Quantum State Classifier to Optimize the Transmission of Highly Entangled States

Qiskit Advocate Mentorship program mid-term presentation

Mentees: Cenk Tüysüz, Spencer King

Mentor: Pierre Decoodt

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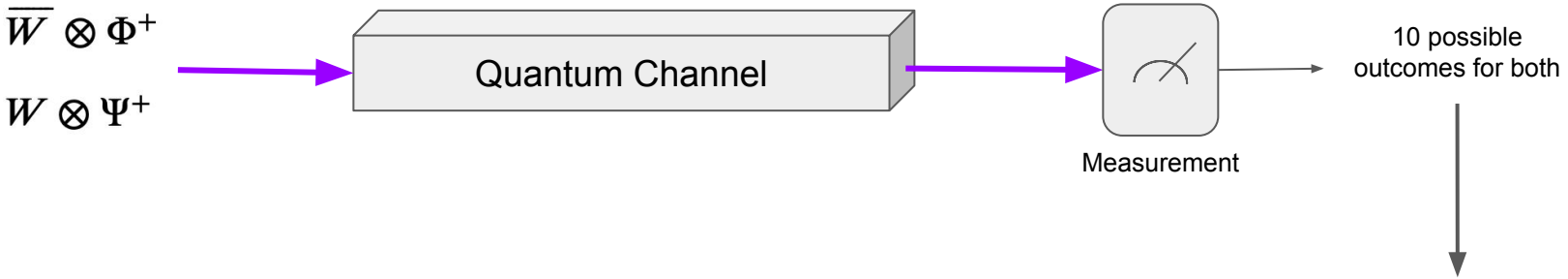
Project Description



$$W = \frac{1}{\sqrt{3}}(|100\rangle + |010\rangle + |001\rangle)$$
$$\overline{W} = \frac{1}{\sqrt{3}}(|011\rangle + |101\rangle + |110\rangle)$$
$$\Psi^+ = \frac{1}{\sqrt{2}}(|01\rangle + |10\rangle)$$
$$\Phi^+ = \frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$$

Set of highly entangled states

How many measurements do we need, in order to classify which state was sent?

Method

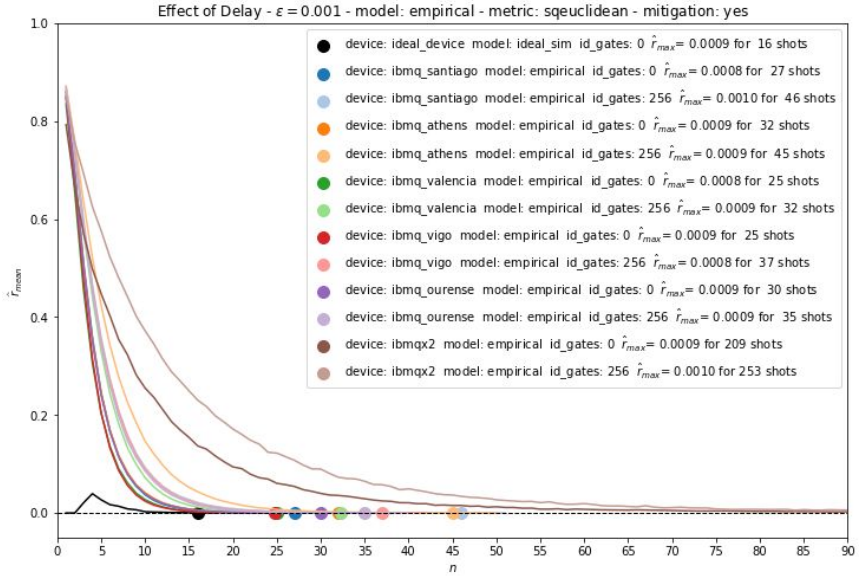
- The Quantum Channel is emulated with 256 identity gates using Qiskit.
- Several IBMQ devices are used to collect data, which was needed to construct Probability Density Matrices (PDM).
- We construct a Monte Carlo (MC) sampler using these PDMs.
- To predict the states, the classifier uses the distances between a training PDM and the MC samples drawn from a test PDM, using metrics such as Jensen-Shannon and Euclidean squared distances (based on the scipy spatial distance module)
- This task is repeated by using more shots until the error rate is less than a given threshold.

Current Progress

We have a working classifier that can handle 5 qubit entangled states, however it takes too much time to run the simulations.

I am working on speeding-up the current classifier to explore;

- If we can use less shots to achieve the same error rate
- Use more statistics
- Maybe more qubits



More details will be covered during Spencer King's talk.