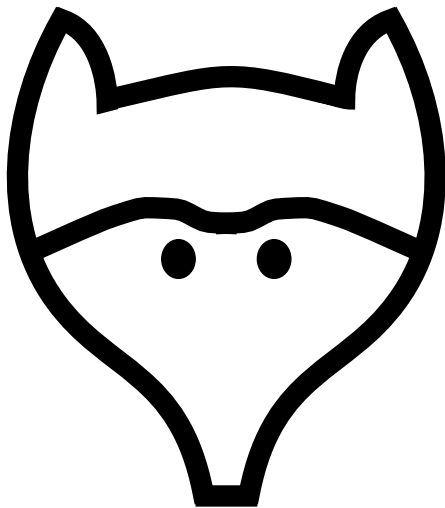


FOCS '98

The 39th Annual
IEEE Computer Society
Conference on Foundations
of Computer Science



November 8–11, 1998
Palo Alto, California

Sponsored by the IEEE Computer Society
Technical Committee on Mathematical
Foundations of Computing
In cooperation with ACM SIGACT

Registration Instructions for FOCS '98

The registration fees for FOCS '98 are listed on the registration form. To qualify for the early registration fee, your registration application must be postmarked by **Monday, October 12**. Refund requests will be honored until October 19. The registration fee includes the Sunday night reception, the Monday night business meeting, coffee breaks, lunches Sunday through Tuesday, and a copy of the proceedings.

Please completely fill out the top half of the registration form. Make check or money order (in U.S. \$, drawn on a U.S. bank) payable to "IEEE - FOCS '98," and send both to the address given at the bottom.

No credit cards: Again, all registration fees must be in the form of a check or money order in U.S. \$, drawn on a U.S. bank. Similarly, at the conference, extra proceedings or tutorial packets will be available, but only by check, money order, or U.S. dollars. We apologize to those who find it inconvenient to pay by check or money order, particularly those attending from outside the U.S. However, taking credit cards would necessarily increase our registration fees by approximately \$10 per person. In the interests of keeping registration as low as possible, we have opted to not accept credit cards this year.

Tutorials: The first day this year will consist of tutorials, which are listed in the schedule. There are no additional charges for these tutorials; they are part of your registration fee. We intend to make available hard copies of the transparencies used in the tutorials at the conference. Booklets of transparencies will be \$7 if ordered in advance, and \$10 (while supplies last) at the conference. Please order the transparencies early if you think you will want them.

Machtey Award: The Machtey Award is presented for the most outstanding paper (or papers) written by a student or collaboration of students, as judged by the Program Committee. The award includes a grant to help defray expenses incurred in attending the Symposium. Please consider making a donation to the Machtey Award Fund so that this award tradition can be sustained. Please use a separate check for your donation.

SUNDAY, NOV 8, 1998

TUTORIAL I: 10:00 am – 12:00 noon

10:00 *Geometric computation and the art of sampling*
Jiří Matoušek, Charles University, Czech Republic.

In computer graphics, in numerical integration, and in many other applications, one needs uniformly distributed point sets to approximate continuous distributions. Random sets are not bad but there are better ways, at least if the dimension is not too large. For derandomizing algorithms in computational geometry efficiently, pseudo-random samples with suitable approximation properties have to be computed fast. For geometric range searching, uniformly distributed point sets are needed as a bad example in lower bound proofs. All of these topics have a common underlying theme: geometric discrepancy. Geometric discrepancy theory studies the question “How uniformly can an n -point set be distributed in a given region of space?”. I plan to discuss some of the classical mathematical results and techniques, more recent combinatorial connections of geometric discrepancy, and relations to various subfields of computer science, such as indicated by the examples above.

Most of the material is covered by an excellent book by Chazelle just finished, and a book by the speaker, soon to be published by Springer-Verlag.

Lunch break: 12:00 noon – 1:30 pm

TUTORIAL II: 1:30 pm – 3:30 pm

1:30 *Theoretical Issues in Probabilistic Artificial Intelligence* Michael Kearns, AT&T Labs.

In the last decade or so, many of the central problems of “classical” artificial intelligence — such as learning, planning and logical inference — have been reformulated in frameworks with statistical or probabilistic underpinnings. The benefits of this trend include the adoption of a common set of mathematical tools for the various AI subdisciplines, increased attention on central algorithmic issues, an emphasis on approximation algorithms for some notoriously hard AI problems... and excellent opportunities for researchers from the theoretical computer science community to contribute to and influence AI.

