Nat Comput (2016) 15:1–3
DOI 10.1007/s11047-015-9535-0

EDITORIAL

Preface

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Published online: 16 December 2015

"Unconventional computation and natural computation" is a phrase that is used to describe a variety of novel forms of computation, human-designed computation inspired by nature, and computational aspects of processes taking place in nature. It includes a large number of research areas such as:

Molecular computing	Cellular automata	Computational systems biology
Quantum computing	Neural computation	Genetic networks
Optical computing	Evolutionary computation	Protein–protein networks
Chaos computing	Swarm intelligence	Transport networks
Physarum computing	Ant algorithms	Computational neuroscience
Hyperbolic space computation	Artificial immune systems	Synthetic biology
Collision-based computing	Artificial life	Cellular (in vivo) computing
Super-Turing computation	Membrane computing	
	Amorphous computing	

The International Conference on Unconventional Computation and Natural Computation, UCNC, is a meeting where scientists with different backgrounds, yet sharing a common interest in such topics, present their latest theoretical or experimental results. The first edition of UCNC (formerly called Unconventional Models of Computation, and Unconventional Computation, respectively) was held in Auckland, New Zealand in 1998. Subsequent sites of the conference were Brussels, Belgium in 2000, Kobe, Japan in 2002, Seville, Spain in 2005, York, UK, in 2006, Kingston, Canada in 2007, Vienna, Austria, in 2008, Ponta Delgada, Portugal in 2009, Tokyo, Japan in 2010, Turku, Finland, in 2011, Orleans, France in 2012, and Milan, Italy in 2013.

The 13th edition in this conference series, UCNC 2014, was organized in London, Ontario, Canada, in the Deparment of Computer Science of the University of Western Ontario, July 14–18, 2014. The meeting was pleased to have four distinguished invited speakers who presented talks touching on several UCNC topics: Yaakov Benenson (ETH Zürich), Charles H. Bennett (IBM Watson Research Center), Hod Lipson (Cornell University), and Nadrian C. Seeman (New York University). The meeting was also pleased to have three distinguished invited tutorial speakers: Anne Condon (University of British Columbia), Ming Li (University of Waterloo), and Tommaso Toffoli (Boston University).

This special issue of *Natural Computing* contains a selection of papers from UCNC 2014, which underwent substantial updates and extensions, and went through an independent review process. This collection of papers gives a snapshot of the rich and fast evolving area of highly interdisciplinary research that is unconventional computation and natural computation.

The paper "Synthetic biology of cell signaling", by Yaakov Benenson and Jonathan Hansen, reviews the latest progress in synthetic biology of signaling pathways. The focus is on post-translational signaling, covering the main synthetic biology chassis such as prokaryotes, yeast, mammalian cells, and plants.

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The paper "Halting the hallmarks: a cellular automaton model of early cancer growth inhibition", by Jenna Leah Butler, Frances Mackay, Colin Denniston, and Mark Daley, presents a method for investigating targeted combination therapy options for early cancer growth by simulating the effect of agents targeted at the "hallmarks of cancer". The simulation is composed of a cellular automata model of cancer growth and a lattice Boltzmann model of biphasic fluid flow—oxygen in blood—which together give more biologically relevant growth dynamics. Results indicate that certain hallmark targeted drugs in combination may be more effective than others, while some combinations could actually enhance cancer growth.

The paper "Pseudo-inversion: closure properties and decidability", by Da-Jung Cho, Yo-Sub Han, Shin-Dong Kang, Hwee Kim, Sang-Ki Ko, and Kai Salomaa, considers a pseudo-inversion operation motivated by DNA modification events. It studies the closure properties of various subfamilies of languages under the operation. It also introduces pseudo-inversion-freeness and examines closure properties and related decidability problems.

The paper "Producibility in hierarchical self-assembly", by David Doty, shows, in the hierarchical model of algorithmic tile assembly, efficient algorithms for the problems of deciding whether an assembly α is producible, and for deciding if an assembly α is the unique producible terminal assembly of a noncooperative temperature 1 tile system. It is also shown that if two assemblies are producible, and if they can be overlapped consistently—i.e., if the positions that they share have the same tile type in each assembly—then their union is also producible.

