VITAE

JURIS HARTMANIS

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EDUCATION

1949	Cand. Phil., University of Marburg	Physics
1951	M.A., University of Kansas City	Mathematics
1955	Ph.D., California Inst. of Technology	Mathematics

EXPERIENCE

1955-57	Instructor, Cornell University
1957-58	Assistant Professor, Ohio State University
1958-65	Research Mathematician, General Electric Research Lab
1965-	Professor, Computer Science Department, Cornell University
1965-71	Chairman, Computer Science Department, Cornell University
1971-72	Sabbatic, Gesselschaft fur Mathematick und Datenverarbeitung, Bonn, West Germany
1977-82	Chairman, Computer Science Department, Cornell University
1980-	Walter R. Read Professor of Engineering, Cornell University
Fall 1985	Sabbatic, Participant in Complexity Year at the Mathematical Sciences Research Institute, Berkeley, California
1992-93	Chairman, Computer Science Department, Cornell University
1993-94	Sabbatic, Max Planck Institute for Computer Science, Saarbruecken, Germany

HONORS & AWARDS

Association for Computing Machinery Turing Award (with R.E. Stearns), 1993

Member: National Academy of Engineering, 1989--
Member: Latvian Academy of Sciences, 1990-- (foreign member)
Member: New York State Academy of Sciences, 1982--
Fellow: Association for Computing Machinery, 1994
Fellow: American Academy of Arts & Sciences, 1992--
Fellow: American Association for the Advancement of Science, 1981--

Humboldt Foundation Senior US Scientist Award, 1993-94
Dr. h.c. University of Dortmund, Germany, 1995
B. Blozano Gold Medal of the Academy of Sciences, Czech Republic, 1995
Doctor of Science (honoris causa), University of Missouri, Kansas City, 1999
CRA Distinguished Service Award, 2000
Grand Medal, Latvian Academy of Science, 2001

PROFESSIONAL ACTIVITIES (since 1985)

Member: Sigma Xi.
Member: American Mathematical Society.
Member: Association for Computing Machinery.
Member: Board of Directors, Computing Research Association, 1989-1993.
Editor: *Lecture Notes in Computer Science*, Springer-Verlag, Berlin, Heidelberg, New York.
Editor: *SIAM Journal of Computing*.
Editor: *Journal of Computer and System Sciences*.
Member: Editorial board, *Fundamenta Informaticae Journal*.
Member: Editorial board, *Mathematical Systems Theory*, 1969-1989.
Editor: *Annals of Pure and Applied Logic*, 1983-1988 (managing editor).
Member: Advisory board, European Association of Theoretical Computer Science (EATCS) Monographs for Theoretical Computer Science, Springer-Verlag.
Member: Board of Visitors, School of Computer & Information Science, Syracuse University, Syracuse, New York.
Member: Visiting Committee, Department of Mathematics, Lehigh University, Bethlehem, Pennsylvania, 1982-1988.
Member: Program Committee, Fundamental of Computation Theory, FCT'85.
Member: Review Committee, EE/CS Department, University of Michigan, October 1985.
Member: Review Committee for Proposed Ph.D. Program in Computer

Engineering, University of Southwestern Louisiana, June 1986.

Delegate: Council Delegate of Electorate A (Mathematics), American Association for the Advancement of Science, 1986-1989.

Chair: Program Committee, ACM Symposium on Theory of Computing, STOC'86.

Member: Program Committee, Structure in Complexity Theory Conference, 1986.

Member: ACM Turing Award Committee, 1986-1991.

Member: Advisory Council in Engineering, Rice University, 1986--1995

Chair: Program Committee, Structure in Complexity Theory Conference, 1988.

Member: Review Committee, Computer Science Department, Courant Institute, New York University, March 1988.

Member: Review Committee, Computer Science Department, State University of New York at Buffalo, April 1988.

Member: Program Committee, Fundamentals of Computation Theory, FCT'89.

Editor: Special STOC'86 Issue of the Journal of Computer & System Sciences, (JCSS), Vol. 38, No. 1 (February 1989) (guest editor).

Member: Program Committee, FOCS'89.

Chair: ACM Turing Award Committee, 1989.

Member: Board of Directors, Computing Research Association, 1989-1994.

Member: IFIP Technical Committee for Foundations of Computer Science, 1989--.

Chair: National Research Council, Study of the Scope and Direction of Computer Science, 1990-1992.

Member: Selection Committee, Presidential Young Investigator Awards, National Science Foundation, 1990.

Member: Review Committee, Department of Computer Science, Iowa State University, Iowa City, Iowa, February 1990.

Member: Review Committee, Computer Science Department, University of Delaware, Newark, Delaware, May 1990.

Member: Review Committee, Computer Science Ph.D. Program, Dartmouth College, Hanover, New Hampshire, May 1990.

Member: Review Committee, Computer Science Department, University of North Carolina, Chapel Hill, North Carolina, April 1991.

Member: Committee for NSF Graduate Fellowships, National Research Council, 1991.

Member: Peer Committee for Computer Science & Engineering, National Academy of Engineering, 1991-1994.

Member: EATCS Council, 1991--.

Member: Review Committee, Computer Science Department, University of Cincinnati, Cincinnati, Ohio, December 1992.

