Curriculum Vitae

Leslie G. Valiant

T. Jefferson Coolidge Professor of Computer Science and Applied Mathematics
School of Engineering and Applied Sciences
Harvard University

Education:

1967-70	B.A. in Mathematics, King's College, Cambridge
1970-71	Diploma in Computing Science, Imperial College, London
1971-73	Ph.D. (1974) in Computer Science, Warwick University Advisor: Michael Paterson

Employment and Visiting Positions:

1973-74	Visiting Assistant Professor Computer Science Department, Carnegie-Mellon University
1974-76	Lecturer Centre for Computer Studies, Leeds University
1977-82	Lecturer, Reader Computer Science Department, Edinburgh University
1982-2001	Gordon McKay Professor of Computer Science and Applied Mathematics, Division of Engineering and Applied Sciences, Harvard University
1986 Apr-Jul	Mathematical Sciences Research Institute, Berkeley, California
1987-88	Visiting Research Fellow, Merton College and Computing Laboratory, Oxford University
1989 August	International Computer Science Institute, Berkeley, California
1997 August	Visiting Fellow, Isaac Newton Institute, Cambridge University
2001-present	T. Jefferson Coolidge Professor, Harvard University

Awards:

1985-86	Guggenheim Fellowship
1986	Nevanlinna Prize (International Mathematical Union)
1997	Knuth Prize
2008	EATCS Award (European Association for Theoretical Computer Science)
2010	Turing Award

Professional Societies:

1991-	Fellow of the Royal Society
1992-	Fellow of the American Association for Artificial Intelligence
2001-	Member of the National Academy of Sciences
2008-	Fellow of the American Association for the Advancement of Science

2013- Fellow of the Association for Computing Machinery

Honorary Degrees:

2012 July	École Normale Supérieure, Lyon, Docteur *honoris causa*
2012 Dec.	Nanjing University, Honorary professor
2013 July	University of Warwick, Hon DSc (Honorary Doctor of Science)
2013 Oct.	University of Waterloo, DMath (Doctor of Mathematics *honoris causa*)

Honorary Appointments:

2013 - Honorary Fellow, King's College, Cambridge

Books:

Circuits of the Mind. Oxford University Press, New York, 1994. Paperback edition with new preface: 2000. Japanese translation: 1997.

Probably Approximately Correct: Nature's Algorithms for Learning and Prospering in a Complex World. Basic Books, New York, 2013.

Patents:

Three US patents on parallel computing.

Articles

1. The equivalence problem for deterministic finite-turn pushdown automata. *Information and Control*, 25, (1974), pp.123-133.

2. Regularity and related problems for deterministic pushdown automata. *J. ACM*, 22, (1975), pp.1-10.

3. Deterministic one-counter automata, (with M. S. Paterson). *J. Computer and System Sciences* 10, (1975) pp.340-350.

4. Parallelism in comparison problems. *SIAM J. on Computing*, 4, (1975), pp.348-355.

5. General context-free recognition in less than cubic time. *J. Computer and System Sciences*, 10, (1975), pp.308-315.

6. On non-linear lower bounds in computational complexity. *Proc. 7th ACM. Symp. on Theory of Computing*, Albuquerque, NM, May 5-7, 1975. pp.45-53.

7. Relative complexity of checking and evaluating. *Information Processing Letters*, 5 (1976), pp.20-23.

8. Shifting graphs and their applications, (with N. J. Pippenger). *J. ACM* 23 (1976), pp.423-432.

9. Graph theoretic properties in computational complexity. *J. Computer and System Sciences* 13, (1976), pp.278-285.

10. Circuit size is non-linear in depth, (with M. S. Paterson). *Theoretical Computer Science*, 2 (1976) pp.397-400.

11. The equivalence problem for DOL systems and its decidability for binary alphabets. In *Automata, Languages and Programming*, (S. Michaelson and R. Milner, eds.), Edinburgh University Press (1976), pp.31-37.

12. Space time tradeoffs in computation. *Asterisque* 38, (1976), pp. 253-264.

13. A note on the succinctness of descriptions of deterministic languages. *Information and Control* 32, (1976), pp.139-145.

14. On time versus space, (with J. E. Hopcroft and W. J. Paul). *J. ACM* 24, (1977), pp.332-337.

15. Fast probabilistic algorithms for Hamiltonian circuits and matchings, (with D. Angluin). *J. Computer and System Sciences*, 18: 2, (1979), pp.155-193.

16. Graph theoretic arguments in low-level complexity. *Lecture Notes in Computer Science 53,* Springer Verlag (1977), pp.162-176.

