

# Eli Upfal

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## Education:

### July, 1983

Ph.D. in Computer Science. The Hebrew University, Jerusalem, Israel. Dissertation Topic - "Distributed Probabilistic Algorithms for Problems in Graph Theory, Communication, Synchronization, and Scheduling".

### September, 1980

M.Sc. in Computer Science. The Feinberg Graduate School of the Weizmann Institute of Science, Rehovot, Israel.

### June, 1978

B.Sc. Cum Laude, in Mathematics and Statistics. The Hebrew University, Jerusalem, Israel.

## Professional appointments:

### 2007 - 2008

Sabbatical at Dipartimento di Ingegneria dell'Informazione, Universita degli Studi di Padova.

### 2002 - 2007

Chair of Computer Science Department, Brown University.

### 1998 - present

Professor of Computer Science, Brown University.

### 1996 - 1997

Manager, Foundations of Computer Science Group, IBM Research Division, Almaden Center.

### 1995 - 1997

Professor, The Weizmann Institute of Science.

**1989 - 1995**

Associate Professor, The Weizmann Institute of Science.

**1988 - 1989**

Senior Researcher, The Weizmann Institute of Science.

**1985 - 1996**

Research Staff Member, IBM Research Division, Almaden Center.

**1984 - 1985**

Post-Doctoral Research Fellow, Stanford University.

**1983 - 1984**

Research Fellow, University of California, Berkeley.

**Editorial board:**

- Journal of Discrete Algorithms (Editor in Chief).
- Journal of the ACM.
- SIAM J. on Computing (2001-2004).
- SIAM J. on Discrete Algorithms (1999-2003).
- Web Intelligence and Agent Systems (2002-2004).
- Journal on Interconnection Networks.
- Computational Complexity (1990-2004).
- Random Structures & Algorithms.
- IEEE Transactions on Parallel and Distributed Computing (1998-2000).

**Honors:**

- ACM Fellow, 2005.
- IBM Faculty Award 2003, 2005.
- IEEE Fellow, 2002.
- IBM Research Division Award, 1997.
- The Levinson Prize in Mathematical Sciences, 1994.

- IBM Outstanding Innovation Award, 1993
- The Norman D. Cohen Professorial Chair of Computer Science at the Weizmann Institute, 1992 – 1997.
- Revson Career Development Award, 1988-1990.
- Bat-Sheva Fellow - Bat-Sheva de Rothschild Award for Young Outstanding Researchers, 1988.
- The Swig-Weiler Career Development Chair, 1987.
- IBM Outstanding Innovation Award, 1986.
- Weizmann Post-Doctoral Fellowship, 1983 – 1985.
- G. Y. Yashinsky memorial fund award for an outstanding Ph.D. thesis, 1982.

### **Funding at the Weizmann Institute (1987–1996):**

- European Union EC-Esprit Project, RAND II.
- Ministry of Science, Israel.
- Israeli Academy of Science.
- The French-Israeli Binational Fellowship.
- The MINERVA Foundation.

### **Funding at Brown University (1998 – present):**

- NSF-CCR-9731477: Design and Analysis of Dynamic Processes: A Stochastic Approach, 7/98-6/02.
- Goldman, Sachs & Co.: Computation Problems in Valuation and Management of Inventory, 9/98-9/00.
- NSF-DBI-9983081: Applying Universal Bases to Achieving the Full Potential of SBH, 7/99-6/02.
- DARPA/Air Force F30602-00-2-0599: Stochastic Models for Web Agents and the Web Environment, 7/00 - 9/02.
- NSF-CCR-0121154: ITR/SY Algorithmic Issues in Large Scale Dynamic Networks, 9/01-9/06.

- NSF-DMI-0121495: ITR/SY Stochastic Combinatorial Optimization, 9/01-8/05.
- NSF-IIS 0325838: ITR Collaborative Proposal: Aurora - Enabling Stream-Based Monitoring Applications, 10/03-10/07.
- NSF DMI-0600384: “*Online Stochastic Combinatorial Optimization*”, 7/06-7/09.
- ONR DEPSCOR Award N000140610607, “*Adaptive and Robust Resource Allocation and Scheduling*”, 7/06-7/09.
- Yahoo! Research Alliance Gift - 2006, 2008.

