Navigating Quantum Realities: A Comprehensive Analysis of Quantum Computers, Providers, and Qiskit Compatibility Challenges and Opportunities

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Introduction

Analysis of the degree of availability, capacity, and compatibility of quantum infrastructure service providers and types of quantum computers running a compatible application to assess the maturity level of available services and infrastructure. Since quantum computers are a promise for the present and future, it is necessary to analyze their compatibility, identify the best development framework that can run on all of them, preserving the investment applied in code..

The renowned scientist Richard Feynman was one of the pioneers in recognizing the importance of quantum computing and understanding that nature could resemble a vast quantum computer. In his paper "Quantum mechanical computers" (1986), he laid the initial foundations for the next step: quantum computing. Although quantum computers are a reality today, the question that remains is how far we can advance with them and what features and compatibilities among them can drive scientific and human progress.

Quantum Photosynthesis

Photosynthesis is a vital process for plants and life on the planet. However, its efficiency, approaching 100%, cannot be fully explained by classical physics. One explanation lies in the use of quantum processes within plant leaves. A simulation based on a quantum circuit was developed and tested on various computers to assess the maturity of Qiskit on these platforms.

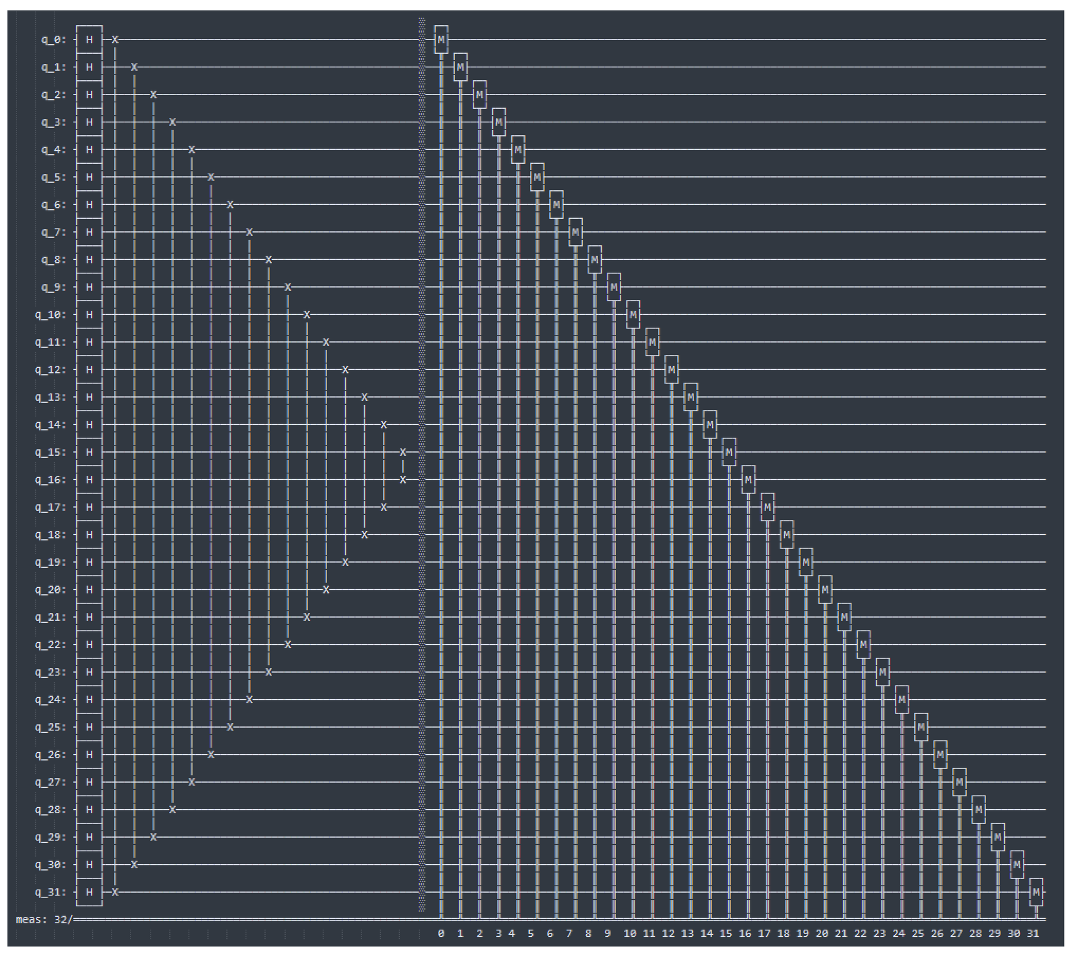
Quantum Bitcoin Mining

The Bitcoin attracts significant investments from banks and companies as a substantial store of value. However, the energy consumption in processing the currency is equivalent to that of some countries. Quantum computers provide a more efficient solution, consuming less energy and processing cryptography rapidly through algorithms designed for this purpose. An address generator was tested using the Grover algorithm on various quantum computing platforms.

