

LNC3 3305

Peter M.A. Slood
Bastien Chopard
Alfons G. Hoekstra (Eds.)

Cellular Automata

**6th International Conference on Cellular Automata
for Research and Industry, ACRI 2004
Amsterdam, The Netherlands, October 2004
Proceedings**



Springer

Peter M.A. Sloot Bastien Chopard
Alfons G. Hoekstra (Eds.)

Cellular Automata

6th International Conference on Cellular Automata
for Research and Industry, ACRI 2004
Amsterdam, The Netherlands, October 25-27, 2004
Proceedings



Springer

Volume Editors

Peter M.A. Sloot
Alfons G. Hoekstra
University of Amsterdam
Informatics Institute, Section Computational Science
Kruislaan 403, 1098 SJ Amsterdam, The Netherlands
E-mail: {sloot, a.g.hoekstra}@science.uva.nl

Bastien Chopard
University of Geneva
Computer Science Department, CUI
24 Rue du Général Dufour, 1211 Geneva 4, Switzerland
E-mail: Bastien.Chopard@cui.unige.ch

Library of Congress Control Number: 2004113647

CR Subject Classification (1998): F.1.1, F.2.2, I.6, C.2

ISSN 0302-9743

ISBN 3-540-23596-5 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media

springeronline.com

© Springer-Verlag Berlin Heidelberg 2004
Printed in Germany

Typesetting: Camera-ready by author, data conversion by PTP-Berlin, Protago-TeX-Production GmbH
Printed on acid-free paper SPIN: 11339403 06/3142 5 4 3 2 1 0

Commenced Publication in 1973

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

Lancaster University, UK

Takeo Kanade

Carnegie Mellon University, Pittsburgh, PA, USA

Josef Kittler

University of Surrey, Guildford, UK

Jon M. Kleinberg

Cornell University, Ithaca, NY, USA

Friedemann Mattern

ETH Zurich, Switzerland

John C. Mitchell

Stanford University, CA, USA

Moni Naor

Weizmann Institute of Science, Rehovot, Israel

Oscar Nierstrasz

University of Bern, Switzerland

C. Pandu Rangan

Indian Institute of Technology, Madras, India

Bernhard Steffen

University of Dortmund, Germany

Madhu Sudan

Massachusetts Institute of Technology, MA, USA

Demetri Terzopoulos

New York University, NY, USA

Doug Tygar

University of California, Berkeley, CA, USA

Moshe Y. Vardi

Rice University, Houston, TX, USA

Gerhard Weikum

Max-Planck Institute of Computer Science, Saarbruecken, Germany

Preface

“What joy to discern the minute in infinity, the vast to perceive in
the small, what divinity!”

Jacob Bernoulli (1654-1705) in *Ars Conjectandi* (1713)

We are proud to present to you the proceedings of the Sixth International Conference on Cellular Automata for Research and Industry (ACRI 2004), held in Amsterdam, The Netherlands on October 25–27, 2004.

Since the first conference in Italy, ACRI, which is held biennially, has become the premier conference in the field of cellular automata in Europe and beyond, and is still growing in quality and size.

This year’s theme was “From Individual to Collective Behavior”, emphasizing the capability of Cellular Automata to simulate macroscopic processes from individual, local interactions. Cellular Automata, in spite of their apparent simplicity, represent a very powerful approach to studying spatio-temporal systems in which complex phenomena build up out of many simple local interactions. In the words of Richard Feynman in the *Character of Physical Law* (1982), “Nature uses only the longest threads to weave her patterns, so each small piece of her fabric reveals the organization of the entire tapestry”.

John von Neumann, who is recognized as the father of cellular automata, would have been 100 years old in 2004. ACRI 2004 wanted to commemorate this date by inviting researchers to submit contributions related to von Neumann’s work or to the emergence of organization in systems in which collaboration between components wins over the individual behavior.

In view of this commemoration we had two very inspiring memorial plenary lectures on the first day: “*Von Neumann’s Century: Too many souls!*” by Prof. Tomasso Toffoli and “*John von Neumann and Cellular Automata*” by Prof. Roland Vollmar

Other invited lectures that were presented in the plenary sessions during the three meeting days were: “*Pattern Discovery and Automated Theory Building*” by Prof. James P. Crutchfield, “*Studying Biological Development and Evolution with Multilevel Particle Systems*” by Prof. Paulien Hogeweg, “*Cell Scale Simulations, the Neglected Link Between Microscopic and Continuum Modeling*” by Prof. James A. Glazier, “*From Cellular Automata to Wetware*” by Prof. Andrew Adamatzky, and “*Structural Design and Optimization Using Cellular Automata*” by Prof. Zafer Gürdal.

We would like to express our sincere thanks to the invited speakers who delivered such inspiring lectures at ACRI 2004.

