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Graph-Based Representation and Reasoning

27th International Conference
on Conceptual Structures, ICCS 2022
Münster, Germany, September 12–15, 2022, Proceedings

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Preface

The 27th edition of the International Conference on Conceptual Structures (ICCS 2022) took place in Münster, Germany, during 12–15 September, 2022, under the title "Graph-based Representation and Reasoning". Since 1993, ICCS has been a yearly venue for publishing and discussing new research methods along with their practical applications in the context of graph-based representation formalisms and reasoning, with a broad interpretation of its namesake conceptual structures. Topics of this year's conference include modeling and knowledge representation, lattices and formal concept analyses, and decision support and prediction. The call asked for regular papers reporting on novel technical contributions and 13 submissions were received. The committee decided to accept 8 papers which corresponds to an acceptance rate of 61%. Each submission received two to four reviews, with 3.5 reviews on average. In total, our Program Committee members, supported by two additional reviewers, delivered 45 reviews. The review process was double-blind, with papers anonymized for the reviewers and reviewer names unknown to the authors. We organized a bidding on papers to ensure that reviewers received papers within their field of expertise. The response to the bidding process allowed us to assign each paper to reviewers who had expressed an interest in reviewing a particular paper. The final decision was made after the authors had a chance to reply to the initial reviews via a rebuttal to correct factual errors or answer reviewer questions. We believe this procedure ensured that only high-quality contributions were presented at the conference.

Next to the regular contributions, we were delighted to host two tutorials, "Data & AI Ethics" by Jesse Dinneen (Humboldt-Universität zu Berlin, Germany) as well as "Forgetting in Knowledge Representation and Reasoning" by Kai Sauerwald (FernUniversität in Hagen, Germany). Furthermore, we were honoured to receive three keynotes talks: "Tractable Probabilistic Models for Ethical and Causal AI" by Vaishak Belle (University of Edinburgh, UK), "Qualitative Spatial Evaluation of Sketch Maps" by Angela Schwering (University of Münster, Germany), and "Neuroconceptual Processing for Learning, Reasoning, and Language Understanding" by Arun Majumdar and John F. Sowa (both ARD Global, LLC). Note that this volume provides the extended abstracts of the keynote talks "Tractable Probabilistic Models for Ethical and Causal AI" by Vaishak Belle and "Neurosymbolic Computation with the Logic Virtual Machine" by Arun Majumdar and John F. Sowa.

As general chair and program chairs, we would like to thank our speakers for their inspiring and insightful talks. We would like to thank the Program Committee members and additional reviewers for their work. Without their substantial voluntary contribution, it would not have been possible to set up such a high-quality conference program. We would also like thank EasyChair for their support in handling submissions and Springer for their support in making these proceedings possible. Our institutions, the University of Münster, Germany, Babeş-Bolyai University of Cluj-Napoca, Romania, and Humboldt-Universität zu Berlin, Germany also provided support for our participation, for which we

are grateful. Last but not least, we thank the ICCS steering committee for their ongoing support and dedication to ICCS.

June 2022

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Neurosymbolic Computation with the Logic Virtual Machine (Abstract of Invited Talk)

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The Logic Virtual Machine (LVM) supports ISO Standard Prolog with tensors as a native datatype. The tensors can represent graphs or networks of any kind. For most applications, the great majority of elements of the tensors are zero, and the nonzero elements are bit strings of arbitrary length. Those bit strings may encode symbolic information, or they may represent integers of any size.

If the nodes encode symbolic information, the tensors may represent conceptual graphs, knowledge graphs, or the logics of the Semantic Web, Formal UML, and other knowledge representation languages. As an extension of Prolog, LVM can perform logical reasoning or other kinds of transformations on or with those notations.

Since the bit strings in the tensors may be interpreted as integers of arbitrary length, operations on those tensors may perform the same kinds of subsymbolic computations used in neural networks. As an extension of Prolog, LVM can relate neural tensors and symbolic tensors for neurosymbolic reasoning.

Since the symbolic and subsymbolic tensors are supported by the same LVM system, operations that relate them can be performed with a single Prolog statement. For special-purpose operations and connections to other systems, LVM can invoke subroutines in Python or C.

By combining the strengths of symbolic AI with neural networks, LVM spans the full range learning and reasoning methods developed for either or both. Three major applications are computational chemistry, sentiment analysis of natural language documents, and fraud analysis in financial transactions.

All three applications take advantage of the unique LVM features: precise symbolic reasoning, neural-network style of learning, and the ability to analyze huge volumes of graphs by precise methods or probabilistic methods. Applications in computational chemistry have obtained excellent results in molecular toxicology for the EPA TOX21 challenge. Applications in sentiment analysis combine Prolog's advantages for natural language processing (NLP) with a neural-network style of learning. Applications in financial fraud analysis combine NLP methods with learning and reasoning methods that must be accurate to fractions of a cent.

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