Zhouhao Yang

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PROFILE

- Current Ph.D. Student in Department of Applied Mathematics and Statistics, Johns Hopkins University.
- Research Interest: AI for Science, LLMs, diffusion models, Reinforcement Learning, stochastic control.
- Diverse research experiences: Ph.D. Candidate of Applied Mathematics and Statistics at JHU, One-Year Ph.D. Student at NUS Computing, Caltech Visiting Undergraduate Research Program.

EDUCATION

Johns Hopkins University Aug 2024 – Present
Ph.D. Candidate, Department of Applied Mathematics and Statistics
Advisor: Haoyang Cao
Research Direction: Reinforcement Learning, Diffusion Models, Stochastic Control Theory, Mean Field Games.

National University of Singapore Aug 2023 – Jun 2024
Ph.D. Candidate, Department of Computer Science
Advisor: Kenji Kawaguchi and Johnathon Scarlett
Research Direction: AI for Science, Physics-Informed Neural Networks, Memory-Efficient Finetuning for LLMs.

Shanghai Jiao Tong University Sep 2019 – Jun 2023
Bachelor of Mathematics and Applied Mathematics (Zhiyuan Honors Program)
Selected Coursework: Probability, Statistics, Stochastic Process, Foundations of data science, Numerical Analysis and Scientific Computing, Partial Differential Equations, Fourier Analysis and Real Analysis, etc.

PUBLICATIONS

In Preparation

1. **Zhouhao Yang**, Vladimir Braverman, Haoyang Cao, "A General Heavy-Tailed Flow Matching Framework with Random Clocks." In preparation (2026).
2. Haoyang Cao*, **Zhouhao Yang***, "Mean Field Games for Randomized Impulse Control." In preparation (2026).

Under Review / In Revision

3. Haoyang Cao*, Yuchao Dong*, **Zhouhao Yang***, "A Two-fold Randomization Framework for Impulse Control Problems." In revision in Siam Journal on Control and Optimization, 2025.
4. **Zhouhao Yang***, Nan Chen*, Soufiane Hayou, "Training-free versus Training-based Intent Classification in LLMs: Accuracy, Robustness, and Failure Modes." Under review in COLM 2026.
5. Yezhen Wang*, **Zhouhao Yang***, Kenji Kawaguchi et al, "Memory-Efficient LLM Training by Various-Grained Low-Rank Projection of Gradients." Under review in IJCAI 2026.

Published / To Appear

6. Yan Hao Ling, **Zhouhao Yang**, Jonathan Scarlett, "Statistical Mean Estimation with Coded Relayed Observations," To appear in IEEE Transactions on Information Theory, 2025.
7. Zheyuan Hu*, **Zhouhao Yang***, Yezhen Wang*, George Em Karniadakis, Kenji Kawaguchi, "Bias-variance trade-off in physics-informed neural networks with randomized smoothing for high-dimensional PDEs." SIAM Journal on Scientific Computing 47.4 (2025): C846-C872.
8. Qianli Shen, Yezhen Wang, **Zhouhao Yang**, Kenji Kawaguchi et al., "Memory-Efficient Gradient Unrolling for Large-Scale Bi-level Optimization," The Thirty-eighth Annual Conference on Neural Information Processing Systems. 2024.
9. **Zhouhao Yang***, Yihong Guo*, Pan Xu, Anqi Liu, and Anima Anandkumar, "Distributionally robust policy gradient for offline contextual bandits," in International Conference on Artificial Intelligence and Statistics, pages 6443–6462. PMLR, 2023.
10. **Zhouhao Yang**, Xingyu Xu and Yuantao Gu, "A General Framework for Accurate and Private Mean Estimation," in IEEE Signal Processing Letters, vol. 29, pp. 2293-2297, 2022, doi: 10.1109/LSP.2022.3219356.

RESEARCH EXPERIENCE

JHU: Training-free versus Training-based Intent Classification in LLMs: Accuracy, Robustness, and Failure Modes

Aug 2025-Sep 2025

- Professor of guidance: Soufiane Hayou.
- Proposed two lightweight training-free intent classification method that operate on prefill-phase, and developed theory explaining their respective strengths.
- Conducted a systematic empirical study comparing training-free and training-based intent classification across seven LLMs (1B--32B parameters). Both paradigms saturate on easy tasks, while training-based methods typically outperform training-free ones on harder, fine-grained distinctions. Meanwhile, training-free methods are typically more robust to mixed-intent prompts and adversarial rephrasings, making them potentially attractive for practical LLM routing settings where inputs are often noisy or ambiguous.

JHU: A Two-fold Randomization Framework for Impulse Control Problems

Dec 2024-Aug 2025

- Professor of guidance: Haoyang Cao.
- Studied the reinforcement learning framework for impulse control problem, a class of stochastic control problems where the controller cannot continuously adjust the system but instead intervenes at discrete times.
- Designed two randomization methods for impulse control problem (Poisson compound measure/ Relation to optimal stopping) which produces the same HJB equation.
- Proved convergence theorem for randomization approach.
- Designed an actor-critic continuous-time RL algorithm and proved the policy improvement theorem.

