



Quantum Neural Networks for Image Classification

2026 Quantum Machine Learning REU Program

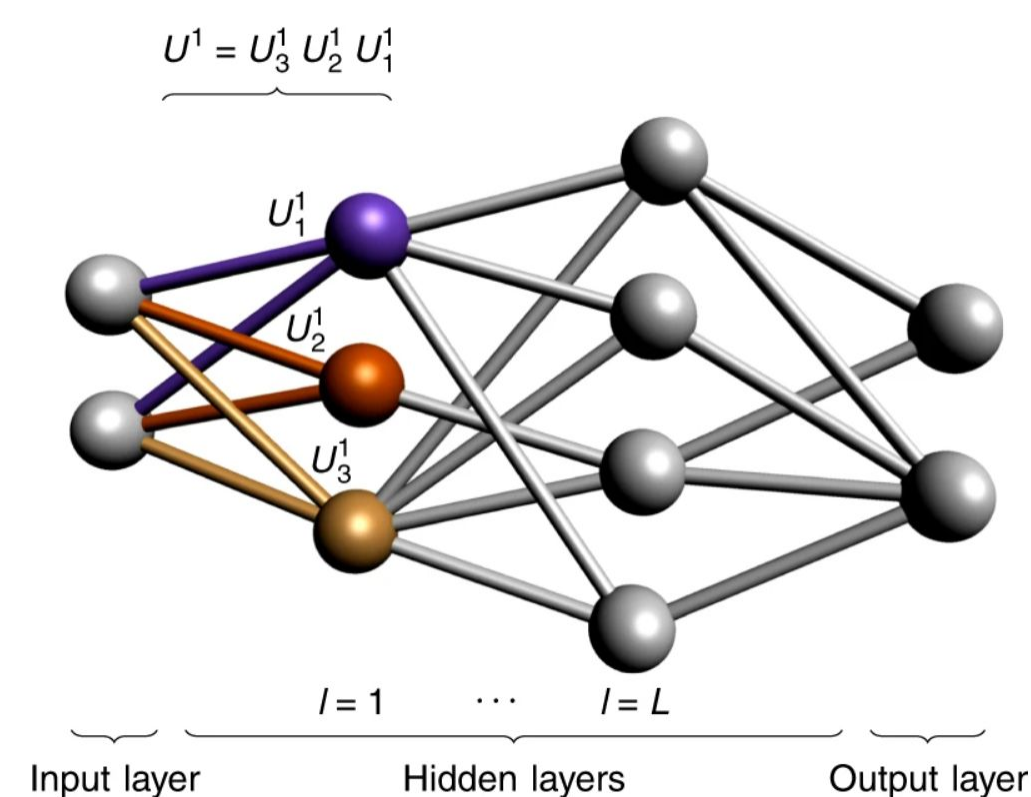
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RESEARCH BACKGROUND/DESCRIPTION

