CLASSIQ

Welcome to the Classiq 2024 Mega Challenge!

In this exciting challenge, you'll have the opportunity to implement a cutting-edge quantum computing paper using the Classiq platform. Your task is to reproduce and analyze results from a significant study in Variational Quantum Algorithms (VQA).

Key Details

- **Deadline:** October 28, 2024, 4:00 pm EST
- **Submission:** Submit your completed challenge HERE
- **Contact:** For any questions, please email shirl@classiq.io

Variational Quantum Algorithms: Symmetry enhanced variational quantum spin eigensolver

Background

Variational Quantum Algorithms (VQAs) have gained attention as promising methods for realizing quantum advantage on Noise Intermediate-Scale Quantum (NISQ) devices. These algorithms consist of fine-tuned parameterized operations to optimize an objective function. Their flexibility and ability to function without error correction techniques make them particularly well-suited to the capabilities of current quantum computing technology.
An important part of building a good VQA for specific applications is to correctly tailor the variational ansatz, which can include symmetries or conserved quantities that reflect on the applications' outputs.

In the context of constructing ansatzes for specific applications, the work Symmetry enhanced variational quantum spin eigensolver by Chufan Lyu *et al.* presents an ansatz specifically tailored to spin systems with conserved total spin number using the Variational Quantum Eigensolver (VQE).

Detailed Challenge Description

In this challenge, your goal is to **reproduce the results obtained in the paper for N=4 qubits**. You should apply both the Sz-conserving ansatz, and hardware efficient ansatzes between 5 and 15 layers. A good solution to this challenge is considered to be composed of **estimates of the ground state energy of this system** as well as an **analysis of the behavior of the algorithm when varying the initial parameters**.

Deliverables

A notebook containing:

- The quantum programs that can run the algorithm;
- A comparative analysis of the different ansatzes, graphically represented; and
- An estimative of the ground state energy obtained.

Resources

Project-specific resources:

1. The paper, by Chufan Lyu *et al.*: Symmetry enhanced variational quantum spin eigensolver.

Classiq resources:

1. Getting Started with Classiq - Classiq 101
2. Classiq's documentation
3. Classiq Library of many implementation algorithms and applications
4. Classiq Community Slack is available for any questions you might have