Melanie E. Moses

University of New Mexico, Department of Computer Science

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Professional Preparation

Stanford University   **Palo Alto, CA**
B.S. in Symbolic Systems, with a concentration in Agent Based Modeling   *1989 – 1993*

University of New Mexico   **Albuquerque, NM**
Ph.D. in Biology, Advisor: Bruce T. Milne   *2000 – 2005*
Dissertation Title: "Metabolic scaling from individuals to societies"

University of New Mexico   **Albuquerque, NM**
Postdoctoral Research in Biology and Computer Science   *2005 – 2007*
Advisors: James H. Brown and Stephanie Forrest

Appointments

University of New Mexico   **Department of Computer Science**
Professor, Albuquerque, NM   *2018 – present*

University of New Mexico   **Department of Computer Science**
Associate Professor, Albuquerque, NM   *2013 – 2018*

Santa Fe Institute
External Faculty, Santa Fe, NM   *2012 – present*

University of New Mexico   **Department of Biology**
Secondary Appointment, Albuquerque, NM   *2010 – present*

UCLA   **Department of Biomathematics**
Visiting Associate Professor, Los Angeles, CA   *Spring 2014*

Universitat Pompeu Fabra   **Complex Systems Lab**
Visiting Associate Professor, Barcelona, Spain   *Fall 2013*

University of New Mexico   **Department of Computer Science**
Assistant Professor, Albuquerque, NM   *2007 – 2013*

Academic Interests

Research: Computational Immunology, Biologically Inspired Computation, Swarm Robotics, Scaling in Complex Systems

Teaching: Complex Adaptive Systems, Evolutionary Robotics, Introductory Programming, Agent Based Modeling, Computational Biology; engaging underrepresented populations in Computer Science

Honors & Awards

Africana Studies Ambassador Award for Computer Science Education for Students of Color: 2017
School of Engineering Harrison Award for Service: 2016

School of Engineering Teaching Award for new faculty: 2013

School of Engineering Research Award for new faculty: 2012

UNM Outstanding New Teacher of the Year Award: 2011

Best Paper Award, IEEE Symposium on Artificial Life: 2011

UNM Faculty of Color Research Award: 2010

New Mexico Academy of Sciences Distinguished Lecturer: 2008

Microsoft New Faculty Fellowship Finalist: 2008

Ford Foundation Dissertation Diversity Fellow: 2004-2005

Environmental Protection Agency Science to Achieve Results Graduate Research Fellow: 2000-2004

Professional Service Activities

Conference and Workshop Leadership & Advisory Board Service

Member, Steering Committee for the Computing Research Association Underrepresented Minority Graduate Cohort, which aims to increase underrepresented groups in computing research beginning with a 2 day workshop in March 2018: 2017-present

Co-organizer, Santa Fe Institute Working Group, *Liquid Brains, Solid Brains*: December 2017

Organizer, *Swarmathon RSS Workshop and Hackathon* with talks by top swarm robotics researchers, mentoring for 28 undergraduates from Minority Serving Institutions, and an overnight Hackathon in which teams programmed robots to forage for resources while navigating through obstacles in a GPS-denied environment: Cambridge, MA; July, 2017

Co-organizer, Santa Fe Institute Working Group, *Evolution & Restraint of Complex Systems*: Dec. 2016

Organizer, *Swarmathon RSS Workshop* including research talks in swarm robotics, mentoring, and a poster session for Swarmathon undergraduates: University of Michigan Ann Arbor; June, 2016

Co-organizer, Santa Fe Institute Working Group, *Motility in the Immune System*: July, 2015

Co-Organizer, *Robot Guru ICRA Workshop* a full day broadening participation in computing workshop: Seattle WA; May, 2015

Co-director, UNM Program in Interdisciplinary Biological and Biomedical Science (PiBBs). NIH and HHMI funded interdisciplinary graduate training program for 20 students who produced over 100 publications in interdisciplinary biology.: 2013-2015

Advisory Board member, PiBBs: 2011-2013

Board member, Social Logic Institute: 2010-2015

Advisory Board Member, UNM Pre-college Math and Science Program. Encourages and prepares primarily African American pre-college students to enter STEM fields: 2013-2014

Co-Chair, 2012 Gordon Research Conference on the Metabolic Basis of Ecology. 100 attendees, 20 speakers and 40 Graduate students: University of New England, 2010-2012

Co-Vice Chair, 2010 Gordon Research Conference on the Metabolic Basis of Ecology: 2008-2010

Service on Program Committees

BDA 2017, 2018 Biological Distributed Algorithms Workshop, co-located with PODC: Washington,London

DARS 2016, 2018 Intl. Symposium on Distributed Autonomous Robotic Systems: London, Denver

ALIFE 2017, IEEE Symposium on Artificial Life: Honolulu; December 2017

ANTS 2016, Tenth International Conference on Swarm Intelligence: Brussels; September, 2016

