

## AI - Quantum Computing Confluence

### Why in news?

Quantum Computing (QC) and Artificial Intelligence (AI) are arguably the two most transformative technologies of our era, pushing the boundaries of computation and cognition, respectively.

#### Key terms

##### Artificial Intelligence

- It is the simulation of human intelligence processes by machines, especially computer systems.
- It is designed to perform various activities which include speech recognition, learning, planning, problem solving.

##### Quantum Computing

- It is a rapidly-emerging technology that harnesses the laws of quantum mechanics to solve problems too complex for classical computers.
- Quantum theory is a branch of physics which deals in the tiny world of atoms and the smaller (subatomic) particles inside them.

### What is Quantum AI?

- It means the use of QC for computation of machine learning algorithms, which takes advantage of *computational superiority* of QC to achieve results that are not possible to achieve with classical computers.
- **Quantum theory-**
  - **Qubits-** It can exist in a *superposition* of two states (both 1 and 0), to encode and manipulate information.
  - **Entanglement-** It is a phenomenon where two qubits can share a quantum state and influence each other, even when they are far apart.
- The potential outcomes are extraordinary as QC redefine the limits of speed and parallelism and AI reshape our understanding of intelligence and automation.

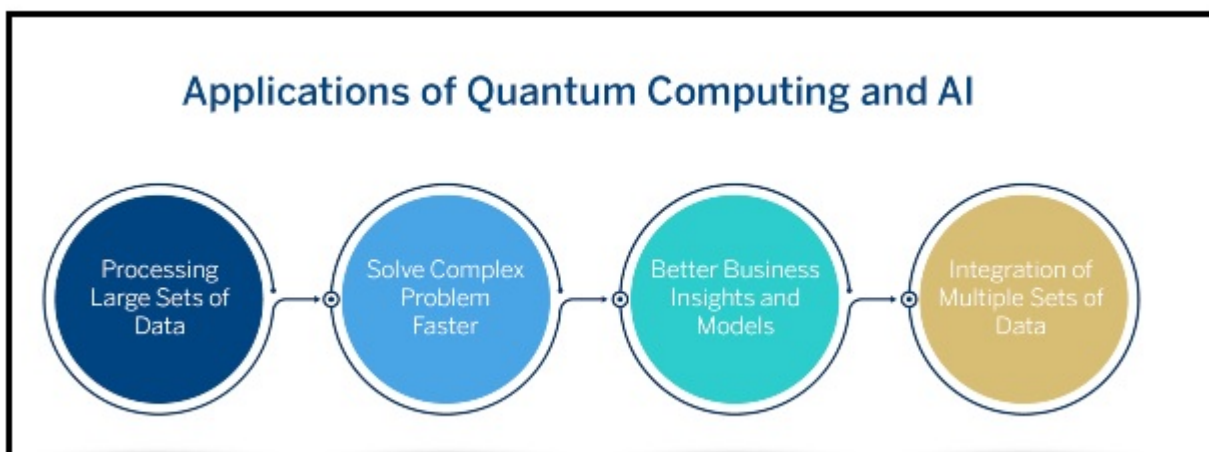
*In 2019, Google's Sycamore quantum processor achieved quantum supremacy solving complex problems in about 200 seconds that would take classical supercomputers millennia.*

## What is the significance of Quantum AI?

- **Computational boost-** It enables to tackle more complex problems and achieve artificial general intelligence.
- **Better automation-** Quantum AI can automate tasks such as optimization, simulation, and encryption that are difficult or impossible for classical computers.
- **Improved security-** Quantum AI can enhance the security of data and communication by using *quantum cryptography and quantum key distribution*, which are immune to hacking.
- **Faster data analytics-** They can process large amounts of data faster and more efficiently than classical computers, such as big data, quantum machine learning, and quantum neural networks.
- **Effective machine learning-** It can improve the performance and accuracy of machine learning models and train them faster by using quantum enhanced learning.
- **Simulation-** It can simulate complex systems that are beyond the reach of classical computers such as quantum chemistry, quantum biology and quantum physics.
- **Optimization - *Quantum annealing*** is a quantum technique that can solve optimisation problems in AI and machine learning.
- It uses quantum tunnelling to escape local minima and reach global optima, which are the optimal solutions.

## Real Time Applications of Quantum AI

- **Quantum Networking-** Leveraging quantum teleportation for transferring quantum states without the physical transfer of individual particles, paving the way for a '*quantum internet.*'
- **Healthcare-** Combining AI's pattern recognition with quantum computing's simulation abilities aids in advancements in drug discovery and personalised medicine.
- **Climate Modelling-** Quantum-enhanced AI may lead to more accurate climate models, offering improved solutions to the climate crisis.



## What are the challenges with Quantum AI?

- **Prone to errors-** Quantum systems are highly sensitive to external disturbances, making them prone to decoherence.
  - Decoherence occurs when the fragile quantum state of a qubit is disrupted, leading to inaccuracies in calculations.

- **Complexity-** Traditional AI algorithms are not directly compatible with QC, hence new algorithms are needed for quantum systems.
- **Lack of skillset-** The scarcity of professionals with interdisciplinary skills of both AI and QC poses a hurdle in the widespread adoption of quantum AI.
- **Cybersecurity risks-** QCs could potentially break existing encryption protocols, enable malicious actors to access sensitive information and disrupt transactions or manipulate records.
- **Lack of neutrality-** Quantum AI could inherit or amplify the biases and unfairness of classical AI, such as discrimination, exclusion, or misrepresentation of certain groups or individuals.
- **Societal impact-** Quantum AI threatens privacy, increases inequality or causes ecological damage.

### What lies ahead?

- The convergence of quantum computing and artificial intelligence signifies not merely a technological leap but a quantum leap.
- The symbiotic relationship between these disciplines has the potential to reshape our digital future.
- The need of the hour is collaboration and ethical frameworks to use these technologies responsibly.

### References

1. [Business Line- When AI meets quantum computing](#)
2. [IBM- What is quantum computing](#)

