

*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*

Frank Dehne Alejandro López-Ortiz  
Jörg-Rüdiger Sack (Eds.)

# Algorithms and Data Structures

9th International Workshop, WADS 2005  
Waterloo, Canada, August 15-17, 2005  
Proceedings



Springer

## Volume Editors

Frank Dehne  
Jörg-Rüdiger Sack  
Carleton University  
School of Computer Science  
Ottawa, Ontario, K1S 5B6, Canada  
E-mail: frank@dehne.net, sack@scs.carleton.ca

Alejandro López-Ortiz  
University of Waterloo  
School of Computer Science  
Waterloo, Ontario, N2L 3G1, Canada  
E-mail: alopez-o@uwaterloo.ca

Library of Congress Control Number: 2005929608

CR Subject Classification (1998): F.2, E.1, G.2, I.3.5, G.1

|         |                                                       |
|---------|-------------------------------------------------------|
| ISSN    | 0302-9743                                             |
| ISBN-10 | 3-540-28101-0 Springer Berlin Heidelberg New York     |
| ISBN-13 | 978-3-540-28101-6 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](http://springeronline.com)

© Springer-Verlag Berlin Heidelberg 2005  
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India  
Printed on acid-free paper SPIN: 11534273 06/3142 5 4 3 2 1 0

# Preface

The papers in this volume were presented at the 9th Workshop on Algorithms and Data Structures (WADS 2005). The workshop took place during August 15 – 17, 2005, at the University of Waterloo, Waterloo, Canada. The workshop alternates with the Scandinavian Workshop on Algorithm Theory (SWAT), continuing the tradition of SWAT and WADS starting with SWAT 1988 and WADS 1989. From 90 submissions, the Program Committee selected 37 papers for presentation at the workshop. In addition, invited lectures were given by the following distinguished researchers: Allan Borodin and Max J. Egenhofer.

On behalf of the Program Committee, we would like to express our sincere appreciation to the many persons whose effort contributed to making WADS 2005 a success. These include the invited speakers, members of the steering and Program Committees, the authors who submitted papers, and the many referees who assisted the Program Committee. We are indebted to Robert Kane for installing and modifying the submission software, maintaining the submission server and interacting with authors as well as for helping with the preparation of the program.

August 2005      Frank Dehne, Alejandro López-Ortiz, and Jörg-Rüdiger Sack

# WADS Organization

## Organizing Institutions



## Steering Committee

Frank Dehne  
Ian Munro  
Jörg-Rüdiger Sack  
Roberto Tamassia

Carleton University, Canada  
University of Waterloo, Canada  
Carleton University, Canada  
Brown University, Canada

## Program Co-chairs

Frank Dehne  
Alejandro López-Ortiz  
Jörg-Rüdiger Sack

Carleton University, Canada  
University of Waterloo, Canada  
Carleton University, Canada

## Conference Chair

Alejandro López-Ortiz

University of Waterloo, Canada

## Program Committee

Pankaj Agarwal  
Michael Atkinson  
Gill Barequet  
Mark de Berg  
Gilles Brassard  
Leah Epstein  
Rolf Fagerberg  
Sandor Fekete  
Faith Fich

Duke University, USA  
University of Otago, New Zealand  
Technion, Israel  
Tech. Universiteit Eindhoven, The Netherlands  
University of Montreal, Canada  
Tel Aviv University, Israel  
University of Southern Denmark, Denmark  
Tech. Universität Braunschweig, Germany  
University of Toronto, Canada

## VIII Organization

|                     |                                               |
|---------------------|-----------------------------------------------|
| Komei Fukuda        | ETH Zürich, Switzerland                       |
| Anupam Gupta        | Carnegie Mellon University, USA               |
| Susanne Hambrusch   | Purdue University, USA                        |
| Valerie King        | University of Victoria, Canada                |
| Rolf Klein          | Universität Bonn, Germany                     |
| Peter Bro Miltersen | University of Aarhus, Denmark                 |
| Alistair Moffat     | University of Melbourne, Australia            |
| Ian Munro           | University of Waterloo, Canada                |
| Venkatesh Raman     | The Institute of Mathematical Sciences, India |
| Rajeev Raman        | University of Leicester, UK                   |
| Andrew Rau-Chaplin  | Dalhousie University, Canada                  |
| Michiel Smid        | Carleton University, Canada                   |
| Srinivasa Rao       | University of Waterloo, Canada                |
| Stefan Szeider      | Durham University, UK                         |
| Peter Widmayer      | ETH Zürich, Switzerland                       |
| Norbert Zeh         | Dalhousie University, Canada                  |

