Qiskit
Fall Fest 2024

Hackathon Prompt

Variational Quantum Algorithms Challenge

Challenge Summary:

Design and implement a variational quantum algorithm (VQA) to solve a complex optimization problem. Participants will leverage the power of quantum computing to develop an efficient and robust algorithm that can find optimal solutions in challenging scenarios. The focus will be on innovation, performance, and practical implementation in real-world applications.

Objective:

Participants are tasked with developing a VQA that emphasizes:

Optimization Efficiency: Utilize quantum computing to optimize complex problems that are difficult for classical algorithms to solve efficiently.

Algorithm Robustness: Ensure the algorithm is stable and can handle variations and imperfections in quantum hardware.

Practical Application: Demonstrate the potential of the algorithm in a practical context, such as finance, logistics, or materials science.

Scenario Context:

Imagine a real-world problem that requires finding the optimal configuration among a vast number of possibilities. This could be optimizing a supply chain network, finding the best investment portfolio, or designing a new material with specific properties. The goal is to develop a VQA that can effectively tackle such problems by harnessing quantum computational power.

Technical Requirements:
Quantum Circuit Design: Develop a variational quantum circuit tailored to the optimization problem.
Classical Optimization: Implement a classical optimization loop to adjust the parameters of the quantum circuit.
Performance Metrics: Define metrics to evaluate the algorithm's performance and efficiency.
Hardware Considerations: Address the limitations and challenges of current quantum hardware, such as noise and gate fidelity.

Expected Deliverables:
Algorithm Design Document: Outline the architecture of the VQA, including the quantum circuit and classical optimization loop.
Prototype Code: Provide a working implementation of the algorithm using a quantum programming framework (e.g., Qiskit, PennyLane).
Performance Analysis: Evaluate the algorithm's performance on simulated or real quantum hardware, including an analysis of robustness and efficiency.
Application Example: Demonstrate the application of the algorithm to a specific real-world problem, showcasing its practical benefits.

Assessment Criteria:
Innovation and Creativity: Originality in the algorithm's design and approach.
Performance and Efficiency: Ability to solve the optimization problem effectively and efficiently.
Implementation Feasibility: Practicality of implementing the algorithm on current or near-term quantum hardware.
Real-World Impact: Potential for the algorithm to address real-world challenges and deliver tangible benefits.

Resources:
- Variational Algorithm Design
- Solve utility-scale quantum optimization problems