Lecture Notes in Computer Science **9099**

Commenced Publication in 1973
Founding and Former Series Editors:
Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison
Lancaster University, Lancaster, 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 Zürich, Zürich, Switzerland
John C. Mitchell
Stanford University, Stanford, CA, USA
Moni Naor
Weizmann Institute of Science, Rehovot, Israel
C. Pandu Rangan
Indian Institute of Technology, Madras, India
Bernhard Steffen
TU Dortmund University, Dortmund, Germany
Demetri Terzopoulos
University of California, Los Angeles, CA, USA
Doug Tygar
University of California, Berkeley, CA, USA
Gerhard Weikum
Max Planck Institute for Informatics, Saarbrücken, Germany

More information about this series at http://www.springer.com/series/7407

Jarkko Kari (Ed.)

Cellular Automata and Discrete Complex Systems

21st IFIP WG 1.5 International Workshop, AUTOMATA 2015
Turku, Finland, June 8–10, 2015
Proceedings

Springer

Editor
Jarkko Kari
University of Turku
Turku
Finland

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-662-47220-0 ISBN 978-3-662-47221-7 (eBook)
DOI 10.1007/978-3-662-47221-7

Library of Congress Control Number: 2015938087

LNCS Sublibrary: SL 1 – Theoretical Computer Science and General Issues

Springer Heidelberg New York Dordrecht London
© IFIP International Federation for Information Processing 2015
This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

Springer-Verlag GmbH Berlin Heidelberg is part of Springer Science+Business Media
(www.springer.com)

Preface

The 21st International Workshop on Cellular Automata and Discrete Complex Systems, AUTOMATA 2015, was held in Turku, Finland, during June 8–10, 2015. It was organized by the Department of Mathematics and Statistics of the University of Turku, and the conference venue was the Educarium building of the university. The event was an IFIP Working Conference and it hosted a meeting of the IFIP Working Group 1.5.

AUTOMATA 2015 continued an annual series of events established in 1995 as a forum for the collaboration of researchers in the field of cellular automata and related discrete complex systems. Topics of interest include, for example, the following aspects and features of such systems: dynamical, topological, ergodic, and algebraic aspects, algorithmic and complexity issues, emergent properties, formal language processing aspects, symbolic dynamics, models of parallelism and distributed systems, timing schemes, phenomenological descriptions, scientific modeling and practical applications. The conference attracted a good number of submissions, which indicates a continued interest in the topics.

There were four invited talks in the conference, and I wish to thank the speakers Andreas Deutsch, Turlough Neary, Ville Salo, and Luke Schaeffer for accepting the invitation and for their presentations. The invited contributions are included in this volume.

There were 33 submissions in the conference. Each submission was reviewed by three Program Committee members. Based on the reviews and discussions the committee decided to accept 15 papers to be presented in the conference and to be included in the proceedings. I would like to thank all authors for their contributions. The conference program involved also short presentations of exploratory papers that are not included in this book, and I wish to extend my thanks to the authors of the exploratory submissions.

I am indebted to the Program Committee and the additional reviewers for their help in selecting the papers. I extend my thanks to the members of the Local Organizing Committee. I am also grateful for the support by the Federation of Finnish Learned Societies, Turku Centre for Computer Science, the University of Turku, and the City of Turku. Finally, I acknowledge the excellent cooperation from the Lecture Notes in Computer Science team of Springer for their help in producing this volume in time for the conference.

