

Lee Spector

OFFICE	School of Cognitive Science Hampshire College Amherst, MA 10002 413-559-5352 413-559-5438 (fax) lspector@hampshire.edu http://hampshire.edu/lspector
HOME	34 Columbus Avenue Northampton, MA 01060 413-584-8742
CITIZENSHIP	U.S.A.
EDUCATION	Ph.D., University of Maryland, Department of Computer Science, May 1992 Dissertation: Supervenience in Dynamic-World Planning Advisor: James Hendler Principal area: Artificial Intelligence Other areas: Programming Languages, Theory of Computation Additional graduate study at George Washington University, Washington D.C. B.A., Oberlin College, Department of Philosophy, May 1984 Other areas: Computer Music, Aesthetics, Conceptual Art, Visual Arts Active in the Technology in Music and Related Arts (TIMARA) program
RESEARCH INTERESTS	Artificial intelligence, artificial life, genetic and evolutionary computation, quantum computation, human and machine learning, computational models of creative processes, computation in the arts, computer science education
EMPLOYMENT	<i>Professor of Computer Science</i> <i>Director, Computational Intelligence Laboratory</i> School of Cognitive Science Hampshire College Full professor rank since 7/04 Acting Dean, Cognitive Science, 10/15–1/16 Dean, Cognitive Science, 7/02–6/05 Faculty Trustee, 7/98–6/00 MacArthur Chair, 7/97–6/00 <i>Adjunct Professor and Associated Five-College Graduate Faculty member</i> College of Information and Computer Sciences University of Massachusetts, Amherst <i>Research Associate and Visiting Assistant Professor of Computer Science</i> Department of Computer Science University of Maryland at College Park <i>Faculty Research Assistant</i> Department of Computer Science University of Maryland at College Park

July, 1992 – present

September, 2007 – present

August 1995 – July 1996

March 1992 – June 1992

Graduate Research Assistant
Systems Research Center
University of Maryland at College Park
August 1988 – March 1992

Graduate Research Assistant
Computer Vision Lab
University of Maryland at College Park
January 1987 – June 1988

Human Interface Programmer
Academic Hospital of Groningen
Groningen, The Netherlands
Summer 1987

Graduate Teaching Assistant
Department of Computer Science
University of Maryland at College Park
Fall 1986

Graduate Research Assistant
Institute for Artificial Intelligence
George Washington University, Washington D.C.
June 1986 – January 1987

Artificial Intelligence Programmer
Intellitek Inc.
Washington D.C.
Summer 1986

Graduate Teaching Assistant
Department of Computer Science
George Washington University, Washington D.C.
Spring 1986

Graduate Research Assistant
Department of Computer Science
George Washington University, Washington D.C.
August 1985 – June 1986

Chief Engineer
WOBC Radio
Oberlin, Ohio
Spring 1984

CURRENT
PROFESSIONAL
POSITIONS

Editor-in-Chief, *Genetic Programming and Evolvable Machines*, a journal published by Springer

Member, Editorial Board, *Evolutionary Computation*, a journal published by MIT Press

Member, Executive Board, *ACM SIGEVO*, a special interest group of the Association for Computing Machinery, on Genetic and Evolutionary Computation (formerly the *International Society for Genetic and Evolutionary Computation*)

PUBLICATIONS

Books

Spector, L. 2007 and 2004. *Automatic Quantum Computer Programming: A Genetic Programming Approach*. New York: Springer Science+Business Media, 2007 (paperback). Boston: Kluwer Academic Publishers, 2004 (hardcover).

Deb, K., R. Poli, W. Banzhaf, H-G Beyer, E. Burke, P. Darwen, D. Dasgupta, D. Floreano, J. Foster, M. Harman, O. Holland, P. Lanzi, L. Spector, A. Tettamanzi, D. Thierens and A. Tyrrell, editors. 2004. *Proceedings of the Genetic and Evolutionary Computation Conference, GECCO-2004*. Lecture Notes in Computer Science, Vol. 3102-3103, Springer-Verlag.

Spector, L., E. Goodman, A. Wu, W.B. Langdon, H.-M. Voigt, M. Gen, S. Sen, M. Dorigo, S. Pezeshk, M. Garzon, and E. Burke, editors. 2001. *Proceedings of the Genetic and Evolutionary Computation Conference, GECCO-2001*. San Francisco, CA: Morgan Kaufmann Publishers.

Whitley, D., D. Goldberg, E. Cantú-Paz, L. Spector, I. Parmee, and H.-G. Beyer, editors. 2000. *Proceedings of the Genetic and Evolutionary Computation Conference, GECCO-2000*. San Francisco, CA: Morgan Kaufmann Publishers.

Spector, L., U.-M. O'Reilly, W. Langdon, and P. Angeline, editors. 1999. *Advances in Genetic Programming, Volume 3*. Cambridge, MA: MIT Press.

Book Chapters

Spector, L., W. La Cava, S. Shanabrook, and T. Helmuth. Random Challenges in Parent Selection. In *Genetic Programming Theory and Practice XV*. New York: Springer, (in press).

Helmuth, T., L. Spector, N. F. McPhee, and S. Shanabrook. Linear Genomes for Structured Programs. In *Genetic Programming Theory and Practice XIV*, edited by W. Worzel, W. Tozier, B. W. Goldman, and R. Riolo. New York: Springer, (in press).

McPhee, N. F., M. D. Finzel, M. M. Casale, T. Helmuth and L. Spector. A detailed analysis of a PushGP run. In *Genetic Programming Theory and Practice XIV*, edited by W. Worzel, W. Tozier, B. W. Goldman, and R. Riolo. New York: Springer, (in press).

Helmuth, T., N. F. McPhee, and L. Spector. 2016. Lexicase selection for program synthesis: a diversity analysis. In *Genetic Programming Theory and Practice XIII*, edited by R. Riolo, W. Worzel, M. Kotanchek, and A. Kordon, pp. 151-167. New York: Springer. New York: Springer.

Kannappan, K., L. Spector, M. Sipper, T. Helmuth, W. La Cava, J. Wisdom, and O. Bernstein. 2015. Analyzing a decade of Human-competitive (“HUMIE”) winners—what can we learn? In *Genetic Programming Theory and Practice XII*, edited by R. Riolo, B. Worzel, and M. Kotanchek, pp. 149–156. New York: Springer.

La Cava, W., and L. Spector. 2015. Inheritable Epigenetics in Genetic Programming. In *Genetic Programming Theory and Practice XII*, edited by R. Riolo, B. Worzel, and M. Kotanchek, pp. 37–51. New York: Springer.

Spector, L., and T. Helmuth. 2014. Uniform Linear Transformation with Repair and Alternation in Genetic Programming. In *Genetic Programming Theory and Practice XI*, edited by R. Riolo, J. H. Moore and M. Kotanchek, pp. 137–153. New York: Springer.

Helmuth, T., and L. Spector. 2013. Evolving SQL Queries from Examples with Developmental Genetic Programming. In *Genetic Programming Theory and Practice X*, edited by R. L. Riolo, M. Ritchie, J. Moore, and E. Vladislavleva, pp. 1–14. New York: Springer.

Spector, L., K. Harrington, B. Martin, and T. Helmuth. 2011. What’s in an Evolved Name? The Evolution of Modularity via Tag-Based Reference. In *Genetic Programming Theory and Practice IX*, edited by R. L. Riolo, E. Vladislavleva, and J. Moore, pp. 1–16. New York: Springer.

Spector, L. 2010. Towards Practical Autoconstructive Evolution: Self-Evolution of Problem-Solving Genetic Programming Systems. In *Genetic Programming Theory and Practice VIII*, edited by R. L. Riolo, T. McConaghy, and E. Vladislavleva, pp. 17–33. New York: Springer.

Langdon, W. B., R. I. McKay, and L. Spector. 2010. Genetic Programming. In *Handbook of*

Metaheuristics, 2nd edition, edited by J.-Y. Potvin and M. Gendreau, pp. 185–226. New York: Springer-Verlag.

Coppinger, R., L. Spector, and L. Miller. 2010. What, if anything, is a Wolf? In *The World of Wolves: New Perspectives on Ecology, Behaviour and Management*, edited by M. Musiani, L. Boitani and P. Paquet. Calgary: The University of Calgary Press.

Klein, J., and L. Spector. 2009. 3D Multi-Agent Simulations in the breve Simulation Environment. In *Artificial Life Models in Software, 2nd edition*, edited by A. Adamatzky and M. Komosinski, pp. 79–106. New York: Springer-Verlag.

Klein, J., and L. Spector. 2008. Genetic Programming with Historically Assessed Hardness. In *Genetic Programming Theory and Practice VI*, edited by R. L. Riolo, T. Soule, and B. Worzel, pp. 61–74. New York: Springer-Verlag.

Spector, L., and J. Klein. 2006. Multidimensional Tags, Cooperative Populations, and Genetic Programming. In *Genetic Programming Theory and Practice IV*, edited by R.L. Riolo, T. Soule, and B. Worzel, pp. 97–112. New York: Springer-Verlag.

