Qublitz 2024 - Beginner Prompt

Princeton Students in Quantum (PSQ)

11/2/2024 - 11/3/2024

Introduction

For those who are new to quantum computing, you may be wondering why people are even interested in this field in the first place. Why not use giant supercomputer clusters for all our computing needs? Aside from energy concerns, there are some problems that are impossible to compute efficiently on classical computers.

Example

One example where quantum computers excel over classical computers is factoring large numbers to crack RSA encryption (e.g. Shor's algorithm). Additionally, quantum computers have a theoretically proven advantage in searching an unstructured list. This task can be performed using an algorithm known as **Grover's algorithm**. More specifically, Grover's algorithm achieves a quadratic speedup over the classical version for the same task, with a time complexity of $O(\sqrt{N})$ compared to the classical $O(N)$.

Prompt

For this task, we ask you to implement and simulate a small version of **Grover's algorithm** in Qiskit. Since many examples of this implementation are available online, we would like you to include the following:

1. **Write out your personal intuition for every step of the algorithm.**
2. **Find a real-world, specific use case relevant to industry or academia** and demonstrate the use case with the small version of your implemented algorithm. The more specific and creative, the better. Avoid use cases readily found online (we will know if you do this)!

Bonus

As a bonus challenge, run the algorithm for your use case on one of IBM's physical quantum computers and demonstrate that it works correctly!

Resources

The following resources may be helpful:

- IBM Quantum Learning: Grover's Algorithm ← Theoretical guide through the algorithm

- IBM Quantum Learning: Qiskit 101 & 102 ← Guide containing examples of running circuits on real quantum computers.

Final Submission

Please submit your work https://forms.gle/H721Ahc5qjJ3KJL29: as a .zip file containing the following:

1. A Jupyter notebook with the Python code.
2. A `README.txt` file containing information about your team members (names, emails, majors, and academic years).