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# Logic for Programming, Artificial Intelligence, and Reasoning

20th International Conference, LPAR-20 2015
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# Preface

This volume contains the papers presented at the 20th International Conference on Logic for Programming, Artificial Intelligence and Reasoning (LPAR-20), held during November 24–28, 2015, at the University of the South Pacific, Suva, Fiji.

Following the call for papers, LPAR-20 received 117 abstracts, materializing into 92 submissions. Each submission was reviewed by a panel of 53 Program Committee (PC) members. The PC was assisted by 107 additional reviewers and decided to accept 43 papers. The EasyChair system provided an indispensible platform for all matters related to the reviewing process, production of these proceedings, program and Web page generation, and registration of participants.

Several workshops were collocated with LPAR-20. The first workshop on Models for Formal Analysis of Real Systems (MARS 2015) was organized by Rob van Glabbeek and Peter Hoefner of NICTA and Jan Friso Groote from Eindhoven University of Technology. The First International Workshop on Focusing was organized by Iliano Cervesato of Carnegie Mellon University and Carsten Schuermann of ITU Copenhagen and Demtech. The 11th International Workshop on the Implementation of Logics was organized by Boris Konev of the University of Liverpool, Stephan Schulz of DHBW Stuttgart, and Laurent Simon of the University of Bordeaux. We were fortunate to have Peter Baumgartner of NICTA as workshop chair.

The local conference organization was arranged by Geoff Sutcliffe and Ansgar Fehnker, and together they put together an excellent event.

LPAR-20 is grateful for the generous support of Microsoft Research and University of the South Pacific.

September 2015

Martin Davis
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# Satisfiability: From Quality to Quantities (Abstract of Invited Talk)

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Satisfiability Modulo Theories, SMT, solvers have in the past decade enabled a number of software engineering tools thanks to improved theorem proving technologies, their support for domains that are commonly used in software and a confluence of advances in symbolic analysis methodologies. These methodologies are diverse and range from bug localization, symbolic model checking algorithms, dynamic symbolic execution for uncovering bugs and creating parametric unit tests, certified development using program verification tools, compiler validation, biological modeling, model based design tools, web sanitizers, and runtime analysis. The synergy with application domains has lead to a constant stream of inspiration for improved domain support and algorithmic advances. A simultaneous trend in applications is leading research on SMT solvers into calculating with quantities. We believe this is part of an overall trend of tools for checking and synthesizing quantitative, including probabilistic, properties.

Using Network Verification as a starting point, we describe how the SMT solver Z3 is used at scale in Microsoft Azure to check network access restrictions and router configurations. Z3 is used in a monitoring system, called SecGuru, that continuously checks configurations as they appear on routers. We learned early on that network operators required a tool that could return a set of models in a compact way. This led us to develop a domain specific algorithm, that works well for access control lists. It enumerates models compactly in fractions of a second. A more ambitious effort is to check reachability properties in large data-centers. Again, our experience was that the domain called for special purpose data-structures and symmetry reduction methods that turn analysis of data-centers with hundreds of routers and a million forwarding rules into very small finite state systems that can be analyzed in fractions of a second.

Our experience with Network Verification is not unlike other domains as we are reaching a point where qualitative analysis has shown its use, but a larger elephant is lurking in the room: most systems rely on performance guarantees. Thus, the need for cheking and synthesizing quantitative properties. To support SMT with quantities we have embarked on long term projects on integrating optimization algorithms with Z3 and integrating methods for counting the number of solutions to constraints. In this context we developed a new MaxSAT algorithm that exploits dualities between unsatisfiable cores and correction sets and we illustrate some uses of the emerging quantitative features in Z3.

The work rests on collaboration with a large number of colleagues including Karthick Jayaraman, George Varghese, Nina Narodytska, Nuno Lopes, Andrey Rybalchenko, Leonardo de Moura, Christoph Wintersteiger, Gordon Plotkin.

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