Quantum Circuits

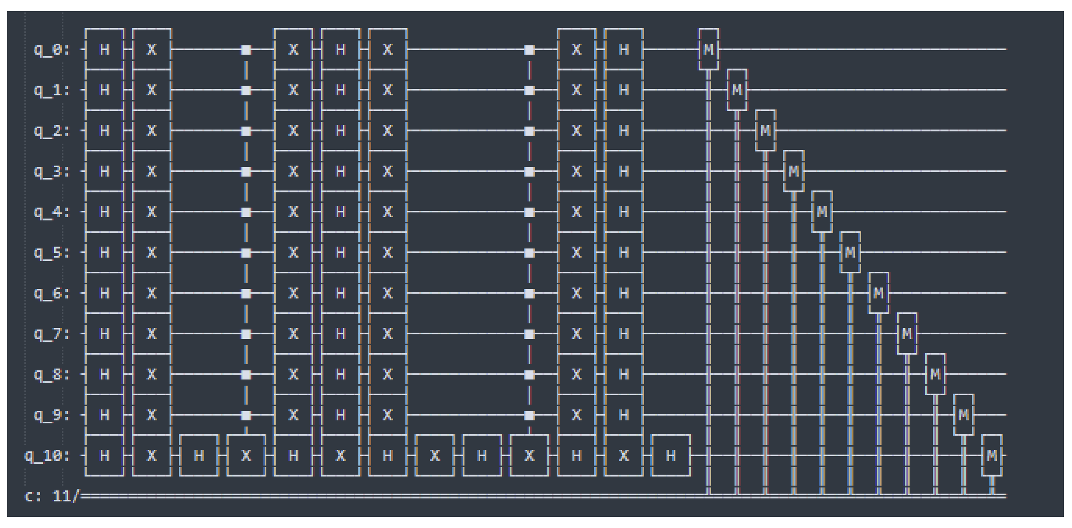
1. Quantum Photosynthesis Simulation:

The quantum circuit was implemented using the Quantum Fourier Transform (QFT), for which the SWAP command was employed as a simplification of the QFT.



2. Bitcoin Simulation:

This code is a basic implementation of the Grover's algorithm for a fictional Bitcoin address search scenario. Grover's algorithm is particularly powerful for unstructured search problems, providing a significant quantum advantage over classical algorithms.



Topic Overview

The thesis aims to analyze the availability, capacity, and compatibility of quantum infrastructure service providers and types of quantum computers to assess the maturity of currently available services and infrastructure. The importance of choosing a development framework compatible with various providers is emphasized, with IBM's Qiskit being the initial choice. Despite testing on various quantum computers in the market, the availability of these machines still does not fully meet the demands of an emerging market seeking to understand and leverage the advantages of this new technology. Several tests could not be completed due to limitations in containers running Jupyter IDEs, presenting significant memory constraints. Additionally, the dependence of quantum computers on classical computers for data input and output is highlighted. More complex constructions, such as Shor and Grover algorithms, often result in failures due to memory overflows.

Conclusions and Future Work

The Qiskit language, a promising tool for the future, opens up possibilities for compatibility among various quantum processor architectures. However, there is still no complete integration among the different available quantum computers. The shortage of machines for testing complicates the debugging and improvement process for Qiskit applications, especially when migrating to other quantum platforms. While the opportunities that quantum computing can offer to humanity are significant, the journey for those embarking on it is challenging, filled with efforts and incremental results.

Looking ahead, it would be interesting for universities to engage in creating a quantum computer model based on Nitrogen Vacancy (NV) Diamonds. Companies in the market already offer these synthetic diamonds for use in quantum computing. NV Diamonds enable the construction of quantum computers at room temperature, are less susceptible to noise, consume less energy, take up little space, and could be the key to developing an open-source computer. This would open up broad opportunities for advancements in the field of quantum computing within educational institutions.

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