

Bibliography

- Adamatzky, A. (2001). *Computing in Nonlinear Media and Automata Collectives*. Bristol: Institute of Physics Publishing.
- Adamatzky, A., De Lacy Costello, B., & Asai, T. (2005). *Reaction-Diffusion Computers*. Amsterdam: Elsevier.
- Adleman, L. M. (1995). On constructing a molecular computer. In R. J. Lipton & E. B. Baum (Eds.), *DNA Based Computers*, Proc. of a DIMACS Workshop (pp. 1–22).
- Anderson, J. (1995). *An Introduction to Neural Networks*. Cambridge, MA: MIT Press.
- Ashley, J. R. (1963). *Introduction to Analog Computing*. New York: John Wiley & Sons.
- Aspray, W. (1993). Edwin l. harder and the anacom: Analog computing at westinghouse. *IEEE Annals of the History of Computing*, 15(2), 35–52.
- Ben-Hur, A., Siegelmann, H., & Fishman, S. (2002). A theory of complexity for continuous time systems. *Journal of Complexity*, 18, 51–86.
- Benioff, P. (1980). The computer as a physical system: A microscopic quantum mechanical Hamiltonian model of computers as represented by Turing machines. *Journal of Statistical Physics*, 22(5), 563–591.
- Benioff, P. (1982). Quantum mechanical Hamiltonian models of Turing machines. *Journal of Statistical Physics*, 29(3), 515–546.
- Bennett, C. H. (1973). Logical reversibility of computation. *IBM Journal of Research and Development*, 17(6), 525–532.

- Bennett, C. H. (1982). The thermodynamics of computation — a review. *Int. J. Theo. Phys.*, 21(12), 905–940.
- Bennett, C. H. (2003). Notes on Landauer’s principle, reversible computation, and Maxwell’s Demon. *Studies in History and Philosophy of Modern Physics*, 34, 501–510.
- Berut, A., Arakelyan, A., Petrosyan, A., Ciliberto, S., Dillenschneider, R., & Lutz, E. (2012). Experimental verification of Landauer’s principle linking information and thermodynamics. *Nature*, 483, 187–189.
- Bissell, C. C. (2004). A great disappearing act: The electronic analogue computer. In *IEEE Conference on the History of Electronics* Bletchley, UK.
- Blum, L., Cucker, F., Shub, M., & Smale, S. (1998). *Complexity and Real Computation*. Berlin: Springer-Verlag.
- Blum, L., Shub, M., & Smale, S. (1988). On a theory of computation and complexity over the real numbers: N_p completeness, recursive functions and universal machines. *The Bulletin of the American Mathematical Society*, 21, 1–46.
- Bournez, O., Campagnolo, M., Graça, D., & Hainry, E. (2006). The General Purpose Analog Computer and computable analysis are two equivalent paradigms of analog computation. In *Theory and Applications of Models of Computation (TAMC 2006)*, volume 3959 of *Lectures Notes in Computer Science* (pp. 631–43). Berlin: Springer-Verlag.
- Bournez, O. & Cosnard, M. (1996). On the computational power of dynamical systems and hybrid systems. *Theoretical Computer Science*, 168(2), 417–59.
- Bowles, M. D. (1996). U.S. technological enthusiasm and British technological skepticism in the age of the analog brain. *Annals of the History of Computing*, 18(4), 5–15.
- Branicky, M. (1994). Analog computation with continuous ODEs. In *Proceedings IEEE Workshop on Physics and Computation* (pp. 265–74). Dallas, TX.

