

# MIHALIS YANNAKAKIS

## **Personal:**

*Born:* September 13, 1953 in Athens, Greece.

*Citizenship:* Greek. Permanent resident of U.S.

*Address:*

Department of Computer Science  
Columbia University  
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New York, NY 10027  
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## **Education:**

January 1979: Ph.D., Dept. of Electrical Engineering and Computer Science  
Princeton University

July 1975: Diploma in Electrical Engineering  
National Technical University of Athens, Greece

## **Experience:**

January 2004 - present: Columbia University  
Percy K. and Vida L. W. Hudson Professor of Computer Science

October 2002 - December 2003: Stanford University  
Professor of Computer Science

August 2001 - September 2002: Avaya Laboratories, Basking Ridge, NJ  
Director, Computing Principles Research Department

September 1978 - July 2001: Bell Laboratories, Murray Hill, NJ  
Director, Computing Principles Research Department, (1991 - 2001)

## **Research Interests:**

Algorithms and Complexity  
Combinatorial Optimization  
Databases  
Testing and Verification

**Awards:**

Knuth Prize, 2005  
Fellow, Association for Computing Machinery (ACM), 1998  
Fellow, Bell Laboratories, 1997  
Bell Labs Distinguished Member of Technical Staff Award, 1985  
Bell Labs President's Gold Award, 2000  
Best Paper Award, 16th ACM Symp. on Principles of Database Systems

**Professional Activities:**

*Editorial Boards:*

SIAM Journal on Computing (1992 - 2003); Editor-in chief (1998 - 2003)  
Journal of ACM (1986 - 2000)  
Journal of Computer and System Sciences (1990 - present)  
Journal of Combinatorial Optimization (1997 - present)  
Journal of Complexity (2004 - present)  
Discrete Applied Mathematics (1988 -97)  
Operations Research (1983 - 86)

*Conference Committee Chairs:*

Program Chair, 33rd ACM Symposium on Theory of Computing, 2001  
Conference Chair, 13th, 14th and 15th ACM Symp. on Principles of Database Systems, 1994, '95, '96  
Program Chair, 31st IEEE Symp. on Foundations of Computer Science, 1990  
Program Chair, 7th ACM Symp. on Principles of Database Systems, 1988

*Program Committee Member:*

23rd, 25th, 27th, 30th, 35th, 46th IEEE Symp. on Foundations of Computer Sci., 1982, '84, '86, '89, '94, 2005  
16th Intl. Symposium on Algorithms and Computation, 2005  
7th Intl. Workshop on Approximation Algorithms for Combinatorial Optimization Problems, 2004  
2nd, 6th, 18th, 22nd, 24th ACM Symp. on Principles of Database Systems, 1983, '87, '99, 2003, '05  
3rd and 7th Annual Intl. Computing and Combinatorics Conf., 1997, 2001  
2nd International Conference on Network Protocols, 1994  
3rd ACM-SIAM Symposium on Discrete Algorithms, 1992  
4th International Conference on Database Theory, 1992  
12th Intl. Colloquium on Automata, Languages and Programming, 1985  
ACM-SIGMOD Intl. Conference on Management of Data, 1981, 1985  
Intl. Symp. on Mathematical Foundations of Computer Science, 1984

*Executive Committees:*

ACM Symp. on Principles of Database Systems, 1988-90, 1994-2000  
DIMACS, the NSF STC Center for Discrete Mathematics and Theoretical Computer Science, Rutgers-Princeton-Bell Labs-AT&T Labs-Bellcore (1991 - 2001)  
- Co-chair of DIMACS Special Years on Networks 1996-2000  
- Advisory Board (2005 - present)  
IMA - Institute for Mathematics and its Applications, Board of Governors, (2003 - present)

## Publications

### Journal Articles:

1. "The Node-Deletion Problem for Hereditary Properties is NP-Complete", (with J. Lewis), *Journal of Computer and System Sciences* (special issue for 10th ACM Symp. on Theory of Computing), 20(2), pp. 219-230, 1980.
2. "The Effect of a Connectivity Requirement on the Complexity of Maximum Subgraph Problems", *Journal of ACM*, 26(4), pp. 618-630, 1979.
3. "Scheduling Interval Ordered Tasks", (with C. H. Papadimitriou), *SIAM Journal on Computing*, 8(3), pp. 405-409, 1979.
4. "Topological Characterizations of Families of Graphs Generated by Certain Types of Graph Grammars", (with T. Pavlidis), *Information and Control*, 42(1), pp. 72-86, 1979.
5. "Equivalences among Relational Expressions with the Union and Difference Operators", (with Y. Sagiv), *Journal of ACM*, 27(4), pp. 633-655, 1980.
6. "Edge-Dominating Sets in Graphs", (with F. Gavril), *SIAM Journal on Applied Mathematics*, 38(3), pp. 364-372, 1980.
7. "Testing the Universal Instance Assumption", (with P. Honeyman and R. E. Ladner), *Information Processing Letters*, 10(1), pp. 14-19, 1980.
8. "Node-Deletion Problems on Bipartite Graphs", *SIAM Journal on Computing*, 10(2), pp. 310-327, 1981.
9. "Edge-Deletion Problems", *SIAM Journal on Computing*, 10(2), pp. 297-309, 1981.
10. "On the Complexity of Testing Implications of Functional and Join Dependencies", (with D. Maier and Y. Sagiv), *Journal of ACM*, 28(4), pp. 680-695, 1981.
11. "Computing the Minimum Fill-In is NP-Complete", *SIAM Journal on Algebraic and Discrete Methods*, 2(1), pp. 77-79, 1981.
12. "A Theory of Safe Locking Policies in Database Systems", *Journal of ACM*, 29(3), pp. 718-740, 1982.
13. "Freedom from Deadlock of Safe Locking Policies", *SIAM Journal on Computing*, 11(2), pp. 391-408, 1982.
14. "On Minimal Eulerian Graphs", (with C. H. Papadimitriou), *Information Processing Letters*, 12(4), pp. 203-205, 1981.
15. "The Clique Problem for Planar Graphs", (with C. H. Papadimitriou), *Information Processing Letters*, 13(4,5), pp. 131-133, 1981.
16. "The Complexity of Restricted Spanning Tree Problems", (with C. H. Papadimitriou), *Journal of ACM*, 29(2), pp. 285-309, 1982.
17. "The Complexity of the Partial Order Dimension Problem", *SIAM Journal on Algebraic and Discrete Methods*, 3(3), pp. 351-358, 1982.
18. "Algebraic Dependencies", (with C. H. Papadimitriou), *Journal of Computer and System Sciences* (special issue for 21st IEEE Symp. on Foundations of Computer Science), 25(1), pp. 2-41, 1982.

