

MODULE 9: Applications of Quantum Computing

Applications

- 1. Artificial Intelligence & Machine Learning**
- 2. Drug Design & Development**
- 3. Cybersecurity & Cryptography**
- 4. Financial Modelling**
- 5. Weather Forecasting**
- 6. Logistics Optimization**
- 7. Computational Chemistry**

1. AI & ML

Faster model training: Quantum computers can speed up optimization tasks used in training ML models.

Quantum-enhanced learning: Algorithms like Quantum SVMs and Quantum Neural Networks (QNNs) enable improved pattern recognition.

Handling large datasets: Quantum algorithms allow parallel processing of high-dimensional data.

Example: Quantum Boltzmann Machines for deep learning tasks.



2. Drug Design &Development

Molecular simulation

Quantum computers can simulate complex molecular structures and reactions.

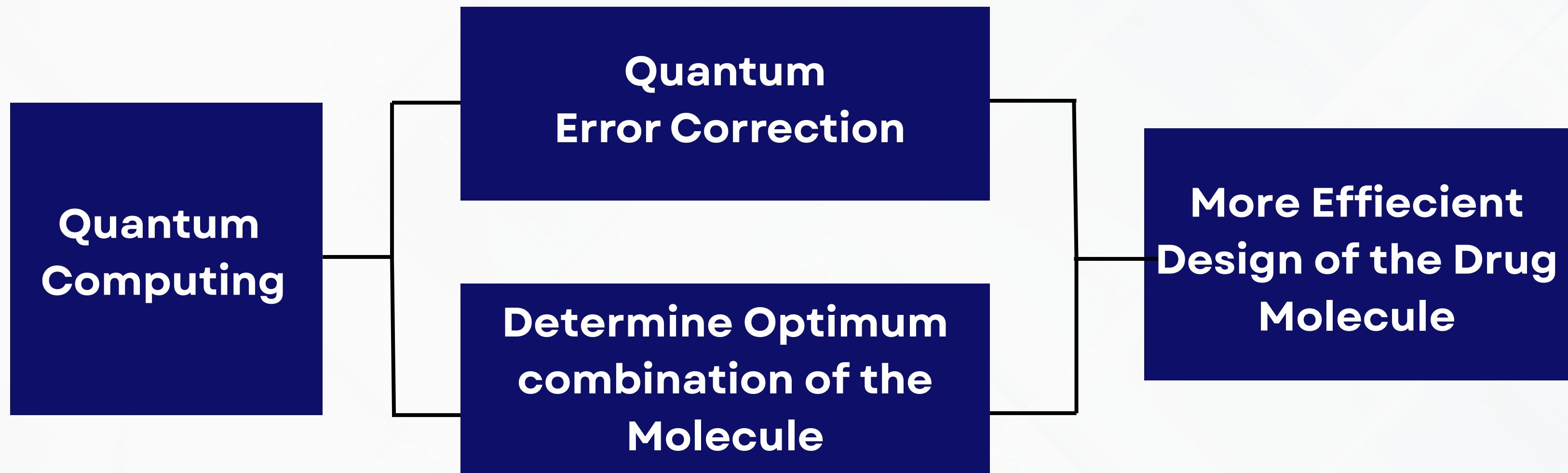
Accelerates R&D

Helps identify promising drug compounds faster than traditional methods.

Cost-effective

Reduces time and financial cost in pharmaceutical research.

Quantum Computing in Drug Design:



3. Cybersecurity & Cryptography

Cybersecurity in quantum computing:

Cybersecurity in quantum computing refers to the study and application of security techniques that protect data and communication systems from threats posed by quantum computers, while also using quantum principles (like entanglement and superposition) to create ultra-secure encryption methods such as Quantum Key Distribution (QKD).

What is quantum cryptography?

Quantum cryptography (also known as quantum encryption) refers to various cybersecurity methods for encrypting and transmitting secure data based on the naturally occurring and immutable laws of quantum mechanics.

Cybersecurity & Cryptography

- 01** Quantum Key Distribution (QKD) enables unhackable communication by using the principles of quantum mechanics.
- 02** Shor's algorithm can efficiently factor large numbers, making RSA and ECC insecure on quantum machines.
- 03** Quantum algorithms like Grover's can weaken hash functions by reducing their effective strength.
- 04** Researchers are designing classical encryption methods that are secure even against quantum attacks.

4. Financial Modelling

Targeting and Prediction:

Quantum-enhanced models predict investment outcomes and identify profitable segments based on historical and real-time data.

