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Loizos Michael · Antonis Kakas (Eds.)

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Editors
Loizos Michael
Open University of Cyprus
Nicosia
Cyprus

Antonis Kakas
University of Cyprus
Nicosia
Cyprus

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Preface

These are the proceedings of the 15th European Conference on Logics in Artificial Intelligence (JELIA 2016), held during November 9–11, 2016, in Larnaca, Cyprus, and organized by the University of Cyprus and the Open University of Cyprus.

The European Conference on Logics in Artificial Intelligence (or Journées Européennes sur la Logique en Intelligence Artificielle — JELIA) began back in 1988, as a workshop, in response to the need for a European forum for the discussion of emerging work in this field. Since then, JELIA has been organised biennially, with proceedings published in the Springer series *Lecture Notes in Artificial Intelligence*. Previous meetings took place in Roscoff, France (1988), Amsterdam, The Netherlands (1990), Berlin, Germany (1992), York, UK (1994), Évora, Portugal (1996), Dagstuhl, Germany (1998), Málaga, Spain (2000), Cosenza, Italy (2002), Lisbon, Portugal (2004), Liverpool, UK (2006), Dresden, Germany (2008), Helsinki, Finland (2010), Toulouse, France (2012), and Madeira, Portugal (2014).

The aim of JELIA is to bring together active researchers interested in all aspects concerning the use of logics in artificial intelligence (AI) to discuss current research, results, problems, and applications of both theoretical and practical nature. JELIA strives to foster links and facilitate cross-fertilization of ideas among researchers from various disciplines, among researchers from academia and industry, and between theoreticians and practitioners.

The increasing interest in this forum, its international level with growing participation of researchers from outside Europe, and the overall technical quality have turned JELIA into a major biennial forum for the discussion of logic-based approaches to AI.

For the 2016 edition of JELIA, authors were invited to submit papers presenting original and unpublished research in all areas related to the use of logics in AI. To encourage a discussion of the links and synergies between AI and cognitive psychology, this year's edition of JELIA encouraged submissions on logics in AI and cognition, and included invited talks related to this topic.

There were 88 submissions, each reviewed by three Program Committee members. The committee decided to accept 32 full papers for regular presentations or system demonstrations, and ten short papers for spotlight/poster presentations. The accepted papers span a number of areas within logics in AI, including: belief revision, answer set programming, argumentation, probabilistic reasoning, handling inconsistencies, temporal logics and planning, description logics, and decidability and complexity results. The program also included five invited talks by Costas Bekas, Tarek R. Besold, Marc Denecker, Torsten Schaub, and Keith Stenning.

We would like to thank the authors of all the submitted papers and the members of the Program Committee and the additional experts who helped during the reviewing process, for contributing and ensuring the high scientific quality of JELIA 2016.

We would also like to acknowledge the support of the University of Cyprus, the Open University of Cyprus, the Cyprus Tourism Organisation, Austrian Airlines, IBM, Springer, and EasyChair.

September 2016

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Abstracts of Invited Talks

Frontiers of Cognitive Computing

Costas Bekas

IBM Research - Zurich, Zurich, Switzerland
bek@zurich.ibm.com

Cognitive Computing is the new frontier of the information age. Computers have evolved into indispensable tools of our modern societies, having modernized numerous aspects of our everyday lives. Computers have facilitated the acquisition, storage and access of huge amounts of data since the very first electronic general purpose machines of the 1940s. Since then, we learned how to program computers in order to allow uses that even the wildest imagination of computer pioneers of the 50s and 60s did not capture, such as the internet, social networks and simulations of nature of incredible fidelity. Cognitive computing turns our trusted programmable machines, into cognitive companions. The systems are not programmed to simply achieve a task, but rather they are developed to reason with us in ways that are natural for us. They can debate with us, test our ideas, as these are expressed in natural language, against incredible volumes of data and give us insights that ultimately free us and let us focus on and use our deepest of human capabilities: intuition and intelligence. Cognitive systems mimic the way we humans reason, allowing us to express in unstructured ways, such as speech and vision in order to achieve in a small fraction of the previously required time feats such as pharmaceuticals and materials discovery, attacking cancer, understand complex natural ecosystems as well as man-made ecosystems such as the economy and technology. We will discuss the remarkable progress of cognitive computing and give a glimpse of what the future may look like.

To the Extent that You Are Like a Grape: Symbolic Models of Analogy and Concept Blending in Cognitive AI

Tarek R. Besold

University of Bremen, Bremen, Germany
tbesold@uni-bremen.de

Analogy is one of the most studied representatives of a family of non-classical forms of reasoning working across different domains, usually taken to play a crucial role in creative thought and problem-solving. In the first part of the talk, I will shortly introduce general principles of computational analogy models (relying on a generalisation-based approach to analogy-making). We will then have a closer look at Heuristic-Driven Theory Projection (HDTP) as an example for a theoretical framework and implemented system: HDTP computes analogical relations and inferences for domains which are represented using many-sorted first-order logic languages, applying a restricted form of higher-order anti-unification for finding shared structural elements common to both domains. The presentation of the framework will be followed by a few reflections on the "cognitive plausibility" of the approach motivated by theoretical complexity and tractability considerations.

In the second part of the talk I will discuss an application of HDTP to modeling essential parts of concept blending processes as current "hot topic" in Cognitive Science. Here, I will sketch an analogy-inspired formal account of concept blending — developed in the European FP7-funded Concept Invention Theory (COINVENT) project— which, among others, combines HDTP with mechanisms from Case-Based Reasoning.

