Stephanie Forrest

Dept. of Computer Science – University of New Mexico
Albuquerque NM 87105
☎ (505) 277 7104   •   ✉ forrest@cs.unm.edu   •   🏠 https://cs.unm.edu/~forrest
March 5, 2017

Education

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

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

St. John's College   **Annapolis, MD and Santa Fe, NM**
B.A. (Liberal Arts, no major offered)   *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. Cybersecurity and cyberpolicy.

Employment

U̇S. Dept. of State, Communication and Information Policy   **Washington, DC**
Senior Science Advisor (sabbatical leave)   *2013–2014*

University of New Mexico   **Albuquerque, NM**
Dept. of Computer Science   *1990–present*
- Distinguished Professor, 2013–present
- Regents Professor, 2012–present
- Dept. Chair, 2006–2011
- Professor, 1999–2013
- Associate Professor, 1994–1999
- Assistant Professor, 1990–1994
- Secondary appointment in Dept. of Biology, 2001–present

Santa Fe Institute   **Santa Fe, NM**
- Research Professor, part-time sabbatical leave, 2003–2006
- Interim Vice President for Academic Affairs, 1999–2000

Massachusetts Institute of Technology   **Cambridge, MA**
Visiting Assoc. Professor (sabbatical leave)   *1996–1997*

Center for Nonlinear Studies, Los Alamos Nat. Laboratory   **Los Alamos, NM**
Director's Postdoctoral Fellow   *1988–1990*

Teknowledge, Inc.   **Palo Alto, CA**
Scientist and Senior Scientist   *1985–1988*

Honors and Awards

IEEE Fellow   *2015–present*
Stanislaw Ulam Lectures
Santa Fe Institute   *2013*

- *Software engineering: Evolving computer programs*
- *Immunology: The complex science of cyberdefense*
- *Modeling computer networks from chips to the Internet*

Jefferson Science Fellowship
National Academies of Science and Engineering *2013–2014*

Allen Newell Award
Association for Computing Machinery and AAAI *2012*

University of New Mexico
- *UNM 57th Annual Research Lecture* (2012)
- *College of Engineering, Outstanding Research Award, Senior Faculty* (2000)
- *General Library Faculty Acknowledgment Award* (1999)
- *Regents Lecturer* (1994-97)
- *College of Engineering, Outstanding Research Award Junior Faculty* (1993)

Women in Technology Award
New Mexico Council on Technology *2009*

SIGEVO GECCO Impact Award
Association for Computing machinery *2009*
Highest impact paper published in the 1999 Genetic and Evolutionary Computation Conference

Humies $5000 Gold Medal Award
For human-competitive results produced by genetic and evolutionary computation *2009*

Manfred Paul Award for Excellence in Software: Theory and Practice
IFIP TC2 *2009*

Senior Fellow
International Society for Genetic and Evolutionary Computation *2003*

St. John's College
Alumni Award of Merit *2002*

National Science Fundation
Presidential Young Investigator Award *1991–1996*

Association of Western Universities Faculty Fellowship
Faculty Fellowship *1991*

Young Faculty Award
GE Foundation *1990*

Selected Professional Activities

Computing Research Association
- Member Board of Directors, 2015–present
- Chair, Government Affairs Committee, 2016–present
- Member Computing Community Consortium (CCC) Council, 2009–2012

National Science Foundation
- CISE Advisory Committee, 2006–2008

Santa Fe Institute
- Science Board Co-Chair, 2010–2013
- Science Board Member, 1991–1997, 1998–2001, 2003–2008, 2009-2015
- Science Steering Committee, 1993-1999
- External Faculty, 1990–present
- Resident Faculty, 2003-2006

Defense Advanced Research Agency
- Information Science and Technology (ISAT) Advisory Group, 2001–2004

DIMACS

Advisory Committee for special focus on epidemiology

- Co-organizer of DIMACS working group on "analogies between computer viruses and immune systems and biological viruses and immune systems" (2001–2004)

Editing

- Evolutionary Computation, Action and Associate Editor, 1994–2002
- Artificial Life, Editorial Board, 1994–present
- Journal of Artificial Intelligence Research, Editorial Board, 1998–2002
- Evolutionary Intelligence, Editorial Board, 2007–present
- Journal of Machine Learning Research, Action Editor, 2005–2010
- Journal of Experimental and Theoretical Artificial Intelligence, Editorial Board, 1989–1996

Program Committees

- Workshop on Economics of Information Security (WEIS), 2015–2016
- 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, 2002–2008, 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, 2012
- IEEE Conference on Evolutionary Computation, 1995
- International Joint Conference on Artificial Intelligence, 1995
- Scientific Advisory Board for the ALife 7 Conference, 2000, 2001

