Enhanced Quantum Autoencoders for Anomaly Detection

Team: Samras
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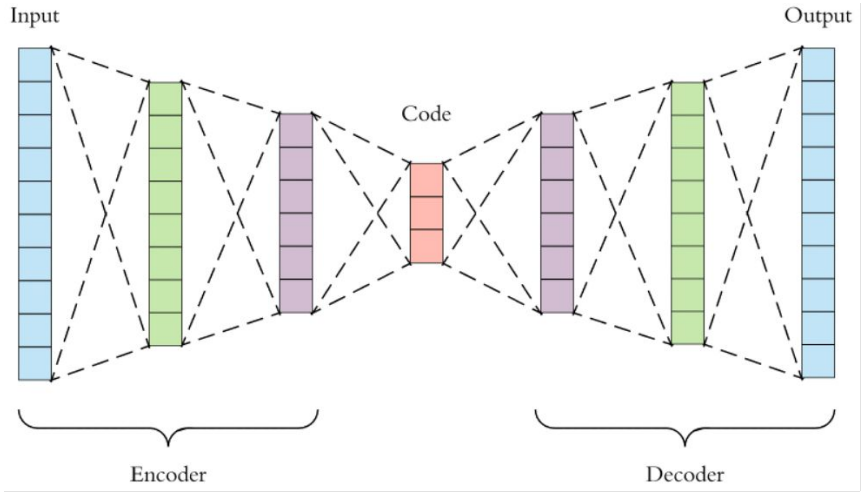
Classical Autoencoders

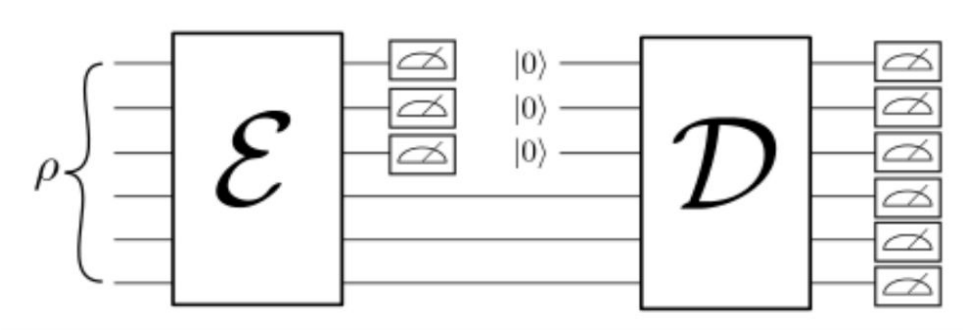
- Take as input a feature vector and use a learning approach to find a encoding and decoding scheme that compresses the data and recovers the data via decompression



Quantum Autoencoder

- Same overall idea with the classical approach, except in this case the input is a quantum state

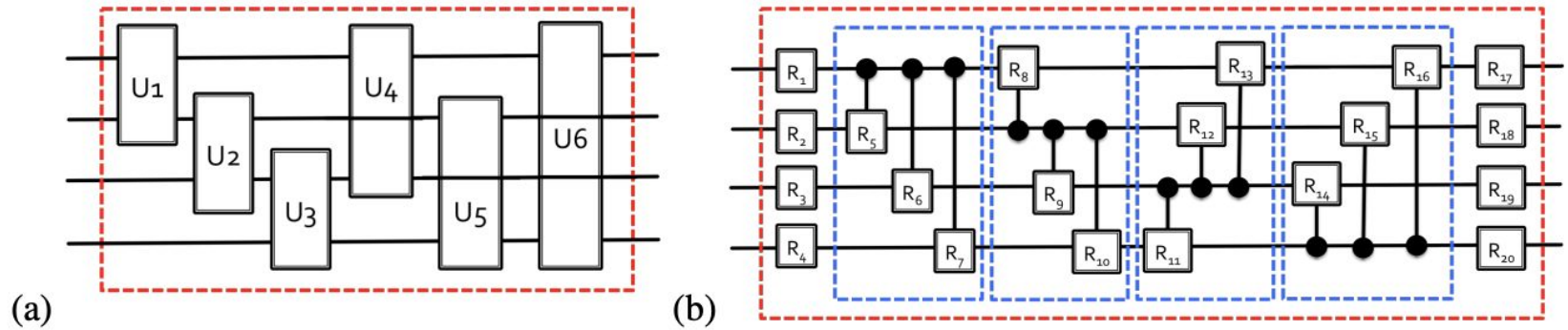
- The encoder and decoder are parameterized circuits and use a variational approach to optimize their parameters, with a cost function based on how well the inputs match the outputs



Romero, Jonathan, et al. "Quantum autoencoders for efficient compression of quantum data."

