

# Stephanie Forrest

Department of Computer Science  
Farris Engineering Center 355E  
The University of New Mexico, Albuquerque, NM 87131

(505) 277-7104, 277-3112  
forrest@cs.unm.edu  
<http://cs.unm.edu/~forrest>

October 8, 2012

## EDUCATION

Ph.D. Computer and Communication Sciences, The University of Michigan, Ann Arbor, MI, 1985.

M.S. Computer and Communication Sciences, The University of Michigan, Ann Arbor, MI, 1982.

B.A. St. John's College, Annapolis, MD and Santa Fe, NM, 1977.

## RESEARCH INTERESTS

Biology and computation, including computational immunology, genetic algorithms, computational modeling of biological systems, automated software repair, and biologically inspired approaches to computer security.

## EMPLOYMENT

1990–present. Department of Computer Science, The University of New Mexico, Albuquerque, NM. Department Chairman, 2006–2011; Professor, 1999–present; Associate Professor, 1994–1999; Assistant Professor, 1990–1994. Secondary appointment in Dept. of Biology, 2001–present.

2003–2006. Santa Fe Institute, Santa Fe, NM. Research Professor (part-time sabbatical leave).

1999–2000. Santa Fe Institute, Santa Fe, NM. Interim Vice President for Academic Affairs.

1996–1997. Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, MA. Visiting Associate Professor (sabbatical leave).

1988–1990. Center for Nonlinear Studies and Computing Division, Los Alamos National Laboratory, Los Alamos, NM. Director's Postdoctoral Research Fellow.

1985–1988. Teknowledge, Inc., Palo Alto, CA. Scientist and Senior Scientist, Research and Advanced Development. Project leader responsible for projects in real-time knowledge-based systems and parallel/distributed software architectures for symbolic computing.

## SELECTED PROFESSIONAL ACTIVITIES

Santa Fe Institute, Santa Fe, NM. Science Board Co-Chair (2010 - present), Science Board Member 1991–1997, 1998–2001, 2003–2008, 2009–present; SSC Steering Committee, 1993–1999; External Faculty, 1990–2003; Resident Faculty, 2003–2006.

Editing: Journal of Machine Learning Research (Action Editor, 2005–2010); Evolutionary Intelligence (Editorial Board, 2007–present); Evolutionary Computation (Associate Editor, 1995–2002; Action Editor, 1994–95); Journal of Artificial Intelligence Research (Editorial Board, 1998–2002); Journal of Experimental and Theoretical Artificial Intelligence (Editorial Board, 1989–1996); Artificial Life (Editorial Board, 1994–present).

Program Chair: Ninth Annual CNLS Conference, Emergent Computation (1989), Fifth International Conference on Genetic Algorithms (1993), Workshop on “Forging an effective immune response” held at Institute for Mathematics and its Applications, Univ. of Minnesota (1998) (Co-chair with one other), Festschrift in honor of John Holland (1999) (Co-organizer with three others), SFI Workshop on Software Evolvability (2005) (Co-chair with two others).

Program Committees: ACM Conference on Computer and Communications Security (2005), New Security Paradigms Workshop (2008), Hot Topics in Operating Systems (2005), International Conference on Artificial Immune Systems (2002, 2003, 2004, 2005, 2006, 2007, 2008, 2011), International Conference on Genetic Algorithms (1991, 1993, 1995, 1997, 1999), Genetic and Evolutionary Computation Conference (2000, 2001, 2004, 2011) Workshop on Foundations of Genetic Algorithms (1992, 1994), Second European Conference on Artificial Life (1993), International Conference on Intelligent Systems for Molecular Biology (1994), Parallel Problem Solving from Nature (1994), IEEE Conference on Evolutionary Computation (1995), International Joint Conference on Artificial Intelligence (1995). Scientific Advisory Board for the ALife 7 Conference (2000, 2001).

Computing Community Consortium (CCC) Council (2009–2012). NSF GENI/NetSE Council (2007–2009). NSF Advisory Committee for the Directorate for Computer and Information Science and Engineering (2006–2008).

DIMACS Advisory Committee for special focus on epidemiology 2001–2004. Co-organizer of DIMACS working group on “analogies between computer viruses and immune systems and biological viruses and immune systems.”

DARPA Information Science and Technology (ISAT) advisory group (2001–2004). Conducts studies on emerging technologies of interest to the Defense Department and advises DARPA on promising directions for new research programs.

Senior Member, IEEE.

## **HONORS AND AWARDS**

University of New Mexico Research Lectureship (2012).

Association for Computing Machinery/AAAI Allen Newell Award. For innovations in computing technology that have made significant contributions enabling computer science to solve real-world challenges (2012)

New Mexico Council on Technology, Women in Technology Award (2009).

ACM SIGEVO GECCO Impact Award for highest impact paper published in the 1999 Genetic and Evolutionary Computation Conference (awarded in 2009 and shared with one other paper).

“Humies” \$5000 Gold Medal Award for human-competitive results produced by genetic and evolutionary computation (2009), shared with 3 others..

IFIP TC2 Manfred Paul Award for Excellence in Software: Theory and Practice (2009), shared with 3 others.

Senior Fellow of the International Society for Genetic and Evolutionary Computation (2003).

St. John’s College Alumni Award of Merit, 2002.

UNM General Library Faculty Acknowledgment Award, 1999. UNM Regents Lecturer, 1994-97, UNM College of Engineering Outstanding Research Award (Junior Faculty award, 1993; Senior Faculty award, 2000).

NSF Presidential Young Investigator Award, 1991-96.

Association of Western Universities Faculty Fellowship, 1991.

GE Foundation Young Faculty Award, 1990.

