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Preface

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This special issue of the Annals of Mathematics and Artificial Intelligence contains thoroughly revised and significantly extended versions of selected papers presented at the Ninth International Symposium on Foundations of Information and Knowledge Systems (FoIKS 2016), which was held in Linz, Austria, March 7–11, 2016.

Previous FoIKS symposia were held in Bordeaux (France) in 2014, Kiel (Germany) in 2012, Sofia (Bulgaria) in 2010, Pisa (Italy) in 2008, Budapest (Hungary) in 2006, Vienna (Austria) in 2004, Schloss Salzau near Kiel (Germany) in 2002, and Burg/Spreewald near Berlin (Germany) in 2000.

The FoIKS symposia provide a biennial forum for presenting and discussing theoretical and applied research on information and knowledge systems. The goal is to bring together researchers with an interest in this subject, share research experiences, promote collaboration, and identify new issues and directions for future research. Another characteristic of the FoIKS symposia is that they are a forum for intensive discussions. Speakers are given ample time to present their results, expound relevant background information, and put their research into context. Furthermore, participants are asked in advance to prepare a first response to a contribution of another author in order to initiate discussion.

FoIKS 2016 solicited original contributions on foundational aspects of information and knowledge systems. This included submissions that apply ideas, theories or methods from

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specific disciplines to information and knowledge systems. Examples of such disciplines are discrete mathematics, logic and algebra, model theory, information theory, complexity theory, algorithmics and computation, statistics, and optimization.

The call for papers for FoIKS 2016 resulted in the submission of 23 full articles. In a rigorous reviewing process, each submitted article was carefully reviewed by at least three international experts. The 12 articles judged best by the Program Committee were accepted for long presentation. In addition, two articles were accepted for short presentation. The conference program was completed by five invited talks kindly presented by Christoph Beierle, Joachim Biskup, Reinhard Pichler, Henry Prakken, and José Maria Turull-Torres.

After the symposium the authors of the papers judged best by the Program Committee were invited to prepare thoroughly revised and significantly extended versions of their conference contributions to be considered for inclusion into this special issue. All these were subject to a rigourous reviewing process, which resulted in the acceptance of the six papers listed below:

- In *Active Integrity Constraints for General-Purpose Knowledge Bases*, Luís Cruz-Filipe, Graça Gaspar, Isabel Nunes, and Peter Schneider-Kamp are concerned with integrity constraints, essential to guarantee database integrity, and the related issue of database repair, which deals with restoring integrity by finding the best way to modify a database to make it satisfy its integrity constraints again. The authors' focus is on active integrity constraints, a formalism aimed at addressing both issues jointly by providing a syntax allowing to specify a particular subclass of integrity constraints together with preferred ways to repair inconsistency. In the work present here, the authors target multi-context systems, a general-purpose framework for combining heterogeneous reasoning systems. They demonstrate that in this framework most other reasoning frameworks can be modeled. They proceed by extending the notions of active integrity constraints and grounded repairs to this generalized setting and defining simple iterative algorithms to find all possible grounded repairs for an inconsistent multi-context system. In this way, they avoid having to solve complex or undecidable problems.
- In *Properties of Skeptical C-Inference for Conditional Knowledge Bases and its Realization as a Constraint Satisfaction Problem*, Christoph Beierle, Christian Eichhorn, Gabriele Kern-Isberner, and Steven Kutsch study plausible, non-monotonic inferences from conditional knowledge bases. To be able to solve benchmark problems such as Irrelevance or Subclass Inheritance, c-representations have been proposed, but it is still an open problem which c-representation is the best. In this study, the authors consider the skeptical inference relation, called c-inference, obtained by taking all c-representations of a given knowledge base into account. They show that c-inference preserves the properties of solving Irrelevance and Subclass Inheritance. They model c-inference as a Constraint Satisfaction Problem and prove correctness and completeness of the modeling. Hence, constraint solvers can be used for implementing c-inference.
- Answer Set Programming has become an increasingly popular formalism for declarative problem solving. In particular, investigations of different equivalence notions between logic programs play a fundamental role for understanding modularity and optimization. In *Equivalence between Answer-Set Programs under (Partially) Fixed Input*, Bernhard Bliem and Stefan Woltran try to fill a hiatus in these investigations by thoroughly studying an equivalence notion which they call rule equivalence. This notion of equivalence is a relationship between two programs whose input is (partially) fixed but where additional proper rules might still be added. Such a notion might be