- Brockett, R. (1988). Dynamical systems that sort lists, diagonalize matrices and solve linear programming problems. In *Proc. 27th IEEE Conf. Decision and Control* (pp. 799–803). Austin, TX.
- Calude, C., Casti, J., & Dinneen, M., Eds. (1998). *Unconventional Models of Computation*. Singapore & New York: Springer.
- Calude, C. & Paun, G. (2001). *Computing with Cells and Atoms*. London & New York: Taylor & Francis.
- Camazine, S., Deneubourg, J., Franks, N. R., Sneyd, J. Theraulaz, G., & Bonabeau, E. (2001). *Self-organization in Biological Systems*. Princeton.
- Changeux, J. (1985). *Neuronal Man: The Biology of Mind*. Oxford: Oxford University Press. tr. by L. Garey.
- Clymer, A. B. (1993). The mechanical analog computers of hannibal ford and william newell. *IEEE Annals of the History of Computing*, 15(2), 19–34.
- Daugman, J. (1993). An information-theoretic view of analog representation in striate cortex. In E. Schwartz (Ed.), *Computational Neuroscience* (pp. 403–423). Cambridge: MIT Press.
- Davidson, E. H. (2006). *The Regulatory Genome: Gene Regulatory Networks in Development and Evolution*. Amsterdam: Academic Press.
- Davies, J. A. (2005). *Mechanisms of Morphogenesis*. Amsterdam: Elsevier.
- Davis, M. (2004). The myth of hypercomputation. In C. Teuscher (Ed.), *Alan Turing: Life and Legacy of a Great Thinker* (pp. 195–212). Berlin: Springer-Verlag.
- Davis, M. (2006). Why there is no such discipline as hypercomputation. *Applied Mathematics and Computation*, 178, 4–7.
- Dennard, R. H., Gaensslen, F., Yu, H.-N., Rideout, L., Bassous, E., & LeBlanc, A. (1974). Design of ion-implanted MOSFET's with very small physical dimensions. *IEEE Journal of Solid-State Circuits*, 9(5), 256–268. Reprinted, Proc. IEEE, vol. 87, no. 4, APRIL 1999, pp. 668–678.

- Deutsch, D. (1985). Quantum theory, the Church-Turing principle, and the universal quantum computer. *Proceedings of the Royal Society London A*, 400, 97–119.
- Eberbach, E., Goldin, D., & Wegner, P. (2003). Turing's ideas and models of computation. In C. Teuscher (Ed.), *Alan Turing: Life and Legacy of a Great Thinker*. Berlin, Heidelberg & New York: Springer-Verlag.
- Fakhraie, S. M. & Smith, K. C. (1997). *VLSI-Compatible Implementation for Artificial Neural Networks*. Boston: Kluwer Academic Publishers.
- Feynman, R. (1986). Quantum mechanical computers. *Foundations of Physics*, 16(6), 507–531.
- Feynman, R. P. (1982). Simulating physics with computers. *International Journal of Theoretical Physics*, 21, 467–488.
- Frank, M. P. (2005a). The indefinite logarithm, logarithmic units, and the nature of entropy. Dept. of Electrical & Computer Engineering, FAMU-FSU College of Engineering.
- Frank, M. P. (2005b). Introduction to reversible computing: Motivation, progress, and challenges. In *CF '05, May 4–6, 2005, Ischia, Italy*.
- Franklin, S. & Garzon, M. (1990). Neural computability. In O. M. Omidvar (Ed.), *Progress in Neural Networks*, volume 1 (pp. 127–145). Norwood, NJ: Ablex.
- Fredkin, E. F. & Toffoli, T. (1982). Conservative logic. *Int. J. Theo. Phys.*, 21(3/4), 219–253.
- Freeth, T., Bitsakis, Y., Moussas, X., Seiradakis, J., Tselikas, A., Mangou, H., Zafeiropoulou, M., Hadland, R., Bate, D., Ramsey, A., Allen, M., Crawley, A., Hockley, P., Malzbender, T., Gelb, D., Ambrisco, W., & Edmunds, M. (2006). Decoding the ancient Greek astronomical calculator known as the Antikythera mechanism. *Nature*, 444, 587–91.
- Garzon, M. & Franklin, S. (1989). Neural computability ii (extended abstract). In *Proceedings, IJCNN International Joint Conference on Neural Networks*, volume 1 (pp. 631–637). New York, NJ: Institute of Electrical and Electronic Engineers.

