Game Theory and Quantum Computing

Exploring the Intersection of Two Revolutionary Fields

Frederick Mark Ferriol

What is Game Theory?

- Game Theory explores the ways individuals engage and decide.
- In strategic games, players select strategies that optimize their outcomes, considering the strategies chosen by others.
- Players, Strategies and Payoffs
- The mathematics of human interactions.
- E.g
    - Prisoner’s Dilemma

History of Game Theory

- 1928: John von Neumann published “Theory of Parlor Games”
- 1950s: Nash Equilibrium
  - No player benefits from a change in strategy
- 1972: Evolutionary Game Theory, Smith and Price
- 2000s-Present: Influence of many fields. E.g
  - Computer Science
  - Artificial Intelligence
  - Network Theory

What is Quantum Computing?

- Quantum computing leverages principles of quantum mechanics to perform computations
- Qubits
- Superposition
- Entanglement
- Quantum parallelism

Quantum Computing and Game Theory

- Extends classical game theory using quantum concepts
- Players can utilize quantum strategies for decision-making
- Players empoy quantum operations as strategies
  - Quantum gates
- Introduces new dimensions to strategic decision-making
- Exploration of novel equilibria beyond classical Nash equilibrium
- Enhances analysis of complex, multi-agent systems.
- E.g.
  - Quantum Auctions
  - Quantum Key Distribution (QKD)

Real-World Applications

- Secure Communication
- Improved Fairness and Efficiency
- Optimizing Game-Theoretic Algorithms

Challenges and Future Directions

Challenges:

- Technical Difficulties in Building Quantum Computers
- Complexity in Understanding Quantum Strategies

Future Prospects:

- Advancements in Quantum Hardware
- New Theoretical Breakthroughs