## FUNDED RESEARCH (since 1990)

- Defense Advanced Research Projects Agency (\$3,200,625) “Scalable RADAR for Co-evolutionary Adversarial Environments” S. Forrest (PI), J. Crandall, M. Moses, W. Weimer (Co-PIs). 2010-2014.
- National Science Foundation (UNM share \$ 500,000) “Collaborative Research: Search, Signals and Information Exchange in Distributed Biological Systems.” M. Moses (PI); S. Forrest, D. Gordon (Co-PIs). 2010-2013.
- Air Force Office of Scientific Research DURIP-10-054 (\$58,189) “Helix Project Testbed: Towards the Self-Regenerative Incorruptible Enterprise.” 2010.
- Department of Energy (UNM share \$600,000) ”ASIM: An integrated agent-based model of a complex network” S. Hofmeyr (PI), S. Forrest (Co-PI). 2009-2012.
- National Science Foundation (\$ 600,000) “Fixing real bugs in real programs using evolutionary algorithms.” W. Weimer (PI), S. Forrest (Co-PI). 2009-2012.
- National Science Foundation (\$69,930) “Safe Computing Workshop: Introspective Hardware Architectures for Information Assurance.” S. Forrest (PI). 2007-2008.
- Air Force Office of Scientific Research (UNM Share \$750,000) “Helix: A Self-Regenerative Architecture for the Incorruptible Enterprise.” J. C. Knight (PI), J. Davidson, D. Evans, W. Weimer, A. Nguyen-Tuong, H. Chen, K. Levitt, J. Rowe, Z. Su, F. Wu, F. Chong, S. Forrest, J. Saia (Co-PI). 2007-2012.
- National Institutes of Health (UNM Share \$144,046) “Modeling Early Influenza Virus Replication in Primary Human Lung Cells.” F. Koster (PI), S. Forrest (Co-PI). 2007-2009.
- National Science Foundation (\$230,921) “Collaborative Research: A Biologically Motivated Scaling Theory for Computing” S. Forrest (PI), J. Brown, A. Davis (Co-PIs). 2006-2009.
- Howard Hughes Medical Institute (\$1,000,000) “Program in Interdisciplinary Biomedical Science (PIBS)” J. Brown (PI), S. Forrest, N. Kenkre and F. Smith (Co-PIs). 2006-2011.
- Motorola (\$150,000) “Biological design for computer security.” 2005-2008.
- SFI International Program (\$17,500) “Instruction set diversification” G. Barrantes, J. Vargas, and S. Forrest. Project activities located at Universidad de Costa Rica. 2005-2006.
- UNM/LANL Joint Science and Technology Laboratory (\$131,750) “Realistic modeling of the immune response in tissue” S. Forrest and A. S. Perelson. 2005-2007.
- National Institutes of Health (\$10,141,000) “COBRE Center for Evolutionary and Theoretical Immunology” 2003-2008. E. S. Loker (PI), S. Forrest, R. D. Miller, A. S. Perelson (Co-PIs). CS share: \$2,123,085.
- National Science Foundation CCR Large ITR Grant (\$12,500,000) “Sensitive Information in a Wired World” 2003-2008. D. Boneh (PI), J. Feigenbaum, S. Forrest, H. Garcia-Molina, R. Kanan, H. Nissenbaum, A. Silberschatz, R. Wright (Co-PIs). UNM share: \$625,000.

National Science Foundation SGER (\$100,000) “Reconstructing Information from Database Fragments Via Negative Partial Match Detection” 2003-2004. S. Forrest (PI), P. Helman (Co-PI).

National Science Foundation (\$1,200,000) “Collaborative Grant: Automated and Adaptive Diversity for Improving Computer Systems Security” 2003-2007. D. Song (PI), M. Reiter, S. Forrest (Co-PIs). Unm Share: \$250,000.

Defense Advanced Research Projects Agency (\$280,000) “Automated Diversity in Computer Systems UNM Component” 2002-2003. Seedling project.

NIH P20 Center for the Spatiotemporal Modeling of Cell Signaling (\$988,815). Planning grant. J. Oliver (PI), S. Steinberg, S. Forrest, and G. Heffelfinger (Co-PIs). 2002-2005.

Intel Corp. (\$154,000) “Information Immune Systems.” 2001-03.

National Science Foundation (\$871,478). Understanding and surviving computation in the wild. S. Forrest (PI), D. Ackley (Co-PI) 2000-2005.

Defense Advanced Research Projects Agency. (\$1,100,000). Computation in the Wild: Moving Beyond the Metaphor. S. Forrest (PI), D. Ackley (Co-PI). 2000-2005.

Office of Naval Research (\$18,600). Dynamics Days Conference. Co-PI with David Egolf. 2000.

National Science Foundation (\$ 321,622). Pilot Program for NSF Physics Graduate Student Fellowships at the Santa Fe Institute. E. Jen (PI), D. Campbell, J. Crutchfield, and S. Forrest (Co-PIs). 1999-2002.

Department of Energy (\$ 606,000). A Broad Program in the Sciences of Complexity. Co-PI with Ellen Goldberg, Erica Jen, and Marc Feldman. 2001-2003.

Office of Naval Research (\$420,072). Emergent Computation. 1999-2003.

Intel Corporation (\$252,000) Information Immune Systems, 2001-2004; Biologically Inspired Approaches to Computer Security (\$169,398), 1998-2000.

National Science Foundation (\$292,350). Computer Immunology. 1997-2000.

IBM Partnership Award (\$20,000). 1998.

Defense Advanced Research Projects Agency (\$755,728). Research on a Simple Definition of Normal Behavior for Unix Processes. 1996-98.

NSF Research Training Grant (\$562,500). A BIO Research Training Group in Ecological Complexity, 1995-2000. CO-PI with five others.

Office of Naval Research N00014-95-1-0364 (\$400,000). Research in Computational Immunology, 1995-98.

NSF Presidential Young Investigator Award IRI-9157644 (\$500,000). Computational Aspects of the Immune System, 1991-96.

Sandia National Laboratories AN-4184 (\$26,039). Genetic programming for automatic learning and image classification. Graduate student support, 1995-96.

Santa Fe Institute (\$131,208). Graduate student support, 1991-95. Project 2050 (\$34,970), 1992-4.

Alfred P. Sloan Foundation (\$30,000). Foundations of Genetic Algorithms (administered through Santa Fe Institute). Principal Investigator with Melanie Mitchell, 1992-94.

Sandia University Research Program (SURP) grant AE-1679 (\$60,000). Inappropriate Convergence in Genetic Algorithms, 1991-93.

Association of Western Universities (AWU) Faculty Fellowship (\$10,000), 1991.

Los Alamos National Laboratory (CNLS) Contract (\$20,382). Genetic Algorithms and Classifier Systems. Release time, 1990-91.

University of California Institutional Collaborative Research (INCOR) grants (\$42,000), 1989-93.

## Ph.D. STUDENTS GRADUATED

- Terry Jones (1995) “Evolutionary algorithms, fitness landscapes and search.” Fluidinfo Ltd.
- Ron Hightower (1996) “Computational aspects of antibody gene families.” Self-employed.
- Derek Smith (1997) “The cross-reactive immune response.” (Nominated for ACM Best Dissertation award). Prof. of Zoology, Cambridge Univ. UK.
- Mihaela Oprea Zavalon (1999) “Optimizing the antibody repertoire for pathogen recognition.” Prof. of Bioinformatics, Univ. of Basel, Switzerland.
- Steven Hofmeyr (1999) “An immunological model of distributed detection and its application to network security.” Lawrence Berkeley Laboratory.
- Wim Hordijk (1999) “Dynamics, emergent computation, and evolution in cellular automata.” Self-employed.
- Patrik D’haeseleer (2000) “Reconstructing gene networks from large scale gene expression data.” Lawrence Livermore National Laboratory
- Anil Somayaji (2002) “Operating system stability and security through process homeostasis.” Assoc. Prof. of Computer Science, Carleton University, Ottawa.
- Dennis L. Chao (2004) “Modeling the cytotoxic T cell response.” Fred Hutchinson Cancer Research Center.
- Christina Warrender (2004) “ Modeling intercellular interactions in the peripheral immune system.” Sandia National Laboratory.
- Gabriela Barrantes (2005) “Automated methods for creating diversity in computer systems.” Prof. and Chair of Computer Science, Universidad de Costa Rica.
- Hajime Inoue (2005) “Anomaly detection in dynamic execution environments.” Principle Scientist, Architecture Technology Corporation.
- Fernando Esponda (2006) “Protecting Data Privacy through Hard-to-Reverse Negative Databases” Assoc. Prof. Instituto Tecnológico Autónomo de México.
- Robert Abbott (2007) “Automated tactics modeling: Techniques and Applications” Principal Member of the Technical Staff, Sandia National Laboratory.
- Todd Kaplan (2008) “Detecting community structure in financial markets” Plektos.
- Eric Trias (2008) “Leveraging positive and negative representations of information” U.S.A.F.
- Josh Karlin (2009) “Distributed Internet security and measurement.” Google.
- George Bezerra (2012) “Energy Consumption in Networks on Chip: Efficiency and Scaling” MIT.
- Michael Groat (2012) “Energy Conserving Privacy Enhancing Algorithms in Resource-Constrained Devices”