19. "Bounds on the Size and Transmission Rate of Communication Protocols", (with A. V. Aho, J. D. Ullman, A. Wyner), *Computers and Mathematics with Applications*, 8(3), pp. 205-214, 1982.
20. "The Complexity of Testing whether a Graph is a Superconcentrator", (with M. Blum, R. M. Karp, O. Vornberger, C. H. Papadimitriou), *Information Processing Letters*, 13(4,5), pp. 164-167, 1981.
21. "Tools for Template Dependencies", (with R. Fagin, D. Maier, J. D. Ullman), *SIAM Journal on Computing*, 12(1), pp. 36-59, 1983.
22. "Scheduling Opposing Forests", (with M. R. Garey, D. S. Johnson, R. E. Tarjan), *SIAM J. on Algebraic and Discrete Methods*, 4(1), pp. 72-93, 1983.
23. "On the Desirability of Acyclic Database Schemes", (with C. Beeri, R. Fagin, D. Maier), *Journal of ACM*, 30(3), pp. 479-513, 1983.
24. "Simple Linear-Time Algorithms to Test Chordality of Graphs, Test Acyclicity of Hypergraphs, and Selectively Reduce Acyclic Hypergraphs", (with R. E. Tarjan), *SIAM J. on Computing*, 13(3), pp. 566-579, 1984.
25. "The Complexity of Facets (and Some Facets of Complexity)", (with C. H. Papadimitriou), *J. of Computer and System Sciences* (special issue for 14th ACM Symp. on Theory of Computing), 28(2), pp. 244-259, 1984.
26. "Independent Database Schemas", (with M. Graham), *J. of Computer and System Sciences* (special issue for 1st ACM Symp. on Principles of Database Systems), 28(1), pp. 121-141, 1984.
27. "Permuting Elements within Columns of a Matrix in Order to Minimize Maximum Row Sum", (with E. G. Coffman), *Mathematics of Operations Research*, 9(3), pp. 384-390, 1984.
28. "Serializability by Locking", *Journal of ACM*, 31(2), pp. 227-244, 1984.
29. "On a Class of Totally Unimodular Matrices", *Mathematics of Operations Research*, 10(2), pp. 280-304, 1985.
30. "A Polynomial Algorithm for the Min Cut Linear Arrangement of Trees", *Journal of ACM*, 32(4), pp. 950-988, 1985.
31. "Querying Weak Instances", in *Advances in Computing Research*, vol. 3, (F. Preparata, P. Kanelakis eds.), pp. 185-211, JAI Press, 1986.
32. "A Note on Succinct Representations of Graphs", (with C. H. Papadimitriou), *Information and Control*, 71(3), pp. 181-185, 1986.
33. "Deadlock-Freedom and Safety of Transactions in a Distributed Database", (with O. Wolfson), *J. of Computer and System Sciences* (special issue for 4th ACM Symp. on Principles of Database Systems), 33(2), pp. 161-178, 1986.
34. "The Maximum k-Colorable Subgraph Problem for Chordal Graphs", (with F. Gavril), *Information Processing Letters*, 24, pp. 133-137, 1987.
35. "The Complexity of Reliable Concurrency Control", (with C. H. Papadimitriou), *SIAM J. on Computing*, 16(3), pp. 538-553, 1987.
36. "How Easy is Local Search?", (with D. S. Johnson, C. H. Papadimitriou), *J. of Computer and System Sciences* (special issue for 26th IEEE Symp. on Foundations of Computer Science), 37(1), pp. 79-100, 1988.