Spector, L., and J. Klein. 2005. Trivial Geography in Genetic Programming. In *Genetic Programming Theory and Practice III*, edited by T. Yu, R.L. Riolo, and B. Worzel, pp. 109–124. Boston, MA: Kluwer Academic Publishers.

Grafman, J., L. Spector, and M.J. Rattermann. 2005. Planning and the Brain. In *The Cognitive Psychology of Planning*, edited by R. Morris and G. Ward, pp. 181–198. New York, NY: Psychology Press (Taylor & Francis Group).

Spector, L. 2003. An Essay Concerning Human Understanding of Genetic Programming. In *Genetic Programming: Theory and Practice*, edited by R. Riolo and B. Worzel, pp. 11–24. Boston, MA: Kluwer Academic Publishers.

Spector, L., H. Barnum, and H.J. Bernstein. 1999. Quantum Computing Applications of Genetic Programming. In *Advances in Genetic Programming, Volume 3*, edited by L. Spector, U.-M. O’Reilly, W. Langdon, and P. Angeline, pp. 135–160. Cambridge, MA: MIT Press.

Spector, L. 1996. Simultaneous Evolution of Programs and their Control Structures. In *Advances in Genetic Programming 2*, edited by P. Angeline and K. Kinnear, pp. 137–154. Cambridge, MA: MIT Press.

Spector, L. and J. Grafman. 1994. Planning, Neuropsychology, and Artificial Intelligence: Cross-Fertilization. In *Handbook of Neuropsychology*, Volume 9, edited by F. Boller, and J. Grafman, 377–392. Amsterdam: Elsevier Science Publishers B.V.

Journal Publications

Spector, L. 2017. Introduction to the peer commentary special section on “On the Mapping of Genotype to Phenotype in Evolutionary Algorithms” by Peter A. Whigham, Grant Dick, and James Maclaurin. In *Genetic Programming and Evolvable Machines*, Vol. 18, No. 3, pp. 351–352. DOI: 10.1007/s10710-017-9287-y

McCaffrey, T., and L. Spector. 2017. An approach to human-machine collaboration in innovation. In *AI-EDAM: Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, DOI: <https://doi.org/10.1017/S0890060416000524>

DelRosso, N. V., S. Hews, L. Spector, and N. D. Derr. 2017. A Molecular Circuit Regenerator to Implement Iterative Strand Displacement Operations. In *Angewandte Chemie International Edition*, DOI: <https://doi.org/10.1002/anie.201610890>.

Spector, L. 2017. Editorial Introduction. In *Genetic Programming and Evolvable Machines*, Vol. 18, No. 1, pp. 1–2.

Taylor, T., M. Bedau, A. Channon, D. Ackley, W. Banzhaf, G. Beslon, E. Dolson, T. Froese, S. Hickinbotham, T. Ikegami, B. McMullin, N. Packard, S. Rasmussen, N. Virgo, E. Agmon, E. Clark, S. McGregor, C. Ofria, G. Ropella, L. Spector, K. O. Stanley, A. Stanton, C. Timperley, A. Vostinar, and M. Wiser. 2016. Open-Ended Evolution: Perspectives from the OEE Workshop in York. In *Artificial Life*, Vol. 22, No. 3, pp. 408–423.

La Cava, W., K. Danai, and L. Spector. 2016. Inference of compact nonlinear dynamic models by epigenetic local search. In *Engineering Applications of Artificial Intelligence*, Vol. 55, pp. 292–306.

La Cava, W., K. Danai, L. Spector, P. Fleming, A. Wright, and M. Lackner. 2016. Automatic identification of wind turbine models using evolutionary multiobjective optimization. In *Renewable Energy*, Vol. 87, Part 2, pp. 892–902.

Clark, D. M., M. Keijzer, and L. Spector. 2016. Evolution of algebraic terms 2: Deep drilling algorithm. In *International Journal of Algebra and Computation*, Vol. 26, No. 6, pp. 1141–1176.

Banzhaf, W., B. Baumgaertner, G. Beslon, R. Doursat, J. A. Foster, B. McMullin, V. Veloso de Melo, T. Miconi, L. Spector, S. Stepney, and R. White. 2016. Defining and simulating open-ended novelty: requirements, guidelines, and challenges. In *Theory in Biosciences*, pp. 1–31.

Spector, L. 2016. Editorial Introduction. In *Genetic Programming and Evolvable Machines*, Vol. 17, No. 1, pp. 1–2.

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Helmuth, T., L. Spector, and J. Matheson. 2014. Solving Uncompromising Problems with Lexicase Selection. In *IEEE Transactions on Evolutionary Computation*. DOI: 10.1109/TEVC.2014.2362729.

Escobedo, R., C. Muro, L. Spector, and R. P. Coppinger. 2014. Group size, individual role differentiation and effectiveness of cooperation in a homogeneous group of hunters. In *Journal of the Royal Society Interface*, Vol. 11, No. 95, 20140204, pp. 1–10.

Spector, L. 2014. Peer commentary on Wolfgang Banzhaf’s “Genetic Programming and Emergence.” In *Genetic Programming and Evolvable Machines*, Vol. 15, No. 1, pp. 61–62.

Spector, L. 2014. Editorial Introduction. In *Genetic Programming and Evolvable Machines*, Vol. 15, No. 1, pp. 1–2.

Spector, L. 2013. Editorial Introduction. In *Genetic Programming and Evolvable Machines*, Vol. 14, No. 1, pp. 1–2.

McCaffrey, T., and L. Spector. 2012. Behind every innovative solution lies an obscure feature. In *Knowledge Management & E-Learning: An International Journal*, Vol. 4, No. 2, pp. 146–156.

Spector, L. 2012. Editorial Introduction. In *Genetic Programming and Evolvable Machines*, Vol. 13, No. 1, pp. 1–2.

- Muro, C., R. Escobedo, L. Spector, and R. P. Coppinger. 2011. Wold-pack (*Canis lupus*) hunting strategies emerge from simple rules in computational simulations. In *Behavioural Processes*, Vol. 88, pp. 192–197.
- Muro, C., R. Escobedo, R. P. Coppinger, and L. Spector. 2011. Wolf-pack hunting strategy: an emergent collective behavior described by a classical robotic model (abstract). In *Journal of Veterinary Behavior: Clinical Applications and Research*, Vol. 6, No. 1, p. 94.
- Spector, L. 2011. Editorial Introduction. In *Genetic Programming and Evolvable Machines*, Vol. 12, No. 1, pp. 1–2.
- Niekum, S., A. Barto, and L. Spector. 2010. Genetic Programming for Reward Function Search. In *IEEE Transactions on Autonomous Mental Development*, Vol. 2, No. 2, pp. 83–90.
- Spector, L. 2010. Editorial Introduction. In *Genetic Programming and Evolvable Machines*, Vol. 11, No. 1, pp. 1–2.
- Spector, L. 2009. Editorial Introduction. In *Genetic Programming and Evolvable Machines*, Vol. 10, No. 1, pp. 1–2.
- Spector, L. 2008. Introduction to the Special Issue on Genetic Programming for Human-Competitive Designs. In *AI-EDAM: Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, Vol. 22, No. 3, pp. 183–184.
- Spector, L., and J. Klein. 2008. Machine Invention of Quantum Computing Circuits by Means of Genetic Programming. In *AI-EDAM: Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, Vol. 22, No. 3, pp. 275–283.
- Spector, L. 2006. Evolution of Artificial Intelligence. In *Artificial Intelligence*, Vol. 170, Issue 18, pp. 1251–1253.
- Spector, L., and J. Klein. 2006. Genetic Stability and Territorial Structure Facilitate the Evolution of Tag-mediated Altruism. In *Artificial Life*, Vol. 12, No. 4, pp. 553–560.
- Spector, L., J. Klein, and K. Harrington. 2005. Selection Songs: Evolutionary Music Computation. In *YLEM Journal*, Vol. 25, No. 6 & 8, pp. 24–26.
- Spector, L., J. Klein, C. Perry, and M. Feinstein. 2005. Emergence of Collective Behavior in Evolving Populations of Flying Agents. In *Genetic Programming and Evolvable Machines*, Vol. 6, No. 1, pp. 111–125.
- Spector, L. 2002. Book Review: The Quest for the Quantum Computer, by J. Brown. In *Genetic Programming and Evolvable Machines*, Vol. 3, No. 4, pp. 391–393.
- Spector, L., and A. Robinson. 2002. Genetic Programming and Autoconstructive Evolution with the Push Programming Language. In *Genetic Programming and Evolvable Machines*, Vol. 3, No. 1, pp. 7–40.
- Spector, L. 2002. Hierarchy Helps it Work That Way. In *Philosophical Psychology*, Vol. 15, No. 2 (June, 2002), pp. 109–117.
- Rattermann, M.J., L. Spector, J. Grafman, H. Levin, and H. Harward. 2001. Partial and total-order planning: evidence from normal and prefrontally damaged populations. In *Cognitive Science*, Vol. 25, No. 6 (November/December, 2001), pp. 941–975.

Barnum, H., H.J. Bernstein, and L. Spector. 2000. Quantum circuits for OR and AND of ORs. *Journal of Physics A: Mathematical and General*, Vol. 33 No. 45 (17 November, 2000), pp. 8047–8057.

