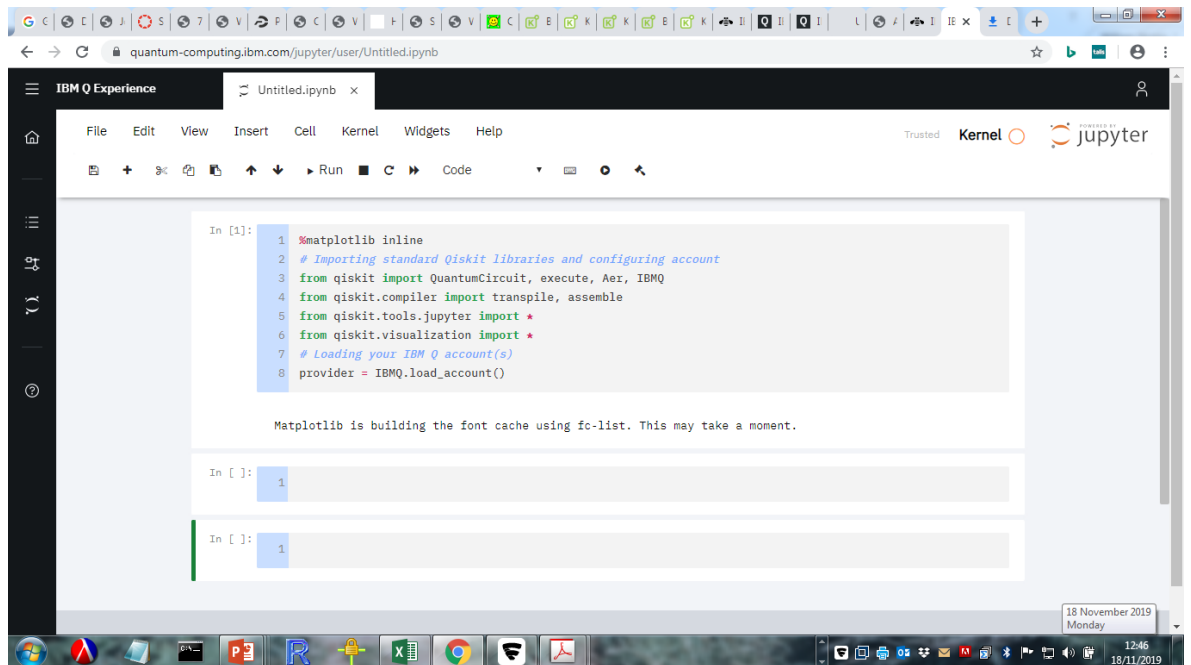


Integrating Quantum Concepts into Cybersecurity

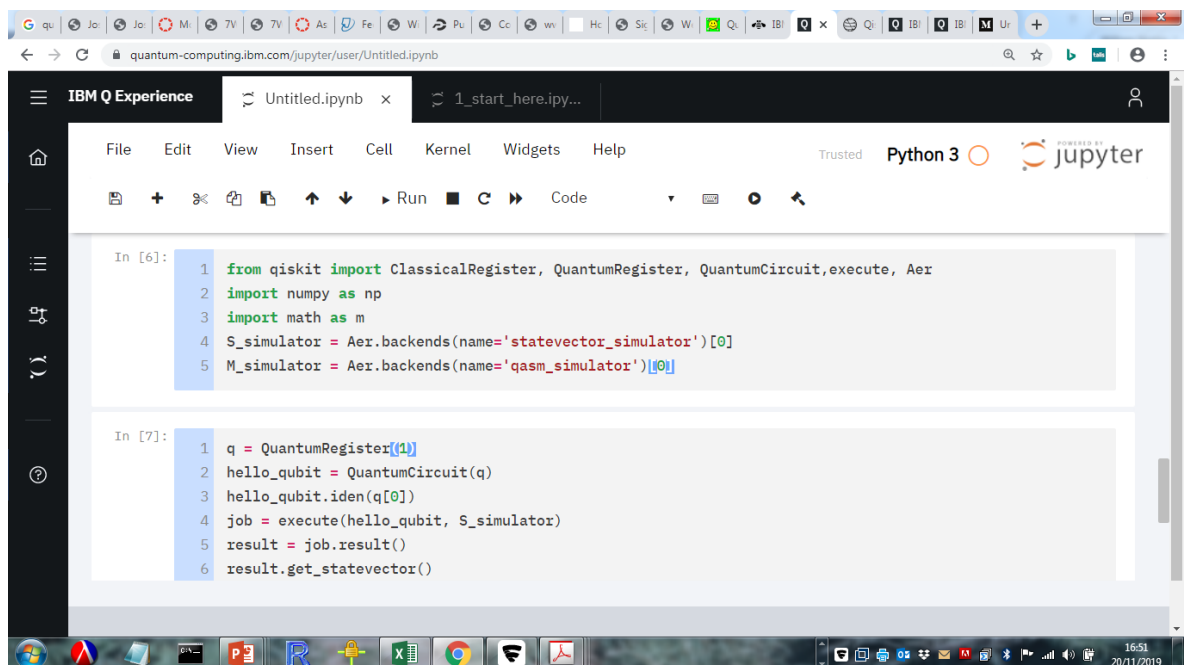
Activity 1c: Qiskit (Quantum Information Science Kit)

Qiskit Programs

1. We start with the introductory Qiskit notebook:



type the following into the following two windows:



