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Special Issue on Machines, Computations and Universality (MCU 2018)

Preface

The conference series *Machines, Computations and Universality* (MCU) traces its roots back to mid of 1990's, and has since been concerned with gaining a deeper understanding of computation through the study of models of general purpose computation. MCU explores computation in the setting of various discrete models (Turing machines, register machines, cellular automata, tile assembly systems, rewriting systems, molecular computing models, neural models, concurrent systems, etc.) and analog and hybrid models (BSS machines, infinite time cellular automata, real machines, quantum computing, etc.). There is a particular (but not exclusive) emphasis given towards the following:

- The search for frontiers between decidability and undecidability in the various models (for example, what is the smallest number of pairs of words for which the Post correspondence problem is undecidable, or what is the largest state-symbol product for which the halting problem is decidable for Turing machines?),
- The search for the simplest universal models (such as small universal Turing machines, universal rewriting systems with few rules, universal cellular automata with small neighborhoods and a small number of states, etc.),
- The computational complexity of predicting the evolution of computations in the various models (for example, is it possible to predict an arbitrary number of time steps for a model more efficiently than explicit step by step simulation of the model?),
- How parallelism can be connected to decidability, complexity and universality, and
- Universality and undecidability in continuous models of computation.

MCU international conference series was initiated by Maurice Margenstern in Paris, France (1995). Subsequent venues were Metz, Fance (1998), Chişinău, Moldova (2001), Saint-Petersburg, Russia (2004), Orléans, France (2007), Zürich, Switzerland (2013), Famagusta, North Cyprus (2015) and Fontainebleau, France (2018).

The 8th edition of MCU (MCU 2018) was held June 28–30, 2018, on the campus of the IUT de Fontainebleau at the University of Paris-Est Créteil, Fontainebleau, France. The meeting was

pleased to have five distinguished invited speakers who presented inspiring talks related to several MCU topics: Erzsébet Csuhaj-Varjú (Eötvös Loránd University, Hungary), Rudolf Freund (TU Wien, Austria), Natasha Jonoska (University of South Florida, USA), Michel Raynal (IRISA, University of Rennes, France) and Damien Woods (INRIA, France). The meeting was co-located with the 17th International Conference on *Unconventional Computation and Natural Computation (UCNC 2018).*

This special issue contains a selection of papers from MCU 2018, which underwent substantial updates and extensions, and went through an independent review process.

The paper "Minimal Size of Counters for (Real-Time) Multicounter Automata" by Viliam Geffert and Zuzana Bednarova studies the problem of the minimal space that is required for accepting a nonregular language by a multicounter automata for both strong and weak space bounds. They show that in the first case the minimal space is $(\log n)^{\varepsilon}$, while in the second case it is n^{ε} for one-way real-time (nondeterministic and alternating) versions of these automata. The first bound also holds for two-way automata, independent of whether they work with strong or weak space bounds, and of whether they are deterministic, nondeterministic, or alternating. The paper also presents a binary nonregular language recognized by a real-time nondeterministic automaton using a single counter, with weak space bound $\log n$.

The paper "Physical Computational Complexity and First-Order Logic" by Richard Whyman presents the concept of a theory machine, which is an atemporal computational formalism that is deployable within an arbitrary logical system. Such machines are intended to capture computation on an arbitrary system, both physical and unphysical, including quantum computers, Blum-Shub-Smale machines, and infinite time Turing machines. The author shows that for finite problems, the computational power of any device characterizable by a finite first-order theory machine is equivalent to that of a Turing machine, while for infinite problems, their computational power is equivalent to that of a type-2 machine.

The paper "On Boolean automata networks (de)composition" by Kévin Perrot, Pacôme Perrotin and Sylvain Sené investigates Boolean automata networks (BANs) that are a generalization of Boolean cellular automata. They explore a way of working with BANs which involves adding external inputs to the base model and linking networks together these mentioned inputs. This allows to develop a formalism for BAN (de)composition. The paper shows the completeness of the definition and different simulation results.

The paper "Improved Descriptional Complexity Results for Simple Semi-Conditional Grammars" by Henning Fernau, Lakshmanan Kuppusamy, Rufus O. Oladele and Indhumathi Raman considers simple semi-conditional grammars corresponding to context-free rules enriched with permitting or forbidding conditions (but not both of them at the same time). The authors show several computational completeness results having small descriptional complexity parameters (the size of the words for permitting/forbidding contexts, the number of non-terminals and the number of conditional rules).

The paper "Circular interval-valued computers and simulation of (red-green) Turing machines" by Benedek Nagy and Sándor Vályi concentrates on the model of interval-valued computing that operates on finite unions of subintervals of the unit interval $[0, 1)$. It introduces a circular variant of interval-valued computations (that is, using quasi-periodic computation sequences) and proves that this modification does not change the simulation power of interval-valued computations: by infinitely looping runs, it is capable to simulate ordinary and red-green Turing machines.

Finally, the paper "Relations between Control Mechanisms for Sequential Grammars" by Artiom Alhazov, Rudolf Freund and Sergiu Ivanov deals with the general framework for regulated rewriting based on the applicability of rules in sequential grammars. Besides the well-known control mechanisms as control graphs, matrices, permitting and forbidden rules, partial order on rules, and priority relations on rules they consider a new variant of activation and blocking of rules. The paper also shows special general results for strings and multisets as well as for arrays in the general variant defined on Cayley grids of finitely presented groups.

The editors warmly thank the authors of the papers and the reviewers for their work to make this special issue, with special thanks to Damian Niwiński, the editor in chief of Fundamenta Informaticae.

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