznan status in s tem zagotovljeno mednarodno varstvo. VKBOZN pa v svoji statistiki obravnava še druge kategorije. Te so: prosilci za azil, ki so že vložili prošnjo za dodelitev statusa begunca, vendar o prošnji še ni odločeno; notranje razseljene osebe (NRO), ki so prisilno zapustile domove, vendar pri tem niso prestopile državne meje; vrnjeni begunci, ki so se na spontani ali organizirani način vrnili v izvorno državo; vrnjene NRO, ki so se na svoje domove vrnile s pomočjo VKBOZN; osebe brez državljanstva (po mednarodnem pravu) in drugo, kamor se uvrščajo osebe, ki ne spadajo v nobeno od prej naštetih kategorij, vendar so bile deležne pomoči VKBOZN (UNHCR, 2017, 4). Vse te kategorije skupaj bi lahko imenovali ljudje na begu ali begunci v širšem smislu. Ta širša kategorija je v prvi vrsti predmet proučevanja v tem besedilu.

Statistični podatki o ljudeh na begu pa so po svoji naravi praviloma nepopolni in ne

dosegajo statističnih standardov moderne statistike. To velja tudi za podatke VKBOZN, saj ti v precejšnji meri spominjajo na registrske podatke, pogosto pa so omejeni le na osebe iz posameznih kategorij, ki jim je pomagal VKBOZN. Pri registrskih podatkih pa se pojavljajo predvsem problemi pri nepopolni evidenci odhodov oziroma izbrisu iz registra. V mnogih primerih so prisotni še drugi problemi. Evropska praksa zadnjih let kaže, da prosilci za azil pogosto zapustijo državo, v kateri so zaprosili za azil, še preden se odloči o njihovi prošnji. Iz te prakse tudi vemo, da je izredno težavno ločevanje ekonomskih migrantov od beguncev v širšem smislu. V ospredje je tako stopilo vprašanje mešanih migracij, ki je še kompleksno zaradi posebej različnega mednarodno pravnega položaja obeh kategorij. Zlasti ekonomski migranti pogosto mislijo, da bodo lažje prišli v namembno državo, če se prikažejo kot begunci.

Problemi statistike beguncev se kažejo že pri ugotavljanju njihovega števila. Še bolj kompleksni pa so problemi pri podatkih o demografskih in drugih strukturah beguncev. Mnogi posamezniki so preprosto brez ustreznih ali sploh kakršnihkoli dokumentov ali pa imajo ponarejene dokumente. Mnogi lahko sami odvržejo dokumente ali jih k temu prisilijo prekupčevalci z ljudmi ali kdo drug. Zaradi vsega tega je zelo težavno preverjati zanesljivost podatkov zbranih s tradicionalnimi načini zbiranja podatkov (popisi, ankete, intervjuji ipd.).

Navedene in druge težave statističnega spremljanja begunske problematike kažejo, da moramo biti pri ocenjevanju in vrednotenju podatkov zelo previdni in pazljivi. Načeloma imamo sicer na voljo podatke pri odhodu iz nekega geografskega območja in podatke o prihodu v drugo geografsko območje. Prvi podatki bi morali biti enaki drugim. Vendar se vmes mnogi begunci izgubijo. Še večji problem pa je preprosto v tem, da v neurejenih političnih razmerah ali celo v vojnem stanju preprosto ni možno kakovostno zbiranje podatkov. Vse to moramo imeti pred očmi, ko uporabljamo statistične podatke o ljudeh na begu.

3 ABSOLUTNA IN RELATIVNA RAST ŠTEVILA LJUDI NA BEGU V SVETU V ZADNJI ČETRTINI STOLETJA OZIROMA PO KONCU HLADNE VOJNE

Obdobje po koncu hladne vojne je naravna izbira za analizo begunske problematike zaradi številnih razlogov. V 2. polovici 20. stoletja se je izoblikoval bipolarni svet, ki je ustvarjal vtis navidezne stabilnosti. Za krajši čas je bilo doseženo ravnovesje moči med glavnima vojaškima silama ZDA in Sovjetsko Zvezo (SZ), ki je bila še podkrepljena z atomskim orožjem na obeh straneh. Zlasti sovjetski blok je vodil politiko zaprtosti in ni dovoljeval večjih mednarodnih migracij, še prav posebej ne med obema blokoma. Vojaški konflikti so bili omejeni na nerazvite države »svetovnega juga«, kjer so pretežno nastajali begunski tokovi. Večina konfliktov je bila povezana s procesom dekolonizacije.

Na področju varstva beguncev se je prvotna zaščita evropskih beguncev leta 1967 razširila na ves svet. Uradni podatki o številu beguncev VKBOZN kažejo, da se je to število povečalo od zelo nezanesljivega enega milijona leta 1951 na 5.691.900 na začetku leta 1980 (UNHCR, 2002, 10). V naslednjem desetletju se je globalno statistično spremljanje beguncev izboljšalo zaradi splošnega razvoja v svetu in še posebej zaradi napredka znanosti in modernih tehnologij. Hkrati so v prebivalstvenem oddelku OZN pripravili globalni pregled begunstva v letu 1989, ki nam omogoča dobro izhodišče naše obravnave. V tabeli 1 zato lahko prikažemo števili beguncev in prebivalstva ter delež prvih med prebivalstvom po velikih regijah sveta.

Tabela 1: Ocenjeno število beguncev (B) in prebivalstva (P) ter delež prvih v drugem v svetu leta 1989 v velikih regijah sveta. Vir: World Population Monitoring 1991; Population Newsletter, June 1991; Demographic Yearbook 1996, str. 131, 155-156 in 158.

Regija	B 1.1.89 v mio	P 30.6.89 v mio	Delež B v P (‰)
Azija	7,0	3.127,6	2,2
Afrika	4,3	612,8	7,0
J. in Srednja Amerika	1,2	430,0	2,8
Ostali svet	2,3	1.024,6	2,2
V tem Avstralija	0,091	16,8	5,4
Kanada	0,380	27,4	13,9
Evropa	0,767	719,0	1,1
ZDA	1,0	245,1	2,8
Skupai	14.8	5,195	2.8

Podatki o beguncih ne vključujejo 2,3 milijona Palestincev, ki so bili pod pristojnostjo UNRWA.

Na predvečer razpada bipolarnega sveta in na začetku obdobja postopnega nastajanja večpolarnega sveta je bilo v svetu približno 17 milijonov beguncev, od katerih je 87 % našlo varstvo v nerazvitem delu sveta. Če upoštevamo še palestinske begunce, se je število beguncev v svetu povečalo od 7,5 milijonov leta 1980 na 17 milijonov v letu 1989 (UN, 1991, 1). To je bilo nekaj manj kot 0,3 % svetovnega prebivalstva. Absolutno število beguncev je bilo najvišje v Aziji, relativno število pa v Afriki, če se pri tem omejimo na celine. Relativni podatki pa kažejo, da je bil delež nad svetovnim povprečjem le v Afriki, Avstraliji in Kanadi. Nekaj večjih držav je vključenih že v tabelo 1. Boljši pregled stanja po izbranih državah pa nam kaže tabela 2, v katero smo uvrstili 10 držav z najvišjim številom beguncev leta 1989.

Tabela 2: Izbrane države sveta z najvišjim številom beguncev po državi azila v letu 1989. Vir: World Population Monitoring 1991; Population Newsletter, June 1991; Demographic Yearbook 1996, str. 154-158.

Država	Št. B v tisoč	Št. P v tisoč	Delež B v P (‰)
Pakistan	3.258	109.140	29,9
Iran	2.800	53.187	52,6
ZDA	1.000	245.100	3,9
Sudan	745	24.989	29,3
Etiopija	680	46.928	14,5
Malavi	628	8.022	78,3
Somalija	600	8.489	70,7
Kanada	380	27.400	13,9
Mehika	356	84.272	4,2
DR Kongo/Zair	341	34.491	9,9

V tabeli 2 sem upošteval samo države z več kot 300 tisoč prebivalci. Med izbranimi 10 državami sta samo 2 razviti državi, ki tvorita S. Ameriko. Če k tema dodamo še Mehiko, lahko rečemo, da je ostalih 7 držav iz Azije in Afrike. Leta 1989 je bilo relativno največ beguncev v treh afriških državah: Malavi, Somalija in Sudan ter v dveh azijskih državah: Pakistan in Iran, ki sta bili na prvih dveh mestih tudi po absolutnem številu beguncev.

Zaradi omejenega obsega bom v naslednjih dveh tabelah prikazal najnovejše podatke iz pravkar objavljenega Statističnega letopisa VKBOZN za leto 2015. Na voljo imamo bolj podrobno strukturirane podatke kot pred četrt stoletja. V tabeli 3 zato prikazujem število ljudi na begu razčlenjeno na begunce, NRO in osebe brez državljanstva skupaj s številom prebivalstva in deležem B v P za velike makro regije OZN..Podatki se nanašajo na konec leta 2015, zato sem število P iz WPP 2017 v tej in naslednji tabeli ocenil s predpostavko, da se je v zadnji polovici leta 2015 število gibalo enako kot med sredinama leta 2014 in 2015.

Tabela 3: Ocenjeno št. glavnih vrst B (po državi azila) po velikih regijah OZN (v tisoč), št. P (v mio) in delež B v P v ‰ 31. 12. 2015. Vir: UNHCR Statistical Yearbook 2015 in WPP 2017.

Regija	B in	NRO in	Osebe brez	Skupaj v	P (v	Delež B v P
	podobni	podobni	državljanstva	skrbi VKB ¹	mio)	v ‰
Afrika	4.811	11.198	1.021	20.277	1.209	16,8
Azija	8.689	17.265	1.943	29.704	4.442	6,7
Evropa	1.816	1.918	587	5.483	741	7,4
J. in Sr.	338	7.113	137	7.659	636	12,0
Amerika						
S. Amerika	409	-	-	715	357	2,0
Oceanija	48	-	-	70	40	1,8
Skupaj	16.111	37.494	3.688	63.908	7.425	8,6

¹ Kategorija skupaj vsebuje tudi vrnjene B in NRO, ki pa niso posebej prikazani.

Število ljudi na begu ni bilo nikoli v zgodovini tako veliko kot ob koncu leta 2015. V primerjavi z letom 1989 in upoštevajoč palestinske begunce se je njihovo število povečalo z indeksom 376,5, delež med prebivalstvom sveta pa je, če zaokrožimo, porasel od 0,3 na 0,9 %. Podrobnejšega razvoja v vmesnem obdobju tukaj ne moremo obravnavati. Na osnovi podatkov letopisov VKBOZN pa lahko rečemo, da sta bila razen rasti skupnega števila glavna trenda rast NRO in zmanjšanje števila vrnjenih B in NRO na domove. To kaže primerjava zadnjega desetletja z desetletjem pred njim. Geografska porazdelitev B po celinah pa se ni veliko spremenila. Afrika in Azija sta najbolj prizadeti celini. Prva ima največje relativno, druga pa največje absolutno število B. Podrobnejšo regionalno sliko pa bomo prikazali s tabelo 4, ki prikazuje podrobnejše podatke o B konec leta 2015 za 20 držav z največ B po državi azila. Tabela 4: Število ljudi pod skrbjo VKBOZN po glavnih skupinah (v tisočih) po državi azila, število P države (v tisočih) konec leta 2015 in delež B v P v ‰. Vir: UNHCR Statistical Yearbook 2015 in WPP 2017.

Država	B in	Osebe v	NRO in	Skupaj v	Р	Delež B
	podobni	postopkih	podobni	skrbi VKB	(v tisoč)	v P v ‰
		za azil		OZN		
Kolumbija	0	0	6.939	6.941	48.447	143,3
Sirija	21	5	6.563	6.754	18.501	365,1
Irak	278	7	4.403	4.746	36.671	129,4
Sudan	310	13	3.218	3.736	39.103	95,5
Pakistan	1.561	6	1.146	3.390	191.298	17,7
Jemen	267	10	2.532	2.809	27.251	103,1
Turčija	2.541	212	-	2.755	78.891	34,9
DR Kongo/Zair	383	1	1.555	2.699	77.434	34,8
Nigerija	1	0	2.173	2.174	183.542	11,8
J. Sudan	263	1	1.790	2.054	12.057	170,4
Afganistan	258	82	1.174	1.767	34.225	51,6
Ukrajina	3	7	1.600	1.645	44.546	36,9
Mjanmar	-	-	451	1.414	52.644	26,9
J. Afrika	122	1.096	-	1.218	55.666	21,9
Somalija	8	10	1.133	1.189	14.105	84,3
Libanon	1.071	12	-	1.088	5.975	182,1
Slonokoščena obala	2	1	308	1.024	23.396	43,8
Iran	979	0	-	979	79.834	12,3
Nemčija	316	421	-	749	81.817	9,2
Etiopija	736	2	_	739	101.126	7,3

0 pomeni število manjše od 500; - ni pojava. V tabeli so izpuščeni vrnjeni B in NRO, osebe brez državljanstva in drugi v skrbi VKBOZN, čeprav so vključeni v celotno število B v skrbi VKBOZN.

Najbolj prizadete države z begunsko problematiko so se v zadnji četrtini stoletja zelo spremenile. Med prvimi desetimi državami z največjim številom ljudi na begu so konec leta 2015 samo 3 države, ki so bile na takem seznamu leta 1989. To so Pakistan, Sudan in Zair. Nikjer v tabeli 4 ni več Kanade, ZDA in Mehike. Med razvitejšimi državami so v tabeli 4 samo Turčija zaradi krize v Siriji in Iraku ter dve evropski državi, Ukrajina in Nemčija. Ukrajina ima veliko NRO zaradi lastnih ruskih upornikov na vzhodu države, Nemčija pa je edina bogata

država na seznamu zaradi najnovejšega sprejema večjega števila predvsem sirskih beguncev, čeprav množični prihod beguncev v Nemčijo v letih 2015/2016 še ni v celoti upoštevan v podatkih VKBOZN.

Vsaka izmed držav v tabeli 4 je doživela specifičen razvoj dogodkov, ki so pognali ljudi v beg ali pa omogočili zaradi geografske bližine ali drugih razlogov prihod beguncev iz kriznih držav. V nekaj potezah in na kratko lahko s pomočjo te tabele ugotovimo, da je v prvih 10 državah več kot 2 milijona ljudi na begu, na samem vrhu pa so 4 zaradi NRO. Vrstni red držav po najvišjem deležu beguncev med prebivalstvom je nekoliko drugačen. Na vrhu je Sirija s 36,5 % prebivalstva v skrbi VKBOZN. Zelo visoko sta tudi Libanon z 18,2 in J. Sudan s 17,0 % prebivalstva v skrbi VKBOZN, vendar so v prvem predvsem begunci iz soseščine, v drugem pa NRO. Več kot 10 %, predvsem NRO, je še v Kolumbiji, Iraku in Jemnu. Implicitno je v podatkih tabele 4 skrito dejstvo, da je v

4 DEMOGRAFSKI POMEN IN ZNAČILNOSTI LJUDI NA BEGU

Na svetovni ravni postaja demografski pomen ljudi na begu ne samo vse bolj pomemben ampak tudi vse bolj kritičen. Povečevanje absolutnega in relativnega števila beguncev se hitro približuje stanju, ko bo vsak stoti prebivalec našega planeta pod skrbjo VKBOZN. Če pa upoštevamo podcenjenost in nepopolnost statističnih podatkov o beguncih, lahko mirno rečemo, da smo to stanje že dosegli. Osebe v skrbi VKBOZN bodo dosegle in presegle to mejo verjetno v naslednjem desetletju zaradi nesposobnosti človeštva, da bi na miren način in z mednarodnim sodelovanjem rešili največje vojaške konflikte in politične krize. Dosežena bo tudi brez bližnje uresničitve velikih naravnih in drugih nesreč kot posledic klimatskih sprememb. Slednje v obravnavanem obdobju še niso posebej izrazito vplivale na poslabšanje begunskih razmer. Implicitno pa so bile gotovo prisotne predvsem v Afriki in Aziji. Vse bolj jasno pa se nakazuje prihodnji razvoj, ki bo zaradi posledic klimatskih sprememb poslal v beg desetine ali celo stotine milijonov ljudi. Sedanje razmere in njihovo zelo verjetno poslabšanje zaradi posledic klimatskih sprememb je alarmantno. Zadnja četrtina stoletja je pokazala, da človeštvo dopušča stalno slabšanje razmer na področju begunstva in da ni sposobno sproti reševati Mjanmaru, Zairu, Slonokoščeni obali in v Pakistanu veliko število oseb brez državljanstva. Ravno tako je specifičen primer J. Afrike, ki ni pripravljena podeliti statusa begunca ljudem iz soseščine. Dodam pa lahko še, kar se je pokazalo pri ocenjevanju števila prebivalstva države ob koncu leta 2015, namreč da kar v 18 državah v tabeli 4 kljub begunskim krizam prebivalstvo narašča. Padanje prebivalstva sta zabeležili samo Ukrajina od leta 1990 in Sirija od leta 2010 (WPP 2017).

vojaških in političnih kriz, ki se neprestano dogajajo. Zato si je danes nemogoče predstavljati, kako bi se svet spopadel z demografskimi posledicami dviga morske gladine za 1 - 2 ali celo za 3 metre. V tem primeru bi moralo zapustiti domove več deset ali celo več sto milijonov oseb (okoljskih beguncev).

Demografski pomen begunstva pa je že danes izredno pomemben na nižji regionalni ravni. Če to raven omejimo na države, so take države skoraj zagotovo vse države v tabeli 4, brez vsakega dvoma pa je to osem držav, kjer je delež ljudi na begu višji kot 8 % prebivalstva. Državam z več kot 10 % moramo prišteti še Sudan in Somalijo. Zanimivo pa je, da sta samo v Siriji vojaški konflikt in politična kriza povzročili zmanjševanje števila prebivalstva. V Ukrajini so za depopulacijo pomembni predvsem ekonomski razlogi, saj je prebivalstvo padalo že veliko pred izbruhom krize.

Za podrobnejšo demografsko analizo beguncev bi potrebovali celo vrsto demografskih podatkov. Žal pa imamo že za osnovna demografska znaka spol in starost zelo pomanjkljive podatke. Praktično nemogoče pa je dobiti dobre podatke o izobrazbi, poklicu, narodnosti, verski pripadnosti ipd. za katerokoli raven zbiranja podatkov. Za blizu 64 milijonov beguncev konec leta 2015 imamo podatke o
spolu in starosti le za 33 % oseb, samo podatke o spolu pa le za 46 % oseb (UNHCR, 2017, 101). Zato se bo analiza strukture beguncev po spolu in starosti omejila le na 8 držav izmed 20 vključenih držav v tabelo 4, za katere imamo dobre podatke o tej strukturi. Ti podatki so prikazani v tabeli 5.

Tabela 5: Struktura oseb v skrbi VKBOZN po starosti in spolu za 8 izbranih držav iz seznama 20 držav z največ ljudmi na begu ob koncu leta 2015 v %. Vir: UNHCR Statistical Yearbook 2015, str. 98-101.

Država	Starost				Skupaj	%	
	0 - 4	5 - 11	12 - 17	18 - 59	60+		žensk
Afganistan	19	21	18	37	4	100	49
Pakistan	13	24	15	44	4	100	46
Jemen	8	26	18	46	3	100	53
Libanon	18	22	12	44	3	100	52
Kongo/Zair	22	25	12	39	2	100	52
Etiopija	16	26	15	41	2	100	50
Somalija	22	22	14	39	3	100	51
Nemčija	8	10	8	70	4	100	34

Podatki v tabeli 5 z izjemo Nemčije niso presenetljivi. Ko morajo ljudje prisilno zapustiti svoje domove, bežijo vsi. Pri prisilnih migracijah ne delujejo običajni selekcijski procesi, ki so zmeraj prisotni pri ekonomskih migracijah. Zato je delež žensk blizu polovice, pa tudi podatki o starostni strukturi so v grobem podobni starostni strukturi celotnega prebivalstva posameznih

5 SKLEP

Podatki o številu vseh vrst beguncev v svetu so nepopolni, saj lahko neprestano spremljamo poročila o tem, da mnogi ljudje na begu umrejo bodisi zaradi nasilja ali raznih nesreč. Mnogi se utopijo v morju. Številni primeri tega ostanejo neevidentirani. K temu lahko prištejemo neznano število beguncev, ki se iz različnih razlogov skrivajo. Zaradi tega so podatki VKBOZN podcenjeni tako s statičnega kot z dinamičnega držav. Manjše odstopanje navzdol je prisotno pri zgornjih dveh starostnih razredih, navzgor pa pri treh starostnih razredih otrok. Poseben primer pa je Nemčija. Starostna struktura v zadnji vrstici tabele 5 kaže izrazito selekcijo, saj v Nemčijo prihajajo pretežno moški in osebe v delovnem kontingentu. To pa potrjuje, da je med temi osebami več ekonomskih migrantov.

vidika. Razen tega se dogajajo tudi napake pri dodeljevanju statusa beguncev osebam na begu. Mnoge države so pri tem preveč omejevalne. Zato lahko mirno ocenimo, da živimo v svetu v katerem je vsak stoti Zemljan begunec.

V besedilu je bila ugotovljena hitra rast absolutnega in relativnega števila beguncev. Ta rast ni bila enakomerna po posameznih letih. Enako velja tudi za posamezne skupine beguncev. Relativni podatki iz zadnjega Statističnega letopisa VKBOZN kažejo, da je bila največja rast NRO in največji padec pri osebah brez državljanstva. Skrbi pa dejstvo, da je delež oseb s priznanim statusom begunca v zadnjih desetih letih padel od 30 na 25 %. K temu lahko dodamo še nizko število oseb v postopku pridobivanja azila. Vsa leta od 2006 do 2014 je bilo to število 2 - 3 %, le v letu 2015 se je povečalo na 5 % (UNHCR, 2017, str. 200). Begunstvo je tudi izrazit problem nerazvitih in revnih držav. Hkrati pa se velike razlike med posameznimi regijami še povečujejo. Pri tem pa nobeden del sveta ni povsem varen, kljub navidezni blaginji in stabilnosti v razvitih državah in v nekoliko odmaknjeni Latinski Ameriki. Vse to je zadosten dokaz, da človeštvo ni uspešno pri pomoči ljudem na begu.

Politični, ekonomski, kulturni in številni drugi vidiki begunske problematike so ostali v tem besedilu ob strani. Jasno pa je, da je najuspešnejša pomoč beguncem tista, ki jim omogoča varno in uspešno vrnitev na domove, iz katerih so bili pregnani. V mednarodnem merilu pa je po dodelitvi začasnega azila potrebno bodisi poskrbeti za repatriacijo, naselitev v državi podelitve prvega azila ali pa preselitev v kakšno tretjo državo. Beguncem je potrebno omogočiti čim bolj svoboden dostop do trga dela. Bistveno večji napor pa bi bilo potrebno nameniti nadaljnjemu razvoju mednarodnega prava na področju varstva beguncev in povečevanju števila držav podpisnic Konvencije in Protokola o statusu beguncev.

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Umetna inteligenca in izbrane demografske-ekonomske analize

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POVZETEK

Pogosto slišimo, da se demografskih, ekonomskih oz. podobnih družbeno kompleksnih pojavov ne da analizirati s formalnimi matematičnimi in računalniškimi metodami. V tem prispevku predstavljamo drugačen pogled – da je umetna inteligenca s svojo neverjetno močjo in rastjo najuspešnejše orodje, ki zmore analizirati tudi zelo "mehke" pojave. S sklicevanjem na tehnike umetne inteligence in objavami avtorja predvsem na demografskem področju ter povzemanjem osnovnih svetovnih podatkov povzemamo najpomembnejše ugotovitve glede ekonomskega in geografskega razvoja v svetu in v Sloveniji. Zaključki v pregledni in zbirni obliki bi lahko oz. bi morali služiti tudi oblikovalcem vladnih demografskih strategij.

ABSTRACT

One can hear that demographic and economic processes are too complex to enable analyses with formal mathematical and computer methods. In this paper we present a different viewpoint – that the progress of artificial intelligence (AI) enables analyses of »soft« areas. In this overview paper, the publications of the author and their conclusions, and some well-known consistent data are presented regarding economy, world and Slovenian demography. The conclusions are based on statistical, computer and particularly AI methods. They might or probably even should serve as background for Slovenian national demographic strategies.

Keywords

Artificial intelligence, demography, economy

1. UVOD

Pogosto slišimo, da pohitrenega razvoja znanja in posebej umetne inteligence niti ne čutimo, ter da so družbeni problemi preveč kompleksni, da bi jih lahko strokovno analizirali s katerokoli metodo, kar naj bi veljalo tudi za metode umetne inteligence.

Poglejmo en primer iz leta 2017: Raziskovalca Michal Kosinski in Yilun Wang s stanfordske univerze sta objavila v reviji Journal of Personality and Social Psychology, da je njun sistem umetne inteligence s točnostjo 91% s petih slik ugotovil, ali je moški homoseksualno ali heteroseksualno usmerjen, za ženske pa s 83% [16]. S samo ene slike so bili odstotki nekaj slabši: 81% za moške in 74% za ženske. Najboljši človeški opazovalci pa so dosegli približno 20 odstotkovnih točk manj. Sistem umetne inteligence se je naučil relacij med posameznimi deli obraza, predvsem čeljusti, nosu in obrvmi. Tipično moške lastnosti so imele homoseksualne ženske, tipično ženske lastnosti pa homoseksualni moški.

Izreden napredek glede na človeške vidne sposobnosti ni nekaj povsem nepričakovanega, saj so na tekmovanjih sistemi globokih

nevronskih mrež iz leta v leto dosegali čedalje boljše rezultate, kot je to razvidno s slike 1. Leta 2015 so dosegli človeške sposobnosti in od tedaj dalje nas posekajo.

Ko se to dogaja na tem in onem področju, smo ljudje vedno znova presenečeni, nepripravljeni, kot da gre za povsem nov pojav [3,4]. Pa vendar je osnovna lastnost na Sliki 1 jasno predstavljena, podobno kot relacija z umetno inteligenco na drugih področjih. Posledice so velike. Poglejmo spet primer ugotavljanja spolne orientacije s slike. V svetu sta dve osnovni teoriji: a) homoseksualnost je prirojena in b) homoseksualnost je pridobljena, recimo zaradi družbenih odnosov v otroštvu. Kako pa lahko družbena izkušnja vpliva na obliko čeljusti? Najbrž ni pričakovati, da bodo zagovorniki privzgojene homoseksualnosti priznali, da se motijo, pa vendar je za inženirsko usmerjene objektivne znanstvenike to dovolj dober dokaz, da je homoseksualnost zelo verjetno prirojena. Ali je umetna inteligenca dokazala nekaj, o čemer so se ljudje prepirali desetletja? Malo velja še počakati, dosežki tu in na drugih področjih pa kažejo na prihajajočo superiornost umetne inteligence in njeno uporabnost za analizo tudi zelo zapletenih mehkih področij, kot je npr. seksualna usmerjenost ljudi.

ILSVRC top-5 error on ImageNet



Slika 1: Izboljševanje kvalitete globokih nevronskih mrež pri vizualnih nalogah z leti. Leta 2015 dosežejo ljudi. Vir: https://devblogs.nvidia.com/parallelforall/tag/deep-learning/page/5/.

Kor primer koristnosti pa prepoznavanje seksualne usmerjenosti ni ravno zglede. Praktične posledice prepoznavanja lastnosti ljudi z obraza bi namreč znale biti dokaj neprijetne. Recimo, da bodo zaposlovalci, npr. v vojski, pregledali, kakšne usmeritve so kandidati. Ali pa bodo v kakšni diktatorsko usmerjeni državi, kjer je homoseksualnost kazniva, zapirali ljudi zaradi njihovega obraza? Ne gre samo za seksualno usmeritev, iz izgleda izraza znajo sistemi umetne inteligence ugotavljati še marsikaj drugega, recimo politično usmerjenost in inteligenčni količnik in raznovrstne bolezni [2].

Ne enem primeru smo pokazali, da sistemi umetne inteligence vplivajo na to, kako živimo in delujemo, pa tudi, da so sposobni zaznati zakonitosti, ki jih ljudje ne zmoremo. Še nekaj se dogaja: Podobno kot profesorji učijo dijake in študente, globoke nevronske mreže (oziroma AI) učijo nas. Čeprav so nevronske mreže dokaj netransparentne, so uspeli razvozlati, kako delujejo v primeru prepoznavanja spolne usmerjenosti. Gre za osnovne lastnosti delov človeškega obraza in za relacije med njimi. Ko to zvemo, znamo tudi ljudje bolje kot prej prepoznavati spolno usmerjenost s slik. Zakaj tega nismo prej ugotovili? En preprost razlog bi znal biti, da nismo pregledali 35.000 obrazov, kot so jih programi v primeru spolne usmerjenosti. Čeprav smo ljudje pametni, imamo precej omejene možnosti pri delu z velikimi količinami podatkov.

Na osnovi primera analize spolne usmerjenosti lahko predvidevamo, da so podobne relacije tudi v demografiji in ekonomiji. Za nekatera področja pa dokazano vemo, da so globoke nevronske mreže bistveno boljše kot ljudje, recimo za prepoznavanje malignih tkiv na sliki. Tu je korist pri reševanju človeških življenj in zmanjševanju trpljenja nesporna in pravzaprav je večina aplikacij umetne inteligence taka. Mnogo je še drugih področij, kjer ljudje žanjemo koristi od izjemne sposobnosti sistemov umetne inteligence, recimo pri izmenjavi organov v ZDA. S pojavom superinteligence pa se bodo razmere za ljudi še bistveno izboljšale [1, 3, 4, 15, 17, 19]. Ali pa znamo spoznanja na področju demografije konstruktivno uporabiti v praksi v Sloveniji, Evropi in svetu?

2. UGOTOVITVE ZADNJIH 10 LET

Zadnjih 10 let se avtor intenzivneje ukvarja z demografskimi analizami, pa tudi ekonomskimi [3-14]. Poglejmo si najprej ekonomske trende.

2.1 Ekonomske razvojne značilnosti

Na kratko povzeto: geografsko širjenje Evropske unije je doživelo dva pomembna udarca: izstop Grenlandije in Velike Britanije. Za oba lahko rečemo, da sta nastala v določeni meri tudi zaradi togosti vodilnih evropskih politikov, ki se manj kot s svetovno dominacijo ukvarjajo s prehitrim notranjim poenotenjem multikulturnega kontinenta.

Drug očiten pojav je počasna ekonomska rast Evrope in ZDA verjetno predvsem zaradi globalizma in ponovno zaradi globalizma verjetno hitra rast predvsem Kitajske, pa tudi drugih držav kot Indije ali Vietnama, kamor se seli proizvodnja. Cenena delovna sila in interes kapitalskih elit sta prinesli stagnacijo ali celo nazadovanje domačega srednjega razreda, kjer se hitro povečuje socialna neenakost, medtem ko je samo na Kitajskem srednji razred porastel za 400 milijonov, prinesel večjo potrošnjo, rast notranjega trga itd. [18].

Na sliki 2 vidimo po letih, kako se je povečeval delež Kitajske in zmanjševal delež Evrope (brez širitev) in ZDA v realnem GDP v svetu (PPP). Sedaj so si vsi trije bloki blizu, međtem ko Rusija glede GDP ostaja na nivoju večjih evropskih držav. Čeprav slika 2 prikazuje le statistične oz. empirične podatke, se je treba zavedati, da je vrsta slovenskih in svetovnih ekonomistov trdila, da se bo Evropa zaradi večje globalizacije sila hitro razvijala [18]. Slika 2 jasno kaže, da to ne drži, torej so klasične ekonomske analize pod vprašajem. Čeprav avtor tega prispevka ni analiziral svetovnih ekonomskih trendov z uporabo metod umetne inteligence, smo pri predmetu »Poslovna inteligenca« sistematično uporabljali metode umetne inteligence za analizo poslovnih pojavov. Ta predmet temelji na pogledu tekmovanja (angleško competitive intelligence) in se ukvarja z vprašanjem, kako uporabiti umetno

inteligenco za pridobitev kompetitivne prednosti. Pri svetovnem pogledu deležev na sliki 2 lahko v smislu poslovne inteligence ugotavljamo slabe rezultate za Ameriko in Evropo in odlične za Kitajsko, torej so strateške usmeritve enih uspešne in drugih ne. Obstaja sicer vrsta pomislekov, da recimo tisti v zaostanku hitreje dohitevajo vodilne kot vodilni brzijo naprej, da se da preskočiti stopnje v razvoju (angleško frog leap), vendar se zdi, da je razlog za tako veliko razliko v hitrosti povezan s slabostmi vodstvenih strategij in slabostmi sedanjih ekonomskih modelov, ki ne gledajo kompetitivno komparativno. Recimo evropsko strateško vodenje sistematični nakupi evropskih vodilnih tehnologij, kot podjetja Volvo z razvojem naprednih avtomobilov, s strani Kitajske so koristni za Kitajsko in verjetno slabi za Evropo, ki s tem izgublja tehnološke prednosti.

Teza je, da bi bilo potrebno analizirati svetovne trende in strategije z metodami umetne inteligence, ki bi za nazaj razkrile, kje so poglavitne slabosti usmeritve zahodne civilizacije in potrdile ali zavrgle hipotezo, da je za zaostajanje kriva tudi trenutna oblika globalizacije, kjer se tovarne selijo na Kitajsko, srednji razred v Evropi in Ameriki stagnira ali nazaduje, zato upada potrošnja in se pojavlja negativna spirala. Brez tega obstajajo samo dokaj močni indici, formalno pa ne moremo biti povsem prepričani.



Slika 2: Delež realnega GDP v svetu. Vir: https://emergingmarketfdi.wordpress.com/2013/06/20/share-of-the-worlds-gdp-since-1820/.

Formalno oz. nominalno je GDP v ZDA in EU še vedno precej večji, kar nakazuje slika 3. Verjetno pa je realnejši prikaz na sliki 2, še posebej če upoštevamo, da Kitajska že sedaj daje največ denarja za znanost, da postavlja svojo vesoljsko postajo, da kupuje strateško najbolj inovativna podjetja v Evropi, ki tovrstne dirigirane akcije spremlja kot neoliberalno odprto trgovino. Medtem ko se realni ali nominalni GDP v ZDA ali EU suče okoli 2% zadnjih nekaj deset let, se Kitajski med 5 in 15%. Druga pomembna komponenta je, da je Evropejcev okoli pol milijarde, ZDA dobrih 300 milijonov in Kitajcev v domovini milijardo in 300 milijonov, torej milijardo več kot Američanov. Morda za lažje razumevanje prikažimo še delež prispevkov na največji konferenci za umetno inteligenco, IJCAI 2017 v Melbournu, Avstralija. Slika 4 pokaže, da je bilo na prestižno znanstveno konferenco poslanih toliko kitajskih referatov kot ameriških in evropskih skupaj. Od kod torej ideja, da bosta EU in Amerika dolgoročno obdržali svojo raziskovalno in tehnološko premoč v svetu?

Kitajska ima največ spletnih uporabnikov, največ kilometrov hitrih vlakov, zadnje leto je podvojila investicije in število turistov v Afriki v moderni legalni »kolonizaciji« Afrike oz. »globalnem sodelovanju«. V zaključku: Ta prispevek vidi rešitev za manj uspešno rast Evrope v odsotnosti uporabe metod umetne inteligence, ki bi razkrile slabosti sedanjih strategij in s tem omogočile nove pristope. Upadanje deleža Evrope in Amerike v svetu v več pogledih (ekonomsko, raziskovalno, pa tudi demografsko, kar bomo videli kasneje) ni dober znak za prebivalce teh držav.



Slika 3: Rast Kitajske napram ZDA in EU po letu 2000 v nominalnem GDP. Vir: http://www.whythings.net/europe.html.



Slika 4: Delež sprejetih referatov na najslovitejši konferenci umetne inteligence IJCAI 2017. Vir: IJCAI 2017.

2.2 Svetovne demografske razmere

Svetovne trende pokaže slika 5. Vidimo, da se svetovno prebivalstvo v zadnjih stotih letih povečuje skoraj eksponentno. Podobno eksponentno pa izumirajo tudi živalske vrste, prikaz uničevanja okolja. Taka rast je očitno nevzdržna na daljše obdobje, saj bo prej ko slej prišlo do velike degradacije okolja in posledično verjetno najprej do stagnacije posameznih civilizacij in nato morebiti celo do stagnacije človeštva. V zadnjih 40 letih je upadlo število živali (ali število njihovih kilogramov) za polovico, hkrati pa je v razvitem zahodnem svetu v istem obdobju število semenčic pri mladih moških upadlo za 60% in trend se nadaljuje. Zgodba o propadu Rimskega cesarstva, po eni teoriji zaradi svinčenih cevi, zaradi katerih se je prebivalstvo zastrupljalo, ne da bi zaradi pomanjkljivega znanja in znanosti to znalo ugotoviti, po drugi teoriji pa zaradi propada družbenih sprememb, recimo vrednot, se morebiti ponavlja po tisočletju in pol z Zahodno civilizacijo. Najverjetneje gre za določene kemikalije, vendar sodobna znanost še ni sposobna odkriti, katere, podobno kot tudi pri izumiranju čebel ne. Hkrati pa se število semenčic v nerazvitem svetu ne spreminja. Ponovno je potrebno uporabiti najbolj napredne klasične metode in metode umetne inteligence, ki v določenih pogojih presegajo tako ljudi kot klasične metode.

Leta 2000 je imel Egipt nekaj čez 60 milijonov prebivalcev. Sedaj jih ima nad 90 milijonov. Število Evropejcev se je v tem obdobju minimalno povečalo. Zaradi tega so se že, še bolj pa se bodo razmerja v svetu močno spremenila, kar prikazuje slika 6. Zahodna civilizacija bo imela nekaj odstotkov svetovnega prebivalstva leta 2100, medtem ko bo v Afriki živela skoraj polovica vsega svetovnega prebivalstva.

Tudi na tem področju avtor prispevka predlaga analizo dogajanj s pomočjo metod umetne inteligence, čeprav je hkrati potrebno povedati, da so večino analiz izvedli s klasičnimi metodami od globalnega segrevanja do izumiranja vrst. Splošne ugotovitve so dokaj znane v svetovni literaturi in je v prvi meri potrebno znane ukrepe realizirati: zmanjšati pretirano rast prebivalstva predvsem v Afriki in ponekod v Aziji, ustaviti padanje prebivalstva v razvitem svetu, zmanjšati je treba uničevanje narave, flore in favne, oz. v seštevku: potrebno je preiti na **trajnostni razvoj**.

Po drugi strani pa se je potrebno zavedati, da podobno kot skušamo preprečiti izumrtje živalskih in rastlinskih vrst, da obdržimo biodiverziteto, je potrebno skrbeti tudi za **demografsko in kulturno raznolikost.** Podatki o dogajanjih so namreč močno zaskrbljujoči.

Humans & The Extinction Crisis



Dete source: Scott, J.M. 2006. Threads to designal Cheroly: Oblack Continental Local V.S. Genitopical Survey, Island Cooperative Felt and Wildle, Research Unit, University Of Lipho.

Slika 5: Eksponentna rast prebivalstva zadnje stoletje sovpada s podobno eksponentnim uničevanjem živalstva in okolja. Vir: http://www.biologicaldiversity.org/programs/population_and_sust ainability/extinction/.



Sika 6: Spreminjanje števila prebivalstva po celinah Vir: http://www.demographics.at/.

Lahko zaključimo, da eksponentna rast človeštva ogroža tako kvaliteto okolja kot tudi človeško civilizacijo, kratkoročno pa predvsem demografsko občutljive združbe, kot je evropska.

Eksponentna rast predvsem v Afriki in dejstvo, da Evropa nima primerne geografske pregrade z Azijo in Afriko daje misliti, da obstaja resna nevarnost, da bodo demografski pritiski zablokirali in morda celo zadušili evropsko civilizacijo, če ne bo odločno ukrepala.

Nekaj primerov: Otok Mavricijus so po letu 1500 odkrili Evropejci in se nekaj časa borili med seboj za prevlado. Danes je Hindujcev / Indijcev 40%, Kreolov (Afro, Afro-Indijcev) 22%, indijskih muslimanov 16%, Tamilcev (južnih Indijcev) 4.5%, drugih Kreolov 3%, Kitajcev 2%, belih Francozov 1%, belih Južnoafričanov 1.5%.



Slika 7: Upadanje deležev svetovna populacije evropskega izvora. Vir:

https://www.reddit.com/r/POLITIC/comments/2h9tf6/percentage_ of_world_population_of_european_descent/.

Kolumb je odkril Ameriko leta 1492, v celoti naseljeno z domorodnimi Indijanci. Danes je Indijancev manj kot 2 milijona v deželi s skoraj 330 milijoni, tretji najštevilčnejši državi sveta.

Avstralijo je odkril James Cook leta 1770, poseljeno z aborigini, ki so tam živeli 65.000 let in govorili okoli 250 jezikov. Danes je aboriginov okoli 2% celotne populacija skoraj 25 milijonov.

Morda bi kdo mislil, da se zgodovina ponavlja in da se belcem, ki so izrinili Indijance iz Amerike in aborigine iz Avstralije dogaja izrinjanje s strani Azijcev in Afričanov. Recimo pred nekaj desetletji je bila večina ljudi na ulicah Londona evropskega izvora, danes pa jih je približno polovica. Matere brez državljanstva v evropskih državah rodijo od 10% do 30% otrok (Avstrija), ta delež pa je v zadnjih 10 letih zrasel za nekaj odstotkov. Kljub temu je večinsko prebivalstvo od 70-90% v večini razvitih zahodno usmerjenih držav (ZDA, Evropa, Avstralija) evropskega izvora. Proces zmanjševanja deleža prebivalstva evropskega prebivalstva bo s takim tempom (brez izrazitega povečanja deleža beguncev) pripeljal do manjšinskega deleža šele v grobo rečeno dvesto letih in brez sprememb do marginalizacije kot v primeru Mauritiusa v nekaj sto letih. V svetu pa se delež potomcev evropejskega izvora giblje približno tako, kot to nakazuje slika 7. Je pa ta slika morda rahlo zavajajoča, saj so npr. mešano črnski-belci šteti kot nebelci.

Po drugi strani pa se svetovna rast prebivalstva ustavlja. Število otrok zadnjih 10 let je precej konstantno. Svetovno prebivalstvo se povečuje predvsem zaradi rasti na določenih geografskih lokacijah in zaradi vztrajnosti.

2.3 Slovenski demografski trendi

Slovenska demografska gibanja in relacije smo analizirali v vrsti lastnih programov in npr. napovedovanja smo nato primerjali s programi EU in EUROSTAT. Poleg tega smo izvedli tudi vrsto demografskih analiz za analizo odvisnosti in relacij, nekaterih relativno preprostih in nekaterih z vrhunskimi metodami na svetovnem nivoju [3-14]. Teh metod in analiz je preveč za povzetek v prispevku, naj navedemo le, da so metode pokazale veliko ujemanje s svetovnimi analizami in precejšnjo razliko glede na mnenje slovenske javnosti in glede analize koristnosti slovenskih nacionalnih strategij.

Glede časovnega razvoja se je pokazalo, da so naše predikcije zelo podobne EUROSTATovim, kar pomeni, da je ob sedanjih predpostavkah prihodnost precej predvidljiva. Seveda lahko pride do spremembe razmer, kar vpliva na dejanska dogajanja, a pri približno nespremenjenih trendih je možno približno napovedovati tudi skoraj 100 let vnaprej. Osnovne slovenske analize smo predstavili na sliki 8. Število Slovencev po narodnosti smo zasnovali glede na obstoječe podatke, tj. zadnjega popisa po narodnosti. Potrebno je napisati, da so najnovejši popisi brez vpisovanja narodnosti, kar je močno vprašljivo tako s stališča stroke kot vprašanj o hiper-globalni miselnosti, ki namenoma degradira lokalno prebivalstvo [3]. Projekcije kažejo, da bo okoli leta 2100 v Slovenji le še pol Slovencev po narodnosti. Podrobnejše analize so dokaj decidivno odgovorile, kaj so ključni vzroki za upadanje rojstev in s kakšnimi ukrepi bi lahko povečali število slovenskih rojstev oz. preprečili izumrtje Slovencev [3-14]. Poleg teg so analize pokazala ali vsaj nakazale, da so nekateri ukrepi kot povečanje porodniškega dopusta draga in neučinkovita metoda, če je namen povečanje rodnosti. Recimo analize v [13] so pokazale, da bi padec domicilnega prebivalstva lahko učinkovito ustavili z idealom treh otrok na žensko v roku nekaj deset let, tako pa so npr. na Švedskem postavili idealno rodnost na 1, na Norveškem pa poročajo, da je pritok migrantov že ogrozil genetsko sliko Norvežanov.



Slika 8: Projekcija prebivalcev Slovenije in Slovencev po narodnosti znotraj Slovenije.

3. DISKUSIJA

Umetna inteligenca je po izkušnjah avtorja [3-14] in po svetovnih poročilih, tako strokovnih kot laičnih, izredno močno orodje, ki omogoča analize in predikcije na nivoju, ki je bil še pred leti znanstvena fantastika. Vsako leto v medijih odmeva kar nekaj fantastičnih dosežkov umetne inteligence, o katerih smo še leto ali dve nazaj le sanjali. Žal slovenska javnost in tudi odločujoči o tem kaj dosti ne vedo, zato – žal – ne morejo tako kvalitetno voditi in upravljati, kot jim omogoča stroka. Še več, zdi se, da smo priča določenem zamegljevanju znanstvenih dosežkov v javnosti in politiki z namenom uveljavljanja določenih strateških ciljev. Postavlja pa se vprašanje, zakaj bi slovenska politika namenoma uvajala demografske in druge strategije, ki po projekcijah nesporno vodijo v marginalizacijo slovenskega naroda?

Za vsak slučaj je potrebno navesti, da je trajnostna rast povezana z določenim migriranjem, vendar bistveno bolj uravnoteženim in skrbnim. Za razliko od Kitajske, ki sistemsko vodi demografsko politiko, ni jasno, kakšno strategijo ima Evropa, iz številk pa je razvidno, da se demografsko zmanjšuje in hkrati prehitro dopušča preveč migriranja. V javnosti pa je o tem težko pisati, ne da bi bil avtor hitro deležen ideološko-političnih napadov o nacionalizmu, izolacionalizmu in podobno.

Poglejmo samo problem migracije – vsako leto iz Slovenije odide nekaj tisoč najsposobnejših v populaciji, ki ima manj kot 20.000 otrok. Pa se glede tega le malo razburjamo, veliko pa je govora o tem, da je potrebno biti odprt v svet, da ne smemo ljudi nasilno zadrževati in podobno. Ampak, če gre pomemben del najsposobnejših mladih v tujino, to vsakemu normalnemu posamezniku pomeni siromašenje bazena mladih prodornih in pametnih, polnih energije in poleta. Jih bodo nadomestili upokojenci?

Neka čudna ideologija, predvsem v smeri globalizma in hiperglobalizma, je omrežila tako evropsko vodenje kot slovensko, pri čemer so posledice za Evropo spričo njene velikosti (približno pol milijarde prebivalcev) bistveno manj boleče kot za Slovenijo, ki je po površini in po prebivalstvu manj kot 0.5% Evrope.

Zakaj slovenski politiki, mediji, množice ne začnejo biti plat zvona zaradi migracije, premalo rojstev, grozeče marginalizacije Slovencev kot narodnosti? Jasnega odgovora avtor v nekaj letih raziskav še vedno nima. Najbolj verjetno se zdi, da so ljudske mase in politiki tako pod vplivom ideoloških pogledov, da niso sposobni razumeti, kaj je za Slovenijo in Slovence dobro in kaj ne [3]. Da ne sprejemajo/razumejo, kakšne neverjetne možnosti nudi stroka, predvsem umetne inteligenca, se delno razume, saj ideologija ne želi stroke, še zlasti, kadar je v nasprotju z njenimi cilji.

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Družinska in druga neformalna oskrba kot nenadomestljiv dejavnik humanega obvladovanja demografske krize

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V Sloveniji za več kot 75 % onemoglih in bolnih starejših ljudi skrbijo družinski oskrbovalci, to so svojci in drugi neformalni oskrbovalci, ki najmanj pet ur tedensko brezplačno oskrbujejo starejše ljudi. Družinski oskrbovalci so ena izmed najbolj obremenjenih skupin prebivalstva, saj pogosto poleg skrbi za odraščajoče otroke in službenih obveznosti, oskrbujejo še svojce. V Sloveniji sistem dolgotrajne oskrbe bistveno zaostaja za tovrstnimi sistemi v EU in smo po razvitosti mreže storitev pomoči na domu med manj razvitimi v EU. Pri nas velika večina družinskih oskrbovalcev ne prijema nobene izmed oblik pomoči javnih služb. Na reprezentativnem vzorcu prebivalcev Slovenije (Inštitut Antona Trstenjaka, 2010) smo raziskovali kdo neformalno oskrbuje starejše ljudi, vrste in stopnjo težav, s katerimi se družinski oskrbovalci pri oskrbovanju spoprijemajo in kaj jih motivira za oskrbovanje. Na podlagi teh podatkov smo dopolnili model podpore družinskim oskrbovalcem, ki ga razvijamo na Inštitutu.

KLJUČNE BESEDE

družinski oskrbovalci, dolgotrajna oskrba, humanost oskrbe, integrirana oskrba, tečaj za družinske oskrbovalce

Family and other informal care is an irreplaceable part of humane management of demographic crisis

In Slovenia, family or other informal carers provide help and support for more than 75 % of fragile and sick elderly people. Informal carers provide unpaid care for at least 5 hours weekly. They are one of the most burdened population groups, since they often care for their aging parents while supporting their own children and still being full time employed.

In Slovenia, the system of long-term care significantly lags behind similar EU systems, since the country is faced by the 2 emerging needs: the need for developed public home care services and the need for support measures for family carers.

Using a representative sample of the representative research The standpoints, needs and potentials of Slovenian population aged 50+ (Antona Trstenjak Institute, 2010), we analysed the profile of family carers, the types and levels of issues that family carers deal with and their motivation for caregiving. Using the acquired data, the Institute's support model for family carers has been upgraded.

KEY WORDS

Family carers, long-term care, humanity of care, integral care, family carers training

1 UVOD

Slovensko prebivalstvo je med najstarejšimi na svetu. Potreba po oskrbovanju starejših se povečuje zaradi hitrega staranja prebivalstva. Eksplicitno jasno je, da bi bili sistemi oskrbe starejših, brez prispevka družinskih oskrbovalcev, nevzdržni. Zato postajajo družinski oskrbovalci znotraj novih sistemov dolgotrajne oskrbe v EU integralni del celostne dolgotrajne oskrbe, vendar v Sloveniji s strani države niso ustrezno podprti. Reprezentativna raziskava o potrebah, zmožnostih in stališčih nad 50 let starih prebivalcev Slovenije kaže, da v Sloveniji oskrbuje 19 % ljudi, starejših od 50 let, oskrbo pa prejema 13,5 % ljudi, starejših od 50 let (Ramovš, 2013). Številne študije izpostavljajo, da je družinska oskrba feminizirana, in sicer naj bi kar dve tretjini oskrbe zagotavljale ženske, ta delež pa še narašča z odvisnostjo oskrbovane osebe. Za oskrbovanje so v glavnem odgovorne ženske srednjih let (stare od 50 do 60 let). V raziskavi Hvalič Touzery (2007) o slovenskih družinskih oskrbovalcih je bilo ugotovljeno naslednje: večji del družinske oskrbe opravijo otroci (prevladujejo hčere) in partnerji starega človeka, pomembno vlogo v oskrbi pa imajo tudi snahe. Kot močna razloga za oskrbovanje je Hvalič Touzery (2007) izpostavila: občutek dolžnosti in moralne odgovornosti in čustveno vez (ljubezen in navezanost). Nacionalna poročila nekaterih evropskih držav kažejo, da partnerji najdejo moč in motiv za oskrbovanje v drži, da so skupaj v dobrem in slabem, otroci pa omenjajo recipročnost. Garcés in sodelavci (2010) so ugotavljali, da ko oskrbovanje preraste oskrbovalčevo telesno in duševno zmožnost, pride do kroničnega stanja stresa, zaradi katerega oskrbovalci pogosteje zbolevajo za duševnimi in telesnimi boleznimi (depresija; anksioznost; psihosomatske, imunološke in srčno-žilne bolezni idr.), pri oskrbovancih pa se poveča tveganje za premestitev iz domače oskrbe v institucijo, za slabšo kakovost oskrbe, zanemarjanje, zlorabo in nasilje. Hvalič Touzery (2007) je v raziskavi ugotovila, da slovenski družinski oskrbovalci ob oskrbovanju najpogosteje čutijo telesni napor (npr. kronično utrujenost), sledi mu duševni napor (malodušje, nebogljenost, strah pred prihodnostjo, čustvena izčrpanost idr.). Oskrbovalci se mnogokrat počutijo osamljene in preobremenjene, često jih spremljajo številni strahovi. V razbremenilno pomoč za oskrbovalce na prvem mestu sodita varstvo za oddih ter usposabljanje za lažje in boljše oskrbovanje, sestavljajo pa jo tudi skupine za samopomoč in razne sprostitvene dejavnosti ter ne nazadnje razporeditev oskrbovalnih vlog med družinskimi člani, torej vse, kar razbremeni svojce pri oskrbovanju in preprečuje njihovo izgorelost (Ramovš, 2015).

2 VZORČENJE IN METODA

2.1. Vzorčenje

Populacija raziskave so bili prebivalci Slovenije, ki so bili 1. maja 2009 stari 50 let in več. Načrtovani vzorec populacije po starosti, spolu in statističnih pokrajinah je pripravil Statistični urad RS, z dvostopenjskim vzorčenjem, tako da je obsegal 200 anketnih okolišev po 9 ljudi. Vzorec je štel 1800 ljudi, pri izvedbi raziskave smo pridobili 1047 veljavno izpolnjenih anket, s čimer smo dosegli visok delež uspešnih anket – nad 58 % vzorca.

2.2. Metoda

Metodično izhodišče je bilo zbrati raziskovalne podatke do skrajnih možnosti kakovostno, z osebnim terenskim anketiranjem reprezentativnega slovenskega prebivalstva, ki je staro 50 let in več. Anketiranje, ki so ga izvajali usposobljeni anketarji, je na enega človeka iz vzorca trajalo v povprečju 2 uri. Raziskovalni vprašalnik je bil kombinacija zaprtih vprašanj za kvantitativno obdelavo in odprtih vprašanj za bolj poglobljeno kvalitativno analizo večine področij, za katere smo zbirali podatke. Celoten vprašalnik, ki je bil razdeljen na 13 področij, je obsegal 183 vprašanj; precej jih je imelo po več podvprašanj. Vprašanja, ki so se nanašala na oskrbo (V66 – V74), so bila del področja *Medgeneracijsko sožitje in solidarnost*.

3 REZULTATI IN DISKUSIJA

Vsak peti prebivalec Slovenije (19,3 %), ki je star 50 let in več, nekoga oskrbuje. Spodnja tabela prikazuje, da je med starejšimi oskrbovalci dve tretjini žensk. Najpogosteje oskrbujejo zakonski partnerji in hčerke, sinov je že za dobro tretjino manj, vendar pa nikakor ne malo, saj tudi pri vsaki drugi od navedenih kategorij družinskih oskrbovalcev (vnuki, snahe, sestre in bratje) ocena presega število 20.000. Isto velja tudi za sosede.

Tabela 1: Ljudje, stari 50 let in več, ki (ne) oskrbujejo

	M (f)	Ž (f)	Skupaj (f)	M (%)	Ž (%)	Skupaj (%)
Da	68	134	202	15,8	22,0	19,3
Ne	338	447	785	78,2	72,6	75,0
Brez odgovora	26	34	60	6,0	5,4	5,7
Skupaj	432	615	1047	100	100	100

Vir: Inštitut Antona Trstenjaka, 2010

Tistih 19,3 % raziskanega vzorca, (202 anketiranca), ki so zadnjega pol leta nudili pomoč in oskrbo kakemu staremu, invalidnemu ali dolgotrajno bolnemu človeku, smo vprašali tudi, »katera je bila njihova največja težava pri oskrbovanju onemoglega človeka?« Na vprašanje ni odgovorilo 25 anketirancev, vsebinsko neustreznih in neveljavnih odgovorov je bilo 64 (njihovi odgovori so: da nima težav (46), 0 (14), ne, navedba dobre izkušnje). Obdelali smo torej 113 vsebinsko ustreznih odgovorov, ki vsebujejo 132 različnih izkušenj. Rezultati so predstavljeni v Sliki 1.

Slika 1: Težave oskrbovalcev pri oskrbovanju



Motivacijo oskrbovalcev za oskrbovanje smo raziskali širše in posredno preko vprašanja V68: »Kaj vam je ostalo v lepem spominu ob tem, ko ste kdaj v življenju nudili pomoč ali nego bolnemu ali onemoglemu človeku?« so odgovarjali vsi anketiranci. Nanj je odgovorilo 89,1 % celotne raziskane populacije, to je 933 anketirancev. Iz odgovorov najbolj odseva etična motivacija pri

oskrbovanju bližnjih, oskrbovančevo dobro počutje in zadovoljstvo in da je oskrbovanec lahko ostal do konca doma.

4 IMPLEMENTACIJA

Na podlagi raziskovalnih rezultatov te raziskave smo dopolnili model usposabljanja za družinske oskrbovalce in druge neformalne oskrbovalce, ki ga na Inštitutu Antona Trstenjaka razvijamo in dopolnjujemo že več kot 10 let. Model združuje 3 področja:

- navezovanje stikov z lokalno skupnostjo;
- tečaj za družinske in druge neformalne oskrbovalce, ki se izvaja v skupini 12 – 25 oskrbovalcev in zavzema10 srečanj po dve uri in pol (Slika 2);
- klub družinskih oskrbovalcev (skupina za samopomoč) + redna srečanja za voditelje klubov svojcev.

5 ZAKLJUČKI

Družinska in druga neformalna oskrba sta hrbtenica sistemov dolgotrajne oskrbe v Evropi in po svetu. S staranjem prebivalstva pa se bodo potrebe po oskrbi še povečevale. Raziskovalni podatki kažejo na veliko motivacijo za oskrbovanje bolnih in onemoglih svojcev, ob tem pa opozarjajo na težave in izzive s katerimi se oskrbovalci srečujejo. Ob tem, da je tako v Sloveniji kot v Evropi profil oskrbovalcev dobro raziskan, veliko podatkov pa je tudi o njihovih potrebah in željah, bi bilo potrebno raziskati še modele za podporo neformalnim oskrbovalcem. Na Inštitutu Antona Trstenjaka vseskozi združujemo teorijo s prakso, zato smo tudi raziskovalne ugotovitve iz reprezentativne raziskave o potrebah, zmožnostih in stališčih nad 50 let starih prebivalcev Slovenije vpletli v nadgradnjo modela za družinske in druge neformalne oskrbovalce.

Slika 2: Tečaj za družinske in druge neformalne oskrbovalce



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Krepitev socialne inteligentnosti ob staranju – prispevek za izboljševanje medgeneracijskega sožitja v času staranja prebivalstva

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Eden izmed pomembnih dejavnikov uspešnega soočanja z demografsko krizo je spoznavanje pozitivnih vidikov staranja in oblikovanje uspešnih programov za krepitev funkcioniranja starejših oseb. Raziskave kažejo, da lahko z višjo starostjo postaja funkcioniranje na emocionalno-socialnem področju vedno bolj učinkovito, čeprav funkcioniranje na kognitivnem in telesnem področju upada. Nedavno smo na Inštitutu Antona Trstenjaka za gerontologijo in medgeneracisjko sožitje izvedli raziskavo emocionalno-socialnih sposobnosti v starosti, v kateri smo merili emocionalno (ESCQ) in socialno (TSIS) inteligentnost pri udeležencih širokega starostnega razpona (N = 219; 18 - 92 let; 65% žensk) ter primerjali razlike med različnimi starostnimi skupinami. Rezultati so pokazali statistično pomembno naraščanje socialne inteligentnosti s starostjo. To spoznanje nam služi kot smerokaz pri oblikovanju programov skupinskega socialnega učenja za lepše medgeneracijsko sožitje.

KLJUČNE BESEDE

Staranje, socialna inteligentnost, emocionalna inteligentnost, skupinsko socialno učenje

Social intelligence strengthening in old-age – contribution for the improvement of intergenerational relations in the times of demographic crisis

Getting knowledge about positive aspects of aging and using that knowledge for the creation of social programs, that would help the elderly to function better, is one of the most important solutions for overcoming the demographic crisis successfully. Research is showing, that one of the positive aspects of ageing could be socioemotional functioning. Unlike the physical and cognitive functioning, socio-emotional functioning seems not to be affected by ageing. Recently we did a research on socio-emotional abilities and ageing at the Anton Trstenjak institute for gerontology and intergenerational relations. We measured emotional intelligence (ESCQ) and social intelligence (TSIS) of wide age range participants (N = 219; 18 - 92 years old; 65% females) and compared the differences between various age groups. The results have shown statistically significant growth of social intelligence with age. We are using this finding in the creation of group social learning programs for quality ageing and quality intergenerational relations.

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KEY WORDS

Ageing, social intelligence, emotional intelligence, group social learning

1 UVOD

V razvitem svetu se krepi zavedanje demografskega staranja prebivalstva in s tem tudi potreba po gerontološkem raziskovanju. Ena od pomembnih strategij soočanja s problemom staranja prebivalstva je spoznavanje pozitivnih vidikov staranja posameznika in družbe. Preusmeritev fokusa raziskovanja iz starostnih izgub na pozitivne vidike staranja lahko pripomore k boljšemu razumevanju dejavnikov, ki so odločilni za avtonomno vsakodnevno funkcioniranje, za zadovoljstvo s svojim življenjem, za kakovost oskrbe v onemoglosti ipd. Boljše razumevanje teh dejavnikov je pogoj za oblikovanje programov za njihovo krepitev.

Osrednjega pomena za blagostanje starejših posameznikov so dobri medosebni odnosi in bivanje v medgeneracisjkem sožitju (Ramovš, 2013). Bistveno za dobre odnose starejših posameznikov pa je učinkovito funkcioniranje na emocionalnem in socialnem področju. Razvoj socialnega in emocionalnega funkcioniranja v odraslosti je postal bolj jasen šele v zadnjem času. Razlog za to je v prepričanju, ki je veljalo v preteklosti in je povzročilo zanemarjanje vseživljenjskega vidika razvoja. Gre za prepričanje, da tako telesni, kot tudi psihični razvoj ljudi obsega zgolj otroštvo in obdobje mladostništva, skozi zgodnjo in srednjo odraslost pa ostane stabilen, ter nato v obdobju pozne odraslosti postane rigiden in dereguliran (Bromley, 1990). Kasneje so raziskave pokazale nasprotno, namreč da se razvoj nadaljuje skozi celotno obdobje posameznikovega življenja (Lawton, Kleban in Dean, 1993; Diener in Diener, 1996; Mroczek in Kolarz, 1998). Dandanes se psiho-socialna stroka zelo dobro zaveda, da je kontinuiran razvoj izjemnega pomena, saj omogoča osebnostno rast posameznika, le-ta pa veliko prispeva k njegovemu zdravju (Ryff in Singer, 2000).

Raziskave kažejo, da se funkcioniranje na socialnem in emocionalnem področju kljub kognitivnim in telesnim starostnim upadom, dobro ohranja (Hess, 2006; Carstensen in Mikels, 2005). Nekatere raziskave kažejo celo porast v socialnih in emocionalnih sposobnostih pri starejših osebah (Staudinger in Pasupathi, 2000; Charles in Carstensen, 2007; Carstensen, Pasupathi, Mayr in Nesselroade, 2000). Ta naj bi bil povezan predvsem z izkušnjami, ki jih posameznik z leti pridobiva v interakciji s svojim socialnim okoljem.

Zanimanje za nekognitivne faktorje inteligentnosti je na področju teoretičnega in empiričnega raziskovanja prisotno že kar precej časa. Začelo se je z Gardnerjevo uvrstitvijo interpersonalne in intrapersonalne inteligentnosti v svojo teorijo mnogoterih inteligentnosti (Gardner, 1999) in nadaljevalo s preučevanjem konstruktov socialne inteligentnosti in emocionalne inteligentnosti. V tem okviru je izjemno pozornost požela emocionalna inteligentnost, ki se je sprva intuitivno, kasneje pa tudi empirično izkazala kot zelo uporaben konstrukt pri napovedovanju uspešnega funkcioniranja posameznika na vseh življenjskih področjih (Salovey in Mayer, 1990; Petrides in Furnham, 2001; Bar-On, 2006). Salovey in Mayer (1997) sta emocionalno inteligentnost definirala kot sposobnost točnega prepoznavanja emocij pri sebi in pri drugih ljudeh, sposobnost izražanja emocij, sposobnost uporabe emocij pri mišljenju in usmerjanju vedenja, sposobnost razumevanja emocij, ter sposobnost učinkovitega uravnavanja emocii.

Silvera, Martinussen in Dahl (2001) so pri operacionalizaciji konstrukta socialne inteligentnosti izhajali iz dejstva, da obstajajo osebe, za katere se zdi, da se v socialnih situacijah znajdejo precej bolje od drugih. Na podlagi raziskave implicitnih teorij socialne inteligentnosti strokovnjakov s področja psihologije, so oblikovali definicijo socialne inteligentnosti kot sposobnosti razumevanja drugih ljudi in njihovih odzivov v različnih socialnih situacijah. Ta sposobnost se nanaša na tri področja - procesiranje socialnih informacij, socialne spretnosti in socialno zavedanje. Sposobnost procesiranja socialnih informacij pomeni učinkovitost posameznika pri uporabi socialnih informacij, ki jih dobi skozi socialno interakcijo, za razumevanje drugih in predvidevanje njihovih odzivov. Procesiranje socialnih informacij se pravzaprav nanaša na sposobnost zaznavanja in prepoznavanja neverbalne komunikacije, obraznih izrazov in vedenja drugih posameznikov. Socialne spretnosti, ki pomenijo učinkovitost posameznika pri vstopanju v socialne interakcije z drugimi posamezniki, tudi nepoznanimi, ter njegovo prilagajanje socialnim situacijam, se nanašajo na vedenjsko področje socialne kompetentnosti. Tretje področje pa je socialno zavedanje, pri katerem gre za posameznikovo razumevanje in predvidevanje vedenja in odzivanja drugih posameznikov, ter razumevanje in predvidevanje vplivanja lastnega vedenja na druge posameznike. To področje socialne inteligentnosti se nanaša na kognitivni vidik zavedanja socialnega dogajanja, ki se kaže v tem, kako pogosto posameznika socialno dogajanje preseneti. Dobro socialno zavedanje omogoča posamezniku večjo občutljivost za zahteve socialnega okolja in socialno primerno vedenje.

Vendar pa se teoretično koncept socialne inteligentnosti v določeni meri prekriva s konceptom emocionalne inteligentnosti, zaradi česar prihaja med različnimi avtorji do različnih opredelitev in poimenovanj the medosebnih vidikov osebnosti. Mnogi avtorji so zaradi tega prekrivanja oba konstrukta združili v konjunkcijo socialno-emocionalne inteligentnosti (Nagler, Reiter, Furtner in Rauthmann, 2014). Mayer in Salovey (1993) sta emocionalno inteligentnost sprva uvrstila v okvir socialne inteligentnosti, kasneje pa sta odnos med tema vrstama inteligentnosti razmejila (Mayer, Salovey in Caruso, 2000). Emocionalno inteligentnost sta pri tem opredelila kot koncept, ki je po eni strani ožji kot socialna inteligentnost, saj se nanaša predvsem na emocionalne aspekte

znotraj socialnih, po drugi strani pa je širši, saj vključuje tudi zasebne, notranje emocije posameznika.

Emocije so vsekakor osrednji del posameznikovega doživljanja in vodijo tako njegove misli, kot tudi njegovo vedenje, sposobnosti na emocionalnem področju pa se kažejo v njegovem socialnem funkcioniranju. Emocije namreč koordinirajo socialno interakcijo. Posredujejo neverbalne informacije o posameznikih in njihovih občutkih, spodbujajo različne odzive pri sogovornikih (npr. simpatijo), ter služijo za spodbujanje socialnega vedenja drugih posameznikov (npr. smeh).

Skozi odraslost se s staranjem življenjske okoliščine ljudi nenehno spreminjajo in zahtevajo od njih prilagajanje. Prilagojeno socialno funkcioniranje lahko pojasnimo v povezavi z razvojem ekspertnega socialnega znanja (Hess, 2006; Hess in Blanchard-Fields, 1999; Blanchard-Fields, Jahnke in Camp, 1995; Blanchard-Fields, Chen in Noriss, 1997). Razvoj ekspertnega znanja se odvija, ko se posameznik tekom življenja vključuje v raznolike socialne situacije in pri tem pridobiva informacije o tem, na kakšen način lahko optimalno socialno funkcionira. Sčasoma lahko kopičenje tega socialnega znanja pripelje do socialne ekspertnosti. To pomeni, da lahko socialne izkušnje oblikujejo bogato bazo podatkov o socialnem svetu. Na podlagi kopičenja tega znanja lahko posameznik razvije vedno bolj učinkovite socialne strategije, s katerimi se lahko bolje prilagaja svojemu socialnemu okolju.

Pred nedavnim smo izvedli raziskavo, s katero smo želeli ugotoviti, ali se socialna inteligentnost in emocionalna inteligentnost, kot pokazatelja socialno-emocionalnega funkcioniranja, s starostjo spreminjata v pozitivni smeri. Ker gre pri oblikovanju ekspertnega socialnega znanja za proces prilagajanja na podlagi akumuliranja izkušenj, smo predpostavili, da se s starostjo socialno znanje in razumevanje socialnih situacij izboljšuje. Prav tako smo na podlagi predhodnih raziskav predpostavili, da se bo tudi emocionalna in teligentnost s starostjo izboljševala.

2 METODA

2.1 Udeleženci

V raziskavi je sodelovalo 219 udeležencev, od tega 77 moških (35 %) in 142 žensk (65 %). Njihov starostni obseg je od 18 do 92 let (M = 42,44; SD = 19,78). Vzorec glede na starost zajema razvojna obdobja mladostništva (18–30 let; 27 %), zgodnje odraslosti (31–45 let; 38 %), srednje odraslosti (46–65 let; 17 %) in pozne odraslosti (66–92 let; 18 %). Izobrazbena struktura udeležencev je raznolika, večja deleža sta visoko (42 %) in srednje izobraženih (32 %), manjši delež udeležencev pa ima poklicno ali osnovnošolsko izobrazbo (26 %). Večina udeležencev je delovno aktivna (48 %), manjša deleža pa sta šolajočih (18 %) in delovno neaktivnih (34 %) udeležencev. Prav tako je večina udeležencev glede na zakonski stan poročena ali drugače vezana (67 %), manjši delež je nevezanih, samskih oziroma ovdovelih (33 %). Vzorec je slučajni, udeležence smo vzorčili priložnostno in po metodi snežene kepe.

2.2 Pripomočki

2.2.1 Emocionalna inteligentnost. Pri merjenju emocionalne inteligentnosti smo uporabili samoocenjevalni vprašalnik emocionalne inteligentnosti ESCO (Emotional Skills and Competence Qustionaire; Takšić, Mohorić in Duran, 2009). Obsega 26 postavk, ki se nanašajo na tri podlestvice prepoznavanie in razumevanie emocii (10 postavk), izražanie in poimenovanje emocij (8 postavk) ter upravljanje z emocijami (8 postavk). Udeleženci postavke ocenijo s pomočjo 5-stopenjske ocenjevalne lestvice Likertovega tipa. Avtorji poročajo o dobrih psihometričnih karakteristikah (Takšić idr., 2009). Vprašalnik je v slovenščino iz hrvaškega jezika prevedla A. Avsec (2005; Takšić idr., 2009). Koeficienti zanesljivosti ESCQ, dobljeni na našem vzorcu, so visoki - za skupni rezultat 0.93, za lestvico prepoznavanje in razumevanje emocij 0.88, za lestvico izražanje in poimenovanje emocij 0.93 ter za lestvico upravljanje z emocijami 0.81.

2.2.2 Socialna inteligentnost. Socialno inteligentnost udeležencev smo izmerili z vprašalnikom socialne inteligentnosti TSIS (Tromso Social Intelligence Scale; Silvera, Martinussen in Dahl, 2001). Vprašalnik sestavlja 21 postavk, na katere so udeleženci podajali odgovore na 7-stopenjski ocenjevalni lestvici. Postavke merijo tri lestvice - procesiranje socialnih informacii, socialne spretnosti in socialno zavedanie. Avtorij poročajo o dobrih merskih karakteristikah (Silvera idr., 2001). Pri izdelavi slovenskega prevoda vprašalnika sta sodelovali dve psihologinji, ki sta vprašalnik neodvisno prevedli v slovenski jezik, opravljen pa je bil tudi povratni prevod v angleški jezik, pri čemer je bila potrjena ustrezna vsebinska skladnost (Vidmar in Avsec, 2011). Koeficienti zanesljivosti, ki smo jih dobili na našem vzorcu, so ustrezno visoki in kažejo na dobro zanesljivost - 0.85 za skupni rezultat, za lestvico procesiranje socialnih informacij 0.79, za lestvico socialne spretnosti 0.76, za lestvico socialno zavedanje pa 0.81.

2.3 Postopek

Pri zbiranju podatkov za raziskavo je bil uporabljen enoten vprašalnik, ki je vključeval vse prej navedene instrumente. Mlajši udeleženci so bili povabljeni k sodelovanju na spletnem socialnem omrežju in v različnih izobraževalnih ustanovah, starejši udeleženci pa na Inštitutu Antona Trstenjaka za gerontologijo in medgeneracijsko sožitje. Ker so bili udeleženci starostnega obdobja pozne odraslosti težje dostopni, smo vse starejše udeležence prosili za pomoč pri dostopu do njihovih starejših sorodnikov, prijateljev in znancev.

3 REZULTATI IN INTERPRETACIJA

Tabela 1 prikazuje rezultate naše študije. S postopkom analize variance smo ugotavljali, pri katerih spremenljivkah so se pokazale statistično pomembne razlike med različnimi starostnimi skupinami. Vidimo lahko, da je prišlo do pomembnih razlik (okrepljen tisk) pri dveh komponentah socialne inteligentnosti, medtem ko pri emocionalni inteligentnosti do pomembnih starostnih razlik ni prišlo.

 Tabela 1. Rezultati enosmerne analize variance za socialnoemocionalne razlike med starostnimi skupinami.

	df1	df2	F	р	
Emocionalna inteligentnost					
1. Prepoznavanje in razumevanje emocij	3	215	0,112	0,953	
2. Izražanje in poimenovanje emocij	3	215	1,856	0,138	
Upravljanje z emocijami	3	215	0,905	0,439	
Socialna inteligentnost					
Procesiranje socialnih informacij	3	215	1,960	0,121	
5. Socialne spretnosti	3	215	3,246	0,023	
6. Socialno zavedanje	3	215	3,320	0,021	
Onombe N=219 min_rest = 18 max rest = 92. Nmladi = 61 Nzg odraslost = 84 Nsr odraslost =					

Opombe. N=219, min_{amos} = 18, max_{strost} = 92; Nnladi = 61, Nzg.odraslost = 84, Nsr.odraslost = 36, Npoz.odraslost = 38; df = stopnje svobode, MS = sredina kvadratov, F = vrednost na F distribuciji, p = statistična pomembnost. Statistično pomembni vplivi so označeni z okrepljenim tiskom.

Smer starostnih razlik nam bolje pojasni Tabela 2. Iz nje je razvidno, da aritmetične sredine pri socialni inteligentnosti s starostjo naraščajo. S starostjo povezane razlike so se pokazale pri dveh komponentah socialne inteligentnosti – pri socialnih spretnostih in pri socialnem zavedanju. Pri socialnih spretnostih je očiten predvsem velik porast iz mladostništva v odraslost, medtem ko v različnih obdobjih odraslosti socialne spretnosti ostajajo enako izražene. Pri socialnem zavedanju pa se je pokazal očiten in enakomeren porast sposobnosti s staranjem.

Tabela 2. Aritmetične sredine socialno-emocionalnih spremenljivk za različne starostne skupine

		М		
	Mladi (18 - 30)	zgodnja odraslost (31 – 45)	srednja odraslost (46 – 65)	pozna odraslost (66 – 92)
Emocionalna inteligentnost				
 Prepoznavanje in razumevanje e. 	35,20	35,73	35,22	35,58
Izražanje in poimenovanje e.	29,13	31,17	29,86	31,45
Upravljanje z emocijami	29,55	30,31	30,49	29,16
Socialna inteligentnost				
Procesiranje socialnih inf.	31,95	33,51	30,86	33,29
Socialne spretnosti	30,92	34,48	33,39	33,71
Socialno zavedanje	27,75	29,49	29,75	32,61

Opombe. N=219, Nmladi = 61, Nzg.odraslost = 84, Nsr.odraslost = 36, Npoz.odraslost = 38; M = aritmetična sredina; statistično pomembne razlike v aritmetičnih sredinah so označene z okrepljenim tiskom.

