COT 5600 Quantum Computing

Spring 2019

Homework 2

Problem 1 (Hadamard test)

Implement in Python a simulation of the Hadamard test for arbitrary unitaries $U \in \mathbb{C}^{2 \times 2}$ and arbitrary quantum tests $|\psi\rangle \in \mathbb{C}^2$. (Do not just code up the formula from slides. The application of each quantum gate has to be simulated.)

Determine the probabilities for $U = X$ (bit flip) and $|+\rangle$ and $|-\rangle$ using your code. Also, plot the probabilities for $U = \mathrm{diag}(1, e^{2\pi i \varphi})$ for $\varphi = [0, 1)$ and $|\psi\rangle = |1\rangle$.

Problem 2 (SWAP test)

Implement in Python a simulation of the SWAP test for arbitrary $|\psi_1\rangle, |\psi_2\rangle \in \mathbb{C}^2$.

Determine the probabilities for $|\psi_1\rangle = |\psi_2\rangle = |0\rangle$ and $|\psi_1\rangle = |0\rangle$ and $|\psi_2\rangle = |1\rangle$.

Plot the probabilities for $|\psi_1 = |0\rangle$ and $|\psi_2\rangle = \sin(2\pi\theta)|0\rangle + e^{2\pi i\varphi}\cos(2\pi\theta)|1\rangle$ for different $\theta, \varphi \in [0, 1)$.