QUANTUM COMPUTING :- How it will revolutionize AI

What is Quantum Computing?

It is the most advanced and innovative field of Computing that operates on quantum mechanics and principles to process information in ways fundamentally different from Classical computers.

Quantum Computing is experiencing rapid growth in demand due to it's potential to solve problems that are intractable for Classical computers.

It is still in its early stage , tech giants like IBM , Google, Intel, Microsoft, Amazon, and startups like Rigetti, IonQ, D-Wave are building quantum processors and racing for dominance.

How it actually works?

Qubits (Quantum bits) : *Classical bits are binary 0 or 1 no in between whereas, qubits can be in a superposition of 0 and 1 that is 0 or1 or in between.*

Superposition : *In this a qubit exists in multiple states at once until measured which enables parallel computation.*

Entanglement : *It is when two or more qubits become correlated like measuring one instantly determines the other's state even when they are at farther distance.*

Einstein called this "spooky action at a distance".

Quantum Gates : *Unlike Classical Gates which are irreversible operations quantum Gates are reversible and manipulate qubits via unity transformations.*

Quantum parallelism and Inference : *Parallelism is when a quantum computer evaluates all possible inputs simultaneously. Inference is when it amplifies correct solutions while canceling wrong ones.*
It is a key to algorithms like Grover's search and shor's factoring.

Shor's algorithms (Breaking RSA Encryption)

Quantum computer does it by initializing qubits using superposition to represent all possible factors and it finds the periodic patterns in the factors. At last , the system collapses to the correct period revealing prime factors.

It is fast because shor's run in polynomial time (~seconds/ minutes).

Quantum computers won't replace laptops or phones because, they are bad at web browsing , video games , spread sheets etc..But , where they do excel is in breaking RSA Encryption, drug discovery, AI acceleration. But , it is still in the process of development and take time to be able to use it.

Quantum Computing + AI

- *It leads to faster machine learning by using quantum algorithms which can process complex databases 1000× faster than classical ml.*

e.g : Google's TFQ integrates QC with deep learning for drug discovery (https://quantumai.google/).

- *Solves intractable optimization problems in seconds rather than years.*

e.g : Volkswagen used QC to optimise traffic flow in Beijing.

- *It enhances data search and pattern recognition useful for fraud detection and real time recommendation engines.*

The use of AI in quantum computing is as follows :

1. *Error correction and qubit control , AI stabilizes qubit by predicting and correcting noise.*

e.g : Google's AI reduced quantum errors by 40% in 2023.

2. Optimizing quantum algorithms, Neural Networks design better quantum circuits.

e.g : IBM's Quiskit + AI hybrid workflows (https://qiskit.org).

Challenges

- *Quantum computers lose data easily because of their sensitivity to sound.*

- *AI needs stable calculations , but today's quantum machines make too many errors.*
- *For now, there are not enough useful AI algorithms yet.*

Instant drug disovery : simulate entire molecules in minutes and unbreakable encryption : safe block chain are two of the important future goals.

Quantum computing could redefine AI and security, if we master its instability. The breakthrough awaits.

References

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