17. Universal circuits. *Proc. 8th ACM. Symp. on Theory of Computing*, Hershey, PA, May (1976), pp.196-203.

18. The complexity of computing the permanent. *Theoretical Computer Science*, 8 (1979), pp. 189-201.

19. The complexity of enumeration and reliability problems. *SIAM J. Computing*, 8:3 (1979), pp.410-421.

20. The complexity of combinatorial computations. In *GI8 Jahrestagung Informatik,* Fachbereichte Band 16, (S. Schindler and W. K. Giloi, eds.) Springer-Verlag (1978), pp.326-337.

21. Completeness classes in algebra. *Proc. 11th ACM. Symp. on Theory of Computing*, Atlanta, GA, April 30 - May 2, 1979. pp. 249-261.

22. Negative results on counting. *Lecture Notes in Computer Science 67,* Springer-Verlag (1979), pp.38-46.

23. Negation can be exponentially powerful. *Theoretical Computer Science* 12 (1980), pp.303-314.

24. A fast parallel algorithm for routing in permutation networks. (with G. Lev and N. J. Pippenger), *IEEE Trans. on Computers* C-30, 2 (1981), pp.93-100.

25. Computing multivariate polynomials in parallel. *Information Processing Letters*, 11:1 (1980), pp. 44-45 and 12:1 (1981), p. 54.

26. Universality considerations in VLSI circuits. *IEEE Trans. on Computers* C-30:2 (1981), pp. 135-140.

27. Reducibility by algebraic projections. Monographie No. 30 de L'Enseignement Mathematique: *Logic and Algorithmic,* Geneva (1982),pp.365-380.

28. A scheme for fast parallel communication. *SIAM J. Computing*, 11: 2 (1982), 350-361.

29. Experiments with a parallel communication scheme. *Proc. 18th Allerton Conference on Communication Control and Computing*, University of Illinois (1980), pp. 802-811.

30. Size bounds for superconcentrators, (with G. Lev). *Theoretical Computer Science* 22, 3 (1983), pp.233-252.

31. Universal schemes for parallel communication, (with G. J. Brebner). *Proc. 13th ACM. Symp. on Theory of Computing*, Milwaukee, IL, May 11-13, 1981, pp.263-277.

32. Fast parallel computation of polynomials using few processors, (with S. Skyum). *Lecture Notes in Computer Science 118,* Springer Verlag (1981), pp.132-139.

33. A complexity theory based on Boolean algebra, (with S. Skyum). *J. ACM* 32: 2 (1985) pp.484-502.

34. Parallel computation. *Proc. of 7th IBM Symp. on Mathematical Foundations of Computer Science*, Hakone, Japan, May 24-26, 1982, pp.171-189.

35. Optimality of a two-phase strategy for routing in interconnection network. *IEEE Trans. on Computers*, C-32:9 (1983), pp.861-863.

36. Fast parallel computation of polynomials using few processors, (with S. Skyum, S. Berkowitz and C. Rackoff). *SIAM J. Computing*, 12:4 (1983), pp.641-644.

37. A logarithmic time sort on linear size networks, (with J. H. Reif). *J. ACM.* 34:1 (1987) 60-76.

38. Exponential lower bounds for restricted monotone circuits. *Proc. 15th ACM. Symp. on Theory of Computing*, Boston, MA, April 25-27, 1983. pp.110-117.

39. Short monotone formulae for the majority function. *J. Algorithms* 5 (1984), pp.363-366.

40. An algebraic approach to computational complexity. *Proc. International Congress of Mathematicians*, August 1983. Polish Scientific Publishers, Warsaw and Elsevier Science Publishers, Amsterdam, Vol. 2, pp. 1637-1644.

41. A theory of the learnable. *C.ACM* 27:11 (1984) pp.1134-1142.

42. Deductive learning. *Phil. Trans. R. Soc. Lond. A 312* (1984), pp.441-446. (Also in *Mathematical Logic and Programming Languages*, C. A. R. Hoare and J. C. Shepherdson, eds. Prentice-Hall, Englewood Cliffs, NJ. (1985), pp. 107-112.

43. Negation is powerless for Boolean slice functions. *SIAM J. Computing.* 15:2 (1986) 531-535.

44. NP is as easy as detecting single solutions. (with V. V. Vazirani) *Theoretical Computer Science.* 47 (1986) 85-93.

45. Learning disjunctions of conjunctions. *Proc. Ninth International Joint Conferences on Artificial Intelligence*, Los Angeles, CA (August 1985) pp. 560-566.

