Preface

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As a field of research, *unconventional computation* expands the study of computational models and their applications beyond classical modes of computation (that is, the Turing and von Neumann models). Intersecting with this field is the study of *natural computation*, which draws inspiration from the physical world to develop new forms of computing. Taken together, these two deeply related fields build a foundation for computing with entirely new forms of devices, as well as providing a space in which to rethink the entire notion of “computation” and “computability”. Topics that are generally considered to be within scope of unconventional/natural computation include (but are not limited to):

- Molecular, cellular, quantum, optical and chaos computing.
- Cellular automata.
- Neural and evolutionary computation.
- Artificial immune systems.
- Ant algorithms and swarm intelligence.
- Amorphous computing.
- Membrane computing.
- Computational systems biology and computational neuroscience.
- Synthetic biology.

One of the main conferences in this combined field is *Unconventional Computation and Natural Computation* (UCNC). The first UCNC was held in Auckland, New Zealand, in 1998, organized 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, 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), and Fayetteville, USA (2017).

The 15th iteration of UCNC was organized and hosted by the Informatics Research Centre (now the Centre for Advanced Computational Science) of Manchester Metropolitan University, UK, and took place between July 11–15, 2016. The conference received 30 full paper submissions, of which we accepted 15 for oral presentation. We were pleased to host six distinguished invited speakers: Bob Coecke (University of Oxford, UK): *In pictures: from quantum foundations to natural language processing*, Steve Furber (University of Manchester, UK): *The SpiN-Naker Project*, Fritz Simmel (Technische Universität München, Germany): *Chemical communication between cell-sized reaction compartments*, Masami Hagiya (University of Tokyo, Japan): *Gellular automata*, Rebecca Schulman (Johns Hopkins University, USA): *Self-assembling adaptive structures with DNA*, and Jon Timmis (University of York, UK): *Many hands make light work: A case study in swarm robotics*.

This special issue of *Natural Computing* presents a selection of contributed papers, each of which has been extended, updated and independently reviewed.

The paper “Reachability problems for continuous chemical reaction networks” (Case, Lutz, and Stull) asks whether, for a continuous chemical reaction network, it is possible to reach a given state from some starting state, via a series of reactions. The main result of this paper is that this problem is decidable in polynomial time, and the authors also show that a version of the problem (which restricts the number of reactions allowed) is NP-complete.

The paper “An all-optical soliton FFT computational arrangement in the 3NLSE-domain” (Bakaoukas) presents a framework for implementing the Fast Fourier Transform (FFT) algorithm using optical solitons. The author

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demonstrates how a number of basic logic components may be constructed using solitons, before showing how these may be combined to implement the FFT.

The paper “Investigations on the power of matrix insertion-deletion systems with small sizes” (Fernau, Kuppusamy, and Raman) discusses the computational power of matrix insertion-deletion systems, which are abstract models inspired, in part, by processes in biology (such as DNA processing and RNA editing). The authors improve and complement existing universality results for these systems.

The paper “Model-based computation” (Beebe) presents an analysis of analog computation using the idea of model-based computation. The aim is to separate out representations (models) from architectural properties or behaviour, in order to better understand the various claims made for different non-standard forms of computation.

The paper “Language recognition power and succinctness of affine automata” (Villagra and Yakaryilmaz) shows

how affine automata can simulate probabilistic and quantum automata, and presents a number of additional results concerning their language recognition properties and efficiency.

We thank the authors and invited speakers for contributing to the meeting, and the workshop organizers for enriching the event. We thank the Programme Committee and the additional reviewers for their exemplary work in assessing the submissions, and the Organizing Committee (James Charnock, Matthew Crossley, Réne Doursat and Emma Norling) for their efforts on behalf of the meeting. We also thank the Dean of Science and Engineering at MMU for sponsoring the event, the LNCS team at Springer (Alfred Hofmann and Anna Kramer) for supporting the continued publication of the UCNC proceedings, and the EasyChair project for providing essential infrastructure.