Quantum Computing for Computer Scientist

Quantum Lab

Lab-5

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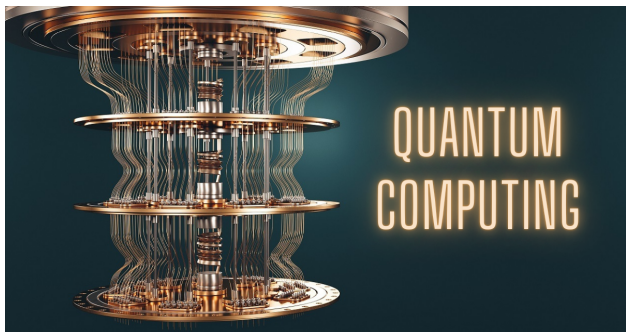


Recall : Last Experiment

qc.measure(q[0],c[0])

Measuring Output

```
from qiskit import QuantumRegister, QuantumCircuit, Aer, execute
from qiskit import ClassicalRegister
M_simulator = Aer.backends(name='qasm_simulator')[0]

q = QuantumRegister(2)
c = ClassicalRegister(2)
qc = QuantumCircuit(q,c)
qc.h(q[0])
qc.h(q[1])
qc.measure(q,c)

M = execute(qc, M_simulator).result().get_counts(qc)
print(M)
```

Recall : Last Experiment

How to make Partial measurements??

Example : qc.measure(q[0],c[0])

We will discuss it later!

Problem-1 : Visualizing Circuit after applying Hadamard in 2-qubits

- Use Qiskit's **circuit_drawer** function
- We know $H|0\rangle \otimes H|0\rangle = \frac{1}{2}(|00\rangle + |01\rangle + |10\rangle + |11\rangle)$

Visualizing QuantumCircuit in terms of gates

```
from qiskit import QuantumRegister, QuantumCircuit, Aer, execute
from qiskit import ClassicalRegister
from qiskit.tools.visualization import circuit_drawer
M_simulator = Aer.backends(name='qasm_simulator')[0]

q = QuantumRegister(2, name='q')
c = ClassicalRegister(2, name='c')
qc = QuantumCircuit(q,c, name= 'qc')
qc.h(q[0])
qc.h(q[1])
qc.measure(q,c)

print(circuit_drawer(qc))
```

Problem-1 : Solution

In given diagram, M represents "measurement" and double lines used to show the results store in Classical register.

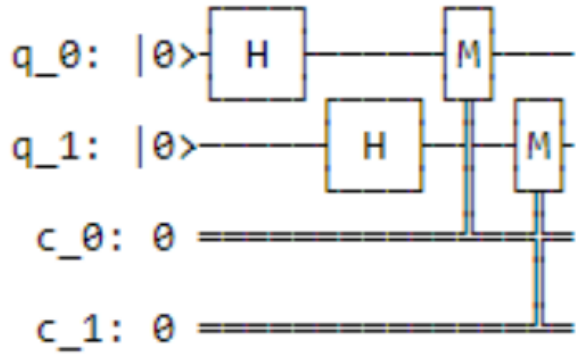


Figure: Quantum Circuit Diagram

Problem-2 : Measuring All 3 qubits Simultaneously

Guess the output?

```
q = QuantumRegister(3)
c = ClassicalRegister(3)
qc = QuantumCircuit(q,c)

qc.x(q[0])
qc.h(q[1])
qc.id(q[2])


S = execute(qc,S_simulator).result().get_statevector()
print(S)
qc.measure(q,c)
M = execute(qc,M_simulator,shots=100).result().get_counts(qc)
print(M)
S = execute(qc,S_simulator).result().get_statevector()
print(S)
print(qc.draw())
```

Gates Provided by Qiskit

- In order to make sure that all cells of code run properly, run the following cell of code

Just testing

```
from qiskit import QuantumRegister, QuantumCircuit, Aer, execute
from qiskit import ClassicalRegister
from qiskit.tools.visualization import circuit_drawer
import Our_Qiskit_Functions as oq
import maths as m
M_simulator = Aer.backends(name='qasm_simulator')[0]
S_simulator = Aer.backends(name='statevector_simulator')[0]
```

