

Lecture Notes in Computer Science

2719

Edited by G. Goos, J. Hartmanis, and J. van Leeuwen

Springer

Berlin

Heidelberg

New York

Barcelona

Hong Kong

London

Milan

Paris

Tokyo

Jos C.M. Baeten Jan Karel Lenstra
Joachim Parrow Gerhard J. Woeginger (Eds.)

Automata, Languages and Programming

30th International Colloquium, ICALP 2003
Eindhoven, The Netherlands, June 30 – July 4, 2003
Proceedings



Springer

Volume Editors

Jos C.M. Baeten

Technische Universiteit Eindhoven, Dept. of Mathematics and Computer Science
P.O. Box 513, 5600 MB Eindhoven, The Netherlands
E-mail: j.c.m.baeten@tue.nl

Jan Karel Lenstra

Georgia Institute of Technology, School of Industrial and Systems Engineering
765 Ferst Drive, Atlanta, GA 30332-0205, USA
E-mail: jkl@isye.gatech.edu

Joachim Parrow

Uppsala University, Department of Information Technology
P.O. Box 337, 75105 Uppsala, Sweden
E-mail: joachim@docs.uu.se

Gerhard J. Woeginger

University of Twente
Faculty of Electrical Engineering, Mathematics and Computer Science
P.O. Box 217, 7500 AE Enschede, The Netherlands
E-mail: g.j.woeginger@math.utwente.nl

Cataloging-in-Publication Data applied for

A catalog record for this book is available from the Library of Congress

Bibliographic information published by Die Deutsche Bibliothek

Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliographie;
detailed bibliographic data is available in the Internet at <<http://dnb.ddb.de>>.

CR Subject Classification (1998): F, D, C.2-3, G.1-2, I.3, E.1-2

ISSN 0302-9743

ISBN 3-540-40493-7 Springer-Verlag 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-Verlag. Violations are liable for prosecution under the German Copyright Law.

Springer-Verlag Berlin Heidelberg New York
a member of BertelsmannSpringer Science+Business Media GmbH

<http://www.springer.de>

© Springer-Verlag Berlin Heidelberg 2003
Printed in Germany

Typesetting: Camera-ready by author, data conversion by PTP-Berlin GmbH
Printed on acid-free paper SPIN: 10928936 06/3142 5 4 3 2 1 0

Preface

The 30th International Colloquium on Automata, Languages and Programming (ICALP 2003) was held from June 30 to July 4 on the campus of the Technische Universiteit Eindhoven (TU/e) in Eindhoven, The Netherlands. This volume contains all contributed papers presented at ICALP 2003, together with the invited lectures by Jan Bergstra (Amsterdam), Anne Condon (Vancouver), Amos Fiat (Tel Aviv), Petra Mutzel (Vienna), Doron Peled (Coventry) and Moshe Vardi (Houston).

Since 1972, ICALP has been the main annual event of the European Association for Theoretical Computer Science (EATCS). The ICALP program can be divided into two tracks, viz. track A (algorithms, automata, complexity, and games) and track B (logics, semantics, and theory of programming).

In response to the Call for Papers, the program committee received 212 submissions: 131 for track A and 81 for track B. The committee met on March 14 and 15 in Haarlem, The Netherlands and selected 84 papers for inclusion in the scientific program. The selection was based on originality, quality and relevance to theoretical computer science. We wish to thank all authors who submitted extended abstracts for consideration, and all referees and subreferees who helped in the extensive evaluation process.

The EATCS Best Paper Award for Track A was given to the paper “The Cell Probe Complexity of Succinct Data Structures” by Anna Gál and Peter Bro Miltersen and the award for Track B was given to the paper “A Testing Scenario for Probabilistic Automata” by Mariëlle Stoelinga and Frits Vaandrager.

