Zexi Fan

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Education

Peking University (PKU) Sep 2022 – Present
B.S., Computational Mathematics
Selected high-grade courses (score): Abstract Algebra (93), Machine Learning (93), Combinatorics (92), Advanced Algebra II (90).

Publications & Preprints

Z. Fan, Y. Sun, S. Yang, Y. Lu. *Physics-Informed Inference Time Scaling via Simulation-Calibrated Scientific Machine Learning*. Preprint (arXiv), Apr 2025. arXiv:2504.16172.

Z. Fan, J. Lu. *Accelerating Non-equilibrium Steady State Sampling in Quantum Markov Processes through Second-Order Lifting*. In preparation (2025), A preliminary version.

Z. Fan, Y. Jin. *Pessimistic Policy Learning for Continuous-Action Bandit Problems without Uniform Overlap*. In preparation (2024), Note.

Research Experience

Accelerating NESS sampling via Second-Order Lifting (Core) Jul 2025 – Present
Advisor: Prof. Jianfeng Lu Duke University

- Introduced a second-order lifting for Lindbladian dynamics; used hypocoercivity and flow-Poincaré techniques to derive provable mixing acceleration to non-equilibrium steady states (NESS).
- Derived spectral-gap bounds and validated speedups on representative quantum Markov chains via numerical experiments.

Continuous-State Contextual Bandit — Pessimism (Core) Aug 2024 – Nov 2025
Advisor: Prof. Ying Jin Harvard University

- Extended pessimism regularization to continuous state/action settings; designed a practical algorithm with confidence penalties adapted to compact action spaces.
- Proved regret guarantees removing the uniform-overlap requirement; developed concentration bounds for continuous policies.

SCaSML: Simulation-Calibrated Scientific ML (Core) Jun 2024 – Apr 2025
Advisors: Prof. Yiping Lu, Dr. Yan Sun Northwestern & Georgia Tech

- Built a calibration pipeline combining PINN/Gaussian surrogates, randomized MLMC and Multilevel Picard iterations to correct surrogate bias for high-dimensional semilinear PDEs.
- Demonstrated improved complexity scaling on 100d+ benchmarks; released code and benchmarks: SCaSML.

Flow-Calibrated RL for Transition Path Sampling Feb 2024 – Jun 2024
Advisors: Prof. Yiping Lu, Dr. Dinghuai Zhang NYU Courant & Mila

- Recast transition-path sampling as a Schrödinger-bridge problem; developed continuous SAC / GFlowNet variants and validated on model SDEs.

Unbiased Square-Root Convergent Estimator for High-Dim PDEs Sep 2023 – Feb 2024
Advisor: Prof. Yiping Lu NYU Courant

- Constructed an unbiased estimator using Multilevel Picard and randomized MLMC; proved bounded variance and improved statistical cost scaling.

Selected Coursework & Academic Activities

Graduate-level: High-Dimensional Probability; Applied Stochastic Analysis; Optimization Methods; Mathematical Processing; Machine Learning.

Seminars: Stochastic Optimal Control; LLMs & Scientific Computing; Blowup in Fluid Equations.

Summer school: "Beauty of Theoretical Computer Science" (NJU), Summer 2024.

Technical Skills

Programming: Python, MATLAB, LaTeX, Bash, Markdown.

Libraries & Tools: PyTorch, JAX, NumPy, SciPy, DeepXDE, Weights & Biases.

Numerical methods & Solvers: Multilevel Picard, MLMC; optimization solvers: Gurobi, Mosek.

Mathematical tools: Stochastic analysis, hypocoercivity, concentration inequalities, optimal transport.

Languages: Mandarin (native); English (fluent).

Service & Leadership

Academic & Innovation Dept., SMS Student Union — Spring 2023
English Debate Club — Summer 2024

Memberships & Invitations

Member, OpenAI Emerging Talent Community.

Member, Valance Lab Community.

Invited reviewer / contributor for *Pure and Applied Mathematics Journal*, *Conference on Applied Mathematics and Information Technology*, *Conference on Computer, Communication and Control Engineering*, *Molecules*, and *World Journal of Mathematics and Statistics*.

Invited participant, Cerebras × Cline Vibe Coder Hackathon, Supervised Program for Alignment Research(SPAR).

Available upon request: references, code links, and extended publication list.