

Catherine Schuman

Curriculum Vitae

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Education

- 2015 **Doctor of Philosophy, Computer Science**, *University of Tennessee*, Advisor: Dr. J. Douglas Birdwell, Concentration: Machine Learning, Funding: National Science Foundation Graduate Research Fellowship.
Dissertation Research: Neuroscience-Inspired Dynamic Architectures, Dissertation Defense: November 2014, Graduation date: May 2015, GPA: 4.0.
- 2010 **Bachelor of Science, Computer Science and Mathematics**, *University of Tennessee*, Advisor: Dr. James S. Plank.
University Honors Program, Mathematics Honors Program, Summa Cum Laude, GPA: 4.0

Research Experience

- Aug. 2015 - present **Liane B. Russell Early Career Fellow**, *Computational Data Analytics Group*, Oak Ridge National Laboratory, Supervisor: Tom Potok.
Main responsibilities:
 - Explore neuromorphic computing architectures and algorithms.
 - Develop evolutionary optimization software for HPC platforms.
 - Serve as neuromorphic computing point of contact.
- Aug. 2010 - May 2015 **PhD Candidate**, *Department of Electrical Engineering and Computer Science*, University of Tennessee, Advisor: Dr. J. Douglas Birdwell.
Main responsibilities:
 - Develop a novel neuroscience-inspired dynamic architecture.
 - Develop and implement a design method based on evolutionary optimization.
 - Collaborate with a team of electrical engineers and computer scientists.
 - Mentor a team of graduate and undergraduate students.
- Jan. - May 2011 **Graduate Research Assistant**, *Department of Electrical Engineering and Computer Science*, University of Tennessee, Advisor: Dr. Michael Langston.
Main responsibilities:
 - Researched novel applications of fast graph coloring heuristics.
 - Participated in a reviewing committee of conference and journal manuscripts.
- Aug. - Dec. 2010 **Graduate Research Assistant**, *Laboratory for Information Technologies*, University of Tennessee, Advisor: Dr. J. Douglas Birdwell.
Main responsibilities:
 - Exploration of data mining related techniques.
 - Software development, testing, and documentation.
- May - Aug. 2008 **Undergraduate Research Assistant**, *Department of Electrical Engineering and Computer Science*, University of Tennessee, Advisor: Dr. James S. Plank.
- May - July 2009 Main responsibilities:
 - Senior thesis topic: An Exploration of Optimization Algorithms and Heuristics for the Creation of Encoding and Decoding Schedules in Erasure Coding.
- May - July 2010
 - Developed software for erasure code scheduling heuristics.
 - Worked with PHP, Javascript, and a SQL database in developing a Facebook application.
 - Conducted a performance comparison of open source erasure coding libraries.
 - Co-author on two papers.

Skills

- Expertise Evolutionary optimization, neural networks, neuromorphic computing.
Proficient C, C++, PHP, Python.
Familiar Java, Linux, MacOS, Windows, Matlab, HTML, CSS, JavaScript, SQL.