# List of Publications

## 1 Book:

- A1. M. Mitzenmacher and E. Upfal. *Probability and Computing: Randomized Algorithms and Probabilistic Analysis*. Cambridge University Press, 2005. Translations: Chinese - 2007, Japanese - 2009.

## 2 Papers in Journals

- B1. I. Katriel, C. Kenyon-Mathieu and E. Upfal. "Commitment under uncertainty: Two-stage stochastic matching problems". *Theor. Comput. Sci.* 408(2-3): 213-223, 2008.
- B2. G. Pandurangan and E. Upfal. "Entropy-Based Bounds for Online Algorithms" *ACM Transactions on Algorithms*, Vol. 3:1, 2007.
- B3. G. Pandurangan, P. Raghavan, and E. Upfal. "Using PageRank to Characterize Web Structure", *Internet Mathematics*, Vol. 3:1 2006, pp. 120.
- B4. A. Anagnostopoulos, I. Kontoyiannis and E. Upfal. Steady state analysis of balanced-allocation routing. *Random Structures & Algorithms*, Volume 26, 2005, pp. 446-467.
- B5. A. Anagnostopoulos, A. Kirsch and E. Upfal. Stability and Efficiency of a Random Local Load Balancing Protocol. *SIAM Journal on Computing*, Vol. 34, 2005, pp. 616-639.
- B6. A. Anagnostopoulos, R. Bent, E. Upfal and P. van Hentenryck. A simple and deterministic competitive algorithm for online facility locations. *Information and Computation*, Vol. 194, 2004, pp. 175-202.
- B7. A. Flaxman, Alan Frieze and E. Upfal "Efficient Communication in an Ad-hoc Network". *Journal of Algorithms*, Vol. 52, pp. 1-7, 2004.
- B8. F. Preparata, S.A. Heath and E. Upfal. "Sequence Construction from nucleic-acid micro-array data". in *Analytical Techniques in DNA Sequencing*, eds. B. Nunnally. Marcel Dekker Inc, 2004.
- B9. C. McDiarmid, M. Luzak and E. Upfal. "On-line routing of random calls". *Probability Theory and Related Fields*, Vol. 125, 2003, pp. 457-482.
- B10. G. Pandurangan, P. Raghavan and E. Upfal. "Building Low-Diameter Peer-to-Peer Networks". *IEEE Journal on Selected Areas in Communication*, Vol. 21, 995-1002, 2003.
- B11. N. Shavit, E. Upfal and A. Zemach. A Wait-Free Sorting Algorithm. *Theory of Computer Systems*, Vol. 34, 2001, pp. 519-544.

- B12. A.Z. Broder, A.M. Frieze, and E. Upfal. “A general approach to dynamic packet routing with bounded buffers.” *J. of the ACM*, Vol. 48, 2001, pp. 324–349.
- B13. M. Hauskrecht, L. Ortiz, I. Tsochantaridis, and E. Upfal. “Efficient Methods for Computing Investment Strategies for Multi-Market Commodity Trading.” *Applied Artificial Intelligence*, Vol. 15, 2001, pp. 429–452.
- B14. Y. Azar, A. Broder, A. Karlin, and E. Upfal. “Balanced allocations”. *SIAM J. on Computing*, Vol. 29, 2000, pp. 180–200.
- B15. F. P. Preparata and E. Upfal. “Sequencing-by-hybridization at the information-theory bound: an optimal algorithm”. *Journal of Computational Biology*, Vol. 7, 2000, pp. 621–630.
- B16. G. Pandurangan and E. Upfal. Static and Dynamic Evaluation of QoS Properties. *Journal of Interconnection Networks*, Vol. 1, 2000, pp. 135–150.
- B17. A.Z. Broder, A.M. Frieze, and E. Upfal. “Static and dynamic path selection on expander graphs: a random walk approach”. *Random Structure & Algorithms*, Vol. 14, 1999, pp. 87–109.
- B18. A.M. Frieze, F.P. Preparata, E. Upfal. “Optimal reconstruction of a sequence from its probes”. *Journal of Computational Biology*, Vol. 6, 1999, pp. 361–368.
- B19. A.L. N. Reddy and E. Upfal. “Real-Time Communication Scheduling in a Multicomputer Video Server”. *Journal of Parallel and Distributed Computing*, Vol. 58, 1999, pp. 425–445.
- B20. P. Raghavan and E. Upfal. “Stochastic contention resolution with short delays”. *SIAM J. on Computing*, Vol. 28, 1998, pp. 709–719.
- B21. A.Z. Broder, A.M. Frieze, S. Suen, and E. Upfal. “Optimal construction of edge-disjoint paths in random graphs.” *SIAM J. on Computing*, Vol. 28, 1998, pp. 541–573.
- B22. N. Shavit, E. Upfal, and A. Zernich. “A steady state analysis of diffracting trees”. Special issue of *Theory of Computing Systems*, Vol 31, 1998, pp. 403–423.
- B23. A. Pelc and E. Upfal. “Reliable fault diagnosis with few tests”. *Combinatorics, Probability and Computing*, Vol. 7, 1998, pp. 323–333.
- B24. A. Borodin, P. Raghavan, B. Schieber, and E. Upfal. “How much can hardware help routing?” *J. of the ACM*, Vol. 44, 1997, pp. 726–741.
- B25. J. Bruck, C.–T. Ho, S. Kipnis, E. Upfal, and D. Weathersby. “Efficient algorithms for all-to-all communication in multiport message-passing systems”. *IEEE Trans. on Parallel and Distributed Computing*, Vol. 8, 1997, pp 1143–1156.
- B26. E. Upfal, S. Felperin, and M. Snir. “Randomized routing with shorter paths”. *IEEE Transactions on Parallel and Distributed Computing*, Vol. 7, 1996, pp. 356–362.