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



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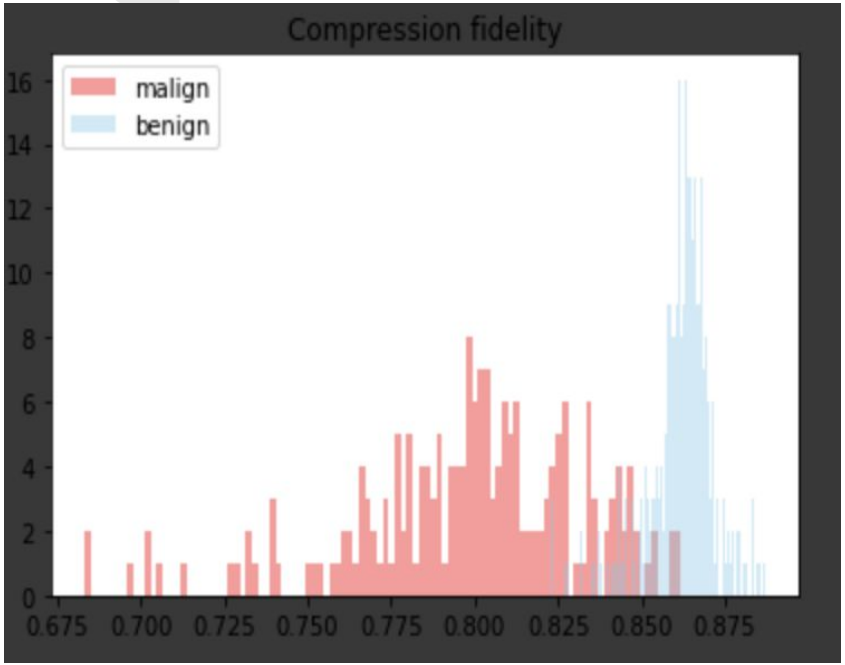
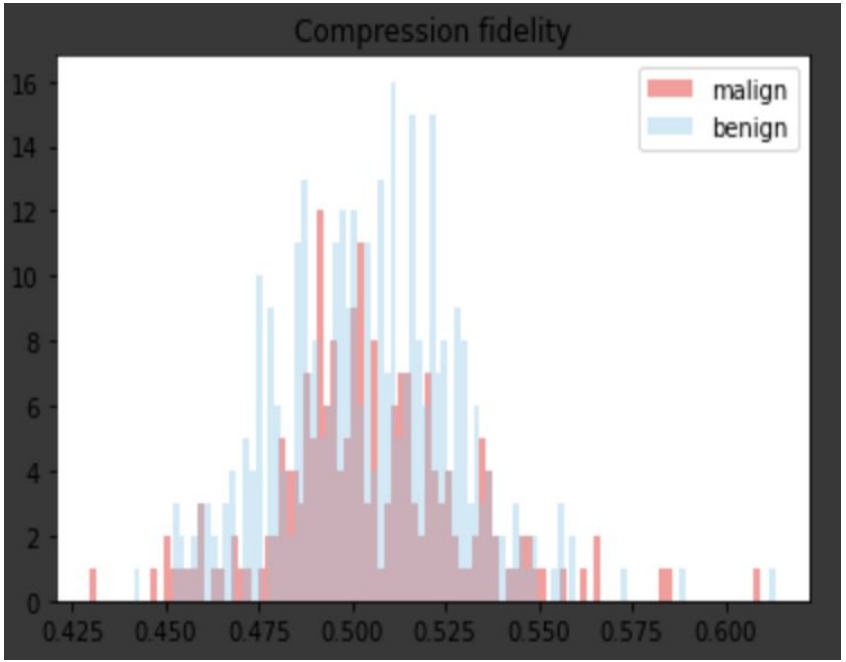
Results

