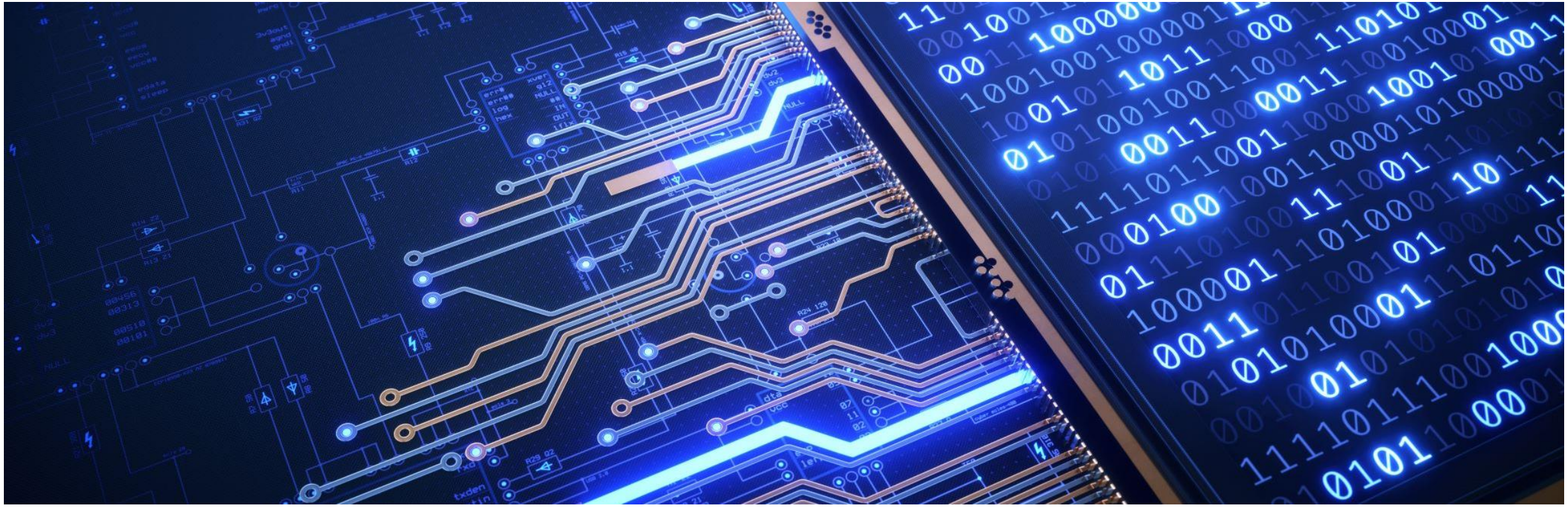
Using Machine Learning to Optimize Quantum Circuits in the Presence of Noise



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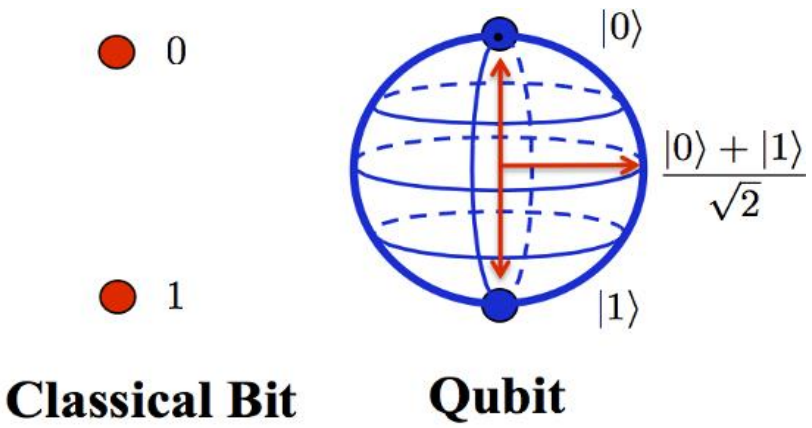
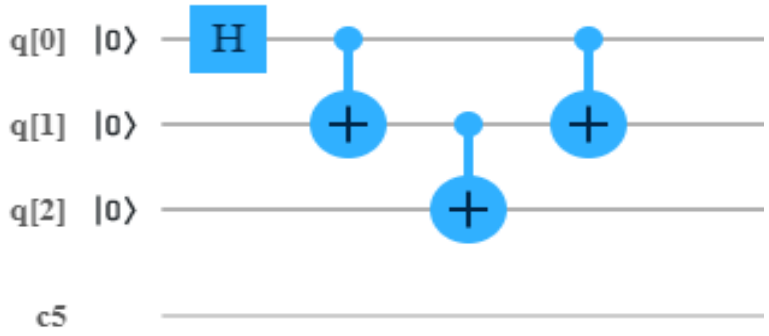
Quantum Computing: Qubits and Quantum Gates