## Referees

|                       |                    |
|-----------------------|--------------------|
| Eyal Ackerman         | Shlomo Hoory       |
| Spyros Angelopoulos   | Riko Jacob         |
| Sunil Arya            | Rohit Khandekar    |
| Franz Aurenhammer     | Christina Knauer   |
| Mihai Badoiu          | Stephen Kobourov   |
| Amotz Bar-Noy         | Peter Kornerup     |
| Hajo Broersma         | Sven O. Krumke     |
| Hervé Brönnimann      | Elmar Langetepe    |
| Paz Carmi             | Asaf Levin         |
| Luc Devroye           | Florent Madelaine  |
| David Eppstein        | Avner Magen        |
| Esther (Eti) Ezra     | Anil Maheshwari    |
| Rudolf Fleischer      | Daniel Marx        |
| Greg Frederickson     | Catherine McCartin |
| Tom Friedetzky        | Ulrich Meyer       |
| Stefan Funke          | David Mount        |
| Joachim Giesen        | Kamesh Munagala    |
| Ansgar Grüne          | Jonathan Naor      |
| Joachim Gudmundsson   | Daniel Paulusma    |
| Sariel Har-Peled      | Leon Peeter        |
| Refael Hassin         | David Peleg        |
| Mathias Hauptmann     | Seth Pettie        |
| Herman Haverkort      | Jeff Phillips      |
| Klaus Hinrichs        | Helmut Prodinger   |
| Winfried Hochstättler | Prabhakar Ragde    |

Dror Rawitz  
 Vera Rosta  
 Nathan Rountree  
 Gerth S. Brodal  
 Peter Sanders  
 Saket Saurabh  
 Yuval Scharf  
 Avishay Sidlesky  
 Somnath Sikdar

Sagi Snir  
 Jan Vahrenhold  
 Yusu Wang  
 Birgitta Weber  
 Tony Wirth  
 Alik Zamansky  
 Uri Zwick  
 Rob van Stee

# Table of Contents

## Session 1

|                                                              |   |
|--------------------------------------------------------------|---|
| Towards a Theory of Algorithms<br><i>Allan Borodin</i> ..... | 1 |
|--------------------------------------------------------------|---|

## Session 2A

|                                                                                                                                                                  |    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| k-Restricted Rotation with an Application to Search Tree Rebalancing<br><i>Alejandro Almeida Ruiz, Fabrizio Luccio, Antonio Mesa Enriquez, Linda Pagli</i> ..... | 2  |
| Heap Building Bounds<br><i>Zhentao Li, Bruce A. Reed</i> .....                                                                                                   | 14 |

## Session 2B

|                                                                                                                               |    |
|-------------------------------------------------------------------------------------------------------------------------------|----|
| The Multi-radius Cover Problem<br><i>Refael Hassin, Danny Segev</i> .....                                                     | 24 |
| Parameterized Complexity of Generalized Vertex Cover Problems<br><i>Jiong Guo, Rolf Niedermeier, Sebastian Wernicke</i> ..... | 36 |
| The Complexity of Implicit and Space Efficient Priority Queues<br><i>Christian W. Mortensen, Seth Pettie</i> .....            | 49 |
| Analysis of a Class of Tries with Adaptive Multi-digit Branching<br><i>Yuriy A. Reznik</i> .....                              | 61 |
| Balanced Aspect Ratio Trees Revisited<br><i>Amitabh Chaudhary, Michael T. Goodrich</i> .....                                  | 73 |

## Session 3B

|                                                                                                                                               |    |
|-----------------------------------------------------------------------------------------------------------------------------------------------|----|
| Improved Combinatorial Group Testing for Real-World Problem Sizes<br><i>David Eppstein, Michael T. Goodrich, Daniel S. Hirschberg</i> .....   | 86 |
| Parameterized Counting Algorithms for General Graph Covering Problems<br><i>Naomi Nishimura, Prabhakar Ragde, Dimitrios M. Thilikos</i> ..... | 99 |



|                                                                                                                             |     |
|-----------------------------------------------------------------------------------------------------------------------------|-----|
| Approximating the Online Set Multicover Problems via Randomized<br>Winnowing<br><i>Piotr Berman, Bhaskar DasGupta</i> ..... | 110 |
|-----------------------------------------------------------------------------------------------------------------------------|-----|

## Session 4A

|                                                                                                                                      |     |
|--------------------------------------------------------------------------------------------------------------------------------------|-----|
| Max-stretch Reduction for Tree Spanners<br><i>Kazuo Iwama, Andrzej Lingas, Masaki Okita</i> .....                                    | 122 |
| Succinct Representation of Triangulations with a Boundary<br><i>Luca Castelli Aleardi, Olivier Devillers, Gilles Schaeffer</i> ..... | 134 |
| Line-Segment Intersection Made In-Place<br><i>Jan Vahrenhold</i> .....                                                               | 146 |