Iz gerontološkega vidika je bolj pomembna komponenta socialne inteligentnosti socialno zavedanje, pri kateri se je pokazal pomemben porast te sposobnosti skozi staranje. To kaže na povezanost te kognitivne komponente socialne inteligentnosti z izkušnjami. Tako je razlika v nivoju socialnega zavedanja v mladostništvu in nivoju socialnega zavedanja v pozni odraslosti kar precejšnja. Glede na to, da smo se za to študijo odločili zato, da bi poiskali morebitno 'močno področje' funkcioniranja navkljub staranju, lahko kot enega izmed takih področij gotovo izpostavimo socialno zavedanje. V pozni starosti očitno pridobimo veliko boljšo občutljivost na zahteve socialnega okolja. Socialno dogajanje nas le redkokdaj preseneti, veliko bolje razumemo vedenje drugih ljudi in ga lahko tudi bolje predvidimo. To nam omogoča manj vznemirjanja in lažje reševanje konfliktov. Pridobivanje izkušenj v odnosih z drugimi igra, kot kaže, zelo pomembno vlogo pri socialnem funkcioniranju v odraslosti.

Nobena od komponent emocionalne inteligentnosti v naši raziskavi s staranjem ni naraščala. Razlike med starostnimi skupinami niso bile pomembne, kar kaže, da je emocionalna inteligentnost stabilnejši konstrukt.

Do rezultatov smo pri naši študiji prišli na podlagi samoocenjevanja udeležencev, samoocena pa ima poleg določenih

prednosti, tudi svoje pomanjkljivosti. Po eni strani nam omogoča enostaven introspektivni dostop do notranjega doživljanja posameznika, po drugi pa je podvržena različnim pristranostim. Še ena omejitev naše raziskave je v raziskovalnem pristopu. Za raziskave, ki skušajo odkrivati s starostjo povezane spremembe, je namreč najustreznejši longitudinalni pristop – preučevanje istih udeležencev v različnih starostnih obdobjih. Prednost naše raziskave pa je predvsem vključitev razvojno-prilagoditvenega vidika emocionalnega in socialnega funkcioniranja, ter vključitev udeležencev vseh starostnih obdobij, tudi pozne starosti. Večina raziskav socialnega in emocionalnega funkcioniranja je bila narejena na mlajših udeležencih, saj so le-ti najlažje dostopni.

4 ZAKLJUČKI

Raziskava je pokazala, da se nekateri vidiki socialne inteligentnosti s starostjo krepijo, kar posredno kaže na pomemben vpliv akumuliranja socialnih izkušenj za učinkovitejše socialno funkcioniranje. Boljša socialna prilagodljivost pa ima velik pomen za oblikovanje lepih medosebnih odnosov in medgeneracijskega sožitja. Na Inštitutu Antona Trstenjaka delamo v smeri krepitve socialne inteligentnosti s pomočjo socialnih programov, utemeljenih na metodi skupinskega socialnega učenja. Skupinsko socialno učenje namreč odpira udeležencem veliko možnosti za pridobivanje lastnih socialnih izkušenj, ter tudi veliko možnosti za učenje iz socialnih izkušenj drugih udeležencev v skupini.

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Demografske spremembe: potrebne so ključne reforme družbenih (pod)sistemov

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POVZETEK

Demografske spremembe imajo številne implikacije v globalni družbi in posameznih državah. V članku se osredotočamo na glavne izzive, ki jih demografske spremembe prinašajo in na bistvene socialne reforme, kot so pokojninska, zdravstvena (dolgotrajna oskrba), ki lahko odgovorijo nanje tako, da preprečijo veliko škodo v prihodnjih desetletjih.

Ključne besede

Demografska politika, staranje prebivalstva, pokojninska reforma, zdravstvena reforma, reforma trga dela, družinska politika.

1. UVOD

Slovenija se stara. V tem nismo nič drugačni kot druge razvite zahodne družbe. Vendar pa mora vsaka odgovorna politika iskati rešitve za vzdržnost vseh naših družbenih sistemov. Staranje prebivalstva zagotovo pomeni večje stroške za pokojninski in zdravstveni sistem ter sistem dolgotrajne oskrbe. Politika je zato dolžna poiskati rešitve, ki bodo omogočile delovanje teh sistemov tudi v okviru napovedanih in neizogibnih sprememb.

2. DEMOGRAFSKI TRENDI VZBUJAJO SKRB

Danes (2016) nas v Sloveniji živi nekaj več kot dva milijona. Po podatkih Statističnega urada Republike Slovenije v državi živi 1,181.953 državljanov, starih med 18 in 59 let, in 525.388, ki so stari 60 let in več. Če ocenimo čez palec, bi lahko rekli, da je četrtina prebivalcev potencialnih upokojencev, polovica prebivalcev potencialno delovno aktivnih državljanov, ostalo pa šolajoča se mladina. Razmerje ni nič kaj spodbudno, trendi pa so še bolj zaskrbljujoči.

Statistika in demografija sta precej eksaktni znanosti, saj lahko zelo natančno napovesta trende v prihodnosti. Napovedi Statističnega urada Republike Slovenije kažejo, da bomo imeli čez 60 let, to je leta 2076, v Sloveniji 681.791 prebivalcev, ki bodo starejši od 60 let, tistih med 18 in 59 let pa bo 963.559. Če ta dva podatka primerjamo s sedanjimi številkami, lahko ugotovimo, da se bo delež starejšega prebivalstva povečal za 30 % v primerjavi z danes, medtem ko se bo delež potencialno aktivnega prebivalstva zmanjšal za 19 %. Četudi država nemudoma ukrepa z učinkovito demografsko politiko, smo že pozni. Naši družbeni in socialni sistemi, zlasti pokojninski in zdravstveni sistem, takšnih neravnovesij ne morejo vzdržati.

Tabela 1: Delež prebivalcev po starostnihrazredih 1990 - 2060



Če poslušate nekatere bolj izpostavljene politike, dobite občutek, da je vse v najlepšem redu in da Slovenija ne potrebuje nobenih prilagoditev. Ti politiki s tem ustvarjajo lažna pričakovanja, ki državi povzročajo dolgoročno škodo. Razmere so alarmantne, vendar ne šele čez 60 let, ampak že danes. Statistični urad napoveduje, da bomo imeli že leta 2026, to je čez deset let, 628.874 državljanov, ki so starejši od 60 let. V desetih letih je to 103.486 starejših oseb več kot danes. Nekaterim so to nepomembna matematična in suhoparna preračunavanja, v resnici pa te številke zgovorno govorijo o izzivih, ki nas čakajo.

Demografski podatki kažejo, da se slovenska družba hitro stara. Hitra rast starejšega prebivalstva se napoveduje prav v prihodnjih desetih letih, potem naj bi se nekoliko umirila in stabilizirala (Tabela 1). Da bo pretres v družbi še večji, je potrebno k staranju prebivalstva v zadnjih letih dodati še mladih. odseljevanje Od izbruha gospodarske in finančne krize Slovenijo letno v povprečju zapusti okrog 15.000 državljanov, polovica teh, ki zapustijo Slovenijo, je mlajših od 35 let. Gre za klasičen beg možganov, ki pa ga zaenkrat še ne občutimo tako intenzivno, saj se v Slovenijo vsako leto priseli približno isto število ljudi, kot se jih iz nje odseli.

3. POTREBNE SO KLJUČNE REFORME

Zaradi specifičnih značilnosti naše države je staranje prebivalstva, in z njim povezani

izzivi, v Sloveniji še bolj izraženo ter pereče vprašanje. Po podatkih Statističnega urada RS bo leta 2060 predvidoma skoraj vsak tretji Slovenec star 65 let ali več. V letu 2015 je bila skoraj petina prebivalstva v Sloveniji stara 65 let in več. Med njimi so skoraj tri petine žensk.

Staranie prebivalstva ima velike socialnoekonomske posledice, ki vplivajo na vse vidike življenja družbe, zato Evropska komisija opozarja države članice, da morajo prilagoditi različne sisteme, kot ie zdravstveni, pokojninski, sistem dolgotrajne oskrbe, izobraževanja in trg dela. V nadaljevanju izpostavljamo tri prednostna ki pomembna področia. so za medgeneracijsko solidarnost in zagotavljanje kakovostne starosti. S spremembami na področju zdravstvenega varstva in zdravstvenega zavarovanja moramo omogočati ustrezno zdravljenje in nego ter hkrati ohraniti finančno vzdržnost zdravstvene blagaine. V povezavi s prilagoditvijo sistemov pokojninsko za zavarovanje imajo oziroma bodo imele demografske spremembe tudi velik vpliv na trg dela v Sloveniji.

3.1 Pokojninska reforma

Potrebno je omiliti pritiske na izdatke pokojninske blagajne. Nanje na eni strani vpliva staranje prebivalstva, v Sloveniji pa na finančno nevzdržnost pokojninskega sistema vpliva tudi nizka rodnost. Relativno visoka brezposelnost in slabo stanie gospodarstva le še povečujeta pritiske na pokojninsko blagajno. Zaradi vsega navedenega je slovenski pokojninski sistem eden od najmanj vzdržnih v Evropi. Razlogov za to je več, med njimi pa je glavni ravno demografija. Danes imamo razmerje med zavarovanci in upokojenci približno 1,37 zavarovanca, leta 2060 pa naj bi število preseglo upokojencev že število zavarovancev (Tabela 2).





Vir: Inštitut za ekonomska raziskovanja

Težava Slovenije je po ocenah strokovnjakov, da tudi gospodarska rast, katere oživljanje se kaže, ne more odpraviti strukturnih neskladij našega pokojninskega sistema.

Tabela 3: Delež pokojnin v BDP2010 - 2060



Vir: Inštitut za ekonomska raziskovanja

Zaenkrat se ukrepi za vzpostavitev vzdržnega pokojninskega sistema usmerjajo

v zviševanje upokojitvene starosti in nižanje odmernih odstotkov. Ti ukrepi pa so omejeni in se ne dajo prilagajati v nedogled. Delež javnih izdatkov za pokojnine se bo povečeval, hkrati pa tudi proračunska doplačila v pokojninsko blagajno, s katerimi se pokriva razlika med vplačanimi prispevki in izplačanimi pokojninami (Tabela 3).

3.2 Dolgotrajna oskrba

V Sloveniji dolgotrajna oskrba še ni sistemsko urejena, pač pa se zagotavlja v okviru različnih zakonodaj oz. preko ločenih sistemov socialne varnosti (zaščite). Zakon, ki bo urejal to področje, je v pripravi že vrsto let, zadnji osnutek zakona pa je bil po podatkih UMAR v javni razpravi leta 2010. Dolgotrajna oskrba je področje, ki je v velikem porastu in se bo v prihodnosti še dodatno širilo. V UMAR-jevi publikaciji o dolgotrajni oskrbi avtorji izpostavljajo vsaj štiri razloge za nadaljnjo rast:

Prvič. demografske spremembe bodo povečale povpraševanje po storitvah dolgotrajne oskrbe v vseh družbah, torej ne glede na različno hitrost staranja prebivalstva državah. Drugič, vzporedno po s spreminjanjem družbenih modelov, kot sta npr. krčenje družinskih struktur in porast vključevanja žensk na trg delovne sile, bomo verietno priča pomanikanju neformalnih oskrbovalcev, kar bo posledično vplivalo na povpraševanje po plačani oskrbi.

Kot tretji razlog izpostavijo vedno večje bogastvo družb, potrebo ljudi po večji kakovosti in bolj odzivnih ter k uporabniku usmerjenim sistemom socialne zaščite. Četrtič, tehnološke rešitve povečujejo možnosti zagotavljanja velikega dela dolgotrajne oskrbe doma, na domu, kar pa posledično zahteva reorganizacijo oskrbe.

3.3 Dvig rodnosti

Po drugi svetovni vojni se je v Sloveniji vsako leto v povprečju rodilo okrog 30.000 otrok, kar je bila številka, ki je omogočala ohranjanje števila prebivalstva. V začetku osemdesetih se je začel viden trend upadanja. Do osamosvojitve so se generacije otrok zmanjšale za tretjino, na okoli 20.000. Najslabše je bilo v letih 1998–2004, ko so se generacije gibale okrog 17.000 otrok na leto. Od 2004 se številčnost generacij postopoma zvišuje in je danes nekaj malega nad 20.000 rojenih otrok na leto (Tabela 4). Današnje generacije so še vedno bistveno manjše kot tiste pred tremi desetletji.

Tabela 4: Gibanje števila živorojenih otrok v Sloveniji v obdobju 1955 - 2013



Rodnost je ključna za preživetje naroda. V Sloveniji se v zadnjih nekaj letih rodi v povprečju 1,5 otroka na žensko v rodni dobi. Stopnja rodnosti je v Sloveniji pod povprečjem držav EU. Za obnavljanje prebivalstva bi Slovenija potrebovala stopnjo rodnosti, ki bi bila višja kot 2,1. Povprečna starost matere ob rojstvu zadnjega otroka se v zadnjem obdobju giblje okrog 30 let (Tabela 5). Omenjeni podatki govorijo o tem, da se pari odločajo za otroke zelo pozno, posledično pa načrtujejo vse manjše družine. Velikih družin s tremi ali več otroki je vse manj.

Tabela 5: Gibanje povprečne starosti ženske ob porodu v Sloveniji v obdobju 1955 - 2013





V času gospodarske in finančne krize, to je od leta 2008 dalje, se je na leto rodilo več otrok kot v primerljivih letih pred tem. Na videz nenavaden podatek, vendar resničen. Razloge za več otrok v času krize je najverjetneje potrebno iskati v podpornih ukrepih države. Starševska nadomestila oziroma porodniške, subvencionirano varstvo predšolskih otrok in drugi družinski prejemki so zagotovo orodja, ki so se staršem v času krize zdela zanesljivejša kot nepredvidljive službe. Po pogovorih z nekaj mladimi družinami je moja temeljna ugotovitev, da so številni zaradi karierne poti odlagali načrtovanje družine v prihodnost, ko pa se je ekonomska situacija poslabšala in ko se je večal pritisk v službah, so prioritete spremenili in se odločili za otroke prej, kot bi se sicer, če kariera ne bi bila ogrožena ali prekinjena.

Zgornja ugotovitev bo morda marsikoga napeljala k razmišljanju, da materialno stanje para ni pomembno pri odločanju za otroke. V določenem delu ta teza zagotovo drži. Pri odločitvi za otroke sta ključna vzgoja in okolje, v katerem sta odraščala zakonca, vsekakor pa ni nepomembno tudi materialno stanje. Ko se mladi pari odločajo za otroke, je seveda velika olajševalna okoliščina, če imajo zagotovljeno stanovanje, varstvo in seveda službo. Če imamo v Sloveniji še vedno najboljših sistemov enega starševskega varstva, pa je država popolnoma odpovedala pri ukrepih, ki bi mladim družinam zagotovili stanovanje. Ne govorim, da bi mladim država podarila stanovanje, govorim pa, da bi država morala

oblikovati mehanizme in vzvode, s katerimi bi si mlade družine lahko privoščile stanovanja.

Pri podpornih ukrepih v korist družine je v zadnjem času vse bolj moteče, da je podpora države vezana na vključenost v sistem, ne pa na otroka. O čem govorim? Poglejmo samo primer vrtca. Kot eden izmed pomembnih ukrepov družinske politike je zagotovo zagotovljeno dostopno in varstvo predšolskih otrok. Problem pa nastane pri financiranju, saj država (in občine) prispeva samo za tiste otroke, ki obiskujejo javne in koncesijske vrtce, ne prispeva pa staršem, katerih otroci obiskujejo privatne vrtce ali pa so v varstvu starih staršev. Vse pravice iz naslova družinske politike bi morali vezati na otroka, ne pa na njegovo vključenost v sistem.

Obstoječe podporne sisteme v korist družine je potrebno izboljšati in jih nadgraditi z novimi. Izboljšati je potrebno dostopnost mladih do stanovanj in služb. Najbolj koristno za mlade starše bi bilo povečanje davčnih olajšav na posameznega otroka, kar z drugimi besedami pomeni, da bi si država od plače mladih staršev odrezala manj denarja. Davčna in socialna politika morata biti družini prijazni.

Slovenska družba se stara. Za dolgoročno preživetje naroda potrebujemo višjo rodnost. Če bi želeli, da bi bila rodnost vsaj 2,1 otroka na mater v rodni dobi, kolikor je potrebno zgolj za obnavljanje prebivalstva, potem bi se moralo letno roditi vsaj 30.000 otrok. To je približno 10.000 več kot danes (Tabela 6). Za dvig rodnosti so seveda pomembni podporni sistemi, ki jih država zagotavlja staršem, vsekakor pa ni zanemarljivo število umetnih splavov.

Tabela 6: Gibanje stopnje celotne rodnosti (število otrok, ki jih ena ženska rodi tekom svoje rodne dobe ob rodnosti iz proučevanega leta) v Sloveniji v obdobju 1955 - 2013





Zagovarjamo svetost življenja vse od spočetja do naravne smrti. Življenju oziroma spočetim otrokom slovenska ustava ne priznava pravic od samega spočetja. Ne nameravamo se spuščati v pravne polemike. ki so lahko izrazito ideološko obremenjene, želimo pa kot politiki storiti vse, da bi čim več žensk splav zavrnilo svobodno in ne zato, ker bi jim ga prepovedala država. Naj jasno povemo, da pri vprašanju splava ne vidim rešitve v zakonski prepovedi splava. V naši družbi bodo vedno obstajale ženske, ki se bodo odločale za splav, zato bi bila zakonska prepoved splava zgolj pilatovsko umivanje rok. Ženske bi izvajalce tovrstnih posegov iskale preko naših meja ali morda v nekvalificiranih, nelegalnih in mazaških ordinacijah. Prizadevati si moramo, da ženskam pokažemo drugo možnost.

Po podatkih Nacionalnega inštituta za javno zdravje je bilo samo leta 1990 opravljenih več kot 15.000 dovoljenih umetnih splavov. Do danes se je ta številka ves čas zniževala in je leta 2008 prvič padla pod 5.000 (Tabela 7). Zavedamo se, da je odločitev za splav izjemno travmatična, saj človeku pusti trajne posledice. Z nekoliko bolj trdimi besedami sem želel povedati, da gre v primeru splava za življenje, ki ga nasilno prekinemo, zato moramo vsi skupaj storiti vse, da bi čim več otrok ugledalo luč tega sveta.

Tabela 7: Število dovoljenih splavov, Slovenija, letno (1990 – 2014)



Vprašanje splava je v Sloveniji zelo ideologizirano, zato se je o njem težko racionalno pogovarjati. Vse se velikokrat osredotoči zgolj na klišejski spopad med konservativci, ki splavu nasprotujemo, in liberalnimi feministkami, ki poudarjajo svobodo žensk, da same odločajo o svojem telesu. Pri tovrstnih spopadih se pozablja na pomembne nianse, ki povzročajo bolečino tistim, ki so se za splav odločili. Tem ljudem visokooktanski politični in ustavno-pravni spopadi ne pomagajo, ker s polariziranjem družbe glede tega vprašanja ne rešujemo njihovih travm.

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Razlogi za starševstvo in pomen otrok pri slovenskih materah

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POVZETEK

Odločitev za starševstvo lahko izhaja iz psiholoških, socialnih ali ekonomske razlogov. Pomen otrok je odvisen od številnih dejavnikov makrosistema, kot so kultura, družbene norme in vrednote. zgodovina naroda, kolektivistična oziroma individualistična usmerjenost kulture in drugo. V raziskavi smo preverili kakšen pomen pripisujejo otrokom slovenske matere. Rezultati so pokazali, da matere otrokom pripisujejo visok psihološki pomen, medtem ko sta socialni in ekonomski pomen nizka, pri čemer je najnižje vrednoten ekonomski pomen otrok. Pokazale so se določene razlike v vrednotenju pomena otrok glede na kraj bivanja. Pomen, ki ga pripisujemo otrokom, nam razkrivajo, kje in kakšno je mesto otroka v družini ter družbi, kar je ključ do razumevanja spreminjajoče se družinske strukture, medgeneracijskih dinamičnih odnosov ter predvidevanja svetovnih trendov populacijske rasti.

Ključne besede

Razlogi za starševstvo, pomen otrok, medkulturna psihologija, makrosistem, psihološki ekonomski in socialni razlogi.

1. TEORETIČNO OZADJE

Pripisovanje pomena otrokom ima močan vpliv na motivacijo, da se posameznik odloči, da bo imel otroke. Hoffman in Hoffman [3] pravita, da je potrebno raziskovati pomen otrok, ker na osnovi tega lahko razberemo motive, ki vplivajo na rodnost oziroma število otrok, predvidimo načine, kako doseči družine z manj otroki, s pomočjo motivov za starševstvo predvidimo populacijske trende ter razumemo vpliv pomena otrok na odnos med starši in otroki. Avtorja pravita, da se »pomen otrok nanaša predvsem na to, kakšno funkcijo bo otrok v družini prevzel ter na to, katere potrebe starši zadovoljujejo preko otrok« [3].

Pomen, ki ga starši pripisujejo otrokom, oziroma razlogi, zakaj se odločajo za starševstvo, so odvisni od različnih dejavnikov. V ospredju so individualni dejavniki, kot so vrednote, interesi, cilji in želje posameznika. Le-ti pa se razvijajo v širšem kontekstu, ki ga Bronfenbrenner [1] imenuje makrosistem in se odraža preko oblikovanja družinskih struktur in odnosov, ki se spreminjajo skupaj s spreminjajočo se družbo in se razlikujejo med različnimi kulturami. Iz tega razloga je te razloge za starševstvo potrebno obravnavati znotraj določene kulture, torej z vidika kulturne in medkulturne psihologije [1,6].

1.1 Pomen otrok

Hoffman in Hoffman [1] sta kategorizirala pomen otrok v devet skupin: Status odraslosti in socialne identitete; Razširjanje sebstva; Moralnost: religija, altruizem, delovanje v dobro skupine, norme glede spolnosti; Primarna povezanost in naklonjenost znotraj družine; Stimulacija, poživitev, novost in zabava; Dosežki, sposobnosti in ustvarjalnost; Moč, vpliv in učinkovitost; Socialna primerjava in tekmovanje; Ekonomska korist. Kasneje je bilo s pomočjo faktorske analize teh devet kategorij strnjenih v tri večje skupine, to so: psihološki pomen, ekonomski/utilitaren pomen ter socialni/družbeni pomen otrok [6].

Ekonomski oz. utilitaren pomen se nanaša na materialno korist, ki jo družina/starši pridobijo s tem, ko imajo otroke. Gre za pomoč pri gospodinjskih opravilih ali pri delih, s katerimi se družina ukvarja (npr. kmetijska opravila, družinski posli), ter skrb za starše v njihovi starosti [6] iz perspektive potomcev pa gre za visoko lojalnost svojim staršem in družini [11].

Psihološki pomen vključuje občutja zadovoljstva, ki jih starši doživljajo, ker imajo otroka. Ta občutja so lahko ponos, moč in občutek dosežka ter napredka v življenju, otrok lahko za starše predstavlja poživitev, družbo, novost, doprinese k svežini in dogajanju v družini [6]. Dodatno ima otrok lahko vpliv na to, da se partnerja zbližata.

Socialni pomen predstavlja občutja splošne sprejetosti v širši družbi, ki so jih starši deležni zaradi dejstva, da imajo otroke. V bolj tradicionalnih družbah posameznik pridobi status »odrasle osebe«, ko dobi otroke. Predvsem materinstvo je v nekaterih kulturah pojmovano kot glavno poslanstvo ženske ter njena glavna vloga v življenju, zato so lahko ženske brez otrok deležne družbenega neodobravanja. Družba lahko ženske, ki so usmerjene k lastni karieri in ne izražajo želje po družini in otrocih, označijo kot sebične ter njihove vrednote kot izkrivljene. Imeti otroke tako predstavlja neko družbeno obveznost, saj otroci predstavljajo prispevek k družbi. Med socialni pomen otrok spada tudi »nadaljevanje družine« ali »nadaljevanje družinskega imena«, da bo otrok, predvsem sin, poskrbel, da se status ali ime družine ne izgubita [6].

1.2 Vpliv makrosistema na pomen otrok

Makrosistem posredno ali pa neposredno vpliva na oblikovanje posameznikovih vrednot, stališč, mišljenja in delovanja preko socialnih dejavnikov iz okolja, kot so družbene norme in vrednote, socializacija znotraj določene kulture, stališča in ideologija kulture, politični in ekonomski vzorci, zgodovina naroda, individualistične ali kolektivistične usmerjenosti kulture, ipd.. [1].

Družbene vrednote: Pomen, ki ga družba pripisuje otrokom, določa njihov položaj v družbi, izobraževanje, pričakovanja do otrok, ravnanja z njimi (npr. "otroško delo"), ipd..[6].

Stopnja razvitosti: se odraža predvsem v treh dimenzijah: ali je območje ruralno ali urbano; socialno-ekonomski status (SES) družine znotraj tega območja; izobrazba in poklic staršev. Za manj razvite države, ruralna območja, družine z nižjim SES-om ter z nižjo izobrazbo staršev je značilen velik vpliv utilitarnih vrednot na odločitev za starševstvo [6].

Individualizem – kolektivizem: se odraža v pojmovanju povezanega/ločenega sebstva od ostalih ljudi oziroma družinskih članov [6]. Ločenost in neodvisnost se povezujeta z zahodnim svetom, individualističnimi kulturami, razvitejšimi državami in urbanim življenjem. Povezanost in soodvisnost pa sta bolj prisotni v nezahodnem svetu, v kolektivističnih družbah, povezujemo jih z državami v razvoju in ruralnim življenjem. Vpliva tudi na različne modele družin. Kağıtçıbaşı [6] opredeljuje tri družinske modele:

a.) model družinske neodvisnosti (individualistični model): Ljudje v gospodinjstvu živijo z ožjo družino oz. zgolj s člani primarne družine. Značilno manjše število otrok. Avtonomnost je visoko cenjena, zato se manjši pomen pripisuje materialni in čustveni soodvisnosti. Ker so v takšni družbi po navadi urejeni sistemi socialne varnosti (predvsem pokojnina), ni ekonomskih razlogov za odločanje za otroke, zato prevladujejo psihološki.

b.) model družinske soodvisnosti (kolektivistični model): Tu so posebej izpostavljene družine nezahodnih držav, iz ruralnih območij z nižjo stopnjo socialno-ekonomske razvitosti. Značilno je večje število otrok, in vključevanje članov razširjene družine ter močna materialna in čustvena soodvisnost članov. Razlogi za starševstvo so pogosteje utilitarni kot psihološki [6,8].

c.) model družinske psihološke soodvisnosti, ki vsebuje elemente prvega in drugega modela ter ponazarja spreminjajočo se družinsko strukturo v nezahodnih državah, ki se socialnoekonomsko hitro razvijajo. Čustveni soodvisnosti je še vedno pripisan velik pomen, upade pa pomen materialne soodvisnosti ter tradicionalne družinske hierarhije (upad utilitarnih vrednot), osebna avtonomnost pa pridobiva na pomenu [6,8]. V takšnih družinah se otrokom pripisuje predvsem psihološki pomen.

2. CILJ

Cilj raziskave je bil ugotoviti, kakšen pomen slovenske matere pripisujejo otrokom, torej, zakaj se odločajo za materinstvo in kateri socialni, ekonomski in kulturni dejavniki vplivajo na te odločitve.

3. METODOLOGIJA

Izvedena je bila kvantitativna anketna raziskava s pomočjo spletnega anketiranja, pri čemer so bile anketirane osebe naključno izbrane po metodi snežne kepe. Anketa je bila oblikovana na podlagi vprašanj iz originalnega strukturiranega intervjuja, ki je bil uporabljen v raziskavi VOC 2, in sicer Vprašalnik za matere (ang. »Value of Children Project: Questionnaire for Mothers with a Target Child«) avtorjev Trommsdorff, Nauck, Schwarz, Chakkarath in Schwenk [11]. Iz originalnega vprašalnika je bilo izluščenih, prevedenih (iz angleščine v slovenščino) in uporabljenih 15 vprašanj. Uporabljena je 5-stopenjska Likertova lestvica (os 1-se ne strinjam, do 5- se strinjam s trditvijo).

3.1 Vzorec

Anketni vprašalnik je bil anonimen in prostovoljen, razdeljen med ženske, ki imajo vsaj enega otroka in prebivajo v Sloveniji. Vzorec predstavlja 125 slovenskih mater, starih med 22 in 64 let. **Starost**

Povprečna starost je bila 38,5 let (SD 10,8). Udeleženke smo za namene analize razvrstili v dve starostni skupini: od 22 do 35 let (mlajša odrasla doba ali »mlajše matere«, 46,5% vseh udeleženk) ter od 36 do 64 let (srednja leta ali »starejše matere«, 53,5% vseh udeleženk).

Število otrok

Največje število otrok med anketiranimi je tri, tri otroke ima 18% vseh vprašanih. Prevladujejo matere z dvema otrokoma (42%), sledijo matere z enim otrokom (40%). Aritmetična sredina je 1,8.

Izobrazba

Večina anketiranih ima univerzitetno ali visokošolsko raven izobrazbe (63,2 %), sledijo anketiranci s srednješolsko izobrazbo oz. poklicnim izobraževanjem (31,2%), le nekaj jih ima dokončan študij magisterija ali doktorata (4%), najmanj anketiranih pa ima izobrazbo nižjo od srednje šole (1,6%). Srednja šola ali manj v nadaljnji analizi predstavlja »nižjo izobrazbo« (33% vseh anketiranih), ostalo pa »višjo izobrazbo« (66% vseh anketiranih).

Zaposlitveni status

Med anketiranimi je 78,5 % zaposlenih, sledijo jim brezposelni z 10,5 %, upokojenih anketiranih je 5,5 %, 5 % pa je dijakinj ali študentk. Ena oseba ima status kmeta.

Zakonski status

Večina anketiranih glede zakonskega statusa opredelila za poročene (58 %) ali da živijo v zunajzakonski skupnosti (29,5%). Nekaj jih je razvezanih (8%), ovdovelih (3%) in samskih (1,5 %).

Socialnodemografski položaj

Največ anketiranih živi v srednje velikem naselju s številom prebivalcev med 3.000 in 15.000 (31 %), sledijo jim anketirani iz manjših naselij/vasi z od 500 do 3.000 prebivalci (22,5%). Iz Ljubljane ali Maribora (naselje nad 50.000 prebivalcev) prihaja 20 % anketiranih, 18,5 % anketiranih prihaja iz majhnih vasi z manj kot 500 prebivalci, 8 % anketiranih pa prihaja iz mest, ki imajo med 15.000 in 50.000 prebivalcev.

Finančni status

63 % anketiranih prejme med 1000 € in 2.500 € mesečih neto prihodkov na gospodinjstvo. Prihodke med 2.500 € in 5.000 € ima 22,5 % vprašanih, najmanj anketiranih je odgovorilo, da ima njihovo gospodinjstvo neto prihodke do 1.000 € (14,5 %)

4. REZULTATI

Najprej smo preverjali, koliko so pri slovenskih izraženi psihološki, ekonomski in socialni razlogi za starševstvo.

Na Sliki 1 so prikazane aritmetične sredine odgovorov, ki se nanašajo na psihološki pomen otrok. Iz Slike 1 lahko razberemo, da sta najpogosteje naveden razlog za starševstvo »Ker se med otrokom in staršem razvije posebna ljubezen" ter »Ker mi je v zadovoljstvo gledati, kako otroci odraščajo«. Kot pomemben psihološki razlog so se izkazale tudi trditve: »Ker starševstvo poveča občutek odgovornosti in pripomore k osebnostnemu razvoju«, »Ker dojenček prinaša radost«), »Ker me vzgajanje otrok nauči veliko o življenju in o sebi« ter »Da imam nekoga rada in skrbim zanj«.



Legenda: 1- Ker me otrok zbliža s partnerjem.; 2- Ker starševstvo poveča občutek odgovornosti in pripomore k osebnostnemu razvoju.; 3 - Ker dojenček prinaša radost.; 4- Ker je zabavno imeti majhne otroke pri hiši.; 5-. Ker mi je v zadovoljstvo gledati, kako otroci odraščajo.; 6 -. Ker se med otrokom in staršem razvije posebna ljubezen.; 7- Ljudje, ki imajo otroke, imajo manj možnosti, da bodo osamljeni v starosti.; 8- Ker me vzgajanje otrok nauči veliko o življenju in o sebi.; 9- Da imam nekoga rada in skrbim zanj.

Slika 1. Aritmetične sredine odgovorov, ki odražajo psihološke razloge za starševstvo.

Kot pomembni psihološki razlogi za starševstvo se niso izkazale trditve kot so: "Ker me otrok zbliža s partnerjem«, »Ker je zabavno imeti majhne otroke pri hiši« ter »Ljudje, ki imajo otroke, imajo manj možnosti, da bodo osamljeni v starosti«. Vse navedene trditve, ki nakazujejo na psihološki pomen otrok, imajo povprečno vrednost na 5-stopenjski lestvici enako ali višjo od 2,6, kar pomeni, da se anketiranci v povprečju niso negativno opredelili glede nobene od trditev oziroma niso izrazili nestrinjanja z določeno trditvijo. To nakazuje na visok psihološki pomen otrok med anketiranimi materami.



Legenda: 1 - Ker otrok pomaga pri hišnih opravilih.; 2 - Ker (več) otrok pripomore k boljšemu finančnemu stanju družine.; 3- Ker bi mi otroci lahko pomagali na stara leta.; 4- Ker z vsakim novim družinskim članom družina pridobi na pomembnosti.; 5 fer otroci krepijo stike s sorodniki.; 6- Ker starševstvo izboljša moj položaj in ugled med sorodniki.; 7- Ker se nekaterim starejšim sorodnikom zdi, da bi morala imeti več otrok.; 8- Ker preko otrok kujem nova poznanstva.; 9- Da nadaljuje družinsko ime.

Slika 2. Aritmetične sredine odgovorov, ki odražajo ekonomske in socialne razloge za starševstvo.

Iz Slike 2 opazimo, da je povprečna vrednost vseh trditev, ki se nanašajo na ekonomskim pomenom otrok (1-3) manjša ali enaka 2,5, kar nakazuje na nizek ekonomski pomen otrok. Izmed šestih trditev, ki se nanašajo na socialni pomen otrok (4-9), imajo štiri aritmetično sredino nižjo od 2,5, kar pomeni, da se anketirane osebe s trditvijo ne strinjajo.

Nadalje nas je zanimalo nas ali je mogoče odkriti povezavo med pripisovanjem psihološkega pomena otrokom ter starostjo anketiranih. njihovo izobrazbo njihovim ter socialnodemografskim položajem. Mlajše anketirane matere pri vseh trditvah (z izjemo trditve 2) odgovarjale z višjimi vrednostmi (M=3,9, SD=0,66) kot starejše matere (M=3,6, SD=0,69). Rezultati so pokazali, da obstaja statistično značilna razlika med mlajšimi in starejšimi materami pri vrednotenju trditev "Ker dojenček prinaša radost." (t(1,98)=2,26, p<0,05), ter "Ker se med otrokom in staršem razvije posebna ljubezen" (t(1,98)=3,60, p<0,05) pri čemer so mlajše matere bolj pozitivno vrednotile psihološki pomen otrok. Rezultati so pokazali da ni statistično značilnih razlik med odgovori anketirank z nižjo ali višjo izobrazbo ter med odgovori anketirank glede na kraj bivanja.

Nadalje smo preverjali, ali je večje število otrok povezano z ekonomskim pomenom otrok. Tudi v tem okviru ni bilo zaslediti statistično značilnih razlik v odgovorih.

Preverili smo tudi, ali sta socialni in ekonomski pomen otrok bolj prisotna pri anketiranih s podeželja oziroma iz ruralnih naselij.



Legenda: glej Sliko 2

Slika 3. Aritmetične sredine odgovorov, ki odražajo ekonomske in socialne razloge za starševstvo glede na kraj bivanja.

Iz Slike 3 vidimo, da sta tako ekonomski kot socialni pomen otrok nekoliko bolj prisotna pri anketirankah iz ruralnih naselij. Statistično značilna razlika med skupinama se je pokazala pri trditvah "Ker otrok pomaga pri hišnih oravilih" (t(1,99)=2,92, p<0,05), "Ker več otrok pripomore k boljšemu finančnemu stanju družine." (t(1,99)=3,21, p<0,05), "Ker starševstvo izboljša moj položaj in ugled med sorodniki." (t(1,99)=2,33, p<0,05), in "Ker se nekaterim starejšim sorodnikom zdi, da bi morala imeti več otrok." (t(1,99)=3,09, p<0,05).

5. ANALIZA REZULTATOV

Rezultati so pokazali, da slovenske matere otrokom pripisujejo predvsem psihološki pomen. Ugotovitev se sklada z rezultati raziskav v drugih državah v Evropi, Aziji in Afriki, ki so pokazali na prevladujoč psihološki pomen otrok v vseh družbah [9].

Ekonomski pomen otrok se pri slovenskih materah ni izkazal za pomembnega ne glede na število otrok, ki jih imajo. Rezultti so skladni z ugotovitvami raziskave v Nemčiji in Češki. V Sloveniji kot razviti državi imamo vzpostavljen sistem socialnega varstva, ki prebivalcem zagotavlja materialno varnost za primer bolezni, brezposelnosti, starosti, invalidnosti, materinstva, preživljanja otrok in drugo, zato se starši jmanj zanašajo na svoje otroke v smislu materialne pomoči in je posledično otrokom pripisan nižji utilitarni pomen kot v državah z nižjo stopnjo razvitosti in visoko stopnjo rodnosti. V teh državah je zastopan individualistični družinski model, kjer je finančna pomoč usmerjena k otroku v nasprotju s kolektivističnim modelom, kjer je materialna pomoč usmerjena k staršem [6]. Ekonomski pomen otrok je najbolj prisoten v Indoneziji, Gani, Indiji, Palestini in Južni Afriki, kar gre pripisati nižjemu življenjskemu standardu, nižji blaginji in izobrazbi ter odsotnosti ali slabo razvitemu sistemu socialnega varstva [5]. Da medgeneracijska materialna odvisnost družinskih članov upada s socialno-ekonomskim razvojem države ter urbanizacijo območja, je pokazala primerjava turških študij VOC 1 in 2 iz leta 1975 ter 2003 iz katere je opaziti izrazit padec ekonomskega pomena otrok, in izrazit porast psiholoških vrednot [4,6]. V okviru ekonomskega pomena je zanimiva analiza trditve »Ker bi mi otroci lahko pomagali na stara leta«, kjer se je 39 % udeleženk opredelilo nevtralno, 43 % se jih ni strinjalo s trditvijo in le 18 % anketiranih se je strinjalo s trditvijo. Ta rezultat se zelo razlikuje z državami kot so Indonezija, kjer je pomembnost te trditve izrazilo 93 % udeleženk v raziskavi, na Filipinih 89 %, na Tajskem in Tajvanu 79 %, v Turčiji 77 %, v Nemčiji in ZDA pa je strinjanje izrazilo le 8 % udeleženk. Slovenski vzorec je torej pokazal nizko stopnjo pričakovanja do otroka, da pomaga staršem na stara leta, kar je značilno za nezahodne razvite države [5].

Ugotovili smo, da slovenske matere otrokom ne pripisujejo velikega socialnega pomena. Rezultate lahko razložimo s teorijo Naucka in Klausa [9], ki pravita, da otroci služijo kot statusni simbol v primeru, da so zanesljiv vir materialne pomoči. Predpostavka povezanosti med ekonomskim ter socialnim pomenom otrok, pomeni, da v razvitejših državah z upadom ekonomskega pomena otrok posledično upade tudi socialni pomen otrok. V primerjavi enajstih držav je bil najvišji socialni pomen otrok v tistih državah, kjer se je tudi ekonomski pomen otrok izkazal za visokega (Indoneziji, Gani, Indiji, Palestini in Južni Afriki). V državah z nizko stopnjo rodnosti, kot so Kitajska, Koreja in Nemčija, kjer je ekonomski pomen otrok že izzvenel, pa je bil socialni pomen otrok v manjši meri še vedno prisoten [9]. Rezultati naše raziskave kažejo, da je vrednotenje socialnega pomena otrok vseeno višje kot vrednotenje ekonomskega pomena otrok. Čeprav v evropskih državah družine niso več tipično sestavljene iz moža, ki je odgovoren, da preskrbi družino, ter žene, ki ima vlogo gospodinje, pa je kljub temu najbolj zaželen in sprejet način življenja »poročen z otroki«, zato socialne vrednote glede otrok ostajajo višje kot ekonomske [2].

Rezultati o povezanosti pomena otroka s starostjo anketiranih mater potrjujejo ugoovitve predhodnih raziskav, da s starostjo staršev upada ekonomski in socialni pomen otrok, psihološki pa pridobiva na pomembnosti. S tem ko je treba otroka čedalje dlje preživljati in vzdrževati (podaljšana leta šolanja, kasnejša odselitev od doma ter kasnejša finančna osamosvojitev), mora ta staršem predstavljati psihološko dobrino, sicer se ne bi odločili imeti družine [6,11].

Rezultati niso pokazali razlik glede na različne izobrazbene profila, kot je zaslediti v VOC 1 študiji [4]. V tem primeru naj izpostavimo potencialno omejitev ugotovitev zaradi premajhnega števila udeležencev posameznih izobrazbenih skupin.

Primerjali smo tudi odgovore glede na kraj bivanja (urbani, ruraqlni). Izkazalo se je, da sta ekonomski in socialni pomen otrok nekoliko bolj prisotna pri anketiranih iz ruralnih naselij, međtem ko pri psihološkem pomenu ni bilo pomembnih razlik. Pripisovanje ekonomskega in socialnega pomena otrokom je torej bolj prisotno pri anketiranih iz podeželskih naselij. Zaradi načina življenja, ki je bil prisoten skozi zgodovino na Slovenskem, še vedno obstajajo razlike med življenjem na podeželju ter življenjem v mestih. V podeželskih in agrarnih območjih Slovenije so otroci kasneje prenehali biti pojmovani kot »ekonomska dobrina staršev«, kot se je to zgodilo v mestih. Z razvojem, urbanizacijo in modernizacijo so se zabrisale jasne razlike med življenjskim stilom na podeželju in življenjskim stilom v mestu, kar ima v sedanjosti za posledico dokaj enotno pojmovanje otrok in otroštva. Kljub temu pa je otroško delo še vedno bolj sprejemljivo v družinah na podeželju kot za starše iz urbanih naselij [5,6].

6. ZAKLJUČEK

Slovenske matere otrokom v veliki meri pripisujejo psihološki pomen, medtem ko sta se ekonomski in socialni pomen izkazala za nizkega. To je značilno za zahodne kulture, kjer je prisoten individualistični družinski model, v katerem je avtonomnost visoko cenjena in urejeni sistemi socialne varnosti, zato se manjši pomen pripisuje materialni in čustveni soodvisnosti. Rezultati potrjujejo trend prehoda iz modela družinske soodvisnosti v model družinske psihološke soodvisnosti, spremembe vrednot pri mlajših generacijah (neodvisnost in avtonomnost) ter spremembo položaja starostnikov v družini in družbi [7,8,9]. Še vedno pa ostajajo določene razike med mestnimi in ruralnimi okolji. Pri slednjih je socialni in ekonomski pomen otrok bolj izražen. Poznavanje spreminjajoče se medosebne družinske dinamike in vrednotenja otrok nam tako nudi vpogled v spreminjajoče se trende vzdrževanja medgeneracijske solidarnosti na katero poskuša vplivati država z aktivno družinsko politiko v najširšem smislu [10].

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Mortality by Causes of Death in European Countries

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ABSTRACT

In this paper, we analyse characteristics of European countries from the mortality point of view, taking causes of death into account. We identify clusters of countries with similar mortality patterns. This knowledge can serve as a source of information for policy makers from various areas (e.g. demography, health care).

Keywords

Cause of death, mortality, clustering, European countries

1. INTRODUCTION

Different health problems across countries result in different sexage specific mortality. Consequently, countries with different mortality level and/or structure face different demographic issues as well as health costs that both have important implications for labour market, social security, health care system and related development strategies [6]. For implementing proper health policy and improving health cost management it is important to know where a certain country is positioned among other countries in a sense of sex-age-cause specific mortality, and what are the differences between groups of countries.

Traditionally, the countries' health and development status is analysed and compared through life expectancy at birth (e_0), that is considered one of the main demographic indicators of country development. However, the e_0 concept is based on mortality level only, without taking causes of death into account.

One possibility for an investigation of differences from the causes of death point of view is to compare the countries on the basis of mortality level by cause of death in sex-age groups simultaneously, and form clusters of similar countries.

2. THE DATA

The data on the number of deaths by different causes of death, age and sex, as well as the data on the number of population by age and sex were taken from the Eurostat database [1, 2]. The most recent Eurostat data referring to year 2014 are available for 32 European countries (28 European Union countries, and Switzerland, Norway, Liechtenstein, and Serbia). We use the 3year average number of deaths in order to reduce the random effect.

We focus on three main groups of causes of death (according to ICD-10 [4]) that represent over 70% of all deaths in the analysed countries in 2014 [3]: diseases of the circulatory system, neoplasms, and diseases of the respiratory system, along with the last group of causes of death (called 'Other') consisting of all other causes of death.

We calculate death rates by those four causes of death, both sexes and seven age groups (0-14 years, 15-34 years, 35-54 years, 55-64 years, 65-74 years, 75-84 years, 85 years or more).

To ensure cross-country comparability we apply these country specific death rates to a standard population, calculated for our purpose from the actual total population of our analysed countries. We divide the number of people in each sex-age group by the total population and multiply by 100000 (our standard population is normalized to 100000). Next, we multiply the previously calculated sex-age-cause specific death rates for each country with the number of citizens in the corresponding sex-age group of our standard population. In such a way we convert the death rates into (sort of) absolute numbers of deaths for each country, that are controlled for different population sex-age structure. Our underlying data are thus the number of deaths (for a standard population) by four groups of causes of death within 14 sex-age groups (2 sex groups for each of the 7 age groups) for 32 European countries for the year 2014.

3. METHODS

For grouping similar countries based on the described data we use the classical Ward clustering with the squared Euclidean distance as the measure of dissimilarity. Clustering is performed component-wise, where a component is mortality by each cause of death in each sex-age group combination.

We compare the clustering result based on the sex-age-cause specific mortality to the one obtained from the life expectancy at birth data that can be considered as a benchmark. Life expectancy at birth is a hypothetical length of life that a newborn can expect if the mortality pattern remains unchanged in the future. As it is calculated on the basis of a demographic model (a life table) it is not affected by the age distribution and is therefore comparable geographically and through time [5] and thus often used as a demographic indicator of country development.

Once the countries are partitioned into clusters it is interesting to know what are those sex-age-cause combinations that discriminate the most between the resulting clusters. For the partition into two clusters we compare pyramids of structural shares for each cause separately, whereas for the lower-level partition into four clusters we apply the Bonferroni correction in ANOVA post-hoc testing.

4. RESULTS

In the first subsection we present the dendrogram (i.e. graphic representations of hierarchical clustering) for our data and compare it to the benchmark dendrogram based on life expectancy at birth. In the second subsection we describe the two main clusters and in the last subsection we identify the most discriminative sex-age-cause combinations considering lower-level partition into four clusters.

4.1 Clustering Results

The dendrogram for clustering 32 European countries based on sex- age-cause specific mortality data is presented in Figure 1.

When comparing this result with the clustering based on life expectancy at birth (dendrogram presented in Figure 2) we can see that the partitions into two clusters are exactly the same for both approaches. However, lower level partitions reveal substantial changes for the 'western' cluster.



Figure 1. Dendrogram for clustering 32 European countries based on sex-age-cause specific mortality

From Figure 1 two well separated groups of countries can be clearly observed. The right-hand side cluster consists of 11 countries from the eastern Europe and the left-hand side cluster consists of 21 middle- and western-European countries.

4.2 Description of the Two Main Clusters

In this section we describe the differences in mortality between the two distinctive geographically separated clusters of countries. The differences in the overall mortality level (the number of all deaths calculated from the standard population) within sex-age groups are presented in Figure 3.



Figure 2. Dendrogram for clustering 32 European countries based on life expectancy at birth



Figure 3. Pyramids for the overall mortality level for the eastern and the western cluster of countries

Comparison of the two pyramids reveals higher mortality levels in the eastern group of countries for both sexes of all age groups, except for the oldest men.

For cause-by-cause comparison between the two clusters we use similar pyramids, although instead of the number of deaths in certain sex-age group they represent structural shares of deaths from the analysed cause within all deaths in that sex-age group.

The pyramids for eastern and western cluster representing structural shares of deaths due to the diseases of the circulatory system are shown in Figure 4.



Figure 4. Pyramids representing structural shares of deaths due to the diseases of the circulatory system for the eastern and the western cluster of countries

In the eastern group of countries the structural shares of the deaths due to circulatory diseases are substantially higher than in the western group, especially in the older ages. As far as structural shares of deaths due to neoplasms are concerned, we notice that they are slightly higher in the west, especially for women.¹

The structural shares of deaths from the diseases of the respiratory system are much higher in the western cluster in the older age groups, whereas they are very large for children of both sexes in the eastern cluster.

For the remainder of the causes ('Other') the structural shares are notably higher in the western cluster for older age groups, when the most common 'Other' causes of death are various dementias [3].

4.3 Identification of the most discriminative sex-age-cause combinations

As the partition into only two clusters of countries is rather general we were interested also in the more detailed analysis of the partition into four groups of countries.

The clustering based on sex-age-cause specific mortality results in the following four groups: two groups of eastern European countries (CZ, EE, HR, HU, PL, SK and BG, LT, LV, RO, RS) and two groups of western European countries (AT, DE, EL, MT, SI and the last group of 16 remaining western countries).²

Using the ANOVA test with the post-hoc Bonferroni procedure we identify those sex-age-cause combinations that discriminate the most between the four clusters. In Table 1 we list those combinations for which all pairwise mean differences are statistically significant.

Table 1. The most discriminative sex-age-cause combinations for partition into four clusters

Sex	Age	Cause	F
W	65-74	Circulatory	263.3
М	75-84	Circulatory	195.3
W	75-84	Circulatory	125.6
W	85+	Circulatory	118.5
М	85+	Circulatory	83.0

Clearly, the deaths due to the diseases of the circulatory system are the main source of differences between the four clusters of countries.

¹ Pyramids for neoplasms, diseases of the respiratory system, and other causes of death are not shown here. They are available upon request from the authors.

² Different from that, the clustering based on life expectancy at birth results in the following four groups of countries: the two groups of eastern European countries are quite similar with only HU switching positions (CZ, EE, HR, PL, SK and BG, HU, LT, LV, RO, RS), whereas the partition of the western primary cluster into two groups is very different (CH, CY, ES, FR, IT, LU and the 15 remaining countries).

5. CONCLUSION

The aim of our study is to provide some evidence-based support to the experts and decision makers in the field of health care system.

It is probably indisputable that the main goal is lowering the general level of mortality. However, with limited health funds it is essential to distribute them properly among different diseases.

We upgrade the traditional comparison based on life expectancy at birth by incorporating the causes of death into the analysis. We identify the main groups of countries with similar mortality distributions over sex-age-cause of death, as well as the main separation/discrimination factors for these groups.

As mortality in certain age from certain cause is usually a consequence of morbidity of the same cause in preceding age group(s), our analysis can help identify those issues that need to be addressed most urgently by appropriate prevention and cure programmes. Our findings suggest that the differences in mortality between groups of similar countries arise mainly from differences in mortality due to the diseases of the circulatory system in older age groups.

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Komentar in predlogi za izboljšanje predloga Resolucije o družinski politiki 2018 – 2028

Tomaž Merše

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Ministrstvo, pristojno za družino, je pripravilo in dalo v javno razpravo predlog Resolucije o družinski politiki 2018 – 2028 z naslovom »Vsem družinam prijazna družba«.

Dokument je po daljšem času pretežno omejevanja in podaljševanja veljavnosti omejevalnih ukrepov na področju družinske politike dobrodošla in pozitivna novica, saj se po dolgem času spet pogovarjamo o tem, kako bi družinsko politiko izboljšali in obogatili.

V predlogi resolucije je kar nekaj dobrih usmeritev in predlogov, žal pa tudi kar nekaj takih, ki niso niti v pravem soglasju z naslovom niti z nekaterimi njegovimi temeljnimi usmeritvami.

Dobro je, da gre za medresorski dokument, ki nalaga delo in odgovornost vsem vladnim resorjem in tako v primeru sprejetja dokumenta lahko upamo, da se bo celotna vlada vsaj malo trudila, da bi ga tudi uresničila.

Nekaj poudarkov

Predlog resolucije predlaga **nekaj dobrih temeljnih usmeritev** družinske politike, kot so:

- Da bo država skozi družinsko politiko spoštovala avtonomijo družine.
- Da je temeljna naloga države je, da ustvarja primerne pogoje za doseganje visoke ravni kakovosti življenja družin ... ter pripravlja spodbudno okolje za odločanje za družino.
- Da želi država spodbuditi pozitiven odnos delodajalcev do izrabe očetovskega in starševskega dopusta,
- Da naj bi ustvarjali pogoje za lažje usklajevanje poklicnega in družinskega življenja,
- Izboljšanje materialnega položaja družin ob rojstvu otroka,
- Dodatna skrb za velike družine in družine z otrokom/otroki, ki potrebujejo posebno nego in varstvo.
- Namen različnih pravic je predvsem poskrbeti, da se družinam zaradi rojstva otroka ne poslabša materialni položaj.
- Univerzalnost družinske politike in ločevanje družinske politike od socialnega varstva.

Žal pa v nekaterih konkretnih predlogih (tudi v že pripravljenem predlogu novele ZSDP) predlaga ravno nasprotno od spoštovanja avtonomije družine in naklonjenosti vsem družinam. Starši smo različni in vsaka družina ima svoj slog življenja, zato si vsem družinam prijazno ali naklonjeno družbo predstavljamo kot družbo, ki podpira družine v različnih življenjskih slogih in jim pri ukrepih družinske politike daje čim več svobode in izbire. Predlagatelji resolucije in novele ZSDP pa predlagajo zmanjševanje izbire in uniformno usmerjanje družin s podporo točno določenih storitev in dobrin.

Premalo konkretnega najdemo glede povečane skrbi za velike družine, za izboljšanje možnosti za usklajevanje poklicnega in družinskega življenja, izboljšanje stanovanjskih možnosti mladih in še posebej mladih družin. Pogrešamo predloge za izboljšanje štipendiranja in čim bolj enakih možnostih izobraževanja za vse.

Prikazi stanja in učinkov bližnje zgodovine

Predlog resolucije v podrobnem prikazu stanja in učinkov bližnje zgodovine na posameznih področjih veliko omenja in kritizira ZUJF kot največji škodljiv ukrep na področju družinske politike v zadnjih letih. Pri tem pa je besedilo selektivno in enostransko, saj izpušča še druge podobno negativne posege na področje družinske politike. Tako niti z besedo v tem smislu ne omeni Svetlikove ti. »Nove socialne politike«, ki je začela veljati nekaj mesecev pred ZUJF in je merjeno v masi sredstev v proračune mnogih družin zarezala celo bolj kot kasneje ZUJF.

Zakon o uveljavljanju pravic iz javnih sredstev je:

- Ukinil otroški dodatek za polnoletne otroke in ga le delno nadomestil z državno štipendijo. Tako so študenti, ki so presegali dokaj nizek cenzus za državno štipendijo ob izgubi otroškega dodatka ostali brez vsakršne državne podpore, pa tudi mnogi, ki so ohranili štipendijo, so dobili manj, kot prej v obliki otroškega dodatka in štipendije skupaj.
- Ukinil državne štipendije za mladoletne dijake. To je bilo kasneje deloma popravljeno.
- Uvedel vrstni red prejemkov, zaradi katerega lahko študent ali dijak ostane brez štipendije zaradi otroškega dodatka za mlajše otroke v družini. Ta diskriminacija kljub rednim

opozorilom (tudi s strani IRSSV) pristojni ministrici velja še danes.

- Uvedel upoštevanje premoženja v obliki fiktivnih dohodkov.
- Udaril predvsem po družinah z nižjimi dohodki in velikih družinah, kar je gotovo tudi eden izmed razlogov, da se je v krizi stopnja tveganja revščine otrok ravno v Sloveniji povečala bolj kot v drugih evropskih državah.

Predlog resolucije ob vsej upravičeni kritiki ZUJF (s tem zakonom je Slovenija med vsemi državami EU najostreje zarezala v ukrepe družinske politike) nikjer jasno ne pove, da so bili ti ukrepi v ZUJF opredeljeni kot začasni, in da so bili že leta 2014 izpolnjeni pogoji, da bi z letom 2016 prav vsi prenehali veljati, večina pa še danes velja zaradi zakonov, ki jih je prav za podaljšanje veljavnosti teh ukrepov sprejela aktualna vlada.

Če naj resolucija predstavlja stanje in razloge zanj, naj to naredi celovito in verodostojno.

Glede na to, da smo konec avgusta izvedeli, da so izpolnjeni tudi visoki pogoji te vlade za ukinitev veljavnih omejitev ukrepov družinske politike, se lahko kar nekaj besedila o nujnem vračanju na stanje pred ZUJF izpusti in se raje posveti bolj inovativnim rešitvam in odgovorom na izzive vedno globlje demografske krize oziroma ukrepom, ki bi lahko prispevali k bolj spodbudnemu okolju za odločanje za družino in za kakšnega otroka več.

Usmeritev od transferjev k podpornim storitvam

Ministrica za družino je na prvi seji Sveta RS za otroke in družine kot eno izmed usmeritev resolucije in prihodnje družinske politike predstavila obrat od transferjev družinam v smer zagotavljanja več podpornih storitev družinam. To se morda lepo sliši, vendar v obliki sofinanciranja od države izbranih programov in ponudb ter hkrati nepodpore drugim programom in ponudbam za zakonce in družine pomeni zmanjševanje avtonomnosti družin in njihovo usmerjanje v uporabo ponudb in storitev od države izbranih izvajalcev, kar odpira možnosti klientelizma in korupcije ter neoptimalne izrabe sredstev, saj ni nujno, da bi država podprla ravno tiste ponudbe in storitve, ki jih starši prepoznavajo kot zanje najboljše. Če bi že hoteli delovati v predlagani smeri, bi to moralo biti v obliki nekakšnih vavčerjev za različna področja, ki bi jih družine lahko izkoristile ali pa ne (enako kot lahko izkoristijo subvencionirano od države izbrano storitev ali pa ne, le da se v tem primeru storitve subvencionirajo ne glede na to, ali jih starši želijo ali ne), tako da bi družine same avtonomno izbirale katera ponudba ali storitev je zanje najboljša.

Če naj bi bila resolucija namenjena temu, da bo Slovenija vsem družinam prijazna družba, bi morala malo manj favorizirati samo določene oblike vse prisotne in vsevedne države in staršem dopuščati več izbire in jih v tem podpirati.

Jezikovne in verjetno tudi ideološke težave resolucije

Čeprav vsak otrok ve, da moški in ženske nismo enaki, ve pa tudi, da moramo imeti enake možnosti in biti

enakopravni, da smo enakovredni, predlagatelji resolucije tega očitno ne razumejo, saj na mnogih mestih uporabljajo besedne zveze kot »enakost spolov«, »enakost med moškimi in ženskami« itd.

Angleška beseda »equality« ne pomeni samo enakosti, ampak tudi enakopravnost (Cambridge slovar daje celo prednost tej razlagi), zato je v slovenščini uporaba pojmov, kot so »enakost spolov« in podobno nepravilna in nesmiselna, saj imamo za prevod angleške »equality« na voljo veliko boljše slovenske besede s pravimi pomeni. Da se otroci ne bodo smejali tem nesmiselnim stavkom, predlagamo, da se v resoluciji raje govori o enakopravnosti in enakovrednosti moških in žensk ter o enakih možnostih žensk in moških.

Nekateri deli besedila malo dišijo po ideoloških floskulah, ki lahko pomenijo tudi kaj takega, s čimer se večina populacije ne bi strinjala. Včasih pa je obravnava nekoliko stereotipna, kar ne povečuje verodostojnosti dokumenta. Nekatere zadeve so zapisane nekoliko nedorečeno, tako da dopuščajo različne interpretacije.

Univerzalnost in spodbudno okolje za kakšnega otroka več

Predlog resolucije na veliko področjih predvideva, da bi pravice nekoč v prihodnosti postale univerzalne, kar je kot usmeritev dobro. Glede na to, da je utopično pričakovati, da bi v državi že kmalu lahko temu področju namenili tako velika sredstva, in glede na to, da bomo ob trenutnem klavrnem demografskem stanju za preživetje naših družbenih sistemov nujno potrebovali nekaj več otrok oziroma več družin, ki si bodo upale imeti še vsaj tretjega in morda četrtega otroka, predlagamo inovativno postopno uvajanje univerzalnosti. Predlagamo, da bi pri večini ukrepov, za katere se predvideva univerzalnost, le-to v prvem koraku in čim prej uvedli za vse tretje in nadaljnje otroke v družini in tako starše pri teh otrocih razbremenili nekaterih večjih stroškov kot so vrtec, šolska prehrana, šolanje na višjih ravneh brez štipendije, ...

Kot eno temeljnih usmeritev resolucije predlagamo usmeritev, da bi bili otroci od tretjega v družini naprej v smislu osnovnih družbenih storitev (še posebej vzgoja in izobraževanje) za starše čim bolj brez stroškov. To pomeni, da bi bil vrtec za tretjega in nadaljnje otroke v družini brezplačen ne glede na to, kdaj jih imajo in koliko jih istočasno obiskuje vrtec. Enako velja za šolsko prehrano, strošek bivanja v dijaškem domu. Za družine s tremi in več otroki bi moral biti dostop do državne štipendije olajšan z ugodnejšim cenzusom, tako da bi bili do nje upravičeni tudi dijaki in študenti z dohodkom do 99% povprečne plače na družinskega člana (Tako bi vsaj za te družine uresničili trditev ob sprejemu ZUPJS, da za polnoletne otroke otroški dodatek nadomešča državna štipendija).

Glede na to, da je družin s tremi n več otroki manj kot 10% družin, to ne bi smel biti pretiran izdatek, država pa bi pokazala, da ceni nadpovprečen demografski prispevek teh družin in jih zato temu primerno podpira.

Staršem še manj možnosti izbire kot doslej

Čeprav bi na podlagi naslova pričakovali, da bo predlog resolucije zaradi različnosti družin prinesel zanje čim

več možnosti izbire, a žal ni tako in prinaša kar nekaj predlogov, ki možnost izbire zmanjšujejo. Vse te predloge odločno zavračamo.

Neizdelane rešitve za stanovanjsko osamosvajanje mladih in mladih družin

Resolucija sicer predvideva nekaj ukrepov za lažje osamosvajanje mladih in mladih družin na stanovanjskem področju, a ocenjujemo, da niso zadostni in bi bili za mnoge mlade na začetku poklicne poti še vedno nedosegljivi.

Zato predlagamo dodaten ukrep, ki bi ga lahko poimenovali »prvo stanovanje« kot izrazito neprofitna najemna stanovanja za mlade in mlade družin za določen čas, ki bi bil odvisen od števila otrok v družini...

Izboljšati skrb za študentske družine

V predlogu resolucije pogrešamo več pozornosti do študentskih družin. Mnogi starši namreč ugotavljajo, da so med študijem imeli mnogo boljše pogoje za očetovstvo in materinstvo kot v prvih letih zaposlitve. Zato bi morali razmisliti tudi o boljši podpori študentskim družinam tako v smislu stanovanjskih možnosti zanje kot v smislu boljšega dohodkovnega položaja (ta del je v predlogu resolucije nekoliko pokrit pri predlogih za izboljšanje starševskega dodatka, a žal ne dovolj).

Ločevanje družinske politike in socialnega varstva

Podpiramo predlagano načelo ločevanja družinske politike in socialnega varstva, ki se v predlogu resolucije kaže predvsem v nekaterih predlogih univerzalnih ukrepov za vse otroke. Pogrešamo pa predloge za ločitev na zakonodajni ravni, kot bi bila npr. odprava vrstnega reda pravic iz javnih sredstev pri državni štipendiji, zaradi katerega otroški dodatek za mlajše otroke vpliva na dodelitev in odmero štipendije za starejše otroke v družini.

Podrobnejši komentarji k posameznim delom besedila

Naslov: "Vsem družinam prijazna družba"

Kako naj razumemo ta naslov? Če to pomeni obrat družinske politike k večji univerzalnosti (se pravi usmeritev k vsem družinam ne glede na dohodek) in k večjemu razumevanju in podpori večjim družinam, kar bi bilo v demografskem smislu nujno, je naslov sprejemljiv, sicer pa bi veliko raje predlagali splošnejši naslov "Slovenija družinam naklonjena družba".

Naklonjenost pomeni podporo tudi v dejanjih, prijaznost pa je lahko tudi samo navidezna.

Sicer pa se pojavi vprašanje, katerim družinam naj Slovenija v tem trenutku ne bi bila prijazna, saj to v samem predlogu resolucije nikjer ni pojasnjeno, čeprav bi bilo dobro, da bi bilo in bi tako naslov postal bolj jasen. Brez tega pa lahko daje tudi prostor za različne za večino neželene ideološke interpretacije, s katerimi smo se v preteklosti že srečevali.

Uvod

Trditev, da »je bila Slovenija edina država na svetu, ki je imela 100 % nadomestilo plače.«, ne drži. Hvalisanje z delnimi resnicami nikoli ni verodostojno in pomembno zmanjšuje verodostojnost celotnega dokumenta. V Estoniji starševski dopust lahko traja do 435 dni in zagotavlja možnost vrnitve na isto delovno mesto do tri leta po porodu. 100% nadomestilo v času materinskega dopusta imajo še nekatere druge države.

Ne držijo tudi trditve glede omejitve nadomestil. Nadomestilo med starševskim dopustom je bilo v SLO že pred ZUJF omejeno na manj kot 2,5 kratnik povprečne plače (ZUTGP). Več držav, ki imajo sicer manj kot 100% nadomestilo, ima možnost izbire precej daljšega starševskega dopusta.

1.1 Namen in cilji

Družina ne predstavlja samo »primarni socialni prostor za (emocionalni in socialni) razvoj otrok«, ampak tudi »primarni socialni prostor za spočetje, rojstvo ter emocionalni in socialni razvoj otrok«.

Med temeljnimi cilji manjka: Zagotavljanje primerljive življenjske ravni družine ne glede na število otrok, oziroma preprečevanje zniževanja blaginje in kakovosti življenja družine, kadar se ta poveča za novega člana.

1.2 Temeljna načela

Tu najdemo kar nekaj floskul brez pravega pomena ali brez jasne razlage (npr. »integralni in vključujoč pristop«, »usmerjenost k vsem družinam« brez pojasnila, h katerim družinam danes družinska politika ni usmerjena, »pozitivna diskriminacija najbolj ranljivih družin« brez pojasnila, katere družine naj bi to bile). Brez jasne razlage se lahko poraja občutek, da gre morda za prikrit poskus vključevanj različnih ideološko spornih pristopov.

2. Stanje na področju družinske problematike, demografska slika ter smernice oziroma ključne usmeritve razvoja družinske politike

Zanimivi statistični podatki. Zanimivo bi bilo izvedeti še, kakšna je statistika med družinami, ki prejemajo otroški dodatek? Kakšen je tam delež enostarševskih družin?

Kako se je ta delež spremenil od uvedbe domneve o zunajzakonski skupnosti, če obstaja skupen otrok? Na kakšen način v primeru privzetega obstoja zunajzakonske skupnosti (skupen otrok) družina dokazuje, da te skupnosti ni? Kako CSD ali ministrstvo to preverja? Koliko je takih primerov?

Glede na zelo velik delež družin s samo enim otrokom bo v prihodnosti potrebno razmišljati že o posebnih spodbudah za drugega otroka, zagotovo pa so ob dejstvu, da so družine s tremi in več otroki redke, z demografskega vidika **takoj nujne večje spodbude vsaj za tretjega in nadaljnje otroke**.

Na 13. strani lahko preberemo: »v letu 2016 se je višina otroškega dodatka z uveljavitvijo Zakona o spremembi in dopolnitvi zakona o uveljavljanju pravic iz javnih sredstev (ZUPJS-E) za vse otroke (približno 97.000 otrok) v 5. in 6. dohodkovnem razredu vrnila na raven pred uveljavitvijo ZUJF;«

Ta stavek je čisto zavajanje in neresnica. Omenjeni zakon ni ničesar vrnil na pred krizno raven, saj bi se vse omejitve ZUJF odpravile brez njega. Ta zakon je predvsem ohranil večino omejitev ZUJF.

Na 14. strani lahko preberemo: »Slovenija zasleduje strateški cilj EU 2020, ki predvideva v vrtec vključenih 95 % otrok drugega starostnega obdobja.«

Morda pa ta cilj sploh ni tako pomemben in **je bolj pomembno, da damo staršem več možnosti izbire** in jim to izbiro v praksi omogočimo, s tem da jo podpremo na enak način, kot se sedaj podpira ena sama privilegirana oblika vzgoje in varstva v javnih vrtcih.

Predlagamo, da se **uvede subvencija za** starše, ki sami poskrbijo za vzgojo in varstvo svojih otrok prvega starostnega obdobja vsaj v višini najnižje subvencije pri plačilu vrtca, ki jo dobijo ne glede na dohodek prav vsi starši otrok v vrtcih. Taka ureditev bi bila za javne blagajne cenejša, saj se je v nekaterih občinah, ki so to naredile, pokazalo, da se s tem opazno zmanjša potreba po prostoru v vrtcih, subvencija pa je tudi znatno nižja od povprečne subvencije za vključenost v vrtec.

S tem bi tudi zmanjšali obolevnost otrok v tem starostnem obdobju. Pediatri staršem v prvem letu otrokovega življenja močno priporočajo, da v tem času starejšega otroka vzamejo iz vrtca in zanj skrbijo doma, da bi bila oba bolj zdrava, a starši k temu niso prav nič spodbujeni, zato se za to odločajo le bolj ozaveščeni.

Na 17. strani lahko preberemo: »Raziskave kažejo, da imajo najbolj razvite družbe inkluzivno oziroma neizključevalno družinsko politiko, kar pomeni, da spoštuje oziroma naslavlja potrebe vseh tipov in oblik družin ter se osredotoča na pozitivne, družinam prijazne ukrepe oziroma ukrepe za lažje usklajevanje družinskega in poklicnega življenja.« Ta navedba potrjuje naš komentar k besedilu o vključevanju v vrtce na strani 14 in državi priporoča, da bi v tem kontekstu bolj spoštovala različne izbire staršev glede življenjskega sloga in zaposlitvenega statusa, ter bolj podprla in ovrednotila tudi izbiro, ko je eden izmed staršev (najpogosteje mama) doma, saj imajo ravno take družine običajno tudi več otrok in tako vsaj malo blažijo katastrofalno demografsko vedenje večine. Danes so te družine v mnogočem prikrajšane (domače varstvo otrok ni cenjeno (ne dobijo nobene subvencije kot otroci v vrtcu), manj bolniških nadomestil za nego ni cenjeno, pokojninsko zavarovanje jim ni naklonjeno, ...).

Temeljna prednostna področja ter cilji, ukrepi in kazalniki

- Med cilji pogrešamo: dvig življenjske ravni družin, preprečevanje zniževanja blaginje družin ob prihodu novega člana, itd. Kje so sploh kakšni cilji, ki se nanašajo na družine?
- Med kazalniki pogrešamo kakšne kazalniki, ki bi merili učinkovitost izvedenega:
 - Zadovoljstvo staršev z ukrepi.
 - Število rojenih otrok.
 - Stopnja rodnosti.
 - Delež družin z več otroki.
 - Stopnja uporabe različnih ukrepov (še posebej za usklajevanje poklicnega in družinskega življenja).
 - Število splavov.

 Stopnja univerzalnosti ukrepov.

3.1 Programi v podporo družini

Na strani 19 najdemo: »Programi so prednostno namenjeni otrokom, mladostnikom ter njihovim družinam«

Kje pa so programi, ki so prednostno namenjeni staršem in staršem kot zakoncem, saj je znano, da je ravno živ, ljubeč in zvest odnos med očetom in mamo daleč najboljše okolje za zdrav razvoj otrok?

V oceni stanja na strani 20 predlagatelji resolucije ugotavljajo: »... in je to področje razmeroma dobro urejeno.«

Koliko je to res dobro urejeno, naj povedo očetje in mame, ki se soočajo s težavami pri uveljavljanju pravic na tem področju.

Nadalje lahko beremo: »mreža programov se postopno zgoščuje in lahko govorimo o razmeroma visoki stopnji pokritosti Slovenije s tovrstnimi programi.«

Zanima nas, kolikšna je udeležba staršev in otrok v teh programih? Koliko je zaposlenih in koliko je uporabnikov programov? Kako so zadovoljni z njimi?

Med ukrepi na strani 21 je navedeno: »ohranjati brezplačen dostop uporabnikov do programov v podporo družini«

Kako je to izvedljivo ob le 80% sofinanciranju države? Zakaj država ne sofinancira tudi programov z delno participacijo uporabnikov oziroma udeležencev?

3.2 Starševsko varstvo in družinski prejemki

Na strani 23 v prvem odstavku med nameni manjka ohranjanje življenjske ravni družin ob prihodu novega člana.

Davčne olajšave za vzdrževane družinske člane so opredeljene v Zakonu o dohodnini in ne v ZSDP.

Pri ciljih:

- Pohvalimo predlog: »izvzem pravic in prejemkov iz morebitnih varčevalnih ukrepov«
- Manjka: Poenostavitev postopkov in zmanjšanje števila postopkov, saj so nekateri povsem nepotrebni in pomenijo nesmiselno birokratsko breme staršev in CSD.
- 3.2.1 Pravice in prejemki, vezani na rojstvo in zgodnja leta otrokovega življenja

V poglavju **pogrešamo usmeritev k večji** možnosti izbire za starše. Tako bi tudi ob tako opevani ureditvi starševskega dopusta lahko pogledali v še v kakšno drugo državo in tudi na tem področju dali staršem več izbire. Kar nekaj držav daje staršem na izbiro krajše obdobje odsotnosti z dela z višjim ali polnim nadomestilom plače ali pa daljše obdobje odsotnosti z dela z nižjim nadomestilom.

Podpiramo predlog o možni izrabi starševskega dopusta v obliki delne odsotnosti z dela v daljšem obdobju.

Ko je govora o nerazumevanju delodajalcev, naj dodamo, da je po izkušnjah mnogih staršev to glavni razlog za manjšo izrabo nekaterih pravic in tu je naloga države, da delodajalce ozavešča, še bolje pa, da jim dodeli kakšno spodbudo (npr. kakšno davčno olajšavo, če pri njih zaposleni očetje ob rojstvu otroka izkoristijo svoje pravice).

Podpiramo **podaljšanje očetovskega dopusta** ob rojstvu dveh ali več otrok in **dvig prispevkov ob delu s skrajšanim delovnim časom** zaradi starševstva, enako pa mora veljati tudi **za enega izmed staršev, ki zaradi skrbi za štiri ali več otrok zapusti trg dela**. Ker dvig na odmero od povprečne plače verjetno ne bo možen zelo kmalu, predlagamo, da se ti prispevki takoj začnejo odmerjati vsaj od dejanske minimalne plače in ne od neke administrativno določene bistveno nižje minimalne plače, kot to velja sedaj.

Predlagana ureditev pomoči ob rojstvu otroka je neprimerna in v nasprotju z načelom spoštovanja avtonomije družine. Namesto zaupanja staršem (ki ga nekateri morda res zlorabijo, a take redke primere se da reševati drugače), bi uvedli obilico nepotrebnega birokratskega dela in še možnost za kakšno korupcijo. Povsem nepotreben predlog.

Namesto tega bi lahko naredili to pomoč progresivno, tako da bi se za drugega otroka povečala na 130% osnovnega zneska, za tretjega otroka na 200% osnovnega zneska, za četrtega in nadaljnje otroke pa bi znašala 300% osnovnega zneska. Progresija bi se lahko tudi nadaljevala.

Podpiramo dvig starševskega dodatka,

vendar opozarjamo, da je 297,53 EUR manj kot 55% neto minimalne plače, kar je določal ZUJF, a je ministrstvo to določbo ves čas veljavnosti ZUJF napačno interpretiralo in starševski dodatek odmerjalo v višini nekaj več kot 250 EUR namesto nekaj več kot 300EUR in ta znesek leta 2014 tudi zapisalo v nov ZSDP. Prevara mamic, ki niso zaposlene, se še kar nadaljuje.

Med kazalnike dodati še:

- Višina nadomestil.
- Število družin z več otroki.
- Zadovoljstvo staršev z ukrepi za lažje usklajevanje poklicnega in družinskega življenja.

- Anketa med starši glede težav pri delodajalcih pri uveljavljanju teh pravic.
- 3.2.2 Pravice in prejemki, vezani na preživljanje, skrb in varstvo otrok

Med cilji manjka preprečevanje zniževanja življenjske ravni družine ob prihodu novega/novih članov oziroma otrok, ki je sicer kot namen ukrepov družinske politike omenjen v odstavku o stanju, vendar pa ta namen zagotovo še ni dosežen v zadovoljivi meri, zato ga je treba uvrstiti tudi med cilje.

