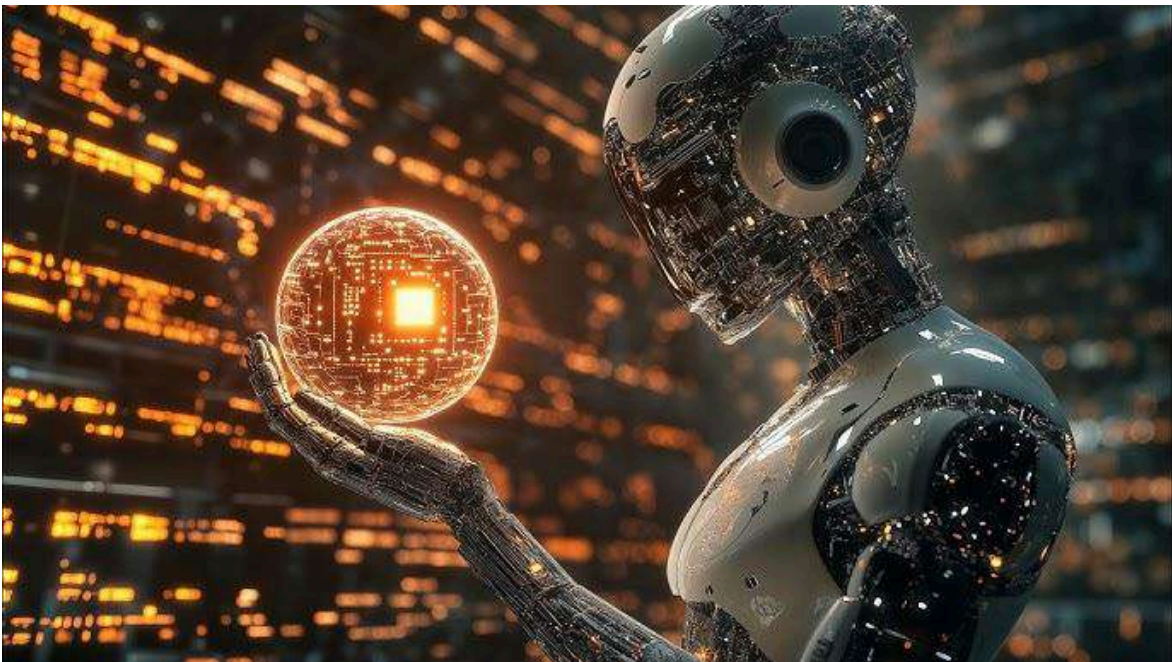


Quantum Information and Intelligence Systems: Revolutionizing the Future of Data and Computation

In the realm of technology, a new era has dawned, and it's all about quantum. The United Nations has proclaimed 2025 as the International Year of Quantum Science and Technology (IYQ). India has joined the quantum race with its National Quantum Mission (NQM), launched in April 2023. This initiative, backed by a budget of ₹6,003.65 crore over eight years, aims to develop intermediate-scale quantum computers with 50–1,000 qubits. At the forefront of this revolution is the Quantum Information and Intelligence Systems (QuIIS) group at Amrita Vishwavidyapeetham, led by Dr. Mrittunjoy Guha Majumdar. In this article, we'll delve into the exciting world of quantum information and intelligence systems, exploring the latest research and advancements in this field.



The Quantum Leap

Quantum computing is no longer just about transistors and lasers; it's about harnessing the power of quantum mechanics to enhance computational efficiency and data analysis capabilities. Quantum machine learning (QML) is an interdisciplinary field that combines quantum computing with machine learning techniques to tackle complex problems. By leveraging quantum bits (qubits) and quantum operations, QML enables

faster training and improved accuracy in predictive models. The QullS group is at the forefront of this research, exploring the potential of quantum resources for increased efficiency and throughput in learning paradigms. At QullS, researchers are diving into algorithms like Variational Quantum Circuits (VQCs) to revolutionize reinforcement learning and generative modeling.

The Three Eras of Quantum Technology

To appreciate the present advancements, it's essential to understand the progression of quantum technology:

- Quantum 1.0: Pioneered by developments like the transistor and LASER.
- Quantum 2.0: Introduced quantum computing and communication protocols.
- Quantum 3.0: A promising era where quantum principles are applied to artificial intelligence (AI) and machine learning (ML), enabling breakthroughs in computational systems.

This third era forms the core of QullS's research as it bridges quantum mechanics, AI, and information theory to redefine data processing and learning paradigms.



Gate-Based, Measurement-Based, Functional Quantum Computing

The QullS group is also working on various aspects of quantum computing, including gate-based, measurement-based, and functional quantum computing. Gate-based quantum computing follows the quantum circuit model, while measurement-based quantum computing leverages highly entangled cluster states. Functional quantum computing explores specialized frameworks like adiabatic quantum computing and quantum annealing, targeting optimization and problem-specific applications. These paradigms complement each other, pushing the boundaries of quantum computation's versatility and real-world applicability.

Quantum Communication and Cryptography

Quantum communication is an advanced field that leverages quantum mechanics to enable secure data transmission. Quantum Key Distribution (QKD) is a method of secure communication that uses quantum bits (qubits) to exchange cryptographic keys. The QullS group is exploring topics relating to quantum network coding, quantum internet, and cryptographic protocols. With the vision of a quantum internet emerging, secure communications and the exchange of qubits between quantum computers are becoming a reality.

Quantum Information Processing for Sustainability

Quantum information processing (QIP) holds significant potential for advancing sustainability by optimizing complex systems and improving resource efficiency. By leveraging quantum algorithms, QIP can address challenges in areas such as supply chain management, energy distribution, and transportation logistics. The QullS group is looking at aspects of energy and resource optimization for sustainability using quantum information paradigms.

Conclusion

The QullS group at Amrita Vishwavidyapeetham is at the forefront of research in quantum information and intelligence systems. With its focus on quantum machine learning, gate-based, measurement-based, and functional quantum computing, quantum communication, and quantum information processing for sustainability, the group is pushing the boundaries of what is possible with quantum technology. As we enter the era of Quantum 3.0, the application of quantum in the realm of AI and machine learning, the QullS group is poised to make significant contributions to this field.