## **POST-DOCTORAL SUPERVISION**

Dipankar Dasgupta (Univ. of Memphis, TN), Andrew Kosoresow (deceased), Derek Smith (Cambridge Univ. UK), Carlo Maley (UCSF), Steven Hofmeyr (LBL), Matt Glickman (Sandia National Labs.), Catherine Beauchemin (Ryerson Univ. CAN), Petter Holme (Royal Institute of Technology, Stockholm), Melanie Moses (Univ. of New Mexico), Hugh Mitchell (Pacific Northwest National Lab.), Terri Oda (current).

## PUBLICATIONS AND PATENTS (Reverse chronological order)

### PATENTS

- L. Allen, S. Forrest, and A. S. Perelson “A method of detecting changes to a collection of digital signals.” U.S. patent 5448668 (Sept. 5, 1995).

### BOOKS AND CONFERENCE PROCEEDINGS

- L. Booker, S. Forrest, M. Mitchell, and R. Riolo (Ed.) *Perspectives on Adaptation in Natural and Artificial Systems*, Oxford University Press (2005).
- S. Forrest (Ed.) *Proceedings of the Fifth International Conference on Genetic Algorithms*. Morgan Kaufmann, Los Altos, CA (1993).
- S. Forrest *Parallelism in Classifier Systems*. In monograph series “Research Notes in Artificial Intelligence.” Pitman Publishing, London and Morgan Kaufmann, Los Altos, CA (1991). Revised version of Ph.D. thesis.
- S. Forrest (Ed.) *Emergent Computation*. MIT Press, Cambridge, MA (1991). Also published as *Physica D* special issue Vol. 42, Nos. 1-3 (1990).

### CHAPTERS OF BOOKS

- C. Le Goues, A. Nguyen-Tuong, H. Chen, J. W. Davidson, S. Forrest, J. D. Hiser, J. C. Knight and M. Van Gundy. “Moving Target Defenses in the Helix Self-Regenerative Architecture.” In S. Jajodia, A. K. Ghosh, V. S. Subrahmanian, V. Swarup, C. Wang, and X. S. Wang Eds. *Moving Target Defense II: Application of Game Theory and Adversarial Modeling*. pp. 115–146 (2012).
- M. Moses and S. Forrest “Beyond Biology,” in *Metabolic Ecology: A Scaling Approach*, Wiley-Blackwell (2012).
- K. Ingham and S. Forrest “Network firewalls.” In V. Rao Vemuri and V. Sreeharirao Eds. *Enhancing Computer security with Smart Technology*, pp. 9-35. CRC Press (2005).
- S. Forrest, J. Balthrop, M. Glickman, and D. Ackley “Computation in the Wild.” E. Jen Ed. *Robust Design: A Repertoire of Biological, Ecological, and Engineering Case Studies*, pp. 207-230. Oxford University Press (2004). Reprinted in K. Park and W. Willinger Eds. *The Internet as a Large-Scale Complex System*, pp. 227-250. Oxford University Press (2005).
- D. J. Smith, A. S. Lapedes, S. Forrest, J. C. deJong, A. D. M. E. Osterhaus, R. A. M. Fouchier, N. J. Cox, and A. S. Perelson, “Modeling the effects of updating the influenza vaccine on the efficacy of repeated vaccination.” In *Options for the control of influenza virus IV*, eds. A.D.M.E. Osterhaus, N. Cox, and A. Hampson, Excerpta Medica, International Congress Series 1219, Amsterdam, 655-660 (2001).

- S. Forrest and S. A. Hofmeyr, Immunology as information processing. In *Design Principles for the Immune System and Other Distributed Autonomous Systems*, edited by L. A. Segel and I. Cohen. Santa Fe Institute Studies in the Sciences of Complexity. New York: Oxford University Press (2001).
- J.H. Holland, L.B. Booker, M. Colombetti, M. Dorigo, S. Forrest, D.G. Goldberg, R.L. Riolo, R.E. Smith, P.L. Lanzi, W. Stolzmann, and S.W. Wilson “What is a Learning Classifier System?” In P.L. Lanzi, W. Stolzmann, S.W. Wilson Eds. *Learning Classifier Systems: An Introduction to Contemporary Research* Springer Verlag, pp. 3–32 (2000).
- D. J. Smith, S. Forrest, D. H. Ackley, and A. S. Perelson “Modeling the effects of prior infection on vaccine efficacy.” In D. Dasgupta (Ed.) *Artificial Immune Systems and Their Applications*, Springer-Verlag, Berlin Germany (1998).
- D. J. Smith, S. Forrest, and A. S. Perelson “Immunological memory is associative.” In D. Dasgupta (Ed.) *Artificial Immune Systems and Their Applications*, Springer-Verlag, Berlin Germany (1998).
- S. Forrest “Genetic algorithms.” In A. B. Tucker (Ed.) *CRC Handbook of Computer Science and Engineering*, CRC Press, Boca Raton, FL (1996).
- M. Mitchell and S. Forrest “Fitness Landscapes: Royal Road Functions.” In Back, Fogel, and Michalewicz (Eds.) *Handbook of Evolutionary Computation*. Institute of Physics Publishing, Philadelphia and Bristol UK, B2.7:1-25 (1997).
- R. Hightower, S. Forrest and A. S. Perelson “The Baldwin effect in the immune system: learning by somatic hypermutation.” In R. K. Belew and M. Mitchell (Eds.) *Adaptive Individuals in Evolving Populations*, Addison-Wesley, Reading, MA, pp. 159-167 (1996).
- C. Burks, M.L. Engle, S. Forrest, R.J. Parsons, C.A. Soderlund, and P.E. Stolorz “Stochastic optimization tools for genomic sequence assembly.” In J.C. Venter (Ed.) *Automated DNA Sequencing and Analysis Techniques* Academic Press, London (1993).
- S. Forrest and G. Mayer-Kress “Genetic algorithms, nonlinear dynamical systems, and global Stability Models.” In L. Davis (ed.) *The Handbook of Genetic Algorithms*. Van Nostrand Reinhold, New York (1991).
- S. Forrest “Knowledge-based approaches for real-time process management.” In M.G. Singh (Ed.) *Systems and Control Encyclopedia, First Supplement*. Pergamon Books, Oxford (1990).