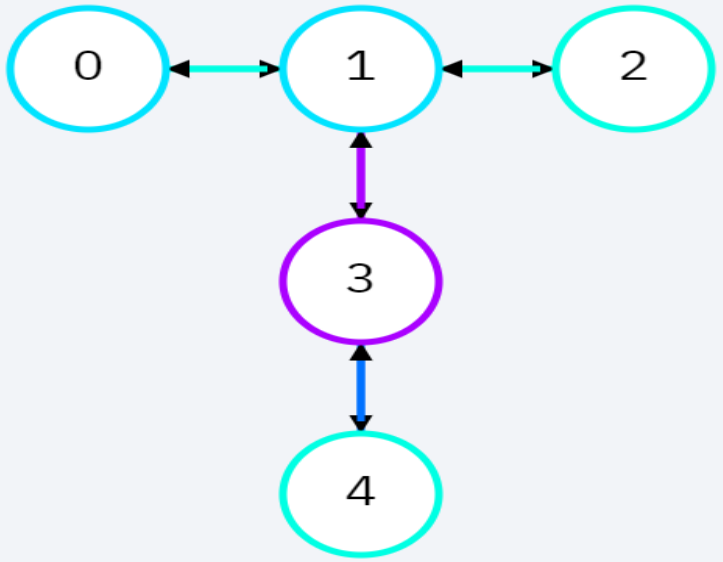


Logical qubit configuration

- Qibits – or quantum bits – are the information carrying components used in quantum computing which take advantage of the quantum properties such as superposition and entanglement to do computation
- Quantum gates operate on qubits in such a way as to change their state and this allows us to carry out computations. They are a principle component in a quantum circuit.

Motivation

$\#of\ states = 2^n$ where n is the # of qubits

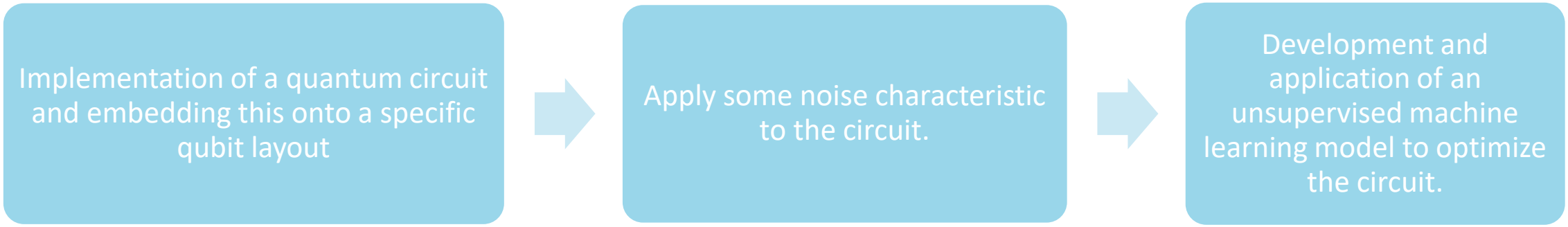


Qubit configuration of IBM's IMBQ London Quantum Computer

- Many simple quantum circuits which use very few qubits can be simulated using classical computers. This becomes an exponentially expensive endeavor as we increase the number of qubits.
- Quantum computing takes place on physical hardware with certain limitations on gates that can be applied to certain qubit pairs.
- However, this computation takes place in the presence of noise, which is caused by the quantum hardware's interaction with its environment. This causes error in the computation.