Spector, L. 2000. The Evolution of Arbitrary Computational Processes. In *IEEE Intelligent Systems*, May/June 2000, pp. 80–83.

Spector, L. 1997. Automatic Generation of Intelligent Agent Programs. In *IEEE Expert*. Jan–Feb 1997, pp. 3–4.

Spector, L. 1996. Social Structure in Evolutionary Computation Systems. In *Communication and Cognition–Artificial Intelligence*. Vol. 13, nos 2–3. pp. 141–161.

Spector, L. 1995. Artificial Intelligence as the Liberal Arts of Computer Science. In *SIGART Bulletin: Special Issue on AI Education*. Volume 6, Number 2, pp. 8–10. The Association for Computing Machinery.

Evelt, M. P., J. A. Hendler, and L. Spector. 1994. Parallel Knowledge Representation on the Connection Machine. *Journal for Parallel and Distributed Computing*. Volume 22, number 2, pp. 168–184.

Grafman, J., A. Sirigu, L. Spector, and J. Hendler. 1993. Damage to the prefrontal cortex leads to decomposition of structured event complexes. In *The Journal of Head Trauma Rehabilitation*, Volume 8, Number 1, Aspen Publishers, Inc., pp. 73–87.

Spector, L. and J. Hendler. 1992. Planning and Reacting Across Supervenient Levels of Representation. In *International Journal of Intelligent and Cooperative Information Systems*, Volume 1, Numbers 3 & 4, pp. 411–449.

Spector, L. and J. Hendler. 1989. Book Review: Minimal Rationality, by C. Cherniak. In *Artificial Intelligence*, Volume 39, Number 1.

Conference and Workshop Papers

Helmuth, T., N. F. McPhee, E. Pantridge and L. Spector. 2017. Improving generalization of evolved programs through automatic simplification. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO '17)*. ACM, New York, NY, USA, 937-944. DOI: <https://doi.org/10.1145/3071178.3071330>

Nominated, Best Paper Award, Genetic Programming Track

Pantridge, E., T. Helmuth, N. F. McPhee, L. Spector. 2017. On the Difficulty of Benchmarking Inductive Program Synthesis Methods. In *Proceedings of GECCO 17 Companion*, Berlin, Germany. DOI: <http://dx.doi.org/10.1145/3067695.3082533>

Spector, L. and E. Moscovici. 2017. Recent Developments in Autoconstructive Evolution. Extended abstract for invited presentation. In *Proceedings of GECCO 17 Companion*, Berlin, Germany. DOI: <http://dx.doi.org/10.1145/3067695.3082058>

Pantridge, E. and L. Spector. 2017. PyshGP: PushGP in Python. In *Proceedings of GECCO 17 Companion*, Berlin, Germany. DOI: <http://dx.doi.org/10.1145/3067695.3082468>

La Cava, W., S. Silva, L. Vanneschi, L. Spector, and J. Moore. 2017. Genetic Programming Representations for Multi-dimensional Feature Learning in Biomedical Classification. In *Applications of Evolutionary Computation. EvoApplications 2017*. Lecture Notes in Computer Science, Vol. 10199.

Springer.

Helmuth, T., N. F. McPhee, and L. Spector. 2016. The Impact of Hyperselection on Lexicase Selection. In *Proceedings of the 2016 Genetic and Evolutionary Computation Conference, GECCO'16*. ACM Press. pp. 717–724.

Nominated, Best Paper Award, Genetic Programming Track

La Cava, W., L. Spector, and K. Danai. 2016. Epsilon-lexicase Selection for Regression. In *Proceedings of the 2016 Genetic and Evolutionary Computation Conference, GECCO'16*. ACM Press. pp. 741–748.

Pantridge, E., and L. Spector. 2016. Evolution of Layer Based Neural Networks: Preliminary Report. In *Companion Publication of the 2016 Genetic and Evolutionary Computation Conference, GECCO'16 Companion*. ACM Press. pp. 1015–1022..

Helmuth, T., N. F. McPhee, and L. Spector. 2016. Effects of Lexicase and Tournament Selection on Diversity Recovery and Maintenance. In *Companion Publication of the 2016 Genetic and Evolutionary Computation Conference, GECCO'16 Companion*. ACM Press. pp. 993–990.

Spector, L., N. F. McPhee, T. Helmuth, M. M. Casale, and J. Oks. 2016. Evolution Evolves with Autoconstruction. In *Companion Publication of the 2016 Genetic and Evolutionary Computation Conference, GECCO'16 Companion*. ACM Press. pp 1349–1356.

McPhee, N. F., M. M. Casale, M. Finzel, T. Helmuth, and L. Spector. 2016. Visualizing Genetic Programming Ancestries. In *Companion Publication of the 2016 Genetic and Evolutionary Computation Conference, GECCO'16 Companion*. ACM Press. pp. 1419–1426.

Spector, L.. Work in Progress on Autoconstructive Evolution (Extended Abstract). 2016. In *Proceedings of the 6th International Conference on Metaheuristics and nature inspired computing, META'2016*. Marrakech, Morocco.

La Cava, W., K. Danai, L. Spector, P. Fleming, M. A. Lackner, and A. Wright. 2015 Automatic Identification of Closed-loop Wind Turbine Dynamics via Genetic Programming. In *Proceedings of the ASME 2015 Dynamic Systems and Control Conference*.

La Cava, W., T. Helmuth, L. Spector, and K. Danai. 2015. Genetic Programming with Epigenetic Local Search. In *Proceedings of the 2015 Genetic and Evolutionary Computation Conference, GECCO'15*. ACM Press. pp. 1055–1062.

Nominated, Best Paper Award, Genetic Programming Track.

Helmuth, T., and L. Spector. 2015. General Program Synthesis Benchmark Suite. In *Proceedings of the 2015 Genetic and Evolutionary Computation Conference, GECCO'15*. ACM Press. pp. 1039–1046.

Liskowski, P., K. Krawiec, T. Helmuth, and L. Spector. 2015. Comparison of Semantic-aware Selection Methods in Genetic Programming. In *Companion Publication of the 2015 Genetic and Evolutionary Computation Conference, GECCO'15 Companion*. ACM Press. pp. 1301–1307.

Helmuth, T., and L. Spector. 2014. Word Count as a Traditional Programming Benchmark Problem for Genetic Programming. In *Proceedings of the 2014 Genetic and Evolutionary Computation Conference, GECCO'14*. ACM Press. pp. 919–926.

Trujillo, L., L. Spector, E. Naredo, and Y. Martinez. 2013. A behavior-based analysis of modal problems. In *Companion Publication of the 2013 Genetic and Evolutionary Computation Conference*,

GECCO'13 Companion. ACM Press. pp. 1047–1054.

Helmuth, T., and L. Spector. 2013. Evolving a digital multiplier with the PushGP genetic programming system. In *Companion Publication of the 2013 Genetic and Evolutionary Computation Conference, GECCO'13 Companion*. ACM Press. pp. 1627–1634.

Spector, L., K. Harrington, and T. Helmuth. 2012. Tag-based Modularity in Tree-based Genetic Programming. In *Proceedings of the 2012 Genetic and Evolutionary Computation Conference, GECCO'12*. ACM Press. pp. 815–822.

Spector, L. 2012. Assessment of Problem Modality by Differential Performance of Lexicase Selection in Genetic Programming: A Preliminary Report. In *Companion Publication of the 2012 Genetic and Evolutionary Computation Conference, GECCO'12 Companion*. ACM Press. pp. 401–408.

Tosch, E., and L. Spector. 2012. Achieving COSMOS: A Metric for Determining When to Give up and When to Reach for the Stars. In *Companion Publication of the 2012 Genetic and Evolutionary Computation Conference, GECCO'12 Companion*. ACM Press. pp. 417–424.

Harrington, K. I., L. Spector, J. B. Pollack, and U.-M. O'Reilly. 2012. Autoconstructive Evolution for Structural Problems. In *Companion Publication of the 2012 Genetic and Evolutionary Computation Conference, GECCO'12 Companion*. ACM Press. pp. 75–82.

Spector, L., B. Martin, K. Harrington, and T. Helmuth. 2011. Tag-Based Modules in Genetic Programming. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-2011)*. ACM Press. pp. 1419–1426.

Helmuth, T., L. Spector, and B. Martin. 2011. Size-Based Tournaments for Node Selection. In *GECCO'11 Workshops, Genetic and Evolutionary Computation Conference*. ACM Press. pp. 799–802.

Harrington, K., E. Tosch, L. Spector, and J. Pollack. 2011. Compositional Autoconstructive Dynamics. *Unifying Themes in Complex Systems Volume VIII: Proceedings of the Eighth International Conference on Complex Systems*. New England Complex Systems Institute Series on Complexity. NECSI Knowledge Press. pp. 856–870. <http://necsi.edu/events/iccs2011/proceedings.html>.

McCaffrey, A.J. and L. Spector. 2011. How the Obscure Features Hypothesis leads to Innovation Assistant software. In *Proceedings of the Second International Conference on Computational Creativity*, pp. 120-122. Universidad Autonoma Metropolitana, Mexico. <http://www.cua.uam.mx>.

