

---

**Ph.D., Mathematics (Applied Topology)**

University of Oregon, Eugene, OR

*Expected June 2023*

- Dissertation: Topological, combinatorial and geometric properties of neural network functions (in progress).
- Advisor: Dev Sinha

**Bachelor's of Science, Double Major in Mathematics and Chemistry**

Walla Walla University, College Place WA *June 2015*

- Honors humanities and general studies
- WA State teaching certification

---

RESEARCH CONTRIBUTIONS

- **Algorithmic Determination of the Combinatorial Structure of the Linear Regions of ReLU Neural Networks.** Marissa Masden (2022). Submitted. Available at <https://arxiv.org/abs/2207.07696>.
- **Local and global topological complexity measures of ReLU neural network functions.** J. Elisenda Grigsby, Kathryn Lindsey and Marissa Masden (2022). Submitted. Available at <https://arxiv.org/abs/2204.06062>.
- **Alloy rupture strength prediction using machine learning and microstructure analysis.** Ram Devanathan, Osman Mamun, Mohammad Taufique, William E. Frazier, Arun Sathanur, Keerti Kappagantula, Jing Wang, Marissa Masden, Madison Wenzlick, Kelly Rose. To appear, TMS 2023 Annual Meeting & Exhibition.
- **Linear discriminant initialization for feedforward neural networks.** Marissa Masden and Dev Sinha (2019). Submitted. Available at [arxiv.org/abs/2007.12782](https://arxiv.org/abs/2007.12782).

---

RESEARCH EXPERIENCE

**University of Oregon** Eugene, OR

*2017-present*

Graduate research

Advisor: Dev Sinha

- Discovered a combinatorial description of ReLU neural networks' linear regions which encodes the face poset of the canonical polyhedral complex of a ReLU neural network by recording sign sequence information about its vertices, and proved this description holds for all but a measure-zero set of neural networks.
- Developed and optimized code in python to compute the face poset of the canonical polyhedral complex of fully-connected feedforward ReLU neural networks implemented in PyTorch, and implemented Sage scripts computing the homology groups of subcomplexes of the canonical polyhedral complex and measured topological invariants of the decision boundaries of neural networks.

**Pacific Northwest National Laboratory** Richland, WA (remote)

*Summer 2021*

NSF Math Sciences Graduate Intern (ORISE)

Ram Devanathan lab

- Proposed and implemented topological data analytic methods to improve neural network segmentation of microscope images, including training a PyTorch model with modified topological loss function.
- Compared scikit-learn and other custom ridge detection algorithms' performance for post-processing deep neural network output with classical accuracy metrics.

**Washington State University** Pullman, WA

*Summers 2013-2014*

Undergraduate Research Intern

Aurora Clark lab

- Developed and improved a C algorithm for finding polyhedral structure in molecular dynamics simulations and incorporated it into preexisting ChemNetworks software (2014)
- Created utility software in R to visualize data output and optimize parameters for the C software (2014)
- Performed literature search on the Markov Clustering algorithm, gave an expository talk on its properties, and helped the research group efficiently implement it by manipulating data structure (2013)

---

## RESEARCH EXPERIENCE (CONTINUED)

---

**Loma Linda University** Loma Linda, CA

*Summer 2013*

*Biomedical Undergraduate Research Program* Intern

Jonathan Neihdigh lab

- Investigated organic pathways for synthesizing selectively methylated amino acids for use in constructing artificially modified proteins.
- Performed and recorded possible synthetic pathways and evaluated success primarily using thin layer chromatography (TLC), high pressure liquid chromatography with UV/Vis and mass spectrometry (HPLC-UV/Vis, HPLC-MS), and nuclear magnetic resonance (NMR).

---

## TEACHING EXPERIENCE

---

**Mathematics Department**, University of Oregon, Eugene OR

*2017-present*

Instructor of Record for the following courses:

- Math 111 (College Algebra)
- Math 112 (Elementary Functions)
- Math 231 (Elements of Discrete Mathematics I)
- Math 243 (Intro. to Methods of Probability and Statistics)
- Math 251 (Calculus I)
- Math 281 (Multivariate Calculus I)

Teaching Assistant and Grader for the following courses:

- Math 243 (Intro. to Methods of Probability and Statistics)
  - Lead TA, Fall 2021
- Math 461 (Intro. to Mathematical Methods of Statistics I)
- Math 635-636 (Algebraic Topology)

**Henrietta Lacks Health and Bioscience High School**, Vancouver WA

*2015-2017*

Certificated Teacher for the following courses:

- Geometry. Developed curriculum meeting state standards and balanced needs of diverse student population.
- AP Statistics. Developed post-exam interdisciplinary project with epidemiology class introducing advanced methods for statistical analysis.

Faculty sponsor of Math Club and supervisor of after-school tutoring

**Walla Walla University**, College Place, WA

*2011-2015*

- Contract Instructor, Remedial Geometry
- Teaching Assistant, Introductory Statistics Lab
- Mathematics Tutor, Teaching Learning Center

*Fall 2013 and 2014*

*Winter 2013-2015*

*2011-2015*

---

## SELECT PRESENTATIONS

---

### Research and Invited Talks

- Topological properties of ReLU network functions, at initialization and during training. To occur, invited talk at JMM 2023 Special Session *Mathematical Methods in Machine Learning and Optimization*.
- Precise computation of cellular topology of neural network functions. To occur, invited talk at JMM 2023 Special Session *Applied Topology: Theory and Implementation*.
- Geometric Duality, Neural Networks, and Decision Boundaries. Invited talk at Cascade Topology Seminar, Portland State University, November 2022.
- Exact Combinatorial and Topological Data for ReLU Networks' Linear Regions. Northeastern University Topology Seminar, May 2022.

