TP session 2 – Quantum teleportation 2023

Note: there can be more than one correct solution to the exercises.

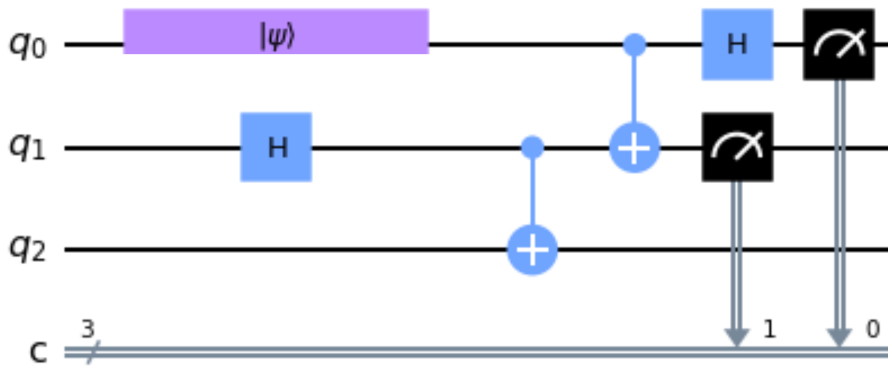
Exercise 1: Program a 1-qubit quantum circuit outputting a superposition state $1/\sqrt{2}$ $(|0\rangle+|1\rangle)$. Visualize the circuit and the final quantum state in the Bloch sphere.

Exercise 2: Program a 2-qubit quantum circuit generating the entangled state $1/\sqrt{2}$ $(|00\rangle+|11\rangle)$. Visualize the circuit and the state. Is it possible to visualize the initial state for each qubit in the Bloch sphere? If not, use the 'qsphere' representation.

Exercise 3: Program a quantum circuit including a 3-qubit quantum register and a 3-bit classical register so that the final state is $|100\rangle$. *Note that the qubit order in Qikist's kets is* $|q_2 q_1 q_0\rangle$. Include a measurement for all qubits and send the results through classical registers. Visualize the final state both in the Bloch sphere and the qsphere. Then compile the circuit and plot the result of the measurements in a histogram.

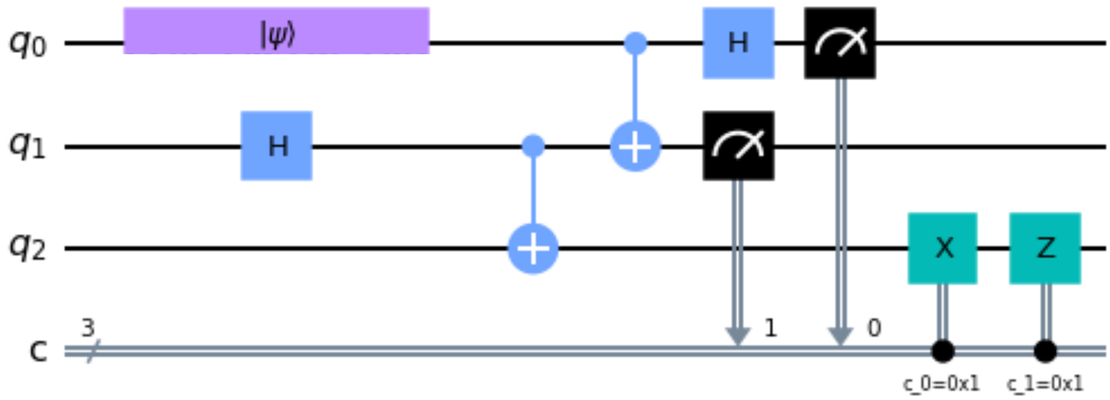
Exercise 4: Program a quantum circuit with a 1-qubit quantum register and one classical register. Generate a random superposition state $|\psi\rangle$ and visualize it in the Bloch sphere. Initialize your quantum circuit with the random state. Run the simulation and visualize the output state in the Bloch sphere, and the count's histogram. Repeat the simulation several times to verify the randomness of the initial gate.

Exercise 5: Program the following quantum teleportation circuit:



Run the simulation. Is teleportation achieved every time?

Add conditional gates to (q_2) where the conditions are if $c_1=1$ apply Z-gate to q_2 and/or if $c_0=1$ apply X-gate to q_2. The resulting circuit is:



Is teleportation achieved now? Comment the results.