

**20th Annual ACM-SIAM
Symposium on Discrete
Algorithms 2009**

**New York, New York, USA
4-6 January 2009**

Volume 1 of 2

ISBN: 978-1-61839-401-9

Printed from e-media with permission by:

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



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

Copyright© (2009) by SIAM: Society for Industrial and Applied Mathematics
All rights reserved.

Printed by Curran Associates, Inc. (2011)

For permission requests, please contact SIAM: Society for Industrial and Applied Mathematics
at the address below.

SIAM
3600 Market Street, 6th Floor
Philadelphia, PA 19104-2688 USA

Phone: (215) 382-9800
Fax: (215) 386-7999

siambooks@siam.org

Additional copies of this publication are available from:

Curran Associates, Inc.
57 Morehouse Lane
Red Hook, NY 12571 USA
Phone: 845-758-0400
Fax: 845-758-2634
Email: curran@proceedings.com
Web: www.proceedings.com

Table of Contents

Sessions:

[1A](#) [1B](#) [1C](#) [2](#) [3A](#) [3B](#) [3C](#) [4A](#) [4B](#) [4C](#) [5A](#) [5B](#) [5C](#) [6](#) [7A](#) [7B](#) [7C](#) [8A](#) [8B](#) [8C](#) [9A](#) [9B](#) [9C](#) [10](#) [11A](#)
[11B](#) [11C](#) [12A](#) [12B](#) [12C](#)

Session 1A

1 [Improved Bounds and New Techniques for Daveport–Schinzel Sequences and Their Generalizations](#)

Gabriel Nivasch

11 [Perfect Matchings via Uniform Sampling in Regular Bipartite Graphs](#)

Ashish Goel, Michael Kapralov, and Sanjeev Khanna

18 [The Ratio Index for Budgeted Learning, with Applications](#)

Ashish Goel, Sanjeev Khanna, and Brad Null

28 [Approximation Algorithms for Restless Bandit Problems](#)

Sudipto Guha, Kamesh Munagala, and Peng Shi

38 [Better Algorithms for Benign Bandits](#)

Elad Hazan and Satyen Kale

Session 1B

48 [The Cover Time of Random Geometric Graphs](#)

Colin Cooper and Alan Frieze

58 [The Complexity of Simulating Brownian Motion](#)

Ilia Binder and Mark Braverman

68 [Sorting by Placement and Shift](#)

Sergi Elizalde and Peter Winkler

76 [Sampling Biased Lattice Configurations Using Exponential Metrics](#)

Sam Greenberg, Amanda Pascoe, and Dana Randall

86 [On the Hitting Times of Quantum Versus Random Walks](#)

Frédéric Magniez, Ashwin Nayak, Peter C. Richter, and Miklos Santha

Session 1C

96 [Efficient Algorithms for the 2-Gathering Problem](#)

Alon Shalita and Uri Zwick

- 106 [Asymptotically Optimal Frugal Colouring](#)
Michael Molloy and Bruce Reed
- 115 [A Quadratic Kernel for Feedback Vertex Set](#)
Stéphan Thomassé
- 120 [Coloring Triangle-Free Graphs on Surfaces](#)
Zdeněk Dvořák, Daniel Král, and Robin Thomas
- 130 [\(Un\)Expected Behavior of Digital Search Tree Profile](#)
Michael Drmota and Wojciech Szpankowski

Session 2

- 139 [Combinatorial Stochastic Processes and Nonparametric Bayesian Modeling](#)
Michael I. Jordan

Session 3A

- 140 [Comparison-Based Time–Space Lower Bounds for Selection](#)
Timothy M. Chan
- 150 [Linear-Time Algorithms for Geometric Graphs with Sublinearly Many Crossings](#)
David Eppstein, Michael T. Goodrich, and Darren Strash
- 160 [Self-Overlapping Curves Revisited](#)
David Eppstein and Elena Mumford
- 170 [Line Transversals of Convex Polyhedra in \$\mathbb{R}^3\$](#)
Haim Kaplan, Natan Rubin, and Micha Sharir
- 180 [Optimal Halfspace Range Reporting in Three Dimensions](#)
Peyman Afshani and Timothy M. Chan

