Summary of Key Concepts

Review and Multi-Qubit Circuits

Week of November 12, 2023

Resources

- QXQ YLC Week 8 Lab Notebook [SOLUTIONS].ipynb
- QXQ YLC Week 8 Homework [SOLUTIONS].ipynb
- YLC 23-24 Cirq Basics Cheat Sheet

Key Terms

Key Term	Definition
CNOT Gate	Also called a Controlled X gate or CX gate is a two qubit gate, the control and target qubit, that acts based on the state of the control qubit. If the control qubit is in the 1 state, the CNOT gate applies an X gate to the target qubit. If the control qubit is in the 0 state, the CNOT gate does nothing.

Lecture

Learning Objectives

1. *Understand* three representations of single qubit states: kets, Bloch sphere, and state vectors.
2. *Understand* how to determine the final state of a quantum circuit involving X, Z, and H gates.
3. *Understand* how to predict the probability of measurement outcomes for a given quantum state.
4. *Recognize* how the CX gate acts on qubits, including what the target and control qubits are.
5. *Recognize* how the CX gate can create entanglement.

Key Ideas

1. The CNOT gate is a two qubit gate that acts on the target qubit based on the state of the control qubit, applying an X gate only if the control qubit is in the 1 state.

2. The CNOT gate can be used to create entanglement between the control and target qubit.

Lab

Learning Objectives

1. *Understand* the basics of Cirq for single qubit circuits.
2. *Recognize* how to implement multi-qubit circuits, including the CNOT gate, in Cirq.
3. *Recognize* how to simulate and interpret measurement results in Cirq.

Key Ideas

1. When creating multi-qubit circuits in Cirq, there are two things to keep in mind:
    a. Prior to creating your circuit, you must create the appropriate number of qubits.
    b. When modifying your circuit with gates and measurements, you must use the correct qubit indices.
2. The CNOT gate is a two qubit gate which applies an X gate to the target qubit if the control qubit is in the 0 state.
3. The CNOT gate can be used to create entanglement between two qubits.
4. A histogram can be used to visually represent measurements from a quantum circuit.