Member: Board of Visitors, Computer Science Division, Office of Naval Research, January 1993.

Member: Review Committee, Department of Computer Science, Princeton University, March 1993.

Member: Visiting Committee, Physical Sciences Division, University of Chicago, Chicago, Illinois, 1992-1995.
Member: Board of Advisors, International Journal for the Foundations of Computer Science, World Scientific, 1994--.
Member: Editorial Board, *Chicago Journal of Theoretical Computer Science*, Electronic Journal, MIT Press, 1994--.
Editor: Foundations Editor, Electronic Journal for Universal Computer Science, Herman Maurer, Managing Editor, Technical University, Graz, Austria, 1994--.
Member: Goedel Prize Committee, 1994--.
Member: ACM Turing Award Committee, 1994--.
Member: NCR Computer Science and Telecommunications Board, 1995--.

Ph.D. STUDENTS

1. Borodin, Allan. Computational Complexity and the Existence of Complexity Gaps. September 1969.
2. Lewis, Forbes Downer. Unsolvability Considerations in Computational Complexity. June 1970.
3. Reingold, Edward. On Some Optimal Algorithms. January 1971.
4. McGowan, Clement. Correctness Results for Lambda Calculus Interpreters. August 1971.
5. Baker, Theodore. Computational Complexity and Nondeterminism in Flowchart Programs. January 1974.
6. Simon, Janos. On Some Central Problems in Computational Complexity. January 1975.
7. Berman, Leonard. Polynomial Reducibilities and Complete Sets. May 1977.
8. Kozen, Dexter. Complexity of Finitely Presented Algebras. May 1977.
9. Schmid, Erik. Succinctness of Descriptions of Context-Free, Regular and Finite Languages. January 1978.
10. Immerman, Neil. First Order Expressibility as a New Complexity Measure. August 1980.
11. Mahaney, Stephen. Sparse NP-Complete Sets. May 1981.
12. Sewelson, Vivian. A Study of the Structure of NP. August 1983.
13. Li, Ming. Lower Bounds in Computational Complexity. January 1985.
14. Cai, Jin-yi. On Some Most Probable Separations of Complexity Classes. August 1986.
15. Longpre, Luc. Resource Bounded Kolmogorov Complexity, A Link between Computational Complexity and Informatic Theory. August 1986.
16. Hemachandra, Lane. Counting in Structural Complexity Theory. May 1987.
17. Kadin, James. Restricted Turing Reducibility and the Structure of the Polynomial Time Hierarchy. May 1988.
18. Chang, Richard. On the Structure of NP Computations under Boolean

Operations. August 1991.

19. Ranjan, Desh. Issues in NP-Optimization and Approximation. August 1992.
20. Rohatgi, Pankaj. On Properties of Random Reductions. January 1994.
21. Chari, Suresh. Randomness as a Computational Resource: Issues in Efficient Computation. August 1994.

PUBLICATIONS

Books

1. *Algebraic Structure Theory of Sequential Machines* (with R. E. Stearns) Prentice-Hall, 1966.
2. *Feasible Computations and Provable Complexity Properties.* Society for Industrial & Applied Mathematics, Philadelphia, Penn., 1978.
3. Editor, *Computational Complexity Theory.* AMS Proceedings of Symposia in Applied Mathematics, Vol. 38, American Mathematical Society, Providence, Rhode Island, 1989.
4. Editor (with H. Lin), *Computing the Future: A Broader Agenda for Computer Science and Engineering*. A report of the National Research Council Study chaired by J. Hartmanis. National Academy Press, Washington, D. C., 1992.

RESEARCH PAPERS

1. Two Embedding Theorems for Finite Lattices, *Proc. Amer. Math. Soc*., Vol. 7, No. 4(1956), 571-577.
2 A Note on the Lattice of Geometries, *Proc. Amer. Math. Soc*., Vol. 8, No. 4 (1957), 560-562.
3. On the Lattice of Topologies, *Can. J. Math*., Vol. 10(1958), 547-553.
4. Lattice Theory of Generalized Partitions, *Can. J. Math*., Vol. 11(1959), 97-106.
5. Linear Multivalued Sequential Coding Networks, *IRE Trans. on Circuit Theory*, Vol. CT-6, No. 1(1959), 69--74.
6. The Application of Some Basic Inequalities for Entropy, *Information and Control*, Vol. 2, No. 3 (1959), 199-213.
7. Symbolic Analysis of a Decomposition of Information Processing Machines, *Information and Control*, Vol. 3, No 2(1960), 154-178.
8. Generalized Partitions and Lattice Embedding Theorems, *Proc. of Symposia in Pure Math.*, Vol. II, Lattice Theory Amer. Math. Soc. (1961), 22-30.
9. On the State Assignment Problem for Sequential Machines, I, *IRE Trans. on Electronic Computers*, Vol. EC-10, No. 2(1961), 157-165.
10. On the State Assignment Problem for Sequential Machines, II, *IRE Trans. on Electronic Computers*, Vol. EC-10, No. 4(1961), 593-603 (J. Hartmanis and R. E. Stearns).

