

George Matthew Fricke
Curriculum vitae

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Citizenship: United States, United Kingdom

APPOINTMENTS **Research Assistant Professor** 2018 - Current
Department of Computer Science, The University of New Mexico

Post-doctoral Fellow 2017 - 2018
Moses Biological Computation Lab, The University of New Mexico

EDUCATION **Doctor of Philosophy** with distinction, Computer Science, May 2017
The University of New Mexico
Title: “Search in T cell and Robot Swarms: Balancing Extent and Intensity”
Advisor: Melanie Moses, PhD
GPA: 3.85

Master of Science, Computer Science, concentration in Artificial Intelligence
The University of New Mexico
Title: “Phylogenetic Reconstruction Using Competitive Neural Networks”
Advisor: Bernard Moret, PhD

Bachelor of Science, Mathematics *cum laude*
The University of New Mexico

Bachelor of Art, Anthropology, concentration in Archaeology
Appalachian State University, Boone, NC

PUBLICATIONS **Journals**

Emma J. Liu, et al. “Aerial strategies advance volcanic gas measurements at inaccessible, strongly degassing volcanoes”, *Science Advances*, (2020), Accepted.

Botvinik-Nezer et al. “Variability in the analysis of a single neuroimaging dataset by many teams”. In: *Nature* (2020), pp. 1–7.

Lu, Qi, G Matthew Fricke, John C Ericksen, and Melanie E Moses. “Swarm Foraging Review: Closing the Gap Between Proof and Practice”. In: *Current Robotics Reports* (2020), pp. 1–11.

Cannon, Judy, Melanie E. Moses, Janie R. Byrum, Paulus Mrass, G Matthew Fricke, and Humayra Tasnim. “Modeling T Cell Motion in Tissues During Immune Responses (Abstract)”. In: *Biophysical Journal* 116 (Feb. 2019), 322a. DOI: 10.1016/j.bpj.2018.11.1749.

Tasnim*, Humayra, G Matthew Fricke*, Janie R Byrum*, Justyna O Sotiris, Judy L Cannon, and Melanie E Moses. “Quantitative Measurement of naïve T cell association With Dendritic cells, FRCs, and Blood Vessels in lymph nodes”. In: *Frontiers in Immunology* 9 (2018).

Mrass, Paulus, Sreenivasa Rao Oruganti, G Matthew Fricke, Justyna Tafoya, Janie R Byrum, Lihua Yang, Samantha L Hamilton, Mark J Miller, Melanie E Moses, and Judy L Cannon. “ROCK regulates the intermittent mode of interstitial T cell migration in inflamed lungs”. In: *Nature communications* 8.1 (2017), p. 1010.

Fricke, G. Matthew, Joshua Hecker, Judy Cannon, and Melanie Moses. “Immune-Inspired Search Strategies for Robot Swarms”. In: *Robotica* (2016).

Fricke, G. Matthew, Kenneth Letendre, Melanie Moses, and Judy Cannon. “Persistence and adaptation in immunity: T cells balance the extent and thoroughness of search”. In: *PLoS Computational Biology* (2016).

*Authors contributed equally.

Flanagan, Tatiana P., Kenneth Letendre, William R. Burnside, G. Matthew Fricke, and Melanie E. Moses. “Quantifying the Effect of Colony Size and Food Distribution on Harvester Ant Foraging”. In: *PLoS ONE* (2012). DOI: 10.1371/journal.pone.0039427.

Hu, Bin, G. Matthew Fricke, James R. Faeder, Richard G. Posner, and William S. Hlavacek. “GetBonNie for building, analyzing, and sharing rule-based models”. In: *Bioinformatics* (2009). DOI: 10.1093/bioinformatics/btp173.

Fricke, G. Matthew and James L. Thomas. “Receptor aggregation by intermembrane interactions: A Monte Carlo Study”. In: *Biophysical Chemistry* (2006). DOI: 10.1016/j.bpc.2005.09.019.