Spector, L., D. M. Clark, I. Lindsay, B. Barr, and J. Klein. 2008. Genetic Programming for Finite Algebras. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-2008)*. ACM Press.

Spector, L., J. Klein, and M. Feinstein. 2007. Division blocks and the open-ended evolution of development, form, and behavior. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-2007)*, pp. 316–323. ACM Press.

Klein, J., and L. Spector. 2007. Unwitting Distributed Genetic Programming via Asynchronous JavaScript and XML. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-2007)*, pp. 1628–1635. ACM Press.

Spector, L., J. Klein, and M. Keijzer. 2005. The Push3 Execution Stack and the Evolution of Control. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-2005)*, pp. 1689–1696. Springer-Verlag.

Stout, A., and L. Spector. 2005. Validation of Evolutionary Activity Metrics for Long-Term Evolutionary Dynamics. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-2005)*, pp. 137–142. Springer-Verlag.

Spector, L., J. Klein, K. Harrington, and R. Coppinger. 2005. Teaching the Evolution of Behavior with SuperDuperWalker. In *Proceedings of the 12th International Conference on Artificial Intelligence in Education (AIED-2005)*, pp. 923–925. IOS Press.

Spector, L., J. Klein, and C. Perry. 2004. Tags and the Evolution of Cooperation in Complex Environments. In *Proceedings of the AAI 2004 Symposium on Artificial Multiagent Learning*. Melno Park, CA: AAI Press.

Spector, L., J. Klein, C. Perry, and M. Feinstein. 2003. Emergence of Collective Behavior in Evolving Populations of Flying Agents. In E. Cantu-Paz, J.A. Foster, K. Deb, L.D. Davis, R. Roy, U.-M. O’Reilly, H.-G. Beyer, R. Standish, G. Kendall, S. Wilson, M. Harman, J. Wegener, D. Dasgupta, M.A. Potter, A.C. Schultz, K.A. Dowsland, N. Jonoska, J. Miller (Eds.), *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-2003)*, pp. 61–73. Berlin: Springer-Verlag. **Winner, Best Paper Award, AAAA Track.**

Spector, L. 2002. Adaptive populations of endogenously diversifying *Pushpop* organisms are reliably diverse. In R. K. Standish, M. A. Bedau, and H. A. Abbass (eds.), *Proceedings of Artificial Life VIII, the 8th International Conference on the Simulation and Synthesis of Living Systems*, pp. 142–145. Cambridge, MA: The MIT Press.

Spector, L., and J. Klein. 2002. Evolutionary Dynamics Discovered via Visualization in the BREVE Simulation Environment. In Bilotta et al. (eds.), *Workshop Proceedings of the 8th International Conference on the Simulation and Synthesis of Living Systems*, pp. 163–170. Sydney, Australia: University of New South Wales.

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Spector, L., and H.J. Bernstein. 2002. Communication Capacities of Some Quantum Gates, Discovered in Part through Genetic Programming. In J.H. Shapiro and O. Hirota, (eds.), *Proceedings of the Sixth International Conference on Quantum Communication, Measurement, and Computing (QCMC)*, pp. 500–503. Princeton, NJ: Rinton Press.

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Weisler, S., R. Bellin, L. Spector, and N. Stillings. 2001. An Inquiry-based Approach to E-learning: The CHAT Digital Learning Environment. In *Proceedings of SSGRR-2001, the International Conference on Advances in Infrastructure for Electronic Business, Science, and Education on the Internet*. Scuola Superiore G. Reiss Romoli, L'Aquila, Italy. Proceedings ISBN: ISBN:88-85280-61-7, URL: <http://www.ssgrr.it/en/ssgrr2001/papers.htm>.

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Luke, S., and L. Spector. 1998. A Revised Comparison of Crossover and Mutation in Genetic Programming. In *Genetic Programming 1998: Proceedings of the Third Annual Conference*, edited by J.R. Koza, W. Banzhaf, K. Chellapilla, K. Deb, M. Dorigo, D.B. Fogel, M.H. Garzon, D.E. Goldberg, H. Iba, and R.L. Riolo. pp. 208–214. San Francisco, CA: Morgan Kaufmann.

Luke, S. and L. Spector. 1997. A Comparison of Crossover and Mutation in Genetic Programming. In *Genetic Programming 1997: Proceedings of the Second Annual Conference*, 240–248. Cambridge, MA: The MIT Press.

Luke, S., L. Spector, D. Rager, and J. Hendler. 1997. Ontology-based Web Agents. In *Proceedings of the First International Conference on Autonomous Agents*, 59–66. W. L. Johnson, Editor. New York: ACM Press.

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Spector, L., and S. Luke. 1996. Culture Enhances the Evolvability of Cognition. In G. Cottrell (editor), *Proceedings of the Eighteenth Annual Conference of the Cognitive Science Society*, 672–677. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

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Evet, M., L. Spector, and J. Hendler. 1989. Knowledge Representation on the Connection Machine. In *Proceedings of Supercomputing '89*, (Reno, NV; Nov. 13-17, 1989), ACM, New York, NY.

Posters and Poster Papers

McPhee, N. F., M. M. Casale, M. Finzel, T. Helmuth, L. Spector. 2017. Visualizing genetic programming ancestries using graph databases. In *Proceedings of GECCO 17 Companion*, Berlin, Germany, July 15-19, 2017, 2 pages. DOI: <http://dx.doi.org/10.1145/3067695.3075617>

McPhee N. F., T. Helmuth, L. Spector. 2017. Using algorithm configuration tools to optimize genetic programming parameters: A case study. In *Proceedings of GECCO 17 Companion*, Berlin, Germany, July 15-19, 2017, 2 pages. DOI: <http://dx.doi.org/10.1145/3067695.3076097>

DelRosso N., N. Derr, L. Spector, and S. Hews. 2016. Triggered Regeneration of Molecular Circuit Components to Implement Iterative DNA Strand Displacement Operations. Presented at: FNANO. 13th Annual Foundations of Nanoscience: Self-Assembled Architectures and Devices; 2016 April 11-14; Snowbird, UT

DelRosso N., N. Derr, L. Spector, and S. Hews. 2016. Triggered Regeneration of Molecular Circuit Components to Implement Iterative DNA Strand Displacement Operations. Presented at: DNA22. 22nd International Conference on DNA Computing and Molecular Programming; 2016 September 4-8; Munich, Germany

Spector, L., and T. Helmuth. 2014. Effective Simplification of Evolved Push Programs Using a Simple, Stochastic Hill-climber. In *Companion Publication of the 2014 Genetic and Evolutionary Computation Conference, GECCO'14 Companion*. ACM Press.

La Cava, W., L. Spector, K. Danai, and M. Lackner. 2014. Evolving differential equations with developmental linear genetic programming and epigenetic hill climbing. In *Companion Publication of the 2014 Genetic and Evolutionary Computation Conference, GECCO'14 Companion*. ACM Press.

Spector, L., and T. Helmuth. 2012. Empirical Investigation of Size-Based Tournaments for Node Selection in Genetic Programming. In *Companion Publication of the 2012 Genetic and Evolutionary Computation Conference, GECCO'12 Companion*. ACM Press. pp. 1485–1486.

Spector, L., and T. Helmuth. 2012. Empirical Investigation of Size-Based Tournaments for Node Selection in Genetic Programming. In *Companion Publication of the 2012 Genetic and Evolutionary Computation Conference, GECCO'12 Companion*. ACM Press. pp. 1485–1486.

McCaffrey, Anthony J., and L. Spector. 2011. Innovation is Built on the Obscure: Innovation-Enhancing Software for Uncovering the Obscure. Poster paper, *The 8th ACM Conference on Creativity and Cognition*.

Spector, L., T. Helmuth, and K. Harrington. 2011. Fecundity and Selectivity in Evolutionary Computation. In *GECCO'11 Posters, Genetic and Evolutionary Computation Conference*. ACM Press. pp. 129–130.

Niekum, S., L. Spector, and A. Barto. 2011. Evolution of Reward Functions for Reinforcement Learning. In *GECCO'11 Posters, Genetic and Evolutionary Computation Conference*. ACM Press. pp. 177–178.

Rattermann, M. J., L. Spector and J. Grafman. 1996. Total and Partial-Order Planning: Application of Results from Artificial Intelligence to Children and Lesioned Adults. Poster presentation. *The Eighteenth Annual Meeting of the Cognitive Science Society*.

Spector, L. 1995. Evolving Control Structures with Automatically Defined Macros. Poster presentation. *Genetic Programming Workshop at the Sixth International Conference on Genetic Algorithms*.

Spector, L., M.J. Rattermann and K. Prentice. 1995. Total and partial-order planning: Application of results from artificial intelligence to children. Poster presented at the biennial meeting of the Society for Research in Child Development.

Spector, L. 1990. An Abstraction-Partitioned Model for Reactive Planning. Poster presentation. University of Maryland Systems Research Center.

