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QUANTUM COMPUTING: THEORY AND APPLICATIONS

Quantum computing is a revolutionary approach to computing that uses quantum mechanics principles to perform calculations. Unlike classical models of computers that use the most fundamental building block, the bit, which can only exist in one of two distinct states, ‘0’ or a ‘1’ quantum computers use ‘quantum bit’, usually referred to as a ‘qubit’.

A quantum computer could perform many operations simultaneously using a single processor. This enables quantum computers to perform certain calculations exponentially faster than classical computers.

Quantum computing is based on a set of principles that differ from classical computing. Some of these principles are as follows.

1. Superposition: Qubits can exist in multiple states at once, allowing for parallel processing of information.

2. Entanglement: Qubits can be linked together so that the state of one qubit is dependent on the state of another qubit, regardless of the distance between them.

3. Parallelism: The ability of a quantum computer to encode multiple computational results into a quantum state in a single quantum computational step.

Quantum algorithms are designed to take advantage of these principles to perform calculations that are difficult or impossible for classical computers.

One example is Shor’s algorithm, which can factor large numbers exponentially faster than classical algorithms. This has implications for cryptography, as many encryption algorithms rely on the difficulty of factoring large numbers.

While quantum computing is still in its early stages, it has the potential to impact a wide range of industries. Here are some examples:

Chemistry. Quantum computers can simulate complex chemical reactions, which could lead to the development of new materials and drugs.

Finance. Quantum computers can optimize investment portfolios and perform risk analysis faster than classical computers.

Cryptography. Quantum computers can break some encryption algorithms, which has implications for data security.

Machine learning. Quantum computers can be used to train machine learning models faster than classical computers.

Cybersecurity. With the help of quantum communication both receiver and sender are alerted when an eavesdropper tries to catch the signal.

Artificial Intelligence. Increasing the speed of operation will help computers to learn faster even using one of the simplest methods - the mistake-bound model for learning.

While there are still challenges that need to be addressed, researchers are making progress in developing quantum computers and quantum algorithms. It will be exciting to see how quantum computing develops in the coming years and the impact it will have on our lives.