### Society for Industrial and Applied Mathematics

# 13<sup>th</sup> Annual ACM-SIAM Symposium on Discrete Algorithms 2002

January 6-8, 2002 San Francisco, California, USA

Volume 1 of 2

Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 www.proceedings.com

ISBN: 0-89871-513-X

Some format issues inherent in the e-media version may also appear in this print version.

# PROCEEDINGS OF THE THIRTEENTH ANNUAL ACM-SIAM SYMPOSIUM ON DISCRETE ALGORITHMS

Proceedings of the Thirteenth Annual ACM-SIAM Symposium on Discrete Algorithms, San Francisco, CA, January 6–8, 2002.

This symposium was sponsored by the ACM Special Interest Group on Algorithms and Computation Theory and the SIAM Activity Group on Discrete Mathematics.

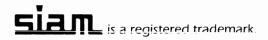
Copyright © 2002 by the Association for Computing Machinery, Inc. and the Society for Industrial and Applied Mathematics.

Copyright for "Faster Approximation Schemes for Fractional Multicommodity Flow Problems" by George Karakostas is retained by Telcordia™ Technologies, Morristown, NJ.

10987654321

All rights reserved. Printed in the United States of America. No part of this book may be reproduced, stored, or transmitted in any manner without the written permission of the publisher. For information, write to the Association for Computing Machinery, 1515 Broadway, New York, NY 10036 and the Society for Industrial and Applied Mathematics, 3600 University City Science Center, Philadelphia, PA 19104-2688.

ISBN 0-89871-513-X



D	re		-	c
-	rei	a	L	c

#### **Acknowledgments**

#### Session 1A

- Static Optimality and Dynamic Search-Optimality in Lists and Trees
  Avrim Blum, Shuchi Chawla, and Adam Kalai
- 9 Optimal Time-Space Trade-Offs for Non-Comparison-Based Sorting Rasmus Pagh and Jakob Pagter
- 19 Union-Find with Deletions
  Haim Kaplan, Nira Shafrir, and Robert E. Tarjan
- **A Locality-Preserving Cache-Oblivious Dynamic Dictionary**Michael A. Bender, Ziyang Duan, John Iacono, and Jing Wu
- **Cache Oblivious Search Trees via Binary Trees of Small Height**Gerth S. Brodal, Rolf Fagerberg, and Riko Jacob

#### Session 1B

- 49 An Approximation Algorithm for the Group Steiner Problem Guy Even and Guy Kortsarz
- **On Directed Steiner Trees**Leonid Zosin and Samir Khuller
- 64 An 8/13-Approximation Algorithm for the Asymmetric Maximum TSP Markus Bläser
- 74 Approximability of Dense and Sparse Instances of Minimum
   2-Connectivity, TSP and Path Problems
   Béla Csaba, Marek Karpinski, and Piotr Krysta
- An Ear Decomposition Approach to Approximating the Smallest 3-Edge Connected Spanning Subgraph of a Multigraph Harold N. Gabow

#### Session 1C

- 94 Censorship Resistant Peer-to-Peer Content Addressable Networks Amos Fiat and Jared Saia
- Web Caching with Request ReorderingTomás Feder, Rajeev Motwani, Rina Panigrahy, and An Zhu

