

Enhanced Quantum Autoencoders for Anomaly Detection



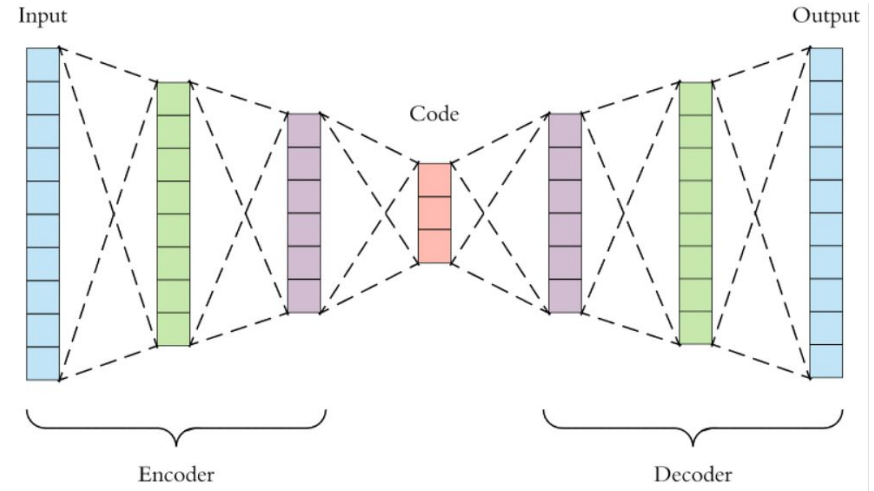
Team: Samras

Members: Michał Bączyk, Stephen DiAdamo, Ankit Khandelwal, Sean Mcilvane, Eraraya Ricardo Muten, Andrei Tomut, and Renata Wong.



Classical Autoencoders

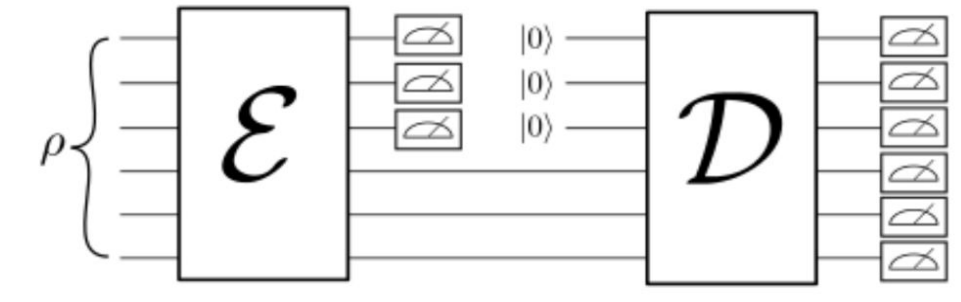
- Take as input a feature vector and use a learning approach to find a encoding and decoding scheme that compresses the data and recovers the data via decompression





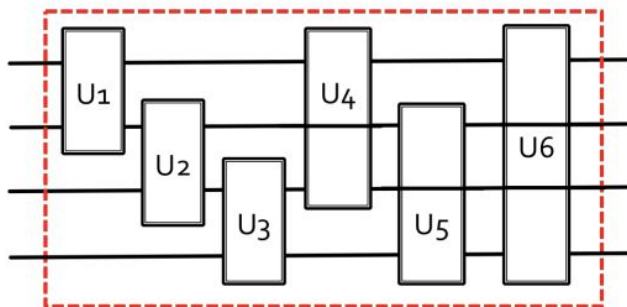
Quantum Autoencoder

- Same overall idea with the classical approach, except in this case the input is a quantum state
- The encoder and decoder are parameterized circuits and use a variational approach to optimize their parameters, with a cost function based on how well the inputs match the outputs

