UCNC 2018 special issue editorial

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Natural computing refers to the interdisciplinary area between computer science, mathematics, physics and biology that tries to formalise and explore the computational processes found in the physical world. It aims to copy natural processes in order to provide new solutions to computationally hard problems. Another investigated direction is the implementation of computation in (non-electronic) physical media. It is not surprising that in many cases the computation performed by obtained formalisms does not fit into the classical concept of Turing computation, mainly because of the highly distributed and parallel structure. The area of *unconventional computation* studies computational models that do not fit into the classical modes of computation, including models not having a physical inspiration.

The research in these aforementioned domains is extremely challenging as many concepts are completely new and were never considered before. This causes many technical difficulties, in particular for formalisation and understanding of the computational process. At the same time the study of such models is intellectually rewarding, providing deep unsuspected connections between areas of mathematics, physics, biology and computer science.

The Unconventional Computation and Natural Computation (UCNC) conference is the main venue for researchers in these fields.

The first UCNC (at that time called Unconventional Models of Computation) was held in Auckland, New Zealand, in 1998, organised by the Centre for Discrete Mathematics and Theoretical Computer Science, University of Auckland, and the Santa Fe Institute. 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 17th edition of UCNC was held June 25–29, 2018, on the campus of the IUT de Fontainebleau at the University of Paris-Est Créteil – Val de Marne, Fontainebleau, France. The meeting was pleased to have four distinguished invited speakers who presented inspiring talks related to several UCNC topics: Satoshi Murata (Tohoku University, Japan), Julian Miller (University of York, UK), Lee Cronin (University of Glasgow, UK) and Damien Woods (INRIA, France). Also the meeting featured a tutorial provided by Jean Krivine (CNRS and University of Paris Diderot, France). The meeting was accompanied by four associated workshops and co-located with Machines, Computations and Universality (MCU 2018) conference.

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

The paper “The alchemy of computation: designing with the unknown” by Julian Miller is the full version of his invited talk presented at the conference. It presents and compares two computer controlled search approaches for computational problems solving: Cartesian genetic programming and the evolution *in materio*. The paper also discusses possible new research directions by borrowing ideas from one and using them in the other.

The paper “Optimal Staged Self-Assembly of Linear Assemblies” by Cameron Chalk, Eric Martinez, Robert Schweller, Luis Vega, Andrew Winslow and Tim Wylie analyses the complexity of building linear assemblies, sets of linear assemblies, and $O(1)$ -scale general shapes in the staged tile assembly model. Upper and lower bounds for the minimal number of stages needed to perform

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corresponding assemblies are shown. Similar results are obtained for the case of flexible glues and $O(1)$ -shapes.

The paper “Quantum information processing in the neighborhood of a black hole” by Tanner Crowder and Marco Lanzagorta studies the problem of the evolution of a massive spin-1/2 particle using an imperfectly prepared state. The authors show that this process violates many standard assumptions made in quantum information theory and they are able to quantify how much information can be transferred through such a quantum process. The paper also shows that relativistic noise can increase the amount of information that can be transferred and that the large Wigner rotation caused by a black hole can greatly increase the informatic content of a qubit.

The paper “Computational Completeness of Simple Semi-Conditional Insertion-Deletion Systems of Degree (2,1)” by Henning Fernau, Lakshmanan Kuppusamy and Indhumathi Raman investigates the model of insertion-deletion systems enriched with a semi-conditional test mechanism for rule applicability. The paper features a series of computational completeness results that improve previous works and that show the trade-offs between different descriptive complexity parameters of the model.

The paper “Perturbations and Phase Transitions in Swarm Optimization Algorithms” by Tomáš Vantuch, Ivan

Zelinka, Andrew Adamatzky and Norbert Marwan studies the phase transition between chaos and order in the frame of swarm intelligence based algorithms. They give statistical evidence that converging iterations of the optimization algorithms are different from non-converging ones in a view of applied chaos, complexity and predictability estimating indicators.

Finally, the paper “Variants of P Systems with Activation and Blocking of Rules” by Artiom Alhazov, Rudolf Freund and Sergiu Ivanov investigates the model of membrane computing where the applicability of rules is controlled by the application of rules in the preceding derivation step(s). The paper gives a formal definition of the concept as well as several results showing the relation of the obtained model with PsETOL and PsRE families. An interesting concept of backward activation is proposed as well as ideas for performing super-Turing computations.

We thank the authors and invited speakers for contributing to the meeting, and the workshop organisers for enriching the event. We also thank the Program Committee and the additional reviewers for their exemplary work in assessing the submissions.

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