Publications

- 2017 **Catherine D. Schuman**, Raphael Pooser, Tiffany Mintz, Md Musabbir Adnan, Garrett S. Rose, Bon Woong Ku, and Sung Kyu Lim. "Simulating and Estimating the Behavior of a Neuromorphic Co-Processor." *International Workshop on Post-Moore's Era Supercomputing (PMES)*, November 2017. Accepted.
- 2017 James S. Plank, Garrett S. Rose, Mark E. Dean, **Catherine D. Schuman**, and Nathaniel C. Cady. "A Unified Hardware/Software Co-Design Framework for Neuromorphic Computing Devices and Applications." *IEEE International Conference on Rebooting Computing (ICRC 2017)*, November 2017. Accepted.
- 2017 J. Parker Mitchell, Grant Bruer, Mark E. Dean, James S. Plank, Garrett S. Rose, and **Catherine D. Schuman**. "NeoN: Neuromorphic Control for Autonomous Robotic Navigation." *2017 IEEE 5th International Symposium on Robotics and Intelligent Sensors*, October 2017. Accepted.
- 2017 **Catherine D. Schuman**, James S. Plank, Garrett S. Rose, Gangotree Chakma, Austin Wyer, Grant Bruer, and Nouamane Laanait. "A Programming Framework for Neuromorphic Systems with Emerging Technologies." *4th ACM International Conference on Nanoscale Computing and Communication*, September 2017. Accepted.
- 2017 **Catherine D. Schuman**. "The Effect of Biologically-Inspired Mechanisms in Spiking Neural Networks for Neuromorphic Implementation." *International Joint Conference on Neural Networks 2017*, May 2017
- 2017 Aleksander Klibisz, Grant Bruer, James S. Plank, and **Catherine D. Schuman**. "Structure-based Fitness Prediction for the Variable-structure DANNA Neuromorphic Architecture." *International Joint Conference on Neural Networks 2017*, May 2017.
- 2017 James S. Plank, Garrett S. Rose, Mark E. Dean, and **Catherine D. Schuman**. "A CAD System for Exploring Neuromorphic Computing with Emerging Technologies." *Government Microcircuit Applications and Critical Technology Conference 2017*, March 2017.
- 2016 **Catherine D. Schuman**, Adam Disney, Susheela Singh, Grant Bruer, J. Parker Mitchell, Aleksander Klibisz, and James S. Plank. "Parallel Evolutionary Optimization for Neuromorphic Network Training," *Machine Learning in High Performance Computing Environments Workshop, Supercomputing 2016*, November 2016.
- 2016 Thomas Potok, **Catherine Schuman**, Federico Spedalieri, Garrett Rose, Jeremy Liu, Ke-Thia Yao, Gangotree Chakma, Steven Young and Robert Patton. "A Study of Complex Deep Learning Networks on High Performance, Neuromorphic, and Quantum Computers," *Machine Learning in High Performance Computing Environments Workshop, Supercomputing 2016*, November 2016.
- 2016 **Catherine D. Schuman**, J. Douglas Birdwell, Mark E. Dean, James S. Plank and Garrett S. Rose. "Neuromorphic Computing: A Post-Moore's Law Complementary Architecture." *International Workshop on Post-Moore's Era Supercomputing (PMES)*, November 2016.
- 2016 Adam Disney, John Reynolds, **Catherine D. Schuman**, Aleksander Klibisz, Aaron Young, and James S. Plank. "DANNA: A Neuromorphic Software Ecosystem." *Biologically-Inspired Cognitive Architectures 2016*.
- 2016 **Catherine D. Schuman**, James S. Plank, Adam Disney, and John Reynolds. "An Evolutionary Optimization Framework for Neural Networks and Neuromorphic Architectures." *International Joint Conference on Neural Networks 2016*.
- 2016 Mark E. Dean, Jason Chan, Christopher Daffron, Adam Disney, John Reynolds, Garrett S. Rose, James S. Plank, J.Douglas Birdwell, and **Catherine D. Schuman**. "An Application Development Platform for Neuromorphic Computing." *International Joint Conference on Neural Networks 2016*.
- 2016 Christopher Daffron, Jason Chan, Adam Disney, Luke Bechtel, Ryan Wagner, Mark E. Dean, Garrett S. Rose, James S. Plank, J.Douglas Birdwell, and **Catherine D. Schuman**. "Extensions and Enhancements for the DANNA Neuromorphic Architecture." *IEEE SoutheastCon 2016*.
- 2015 **Catherine D. Schuman**, Adam Disney, and John Reynolds. "Dynamic Adaptive Neural Network Arrays: A Neuromorphic Architecture," *Machine Learning in High Performance Computing Environments Workshop, Supercomputing 2015*, November 2015.
- 2014 Margaret Drouhard, **Catherine D. Schuman**, J. Douglas Birdwell, and Mark E. Dean. "Visual analytics for neuroscience-inspired dynamic architectures." *Foundations of Computational Intelligence (FOCI), 2014 IEEE Symposium on.* IEEE, 2014.