37. "Embedding Planar Graphs in Four Pages", *J. of Computer and System Sciences* (special issue for 18th ACM Symp. on Theory of Computing), 38(1), pp. 36-67, 1989.
38. "On Generating All Maximal Independent Sets", (with D. S. Johnson, C. H. Papadimitriou), *Information Processing Letters*, 27(3), pp. 119-123, 1988.
39. "Optimal Scheduling of Products with Two Subassemblies on a Single Machine", (with E. G. Coffman, A. Nozari), *Operations Research*, 37(3), pp. 426-436, 1989.
40. "On Recognizing Integer Polyhedra", (with C. H. Papadimitriou), *Combinatorica*, 10(1), pp. 107-109, 1990.
41. "Deleting Completed Transactions", (with T. Hadzilacos), *J. Computer and System Sciences* (special issue for 5th ACM Symp. on Principles of Database Systems), 38(2), pp. 360-379, 1989.
42. "Pfaffian Orientations, 0/1 Permanents, and Even Cycles in Directed Graphs", (with V. Vazirani), *Discrete Applied Mathematics*, 25(1-2), pp. 179-190, 1989.
43. "Towards an Architecture-Independent Analysis of Parallel Algorithms", (with C. H. Papadimitriou), *SIAM J. on Computing*, 19(2), pp. 322-328, 1990.
44. "Simple Local Search Problems that are Hard to Solve", (with A. Schaffer), *SIAM J. on Computing*, 20(1), pp. 56-87, 1991.
45. "Shortest Paths without a Map", (with C. H. Papadimitriou), *Theoretical Computer Science* (special issue for 16th Intl. Coll. on Automata, Languages and Programming), 84(1), pp. 127-150, 1991.
46. "Optimization, Approximation and Complexity Classes", (with C. H. Papadimitriou), *J. Computer and System Sciences* (special issue for 20th ACM Symp. on Theory of Computing), 43(3), pp. 425-440, 1991.
47. "Expressing Combinatorial Optimization Problems by Linear Programs", *J. Computer and System Sciences* (special issue for 20th ACM Symp. on Theory of Computing), 43(3), pp. 441-466, 1991.
48. "Modularity of Cycles and Paths in Graphs", (with E. M. Arkin, C. H. Papadimitriou), *Journal of ACM*, 38(2), pp. 255-274, 1991.
49. "Batch Sizing and Job Sequencing on a Single Machine", (with E. G. Coffman Jr., M. J. Magazine, C. Santos), *Annals of Operations Research*, 26, pp. 135-147, 1990.
50. "High-Probability Parallel Transitive Closure Algorithms", (with J. D. Ullman), *SIAM J. on Computing*, 20(1), pp. 100-125, 1991.
51. "The Traveling Salesman Problem with Distances One and Two", (with C. H. Papadimitriou), *Mathematics of Operations Research*, 18(1), pp. 1-11, 1993.
52. "The Input-Output Complexity of Transitive Closure", (with J. D. Ullman), *Annals of Mathematics and Artificial Intelligence*, 3, pp. 331-360, 1991.
53. "Memory Efficient Algorithms for the Verification of Temporal Properties", (with C. Courcoubetis, M. Vardi, P. Wolper), *Formal Methods in System Design* (special issue for 2nd Conf. on Computer Aided Verification), 1, pp. 275-288, 1992.
54. "Minimum and Maximum Delay Problems in Real Time Systems", (with C. Courcoubetis), *Formal Methods in System Design* (special issue for 3rd Conf. on Computer Aided Verification), 1(4), pp. 385-415, 1992.

55. "Testing Finite State Machines: State Identification and Verification", (with D. Lee), *IEEE Trans. on Computers*, 43(3), pp. 306-320, 1994.
56. "Computing the Throughput of a Network with Dedicated Lines", (with C. H. Papadimitriou, P. Serafini), *Discrete Applied Mathematics*, 42(2-3), pp. 271-278, 1993.
57. "Testing Finite State Machines: Fault Detection", (with D. Lee), *J. Computer and System Sciences* 50 (2) (special issue for 23rd ACM Symp. on Theory of Computing), pp. 209-227, 1995.
58. "On the Approximation of Maximum Satisfiability", *Journal of Algorithms* (special issue for 3rd ACM-SIAM Symp. on Discrete Algorithms), 17, pp. 475-502, 1994.
59. "The Complexity of Multiterminal Cuts", (with E. Dalhaus, D. S. Johnson, C. H. Papadimitriou, P. D. Seymour), *SIAM J. on Computing*, 23(4), pp. 864-894, 1994.
60. "On Datalog vs. Polynomial Time", (with F. Afrati, S. Cosmadakis), *J. Computer and System Sciences* (special issue for 10th ACM Symp. on Principles of Database Systems), 51(2), pp. 177-196, 1995.
61. "The Complexity of Probabilistic Verification", (with C. Courcoubetis), *Journal of ACM*, 42(4), pp. 857-907, 1995.
62. "Linear Approximation of Shortest Superstrings", (with A. Blum, T. Jiang, M. Li, J. Tromp), *Journal of ACM*, 41(4), pp. 630-647, 1994.
63. "On the Hardness of Approximating Minimization Problems", (with C. Lund), *Journal of ACM* 41(5), pp. 960-981, 1994.
64. "Approximate Max-Flow Min-(Multi)cut Theorems and Their Applications", (with N. Garg, V. V. Vazirani), *SIAM J. on Computing*, 25 (2), pp. 235-251, 1996.
65. "Timing Verification by Successive Approximation" (with R. Alur, A. Itai, R. P. Kurshan), *Information and Computation*, 118 (1), pp. 142-157, 1995.
66. "Tie-Breaking Semantics and Structural Totality", (with C. H. Papadimitriou), *J. Computer and System Sciences* (special issue for 11th ACM Symp. on Principles of Database Systems), 54 (1), pp. 48-60, 1997.
67. "On Limited Nondeterminism and the Complexity of the V-C Dimension", (with C. H. Papadimitriou), *J. Computer and System Sciences* (special issue for 8th IEEE Structures Conf.), 53 (2), pp. 161-170, 1996.
68. "Primal-Dual Approximation Algorithms for Integral Flow and Multicut in Trees", (with N. Garg, V. V. Vazirani), *Algorithmica*, 18, pp. 3-20, 1997.
69. "Computational Complexity of Local Search", chapter in book *Local Search in Combinatorial Optimization*, E.H.L. Aarts, J.K. Lenstra eds., John Wiley, 1997.
70. "Principles and Methods of Testing Finite State Machines - A Survey", (with D. Lee), invited paper, *Proceedings of the IEEE*, 84 (8), pp. 1090-1126, 1996.
71. "An Efficient Algorithm for Minimizing Real-Time Transition Systems", (with D. Lee), *Formal Methods in System Design* (special issue for 5th Conf. on Computer Aided Verification), 11, pp. 113-136, 1997.
72. "Conformance Testing", (with D. Lee), *Encyclopedia of Electrical and Electronics Engineering*, J. Webster ed., John Wiley, 1998.