ICALP 2003 was a special ICALP. Two other computer science conferences co-located with ICALP this time: the 24th International Conference on Application and Theory of Petri Nets (ATPN 2003) and the Conference on Business Process Management (BPM 2003). During ICALP 2003 the following special events took place: the EATCS Distinguished Service Award was given to Grzegorz Rozenberg (Leiden), and the Lifetime Achievement Award of the NVTI (Dutch Association for Theoretical Computer Science) was given to N.G. de Bruijn (Eindhoven). Several high-level workshops were held as satellite events of ICALP 2003, coordinated by Erik de Vink. These included the following workshops: Algorithms for Massive Data Sets, Foundations of Global Computing (FGC), Logic and Communication in Multi-Agent Systems (LCMAS), Quantum Computing, Security Issues in Coordination Models, Languages and Systems (SecCo), Stochastic Petri Nets, Evolutionary Algorithms, the 1st International Workshop on the Future of Neural Networks (FUNN), and Mathematics, Logic and Computation (workshop in honor of N.G. de Bruijn’s 85th birthday). In addition, there was a discussion forum on Education Matters — the Challenge of Teaching Theoretical Computer Science organized by Hans-Joerg Kreowski.

The scientific program of ICALP 2003 and satellite workshops showed that theoretical computer science is a vibrant field, deepening our insights into the foundations and future of computing and system design in many application areas.

The sponsors of ICALP 2003 included the municipality of Eindhoven, Sodexo, Océ, the research school IPA, the European Educational Forum, Springer-Verlag, Elsevier, Philips Research, Atos Origin, Pallas Athena, Pearson Education Benelux, and ABE Foundation. We are very grateful to the Technische Universiteit Eindhoven for supporting and hosting ICALP 2003. The organizing committee consisted of Jos Baeten, Tijn Borghuis, Erik Luit, Emmy van Otterdijk, Anne-Meta Oversteegen, Thieu Rietjens, Karin Touw and Erik de Vink, all of the TU/e. Thanks is owed to them, and to everybody else who helped, for their outstanding effort in making ICALP 2003 a success.

June 2003

Jos Baeten
Jan Karel Lenstra
Joachim Parrow
Gerhard Woeginger

Program Committee

Track A

Harry Buhrman, CWI Amsterdam
Jens Clausen, DTK Lyngby
Martin Dyer, Leeds
Lars Engebretsen, KTH Stockholm
Uri Feige, Weizmann
Philippe Flajolet, INRIA Rocquencourt
Kazuo Iwama, Kyoto
Elias Koutsoupas, UCLA
Jan Karel Lenstra, Georgia Tech, Co-chair
Stefano Leonardi, Roma
Rasmus Pagh, Copenhagen
Jean-Eric Pin, CNRS and Paris 7
Uwe Schoening, Ulm
Jiri Sgall, CAS Praha
Micha Sharir, Tel Aviv
Vijay Vazirani, Georgia Tech
Ingo Wegener, Dortmund
Peter Widmayer, ETH Zürich
Gerhard Woeginger, Twente, Co-chair

Track B

Samson Abramsky, Oxford
Eike Best, Oldenburg
Manfred Broy, TU München
Philippe Darondeau, INRIA Rennes
Rocco De Nicola, Firenze
Rob van Glabbeek, Stanford
Ursula Goltz, Braunschweig
Roberto Gorrieri, Bologna
Robert Harper, Carnegie Mellon
Holger Hermanns, Twente
Kim Larsen, Aalborg
Jean-Jacques Levy, INRIA Rocquencourt
Flemming Nielson, DTU Lyngby
Prakash Panangaden, McGill
Joachim Parrow, Uppsala, chair
Amir Pnueli, Weizmann
Davide Sangiorgi, INRIA Sophia
Bernhard Steffen, Dortmund
Björn Victor, Uppsala