March 2015 Jarkko Kari

Organization

Program Committee

Matthew Cook	University of Zurich and ETH Zurich, Switzerland
Pedro de Oliveira	Universidade Presbiteriana Mackenzie, Brazil
Nazim Fatès	Inria Nancy Grand-Est, France
Enrico Formenti	Université Nice Sophia Antipolis, France
Eric Goles	Adolfo Ibáñez University, Chile
Jarkko Kari	University of Turku, Finland
Martin Kutrib	Universität Giessen, Germany
Andreas Malcher	Universität Giessen, Germany
Kenichi Morita	Hiroshima University, Japan
Nicolas Ollinger	Université d'Orléans, France
Ivan Rapaport	Universidad de Chile, Chile
Klaus Sutner	Carnegie Mellon University, USA
Véronique Terrier	Université de Caen, France
Guillaume Theyssier	CNRS, Université de Savoie, France
Hiroshi Umeo	Osaka Electro-Communication University, Japan
Thomas Worsch	Karlsruhe Institute of Technology, Germany

Organizing Committee

Mikhail Barash	University of Turku, Finland
Jarkko Kari	University of Turku, Finland
Michal Szabados	University of Turku, Finland
Ilkka Törmä	University of Turku, Finland
Sonja Vanto	University of Turku, Finland

Additional Reviewers

Aubrun, Nathalie
Barbieri, Sebastián
Boyer, Laurent
Capobianco, Silvio
Chassaing, Philippe
Das, Sukanta
Delacourt, Martin
Deutsch, Andreas
Fukś, Henryk
Grandjean, Anaël
Hellouin De Menibus, Benjamin
Holzer, Markus
Inokuchi, Shuichi
Jakobi, Sebastian
Landman, Kerry
Lee, Jia
Leporati, Alberto
Manzoni, Luca
Marcovici, Irène
Meckel, Katja

Meunier, Pierre-Étienne
Namiki, Takao
Richard, Gaétan
Romashchencko, Andrei
Salomaa, Kai
Sirakoulis, Georgios Ch.
Spencer, Jason
Szabados, Michal
Taati, Siamak
Truthe, Bianca
Törmä, Ilkka
Vanier, Pascal
Wendlandt, Matthias
Yunès, Jean-Baptiste
Zinoviadis, Charalampos

Contents

Invited Papers

Cellular Automaton Models for Collective Cell Behaviour 1
Andreas Deutsch

Tag Systems and the Complexity of Simple Programs 11
Turlough Neary and Damien Woods

Groups and Monoids of Cellular Automata 17
Ville Salo

A Physically Universal Quantum Cellular Automaton 46
Luke Schaeffer

Regular Papers

Effect of Graph Structure on the Limit Sets of Threshold Dynamical Systems 59
Abhijin Adiga, Chris J. Kuhlman, Henning S. Mortveit, and Sichao Wu

A Cellular Automaton for Blocking Queen Games 71
Matthew Cook, Urban Larsson, and Turlough Neary

Hard Core via PCA: Entropy Bounds 85
Kari Eloranta

Classification of Elementary Cellular Automata Up to Topological Conjugacy 99
Jeremias Epperlein

Remarks on the Cellular Automaton Global Synchronisation Problem 113
Nazim Fatès

L-Convex Polyominoes Are Recognizable in Real Time by 2D Cellular Automata 127
Anaël Grandjean and Victor Poupet

Shrinking One-Way Cellular Automata 141
Martin Kutrib, Andreas Malcher, and Matthias Wendlandt

Universal Time-Symmetric Number-Conserving Cellular Automaton 155
Diego Maldonado, Andrés Moreira, and Anahí Gajardo

The Ideal Energy of Classical Lattice Dynamics 169
Norman Margolus

On the Periods of Spatially Periodic Preimages in Linear Bipermutive Cellular Automata 181
Luca Mariot and Alberto Leporati

Merging Cellular Automata Rules to Optimise a Solution to the Modulo-*n* Problem 196
Claudio L.M. Martins and Pedro P.B. de Oliveira

Network Structure and Activity in Boolean Networks 210
Abhijin Adiga, Hilton Galyean, Chris J. Kuhlman, Michael Levet, Henning S. Mortveit, and Sichao Wu

Group-Walking Automata 224
Ville Salo and Ilkka Törmä

Restricted Density Classification in One Dimension 238
Siamak Taati

Recognition of Linear-Slender Context-Free Languages by Real Time One-Way Cellular Automata 251
Véronique Terrier

Author Index 263