The conference was organized along the following tracks:

- Methods and Theory
- Evolved CA
- Traffic, Networks and Communication

- Applications in Science and Engineering
- Bio-medical Applications
- Natural Phenomena and Ecology
- Social and Economical Applications

This volume contains peer reviewed original work on the theory and application of Cellular Automata. After peer review by three experts in the field, 40% of the 150 papers submitted were selected for oral presentation and 30% for poster presentation. A total of 30% of the submitted papers were rejected.

This conference would not have been possible without the support of many people and organizations that helped in different ways to make it a success.

First of all we would like to thank the authors for making the effort to submit so many high-quality papers. We thank the Program Committee for their excellent job in reviewing the submissions and thus guaranteeing the quality of the conference and the proceedings. We thank Liesbeth Otte and the conference office of the University of Amsterdam for their practical assistance and support. Many thanks go to Coco van der Hoeven for her secretarial work. Dick van Albada, Berry Vermolen and Jiangjun Cui are acknowledged for their punctuality in preparing the draft of the proceedings.

We thank our sponsors for their financial support: the board of the University of Amsterdam, the Science Faculty and the Institute for Informatics. Finally we thank the Dutch Science Foundation NWO, section Exact-Sciences, as well as the section Computational Life Sciences.

September 2004

Peter Sloot
Bastien Chopard
Alfons Hoekstra

Organization

Scientific Committee

Peter M.A. Sloot, General Chair (University of Amsterdam, The Netherlands)
Bastien Chopard, General Co-Chair (University of Geneva, Switzerland)
Alfons G. Hoekstra, Program Committee Chair (University of Amsterdam, The Netherlands)

Local Organizing Committee

Liesbeth Otte (University of Amsterdam, The Netherlands)
Dick van Albada (University of Amsterdam, The Netherlands)
Berry Vermolen (University of Amsterdam, The Netherlands)
Jiangjiun Cui (University of Amsterdam, The Netherlands)

Program Committee

Albuquerque, Paul, University of Geneva, Switzerland
Bagnoli, Franco, University of Florence, Italy
Ballegooijen, Marijn van, Amsterdam, The Netherlands
Bandini, Stefania, University of Milano-Bicocca, Milan, Italy
Bandman, Olga, Institute of Computational Mathematics and Mathematical Geophysics, Novosibirsk, Russia
Berec, Ludek, Ceske Budejovice, Czech Republic
Cattaneo, Gianpiero, University of Milano-Bicocca, Milan, Italy
Chopard, Bastien, University of Geneva, Switzerland
Emde Boas, Peter van, University of Amsterdam, The Netherlands
Deutsch, Andreas, Technical University of Dresden, Germany
Di Gregorio, Salvatore, University of Calabria, Italy
Dupuis, Alexandre, Oxford University, UK
Dzwiniel, Witold, AGH University of Science and Technology, Krakow, Poland
El Yacoubi, Samira, University of Perpignan, France
Green, Frederic, Clark University, USA
Haeseler, Friedrich von, KU Leuven, Belgium
Hoekstra, Alfons (Chair), University of Amsterdam, The Netherlands
Kaandorp, Jaap, University of Amsterdam, The Netherlands
Legendi, Tamas, Hungary
Manoussaki, Daphne, Hania, Greece
Marconi, Stephane, University of Geneva, Switzerland

VIII Organization

Mauri, Giancarlo, University of Milano-Bicocca, Milan, Italy
Meyer-Hermann, Michael, Dresden, Germany
Morishita, Shin, Yokohama National University, Japan
Nishinari, Katsuhiro, Ryukoku University, Shiga, Japan
Plapp, Mathis, Palaiseau, France
Serra, Roberto, Centro Ricerche e Servizi Ambientali Fenice, Italy
Sipper, Moshe, Ben-Gurion University, Beer-Sheva, Israel
Sloot, Peter, University of Amsterdam, The Netherlands
Spezzano, Giandomenico, ICAR-CNR, Italy
Talia, Domenico, University of Calabria, Italy
Tempesti, Gianluca, EPFL, Lausanne, Switzerland
Tomassini, Marco, University of Lausanne, Switzerland
Torenvliet, Leen, University of Amsterdam, The Netherlands
Trautteur, Giuseppe, University of Naples Federico II, Naples, Italy
Umeo, Hiroshi, Univ. of Osaka Electro-Communication, Japan
Vollmar, Roland, University of Karlsruhe, Germany
Worsch, Thomas, University of Karlsruhe, Germany
Zomaya, Albert, The University of Sydney, Australia

Sponsoring Organizations

The University of Amsterdam, The Netherlands
The Dutch Science Foundation NWO, section Exact Sciences and section Computational Life Sciences

Lecture Notes in Computer Science

For information about Vols. 1–3180

please contact your bookseller or Springer

Vol. 3305: P.M.A. Sloot, B. Chopard, A.G. Hoekstra (Eds.), *Cellular Automata*. XV, 883 pages. 2004.

