Qingyu Song

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EDUCATION

The Chinese University of Hong Kong, Hong Kong, China 2021-2025
Ph.D., Computer Science and Engineering
Advisor: Prof. Hong Xu
Thesis: Exploring the Foundation of Learning to Optimize: From Practice to Theory.

Tsinghua University, Beijing, China 2018-2021
M.S., Control Engineering
Advisor: Prof. Jianming Hu
Thesis: Traffic Time Series Data Prediction with Graph Neural Networks.

Harbin Institute of Technology, Weihai, China 2014-2018
B.S., Software Engineering
Advisor: Dr. Xuefeng Piao
Thesis: Vehicle Trajectory Cleaning and Traffic Flow Prediction with Deep Learning Methods.

RESEARCH INTEREST

I am broadly interested in (theoretical) foundations and applications of deep learning on the following topics:

- Optimization in Deep Learning. [A2]
- Learning to Optimize. [A2, A1, C7, C6, C5, W2, W1]
- AI for Network Management. [C7, C5, W2, W1]
- Communication Efficient Federated Learning. [C4]
- Graph Neural Networks. [C5, W2, W1, C3, C1]
- Time Series Prediction. [C3, C1]

PUBLICATIONS

In submission

A2. **Qingyu Song**, Wei Lin, and Hong Xu. "Learning Provably Improves the Convergence of Gradient Descent." arXiv preprint arXiv:2501.18092 (2025).

A1. Wei Lin, **Qingyu Song**, and Hong Xu. "Adaptive Coordinate-Wise Step Sizes for Quasi-Newton Methods: A Learning-to-Optimize Approach." arXiv preprint arXiv:2412.00059 (2024).

Conference Proceedings

C7. Siyong Huang, **Qingyu Song**, Kexin Yu, Zhaoning Wang, Zhizhen Zhong, Qiao Xiang, and Jiwu Shu. "Toward Scalable Learning-Based Optical Restoration". In ACM APNet, 2025.

C6. **Qingyu Song**, Wei Lin, Juncheng Wang, Hong Xu. Towards Robust Learning to Optimize with Theoretical Guarantees. In IEEE/CVF CVPR, 2024.

C5. **Qingyu Song**, Juncheng Wang, Jingzong Li, Guocheng Liu, Hong Xu. A Learning-only Method for Multi-Cell Multi-User MIMO Sum Rate Maximization. In IEEE INFOCOM, 2024.

C4. Yu Zhang, Wei Lin, Sisi Chen, **Qingyu Song**, Jiaxun Lu, Yunfeng Shao, Bei Yu, Hong Xu. Fed2Com: Towards Efficient Compression in Federated Learning. In IEEE ICNC, 2024.

C3. **Qingyu Song**, RuiBo Ming, Jianming Hu, Haoyi Niu, Mingyang Gao. Graph Attention Convolutional Network: Spatiotemporal Modeling for Urban Traffic Prediction. In IEEE ITSC, 2020.

C2. Jinhua Chen, **Qingyu Song**, Can Zhao, Zhiheng Li. Graph Database and Relational Database Performance Comparison on a Transportation Network. In ICACDS, 2020.

C1. **Qingyu Song**, Jianming Hu, Ruobing Zhang, Zuo Zhang. An Urban Topological Map Generation Method for Traffic Flow Prediction Based on Road Segment Clustering with Floating Vehicle Trajectory Dataset. In COTA CICTP, 2019.

Workshops

W2. **Qingyu Song**, Guocheng Liu, Hong Xu. Learning to Optimize Non-Convex Sum-Rate Maximization Problems. In ICML 2023, 1st Workshop on Synergy of Scientific and Machine Learning Modeling.

W1. **Qingyu Song**, Guocheng Liu, Hong Xu. Towards a Learning-Only Approach for Non-Convex Sum Rate Maximization. In ACM SigMetrics 2023, 1st Workshop on Learning-augmented Algorithms: Theory and Applications.

RESEARCH & WORK EXPERIENCE

Jan. 2025 - Apr. 2025 Intern, Huawei Noah's Ark Lab. Mentor: Dr. Hui-Ling Zhen
Project: LLM Quantization.
We comprehensively evaluate the on-device LLM inference framework (Llama.cpp) and different quantization methods.
Mar. 2024 - Jan. 2025 CUHK Advisor: Prof. Hong Xu
Project: Learning Provably Improves the Convergence of Gradient Descent.
We try to prove the convergence of an algorithm unrolling (under-parameterized) system in solving quadratic programming problems. The key idea is to avoid exploding in unrolling process by the convergence of back bone algorithm.

