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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, and biologically inspired approaches to computer security.

RECENT EMPLOYMENT

1990–present. Department of Computer Science, The University of New Mexico, Albuquerque, NM. Chairman, 2006–present; 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 (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. External Faculty, 1990–2003; Resident Faculty, 2003–present; Science Board, 1991–1997,1998–2001; 2003–present; Steering Committee, 1993–1999.

Editing: Journal of Machine Learning Research (Action Editor, 2005–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), Workshop on Software Evolvability (2005) (Co-chair with two others).

Program Committees: ACM Conference on Computer and Communications Security (2005), Hot Topics in Operating Systems (2005), International Conference on Artificial Immune Systems (2002,2003, 2004, 2005, 2006), International Conference on Genetic Algorithms (1991, 1993, 1995, 1997, 1999), Genetic and Evolutionary Computation Conference (2000, 2001, 2004) Workshop on Foundations of Genetic Algorithms (1992, 1994), Second European Conference on Artifical 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).

NSF Advisory Committee for the Directorate for Computer and Information Science and Engineering (2006-present).

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

Elected 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)

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). Submitted June, 2006.

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 ($26,480) "Biological design for computer security." 2005-2006.

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."

Ron Hightower (1996) "Computational aspects of antibody gene families."

Derek Smith (1997) "The cross-reactive immune response." (Nominated for ACM Best Dissertation award).

Mihaela Oprea (1999) "Optimizing the antibody repertoire for pathogen recognition."

Steven Hofmeyr (1999) "An immunological model of distributed detection and its application to network security."

Wim Hordijk (1999) "Dynamics, emergent computation, and evolution in cellular automata."

Patrik D'haeseleer (2000) "Reconstructing gene networks from large scale gene expression data."

Anil Somayaji (2002) "Operating system stability and security through process homeostasis."

Dennis L. Chao (2004) "Modeling the cytotoxic T cell response."

Christina Warrender (2004) " Modeling intercellular interactions in the peripheral immune system."

Gabriela Barrantes (2005) "Automated methods for creating diversity in computer systems."

Hajime Inoue (2005) "Anomaly detection in dynamic execution environments."

Fernando Esponda (2005) "Negative representations of data."

POST-DOCTORAL SUPERVISION

Dipankar Dasgupta (Univ. of Memphis, TN), Andrew Kosoresow (deceased), Derek Smith (Cambridge Univ. UK), Carlo Maley (Fred Hutchinson Cancer Research Center, Seattle), Steven Hofmeyr (Sana Security, CA), Matt Glickman (Sandia National Labs.), Catherine Beauchemin (current), Petter Holme (current), Melanie Moses (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

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

P. Holme, J. Karlin, and S. Forrest "Radial structure of the Internet." *Phys. Rev. E* (submitted Aug. 2006 http://arxiv.org/abs/cs/0608088).

K. Ingham, A. Somayaji, S. Forrest, and J. Burge "Learning DFA representations of HTTP for protecting web applications." *Journal on Computer Networks* (in press).

R. Gerety, S. Spencer, K. Pienta, and S. Forrest "Modeling somatic evolution in tumorigenesis." *PLoS Computational Biology* 2:8 e108 (2006).

F. Esponda, S. Forrest, and P. Helman "Negative representations of information." *International Journal of Information Security* (submitted March 2005).

R. G. Abbott, S. Forrest, and K. J. Pienta "Simulating the hallmarks of cancer." *Journal of Artificial Life* 12:4 (in press).

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 randomization" *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). w

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. Erman, 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. 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 Netowrk Protocols (in press).

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 SecuIrity 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-nonself 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).

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