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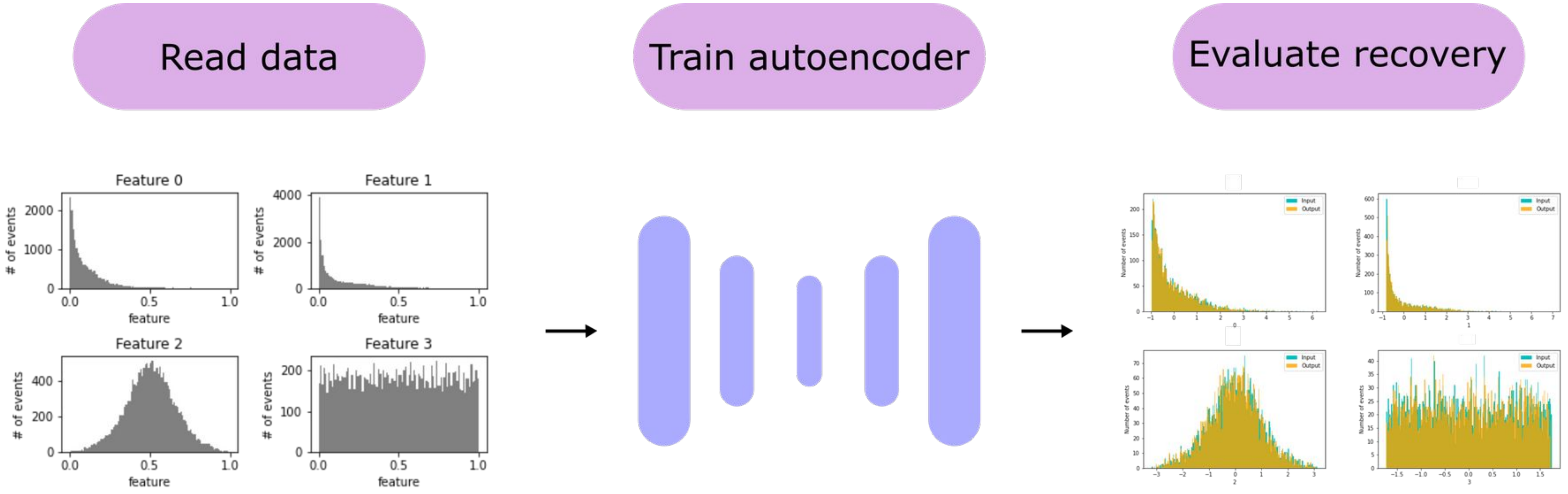
Evaluation exercise report for GSoC -

ATLAS autoencoders

Problem statement

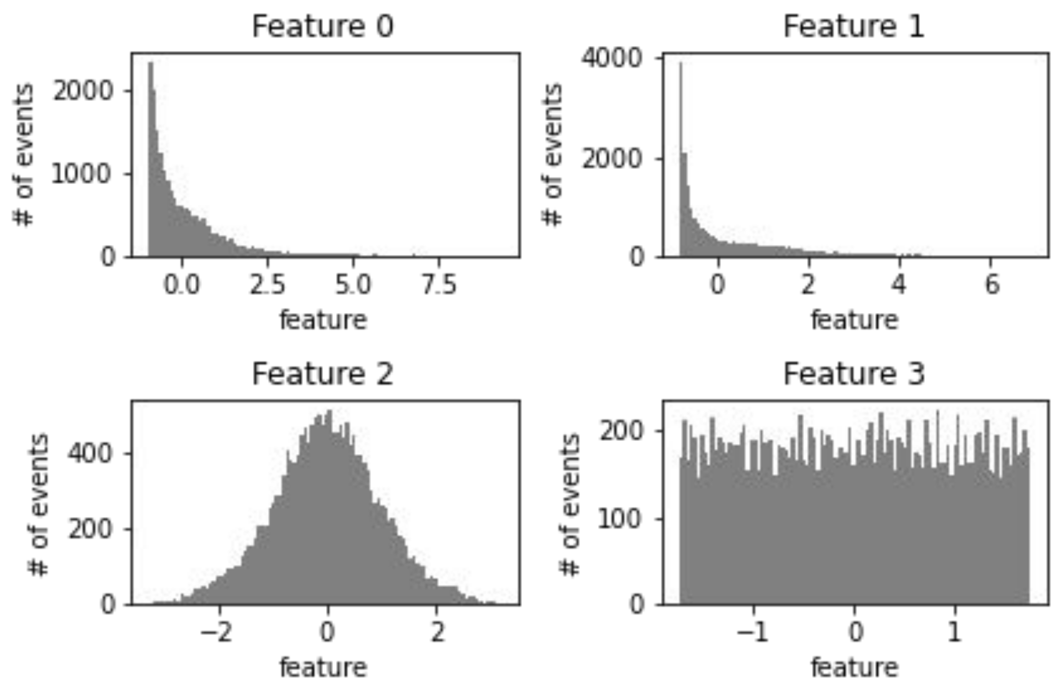
- Read and preprocess data
- Set up the autoencoder model
- Calculate metrics to evaluate the recovery of the compressed data