46. Random generation of combinatorial structures from a uniform distribution. (with M. R. Jerrum and V. V. Vazirani). *Theoretical Computer Science* 43 (1986) 169-188.

47. On the learnability of Boolean formulae. (with M. Kearns, M. Li, and L. Pitt) *Proc. 19th ACM Symp. on Theory of Computing,* New York, NY, May 25-27 (1987) 285-295.

48. Recent results on Boolean concept learning. (with M. Kearns, M. Li and L. Pitt) *Proc 4th Int. Workshop on Machine Learning*, Morgan Kaufmann, Los Altos, CA (1987) 337-352.

49. Computational limitations on learning from examples, (with L. Pitt). *J. ACM*, 35:4 (1988) 965-984.

50. A general lower bound on the number of examples needed for learning. (with A. Ehrenfeucht, D. Haussler and M. Kearns) *Inf. and Computation.* 82:2 (1989) 247-261.

51. Optimally universal parallel computers. *Phil. Trans. R. Soc. London.* A*326* (1988) 373-376.

52. Functionality in neural nets. *Proc. American Association for Artificial Intelligence 1988*, Morgan Kaufmann, San Mateo, CA, (1988) 629-634.

53. Bulk-synchronous parallel computers. In *Parallel Processing and Artificial Intelligence*. (M. Reeve and S. Zenith, eds.), John Wiley and Sons, (1989) 15-22.

54. General purpose parallel architectures. In *Handbook of Theoretical Computer Science* (J. van Leeuwen, ed.), North Holland, Amsterdam (1990) pp. 944-971.

55. A bridging model for parallel computation. *C.ACM*, 33:8 (1990) pp. 103-111.

56. A view of computational learning theory. In *Computation and Cognition* (C.W. Gear, ed.), Soc. Ind. and Appl. Math., Philadelphia, (1990) 32-53.

57. Why is Boolean complexity theory difficult? In *Boolean Function Complexity,* (M.S. Paterson, ed.), *London Mathematical Society Lecture Note Series*, Cambridge University Press, 169 (1992) 84-94.

58. Direct bulk-synchronous parallel algorithms. (with A.V. Gerbessiotis.) In *Algorithm Theory – SWAT'92. Lecture Notes in Computer Science* vol 621, Springer-Verlag, (1992) 1-18. Extended version in *J. of Parallel and Distributed Computing* 22 (1994) 251-267.

59. A combining mechanism for parallel computers. In *Parallel Architectures and Their Efficient Use. Lecture Notes in Computer Science* vol. 678, Springer-Verlag, (1993) 1-10.

60. Why BSP computers? In *Proc 7th International Parallel Processing Symposium*, IEEE Computer Society Press, Los Alamitos, CA (1993) 2-5.

61. Cryptographic limitations on learning Boolean formulae and finite automata. (with M. Kearns) *J. ACM*, 41:1 (1994) 67-95.

62. Learning Boolean formulas (with M. Kearns and M. Li) *J.ACM*, 41:6 (1994) 1298-1328.

63. A neuroidal model for cognition. In *Natural and Artificial Parallel Computation*, (D.L. Waltz, ed.) Soc. Ind. and Appl. Math., Philadelphia, (1995) 127-140.

64. Bulk-synchronous parallel computing – a paradigm for transportable software. (with T. Cheatham, A. Fahmy, and D. Stefanescu.) In *Proc. 28th Hawaii International Conference on System Science*, Wailea, Maui, Hawaii, Jan 3-6 (1995).

65. Rationality. *Proc. 8th ACM Workshop on Computational Learning Theory*, ACM Press, (1995), 3-14.

66. Some theoretical questions in neuroscience, In Cortical Dynamics in Jerusalem (M. Abeles and H. Sompolinsky, eds.), The Hebrew University Center for Neural Computation, (1995) 793-798.

67. Cognitive computation. *Proc. 36th IEEE Symp. on Foundations of Computer Science*, IEEE Press, (1995) 2-3.

68. Managing complexity in neuroidal circuits. In *Algorithmic Learning Theory* (S. Arikawa and A.K. Sharma, eds.) *Lecture Notes in Artificial Intelligence*, Vol. 1160, Springer Verlag, Berlin 1996, pp. 1-11.

69. Relational learning for NLP using linear threshold elements. (with R. Khardon and D. Roth), In *Proc Sixteenth International Joint Conferences on Artificial Intelligence, IJCAI* 1999, Stockholm, July 1999. Morgan Kaufmann, 911-917.