- 2014 **Catherine D. Schuman**, J. Douglas Birdwell, and Mark E. Dean. "Spatiotemporal Classification using Neuroscience-Inspired Dynamic Architectures," *Procedia Computer Science*, Volume 41, 2014.
- 2014 Mark E. Dean, **Catherine D. Schuman**, and J. Douglas Birdwell. "Dynamic Adaptive Neural Network Array." *Unconventional Computation and Natural Computation*, 2014.
- 2014 **Catherine D. Schuman**, J. Douglas Birdwell, Mark E. Dean. "Neuroscience-Inspired Dynamic Architectures," *2014 Annual Biomedical Science and Engineering Center Conference (BSEC)*, Oak Ridge National Laboratory, 2014.
- 2013 **Catherine D. Schuman** and J. Douglas Birdwell, "Dynamic Artificial Neural Networks with Affective Systems," *PLOS ONE*, Volume 8 (11), 2013.
- 2013 **Catherine D. Schuman** and J. Douglas Birdwell, "Variable-Structure Dynamic Artificial Neural Networks," *Biologically Inspired Cognitive Architectures*, Volume 6, 2013.
- 2012 James S. Plank, **Catherine D. Schuman**, and B. Devin Robison, "Heuristics for Optimizing Matrix-Based Erasure Codes for Fault-Tolerant Storage Systems," *DSN-2012: The International Conference on Dependable Systems and Networks*, Boston, MA, 2012.
- 2011 **Catherine D. Schuman**, "An Exploration of Optimization Algorithms and Heuristics for the Creation of Encoding and Decoding Schedules in Erasure Coding," *Pursuit - The Journal of Undergraduate Research at the University of Tennessee*, 3 (1), 2011.
- 2009 James S. Plank, Jianqiang Luo, **Catherine D. Schuman**, Lihao Xu and Zooko Wilcox-O'Hearn, "A Performance Evaluation and Examination of Open-Source Erasure Coding Libraries For Storage," *FAST-2009: 7th Usenix Conference on File and Storage Technologies*, San Francisco, CA, 2009.

Presentations

- 2017 "High Performance Computing for Spiking Neuromorphic Network Training." Poster presentation. Women in HPC Workshop, Supercomputing 2017. November 2017.
- 2017 "Evolutionary Optimization Training for Neuromorphic Systems for Scientific Applications." Poster presentation. International Conference on Rebooting Computing. November 2017.
- 2017 "The Future of Computing Beyond Moore's Law: What's Next for Software Engineering." Presentation. Grace Hopper Celebration of Women in Computing. October 2017.
- 2017 "DANNA: A Comprehensive Neuromorphic System." Poster presentation. Grace Hopper Celebration of Women in Computing. October 2017.
- 2017 "Neuromorphic Computing: Past, Present, and Future." Keynote presentation. Neuromorphic Computing Symposium, Knoxville, Tennessee. July 2017.
- 2017 "Programming Neuromorphic Computers." Invited presentation, Data Science in High Energy Physics, Batavia, Illinois. May 2017.
- 2017 "The Effect of Biologically-Inspired Mechanisms in Spiking Neural Networks for Neuromorphic Implementation." Poster presentation, Neuro-Inspired Computational Elements Workshop, Almaden, California. March 2017.
- 2016 "Research Challenges in Neuromorphic Computing: A Computer Science Perspective." Invited Speaker, Workshop on Hardware and Algorithms for Learning On-a-chip, International Conference On Computer Aided Design, Austin, Texas, November 2016.
- 2016 "Neuromorphic Computing: Introduction, Motivation, and Research Challenges." Presentation, Grace Hopper Celebration of Women in Computing, Houston, Texas, October 2016.
- 2016 "The Importance of Evolution for Learning in Neuromorphic Systems." Presentation, Workshop on Neuromorphic Computing and Algorithms, Web-intelligence and Brain Informatics and Health Conference, Omaha, Nebraska. October 2016.
- 2016 "Neuromorphic Computing from the Computer Science Perspective." Invited Speaker, IEEE Computer Society Annual Symposium on VLSI, Pittsburgh, Pennsylvania. July 2016.
- 2016 "Roadmap for Neuromorphic Computing: A Computer Science Perspective." Invited Keynote Speaker, Neuromorphic Computing: Architectures, Models, and Applications Workshop, Oak Ridge, Tennessee. June 2016.
- 2016 "Evolutionary Optimization: A Training Method for Neuromorphic Systems." Presentation, Neuro-Inspired Computational Elements Workshop, Berkeley, California. March 2016.

