Josh Ascher

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(Updated October 24, 2024)

EDUCATION

PhD Computer Science Philadelphia, PA |
Drexel University
BSc. Mathematics, Minor Computer Science Pittsburgh, PA | Apr 2023
University of Pittsburgh

UNDERGRADUATE PROJECTS

DRAWING GEODESICS IN THE HEISENBERG GROUP

C#, Unity

This was an undergraduate research project with Dr. Armin Schikorra:
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.

EXPLORING METRICS IN THE HEISENBERG GROUP

This was an undergraduate research project with Dr. Armin Schikorra:
We discuss the Heisenberg group $\mathbb{H}_1$, the three-dimensional space $\mathbb{R}^3$ equipped with one of two equivalent metrics, the Korányi- and Carnot-Carathéodory metric. We show that the notion of length of curves for both metrics coincide, and that shortest curves, so-called geodesics, exist 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 worked to design a more efficient algorithm for generating depth-robust graphs. 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.

ONLINE MONOTONIC METRIC MATCHING

This was an undergraduate research project with Dr. Kirk Pruhs:
Motivated by demand-responsive parking pricing systems, we consider posted-price algorithms for the online metric matching problem. We give an $O(\log n)$-competitive posted-price randomized algorithm in the case that the metric space is a line. In particular, in this setting we show how to implement the ubiquitous guess-and-double technique using prices.

PUBLICATIONS AND CONFERENCES

- *An $O(\log n)$-Competitive Posted-Price Algorithm for OML* - published in *Conference on Combinatorial Optimization and Applications* (2023)
- *Resource Augmentation Analysis of the Greedy Algorithm for the Online Transportation Problem* - published in *Latin American Algorithms, Graphs, and Optimization Symposium* (2023)
- *Carnot-Carathéodory and Korányi-Geodesics in the Heisenberg Group* - published in Ball State University's *Mathematics Exchange* (2022)
- "Geodesics in the Heisenberg Group" at WVU 2022 Summer Undergraduate Research Symposia (2022)
- "Heisenberg-Man" at Unviersity of Pittsburgh's MathFest (2022,2023)

AWARDS AND HONORS

- University of Pittsburgh Integration Bee Winner(2022)
- Montgomery M. Culver Prize *for outstanding academic performance in Mathematics* (2022,2023)
- 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 – Apr 2023

- 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 2022 – Apr 2023

- TA Sections
  - CS 0441 - Discrete Structures