Additional Scientific Publications

Helmuth, T., and L. Spector. 2015. Detailed Problem Descriptions for General Program Synthesis Benchmark Suite. University of Massachusetts, Amherst, Computer Science Technical Report UM-CS-2015-006.
<https://web.cs.umass.edu/publication/details.php?id=2387>

Spector, L., C. Perry, J. Klein, and M. Keijzer. 2004. Push 3.0 Programming Language Description. Hampshire College Cognitive Science Technical Report HC-CSTR-2004-02.
http://www.hampshire.edu/cms_PDF/HC-CSTR-2004-02.pdf

Spector, L., E. Anderson, J. Miller, L. Sizer, and N. Stillings. 2004. Hampshire College School of Cognitive Science - Self Study Report. Hampshire College Cognitive Science Technical Report HC-CSTR-2004-01.
http://www.hampshire.edu/cms_PDF/HC-CSTR-2004-01.pdf

Crawford-Marks, R., L. Spector, and J. Klein. 2004. Virtual Witches and Warlocks: A Quidditch Simulator and Quidditch-Playing Teams Coevolved via Genetic Programming. In *Late-Breaking Papers of GECCO-2004, the Genetic and Evolutionary Computation Conference*. Published by the International Society for Genetic and Evolutionary Computation.

Spector, L., C. Perry, and J. Klein. 2003. Push 2.0 Programming Language Description.
<http://hampshire.edu/lspector/push2-description.html>

- Robinson, A., and L. Spector. 2002. Using Genetic Programming with Multiple Data Types and Automatic Modularization to Evolve Decentralized and Coordinated Navigation in Multi-Agent Systems. In *Late-Breaking Papers of GECCO-2002, the Genetic and Evolutionary Computation Conference*. Published by the International Society for Genetic and Evolutionary Computation.
- Spector, L., R. Moore, and A. Robinson. 2001. Virtual Quidditch: A Challenge Problem for Automatically Programmed Software Agents. In E.D. Goodman, editor, *Late-Breaking Papers of GECCO-2001, the Genetic and Evolutionary Computation Conference*. Published by the International Society for Genetic and Evolutionary Computation.
- Barnum, H., H. J. Bernstein, and L. Spector. 2000. Quantum circuits for OR and AND of OR's. Technical Report CSTR-00-014, Dept. of Computer Science, University of Bristol, August 2000.
- Spector, L, H. Barnum, H.J. Bernstein, and N. Swamy. 1999. Abstract for Invited Presentation: Quantum Computing and AI. In *Proceedings of the Sixteenth National Conference on Artificial Intelligence, AAAI-99*, AAAI Press.
- Spector, L., H. Barnum, H.J. Bernstein, and N. Swamy. 1999. Finding a Better-than-Classical Quantum AND/OR Algorithm using Genetic Programming. In *Proceedings of the 1999 Congress on Evolutionary Computation*, pp. 2239–2246. IEEE Press.
- Barnum, H., Bernstein, H. J., and Spector, L. 1999. Better-than-classical Circuits for OR and AND/OR Found Using Genetic Programming. Los Alamos Preprint Archive, <http://xxx.lanl.gov/abs/quant-ph/9907056>
- Luke, S., L. Spector, and D. Rager. 1996. Ontology-Based Knowledge Discovery on the World-Wide Web. In *Working Notes of the AAAI-96 Workshop on Internet-based Information Systems*.
- Luke, S., and L. Spector. 1996. Evolving Graphs and Networks with Edge Encoding: Preliminary Report. In Koza, John R. (editor), *Late-Breaking Papers at the Genetic Programming 1996 Conference*. Palo Alto, CA: Stanford Bookstore (ISBN 0-18-201-031-7).
- Spector, L. 1995. Evolving Control Structures with Automatically Defined Macros. *Working Notes of the AAAI Fall Symposium on Genetic Programming*. The American Association for Artificial Intelligence. pp. 99–105.
- Spector, L., and A. Alpern. 1995. Induction and Recapitulation of Deep Musical Structure. In *Working Notes of the IJCAI-95 Workshop on Artificial Intelligence and Music*. pp. 41–48.
- Spector, L. 1994. Artificial Intelligence as the Liberal Arts of Computer Science. In *Working Notes of the AAAI Fall Symposium on Improving the Instruction of Introductory AI*. The American Association for Artificial Intelligence. pp. 31–33.
- Spector, L. 1992. Supervenience in Dynamic-World Planning, Doctoral dissertation. CS-TR-2899, UMIACS-TR-92-55, Department of Computer Science, University of Maryland.
- Spector, L., B. Andersen, J. Hendler, B. Kettler, E. Schwartzman, C. Woods, and M. Evett. 1992. Knowledge Representation in PARKA – Part 2: Experiments, Analysis, and Enhancements. CS-TR-2837, UMIACS-TR-92-16, Department of Computer Science, University of Maryland.
- Spector, L. and J. Hendler. 1991. The Supervenience Architecture. In *Proceedings of the AAAI Fall Symposium on Sensory Aspects of Robotic Intelligence*. The American Association for Artificial Intelligence.

Spector, L. and J. Hendler. 1991. The Supervenience Architecture. In *The Proceedings of the IJCAI-91 Workshop on Theoretical and Practical Design of Rational Agents*, Sydney, Australia.

Spector, L. and J. Hendler. 1990. Knowledge Strata: Reactive Planning with a Multi-level Architecture. UMIACS-TR-90-140, CS-TR-2564, Department of Computer Science, University of Maryland.

Spector, L., J. Hendler, and M. Evett. 1990. Knowledge Representation in PARKA. UMIACS-TR-90-23, CS-TR-2410, Department of Computer Science, University of Maryland.

Evett, M., J. Hendler, and L. Spector. 1990. PARKA: Parallel Knowledge Representation on the Connection Machine. UMIACS-TR-90-22, CS-TR-2409, Department of Computer Science, University of Maryland.

Spector, L., J. Hendler, J. Canning, and A. Rosenfeld. 1988. Symbolic Model/Image Matching in Expert Vision Systems. CAR-TR-370, CS-TR-2060, University of Maryland Center for Automation Research.

Newspaper Op-Ed

And now, digital evolution. In *The Boston Globe*, August 29, 2005.

Letters to the Editor

Letter to the editor, *The Daily Hampshire Gazette*, regarding local taxes, May 30, 2009.

Letter to the editor, *The Daily Hampshire Gazette*, regarding funding for public education, May 19, 2006.

Letter to the editor, *New York Times*, regarding warrantless surveillance, March 10, 2006.

Letter to the editor, *Scientific American*, regarding nanobots, January, 2002.

Letter to the editor, *Circuits* section, *New York Times*, regarding robotic pets, May 11, 2000.

Letter to the editor, *IEEE Intelligent Systems*, regarding quantum computing, September/October, 1999.

PRESENTATIONS

(in addition to those for conference/workshop papers and posters listed above)

Genetic Programming with Autoconstructive Evolution. MIT Computational Cognitive Science Group. November 17, 2017.

Expressive Genetic Programming: Concepts and Applications. With N. F. McPhee. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2017. Slides published in *GECCO '17 Companion*, <http://dx.doi.org/10.1145/3067695.3067699>

Expressive Genetic Programming: Concepts and Applications. With N. F. McPhee. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2016.

Artificial Intelligence, Evolutionary Computation, and Autoconstructive Evolution. Guest lecture for the Honors Colloquium class visiting from Holyoke Community College, at Hampshire College, April 8, 2016.

Autoconstructive Evolution. School of Cognitive Science, Hampshire College, March 2, 2016.

Genetic Programming in Clojure. Presentation at Clojure/Conj, Philadelphia, PA, November 17, 2015.

Automatic Programming via Evolution. Invited presentation, *Complex Systems Digital Campus 15 – World e-Conference*, organized by the Complex Systems Digital Campus (CS-DC), a UNESCO UniTwin, September 30, 2015.

Automatic Programming via Evolution. School of Cognitive Science, Hampshire College, September 30, 2015.

The Future of AI. Interview, *The Technoskeptic* podcast (thetechnoskeptic.com), July 15, 2015.

Expressive Genetic Programming. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2015.

Solving Uncompromising Problems with Lexicase Selection. Presentation for the “Hot Off the Press” track, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2015.

The possibility of developing an artificial brain, and what the development of artificial people means both for them and for us. *Science on Screen* presentation in conjunction with a screening of *Blade Runner* at Amherst Cinema, May 6, 2015.

The Future of Genetic Programming. Guest lecture. Mount Holyoke College, April 15, 2015.

Evolution of Expressive Programs: Principles, Products, and Prospects. Keynote presentation, BEACON Congress, BEACON (An NSF Center for the Study of Evolution in Action), Michigan State University, August 18, 2014.

Expressive Program Evolution. Invited presentation, Computer Science Department and Molecular and Cellular Biology Program, Dartmouth College, July 28, 2014.

Expressive Genetic Programming. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2014.

Steps toward the evolution of arbitrary software. Presentation at *Genetic Programming Theory and Practice Workshop*, with Thomas Helmuth, University of Michigan, Ann Arbor, May 9, 2014.