73. "Markov Decision Processes and Regular Events", (with C. Courcoubetis), *IEEE Trans. on Automatic Control*, 43(10), pp. 1399-1418, 1998.
74. "On the Complexity of Protein Folding", (with P. Crescenzi, D. Goldman, C. Papadimitriou, A. Piccolboni), *J. Computational Biology* 5(3), pp. 423-466, 1999.
75. "On the Complexity of Database Queries", (with C. H. Papadimitriou), *J. Computer and System Sc.*, (special issue for 16th ACM Symp. on Principles of Database Systems), 58(3), pp. 407-427, 1999.
76. "Bin Packing with Discrete Item Sizes, Part I: Perfect Packing Theorems and the Average Case Behavior of Optimal Packings", (with E. G. Coffman Jr., C. Courcoubetis, M. R. Garey, D. S. Johnson, P. W. Shor, R. R. Weber), *SIAM J. on Discrete Math.*, 13(3), pp. 384-402, 2000.
77. "Model Checking of Hierarchical State Machines", (with R. Alur), *ACM Trans. on Programming Languages and Systems*, 23(3), pp. 273-303 2001.
78. "On Complexity as Bounded Rationality" (with C. H. Papadimitriou), submitted to *Mathematics of Operations Research*.
79. "Closed Partition Lattice and Machine Decomposition", (with D. Lee), *IEEE Trans. on Computers*, 51(2), pp. 216-228 2002.
80. "Black Box Checking", (with D. Peled, M. Vardi), *Journal of Automata, Languages and Combinatorics*, 7(2), pp. 225-246, 2002.
81. "Perfect Packing Theorems and the Average Case Behavior of Optimal and On-line Packings" (with E. G. Coffman Jr., C. Courcoubetis, M. R. Garey, D. S. Johnson, P. W. Shor, R. R. Weber), *SIAM Review*, 44, pp. 384-402, 2002.
82. "Inference of Message Sequence Charts", (with R. Alur, K. Etessami), *IEEE Trans. on Software Engineering*, 29(7), pp. 623--633, 2003.
83. "Near-Optimal Hardness Results and Approximation Algorithms for Edge-Disjoint Paths and Related Problems", (with V. Guruswami, S. Khanna, R. Rajaraman, B. Shepherd), *J. of Computer and System Sc.*, 67(3), pp. 473-496, 2003.
84. "Multiway Cuts in Node Weighted Graphs", (with N. Garg, V. Vazirani), *J. of Algorithms*, 50(1), pp. 49-61, 2004.
85. "Realizability and Verification of MSC Graphs", (with R. Alur, K. Etessami), *Theoretical Computer Science* (special issue from ICALP'01), 331, pp. 97-114, 2005.
86. "Analysis of Recursive State Machines", (with R. Alur, M. Benedikt, K. Etessami, P. Godefroid, T. Reps), *ACM Trans. on Programming Languages and Systems*, 27(4), pp. 786-818, 2005.
87. "Efficiently Computing Succinct Trade-off Curves", (with S. Vassilvitskii), *Theoretical Computer Science* (special issue from ICALP'04), 348, pp. 334-356, 2005.
88. "Adaptive Model Checking", (with A. Groce, D. Peled), *Logic Journal of the IGPL*, Oxford Univ. Press, to appear.

### Conference papers:

(Many of these papers were subsequently published as journal articles.)

1. "Node- and Edge-Deletion NP-Complete Problems", *Proc. 10th Annual ACM Symposium on Theory of Computing*, pp. 253-264, San Diego, California, 1978.
2. "Topological Characterizations of Families of Graphs Generated by Certain Types of Graph Grammars", (with T. Pavlidis), *Proc. IEEE Conference on Pattern Recognition and Image Processing*, pp. 269-274, Chicago, Illinois, 1978.
3. "Equivalence among Relational Expressions with the Union and Difference Operators", (with Y. Sagiv), *Proc. 4th Intl. Conf. on Very Large Data Bases*, pp. 535-548, Berlin, Germany, 1978.
4. "The Complexity of Restricted Minimum Spanning Tree Problems", (with C. H. Papadimitriou), *Proc. 6th Intl. Coll. on Automata, Languages and Programming*, pp. 460-470, Austria, 1979.
5. "Locking Policies: Safety and Freedom from Deadlock", (with H. T. Kung and C. H. Papadimitriou), *Proc. 20th Annual Symposium on Foundations of Computer Science*, pp. 286-297, San Juan, Puerto Rico, 1979.
6. "Modeling Communications Protocols by Automata", (with A. V. Aho and J. D. Ullman), *Proc. 20th Annual Symposium on Foundations of Computer Science*, pp. 267-273, 1979.
7. "Sorting the Cartesian Product", (with A. V. Aho and T. G. Szymanski), *Proc. Conference on Information Sciences and Systems*, pp. 557-558, Princeton, New Jersey, 1980.
8. "Algebraic Dependencies", (with C. H. Papadimitriou), *Proc. 21th Annual Symposium on Foundations of Computer Science*, pp. 328-332, Syracuse, New York, 1980.
9. "On a Class of Totally Unimodular Matrices", *Proc. 21th Annual Symposium on Foundations of Computer Science*, pp. 10-16, Syracuse, New York, 1980.
10. "Properties of Acyclic Database Schemes", (with C. Beeri, R. Fagin, D. Maier, A. Mendelzon, J. D. Ullman), *Proc. 13th Annual ACM Symposium on Theory of Computing*, pp. 355-362, Milwaukee, Wisconsin, 1981.
11. "Issues of Correctness in Database Concurrency Control by Locking", *Proc. 13th Annual ACM Symposium on Theory of Computing*, pp. 363-367, Milwaukee, Wisconsin, 1981.
12. "Bounds for Planar Independent Sets", (with C. H. Papadimitriou), *CORS-TIMS-ORSA 1981 Joint National Meeting*, Toronto, Canada, 1981.
13. "Algorithms for Acyclic Database Schemes", *Proc. 7th Intl. Conf. on Very Large Data Bases*, pp. 82-94, Cannes, France, 1981.
14. "Worst-Case Ratios in Planar Graphs and the Method of Induction on Faces", (with C. H. Papadimitriou), *Proc. 22nd Annual Symp. on Foundations of Computer Science*, pp. 358-363, Nashville, Tennessee, 1981.
15. "Independent Database Schemas", (with M. H. Graham), *Proc. 1st ACM Symp. on Principles of Database Systems*, pp. 199-204, Los Angeles, California, 1982.
16. "The Complexity of Facets (and Some Facets of Complexity)", (with C. H. Papadimitriou), *Proc. 14th ACM Symp. on Theory of Computing*, pp. 255-260, San Francisco, California, 1982.
17. "On Notions of Information Transfer in VLSI Circuits", (with A. V. Aho, J. D. Ullman), *Proc. 15th ACM Symp. on Theory of Computing*, pp. 133-139, Boston, Massachusetts, 1983.

