Preface

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The International Conference on DNA Computing and Molecular Programming, initially held in 1995, has now become the foremost venue for biomolecular computing research. Currently, under the auspices of the International Society for Nanoscale Science, Computation, and Engineering, this conference draws a growing community of scientists from the diverse fields of computer science, mathematics, chemistry, biophysics, and molecular biology.

This special issue contains a selection of seven papers originally presented in preliminary form at DNA 19: the 19th International Conference on DNA Computing and Molecular Programming, held in September 2013 at Arizona State University, Tempe, AZ, USA. All papers herein were reviewed independently of the conference referee process and contain extensive additional material.

“DNA Walker Circuits: Computational Potential, Design, and Verification” by Frits Dannenberg, Marta Kwiatkowska, Chris Thachuk, and Andrew J. Turberfield investigates the computational potential of localized hybridization reactions from DNA ‘walker’ systems for forming composable Boolean circuits. Such circuits are expected to have several important advantages over ‘well-mixed’ molecular circuits.

“Leaderless Deterministic Chemical Reaction Networks” by David Doty and Monir Hajiaghayi proves that

any semilinear function can be computed by a chemical reaction network starting from an initial configuration containing just the input molecules. Thus, semilinear chemical computation does not require preparing exact amounts of any species other than the inputs.

“Parallel Computation Using Active Self-Assembly” by Moya Chen, Doris Xin and Damien Woods studies parallel computation in the nubot model, a model of self-assembly, which captures coherent molecular or cellular motion. Along the way to showing that the model is capable of highly parallel computation, the authors develop nubot algorithms for a number of problems of independent interest, including line growth, sorting, matrix multiplication, and space-bounded Turing machine simulation.

“Signal Transmission Across Tile Assemblies: 3D Static Tiles Simulate Active Self-Assembly by 2D Signal-Passing Tiles” by Tyler Fochtman, Jacob Hendricks, Jennifer E. Padilla, Matthew J. Patitz, and Trent A. Rogers reveals that complex ‘signal-passing’ tiles can be simulated by regular (passive) tiles in algorithmic self-assembly at the cost of an extra dimension (moving from 2D to 3D).

“Exponential Replication of Patterns in the Signal Tile Assembly Model” by Alexandra Keenan, Robert Schweller, and Xingsi Zhong also takes a model of algorithmic tile assembly augmented with signal passing and shows that there exists a single, general purpose, 2D signal tile system that exponentially replicates any rectangular 2D pattern. For the first time, a template-directed method of exponential self-replication within tile assembly is described where the child molecule fully detaches from the parent.

“3-Color Bounded Patterned Self-assembly” by Lila Kari, Steffen Kopecki, and Shinnosuke Seki gives a new take on the computational complexity of finding a minimal tile set which self-assembles a pattern. The work shows that, even if the number of tile types of each color is

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restricted, the problem remains NP-complete. This result augments our understanding of this important problem and gives a new, concise, proof for the NP-completeness of the unrestricted tile-set synthesis problem.

“Staged Self-Assembly and Polyomino Context-Free Grammars” by Andrew Winslow reinforces the connection between context-free grammars and staged self-assembly (a model of self-assembly in which assemblies produced by one system are to be used as reagents for another). This work draws a nearly complete picture of how smallest

context-free grammars and staged assembly systems compare for producing a 2D labeled pattern.

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