In this tutorial, I will survey the probabilistic frameworks and the central computational problems posed in several well-developed areas of AI. I will describe some of the algorithms proposed for these problems, overview what is formally known about them (and also what is suspected but not proven), and try to give a flavor of the mathematical techniques involved. The tutorial will be self-contained, designed to be accessible to anyone in the STOC/FOCS community, with an emphasis on the interesting open problems. Likely topics include:

Graphical Models and Probabilistic Inference: graph-theoretic representations of distributions; the junction tree algorithm for exact inference in sparse networks; variational methods from statistical physics for approximate inference in dense networks.

Markov Decision Processes for Planning and Reinforcement Learning: planning in MDP’s via value iteration, linear programming, and sparse sampling; the Q-learning algorithm; the exploration-exploitation trade-off and mixing times.

Supervised Learning: basics and recent advances in boosting; maximum margin analyses of generalization error.

Break: 3:30 pm – 4:00 pm

TUTORIAL III: 4:00 pm – 6:00 pm

4:00 *Information Retrieval on the Web* Andrei Broder and Monika R. Henzinger, Compaq Systems Research Center.

The Web explosion offers a bonanza of algorithmic problems. In particular, information retrieval in the web context requires methods and ideas that have not been addressed in the classic IR literature. This tutorial will survey emerging techniques for IR in the web context and discuss some of the pertinent open problems.

Preliminary list of topics: search engine technology, ranking and classification methods, web measurements (usage, size, connectivity), and new graph and data structure problems arising in the web IR context.

Reception: 6:00 pm – 8:00 pm

MONDAY, NOV 9, 1998

Continental Breakfast: 8:00 am – 8:30 am

Session 1A: 8:30 am – 10:10 am

Chair: Mihir Bellare

- 8:30 *A tight characterization of NP with 3 query PCPs* Venkatesan Guruswami, Daniel Lewin, Madhu Sudan, Luca Trevisan, MIT.
- 8:55 *Probabilistically Checkable Proofs with Low Amortized Query Complexity* Madhu Sudan, Luca Trevisan, MIT.
- 9:20 *Improved Decoding of Reed-Solomon and Algebraic-Geometric Codes* Venkatesan Guruswami, Madhu Sudan, MIT.

Session 1B: 8:30 am – 10:10 am

Chair: Jon Kleinberg

- 8:30 *The Access Network Design Problem* Matthew Andrews, Lisa Zhang, Bell Labs.
- 8:55 *Jitter Control in QoS networks* Yishay Mansour, Boaz Patt-Shamir, Tel Aviv Univ.
- 9:20 *Stability of Adversarial Queues via Fluid Models* David Gamarnik, IBM TJ Watson.
- 9:45 *Delayed Information and Action in On-line Algorithms* Susanne Albers, Max-Planck-Institut für Informatik; Moses Charikar, Stanford Univ.; Michael Mitzenmacher, Compaq Systems Research Institute.

Break: 10:10 – 10:40

Session 2A: 10:40 am – 11:55 am

Chair: Miklós Ajtai

- 10:40 *The Complexity of the Approximation of the Bandwidth Problem* Walter Unger, RWTH Aachen.
- 11:05 *The Shortest Vector in a Lattice is Hard to Approximate to within Some Constant* Daniele Micciancio, MIT.
- 11:30 *Approximating CVP to Within Almost-Polynomial Factors is NP-hard* Irit Dinur, Guy Kindler, Shmuel Safra, Tel Aviv Univ.

Session 2B: 10:40 am – 12:20 pm

Chair: Christos Papadimitriou

- 10:40 *Satisfiability of Word Equations with Constants is in Exponential Space* Claudio Gutiérrez, Wesleyan.

11:05 *Decidability of bisimulation equivalence for equational graphs of finite out-degree* Gérard Sénizergues, Univ. de Bordeaux.

11:30 *A Primitive Recursive Algorithm for the General Petri Net Reachability Problem* Zakaria Bouziane, INRIA.

11:55 *Algorithms to Tile the Infinite Grid with Finite Clusters* Mario Szegedy, AT&T Labs.

