Quantum Convolutional Neural Network

A project of the Qiskit Fall Fest Hackathon
University of Montpellier
15 – 22 October 2021

Convolutional Neural Network

Convolutional neural networks are used in a wide variety of fields:

- Facial recognition
- Medical image computing
- Drug discovery
- Remote sensing using satellite images
- Financial time series
- Determining oil well placement
- Autonomous driving

Quantum Convolutional Neural Network

- QCNN is the quantum analogue of the classical convolutional neural network
- QCNN makes use of O(log N) parameters for input sizes of N qubits, instead of O(N) parameters in the classical algorithm

Number of pixels	Number classical bits	Number qubits
16	128	12
1024	8192	16
1048576	8388608	28

- This project follows the work of Iris Cong, Soonwon Choi and Mikhail D Lukin

Data preparation

Define a cluster state, which is an alternative representation of a quantum circuit

The cluster state is based on graph theory

Generate the cluster state data

Classification phase

Quantum Convolution

- Combine adjacent qubits

Quantum Pooling

- Pool N qubits into N/2 qubits by reducing the entanglement

Proposed improvements to Qiskit

During the implementation we found the following issues, and propose improvements in Qiskit.

The plot of the phase of the state vectors in Qiskit is sometimes wrong. This has been reported on the Qiskit GitHub.

The representation of the Bell state $|\Psi^-\rangle$ in the Qiskit Primer has a qubit sequencing from left to right, instead of right to left in Qiskit notation.