Special issue

Games, Automata, Logics, and Formal Verification (GandALF 2013)

Preface

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This issue contains a collection of 8 papers that were selected among the 3 invited contributions and the 17 papers accepted for presentation at the *Fourth International Symposium on Games, Automata, Logic and Formal Verification* (GandALF 2013). The symposium took place in Borca di Cadore, Italy, from 29th to 31st of August 2013.

The GandALF symposium was established by a number of Italian computer scientists interested in mathematical logic, automata theory, game theory, and their applications to the specification, design, and verification of complex systems. It aims at providing a forum where people from different areas, and possibly with a different background, can fruitfully interact. Even though the idea of the symposium emerged within the Italian research community, the event has a truly international nature, as witnessed by the composition of the conference committees and by the country distribution of the submitted papers.

The authors invited to contribute to the special issue were asked to submit an extended and revised version of their GandALF paper. The submitted papers went through a careful two-phase review process. The collection of papers in this issue covers a variety of topics in game theory (randomized strategies, Banach-Mazur games, parity games), logics (logics for hybrid traces, linear and interval temporal logics, logics for dependencies), and automata theory (determinization of Büchi automata).

The paper *Randomness for Free*, coauthored by Krishnendu Chatterjee, Laurent Doyen, Hugo Gimbert, and Thomas A. Henzinger, studies several variants of two-player zero-sum games on finite-state graphs in which both the transition function and the strategies can be probabilistic. It characterizes those classes of games where randomness is for free, namely, (i) games where probabilistic transitions can be simulated by deterministic transitions and (ii) games where pure strategies are as powerful as randomized strategies. As a consequence of this characterization and some previous results in the literature, one obtains that the almost-sure winning problem for one-sided complete-observation deterministic games with ω-regular objectives is undecidable.

The paper *Simple Strategies for Banach-Mazur Games and Fairly Correct Systems*, by Thomas Brihaye and Quentin Menet, considers generalizations of Banach-Mazur games for characterizing the topological notion of "large" set and the concept of fair correctness for concurrent and reactive systems. The paper builds up on a previous work by Varacca and Völzer, which shows that, when considering ω-regular properties on finite systems, the almost-sure correctness and the large correctness coincide for bounded Borel measures. The main contribution of the paper is a characterization of those countable intersections of open sets that have probability 1 (under a reasonable probabilistic measure) in terms of a probabilistic version of the Banach-Mazur game. As a by-product of this result, one gets determinacy of probabilistic Banach-Mazur games for countable intersections of open sets.

The paper *The Rabin Index of Parity Games*, coauthored by Michael Huth, Jim Huan-Pu Kuo, and Nir Piterman, studies the descriptive complexity of parity games, starting from the observation that most algorithms that solve these games have a worst-case running time that depends exponentially on the number of priorities (node colors). To approximate the optimal number of priorities in a parity game, a parameter is introduced, called abstract Rabin index, that measures the complexity of a parity game by taking into account the cycles and the priorities in the arena. The paper shows that on any class of graphs of bounded abstract Rabin index, parity games can be decided in polynomial time. It also provides experiments to assess the performance of some algorithms that solve parity games and that are based on computing abstract Rabin indices to reduce the numbers of priorities.

The paper *HRELTL: A Temporal Logic for Hybrid Traces*, by Alessandro Cimatti, Marco Roveri, and Stefano Tonetta, presents a formalism based on a variant of temporal logic for specifying continuous and discrete behaviours of dynamic systems (hybrid systems). Specifically, the formalism, called HRELTL, allows the definition of constraints both on the derivatives of the continuous variables and on the discrete changes of the system. The paper also considers a fragment of HRELTL that restricts the constraints on derivatives to be linear and then provides a satisfiability-preserving translation of this fragment to a discrete-time extension of LTL with Real Arithmetic predicates. In many practical cases, this enables the use of automated reasoning techniques for checking satisfiability of HRELTL formulas.