Vol. 3293: C.-H. Chi, M. van Steen, C. Wills (Eds.), *Web Content Caching and Distribution*. IX, 283 pages. 2004.

Vol. 3274: R. Guerraoui (Ed.), *Distributed Computing*. XIII, 465 pages. 2004.

Vol. 3273: T. Baar, A. Strohmeier, A. Moreira, S.J. Mellor (Eds.), *<<UML>> 2004 - The Unified Modelling Language*. XIII, 454 pages. 2004.

Vol. 3271: J. Vicente, D. Hutchison (Eds.), *Management of Multimedia Networks and Services*. XIII, 335 pages. 2004.

Vol. 3270: M. Jeckle, R. Kowalczyk, P. Braun (Eds.), *Grid Services Engineering and Management*. X, 165 pages. 2004.

Vol. 3269: J. López, S. Qing, E. Okamoto (Eds.), *Information and Communications Security*. XI, 564 pages. 2004.

Vol. 3266: J. Solé-Pareta, M. Smirnov, P.V. Mieghem, J. Domingo-Pascual, E. Monteiro, P. Reichl, B. Stiller, R.J. Gibbens (Eds.), *Quality of Service in the Emerging Networking Panorama*. XVI, 390 pages. 2004.

Vol. 3265: R.E. Frederking, K.B. Taylor (Eds.), *Machine Translation: From Real Users to Research*. XI, 392 pages. 2004. (Subseries LNAI).

Vol. 3264: G. Paliouras, Y. Sakakibara (Eds.), *Grammatical Inference: Algorithms and Applications*. XI, 291 pages. 2004. (Subseries LNAI).

Vol. 3263: M. Weske, P. Liggesmeyer (Eds.), *Object-Oriented and Internet-Based Technologies*. XII, 239 pages. 2004.

Vol. 3262: M.M. Freire, P. Chemouil, P. Lorenz, A. Gravey (Eds.), *Universal Multiservice Networks*. XIII, 556 pages. 2004.

Vol. 3261: T. Yakhno (Ed.), *Advances in Information Systems*. XIV, 617 pages. 2004.

Vol. 3260: I.G.M.M. Niemegeers, S.H. de Groot (Eds.), *Personal Wireless Communications*. XIV, 478 pages. 2004.

Vol. 3258: M. Wallace (Ed.), *Principles and Practice of Constraint Programming – CP 2004*. XVII, 822 pages. 2004.

Vol. 3257: E. Motta, N.R. Shadbolt, A. Stutt, N. Gibbins (Eds.), *Engineering Knowledge in the Age of the Semantic Web*. XVII, 517 pages. 2004. (Subseries LNAI).

Vol. 3256: H. Ehrig, G. Engels, F. Parisi-Presicce, G. Rozenberg (Eds.), *Graph Transformations*. XII, 451 pages. 2004.

Vol. 3255: A. Benczúr, J. Demetrovics, G. Gottlob (Eds.), *Advances in Databases and Information Systems*. XI, 423 pages. 2004.

Vol. 3254: E. Macii, V. Paliouras, O. Koufopavlou (Eds.), *Integrated Circuit and System Design*. XVI, 910 pages. 2004.

Vol. 3253: Y. Lakhnech, S. Yovine (Eds.), *Formal Techniques, Modelling and Analysis of Timed and Fault-Tolerant Systems*. X, 397 pages. 2004.

Vol. 3250: L.-J. (LJ) Zhang, M. Jeckle (Eds.), *Web Services*. X, 301 pages. 2004.

Vol. 3249: B. Buchberger, J.A. Campbell (Eds.), *Artificial Intelligence and Symbolic Computation*. X, 285 pages. 2004. (Subseries LNAI).

Vol. 3246: A. Apostolico, M. Melucci (Eds.), *String Processing and Information Retrieval*. XIV, 332 pages. 2004.

Vol. 3245: E. Suzuki, S. Arikawa (Eds.), *Discovery Science*. XIV, 430 pages. 2004. (Subseries LNAI).

Vol. 3244: S. Ben-David, J. Case, A. Maruoka (Eds.), *Algorithmic Learning Theory*. XIV, 505 pages. 2004. (Subseries LNAI).

Vol. 3243: S. Leonardi (Ed.), *Algorithms and Models for the Web-Graph*. VIII, 189 pages. 2004.

Vol. 3242: X. Yao, E. Burke, J.A. Lozano, J. Smith, J.J. Merelo-Guervós, J.A. Bullinaria, J. Rowe, P. Tiño, A. Kabán, H.-P. Schwefel (Eds.), *Parallel Problem Solving from Nature - PPSN VIII*. XX, 1185 pages. 2004.

Vol. 3241: D. Kranzlmüller, P. Kacsuk, J.J. Dongarra (Eds.), *Recent Advances in Parallel Virtual Machine and Message Passing Interface*. XIII, 452 pages. 2004.

