INTRODUCTION

The beginning of the 20th century saw the development of quantum computing as researchers started to study the quantum mechanics of atomic and subatomic particles.

The creation of quantum hardware, algorithms, and applications has advanced significantly since that time. There are several possible uses for quantum computing today, including in machine learning, simulation, cryptography, and other fields.

Theoretical and experimental studies have made important advancements that have accelerated the development of quantum computing. There have been significant recent advances in the design of quantum hardware and software, as well as in fields including quantum communication, error correction, and algorithms. Researchers from across the world are investigating how quantum computing may be used to solve challenging issues in disciplines including chemistry, encryption, and optimization. Leaders in the industry, like IBM, Google, and Microsoft, have also embraced quantum computing more and more as they attempt to create useful applications for the technology. To fully exploit the promise of quantum computing, there is an increasing need for multidisciplinary collaboration amongst physicists, mathematicians, computer scientists, and engineers.

THE TOP RESEARCH PAPERS

This Published on the topic of quantum computing since 2019:

1. "Quantum Approximate Optimization Algorithm: Performance, Mechanism, and Implementation on Near-Term Devices" by Zhikuan Zhao et al. (2020)

This paper presents an analysis of the Quantum Approximate Optimization Algorithm (QAOA), a quantum algorithm for solving combinatorial optimization problems.

2. "Scalable Quantum Simulation of Molecular Energies" by Nhung H. Nguyen et al. (2019)

This paper proposes a scalable quantum algorithm for simulating molecular energies using a hybrid classical-quantum approach.

3. "Quantum Machine Learning" by Jacob Biamonte et al. (2019)

This paper provides a comprehensive survey of quantum machine learning algorithms and their applications.

4. "Quantum Approximate Optimization Algorithm for Max-Cut: A Fermionic Viewpoint" by Sonika Johri and Yudong Cao (2021)

This paper provides a new perspective on the QAOA algorithm for the maximum cut problem using a fermionic viewpoint.

REAL LIFE EXAMPLES

By resolving intricate issues that are now beyond the capabilities of classical computers, quantum computing has the potential to change a variety of industries.

1. Quantum Cryptography:
2. Quantum Simulation:
3. Quantum Machine Learning:

Quantum machine learning combines the principles of quantum mechanics and machine learning to develop new algorithms for data analysis and pattern recognition.

MODELS

There are several models of quantum computing that have been proposed, each with its own advantages and disadvantages. Here are some of the most studied models:

1. Circuit-based Quantum Computing (CBQC)
2. Adiabatic Quantum Computing (AQC)
3. Topological Quantum Computing (TQC)
4. Measurement-based Quantum Computing (MBQC)
5. Quantum Annealing
6. Quantum Walk-based Quantum Computing (QWQC)

COMPARISON

A brief comparison of the models of quantum computing:

Circuit-based quantum computing is the most widely used and best-known model of quantum computing, and is based on the manipulation of qubits using quantum gates.

Adiabatic quantum computing is a model that is specifically designed for solving optimization problems by slowly changing the Hamiltonian of the system.

Topological quantum computing is a relatively new field that uses the non-local properties of materials to encode and manipulate qubits.

Measurement-based quantum computing uses highly entangled cluster states and distributed measurements to perform quantum computations.

Quantum annealing is another model that is specifically designed for optimization problems, but is based on the evolution of the system under a slowly changing Hamiltonian.

ALGORITHMS

Shor's algorithm - used for integer factorization

Grover's algorithm - used for unstructured search

Quantum phase estimation algorithm - used for eigenvalue estimation

HHL algorithm - used for solving systems of linear equations

Quantum approximate optimization algorithm (QAOA) - used for optimization problems

Variational quantum eigen solver (VQE) - used for calculating the ground state energy of a molecule

Quantum Fourier transform - used for efficient classical signal processing

Quantum annealing - used for optimization problems

Hidden subgroup problem algorithm - used for finding hidden structures in certain groups

Quantum walk algorithm - used for searching on a graph

Each of these algorithms has its own specific use case and is designed to solve a particular problem faster than classical algorithms.

ANALYSIS

Using the power of computing and the principles of quantum mechanics, quantum computing is a quickly expanding area that enables the development of machines that can solve issues that are beyond the capabilities of conventional computers. Improved data processing algorithms, better cryptography, and the capacity to model intricate quantum systems are some of the possible advantages of quantum computing. But there are also major difficulties with quantum computing, such as the need for extremely specialized hardware and software, the requirement for error correction because quantum systems are sensitive to outside noise, and the scarcity of qubits. Despite these obstacles, the area of quantum computing is quickly developing, and new discoveries and advancements are consistently being made.

CONCLUSION

The area of quantum computing is developing quickly and has a great deal of promise for solving issues that are outside the purview of classical computing. Quantum computing is set to revolutionize the disciplines of encryption, optimization, and machine learning through the development of new hardware and methods. To fully realize the promise of quantum computing, much more study is still required due to the formidable difficulties in creating and scaling quantum computing systems. Despite these obstacles, the field of quantum computing is still expanding and developing, with new discoveries and advancements being made frequently. We can anticipate quantum computing to have a significant effect on many fields of science and technology as it advances and becomes more broadly accessible, from medicine discovery to finance to artificial intelligence.

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