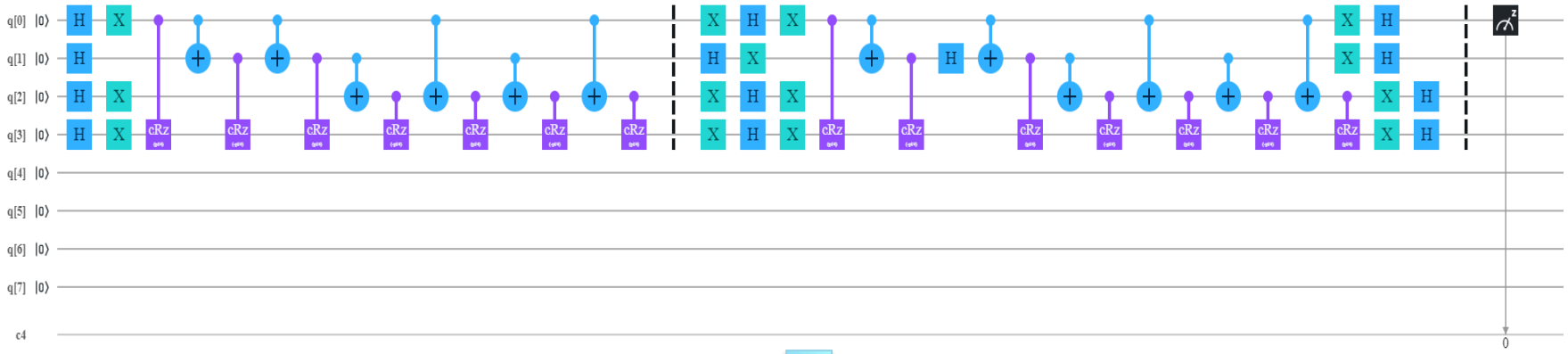
Objectives

- Long Term: To develop a machine learning model to optimize a quantum circuit based on quantum hardware in which the qubits have nearest neighbor connections

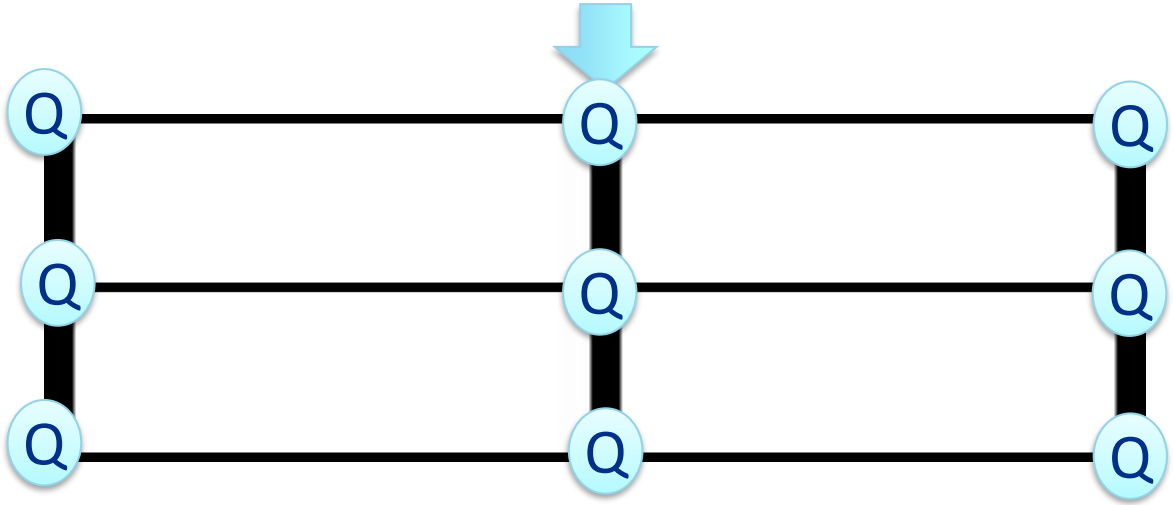


Current Works

- Currently working on implementing the quantum search algorithm (Grover, 1996) in Qutip and embedding this onto a grid lattice of nine qubits.



Quantum search algorithm circuit diagram



Target physical qubit layout for the algorithm.

Fermilab