Vol. 3240: I. Jonassen, J. Kim (Eds.), *Algorithms in Bioinformatics*. IX, 476 pages. 2004. (Subseries LNBI).

Vol. 3239: G. Nicosia, V. Cutello, P.J. Bentley, J. Timmis (Eds.), *Artificial Immune Systems*. XII, 444 pages. 2004.

Vol. 3238: S. Biundo, T. Frühwirth, G. Palm (Eds.), *KI 2004: Advances in Artificial Intelligence*. XI, 467 pages. 2004. (Subseries LNAI).

Vol. 3236: M. Núñez, Z. Maamar, F.L. Pelayo, K. Pousttchi, F. Rubio (Eds.), *Applying Formal Methods: Testing, Performance, and M/E-Commerce*. XI, 381 pages. 2004.

Vol. 3235: D. de Frutos-Escrig, M. Nunez (Eds.), *Formal Techniques for Networked and Distributed Systems – FORTE 2004*. X, 377 pages. 2004.

Vol. 3232: R. Heery, L. Lyon (Eds.), *Research and Advanced Technology for Digital Libraries*. XV, 528 pages. 2004.

Vol. 3231: H.-A. Jacobsen (Ed.), *Middleware 2004*. XV, 514 pages. 2004.

Vol. 3230: J.L. Vicedo, P. Martínez-Barco, R. Muñoz, M.S. Noeda (Eds.), *Advances in Natural Language Processing*. XII, 488 pages. 2004. (Subseries LNAI).