Podpiramo in pohvalimo drugi cilj: »**posebna skrb za velike družine** (staršem olajšati skrb za otroke in zagotoviti, da zaradi velike družine ne bodo prikrajšani), vendar pogrešamo več konkretnih predlogov za doseganje tega cilja. V pričujočem dokumentu jih ponujamo kar nekaj.

Otroški dodatek: Všeč nam je predlagana usmeritev k večji univerzalnosti ureditve otroškega dodatka in širitev pravice tudi nad obstoječi osmi dohodkovni razred. Ker pa pri družinah z višjimi dohodki vlogo otroškega dodatka precej dobro pokrijejo davčne olajšave, in je tako na tem področju zagotovljena dokaj dobra univerzalnost, ocenjujemo, da bolj kot širitev otroškega dodatka v še višje dohodkovne razrede potrebujemo večja vlaganja v spodbude za tretjega in nadaljnje otroke v družinah, zato predlagamo, da bi sredstva, ki bi jih potrebovali za ta predlog, raje čim prej usmerili tja.

Istočasno pa odločno zavračamo predlog, da bi »del zneska otroškega dodatka starši, ki presegajo 53 % neto povprečne plače na osebo (kar je cenzus za brezplačno malico) lahko prejeli v obliki subvencionirane malice za otroke v osnovni šoli ali v obliki plačila šole v naravi in drugih obveznih taborov.«

Ta predlog je v nasprotju s temeljno usmeritvijo o spoštovanju avtonomije družine, izraža nezaupanje do staršev in zmanjševanje možnosti njihove izbire ter bi prinesel birokratizacijo in zapletanje ukrepa, ki bi moral v taki obliki upoštevati tudi kopico izjem, ko ima otrok npr, posebno dieto ali kakšen drug razlog da ne želi jesti šolske malice ali mu starši želijo po svojih merilih pripravljati malico doma.

Dodatek za veliko družino

V smislu večkrat omenjene povečane skrbi za velike družine in povečanja priznanja tem družinam, bi lahko ravno dodatek za velike družine bil progresiven tudi pri večjem številu otrok. Glede na to, da bi za izboljšanje demografske slike nujno potrebovali več družin z vsaj tremi in več otroki, bi lahko dodatek od 4 naprej še vedno naraščal za npr 50 EUR za vsakega dodatnega otroka. Predlagana ureditev brezplačnega dostopa na kulturne in druge prireditve in ustanove za velike družine se lepo sliši, a je zasnovana zelo nerodno in neuporabno, ko pravico omejuje na udeležbo celotne družine. Nesmiselna omejitev, ki kaže na veliko nepoznavanje življenja v velikih družinah. Zaradi večjega števila otrok so razlike v starosti velike in se le redko cela družina udeleži istega dogodka. Družinam dajmo možnosti izbire brez nepotrebnih birokratskih ovir in zahtev. Kulturo je treba približati vsem družinam. Država naj da možnost cenejšega ali celo brezplačnega dostopa na prireditve in v ustanove po izbiri družin v odvisnosti od števila otrok, ki se udeležijo dogodka (npr. da polno ceno plačajo le za prvega otroka, za vsakega nadaljnjega pa vedno manj, od tretjega ali četrtega udeleženega otroka iz iste družine naprej pa naj bo povsem brezplačno. Pravica naj bo odvisna od števila prisotnih otrok in ne od tega, ali so prišli vsi iz družine. Izvedena naj bo v obliki voucherja in ne v obliki vnaprejšnjega sofinanciranja izbranih prireditev in ustanov.

Subvencija vinjet

Pozdravljamo. Približno tako ureditev smo v Družinski pobudi predlagali že ob pripravi novele ZSDP v letu 2014, a ministrstvo ni imelo posluha za to.

Med ukrepi zavračamo spremembo otroškega dodatka v namensko obliko.

Podpiramo zvišanje zneska delnega plačila za izgubljeni dohodek na znesek minimalne plače po predpisu, ki ureja minimalno plačo, pri čemer mora enako veljati tudi za prispevke pri delu s skrajšanim delovnim časom zaradi starševstva in pri prispevkih za enega izmed staršev štirih otrok, ki zapusti trg dela.

Podpiramo **zvišanje starostne meje izrabe pravice do plačila prispevkov** v primeru štirih ali več otrok na 10 let starosti najmlajšega otroka, kar smo že imeli, a smo kljub nasprotovanju družinskih organizacij z novelo ZSDP v letu 2014 izgubili. Lepo, da starši, ki jih to zadeva, morda dobila nazaj. Izvedba mora biti enaka, kot je bila v prvih letih, ko je pravica dejansko trajala do 10, leta starosti najmlajšega otroka.

3.3 Nadomestno varstvo otrok

3.3.1 Rejništvo

Poglavja o rejništvu v tem komentarju nismo uspeli podrobneje obdelati, zato odsotnost komentarjev na to poglavje ne pomeni niti da ga v predlagani obliki podpiramo, niti da mu nasprotujemo.

- 3.3.2 Posvojitev

Podpiramo namen in usmeritev, da » sodobnih družbah posvojitev v središče postavlja otroka, ki potrebuje primerno družinsko okolje, in je usmerjena predvsem v zagotavljanje varstva in vzgoje otroka.« in cilj »zagotoviti otrokom, ki potrebujejo posvojitev, čim bolj primerne nadomestne starše,«, vendar opozarjamo, da je še danes mnogo primerov, pri katerih pristojne službe (predvsem CSD) ne delujejo v tem duhu.

Podrobneje tudi tega poglavja žal nismo uspeli obdelati.

- 3.4 Socialno varstvo družine

Podrobneje tudi tega poglavja žal nismo uspeli obdelati.

3.5. Trg dela in zaposlovanje

V splošnem podpiramo usmeritev tega poglavja, ki žal kljub obsežnemu besedilu podaja razmeroma malo konkretnih rešitev, občasno pa zdrsne v področje stereotipnega in ideološkega.

Med predlaganimi ukrepi **pogrešamo splošno izboljšanje poslovnega okolja z nižjo obdavčitvijo dela**, ki bo bolj privlačno za investicije in razvoj gospodarstva v Sloveniji.

Za lažje usklajevanje družinskega in poklicnega življenja bi potrebovali tudi **spodbude delodajalcem** za lažje uveljavljanje pravice do dela s skrajšanim delovnim časom zaradi starševstva. Država bi lahko zagotovila subvencioniranje dela stroškov delodajalca, ki so neodvisni od obsega delovne obveznosti (prevoz, malica, regres), da taki delavci ne bi bili za delodajalce sorazmerno dražji kot tisti, ki delajo s polnim delovnim časom.

Pri zaposlenih starših bi lahko bili **prispevki** delodajalca za pokojninsko zavarovanje odvisni od števila otrok, za katere zaposleni skrbi. Tako bi bili starši z več otroki za delodajalca cenejši.

Med kazalniki manjka število staršev, ki delajo s skrajšanim delovnim časom.

3.6.1 Porazdelitev skrbstvenih in družinskih obveznosti med ženske in moške

Namesto da bi se ukvarjali s stereotipi in slabšalnimi pomeni tradicionalnega, bi morali več energije posvetiti vzgoji in spodbujanju ljubečih in spoštljivih partnerskih odnosov med zakonci, saj v takem ozračju oba iščeta poti, kako se medsebojno podpirati in drug drugemu lajšati bremena.

Sicer pa zelo podpiramo spodbujanje bolj dejavnega očetovstva in večje prisotnosti očetov v družinah.

3.7.1 Zdravstveno varstvo odraslih
Kako je lahko zagotavljanje dostopnosti do brezplačne kontracepcije, splava in oploditve z biomedicinsko pomočjo navedeno prednostno pred storitvami v času nosečnosti, poroda in poporodnega obdobja ter zgodnjim odkrivanjem bolezni reproduktivnega sistema? Kaj je tisto, kar je prednostno in v službi družine in življenja?

Kako se sploh odvzem življenja nerojenemu otroku lahko imenuje »reproduktivna« pravica, ko gre vendar ravno za nasprotno od reproduktivnosti?

Podpiramo **razširitev možnosti za koriščenje dopusta za nego družinskega člana** (npr. otroka bi lahko negovali tudi stari starši, tete, strici; dopust za nego bi pripadal tudi za nego staršev). Upoštevati je treba tudi krušne starše v reorganiziranih družinah (nove partnerje očeta ali mame otroka), četudi otroka niso posvojili.

Manjka pravica staršev do **bolniškega dopusta za nego v primeru ko je predšolski otrok hospitaliziran** in je za potek in učinkovitost zdravljenja zelo koristno, da je z njim tudi oče ali mama ali kdo drug bližnji.

Potrebno je **spremeniti ureditev, po kateri morajo pediatri na primarni ravni ugotavljati statuse in okoliščine**, ki določajo, ali in do koliko bolniške odsotnosti za nego je upravičen kateri zmed staršev. Naloga in pristojnost zdravnika naj bo ugotovitev, ali otrok potrebuje nego staršev ali druge odrasle osebe, pravico do bolniške odsotnosti pa naj v nejasnih primerih upravičenci urejajo neposredno z ZZZS (pooblaščenec za ta namen bi lahko bil v vsakem zdravstvenem domu).

3.7.2 Zdravstveno varstvo otrok in mladostnic oziroma mladostnikov

Podpiramo zdravstveno zavarovanje otrok neodvisno od zavarovanje staršev, saj zavarovanje otrok naj ne bi bil odvisno od zaposlitve staršev in plačilne discipline njihovih delodajalcev.

Med ukrepi ocenjujemo »uvedbo celovitega in interdisciplinarnega programa vzgoje za zdravo spolnost za mladostnike in mladostnice« kot bistveno premalo opredeljen, da bi ga lahko enoumno podprli ali pa ne.

Gre za zelo zahtevno področje, kjer bo treba zadevo narediti na moder in premišljen način, da ne bo prinesel več škode kot koristi. Zato bi bilo treba to alinejo nekoliko bolje opredeliti, da bi vsaj vedeli, kaj naj bi predstavljal pojem "zdrava spolnost". Nekatere delavnice na to temo v zadnjih letih v šolah nikakor niso bile koristne in bi bilo bolje, če jih ne bi bilo.

Pozitiven rezultat je lahko samo program, ki bo imel široko podporo med starši vseh nazorov in v širši družbi. Še bolj kot spolno vzgojo (ki je nikakor vnaprej ne zavračamo) bi bilo treba v šolski program vključiti vsebine za pripravo na osrečujoče zakonsko in družinsko življenje kot so osnovne značilnosti, zakonitosti in razlike med moško in žensko naravo (ja, nismo enaki), osnovne zakonitosti dobrih medsebojnih odnosov, komunikacije, ...

Med ukrepi **manjka pravica staršev do bolniškega dopusta za nego, v primeru ko je predšolski otrok hospitaliziran** in je za potek in učinkovitost zdravljenja zelo koristno, da je z njim tudi eden izmed staršev ali drug bližnji.

Med ukrepi **manjka tudi okrepitev mreže primarnih pediatrov**, saj se nabor storitev in ukrepov, ki jih morajo izvajati, stalno povečuje, kar pomeni njihovo vedno večjo preobremenjenost in nezmožnost kakovostno opravljati svoje delo.

3.8 Vzgoja, varstvo in izobraževanje
 3.8.1 Predšolska vzgoja

Med cilji **manjka več možnosti izbire staršev**, ki bile enako dobro sprejete in podprte kakor javni vrtci.

Kot obliko v predlogu resolucije večkrat omenjene večje podpore velikim družinam bi lahko uvedli **subvencijo za vzgojo in varstvo za otroke, za katere za to poskrbijo starši sami**. Taki starši so danes v tem smislu zapostavljeni, saj najnižjo subvencijo za otroka v vrtcu dobijo tudi starši z najvišjimi dohodki, starši, ki sami poskrbijo za vzgojo in varstvo, pa za ta namen ne dobijo prav nič.

Predlagamo, da bi bili starši, ki otrok v prvem starostnem obdobju ne vključijo v vrtec, ampak sami poskrbijo za drugo obliko vzgoje in varstva, ki se jim zdi najprimernejša, upravičeni vsaj do najnižje subvencije za plačilo programa prve starostne skupine v javnem vrtcu v njihovi občini (za poenostavitev bi jo lahko določili tudi pavšalno na podlagi povprečne cene programov za celotno državo).

Če je za določene skupine otrok (npr. priseljenci zaradi jezika in kulture) bolje, da se zanje zaradi integracije in boljše priprave na šolo zahteva vključenost v vrtec, se to lahko naredi v okviru predpisov, ki se nanašajo nanje, nikakor pa ni potrebno na splošno favorizirati samo ene oblike vzgoje in varstva otrok.

Prav tako je potrebno zagotoviti enako 100% financiranje programov v zasebnih vrtcih kakor v javnih.

Oba ukrepa sta za javna sredstva cenejša kot neprestano povečevanje števila oddelkov in mest v javnih vrtcih, staršem pa dajeta možnost avtonomne izbire, pri kateri ne bodo ob določeni izbiri prikrajšani v primerjavi z drugo.

Načeloma podpiramo predlagano **širitev možnosti zniževanja plačila vrtca pri več otrocih**, vendar se nam zdi predlagana rešitev toga in pomanjkljiva. Predlagamo, da bi ukrep nadgradili v smeri večjega spodbujanja oziroma lažje odločitve za kakšnega otroka več. Otroci od tretjega v družini naprej bi morali biti v smislu osnovnih družbenih storitev (še posebej vzgoja in izobraževanje) za starše čim bolj brez stroškov.

Tako bi lahko za hitrejše odločanje za otroke ponovno uvedli 100% subvencijo za drugega otroka, ki je istočasno v vrtcu, poleg tega pa **100% subvencijo za vse otroke od tretjega naprej, ne glede na to, kdaj jih starši imajo.** Kot država in družba se lahko še posebej veselimo vsake družine, ki ima pogum in veselje do življenja, da sprejme tudi tretjega in še kakšnega otroka, kar je v velikem interesu celotne družbe in države. Zato je prav, da ta tudi prevzame večji del stroškov za te otroke kot samo do ravni enostavne reprodukcije, saj so njihovi starši v smislu stroškov in drugih vlaganj v otroke obremenjeni bolj kot tisti z manj otroki.

Odločno zavračamo ukinitev 20% višjega otroškega dodatka za otroke od četrtega leta naprej, če niso v vrtcu. Ta dodatek je tako majhen, da nikogar ne destimulira pri vpisu v vrtec. Vrtec je za družine z zelo nizkimi dohodki (najmanj izobraženi starši) v resnici poceni in zato niso destimulirani za vključevanje v vrtec. Vrtec je drag za starše od tretjega dohodkovnega razreda naprej (30% povprečne plače na družinskega člana - plačilo 20% cene programa, kar je 70 do 90 EUR mesečno). Ukinitev tega dodatka bi starši doživeli predvsem kot nezaupanje njihovi izbiri.

Vprašanje je, ali je v okoljih, kjer je vključenost nizka, to posledica želje staršev ali premajhnega števila prostih mest ali previsoke cene vrtca. Ali za starostno obdobje od 4. do 6. leta res ni težav dobiti prosto mesto v vrtcu?

Podpiramo razvoj oblik varstva, ki bodo omogočili varstvo otroka od zaključka starševskega dopusta do vstopa otroka v vrtec (če otrok ne dobi mesta v vrtcu).

- 3.8.2 Osnovnošolsko izobraževanje

Cilje: »vzpostaviti šolsko okolje kot okolje, kjer je zagotovljena najvišja stopnja enakosti in nediskriminacije« ter »dvigniti raven znanja na področju človekovih pravic, strpnosti in enakih možnosti.« ocenjujemo kot ideološke floskule brez prave vsebine, za katerimi pa se lahko skriva tudi vsebina, ki nima nobene zveze s tem, kar ljudje običajno razumemo pod temi izrazi in kar ti izvorno pomenijo. Zato pričakujemo, da se jih v nadaljnjem razvoju dokumenta razloži, da se bo do njih dalo opredeljevati, ali pa se jih opusti.

Pogrešamo pa cilj, da bi osnovno šolanje moralo dati otroku osnovne veščine in znanje za normalno življenje tudi v zakonu in družini ter širši družbi.

V oceni stanja, kjer je govora o ti. deprivilegiranih družinah, se predlog resolucije omejuje predvsem na materialni položaj družin, manjka pa pogled v nematerialno stanje teh deprivilegiranih družin. Pogosto ni največji problem materialno stanje, ampak nedelujoče, razpadle družine, čemur se danes sicer moderno reče "pluralnost družinskih oblik", v resnici pa gre za veliko trpljenja, ki je tudi posledica napačnega izobraževanja in vzgoje ter širjenja in spodbujanja za ljudi škodljivih odločitev in vedenjskih vzorcev.

Morda bi morali predvsem več narediti za pomoč ljudem pri vzdrževanju zakonskega odnosa in družinskih odnosov.

Med ukrepi pozdravljamo **zagotavljanje brezplačnih učnih gradiv**, a se ne strinjamo, da se to začne z uvajanjem ravno pri prvošolcih. Zakaj ravno za prvošolce, ki potrebujejo najmanj teh gradiv?

Če naj bi se postopno ukrep širil tudi na ostale razrede, bi bilo medgeneracijsko mnogo **bolj pošteno, da bi ga začeli uvajati v 9. razredu**, saj bi tako bilo ukrepa deležnih največ generacij enakomerno. Tako pa bi bila ena generacija, s katero se je ukrep začel v prvem razredu, privilegirana v primerjavi z vsemi predhodnimi.

Podpiramo predlog vsem učencem zagotoviti kakovostno in zdravo brezplačno malico in/ali kosilo. Ker pa se zavedamo, da bo težko v kratkem času najti dovolj denarja za tak ukrep v celoti, predlagamo, da bi za začetek univerzalen ukrep sprejeli za tretjega in vse nadaljnje otroke v družini. Tako bi zagotovili, da bi starši nosili stroške izobraževanja za prva dva otroka, za tretjega in nadaljnje, ki so demografsko za družbo še posebej pomembni, pa jim teh stroškov ne bi bilo več treba nositi, Tako bi finančno močno olajšali življenje velikih družin, ki v demografskem smislu družbi prispevajo več kot drugi, in zmanjšali eno oviro pri odločanju za kakšnega otroka več, stroški pa ne bi bili pretirani, saj gre za manj kot 10% družin in bi lahko bili samo veseli, če bi se ta delež tudi s takimi ukrepi sčasoma povečal.

Med ukrepi bi bilo bistveno bolj jasno treba opredeliti, kaj naj bi se razumelo pod »ukrepi pozitivne diskriminacije«, saj je tako nejasna formulacij lahko tudi vir zlorab in neupravičenih diskriminacije.

Med kazalniki predlagamo črtanje »števila predmetov pri katerih so vključene vsebine in koncepti: pravičnost, strpnost, solidarnost, nediskriminatornost, enakost, nenasilje idr. ter obseg teh vsebin.«, ker je bilo v praksi to že doslej pogosto le pretveza za ideološko indoktrinacijo otrok, ki s temi pojmi v njihovem pravem pomenu nima nobene zveze.

3.8.3 Srednješolsko izobraževanje

Cilj »vzpostaviti šolsko okolje kot okolje, kjer je zagotovljena najvišja stopnja enakosti.« zveni predvsem kot ideološka floskula, za katero se lahko skriva marsikaj, kar ne otrokom ne družbi ne bi prav nič koristilo. Ali naj bo razloženo in jasno določeno, da je mišljeno, kakor to večina dobronamerno razume, ali pa naj se črta.

Tudi **bivanje v dijaškem domu** je zadeva, kjer bi poleg obstoječe olajšave v primeru, ko istočasno v dijaškem domu biva več kot en otrok, morali velike družine razbremeniti stroškov za tretjega in vse nadaljnje otroke ne glede na to, ali so v domu istočasno ali posamezno.

Pri državni štipendiji je napačno naveden trenutni cenzus (64% namesto 56%). Je pa res, da mora s 1.1.2018 začeti veljati cenzus 64% povprečne plače.

Glede na to, da je bilo ob ukinitvi otroškega dodatka za polnoletne otroke rečeno, da zanje otroški dodatek nadomešča državna štipendija, bi bilo treba cenzus za dostop do državne štipendije dvigniti na isto raven kot sicer velja za otroški dodatek. Če pa že ne naredimo tega takoj za vse dijake in študente, bi morali ta cenzus takoj dvigniti vsaj za velike družine, tako da bi bil **dostop do državne štipendije za otroke iz družin s tremi in več otroki olajšan z ugodnejšim cenzusom**, tako da bi bili do nje upravičeni tudi dijaki in študenti z dohodkom do 99% povprečne plače na družinskega člana. Med ukrepi manjka **ukinitev vrstnega reda pravic iz javnih sredstev pri državni štipendiji**, tako da otroški dodatek za mlajše otroke v družini ne bo več vplival na dodelitev in odmero državne štipendije starejšim otrokom v družini.

Podpiramo predlog »vsem dijakinjam in dijakom zagotoviti kakovostno in zdravo brezplačno malico«, kot prvi korak v dokaz, da država misli resno, pa predlagamo, da bi tak univerzalen ukrep najprej sprejeli za tretjega in vse nadaljnje otroke v družini. Tako bi zagotovili, da bi starši nosili stroške izobraževanja za prva dva otroka, za tretjega in nadaljnje, ki so demografsko za družbo še posebej pomembni, pa jim teh stroškov ne bi bilo več treba nositi, Tako bi finančno močno olajšali življenje velikih družin, ki v demografskem smislu družbi prispevajo več kot drugi, in zmanjšali eno oviro pri odločanju za kakšnega otroka več, stroški pa ne bi bili pretirani, saj gre za manj kot 10% družin in bi lahko bili samo veseli, če bi se ta delež tudi s takimi ukrepi sčasoma povečal.

Med ukrepi in kazalniki enak komentar kot pri osnovni šoli glede »števila predmetov pri katerih so vključene vsebine in koncepti: pravičnost, strpnost, solidarnost, nediskriminatornost, enakost, nenasilje idr. ter obseg teh vsebin.«, ker je bilo v praksi to že doslej pogosto le pretveza za ideološko indoktrinacijo otrok, ki s temi pojmi v njihovem pravem pomenu nima nobene zveze.

3.9 Stanovanjska problematika 3.9.1 Osamosvajanje mladih družin

Med ukrepi pogrešamo uvedbo močno ugodnih najemnih stanovanj (z izrazito neprofitno najemnino) za mlade za določen čas, pri čemer bi imele prednost mlade družine in mladi pari. Bivanje v take stanovanju bi bilo časovno omejeno (npr. na pet let za par brez otrok z možnostjo podaljšanja za določen čas za vsakega otroka v družini), tako da bi se družina lažje materialno okrepila, da bi po izteku te dobe svoje stanovanjsko vprašanje lahko reševala na trgu ali z enim izmed preostalih mehanizmov, ki so predlagani v predlogu resolucije, a so za mlade takoj na začetku poklicne poti praviloma vsaj nekaj let nedosegljivi oziroma finančno prezahtevni.

Zaposlenost na Švedskem kot zgled za izboljšanje dolgoročne ekonomske vzdržnosti v Sloveniji

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POVZETEK

Slovenija bo v prihodnje deležna hitrega staranja prebivalstva. Po najnovejših projekcijah Eurostata naj bi se delež starih 65 let in več povišal z 18 % v letu 2015 na 31 % vseh prebivalcev Slovenije v letu 2050. Velika večina teh prebivalcev je ekonomsko odvisnih, saj je njihova potrošnja večja od tega kar proizvajajo. Na drugi strani se bo delež starih od 20 do 64 let v navedenem obdobju predvidoma znižal s 63 % na 50 %. Gre za prebivalce, katerih proizvodnja večinoma presega njihovo potrošnjo in ki lahko vzdržujejo druge - tako mlajše v starosti 0-19 (predvsem privatni transferji svojim otrokom) kot tudi prej omenjene starejše v starosti 65+ (predvsem javni transferji v obliki pokojnin, zdravstva in dolgotrajne oskrbe). V članku omenjene demografske projekcije povežemo z rezultati Računov nacionalnih transferjev (angl. National Transfer Accounts, NTA), ki prikazujejo, koliko v posamezni starosti trošimo in koliko proizvajamo. Ob obstoječih starostnih vzorcih potrošnje in proizvodnje bi nastajal vedno večji razkorak med celotno potrošnjo in celotno proizvodnjo Slovenije. Ugotovimo, da bi približno polovico tega povečanja lahko izničili, če bi postopoma prevzeli starostni vzorec zaposlenosti Švedske. Na Švedskem namreč posamezniki ostajajo bistveno dalj časa na trgu dela.

1 UVOD

Na gibanje števila prebivalstva vplivajo trije dejavniki dinamike prebivalstva: rodnost, smrtnost in selitve. Skupno število prebivalstva in njegova starostna struktura so v danem trenutku odvisni od delovanja teh treh dejavnikov v preteklosti. Hkrati pa je vpliv rodnosti, smrtnosti in selitev na gibanje prebivalstva v prihodnje odvisen od obstoječe starostne strukture prebivalstva. V prihodnjih treh desetletjih bodo demografska gibanja z vidika starostne strukture prebivalstva izrazito neugodna.

Po letu 1980 se je stopnja celotne rodnosti znižala pod raven 2,1 otroka na žensko, kolikor je potrebno, da se v odsotnosti selitev prebivalstvo na dolgi rok obnavlja. V letu 2003 je

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stopnja celotne rodnosti v Sloveniji znašala samo 1,2 otroka [5]. To pomeni, da bi ob rodnosti, kot smo jo beležili v letu 2003, ena ženska tekom rodne dobe rodila v povprečju 1,2 otroka, ob predpostavki, da bi dočakala konec rodne dobe. V zadnjih letih se vrednosti gibajo med 1,5 in 1,6 otroka na žensko. V prihodnjih desetletjih bodo te številčno šibke generacije vstopale na trg dela in v rodno dobo, kar bo zniževalo delež delovnega kontingenta.

Na drugi strani se nam povprečno trajanje življenja hitro podaljšuje. Leta 1985 je življenjsko pričakovanje ob rojstvu v Sloveniji znašalo 72 let, leta 2015 pa že 81 let [6]. Poleg tega, da bistveno dlje živimo, sedaj prestopajo v starostni razred 65+ številčne generacije, rojene po drugi svetovni vojni, v obdobju izbruha rodnosti (baby-boom generacije).

Nadaljnje , neto priseljevanje, ki je v letih 1993–2009 znašalo v povprečju 5000 neto priseljenih letno, je v obdobju 2010–2016 znašalo v povprečju samo še okrog 500 neto priseljenih letno [3].

Projekcije prebivalstva tako kažejo, da bo Slovenija v prihodnje deležna hitrega staranja prebivalstva. Po najnovejših projekcijah Eurostata naj bi se naj delež starih 65 let in več povišal z 18 % v letu 2015 na 31 % vseh prebivalcev Slovenije v letu 2050 [1]. Velika večina teh prebivalcev je ekonomsko odvisnih, saj je njihova potrošnja večja od tega kar proizvajajo. Na drugi strani se bo delež starih od 20 do 64 let v navedenem obdobju predvidoma znižal s 63 % na 50 % [6]. Razmerje med številom odvisnih (stari 0-19 let in stari 65+) in delovnim kontingentom (stari 20-64 let) imenujemo koeficient starostne odvisnosti, ki kaže, kako je prebivalstvo v delovni starosti obremenjeno z odvisnimi prebivalci. Na ta način dobimo informacijo o tem, ali se zaradi demografskih sprememb (staranje prebivalstva) razmere glede ekonomske vzdržnosti v neki državi zaostrujejo inv kolikšni meri.

Vendar pa pri tem ni določeno, kolikšno odvisnost si lahko država privošči, da so razmere še vzdržne. Gre torej za nekakšen osnovni demografski kazalec, ki predpostavlja, da so prebivalci do svojega 20. rojstnega dneva vzdrževani, nato oni vzdržujejo druge, od svojega 65. rojstnega dneva naprej pa so ponovno vzdrževani. Ob tem se hkrati implicitno predpostavlja, da je raven njihove odvisnosti do 20. leta starosti ves čas enaka in da je enaka tudi po 65. letu starosti. Implicitno se predpostavlja tudi, da je raven posameznikovega presežka proizvodnje nad potrošnjo v obdobju od 20. do 64. leta starosti ves čas enaka.

V nadaljevanju predstavljamo, da nam metodologija Računov nacionalnih transferjev (angl. *National Transfer Accounts, NTA*) omogoča mnogo bolj natančno analizo ekonomske odvisnosti – tako glede starostnega obdobja odvisnosti kot tudi glede ravni odvisnosti. Ekonomsko odvisnost (oz. neodvisnost – vzdrževanje drugih) v posamezni starosti namreč izračunamo kot razliko med dejansko potrošnjo in dohodkom iz dela v posamezni starosti. Obstoječo starostno porazdelitev potrošnje in dohodka iz dela bomo nato povezali z demografskimi projekcijami, da bomo dobili informacijo o (ne)vzdržnosti obstoječih starostnih vzorcev potrošnje in proizvodnje na dolgi rok.

2 METODOLOGIJA IN PODATKI

Računi nacionalnih transferjev (NTA) so usklajeni z ustaljenim in široko uporabljanim sistemom nacionalnih računov – System of national accounts (SNA). NTA merijo premike ekonomskih resursov od posameznikov neke starostne skupine k posameznikom druge starostne skupine. Ta realokacija nastane, ker v nekih starostnih skupinah posamezniki porabljajo več kot proizvajajo, v drugih pa proizvajajo več kot porabljajo.

Osrednja kategorija NTA je primanjkljaj življenjskega cikla (angl. life cycle deficit), ki predstavlja razliko med potrošnjo posameznega starostnega razreda in njihovim dohodkom iz Prerazporeditve ekonomskih resursov med dela. posameznimi starostnimi razredi lahko potekajo v obliki transferjev ali kot prerazporeditev iz naslova sredstev (angl. asset-based reallocation). Vse navedeno lahko poteka prek zasebnega ali javnega sektorja. Odlivi, ki potekajo preko javnega sektorja predstavljajo plačila posameznikov v obliki raznih davkov in prispevkov, ki so namenjeni za financiranje javnega sistema. Na drugi strani so s strani javnega sektorja posamezniki deležni raznih prilivov. Ti so lahko v denarni ali v nedenarni obliki (angl. in-kind). Slednji so v NTA po definiciji enaki potrošnji javnega sektorja. Tokovi zasebnega sektorja lahko potekajo znotraj istega gospodinjstva (angl. intra-household transfers) ali pa med člani različnih gospodinjstev (angl. inter-household transfers), kamor spadajo tudi transferji, ki potekajo preko dobrodelnih organizacij. Transferji med člani istega gospodinjstva, ki predstavljajo predvsem transferje od staršev k otrokom, so praviloma mnogo pomembnejši kot transferji med različnimi gospodinjstvi. Tako torej izdatki staršev za hrano, obleko svojih otrok, stanovanje itd. pomenijo za starše odlive, za otroke pa prilive. Zapisano predstavljamo tudi v obliki identitete:



Prerazdeljevanje med starostnimi skupinami

pri čemer *C* predstavlja potrošnjo, *YL* dohodek iz dela, *YA* dohodek od kapitala, *S* varčevanje, T_g^+ javnofinančne prilive, T_g^- javnofinančne odlive, T_f^+ privatne prilive, T_f^- pa privatne odlive. Vsaka kategorija ima dimenzijo starosti *a*, ki poteka od starosti 0 do najvišje starosti (običajno 90+ ali 80+). Navedena identiteta velja za vsak starostni razred.

Porazdelitev posameznih kategorij potrošnje in dohodkov po starosti se izvede s pomočjo uporabe številnih podatkovnih virov. Za nekatere kategorije so na voljo agregatni podatki, ki so že razčlenjeni po starosti, kar pomeni, da imamo »starostni profil« teh kategorij že na voljo. V splošnem pa se starostni profili izračunavajo v dveh stopnjah. Najprej na osnovi anketnih mikro podatkov izračunamo povprečja za posamezni starostni razred in s tem dobimo relativni starostni profil. Tako dobljeni starostni profil nato množimo s številom prebivalstva po starostnih razredih in preverimo, ali smo dobili agregatno vrednost kot je poročana v Sistemu nacionalnih računov. Dobljena vrednost se seveda praviloma razlikuje od dejanskih agregatnih vrednosti iz Sistema nacionalnih računov. Z razmerjem med dejansko agregatno vrednostjo in ocenjeno agregatno vrednostjo mikropodatkov dobimo skalar, s katerim nato množimo »starostne profile« (povprečne vrednosti po starosti), dobljene iz mikropodatkov. Pri razporejanju zasebne potrošnje na posameznike moramo sprejeti nekatere predpostavke, saj se v Anketi o porabi gospodinjstev ti podatki poročajo samo na ravni gospodinjstva kot celote. Za zasebne izdatke za zdravstvo in izobraževanje se tako uporablja regresijska metoda. Pri zdravstvu so odvisna spremenljivka izdatki gospodinjstva za zdravstvo, pojasnjevalne pa število prebivalcev gospodinjstva v posameznem starostnem razredu. Regresijska enačba nima konstante, da se celotni izdatki gospodinjstva razporedijo na posameznike v gospodinjstvu - teoretično odsotnost konstantnega člena namreč pomeni, da gospodinjstvo brez posameznikov nima izdatkov. Pri zasebnih izdatkih za izobraževanje je postopek enak, le da se na desni strani regresijske enačbe upoštevajo samo posamezniki, ki so formalno vključeni v izobraževalni proces. Relativne vrednosti parcialnih regresijskih koeficientov za posamezni starostni razred uporabimo pri razporejanju izdatkov gospodinjstva (poročano v Anketi o porabi v gospodinjstvih) na posamezne člane. Največjo kategorijo zasebne potrošnje predstavlja »ostala zasebna potrošnja«, kjer za razporejanje izdatkov , ki jih poroča gospodinjstvo, uporabimo ekvivalenčno lestvico. Otrokom do starosti 4 leta dodelimo utež 0,4, nato pa uteži linearno naraščajo na vrednost 1,0 v starosti 20 let. Od starosti 20 let pa do najvišjih starostnih razredov je nato vrednost uteži na nespremenjeni ravni 1,0. Za podrobnejši opis NTA metodologije glej Istenič Tanja, Šeme Ana, Hammer Bernhard, Lotrič Dolinar Aleša, & Sambt Jože [2] in United Nations [4].

3 REZULTATI

V nadaljevanju bomo predstavljeno metodologijo uporabili na primeru Slovenije in Švedske. Rezultate prikazujemo za dva osrednja starostna profila – potrošnjo in dohodek iz dela.



Slika 1: *NTA rezultati za Slovenijo in Švedsko: povprečna potrošnja in dohodek iz dela po starosti*

Prikazana starostna profila potrošnje in dohodka iz dela apliciramo na demografske projekcije prebivalstva - ločeno za Slovenijo in Švedsko. V letu 2010 je v obeh državah celotna potrošnja presegala celotni dohodek iz dela za nekaj manj kot 10 % (Slika 2). Tega samega po sebi ne moremo vrednotiti, ali je to na dolgi rok vzdržno ali ne. Da celotna potrošnja presega celotni dohodek iz dela je namreč do določene mere povsem vzdržno, saj se lahko razlika financira iz prerazporeditve iz naslova sredstev (dohodek iz kapitala minus varčevanje). Povedano drugače, ker se je v preteklosti akumulirala določena raven kapitala, ki ga sedaj imamo na voljo, ta kapital sedaj ustvarja dohodek, ki je višji od varčevanja, s katerim se obnavlja obrabljeni kapital.



Slika 2: Presežek *celotne potrošnje nad celotnim dohodkom iz dela* (*v* %)

Bistvena razlika med državama nastane tekom obdobja projekcij. Če bi v prihodnje ostali vzorci potrošnje in dohodka iz dela po starosti ves čas enaki, bi razkorak med potrošnjo in dohodkom iz dela narasel do leta 2050 v Sloveniji kar na 46 % dohodka iz dela, medtem ko bi na Švedskem narasel samo na 20 %.

Za Švedsko bo naraščanje razkoraka med potrošnjo in dohodkom iz dela bistveno manjše zaradi 1) počasnejšega staranja prebivalstva v prihodnje, kot tudi zaradi 2) oblike dohodka iz dela. Prvega dejavnika, torej projekcij prebivalstva za Švedsko podrobneje ne bomo opisovali. Povejmo samo, da se bo na Švedskem prebivalstvo v prihodnje mnogo manj intenzivno staralo kot v Sloveniji. Po najnovejših projekcijah prebivalstva [1] naj bi se delež starih 65 let in več na Švedskem povečal z 19,6 % v letu 2015 na 22,7 % v letu 2050, kar je mnogo nižje povišanje kot v Sloveniji (z 17,9 % v letu 2015 na 30,5 % v letu 2050). V povezavi z drugim dejavnikom pa lahko v Sliki 1 vidimo, da ljudje na Švedskem mnogo dlje časa ostajajo v zaposlitvi sodeč po sliki za okrog 7 let. Ob tem pa ljudje na Švedskem ne živijo v povprečju nič kaj dosti dlje kot v Sloveniji - v letu 2015 je razlika v življenjskem pričakovanju ob rojstvu znašala samo 1,3 leta (82,2 leti na Švedskem in 80,9 v Sloveniji) [6].

Ne vidimo posebnega razloga, zakaj ne bi mogli v Sloveniji precej dalj časa ostajali v zaposlitvi, če upoštevamo izkušnje iz Švedske. Še več, v projekcijah prebivalstva se pričakuje, da naj bi že v prihodnih petih letih v Sloveniji dosegli enako življenjsko pričakovanje ob rojstvu, kot ga je imela Švedska v letu 2015.

Tako se bomo v nadaljevanju vprašali, za koliko bi se v Sloveniji v prihodnje ublažil pritisk na razkorak med celotno potrošnjo in celotnim dohodkom iz dela, če bi postopoma prevzeli Švedsko obliko dohodka iz dela. Pri tem predpostavljamo, da do leta 2019 ne bi bilo nobenih sprememb (kar je v skladu s trenutno politično diskusijo glede prihodnje pokojninske reforme v Sloveniji), nato pa bi v letu 2020 pričeli z linearnim prehodom na obliko dohodka iz dela kot ga je imela Švedska v letu 2010. V Sliki 3 smo tako glede na Sliko 2 dodali linijo, ki prikazuje rezultate za Slovenijo ob opisani konvergenci.



Slika 3: Presežek celotne potrošnje nad celotnim dohodkom iz dela (v %); postopna konvergenca dohodka iz dela k starostnemu profilu za Švedsko

Ugotovimo lahko, da bi omenjena konvergenca bistveno zmanjšala razkorak med potrošnjo in dohodkom iz dela v prihodnje. Ob opisanih predpostavkah bi se prihodnje povečanje razkoraka med potrošnjo in dohodkom iz dela, gledano na sedanje leto (2017), približno prepolovilo. Iz sedanjih 15 % se ne bi povečal na 46 %, temveč na okrog 30%.

4 SKLEP

Prebivalstvo Slovenije se hitro stara, delež starejših, ki so ekonomsko odvisni, se bo v prihodnje hitro povečeval, delež delovnega kontingenta pa na drugi strani zniževal. V analizi smo uporabili metodologijo Računov nacionalnih transferjev (angl. National Transfer Accounts, NTA), ki nam med drugim nudi starostno porazdelitev potrošnje in dohodka iz dela. Razkorak med celotno potrošnjo in celotnim dohodkom iz dela se bo v Sloveniji povečeval mnogo hitreje kot na Švedskem. Deloma je to posledica počasnejšega staranja švedskega prebivalstva, deloma pa tega, da se iz zaposlitve umikamo okrog 7 let prej kot na Švedskem. Če za Slovenijo predpostavljamo postopno konvergenco dohodka iz dela k obliki, ki jo je imela Švedska leta 2010, se prihodnje povišanje razkoraka med potrošnjo in dohodkom iz dela približno prepolovi. Morebiti se sliši ostajanje v zaposlitvi za dodatnih 7 let veliko, ampak to Švedi dejansko že sedaj dosegajo ob samo 1,3 leta višjem življenjskem pričakovanju ob rojstvu, ki naj bi ga v Sloveniji dosegli že čez okrog 5 let. Predvsem pa se moramo zavedati, da bodo leta 2050 to precej drugačne generacije kot tiste, ki se upokojujejo sedaj. Najverjetneje bodo bistveno bolj vitalne in v še višjem deležu zaposlene v storitvenem sektorju kot sedaj.

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Hoja in drugo gibanje kot osnovni varovalni dejavnik zdravja v času množičnega staranja

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Na 21. svetovnem kongresu geronologije in geriatrije julija 2017 v San Franciscu v Kaliforniji se je pokazalo, da je najbolj zaželen pridevnik k besedi staranje »zdravo«. Koncept krepitve celostnega telesnega, duševnega in socialnega zdravja, ki ga od leta 1946 uspešno promovira WHO, je dovolj širok za oblikovanje programov in politik staranja v času demografske krize. Analiza podatkov naše obsežne reprezentativne terenske raziskave (N =1047) Potrebe, zmožnosti in stališča prebivalce Slovenije, ki so stari 50 in več let, je pokazala, da je hoja univerzalen varovalni dejavnik zdravega staranja. Ljudje, ki so navajeni hoditi peš po opravkih v oddaljenosti kilometer v okolici doma, in tisti, ki so navajeni hoditi tedensko na 2-urni pohod imajo boljše parametre telesnega, duševnega, duhovnega in socialnega funkcioniranja. Podobno velja tudi za druge vidike rednih gibalnih navad, zlasti kolesarjenje in delo na vrtu. Hoja je najenostavnejši in najcenejši način gibanja. Sodobna informacijska tehnologija (npr. pedometer) omogoča merljivo spremljanje gibanja pacientov s kroničnimi boleznimi, obenem pa je dober motivator starejših ljudi na redno hojo. Inštitut Antona Trstenjaka za gerontologijo in medgeneracijsko sožitje, ki razvija programe za zdravo staranje in za osvajanje tovrstnih navad, vgrajuje vanje navajanje na hojo vzporedno z navadami za boljše komuniciranje, vadbo mentalnih zmožnosti in vajami za krepitev ravnotežja.

KLJUČNE BESEDE

hoja, gibanje, gibalne navade, celostno zdravje, programi za zdravo staranje, pedometer MAJA RANT, Inštitut Antona Trstenjaka za gerontologijo in medgeneracijsko sožitje, Resljeva 7, p.p. 4443, 1001 Ljubljana, tel.št.: +386 1 433 93 01, e-mail: <u>maja@instantonatrstenjaka.si</u>, TJAŠA MLAKAR, Inštitut Antona Trstenjaka za gerontologijo in medgeneracijsko sožitje, Resljeva 7, p.p. 4443, 1001 Ljubljana, tel.št.: +386 1 433 93 01, e-mail: <u>tjasa.mlakar.iat@gmail.</u> <u>com</u>

Walking and other ways of motion as the universal protective factor for a healthy life in times of accelerated ageing

As it was presented on the 21st World Kongress of Gerontology and Geriatrics in San Francisco in July 2017, the most desirable adjective for the word ageing is "healthy". The concept of strengthening the health from holistic point of view - physicaly, psychicaly and socialy, that WHO has been sucessfuly promoting since 1946, is wide enough for the creation of ageing programs and ageing politics in times of demographic crisis. Analysis of the data from our extensive study (N = 1047) Needs, potentials, abilities and standpoints of Slovene population aged 50 years and over showed, that walking is the universal protective factor of healthy ageing. Individuals, that are used to walk every errand in the distance of one kilometer around their home, and individuals, that are used to go on a 2-hours hike every week, have got better parameters of phyisical, psychical, spiritual and social functioning. That is also right for other regular motion habits, particularly for bike riding and gardening. Walking is the easiest and the chipest way of motion. Modern information technologies (f. e. pedometer) enabels us to monitor and measure the motion of patients with chronic deseases and at the same time they provide an efficient regular motion motivation for elderly individuals. At the Institute of Anton Trstenjak for gerontology and intergenerational relations we are creating programs for healthy ageing and healthy habits with implementation of walking habit developement as a side to efficient communication habits, mental skills training and balance excercises.

KEY WORDS

Walking, motion, motion habits, holistic health, healthy ageing programs, pedometer

1 UVOD

Gibljivost, zlasti zmožnost za hojo, ljudje pogosto enačijo z zdravjem. Zdravje je Svetovna zdravstvena organizacija (WHO) v svoji ustanovni listin leta 1946 opredelila čim bolj popolno telesno, duševno in sožitno (socialno) blagostanje vsakega človeka (WHO, 2005) in s tem postavila enega od učinkovitejših razvojnih programov v svoji zgodovini. Če torej povežemo definicijo zdravja in doživljanje ljudi, bi lahko rekli, da je zdravje človekova čim bolj popolna telesna, duševna in duhovna ter socialna gibljivost.

Pri govorjenju o gibljivosti imamo običajno pred očmi telesno gibljivost in gibčnost. Telesna gibljivost pa je tesno povezana z gibljivostjo v vseh drugih človekovih razsežnostih. Zato jo je smiselno opredeliti z vidika celostne antropologije (Ramovš, 2003): gibljivost je zmožnost za smiselno telesno, duševno, duhovno, socialno, razvojno in bivanjsko premikanje v prostoru in času, tako pri svojem osebnem razvoju kot v povezavi z drugimi ljudmi, življenjskimi nalogami in celotno stvarnostjo. Pri tem ni socialna »gibčnost« v navezovanju in vzdrževanju lepih odnosov z ljudmi nič manj pomembna kakor telesna sposobnost za hojo. Duhovna prožnost za iskanje smiselnega razvoja v življenjskih krizah ni nič manj pomembna kakor zmožnost za vožnjo avtomobila.

Gibljivosti vseh človekovih razsežnostih so med seboj povezane tako, da vsaka od njih komplementarno dopolnjuje in krepi vse druge; iz te izkušnje je nastal latinski rek Zdrav duh v zdravem telesu (mens sana in corpore sano). Telesno gibanje torej krepi tudi duševne zmožnosti (npr. spomin, mišljenje, čustva, vedrino razpoloženja in pozitivno usmerjenost in umirjenost), socialne zmožnosti (npr. komuniciranje, sodelovanje in prevzemanje primernih vlog v sožitju) ter duhovne in bivanjske zmožnosti, zlasti odgovorno svobodo in doživljanje smisla. V primerih, ko telesna gibljivost odpoveduje zaradi bolezni ali onemoglosti, ostaja kakovost življenja višja, če je človek gibčen v višjih razsežnostih, zlasti socialni (v navezovanju in vzdrževanju medčloveških odnosov, hvaležnosti pri prejemanju oskrbe) ter duhovni in bivanjski (ko npr. kljub telesni omejitvi uspešno išče smisel svoje preteklosti, sedanjosti in prihodnosti). Izkušnja kaže, da v primeru invalidnosti ali kronične bolezni lahko s kakovostnim razvojem v socialni, duševni, zlasti pa duhovni in bivanjski razsežnosti dosežemo, da velja obratno: Zdrav duh v bolnem telesu, kakor se je glasil naslov razstave izdelkov bolnikov in invalidov ter spremljajočih strokovnih dogodkov. Pri starostnem pešanju se človekovi stiki z drugimi ponavadi redčijo vzporedno z zmanjševanjem gibljivosti, skokovito npr. upadejo, ko ni več zmožen voziti avtomobila.

Gibljivost je temeljna oblika osebne

samostojnosti in svobode. Otrok, preden shodi, in človek, ki zaradi onemoglosti ne more več hoditi, sta pri opravljanju vsakdanjih opravil odvisna od pomoči drugih. Zmanjševanje človekove gibljivosti večinoma zelo vpliva tudi na pešanje ostalih njegovih zmožnosti; ko ne morejo več hoditi, začno mnogi naglo duševno pešati. Povezava je tudi v obratni smeri: človek, ki izgublja duševno prožnost, se običajno čedalje manj giblje ter zakrneva in oboleva tudi telesno. Zavestno osvajanje učinkovitih načinov za ohranjanje in večanje gibljivosti je torej nepogrešljiva sestavina osebnih prizadevanj za zdravo staranje. Zdravo staranje pa ostaja konstantno temeljni pojem svetovnih prizadevanj za obvladovanje nalog ob staranju prebivalstva, čeprav ga občasno zamegli ta ali oni modni pridevnik k besedi staranje, npr. aktivno staranje; na nedavnem 21. svetovnem kongresu geronologije in geriatrije julija 2017 v San Franciscu se pojem zdravo staranje spet pokazal za osrednjega. Zaradi povezave med zdravjem in gibanjem tudi sodobnega sistema za kakovostno dolgotrajno oskrbo ni mogoče načrtovati, ne da bi poznali in upoštevali podatke o gibljivosti starejših ljudi, dostopnosti sodobnih pripomočkov pri oslabljeni gibljivosti in koliko imajo svoje bivalno okolje prilagojeno za življenje ob zmanjšani gibljivosti.

Pri raziskovanju duševnih motenj med starejšimi, zlasti demence in depresije, ugotavljajo, da je telesno gibanje varovalni dejavnik. To povezavo potrjuje tudi raziskava SHARE (Lindwall, 2011).

Françoise Forette je v preglednem referatu na Globalni konferenci o staranju v Pragi izpostavila ugotovljeno povezavo med telesno aktivnostjo in ohranjanjem kognitivne funkcije (Ramovš K. in dr., 2012).

Ugotovitve o telesni vadbi kot varovalnem dejavniku pred duševnimi motnjami navaja Tatjana Novak v doktorski disertaciji (Berčič, 2012a).

V leksikonski razlagi pojma demenca je zapisano, da redna psihična in telesna aktivnost, uravnotežena prehrana, izogibanje škodljivim razvadam in ohranjanje socialne mreže lahko odložijo ali upočasnijo razvoj demence, mogoče pa tudi preprečijo njen pojav (Lipar, 2012).

Epidemiološki podatki podpirajo dejstvo, da več aktivne telesne dejavnosti zmanjšuje tveganje za razvoj Alzheimerjeve in Parkinsonove bolezni, telesna vadba pa lahko tudi upočasni njuno napredovanje (Paillard in sod., 2015).

Rezultati študije o učinku telesne vadbe na stopnjo neodvisnosti starejših (Loaiza in sod., 2017) so pokazali, da se je v eksperimentalni skupini, kjer so starejši izvajali telesno aktivnost, delež neodvisnih starejših dvignil za 15,4 %, v kontrolni skupini, kjer vadbe niso izvajali, se je ta delež dvignil le za 3,8 %. Raziskovalci so ugotovili, da lahko 3-mesečni program telesne aktivnosti pri starejših izboljša njihovo stopnjo samostojnosti.

Ugoden vpliv telesne vadbe se je potrdil tudi v raziskavi o biološkem sindromu krhkosti (frailty), s katerim je povezana večja stopnja invalidnosti, hospitalizacije in smrti. S programom večkomponentne vadbe se je povečala telesna zmogljivost in se izboljšalo kognitivno, čustveno in socialno stanje pri starejših (Tarazona-Santabalbina in sod., 2016).

Raziskovalna spoznanja in izkušnje se torej stekajo v trditev, da je gibanje med najbolj pomembnimi varovalnimi dejavniki zdravega staranja, hoja pa je najbolj univerzalen in najenostavnejši način gibanja. Zato smo v naši raziskavi ugotavljali količino hoje in njeno povezanost z zdravim staranjem.

2 NAŠA RAZISKAVA

2.1 Populacija, merski inštrumenti in izvedba

Reprezentativno raziskavo Potrebe, zmožnosti in stališča prebivalcev Slovenije, ki so stari 50 let in več smo opravili na Inštitutu Antona Trstenjaka za gerontologijo in medgeneracijsko sožitje leta 2010. Z osebnim terenskeim anketiranjem je bil zajet vzorec 1.047 oseb. Njen namen je bil pridobiti široko paleto podatkov o starajoči se slovenski populacije z vidika interdisciplinarne celote telesne, duševne, duhovne, socialne, razvojne in eksistencialne človeške razsežnosti.

Obsežni vprašalnik zajema zdravstveno stanje, uporabo zdravil, varovanje zdravja, izkušnje in stališča do zdravstvenega sistema, gibljivost in opravljanje vsakdanjih opravil, stanovanje in njegovo prilagojenost za starost, sožitje z bližnjimi in oskrba v onemoglosti, duševno počutje, duhovna in bivanjska stališča, staranje, prenos življenjskih izkušenj, medgeneracijski odnosi in solidarnost, življenje v domačem kraju in selitve, kultura in materini jezik, informacijsko-komunikacijska tehnologija, poklic, zaposlitev, delo, uporaba svojih zmožnosti, upokojitev in premoženje, otroci in vnuki ter obsežen sklop demografskih vprašanj.

Raziskava in njeni rezultati so bili predstavljeni v obsežni monografiji (Ramovš, ured., 2013), v več deset znanstvenih člankih, referatih na domačih in tujih kongresih ter disertacijah in diplomskih nalogah, zdravstvni podatki raziskave so bili predstavljeni z javnozdravstvenim komentarjem (Voljč, 2012), precej aktualnih vsebin pa še čaka na podrobno obdelavo.

2.2 Rezultati in interpretacija

Izhodiščni podatki za nas so odgovori na vprašanje: *Kolikšna je vaša sposobnost za hojo?* Odgovore po starostnih skupinah kaže slika 1. Tisti, ki brez težav prehodijo daljše razdalje, so odgovorili dodatno vprašanje o tem, kako razširjena je zdrava navada redne daljše hoje: V zadnjem letu ste hodili po več kilometrov skupaj približno ... krat na teden, vsakokrat po približno ... ur(e). V zadnjem letu so vsak teden hodili povprečno 2,63 krat na daljši pohod, ki je trajal povprečno skoraj dve uri (1,91 ure). Ta podatek se skoraj povsem ujema s podatkom o daljših pohodih v zadnjem tednu, ki je povprečeno 2,61 krat.

Drug pomemben podatek za nas so odogovri na vprašanje: *Na kakšen način najpogosteje premostite razdaljo okrog 1 km, ko morate po opravkih?* Na izbiro so bili odgovori: grem peš, se peljem z avtom, kolesom itd.. Pri obdelavi smo bili pozorni tudi na odgovore o tem, s čim poskrbijo za svoje zdravje in ohranjanje telesnih moči ter na odgovore na različna vprašanja o telesnem, duševnem, duhovnem in socialnem zdravju. Ugotovitve potrjujejo izsledke sorodnih raziskav, da gibanje krepi vse razsežnosti zdravja; naši rezultati za duševno, socialno in duhovno zdravje kažejo:

- med tistimi, ki manjkrat pozabljajo, kaj so počeli včeraj, jih relativno več hodi peš, kakor med tistimi, ki pogosteje pozabljajo;
- med tistimi, ki se manjkrat počutijo tesnobno, jih relativno več hodi peš, kakor med tistimi, ki se pogosteje počutijo tesnobno;
- med tistimi, ki so manjkrat otožni, jih relativno več hodi peš, kakor med tistimi, ki so pogosteje otožni;
- med tistimi, ki se manjkrat počutijo osamljeni, jih relativno več hodi peš, kakor med tistimi, ki se pogosteje počutijo osamljeni;
- med tistimi, ki se jim manjkrat zdi, da je vse nesmiselno, jih relativno več hodi peš, kakor med tistimi, ki se jim pogosteje zdi, da je vse nesmiselno.

Če povezavo med hojo in navedenimi duševnimi, socialnimi in duhovno-bivanjskimi zmožnostmi pogledamo v obratni smeri, je ista povezava: tisti, ki so navajeni hoditi peš, jim relativno bolje delujejo duševne zmožnosti (manjkrat pozabljajo, se manjkrat počutijo tesnobno, so manjkrat otožni in nemirni), kakor tisti, ki se po opravkih v bližnji okolici vozijo; isto velja za socialne zmožnosti (se počutijo manjkrat osamljeni) in duhovno-bivanjske zmožnosti (se jim manjkrat zdi, da je vse nesmiselno).

Slika 1: Kakšna je vaša sposobnost za hojo? – prikaz po starostnih skupinah



Vir: Inštitut Antona Trstenjaka 2010

3 ZAKLJUČKI

Vrata do zdravega staranja imamo torej v vseh razsežnostih; seveda velja enako, da imamo v vseh razsežnosti tudi vrata za kvarjenje svojega zdravja. Najbolj prvinska in verjetno najlažja je krepitev zdravja skozi telesna vrata: z gibanjem – zlasti s hojo, z zdravo prehrano, zdravim razmerjem in ritmično menjavo dela in počitka. Ko zavestno krepimo svoje zdravje z zdravimi telesnimi dejavnostmi, zlasti s hojo in gibanjem, krepimo obenem s telesnim tudi duševno, socialno in duhovno zdravje.

Ta raziskovalna spoznanja uporabljamo na Inštitutu Antona Trstenjaka za gerontologijo in medgenercijsko sožitje pri razvijanju metod za zdravo staranje ter pri oblikovanju in širjenju programov, ki ljudjem pomagajo osvjati navade za zdravo straranje. Naša metoda, ki ji pri tem posvečamo največ pozornosti je skupinsko socialno učenje iz dobrih izkušenj članov skupine. To velja tudi za hojo in druge oblike gibianja, npr. za redno vadbo krepitve ravnotežja za preprečevanje padcev v starosti. V skupini se pod vodstvom usposoblienih prostovolicev širiteliev (multiplikatoriev) in priročnikov za vse člane skupine uvajajo v določeno obliko zdrave dejavnosti. Tedenski skupinski pogovor o dobrih izkušenjah pri tem v preteklem tednu utrjuje v ljudeh motivacijo zanjo, večja izkušnje in zadovoljstvo ob uspehih. Ta metoda se je izkazala za zelo dobro pri uvajanju v krepitev zdravja z gibanjem, prav tako pa učenju boljših načinov za medgeneracijsko komuniciranje in druge oblike zdravega sožitja v vsakdanjem življenju.

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STRATEGIJA DOLGOŽIVE DRUŽBE Ključni poudarki

Družba postaja dolgoživa: pričakovano trajanje življenja se podaljšuje. Spremenjena starostna struktura zahteva spremembe in nove rešitve. Zato smo oblikovali Strategijo dolgožive družbe - dokument prinaša razvojna izhodišča, ključne poudarke nove paradigme, vizijo in cilje ter predloge možnih usmeritev.

Vizija strategije

Vizija Strategije dolgožive družbe so družba in sistemi, ki bodo v spremenjenih demografskih razmerah vsem zagotavljali kakovostno življenje.

Razvojni cilji za njeno uresničitev:

- 1. Blaginja vseh generacij in dostojno ter varno staranje v domačem okolju.
- 2. Vključenost vseh generacij v ekonomsko, družbeno, socialno in kulturno življenje v skladu z njihovimi preferencami in potrebami, ter medgeneracijsko sožitje.
- 3. Ohranjanje in izboljšanje telesnega in duševnega zdravja ljudi vseh starosti.

Konceptualni okvir Strategije dolgožive družbe

USTVARJALNOST IN AKTIVNOST V VSEH ŽIVLJENJSKIH OBDOBJIH TER SKRB ZA ZDRAVJE

Trendi v širšem okolju, ki vplivajo na oblikovanje strategije

- a) Tehnološki razvoj in z njim povezani digitalizacija in robotizacija družbe
- b) Fleksibilizacija trga dela
- c) Drugačno pojmovanje življenjskega cikla:



Štirje stebri Strategije dolgožive družbe



Usmeritve Strategije dolgožive družbe po stebrih

1. Trg dela in izobraževanje

- prilagoditve na trgu dela in nova delovna mesta
- spodbujanje priseljevanja tuje delovne sile,
- vseživljenjsko izobraževanje in usposabljanje, medgeneracijski prenos znanja.
- 2. Samostojno, zdravo in varno življenje vseh generacij
 - dostopnost do zdravstvenih storitev in dolgotrajne oskrbe,
 - zagotoviti financiranje sistemov socialne zaščite,
 - skrb za zdravje,
 - zmanjševanje neenakosti v zdravju.

3. Vključenost v družbo

- medgeneracijsko sodelovanje,
- prostovoljstvo,
- IKT v komunikaciji,
- preprečevanje starostne diskriminacije,
- politična in civilna participacija.
- 4. Oblikovanje okolja za aktivnost v celotnem življenjskem obdobju
 - prilagoditve v gospodarstvu,
 - prilagodite bivalnih razmer in prometne ureditve s podporo IKT in tehnoloških rešitev.

Nadaljnji koraki:

Za uresničitev začrtanih usmeritev bo ključno zavedanje širše javnosti in posameznikov o pomenu predlaganih sprememb in pomenu osnovnega soglasja ter zavezanosti družbenih deležnikov k uresničevanju Strategije. Vlada RS je julija 2017 sprejela Strategijo dolgožive družbe in sklep, s katerim je naložila ministrstvom, pristojnim za finance, trg dela in zaposlovanje, za izobraževanje in znanost, zdravje, infrastrukturo in promet, gospodarstvo, okolje in prostor, lokalno samoupravo, informacijsko tehnologijo ter kulturo, da na podlagi usmeritev zapisanih v Strategiji dolgožive družbe pripravijo »Akcijske načrte« s predlogi ciljev in ukrepov za njihovo izvedbo v šestih mesecih od dneva sprejema te strategije.

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Sodelovanje, programska oprema in storitve v informacijski družbi Collaboration, Software and Services in Information Society

Uredil / Edited by

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PREDGOVOR

Konferenco "Sodelovanje, programska oprema in storitve v informacijski družbi" organiziramo v sklopu multikonference Informacijska družba že sedemnajstič. Kot običajno, tudi letošnji prispevki naslavljajo aktualne teme in izzive, povezane z razvojem sodobnih programskih in informacijskih rešitev ter storitev kot tudi sodelovanja v splošnem.

Informatika in informacijske tehnologije so že več desetletij gonilo inoviranja na vseh področjih poslovanja podjetij ter delovanja posameznikov. Odprti standardi in interoperabilnost ter vedno višja odzivnost informatikov vodijo k razvoju inteligentnih digitalnih storitvenih platform in inovativnih poslovnih modelov ter novih ekosistemov, kjer se povezujejo in sodelujejo ne le partnerji, temveč tudi konkurenti. Vse večja in pomembnejša je tudi vključenost končnih uporabnikov naših storitev in rešitev. Napredne informacijske tehnologije in sodobni pristopi k razvoju, vpeljavi in upravljanju omogočajo višjo stopnjo avtomatizacije in integracije doslej ločenih svetov, saj vzpostavljajo zaključeno zanko in zagotavljajo nenehne izboljšave, ki temeljijo na aktivnem sodelovanju in povratnih informacijah vseh vključenih akterjev. Ob vsem tem zagotavljanje kakovosti ostaja eden pomembnejših vidikov razvoja in vpeljave na informacijskih tehnologijah temelječih storitev.

Prispevki, zbrani v tem zborniku, omogočajo vpogled v in rešitve za izzive na področjih kot so npr.:

- modeliranje vrednostih verig storitvenih ekosistemov;
- načrtovanje pokrajin procesov;
- zaznavanje neustreznih načrtovalskih odločitev;
- identifikacija pomanjkljivih programskih komponent;
- odkrivanje semantičnih spletnih storitev;
- vrednotenje naprednih spletnih tehnologij;
- klasifikacija orodij učnega stolpiča;
- identifikacija znanj in kompetenc podatkoslovca;
- učenje in ovrednotenje klasifikatorjev naravnega jezika;
- uporaba algoritmov strojnega učenja v praksi.

Upamo, da boste v zborniku prispevkov, ki povezujejo teoretična in praktična znanja, tudi letos našli koristne informacije za svoje nadaljnje delo tako pri temeljnem kot aplikativnem raziskovanju.

Marjan Heričko

FOREWORD

This year, the Conference "Collaboration, Software and Services in Information Society" is being organised for the seventeenth time as a part of the "Information Society" multi-conference. As in previous years, the papers from this year's proceedings address actual challenges and best practices related to the development of advanced software and information solutions as well as collaboration in general.

Information technologies and the field of Informatics have been the driving force of innovation in business, as well as in the everyday activities of individuals for several decades. Open standards, interoperability and the increasing responsiveness of IS/IT experts are leading the way to the development of intelligent digital service platforms, innovative business models and new ecosystems where not only partners, but also competitors are connecting and working together. The involvement and engagement of end users is a necessity. On the other hand, quality assurance remains a vital part of software and ICT-based service development and deployment. The papers in these proceedings provide a better insight and/or propose solutions to challenges related to:

- Modelling large ecosystems value chain;
- Designing process landscape;
- Detecting bad design decision and code smells;
- Discovering semantic web services;
- Evaluation of advanced Web technologies;
- Classification of learning stack tools;
- Identifying skills and competencies of data scientists;
- Training and evaluation of natural language classifiers.
- Applying machine learning algorithms in practice.

We hope that these proceedings will be beneficial for your reference and that the information in this volume will be useful for further advancements in both research and industry.

Marjan Heričko

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Crop Yield Prediction in the Cloud: Machine Learning Approach

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ABSTRACT

Crop yield prediction provides critical information for decision makers and directly affects the agricultural policies and trade. Current emerging technologies such as Internet of Things (IoT), big data analytics, cloud computing, and machine learning enabled researchers to design and implement high-performance yield prediction models. In this work, we aimed at investigating several machine learning-based regression techniques such as Boosted Decision Tree Regression and Neural Network Regression for this challenging problem and implementing a wheat yield prediction web service to host on the Azure cloud computing platform. Case studies were performed on the data obtained for south-east region of Turkey and four states in the United States. Experimental results demonstrated that while neural network regression technique provides the best performance for large-scale crop yield prediction datasets, linear regression technique is more appropriate for small-scale datasets.

Categories and Subject Descriptors

I.2.6. [Computing Methodologies]: Learning

General Terms

Algorithms, Measurement, Performance, Experimentation.

Keywords

Crop Yield Prediction; Internet of Things; Sensors; Machine Learning; Regression Techniques; Cloud Computing

1. INTRODUCTION

It is reported that 795 million people in the world are undernourished which means that one in nine people today live without sufficient food [1]. While the current world population is around 7.5 billion people, it's estimated that it will be 9.7 billion people which is 30% higher than the current population [2]. To supply adequate food to this huge population, global food production must improve dramatically. It's estimated that while one farmer now feeds 155 people in the world, by 2050 one farmer will need to feed 250 people which is 61% higher than the current situation [3]. United Nations aims at ending hunger by 2030 and ensuring access to safe and adequate food by all people in the world [4].

Crop yield prediction before harvest can help to manage the agricultural trade policies [5], provide critical data for economic

and political stakeholders, and evaluation of climate change impact [6]. Therefore, researchers are still actively involved in the development of crop yield prediction models at national, subnational, and international levels [6]. Since traditional survey methods are time consuming and error-prone, accurate prediction approaches are currently being developed by different research groups. In addition to the survey method, there are different approaches such as statistical methods, crop simulation models, and remote sensing-based techniques.

In this study, our main objective is to design and implement a wheat yield prediction system based on the data obtained from sensors positioned in stations in south-east region of Turkey. To retrieve and process this data, we collaborated with TARBIL Agro-Informatics Research Centre in Istanbul Technical University which has a terrestrial network called Agricultural Monitoring and Information System (AgriMONIS) with 441 active RoboStations. In addition to the analysis performed on this data, we also developed machine learning-based models for wheat data obtained from four states in the United States. Machine learning-based models were designed and evaluated in Azure Machine Learning Studio platform. The best algorithm in terms of coefficient of determination parameter was transformed into a web service and deployed in Azure cloud computing platform. A client-side web application was implemented using ASP.NET technology to handle the requests of the end users and farmers are being informed via this web application about the yield prediction results.

2. RELATED WORK

There are several studies on crop yield prediction, but we did encounter an end-to-end crop yield prediction system which uses Azure Machine Learning Studio, Azure Cloud platform, and web services technology. Most of the studies in the literature only report experimental results, but do not provide any practical information to build a crop yield prediction system for the realworld scenarios. Also, there is very limited number of studies which applied data in south-east region of Turkey. Cakır et al. [5] built an Artificial Neural Network to estimate the wheat yield prediction in south-east region of Turkey and utilized from meteorological data such as temperature and rainfall records. They used data regarding to the years 2011 and 2012 for training the model, and applied the data regarding the year 2013 to test the prediction model. They reported that results are better than the regression method when Multi-Layer Perceptron (MLP) is applied. The optimal value for the Number of neurons was reported as 15. Chen and Jing [7] compared two adaptive multivariate Analysis methods based on Landsat-8 images to forecast wheat yield and reported that Artificial Neural Networks (ANN) provides better results than Partial Least Squares Regression (PLSR) technique in terms of coefficient of determination and root mean squared error (RMSE) parameters. Gouache et al. [6] developed wheat yield prediction models in France for 23 departments using yield statistics from 1986 to 2010. They started with 250 variables and reached to 5-7 variables using forward stepwise regression methods to design their prediction models. For 20 departments, acceptable models were implemented. Stas et al. [8] compared Boosted Regression Trees (BST) and Support Vector Machines (SVM) algorithms for the prediction of wheat yields and reported that BST provides better performance than SVM. Our paper is different than these studies as we decided to build a cloud-based prediction system and use state-of-the-art regression algorithms in Azure machine learning platform.

3. METHODOLOGY

While there are many tools available, we preferred Azure Machine Learning Studio due to its cloud computing capabilities and its easy to use nature. The collaboration with TARBIL, which is a focused science center on agriculture that has over 400 stations equipped with various sensors that monitor every phenological state of a field, enabled us to get the precise datasets for our experiments. In addition to those datasets, we also came across with a set of datasets focused on wheat yield in USA [9] which created an opportunity for another case study to evaluate our models.

During our experiments, every regression model available in Azure Machine Learning Studio is tested, however due to some constraints created by the datasets available to us we narrowed our regression options to four which are explained briefly below:

- 1. Linear Regression: Despite being the most simplistic method amongst other regression models, linear regression is frequently used in many case studies since what it simply does is to attempt to create a linear relationship between one or more features to be used for a prediction of a numeric outcome.
- 2. Bayesian Linear Regression: It is like linear regression approach however, it uses Bayesian inference that update probability distribution.
- 3. Boosted Decision Tree Regression: Using an efficient implementation of MART gradient boosting algorithm, Boosted Decision Tree Regression aims to build each regression tree in a step by step fashion, eliminating weaker prediction models.
- 4. Neural Network Regression: While neural networks are widely used for deep learning and modelling sophisticated problems, they can also be adapted to regression models where more traditional regression models falls short.

We had two different datasets one was from South-East region of Turkey the other one was from four states of United States of America. Having two sets of data, led us to approach this problem in two case studies. In case study one, we had both phenological data and crop yield information from nine different stations equipped with sensors for the years between 2013 and 2016 which enabled us to use the data from 2013 to 2015 for training and prediction 2016 yield results with given features (Figure 1).



Figure 1. All regression models tested for train and score model South-East Region of Turkey

After combining the two datasets to one both test and train datasets also run with ten-fold cross-validation settings as seen in Figure 2.



Figure 2. All regression models tested for cross validation model South-East Region of Turkey

Cross-validation evaluation helped us to compare our findings with second case study. In the second case study, we had more than 300.000 records in the dataset. However, since we had only two-years of data, we did not perform a test which uses an external test dataset. Therefore, we made only cross-validation experiment for this large dataset.



Figure 3 - All regression models tested for cross validation model

For the datasets from Turkey, yield information was in kilograms while in the USA dataset it was percentage based information.

4. EXPERIMENTAL RESULTS

As mentioned earlier, we applied four different regression models to our datasets. We applied 10-fold cross-validation approach for all the case studies and calculated the Coefficient of Determination parameter with the help of Azure Machine Learning Studio. Coefficient of Determination is a value between 0-1 which determines how close the prediction is to the reality. While experimenting, we have seen that both the features and the amount of data affect the results. As seen in Table 1 in our train/score model, the most simplistic approach which is the Linear Regression scored the best results. Neural Network regression failed because of the insufficient number of records. During the 10-fold cross validation experiments after adding the 2016 data to the training dataset which consisted of the data from 2013-2015 we observed significant changes on the results, especially for Bayesian Linear Regression. As the number of records raised in the dataset, Boosted Decision Tree regression had more information to train itself with better results.

In the second case study, we only had two years data with great amount of records for machine learning algorithms to learn from. As in Table 2 all the ten-fold cross validation results increased while Neural Network Regression model, unlike in the first case study, giving a satisfying result. With the lack of the past two year's data, we chose to base our web service on the first case study's dataset and developed further on from there. The web application we developed uses a basic input-output style interface to interact with the user and predict the crop yield when given the input. Input consists of the following features: Region and provenance of the field, current temperature, yearly maximum and minimum temperature, total precipitation, growing day degree, temperature difference parameter, Photo Thermal Unit, Helio Thermal Unit and evapotranspiration parameter.

5. CONCLUSION AND FUTURE WORK

The objective of the crop yield prediction studies is to forecast the crop yield as early as possible during the crop growing season. Weather and climate affect this agricultural production dramatically. In this study, we developed an end-to-end wheat yield prediction system using machine learning algorithms. Case studies were performed on the datasets retrieved from south-east region of Turkey and four states in United States. Linear

Regression algorithm provided the best performance in south-east region in terms of coefficient of determination parameter when external test set was used. Neural Network Regression algorithm was the best option for the US dataset when cross-validation analysis was applied. As part of the future work, web application can be replaced with a mobile application and new experiments can be performed when more regions are added to the datasets. Deep learning algorithms might be considered when the dataset becomes very large.

	South East Region of Turkey Wheat Yield ML Results			
	Regression Type	Relative Absolute Error	Relative Squared Error	Coefficient of Determination
	Linear Regression	0.484972	0.300939	0.699061
	Bayesian Linear Regression	0.643469	0.396072	0.603928
	Boosted Decision Tree Regression	0.669278	0.646339	0.353661
	Neural Network Regression	0.969594	1,4013830	-0,4013830
	Regression Type	Relative Absolute Error	Relative Squared Error	Coefficient of Determination
	Linear Regression	0.572134	0.391993	0.608007
	Bayesian Linear Regression	0.325579	0.157755	0.842245
	Boosted Decision Tree Regression	0.512205	0.329844	0.670156
	Neural Network Regression	1,7276340	3,7723160	-2,7723160

Table 1 South East Region of Turkey Wheat Yield ML Results

Unit	United States of America Wheat Yield ML Results			
Reg	ression Type	Relative Absolute Error	Relative Squared Error	Coefficient of Determination
Line	ar Regression	0.376717	0.173927	0.826073
Baye Regi	esian Linear ression	0.389548	0.180413	0.819587
Boo Tree	sted Decision Regression	0.105499	0.01352	0.98648
Neu Regi	ral Network ression	0.000736	0.000001	0.999999

Table 2 United States of America Wheat Yield ML Results

6. ACKNOWLEDGMENTS

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Using cognitive software to evaluate Natural Language Classifiers - A Use Case

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ABSTRACT

The current techniques for natural language processing can be used to identify valuable information such as sentiments or patterns recognized and adjusted for different topics. To apply these techniques, it is required to know how to use and tune prediction models. This requires time, experience and the implementation of different tests to ensure the correct behavior of the models. The aim of this paper is to detect the features to train and evaluate classifiers instances using optimized software, specifically, IBM Bluemix, and its module named Natural Language Classifier. The created classifier was trained with real tweets to classify the texts into three categories: Positive, neutral and negative texts. Afterwards, the classifier was validated with a set of already classified texts. The obtained results indicate how the number of training examples impact the behavior of the classifier and, that the highest accuracy was achieved for positive and negative categories.

Categories and Subject Descriptors

H.4 [Information Systems Applications]: Miscellaneous; I.2.7 [Artificial Intelligence]: Natural Language Processing—*Text analysis*

General Terms

Algorithms, Measurement, Experimentation

Keywords

Natural Language, Classifiers, Machine Learning, Bluemix, Watson

1. INTRODUCTION

The daily use of social networks currently results in the large-scale growth in the data and information generated in the world. There is an expected expansion of 40% per year and an estimated size of 50 times by 2020 [1]. Generated data are mostly texts created by users in social networks such as comments or tweets that, in some cases, have free

access, while in others, they can be accessed by purchasing on demand packages. This type of information allows companies to carry out market analysis or search for communities of potential clients [2].

The available literature presents several research projects about the algorithms and techniques used for natural language processing [3]. Their results indicate that the time required to implement such techniques and algorithms depends on users' previous mathematical knowledge and on the tuning of the mathematical functions used in the process. Therefore, despite the existing different solutions for text analysis, the implementation of such algorithms may be slow because of different influencing factors such as the tuning required for each process and the tests with different parameters.

To address this problem we evaluate the proficiency of a tool to analyze and classify texts generated from social networks. The texts classifications are labeled with the basic polarity used for sentiment analysis, i.e. positive, negative and neutral labels [4]. The databases for testing and training sets were obtained from the public Twitter API and the Spanish Society for Natural Language Processing (SEPLN).

Among the existing technologies for natural language processing, there are platforms such as IBM Watson, Microsoft LUIS, API.ai, WIT.ai, etc. We decided to use IBM Bluemix, which includes a large variety of Watson services, where the wide catalog of options can be used for intelligent chats, texts' classifications and understanding, as well as the demonstrated results and tests of Watson, such as the Jeopardy game. Here, Watson shows the proficiency to give right answers using natural language processing [5, 6]. We have used the Natural Language Classifier component of the Watson suite that uses convolutional neural networks to do the cognitive process from language [7].