11. Task Simplification and Learning Devices, *Proc. Symp. on "Information Theory"*, London, 1960(1961), 327-334.
12. Loop-Free Structure of Sequential Machines, *Information and Control*, Vol. 5, No. 1(1962), 25-43.
13. Maximal Autonomous Clocks of Sequential Machines, *IRE Trans. Electronic Computers*, Vol. EC-11, No. 1(1962), 83-86.
14. Some Dangers in State Reduction of Sequential Machines, *Information and Control*, Vol. 5, No. 3(1962), 252-260 (with R. E. Stearns).
15. A Study of Feedback and Errors in Sequential Machines, *IEEE Trans. Electronic Computers*, Vol. EC-12, No. 3(1963), 223-232 (with R. E. Stearns).
16. The Equivalence of Sequential Machine Models, *IEEE Trans. Electronic Computers*, Vol. EC-12, No. 1(1963), 18-19.
17. Further Results on the Structure of Sequential Machines, *JACM*, Vol. 10, No. 1(1963), 78-88.
18. Regularity Preserving Modifications of Regular Expressions, *Information and Control*, Vol. 6, No. 1(1963), 55-69 (with R. E. Stearns).
19. Computational Complexity of Recursive Sequences, *Proceedings of the 5th Annual Symposium on Switching Circuit Theory and Logical Design, IEEE*, New York (1964), 82-90 (with R. E. Stearns) (related to No. 23).
20. On the Application of Pair Algebra to Automata Theory, *Proceedings of the 5th Annual Symposium on Switching Circuit Theory and Logical Design, IEEE*, New York (1964), 192-195 (with R. E. Stearns) (related to No. 21).
21. Pair Algebras and Its Application to Automata Theory, *Information and Control*, Vol. 7, No. 4 (Dec. 1964), 485-507 (with R. E. Stearns).
22. Loop-Free Structure of Sequential Machines, in *Sequential Machines: Selected Papers*, Edward F. Moore (ed.). Addison-Wesley, Reading, Massachusetts (1964), 115-131. (No. 12 reprinted.)
23. On the Computational Complexity of Algorithms, *Trans. Amer. Math. Soc.*, Vol. 117, Issue 5 (May 1965), 285-306 (with R. E. Stearns).
24. Classification of Computations by Time and Memory Requirements, *Proc. of IFIP Congress 1965*, Vol. 1, Spartan Books, Washington, D.C. (1965), 31-35 (with P. M. Lewis and R. E. Stearns).
25. Linear Multivalued Sequential Coding Networks, in *Linear Sequential Switching Circuits: Selected Technical Papers,* William H. Kautz (ed.), Holden-Day, Inc., San Francisco (1965), 63-78.
26. Hierarchies of Memory Limited Computations, *Proc. of the Sixth Annual Symposium on Switching Circuit Theory and Logical Design, IEEE*, New York (1965), 179-190 (with P. M. Lewis and R. E. Stearns).
27. Memory Bounds for Recognition of Context-Free and Context-Sensitive Languages, *Proc. of the Sixth Annual Symposium on Switching Circuit Theory and Logical Design*, IEEE, New York (1965), 191-202 (with

P. M. Lewis and R. E. Stearns).

28. Two Tests for the Linearity of Sequential Machines, *IEEE Trans. on Electronic Computers*, Vol. EC-14, No. 6 (Dec. 1965), 781-786.
29. Minimal Feedback Realizations of Sequential Machines, *IEEE Trans. on Electronic Computers*, Vol. EC-15, No. 6 (Dec. 1966), 931-933.
30. Sets of Numbers Defined by Finite Automata, *The American Mathematical Monthly*, Vol. 74, No. 5 (May 1967), 539-542 (with R. E. Stearns).
31. On Memory Requirements for Context-Free Language Recognition, *JACM*, Vol. 14, No. 4 (Oct. 1967), 663-665.
32. Context-Free Languages and Turing Machine Computations, *Proc. in Applied Mathematics, Amer. Math. Soc.*, Vol. 19 (1967), 42-51.
33. Homomorphic Images of Linear Sequential Machines, *JCSS*, Vol. 1, No. 2 (Aug. 1967), 155-165 (with W. A. Davis).
34. On the Structure of Finite Automata, *Proc. of Systems & Computer Science Conference, University of Western Ontario, Sept. 1965*, John F. Hart and Satoru Takasu (eds.), (1967), 3-13.
35. On the Complexity of Undecidable Problems in Automata Theory, *Conference Record of the IEEE Eighth Annual Symposium on Switching and Automata Theory*, (Oct. 1967), 112-116 (related to No. 41).
36. Computational Complexity of One-Tape Turing Machine Computations, *JACM*, Vol. 15, No. 2 (April 1968), 325-339.
37. On the Recognition of Primes by Automata, *JACM*, Vol. 15, No. 3 (July 1968), 382-389 (with H. Shank).
38. Tape Reversal Bounded Turing Machine Computations, *JCSS*, Vol. 2, No. 2 (Aug. 1968), 117-135 (related to No. 39).
39. Tape Reversal Complexity Hierarchies, *IEEE Conference Record of the 1968 Ninth Annual Symposium on Switching and Automata Theory*, (Oct. 1968), 373-382 (with P. C. Fischer and M. Blum).
40. Structure of Undecidable Problems in Automata Theory, *IEEE Conference Record of 1968 Ninth Annual Symposium on Switching and Automata Theory*, (Oct. 1968), 327-333 (with J. E. Hopcroft).
41. On the Complexity of Undecidable Problems in Automata Theory, *JACM*, Vol. 16, No. 1 (Jan. 1969), 160-167.
42. Automata-based Computational Complexity, *Information Sciences*, Vol. 1, No. 2 (April 1969), 173-184 (with R. E. Stearns).
43. Two Memory Bounds for the Recognition of Primes by Automata, *Math. Systems Theory*, Vol. 3, No. 2 (1969), 125-129 (with H. Shank).
44. A Note on One-Way and Two-Way Automata, *Math. Systems Theory*, Vol. 4, No. 1 (1970), 24-28.
45. What Makes Some Language Theory Problems Undecidable, *JCSS*, Vol 4, No. 4 (Aug. 1970), 368-376 (with J. E. Hopcroft).
46. The Use of Lists in the Study of Undecidable Problems in Automata Theory, *JCSS*, Vol. 5, No. 1 (Feb. 1971), 54-66 (with F. D. Lewis).