The FO(.) Knowledge Base System Project

Marc Denecker

Katholieke Universiteit Leuven, Leuven, Belgium
Marc.Denecker@cs.kuleuven.be

The goal of this project is to build a Knowledge Base System for an expressive knowledge representation language. Such systems allow to separate declarative knowledge from the problems that arise in the application domain, allowing to reuse the knowledge base to solve different computational tasks by applying different forms of inference. On the logical level, we start from classical first order logic (FO) (the notation FO(.) is used here as a generic term to denote extensions of classical first order logic FO). In this logic, we integrate various language constructs from different computational logic paradigms: types, inductive definitions, aggregates, (bounded) arithmetic, … The goal is to achieve an expressive, cleanly integrated knowledge representation language with possible world semantics and a well-understood informal semantics of mathematical precision. On the computational level, the project aims to integrate and extend technologies developed in various computational logic fields to build a Knowledge Base System that supports various forms of inference.

Motivations, principles and research questions raised by such a project will be discussed. I will give an overview and demonstration of the current IDP system and some applications. An application for interactive configuration will serve to highlight a principle that distinguishes declarative modelling from programming: the separation of knowledge from problems and the possibility to apply multiple forms of inference on the knowledge base to solve different computational tasks. We discuss how even interactive systems can be described and "run" within FO(.).

Hybrid Reasoning with Answer Set Programming

Torsten Schaub

University of Potsdam, Potsdam, Germany
Inria Rennes, Rennes, France
torsten@cs.uni-potsdam.de

Answer Set Programming (ASP) provides an approach to declarative problem solving that combines a rich yet simple modeling language with effective Boolean constraint solving capacities. This makes ASP a model, ground, and solve paradigm, in which a problem is expressed as a set of first-order rules, which are subsequently turned into a propositional format by systematically replacing all variables, before finally the models of the resulting propositional rules are computed. ASP is particularly suited for modeling problems in the area of Knowledge Representation and Reasoning involving incomplete, inconsistent, and changing information due to its non-monotonic semantic foundations. From a formal perspective, ASP allows for solving all search problems in NP (and NP^{NP}) in a uniform way. Hence, more generally, ASP is well-suited for solving hard combinatorial search (and optimization) problems. Interesting applications of ASP include decision support systems for NASA shuttle controllers, industrial team-building, music composition, natural language processing, package configuration, phylogenetics, robotics, systems biology, timetabling, and many more.

However, despite its growing popularity, ASP is not a silver bullet. For instance, it became clear early on that ASP fails to handle large numeric domains. This was addressed by Gelfond et al. in 2005 by proposing an integration of ASP and Constraint Processing (CP). This influential work has given rise to the subarea of Constraint ASP (CASP). Although this is an exemplar of hybridizing ASP, the need for integrating special-purpose reasoning is omnipresent when it comes to attacking real-world applications. This includes the integration of ASP with linear programming in bio-informatics, with geometrical reasoning in robotics, simulation in hardware design, and many more. This reveals the need for a principled way of integrating ASP with dedicated reasoning formalisms, both at the semantic and implementation level. Although this development has already been anticipated in the area of Satisfiability Testing (SAT), leading to the subfield of SAT Modulo Theories (SMT), it only serves as a limited blueprint for ASP. This is because (i) it only deals with solving and ignores modeling and grounding and (ii) it is monotonic and thus follows different semantic principles.

The talk will start with an introduction to CASP and sketch important aspects and insights gained in the development of the CASP solver *clingcon*. Building on this, we will describe the general framework for integrating theory reasoning into ASP offered by the fifth generation of the ASP system *clingo*. And finally we sketch a novel semantic approach to integrating ASP and CP, called the logic of *Here-and-There with constraints*.

We Reason in Uncertainty, But of What Kinds?

Keith Stenning

The University of Edinburgh, Scotland, UK
k.stenning@ed.ac.uk

If logic is to be helpful in analysing human reasoning, we first need to acknowledge the heterogeneity of the kinds of reasoning that people do. There has been a strong shift in the study of human reasoning away from classical logic toward probability theory as the formal framework, and for many researchers probability is all that is needed to analyse any human reasoning. Reasoning in this respect is held to be homogeneous. We have argued elsewhere that this move is from the frying pan into the fire, not because probability (or classical logic) cannot be useful, but because homogeneity is empirically and formally disastrous (Stenning et al. (submitted); Stenning and van Lambalgen (2008); Besold et al. (submitted)). We take it that in AI, this is all commonplace. But some of the insights arising in cognition may be of interest to AI researchers. Engaging with logical multiplicity focusses attention on qualitatively different kinds of uncertainty, and how to characterise them. This talk will present some current thinking on that question. The idea is to use logics to individuate kinds of uncertainty. In particular we contrast Logic Programming (LP) as a nonmonotonic logic, here specialised for analysing human discourse processing, and with some track record in modelling discourse semantics, with, on the one hand classical logic, and on the other probability. When examined close up, it is emerges just how what different kinds of things the uncertainties of these three system are.

References

Besold, T.R., Garcez, A., Stenning, K., Torre, L.V.D.: Reasoning in Non-probabilistic Uncertainty: Logic Programming and Neural- Symbolic Computing as Examples. Minds and Machines (submitted)

Stenning, K., Martignon, L., Varga, A.: Adaptive Reasoning: Integrating Fast and Frugal Heuristics with a Logic of Interpretation. Decision (submitted)

Stenning, K., van Lambalgen, M.: Human Reasoning and Cognitive Science. MIT Press, Cambridge (2008)

Over, D.E.: New paradigm psychology of reasoning. Think. Reason. **15**(4), 431–438 (2009)

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