Book Chapters

Suderman, Ryan, G Matthew Fricke, and William Hlavacek. “Using RuleBuilder to Graphically Define and Visualize BioNetGen-Language Patterns and Reaction Rules”. In: *Methods in Molecular Biology*. Vol. 1945. Apr. 2019, pp. 33–42. ISBN: 978-1-4939-9100-6. DOI: 10.1007/978-1-4939-9102-0_2.

Moses, Melanie, Tatiana Flanagan, Kenneth Letendre, and Matthew Fricke. “Ant Colonies as a Model of Human Computation”. In: *Handbook of Human Computation*. Ed. by Pietro Michelucci. New York, NY: Springer, 2014, pp. 25–39. DOI: 10.1007/978-1-4614-8806-4.

Conference Proceedings

Lu Qi, G. Matthew Fricke, Takaya Tsuno, and Melanie E. Moses, “A Bio-Inspired Transportation Network for Scalable Swarm Foraging”, *International Conference on Robotics and Automation (ICRA)* (2020), Accepted.

Ericksen John, Abhinav Aggarwal, G. Matthew Fricke, and Melanie E. Moses, “LoCUS: A loss-tolerant volcano survey algorithm”, *IEEE Robotics and Computing Conference (IRC)* (2020), Accepted.

Aggarwal, Abhinav, Diksha Gupta, William F. Vining, G. Matthew Fricke, and Melanie E. Moses. “Ignorance Is Not Bliss: An Analysis of Central-Place Foraging Algorithms”. In: *Proceedings of the International Conference on Intelligent Robots and Systems (IROS)*. IEEE, 2019.

Qi, Lu, Antonio D. Griego, G. Matthew Fricke, and Melanie E. Moses. “Comparing Physical and Simulated Performance of a Deterministic and a Bio-inspired Stochastic Foraging Strategy for Robot Swarms”. In: *Proceedings of the International Conference on Robotics and Automation (ICRA)*. IEEE, 2019.

Fricke, G. Matthew, Joshua P Hecker, Antonio D. Griego, Linh Tran, and Melanie E. Moses. “A Distributed Deterministic Spiral Search Algorithm for Robot Swarms”. In: *Proceedings of the International Conference on Intelligent Robots and Systems (IROS)*. IEEE, 2016.

Fricke, G. Matthew, Joshua P Hecker, Sarah R Black, Judy L Cannon, and Melanie E. Moses. “Distinguishing Adaptive Search From Random Search in Robots and T cells”. In: *Proceedings of the Conference on Genetic and Evolutionary Computation (GECCO)*. ACM, 2015. DOI: 10.1145/2739480.2754794.

Fricke, G. Matthew, François Asperti-Boursin, Joshua Hecker, Judy Cannon, and Melanie Moses. “From Microbiology to Microcontrollers: Robot Search Patterns Inspired by T Cell Movement”. In: *The European Conference on Artificial Life (ECAL)*. Vol. 12. 2013, pp. 1009–1016.

Flanagan, Tatiana P., Kenneth Letendre, William R. Burnside, G. Matthew Fricke, and Melanie E. Moses. “How Ants Turn Information Into Food: A Case Study in Distributed Search”. In: *IEEE Symposium on Artificial Life (ALIFE)*. IEEE, 2011, pp. 178–185. DOI: 10.1109/ALIFE.2011.5954650.

Technical Reports

Andy Claiborne and G. Matthew. Fricke and L. Lopes and George Luger, “Emergent Representation in a Robot Control Architecture”, 2nd Annual UNM-NASA PURSUE Conference on Autonomous Control Systems, 2000, UNM Computer Science Technical Report TR-CS-2000-55

Abstracts and Extended Abstracts

Janie Rae Byrum et al., “Interleukin 7 regulates naïve T cell metabolism to promote motility of naïve T cells” American Association of Immunologists, Honolulu, Hawaii, US, 2020

Arellano, Santiago R., et al., “UAV-based Measurements of the High-Altitude Plume of Manam Volcano.” American Geophysical Union Fall Meeting (AGUFM 2019): EP13A-02.

