Chapter 6
Quantum Program: A Sequence of Quantum Circuits Using Qiskit

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ABSTRACT

The rapid evolution of quantum theory and technology has improved a lot in diverse fields. Quantum computing develops quantum-mechanical effects to execute a computation efficiently, and its benefits reduce both the execution duration and energy consumption compared to conventional computing. Recently, Google declared that quantum supremacy reached a maximum reach, and the quantum computer can effectuate an intractable calculation on a supercomputer. The different quantum algorithms implemented in quantum computers enhance efficiency and speed up the process with classical algorithms. The quantum software Qiskit is used to write quantum computing codes with different stages including building and execution stages. The single Qubit gates controlled two-bit gates and multi-controlled gates help identify the rotations of different dimensions of the plans. The three phenomena of quantum computing will be explained in detail on superposition, quantum measurement, and entanglement to evaluate its functioning.

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INTRODUCTION

In today's world, fast computing plays a significant role in every individual's personal and public life. However, this leads to a lot of power consumption. The Complementary Metal-Oxide Semiconductor (CMOS) transistor shown by progressions in transistor technology solved this problem. Yet, various applications of computing technologies such as trade, medicine, administration, and logistics using CMOS still demand an even higher computing speed. Therefore, the current computation methods require a more efficient replacement. Quantum computing is considered as one such notable alternative (Wille et al. 2019). Quantum computation is defined as the data processing technique using the physical properties of quantum states on a quantum computer (Black et al., 2002). It is the juncture of fields like mathematics, physics, and computer science. The initial point of development of quantum computers can be traced to the 1980s when physicists questioned whether a universal device could simulate quantum mechanical systems (Hassija et al., 2020). Quantum computers perform computations based on the fundamental properties of quantum mechanics like a superposition of states, interference, and entanglement. In addition, they possess the computational benefit of having critical properties of reversibility. These properties enable quantum computers with the prospect of widespread abilities of quantum data processing in the areas like sensing and communication (Wille et al. 2019). Since quantum computing can process information exponentially, quicker than any supercomputer, many private sector companies have started participating in quantum computing-based R&D to avail of maximum opportunities. Numerous experts in this area consider that the improvement of quantum computing technologies may not follow the standard smooth curve of evolution. It may take several years before it can be employed to solve real-life tasks. In this initial development stage, corporations that have started financing and developing plans to integrate their trade structure with quantum supremacy have far superior chances to take advantage of the upcoming market(Hassija et al., 2020).

There are four groups of problems where a quantum computer can stand considerably beneficial over a classical computer. They cover most of the applications established by many industries to produce new commercial prospects and ensure a competitive advantage.

- Combinatorial optimization is the method of detecting the maxima or minima of an objective function, for example, judging the shortest distance among a specified set of points.
- Linear algebra problem: It functions as an essential pillar to machine learning, which has a noticeable impact in several uses across industries.