47. Complexity of Formal Translations and Speed-Up Results, *Proc. Third ACM Symposium on Theory of Computing*, May 1971, 244-250 (with R. L. Constable).
48. An Overview of the Theory of Computational Complexity, *JACM*, Vol. 18, No. 3 (July 1971), 444-475 (with J. E. Hopcroft).
49. Computational Complexity of Random Access Stored Program Machines, *Math. Systems Theory*, Vol. 5, No. 3 (1971), 232-245.
50. Size Arguments in the Study of Computation Speeds, *Proc. Symposium on Computers and Automata*, Polytechnic Institute of Brooklyn, New York, April 1971 (1972), 232-235.
51. On Non-Determinancy in Simple Computing Devices, *Acta Informatica*, Vol. 1 (1972), 336-344.
52. Group Theoretic Characterization of Linear Permutation Automata, *JCSS* Vol. 7, No. 2 (April 1973), 168-188 (with H. Walter).
53. On the Problem of Finding Natural Computational Complexity Measures, *Proc. Symp. on Mathematical Foundations of Computer Science*, High Tatras, Czechoslovakia, Sept. 1973, published by Mathematical Institute of the Slovak Academy of Sciences, 95-103.
54. On Simple Goedel Numberings and Translation, *Automata, Languages and Programming,* 2nd Colloquium, University of Saarbruecken, 1974, *Lecture Notes in Computer Science*, Vol. 14, Springer-Verlag, 1974, 301-316 (with T. Baker) (related to No. 60).
55. On the Power of Multiplication on Random Access Machines, *Proc. of the IEEE Fifteenth Symposium on Switching and Automata Theory*, Oct. 1974, 13-23 (with J. Simon).
56. Computational Complexity of Formal Translations, *Math. Systems Theory*, Vol. 8 (1974), 156-166.
57. On the LBA Problem and Its Importance in the Theory of Computing, *SIAM-AMS, Proc. 7*, 1974, 1-26 (with H. B. Hunt).
58. On the Structure of Feasible Computations, *Proc. Fourth GI Conference, Lecture Notes in Computer Science*, Vol. 26 (1974), Springer-Verlag, 3-51 (with J. Simon).
59. On Simple Goedel Numberings and Translations, *SIAM J. Computing*, Vol. 4 (March 1975), 1-11 (with T. Baker).
60. A Note on Tape Bounds for SLA Language Processing, *IEEE Sixteenth Symp. on Foundations of Computer Science*, Oct. 1975, 60-65 (with L. Berman).
61. On Effective Speed-Up and Long Proofs of Trivial Theorems in Formal Systems, *Revue Francaise d'Automatique, R.A.I.R.O. Informatique Theoretique*, Vol. 10 (March 1976).
62. On Isomorphisms and Density of NP and Other Complete Sets, *Proc. Eighth ACM Symp. of Theory of Computing*, 1976, 30-40 (with L. Berman).
63. On the Structure of Feasible Computations, *Advances in Computers 14*, M. Rubinoff and M. C. Yovits, Eds. Academic Press, New York, 1976,

1-43 (with J. Simon) (related to No. 58).