- Vol. 3229: J.J. Alferes, J. Leite (Eds.), *Logics in Artificial Intelligence*. XIV, 744 pages. 2004. (Subseries LNAI).
- Vol. 3226: M. Bouzeghoub, C. Goble, V. Kashyap, S. Spaccapietra (Eds.), *Semantics for Grid Databases*. XIII, 326 pages. 2004.
- Vol. 3225: K. Zhang, Y. Zheng (Eds.), *Information Security*. XII, 442 pages. 2004.
- Vol. 3224: E. Jonsson, A. Valdes, M. Almgren (Eds.), *Recent Advances in Intrusion Detection*. XII, 315 pages. 2004.
- Vol. 3223: K. Slind, A. Bunker, G. Gopalakrishnan (Eds.), *Theorem Proving in Higher Order Logics*. VIII, 337 pages. 2004.
- Vol. 3222: H. Jin, G.R. Gao, Z. Xu, H. Chen (Eds.), *Network and Parallel Computing*. XX, 694 pages. 2004.
- Vol. 3221: S. Albers, T. Radzik (Eds.), *Algorithms – ESA 2004*. XVIII, 836 pages. 2004.
- Vol. 3220: J.C. Lester, R.M. Vicari, F. Paraguaçu (Eds.), *Intelligent Tutoring Systems*. XXI, 920 pages. 2004.
- Vol. 3219: M. Heisel, P. Liggesmeyer, S. Wittmann (Eds.), *Computer Safety, Reliability, and Security*. XI, 339 pages. 2004.
- Vol. 3217: C. Barillot, D.R. Haynor, P. Hellier (Eds.), *Medical Image Computing and Computer-Assisted Intervention – MICCAI 2004*. XXXVIII, 1114 pages. 2004.
- Vol. 3216: C. Barillot, D.R. Haynor, P. Hellier (Eds.), *Medical Image Computing and Computer-Assisted Intervention – MICCAI 2004*. XXXVIII, 930 pages. 2004.
- Vol. 3215: M.G.. Negoita, R.J. Howlett, L.C. Jain (Eds.), *Knowledge-Based Intelligent Information and Engineering Systems*. LVII, 906 pages. 2004. (Subseries LNAI).
- Vol. 3214: M.G.. Negoita, R.J. Howlett, L.C. Jain (Eds.), *Knowledge-Based Intelligent Information and Engineering Systems*. LVIII, 1302 pages. 2004. (Subseries LNAI).
- Vol. 3213: M.G.. Negoita, R.J. Howlett, L.C. Jain (Eds.), *Knowledge-Based Intelligent Information and Engineering Systems*. LVIII, 1280 pages. 2004. (Subseries LNAI).
- Vol. 3212: A. Campilho, M. Kamel (Eds.), *Image Analysis and Recognition*. XXIX, 862 pages. 2004.
- Vol. 3211: A. Campilho, M. Kamel (Eds.), *Image Analysis and Recognition*. XXIX, 880 pages. 2004.
- Vol. 3210: J. Marcinkowski, A. Tarlecki (Eds.), *Computer Science Logic*. XI, 520 pages. 2004.
- Vol. 3209: B. Berendt, A. Hotho, D. Mladenice, M. van Someren, M. Spiliopoulou, G. Stumme (Eds.), *Web Mining: From Web to Semantic Web*. IX, 201 pages. 2004. (Subseries LNAI).
- Vol. 3208: H.J. Ohlbach, S. Schaffert (Eds.), *Principles and Practice of Semantic Web Reasoning*. VII, 165 pages. 2004.
- Vol. 3207: L.T. Yang, M. Guo, G.R. Gao, N.K. Jha (Eds.), *Embedded and Ubiquitous Computing*. XX, 1116 pages. 2004.
- Vol. 3206: P. Sojka, I. Kopecek, K. Pala (Eds.), *Text, Speech and Dialogue*. XIII, 667 pages. 2004. (Subseries LNAI).
- Vol. 3205: N. Davies, E. Mynatt, I. Siio (Eds.), *UbiComp 2004: Ubiquitous Computing*. XVI, 452 pages. 2004.
- Vol. 3204: C.A. Peña Reyes, *Coevolutionary Fuzzy Modeling*. XIII, 129 pages. 2004.
- Vol. 3203: J. Becker, M. Platzner, S. Vernalde (Eds.), *Field Programmable Logic and Application*. XXX, 1198 pages. 2004.
- Vol. 3202: J.-F. Boulicaut, F. Esposito, F. Giannotti, D. Pedreschi (Eds.), *Knowledge Discovery in Databases: PKDD 2004*. XIX, 560 pages. 2004. (Subseries LNAI).
- Vol. 3201: J.-F. Boulicaut, F. Esposito, F. Giannotti, D. Pedreschi (Eds.), *Machine Learning: ECML 2004*. XVIII, 580 pages. 2004. (Subseries LNAI).
- Vol. 3199: H. Schepers (Ed.), *Software and Compilers for Embedded Systems*. X, 259 pages. 2004.
- Vol. 3198: G.-J. de Vreede, L.A. Guerrero, G. Marín Raventós (Eds.), *Groupware: Design, Implementation and Use*. XI, 378 pages. 2004.
- Vol. 3196: C. Stary, C. Stephanidis (Eds.), *User-Centered Interaction Paradigms for Universal Access in the Information Society*. XII, 488 pages. 2004.
- Vol. 3195: C.G. Puntonet, A. Prieto (Eds.), *Independent Component Analysis and Blind Signal Separation*. XXIII, 1266 pages. 2004.
- Vol. 3194: R. Camacho, R. King, A. Srinivasan (Eds.), *Inductive Logic Programming*. XI, 361 pages. 2004. (Subseries LNAI).
- Vol. 3193: P. Samarati, P. Ryan, D. Gollmann, R. Molva (Eds.), *Computer Security – ESORICS 2004*. X, 457 pages. 2004.
- Vol. 3192: C. Bussler, D. Fensel (Eds.), *Artificial Intelligence: Methodology, Systems, and Applications*. XIII, 522 pages. 2004. (Subseries LNAI).
- Vol. 3191: M. Klusch, S. Ossowski, V. Kashyap, R. Unland (Eds.), *Cooperative Information Agents VIII*. XI, 303 pages. 2004. (Subseries LNAI).
- Vol. 3190: Y. Luo (Ed.), *Cooperative Design, Visualization, and Engineering*. IX, 248 pages. 2004.
- Vol. 3189: P.-C. Yew, J. Xue (Eds.), *Advances in Computer Systems Architecture*. XVII, 598 pages. 2004.
- Vol. 3188: F.S. de Boer, M.M. Bonsangue, S. Graf, W.-P. de Roeer (Eds.), *Formal Methods for Components and Objects*. VIII, 373 pages. 2004.
- Vol. 3187: G. Lindemann, J. Denzinger, I.J. Timm, R. Unland (Eds.), *Multiagent System Technologies*. XIII, 341 pages. 2004. (Subseries LNAI).
- Vol. 3186: Z. Bellahsene, T. Milo, M. Rys, D. Suciu, R. Unland (Eds.), *Database and XML Technologies*. X, 235 pages. 2004.
- Vol. 3185: M. Bernardo, F. Corradini (Eds.), *Formal Methods for the Design of Real-Time Systems*. VII, 295 pages. 2004.
- Vol. 3184: S. Katsikas, J. Lopez, G. Pernul (Eds.), *Trust and Privacy in Digital Business*. XI, 299 pages. 2004.
- Vol. 3183: R. Traummüller (Ed.), *Electronic Government*. XIX, 583 pages. 2004.
- Vol. 3182: K. Bauknecht, M. Bichler, B. Pröll (Eds.), *E-Commerce and Web Technologies*. XI, 370 pages. 2004.
- Vol. 3181: Y. Kambayashi, M. Mohania, W. Wöß (Eds.), *Data Warehousing and Knowledge Discovery*. XIV, 412 pages. 2004.

