

Sarah Katherine Luca

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EDUCATION

The University of Arizona, Tucson, AZ

Doctor of Philosophy in Applied Mathematics, 3.77/4.0 GPA

Expected 2026

Master of Science in Applied Mathematics 3.77/4.0 GPA

Awarded December 2020

University of North Carolina at Asheville, Asheville, NC

Bachelor of Arts in Pure Mathematics and General Psychology, 3.86/4.0 GPA
Neuroscience Minor

Awarded May 2016

RESEARCH INTERESTS

Algorithm design for neuromorphic hardware, spiking neural networks, biologically inspired computation, machine learning/artificial intelligence, dynamical systems, group theory, category theory

RESEARCH EXPERIENCE

Sandia National Laboratories, Albuquerque, NM

Year-Round Graduate Research Intern, Department of Cognitive and Emerging Computing

Project: *A Spiking Neural Algorithm for Markov Reward Processes*

Fall 2023 – Present

Research Advisor: Dr. Srideep Musuvathy

- Developed a spiking algorithm for estimating the state-value function of a Markov reward process using composable spiking circuits for streaming binary arithmetic
- Implemented the algorithm in Lava and on the Loihi 2 neuromorphic chip

Project: *Localization through Grid-based Encodings on Digital Elevation Models*

Summer 2021 – Fall 2023

Research Advisor: Dr. Felix Wang

- Developed a metric for estimating the difference between two points in a phase-space coordinate system
- Developed a spiking algorithm that performs binary to unary conversion to be used in a neuromorphic implementation of the grid-based localization algorithm.

The University of Arizona, Tucson, AZ

Semester Research Projects, Department of Mathematics

Project: *Characterizing Spindles using Feature Extraction, PCA, and Fuzzy C-Means Clustering*

Spring 2020 – Fall 2020

Research Advisor: Dr. Jean-Marc Fellous

- Analyzed time-series data using principal component analysis and fuzzy c-means clustering
- Developed MATLAB code for the generation of artificial time-series data (spindles)

Project: *Achieving a Balanced State in Cortical Network Models*

Fall 2019

Faculty Advisor: Dr. Kevin Lin

- Researched methods of modeling self-organized balance of neural activity
- Explored integrate-and-fire and Hodgkin-Huxley neuron models
- Implemented simple integrate-and-fire model in MATLAB

Massachusetts Institute of Technology, Cambridge, MA

Summer Research Intern, MIT Summer Research Program in Biology

Project: *Invariant Representation of Images Under Change in Illumination* May 31, 2015 – August 8, 2015

Research Advisors: Dr. Georgios Evangelopoulos and Dr. Fabio Anselmi

Faculty Advisor: Dr. Tomaso Poggio

- Collaborated with advisors on developing a theoretical framework for recognition of images of faces containing varying illumination conditions
- Applied concepts from group theory, linear algebra, artificial intelligence and machine learning
- Developed MATLAB code for testing the theoretical framework

University of North Carolina Asheville, Asheville, NC

Undergraduate Researcher, Department of Psychology

Project: *Measuring the Effects of Lumosity™ on Cognition*

August 2014 – May 2016

Research Advisors: Dr. Patrick Foo and Dr. Angeldeep Kaur

- Collaborated with advisors and peers to design an experiment for testing the effects of Lumosity™ and other forms of brain training games on fluid intelligence, cognitive flexibility, and working memory
- Recruited participants, scheduled pre- and post- tests, obtained informed consent, collected data, and contacted subjects with weekly reminders during a six-week period of brain training
- Analyzed the data using ANOVA and post-hoc analyses to determine the effects of brain training

Project: *Dynamical Analysis of Postural Sway*

January 2014 – May 2014

Research Advisor: Dr. Patrick Foo

- Collaborated with faculty advisor to measure changes in balance across the lifespan from the force plate data of young, middle aged, and older participants
- Applied concepts from nonlinear dynamical systems, Brownian motion, chaos theory, and fractals
- Used Hurst's rescaled range and approximate entropy to measure the randomness of participants' force plate data
- Presented and communicated complex research ideas to an audience with a wide range of backgrounds

GRANT

Effect of Brain Training Through Lumosity™ on Flexibility in College Students, University of North Carolina Asheville Fall Grant Award, \$500, 2014.

PUBLICATIONS

- F. Wang, C. Teeter, **S. Luca**, S. Musuvathy, and B. Aimone, "Localization through Grid-based Encodings on Digital Elevation Models," *NICE '22: Proceedings of the 2022 Annual Neuro-Inspired Computational Elements Conference*, Mar. 2022.
- **S. Luca**, E. Nauert, K. Chichester, J. Buckner, P. Foo, and A. W. Kaur, "Working memory and cognitive flexibility training reveals no relationship to fluid intelligence in college students," *IMPULSE*, vol. 14, no. 1, Jan. 2017.