## REFEREED JOURNAL PUBLICATIONS

- D. Levin, S. Forrest, S. Banerjee, C. Clay, M. Mitchell, and F. Koster “Spatially explicit model of the lymphocyte diaspora in influenza-infected lung quantifies constraints of chemokine directed migration.” *PLoS Computational Biology* (submitted Sept. 2012).
- M. Groat, B. Edwards, J. Horey, W. He, S. Forrest “Enhancing privacy in participatory sensing applications with multidimensional data” *Pervasive and Mobile Computing* (in revision).

- F. Esponda, E. Trias, E. Ackley, S. Forrest “Operations over negative databases: A relational algebra” *Natural Computing* (in press).
- C. Le Goues, T. Nguyen, S. Forrest, W. Weimer “GenProg: Automatic Bug Correction in Real Programs.” *ACM Transactions on Software Engineering* 38:1 pp. (2012).
- H. Mitchell, D. Levin, S. Forrest, C. Beauchemin, J. Tipper, J. Knight, N. Donart, C. Layton, J. Pyles, P. Gao, K. Harrod, A. Perelson, and F. Koster “Higher replication efficiency of 2009 (H1N1) pandemic influenza than seasonal and avian strains: Kinetics from epithelial cell culture and computational modeling.” *J. Virology* 85:2 pp. 1125-1135 (2011). doi:10.1128/JVI.01722-10.
- W. Weimer, S. Forrest, C. Le Goues, T. Nguyen “Automatic program repair with evolutionary computation.” *Communications of the ACM Research Highlight* 53:5 pp. 109-116 (2010).
- F. Esponda, S. Forrest, and P. Helman “Negative representations of information.” *International Journal of Information Security* 8:5 pp. 331 (2009). doi:10.1007/s10207-009-0078-1.
- J. Karlin, J. Rexford, and S. Forrest “Autonomous security for autonomous systems” *Computer Networks* 52:2908-2923 (2008).
- P. Holme, J. Karlin, and S. Forrest “An integrated model of traffic, geography and economy in the Internet.” *ACM SIGCOMM Computer Communication Review* 38:3, pp. 7-15 (2008).
- M. Moses, S. Forrest, A. L. Davis, M. Lodder, and J. H. Brown “Scaling theory for information networks.” *Journal of the Royal Society Interface* 5:29, pp. 1391-1510 (2008).
- F. Esponda, E. S. Ackley, P. Helman, H. Jia, and S. Forrest “Protecting Data Privacy through Hard-to-Reverse Negative Databases.” *Int. Journal of Information Security* 6:6 (2007).
- S. Forrest and C. Beauchemin “Computer Immunology.” *Immunological Reviews* 216:176-197 (2007).
- P. Holme, J. Karlin, and S. Forrest “Radial structure of the Internet.” *Proc. Royal Society A* 463:1231-1246 (2007).
- K. Ingham, A. Somayaji, S. Forrest, and J. Burge “Learning DFA representations of HTTP for protecting web applications.” *Journal of Computer Networks* 51:5, pp. 1239-1255 (2007).
- R. Gerety, S. Spencer, K. Pienta, and S. Forrest “Modeling somatic evolution in tumorigenesis.” *PLoS Computational Biology* 2:8 e108 (2006).
- R. G. Abbott, S. Forrest, and K. J. Pienta “Simulating the hallmarks of cancer.” *Journal of Artificial Life* Vol. 12, No. 4: 617-634 (2006).
- H. Inoue, D. Stefanovic, and S. Forrest. “On the prediction of Java object lifetimes.” *IEEE Transactions on Computers* 55:7, pp. 880- 892 (2006).
- C. Warrender, S. Forrest, and F. Koster “Modeling intercellular interactions in early Mycobacterium infection.” *Bulletin of Mathematical Biology* 66:6, pp. 1493 - 1514 (2006).
- D L. Chao, M. P. Davenport, S. Forrest, A. S. Perelson “The effects of thymic selection on the range of T cell cross-reactivity” *European Journal of Immunology* 35:3452-3459 (2005).

- G. Barrantes, D. Ackley, S. Forrest, and D. Stefanovic “Randomized instruction set emulation” *ACM Transactions on Information Systems Security (TISSEC)* 8:1, pp. 3-40 (2005).
- M. Glickman, J. Balthrop, and S. Forrest. “A machine learning evaluation of an artificial immune system.” *Evolutionary Computation Journal* Vol. 13:2, pp. 179-212 (2005).
- F. Esponda, E. S. Ackley, S. Forrest, and P. Helman “On-line negative databases.” *Journal of Unconventional Computing* 1:3, pp. 201-220 (2005).
- C. Warrender, S. Forrest, and L. Segel. “Homeostasis of peripheral immune effectors.” *Bulletin of Mathematical Biology* 66:6, pp. 1493-1514 (2004).
- D. L. Chao, M. P. Davenport, S. Forrest, and A. S. Perelson. “A stochastic model of cytotoxic T cell responses.” *Journal of Theoretical Biology* Vol. 228:227-240 (2004).
- D. L. Chao, M. P. Davenport, S. Forrest, and A. S. Perelson “Modeling the impact of antigen kinetics on T cell activation and response.” *Immunology and Cell Biology* 82:1 (2004).
- J. Balthrop, S. Forrest, M. Newman, and M. Williamson. “Technological networks and the spread of computer viruses.” *Science* 304:527-529 (2004).
- C. C. Maley, B. J. Reid, and S. Forrest. “Cancer prevention strategies that address the evolutionary dynamics of neoplastic cells: Simulating benign cell boosters and selection for chemosensitivity.” *Cancer Epidemiology, Biomarkers and Prevention* 13(8):1375-84 (2004).
- F. Esponda, S. Forrest, and P. Helman. “A formal framework for positive and negative detection.” *IEEE Transactions on Systems, Man, and Cybernetics* 34:1 pp. 357-373 (2004).
- D. L. Chao and S. Forrest. “Information immune systems.” *Genetic Programming and Evolvable Machines* Vol 4:4, pp. 311-331 (2003).
- M. Newman, S. Forrest, and J. Balthrop. “Email networks and the spread of computer viruses.” *Physical Review E* 66, 035101 (2002).
- M. Moses and S. Forrest. Book review of *The Computational Beauty of Nature* by G. Flake. *Artificial Intelligence* 128:239-242 (2001).
- S. Forrest and S. Hofmeyr, “Engineering an immune system.” *Graft* Vol. 4:5 pp. 5-9 (2001).
- C. C. Maley and S. Forrest. Exploring the relationship between neutral and selective mutations in cancer. *Artificial Life* 6: 325-345 (2000).
- S. Hofmeyr and S. Forrest. “Architecture for an artificial immune system.” *Evolutionary Computation Journal* Vol. 8:4 pp. 443-473 (2000).
- D. J. Smith, S. Forrest, D. H. Ackley, and A. S. Perelson “Variable efficacy of repeated annual influenza vaccination.” *Proceedings of the National Academy of Sciences* 96:14001-14006 (1999).
- D. J. Smith, S. Forrest, D. H. Ackley, and A. S. Perelson “Using lazy evaluation to simulate realistic-size repertoires in models of the immune system.” *Bulletin of Mathematical Biology* Vol. 60, pp. 647-658 (1998).