Funded Research

Air Force Research Laboratory	**Submitted Jan. 2017**
Trusted and Resilient Mission Operation	*$1,275,000 (UNM share: $150,000)*
W. Weimer (PI), J.Davidosn, S. Forrest C. Le Goues, A. Paulos, E. Smith (co-PIs)	
National Science Foundation	**Submitted Oct. 2016**
Robustness and Evolvability for Computation	*$1,000,000 (UNM share: $500,000)*
S. Forrest (PI) and W. Weimer (co-PI)	
National Science Foundation	**2016-2021**
ADVANCE at UNM: Institute for Diversity and Equity Across STEM (IDEAS)	*$3,358,125*
J. Fulghum (PI), M.J Daniel, S. Forrest, P. Gonzales, M. Htun (co-PIs)	
Sandia Nat. Labs. Academic Alliance	**2016-2017**
Applying Bio. Imm.-Sys. Concepts to Improve Electronic Biosurveillance Sys. Performance	*$50,000*
S. Forrest (PI)	
National Science Foundation	**2016-2017**
CS 10K: New Mexico Computer Science for All (NM CSforAll)	*$169,407*
(Subaward from Santa Fe Institute)	
National Science Foundation	**2015-2018**
NeTS: Large: Measuring and Modeling Internet Choke Points as Threats to Online Freedom	*$1,400,000*
J. Crandall (PI), M. Faloutsos, S. Forrest (Co-PIs)	
Defense Advanced Research Projects Agency	**2015-2018**
Double Helix: High-Assurance N-Variant Systems	*$5,330,000 (UNM share: $812,866)*
J. Davidson (PI), S. Forrest, B. Dutertre (Co-PIs)	
Air Force Research Laboratory	**2015-2017**
Cooperative, Trusted Software Repair for Cyber Physical System Resiliency	*$899,948 (UNM share: $216,000)*
W. Weimer (PI), S. Forrest, M. Kim, C. LeGoues (co-PIs)	

National Science Foundation EAGER 2014-2016

SBE: Collab. Res.: Policies for Enhancing U.S. Leadership in Cyberspace $201,129 (UNM Share: $102,583)

S. Forrest (PI), R. Axelrod (co-PI)

Defense Advanced Research Projects Agency 2010-2015

Scalable RADAR for Co-evolutionary Adversarial Environments $3,200,625

S. Forrest (PI), J. Crandall, M. Moses, W. Weimer (Co-PIs)

National Science Foundation 2010-2013

Collaborative Research: Search, Signals and Information Exchange in Distributed Biological Systems $500,000

M. Moses (PI); S. Forrest, D. Gordon (Co-PIs)

Air Force Office of Scientific Research DURIP-10-054 2010

Helix Project Testbed: Towards the Self-Regenerative Incorruptible Enterprise $58,189

S. Forrest (PI)

Department of Energy 2009-2012

ASIM: An integrated agent-based model of a complex network UNM share: $600,000

S. Hofmeyr (PI), S. Forrest (Co-PI)

National Science Foundation 2009-2012

SHF: Medium: Collab. Res.: Fixing real bugs in real programs using evolutionary algorithms $600,000

W. Weimer (PI), S. Forrest (Co-PI)

National Science Foundation 2007-2008

Safe Computing Workshop: Introspective Hardware Architectures for Information Assurance $69,930

S. Forrest (PI)

Air Force Office of Scientific Research MURI 2007-2012

Helix: A Self-Regenerative Architecture for the Incorruptible Enterprise UNM Share: $750,000

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)

National Institutes of Health 2007-2009

Modeling Early Influenza Virus Replication in Primary Human Lung Cells UNM Share: $144,046

F. Koster (PI), S. Forrest (Co-PI)

National Science Foundation 2006-2009

Collaborative Research: A Biologically Motivated Scaling Theory for Computing $230,921

S. Forrest (PI), J. Brown, A. Davis (Co-PIs)

Howard Hughes Medical Institute 2006-2011

Program in Interdisciplinary Biomedical Science (PIBS) $1,000,000

J. Brown (PI), S. Forrest, N. Kenkre and F. Smith (Co-PIs).

Motorola 2005-2008

Biological Design for Computer Security $150,000

S. Forrest (PI)

SFI International Program 2005-2006

Instruction Set Diversification $17,500

G. Barrantes, J. Vargas, and S. Forrest (PIs)

UNM/LANL Joint Science and Technology Laboratory 2005-2007

Realistic Modeling of the Immune Response in Tissue $131,750

S. Forrest and A. S. Perelson (PIs)

National Institutes of Health 2003-2008

COBRE Center for Evolutionary and Theoretical Immunology $10,141,000

E. S. Loker (PI), S. Forrest, R. D. Miller, A. S. Perelson (Co-PIs)

National Science Foundation CCR Large ITR 2003-2008

Sensitive Information in a Wired World $12,500,000, UNM share: $625,000

D. Boneh (PI), J. Feigenbaum, S. Forrest, and 5 others (Co-PIs)

National Science Foundation SGER 2003-2004

Reconstructing Information from Database Fragments Via Negative Partial Match Detection $100,000

S. Forrest (PI), P. Helman (Co-PI)

National Science Foundation   **2003-2007**
Automated and Adaptive Diversity for Improving Computer Sys. Sec.   *$1,200,000, UNM Share: $250,000*
D. Song (PI), M. Reiter, S. Forrest (Co-PIs)

Defense Advanced Research Projects Agency   **2002-2003**
Automated Diversity in Computer Systems UNM Component   *$280,000*
S. Forrest (PI)

National Institutes of Health   **2002-2005**
P20 Center for the Spatiotemporal Modeling of Cell Signaling Planning Grant   *$988,815*
J. Oliver (PI), S. Steinberg, S. Forrest, and G. Heffelfinger (Co-PIs)

Intel Corp.   **2001-2003**
Information Immune Systems   *$154,000*
S. Forrest, PI

National Science Foundation   **2000-2005**
Understanding and Surviving Computation in the Wild   *$871,478*
S. Forrest (PI), D. Ackley (Co-PI)

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

Office of Naval Research   **2000**
Dynamics Days Conference   *$18,600*
S. Forrest, David Egolf (PIs)

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

Department of Energy   **2001-2003**
A Broad Program in the Sciences of Complexity   *$606,000*
Co-PI with E. Goldberg, E. Jen, and M. Feldman

Office of Naval Research   **1999-2003**
Emergent Computation   *$420,072*
S. Forrest (PI)

