# Hengyu Fu

Tel: (+86) 15680881723, E-mail: 2100010881@stu.pku.edu.cn

## EDUCATION

**PEKING UNIVERSITY**

Sep. 2021 - Jul. 2025 (Expected)

*School of Mathematical Sciences: Major:* **Mathematics**, *Double Major:* **Economics**

- **Academic Achievement:** Overall GPA: 3.91/4.00
- **Selected Coursework:** Mathematical Analysis (I) 97.5, Mathematical Analysis (II) (H) 96, Geometry(I) 98, Advanced Algebra (I) 92.5, Advanced Algebra (II) 94.5, Probability Theory 99, Abstract Algebra 97, Statistical Thinking 92, Applied Stochastic Processes 97, Mathematical Statistics 100, Intermediate Microeconomics 100, International Trade 100.
- **Honors and Awards:** Gold Medal in the 36th China Mathematics Olympics Final (2020), Peking University 2021-2022 Third-Class Scholarship, Peking University 2021 "Jin Qin" Scholarship, School of Mathematical Sciences Social Work Award.

## PUBLICATIONS

- **Hengyu Fu,** Tianyu Guo, Yu Bai, Song Mei, "What can a Single Attention Layer Learn? A Study Through the Random Features Lens", submitted to NeurIPS 2023, arXiv preprint https://arxiv.org/abs/2307.11353.

## RESEARCH EXPERIENCE

**Learnability of the attention layers in Transformers**

Jan. 2023 - Jul. 2023

*Advisor: Prof. Song Mei, Department of Statistics, University of California, Berkeley.*

- Studied theoretically on the learning and generalization of a single multi-head attention layer in the random feature setting.
- Analyzed the effect of the sampling distribution of the query-key weight matrix on the approximation behavior.
- Conducted experiments on simulated data to substantiate our theoretical findings and further illustrate the interplay between the sample size and the complexity of the target function.

**Sparse Learning with Branch-and-Bound Solver**

Jan. 2023 - Present

*Advisor: Prof. Rahul Mazumder, Operations Research Center (ORC), Massachusetts Institute of Technology.*

- Studied various types of sparse learning problems with different regularizers and constraints and developed a generalized Branch-and-Bound solver for them.
- Designed a relaxed form of the primal mixed integer programming problem; developed an Active-Set algorithm based on a refined PGD method to solve the relaxed problem at high speed.
- Developed effective heuristic strategies that yield feasible solutions close to the optimum.
- Conducted theoretical analysis: derived the proximal operator and conjugate function of the objective function in the relaxed problem; established the theoretical guarantee for global convergence of the proposed method.
- Working on refining the Branch-and-Bound framework (e.g., designing better branching and pruning rules) and conducting appropriate numerical experiments to demonstrate its superior performance.

**"SDPDAL" for Riemannian Optimization**

Aug. 2022 – Jan. 2023

*Advisor: Prof. Zaiwen Wen, Beijing International Center for Mathematical Research (BICMR), Peking University.*

- Repackaged a decomposition augmented Lagrangian method called "SDPDAL" for low-rank SDP from MatLab into C++ and developed a software package based on this method.
- Refined the SDPDAL solver and applied it to practical problems such as coloring problems.
- Performed related numerical experiments to demonstrate its excellent performance.

## STANDARDIZED TESTS

- **TOEFL iBT:** 103 (Reading 28, Listening 28, Speaking 22, Writing 25)
- **GRE General:** 324+4.0 (Verbal 154, Quantitative 170, Analytical Writing 4.0)

## SKILLS & OTHERS

- **Computer Skills:**　Python, MATLAB, C++, LaTeX
- **Language:** Chinese (Native), English (Fluent)
- **Student Service:** Chair of Academic Practice Department of Student Union