- B27. S. Felperin, P. Raghavan, and E. Upfal, “A theory of wormhole routing in parallel computers”. *IEEE Transactions on Computing*, Vol. 45, 1996, pp. 704–713.
- B28. Andrei Z. Broder, Martin E. Dyer, Alan M. Frieze, Prabhakar Raghavan, and Eli Upfal. “The worst-case running time of the random simplex algorithm is exponential in the height”. *Information Processing Letters*, Vol. 56, 1995, pp. 79–81.
- B29. A. Broder, A. Karlin, P. Raghavan and E. Upfal, “Trading space for time in undirected  $s - t$  connectivity”. *SIAM J. on Computing*, Vol. 23, 1994, pp. 324–334.
- B30. A. Broder, A. Frieze, E. Shamir, and E. Upfal, “Near-perfect token distribution”. *Random Structure & Algorithms*, Vol. 5, 1994, pp. 559–572.
- B31. U. Feige, D. Peleg, P. Raghavan and E. Upfal, “Computing with noisy information”. *SIAM J. on Computing*, Vol. 23, 1994, pp. 1001–1018.
- B32. A. Broder, A. Frieze, and E. Upfal, “The existence and construction of edge disjoint paths on expander graphs”. *SIAM J. on Computing*, Vol. 23, 1994, pp. 976–989.
- B33. E. Upfal, “Tolerating linear number of faults in networks of bounded degree”. *Journal of Information and Computation*, Vol. 114, 1994, pp. 312–320.
- B34. E. Upfal, “An  $O(\log N)$  deterministic packet routing algorithm”. *J. of the ACM*, Vol. 39, 1992, pp. 55–70.
- B35. S. Assaf and E. Upfal, “Fault tolerant sorting network”. *SIAM J. on Discrete Mathematics*, Vol. 4, 1991, pp. 472–480.
- B36. P. Peleg and E. Upfal, “A time-randomness tradeoff for oblivious routing”. *SIAM J. on Computing*, Vol. 19, 1990, pp. 256–266.
- B37. U. Feige, D. Peleg, P. Raghavan, and E. Upfal, “Randomized broadcast in networks”. *Random Structures & Algorithms*, Vol. 1, 1990, pp. 447–460.
- B38. D. Peleg and E. Upfal, “Constructing disjoint paths on expander graphs”. *Combinatorica*, Vol. 9, 1989, pp. 289–313.
- B39. D. Peleg and E. Upfal, “The token distribution problem”. *SIAM J. on Computing*, Vol. 18, 1989, pp. 229–243.
- B40. D. Peleg and E. Upfal, “A tradeoff between space and efficiency for routing tables”. *J. the of ACM*, Vol. 36, 1989, pp. 510–530.
- B41. R.M. Karp, E. Upfal and A. Wigderson, “The complexity of parallel search”. In Special Issue of *J. of Computer and System Sciences*, Vol. 36, 1988, pp. 225–253.
- B42. C. Dwork, D. Peleg, N. Pippenger and E. Upfal, “Fault tolerance in network of bounded degree”. *SIAM J. on Computing*, Vol. 17, 1988, pp. 975–988.

