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Pengyu Liu

Research Interests

Quantum Error Correction; Quantum Computer Architecture and Systems; Quantum Compilers

Education

2023.09 - Present **Carnegie Mellon University**
- Ph.D. Student, Computer Science Department
- Advisor: Prof. Umut A. Acar

2019.09 - 2023.06 **Tsinghua University**
- BEng in Computer Science, Institute for Interdisciplinary Information Sciences, founded by Prof. Andrew Yao
- Advisor: Prof. Xiongfeng Ma
- GPA: 3.98/4.00 (TOP 1/30)

Selected Honors and Awards

2023 **1st/73 Place** of ACM/IEEE Quantum Computing for Drug Discovery Challenge
2022-2023 **Honored graduate**, Beijing
2022-2023 **Honored graduate**, Tsinghua University (2/91)
2021-2022 **Comprehensive Excellent Award**, Tsinghua University
2021-2022 **Yao Award**, Institute for Interdisciplinary Information Sciences
2020-2021 **Comprehensive Excellent Award**, Tsinghua University
2020-2021 **Outstanding Youth**, Tsinghua University (2/91)
2019-2020 **Comprehensive Excellent Award**, Tsinghua University (1/91, Highest honor)
2018 **Gold Medal**, Chinese Physics Olympiad (Rank 7^{th} nationwide)
2018 **First Prize**, Chinese Physics Olympiad Provincial (Rank 1^{st} in Hebei Province)

Publications

*: Equal Contribution

QCE'25 **ConiQ: Enabling Concatenated Quantum Error Correction on Neutral Atom Arrays**
Pengyu Liu, Mingkuan Xu, Hengyun Zhou, Hanrui Wang, Umut A. Acar, Yunong Shi
IEEE International Conference on Quantum Computing and Engineering

QCE'25 **Local Optimization of Quantum Circuits**
Jatin Arora, Mingkuan Xu, Sam Westrick, **Pengyu Liu**, Dantong Li, Yongshan Ding, Umut A. Acar
IEEE International Conference on Quantum Computing and Engineering
Best Paper Award(1st place)

SPAA'25 **POPQC: Parallel Optimization for Quantum Circuits**
Pengyu Liu, Jatin Arora, Mingkuan Xu, Umut A. Acar
ACM Symposium on Parallelism in Algorithms and Architectures

QCE'24 **GraFeyn: Efficient Parallel Sparse Simulation of Quantum Circuits**
Sam Westrick, **Pengyu Liu**, Byeongjee Kang, Colin McDonald, Mike Rainey, Mingkuan Xu, Jatin Arora, Yongshan Ding, Umut A. Acar
IEEE International Conference on Quantum Computing and Engineering
Best Paper Award(2nd place)

ISCA'24 **Atomique: A Quantum Compiler for Reconfigurable Neutral Atom Arrays**
Hanrui Wang, **Pengyu Liu**, Bochen Tan, Yilian Liu, David Z. Pan, Jason Cong, Umut Acar, Song Han
The International Symposium on Computer Architecture

DAC'24 **Q-Pilot: Field Programmable Qubit Array Compilation with Flying Ancillas**
Hanrui Wang, Bochen Tan, **Pengyu Liu**, Yilian Liu, Jiaqi Gu, Jason Cong, Song Han
Design Automation Conference (DAC), 2024

POPL'24 **SimuQ: A Domain-Specific Language For Quantum Simulation With Analog Compilation**
Yuxiang Peng, Jacob Young, **Pengyu Liu**, and Xiaodi Wu
51st ACM SIGPLAN Symposium on Principles of Programming Languages
Distinguished Paper Nominated

PRL **Fundamental Limitation on the Detectability of Entanglement**
Pengyu Liu, Zhenhuan Liu, Shu Chen, and Xiongfeng Ma
Physical Review Letters 129, 230503 (2022)
Editors' Suggestion (Top 16%)

