grover_3qb_figgat

October 24, 2019

```
In [1]: import qiskit
        qiskit.__version__

Out[1]: '0.10.0'

In [2]: from qiskit import IBMQ
        IBMQ.update_account()

Found 1 credentials.
The credentials stored will be replaced with a single entry with token "ef4480d28ebba73ab98f35

In order to access the provider, please use the new "IBMQ.get_provider()" methods:

  provider0 = IBMQ.load_account()

Note you need to update your programs in order to retrieve backends from a specific provider di

  backends = provider0.backends()
  backend = provider0.get_backend('ibmq_qasm_simulator')

Update the credentials? [y/N]: y


Out[2]: <qiskit.providers.ibmq.credentials.credentials.Credentials at 0x7f211f48edd0>

In [3]: # Grover search as per Figatt 3-qubits and qiskit textbook
        # IMPORTS & initialization
        import matplotlib.pyplot as plt
        %matplotlib inline
        import numpy as np

        #qiskit
        from qiskit import IBMQ
        from qiskit import BasicAer
        from qiskit.providers.ibmq import least_busy
        from qiskit import QuantumCircuit, ClassicalRegister, QuantumRegister, execute

        # import basic plot tools
        from qiskit.tools.visualization import plot_histogram
```

```
In [4]: # create a PHASE oracle (not boolean) that will mark the states |101> and |110> as sta
        def phase_oracle(circuit, register):
            circuit.cz(qr[2],qr[0])
            circuit.cz(qr[2],qr[1])
```

```
In [5]: # set up the circuit for inversion, where first we define a function that creates mult
        def n_controlled_Z(circuit, controls, target):
            """Implement a Z gate with multiple controls"""
            if (len(controls) > 2):
                raise ValueError('The controlled Z with more than 2 controls is not implemente
            elif (len(controls) ==1):
                    circuit.h(target)
                    circuit.cx(controls[0],target)
                    circuit.h(target)
            elif (len(controls) ==2):
                    circuit.h(target)
                    circuit.ccx(controls[0], controls[1], target)
                    circuit.h(target)
```

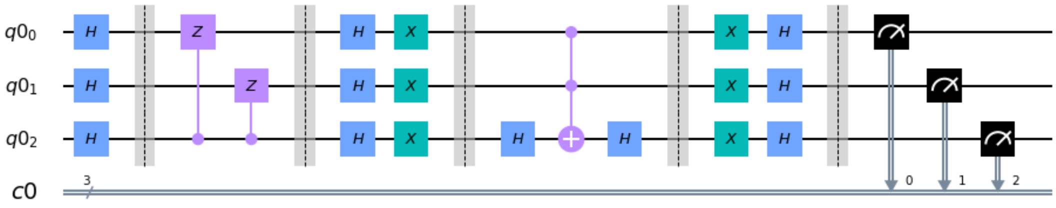
```
In [6]: # the inversion is about average, so
        def inversion_about_average(circuit, register, n, barriers):
            """Apply inversion about the average step of Grover's algo"""
            circuit.h(register)
            circuit.x(register)

            if barriers:
                circuit.barrier()

            n_controlled_Z(circuit, [register[j] for j in range(n-1)], register[n-1])

            if barriers:
                circuit.barrier()

            circuit.x(register)
            circuit.h(register)
```

```
In [7]: # put things together: start with a uniform superposition AND a measurement at the end
        # one iteration is enough <= since there are 2 solutions and 8 possibilities
        barriers = True

        qr = QuantumRegister(3)
        cr = ClassicalRegister(3)

        groverCircuit = QuantumCircuit(qr,cr)
        groverCircuit.h(qr)

        if barriers:
            groverCircuit.barrier()
        phase_oracle(groverCircuit, qr)

        if barriers:
            groverCircuit.barrier()

        inversion_about_average(groverCircuit, qr, 3, barriers)

        if barriers:
            groverCircuit.barrier()

        groverCircuit.measure(qr,cr)
```

```
Out[7]: <qiskit.circuit.instructionset.InstructionSet at 0x7f211f440e10>
```

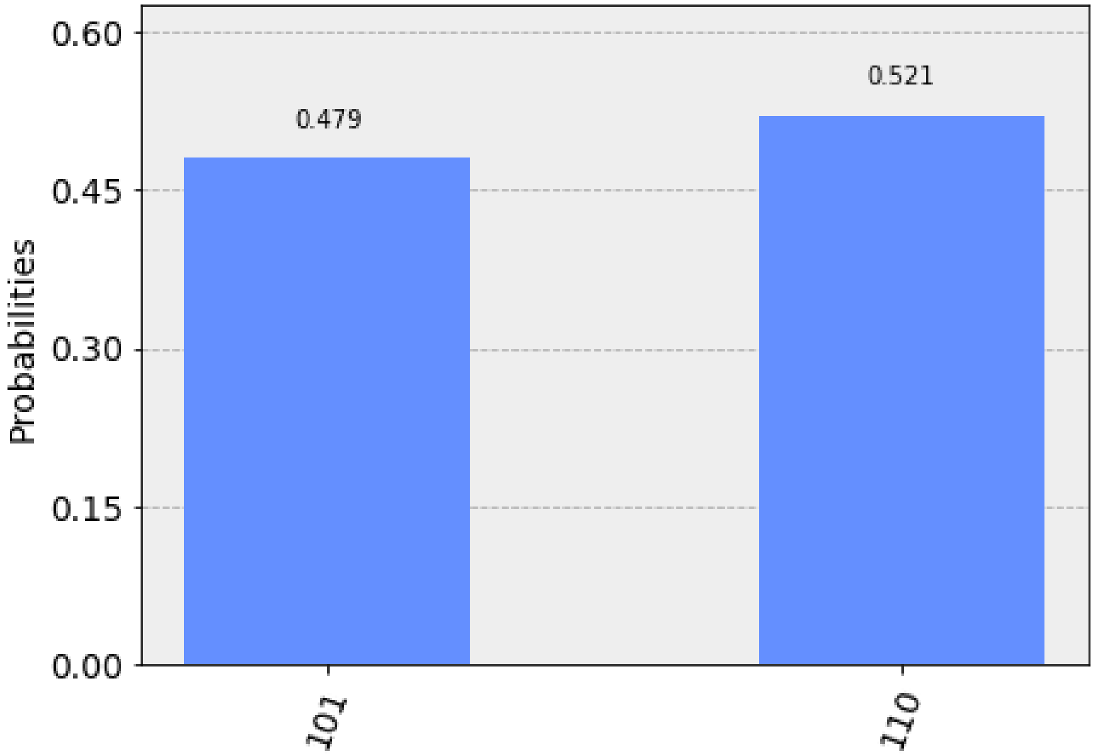
```
In [8]: # draw the circuit
        groverCircuit.draw(output="mpl")
```