AIS 2014, Artificial Immune Systems workshop at GECCO: Vancouver; July, 2014

ALIFE 2014, The 14th Intl. Conf. on the Synthesis & Simulation of Living Systems: New York, July 2014

Other Reviewer Service

IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS): 2013- 2017

IEEE International Conference on Robotics and Automation (ICRA): 2015

The First International Symposium on Multi-Robot and Multi-Agent Systems: 2017

Member, IEEE Task Force on Artificial Life and Complex Adaptive Systems: 2017-present

Member, Scientific Review Committee, University of Maryland National Socio-Environmental Synthesis Center (SESYNC), twice yearly proposal review panels: 2014-2017

NSF reviews, adhoc or in-person panel reviews approximately annually: 2009-2017

Example Journal Reviews *American Naturalist, Autonomous Agents and Multi-Agent Systems, Autonomous Robots, Biology Letters, Bulletin of Mathematical Biology, Ecology Letters, Evolutionary Computation, Frontiers in Microbiology, Frontiers in Robotics and AI (section Evolutionary Robotics Review Editor), Functional Ecology, Journal of the Royal Society Interface, Insect Science, Journal of Theoretical Biology, Nature, Networks and Spatial Economics, Oecologia, Physica A, PLoS Computational Biology, PLoS ONE, Proceedings of the National Academy of Science, Proceedings of the Royal Society B, Robotica, Science Advances, Swarm Intelligence, Transactions on Parallel and Distributed Systems*

Educational Outreach Activities

Principal Investigator, NM CSforAll (`http://cs4all.cs.unm.edu`) trained 60 teachers to teach introductory computer science for UNM dual credit to 1100 students in 30 New Mexico high schools. The course teaches computer programming and computational thinking through scientific modeling. We established NM CSforAll as the first Computer Science course to satisfy a core UNM graduation requirement (in Natural Science): 2015-present

Principal Investigator, NASA Swarmathon (`http://NasaSwarmathon.com`) a NASA-funded swarm robotics programming challenge. 1000 undergraduates from 44 Minority Serving Institutions and 500 high school students have participated in the competition. 500 students have traveled to Kennedy Space Center to watch the robots they have programmed compete in autonomous collaborative 'swarms' that collect resources. The algorithms developed by students in this competition support the NASA Journey to Mars mission in which robots will collect resources to support human settlements. Press coverage including dozens of newspaper articles and several educational television shows and radio broadcasts about the project are available at `http://swarms.cs.unm.edu/press.html` and `http://NasaSwarmathon.com/gallery/`: 2015-present

Presentations at seminars and workshops to promote interdisciplinary education including to the PIBBS program, CETI program, MIND Institute, ARTS Lab, Biological Discovery and Innovation Seminar, Consortium of the Americas, New Mexico Super Computing Challenge, SFI NSF workshop to redesign the Computing curriculum, SFI Education Committee, UNM School of Medicine Spatiotemporal Modeling Center (STMC): 2007-present

Panelist to promote diversity in education including with the Project for New Mexico Graduates of Color, Black Graduate and Professional Student Association, Strategies for Ecology Education Diversity and Sustainability (SEEDS) Program, Out Queer Grads, Project GUTS, Science Cafes, Central New Mexico Community College (CNM), K-12 teachers and students, the New Mexico Celebration of Women in Computing, UNM Society for Women Engineers: 2007-present

University Service

Co-PI, ADVANCE at UNM, NSF program to create sustainable changes in the UNM climate, contributing to increased success of women and minority faculty: Faculty member 2016-2017; Co-PI, 2017-present

Member, School of Engineering Committee on Visibility and Reputation: 2017-present

Chair, Research Excellence Working Group of the OVPR Research Strategic Planning Committee. The Research Excellence report is available at `http://research.unm.edu/strategic-plan`: 2016

Co-PI and Department of Computer Science Faculty Advisor for STEPs in the Right Direction: Transforming Engineering/Computer Science Education at the University of New Mexico funds summer internships for 70 undergraduates each year and quarterly meetings of mentoring "families" of students a

faculty mentor: 2011-2016

Reviewer, SOE Awards: 2013, 2017

Reviewer, UNM CETI seed grants: 2009, 2011, 2014

Reviewer, UNM Teacher of the Year Award Committee: 2012

Member, Biology Research Professor Search Committee: 2012

Member, School of Engineering Associate Dean for Research Search Committee: 2010

Computer Science Department Service

Chair, CS Department Outreach Committee organized CS outreach for SOE Open House each fall, New UNM student orientation each summer, STEAM-H for teachers and students, several K-12 demonstrations and interactive activities every semester: 2014-2016