Santiago R Arellano et al. “UAV-based Measurements of the High-Altitude Plume of Manam Volcano” (ID: 518048), American Geophysical Union Fall Meeting, San Francisco, 2019.

Sarah M. Ackerman et al., “The Swarmathon: An autonomous swarm robotics competition,” Workshop on Swarms: From Biology to Robots and back at the 2018 IEEE/RSJ International Conference on Robotics and Automation (ICRA), Brisbane, Australia, arxiv.org/abs/1805.08320, 2018.

G. Matthew Fricke, Diksha Gupta, and Melanie Moses, “Biologically-Inspired Distributed Spatial Search for Ground-Based Foraging Swarms”, 5th Annual Biological Distributed Algorithms (BDA) Workshop, Washington, DC, 2017

CONFERENCE PRESENTATIONS Oral Presentations

Aggarwal, Abhinav, Diksha Gupta, William F. Vining, G. Matthew Fricke, and Melanie E. Moses, “Ignorance Is Not Bliss: An Analysis of Central-Place Foraging Algorithms”, 32nd Annual International Conference on Intelligent Robots and Systems, Macau, China, 2019 (presenting author)

G. Matthew Fricke, Joshua P. Hecker, Antonio Griego, Linh Tran, and Melanie Moses, “A Distributed Deterministic Spiral Search Algorithm for Swarms”, 29th Annual International Conference on Intelligent Robots and Systems, Daejeon, South Korea, 2016 (presenting author)

G. Matthew Fricke, “Swarmathon: Training the Next Generation of ROS Programmers”, RosCon 2016 Lightning Talks, Seoul, South Korea, 2016 (presenter)

G. Matthew Fricke, Joshua P. Hecker, “Swarmathon Technical Tutorial: Extended Kalman Filters”, Robotics: Science and Systems (RSS), Ann Arbor, MI, 2016, (presenter)

G. Matthew Fricke, Josh P. Hecker, Antonio Griego, Linh Tran, and Melanie Moses, “Spiral Search in Robot Swarms”, 12th Annual UNM Computer Science Student Conference, 2016, Albuquerque, NM. (presenting author)

G. Matthew Fricke, Judy Cannon and Melanie Moses, “Efficiency of T Cell Search in Lymph Nodes”, 12th Annual Conference on Complex Systems, Phoenix, AZ. 2016 (presenting author)

G. Matthew Fricke, Judy Cannon, and Melanie Moses, “T Cell Search Inspired Computation”, Motility in the Immune System: From Microscopic Movement to Macroscopic Function, Workshop, Santa Fe Institute, Santa Fe, NM, 2015 (presenter)

Tatiana Flanagan, G. Matthew Fricke, Joshua P. Hecker, Kenneth Letendre, Drew Levin, Stephanie Forrest, Deborah Gordon and Melanie Moses, “Using Information to Improve Collective Search”, 12th Annual Conference on Complex Systems, Phoenix, AZ, 2015, (presentation, author)

G. Matthew Fricke, Sarah R. Black, Joshua P. Hecker, Judy L. Cannon, and Melanie E. Moses. “Distinguishing Adaptive Search From Random Search in Robots and T Cells”, 17th Annual Genetic and Evolutionary Computation Conference, Madrid, 2015 (presenting author)

G. Matthew Fricke, François Asperti-Boursin, Judy Cannon, and Melanie Moses, “T Cell Motility and Robotic Search”, 10th Annual UNM Computer Science Student Conference, 2014 Apr 18th, Albuquerque, NM, (presenting author)

Posters

Jake Nichol, Matthew Peterson, Kara Peterson, David Stracuzzi, G. Matthew Fricke, and Melanie Moses, “Machine Learning to Compare Features of Simulated and Observed Arctic Sea Ice Extent.”, American Geophysical Union (Fall Meeting), San Francisco, 2019

