Chenghao Liu

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Education

City University of Hong Kong — Hong Kong
Ph.D. | Department of Data Science — 2022/09 – 2026/07
Advisor: Prof. Minghua Chen

Zhejiang University — Hangzhou, Zhejiang
B.Sc. | School of Mathematical Sciences — 2018/09 – 2022/07
GPA: 3.8/4.0, Rank: Top 20%

Research Interests

Deep Learning Theory, Learning + Optimization

Approximation Theory

- universal approximation capability of neural networks
- curse of dimensionality: between theory and practice

Learning Theory

- how mathematical principles can be applied to understand and improve the learning processes of algorithms.

Learning for Optimization

- algorithms, convergence rates
- learning-based optimization

Publication

Conference Proceedings — †: Corresponding Authors; ∗: Equal Contribution

- Characterizing ResNet's Universal Approximation Capability.
  Chenghao Liu, Enming Liang, Minghua Chen†.
  in Proceedings of the 41st International Conference on Machine Learning (**ICML 2024**).
- ReLU Network with Width $d + \mathcal{O}(1)$ Can Achieve Optimal Approximation Rate.
  Chenghao Liu, Minghua Chen†.
  in Proceedings of the 41st International Conference on Machine Learning **(ICML 2024)**.
- Fast Projection-Free Approach (without Optimization Oracle) for Optimization over Compact Convex Set.
  Chenghao Liu, Enming Liang†, Minghua Chen†.
  in Proceedings of the 39th Annual Conference on Neural Information Processing Systems (**Spotlight–top 3.3%, NeurIPS 2025**)

Ongoing Work

Learning-Based Optimization Methods

- **Fast Learning-Based Projection-Free Approach for Optimization over Ball-Homeomorphic Set.** This work aims to design a novel projection-free method for optimization over ball-homeomorphic (BH) constraint sets. Our approach utilizes a (learned) homeomorphic mapping between the constraint set and a unit ball to transform the original optimization problem into a ball-constrained problem, while maintaining landscape properties and convergence guarantees. This transformation enables efficient projection-free first-order optimization methods in the transformed space.

- **Fast (Learning-Based) Projection-Free Approach for Constrained Optimization on Manifolds.** For non-convex optimization with manifold (non-linear) equality constraints, existing methods will incur an expensive cost of solving the non-linear equality constraints in each iteration. This work aims to address this gap. We consider a (geodesic convex) constrained optimization on manifolds and utilize a constructed/learned homeomorphism to transform the optimization to a ball optimization in the tangent space at a given interior point of the constrained set. Convergence rate and performance analysis need to be investigated further.

Approximation Theory in Deep Learning

- **On Learning Solution Mapping of the Multi-Parametric Quadratic Programming (MPQP) without the Curse of Dimensionality.** MPQP arises in many applications, such as power flow optimization and model predictive control (MPC). Recently, learning-based methods have been widely adopted to accelerate the inference of MPQP solutions. In practice, small feedforward neural networks (FNNs) can effectively learn the solution mapping. However, theoretical results suggest that approximating continuous functions suffers from the curse of dimensionality, revealing a gap between theory and practice. This discrepancy motivates further investigation into the underlying mathematical structure of the mpQP solution mappings.

Awards & Honors

B.Sc. in Zhejiang University 2018-2022

- Academic Excellence Award (top 20%) | 2019-2020
- Zhejiang University Scholarship-Third Prize | 2019-2020
- Academic Excellence Award (top 10%) | 2020-2021
- Zhejiang University Scholarship-Third Prize | 2020-2021

Ph.D. in City University of Hong Kong 2022-2026

- **Institutional Research Tuition Scholarship 2024**
- **Outstanding Academic Performance Award 2024**

Professional Services

Conference Reviewer

- Conference on Neural Information Processing Systems (NeurIPS) 2025
- Conference on International Conference on Learning Representations (ICLR) 2026

Tutorial & Teaching

Teaching Assistant at CityU, HK 2023-present

- 2023/24 Semester B | SDSC3060 Operations Research
- 2024/25 Semester A | SDSC3019 Intro to Networked Life & DS
- 2024/25 Semester B | SDSC3060 Operations Research
- 2025/26 Semester A | SDSC6011 Optimization for Data Science