Intel Corporation   **1998-2004**
Biologically Inspired Approaches to Computer Security   *$42,1393*
S. Forrest (PI)

National Science Foundation   **1997-2000**
Computer Immunology   *$292,350*
S. Forrest (PI)

IBM   **1998**
Partnership Award   *$20,000*
S. Forrest (PI)

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

NSF Research Training Grant   **1995-2000**
A BIO Research Training Group in Ecological Complexity   *$562,500*
J. H. Brown (PI), S. Forrest, B. T. Milne, J. Rasure, L. M. Simmons, and G. C. Stevens (co-PIs)

Office of Naval Research   **1995-98**
Research in Computational Immunology   *$400,000*

NSF Presidential Young Investigator Award   **1991-1996**
Computational Aspects of the Immune System   *$500,000*

Sandia National Laboratories	**1995-1996**
Genetic programming for automatic learning and image classification	*$26,039*
Santa Fe Institute	**1991-1995**
Graduate student support	*$166,178*
Alfred P. Sloan Foundation	**1992-1994**
Foundations of Genetic Algorithms	*$30,00*
S. Forrest, M. Mitchell (co-PIs)	
Sandia University Research Program (SURP)	**1991-1993**
Inappropriate Convergence in Genetic Algorithms	*$60,000*
Association of Western Universities (AWU)	**1991-1991**
Faculty Fellowship	*$10,000*
Los Alamos National Laboratory (CNLS	**1990-1991**
Genetic Algorithms and Classifier System	*$20,382*
University of California	**1989-1993**
Institutional Collaborative Research (INCOR) grant	*$42,000*

Ph.D. Students Graduated

- Terry Jones (1995) *Evolutionary algorithms, fitness landscapes and search* Cambridge Univ. UK
- 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 Tecnologico Autonomo de Mexico
- Kenneth Ingham (2007) *Anomaly Detection for HTTP Intrusion Detection: Algorithm Comparisons and the Effect of Generalization on Accuracy* Self-employed
- Robert Abbott (2007) *Automated tactics modeling: Techniques and Applications* (UNM Popejoy Best Dissertation Award), Principal Member of the Technical Staff, Sandia National Laboratory
- Todd Kaplan (2008) *Detecting community structure in financial markets* Indeed.com
- 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* TripAdvisor

- Michael Groat (2012) *Energy Conserving Privacy Enhancing Algorithms in Resource-Constrained Devices* City of Farmington, NM
- ThanhVu Nguyen (2014) *Automating Program Verification and Repair Using Invariant Analysis and Test-input Generation* Asst. Professor, Univ. Nebraska, Lincoln
- Eric Schulte (2014) *Neutral Networks of Real-World Programs and their Application to Automated Software Evolution* Grammatech
- Drew Levin (2016) *The environment constrains successful search strategies in natural distributed systems* Sandia National Labs.
- Benjamin J. Edwards (2016) *Evidence-based cybersecurity: data-driven and abstract models* IBM, Thomas J. Watson Research Center.

Postdoctoral Supervision

- Dipankar Dasgupta (Univ. of Memphis, TN), Andrew Kosoresow (deceased), Derek Smith (Cambridge Univ. UK), Carlo Maley (Univ. California San Francisco), Steven Hofmeyr (Lawrence Berkeley Lab.), 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 (Intel Corp.), David Mohr (Google)

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

S. Forrest. *Proc. of the Fifth Intl. Conference on Genetic Algorithms*. Morgan Kaufmann, Los Altos, CA, 1993.

S. Forrest. *Parallelism in Classifier Systems*. Research Notes in Artificial Intelligence. Pitman Publishing and Morgan Kaufmann, London and Los Altos, CA, 1991. Revised version of Ph.D. dissertation.

S. Forrest, editor. *Emergent Computation*. MIT Press, Cambridge, MA, 1991. Also published as *Physica D* special issue Vol. 42, Nos. 1-3 (1990).

L. Booker, S. Forrest, M. Mitchell, and R. Riolo, editors. *Perspectives on Adaptation in Natural and Artificial Systems*. Oxford University Press, 2005.

Chapters of Books

M. Moses and S. Forrest. Beyond biology. In R. M. Sibley, J. H. Brown, and A. Kodrik-Brown, editors, *Metabolic Ecology: A Scaling Approach*, chapter 24, pages 293–301. Wiley-Blackwel, 2012.

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 et al., editor, *Moving Target Defense II: Application of Game Theory and Adversarial Modeling*, pages 115–146, 2012.

K. Ingham and S. Forrest. Network firewalls. In V. Rao Vemuri and V. Sreeharirao, editors, *Enhancing Computer security with Smart Technology*, pages 9–35. CRC Press, 2005.

S. Forrest, J. Balthrop, M. Glickman, and D. Ackley. Computation in the wild. In E. Jen, editor, *Robust Design: A Repertoire of Biological, Ecological, and Engineering Case Studies*, pages 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 A. D. M. E. Osterhaus, N. Cox, and A. Hampson, editors, *Options for the control of influenza virus IV*, International Congress 1219, pages 655–660. Excerpta Medica, Amsterdam, 2001.

S. Forrest and S. A. Hofmeyr. Immunology as information processing. In L. A. Segel and I. Cohen, editors, *Design Principles for the Immune System and Other Distributed Autonomous Systems*, Santa Fe Institute Studies in the Sciences of Complexity. 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, and S .W. Wilson, editors, *Learning Classifier Systems: An Introduction to Contemporary Research*, pages 3–32. Springer Verlag, 2000.