Lunch break: 12:20 pm – 1:50 pm

Session 3A: 1:50 pm – 3:30 pm

Chair: Frances Yao

- 1:50 *On Approximate Nearest Neighbors in Non-Euclidean Spaces* Piotr Indyk, Stanford Univ.
- 2:15 *Pattern Matching for Spatial Point Sets* David Cardoze, Leonard Schulman, Georgia Tech.
- 2:40 *Faster algorithms for string matching problems: matching the convolution bound* Piotr Indyk, Stanford Univ.
- 3:05 *Overcoming the memory bottleneck in suffix tree construction* Martin Farach, Bell Labs and Rutgers Univ.; Paolo Ferragina, Max-Planck-Institut für Informatik; S. Muthukrishnan, Bell Labs.

Session 3B: 1:50 pm – 3:30 pm

Chair: Dan Spielman

- 1:50 *Bivariate Polynomial Multiplication* Markus Bläser, Univ. of Bonn
- 2:15 *A superfast state-space algorithm for tangential Nevanlinna-Pick interpolation problem* Vadim Olshesky, Georgia State Univ.; Victor Pan, Lehman College, CUNY.
- 2:40 *Unsatisfiable systems of equations, over a finite field* Alan R. Woods, Univ. of Western Australia.
- 3:05 *Multiplicative Complexity of Taylor Shifts and a New Twist of the Substitution Method* Arnold Schönhage, Univ. of Bonn.

Break: 3:30 pm – 4:00 pm

Session 4A: 4:00 pm – 5:40 pm

Chair: David Williamson

- 4:00 *Local Search in Smooth Convex Sets* Ravi Kannan, Yale Univ.; Andreas Nolte, University of Köln.
- 4:25 *A TDI System and Its Application to Approximation Algorithms* Mao-cheng Cai, Academia Sinica; Xiaotie Deng, City University of Hong Kong; Wenan Zang, The University of Hong Kong.

4:50 *Geometric separator theorems and applications* Warren D. Smith, *NEC*; Nick Wormald, *Univ. of Melbourne*.

5:15 *Approximation of Radii and Norm-Maxima: No Need to Randomize* Andreas Brieden, Peter Gritzman, *Technische Universität München*; Ravi Kannan, *Yale Univ.*; Victor Klee, *Univ. of Washington, Seattle*; László Lovász, *Yale Univ.*; Miklós Simonovits, *Mathematical Institute of the Hungarian Academy of Sciences*.

Session 4B: 4:00 pm – 5:40 pm

Chair: Allan Borodin

4:00 *Time-Space Tradeoffs for Branching Programs* Paul Beame, *Univ. of Washington, Seattle*; Michael Saks, *Rutgers Univ.*; Jayram S. Thathachar, *Univ. of Washington, Seattle*.

4:25 *Optimal Time-Space Trade-offs for Sorting* Jakob Pagter, Theis Rauhe, *BRICS, Univ. of Aarhus*.

4:50 *Exponential Complexity Lower Bounds for Depth 3 Arithmetic Circuits in Algebras of Functions Over Finite Fields* Dima Grigoriev, *Penn State Univ.*; Alexander Razborov, *Steklov Mathematical Institute*.

5:15 *Lower Bounds for (MOD p - MOD m) Circuits* Vince Grolmusz, *Eötvös Univ.*; Gábor Tardos, *Mathematical Institute of the Hungarian Academy of Sciences*.

Business Meeting: 9 pm – 11 pm

TUESDAY, NOV 10, 1998

Continental Breakfast: 8:00 am – 8:30 am

Session 5A: 8:30 am – 10:10 am

Chair: Jon Kleinberg

8:30 *On the Single-Source Unsplittable Flow Problem* Yefim Dinitz, *Technion*; Naveen Garg, *Indian Institute of Technology, New Delhi*; Michel Goemans, *CORE, Univ. of Louvain*.

8:55 *Faster and Simpler Algorithms for Multicommodity Flow and other Fractional Packing Problems* Naveen Garg, *Indian Institute of Technology, New Delhi*; Jochen Koenemann, *Universität des Saarlandes*.