- S. Hofmeyr, S. Forrest, and A. Somayaji "Intrusion detection using sequences of system calls." *Journal of Computer Security* Vol. 6, pp. 151-180 (1998).
- D. J. Smith, S. Forrest, R. R. Hightower, and A. S. Perelson "Deriving shape-space parameters from immunological data for a model of cross-reactive memory." *Journal of Theoretical Biology* Vol. 189: 141-150 (1997).
- S. Forrest, S. Hofmeyr, and A. Somayaji "Computer immunology" *Communications of the ACM* Vol. 40, No. 10, pp. 88-96 (1997).
- P. Hraber, T. Jones, and S. Forrest "The ecology of Echo." *Artificial Life* Vol. 3, No. 3, pp. 165-190 (1997).
- A. Perelson, R. Hightower, and S. Forrest "Evolution (and learning) of v-region genes." *Research in Immunology* Vol. 147, pp. 202-208 (1996).
- S. Forrest "Genetic Algorithms." *ACM Computing Surveys* Vol. 28:1, pp. 77-80 (1996).
- R. Parsons, S. Forrest, and C. Burks "Genetic operators for the DNA fragment assembly problem" *Machine Learning* Vol. 21:1/2, pp. 11-33 (1995).
- M. Mitchell and S. Forrest "Genetic algorithms and artificial life." *Artificial Life* 1:3, pp. 267-289 (1994). Reprinted in C. G. Langton (Ed.) *Artificial Life: An Overview*, MIT Press, Cambridge, MA (1995).
- S. Forrest "Genetic algorithms: principles of natural selection applied to computation." *Science* Vol. 261, pp. 872-878 (Aug. 13, 1993).
- S. Forrest, B. Javornik, R. E. Smith and A. S. Perelson "Using genetic algorithms to explore pattern recognition in the immune system." *Evolutionary Computation* 1:3, pp. 191-211 (1993).
- R. E. Smith, S. Forrest, and A. S. Perelson "Searching for diverse, cooperative populations with genetic algorithms." *Evolutionary Computation* 1:2, pp. 127-149 (1993).
- S. Forrest and M. Mitchell "What makes a problem hard for a genetic algorithm? Some anomalous results and their explanation." *Machine Learning* 13:2/3, pp. 129-163 (1993).
- S. Forrest "Introduction to the Proceedings of the Ninth Annual CNLS Conference." *Physica D* Vol. 42:1-3, pp. 1-11 (1990).
- S. Forrest and J. H. Miller "Emergent behaviors of classifier systems." *Physica D* Vol. 42:1-3, pp. 213-227 (1990).
- J. Lark, L. Eрман, S. Forrest, K. Gostelow, F. Hayes-Roth, J. Lark, and D. Smith "Concepts, methods, and languages for building timely intelligent systems." *Real-time Systems* 2:1 (1990).
- R. Belew and S. Forrest "Learning and programming in classifier systems." *Machine Learning* 3: 193-223 (1988).
- B. D'Ambrosio, M. Fehling, S. Forrest, P. Raulefs, and M. Wilber "Real-time process management for materials composition in chemical manufacturing." *IEEE Expert* pp. 80-93 (Summer, 1987).

## REFEREED CONFERENCE PUBLICATIONS

- E. Schulte, J. DiLorenzo, W. Weimer, S. Forrest "Automated repair of binary and assembly programs for cooperating embedded devices." ASPLOS'13 (submitted July, 2012).
- B. Edwards, T. Moore, G. Stelle, S. Hofmeyr and S. Forrest. "Beyond the Blacklist: Modeling Malware Spread and the Effect of Interventions." New Security Paradigms Workshop (2012).
- M. Groat, B. Edwards, J. Horey, W. He, and S. Forrest "Enhancing Privacy in Participatory Sensing Applications with Multidimensional Data" Pervasive Computing 2012 (PERCOM).
- C. Le Goues, W. Weimer, and S. Forrest "Representations and Operators for Improving Evolutionary Software Repair." Genetic and Evolutionary Computation Conference (GECCO 2012). Nominated for best paper.
- T. Nguyen, D. Kapur, W. Weimer, and S. Forrest "Using Dynamic Analysis to Discover Polynomial and Array Invariants." International Conference on Software Engineering (ICSE 2012). ACM SIGSOFT Distinguished Paper Award.
- C. Le Goues, M. Dewey-Vogt, S. Forrest, and W. Weimer "A systematic study of automated program repair: Fixing 55 out of 105 bugs for \$8.00 each." International Conference on Software Engineering (ICSE 2012).
- J. Horey, M. Groat, and S. Forrest "Reconstructing spatial distributions from anonymized Locations" Workshop on Secure Data Management at ICDE. 2012.
- S. Banerjee, D. Levin, M. Moses, F. Koster, and S. Forrest "The Value of Inflammatory Signals in Adaptive Immune Responses." International Conference on Artificial Immune Systems (ICARIS). 2011.
- G. Bezerra, S. Forrest and P. Zarkesh-Ha "Reducing Energy and Increasing Performance with Traffic Optimization in Many-core Systems." ACM/IEEE International Workshop on System Level Interconnect Prediction (SLIP '11) ACM New York, NY (2011).
- S. Hofmeyr, T. Moore, S. Forrest, B. Edwards and G. Stelle "Modeling Internet-scale policies for cleaning up malware." Tenth Workshop on Economics of Information Security (WEIS) (2011).
- C. Le Goues, S. Forrest, W. Weimer "The case for software evolution." 2010 FSE/SDP Workshop on the Future of Software Engineering Research (2010).
- E. Schulte, S. Forrest, and W. Weimer "Automated Program Repair through the Evolution of Assembly Code" 25th IEEE/ACM International Conference on Automated Software Engineering Short Paper, pp. 313-316 (2010).
- M. Groat, W. He, and S. Forrest "KIPDA:  $k$ -Indistinguishable privacy-preserving data aggregation in wireless sensor networks" INFOCOM (2011).