- B43. A. Borodin, F. Fich, F. Meyer auf der Heide, E. Upfal and A. Wigderson, "A tradeoff between search and update time for the implicit dictionary problem". *Theoretical Computer Science*, Vol. 58, 1988, pp. 57-68.
- B44. A. Karlin and E. Upfal, "Parallel Hashing - an efficient implementation of shared memory". *J. of the ACM*, Vol 35, 1988, pp. 876-892.
- B45. A. Borodin, F. Fich, F. Meyer auf der Heide, E. Upfal and A. Wigderson, "Time space tradeoff for element distinctness". *SIAM J. on Computing*, Vol. 16, 1987, pp. 97-99.
- B46. E. Upfal and A. Wigderson, "How to share memory in a distributed system". *J. of the ACM*, Vol. 34, 1987, pp. 116-127.
- B47. E. Shamir and E. Upfal, "A probabilistic approach to the load-sharing problem". *Journal of Parallel and Distributed Computing*, Vol. 4, 1987, pp. 521-530.
- B48. D. Peleg and E. Upfal, "The generalized packet routing problem". *Theoretical Computer Science*, Vol. 53, 1987, pp. 281-293.
- B49. D. Dolev, E. Upfal and M. Warmuth, "The parallel complexity of scheduling with precedence constrains". *Journal of Parallel and Distributed Computing*, Vol. 3, 1986, pp. 553-576.
- B50. R.M. Karp, E. Upfal and A. Wigderson, "Constructing a perfect matching is in Random NC". *Combinatorica*, Vol. 6, 1986, pp. 35-48.
- B51. J. Schmidt-Przuan, E. Shamir and E. Upfal, "Random hypergraph coloring algorithms and the weak chromatic number". *Journal of Graph Theory*, Vol. 8, 1985, pp. 347-362.
- B52. E. Shamir and E. Upfal, "A fast parallel construction of disjoint paths in networks". In *Topics in the Theory of Computing*, M. Karpinski and J. van Leeuwen ed. *Annals of Discrete Mathematics*, Vol 24, 1985, pp. 141-154.
- B53. E. Upfal, "Efficient schemes for parallel communication". *J. of the ACM*, Vol. 31, 1984, pp. 507-517.
- B54. E. Shamir and E. Upfal, "Large regular factors in random graphs". *Annals of Discrete Math*, Vol. 20, 1984, pp. 271-282.
- B55. E. Shamir and E. Upfal, "Sequential and distributed graph coloring algorithms with performance analyses in random graphs spaces". *Journal of Algorithms*, Vol. 5, 1982, pp. 488-501.
- B56. E. Upfal, "Formal correctness proofs of a nondeterministic program". *Information Processing Letters*, Vol. 14, 1982, pp. 86-92.
- B57. E. Shamir and E. Upfal, "One-factor in random graphs based on vertex choice". *Discrete Math*. Vol. 41, 1982, pp. 281-286.
- B58. E. Shamir and E. Upfal, "One factor in random graphs". *Israel Journal of Math*. Vol. 39, 1981, pp. 296-302.