The Calculator Problem and the Evolutionary Synthesis of Arbitrary Software. Invited presentation, *The 28th CREST Open Workshop: Genetic Programming for Software Engineering*, University College London, October 14, 2013.

Quantum Computing. Guest lecture in Jaime Davila’s *Privacy in the Age of the Internet* class. Hampshire College, March 4, 2014.

Expressive Genetic Programming. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2013.

Expressive Genetic Programming. Tutorial, *12th International Conference on Parallel Problem Solving From Nature (PPSN)*, September, 2012.

Expressive Genetic Programming. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2012.

The Evolution of Identity and Modularity in Nature and Computation. Invited presentation, Neu-

rosience Department, Oberlin College, March 16, 2012.

3D Models. Guest lecture for Keith Downing’s modeling seminar, Oberlin College, March 16, 2012.

Genomes as Reactive Systems: A Computational Perspective. Guest lecture in *Frontiers in Biomathematics*. Smith College, March 14, 2012.

Biologically-Inspired Evolution of Computer Programs: Tag-based Modularity in Genetic Programming. Guest lecture in Hava Siegelmann’s *Computational Social Neuroscience* seminar. University of Massachusetts, Amherst, February 29, 2012.

Other Minds Produced by Computational Evolution. Two guest lectures in Laura Sizer’s *Other Minds* course, Hampshire College, October 26 and 31, 2011.

Evolving Quantum Computer Algorithms. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2011.

Biologically-Inspired Evolution of Computer Programs: Tag-based Modularity in Genetic Programming. Guest lecture in Hava Siegelmann’s *Introduction to Modern Computational Neuroscience* seminar. University of Massachusetts, Amherst, April 22, 2011.

Biologically-Inspired Evolution of Computer Programs: Tag-based Modularity in Genetic Programming. School of Cognitive Science, Hampshire College, March 2, 2011.

Other Minds Produced by Computational Evolution. Two guest lectures in Laura Sizer’s *Other Minds* course, Hampshire College, November 15 and 17, 2010.

Expressive Languages for Evolved Programs and Autoconstructive Evolution. Invited presentation, CSE Department and BEACON Center, Michigan State University, November 12, 2010.

Evolving the Future of Mathematics. “Prime Time” presentation for *Hampshire College Summer Studies in Mathematics*, Hampshire College, August 12, 2010.

Evolution of Quantum Algorithms. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2010.

Hampshire on the Technological Cutting Edge and Computational Intelligence at Hampshire. Presentations at the *Hampshire College 40th Anniversary* celebration, June, 2010.

From Bits to Brains that Make and Appreciate Art. *Art on the Brain* conference, Mount Holyoke College, June, 2010.

Computer Science, Cognitive Science, and Artificial Life at Hampshire. Accepted student’s day presentation, Hampshire College, April, 2010.

Expressive Languages for Evolved Programs. Machine Learning and Friends Lunch presentation. University of Massachusetts, Amherst, November 12, 2009.

Evolving Quantum Computer Algorithms. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July, 2009.

Trivial Geography and Historically-Assessed Hardness: Two simple techniques for enhancing the problem-solving power of genetic programming. University of Tokyo, Japan, June 24, 2009.

Quantum Computing and Evolutionary Computation. Tutorial, *World Summit on Genetic and Evolutionary Computation*, Shanghai, China, June 13, 2009.

Comments on Douglas Saddy's "Perceiving and Processing Recursion in Formal Grammars." *Recursion: Structural Complexity in Language and Cognition* conference, University of Massachusetts, Amherst, May 28, 2009.

The Computational Creativity Curriculum. National Science Foundation CreativeIT Principal Investigators meeting, January 15, 2009.

Past and Future Origins of Artificial Life. School of Cognitive Science, Hampshire College, November 19, 2008.

Examples for the Aesthetics of Data Workshop. *Aesthetics of Data and its Analysis* workshop, Kahn Liberal Arts Institute, Smith College, October 18, 2008.

Darwin Machines for Science and Art. Hampshire College event for trustees, alumni and prospective students, September 25, 2008.

Genetic Programming for Finite Algebras. "Prime Time" presentation for *Hampshire College Summer Studies in Mathematics*, Hampshire College, July 29, 2008.

Quantum Computing. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, June, 2008.

Climate Change and Complex Adaptive Systems. *Focus Hampshire*, a climate change teach-in, Hampshire College, March 7, 2008.

Evolution, the Programmer and Mathematician. School of Cognitive Science, Hampshire College, February 20, 2008.

Advanced Computing in a Complex World. Vermont Advanced Computing Center, University of Vermont, January, 2008.

The Computational Creativity Curriculum. School of Cognitive Science, Hampshire College, October, 2007.

Quantum Computing. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, June, 2007.

Intelligence Evolving. Invited presentation. *Oberlin Club of Western New England*, Northampton, Massachusetts, May 6, 2007.

Evolutionary Computation for Science, Engineering and Art. Invited presentation. *School of Science & Engineering Colloquium Series*, State University of New York at New Paltz, April 26, 2007.

Algorithmic Art. Invited presentation. Hampshire College course on *Topics in Computer Graphic Animation Arts*, taught by Eric Wilson, March 13, 2005.

Strange Bits: Quantum Computing and the Search for New Quantum Algorithms. Invited Presentation. *Sigma Xi* Scientific Research Society, Swarthmore College Chapter, January 30, 2007.

Cooperation and Computational Evolution. *The Grey Thumb Society*, Cambridge, MA, December 4, 2006.

Division Blocks. School of Cognitive Science, Hampshire College, October 12, 2006.

Quantum Computing. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, June, 2006.

Evolution of Irreducible Complexity by Natural Selection. *Evolution, Science, and Intelligent Design - A Panel Discussion*, Hampshire College, February 8, 2006.

Guest presentations on topics in science and math at Bridge Street Elementary School, Northampton MA. Topics included robotics, physics of sound, fractals, logo programming, binary, light and spectroscopy, planetary orbits, the Krypto math game, insects and swarm intelligence, digital microscopy, and the fourth dimension.

Algorithmic Arts. *Art and Technology Retreat*, Hampshire College, January 27, 2006.

The Chomsky Hierarchy. Invited presentation. Hampshire College course on *Human Nature, Language, and Politics: Noam Chomsky and His Critics*, taught by Ernie Alleva and Steve Weisler, December 5, 2005.

Quantum Computing. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, June, 2005.

The Evolution of Arbitrary Computational Processes. Invited presentation. Department of Computer Science, University of Maryland, College Park, March 7, 2005.

Automated Invention by Means of Genetic Programming. Tutorial, with John Koza, *Nineteenth National Conference on Artificial Intelligence, AAAI-04*, July 25, 2004.

Quantum Computing. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July 13, 2003.

Quantum Computing for Genetic Programmers. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July 9, 2002.

Quantum Computing and Artificial Intelligence. Chevron TechNet Advanced Information-Based Modeling seminar series. November 12, 1999.

Quantum Computing and AI. Invited Presentation, *Sixteenth National Conference on Artificial Intelligence, AAAI-99*, 1999.

Quantum Computation. Tutorial, *Genetic and Evolutionary Computation Conference (GECCO)*, July 14, 1999.

Genetic Programming of Intelligent Agents and Artists. Invited lecture. Swarthmore College Cognitive Science Colloquium Series. 1996.

Genetic Programming of Cognitive Models. Invited presentation. Cognitive Neuroscience Unit, National Institute of Neurological Disorders and Stroke, National Institutes of Health. 1996.

Automatic Generation of Planning Systems. Georgia Institute of Technology. 1996.

Artificial Intelligence as the Liberal Arts of Computer Science. Cognitive Science Brown Bag Lunch Presentation, Georgia Institute of Technology. 1996.

Exploring the Internet. Science Education Partnership , Hampshire College. 1994.

What Computers Can't Do. Guest lecture. Smith College. 1993.

Representations and Processes in Human Prefrontal Cortex: Convergence of Cognitive Neuroscience, Cognitive Science, and Artificial Intelligence Research. Panel presentation. Thirteenth Annual Conference of the Cognitive Science Society. 1991.

PARKA: Knowledge Representation on the Connection Machine. Panel presentation. Workshop on Term Subsumption Languages in Knowledge Representation. 1989.

GRANTS AND AWARDS

National Science Foundation, Division of Information and Intelligent Systems, Directorate for Computer and Information Science and Engineering, Robust Intelligence program. RI: Small: RUI: Synthesis of Robust Artificial Systems by Adaptive Genetic Programming. PI: L. Spector. \$418,897. 2016–2019.

Google, CS Engagement Award. Programming for Science. \$5,000. 2015.

National Science Foundation, Division of Computing and Communication Foundations. Human-Competitive Evolutionary Computation. Co-Principal Investigators: L. Spector and M. Sipper. \$42,000. 2013–2016.

National Science Foundation, Division of Biological Infrastructure, Interdisciplinary Training in Biology and Mathematics. UBM-Institutional-Collaborative Research: Four College Biomath Consortium. Co-Principal Investigators: L. Spector and S. Hews. \$181,159. 2011–2016.

National Science Foundation, Division of Information and Intelligent Systems. RUI: Evolution of Robustly Intelligent Computational Systems. \$423,288. 2010–2015.