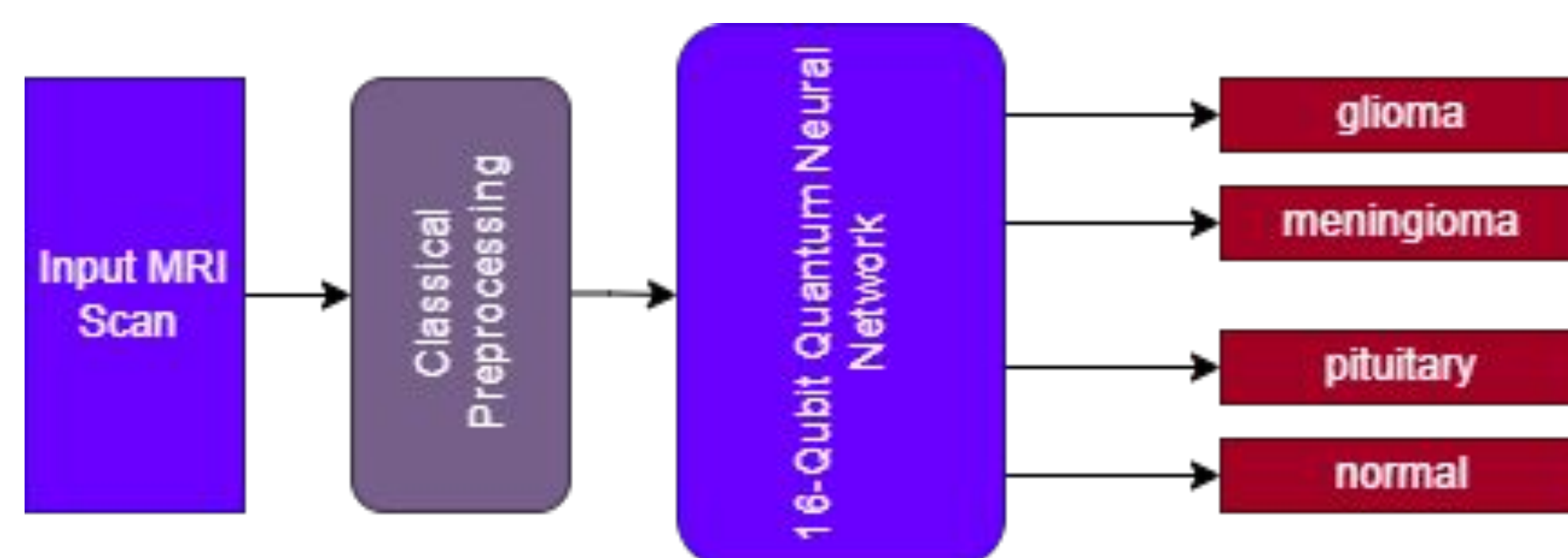
- Brain tumors remain one of the most dangerous diagnoses to receive due to the severity needed to make a diagnosis.
- Quantum Neural Networks (QNNs) utilize classical neurons to feed information through a quantum circuit in order to process information.



- There is a proposed quantum advantage with the application of QNNs in image classification.
- QNNs can fall victim to quantum noise and barren plateaus.