Table of Contents

Tom Thumb Algorithm and von Neumann Universal Constructor	1
<i>Joël Rossier, Enrico Petraglio, André Stauffer, Gianluca Tempesti</i>	
Elementary Probabilistic Cellular Automata with Memory in Cells	11
<i>Ramón Alonso-Sanz, Margarita Martín</i>	
Universal Construction on Self-Timed Cellular Automata	21
<i>Yousuke Takada, Teijiro Isokawa, Ferdinand Peper, Nobuyuki Matsui</i>	
Computing Phase Shifts of Maximum-Length 90/150 Cellular Automata Sequences	31
<i>Sung-Jin Cho, Un-Sook Choi, Yoon-Hee Hwang, Han-Doo Kim, Yong-Soo Pyo, Kwang-Seok Kim, Seong-Hun Heo</i>	
Cellular Automata Evolution for Distributed Data Mining	40
<i>Pradipta Maji, Biplab K. Sikdar, P. Pal Chaudhuri</i>	
A Comparative Study of Optimum-Time Synchronization Algorithms for One-Dimensional Cellular Automata – A Survey	50
<i>Hiroshi Umeo, Masaya Hisaoka, Takashi Sogabe</i>	
A Cellular Automaton Model for an Immune-Derived Search Algorithm	61
<i>Niloy Ganguly, Andreas Deutsch</i>	
Randomized Computation with Cellular Automata	71
<i>Bastien Chopard, Marco Tomassini</i>	
Applying Cell-DEVS in 3D Free-Form Shape Modeling	81
<i>Pengfei Wu, Xiuping Wu, Gabriel Wainer</i>	
Universality of Hexagonal Asynchronous Totalistic Cellular Automata ...	91
<i>Susumu Adachi, Ferdinand Peper, Jia Lee</i>	
Efficient Simulation of CA with Few Activities	101
<i>Richard Walter, Thomas Worsch</i>	
Perturbing the Topology of the Game of Life Increases Its Robustness to Asynchrony	111
<i>Nazim Fatès, Michel Morvan</i>	
Local Information in One-Dimensional Cellular Automata	121
<i>Torbjørn Helvik, Kristian Lindgren, Mats G. Nordahl</i>	

Diffusion Controlled Cellular Automaton
Performing Mesh Partitioning 131
Jiří Kroc

Cellular Automata with Majority Rule on Evolving Network 141
Danuta Makowiec

Searching for Pattern-Forming Asynchronous Cellular Automata –
An Evolutionary Approach 151
Tomoaki Suzudo

Heredity, Complexity, and Surprise: Embedded Self-Replication
and Evolution in CA 161
Chris Salzberg, Hiroki Sayama

Unlearning Phenomena in Co-evolution
of Non-uniform Cellular Automata 172
Boaz Leskes, Peter M.A. Sloot

Evolving Transition Rules for Multi Dimensional Cellular Automata 182
Ron Breukelaar, Thomas Bäck

Traffic of Ants on a Trail:
A Stochastic Modelling and Zero Range Process 192
*Katsuhiro Nishinari, Andreas Schadschneider,
Debashish Chowdhury*

Cellular Automata and Roundabout Traffic Simulation 202
Enrico G. Campari, Giuseppe Levi, Vittorio Maniezzo

Acquisition of Local Neighbor Rules in the Simulation
of Pedestrian Flow by Cellular Automata 211
Katsutoshi Narimatsu, Toshihiko Shiraishi, Shin Morishita

Two-Phase Automaton for Porous Structure
and Combustion Simulation 220
Kazuhiro Yamamoto

Approximation of Continuous Media Models for Granular Systems
Using Cellular Automata 230
Marta Pla-Castells, I. García, R.J. Martínez

A Topological Framework for the Specification and the Simulation
of Discrete Dynamical Systems 238
Antoine Spicher, Olivier Michel, Jean-Louis Giavitto

A Basic Qualitative CA Based Model of a Frustrated Linear
Josephson Junction Array (JJA) 248
Claudia R. Calidonna, Adele Naddeo

