Branching Quantum Convolutional Neural Networks

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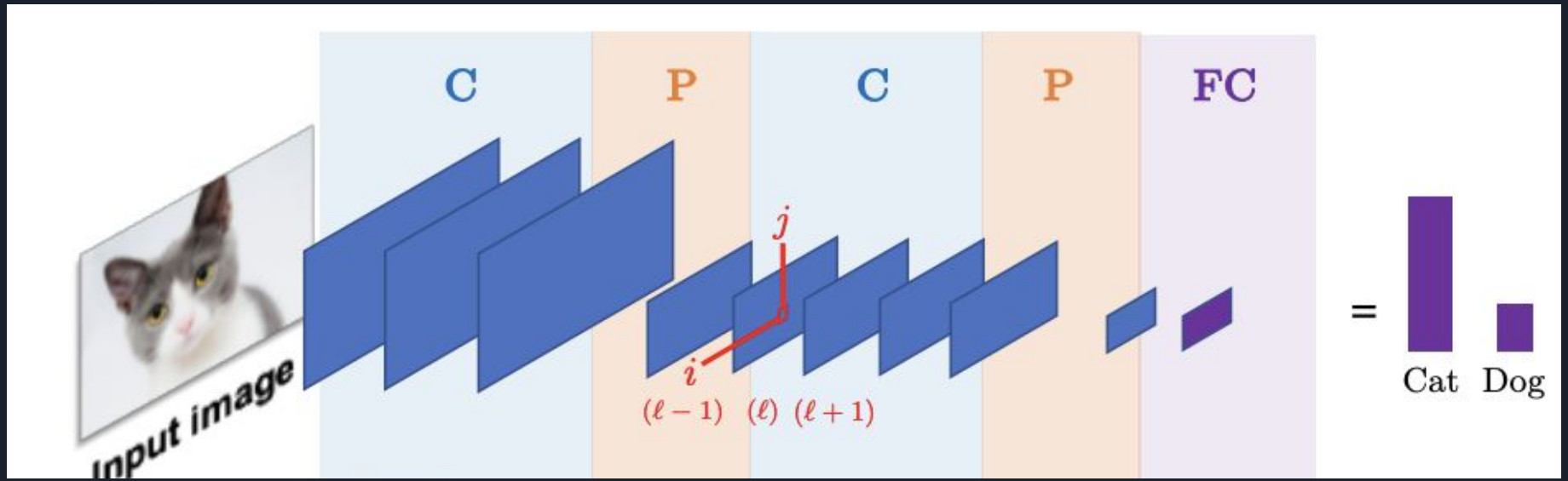
Background