70. Projection learning. *Machine Learning* 37:2 (1999)115–130.

71. Robust logics. *Artificial Intelligence Journal*, 117 (2000) 231–253.

72. A neuroidal architecture for cognitive computation. *J. Association Computing Mach.* 47:5 (2000) 854-882.

73. Quantum computers that can be simulated classically in polynomial time. *Proc. 33rd ACM Symp. on Theory of Computing*, ACM Press, NY, (2001) 114-123.

74. Quantum circuits that can be simulated classically in polynomial time. *SIAM J. on Computing*, 31:4 (2002) 1229-1254.

75. Expressiveness of matchgates. *Theoretical Computer Science*, 289:1 (2002) 457-471. Corrigendum: 299 (2003) 795.

76. Three problems in computer science, *J. Association Computing Mach.* 50:1 (2003) 96-99.

77. Holographic algorithms (extended abstract), *Proc. 45th Annual IEEE Symposium on Foundations of Computer Science,* Oct 17-19, Rome, Italy, (2004). IEEE Press, 306-315.

78. Memorization and association on a realistic neural model, *Neural Computation*, 17:3 (2005) 527-555.

79. Holographic circuits, *Proc. 32nd International Colloquium on Automata, Languages and Programming,* July 11-15, Lisbon, Portugal, LNCS, Vol. 3580, (2005), Springer-Verlag, 1-15

80. Completeness for parity problems, *Proc. 11th International Computing and Combinatorics Conference*, Aug 16-19, Kunming, China, *LNCS*, Vol. 3959, (2005), Springer-Verlag, 1-9.

81. A quantitative theory of neural computation, *Biological Cybernetics*, 95:3 (2006) 205-211.

82. Knowledge infusion, *Proc. 21st National Conference on Artificial Intelligence*, AAAI06, Jul 16-20, Boston, MA, AAAI Press, (2006), 1546-1551.

83. Accidental algorithms, *Proc. 47th Annual IEEE Symposium on Foundations of Computer Science*, Oct 22 -24, Berkeley, CA, IEEE Press, (2006), 509-517.

84. Holographic algorithms, *SIAM J. on Computing*, 37:5, (2008) 1565-1594. (Earlier version: *Electronic Colloquium on Computational Complexity*, TR05-099, (2005).)

85. A first experimental demonstration of massive knowledge infusion, (with Loizos Michael), *Proc. 11th International Conference on Principles of Knowledge Representation and Reasoning*, Sept. 16-20, 2008, Sydney, Australia, Sept. 16-20, (2008) 378-389.

86. Knowledge infusion: In pursuit of robustness in artificial intelligence, *Proc. 28th IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science*, Bangalore, India, Dec. 9-11, (2008) 415-422.

87. Evolvability, *J. Assoc. Computing Machinery*, 56:1 (2009) 3:1 - 3:21. (Earlier version: *Proc. 32nd International Symposium on Mathematical Foundations of Computer Science*, Aug. 26-31, Cesky Krumlov, Czech Republic, *LNCS*, Vol 4708, (2007) Springer-Verlag, 22-43.)

88. Experience-induced neural circuits that achieve high capacity, (with Vitaly Feldman), *Neural Computation*, 21:10 (2009), 2715-2754.

89. Some observations on holographic algorithms, *Proc. 9th Latin American Theoretical Informatics Symposium*, LATIN 2010: Oaxaca, Mexico, April 19-23, 2010, LNCS, Vol 6034 Springer-Verlag (2010), 577-590.

90. Evolution with drifting targets, (with Varun Kanade and Jennifer Wortman Vaughan), *Proc. 23rd Annual Conference on Learning Theory*, COLT 2010, (2010), 155-167.

91. A bridging model for multi-core computing, *Journal of Computer and System Sciences*, 77:1 (2011) 154-166 . (Earlier version: *Proc. 16th Annual European Symposium on Algorithms*, Sept. 15-17, 2008, Karlsruhe, Germany, LNCS, Vol 5193, (2008), Springer-Verlag, 13-28.)

92. The hippocampus as a stable memory allocator for cortex, *Neural Computation*, 24:11 (2012) 2873-2899.

93. The complexity of symmetric Boolean parity holant problems, (with Heng Guo and Pinyan Lu), *SIAM J. on Computing*, 42:1 (2013) 324-356.

94. What must a global theory of cortex explain? *Current Opinion in Neurobiology*, 25C (2014) 15-19.

Current Research Interests

Computational complexity, machine learning, computational neuroscience, artificial intelligence, biological evolution, parallel algorithms and architectures.