

Shuyang Gong

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RESEARCH INTERESTS

Mathematics of Probability theory, especially in high-dimensional settings.

EDUCATION

Peking University, Beijing, China
PhD in Mathematics

September, 2021 — June, 2026(expected)

Shandong University, Jinan, China
Bachelor of Mathematics: GPA ranked 1st/132

September, 2017 — June, 2021

PUBLICATIONS/PREPRINTS

- **A polynomial-time approximation scheme for the maximal overlap of two independent Erdős-Rényi graphs.**

Preprint: <https://arxiv.org/abs/2210.07823>, to appear in *Random Structures and Algorithms*

Coauthors: Jian Ding (PKU) and Hang Du (MIT)

Abstract: We presented a polynomial-time algorithm that finds a vertex correspondence which maximizes the overlap of two independent Erdős-Rényi graphs with a constant arbitrarily close to 1 compared with the asymptotic of the maximal overlap. This result gives a new example to the few problems that efficient algorithms exist for random instances while worst-cases are known to be NP-hard.

- **The algorithmic phase transition of random graph alignment problem.**

Preprint: <https://arxiv.org/abs/2307.06590>, *submitted*

Coauthors: Hang Du (MIT) and Rundong Huang (PKU)

Abstract: We study the graph alignment problem over two independent Erdős-Rényi graphs on n vertices, with edge density p falling into two regimes separated by the critical window around $p_c = \sqrt{\log n/n}$. Our result reveals an algorithmic phase transition for this random optimization problem: polynomial-time approximation schemes exist in the sparse regime, while statistical-computational gap emerges in the dense regime. Additionally, we establish a sharp transition on the performance of online algorithms for this problem when p lies in the dense regime, resulting in a $\sqrt{8/9}$ multiplicative constant factor gap between achievable and optimal solutions.

- **The Umeyama algorithm for matching correlated Gaussian geometric models in the low-dimensional regime.**

Preprint: <https://arxiv.org/abs/2402.15095>.

Coauthor: Zhangsong Li (PKU)

Abstract: Motivated by the problem of matching two correlated random geometric graphs, we study the problem of matching two Gaussian geometric models correlated through a latent node permutation. Specifically, given an unknown permutation π^* on $\{1, \dots, n\}$ and given n i.i.d. pairs of correlated Gaussian vectors $\{X_{\pi^*(i)}, Y_i\}$ in R^d with noise parameter σ , we consider two types of (correlated) weighted complete graphs with edge weights given by $A_{i,j} = \langle X_i, X_j \rangle$, $B_{i,j} = \langle Y_i, Y_j \rangle$. The goal is to recover the hidden vertex correspondence π^* based on the observed matrices A and B . For the low-dimensional regime where $d = O(\log n)$, Wang, Wu, Xu, and Yolcu established the information thresholds for exact and almost exact recovery in matching correlated Gaussian geometric models. They also conducted numerical experiments for the classical Umeyama algorithm. In our work, we prove that this algorithm achieves exact recovery of π^* when the noise parameter $\sigma = o(d^{-3}n^{-2/d})$, and almost exact recovery when $\sigma = o(d^{-3}n^{-1/d})$. Our results approach the information thresholds up to a $\text{poly}(d)$ factor in the low-dimensional regime.

TALKS

- An Introduction to First Passage Percolation. Shandong University/October 12, 2020
- A polynomial-time approximation scheme for the maximal overlap of two independent Erdős-Rényi graphs. Shandong University/November 7, 2022
- Algorithms and Phase Transitions in Random Graph Alignment Problem. Peking University/September 11, 2023
- Optimizing the overlap of two independent Erdős-Rényi graphs. Sichuan University/January 15, 2024

AWARDS

- National Scholarship October, 2019/Shandong University

- National Scholarship
- Principal Scholarship (Top Award for Undergraduates)
- Schlumberger Scholarship

October, 2020/Shandong University
 October, 2020/Shandong University
 October, 2023/Peking University

TEACHING EXPERIENCES

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| • Calculus (C) | Fall, 2021 |
| • Applied Stochastic Processes | Spring, 2022 |
| • Applied Stochastic Processes | Fall, 2022 |
| • Measure Theory | Spring, 2023 |
| • Advanced Probability Theory | Fall, 2023 |
| • Stochastic Processes and Statistical Physics | Spring, 2024 |