

# SEAN GRATE

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306 N 11th Street Apartment B, Opelika AL 36801

(859) 753-7189 ♦ szg0126@auburn.edu

## EDUCATION

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**University of Kentucky, Lexington**

*August 2016 - May 2020*

B.S. in Mathematics with minors in History and Classics, *cum laude*

## RESEARCH

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**Noncommutative Polytopes of the Heisenberg Group**

*January 2019–May 2020*

Studied the polytopes generated by the Heisenberg group in  $\mathbb{Z}^3$ . Looked at 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–Present*

Used machine learning to estimate the flight path a plane capturing LiDAR data took. Implemented with PyTorch. Working under the direction of Nathan Jacobs.

**Resampling Point Clouds**

*August 2019–Present*

Used machine learning and geometric approaches to develop methods for resampling point clouds. This allows for arbitrary resolutions of the point cloud from any arbitrary view angle. Implemented with PyTorch. Joint work with Hunter Blanton and Nathan Jacobs.

## PROJECTS

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**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.

**Generating Minecraft Worlds**

Using tools available in machine learning and borrowing persistent homology from computational topology, we try to generate Minecraft-like worlds through a generative adversarial network or a variational autoencoder. This will allow us to generate Minecraft-like worlds with realistic topological features such as caves, a defining feature of Minecraft.

## TECHNICAL STRENGTHS

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**Software & Tools**

Python, PyTorch, SageMath, C++

## RELEVANT WORK EXPERIENCE

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### UK Department of Computer Science

August 2019–Present

*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

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Best presentation at UK Computer Science Summer Research Program

*August 9th, 2019*

Dean's List

*Fall 2016, Spring 2017, Fall 2017, Spring 2019, Spring 2020*

Kentucky Educational Excellence Scholarship (KEES)

*\$2,225 per year*

University of Kentucky Provost Scholarship

*\$1,500 per year*

## SERVICE

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University of Kentucky Math Club

2019 Julia Robinson Math Festival volunteer

Tau chapter of the Eta Sigma Phi Classics honorary at the University of Kentucky