Data preprocessing

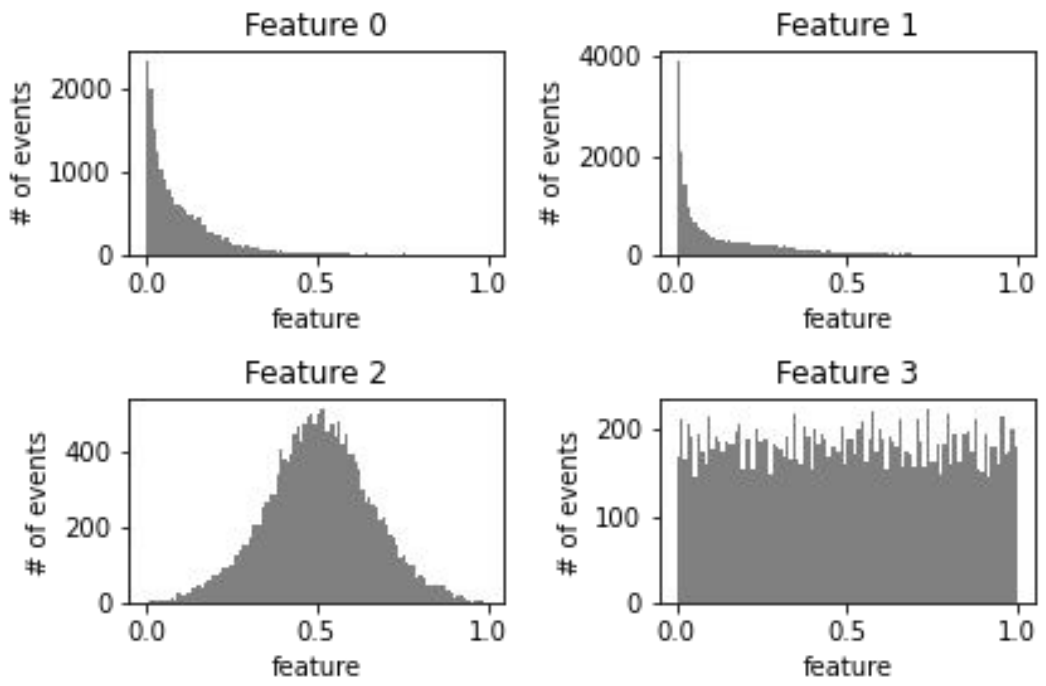
Standard normalization

$$\mathbf{z} = \frac{\mathbf{x} - \mu}{\sigma}$$



MinMax normalization

$$\mathbf{z} = \frac{\mathbf{x} - min(\mathbf{x})}{max(\mathbf{x}) - min(\mathbf{x})}$$