- Garzon, M. & Franklin, S. (1990). Computation on graphs. In O. M. Omidvar (Ed.), *Progress in Neural Networks*, volume 2 chapter 13. Norwood, NJ: Ablex.
- George, S., Kim, S., Shah, S., Hasler, J., Collins, M., Adil, F., Wunderlich, R., Nease, S., & Ramakrishnan, S. (2016). A programmable and configurable mixed-mode FPAA SoC. *IEEE Transactions on Very Large Scale Integration (VLSI) Systems*, 24(6), 2253–2261.
- Goldstine, H. (1972). *The Computer from Pascal to von Neumann*. Princeton, NJ: Princeton.
- Grossberg, S. (1967). Nonlinear difference-differential equations in prediction and learning theory. *Proceedings of the National Academy of Sciences, USA*, 58(4), 1329–1334.
- Grossberg, S. (1973). Contour enhancement, short term memory, and constancies in reverberating neural networks. *Studies in Applied Mathematics*, LII, 213–257.
- Grossberg, S. (1976). Adaptive pattern classification and universal recoding: I. parallel development and coding of neural feature detectors. *Biological Cybernetics*, 23, 121–134.
- Harnad, S. (1990). The symbol grounding problem. *Physica D*, 42, 335–346.
- Harnad, S. (1993). Grounding symbols in the analog world. *Think*, 2, 12–78.
- Hartl, D. L. (1994). *Genetics*. Boston: Jones & Bartlett, 3rd edition.
- Haykin, S. (2008). *Neural Networks and Learning Machines*. New York: Pearson Education, third edition.
- Hopfield, J. (1984). Neurons with graded response have collective computational properties like those of two-state neurons. *Proceedings of the National Academy of Sciences USA*, 81, 3088–92.
- Howe, R. M. (1961). *Design Fundamentals of Analog Computer Components*. Princeton, NJ: Van Nostrand.
- Khatib, O. (1986). Real-time obstacle avoidance for manipulators and mobile robots. *International Journal of Robotics Research*, 5, 90–9.

- Kirchhoff, G. (1845). Ueber den durchgang eines elektrischen stromes durch eine ebene, insbesondere durch eine kreisförmige. *Annalen der Physik und Chemie*, 140/64(4), 497–514.
- Landauer, R. (1961). Irreversibility and heat generation in the computing process. *IBM Journal of Research and Development*, 5(3), 183–191. Reprinted, Vol. 44 No. 1/2, Jan./March 2000, pp. 261–269.
- Lang, G. F. (2000). Analog was not a computer trademark! Why would anyone write about analog computers in year 2000? *Sound and Vibration*, (pp. 16–24).
- Leff, H. S. & Rex, A. F. (1990). *Maxwell's Demon: Entropy, Information, Computing*. Princeton, NJ: Princeton University Press.
- Leff, H. S. & Rex, A. F. (2003). *Maxwell's Demon 2: Entropy, Classical and Quantum Information, Computing*. Bristol and Philadelphia: Institute of Physics Publishing.
- Lipka, J. (1918). *Graphical and Mechanical Computation*. New York: Wiley.
- Lipshitz, L. & Rubel, L. A. (1987). A differentially algebraic replacment theorem. *Proceedings of the American Mathematical Society*, 99(2), 367–72.
- Maass, W. & Sontag, E. (1999a). Analog neural nets with Gaussian or other common noise distributions cannot recognize arbitrary regular languages. *Neural Computation*, 11, 771–782.
- Maass, W. & Sontag, E. (1999b). Analog neural nets with Gaussian or other common noise distributions cannot recognize arbitrary regular languages. *Neural Computation*, 11(3), 771–782.
- MacLennan, B. J. (1987). Technology-independent design of neurocomputers: The universal field computer. In M. Caudill & C. Butler (Eds.), *Proceedings of the IEEE First International Conference on Neural Networks*, volume 3 (pp. 39–49): IEEE Press.
- MacLennan, B. J. (1990). *Field Computation: A Theoretical Framework for Massively Parallel Analog Computation, Parts I–IV*. Technical Report CS-90-100, Department of Computer Science, University of Tennessee, Knoxville. Also available from web.eecs.utk.edu/~mclennan.

