Katerina Zdravkova
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ICT Innovations 2022

Reshaping the Future Towards a New Normal

14th International Conference, ICT Innovations 2022
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Preface

This volume contains the best papers and the extended abstracts of keynote talks of 14th ICT Innovations 2022, which was held at the Faculty of Computer Science and Engineering (FCSE) in Skopje from September 29 to October 1, 2022. After two years of online events due to the restrictions caused by COVID-19 pandemic, this edition was hybrid, uniting more than 50 researchers in-person and additional 50 participants who joined the conference, the poster session and the satellite workshops virtually. We cordially thank FCSE computing center staff, who created and maintained an impeccable working environment.

The focal topic of 14th ICT Innovations 2022 was "Reshaping the future towards a new normal". Four keynote speakers prepared talks in line with the topic.

By the final deadline on 30 June 2022, 42 papers prepared by 119 authors from 15 countries were submitted. They were thoroughly examined and graded by 108 reviewers from 33 countries. For each paper, four to five reviewers were assigned, all coming from different countries than the authors. The review process was double-blind, increasing the objectivity of the judgements. The best 14 papers are part of these proceedings. Additionally, 15 papers and three posters were accepted. They are published in the conference web proceedings.

The papers were related to many topic areas, which were clustered into the follow-ing: artificial intelligence applications; business and application software; computer sciences and edge computing; education; health (medical) informatics; and signal processing and machine learning.

For the first time, a best paper was awarded. A joint jury consisting of program and scientific committee members made the decision to award the paper: "An explo-ration of autism spectrum disorder classification from structural and functional MRI images".

The conference was organized by the Association for Information and Communi-cation Technologies (ICT-ACT), whose main goal is to support the development of information and communication technologies, especially in the area of education, research and application of innovative technologies. The conference was supported and hosted by the Faculty of Computer Science and Engineering of the University Ss. Cyril and Methodius in Skopje, the oldest and the best university in Macedonia. It was officially opened by Ordan Chukaliev, vice-rector for international cooperation.

We cordially thank all the authors, chairpersons, scientific and program committee members, reviewers, sub-reviewers, technical committee members, and, in particular, ICT-ACT chair Sasho Gramatikov, whose enthusiasm, proactivity and considerate support inspired us to finish our obligations timely.

We were privileged that our distinguished keynote speakers accepted the invitation and gave the impressive talks: "AI ethics as ecosystems ethics? Towards a new nor-mal of understanding ethical issues in AI" (Bernd Carsten Stahl, De Montfort Univer-sity, UK; online); "Strange roads" (Kai Kimppa, University of Turku, Finland; in-person);

"The new normal: innovative informal digital learning after the pandemic" (John Traxler, University of Wolverhampton, UK; online); and "AI-based approaches in processing big data in precision medicine" (Mirjana Ivanovic, University of Novi Sad, Serbia; in-person). We are grateful to all the presenters and conference partici-pants for their provoking contributions. They helped to made ICT Innovations 2022 a successful event.

We look forward to seeing you at the jubilee 15th edition of the conference next year.

October 2022

Katerina Zdravkova
Lasko Basnarkov

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Keynote Talks
(Extended Abstracts)

AI Ethics as Ecosystems Ethics? Towards a New Normal of Understanding Ethical Issues in AI

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Abstract. This brief overview document outlines some of the key ideas developed with regards to how we may look at questions of the ethics of AI in future. It is based on prior research undertaken in the context of the EU project SHERPA which explored empirical and conceptual aspects of the current engagement with AI. It proposes that the use of the metaphor of an ecosystem may be helpful in understanding AI. If accepted, this position raises numerous follow-on questions about how ethics of ecosystems can be conceptualized and implemented.

Keywords: Artificial intelligence · Ecosystems · Ethics

1 Introduction

When we talk about the "new normal" in the autumn of 2022, we typically refer to the way things will go in future, after the ebbing of the Covid pandemic when individuals and societies have found ways of coping with this new and persistent health threat. It typically refers to questions such as the future of work, changing travel practices or heightened attention to the importance of personal hygiene in preventing infections. The new normal can also be interpreted more broadly, looking at other social changes, e.g. the use and consumption of energy in light of the looming climate catastrophe or ways in which societies deal with fuel and other poverty.