This paper is organized as follows. We present the context and the research questions in Section 2. Section 3 summarizes the related work for tweets' polarity classification. The methodology to address the problem is explained in Section 4. Furthermore, we introduce a detailed explanation of the developed proposal in Section 5. The results of the provided work are shown in Section 6. Finally, Section 7 brings the conclusions of the paper.

2. CONTEXT AND RESEARCH QUESTIONS

During the classifier training, problems such as over-fitting or poor estimation of the models for the training sets, might occur [8, 9]. These factors should be taken into account in order to avoid a bad prediction. Furthermore, adjusting and finding the correct parameters for the adequate behavior of the algorithm is a task that demands time and effort. Technologies, such as IBM Bluemix, already have a set of services used for the natural language processing. These can be solutions that save time consumed for the tuning of classifiers.

The identified problem and the context of using classifiers through the natural language processing for sentiment analysis (polarity) in text, particularly tweets, results in the definition of the following research questions:

- Which are the characteristics under which a classifier should be trained using technologies for the natural language processing and sentiment analysis?

- How effective are classifiers trained using frameworks and automated tools for natural language processing and sentiment analysis?

3. RELATED WORK

One of the most treated problems found in the studied literature is data pre-processing before being used to train classifiers. Elements such as sarcasm, expressions, abbreviations, among others, can generate erroneous predictions. Khan et al. [10, 11] focused on developing classifiers with good preprocessing before training. At the same time, they propose hybrid models based on the classification of emoticons, bags of words, etc. For pre-processing, procedures were proposed such as searching dictionaries to check the existence of terms, replacing abbreviations, completing incomplete words and performing spelling checks.

Mertiya et al. [12] proposed the usage of bayesian classifiers to obtain the polarity of a database of tweets that results in classifications with several false positives, which are submitted to an analysis of adjectives in order to be polarized correctly. The problem with this type of classifiers is that the short texts of the tweets have a characteristic named sparsity, meaning that the data is not very significant, therefore, the classifiers may have errors or bad predictions.

To avoid the problems that happen when this type of short texts are classified, He et al. [13] proposed a different approach using a clustering algorithm called k-means in order to discover related topics, based on the premise that the texts will be more informative if they are grouped into similar topics. Then, the obtained clusters are used to train a bayesian classifier.

Almeida et al. [14] performed an evaluation of supervised al-

gorithms for mining opinions on twitter and emphasized the actions of cleaning and pre-processing the information before it is submitted to a classifier. Furthermore, they proposed a process to make similar classifications according to the process carried out in this study, not only based on polarity and sentiment analysis, but also on the objective classification of the opinions expressed in the texts.

Finally, several of the papers found in the literature identified different problems related to various types of classifiers and, accordingly, there are models that attempt to solve the issues combining different types of classifiers. Lima et al. [4] and Brahimi et al. [15] proposed hybrid solutions to improve classification results using bayesian classifiers, support vector machines, decision trees and k-nearest neighbors. These types of solutions make it possible to increase the accuracy of classifications and to evaluate which learning methods perform best.

The different algorithms and techniques found in this related work are processes that require time in each of the different phases: Pre-processing, extraction, development or algorithms' testing. In this work, we use algorithms already tested in order to speed up the sentiment analysis and polarity detection in tweets. We used IBM Bluemix specifically Watson and its Natural Language Classifier module.

4. METHODOLOGY

We propose an approach for the tool evaluation through the method developed by Wieringa et al. [16]. We try to solve a problem through an engineering cycle, which is carried out by the treatment or planning of solutions, and is validated with questions and answers that we made before and after the treatment. The expected effects are mentioned, and finally, the process is concluded using the results obtained in the treatment. The treatment of this work is described based on the process carried out for the supervised learning introduced by Kotsiantis [17], where the emphasis is on the pre-processing of the data. In order to validate the results, a database with texts of already classified tweets was obtained through the Spanish Society for Natural Language Processing (SEPLN).

5. USING NATURAL LANGUAGE PROCESS-ING

We based our proposal on the supervised learning process presented by Kotsiantis [17], where we start with the identification of the required data. Figure 1 shows this process's steps, which are modified for the use case described in this study. First, we obtained the training sets from our own tool, and then we made the texts' pre-processing for their correct interpretation in Watson. Furthermore, we present the contribution for the use of Bluemix.

5.1 Data identification

The used data are the different texts from the tweets database. We used Cloudant, a managed NoSQL JSON database service, to perform querying easily through an HTTP API. We imported the data in order to create the training sets.



Figure 1: Supervised learning process exposed by Kotsiantis [17] and complemented in this paper.

5.2 Definition of the training sets

To facilitate the selection of the tweets, we developed a web application in Node.js which makes queries to the database and selects a tweet randomly. The selected tweet must be assigned to one of the defined classes (positive, negative or neutral). If it is not possible to label it with one of these polarities, labeling can be omitted or N/A (not applicable) selected. When each class contains approximately 600 tweets, they are exported in CSV format using a script in Node.js which queries the instances through the Cloudant HTTP API.

5.3 Data pre-processing

The texts used as training should go through a cleanup process where special characters like quotes and break lines are replaced as indicated in the Bluemix documentation. For example, each text must be enclosed in quotation marks, if this character is repeated, it must be added twice, i.e. replacing " so as "" to distinguish it from the one that encloses the training text. We perform this process when the CSV file is created. Table 1 shows a file example with two columns, the first one has the training texts and the second the class to which each sentence corresponds.

5.4 Training the classifier

We used the HTTP API of Bluemix, which, through a web service, creates the classifier from the training file separated by commas. At the beginning the classifier is in a training state. The time the classifier needs to be prepared for the consultation varies, depending on the size of the training set.

Table 1: File structure and example			
Text	Class		
"Let's leave the skin to create a job and our econ- omy grows again. #MensajeGriñan"	positive		
"2012 will be a year of titles. Play in a team. Win as a team. Who's with me?#makeitcount http://t.co/Ue7Kh2De"	positive		
"#FF @BRmodainfantil moms with children, do not miss it, the best online shop for children's fashion!"	positive		
"Impressed by the violence of the media in Mo- rocco. Pushing to photograph Rajoy in Rabat"	negative		
"The one who does not want to follow me does not follow me, but the masochist must stop com- plaining and enjoy"	negative		
"These are hard times for everyone! The worst thing will be the staff adjustments, which will not be delayed"	negative		
"You can also follow it in the channel 24 hours of RTVE"	neutral		
"A few hours remain to close the last draw of the year. There is still time to sign up"	neutral		
"In the Vatican City"	neutral		

Finally, the classifier can also be consulted through HTTP requests. The obtained results are the probabilities that an evaluated text could be in each class.

5.5 Evaluation with the test set

To perform the evaluation of the created classifier, we used a test dataset with texts already polarized by the SEPLN. We used 15,000 texts to retrain the classifier in order to make comparisons with the first training set and, at the same time, be evaluated with a test subset taken from the total texts.

After we retrained the classifier, we used a subset from the test database to perform the validation and test the accuracy for the classifier with the respective training sets. We took 300 texts for each class, i.e. in total there were 900 tweets, to test how much the classifiers instances approached their predictions regarding their polarity from the SEPLN. We use these 900 texts in both classifiers instances to compare the results.

6. **RESULTS**

Following the proposed engineering cycle, and based on the results from the performed tests, some answers can be derived for the raised research questions. Regarding the effectiveness of the classifiers, the results obtained were acceptable in the positive and negative classes for the second training set. The neutral texts class presents results varying in both tests, which leaves evidence of the subjectivity that this type of sentences present. It is important to note that the texts have not been filtered by any process to remove stop words, URLs, hashtags, and other types of words that could affect the classifiers' prediction. Tables 2 and 3 show the results for the first and the second training set.

We observe that the classifier with the second training set presents better results than the classifier with the first training set. The second training set was created with 15,000 records, which is the maximum number of records supported

 Table 2: Results of the test set for the first training set

	Total	Right pre- dictions	Right predictions' rate
Positive	300	105	35%
Negative	300	158	52.6%
Neutral	300	191	63.6%

Table 3: Results of the test set for the second training set

	Total	Right pre- dictions	Right predictions' rate
Positive	300	235	78.3%
Negative	300	254	84.7%
Neutral	300	147	49%

Table 4: Accuracy for each training set

	Training set 1	Training set 2
Accuracy	50.4%	70.7%

by the Bluemix Natural Language Classifier module. It is probable that the large set of texts and the type of texts used by the SEPLN, made the classifier with the second training set get a better prediction and closer to the original polarity of the test database. It is also probable that the class for neutral texts will be more subjective and, therefore, could be the reason for obtaining different results in the two tests. We conclude that the classifier obtained better results with the second training set because of the large number of examples.

7. CONCLUSION

We proposed the usage of natural language classifiers, using IBM Bluemix and its services for text analysis, in order to speed up the process of parameterization and algorithms' tuning. We conclude that the classifiers created in this manner have a good effectiveness according to the texts' cleaning process. The neutral classification is the most subjective and prone to bad predictions. It is important to emphasize that the cleaning process has a great influence on the classification results, in addition to the subjectivity in the creation of the training sets.

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An Analysis of BPMN-based Approaches for Process Landscape Design

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ABSTRACT

Process landscapes represent the top part of an organizational process architecture. As such, they define the scope and relationships between its processes. Process landscapes diagrams simplify process-related communication by leveraging the benefits of visual notations. However, in contrast to business process diagrams, where nowadays BPMN is the prevalent notation, process landscape diagrams lack of standardization. In the article, we review and analyze notations used for modeling process landscapes, as well as non-normative BPMN-based approaches applicable for their representation. Based on analyzed approaches, we evaluate the applicability of BPMN for process landscape design.

Categories and Subject Descriptors

C.0 [Computer Systems Organization]: General - Modeling of *computer* architecture; D.2.9 [Software engineering]: Management – Software process models (e.g., CMM, ISO, PSP)

General Terms

Management, Documentation, Standardization, Verification

Keywords

Process landscape, process map, BPMN, analysis

1. INTRODUCTION

A common starting point for process design and all activities related to BPM is to identify and structure organization's processes (i.e. process identification phase) [1]. Regularly, users tend to represent identified processes in a visual manner in the form of a process landscape (i.e. process map) diagram.

The main purpose of process landscapes is to specify organizational processes on a bird's-eye view. With process landscapes, an organization can more easily gain an overview of its main processes and their major interdependencies. Therefore, the usage of process landscapes simplifies process-related communication and represent a starting point for detailed process discovery (i.e. AS-IS process modeling). Besides, process landscapes are a common way to represent processes-based reference models for the operation (e.g. ITIL, CMMI) and the management (e.g. COBIT) of organizational IT infrastructure and services.

There are no standardized languages for creating process landscapes. Consequently, modelers most commonly define their own 'overviews of processes' by imitating existing diagrams (e.g. value chains) or proposing their own more or less intuitive representations. A common approach for BPMN experts is to represent process landscapes with a subset of BPMN elements. However, despite BPMN is an ISO and de-facto standard for process modeling, landscapes are out of its scope.

While the non-normative BPMN-based process landscape diagrams appear in practice, this article reviews and analyses related approaches to identify their strengths and weaknesses. Based on analyzed approaches, we evaluate the applicability of BPMN for such modeling purpose.

2. PROCESS ARCHITECTURES AND LANDSCAPES

Process landscapes represent the top part of a process architecture - a conceptual model that organizes processes of a company and makes their relationships explicit (Figure 1).



Figure 1: A conceptual representation of a process architecture

A process architecture usually defines two types of relationships: horizontal and vertical. Horizontal relationships define 'output/input' relationships between processes, i.e. the outcome of a process represents an input for the next process, (e.g. 'consumerproducer' or 'order-to-cash' relationship). Vertical relationships between processes define different levels of details of a process, i.e. a process diagram on a lower level represents a more detailed view of the same process on the level above.

The top-level of a process architecture is commonly reserved for process landscape diagrams. A single process landscape diagram shows the main processes of an organization as well as the dependencies between them, which is shown in the Figure 2 and Figure 3. Those two figures represent the two examples of process landscape diagrams with processes as 'black-boxes' and arrows representing the flow of deliverables between different processes. Rectangles represent the stakeholders, external to an organization.



Figure 2: An example landscape diagram (ISO 9001)



Figure 3: An example landscape diagram [2]

A process landscape diagram serves as a framework for defining the priorities and the scope of process modeling and redesign projects. Each element of a process landscape model may point to a more concrete business processes on the lower levels.

2.1 Process landscape notation

A visual notation (i.e. visual language, graphical notation, or diagramming notation) consists of a set of graphical symbols (visual vocabulary), a set of compositional rules (visual grammar) and definitions of the meaning of each symbol (visual semantics). A common denominator of process landscape diagrams (Figure 2 and Figure 3) are the following elements:

a. **Business process.** Although not explicitly defined, the landscape diagrams clearly highlight the concept of a business process. Visually, a business process is frequently represented with an arrow, where there are also alternative representations, e.g. a rectangle and a rectangle with rounded corners (Figure 4).



Figure 4: Business process symbols

b. Process groups / types. On a process landscape diagram, the business processes are commonly distinguished by their purpose (e.g. core processes, management processes and supportive processes), which is visualized either by (1) encircling and labelling a set of processes (Figure 5, left) or (2) specializing the process symbol for individual types of processes (Figure 5, right).



Figure 5: Representation of a group (left) and/or type of processes (right)

Besides manipulating the shapes of symbols, the planar visual variables and symbol orientation might imply the type of a

process. E.g., supportive processes are usually positioned below the core processes, with arrows pointing up, whereas management processes are positioned above them, with arrows pointing down (Figure 5).

c. Parent / **child process relationships.** Processes may be hierarchically organized which is represented either by (1) visualizing sub-processes by using (visual) sub-sets or (2) by using non-directed solid lines between processes as common in 'organizational charts' (Figure 6).



Figure 6: Hierarchical relationships between processes – subsets (left), organigram-based (right)

d. **Process sequence**. The sequence which defines the order on how processed are performed is mainly represented implicitly with a horizontal sequence of process symbols (Figure 7, the left process is performed prior to the right one).



Figure 7: Implicit representation of a sequential relationship between processes

However, since this implicit representation of a sequential relationship enables only a simple linear relationship between processes, explicit representations of processes orderings are visualized with solid directed lines (Figure 8). Another drawback of implicitly ordering the processes is that a diagram reader could misinterpret a set of non-sequentially performed processes, put in a line, as being performed sequentially.



Figure 8: Explicit representation of a sequential relationship between processes

Arrows-based representation of process ordering enables more complex ordering relationships (e.g. when a process ends, two processes are initialized). Sequential relationships might be labelled, representing artefacts or data being transferred between processes (i.e. process outputs – process inputs as presented in the Figure 3).

e. **Participant.** A participant, usually visualized with a rectangle (Figure 9), presents someone who is involved (i.e. internal participant) or interacts (i.e. external participant) with a business process. Most commonly, process landscapes visualize external participants (e.g. suppliers and customers), which are related to processes, either by providing inputs or receiving outputs. This corresponds to the concept of a 'value system' which consists of following value chains: supplier, the focal enterprise and consumer [2]. The relationships to participants are represented either implicitly (e.g. with leveraging visual planar variables) or explicitly (with solid arrows).



Figure 9: Representation of (external) process participants and their (explicit) relations

3. BPMN-based approaches

Business Process Model and Notation (BPMN) is a wellestablished standard for process modeling and automation [3]. From the modeling aspect, it defines a vocabulary, grammar and semantics for creating different types of process diagrams, namely: process diagrams, collaboration diagrams, choreography diagrams and conversation diagrams. In light of process diagrams, BPMN states that [4] "processes can be defined at any level from enterprise-wide Processes to Processes performed by a single person.". Although this could be understood as BPMN supports modeling of process landscapes, they are not mentioned in any version of the specification, nor recommended by researchers [5].

Nevertheless, since BPMN is widely adapted by industry, modelers frequently use BPMN for visualizing systems of black-box processes (i.e. some kind of process landscapes) by applying the approaches, presented in the next sub-chapters.

3.1.1 Abstract collaboration diagrams

A common and syntactically valid BPMN representation of process landscapes is to use black-box Pools and Message flows, i.e. collaboration diagrams with hidden details (Figure 10). A BPMN Pool is a visual representation of a Participant, which may reference at most one business process. A Message flow represents exchange of messages between two 'message aware' process elements (e.g. activities, message events and black-box Pools).



Figure 10: BPMN Pools and Message flows

The strength of such representation of a process landscape is compliance with BPMN specification and simplicity. On the other hand, there are several drawbacks. First, the visual appearance of this approach is unconventional for process landscapes (i.e. processes being represented with rectangles). Second, the relationships between processes represent information exchange, where process landscape diagrams most commonly visualize sequential relationships between processes and processes clustering. Third, there is a lack of concepts, which may be regularly used for landscape modeling, namely, sequential relationships, process hierarchy and process types, whereas there is a symbol deficit in case of representing a participant and a process (rectangle symbol is used in both cases).

3.1.2 Conversation diagrams

Conversation diagrams. Another valid way for representing process landscapes in BPMN is by using Conversation diagrams (Figure 11), which were introduced in the second major revision of BPMN. Formally, they are not a standalone type of BPMN

diagrams but merely an abstract view of BPMN collaboration diagrams.



Figure 11: BPMN Conversation diagram

Conversation diagrams are an effective way for representing interactions between processes; however, similar to previous approach, they are based on a small set of elements, which are inappropriate for modeling of conventional process landscapes (i.e. conversation nodes, representing correlated messages and pools, representing participants or processes).

3.1.3 Enterprise-wide process diagrams

As stated in the specification [4], BPMN can be used for business process modeling on any level of granularity. In accordance to this, the system of an organization's processes may be modeled as a single process consisting of individual processes being modeled as activities, i.e. sub-processes (Figure 12).



Figure 12: BPMN Sub-processes representing processes

By using this approach, one is able to present the majority of process landscape constructs, namely processes (i.e. with BPMN sub-processes), sequential interactions (i.e. BPMN sequence flows), groups or types of processes (i.e. BPMN group element) and participants (i.e. BPMN lanes). However, there are several major drawbacks of this approach. First, such diagrams are visually inconsistent with process landscape diagrams (e.g. processes being represented with rounded rectangles and participants with horizontal lines). Second, these diagrams are inconsistent with BPMN syntax and semantics, making them invalid (e.g., BPMN Process and BPMN Sub-process are two distinct BPMN metamodel elements). Third, this approach is also impractical, since the majority of processes are discovered on a lower level of granularity (e.g. based on the services or products a business process delivers) and afterwards interrelated into a process landscape diagram.

4. **DISCUSSION**

Table 1 summarizes a comparison of BPMN-based approaches for landscape design in respect to common process landscape concepts.

In respect to abstract syntax comparison, we can conclude that none of aforementioned BPMN approaches supports all of the concepts common in process landscapes modeling. Besides, the following inconsistencies exist. The first and second approach uses the same element for representing a participant and a process – BPMN Pool (i.e. symbol overload), whereas the third approach uses element BPMN Activity in contrast to its definition (i.e. semantics).

Process landscape	Common	BPMN	approach for landscapes modeling	
concept	visualization [–]	1 - Abstract collaboration diagrams	2 - Conversation diagrams	3 - Enterprise-wide process diagrams
Business process	See Figure 4	BPMN Pool	BPMN Pool	BPMN Activity +
Process group / cluster	See Figure 5, left	BPMN Group	BPMN Group	BPMN Group
Process type	See Figure 5, right	No standardized BPMN element	No standardized BPMN element	No standardized BPMN element
Hierarchical relationship between processes	See Figure 6	No standardized BPMN element	No standardized BPMN element	Parent activity – child activity relationship
Sequential relationship between processes	See Figure 7 and Figure 8	No standardized BPMN element	No standardized BPMN element	BPMN Sequence flow
Information flows	See Figure 8	⊃– – – – – – BPMN Message flow	Conversation Node	>> Directed association
Internal and external participant	See Figure 9	BPMN Pool	BPMN Pool	BPMN Pool

Table 1: Comparison of BPMN-based approaches for landscape design

In respect to the concrete syntax comparison (i.e. notation), Table 1 demonstrates that none of BPMN approaches result in diagrams with a graphical similarity to common landscape diagrams.

According to above, we can conclude that BPMN is inappropriate for modeling the process landscapes. This finding is also supported by Freund and Rücker [6], who state that 'even when we've already modeled one or more process landscapes using BPMN at a customer's request, primarily with the collapsed pools and message flows described we cannot recommend doing this'.

Analytically, this was confirmed by Malinova [7], who performed a semantical mapping between BPMN and 'Process maps'. Her results show that BPMN is not appropriate for process landscape design.

According to the benefits and weaknesses of existing approaches for (BPMN-based) process landscape design, following research directions are feasible. First, a standardized language for process landscapes may be designed by considering the best practices of non-formal process landscape notations. The focal risk of this research direction is to develop a solution, which has to gain standardization and industry adoption. Second, BPMN structure and the notation may be extended for effective support of process landscapes. In this case, the major risk is the intervention into the structure and notation of a well-adopted and standardized language.

5. ACKNOWLEDGMENTS

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Approach to an alternative value chain modeling

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ABSTRACT

This paper is focused on describing an alternative approach to modeling value chains, which are an important part of presenting business activities, and the value each activity delivers. They document translation of data and services into business value, essential in times of ever growing productivity and competition. There are several possible notations for value chain modeling, each holding specific characteristics. Since each domain has its own demands, the goal of this paper is focused on finding the most suitable approach to modeling based on one or more notations, addressing a representative domain within smart cities (a case study of the health domain is included). An approach to value chain modeling is supported by existing notations and documentation techniques.

Categories and Subject Descriptors

H.5.3 [Information interfaces and presentation]: Group and Organization Interfaces - *collaborative computing*, organizational design.

General Terms

Documentation. Design.

Keywords

Value chains, use cases, smart city.

1. INTRODUCTION

The paradigm shift in business practices is going from the "product-driven orientation" of the past to today's "customerdriven orientation", which is characterized by increased demand of variability, product variety, amounts of customer-specific products, and shortening product life cycles [1]. Therefore, it is beneficial to the business to identify the key activities and capabilities that flow through the business and define a value chain [2]. A value chain is a high-level model intended to describe the process by which businesses receive raw materials, add value to the raw materials through various processes to create a finished product, and then sell that end product to customers. The concept was suggested by Michael Porter in 1985 [4]. The raw material and product concept can also be transferred to business services and different, intangible business goals. For achieving business goals, companies have to cooperate with or within each other, and their value chains are connected in socalled value systems. Each value system consists of a number of value chains, each of which is associated with one enterprise.

A value chain simplifies complex value systems, since it breaks down the activities a company performs, and analyzes their contribution to the commercial success. In a way it organizes the activities of an enterprise. For example, value chains are a well-known approach in business administration to organize the work that a company conducts to achieve its business goals. Value chains are often used in business modeling for different areas, e.g. medicine, lists of online services, etc. In this paper, we propose an adapted approach to model value chains in the smart city domain, where the value chain describes the transformation cycle of data into value for the benefits of citizens and the community [3].

After the Introduction section, the history of value chain notations is presented in Section 2. The proposed approach is described in Section 3, supported by an example of modeling value chains in Section 4. Lastly, conclusions and future work are presented.

2. VALUE CHAINS

The idea of value chains is to represent an organization as a system divided into subsystems with inputs, transformations and outputs. The process of turning inputs into value-added outputs usually consists of various activities, where some of them are primary, and others are supporting activities [5]. The most common notation for a value chain is by Porter; often used within EU projects like "Project BLUENE", "European Big Data Value Partnership Strategic Research and Innovation Agenda", "European Data Portal". Porter's value chains are, basically, used to identify activities conducted by specific companies, with the purpose of providing a product or a service. They can be applied in different fields, such as the definition of B2B and B2C segments in any field. An example of a classic Porter's value chain is presented in Figure 1.



Figure 1. Classic value chain by Porter [4]

With Porter, notation support is provided to describe not only classic supply chain processes, but also services and collaborations among companies that use them. Despite their popularity, classic value chains are useful only in a limited range of domains. The main disadvantage is their manufacturing oriented format. Therefore, other forms of value chains appeared, especially in the field of ICT, where there are several alternatives to value chain modeling. The first who applied value chains to Information Systems were Rayport and Sviokla within their work on virtual value chains [6]. Some other relevant value chains in the ICT domain are the following:

- Service value chain the relative value of the activities required to establish the product or service,
- Service value network a dynamic way of providing services based on a coordinated value chain of companies,
- Value stream mapping a method for analyzing the current state and planning a future sequence of events that lead the product or service from beginning to client,
- Data value chain information flow is described as a series of steps needed to generate value and useful insights from data [7],
- **Big data value chain** –modeling the high-level activities that comprise an information system, and
- **Digital value chain** –a set of processes designed to transform raw data into actionable information that can drive better decisions and insights [8].

Every value chain begins with inputs. In manufacturing, these are raw materials like steel or wood, while in the field of ICT raw materials can be considered as raw data. In this step, heterogeneous data can be gathered from mobile internet devices, sensor-devices, or extracted from existing sources in structured or unstructured format. Applying new technologies to existing products, practices and processes can be best described with digital value chains, the activities of which are depicted in Figure 2 and described in the continuation.



Figure 2. Digital Value Chain [8]

Raw data does not have any value until it is processed. Therefore, in the second step, collected data is processed and, if necessary, mashed up and/or visualized. In the processing, activity data is transformed and mapped from raw format to determined format trough actions such as parsing, joining, standardizing, augmenting, cleansing, consolidating and filtering. Processed data can be combined and exposed through the web APIs, which are analogous to components in manufacturing. More details on this activity are presented within data value chain [9]. As an output, a refined data is provided, new information, or even enhanced functionality, which can be input into the next value chain or used by application developers, leaders or other end users. Application developers can take aggregated data streams and combine them in any number of ways to create information components. Leaders can help with new visualizations to improve decision- making, and others can use information and services to improve their effectiveness [9]. Sharing outcomes is important for promotional purposes, to inform not just end users about it, but also especially developers, who can use it as inputs to develop new innovative solutions. The final step is actually repeating. With new data, technology updates and a new audience, a digital value chain is changing constantly.

3. PROPOSED APPROACH

Despite several notations which were listed and described briefly, none of them fulfilled completely the needs of a complex smart city. In this paper, a proposal of an alternative approach is given, aggregating existing practices, adjusted to the needs of a smart city domain. Usually the aim of the value chain is to increase profits by creating a value, but value chains can also be used to identify opportunities where end users benefit from the final outcome. In the ICT domain, identification of value chains needs detailed consideration of existing problems, obstacles, potential improvements based on ICT, and the inclusion of various stakeholders. The approach described in this paper is based on digital value chains and on documenting existing data, services and processes. It is designed to address and solve issues in several smart city fields using ICT tools and techniques. The most important activity is the documentation of key challenges, target groups and actors, existing data sources, web services and potential scenarios.

In the process of identification and documentation of challenges, each challenge was described clearly with all specifics and details, so that everyone could understand it. References to a service, which presents a potential solution were also provided. An example of current challenges in the context of health would be long waiting hours, unnecessary visits to the doctor and improved control of a patient's progress.

A list of target groups describes key actors who are involved in scenarios. Some of the actors are providers, and others are end users such as citizens.

By documenting available data sources and services, various information needs to be provided. Besides the title and description, each end user must understand the data or service purpose and benefits, know who are the owners and potential consumers, and has to be informed about accessibility, privacy restrictions and price. In the case of web services, input and output parameters are important as well.

Based on the inventory of existing data and services, potential scenarios can be defined. Each scenario is described through flow of events with alternatives, and the entire concept is presented with use cases. Some additional information regarding initiating events, participants, included services, inputs/outputs and execution is also provided.

4. AN EXAMPLE OF MODELING A VALUE CHAIN OF A HEALTH CARE SCENARIO

In this chapter, a real example is presented of an applied approach to value chain documentation in the smart city domain. Customized value chains have already been used to define the role and impact of ICT in developing smart cities within other related works [10].

Value chains were designed in accordance with our approach within the EkoSMART program, the purpose of which is to develop a smart city ecosystem with all the supporting mechanisms necessary for efficient, optimized and gradual integration of individual areas into a unified and coherent system of value chains [11]. One of the most important objectives of the program is to integrate solutions from different sectors into a common ecosystem. The resulting value chains, based on technologies like electronic and mobile devices, related software solutions and intelligent data processing, are enhancing the quality of current services. Moreover, sectoral value chains will be inputs for the cross-sectoral value chains.

4.1 Smart cities and their characteristics

Cities are marked with locations that have a high level of accumulation and concentration of economic activities; they are spatially complex and connected with transport systems. The larger the city, the greater the complexity and the challenges and the risks of disturbances. The fundamental paradigm of the present world is the continuous technological advancement, which, on the one hand, represents a certain proportion of new problems, but, on the other hand, technology is precisely the one thing where key solutions to this problem can be found. Since the world cannot be "reversed", it is necessary to look for suitable solutions that would facilitate modern pressures to focus on the core of new life, which is represented largely by Information and Communication Technologies (ICT). The quality services provided by ICT can relieve people greatly, help them with time optimization, organization, and, last but not least, motivate them.

The purpose of the field is to develop approaches and prototypes, which provide the basic conditions for effective transformation of the healthcare, traffic, energy, waste and other systems, focusing on the following main fields:

- Smart economy,
- Smart people,
- Smart governance,
- Smart mobility,
- Smart environment.
- Smart living.

In the context of a smart city, a value chain is defined as connected activities within a particular sector with various stakeholders, which collaborate with the aim to provide quality services to enhance the life quality and/or strengthen economic growth in an environmentally friendly manner. Designed value chains are intended for data owners, service providers, application developers, city leaders, citizens and others.

4.2 Designing a value chain for the Health sector

In the Health sector, value chains were identified that should be considered within the context of the introduction of smart healthcare services, like telemedicine and telecare. The main goal is the preparation of quality and comprehensive healthcare services using ICT tools and techniques, where value chains are designed to identify and upgrade the occasionally problematic quality of today's treatment and care of these groups, primarily through the use of electronic and mobile devices and related software solutions, in particular artificial intelligence in the cloud, or locally, for example, on a mobile device or with customized sensors and carrying devices. A connection of existing solutions is planned with new smart city solutions. By documenting health processes based on meetings with representatives from the field, the following problems were detected:

- Multiple treatments
- Distribution of services
- Inflexible working time and poor ordering system
- The burden on healthcare personnel and the long waiting period
- Patient monitoring disabled
- Inaccessibility of data
- Deficient legislation, missing Standards and protocols



Figure 3: Use case diagram for health vertical.

In order to address these problems effectively, target groups were identified in addition to data and services which are needed to enhance existing processes. All the parts were described and connected in a comprehensive diagram of use cases, which includes a list of activities of identified participants (Figure 3). The common use case diagram includes several possible application scenarios.

Individual usage scenarios were also presented in more detail with a detailed description, characteristics, flow of events and separate use case diagram. The *Establishing treatment* scenario is explained as an alternative value chain presentation, where activities are as follows: The patient has a problem, (1) Enters the system, (2) The system is assigned a medical treatment, and (3) The patient follows this treatment, trying to achieve the set criteria. Characteristics of the scenario are categorized in the following groups: Basic information, People and IT, Inputs / outputs and Implementation. Table I represents actual characteristics for the *Establishing treatment* scenario.

A high-level representation of a final value chain with participants, inputs, outputs and intermediate assets can be seen in Figure 4. The value chain has four pillars: Participants, Input Data, Information/Services and Output results. The participants are the providers as well as users of the service, followed by all data necessary and, further, more services, designed by and for the participants, based on accumulated data. Finally, based on all previous pillars, final services with added value for the city (or company) in the form of different outputs and results are presented.



Figure 4. High-level representation of a value chain in the Healthcare domain.

Table I Characteristics for the scenario "Establishing treatment"

Scenario name	Establishing medical treatment		
Description of	The purpose of the scenario is to		
the scenario	describe the initialization of the		
	treatment of a patient with a chronic		
	disease. The scenario involves ordering		
	a patient for a review where the doctor		
	gives them a treatment, and the nurse		
	introduces treatment information and		
	informs the patient of the use of the		
	assigned equipment and the		
	implementation of the activity.		
Variants	If the patient has several treatments, the		
	doctor will obtain further findings and,		
	on the basis of communication with		
	other doctors, will form a joint therapy		
The trigger of	The process is passed by a patient who		
the scenario.	comes to the check due to the problem.		
Participants	Patient, Health personnel		
Included services	A service for entering data processing		
	and Editing educational content		
Scenario input.	Patient information, Data processing		
Scenario output	Program, Schedule, Therapies,		
	Educational content		
Activities	Obtaining / entering patient		
	information, Data entry information,		
	Entering therapy, Establishing patient /		
	doctor and doctor / doctor		
	communication, Editing educational		
	content		

5. CONCLUSION AND FUTURE WORK

Graphical presentation value within any company is an important part of understanding the focus of business processes, their strengths and weaknesses. Several techniques can be used to present the value flow. However, a combination of notations was used for the purpose of presenting the smart city complex system of users, data, services and scenarios. A use case diagram was used to present the behavior and set of actions of several participants. Within a use case diagram, several scenarios can be derived; each scenario defined in the form of a Table (characteristics of a scenario). Lastly, a high-level representation of a value chain is presented (including the four value pillars). In the future work, refinement of the approach will be performed.

6. ACKNOWLEDGMENTS

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Using Property Graph Model for Semantic Web Services Discovery

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ABSTRACT

Web services have significantly contributed to the integration of different businesses. Service-oriented computing (SOC) paradigm still represents an implementation challenge for developers. Several approaches have been developed over the years for different processes related to Web services. Nowadays, traditional Web services are often supplemented with semantics to achieve higher levels of automation and interoperability. In this paper, a new approach for semantic Web services discovery based on property graphs is proposed. The proposed model proves that the semantic Web service model specified in OWL-S language can be represented as a property graph, which can be queried to discover Web services based on query parameters.

Categories and Subject Descriptors

H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval – *Query formulation, Retrieval models, Search process, Selection process.*

H.3.5 [Information Storage and Retrieval]: Online Information Services - *Web-based services*.

General Terms

Design, Languages, Standardization, Theory.

Keywords

Labeled property graph model, web services discovery, PGQL.

1. INTRODUCTION

Application integration is an important challenge in the modern business environment. Over the years, many concepts and solutions have been developed to address this challenge (e.g., middleware or Enterprise Application Integration solutions). The most recent solution for integrating multiple applications are Web services. Their compliance with the existing Web technologies and standards and platform independency represent a significant advantage.

Web services can be defined as a "software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards."[17].

Nowadays, due to the information overload of SOAP messages, RESTful Web services are used more often. Since their focus is on resources[11], the messages exchanged between applications have a simpler format, which makes REST services a simpler alternative to SOAP-based services, which is more applicable in many situations. Through both technologies, the client can access and retrieve the required data from a specific Web service by invoking the correct interface method of that service.

According to [16], each Web service should be capable of being defined, described, and discovered. Web service description process can be divided into three layers[14]:

- 1. service invocation
- 2. service publication and discovery description
- 3. composite web services description

Recently, the concept of SOA has been supplemented with semantic Web concepts, which resulted in semantic Web services (SWS) technology. SWS enables the Web services to be automated and carried out by intelligent software agents [4]. In SWS, additional meaning is added to the basic Web service information. Thus, the main motivation behind this technology is to increase the level of automation of information processing, and to improve the interoperability of Web services.

There are several languages developed for semantic Web services as well. OWL-S is the most popular Web service ontology used for SWS description. In OWL-S, a semantic Web service description consists of three elements [8]:

- service profile contains general information about the service (name, description, inputs, outputs, preconditions, results)
- 2. service model contains information about how the service works (by using structures like loops, sequences, etc.)
- 3. service grounding contains information about how to use the service

In this paper, the focus will be on the **service model** element. The process of semantic Web services discovery will be discussed by analyzing several models proposed in the literature. Based on this work, a new approach will be proposed and explained.

The rest of the paper is organized as follows: in Section 2, different approaches for semantic Web services discovery process will be discussed. In Section 3 and 4, labeled property graph model and the property graph query language (PGQL) properties will be explained. In Section 5, the new approach will be introduced and described. Finally, a conclusion will be made to summarize the characteristics of the proposed approach and challenges, which will be further analyzed in future work.

2. SEMANTIC WEB SERVICES DISCOVERY APPROACHES

Web services discovery in general is "the act of locating a machineprocessable description of a Web service that may have been previously unknown and that meets certain functional criteria" [15]. The goal of the process is to find an appropriate service within the Web service directory which meets some predefined criteria. It is worth mentioning that in recent years the importance of other nonfunctional criteria (e.g., reliability, response time, availability, etc.)[12] has also been recognized, which led to the development of different Quality of Service (QoS) modeling approaches in the (semantic) Web services description, discovery and composition processes.

As already mentioned, OWL-S is one of the ontology languages, which can be used in the SWS discovery process. OWL-S service model contains Web services viewed as a collection of processes, which represent the specification of how the client interacts with the service [9]. If the process receives information and returns some new information based on its input, the information production is described only by specifying inputs and outputs of that process. Otherwise, if the process makes more complex transformations and changes, then the production is described by the process preconditions and results [9]. A process may require some information to be executed, i.e., it can have any number of inputs, and it can also produce any number of outputs for Web service requestors. Thus, process inputs and outputs specify the data transformation, which takes place during the process execution.

A sample OWL-S service model is shown in Fig. 1. A Web service called "BorrowedBooks" is shown as a process, which returns the Transaction ID, client name, date when a requested book was borrowed, and whether the book was returned for a given title of the book and its author. Input information is shown as an incoming edge, and output information as the outgoing edge from the process.

Many different approaches have been proposed in the literature for the discovery (selection) process.



Figure 1. Sample OWL-S service model

3. RELATED WORK

In [2], authors have divided different SWS discovery approaches into three categories: algebraic, deductive and hybrid approaches. The algebraic approach includes approaches based on graph theory (e.g., iMatcher, AASDU¹, etc.), the deductive approach uses logicbased reasoning (e.g., Inputs and Outputs, Preconditions and Effects matching, etc.), while the hybrid approach combines both algebraic and deductive approach.

Sachan et al. [12] proposed a new modeling approach for QoSbased semantic WS model and formalization of several QoS

¹ AASDU (Agent Approach for Service Discovery and Utilization)

attributes. The proposed QoS approach is agent-based, i.e., introduces the additional mediator Agent, which selects the most appropriate Web service available based on different QoS parameters set by the clients (users). The authors built an ontology of selected QoS parameters, and used that ontology on the model built in OWL-S Editor available in Protégé.

Klusch et al. [5] introduced a hybrid SWS matching approach with a mechanism called OWLS-MX, which they applied to services specified in OWL-S. The authors managed to prove that logical reasoning is not sufficient for semantic Web services discovery, so they combined logical reasoning with information retrieval (IR) similarity metrics.

Srinivisan et al. [13] presented an OWL-S/UDDI matchmaker architecture. The authors used OWL-S Integrated Development Environment (IDE) to build and discover OWL-S based Web services. OWL-S IDE supports various processes of the SWS lifecycle (service description, publication, discovery and execution). The Web service description can be generated based on code or model within the OWL-S Editor. Services descriptions are stored inside OWL-S registry. Web service discovery is performed through executing a query to the registry by using a specific Application Programming Interface (API). The registry performs a matching process, and returns OWL-S descriptions of the matched services.

4. PROPERTY GRAPH MODEL

The property graph data model is nowadays the base data model for many graph databases (e.g., Neo4j, Titan, etc.). This model is an easy-to-understand representation of the way data is stored in graph databases. Since it represents an extension to graphs in mathematics, it can be formalized in the following way [1]:

A property graph G is a tuple (V,E, ρ , λ , σ), where:

- a. V is a finite set of vertices (or nodes).
- b. *E* is a finite set of edges (or relationships) such that *V* and *E* have no elements in common.
- c. $\rho: E \to (V \times V)$ is a total function. Intuitively, $\rho(e) = (v1, v2)$ indicates that e is a directed edge from node v1 to node v2 in G.
- *d.* $\lambda : (V \cup E) \rightarrow Lab$ is a total function with Lab a set of

labels. Intuitively, if $v \in V$ (resp., $e \in E$) and $\rho(v) = e$ (resp., $\rho(e) = e$), then e is the label of node v (resp., edge e) in G.

e. $\sigma : (V \cup E) \times Prop \rightarrow Val$ is a partial function with Prop a finite set of properties and Val a set of values. Intuitively, if $v \in V$ (resp., $e \in E$), $p \in Prop$ and $\sigma(v, v)$

p) = s (resp., $\sigma(e, p)$ = s), then s is the value of property p for node v (resp., edge e) in the property

(Labeled) property graph data model consists of the following elements [6]:

- Nodes different entities with attributes and unique identifier
- Labels semantical description of the role of each entity, where a single node or relationship can have multiple labels at the same time
- Relationships connections between nodes, where each connection has a start and an end node

Properties - key-value pairs, which represent node and relationship attributes

A simple property graph model shown in Fig. 2 contains 3 nodes. Node labeled "Group" has a property "Name", and the other two nodes with no labels have properties "Name" and "Age". These two nodes are connected with a relationship labeled "knows", which has a property "Since" indicating for since when the two persons know each other.



Figure 2. Sample property graph model [3]

Property graphs represent an expressive and simple mechanism for describing the richness of data [7], where a connection between two nodes is easily represented, and both nodes and relationships can have various attributes of different complexity. The property graph model is an easy-to-understand representation of the property graph, which is why it can be used for modeling semantic information about Web services. As shown in the previous section, the OWL-S service model is also a directed graph. Thus, in the proposed approach the described concepts of the property graph data model will be applied to the OWL-S service model.

However, in order to efficiently query the property graph model, several query languages have been developed. In the following section, the characteristics of the Property Graph Query Language (PGQL) will be discussed.

5. PROPERTY GRAPH QUERY LANGUAGE (PGQL)

PGQL is a new SQL-like query language for property graphs developed by Oracle [10]. The language offers a wide collection of statements to be executed in order to query the property graph and find the required data.

PGQL is based on graph pattern matching algorithm, i.e., when executing a PGQL query, the query engine finds all subgraphs within the original graph, that match the specified query pattern.

To query a property graph, the SELECT clause is used, which specifies the data entities to be returned in the query result. In the example property graph shown in Fig. 3, to return the name of the persons who know each other, the following PGQL would be executed:

SELECT n.name, m.name

WHERE

(*n* WITH type='Person')-[e:knows]->(*m* WITH type='Person')

The pattern (n)-[e]->(m) defined in the WHERE clause represents a topology constraint, which is a description of a connectivity relationship between vertices and edges in the pattern [10].

For n-step hops between nodes it is possible to specify path expressions, which are then used in the WHERE clause of the query.

6. PROPERTY GRAPH-BASED APPROACH FOR SEMANTIC WEB SERVICES DISCOVERY

Since the OWL-S representation of the service model is a graph, the characteristics of property graph models can be applied to the OWL-S service model. This graph-based service model can then be queried using the PGQL clauses during the semantic Web services discovery process.

The proposed approach will be explained on the sample Web service model shown in Fig. 3. The Web service called "MovieService" contains the following three processes:

- 1. *GetMovieGenres* for a given movie name and year returns the genre name of that movie
- 2. *GetMoviePersonnel* for a given movie name and year return the list of all actors' and directors' names of that movie
- 3. *GetGenreDirectors* for a given genre name returns the list of directors' names which produced movies in that genre



Figure 3. Sample service model of the proposed approach

The sample service model contains three processes with different number of input and output parameters. Since this is a property graph, both nodes and relationships can be supplemented with additional labels and properties. The processes shown in this model are simple, so they are described only with their input and output parameters.

In the example, the nodes representing the processes have a label (type) "Process", which distinguishes them from parameter nodes labeled "Parameter". A parameter node can represent both an input and an output parameter of the process (e.g., parameter "Genre Name" is the output parameter of the "GetMovieGenres" process, but the input parameter of the "GetGenreDirectors" process).

The defined property graph service model can be queries by using PGQL.

In order to discover (find) Web services, which use movie name as an input parameter, the following PGQL query would be executed:

SELECT s.name

WHERE (p1 WITH name = 'MovieName')-[e1]->(s)

It is also possible to discover which Web services can be called to find director names for a given movie name with the following PGQL query:

PATH get_directors := ()-[]->(s WITH type = 'Process')-[]->()

SELECT s.name

WHERE

(p1 WITH name = 'MovieName')-/:get_directors*/->

(p2 WITH name = 'DirectorNames')

The proposed property graph model representing the service model can be easily implemented in a graph database (e.g., Neo4j). By using different libraries developed for connecting with graph databases, a developer can create Web services input and output parameters as node instances (classes), store them in a graph database instance, and include them in a specific Web service class definition. The PGQL queries can then be executed on the database instance to find the necessary web service and other information.

Therefore, the property graph model represents a new approach, which combined with the PGQL query language could be used for semantic Web services discovery. At this moment, the model can be used to represent a simplified OWL-S service model without including QoS parameters mentioned in the previous sections.

7. CONCLUSION AND FUTURE WORK

In this paper, the characteristics of semantic Web services have been discussed with a special focus on SWS discovery approaches. Based on the OWL-S ontology language and its graph representation of semantic Web service model, a new approach has been proposed. The approach includes using property graphs to model semantic Web services, and discovering the required services by executing PGQL queries on that property graph. The built property graph can be implemented in graph databases to build a graph database of existing Web services and used for SWS composition process. Future work includes extending the model by adding Web services methods (operations), and by including and verifying different QoS parameters against the proposed model.

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Statecharts representation of program execution flow

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ABSTRACT

Source code and software in general is prone to errors. This is due to bad design decisions, lack of experience of developers and constant need to change the existing software. Because the code changes rapidly and in strict time limitations, it is not always possible to preserve the quality and reliability of the source code. It is very important to detect errors in time and to fix or remove them in an automated or semi-automated manner. Automation of error detection and removal can be accomplished by various tools or platforms. The platform which is used for software quality analysis in this case is a static analysis oriented, language independent, SSQSA (Set of Software Quality Static Analyzers), which is based on an universal intermediate source code representation, eCST (enriched Concrete Syntax Tree). The tree structure is useful for code representation and comprehension, however its structure is not immediately suitable for representing program control flow. That is why the control flow graphs were introduced to SSOSA and were represented later visually in the form of higher level automata, statecharts. Apart from introducing formal representation of control flow graphs, statecharts introduced additional functionalities to SSQSA. Some of them are hierarchical control flow graph representation, possibility of simulation in one or more parallel work flows, also planned to be expanded to interprocedural level, and performing various kinds of estimation.

Categories and Subject Descriptors

D.2.4 [Software Engineering]: Software/Program Verification—Formal methods

General Terms

Measurement, Languages

Keywords

software quality, static analysis, formal methods, control flow graphs, statecharts

1. INTRODUCTION

Formal methods are getting more and more attention in the world of software. In the beginning, using formal representation was more usual for hardware than for software. Software is more complex in terms of state components and the process to produce abstract models is more difficult.[1, 3] Formal verification of software systems is seldom automated. Usually, an abstract model is manually created in order to perform formal verification of a large system. This requires investing a considerable amount of time and expertise. However, because the model was manually made, analysis of this model cannot be considered reliable. Systems are also usually large and change quickly. This means that it is very complex to continuously create new and update existing abstract models, as well as expensive, prone to errors and difficult to optimize. For all those reasons, an automated solution to abstract model generation is needed. [2, 5] Also, there has been a lot of foundational work on defining safe abstractions, but research for model reduction has not been explored enough.[3]

There are many approaches to software analysis and software quality measurement. Algorithms that are implemented for this purpose usually operate on some internal representations of this code, such as trees, graphs or some meta models.[5] SSQSA platform [9] uses its own structure, called enriched Concrete Syntax Tree and derived graph-based representations. Some of the algorithms for software quality measurement in SSQSA use this intermediate structure to perform their calculations and analysis, such as software metrics analysis, timing analysis and code clone detection.

Enriched Concrete Syntax Tree is the key of language independence of SSQSA. It is a syntax tree which contains all concrete tokens from the original source code, including comments, and enriched by a predefined set of universal nodes. These nodes are created in order to generalize different structures of various programming languages whose purpose is the same. The set of universal nodes is minimal, and the nodes were carefully selected, so that they are applicable to the structure of all languages supported by SSQSA. They are inserted as imaginary nodes in this tree together with the original source code tokens. For example, if we represented a semicolon and a comma with a universal node SEPARATOR, we would also have the data that precisely represents the SEPARATOR universal node. The whole source code is represented like this and it is possible to completely reconstruct the original source code from eCST. Sometimes it is not necessary to have a structure which contains the amount of data such as eCST and it is not optimal for all kinds of analysis. That is why it was necessary to introduce Control Flow Graphs [6] to this platform. They were derived from eCST by extracting only the nodes which were of importance for control flow analysis.

Although this was an upgrade to SSQSA features and some additional algorithms were implemented on this structure, there was still a problem in the case of larger pieces of code, where the resulting graphs were quite complex [1]. Representing control flow graphs in a hierarchical manner seemed like a good solution for reduction of complexity. That is one of the reasons why statecharts were introduced to SSQSA. Apart from solving the complexity issue, they give us the possibility of simulation, parallel execution and estimation.

The rest of the paper is organized as follows: Section 2 reflects on some of the related papers and tools. Section 3 describes the introduction of Control Flow Graphs to SSQSA. Section 4 explains the meaning and purpose of statecharts in SSQSA. In Section 5, an example of a statechart is shown and described in more detail. In Section 6, future work is presented and finally, we conclude our paper in Section 7.

2. RELATED WORK

There are many tools and papers that deal with visual representations and simulation of the source code. However, most of them lack some features. Usually, they focus on some specific programming language. Some of them are able to represent the control flow or the structure of programs in a visual way, but most of them do not have the possibility of simulation and testing. If there are testable representations, then another problem emerges: the state explosion problem [1]. Also, many of them are not formal representations and not all of them are platform independent.

There have already been some attempts at creating formal representations of source code. In papers, such as [2] it is explained how the authors extracted finite state models from Java source code. Their approach also addresses the state explosion problem and tries to solve it. However, this solution is only applicable to Java code.

Work by [7] deals with interprocedural graphs. The intention is to check if fixing errors in code actually eliminate them and whether fixing errors means introducing some new ones. The whole approach is based on static analysis and it generates the graph based on all existing versions of program and tries to discover and fix faults and propagate that to newer versions.

A PhD thesis [10] performs static analysis of programs, based on their dependence graphs. The idea is that a single statement can affect some other statements and parts of code. This approach is formal and language independent. It focuses on sequential, imperative programs.

2.1 Related tools

Visustin v7 Flow chart generator¹ is a visualization tool that can represent code in the form of program flow diagram and

activity diagram. It has support for 43 languages, such as C, COBOL, Fortran, Java, JavaScript, Pascal, PHP and Ruby. It has also support for simulation, but it has a problem when it is presented with large pieces of code - it becomes hard to analyze and has no hierarchical representation.

Graphviz (Graph Vizualization Software)² is open source and it is used for graph visualization. Graphviz has wide use in networking, bioinformatics, software engineering, database design, machine learning... This tool performs graph drawing, based on specifications in DOT³ language. The downside is that the graphs have to be first specified in DOT language in order to be represented by Graphviz. It is also not able to simulate control flow behavior.

Apart from these, there are also other tools that have some similar features, such as $MOOSE^4$ and $RefactorErl^5$. However, some of them are not oriented towards formal representation and some cannot simulate the represented code.

3. CONTROL FLOW GRAPHS IN SSQSA

The control flow graph can be represented as a set

$$G = (N, A, S, E) \tag{1}$$

where N are the nodes of the graph, A is a binary relation N x N, which represents the graph transitions, S and E are start and end nodes of the graph [6]. The purpose of control flow graphs is to track all possible paths of program execution for important reasons, such as to detect dead code or infinite loops. In order to generate them, it was necessary to extract them from eCST. The subset of universal nodes was selected and it was enough to represent the program flow accurately.

Some nodes of importance for the control flow representation are statement nodes, such as assignment statements and function calls. Apart from them, nodes which were also included in the graph are branch statements, branches and loop statements, as well as their corresponding condition nodes. Some pieces of information were included because of their importance for generating statecharts. Statecharts are highly structured and it is important for us to preserve that structure by saving information about nodes such as compilation unit, block scope and function declaration in the control flow graph.

The control flow graph that was first created in SSQSA focused only on one function or procedure. The starting node was the entry point of this function/procedure. The rest of the control flow graph was created by extracting previously defined nodes of interest from eCST and connecting them in a way that they represent control flow of the original source code. This graph is directed and it has cycles, which exist due to the nature of source code. If the language independent condition evaluation is successfully implemented (the number of repetitions of some cycles is calculated), it will be possible to perform calculations, such as worst case execution time estimation. Currently, we are trying to create interprocedural graphs [8], described in detail in Section 6.

¹http://www.aivosto.com/visustin.html

²http://www.gnu.org/softwarhttp://www.graphviz.org/

³http://www.graphviz.org/doc/info/lang.html

⁴The MOOSE book, http://www.themoosebook.org/book ⁵http://plc.inf.elte.hu/erlang/

4. STATECHARTS

Statecharts are defined as a visual formalism for complex systems [4]. They were later included in UML diagrams. Another name for this diagram is Harel's automaton⁶. The main benefit of using statecharts reflects in the ability of representing parallel states, tracking history within complex states and tracking values of variables throughout the flow. They are highly expressive - they are able to show a very detailed preview of the system which is to be created, but they can also be very compact due to their hierarchical nature and show only the system on higher levels of abstraction.

Statecharts take care of modelling hierarchy, concurrency and communication and that makes them important for tracking complex real-time systems. Reactive systems are event driven and they constantly have to react on various kinds of internal and external events. It was very difficult to represent them in a way that was realistic, but also formal and precise. Statecharts are a solution to that problem, since they make the process of specifying and designing these complex systems a lot easier and more natural. All possible behavior of reactive systems was easily represented by a set of allowed in and out events, conditions and actions and some time limitations.

Dynamic behavior of a complex system is easily represented by using states and events. The system is always in at least one state and if some event occurs, it transitions to another state under some conditions. A transition can occur from one state to another, which can all happen inside a complex state. Transitions can also be recursive if they have the same state as origin and target. Some transitions can cause to exit or enter a complex state. They can also trigger events, which affect the simulation. If standard finite automata were used for this purpose, they would be very difficult to understand due to very large complexity because of the generated number of states. Statecharts use hierarchy, they provide us modularity and good structure and make it easy to represent independent parallel execution.[4]

4.1 The importance of statecharts for SSQSA

Statecharts introduced graphical representation of Control Flow Graphs to SSQSA and created a more compact version of them. Also, because statecharts are a formal representation, the system is represented in a non-ambiguous way and it becomes a very trivial problem to detect program paths which are possible and the ones which are not. This component is useful for testing parts of code in early stages of development. It has some features of a debugger - it can show us if parts of code show odd behavior, why the control flow unexpectedly changes, and it includes much more visualization in representing what is currently happening.

4.2 Implementing statecharts in SSQSA

Statecharts consist of two kinds of states, complex (which can also be orthogonal, with parallel regions) and simple ones. Based on the nature of the universal nodes that were used (if they represented complex or simple program structures), they were transformed into suitable kind of states. Universal nodes that stand for complex program constructs (i.e. that contain other program elements) were represented as complex states. For example, these are compilation units which can consist of elements such as functions, or function declarations which can contain statements. Some statements are also represented as complex states because they contain other statements, such as branch statements (and their branches) and loop statements. These complex states can contain other simple or complex states. Universal nodes that were represented as simple states can only trigger some events or manipulate the variable values. Statecharts also have some additional states related to entering and exiting the whole statechart or its complex parts.

For the purpose of testing statecharts, Yakindu SCT^7 was used. Parts of this tool are open source. Some of the limitations are directly related to this tool, such as lack of complex data types. For now, only integer, real, boolean, string and void are supported. These data types are enough for the proof of concept phase, but it is necessary to additionally implement these features or replace this tool with one that can also represent nontrivial pieces of code.

5. EXAMPLE

In Figure 1, we present a statechart generated based on a piece of code written in programming language Modula-2. It represents a part of an algorithm which counts factoriel of a given number. The purpose of this figure is to show how the part of code which is a loop is represented in a simplified way. In Figure 2, we present how this loop statement looks like when it is expanded and what is really happening inside this complex state.

The same algorithm was implemented in Java programming language. The resulting statecharts are identical to the ones in Figure 1 and 2. A more detailed preview and comparison of different algorithms can be found in [11].

6. FUTURE WORK

Although statecharts are currently focused on representing the control flow of one function or procedure, the idea is to make an interprocedural representation, first on the level of a compilation unit and then to expand it to represent the

 $^{7} https://www.itemis.com/en/yakindu/state-machine/$



Figure 1: Statechart based on sample code in Modula-2, which shows how factoriel of a number is calculated. The loop statement is collapsed.

⁶After David Harel, the creator of statecharts



Figure 2: Statechart based on sample code in Modula-2, which shows the expanded loop statement in factoriel calculation.

complete software. This will be done using the graph dependency networks. Once the control flow graphs for all procedures and functions are constructed, function call nodes will be detected and these graphs will be connected into one, which represents the whole system. By implementing this, it will be possible to improve statecharts, also in an interprocedural way. So far, statecharts were tested mostly on one object-oriented language (Java) and one procedural Pascallike language (Modula-2). Therefore, there is also room for improvement in terms of testing how statecharts are generated based on source code written in other languages.

Another idea is that, if we succeeded in refining statecharts to the lowest level and if we introduced the environment variable, we would greatly improve simulation of the source code in the evaluator. That would mean having the most realistic representation of how whole or a part of source code would execute in reality.

7. CONCLUSIONS

The eCST provides us with complete information about the source code. Therefore, possible limitations will not be related to lack of information about the source code. The true challenge will be to represent everything that is important in a manner suitable to the nature of statecharts. Our approach has proven feasible so far, but that will be put under further inspection once more complex pieces of code are introduced.

Once we have a component that is possible to visualize and simulate the complete code under analysis and test existing systems or the ones that are still under development, detecting obvious flaws in source code design and execution will be trivial. The tool will be able to simulate the execution of the code without the need for setting up the environment and running the code. Statecharts could also be used to introduce new people to various projects. One will be able to view the system on different levels of abstraction and take a step by step approach in getting familiar with it. A statechart is more dynamic than a simple diagram which represents project structure. Statecharts in SSQSA would mean the ability of viewing systems, simulating them, and not having to worry if parts of this system are written in different languages.

It is also important to note that statecharts are not introduced to SSQSA only to visualize and simulate the system. They are important for predicting different outcomes if some parts of code are executed and to evaluate qualities, such as correctness and reliability.[4]

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Code smell detection: A tool comparison

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ABSTRACT

Technical debt can be identified with different techniques, including code smell detection. Furthermore, different approaches are available to detect code smells and some of those approaches are implemented among different tools. In this article, different tools for code smell detection were selected with the goal of comparing their outputs. The fact is that compared tools detect different code smells with varying degrees of success and that the intersection of detected code smells within tools is very small. Because of this, the connection between detected code smells and the value of technical debt is hard to define. The results are supported with empirical analysis from 32 software projects, different code smells and 3 code smell detection tools.

Categories and Subject Descriptors

D.2.8 [Software Engineering]: Metrics

D.2.9 [Software Engineering]: Management-Software quality assurance (SQA)

General Terms

Measurement

Keywords

Code smell, technical debt, intersection of detected code smells

1. INTRODUCTION

Since there is a growing need for rapid changes, some decisions have to be accepted quickly. Those decisions, especially the inadequate ones, affect the whole software development life cycle and can have a significant impact on code quality. We have to be especially careful and pay attention to those program entities that contain irregularities or deficiencies.

The technical debt helps evaluate resulting problems and one of the most recognized techniques for identifying technical debt is the detection of code smells. There are different types of code smells, divided into different groups aimed at achieving a better understanding. A lot of tools can be found in the literature that help detect code smells, but each of them detect code smells with the help of different techniques.

The goal of our research was to look into available code smell detection tools and, using selected ones, compare the detected code smells while also analyzing the intersection of the results. Since code smell is a technique of identifying technical debt, the second part of the research was aimed at finding a connection

between detected code smells and the value of calculated technical debt.

The article is organized as follows. First, the theoretical background about technical debt and code smell is presented. Section 4 presents the case study we carried out while section 5 and 6 contain a discussion of obtained results. The article is concluded with section 7.

2. TECHNICAL DEBT

The technical debt was first named in 1992 by Ward Cunningham as "not-quite-right code" [1]. Through the years, technical debt has won more recognition and its basic meaning has been upgraded. Since it represents a metaphor that can be subjectively understood [2], [3], a single generally accepted definition of technical debt still cannot be found.

Nevertheless, authors describe technical debt as a set of decisions taken within a project. Those decisions usually bring short-term success, but in the future they can cause problems, which are resolved with more effort than would be needed in the beginning [4]–[9].

Through the time, different types of technical debt were introduced. For example design debt, architecture debt, documentation debt, test debt, code debt and environment debt [5]–[7], [10], [11]. Soon, based on research and needs, some other types of technical debt appeared in the literature. For example, build debt, defect debt, requirement debt, test automation debt, service debt, versioning debt, people debt, process debt and usability debt [5]–[7].

2.1 Technical debt identification

One of the technical debt identification methods is source code analysis, where techniques can be divided between a static and dynamic analysis [8], [12]. Each one focuses on a specific field in a source code and does not provide for the detection of a variety in code smell. In the literature, the most represented ones are the following techniques:

- Modularity violations [12], [13].
- Design patterns and grime buildup [12], [13].
- Code smells [8], [12]–[14].
- Automatic static analysis [8], [12], [13].
- Source code comments [15].

3. CODE SMELL

One of the techniques for identifying technical debt is code smell detection. It refers to indicators within source code that point to

deeper problems in a software product [16]. Code smell means writing code in a way that violates the principles of best programing practices. The removal of code smells is usually done with source code refactoring, where the need for refactoring increases the likelihood of the existence of code smells in software [17].

Tufano et al. [18] presents an analysis of occurrence of code smells in software products. Usually code smell emerges when adding new functionalities and changing existing ones. This interesting finding was also that by refactoring existing source code new types of code smells can enter.

3.1 Code smell groups and types

Many different types of code smells are defined in the literature. For a better understanding of different types of code smells, several groups were defined, each containing different code smell types [19]: (1) *Bloaters* represent something in the code that is so big it cannot be effectively handled; (2) *Object-Orientation Abusers* contain examples where the possibilities of OO design is not fully exploited; (3) *Change Preventers* contain code smells that refers to code structures that considerably hinder software modification; (4) *Dispensables* present parts that are unnecessary and should be removed from a source code; (5) *Encapsulators* joins code smells connected to data communication mechanisms or encapsulations; (6) *Couplers* express the code, which is tightly coupled; (7) *Other* code smells.

3.2 Code smell detection

Code smell detection can be done with the help of software metrics. Different authors connected selected software metrics with detection of specific types of code smells [20], [21]. Based on the correlation between software metrics and code smell types, tools that identify some of these types have been developed [16], [22]–[24]. When identifying code smells with a software metric it is important to use reliable software metric threshold values. If thresholds are not set properly, a variety of false positive values can be detected [25]. Based on this, some other code smell detection techniques have been developed, for example, a technique based on the combination of machine learning algorithms, which achieved more than 96% accuracy when detecting different code smells [26].

4. CASE STUDY

As part of the case study, two research questions were formed:

- Are different open source tools for detecting code smells providing different results?
- What is the connection between detected code smells in selected tools and the value of technical debt calculated in the SonarQube tool?

To answer these questions, different software projects were analyzed to gather empirical data. We analyzed the projects gathered in "Qualitas Corpus." But since we needed the projects compiled to byte code to make an analysis, we chose a compiled version of the Qualitas Corpus [27]. So we can provide analysis without major changes in source code. In the end, based on criteria, 32 software projects were analyzed. Also, the criteria was set to select appropriate code smell types and tools for code smell detection to be used within a case study. The criteria were inspired by data gathered in a preliminary literature review.

4.1 Selected tools and code smells

Based on criteria, two tools for code smell detection were selected and corresponding code smell types. The information is presented in Table 1. Both selected tools are Eclipse extensions. To be able to answer the second question, we have to prepare the SonarQube tool, which detects code smells based on predefined rules. Among 255 rules that indicate the existence of code smells, 12 that follow Fowler definition [28], were selected. Because SonarQube does not enable code smell classification in different groups, this step was done by hand. The rules that follow before mentioned definitions was combined in a profile and classified into groups.

Fable 1. Selected tools and code s	smells
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Tool	Code smell	Tool version
JSpIRIT	God class, Feature envy, Brain method Brain class	4.3.2
JDeodorant	God class, Feature envy, Long	5.0.64
SonarQube	God class, Feature envy, Brain method, Long method, Brain	5.6.4 LTS

4.2 Analysis of empirical data

In the first step, selected projects were analyzed using the selected tools. The aim was to detect and count different code smell occurrence within different projects. Also, the distribution of activated rules in SonarQube was done. With this, we gain an insight into the appropriateness of the mapping rules for forming different groups in SonarQube and different types of code smells in JSpIRIT and JDeodorant. The secondary appropriateness of mapping rules was done with the intersection of detected code smells among the tools.

All gathered data present a starting point for finding correlations between code smell and technical debt and comparison of different tools for code smell detection.

5. COMPARISON OF DETECTED CODE SMELLS

Used tools and considered code smells within the case study are presented in Table 1.



Graph 1 – Identification of God class and Brain class code smells within tools

In this analysis, we combine results for God class and Brain class (Graph 1), Brain method and Long Method (Graph 2), while with Feature envy (Graph 3) code smell was analyzed independently. As can be seen in Graph 1 and Graph 2, the SonarQube detected more God class/Brain class and Long method/Brain method code

smells than the tools JSpIRIT and JDeodorand did together. However, SonarQube has a problem with detecting Feature envy code smell, since it was not able to detect it within software project analysis (Graph 3). For this purpose we look again at the rules in SonarQube, but it cannot be stated that one of those rules can reliablly detect Feature envy code smell. The rule that we select is, in our opinion, the one that has the highest probability of detecting the mentioned code smell. On the other hand, when detecting Feature envy (Graph 3), JSpIRIT prevails, which detected 500 more occurrence than JDeodorand did. The latter has the tendency of detecting God class and Brain method. Overall, the most code smells are detected in SonarQube.



Graph 2 - Identification of Long method and Brain method code smells within tools



Graph 3 - Identification of Feature envy code smells within tools

Based on the results, we identified the intersection of detected code smells among the tools, presented in Figure 1. This was done by analyzing a project that was not selected for analysis, but is still a part of Qualitas Corpus. When identifying God class/Brain class code smell, the intersection between all the tools is 2.7% and when detecting Long method/Brain method it is 6.08%. To identify the causes for low intersection, we again look into the SonarQube tools. We looked into rules that are activated when detecting code smell common to other two tools.

6. THE CONNECTION BETWEEN CODE SMELLS AND TECHNICAL DEBT

For establishing a correlation between code smell and technical debt, the data about time contributed by each of the 12 used rules in SonarQube was acquired. The technical debt, when all 255 rules were used, was 5,460 days. When we activate just 12 selected rules, the technical debt was 1,982 days, which is 27% of all technical debt.

Since these 12 rules are used for code smell detection, it can be seen how much they contribute to the overall technical debt of a project. But the problem lies in the low intersection between tools when detecting code smells. An even more detailed analysis about activated rules within selected code smells does not bring any clearer results.

7. CONCLUSION

The case study was made to compare detected code smells among three different tools: JSpIRIT, JDeodorand and SonarQube. Since the first two define code smells which are not part of SonarQube, the rules within the SonarQube were mapped to a variety of groups, representing selected code smells.



Figure 1 – Intersection between tools for code smell detection

The detected code smells by tools were compared within three identified categories, and the intersection of detected code smells was presented. The intersection between the used tool is very small (Figure 1). This can be attributed to the use of different detection techniques in different tools. JDeodorand proved to be the best at detecting Long method code smell, JSpIRIT at detecting Feature envy code smell and SonarQube at detecting God class/Brain class and Long method/Brain method code smells.

The second part of the case study was aimed at finding a connection between detected code smell and technical debt in SonarQube. The intersection of detected code smells between different tools and SonarQube is very small. We can also add the fact that the classified rules are not activated proportionally. Since rules do not contribute equality to a technical debt calculation, the impact of code smell detection to technical debt cannot be defined.

There are many research opportunities in this area. The rules for code smell detection among tools could be compared in details for the purpose of unification. In addition, the future work can be oriented in an attempt to provide the generally accepted definition of technical debt. At last, selected tools, JSpIRIT and JDeodorand could be upgraded for technical debt calculation.

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A Qualitative and Quantitative Comparison of PHP and Node.js for Web Development

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ABSTRACT

In this paper, the possibilities and uses of PHP and Node.js for web development were studied and presented. Based on the results of a literature overview, a model for analysis and comparison of technologies was defined, where experiences gained from the development of an equivalent web solution using both evaluated server-side technologies were also taken into consideration. We found out that technologies, apart from maturity and popularity, differ the most in available support and aspects related to performance.

Categories and Subject Descriptors

D.3.2 [**Programming Languages**]: Language Classifications – *JavaScript*.

General Terms

Measurement, Documentation, Performance, Economics, Security, Languages

Keywords

Web Development, Web Technologies, Server-side Programming, PHP, JavaScript, Node.js

1. INTRODUCTION

With the ongoing and rapid development of web technologies, web developers have to make a difficult decision. With so many available web technologies, choosing one or a few of them for developing web sites and web applications is often a very challenging task. Therefore, we compared PHP with Node.js to evaluate the main similarities and differences between these technologies.

The dynamic scripting language PHP is widely used in the field of web development and has become one of the most used and dominant web technologies for server-side programming over the last few years [25, 35]. On the contrary, the dynamic scripting language JavaScript has become enormously popular for front-end development. However, with the birth of Node.js, JavaScript offered a new and promising server-side technology based on JavaScript [32].

The rest of this paper is structured as follows. Section 2 discusses related work. Section 3 describes the proposed model for analysis and comparison of technologies PHP and Node.js. Section 4 presents the result of our analysis and a comparison. Section 5 summarizes the main results of our work.

2. RELATED WORK

There are a lot of studies evaluating and analyzing different Web technologies. In the literature overview, we came across only two works that compared PHP and Node.js. Both evaluated these technologies based on performance.

Lei et al. [12] compared the performance of Node.js, Python-Web and PHP with objective systematic tests and realistic user behavior tests. The results yielded some valuable performance data, showing that Node.js performs much better than the traditional PHP in a high concurrency situation, especially in input/output intensive situations. PHP handles small requests well, but struggles with large requests. Both Node.js and PHP are not suitable for computation-intensive situations [12].

Chaniotis et al. [10] conducted a series of stress tests on popular server-side technologies. Once again PHP proved to be less effective in input/output operations and resource utilization with an increasing number of concurrent users than Node.js.

The rest of the studies in the field of PHP and Node.js comparison were not scientifically based. Rather, they are founded on expert judgement. Some of them are stated below.

C. Buckler [28] evaluated PHP and Node.js based on ten rounds. Each of them considered a general development challenge which could be applied to any web technology. According to his study, PHP had better help and support, better integration, and easier deployment, and it was simpler to build a basic web page, whereas Node.js had an easier and more logical language syntax, better development tools, more supported environments, better performance, and higher programmer passion. The author could not decide which one had a brighter future ahead of it.

P. Wayner [9] also compared PHP with Node.js and found out that PHP was better when mixing code with content, had a better deep code base, was simpler, had better support, did not need a client app, had better integration for SQL, enabled a higher speed of coding and was more popular among developers. Node.js was better with separating concerns, had a modern syntax and new modern features, had dozens of language options, thinner service calls, better integration for JSON, was faster and was better based on solidarity.

3. PROPOSED MODEL FOR ANALYSIS AND COMPARISON OF TECHNOLOGIES

When analyzing and comparing web technologies, many aspects should be considered. To the best of our knowledge, there are only two scientific papers evaluating PHP and Node.js, both only by performance. Thus, we examined the literature that compared web technologies in general [1, 5, 11, 13, 14, 16, 17, 18, 26, 27] and based on the results we defined a model for analysis and comparison of technologies with the following criteria: development, supported platforms, costs, community and support, performance, and security. For every criterion we defined various variables, as seen in Table 1.

Table	1.	Proposed	model f	for	analysis	and	comparison o	f
			tech	nol	logies.			

Criterion	Variable			
Development	Syntax			
	Libraries			
	Learning curve			
	IDE			
Supported	Operating system			
Platforms	Web servers			
Tationis	Databases			
	Technology			
Costs	Operating system			
COSIS	Webservers			
	Databases			
	Quality of Documentation			
Community	Release frequency			
and Support	Maturity			
and Support	Popularity among developers			
	Usage for web sites			
	Simple web site			
Performance	Input/output intensive web site			
	Computation-intensive web site			
Soourity	SQL injection			
	Cross-site scripting			
Security	Cross-site request forgery			
	Denial of service			

Results were retrieved based on a documentation analysis, official web sites of PHP and Node.js, literature, performance tests and experiences, gained from developing equivalent web applications with both technologies. More details have been given in our previous work [34].

4. ANALYSIS AND COMPARISON OF PHP AND NODE.JS

4.1 Development

PHP is known for having a large variety of functions, however the problem of inconsistent naming between versions exists. It does not promote good structure of code; however, it enables it. Node.js has brought JavaScript to the back-end and therefore can be used both client and server side. Its syntax is quite modern and therefore Node.js offers a modern development approach. However, it only has a few core statements and functions, everything else must be included with extra modules, which are very simple to install, include, and use with the help of the Node Package Manager. PHP also has a lot of libraries available. However, searching for them, installing them, and using them is a bit more difficult. PHP is quite simple and provides a quick and easy introduction for new PHP developers, whereas Node.js is more complex and harder to learn. Development with both technologies can be done in various IDEs.

4.2 Supported Platforms

PHP and Node.js are quite similar based on the (in)dependence of platforms. They are both compatible with the most popular

operating systems, web servers and databases. Both technologies can therefore be used with Microsoft Windows, macOS and Linux [22, 25] operating systems, which together have a 97.7 % market share [31]. Both are compatible with Apache, nginx and IIS web servers [15, 25], which together have a 94.7 % market share [36]. PHP and Node.js can also be used with various databases both relational (Oracle, MySQL, Microsoft SQL Server, PostgreSQL, DB2, SQLite) and non-relational (MongoDB, Cassandra, Redis) [8]. The main difference between the two technologies is that Node.js can configure its own web server [22].

4.3 Costs

Both technologies are free and open source [22, 25]. Because of the extensive support of the most popular platforms, both have free and payable versions available. Microsoft Windows has licensing costs [20], macOS is free for users of Mac computers [4], while Linux is free for everybody [33]. The Apache web server is free to use [3]. Nginx has both a free and payable option available [21]. IIS can be used without licensing costs on Windows operating systems [19]. Also, the HTTP module, which offers Node.js the ability to configure a web server, is free to use because it is included in Node.js by default [22]. Databases MySQL, MongoDB, PostgreSQL, Cassandra, SQLite and Redis are free, whereas Oracle, Microsoft SQL Server and DB2 are payable with limited free versions [8].

4.4 Community and Support

Based on help and support that is available for both technologies, we discovered that PHP [25] has better official documentation than Node.js [22], especially for beginners, whereas documentation for Node.js includes more complex examples. PHP was created in 1995 [25] while Node.js appeared in 2009 [2]. However, even though PHP has existed for nearly 22 years, it has 239 known releases [25] which is less releases than the relatively vounger Node.js, which has only existed for 8 years and has 371 known releases [22]. Node is has also had more frequent releases in the most recent period (from 1st January 2016 until 31st December in 2016). In this one-year period, Node.js had 68 releases [22], whereas PHP had 33 [25]. Therefore, although both technologies are actively developing, Node.js is developing faster. However, PHP remains far more popular among developers and has more experienced developers, according to results from an analysis of available help and support on two popular web forums: Stack Overflow and Code Project. Also, according to statistics of usage of technologies for web sites. There are 1,101,785 asked questions tagged with PHP [30] on Stack Overflow and 183,444 tagged with Node.js [29]. On Code Project there is 33,761 hits for PHP [7] and 1,825 for Node.js [6]. Statistics from the 1st of September show that PHP is used by 82.8% of all web sites whose server-side programming language is known, whereas Node.js is used by only 0.4 % [35].

4.5 Performance

For assessing performance, we designed, developed, and conducted three test scenarios with each of the evaluated technologies. With all tests, we kept requests at 5000 with 10, 50, 100, 150 and 200 concurrent users. We used requests per second as metrics data. Each test was repeated ten times. The lowest and the highest results from each test were excluded and an average from the rest of the data was calculated.

For our tests we used PHP 7.1.7, Apache 2.4.27 and MySQL 5.7.18 to test the performance of PHP. To test the performance of Node.js, we used Node.js v8.2.1 with a mysql module and MySQL 5.7.18. The client/server machine in our test ran a Windows 10, 64-bit

operating system with an Intel i5 processor and 4 GB of RAM. As a testing tool we used ApacheBench 2.3.

To test the performance of a basic web site developed in each technology we used a web site that only outputs some text. The results of the first basic performance comparison showed that the performance of Node.js is better than PHP with the same number of concurrent users, especially when the number of users increases (Figure 1.).