- P. Zarkesh-Ha, G. Bezerra, S. Forrest, and M. Moses “Hybrid Network on Chip (HNOc): Local Buses with a Global Mesh Architecture.” ACM/IEEE International Workshop on System Level Interconnect Prediction (SLIP’10) Anaheim, CA. ACM, New York, NY pp. 9-14 (2010).
- G. Bezerra, S. Forrest, M. Moses, A. Davis, and P. Zarkesh-Ha. “Communication Probability Distribution and Energy Consumption in Networks on Chip.” ACM/IEEE International Workshop on System Level Interconnect Prediction (SLIP’10) Anaheim, CA. ACM, New York, NY pp. 3-8 (2010).
- E. Fast, C. Le Goues, W. Weimer, and S. Forrest “Designing better fitness functions for automated program repair.” Genetic and Evolutionary Computation Conference (2010).
- S. Forrest, T. Nguyen, W. Weimer, and C. Le Goues “A Genetic Programming Approach to Automated Software Repair.” Genetic and Evolutionary Computation Conference (2009) Best Paper Award, Genetic Programming Track.
- W. Weimer, T. Nguyen, C. Le Goues, and S. Forrest “Automatically finding patches using genetic programming.” ICSE ’09: Proceedings of the 2009 IEEE 31st International Conference on Software Engineering, pp. 364–374. IEEE Computer Society, Washington, DC. (2009) ACM SIGSOFT Distinguished Paper and IFIP TC2 Manfred Paul Award for Excellence in Software: Theory and Practice.
- S. Forrest, S. Hofmeyr, and A. Somayaji “The evolution of system-call monitoring” 2008 Annual Computer Security Applications Conference (ACSAC 24) (invited paper for Classic Papers session, 2008).
- E. Trias, J. Navas, E. Ackley, S. Forrest, and M. Hermenegildo “Negative ternary set sharing” International Conference on Logic Programming (ILCP) (2008).
- E. Trias, J. Navas, E. Ackley, S. Forrest, and M. Hermenegildo “Two Efficient Representations for Set-sharing Analysis in Logic Programs.” Proceedings of the 17th International Workshop on Functional and (Constraint) Logic Programming. Electronic Notes in Theoretical Computer Science [www.elsevier.nl/locate/entcs](http://www.elsevier.nl/locate/entcs) (2008).
- J. R. Crandall, R. Ensafi, S. Forrest, J. Ladau, and B. Shebaro. “The ecology of modern malware.” Proceedings of the New Security Paradigms Workshop (NSPW) (2008).
- J. Horey, M. Groat, S. Forrest, and F. Esponda. “Anonymous data collection in sensor networks.” The 4th Annual International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services. (2007).
- E. G. Barrantes and S. Forrest. “Increasing Communications Security through Protocol Parameter Diversity”. In Proceedings of the XXXII Latin-American Conference on Informatics (CLEI 2006), Santiago, Chile 20-25 August 2006.
- C. Beauchemin, S. Forrest, and F. Koster “Modeling influenza viral dynamics in tissue.” In The 5th International Conference on Artificial Immune Systems (ICARIS), Lecture Notes In Computer Science Vol. 4163, Springer, Berlin pp. 23-36 (2006).
- J. Karlin, J. Rexford, and S. Forrest “Pretty Good BGP: Improving BGP by cautiously adopting routes.” In International Conference on Network Protocols (2006).

- F. Esponda, H. Jia, S. Forrest, and P. Helman "Protecting Data Privacy through Hard-to-Reverse Negative Databases." In Proceedings of the Information Security Conference 2006 (ISC06) Springer Lecture Notes in Computer Science (2006).
- D. L. Chao, J. Balthrop, and S. Forrest. "Adaptive Radio: Achieving consensus using negative preferences." ACM Group 2005 (2005).
- H. Inoue and S. Forrest "Inferring Java security policies through dynamic sandboxing." "2005 International Conference on Programming Languages and Compilers (PLC'05) (2005).
- F. Esponda, E. Ackley, S. Forrest, and P. Helman. "On-line negative databases." Third International Conference on Artificial Immune Systems (ICARIS) Best paper award (2004).
- G. Barrantes, D. Ackley, S. Forrest, T. Palmer, D. Stefnaovic, and D. Zovi. "Randomized instruction set emulation to disrupt binary code injection attacks." 10th ACM Conference on Computer and Communications Security (2003).
- F. Esponda, S. Forrest and P. Helman, "The Crossover Closure and Partial Match Detection." The second International Conference on Artificial Immune Systems (ICARIS), Number 2787 in Lecture Notes in Computer Science. Springer-Verlag, Berlin. Best paper award (2003).
- D. L. Chao, M. Davenport, S. Forrest, and A. Perelson. "Stochastic Stage-structured Modeling of the Adaptive Immune System." IEEE Computer Society Bioinformatics Conference, CSB2003 (2003).
- D. L. Chao and S. Forrest. "Generating biomorphs with an aesthetic immune system." In Artificial Life VIII: The 8th International Conference on the Simulation and Synthesis of Living Systems, pp. 89-92. The MIT Press, Cambridge, MA. (2003).
- H. Inoue and S. Forrest. "Anomaly intrusion detection in dynamic execution environments." In Proceedings of the New Security Paradigms Workshop, ACM Press, Danvers, MA, pp. 52-60 (2002).
- D. L. Chao and S. Forrest "Information Immune Systems." International Conference on Artificial Immune Systems (ICARIS), University of Kent at Canterbury, UK, pp. 132-140 (2002).
- J. Balthrop, F. Esponda, S. Forrest, and M. Glickman. "Coverage and Generalization in an Artificial Immune System" In W.B.Langdon, E.Cantu-Paz, K.Mathias, R. Roy, D.Davis, R. Poli, K.Balakrishnan, V. Honavar, G. Rudolph, J. Wegener, L. Bull, M. A. Potter, A.C. Schultz, J. F. Miller, E. Burke, and N.Jonoska, editors. Proceedings of the Genetic and Evolutionary Computation Conference (GECCO 2002), Morgan Kaufmann. New York, pp. 3-10 (2002).
- J. Balthrop, S. Forrest, and M. Glickman. "Revisiting LISYS: Parameters and Normal Behavior." Proceedings of the 2002 Congress on Evolutionary Computation (2002).
- C. Warrender, S. Forrest and L. Segel "Effective feedback in the immune system." Presented at the Evolutionary Evolutionary COMputation and Multi-Agent Systems (ECOMAS) workshop at the Genetic and Evolutionary Computation Conference, San Francisco, CA, July 7, 2001.

