GETTING STARTED WITH IBM Q EXPERIENCE

Step 1

1. **Open https://quantum-computing.ibm.com**
2. **Click on Create an IBMid account**
3. **Click on Create an IBMid**
4. **Fill in the details and click on continue**
5. **You will get a 7-digit code that you will enter in the form after clicking on continue.**
6. **Account setup is done!**

Step 2

1. **Open https://quantum-computing.ibm.com**
2. **Click on Sign in to get started , and sign in with your new account details**
3. **Read the privacy and terms, accept the End User License Agreement**
4. **Click on accept and continue**
5. **You’re ready to start coding!**

Qiskit cheat sheet

Circuit Basics

Create a classical register wiith 3 bits

cr = ClassicalRegister(3)

Create a quantum register with 3 qubits

qr = QuantumRegister(3)

Create an initial circuit with classical and quantum registers

circ = QuantumCircuit(qr,cr)

Gates

X on qubit 0: circ.x(qr[0])

H on qubit 0: circ.h(qr[0])

CNOT on qubit 0,1: circ.cx(qr[0], qr[1])

Measurement

circ.measure(qr, cr)

Visualization

circ.draw(output = 'mpl')

Running experiments on a simulator

simulator = Aer.get_backend('qasm_simulator')

Execute a job

result = execute (circ, backend=simulator, shots=1024).result()

Plot a histogram

plot_histogram(result.get_counts(circ))

Running experiments on a real quantum computer

Load accounts

from qiskit import IBMQ

IBMQ.load_account()

Get Backends

provider = IBMQ.get_provider(hub='ibm-q')

provider.backends()

Choose a backend

mel= provider.get_backend('ibmq_16_melbourne')

Execute a job

job_mel16 = execute(circ, backend=mel)

Job Monitor

from qiskit.tools.monitor import job_monitor

job_monitor(job_mel16)

Plot a histogram

result_mel16 = job_mel16.result()

plot_histogram(result_mel16.get_counts(circ))

QUANTUM STATES FOR SINGLE QUBIT SYSTEMS

Question 1

We define a state $|\psi >= \alpha|0> + \beta|1>$ to be a valid quantum state if $|\alpha|^2 + |\beta|^2 = 1$. Which of the following equations describe a valid quantum state?

(a) Example: $|\psi >= \frac{1}{\sqrt{2}}|0> + \frac{1}{\sqrt{2}}|1>$

$$\alpha = \frac{1}{\sqrt{2}}, \beta = \frac{1}{\sqrt{2}}$$

$$\alpha^2 + \beta^2 = (\frac{1}{\sqrt{2}})^2 + (\frac{1}{\sqrt{2}})^2 = 1$$

Since $\alpha^2 + \beta^2 = 1$, $|\psi >= \frac{1}{\sqrt{2}}|0> + \frac{1}{\sqrt{2}}|1>$ is a valid quantum state.

(b) $|\psi >= \frac{1}{4}|0> + \frac{3}{4}|1>$

(c) $|\psi >= |0> + |1>$

(d) $|\psi >= \frac{5}{13}|0> + \frac{12}{13}|1>$

(e) $|\psi>= \frac{3}{5}|0> + \frac{4}{5}|1>$

(f) $|\psi>= |1>$

(g) $|\psi>= \frac{1}{4}|0>$

(h) $|\psi>= \frac{\sqrt{3}}{2}|0> + \frac{1}{2}|1>$

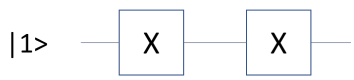
(i) $|\psi>= \frac{\sqrt{7}}{4}|0> + \frac{\sqrt{5}}{4}|1>$

QUANTUM GATES AND MEASUREMENT

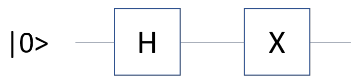
Question 2

What is the resulting states for each of the circuits below?