## SELECT PRESENTATIONS (CONTINUED)

---

- Persistent Homology for Machine Learning in Microstructure Analysis. NSF Math Sciences Graduate Internship 2021 Summer Presentations, Summer 2021.
- Neural Networks at Initialization. Boston College Math and Machine Learning Seminar (remote), Boston College, Fall 2020.

### Expository Talks and Posters

- Piecewise Linear Morse theory: An overview. Geometry-Topology Seminar, Oregon State University, Fall 2021.
- Understanding ReLU Activation Patterns through the Sign Sequence Cubical Complex. Poster at Applied Algebraic Topology Network Poster Session, Fall 2021.
- Using Persistence Signatures in Machine Learning. Geometry-Topology Seminar, Oregon State University, Spring 2020.
- Understanding Neural Networks through Geometry. 1st Midwest Graduate Student Conference: Geometry and Topology Meet Data Analysis and Machine Learning, The Ohio State University, 2019

## LEADERSHIP, SERVICE AND OUTREACH

---

**Directed Reading Program Mentor**, University of Oregon Mathematics Department AY 2021-2022

- Lead an undergraduate through a 12-week directed reading on finite-state Markov chains and stochastic processes. Selected readings and appropriate problems, designed code exercises, and met 1-2 hours weekly.
- Guided the undergraduate through preparing a 10-minute academic mathematics talk about Markov chains and steady states to their peers.

**Association for Women in Mathematics**, UO Student Chapter

- President, 2020-2021 and 2022-2023
- Secretary, AY 2019-2020
- K-12 Outreach Committee, 2018-present; co-chair 2019-2022

**American Mathematical Society**, UO Student Chapter

- Departmental Liaison (elected position), 2021-2022

**Graduate Affairs Committee**, UO Mathematics Department

- Graduate student representative (nominated position), 2018-2020
- Graduate Student Peer Mentor, 2019-2022

**Graduate Student Mathematics Teaching Seminar**, UO Mathematics Department

- Co-organizer, 2019-present

## SELECT CONFERENCES AND WORKSHOPS

---

- Joint Mathematics Meetings. Boston, Massachusetts, January 2023. *Invited Speaker at AMS Special Session on Mathematical Methods in Machine Learning and Optimization and AMS Special Session on Applied Topology: Theory and Implementation.*
- Cascade Topology Seminar. Fariborz Maseeh Department of Mathematics and Statistics, Portland State University, Portland OR, November 2022. *Invited Speaker.*
- Institute of Advanced Studies 2022 Women and Mathematics program: The Mathematics of Machine Learning. Princeton, NJ, May 2022.  
*One of 50 attendees to a program focused on interpretable and distributed machine learning.*

## SELECT CONFERENCES AND WORKSHOPS (CONTINUED)

---

- Oxford Applied Topology School. University of Oxford, Oxford, UK, March 2020.  
*Awarded travel funding. Cancelled due to COVID-19.*
- Neural Information Processing Systems (NeurIPS). Vancouver, BC, Canada, December 2019.
- FRG Workshop on Discrete Shapes. University of California, Davis, 2019.  
*Awarded travel funding.*
- The 1st Midwest Graduate Student Conference: Geometry and Topology meet Data Science and Machine Learning.  
The Ohio State University, 2019. *Speaker, awarded travel funding.*

## HONORS AND AWARDS

---

<b>NSF Research Training Grant</b> , UO Mathematics Department	Summer 2022
<b>Johnson Fellowship</b> , UO Mathematics Department	Summer 2019
<b>Dean's First Year Merit Award</b> , UO Mathematics Department	AY 2017-2018
<b>Schofield Memorial Scholarship</b> , WWU Education Department	2015
<b>Honors Program Scholarship</b> , WWU Honors General Studies Program	2015
<b>Schottlauer Math Scholarship</b> , WWU Mathematics Department	2015
<b>M&amp;I Johnstone Scholarship</b> , WWU Mathematics Department	2014-2015
<b>President's Scholarship for National Merit Scholars</b> , WWU	2010-2014
<b>C&amp;L Jones Chemistry Scholarship</b> , WWU Chemistry Department	2010-2011
<b>Boeing National Merit Scholarship</b>	2010-2011

## PROFESSIONAL AFFILIATIONS

---

**American Mathematical Society (AMS)** member 2021-present  
**Association for Women in Mathematics (AWM)** member 2019-present

## TECHNICAL SKILLS

---

### Programming Languages:

- *Proficient* in Python, C/C++, SageMath, R, L<sup>A</sup>T<sub>E</sub>X, Git
- *Light experience* in HTML/CSS/JavaScript, Ruby/Jekyll, Bash

### Select Python Skills:

- Machine Learning: PyTorch and TensorFlow/Keras
- Topological Data Analysis: Ripser, GUDHI, scikit-tda
- Network Analysis: NetworkX, igraph
- Data Analysis: scikit-learn, scikit-image, scipy, numpy, pandas
- Environment Control: Anaconda, Jupyter, venv

### Scientific Computing Experience:

- *Significant experience* scheduling jobs using SLURM workload management system
- *Light experience* performing molecular dynamics simulations using NWChem and Visual Molecular Dynamics (VMD)