RESEARCH OBJECTIVES/PLAN

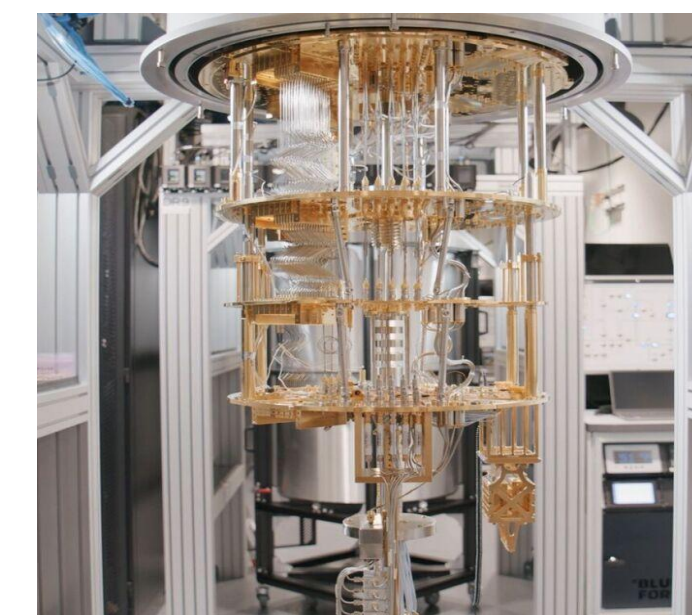
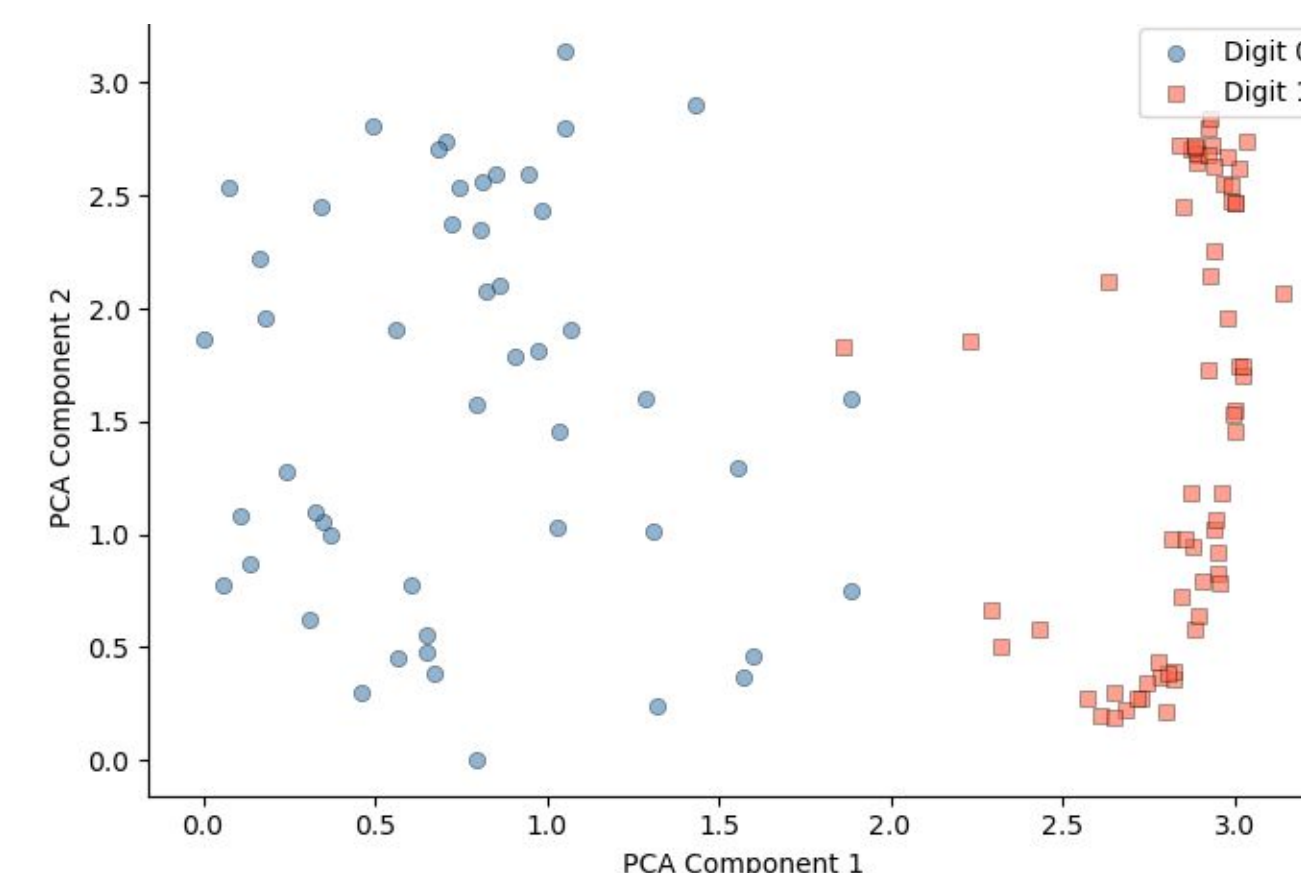
- The integration of this QNN has the potential to enhance classification accuracy, improve generalization on limited medical datasets, and accelerate the diagnostic pipeline.



METHODS & ALGORITHMS

- The input images will be compressed using Principal Component Analysis (PCA) to take the images into a 16x16 pixel size.

Binary PCA Prediction (MNIST)



