

Jingchu Gai

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EDUCATION

Carnegie Mellon University, Machine Learning Department, Pittsburgh, PA 2025 – Present

Ph.D. in Machine Learning · Advisors: Prof. Andrej Risteski, Prof. Aditi Raghunathan

Peking University, School of Mathematical Sciences, Beijing, China 2021 – 2025

B.S. in Mathematics · Advisor: Prof. Liwei Wang

GPA 3.957/4.00 · **Ranked 1/217**

RESEARCH INTERESTS

- LLM reasoning and post-training: reinforcement learning for LLMs, entropy control, mitigating sharpening and premature confidence
- Theoretical foundations of reinforcement learning and imitation learning, robust multi-agent RL
- Graph representation learning: GNN expressiveness, graph theory, algebraic graph theory

PUBLICATIONS

* denotes equal contribution; † denotes corresponding author.

- [1] **Beyond Weisfeiler-Lehman: A Quantitative Framework for GNN Expressiveness**
Bohang Zhang*, Jingchu Gai*, Yiheng Du, Qiwei Ye, Di He, Liwei Wang
ICLR 2024 · **Best Paper Honorable Mention, Oral**
- [2] **Homomorphism Expressivity of Spectral Invariant Graph Neural Networks**
Jingchu Gai, Yiheng Du, Bohang Zhang, Haggai Maron, Liwei Wang
ICLR 2025 · **Oral**
- [3] **Demystifying Entropy Control in LLM RL Training: Theoretical Analysis and Dynamic Scheduling**
Jingchu Gai*, Guanning Zeng*, Huaqing Zhang, Han Zhong, Yige Hong, Andrej Risteski, Aditi Raghunathan
ICML 2026 · **Spotlight**
- [4] **Differential Smoothing Mitigates Sharpening and Improves LLM Reasoning**
Jingchu Gai*, Guanning Zeng*, Huaqing Zhang*, Aditi Raghunathan
ICML 2026
- [5] **Towards Solving the Gilbert–Pollak Conjecture via Large Language Models**
Yisi Ke, Tianyu Huang, Yankai Shu, Di He, Jingchu Gai†, Liwei Wang†
ICML 2026
- [6] **Breaking the Curse of Multiagency in Robust Multi-Agent Reinforcement Learning**
Laixi Shi*, Jingchu Gai*, Eric Mazumdar, Yuejie Chi, Adam Wierman
ICML 2025
- [7] **Understanding and Mitigating Premature Confidence for Better LLM Reasoning**
Jingchu Gai*, Guanning Zeng*, Christina Baek*, Chen Wu*, J. Zico Kolter, Andrej Risteski, Aditi Raghunathan
COLM 2026
- [8] **Towards Understanding the Benefits of Online Imitation Learning**
Huaqing Zhang*, Jingchu Gai*, Juno Kim, Bingbin Liu, Andrej Risteski
ICLR 2026 Workshop on Scaling Post-training for LLMs

- [9] **Pretraining Data Scale Reverses the AdamW–Muon Fine-Tuning Gap**
 Catherine Li, **Jingchu Gai**, Jacob Mitchell Springer, Aditi Raghunathan
COLM 2026 Workshop on Methods and Opportunities at Small Scale (MOSS) · **Oral**
- [10] **Momentum Streams for Optimizer-Inspired Transformers**
Jingchu Gai*, Nai-Chieh Huang*, Jiayun Wu* (authors in alphabetical order)
Preprint
- [11] **Lossless Anti-Distillation Sampling**
 Zhihang Diao, **Jingchu Gai**, Xinyu Ai, Zihao Zhang, Zhonghao He, Di He
Preprint
- [12] **Taming the Curses of Multiagency in Robust Markov Games with Large State Space through Linear Function Approximation**
Jingchu Gai, Laixi Shi
Preprint

RESEARCH EXPERIENCE

Graduate Research Assistant, Carnegie Mellon University

Advisors: Prof. Aditi Raghunathan, Prof. Andrej Risteski

Research Intern, Carnegie Mellon University

Advisors: Prof. Yuejie Chi, Prof. Laixi Shi · Robust multi-agent reinforcement learning

Research Intern, Princeton University

Advisor: Prof. Chi Jin · Partially observable and multi-agent reinforcement learning theory

Undergraduate Researcher, Peking University

Advisor: Prof. Liwei Wang · Graph representation learning, GNN expressiveness

TALKS

Homomorphism Expressivity of Spectral Invariant Graph Neural Networks	2025
Oral presentation, International Conference on Learning Representations (ICLR), Singapore	

HONORS AND AWARDS

ICLR 2024 Best Paper Honorable Mention (as first author)	2024
SenseTime Scholarship (25 undergraduates across China talented in AI)	2024
National Scholarship of China (highest honor for undergraduates in China)	2024
National Scholarship of China (highest honor for undergraduates in China)	2023
Merit Student of Peking University	2024
Merit Student of Peking University	2023
First Prize, 14th Chinese College Students' Mathematical Contest	2023
Winner Prize, 14th S.-T. Yau College Student Mathematics Contest	2023
Academic Merit Student of Peking University	2022
Freshman Scholarship of Peking University	2021
First Prize, 37th Chinese Physics Olympiad	2020

COURSEWORK

- **Analysis:** Mathematical Analysis I (94), II (98), III (98); Theory of Functions of Complex Variables (99); Ordinary Differential Equations (96)
- **Algebra:** Advanced Algebra I (93), Advanced Algebra II (99), Abstract Algebra (97)
- **Statistics:** Probability Theory (98), Mathematical Statistics (100), Statistical Thinking (99)

- **Programming:** Introduction to Computation (98.5), Data Structures and Algorithms (99)
- **Geometry:** Geometry (96.5) · **Others:** Game Theory (100)
- **Graduate:** Applied Stochastic Processes (99), High-Dimensional Probability (95), Statistical Models and Computing Methods (97.3), Mathematical Methods of Classical Mechanics (95)

SKILLS

- **Programming:** Python, C++
- **TOEFL iBT:** 109/120 (R 30, L 30, S 23, W 26) · **GRE General:** 335/340 (V 166, Q 169)