### 3 Papers in Refereed Conferences:

- C1. A. Slivkins and Eli Upfal. "Adapting to a Changing Environment: the Brownian Restless Bandits" *Proceedings of the 21st Annual Conference on Learning Theory (COLT)*, 2008, 343-354.
- C2. F. Radlinski, D. Chakrabarti, R. Kumar, E. Upfal. "Mortal Multi-Armed Bandits". *Proceedings of the 22nd Annual Conference on Neural Information Processing Systems (NIPS 2008)*.
- C3. R. Kleinberg, A. Slivkins and Eli Upfal. "Multi-armed bandits in metric spaces." *Proceedings of the 40th ACM Symposium on Theory of Computing (STOC 2008)*, pp. 681-690.
- C4. A. Z. Broder, A. Kirsch, R. Kumar, M. Mitzenmacher, E. Upfal and S. Vassilvitskii. "The hiring problem and Lake Wobegon strategies". *SODA '08: Proceedings of the nineteenth annual ACM-SIAM symposium on Discrete algorithms*, 2008, pp. 1184–1193.
- C5. I. Katriel, M. Sellmann, E. Upfal, and P. Van Hentenryck. "Propagating Knapsack Constraints in Sublinear Time. *Proceedings of the Twenty-Second Conference on Artificial Intelligence, (AAAI07)*, Vancouver, Canada.
- C6. I. Katriel, C. Kenyon and E. Upfal. "Commitment Under Uncertainty: Two-Stage Stochastic Matching Problems". *Proceedings of the 34th International Colloquium on Automata, Languages and Programming (ICALP)*, Wroclaw, Poland. July, 2007.
- C7. F. Chierichetti, A. Panconesi, P. Raghavan, M. Sozio, A. Tiberi and E. Upfal. "Finding Near Neighbors Through Cluster Pruning". *Proceedings of the 26th ACM SIGMOD-SIGACT-SIGART Symposium on Principles of Database Systems (PODS)*, Beijing, China. June 10-15, 2007.
- C8. Will Sheffler, Eli Upfal, John Sedivy and William Stafford Noble. "A learned comparative expression measure for Affymetrix GeneChip DNA microarrays." *Proceedings of the Computational Systems Bioinformatics Conference*, August 8-11, 2005, Stanford, CA. pp. 144-154.
- C9. A. Anagnostopoulos, A. Kirsch and Eli Upfal. "Stability and Efficiency of a Random Local Load Balancing Protocol." *28th Annual Symposium on Foundations of Computer Science (FOCS)*, Boston, MA, November 2003.
- C10. A. Anagnostopoulos, I. Kontoyiannis and E. Upfal. "The Advantage of Balanced-Allocation Routing for ATM Networks". *2003 IEEE International Symposium on Information Theory (ISIT-2003)*, Yokohama, Japan, June 2003.
- C11. G. Pandurangan, P. Raghavan, and E. Upfal. "Using PageRank to Characterize Web Structure", *Proceedings of the 8th Annual International Conference on Combinatorics and Computing (COCOON)*, Singapore, 2002, LNCS 2387, Springer-Verlag, pages 330-339.

- C12. Gopal Pandurangan, Prabhakar Raghavan and Eli Upfal. “Building Low-diameter P2P Networks”. *42nd Annual Symposium on Foundations of Computer Science*, Las Vegas, Nevada, 2001, pp. 492–499.
- C13. M. Hauskrecht and E. Upfal. “A Clustering Approach to Solving Large Stochastic Planning Problems”. *17th Conference on Uncertainty in Artificial Intelligence (UAI-2001)*, August 2001.
- C14. G. Pandurangan and E. Upfal. “Can Entropy Characterize Performance of Online Algorithms?” *12th ACM-SIAM Symposium on Discrete Algorithms*, January 2001.
- C15. R. Kumar, P. Raghavan, S. Rajagopalan, D. Sivakumar, A. Tomkins, and Eli Upfal. “Stochastic models for the Web graph.” *Proceedings of the 41st IEEE Symp. on Foundations of Computer Science*. November 2000, pp. 57–65.
- C16. F.P. Preparata and E.Upfal. “Sequencing-by-hybridization at the information-theory bound: an optimal algorithm.” *Fourth Annual International Conference on Computational Molecular Biology*. April 2000.
- C17. M. Hauskrecht, L. Ortiz, I. Tsochantaridis, and E. Upfal. “Computing Global Strategies for Multi-Market Commodity Trading.” *The Fifth International Conference on Artificial Intelligence Planning & Scheduling (AIPS2000)*, April 2000, pp. 159–166.
- C18. G. Pandurangan and E. Upfal. Static and Dynamic Evaluation of QoS Properties. *Proceedings of the 31st ACM Symp. on Theory of Computing*. 1999, Atlanta, Georgia, pp. 566–573.
- C19. M. L. Luczak and E. Upfal. “Reducing Network Congestion and Blocking Probability Through Balanced Allocation”. *Proceedings of the 40th IEEE Symp. on Foundations of Computer Science*. 1999, New York, NY, pp. 587-595.
- C20. M. Hauskrecht, G. Pandurangan, and E. Upfal. Computing Near Optimal Strategies for Stochastic Investment Planning Problems. *Proceedings of the 16th International Joint Conference on Artificial Intelligence*, pp. 1310–1315, July 1999.
- C21. F.P. Preparata, A.M. Frieze, E. Upfal. On the Power of Universal Bases in Sequencing by Hybridization. *Third Annual International Conference on Computational Molecular Biology*. April 11 - 14, 1999, Lyon, France, pp. 295–301.
- C22. R. Cole, A. Frieze, B.M. Maggs, M. Mitzenmacher, A. W. Richa, R.K. Sitaraman, Eli Upfal. On Balls and Bins with Deletions. *Randomization and Approximation Techniques in Computer Science, 2nd Intl. Workshop, Random 98*, Barcelona, Spain, 1998. In LNCS 1518, pp. 145-158
- C23. A. Broder, A. Frieze, and E. Upfal. “Dynamic packet routing on arrays with bounded buffers”. *Third Latin American Symposium on Theoretical Informatics - LATIN '98* Campinas, Brazil. April 1998. In *Springer-Verlag Lecture Notes in Computer Science 1380*, pp 273–281, 1998.