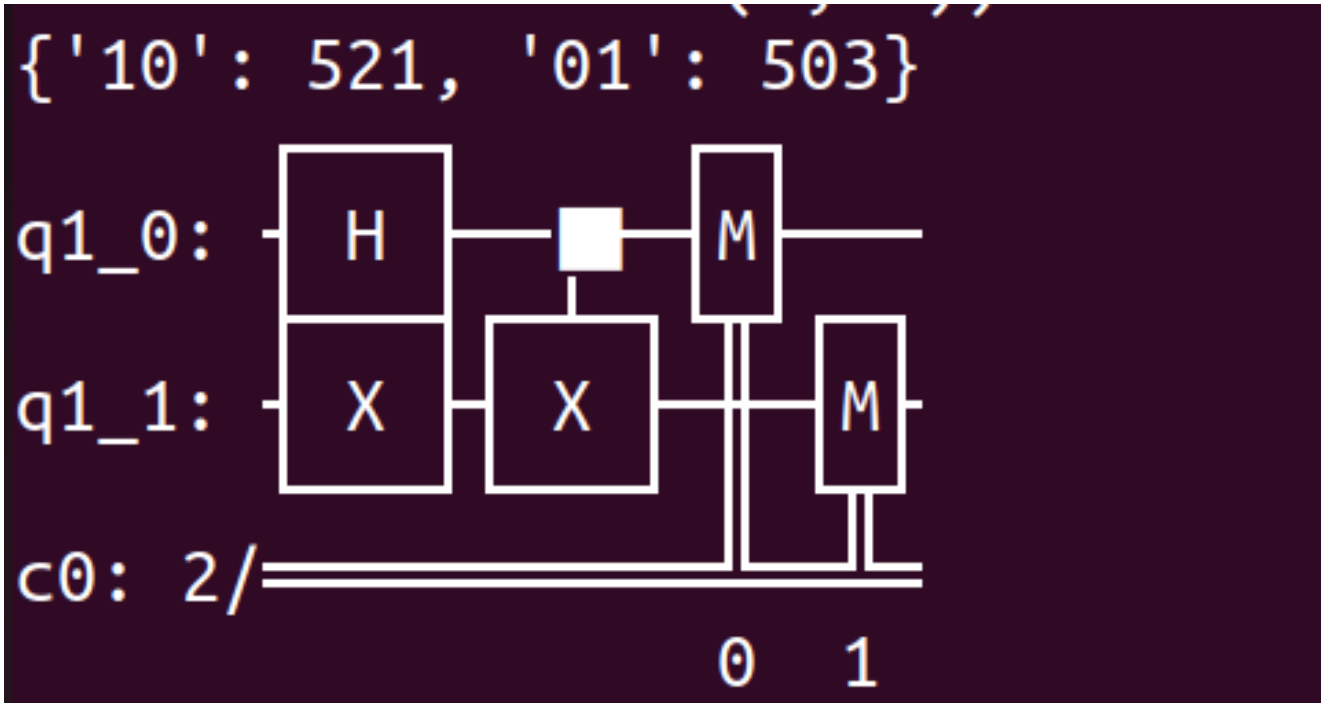
Problem-3 : Implement cNOT Gate using Qiskit

cNOT

```
q = QuantumRegister(2)
c = ClassicalRegister(2)
qc = QuantumCircuit(q,c)

qc.h(q[0])
qc.x(q[1])

S = execute(qc,S_simulator).result().get_statevector()
print(S)
qc.cx(q[0],q[1])

S = execute(qc,S_simulator).result().get_statevector()
print(S)
print("-----------------------------------------------------------------------")
qc.measure(q, c)
M = execute(qc, M_simulator).result().get_counts(qc)
print("After Measurememt :", M)
print(qc.draw())
```

cNOT

Output



Inclass Assignment-3

Problem-1

Tweak the input to generate outputs $|00\rangle$ *and* $|11\rangle$

Problem-2

Prove that cNOT is reversible. Also, give Visualization using Qiskit Circuit Diagram

