Lecture Notes in Computer Science 6714

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

Cristian S. Calude Jarkko Kari
Ion Petre Grzegorz Rozenberg (Eds.)

Unconventional Computation

10th International Conference, UC 2011
Turku, Finland, June 6-10, 2011
Proceedings

Springer

Volume Editors

Cristian S. Calude
The University of Auckland, Dept. of Computer Science, Science Centre
38 Princes Street, Auckland 1142, New Zealand
E-mail: cristian@cs.auckland.ac.nz

Jarkko Kari
University of Turku, Department of Mathematics
20014 Turku, Finland
E-mail: jkari@utu.fi

Ion Petre
Åbo Akademi University, Dept. of Information Technologies, ICT building
Joukahaisenkatu 3-5 A, 20520 Turku, Finland
E-mail: ipetre@abo.fi

Grzegorz Rozenberg
Leiden University, Leiden Institute of Advanced Computer Science (LIACS)
Niels Bohrweg 1, 2333 CA Leiden, The Netherlands
E-mail: rozenber@liacs.nl

ISSN 0302-9743 e-ISSN 1611-3349
ISBN 978-3-642-21340-3 e-ISBN 978-3-642-21341-0
DOI 10.1007/978-3-642-21341-0
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: Applied for

CR Subject Classification (1998): F.1, F.2, I.1, C.1.3, C.1, J.2

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

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

The 10th International Conference on Unconventional Computation, UC 2011, was organized under the auspices of EATCS and Academia Europaea, by the Department of Mathematics of the University of Turku (Turku, Finland), and the Center for Discrete Mathematics and Theoretical Computer Science (Auckland, New Zealand). The event was held in Turku, Finland, during June 6–10, 2011. The conference venues were the Calonia and Arcanum buildings of the university.

The city of Turku was founded in the thirteenth century, which makes it the oldest town in Finland. For centuries, it remained the capital of Finland, until 1812 when the capital was moved to Helsinki. Turku is situated by the Baltic Sea and surrounded by one of the largest and most beautiful archipelagoes of the world. The archipelago consists of thousands of small islands and provides a unique and spectacular natural environment for travelers to enjoy. Turku was European Capital of Culture in 2011, and many cultural events were organized in the city throughout the year, also during the Unconventional Computation conference.

The International Conference on Unconventional Computation (UC) series is devoted to all aspects of unconventional computation theory as well as experiments and applications. Typical, but not exclusive, topics are: natural computing including quantum, cellular, molecular, membrane, neural, and evolutionary computing, as well as chaos and dynamical system-based computing, and various proposals for computational mechanisms that go beyond the Turing model. The first venue of the Unconventional Computation Conference (formerly called Unconventional Models of Computation) was Auckland, New Zealand, in 1998. Subsequent sites of the conference were Brussels, Belgium, in 2000, Kobe, Japan, in 2002, Seville, Spain, in 2005, York, UK, in 2006, Kingston, Canada, in 2007, Vienna, Austria, in 2008, Ponta Delgada, Portugal, in 2009, and Tokyo, Japan, in 2010.

The six keynote speakers of the 2011 conference were:

- Samson Abramsky (University of Oxford, UK): "The Logic and Topology of Non-locality and Contextuality"
- Bastien Chopard (University of Geneva, Switzerland): "A Framework for Multiscale and Multiscience Modeling Based on the Cellular Automata and Lattice Boltzmann Approaches"
- David Corne (Heriot-Watt University, UK): "Unconventional Optimizer Development"
- Juhani Karhumäki (University of Turku, Finland): "Weighted Finite Automata: Computing with Different Topologies"
- Gheorghe Păun (Institute of Mathematics of the Romanian Academy, Romania): "Membrane Computing at Twelve Years (Back to Turku)"
- Grzegorz Rozenberg (Leiden University, The Netherlands): "A Formal Framework for Bioprocesses in Living Cells"

The conference also included three tutorials:

- Mika Hirvensalo (University of Turku, Finland): "Quantum Information"
- Nicolas Ollinger (Aix-Marseille University, France): "Cellular Automata"
- Ignacio Pérez-Hurtado, Mario J. Pérez-Jiménez, Agustín Riscos-Núñez, and Francisco J. Romero-Campero (University of Seville, Spain): "Membrane Computing"

In addition to the main UC2010 conference, four workshops were also hosted: "Physics and Computation" and "Hypercomputation" were organized by Mike Stannett (University of Sheffield, UK), "Language Theory in Biocomputing" was organized by Tero Harju (University of Turku, Finland), and "Summer Solstice Conference on Discrete Models of Complex Systems" was organized by Danuta Makowiec (University of Gdansk, Poland), Anna Lawniczak (University of Guelph, Canada), and Bruno Di Stefano (Nuptek Systems Ltd., Canada).

The Program Committee selected 17 papers (out of 33 submissions) to be presented at the conference. This volume includes 6 (extended) abstracts of invited talks, 3 (extended) abstracts of tutorials, and 17 regular papers. The papers presented at the workshops appeared in a separate proceedings volume, published by the Turku Centre for Computer Science (TUCS). The conference also hosted a poster session.

The editors are grateful to all the contributors to the scientific content of the conference. We thank especially the invited speakers, tutorial speakers, all authors of contributed papers, and the organizers of the satellite workshops. We are indebted to the Program Committee and the additional reviewers for their help in selecting the papers. We extend our thanks to the members of the local Organizing Committee. We are also grateful for the support by the Federation of Finnish Learned Societies, Finnish Academy of Science and Letters, Turku Centre for Computer Science, the University of Turku and the City of Turku. Finally, we 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 2011

Cristian S. Calude
Jarkko Kari
Ion Petre
Grzegorz Rozenberg

Organization

Program Committee

Selim Akl	Queen's University, Canada
Olivier Bournez	Ecole Polytechnique, France
Thomas Bäck	Leiden University, The Netherlands
Adan Cabello	University of Seville, Spain
Barry Cooper	University of Leeds, UK
José Félix Costa	IST – Technical University of Lisbon, Portugal
Nachum Dershowitz	Tel Aviv University, Israel
Eric Goles	Universidad Adolfo Ibáñez, Chile
Shan He	University of Birmingham, UK
Mika Hirvensalo	University of Turku, Finland
Natasha Jonoska	University of South Florida, USA
Jarkko Kari	University of Turku, Finland (Co-chair)
Giancarlo Mauri	University of Milano-Bicocca, Italy
Kenichi Morita	Hiroshima University, Japan
Ion Petre	Åbo Akademi University, Finland (Co-chair)
Kai Salomaa	Queen's University, Canada
Hava Siegelmann	University of Massachusetts Amherst, USA
Susan Stepney	University of York, UK
Fumiaki Tanaka	University of Tokyo, Japan
Jon Timmis	University of York, UK

Organizing Committee

Pierre Guillon	Juhani Karhumäki	Petri Salmela
Tero Harju	Jarkko Kari (Chair)	Charalampos Zinoviadis
Mika Hirvensalo	Arto Lepistö	
Timo Jolivet	Ion Petre	

External Referees

Scott Aaronson	Claudio Ferretti	Gheorghe Păun
Alastair Abbott	Yoichi Hirai	Vladimir Rogojin
Alhazov Artiom	Katsunobu Imai	Ville Salo
Sepinoud Azimi	Timo Jolivet	Siamak Taati
Robert Brijder	Ibuki Kawamata	Tarmo Uustalu
Cris Calude	Alberto Leporati	Akihiro Yamashita
Salimur Choudhury	Yusuke Matsumura	Charalampos Zinoviadis
Erzsébet Csuhaj-Varjú	Victor Mitrana	
Eugen Czeizler	Simon O'Keefe	

Table of Contents

Invited Lectures and Tutorials

Regular Contributions