D. J. Smith, S. Forrest, and A. S. Perelson. Immunological memory is associative. In D. Dasgupta, editor, *Artificial Immune Systems and Their Applications*. Springer-Verlag, Berlin, 1998.

D. J. Smith, S. Forrest, D. H. Ackley, and A. S. Perelson. Modeling the effects of prior infection on vaccine efficacy. In D. Dasgupta, editor, *Artificial Immune Systems and Their Application*. Springer-Verlag, Berlin, 1998.

M. Mitchell and S. Forrest. Fitness landscapes: Royal road functions. In Back, Fogel, and Michalewicz, editors, *Handbook of Evolutionary Computation*, volume B2.7, pages 1–25. Institute of Physics Publishing, Philadelphia and Bristol UK, 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, editors, *Adaptive Individuals in Evolving Populations*, pages 159–167. Addison-Wesley, Reading, MA, 1996.

S. Forrest. Genetic algorithms. In A. B. Tucker, editor, *CRC Handbook of Computer Science and Engineering*. CRC Press, Boca Raton, 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, editor, *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, editor, *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, editor, *Systems and Control Encyclopedia, First Supplement*. Pergamon Books, Oxford, 1990.

Refereed Journal Articles ....

J. Dorn, J. Lacomis, W. Weimer, and S. Forrest. Scalable software energy reduction. *Transactions on Software Engineering*, (submitted Dec. 2016).

B. Edwards, A. Furnas, S. Forrest, and R. Axelrod. Strategic aspects of cyber attack, attribution, and blame. *Proc. Nat. Acad. Sci (PNAS)*, (early edition, Feb. 27, 2017).

M. Moses, G. Bezerra, B. Edwards, J. H.Brown, and S. Forrest. Energy and time determine scaling in biological and computer designs. *Phil. Trans. of the Royal Society B*, 371(1701), 2016.

D. Levin, S. Forrest, S. Banerjee, C. Clay, J. Cannon, M. Moses, and F. Koster. A spatial model of the efficiency of T cell search in the influenza-infected lung. *J. Theoretical Biology*, 398:52–63, 2016. doi 10.1016/j.jtbi.2016.02.022.

S. Forrest and M. Mitchell. Adaptive computation: The multidisciplinary legacy of John H. Holland. *Communications of the ACM*, 59(8):58–63, 2016. doi 10.1145/2964342.

B. Edwards, S. Hofmeyr, and S. Forrest. Hype and heavy tails: Analyzing ten years of data breaches. *Journal of Cybersecurity*, 2(1):3–14, 2016. doi: 10.1093/cybsec/tyw003 (Updated and expanded revision of WEIS 2015 conference paper.).

C. Le Goues, N. Holtschulte, E. Smith, Y. Brun, P. Devanbu, S. Forrest, and W. Weimer. The ManyBugs and IntroClass benchmarks for automated repair of C programs. *ACM Trans. on Software Engineering*, 41(12), 2015.

E. Schulte, Z. P. Fry, E. Fast, W. Weimer, and S. Forrest. Software mutational robustness. *Genetic Programming and Evolvable Machines*, 15(3):281–312, 2014. DOI 10.1007/s10710-013-9195-.

T. Nguyen, D. Kapur, W. Weimer, and S. Forrest. DIG: A dynamic invariant generator for polynomial and array invariants. *ACM Trans. on Software Engineering and Methodology*, 23(4), 2014. DOI 10.1145/2556782.

M. Groat, B. Edwards, J. Horey, W. He, and S. Forrest. Application and analysis of multidimensional negative surveys in participatory sensing applications. *Pervasive and Mobile Computing*, 9(3):372–391, 2013.

C. Le Goues, S. Forrest, and W. Weimer. Current challenges in automatic software repair. *Software Quality*, 21:421–443, 2013. DOI 10.1007/s11219-013-9208-0.

C. Le Goues, T. Nguyen, S. Forrest, and W. Weimer. GenProg: Automatic bug correction in real programs. *ACM Trans. on Software Engineering*, 38(1), 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):1125–1135, 2011. doi:10.1128/JVI.01722-10.

W. Weimer, S. Forrest, C. Le Goues, and T. Nguyen. Automatic program repair with evolutionary computation. *Communications of the ACM*, 53(5):109–116, Research Highlight 2010.

F. Esponda, S. Forrest, and P. Helman. Negative representations of information. *Intl. J. of Information Security*, 8(5), 2009. doi:10.1007/s10207-009-0078-1.

M. Moses, S. Forrest, A. L. Davis M. Lodder, and J. H. Brown. Scaling theory for information networks. *Royal Society Interface*, 5(29):1391–1510, 2008.

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. *Computer Communication Review*, 38(3):7–15, 2008.

K. Ingham, A. Somayaji, S. Forrest, and J. Burge. Learning dfa representations of http for protecting web applications. *Computer Networks*, 51(5):1239–1255, 2007.

P. Holme, J. Karlin, and S. Forrest. Radial structure of the internet. *Proc. Royal Society A*, 463:1231–1246, 2007.

S. Forrest and C. Beauchemin. Computer immunology. *Immunological Reviews*, 216:176–197, 2007.

F. Esponda, E. S. Ackley, P. Helman, H. Jia, and S. Forrest. Protecting data privacy through hard-to-reverse negative databases. *Intl. J. of Information Security*, 6(6), 2007.

C. Warrender, S. Forrest, and F. Koster. Modeling intercellular interactions in early mycobacterium infection. *Bulletin of Mathematical Biology*, 66(6):1493–1514, 2006.

