Relational and Algebraic Methods in Computer Science

Relational and algebraic methods, such as allegories, Kleene algebras and relation algebras, allow concise and abstract formalisation for problems occurring in computer science. These algebras usually allow formal reasoning in a 'point-free' style, which also offers good tool support by automated and interactive theorem provers.

Since 1994, the conference series 'Relational and Algebraic Methods in Computer Science' (RAMiCS) focusses on both the theoretical foundations of such methods and on applications in computer science. Until 2009 the series was known as 'Relational Methods in Computer Science' (RelMiCS), and was since 2003 held in conjunction with 'Applications of Kleene Algebra' (AKA).

The 14th International Conference on Relational and Algebraic Methods in Computer Science (RAMiCS 2014) took place in Marienstatt, Germany, from April 27 to May 1, 2014; the proceedings of this conference have been published as Lecture Notes in Computer Science (LNCS), volume 8428, which contains 2 invited talks and 25 contributed papers, each reviewed by at least three referees. The programme committee of RAMiCS 2014 selected six papers presented at the conference; we invited their authors and the three invited speakers to submit an extended version for this special issue of the Journal of Logic and Algebraic Methods in Programming. The nine substantially extended and revised submissions received were again evaluated by at least three referees. The resulting collection of papers, presented in this volume, illustrates the wide spectrum of different formalisms sharing these common algebraic roots, and includes a number of different application areas, such as modal logics, databases and concurrent programming.

- José Nuno Oliveira and Victor Cacciari Miraldo propose an approach for systems with quantified non-determinism, as for example needed in approaches that try to quantify software (un)reliability in the presence of faults. In their paper *'"Keep definition, change category" — A Practical Approach to State-based System Calculi'* they illustrate that such an approach can be performed without sacrificing the simplicity of the original (qualitative) definitions, by keeping quantification implicit rather than explicit.
- In *'Relation Lifting, A survey'* Alexander Kurz and Jiří Velebil present an overview of work in category theory and coalgebra on how to extend a functor from maps to relations. Using a universal property of this lifting they present generalisations to monotone and many-valued relations. It is shown how different notions of bisimulation, simulation and modal logics arise.
- The special modal logic BISKT, offering two adjoint pairs of tense operators, is introduced by John G. Stell, Renate A. Schmidt and David Rydeheard in *'A Bi-Intuitionistic Modal Logic: Foundations and Automation'*. Special models of this logic arise from graphs in which the worlds are interpreted as nodes and edges of graphs, and formulae represent subgraphs. A comprehensive study of the logic shows decidability, complexity and correspondence results for BISKT.
- In *'An Algebraic Approach to Computations with Progress'*, Walter Guttmann presents another application for algebraic methods in computer science. He introduces a model of sequential computations that generalises and abstracts the notion of progress, appearing in various computation models by generalising existing algebras for non-termination and derives an approximation order for computations with time and for trace-based computations.
- Tadeusz Litak, Szabolcs Mikulás and Jan Hidders study the equational theory of relational lattices. Their paper *'Relational Lattices: From Databases to Universal Algebra'* shows that addition of just the header constant to the lattice signature leads to undecidability of the quasi-equational theory.
- Inspired by an automata approach by Bloom, Ésik and Stefanescu, in *'Algorithms for Kleene Algebra with Converse'*, Paul Brunet and Damien Pous provide a PSPACE algorithm for the equational theory of Kleene algebra with converse. While the problem is easily shown to be PSPACE-hard, they prove that this equational theory is PSPACE-complete. They also develop other algorithms for Kleene algebra with converse that are time-efficient in practice, despite not being PSPACE.
- Takeo Uramoto studies *'Canonical Finite Models of Kleene Algebra with Tests'*. Continuing Kozen's work on Kleene Algebra with tests, he analyses the decidability of existentially quantified equational formulas

over a fixed collection of KAT terms. To design a systematic strategy of deciding problems of this form, an effective procedure is given that constructs a finite KAT model, called the canonical finite model, for each KAT term.

– The paper *'Developments in Concurrent Kleene Algebra'* by Tony Hoare, Stephan van Staden, Bernhard Möller, Georg Struth and Huibiao Zhu develops links between algebraic presentations of the principles of programming and the exploitation of concurrency in modern programming practice. The presented algebraic laws are supported by a hierarchy of models, applicable and adaptable to a range of different purposes and to a range of different programming languages.
– In their paper *'Concurrent Kleene Algebra with Tests and Branching Automata'*, Peter Jipsen and M. Andrew Moshier combine Kleene algebra with tests and concurrent Kleene algebra. To give a concrete language model for this algebra, they generalise guarded strings to *guarded series-parallel strings*. They also define deterministic branching automata and investigate their relation to (non-deterministic) branching automata.

We are grateful to all the authors for submitting their papers and to the referees for their careful scrutiny. We are also most grateful to Rocco De Nicola for making such a special issue once again possible—this volume presents the seventh incarnation of special issues of relational and algebraic methods in computer science published in the Journal of Logic and Algebraic Programming (JLAP) and in the Journal of Logic and Algebraic Methods in Programming (JLAMP). Special thanks go to Hilda Xu, Joseph Neethu, Luca Aceto, and Alberto Lluch Lafuente, for helping us to produce this special issue. We thank the programme committee of RAMiCS 2014 for preselecting the papers; last, but not least, we would like to thank the Bonn Rhein Sieg University of Applied Sciences and the Deutsche Forschungsgemeinschaft (DFG) for supporting the RAMiCS 2014 conference.

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