Summary of Key Concepts

How to Talk About Qubits

Week of October 15, 2023

Resources

- QxQ YLC Week 6 Lab [SOLUTIONS].ipynb
- QxQ YLC Week 6 Homework [SOLUTIONS].ipynb

Key Terms

Key Term	Definition
Bloch Sphere	A geometric representation of a quantum state utilizing a sphere with a radius of one.
Vectors	A mathematical object that represents (for the sake of this course), the contribution of the 0 state and 1 state of a quantum system. Vectors can be generalized beyond quantum systems.
Normalization	The process of scaling a vector such that its length is 1. This allows us to determine the probability of measuring a state.
Quantum Circuit	Analogous to classical circuit in classical computing, a quantum circuit is a model for quantum computation where a qubit can be acted upon by a series of gates and measurements.

Lecture

Learning Objectives

1. *Recognize* three representations of single qubit states: kets, Bloch sphere, and state vectors.
2. *Recognize* Born's rule.
3. *Recognize* normalization.

Key Ideas

1. There are three main ways to represent qubit states, and each way has strengths and weaknesses.

    a. Ket Notation contains all the information we need about a quantum state and is easy to work with mathematically, but is not helpful when it comes to visualizing quantum states.

    b. The Bloch Sphere makes it easy to visualize quantum states, but cannot be used for math and cannot be communicated to a computer.

    c. Vectors are a good blend of both visual and mathematical methods of visualizing quantum states, but do not do either part as effectively as Ket Notation or the Bloch Sphere.

2. Normalization is a vital step whenever working with vectors in order to ensure that Born's Rule can be properly applied to determine the probability of measuring individual states.

Lab

Learning Objectives

1. *Recognize* the landscape of quantum programming options.
2. *Recognize* the basics of lists in python.
3. *Recognize* the basics of Cirq.
4. *Recognize* how to represent qubits and their states in Cirq.

Key Ideas

1. Cirq uses much of the same language as lists in python, so becoming comfortable with creating and modifying lists will make working with Cirq easier and will also allow for creating multi-qubit circuits in the future.