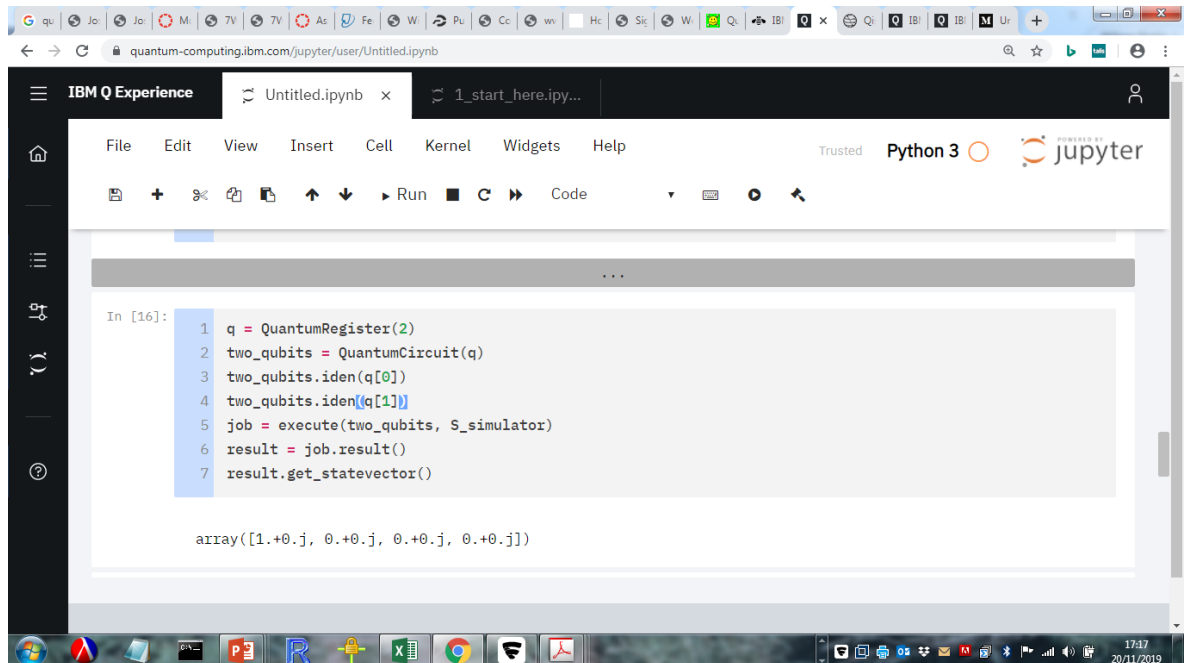
2. When you run your program you should get the following output:

```
array([1.+0.j, 0.+0.j])
```

3. In line 3 we have: `hello_qubit.iden(q[0])`. What happens if you replace `hello_qubit.iden(q[0])` with `hello_qubit.x(q[0])`?
4. What if we replace 'iden' in `hello_qubit.iden(q[0])` with `y` or `z`, or `h`?