The paper *Deciding the Satisfiability of MITL Specifications*, coauthored by Marcello M. Bersani, Matteo Rossi, and Pierluigi San Pietro, considers the problem of checking satisfiability of Metric Interval Temporal Logic (MITL), an extension of Linear Temporal Logic (LTL) interpreted over dense time domains where the temporal operators can be annotated with intervals. The paper proposes a new approach to decide satisfiability of MITL formulas by translating them into equi-satisfiable formulas of Constraint LTL with clocks, for which there exist efficient decidability algorithms based on SMT solvers. The translation has also been implemented into a prototype tool and a number of experiments with practically relevant formulas were performed.

The paper *Satisfiability of ATL with strategy contexts*, by Francois Laroussinie and Nicolas Markey, studies the extension of the alternating-time temporal logic (ATL) with a semantics based on strategy contexts. Unlike the original semantics, in this framework the strategy quantifiers do not reset the previously selected strategies. The logic turns out to be very expressive, and this comes at the price of an increase of the computational complexity: the satisfiability problem becomes undecidable and the model checking problem turns out to have non-elementary complexity. However, it is shown that decidability of the satisfiability problem is recovered when restricting to turn-based games, as well as in the case where the set of actions available to the players is fixed in advance. Similar results hold for Strategy Logic, an existing formalism that was introduced for reasoning explicitly on strategies by means of first-order quantifications. As a matter of fact, the techniques that are used to decide ATL under strategy context semantics can be applied to Strategy Logic as well.

The paper *Upwards Closed Dependencies in Team Semantics* by Pietro Galliani studies the expressiveness of first-order logic interpreted using a a generalization of Tarski's semantics, called team semantics. Intuitively, team semantics defines satisfiability of formulas with respect to sets of assignments, rather than single assignments. Team semantics emerged as a natural formalism for studying dependence relations between quantified variables. The main contribution of the paper is the proof that adding upward-closed dependencies and constancy atoms to first-order logic with team semantics does not increase its expressive power. A consequence of this result is that a number of constructs can be safely added to first-order logic without increasing its expressive power. Examples of these constructs are negations of functional dependence, conditional independence, inclusion and exclusion atoms.

Finally, the paper *Profile Trees for Büchi Word Automata, with Application to Determinization*, coauthored by Seth Fogarty, Orna Kupferman, Moshe Vardi, and Thomas Wilke, considers the fundamental problem of determinizing Büchi automata. The paper presents a novel determinization procedure based on the notion of profile tree. Unlike previous constructions, most notably, Safra's determinization procedure, the construction proposed in the paper is more declarative in nature. This declarative approach eases the understanding and exposes in a better way the mathematical objects underlying the determinization of Büchi automata. Moreover, the construction can be easily specialized to obtain deterministic automata with Rabin-pairs acceptance condition, Rabin-pairs edge acceptance condition, or Parity edge acceptance condition.

We would like to thank all authors of submitted papers and the reviewers Guy Avni, Patricia Bouyer, Davide Bresolin, Veronique Bruyere, Lorenzo Clemente, Pieter Collins, Dario Della Monica, Arnaud Durand, Nathanaël Fijalkow, Bernd Finkbeiner, Marco Gaboardi, Gilles Geeraerts, Raffaella Gentilini, Dan Ghica, Valentin Goranko, Erich Grädel, Denis Kuperberg, Simon Lessenich, Christof Löding, Aniello Murano, Andrzej Murawski, Damian Niwinski, Carla Piazza, Pavithra Prabhakar, Mark Reynolds, Roberto Segala, Jouko Vaananen, Yaron Velner, Dirk Walther, Zhilin Wu, and Wieslaw Zielonka for their invaluable work in refereeing the papers. We would also like to thank Rob van Glabbeek for his kindness and competence in assisting us to prepare this special issue.

We hope that you will enjoy reading these papers.