Convolutional Neural Network

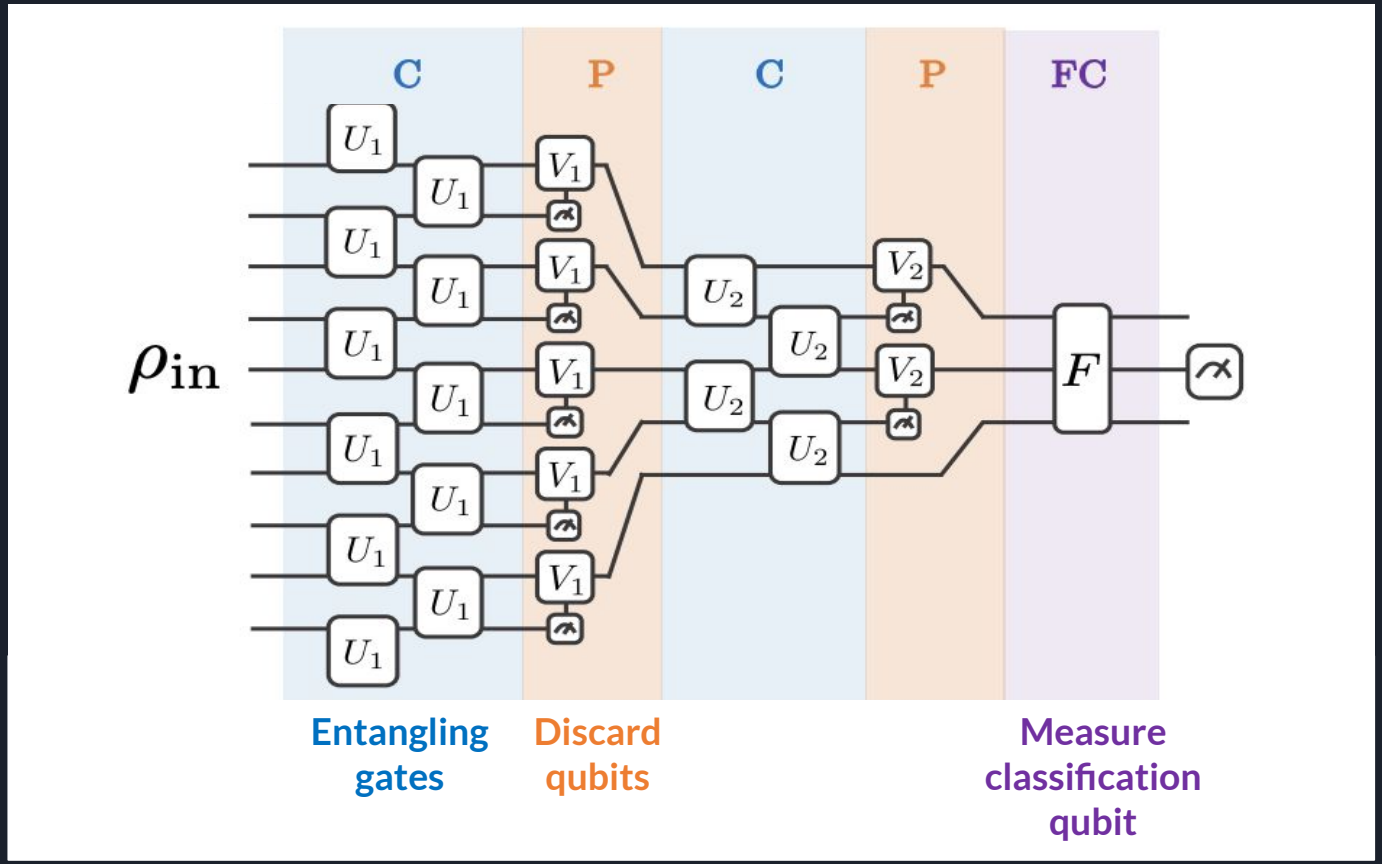
Quantum Convolutional Neural Network

Branching Quantum Convolutional Neural Network

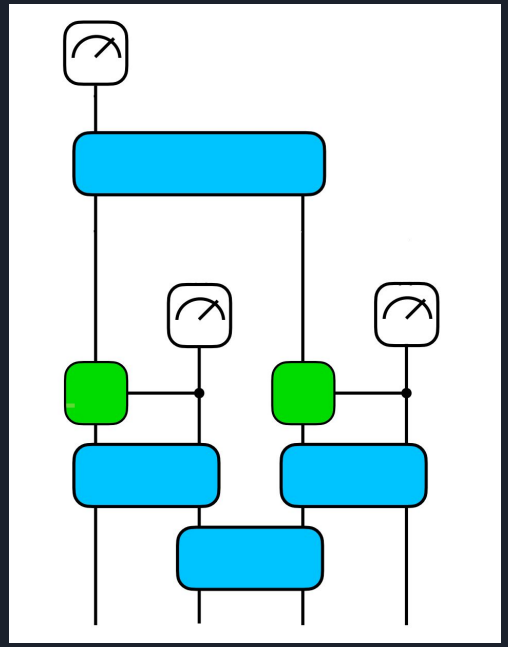
Convolutional Neural Network (CNN)



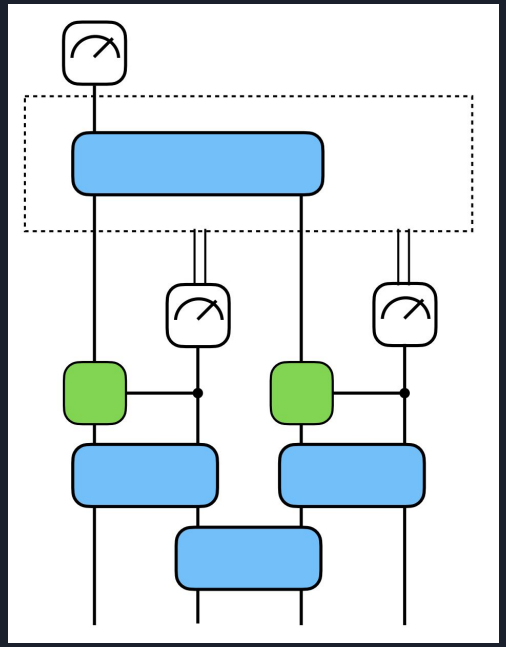
Quantum Convolutional Neural Network (QCNN)



Branching Quantum Convolutional Neural Network (bQCNN)



