Josh Ascher

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EDUCATION

BSc. Mathematics, Minor Computer Science   Pittsburgh, PA | Apr 2023
UNIVERSITY OF PITTSBURGH
Advanced Math Coursework: Partial Differential Equations; Abstract Algebra; Advanced Calculus I-II(courses taken as prep for the graduate analysis preliminary exam), Graduate Measure Theory
Advanced CS Coursework: Algorithm Design, Graduate Algorithms, Theory of Computation, Graduate Network Optimization(at CMU)

PROJECTS

DRAWING GEODESICS IN THE HEISENBERG GROUP ↗   C#, UNITY

For this project, I learned C# and Unity to create a virtual reality game that allows users to understand the geometry of the Heisenberg Group. This geometry is not intuitive and very hard to visualize because it is not possible to travel in every direction. Whereas in the "normal" 3 dimensional space, one can move in any direction, in the Heisenberg Group, one can only move in two directions, which change based on location. In creating this game, I implemented an algorithm to find shortest curves with respect to the Carnot-Carathéodori metric.
To create this game, I had to become very familiar with Unity and Oculus. I learned a lot about game design and how to integrate virtual reality into Unity. A more in depth page is linked above, which includes a QR code for the game.

EXPLORING METRICS IN THE HEISENBERG GROUP ↗

In this project, I studied the Heisenberg with respect to two metrics: Carnot-Carathéodori and Korányi. I proved the existence of shortest curves between arbitrary points for the Korányi metric. Then, I showed that length of the shortest curve with respect to the Korányi metric is equal to the length of the shortest curve with respect to the Carnot-Carathéodori metric. This resulted in a paper which has been accepted to Ball State University's Mathematics Exchange. Both this project and the above project were under the direction of Dr. Armin Schikorra. The paper is linked above.

CONCRETE CONSTRUCTIONS OF DEPTH ROBUST GRAPHS

This project was part of an REU at the University of Illinois, Urbana-Champaign under the direction of Dr. Ling Ren. While working on this project, I studied Directed Acyclic Graphs(DAGs) and showed that a certain construction was depth robust with high probability. Additionally, I implemented well known attacks and used them to test the efficiency of the construction.

ONLINE TRANSPORTATION WITH RESOURCE AUGMENTATION ↗

This was an undergraduate research project with Dr. Kirk Pruhs:
We consider the online transportation problem set in a metric space containing parking garages of various capacities. Cars arrive over time, and must be assigned to an unfull parking garage upon their arrival. The objective is to minimize the aggregate distance that cars have to travel to their assigned parking garage. We show that the natural greedy algorithm, augmented with garages of $k \geq 3$ times the capacity, is $\left(1 + \frac{2}{k-2}\right)$-competitive.

PUBLICATIONS AND CONFERENCES

- *Resource Augmentation Analysis of the Greedy Algorithm for the Online Transportation Problem* -
- *Carnot-Carathéodory and Korányi-Geodesics in the Heisenberg Group* - published in Ball State University's *Mathematics Exchange*
- "Geodesics in the Heisenberg Group" at WVU 2022 Summer Undergraduate Research Symposia
- "Heisenberg-Man" at Unviersity of Pittsburgh's MathFest

AWARDS AND HONORS

- University of Pittsburgh Integration Bee Winner(2022)
- Montgomery M. Culver Prize *for outstanding academic performance in Mathematics*
- 3rd Place in University of Pittsburgh's 2022 MathFest Poster Session

TEACHING EXPERIENCE

UNIVERSITY OF PITTSBURGH | Math Teaching Assistant and Tutor   Pittsburgh, PA | Aug 2021 –

- TA Sections
  - Math 0031 - College Algebra
  - Math 0120 - Business Calculus
  - Math 0200 - Prep for Scientific Calculus(Pre-Calc)
- Tutored Classes
  - College Algebra and Precalculus
  - Calculus 1-3 and Business Calculus
  - Differential Equations
  - Introduction to Theoretical Math

UNIVERSITY OF PITTSBURGH | Computer Science Teaching Assistant   Pittsburgh, PA | Aug 2021 –

- TA Sections
  - CS 0441 - Discrete Structures

SKILLS

Languages: Java, Python, C#
Technology: Unity, LaTeX