Referees

Karen Aardal	Julien Cassaigne	Paul Fischer
Parosh Abdulla	Didier Caucal	Hans Fleischhack
Luca Aceto	Amit Chakrabarti	Emmanuel Fleury
Jiri Adamek	Christian Choffrut	Wan Fokkink
Pankaj Agarwal	Marek Chrobak	Cédric Fournet
Susanne Albers	Mark Cieliebak	Gudmund Frandsen
Alessandro Aldini	Mario Coppo	Martin Fränzle
Jean-Paul Allouche	Robert Cori	Thomas Franke
Noga Alon	Flavio Corradini	Séverine Fratani
André Arnold	Cas Cremers	Ari Freund
Lars Arvestad	Vincent Cremet	Alan Frieze
Vincenzo Auletta	Maxime Crochemore	Toshihiro Fujito
Giorgio Ausiello	Mary Cryan	Naveen Garg
Holger Austinat	Artur Czumaj	Olivier Gascuel
Yossi Azar	Peter Damaschke	Michael Gatto
Marie-Pierre Béal	Ivan Damgaard	Stéphane Gaubert
Christel Baier	Zhe Dang	Cyril Gavoille
Amotz Bar-Noy	Olivier Danvy	Blaise Genest
Peter Baumgartner	Pedro D'Argenio	Dan Ghica
Danièle Beauquier	Giorgio Delzanno	Jeremy Gibbons
Luca Becchetti	Jörg Derungs	Oliver Giel
Marek Bednarczyk	Josee Desharnais	Inge Li Gørtz
Gerd Behrmann	Alessandra Di Pierro	Leslie Goldberg
Michael Bender	Volker Diekert	Mikael Goldmann
Thorsten Bernholt	Martin Dietzfelbinger	Roberta Gori
Vincent Berry	Dino Distefano	Mart de Graaf
Jean Berstel	Stefan Droste	Serge Grigorieff
Philip Bille	Abbas Edalat	Martin Grohe
Lars Birkedal	Stefan Edelkamp	Jan Friso Groote
Markus Blaaser	Stephan Eidenbenz	Roberto Grossi
Bruno Blanchet	Isaac Elias	Claudia Gsottberger
Luc Boasson	Leah Epstein	Joshua Guttman
Chiara Bodei	Thomas Erlebach	Johan Håstad
Hans Bodlaender	Eric Fabre	Stefan Haar
Beate Bollig	Rolf Fagerberg	Lisa Hales
Viviana Bono	Francois Fages	Mikael Hammar
Michele Boreale	Stefan Felsner	Chris Hankin
Ahmed Bouajjani	Paolo Ferragina	Rene Rydhof Hansen
Peter Braun	Jiří Fiala	Sariel Har-Peled
Franck van Breugel	Amos Fiat	Jerry den Hartog
Mikael Buchholtz	Andrzej Filinski	Gustav Hast
Daniel Bünzli	Bernd Finkbeiner	Anne Haxthausen
Marzia Buscemi	Alain Finkel	Fabian Hennecke
Nadia Busi	Thomas Firley	Thomas Hildebrandt

Yoram Hirshfeld
 Thomas Hofmeister
 Jonas Holmerin
 Juraj Hromkovic
 Michaela Huhn
 Hardi Hungar
 Thore Husfeldt
 Michael Huth
 Oscar H. Ibarra
 Keiko Imai
 Purush Iyer
 Jan Jürjens
 Radha Jagadeesan
 Jens Jägersküpper
 Petr Jančar
 Klaus Jansen
 Thomas Jansen
 Mark Jerrum
 Tao Jiang
 Magnus Johansson
 Georgi Jojgov
 Jørn Justesen
 Erich Kaltofen
 Viggo Kann
 Haim Kaplan
 Juhani Karhumäki
 Anna Karlin
 Joost-Pieter Katoen
 Claire Kenyon
 Rohit Khandekar
 Joe Kilian
 Josva Kleist
 Bartek Klin
 Jens Knoop
 Stavros Kolliopoulos
 Petr Kolman
 Jochen Konemann
 Guy Kortsarz
 Juergen Koslowski
 Michal Koucký
 Daniel Král
 Jan Krájček
 Dieter Kratsch
 Matthias Krause
 Michael Krivelevich

Werner Kuich
 Dietrich Kuske
 Salvatore La Torre
 Anna Labella
 Ralf Laemmel
 Jim Laird
 Cosimo Laneve
 Martin Lange
 Ruggero Lanotte
 Francois Laroussinie
 Thierry Lecroq
 Troy Lee
 James Leifer
 Arjen Lenstra
 Reinhold Letz
 Francesca Levi
 Huimin Lin
 Andrzej Lingas
 Luigi Liquori
 Markus Lohrey
 Sylvain Lombardy
 Michele Loreti
 Roberto Lucchi
 Gerald Luetzgen
 Eva-Marta Lundell
 Parthasarathy
 Madhusudan
 Jean Mairesse
 Kazuhisa Makino
 Oded Maler
 Luc Maranget
 Alberto
 Marchetti-Spaccamela
 Martin Mareš
 Frank Marschall
 Fabio Martinelli
 Andrea Masini
 Sjouke Mauw
 Richard Mayr
 Colin McDiarmid
 Pierre McKenzie
 Michael Mendler
 Christian Michaux
 Kees Middelburg
 Stefan Milius

