Yanling Shen

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Education

Columbia University, *New York, NY* Expected Dec 2024
M.S. in Applied Mathematics, GPA: 3.86

Columbia University, *New York, NY* May 2023
B.S. in Applied Mathematics, Magna Cum Lauda, GPA: 3.91
honor: Magna Cum Laude, Dean's List

Research Interests

My research interests lie at the intersection of theoretical frameworks and computational approaches in optimization and data science. I have gained experience working on SDP and convex relaxations for combinatorial optimization and graph-related problems, developing and simulating agent-based models, and processing and analyzing datasets within appropriate mathematical frameworks.

Publications & Preprints

Y. Wang, Y. Shen, V. A. Kobzar. *Lower Bounds on Block-Diagonal SDP Relaxations for the Clique Number of the Paley Graphs and Their Localizations.* In Proceedings of the ACM Symposium On Theory of Computing (STOC 2025). Submitted for review.
Work presented at *Foundations of Data Science Workshop* at Data Science Institute, Columbia University.

Research Experience

Lower Bounds on Block-Diagonal SDP Relaxations for the Clique Number of the Paley Graphs and Their Localizations
supervised by Prof. Vladimir A. Kobzar, Columbia University May 2023 - Nov 2024

- Simplified each PSD constraint of any level of block-diagonal relaxations, which generalized the previous simplification of lower level of block-diagonal relaxations.
- Established lower bound on the block-diagonal hierarchy, an intermediate SDP relaxation nested between the Lovasz-Schrijver hierarchy and sum-of-squares hierarchy, of the Paley graph clique problem.
- Manifested the relaxation-localization trade-off conjectured in literature for the two approaches, namely, relaxations and localizations, to bound the clique number.

Genetic Drift of Multi-Alleles Jan 2024 - May 2024
supervised by Prof. Qi Wang, Columbia University

- Studied the theoretical framework of genetic drift of multi-alleles under Wright-Fisher and the Moran model.
- Extended the haploid two-allele model to three-allele model, simulated and verified the relationship between the selection coefficient and relative fitness v.s. fixation frequency derived in the literature.

Newell's Car-Following model Jan 2024 - May 2024
supervised by Prof. Xuan (Sharon) Di, Columbia University

- Simulated the trajectories of vehicles in multiple traffic signal cycles under Newell's Car-Following model.
- Explored the relationship between the traffic signal cycle length and the average speed of the vehicles, and determined the optimal traffic signal cycle length.

Social Force Model Jan 2024 - May 2024
supervised by Prof. Xuan (Sharon) Di, Columbia University

- Simulated the movement of pedestrians based on a multi-particle self driven system framework, assuming each pedestrian perceives and responds to the surroundings.
- Improved the model by adding pedestrian attributes and group interactions, with a focus on the escape panic mode, and manifested the bottleneck flow in a combination of several crowd motion base cases.

Mathematics of Swarm Equilibria Sep 2023 - Dec 2023

advised by Prof. Wang Qi and Prof. Ren Kui, Columbia University

- Explored the behavior of locust swarms by modeling swarms as interacting individuals, with a focus on the equilibrium positions in the discrete case and equilibrium density solutions in the continuous case.
- Simulated approximated solutions to the mathematical model verified by the actual biological model.

Enhancing Engagement and Outcomes: Quantify the Impact of Gamification in Educational Through Data Driven Decision Model

advised by Prof. Yi Zhang, Columbia University Jan 2023 - May 2023

- Retrieved, processed and analyzed datasets under mathematical framework corresponding to different features.
- Studied the effect of gamification on education and visualized the effect using network graphs, and proposed strategies that may help to utilize gamification more efficiently in education.

Estimating COVID-19 Related Learning Loss for Students in Grades 3-8 Sep 2022 - Dec 2022

advised by Prof. Vladimir A. Kobzar, Columbia University

- Retrieved, processed and feature engineered dataset by supplement dataset with additional information.
- Constructed models capturing the relation between academic performance growth and possible factors.
- Predicted the academic growth for the subsequent two years and conducted error analysis for the prediction.

Adomian Decomposition Method for First Order Nonlinear PDE Sep 2022 - Dec 2022

advised by Prof. Chris Wiggins, Columbia University

- Studied the mathematical framework, including PDE derivations from the conservation laws, Adomian Decomposition Method, and the convergence of the apprximation.
- Simulated the shock waves using Adomian Decomposition Method to 1D nonlinear PDE.

COURSEWORKS

- **(Mathematics):** Analytical Methods for PDE, Numerical Analysis of PDE, Functional Analysis, Intro to Applied Analysis, Functions of Complex Variables, Number theory and Cryptography, Abstract Algebra, Probability Theory
- **(Applied Mathematics & Data Science):** Applied Stochastic Analysis, Stochastic Models, Stochastic Calculus, Optimization Models and Methods, Numerical Algebra & Optimization, Mathematics of Data Science, Dynamical Systems, Intro to Numerical Methods, Advanced Linear Algebra, Data-driven Decision Modeling

COMPUTING & SOFTWARE

- **Coding Languages:** Python, Matlab, Java, Mathematica
- **Tools & Software:** Pandas, Scikit-learn, Jupyter Notebook, Git, NumPy, SciPy, Matplotlib