64. On Tape Bounds for Single Letter Alphabet Language Processing, *Theoretical Computer Science 3* (1976), 213-224 (with L. Berman).
65. Independence Results in Computer Science, *ACM SIGACT News*, Vol. 8, No. 4 (Oct.-Dec. 1976), 13-24 (with J. E. Hopcroft).
66. On Polynomial Time Isomorphism of Complete Sets, *Theoretical Computer Science, Third GI Conference*, March 1977, *Lecture Notes in Computer Science*, Vol. 48, Springer-Verlag, 1-15 (with L. Berman).
67. Relations between Diagonalization, Proof Systems, and Complexity Gaps, *Proc. Ninth ACM Symp. of Theory of Computing*, 1977, 223-227.
68. On Isomorphisms and Density of NP and Other Complete Sets. *SIAM J. on Computing*, Vol. 6 (June 1977), 305-322 (with L. Berman).
69. On Polynomial Time Isomorphisms of Some New Complete Sets, *JCSS*, Vol. 16 (1978), 418-422 (with L. Berman).
70. On Log-Tape Isomorphisms of Complete Sets, *Theoretical Computer Science*, Vol. 7 (1978), 273-286.
71. Feasible Computations and Provable Complexity Properties, *CBMS-NSF Regional Conference Series in Applied Mathematics 30*, SIAM Monograph, 62 pages, 1978.
72. One-Way Log-Tape Reductions, *Proc. Nineteenth Symp. Foundations of Computer Science*, Oct. 1978, 65-71 (with N. Immerman and S. Mahaney).
73. Relations between Diagonalizations, Proof Systems and Complexity Gaps, *Theoretical Computer Science 8* (1979), 239-253 (related to No. 67).
74. On the Succinctness of Different Representations of Languages, *Proc. Int. Symp. on Automata and Languages, Lecture Notes in Computer Science*, Vol. 71, Springer-Verlag, 1979, 282-288.
75. Relative Succinctness of Representation of Language and Separation of Complexity Classes, *Proc. Ninth Symp. on Mathematics Foundations of Computer Science, Lecture Notes in Computer Science*, Vol. 74, Springer-Verlag, 1979, 70-88 (with T. Baker).
76. Observations about the Development of Theoretical Computer Science, *Proc. 20th IEEE Symp. on Foundations of Computer Science*, Oct. 1979, 224-233.
77. Succinctness, Verifiability and Determinism in Representations of Polynomial-Time Languages, *Proc. 20th IEEE Symp. on Foundations of Computer Science*, Oct. 1979, 392-396 (with T. Baker).
78. On the Succinctness of Different Representations of Languages, *SIAM J. on Computing,* Vol. 9 (1980), 114-120 (related to No. 74).
79. An Essay about Research on Sparse NP Complete Sets, *Proc. 9th Symp. on Mathematical Foundations of Computer Science, Lecture Notes in Computer Science*, Vol. 88 (1980), 40-57 (with S. Mahaney).
80. Observations about the Development of Theoretical Computer Science,

Annals of the History of Computing, Vol. 3, No. 1 (Jan. 1981), 42-51 (related to No. 76).

81. Languages Simultaneously Complete for One-Way and Two-Way Log-Tape Automata, *SIAM J. on Computing*, Vol. 10 (May 1981), 383-390.
82. A Note on Natural Complete Sets and Goedel Numberings. *Theoretical Computer Science*, Vol. 17 (1982), 75-89.
83. On the Structure of Feasible Computations, *Proc. 7th IBM Symp. on Mathematical Foundations of Computer Science: Mathematical Theory of Computations* (May 1982), Hakone, Japan, 25-48.
84. On Sparse Sets in NP-P, *Information Processing Letters*, Vol. 16, No. 2 (Feb. 1983), 55-60.
85. On Sparse Sets in NP-P: EXPTIME versus NEXPTIME, *Proc. 15th Annual ACM Symp. on Theory of Computing* (April 1983), 328-391 (with N. Immerman and V. Sewelson).
86. Computation Times of NP Sets of Different Densities, *Proc. 10th ICALP, Lecture Notes in Computer Science*, Vol. 154, Springer-Verlag, 1983, 319-330 (with Y. Yesha).
87. Generalized Kolmogorox Complexity and the Structure of Feasible Computations, *Proc. 24th Annual Symp. on Foundations of Computer Science*, IEEE Computer Society (Nov. 1983), 439-445.
88. On Goedel Speed-up and Succinctness of Language Representations, *Theoretical Computer Science*, Vol. 26, 1983, 335-342.
89. On Non-Isomorphic NP Complete Sets, *Bulletin of the European Association for Theoretical Computer Science (EATCS)*, No. 24 (Oct. 1984), 73-78.
90. Computation Times of NP Sets of Different Densities. *Theoretical Computer Science*, Vol. 34 (1984), 17-32 (with Y. Yesha). (related to No. 86).
91. On Complete Problems for NP $\cap$ coNP, *Proc. 12th ICALP*, *Lecture Notes in Computer Science*, Vol. 194, Springer-Verlag (July 1985), 250-259 (with N. Immerman).
92. Independence Results about Context-Free Languages and Lower Bounds, *Information Processing Letters*, Vol. 20 (1985), 241-248.
93. Sparse Sets in NP-P: EXPTIME versus NEXPTIME, *Information and Control*, Vol. 65 (May-June 1985), 158-181 (J. Hartmanis, N. Immerman and V. Sewelson).
94. Solvable Problems with Conflicting Relativizations, *Bulletin of European Association for Theoretical Computer Science*, Vol. 27 (Oct. 1985), 40-49.
95. On Sparse Oracles Separating Feasible Complexity Classes, *Proc. 3rd Annual Symp. on Theoretical Aspects of Computer Science - STACS 86, Lecture Notes in Computer Science*, Vol. 210 (1986), Springer-Verlag, 321-333 (with L. Hemachandra).