Cellular Automata Based Encompression Technology for Voice Data	258
<i>Chandrama Shaw, Pradipta Maji, Sourav Saha, Biplab K. Sikdar, S. Roy, P. Pal Chaudhuri</i>	
A MCA Motion-Planner for Mobile Robots with Generic Shapes and Kinematics on Variable Terrains	268
<i>Fabio M. Marchese</i>	
Simulation of the Dynamics of Pulsed Pumped Lasers Based on Cellular Automata	278
<i>J.L. Guisado, F. Jiménez-Morales, J.M. Guerra</i>	
Surface Roughening in Homoepitaxial Growth: A Lattice Gas Cellular Automaton Model	286
<i>A. Gerisch, A.T. Lawniczak, R.A. Budiman, H. Fukś, H.E. Ruda</i>	
Ant Colony System for JSP	296
<i>Urszula Boryczka</i>	
Using de Bruijn Diagrams to Analyze 1d Cellular Automata Traffic Models	306
<i>René Rodríguez Zamora, Sergio Víctor Chapa Vergara</i>	
Using Cellular Automata to Determine Bounds for Measuring the Efficiency of Broadcast Algorithms in Highly Mobile Ad Hoc Networks	316
<i>Michael Kirkpatrick, Frances Van Scoy</i>	
From Individual to Collective Behaviour in CA Like Models of Data Communication Networks	325
<i>A.T. Lawniczak, K.P. Maxie, A. Gerisch</i>	
Agent-Driven Resource Optimization in User Networks: A Game Theoretical Approach	335
<i>J.C. Burguillo-Rial, F.J. González-Castaño, E. Costa-Montenegro, J. Vales-Alonso</i>	
Lattice Boltzmann Modeling of Injection Moulding Process	345
<i>Jonas Latt, Guy Courbebaisse, Bastien Chopard, Jean Luc Falcone</i>	
Cellular Automata Diffusion-Kinetic Model of Dendritic Growth	355
<i>Andriy Burbelko, Edward Fras, Wojciech Kapturkiewicz, Ewa Olejnik</i>	

Cellular Automata with Rare Events; Resolution of an Outstanding Problem in the Bootstrap Percolation Model	365
<i>Paolo De Gregorio, Aonghus Lawlor, Phil Bradley, Kenneth A. Dawson</i>	
Plastic Deformation Development in Polycrystals Based on the Cellular Automata and Relaxation Element Method	375
<i>G. V. Lasko, Y. Y. Deryugin, S. Schmauder</i>	
Predicting Wildfire Spreading Through a Hexagonal Cellular Automata Model	385
<i>Giuseppe A. Trunfio</i>	
Modelling Wildfire Dynamics via Interacting Automata	395
<i>Adam Dunn, George Milne</i>	
Sympatric Speciation Through Assortative Mating in a Long-Range Cellular Automaton	405
<i>Franco Bagnoli, Carlo Guardiani</i>	
A Cellular "Blocks" Model for Large Surface Flows and Applications to Lava Flows	415
<i>Maria Vittoria Avolio, Salvatore Di Gregorio</i>	
Cell-Oriented Modeling of <i>In Vitro</i> Capillary Development	425
<i>Roeland M. H. Merks, Stuart A. Newman, James A. Glazier</i>	
Neuropercolation: A Random Cellular Automata Approach to Spatio-temporal Neurodynamics	435
<i>Robert Kozma, Marko Puljic, Paul Balister, Bela Bollobas, Walter J. Freeman</i>	
The Use of Hybrid Cellular Automaton Models for Improving Cancer Therapy	444
<i>B. Ribba, T. Alarcón, K. Marron, P. K. Maini, Z. Agur</i>	
A Stochastic Model of the Effector T Cell Lifecycle	454
<i>John Burns, Heather J. Ruskin</i>	
A Cellular Automata Model of Population Infected by Periodic Plague	464
<i>Witold Dzwiniel</i>	
Mining Ecological Data with Cellular Automata	474
<i>Alexander Campbell, Binh Pham, Yu-Chu Tian</i>	
Reconstructing Forest Savanna Dynamics in Africa Using a Cellular Automata Model, FORSAT	484
<i>Charly Favier, Marc A. Dubois</i>	

Learning What to Eat: Studying Inter-relations Between Learning, Grouping, and Environmental Conditions in an Artificial World	492
<i>Daniel J. van der Post, Paulien Hogeweg</i>	
Cellular Automata in Ecological and Ecohydraulics Modelling	502
<i>Arthur Mynett, Qiuwen Chen</i>	
Chaos in a Simple Cellular Automaton Model of a Uniform Society	513
<i>Franco Bagnoli, Fabio Franci, Raúl Rechtman</i>	
Replication of Spatio-temporal Land Use Patterns at Three Levels of Aggregation by an Urban Cellular Automata	523
<i>Charles Dietzel, Keith C. Clarke</i>	
Perturbation in Genetic Regulatory Networks: Simulation and Experiments	533
<i>A. Semeria, M. Villani, R. Serra, S.A. Kauffman</i>	
A Hybrid Discrete-Continuum Model for 3-D Skeletogenesis of the Vertebrate Limb	543
<i>R. Chaturvedi, C. Huang, J.A. Izaguirre, S.A. Newman, J.A. Glazier, M. Alber</i>	
A Cellular Automata Model of Early T Cell Recognition	553
<i>Aranca Casal, Cenk Sumen, Tim Reddy, Mark Alber, Peter P. Lee</i>	
Simulation of Cell Population Dynamics Using 3-D Cellular Automata	561
<i>Belgacem Ben Youssef</i>	
Synchronization of Protein Motors Modeled by Asynchronous Cellular Automata	571
<i>Ferdinand Peper, Kazuhiro Oiwa, Susumu Adachi, Chikako Shingyoji, Jia Lee</i>	
Hybrid Techniques for Pedestrian Simulations	581
<i>Christian Gloor, Pascal Stucki, Kai Nagel</i>	
A CA Approach to Study Complex Dynamics in Asset Markets	591
<i>Stefania Bandini, Sara Manzoni, Ahmad Naimzada, Giulio Pavesi</i>	
Modeling the Effect of Leadership on Crowd Flow Dynamics	601
<i>François Aubé, Robert Shield</i>	
Cellular Automata Application to the Linearization of Stream Cipher Generators	612
<i>Amparo Fúster-Sabater, Dolores de la Guía-Martínez</i>	