- MacLennan, B. J. (1991). *Gabor Representations of Spatiotemporal Visual Images*. Technical Report CS-91-144, Department of Computer Science, University of Tennessee, Knoxville. Also available from web.eecs.utk.edu/~mclennan.
- MacLennan, B. J. (1993). Grounding analog computers. *Think*, 2, 48–51. Also available from web.eecs.utk.edu/~mclennan and at cogprints.org/542/.
- MacLennan, B. J. (1994a). Continuous computation and the emergence of the discrete. In K. H. Pribram (Ed.), *Origins: Brain & Self-Organization* (pp. 121–151). Hillsdale, NJ: Lawrence Erlbaum. Also available from web.eecs.utk.edu/~mclennan and at cogprints.org/540/.
- MacLennan, B. J. (1994b). Continuous symbol systems: The logic of connectionism. In D. S. Levine & M. Aparicio IV (Eds.), *Neural Networks for Knowledge Representation and Inference* (pp. 83–120). Hillsdale, NJ: Lawrence Erlbaum. Also available from web.eecs.utk.edu/~mclennan.
- MacLennan, B. J. (1994c). “Words lie in our way”. *Minds and Machines*, 4(4), 421–437. Also available from web.eecs.utk.edu/~mclennan and at cogprints.org/383/.
- MacLennan, B. J. (1995). Continuous formal systems: A unifying model in language and cognition. In *Proceedings of the IEEE Workshop on Architectures for Semiotic Modeling and Situation Analysis in Large Complex Systems* (pp. 161–172). Monterey, CA. Also available from web.eecs.utk.edu/~mclennan and at cogprints.org/541.
- MacLennan, B. J. (1999). Field computation in natural and artificial intelligence. *Information Sciences*, 119, 73–89. Also available from web.eecs.utk.edu/~mclennan.
- MacLennan, B. J. (2001). *Can Differential Equations Compute?* Technical Report UT-CS-01-459, Department of Computer Science, University of Tennessee, Knoxville. Also available from web.eecs.utk.edu/~mclennan.
- MacLennan, B. J. (2003). Transcending Turing computability. *Minds and Machines*, 13, 3–22.

- MacLennan, B. J. (2004). Natural computation and non-Turing models of computation. *Theoretical Computer Science*, 317, 115–145.
- MacLennan, B. J. (2008). *Aspects of Embodied Computation: Toward a Reunification of the Physical and the Formal*. Technical Report UT-CS-08-610, Department of Electrical Engineering and Computer Science, University of Tennessee, Knoxville.
- MacLennan, B. J. (2009a). Field computation in natural and artificial intelligence. In R. Meyers et al. (Ed.), *Encyclopedia of Complexity and System Science* chapter 6, entry 199, (pp. 3334–3360). Springer.
- MacLennan, B. J. (2009b). Super-Turing or non-Turing? Extending the concept of computation. *International Journal of Unconventional Computing*, 5(3–4), 369–387.
- MacLennan, B. J. (2010). The U-machine: A model of generalized computation. *International Journal of Unconventional Computing*, 6(3–4), 265–283.
- MacLennan, B. J. (2013). Cognition in Hilbert space. *Behavioral and Brain Sciences*, 36(3), 296–7.
- Maini, P. K. & Othmer, H. G., Eds. (2001). *Mathematical Models for Biological Pattern Formation*. Springer-Verlag.
- Markov, A. (1961). *Theory of Algorithms*. Jerusalem, Israel: Israel Program for Scientific Translation. US Dept. of Commerce Office of Technical Service OTS 60-51085, transl. by Jacques J. Schorr-Kon & PST Staff. Translation of *Teoriya Algorifmov*, Academy of Sciences of the USSR, Moscow, 1954.
- Maziarz, E. & Greenwood, T. (1968). *Greek Mathematical Philosophy*. New York: Frederick Ungar.
- McClelland, J., Rumelhart, D., & the PDP Research Group (1986). *Parallel Distributed Processing: Explorations in the Microstructure of Cognition, Volume 2: Psychological and Biological Models*. Cambridge, MA: MIT Press.