QCNN



bQCNN

CNN vs. QCNN vs. bQCNN

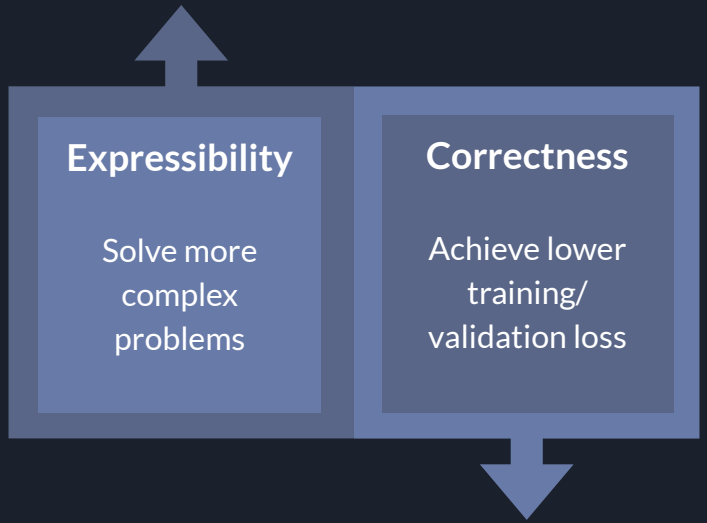
	Convolution Layer	Pooling Layer	Trainable Parameters *
CNN	Apply filter to image	Pools image data to reduce dimensions (i.e. MaxPool)	5
QCNN	Entangling gates	Controlled rotations and qubit discard based on adjacent qubit	66
bQCNN	Entangling gates	Controlled rotations and mid-circuit measurement for branching	111

*Trainable Parameters are based off of the claims of the bQCNN paper for 4-qubit models or for a CNN of similar depth and input size

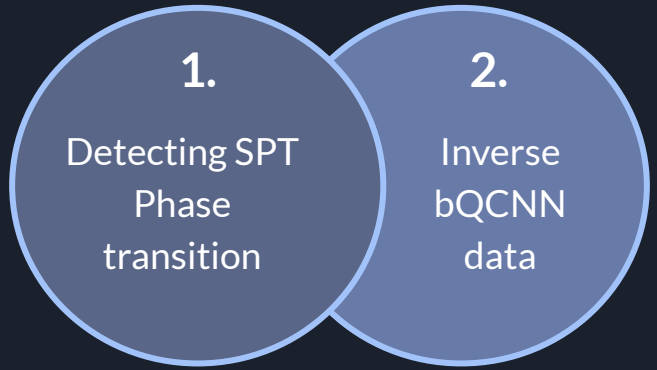
Claim

bQCNN always performs at least as good as QCNN, if not better

Metrics



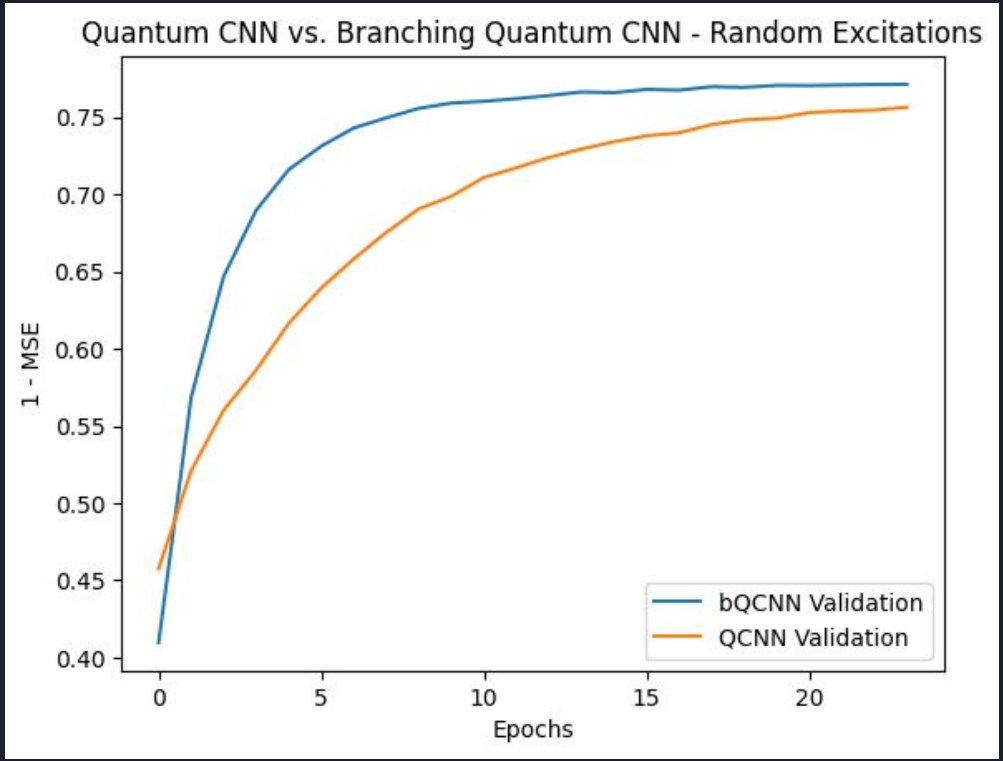
Tasks



Design choices

	Selected ✅	**Alternatives ❌**
Framework	Tensorflow Quantum	Qiskit, PennyLane
# input qubits	4 qubits	8 qubit
Loss function	MSE	MAE
Dataset	- Excitations to cluster state - Simplified bars & stripes (2x2 image)	- SPT - Inverse bQCNN parameters

Results - Random excitations to cluster state



Results - Image classification