Two qubits

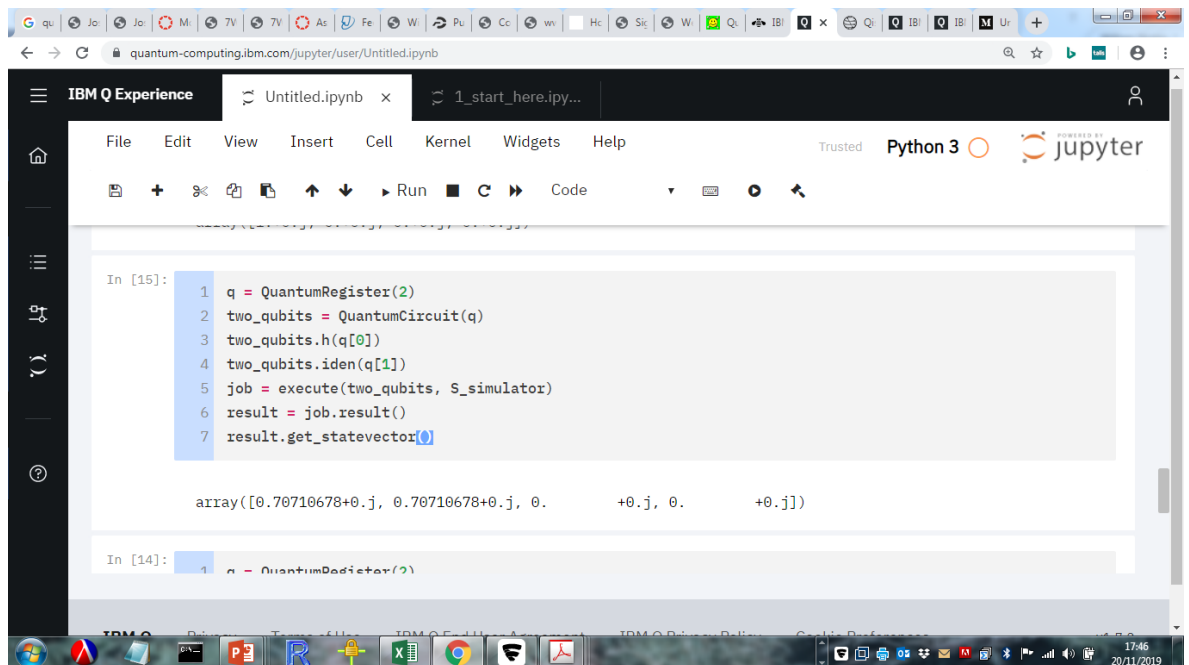
5. For two qubits we can write



```
In [16]:  
1 q = QuantumRegister(2)  
2 two_qubits = QuantumCircuit(q)  
3 two_qubits.iden(q[0])  
4 two_qubits.iden(q[1])  
5 job = execute(two_qubits, S_simulator)  
6 result = job.result()  
7 result.get_statevector()  
  
array([1.+0.j, 0.+0.j, 0.+0.j, 0.+0.j])
```

What do we interpret the array?

