Quantum Computing for Computer Scientist

Quantum Lab
Lab-4

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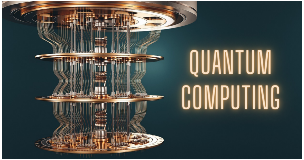
Faculty: **Dr. Dhiman Saha**



Recall : Last Experiemnt

H (Hadamard 2-Qubit Superposition state)

```
from qiskit import QuantumRegister, QuantumCircuit, Aer, execute
S_simulator = Aer.backends(name='statevector_simulator')[0]
q = QuantumRegister(2)
qubit = QuantumCircuit(q)
qubit.h(q[0])
qubit.h(q[1])
job = execute(qubit,S_simulator)
result = job.result()
print(result.get_statevector)
```

Guess the output.....??

Give mathematical explanation of your output !

Problem-1 :Measuring Quantum State

- To measure quantum state, it has to collapse with the classical state.
- Let's do this experiment

Measuring Single Qubit State

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

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

job = execute(qc, S_simulator)
result = job.result()
print(result.get_counts(qc))
```

Problem-1 : Measuring Single Qubit State

Guess the Output?

Explanation for Problem-1

- Quantum and Classical registers are well known attribute.
- By statement "qc = QuantumCircuit(q,c)", both becomes part of quantum circuit.

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

- Initializing qubit 0 with Hadamard gate, creates the system in following state :-
  H $|0\rangle = \frac{1}{\sqrt{2}} (|0\rangle + |1\rangle)$
- Now measure the output captures into classical register

Explanation for Problem-1 Cont...

- M simulator = Aer.backends(name='qasm simulator')[0]
- **qasm simulator** allows us to simulate measurements on our quantum state
- **get_counts** is a dictionary-type object that return 1024 simulated measurements.

Final Output

{'1': 522, '0': 502}

Problem-2 : Different way of capturing output from Quantum State

From Entries of Dictionary

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

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

M = execute(qc, M_simulator).result().get_counts(qc)
print("Disctionary entry "0" : ',M['0'])
print("Disctionary entry "1" : ',M['1'])
```

Guess the output?

Problem-3 : Measuring 2-Qubits State

Problem-3

```
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)
```

In this example, we pass the entire quantum and classical registers as arguments to measure

Explanation for Problems-3

By default qiskit makes total measurement of system and store each qubit's measured results to the corresponding index in ClassicalRegister

Output

{'10': 246, '11': 262, '00': 236, '01': 280 }

Print State Vector after Measurement

Just run this code and see the 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)

S = execute(qc,S_simulator).result().get_statevector()
print(S)
```

What is the Output

Let's understand with other example

Just run this code and see the output

Problem-4

```
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[0],c[0])

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

Explanation for Problems-4

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

- Means "make a measurement on qubit 0 and store the result in ClassicalRegister 'c' index 0"
- Our system is still left in a superposition of two states

- Print State Vector
- What is the difference from previous output

InClass Assignment-2

Problem-1

Create 3-Qubits out of which first is NOT, second is Hadamard and third is Identical. Measure their output in classical state considering:-
(i) Total measurement of quantum system
(ii) Make measurement at only one qubit
Print the State Vector for both case and give 1 line explanation in output

InClass Assignment-2

Problem-2

Create a function that will simulate one 'Quantum Coin' flip, using a single qubit in a superposition state:

Thank You!