

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, 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. 2018 - present **Research Scientist**, *Computational Data Analytics Group*, Oak Ridge National Laboratory, Supervisors: Tom Potok and Robert Patton.
Main responsibilities:
 - Explore neuromorphic computing architectures and algorithms.
 - Develop evolutionary optimization software for HPC platforms.
 - Serve as neuromorphic computing point of contact.
- Aug. 2015 - Aug. 2018 **Liane B. Russell Early Career Fellow**, *Computational Data Analytics Group*, Oak Ridge National Laboratory, Supervisors: Tom Potok and Robert Patton.
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	Neuromorphic computing, neural networks, evolutionary optimization.
Proficient	C, C++, Python, PHP.
Familiar	Java, Linux, MacOS, Windows, Matlab, HTML, CSS, JavaScript, SQL.

Publications

- 2019 **Catherine D. Schuman**, James S. Plank, Grant Bruer, and Jeremy Anatharaj. "Non-Traditional Input Encoding Schemes for Spiking Neuromorphic Systems." *International Joint Conference on Neural Networks 2019*. IEEE, 2019.
- 2019 John J.M. Reynolds, James S. Plank, **Catherine D. Schuman**, "Intelligent Reservoir Generation for Liquid State Machines using Evolutionary Optimization." *International Joint Conference on Neural Networks 2019*. IEEE, 2019.
- 2019 **Catherine D. Schuman**, James S. Plank, Robert M. Patton, and Thomas E. Potok. "Island model for parallel evolutionary optimization of spiking neuromorphic computing." *Proceedings of the Genetic and Evolutionary Computation Conference Companion*. ACM, 2019.
- 2019 **Catherine D. Schuman**, Kathleen Hamilton, Tiffany Mintz, Md MusabbirAdnan, Bon Woong Ku, Sung-Kyu Lim, and Garrett S. Rose. "Shortest Path and Neighborhood Subgraph Extraction on a Spiking Memristive Neuromorphic Implementation." *Neuro-Inspired Computational Elements Workshop (NICE '19)*, ACM, 2019.
- 2019 James S. Plank, Charles Rizzo, Kirolos Shahat, Grant Bruer, Trevor Dixon, Michael Goin, Grace Zhao, Jeremy Anantharaj, **Catherine D. Schuman**, Mark E. Dean, Garrett S. Rose, Nathaniel C. Cady and Joseph Van Nostrand. "The TENNLab Suite of LIDAR-Based Control Applications for Recurrent, Spiking, Neuromorphic Systems." *44th Annual GOMACTech Conference*, 2019.
- 2019 Linghao Song, Fan Chen, Steven R. Young, **Catherine D. Schuman**, Gabriel Perdue and Thomas E. Potok. "Deep Learning for Vertex Reconstruction of Neutrino-Nucleus Interaction Events with Combined Energy and Time Data." *ICASSP 2019-2019 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. IEEE, 2019.
- 2019 Prasanna Date, Robert Patton, **Catherine D. Schuman**, and Thomas E. Potok. "Efficiently Embedding QUBO Problems on Adiabatic Quantum Computers." *Quantum Information Processing: 18 (4)*, Springer, 2019.
- 2019 Prasanna Date, **Catherine D. Schuman**, Robert Patton, and Thomas E. Potok. "A Classical-Quantum Hybrid Approach for Unsupervised Probabilistic Machine Learning." *Future of Information and Communication Conference*. Springer, 2019.
- 2018 James S. Plank, **Catherine D. Schuman**, Grant Bruer, Mark E. Dean, and Garrett S. Rose. "The TENNLab Exploratory Neuromorphic Computing Framework." *IEEE Letters of the Computer Society*, IEEE, December 2018.
- 2018 Robert M. Patton, J. Travis Johnston, Steven R. Young, **Catherine D. Schuman**, Don D. March, Thomas E. Potok, Derek C. Rose, Seung-Hwan Lim, Thomas P. Karnowski, Maxim A. Ziatdinov, Sergei V. Kalinin. "167-PFlops deep learning for electron microscopy: from learning physics to atomic manipulation." *Proceedings of the International Conference for High Performance Computing, Networking, Storage, and Analysis*, IEEE, November 2018.
- 2018 Sonia Buckley, Adam N. McCaughan, Jeff Chiles, Richard P. Mirin, Sae Woo Nam, Jeffrey M. Shainline, Grant Bruer, James S. Plank, and **Catherine D. Schuman**. "Design of superconducting optoelectronic networks for neuromorphic computing." *2018 IEEE International Conference on Rebooting Computing (ICRC)*, IEEE, 2018.
- 2018 Md Sakib Hasan, **Catherine D. Schuman**, Joseph S. Najem, Ryan Weiss, Nicholas D. Skuda, Alex Belianinov, C. Patrick Collier, Stephen A. Sarles, and Garrett S. Rose. "Biomimetic, Soft-Material Synapse for Neuromorphic Computing: from Device to Network." *2018 IEEE 13th Dallas Circuits and Systems Conference (DCAS)*, IEEE, 2018.
- 2018 Md Musabbir Adnan, Sagarvarma Sayyaparaju, Garrett S. Rose, **Catherine D. Schuman**, Bon Woong Ku, and Sung-Kyu Lim. "A Twin Memristor Synapse for Spike Timing Dependent Learning in Neuromorphic Systems." *2018 31st IEEE International System-on-Chip Conference (SOCC)*, IEEE, 2018.

