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).

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).

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

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

- 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

Advisor: Prof. Ju Ren (Tsinghua University)

- 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

Advisors: Prof. Liang Xiao and Prof. Bin Dong (BICMR, Peking University)

- 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

Advisor: Prof. Xiaojing Shen (Sichuan University)

- 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 — Oct 2024
- Provincial First Prize, Chinese Mathematics Competitions (Mathematics Majors) — Nov 2024
- Provincial Second Prize, National English Competition for College Students — May 2023

Scholarships

- **National Scholarship** — Oct 2024, Oct 2023
- BYD Undergraduate Scholarship — Nov 2025

Honors

- **Provincial Outstanding Graduate** — Jan 2026
- Outstanding Graduate, Sichuan University — Oct 2025
- Outstanding Student, Sichuan University — Oct 2024

Skills and Languages

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