Chapter 8

Applications of Quantum Artificial Intelligence: A Systematic Review

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ABSTRACT

Quantum Artificial Intelligence is an exciting new area, which integrates quantum computing with artificial intelligence (AI) in order to produce increasingly sophisticated and effective computational methods, models, and systems. The goal is to use quantum mechanics properties like superposition and entanglement to boost AI's computational power and speed. Quantum computers use quantum bits (qubits) to encode information, in contrast to classical computers, which run on binary digits (bits). Quantum computers can perform some computations faster than classical computers because qubits can exist in multiple states simultaneously. In order to achieve superior computational power in the field of artificial intelligence, this article emphasizes the importance of utilizing quantum mechanical principles. It also explores the potential uses of quantum AI, including machine learning, data analysis, and optimization issues. It deals with the state of art of semiconductors in Quantum computing.

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I. INTRODUCTION

Without question, one of the valuable scientific discoveries of the 20th century was the development of quantum theory. It offers a consistent foundation for the development of numerous contemporary physical ideas. After more than 50 years, the addition of quantum theory and computer science gave rise to the contemporary discipline of quantum computation. This was another major intellectual achievement of the 20th century. Richard Feynman, a Nobel Prize-winning physicist, proposed quantum computers in 1982. He believed that since no normal computer should assemble some quantum phenomena externally encountering an exponential delay, quantum mechanical effects should provide something truly original to computation. In Deutsch's seminal work from 1985, which extended and formalized Feynman's theories, a quantum Turing machine was stated. Specifically, the Quantum parallelism method is developed by Deutsch, which is based on the superposition foundation of quantum physics and enables a quantum Turing machine to concurrently process all of the inputs encoded on a tape. Additionally, his perspective is that quantum computers might be adept to operate some estimation that classical computers can only accomplish very unproductively (Ying, 2007). (Ahnefeld, 2022) made one of the most remarkable advancements in 1994. By utilizing the potential of quantum parallelism, he developed a polynomial-time method for prime factorization on quantum computers, whereas exponential is the most prominent algorithm on traditional computers (Ying, 2005). Grover (Stoudenmire, 2023) presented another groundbreaking use of quantum computation in 1996 when he discovered a quantum technique that allowed for the square root-speedy search of a particular item in a raw database. Shor and Grover's discoveries inspired a thorough examination into quantum processing since databases, search, and prime factorization are crucial issues in computer science and cryptography, respectively, and quantum algorithms for both are significantly quicker than classical ones. Since that time, quantum computation has been a highly intriguing and expanding topic of study.

We have to reconsider many fields of computer science as a result of quantum computation, which profoundly changed the way we think about computation. Artificial intelligence is no exception. Generally, AI has two main objectives: Engineering's purpose is to create intelligent machines, and science's goal is to comprehend how brilliant humans, animals, and machines behave. Computing strategies are mostly used by AI researchers to accomplish their technical and scientific objectives. In fact, McCarthy recently made the point that "computational intelligence" is a better name for the area of artificial intelligence (AI) to emphasize the essential role that computers play in AI (Chauhan,2023). We naturally wonder how this new computing method may assist us in accomplishing the objectives of AI given the expeditious development of quantum computation. While it may seem obvious that applying quantum computation to different AI systems will speed up computation, it is actually exceedingly difficult to develop quantum algorithms that are superior to the currently known classical algorithms for solving particular AI challenges. Currently, it is also unclear how quantum processing may be applied to accomplish the scientific target of AI,

however, no significant study is exploring this issue. It is amazing that much has been written about how quantum theory may be applied to AI and vice versa rather than through quantum computation. The research that is currently accessible demonstrates that quantum theory, due to its inherent probabilistic nature, is more naturally related to numerical AI than to logical AI.