SEAN GRATE

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EDUCATION

Auburn University, Auburn *August 2020 - Present*
Graduate Student (Ph.D. Program), Mathematics

University of Kentucky, Lexington *August 2016 - May 2020*
B.S. in Mathematics with minors in History and Classics, *cum laude*

RESEARCH

Statistics on Persistence Diagrams *July 2021–Present*
Topological data analysis uses algebraic and topological tools to analyze data and can be summarized through a persistence diagram. Computing persistent homology is computationally expensive, so subsampling methods are desired to get faster and accurate results. Joint with Jordan Eckert, we wish to use statistical methods directly on persistence diagrams to get a performance boost in computing persistent homology.

Using Persistent Homology to Spot Regularity *July 2021–Present*
Persistent homology computations can be summarized through a barcode diagram. If a barcode appears multiple times, it may suggest some symmetry in the data. This has been explored before in drug design. Joint with Robert Dixon and Hal Schenck, we wish to develop a method to identify these symmetries that might be present in the data or the barcode diagrams.

Noncommutative Polytopes of the Heisenberg Group *January 2019–May 2020*
Studied the polytopes generated by the Heisenberg group in $\mathbb{Z}^3$. Explored the asymptotic growth and behavior of these polytopes. Used Python for computations and generating STL files for 3D models of the polytopes. Investigated under the direction of Christopher Manon.

Estimating Flight Lines *July 2019–May 2020*
Used machine learning to estimate the flight path a plane capturing LiDAR data took. Implemented with PyTorch. Worked under the direction of Nathan Jacobs.

Resampling Point Clouds *August 2019–May 2020*
Used machine learning and geometric approaches to develop methods for resampling point clouds. This allows for arbitrary resolutions of the point cloud from an arbitrary view angle. Implemented with PyTorch. Joint work with Hunter Blanton and Nathan Jacobs.

PROJECTS

Math Lab Assignments
Implemented algorithm to match students to faculty-led lab groups under constraints such as time availability and student preferences. Investigated under the direction of Kate Ponto.

Visualizing Algebraic Surfaces
Created 3D-printed interactive representations of common surfaces and objects encountered in a Calculus III course. Moved on to generating more complex surfaces such as the Clebsh cubic surface. Used Python, Tinkercad, Mathematica, and Blender to generate STL files. Joint work with Nathan Fieldsteel and Peter Bonventre.

PUBLICATIONS

[1] Hunter Blanton, Sean Grate, and Nathan Jacobs. "Surface Modeling for Airborne LiDAR". In: *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*. 2020.

TECHNICAL STRENGTHS

Software & Tools Python, PyTorch, SageMath, C++

RELEVANT WORK EXPERIENCE

Auburn University Department of Mathematics and Statistics August 2020–Present
Graduate Teaching Assistant

- Teaching: MATH 1610 Calculus I, MATH 1120 Precalculus Algebra.
- Tutoring: MATH 1680 Business Calculus I, MATH 1610 Calculus I.

UK Department of Computer Science August 2019–August 2020
Undergraduate Research Assistant

- Continued researching the topics studied at the 2019 Computer Vision REU, e.g. estimating flight routes. Also performed research on point cloud resampling via machine learning where the goal is to produce arbitrary resolutions for a given point cloud.

Computer Vision REU May–August 2019
Undergraduate Researcher

- REU in computer vision under the guidance of Dr. Nathan Jacobs at the University of Kentucky. Used machine learning to estimate the flight paths of planes capturing LiDAR data across all of Kentucky.

Expanding Your Horizons April 21st, 2019
Workshop Mentor

- Planned and ran a workshop with two fellow undergraduates that taught middle school girls the basics of rockets and propulsion. We built bottle rockets with vinegar and baking soda and then launched them outside.

ACADEMIC ACHIEVEMENTS AND AWARDS

Auburn University 2022 COSAM Outstanding GTA Award *Spring 2022*

Auburn University 2022 DMS Research Citation Award *Fall 2021*

Best presentation at UK Computer Science Summer Research Program *August 9th, 2019*

University of Kentucky Dean's List *Fall 2016, Spring 2017, Fall 2017, Spring 2019, Spring 2020*

Kentucky Educational Excellence Scholarship (KEES) *$2,225 per year (2016-2020)*

University of Kentucky Provost Scholarship *$1,500 per year (2016-2020)*

SERVICE

Graduate Student Representative on the Auburn University DMS Graduate Student Council (2021-Present)

President of the Mathematics Club at Auburn University (2021-Present)

University of Kentucky Math Club (2016-2020)

2019 Julia Robinson Math Festival volunteer