C. Kempes, L. Chou, N. Greenstette, V. Da Poian, M, Fricke, “Mass Spectrometry Agnostic Identification of Complexity”, Mars Extant Life: What’s Next Conference, Carlsbad, NM, 2019

Emma J. Liu et al. “The View From ABOVE: Aerial-Based Observations of Volcanic Emissions at Manam, Papua New Guinea”, Deep Carbon Observatory Conference, Washington DC, 2019

Kirubel Tadesse, George Matthew Fricke, Joshua Peter Hecker, Melanie Moses, “April Tag Detection: Calculating Distance Use ROS Transform Package”, 29th Annual International Conference on Intelligent Robots and Systems, Daejeon, South Korea, 2016

G. Matthew Fricke, Joshua P. Hecker, Melanie E. Moses, “The Adaptive Lévy Search Algorithm Applied to a Robot Swarm”, Quantifying Complex Transport with Lévy Walks: From Cold Atoms to Humans and Robots, Physikzentrum Bad Honnef, 2016

Byrum, J.R., Tafoya, J., Fricke, G.M., Moses, M.E., Cannon, J.L. “Quantitating Dendritic Cell Distribution in Lymph Nodes”, American Association of Immunologists, Seattle, WA. 2016

G. Matthew Fricke, Judy Cannon, François Asperti-Boursin and Melanie Moses, “T Cell Stochastic Search Patterns”, Stochastic Single-Cell Dynamics in Immunology Experimental and Theoretical Approaches, Workshop, Netherlands Royal National Academy, Amsterdam, 2015

G. Matthew Fricke, François Asperti-Boursin, Judy Cannon, and Melanie Moses, “Efficiency and Robustness of T Cell Search”, 3rd Biennial Conference on Systems Approaches to Immunology and Infectious Diseases, Santa Fe, NM, 2014

Tatiana M. Paz, G. Matthew Fricke, Kenneth Letendre, William R. Burnside and Melanie Moses, “Effects of Colony Size and Resource Distribution on the Foraging Behavior of Three Species of Desert Harvester Ants” 94th Ecological Society of America Annual Meeting, Albuquerque, NM, 2009

James R. Faeder, Michael L. Blinov, G. Matthew Fricke, Jeremy E. Kozdon, Nathan Lemons and William S. Hlavacek, “Rule-Based Modeling of Biochemical Networks with BioNetGen2” 6th International Conference on Systems Biology (ICSB), Boston, MA, 2005

TEACHING

Computer Programming Fundamentals for Non-Majors Spring 2020
The University of New Mexico Computer Science Dept.

- Instructor of Record. Provides a rigorous foundation in programming with application to mathematical modelling. This course is designed for students in the engineering school. Students learn Python and MATLAB.

Experimental Methods in Computer Science Spring 2019
The University of New Mexico Computer Science Dept.

- Instructor of Record. Graduate students learn how to use a data-driven approach to understand computing phenomena, formulate hypotheses, design computing experiments to test and validate or refute hypotheses, and evaluate and interpret empirical results. This lays the foundation for rigorous graduate-level research.

Introduction to Programming Swarm Robots Fall 2017
The University of New Mexico Computer Science Dept.

- Instructor of Record. Dual graduate and undergraduate course in Swarm Robotics. Students learn to program robots in hardware and using the Gazebo simulator. Emphasis on writing collaborative algorithms using the Robot Operating System (ROS) and ARGoS frameworks.

Complex Adaptive Systems Spring 2017
The University of New Mexico Computer Science Dept.

- Instructor of Record. Graduate course in Complex Adaptive Systems. Topic included dynamical systems, genetic algorithms, game theory, cellular automata, and network theory.

Quantifying and Modeling T cell Motility in Lymph Nodes Summer 2016, 2018
Quantitative Biology (q-bio) Summer School, Albuquerque, NM

- Guest Lecturer: taught maximum likelihood analysis and methods for distinguishing motility models.