96. Complexity Classes without Machines: On Complete Languages for UP. *Proc. 13th International Colloquium on Automata, Languages, and Programming, Lecture Notes in Computer Science*, Vol. 226, (1986), Springer-Verlag, 123-135 (with L. Hemachandra).
97. Containment, Separation, Complete Sets, and Immunity of Complexity Classes, *Proc. 13th International Colloquium on Automata, Languages and Programming, Lecture Notes in Computer Science,* Vol. 226, (1986), Springer-Verlag, 136-145 (with M. Li and Y. Yesha).
98. Pragmatic Aspects of Complexity Theory, Information Processing '86, *Proc. of the IFIP 10th World Computer Congress*, North-Holland, 1986, 3-4.
99. The Structural Complexity Column: A Retrospective on Structural Complexity. *Bulletin of the European Association for Theoretical Computer Science* (EATCS), Vol. 31, (Feb. 1987), 115-122.
100. One-Way Functions, Robustness and the Non-Isomorphism of NP-Complete Problems. *Proc. Structure in Complexity Theory*, IEEE Computer Science Press (June 1987), 160-174 (with L. Hemachandra).
101. The Structural Complexity Column: Sparse Complete Sets for NP and the Optimal Collapse of the Polynomial Hierarchy. *Bulletin of the European Association for Theoretical Computer Science (EATCS)*, Vol. 32, (June 1987), 73-81.
102. Some Observations about NP Complete Sets, *Fundamentals of Computation Theory FCT'87*, Kazan, USSR; *Lecture Notes in Computer Science*, Vol. 278, Springer-Verlag, 1987, 185-196.
103. The Structural Complexity Column: The Collapsing Hierarchies, *Bulletin of the European Association for Theoretical Computer Science (EATCS)*, Vol. 33 (Oct. 1987), 26-39.
104. The Structural Complexity Column: Some Observations about Relativization of Space Bounded Computations, *Bulletin of the European Association for Theoretical Computer Science (EATCS)*, Vol. 35 (June 1988), 82-92 (with R. Chang, J. Kadin, and S. Mitchell).
105. New Developments in Structural Complexity Theory, Proc. 15th International Colloquium on Automata, Languages, and Programming, Lecture Notes in Computer Science, Vol. 317 (1988), Springer-Verlag, 270-286.
106. Complexity Classes without Machines: On Complete Languages for UP, *Theoretical Computer Science*, Vol. 58 (1988), 129-142 (with L. Hemachandra) (related to No. 96).
107. On Sparse Oracles Separating Feasible Complexity Classes, *Information Processing Letters*, Vol. 28 (1988), 291-295 (with L. Hemachandra) (related to No. 95).
108. The Boolean Hierarchy I: Structural Properties, SIAM *Journal on Computing*, Vol. 17 (Feb. 1988), 1232-1252 (with J. Cai, T. Gunderman, L. Hemachandra, V. Sewelson, K. Wagner and G. Wechsung).
109. The Boolean Hierarchy II: Applications, SIAM Journal on Computing,

Vol. 18 (Feb. 1989), 95-111 (with J. Car, T. Gunderman, L. Hemachandra, V. Sewelson, K. Wagner and G. Wechsung).

110. Structural Complexity Column: On the Importance of Being Π_2 Hard, *Bulletin of the European Association of Theoretical Computer Science, (EATCS)*, Vol. 37 (Feb. 1989), 117-127.
111. The Cornell Commission: On Morris and the Worm, *Communications of the ACM*, Vol. 32 (June 1989), 706-709 (with T. Eisenberg, D. Gries, D. Holcomb, M. S. Lynn, and T. Santoro).
112. The Complexity of the Real Line Is a Fractal, *Proc. Structure in Complexity Theory*, IEEE Computer Science Press, (June 1989), 138-146 (with J. Cai).
113. Computational Complexity Theory, *AMS Proceedings of Symposia in Applied Mathematics* (J. Hartmanis, ed.), Vol. 38, American Math Society, Providence, Rhode Island, 1989.
114. Overview of Computational Complexity Theory, in *Computational Complexity Theory*, 1-17, American Math Society, Providence, Rhode Island, 1989.
115. The Structural Complexity Column: Goedel, von Neumann and the P=?NP Problem, *Bulletin of the European Association for Theoretical Computer Science (EATCS)*, Vol. 38 (June 1989), 101-107.
116. Space Bounded Computations: Review and New Separation Results, *Proc. Mathematical Foundations of Computer Science*, *Lecture Notes in Computer Science*, Vol. 379, 47-66 (Porabka-Kozubnik, Aug. 1989) (with D. Ranjan).
117. Goedel, von Neumann, and the P=?NP Problem, Springer-Verlag Point, Summer 1989, 13-16 (reprint of No. 115).
118. New Developments in Structural Complexity Theory, *Theoretical Computer Science*, Vol. 71 (1990), 79-93 (related to No. 105).
119. Structural Complexity Theory: Recent Surprises, Proc. SWAT 90, Lecture Notes in Computer Science, Vol. 447 (1990), 1-12, Springer-Verlag (with R. Chang, D. Ranjan, and P. Rohatgi).
120. The Structural Complexity Column: On IP = PSPACE and Theorems with Narrow Proofs, *Bulletin of the European Association for Theoretical Computer Science (EATCS)*, Vol. 41 (June 1990), 217-225 (with L. Hemachandra).
121. Robust Machines Accept Easy Sets, *Theoretical Computer Science*, Vol. 74 (1990), 217-225 (with L. Hemachandra).
122. Computational Complexity (P. Wegner, ed.), *Strategic Directions in Computing Research*, Conference Report, ACM Press, 1990, 21-23.
123. The Cornell Commission: On Morris and the Worm, in *Computer Under Attack: Intruders, Worms, and Viruses* (P. Denning, ed.), Addison-Wesley, Reading, Massachusetts, 1990, 253-259 (with T. Eisenberg, D. Gries, D. Holcomb, M.S. Lynn, and T. Santoro).
124. Space Bounded Computations: Review and New Separation Results,