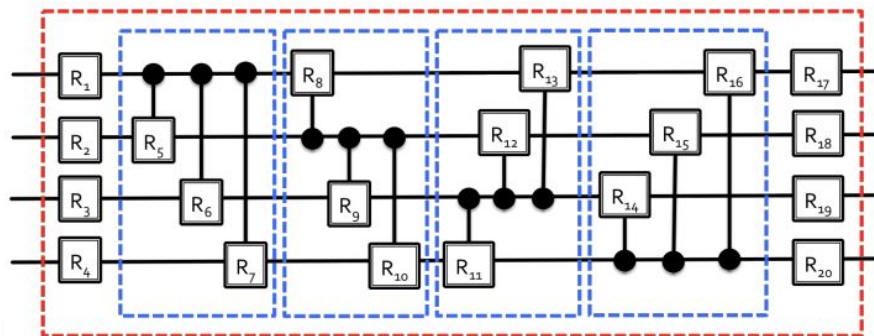


Our Autoencoder Implementations

- Using the various encoding and decoding approaches found in literature, we programmed them in Qiskit and PennyLane using parameterized circuits in order to compare them
- We used optimizers such as Scipy Optimize library and Tensor based optimizers like Adam
- We trained our models using two approaches, the fidelity, a swap test approach, and an approach which tests how decoupled the trash qubits become from the data qubits



(a)

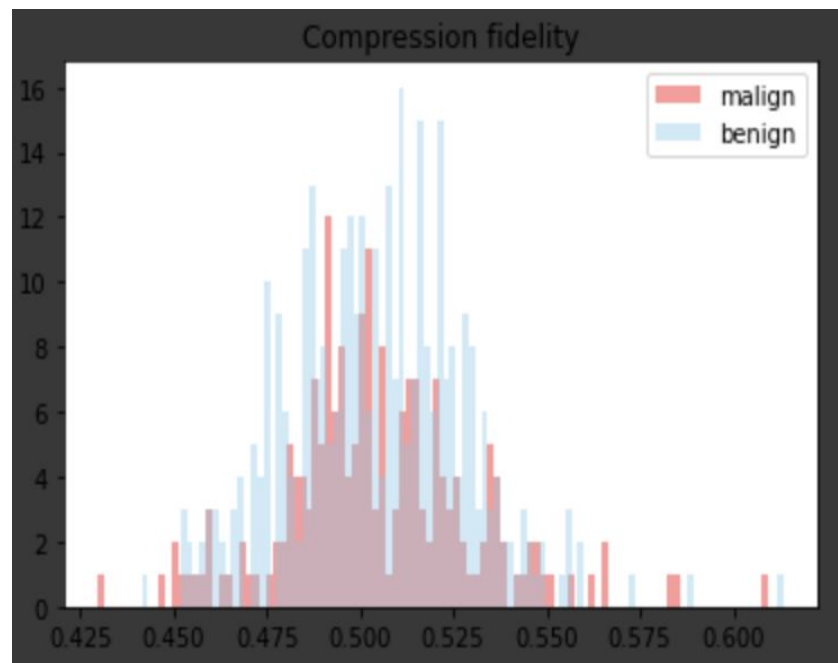
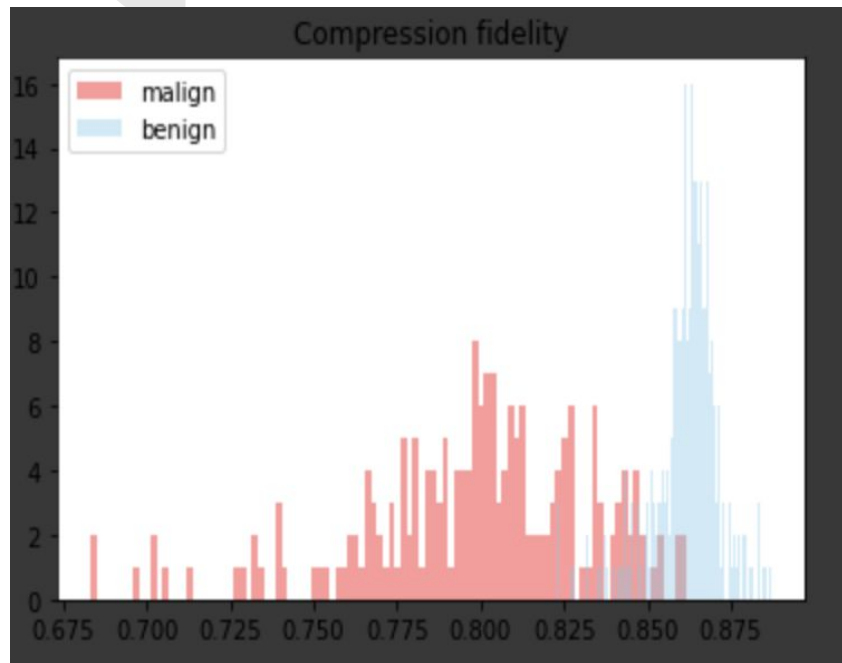