Sep. 2023 - Dec. 2023 CUHK Advisor: Prof. Hong Xu, Prof. Juncheng Wang (HKBU)
Project: Convergence Analysis of Learning to Optimize (L2O) in Out-of-Distribution (OOD) Scenarios
We define L2O's OOD problem and rigorously analyze its effect on convergence. The key idea is to align sequences generated by the L2O model between OOD and InD scenarios. We achieve quantization of OOD and derive convergence rates with rigorous OOD formulations.

Nov. 2022 - May. 2023 Visiting Researcher, Huawei Noah's Ark Lab Mentor: Dr. Guochen Liu
Project: Learning-Based Precoding for Multi-Cell, Multi-User MIMO Interference Reduction.
We propose a learning-only method for solving the MIMO SINR maximization problem. The key idea is to unroll a SOTA non-learning algorithm with Graph Neural Networks and improve solvability by learning a mapping to construct a higher dimensional equivalent problem.

Nov. 2020 - May. 2021 Research Assistant, Tsinghua University Advisor: Prof. Jianming Hu
Project: National Key R&D Program, 5.1 Efficient and Intelligent Vehicle-to-Vehicle Networking Technology for Tokyo Olympics, Topic 2 - Research on Traffic State Perception System.
We design a state perception system for V2X scenarios with a software engineering methodology and a generative

model to predict the trajectories of vehicles and pedestrians. The key idea for trajectory prediction is based on an existing SOTA conditional-VAE model. We propose a heterogeneous attention scheme based on semantics in traffic scenarios and apply a two-layer GRU to memorize trajectories of itself and neighbors.

Jan. 2020 - May. 2020 Research Assistant, Tsinghua University Advisor: Prof. Jianming Hu
Project: Graph Neural Network-based Traffic Flow Prediction.
We utilize attention mechanism and graph neural networks to improve the accuracy of traffic flow prediction on benchmarks. The key idea is to fully use attention methods in spatial and temporal modeling and use temporal graph convolution networks to achieve faster temporal modeling than RNN methods.

Mar. 2018 - May. 2018 UG Research Assistant, Tsinghua University Advisor: Prof. Jianming Hu
Project: Vehicle Traffic Trajectory Data Cleaning and Augmentation.
We eliminate extreme outliers using the Kalman filter and project slight outliers to road map using the shortest path algorithm.

Oct. 2017 - Jan. 2018 R&D Intern, NEBULA-LINK Internet Technology Co., Ltd. Mentor: Dr. Yizhi Wang
Project: Android App Development and Data Analysis for Advanced Driver Assistance Systems.
We develop a client in a real-time system to read and present ADAS data from V2X devices.

May. 2016 - May. 2017 Part-time R&D Intern, HITWH Mentor: Dr. Xuefeng Piao
Project: Android App Development for Inspection System with Client/Server Architecture.
We develop a Client-Server system to support on-campus inspections and inspections for the water resource bureau of the People's Government of Jining City. The main tasks include the definition of inspections, system design, and pattern of client application. The developed application achieves checking-in with the NFC technique and data downloading and picture uploading with the server.

TEACHING ASSISTANT

Spring 2022	CUHK CSCI 4430 / ESTR 4120, Data Communication and Computer Networks
Spring 2021	CUHK CSCI 4430, Data Communication and Computer Networks
Fall 2021	CUHK ENGG 2760A / ESTR 2018: Probability for Engineers

AWARDS

Mar. 2024 Student Travel Grant, IEEE INFOCOM 2024.

Jul. 2023 Registration Grant, ICML 2023, 1st Workshop on Synergy of Scientific and Machine Learning Modeling.

2021 - 2025 Full Postgraduate Studentship, CUHK.

2019 - 2020 First Honor and Second Honor Scholarships, SIGS Tsinghua University.

Jun. 2018 Outstanding Graduate Award at Provincial Level, People's Government of Shandong Province.

2015 - 2017 First Honor and Second Honor Scholarships, Harbin Institute of Technology, Weihai.

SERVICES

Conference Reviewer: ICLR 2025, IJCAI 2025, ICML 2025, NeurIPS 2025, ECAI 2025.

Journal Reviewer: TNSE.

Updated April 2025