- Mead, C. (1987). Silicon models of neural computation. In M. Caudill & C. Butler (Eds.), *Proceedings, IEEE First International Conference on Neural Networks*, volume I (pp. 91–106). Piscataway NJ: IEEE Press.
- Mead, C. (1989). *Analog VLSI and Neural Systems*. Reading, MA: Addison-Wesley.
- Mermin, N. D. (2007). *Quantum Computer Science: An Introduction*. Cambridge: Cambridge University Press.
- Mills, J. W. (1996). The continuous retina: Image processing with a single-sensor artificial neural field network. In *Proceedings IEEE Conference on Neural Networks*: IEEE Press.
- Mills, J. W., Himebaugh, B., Kopecky, B., Parker, M., Shue, C., & Weilemann, C. (2006). “Empty space” computes: The evolution of an unconventional supercomputer. In *Proceedings of the 3rd Conference on Computing Frontiers* (pp. 115–26). New York: ACM Press.
- Milner, R. (1993). Elements of interaction. *Communications of the ACM*, 36(1), 78–89.
- Milner, R., Parrow, J., & Walker, D. (1992). A calculus of mobile processes, I & II. *Information and Computation*, 100, 1–77.
- Moore, C. (1996). Recursion theory on the reals and continuous-time computation. *Theoretical Computer Science*, 162, 23–44.
- Moore, G. E. (1965). Cramming more components onto integrated circuits. *Electronics*, 38(8), 114–117.
- Murray, J. D. (1977). *Lectures on Nonlinear Differential-Equation Models in Biology*. Oxford: Oxford.
- Nielsen, M. A. & Chuang, I. L. (2010). *Quantum Computation and Quantum Information*. Cambridge, 10th anniversary edition edition.
- Omohundro, S. (1984). Modeling cellular automata with partial differential equations. *Physica D*, 10, 128–34.
- Orponen, P. (1997). A survey of continuous-time computation theory. In *Advances in Algorithms, Languages, and Complexity* (pp. 209–224).

- Orponen, P. & Matamala, M. (1996). Universal computation by finite two-dimensional coupled map lattices. In *Proceedings, Physics and Computation 1996* (pp. 243–7). Cambridge, MA: New England Complex Systems Institute.
- Owens, L. (1986). Vannevar bush and the differential analyzer: The text and context of an early computer. *Technology and Culture*, 27(1), 63–95.
- Peterson, G. R. (1967). *Basic Analog Computation*. New York: Macmillan.
- Pothos, E. M. & Busemeyer, J. R. (2013). Can quantum probability provide a new direction for cognitive modeling? *Behavioral and Brain Sciences*, 36, 255–327.
- Pour-El, M. (1974a). Abstract computability and its relation to the general purpose analog computer (some connections between logic, differential equations and analog computers). *Transactions of the American Mathematical Society*, 199, 1–29.
- Pour-El, M. & Richards, I. (1979). A computable ordinary differential equation which possesses no computable solution. *Annals of Mathematical Logic*, 17, 61–90.
- Pour-El, M. & Richards, I. (1981). The wave equation with computable initial data such that its unique solution is not computable. *Advances in Mathematics*, 39, 215–239.
- Pour-El, M. & Richards, I. (1982). Noncomputability in models of physical phenomena. *International Journal of Theoretical Physics*, 21, 553–555.
- Pour-El, M. B. (1974b). Abstract computability and its relation to the general purpose analog computer (some connections between logic, differential equations and analog computers). *Transactions of the American Mathematical Society*, 199, 1–29.
- Puchta, S. (1996). On the role of mathematics and mathematical knowledge in the invention of vannevar bush’s early analog computers. *IEEE Annals of the History of Computing*, 18(4), 49–59.
- Reiner, J. M. (1968). *The Organism as an Adaptive Control System*. Englewood Cliffs: Prentice-Hall.