Figure 1. Performance of simple web site.

The test scenario for evaluating the performance of an input/output intensive web site was based on a select operation of the database. The retrieved results distinguished the difference between the two technologies. Node.js is far more adapted at input/output intensive operations, even when the number of concurrent users increases.



Figure 2. Performance of input/output intensive web site.

We used a calculation of the fifteenth value of Fibonacci for assessing performance of a computation-intensive web site. Neither PHP nor Node.js are suitable for computation-intensive situations. However, Node.js performs better among the two (Figure 3).





The results of our performance tests are in accordance with studies from other authors [9, 12] and were also expected. Node.js uses an event-driven, asynchronous model, which enables it to respond rapidly to an input/output operation. Therefore, it is suitable for data intensive, fast responding, real time web applications and applications with many users. However, it is not adapted to computation-intensive situations. On the other hand, PHP, although efficient on the server-side, is more suitable for middle and smallscale websites.

4.6 Security

Both PHP and Node.js offer solutions against popular security risks, such as SQL injection, cross-site scripting, cross-site request forgery and denial of service. PHP has a mostly built-in solution, e.g. prepared statement and validation functions for protection against SQL injections [25]. Some of the solutions are not included and must be added with libraries, e. g. when preventing cross-site scripting attacks [24]. Node.js does not include any safety solutions by default. All of them must be added with the help of modules, which can be installed by the Node package manager, e. g. the mysql module offers an escape function for preventing SQL injection [23].

5. CONCLUSION

We analyzed and compared two web technologies – PHP as the most used technology for server-side development, and Node.js as a relatively young technology with much potential. PHP is known for being quite easy to learn and easy to develop with and offers the possibility of simply mixing PHP and HTML code. Node.js, on the other hand, has more modern syntax and features, with the main feature being a non-blocking, evet-driven, asynchronous input/output model. One of its primary characteristics is also the movement of the usage of JavaScript from front-end to back-end in one language – JavaScript.

Based on the analysis and comparison of technologies, we found out that technologies are very similar based on the basic characteristics of supported platforms and costs. The only difference between them is that Node.js can create its own server. When evaluating security, both technologies offer solutions against the most common web attacks. PHP is older and simpler to learn when compared with the younger and more modern Node.js, with better support and help from both official documentation and the community of developers. The main difference between technologies is in performance, where PHP is more suitable for sites for managing content and displaying data and Node.js is more for complex solutions with many concurrent users and more difficult processing. Therefore, the technologies, apart from their maturity and popularity, differ the most in available support and aspects related to performance.

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Skills, Competences and Platforms for a Data Scientist

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ABSTRACT

In this paper, we identify the core competences and skills of a Data Scientist, where we build on already existing research about the already practicing Data Scientists and on existing frameworks. We complement this research with the practitioners' survey about popular Data Science platforms and our own research on the search term trends and job posting trends.

Categories and Subject Descriptors

H.4 [Information Systems Applications]: Miscellaneous

I.2.m [Artificial Intelligence]: Miscellaneous

General Terms

Data Science, Framework, Platforms.

Keywords

Data science, data scientist, skills, competences, platforms.

1. INTRODUCTION

In the last few years, Data Science has become one of the most rapidly growing interdisciplinary fields, where it combines different aspects of computer engineering, mathematics, and other managerial skills. The employer and employee review website Glassdoor even rates Data Scientist as the number one best job in America in 2017 (regarding the job satisfaction, number of a job openings and median base salary) [1].

The precise skill set of a Data Scientist is not so well defined yet, as it gets mixed up with other job roles, such as Data Analyst, Machine Learning Engineer, Statistician, Data Engineer, Business Analyst, Data Architect and others. The differences between these titles are not always clear and are used interchangeably, especially among people outside the domain of Data Science. The purpose of this paper is not to make a clear differential line between these different job roles, but to define what core skills of a Data Scientist are. This could help any employers to identify if the Data Scientist is the one they need in their organization. Also, the clear list of definitions, skill sets and most common platforms used by Data Scientists could be used by people striving to become a Data Scientist and work on each skill of the broad spectrum of competences and skills needed and expected by a Data Scientist.

2. DATA SCIENCE COMPETENCES AND SKILLS FRAMEWORKS

With the growing demand for staff with knowledge and skills of Data Science, several more or less commonly accepted frameworks that have been used for defining Data Science

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(alongside with general computer science, ICT and similar) competences, skills and subject domain classifications, have emerged. These frameworks can be, with some alignment, built upon and re-used for better acceptance from research and industrial communities. One of the most elaborate is EDISON Data Science Framework (ESDF), developed within the scope of European project "Edison – building the data science profession" [2]. The ESDF provides a collection of documents that define the Data Science profession, which have been developed to guide educators and trainers, employers and managers, and Data Scientists themselves, collectively breaking down the complexity of the skills and competences need to define Data Science as a professional practice.

The ESDF itself, however, builds on existing standard and commonly accepted frameworks, as is the Big Data Interoperability Framework, published by the NIST Big Data Working in September 2015 [3]. It provides various definitions, among them for Data Science, Data Scientist and Data Life Cycle, which can be used as a starting point for further analysis.

"Data Science is the extraction of actionable knowledge directly from data through a process of discovery, or hypothesis formulation and hypothesis testing. Data Science can be understood as the activities happening in the processing layer of the system architecture, against data stored in the data layer, in order to extract knowledge from the raw data.

Data Science across the entire data life cycle incorporates principles, techniques, and methods from many disciplines and domains including data cleansing, data management, analytics, visualization, engineering, and in the context of Big Data, now also includes Big Data Engineering. Data Science applications implement data transformation processes from the data life cycle in the context of Big Data Engineering." [3]

"A Data Scientist is a practitioner who has sufficient knowledge in the overlapping regimes of business needs, domain knowledge, analytical skills, and software and systems engineering to manage the end-to-end data processes in the data life cycle.

Data Scientists and Data Science teams solve complex data problems by employing deep expertise in one or more of these disciplines, in the context of business strategy, and under the guidance of domain knowledge. Personal skills in communication, presentation, and inquisitiveness are also very important given the complexity of interactions within Big Data systems." [3]

The main focus of a data scientist is thus to discover meaningful patterns in data and synthesize useful knowledge by performing all the necessary steps throughout the whole data life cycle - the

collection of raw data, (pre-)processing of data and transforming it into useful information, performing data analysis via various data analytics algorithms and tools, interpreting and evaluating the discovered patterns in order to produce useful knowledge, and validating the induced knowledge models to produce value. Analytics is used to refer to the methods, their implementations in tools, and the results of the use of the tools as interpreted by the practitioner [4]. The analytics process is the synthesis of knowledge from information.



Figure 1. Data Science definition by NIST BD-WG [3].

In order to cover the competence, required from a Data Scientist, a good knowledge of data analytics is needed (the two most important fields of analytics are statistics and machine learning), a good understanding of engineering (programming, software engineering and data management in order to provide analytical applications), as well as a fair amount of domain expertise. Figure 1 provides graphical presentation of the multi-factor/multi-domain Data Science definition.

2.1 General/research vs. business profile

As the Data Science covers a lot of topics, many different competences and skills are required from a data scientist. In this manner, data scientists tend to focus on some specialization within the whole data science scope. In general, two major profiles can be identified – a general, research oriented profile, and a business oriented profile (see Figure 2). For both profiles a fair amount of analytics and engineering knowledge as well as the domain expertise is required. Besides that, the research oriented profile concentrates primarily on the use of scientific methods – formulation of test hypothesis, experiment design, data collection and analysis, pattern discovery and explanation of discovered knowledge. On the other hand, the business oriented profile focuses on business process management – monitoring the important data and designing, modelling, optimizing, and executing the data-driven business processes.

3. DATA SCIENTISTS' SKILL SETS

The existing standard and commonly accepted frameworks for defining Data Science competences are very good aligned with

several reports and scientific papers which provide research results of what skills a data scientist should have.



(a) Data Science competence groups for general or research oriented profiles



(b) Data Science competence groups for business oriented profiles

Figure 2. Relations between the Data Science competence groups for (a) general or research oriented and (b) business oriented professions/profiles [4].

In [5] the authors present the findings compiled from 50 different reports of research in articles, journals, and books, and conducted via experts' views using the Delphi technique, regarding data scientist skills required by the industry. They provided a list of 41 data scientists' skills and categorize them into five major categories adapted from [6] – computer science, analytics, data management, decision management, and entrepreneurship:

• **Computer Science** includes programming, where R and Python are predominant programming languages, as well as privacy, security and systems architecture.

• Analytics focuses primarily on statistics and machine learning, and includes natural language processing, probability, simulation.

• **Data management** covers all data handling skills and puts emphasis on databases, data modelling and visualization, data mining, business intelligence and general data processing.

• **Decision management** focuses on decision making, while encompassing communication and ethics.

• Finally, **Entrepreneurship** includes business and economics.

On the other hand, the EDSF also categorizes all the skills required for a data scientist into five major categories, namely analytics, engineering, data management, research methods and project management, and business analytics [4]:

• Analytics focuses on the use of machine learning, data mining and text mining techniques, the application of predictive and prescriptive analytics, the use of statistics, operations research, optimization and simulations, and the assessment, evaluation and validation of results.

• **Engineering** includes the use of ICT systems and software engineering, cloud computing and big data technologies, databases, data security, privacy and intellectual property rights protection, as well as algorithms design.

• **Data management** put emphasis on specifying, developing and implementing enterprise data management and data governance strategy and infrastructure and includes data storage systems, data modeling and design, data lifecycle support, data quality, integration, and digital libraries and open data.

• Research methods and project management encompasses the use of research methods principles in developing data driven applications and implementing the whole cycle of data handling, development and implementation of data collection processes, and consistent application of project management workflow.

• **Business analytics** focuses on the use business intelligence, business process management, econometrics for data analysis and applications, user experience design, data warehouses for data integration, and data driven marketing.

4. PRACTITIONER PLATFORM SURVEY AND TRENDS

After defining what the required skills for a Data Scientist are, in this section we look at what the current state of the skills is among active practitioners of Data Science. So far, no thorough analysis of all skills of Data Scientists was done, but there is a good survey about the frameworks they use in their line of work.

In August of 2017 KDnuggets, one of the most popular websites about data science based on independent ranking [7], had a poll for their readers [8]. The poll asked the following question: "Did you use R, Python (along with their packages), both, or other tools for Analytics, Data Science, Machine Learning work in 2016 and 2017?". The poll was completed by 954 people and it showed the following results.

The results of the poll clearly indicate that there is a shift from R programming language to Python programming language in respect of Data Science, Analytics and Machine Learning (see Figure 3). The usage of R programming language fell by 6 percentage points, while usage of Python rose from 34% to 41% (the increase of 7 percentage points) of readers that finished the poll. The poll indicates that use of both, R and Python for Data Science, Analytics and Machine learning also rose from 8.5% to 12% (the increase of 3.5 percentage points), which can be contributed to practitioners slowly switching from R to Python but still using R for some specific part of work.

Next, the poll results also show the transitions from one to another platform for Analytics, Data Science, and Machine learning (see Figure 4). The chart in Figure 4 clearly shows the following. Python users are more loyal than R users, as 91% of readers stuck with Python from 2016 to 2017, and only 74% of readers stuck with R from 2016 to 2017. Also, only 60% of readers that use other platform and languages stuck to those from 2016 to 2017.



Figure 3. Share of R, Python, both R and Python, or other platforms usage for Analytics, Data Science or Machine Learning for 2016 and 2017 [8].



Figure 4. The transition between different programming languages for Data Science, Analytics and Machine Learning from 2016 to 2017 [8].

As the chart shows, only 5% of Python users switched to R exclusively, while 10% of R users switched to using Python exclusively. There is a clear flow of R users (15%) that switched to using both, R and Python, but users of both platforms in 2016 had a major switch to using Python exclusively (38%). There was only 4% of switch by Python users to using both platforms, and only 11% of readers that used both platforms in 2016 that switched to using only R. There is also a clear flow of users that are using either R or Python for Analytics, Data Science and Machine Learning from other platforms - 17% to using only R, 19% to using only Python and 4% to using both, R and Python.

KDnuggets performed a similar poll in 2015 [9], which served as a basis for trend recognition of platform usage. Figure 5 shows these trends of using different programming languages/platforms for Analytics, Data Science, and Machine Learning. The Figure 5 clearly shows that the use of other platforms (not R or Python) is dropping and it will probably continue to drop in the following years. The usage of R peaked in 2015 but had a somehow sharp drop in 2017, while the usage of Python programming language is steadily rising and should continue to grow if this trend continues.



Figure 5. Platform usage for Analytics, Data Science and Machine Learning from 2014 to 2017 [8].

We made a quick glance at the popularity of R and Python platforms for Data Science, ourselves. Figure 6 shows the Google Trend chart, where it shows search term popularity on the timeline. We compared two search terms: "Python Data Science" (blue trend line), and "R Data Science" (red trend line).



Figure 6. Google Trends search term popularity for last five years for terms "Python Data Science" for blue trend line and "R Data Science" for red trend line (September 9th, 2017).



Figure 7. Job posting trends on Indeed.com for last five years for terms "Python Data Science" for blue trend line and "R Data Science" for orange trend line (September 9th, 2017).

As chart shows, there was the almost even popularity of both search terms until the end of 2016, there was just a slight lead of R in the year 2015. In the beginning of 2016, the Python search term took over the lead and its search term popularity gained more and more lead as the time progressed. Although popularity for both terms increased, the search term for Python platform has a clear advantage. After that, we also did a trend analysis on the job

posting site Indeed.com. Figure 7 shows two trends for the same search terms as before ("Python Data Science" and "R Data Science") for last five years. Even in the job posting aspect, the Python platform has a clear advantage in comparison to R.

5. CONCLUSION

In this paper, we present the definition of a Data Scientist and some frameworks of its required skill set and competences. We presented existing research in the field of identifying the core skills and competences and survey the current state of needed and popular skills among practicing Data Scientists. We may conclude that a Data Scientist requires a diverse set of skills and has to adapt to new platforms as their popularities change throughout the time. It is yet to be seen how these skills and popular frameworks used in the work of a Data Scientist will change in the future, but for now we can conclude that skills of analytics, engineering, data management, research methods, project management and business analytics using Python and R platforms present a core of skills every Data Scientist needs.

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Towards a Classification of Educational Tools

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ABSTRACT

As part of Didakt.UM project, which aims to exchange of experience and create a platform that would enable the efficient search and selection of suitable ICT solutions, used for educational purposes within the University of Maribor, an analysis and classification of such ICT solutions were made. Out of 82 entries, 63 tools were classified into the broad classification, which intends to cover the widest range of ICT solutions, used by the students and staff of University of Maribor.

Categories and Subject Descriptors

K.3 [Computers and education]: General; H.4 [Information systems applications]: General; K.6 [Management of computing and information systems]: General

General Terms

Management, Documentation, Performance, Economics, Human Factors, Standardization, Legal Aspects.

Keywords

Software classification, Software taxonomy, Educational software, Software usage, Learning stack

1. INTRODUCTION

The preparation of an exhaustive list of ICT solutions presents a complex challenge due to the extremely high number and variety of solutions and their respective domains of use. The need to place these solutions within the different levels of the classification makes the challenge even more complex [1].

The purpose and objective of our research was two folded. Firstly, we provided an analysis of the existing situation regarding the usage of ICT solutions, used for educational purposes by the students and staff of University of Maribor (from hereinafter referred to as UM). Secondly, the classification of aforementioned ICT solutions was prepared to give a foundation for establishing the learning stack [2], which represents a collection of applications, cloud services, content repositories and data sources that can be accessed through a content platform. Such platform would enable the pedagogical staff to search, comment and rate the suitable ICT tools within the repository and to exchange the didactic experience and good practices within the UM environment.

The document consists of the following sections. We provide a short overview of related work that covers different approaches in classifying the ICT resources in section 2.

Secondly, we present our classification proposal with a mind map of the classification with the first level categories in section 3.1. We continue with statistical analysis of the survey of the usage of ICT tools within the UM in section 3.2.

Lastly, we provide a sneak-peak into a project deliverable in the form of a two-level classification table, which offers a more detailed overview of the resulting classification.

2. RELATED WORK

At the highest level, technological infrastructure can be divided into hardware and software resources [3]. Hardware refers to the mechanical, visible and tangible part of the information technology, while software presents a set of instructions prepared to obtain an adequate final result [4]. With the rapid development of smartphones and embedded systems, the hardware-dependent software has been recently gaining unprecedented use within a wide range of domains such as medicine, telecommunications, automotive industry and others [5].

A global classification of educational tool was not found. Various sub-classifications, related to specific use-cases or niche domains were included in the analysis. In general, software is usually divided into application and system solutions [4]. The latter offer an infrastructure environment for running application software and include operating systems, drivers, system utilities, and servers. The category of application solutions can include software that information management, education, enables business infrastructure, simulation, media processing, software development and solutions that contain the concepts of gamification [6], [7]. Multiple taxonomies for classifying software already exist, one of most known being the ACM Computing Classification System, which was lastly revised in 2012 [8]. Main categories from the ACM taxonomy are: General and reference; Hardware, Computer systems organization; Networks; Software and its engineering; Theory of computation; Mathematics of computing; Information systems; Security and privacy; Human-centered computing; Computing methodologies; Applied computing; Social and professional topics; Proper nouns: People, technologies and companies. The purpose of ACM taxonomy is to provide a categorization of technology-related topics. From application domain standpoint it provides relatively poor coverage for some application types, such as information display and consumeroriented software [9]. On the other hand, open-source community, with sites as SourceForge and Google Code, provide a good overview of most types of software, developed by such communities. Google's approach for defining application domains avoids the hierarchical structure and relies on tagging [9]. Additionally, many authors have developed their own more or less up-to-date taxonomies, which divide software into categories based on the purpose of use (e.g. data-dominant, systems, control dominant and computation-dominant software, the categories that are furtherly divided into domains of use) [9] or directly by the domain of use [10].

3. CLASSIFICATION PROPOSAL

3.1 Classification attributes

We aimed to avoid classifying software only by purpose and domain of use and strived to provide more comprehensive and holistic approach for classifying software in education sector. Thus, we included a multitude of other factors (attributes). Examples of such factors include the type of the usage [11] (e.g. web, mobile and desktop), usage domain [12] (e.g. general-purpose or specific, such as Mathematics or Medicine), group work support (on a scale of a team, community, organization) [13], time aspect of collaboration [14] (synchronous and asynchronous) and the purpose of the use, which was further divided to functionalities. This was done to cover the widest possible range of application software, which will, of course, continue to expand in the future with the development of the ICT field. Regarding the purpose of use, we placed an emphasis on solutions in the field of education, where we divided the purpose of using such tools into three sections: learning content management [15], knowledge testing and evaluation [15] and learning analytics [16].

Among the other purposes of use, that are furtherly divided into more specific functionalities, are polling capabilities, group work support (collaboration, communication and coordination), media processing, statistical data processing, data storage, software development, software deployment, enterprise resource planning, modeling, project management, virtualization and simulation.

The initial part of the classification is a general description of tools, with data regarding the manufacturer, type of license, price of tools, solution provider within the UM and support/service level, examples of usage both in general and within the UM and a corresponding contact person. General description is followed by positioning the ICT solutions according to the Klasius P [17] classification.

The following diagram shows the classification of ICT solutions used for educational purposes within the UM. For reasons of greater transparency, we only show the first level nodes of classification.



Figure 1. Top level attributes of the proposed classification.

3.2 Statistical analysis of ICT tools usage

Based on data from the survey on the usage of ICT solutions within the UM, we identified 82 entries, of which 19 entries were defective, with missing data regarding the type of solution, manufacturer etc.

Altogether, we classified the following 63 ICT solutions, namely:

Moodle, Geogebra, Sony Virtuoso in Soloist, Expression Studio, CyberLink PowerDirector, Articulate, iSpring, Hype, Sibelius, Adobe Photoshop, Photofiltre Studio X, Audacity, Windows Movie Maker, HandBrake, MKVTToolNix, Subtitle Edit, Hot Potatoes, Google Docs, Sheets, Slides, Forms, Poll Maker, Skype, The Jupyter Notebook, matplotlib, WinMIPS64, XAMPP, Usb Web Server, UwAmp, WampServer, SonarQube, Java Web Start, ERPSim, Vox Armes, BIM server, Xerte, Oracle database server, Adonis CE, Pantheon X, Bizagi Business Process Modeler, Microsoft Visio, Microsoft Dynamics Nav, Microsoft Project, Aris Architect & Designer, Aris Express, JDeveloper, Eclipse, SQL Developer, SQL Developer Data Modeler, Greenfoot, Tableau, Orange, SAP Lumira, SAP-ERP, Oracle VM VirtualBox, VMware Workstation Player, Linux Ubuntu, Kali Linux, SPSS, AnyLogic, Turning Point, Kahoot, Padlet, Anatomy 4D, Virtual Patient MedU, ThinkDesign Suite.

The column chart in Figure 2 shows the number of solutions according to the domains of the usage. It is important to stress that one tool can belong to more than one domain. Majority of tools represented the computer science and informatics domain (28), while 19 tools were general-purpose tools (such as Skype, Google Docs) that can be used within any domain.





Figure 2. Number of solutions by usage domain.

The pie chart in Figure 3 shows the ratio between the open source and proprietary solutions. Most of the documented equipment (39 out of 63) were proprietary.



Figure 3. Ratio between open-source and proprietary tools



Figure 4. Number of solutions by the purpose of usage.

The column diagram in Figure 4 shows the number of tools that support at least one functionality from the categories, which describe purpose of use. Most often, the tool was intended for modeling (18); cooperation, communication and coordination (16); multimedia management (16), software development (12) and learning content management (10).



Figure 5. Ratio of collaboration-supported tools.

The pie chart in Figure 5 shows the proportion of solutions in terms of collaboration support. The 19 tools from the survey allow groups to work together, while the remaining 44 solutions do not have such support.



Figure 6. Number of solutions by the type of the usage.

The column chart in Figure 6 shows the number of solutions based on the type of client, with 32 tools permitting online use within the browser. The 14 tools can be accessed with mobile smartphones and 51 tools are developed as desktop applications. Again, it is important to stress that each of the tool can have more than type of a client.

The column chart in Figure 7 shows the number of solutions according to the types of ICT solutions as proposed in our classification. Most tools meet the following types of ICT solutions: information management (30), software development (17), and education (16).



Figure 7. Number of solutions by the ICT type.

3.3 Proposed two-level classification

The Table 1 presents the more detailed introspection into our classification proposal. Within this article, we limited the number of attribute hierarchy level into two levels. The actual classification was divided into the three-level hierarchy of classification attributes, hence being even more comprehensive.

Table 1. Classification of used solutions (to the	e second	level)
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1st level of classification	2nd level of classification
General information	Name of the solution; Description; Manufacturer; Manufacturer's URL; License type; Price; Provider; Provider's URL; Support/service level; Minimum system requirements; General use case; UM use case; UM contact person
Faculty usage (Klasius P)	 1 - Teacher training and education science; 2 - Humanities and arts; 3 - Social sciences, business and law; 4 - Science, Mathematics and Computer Science; 5 - Engineering, manufacturing and construction; 6 - Agriculture, Forestry, Fisheries, Veterinary; 7 - Health and welfare; 8 - Services
Use case domain	General-purpose; Specific
Type of ICT solutions	System software; Application software
Type of the usage	Web; Mobile; Desktop
Channel of communication	Video; Sound; Text

<i>Type / format of the content</i>	Video material; Graphical material; Sound; Text; Spreadsheet; Presentation; Any file
Group work support	Among the members of the organization; Among the members of the community; Among the team members
The time aspect of collaboration	Asynchronous; Synchronous
Cooperation between the roles within UM	Student; Teacher; Domain expert; Administrator
The purpose of usage	Learning content management; Knowledge testing and evaluation; Polling; Learning analytics; Cooperation, communication and coordination; Multimedia management; Statistical data analysis; Data storage; Software Development; Software Deployment; Enterprise resource planning; Modeling; Project management; Virtualization; Simulation

The result of our in-depth analysis was a report in which we provided the three-level classification of ICT solutions, a brief description of each attribute of the classification and the actual placement of 63 identified ICT solutions within our proposed classification.

4. CONCLUSION

Classification of educational tools is a broad topic that still has a lot of room for improvement and research. In the future, we suggest additional classification and categorization of tools combined with pedagogical learning approaches related to the specific needs of the instructor. Moreover, the framework could be expanded with pedagogical classifications and requirements related to regional/local pedagogical classifications (i.e. related to the specific country).

5. ACKNOWLEDGEMENTS

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PREDGOVOR

Pod okriljem multikonference »Informacijska družba« po krajšem premoru zopet organiziramo tudi konferenco Robotika, s katero nadaljujemo tradicijo raziskovalne robotike v Sloveniji.

Robotika je v vzponu in čeprav jo mnogi še zmeraj dojemajo kot znanstveno fantastiko, je tudi uporabniška robotika že nekaj časa nekaj povsem realnega in oprijemljivega, kmalu pa bo tudi že nekaj običajnega. Robotika je tudi skorajda vseprisotna. Brez robotskih manipulatorjev si ne znamo več predstavljati sodobnih industrijskih procesov. Ne presenečajo niti kirurški roboti ali servisni mobilni roboti, ki dostavljajo pakete in hrano ter čistijo in stražijo javno infrastrukturo. Domišljija in pa želje ljudi ne poznajo mej, zato se raziskovalna robotika trudi z razvojem velikih večnamenskih robotskih hišnih pomočnikov. Pri razvoju tako kompleksnih in avtonomnih sistemov, kar nekateri ocenjujejo, da je težje kot raketna znanost, je pomembna izmenjava idej in mnenj, kar je tudi namen konference Robotika.

V zborniku so zbrani prispevki raziskovalcev Odseka za avtomatiko, biokibernetiko in robotiko na Inštitutu Jožef Stefan, veseli pa smo, da imamo letos prispevke s svetovno priznane Tehniške Univerze v Muenchnu, Nemčija. Upamo, da bo izmenjava idej in raziskovalnih rezultatov vodila v nadaljnje skupne podvige, ki bodo še naprej pomagali soustvarjati trende raziskovalne robotike.

Andrej Gams in Aleš Ude

FOREWORD

Robotics conference in the scope of the Information Society is after a short break again a part of the multiconference, and continues the rich tradition of research robotics in Slovenia.

Robotics is on the rise and even though many people still perceive it as science fiction, even consumer robotics has passed from the realm of fiction to something real, tangible. Robotics is also omnipresent. Many industrial processes today simply cannot be conceived without the use of robotic manipulators. The use of surgical and mobile service robots, which deliver packages and food and clean and guard public infrastructure is not a surprise anymore. As human imagination and wishes do not know any borders, research robotics is working hard towards the development of multipurpose, autonomous, robotic household assistants. The development of such systems, which some consider more complex than rocket science, requires cooperation between researchers and the exchange of ideas and opinions. Exchange of ideas and opinions is also the main aim and goal of the Robotics conference in the scope of the Information Society multiconference.

The conference proceedings contain papers from researchers of the Department for Automatics, Biocybernetics and Robotics of Jožef Stefan Institute. We are delighted to have attracted contributions from researchers of the world-renowned Technical University of Munich, Germany. We hope that the exchange of ideas will lead to joint undertakings and will help to co-shape the trends of research robotics in the future.

Andrej Gams and Aleš Ude

PROGRAMSKI ODBOR / PROGRAMME COMMITTEE

Andrej Gams

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Compliant Bimanual Actions through Learning of Primitives

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ABSTRACT

Compliant Movement Primitives (CMP) provide the means to achieve low trajectory errors and compliant control without explicit dynamic models of the task. This paper addresses the application of CMPs to bimanual tasks. Besides performing the task, the robots have to maintain their relative posture even in the presence of external perturbations on any of the robots, not to exert force on the object they are carrying. Thus, they act compliantly in their absolute task, but remain stiff in their relative task. For compliant absolute behavior and stiff relative behavior we combine previously developed joint-space CMPs with the symmetric control approach. We further augment it by applying a virtual force vector at the end-effector, calculated through the measured external joint torques on the perturbed robot, to increase bimanual compliance. Experiments with two Kuka LWR-4 robots in a bimanual setting show applicability of the system.

1. INTRODUCTION

Robots were considered dangerous to humans and objects in their workspace and were thus confined to cages [7]. This is due to high stiffness and position control used to accomplish accurate execution of their given tasks. However, the notion of collaborative robotics, where both the human and robot share their workspace to accomplish a common task [8], has gone beyond that. Collaborative robotics applications go beyond the factory work-floor to everyday human environments, including bimanual and humanoid robots.

Safety of the human is the primary task in shared environments. This can be ensured through the compliance of the robot. Compliance can be active, originating from contact detection with an artificial tactile skin [11]. On the other hand, elastic elements can introduce passive compliance. Passive compliance can also be actively changed using variable stiffness actuators [1]. Appropriate active torque strategies, relying on comparing the actual torques and the required theoretical torques [9] have also been used to implement active compliance. However, such methods require the correct dynamic model of both the robot and of the task. Such models of task dynamics are often often difficult to derive.

To bypass the need to develop dynamical models, one can learn the specific required torques for the specific task with learning by demonstration (LbD). Learned torques are apAleš Ude Humanoid and Cognitive Robotics Lab Dept. of Automatics, Biocybernetics and Robotics Jožef Stefan Institute ales.ude@ijs.si



Figure 1: Bimanual robot performing a task while being perturbed by a human.

plied for the repetition of the exact same action. Such an approach was utilized in [5] and termed Compliant Movement Primitives (CMPs). It is applicable to robots with active torque control. In this paper we show how we can extend the CMP framework to make it applicable for bimanual task. For bimanual operation, we need to maintain the relative task. We implement this by integrating the symmetric controller into the framework. For increased compliance, which allows safe physical interaction with humans, we also utilize virtual force translation, where we copy the perturbation to the robot from one robotic arm to the other. The experimental system used is presented in Fig. 1.

1.1 Related Work

Many papers have dealt with the topics of compliant control. It commonly relies on explicit dynamics of the robot and the task [13]. Compliant movement primitives, which represent the basic background of this paper, mitigate this need through learning of required torques. Similar approaches that rely on task-specific models have been presented. [3] used tactile sensors to determine the force of contact with the environment on the iCub robot, and then calculate the joint-torques from the measured arm pose. The calculated joint torques were used in a feed-forward manner in control. In an analogous manner in [15] the authors recorded joint torques along the kinematic trajectory and then used as the feed-forward signal for increased accuracy in the next execution of the same in-contact task.

Different approaches for bimanual control of robots have also

been presented, with a basic separation in being either asymmetric or symmetric control. While the former controls each robot independently, the latter considers both robots as a single system. For example, in [6] an asymmetric control scheme using motion primitives is described. The robots are coupled through learned feed-forward signals. However, the robots themselves are completely stiff. A dynamical system that combines single or bimanual robot operation based on dynamical systems was presented in [14]. The authors use a virtual object to define the motion of robotic arms.

Asymmetric system, on the other hand, can describe a cooperative operational space. Thus it allows the user to determine the relative and the absolute tasks. This also allows to define geometrical variables at the position/orientation level [4]. An example of such is presented in [12], showing a human-robot cooperation scheme for bimanual robots. It is based on separately defining the gains for absolute and relative motion. However, trajectory tracking errors will increase considerably when the absolute gains are set low.

2. COMPLIANT MOVEMENT PRIMITIVES

Compliant movement primitives rely on the impedance controller, such as the one used in the Kuka LWR robot [2], and add feed-forward torques $\vec{\tau}_{ff}$. Thus, the low-level robot controller is given by

$$\vec{\tau}_u = \mathbf{K}_q(\vec{q}_d - \vec{q}) + \mathbf{D}_q(\dot{\vec{q}}_d - \dot{\vec{q}}) + \vec{f}_{\text{dynamic}}(\vec{q}, \dot{\vec{q}}, \ddot{\vec{q}}) + \vec{\tau}_{ff}.$$
(1)

Here $\vec{\tau}_u$ is the control torque vector, \mathbf{K}_q is a diagonal jointstiffness matrix, \vec{q}_d and \vec{q} are vectors of the desired and measured joint positions, respectively, \mathbf{D}_q is a diagonal damping matrix, \vec{q}_d and \vec{q} are the desired and measured vectors of joint velocities, respectively, and $\vec{f}_{dynamic}(\vec{q}, \vec{q}, \vec{q})$ represents the robot dynamics and the non-linearities occurring in the robot.

If the robot is made compliant by lowering the stiffness (\mathbf{K}_q) , this increases the trajectory tracking error. To compensate, feed-forward torques $\vec{\tau}_{ff}$ are added to the motor torque to preserve trajectory tracking. These feed-forward torques $\vec{\tau}_{ff}$ are usually calculated from an explicit dynamical model. However, for repeatable tasks, we can use previously learned torques to provide low trajectory tracking errors. That is the basic principle of the the CMP framework [5].

A CMP combines desired joint motion trajectories (joint positions $\vec{q}_d(t)$) and corresponding joint torque signals $\vec{\tau}_{ff}(t)$

$$\vec{h}(t) = [\vec{q}_d(t), \vec{\tau}_{ff}(t)].$$
 (2)

Joint positions for all degrees-of-freedom (DOF) are learned, for example through imitation, while joint torques are recorded from a stiff execution. Because CMPs encode only taskspecific torques, we gain them by subtracting the known robot's $\vec{f}_{\rm dynamic}(\vec{q}, \dot{\vec{q}}, \ddot{\vec{q}})$ from the actual measured torques $\vec{\tau}_m$ at robots joints

$$\vec{\tau}_{ff} = \vec{\tau}_m - \vec{f}_{\text{dynamic}}(\vec{q}, \dot{\vec{q}}, \ddot{\vec{q}}).$$
(3)

Joint positions are encoded as dynamic movement primitives (DMPs) [10] and the corresponding torques are encoded as a combination of radial basis functions (RBFs). We again refer the reader to [5] for details.

CMPs operate in joint space. For bimanual tasks, the relation of the robots is in task space.

3. SYMMETRIC ROBOT CONTROL

In this paper we provide a reduced description for the control of a bimanual system. The absolute coordinates describe the position and orientation of a common coordinate frame (CF) of the robots in reference to the inertial CF. The relative ones (6 DOF) describe the position and orientation of one robot end-effector relative to the other.

The Jacobian matrix of a bimanual system includes both the absolute and the relative parts.

$$\mathbf{J} = \begin{bmatrix} \mathbf{J}_{abs} \\ \mathbf{J}_{rel} \end{bmatrix}.$$
 (4)

We can iteratively calculate the inverse kinematics using

$$\dot{\vec{q}} = \mathbf{J}^{\dagger} \left(\vec{v}_d + \mathbf{K} \vec{e} \right), \tag{5}$$

where \mathbf{J}^{\dagger} is the Moore-Penrose pseudo-inverse of the Jacobian matrix from (4). In (5) $\dot{\vec{q}} = \begin{bmatrix} \dot{q}_1^T & \dot{q}_2^T \end{bmatrix}^T$ is the vector of angular velocities, $\vec{e} = \begin{bmatrix} \vec{e}_{abs}^T & \vec{e}_{rel}^T \end{bmatrix}^T$ is the vector of task space errors, $\vec{v}_d = \begin{bmatrix} \vec{v}_{absd}^T & \vec{v}_{reld}^T \end{bmatrix}^T$ are the desired task space velocities and **K** is a 12 × 12 diagonal gain matrix. The absolute error is given by

$$\vec{e}_{abs} = \begin{bmatrix} \vec{p}_{absd}^{w} - \vec{p}_{abs}^{w} \\ \frac{1}{2} \left(\mathbf{S} \left(\vec{n}_{abs}^{w} \right) \vec{n}_{absd}^{w} + \mathbf{S} \left(\vec{s}_{abs}^{w} \right) \vec{s}_{absd}^{w} + \mathbf{S} \left(\vec{a}_{abs}^{w} \right) \vec{a}_{absd}^{w} \\ + \mathbf{S} \left(\vec{a}_{abs}^{w} \right) \vec{a}_{absd}^{w} \end{bmatrix}$$
(6)

For the relative coordinates we have

$$\vec{e}_{rel} = \begin{bmatrix} \mathbf{R}_{abs}^{w} \vec{p}_{reld}^{abs} - \vec{p}_{r}^{w} \\ \frac{1}{2} \mathbf{R}_{1}^{w} \left(\mathbf{S} \left(\vec{n}_{rel}^{1} \right) \vec{n}_{reld}^{1} + \mathbf{S} \left(\vec{s}_{rel}^{1} \right) \vec{s}_{reld}^{1} + \\ + \mathbf{S} \left(\vec{a}_{rel}^{1} \right) \vec{a}_{reld}^{1} \end{bmatrix}$$
(7)

Desired velocities are then

$$\vec{v}_{absd} = \begin{bmatrix} \dot{\vec{p}}_{absd}^w \\ \vec{\omega}_{absd}^w \end{bmatrix}$$
(8)

$$\vec{v}_{reld} = \begin{bmatrix} \mathbf{R}^w_{abs} \dot{\vec{p}}^{abs}_{reld} + \mathbf{S}(\vec{\omega}^w_{abs}) \mathbf{R}^w_{abs} \vec{p}^{abs}_{reld} \\ \vec{\omega}^1_{reld} \end{bmatrix}$$
(9)

where the subscript suffix d stands for desired, $\mathbf{S}(\cdot)$ is the skew-symmetric operator and $\vec{n}_i^j, \vec{s}_i^j, \vec{a}_i^j$ are, respectively, the first, second and third column of a rotation matrix. i.e. $\mathbf{R}_i^j = [\vec{n}_i^j \vec{s}_i^j \vec{a}_i^j]$.

To control the joint torques of a bimanual system, we can now use

$$\vec{\tau}_{\text{biman}} = \mathbf{J}^T \left(\mathbf{K}_{\text{t}} \vec{e} + \mathbf{D}_{\text{t}} \dot{\vec{e}} \right).$$
(10)

Here \mathbf{K}_t and \mathbf{D}_t are diagonal gain matrices for stiffness and damping, respectively. Low values on their diagonal will

result in compliant behavior, resulting in poor trajectory tracking and high errors.

The drawback of the controller (10) is that it changes the torques of both manipulators. By pushing on one robot, additional torques will appear in both of them to neutralize the perturbation. An unintentional collision will thus result in less compliant behavior of the bimanual system. We increase the compliancy of the bimanual system, by additionally introducing a virtual force translation.

From measured joint torques we can calculate the end-effector force using the virtual work theorem, which states

$$\vec{\tau_e} = \mathbf{J}^T \vec{f_e}.$$
 (11)

A perturbation on one robot can thus be used to estimate the end-effector force of that manipulator \vec{f}_{1e} using (11). We apply the same end-effector force through the joint torques to the other robot. Thus we have

$$\vec{f}_{1e} = \vec{f}_{2e}.$$
 (12)

Only the virtual torques caused by the perturbation should be translated to the other robot, not the complete joint torques. These are calculated by

$$\Delta \vec{\tau}_i = \vec{\tau}_{i_\text{expected}} - \vec{\tau}_{i_\text{measured}}, \ i = 1, 2.$$
(13)

The translated torque is thus

$$\vec{\tau}_{\rm vft} = \begin{bmatrix} \vec{\tau}_{\rm vft,1} \\ \vec{\tau}_{\rm vft,2} \end{bmatrix} = \begin{bmatrix} \mathbf{J}_1^T \left(\mathbf{J}_2^\dagger \right)^T \Delta \vec{\tau}_2 \\ \mathbf{J}_2^T \left(\mathbf{J}_1^\dagger \right)^T \Delta \vec{\tau}_1 \end{bmatrix}.$$
(14)

4. BIMANUL CONTROL USING CMPS

If we use low gains in (10), we introduce introduce compliance to the system, but also high trajectory tracking errors. Therefore we need to add also the feed-forward torques. Feed-forward torques $\vec{\tau}_{ff}$, which we use in (1), are now composed of three components

$$\vec{\tau}_{ff} = \begin{bmatrix} \vec{\tau}_{ff,1} \\ \vec{\tau}_{ff,2} \end{bmatrix} = \vec{\tau}_{\text{rec}} + \vec{\tau}_{\text{biman}} - \vec{\tau}_{\text{vft}}.$$
 (15)

The pre-recorded or learned task torque $\vec{\tau}_{\rm rec}$ ensures trajectory tracking. It is the direct output of the CMP. However, the reference joint trajectories are calculated from the task-space trajectories using (5). Note that the inverse kinematics solution needs to match the posture of the robot during the demonstration, which might become a problem with redundant tasks.

5. EXPERIMENTAL EVALUATION

We performed our experiments on two Kuka LWR-4 7 DOF robots. We locked the rotation of the 3rd axis on both robots, so that our system was not redundant for the task. The system was controlled from Matlab. The robots were controlled with (1), with joint stiffness set to 25 Nm/rad for all the used joints.

The task of the bimanual system was to perform a bimanual trajectory while being compliant. This means that the trajectory tracking error was low when there were no perturbations, but the robot was compliant in the absolute task when a perturbation occured. The robots were each carrying a 2.5 kg load. The robots were not physically coupled through holding a common object, so that the relative task conformity is clearly expressed. In this experiment we controlled the relative position of the system, but did not control the relative orientation.



Figure 2: Absolute error (top), relative error (middle) and end-effector perturbation (calculated from measured joint torques) when using the complete controller, given by (15).



Figure 3: The feed-forward torque on the first joint of the right robot, and separate components when using the complete controller, given by (15). See the bottom plot of Fig. 2 for the perturbation.

The result of using the complete controller, given by (15) is compliant operation in the absolute task, but maintains low errors in the relative task despite the high external perturbation forces on the one side, but also maintaining low trajectory tracking errors if no perturbation is present. The results are shown in Fig. 2. The effect of including the virtual force translation in τ_{ff} is seen also at seconds 18 - 20 in the bottom plot of Fig. 2. There, the right robot did not include $\tau_{\rm vft}$. Thus, a twice higher perturbation resulted in a much lower absolute error, meaning that the system was far less compliant, when $\tau_{\rm vft}$ was not included.

Figure 3 shows the complete torque $\tau_{1,\text{RIGHT}}$ and the contributions of separate components of the controller for the first joint of the right robot. It is evident that $\tau_{\text{vft},1}$ and $\tau_{\text{biman},1}$ are similar. Thus, when perturbing the left robot, the perturbation is not fighting $\vec{\tau}_{\text{biman}}$ of the right robot, because it only has to account for a much smaller relative error. A



Figure 4: Bimanual robotic system performing the experimental compliant bimanual task. A person was perturbing the motion.

small relative error remains due to different postures of the robots that make force-vector copy inaccurate. We can also see that when there is no perturbation, the contribution of the bimanual symmetric torque controller and of the virtual force translation is practically 0. The plot also shows that $\tau_{\rm rec,1}$ is the actual learned feed-forward torque, while the other two react to perturbations.

Figure 4 shows a series of still photos showing the bimanual execution and physical interaction of the bimanual system with a person.

6. CONCLUSION

In this paper we have shown how one can extend the compliant movement primitives framework to include bimanual task execution. In the experiments, the robots were not physically coupled through holding a rigid object, yet we showed that the system maintains the relative posture, but is compliant in the absolute coordinate frame. Without perturbations, the system maintains low tracking error and that is the real contribution of compliant movement primitives.

The presented approach can be applied to a specific, prelearned task. On the other hand, generalization has the potential to extend it for a wider region of operations. That remains to be researched in the future. Another topic for the future is dealing with redundant robots. When the robots are redundant for the task, kinematic mapping offers numerous solutions. Learning of torques for all solutions is not viable, as there could literally be infinite. The posture of the robots needs to be maintained to match the posture of learning the torques. Going beyond this with CMPs remains an open research question.

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Collaborative Tasks Synthesis through a Hierarchical Database

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ABSTRACT

Collaborative human-robot task execution is presented in this paper. Example collaborative movements are encoded in a dual hierarchical database. The primary part of the database is used for human movement recognition, while the data in the secondary database is used to synthesize appropriate collaborative robot movements.

Keywords

Programming by Demonstration, Motion Recognition, Collaborative Tasks, Human-Robot Interaction

1. INTRODUCTION

By moving robots into an unstructured environment, programming its movements by hand becomes unfeasible. New movements can alternatively be gained through programming by demonstration (PbD) [14, 6], where a human demonstrates example movements. While multiple approaches can be used to record human movements [16, 12, 17], we use kinesthetic guidance, where a human physically moves the robot [8, 13].

Important aspect of using robots in a home environment or in a small to medium enterprise, is human-robot collaboration. In this two step process, human intentions are recognized first. Then an appropriate collaborative robot movement is synthesized and executed. Various approaches were used by several authors: Hidden Markov Models [10, 2]; extension of DMPs, called Interaction Primitives (IPs) [1]; Probabilistic Movement Primitives [11, 7]; etc. Similar to our approach, Yamane et al. [19, 18] used a binary tree database to recognize and synthesize movements.

Our presented approach is based on a dual hierarchical database of example collaborative movements. While the primary database encodes example human movements and is used for recognition, the second database encodes example corresponding robot movements and is used for cooperative movement synthesis. Previously, new movements were synthesize using a single hierarchical database [5]. An extended dual database was used to synthesize new compliant movement primitives [4]. Using a dual database for human robot collaborative tasks was preliminary evaluated through comparison [3]. Aleš Ude Humanoid and Cognitive Robotics Lab. Dept. of Automatics, Biocybernetics and Robotics Jožef Stefan Institute Ljubljana, Slovenia ales.ude@ijs.si



Figure 1: A simple representation of a dual database. The primary part, used for construction and motion recognition, can be seen on the left. The secondary part, seen on the right, stores corresponding robot movements.

2. METHODOLOGY

The first part of the proposed approach consists of dual hierarchical database construction. A simple representation of a dual hierarchical database is shown in Fig. 1. Its construction starts by demonstrating a set of n_S human-robot collaborative movements **D**. Each one contains n_D state vectors,

$$\mathbf{D} = [\mathbf{y}_1, \mathbf{y}_2, \dots, \mathbf{y}_{n_D}],\tag{1}$$

sampled at a given discrete time t_D . Each state vectors,

$$\mathbf{y}_i = [\mathbf{y}_i^h, \mathbf{y}_i^r]^T, \qquad (2)$$

includes human state vectors \mathbf{y}_i^h , and corresponding robot state vectors \mathbf{y}_i^r . Human movements are used to build the primary part of the database. Clustering is used to construct multiple levels which encode all demonstrated movements at different granularities. Each level includes a weighted directed graph, i.e. a transition graph (TG). It is based on demonstrated movements and represents transitions between the nodes at that level. The secondary database encodes corresponding robot movements. At each level the nodes are mirrored from the primary database. This means that each node in the primary database has a mirrored node in the secondary database, which includes robot state vectors recorded at the same time as human state vectors.



Figure 2: Recognition and cooperative movement synthesis overview.

The further details on hierarchical database construction are omitted and the reader is referred to [5, 3].

The second part of the proposed approach uses the dual database for human movement recognition and corresponding robot movement synthesis. The process, shown in Fig. 2, can be divided into three components: human movement *recognition*, which finds the most probable human nodes w.r.t. the current sliding window; human path *prediction*, which uses transition graphs to predict a full human path; and robot movement *synthesis*, which uses DMPs to interpolate between corresponding robot nodes and generates an executable participating robot trajectory.

Each recognition iteration starts by updating the sliding window, which consists of last n_W human state vectors observed in the current human movement,

$$\mathbf{Y}^{o} = \{\mathbf{y}^{o}_{n_{o}-n_{W}}, \dots, \mathbf{y}^{o}_{n_{o}-1}, \mathbf{y}^{o}_{n_{o}}\},\tag{3}$$

where *o* represents *observed*, and the complete number of human state vectors observed from the start of the movement is denoted by n_o . At each iteration, recognition is done by traversing down the levels of the primary database. Several steps are done at every level l: 1) determine the considered nodes at this level, i.e., the nodes who's parents were above the cut-off range at the previous level; 2) build a matrix of considered nodes, where each row of length n_W is a permutation of considered nodes; 3) calculate the recognition score for each permutation based on the TG and similarities between the observations and considered nodes; 4) determine the nodes with recognition score above the cut-off range, who's children nodes will be considered as we move down a level. As we reach the last level, the permutation of nodes with the best recognition score is determined as the most probable human sequence of nodes.

Next component uses these results for robot sequence prediction. It follows the most probable human sequence on the TG w.r.t. highest weights until it reaches an end node. It then mirrors it to the secondary database and predicts the most suitable robot node sequence.

Last component is synthesis, which enhances the most suitable robot node sequence with time stamps and interpolates it. Time stamps are determined based on estimated duration of nodes. Time duration t_v of a single node v is estimated as

$$t_v = \frac{n_v}{m_v} t_D,\tag{4}$$



Figure 3: Set of demonstrated cooperative trajectories seen in two dimensions Robot trajectories, denoted in red, were converted to task space for presentation purposes. Human trajectories are denoted in green.

where n_v denotes the number of state vectors clustered in node v and m_v denotes the number of demonstrated trajectories passing through it. The interpolation of robot state vectors belonging to the most suitable robot node sequence, and enhanced with time stamps, is done with Dynamic Movement Primitives (DMPs). The details on DMPs are omitted and the reader is referred to [15, 9]. DMPs ensure smooth and continuous robot movements, even in the events of sudden recognition change.

3. EVALUATION

Evaluation was done on a robot system consisting of: a KUKA-LWR4 robot arm, a three-fingered Barret Hand gripper, and a passive marker based system OptiTrack. Six collaborating tasks were executed, with one demonstrator kinesthetically guiding the robot and the other executing the task with markers on his hand. Six human movements and corresponding robot movements are shown in Fig. 3. They are shown in two dimensions for presentational purposes. The robot movements were captured and encoded in the database in joint space. For this image they were converted to task space. The recorded set of collaborating movements can be divided into to two sets of three movements. Each set executes a variation of a pick and place task with one of two objects. The human part of the task was to grab up one of two object (peg or cover) and move it to one of three final position for each object. He then inserted/put


Figure 4: Computation time of components. Mean values of computation times over all 10 experiments are presented in the 3 graphs. They present computation times needed for separate components of the process.

the object in/on the cylinder. The robot's task, which was holding the cylinder, was to rotate it appropriately. As described in the previous section, the collaborative movements were used to build a dual hierarchical database.

Ten experiments were performed. In each the same dual database was used to recognize human movement and synthesize an appropriate collaborative robot movement. In each experiment the human performed a different movement: picking up an object and moving to one of the 6 final positions, picking up an object and while moving it changing its mind about the final position, and moving to pick one object, but then changing his mind and picking up the other one.

As our goal was to perform the recognition and synthesis on-line, we first evaluated the needed computation time of the approach. Mean values of calculation times over all 10 experiments presented in Fig. 4 are divided over the components: recognition of human movement, robot node sequence prediction, and robot movement synthesis. We can observe the majority of the computation time is used for recognition component. With the exception of the occasional rise above the desired 30 Hz, the sum computation times of all three components, remained approximately 0.02 s.

Images in Fig. 5 show two example executions of on-line movement recognition and cooperative task execution. Top 6 images show the human picking up the cover and placing it on the object. The bottom 6 images show another example, where the human moves the peg. We can observe the robot executing appropriate collaborative movements.

4. CONCLUSIONS

Human movement recognition and collaborative robot movements synthesis was presented in this paper. A set of humanrobot collaborative movements was demonstrated and encoded in a dual hierarchical database. While the primary part was used for human movement recognition, the secondary part was used for collaborative robot movement synthesis. Incorporated DMP approach ensures a smooth and continuous trajectory for its execution on a robot.

Performed experiments showed on-line execution was viable,

due to a satisfactory computation time. In all ten experiments the human movement was recognized and an appropriate collaborative robot movement was synthesized. All robot movement were smooth and continuous.

Future work involves further evaluation, including responses to sudden human movement changes. The approach will also be evaluated with a bigger set of more various demonstrated collaborative movements. Computation time needed for the recognition component could be further reduced to make the whole process perform faster.

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Figure 5: Images from two example executions of on-line movement recognition and cooperative task execution. The human reaching for the cover and moving it to one of the final positions, is shown in top 6 images. The robot immediately starts the suitable rotation for the cover and then moves to the appropriate end point. Bottom six images show another example execution. Here the human reaches for the peg and moves it to one of its final positions. Again, the robot executes an appropriate movement.

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Active Reconfiguration of Software and Hardware in a Robotic Workcell

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ABSTRACT

High volume production has been a prerequisite in order to invest into automation of the manufacturing process for decades. The high cost of setup and the inflexibility of the solution meant low batch productions, often present in small and medium-sized enterprises (SMEs), were dismissed for automation. In order to bring automation closer to SMEs a flexible solution is required that can accommodate more than one manufacturing process, allows rapid change between them and doesn't require expertise knowledge for set up. In this paper we present a novel robotic workcell that enables active reconfiguration of software and hardware components, facilitating set up and production of several manufacturing processes on a single robotic cell. The ROS based software has been designed to be robot independent and modular. Special user interfaces have been developed for cell calibration, programming by demonstration and set up of quality control and part localization tasks. The proposed workcell is applicable in companies with product families, where manufacturing processes are similar and where fast changeover is required in order to adapt to new production requirements quickly. Due to the emphasis put on ease of use it will also be of interest to companies getting into automation for the first time.

1. INTRODUCTION

Fast changes in market demands lead to great fluctuation of orders down the manufacturing chain. Companies must react quickly, efficiently, and in an economically viable way. Robots have been successful in industrial production processes, when applied to repetitive tasks with long production runs and high unit volume. However, frequent shifts in the required product type or in the number of required products has prevented many companies from automating their manufacturing processes.

These so-called *few-of-a-kind* assembly production scenarios [7] are typical of SMEs. Since SMEs are the "backbone of the manufacturing industry", e.g. providing some $\sim 45\%$ of the value added by manufacturing in the European Union [8],

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Figure 1: The proposed reconfigurable workcell prototype shown at Hanover fair 2017.

it would be highly beneficial if robotic workcells could be developed specifically to address such use-cases.

The main barrier to greater adoption of robot production in SMEs are the expertise needed in setting up existing solutions and the time for testing and fine-tuning. Since SMEs usually do not have such expertise available, they avoid introducing such solutions, even when they are economically justifiable. We can recognize that these problems are due to the time costs involved in re-configuring and re-programming the robot workcell for new assembly tasks, which are often too prohibitive to make the application of robots profitable.

In this paper, we present the design of a new kind of autonomous robot workcell that is attractive not only for large production lines, but also for few-of-a-kind production. We propose reducing set-up times by exploiting a number of hardware and software technologies, some of which were partially developed in prior work, and some of which are novel contributions in this paper particular to the proposed workcell design. The main novelty of the workcell lies in the active reconfiguration of passive fixtures and other passive elements in the cell, which can be performed by the robots installed therein. This reconfiguration process allows the robots to autonomously configure their workspace and prepare the workcell for the execution of new assembly tasks.

1.1 Related Work

Many surveys in recent years have followed the development of reconfigurable robotic systems, both in research and in industry [4]. Work of Chen [2] focuses on the modular reconfigurability aspect in particular by finding optimal module assembly configurations from a given set of module components for a specific task. His subsequent work on the design of a reconfigurable robotic workcell for rapid response manufacturing [3] is of particular relevance with respect to the workcell proposed in this paper. However, his work involved a workcell containing hardware elements that can only be reconfigured *manually*. Our proposed workcell focuses on introducing hardware elements that can be actively reconfigured *automatically* by the system itself [5].

In the work of Krüger *et al.* [7,9], a set of methods was developed to facilitate the set-up of complex automated assembly processes. The proposed set of methods included pose estimation and tracking of parts using a 3-D vision system, fast and robust robot trajectory adaptation using *dynamic movement primitives* (*DMP*) [10], and ROS-based software control and state machine programming. In this work we build on these approaches and add the ability to automatically reconfigure the workcell, while adding a user interfaces to facilitate task set up. The proposed system advances beyond synthetic benchmarks and demonstrates the viability of the system on actual industrial use-case.

2. RECONFIGURABLE SOFTWARE

The introduction of a robotic cell into a production line represents a big investment for SMEs. The high costs usually come from the price of the necessary hardware and the time spent for the integration of the robotic system into the production line. One of the time-consuming aspects is the programming of task sequences for the robots involved in the production process. The programming is normally done via on-line programming using a robot teach pendant connected to the robot controller, or via off-line programming in a simulation environment. Because specific robot system knowledge is required for both approaches, we developed a software system that would facilitate the programming of robot tasks regardless of the robot system. The software system is designed to be distributed, modular and offers seamless reconfiguration of the robot cell. The package also provides the necessary tools to enable simple, intuitive programming of robot tasks.

Our system was build using *Robot Operating System (ROS)* framework, where the hard real-time components were developed using a *Matlab Simulink Real-Time (SLRT)* server, since ROS in its current form does not provide any form of hard real-time implementation. This is a crucial requirement for reliable and accurate robot control.

2.1 System Architecture Overview

Elements of the software architecture of a typical workcell design can be seen in Figure 2. The "Robot Module"s, rep-



Figure 2: Schematics of the workcell software and hardware architecture.

resent a robot with its robot control SLRT server, one additional measurement unit, and all of its tools and grippers. The "ROS Master Computer" refers to the computer in the system that runs the ROS core and our basic nodes. In order to access various periphery from the workcell a "Digital Interface Unit" is used for bridging the connection from PLC to ROS. Other typical modules include a "Vision Module" and a "Simulation Computer". The Vision Module represents a user programmable processing unit for typical vision tasks like quality control and part localization. The Simulation Computer offers a dynamic simulation environment provided by the VEROSIM software package, where the production can be planned and evaluated. Depending on requirements, the workcell design can be adapted by adding or removing various modules.

2.2 Simulink Real-Time Server

The SLRT server, responsible for robot control, connects directly to the robot controller via Ethernet. Standard robot controllers usually only offer basic control methods and not state-of-the-art trajectory generation methods implemented on the SLRT server. Importantly this approach also makes our system independent of the robot. Compatible robots must enable receiving a joint stream over Ethernet and all it takes is a modification of the kinematics model on the SLRT server in order to integrate a new robot. The SLRT server also connects to some other measurement units (e.g. force/torque sensors) that can be used for closed loop control policies (e.g. force control).

The trajectory generation algorithms that have been implemented so far cover the most common robot motion needs in the context of automated assembly. These are: trapezoidal speed profile in joint space; minimum jerk for position and minimum jerk SLERP for orientation trajectories in Cartesian space; admittance force control [1]; joint space dynamic movement primitives for free-form movements [6]; Cartesian space dynamic movement primitives free-form movements in Cartesian space [10].

2.3 ROS Software Package

To allow the robot workcell to be accessed, controlled and calibrated within the ROS environment, various ROS nodes have been developed to offer an interface to the SLRT server and other modules in the workcell. *SLRT State Publisher* to read joint positions, velocities, payload, tool information, force/torque sensor data from the SLRT server and publish it via ROS topics using standard ROS messages.

Action Servers handle communication to the SLRT server and are used to trigger robot motion and monitor the progress of the trajectory using *actionlib*. Each trajectory generation algorithm that is implemented on the SLRT server is offered as a separate action server with its own goal, feedback and result messages. The low level logic of all of the action servers ensures that only one motion can be executed at a time.

ROS Services for handling short duration tasks such as changing the state of digital outputs. Our ROS package includes services for changing the robot mode from position control to gravity compensation mode, triggering direct joint control on the SLRT server and setting digital outputs on the robot controller.

Database for keeping track of the workcell state at all times, be it during operation or downtime. We followed a common approach with wide support in the community and implemented a MongoDB database for persistent storage.

Robot Capture Program for capturing and storing various robot related configurations in the database. It is commonly used in conjunction with the kinesthetic guiding of the robot, where the programmer of the robot workcell can freely move the robot in its workspace and then save the points of interest. The functionality is commonly used for calibrating the workcell state (reconfigurable fixture positions, tool pick-up slots) and for saving pick-and-place poses of the robot assembly task.

Programming by Demonstration as an intuitive method for teaching the robot how to move to either points in Cartesian or joint space or over whole trajectories. This method has increased in popularity in recent years and more robot manufacturers are starting to implement the functionality on their robots.

Adaptation of Learned Trajectories by using admittance control. The displacement due to the force error is used as a correcting offset to our DMP encoded trajectory, when the learned trajectory is not ideal or optimal [1].

3. RECONFIGURABLE HARDWARE

The proposed robotic workcell is in large part constructed of modular hardware that allows for fast and easy reconfiguration; from the structural frame to the fixtures, end-effectors, tool exchange system, P&P connectors, and other peripheral devices. With this approach we make it possible to use the proposed workcell in a wide range of industrial applications and environments. Furthermore, we also make it relatively easy to alter its shape and purpose within those environments. The workcell follows the notion that automatic reconfiguration is achieved using robots, which actively reconfigure the passive elements inside the workcell. This concept drives down the cost of the cell making it more affordable for SMEs. The following technologies and solutions were used to achieve said hardware reconfigurability. *Reconfigurable Frame* made of rectangular steel beams that are connected via the *BoxJoint* patented modular frame coupling technology. The advantage of this technology is that a workcell frame can be easily configured into a large variety of shapes.

Tool Exchange System for the robots to equip themselves with different grippers needed for different assembly tasks. Tools are introduced into the workcell on trolleys that connect to the P&P connector. If reconfiguration of the cell is needed to assemble a different workpiece, a new trolley with different end-effectors can be introduced into the workcell.

Passive Sensor-less Reconfigurable Fixtures designed in a Stewart platform-esque configuration with six legs, named "hexapod". These fixtures can be actively reconfigured by the robot arms on demand by connecting a robot to a fixture via the tool exchange system, releasing the fixture brakes, manipulating the fixture into the desired pose, re-applying the brakes, and disconnecting the robot from the fixture.

Passive Sensor-less Linear Unit, on which the robot is mounted, to enlarge the work area of the robot within the work cell. The robot is used to propel itself along the linear axis by connecting the end-effector to the frame and moving the base to a new position. Compared to conventional actuated solutions that are much more expensive, this approach is appropriate for applications where the need to move the robot is relatively infrequent.

4. USE CASE EVALUATION

In order to evaluate our proposed robotic cell, we implemented a real industrial use-case. The industrial partner is involved in automotive light production, where the demand for different lights can vary substantially in a single year. The total production of each light housing is typically between 100,000-300,000 units per item. However, these lights are not assembled in one batch. Following the just-in-time production paradigm, a switch from production of one automotive light type to another is often necessary. The company uses product specific assembly devices, which are stored in a warehouse, when not in use. The devices must be stored to produce spare parts for at least the next five years. Production of spare parts in particular is a low quantity production scenario and usually occurs only a few times per year. Each changeover of production lasts several hours and presents a significant cost. It would therefore be extremely useful for suppliers to have a single robot cell available which is capable of assembling many different types of lights, while also being rapidly reconfigurable for alternating production scenarios.

The assembly device are currently operated by people, who insert parts in the machine and check the quality after assembly. Manual work and quality is highly dependent on workers' qualifications, skills and their knowledge of the assembly process. Customers expect that the supplier company is very flexible in coping with changes in demand. This is why SMEs seek to time every task carefully and look for optimizations. A fully automated assembly procedure also implements quality control checks and integrates in the company's business intelligence infrastructure providing key performance indicators (KPIs). Defective products can be detected before delivery and the KPIs can be used for analysis and prevention of defects and production optimization.



(a) Active reconfiguration of(b) Housing insertion and part passive fixtures. pickup.





(c) Part assembly.

(d) Finished product removal

Figure 3: Key production steps for assembly of an automotive light using active reconfiguration.

The technologies described in this paper have been implemented for light assembly in the following way (c.f. Fig.3). Before the start of the production of a new light housing model, the reconfigurable fixtures are actively placed in the appropriate configuration by robots, to accommodate the housing (main body of the headlamp) that comes directly from an injection molding machine. This step happens only once per production of a single type of headlamp (c.f. Fig. 3a). In the next step, the robots equip themselves with grippers with which it will pick up assembly parts. The assembly parts are detected using a calibrated visual localization system. The robot places the light housing into the fixture and inserts the remaining parts into the housing one by one (c.f.Fig. 3b,3c). After the assembly the robot grasps a camera to inspect the quality of the assembly. Finally, the other robot removes the housing from the fixtures, moving it on to the next step of the production process.

5. CONCLUSION AND FUTURE WORK

In this paper we presented a reconfigurable robotic workcell that targets the manufacturing industry with small production batches where changes in demand happen rapidly. The developed workcell consist of both modular software components and reconfigurable hardware elements. Affordable passive elements are actively reconfigured via robot manipulation to accommodate a different manufacturing process. To demonstrate the benefit of using such a workcell in an actual industrial scenario, a case study has been implemented with a partner from the automotive industry. In our experiments we demonstrated that the developed reconfigurable robot workcell provides the much needed flexibility and fast changeover characteristics for automated assembly processes in the context of automotive lights product family. In the future, we will focus on methods for finding a workcell configuration of reconfigurable components for assembly of a new product automatically, taking into account the constraints of the assembly procedure and the current workcell components.

6. ACKNOWLEDGMENTS

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SMACHA: An API for Rapid State Machine Assembly

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ABSTRACT

Given the burgeoning complexity and diversity of both the hardware and software components of robotic systems, software libraries that use *state machines* as a basis for robot control by seamlessly connecting between low-level imperative task scripting and higher-level task planning have been in active development over the past decade or so. However, while they provide much in terms of power and flexibility, their overall task-level simplicity can often be obfuscated at the script-level by boilerplate code, intricate structure and lack of code reuse between state machine prototypes. To address these issues, we propose a code generation, templating and meta-scripting methodology for state machine assembly, as well as an accompanying application programming interface (API) for the rapid, modular development of robot control programs. The API has been developed within the ROS ecosystem to function effectively as either a front-end for concise scripting or a back-end for code generation for visual programming systems. Its capabilities are demonstrated in experiments using the Baxter robot simulator.

1. INTRODUCTION

The Robot Operating System (ROS) has, in recent years, become a popular choice of middleware for communication and control when designing robotic applications, and various packages within its ecosystem have come to the fore as being especially useful for dictating control flow. The SMACH high-level executive [3], in particular, has proven to be an exceptionally versatile and robust task-level architecture for state machine construction in ROS-based systems. It allows for the description of nested hierarchical state machines in Python in which parent container states contain child state sequences. State machines may describe lists of different possible outcomes and transitions are specified between states that depend on the outcomes in order to specify the control flow. These transitions are easily remapped across different depth levels in the hierarchy. Data may be passed between states as defined by a *userdata* object and the inputs and outputs of states may be remapped to userdata variables in order to control the flow of data.

While the ideas encapsulated by SMACH are conceptually simple, its usage still demands a significant degree of domainspecific expertise and prototyping time in order to define a functional state machine for a given robot control application. Another library that builds on the functionality of SMACH named FlexBE [5] aims at addressing this by providing a visual programming interface from which code may



Figure 1: SMACHA API overview.

be generated. However, the generated code is languagespecific and would therefore be brittle with respect to any significant changes to the programmatic approach.

Here we present an application programming interface (API) named SMACHA¹ that aims at distilling the task-level simplicity of SMACH into compact scripts in the foreground, while retaining all of its power and flexibility in code templates and a custom code generation engine in the background. One of the major potential advantages of SMACHA is that it is is designed to be both language and framework agnostic. Although this has not yet been implemented, it would be possible, for example, to design templates to generate FlexBE code instead of SMACH code, or even state machine code written in a language other than Python, while maintaining the same scripting front-end.

2. SMACHA API OVERVIEW

The SMACHA API is composed of three main components as depicted in Fig. 1: a *parser*, a *templater* and a *generator*. The parser parses simple data-oriented scripts that describe the high-level arrangement of state machines to be constructed into operational program code by the generator and templater. We refer to this concept as *meta-scripting* and it is described below in Section 2.1. The templater retrieves and renders code templates as required by the generator in order to produce the code, and is described in Section 2.2. The generator recursively processes the parsed script and generates the final program code using the templater. It is described in Section 2.3. The relationship between the scripting and templating functionality, as well as the overall recursive code generation process, is depicted in Fig. 2.

¹https://github.com/ReconCell/smacha



Figure 2: SMACHA recursive meta-scripting, templating and code generation pipeline example. Dashed arrows show nested state template selection from the SMACHA script and the blue shaded boxes indicate the depth level in the state hierarchy. Solid arrows and green shaded boxes show recursive template rendering flow, from child state templates at bottom-left and bottom-right, to a parent container *StateMachine* template at bottom-centre, to its parent *BaxterBase* template in the middle, to the final generated SMACH code on the right. Template inheritance is indicated by the dotted arrow and orange boxes.

2.1 Meta-Scripting

One of the core ideas behind the development of SMACHA is that state machines are essentially simple entities that can be almost entirely described via natural language constructs, perhaps augmented by some essential additional information necessary to describe how transitions should occur and how data should be passed between states. With this in mind, in order to transcribe the high-level logic of state machine description in as simple a manner as possible with a view towards offloading the more complex aspects to be processed by a code generation system working in the background we selected YAML (YAML Ain't Markup Language) as our scripting front-end [2]. YAML scripts are data-oriented and so are built around constructs such as lists and associative arrays that may be easily translated into corresponding machine code constructs and, more importantly for our purposes, can be used to represent both sequences of states and their individual data representations respectively. They can also represent data hierarchies very effectively, and are therefore well-suited to describing SMACH container states and nested state hierarchies. Thus, SMACHA scripts are YAML files that are used to describe how SMACHA should generate SMACH code. An example of a script that was written for a pick and place demonstration for the Baxter simulator can be see in Listing 1.

2.1.1 Base Variables

The base of a main SMACHA script file specifies the following variables: *name* (a name for the overall state machine), *template* (the name of its base template), *manifest* (an optional ROS manifest name), *node_name* (a name for its associated ROS node), *outcomes* (a list of its possible outcomes) and *states* (a list of its constituent states). Each of the states in the base script may, in turn, specify similar variables of their own, as discussed in the following.

1	# Modular SMACHA mick and place test script for the Barton simulaton
- 5	# noutar Shacha pick and place lest script for the Batter Similator.
3	Hame, Sm tamplata: RaytarRaga
4	node name havter smach nick and nlace test
- 5	outcomes: [succeeded_aborted_preempted]
6	usardata:
7	bour offset: [[0 0 0 0 0 15] [0 0 0 0 0 0 1 0]]
8	http://www.insec. [[0.0, 0.0, 0.10], [0.0, 0.0, 0.0, 1.0]]
ğ	- LOAD TABLE MODEL ·
10	template: LoadGazeboModelState
11	model name: cafe table
12	model path: rospkg.BosPack().get path('baxter sim examples') +
13	'/models/cafe table/model.sdf'
14	userdata:
15	table model pose world: Pose(position=Point($x=1.0, y=0.0, z=0.0$)
16	table model ref frame: world
17	remapping: {pose: table model pose world.
18	reference frame: table model ref frame}
19	transitions: {succeeded: LOAD BLOCK MODEL}
20	
21	- LOAD BLOCK MODEL:
22	template: LoadGazeboModelState
23	model_name: block
24	<pre>model_path: rospkg.RosPack().get_path('baxter_sim_examples') +</pre>
25	'/models/block/model.urdf'
26	userdata:
27	block_model_pick_pose_world: [[0.6725, 0.1265, 0.7825],
28	[0.0, 0.0, 0.0, 1.0]]
29	block_model_pick_ref_frame: world
30	block_model_pick_pose: [[0.7, 0.15, -0.129],
31	[-0.02496, 0.99965, 0.00738, 0.00486]]
32	block_model_place_pose: [[0.75, 0.0, -0.129],
33	[-0.02496, 0.99965, 0.00738, 0.00486]]
34	remapping: {pose: block_model_pick_pose_world,
35	reference_frame: block_model_pick_ref_frame}
36	transitions: {succeeded: MUVE_TU_START_PUSITION}
37	
38	- MUVE_IU_SIAKI_PUSIIIUN:
39	link link
40	limb: left
41	[10000 - 0.0000 - 1.0000 - 1.0000 - 0.0000 - 0.0000 - 0.0000]
42	[-0.0000, -0.3556, -1.1657, 1.3402, 0.0000, 1.03001, -0.30000]]
43	temapping, (positions, joint_start_positions)
45	traistrious. (succeeded. Fick_BLOCK)
46	- DICK BIOCK.
47	scrint, nick block
48	remanning: {nick nose: block model nick nose
49	hover offset}
50	transitions: {succeeded: PLACE BLOCK}
51	Classicions: [Baccoddal (Lmol_block]
$\tilde{5}\tilde{2}$	- PLACE_BLOCK:
53	script: place_block
54	remapping: {place_pose: block_model_place_pose,
55	hover_offset: hover_offset}
56	transitions: {succeeded: succeeded}
_	

Listing 1: SMACHA pick and place demo script.

2.1.2 States

Each state, including the base, must specify a template from which its respective code should be generated (see *e.g.* lines 3, 10, 22 and 39 of Listing 1). States may be specified as lists specifying their transition order (see *e.g.* lines 8, 9, 21, 38, 46

and 52 of Listing 1), and may also be nested as described in the SMACH documentation using appropriate combinations of template and state specifications. Possible state outcomes may be specified as a list in the base state machine and in each container state (see *e.g.* line 5 of Listing 1). Possible state transitions may be specified as an associative array in each state (see *e.g.* lines 19, 36, 44, 50 and 56 of Listing 1). Input and output remappings of user data may be specified as an associative array in each state (see *e.g.* lines 17, 34, 43, 48 and 54 of Listing 1).

2.1.3 Modularity

Modularity is achieved at the scripting level by allowing useful subroutines wrapped in container states to be saved as separate YAML script files called *sub-scripts* which can be included in a main script as states. Examples of this can be seen in lines 46–50 and 52–56 of Listing 1, where the sub-scripts "pick_block" and "place_block" are included in the main pick and place state machine script to define its sub-states. The input and output userdata keys expected by the container states in the sub-scripts may be remapped as appropriate in the main script along with their state transitions. The use of this functionality encourages low coupling and high cohesion, while allowing for extremely rapid and easily specified reuse of common patterns.

2.2 Templating

Code templating is implemented using the Jinja2 templating library [1]. Core templates are provided by default to support standard SMACH states and custom templates may be defined for particular use cases.

2.2.1 Core Templates

SMACHA provides default core templates for many of the SMACH states and containers, as well as for other useful constructs. At the time of writing, the following core templates are present and functional: *Base* (Python script skeleton), *State* (contains functionality common to all states, *e.g.* userdata specification), *StateMachine* (container), *Concurrence* (container), *ServiceState* (generic state), *SimpleActionState* (generic state), *ReadTopicState* (custom state used for reading messages from ROS topics) and *TF2ListenerState* (custom state used for reading TF2 transforms).

2.2.2 Code Generation Variables and Code Blocks

There are a number of core code generation variables and code blocks present in the core templates that enable SMACHA to produce code in the appropriate places. In most cases, a code block contains a variable of the same name within it to indicate where code from child state templates should be rendered into. The main code blocks are as follows: base_header (for code that must appear near the top of the program script), defs (for function definitions), class_defs (for class definitions), main_def (for the main function definition), header (for code that is to be rendered into the header variable the parent template), body (for code that is to be rendered into the *body* variable of the parent template), *footer* (for code that is to be rendered into the *footer* variable of the parent template), execute (for the code necessary for executing the state machine), *base_footer* (for any code that must appear near the bottom of the program script) and main (for the code necessary to execute the main function).

The most important block for most state templates is the *body* block and its associated *body* variable, as it is where the state template should render the code necessary to add the state to the parent state machine, which will either be some container state or the base state machine itself. Note that all of the above code generation variables and code blocks may be either removed, modified or arbitrarily customized within the API for particular use cases. The code insertion order may also be specified within the API, i.e. code may be either prepended or appended to a variable. An example of how code generation variables work together with code blocks is depicted in Fig. 2.

2.2.3 Template Inheritance

Jinja2 provides powerful functionality, including the ability to extend templates via template inheritance, such that their constituent code blocks may be overridden or extended. SMACHA aims to incorporate as much of this functionality as possible, thus the core templates may be overridden or augmented by custom user-specified templates via the usual Jinja2 template inheritance mechanisms, with some caveats. This works in the usual way using the following Jinja2 variables and expressions: {% extends "<template_name>" %} (to inherit code blocks from the parent template specified by <template_name>), {{ super() }} (when this appears in a block, the code from the same block in the parent template as specified by {{ extends }} will be rendered at its position) and {% include "<template_name>" %} (to include all code from the template specified by <template_name>).

Regarding the aforementioned caveats, there is a behaviour that is specific to SMACHA that goes beyond the usual capabilities of Jinja2 and that was designed as a means of dealing with the recursive state machine processing required by this particular use case. If a state template contains blocks, but does not contain an {{ extends }} expression at the top of a template, it is implied that the code for the blocks will be rendered into variables and blocks with the same names as the blocks in the state template as dictated by the SMACHA script and as defined usually either by the base template or container templates. In the current implementation, only base templates use the {% extends %} inheritance mechanism, whereas state and container templates use the {% include %} mechanism to inherit code from other templates. This is partially illustrated in Fig. 2.