Sherman Fairchild Foundation, Design, Art, and Technology: Innovation Synergy. Grant to Hampshire College; Ellen Donkin and Lee Spector, Co-Directors. \$300,000. 2009–2012.

Gold medal, GECCO-2008 Human-Competitive Results competition. With David M. Clark, Ian Lindsay, Bradford Barr, and Jon Klein. \$5,000. 2008.

National Science Foundation, CreativeIT program. The Computational Creativity Curriculum. Co-Principal Investigators: J. Davila, C. Perry. \$49,641. 2008–2009.

Elected *Fellow*, International Society for Genetic and Evolutionary Computation. 2004.

Gold medal, GECCO-2004 Human-Competitive Results competition. With Herbert J. Bernstein and Howard Barnum. \$1,500. 2004.

National Science Foundation, Director's Award for Distinguished Teaching Scholars. Open-Ended Evolution in Visually Rich Virtual Worlds: Implementation, Analysis, and Use in Undergraduate Education. \$300,000. 2003–2007.

Best Paper Award, Genetic and Evolutionary Computation Conference (GECCO-2003), AAAA Track (A-Life, Adaptive Behavior, Agents, and Ant Colony Optimization).

National Science Foundation, Major Research Instrumentation program and Research in Undergraduate Institutions program. Acquisition of Instrumentation for Research in Genetic Programming, Quantum Computation, and Distributed Systems. \$99,751. 2002–2005.

Defense Advanced Research Projects Agency (DARPA) program on Agent Based Computing. Multi-type, Self-adaptive Genetic Programming for Complex Applications. \$295,936. 2001–2004.

Hampshire College support for the Institute for Computational Intelligence.

MacArthur Chair at Hampshire College. \$45,000. 1997–2000.

National Science Foundation, Learning and Intelligent Systems Program. Inquiry-Based Science Education: Cognitive Measures and Systems Support. Co-Principal Investigators: N. Stillings, L. Spector, S. Weisler, L. Winship, and B. Woolf. \$1,100,000. 1997.

Lemelson National Program in Invention, Innovation and Creativity. Applications of Evolved Complex Dynamic Systems. With Mark Feinstein. \$3,000. 1997.

Lemelson National Program in Invention, Innovation and Creativity. Enhancing the human/computer interface: video-based movement analysis. With Slavoljub Milekic and Mark Feinstein. \$6,200. 1996.

Hewlett-Mellon Faculty Development Grant. Intelligent Real-time Music Processing. \$700. 1996.

Hewlett-Mellon Faculty Development Grant. Evolutionary Computation and the Arts. \$1,500. 1995.

Lemelson National Program in Invention, Innovation and Creativity. MIDI/Motion Device, Demonstration and Enhancement. \$2,500. 1995.

Hewlett-Mellon Faculty Development Grant. The Virtual Student Union. \$1,500. 1994.

Lemelson National Program in Invention, Innovation and Creativity. Travel grant for AAAI-94. \$1,000. 1994.

Lemelson National Program in Invention, Innovation and Creativity. Grant for the establishment of the Creative Cognition Laboratory. \$15,000. 1993.

SERVICE

Professional Conference Program Committees

Genetic and Evolutionary Computation Conference, GECCO-2018

European Conference on Genetic Programming, EuroGP-2018

Genetic and Evolutionary Computation Conference, GECCO-2017

European Conference on Genetic Programming, EuroGP-2017

Genetic and Evolutionary Computation Conference, GECCO-2016

Genetic and Evolutionary Computation Conference, GECCO-2015

European Conference on Genetic Programming, EuroGP-2015

The 6th annual Symposium on Search-Based Software Engineering, SSBSE-2014

The 14th International Conference on the Synthesis and Simulation of Living Systems, ALIFE-14

Genetic and Evolutionary Computation Conference, GECCO-2014

European Conference on Genetic Programming, EuroGP-2014

Genetic and Evolutionary Computation Conference, GECCO-2013

European Conference on Genetic Programming, EuroGP-2013

Genetic and Evolutionary Computation Conference, GECCO-2012

European Conference on Genetic Programming, EuroGP-2012

Genetic and Evolutionary Computation Conference, GECCO-2011:

Co-chair, genetic programming track

European Conference on Genetic Programming, EuroGP-2011

Genetic and Evolutionary Computation Conference, GECCO-2008

Genetic and Evolutionary Computation Conference, GECCO-2006

Fourth European Workshop on Evolutionary Music and Art, EvoMUSART-2006
 IEEE Computational Intelligence and Games, CIG-2005
 Third European Workshop on Evolutionary Music and Art, EvoMUSART-2005
 AAAI 2004 Fall Symposium on Artificial Multi-Agent Learning:
 Organizing committee
 Genetic and Evolutionary Computation Conference, GECCO-2004:
 Chair, genetic programming track
 Judge, TinyGP competition
 European Conference on Artificial Intelligence, ECAI 2004
 Genetic and Evolutionary Computation Conference, GECCO-2003
 Genetic and Evolutionary Computation Conference, GECCO-2001:
 Proceedings Editor-in-Chief
 Genetic and Evolutionary Computation Conference, GECCO-2000:
 Chair, genetic programming and evolvable hardware tracks
 Sixteenth National Conference on Artificial Intelligence, AAAI-99:
 Senior program committee
 Fifteenth National Conference on Artificial Intelligence, AAAI-98
 Third International Conference on Genetic Programming, GP-98
 Thirteenth National Conference on Artificial Intelligence, AAAI-96
 First International Conference on Genetic Programming, GP-96
 Genetic Programming Track, IEEE Intl. Conference on Evolutionary Computation, ICEC-96
 Florida Artificial Intelligence Research Society (FLAIRS) conference

Additional Reviewing

Adaptive Behavior (journal)
Advances in Genetic Programming 2 (MIT Press)
Artificial Intelligence (journal)
Artificial Life (journal)
BioSystems (journal)
Computational Intelligence (journal)
Design Automation Conference, 2004, Ph.D. Forum
Evolutionary Computation (journal)
Genetic Programming and Evolvable Machines (journal)
Genetic Programming: Theory and Practice (Kluwer Academic Publishers)
IEEE Transactions on Evolutionary Computation (journal)
IEEE Transactions on Systems, Man, and Cybernetics—Part C: Applications and Reviews (journal)
Journal of Experimental and Theoretical Artificial Intelligence (journal)
 The Marsden Fund (The Royal Society of New Zealand)
 National Science Centre Poland
 National Science Foundation Distinguished Teaching Scholars Panel
 National Science Foundation Instrumentation and Laboratory Improvement Review Panel
 National Science Foundation Robust Intelligence Panel
 National Science Foundation Graduate Research Fellowship Program
 Natural Sciences and Engineering Research Council of Canada
 Nederlandse Organisatie voor Wetenschappelijk Onderzoek (The Netherlands)
 The Netherlands Organisation for Scientific Research (NWO), council for physical sciences
Nature Reviews Genetics (journal)
Physical Review Letters (journal)
PLOS Computational Biology (journal)
Royal Society Interface (journal)
 Science Foundation Ireland
 Sherman Fairchild Foundation (Arts and Technology program site visits)
Trends in Ecology and Evolution (journal)

UK Engineering and Physical Sciences Research Council

Additional Service

Hampshire College Strategic Plan Implementation Planning Group
Hampshire College Design, Art and Technology Program (co-director)
Hampshire College Governance Task Force
Hampshire College Creativity Center Steering Committee
Five College Logic Certificate Program (Hampshire representative)
Hampshire College Making of the College 2.0 Oversight Committee (co-chair)
Hampshire College Wabash Study Task Force
Faculty representative to the Hampshire College Board of Trustees
Hampshire College Educational Policy Committee
Hampshire College Campus Committee on Faculty Reappointments and Promotions
Hampshire College Information Technology Steering Committee
Hampshire College Faculty Compensation Committee
Hampshire College Executive Committee of the Faculty
Hampshire College Task force to examine the granting of graduate degrees (chair)
Several additional Hampshire College task forces and faculty/staff search committees
Science Fair judge, Northampton MA Public Schools
Science and math enrichment activity presenter, Northampton MA Public Schools
Graduate Student Workshop judge, Genetic and Evolutionary Computation Conference
Competitions judge (several occasions), Genetic and Evolutionary Computation Conference

GRADUATE STUDENT COMMITTEE MEMBERSHIPS OR ADVISORSHIPS

Kyle Harrington (Ph.D. student, Brandeis University)
Thomas Helmuth (Ph.D. student, U. Massachusetts)
Karthik Kannappan (M.S. student, U. Massachusetts)
Brian Kettler (Ph.D. student, U. Maryland)
Jon Klein (Ph.D. student, Chalmers U., Sweden)
William La Cava (Ph.D. student, U. Massachusetts)
Jason Lohn (Ph.D. student, U. Maryland)
Sean Luke (Ph.D. student, U. Maryland)
Blossom Metevier (Ph.D. student, U. Massachusetts)
Eva Moshkovich (M.S. student, U. Massachusetts)
Dov Pechenick (Ph.D. student, Dartmouth College)
Anil Kumar Saini (Ph.D. student, U. Massachusetts)
Oliver Seeliger (M.S. student, U. Maryland)
Joshua Shinavier (Ph.D. student, Rensselaer Polytechnic Institute)
Emma Tosch (Ph.D. student, U. Massachusetts)
Terry Van Belle (Ph.D. student, U. New Mexico)

