Preface

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The present special issue of Natural Computing is dedicated to the study of algebraic, dynamical, algorithmic and complexity-theoretic aspects of cellular automata (CA) and discrete complex systems (DCS). It contains six extended and improved versions of selected papers presented at the 25th International Workshop on Cellular Automata and Discrete Complex Systems, AUTOMATA 2019, held on June 26th–28th, 2019, at the University Center of Exact Sciences and Engineering, University of Guadalajara, Mexico.

The conference AUTOMATA 2019 was the official annual event of the Technical Committee 1, on Foundations of Computer Science, Working Group 5, on CA and DCS, of the International Federation for Information Processing (IFIP). It is part of an annual series of conferences established in 1995 as a collaboration forum between researchers in CA and DCS. This was the fourth time that AUTOMATA took place in a Latin American country, with the last one taking place in Santiago, Chile, in 2011. As a celebration of its Silver Jubilee, the event had a special session commemorating this occasion, with a presentation by Martin Kutrib on historical landmarks and anecdotes. The conference included three invited talks given by Pablo Arrighi, Hector Zenil, and Tullio Ceccherini-Silberstein, as well as seven presentations of full papers, and three presentations of exploratory papers.

The conference proceedings were published in the Lecture Notes in Computer Science by Springer. The extended versions of selected papers included in this special issue went through an independent peer-review process.

The paper *Iterative arrays with finite inter-cell communication* by M. Kutrib and A. Malcher studies the multi-dimensional discrete devices known as iterative arrays that, in contrast with classical CA, have a sequential input mode. In particular, it considers iterative arrays whose maximum number of inter-cell communications is bounded by a constant, and it studies their computational capacity through decidability problems such as the emptiness, finiteness, inclusion, and equivalence problems.

The paper *The effect of jumping modes on various automata models* by S. Z. Fazekas, K. Hoshi and A. Yamamura examines finite, pushdown, and linearly bounded automata with jumping and one-way jumping modes of tape heads, recently introduced non-sequential machine models. By using adapted versions of pumping lemmas and other methods, it compares the languages accepted by these automata models with their classical counterparts, and it shows that the resulting language classes are not closed under the most fundamental language operations.

The paper *On the minimal number of generators of endomorphism monoids of full shifts* by A. Castillo-Ramirez considers cellular automata over a group G and studies the minimal cardinality of a generating set (i.e., the rank) of the monoid of all cellular automata over G and of the group of all invertible cellular automata over G . When G is finite, it gives upper and lower bounds for the rank of the group of invertible cellular automata, while, when G is infinite with a decreasing chain of normal subgroups of finite index, it shows that the monoid of cellular automata over G is not finitely generated.

The paper *Iterative arrays with self-verifying communication cell* by M. Kutrib studies the computational capacity of self-verifying iterative arrays (SIVAs), i.e., iterative arrays with a symmetric nondeterministic behavior. It shows that the family of languages accepted by SIVAs is the complementation kernel of nondeterministic iterative array languages, and that SIVAs are as powerful as linear time self-verifying cellular automata and vice versa. This implies that SIVAs are strictly more powerful than deterministic devices.

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The paper *Complexity-theoretic aspects of expanding cellular automata* by A. Modanese considers expanding cellular automata (XCA), which are one-dimensional CA that can dynamically create new cells between existing ones. It shows that the class of polynomial-time XCA language deciders coincides with the class of decision problems polynomial-time truth-table reducible to NP, and that XCAs with multiple accept and reject states are polynomial-time equivalent to the original XCA model.

The paper *On the predictability of the abelian sandpile model* by J. A. Montoya and C. Mejia studies the dynamics of an avalanche in the abelian sandpile model, which is a well-known dynamical system displaying self-organized criticality. It considers the problem of deciding whether all

the nodes of a sandpile grid will be toppled by an evolving avalanche, and the problem of efficiently stopping an evolving avalanche. It is shown that avalanches cannot be predicted by a sequential algorithm, and that stopping two-dimensional avalanches is harder than the classical firefighter problem of stopping fires in a forest of low depth.

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