- A. Somayaji and S. Forrest "Automated response using system-call delays." Usenix 2000.
- C. Maley and S. Forrest "Modeling the Role of Neutral and Selective Mutations in Cancer." In Proceedings of the Seventh Artificial Life Conference (2000).
- D. Dasgupta and S. Forrest "Artificial Immune Systems in Industrial Applications" Accepted for presentation at the International conference on Intelligent Processing and Manufacturing Material (IPMM), Honolulu, HI (July 10-14, 1999).
- M. Oprea and S. Forrest "How the immune system generates diversity: Pathogen space coverage with random and evolved antibody libraries." Proceedings of the Genetic and Evolutionary Computation Conference (GECCO), Morgan-Kaufmann, San Francisco, CA, pp. 1651-1656 (1999).
- S. Hofmeyr and S. Forrest "Immunity by Design: An Artificial Immune System." Proceedings of the Genetic and Evolutionary Computation Conference (GECCO), Morgan-Kaufmann, San Francisco, CA, pp. 1289-1296 (1999).
- C. Warrender, S. Forrest, B. Pearlmutter "Detecting intrusions using system calls: Alternative data models." 1999 IEEE Symposium on Security and Privacy, IEEE Computer Society pp. 133-145 (1999).
- M. Oprea and S. Forrest "Simulated evolution of antibody gene libraries under pathogen selection." 1998 IEEE International Conference on Systems, Man, and Cybernetics.
- A. Somayaji, S. Hofmeyr, and S. Forrest "Principles of a Computer Immune System." New Security Paradigms Workshop (presented September, 1997).
- S. Forrest, A. Somayaji, and D. H. Ackley "Building diverse computer systems." In Proceedings of the Sixth Workshop on Hot Topics in Operating Systems, IEEE Computer Society Press, Los Alamitos, CA, pp. 67-72 (1997).
- D. Dasgupta and S. Forrest "Novelty detection in time series data using ideas from immunology." The International Conference on Intelligent Systems (1996). Best paper award at conference.
- P. D'haeseleer, S. Forrest, and P. Helman "An immunological approach to change detection: algorithms, analysis, and implications." In Proceedings of the 1996 IEEE Symposium on Computer Security and Privacy, IEEE Computer Society Press, Los Alamitos, CA, pp. 110-119 (1996).
- S. Forrest, S. A. Hofmeyr, A. Somayaji, and T. A. Longstaff "A sense of self for Unix processes." In Proceedings of the 1996 IEEE Symposium on Computer Security and Privacy, IEEE Computer Society Press, Los Alamitos, CA, pp. 120-128 (1996).
- R. Hightower, S. Forrest, and A. S. Perelson "The evolution of emergent organization in immune system gene libraries." In L. J. Eshelman (Ed.) Proceedings of the Sixth International Conference on Genetic Algorithms, Morgan Kaufmann, San Francisco, CA, pp. 344-350 (1995).
- T. Jones and S. Forrest "Fitness Distance Correlation as a measure of problem difficulty for genetic algorithms." In L. J. Eshelman (Ed.) Proceedings of the Sixth International

- Conference on Genetic Algorithms, Morgan Kaufmann, San Francisco, CA, pp. 184–192 (1995).
- S. Forrest and T. Jones “Modeling complex adaptive systems with Echo.” In R.J. Stonier and X.H. Yu (Eds.) *Complex Systems: Mechanism of Adaptation*, IOS Press, Amsterdam, pp. 3–21 (1994).
- S. Forrest, A. S. Perelson, L. Allen, and R. Cherukuri “Self-nonsel self discrimination in a computer.” In *Proceedings of the IEEE Symposium on Research in Security and Privacy*, IEEE Computer Society Press, Los Alamitos, CA, pp. 202–212 (1994).
- M. Mitchell, J. H. Holland, and S. Forrest “When will a genetic algorithm outperform hill climbing?” In J. D. Cowan, G. Tesauro, and J. Alspector (Eds.), *Advances in Neural Information Processing Systems 6*. San Mateo, CA. Morgan Kaufmann (1994).
- R. Parsons, S. Forrest, and C. Burks “Genetic algorithms for DNA sequence assembly.” In L. Hunter, et al. (Eds.) *Proceedings of the First International Conference on Intelligent Systems for Molecular Biology*. AAAI/MIT Press, Menlo Park CA (1993).
- W.E. Schmitendorf, O. Shaw, R. Benson, and S. Forrest “Using genetic algorithms for controller design: simultaneous stabilization and eigenvalue placement in a region.” In *Proceedings of AIAA Guidance Navigation and Control Conference*. Hilton Head, SC (August 1992).
- R. Smith, S. Forrest, and A. S. Perelson “An immune system model for maintaining diversity in a genetic algorithm.” In L. D. Whitley (Ed.) *Proceedings of a Workshop on Foundations of Genetic Algorithms*, Morgan Kaufmann, Los Altos, CA (1993).
- S. Forrest and M. Mitchell “Towards a stronger building-blocks hypothesis: effects of relative building-block fitness on GA performance.” In L. D. Whitley (Ed.) *Proceedings of a Workshop on Foundations of Genetic Algorithms*, Morgan Kaufmann, Los Altos, CA (1993).
- M. Mitchell, S. Forrest, and J. Holland “The Royal Road for genetic algorithms: fitness landscapes and GA performance.” In Varela and Bourguine (Eds.) *Proceedings of the First European Conference on Artificial Life*, MIT Press, Cambridge, MA (1992).
- S. Forrest and M. Mitchell “The performance of genetic algorithms on Walsh polynomials: some anomalous results and their explanation.” In R. K. Belew and L. Booker (Eds.) *Proceedings of the Fourth International Conference on Genetic Algorithms*, Morgan-Kaufman, Los Altos, CA (1991).
- S. Forrest and A. S. Perelson “Genetic algorithms and the immune system.” In H. Schwefel and R. Maenner (Eds.) *Parallel Problem Solving from Nature*, Springer-Verlag, Berlin, 1991 (Lecture Notes in Computer Science).
- T.M. Murdock, W.E. Schmitendorf, and S. Forrest “Use of a genetic algorithm to analyze robust stability problems.” In *Proceedings of the American Automatic Control Conference*, Boston MA (1991).
- J. H. Miller and S. Forrest “A dynamical systems approach to classifier systems.” In J. Grefenstette (Ed.) *Proceedings of the Third International Conference on Genetic Algorithms*, Morgan Kaufmann (1989).

- S. Forrest “Modeling high-level symbolic structures in parallel systems that support learning.” In Elzas, M., Oren, T., and Zeigler, B. (Eds.) *Modelling and Simulation Methodology: Knowledge Systems Paradigms*, North Holland Publishing Co. (1989). Also presented at the 4th International Symposium on Modelling and Simulation Methodology, 1987.
- S. Forrest “The classifier system: a computational model that supports machine intelligence.” In Proceedings of the 1986 International Conference on Parallel Processing, IEEE (1986).
- L. Erman, M. Fehling, S. Forrest, and J. Lark “ABE: architectural overview.” In Proceedings of the Workshop on Distributed Artificial Intelligence (1985).
- S. Forrest “Implementing semantic network structures using the classifier system.” In J. Grefenstette (Ed.) Proceedings of An International Conference on Genetic Algorithms and Their Applications (1985).