Chair, CS Department Faculty Search Committee: 2012

Member, CS Department Faculty Search Committee: 2007, 2009, 2010, 2011

Member, CS Department Lecturer Search Committee: 2006, 2007, 2017

Faculty Advisor to the Computer Science Graduate Student Association: 2010-12

Chair, Annual Review of CS Graduate Student Progress: 2011-13

Member, Incoming Graduate Student Advising Committee: 2008-2009

Co-chair, Annual Graduate Student Recruiting Event and Graduate Student Orientation: 2008-2009

Member, Master's Curriculum Re-design Committee: 2007

External Funding

CURRENT

	Total award to UNM
NASA MUREP NNX15AM14A	**$2,242,000**
Swarmathon: A NASA challenge to develop cooperative robots and revolutionize space exploration	*2015-2018*
Role: PI	
McDonnell Foundation Complex Systems Scholar Award	**$450,000**
Emergent Cooperative Search in Natural and Engineered Systems	*2014-2020*
Role: PI	
Sandia National Labs Academic Alliance LDRD award	**$100,000**
Collaborative Research on Artificial Immune Systems and Complex Systems	*2016-2018*
Role: PI	
Microsoft Research	**$50,000**
Distributed Computation in Ant Pheromone Networks	*2008-2020*
Role: PI	
Google	**$50,000**
Swarm Robotics Research and Education	*2008-2020*
Role: PI	
DARPA	**$667,000**
Interacting Swarms from Immunology to Social Media, SBIR Phase II, Awarded Nov. 2017	*2017-2019*
Role: Co-PI of UNM Subaward to Tau Technologies, (total award **$1.5 Million**)	

PENDING

NSF	**$2,931,417**
Culturally Responsive Adaptive Teaching of Computational Science (CReATe-CS), Submitted	*2018-2022*
Role: PI	

NSF		**$1,500,000**
Calderas, Canyons and Co-Robots: Predicting Volcanic Eruptions & Uncovering Ancient Cultures		*2018-2022*
Role: PI		
NSF		**$212,000**
MRI: Development of Drones for volcano sensing, Submitted		*2018-2020*
Role: Co-PI		

PRIOR ....

NSF CISE 1240992		**$195,000**
New Mexico Computer Science for All (NM CSforAll)		*2016-2017*
Role: PI through the Santa Fe Institute; subaward to UNM.		
DARPA CRASH P-1070-113237		**$3,200,000**
Scalable Robust Adaptive Decentralized search with Automated Response (RADAR)		*2010-2015*
Role: Co-PI		
NSF Advancing Theory in Biology EF 1038682		**$500,000**
Collaborative Research: Search, Signal and Information Exchange in Distributed Biological Systems		*2010-2014*
Role: PI		
NSF STEP Program		**$2,500,000**
STEPs in the Right Direction: Transforming Engineering/Computer Science Education at UNM		*2011-2017*
Role: Co-PI		
NIH R01AI097202-01A1		**$25,000**
The role of PKCtheta in T cell and T-ALL migration		*2012-2017*
Role: consultant		
NIH, IDeA Program of the National Center for Research Resources P20RR018754		
Subprojects of the UNM COBRE Center for Evolutionary and Theoretical Immunology (CETI)		*2008-2011*
Total renewal Award to UNM CETI, $10,754,836		
NIH, IDeA Program of the National Center for Research Resources P20RR018754		**$603,482**
Predicting Pathogenesis, Immune Response and Epidemic Spread of Multi- host Pathogens		*2009-2011*
Role: project leader		
NIH, IDeA Program of the National Center for Research Resources P20RR018754		**$310,000**
Modeling viral dynamics and immune response in vertebrates		*2008-2009*
Role: project leader		

Ph.D. Students Graduated

Dr. Matthew Fricke	**2017**
Postdoctoral Researcher, University of New Mexico	*Albuquerque, NM*
Dr. Kimberly Kannigel Winner	**2015**
Postdoctoral Fellow, Computational Biosciences, University of Colorado	*Denver, CO*
Dr. Joshua P. Hecker	**2015**
Senior Software Engineer, Lockheed Martin Autonomous Systems	*Denver, CO*
Dr. Tatiana Paz Flanagan	**2013**
Research Scientist, Sandia National Laboratories	*Albuquerque, NM*
Dr. Soumya Banerjee	**2013**
Postdoctoral Researcher, Centre for Industrial and Applied Mathematics, University of Oxford	*Oxford, UK*

Postdoctoral Fellows Advised

Dr. Matthew Fricke, Swarmathon Technical Lead: 2017-present

Dr. Tatiana Paz Flanagan, half time appointment with Sandia National Laboratories: 2017-present

Dr. Joshua P. Hecker: Swarmathon Technical Lead 2015-2017, currently Senior Software Engineer at Lock-

heed Martin Autonomous Systems in Denver, CO

Dr. Paulus Mrass: co-mentored with Prof. Cannon, UNM School of Medicine, 2015-2017; currently Research Professor, UNM Molecular Genetics and Microbiology

Dr. Francois Asperti-Boursin: co-mentored with Prof. Cannon, UNM School of Medicine, 2012-2015