2.3 Code Generation

The SMACHA code generator is a custom-designed engine for recursively generating state machine code based on the scripts described in Section 2.1 and using the templates described in Section 2.2. Recursive processing was necessary given the potentially arbitrary depth levels of state machine nesting that are possible under the SMACH API. The basic operation scheme behind the code generator is thus to iterate through the data constructs of a parsed script, evaluate them based on their type, and determine whether they should be rendered as code using the appropriate templates, passed on for recursive processing, or some combination of both. When iteratively processing a script, data items that are encountered are either lists or associative arrays. When a list is encountered, it is assumed that it is a list of states and is passed on for further recursive processing. When processing an associative array, there are three main cases that



Figure 3: Pick and place (left) and stacking (right) tasks running on the Baxter simulator using SMACHA-generated code.

need to be handled separately: *container states*, *sub-script states* and *leaf states*. The recursive processing of container and leaf states is partially illustrated in Fig. 2.

3. EXPERIMENTS

For the experiments, we chose to use the Rethink Robotics Baxter robot [4] simulator which uses the Gazebo simulation system and comes equipped with extensive ROS support by default. Custom code templates were designed to facilitate the development of the necessary states required for the experiments. Two experiments were performed in total using these templates: a pick and place experiment and a block stacking experiment². The first of these is a replication of the pick and place demo that comes as standard with the Baxter SDK. It was initially re-programmed from scratch in order to make use of SMACH and such that the control logic of the demo could be specified using a state machine. After that it was possible to design the necessary code templates and script the demo using SMACHA. Once the custom templates and the SMACHA script had been created for the first demo, it was possible to reuse both of them to very rapidly script the second experiment for block stacking. In both cases, it was possible to run the Python SMACH code generated by SMACHA without further modification with both experiments completing successfully.

The Baxter SMACHA package³ includes the following custom code templates: BaxterBase (extends the core Base template), LoadGazeboModelState (allows allows a specified Gazebo model to be loaded into the simulator), MoveTo-JointPositionsState (moves a Baxter limb to a specified set of joint positions), PoseToJointTrajServiceState (uses inverse kinematics to calculate a set of joint positions from a specified end-point pose), and GripperInterfaceState (either opens or closes a specified gripper). In the initial states of the pick and place experiment state machine, as specified by the SMACHA script in Listing 1, a table model must be loaded into the simulator using the LoadGazeboModel-State template, followed by a block model placed at a specified pose on the table, and the left limb of the robot must be moved to a starting position using the MoveToJoint-PositionsState template. Subsequently, the robot enters a "PICK_BLOCK" state as specified by the "pick_block" subscript in order to pick the block from the table, followed by a "PLACE_BLOCK" state as specified by the "place_block" sub-script in order to place the block at a given placement pose. The stacking experiment initialises similarly to the pick and place experiment, only in this case, two block models are loaded instead of one, and the robot is tasked with stacking one on top of the other. This essentially involves two pick and place sequences, one for each block, so the "pick_block" and "place_block" sub-scripts used in the previous experiment are reused. The results of both experiments are depicted in Fig. 3.

4. CONCLUSION

We have developed an API for the rapid assembly of state machines for modular robot control using a meta-scripting, code templating and code generation paradigm. It has been demonstrated on a simulated humanoid robot platform in two different experiments.

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²Video available at: https://youtu.be/WFp_keDsA6M

³https://github.com/abr-ijs/baxter_smacha

Extending the Workspace of Pseudo-Linear Variable-Lever Variable Stiffness Actuator

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ABSTRACT

Among the different mechanically compliant actuators, variable stiffness actuators have the possibility to change their mechanical compliance on the fly, which is favorable in many force control applications. Though their control and mechanics are of higher complexity, their simplification is in the research focus of many groups. In this work we propose a modification by adding additional springs to our novel variable stiffness principle, which solves the rising stiffness torque drawback of the previous design. We performed a parameter search over two modification parameters to find the combination with the most suitable workspace. The proposed mechanical modification extends the torque/deflection workspace of the original principle, while keeping its favorable properties, i.e. pseudo-linear torque deflection characteristics and low power to change stiffness.

Keywords

mechanically compliant actuator, variable stiffness, optimization, parameter search

1. INTRODUCTION

Robots using mechanical compliance have several advantages when compared to classical stiff actuators [1], including safer humanrobot interaction and higher energy efficiency. The compliant element is a low-pass filter [2] that reduces the peak gear forces, however, at the same time it also reduces the bandwidth of the actuator. Improved force accuracy in higher stability is another advantage.

Much of the research is focused in this field because of the favorable properties of such devices. Higher mechanical and control complexity offer many simplification possibilities in combination with a wide array of possible applications. Researchers focus on the novel device architectures development and prototype manufacturing due to commercial unavailability of such devices. We point the reader to some articles that provide an overview over different design architectures, for example, [3], [4] and [5].

There already exist many interesting applications that utilize the principle of mechanical compliance. One of them is a small jumping robot called Salto [6], that is capable of jumping to a 1m height, trying to mimic a jumping animal called Senegal bushbaby (Galago senegalensis). Another interesting example is the passive-ankle exoskeleton [7], which is able to reduce the users walking effort for 10% in a passive manner without using motors as power inputs by utilizing springs. We developed a similar exoskeleton, where we implemented a mechanism to close the clutch using a small motor [8], which increased its operation reliability.

This work is the development continuation of a novel variable stiffness actuator principle presented in [9]. A quasi-linear torquedeflection is the main advantage of the proposed configuration. Andrej Gams Institute Jožef Stefan Jamova cesta 39 Ljubljana, Slovenia andrej.gams@ijs.si

Another advantage is the simplicity of mechanical configuration. However, a drawback of the device is the growing pressure angle at lower stiffness positions, which increases the torque required to change the stiffness and limits the devices maximum deflection. We begin the article with a description of the original operation principle in section 2 and explain the modification in section 3. In section 4 we explain the parameter optimization and show its results in section 5. We conclude the work in section 6.

2. VSA OPERATION PRINCIPLE

The development of a variable stiffness actuator (VSA) encompasses a complex design process with many parameters [10]. The number of parameters is higher than with classical stiff actuators. Furthermore, mechanical convenience is also important to keep the design simple and easy to manufacture, and is hard to achieve due to so many parameters. The devices requirements also differ based on the desired application.

The goal of our design is to keep the structure simple, with a favorable torque deflection characteristic. The weight of the device and its power requirements should also be minimal.

The core of our device is a combination of a cam mechanism and a variable lever principle (see Fig. 1). A curved lever arm rotates (φ_d) around the pivot A and compresses the spring follower. This provides a reaction torque to the external load. Via the follower rotation (φ_s) around pivot B, the effective radius of the spring to the pivot A changes, thus changing the stiffness of the mechanism. The system is in principle unidirectional, since the spring can be compressed only. To achieve a bidirectional application, a system of gears or cables can be used to change the bidirectional motion of the external link to unidirectional motion for spring compression. At zero deflection, the follower can be rotated with minimal torque. The reason is, that the device uses a pretension-less spring principle [10].

The analytical model of the torque/deflection characteristics was



Figure 1: The actuator working principle: a) equilibrium position, b) deflection under external load, and c) varying stiffness.

derived in [9]. To test the principle, a rapid-prototype was also developed. In this article, we consider a case of a real prototype, with the theoretical data specified in Table 1.

Variable	Name	Value	Unit
Rs	Cam curve radius	50	[mm]
k _{lin}	Linear spring stiffness	72.6	[N/mm]
$\varphi_{\rm d}$	Deflection angle (min/max)	± 40	[⁰]
$\varphi_{\rm s}$	Stiffness setup angle range	0 - 90	[0]
Tpn	Pos. motor nominal torque	15	[Nm]
T _{pp}	Pos. motor peak torque	22.5	[Nm]
T _{sn}	Stiff. motor nominal torque	5	[Nm]
T _{sp}	Stiff. motor peak torque	6.3	[Nm]

Table 1: Calculation and prototype parameters

Due to nominal and peak torque limits of the position motor and stiffness motor gearboxes, a torque/deflection graph for the selected mechanism with marked operation areas can be created. The blue area marks the workspace where both motors operate below the nominal torque, while the red area represents the torque levels between the nominal and peak torque limits.



Figure 2: Normal torque/deflection workspace and the corresponding stiffness graph.

One drawback of the proposed system is the rising pressure angle at lower stiffness presets and higher deflections. Due to the curvature of the deflection lever, no torque is theoretically needed to change the stiffness at zero deflection. However, as the deflection increases, the stiffness torque rises due to an increasing pressure angle. This is one of the drawbacks of the current system architecture.

The stiffness torque required to change the stiffness is shown in Fig. 3 for different stiffness presets. One can see that the stiffness motor torque theoretically easily gets higher than 30 Nm, which is above the peak torques of the stiffness motor and the position motor. Though a stronger motor could be used, a mechanical solution would be far more convenient. Seeing Fig. 2, the torque limits separate the torque/deflection graph into three areas. The yellow workspace area is where the stiffness torque overpowers the stiffness motor. It is possible to stay outside of the yellow area by keeping the stiffness angle above $\varphi_s > 40^\circ$. Here the actuator operates reliably. However, by implementing two additional springs, the workspace can be extended.



Figure 3: The torque required to change the device stiffness for the original case.

3. EXTENDING THE VSA WORKSPACE

In order to extend the torque/deflection workspace, we propose to add two more springs into the system. With this we are able to keep the torque required to change stiffness low while extending the devices workspace. The modification is shown in Fig. 4.



Figure 4: The main device parameters (left) with the two proposed modifications (right).

The first modification is the addition of a torsion spring k_{tor} (see Fig. 4). The stiffness torque at zero deflection is negligible and it rises with the deflection, whereas it is higher at lover stiffness positions and lower at high stiffness positions. We can thus increase the workspace by adding a torsion spring to create a negative stiffness torque offset. This way, the compensation stiffness torque (M_{cs}) , due to spring k_{tor} , rises linearly from $\varphi_s = 90^o$ to $\varphi_s = 5^o$ as described in equation

$$M_{\rm sc}(\varphi_s) = \frac{M_0}{90^o - 5^o} \cdot (90^o - \varphi_s), \qquad (1)$$

where the M_{cs} is the compensation torque, T_0 is the maximum torque and φ_s the stiffness angle. The maximum stiffness compensation torque is reached at $\varphi_s = 5^o$. The workspace below $\varphi_s = 5^o$ is deemed unusable. By calculating the new stiffness torque, an increase in the workspace can be observed as seen Fig. 5. The black area represents the workspace before and the (red and blue area) after the addition of the torsion spring.

Second modification is the addition of a linear spring (k_{lin2}), which is not as trivial as before. It is best, if the torque required to assist the stiffness motor comes directly from the external torque. Therefore, the second modification is a spring connected between the curved deflection arm and the follower. Note, that since the follower can be rotated, the spring system is compression based only. This way, at lower stiffness angles the assistance is the strongest, while at the higher stiffness presets the assistance is minimal or there is none. The combination of the L_1 and k_{lin2} parameter has an optimal solution. To find it, we need a new mathematical model.



Figure 5: Normal deflection torque (black area) and the new workspace with torsion spring (red-blue area). The corresponding stiffness torque is on the right graph.

Considering the two additional springs, the new torque/deflection characteristics can be calculated as

$$M_{\rm dnew} = M_{\rm d} + M_{\rm dk2},\tag{2}$$

where the M_d presents the torque from the old system, derived in [9]. The torque needed to compress the new spring k_{lin2} is M_{dk2} and can be calculated as a vector product

$$M_{\rm dk2} = \left| \vec{r}_{01} \times \vec{F}_{\rm k2} \right|,\tag{3}$$

where the \vec{F}_{k2} is the force from the k_{lin2} spring compression and \vec{r}_{01} the lever vector, as can be seen from Fig. 6. The new stiffness torque is calculated as

$$M_{\rm snew} = M_{\rm s} - M_{\rm sc} - M_{\rm sk2}, \tag{4}$$

where the M_s is adapted from [9] and the M_{sc} from (1). The M_{sk2} represents the stiffness torque resulting from the spring compression and is calculated as the vector product

$$M_{\rm sk2} = \left| \vec{r}_{34} \times \vec{F}_{\rm k2} \right|. \tag{5}$$

Again, see Fig. 6. Note, that when the stiffness motor rotates (φ_s), the spring k_{lin2} is only active when the distance between points (x_4, y_4) and (x_1, y_1) is smaller than the no-load spring length.

4. PARAMETER OPTIMIZATION

In order to determine the optimal parameters r and k_{lin} , we performed a parameter search. Fig. 7 represents the workspace for normal PLVL-VSA configuration and the one with additional springs.



Figure 6: A scheme of the proposed mechanism with the force and distance vectors.

The gray (black) area represents the workspace, where the stiffness



Figure 7: Workspace comparison between the normal and modified mechanism version, where red-blue area is desired and black undesired.

setup motor does not have enough torque to move. One can see, that by addition of the springs, the black area shrinks. In the blue area, the motor torque is below nominal and in the red, the motor torque is between nominal and peak operation limits. The size of the areas can be numerically calculated and compared for different parameter combinations. The parameters T_{pn} , T_{pp} , T_{sn} and T_{sp} represent the limits of the position motors and stiffness motors gearboxes. Their values can be found in Table 1. These parameters limit the torque/deflection workspace of our actuator.



Figure 8: Black, red-blue area sizes and the corresponding cost value for different k_{lin} and L_1 parameter combinations.

Our goal is to find the optimal combination of parameters L_1 and k_{lin2} , where the black area of the actuator is of minimal size and the red-blue area is of maximal size. We cycle through both parameters in range $L_1 = 10 - 40$ mm and $k_{lin2} = 1 - 20$ N/mm. For each parameter set of L_1 and k_{lin2} , we use the theoretical model and calculate the torque/deflection graph with nominal/peak torque limits. We numerically measure the areas of the workspace areas and collect them into a matrix. We determine the optimal configuration by taking the normalized versions of areas using the following cost function

$$\delta = A_{redblue} * (1 - A_{black})^{10}, \tag{6}$$

where $A_{redblue}$ represents the area of the sum of red and blue workspaces and the A_{black} represents the black workspace. The 10th exponential makes the local maxima easier to see. The optimization graphs are shown in Fig. 8. Looking at the graph titled Cost value, one can spot a local maxima near parameter combination $L_1 = 25$ mm and $k_{lin} = 5.5$ N/mm. A rounded approximation close to the real optimal value is better suited for manufacturing. At the chosen parameters, the sum of red-blue area is at maximum while the black area is at minimum.

5. OPTIMIZED WORKSPACE

The optimal parameter torque/deflection graphs are shown in Fig. 9. One can see, that the system still preserves the quasi-linearity, which



Figure 9: The torque/deflection workspace for the new mechanism with the corresponding stiffness.

is favorable from the control perspective. The deflection range is now extended to 40° at lower stiffness presets. As can be observed, we can vary the stiffness between 30 to 200 Nm/rad. The stiffness torque, required to change the stiffness, is shown in Fig. 10. As predicted, due to the modifications, the new stiffness torque is kept between the peak torque limits. This shows that the proposed modifications increases the performance of the device while using the same motors as in the original concept. Since the motors contribute a lot of weight to the overall system, keeping the motors small also helps keeping the overall device light, small and compact.



Figure 10: The stiffness torque of the modified mechanism.

6. CONCLUSIONS

We presented the continuing development of a novel variable stiffness actuator. The proposed modifications of the original operation principle extends the devices torque/deflection workspace, while keeping the same stiffness and position motors. The modification successfully minimizes the effects of the original principles main drawback, the rising stiffness torque due to the rising pressure angle. In the future, the proposed modifications will be implemented in a real-world prototype.

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Soft Humanoid Robots

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ABSTRACT

A human can exhibit intelligent behavior. Yet, we do not completely understand the mechanism how the behavior emerges. Adaptive behavior is obviously generated by the brain, but brain alone cannot explain everything. Key components are soft tissue, muscles, bones, and skin.

This talk will introduce our challenges to build soft humanoid robots consisting of muscles, bones, and skin so that we can constructively understand the human's adaptive intelligence.



Semantic Reasoning under Realistic Conditions

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ABSTRACT

One fundamental issue of autonomous robots in task domains is its capability to learn new skills and to re-use past experiences under different situations as efficient, intuitive and reliable as possible. A promising mechanism to achieve that is via learning from demonstrations or observations. In this abstract, we present a novel learning method that generates compact and general semantic models to infer human activities. We propose a method that allows robots to obtain and determine a higher-level understanding of a demonstrator's behavior via semantic representations [4]. First, the low-level information is extracted from the sensory data, then a meaningful semantic description, the high-level, is obtained by reasoning about the intended human behaviors [6]. The introduced method has been assessed on different robots, e.g. the iCub [3], REEM-C [5], and TOMM [2], with different kinematic chains and dynamics. Furthermore, the robots use different perceptual modalities, under different constraints and in several scenarios ranging from making a sandwich to driving a car assessed on different domains (home-service and industrial scenarios). Each of the studied scenarios poses distinct and challenging levels of complexity to demonstrate, that our method does not depend on the analyzed task, thus presenting a major benefit compared to classical reasoner approaches. Another important aspect of our approach is its scalability and adaptability toward new activities, which can be learned on-demand.

Our semantic reasoning method can be extended to a more higher level for the generation of tasks. Since our system is able to on-line recognize and learn new activities on-demand, thus we can produce a graph of all related activities that produce a task. Therefore, our learning system extracts general task structures which together with the obtained knowledge can improve and accelerate the teaching of new tasks. Furthermore, we improved and validate this approach using a Virtual Reality system, which presents a realistic, cluttered, space in which a variety of tasks can be accomplished. Using task graphs also allowed the robot to utilize sparse sets of instructions to construct the complete set of steps necessary to carry out complex tasks [1]. Overall, the presented compact and flexible solutions are suitable to tackle complex and challenging problems for autonomous robots.

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Figure 1: Main modules of our framework for the segmentation and recognition of human everyday activities using multiple sensors.

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Integrating Multi-modal Tactile Signals to a Compliant Control to Improve physical HRI

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ABSTRACT

The development of breakthrough technologies helps the deployment of robotic systems in the industry. The implementation and integration of such technologies will improve productivity, flexibility and competitiveness, in diverse industrial settings specially for small and medium enterprises. In this talk, we present a framework [1] that integrates three novel technologies, namely safe robot arms with multi-modal and auto-calibrated robot skin [4], an end-to-end approach for transforming multi-modal tactile signals into a compliant control to generate different dynamic robot behaviors [2], and an intuitive and fast teaching by demonstration method that segments and recognizes the robot activities on-line based on re-usable semantic descriptions [6]. A key component of our framework is a robot parametric modeling based on the artificial skin multi-modal sensors (proximity, force and acceleration) [5]. We validate our approach in our robot TOMM [3] with an industrial application.



Figure 1: Main modules of our approach.

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Event-Driven Systems for Efficient Reactive Control with Large Scale Robot Skin

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ABSTRACT

Tactile human-robot interaction is essential for collaborative robots in industrial, health-care and household application scenarios and increases the robot's intuitiveness, flexibility and safety. One key element of enabling intuitive interactions is the ability to manually guide the robot by touching it for e.g. in teach-in scenarios [4]. A promising approach to upgrade existing robot systems with such abilities is to use skin for robots and implement multi-contact controllers. For taking full advantage of skin, the skin has to cover the robot completely. However, the application of large scale skin induces new challenges: 1) solving issues in transmitting huge amounts of tactile information with low-latency and 2) processing huge amounts of tactile information in real-time. In this abstract we present our new event-driven approach to tackle these challenges. We developed a novel multi-modal event-driven robot skin [1, 2] and combined it with our novel efficient event-driven reactive skin controller for large scale robot skin [3]. Event-driven systems only sample, transmit and process information when the novelty of the information is guaranteed. This increases their efficiency in comparison to synchronous systems. We evaluated our system in a comprehensive performance evaluation with our robot TOMM. TOMM has two UR5 robot arms, each covered with 253 multi-modal skin cells. The results show that the event-driven reactive skin controller always outperforms the synchronous reference controller while both controllers show exactly the same response. When the robot is not moving then the event-driven controller reduces the CPU usage by 78% in comparison to the synchronous reference controller. When the robot is responding to contacts then the CPU usage reduces by 66%.



Figure 1: The robot TOMM [5] with two arms and two grippers covered with skin; the robot holds a paper towel in its left gripper which it uses to push the right arm; the right arm is controlled by our novel event-driven tactile reaction controller; it tries to avoid contacts and moves to the right.

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PREDGOVOR

V letu 2017 smo pripravili tretjo delavnico na temo »e&m-zdravstva« (elektronsko in mobilno zdravstvo, kratko EMZ), tj. predlog izvedbe infrastrukture in vpeljave uporabe informacijsko in mobilno podprte celostne zdravstvene oskrbe za izboljševanje preventivne, diagnostične in terapevtske obravnave državljanov, ki bi zmanjšala stroške, obenem pa povečala dostopnost zdravstvene oskrbe v obdobju 2016-2020.

V letu 2016 je bil sprejet Raziskovalno Razvojni in Inovacijski (RRI) program EkoSMART v domeni pametne specializacije S4 na področju pametnih mest in skupnosti, kjer EMZ predstavlja enega od šestih nosilnih stebrov programa v obliki RRP (Raziskovalno-Razvojnega Projekta). V okviru javnega razpisa »RRI v verigah in mrežah vrednosti« – sklop 1: »Spodbujanje izvajanja raziskovalno-razvojnih programov (TRL 3-6)« je predvidenih 5,9 milijona evrov nepovratnih javnih sredstev za program EkoSMART.

Projekt EMZ sestavlja 5 delovnih sklopov oziroma delovnih paketov (DP), ki jih vodijo UKCL, IJS, FERI UM in FRI UL:

- Informacijske tehnologije za podporo celostni oskrbi / bolnice / prof. Z. Pirtošek
- Podpora na domu za zdrave, starejše in za kronične bolnike / doma / prof. M. Gams
- Mobilno spremljanje vitalnih in okolijskih podatkov / mobilno / dr. R. Trobec
- Računalniška podpora, podatki, kreiranje novih znanj /algoritmi / prof. P. Kokol
- IKT platforma / prof. M. Bajec

Delavnica EMZ omogoča celoletno pregledovanje in usklajevanje sklopa EMZ znotraj programa EkoSMART. Podobno kot v letu 2016 se bodo partnerji javno predstavili vsem drugim z že precej usklajenim predlogom. Vse predstavitve bomo nato dokončno uskladili in pripravili specifikacijo dela na programu za naslednje obdobje (sep. 2017 – avg. 2018). Potrebno se je zavedati, da je prvo leto dela že za nami in da je potrebno pregledati in predvsem povezati prispevke v smiselno celoto. Povezovali jih bomo najprej znotraj delovnih sklopov (delovnih paketov), nato znotraj RRP EMZ, nato pa še znotraj celotnega programa EkoSMART. Prvi povezovalni okvir je narejen za vse slovenske občine na ui-obcine.ijs.si, kjer sta tudi repozitorija prototipov in domen. Na delavnici bomo vse prispevke poskušali povezati z omenjenim okvirjem.

Pobudo e&m-zdravstvo so vzpodbudile potrebe po horizontalnem in vertikalnem povezovanju, trendi in dileme področja. Predlagana pobuda e&m-zdravje vpeljuje v zdravstveno oskrbo nove koncepte, ki bodo s svojimi multiplikacijskimi in sinergijskimi učinki sprožili hitrejšo in učinkovitejšo prilagoditev obstoječega sistema celostne zdravstvene oskrbe na današnje izzive. Ključna strokovna komponenta je umetna inteligenca, ki bo po napovedih strokovnjakov revolucionirala zdravstvo skupaj z novimi IKT rešitvami. Javno zdravstvo po vsem svetu se otepa izrednih problemov, najboljšo rešitev pa strokovnjaki po svetu vidijo v vpeljavi storitev IKT in umetne inteligence.

E&m-zdravstvo (EMZ) vidimo kot eno najbolj perspektivnih smeri v več pobudah od zdravstva do pametnih mest. E&m-storitve nudijo izboljšano kvaliteto življenja državljanom ob zmanjšanih stroških, hkrati pa omogočajo preboj Slovenije v svet na e&m-področju. E&m-zdravstvo se bo predvidoma vsebinsko oblikovalo delno kot samostojna pobuda s svojo platformo, organizacijo in projekti, ki bo povezana tako s pametnimi mesti kot z zdravjem. Ključne komponente za uspešno izvedbo EMZ so inovativni človeški viri, njihovo usklajeno delovanje in vpeljava EMZ v Sloveniji.

Amerika generira dvakrat več pomembnih inovacij v zdravstvu kot EU ter vlaga štirikrat več sredstev v nova, z medicino povezana podjetja. Kitajska namenja največ sredstev za znanost, medtem ko je Slovenija tretja najslabša po državnem financiranju znanosti v Evropi. Leta 2025 bo več kot milijarda, ali skoraj osmina svetovnega prebivalstva, starejša od 60 let. Stroški za zdravstveno oskrbo starejše populacije predstavljajo v EU skoraj polovico vseh stroškov za zdravstvo, kar pomeni, da grozi zdravstvenemu in gospodarskemu sistemu in kvaliteti življenja zlom, če ne bomo vpeljali storitev e&mzdravja.

Druga pomembna komponenta je povezovanje in ustvarjanje kritične mase komplementarnih partnerjev, ki edino omogoča uspešen prodor na svetovna tržišča. Slovenija potrebuje sodelovanje in koordiniranje že zaradi svoje relativne majhnosti, kar dokazuje relativno slaba izkušnja z velikim številom malih in razdrobljenih projektov, ki nimajo dovolj podpore za vpeljavo novih rešitev.

Tretja ključna komponenta je vpeljava EMZ v slovensko zdravstvo, ki bo na ta način dobilo novo priložnost, da vzpostavi nacionalno platformo in mednarodne standarde, preseže ujetost v nedopustno dolge čakalne dobe za pregled pri specialistih, poveže razdrobljene in nekompatibilne sisteme in že samo s tem opraviči vložena sredstva. Po zadnjem povečanju sredstev za področje zdravstva so se čakalne vrste povečale, kar kaže, da sedanji tradicionalni pristop ne zmore prinesti realnih izboljšav.

Matjaž Gams, Aleš Tavčar

PROGRAMSKI ODBOR / PROGRAMME COMMITTEE

Matjaž Gams (chair)

Marko Bajec (co-chair)

Roman Trobec (co-chair)

Zvezdan Pirtošek (co-chair)

Roland Petek

Jure Bon

Peter Kokol

Andrej Kos

Marko Hren

Aleš Tavčar

Stanislav Erzar

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Integracija v EMZ EkoSMART

Matjaž Gams, Aleš Tavčar Jozef Stefan Institute Jamova 39, 1000 Ljubljana, Slovenia <u>matjaz.gams@ijs.si</u>

POVZETEK

V prispevku je na kratko predstavljen modul Elektronsko in mobilno zdravje (EMZ) znotraj programa EkoSMART. Sledijo navodila za sestavljanje prispevkov in partnerjev v integriran projekt.

Ključne besede

Elektronsko in mobilno zdravstvo, pametna mesta, pametna specializacija

1. UVOD

V letu 2016 je bil sprejet Raziskovalno Razvojni in Inovacijski (RRI) program EkoSMART [3] v domeni pametne specializacije S4 na področju pametnih mest in skupnosti, kjer EMZ predstavlja enega od šestih nosilnih stebrov programa v obliki RRP (Raziskovalno-Razvojnega Projekta). V okviru javnega razpisa »RRI v verigah in mrežah vrednosti« – sklop 1: »Spodbujanje izvajanja raziskovalno-razvojnih programov (TRL 3-6)« je predvidenih 5,9 milijona evrov nepovratnih javnih sredstev za program EkoSMART.

Projekt EMZ sestavlja 5 delovnih sklopov oziroma delovnih paketov (DP), ki jih vodijo UKCL, IJS, FERI UM in FRI UL:

- Informacijske tehnologije za podporo celostni oskrbi / bolnice / prof. dr. Z. Pirtošek Podpora aktivnostim v bolnici.
- Podpora na domu za zdrave, starejše in za kronične bolnike / doma / prof. dr. M. Gams Podpora predvsem starejšim doma.
- Mobilno spremljanje vitalnih in okolijskih podatkov / mobilno / prof. dr. R. Trobec Senzorji.
- Računalniška podpora, podatki, kreiranje novih znanj /algoritmi / prof. dr. P. Kokol Navezava na dentalno zdravstvo.
- 5. IKT platforma / prof. dr. M. Bajec Platforma in povezovanje z EkoSMART.

V letu 2016 smo zastavili povezovanje preko bele knjige EMZ [1], v letu 2017 gremo na delavnici EMZ korak dlje.

2. EMZ IN OBČINE

Razvili smo ogrodje in nekaj sistemov [2] (ui-obcine.ijs.si) občin kot korak dlje od pametnih mest in oboje sistematično skušamo vpeljati v občine, društva upokojencev in druga društva ter v civilno družbo z namenom, da Slovenija ponudi boljšo izkušnjo za vse občane - da imajo več informacij, storitev in podpore. Umetna inteligenca in IKT napredujeta neverjetno hitro, raziskovalni oddelki razvijajo fantastične nove sisteme, spotoma pa nastajajo tudi sistemi, ki jih lahko namestijo in vzdržujejo inštitucije lokalne samouprave in civilne družbe.

Sistem sestavljajo naslednji bloki:

- Občinska televizija vsakdo lahko razvije svojo občinsko televizijo s sledenjem navodilom. Potreben je prenosnik in kamera in nekaj znanja računalništva. Običajno občinska TV prenaša ali sprotno dogajanje v živo, ali pa se veti predpripravljena datoteka s tekočimi informacijami za tekoči teden.
- 3D virtualni asistent ponovno je z nekaj znanja računalništva po navodilih možno izdelati sistem 3D virtualnega asistenta, ki vodi po stavbah, recimo upravni stavbi občine.
- Turizem sistem omogoča informiranj o turističnih znamenitostih v naravnem jeziku in načrtovanje turističnih obiskov. Sistem vsebuje preko 3000 znamenitosti in je neposredno uporaben.
- Asistenti za vsako slovensko občino je narejen svoj občinski asistent, ki odgovarja na vprašanja v naravnem jeziku. Obstaja tudi pokrajinski asistent in slovenski asistent – slednja sta sestavljena iz pripadajočih občinskih asistentov. Obstaja pa tudi asistent za starejše občane (zdusko) in za EkoSMART. Narejeni sta dve interaktivni mapi Slovenije, prva z občinami in druga z društvi upokojencev. Ko kliknete na mapo, se vzpostavi povezava z občino oz. društvom.

Partnerji EkoSMART so povabljeni, da se vključujejo v obstoječe bloke oz. dodajajo nove.

Za EMZ pa je najpomembnejši blok Zdravje.

3. EMZ IN ZDRAVJE

Blok »zdravje« v okviru občin (ui-obcine-ijs.si) nudi informacije o prvi pomoči, zdravstvene nasvete doma in iz tujine, informacije iz NIJZ, iz programa pametne specializacije EkoSMART ter podprojekta Elektronsko in mobilno zdravje, repozitorijev domen in prototipov, sistemov za nadziranje stresa in skrb za starejše. Storitev je dostopna v asistentih – kliknete na svojo občino, levo zgoraj, izberete aplikacijo »Zdravje«.

V nadaljevanju so našteti podsistemi in kako se vključevati v njih:

Prva pomoč: Tu dobite nasvete v primeru nujne pomoči (Mobilno Android IOS). Sistem zna do neke mere tudi sam odgovarjati na enostavna vprašanja tipa »zlomil sem si nogo«.

Integracija: dodati nove storitve prve pomoči.

Zdravstveni nasveti slovensko: Če imate zdravstvene težave, je pametno obiskati zdravnika, neodvisno od tega pa lahko pogledate, kaj pravijo strokovnjaki na spletu.

Integracija: dodati nove storitve slovenskih zdravstvenih nasvetov.

Tuji zdravstveni sistemi za pomoč, svetovanje in drugo mnenje:

Uptodate

health.com

webmd.com

10 najboljših aplikacij zdravstvenih svetovalnic

NIJZ: Tu je zbrana vrsta koristnih storitev za zdravje.

Integracija: povezovati storitve EMZ in NIJZ.

PROJEKTI

IN LIFE: s projektom IN LIFE želimo omogočiti starejšim z opešanimi kognitivnimi sposobnostmi bolj samostojno življenje. Če vas zanima testiranje sistema, pišite na jani.bizjak (at) ijs.si

E-gibalec: aplikacija za mobilne telefone, ki je bila razvita z namenom približati osnovnošolcem športne aktivnosti in jih spodbuditi k več gibanja.

ASPO: spletna aplikacija za prepoznavanje in informiranje o spolno prenosljivih okužbah.

Zaznavanje stresa: cilj študentskega projekta OSVET je spletni pogovorni svetovalec (chatbot) za zaznavanje stresa pri uporabnikih in nudenje psihosocialne pomoči preko spleta. Uporabnik lahko izpolni tudi anketo, ki izračuna stopnjo stresa. Aplikacija je še v razvoju.

EkoSmart, EMZ: namen programa EkoSmart je razviti ekosistem pametnega mesta. V okviru EMZ (Elektronsko in Mobilno Zdravje) zbiramo repozitorije domen in prototipov, tako lahko vidite, kdo v Sloveniji hrani katere podatke in katere prototipe. Tu razvijamo asistenta za EMZ.

Integracija: dodajati projekte partnerjev EMZ.

Obstajata **repozitorija domen in prototipov** v obliki spletnih aplikacij.

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Slika 1: Del izpisa vsebine repozitorija domen.

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Slika 2: Del izpisa vsebine repozitorija prototipov.

Integracija: dodajati nove prototipe in domene v repozitorija.

4. ZAKLJUČEK

Narejen je okvir in znotraj tega vrsta storitev, kamor bodo partnerji EMZ in EkoSMART dodajali svoje storitve, sisteme in dosežke. Če ni jasno, kako se doda oz. integrira, potem je najbolje poslati elektronsko pošto avtorjema tega prispevka.

5. ZAHVALA

Raziskave/delo je delno sofinancirano s strani Ministrstva za izobraževanje, znanost in šport in Evropske unije iz Evropskega sklada za regionalni razvoj (ESRR).

6. REFERENCES

[1] Bela knjiga EMZ EkoSMART https://dis.ijs.si/?p=2057 [2] Ogrodje pametnih občin

Ui-obcine.ijs.si

[3] Program EkoSMART http://ekosmart.net/sl/o-projektu/

Razvoj intervencij na platformi eOskrba

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POVZETEK

Slovenija in celotna Evropa se srečujeta z demografskimi spremembami z izrazitim staranjem prebivalstva in nizko rodnostjo. Skladno s povečevanjem števila in deleža starejših se povečuje število bolnikov z nenalezljivimi kroničnimi boleznimi (NKB), ki predstavljajo največji delež sredstev zdravstvenega sistema. Učinkovito obvladovanje NKB bo v prihodnje ključno za vzdržnost zdravstvenih sistemov. Večja vključenost pacientov v proces zdravljenja skupaj z uporabo sodobnih tehnologij predstavlja osrednjo izhodišče za dosego finančno učinkovitejšega sistema.

V projektu EkoSmart bomo na raziskovalni platformi eOskrba razvili in klinično validirali nove intervencije, ki bodo namenjene tako osebju in bolnikom v klinični praksi oz. posameznim raziskovalnim skupinam za potrebe znanstveno-raziskovalnega dela. Tako bomo v sodelovanju Univerzitetnega kliničnega centra Ljubljana (UKC), Medicinske fakultete (MF) in Fakultete za računalništvo in informatiko Univerze v Ljubljani (FRI) razvili pilotni sistem za spremljanje EKG in ostalih parametrov pri kardiovaskularnih bolnikih v postoperativni fazi. Sistem bo omogočal tudi medsebojno primerjavo različnih senzorjev in s tem njihovo klinično validacijo.

Ključne besede

EkoSmart, e-zdravje, interoperabilnost, Parkinsonova bolezen, srčno-žilne bolezni, diabetes, astma, debelost.

1. IZHODIŠČA

Staranje prebivalstva je v t.i. zahodnem svetu prisotno in neizogibno, poglavitna razloga pa sta nizka rodnost in daljša življenjska doba. Tako naj bi se po napovedih Eurostata delež starejših od 65 let povečal do leta 2040 s sedanjih 19% na 27% celotnega prebivalstva [1]. Ob povečevanju števila (in še bolj izrazito deleža) starejših prebivalcev se sočasno povečuje tudi število bolnikov z NKB, ki že danes predstavljajo kar 70% vseh vzrokov smrtnosti [2].

Obvladovanje stroškov naraščujočih kroničnih bolezni kot so astma, diabetes, bolezni srca in ožilja in nevrodegenerativne bolezni, je bistveno za dolgoročno vzdržnost zdravstvenega sistema, k čemur lahko pomembno prispeva dobro načrtovana vpeljava novih informacijskih in komunikacijskih tehnologij (IKT).

Pri vpeljavi IKT v zdravstveno okolje je med drugim ključno:

- Uporaba že obstoječih tehnologij oz. razvoj novih, ko je to potrebno/smiselno.
- Zagotavljanje semantične interoperabilnosti podatkov med posameznimi deležniki v zdravstvu.
- Aktivno vključevanje medicinske stroke in pacientov že v fazah izdelave z IKT podprtih procesov zdravstvene oskrbe.
- Zagotavljanje finančne učinkovitosti vpeljevanja novih / prilagojenih storitev, tudi s podporo odprtokodnih rešitev.

V različnih zdravstvenih sistemih v različnih državah, tudi v Sloveniji, so v preteklih letih pilotno vpeljali in klinično validirali že večje število IKT podprtih kliničnih poti (intervencij). Tako je bila v Sloveniji med prvimi dokazovana tako klinična [3] kot finančna [4] učinkovitost z IKT podprte intervencije za bolnike z depresijo.

Korak naprej v razvoju tehnološko naprednih rešitev za implementacijo zdravstvenih intervencij predstavlja odprtokodna rešitev eOskrba, kjer so bile na enotni platformi razvite in pilotno preizkušane različne intervencije (eAstma, eDiabetes, eHujšanje) na različnih nivojih zdravstvene oskrbe (primarna, sekundarna, terciarna); učinkovitost intervencij pa je bila tudi klinično validirana [5].

V okviru projekta EkoSmart se na osnovi platforme eOskrba razvijajo nove intervencije, tudi z vpeljavo zbiranja in analize večjega števila podatkov iz različnih senzorjev. Zelo pomembno mesto pri razvoju novih intervencij bomo namenili (z)možnosti sistema za avtomatizirano pošiljanje podatkov v nacionalno informacijsko hrbtenico in posledično dostopnost (anonimiziranih) podatkov vsem (tudi raziskovalno usmerjenim) zainteresiranim uporabnikom.

1.1 Tehnologija

Ročno merjenje in beleženje posameznih zdravstvenih podatkov, ne glede na mesto njihovega nastanka (pacient doma ali zdravstveni delavec v ustanovi) je še vedno zelo prisotno. Avtomatizirano odčitavanje in (brezžično) elektronsko beleženje podatkov je postalo mnogo učinkovitejše (hitrejše, cenejše) od prej omenjenega načina. Tako lahko z relativno majhnimi sredstvi uporabimo tehnologije, ki so že na voljo, npr. mobilni telefon, ki lahko v procesu zdravstvene oskrbe deluje kot:

- zaslon za spremljanje (zdravstvenih) podatkov, meritev, video posnetkov;
- vmesnik za brezžični zajem podatkov iz specializiranih medicinskih naprav;
- lokalno skladišče podatkov;
- komunikacijska naprava s spletom;
- zajem podatkov kot so: lokacija, smer in hitrost gibanja (GPS); pospeški in pojemki (pospeškometer), slika in video (kamera), zvok (mikrofon).

Posebno prednost predstavljajo operacijski sistemi (iOS, Android), ki omogočajo praktično neomejen razvoj in uporabo mobilnih aplikacij.

1.2 Izmenljivost informacij

Uporaba IKT orodij omogoča hitro in zanesljivo pridobivanje kliničnih in ostalih podatkov oz. informacij, pogosto ključnih za obravnavo pacientov. Hiter razvoj naprednih senzorjev z brezžičnim in avtomatiziranim prenosom podatkov na mobilne naprave nudi številne možnosti razvoja naprednih rešitev za uporabnike: zdravstveno osebje, paciente in ostale deležnike v procesu zdravljenja.

Čeprav so posamezne informacije o pacientu s pomočjo omenjene tehnologije za diagnostiko (in spremljanje terapije) že zelo uporabne, pa še vedno obstaja izrazito ozko grlo zaradi lokalne (proizvajalec naprave) hrambe posameznih podatkov. Prav tako tehnološka podjetja praviloma t.i. »surove podatke« obdelujejo in končnemu uporabniku ponujajo le t.i. »obdelane podatke«. Neusklajenost med posameznimi ponudniki in različnimi informacijskimi sistemi se rešuje z vpeljavo standardov, ki omogočajo semantično interoperabilnost - bistveno za enoznačno interpretacijo podatka/informacije v različnih informacijskih sistemih [6].

V projektu EkoSmart bomo uporabili standard OpenEHR, posamezne podatke pa se bo pošiljalo v nacionalno bazo pri NIJZ; s čimer bodo podatki na voljo ostalim zaintereiranim uporabnikom, anonimizirani podatki pa bodo na voljo tudi za raziskovalne namene.

1.3 Vključevanje uporabnikov

Nove storitve so namenjene uporabnikom, ki so v zdravstvenem sistemu praviloma medicinsko osebje, pacienti in (v nekaterih primerih) njihovi svojci. Uspešnost vpeljave novih storitev je v mnogočem odvisna od dejstva, kako bodo nove storitve zadovoljevale pričakovanja in zahteve zdravnikov, medicinskih sester, bolnikov, svojcev itd. Za učinkovit razvoj in uporabo z IKT podprtih zdravstvenih storitev je tako ključno sodelovanje zgoraj omenjenih skupin uporabnikov od prvih faz (t.j. načrtovanje storitev) do končne validacije.

1.4 Finančni vidik

Inovativna dejavnost na področju zdravstvene oskrbe s pomočjo vpeljave IKT rešitev je lahko finančno učinkovita, vendar pa to ni samoumevno. Pravilno načrtovanje razvoja, vpeljave in validacije posameznih novosti je bistveno za izboljšanje zdravstvenega stanja (kroničnih) bolnikov, ki ima hkrati tudi finančno ugodne posledice (cenejše zdravljenje).

Spremljanje finančnega učinka bomo uvedli tudi pri razvoju novih intervencij.

2. EKOSMART IN RAZVOJ NOVIH INTERVENCIJ

V okviru projekta EkoSmart razvijamo dve intervenciji, ki bosta namenjeni kardiovaskularnim bolnikom v postoperativni bolnišnični obravnavi in bolnikom s parkinsonovo boleznijo, oz. zdravstvenim delavcem pri vodenju zdravstvene oskrbe omenjenih skupin bolnikov.

2.1 eOskrba – (tudi) raziskovalna platforma

V preteklih letih se je v slovenskem prostoru že validirala vpeljava novih intervencij z uporabo IKT storitev na področju oskrbe bolnikov s NKB. Tako je bila med drugim razvita odprtokodna platforma eOskrba, na kateri bomo v okviru projekta EkoSmart razvili dve novi intervenciji. Poleg tega se bo razvil vmesnik za pošiljanje podatkov v nacionalno bazo podatkov o pacientu. Razviti intervenciji bosta vključevali tudi uporabo sodobnih, brezžičnih senzorjev.

2.2 Postoperativno vodenje kardiovaskularnih bolnikov

Spremljanje kardiovaskularnih bolnikov v postoperativni fazi je izrazito pomembno zaradi pojava morebitnih zapletov, med drugim tudi atrijske fibrilacije. Z uporabo EKG naprav, ki so lahko bodisi prenosne bodisi stacionarne, se lahko doseže relativno dober nadzor nad bolniki. Težavo predstavljata visoka cena prenosnih EKG merilcev (t.i. holter aprati) in neažurnost podatkov – prenosne EKG naprave praviloma ne pošiljajo podatkov v realnem času na strežnik, ampak se podatki hranijo lokalno v napravi in jih zdravniki odčitajo ob ponovnem prihodu v bolnišnico.

Predvidevamo, da bi uporaba cenejše naprave, ki omogoča prenos podatkov »skoraj v realnem času« lahko pomembno hitreje zaznala morebitne zaplete in na ta način preprečila marsikateri postoperativni zaplet.

V okviru projekta razvijamo celovito storitev, ki med drugim omogoča sočasno spremljanje/beleženje podatkov iz obstoječih standardnih EKG naprav in mobilnega EKG senzorja Savvy, z namenom primerjave pridobljenih podatkov in izboljšave klinične oskrbe.

2.3 Vodenje bolnikov s Parkinsonovo boleznijo

Parkinsonova bolezen je ena izmed najpogostejših oblik nevroloških bolezni, zaradi staranja prebivalstva pa se število bolnikov hitro povečuje. Tako naj bi se število bolnikov od leta 2010 do 2040 podvojilo, sami stroški zdravljenja in izgube zaradi bolezni so (za ZDA) ocenjeni na 22.800 USD na pacienta [7].

V okviru projekta razvijamo spletno-mobilno aplikacijo za spremljanje bolnikov s parkinsonovo boleznijo, predvsem z namenom aktivne uporabe (tudi v raziskovalne namene) beleženih podatkov. Kasneje predvidevamo integracijo s specifičnimi senzorji, ki se uporabljajo za spremljanje zdravstvenega stanja bolnikov in v prihodnosti razvoj celovite storitve, tako za bolnišnično oskrbo, kot tudi spremljanje pacientov na domu.

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Visual Working Memory and its impairments in Parkinson's disease

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ABSTRACT

Visual Working Memory (vWM) is a set of processes enabling short-term visual information maintenance and manipulation. Methodological developments in the past twenty years have encouraged more standardized and reliable ways to quantify vWM capacity and probe its sub-processes. Visual WM is recognized as a bottleneck in information processing system due to its highly limited capacity, yet, its central role in human cognition makes it a key research topic in understanding cognitive deficits and impairments in clinical populations. Parkinson's disease (PD) is one of the neurodegenerative disorders marked by vWM impairments. Considering that vWM impairments start at the early stages of PD, behavioral and electrophysiological vWM capacity measurements could act as important early disease biomarkers. This work was carried out for the purposes of developing the peripheral sensing techniques for EkoSMART project.

General Terms

Experimentation, Human Factors, Theory

Keywords

Visual Working memory, Parkinson's disease

1. INTRODUCTION

1.1.1. Visual working memory definition

Visual Working memory (vWM) is a capacity-limited system responsible for the short-term maintenance and manipulation of visual information [4]. It is an integrative part of the visual information processing system, responsible for such functions as integration of pre-saccadic and post-saccadic retinal images and binocular integration [10]. Furthermore, the functional role of visual WM expands beyond perceptual and processing roles. It has been repeatedly and reliably shown that vWM underlies a range of higher cognitive functions, such as fluid intelligence, reasoning, language comprehension and math abilities [11], acting as an online workspace for keeping information "in mind" [7]. Growing recognition of the vWM role in healthy and impaired cognition has resulted in a substantial increase in studies and publications related to the topic: In 2014 there were 18.224 citations in PubMed and 1.580.000 search results in Google Scholar related to working memory, whereas in 2017 the number grew to 42.474 PubMed citations and 4.750.000 Google Scholar search results [3].

1.1.2. Behavioral vWM capacity quantification

One of the most prominent and researched properties of vWM is its highly limited capacity. Different theoretical models and frameworks have always recognized that short-term storage and control mechanisms are the bottleneck in the human information processing system. However, despite the long history of research, the precise quantification of vWM capacity had varied greatly from one study to another due to the general lack of standardized measurement procedures. The turn point in the field was marked by a seminal paper of S. Luck and E. Vogel in 1997 [9]. Through a set of influential experiments, the authors introduced a gamechanging discrete-slot framework of vWM capacity, as well as popularized a change-detection paradigm and a behavioral vWM capacity index K.

According to their discrete-slot model, vWM capacity is limited to, on average, 3-4 memory representations. As a result, in case of a supra-threshold memory set, only a fraction of information (3-4 representations) can be retained in vWM [5, 9]. Moreover, the individual differences in memory capacity, ranging from 1.5 to 6 items, are stable both across different stimulus modalities and time.

In addition, S. Luck and E. Vogel popularized a change-detection paradigm for quantification of vWM capacity which remains one of the dominant experimental paradigms in the field. Essentially, in a change detection paradigm the observer is presented with a memory set for a brief period of time (typically 100-200 ms) and after a short period of retention (typically around 900 ms) he is shown a probe and has to indicate whether a change has occurred [9]. There are two variants of the change-detection task: A singleprobe version requires the subject to make a judgment about one item, while a whole-display version requires to make a decision regarding any element in the whole memory set. The change detection paradigm has been used and established for a variety of visual features, such as color, shape, size or orientation [9], as well as complex visual stimuli [6]. Although the change-detection task is very simple and straightforward, it has been shown to correlate well with a range of more complex tasks for fluid intelligence and high level aptitude tests [11].

Finally, S. Luck and Vogel have popularized a behavioral capacity index K for standardized vWM capacity measurement. The capacity index K is derived from accuracy parameters, such as false alarm rate and hit rate, and adjusted to the memory set size and the version of change detection task (single-probe or whole-display) [12]. The index K has enabled reliable

quantification of vWM capacity across different stimuli and task modifications.



Figure 1. Example of simplified bilateral change-detection task design

1.1.3. Electrophysiological vWM capacity marker

It has been long observed that visual WM tasks are accompanied by a slow negative wave at temporal and occipital scalp sites [4]. However, the productive use of this observation was impeded by difficulties in separating visual working memory processes from those of visual perception, general effort or task difficulty. The ground-breaking change in the electrophysiological study of vWM came from E. Vogel and M. G. Machizawa [13] with the introduction of a modified bilateral variant of the changedetection paradigm (Figure 1). The modified task differed from the original one in a directional cue preceding the memory set, resulting in vWM processing being focused on one visual hemifield. This method, known as contralateral control method, can be applied to any lateralized brain system, such as visual or motor, in order to isolate specific processes.

Consequently, E. Vogel and M. G. Machizawa observed a slow negative wave larger at the contralateral (to the stimuli) temporal and posterior electrode sites. They used a subtraction method to construct a difference wave and termed it the Contralateral Delay Activity (CDA). They immediately noticed that the CDA has a great load sensitivity, which is reflected by its amplitude changes (Figure 2). Moreover, the CDA has been shown to mirror the same interpersonal vWM capacity differences as those reflected by the behavioral index K [13, 14]. Importantly, while the index K is a summary measurement of the overall performance (accuracy), the CDA allows online probing into different vWM sub-processes, such as encoding, maintenance and retrieval.

As a result, it has been shown that individual differences in vWM capacity in healthy adults can be explained by the differences in the resistance to distractors rather than the capacity itself. E. Vogel and colleagues [14] termed this vWM property Filtering Efficiency (FE). Essentially, FE indicates how well a person can resist encoding task-irrelevant distractors and use his highly limited vWM capacity efficiently. It has been since shown that FE deficits are present in many neurodegenerative and psychiatric disorders characterized by some kind of vWM impairments.



Figure 2. Example of a CDA waveform at memory load of 2 (red line) and 4 (blue line), based on real experimental data from healthy participants

1.1.4. Visual WM deficits in Parkinson's disease

One of the clinical populations marked by vWM deficits comprise Parkinson's disease (PD) patients. PD is a neurodegenerative disorder characterized by a range of motor symptoms, such as resting tremor, rigidity, and bradykinesia [2]. The motor symptoms, however, are accompanied by cognitive deficits in executive functions and goal-directed behavior [2, 8]. It is known that both the motor and cognitive symptoms are caused by dopaminergic deficit in basal ganglia, as L-dopa administration has been shown to ameliorate performance deficits in cognitive tasks, both in terms of accuracy and reaction times [2].

Visual WM deficits in PD were first defined with regard to its reduced capacity, however, development of the CDA allowed more accurate dissection of the vWM pathology in PD. E. Y. Lee and colleagues [8] used a bilateral whole-display change-detection task to quantify vWM performance in 21 idiopathic PD patient and 28 healthy controls. The behavioral capacity index K and CDA provided convincing evidence that Parkinson's disease patients have both reduced vWM capacity and impaired filtering efficiency. The authors hypothesized that the loss of dopaminergic input to the basal ganglia could lead to reduced function of globus pallidus in regulating task-relevant information storage in vWM. They also suggested that bradyphrenia could cause the observed reduced capacity and filtering efficiency, as patients could not deal efficiently with the rapid pace of the task.

Visual WM studies in PD patients are important not just for obtaining a better insight into the underlying pathology. P. S. Boggio with colleagues [1] have reported a significant improvement in WM task accuracy after active anodal tDCS stimulation over IDLPFC with 2mA, opening a discussion about possible therapeutic cognitive rehabilitation in PD.

2. CONCLUSIONS

Improved methodology in behavioral and electrophysiological quantification of visual working memory allows more accurate understanding of vWM impairments in PD patients. Considering that vWM impairments start at the early stages of PD, behavioral and electrophysiological vWM capacity measurements could act as important early disease biomarkers.

3. ACKNOWLEDGEMENTS

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Open Source C++ Libraries for Electrophysiological Data Preprocessing and Analysis

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ABSTRACT

In this paper, we describe two open source C++ libraries developed to facilitate and automate preprocessing and analysis of electromyography (EMG) and electroencephalography (EEG) data (palMEP and palEEG, respectively). Additionally, we introduce a graphical user interface (GUI) software for EMG data analysis. These tools fill existing gaps in open source data preprocessing and analysis solutions in the field of electrophysiology and neurostimulation. They are aimed at enabling research and its reproducibility and, at the same time, facilitate the transition of experimental clinical therapeutic methods from an open loop brain stimulation paradigm towards an adaptive more personalized closed loop paradigm. This work was carried out for the purposes of developing the peripheral sensing techniques for EkoSMART project. First, the purpose of developed tools will be introduced in the context of neuroscientific research in general and non-invasive neuro-stimulation in particular. Secondly, the inner workings of the libraries will be thoroughly described. Finally, current work in progress and future directions in development will be discussed.

Keywords

EMG, EEG, Neurostimulation, FFT, open source.

1. INTRODUCTION

Open source solutions for preprocessing and analysis of electrophysiological and neuroimaging data are now mainstream in neuroscientific research. Publically available toolboxes, such as EEGLAB[1], FieldTrip [2], or SPM[3], have gained major adhesion from the international research community. The rapid pace at which new preprocessing and analysis methods appear as well as the dynamic nature of their implementation made it somewhat necessary that toolboxes be created within the open source community so that the software would be up to date with the ongoing progress in research methodologies. Moreover, the open source model enables and promotes the interaction and exchange of information among scientist in the neuroscientific community. This, in turn, allows the seamless implementation of cutting edge methods on common universally available platforms, which is then reflected in evermore standardized data preprocessing and analysis pipelines and, hence, higher transparency and replicability of research methods and results.

While there is an abundance of well-established open source EEG and neuroimaging data preprocessing and analysis tools, there is a

lack of specific solutions for the analysis of EMG data obtained in the context of non-invasive electric and magnetic transcranial stimulation, which is a well stablished neuroscientific research method for studying and altering brain function non-invasively [4]. Additionally, well-established software solutions for the analysis of EEG and MEG data, such as EEGLAB or FieldTrip, are mostly developed and implemented within the Matlab (MathWorks, Inc. Chicago) programing environment, which is a leading commercial software in scientific computing. While Matlab is commonly available in research institutions throughout the world, many research groups and individuals are often unable to afford the licence fees associated with commercial software packages, and are, therefore, forced to operate outside the mainstream of preprocessing and analysis methods.

The aim of the work in progress that the libraries here presented constitute, is to fill the two aforementioned gaps. On the one hand, we have developed an open source solution, named palMEP, to perform preprocessing and analysis of EMG data in general, and of data that has been gathered while using electric or magnetic stimulation, in particular. The methods and functionality of palMEP have been developed according to standard practices in the research community and reflect the idiosyncrasies and challenges that researchers in the field of neuro-stimulation typically face when dealing with EMG data gathered concurrently with methods such as Transcranial Magnetic Stimulation (TMS) or peripheral electric stimulation. On the other hand, we are currently developing a homologue of the EEGLAB and FieldTrip toolboxes, named palEEG, which will not be dependent on a commercial software development framework. At the moment, palEEG includes an interface to import Matlab based files containing workspace variables in general and EEGLAB and ERPLAB data structures in particular. palEEG also currently implements an experimental implementation of time-frequency decomposition using Morlet wavelets.

2. palMEP

In this section we describe the philosophy and implementation of an open source GUI based software for the preprocessing and analysis of EMG data.

2.1. Intended usage and Scope

This software is aimed at students, researchers and clinicians in electrophysiology and neuroscience, who have little or no experience in programming and/or in signal processing and analysis. This program is also intended for users who do have this knowledge, but would benefit from an easy to use tool for manipulation, visualization and automation of motor evoked potentials (MEPs) analysis and preprocessing tasks.

To this end, the user interface is designed to be intuitive and simple, stripped down to the most necessary elements to reach the most commonly sought after goal: to get reliably preprocessed MEP measures in a format that is friendly to mainstream statistical analysis softwares, such as SPSS[©] or R[5].

The measures of choice included in this program, peak to peak, log and root mean square amplitude, are the most widely used to describe MEPs elicited by transcranial magnetic and electric stimulation. When using these stimulation methods, a large intertrial variability is to be expected [6], hence, visual inspection of single trials might be necessary in order to reject MEPs which might have been influenced by unwanted background muscle contraction [7], or which are far too large or small. This software provides a clear and intuitive signal viewer for trial by trial visual exploration. Additionally, mean and standard deviation are also calculated, in order to allow further analysis outside this software.

This software supports the commonly used CED (Cambridge Electronic Design Limited, Cambridge, UK) Signal and Spike2 software files, as well as comma, space or tab delimited text files, which further extends the compatibility of this program to any other software which supports custom text file export.

This software is distributed, together with the source code, under the GNU GPLv3 licence. The source code is fully documented according to the Doxygen standard. The software also includes a detailed user manual in pdf format.

2.2. Implementation and Functionality

palMEP is implemented in C++ using the QT (The Qt Company Ltd) programing environment. This software depends on the CED CFS library and the CEDS64ML interface libraries, for reading Signal and Spike files, respectively. Additionally, it depends on the QCustomPlot library by Emanuel Eichhammer for signal plotting and visualization. All these dependencies are publically available and routinely maintained.

palMEP has two main modes of operation: single-trial based processing, and automatic processing of single or multiple files.

In single-trial mode, the user can easily highlight the area of interest where measures will be performed in for each trial using two interactive vertical cursor bars (see Figure 1).



Figure 1. palMEP GUI layout.

palMEP computes the following measures and metadata of interest, and stores them in a tab delimited text file of the users choosing (see Figure 2 for a sample of the output):

- 1) The peak to peak amplitude: $|V_{max}| + |V_{min}|$
- 2) The natural logarithm of the peak to peak amplitude: $\ln(|V_{max}| + |V_{min}|).$
- 3) The root mean square amplitude [9]: $RMS = \sqrt{\frac{1}{T} \sum_{t=1}^{T} EMG^2(t_i)}$. Where $EMG^2(t_i)$ is the squared value of each datum of EMG within the data window [10].
- 4) The latency in milliseconds: $\frac{indx_2 indx_1}{sampling rate(Hz)}$. Where $indx_i$ is the index of a data point in a time series. For unknown sampling rates (delimited text files), the latency is expressed in number of data points: $indx_2 indx_1$.
- 5) The sampling state, as defined in the original Signal file, or as computed from a marker channel in a Spike file. For delimited text files, state is always 0.
- 6) The name of the data channel as described in the original Signal or Sipke file. For delimited text files 'Channel_ID' is always 'unknown'.

7) The full path of the processed file.

Figure 2. palMEP results output sample.

An innovative feature of this software is an algorithm designed to detect the MEP automatically, without any user input. This allows automatic processing of an unlimited number of files without previous visual inspection. The algorithm implements two methods, and if they do not coincide, it picks the solution of the one which provided the smaller result (discrepancy is usually due to one method detecting the artifact and the other detecting the MEP). The first method finds the maximum difference between each pair of consecutive data points in the sweep. The second method estimates the rate of change by iteratively calculating the first derivative in 5 data point segments, then the segment with the maximum rate of change is taken.

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3. palEEG

In this section we describe the philosophy and implementation of an open source library for importing Matlab based variables, as well as EEGLAB and ERPLAB [8] data structures, and performing time-frecuency decomposition using Morlet wavelets.

3.1. Intended usage and Scope

This library is work in progress, and is intended to become a homologue alternative to the Matlab based EEGLAB, ERPLAB and FieldTrip toolboxes. At the moment, the library includes a set of useful functions and, in the near future, will include a GUI similar to palMEP to enable easy access to EEG preprocessing and analysis methods and data visualization.

This software is distributed, together with the source code, under the GNU GPLv3 licence.

3.2. Implementation and Functionality

palEEG is implemented in C++ using the QT programing environment. This software depends on the Armadillo linear algebra library [9] for matrix operations and manipulations. We have chosen Armadillo (namespace: 'arma'), because it is wellestablished and maintained, it has good performance and provides a syntax and functionality similar to Matlab. For reading Matlab files, palEEG depends on the MAT File I/O Library by Christopher C. Hulbert. We have chosen this library because it constitutes a decent open source alternative to the proprietary library provided by Matlab. For computing discrete Fourier transforms (DFT) palEEG depends on the Fastest Fourier Transform in the West (FFTW) library [10]. This library has been chosen because it is possibly the fastest implementation of the fast Fourier transform (FFT) algorithm, and is also the library used by Matlab to compute FFT.

FFTW uses the following formulas for the FFT and its inverse:

$$Y_{k} = \sum_{j=0}^{n-1} X_{j} e^{-2\pi j k \sqrt{-1/n}}$$
$$Y_{k} = \sum_{j=0}^{n-1} X_{j} e^{2\pi j k \sqrt{-1/n}}$$

palEEG currently includes 4 functions for loading Matlab files, these functions are declared and implemented in *'readmat.h'* and *'readmat.c'*, respectively:

 'read_2dmat', allows reading a single vector or 2d matrix (rown x coln) from a .mat Matlab file.

int read_20mat(const char* filename, armaiinat &matout);

'read_3dmat', allows reading a 3d matrix (rown x coln x slicen) from a .mat Matlab file.

int read_30mat(const char* filename, arma::cube &matout);

3) *'read_EEG'*, allows reading an EEGLAB EEG data structure contained in either a .set or .mat data file.

int read_EEG(const char* filename, eegData &EEG);

4) *'read_EEG'*, allows reading an ERPLAB ERP data structure contained in either a .erp or .mat data file.

int read_ERP(const char* filename, erpData &ERP);

All 4 reading functions are numeric type sensitive (integer, single or double precision floating point numbers), and will convert the values to double precision, when appropriate. The functions carry out sufficient error checking to avoid crashes and will return success or failure accordingly.

Funcitons 3 and 4 store the read data into an eegData or erpData structure, respectively. These data structures are designed to keep the structure of the data as close as possible to the original EEG or ERP structure in Matlab, while only retaining the essential information for further processing in palEEG. A simplified declaration of the 2 data structures would be as follows:

struct segDate: public	Q0bject{	attunt erpOsts: public	QObject[
Q_GBJECT		0 OBJECT			
public:		mblict			
double	urate;	dauble	scate;		
QVector <int></int>	dima:	QVectorsint>	d fine :		
ermal:Cube <double?< td=""><td>data;</td><td>arma::Cube<double></double></td><td>data;</td></double?<>	data;	arma::Cube <double></double>	data;		
QVector <double></double>	timets;	QVector <double></double>	timest		
QVector (QString)	shannels;	QVector <qstring></qstring>	channels;		
eventStrut	avent:	QVector <qstring></qstring>	bindeser;		
111	inloaded = 0;	THE	isloaded = 0;		
public slats:		public slots;			
a famala:		a anala:			
11					

The *'eventStruc'* stores all the relevant marker and event information from the original Matlab event structure, retaining the subfield names for easier portability.

```
struct eventStruc: public QObject[
    Q_OBJECT
    public;
    QVector/QString> type;
    QVector/double> epoch;
    QVector/QString> estat;
    public stotu:
    signals:
```

The time-frequency decomposition functions are declared and implemented in 'dotf.h' and 'dotf.c', respectively.

The main function is declared as follows:

It takes the imported data and first computes the event-related potential (ERP) for any chosen experimental condition and EEG channel. It then performs the FFT of the vectorized original data. Next, it creates the Morlet Wavelet [11], according to the 'cycles' parameter defined by the user, and computes its FFT. The FFT of the data is then element-wise multiplied by the FFT of the wavelet. Finally, the inverse FFT of the resulting multiplication is computed. This results in a vector of complex elements containing power and phase information for all the chosen time points in each of the specified frequencies. The resulting vector is then reshaped into 3 different 3d matrices (channel x Frequency x

11
Time), containing the raw complex-number result of the decomposition, the power and the ITPC results, respectively, and stored into a '*tfData*' structure, which is defined as follows:

```
struct tilatal public Q0bjecti
     0.00.001
publis:
     ereation_mat
                                  wat:
                                tf_pow;
tf_itps;
     prestingt.
     unnellmat.
armellmat
                                ero;
     atd:/vector/double> frees
                                           311
     std::vector:double> haseline 2];
std::vector:double> time:fes 2];
     std::string
                                channel2use:
stdristring
public slots:
                                binduse:
Statulo:
1:
```

The '*do_TFeeg*' function supports three different modes of operation, that can be specified via the '*type*' parameter:

- 'Absolute Power', computes the total power (phase-locked + non-phase-locked power) and the inter-trial phase coherence.
- 2) 'Phase locked' Power, computes the power of the ERP only.
- 'Non-phase-locked Power', subtracts the ERP from each individual trial in the original data before running time-frequency decomposition.

The different time-frequency measures follow the definitions by Brian J. Roach and Daniel H. Mathalon [12], while the algorithms used to compute time-frequency decomposition closely follow Mike X. Cohen [13].

Subsequent iterations of palEEG will include a GUI, additional data preprocessing tools, such as filtering and ICA based artifact rejection, new data and result visualization methods, as well as time-frequency based connectivity measures.

4. CONCLUDING REMARKS

The libraries here described constitute work in progress meant to fill existing gaps in open source data preprocessing and analysis solutions in the field of electrophysiology and neuro-stimulation. These tools are aimed at enabling research and its reproducibility and, at the same time, facilitate the transition of experimental clinical methods from an open loop paradigm towards an adaptive more personalized closed loop paradigm, which we hope to achieve by developing fully open source optimized solutions for data preprocessing and analysis.

If you would be interested in either getting a copy or collaborating in the development of these libraries, contact the author of this paper.

5. ACKNOWLEDGEMENTS

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Using brain state-dependent transcranial magnetic stimulation for investigating causal role of cortical oscillations in functional states

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ABSTRACT

Non-invasive brain stimulation is being used for manipulation of cortical oscillations in research and clinical context for development of possible therapeutic applications in brain disorders. Effects of brain stimulation show strong inter- and intra-individual variation. In general there are several sources of this variability, e.g. neuroanatomical and neurochemical factors. This article describes our work in the scope of EkoSMART consortium on development of peripheral sensing techniques. Here we focus on the rapidly varying neurophysiological factors cortical oscillations. Current state of cortical oscillations can be continually recorded with peripheral sensors like EEG scalp electrodes and used online for continuous monitoring and adjustments of brain stimulation parameters. By adjusting the timing, intensity and frequency of transcranial stimulation to specific brain states it is possible to reduce variation in the treatment effects. However, since brain state-dependent stimulation (BSDS) requires online monitoring and analysis of neurophysiological data, it is technically demanding. BSDS has been made possible by recent technological advances and advances in analytical procedures. While EEG data has been traditionally analyzed in time- or frequency-domain only, timefrequency analysis is being increasingly used and it offers better insight into neurophysiology of oscillations. BSDS is useful in the field of clinical neuroscience, where it can be used to personalize stimulation parameters, e.g. adjust deep brain stimulation depending on the severity in symptoms in Parkinson's disease. Because it enables manipulation of cortical oscillations when a specific brain state is detected, it allows stronger causal inferences about their role in behavior and brain states. Therefore, BSDS can be also used as a tool for verification or falsification of hypotheses in cognitive neuroscience.

Keywords

Brain state-dependent stimulation, transcranial magnetic stimulation, time-frequency analysis, electroencephalography, cortical oscillations.

1. INTRODUCTION

Transcranial magnetic stimulation (TMS) is a non-invasive brain stimulation method during which magnetic field in a coil induces an electric current in nearby conductive tissue – the brain –

thereby inducing action potentials in neurons. It is a common technique for manipulating neuronal oscillations and is used for research and clinical purposes. Transcranial alternate or direct current stimulation (TACS / TDCS) is a similar, although much weaker technique for modulating neural activity.

Effects of the TMS treatment show strong inter- and intraindividual variability and are influenced by neuroanatomical. neurochemical and neurophysiological factors [10]. These factors can be trait-related and can be stable (e.g. cortical thickness. individual alpha rhythm frequency) or can vary intra-individually (e.g. circadian fluctuations). On the other hand, state-related determinants can vary strongly and rapidly within and between treatment sessions. For example, it has been shown that phase and amplitude of cortical oscillations influence corticospinal excitability as measured with motor evoked responses [1, 15]. In the case of trait-related factors, variability of TMS intervention can be reduced by pre-selection of individuals based on a certain trait or by homogenizing the influencing variable, e.g. applying the treatment at the same time of the day. However, cortical oscillations can also vary on a millisecond scale and to reduce the effects of these factors, brain-state dependent stimulation is needed.

2. FEASIBILITY OF BRAIN-STATE DEPENDENT STIMULATION

Brain-state dependent stimulation (BSDS) requires online monitoring and analysis of neurophysiological data (see Figure 1). Karabanov et al. [10] distinguish between (1) state-informed noninvasive transcranial stimulation (NTBS) and (2) adaptive, closed-loop¹ NTBS. In the former, the timing, frequency or the intensity of stimulation is adjusted according to the predefined state (e.g. phase or power of cortical oscillations), whereas in the latter, stimulation is dynamically adjusted depending on the stimulation-induced state changes.

¹ In the literature, the term closed-loop stimulation is sometimes being used for both types of stimulation. However, Karabanov et al. [10] emphasize, that state-informed stimulation is not the same as "closed-loop" stimulation and that the latter term should only be used for a stimulation which adapts depending on stimulation effects in real-time.

In recent years several studies have shown feasibility of both types of stimulation. An example of state-informed NTBS is a study by Bergmann et al. [2]. To answer the question how the phases of cortical oscillations affect cortical excitability, Bergmann et al. applied TMS during sleep while concurrently measuring electroencephalographic (EEG) signal. Single-pulse TMS was triggered by automatic detection of up- and down-states in slowoscillations during non-rapid eye movement sleep. It was shown that motor-evoked potentials (MEPs) and TMS-evoked potentials (TEPs) were larger during slow-oscillations up-states than during down-states. Similarly, Gharabaghi et al. [6] and Kraus et al. [11] showed that single-pulse TMS controlled by beta-band eventrelated desynchronization (ERD) during motor imagery resulted in an increase of corticospinal excitability whereas in the non-BSDS condition this effect was absent.

An example of an adaptive closed-loop stimulation is a study by Brittain et al. [4] who applied transcranial alternating current stimulation (TACS) over the motor cortex of patients with Parkinson's disease. Stimulation was delivered at tremorfrequency and adjusted in a way to produce phase-cancellation and thus achieving tremor-suppression up to 50%. Similarly, in a study by Little et al. [12] it was shown that deep brain stimulation in Parkinson's disease can be adjusted by providing feedback from local field potentials from the electrodes. This type of adaptive deep brain stimulation was more effective and efficacious than conventional continuous stimulation. While these studies provide proof-of-principle, it remains to be shown that EEG combined with non-invasive transcranial stimulation can also be used in a closed-loop, adaptive fashion [2].



Figure 1. Closed-loop brain state-dependent non-invasive transcranial brain stimulation. Source: Bergmann et al., 2016 [3]. Originally published under CC BY license (https://creativecommons.org/licenses/by/4.0/).

Both neuroimaging (e.g. functional magnetic resonance) and electrophysiological methods (e.g. EEG) can be coupled with TMS for BSDS. TMS can be combined with fMRI for brain-states with slow fluctuations (e.g. resting state connectivity) and when spatial resolution and sensitivity to subcortical structures is important, whereas EEG is more appropriate when timing precision on sub-second level is more relevant.



Figure 2. Same data analysed in time-domain (event-related potential, top) and with time-frequency analysis (bottom).

2.1 Challenges in online real-time analysis of brain-states

Traditionally, EEG data has been analyzed in time- or frequencydomain. In time domain analyses (see Figure 2, top), data are typically averaged across epochs based on markers, which represent events (e.g. stimulus presentation or participants' response) by which event-related potentials (ERPs) are observed. This procedure is based on an assumption that signal is constant across trials, whereas all trial-to-trial variability is considered to be noise. One major disadvantage of ERP technique which originates from this assumption is that it requires a lot of trials to achieve acceptable signal-to-noise ratio. While this procedure is still being used, it is now known that this assumption is false since even temporally fluctuating potentials (so-called non-phaselocked or induced activity) are averaged out from the signal and therefore cannot be reliably detected with ERP technique.

In frequency-domain analyses, EEG data is decomposed from time-domain into frequency-domain using Fourier transform. With this procedure it can easily be estimated which frequencies constitute EEG signal, e.g. whether there is more activity in theta-band (4–7 Hz), beta-band (16–30 Hz), etc. This type of analysis is

relatively simple and therefore widely used, e.g. for research on resting state EEG. However, the fact that brain is highly nonstationary renders results of frequency-domain analyses hard to interpret, especially when we are interested in how oscillations change in response to events. The third way to analyze EEG data is by means of time-frequency analysis. Time-frequency analysis offers good time and frequency resolution (although there exists a trade-off between them) [5]. Its results are closer to actual neurophysiology in comparison to the other two methods and therefore easier to interpret. Since it does not require a large number of trials to achieve acceptable signal-to-noise ratio and since it can be used to disentangle phase-locked and non-phaselocked activity, it is more appropriate for single-trial analyses. It also enables calculation of various connectivity measures based on phase, power, etc.

Although time-frequency analysis is more computationally consuming, it is more suitable for BSDS in comparison to time- or frequency-domain analyses. Besides usefulness in online monitoring of cortical oscillations in real-time, time-frequency analysis can also be used to generate hypotheses about the causal role of different types of oscillations and for evaluating the effects of transcranial stimulation.

Another important issue in BSDS with TMS are strong artefacts produced by stimulation lasting several milliseconds [16] and TEPs caused by stimulation. In state-informed open-loop stimulation a refractory period of several seconds can be used to avoid triggering of TMS by artefacts or TEPs, whereas for closedloop stimulation methods for online artefact reduction yet need to be developed.

3. BRAIN STATE-DEPENDENT STIMULATION ENABLES STRONGER CAUSAL INFERENCES ABOUT CORTICAL OSCILLATIONS

Whereas the usefulness of BSDS in clinical context is evident as illustrated by examples described above, BSDS can also foster progress in cognitive neuroscience. Currently, dominant approach for investigating the role of cortical oscillations in cognition is to randomly present events and then observe changes in eventrelated potentials or event-related oscillations. In the case of investigation of effects of TMS on the brain, EEG is correlated with TEPs or MEPs. This approach is useful for generating hypotheses about relationship between brain and functional states, however, it is essentially a correlational approach. Stronger causal inferences are possible if events are triggered when a specific brain state is detected.

Besides BSDS where transcranial stimulation is adapted to the brain state, a stimulus presentation or task can also be adapted to the brain state, resulting in the so-called brain-state dependent task (BSDT) [8]. For example, Ngo et al. [13] applied auditory closed-loop stimulation in phase with slow oscillation up-states during sleep. This improved memory consolidation and enhanced declarative memory retention.

All three approaches can be used complementary: first, it can be shown that a specific oscillatory pattern is linked to behavior. For example, Osipova et al. [14] have shown that stronger gamma and theta activity during visual stimuli presentation predicted subsequent retrieval. A hypothesis that gamma and theta activity is causally linked to memory encoding could further be tested using BSDS, where oscillations in gamma and theta spectra would be manipulated using transcranial brain stimulation. Further, using BSDT, if low theta or gamma power were detected during stimuli presentation, these stimuli could then be presented multiple times and in this way learning would be more efficient.

4. CONCLUSION

Computational advances and advances in statistical methods have in recent years enabled analysis of trial-to-trial variations in the field of neurophysiology. This has led to new hypotheses about the functional role of cortical oscillations. Brain state-dependent stimulation can be used as a tool for testing these hypotheses and thus enables making strong causal inferences about cortical oscillations. BSDS is a significant step towards optimizing noninvasive transcranial brain stimulation interventions, thus enabling more efficient stimulation adapted to the individual's brain and/or functional state. To conclude, research on brain statedependent stimulation is still in its infancy and shows considerable promise in fostering progress in cognitive and clinical neuroscience.

