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Preface

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The International Conference on Unconventional Computation and Natural Computation (UCNC) is dedicated to both theoretical and experimental papers in both natural computing and unconventional computing. These include the topics of molecular computation, quantum computing, optical computing, chaos computing, cellular automata, neural computation, evolutionary computation, nature-inspired algorithms, artificial life, systems biology, synthetic biology, and cellular (*in vivo*) computing.

The first edition of UCNC (then called Unconventional Models of Computation) was established by Cristian S. Calude and it took place in 1998 in Auckland, New Zealand. Since then, it has been held in Brussels, Belgium (2000), Kobe, Japan (2002), Seville, Spain (2005), York, UK (2006), Kingston, Canada (2007), Vienna, Austria (2008), Ponta Delgada, Azores, Portugal (2009), Tokyo, Japan (2010), Turku, Finland (2011), Orléans, France (2012), Milano, Italy (2013), London, Ontario, Canada (2014), Auckland, New Zealand (2015), Manchester, UK (2016), Fayetteville, USA (2017), Fontainebleau, France (2018), and Tokyo, Japan (2019).

The 18th International Conference on Unconventional Computation and Natural Computation took place in Tokyo, Japan from June 3–7, 2019. The conference had five distinguished invited speakers, Noura Al Moubayed, Ho-Lin Chen, Akira Kakugo, Ion Petre, and Susan Stepney.

This special edition contains selected papers from the 18th edition of the conference. All papers accepted contain substantial extensions, and they also went through an independent review process.

The paper "Hairpin Completions and Reductions: Semilinearity Properties" by Henning Bordihn, Victor Mitrana, Andrei Păun, and Mihaela Păun studies some word operations inspired by hairpin completion and reduction, on words and languages. In particular, they examine non-iterated and iterated versions of these operations and investigate conditions by which they preserve semilinearity.

The paper "Reservoir Computing Quality: Connectivity and Topology" by Matthew Dale, Simon O'Keefe, Angelika Sebald, Susan Stepney, and Martin A. Trefzer investigates the effect of connectivity and topology on Reservoir Computers. Their work shows that there are benefits to using dynamical behaviour to assess the quality of computing substrates.

The paper "DNA Origami Words, Graphical Structures and Their Rewriting Systems" by James Garrett, Nataša Jonoska, Hwee Kim, and Masahico Saito examine rectangular DNA origami structures, and classify them based on their scaffold and staple organization. By associating modules to symbols, a word can correspond to a graphical representation of a DNA origami structure. Two types of module structures together with rewriting rules are defined, and the number of possible structures is determined by examining equivalence classes of words.

The paper "The Representational Entity in Physical Computing" by Susan Stepney and Viv Kendon demonstrates how the representational entity in abstraction/representation theory can be used within the computing cycle. The representational entity can form a complementary model that is associated with the physical computing model.

In the paper "Geometric Tiles and Powers and Limitations of Geometric Hindrance in Self-Assembly," Daniel Hader and Matthew J. Patitz work within variations of tile-based self-assembly systems. They explore how the use of geometric hindrance as a restriction on which tiles can bind in given locations can provide additional power (in terms of what can be built), but also some of its limitations (in

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comparisons across models, as well as with systems which utilize glue cooperation).

The paper "Computational Limitations of Affine Automata and Generalized Affinite Automata" by Mika Hirvensalo, Etienne Moutot, and Abuzer Yakaryılmaz studies computational power of affine automata under various limitations. The limitations include having and not having a right end marker, which enables postprocessing—a type of field over which the transition matrix and state vector are defined—and whether columns of a transition matrix are required to sum up to 1 or not.

The paper "On Computing the Lyapunov Exponents of Reversible Cellular Automata" by Johan Kopra proves that the Lyapunov exponents are uncomputable even for one-dimensional reversible cellular automata. He also considers classes of cellular automata whose Lyapunov exponents can be computed, and for the family of multiplication automata, he computes not only the exponent but also its measure theoretical variant, i.e., the average Lyapunov exponent.

The paper "Solving Combinatorial Optimization Problems Using Oscillator Based Ising Machines" by Tianshi Wang, Leon Wu, Parth Nobel, and Jaijeet Roychowdhury proposes a novel implementation of Ising machines as networks of coupled, self-sustaining nonlinear oscillators and shows that the proposed oscillator-based Ising machines outperform existing methods on MAX-CUT and graph coloring problems. Working prototypes are also presented.

We thank the invited speakers and the authors of the papers at the conference, the organizing committee, Szilárd Zsolt Fazekas, Kohei Maruyama, Reoto Morita, Kei Taneishi, and Fumie Watanabe, for their excellent help, and also the program committee. Lastly, we thank the authors of this special issue.