TQC **Fundamental Limitation on the Detectability of Entanglement**
Pengyu Liu, Zhenhuan Liu, Shu Chen, and Xiongfeng Ma
Conference on the Theory of Quantum Computation, Communication and Cryptography

PRL **Detecting Entanglement in Quantum Many-body Systems via Permutation Moments**
Zhenhuan Liu, Yifan Tang, Hao Dai, **Pengyu Liu**, Shu Chen, and Xiongfeng Ma
Physical Review Letters 129, 260501 (2022)

ICCAD'22 **QuEst: Graph Transformer for Quantum Circuit Reliability Prediction**
Hanrui Wang, **Pengyu Liu**, Jinglei Cheng, Zhiding Liang, Jiaqi Gu, Zirui Li, Yongshan Ding, Weiwen Jiang, Yiyu Shi, Xuehai Qian, David Z. Pan, Frederic T. Chong, Song Han
IEEE/ACM International Conference on Computer-Aided Design (ICCAD), 2022

Workshop Papers

FastML at ICCAD'23 **ResilienQ: Boosting Fidelity of Quantum State Preparation via Noise-Aware Variational Training**
Hanrui Wang*, Yilian Liu*, **Pengyu Liu***, Song Han

FastML at ICCAD'23 **TT-QEC: Transferable Transformer for Quantum Error Correction Code Decoding**
Hanrui Wang, **Pengyu Liu**, Kevin Shao, Dantong Li, Jiaqi Gu, David Z. Pan, Yongshan Ding, Song Han

ScaleOPT at NeurIPS'25 **Quantum-Inspired Hamiltonian Descent for Mixed-Integer Quadratic Programming**
Shreya Chaudhary, Jinglei Cheng, Samuel Kushnir, Jiaqi Leng, **Pengyu Liu**, Yuxiang Peng, Hanrui Wang, Xiaodi Wu

Preprints & In-preparation

APS March Meeting'26 **Efficient Atom Loss Decoding via Pauli Boundedness and Adaptive Re-weighting**
Pengyu Liu, Shi Jie Samuel Tan, Eric Huang, Umut A. Acar, Hengyun Zhou, Chen Zhao

DGR: Tackling Drifted and Correlated Noise in Quantum Error Correction via Decoding Graph Re-weighting
Hanrui Wang*, **Pengyu Liu***, Yilian Liu, Jiaqi Gu, Jonathan Baker, Frederic T. Chong, Song Han

Teaching Experiences

2026 **Teaching Assistant** "15-459: Undergraduate Quantum Computation"
2023 **Teaching Assistant** "General Physics"
2022 **Teaching Assistant** "Quantum Communication and Cryptography"

Working and Exchanging Experiences

2025.05 - 2025.08 **QuEra Computing Incorporated**, *Boston, MA*, Research Intern
- Advised by Dr. Chen Zhao.
- Worked on characterizing the effect of atom loss on quantum error correction, designing syndrome extraction and decoding strategies.

2022.07 - 2023.06 **Massachusetts Institute of Technology**, *Boston, MA*, Research Assistant
- Advised by Prof. Song Han.
- Worked on quantum machine learning and quantum computer architecture.

2022.03 - 2022.11 **University of Maryland**, *College Park, MD*, Research Assistant
- Advised by Prof. Xiaodi Wu.
- Worked on analog quantum simulation.

Academic Services

2022-present Student Volunteer Quantum Computer System Lecture Series
2022-2023 Member of organizing committee of Yao Seminar

Journal Reviewer,
- IEEE Transactions on Quantum Engineering
- ACM Transactions on Quantum Computing
- Journal of Parallel and Distributed Computing
- Quantum Information Processing
- Future Generation Computer Systems
- ACM Computing Surveys

Conference Reviewer,
- IEEE International Conference on Quantum Computing and Engineering (2024, 2025),
- ACM Symposium on Parallelism in Algorithms and Architectures (2025)