Dr. Sheldon Jordan: Research in Computational Immunology 2011-2012; currently research Scientist, Sandia National Laboratories

Dr. Horacio Samaniego: Research in City Scaling 2009-2010; currently Associate Professor Universidad Austral de Chile

Other current and former students

Current PhD students: Qi Lu, Wayne Just, John Ericksen, Humayra Tasnim, Vanessa Surjadidjaja, Sarah Salmonson, Will Vining, Akil Andrews

MS research student advises: Kristiana Rendon (current), Bianca Bologa (current), Safeeul Bashir Safee 2017, Neal Holtschulte 2015, Tanya Brunnetti 2015, Karl Stoleis 2013, Chris Miles 2013, Mark Flynn 2011, Kenneth Letendre 2010, Tamanna Arora 2009

Visiting graduate students: Tatsuhiro Morimoto Fall 2017, Tomoka Ogura Fall 2016

Undergraduate research advisees: Antonio Griego (2014 - present), Jarret Jones (2016-present), Jeffery Schlindwein (2017-present), Linh Tran (McNair 2015-2017), Valuable Sheffy (REU 2017), Kelsey Grieger (REU 2017), Tobi Ogunyale (REU 2017), Manuel Meraz (REU 2016, 2017), Kirubel Tadesse (REU 2016), Micheal Sosebee (STEP 2016), Troy Squacili 2016, Elizabeth Esterly 2015-2016, J. Jake Nichols 2015-2016, Justin Carmicheal 2013-2016 (honors thesis), Justyna Tafoya (IMSD 2015-2016), Bjorn Swenson 2011-2014, Adetomiwa Oguntuga (REU 2010, 2011), Sam Hopkins 2008-2010

High School Research Interns: Kiana Gerhart (summer 2017), Naomi Rankin (summer 2016), Daniel Washington (2011-2012)

Journal Publications

[J1] Q. Lu*, J. P. Hecker*, and M. E. Moses, "Multiple-place swarm foraging with dynamic depots," *Autonomous Robots*, pp. 1–18, 2018.

[J2] H. Tasmin*, M. G. Fricke*, J. Byrum, J. Tafoya*, J. Cannon, and M. E. Moses, "Quantitative measurement of Naive T Cell Association with Dendritic Cells, FRC, and Blood Vessels in Lymph Nodes," *Frontiers in Immunology*, vol. 9, p. 1571, 2018.

[J3] S. Banerjee*, A. S. Perelson, and M. E. Moses, "Modelling the effects of phylogeny and body size on within-host pathogen replication and immune response," *Journal of The Royal Society Interface*, vol. 14, no. 136, p. 20170479, 2017.

[J4] P. Mrass*, S. Oruganti, G. M. Fricke*, J. Tafoya*, J. Byrum, L. Yang, S. Hamilton, M. Miller, M. Moses, and J. Cannon., "Rock regulates the intermittent mode of interstitial T cell migration in inflamed lungs," *Nature Communications*, vol. 8, no. 1, p. 1010, 2017.

[J5] M. Moses, G. Bezerra, B. Edwards, J. Brown, and S. Forrest, "Energy and time determine scaling in biological and computer designs," *Philosophical Transactions of the Royal Society B*, vol. 371, no. 1701, p. 20150446, 2016.

[J6] G. M. Fricke*, J. P. Hecker*, J. L. Cannon, and M. E. Moses, "Immune-inspired search strategies for robot swarms," *Robotica*, vol. 34, no. 08, pp. 1791–1810, 2016.

[J7] S. Banerjee*, J. Guedj, R. M. Ribeiro, M. Moses, and A. S. Perelson, "Estimating biologically relevant

parameters under uncertainty for experimental within-host murine West Nile Virus infection," *Journal of The Royal Society Interface*, vol. 13, no. 117, p. 20160130, 2016.

[J8] G. M. Fricke*, K. A. Letendre*, M. E. Moses, and J. L. Cannon, "Persistence and adaptation in immunity: T cells balance the extent and thoroughness of search," *PLOS Comput Biol*, vol. 12, no. 3, p. e1004818, 2016.

[J9] 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," *Journal of theoretical biology*, vol. 398, pp. 52–63, 2016.

[J10] K. R. K. Winner*, M. P. Steinkamp, R. J. Lee, M. Swat, C. Y. Muller, M. E. Moses, Y. Jiang, and B. S. Wilson, "Spatial modeling of drug delivery routes for treatment of disseminated ovarian cancer," *Cancer research*, vol. 76, no. 6, pp. 1320–1334, 2016.

[J11] K. Letendre*, E. Donnadieu, M. E. Moses, and J. L. Cannon, "Bringing statistics up to speed with data in analysis of lymphocyte motility," *PLOS ONE*, vol. 10, no. 5, p. e0126333, 2015.