H. Inoue, D. Stefanovic, and S. Forrest. On the prediction of Java object lifetimes. *IEEE Trans. on Computers*, 55(7):880–892, 2006.

R. Gerety, S. Spencer, K. Pienta, and S. Forrest. Modeling somatic evolution in tumorigenesis. *PLoS Computational Biology*, 2(8), 2006.

R. G. Abbott, S. Forrest, and K. J. Pienta. Simulating the hallmarks of cancer. *Artificial Life*, 12(4):617–634, 2006.

M. Glickman, J. Balthrop, and S. Forrest. A machine learning evaluation of an artificial immune system. *Evolutinoary Computation Journal*, 13(2):179–212, 2005.

F. Esponda, E. S. Ackley, S. Forrest, and P. Helman. On-line negative databases. *J. of Unconventional Computing*, 1(3):201–220, 2005.

D L. Chao, M. P. Davenport, S. Forrest, and 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 Trans. on Information Systems Security (TISSEC)*, 8(1):3–40, 2005.

C. Warrender, S. Forrest, and L. Segel. Homeostasis of peripheral immune effectors. *Bulletin of Mathematical Biology*, 66(6):1493–1514, 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 positive and negative detection. *IEEE Trans. on Systems, Man, and Cybernetics*, 34(1):357–373, 2004.

D. L. Chao, M. P. Davenport, S. Forrest, and A. S. Perelson. A stochastic model of cytotoxic T cell responses. *J. Theoretical Biology*, 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.

D. L. Chao and S. Forrest. Information immune systems. *Genetic Programming and Evolvable Machines*, 4(4):311–331, 2003.

M. Newman, S. Forrest, and J. Balthrop. Email networks and the spread of computer viruses. *Physical Review E*, 66, 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*, 4(5):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*, 8(4):443–473, 2000.

D. J. Smith, S. Forrest, D. H. Ackley, and A. S. Perelson. Variable efficacy of repeated annual influenza vaccination. *Proc. 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*, 60:647–658, 1998.

S. Hofmeyr, S. Forrest, and A. Somayaji. Intrusion detection using sequences of system calls. *J. of Computer Security*, 6:151–180, 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. *Theoretical Biology*, 189:141–150, 1997.

P. Hraber, T. Jones, and S. Forrest. The ecology of Echo. *Artificial Life*, 3(3):165–190, 1997.

S. Forrest, S. Hofmeyr, and A. Somayaji. Computer immunology. *Communications of the ACM*, 40(10):88–96, 1997.

A. Perelson, R. Hightower, and S. Forrest. Evolution (and learning) of v-region genes. *Research in Immunology*, 147:202–208, 1996.

S. Forrest. Genetic algorithms. *ACM Computing Surveys*, 28(1):77–80, 1996.

R. Parsons, S. Forrest, , and C. Burks. Genetic operators for the DNA fragment assembly problem. *Machine Learning*, 21(1/2):11–33, 1995.

M. Mitchell and S. Forrest. Genetic algorithms and artificial life. *Artificial Life*, 1994.

R. E. Smith, S. Forrest, and A. S. Perelson. Searching for diverse, cooperative populations with genetic algorithms. *Evolutionary Computation*, 1(2):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):129–163, 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):191–211, 1993.

S. Forrest. Genetic algorithms: principles of natural selection applied to computation. *Science*, 261:872–878, Aug. 1993.

J. Lark, L. Erman, S. Forrest, K. Gostelow, F. Hayes-Roth, and D. Smith. Concepts, methods, and languages for building timely intelligent systems. *Real-time Systems*, 2(1), 1990.

S. Forrest and J. H. Miller. Emergent behaviors of classifier systems. *Physica D*, 42(1–3):213–227, 1990.

S. Forrest. Introduction to the proceedings of the ninth annual CNLS conference. *Physica D*, 42(1-3):1–11, 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*, pages 80–93, 1987.

Refereed Conference Papers

T. Nguyen, W. Weimer, D. Kapur, and S. Forrest. Connecting program synthesis and reachability: Automatic program repair using test-input generation. In *International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS)*, (in press).

G. Stelle, D. Stefanovic, S. Olivier, and S. Forrest. Cactus environment machine: Shared environment call-by-need. In *The 17th Symposium on Trends in Functional Programming*, (2016).

M. Co, J. W. Davidson, J. D. Hiser, A. Nguyen-Tuong J. C. Knight, W. Weimer, J. Burket, G. L. Frazier, B. Dutertre T. M. Frazier, I. Mason, N. Shankar, and S. Forrest. Double Helix and RAVEN: A system for

Cyber Fault Tolerance and Recovery. In *Proc. of the 11th Cyber and Information Security Research Conf.* Oak Ridge National Laboratory, 2016. Runner up, best paper.

E. Schulte, W. Weimer, and S. Forrest. Repairing COTS router firmware without access to source code or test suites: A case study in evolutionary software repair. In *The First Intl. Genetic Improvement Workshop (GI)*, 2015. Best paper award.

D. Levin, J. Hecker, M. Moses, and S. Forrest. Volatility and spatial distribution of resources determine ant foraging strategies. In *The 13th European Conf. on Artificial Life (ECAL)*, 2015.

B. Edwards, S. Hofmeyr, S. Forrest, and M. van Eeten. Analyzing and modeling longitudinal security data: Promise and pitfalls. In *Proc. of the 31st Annual Computer Security Applications Conf. (ACSAC)*, pages 391–400. ACM, 2015.

B. Edwards, S. Hofmeyr, and S. Forrest. Hype and heavy tails: A closer look at data breaches. In *Workshop on the Economics of Information Security*, June 2015. Best paper award.