In this short abstract, I will propose a new normal for a different type of topic, which nevertheless has potential bearings on all of the above topics, namely how we see artificial intelligence (AI) and the ethical issues that are linked to it. In the next section I will propose the use of the metaphor of an ecosystem to describe AI and explain why this is a suitable perspective. The final section will then look at the challenges that adopting this perspective entails.

2 AI as an Ecosystem

The idea to describe AI as an ecosystem is not new. References to AI ecosystems can frequently be found, in particular in policy-oriented documents, such as [1–3]. The attractions of this approach are easy to see. AI is not a monolithic technology, but rather a family of socio-technical systems that share some characteristics, notably the use of some digital technologies, most prominently machine learning. The ecosystems metaphor can accommodate the fact that there are many different and changing members of the systems and that there are nested systems of different sizes (e.g. organizational, national, international) that share this socio-technical nature. Ecosystems are furthermore not easily governed, as the relationships between their members tend to be complex, non-linear and often unpredictable.

This unpredictable nature of AI ecosystems is a reason for using the metaphor when talking about the ethics of AI. AI ecosystems consist of many different human, technical and organizational stakeholders. They raise a multitude of possible ethical and social concerns, many of which have no simple and obvious solutions. Elsewhere we have tried to explore what the use of the ecosystems metaphor means for the ethics of AI [4–6]. From this work arise a number of proposals of how AI ecosystems could be shaped in a way that would be conducive to human flourishing. We developed recommendations around three main areas: the delimitation of ecosystems, governance structures of ecosystems and the knowledge base of ecosystems. We propose that these different recommendations, taken together, offer the opportunity to better identify and address ethical and social concerns about AI.

3 Ethics and Systems – Future Challenges

While the use of the metaphor of an ecosystem provides a useful way of thinking about AI and its ethical issues, it also raises some new concerns. Ethical theory traditionally does not deal well with systems. Most approaches to ethics focus on the individual human being as the place of ethics and moral responsibility. Some suggestions have been made that clearly structured organizations might count as moral agents as well [7]. But loose agglomerations of agents such as those we find in an ecosystem are typically not covered by ethical theory.

This is a problem for moral philosophy, but it is one that translates into a problem of the practice of dealing with the ethics of AI. If ethics requires an individual rational agent but the ethical consequences of AI arise due to systems-based interaction, then there is no simple way of addressing these ethical issues.

It is therefore worth thinking about what an ethics of large socio-technical systems would look like. This calls for conceptual developments but also for empirical research to better understand how ethics is perceived and enacted in practice. This research programme will not only be important for dealing with the ethics of AI, but will have broader repercussions for the ethics of emerging technology more broadly. In light of the ever-growing importance of such emerging technologies for all aspects of human life, I believe that this research programme should be adopted with high priority.

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Managing Health Data Using Artificial Intelligence

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Abstract. Nowadays significant number of people suffer from a range of diseases. Also, population is getting older and older. It causes emergent need to produce a variety of medical and healthcare services that will help them to cope well with everyday activities. In this short paper we will put light on important aspects of health data management in order to achieve better patients' treatments.

Keywords: Machine learning · Health data management · Complex health data

1 Introduction

Modern population is facing everyday stressful situations, tense communication with other people, but also numerous unhealthy habits. There are a lot of possible circumstances, global serious health diseases like Covid-19 pandemic, that badly influence individual's health conditions. These key factors significantly increase appearance of critical health problems like cardiovascular, cancer, neurological, and others. Accordingly different key medical players and stakeholders initiated development of a range of medical/health platforms, frameworks and services with aim to help sick people to keep and even increase their quality of life (QoL) and wellbeing [1].

To achieve better diagnosis, treatment and propose better medical interventions it is necessary to have adequate datasets that contain comprehensive info of patients' health status, about disease, follow-ups, nutrition data, activity data and so on. Health data management is first step for preparation useful datasets for training personalized predictive machine learning (ML) models that will be used in everyday practice and support better medical decisions. After achieving reliable predictive models, it is necessary to present obtained results to physicians in more understandable and friendly way using techniques of data visualization and explainable artificial intelligence [1].