[J12] J. P. Hecker* and M. E. Moses, "Beyond pheromones: evolving error-tolerant, flexible, and scalable ant-inspired robot swarms," *Swarm Intelligence*, vol. 9, no. 1, pp. 43–70, 2015.

[J13] J. L. Cannon, F. Asperti-Boursin*, K. A. Letendre*, I. K. Brown, K. E. Korzekwa, K. M. Blaine, S. R. Oruganti, A. I. Sperling, and M. E. Moses, "Pkcθ regulates T cell motility via ezrin-radixin-moesin localization to the uropod," *PLOS ONE*, vol. 8, no. 11, p. e78940, 2013.

[J14] T. P. Flanagan*, N. M. Pinter-Wollman, M. E. Moses, and D. M. Gordon, "Fast and flexible: Argentine ants recruit from nearby trails," *PLOS ONE*, vol. 8, no. 8, p. e70888, 2013.

[J15] M. P. Steinkamp, K. Kanigel-Winner*, S. Davies, C. Y. Muller, Y. Zhang, A. Shirinifard, M. Moses, Y. Jiang, and B. S. Wilson, "Ovarian tumor attachment, invasion, and vascularization reflect unique microenvironments in the peritoneum: insights from xenograft and mathematical models," *Frontiers in oncology*, vol. 3, p. 97, 2013.

[J16] M. Steinkamp, K. Kanigal-Winner*, M. Moses, S. Davies, C. Muller, R. Hoffman, Y. Jiang, and B. Wilson, "Tissue microenvironments within the peritoneum affect tumor morphology, attachment and invasion in a mouse model of ovarian cancer relapse," *Gynecologic Oncology*, vol. 125, p. S108, 2012.

[J17] N. Holtschulte* and M. Moses, "Diversity and resistance in a model network with adaptive software," *Security Informatics*, vol. 1, no. 1, p. 19, 2012.

[J18] T. P. Flanagan*, K. Letendre*, W. R. Burnside, G. M. Fricke*, and M. E. Moses, "Quantifying the effect of colony size and food distribution on harvester ant foraging," *PLOS ONE*, vol. 7, no. 7, p. e39427, 2012.

[J19] W. Zuo, M. E. Moses, G. B. West, C. Hou, and J. H. Brown, "A general model for effects of temperature on ectotherm ontogenetic growth and development," *Proceedings of the Royal Society of London B: Biological Sciences*, vol. 279, no. 1734, pp. 1840–1846, 2012.

[J20] W. R. Burnside, J. H. Brown, O. Burger, M. J. Hamilton, M. Moses, and L. Bettencourt, "Human macroecology: linking pattern and process in big-picture human ecology," *Biological Reviews*, vol. 87, no. 1, pp. 194–208, 2012.

[J21] M. Moses and S. Banerjee*, "Biologically inspired design principles for scalable, robust, adaptive, decentralized search and automated response (radar)," in *Artificial Life (ALIFE), 2011 IEEE Symposium on*, pp. 30–37, IEEE, 2011.

[J22] S. Banerjee* and M. Moses, "Scale invariance of immune system response rates and times: perspectives on immune system architecture and implications for artificial immune systems," *Swarm Intelligence*, vol. 4, no. 4, pp. 301–318, 2010.

[J23]   M. J. Hamilton, O. Burger, J. P. DeLong, R. S. Walker, M. E. Moses, and J. H. Brown, "Population stability, cooperation, and the invasibility of the human species," *Proceedings of the National Academy of Sciences*, vol. 106, no. 30, pp. 12255–12260, 2009.

[J24]   J. P. DeLong, J. G. Okie, M. E. Moses, R. M. Sibly, and J. H. Brown, "Shifts in metabolic scaling, production, and efficiency across major evolutionary transitions of life," *Proceedings of the National Academy of Sciences*, vol. 107, no. 29, pp. 12941–12945, 2010.

[J25]   J. R. Banavar, M. E. Moses, J. H. Brown, J. Damuth, A. Rinaldo, R. M. Sibly, and A. Maritan, "A general basis for quarter-power scaling in animals," *Proceedings of the National Academy of Sciences*, vol. 107, no. 36, pp. 15816–15820, 2010.

[J26]   H. Samaniego* and M. E. Moses, "Cities as organisms: Allometric scaling of urban road networks," *Journal of Transport and Land use*, vol. 1, no. 1, 2008.

[J27]   C. Hou, W. Zuo, M. E. Moses, W. H. Woodruff, J. H. Brown, and G. B. West, "Energy uptake and allocation during ontogeny," *Science*, vol. 322, no. 5902, pp. 736–739, 2008.

[J28]   M. E. Moses, C. Hou, W. H. Woodruff, G. B. West, J. C. Nekola, W. Zuo, and J. H. Brown, "Revisiting a model of ontogenetic growth: estimating model parameters from theory and data," *The American Naturalist*, vol. 171, no. 5, pp. 632–645, 2008.

