CSCI 4140 Laboratory Four

Quantum Phase Estimation

Introduction

In this lecture you will repeat the implementation of the quantum phase estimation algorithm using a different grate than the one used in the Qiskit textbook and the lecture on quantum phase estimation. You can copy the code from the Qiskit textbook or the lecture as the starting point for the laboratory. You will need the following import statements at the start of your Jupyter notebook:

```
import matplotlib.pyplot as plt
import numpy as np
import math
from numpy import pi
from qiskit import IBMQ, Aer
from qiskit import QuantumCircuit, ClassicalRegister, QuantumRegister, execute
from qiskit.visualization import plot_histogram
```

Phase Estimation for the S gate

Recall that the S gate rotates through twice the angle of the T gate, so we would expect an angle of $\theta = {}^{2}/_{8} = {}^{1}/_{4}$. The only change that you need to make to the program is to double the angle passed to the CU1 gate. Make the change to the program and run it. Observe the histogram that is produced. Does this agree with the expected value? Cut and paste the histogram into your report for this laboratory.

Phase Estimation

The S gate produces an exact result, but that isn't always the case. The textbook and the lecture include a program for estimating $\theta = {}^{1}/_{3}$ which cannot be accurately represented as a binary fraction. In this laboratory we will do the same with $\theta = 0.2$ which again can't be represented by a binary fraction. To do this you only need to make a simple change to the program. In the line where angle is computed replace the 3 by a 5. Observe the histogram that is produced by this circuit. Note that there are two tall bars adjacent to the correct value. Cut and paste the histogram into your report for this laboratory report.

Laboratory Report

Your laboratory report should consist of two histograms. Submit this as a PDF or a PNG file through Canvas.