Zihan Chen

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Education

Rutgers University — New Brunswick, New Jersey
Ph.D. in Computer Science — *Expected in 2029*
Advised by Dr. Eddy Z. Zhang
M.Sc. in Computer Science — *Sep. 2022 – May 2024*

Nanjing University of Information Science & Technology — Nanjing, China
B.E. in Telecommunication Engineering — *Sep. 2018 – May 2022*
Changwang School of Honors, *joint program with* University of Chinese Academy of Sciences

Selected Publications

[1] **Zihan Chen***, Jiakang Li*, Minghao Guo*, Henry Chen, Zirui Li, Joel Bierman, Yipeng Huang, Huiyang Zhou, Yuan Liu, Eddy Z. Zhang. 2025. *Genesis: A Compiler for Hamiltonian Simulation on Hybrid CV-DV Quantum Computers.* In *Proceedings of the 52nd Annual International Symposium on Computer Architecture (ISCA '25).*

[2] **Zihan Chen**, Henry Chen, Yuwei Jin, Minghao Guo, Enhyeok Jang, Jiakang Li, Caitlin Chan, Won Woo Ro, Eddy Z. Zhang. 2025. *PhasePoly: An Optimization Framework for Phase Polynomials in Quantum Circuits. arXiv preprint arXiv:2506.20624.*

* indicates equal contribution.

Projects

Compilation for Hamiltonian Simulation on Hybrid CV-DV Quantum Computers
Genesis Compiler: ISCA'25 & Slides & Code — *May 2024 – Present*

Developed **Genesis**, the first end-to-end compiler framework for Hamiltonian simulation on hybrid continuous-variable (CV) and discrete-variable (DV) quantum computers, supporting multi-level quantum computing compilation and hardware-specific circuit mapping

- Designed and implemented a hybrid CV–DV domain-specific language (DSL) with a compiler pipeline built using Python and ANTLR, developing the **Hamiltonian Grammar** and **CVDV-QASM** to translate mathematical Hamiltonian expressions into multiple intermediate representations (IRs) and efficiently compile them into optimized low-level CV–DV quantum gate sequences
- Automated the decomposition of complex Hamiltonian terms for fermionic and bosonic operators using **recursive template rewriting**, applying product formulas and block-encoding techniques as pattern-matching templates to replace manual derivations and enable symbolic compilation of numerically challenging decompositions
- Addressed emerging hybrid CV–DV hardware compilation challenges through connectivity-aware gate synthesis and circuit mapping analogous to discrete-variable systems, incorporating ancilla qumode routing and SWAP insertion for both qumode–qumode and qubit–qumode operations
- Developed and maintained installation and grammar documentation, and integrated debugging modes, comprehensive unit tests for Hamiltonian term decomposition, statistics collection, and batch-processing capabilities to enhance usability and scalability
- Upcoming development goals include faster pattern-matching performance, greater flexibility based on bosonic opeartors' commutation rules, and enhanced analysis of decomposition correctness and approximation levels

Optimization for Quantum Circuits Compilation
PhasePoly Optimizer: Arxiv & QCE'25 Poster & Available Soon — *Aug. 2024 – Present*

Developed PhasePoly, a quantum circuit optimization framework that systematically reduces and synthesizes phase-polynomial quantum circuits composed of **CNOT and** R_z gates

- Developed a comprehensive **circuit co-optimization pass** that unifies phase rotations and qubit state transformations into a single parity-matrix representation, enabling holistic optimization of both the phase-gate implementation network and the output-state CNOT network, and overcoming the limitations of prior methods that handled these components separately
- Implemented a size-bounded **A-star** search algorithm to efficiently explore large solution spaces, achieving up to 50% total gate reduction (avg. 35.83%) and up to 48.57% CNOT gate reduction (avg. 27.9%) on standard benchmark circuits, outperforming state-of-the-art optimizers

- Broke through the limitations of traditional circuit optimizer in handling dependencies by merging phase-polynomial blocks together and exploring the reuse of identical qubit states to enable more efficient circuit synthesis
- Demonstrated superior scalability and optimization efficiency over leading subcircuit-rewrite quantum circuit optimizers (e.g., QUESO, Quartz) and legacy phase-polynomial frameworks (e.g., GRAY-SYNTH), particularly for large circuits (100–400 qubits), through holistic phase-polynomial optimization and multi-block merging techniques
- Enabled hardware-efficient optimizations by synthesizing subcircuits compatible with linear-connectivity constraints, significantly simplifying physical qubit mapping and reducing the need for SWAP-gate insertions on sparse-connectivity quantum hardware
- Aiming to introduce them to the fault-tolerant T-gate injection strategy to help FTQC era circuit optimization

Experience

Software Engineer Intern, CARINA AI | Python, C# Remote, USA
Mentor: Dr. Feng Xue. Contributed to INTContour, DeIdentifier, and AutoBrachy *May 2023 – May 2024*

Converted GPU-based products from local server deployment to a secure cloud solution, maintaining full compliance with medical privacy regulations

- Extracted medical imaging data and diagnostic reports from clinic databases using C# and Python APIs, utilized **DICOM** protocols and **FHIR** standard for querying and retrieval
- Employed cryptographic hashing algorithms for the **deidentification** and subsequent **reidentification** of client local data, establishing an index table that maps original values to their encrypted counterparts
- Optimized cloud-based querying and retrieval of the image segmentation and quality assurance process
- Designed data-forwarding nodes specifically to meet the operational demands of clinics' cloud platforms, ensuring strict data security standards and seamless integration
- Refactored codebases using **MVVM** to enhance modularity, accelerating the development of the following products

Teaching Assistant New Brunswick, New Jersey
Rutgers University *Sep. 2023 – Present*

- CS 336: Principles of Information and Data Management (**3 times**)
- ECE 568: Software Engineering of Web Applications (**1 time**)
- ECE 518: Mobile Embedded Systems and On-Device AI (**1 time**)

Academic Service

Co-organizer of Rutgers QEC: Theory and Systems Reading Group

- Organized weekly reading groups discussing Quantum Error Correction (QEC), covering theoretical concepts, compiler optimizations, and AI-driven techniques.
- One group of presenter(s) each week, followed by group discussion and Q&A session.

Conference Subreviewer

- QCE'25

Artifact Evaluation Committee

- SOSP'25
- MICRO'25

Talks and Presentations

[Talk] Compiler framework on hybrid CV-DV quantum computers for Hamiltonian simulation
North Carolina State University CV-DV Group Meeting. *Remote. May 21, 2025.*

- Slides Available

Selected Patents

- Chinese Patent CN114388129B, *Atherosclerosis Risk Prediction Method Based on Dynamic Information Value Criterion and Ensemble Learning.*
- Chinese Patent CN114550941B, *Low-redundancy Atherosclerosis Risk Prediction Method Based on Dijkstra's Algorithm.*

Skills

Programming: Python, C++, C#, Java, Go, JavaScript, SQL
Libraries: Qiskit, BQSKit, PyTorch, Scikit-learn
Developer Tools: Git, Docker, AWS, Google Cloud
Miscs: Powerlifting, Boxing, Chess, Yo-Yo Ma's Music