QRISE 2024
Classiq - Implementing an Exponential Quantum Advantage Algorithm

Team Quantupid:

1. Dev Saran Sujan, B.Sc. CS
2. Shreya Satsangi, B.Sc. Physics

Problem Statement

Our challenge was to implement the paper called Exponential Quantum Speedup in Simulating Coupled Classical Oscillators using the Classiq platform.

Procedure

Hamiltonian Formation: We will first create a Hamiltonian matrix using the conditions given in the paper, we were able to produce a 5X5 matrix sample and then we convert it into an 8X8 matrix to work with the Hamiltonian.

Pauli Decomposition: After reaching to the hamiltonian matrix we convert the matrix into pauli gates using the qml.pauli_decompose feature from pennylane.

Construction of Circuit: Now based on the Pauli gates that we get from using Pauli decompose, we then convert those gates into quantum circuits, which we can later run on quantum computer or any simulator.

Transpilation: The final circuit is transpiled for optimization using Qiskit's transpile function

Precision Checking: The precision of the produced circuit is checked by comparing it with the ideal unitary operator U_perfect. Special care is taken to handle global phase issues introduced during transpilation.

coding part: kindly refer the git repo
https://github.com/shreyasat27/quantupid_10

Future Work

- In future, we will try to use the Hamiltonina given in the paper to run on the real quantum hardware so see the exponential growth.
- Use a variety of circuits (like GHZ, RB) and multitude of errors.
- Investigate sampling in PEC and how to speed it up.
- Run it on non-cirq frontends and real backends.

References

- qml.pauli_decompose
- Exponential Quantum Speedup in Simulating Coupled Classical Oscillators
- classiq
- Classiq's Hamiltonian Problem