[J29]   M. E. Moses, S. Forrest, A. L. Davis, M. A. Lodder, and J. H. Brown, "Scaling theory for information networks," *Journal of The Royal Society Interface*, vol. 5, no. 29, pp. 1469–1480, 2008.

[J30]   E. L. Charnov, R. Warne, and M. Moses, "Lifetime reproductive effort," *The American Naturalist*, vol. 170, no. 6, pp. E129–E142, 2007.

[J31]   J. M. Cable, B. J. Enquist, and M. E. Moses, "The allometry of host-pathogen interactions," *PLOS ONE*, vol. 2, no. 11, p. e1130, 2007.

[J32]   E. H. Decker, A. J. Kerkhoff, and M. E. Moses, "Global patterns of city size distributions and their fundamental drivers," *PLOS ONE*, vol. 2, no. 9, p. e934, 2007.

[J33]   M. E. Moses and J. H. Brown, "Allometry of human fertility and energy use," *Ecology Letters*, vol. 6, no. 4, pp. 295–300, 2003.

Peer-Reviewed Conference Publications

[C1]   W. Just* and M. Moses, "Flexibility through autonomous decision-making in robot swarms," in *Proceedings of the 2017 IEEE Symposium Series on Computational Intelligence (SSCI).*, pp. 1–8, 2017.

[C2]   J. Ericksen*, M. Moses, and S. Forrest, "Automatically evolving a general controller for robot swarms," in *Proceedings of the 2017 IEEE Symposium Series on Computational Intelligence (SSCI)*, pp. 2255–2262, 2017.

[C3]   V. Svihla, M. E. Moses, W. Lim, T. B. Peele-Eady, I. A. Lee, E. E. Esterly, and P. Prescott, "Designing for assets of diverse students enrolled in a freshman-level computer science for all course," in *2017 ASEE Annual Conference & Exposition*, (Columbus, Ohio), ASEE Conferences, June 2017. https://peer.asee.org/28127.

[C4]   Q. Lu*, J. P. Hecker*, and M. E. Moses, "The MPFA: A multiple-place foraging algorithm for biologically-inspired robot swarms," in *Intelligent Robots and Systems (IROS), 2016 IEEE/RSJ International Conference on*, pp. 3815–3821, IEEE, 2016.

[C5]   G. M. Fricke*, J. P. Hecker*, A. D. Griego*, L. T. Tran*, and M. E. Moses, "A distributed deterministic spiral search algorithm for swarms," in *Intelligent Robots and Systems (IROS), 2016 IEEE/RSJ International Conference on*, pp. 4430–4436, IEEE, 2016.

[C6]   J. P. Hecker*, J. C. Carmichael, and M. E. Moses, "Exploiting clusters for complete resource collection in biologically-inspired robot swarms," in *Intelligent Robots and Systems (IROS), 2015 IEEE/RSJ International Conference on*, pp. 434–440, IEEE, 2015.

[C7]   D. Levin, J. P. Hecker*, M. E. Moses, S. Forrest, G. M. Fricke*, S. R. Black, J. L. Cannon, F. Asperti-Boursin*, K. Stolleis, B. Swenson*, *et al.*, "Volatility and spatial distribution of resources determine ant foraging strategies," in *Proceedings of the European Conference on Artificial Life*, pp. 256–263, 2015.

[C8]   G. M. Fricke*, S. R. Black, J. P. Hecker*, J. L. Cannon, and M. E. Moses, "Distinguishing adaptive search from random search in robots and T cells," in *Proceedings of the 2015 Annual Conference on Genetic and Evolutionary Computation*, pp. 105–112, ACM, 2015.

[C9]   G. M. Fricke*, F. Asperti-Boursin*, J. P. Hecker*, J. L. Cannon, and M. E. Moses, "From microbiology to microcontrollers: Robot search patterns inspired by T cell movement.," in *ECAL*, pp. 1009–1016, 2013.

[C10]   J. P. Hecker*, K. Stolleis, B. Swenson*, K. Letendre*, and M. E. Moses, "Evolving error tolerance in biologically-inspired iAnt robots.," in *ECAL*, pp. 1025–1032, 2013.

[C11]   M. E. Moses, K. Letendre*, J. P. Hecker*, and T. P. Flanagan*, "In vivo, in silico, in machina: ants and robots balance memory and communication to collectively exploit information," in *Proceedings of the European Conference on Complex Systems 2012*, pp. 621–628, Springer International Publishing, 2013.

[C12]   J. P. Hecker* and M. E. Moses, "An evolutionary approach for robust adaptation of robot behavior to sensor error," in *Proceedings of the 15th annual conference companion on genetic and evolutionary computation*, pp. 1437–1444, ACM, 2013.

[C13]   N. J. Holtschulte* and M. Moses, "Benchmarking cellular genetic algorithms on the bbob noiseless testbed," in *Proceedings of the 15th annual conference companion on genetic and evolutionary computation*, pp. 1201–1208, ACM, 2013.