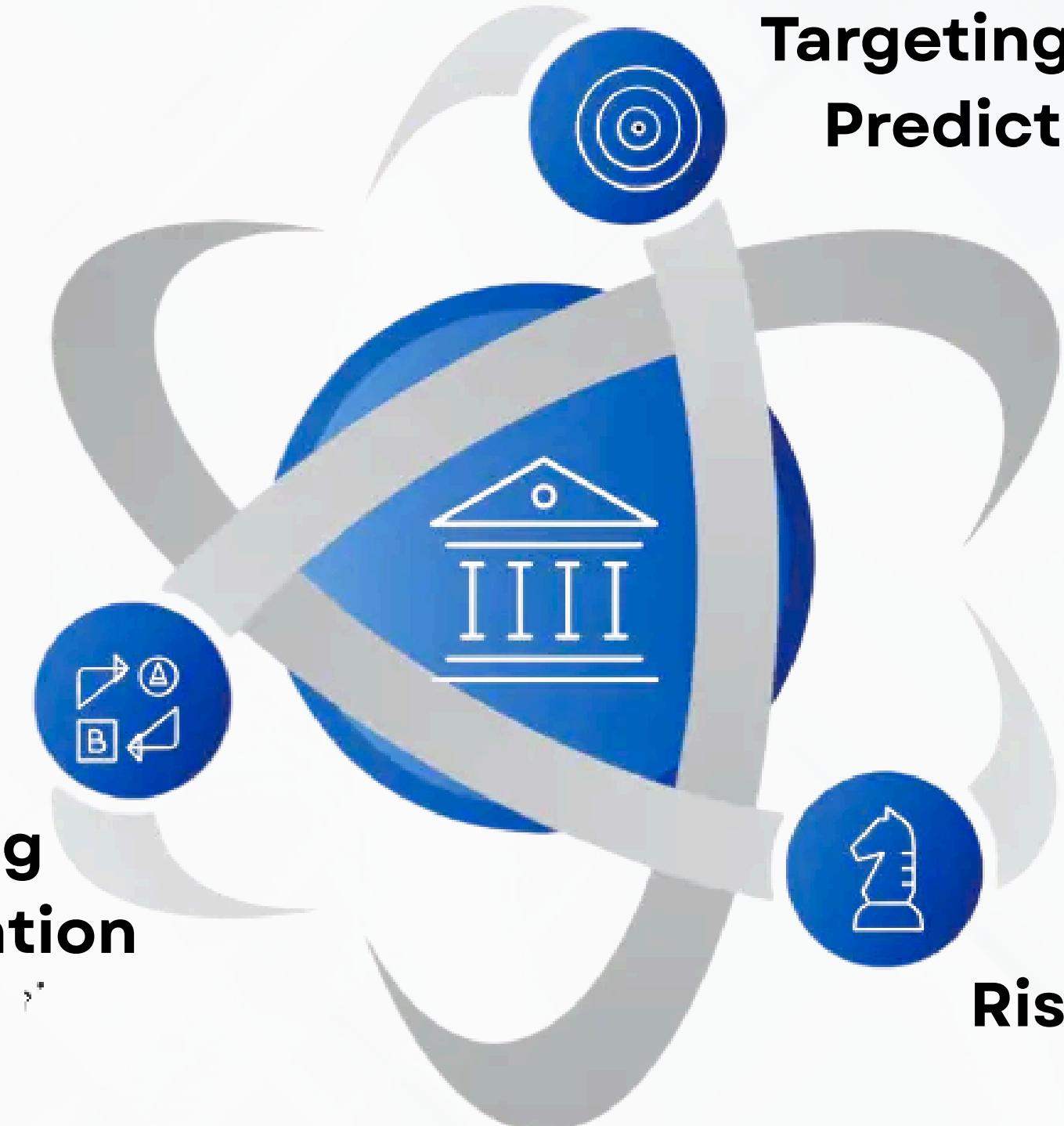
Risk Profiling:

Quantum algorithms evaluate investor behavior and market volatility to assign accurate risk profiles quickly.

Trading Optimization:

Quantum systems optimize trade execution by analyzing multiple market parameters simultaneously for better pricing and timing.

Targeting and Prediction



5. Weather Forecasting

Better Simulations:

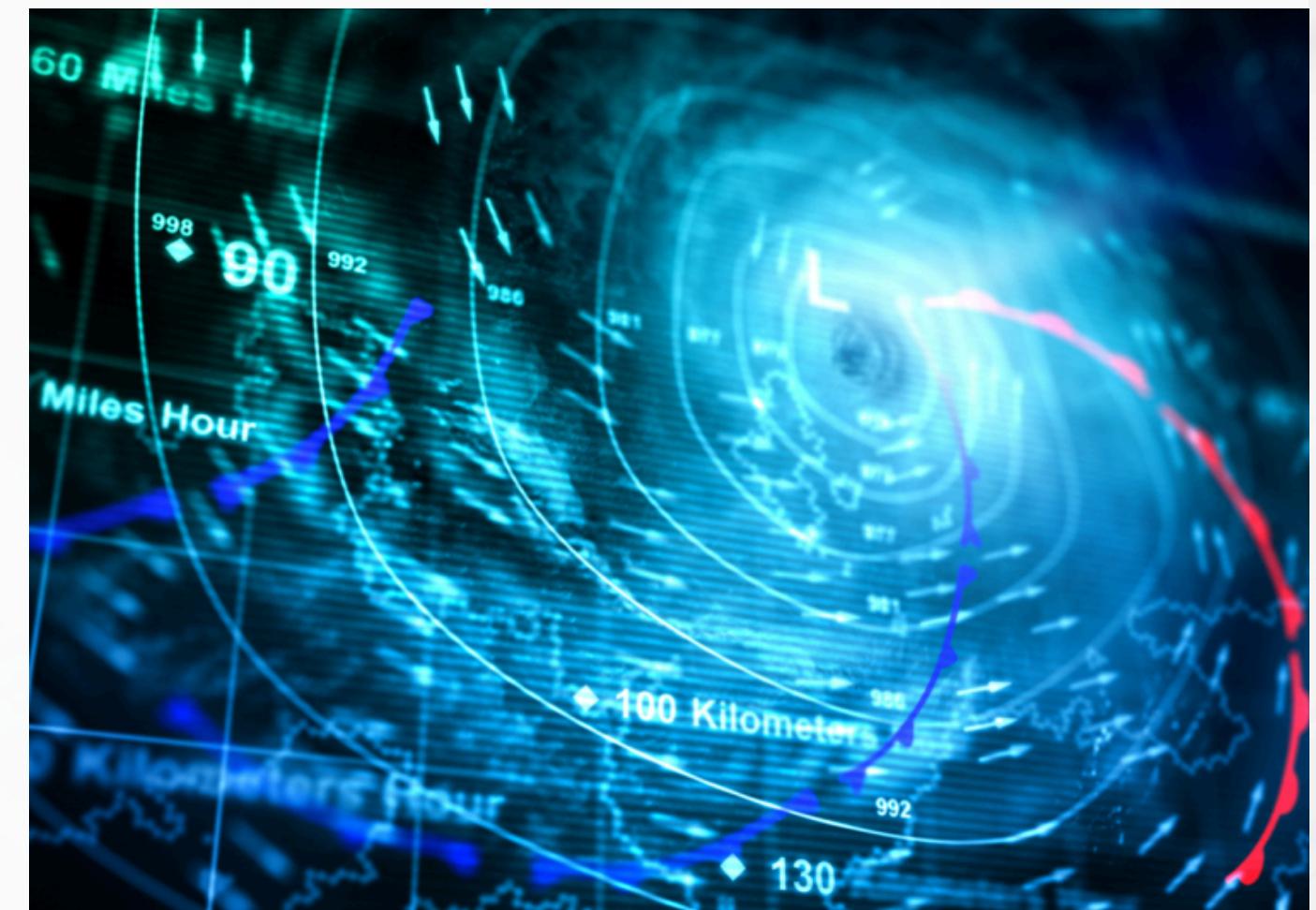
Quantum computers can simulate highly complex atmospheric systems with greater precision, helping meteorologists understand intricate interactions like ocean-atmosphere coupling and jet streams.

Faster Predictions:

With the ability to process large-scale meteorological data in parallel, quantum computing enables real-time weather forecasting with reduced computational time.

Climate Modeling:

Quantum computers can simulate highly complex atmospheric systems with greater precision, helping meteorologists understand intricate interactions like ocean-atmosphere coupling and jet streams.



6. Logistics Optimization

Routing Problems:

Quantum algorithms (like QAOA and quantum annealing) are highly effective in solving the Vehicle Routing Problem (VRP), helping companies minimize delivery time and fuel costs.

Real-time Decision Making:

Quantum systems can process traffic data and delivery constraints in real time, enabling dynamic route adjustments for faster cargo movement and reduced delays.

Supply Chain Optimization:

Quantum computing improves inventory management, demand forecasting, and distribution planning, making the entire supply chain more resilient and cost-effective.



6. Computational Chemistry

Accurate Reaction Modeling:

Quantum computers can simulate electron interactions and molecular orbitals at the quantum level, enabling precise modeling of chemical reactions, bonding, and energy states.

New Material Discovery:

Quantum simulations accelerate the discovery of advanced materials like superconductors, catalysts, and battery components, which are vital in energy, electronics, and manufacturing industries. Lowers dependency on costly lab experiments.

Molecular Structure Prediction:

Quantum algorithms can determine the ground state and conformational stability of complex molecules faster than classical methods.

Question and Answer...



Thank You