Peter Bro Miltersen
 Joe Mitchell
 Eiji Miyano
 Faron Moller
 Franco Montagna
 Christian Mortensen
 Peter Mosses
 Tilo Muecke
 Markus Mueller-Olm
 Madhavan Mukund
 Haiko Muller
 Ian Munro
 Andrzej Murawski
 Anca Muscholl
 Hiroshi Nagamochi
 Seffi Naor
 Margherita Napoli
 Uwe Nestmann
 Rolf Niedermeier
 Mogens Nielsen
 Stefan Nilsson
 Takao Nishizeki
 Damian Niwinski
 John Noga
 Thomas Noll
 Christian N.S. Pedersen
 Gethin Norman
 Manuel Núñez
 Marc Nunkesser
 Anna Östlin
 David von Oheimb
 Yoshio Okamoto
 Paulo Oliva
 Nicolas Ollinger
 Hirotaka Ono
 Vincent van Oostrom
 Janos Pach
 Catuscia Palamidessi
 Anna Palbom
 Mike Palis
 Alessandro Panconesi
 Christos Papadimitriou
 Andrzej Pelc
 David Peleg
 Holger Petersen

Seth Pettie	Norbert Schirmer	Mauro Torelli
Iain Phillips	Konrad Schlude	Stavros Tripakis
Giovanni Pighizzini	Philippe Schnoebelen	John Tromp
Henrik Pilegaard	Philip Scott	Emilio Tuosto
Sophie Pinchinat	Roberto Segala	Irek Ulidowski
G. Michele Pinna	Helmut Seidl	Yaroslav Usenko
Conrad Pomm	Peter Selinger	Frits Vaandrager
Ely Porat	Nicolas Sendrier	Frank Valencia
Giuseppe Prencipe	Maria Serna	Vincent Vanackère
Corrado Priami	Alexander Shen	Moshe Vardi
Guido Proietti	Natalia Sidorova	Helmut Veith
Pavel Pudlák	Detlef Sieling	Laurent Viennot
Rosario Pugliese	Marc Sihling	Alexander Vilbig
Uri Rabinovich	Hans Simon	Jørgen Villadsen
Theis Rauhe	Alex Simpson	Erik de Vink
Andreas Rausch	Michael Sipser	Paul Vitanyi
António Ravara	Martin Skutella	Berthold Voecking
Klaus Reinhardt	Michiel Smid	Walter Vogler
Michel A. Reniers	Pawel Sobocinski	Marc Voorhoeve
Arend Rensink	Eljas Soisalon-Soininen	Tjark Vredeveld
Christian Retoré	Ana Sokolova	Stephan Waack
James Riley	Frits Spieksma	Igor Walukiewicz
Martin Roetteler	Renzo Sprugnoli	Dietmar Wätjen
Maurice Rojas	Jiří Srba	Birgitta Weber
Marie-Francoise Roy	Rob van Stee	Heike Wehrheim
Oliver Ruething	Angelika Steger	Elke Wilkeit
Bernhard Rumpe	Christian Stehno	Tim Willemse
Wojciech Rytter	Ralf Steinbrueggen	Harro Wimmel
Géraud Sénizergues	Colin Stirling	Peter Winkler
Nicoletta Sabatini	Leen Stougie	Carsten Witt
Andrei Sabelfeld	Martin Strecker	Philipp Woelfel
Kunihiko Sadakane	Werner Struckmann	Ronald de Wolf
Marie-France Sagot	Hongyan Sun	Derick Wood
Louis Salvail	Ichiro Suzuki	Jürg Wullschleger
Bruno Salvy	Tetsuya Takine	Shigeru Yamashita
Christian Salzmann	Hisao Tamaki	Wang Yi
Peter Sanders	Amnon Ta-Shma	Heisung Yoo
Miklos Santha	David Taylor	Hans Zantema
Martin Sauerhoff	Pascal Tesson	Gianluigi Zavattaro
Daniel Sawitzki	Simone Tini	Pascal Zimmer
Andreas Schaefer	Takeshi Tokuyama	Uri Zwick

Table of Contents

Invited Lectures

Polarized Process Algebra and Program Equivalence	1
<i>Jan A. Bergstra, Inge Bethke</i>	
Problems on RNA Secondary Structure Prediction and Design	22
<i>Anne Condon</i>	
Some Issues Regarding Search, Censorship, and Anonymity in Peer to Peer Networks	33
<i>Amos Fiat</i>	
The SPQR-Tree Data Structure in Graph Drawing	34
<i>Petra Mutzel</i>	
Model Checking and Testing Combined	47
<i>Doron Peled</i>	
Logic and Automata: A Match Made in Heaven	64
<i>Moshe Y. Vardi</i>	