[C14]   K. Letendre* and M. E. Moses, "Synergy in ant foraging strategies: memory and communication alone and in combination," in *Proceedings of the 15th annual conference on genetic and evolutionary computation*, pp. 41–48, ACM, 2013.

[C15]   J. P. Hecker*, K. Letendre*, K. Stolleis, D. Washington, and M. E. Moses, "Formica ex machina: Ant swarm foraging from physical to virtual and back again," in *International Conference on Swarm Intelligence*, pp. 252–259, Springer Berlin Heidelberg, 2012.

[C16]   M. Flynn* and M. Moses, "Improving peer review with ACORN: ACO algorithm for reviewers network," in *International Conference on Swarm Intelligence*, pp. 260–267, Springer Berlin Heidelberg, 2012.

[C17]   S. Banerjee*, D. Levin, M. Moses, F. Koster, and S. Forrest, "The value of inflammatory signals in adaptive immune responses," in *International Conference on Artificial Immune Systems*, pp. 1–14, Springer Berlin Heidelberg, 2011.

[C18]   T. P. Flanagan*, K. Letendre*, W. Burnside, G. M. Fricke*, and M. Moses, "How ants turn information into food," in *2011 IEEE Symposium on Artificial Life (ALIFE)*, pp. 178–185, IEEE, 2011.

[C19]   G. B. Bezerra, S. Forrest, M. Moses, A. Davis, and P. Zarkesh-Ha, "Modeling NoC traffic locality and energy consumption with Rent's communication probability distribution," in *Proceedings of the 12th ACM/IEEE International Workshop on System Level Interconnect prediction*, pp. 3–8, ACM, 2010.

[C20]   P. Zarkesh-Ha, G. B. Bezerra, S. Forrest, and M. Moses, "Hybrid network on chip (HNoC): local buses with a global mesh architecture," in *Proceedings of the 12th ACM/IEEE International Workshop on System Level Interconnect Prediction*, pp. 9–14, ACM, 2010.

[C21]   S. Banerjee* and M. Moses, "Modular RADAR: An immune system inspired search and response strategy for distributed systems," in *International Conference on Artificial Immune Systems*, pp. 116–129, Springer Berlin Heidelberg, 2010.

[C22]   T. Arora* and M. E. Moses, "Ant colony optimization for power efficient routing in manhattan and non-manhattan vlsi architectures," in *IEEE Swarm Intelligence Symposium*, pp. 137–144, IEEE, 2009.

[C23]   S. Banerjee* and M. E. Moses, "A hybrid agent based and differential equation model of body size effects on pathogen replication and immune system response," in *International Conference on Artificial Immune Systems*, pp. 14–18, Springer Berlin Heidelberg, 2009.

Book Chapters

[B1]   M. Moses, T. Flanagan*, K. Letendre*, and M. Fricke*, "Ant colonies as a model of human computation," in *Handbook of human computation*, pp. 25–37, Springer New York, 2013.

[B2]   M. E. Moses and S. Forrest, "Beyond biology," in *Metabolic Ecology: A scaling approach*, pp. 293–301, Wiley-Blackwell, 2012.

[B3]   A. Hayward, J. Gillooly, and M. Moses, "Metabolic theory of ecology," in *Encyclopedia of theoretical ecology*, no. 4, pp. 426–433, Univ of California Press, 2012.

Workshop Papers

[W1]   S. M. Ackerman*, G. M. Fricke*, J. P. Hecker*, K. M. Hamed, S. R. Fowler, A. D. Griego*, J. C. Jones*, J. J. Nichol*, K. W. Leucht, and M. E. Moses, "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), arxiv.org/abs/1805.08320, 2018.

[W2]   D. Levin, M. E. Moses, T. P. Flanagan*, S. Forrest, and P. Finley, "Negative selection based anomaly detector for multimodal health data," in *Proceedings of the 2017 IEEE Symposium Series on Computational Intelligence (SSCI). in press*, pp. 2279–2285, 2017.

[W3]   M. M. Woong Lim and V. Svihla, "How do coding experiences help build algebra skills of symbols and notations?," in *Psychology of Mathematics Education 41 Annual Conference*, 2017.

[W4]   Q. Lu*, M. E. Moses, and J. P. Hecker*, "A scalable and adaptable multiple-place foraging algorithm for ant-inspired robot swarms," Workshop on On-line decision-making in multi-robot coordination at the 2016 Robotics Science and Systems Conference, preprint published in arXiv:1612.00480.

[W5]   N. Holtschulte* and M. Moses, "Should every man be an island?," GECCO Black Box Optimization Benchmarking Workshop, 2013.

[W6]   H. Samaniego* and M. E. Moses, "Cities as organisms: allometric scaling as an optimization model to assess road networks in the usa," in *Access to Destinations II Conference, Minneapolis*, 2007.

