

Hengrui Zhang

Master's Student in Big Data | School of Mathematical Sciences, Peking University

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Education

- 2026 – Present ▪ **Peking University**
M.Sc. in Big Data, School of Mathematical Sciences
- 2022 – 2026 ▪ **Sichuan University**
B.S. in Mathematics and Applied Mathematics (Base Class)
School of Mathematics
Average score: **91.39/100** GPA: **3.90/4.0** Rank: **1/40**

Publications and Manuscripts

* Co-first authors.

- 1 On the Convergence of Stochastic Gradient Descent with Perturbed Forward-Backward Passes**
Boao Kong*, Hengrui Zhang*, Kun Yuan
Preprint ([arXiv:2602.20646](#)); under review at *Mathematical Programming*.
- 2 ReasFlow: Assisting Reasoning-Centric Scientific Discovery in Applied Mathematics via a Knowledge-Based Multi-Agent System**
Yutong He*, Daibo Li*, Guohong Li*, Jiahe Geng*, Zhengyang Huang*, Can Ren*, Zekun Zhang, Yifan Liu, Shuchen Zhu, Hengrui Zhang, Boao Kong, Ming Sun, Shu Li, Chenyi Li, Jiang Hu, Kun Yuan, Zaiwen Wen, Pingwen Zhang
Preprint ([arXiv:2607.14178](#)); under review at *Nature Communications*.
- 3 SUDA-Muon: Structural Design Principles and Boundaries for Fully Decentralized Muon**
Hengrui Zhang*, Boao Kong*, Jiahe Geng, Zhengyang Huang, Kun Yuan
Preprint ([arXiv:2604.23980](#)); under review at *SIAM Transactions on Applied Mathematics*.
- 4 BRoS: Bias-Corrected Randomized Subspaces for Memory-Efficient Single-Loop Bilevel Optimization**
Hengrui Zhang*, Boao Kong*, Engao Zhang*, Kun Yuan
Preprint ([arXiv:2605.10288](#)).

Research Experience

OptBound

Jun 2026 – Sep 2026

Advisor: Prof. Kun Yuan (CMLR, Peking University)

- Built agents to organize and extract results from **200+ papers** on lower and upper bounds for optimization algorithms; coordinated expert validation, blog writing, and website development.
- Released the benchmark online at [optbound.reaslab.io](#).

Randomized Subspace Primer

Sep 2025 – Jun 2026

Advisor: Prof. Kun Yuan (CMLR, Peking University)

- Coordinated a survey of randomized subspace methods across **8 application settings** and **10+ algorithm families**, including stochastic, bilevel, and distributed optimization and federated learning; conducted ablation studies and produced a practical guide of **over 70 pages**.
- Developed algorithms, conducted experiments, and wrote sections on bilevel, zeroth-order, and second-order optimization, and LLM pretraining and fine-tuning.

Research Experience (continued)

Compositional Error Propagation	Feb 2025 – Jun 2025
<i>Advisor: Prof. Kun Yuan (CMLR, Peking University)</i>	
- Investigated error-tolerance limits of compression operators in noisy multilayer composite functions. - Constructed non-convergence counterexamples for SGD and mSGD under constant-magnitude perturbations in pipeline-parallel architectures; proved non-convergence using difference equations and spectral analysis.	
Optimization-based Nash Learning	Feb 2025 – May 2025
<i>Advisor: Prof. Ju Ren (Tsinghua University)</i>	
- Reproduced the Nash learning approach of Munos et al. (2024) for reinforcement learning from human feedback (RLHF) and formulated the Nash winner problem as a linear program. - Derived convergence bounds and theoretical guarantees; analyzed differences between Nash Learning and Bradley–Terry-based RLHF through their convergence behavior.	
AI for Mathematics Summer School	Jul 2024 – Aug 2024
<i>Advisors: Prof. Liang Xiao and Prof. Bin Dong (BICMR, Peking University)</i>	
- Studied mathematical formalization and theorem proving in Lean 4; wrote 4,000+ lines of proof code and prompts and independently formalized 80+ theorems. - Ranked 12/100; received the Outstanding Participant Award and Special Prize.	
ADMM-based Target Localization in Sensor Networks	Oct 2023 – Mar 2024
<i>Advisor: Prof. Xiaojing Shen (Sichuan University)</i>	
- Studied wireless sensor network localization and the foundations of ADMM, ALM, and GCNs; reproduced the fixed-penalty ADMM algorithm of Wang & Zhang (2019). - Introduced stochastic optimization into data exchange, reducing total runtime by 10%–15% while maintaining convergence guarantees.	

Awards and Honors

Awards	
National First Prize, China Undergraduate Mathematical Contest in Modeling - Provincial First Prize, Chinese Mathematics Competitions (Mathematics Majors) - Provincial Second Prize, National English Competition for College Students	Oct 2024 Nov 2024 May 2023
Scholarships	
National Scholarship - BYD Undergraduate Scholarship	Oct 2024, Oct 2023 Nov 2025
Honors	
Provincial Outstanding Graduate - Outstanding Graduate, Sichuan University - Outstanding Student, Sichuan University	Jan 2026 Oct 2025 Oct 2024

Skills and Languages

Programming	Highly proficient in C++; familiar with Python (PyTorch), MATLAB, and Lean 4.
Tools	- Provincial First Prize in CSP-J and Provincial Second Prize in CSP-S. - Proficient in $\text{\LaTeX}$ and Markdown.
English	IELTS 7.5 overall (Reading 8.5, Writing 7.5); CET-6: 579.