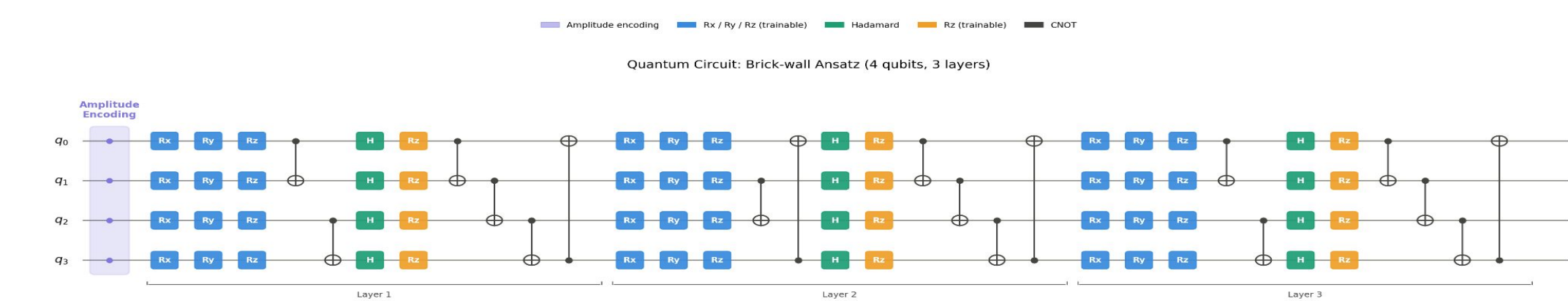
- The data is then run through a quantum circuit in which features are extracted and a classification is made.
- 16 qubits are utilized—one for each feature.
- Measurements are made after running through an amplitude-encoding and ansatz circuit. The expectation values are then used for a classifier.

REFERENCES

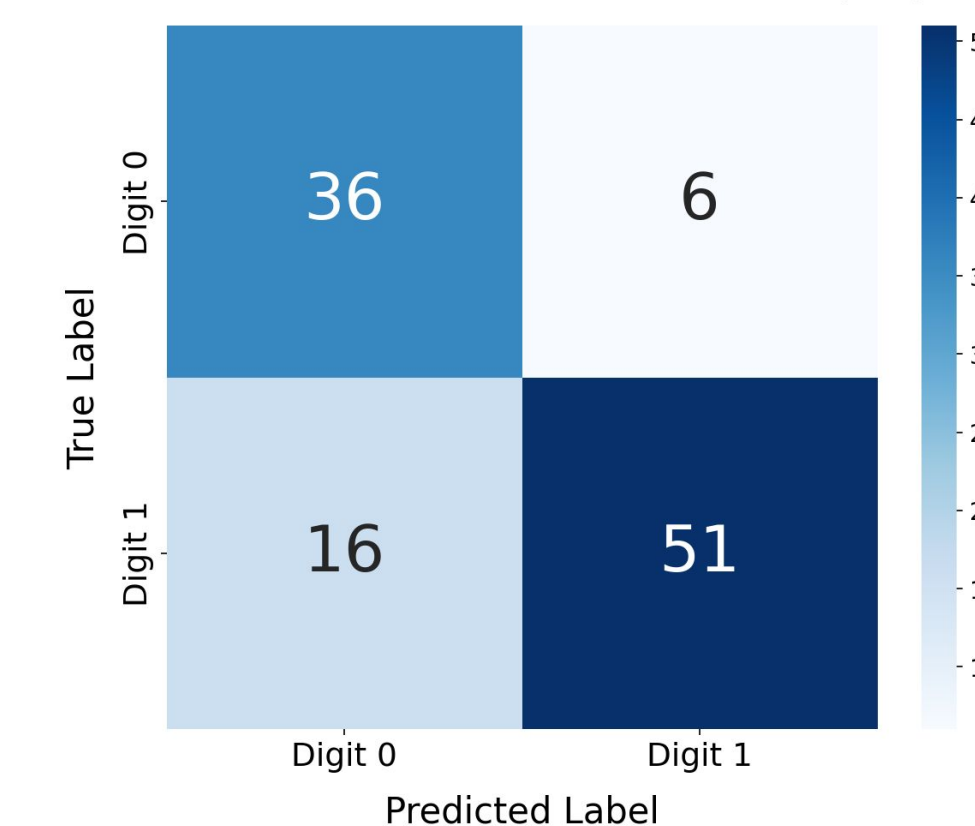
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EXPERIMENTAL RESULTS

- The loss decreases over each epoch measured.
- A range of learning rates have shown different accuracy results.



Confusion Matrix: Quantum MNIST Classifier (RAE)



- The QNN is built using the above Variational Quantum Circuit with updated parameters over ~50 epochs.

CONCLUSIONS & FUTURE WORK

- QNNs offer a faster method of machine learning when it comes to image classification.
- Noise models such as garnet and emerald need to be applied
- Future work will include using another dataset of MRI scans to test capabilities.