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Diagnosticiranje parkinsonove bolezni iz glasu osebe

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POVZETEK

Zgodnje odkrivanje parkinsonove bolezni je pomembno za lajšanje simptomov pri bolnikih. Za prakso bi bile koristne nezahtevne, splošno uporabne avtomatizirane metode odkrivanja znakov bolezni. Ena možnost v tem pogledu je diagnosticiranje z avtomatsko analizo glasu osebe. V tem prispevku so opisani poskusi z učenjem diagnosticiranja parkinsonove bolezni iz zvočnih posnetkov glasu oseb v treh bazah podatkov, predvsem Sage Bionetworks. V poskusih ocenjena diagnostična točnost iz 10 sekundnega zvočnega posnetka je 80,7%.

Ključne besede

Strojno učenje, medicinske aplikacije, parkinsonova bolezen, diagnostika

1. UVOD

Parkinsonova bolezen je nevrodegenerativna bolezen, katere glavni simptomi so tremor v mirovanju, počasno začenjanje gibov, mišična rigidnost in tudi težave z govorom. Zgodnje odkrivanje parkinsonove bolezni je pomembno za lajšanje simptomov pri bolnikih. Za prakso bi bile koristne nezahtevne, splošno uporabne avtomatizirane metode odkrivanja znakov bolezni. Ena možnost v tem pogledu je avtomatska analiza glasu osebe, kot kažejo npr. raziskave M. Littla, A. Tsanasa in sodelavcev [2,3,7,8,9]. V njihovih raziskavah je šlo predvsem za daljinsko spremljanje poteka bolezni.

Nekatera izhodišča za pričujoče delo so opisana v [12]. V tem prispevku želimo z uporabo strojnega učenja razviti model za prepoznavanje znakov parkinsonove bolezni v glasu osebe, ki bi bil splošno uporaben kot mobilna aplikacija za zgodnje diagnosticiranje parkinsonove bolezni. Model je naučen iz primerov zvočnih posnetkov glasu »aaaa«, ki so jih bolniki in zdrave osebe posnele z elektronsko napravo. Te posnetke je potrebno analizirati in izračunati atribute, na osnovi katerih se učimo klasificirati posnetke. Rezultat klasifikacije govori o tem, ali kaže zvočni posnetek znake parkinsonove bolezni ali ne.

2. UPORABLJENI PODATKI

Za učenje učnega modela smo uporabili tri podatkovne zbirke. Dve podatkovni zbirki sta prosto dostopni na spletnem repozitoriju UCI Machine Learning Repository [1]. Tretjo podatkovno zbirko smo pridobili pri neprofitni organizaciji Sage Bionetworks. Baza je z ustrezno registracijo dostopna preko spletnega portala Synapse (<u>https://synapse.org</u>). Ivan Bratko Univ. of Ljubljana, Faculty of Computer and Info. Sc. Večna pot 113 1000 Ljubljana +386 1 4798278 bratko@fri.uni-lj.si

Podatkovne zbirke, ki smo jih uporabili, so objavili:

(1) Athanasios Tsanas in Max Little [2], ki sta s pomočjo desetih zdravstvenih ustanov in podjetjem Intel s pomočjo naprave za nadzor na daljavo (angl. telemonitoring) spremljala 42 oseb v obdobju šestih mesecev, ki so bile v zgodnji fazi PB. Vsaka oseba je posnela približno 200 zvočnih zapisov. V podatkovni zbirki so že izračunani atributi 5875 posnetkov. Vsak posnetek je predstavljen s 26 atributi. Celotna podatkovna zbirka obsega 890 KB.

(2) Max Little [3], ki je skupaj z Nacionalnim centrom za glas in govor (angl. National Centre for Voice and Speech) iz Denverja v Koloradu naredil raziskavo z 31 osebami, med katerimi jih je 23 imelo PB, drugih osem je predstavljalo kontrolno skupino. Vsaka oseba je posnela približno šest zvočnih zapisov. V podatkovni zbirki so že izračunani atributi 195 posnetkov. Vsak posnetek je predstavljen s 23 atributi. Celotna podatkovna zbirka obsega približno 40 KB.

(3) Sage Bionetworks [4], ki je sponzorirala raziskavo, pri kateri so sodelujoči naložili na svoj mobilni telefon aplikacijo mPower. S to aplikacijo so lahko opravili nekaj enostavnih testov (anketa, snemanje glasu, uporaba aplikacije med hojo, tapkanje in igra za testiranje spomina). Rezultati teh testov so se shranili na spletnem strežniku za poznejšo obdelavo in analizo. Izmed vseh teh informacj smo uporabili rezultate anket in posnetke glasu. Anketo je izpolnilo 6805 različnih oseb, od katerih je svoj glas posnelo 5826 različnih oseb. Sodelujoči so svoj glas lahko posneli večkrat, tako je v podatkovni zbirki 65022 zvočnih posnetkov, ki so dolgi 10 sekund in še nimajo izračunanih atributov. Število oseb, ki so izpolnile anketo in posnele svoj glas, je 4962. Izmed teh je 970 ljudi označilo, da imajo diagnosticirano parkinsonovo bolezen, drugih 3992 oseb pa ne. Ta podatkovna zbirka obsega 81.3 GB. Pri interpretaciji naših rezultatov je treba predpostaviti, da je tako pridobljena informacija o zdravstvenem stanju sodelujočih oseb dovolj zanesljiva.

3. POSKUSI

Poskuse smo izvajali v programskem jeziku Python. Pri implementaciji učnih algoritmov, kot so naključni gozdovi, metoda podpornih vektorjev in drugih, smo si pomagali s knjižnico Scikit-learn [5]. Za implementacijo nevronskih mrež smo uporabili knjižnici Keras [6] in CNTK (<u>https://www.microsoft.com/en-us/cognitive-toolkit/</u>). Pri preverjanju pravilnosti modela smo uporabili 10-kratno prečno preverjanje.

Za lažje nadaljnje delo smo vizualizirali nekatere anketne odgovore v bazi Sage Bionetworks. Tako smo dobili boljši

pregled nad podatki, ki smo jih uporabili. Pri tem smo opazili, da so ljudje s parkinsonovo boleznijo večkrat posneli svoj glas kot ljudje brez. V povprečju so osebe s parkinsonovo boleznijo 40 krat posnele svoj glas, medtem ko so zdrave osebe v povprečju posnele svoj glas šest krat. Med analizo anketnih odgovorov smo ugotovili tudi, da so nekatere osebe, ki nimajo diagnosticirane parkinsonove bolezni, prav tako navedle letnico, kdaj naj bi se jim pojavili prvi simptomi ali pa katerega leta naj bi bili diagnosticirani s parkinsonovo boleznijo. Posnetkov teh oseb v nadaljnji analizi nismo uporabili, saj jih nismo mogli obravnavati kot dovolj zanesljive. Prav tako v nadaljnjem delu nismo uporabili posnetkov oseb, ki nimajo parkinsonove bolezni, vendar imajo kakšno drugo bolezen. S tem se je zmanjšalo število primernih oseb za analizo v podatkovni zbirki pridobljeni preko spletnega portala Synapse na 2909.

Da bi lahko združili podatkovne zbirke v eno, smo morali uporabiti atribute izračunane z enakimi algoritmi. Zbirki, ki sta jih objavila Athanasios Tsanas in Max Little, sta že imeli izračunane atribute, vendar je bilo med temi atributi samo deset takšnih, ki so bili izračunani z enakimi algoritmi in katere lahko tudi sami izračunamo. Te atribute lahko izračunamo s pomočjo knjižnice Voice Analysis Toolbox, ki jo je izdal Athanasios Tsanas (https://people.maths.ox.ac.uk/tsanas/software.html), [7] [8] [9]. To knjižnico smo v prvem delu analize uporabili za izračun atributov zvočnih posnetkov, ki smo jih pridobili preko spletnega portala Synapse. Za izračun atributov smo uporabili samo prvi veljavni posnetek posamezne osebe. Za tako izbiro smo se odločili, da bi se izognili morebitnemu vplivu privajanja pri kasnejših posnetkih.

4. REZULTATI

Klasifikacijski model, induciran iz podatkov iz prvih dveh baz z originalno izračunaninimi atributi (Tsanas in Little), je imel klasifikacijsko točnost 99.5% [11]. Zaradi suma, da tak rezultat ne more biti realen, smo iskali razlago, kako bi lahko prišlo do tako visoke točnosti. Ena možnost je, da podatkovna množica ni bila dovolj uravnotežena glede na zastopanost obeh razredov v učni množici (posnetkov zdravih oseb je bilo manj kot 1%). Druga možnost je pristranskost, saj bi lahko učni model našel povezave med posnetki istih oseb, ki so bili v podatkovnih zbirkah, ki sta jih objavila Athanasios Tsanas in Max Little. Tako bi lahko klasifikator določal razred glede na to, ali gre za isto osebo, ne pa, ali gre za znake bolezni. Verjetna razlaga bi lahko bila tudi, da so bili podatki v teh dveh zbirkah drugače obdelani. Zaradi tega smo opustili ti dve podatkovni zbirki in se osredotočili samo na podatke iz portala Synapse. Z uporabo samo enega posnetka osebe in uravnoteženo množico je imel najboljši učni model klasifikacijsko točnost 67.8%. Ta klasifikator je bil naučen z metodo podpornih vektorjev. Ta rezultat je zanimiv tudi zato, ker kaže, kako zavajajoči so lahko rezultati učenja iz izrazito neuravnoteženih podatkovnih množic. V našem prvem poskusu [11] je bila točnost preko 99%, čeprav smo pri tem uporabili metode za avtomatsko uravnotežanje podatkov.

Klasifikacijske modele, naučene z atributi izračunanimi z uporabo knjižnice Voice Analysis Toolbox, smo želeli primerjati z drugimi modeli, ki bi se učili na večjem številu izračunanih atributov. V ta namen smo uporabili tudi knjižnico OpenSmile [10], s katero smo izračunali za vsak posnetek 6375 atributov. S to knjižnico smo lahko analizirali samo podatke pridobljene preko spletnega portala Synapse, saj smo le pri teh podatkih imeli na razpolago dejanske zvočne posnetke. Prav tako smo s to knjižnico analizirali le prve veljavne posnetke posamezne osebe.

Z uporabo istih zvočnih posnetkov, le da z atributi izračunanimi s knjižnico OpenSmile, je imel klasifikator, naučen z uporabo metode podpornih vektorjev klasifikacijsko točnost 77.9%. Na teh podatkih se je med vsemi najbolje odrezal klasifikator z uporabo ansambelske metode GradientBoostingClassifier, ki je dosegel klasifikacijsko točnost 80,7%. Ta rezultat je treba interpretirati z določeno mero previdnosti glede na to, da podatki v bazi Sage Bionetworks niso uravnoteženi glede na starost ob prisotnosti oz. neprisotnosti bolezni. V podatkovni bazi je namreč povprečna starost oseb z boleznijo bistveno višja kot pri zdravih osebah.

5. ZAKLJUČKI

Naša doslej dosežena točnost diagnosticiranja parkinsonove bolezni iz glasu (parkinsonova bolezen da/ne) je 80.7%. V nadaljevanju projekta nameravamo ta rezultat, dobljen s podatki iz Sage Bionetworks, preveriti glede na možen vpliv porazdelitve oseb po starosti odvisno od prisotnosti bolezni. Izvedli bomo tudi poskuse z neposrednim učenjem z globokimi nevronskimi mrežami iz zvočnega posnetka, brez računanja izpeljanih atributov iz posnetka.

6. ZAHVALA

Raziskava je bila delno financirana s strani Ministrstva RS za izobraževanje, znanost in šport (projekt EMZ) in Evropske unije iz Evropskega sklada za regionalni razvoj (ESRR) ter raziskovalnega programa ARRS Umetna inteligenca in inteligentni sistemi. Avtorja se zahvaljujeta Dejanu Georgijevu, Zvezdanu Pirtošku in Aleksandru Sadikovu za koristno diskusijo.

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Arhitektura sistema za oddaljeno spremljanje pacientov

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POVZETEK

V prispevku predstavimo arhitekturo sistema za oddaljeno spremljanje pacientov MyDataHub, ki nastaja v sklopu projekta EkoSmart. Sistem sestoji iz zaledne aplikacije, zgrajene na osnovi mikrostoritev, certifikatne agencije, kriptirane podatkovne baze, avtentikacijskega ter avtorizacijskega strežnika in mDH naprav, ki jih uporabljajo pacienti za zajem vitalnih znakov. Namen sistema je zagotavljati varno povezljivost med napravami mDH in ostalimi sistemi.

1. UVOD

V Evropi je prisoten trend staranja prebivalstva [1] ter naraščanja bolnikov s kroničnimi boleznimi [2]. Slednje predstavlja veliko družbeno in ekonomsko breme in kliče po inovativnih IKT rešitvah, ki bi razbremenile medicinsko osebje ter posledično zmanjšale čakalne vrste s pomočjo oddaljenega spremljanja pacientov. Kot odgovor na nastalo stanje se je na trgu že pojavilo veliko različnih rešitev (npr. OpenTeleHealth [3]). Med drugim tudi v sklopu projekta EkoSmart nastaja rešitev MyDataHub (mDH), ki bo omogočala oddaljeno spremljanje pacienta s poudarkom na zajemu vitalnih znakov z uporabo različnih merilnih naprav. V prispevku je predstavljena arhitektura sistema mDH in vmesniki. Pri zasnovi arhitekture je bil glavni poudarek na varovanju osebnih podatkov in zagotovitvi varnega kanala za prenos podatkov.

2. ARHITEKTURA mDH

Sistem mDH sestoji iz zaledne aplikacije, zgrajene na osnovi mikrostoritev, certifikatne agencije, kriptirane podatkovne baze in avtentikacijskega ter avtorizacijskega strežnika. Namen sistema je zagotavljati varno povezljivost med napravami mDH, ki jih uporabljajo pacienti za merjenje svojih vitalnih znakov, in ostalimi sistemi. Slednji zagotavljajo delovanje celostne zdravstvene storitve od začetka telemedicinske obravnave, tehničnega in zdravstvenega nadzora, do zaključka ali predaje naprave drugemu uporabniku. Za zunanje sisteme predstavlja mDH enotno točko za vso realnočasovno ali odloženo komunikacijo s pacienti ter za dostop do njihovih podatkov. Zaradi ustreznega zagotavljanja varnosti mDH vključuje lastno certifikatno agencijo in nabor štirih programskih vmesnikov, ki so ločeni glede na funkcionalne zahteve zunanjih sistemov. Vsakega od programskih vmesnikov in primerov zunanjih sistemov na kratko predstavimo v sledečih razdelkih (2.1, 2.2, 2.3 in 2.4).

2.1 Pacientov portal in aplikacije

Vmesnik /patient omogoča dostop do vseh podatkov vitalnih znakov, ki jih je pacient ustvaril s pomočjo naprav mDH. Preko portala jih lahko dopolni z dodatnimi kontestualnimi podatki, deli z drugimi ali omogoča dostop do njih svojim družinskim članom. V primerjavi z napravo mDH, so lahko na portalu na voljo naprednejše vizualizacije in morebitne avtomatske interpretacije meritev ali napredek.



Slika 1: Arhitektura integriranega sistema, ki omogoča komunikacijo z mobilnimi zdravstvenimi napravami pacientov in integracijo z zunanjimi sistemi z namenom zagotovitve celostnih zdravstvenih storitev.

2.2 Zdravstvena hrbtenica ali zdravniški portal

Povezava z zdravniškimi sistemi (vmesnik /health) je poleg naprav mDH eden ključnih za doseganje višje dodane vrednosti v okviru elektronskih in mobilnih storitev v zdravstvu. Integracija z zdravniškimi sistemi omogoča zdravnikom, da nadzorujejo svoje paciente, so o njihovem poslabšanem stanju avtomatsko obveščeni, preverjajo njihove podatke, neposredno komunicirajo z njimi in jim oddaljeno določajo zahteve po merjenju vitalnih znakov.

2.3 Upravljalski sistem

Preko vmesnika /manage je omogočeno celovito upravljanje z arhitekturo mDH. Upravljalski sistem definira storitve, ki zdravnikom in pacientom zakrijejo postopke vzpostavitve novih mDH naprav, reklamacij, menjav, beleženja aktivnosti, zagotavljanja sledljivosti in skalabilnost glede na predvidene potrebe. Preko vmesnika je možno mDH integrirati v obstoječi večji sistem in ga tako upravljati programsko. Prav tako je na voljo razvit upravljalski portal mDH, ki podpira osnovno delovanje in nadzor vseh storitev mDH.

2.4 Naprave mDH

Naprave mDH skrbijo za zajem podatkov iz senzorjev ali merilnikov vitalnih znakov in povezavo s sistemom mDH. Preko vmesnika /hub sta izpostavljena dva tipa storitev - HTTPS REST in WSS. Websocket povezava med napravo in sistemom je vzpostavljena ves čas, ko je hub povezan v Internet, saj tako omogoča oddaljen nadzor in pošiljanje novih zahtevkov ali neposredno avdio-video komunikacijo z zdravnikom. Preko te povezave hub tudi pošilja nove rezultate meritev, ki jih v primeru nepovezljivosti hrani do 30 dni in so poslane takoj ob vzpostavitvi povezave. Storitve tipa REST pa omogočajo vzpostavitev nove mDH naprave, pošiljanje večjih binarnih datotek (na primer EKG meritve) ali posodobitve programske opreme. Vsaka mDH naprava ima dodeljen lasten odjemalski certifikat, preko katerega lahko dostopa do vseh storitev. V primeru komprimitiranja naprave pa se lahko ta certifikat doda na črno listo in tako onemogoči vzpostavljanje povezave z mDH sistemom.

3. ZAKLJUČEK

V prihodnosti lahko pričakujemo porast sistemov in aplikacij, ki bodo omogočale zajem podatkov o našem zdravstvenem stanju ter podatke posredovale v zaledni sistem, kjer bodo na voljo zdravniku. Pri zasnovi arhitekture takega sistema je potrebno posebno pozornost nameniti zasebnosti in varnosti. V prispevku smo predstavili arhitekturo sistema mDH, ki nastaja v okviru projekta EkoSmart. Z mDH lahko pripomoremo k optimizaciji zdravstvene oskrbe in uspešnosti zdravljenja.

4. ZAHVALA

Raziskave/delo je delno sofinancirano s strani Ministrstva za izobraževanje, znanost in šport in Evropske unije iz Evropskega sklada za regionalni razvoj (ESRR).

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Razvoj zapestnice za pomoč starejšim

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POVZETEK

Razvoj zapestnice za pomoč starejšim narekuje uporabo najnovejših tehnologij in dognanj na področju umetne inteligence, da bi lahko zadovoljili želje in potrebe uporabnikov. Razvoj na področju elektronike in umetne inteligence omogoča izdelavo zapestnic, ki bodo omogočale samodejen klic na pomoč ob nevarnih situacijah. V tem delu so predstavljene ključne funkcije, ki jih zapestnica lahko nudi in kako te vplivajo na uporabnikovo izkušnjo. V drugem delu so predstavljene zahteve, ki so sestavljene na podlagi uporabniških izkušenj in mnenj strokovnjakov na tem področju.

Ključne besede

zdravje, starejši, zapestnica

1. UVOD

Trend staranja prebivalstva v razvitih državah narekuje iskanje novih rešitev tako na družbenem, socialnem, poslovnem ter finančnem, kot tudi na tehnološkem področju. Razvoj novih tehnologij omogoča izboljšanje kakovost življenja starejšim, vendar mora biti način implementacije prilagojen posebej njim.

Naprave namenjene starejšim morajo biti prilagojene njihovim željam, sposobnostim ter morajo reševati težave, ki jih imajo. Ena izmed glavnih težav starejše populacije je, da je kljub temu, da je velik del te populacije povsem sposoben samostojnega bivanja v svojem gospodinjstvu, prisiljen življenja v varovanih domovih, saj se bojijo, da jim v primeru ko bodo potrebovali pomoč, ta ne bo na voljo. Pri starostnikih, ki živijo sami v svojem gospodinjstvu je namreč verjetnost, da ob kritičnih situacijah ne bodo zmogli izvesti klica na pomoč večja kot pri ostali populaciji. Prav tako so lahko alarmantne spremembe v njihovem obnašanju, ki jih starostniki sam ne opazijo. Vse te težave so rešljive z uporabo sodobnih tehnologij.

Pri pregledu sorodnega dela, smo naleteli na nekaj rešitev [1, 2, 3, 4, 5], ki že nudijo funkcionalnost klica v sili, nekatere imajo tudi možnost lokalizacije in samodejne detekcije padcev, medtem ko nismo našli rešitve, ki bi obenem merila tudi uporabnikovo aktivnost. Pregledane naprave imajo različno dolgo življenjsko dobo baterije, ki se giblje od 36 ur pa vse do 30 dni. Oblika omogoča nošnjo v žepu, pripeto na pas ali kot verižico okrog vratu, nismo pa je našli v obliki zapestnice. V nadaljevanju so predstavljene funkcionalnosti in zahteve za razvoj zapestnice.

2. FUNKCIJE

Na podlagi zbranih mnenj strokovnjakov in uporabnikov, smo prišli do nabora funkcij, ki jih mora zapestnica omogočati. Te so: (1) zvočna komunikacija, (2) ročno proženje alarma, (3) detekcija padcev, (4) lokalizacija in (5) merjenje aktivnosti.

2.1 Zvočna komunikacija

Zapestnica omogoča zvočno komunikacijo med uporabnikom in klicnim centrom oz. drugo osebo, ki ji lahko v krizni situaciji nudi pomoč. Izbrana zvočna komunikacija je starejšim uporabnikom enostavna za uporabo (velika večina uporabnikov zna uporabljati vsaj stacionarni telefon) ter omogoča komunikacijo ne glede na namen vzpostavitve povezave. Prav tako je razlog za izbor v enostavnosti implementacije in majhnih zahtevah v hitrosti povezave, ki je potrebna med napravo in klicano napravo. Za enako izbiro so se odločili tudi vsi sorodni produkti, ki smo jih pregledali.



Slika 1: Govorna komunikacija.

2.2 Ročno proženje alarma

Razvita zapestnica mora omogočati klic v sili ob zahtevi uporabnika. Ta funkcionalnost omogoča klic na pomoč ob vsaki nevarni situaciji, kot je npr. slabost, nesreča, pomoč drugi osebi ipd. Tak pristop omogoča hiter klic na pomoč in omogoča hitrejše posredovanje pristojnih organizacij ali posameznikov. Čas med nesrečo in obvestilom nujne pomoči je namreč pri starejših v primerjavi z veščimi uporabniki sodobnih tehnologij lahko precej daljši. V nekaterih primerih pride celo do tega, da starejši ne zmore priti do mobilnega ali stacionarnega telefona, s katerim bi poklical na pomoč.

Z namestitvijo komunikacijske naprave na zapestje navide-

zno skrajšamo razdaljo med uporabnikom in potrebno pomočjo, saj se ta nahaja na uporabnikovem zapestju. Da bi zmanjšali število neželenih klicev, je potrebno gumb implementirati na pravem mestu, oziroma dodati več gumbov, ki šele ob hkratnemu pritisku sprožijo alarm.



Slika 2: Ročno proženje alarma.

2.3 Detekcija padcev

Detekcija padcev nadgrajuje pomanjkljivosti ročnega proženja alarma, saj obstaja možnost, da v primeru padca uporabnik ni sposoben aktivirati ročnega klica na pomoč. V takih primerih lahko zapestnica samodejno zazna padec ter samodejno pokliče na pomoč. S to funkcionalnostjo dodatno povečamo nabor morebitnih nevarnih dogodkov ob katerih zapestnica nudi pomoč uporabniku.





Trenutni sistemi zaznavajo padce s precej nizko točnostjo. V [6] poročajo o rezultatih realnih testov, v katerega je bilo vključenih 18 uporabnikov v obdobju 4 mesecev, pri čemer je bil kar v 8% zaznan padec, čeprav le tega ni bilo, dejanski padci pa so bili zaznani le v 25%. Ti podatki kažejo o velikem deležu napačno proženih alarmih, ki so lahko za uporabnika zelo moteči, ter o majhnem številu pravilno razpoznanih padcih, kar v realnosti nudi le malo pomoči uporabnikom.

Kljub temu je s hitrim razvojem umetne inteligence mogoče pričakovati, da bomo lahko ta problem boljše rešili že v bližnji prihodnosti [7]. Glavna težava je pridobitev zadostne količine podatkov o padcih, saj je njihova pojavitev redka, vendar je z velikim številom naprav in uporabnikov mogoče pridobiti zadosten vzorec padcev. Ti bodo služili kot učni in testni podatki na podlagi katerih bo v prihodnosti mogoče zgraditi algoritme za boljše zaznavanje padcev.

2.4 Lokalizacija

Pozicioniranje ali lokalizacija uporabnika je uporabna funkcija, ki močno poenostavi iskanje osebe v primeru kritičnih situacijah. Za enkrat sta predvideni dve funkcionalnosti v povezavi z lokalizacijo: (1) lociranje uporabnika ob klicu na pomoč in (2) lociranje uporabnika, ob izginotju ali nenavadni odsotnosti.



Slika 4: Globalna in lokalna lokalizacija.

Prva lokalizacija se proži ob ročnem ali avtomatskem klicu na pomoč, pri čemer klicanemu pošlje sporočilo s koordinatami uporabnika. Na ta način je mogoče locirati uporabnika, brez njegovega govornega opisa lokacije. To lahko bistveno skrajša čas za iskanje osebe v nevarnosti.

Druga funkcionalnost omogoča lociranje uporabnika, v kolikor se pojavi sum na izginotje, zaradi česar bi lahko bil uporabnik v nevarnosti. Najbolj ranljivi so predvsem dementni ljudje, saj lahko pride do tega, da zaidejo in se ne znajo vrniti v svoje bivalno okolje. Obe funkcionalnosti enostavno rešujeta precej težke situacije, ki so brez lokalizacije težko rešljive.

2.5 Merjenje aktivnosti

Spremembe v aktivnosti uporabnika lahko nakazujejo na zdravstvene težave, zaradi česar je potrebna pomoč uporabniku. Z meritvijo uporabnikove aktivnosti je mogoče zaznavati odklone od normalnih okvirov ter pravočasno ukrepati. Podatki o uporabnikovi aktivnosti lahko služijo tudi za oceno uporabnikove fizične pripravljenosti ter za svetovanje glede pravilne količine gibanja, ki je primerna za posameznega uporabnika.

V zadnjem času se je na trgu pojavilo veliko število zapestnic, ki omogočajo štetje števila korakov, merjenje spanca [8], merjenje aktivnosti [9] in podobno. Med raziskavo sorodnih naprav pa nismo naleteli na nobeno zapestnico, ki bi vsebovala zgoraj opisane funkcionalnosti in bi poleg tega nudila merjenje aktivnosti. Prav tako nismo našli zapestnice, ki bi omogočala ugotavljanje sprememb v gibanju.

Ob zaznavi odklona uporabnikove aktivnosti, je predvideno obveščanje skrbnika, ki lahko preko klicne povezave preveri ali osebno preveri, če je z varovancem vse v redu. Ta funkcionalnost omogoča zgodnje odkrivanje težav ter njihovo odpravljanje, kar lahko pripomore k hitrejšemu okrevanju. Poleg tega je mogoče zaznati tudi prevelike napore uporabnika, ob čemer se lahko uporabnika opozori ter vpraša če potrebuje pomoč pri opravilu, ki ga počne. Ta funkcionalnost omogoča personalizirano svetovanje uporabniku s čemer je mogoče na dolgi rok izboljšati zdravje in dobro počutje uporabnika.

3. ZAHTEVE

V tem poglavju so predstavljene zahteve, ki temeljijo na v prejšnjem poglavju opisanih funkcionalnostih. Glavne zahteve so razdeljene na tri podpoglavja in sicer: (1) območje delovanja, (2) enostavnost uporabe in (3) interakcija z uporabnikom.

3.1 Področje delovanja

V splošnem ločimo naprave, ki so namenjene lokalni (npr. varovani domovi) ali globalni uporabi. V primeru lokalne uporabe, sistem navadno potrebuje dodatno infrastrukturo, ki omogoča locirati uporabnika znotraj objekta. V primeru globalne uporabe je navadno uporabljena satelitska navigacija, ki omogoča lociranje kjerkoli na svetu, če naprava prejema signal z vsaj treh navigacijskih satelitov. V splošnem je globalna uporaba bolj primerna, saj uporabnika ne omejuje, da se giblje le v varovanem območju. Slabost satelitske navigacije je v tem, da ne deluje v zaprtih prostorih. V nasprotju z globalnim lociranjem, je slabost lokalnega lociranja omejitev območja varnega gibanja ter potreba po dodatni infrastrukturi, kar vpliva tudi na ceno sistema.

Mogoča je tudi kombinacija obeh tipov senzorjev. V primeru ko se oseba nahaja znotraj svojega bivalnega okolja, se to zazna z uporabo lokalne navigacije, medtem ko se osebo, ki je zunaj, locira z uporabo satelitske navigacije. Še vedno pa so problematični vsi ostali zaprti prostori, ki nimajo potrebne infrastrukture za lokalizacijo. V takšnih primerih celoten sistem sloni na verbalni komunikaciji med uporabnikom in klicnim centrom.

3.2 Enostavnost uporabe

Enostavnost uporabe je prilagojena starejšim uporabnikom z namenom, da je možnih nepravilnosti pri uporabi čim manj. Prva nepravilnost, ki jo želimo preprečiti je, da bi uporabnik pozabil nositi napravo. V tem primeru uporabnik morda ne bo mogel poklicati na pomoč, saj bo naprava preveč oddaljena od mesta, kjer se nahaja. Da bi zmanjšali možnost pozabljanja nošenja naprave, smo napravo predvideli kot zapestnico, ki se nosi na zapestju. Poleg tega mora ta omogočati več dnevno, več tedensko ali celo nekaj mesečno uporabo, brez da bi jo uporabnik moral polniti. Na ta način ima uporabnik manj možnosti, da pozabi napravo, saj jo le redko odstrani z zapestja. Da bi še dodatno zmanjšali potrebo po odstranitvi zapestnice, je potrebno to narediti vodoodporno, s čimer jo lahko uporabnik nosi tudi pri aktivnostih, ki vključujejo vodo.

Druga nepravilnost je nošenje zapestnice s praznim akumulatorjem. Tudi če smo rešili težavo z nošnjo zapestnice, je ta v primeru ko ima prazen akumulator, neuporabna. V ta namen mora zapestnica samodejno opozarjati uporabnika na stanje akumulatorja in potrebo po polnjenju. Zelo dobrodošlo je brezkontaktno polnjenje, ki zmanjša možnost nepravilnega polnjenja ter prenehanja delovanja. Poleg tega je uporabniku veliko bolj enostavno položiti napravo na brezžični polnilec, kot priključiti polnilni kabel. Ko se zapestnica napolni lahko uporabnika o tem obvesti ter ga s tem spomni, da si zapestnico ponovno nadene na roko.

3.3 Interakcija z uporabnikom

Interakcija uporabnika z napravo mora biti enostavna in hitra ter intuitivna za starejše uporabnike. Uporabljeni so lahko zvočni, svetlobni ali vibrirajoči efekti, ki uporabniku enoznačno nakažejo stanje naprave oziroma akcijo, ki se vrši. Prav tako je količina nepotrebnih elementov zmanjšana na najmanjšo možno vrednost, s čimer postane uporabniku bolj intuitivna in ga različne možnosti ne zmedejo. Zelo pomembno je, da zapestnica nudi hiter odziv ter pridobi uporabnikovo zaupanje, da bo v kritičnih situacijah pravilno delovala.

4. ZAKLJUČEK

Pri razvoju zapestnice za starejše je potrebno paziti na mnogo dejavnikov, ki lahko močno vplivajo na uporabnost in učinkovitost le te. Nekatere podatke za načrtovanje je mogoče pridobiti od uporabnikov samih, v pomoč pa pridejo tudi njihovi skrbniki, ki znajo bolj objektivno oceniti in ovrednotiti težave, ki jih imajo starejši.

5. ZAHVALE

Raziskava je bila izvedena v okviru projekta "Ekosistem Pametnega mesta (EkoSmart)" in je sofinancirana s strani Republike Slovenije in Ministrstva za izobraževanje, znanost in šport ter Evropske unije iz Evropskega sklada za regionalni razvoj (ESRR).

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Aplikacija tehnologije BLE za avtomatično zaznavanje prisotnosti oseb in predmetov

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POVZETEK

Vedno več je prenosnih elektronskih naprav, ki imajo v sebi vmesnik Bluetooth Low Energy (BLE). Te naprave je možno uporabiti za avtomatsko zaznavanje prisotnosti ljudi ali predmetov v prostorih, kar je uporabno za več aplikacij od poslovnih do osebnih. V prispevku prikažemo izkušnje pri uporabi tehnologije BLE v ta namen in nekaj možnosti uporabe te tehnologije.

Ključne besede

BLE, zaznavanje prisotnosti, zapestnice, pametne ure, spremljanje gibanja, senzorska omrežja

1. UVOD

Večina raznih informacijskih sistemov trenutno zaznava prisotnost oseb ali predmetov preko namenskih sistemov za avtomatsko identifikacijo ali preko ročnega vnosa prisotnosti. Večinoma se uporabljajo čipi ali kartice RFID.

S pojavom vedno več prenosnih naprav, ki imajo v sebi vmesnike Bluetooth Low Energy (BLE), je za identifikacijo možno uporabiti BLE naprave, ki jih nosijo ljudje ali predmeti na sebi [3]. Domet naprav BLE, padajoča cena in široka dosegljivost teh naprav še povečujejo možnost takih rešitev.

Za celovito uporabno rešitev za tako vrsto identifikacije je potrebno postaviti omrežje fiksnih senzorjev BLE, ki bodo zaznavali premične identifikatorje BLE in njihovo prisotnost javljali v nadzorni sistem. Tako rešitev lahko umestimo v več različnih področij, tako v poslovno kot v osebno uporabo: Pametni dom, Pametne zgradbe ali Pametne tovarne.



Slika 1. Shema celotnega sistema

V okviru projekta EkoSmart smo raziskali tehnologijo BLE za namen identifikacije oseb in predmetov, njeno uporabo in

zmožnosti integracije v razne rešitve ter postavili prototip sistema za avtomatično zaznavanje premičnih objektov v poslovnem okolju.

2. Sestavni deli rešitve

2.1 Prenosni identifikator BLE

Kot prenosni identifikator, ki označuje osebo ali predmet, smo uporabili različne prenosne naprave z vgrajeno tehnologijo BLE in sicer: a) osebna zapestnica za sledenje fizičnih aktivnosti XiaoMi MiBand, b) značka Chipolo BLE, in c) novejši pametni telefon Android. V poslovnem svetu je najbolj primerna naprava mobilni telefon z BLE. V privatni sferi pa je najbolj primerna zapestnica BLE ali pametna ura z vmesnikom BLE. Za označevanje predmetov pa je najbolj primerna značka Chipolo. Vse izbrane naprave delujejo na akumulatorsko baterijo, ki jo je potrebno občasno napolniti, eno polnjenje pa zadošća za uporabo od enega dneva (pametni telefon) do nekaj let (Chipolo), kar močno vpliva na uporabnost naprav.

2.2 Fiksno senzorsko omrežje BLE

Naloga fiksnih senzorjev BLE je zaznavati prisotnost naprav BLE in v nadzorni sistem javljati unikatne naslove MAC in časovne žige, ko je bila posamezna naprava BLE identificirana. Za namen prototipa smo senzor BLE vgradili v Špica Time&Space fiksni registrator Zone Touch.



Slika 2. Fiksni terminal Zone Touch z vgrajenim senzorjem BLE

Izbrali smo tak modul BLE, da se je lahko tehnično vklopil v napravo (USB vmesnik) s hkrati dovolj nizko ceno (velikosti 10 EUR). Prototipna naprava se v zaledni sistem povezuje preko vmesnika Ethernet. Naprava zaznava vse avtorizirane, prisotne in dostopne naprave BLE in v zaledni sistem javlja svojo identifikacijsko oznako, naslov MAC zaznane prenosne značke BLE in časovni žig. Naprava opravlja osnovno filtriranje, da zalednega sistema ne preobremenjuje s preveč podatki.

2.3 Baza podatkov

Podatki o prisotnosti objektov iz vseh senzorjev se morajo hraniti v centralni bazi podatkov. Za prototipne potrebe se podatki hranijo v posebni prototipni bazi podatkov, kjer je zabeležena identifikacija točke, kjer je bil objekt zaznan, naslov MAC zaznane značke BLE in časovni žig dogodka.

V eni od prototipnih postavitev na IBM Innovation centru v Ljubljani se ti podatki shranjujejo v IBM Bluemix platformi v oblaku.

3. Odkriti in odprti problemi

V okviru raziskav in izdelave prototipa smo odkrili nekaj težav, ki jih moramo v bodoče še nasloviti in poskušati najti primerne rešitve.

3.1 Kaj je dogodek?

V praksi se dogaja, da senzor BLE zazna časovno zelo kratko prisotnost značke BLE. Odločiti se je potrebno, ali lahko tako kratko prisotnost štejemo kot dogodek ali ne. Lahko da gre za nehoteno zaznavanje človeka, ki se je samo sprehodil mimo senzorja in ga niti ne bi bilo potrebno zaznati. Problem je možno reševati na več načinov: s časovnim filtriranjem, z nastavljanjem dometa senzorja BLE, s postavitvijo več sprejemnikov BLE, s pokrivanjem celotnega prostora z BLE ali s poslovnimi pravili[4].

3.2 Kakšna je smer gibanja predmeta?

Nekatere aplikacije zahtevajo določitev smeri gibanja predmeta. Pri kontroli pristopa ali registraciji delovnega časa je pomembno, ali gre zaposleni v prostor ali iz prostora. Podobno je pri sledenju logističnih enot. Tehnologija BLE sama po sebi ne zmore zaznati smeri gibanja in bi bilo potrebno smer določiti s pomočjo dveh točk BLE v prostoru in s pametno interpretacijo časovnih žigov pri zaznavanju značk BLE. Zaradi časovnih zakasnite in težke kontrole nad razdaljo zaznavanja značk BLE je metoda časovnih zakasnitev precej nezanesljiva za ugotavljanje smeri gibanja.

3.3 Sprejemljivost avtomatičnega zaznavanja oseb

Povečana skrb za zasebnost ljudi povzroča zadržanost oseb glede avtomatičnega sledenja njihove prisotnosti. Ljudje ne želijo biti avtomatično zaznavani, razen če od tega nimajo izrazitih koristi. Glavna korist, zaradi katere so se ljudje pripravljeni odreči delu zasebnosti, je varnost. Tehnologijo avtomatičnega zaznavanja oseb smo tako do sedaj uporabili le pri sledenju vhoda oseb v rudnik, ki je izrazito nevarno okolje. V tem primeru so se bili upravitelj rudnika in rudarji ter ostali zaposleni v jami pripravljeni odreči zasebnosti, pa še tu je prihajalo po odpora posameznih ljudi [5].

4. Možne aplikacije

4.1 Avtomatična registracija delovnega časa

Sistemi za registracijo delovnega časa večinoma delujejo preko izrecne prijave zaposlenih s pomočjo osebnih kartic RFID na razdaljo nekaj cm od čitalca RFID. V primeru pogostih prihodov in odhodov v službo ali pri prehajanju med različnimi kategorijami delovnega časa (različna stroškovna mesta) bi bilo zaposlenim precej bolj enostavno pripraviti avtomatično registracijo prehodov. Tako bi lahko delovni čas lahko precej bolj natančno razdelili med različen kategorije, na primer priprava na delo, hoja med prostori, delo v proizvodnji, odmor, delo v skladišču, administracija, delo na stroju A, delo na stroju B, delo na nalogi C itd. [6]

4.2 Kontrola pristopa

V primeru, ko so določena vrata v poslovnih prostorih zaprta in je prehod dovolj le avtoriziranim osebam, se ta vrata sedaj navadno odpirajo s pomočjo osebne kartice RFID, podobno kot pri registraciji delovnega časa. Identifikacijo pooblaščene osebe pred vrati bi s pomočjo sistema BLE zaznali avtomatsko in vrata avtomatsko odklenili.

4.3 Evidentiranje prisotnosti pošiljk

Ena od konkretnih možnosti uporabe je tudi v logistiki, kjer bi značke BLE namestili bodisi na vozičke, palete ali druge transportne enote, bodisi na same pošiljke ali artikle. Uporaba tehnologije BLE na pošiljkah ali artiklih je še predraga in zato neprimerna. Uporaba na vozičkih pa je že poslovno sprejemljiva, saj se z BLE označeni vozički uporabljajo večkrat oz. se vračajo k lastniku in gre za t.i. zaprt krog. [2]

4.4 Spremljanje gibanja doma

Starejši v domačem okolju bi uporabljali vsak svojo osebno zapestnico BLE, vsak prostor v njihovem domu bi bil opremljen z senzorjem BLE, skrbniki bi imeli vpogled v grobo gibanje svojih oskrbovalcev. Nadzorni sistem bi lahko avtomatično ugotavljal trende pri gibanju in sam alarmiral skrbnike v primeru sprememb v načinu bivanja in gibanja. [1]

5. Zahvala

Projekt EkoSmart, v okviru katerega so nastali opisani rezultati, je delno sofinanciran s strani Ministrstva za izobraževanje, znanost in šport. Naložbo sofinancirata Republika Slovenija in Evropska unija iz Evropskega sklada za regionalni razvoj.

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Technology for training and assessment of precise movements in persons with Parkinson's disease

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ABSTRACT

We have developed a system for training and assessment of precise movements with upper extremities. The system consists of mainly commercially available hardware components and is intended for home use or telerehabilitation in persons with Parkinson disease. Small range motion with upper extremity and movements with fingers were recorded with miniature 3D camera. The person was expected to collect virtual cubes within the virtual environment. The system was preliminarily tested in neurologically intact person and in patient with Parkinson's disease. The kinematics of the hand and fingers were analyzed offline and characteristic features were extracted to build the assessment procedure. The major objective of the project is targeted towards the development of novel instrument for the assessment that is closer to the existing validated clinical instrument (e.g. Box & Block Test).

Keywords

virtual reality, kinematics, upper extremity, Parkinson's disease, telerehabilitation

1. **INTRODUCTION**

Parkinson's disease (PD) is a slowly progressive degenerative disease of the extrapyramidal system [1]. The disease may affect people at the age between 35 and 60 years. Typically affects daily activities, participation and quality of life. The patients with PD are mainly subject to drug treatment and rarely receive comprehensive rehabilitation including physiotherapy and occupational therapy. There are also contradictory reports about the successfulness of physiotherapy [2].

However, in the forthcoming project we propose that intensified training of upper extremity skills and finger movements may increase the person's ability to focus on motor function [3] keeping the same or even decreased dose of the medicine. Telerehabilitation as a service may keep the person active and taking less medicine.

2. METHODOLOGY

The hand, palm and finger movements were tracked by small 3D camera (Leapmotion Inc, USA). The entire kinematics of the fingers and palm were used for calculation of the virtual hand in the designed virtual environment (Unity3D, Unity Technologies, CA, USA). We have designed a simple task, 10Cubes, where the person was asked to pick and place 10 virtual cubes in the virtual wooden chest. These cubes were randomly spread over the area, leaving the participants to choose their own strategy of putting all the 10 cubes in the chest within 2 min.

We have extracted the kinematics of the hand while moving in the free space and when grabbing the cube; the time of holding the

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cube, the pick & place time, the average time required for cube placement, number of unsuccessful trials and number of cubes successfully placed in the chest. Besides, the high-frequency and low amplitude hand movements in the random directions were observed and the tremor of the hand was estimated. Additionally validated clinical instrument Box & Block Test (BBT) was carried out.



Figure 1. 10Cubes, a 2D games, also convenient for home based physiotherapy or telerehabilitation.

The system was preliminary tested in one neurologically intact person and a person with PD in order to estimate the feasibility of the approach (Figure 1).

3. RESULTS

A real-life test demonstrated that the neurologically intact subject grabbed each cube and placed in the chest without failures, while the person with PD occasionally dropped the cube, grabbed it again or even misplaced the cube (Figure 2,). The healthy participant scored 62 and patient with PD only 42 with the BBT.

4. DISCUSSION

The preliminary tests were successful, demonstrating that major differences in kinematics and strategy exists between the healthy person and the person with PD. The person with PD was able to put all the 10 cubes in the chest only in his fifth attempt. During the task we recorded several unsuccessful trials like misplacement of the cube, cubes falling out of the hand, causing tremendous hand tremor and other measurable components supported by literature [5].

However, in the near future we plan a larger inpatient hospital trial with >20 patients with PD and 1-2 trial on patient's home. In these trials we plan to perform also clinical test [4] before and after the training tasks and record the medication plan.



Figure 2. Pick & place of 10cubes: each cube has its own color; left: healhty person, right: person with PD

5. ACKNOWLEDGMENTS

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Smart Dentistry and Smart Tooth Brushing

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ABSTRACT

In this paper, we describe some smart dentistry tools and applications developed in the scope of the EkoSmart project.

General Terms

Smart medicine

Keywords

Smart dentistry, smart tooth brush, serious games, kinect

1. INTRODUCTION

Latest advances in information, communication and health technologies triggered a paradigm shift in modern medicine – the transition to so called smart medicine. The predicted trends in dentistry like increasing digitization [1] show that key technology trends emerging in smart medicine like personalized and precision medicine, gamification based treatment, artificial intelligence, 3D printing, nanotechnology, robotics, Internet of things (IoT) and

semantic health records should also be integrated into future/smart dental care [2].

The bibliometric analysis performed with VOSviewer software (Leiden University, Netherlands) [3] of 2567 papers related to smart dentistry retrieved from the Scopus bibliographical database (Elsevier, Netherlands) using the search string *smart* or *personalized* or *precision* or *G4H* or *"artificial intelligence"* or *"3D print*"* or *nanotechnology* or *robotic** or *IoT* or *"semantic health record"* showed a fast growing trend in research endeavors. The research was mainly focused on the following themes:

- Smart materials and brackets
- Computer aided design and 3D printing
- Digital impression
- Smart dental implants, abutments and crowns
- Periodontal diseases and smart therapy

The analysis showed that smart dentistry in general is following smart medicine trends however there are substantial gaps especially concerning smart tooth brushing, gamification and use of artificial intelligence.

2. SMART TOOTH BRUSHING

The area of smart toothbrushes has recently had quite some technological leaps forward. In the frontier in the field of smart toothbrushes, Oral-B SmartSeries, has in 2016 allowed us to monitor the duration, location and pressure of brushing, using a smartphone, in 2017 the toothbrush Kolibree Ara has moved the measurement of mentioned physicalities to the toothbrush, in order to store and measure everything even in the absence of a smartphone. They capture the data using a 3D sensor, then they process the data using artificial intelligence. Onvi Prophix went even a step further, for around 400 USD (almost two times the price of other smart toothbrushes) they are offering a smart toothbrush with four different adaptors and an HD camera that is recording the brushing process using a phone app. Grush has an interesting solution that can be compared with ours. Using Intel's module, it captures data of this smart toothbrush, this data is than used to change brushing your teeth into a game.

All the toothbrushes mentioned before only measure the position and brushing time. Our toothbrush, however, also measures pressure and acceleration, and thus allows us to grade additional parameters for proper cleaning. The other major difference between the before mentioned smart toothbrushes and our solution is that all commercially available toothbrushes have an electrically driven head, while our toothbrush is conventional and therefore its use is more flexible and the price considerably lower.



Fig 1 Smart toothbrush prototype

The prototype toothbrush is shown in Fig.1 (without housing). In the Fig.2, the complete prototype with the 3D mobile application, demonstrating the movements of the toothbrush, are given.



Fig 2 Smart toothbrush prototype with the mobile application

The next prototype will be 3D-printed, the preparatory model is depicted in the Fig 3.



Fig 3 3D model prepared for 3D printing

The functionality and usability of the smart toothbrush can be further extended with a Kinect application. The main application functionality is the visual assistance for correct positioning of body, head and arm in the beginning of and during tooth brushing and together with data from the toothbrush to detect "anomalous movements" (Fig 4). The application supports finding correct starting position, provides appropriate relativisation of the perception of movement of the brush and head, and enables time synchronization of the smart toothbrush sensors with Kinect. The exchange of data is performed by Bluetooth connection, with time-coordinated recording of the body position and collection of toothbrush data.



Fig 4 The Kinect application (palm distance from the mouth - violet dot (full circle) means that the palm is positioned correctly in front of the head; the position of the palms in front of the mouth - a light green circle surrounding the mouth indicates the area in which the palm needs to be positioned (the violet dot must be within this circle); position of the wrist in front of the mouth - yellow section of the circle marks the right position of the wrist; the position of the arm - the green section of the circle indicates the right hand position; the position of the head and body; - a green circle section indicates the right position of the head and body)

2.1 Gamification

Serious games are games that aren't designed only for the sake of entertainment [4]. Serious games for health care can offer new and potentially highly effective paradigm for behaviour change, influence outcome and increase knowledge [5]. In paediatrics, serious games can be used for different purposes. Through interactive experiences, they can offer children: goals, challenges, problem solving, experience and intense moments that provide a high level of motivation [6]. Based on the positive experience in using games for health we developed a serious dentistry game which based on the outputs from our smart toothbrush configures the game playing platform and motivates children to brush their teeth regularly and in the correct way.



Fig 5 The initial scenario of a serious dental game

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Prototipi aplikacij za prenos mobilnih EKG meritev od uporabnika senzorja do zdravnika

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POVZETEK

Pri prenosu podatkov od pacienta do informacijskega sistema zdravstvene ustanove se soočamo z več izzivi. Lokalno shranjevanje podatkov meritev, kot je npr. zajem elektrokardiogramskega (EKG) signala z uporabo merilnika Savvy EKG, predstavlja namreč dodaten in dostikrat nepotreben korak. Takšno lokalno meritev je nato namreč potrebno prenesti do zdravstvenega osebja, da jo lahko obravnava. Z uporabo samodejnega shranjevanja meritev v pacientov zdravstveni karton (EHR) lahko takšen vmesni korak odstranimo in zdravstvenemu osebju poenostavimo dostop do pacientovih meritev. Z razvojem prototipa za zajem EKG meritev na Savvy EKG prenosnem merilniku in prenos surovih neprekinjenih meritev ter PDF poročil v Think!EHR platformo smo prikazali avtomatski in predvsem varen način prenašanja podatkov iz zunanjih sistemov v centralno platformo. Razvili smo model za shranjevanje EKG podatkov in Representational State Transfer Application Programming Interface (REST API) vmesnike za prenos podatkov. Z uporabo prototipa integracije prikaza surovih EKG podatkov pa lahko zdravnik na enostaven način išče podatke pacienta v zdravstvenem informacijskem sistemu.

KLJUČNE BESEDE

Integracija medicinskih naprav, EKG, Savvy, zdravstveni informacijski sistemi, REST API.

1. PROTOTIPI

Skupina partnerjev na tej nalogi, ki obsega Inštitut Jožef Stefan (IJS), Marand, SRC, Saving in Univerzitetni klinični center Ljubljana (UKC) ter Medicinsko fakulteto Univerze v Ljubljani (MF LJ), je pripravila skupino prototipov, ki skrbijo za dostopnost mobilnih elektrokardiogramskih (EKG) meritev, s tem ko jih samodejno prenašajo od pacienta do zdravnika.

V okviru raziskovalnega dela smo si zadali izdelavo naslednjih prototipov:

- prototip za shranjevanje surovih EKG podatkov in EKG poročil v Portable Document Format (PDF) obliki na Think!EHR platformi skupaj z vmesniki za shranjevanje in dostop do teh podatkov (Marand);
- razvoj podatkovnega modela za shranjevanje EKG podatkov: analiza in postavitev modela za shranjevanje EKG podatkov v oblikah S2 in PDF skupaj z metapodatki (Marand);

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- postavitev vmesnikov API za dostop in upravljanje z EKG podatki na Think!EHR platformi (Representational State Transfer Application Programming Interface – REST API), ki omogoča shranjevanje, branje in upravljanje z EKG podatki (Marand);
- prototip za zajem podatkov EKG meritev na Savvy EKG prenosnem merilniku in prenos surovih podatkov neprekinjenih meritev [1] ter PDF poročil v Think!EHR platformo [2] (IJS, Marand);
- prototip za prikaz PDF EKG poročil v zdravstvenih informacijskih sistemih ISOZ21 in BIRPIS21, pri čemer je vir podatkov Think!EHR platforma, kjer zdravstveni informacijski sistem poizveduje po poročilih za izbranega pacienta (SRC, Marand);
- prototip integracije prikaza surovih podatkov EKG meritev v zdravstvenem informacijskem sistemu., pri čemer zdravstveni informacijski sistem poišče surove EKG podatke pacienta prek centralne Think!EHR platforme in jih prikaže s pomočjo VisECG aplikacije (SRC, Marand, IJS).

2. PREGLED SORODNEGA DELA IN OBSTOJEČE PODOBNE REŠITVE

V zalednih zdravstvenih informacijskih sistemih že obstajajo določeni integracijski vmesniki, ki omogočajo komunikacijo z EKG sistemi. Prav tako obstajajo prenosni merilniki EKG za daljše časovno obdobje, kot je npr. Holter. Prednost predlagane rešitve je v tem, da omogoča povezavo med Savvy EKG merilnikom [3] in platformo za shranjevanje medicinskih podatkov Think!EHR [2], od koder so podatki lahko brezšivno integrirani z zalednimi zdravstvenimi sistemi, ki jih prikazujejo zdravstvenemu osebju na enoten način. Ker so meritve na voljo šele po njihovem zaključku, sistemu dodajamo tudi možnost aktivne udeležbe pacienta. Slednji lahko med meritvijo doda komentar svojega počutja ali opombo o zaznani nepravilnosti v delovanju srca. Sistem za komentar avtomatsko ustvari poročilo s kopijo dela EKG signala v časovnem intervalu nekaj minut pred in po pacientovem komentarju. To poročilo tudi takoj posreduje v Think!EHR platformo, od koder je v skoraj realnem času na voljo zdravniškemu osebiu.

3. OPIS PROTOTIPOV

Izdelani prototipi so namenjeni zdravnikom in njihovim pacientom, ki potrebujejo spremljanje EKG izven okolja zdravstvenih ustanov. Savvy EKG je prenosni medicinski pripomoček za trajno in natančno spremljanje srčnega ritma ter opredelitev morebitnih odstopanj od normalnega [3]. Razvit je bil v sodelovanju z raziskovalno-razvojno skupino Laboratorija za vzporedne in porazdeljene sisteme, Odseka za komunikacijske sisteme na Institutu Jožef Stefan. Ustreza evropskim zdravstvenim standardom. Ima certifikat CE za celovito zasnovo in za vse sestavne dele. Savvy je preprost za uporabo. Zaradi brezžičnega delovanja, majhnosti in uporabljenih materialov je nemoteč tudi med delom, gibanjem in športom.

S prototipom za zajem EKG meritev na Savvy EKG prenosnem merilniku in prenos surovih neprekinjenih meritev ter PDF poročil v Think!EHR platformo smo vzpostavili pomembno transportno pot za EKG meritve. Do sedaj so se meritve, pridobljene iz Savvy EKG merilnika, shranjevale na pacientovem mobilnem telefonu ali računalniku in niso imele ustaljene poti do zdravniškega osebja, ki bi bilo usposobljeno za njihovo pregledovanje in obdelavo. Prototip predstavlja izboljšavo v tem, da omogoča enostavno in sprotno prenašanje zajetih meritev do cilinega zdravniškega osebia. Odvisno od okolia, v katerem se Savvy EKG uporablja, lahko pacient, njegov skrbnik, ali pa medicinsko osebje poveže pacientovo mobilno napravo, ki sprejema podatke iz EKG merilnika, prek internetne povezave v pacientov elektronski zdravstveni karton (EHR). Ko je povezava vzpostavliena, meritve samodeino shranimo v elektronski zdravstveni karton. Na pacientovo željo (npr. ko se ne počuti najbolje oziroma kako zazna nepravilno bitje srca ali kako drugo motnjo v počutju) sistem izdela tudi avtomatsko poročilo s kratkim, vendar detajlnim izsekom meritve in ga shrani v elektronski zdravstveni karton.

Prototip za shranjevanje surovih EKG podatkov in EKG poročil v PDF obliki na Think!EHR platformi omogoča skupaj z vmesniki za shranjevanje in dostop do teh podatkov shranjevanje podatkov EKG meritev zajetih s Savvy EKG merilnikom. V ta namen smo razvili podatkovni model za shranjevanje EKG podatkov. Analizirali in postavili smo model za shranjevanje EKG podatkov v S2 in PDF obliki skupaj z metapodatki in definirali predlogo (angl. *template*) za EKG, ki vsebuje in strukturira podatke, ki jih dobimo s samega aparata. Predloga bo uporabna tudi za EKG meritve iz drugih virov in jo je mogoče razširiti z dodatnimi podatki, ki jih želijo spremljati in jih bodo definirali zdravniki. Postavljen je bil vmesnik REST API za dostop in upravljanje z EKG podatki na Think!EHR platformi in dodaten vmesnik REST API vmesnik za njihovo shranjevanje, branje in upravljanje. Na ta način omogočajo definirani vmesniki za dostop do teh podatkov enoten, vendar prilagodljiv način za shranjevanje in dostop do teh podatkov.

Prototip za prikaz PDF EKG poročil v zdravstvenih informacijskih sistemih povezuje Think!EHR platformo, ki shranjuje EKG zapise z zdravstvenima informacijskima sistemoma ISOZ21 in BIRPIS21. Zdravstveni informacijski sistem pridobi zapise EKG poročila pacienta iz Think!EHR platforme s pomočjo poizvedbe in ga prikaže v sami aplikaciji. Na ta način ima zdravnik dostop do podatkov EKG v svoji delovni aplikaciji, ki jo že uporablja, zato učenje uporabe nove programske opreme ni potrebno.

Prototip integracije prikaza surovih EKG podatkov v zdravstvenem informacijskem sistemu omogoča, da zdravnik na enostaven način poišče surove EKG podatke pacienta, ki so shranjeni v Think!EHR, ti pa se prikažejo s pomočjo zunanjega prikazovalnika VisECG [3]. Prikazovalnik VisECG je prilagojen za prikaz meritev izmerjenih na Savvy ECG, ki so časovno neomejene (v praksi so navadno dolge med nekaj ur do enega tedna) in niso primerne za obstoječe komercialno dostopne prikazovalnike. Prikazovalnik podpira tudi prikaz dogodkov, ki jih določi pacient ob boku EKG signal, tj. povezavo med prikazanim EKG signalom in EKG poročilom, ki je prav tako dostopno na Think!EHR platformi.

Z razvojem prototipom smo pokazali, da je zadan cilj avtomatskega prenosa EKG podatkov z merilne naprave v zdravstveni informacijski sistem, ki ga zdravniško osebje že uporablja, zelo smiseln in povsem izvedljiv.

4. ZAHVALA

Prispevek je nastal v okviru raziskovalnega dela na projektu EkoSMART [4], ki ga sofinancirata Republika Slovenija in Evropska unija iz Evropskega sklada za regionalni razvoj.

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Particle Accelerators as Medical Devices

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Abstract

Particle accelerators have many applications; one of these that is gaining popularity is their use in medicine for cancer therapy. Proton and Carbon Ion therapy machines are used to accelerate a beam of particles and to deliver it very accurately into the tumor area. This kind of treatment is called Proton, Ion or simply Particle Therapy, and it presents several advantages over classic radiotherapy.

The accelerator machines involved in particle therapy are fairly modest either in power and complexity; yet the distance between the lab and the hospital is great – especially in paper work. One of the tasks that need to be fulfilled is to demonstrate that the machine is safe and effective, as required by the standards and regulations. The purpose of this article is to present a starting point for understanding what it takes to make a Particle Therapy Machine that is compliant with regulations.

1. Medical Devices

A particle accelerator, though complicated by itself, it is not enough to conduct ion therapy on patients, and it cannot be considered a "medical device". Why? Because an accelerator is a machine that generates raw beam, without means of controlling or quantifying dose and position, and from a medical perspective is useless and even dangerous. The system that we call a "Particle Therapy Machine" is composed of different subsystems; in general: one to generate the beam, one to carry and direct it to the treatment area (for example, beamline and gantry), one to measure and control its delivery (dose delivery/scanning), one to accurately position the patient (robot and X-ray imaging), one to control the operation and execution of the treatment (treatment control system), and various systems for control and safety. They altogether constitute a "medical device", as such it will have to be approved prior to its placement on the market. It is clear, for example, that it does not make sense to market a power supply magnet or a "dose control system" alone as medical devices since they do not have an intended use in

medical treatment. And even if its purpose as a component of a therapy machine is undeniable, as in the case of a dose delivery system, it is not possible to judge its safety or effectiveness without knowing the properties of the remaining components of the system. Nonetheless, quite often manufacturers of components and parts for medical accelerators deliver products that are "certification ready", meaning that the component meets all applicable standards and regulations and that all necessary documentation is provided to the manufacturer of the Particle Therapy Machine.

2. Safety and Effectiveness

There are two distinct and equally important aspects of medical devices that every medical device needs to fulfill:

- 1. It must be safe.
- 2. It must be effective.

It's easy to understand why a Particle Therapy system needs to be safe: it is of no use to have a machine that cures cancer, while it is very likely to injure a patient every once in a while. At the same time, it is important for it to be effective, i.e. it is capable of fulfilling its medical purpose. Again, a system that it is safe but it does not do what it is supposed to do is useless. Imagine a wheelchair (also a medical device, though a simple one) that is tightly screwed to the floor: it may be as safe as it gets, but it does not allow the patient to move around, as it is supposed to.

That is why the laws regulating the market of medical devices take care of these two aspects. These are addressed in different ways. The manufacturer must demonstrate that his device is safe and effective, as required by the country where the device is to be sold. To prove safety, a lot of documentation must be provided: extensive test reports, detailed design documents, compliance with applicable standards, and so forth. In contrast, effectiveness is proven either by doing clinical trials and investigations involving animals or humans, or by claiming that the device in question is similar to other devices already being used, and demonstrating it by pointing to scientific articles or other literature.

3. Medical requirements

The regulatory requirements that a medical device or component needs to fulfil are different from country to country, but quite often they end up being quite similar, since it is common that countries around the world recognize the use of international standards in their essence as a valid (and often necessary) mechanism to comply with their (local) regulations. All components of a Particle Therapy Machine can be very different in operation and purpose. Some come into contact with the patient or are installed within the treatment area, some not. Some are mechanical and have moving parts, others can be only electrical control and processing units. Some use high power or voltage, others not. Some contain or consist of software, some are fully analog or discretely digital. And the list goes on. There are lots of different regulatory requirements whose applicability depends on all these factors. But there are general things that are required for all "medical components". Regardless of the above mentioned technical factors, a Quality Management System (such as [1]) must be established, a Risk Management (as [2]) process must be defined and executed, and the safety and effectiveness of the component must be proven.

4. Industrial requirements

Do all the subsystems or components of a Particle Therapy Machine need to be designed and manufactured according to the regulatory requirements for medical devices, or is there any possible exceptions? This is an important question, since devices that follow these are much more expensive than ordinary industrial stuff. The rule is that some of the components or subsystems may not need to comply with the applicable medical standards, as soon as it is possible to demonstrate that their malfunction can never lead to an unacceptable risk, for the patient and for other people involved. Even in cases where one of the subsystems is inherently critical to the safety or the essential performance of the whole system, it is possible to mitigate the potential risk by implementing alternative safety measures. The logic behind this approach is that we cannot really trust industrial ("non-medical") devices since they were not designed and manufactured following quality processes required by medical standards, therefore it is assumed that they can contain bugs or can fail at any time. The mechanism to assess the initial risk

and the suitability of the chosen risk mitigation measures is the Risk Management, usually at the system level.

A common example from the Particle Therapy industry is to build the beam generation subsystem (the particle accelerator itself) as an industrial device, and then to include in the system safety components (built as medical devices) that constantly monitor the beam parameters such as energy, current and position, and shutoff the beam if any of these is out of tolerance. This strategy may help to save resources, but not always, since some complex industrial subsystems require safety measures sometimes so complex, that it is necessary to build a whole redundant instance of the original system, and this only to monitor the behavior of the original component. As an example, let's imagine an ion therapy system in which, besides the particle accelerator, the system that measures and controls the delivery of the dose to the patient is also a nonmedical device. In that case, the only possible way to mitigate the risk of patient overdose due to a failure would be to have an additional medical component that measures and monitors the delivered beam. Such redundancy would be unnecessary.

That is why we recommend writing the medical compliance strategy very early in the design process. (For those of you more interested in this aspect, I recommend taking a look at the standard IEC 60601-1, section 16, and the informative Annex I).

5. Medical Software and Verification & Validation

Today, every relatively complex medical device contains at least some software. We all know that software is special, very different in nature and behavior to hardware. Even digital hardware systems composed of discrete logic are not comparable to software. The two main reasons for this are the complexity of software, with its enormous number of possible internal states, and the usual software development workflow itself, which is in practice more organic and less constrained than hardware design. The first factor determines that it is practically impossible to test a software module in all its internal states, leaving a room for latent bugs. The second factor also influences reliability, because since the nature of software allows for quick changes or last-minute fixes (that can go unnoticed), there is always a temptation to do it without the necessary care and to inadvertently introduce bugs.

If these two aspects are not addressed properly, software cannot be considered reliable enough for

medical devices, especially when there is a risk to people associated with it. That's way the regulations and standards for medical devices take special care of software: to ensure that, although the possibility of bugs cannot be totally eliminated, their probability can be reduced and its associated risk mitigated; with good processes, proper testing, risk management and validation. There is an international standard that deals with this: "IEC62304: Medical device software -- Software life cycle processes."

But software cannot exist without the associated hardware, and its proper operation in the context of the whole machine cannot be judged without testing them together. Yet, in a system that is as complex as a Particle Therapy Machine, there are many different subsystems or components that may contain software, and it is impractical or impossible to execute the full set of tests for every software module, all integrated and operating in the final machine. That is why this is never done in that way, and there is always a strategy to hierarchize and segregate testing into different levels, according to the system level architecture and the "V-model" (Figure 1), in order to make testing effective and practicable. This is the purpose of the set of activities usually referred to as "Verification and Validation": to Verify, at different system levels, that the build system works as specified, and to Validate that it is capable of fulfilling its intended purpose. More about verification and validation of Programmable Electrical Medical Systems can be found in the standard IEC60601-1, section 14, and informative annex H.



Figure 1: V-model

6. Purpose of Processes and Standards

Sometimes I hear, mostly amongst engineers and physicists, arguments about whether following the standards, regulations and processes can really enhance safety and effectiveness, or is it just a "placebo" to create an appearance of safety, which somehow relieves the engineering conscience from the responsibility of thinking. The argument is valid and it has to be taken seriously. I find that for some people, for example, passing a list of tests automatically means that the device has no bugs, or that the relentless application of risk management can give you a 0-1 type of indication about the degree of safety of a device. As a consequence of the previous misconceptions, there are people that do what is called "safety by paperwork", which means tweaking the documentation and doing 'assessments' until it is proven that the device is safe enough to meet the regulations. It is always possible to fool the system, and it is not in the scope of quality systems, processes and technical requirements to completely avoid it. Yet, what standards and regulations do over anything else is to establish clear responsibilities and minimum requirements, so when things go wrong - no one can say "I didn't know".

On the other hand, it is important to understand that a good process helps you to keep organized through the development lifecycle. When projects are late or about to go over budget, there is a natural temptation to rush and skip steps. This may appear to save some time, but can also lead to dangerous mistakes. Having a well-established process naturally helps to resist the temptation. Furthermore, processes define what steps to take if there is an unexpected problem. And if the processes are wisely designed, they not only enhance safety but even make the development more efficient by keeping pace, consistency and making sure that no aspect or requirement is left neglected.

7. Conclusion

Building a Particle Therapy system is a technical challenge by itself. To make it compliant with standards and regulations it is yet another challenge, which is sometimes underestimated. Our experience shows that it is best to start designing the medical compliance strategy together with the machine itself and to already have solid processes established when the development and implementation start. Smart processes not only help to design a safe device and get through compliance; they may also increase productivity and decrease the uncertainties and defects, which may be, at the end of the day, the differentiators for staying in the game.

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 ISO 13485:2003: Medical devices -- Quality management systems -- Requirements for regulatory purposes (https://www.iso.org/standard/36786.html)
 ISO 14971:2000: Medical devices -- Application of risk management to medical devices (https://www.iso.org/standard/31550.html)

MOBILNO SPREMLJANJE OKOLJSKIH DEJAVNIKOV IN NJIHOVEGA VPLIVA NA ZDRAVJE

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1. UVOD

V projektu EkoSmart, ki je sofinanciran s strani Ministrstva za izobraževanje, znanost in šport ter Evropskega sklada za regionalni razvoj, bomo v razvojnem centru Nela razvili inteligentni sistem za spremljanje okoljskih dejavnikov. Zavedamo se, da danes povprečni človek preživi približno 80-90% svojega časa v notranjih prostorih, kjer pa kakovost zraka ni vedno ustrezna. Zato je z vidika ohranjanja udobja in zdravja človeka, ključnega pomena spremljanje okoljskih parametrov, katere lahko z enostavnimi ukrepi tudi ustrezno obvladujemo. Cenovno dostopni senzorji in mobilna aplikacija, bodo predstavljali dve ključni komponenti inteligentnega sistema za monitoring okoljskih parametrov. Ključna inovativnost projekta – avtomatska regulacije okoljskih pogojev v prostoru, pa bo še dodatno pripomogla k obvladovanju in vzpostavitvi idealnih okoljskih pogojev za bivanje.

2. SENZORIKA

Kot ključne parametre, ki lahko vplivajo na človekovo počutje in zdravje, smo določili temperaturo zraka, relativno vlago, hitrost zraka, osvetljenost, koncentracija CO₂, koncentracija VOC (nevarne organske spojine v zraku), radon. Na podlagi definiranih tehničnih karakteristik smo izvedli testiranja senzorjev različnih proizvajalcev, ki so dostopni na trgu.

Tabela 1: Tehnične karaketristike izbranih senzorjev

Izbor senzorjev je temeljil na podlagi rezultatov izvedenih laboratorijskih testiranj, izvedenih na podlagi tehničnih protokolov, skladnih s standardom ISO 17025. Ustreznost delovanja senzorja smo spremljali predvsem z vidika ustrezne točnosti in stabilnosti. Za pripravo končnih poročil z rezultati o izvedenih meritvah smo uporabili inovativni laboratorijski informacijski sistem.

Tekom projekt smo testirali tudi delovanje različnih načinov komunikacije za posamezne senzorje in sicer I2C, Modbus, RS 485, RS 232, wi-fi, analogno odčitavanje Pt100/Pt1000, 0-10V, 4-20mA, s spremljanjem dometa pri različnih okoljskih obremenitvah. Rezultati testiranj so pokazali, da je Modbus še vedno najbolj stabilen princip komunikacije.

3. MOBILNA APLIKACIJA

Mobilna aplikacija bo pri uporabniku predstavljala enega izmed ključnih izbirnih parametrov. Zato smo tekom razvoja, prilagajanja in nadgradnje sistema, poleg zahtevanih tehničnih karakteristik, upoštevali tudi enostavno in logično infografiko, ki bo uporabniku na atraktiven način predstavila le ključne informacije. Spodaj so podani primeri izbora grafičnih elementov

Parameter, veličina	Merilno območje	Odčitavanje	Točnost
Temperatura	od -20 °C do 60 °C	0,1 °C	0,2 °C
Relativna vlaga	od 0 % do 100 %	1%	2,5 %
Zračni tlak	od 500 mbar do 1150 mbar	1 mbar	2 mbar
Osvetljenost	do 100.000 lux	0,25 lux	
Nivo CO ₂	do 10.000 ppm (vol)	20 ppm 1 %	30 ppm
			5%
Nivo VOC	450 ppm - 65.000 ppm (equiv.)	1 ppm	
Hitrost zraka	0 do 2 m/s	0,001m/s	0,001 m/s
Senzor odprtih vrat	Odprto/zaprto	1/0	/
Radon	0.1 ~ 99.99 pCi/l	0.5cpm/pCi/l	< 10%



Kot ključne lastnosti mobilne aplikacije smo opredelili: izpis online meritev in pregled zgodovine, izpis min/max/povprečne vrednosti, drevesna struktura (pregled po lokacijah), alarm (sms, e-mail), izdelava poročil, modularna izvedba.

Z definiranjem koncepta povezovanja database – service - client ter z nadgradnjo MS SQL serverja smo vzpostavili ustrezno okolje za beleženje, shranjevanje in obdelovanje podatkov izmerjenih vrednosti. Prikaz on-line meritev, ki je prikazana na spodnji sliki, uporabniku omogoča vpogled trenutnih vrednosti.





4. ZAKLJUČEK

Nadaljnji razvoj bo temeljil predvsem na razvoju sistema za pregled zgodovine meritev, izpisu poročil, alarmiranja in načinu uporabniškega dostopa. Poleg tega se bomo osredotočili na procese, ki bodo predstavljali korak k doseganju avtomatske regulacije okoljskih pogojev.

ZAHVALA

Delo je nastalo v okviru programa EKOSMART.

Application for Viral Hepatitis Infection Risk Assessment

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ABSTRACT

Globally, an estimated 330 million people are chronically infected with hepatitis viruses. With the aim to provide information on the risks for acquiring infection and educate on its signs and symptoms, a web application was developed for raising awareness in general as well as high-risk populations. The website contains a questionnaire and informational web pages, with the main focus to help the users disclose their potential exposures to viral hepatitis infection during their past life and brings about prevention measures to avoid it in the future. Thus the application serves as an educational as well as a preventative tool, helping the users learn more about the dangers and causes of viral hepatitis infections and, in case of exposure, refer to proper medical services. It uses a robust system that provides anonymity and also delivers the content to the user in a responsive manner.

Keywords

Viral hepatitis, infection, web application, questionnaire, diagnosis, risk level assessment, informative, sexually transmitted infections

1. INTRODUCTION

Hepatitis is an inflammation of the liver tissue as a result of infectious or noninfectious causes. In more than half of the cases it is caused by hepatitis viruses that have currently been estimated to affect 330 million of people worldwide [1]. Viral hepatitis is caused by one of the five hepatitis viruses: hepatitis A virus (HAV), hepatitis B virus (HBV), hepatitis C virus (HCV), hepatitis D virus (HDV) and hepatitis E virus (HEV) [2]. It is estimated that less than 1% of the population in Slovenia is infected with HBV and around 0.4% with HCV [3]. Infections by HBV, HCV and HDV can be transmitted by infected blood, sexual intercourse or from mother to child, whereas HAV and HEV are mainly transmitted by contaminated food or water. Viral hepatitis may be present as an acute or a chronic disease. Infection with each of the five hepatitis viruses can result in acute disease which can be symptomless or presents with symptoms of nausea, fatigue, abdominal pain and jaundice [4]. The natural course of acute HBV and HCV infection can lead to a chronic one. Due to common lack of signs and symptoms, patients with chronic viral hepatitis infection are the main source of spreading the disease, mostly by risk behavior. Furthermore, chronic HBV and HCV infection may lead to develop cirrhosis and hepatocellular carcinoma which can lead to liver failure and death [2]. The main problem with hepatitis virus infections is that the patients typically do not exhibit symptoms until the disease has already developed to an advanced stage, at which point it becomes difficult to treat. The problematic element of this is that a symptomless infected person can also transmit the virus to other people. Since it is possible to successfully treat or at least manage patients with viral hepatitis infections, it is important to identify the infected individuals as soon as possible and act accordingly. People often seek medical information online, therefore it is important that all relevant information is available in a centralized location. Here, we present a web application that aims to educate users about viral hepatitis infections and to assess possible risks of infection. The application is a follow-up of an application to educate about and assess risks for sexually transmitted infections ASPO [5], built on an improved platform with modified goals. We discuss the implementation and the functionality.

2. PROCESS/METHODOLOGY

Creating a website that provides medical information requires use of scientifically proven facts to build user's trust. Website design and transparency of the developers also play an important contribution in this aspect. Therefore, the site has been built from the bottom up with external libraries that don't collect any user information. To address transparency, the project description and information is accessible on the main site, with references to the individuals that have helped build it. The users can immediately recognize that the site was also officially endorsed by reputable sources by seeing logos accompanying the main site. The other part of the initial design is that the site had to be simple and clearly indicate from the very start what it is offering. Server-side logic is managed by Django [6], a python based web framework. Another part of achieving user trust is that the site cannot track or use any data that the user has provided, either voluntarily or involuntarily (e.g. recording IP address, cookies, tracking data). As a result, the site does not use any cookies and only stores information from the questionnaire if the user has agreed to it (for the purpose of potential statistical analysis in future).

2.1 ETHICAL CONCERNS

When building the question base, we had to make sure to include questions that would include an informative narrative, but also would not capture any of the personal information which could be used to identify the user. Even though we don't need or use any user data, we believe they could still be useful for statistical and health studies. We've decided to implement a simple solution, to put a question at the end of the questionnaire which would ask for the user's permission to anonymously use the answers they have provided through solving the questionnaire. This required to change our database logic a bit since we thought it would be best if this particular question would append to a questionnaire, as opposed to it just being treated like another question. The only elements that are stored in the actual database are a unique user id (which only translates to the sequence of the users as they've taken the questionnaire) and their recorded answers.

