# Anomaly Detection

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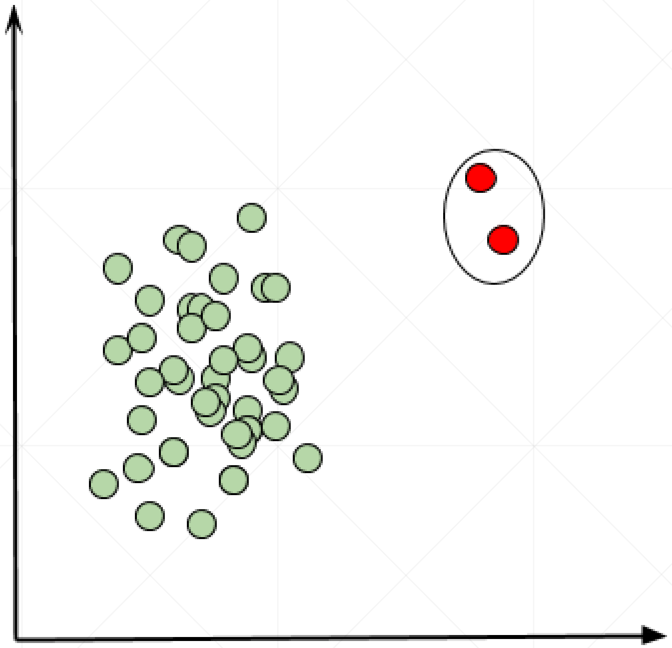
# Content Layout

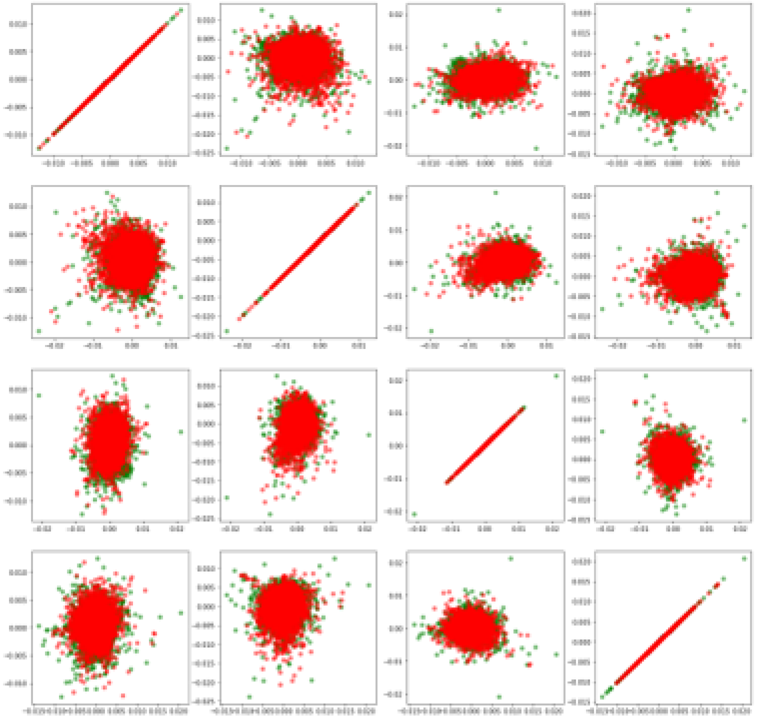
- Introduction
- Methodology
- Results
- Conclusion



https://github.com/SSANGMAN/Anomaly_Detection

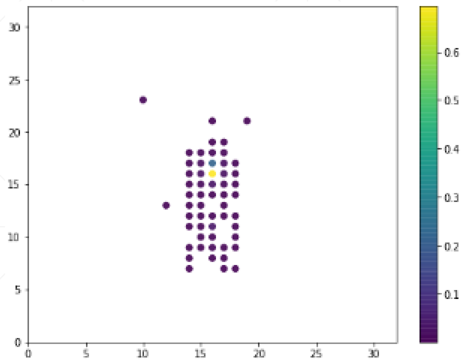
# Introduction

- Electrons and Photons are very similar in their energies and distributions.
- The best results of using classical classification methods, like CNN, were 72-84% of AUC.
- We tried many ways of classifying these signals using different autoencoders, which achieved similar results to the CNN.
- When applying these methods to anomaly detection, things worsen. As shown in the figure, the two classes are overlapped in the latent space of a Convolutional Variational Autoencoder (CVAE).