## OTHER PAPERS AND TECHNICAL REPORTS

- M Moses, D Levin, S Banerjee, F Koster, and S Forrest “Modeling the Role of Inflammatory Signals in Adaptive Immune Response” Abstract accepted to Keystone Symposium on Chemokines and Leukocyte Trafficking in Homeostasis and Inflammation (in press).
- F. Esponda, E. D. Trias, E. S. Ackley, and S. Forrest “A Relational Algebra for Negative Databases” TR-CS-2007-18.
- Josh Karlin, Stephanie Forrest and Jennifer Rexford “Protecting BGP from Invalid Paths.” Sept., 2007.
- C. Warrender, S. Forrest, and L. Segel. “Modeling intercellular signalling in Tuberculosis.” Abstract accepted for presentation at the International Conference on Systems Biology, St. Louis, MO. Nov. 5-9, 2003.
- K. Ingham and S. Forrest “A history and survey of firewalls.” TR-CS-2002-37 University of New Mexico, Albuquerque, NM (2002).
- H. Inoue and S. Forrest “Generic application intrusion detection.” TR-CS-2002-07 University of New Mexico, Albuquerque, NM (2002).
- F. Esponda and S. Forrest “Detector coverage under the r-contiguous bits matching rule.” TR-CS-2002-03 University of New Mexico, Albuquerque, NM (2002).
- F. Esponda and S. Forrest “Defining self: Positive and negative detection.” TR-CS-2002-02 University of New Mexico, Albuquerque, NM (2002).
- J. Giesl, F. Esponda, and S. Forrest “Genetic Algorithms for Finding Polynomial Orderings.” TR-CS-2001-26 University of New Mexico, Albuquerque, NM (2001).
- C. C. Maley, F. Esponda, S. Forrest, L. Prevo, and B. J. Reid “Reconstructing the evolutionary history of neoplastic cells.” Abstract presented at the conference on Oncogene 2000: Evolution of the Cancer Cell. Salk Institute, San Diego, CA (June, 2000).
- S. Forrest and S. A Hofmeyr “John Holland’s invisible hand: An artificial immune system.” Presented at the Festschrift held in honor of John Holland (May, 1999).

- S. A. Hofmeyr, S. Forrest, and P. D’haeseleer “An immunological approach to distributed network intrusion detection” First International Workshop on the Recent Advances in Intrusion Detection (RAID’98), Louvain-la-Neuve, Belgium. Extended abstract. (September 1998).
- T. Jones and S. Forrest “Genetic Algorithms and Heuristic Search.” Technical Report 95-02-021, Santa Fe Institute, Santa Fe, NM (1995).
- D. Dasgupta and S. Forrest “Tool breakage detection in milling operations using a negative-selection algorithm.” Technical Report No. CS95-5, University of New Mexico, Albuquerque, NM (1995). Revised version to be submitted to *Intelligent Manufacturing*.
- P. Helman and S. Forrest “An Efficient Algorithm for Generating Random Antibody Strings.” Technical Report 94-07, University of New Mexico, Albuquerque, NM (1994).
- T. Jones and S. Forrest “An Introduction to SFI Echo.” Technical Report 93-12-074, Santa Fe Institute, Santa Fe NM (1993).
- R. Hightower, S. Forrest, and A. S. Perelson “The evolution of cooperation in immune system gene libraries.” Technical Report CS-92-20, University of New Mexico, Albuquerque, NM (1992).
- C. Burks, M. Engle, S. Forrest, R. Parsons, C. Soderlund, and P. Stolorz “Optimization tools for DNA fragment assembly: algorithm comparison.” Abstract presented at the DOE Human Genome Workshop (Nov. 1992).
- L. Desjarlais and S. Forrest “Linked learning classifier systems: a control architecture for mobile robots.” Extended Abstract presented at the First International Workshop on Learning Classifier Systems, Houston, TX (Oct. 1992).
- R. E. Smith, S. Forrest, and A. S. Perelson “Maintaining diversity with a genetic algorithm.” Extended Abstract presented at the First International Workshop on Learning Classifier Systems, Houston, TX (Oct. 1992).
- S. Forrest and A. S. Perelson “Computation and the immune system.” SIGBIO Newsletter, Association for Computing Machinery, Vol. 12, Num. 2 (June, 1992).
- S. Forrest “Emergent computation, genetic algorithms, and the immune system.” American Mathematical Society (1991). Abstract.
- S. Forrest “Classifier systems as dynamical systems.” Center for Nonlinear Studies Newsletter LALP-89-04, Los Alamos National Laboratory (1989).
- S. Forrest and J. H. Miller “The dynamics of classifier systems: empirical results.” Technical Report LA-UR 89-3287, Los Alamos National Laboratory (1989).
- S. Forrest and J. Lark “Parallel and distributed processing in ABE.” Technical Report, Teknowledge, Inc. (1988).
- S. Forrest “A critique of conventional parallelism, fine-grained and otherwise.” In Proceedings of the AAAI Spring Symposium Series, Mini-Symposium on Parallel Models of Intelligence: How Can Slow Components Think So Fast? (1988). Extended abstract.

- M. Fehling, S. Forrest, and M. Wilber “The Heuristic Control Virtual Machine.” In Proceedings of the AAAI Workshop on Blackboard Systems Implementation Issues (1987).
- S. Forrest “A study of parallelism in the classifier system and its application to classification in KL-ONE semantic networks.” Ph.D. Thesis, The University of Michigan (1985).
- S. Forrest “KL-ONE, CUE, and Process Scripts.” Consul Note #14, USC Information Sciences Institute, Marina del Rey, CA (1982).
- S. Forrest “A parallel algorithm for classification in KL-ONE networks.” Consul Note #15, USC Information Sciences Institute, Marina del Rey, CA (1982).

## **RECENT INVITED TALKS (PAST FOUR YEARS)**

- Plenary talk, International Conference on Artificial Immune Systems (ICARIS), Taormina IT “The biology of software” (2012)
- Sandia National Laboratories ”Evolutionary software repair” (2012)
- World Economic Forum, Davos, Switzerland “Biological models for software security” (2012)
- Morrison Lecture, Stanford Univ. “Evolvable software” (2011)
- Colorado State University, ISTE C Distinguished Lecture “Evolutionary software repair”
- Keynote Address, University College, London, CREST Open Workshop ”Genetic programming for software engineering” (2011)
- Panel Presentation, In-Q-Tel CEO Summit, San Francisco CA ”Cyberattack and defense” (2010)
- AI Colloquium, UT Austin Dept. of Computer Science “Automatic program repair with evolutionary computation” (2010)
- JASON Advisory Group, San Diego summer meeting “Bridging CS and biology for cyberSecurity” (2010)
- Keynote Address, Conference on Object-Oriented Programming, Languages, Systems (OOPSLA/SPLASH) “The case for evolvable software” (2010)
- Dept. Colloquium, Univ. of Massachusetts, Amherst “Evolutionary program repair” (2010)
- Nanyang Technological University, Singapore, “Evolving software to fix real bugs in real programs” (2009)
- Syracuse University, NY “Evolution of Software” (2009)
- UC Berkeley TRUST Seminar series “Anomaly detection and response” (2009)
- Portland State University, OR ”Evolution of software” (2009)
- Univ. Pennsylvania, School of Medicine “Agent-based modeling of evolutionary diseases” (2008)

ITAM (Instituto Tecnológico Autónomo de México) “Technological Networks: From Empirical Laws to Theory”, Mexico City; Mexico Conference on Artificial Intelligence, Tecnológico de Monterrey, Mexico City Plenary talk: “Computer Immunology” (2008)

Microsoft Research, Trento, Italy. Meeting on Biological Complexity. “Agent-based modeling of evolutionary multi-cellular systems” (2008)

NSF/NSA meeting, Oakland, CA “Biology is the Science of Security”