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Preface

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This special issue is devoted to all aspects of unconventional computation and natural computation. The research area seeks novel, often surprising approaches and platforms to information processing. Typically, but not always, the approaches are inspired by nature. Also information processing related phenomena that take place in nature are of interest. Computation goes on all around us all the time—it does not need much to happen—and the list of proposed unorthodox information processing approaches is long and versatile, ranging from well-known quantum and DNA computers to some quite remarkable systems that use slime mold or bacteria to compute.

The international conference series on *Unconventional Computing and Natural Computing* (UCNC) is an established forum to share most recent and exciting ideas on the field. The first venue of the series was Auckland, New Zealand, in 1998, and till today eighteen events have been organized. The conference UCNC 2020 was planned to be held in Vienna, Austria, in August 2020, but the global COVID-19 pandemic forced the event to be cancelled. Nevertheless, in order to facilitate sharing recent research on the topics of the conference, the Steering Committee decided to make a call for a special issue of the journal *Natural Computing*. All submissions were independently reviewed by at least two external reviewers. This procedure resulted in the acceptance of the nine articles presented here. The accepted papers cover several active topics in unconventional computation and natural computation, and they demonstrate the versatility of potential non-classical approaches to information processing.

The first article of the issue shows how a deck of playing cards provides an unconventional platform to implement cryptographic protocols. This article, titled *Committed-Format AND Protocol Using Only Random Cuts* by Yuta Abe, Takaaki Mizuki, and Hideaki Sone, proposes a card-based committed-format AND protocol using random cuts on a deck of only six cards. The protocol terminates after just two cuts. This improves previous results in terms of the number of cards as well as the number and the type of the cut operations used.

The second article *Conjugate Word Blending—Formal Model and Experimental Implementation* by XPCR by Francesco Bellamoli, Giuditta Franco, Lila Kari, Silvia Lampis, Timothy Ng, and Zihao Wang involves both theoretical and experimental aspects of DNA computing. The authors propose a new word operation called conjugate word blending to explain some unexpected results of an experimental DNA wet lab protocol, cross-pairing Polymerase Chain Reaction (XPCR), in the specific set-up when used to attempt concatenating two copies of the same gene. Computational and formal language aspects of the proposed operation are studied, and experiments are reported that led to the new operation.

In *Fast Reconfiguration of Robot Swarms with Uniform Control Signals*, the authors David Caballero, Angel A. Cantu, Timothy Gomez, Austin Luchsinger, Robert Schweller, and Tim Wylie investigate the problem of controlling a swarm of robots or other particles by global instruction sequences to make them form desired shapes. Two types of commands are considered separately: step instructions that make all robots move one step in the given direction unless blocked, and tilt instructions that make all robots move maximally in the given direction. With a suitable choice of obstacles a universal board is obtained that allows any pattern of n robots to be reconfigured into any desired shape in asymptotically optimal time.

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Insertion and deletion operations on words have their origins in language theory, but they are also relevant in the field of molecular computing. The article titled *On the Generative Capacity of Matrix Insertion-Deletion Systems of Small Sum-Norm* by Henning Fernau, Lakshmanan Kuppusamy, and Indhumathi Raman is a theoretical study of the power of the matrix insertion-deletion systems of limited resources. The considered complexity measure involves seven parameter values and several parameter combinations yield improved computational completeness results.

Oritatami is a geometric computation model for shape self-assembly, based on RNA cotranscriptional folding. In *Impossibility of Strict Assembly of Infinite Fractals by Oritatami*, the authors Yo-Sub Han and Hwee Kim prove limitations on the folding ability of oritatami systems. They show that deterministic cyclic oritatami systems cannot self-assemble into certain infinite aperiodic non-self-touching curves. In particular, one cannot construct two well-known infinite fractal curves, the Koch curve and the Minkowski curve.

The article *Single Semi-contextual Insertion-deletion Systems* by Sergiu Ivanov and Sergey Verlan deals with insertion-deletion systems where a single letter can be inserted or deleted in a word as long as certain global permitting and forbidding conditions are satisfied by the word. In particular, the authors consider short permitting and forbidding substrings, and discover asymmetry in the sense that permitting strings of length one and forbidding strings of length two admit computational completeness whereas forbidding strings of length one do not, regardless of the length of the permitting strings.

Constructing a text from a dictionary problem is a string processing problem with applications in reconstructing long DNA sequences from small fragments. This problem is studied in the article *Classical and Quantum Algorithms for Constructing Text from Dictionary Problem* by Kamil Khadiev and Vladislav Remidovskii. The authors provide efficient classical randomized and quantum algorithms for the problem and provide a lower bound result in the classical setting.

Watson-Crick finite automata operate on two-stranded input tapes with reading heads on both strands. In *State-deterministic* 5' $\rightarrow$ 3' *Watson-Crick Automata* Benedek Nagy studies Watson-Crick automata whose heads start from the opposite ends of the strands, and the computation ends as soon as the heads meet. The paper focuses on state-deterministic automata where the next state is solely determined by the present state. The author places the new state-deterministic class in the hierarchy formed under other restrictions on Watson-Crick finite automata, such as all-final, stateless or 1-limited variants and their combinations.

A morphogenetic system (M system) is a computational model inspired by morphogenetic phenomena that extends principles of membrane computing with geometric considerations. The article *Self-Healing Turing-Universal Computation in Morphogenetic Systems* by Petr Sosík, Max Garzon, and Jan Drastík demonstrates that morphogenetic systems can be Turing universal and self-healing at the same time.

We thank all the authors for their contributions to this special volume. We are also very grateful to the members of the program committee of the originally planned cancelled UCNC 2020 conference for their flexibility to switch from handling conference submissions to helping in processing the journal submissions instead, and we thank all reviewers for their time and effort. Finally, we would like to thank Joost Kok and Grzegorz Rozenberg for their support and guidance.