USC Viterbi School of Engineering
Ming Hsieh Department of Electrical and Computer Engineering

Seminar

A Hybrid Computing Ecosystem for Practical Quantum Advantage

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10:00am – 11:00am
EEB 248
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Abstract: As quantum computing transforms from lab curiosity to technical reality, we must unlock its full potential to enable meaningful benefits on real-world applications with imperfect quantum technology. Achieving this vision requires computer architects to play a key role, leveraging classical computing principles to build and facilitate a hybrid computing ecosystem for practical quantum advantage.

First, I will introduce my four research thrusts toward building this hybrid ecosystem: Classical Application Transformation, Adaptive Noise Mitigation, Scalable Error Correction and Efficient Resource Management.

Second, from the Classical Application Transformation thrust, I will present "CAFQA: A classical simulation bootstrap for variational quantum algorithms", which enables accurate classical initialization for VQAs by searching efficiently through the classically simulable portion of the quantum space with Bayesian Optimization. CAFQA recovers as much as 99.99% of the accuracy lost in prior state-of-the-art classical initialization, with mean improvements of 56x.

Third, from the Scalable Error Correction thrust, I will present "Clique: Better than worst-case decoding for quantum error correction", which proposes the Clique QEC decoder for cryogenic quantum systems. Clique is a lightweight cryo-decoder for decoding and correcting common trivial errors, so that only the rare complex errors are handled outside the cryo-refrigerator. Clique eliminates 90-99+% of the cryo-refrigerator I/O decoding bandwidth, while supporting more than a million physical qubits.

Finally, I will conclude with an overview of other prior and ongoing work, along with my future research vision toward practical quantum advantage.

Bio: Gokul Subramanian Ravi is a 2020 NSF CI Fellows postdoctoral scholar at the University of Chicago, mentored by Prof. Fred Chong. His research targets quantum computing architecture and systems, primarily on themes at the intersection of quantum and classical computing. He received his PhD in computer architecture from UW-Madison in 2020 and was advised by Prof. Mikko Lipasti. He was awarded the 2020 Best ECE Dissertation Award from UW-Madison and named a 2019 Rising Star in Computer Architecture. His quantum and classical computing research have resulted in publications at top computer architecture, systems, and engineering venues, as well as two granted and three pending patents. His co-authored work was recognized as the Best Paper at HPCA 2022 and as a 2023 IEEE Micro Top Picks Honorable Mention.

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