- 2018 Md Sakib Hasan, Joseph S. Najem, Ryan Weiss, **Catherine D. Schuman**, Alex Belianinov, C. Patrick Collier, Stephen A. Sarles, and Garrett S. Rose. "Response of a Memristive Biomembrane and Demonstration of Potential Use in Online Learning." *Proceedings of 2018 IEEE 13th Nanotechnology Materials and Devices Conference (NMDC)*, IEEE, 2018.
- 2018 Ryan Weiss, Joseph S. Najem, Md Sakib Hasan, **Catherine D. Schuman**, Alex Belianinov, C. Patrick Collier, Stephen A. Sarles, and Garrett S. Rose. "A Soft-Matter Biomolecular Memristor Synapse for Neuromorphic Systems." *Biomedical Circuits and Systems Conference*, IEEE, October 2018.
- 2018 **Catherine D. Schuman**, Grant Bruer, Aaron Young, Mark Dean, and James S. Plank. "Understanding Selection And Diversity For Evolution Of Spiking Recurrent Neural Networks." *International Joint Conference on Neural Networks (IJCNN)*, IEEE, July 2018.
- 2018 Aaron Young, Mark Dean, James S. Plank, Garrett S. Rose, and **Catherine D. Schuman**. "Neuromorphic Array Communications Controller to Support Large-Scale Neural Networks." *International Joint Conference on Neural Networks (IJCNN)*, IEEE, July 2018.
- 2018 Thomas E. Potok, **Catherine D. Schuman**, Steven Young, Robert Patton, Federico Spedalieri, Jeremy Liu, Ke-Thia Yao, Garrett Rose, and Gangotree Chakma. "A Study of Complex Deep Learning Networks on High-Performance, Neuromorphic, and Quantum Computers." *ACM Journal on Emerging Technologies in Computing Systems (JETC)* 14, no. 2, ACM, 2018.
- 2018 Kathleen Hamilton and **Catherine D. Schuman**. "Towards adaptive spiking label propagation." *Proceedings of the International Conference on Neuromorphic Systems*. ACM, July 2018.
- 2018 John Reynolds, James S. Plank, **Catherine D. Schuman**, Grant Bruer, Adam Disney, Mark E. Dean, and Garrett S. Rose. "A Comparison of Neuromorphic Classification Tasks." *Proceedings of the International Conference on Neuromorphic Systems*. ACM, July 2018.
- 2018 Kathleen Hamilton, **Catherine D. Schuman**, Steven R. Young, Neena Imam, and Travis Humble. "Neural Networks and Graph Algorithms with Next-Generation Processors." *2018 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*. IEEE, May 2018.
- 2018 Gangotree Chakma, Nicholas D. Skuda, **Catherine D. Schuman**, James S. Plank, Mark E. Dean, and Garrett S. Rose. "Energy and Area Efficiency in Neuromorphic Computing for Resource Constrained Devices." *28th ACM Great Lakes Symposium on VLSI (GLSVLSI)*. ACM, May 2018.
- 2018 Jeremy Liu, Federico Spedalieri, Ke-Thia Yao, Thomas E. Potok, **Catherine D. Schuman**, Steven R. Young, Robert Patton, Garrett S. Rose, and Gangotree Chakma. "Adiabatic Quantum Computation Applied to Deep Learning Networks." *Entropy*. MDPI, May 2018.
- 2018 Nicholas D. Skuda, **Catherine D. Schuman**, Gangotree Chakma, James S. Plank, and Garrett S. Rose. "High-Level Simulation for Spiking Neuromorphic Computing Systems." *Circuits and Systems (ISCAS), 2018 IEEE International Symposium on*. IEEE, May 2018.
- 2018 **Catherine D. Schuman**, Thomas E. Potok, Steven Young, Robert Patton, Gabriel Perdue, Gangotree Chakma, Austin Wyer, Garrett S. Rose. "Neuromorphic computing for temporal scientific data classification." *NCS '17: Neuromorphic Computing Symposium*, April 2018.
- 2018 Austin Wyer, Md Musabbir Adnan, Bon Woong Ku, Sung Kyu Lim, **Catherine D. Schuman**, Raphael C. Pooser, Garrett S. Rose. "Evaluating online-learning in memristive neuromorphic circuits." *NCS '17: Neuromorphic Computing Symposium*, April 2018.
- 2018 Joseph S. Najem, Graham J. Taylor, Ryan J. Weiss, Md Sakib Hasan, Garrett Rose, **Catherine D. Schuman**, Alex Belianinov, C. Patrick Collier, and Stephen A. Sarles. "Memristive Ion Channel-Doped Biomembranes as Synaptic Mimics." *ACS nano*, March 2018.
- 2017 Gangotree Chakma, Md Musabbir Adnan, Austin R. Wyer, Ryan Weiss, **Catherine D. Schuman**, and Garrett S. Rose. "Memristive Mixed-Signal Neuromorphic Systems: Energy-Efficient Learning at the Circuit-Level ." *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*, November 2017.
- 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.
- 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.