2.2 SAFETY/ANONIMITY

It is important that the users feel secure while using the website, since many of the questions tackle sensitive personal information. As the site does not use any cookies, none of the user information is stored locally. The website also uses a secure connection (HTTPS) to the server to make sure that all of the traffic is encrypted. The end answers are stored on a server without any identifiable information where only authorized personnel have actual access to the physical machine.

3. SYSTEM

3.1 TECHNICAL CONSIDERATIONS

When we began building the new system we had to consider if it would be wise to keep the old code base from a previous project, ASPO [5]. Due to differences, this project would require a completely different approach and we had to warrant different needs that this project will inevitably require. We had ultimately decided to keep the frontend largely the same and to focus on addressing the issue of too many connections crashing the server.

We were also dealing with a different rule set for questions, now the questions had to display a comment depending on the answer that the user had picked. There is a possibility of multiple comments on the same question as well as different answers leading to the same comment. An additional problem arose as we had to change the functioning algorithm of displaying the questions in the first place.

Finally, instead of a generic screen at the end which would only tell you an arbitrary risk level, the new website outlines everything you have clicked and presents a list of behavior (based on your answers) that could be considered promiscuous or risky. We approached this problem by scratching everything we had done for the original project and focused on building a new system with these new requirements.

3.2 FRONTEND

The frontend consists of a Bootstrap CSS [7] base which is mainly used for its ability to work on different devices while maintaining its integrity. The interactive part of the website (questionnaire, switching menus, loading subpages) is built primarily using AngularJS [8], which serves and loads the files as they are requested. The questionnaire itself is transferred once when it is started and the rest is taken care of by AngularJS, which properly switches between questions and comments. This way, even if the user disconnects in between, the questions and their answers are temporarily stored in the scope variable. When the questionnaire is finished, the user locally receives the response and only in the case if they have agreed to store anonymous answers into the database, the connection to the server is established again. The response consists of summarized comments that have appeared through the questionnaire, relating to possible exposures to an infection. If the user had any risk factors, the background is colored orange or green (risk factors might include not being vaccinated, travelling to different

countries without proper precautions, eating uncooked food, piercings, etc.). The page includes several menus, each being divided into multiple submenus, based on context. Each page is accompanied by a static background.



Figure 1 Screenshot of the webpage

3.3 BACKEND

The majority of the work was done on the backend of the application. We looked at a few different possible web frameworks that could have been used, but ultimately, we've decided on Django because of its familiarity, simplicity and adaptability with other libraries we would be using throughout the project. The first part was creating the database that would hold all of the necessary information (page layout, questions and answers, unique identifiers, etc.). While the initial premise was relatively simple, as the project evolved we had to address different concerns and keep adding more intricacies to the working logic. An example of this would be addressing different types of answers. They could've either been a multiple choice, single choice or a completely custom input. While we don't use any custom inputs, it was important to assure that the database would be scalable if the need arose. Some of the other elements that we had to keep in mind were an adaptable quantity of questions, different methods of input and most importantly, the ability to change the underlying system at any time. The most important part was that the system had to be designed in a way which could be operated without the need of a computer expert. The way this works is that every answer has a parameter which disables a particular question based on its unique identifier. This means that before the next question is loaded, we check if that question has been disabled by another answer previous to that and with that, we don't display it and skip right onto the next one. This system allows anyone to manipulate the rules and the order of these questions, provided they have the access to the database.

Regarding the REST (Representational state transfer) interface, we've decided to use Django REST framework [9], which serves as an intermediary between the information that consists in the database and a URL, which allows both for a way to access it from an outside, secure source, as well as allow the system to reach it through internal means, after which it can be deserialized and properly displayed as the questions appear. REST is a system commonly used to simplify the connection between the database and the program itself. The service itself provides a predefined set of operations in order to access, modify or change data that is on the server.

The next part of the backend are the static pages. Django allows for a fine distinction between dynamically and statically loaded pages. For example, the problem was that both AngularJS and static pages are mainly descriptions of different diseases and guidelines of what to watch out for if you want to avoid an infection. There is also a set of pages containing the information about where to find the proper treatment in case if you want to get tested or treated for the general hepatitis infections. Static pages load up as soon as the user requests that particular subpage and they are fetched from the server and transferred to client. AngularJS then displays them, providing the information that the user has requested.

4. QUESTIONNAIRE

The full questionnaire consists of 28 questions in total with the intent of reducing these questions as much as possible, so the user is not required to go through every single one of them in order to get the final risk assessment. There are several questions where the answers trigger/disable sub-questions, therefore reducing the total number of questions that the user has to take. For example, by answering "No." to the question "Have you travelled somewhere in the past three months?" the questionnaire would omit questions about travel.

Following some general demographic questions, the 4th question asks the user about their specific interests, related to groups of possible risks - travel, lifestyle, exposure to hepatitis infection in the past, and medical issues. Based on the answer, the questions from the group of interest are displayed first.

Each question can either be a "checkbox" or a "radio" type question, where the former allows the user to select multiple choices and the latter allows the user to only select one. We have discussed the possibility of open-ended answers (where the user would input their own values), but have decided against it as we felt like the constraints work better in terms of providing useful feedback for analysis.

Some of the questions also have image components to them. These provide a visual representation of what the question is currently asking. All of these types of questions have maps included in them that show where the infection of a particular disease is most prevalent. For example, a question like "Have you been born in any of the countries where hepatitis A is prevalent?", would have an image showing the different infection rates for countries around the world.

The final and the most important part of the questionnaire is that we wanted it to have both an educational, as well as an informational component. That would allow for the user to see which of their answers/actions have an inherent risk to them. This is most obviously seen in the comments that show up depending on what the user has answered. Sometimes they are purely informational (e.g. "A vaccine for hepatitis B will decrease your likelihood of contracting the disease"), while in other cases they can be educational as well (e.g. "In order to make sure you are treated against a particular hepatitis infection, you need to have a sufficient amount of anti-bodies"). These comments are aggregated and at the end shown back to the user.

Some question/comment examples:

Q: "Are you vaccinated for Hepatitis B?"

1. Yes, I was vaccinated within the national program for children before entering school (born after 1992)

2. Yes, I was vaccinated individually

3. No (We suggest to get vaccinated for hepatitis B and checking if the vaccination was successful after the third dose. In order for the vaccine to be effective,

a small margin of the population has to be vaccinated more than three times.)

Q: "Are you or your parent born in the countries where hepatitis B infections are common?"

1. Yes (There exists a higher chance of infection if you or your parents are born in a country where hepatitis B is common.)

2. No

5. SUMMARY

As number of viral hepatitis cases have risen up in the past few years, we have combined modern technology alongside with modern design principles and the latest knowledge about viral hepatitises to create a web application for informing users about the topic. Awareness and risk assessment are very important as they influence more people to get tested for viral hepatitis infections and get appropriate treatment in case they have the disease. We have several goals, the first and the utmost important one is to decrease the number of newly discovered patients with end stage diseases. Since viral hepatitis can be treated if discovered early enough, that can also prevent the disease from spreading. Another element of this is information, as spreading it will allow people to be more aware of the proper precautions, which will hopefully reduce overall exposure to hepatitis infections. If enough users agree to it, we also hope to collect enough relevant medical data that will allow for further analysis on addressing this growing problem. With gathering this epidemiological data, we hope to help more easily identify those with a higher risk factor and urge them to seek treatment in the earlier stages of the disease. By introducing this website, we hope to allow the users to access useful and verified information all in one place.

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Spletno svetovanje študentom v stiskah

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POVZETEK

V članku opisujemo študentski projekt »Spletno svetovanje študentom v stiskah«. V okviru projekta študenti ob pomoči pedagoškega mentorja in strokovnega sodelavca iz raziskovalnega zavoda interdisciplinarno proučujejo in razvijajo metode za zgodnje odkrivanje stresa in nudenje pomoči preko spleta.

Aplikacija, ki je še v razvoju, bo omogočala enostaven dostop do strokovno zasnovanih storitev pomoči v primerih, ko se študent sooča s stresom ali s telesnimi ali duševnimi težavami kot posledicami stresa. Aplikacija bo sprva na razpolago študentom Univerze v Ljubljani, ki pogosto sodelujejo z Institutom »Jožef Stefan«, kasneje pa bo dostopna tudi za druge visokošolske ustanove in univerze v regiji ter širše družbeno okolje.

Opisane so tehnične specifikacije in druge karakteristike sistema.

Ključne besede

Spletno svetovanje, stres, stresna situacija, prepoznavanje stresa, obvladovanje stresa, študent, asistent.

1. UVOD

Stres je fiziološki, psihološki in vedenjski odgovor posameznika, ki se poskuša prilagoditi in privaditi potencialno škodljivim ali ogrožajočim dejavnikom, ali drugače stresorjem. Stres prinese spremembe s katerimi se moramo soočiti, to pa počne vsak na svoj način, ki se mu zdi najbolj primeren. [1]

V Evropi trpi zaradi duševnih motenj vsaj enkrat v življenju tretjina prebivalstva. Ta procent se zaradi družbenih sprememb, nezaposlenosti, pritiska na srednji razred itd., viša. Uspešne prakse v tujini kažejo, da postaja obravnava psihičnih težav vse bolj interdisciplinarna in podprta z novimi informacijskimi tehnologijami, ki se kljub zavedanju možnega tveganja, čedalje bolj širijo na vse ravni podpore. Takšni pristopi so še posebej zanimivi za mlade generacije, ki se jih najpogosteje poslužujejo. Počasi se uporaba prenaša tudi na starejše generacije in zajema celotno družbo.

Stresno življenje je značilnost moderne, hitro razvijajoče se, uveljavitveno usmerjene družbe. Ko študenti vanjo resno in odgovorno vstopajo, morajo izpolnjevati visoke zahteve iz okolja, hkrati pa se soočati z lastnimi dvomi, sposobnostmi in interesi. Zato so v tem obdobju strategije spoprijemanja s stresnimi situacijami izrednega pomena. Marsikdaj se prav tedaj izkažejo za neučinkovite, kar lahko pripelje do blažjih ali hujših duševnih stisk in zdravstvenih težav, ki se z neukrepanjem še poglabljajo. [2]

Zdravstveni podatki kažejo, da so težave zaradi stresa eden izmed ključnih izzivov prihodnosti. [3, 4]

2. NAMEN PROJEKTA

S spletnim svetovanjem študentom v lokalnem okolju se želi spodbudili preventivno ukvarjanje z mentalno higieno in tudi omogočili lažji dostop do strokovne pomoči v primeru osebnih težav in duševnih stisk. V splošnem bo rešitev prispevala k zmanjševanju stigmatizacije ljudi s težavami v duševnem zdravju. Konkretno bo rešitev pomagala študentom naučiti se ustrezno pristopati k stresnim situacijam in imela pozitivne učinke na zvišanje zadovoljstva in motivacije za študij ter splošno v vsakdanjem življenju. Spodbujanje razvoja konstruktivnih strategij spoprijemanja s stresom bo pozitivno doprineslo tudi k zaposlitvenim možnostim in tudi zadovoljstvu delodajalcev.

Tekom projekta se razvija sodelovanje, komunikacija in izmenjava znanj med akademskimi in raziskovalnimi ustanovami ter neposreden prenos tega znanja na študente. Študentje pridobljeno teoretično znanje uporabljajo pri reševanju praktičnih in aktualnih družbenih problemov. Pridobivajo dragocene izkušnje in s tem boljše možnosti za hitro prvo zaposlitev, kar prispeval k zmanjševanju brezposelnosti med mladimi. Predvsem pa se vzpostavilo tvorno sodelovanje med tehnično in družboslovno stroko.

V okviru projekta študenti proučujejo različne inovativne rešitve za izzive družbenega okolja v katerem živijo in na takšen način osvojijo nov način razmišljanja, ki povečuje njihovo ustvarjalnost in kreativnost. To pa je dobra podlaga za kasnejši razvoj novih inovativnih storitev z visoko dodano vrednostjo.

3. OPIS VSEBINE PROJEKTA

Pri obvladovanju stresa si lahko med drugim pomagamo z različnimi tehnološkimi pripomočki ali storitvami kot npr. zapestnica za stres in spletno svetovanje.

V okviru projekta se razvijajo računalniški algoritmi za prepoznavo stresa (npr. na podlagi spremembe srčnega utripa, spremembe v govoru ipd.), kar je zahteven in še ne dovolj dobro rešen problem. Izdeluje se spletna aplikacija, ki bo predstavljala strokovno osnovano psihosocialno prvo pomoč za študente v stiski. S tem bo študentom omogočen prvi strokovno osnovan svetovalno terapevtski stik, za katerega se jim ne bo potrebno vključiti v socialno zdravstveni sistem. Za to je potrebno analizirati in izbrati ustrezen psihoterapevtski pristop, opredeliti ključne koncepte, način kategorizacije in oblikovati ustrezne scenarije dialoga, vaje ter napotke. Načrtovani spletni svetovalec bo študente opremil z osnovnimi strategijami za diagnostiko in obravnavo njihove težave, jim zagotovili ustrezne informacije in jih po potrebi napotili v ustrezne inštitucije. Aplikacija bo študente tudi preventivno usmerjala k zdravemu načinu življenja s splošnim izobraževanjem o stresu, načinih spoprijemanja,

tehnikah sproščanja, pomembnosti prave socialne podpore, vpliva (ne)zdrave prehrane in športne aktivnosti.

Tekom izvajanja projekta bo na osnovi teoretičnih izhodišč zastavljena klasifikacija študentskih težav povezanih s stresom, opisi simptomatike in ustrezne obravnave, razvit vprašalnik za diagnosticiranje in klasificiranje težav ter pripravljen osnovni načrt svetovanja z nalogami za uporabnike z različnimi težavami. Preizkušeni bodo različni pristopi avtomatske detekcije stresa. S tem bo razvita prva verzija aplikacije, ki bo študente s težavami zaradi stresa vodila skozi njihovo problematiko, jih učila, ozaveščala, motivirala, jim ponujala prilagojene domače naloge. Aplikacija bo vključevala tudi povezavo z bazo terapevtov in svetovalcev ter osebnih storitev, ki bodo vključeni po potrebi v program pomoči. Vse bo na uporabniku prijazen in prilagojen način integrirano v spletno okolje. Aplikacija bo testirana in pripravljena za osnovno uporabo.

4. ZASNOVA OZ. SPECIFIKACIJA SISTEMA

Groba zasnova sistema je prikazana na sliki 1. Uporabnik lahko najprej izpolni spletni vprašalnik, ki oceni stopnjo stresa uporabnika. Na podlagi doseženega rezultata se uporabniku, v primeru velikega stresa, priporoči direkten pogovor s terapevtom. Če pa se iz vprašalnika zazna blažjo stopnjo stresa, se predlaga pogovor s spletnim pogovornim svetovalcem. Ob potrditvi se preusmeri pogovor na spletni obrazec, ki omogoča vnos teksta in prikaz pogovora s virtualnim svetovalcem.



Slika 1. Shema sistema za spletno svetovanje študentom v stiski

Pogovorni svetovalec prejeti tekst najprej posreduje modulu za predprocesiranje teksta, ki naj bi odstranil bolj pogoste besede, ki ne prinašajo dodatnih informacij. Preverili bomo tudi možnost dodajanja funkcionalnosti urejanja sintaktičnih napak v tekstu. Naslednji korak v pogovornem svetovalcu je klasifikacija v pravo kategorijo stresa. Sistem poskuša preko zaznavanja ključnih besed in fraz klasificirati tekst v določeno kategorije stresa, saj je mogoče na podlagi te informacije uporabniku posredovati specifična vprašanja, naloge ali voden scenarij, ki naj bi pomagal pri spopadanju s tovrstno obliko stresa. Pri razpoznavanju smo uporabljali platformo API.AI [5], ki je namenjena analizi naravnega jezika (Natural language processing). V sistem se vnese kategorije v katere želimo klasificirati tekst, nato se poda učne primere pogovorov, ki so značilni za tovrstno kategorijo. V API. AI se kreira novega agenta, za katerega lahko, z uporabo strojnega učenja in pravil, ustvarimo enostaven model, ki je sposoben klasifikacije podanega teksta v naravnem jeziku. Ta agent nato lahko

Preko anketnega vprašalnika se je identificiralo vsebinske kategorije stresa pri študentih po pogostosti, od najpogostejše do najmanj:

- 1. Študij Urnik predavanj, stres med izpitnimi obdoblji.
- 2. Denar Preslabo plačano delo, odvisnost od staršev ali sistema.
- 3. Odnosi Največkrat s starši ali partneji.
- Osamljenost Oddaljenost od doma, prejšnjih prijateljev ali pomanjkanje hobijev.
- 5. Samopodoba/samozavest Nezadovoljstvo s samim seboj.
- 6. Bolezen Pri študentih ali družini, depresija, anksioznost itd.
- 7. Družinske tragedije Smrt starša, sorodnikov.
- 8. Selitev v mesto Predvsem iz manjšega kraja v Ljubljano.

Vse kategorije se bo v nadaljevanju izvajanja projekta vneslo v agenta znotraj API.AI in vsaki kategoriji dodalo množico učnih primerov (teksta), ki so značilni za tovrstno kategorijo stresa. Predvidevamo, da pri pogovoru o problemih s študijem bo v tekstu več besed ali zvez, kjer so omenjeni urniki, predavanja, izpiti, naloge ipd. Strojno učenje bi moralo take značilne, ključne koncepte zaznati in jih vključiti v odločitveni model za to kategorijo.

5. PRIMER POGOVORA

Uporabniku je ob prihodu na stran ponujena možnost izpolnjevanja vprašalnika, ki oceni njegovo stopnjo stresa. Del pripravljenega vprašalnika je prikazan na Sliki 2. Uporabniku se postavi množica vprašanj, kjer je mogoča izbira enega ali več predpripravljenih odgovorov. Aplikacija ovrednoti odgovore in rezultat prikaže uporabniku v grafični obliki. Uporabniku nato ponudi direkten pogovor s terapevtom ali pa pogovor s spletnim svetovalcem.

Vprasalnik: Ali vas stres ogroža

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Slika 2. Del anketnega vprašalnika za ugotavljanje stopnje stresa.

Pogovor med uporabnikom in spletnim svetovalcem poteka v naravnem jeziku. Uporabnik postavi vprašanje in sistem mu odgovori, svetuje ali poda naloge glede na določen scenarih.

V prvi fazi se najprej na osnovi uporabnikovega opisa problema klasificira miselna napaka. Primer pogovora:

Uporabnik: Živjo

Svetovalec: Pozdravljeni, kako vam lahko pomagam?

Uporabnik: Kaj znaš?

- Svetovalec: Sem virtualni svetovalec, ki vam lahko svetu preko pogovora. Prosim napišite težave ali probleme s katerim se soočate in poskušal bom zaznati miselno napako ter ustrezno prilagoditi pogovor in naloge. Sem še v razvoju in zato vsega še ne znam.
- **Uporabnik:** Naslednji teden začnem s študijem in se bojim, da se ne bom vklopil in našel novih, pristnih prijateljstev.
- Svetovalec: Iz podanega opisa problema je mogoče razbrati, da pri vas obstaja nagnjenost k pretiranemu osredotočanju na (negativno) prihodnost, temu strokovno rečemo Napovedovanje prihodnosti, kar preprečuje delovanje, sprevrže se v samo izpolnjujočo prerokbo.

Svetovalec: Ali se vam zdi, da je to značilno za vas?

Uporabnik: Da

V primeru, da sistem ne zmore klasificirati opisa v nobeno izmed napak prosi uporabnika, naj mu podrobneje, oziroma drugače opiše problem. Na primer:

Uporabnik: Živjo

Svetovalec: Pozdravljeni, kako vam lahko pomagam?

Uporabnik: Saj ne vem kako razložiti zadeve, ker so občutki mešani in se počutje spreminja enkrat na dobro, drugič na slabo.

Svetovalec: Ali lahko prosim opišete kakšno situacijo, ki vas spravlja v stresno situacijo.

Ko sistem klasificira opis uspe klasificirati, zahteva potrditev s strani uporabnika. V primeru, da uporabnik zavrne predlagano napako, ga svetovalec pozove naj še na drug način opiše probleme s katerimi se sooča. Ko uporabnik potrdi ustreznost opisa njegovega razmišljanja sistem uporabi določen scenarij, to je pogovor, ki pomaga uporabniku, da spremeni svoj način razmišljanja. Kratek primer:

Svetovalec: Če bi ocenili na lestvici od 1 do 10 (1 pomeni »me sploh ne obremenjuje«, 10 »neizmerno me obremenjuje«). S katero številko bi ocenili vaše trenutno stanje?

Uporabnik: 6

- Svetovalec: Zapišite sedaj situacijo čez 1 leto, pomislite, da se še vedno ni nič spremenilo. Vse ostaja enako, vaše težave so še vedno tukaj, morda še v večji razsežnosti, kot so bile pred letom dni. (vzemite si čas preden zapišete).
- **Uporabnik:** To bi bilo nevzdržno, saj se že zdaj dnevno obremenjujem s tem in si predstavljam, da bi to precej vplivalo na moje takratnje počutje.
- Svetovalec: In sedaj si zamislite isto situacijo čez 5 let, še vedno ne naredite nobene spremembe, ker verjamete, da tako ali tako nima smisla. Venomer se sprašujete, kako bi bilo, če bi se odločili in se podali na drugo pot, če bi poizkusili narediti nekaj drugače. Stres, ki ga doživljate sedaj je narasel za petkratno vrednost?
- Svetovalec: Napišite mi, kako živite, kako se počutite, kako izgledate po toliko letih neprestanega stresa, premišljevanja, kaj bi bilo, če bi si dovolili narediti drugače?

.

Scenarij pogovora se lahko še nadaljuje in uporabniku posreduje nasvete ali naloge. Vsak scenarij, zbirka nalog ali pogovorov je za vsako kategorijo ali miselno napako različna in se sproži po uspešni klasifikaciji. Ta mehanizem daje upravljavcem širok nabor možnosti spopadanja z različnimi tipi stresa.

6. ZAKLJUČEK

Predstavljen je bil projekt za spletno svetovanje študentom v stiskah, ki se še izvaja. S projektom bo nastala osnovna verzija aplikacije za svetovanje študentom. Aplikacija se bo nato integrirala z drugimi obstoječimi spletnimi funkcionalnostmi na področju svetovanja.

Spremljalo se bo odzive uporabnikov in po potrebi rešitev korigiralo. K osnovni rešitvi se bo kasneje razvijalo še dodatne funkcionalnosti ter se jo promoviralo v okviru širše regije in celotne države. Ko bo aplikacija dodelana do ustrezne stopnje, se jo bo integriralo tudi v Nacionalni inštitut za psihoterapijo, ki deluje v okviru prijavitelja projekta.

Delo, opravljeno v okviru tega projekta, bo sestavni del obsežnejše, splošno zasnovane spletne aplikacije za zdravstveno svetovanje državljanom.

7. ZAHVALA

Projekt »Spletno svetovanje študentom v stiskah« je delno financirala Evropska unija, in sicer iz Evropskega socialnega sklada, v okviru Operativnega programa za izvajanje evropske kohezijske politike v obdobju 2014-2020 kot neposredna potrditev operacije - programa »Projektno delo z negospodarskim in neprofitnim sektorjem v lokalnem in regionalnem okolju – Študentski inovativni projekti za družbeno korist 2016 – 2018«, 10. prednostne osi »Znanje, spretnosti in vseživljenjsko učenje za boljšo zaposljivost«, 10.1 prednostne naložbe »Izboljšanje enakega dostopa do vseživljenjskega učenja za vse starostne skupine pri formalnih, neformalnih in priložnostnih oblikah učenja, posodobitev znanja, spretnosti in kompetenc delovne sile ter spodbujanje prožnih oblik učenja, tudi s poklicnim svetovanjem in potrjevanjem pridobljenih kompetenc« in 10.1.3 specifičnega cilja »Spodbujanje prožnih oblik učenja ter podpora kakovostni karierni orientaciji za šolajočo se mladino na vseh ravneh izobraževalnega sistema«.

Izvajalec javnega razpisa je bil Javni štipendijski, razvojni, invalidski in preživninski sklad Republike Slovenije.

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Upgrade of AH-Model with Machine Learning Algorithms

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ABSTRACT

The goal of this research is upgrading of AH model with introduction of classification algorithms to explain connection between human well-being and efficiency.

Three different algorithms (JRip, SVM, decision trees) were implemented and tested on the same data with samples of 10, 100 and 2031. JRip predicted correctly about two thirds of connections. It is not sensitive on choosing different training and learning sets and accuracy was achieved at a sample of 100. It, however, does not offer useful explanation about wellbeing's influence on efficiency. SVM algorithm is not useful for this kind of data; predicted error rate is too high.

Decision tree algorithm offered the best output. It identified relations between particular elements of well-being and efficiency. Obtained results are reflection of the work place characteristics (data was collected in real work places) and identify relation between elements of well-being and efficiency which is understandable to user.

Decision tree algorithm upgrades AH model with description of relationship between QAA data and workers' performance-efficiency.

Categories and Subject Descriptors

H.1.2 [Models and Principles]: User/Machine Systems human factors, I.2.1 [Artificial Intelligence]: Applications and Expert Systems - medicine and science, J.4 [Computer Applications]: Social and Behavioral Sciences - psychology

General Terms

Algorithms, Human Factors, Measurement, Reliability.

Keywords

AH-model, classification algorithms, JRip, SVM, decision trees.

1. INTRODUCTION

Aim of this paper is to compare different AI approaches to data mining; more specifically to individual behavior modeling. This comparison is executed on data collected from standardized Questionnaire of Actual Availability (QAA). The goal of data analysis, performed on this data, is to better understand individual's behavior – that is to better understand connection between different individual's attributes and influence of availability on prediction of performance on real working situation.

Data is collected with Questionnaire of Actual Availability from AH-model (psychometric data) [1]. It is comprised of subjective self-assessment of workers; workers assessed their psychophysical condition. Besides their assessment of psychophysical condition and well-being their actual work performance-efficiency was also noted.

The goal of data analysis is to determine the influence of perceived well-being and self-estimation of actual availability Martin Molan Faculty of Mathematics and Physics Jadranska cesta 19 1000 Ljubljana +38640516254 martin@molan.net

on workers' performance. This paper tries to determine which data mining algorithm best predicts actual work performance from perceived well-being.

2. CLASSIFICATION

Classification process involves training (learning) and test sets. Individual instance (in the training set) usually contains one target value (which identifies the class – leaf in a data tree) and several additional attributes. End goal of decision tree algorithm is to produce a target value (leaf identifier) based only on attributes. In this sense, classification problem can be examined (as illustration) on example of two classes where the algorithm is tasked with separation of classes based on available examples. Algorithm should produce and identify function (segregation function), based from training data, that works well on unseen examples (test data). Successfulness of segregation algorithm is determined by its ability to perform on test data [2].

2.1 SVM Algorithm

Based on statistical learning theory, Support Vector Machines is a method of supervised learning used for classification and regression [3]. SVM creates non-overlapping partitions of data employing all attributes of particular instance (e.g. individual). In order to produce linear partitions, data is segmented in a single pass. Although similar to probabilistic approaches (they are based on maximum margin linear discriminants), SVM do not take into account possible co-dependencies between attributes.

In contrast to traditional neural networks SVM algorithms do not suffer problems with generalization (SVMs have no tendency to over fit the data as a result of optimization measures). Consequently, SVMs seem to promise great empirical performance [4]. Structural risk minimization (SRM) [5], which is the basis of SVMs, seems to be superior to Empirical Risk Minimization (ERM) [6] (traditional approach employed by neural networks). In contrast to ERM, which optimizes the training data, SRM optimizes the upper bound on the expected risk. Consequently SRM has much greater generalization ability.

SVMs present data patterns in higher dimension than the original space (defined by attributes of particular entity). Segregations of two categories (hyperplane separating two patterns) can be achieved by nonlinear mapping to a sufficiently high dimension [4].

2.2 Decision tree algorithm

Decision trees are implementation of divide and conquer principle [7]. Differences between different implementations of decision trees are in how to approach and execute division into smaller problems. Decision trees based classifiers divide the data into smaller groups (where each node of a tree represents a criteria for data segmentation) until desired homogeneity of a subgroup is achieved (this subgroup is represented as a leaf containing class majority). Classification is achieved by following the classification criteria (nodes in the tree) until a desired group is reached (represented as a leaf in the tree) [7].

2.3 JRip propositional rule learning

JRip is rule-based machine learning method called propositional rule learning and is based on association rules with reduced error pruning. Data, analyzed by propositional rule learner, is split into growing and pruning set (learning and testing set). An initial rule is formed on the growing set (learning set) and then repeatedly optimized (simplified) by the pruning set (testing set). For each stage of pruning (optimization) the set of rules with greatest error reduction is chosen as the rule. Optimization ends when additional alternations (optimizations) of rules yield additional error instead of error reduction. JRip implementation of propositional rule learner is an optimized version of Incremental Reduction Error Pruning (IREP) proposed by William W. Cohen [8].

3. Results

All three algorithms are compared for three different numerousness: 10, 100 and 2062. For each sample each algorithms is tested ten times to assure different random generated learning sets.

3.1 JRip propositional rule learning

algorithm

n = 10:

100% correctly classified instances. In all ten trials, the result is the same: 100% correctly classified instances.

Let denote efficiency measured as 1, it means the best efficiency, with E1, efficiency measurement value 2 with E2, and so forth to measurement value 5 denoted with E5. In table 1 are presented results of the AI model generated with JRip classification algorithm for the instances of the test set. This presents expected results of the generated model for real-world data.

Table 1 Classification correctness with JRip method for n=10

	Classified as E1	as E2	as E3
E1	5	0	0
E2	0	3	0
E3	0	0	2

n=100:

68% correctly classified instances, 32% incorrectly classified instances. The best matching is with efficiently 2. In all ten trials, results are in the interval between 66-71% for correct classification and in the interval between 29-34% for incorrect classification.

Table 2 Classification correctness with JRip method for n=100

	Classified as E1	as E2	as E3	as E4
E1	19	18	0	0
E2	3	49	0	0
E3	0	10	0	0
E4	0	1	0	0

n=2031:

72% correctly classified instances, 28% incorrectly classified instances. The best matching is with efficiency 2 and 1. In all trials the intervals are between 70-72% for correct classification and 28-30% for incorrect classification.

Table 3 Classification correctness with JRip method for n=2031

	Classified as E1	as E2	as E3	as E4	as E5
E1	402	267	3	1	0
E2	120	873	46	2	0
E3	1	109	157	7	0
E4	3	11	6	21	0
E5	0	1	0	0	2

The algorithm JRip is not sensitive in choosing different training and learning set. The first adequate level of accuracy is achieved at n=100.

3.2 SVM Algorithm

n=10:

The algorithm does not work. Number of parameters is too big for this sampling size and algorithm fails with error "'cross' must not exceed sampling size".

n=100:

SVM algorithm returns similar results as JRip propositional rule learning algorithm, it returns classification correctness table. For n=100 are only 17% correct predictions for efficiency 1, 2, and 3.

Table 4	Classification correctness	with	SVM	algorithm	for
	n=100				

	Classified as E1	as E2	as E3	as E4	as E5
E1	7	4	0	0	0
E2	6	8	1	0	0
E3	0	2	2	0	0
E4	0	0	0	0	0
E5	0	0	0	0	0

n=2031:

Only 20% of correct predictions, mostly for efficiency 2.

Table 5 Classification correctness with SVM algorithm for n=100

	Classified as E1	as E2	as E3	as E4	as E5
E1	145	69	1	1	0
E2	59	223	38	3	0
E3	2	16	43	8	1
E4	0	0	0	0	0
E5	0	0	0	0	0

The algorithm SVM is not applicable for analyzed data. Correct prediction is poor without useful information for user.

3.3 Decision tree algorithm

Problem of decision tree can be complexity of a tree which is a result from decision tree algorithm. To overpass this problem, it is possible to check a visual representation of the crossvalidation results. It gives a geometric presentation of values of complexity parameter (cp) related with tree size and expected relative error. The cp value is the input value for tree pruning algorithm that reduce tree size and increase expected
correctness of proposed decisions, but decisions has less detail argumentations.

n=10:

Resulting tree is not complex enough to require pruning. There is distinction in identification of psychical well-being on efficiency 1. There is also identification of psychical impact on efficiency 2. Decision tree is simple; the only influential item is psychical well-being.



Figure 1 Not pruned decision tree for n=10

n=100:

In 46% of overall estimation of well-being below 1,649 is related mostly with efficiency 1 and some of them with efficiency 2. In 54% of overall estimation of well-being are above 1,649 and they are related mostly with efficiency 2, only a little of them with 1, 3, and 4. There is a complex decision tree presenting influence of other elements of well-being.





Tree pruning is implemented to decrease relative error and to simplify decision tree. The cp=0.051 is used for pruning parameter according to adequate size of tree and adequate relative error



Figure 3 Visual representation of the cross-validation results for n=100

After the pruning of the decision tree influential elements are defined – another important influential factor is stress. Pruned decision tree is clear and offers possibility for identification of influential elements of well-being on efficiency, mostly on 1 and 2.



Figure 4 Pruned decision tree for n=100

n=2031:

In 36% there is psychical well-being below 1.4295 determining efficiency 1. In 49%, psychical well-being below 2,4295 predict efficiency 2. In 15% psychical well-being above 2,4295 predict efficiency 3. The same as for n=100, tree pruning is implemented to decrease relative error and to simplify decision tree.



Figure 5 Visual representation of the cross-validation results for n=2031

Similar as for n=100, value cp=0.051 is used for pruning parameter according to adequate size of tree and adequate relative error. After pruning of decision tree psychical well-being below 1,429 is crucial in prediction of efficiently 1. Efficiency 2 is predicted with psychical well-being below 2,429. If psychical well-being is above 2,429 the efficiency is 3. The correct prediction for 3 is 15%.



Figure 6 Pruned decision tree for n=2031

The decision tree algorithms identifies relations between elements of well-being and efficiency. User gets possibility for implementation and interpretation.

4. Conclusion

Comparison of three algorithms answers a question: Which algorithms is the most suitable? According to the analysis JRip is too dependent on sampling of learning sets. It correctly predicts efficiency 1 and sometimes 2 but does not identifies influential elements of well-being.

SVM algorithm is not applicable for this kind of data.

The decision tree algorithm is the most suitable for implementation of QAA data from AH. It offers identification of the most influential well-being element on efficiency with distinguished limits. From the aspect of end user – psychologist or human factor specialist it offers an upgrade to the AH model. Upgrade of AH model with decision tree algorithm offers clear limits of expected values of efficiency depend on well-being perception. Due to the nature of data (QAA data was collected at workplaces with psychical workloads) obtained results reflect workplace characteristics, perception of well-being and their influence on efficiency.

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Wireless Sensor Prototype for Industrial Harsh Environments

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ABSTRACT

The overall goal of the ECSEL project MANTIS is to provide a proactive maintenance service platform architecture based on Cyber Physical Systems. Proactive maintenance can be regarded as upgrade of conventional preventive and predictive maintenance and goes further by focusing on problem causes. In this way, problems are settled before they actually occur. The MANTIS project comprises eleven distinct industrial partners and deals with maintenance use cases in different environments (e.g., industrial machines, vehicles, renewable energy assets). An important issue of the MANTIS project is provision of reliable communication. In this paper we present a solution of wireless pressure sensor developed for possible replacement of the existing cable-connected sensors in a harsh industrial environment.

Categories and Subject Descriptors

C.2.1 Network Architecture and Design; Wireless communication, C.3 Special-Purpose And Application-Based Systems; Real-time and embedded systems

General Terms

Measurement, Performance, Reliability

Keywords

Cyber-Physical Systems, proactive maintenance, sesnsors

1. INTRODUCTION

Cyber-Physical Systems (CPS), which represent the next generation embedded intelligent ICT systems, are characterized by large numbers of tightly integrated heterogeneous components, which may dynamically expand and contract with each other. Multiple sensors and actuation units that gather, process, exchange and use information bring together the world of computing and communications with the physical and biological worlds [1]. CPS components are collaborative, autonomous and provide computing and communication, monitoring/control of physical components/processes in various applications. The concept of CPS is being widely applied in indistry, energy economy, health care, to mention just the few most prominent examples.

While CPS are known to be difficult to analyze due to their increasing complexity, the maintenance of CPS-based industrial

systems represents a great challenge. In the near future, maintenance of industrial systems will change from traditional monitoring, based on the detection of malfunctions, to advanced techniques that prevent malfunctions by predicting the faults. To this day, four different maintenance plans are used: reactive maintenance, preventive maintenance, predictive maintenance and proactive maintenance [2].

In the case of reactive maintenance, the equipment is replaced or repaired only after it breaks. This approach has the advantage of minimizing the manpower to keep things running. Disadvantages are unpredictable production capacity and high overall maintenance costs.

In preventive maintenance, maintenance tasks are performed periodically, based on specific time period or the amount of working hours of machine use. The drawback is that the production is stopped during the maintenance. On the other hand, the equipment lifetime is prolonged and the probability of malfunction is reduced [3].

Predictive maintenance or condition-based maintenance, relies on physical measurements of the equipment conditions, such as temperature, vibration, noise, lubrication and corrosion [4]. When these measures reach a certain threshold, preventive maintenance task is applied.

Proactive maintenance benefits from the preventive and prediction methods and goes further by focusing on problem causes. In this way, problems are settled before they actually occur. Proactive maintenance is a constant process of operation improvement that starts at the early design phase and comprises the whole periodic life cycle analysis. By employing prediction methods it relies on constant condition monitoring and evaluation to avoid machine failures. Condition monitoring is achieved through extensive sensor data collection and analysis [5].

The overall goal of the MANTIS project (http://www.mantisproject.eu/) is building a maintenance service platform that will enable proactive maintenance strategies in different environments (e.g., industrial machines, vehicles, renewable energy assets). For this purpose, advanced data monitoring, communication and analytics is required. Since the maintenance service platform will operate in different environments including harsh conditions, ensuring reliable communication is one of the major issues. In the following we present a solution of wireless pressure sensor developed for possible replacement of the existing cableconnected sensors in a harsh industrial environment.

2. WIRELESS SENSOR PROTOTYPE

2.1 Sensor

Sensor prototype is based on HYB pressure transducer for differential wet-wet applications. It is a new generation of ceramic pressure sensors made with low temperature cofired ceramic (LTCC) technology using piezo-resistive principle to detect the pressure. The LTCC material is compatible with many types of aggressive media like water, hydraulic oils, diesel and others, which makes the sensor suitable for pressure measurements in harsh environments. Special protection of the piezo-resistors also makes this sensor suitable for wet-wet applications. High performance and accuracy are achieved with the special sensor construction, which allows this sensor to be used in many applications, and with its compact and convenient design it is very suitable for OEM users requiring use in harsh environment. The output signal from the sensor is analog and digital. The HPSD 7000 analog output signal is amplified and temperature compensated from 0 to 70°C with signal conditioning electronics.



Figure 1: HPSD 7000 pressure sensor

The digital output signal is available via standard I2C communication with default slave address 0x78 (1111000b). Pressure and temperature output signals form HPSD7000 pressure sensors are 15 bit values from the data acquisition output register. Data transfer is initiated by I2C master with the start condition. followed by 7 bit slave address (factory default is 0x78) and data direction bit R/W (for read data R/W="1"). Slave confirms this address with acknowledge (A) bit followed by pressure data as 2 byte value, MSB first and temperature data as 2 byte value, MSB first. Master must confirm each received byte with acknowledge bit and terminate the data transfer by sending the stop condition.

Master receives pressure data as a 15 bit values which can be converted to actual pressure value with pressure units in mbar using simple linear transformation using data from the datasheet for Pmin, Pmax, Dmin and Dmax, where values are min pressure (mbar), max pressure (mbar), max digital pressure (counts) and min digital pressure (counts), respectively.

$$S = \frac{Dmax - Dmin}{Pmax - Pmin}$$

$$P = \frac{D - Dmin}{S} + Pmin$$

2.2 Power management

Sensor is powered by small Lithium battery charged via standard USB connector, commonly used as a mobile phone charging device. The electronics is supplyed at 3,3V. The Lithium battery has own protection circuit to avoid over-charge, over-discharge, over-current and short circuit conditions which may permanently damage the battery cell. The cell voltage could be over 3,3V and below 3,3V during the discharge cycle. This requires Buck-Boost DCDC converter. Due to low power overall consumption, the synchronous buck boost converter was selected with maximum efficiency 97% at lower currents in the range of 100mA. The device operates from 0.65V to 4.5V input supplying max. 200mA of current from single battery cell. No other power switching was done with usual mechanical SPST switch.

2.3 Wireless interface

The wireless part of the sensor is based on ESP8266 from Espresiff in the form factor of small WiFi Module. It is a selfcontained SOC with integrated TCP/IP protocol stack with additional interfaces to give the device access to WiFi network. The module has a powerful enough on-board processing and storage capability that allows it to be integrated with the HPSD7000 sensor through its GPIOs. Its high degree of on-chip integration allows for minimal external circuitry and occupying minimal PCB area.

2.4 Software

WiFi module operates as an Access Point by setting up a network of its own, allowing other devices to connect directly to the sensor. The WiFi client connects to the SOC and exchange packets via User Datagram Protocol (UDP). This represents lowest possible load to the sensor, client and allows low latency. The drawback is lack of control mechanisms when packets are not delivered. The tradeoff between data loss and latency seems to be optimal for such short range peer-to-peer communication.



Figure 2: Communication start dialog

Prototype was tested using smart phone with installed "UDP terminal" application. First, the phone is connected to the access point using default password.



Figure 3: UDP terminal application

Then UDP terminal application is started. Packets are sent from phone to sensor on port 4096 and received by phone on port 11000.

When the letter "P" is sent with UDP packet on port 4096, the sensor returns pressure readout on port 11000. It is up to the client application to calculate the pressure from the readout.



Figure 4: Pressure sensor readouts

2.5 Hardware prototype

The prototype was developed and tested using multi-module stack shown in Figure 5.



Figure 5: Wireless pressure sensor prototype

Preliminary prototype was assembled inside 3D-printed plastic housing as shown in Fig. 6.



Figure 6: 3D model of the housing, which was printed using 3D printer and PLA plastic material

2.6 Extending the range of the wireless module

The on-board antenna has potentially low range, especailly indoors. Some preliminary experiments have shown the indoor range of about 20m when sensor and client were placed in the same room. When obstacles, like human body, wall, doors or other objects were placed in the signal propagation path, the range was significantly lower.

Possible improvement is additional antenna. The module used in the prototype was ESP8266-12E with PIFA (Planar Inverted »F« Antenna) integrated on the module itself. Modules with the same functionality and connector for external antenna exist. Most widely used is module ESP8266-05, which has »u.Fl« type of antenna connector. Such small connector is not suitable for direct antenna connection and requires some adapter. The adapter has u.Fl connector on one side and SMA or similar connector on the other side of the coaxial cable. The SMA connector is more suitable for integration on the sensor housing and sealed against external environment.

One example is shown in Fig. 7. Advantage of such adapter is the possibility to attach external antenna for 2,4GHz or connect remote antenna with coaxial cable between SMA connector and antenna location.

Another option to improve the wireless sensor range is to use larger patch antenna, which is placed outside the housing. Advantage of this lies in easier sealing against environment (dust, moisture, water). The main disadvantage is larger dimension.



Figure 7: External antenna options: adapter cable (above), larger patch antenna (middle) and SMD solderable antenna (below).

3. CONCLUSIONS

The presented pressure sensor prototype has been developed for the proof of concept for possible replacement of wired sensors in existing industrial use case installations. Initial test is planned to be carried out at Philips shaver production plant.

4. ACKNOWLEDGMENTS

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Napovedovanje časovnih vrst za podporo energetski optimizaciji stavbe

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POVZETEK

V naslednjem sestavku predstavljamo komponento sistema za optimizacijo upravljanje energije, ki napoveduje proizvodnjo in porabo električne energije. V ta namen je bil izveden demonstracijski projekt za sistem večstanovanjske zgradbe, ki (i) je priključen na električno omrežje in sistem daljinskega ogrevanja, (ii) je priključen na fotovoltaično elektrarno, (iii) vsebuje toplotno črpalko z zalogovnikom za ogrevanje stanovanj in (iv) vsebuje baterije. Namen celotnega projekta je demonstracija sistema za optimizirano usmerjanje energetskih tokov, kjer želimo doseči ali maksimirano lastno rabe energije ali minimizacijo stroškov. Medtem ko je izvajanje prve strategije razmeroma enostavno, pa je za drugo potrebno planiranje delovanja sistema v prihodnosti na osnovi predvidevanj. V ta namen smo razvili komponento za napovedovanje proizvodnje električne in porabo električne ter toplotne energije.

Ključne besede

Poraba energije, proizvodnja energije, toplota, elektrika, napovedovanje, strojno učenje, sončna elektrarna

1. UVOD

Napredno upravljanje energije v stanovanjskih objektih z možnostjo shranjevanja energije pomeni vključevanje posebnih metod, ki omogočajo izvedbo kratkoročnega in srednjeročnega planiranja razporejanje energije. Planiranje je pomembno predvsem zaradi nadzora upravljanja energijskih tokov, katere je mogoče upravljati skladno s cenovno ali energetsko učinkovitimi strategijami.

V ta namen smo za demonstracijski projekt [1] izdelali modul za napovedovanje determinističnih in stohastičnih časovnih vrst, ki predstavljajo proizvodnjo in porabo električne energije, ter porabo toplotne energije. Pri zasnovi modela napovedovanja smo si pomagali s simulacijo delovanja sistema na osnovi podatkov, pridobljenih na primerljivem objektu. Namen izvedbe je priprava napovedanih vrednosti, ki predstavljajo vhod v fazo optimizacije [2], ki pa ni tema tega prispevka.

Sorodne raziskave opisujejo različne metode napovedovanja časovnih porabe energije, na primer primerjava različnih implementacij z nevronskimi mrežami [3] ali kratkoročno napovedovanje z poznavanjem vremenskih podatkov [4]. Drugi so uporabili različne podporne podatke, kot na primer podatki o delovanju električnih naprav [5] in aktivnosti uporabnikov, medtem ko so v [6] potrdili, da se napovedljivost porabe zelo razlikuje glede na stanovanja in uporabnike in da je kratkoročno napovedovanje na urni ravni bolj natančno z napovedovanjem porabe posameznih naprav, medtem ko je napovedovanje za nekaj dni v naprej natančnejše na agregiranem sistemu celotnega objekta. Drugo poglavje opisuje energijsko shemo sistema ter na kratko opiše energijske komponente sistema. Tretje poglavje opisuje postopek modeliranja sončne elektrarne in izvedbo napovedi ob predpostavki, da je znana napoved sončnega obsevanja. Četrto poglavje opisuje postopek za izvedbo napovednega modela za porabo električne in toplotne energije ob predpostavki, da je poznana zgodovina porabe za obdobje zadnjih nekaj dni in napoved zunanje temperature. Peto poglavje je namenjeno prikazu rezultatov in vrednotenju izvedenih modelov, v zadnjem poglavju je podan zaključek.

2. ENERGIJSKA SHEMA SISTEMA

Slika 1 prikazuje energijsko shemo sistema. Zelena barva predstavlja električne P, rdeča pa toplotne \dot{Q} moči. Puščice označujejo smer tokov, pri čimer so dejanske smeri P_G, P_B, \dot{Q}_T lahko tudi nasprotne. Kot vidimo iz slike, je stanovanjska zgradba porabnik tako električne, kot tudi toplotne energije. Sončna elektrarna predstavlja vir energije. Električno omrežje lahko predstavlja vir lahko pa tudi porabnik energije. Sistem daljinskega ogrevanja predstavlja vir energije. Na koncu so še baterije kot hranilniki električne energije in zalogovnik kot hranilniki toplote.



Slika 1: Energijski tokovi v sistemu

V povezavi s planiranjem nas zanima predvsem, kakšna bo poraba energije stanovanj in kakšna bo proizvodnja elektrike v bližnji prihodnosti. Primer: če želimo zagotoviti maksimalno samozadostnost zgradbe, potem je potrebno napolniti baterije in zalogovnik ravno toliko, da bo zadosti energije za potrebe zgradbe, čim več ostale energije pa želimo prodati. Poraba stanovanjske zgradbe je stohastičnega tipa, za katerega nimamo fizikalne formulacije, medtem ko je proizvodnja elektrike odvisna od samih dimenzij elektrarne in od sočnega obsevanja.

V naslednjih dveh poglavjih bosta opisana postopka za napovedovanje porabe energije in proizvodnje električne energije.

3. MODELIRANJE SONČNE ELEKTRARNE

Model za napovedovanje proizvodnje energije smo izdelali na osnovi nazivnih parametrov sončne elektrarne in podatkov o geolokaciji elektrarne. Pri razvoju modela napovedovanja smo privzeli naslednje dinamične podatke, ki jih bo model potreboval za izvedbo napovedi:

- 1. napoved sončnega obsevanja na horizontalno površino $I_s[W]$
- 2. povprečna dnevna proizvodnja energije sistema $E_d [kWh]$
- 3. povprečna dnevna količina sončnega obsevanja na enoto površine, ki jo prejme sistem $H_d [kWh/m^2]$

Točko 1 - napoved sončnega obsevanja na horizontalno površino je mogoče pridobivati preko vremenskega servisa, na primer Meteomedia¹ na urni ravni. Podatke za točki 2 in 3 pa pridobimo za celo leto s pomočjo spletne aplikacije PVGIZ², kjer vnesemo geolokacijo elektrarne in podatke o azimutu ter naklonu strehe.

Shema sončne elektrarne je prikazana na Sliki 2. Desna stran slike kaže satelitski posnetek strehe. Elektrarna je razdeljena na vzhodno stran z nazivno močjo 15 kWp in zahodno stran z nazivno močjo 30 kWp. Leva stran slike prikazuje azimut vzhodnega in zahodnega dela elektrarne ter naklon strehe.



Slika 2: Koti sončne elektrarne

Koeficient učinkovitosti posamezne strani elektrarne izračunamo kot razmerje med sončnim obsevanjem na elektrarno in prejeto energijo, pomnoženo z nazivno močjo elektrarne Enačba (1).

$$k_{EHd,inst} = \frac{E_{d,tilt}}{H_{d,hor}} \times P_{inst},$$
(1)

kjer je $E_{d,tilt}$ povprečna dnevna proizvodnja energije za elektrarno z naklonom *tilt*, $H_{d,hor}$ je povprečna dnevna količina sončnega

obsevanja na enoto horizontalne površine, P_{inst} pa je nazivna moč elektrarne. Če označimo koeficienta učinkovitosti obeh strani elektrarn kot $k_{EHd,15}$ in $k_{EHd,30}$, pri izračunu pa upoštevamo vrednosti, izračunane z aplikacijo PVGIZ za $E_{d,tilt,15}$, $E_{d,tilt,30}$, $H_{d,hor}$ ter nazivni moči posameznih strani $P_{inst,15}$ in $P_{inst,30}$ kot 15 kWp in 30 kWp, potem je skupna učinkovitost vsota, podana z Enačbo (2).

$$k_{EHd} = k_{EHd,15} + k_{EHd,30}$$
(2)

Napoved moči proizvodnje glede na napovedano sončno obsevanje na horizontalno ploskev $I_{s,n}$ napovemo v skladu z Enačbo (3).

$$P_n = k_{EHd} \times I_{s,n} \tag{3}$$

Napoved sončnega obsevanja $I_{s,n}\left[\frac{kWh}{m^2}\right]$ je za dotično lokacijo mogoče pridobiti preko vremenskega servisa, na primer Meteomedia.

4. MODELIRANJE PORABE ELEKTRIČNE IN TOPLOTNE ENERGIJE

Napoved porabe električne in toplotne energije v stanovanjskih objektih predstavlja problem, ki ga ni mogoče enostavno zapisati kot enoznačen matematični zapis. Poraba električne in toplotne energije je odvisna od človeških zahtev, ki pa se med posamezniki razlikujejo.

Za potrebe optimizacije planiranja shranjevanja energije v baterijah in zalogovniku smo problem napovedovanja porabe energije zasnovali na osnovi stohastičnega modela, generiranega s pomočjo metod umetne inteligence. Postopek izvedbe napovednega modela in izvajanja napovedi je prikazan na Sliki 3.



Slika 3: Proces stohastičnega napovedovanja časovnih vrst

¹ Meteomedia - spletna storitev za napoved vremenskih podatkov za geografsko lokacijo (http://wetterstationen.meteomedia.de/), zadnjič pridobljeno: 20.9.2017

² PVGIZ - Spletna aplikacija za izračun proizvodnje električne energije (http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php), zadnjič pridobljeno: 20.9.2017

4.1 Priprava učnih podatkov

Med delovanjem sistema je potrebno z logiranjem pridobivati zgodovino z datumom in časom opremljenih podatkov o porabi toplotne in električne energije ter podatke o zunanji temperaturi ter jih shranjevati v bazo podatkov. Ker so podatki o električni in toplotni porabi pridobljeni iz električnih števcev in kalorimetrov v obliki energije, jih je potrebno filtrirati, kar obsega:

- izbor zapisov z enakimi časovnimi koraki,
- izračun diferenc za prevod energije v moč,
- skaliranje za zapis v kW,
- brisanje ekstremnih vrednosti in drugih nepravih podatkov.

Postopek priprave učnih podatkov obsega tudi dodajanje atributov, ki določijo dan v tednu, mesec, tip dneva (delavnik / prost dan), čas v dnevu (dopoldan / popoldan).

4.2 Učenje, napovedovanje in vrednotenje

Učenje napovednega modela smo izvedli s pomočjo modula za napovedovanje časovnih vrst v sklopu programskega okolja Weka [3]. Pri tem smo preizkusili delovanje naslednjih algoritmov:

- metoda podpornih vektorjev
- k-ti najbližji sosed z vrednostmi k: 3, 5, 7 in 10
- linearna regresija
- Gaussovi procesi
- metoda naključnih gozdov

Za potrebe vrednotenja delovanja algoritmov smo izvedli simulacijski postopek, ki zajame celotno zgodovino meritev in izvede postopek priprave učno množico podatkov. Za vsakega od zgoraj navedenih algoritmov strojnega učenja v prvem koraku izbere podatkovne instance za prvih 14 dni in testne podatke na naslednji dan, izvede strojno učenje, izdela napovedi in jih shrani. Potem za vsak naslednji dan poveča učno množico za en dan, izvede učenje, izdela napovedi ter jih doda dotedanjim napovedim. Postopek tako iterativno ponavlja, dokler ne naredi napovedi za zadnji dan podatkov.

Po končanem postopku smo vse napovedane vrednosti porabe primerjali z merjenimi vrednostmi in izračunali še srednjo absolutno napako, srednjo relativno napako ter koren srednje kvadratne napake. Na ta način smo pridobili informacijo o uspešnosti posameznih algoritmov napovedovanja in jo uporabili kot podlago za izbor primernega algoritma za delovanje na realnem objektu. Rezultati bodo predstavljeni v naslednjem poglavju.

5. Rezultati in diskusija

Sledeče poglavje predstavlja rezultate vrednotenja modela za napoved proizvodnje sončne elektrarne. Za tem sledi primerjava algoritmov za napovedovanje porabe električne in toplotne energije. Nazadnje bo na kratko predstavljeno še delovanje sistema na realnem objektu, kjer smo simulator priredili za delovanje v produkcijsko verzijo.

5.1 Vrednotenje modela sončne elektrarne

Model sončne elektrarne smo vrednotili tako, da smo primerjali proizvodnjo, napovedano z našim modelom na osnovi napovedanega sončnega obsevanja in izmerjeno proizvodnjo sončne energije. Slika 4 prikazuje rezultate napovedovanja proizvodnje sončne elektrarne. Napovedane in merjene vrednosti so prikazane kot dnevne integrale moči v času – torej dnevne vsote energije. Napaka je prikazana kot razlika med napovedano in dejansko proizvedeno energijo. Prazni prostori na grafu pomenijo izpad meritev zaradi vzdrževalna ali druga dela, ali zaradi napak v komunikaciji in v teh obdobjih ni bilo pridobljenih podatkov, ali pa so bili napačni. Slika 5 prikazuje primer urnih napovedi za obdobje med 1.9.2016 in 5.9.2016.

Rezultati kažejo na zadovoljivo napovedovanje, pri čimer je potrebno upoštevati geografsko razliko med podano vrednostjo sončnega obsevanja za lokacijo vremenske postaje in lokacijo elektrarne. Na proizvodnjo vplivajo tudi dimniki in drevo, ki mečejo senco na elektrarno, predvsem pa je sončna elektrarna močno občutljiva na stopnjo oblačnosti.



Slika 4: Prikaz vsote dnevnih vsot napovedi, dnevnih vsot meritev proizvodnje in napake (maj 2016 – januar 2017)



Slika 5: Prikaz urnih napovedi proizvodnje, meritev proizvodnje ter napako za obdobje med 1.9. in 5.9.2016

Napake dnevnih vsot napovedi so razmeroma nizke in ker sistem vsebuje baterije, se urne napake kompenzirajo tekom dneva in posledično natančnost urnih napovedi ne pomeni zadovoljivo delovanje, ki bo potrebno pri kasnejši izvedbi planiranja nakupa, prodaje in hranjenja električne energije.

5.2 Vrednotenje in primerjava algoritmov za napoved porabe energije

Primerjava algoritmov je prikazana v Tabeli 1. Posamezni stolpci vsebujejo različne izvedbe algoritmov. Za vsako od množic napovedi, ki so bile izvedene z različnimi algoritmi smo izračunali naslednje tipe napak: koren srednje kvadratne napake, srednjo kvadratno napako, srednjo napako, srednjo absolutno in srednjo odstotno absolutno napako ter standardni odklon napake. Stolpci so obarvani tako, da zelena barva prikazuje boljše rezultate, rdeča pa slabše.

	Metoda							
	podpornih	Linearna					Naključni	Gaussovi
	vektorjev	regresija	kNN, n=3	kNN, n=4	kNN, n=5	kNN, n=6	gozdovi	procesi
koren sr. kvadratne napake	1.838	1.883	1.978	1.958	1.929	1.919	1.685	1.766
sr. kvadratna napaka	3.379	3.545	3.914	3.835	3.723	3.681	2.841	3.119
sr. napaka	0.060	-0.154	0.043	0.012	-0.001	-0.001	-0.124	-0.112
sr. absolutna napaka	1.403	1.430	1.507	1.493	1.473	1.465	1.282	1.350
standardni odklon napake	1.837	1.877	1.978	1.958	1.929	1.919	1.681	1.763
sr. odstotna abs. napaka	28.80%	31.39%	31.35%	31.50%	31.36%	31.43%	28.15%	28.97%

Tabela 1: Primerjava algoritmov za napovedovanje električne in toplotne energije

Najboljši algoritem je označen z poudarjenimi črkami v tabeli. Podatki, ki smo jih uporabili za vrednotenje algoritmov, so bili pridobljeni v obdobju med 26.6.2016 in 24.10.2016.

Že prvi pogled na tabelo pokaže, da najboljše rezultate izkazuje algoritem naključnih gozdov po skoraj vseh kriterijih. Ta algoritem se v primerjavi z drugimi, predvsem 5. in 6. najbližjim sosedom, izkaže kot slab le v kategoriji srednje napake. Dober rezultat kaže tudi algoritem Gaussovi procesi, kar je ugodno zaradi hitrega učenja modela v primerjavi z naključnimi gozdovi.

Kljub temu, da je kategorija srednje napake pomembna, saj se podobno kot pri proizvodnji tudi poraba energije tekom časa kompenzira zaradi hranilnikov energije, smo se za implementacijo na realnem modelu odločili za implementacijo algoritma naključnih gozdov na realni sistem. Slika 6 prikazuje urne napovedi porabe električne energije za obdobje med 10.8. in 14.8.2016. Slika



Slika 6: Prikaz urnih napovedi porabe električne energije za obdobje med 10.8. in 14.8.2016



Slika 7: Prikaz urnih napovedi toplotne energije za obdobje med 21.11. in 25.11.2016

6. ZAKLJUČEK

V prispevku je opisan postopek modeliranja in uporabe napovednih modelov za proizvodnjo in porabo električne in porabo toplotne energije. Modeliranje proizvodnja električne energije je izvedeno na osnovi matematičnega modela preko logičnih fizikalnih relacij saj je odvisna od sončnega obsevanja. Poraba električne in toplotne energije pa je poleg stanja vremena – zunanje temperature odvisna tudi od uporabnikov stanovanja, kar je razlog za izvedbo stohastičnih napovednih modelov, ki uporabljajo metode strojnega učenja. V prispevku so poleg modeliranja prikazane tudi metode za izbor algoritma strojnega učenja. Rezultati prikazujejo uspešno izvedbo na realnem objektu.

7. ZAHVALA

Izvedbo raziskav in razvoja so omogočili podjetje Hitachi Chemical, ltd. v sklopu projekta »Self-consumption HEMS with PV and battery demonstration project«, projekt EcoSmart in Agencija Republike Slovenije za Raziskovalno dejavnost v sklopu programa »Spodbujanje zaposlovanja mladih doktorjev znanosti« in projekta ARRS-MDR-ZP-2017-02.

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Avtomatizacija in digitalizacija vrta

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POVZETEK

Prispevek opisuje razvoj sistema digitalizacije in avtomatizacije agrikulturnih oziroma vrtnih površin. Sistem je sestavljen iz treh glavnih delov. Oddaljeni moduli imajo priključene senzorje za temperaturo in vlago zraka, vlažnost zemlje ter osvetljenost okolice. Oddaljeni moduli imajo tudi funkcijo avtomatičnega zalivanja. Glavni modul sprejema podatke iz oddaljenih modulov in jih posreduje strežniku. Na strežniku je podatkovna baza za shranjevanje podatkov in spletna stran za pregled teh podatkov.

Splošni izrazi

Agrokultura, meritve, pošiljanje podatkov, testiranje.

Ključne besede

Digitalizacija, avtomatizacija, senzorika, baza podatkov.

1. UVOD

V dobi hitro spreminjajočega sveta se spreminjajo tudi najbolj osnovne človekove dejavnosti, kot je pridelava sadja in zelenjave. S tem povezani postopki se poskušajo avtomatizirati, okoljski parametri pa zajeti z računalniki oziroma digitalizirati. Podatki digitalizacije se selijo na splet. Tam se spremljajo in iz njih razbirajo razmere zraka, sonca in zemlje, kjer se vzgajata sadje in zelenjava. Iz teh podatkov je razvidno, kako se razmere spreminjajo preko dneva, skozi letne čase in kako se skozi leta spreminjajo podnebne razmere. Na začetku je bil namen avtomatizacije poljedelskih in vrtnih površin zmanjšati in poenostaviti delo pridelovalcev in oskrbnikov. Sistemi so bili preprosti in nepovezani, namenjeni so bili predvsem intervalnemu zalivanju površin, kar pa ni bilo vedno usklajeno s pomembnimi zunanjimi dejavniki, kot sta trenutna namočenost zemlje in osončenost zemljišča. Vpliv enega in drugega je lahko za rastline uničujoč, v prvem primeru povzroči gnitje, v drugem učinek povečevalnega stekla na moč sončnih žarkov. Kasneje so se sistemi izboljšali in začeli upoštevati zunanje dejavnike ter se jim prilagajati. Nadzorovali so izvajanje različnih potrebnih aktivnosti - poleg zalivanja so ogrevali tople grede, optimizirali vlago v zraku, zastirali sonce s premičnimi strehami,

Agrikultura je največja in za človekov obstoj ena izmed najbolj pomembnih panog. Pod besedo agrikulturo spadata kmetijstvo in poljedelstvo. Z namenom kvalitetne avtomatizacije in digitalizacije smo izdelali sistem, ki je prilagodljiv glede na velikost in število agrikulturnih površin, prav tako pa sistem uporabniku na prijazen način ponuja podatke, ki mu omogočajo kvalitetno vzgojo zdravega sadja in zelenjave.

2. PARAMETRI ZA NADZOR AGRIKULTURNIH POVRŠIN

Pri izbiri parametrov, ki smo jih želeli nadzorovati na agrikulturnih površinah, smo se odločali na podlagi dveh kriterijev pomembnost [1]: za rast in razvoj rastlin in obstoju senzorjev za merjenje tega parametra. Npr. parameter pH (kislost ali bazičnost zemlje) je pomemben za zdrav razvoj rastline, a senzor, ki bi ga meril, ni preprost za uporabo. Potrebno ga je namreč vsake toliko časa kalibrirati z različnimi raztopinami \cite{ph}, nezanemarljiva pa je tudi izrazito višja cena v primerjavi z ostalimi senzorji. Izbrani parametri, ki so bili smiselni pri našem projektu, so:

- <u>svetloba</u>; spada med najpomembnejše dejavnike za rast in zdrav razvoj vsake rastline. Rastlina s pomočjo svetlobe ustvarja fotosintezo, biokemijski proces, ki ji omogoča, da le-to pretvori v energijo za lastno rast
- temperatura; prav tako eden izmed nepogrešljivih dejavnikov za rastlino. Večina rastlin uspeva med 0°C in 50°C. Optimalna temperatura skozi dan, skozi noč in najvišja še sprejemljiva temperatura za rastlino pa so različne za posamezne rastline
- <u>vlaga zraka</u>; je količina razpršene vode v zraku, ta količina pa je povezana s temperaturo zraka. Toplejši zrak ima zmožnost zadržati več vode kot hladnejši
- <u>vlaga zemlje</u>; je količina vode v zemlji, prav tako pomembna za obstoj rastline. V primeru, da je vlaga zemlje visoka dlje časa, obstaja nevarnost, da rastlina zgnije. Če je vlage premalo, pa rastlina ne more vsrkati dovolj vode in odmre zaradi pomanjkanja

3. DELOVANJE SISTEMA

3.1 Oddaljeni moduli

Oddaljeni moduli delujejo na Arduino mikrokrmilniku in so namenjeni temu, da se postavijo na vrtne površine in brezžično glavnemu modulu pošiljajo podatke, ki jih beležijo s pomočjo vgrajenih senzorjev. Prav tako omogočajo samodejno zalivanje vrtov z vgrajenim relejem, ki preko ventila sproža dovod vode do namakalnih sistemov. Uporabljeni senzorji na oddaljenih modulih:

- senzor FC-28; za merjenje vlage zemlje
- senzor DHT-11; za merjenje vlage zraka in temperature okolice
- foto upor; za merjenje osvetljenosti
- modul nRF24l01; za brezžično komunikacijo z glavnim modulom

3.2 Glavni modul

Glavni modul deluje na mini računalniku Raspberry Pi [2], na katerem teče programska koda, napisana v programskem jeziku Python. Ta sprejema podatke iz oddaljenih modulov, nato pa jih posreduje naprej na strežnik. Podatke iz oddaljenih modulov pridobiva s pomočjo serijske komunikacije, saj je preko USB vodila povezan na Arduin-a, ki s pomočjo modula nRF24101 [3] komunicira z oddaljenimi moduli. Glavni modul uporablja:

- senzor DHT-11; za merjenje vlage zraka in temperature okolice
- senzor BMP085; za merjenje zračnega pritiska

3.3 Strežnik in spletna stran

Tretji del predstavlja strežnik, na katerem je podatkovna baza, ki shranjuje podatke, katere dobiva iz glavnega modula. Na strežniku se nahaja tudi spletna stran, ki končnemu uporabniku na preprost način prikazuje relevantne podatke iz njegovih vrtov. Ti podatki, ki jih lahko spremlja od kjerkoli, mu omogočajo pregled nad trenutnim dogajanjem na njegovem vrtu. Ti uporabniku pomagajo pri odločitvah za možne izboljšave na vrtu. Poenostavljen prikaz vidimo na sliki 1.



Slika 1: Poenostavljen prikaz delovanja

3.4 Samodejno zalivanje

Naš oddaljen modul ima tudi možnost namakanja zemlje, ki se zgodi pod določenimi pogoji, ki so prikazani na sliki 2. Sistem deluje s pomočjo solenoidnega ventila. To je vodni ventil, ki ga lahko po želji vključimo ali izključimo z dovodom električnega toka. Ta ventil deluje na 12V napetost, zato je bila potrebna baterija s takšno napetostjo. Dovod napetosti, da se ventil odpre, se regulira s 5V relejem, ki smo ga lahko upravljali direktno iz Arduina-a. Na začetek in konec ventila smo namestili nastavek za povezavo na navadno vrtno cev, katere en konec gre na dovod vode, drugi konec cevi pa se priključi na nastavek za zalivanje, npr. škropilnik, porozna cev za namakanje. Kot alternativa solenoidnega ventila za manjše vrtove oziroma lončnice je priključitev na majhno vodno črpalko.



Slika 2: Posplošen prikaz algoritma za zalivanje

4. STREŽNIK IN SPLETNA STRAN

4.1 Strežnik

Glavna funkcija našega strežnika je pridobivanje podatkov iz oddaljenih modulov, jih shraniti v podatkovno tabelo in nato posredovati spletni strani, ki jih prikaže. Naš strežnik temelji na ASP.NET [4] platformi, programski jezik, ki smo ga uporabljali je C#, za programersko okolje smo uporabili Microsoft-ov program Visual Studio.

4.2 Spletna stran

Spletna stran je namenjena prezentaciji podatkov iz vrtov uporabniku. Želeli smo, da je spletna stran:

- preprosta za uporabo
- pregledna in nenasičena
- daje uporabniku le pomembne podatke
- uporabna tudi na mobilnih napravah

Kot že omenjeno, naša spletna stran pridobiva podatke iz modulov preko GET ukaza iz strežnika. Ta ukaz se sproži ob zagonu spletne strani. Od podatkov iz glavnega modula spletna stran uporabi le zadnji vnos v podatkovno tabelo. To dobimo s pomočjo SQL ukaza TOP in jih sortiramo po datumu. Ti podatki so le informativne narave. Iz oddaljenih modulov se uporabi za grafični prikaz le nekaj zadnjih podatkov (ob zagonu spletne strani zadnjih 500 podatkov), število le-teh lahko določimo s pomočjo znaka + in - ob grafu ter s tem spreminjamo časovni razpon na grafu. Preberejo se še podatki kot so koordinate in ime vrta. Prikaz grafa enega izmed vrtov, med zalivanjem, na sliki 3.



Slika 3: Graf enega izmed vrtov

Spletna stran je narejena v AngularJS, ki je odprtokodno ogrodje za izdelavo dinamičnih spletnih strani. V našem projektu smo uporabili precej knjižnic in en API za pridobivanje podatkov. API je namenjen pridobivanju trenutnih vremenskih razmer. API deluje tako, da spletni naslov spremenimo na naše koordinate vrta. Ta pa nam nazaj v obliki XML sporoča trenutne razmere. V našem projektu uporabimo trenutno temperaturo, ki jo lahko primerjamo z izmerjeno s strani naših modulov in trenuten opis vremenskih razmer, npr. oblačno, megleno, ...

4.3 Elektronsko obveščanje uporabnika

V naš projekt smo dodali še elektronsko obveščanje skrbnika vrta v primeru, ko vlažnost zemlje pade pod določeno kritično vrednost. To se lahko zgodi v treh primerih:

- možnost mehanske napake ni dovoda vode, ker se le-ta nekje v sistemu prekine
- nepovezanost oddaljenega modula z ventilom, ki sprošča dovod vode ali pa se ventil pokvari
- izsušitev zemlje, kadar ni vode v vodovodnem sistemu

Sistem obveščanja se sproži, kadar senzor pokaže vrednost med 50 in 10. To pomeni, da je zemlja suha. Ne more pa se sprožiti, če pade vrednost pod 10, ker to z veliko verjetnostjo pomeni, da je bil modul iztaknjen iz zemlje. Ko dobimo podatek iz modula, da je na vrtu zemlja suha, se na elektronski naslov pošlje sporočilo, da je na točno določenem vrtu (npr. tomato garden) močno padla vlažnost zemlje. To elektronsko sporočilo se pošilja na največ triurne intervale, da ne poplavimo elektronskega nabiralnika. Elektronski naslov je lahko drugačen za vsak vrt posebej, kar je uporabno, če imajo vrtovi različne oskrbovalce, saj s tem vsakemu posebej pošlje sporočilo samo za njegov vrt.

5. TESTIRANJE

Projekt smo testirali na čiliju, vrsti paprike, ki je občutljiva rastlina in za zdrav razvoj zahteva ugodne pogoje. Odločili smo se za vrsto Carolina Reaper, ki je v času izdelave tega projekta najmočnejši čili na svetu. Semena smo sprva posadili v skupen lonček, ko pa so rastlinice razvile po dva para listkov, smo jih po štiri do pet razdelili v štiri različne testne lončke. Vsi lončki so imeli isti vir svetlobe in čas osvetlitve - žarnica, ki je gorela 12 ur na dan, s čimer smo simulirali idealno osvetlitev, ki jo ta vrsta rastline potrebuje. Lončki so se med seboj razlikovali le glede na režim namakanja. Poimenovali smo jih s črkami od A do D:

- skupina A namakanje je bilo samodejno s pomočjo našega algoritma zalivanja
- skupina B ročno zalivanje glede na podatke, ki jih je uporabnik izvedel iz naše spletne strani
- skupina C ročno zalivanje vsak tretji dan ob isti uri
- skupina D ročno zalivanje "po občutku"

6. REZULTATI

Rezultate testiranja smo analizirali po dveh mesecih, tako da je vsak lonček imel dovolj časa za rast in razvoj. Rezultati pa so sledeči:

- skupina A; Vse štiri rastline so razvile podobno velikost, kar nam sporoča, da je bila voda enakomerno razporejena po celotnem lončku. Vse rastline so zdrave, kar nam pove, da so bili pogoji za rast dobri. Zemlja ni bila nikoli preveč razmočena in nikoli presuha. S to skupino smo bili zadovoljni, saj nam je v praksi pokazala, da je naš algoritem zalivanja pravilno in dobro deloval.
- skupina B; Razvile so se vse štiri rastline, vendar so bile dokaj različne glede višine. Ena izmed njih je izstopala, ostale so bile precej nižje, a še vedno nekoliko manjše kot rastline v skupini A. Večina rastlin iz te skupine je bila zdravega izgleda, le najvišja je, zaradi hitre rasti, imela tanko in krhko steblo. Predvidevamo, da je do opisane razlike prišlo iz dveh razlogov. Po eni strani ročno zalivanje lahko privede do neenakomerne navlaženosti zemlje. Tako smo včasih zalili vse rastline enako, včasih pa je bila kakšna bolj, druga manj zalita. Po drugi strani pa je ročno zalivanje manj optimalno glede na dejansko vlažnost zemlje, kot če je avtomatsko. Vendar smo tudi s temi rezultati bili zadovoljni, saj so nam sporočali, da sistem dobro deluje tudi, če nas samo opozarja, kdaj moramo zalivati rastline.
- skupina C; Razvile so se vse štiri rastline, vendar precej različno. Ena rastlina je na robu preživetja, dve rasteta počasi. Le ena od štirih rastlin je dokaj primerne rasti. Samo dve od štirih rastlin izgledata zdravi. Tretja ima rumene listke, četrta je izrazito zakrnela. Vzrok izraziti raznolikosti v izgledu rastlin je verjetno le močno nihanje namočenosti zemlje, ki se je lahko v treh dneh popolnoma izsušila ali pa je bila še vlažna, ko je bil čas ponovnega zalivanja. Torej rastline v bistvu nikoli niso bile primerno zalite. Ta test nam je nazorno pokazal, da

avtomatično časovno namakanje slabo zadosti potrebam rastline po vodi.

- skupina D; V tej testni skupini sta od posajenih petih rastlin dve propadli. Preostale tri so se v višino razvile različno. Preostale rastline izgledajo zdrave, vendar so v povprečju precej nižje kot v testih A in B. Le ena od rastlin je dosegla podobno velikost kot v prvih dveh skupinah. Vzrokov za takšen rezultat je več neenakomerno zalivanje, različni časovni intervali, včasih je oseba na rastline pozabila, včasih pa jih je premočno zalila. S tem testom smo dobro ponazorili običajno zalivanje rastlin. Tudi rezultati so temu primerni.

Na sliki 4 so prikazani lončki po dveh mesecih rasti.



Slika 4: Lončki po dveh mesecih

7. ZAKLJUČEK

V našem projektu smo si zadali nalogo izdelati sistem, ki bi omogočal digitalizacijo in avtomatizacijo vrtnih površin. Sistem deluje na principu glavnega modula, ki sprejema podatke oddaljenih modulov. Oddaljeni moduli so postavljeni po vrtovih, iz katerih želimo pridobivati podatke, pomembne za zdravo rast in razvoj rastlin. Sistem omogoča tudi avtomatično zalivanje vrtov. Zalivanje se prilagaja trenutnim razmeram na vrtu in dejanski potrebi rastlin po vodi, s principom logike čakanja pa se voda enakomerno razporedi po zemlji pred ponovnim namakanjem. Sistem uporabniku nudi tudi spletno stran, preko katere lahko spremlja svoje vrtove, prav tako omogoča obveščanje preko spletne pošte v primeru, da se zemlja na vrtu preveč izsuši.

V splošnem pa smo z delovanjem projekta zadovoljni. Sistem deluje podobno, kot smo si ga že na začetku zamislili. Najbolj nas je prepričalo testiranje našega sistema, ki smo ga implementirali v razvoj sadik čilija. Rezultati so zanesljivo govorili v prid našega projekta, saj so tako občutljive rastline, zalivane z našim sistemom zalivanja, zrasle najvišje in bile med najbolj zdravimi sadikami.

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