9:20 *All Pairs Shortest Paths in weighted directed graphs – exact and almost exact algorithms* Uri Zwick, *Tel Aviv Univ.*

9:45 *A divide-and-conquer algorithm for min-cost perfect matching in the plane* Kasturi R. Varadara-
jan, *Duke Univ.*

Session 5B: 8:30 am – 10:10 am

Chair: Edith Cohen

8:30 *1-way quantum finite automata: strengths, weaknesses and generalizations* Andris Ambainis, *U.C. Berkeley*; Rūsiņš Freivalds, *Univ. of Latvia*.

8:55 *The Quantum Communication Complexity of Sampling* Andris Ambainis, *U.C. Berkeley*; Leonard Schulman, *Georgia Tech*; Amnon Ta-Shma, Umesh Vazirani, *U.C. Berkeley*; Avi Wigderson, *Hebrew Univ.*

9:20 *Quantum Lower Bounds by Polynomials* Robert Beals, *Univ. of Arizona*; Harry Buhrman, *CWI, Amsterdam*; Richard Cleve, *Univ. of Calgary*; Michele Mosca, *CWI, Amsterdam*; Ronald de Wolf, *CWI and Univ. of Amsterdam*.

9:45 *Quantum Oracle Interrogation: Getting all information for almost half the price* Wim van Dam, *Univ. of Oxford and CWI, Amsterdam*.

Break: 10:10 – 10:40

Session 6A: 10:40 am – 12:20 pm

Chair: David Williamson

10:40 *Fast Monte-Carlo Algorithms for finding low-rank approximations* Alan Frieze, *CMU*; Ravi Kannan, *Yale Univ.*; Santosh Vempala, *MIT*.

11:05 *Approximating a Finite Metric by a Small Number of Tree Metrics* Moses Charikar, Chandra Chekuri, Ashish Goel, Sudipto Guha, Serge Plotkin, *Stanford Univ.*

11:30 *Random Projection: a new approach to VLSI layout* Santosh Vempala, *MIT*.

11:55 *Map graphs in polynomial time* Mikkel Thorup, *Univ. of Copenhagen*.

Session 6B: 10:40 am – 12:20 pm

Chair: Sally Goldman

10:40 *On learning monotone Boolean functions* Avrim Blum, Carl Burch, John Langford, *CMU*.

11:05 *Orchestrating Quartets: Approximation and Data Correction* Tao Jiang, *McMaster Univ.*; Paul Kearney, Ming Li, *Univ. of Waterloo*.

11:30 *Testing Monotonicity* Oded Goldreich, *Weizmann Institute of Science*; Shafi Goldwasser, Eric Lehman, Dana Ron, *MIT*.

11:55 *Evolutionary Trees can be Learned in Polynomial Time in the Two-State General Markov Model* Mary Cryan, Leslie Ann Goldberg, Paul W. Goldberg, *Univ. of Warwick*.

Lunch break: 12:20 pm – 1:50 pm

Session 7A: 1:50 pm – 3:30 pm

Chair: Joseph Naor

- 1:50** *A Factor 2 Approximation Algorithm for the Generalized Steiner Network Problem* Kamal Jain, *Georgia Tech*.
- 2:15** *The Finite Capacity Dial-A-Ride Problem* Moses Charikar, *Stanford Univ.*; Balaji Raghavachari, *Univ. of Texas at Dallas*.
- 2:40** *A Randomized Approximation Scheme for Euclidean MAX-CUT* W. Fernandez de la Vega, Claire Kenyon, *Univ. of Paris Sud*.
- 3:05** *Semidefinite Relaxations for Parallel Machine Scheduling* Martin Skutella, *Technische Universität Berlin*.

Session 7B: 1:50 pm – 3:30 pm

Chair: Mihir Bellare

- 1:50** *Zero Knowledge on the Internet* Joe Kilian, *NEC*; Erez Petrank, *IBM Haifa*; Charlie Rackoff, *Univ. of Toronto*.
- 2:15** *Oblivious Transfer with a Memory-Bounded Receiver* Christian Cachin, *MIT*; Claude Crépeau, *McGill Univ.*; Julien Marcil, *Université de Montréal*.
- 2:40** *Quantum Cryptography with Imperfect Apparatus* Dominic Mayers, Andrew Yao, *Princeton Univ.*
- 3:05** *The Security of Individual RSA Bits* Johan Håstad, Mats Näslund, *Royal Institute of Technology, Stockholm*.