Session 3B

- 187 [Optimality of Belief Propagation for Random Assignment Problem](#)
J. Salez and D. Shah
- 197 [Termination Criteria for Solving Concurrent Safety and Reachability Games](#)
Krishnendu Chatterjee, Luca de Alfaro, and Thomas A. Henzinger
- 207 [An Efficient Sparse Regularity Concept](#)
Amin Coja-Oghlan, Colin Cooper, and Alan Frieze
- 217 [Almost All Hypergraphs without Fano Planes Are Bipartite](#)

Yury Person and Mathias Schacht

- 227 [Hypergraph Regularity and Quasi-Randomness](#)
Brendan Nagle, Annika Poerschke, Vojtěch Rödl, and Mathias Schacht

Session 3C

- 236 [Shortest Paths in Directed Planar Graphs with Negative Lengths: A Linear-Space \$O\(n \log^2 n\)\$ - Time Algorithm](#)
Philip Klein, Shay Mozes, and Oren Weimann
- 246 [A Near-Linear Time Algorithm for Constructing a Cactus Representation of Minimum Cuts](#)
David R. Karger and Debmalya Panigrahi
- 256 [Testing Halfspaces](#)
Kevin Matulef, Ryan O'Donnell, Ronitt Rubinfeld, and Rocco A. Servedio
- 265 [Fast Edge Orientation for Unweighted Graphs](#)
Anand Bhalgat and Ramesh Hariharan
- 273 [A Unified Approach to Distance-Two Colouring of Planar Graphs](#)
Omid Amini, Louis Esperet, and Jan van den Heuvel

Session 4A

- 283 [Approximate Euclidean Shortest Paths amid Convex Obstacles](#)
Pankaj K. Agarwal, R. Sharathkumar, and Hai Yu
- 293 [Approximate Line Nearest Neighbor in High Dimensions](#)
Alexandr Andoni, Piotr Indyk, Robert Krauthgamer, and Huy L. Nguyen
- 302 [Decomposition of Multiple Coverings into More Parts](#)
Greg Aloupis, Jean Cardinal, Sébastien Collette, Stefan Langerman, David Orden, and Pedro Ramos
- 311 [On Stars and Steiner Stars. II](#)
Adrian Dumitrescu, Csaba D. Tóth, and Guangwu Xu
- 318 [Combinatorial Algorithms for Nearest Neighbors, Near-Duplicates and Small-World Design](#)
Yury Lifshits and Shengyu Zhang

Session 4B

- 327 [Computing the Nucleolus of Weighted Voting Games](#)
Edith Elkind and Dmitrii Pasechnik
- 336 [High Rate Fingerprinting Codes and the Fingerprinting Capacity](#)
Ehsan Amiri and Gábor Tardos
- 346 [On the Power of Two, Three and Four Probes](#)
Noga Alon and Uriel Feige
- 355 [Exponential Lower Bounds and Integrality Gaps for Tree-Like Lovász–Schrijver Procedures](#)
Toniann Pitassi and Nathan Segerlind
- 365 [3-Bit Dictator Testing: 1 vs. 5/8](#)
Ryan O’Donnell and Yi Wu

Session 4C

- 375 [Inserting a Vertex into a Planar Graph](#)
Markus Chimani, Carsten Gutwenger, Petra Mutzel, and Christian Wolf
- 384 [Fast Algorithms for \(max, min\)-Matrix Multiplication and Bottleneck Shortest Paths](#)
Ran Duan and Seth Pettie
- 392 [Sorting and Selection in Posets](#)
Constantinos Daskalakis, Richard M. Karp, Elchanan Mossel, Samantha Riesenfeld, and Elad Verbin
- 402 [Finding Duplicates in a Data Stream](#)
Parikshit Gopalan and Jaikumar Radhakrishnan
- 412 [Compressed Counting](#)
Ping Li

Session 5A

- 422 [Natural Algorithms](#)
Bernard Chazelle
- 432 [Maximal Biconnected Subgraphs of Random Planar Graphs](#)
Konstantinos Panagiotou and Angelika Steger
- 441 [Approximate Shared-Memory Counting Despite a Strong Adversary](#)
James Aspnes and Keren Censor

451 [On Smoothes \$k\$ -CNF Formulas and the Walksat Algorithm](#)
Amin Coja-Oghlan, Uriel Feige, Alan Frieze, Michael Krivelevich, and Dan Vilenchik

461 [Improved Smoothed Analysis of the \$k\$ -Means Method](#)
Bodo Manthey and Heiko Röglin

Session 5B

471 [Pairing Heaps with \$O\(\log \log n\)\$ Decrease Cost](#)
Amr Elmasry

477 [A Simpler Implementation and Analysis of Chazelle's Soft Heaps](#)
Haim Kaplan and Uri Zwick

