Due: November 26th, 2019
Date: October 23, 2019

Coding Assignment

Instructions

- Please choose a quantum programming language and learn to solve the following two problems using your choice of quantum programming language. Some recommendations are provided on page `https://www.cs.umd.edu/class/fall2019/cmsc657/homework.html`.
- For each problem, please submit your codes with appropriate comments as well as one accompanying document. In the document, please include a brief description of **how you design your codes, why they are correct, how to evaluate your codes, and what test cases you used**.
- Please package your codes and documents in a single ZIP file.
- Please feel free to read any online reference. However, you need to write down and test your own code.
- Note that this is NOT a group assignment. Everyone needs to submit the ZIP file electronically to ELMS. Please let us know if you have any trouble with it.

Problem 1. (Teleportation: 20 points) Quantum teleportation is a fundamental problem for quantum information. Your task is to implement the quantum teleportation with any quantum programming language. You may verify the correctness by a tomography on the final state. Specific (additional) requirements:

- Set up the circuit with three qubits. The first one is in an arbitrary state, and the next two are $|0\rangle$.
- You may employ either theoretical explanation or black-box verification using simulation for the correctness of your codes.

Problem 2. (Distinguish three-qubit states: 40 points) You are given 3 qubits which are guaranteed to be in one of the two states, where $\omega = e^{\frac{i2\pi}{3}}$,

$$|\psi_0\rangle = \frac{1}{\sqrt{3}}(|100\rangle + \omega\,|010\rangle + \omega^2\,|001\rangle), \text{ or}$$
$$|\psi_1\rangle = \frac{1}{\sqrt{3}}(|100\rangle + \omega^2\,|010\rangle + \omega\,|001\rangle).$$

Your task is to perform necessary operations and measurements to figure out which state it was and to return 0 if it was $|\psi_0\rangle$ state or 1 if it was $|\psi_1\rangle$ state. The state of the qubits after the operations does not matter. Specific (additional) requirements:

- Consider implementing an operation that takes a 3-qubit state as input and output 0/1.
- Please describe your strategy to distinguish between $|\psi_0\rangle$ and $|\psi_1\rangle$.

Reference: This is a problem from Microsoft Q# coding contest.