(b)

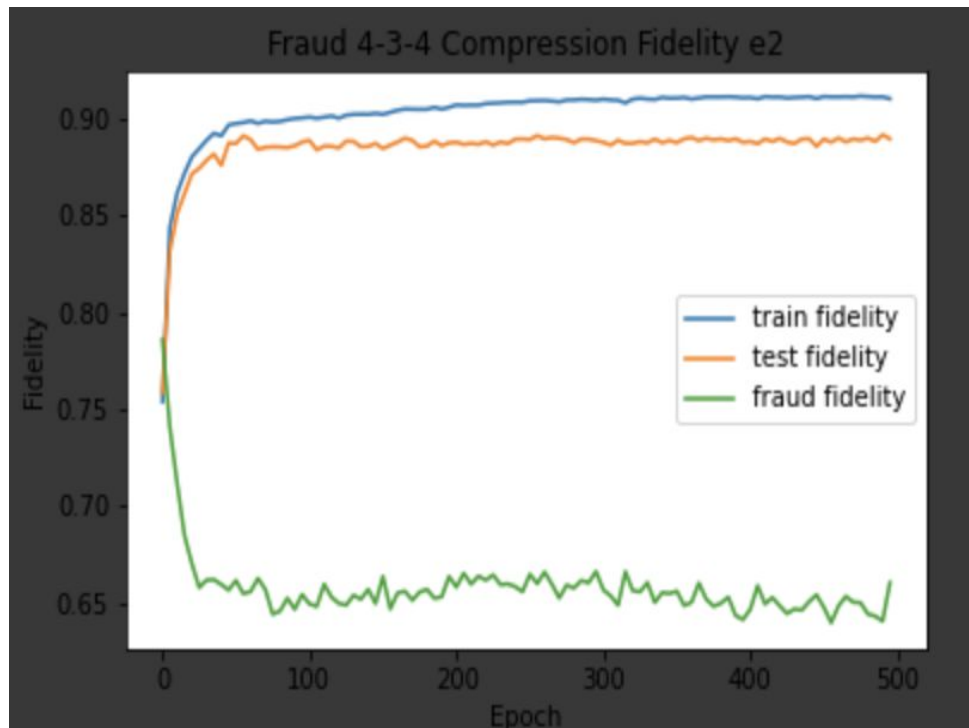


Results

- We tested our approach on three data sets
 - MNIST
 - Breast cancer scans
 - Fraudulent credit card Transactions
- We observed high detection accuracy throughout our experiments



Fraudulent Transaction Detection

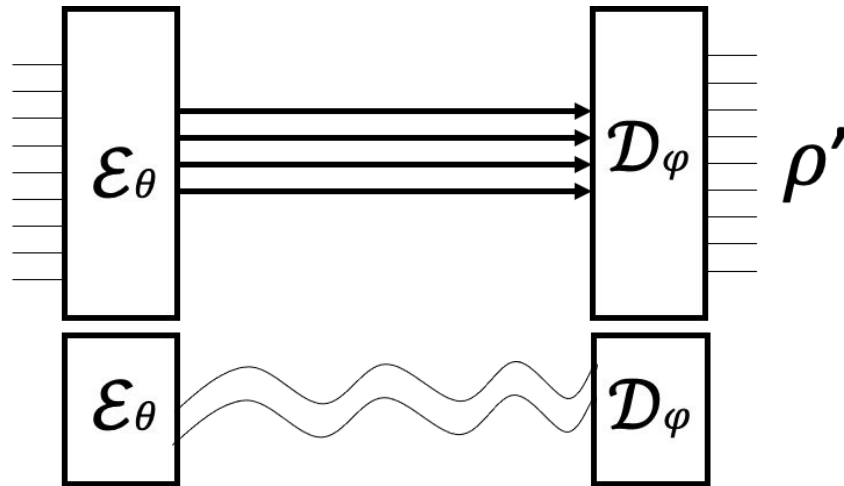




Entanglement-Enhanced Autoencoder

- To push the accuracy of the anomaly detection via autoencoding further, we added additional entanglement-resources in various ways
- In our preliminary approaches, we tested a number of ways of interacting the entanglement resources with the data encoded qubits
- Although our results did not yet show an improvement, future work will be to investigate other scenarios in which entanglement can play a meaningful role

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Thanks!

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