Algorithms

Pushdown Automata and Multicounter Machines, a Comparison of Computation Modes	66
<i>Juraj Hromkovič, Georg Schnitger</i>	
Generalized Framework for Selectors with Applications in Optimal Group Testing	81
<i>Annalisa De Bonis, Leszek Gąsieniec, Ugo Vaccaro</i>	
Decoding of Interleaved Reed Solomon Codes over Noisy Data	97
<i>Daniel Bleichenbacher, Aggelos Kiayias, Moti Yung</i>	

Process Algebra

On the Axiomatizability of Ready Traces, Ready Simulation, and Failure Traces	109
<i>Stefan Blom, Wan Fokkink, Sumit Nain</i>	
Resource Access and Mobility Control with Dynamic Privileges Acquisition	119
<i>Daniele Gorla, Rosario Pugliese</i>	

Replication vs. Recursive Definitions in Channel Based Calculi	133
<i>Nadia Busi, Maurizio Gabbrielli, Gianluigi Zavattaro</i>	

Approximation Algorithms

Improved Combinatorial Approximation Algorithms for the k -Level Facility Location Problem	145
<i>Alexander Ageev, Yinyu Ye, Jiawei Zhang</i>	

An Improved Approximation Algorithm for the Asymmetric TSP with Strengthened Triangle Inequality	157
<i>Markus Bläser</i>	

An Improved Approximation Algorithm for Vertex Cover with Hard Capacities	164
<i>Rajiv Gandhi, Eran Halperin, Samir Khuller, Guy Kortsarz, Aravind Srinivasan</i>	

Approximation Schemes for Degree-Restricted MST and Red-Blue Separation Problem	176
<i>Sanjeev Arora, Kevin L. Chang</i>	

Approximating Steiner k -Cuts	189
<i>Chandra Chekuri, Sudipto Guha, Joseph Naor</i>	

MAX k -CUT and Approximating the Chromatic Number of Random Graphs	200
<i>Amin Coja-Oghlan, Cristopher Moore, Vishal Sanwalani</i>	

Approximation Algorithm for Directed Telephone Multicast Problem ...	212
<i>Michael Elkin, Guy Kortsarz</i>	

Languages and Programming

Mixin Modules and Computational Effects	224
<i>Davide Ancona, Sonia Fagorzi, Eugenio Moggi, Elena Zucca</i>	

Decision Problems for Language Equations with Boolean Operations	239
<i>Alexander Okhotin</i>	

Generalized Rewrite Theories	252
<i>Roberto Bruni, José Meseguer</i>	

Complexity

Sophistication Revisited	267
<i>Luís Antunes, Lance Fortnow</i>	

Scaled Dimension and Nonuniform Complexity	278
<i>John M. Hitchcock, Jack H. Lutz, Elvira Mayordomo</i>	

Quantum Search on Bounded-Error Inputs	291
<i>Peter Høyer, Michele Mosca, Ronald de Wolf</i>	

A Direct Sum Theorem in Communication Complexity via Message Compression	300
<i>Rahul Jain, Jaikumar Radhakrishnan, Pranab Sen</i>	

Data Structures

Optimal Cache-Oblivious Implicit Dictionaries	316
<i>Gianni Franceschini, Roberto Grossi</i>	

The Cell Probe Complexity of Succinct Data Structures	332
<i>Anna Gál, Peter Bro Miltersen</i>	

Succinct Representations of Permutations	345
<i>J. Ian Munro, Rajeev Raman, Venkatesh Raman, Satti Srinivasa Rao</i>	

Succinct Dynamic Dictionaries and Trees	357
<i>Rajeev Raman, Satti Srinivasa Rao</i>	

Graph Algorithms

Labeling Schemes for Weighted Dynamic Trees	369
<i>Amos Korman, David Peleg</i>	

A Simple Linear Time Algorithm for Computing a $(2k - 1)$ -Spanner of $O(n^{1+1/k})$ Size in Weighted Graphs	384
<i>Surender Baswana, Sandeep Sen</i>	