486 [Biased Range Trees](#)
Vida Dujmović, John Howat, and Pat Morin

496 [The Geometry of Binary Search Trees](#)
Erik D. Demaine, Dion Harmon, John Iacono, Daniel Kane, and Mihai Pătraşcu

506 [Dual-Failure Distance and Connectivity Oracles](#)
Ran Duan and Seth Pettie

Session 5C

516 [On the Maximum Quadratic Assignment Problem](#)
Viswanath Nagarajan and Maxim Sviridenko

525 [Towards Computing the Grothendieck Constant](#)
Prasad Raghavendra and David Steurer

535 [Approximating Submodular Functions Everywhere](#)
Michel X. Goemans, Nicholas J. A. Harvey, Satoru Iwata, and Vahab Mirrokni

545 [Maximizing Submodular Set Functions Subject to Multiple Linear Constraints](#)
Ariel Kulik, Hadas Shachnai, and Tami Tamir

555 [Combinatorial Algorithms for Wireless Information Flow](#)
Aurore Aumaudruz and Christina Fragouli

Session 6

565 [Probability, Algorithms and Complexity](#)
Volker Strassen

Session 7A

- 566 [Generating Random Graphs with Large Girth](#)
Mohsen Bayati, Andrea Montanari, and Amin Saberi
- 576 [Expanders via Random Spanning Trees](#)
Navin Goyal, Luis Rademacher, and Santosh Vempala
- 586 [The Extended \$k\$ -Tree Algorithm](#)
Lorenz Minder and Alistair Sinclair
- 596 [Sequential Cavity Method for Computing Limits of the Log-Partition Function for Lattice Models](#)
David Gamarnik and Dmitriy Katz
- 606 [A Universally Fastest Algorithms for Max 2-Sat, Max 2-CSP, and Everything in Between](#)
Serge Gaspers and Gregory B. Sorkin

Session 7B

- 616 [Finding Shortest Contractible and Shortest Separating Cycles in Embedded Graphs](#)
Sergio Cabello
- 625 [Cell Probe Lower Bounds for Succinct Data Structures](#)
Alexander Golynski
- 635 [Succinct Geometric Indexes Supporting Point Location Queries](#)
Prosenjit Bose, Eric Y. Chen, Meng He, Anil Maheshwari, and Pat Morin
- 645 [Exact Algorithms for Partial Curve Matching via the Fréchet Distance](#)
Kevin Buchin, Maike Buchin, and Yusu Wang
- 655 [String Hashing for Linear Probing](#)
Mikkel Thorup

Session 7C

- 665 [Parameterized Approximation Scheme for the Multiple Knapsack Problem](#)
Klaus Jansen
- 675 [Improved Approximation Algorithms for Scheduling with Fixed Jobs](#)
Florian Diedrich and Klaus Jansen
- 685 [Scalably Scheduling Processes with Arbitrary Speedup Curves](#)

Jeff Edmonds and Kirk Pruhs

693 [Speed Scaling with an Arbitrary Power Function](#)

Nikhil Bansal, Ho-Leung Chan, and Kirk Pruhs

702 [A Logarithmic Approximation for Unsplittable Flow on Line Graphs](#)

Nikhil Bansal, Zachary Friggstad, Rohit Khandekar, and Mohammad R. Salavatipour

Session 8A

710 [On the Complexity of Nash Equilibria of Action-Graph Games](#)

Constantinos Daskalakis, Grant Schoenebeck, Gregory Valiant, and Paul Valiant

720 [How Hard Is It to Approximate the Best Nash Equilibrium?](#)

Elad Hazan and Robert Krauthgamer

728 [Improved Equilibria via Public Service Advertising](#)

Maria-Florina Balcan, Avrim Blum, and Yishay Mansour

738 [Stepwise Randomized Combinatorial Auctions Achieve Revenue Monotonicity](#)

Baharak Rastegari, Anne Condon, and Kevin Leyton-Brown

748 [Equilibria of Atomic Flow Games Are not Unique](#)

Umang Bhaskar, Lisa Fleischer, Darrell Hoy, and Chien-Chung Huang

Session 8B

758 [A Generic Top-Down Dynamic-Programming Approach to Prefix-Free Coding](#)

Mordecai Golin, Xiaoming Xu, and Jiajin Yu

768 [On the Bit-Complexity of Lempel–Ziv Compression](#)