helpful in the debugging of programs. The authors provide full characterization results and a complexity analysis for the propositional case of rule equivalence and its relativized versions. Moreover, they address the problem of program simplification under rule equivalence. They show that rule equivalence is decidable in the non-ground case.

– Dependence logic was introduced by Vaätanen in 2007 and extends first-order logic with dependence atoms. The notion of dependence has real meaning only in plurals. Thus, in contrast to the usual Tarskian semantics, in dependence logic, satisfaction of formulae is defined not via single assignments but via sets of assignments. Such sets are called teams and the semantics is called team semantics. In *Approximation and Dependence via Multiteam Semantics*, Arnaud Dur, Miika Hannula, Juha Kontinen, Arne Meier, and Jonni Virtema define a variant of team semantics, called multiteam semantics, which is based on multisets. They study the properties of various logics in this framework. In particular, they define natural probabilistic versions of inclusion and independence atoms and certain approximation operators motivated by approximate dependence atoms in the work of Vaätanen.
– In *A Unifying Logic for Non-Deterministic, Parallel and Concurrent Abstract State Machines*, the focus is on the well-known Abstract State Machines of Gurevich. Flavio Ferrarotti, Klaus-Dieter Schewe, Loredana Tec, and Qing Wang develop a logic which enables reasoning about single steps of non-deterministic and parallel Abstract State Machines. The logic developed by the authors builds upon the unifying logic introduced by Nanchen and Stärk for reasoning about hierarchical (parallel) Abstract State Machines. The main contribution of this study lies in the handling of non-determinism within the logical formalism. The authors manage to do this without sacrificing the completeness of the logic for statements about single steps of non-deterministic and parallel Abstract State Machines such as invariants of rules, consistency conditions for rules, or step-by-step equivalence of rules. Moreover, the authors show that the proposed one-step logic can be easily extended to a multiple-step logic which enables reasoning about concurrent Abstract State Machines.
– Finally, in *The Complexity of Satisfiability in Non-Iterated and Iterated Probabilistic Logics*, Ioannis Kokkinis studies both non-iterated and iterated versions of probabilistic logics. If L is some extension of classical propositional logic, the non-iterated probabilistic logic over L is the logic *PL* defined by adding non-nested probabilistic operators to the language of L. For example, one can express in *PL* statements such as "the probability of truthfulness of A is at least 0.3," where A is a formula of L. In *PPL*, the iterated probabilistic logic over L, probabilistic operators may be iterated (nested). For example, one can express in *PPL* statements such as "this coin is counterfeit with probability 0.6." In this work, the author investigates the influence of probabilistic operators in the complexity of satisfiability in *PL* and *PPL*. This results in complexity bounds for the aforementioned satisfiability problem, which are parameterized in the complexity of satisfiability of conjunctions of positive and negative formulas that have neither a probabilistic nor a classical operator as a top-connective. As a corollary, Kokkinis obtains tight complexity bounds for the satisfiability problem in *PL* and *PPL* in the case where L is classical propositional logic or justification logic.

We like to thank all authors for preparing, submitting, and revising their contributions to this special issue. We also thank all members of the FoIKS 2016 Program Committee, and we are deeply indebted to all reviewers of this special issue for their timely expertise in carefully reviewing the contributions.

List of reviewers

Christoph Beierle	Stefan Borgwardt	François Bry
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