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Challenges for Smart Environments – Human-Centered Computing, Data Science, and Ambient Intelligence

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Data Science and Information-theoretic Approaches for Smart Systems, and Technical Challenges for Smart Environments

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Modern technologies and various domains of human activities increasingly rely on data science to develop smarter and autonomous systems. This trend has already changed the whole landscape of the global economy becoming more AI-driven. Massive production of data by humans and machines, its availability for feasible processing with advent of deep learning infrastructures, combined with advancements in reliable information transfer capacities, open unbounded horizons for societal progress in close future. Quite naturally, this brings also new challenges for science and industry.

In that context, Internet of things (IoT) is an enormously huge factory of monitoring and data generation. It enables countless devices to act as sensors which record and manipulate data, while requiring efficient algorithms to derive actionable knowledge. Billions of end-users equipped with smart mobile phones are also producing immensely large volumes of data, being it about user interaction or indirect telemetry such as location coordinates. Social networks represent another kind of data-intensive sources, with both structured and unstructured components, containing valuable information about world's connectivity, dynamism, and more. Last but not least, to help businesses run smoothly, today's cloud computing infrastructures and applications are also serviced and managed through measuring huge amounts of data to leverage in various predictive and automation tasks for healthy performance and permanent availability. Therefore, all these technology areas, experts and practitioners, are facing innovation challenges on building novel methodologies, accurate models, and systems for respective data-driven solutions which are effective and efficient. In view of the complexity of contemporary neural network architectures and models with millions of parameters they derive, one of such challenges is related to the concept of explainability of the machine learning models. It refers to the ability of the model to give information which can be interpreted by humans about the reasons for the decision made or

recommendation released. These challenges can only be met with a mix of basic research, process modeling and simulation under uncertainty using qualitative and quantitative methods from the involved sciences, and taking into account international standards and adequate evaluation methods.

Based on a successful funded collaboration between the American University of Armenia, the University of Duisburg-Essen and the University of Chile, in previous years a network was built, and in September 2020 a group of researchers gathered (although virtually) for the 2nd CODASSCA workshop on "Collaborative Technologies and Data Science in Smart City Applications". This event has attracted 25 paper submissions which deal with the problems and challenges mentioned above. The studies are in specialized areas and disclose novel solutions and approaches based on existing theories suitably applied.

The authors of the best papers published in the conference proceedings on Collaborative Technologies and Data Science in Artificial Intelligence Applications by Logos edition Berlin were invited to submit significantly extended and improved versions of their contributions to be considered for a journal special issue of J.UCS. There was also a J.UCS open call so that any author could submit papers on the highlighted subject. For this volume, we selected those dealing with more theoretical issues which were rigorously reviewed in three rounds and 6 papers nominated to be published.

The editors would like to express their gratitude to J.UCS foundation for accepting the special issues in their journal, to the German Research Foundation (DFG), the German Academic Exchange Service (DAAD) and the universities and sponsors involved for funding the common activities and thank the editors of the CODASSCA2020 proceedings for their ongoing encouragement and support, the authors for their contributions, and the anonymous reviewers for their invaluable support.

The paper "Incident Management for Explainable and Automated Root Cause Analysis in Cloud Data Centers" by Arnak Poghosyan, Ashot Harutyunyan, Naira Grigoryan, and Nicholas Kushmerick addresses an increasingly important problem towards autonomous or self-X systems, intelligent management of modern cloud environments with an emphasis on explainable AI. It demonstrates techniques and methods that greatly help in automated discovery of explicit conditions leading to data center incidents.

The paper "Temporal Accelerators: Unleashing the Potential of Embedded FPGAs" by Christopher Cichiwskyj and Gregor Schiele presents an approach for executing computational tasks that can be split into sequential sub-tasks. It divides accelerators into multiple, smaller parts and uses the reconfiguration capabilities of the FPGA to execute the parts according to a task graph. That improves the energy consumption and the cost of using FPGAs in IoT devices.

The paper "On Recurrent Neural Network based Theorem Prover for First Order Minimal Logic" by Ashot Baghdasaryan and Hovhannes Bolibekyan investigates using recurrent neural networks to determine the order of proof search in a sequent calculus for first-order minimal logic with a history mechanism. It demonstrates reduced durations in theorem proving.

The paper "Incremental Autoencoders for Text Streams Clustering in Social Networks" by Amal Rekik and Salma Jamoussi proposes a deep learning method to identify trending topics in a social network. It is built on detecting changes in streams

of tweets. The method is experimentally validated to outperform relevant data stream algorithms in identifying "hot" topics.

The paper "E-Capacity–Equivocation Region of Wiretap Channel" by Mariam Haroutunian studies a secure communication problem over the wiretap channel, where information transfer from the source to a legitimate receiver needs to be realized maximally secretly for an eavesdropper. This is an information-theoretic research, which generalizes the capacity-equivocation region and secrecy-capacity function of the wiretap channel subject to error exponent criterion, thus deriving new and extended fundamental limits in reliable and secure communication in presence of a wiretapper.

The paper "Leveraging Multifaceted Proximity Measures among Developers in Predicting Future Collaborations to Improve the Social Capital of Software Projects" by Amit Kumar and Sonali Agarwal targets improving the social capital of individual software developers and projects using machine learning. Authors' approach applies network proximity and developer activity features to build a classifier for predicting the future collaborations among developers and generating relevant recommendations.