18. "Cutting and Partitioning a Graph after a Fixed Pattern", (with P. C. Kanellakis, S. C. Cosmadakis, C. H. Papadimitriou), *Proc. 10th Intl. Coll. on Automata, Languages and Programming*, pp. 712-722, Barcelona, Spain, 1983.
19. "A Polynomial Algorithm for the Min Cut Linear Arrangement of Trees", *Proc. 24th Annual Symp. on Foundations of Computer Science*, pp. 274-281, Tucson, Arizona, 1983.
20. "Querying Weak Instances", *Proc. 3rd ACM Symp. on Principles of Database Systems*, pp. 275-280, 1984.
21. "On Monotone Formulae with Restricted Depth", (with M. Klawe, W. Paul, N. Pippenger), *Proc. 16th Annual ACM Symp. on Theory of Computing*, pp. 480-487, 1984.
22. "Deadlock-Freedom (and Safety) of Transactions in a Distributed Database", (with O. Wolfson), *Proc. 4th ACM Symp. on Principles of Database Systems*, pp. 105-112, 1985.
23. "The Complexity of Reliable Concurrency Control", (with C. H. Papadimitriou), *Proc. 4th ACM Symp. on Principles of Database Systems*, pp. 230-234, 1985.
24. "How Easy is Local Search?", (with D. S. Johnson, C. H. Papadimitriou), *Proc. 26th Annual Symp. on Foundations of Computer Science*, pp. 39-42, 1985.
25. "Deleting Completed Transactions", (with T. Hadzilacos), *Proc. 5th ACM Symp. on Principles of Database Systems*, pp. 43-46, 1986.
26. "Four Pages are Necessary and Sufficient for Planar Graphs", *Proc. 18th Annual ACM Symp. on Theory of Computing*, pp. 104-108, 1986.
27. "Linear and Book Embeddings of Graphs", (invited paper), *Proc. Aegean Workshop on Computing: VLSI Algorithms and Architectures, Springer Verlag LNCS 227*, pp. 226-235, 1986.
28. "Towards an Architecture-Independent Analysis of Parallel Algorithms", (with C. H. Papadimitriou), *Proc. 20th Annual ACM Symp. on Theory Of Computing*, pp. 510-513, 1988.
29. "Optimization, Approximation, and Complexity Classes", (with C. H. Papadimitriou), *Proc. 20th Annual ACM Symp. on Theory of Computing*, pp. 229-234, 1988.
30. "Expressing Combinatorial Optimization Problems by Linear Programs", *Proc. 20th Annual ACM Symp. on Theory of Computing*, pp. 223-228, 1988.
31. "Pfaffian Orientations, 0/1 Permanents, and Even Cycles in Directed Graphs", (with V. Vazirani), *Proc. 15 Intl. Coll. Automata, Languages and Programming*, pp. 667-681, 1988.
32. "Verifying Temporal Properties of Finite-State Probabilistic Programs", (with C. Courcoubetis), *Proc. 29th Annual Symp. on Foundations of Computer Science*, pp. 338-345, 1988.
33. "Shortest Paths without a Map", (with C. H. Papadimitriou), *Proc. 16th Intl. Coll. Automata, Languages and Programming*, pp. 610-620, 1989.
34. "The Analysis of Local Search Problems and Their Heuristics", (invited paper), *Proc. 7th Annual Symp. on Theoretical Aspects of Computer Science*, pp. 298-311, 1990. Also, republished in Czech translation in *Pokroky Matematiky, Fyziky a Astronomie*, 37(1), pp. 12-30, 1992.
35. "Graph Theoretic Methods in Database Theory", (invited paper), *Proc. 9th ACM Symp. on Principles of Database Systems*, pp. 230-242, 1990.
36. "On the Complexity of Local Search", (with C. H. Papadimitriou, A. Schaffer), *Proc. 22nd Annual ACM Symp. on Theory of Computing*, pp. 438-445, 1990.