Paolo Ferragina, Igor Nitto, and Rossano Venturini

778 [From Coding Theory to Efficient Pattern Matching](#)

Raphaël Clifford, Klim Efremenko, Ely Porat, and Amir Rothschild

785 [Monotone Minimal Perfect Hashing: Searching a Sorted Table with \$O\(1\)\$ Accesses](#)

Djamal Belazzougui, Paolo Boldi, Rasmus Pagh, and Sebastiano Vigna

795 [On Risks of Using Cuckoo Hashing with Simple Universal Hash Classes](#)

Martin Dietzfelbinger and Ulf Schellbach

Session 8C

805 [Assignment Problem in Content Distribution Networks: Unsplittable Hard-Capacitated Facility Location](#)

Mohammad Hossein Bateni and MohammadTaghi Hajiaghayi

815 [Efficient Coordination Mechanisms for Unrelated Machine Scheduling](#)

Ioannis Caragiannis

825 [Clique-Width: On the Price of Generality](#)

Fedor V. Fomin, Petr A. Golovach, Daniel Lokshtanov, and Saket Saurabh

835 [Reasoning about Online Algorithms with Weighted Automata](#)

Benjamin Aminof, Orna Kupferman, and Robby Lampert

845 [Appointment Scheduling with Discrete Random Durations](#)

Mehmet A. Begen and Maurice Queyranne

Session 9A

855 [Hardness of Embedding Simplicial Complexes in \$\mathbb{R}^d\$](#)

Jiří Matoušek, Martin Tancer, and Uli Wagner

865 [Overcoming the \$\ell_1\$ Non-Embeddability Barrier: Algorithms for Product Metrics](#)

Alexandr Andoni, Piotr Indyk, and Robert Krauthgamer

875 [On Low Dimensional Local Embeddings](#)

Ittai Abraham, Yair Bartal, and Ofer Neiman

885 [The Johnson–Lindenstrauss Lemma Almost Characterizes Hilbert Space, but Not Quite](#)

William B. Johnson and Assaf Naor

892 [Maximum Independent Set of Rectangles](#)

Parinya Chalermsook and Julia Chuzhoy

Session 9B

902 [Approximating Fractional Hypertree Width](#)

Dániel Marx

912 [An Almost \$O\(\log k\)\$ -Approximation for \$k\$ -Connected Subgraphs](#)

Zeev Nutov

922 [Improved Approximating Algorithms for Directed Steiner Forest](#)

Moran Feldman, Guy Kortsarz, and Zeev Nutov

932 [Transitive-Closure Spanners](#)

*Arnab Bhattacharyya, Elena Grigorescu, Kyomin Jung, Sofya Raskhodnikova,
and David P. Woodruff*

- 942 [Partitioning Graphs into Balanced Components](#)
Robert Krauthgamer, Joseph (Seffi) Naor, and Roy Schwartz

Session 9C

- 950 [Efficient Algorithms on Sets of Permutations, Dominance, and Real-Weighted APSP](#)
Raphael Yuster

- 958 [Discounted Deterministic Markov Decision Processes and Discounted All-Pairs Shortest Paths](#)
Omid Madani, Mikkel Thorup, and Uri Zwick

- 968 [An Improved Approximation Algorithm for the Column Subset Selection Problem](#)
Christos Boutsidis, Michael W. Mahoney, and Petros Drineas

- 978 [Column Subset Selection, Matrix Factorization, and Eigenvalue Optimization](#)
Joel A. Tropp

- 987 [Loopless Generation of Multiset Permutations Using a Constant Number of Variables by Prefix Shifts](#)
Aaron Williams

Session 10

- 997 [The Unreasonable Effectiveness of Martingales](#)
Yuval Peres

Session 11A

- 1001 [Dimension Detection via Slivers](#)
Siu-Wing Cheng and Man-Kwun Chiu

- 1011 [Persistent Homology for Kernels, Images, and Cokernels](#)
David Cohen-Steiner, Herbert Edelsbrunner, John Harer, and Dmitriy Morozov

- 1021 [Analysis of Scalar Fields over Point Cloud Data](#)
Frédéric Chazal, Leonidas J. Guibas, Steve Y. Oudot, and Primoz Skraba

- 1031 [Constructing Laplace Operator from Point Clouds in \$\mathbb{R}^d\$](#)
Mikhail Belkin, Jian Sun, and Yusu Wang