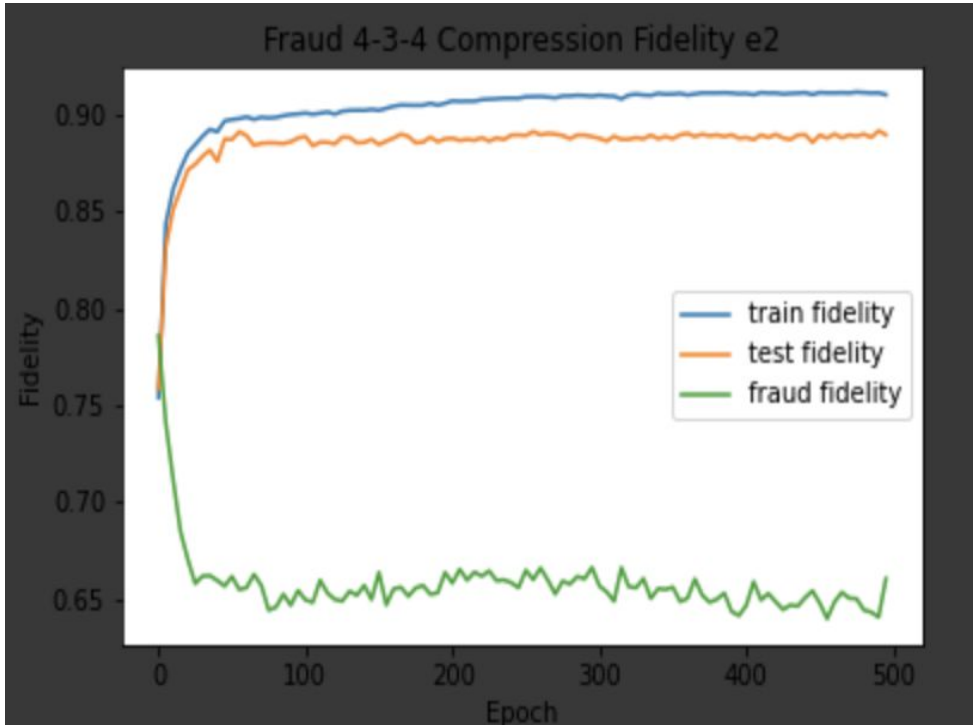
- We tested our approach on three data sets
  - MNIST
  - Breast cancer scans
  - Fraudulent credit card Transactions
- We observed high detection accuracy throughout our experiments

Breast Cancer Detection



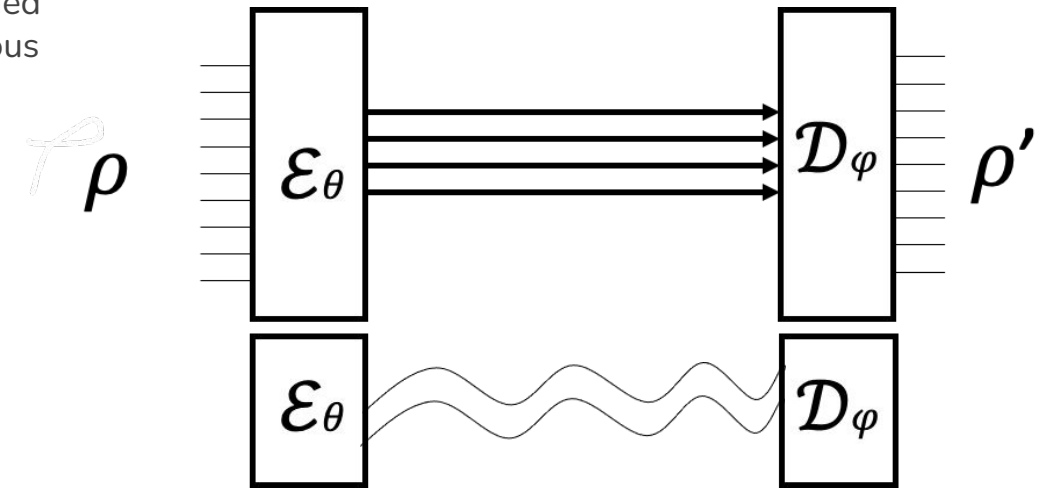


Fraudulent Transaction Detection



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



Conclusion & Outlook

Todo: Summarize in 2 points

Todo: Discuss road head, how will we proceed?

SD: I think let’s just delete this slide, we don’t really need to conclude for such a short talk

Thanks!

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