E. Schulte, J. Dorn, S. Forrest, and W. Weimer. Post-compiler software optimization for reducing energy. In *Nineteenth Intl. Conf. on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, 2014.

ThanhVu Nguyen, Deepak Kapur, Westley Weimer, and Stephanie Forrest. Using dynamic analysis to generate disjunctive invariants. In *Intl. Conf. on Software Engineering*, 2014.

Sharon Goldberg and Stephanie Forrest. Implications of security enhancements and interventions for core Internet infrastructure. In *42nd Research Conf. on Communication, Information and Internet Policy (TPRC, 2014)*, 2014.

W. Weimer, Z. Fry, and S. Forrest. Leveraging program equivalence for adaptive program repair: Models and first results. In *Automated Software Engineering (ASE) Conf.*, 2013.

E. Schulte, J. DiLorenzo, W. Weimer, and S. Forrest. Automated repair of binary and assembly programs for cooperating embedded devices. In *Proc. of the Eighteenth Intl. Conf. on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, 2013.

G. Bezerra and S. Forrest. Empirical and theoretical lower bounds on energy consumption for networks on chip. In *NoCArc*, 2013.

T. Nguyen, D. Kapur, W. Weimer, and S. Forrest. Using dynamic analysis to discover polynomial and array invariants. In *ICSE '12: Proc. of the IEEE 34th Intl. Conf. on Software Engineering*, Washington, DC, USA, 2012. IEEE Computer Society. SIGSOFT Distinguished Paper Award.

J. Horey, M. Groat, and S. Forrest. Reconstructing spatial distributions from anonymized locations. In *Workshop on Secure Data Management (ICDE)*, 2012.

M. Groat, B. Edwards, J. Horey, W. He, and S. Forrest. Enhancing privacy in participatory sensing applications with multidimensional data. In *2012 IEEE Intl. Conf. on Pervasive Computing and Communications (PerCom)*, pages 144–152. IEEE, 2012.

C. Le Goues, W. Weimer, and S. Forrest. Representations and operators for improving evolutionary software repair. In *Genetic and Evolutionary Computation Conf. (GECCO)*, 2012. Nominated for best paper.

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. In *ICSE '12: Proc. of the IEEE 34th Intl. Conf. on Software Engineering*, Washington, DC, USA, 2012. IEEE Computer Society.

B. Edwards, T. Moore, G. Stelle, S. Hofmeyr, and S. Forrest. Beyond the blacklist: Modeling malware spread and the effect of interventions. In *Proc. of the 2012 Sorkshop on New security paradigms*, pages 53–66. ACM, 2012.

Steven Hofmeyr, Tyler Moore, Stephanie Forrest, Benjamin Edwards, and George Stelle. Modeling internet-scale policies for cleaning up malware. In *Workshop on the Economics of Information Security and Privacy (WEIS)*, pages 149–170. Springer, 2011.

M. Groat, W. He, and S. Forrest. Kipda: k-indistinguishable privacy-preserving data aggregation in wireless sensor networks. In *INFOCOM*, 2011.

G. Bezerra, S. Forrest, and P. Zarkesh-Ha. Reducing energy and increasing performance with traffic optimization in any-core systems. In *ACM/IEEE Intl. Workshop on System Level Interconnect Prediction (SLIP)*, New York, NY, 2011. ACM.

S. Banerjee, D. Levin, M. Moses, F. Koster, and S. Forrest. The value of inflammatory signals in adaptive immune responses. In P. Li, G. Nicosia, and T. Stibor, editors, *Intl. Conf. on Artificial Immune Systems (ICARIS)*, 2011.

P. Zarkesh-Ha, G. Bezerra, S. Forrest, and M. Moses. Hybrid network on chip (hnoc): Local buses with a global mesh architecture. In *ACM/IEEE Intl. Workshop on System Level Interconnect Prediction (SLIP)*, Anaheim, CA, 2010. ACM.

E. Schulte, S. Forrest, and W. Weimer. Automated program repair through the evolution of assembly code. In *25nd IEEE/ACM Intl. Conf. on Automated Software Engineering*, pages 313–16, 2010.

C. Le Goues, S. Forrest, and W. Weimer. The case for software evolution. In *FSE/SDP Workshop on the Future of Software Engineering Research*, 2010.

E. Fast, C. Le Goues, W. Weimer, and S. Forrest. Designing better fitness functions for automated program repair. In *Proc. of the 12th Genetic and Evolutionary Computation Conf. (GECCO)*, 2010.

G. Bezerra, S. Forrest, M. Moses, A. Davis, and P. Zarkesh-H. Communication probability distribution and energy consumption in networks on chip. In *ACM/IEEE Intl. Workshop on System Level Interconnect Prediction (SLIP)*, Anaheim, CA, 2010. ACM.

W. Weimer, T. Nguyen, C. Le Goues, and S. Forrest. Automatically finding patches using genetic programming. In *ICSE '09: Proc. of the 2009 IEEE 31st Intl. Conf. on Software Engineering*, pages 364–374, Washington, DC, USA, 2009. IEEE Computer Society. SIGSOFT Distinguished Paper Award.

S. Forrest, T. Nguyen, W. Weimer, and C. Le Goues. A genetic programming approach to automated software repair. In *GECCO '09: Proc. of the 11th Annual Conf. on Genetic and Evolutionary Computation*, pages 947–954, New York, NY, USA, 2009. ACM. Best paper award.