The paper "Computational completeness of complete, star-like, and linear hybrid networks of evolutionary processors with a small number of processors", by Artiom Alhazov, Rudolf Freund, Vladimir Rogozhin and Yurii Rogozhin, shows that hybrid network of evolutionary processors with random-context filters are computationally complete when the underlying graph structure for the communication between the evolutionary processors is the complete or the linear graph with five nodes, whereas with a star-like communication graph six nodes are needed. If the final results are defined by only taking the terminal strings out of the designated output node, then for these extended hybrid networks of evolutionary processors only four nodes are needed in all cases, i.e., the underlying communication structure can be a complete or a linear graph, but now even a star-like graph, too.

The paper "Doubles and negatives are positive (in self-assembly)", by Jacob Hendricks, Matthew Patitz, and Trent Rogers, shows that the temperature-1 restricted glues Tile Assembly Model (rgTAM) is unable to simulate the strongly cooperative behavior of the temperature-2 abstract Tile Assembly Model (aTAM). The dupled restricted glues Tile Assembly Model (DrgTAM) is also defined, and it is shown that this model is intrinsically universal for the aTAM.

The paper "On string languages generated by sequential spiking neural P systems based on the number of spikes", by Keqin Jiang, Wenli Chen, Yuzhou Zhang, and Linqiang Pan, investigates the computational power, as language generators, of sequential spiking neural P systems, based on the number of spikes. A characterization of recursively enumerable languages is given as projections of inverse-morphic images of languages generated by such sequential spiking neural P systems.

The paper "Counter machines and crystallographic structures", by Natasha Jonoska, Mile Krajcevski, and Greg McColm, initiates a formal language theory approach in studies of periodic nanostructures by examining languages associated with cyclic walks in periodic digraphs. It is observed that labels of such walks in periodic digraphs are closely related to new classes of languages that form a hierarchy of intersection languages. This hierarchy is included within the hierarchy of intersection of deterministic context-free languages.

The paper "Fast arithmetic in algorithmic self-assembly", by Alexandra Keenan, Robert Schweller, Michael Sherman, and Xingsi Zhong, considers the time complexity of adding two n-bit numbers together within the tile self-assembly model. It determines that this problem, along with multiplication, has a worst case lower bound of $\Omega(\sqrt{n})$ in 2D assembly, and $\Omega(\sqrt[3]{n})$ in 3D assembly. The paper also considers the average case complexity of addition over uniformly distributed n-bit strings and shows how one can achieve $O(\log n)$ average case time with a simultaneous $O(\sqrt{n})$ worst case run time in 2D.

The paper "More on quantum, stochastic, and pseudo stochastic languages with few states", by Arseny Shur and Abuzer Yakarylmaz, studies three main models of finite automata with cutpoint over real numbers. The smallest unary automata recognizing uncountably many languages are found, and the full description of languages recognized by one-state automata is given. The counterparts of these results for the automata with inclusive/exclusive cutpoint are presented.

The paper "Size-separable tile self-assembly: a tight bound for temperature-1 mismatch-free systems", by Andrew Winslow, explores DNA tile assembly size-based filtering, used to separate larger complete assemblies from smaller incomplete assemblies. It gives an optimal algorithm for modifying systems of a special class to maximize the difference in size between complete and incomplete assemblies. Specifically, non-cooperative, mismatch-free systems with unique terminal assemblies are obtained.

We are grateful for the support of the FIELDS Institute for Research in Mathematical Sciences, the PERIMETER Institute for Theoretical Physics, the Department of Computer Science and the Faculty of Science of the University of Western Ontario, Research Western, IBM, and the Rotman Institute of Philosophy for the organization of UCNC 2014.

We also express our thanks to all authors of the articles submitted to this Special Issue, and gratefully acknowledge the efforts of our many reviewers.