6. Here are two more examples



```
In [15]:  
1 q = QuantumRegister(2)  
2 two_qubits = QuantumCircuit(q)  
3 two_qubits.h(q[0])  
4 two_qubits.iden(q[1])  
5 job = execute(two_qubits, S_simulator)  
6 result = job.result()  
7 result.get_statevector()  
  
array([0.70710678+0.j, 0.70710678+0.j, 0.  
+0.j, 0.  
+0.j])  
  
In [14]:  
1 q = QuantumRegister(2)
```

```
In [14]:  
1 q = QuantumRegister(2)  
2 two_qubits = QuantumCircuit(q)  
3 two_qubits.h(q[0])  
4 two_qubits.cx(q[0],q[1])  
5 job = execute(two_qubits, S_simulator)  
6 result = job.result()  
7 result.get_statevector()
```

array([0.70710678+0.j, 0. +0.j, 0. +0.j, 0.70710678+0.j])

```
In [ ]:  
1
```

7. So what is the above circuit doing?

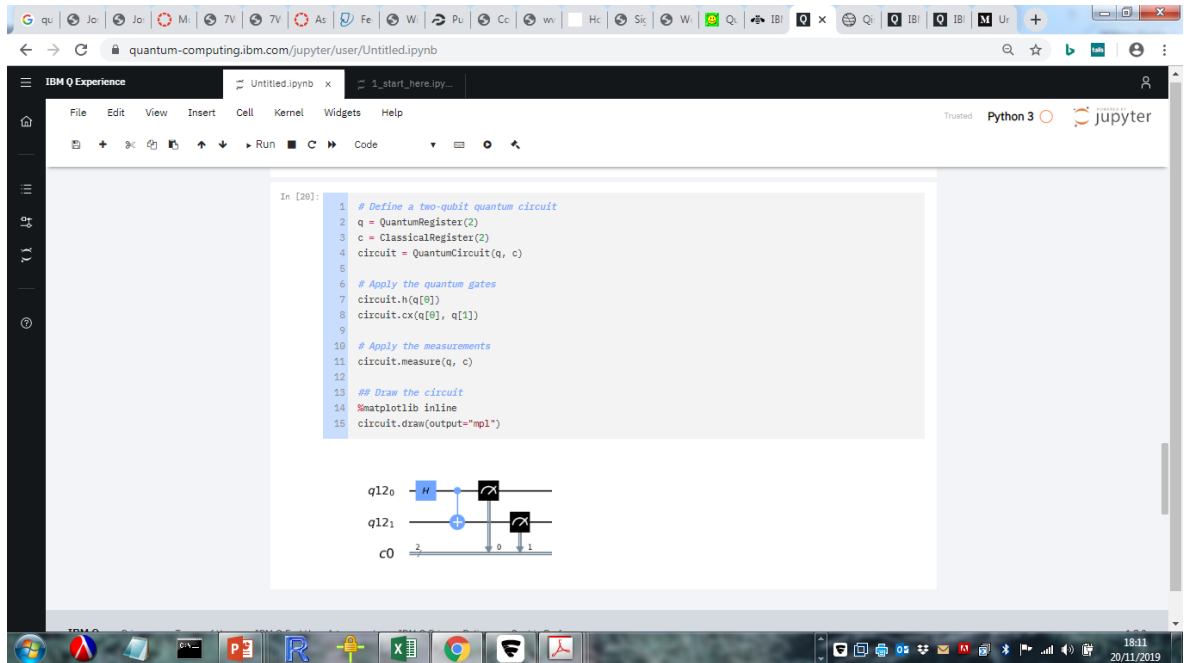
```
In [18]:  
1 ## Define a two-qubit quantum circuit  
2 q = QuantumRegister(2, 'q')  
3 circuit = QuantumCircuit(q)  
4  
5 ## Apply the quantum gates  
6 circuit.h(q[0])  
7 circuit.cx(q[0], q[1])  
8  
9 ## Draw the circuit  
10 %matplotlib inline  
11 circuit.draw(output="mpl")
```

