Project: Error Mitigation of Quantum Chemistry Computations
Some of the most promising near-term applications of quantum computers lie in solving classically intractableproblems in chemistry, leading to potential breakthroughs in disease prevention. However, quantum computersof today are both highly susceptible to errors and limited by the number of qubits to correct them. For the nearterm, scientists are exploring error mitigation techniques to reduce the effects of quantum computational noise.As part of this effort, I developed novel and benchmarked existing error mitigations strategies to improveaccuracy of ground state energy calculations of the Hydrogen molecule and Lithium Hydride on noisy quantumdevices. These strategies pave the way for achieving chemical accuracy on near term quantum devices.
Skills: Variational Quantum Algorithms; Quantum Noise and Error Mitigation; Scientific Computing and StatisticalModeling in Python; Programming using IBM's QISKIT, Numpy and Matplotlib frameworks

Project: Quantum Algorithms for Combinatorial Optimization

Hybrid quantum-classical algorithms such as the Quantum Approximate Optimization Algorithm (QAOA) havegreat potential for demonstrating quantum advantage. QAOA relies on the optimization of classical parametersto find the minimum energy solution. Various techniques have been proposed to avoid the direct optimizationof parameters for a given instance to speed up calculations. One of the promising techniques is transferring orreusing optimal parameters of similar QAOA instances. However, defining and computing such transferabilityremains a challenge.

In this project, I developed and tested multiple similarity metrics that predict the transferability of optimalparameters between QAOA instances. Aside from predicting transferability, I also developed a novel schemeto directly predict QAOA optimal parameters of a graph. Taken together, my findings present a pathway to uselocal properties of instances to speed up QAOA and other hybrid quantum-classical algorithms.

Skills: Tensor Network Simulators and contraction algorithms; Numerical Optimization Techniques; Python DataVisualization; Introduced to High Performance Computing Infrastructure and Quantum Machine Learning techniques.

Project: Quantum Optimal Control of Superconducting Qubits

One leading platform for constructing quantum computers combines superconducting circuits and microwave cavities. Here, efficient control of cavities, or a collection of quantum harmonic oscillators, is essential for error-corrected computation, quantum-enhanced sensing, robust quantum communication, and quantum simulation.At Chakram Lab, I am developing numerical strategies for such high fidelity control of a multimode cavity weakly coupled to a transmon qubit.

Skills: Reinforcement Learning; Parameter Optimization; Circuit Quantum Electrodynamics; Design of superconducting quantum systems; Quantum Optimal Control