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Matthew Cook · Turlough Neary (Eds.)

Cellular Automata and Discrete Complex Systems

22nd IFIP WG 1.5 International Workshop, AUTOMATA 2016
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Preface

This volume contains the papers presented at the 22nd International Workshop on Cellular Automata and Discrete Complex Systems, AUTOMATA 2016. The conference was held at the University of Zurich, Switzerland, June 15–17, 2015. AUTOMATA 2016 was an IFIP event of IFIP Working Group 1.5.

The AUTOMATA series began in Dagstuhl, Germany, in 1995 and has since been run yearly, appearing in Europe, North and South America, and Asia. As with previous editions of the series, AUTOMATA 2016 provided a focal point for researchers interested in cellular automata and related discrete complex systems where they could exchange ideas, present their latest research, and forge new collaborative partnerships. The AUTOMATA series is concerned with research on all fundamental aspects of cellular automata and related discrete complex systems. Topics of interest include: dynamics, topological, ergodic and algebraic aspects, algorithmic and complexity issues, emergent properties, formal language processing, symbolic dynamics, models of parallelism and distributed systems, timing schemes, phenomenological descriptions, scientific modeling, and practical applications.

We would like to express our appreciation to the invited speakers, Klaus Sutner, Guillaume Theyssier, Tommaso Toffoli, and Andrew Winslow. We also thank them for their contributions to this volume.

We thank all the authors who submitted to AUTOMATA 2016. There were 23 submissions in total. Each paper was assigned to three members of the Program Committee and following a complete reviewing process and subsequent discussion by the committee 12 papers were accepted for publication in these proceedings. In addition, there were a number of exploratory papers presented at the conference and we would like to take this opportunity to thank those who submitted to the exploratory track.

We thank the Program Committee for their diligent work, and the reviewers who assisted in the evaluation of papers. We would like to thank the AUTOMATA Steering Committee for giving us the opportunity to host AUTOMATA 2016 at the University of Zurich and for their invaluable advice and support with a special thank you to Jarkko Kari and Pedro de Oliveira. We are grateful to the Lecture Notes in Computer Science team of Springer for all their help in preparing this volume. Finally, we would like to thank iniForum and the administrative staff at the Institute of Neuroinformatics for their help in organizing this event, in particular Kathrin Aguilar Ruiz-Hofacker, Maik Berchten, David Lawrence, and Simone Schumacher, who were always ready to provide advice and assistance.

April 2016

Turlough Neary
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Invited Talk Abstracts

Automata, Semigroups and Dynamical Systems

Klaus Sutner

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Abstract. Invertible transducers are Mealy automata that determine injective maps on Cantor space and afford compact descriptions of their associated transduction semigroups and groups. A lot of information has been unearthed in the last two decades about algebraic aspects of these machines, but relatively little is known about their automata-theoretic properties and the numerous computational problems associated with them. For example, it is quite difficult to pin down the computational complexity of the orbits of maps defined by invertible transducers. We study some of these properties in the context of so-called m-lattices, where the corresponding transduction semigroup is a free Abelian group of finite rank. In particular we show that it is decidable whether an invertible transducer belongs to this class.

Propagation, Diffusion and Randomization in Cellular Automata

Guillaume Theyssier(✉)

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Abstract. A large part of the study of of cellular automata dynamics consists in comparing pairs of configurations and their orbits. Here we focus on pairs of configurations having a finite number of differences (diamonds) like in the celebrated Garden-of-Eden theorem. First, we show that it allows to study expansive-like phenomena where classical notions of chaotic behavior like positive expansivity or strong transitivity don't apply (in reversible CAs for instance). Second, we establish that for a large class of linear CA, diffusion of diamonds is equivalent to randomization (a large class of probability measures converge weakly towards the uniform measure under the action of the CA). Both properties are also equivalent to the absence of gliders in the CA. Finally, we give examples of reversible linear CAs that are strong randomizers (the convergence towards the uniform measure is simple and not only in Cesaro mean). This strong behavior is however provably impossible with linear CA having commuting coefficients (e.g. linear CA over cyclic groups).

Forewords. This extended abstract is based upon unpublished works in collaboration with A. Gajardo and V. Nesme on one hand (pre-expansivity), and B. Hellouin de Menibus and V. Salo on the other hand (randomization).

What Automata Can Provide a Medium for Life?

Tommaso Toffoli(✉)

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Abstract. Hadn't this question already been answered? We all know about computation-universal Turing Machines. And we know that any such machine can simulate a space-time dynamics not unlike von Neumann's cellular automaton, which is computation- and construction-universal and among other things can play host to self-replicating machines. And that self-replication sprinkled with a bit of randomness should inexorably lead to descent with variation, competition, and thence to evolution and all that.

And note that the state of the art has much advanced in the fifty years since. "So?" Enrico Fermi would have asked, "Where are they?"

It turns out that life is by its very nature a marginal, fragile, and ephemeral kind of phenomenon. For a substrate or a "culture medium" to be able to support it, computation- and construction-universality are necessary—but by no means sufficient! Most automata (including, I suspect, Conway's very game of "life") will go through their entire life course without ever originating anything like life.

What questions, then, should we ask of a prospective medium—be it a Turing machine, a cellular automaton, or some other kind of automaton—that will probe its capabilities to originate and/or sustain some form of life?

A Brief Tour of Theoretical Tile Self-Assembly

Andrew Winslow(✉)

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Abstract. The author gives a brief historical tour of theoretical tile self-assembly via chronological sequence of reports on selected topics in the field. The result is to provide context and motivation for these results and the field more broadly.

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