## Session 4B

|                                                                                                                                                                                                            |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Improved Fixed-Parameter Algorithms for Two Feedback Set Problems<br><i>Jiong Guo, Jens Gramm, Falk Hüffner, Rolf Niedermeier,<br/>Sebastian Wernicke</i> .....                                            | 158 |
| Communication-Aware Processor Allocation for Supercomputers<br><i>Michael A. Bender, David P. Bunde, Erik D. Demaine,<br/>Sandor P. Fekete, Vitus J. Leung, Henk Meijer,<br/>Cynthia A. Phillips</i> ..... | 169 |
| Dynamic Hotlinks<br><i>Karim Douïeb, Stefan Langerman</i> .....                                                                                                                                            | 182 |

## Session 5

|                                                                      |  |
|----------------------------------------------------------------------|--|
| Invited Presentation (No paper available)<br><i>Max J. Egenhofer</i> |  |
|----------------------------------------------------------------------|--|

## Session 6A

|                                                                                                                                |     |
|--------------------------------------------------------------------------------------------------------------------------------|-----|
| The Minimum-Area Spanning Tree Problem<br><i>Paz Carmi, Matthew J. Katz, Joseph S.B. Mitchell</i> .....                        | 195 |
| Hinged Dissection of Polypolyhedra<br><i>Erik D. Demaine, Martin L. Demaine, Jeffrey F. Lindy,<br/>Diane L. Souvaine</i> ..... | 205 |

**Session 6B**

Convex Recolorings of Strings and Trees: Definitions, Hardness Results  
and Algorithms

*Shlomo Moran, Sagi Snir* ..... 218

Linear Time Algorithms for Generalized Edge Dominating Set  
Problems

*André Berger, Ojas Parekh* ..... 233

**Session 7A**

On Geometric Dilation and Halving Chords

*Adrian Dumitrescu, Annette Ebbers-Baumann, Ansgar Grüne,  
Rolf Klein, Günter Rote* ..... 244

Orthogonal Subdivisions with Low Stabbing Numbers

*Csaba D. Tóth* ..... 256

Kinetic and Dynamic Data Structures for Convex Hulls and Upper  
Envelopes

*Giora Alexandron, Haim Kaplan, Micha Sharir* ..... 269

**Session 7B**

Approximation Algorithms for Forests Augmentation Ensuring Two  
Disjoint Paths of Bounded Length

*Victor Chepoi, Bertrand Estellon, Yann Vaxès* ..... 282

A Dynamic Implicit Adjacency Labelling Schemes for Line Graphs

*David Morgan* ..... 294

The On-line Asymmetric Traveling Salesman Problem

*Giorgio Ausiello, Vincenzo Bonifaci, Luigi Laura* ..... 306

**Session 8A**

All-Pairs Shortest Paths with Real Weights in  $O(n^3/\log n)$  Time

*Timothy M. Chan* ..... 318

k-Link Shortest Paths in Weighted Subdivisions

*Ovidiu Daescu, Joseph S.B. Mitchell, Simeon Ntafos,  
James D. Palmer, Chee K. Yap* ..... 325

Power-Saving Scheduling for Weakly Dynamic Voltage Scaling Devices  
*Jian-Jia Chen, Tei-Wei Kuo, Hsueh-I Lu* ..... 338

**Session 8B**

Improved Approximation Algorithms for Metric Maximum ATSP and  
Maximum 3-Cycle Cover Problems  
*Markus Bläser, L. Shankar Ram, Maxim Sviridenko* ..... 350

On the Vehicle Routing Problem  
*Piotr Berman, Surajit K. Das* ..... 360

**Session 9A**

The Structure of Optimal Prefix-Free Codes in Restricted Languages:  
The Uniform Probability Case  
*Mordecai J. Golin, Zhenming Liu* ..... 372

Tradeoffs Between Branch Mispredictions and Comparisons for Sorting  
Algorithms  
*Gerth Stølting Brodal, Gabriel Moruz* ..... 385

Derandomization of Dimensionality Reduction and SDP Based  
Algorithms  
*Ankur Bhargava, S. Rao Kosaraju* ..... 396

**Session 9B**

Subquadratic Algorithms for 3SUM  
*Ilya Baran, Erik D. Demaine, Mihai Pătraşcu* ..... 409

Near-Optimal Pricing in Near-Linear Time  
*Jason D. Hartline, Vladlen Koltun* ..... 422

Improved Approximation Bounds for Planar Point Pattern Matching  
*Minkyung Cho, David M. Mount* ..... 432

**Author Index** ..... 445