E. Trias, J. Navas, E. Ackley, S. Forrest, and M. Hermenengildo. Two efficient representations for set-sharing analysis in logic programs. In *Proc. of the 17th Intl. Workshop on Functional and (Constraint) Logic Programming*, Electronic Notes in Theoretical Computer Science. www.elsevier.nl/locate/entcs, 2008.

E. Trias, J. Navas, E. Ackley, S. Forrest, and M. Hermenegildo. Negative ternary set sharing. In *Proc. of the Intl. Conf. on Logic Programming (ILCP)*, volume 5366 of *Lecture Notes in Computer Science*, pages 301–316, Berlin / Heidelberg, 2008. Springer.

S. Forrest, S. Hofmeyr, and A. Somayaji. The evolution of system-call monitoring. In *ACSAC '08: Procc. of the 2008 Annual Computer Security Applications Conf.*, pages 418–430, Washington, DC, USA, 2008. IEEE Computer Society. Invited paper for Classic Papers session.

J. R. Crandall, R. Ensafi, S. Forrest, J. Ladau, and B. Shebaro. The ecology of modern malware. In *Proc. of the New Security Paradigms Workshop (NSPW)*, 2008.

J. Horey, M. Groat, S. Forrest, and F. Esponda. Anonymous data collection in sensor networks. In *The 4th Annual Intl. Conf. on Mobile and Ubiquitous Systems: Computing, Networking and Services (MOBIQUITOUS)*, 2007.

J. Karlin, J. Rexford, and S. Forrest. Pretty Good BGP: Improving BGP by cautiously adopting routes. In *Intl. Conf. on Network Protocols (ICNP)*, 2006.

F. Esponda, H. Jia, S. Forrest, and P. Helman. Protecting data privacy through hard-to-reverse negative databases. In *Proc. of the Information Security Conf. (ISC06)*, Lecture Notes in Computer Science, Berlin, 2006. Springer.

C. Beauchemin, S. Forrest, and F. Koster. Modeling influenza viral dynamics in tissue. In *Proc. of the 5th Intl. Conf. on Artificial Immune Systems (ICARIS)*, volume 4163 of *Lecture Notes In Computer Science*, pages 23–36, Berlin, 2006. Springer.

E. G. Barrantes and S. Forrest. Increasing communications security through protocol parameter diversity. In *Proc. of the XXXII Latin-American Conf. on Informatics (CLEI 2006)*, Santiago, CHILE, 2006.

H. Inoue and S. Forrest. Inferring Java security policies through dynamic sandboxing. In *Intl. Conf. on Programming Languages and Compilers (PLC'05)*, 2005.

D. L. Chao, J. Balthrop, and S. Forrest. Adaptive Radio: Achieving consensus using negative preferences. In *ACM Group*, 2005.

F. Esponda, E. Ackley, S. Forrest, and P. Helman. On-line negative databases. In *Third Intl. Conf. on Artificial Immune Systems (ICARIS)*, 2004. Best paper award.

F. Esponda, S. Forrest, and P. Helman. The crossover closure and partial match detection. In *The second Intl. Conf. on Artificial Immune Systems (ICARIS)*, number 2787 in Lecture Notes in Computer Science, Berlin, 2003. Springer-Verlag. Best paper award.

D. L. Chao and S. Forrest. Generating biomorphs with an aesthetic immune system. In *Artificial Life VIII: The 8th Intl. Conf. on the Simulation and Synthesis of Living Systems*, pages 89–92, Cambridge, MA, 2003. The MIT Press.

D. L. Chao, M. Davenport, S. Forrest, and A. Perelson. Stochastic stage-structured modeling of the adaptive immune system. In *IEEE Computer Society Bioinformatics Conf. (CSB2003)*, 2003.

G. Barrantes, D. Ackley, S. Forrest, T. Palmer, D. Stefnaovic, and D. Zovi. Randomized instruction set emulation to disrupt binary code injection attacks. In *10th ACM Conf. on Computer and Communications Security*, 2003.

H. Inoue and S. Forrest. Anomaly intrusion detection in dynamic execution environments. In *Proc. of the New Security Paradigms Workshop*, pages 52–60, Danvers, MA, 2002. ACM Press.

D. L. Chao and S. Forrest. Information immune systems. In *Intl. Conf. on Artificial Immune Systems (ICARIS)*, pages 132–140, UK, 2002. University of Kent at Canterbury.

J. Balthrop, S. Forrest, and M. Glickman. Revisiting LISYS: Parameters and normal behavior. In *Congress on Evolutionary Computation (CEC)*, 2002.

J. Balthrop, F. Esponda, S. Forrest, and M. Glickman. Coverage and generalization in an artificial immune system. In W. B. Langdon et al., editor, *Proc. of the Genetic and Evolutionary Computation Conf. (GECCO)*, pages 3–10, New York, 2002. Morgan Kaufman.

C. Warrender, S. Forrest, and L. Segel. Effective feedback in the immune system. In *Evolutionary Evolutionary COmputation and Multi-Agent Systems (ECOMAS) workshop, GECCO*, San Francisco, CA, 2001.

A. Somayaji and S. Forrest. Automated response using system-call delays. In *Usenix*, 2000.

C. Maley and S. Forrest. Modeling the role of neutral and selective mutations in cancer. In *Seventh Artificial Life Conf.*, 2000.

C. Warrender, S. Forrest, and B. Pearlmutter. Detecting intrusions using system calls: Alternative data models. In *IEEE Symposium on Security and Privacy*, pages 133–145. IEEE Computer Society, 1999.

M. Oprea and S. Forrest. How the immune system generates diversity: Pathogen space coverage with random and evolved antibody libraries. In *Proc. of the Genetic and Evolutionary Computation Conf. (GECCO)*, pages 1651–1656. Morgan-Kaufmann, 1999.