- C24. A.Z. Broder, A.M. Frieze, and E. Upfal. “Static and dynamic path selection on expander graphs: a random walk approach”. *Proceedings of the 29th ACM Symp. on Theory of Computing*. El Paso, 1997, pp. 531–539.
- C25. N. Shavit, E. Upfal, and A. Zemach. “A Wait-Free Sorting Algorithm”. *SIGACT - SIGOPS Symp. on Principles of Distributed Computing*. Santa Barbara, 1997, pp. 121–128.
- C26. A.Z. Broder and E. Upfal. “Dynamic deflection routing on arrays.” *Proceedings of the 28th ACM Symp. on Theory of Computing*. Philadelphia, 1996, pp. 348–355.
- C27. A.Z. Broder, A.M. Frieze, S. Suen, and E. Upfal. “An Efficient Algorithm for the Vertex-Disjoint Paths Problem in Random Graphs.” *Proceedings of the 7th Annual ACM-SIAM Symposium on Discrete Algorithms*. Atlanta, 1996, pp. 261–268.
- C28. N. Shavit, E. Upfal, and A. Zemach. “A steady state analysis of diffraction trees” *Proceedings of the Eighth Annual ACM Symp. on Parallel Algorithms and Architectures*. Padua, 1996, pp. 33–41.
- C29. A.Z. Broder, A.M. Frieze, and E. Upfal. “A general approach to dynamic packet routing with bounded buffers.” *Proceedings of the 37th IEEE Symp. on Foundations of Computer Science*. Burlington, 1996, pp. 390–399.
- C30. S. Preminger and E. Upfal. “Safe and efficient traffic laws for mobile robots”. *Scandinavian Workshop on Algorithm Theory*, Reykjavik, July 1996. In *Springer-Verlag Lecture Notes in Computer Science 1097*, pp. 357–367, 1996.
- C31. P. Raghavan and E. Upfal. “Stochastic contention resolution with short delays”. *Proceedings of the 27th ACM Symp. on Theory of Computing*. Las-Vegas, 1995, pp. 229–237.
- C32. P. Raghavan and E. Upfal. “Efficient routing in all-optical networks”. *Proceedings of the 26th ACM Symp. on Theory of Computing*. Montreal, 1994, pp. 134–143.
- C33. Y. Azar, A. Broder, A. Karlin, and E. Upfal. “Balanced Allocations”. *Proceedings of the 26th ACM Symp. on Theory of Computing*. Montreal, 1994, pp. 593–602.
- C34. A.Z. Broder, A.M. Frieze, S. Suen, and E. Upfal. “Optimal Construction of Edge-Disjoint Paths in Random Graphs.” *Proceedings of the 5th Annual ACM-SIAM Symposium on Discrete Algorithms*. Arlington, 1994, pp. 603–612.
- C35. A. Borodin, P. Raghavan, B. Schieber, and E. Upfal. “How much can hardware help routing?” *Proceedings of the 25th ACM Symp. on Theory of Computing*. San Diego, 1993, pp. 573–582.
- C36. A.Z. Broder, A.M. Frieze, and E. Upfal. “On the satisfiability and maximum satisfiability of random 3-CNF Formulas.” *Proceedings of the Fourth Annual ACM-SIAM Symp. on Discrete Algorithms*. Austin, 1993, pp. 322–330.