COURSES TAUGHT

Advanced Topics in Artificial Intelligence
Algorithmic Arts
Animals and Animats: Natural and Artificial Intelligence and Behavior
Artificial Intelligence
Artificial Intelligence in 3D Virtual Worlds
Beginning Coding for Science
Biocomputational Developmental Ecology
Code Immersion
Cognitive Science Fiction

Computational Models of Biological Systems
 Computer Science Projects
 Computing Concepts: Creative Machines?
 Creative Programming Workshop
 Current Issues in Cognitive Science
 Evolutionary Computation
 Genetic Programming
 Hypertext
 Introduction to Artificial Intelligence
 Introduction to Cognitive Science
 Introduction to Computer Science
 Programming Creativity
 Programming for Science
 Programming Language Paradigms
 Quantum Computing with No Prerequisites of Any Kind
 Radical Innovation in Digital Arts
 Reasoning About Action
 Research in Artificial Intelligence
 Unconventional Computing
 What Computers Can't Do (limits of computing)
 When Machines Talk (natural language processing)

SOFTWARE
DEVELOPMENT
PROJECTS

LGP, HiGP, MidGP, PushGP, Pushpop and other tools for genetic programming research and applications. 1995–present. See <http://hampshire.edu/lspector/code.html>.

QGAME (Quantum Gate and Measurement Emulator), a system for simulating quantum computer algorithms on ordinary (classical) computer hardware, based on the quantum gate array model of quantum computation. 1999–present. See <http://hampshire.edu/lspector/qgame.html>.

SwarmEvolve, a framework for experiments on the emergence of collective behavior in populations of flying agents. 2002–2005. See <http://hampshire.edu/lspector/gecco2003-collective.html>.

PLANET H, a framework for experiments on the cognitive psychology of human planning. With Jordan Grafman at the National Institutes of Health, NINDS. 1996–present.

What about AIDS?, WWW and CD ROM versions of the New York Hall of Science exhibit on AIDS. With Christopher Chase, Richard Muller, and Rebecca S. Neimark. 1994–1998.

CHORES, a framework for experiments on the cognitive psychology of human planning. With Jordan Grafman at the National Institutes of Health, NINDS. 1992–1996.

ErunticLab, an artificial life environment with genetic programming components. 1995. See <http://hampshire.edu/lspector/code.html>.

Semantic network-based “Stream of Consciousness” interface concept for James Joyce *Ulysses* CD ROM. With StonySoft. 1994.

ARTS AND MEDIA
PROJECTS

Simulation-based animations demonstrating gene flow for the *RACE: Are We So Different?* museum exhibit. With Alan Goodman and Robert Garfinkle. 2010.

First Week, audio composition derived from a Division Blocks simulation. Submitted to the Fundación Telefónica VIDA 10.0 International Competition.

<http://hampshire.edu/lsector/firstweek/firstweek.html>.

Selection Songs, music produced by evolving agents in a 3D virtual world. *YLEM Journal*, Vol. 25, No. 6 & 8, pp. 24–26, and accompanying CD. With Jon Klein and Kyle Harrington. 2005.

Albers Automaton, 13x13, a digital projection piece based on the self-organization of colored fields. Gallery Tk (Northampton, Massachusetts); November 18 – December 5, 2004.

CA3D, projection artworks based on 3D cellular automata. Venues include Show Gallery’s October, 2002 MASQ fundraiser (Northampton, Massachusetts); Pablo (Bongohead) Yglesias’s 2002 Bar 19 show (Northampton, Massachusetts); Open Square Arts Party, April, 2004 (Holyoke, Massachusetts).

SwarmEvolveMusic, projection artworks (with audio) based on simulations of evolving, goal-directed swarms. Venues include Show Gallery’s October, 2002 MASQ fundraiser (Northampton, Massachusetts) and Bar 19 (Northampton, Massachusetts). 2002.

Autonomous Color Studies, flat panel/projection artworks based on 2D cellular automata. 1999.

Adapta, musical piece for singing audience and evolutionary computation. Invited concert presentation. New Music Mini-Festival, Center for the Arts, Wesleyan University. 1996.

Twitchy, interactive sculpture with video sensing and sound and servo motor motion output. Lemelson-funded E-Team project. Hampshire College. With James Carlson and Garth Zenie. 1995.

Speech activated interactive component of *King Anthracite* installation. With Stashu Kybartas. 1993.

Life & Death, interactive sound installation. 18th Annual Electronic Music Plus Festival. With Benjy Bernhardt and Rebecca S. Neimark. 1991.

MEDIA

Quotes and Mentions

The Boston Globe, “Possible cheating uncovered in popular Harvard computer class,” by Travis Andersen and Brian MacQuarrie. May 5, 2017. <https://www.bostonglobe.com/metro/2017/05/04/possible-cheating-uncovered-popular-harvard-computer-class/4Wu2EfzWMEwXveBuu09qFJ/story.html>

Harvard Business Review. “There Will Always Be Limits to How Creative a Computer Can Be,” by Tony McCaffrey. April 24, 2017. <https://hbr.org/2017/04/there-will-always-be-limits-to-how-creative-a-computer-can-be>

WFCR, National Public Radio, “Rethinking Computer Intelligence,” by Karen Brown, radio story. June 17, 2014. <http://nepr.net/news/2014/06/17/rethinking-computer-intelligence/>

Ars Technica website, “Scientific computings future: Can any coding language top a 1950s behemoth?,” by Lee Phillips. May 7, 2014. <http://arstechnica.com/science/2014/05/scientific-computings-future-can-any-coding-language-top-a-1950s-behemoth/>

New Scientist magazine, “Wolf packs don’t need to cooperate to make a kill,” by Michael Marshall. Co-authored paper cited; co-author quoted. October 26, 2011.

WFCR, National Public Radio, “Hampshire Prof. Wins Grant to Create Computer Software That Can Evolve On Its Own,” by Fred Bever, radio story. September 6, 2010.

The Daily Hampshire Gazette, “Eureka: Evolution as world’s greatest calculator,” by Kristin Palpini. Column on the receipt of the gold medal in the “Human-Competitive Results” competition at the 2008 Genetic and Evolutionary Computation Conference. August 15, 2008.

The Daily Hampshire Gazette, news item on a grant from the NSF CreativeIT program. October 19, 2007.

The Poughkeepsie Journal, announcing “Evolutionary Computation for Science, Engineering and Art,” a presentation at SUNY New Paltz. April 26, 2007.

The Daily Hampshire Gazette, news item on the receipt of the gold medal in the “Human-Competitive Results” competition at the 2004 Genetic and Evolutionary Computation Conference, by Cheryl B. Wilson. August 23, 2004.

The Chronicle of Higher Education, on receiving the NSF Director’s Award for Distinguished Teaching Scholars. “National Science Foundation Honors Teaching Scholars.” On-line version: May 9, 2003, <http://chronicle.com/prm/daily/2003/05/2003050905n.htm>

The Daily Hampshire Gazette, feature story on the NSF Director’s Award for Distinguished Teaching Scholars. “Hampshire prof wins national teaching award,” by Cheryl B. Wilson. May 12, 2003.

The Daily Hampshire Gazette, on the awarding of an NSF/MRI grant. May 13, 2002.

The Daily Hampshire Gazette, on the politics of software choices. “Hampshire takes lead on software,” by Stacey Butterfield. November 24, 2001.

Technology Research News, on the use of digital organisms in the study of evolutionary dynamics. “Virtual beings boost evolutionary theory,” by Ted Smalley Bowen. October 10, 2001.

The Chronicle of Higher Education, on open-source software. “Hampshire College Favors Noncommercial Web Software Open to All.” Print version: October 26, 2001, page A35.

New Scientist, on the use of genetic programming for applications in quantum computing. January 20, 2001.

The Orlando Sentinel, on robotic pets. “They Bark, They Byte. Robotic Rovers Are The Rage — Woof It Up With Our Computerized-Pets Guide.” Friday, December 8, 2000.

Details magazine, on the possibility of computers having senses of humor. “Take My Hard Drive... Please; A computer may have beaten chess champion Garry Kasparov, but will one ever be able to tell a joke?” March, 2000.

The Daily Hampshire Gazette, on the importance of computers in the 20th century. “It was a century for invention.” January 1/2, 2000.

Salon.com on-line magazine, on genetic programming applications to quantum computing and jazz composition. “Software that Writes Software.” August 10, 1999. http://www.salon.com/tech/feature/1999/08/10/genetic_programming/index.html

Scientific American, on the use of “cultures” in genetic programming and on ontogenetic programming. “Programming With Primordial Ooze.” October, 1996.

Association for Computing Machinery (ACM)
ACM SIGEVO (formerly Int. Soc. Genetic and Evolutionary Comp.), Executive Committee Member
International Society for Artificial Life