q0 — H — CNOT —
q1 — CNOT —

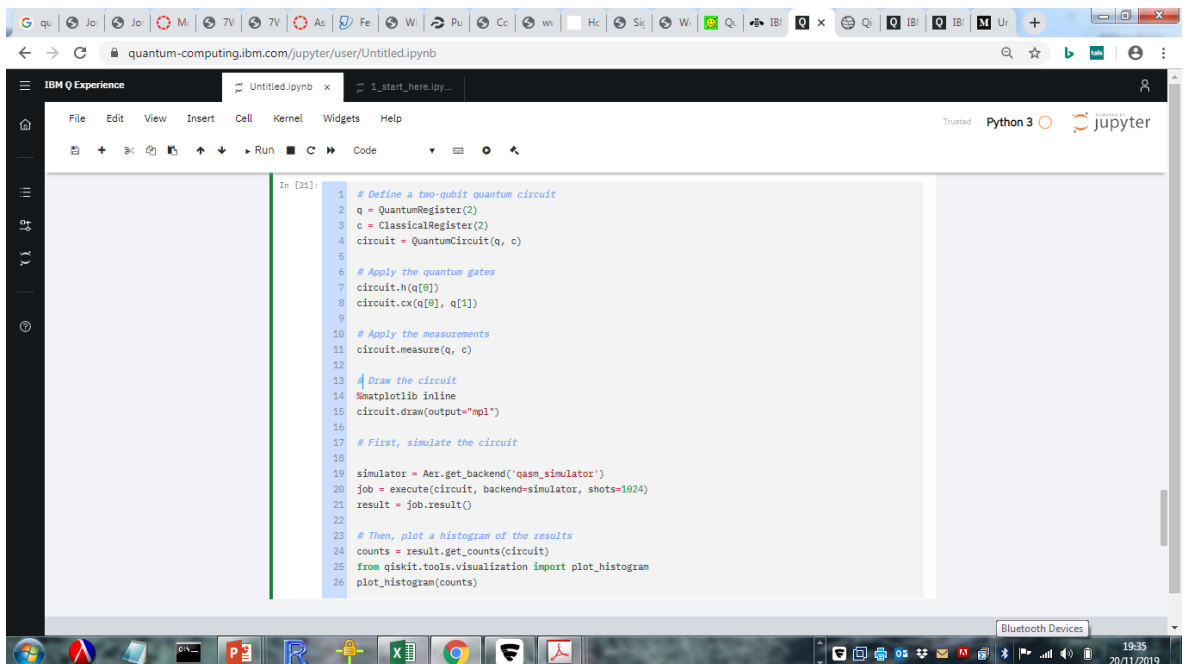
Simulations

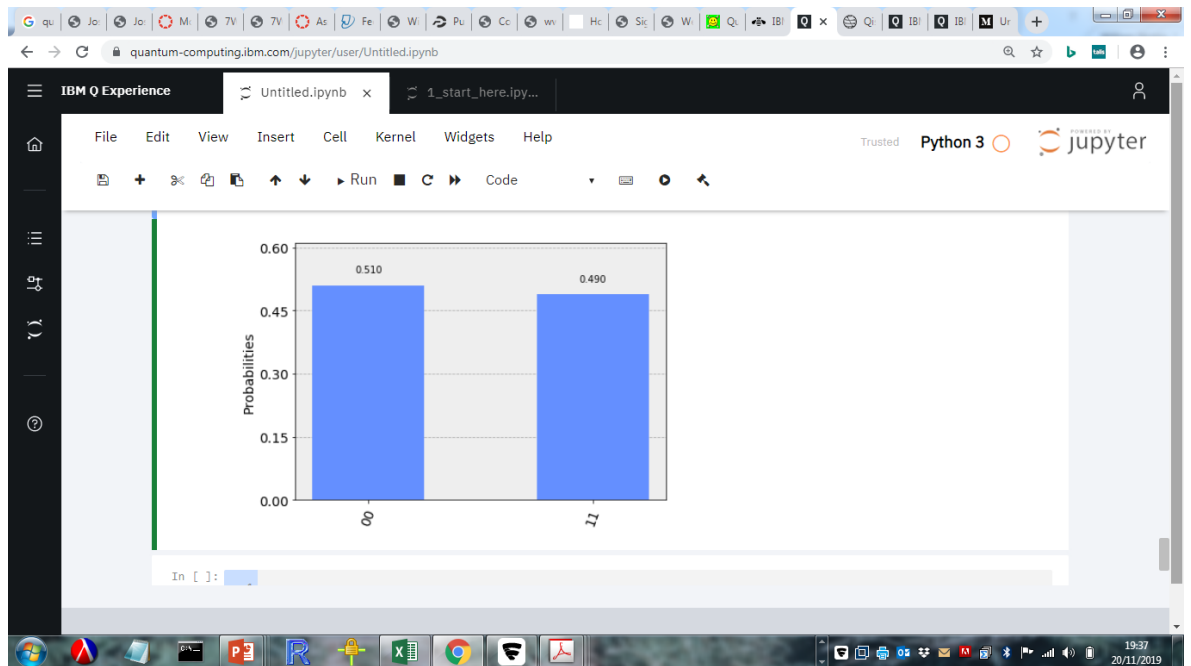
Ok lets look at a simulation. These are carried out under the assumption that there is no noise or decoherence. So it's an ideal theoretical simulation.