NUS: Statistical Mean Estimation with Coded Relayed Observations

May 2024-Aug 2024

- Professor of guidance: Jonathan Scarlett.
- Studied the problem of statistical mean estimation, in which the samples are not observed directly, but are instead observed by a relay (“teacher”) that transmits information through a memoryless channel to the decoder (“student”), who then produces the final estimate.
- Focused on Bernoulli sources and binary symmetric channels, and then sub-Gaussian and heavy-tailed settings along with arbitrary discrete memoryless channels.
- Designed a block-structured strategy, proved its superiority on error rate compared with baselines.

NUS: Bias-Variance Trade-off in Physics-Informed Neural Networks with Randomized Smoothing for High-Dimensional PDEs

Aug 2023-Nov 2023

- Professor of guidance: George Em Karniadakis from Brown University, Kenji Kawaguchi from NUS.
- Conducted in-depth research for physics-informed neural network with randomized smoothing, a backpropagation-free method for high-dim PINN, which addresses the memory and time costs brought by curse of dimension.
- Analyzed the bias-variance trade-off in Randomized Smoothing-PINN training.
- Corrected the bias brought by randomized smoothing in non-linear MSE loss and PDE terms.
- Proposed a hybrid loss function of biased and unbiased version to accelerate convergence of training and improve final accuracy. Biased training loss provides faster convergence, while unbiased training loss ensures better accuracy.
- Conducted extensive experiments on various PDEs including Fokker-Planck, HJB, Allen-Cahn, Sine-Gorden, etc.

NUS: Gradient-Enhanced Physics-Informed Neural Networks with Variance Reduced Randomized Smoothing for High-Order and High-dimensional PDEs

Aug 2023-Jan 2024

- Professor of guidance: George Em Karniadakis from Brown University, Kenji Kawaguchi from NUS.
- Generalized RS-PINN to high-order derivatives and various differential operators.
- Proposed variance reduction methods for randomly smoothed derivative estimators, including antithetic variate method, importance sampling, and Gaussian quadrature.
- Proved that gradient-enhanced techniques are basically free lunch under randomized smoothing, which greatly improves the efficiency of training.
- Conducted thorough experiments on low-dim and high-dim PDEs with RS-GPINN.

Caltech VURP (Visiting Undergraduate Research Program): Distributionally Robust Policy Gradient for Offline Contextual Bandits Mar 2022-Oct 2022

- Professor of guidance: Anima Anandkumar from Caltech, Pan Xu from Duke University.
- Proposed a distributionally robust policy optimization method (DROPO) for offline contextual bandits, addressing the distributional shift between the static logging policy and the learning policy in policy gradient.
- Modelled the distributionally robust policy optimization problem as a minimax optimization problem, which has an analytical framework of solution.
- Generalized the DROPO method to contextual bandits with limited online exploration.
- Provided a generalization bound and a convergence analysis for DROPO.
- Designed and implemented experiments on *UCI Optdigits* and *MNIST*.

A General Framework for Accurate and Private Mean Estimation July 2021-Jun 2022

- Professor of guidance: Yuantao Gu from Tsinghua University.
- Proposed a differentially private mean estimation algorithm for general types of distributions with given cumulative distribution function.
- Proved an upper bound for the algorithm's sample complexity, which is tailored to the cumulative distribution function of underlying population.
- Illustrated that our complexity bound is better in order for heavy-tailed distribution and at least enjoys the same order for light-tailed distribution.
- Designed and implemented experiments on Gaussian distribution and Levy-stable distribution.
- Independently studied the book *"High-dimensional Probability"* written by Roman Vershynin.

Bachelor's Thesis: Machine Learning Methods-Based Inverse Lithography Technology Aug 2021-May 2023

- Professor of guidance: Dan Hu from Shanghai Jiao Tong University.
- Conducted a thorough literature review for the development of Inverse Lithography Technology over past decades.
- Proposed a complete machine learning methods-based ILT framework is proposed, which consists of a sequential framework of machine learning-based ILT and simulated annealing method-based ILT.
- Designed a convolutional neural network (UNet) to learn the mapping from on-wafer patterns to masks.
- Introduced a simulated annealing method based-ILT framework to refine the quasi-optimized masks and achieve better mask quality.
- Implemented the ML-based ILT framework and conducted experiments on ICCAD 2013 dataset.

HONORS AND AWARDS

- Outstanding students Scholarship of Shanghai Jiao Tong University 2019-2023 (four times)
- Honors scholarship for students of Zhiyuan College 2019-2023 (four times)
- Travel Award for Poster Presentation at ECMF9 Sep 2025

TEACHING EXPERIENCE

- Teaching Assistant for Introduction to Computational Mathematics (EN.553.385) Aug 2024-May 2025
- Instructor of Probability Theory at MSE Orientation 2025 Aug 2025

SKILLS

- Python (PyTorch, pandas, numpy, scipy, etc.), MATLAB, Linux