#### 106 Improved Algorithms for the Data Placement Problem

Sudipto Guha and Kamesh Munagala

### 108 Undiscretized Dynamic Programming: Faster Algorithms for Facility Location and Related Problems on Trees

Rahul Shah and Martin Farach-Colton

#### 116 Temporary Tasks Assignment Resolved

Amitai Armon, Yossi Azar, Leah Epstein, and Oded Regev

#### Session 2A

### 125 Dense Point Sets Have Sparse Delaunay Triangulations, or "...But Not Too Nasty"

Jeff Erickson

#### 135 Delaunay Triangulation Programs on Surface Data

Sunghee Choi and Nina Amenta

#### 137 Quality Meshing with Weighted Delaunay Refinement

Siu-Wing Cheng and Tamal K. Dey

#### 147 Linear-Size Approximate Voronoi Diagrams

Sunil Arya and Theocharis Malamatos

#### 156 Motorcycle Graphs and Straight Skeletons

Siu-Wing Cheng and Antoine Vigneron

#### Session 2B

#### 166 Faster Approximation Schemes for Fractional Multicommodity Flow Problems

George Karakostas

#### 174 Flows over Time with Load-Dependent Transit Times

Ekkehard Köhler and Martin Skutella

#### 184 Improved Bounds for the Unsplittable Flow Problem

Petr Kolman and Christian Scheideler

#### 194 NP-Hardness of Broadcast Scheduling and Inapproximability of Single-Source Unsplittable Min-Cost Flow

Thomas Erlebach and Alexander Hall

#### 203 How Unfair Is Optimal Routing?

Tim Roughgarden

#### Session 2C

#### 205 Approximation Algorithms for Grammar-Based Compression

Eric Lehman and Abhi Shelat

#### 213 Improving Table Compression with Combinatorial Optimization

Adam L. Buchsbaum, Glenn S. Fowler, and Raffaele Giancarlo

#### 223 Linear-Time Compression of Bounded-Genus Graphs into Information-Theoretically Optimal Number of Bits

Hsueh-I Lu

# Succinct Representations of *Icp* Information and Improvements in the Compressed Suffix Arrays

Kunihiko Sadakane

### 233 Succinct Indexable Dictionaries with Applications to Encoding *k*-ary Trees and Multisets

Rajeev Raman, Venkatesh Raman, and S. Srinivasa Rao

#### Session 3A

#### 243 Jenga

Uri Zwick

#### 247 Guessing Secrets with Inner Product Questions

Fan Chung, Ronald Graham, and Linyuan Lu

#### 254 Guessing Secrets Efficiently via List Decoding

Noga Alon, Venkatesan Guruswami, Tali Kaufman, and Madhu Sudan

#### 263 How to Cut a Cake Almost Fairly

Sven O. Krumke, Maarten Lipmann, Willem E. de Paepe, Diana Poensgen, Jörg Rambau, Leen Stougie, and Gerhard J. Woeginger

#### 265 The Mathematics of Playing Golf

Giovanni Rinaldi, Ulrich Voigt, and Gerhard J. Woeginger

#### Session 3B

#### 267 Computing Shortest Paths with Comparisons and Additions

Seth Pettie and Vijaya Ramachandran

#### 277 An Optimal Algorithm for Checking Regularity

Y. Kohayakawa, V. Rödl, and L. Thoma

#### 287 Edge Dominating and Hypomatchable Sets

Ojas Parekh

# 292 An Algorithm for Counting Maximum Weighted Independent Sets and Its Applications

Vilhelm Dahllöf and Peter Jonsson

#### 299 Algorithms for Quantified Boolean Formulas

Ryan Williams

Ses			

308	Balls and	Rinc	Models	with	Foodback
300	bans and	DILIZ	Models	willi	reeuback

Eleni Drinea, Alan Frieze, and Michael Mitzenmacher

#### 316 A Note on Random 2-SAT with Prescribed Literal Degrees

Colin Cooper, Alan Frieze, and Gregory B. Sorkin

#### 321 Mixing Time and Long Paths in Graphs

Igor Pak

#### 329 The Diameter of a Long Range Percolation Graph

Don Coppersmith, David Gamarnik, and Maxim Sviridenko

#### 338 Is the Internet Fractal?

Cedric Adjih, Leonidas Georgiadis, Philippe Jacquet, and Wojciech Szpankowski

#### Session 4A

#### 346 Center and Diameter Problems in Plane Triangulations and Quadrangulations

Victor Chepoi, Feodor Dragan, and Yann Vaxès

#### 356 Symmetric Drawings of Triconnected Planar Graphs

Seok-Hee Hong, Brendan McKay, and Peter Eades

#### 366 Layout Area of the Hypercube

Shimon Even and Roni Kupershtok

#### 372 I/O-Optimal Algorithms for Planar Graphs Using Separators

Anil Maheshwari and Norbert Zeh

#### 382 Polynomial Time Recognition of R-Structure

R. B. Hayward, S. Hougardy, and B. A. Reed

#### Session 4B

#### 390 Adaptive Intersection and t-Threshold Problems

Jérémy Barbay and Claire Kenyon

### 400 Separable Attributes: A Technique for Solving the Submatrices Character Count Problem

Amihood Amir, Kenneth W. Church, and Emanuel Dar

#### 402 Tiling Groups for Wang Tiles

Cristopher Moore, Ivan Rapaport, and Eric Rémila

#### 412 Generating Random Factored Numbers, Easily

Adam Kalai

_		
50	ssin	$\Lambda$

#### 413 Tight Bounds for Worst-Case Equilibria

Artur Czumaj and Berthold Vöcking

#### 421 Broadcast Scheduling: When Fairness is Fine

Jeff Edmonds and Kirk Pruhs

#### 431 Harmonic Broadcasting Is Optimal

Lars Engebretsen and Madhu Sudan

#### 433 Windows Scheduling Problems for Broadcast Systems

Amotz Bar-Noy and Richard E. Ladner

#### 443 Scheduling Protocols for Switches with Large Envelopes

Matthew Andrews and Lisa Zhang

#### Session 5A

#### 453 Covering Shapes by Ellipses

Alon Efrat, Frank Hoffmann, Christian Knauer, Klaus Kriegel, Günter Rote, and Carola Wenk

