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.



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