Mathematical Foundations of Computer Science Summer 2013
The University of New Mexico Computer Science Dept.

- Instructor of Record: Responsible for all aspects of this course in discrete math. Topics covered include proofs, set theory, logic, combinatorics, state machines, generator functions and recurrence relations.

Complex Adaptive Systems Spring 2013
The University of New Mexico Computer Science Dept.
• Teaching Assistant: Assisted Prof. Moses in organizing, grading, and teaching this graduate level course.

Intermediate Programming with Java Fall 2012
The University of New Mexico Computer Science Dept.
• Teaching Assistant: Lectured on Java programming, ran labs, designed and graded assignments and exams.

Computer Programming Fundamentals with C++ Summer 2003
The University of New Mexico Computer Science Dept.
• Instructor of Record. Responsible for all aspects of this course which provides engineering students with a foundation in problem solving using C++.

Discrete Math Spring 2002
The University of New Mexico Computer Science Dept.
• Guest Lecturer: taught inference rules and proof techniques.

**PROFESSIONAL
EXPERIENCE**

Research Assistant Professor 2018-Current
Computer Science Department, The University of New Mexico
• Topic supervisor for graduate students in computer science researching synthetic biology, machine learning applied to climate change, and algorithms for swarm drone monitoring of volcanoes.
• Teach computer science courses as an Adjunct Assistant Professor as required (see teaching section).

Research Assistant Professor 2018-Current
Center for Advanced Research Computing, The University of New Mexico
• CARC is the primary high performance computing center at UNM and is one of the largest in New Mexico. I have implemented scientific computing code to solve problems in fluid dynamics, radio-astronomy, quantum-computing, molecular biology, deep-learning, very large genome analysis, phylogenetic reconstruction, and others in support of the research community at UNM. I supervise three graduate students.

NASA Swarmathon Technical Lead 2015-2019
Department of Computer Science, The University of New Mexico, Albuquerque, NM
• Promoted from Software Lead in 2017
• Supervise eight graduate and undergraduate programmers.
• Swarmathon: Responsible for all technical aspects of the UNM-NASA swarm robotics resource collection competition including software, hardware, team support, outreach organization, and purchasing. This program has a budget of \$3 million and has three components: outreach to more than 40 underserved universities and colleges (more than 1,500 students) and more than 50 high schools; novel swarm robot hardware, and development of swarm search algorithms for those robots.

Graduate Research Assistant 2012-2015
Dept. of Computer Science, The University of New Mexico
• Supervised two programmers and a mathematician.
• Analysis of immunological search processes.
• Development of novel swarm search algorithms using ARGoS and a Beowulf cluster.

Research Programmer Spring 2011
Institute for Mathematics and Education, University of Arizona
• Designed and coded mathematical problems as examples of the Common Core States Standards for mathematics for the Illustrative Mathematics Project website. Funded by the Bill and Melinda Gates Foundation.

Research Programmer (Contractor) 2004-2010
Theoretical Biology and Biophysics Group, Los Alamos National Labs, Los Alamos, NM
• Team leader supervising two programmers.

- Developed a biochemical reaction network generator and analyzer (RuleBuilder) for BioNet-Gen using Perl and Java under Bill Hlavacek and James Faeder.
- Developed a web-based version of the software (GetBonnie) using PHP, Java, and SQL under Redhat linux (LAMP).

Graduate Research Assistant

Summer 2003

Department of Physics and Astronomy, University of New Mexico

- Developed a Monte-Carlo computer simulation of IgE cell signaling in C++ with James Thomas (UNM Physics).

Analyst-Programmer II

Summer 2002

Center for Advanced Research Computing, University of New Mexico

- Summer position working with Gregory Starr (UNM Mechanical Engineering) at the CoMeT (Computational Mechanics Toolkit) robotics group.
- Implemented Neural Networks, Fuzzy Logic Systems in order to generate robotic hand grasp parameters for nuclear waste handling in C++ and Scheme. Funded by the Department of Energy and the Idaho National Engineering and Environmental Laboratory.