In the rest of the paper, we will briefly present key steps in processing big health data and some aspects of influences of AI techniques to support medical decisions.

2 Health Data Management

Monitoring health conditions is necessary to help physicians to better maintain patient's wellbeing. It is also essential step towards better prevention in decreasing appearance of serious diseases. Nowadays almost unavoidable is trend of using different smart and wearable devices for collection additional data of patient's activities [2] like weight, heart rate, number of steps, calories burned, sleep stages, and so on. Such additional sources of patient's data can increase reliability of developed predictive models.

To process patients' health records stored in databases and enhanced with additional sources like data from wearable devices, nutrition data, environmental data different health terminologies and ontologies have been used to achieve great level of standardization in data representations. These approaches support higher level of interoperability between different health information systems, services and data sources. Apart from necessary processes of standardization it is required to prepare datasets in forms suitable for processing using advanced techniques of artificial intelligence (AI) and ML.

The process of data aggregation is important step in producing compact patients' health records combining information from multiple sources. Individual patient's data are useful for physicians to make more effective treatment decisions, but they are limited only on the particular case. However, possibility to aggregate health data of numerous similar cases offers to a physician better understanding of status of a patient and helps to make better decisions. Aggregate management is crucial in patients' treatment as offers important insight in his/her health status [3].

Privacy preserving [4] is specific requirement in all situations when sensitive patients' data are exposed and should be used within health platforms, systems, and services. To prevent discovering sensitive patients' data at any stage of processing and using achieved results there are numerous techniques for de-identification like: Character/record masking, Shuffling, Anonymization, Collectively de-identification, Pseudonymization, Generalization. Apart from some widely use privacy preserving techniques like K-anonymity, L-diversity, and T-Closeness nowadays techniques as Differential privacy and Homomorphic Encryption plays essential role in big Cloud/Edge health architectures for processing complex health data [5].

Differential privacy is the systematic randomized modification that can be applied on dataset or on algorithm used for processing data in order to reduce information about the single patient. Homomorphic Encryption is security preserving technique that enables arithmetic operations on ciphertexts without need to decrypt original data. It is popular way to protecting sensitive patients' data leakage in distributed environments.

3 Health Data – AI/ML Models Development – Use of Models

From the point of view of application of powerful AI and specifically ML methods for processing big health datasets it is very important to have good quality patients' data. Incorrect and unclean data usually lead to wrong results and consequently negatively influence health decisions. For successful processing and use of health data several consecutive steps should be followed: Understanding of particular health domain and problem to be tackled; Think about ML aspects and collect necessary data; Data cleaning in order to correct inconsistencies and deal with missing values; Feature engineering that will help in selecting most influential features within available data-types; Train predictive models, evaluate them and use them for predictions; Visualize predictive models results in friendly form to be presented to physicians and health stakeholders.

Essential step when health data is cleaned and properly aggregated is building predictive models. Nowadays very popular approaches are Neural networks and Deep learning. These techniques reach very good performances however their results are usually hard to be interpreted/visualized. Therefore, simpler classification and regression techniques which are also very powerful in processing health date are applied. Their advantage is that results can be easily visualized and presented using explainable AI.

Usual classification learning algorithms used for processing health data are: Naive Bayes, K-nearest neighbors, Decision Trees, (bagging) Classification and Regression Trees, C5.0, Random Forests, Logistic Regression, Artificial Neural Network, Support Vector Machines and Linear Discriminant analysis. Characteristics regression approaches that are usually used for predicting numeric values, specific interventions or continuous variable are: Linear regression, Ridge regression, Lasso regression, Elastic net regression, Kernel ridge regression, regression by Support vector machines, Regression by random forests, and K-nearest neighbors [1, 6].

4 Conclusion

Rapid technological development, stressful style of life cause higher appearance of serious and chronic diseases. On the other hand, individual's QoL and wellbeing are getting to be more and more important. Emergent technologies and powerful AI techniques supports efficient big health data processing and offers better health services and more reliable medical decisions that help in increasing patient' QoL [7]. Unfortunately, personalized medicine has some limitations [6] that should be solved in order to support reliable use in everyday practice in hospitals and healthcare institutions.

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