37. "The Input/Output Complexity of Transitive Closure", (with J. D. Ullman), *Proc. 1990 ACM SIG-MOD Intl. Conf. on Management of Data*, pp. 44-53, 1990.
38. "Markov Decision Processes and Regular Events", (with C. Courcoubetis), *Proc. 17th Intl. Coll. Automata, Languages and Programming*, pp. 336-349, 1990.
39. "High Probability Parallel Transitive Closure Algorithms", (with J. D. Ullman), *Proc. 2nd ACM Symp. on Parallel Algorithms and Architectures*, pp. 200-209, 1990.
40. "Memory Efficient Algorithms for the Verification of Temporal Properties", (with C. Courcoubetis, M. Vardi, P. Wolper), *Proc. 2nd Conf. on Computer-Aided Verification*, AMS, pp. 207-218, 1990.
41. "Fundamental Discrepancies Between Average Case Analyses Under Discrete and Continuous Distributions: A Bin Packing Case Study", (with E. G. Coffman Jr., C. Courcoubetis, M. R. Garey, D. S. Johnson, L. A. McGeogh, P. Shor, R. Weber), *Proc. 23rd Annual ACM Symp. on Theory of Computing*, pp. 230-240, 1991.
42. "Linear Approximation of Shortest Superstrings", (with A. Blum, T. Jiang, M. Li, J. Tromp), *Proc. 23rd Annual ACM Symp. on Theory of Computing*, pp. 328- 337, 1991.
43. "Testing Finite State Machines", (with D. Lee), *Proc. 23rd Annual ACM Symp. on Theory of Computing*, pp. 476-485, 1991.
44. "On Datalog vs. Polynomial Time", (with F. Afrati, S. Cosmadakis), *Proc. 10th ACM Symp. on Principles of Database Systems*, pp. 13-25, 1991.
45. "On the Value of Information in Distributed Decision-Making", (with C. H. Papadimitriou), *Proc. 10th Annual ACM Symp. on Principles of Distributed Computing*, pp. 61-64, 1991.
46. "Minimum and Maximum Delay Problems in Real Time Systems", (with C. Courcoubetis), *Proc. 3rd Conf. on Computer-Aided Verification*, 1991.
47. "On the Approximation of Maximum Satisfiability", *Proc. 3rd Annual ACM-SIAM Symp. on Discrete Algorithms*, pp. 1-9, 1992.
48. "The Complexity of Multiway Cuts", (with E. Dalhaus, D. S. Johnson, C. H. Papadimitriou, P. D. Seymour), *Proc. 24th Annual ACM Symp. on Theory of Computing*, pp. 241-251, 1992.
49. "Online Minimization of Transition Systems", (with D. Lee), *Proc. 24th Annual ACM Symp. on Theory of Computing*, pp. 264-274, 1992.
50. "Suboptimal Cuts: Their Enumeration, Weight and Number", (with V. V. Vazirani), *Proc. 19th Intl. Coll. on Automata, Languages and Programming*, pp. 366-377, 1992.
51. "Tie-Breaking Semantics and Structural Totality", (with C. H. Papadimitriou), *Proc. 11th Annual ACM Symp. on Principles of Database Systems*, pp. 16-22, 1992.
52. "Timing Verification by Successive Approximation" (with R. Alur, A. Itai, R. P. Kurshan), *Proc. 4th Conf. on Computer-Aided Verification*, 1992.
53. "On Limited Nondeterminism and the Complexity of the V-C Dimension", (with C. H. Papadimitriou), *Proc. 8th Annual IEEE Conf. on Structure in Complexity Theory*, 1993.
54. "On the Hardness of Approximating Minimization Problems", (with C. Lund), *Proc. 25th Annual ACM Symp. on Theory of Computing*, pp. 286-293, 1993.
55. "Approximate Max-Flow Min-(Multi)cut Theorems and Their Applications", (with N. Garg, V. V. Vazirani), *Proc. 25th Annual ACM Symp. on Theory of Computing*, pp. 698-707, 1993.

56. "Linear Programming without the Matrix", (with C. H. Papadimitriou), *Proc. 25th Annual ACM Symp. on Theory of Computing*, pp. 121-129, 1993.
57. "The Approximation of Maximum Subgraph Problems", (with C. Lund), *Proc. 20th Intl. Colloquium on Automata, Languages, and Programming*, pp. 40-51, 1993.
58. "Primal-Dual Approximation Algorithms for Integral Flow and Multicut in Trees, with Applications to Matching and Set Cover", (with N. Garg, V. V. Vazirani), *Proc. 20th Intl. Colloquium on Automata, Languages, and Programming*, pp. 64-75, 1993.
59. "An Efficient Algorithm for Minimizing Real-Time Transition Systems", (with D. Lee), *Proc. 5th Conference on Computer-Aided Verification*, pp. 210-224, 1993.
60. "Recent Developments in the Approximability of Combinatorial Problems", (invited paper), *Proc. 4th Intl. Symposium on Algorithms and Computation*, pp. 363-368, 1993.
61. "Some Open Problems in Approximation", (invited paper), *Proc. 2nd Italian Conf. on Algorithms and Complexity*, pp. 33-39, 1994.
62. "On Complexity as Bounded Rationality" (with C. H. Papadimitriou), *Proc. 26th Annual ACM Symp. on Theory of Computing*, pp. 726-733, 1994.
63. "Multiway Cuts in Directed and Node Weighted Graphs", (with N. Garg, V. V. Vazirani), *Proc. 21st Intl. Coll. on Automata, Languages and Programming*, pp. 487-498, 1994.
64. "Distinguishing Tests for Nondeterministic and Probabilistic Machines", (with R. Alur, C. Courcoubetis), *Proc. 27th Annual ACM Symp. on Theory of Computing*, pp. 363-372, 1995.
65. "Perspectives on Database Theory", (invited paper), *Proc. 36th Annual Symp. on Foundations of Computer Science*, pp. 224-246, 1995.
66. "Searching a Fixed Graph", (with E. Koutsoupias, C. H. Papadimitriou), *Proc. 23rd Intl. Coll. on Automata, Languages and Programming*, pp. 280-289, 1996.
67. "On Nested Depth First Search", (with G. Holzmann, D. Peled), *Proc. 2nd SPIN Verification Workshop*, pp. 23-32, 1996.
68. "Optimization Problems from Feature Testing of Communication Protocols", (with D. Lee), *Proc. Intl. Conf. on Network Protocols*, pp. 66-75, 1996.
69. "On the Complexity of Database Queries", (with C. H. Papadimitriou), *Proc. 16th Annual ACM Symp. on Principles of Database Systems*, pp. 12-19, 1997.
70. "Existence of Reduction Hierarchies", (with O. Kupferman, R. Kurshan), *Proc. 1997 Annual Conf. of the Eur. Assoc. for Comp. Sci. Logic*, Springer-Verlag LNCS 1414, pp. 327-340, 1997.
71. "On the Complexity of Protein Folding", (with P. Crescenzi, D. Goldman, C. Papadimitriou, A. Piccolboni), *Proc. 30th Annual ACM Symp. on Theory of Computing*, pp. 597-603, 1998; also, abstract in *Proc. RECOMB*, pp. 61-62, 1998.
72. "Model Checking of Hierarchical State Machines", (with R. Alur), *Proc. 6th ACM Symp. on Foundations of Softw. Eng.*, pp. 175-188, 1998.
73. "Protocol Feature Interactions", (with T. F. LaPorta and D. Lee and Y.-J. Lin), *Proc. FORTE-PSTV (IFIP Joint Intl. Conf. on Formal Description Techniques for Distr. Sys. and Commun. Prot. - Protocol Specification, Testing and Verification)*, 1998.

