Emergence, Complexity and Computation

Volume 20

About this Series

The Emergence, Complexity and Computation (ECC) series publishes new developments, advancements and selected topics in the fields of complexity, computation and emergence. The series focuses on all aspects of reality-based computation approaches from an interdisciplinary point of view especially from applied sciences, biology, physics, or Chemistry. It presents new ideas and interdisciplinary insight on the mutual intersection of subareas of computation, complexity and emergence and its impact and limits to any computing based on physical limits (thermodynamic and quantum limits, Bremermann's limit, Seth Lloyd limits...) as well as algorithmic limits (Gödel's proof and its impact on calculation, algorithmic complexity, the Chaitin's Omega number and Kolmogorov complexity, non-traditional calculations like Turing machine process and its consequences,...) and limitations arising in artificial intelligence field. The topics are (but not limited to) membrane computing, DNA computing, immune computing, quantum computing, swarm computing, analogic computing, chaos computing and computing on the edge of chaos, computational aspects of dynamics of complex systems (systems with self-organization, multiagent systems, cellular automata, artificial life,...), emergence of complex systems and its computational aspects, and agent based computation. The main aim of this series it to discuss the above mentioned topics from an interdisciplinary point of view and present new ideas coming from mutual intersection of classical as well as modern methods of computation.Within the scope of the series are monographs, lecture notes, selected contributions from specialized conferences and workshops, special contribution from international experts.

More information about this series at http://www.springer.com/series/10624

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Designing Beauty: The Art of Cellular Automata

Springer

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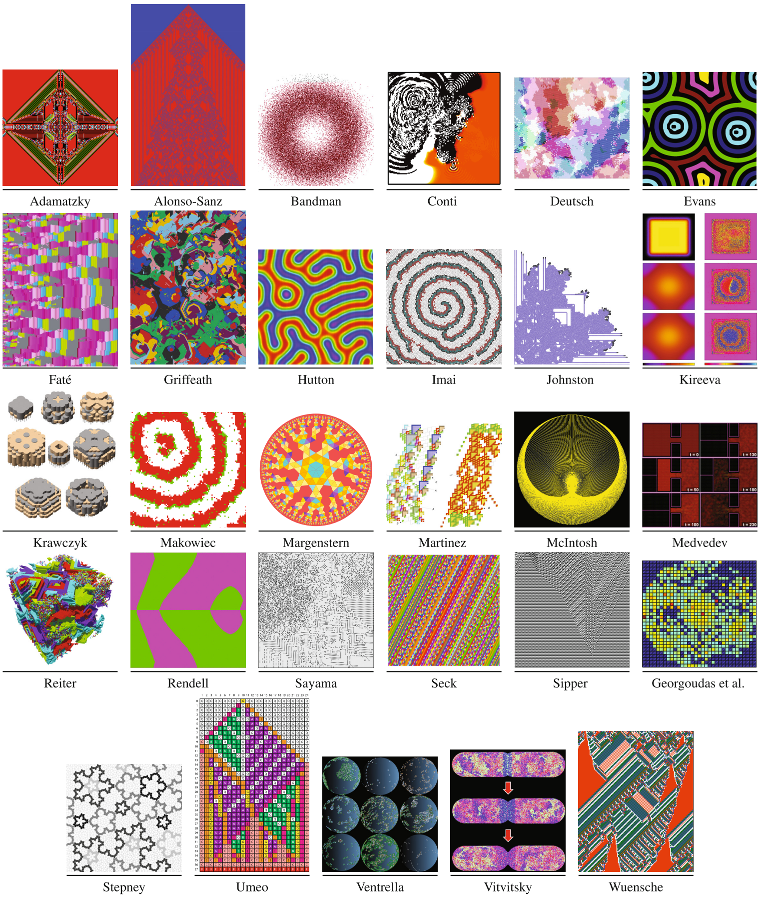
Preface

Cellular automata are regular uniform networks of locally-connected finite-state machines.They are discrete systems with non-trivial behaviour. Cellular automata are ubiquitous. They are mathematical abstractions of computation, models of physical, chemical and livings systems, and architectures of massive-parallel processors. Cellular automata generate patterns. These patterns feed our visual thinking. They help us to discover novel properties of spatially extended systems. They aid us in design of parallel algorithms. Also the patterns excite us. They fuel our imagination and guide us on the trips into depth of unknown, in the galaxies of the Computing Universe.

Science aims for results. Art is driven by process. A kaleidoscope of colourful complex patterns produced by apparently simple rules is where science merges with art, and art becomes part of science. World leading mathematicians, computists, physicists, and engineers brought together marvellous, entertaining and often esoteric configurations generated by cellular automata with a rich family of local state-transition rules, including totalistic, cyclic and reversible automata, majority vote, asynchronous, excitable and lattice-gas automata. The automata evolve on orthogonal and hexagonal lattices, Penrose tilings, geodesic grids and hyperbolic planes. Many works are produced using Conway's Game of Life automata and their modifications: Larger than Life, Life without Death, enlightened Game of Life. Computational potential of cellular automata is illustrated by snapshots of evolving counters, automata solving firing squad synchronisation and Prisoner's dilemma problems, self-reproduction, and a design of universal Turing machine implemented in the Game of Life.

Configurations produced by cellular automata help us to get an insight into the mechanics of pattern formation, propagation and interaction in natural systems: heart pacemaker, bacterial membrane proteins, chemical reactors, water permeation in soil, compressed gas, cell division, population dynamics and non-trivial collective behaviour, reaction-diffusion media and self-organisation. Examples of real architectural forms, ornamental systems and floor tilings presented in the book bridge virtual beauty of local transitions rules with aesthetic appealing of physical objects generated by the rules. Many of the cellular automata art works have been shown at major art exhibitions, installations and performances; others are newly born and awaiting for their fame to come.

The book offers in-depth insights and first-hand working experiences into production of art works, using simple computational models with rich morphological behaviour, at the edge of mathematics, computer science, physics and biology. We believe the works presented will inspire artists to take on cellular automata as their creative tool and will persuade scientists to convert products of their research into the artistic presentations attractive to general public.



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