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Preface: Special Issue of Selected Extended Papers of IJCAR 2010

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This special issue of the *Journal of Automated Reasoning* contains extended and revised versions of six selected papers presented at the *5th International Joint Conference on Automated Reasoning* (IJCAR) held at the University of Edinburgh, UK, in July 2010, as part of the *Federated Logic Conference* (FLoC) 2010.

IJCAR is the premier international joint conference on all topics in automated reasoning, including foundations, implementations, and applications. In 2010, IJCAR was the fusion of the *International Conference on Automated Deduction* (CADE), the *International Symposium on Frontiers of Combining Systems* (FroCoS), the *International Workshop on First-Order Theorem Proving* (FTP), and the *International Conference on Automated Reasoning with Analytic Tableaux and Related Methods* (TABLEAUX).

The six papers selected for this special issue underwent two thorough rounds of reviewing: first, the IJCAR 2010 program committee selected 28 regular papers and 12 system descriptions from 63 regular papers and 26 system descriptions that were submitted initially. From the 40 papers published in the conference proceedings [1], the editors then selected six of the best and most representative contributions to be invited for the present special issue. All of these papers were completely revised and contain substantial new results compared to the versions published in the conference proceedings. Each paper was also fully reviewed again by at least two reviewers according to the usual standards of the *Journal of Automated Reasoning*.

The current special issue gives a fascinating snapshot of the breadth and depth of contemporary research in the field of automated reasoning. Applications and theory, classical and nonclassical logic are equally well represented.

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Applications in software verification recently became one of the most important drivers for research in automated reasoning. This development is also reflected here in three out of six papers. It can be seen directly in the paper by Angelo Brillout, Daniel Kroening, Philipp Rümmer, and Thomas Wahl. They start from McMillan's idea to generate candidates for loop invariants by computing Craig interpolants and extend it to a language that includes quantifier-free Presburger arithmetic. The main contribution of the paper is to provide an efficient solution to this problem that is not based on costly quantifier elimination, but on a tailored sequent calculus.

The problem tackled in the paper by Jasmin Christian Blanchette and Alexander Krauss is also motivated by a verification context: the model finder of the interactive higher-order theorem prover Isabelle is often challenged by large, and in particular, by infinite domains. However, if higher-order formulas are monotonic then the search space can be pruned as soon as a model is found and large domains need not be investigated. While monotonicity is undecidable in general, the authors devised calculi that approximate the problem and, in many practically relevant cases, infer monotonicity.

Partial functions occur naturally when reasoning about properties of possibly nonterminating programs, but they are also important when modeling mathematical problems. For this reason, logics with partial functions have been well investigated in the literature, but it has been proven difficult to come up with a solution that (i) is based on classical logic and has a natural semantics, (ii) avoids unwanted conclusions of "ill-typed" formulas, and (iii) has a sound and complete proof theory amenable to automation. These are exactly the properties that the logic and calculus presented in Hans de Nivelle's paper have, which makes his theory a particularly attractive solution for automated reasoning about partial functions.

A different application context than software verification motivates the work of Despoina Magka, Yevgeny Kazakov, and Ian Horrocks: while description logics have become the standard tool in knowledge engineering and are by now well understood, it is still a challenge to develop description logics with the right trade-off between expressivity and efficiency. Specifically, numerical data types are indispensable for modeling realistic problems, but they easily render the complexity of reasoning in a logic intractable. In this paper, a notion of safety for numerical data types is introduced that is practically relevant, yet retains polynomial time decidability for the main reasoning problems.

The paper by Julian Backes and Chad Brown is again concerned with higher-order logic. It presents a novel cut-free tableau calculus for Church's simple type theory with a choice operator and an if-then-else operator. The authors prove soundness and completeness of their calculus w.r.t. the Henkin semantics. As the calculus is designed with automated proof search in mind, it is well suited as a basis for automated reasoning in such logics. Indeed, the authors implemented a competitive higher-order automated theorem prover based on the calculus in this paper.

The final paper by Nao Hirokawa and Aart Middeldorp presents new methods to prove confluence of term rewrite systems automatically. Such proofs are needed for many applications in equational reasoning. There are two classical confluence criteria: the criterion of Knuth and Bendix states that a rewrite system is confluent if it is terminating and its critical pairs are joinable and Rosen's criterion states that orthogonality implies confluence. The main contribution of the paper generalizes and unifies these two criteria. It shows that to infer confluence for left-linear rewrite

systems with joinable critical pairs, instead of termination, it suffices if just the rewrite steps that give rise to critical pairs are relatively terminating with respect to the rewrite rules. The proof is based on van Oostrom's decreasing diagrams technique. Moreover, the paper discusses a second confluence criterion also based on decreasing diagrams, which checks decreasingness of critical pairs w.r.t. a rule-labeling. The paper shows how to encode the rule-labeling heuristic as a satisfiability problem. The authors implemented both confluence criteria and give experimental evidence for their strength.

We would like to thank the authors of the papers in this special issue for submitting substantially extended, high quality revisions of their IJCAR 2010 papers. We would also like to thank the original IJCAR reviewers and the additional reviewers for the special issue for their detailed comments and suggestions. Finally, we are grateful to the *Journal of Automated Reasoning*'s Editor-in-Chief Tobias Nipkow for kindly agreeing to this special issue.

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Reference

1. Giesl, J., Hähnle, R. (eds.): Automated Reasoning: 5th International Joint Conference, IJCAR 2010, Edinburgh, UK, Lecture Notes in Artificial Intelligence, vol. 6173. Springer-Verlag (2010)