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Authors

Furbach, Ulrich

Hölldobler, Steffen

Ragni, Marco

et al.

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Bridging the Gap: Is Logic and Automated Reasoning a Foundation for Human Reasoning?

Ulrich Furbach (uli@uni-koblenz.de)

Department of Informatik, University of Koblenz-Landau, Koblenz, Germany

Steffen Hölldobler (sh@iccl.tu-dresden.de)

International Center for Computational Logic, TU Dresden, Dresden, Germany

Marco Ragni (ragni@cs.uni-freiburg.de)

Cognitive Computation Lab, University of Freiburg, Freiburg, Germany

Claudia Schon (schon@uni-koblenz.de)

Department for Web Science and Technologies (WeST), University of Koblenz-Landau, Koblenz, Germany

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Introduction

Reasoning is a core ability in human cognition. Its power lies in the ability to theorize about the environment, to make implicit knowledge explicit, to generalize given knowledge and to gain new insights. It is a well researched topic in cognitive psychology and cognitive science and over the past decade impressive results have been achieved. Early researchers starting with Störing (1908) often used propositional logic as a normative framework. Any deviation from it has been considered an error. Central results like findings from the Wason selection task (Wason, 1968) or the suppression task (Byrne, 1989) inspired a shift from propositional logic and the assumption of monotonicity in human reasoning towards other reasoning approaches. This includes but is not limited to models using probabilistic approaches (Oaksford & Chater, 2007), mental models (Johnson-Laird, 2006), or non-monotonic logics (Stenning & Lambalgen, 2008). Considering cognitive theories for syllogistic reasoning show that none of the existing theories is close to the existing data (Khemlani & Johnson-Laird, 2012). But some formally inspired cognitive complexity measures can predict human reasoning difficulty for instance in spatial relational reasoning (Ragni & Knauff, 2013).

Automated deduction, on the other hand, is mainly focusing on the automated proof search in logical calculi. And indeed there is tremendous success during the last decades. Recently a coupling of the areas of cognitive science and automated reasoning is addressed in several approaches. For example there is increasing interest in modeling human reasoning within automated reasoning systems including modeling with answer set programming, deontic logic or abductive logic programming (Dietz & Hölldobler, 2015; Dietz, Hölldobler, & Wernhard, 2014). There are also various approaches within AI research for common sense reasoning (Furbach & Schon, 2014, 2016).

Despite a common research interest – reasoning – there are still several milestones necessary to foster a better inter-

disciplinary research. First, to develop a better understanding of methods, techniques, and approaches applied in both research fields. Second, to have a synopsis of the relevant state-of-the-art in both research directions. Third, to combine methods and techniques from both fields and find synergies. E.g., techniques and methods from computational logic have never been directly applied to model adequately human reasoning. They have always been adapted and changed. Fourth, we need more and better experimental data that can be used as a benchmark system. Fifth, cognitive theories can benefit from a computational modeling. Hence, both fields – human and automated reasoning – can both contribute to these milestones and are in fact a *conditio sine qua non*. Achievements in both fields can inform the others. Deviations between fields can inspire to seek a new and profound understanding of the nature of reasoning.

This is the third workshop in a series of successful *Bridging the Gap* workshop¹ located at previous conferences: 2015 at the International Conference on Automated Deduction in Berlin (CADE-25) focused on the automated reasoning aspects. 2016 at the International Conference on Artificial Intelligence in New York (IJCAI 2016) included an AI perspective. The Annual Meeting of the Cognitive Science Society is the central place for bringing a strong human centric perspective into discussion.

Goal and Scope

The goal of this workshop is to bring together leading researchers from cognitive science, computational logics, and psychology interested in computational foundations of human reasoning – both as speakers and as audience members. Its ultimate goal is to share knowledge, discuss open research questions, and inspire new paths. Like its preceding event, it is intended to get an overview of existing approaches and make a step towards a cooperation between computational logic and cognitive science. Topics of interest include, but are not limited to the following:

- Benchmark problems relevant in both fields

¹<http://ratiolog.uni-koblenz.de/bridging.html>

- limits and differences between automated and human reasoning
- psychology of deduction and common sense reasoning,
- logics modeling human reasoning
- non-monotonic, defeasible, and classical reasoning

The workshop is planned as a half-day event. There will be an invited speaker, sponsored by IFIP TC 12 (this is why this Workshop would have the “(supported by IFIP TC 12)” in its announcement.

Workshop Organization

Ulrich Furbach is a Senior Research Professor of Artificial Intelligence at the University of Koblenz. His research interests include knowledge management, automated reasoning, multi-agent systems, and e-learning. He is co-founder of the spin-off company wizAI (www.wizai.com), which develops knowledge management systems and information extraction tools. **Steffen Hölldobler** is professor for Knowledge Representation and Reasoning at the Technical University Dresden. He is currently Director of the International Center for Computational Logic and co-ordinator of the European Master’s Program in Computational Logic. He is particularly interested in combining methods and techniques from computational logic and cognitive science to adequately model human reasoning and to develop connectionist systems for human reasoning. **Marco Ragni** is a DFG-Heisenberg fellow and associate professor at the technical faculty and the Center for Cognitive Science of the Albert-Ludwigs-University Freiburg and associated with Department. His research interests include qualitative spatio-temporal reasoning, knowledge representation and reasoning, cognitive modelling, and complex cognition with a special focus on analyzing why and how human reasoning often deviates from classical logical approaches. **Claudia Schon** is a postdoctoral researcher at the Institute for Web Science and Technologies at the University of Koblenz-Landau. During the last years, she was working in various projects in the area of artificial intelligence. One of these projects was the RATIOLOG project where she focused her research on commonsense reasoning and modeling human deduction.

Target Audience

Our specific focus dovetails this years overall conference theme: “Computational Foundations of Cognitive Science”. Hence, the target audience for this workshop overlaps significantly with the target audience of Cognitive Science conference. The workshops central topics (psychology of deduction, common sense reasoning, logic, non-monotonic reasoning, formal systems) are core topics of Cognitive Science with the multidisciplinary nature of the workshop being particularly appropriate for the multidisciplinary Cognitive Science conference.

Confirmed Speakers

- E-A. Dietz Saldanha, TU Dresden, Germany
- S. Hölldobler, TU Dresden, Germany
- S. Khemlani, Naval Research Lab, USA
- B. Kowalski Imperial College London, GB
- A. Kakas, University Cyprus, Cyprus
- L. Pereira, Universidade Nova Lisboa, Portugal
- M. Ragni, University of Freiburg, Germany

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