- 2015 "Neuroscience-Inspired Dynamic Architectures." Presentation, Grace Hopper Celebration 2015, Houston, Texas. October 2015.
- 2015 "Neuroscience-Inspired Dynamic Architectures." Poster Presentation, Smoky Mountain Conference 2015, Gatlinburg, Tennessee. September 2015.
- 2015 "A Programmable Array of Neuromorphic Elements." Invited Speaker, Neuro-Inspired Computational Elements Workshop, Albuquerque, New Mexico. February 2015.
- 2014 "Neuroscience-Inspired Dynamic Architectures." Doctoral Consortium, IEEE Symposium Series on Computational Intelligence, Orlando, Florida. December 2014.
- 2014 "Neuroscience-Inspired Dynamic Architectures." Poster Presentation, Grace Hopper Celebration 2014, Phoenix, Arizona. October 2014.
- 2013 "Variable-Structure Dynamic Neural Networks with Affective Systems." Southeast Women in Computing Conference 2013, Lake Guntersville, Alabama. November 2013.

Patents

Birdwell, J. Douglas, Mark E. Dean, Margaret Drouhard, and **Catherine Schuman**, Method and Apparatus for Constructing a Neuroscience-Inspired Artificial Neural Network with Visualization of Neural Pathways, U.S. Patent 9,753,959, filed October 14, 2014.

Patent Applications

Birdwell, J. Douglas and **Catherine Schuman**, Method and Apparatus for Constructing a Neuroscience-Inspired Artificial Neural Network, U. S. Patent Application 14/513,280, filed October 14, 2014.

Birdwell, J. Douglas, Mark E. Dean, and **Catherine Schuman**, Method and Apparatus for Constructing a Dynamic Adaptive Neural Network Array (DANNA), U. S. Patent Application 14/513,297, filed October 14, 2014.

Birdwell, J. Douglas, Mark E. Dean, and **Catherine Schuman**, Method and Apparatus for Providing Random Selection and Long-Term Potentiation and Depression in an Artificial Network, U. S. Patent Application 14/513,334, filed October 14, 2014.

Birdwell, J. Douglas, Mark E. Dean, and **Catherine Schuman**, Method and Apparatus for Constructing, Using and Reusing Components and Structures of an Artificial Neural Network, U. S. Patent Application 14/513,388, filed October 14, 2014.

Birdwell, J. Douglas, Mark E. Dean, and **Catherine Schuman**, Method and Apparatus for Providing Real-Time Monitoring of an Artificial Neural Network, U.S. Patent Application 14/513,447, filed October 14, 2014.

Teaching Experience

Sep. 2016 - present **Joint Faculty Assistant Professor**, *Department of Electrical Engineering and Computer Science*, University of Tennessee.

Main Responsibilities:

- o Neuromorphic Computing Research Group.
- o Mentoring graduate and undergraduate students.

Sep. 2015 - Sep. 2016 **Adjunct Assistant Professor**, *Department of Electrical Engineering and Computer Science*, University of Tennessee.

Main Responsibilities:

- o Neuromorphic Computing Research Group.
- o Mentoring senior design teams.
- o Mentoring graduate and undergraduate students.

Aug. 2010 - May 2015 **Graduate Teaching Assistant**, *Department of Electrical Engineering and Computer Science*, University of Tennessee, Advisor: Dr. James S. Plank.

Main responsibilities:

- o CS 302: Data Structures and Algorithms 2 (Fall 2010, 2011, 2012, 2013, 2014).
- o CS 360: Systems Programming (Spring 2011, 2012, 2013, 2014, 2015).
- o Conduct labs for undergraduate students.
- o Mentor other teaching assistants.

- May - Aug. **Lecturer**, *Department of Electrical Engineering and Computer Science*, University of Tennessee,
2011 Mentor: Dr. Harry Richards.
Main responsibilities:
◦ CS 594: Computer System Fundamentals (Summer 2011).
◦ Developed and taught an introductory computer science course to graduate students in other STEM disciplines in order to promote interdisciplinary research.
◦ Funded by SCALE-IT, an NSF IGERT program.