#### 455 Slice and Dice: A Simple, Improved Approximate Tiling Recipe

Piotr Berman, Bhaskar DasGupta, and S. Muthukrishnan

### 465 Binary Space Partitions for Line Segments with a Limited Number of Directions

Csaba D. Tóth

#### 472 Closest-Point Problems Simplified on the RAM

Timothy M. Chan

#### 474 Semi-Online Maintenance of Geometric Optima and Measures

Timothy M. Chan

#### Session 5B

#### 484 Generalized Clustering

Sudipto Guha and Kamesh Munagala

#### 486 New Bounds for Multi-Dimensional Packing

Steven S. Seiden and Rob van Stee

#### 496 Computer Assisted Proof of Optimal Approximability Results

Uri Zwick

#### 506 MAX CUT in Cubic Graphs

Eran Halperin, Dror Livnat, and Uri Zwick

#### 514 Approximating Minimum Unsatisfiability of Linear Equations

Piotr Berman and Marek Karpinski

_		-			_	_
•	es	CI	n	n	٠.	"
_	L.	31	v		_	•

517	On-Line Algorithms for the Dynamic Traveling Repair Problem
	Sandy Irani, Xiangwen Lu, and Amelia Regan

#### 525 Competitive On-Line Switching Policies

Amotz Bar-Noy, Ari Freund, Shimon Landa, and Joseph (Seffi) Naor

### A Randomized Online Algorithm for Bandwidth Utilization

Sanjeev Arora and Bo Brinkman

#### 540 Caching with Expiration Times

Parikshit Gopalan, Howard Karloff, Aranyak Mehta, Milena Mihail, and Nisheeth Vishnoi

### On-Line Scheduling of a Single Machine to Minimize Total Weighted Completion Time

E. J. Anderson and C. N. Potts

#### Session 6A

#### 558 Hardware-Assisted Computation of Depth Contours

Shankar Krishnan, Nabil H. Mustafa, and Suresh Venkatasubramanian

#### The Freeze-Tag Problem: How to Wake up a Swarm of Robots

Esther M. Arkin, Michael A. Bender, Sándor P. Fekete, Joseph S. B. Mitchell, and Martin Skutella

# 578 The Wake Up and Report Problem Is Time-Equivalent to the Firing Squad Synchronization Problem

Darin Goldstein and Nick Meyer

#### 588 Tree Exploration with Little Memory

Krzysztof Diks, Pierre Fraigniaud, Evangelos Kranakis, and Andrzej Pelc

#### Session 6B

#### 598 Efficient Proper 2-Coloring of Almost Disjoint Hypergraphs

József Beck and Sachin Lodha

#### 606 Experimental Analysis of Simple, Distributed Vertex Coloring Algorithms

Irene Finocchi, Alessandro Panconesi, and Riccardo Silvestri

### 616 On Semidefinite Programming Relaxations for Graph Coloring and Vertex Cover

Moses Charikar

#### 621 Approximating k- Cuts via Network Strength

R. Ravi and Amitabh Sinha

_	-			_
Ses		m	<i>/</i> ~	•

623	Reductions in Streaming Algorithms, with an Application to Counting
	Triangles in Graphs

Ziv Bar-Yossef, Ravi Kumar, and D. Sivakumar

#### 633 Sampling from a Moving Window over Streaming Data

Brian Babcock, Mayur Datar, and Rajeev Motwani

#### 635 Maintaining Stream Statistics over Sliding Windows

Mayur Datar, Aristides Gionis, Piotr Indyk, and Rajeev Motwani

#### 645 Testing Satisfiability

Noga Alon and Asaf Shapira

#### Session 7A

#### 655 Efficient Pattern-Matching with Don't Cares

Adam Kalai

#### 657 Efficient Algorithms for Document Retrieval Problems

S. Muthukrishnan

#### 667 The String Edit Distance Matching Problem with Moves

Graham Cormode and S. Muthukrishnan

#### 677 Simple Approximation Algorithm for Nonoverlapping Local Alignments

Piotr Berman, Bhaskar DasGupta, and S. Muthukrishnan

### 679 A Sub-Quadratic Sequence Alignment Algorithm for Unrestricted Cost Matrices

Maxime Crochemore, Gad M. Landau, and Michal Ziv-Ukelson

#### Session 7B

#### 689 On Adaptive Deterministic Gossiping in ad hoc Radio Networks

Leszek Gasieniec and Andrzej Lingas

#### 691 Expansion of Product Replacement Graphs

Alexander Gamburd and Igor Pak

### 697 Explicit Constructions of Selectors and Related Combinatorial Structures,

with Applications

Piotr Indyk

#### 705 Derandomized Dimensionality Reduction with Applications

Lars Engebretsen, Piotr Indyk, and Ryan O'Donnell

# 713 Minimizing Randomness in Minimum Spanning Tree, Parallel Connectivity, and Set Maxima Algorithms

Seth Pettie and Vijaya Ramachandran

#### Session 7C

### 723 Existence Theorems, Lower Bounds and Algorithms for Scheduling to Meet Two Objectives

April Rasala, Cliff Stein, Eric Torng, and Patchrawat Uthaisombut

#### 732 Scheduling Split Intervals

Reuven Bar-Yehuda, Magnús M. Halldórsson, Joseph (Seffi) Naor, Hadas Shachnai, and Irina Shapira