Multicommodity Flows over Time: Efficient Algorithms and Complexity	397
<i>Alex Hall, Steffen Hippler, Martin Skutella</i>	

Multicommodity Demand Flow in a Tree.....	410
<i>Chandra Chekuri, Marcelo Mydlarz, F. Bruce Shepherd</i>	

Automata

Skew and Infinitary Formal Power Series	426
<i>Manfred Droste, Dietrich Kuske</i>	

Nondeterminism versus Determinism for Two-Way Finite Automata: Generalizations of Sipser's Separation	439
<i>Juraj Hromkovič, Georg Schnitger</i>	

Residual Languages and Probabilistic Automata	452
<i>François Denis, Yann Esposito</i>	

A Testing Scenario for Probabilistic Automata	464
<i>Mariëlle Stoelinga, Frits Vaandrager</i>	
The Equivalence Problem for t -Turn DPDA Is Co-NP	478
<i>Géraud Sénizergues</i>	
Flip-Pushdown Automata: $k + 1$ Pushdown Reversals Are Better than k	490
<i>Markus Holzer, Martin Kutrib</i>	

Optimization and Games

Convergence Time to Nash Equilibria	502
<i>Eyal Even-Dar, Alex Kesselman, Yishay Mansour</i>	
Nashification and the Coordination Ratio for a Selfish Routing Game	514
<i>Rainer Feldmann, Martin Gairing, Thomas Lücking, Burkhard Monien, Manuel Rode</i>	
Stable Marriages with Multiple Partners: Efficient Search for an Optimal Solution	527
<i>Vipul Bansal, Aseem Agrawal, Varun S. Malhotra</i>	
An Intersection Inequality for Discrete Distributions and Related Generation Problems	543
<i>Endre Boros, Khaled Elbassioni, Vladimir Gurvich, Leonid Khachiyan, Kazuhisa Makino</i>	

Graphs and Bisimulation

Higher Order Pushdown Automata, the Causal Hierarchy of Graphs and Parity Games	556
<i>Thierry Cachat</i>	
Undecidability of Weak Bisimulation Equivalence for 1-Counter Processes	570
<i>Richard Mayr</i>	
Bisimulation Proof Methods for Mobile Ambients	584
<i>Massimo Merro, Francesco Zappa Nardelli</i>	
On Equivalent Representations of Infinite Structures	599
<i>Arnaud Carayol, Thomas Colcombet</i>	

Online Problems

Adaptive Raising Strategies Optimizing Relative Efficiency	611
<i>Arnold Schönhage</i>	
A Competitive Algorithm for the General 2-Server Problem	624
<i>René A. Sitters, Leen Stougie, Willem E. de Paepe</i>	

On the Competitive Ratio for Online Facility Location	637
<i>Dimitris Fotakis</i>	

A Study of Integrated Document and Connection Caching	653
<i>Susanne Albers, Rob van Stee</i>	

Verification

A Solvable Class of Quadratic Diophantine Equations with Applications to Verification of Infinite-State Systems	668
<i>Gaoyan Xie, Zhe Dang, Oscar H. Ibarra</i>	

Monadic Second-Order Logics with Cardinalities	681
<i>Felix Klaedtke, Harald Rueß</i>	

$\Pi_2 \cap \Sigma_2 \equiv AFMC$	697
<i>Orna Kupferman, Moshe Y. Vardi</i>	

Upper Bounds for a Theory of Queues	714
<i>Tatiana Rybina, Andrei Voronkov</i>	

Around the Internet

Degree Distribution of the FKP Network Model	725
<i>Noam Berger, Béla Bollobás, Christian Borgs, Jennifer Chayes, Oliver Riordan</i>	

Similarity Matrices for Pairs of Graphs	739
<i>Vincent D. Blondel, Paul Van Dooren</i>	

Algorithmic Aspects of Bandwidth Trading	751
<i>Randeep Bhatia, Julia Chuzhoy, Ari Freund, Joseph Naor</i>	

Temporal Logic and Model Checking

CTL ⁺ Is Complete for Double Exponential Time	767
<i>Jan Johannsen, Martin Lange</i>	

Hierarchical and Recursive State Machines with Context-Dependent Properties	776
<i>Salvatore La Torre, Margherita Napoli, Mimmo Parente, Gennaro Parlato</i>	

Oracle Circuits for Branching-Time Model Checking	790
<i>Philippe Schnoebelen</i>	