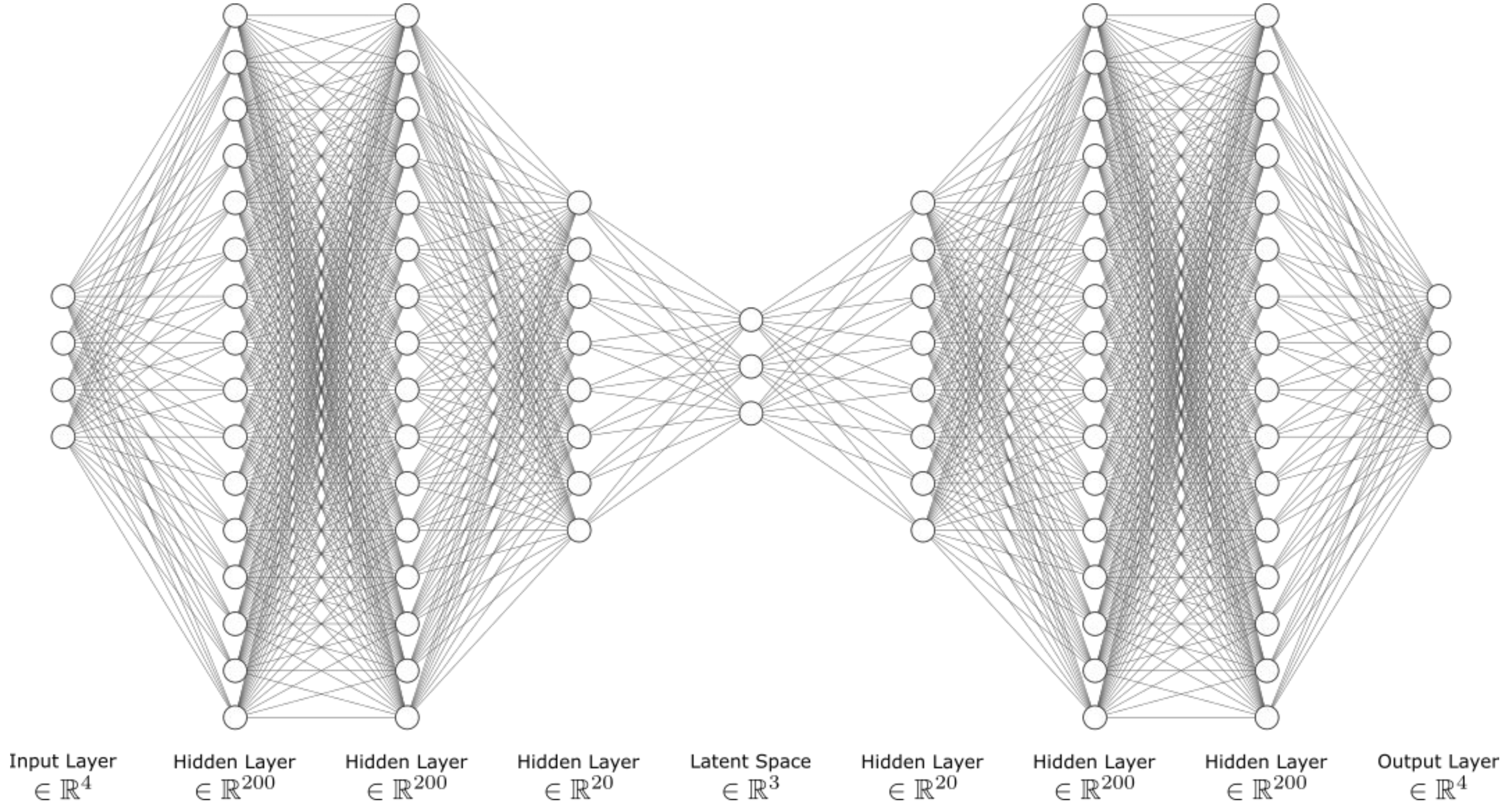


A normalization step is important to overcome the value range difference in the features and avoid the gradient explode problem in normalized data.

I experimented with two types of normalization.

- Standard normalization
- MinMax normalization

Autoencoder Model



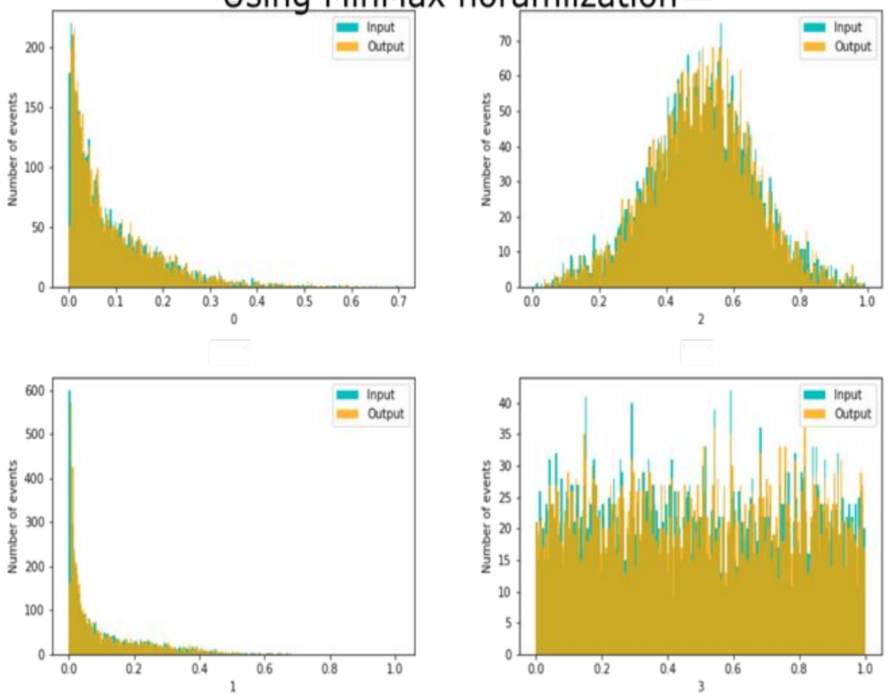
Loss function: $MSE = \frac{1}{N} \sum_{i=1}^{N} (\hat{x}_i - x_i)^2$