S. Hofmeyr and S. Forrest. Immunity by design: An artificial immune system. In *Proc. of the Genetic and Evolutionary Computation Conf. (GECCO)*, pages 1289–1296. Morgan-Kaufmann, 1999.

D. Dasgupta and S. Forrest. Artificial immune systems in industrial applications. In *Intl. Conf. on Intelligent Processing and Manufacturing Material (IPMM)*, Honolulu, HI, 1999.

M. Oprea and S. Forrest. Simulated evolution of antibody gene libraries under pathogen selection. In *IEEE Intl. Conf. on Systems, Man, and Cybernetics*, 1998.

A. Somayaji, S. Hofmeyr, and S. Forrest. Principles of a computer immune system. In *New Security Paradigms Workshop*, 1997.

S. Forrest, A. Somayaji, and D. H. Ackley. Building diverse computer systems. In *Sixth Workshop on Hot Topics in Operating Systems (HotOS)*, pages 67–72, Los Alamitos, CA, 1997. IEEE Computer Society Press.

S. Forrest, S. A. Hofmeyr, A. Somayaji, and T. A. Longstaff. A sense of self for unix processes. In *IEEE Symposium on Computer Security and Privacy*, pages 120–128. IEEE Computer Society Press, 1996.

P. D'haeseleer, S. Forrest, and P. Helman. An immunological approach to change detection: algorithms, analysis, and implications. In *IEEE Symposium on Computer Security and Privacy*, pages 110–119. IEEE Computer Society Press, 1996.

D. Dasgupta and S. Forrest. Novelty detection in time series data using ideas from immunology. In *Intl. Conf. on Intelligent Systems*, 1996. Best paper award.

T. Jones and S. Forrest. Fitness distance correlation as a measure of problem difficulty for genetic algorithms. In L. J. Eshelman, editor, *Sixth Intl. Conf. on Genetic Algorithms*, pages 184–192. Morgan Kaufmann, 1995.

R. Hightower, S. Forrest, and A. S. Perelson. The evolution of emergent organization in immune system gene libraries. In L. J. Eshelman, editor, *Sixth Intl. Conf. on Genetic Algorithms*, pages 344–350. Morgan Kaufmann, 1995.

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, editors, *Advances in Neural Information Processing Systems (NIPS) 6*. Morgan Kaufmann, 1994.

S. Forrest, A. S. Perelson, L. Allen, and R. Cherukuri. Self-nonself discrimination in a computer. In *IEEE Symposium on Research in Security and Privacy*, pages 202–212. IEEE Computer Society Press, 1994.

S. Forrest and T. Jones. Modeling complex adaptive systems with Echo. In R.J. Stonier and X.H. Yu, editors, *Complex Systems: Mechanism of Adaptation*, pages 3–21, Amsterdam, 1994. IOS Press.

R. Smith, S. Forrest, and A. S. Perelson. An immune system model for maintaining diversity in a genetic algorithm. In L. D. Whitley, editor, *Proc. of a Workshop on Foundations of Genetic Algorithms (FOGA)*. Morgan Kaufmann, 1993.

R. Parsons, S. Forrest, and C. Burks. Genetic algorithms for dna sequence assembly. In et al. L. Hunter, editor, *First Intl. Conf. on Intelligent Systems for Molecular Biology*. AAAI/MIT Press, 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, editor, *Workshop on Foundations of Genetic Algorithms (FOGA)*. Morgan Kaufmann, 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 *AIAA Guidance Navigation and Control Conf.*, Hilton Head, SC, 1992.

M. Mitchell, S. Forrest, and J. Holland. The royal road for genetic algorithms: fitness landscapes and ga performance. In *Proc. of the First European Conf. on Artificial Life (ECAL)*. MIT Press, 1992.

T. M. Murdock, W. E. Schmitendorf, and S. Forrest. Use of a genetic algorithm to analyze robust stability problems. In *Proc. of the American Automatic Control Conf.*, Boston, 1991.

S. Forrest and A. S. Perelson. Genetic algorithms and the immune system. In H. Schwefel and R. Maenner, editors, *Parallel Problem Solving from Nature (PPSN)*, Lecture Notes in Computer Science, Berlin, 1991. Springer-Verlag.

S. Forrest and M. Mitchell. The performance of genetic algorithms on walsh polynomials: Some anomalous results and their explanation. In *Fourth Intl. Conf. on Genetic Algorithms (ICGA)*, 1991.

J. H. Miller and S. Forrest. A dynamical systems approach to classifier systems. In J. Grefenstette, editor, *Proc. of the Third Intl. Conf. on Genetic Algorithms (ICGA)*. Morgan Kaufmann, 1989.

S. Forrest. Modeling high-level symbolic structures in parallel systems that support learning. In M. Elzas, T. Oren, and B. Zeigler, editors, *Modelling and Simulation Methodology: Knowledge Systems Paradigms*. North Holland, 1989. Presented at the 1987 4th Intl. Symposium on Modeling and Simulation Methodology.

S. Forrest. The classifier system: a computational model that supports machine intelligence. In *IEEE Intl. Conf. on Parallel Processing (ICPP)*, 1986.

S. Forrest. Implementing semantic network structures using the classifier system. In J. Grefenstette, editor, *Intl. Conf. on Genetic Algorithms and Their Applications (ICGA)*, 1985.

L. Erman, M. Fehling, S. Forrest, and J. Lark. Abe: architectural overview. In *Proc. of the Workshop on Distributed Artificial Intelligence*, 1985.