- 1041 [Size Complexity of Volume Meshes vs. Surface Meshes](#)
Benoît Hudson, Gary L. Miller, Todd Phillips, and Don Sheehy

Session 11B

- 1048 [Packing Multitway Cuts in Capacitated Graphs](#)
Siddharth Barman and Shuchi Chawla
- 1058 [On the Approximability of Dodgson and Young Elections](#)
Ioannis Caragiannis, Jason A. Covey, Michal Feldman, Christopher M. Homan, Christos Kaklamanis, Nikos Karanikolas, Ariel D. Procaccia, and Jeffrey S. Rosenschein
- 1068 [Approximate Clustering without the Approximation](#)
Maria-Florina Balcan, Avrim Blum, and Anupam Gupta
- 1078 [Robust PCA and Clustering in Noisy Mixtures](#)
S. Charles Brubaker
- 1088 [Coresets and Approximate Clustering for Bregman Divergences](#)
Marcel R. Ackermann and Johannes Blömer

Session 11C

- 1098 [Multi-Dimensional Online Tracking](#)
Ke Yi and Qin Zhang
- 1108 [A New Approach to Incremental Topological Ordering](#)
Michael A. Bender, Jeremy T. Fineman, and Seth Gilbert
- 1116 [Online Scheduling to Minimize the Maximum Delay Factor](#)
Chandra Chekuri and Benjamin Moseley
- 1126 [Collecting Weighted Items from a Dynamic Queue](#)
Marcin Bienkowski, Marek Chrobak, Christoph Dürr, Mathilde Hurand, Artur Jeż, Łukasz Jeż, and Grzegorz Stachowiak
- 1136 [Paging and List Update under Bijective Analysis](#)
Spyros Angelopoulos and Pascal Schweitzer

Session 12A

- 1146 [Algorithms for Finding an Induced Cycle in Planar Graphs and Bounded Genus Graphs](#)
Yusuke Kobayashi and Ken-ichi Kawarabayashi
- 1156 [List-Color-Critical Graphs on a Fixed Surface](#)

Ken-ichi Kawarabayashi and Bojan Mohar

1166 [Additive Approximation Algorithms for List-Coloring Minor-Closed Class of Graphs](#)

Ken-ichi Kawarabayashi, Erik D. Demaine, and MohammadTaghi Hajiaghayi

1176 [Three-Coloring Triangle-Free Planar Graphs in Linear Time](#)

Zdeněk Dvořák, Ken-ichi Kawarabayashi, and Robin Thomas

1183 [A Nearly Linear Time Algorithms for the Half Integral Parity Disjoint Paths Packing Problem](#)

Ken-ichi Kawarabayashi and Bruce Reed

Session 12B

1193 [The Uniform Hardcore Lemma via Approximate Bregman Projections](#)

Boaz Barak, Moritz Hardt, and Satyen Kale

1201 [Improved Approximation Bound for Quadratic Optimization Problems with Orthogonality Constraints](#)

Anthony Man-Cho So

1210 [On the Approximability of the Maximum Feasible Subsystem Problem with 0/1-Coefficients](#)

Khaled Elbassioni, Rajiv Raman, Saurabh Ray, and René Sitters

1220 [On the Relative Strength of Split, Triangle and Quadrilateral Cuts](#)

Amitabh Basu, Pierre Bonami, Gérard Cornuéjols, and François Margot

1230 [A Simple Combinatorial Algorithm for Submodular Function Minimization](#)

Satoru Iwata and James B. Orlin

Session 12C

1238 [Weighted Flow Time Does not Admit \$O\(1\)\$ -Competitive Algorithms](#)

Nikhil Bansal and Ho-Leung Chan

1245 [Secretary Problems: Weights and Discounts](#)

Moshe Babaioff, Michael Dinitz, Anupam Gupta, Nicole Immorlica, and Kunal Talwar

1255 [Stream Sampling for Variance-Optimal Estimation of Subset Sums](#)

Edith Cohen, Nick Duffield, Haim Kaplan, Carsten Lund, and Mikkel Thorup

1265 [An Online Mechanism for Ad Slot Reservations with Cancellations](#)

Florin Constantin, Jon Feldman, S. Muthukrishnan, and Martin Pál

1275 [Online Story Scheduling in Web Advertising](#)
Anirban Dasgupta, Arpita Ghosh, Hamid Nazerzadeh, and Prabhakar Raghavan