Additional metric: $PSNR = 20 log_{10} \left(\frac{MAX\_RANGE}{\sqrt{MSE}} \right)$

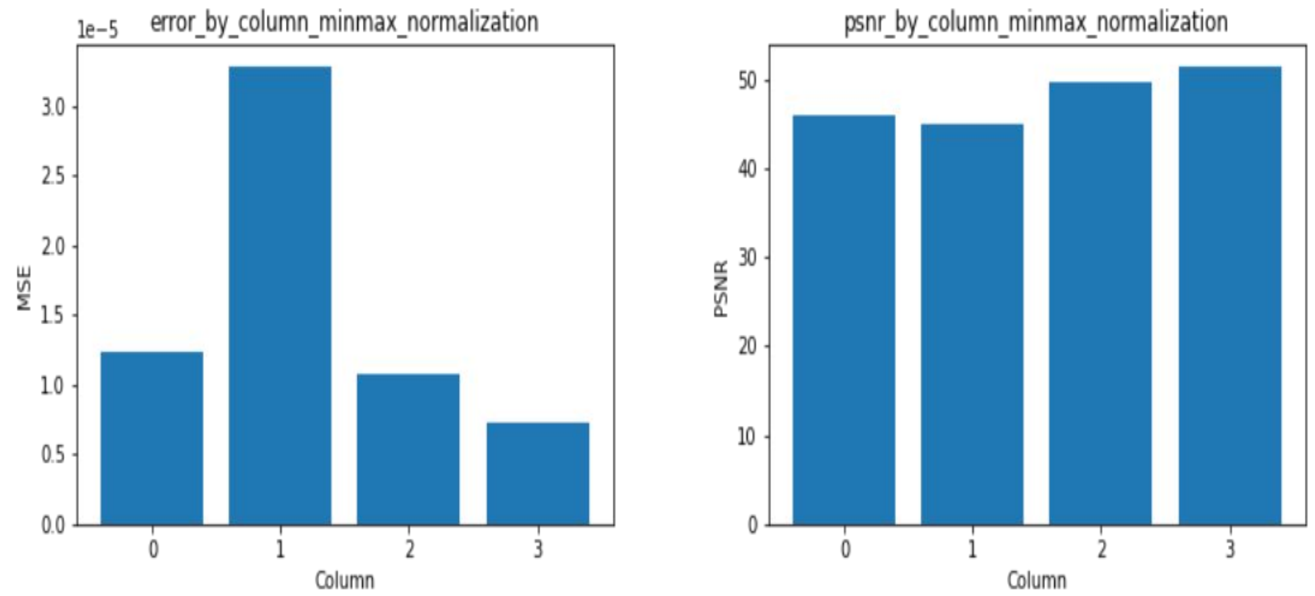
- The figure corresponds with the autoencoder model used in the training.
- A major architecture change is the use of Leaky Relu as the activation function on each layer instead of tanh.
- To evaluate performance, the MSE and PSNR metrics were calculated.