74. "Testing of Finite State Systems", invited paper, (with D. Lee), *Proc. 1998 Annual Conf. of the European Assoc. for Comp. Sci. Logic*, Springer-Verlag 1584, pp. 29-44, 1998.
75. "A Convex Relaxation for the Asymmetric TSP", (with S. Vempala), *Proc. 10th Annual ACM-SIAM Symp. on Disc. Alg.*, 1999.
76. "Model Checking of Message Sequence Charts", (with R. Alur), *Proc. 10th Intl. Conf. on Concurrency Theory*, Springer Verlag LCNS 1664, pp. 114-129, 1999.
77. "Communicating Hierarchical State Machines", (with R. Alur, S. Kannan), *Proc. 26th Intl. Coll. on Automata, Languages and Programming*, 1999.
78. "Near-Optimal Hardness Results and Approximation Algorithms for Edge-Disjoint Paths and Related Problems", (with V. Guruswami, S. Khanna, R. Rajaraman, B. Shepherd), *Proc. 31st ACM Symp. on Theory of Computing*, pp. 19-28, 1999.
79. "Complexity of Local Search", *3rd Metaheuristics Intl. Conf* (invited), 1999.
80. "Black Box Checking", (with D. Peled, M. Vardi), *Proc. IFIP Joint Intl. Conf. FORTE -PSTV*, Kluwer, pp. 225-240, 1999.
81. "Inference of Message Sequence Charts", (with R. Alur, K. Etessami), *Proc. 22nd Intl. Conf. on Software Engineering*, pp. 304-313, 2000.
82. "On the Approximability of Trade-Offs and Optimal Access of Web Sources", (with C. H. Papadimitriou), *Proc. 41st Annual IEEE Symp. on Foundations of Computer Science*, pp. 86-92, 2000.
83. "From Rule-Based to Automata-Based Testing", (with K. Etessami), *Proc. IFIP Joint Intl. Conf. FORTE XIII-PSTV XX*, Kluwer, pp. 53-68, 2000.
84. "Hierarchical State Machines" (invited paper), *Proc. IFIP TCS 2000*, Springer-Verlag LNCS 1872, pp. 315-330, 2000.
85. "Multiobjective Query Optimization", (with C. H. Papadimitriou), *Proc. 20th ACM Symp. on Principles of Database Systems*, pp. 52-58, 2001.
86. "Analysis of Recursive State Machines", (with R. Alur, K. Etessami), *Proc. 13th Intl. Conf. on Computer-Aided Verification*, 2001.
87. "Realizability and Verification of MSC Graphs", (with R. Alur, K. Etessami), *Proc. 28th Intl. Coll. on Automata, Languages and Programming*, Springer-Verlag LNCS 2076, pp. 797-808, 2001.
88. "Approximation of Multiobjective Optimization Problems" (invited), *Proc. 7th Intl. Workshop on Algorithms and Data Structures*, 2001.
89. "AMC: An Adaptive Model Checker", (with A. Groce, D. Peled), *Proc. 14th Intl. Conf. on Computer-Aided Verification*, 2002.
90. "Adaptive Model Checking", (with A. Groce, D. Peled), *Proc. 8th Intl. Conf. on Tools and Algorithms for Construction and Analysis of Systems*, pp. 357-370, 2002.
91. "Testing and Checking of Finite State Systems" (invited), *Proc. 5th LATIN American Conf. on Theoretical Informatics*, 2002.
92. "Compression of Partially Ordered Strings", (with R. Alur, S. Chaudhuri, K. Etessami, S. Guha), *Proc. 14th Intl. Conf. Concurrency Theory*, 2003.

