Zixun Huang

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Research Interest

Theoretical Foundations of Machine Learning, Scaling Laws, Reinforcement Learning Theory

Education

- **Peking University, School of Mathematical Sciences** *Sept. 2022 – Present*
  - *B.S. in Statistics*, GPA: 3.68/4.0
  - Member of Elite Undergraduate Program for Applied Mathematics **(Top 10%)**
  - **Core Coursework:** Mathematical Analysis (94), Advanced Algebra (97.5), Mathematical Modeling (91), Numerical Methods (88), Deep Learning Theory (87), Leaming Data Science with Python (90), Mathematical Statistics (97)
- **University of California, Berkeley** *Jan. 2025 – Aug. 2025*
  - *Visiting Student*, GPA: 4.0/4.0
  - **Core Coursework:** Theoretical Statistics (A+), Advanced Topics in Probability and Stochastic Processes (A), Modern Statistical Prediction and Machine Learning (A+), Structure and Interpretation of Computer Programs (A+)

Publications

- Binghui Li*, Fengling Chen*, **Zixun Huang***, Lean Wang*, Lei Wu. *Unveiling the Role of Learning Rate Schedules via Functional Scaling Laws.* **NeurIPS 2025 (Spotlight)**. [Paper]
- **Zixun Huang***, Jiayi Sheng*, Zeyu Zheng. *OBLR-PO: A Theoretical Framework for Stable Reinforcement Learning.* Submitted to **AISTATS 2026 (Reviewer scores: 6, 5, 5 (max 7))**.

Research Experience

- **Functional Scaling Laws for Learning Rate Schedules (Core)** *May. 2024 – Nov. 2025*
  - *Advisor: Prof. Lei Wu*
  - Proposed a novel Functional Scaling Law (FSL) by modeling SGD as an intrinsic-time SDE
  - Analyzed learning-rate schedules under data and compute constraints, revealing efficiency trade-offs
  - Validated FSL through kernel regression and LLM pre-training, producing optimal schedules
- **OBLR-PO: Theory for Stable Reinforcement Learning (Core)** *Feb. 2025 – Oct. 2025*
  - *Advisor: Prof. Zeyu Zheng*
  - Established theoretical guarantees for policy optimization, including variance bounds and convergence
  - Introduced gradient-weighted baselines for principled variance reduction
  - Implemented OBLR-PO and demonstrated superior performance on Qwen3-4B/8B vs. GRPO
- **Combining Simulation with Linear Algebra: COSIMLA** *May. 2025 – Jul. 2025*
  - *Advisor: Prof. Zeyu Zheng*
  - Implemented and evaluated five COSIMLA estimators across diverse parameter regimes
  - Analyzed variance–bias–efficiency trade-offs, confirming improved stability and speed

- **Saturation Phenomenon Under Kernel Method** *Feb. 2024 – May. 2024*
  - *Advisor: Prof. Lei Wu*
  - Derived loss functions for kernel ridge regression and gradient descent; analyzed the saturation phenomenon through bias–variance tradeoff and Fourier perspective
  - Identified a noiseless setup saturation effect previously overlooked in prior work
- **Cross Modal Alignment** *May. 2024 – Jun. 2024*
  - *Advisor: Prof. Junfeng Hu*
  - Developed an alignment strategy for movie posters and text introductions using vector embeddings
  - Established baseline accuracy and reported insights on model and network pre-training effects
- **Analysis for Grokking Phenomenon** *Nov. 2023 – Jan. 2024*
  - *Advisor: Prof. Lei Wu*
  - Replicated grokking phenomenon experiments (MLP, LSTM) on modular addition task
  - Conducted theoretical and empirical analysis from training-dynamics and landscape perspectives

Selected Honors and Awards

- Hong Sheng Scholarship **(Top 12%)** *Sept. 2024*
- Yau Contest Groups Prize **(Top 5%)** *May. 2024*
- First Prize, Chinese Mathematics Contest **(Top 1%)** *Apr. 2024*
- Xiaomi Scholarship **(Top 12%)** *Sept. 2023*
- Gold Prize, Chinese Mathematical Olympiad *Dec. 2021*
- Silver Prize, Chinese Mathematical Olympiad *Nov. 2020*

Extracurricular Activities

- **Applied Mathematics Seminar, Peking University** *Jun. 2024 – Jul. 2024*
  - Teaching Assistant for *Prof. Zhi-Qin John Xu*
  - Assisted in developing and organizing lecture materials
- **Peking University Runners Association** *Oct. 2022 – Dec. 2023*
  - Core Team Member
  - Organized and coordinated running events; participated in volunteer activities
  - Completed the Nanjing Half Marathon

Skills and Others

- **Languages** Chinese (Native), English (Fluent)
- **TOEFL iBT** Total 101: 28(R), 23(L), 23(S), 27(W)
- **Quantitative Skills** GRE General: V160, Q170; GRE Math: 970 (95th percentile)
- **Programming** Python, MATLAB, LaTeX, PyTorch, C++, Go, R, SQL