Reviews and Commentary

[R1]   M. E. Moses, "Information technology: Slouching towards utopia," *Nature*, vol. 502, no. 7471, pp. 299–300, 2013.

[R2]   M. Moses, "Being human: Engineering: Worldwide ebb," *Nature*, vol. 457, no. 7230, pp. 660–661, 2009.

[R3]   W. Zuo, M. E. Moses, C. Hou, W. H. Woodruff, G. B. West, and J. H. Brown, "Response to comments on 'Energy uptake and allocation during ontogeny'," *Science*, vol. 325, no. 5945, pp. 1206–1206, 2009.

[R4]   V. M. Savage, E. P. White, M. E. Moses, S. M. Ernest, B. J. Enquist, and E. L. Charnov, "Comment on 'The illusion of invariant quantities in life histories'," *Science*, vol. 312, no. 5771, pp. 198b–198b, 2006.

[R5]   M. Moses and S. Forrest, "Review of the computational beauty of nature by Gary William Flake, MIT Press, Cambridge, MA, 1998.," *Artificial Intelligence*, vol. 128, no. 1-2, pp. 239–242, 2001.

Patent

[P1]   M. E. Moses, J. P. Hecker*, K. Letendre*, and K. A. Stolleis, "iAnt swarm robotic platform and evolutionary algorithms," Sept. 20 2016. US Patent 9,446,512.

Recent Invited Talks

Information and Energy Processing in Biology and Computation   **July, 2018**
Invited Presentation, Gordon Research Conference: Unifying Ecology Across Scales , U. of New England

What contributes to scale invariance in adaptive immune response?   **June, 2018**
Invited Presentation, BIRS Workshop: Quantitative Analysis of Immune Cell Migration, Oaxaca, MX

Scalable Cooperation in Immune Systems and Robots   **May, 2018**
Invited Presentation, Swarms from Biology to Robots and Back Workshop at IEEE ICRA, Brisbane

Collective Search Strategies in Immune Systems and Bio-inspired Robot Swarms   **May, 2018**
Invited Presentation, Conference on Collective Behavior, Intl. Centre for Theoretical Physics, Trieste

Swarms: Collective action without hierarchy   **September, 2017**
Keynote at the UNM Research Administrators Symposium, Albuquerque, NM

Disease Surveillance: Design Principles from Immunology   **September, 2017**
Keynote at the Evolution, Development and Complexity Satellite, Cancun, Mexico
Conference of Complex Systems 2017

Designing Scalable Swarms   **July, 2017**
Become a Swarm Robotics Hacker Overnight, Swarmathon Workshop & Hackathon, Cambridge, MA
2017 Robotics Science and Systems Conference at MIT

Scaling in Biology and Computation & Toward Infinitely Scalable Robotic Swarms   **July, 2017**
Invited presentation, Complex Systems Summer School, Santa Fe Institute, Santa Fe, NM

The Swarmathon: Swarm Robotics for Space Exploration   **May, 2017**
Talk and seminar, Symbolic Systems Program 30th Anniversary Celebration, Palo Alto, CA
Stanford University

Emergent Cooperation in Natural and Engineered Swarms   **March, 2017**
Invited seminar, Depts. of Biology and Mechanical Engineering, Gainesville, FL
University of Florida

Robots Learn from Nature's Flexible Foragers   **November, 2016**
Invited seminar, Spatio-Temporal Modelling Center, Albuquerque, NM
University of New Mexico

Incorporating Information into Ecological Theory   **September, 2016**
Invited talk, Frontiers of Ecological Theory Integration, Santa Fe, NM
Santa Fe Institute

Complex Collective Behaviors Emerge from Simple Algorithms   **July, 2016**
Keynote, Biological Distributed Algorithms (BDA) Workshop, Chicago, IL
ACM Symposium on Principles of Distributed Computing (PODC)

Emergence, Cooperation & Diversity: Evolution of Natural & Engineered Swarms   **September, 2016**
Keynote, ACM Richard Tapia Celebration of Diversity in Computing, Austin,TX

Emergence, Cooperation, & Diversity: Evolution of Natural & Engineered Swarms   **June, 2016**
Invited Seminar, HHMI Summer Research Program, Claremont, CA
Harvey Mudd College

The Evolution of Error-Tolerant, Flexible, and Scalable Ant-Inspired Robot Swarms   **March, 2016**
Invited Seminar, Department of Computer and Software Engineering, Montreal, Quebec Canada
Polytechnique Montreal

Black Women in STEM: Perspective from a US Research University   **October, 2015**
Invited Panelist, Women in STEM Conference, Johannesburg, South Africa
US Delegation to the Howard University Republic of South Africa Project

Ant-like Swarmies and Other Robots Inspired by Nature   **August, 2015**
Invited Talk, Kennedy Engineering Academy, NASA Kennedy Space Center, Cape Canaveral, FL