YUXIANG PENG

Department of Computer Science
University of Maryland, College Park, USA
+1 2406599240 | ypeng15@umd.edu

EDUCATION

University of Maryland, College Park — Maryland, USA
Ph.D. candidate in Department of Computer Science — Sep. 2019 – Present
Master in Department of Computer Science — Sep. 2019 – June 2022

Tsinghua University — Beijing, China
Bachelor in Institute for Interdisciplinary Information Science — Sep. 2015 – June 2019
Bachelor in Department of Mathematical Science (Double Major) — Sep. 2016 – June 2019

PUBLICATIONS

(*: equal contribution)

1. **Yuxiang Peng**, Jacob Young, Pengyu Liu, Xiaodi Wu, "SimuQ: A Domain-Specific Language For Quantum Simulation With Analog Compilation", *arXiv preprint: 2303.02775, 2023.*
2. **Yuxiang Peng**, Kesha Hietala, Runzhou Tao, Liyi Li, Robert Rand, Michael Hicks, Xiaodi Wu, "A Formally Certified End-to-End Implementation of Shor's Factorization Algorithm", *Proceedings of the National Academy of Sciences 120.21 (2023): e2218775120.*
3. Haowei Deng, **Yuxiang Peng,** Micheal Hicks, Xiaodi Wu, "Automating NISQ Application Design with Meta Quantum Circuits with Constraints (MQCC)", *ACM Transactions on Quantum Computing (TQC), Volume 4, Issue 3, 2023.*
4. Jiaqi Leng*, **Yuxiang Peng***, Yi-Ling Qiao*, Ming Lin, Xiaodi Wu, "Differentiable Analog Quantum Computing for Optimization and Control", *the 36th Conference on Neural Information Processing Systems (NeurIPS 2022)*
5. Liyi Li, Finnegan Voichick, Kesha Hietala, **Yuxiang Peng**, Xiaodi Wu, Michael Hicks, "Verified Compilation of Quantum Oracles", *Object-Oriented Programming, Systems, Languages & Applications (OOPSLA), 2022.*
6. **Yuxiang Peng**, Mingsheng Ying, Xiaodi Wu, "Algebraic Reasoning of Quantum Programs via Non-idempotent Kleene Algebra", *Proceedings of the 43rd ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI 2022).*
7. Ming-Han Li, Xingjian Zhang, Wen-Zhao Liu, Si-Ran Zhao, Bing Bai, Yang Liu, Qi Zhao, **Yuxiang Peng**, Jun Zhang, Yanbao Zhang, William J. Munro, Xiongfeng Ma, Qiang Zhang, Jingyun Fan, Jian-Wei Pan, "Experimental Realization of Device-Independent Quantum Randomness Expansion", *Physical Review Letters 126.5 (2021): 050503.*
8. Yilun Chen*, Zhicheng Wang*, **Yuxiang Peng**, Zhiqiang Zhang, Gang Yu, Jian Sun, "Cascaded Pyramid Network for Multi-Person Pose Estimation", *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2018*.

SELECTED RESEARCH EXPERIENCE

University of Maryland (Joint Center of Quantum Information and Computer Science) — Maryland, USA
Ph.D. candidate under the supervision of Professor Xiaodi Wu — Sep. 2019 – Present

Framework for quantum simulation on analog quantum simulators

- Built SimuQ, the first domain-specific language for Hamiltonian simulation that supports pulse-level compilation to heterogeneous analog quantum simulators.
- Proposed Hamiltonian modeling language for programming quantum systems, and provided programmability of analog simulators specified through a new abstraction called the abstract analog instruction set.
- Provided multi-platform supports for SimuQ, including QuEra's Rydberg systems, IBM's superconducting systems, and IonQ's ion trap systems.

Differentiation of analog quantum computing

- Established a differentiable framework for quantum devices with analog control.
- Analyzed the framework's efficiency and robustness.
- Applied it to quantum optimization problems (ground state search and max-cut search) and quantum control problems (state preparation and gate synthesis) and obtained significant performance improvements.

Formal certification of end-to-end implementation of Shor's algorithm

- Implemented Shor's algorithm in SQIR, a quantum programming language embedded in Coq.
- Built reversible circuit intermediate representation (RCIR) in Coq, and implemented and certified modular exponentiation in RCIR.

- Formally certified our end-to-end implementation, including reduction of factorization to order finding, continued fraction expansion, and quantum phase estimation on modular exponentiation.
- Extracted the code to OCaml to generate quantum circuits in OpenQASM, and simulated them by DDSIM.

Reasoning of quantum while-programs via non-idempotent Kleene algebra (NKA)

- Studied NKA, a variant of Kleene algebra, and derivable rules in it.
- Established quantum path model, a sound and complete model of NKA, and linked it to quantum programs.
- Algebraically validated several quantum compiler rules via NKA.
- Proved a normal form theorem for quantum while-programs.
- Extended NKA with tests and reasoned about propositional quantum Hoare logic.

University of Maryland (Joint Center of Quantum Information and Computer Science) Maryland, USA
Visiting student under the supervision of Professor Andrew Childs and Professor Xiaodi Wu Mar. 2018 – Sept. 2018

Analysis of invariants from quantum programs

- Solved the invariants for several specific quantum programs like Grover's and repeat-until-success algorithms.
- Analyzed the approximate invariant of quantum programs and applied it to programs with noises.

Resource estimation of the quantum walk-based Hamiltonian simulation algorithm

- Employed Quipper, a quantum programming language embedded in Haskell, to implement quantum walk-based Hamiltonian simulation algorithm.
- Analyzed the errors in the implementation.
- Benchmarked the quantum walk-based Hamiltonian simulation algorithm on Heisenberg model.

WORK EXPERIENCE

Megvii Inc. Beijing, China
Research intern, detection group (mentor: Gang Yu). Nov. 2015 – Oct. 2017

Human pose estimation

- Employed neural networks to estimate the confidence map of human pose, designed new architectures, and used large models' ensemble to predict single-person pose estimation, which makes use of feature extraction and context understanding process in neural networks.
- Exploited the bounding box detection framework and modified the post-processing to predict multiple-person pose estimation.
- Increased the average AP of multi-person pose estimation by 7.5% (65.5%→73.0%)
- Participated in the Common Object in Context (COCO) keypoints challenge held by Microsoft, and won fourth place in 2016, and first place in 2017.

SELECTED AWARDS AND HONORS

- University of Maryland Invention of the Year Award, Finalist 2023
- ACM Student Research Competition of POPL, Second Place of Graduate Category 2021
- Yao Award, Bronze Medal 2018
- Chinese Outstanding Patented Invention Award, Honorable Mention 2018
- Common Objects in Context, Keypoints Challenge Track, First Place 2017
- Common Objects in Context, Keypoints Challenge Track, Fourth Place 2016