CONFERENCE PRESENTATIONS

- **S. Luca**, S. Musuvathy, and F. Wang, "A Spiking Neural Algorithm for Markov Reward Processes," Poster presentation at *Neuro-Inspired Computational Elements Conference*, San Diego, CA, Apr. 2024.
- **S. Luca**, P. Foo, and A. Kaur, "Cognitive Training May Improve Your Mind, but It's No Magic Bullet," Oral presentation at *Synapse*, Presbyterian College, Clinton, SC, Apr. 2016.
- J. Buckner, K. Chichester, **S. Luca**, E. Nauert, A. Schaefer, P. Foo, and A. Kaur, "Effects of Lumosity™ Brain Training on Memory, Flexibility, and Fluid Intelligence," Oral presentation at *Undergraduate Research and Community Engagement Symposium*, University of North Carolina Asheville, Asheville, NC, 2015.
- **S. Luca**, E. Nauert, K. Chichester, P. Foo, & A. Kaur, "Effects of Cognitive Training Games on Flexibility and Fluid Intelligence," Poster presented at *Big South Undergraduate Research Symposium*, Campbell University, Buies Creek, NC, 2015.
- J. Buckner, K. Chichester, **S. Luca**, E. Nauert, A. Schaefer, P. Foo, and A. Kaur, "Motivation and Attrition in Cognitive Training Programs," Poster presented at *Synapse*, Asheville, NC, 2015.
- E. Nauert, A. Allen, **S. Luca**, P. Foo, and A. Kaur, "Effect of Brain Training Through Lumosity™ on Flexibility in College Students," Poster presented at *State of North Carolina Undergraduate Research and Creativity Symposium*, North Carolina State University, Raleigh, NC, 2014.
- **S. Luca**, J. R. Wingert, and P. Foo, "Nonlinear Dynamics of Postural Stability," Poster presented at *Synapse*, University of North Carolina Asheville, Asheville, NC, 2014.

TEACHING EXPERIENCE

The University of Arizona, Tucson, AZ

Graduate Teaching Assistant

MATH 100: Math Lab

Fall 2019

- Led the lab discussion section for a class size of roughly 100+ students

MATH 107: Exploring and Understanding Data

Spring 2020

- Assisted instructor with answering questions during lecture, held office hours and graded assignments
- Presented two of the lectures during the semester

MATH 113: Elements of Calculus

Fall 2020

- Assisted instructor with answering questions during lecture, held office hours and graded assignments
- Presented two of the lectures during the semester

MATH 119A: Mathematics of Biological Systems: a calculus based approach

Spring 2021, Fall 2022

- Assisted instructor with answering questions during lecture, held office hours and graded assignments
- Led the lab section and assisted students with learning SageMath to solve partial differential equations numerically
- Designed review guides with SageMath content to help students study for exams

MATH 120R: Calculus Preparation

Fall 2021

- Prepared and gave lectures to a class size of ~30 students, wrote and graded exams and written assignments, and held office hours

Asheville Math, Asheville, NC

K-12 Mathematics Tutor

October 2013 – December 2016

- Tutored children and teens ages 5-18 in mathematics courses, answered the phone, scheduled appointments and processed payments
- Successfully applied Socratic teaching method to help students achieve better self-sufficiency and confidence in approaching problems

- Helped design “study guides” based on students’ needs to build a better foundation of mathematics skills

University of North Carolina at Asheville, Asheville, NC

Math Lab Assistant, Parson’s Math Lab

August 2012 – May 2016

- Provided peers with assistance in completing assignments and establishing an understanding of concepts in undergraduate mathematics and physics courses
- Assisted students in using mathematical tools in the lab (computer software such as Excel, Mathematica, MATLAB, etc. and calculators) and helped establish comfort with using such tools

Psychology Peer Tutor, Peer Tutoring Program

January 2014 – May 2016

- Assisted peers with studying for undergraduate psychology courses to improve understanding and increase preparedness on exams
- Helped students design research proposals and facilitated the learning of statistical methods in psychology for achieving success in research methods courses

HONORS/AWARDS/ACHIEVEMENTS

- Successfully completed a thru-hike of the 2,190-mile Appalachian Trail (March 2017 – September 2017)
- Top Graduating Mathematics Student – University of North Carolina Asheville (2016)
- University Research Scholar – University of North Carolina Asheville (2016)
- SYNAPSE Conference Travel Award – Presbyterian College (2016)

TECHNICAL SKILLS

- *Software:* Microsoft Office, MATLAB, LaTeX, Mathematica, SPSS, Lava
- *Programming Languages:* Java, Python
- *Hardware:* CPU, Linux, Mac, Loihi, SpiNNaker