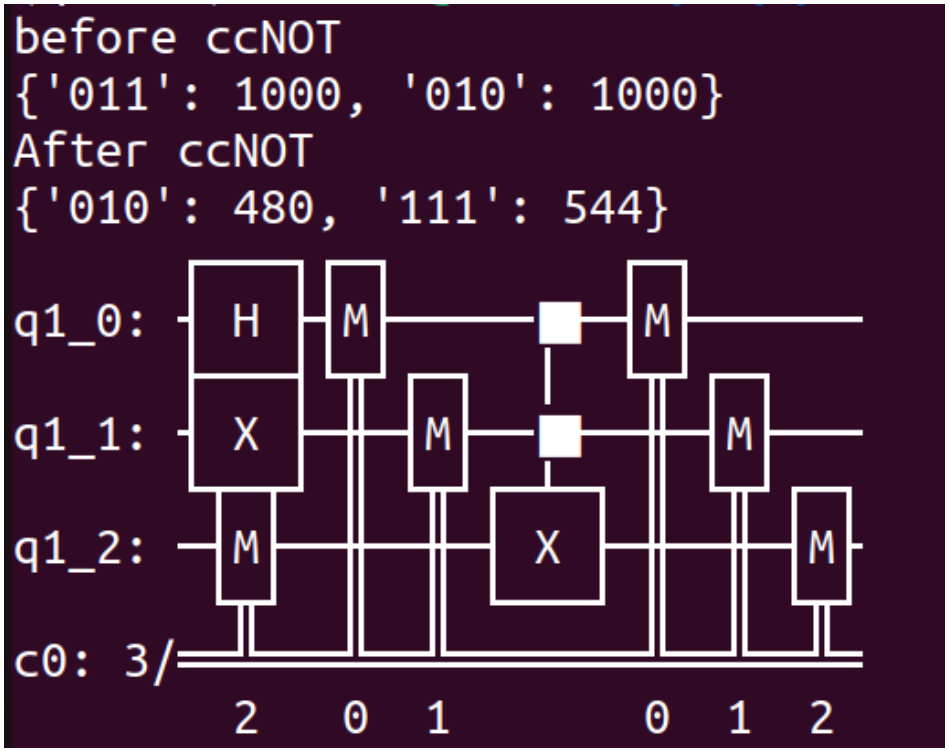
ccNOT Toffoli Gate

```
1 from qiskit import ClassicalRegister, QuantumRegister, QuantumCircuit, Aer, execute
2 from qiskit.tools.visualization import circuit_drawer
3 import numpy as np
4 S_simulator = Aer.backends(name='statevector_simulator')[0]
5 M_simulator = Aer.backends(name='qasm_simulator')[0]
6
7 q = QuantumRegister(3)
8 c = ClassicalRegister(3)
9 qc = QuantumCircuit(q,c)
10 qc.h(q[0])
11 qc.x(q[1])
12 qc.measure(q,c)
13 M = execute(qc,M_simulator,shots = 2000).result().get_counts(qc)
14 print("before ccNOT")
15 print(M)
16 qc.ccx(q[0],q[1],q[2])
17
18 qc.measure(q,c)
19 M = execute(qc,M_simulator).result().get_counts(qc)
20 print("After ccNOT")
21 print(M)
22 print(qc.draw())
```

ccnot

Output

```
before ccNOT
{'011': 1000, '010': 1000}
After ccNOT
{'010': 480, '111': 544}
```



InClass Assignment-3 Universality of Toffoli Gate

Problem 3

Tweak the inputs of the Toffoli gate in a way that produces a fanout of values, along with Visualization using the Qiskit Circuit Diagram.

Problem 4

Tweak the inputs of Toffoli gate to AND Gate, along with Visualization using Qiskit Circuit Diagram.

Problem 5

Tweak the inputs of Toffoli gate to NOT Gate, along with Visualization using Qiskit Circuit Diagram.

Thank You!