Exploring Quantum Neural Networks (QNNs) and Quantum Convolutional Neural Networks (QCNNs)

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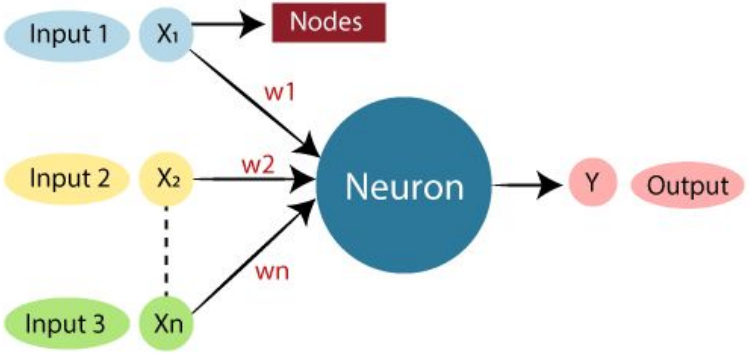
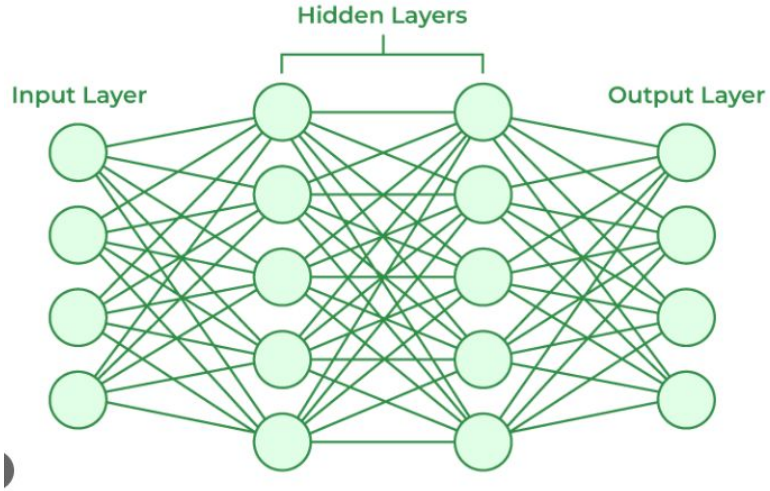
Code link: https://github.com/an20805/QNN-and-QCNN

Neural Networks

Neural Networks are parameterized mathematical models which are used to predict patterns or approximate functions with the help of large amount of data or samples.



