A Brief Introduction to Quantum Circuits

Rio Weil, Student # 47189394

This document was typeset on February 14, 2021

Contents

1 Introduction **1**

2 What is a Qubit, anyway? **1**
2.1 Motivation 1
2.2 From a classical bit to a qubit 1
2.3 Quantum Measurement and Probabilities 2

3 One Qubit Quantum Circuits **2**
3.1 The Bloch Sphere 2
3.2 The Identity "Gate" 2
3.3 The Pauli Gates 2
3.4 The Phase (ST) Gates 2
3.5 The Hadamard Gate 2

4 Two Qubit Quantum Circuits **2**
4.1 The Tensor Product - Qubits 2
4.2 The Tensor Product - Gates 2
4.3 Entanglement and CNOT Gates 2

1 Introduction

This document is meant to serve as a bare-bones introduction to the math of quantum computing. This is no means a comprehensive review on the topic, but is meant to provide some background information that might be useful for understanding the project. This set of notes assumes some prior knowledge of linear algebra as well as some basic knowledge of complex variables. This set of notes is based off of information from a TRIUMF Lecture series about introductory quantum computing given by Dr. Olivia Di Matteo[1] as well a information from sections 1.1-2.2 of the Qiskit Quantum computing textbook[2]. For further (more comprehensive) reading on Quantum Computation, both the Qiskit textbook, as well as *Quantum Computation and Quantum Information* by Nielsen and Chuang are good sources.

2 What is a Qubit, anyway?

2.1 Motivation

2.2 From a classical bit to a qubit

One may be already familiar with the classical bit, where the state is represented by a single binary value; 0 or 1. Physically, this corresponds to voltage above some threshold in computer hardware.

[1] `https://github.com/glassnotes/Intro-QC-TRIUMF`
[2] `https://qiskit.org/textbook/ch-states/introduction.html`

2.3 Quantum Measurement and Probabilities

3 One Qubit Quantum Circuits

3.1 The Bloch Sphere

3.2 The Identity "Gate"

3.3 The Pauli Gates

3.4 The Phase (ST) Gates

3.5 The Hadamard Gate

4 Two Qubit Quantum Circuits

4.1 The Tensor Product - Qubits

4.2 The Tensor Product - Gates

4.3 Entanglement and CNOT Gates