Agents in Housing Market. A Model for Siena Historical Centre.....	622
<i>Francesco Lapiana, Giuliano Bianchi, Giovanni Rabino</i>	
On the Omni-directional Emergence of Form in Computation.....	632
<i>J.F. Nystrom</i>	
A Flexible Automata Model for Disease Simulation.....	642
<i>Shih Ching Fu, George Milne</i>	
A Novel Artificial Life Ecosystem Environment Model	650
<i>Zhengyou Xia, Yichuan Jiang</i>	
Cellular Automata Evolution for Pattern Classification	660
<i>Pradipta Maji, Biplab K. Sikdar, P. Pal Chaudhuri</i>	
Simulation and Experimental Investigation of Two Dimensional Cracks Propagation in Ceramic Materials	670
<i>Jacek Bomba, Julita Czopor, Marek Rybaczuk</i>	
Cellular Automata in the Hyperbolic Plane: Proposal for a New Environment	678
<i>Kamel Chelghoum, Maurice Margenstern, Benoît Martin, Isabelle Pecci</i>	
Algebraic Properties of Cellular Automata: The Basis for Composition Technique.....	688
<i>Olga Bandman</i>	
DSCA Implementation of 3D Self-Replicating Structures	698
<i>André Stauffer, Daniel Mange, Enrico Petraglio, Fabien Vannel</i>	
Calculation of the Critical Point for Two-Layer Ising and Potts Models Using Cellular Automata	709
<i>Yazdan Asgari, Mehrdad Ghaemi, Mohammad Ghasem Mahjani</i>	
Directed Ligand Passage over the Surface of Diffusion-Controlled Enzymes: A Cellular Automata Model	719
<i>Mehrdad Ghaemi, Nasrollah Rezaei-Ghaleh, Mohammad-Nabi Sarbolouki</i>	
An Evolutionary Approach for Modelling Lava Flows Through Cellular Automata	725
<i>William Spataro, Donato D'Ambrosio, Rocco Rongo, Giuseppe A. Trunfio</i>	
CAME _{&} L - Cellular Automata Modeling Environment & Library	735
<i>Lev Naumov</i>	
SAT-Based Analysis of Cellular Automata	745
<i>Massimo D'Antonio, Giorgio Delzanno</i>	

The Kernel Hopfield Memory Network	755
<i>Cristina García, José Alí Moreno</i>	
Timescale Separated Pollination-Colonisation Models	765
<i>J.A. Stewart-Cox, N.F. Britton, M. Mogie</i>	
Characterization of a Class of Complemented Group Cellular Automata	775
<i>Debdeep Mukhopadhyay, Dipanwita Roy Chowdhury</i>	
Block Encryption Using Reversible Cellular Automata	785
<i>Marcin Seredynski, Pascal Bouvry</i>	
Cellular Model of Complex Porous Media Application to Permeability Determination	793
<i>André Chambarel, Hervé Bolvin, Evelyne Ferry</i>	
Improved Cell-DEVS Model Definition in CD++	803
<i>Alejandro López, Gabriel Wainer</i>	
Characterization of Reachable/Nonreachable Cellular Automata States	813
<i>Sukanta Das, Biplab K. Sikdar, P. Pal Chaudhuri</i>	
Building Classifier Cellular Automata	823
<i>Peter Kokol, Petra Povalej, Mitja Lenic, Gregor Štiglic</i>	
On Evolutionary 3-Person Prisoner's Dilemma Games on 2-D Lattice	831
<i>László Gulyás, Tadeusz Płatkowski</i>	
Optimizing the Behavior of a Moving Creature in Software and in Hardware	841
<i>Mathias Halbach, Wolfgang Heenes, Rolf Hoffmann, Jan Tisje</i>	
A Generalized Rapid Development Environment for Cellular Automata Based Simulations	851
<i>Ivan Blecic, Arnaldo Cecchini, Giuseppe A. Trunfio</i>	
Characterizing Configuration Spaces of Simple Threshold Cellular Automata	861
<i>Predrag T. Tosic, Gul A. Agha</i>	
Lattice Boltzmann Approach to Incompressible Fluidynamics Dimensional Investigation and Poiseuille Test	871
<i>Gianpiero Cattaneo, Alberto Dennunzio, Fabio Farina</i>	
Author Index	881