Mentor Experience

- 2017 Mentor to three ORNL summer interns, a graduate student in computer science from the University of Tennessee, an undergraduate student in computer science from Dartmouth College and an undergraduate student in computer engineering from University of Tennessee.
- 2016 Mentor to two ORNL summer interns, a graduate student in statistics from North Carolina State University and an undergraduate student in computer science from University of Tennessee.
- 2015-2016 Mentor to a senior design group of seven students working on a TrueNorth neuromorphic computing application.
- 2014 Mentor to a senior design group of seven students working on a neuromorphic computing application.
- 2013-present Co-founded Systems: Women in EECS @ UTK, whose mission is to recruit, mentor, and retain women in Department of Electrical Engineering and Computer Science department at University of Tennessee. Co-founded and chaired the mentorship program. Mentor to board of Systems.
- 2011-2015 Graduate teaching assistant mentor to Dr. Plank's teaching assistants.
- 2009-present Departmental mentor to undergraduate and graduate students in EECS at University of Tennessee. Advised students on courses, internships, scholarships, fellowships, and graduate school options.
- 2008-2010 STARS Alliance mentor, funded through the National Science Foundation. The goal of the STARS Alliance program is to mentor students in underrepresented groups in computing.

Honors

- 2015 **Outstanding Computer Science Graduate Teaching Assistant, Department of Electrical Engineering and Computer Science, University of Tennessee**
Excellence in Research, Department of Electrical Engineering and Computer Science, University of Tennessee
- 2014 **Excellence in Research, Department of Electrical Engineering and Computer Science, University of Tennessee**
- 2013 2013 Southeastern Women in Computing Scholarship Recipient
2013 Grace Hopper Celebration of Women in Computing National Science Foundation Scholarship Recipient
- 2012 **National Science Foundation Graduate Research Fellow**
Department of Energy Office of Science Graduate Fellowship Finalist
- 2011 Outstanding Graduate Teaching Assistant in Computer Science, University of Tennessee
- 2010 Bodenheimer Fellow, Department of Electrical Engineering and Computer Science, University of Tennessee
Outstanding Graduate in Computer Science, University of Tennessee
Top Graduate in Natural Sciences, University of Tennessee
- 2009 Outstanding Senior in Computer Science, University of Tennessee
Phi Beta Kappa
- 2008 Outstanding Junior in Computer Science, University of Tennessee
Phi Kappa Phi's Outstanding Sophomore in the College of Arts and Sciences, University of Tennessee
- 2007 Outstanding Sophomore in Computer Science, University of Tennessee

Activities

- 2017-present **ACM Future of Computing Academy Member**. Chair of the Educational Outreach Working Group.

- 2017 **Neuromorphic Computing: Architectures, Models, and Applications Symposium Co-Organizer.** July 17-19, 2017, Knoxville, Tennessee
- 2017 **Grace Hopper Celebration of Women in Computing AI Track Committee Co-Chair.**
- 2016 **Neuromorphic Computing: Architectures, Models, and Applications Workshop Co-Organizer.** June 29-July 1, 2016, Oak Ridge, Tennessee
- 2016 **Grace Hopper Celebration of Women in Computing AI Track Committee Co-Chair.**
- 2015-present **ORNL Women in Computing.** Co-chair for FY17.
- 2014-2015 **University of Tennessee Technology Advisory Board.** Graduate Student Representative.
- 2014-2015 **University of Tennessee Graduate Student Senate.** Representative for the Department of Electrical Engineering and Computer Science. Committee for Equity and Diversity member.
- 2013-present **Systers: Women in EECS @ UTK.** Founding Member. Vice President (2013-2014). Co-chair of Mentorship Committee (2013-2014). Mentorship committee member (2014-2015).
- 2013-present **Institute of Electrical and Electronics Engineers (IEEE).**
- 2012-2015 **NeuroNET: University of Tennessee's Interdisciplinary Neuroscience Group.** Graduate student committee member. Spring speaker series committee member.
- 2008-present **Association of Computing Machinery (ACM).** Served as secretary (University of Tennessee chapter) 2009 - 2010.