IBM Q practice 3 : April 23-24, 2020
Hmw Quantum Computation

You are asked to start exploring the Qiskit tutorials and start using this software to simulate quantum circuits as well as run real experiments on the public ibm devices. See links on the course web page for introductory slides, examples and tutorials.

Implementation of Bernstein-Vazirani algorithm

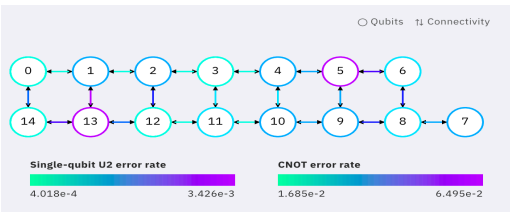
Consider the Bernstein-Vazirani variation on the Deutsch-Josza algorithm. See homework 4, exercise 3. In this algorithm we have a function

$$f(x_0, \cdots, x_{n-1}) = a_0 x_0 \oplus a_1 x_1 \oplus \cdots \oplus a_{n-1} x_{n-1} \oplus b$$

where a_i and x_i and b are in $\{0, 1\}$ for $i = 0, \cdots n-1$. And $\oplus$ is the sum mod 2. One can determine the vector $(a_0, \ldots, a_{n-1})$ using the Deutsch-Josza circuit with one run of the circuit (in a noiseless situation). Of course one has to implement a sub-circuit for U_f.

You are asked to implement a notebook in the Qiskit language to implement this circuit for the function

$$f(x_0, \cdots, x_{15}) = x_6 + x_7 + x_9$$

and find the vector $(a_0, a_1, \cdots, a_{15})$. You are asked to use the ibm q 16 melbourbe device (15 qubits). The geometry of the device is shown in the figure below (see https ://quantum-computing.ibm.com/). Use the four qubits numbered 6, 7, 8, 9 where 8 is used as an auxiliary (ancilla) qubit.

Make a jupyter notebook using Qiskit. Run the simulator and verify the theoretical prediction (with one shot or run you find the correct vector with probability one). Experiment with the ibm q 16 melbourne device : with one shot (a few times) and with 1024 shots. Comment the results.