Results

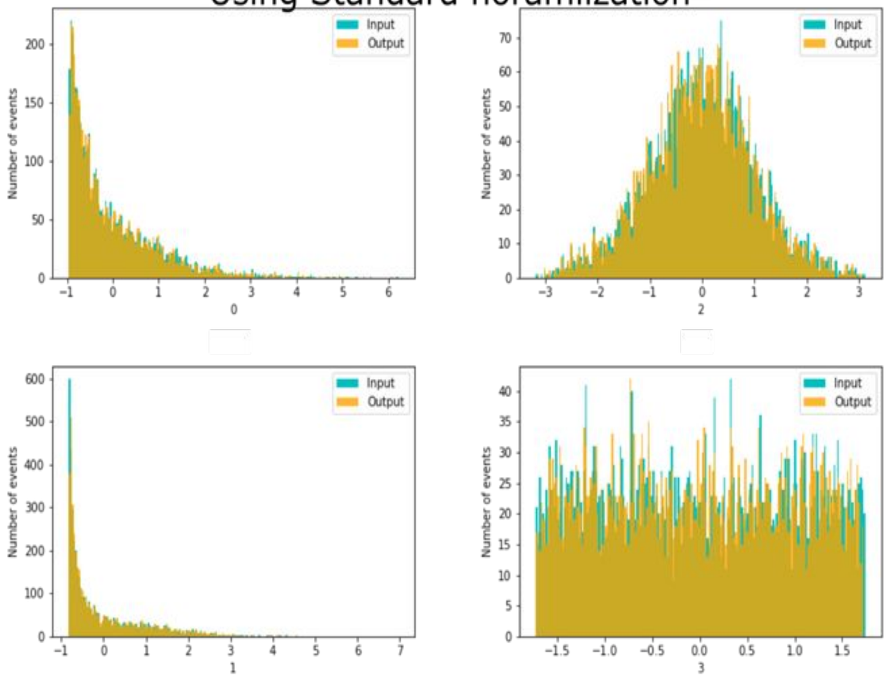
Histogram of each element in the 4D data
Using MinMax noramlization



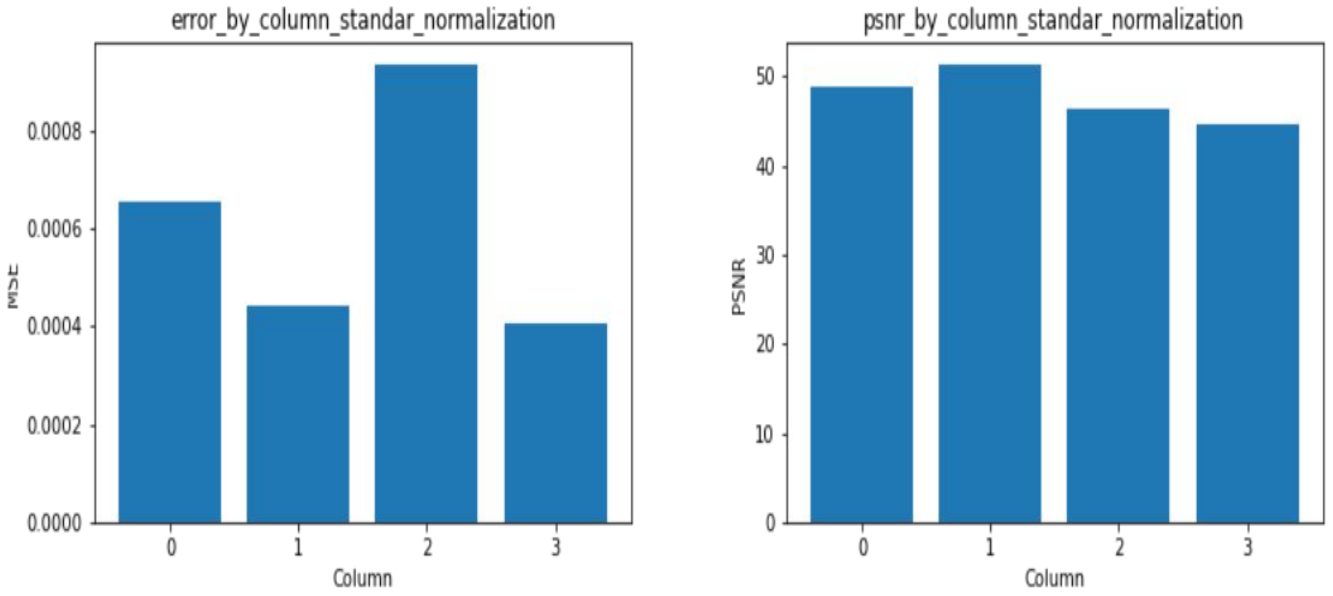
Calculated MSE and PSNR over the test set with MinMax noramlization



Histogram of each element in the 4D data
Using Standard noramlization



Calculated MSE and PSNR over the test set with standard noramlization



- The figures in the left shows a comparison of the distribution of the data compressed and the original
- In the right the MSE and PSNR were calculated at every element in the momentum data

Note that

- The distribution of the recovery data fits with the input data
- The difference in the MSE is due to the range of the normalization, however the results in PSNR are similar.

Summary

- An autoencoder to compress the four-momentum of a sample of simulated particles from 4 to 3 variables was successfully implemented and evaluated using PSNR and MSE.
- Two different methods to normalized data were evaluated achieving outstanding results, therefore, any of these normalizations methods could be used to train the autoencoder.

Scan this QR code to access the repo