Haoyu Wu

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Education

Bachelor of Science — *Hong Kong University of Science and Technology*
Major in Mathematics (Pure Math Advanced) — *September 2020 – July 2024*
CGA: 3.74/4.3 (Around Top 5% in Math Major)
Graduate Courses: Applied Analysis, Advanced Probability

Exchange Student — *Columbia University in the City of New York*
Columbia College — *2023 Spring*
CGA: 4.0/4.0
Graduate Courses: Optimization II, Convex Optimization

Research Interest

My research interests are on the mathematical, theoretical, and algorithmic foundations of a wide range of problems with applied and computational mathematics, especially with an optimization background.

Publication

Haoyu Wu, Ao Tang. *Error Estimation via a Refined Shapley-Folkman Lemma. preprint*

Research Experience

Strongest Position in a Voting Model — *From September 2023*
Key words: Convex Opt., Game Theorey, High D Prob.; Advised by Prof. A. Kevin Tang — *Remotely*

- It's well-known that the existence of the equilibria is not guaranteed in high dimensions and some previous results state conservative symmetric conditions. We compute the strongest position on the policy space with minimized volume that could beat this chosen position.
- Our conjecture is the ratio of the minimized volume to the measure of the whole policy space is decreasing, as the dimension increases.

Error Estimation via a Refined Shapley-Folkman Lemma — *May 2023 - August 2023*
Key words: Nonconvex Opt.; Advised by Prof. A. Kevin Tang — *Cornell University, Ithaca, U.S.*

- Our work focused on applying the refined lemma to improve the estimation of the Hausdorff distance between the Minkowski sum and its convex hull, categorizing the convexity. Our result offers qualitative improvement in specific cases.
- The main idea of our work, instead of the traditional method of separately estimating each component of the Minkowski sum, considers all components jointly and uses the constraint on convexity from the refined lemma to reach a tighter bound. The paper has been submitted for peer review.

Maximization of Submodular Functions — *February 2023 - April 2023*
Key words: Combinatorial Opt., Adaptivity; Advised by Prof. Eric Balkanski *Columbia University, New York, U.S.*

- Employed adaptive algorithms to solve the problem of maximizing submodular functions subjecting to matroid constraints.
- Implemented the threshold method to iteratively add elements to the chosen set or remove elements from the ground set.
- Investigated the employment of the binary search for thresholds to solve the partition matroid case with lower adaptivity compared to the original adaptive algorithm utilizing thresholds.

Signal Recovery Method — *July 2022 – December 2022*
Key Words: Signal Recovery, Convex Opt.; Advised by Prof. Jian-feng Cai — *HKUST, Hong Kong*

- Implemented signal recovery techniques for reconstructing signals with simultaneous structures observed through a linear operator. Estimateing the lower bounds of Gaussian measurements of convex methods, as a sum of multiple norms.
- Developed a comprehensive understanding of the 'square norm' method for recovering low (tucker) rank tensors, which can be viewed as multi-structured signals.
- Implemented the application of 'atomic norms' to recover multi-structured signals by combining their corresponding atomic sets to obtain a new atomic set.

Optimal Transport *February 2022 – June 2022*
Key words: Convex Opt., Entropy; Advised by Prof. Jian-feng Cai *HKUST, Hong Kong*

- Concentrated on approximately solving the optimal transport problem within modern computational methods, with a primary focus on the Sinkhorn algorithm.
- Investigated the entropic regularization and extensively examined the local and global convergence properties of the Sinkhorn algorithm.
- Implemented modifications to the Sinkhorn algorithm, such as the Greenkhorn algorithm, with the aim of acceleration.

Shrinking a convex curve via Heat Equation *June 2021 – August 2021*
Key words: Flow geometry; Advised by Prof. Tsz-Ho Fong *HKUST, Hong Kong*

- Focused on the problem of how to shrink a curve to a point through a certain way, related heat equation, and curvature of the cure. It's a well-known problem and was solved in the 1980s.

Skills

Coding Python, Matlab, LaTeX, R
Language Fluent in English, Native Mandarin Chinese, and Cantonese

Activities

Teaching Assistant of Honor Calculus I	2023 Fall
Tutor of Math Support Center, HKUST	2022 Fall
China Social Media Team, UG Recruitment and Admission Office, HKUST	Since 2020
Deupty Head Student Ambassador, UG Recruitment and Admission Office, HKUST	Since 2020
Member of Executive Committee, Chinese Folk Art Society HKUSTSU	2021-2022
Student Representative of Math Student Liaison Subcommittee Meeting	2021,2022

Awards (Selected)

Honorable Mention Award	HKUST Math Dept	*2023*
Lee's Pharmaceutical - Kanya Lee Scholarship	HKUST School of Science	*2023*
Chern Class Talent Scholarship	HKUST Math Dept	*2021,2022,2023*
Dean's List	HKUST School of Science	*2021,2022,2023*