Graph Problems

There Are Spanning Spiders in Dense Graphs (and We Know How to Find Them)	802
<i>Luisa Gargano, Mikael Hammar</i>	
The Computational Complexity of the Role Assignment Problem	817
<i>Jiří Fiala, Daniël Paulusma</i>	
Fixed-Parameter Algorithms for the (k, r) -Center in Planar Graphs and Map Graphs	829
<i>Erik D. Demaine, Fedor V. Fomin, Mohammad Taghi Hajiaghayi, Dimitrios M. Thilikos</i>	
Genus Characterizes the Complexity of Graph Problems: Some Tight Results	845
<i>Jianer Chen, Iyad A. Kanj, Ljubomir Perković, Eric Sedgwick, Ge Xia</i>	

Logic and Lambda-Calculus

The Definition of a Temporal Clock Operator	857
<i>Cindy Eisner, Dana Fisman, John Havlicek, Anthony McIsaac, David Van Campenhout</i>	
Minimal Classical Logic and Control Operators	871
<i>Zena M. Ariola, Hugo Herbelin</i>	
Counterexample-Guided Control	886
<i>Thomas A. Henzinger, Ranjit Jhala, Rupak Majumdar</i>	
Axiomatic Criteria for Quotients and Subobjects for Higher-Order Data Types	903
<i>Jo Hannay</i>	

Data Structures and Algorithms

Efficient Pebbling for List Traversal Synopses	918
<i>Yossi Matias, Ely Porat</i>	
Function Matching: Algorithms, Applications, and a Lower Bound	929
<i>Amihoud Amir, Yonatan Aumann, Richard Cole, Moshe Lewenstein, Ely Porat</i>	
Simple Linear Work Suffix Array Construction	943
<i>Juha Kärkkäinen, Peter Sanders</i>	

Types and Categories

Expansion Postponement via Cut Elimination in Sequent Calculi for Pure Type Systems	956
<i>Francisco Gutiérrez, Blas Ruiz</i>	
Secrecy in Untrusted Networks	969
<i>Michele Bugliesi, Silvia Crafa, Amela Prelic, Vladimiro Sassone</i>	
Locally Commutative Categories	984
<i>Arkadev Chattopadhyay, Denis Thérien</i>	

Probabilistic Systems

Semi-pullbacks and Bisimulations in Categories of Stochastic Relations ..	996
<i>Ernst-Erich Doberkat</i>	
Quantitative Analysis of Probabilistic Lossy Channel Systems	1008
<i>Alexander Rabinovich</i>	
Discounting the Future in Systems Theory	1022
<i>Luca de Alfaro, Thomas A. Henzinger, Rupak Majumdar</i>	
Information Flow in Concurrent Games	1038
<i>Luca de Alfaro, Marco Faella</i>	

Sampling and Randomness

Impact of Local Topological Information on Random Walks on Finite Graphs	1054
<i>Satoshi Ikeda, Izumi Kubo, Norihiro Okumoto, Masafumi Yamashita</i>	
Analysis of a Simple Evolutionary Algorithm for Minimization in Euclidean Spaces	1068
<i>Jens Jägersküpper</i>	
Optimal Coding and Sampling of Triangulations	1080
<i>Dominique Poulalhon, Gilles Schaeffer</i>	
Generating Labeled Planar Graphs Uniformly at Random	1095
<i>Manuel Bodirsky, Clemens Gröpl, Mihyun Kang</i>	

Scheduling

Online Load Balancing Made Simple: Greedy Strikes Back	1108
<i>Pilu Crescenzi, Giorgio Gambosi, Gaia Nicosia, Paolo Penna, Walter Unger</i>	
Real-Time Scheduling with a Budget	1123
<i>Joseph Naor, Hadas Shachnai, Tami Tamir</i>	

Improved Approximation Algorithms for Minimum-Space Advertisement
Scheduling 1138
Brian C. Dean, Michel X. Goemans

Anycasting in Adversarial Systems: Routing and Admission Control 1153
Baruch Awerbuch, André Brinkmann, Christian Scheideler

Geometric Problems

Dynamic Algorithms for Approximating Interdistances 1169
Sergei Bespamyatnikh, Michael Segal

Solving the Robots Gathering Problem 1181
Mark Cieliebak, Paola Flocchini, Giuseppe Prencipe, Nicola Santoro

Author Index 1197