Out[8]:



```
In [9]: # run with simulator
        backend = BasicAer.get_backend('qasm_simulator')
        shots = 1024
        results = execute(groverCircuit, backend=backend, shots=shots).result()
        answer = results.get_counts()
        plot_histogram(answer)
```

Out[9]:



```
In [17]: #IBMQ.update_accounts()
         #print(str(IBMQ.stored_account()))
```

```
    ---------------------------------------------------------------------------

    AttributeError                            Traceback (most recent call last)

    <ipython-input-17-1ca7c621f4df> in <module>
----> 1 IBMQ.update_accounts()
      2 #print(str(IBMQ.stored_account()))


    AttributeError: 'IBMQProvider' object has no attribute 'update_accounts'
```

```
In [12]: # run with real device (max 5 qubits)
         IBMQ.load_account()
         prov_now=IBMQ.get_provider(hub='ibm-q')
         backend = least_busy(prov_now.backends(filters=lambda x: x.configuration().n_qubits <
                                                   not x.configuration().simulator and x.status().ope
         print("least busy backend: ", backend)
```

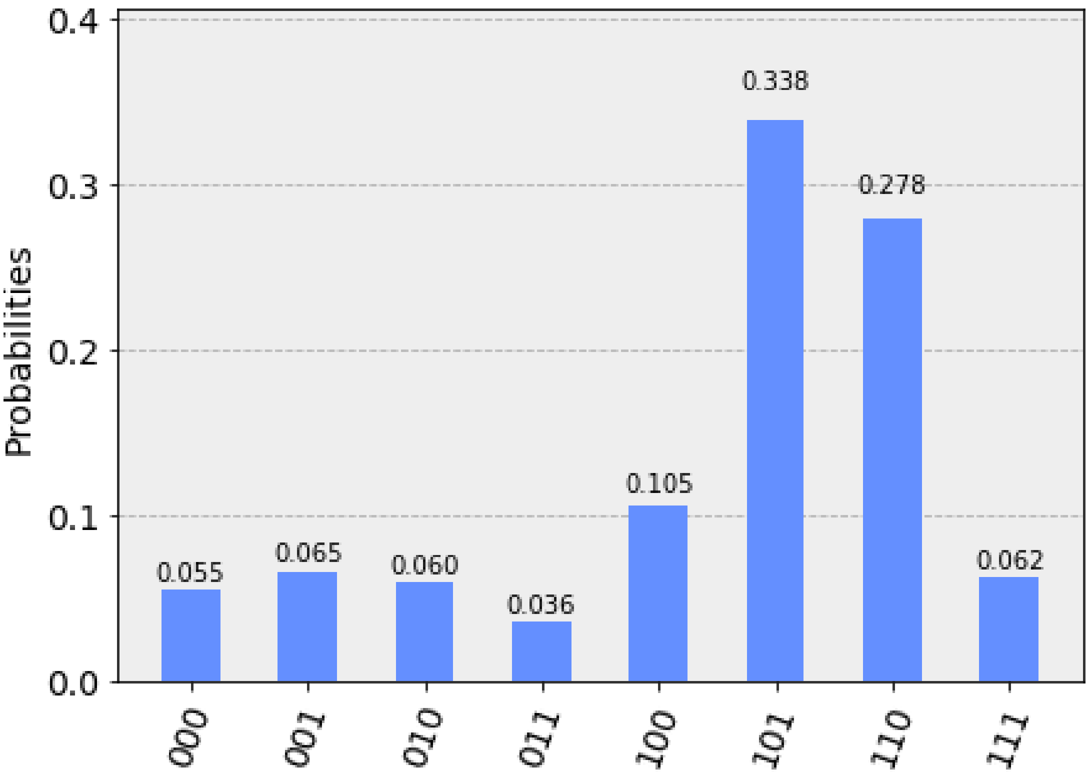
```
least busy backend:  ibmq_vigo
```

```
In [13]: # Run our circuit on the least busy backend. Monitor the execution of the job in the
         from qiskit.tools.monitor import job_monitor

         shots = 1024
         job = execute(groverCircuit, backend=backend, shots=shots)

         job_monitor(job, interval = 2)
```

```
Job Status: job has successfully run
```

```
In [14]: # Get the results from the computation
         results = job.result()
         answer = results.get_counts(groverCircuit)
         plot_histogram(answer)
```

```
Out[14]:
```



```
In [ ]:
```