Break: 3:30 pm – 4:00 pm

Session 8A: 4:00 pm – 5:15 pm

Chair: David Karger

- 4:00** *Protocols for Asymmetric Communication Channels* Micah Adler, *Univ. of Toronto*; Bruce Maggs, *CMU*.
- 4:25** *Marked Ancestor Problems* Stephen Alstrup, *Univ. of Copenhagen*; Thore Husfeldt, *BRICS, Univ. of Aarhus*; Theis Rauhe, *Lund Univ.*

4:50 *Towards an Optimal Bit-Reversal Permutation Program* Larry Carter, Kang Su Gatlin, *U.C. San Diego*.

Session 8B: 4:00 pm – 5:15 pm

Chair: Joseph Naor

- 4:00** *The Minimum Equivalent DNF Problem and Shortest Implicants* Christopher Umans, *U.C. Berkeley*.
- 4:25** *Concurrent Reachability Games* Luca de Alfaro, Thomas A. Henzinger, Orna Kupferman, *U.C. Berkeley*.
- 4:50** *Perfect Information Leader Election in $\log^* n + O(1)$ Rounds* Alexander Russell, David Zuckerman, *Univ. of Texas at Austin*.

WEDNESDAY, NOV 11, 1998

Continental Breakfast: 8:00 am – 8:30 am

Session 9A: 8:30 am – 10:10 am

Chair: Emo Welzl

- 8:30** *Random Sampling, Halfspace Range Reporting, and Construction of $(\leq k)$ -Levels in Three Dimensions* Timothy M. Chan, *Univ. of Miami*.
- 8:55** *Parametric and Kinetic Minimum Spanning Trees* Pankaj K. Agarwal, *Duke Univ.*; David Eppstein, *U.C. Irvine*; Leonidas J. Guibas, *Stanford Univ.*; Monika R. Henzinger, *Compaq Systems Research Center*.
- 9:20** *On the Combinatorial and Topological Complexity of a Single Cell* Saugata Basu, *IBM TJ Watson*.
- 9:55** *Which crossing number is it, anyway?* János Pach, *New York Univ. and Hungarian Academy of Sciences* Géza Tóth, *DIMACS and Hungarian Academy of Sciences*.

Session 9B: 8:30 am – 10:10 am

Chair: Toni Pitassi

- 8:30** *An Improved Exponential-time Algorithm for k -SAT* Ramamohan Paturi, *U.C. San Diego*; Pavel Pudlák, *Mathematical Institute ČSAV, Czech Republic*; Michael Saks, *Rutgers Univ.*; Francis Zane, *U.C. San Diego*.
- 8:55** *Exponential Separations between Restricted Resolution and Cutting Planes Proof Systems* Maria Luisa Bonet, Juan Luis Esteban, Nicola Galesi, *Universitat Politècnica de Catalunya*; Jan Johannsen, *U.C. San Diego*.

- 9:20** *Tseitin's Tautologies and Lower Bounds for Nullstellensatz Proofs* Dima Grigoriev, *Penn State Univ.*
- 9:55** *Which Problems have Strongly Exponential Complexity?* Russell Impagliazzo, Ramamohan Paturi, Francis Zane, *U.C. San Diego.*

Break: 10:10 – 10:40

Session 10A: 10:40 am – 12:20 pm

Chair: Edith Cohen

- 10:40** *Recommendation systems: a probabilistic analysis* S. Ravi Kumar, Prabhakar Raghavan, Sridhar Rajagopalan, Andrew Tomkins, *IBM Almaden.*
- 11:05** *Heuristics for finding large independent sets, with applications to coloring semi-random graphs* Uri Feige, *Weizmann Institute of Science*; Joe Kilian, *NEC.*
- 11:30** *Improved bounds and algorithms for hypergraph two-coloring* Jaikumar Radhakrishnan, *Tata Institute of Fundamental Research, India*; Aravind Srinivasan, *National University of Singapore.*
- 11:55** *Local Divergence of Markov Chains and the Analysis of Iterative Load Balancing Schemes* Yuval Rabani, *Technion*; Alistair Sinclair, *U.C. Berkeley*; Rolf Wanka, *Paderbon Univ.*