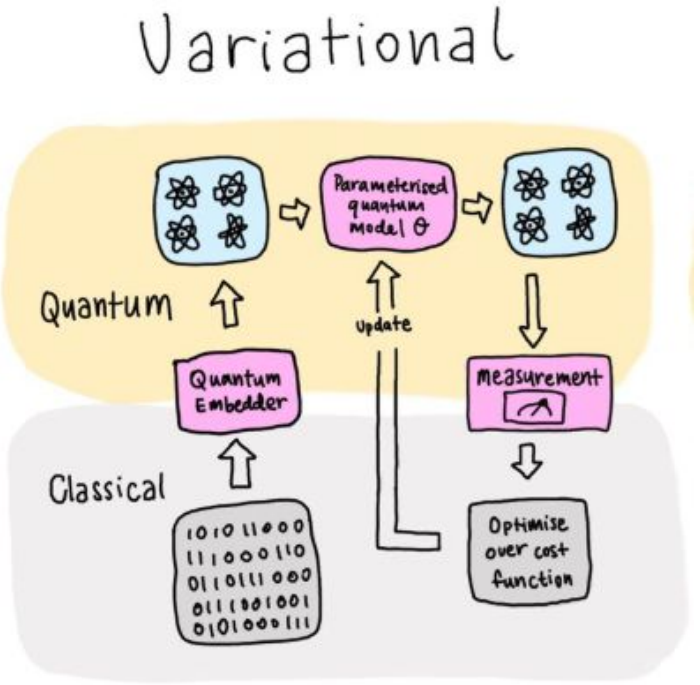


Why QNNs

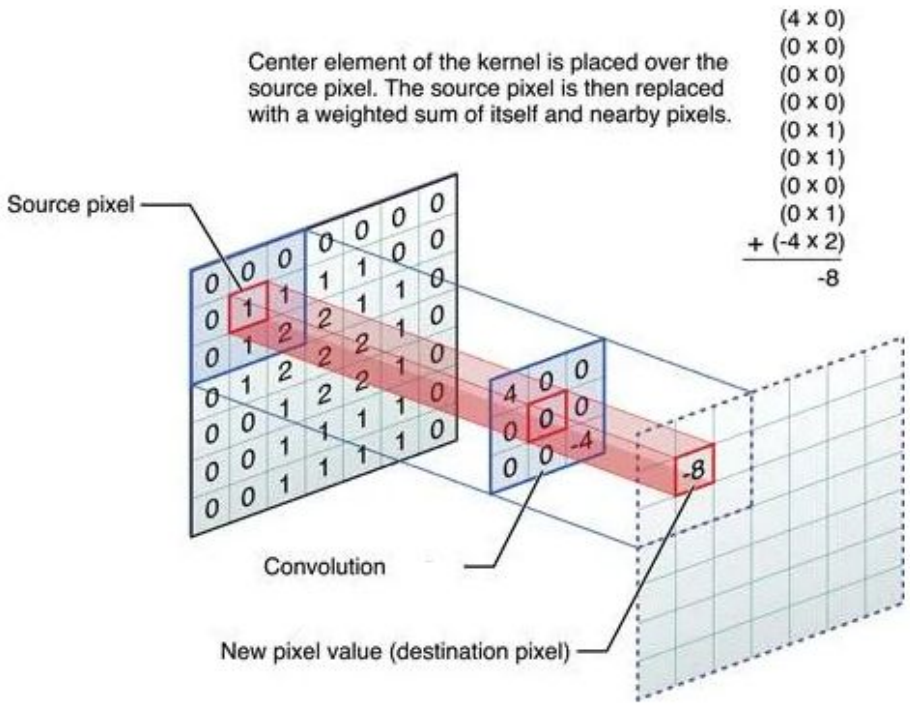
1. **QNNs can represent a broader class of functions than classical neural networks by leveraging quantum superposition and entanglement.**
2. **Quantum states allow simultaneous computation on multiple states, enabling faster data processing for certain problems**
3. **Quantum systems can achieve similar or better outcomes with fewer parameters compared to classical models**

Implementing QNNs

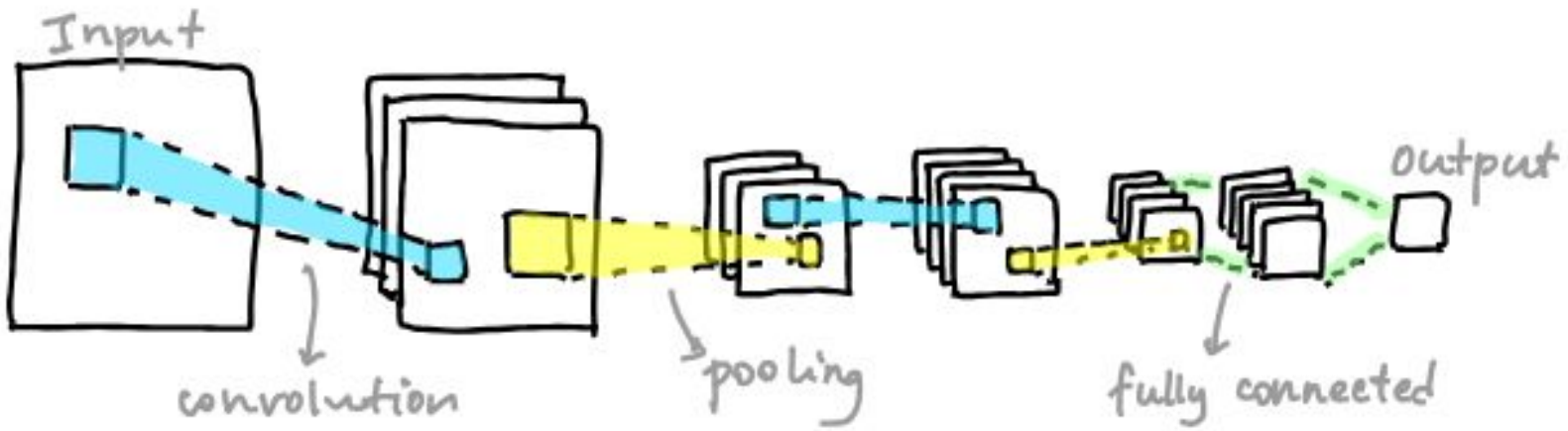
1. **Input Encoding:** Convert classical data into quantum states using techniques like amplitude encoding, angle encoding
2. **Quantum Circuit Construction:** Circuit is constructed through parameterised rotation gates and CNOTs
3. Add measurement operations to extract meaningful outputs