Research Assistant

2001 - 2002

University of New Mexico NASA Pursue Program

- Worked in George Luger's (UNM Computer Science) lab on the design and implementation of an embodied, agent-based, robotic control system. Funded by the NASA Center for Autonomous Control Engineering.

Programmer II, Systems Analyst I

1993 - 1999

University of New Mexico Health Sciences Center, CPH and MHC.

- System administration, design, and implementation. Began as helpdesk technician II for several thousand computers in a heterogeneous network environment, promoted to systems analyst responsible for planning and administration of all computer and network systems for two UNM departments. Implemented system administration tools.
- Supervised three full time employees.

Field Archaeologist

1991-93

Mariah and Associates, National Park Service, and Appalachian State University

COMPUTER SKILLS

Languages: C++ (QT, ROS, OpenGL), MPI, Matlab, Java, Javascript, SQL, HTML5, PHP and Java web interfaces (full stack including node.js)

Systems Administration: Linux (Ubuntu, Redhat, CentOS), Windows Server and AD, network infrastructure (DNS, DHCP, NFS, LDAP, Apache and IIS web services), HPC administration (Spack, Warewulf, Torque, Slurm, and Docker/Singularity).

Certifications: Certified Systems Engineer, Certified Network Engineer

COMMUNITY SERVICE

- Reviewer for *Swarm Intelligence*, *Automatica*, *Journal of Theoretical Biology*, *IEEE Robotics and Automation Letters*, DARS: Distributed Autonomous Robotic Systems, IROS: IEEE/RSJ Intl. Conference on Intelligent Robots and Systems, Alife: Conference on the Synthesis and Simulation of Living Systems, BDA: Biological Distributed Algorithms, ICRA: International Conference on Robotics and Autonomy, and ISRR: International Symposium on Robotics Research.
- Workshop Organizer, Robotics Science and Systems Conference, Workshop Hackathon: "Become a swarm programmer overnight". MIT, 2017.
- Contributor to the Rcpp package for R: the Project for Statistical Computing
- Instructor, 29th Annual Supercomputing Challenge, 2018
- Volunteer, UNM/VEX Robotics Competition, 2014
- Instructor, UNM Computer Science Middle School Outreach, 2014, 2015
- Judge, Senior Mathematics, Senior Computer Science, Annual Central NM Regional Science & Engineering Research Challenge, 2012, 2013, 2016 and 2017
- Volunteer Grader, Public Service Company of New Mexico State Math Competition, 2012

PROF. ORGS.

- Association for Computing Machinery (ACM)
- International Association for Artificial Life (ALIFE)
- Institute of Electrical and Electronics Engineers (IEEE)
- Complex Systems Society (CSS)

GRANTS AND AWARDS

- GeorgeTown University, “Agnostic Biosignatures for Extant Life”, 2019-2020.
- Biological Distributed Algorithms Workshop Travel Grant, 2017
- Best Poster, Quantifying Complex Transport with Lévy Walks at the From Cold Atoms to Humans and Robots Workshop, 2016
- NSF Travel Grant distributed by Rice University R3G410, 2016
- 1st place 12th Annual UNM Computer Science Graduate Conference, 2016
- University of New Mexico Office of Graduate Studies Travel Grant, 2015
- 2nd place 10th Annual UNM Computer Science Graduate Conference, 2014
- 1st place Tech New Mexico Competition 2013
- 1st place, Student Paper Competition, IEEE Symposium on Artificial Life, 2011
- Appalachian State University *dean’s list* 1st year.

REFERENCES

Melanie Moses, PhD, Professor melaniem@cs.unm.edu
Department of Computer Science (505) 277-3112
University of New Mexico
and the Santa Fe Institute

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Lockheed-Martin Corporation

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