93. "Efficiently Computing Succinct Trade-off Curves", (with S. Vassilvitskii), *Proc. 31st Intl. Coll. on Automata, Languages, and Programming*, pp. 1201-1213, 2004.
94. "Testing, Optimization, and Games" (invited), *Proc. 31st Intl. Coll. on Automata, Languages, and Programming*, pp. 28-45, 2004. Also, in *Proc. 19th IEEE Symp. on Logic in Computer Science*, pp. 78-88, 2004.
95. "Protocol System Integration, Interface and Interoperability", (with D. Lee, C.Liu), *Proc. 8th Intl. Conf. on Principles of Distributed Systems*, pp. 1-19, Springer-Verlag LNCS 3544, 2004.
96. "Recursive Markov Chains, Stochastic Grammars, and Monotone Systems of Nonlinear Equations", (with K. Etessami), *Proc. 22nd Symp. Theoretical Aspects of Computer Science*, pp. 340-352, 2005.
97. "Testing Hierarchical Systems", (with D. Mosk-Aoyama), *Proc. 16th ACM-SIAM Symp. on Discrete Algorithms*, pp. 1126-1135, 2005.
98. "Algorithmic Verification of Recursive Probabilistic State Machines", (with K. Etessami), *Proc. 11th Intl. Conf. on Tools and Algorithms for Construction and Analysis of Systems*, pp. 253-270, Springer-Verlag LNCS 3440, 2005.
99. "Recursive Markov Decision Processes and Recursive Stochastic Games", (with K. Etessami), *Proc. 32nd Intl. Coll. on Automata, Languages, and Programming*, pp. 891-903, 2005.
100. "Checking LTL Properties of Recursive Markov Chains", (with K. Etessami), *Proc. 2nd Intl. Conf. on Quantitative Evaluation of Systems*, pp. 155-164, 2005.
101. "Probability and Recursion" (invited), (with K. Etessami), *Proc. 16th Intl. Symp. on Algorithms and Computation*, pp. 2-4, Springer-Verlag LNCS 3827, 2005.
102. "Efficient Qualitative Analysis of Classes of Recursive Markov Decision Processes and Simple Stochastic Games", (with K. Etessami), *Proc. 23rd Symp. Theoretical Aspects of Computer Science*, pp. 634-645, Springer-Verlag 3884, 2006.
103. "Key Management for Large Scale Emergency Alert Systems", (with G. Shu, D. Lee), *Proc. 2nd Intl. Workshop on Security in Systems and Networks*, to appear, 2006.
104. "Recursive Concurrent Stochastic Games", (with K. Etessami), *Proc. 33rd Intl. Coll. on Automata, Languages, and Programming*, to appear, 2006.

## Patents

1. "Timing Verification by Successive Approximation", (with R. Alur, A. Itai, R. Kurshan), US patent no. 5,483,470 (1996).
2. "Methods And Apparatus For Generating Passive Testers From Properties", (with G. J. Holzmann), U.S. patent no. 6,061,812 (2000).
3. "Model Checking of Hierarchical State Machines", (with R. Alur), U.S. patent no. 6,324,496 (2001).
4. "Model Checking of Message Flow Diagrams", (with R. Alur), US patent no. 6,516,306 (2003).
5. "Directly verifying a black box system", (with D. Peled, M. Y. Vardi), U.S. patent no. 6,526,544, (2003).
6. "Implied Message Sequence Charts", (with R. Alur, K. Etessami), U.S. patent no. 6,681,264 (2004).
7. "Automatic Generation and Regeneration of a Covering Test Case Set from a Model", (with G. J. Holzmann, M. H. Holzmann, J. J. Striegel), U.S. patent no. 6,804,634 (2004).

**Invited and Distinguished Lectures** (selected)

Knuth Prize Lecture, 46th IEEE Symp. On Foundations of Computer Science, 2005  
Invited Plenary Talk, 16th Intl. Symp. on Algorithms and Computation, China, 2005  
Distinguished Lecture, University of Toronto, 2005  
Invited Joint Plenary Talk, 31st Intl. Coll. on Aut., Lang. and Progr., and 19th Ann. IEEE Symp. on Logic in Computer Science, 2004  
Annual Milner Distinguished Lecture, University of Edinburgh, 2004  
Distinguished Lecture, University of California at Riverside, 2003  
Invited Plenary Talk, 5th LATIN American Conf. on Theoretical Informatics, Mexico, 2002  
Invited Plenary Talk, 7th Intl. Workshop on Algorithms and Data Structures, 2001  
First Kannelakis Memorial Lecture, Brown University, 2001  
Distinguished Lecture, University of Pennsylvania, 2001  
Distinguished Lecture, University of Texas at Austin, 2001  
Invited Talk, IBM-NYU-Columbia Theory Day, 2001  
Invited Talk, 1st IFIP Theoretical Computer Science Conf., Japan, 2000  
Invited Talk, 3rd International Conf. on Metaheuristics, Brasil, 1999  
Distinguished Lecture, University of California, Santa Barbara, 1999  
Invited Plenary Talk, Joint Computer Science Logic & Math. Found. of CS Conf, 1998  
Distinguished Lecture, Brown University, 1996  
Invited Plenary Talk, 36th IEEE Symp. on Foundations of Computer Science, 1995  
Distinguished Lecture, University of Maryland, 1995  
Invited Plenary Talk, 7th SIAM Conf. on Discrete Mathematics, Albuquerque, 1994  
Invited Talk, 2nd Italian Conf. on Algorithms and Complexity, Rome, 1994  
Invited Tutorial Talk, 21st Intl. Coll. on Automata, Languages and Programming, Jerusalem, 1994  
Invited Talk, 4th Intl. Symp. on Algorithms and Computation, Hong Kong, 1993  
Distinguished Lecture, University of Texas at Austin, 1993  
Invited Talk, 7th Maryland Theoretical Computer Science Day, 1992  
Invited Talk, Symp. on 20th Anniversary of NP-completeness, Italy, 1991  
Invited Talk, Columbia Theory Day, 1991  
Invited Talk, 7th Symp. on Theoretical Aspects of Computer Science, France, 1990  
Invited Talk, 9th ACM Symp. on Principles of Database Systems, Nashville, 1990  
Distinguished Cray Lecture, University of Minnesota, 1989

Many other invited talks at universities and workshops.