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

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:

- Deep Learning Efficiency: Theoretical model/training analysis and improvement.
- Learning to Solve Optimization Problems. [C6, C5, W2, W1]
- Learning-Augmented Multi-Cell Multi-User MIMO Interference Reduction. [C5]
- Communication Efficient Federated Learning. [C3]
- Graph Neural Networks for Time Series Analysis. [C5, C3, C1, W2, W1]

PUBLICATIONS

Conference Proceedings

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

Mar. 2024 - Now CUHK Advisor: Prof. Hong Xu
Project: Convergence of Training An Algorithm-Embedded Under-parameterized System
We try to prove the convergence of an algorithm unrolling (under-parameterized) system for solving quadratic programming problems. The key idea is to eliminate the strict constraints in the Neural Tangent Kernel method by learning a bounded hyper-parameter in the unrolling process.

Sep. 2022 - 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 Student Visiting Researcher, Huawei Mentor: Dr. Guochen Liu
Project: Learning-based Precoding for 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.

Jan. 2020 - Aug. 2020 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.

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: ADAS Android App Development and Data Analysis.
We develop a client in a real-time system to monitor ADAS data from V2X devices.

May. 2016 - Sep. 2017 UG R&D Intern, HITWH Mentor: Dr. Xuefeng Piao
Project: Android App Development for Inspection System.
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.

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 Scholarship with First Honor, Second Honor, SIGS Tsinghua University.

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

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

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