- C37. E. Upfal, S. Felperin, and M. Snir. “Randomized routing with shorter paths”. *Proceedings of the Fifth Annual ACM Symp. on Parallel Algorithms and Architectures*. Velen, 1993, pp. 283–292.
- C38. A. Broder, A. Frieze, and E. Upfal, “The existence and construction of edge disjoint paths on expander graphs”. *Proceedings of the 24th ACM SIGACT Symp. on Theory of Computing*. Victoria, 1992, pp. 140–149.
- C39. A. Broder, A. Frieze, E. Shamir, and E. Upfal. “Near-perfect token distribution”. *International Colloquium on Automata, Languages and Programming. In Lecture Notes in Computer Science 623, Springer-Verlag*, 1992, pp. 308–317.
- C40. S. Felperin, P. Raghavan, and E. Upfal, “A theory of wormhole routing in parallel computers” *Proceedings of the 33rd IEEE Symp. on Foundations of Computer Science*. Pittsburgh, 1992, pp. 563–572.
- C41. E. Upfal, “Tolerating linear number of faults in networks of bounded degree”. *SIGACT - SIGOPS Symp. on Principles of Distributed Computing*. Vancouver, 1992, pp. 83–89.
- C42. A. Broder, A. Karlin, P. Raghavan, and E. Upfal, “On the parallel complexity of evaluating game-trees”. *Proceedings of the Second ACM-SIAM Symposium on Discrete Algorithms*. San Francisco, 1991, pp. 404-413.
- C43. L. Rudolph, M. Slivkin-Allalouf, and E. Upfal, ”A simple load balancing scheme for task allocation in parallel machines”. *Proceedings of the Third Annual ACM Symposium on Parallel Computing*. Hilton Head, South Carolina, 1991, pp. 237-245.
- C44. U. Feige, D. Peleg, P. Raghavan and E. Upfal, “Computing with noisy information”. *Proceedings of the ACM SIGACT Symp. on Theory of Computing*. Baltimore, 1990, pp. 128-137.
- C45. S. Assaf and E. Upfal, “Fault tolerant sorting network”. *Proceedings of the IEEE Symposium on Foundations of Computer Science*. St. Louis, 1990, pp. 275–284.
- C46. U. Feige, D. Peleg, P. Raghavan, and E. Upfal, “Randomized broadcast in networks”. *Proceedings of the First SIGAL International Symposium on Algorithms*, Tokyo, Aug 1990. In *Springer-Verlag Lecture Notes in Computer Science* vol. 450 (T. Asano, T. Ibaraki, H. Imai and T. Nishizeki, Editors), 1990, pp. 128-137.
- C47. E. Upfal, “An  $O(\log N)$  deterministic packet routing algorithm”. *Proceedings of the ACM SIGACT Symp. on Theory of Computing*. Seattle, 1989, pp. 241-250.
- C48. A. Broder, A. Karlin, P. Raghavan and E. Upfal, “Trading space for time in undirected  $s-t$  connectivity”. *Proceedings of the ACM SIGACT Symp. on Theory of Computing*. Seattle, 1989, pp. 543-549.