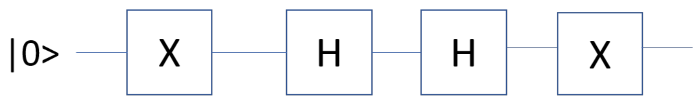
(a)



(b)



(c)

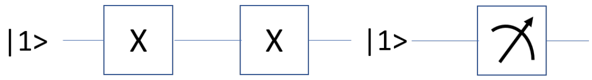


(d)

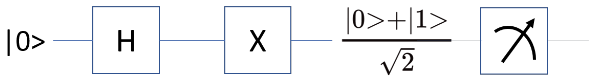
Question 3

What can we expect on measurement?

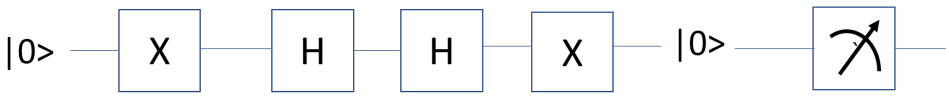
(a)



(b)



(c)



(d)

QUANTUM STATES FOR TWO QUBIT SYSTEMS

Question 1

We define a state $|\psi>= \alpha|00> + \beta|01> + \gamma|10> + \delta|11>$ to be a valid quantum state if $|\alpha|^2 + |\beta|^2 + |\gamma|^2 + |\delta|^2 = 1$. Which of the following equations describe a valid quantum state?

(a) Example: $\frac{1}{2}|00> + \frac{1}{2}|01> + \frac{1}{2}|10> + \frac{1}{2}|11>$

$$\alpha = \frac{1}{2}, \beta = \frac{1}{2}, \gamma = \frac{1}{2}, \delta = \frac{1}{2}$$

$$\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = (\frac{1}{2})^2 + (\frac{1}{2})^2 + (\frac{1}{2})^2 + (\frac{1}{2})^2 = 1$$

Since $\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = 1$, $|\psi>$ is a valid quantum state.

(b) $|\psi>= \frac{\sqrt{7}}{5}|00> + \frac{\sqrt{7}}{\sqrt{5}}|01> + \frac{3}{5}|10> + \frac{\sqrt{2}}{5}|11>$

(c) $|\psi>= |00>$

(d) $|\psi>= |00> + |01> + |10> + |11>$

(e) $|\psi>= \frac{3}{5}|00> + \frac{4}{5}|01>$

MEASUREMENT

Question 2

For the following, quantum states, what would the qubits most likely collapse to?

(a) Example: $\frac{1}{2}|00> + \frac{1}{2}|01> + \frac{1}{2}|10> + \frac{1}{2}|11>$

This state is in an equal superposition of the four states |00>, |01>, |10>, |11>. Therefore, we can equally expect the states to be:
First Qubit: 0, Second Qubit: 0
First Qubit: 0, Second Qubit: 1
First Qubit: 1, Second Qubit: 0
First Qubit: 1, Second Qubit: 1

(b) $|\psi>= |00>$

(c) $|\psi>= \frac{1}{\sqrt{2}}|0> + \frac{1}{\sqrt{2}}|1>$

(d) $|\psi >= \frac{1}{\sqrt{2}}|00> + \frac{1}{\sqrt{2}}|11>$

(e) For $|\psi >= \frac{1}{\sqrt{2}}|00> + \frac{1}{\sqrt{2}}|11>$*, if we measure the first qubit to result in 0, what can we say about the second qubit?*

(f) For $|\psi >= \frac{1}{\sqrt{2}}|01> + \frac{1}{\sqrt{2}}|10>$*, if we measure the first qubit to result in 0, what can we say about the second qubit?*

(g) For $|\psi >= \frac{1}{\sqrt{2}}|00> + \frac{1}{\sqrt{2}}|11>$*, if we measure the first qubit to result in 1, what can we say about the second qubit?*

(h) For $|\psi >= \frac{1}{\sqrt{2}}|00> + \frac{1}{\sqrt{2}}|01>$*, if we measure the first qubit to result in 0, what can we say about the second qubit?*

ENTANGLEMENT: BELL STATES

Question 3

Prepare bell states starting with the states |00>, |01>, |10>, |11>. What is the resulting state?