#### 742 Throughput Maximization of Real-Time Scheduling with Batching

Amotz Bar-Noy, Sudipto Guha, Yoav Katz, Joseph (Seffi) Naor, Baruch Schieber, and Hadas Shachnai

#### 752 (Incremental) Priority Algorithms

Allan Borodin, Morten N. Nielsen, and Charles Rackoff

#### 762 Improved Algorithms for Stretch Scheduling

Michael A. Bender, S. Muthukrishnan, and Rajmohan Rajaraman

#### Session 8A

#### 772 Shape Dimension and Approximation from Samples

Tamal K. Dey, Joachim Giesen, Samrat Goswami, and Wulue Zhao

#### 781 Smooth-Surface Reconstruction in Near-Linear Time

Stefan Funke and Edgar A. Ramos

#### 791 Computing the Writhing Number of a Polygonal Knot

Pankaj K. Agarwal, Herbert Edelsbrunner, and Yusu Wang

#### 800 Pseudo-Line Arrangements: Duality, Algorithms, and Applications

Pankaj K. Agarwal and Micha Sharir

#### 810 On the Overlay of Envelopes in Four Dimensions

Vladlen Koltun and Micha Sharir

#### Session 8B

### 820 Preprocessing an Undirected Planar Network to Enable Fast Approximate Distance Queries

Philip Klein

#### 828 Approximate Distance Oracles for Geometric Graphs

Joachim Gudmundsson, Christos Levcopoulos, Giri Narasimhan, and Michiel Smid

### 838 Oracles for Distances Avoiding a Link-Failure

Camil Demetrescu and Mikkel Thorup

#### 844 Roundtrip Spanners and Roundtrip Routing in Directed Graphs

Liam Roditty, Mikkel Thorup, and Uri Zwick

# 852 Light Spanners and Approximate TSP in Weighted Graphs with Forbidden Minors

Michelangelo Grigni and Papa Sissokho

#### Session 8C

#### 858 Capacitated Vertex Covering with Applications

Sudipto Guha, Refael Hassin, Samir Khuller, and Einat Or

#### 866 Construction of Probe Interval Models

Ross M. McConnell and Jeremy P. Spinrad

#### 876 A New Algorithm for Protein Folding in the HP Model

Alantha Newman

# An Optimal (Expected Time) Algorithm for Minimizing Lab Costs in DNA Sequencing

David Hart

### Approximating Minimum Quartet Inconsistency

Gianluca Della Vedova, Tao Jiang, Jing Li, and Jianjun Wen

#### Session 9A

894

# 896 Matrix Rounding under the L<sub>ρ</sub>-Discrepancy Measure and Its Application to Digital Halftoning

Tetsuo Asano, Naoki Katoh, Koji Obokata, and Takeshi Tokuyama

### 905 Smoothed Analysis of the Perceptron Algorithm for Linear Programming

Avrim Blum and John Dunagan

#### 915 A Fully Combinatorial Algorithm for Submodular Function Minimization

Satoru lwata

#### 920 0/1 Optimization and 0/1 Primal Separation Are Equivalent

Friedrich Eisenbrand, Giovanni Rinaldi, and Paolo Ventura

#### Session 9B

#### 927 Labeling Schemes for Flow and Connectivity

Michal Katz, Nir A. Katz, Amos Korman, and David Peleg

#### 937 Reachability and Distance Queries via 2-Hop Labels

Edith Cohen, Eran Halperin, Haim Kaplan, and Uri Zwick

#### 947 Improved Labeling Scheme for Ancestor Queries

Stephen Alstrup and Theis Rauhe

#### 954 A Comparison of Labeling Schemes for Ancestor Queries

Haim Kaplan, Tova Milo, and Ronen Shabo

_				_	_
	22	$\sim$	n	C)	•

### 964 Incentive-Compatible Online Auctions for Digital Goods

Ziv Bar-Yossef, Kirsten Hildrum, and Felix Wu

#### 971 Online Algorithms for Market Clearing

Avrim Blum, Tuomas Sandholm, and Martin Zinkevich

#### 981 Pricing Multicasting in More Practical Network Models

Micah Adler and Dan Rubenstein

#### 991 Frugal Path Mechanisms

Aaron Archer and Éva Tardos

#### **Erratum**

#### 1000 Erratum: An Approximation Algorithm for Minimum-Cost Vertex-Connectivity Problems

R. Ravi and David P. Williamson

**Author Index**