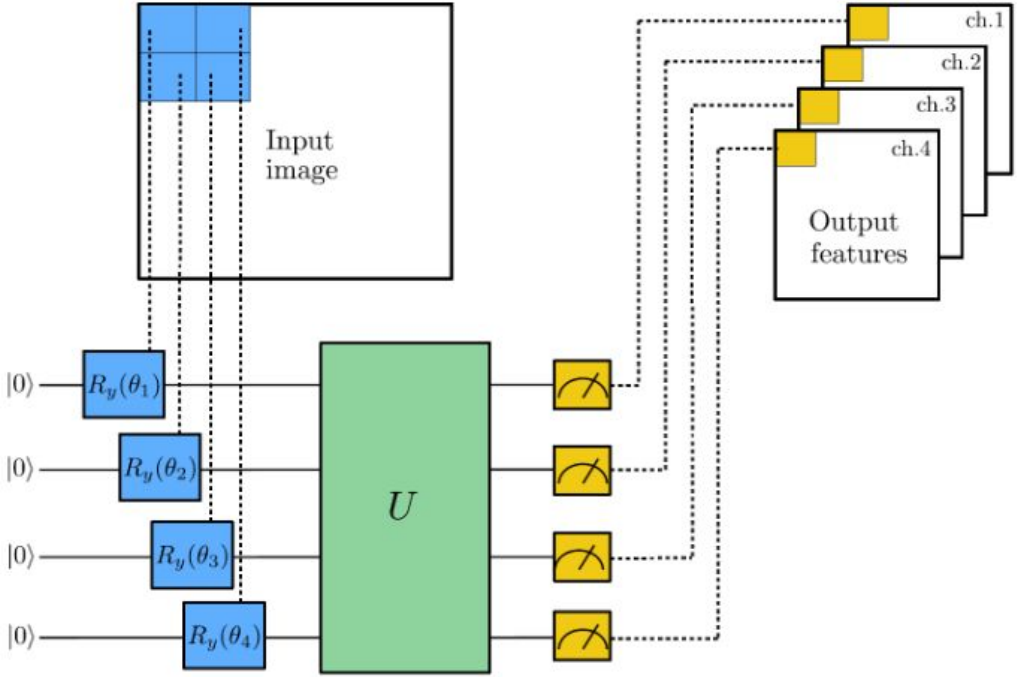
Convolution Operation

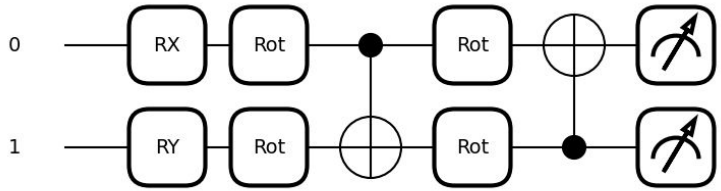


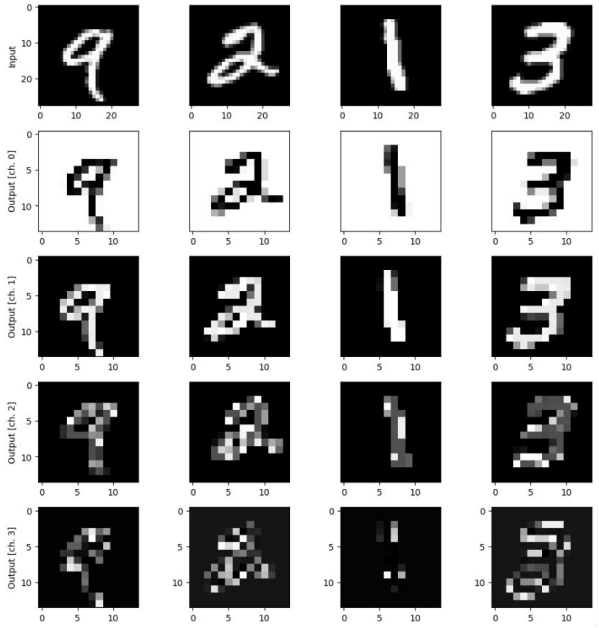
Convolutional Neural Networks (CNNs)



Quanvolutional Neural Networks







Our Experiments

- Achieved 80% accuracy on Iris dataset with just 12 parameters.
- Used Quantum Convolution as pre-processing
- Observed better results with quanvolutional preprocessing