Theoretical Computer Science, Vol. 80 (1991), 289-302 (with R. Chang and D. Ranjan).

125. On the Structure of Feasible Computations, *Proc. Hamburg Mathematical Society*, 1992, 961-975.

126. The Structural Complexity Column: Relativization: A Revisionistic Retrospective, *Bulletin of the European Association for Theoretical Computer Science (EATCS)*, Vol. 47 (June 1992), 144-153 (with R. Chang, S. Chari, D. Ranjan, and P. Rohatgi).

129. *Computing the Future: A Broader Agenda for Computer Science and Engineering*. J. Hartmanis and H. Lin, eds. National Academy Press, Washington, D. C., 1992. Report of the National Research Council study, chaired by J. Hartmanis.

128. The King Is Dead! Long Live the King! *Computing Research News*, Vol. 4, No. 4, Sept. 1992, 7 (with H. Lin).

129. Computing the Future. Committee to Assess the Scope and Directions of Computer Science and Technology of the National Research Council, J. Hartmanis, chair. *Communications of the ACM*, Vol. 35, No. 11, Nov. 1992, 30-40.

130. Some Observations about the Nature of Computer Science, *Proc. 13th Conference on the Foundations of Software Technology and Theoretical Computer Science*, R. K. Shyamasundar, ed., *Lecture Notes in Computer Science*, Vol. 761, 1-12, Springer-Verlag, Heidelberg, January, 1993.

131. The Structural Complexity Column: A Broader Research Agenda for Theory, *Bulletin of the European Association for Theoretical Computer Science (EATCS)*, Vol. 49 (Feb. 1993), 125-129.

132. Structural Complexity (J. Hartmanis and guest editors), in *Current Trends in Theoretical Computer Science, Essays and Tutorials,* G. Rozenberg and A. Salomaa, eds., World Scientific, New Jersey, 1993, 395-547 (selected Structural Complexity Columns from the *Bulletins of the European Association of Theoretical Computer Science (EATCS)*).

133. On the Intellectual Terrain around NP, *Proc. 2nd Italian Conference on Algorithms and Complexity*, M. Bonuccelli, P. Crescenzi, and R. Petreschi, eds., *Lecture Notes in Computer Science*, Vol. 778, 1-11, Springer-Verlag, Heidelberg, February 1994.

134. The Random Oracle Hypothesis Is False, (with R. Chang, B. Chor, O. Goldreich, J. Hastad, D. Ranjan, and P. Rohatgi). *Journal of Computer and System Sciences*, Vol. 49, No. 1 (August 1944) 24-39.

135. The Structure of the Complexity of Computations: A Guided Tour Through Complexity Classes. *Proc. 13th World Computer Congress 94*. Vol. 1. Elsevier Sciences BV (North Holland) 213-220.

136. On Hausdorff and Topological Dimensions of the Kolmogorov Complexity of the Real Line. *Journal of Computer and System Sciences.* Vol. 49,

No. 3, (December 1994) 605-619. (With Jin-yi Cai).

137. The Structural Complexity Column: On the Weight of Computations. *Bulletin of the European Association for Theoretical Computer Science (EATCS)*, Vol. 55 (February, 1995) 136-138.

138. On the Computing Paradigm and Computational Complexity. Mathematical Foundations of Computer Science. (August - September, 1995, Prague), Jiri Wiedermann and Peter Hajek, editors. *Lecture Notes in Computer Science*, Vol. 969, 82-02. Springer-Verlag, Heidelberg.

139. Turing Award Lecture: On Computational Complexity and the Nature of Computer Science. *ACM Computing Surveys*, Vol. 27, No. 1. (March 1995) 7-16 (Reprinted from *Communications of the ACM*, Vol 37, No. 10 (1994) as part of Computing Surveys Symposium on Computational Complexity and the Nature of Computer Science, *ACM Computing Surveys,* Vol. 27, No. 1 (March 1995) 5-61.

140. Response to the Essays "On Computational Complexity and the Nature of Computer Science". *ACM Computing Surveys,* Vol. 27, No. 1 (March 1995) 59-61.

141. Computational Complexity and Mathematical Proofs. *Informatics – 10 Years Back, 10 Years Ahead.* Reinhard Wilhelm, editor. Springer-Verlag LNCS 2000, 251-256 (2001).

142. Separation of Complexity Classes. *Journal of the ACM, Fiftieth Anniversary Special Issue* (50)1: 58-62 (January 2003).