- 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.
- 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.
- 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.
- 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

- 2019 "Evolving Low Power Neuromorphic Solutions for Real World Applications." Invited keynote. IEEE Cognitive Communications for Aerospace Applications Workshop. June 2019.
- 2019 "A Benchmarking and Programming Framework for Spiking Neuromorphic Computing Systems." Invited presentation. RIKEN International Workshop on Neuromorphic Computing. March 2019.
- 2019 "A Software Framework for Spiking Neuromorphic Computing Systems." Invited presentation. SIAM Computational Sciences and Engineering. March 2019.
- 2018 "Use Cases of Neuromorphic Co-Processors in Future HPC Environments." Presentation. Women in HPC Workshop, Supercomputing, November 2018.
- 2018 "A Co-Design Framework for Neuromorphic Computing Research." Invited presentation. Cognigron Center Kick-Off Meeting. October 2018.
- 2018 "Neuromorphic Computing: When Hardware Met AI." Presentation. Grace Hopper Celebration of Women in Computing. September 2018.
- 2018 "Beyond Moore's Law and Emerging Technologies: What's Next for Computing?" Presentation. Grace Hopper Celebration of Women in Computing. September 2018.
- 2018 "The Importance of High-Level Simulation in the Co-Design of Neuromorphic Systems." Poster presentation. International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication (EIPBN). May 2018.
- 2018 "Evolutionary Optimization for Neuromorphic Systems." Presentation. CRNCH Neuromorphic Workshop. April 2018.
- 2018 "Survey of neuromorphic computing and neural networks in hardware." Invited presentation. Neuromorphic Computing Tutorial, GOMACTech. March 2018.
- 2018 "Neuromorphic Computing for Scientific Applications." Invited presentation. SIAM Parallel Processing for Scientific Computing. March 2018.
- 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, issued September 5, 2017.

Birdwell, J. Douglas and **Catherine Schuman**, Method and Apparatus for Constructing a Neuroscience-Inspired Artificial Neural Network, U. S. Patent 9,798,751, issued October 24, 2017.

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 10,019,470, issued July 10, 2018.

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 10,055,434, issued August 21, 2018.

Birdwell, J. Douglas, Mark E. Dean, and **Catherine Schuman**, Method and Apparatus for Constructing a Dynamic Adaptive Neural Network Array (DANNA), U. S. Patent 10,095,718, issued October 9, 2018.

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 10,248,675, issued April 2, 2019.

Teaching Experience

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

Main Responsibilities:

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

- Aug. 2010 - **Graduate Teaching Assistant**, *Department of Electrical Engineering and Computer Science*,
 May 2015 University of Tennessee, Advisor: Dr. James S. Plank.
- Main responsibilities:
- CS 302: Data Structures and Algorithms 2 (Fall 2010, 2011, 2012, 2013, 2014).
 - CS 360: Systems Programming (Spring 2011, 2012, 2013, 2014, 2015).
 - Conduct labs for undergraduate students.
 - 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

- 2019 Mentor or co-mentor to five ORNL summer interns, a graduate student in electrical engineering from Purdue University, a graduate student in electrical engineering from Virginia Tech, a graduate student in computer science from the University of Tennessee, an undergraduate student in computer science from the University of Tennessee, and a high school student from Oak Ridge High School. Director of the ORNL AI Summer Institute, which included eleven undergraduate or graduate students.
- 2018 Mentor or co-mentor to six ORNL summer interns, a graduate student in computer science from the University of Tennessee, a graduate student in computer science from Rensselaer Polytechnic Institute, two graduate students in computer engineering from Duke University, an undergraduate student in computer science from the University of Tennessee, and a high school student from Clinton High School.
- 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

- 2019 **Department of Energy Early Career Award**
- 2015 **Liane Russell Early Career Fellowship**, Oak Ridge National Laboratory (2015-2018)
- 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

- 2019 **International Conference on Neuromorphic Systems (ICONS) 2019 - Organizing Committee member and Program Committee Chair.**
- 2019 **Director of the ORNL AI Summer Institute.**
- 2019 **Grace Hopper Celebration of Women in Computing Hardware Track Committee Co-Founder and Co-Chair.**
- 2018 **International Conference on Neuromorphic Systems (ICONS) 2018 - Organizing Committee member and Program Committee Chair.**
- 2018 **Grace Hopper Celebration of Women in Computing AI Track Committee Co-Chair.**
- 2017-present **ACM Future of Computing Academy Member.** Chair of the Educational Outreach Working Group (June 2017-February 2018).
- 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.
- 2013-2015 **Systems: 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.