1. We will start by including measurements into our circuit. This will produce the following:



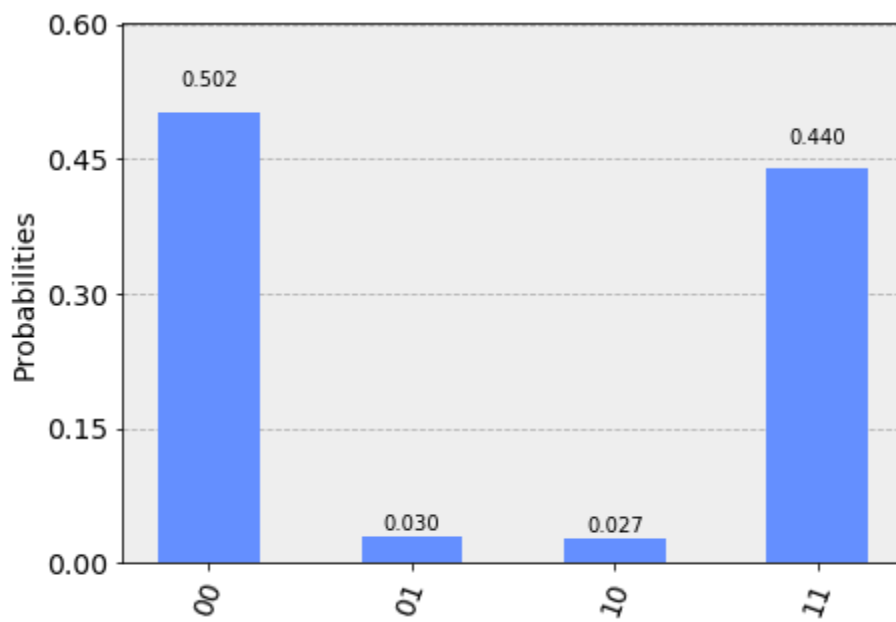
2. Sim





(Qiskit Tutorial)

3. On a quantum computer in the real world noise and decoherence may generate the following:



(Qiskit Tutorial)

Question

1. What code would you write for a 3 qubit circuit?

References

- [1] <https://www.ibm.com/quantum-computing/technology/experience/>
- [2] <https://quantum-computing.ibm.com/support>
- [3] https://quantum-computing.ibm.com/jupyter/tutorial/1_start_here.ipynb
- [4] <https://medium.com/qiskit/untangling-quantum-teleportation-919cbd673074>
- [5] Daniel Koch, Laura Wessing and Paul M Alsing, Introduction to Coding Quantum Algorithms: A Tutorial Series Using Qiskit, <https://arxiv.org/abs/1903.04359>