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*

PROFESSIONAL EXPERIENCE

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

- Instructor of Record
  - MATH 1610 Calculus I *(Spring 2022)*
  - MATH 1120 Precalculus Algebra *(Fall 2021)*
- Recitation Leader
  - MATH 1610 Calculus I *(Fall 2022, Spring 2023, Fall 2023)*
- Tutor
  - MATH 1120 Precalculus Algebra
  - MATH 1610 Calculus I
  - MATH 1680 Business 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.

RESEARCH

WLP for Artinian Reductions of Point Configurations in $\mathbb{P}^3$ *September 2022–May 2023*
Associated to any set of points is the ideal consisting of polynomials that vanish at all of the points. Its Artinian reduction is said to have the weak Lefschetz property (WLP) if multiplication by a general linear form has maximal rank, i.e. it is either injective or surjective. Joint with Hal Schenck, we study configurations of points to determine how the geometry of the points influences the ideal of the points having the WLP.

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.

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] Sean Grate and Hal Schenck. "Betti tables forcing failure of the Weak Lefschetz Property". In: *Springer INdAM series: The strong and weak Lefschetz properties* (2023), to appear. arXiv: 2307.13126 [math.AC].

[2] Hunter Blanton, Sean Grate, and Nathan Jacobs. "Surface Modeling for Airborne Lidar". In: *IGARSS 2020 - 2020 IEEE International Geoscience and Remote Sensing Symposium*. 2020, pp. 1110–1113. DOI: 10.1109/IGARSS39084.2020.9323522.

AWARDS AND HONORS

Auburn University DMS Research Citation Award	*2021, 2022*
Auburn University DMS Teaching Citation Award	*2022*
Auburn University COSAM Outstanding GTA Award	*2022*
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)*

PRESENTATIONS

- "Betti tables forcing failure of the Weak Lefschetz Property", Workshop on Lefschetz Properties in Algebra, Geometry, Topology and Combinatorics, May 2023
- Auburn University
  - "A brief introduction to tropical geometry", Graduate Student Seminar, August 2022
  - "An overview of topological data analysis", Math Club, February 2022
  - "A brief introduction to tropical geometry", Algebra Seminar, November 2021
  - "Computations in topological data analysis", Graduate Algebra Seminar, August 2021
  - "Tropical algebra", Graduate Algebra Seminar, July 2021
  - "Geometry in Noncommutative Algebra", First Year Graduate Student Seminar, January 2021
  - "What/Why/How of Neural Networks", First Year Graduate Student Seminar, November 2020

CONFERENCES AND WORKSHOPS

Macaulay2 Week (June 2023)

Simons Laufer Mathematical Sciences Institute Commutative Algebra Summer School (May 2023)

Workshop on Lefschetz Properties in Algebra, Geometry, Topology and Combinatorics (May 2023)

Mathematical Sciences Research Institute (MSRI) Tropical Geometry Summer School (August 2022)

SERVICE AND OUTREACH

Secretary for the Auburn University DMS Graduate Student Council (August 2022-August 2023)

Graduate Student Representative on the Auburn University DMS Graduate Student Council (August 2021-August 2023)

Auburn Mathematical Puzzle Challenge (AMP'd) (November 2022)

Destination STEM (October 2022)

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

University of Kentucky Math Club (2016-2020)

Expanding Your Horizons workshop mentor (2019)

2019 Julia Robinson Math Festival volunteer

TECHNICAL STRENGTHS

Software & Tools Python, Macaulay2, PyTorch, SageMath