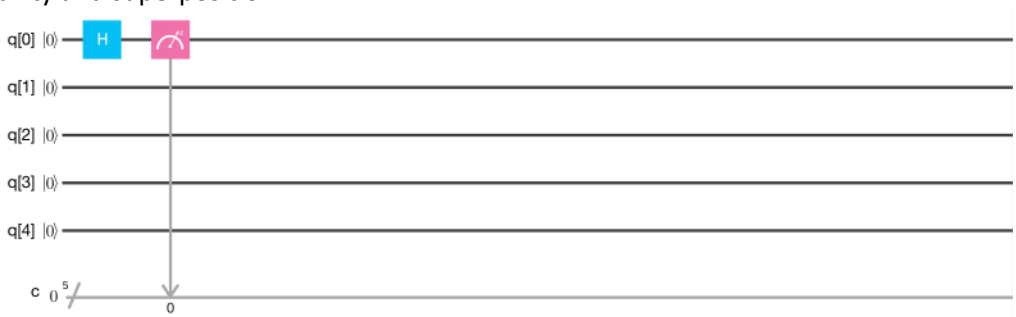
SHINE Quantum Workshop with IBM Q Experience

July 20, 2018

Task I.Flip a quantum coin

In this task we will explore what **quantum superposition** is and how to control it using different gate operations.

(a) Put one single qubit in superposition with a Hardmard gate H, then measure its state. You will have your first quantum coin! Get the measurement result and try to explain it using the concept of probability and superposition.



(b) Can the following gates put a qubit into superposition? Find the answer by running the experiments!

Task II. Capture effect of noise

In this task we will explore what noise from the environment does to a quantum computer.

(a) A qubit is initialized in the ground state $|0\rangle$. Compare the case where you immediately measure the state after preparing it to the case where you wait for some time and then measure. (Hint: you can adjust the wait time using different numbers of identity gates id.) Plot the probability of finding the qubit in state $|0\rangle$ as a function of wait time.

(b) Prepare a qubit in its excited state $|1\rangle$ by applying X gate. Repeat (a) for qubit state $|1\rangle$. Plot the probability of finding the qubit in state $|1\rangle$ as a function of wait time.

(c) Simulation is a good way to check your answer. Simulate the same experiments in (a) and (b) on the simulator. Is there a difference between your simulation results and the results you get from a real quantum computer? If you see a difference, describe it and try to explain why.
(You can choose to either stimulate your experiments or run it on a real quantum computer by clicking the knobs on the upper right corner.)

(d) Ideally, an even number of X gates, or that of Y gates should act the same as a sequence of id gates (if you do not see this, verify this first on the simulator). See if this still holds on a real quantum computer.