- Rieffel, E. & Polak, W. (2000). An introduction to quantum computing for non-physicists.
- Rimon, E. & Koditschek, D. (1989). The construction of analytic diffeomorphisms for exact robot navigation on star worlds. In *Proceedings of the 1989 IEEE International Conference on Robotics and Automation, Scottsdale AZ* (pp. 21–6). New York: IEEE Press.
- Rogers, A. & Connolly, T. (1960). *Analog Computation in Engineering DESIGN*. New York: McGraw-Hill.
- Rubel, L. A. (1985). The brain as an analog computer. *Journal of Theoretical Neurobiology*, 4, 73–81.
- Rubel, L. A. (1988). Some mathematical limitations of the general-purpose analog computer. *Advances in Applied Mathematics*, 9, 22–34.
- Rubel, L. A. (1993). The extended analog computer. *Advances in Applied Mathematics*, 14, 39–50.
- Rumelhart, D., McClelland, J., & the PDP Research Group (1986). *Parallel Distributed Processing: Explorations in the Microstructure of Cognition, Volume 1: Foundations*. Cambridge, MA: MIT Press.
- Sanger, T. (1996). Probability density estimation for the interpretation of neural population codes. *Journal of Neurophysiology*, 76, 2790–3.
- Shannon, C. E. (1941). Mathematical theory of the differential analyzer. *Journal of Mathematics and Physics of the Massachusetts Institute Technology*, 20, 337–354.
- Shannon, C. E. (1993). Mathematical theory of the differential analyzer. In N. J. A. Sloane & A. D. Wyner (Eds.), *Claude Elwood Shannon: Collected Papers* (pp. 496–513). New York: IEEE Press.
- Siegelmann, H., Ben-Hur, A., & Fishman, S. (1999). Computational complexity for continuous time dynamics. *Physical Review Letters*, 83(7), 1463–6.
- Siegelmann, H. & Sontag, E. (1994a). Analog computation via neural networks. *Theoretical Computer Science*, 131, 331–360.

- Siegelmann, H. & Sontag, E. (1994b). Analog computation via neural networks. *Theoretical Computer Science*, 131, 331–360.
- Siegelmann, H. T. (1999). *Neural Networks and Analog Computation: Beyond the Turing Limit*. Boston: Birkhäuser.
- Small, J. S. (1993). General-purpose electronic analog computing. *IEEE Annals of the History of Computing*, 15(2), 8–18.
- Small, J. S. (2001). *The Analogue Alternative*. London & New York: Routledge.
- Sprecher, D. (1965). On the structure of continuous functions of several variables. *Transactions of the American Mathematical Society*, 115, 340–355.
- Stannett, M. (1990). X-machines and the halting problem: Building a super-Turing machine. *Formal Aspects of Computing*, 2, 331–341.
- Stepney, S. (2004). Journeys in non-classical computation. In T. Hoare & R. Milner (Eds.), *Grand Challenges in Computing Research* (pp. 29–32). Swindon: BCS.
- Thomson, W. (1876). Mechanical integration of the general linear differential equation of any order with variable coefficients. *Proceedings of the Royal Society*, 24, 271–275.
- Thomson, W. (1878). Harmonic analyzer. *Proceedings of the Royal Society*, 27, 371–373.
- Thomson, W. (1938). The tides. In *The Harvard Classics*, volume 30: Scientific Papers (Lord Kelvin) (pp. 274–307). New York: Collier.
- Tong, D. (Lent Term, 2011 and 2012). *Statistical Physics: University of Cambridge Part II Mathematical Tripos*.
- Truitt, T. D. & Rogers, A. E. (1960). *Basics of Analog Computers*. New York: John F. Rider.
- van Gelder, T. (1997). Dynamics and cognition. In J. Haugeland (Ed.), *Mind Design II: Philosophy, Psychology and Artificial Intelligence* chapter 16, (pp. 421–450). Cambridge MA: MIT Press, revised & enlarged edition.

- Wegner, P. (1997). Why interaction is more powerful than algorithms. *Communications of the ACM*, 40(5), 81–91.
- Wegner, P. (1998). Interactive foundations of computing. *Theoretical Computer Science*, 192(2), 315–351.
- Wegner, P. & Goldin, D. (2003). Computation beyond Turing machines: Seeking appropriate methods to model computing and human thought. *Communications of the ACM*, 46(4), 100–102.
- Weyrick, R. C. (1969). *Fundamentals of Analog Computers*. Englewood Cliffs: Prentice-Hall.
- Winfrey, E. (1998). *Algorithmic Self-Assembly of DNA*. PhD thesis, California Institute of Technology.
- Wolpert, D. (1991). *A Computationally Universal Field Computer which is Purely Linear*. Technical Report LA-UR-91-2937, Los Alamos National Laboratory.
- Wolpert, D. H. & MacLennan, B. J. (1993). *A Computationally Universal Field Computer that is Purely Linear*. Technical Report CS-93-206, Dept. of Computer Science, University of Tennessee, Knoxville. Also available from web.eecs.utk.edu/~mclennan.