Investigating the Effects on Convergance of Various Optimizers on a VQC with an Efficient SU(2) on a NISQ Superconducting Quantum Computer

Introduction $\qquad$ Quantum computing has the potential to impact a broad array of industries, from finance, to chemistry, to machine learning [0-2]. Theoretical computing speedups are proven due to a quantum computer's ability to utilize the inifinite-dimisional Hilbert space, offering 2^n simultaneously nonreal accessable states for every n qubits as opposed to 1 simultaneuosly real accessible state on a classical system. Numerous models have been proposed to create a VQC that provide performance boosts over fair classical classifier algorithms; yet, current VQC algorithms do not present quantum advantage. The efficient $SU(2)$ provides as a HEA In this work, we will focus on quantum optimizers as they apply to the performance of a variational quantum classifier.

Methodology

Experiment Purpose

Global Settings

While the Adhoc dataset and initial optimization points are randomly generated, they have a controlled random seed of 3142; the choice of seed is arbituary and will not have an effect on computation. Consequentially, all experiments will have the same dataset and initial points; allowing us Further, our quantum simulators will not have a constant random seed, as we want to mimic the stohastic properties of our qubits in an attempt to have as realistic of a quantum simulator as possible. The device we submit jobs to will not change; switching devices from epoch to epoch will introduce confounding variables such as inconsistency in quantum architecture, wildly changing error rates, and qubit mapping conflicts.

Device Imhogeneity

Our ability to control quantum computers is limited due to precision in microwave control, readout, and coupling.

Adhoc Dataset to Avoid Confounding Variables

The purpose of using an adhoc dataset is to isolate the performance of the optimizer. The adhoc is useful because it is a toy dataset designed to have the ability to be fully seperated from the second-order Z evolution circuit that will be used to encode our data in the preprocessing stage of the model. This is so as we are not examining the model on the encoding of the `ZZFeatureMap`. So, we can elimate the encoder's ability to

Higher-Order Encoding with the Second-Order Z Evolution

The `ZZFeatureMap` will act as a quantum 'cast' for our efficient $SU(2)$, mapping the classical adhoc dataset to a higher-order space. The `ZZFeatureMap` consists of three sectors: entangling gates, unitary phases, and

Predictions and Test Accuracy

Optimization

On the Use of Quantum Simulators

We will use QASM 3 for this experiment, namely due to its accuracy of approximating IBM Quantum systems. Since IBM's quantum computers are a highly limited resource, using quantum simulators provides a time-efficient solution