Session 10B: 10:40 am – 12:20 pm

Chair: Miklós Ajtai

- 10:40** *The Complexity of Acyclic Conjunctive Queries* G. Gottlob, N. Leone, F. Scarcello, *Technische Universität Wien.*
- 11:05** *A characterization of NC by tree recurrence* Daniel Leivant, *Indiana Univ., Bloomington.*
- 11:30** *A Linguistic Characterization of Bounded Oracle Computation and Probabilistic Polynomial Time* John Mitchell, Mark Mitchell, *Stanford Univ.*; Andre Scedrov, *Univ. of Pennsylvania.*
- 11:55** *Randomness vs. Time: De-randomization under a uniform assumption* Russell Impagliazzo, *U.C. San Diego*; Avi Wigderson, *Hebrew Univ.*

Program Ends: 12:20 pm

General Information

See the web site <http://theory.stanford.edu/~focs98/>

Location: All conference events will take place at the Hyatt Rickey's, Palo Alto, California. Palo Alto is located about 30 miles southeast of San Francisco, and 20

miles northwest of San Jose. Both cities have major airports – pick whichever has more convenient connections, although San Jose is generally more convenient after arrival. Stanford University and downtown Palo Alto are about four miles away from the hotel. If you don't plan to travel outside Palo Alto, there is little need for a rental car.

Registration: The registration desk will be open from 8 am - 8 pm on Sunday, and during the day Monday and Tuesday. Additional copies of the proceedings will be sold during the conference at the registration desk.

Accommodations: A block of rooms has been reserved at the Hyatt Rickey's at favorable rates; please make the reservation as early as possible to ensure getting a room. The hotel provides free parking, local shuttle service, a fitness center, an outdoor pool, a putting green, etc. The hotel has a restaurant and sports bar on-site. Call them at (650)-493-8000. if you have any special needs.

Transportation: Please see the conference web page for the phone numbers of various shuttle services available. You should have no trouble finding a shuttle without reservations if you arrive during normal hours.

The easiest directions to the hotel are as follows: take the 101 freeway to the San Antonio Road exit (South). Follow San Antonio to El Camino Real. Turn right on El Camino. Proceed approximately 1/2 mile. The hotel is on the right hand side, before the third stop light.

Climate: The weather in Palo Alto at the beginning of November is usually very pleasant. Daily highs are around 70 degrees, night lows are around 45. Bring both a jacket and a swimming suit - the hotel has a pool. The likelihood of rain is under 10%, but bring an umbrella just in case. (San Francisco is somewhat colder and *feels* much colder. If you go to the City, take a windbreaker along, no matter how warm in Palo Alto.)

Things To Do: Palo Alto is a university and high tech town. There are many interesting bookstores, cafes, restaurants, and shops, all a short ride from the hotel. Go to a cafe, order a double low-fat decaff latte, and check the free Palo Alto Weekly for current events. Some nearby places to visit: Stanford University (daily tours), the SLAC Linear Accelerator, US Geological Survey, etc. Farther away, you can take the train to San Francisco (about 1 hour away), or, if you have a car, visit the Monterey Peninsula, Carmel, etc. Palo Alto is a great city for biking. You might try to explore the area by bike – there are bike lanes all over the town and some challenging terrain nearby.

Conference Events: A reception will be held at the Holiday Inn from 6PM until 8PM on Sunday, November 8 after the tutorials. Drinks and hors d'oeuvres will be served. There will be a business meeting on Monday, November 9; refreshments will be served. Lunches will be served in the conference hotel Sunday through Tuesday.

Local Arrangements Chair: Michael Mitzenmacher, Compaq Systems Research Center, 130 Lytton Avenue, Palo Alto, CA 94301. Phone: 650-853-2150. Fax: 650-853-2104. E-mail: michaelm@pa.dec.com

Program Committee Chair: Rajeev Motwani, Computer Science Department, Stanford University, Stanford, CA 94305.

Program Committee: Miklos Ajtai, Mihir Bellare, Allan Borodin, Edith Cohen, Sally Goldman, David Karger, Jon Kleinberg, Rajeev Motwani, Seffi Naor, Christos Papadimitriou, Toni Pitassi, Dan Spielman, Eli Upfal, Emo Welzl, David Williamson, and Frances Yao.