Quantum Computing

Lab 1. Quantum Circuits

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[1]:
```
from qutip import *
from qutip.qip.operations import *
import numpy as np
```

Quirk

- Start quirk (local) or remote (remote)
- Familiarise yourself with the top toolbox and understand how to construct circuits
  - View the tutorial
- Create a circuit to generate the following single qubit states
  - $(|0\rangle + |1\rangle)/\sqrt{2}$
  - $(|0\rangle - i|1\rangle)/\sqrt{2}$
  - $(|0\rangle + i|1\rangle)/\sqrt{2}$
  - $|1\rangle$
- Create a circuit to produce a GHZ (Greenberger Horne Zeilinger) state: $(|000\rangle + |111\rangle)/\sqrt{2}$
  - Note, GHZ states for more quibits are equivalently defined to this 3-qubit state

Solution

- Create your single qubit states circuit here
- Create your GHZ state circuit here

CNOT with Hadamard Gates

- Consider the Hadamard with CNOT circuit
- Which two qubit gate is equivalnet to this circuit? Proof your answer by calculating the circuit matrix (with qutip, numpy or manually) and construct the equivalent circuit in quirk.

Solution

[2]:
```
# Python code to calculate circuit operator
```

Create your equivalent quirk circuit here

Circuit Equivalence

Show that in this circuit from the lecture, the gate on the first three qubits is identical to the gate on the last three qubits (using qutip, numpy or manually).

Create a similar circuit equivalence for a controlled Y gate.

Solution

[3]:
```python
# Python code to compare the circuits
```

Create your circuit for CCY here