INVITED LECTURES (since 1990)

1. Recent Developments in Structural Complexity Theory. New Mexico State University, Las Cruces, New Mexico, February 23, 1990.
2. On the Structure of Feasible Computations. 300th Anniversary Celebration of the Mathematical Society of Hamburg, Hamburg, Germany, March 22, 1990.
3. Structural Computational Complexity: Recent Developments. State University of New York at Stony Brook, Stony Brook, New York, April 27, 1990.
4. Introduction to Complexity Theory. A series of five lectures at the Second International School of Theoretical Computer Science: Algorithms and Complexity, June 18-22, 1990, Acireale, Sicily, Italy.
5. Structural Complexity Theory: Recent Surprises. Invited lecture, SWAT '90, Bergen, Norway, July 9, 1990.
6. On the Computational Complexity of Doing Mathematics. Invited MAA-ACM address at the 75th Anniversary Celebration of MAA. AMS-MAA Summer Meeting, Columbus, Ohio, August 11, 1990.
7. Computational Complexity and the Complexity of Doing Mathematics.

Distinguished Lecture Series, Marist College, Poughkeepsie, New York, November 15, 1990.

8. On the Complexity of Computations, Theorem Proving and Trusting Proofs. University of Maine, Orono, Maine, March 18, 1991.
9. -----. NSF-CISE Colloquium, Washington, D.C., May 2, 1991.
10. -----. Supercomputing Research Center, Washington, D.C., May 3, 1991.
11. Computational Complexity, Celebration of NP-Completeness: The First 20 Years. Erice, Sicily, Italy, June 25, 1991.
12. From Goedel and von Neumann to Interactive Proofs. University of California, Santa Barbara, California, March 2, 1992.
13. -----. Distinguished Lecture Series, Computer Science Department, University of California, Los Angeles, California, March 3, 1992.
14. From Goedel and von Neumann to P=?NP and Interactive Proofs. Distinguished Lecture Series, College of Computing, Georgia Institute of Technology, Atlanta, Georgia, April 29, 1992.
15. From Goedel and von Neumann to P=?NP and Interactive Proofs: The Search for the Limits of Feasible Computability. 25th Anniversary Celebratory Symposium, Department of Computer Science, State University of New York, Buffalo, New York, May 4, 1992.
16. From Goedel and von Neumann to P=?NP to Interactive Proofs. Logical Methods in Mathematics and Computer Science: A Symposium in Honor of Anil Nerod on the Occasion of His 60th Birthday, Cornell University, Ithaca, New York, June 1-3, 1992.
17. Computing the Future: A Broader Agenda for Computer Science and Engineering. Computer Research Association Snowbird Conference, Snowbird, Utah, July 13, 1992.
18. -----. Computer Science and Telecommunications Board presentation, Washington, D.C., September 21, 1992.
19. -----. In a series of Distinguished Lectures in Computer Science, University of Toronto, Toronto, Canada, November 10, 1992.
20. -----. Distinguished Lecture Series, University of Illinois, Urbana, Illinois, November 19, 1992.
21. From Goedel and von Neumann to P=?NP to Interactive Proofs, University of Cincinnati, Cincinnati, Ohio, December 9, 1992.
22. Computing the Future: A Broader Agenda for Computer Science. Lecture in the American Academy of Arts & Sciences Annual meeting, CSTB and HPCC Session, Boston, Massachusetts, February 12, 1993.
23. Computing the Future. Perspectives in Informatic Meeting, Dagstuhl, Germany, November 15, 1993.
24. The Intellectual Terrain around NP. Technical University, Karlsruhe, Germany, November 16, 1993.
25. Some Observations about the Nature of Computer Science. Invited

lecture, 13th Foundations of Software Technology and Theoretical Computer Science, Bombay, India, December 15, 1993.

26. -----. University of Hamburg, Hamburg, Germany, January 31, 1994.
27. On the Intellectual Terrain around NP. University of Hamburg, Hamburg, Germany, February 1, 1994.
28. -----. Invited lecture, 2nd Italian Conference on Algorithms and Complexity, Rome, Italy, February 23, 1994.
29. Computational Complexity. Turing Award Lecture, ACM Conference, Phoenix, Arizona, March 9, 1994.
30. -----. Symposium to Honor 1993 Turing Award Recipients, Schenectady, New York, March 18, 1994.
31. Separation Problems in Computational Complexity. Max Planck Institute, Saarbruecken, Germany, July 5, 1995.
32. The Computing Paradigm and Computational Complexity. Acceptance Lecture for the award of Dr.h.c. University of Dortmund, Dortmund, Germany, July 7, 1995.
33. The Computing Paradigm and Computational Complexity. Keynote Lecture of the 20th Anniversary Mathematical Foundations of Computer Science Conference, Prague, Czech Republic, August 28, 1995.
34. On the Nature of Computer Science as a Science. Antonin Svoboda's Seminar, Czech Society for Cybernetics and Informatics, Prague, Czech Republic, September 4, 1995.
35. The Computing Paradigm and Computational Complexity. 13th Maryland Theoretical Computer Science Day. University of Maryland, October 6, 1995.
36. The Computing Paradigm and Computational Complexity. Distinguished Lecture Series, University of Pittsburgh, March 15, 1996.