- C49. D. Krizanc, D. Peleg and E. Upfal, "A time-randomness tradeoff for oblivious routing." *Proceedings of the ACM SIGACT Symp. on Theory of Computing*. Chicago, 1988, pp. 93-102.
- C50. D. Peleg and E. Upfal, "A tradeoff between space and efficiency for routing tables". *Proceedings of the ACM SIGACT Symp. on Theory of Computing*. Chicago, 1988, pp. 43-52.
- C51. D. Peleg and e. Upfal, "Constructing disjoint paths on expander graphs." *Proceedings of the ACM SIGACT Symp. on Theory of Computing*. New York, 1987, pp. 264-273.
- C52. A. Karlin and E. Upfal, "Parallel Hashing - an efficient implementation of shared memory". *Proceedings of the ACM SIGACT Symp. on Theory of Computing*. Berkeley, 1986, pp. 160-168.
- C53. C. Dwork, D. Peleg, N. Pippenger and E. Upfal, "Fault tolerance in networks of bounded degree". *Proceedings of the ACM SIGACT Symp. on Theory of Computing*. Berkeley, 1986, pp. 370-379.
- C54. D. Peleg and E. Upfal, "The token distribution problem". *Proceedings of the IEEE Symposium on Foundations of Computer Science*. Toronto, 1986, pp. 418-427.
- C55. A. Borodin, F. Fich, F. Meyer auf der Heide, E. Upfal and A. Wigderson, "A tradeoff between search and update time for the implicit dictionary problem". *International Colloquium on Automata, Languages and Programming*. In *Lecture Notes in Computer Science 226*, Springer-Verlag, 1986, pp. 50-59.
- C56. A. Borodin, F. Fich, F. Meyer auf der Heide, E. Upfal and A. Wigderson, "Time space tradeoff for element distinctness". *3rd Annual Symposium on Theoretical Aspects of Computer Science*. France 1986. In *Lecture Notes in Computer Science 210*, Springer-Verlag, 1986, pp. 353-358.
- C57. R.M. Karp, E. Upfal and A. Wigderson, "Constructing a perfect matching is in Random-NC". *Proceedings of the ACM SIGACT Symp. on Theory of Computing*. Providence, 1985, pp. 22-32.
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- D1. E. Upfal. Tutorial: Performance Analysis of Dynamic Network Processes. *Proceedings of the 44th Annual Symp. on Foundations of Computer Science*, 2003.
- D2. S.R. Kumar, P. Raghavan, S. Rajagopalan, D. Sivakumar, A. Tomkins, E. Upfal. The Web as a graph. *Proceedings of the 19th ACM Symposium on Principles of Database Systems*, pp. 1-10, 2000.
- D3. E. Upfal. “Design and Analysis of Dynamic Processes: A Stochastic Approach. *Algorithm - 6th Annual European Symposium*, Venice, Italy, August 1998, pp. 26–34.
- D4. E. Upfal. “Stochastic Analysis of Dynamic Processes”. *11th International Symposium on Fundamentals of Computation Theory*, Krakow, Poland, September 1997, pp 85–92.
- D5. E. Upfal. “On the theory of interconnection networks for parallel computers”. *21st International Colloquium on Automata, Languages and Programming*. In *Lecture Notes in Computer Science*, Springer-Verlag, July 1994, pp. 473–486.
- D6. S. Felperin, P. Raghavan, and E. Upfal. “An Experimental Study of Wormhole Routing in Parallel Computers.” *Parallel Architectures and Their Efficient Use - First Heinz Nixdorf Symposium*, Paderborn, Germany, 1992, pp. 156–165.

## 5 Patents:

- E1. J. Oliver, F.P. Preparata and E. Upfal. “Systems and methods for sequencing by hybridization III” U.S. patent 7,071,324, July 4, 2006.
- E2. F.P. Preparata and E. Upfal. “Systems and Methods for Sequencing by Hybridization II”. U.S. patent 7,034,143, April 24, 2006.
- E3. J. Palmer, R. Strong, and E. Upfal. “Method and Apparatus for Accessing Shared Resources with Asymmetric Safety in Multiprocessing System”. U.S. Patent 6,748,438, June 8, 2004.
- E4. F.P. Preparata and E. Upfal. “Systems and Methods for Sequencing by Hybridization I”. U.S. patent 6,689,563, February 10, 2004.
- E5. H.T. Olnowich, J.W. Fenney, J. Bruck, and E. Upfal. “Increasing probability multi-stage network”. U.S. patent 6,226,683, May 1, 2001.
- E6. J. Palmer, R. Strong, and E. Upfal. “Method and Apparatus for Ordered Reliable Multicast with Asymmetric Safety in Multiprocessing System”. U.S. Patent 6,092,220, July 18, 2000.
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- E9. H.T. Olnowich, J. Bruck, J.W. Feeney, M.H. Fisher, E. Upfal, and A.R. Williams. “Multi-stage interconnection network with selectable function — switching apparatus”. U.S. patent 5,835,024, November 10, 1998.
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- E11. S. Arora, T.K. Knight, F.T. Leighton, B.M. Maggs, and E. Upfal. “Switching networks with expansive and/or dispersive logical clusters message routing”. U.S. patent 5,521,591, March 1996.
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