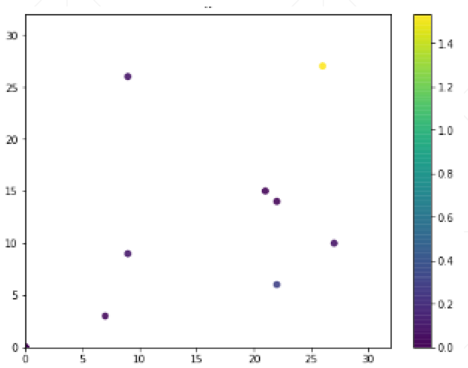


# Methodology

- We use Contrastive Learning (Siamese Network).
- Mean Absolute Error (MAE) loss.
- Adam Optimizer.



Original
(Label = 0)



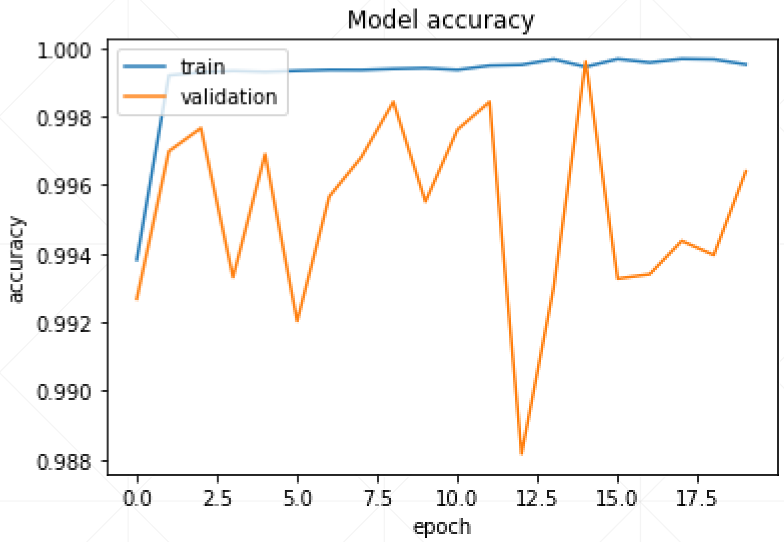
Cropped channel of Top
Quark- Random Samples
(Label = 1)

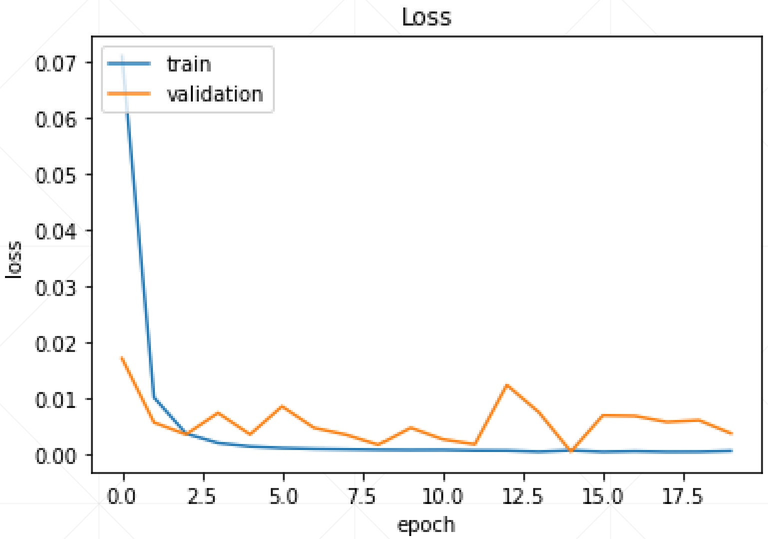
Pairs of ((0-0), (0,1))

Train the model and try to maximize the distance between 0,1 and minimize it for 0,0

Test the model on:
- normal- random samples
- normal-anomaly samples
-normal-normal samples

# Results




We are still verifying these results!

```
#testing the model based on Photon-Photon and Photon-Random
siamese.evaluate([x_test_1, x_test_2], labels_test)
```

```
2641/2641 [==============================] - 7s 3ms/step - loss: 0.0027 - accuracy: 0.9973
[0.002735879505053162б, 0.9972894191741943]
```

```
#Evaluating the model based on Photon-Photon and Photon-Electron datasets
siamese.evaluate([x_testn, x_testn2], labels)
```

```
2641/2641 [==============================] - 9s 3ms/step - loss: 0.0028 - accuracy: 0.9972
[0.002788472454994917, 0.9972184300422668]
```

# Conclusion

The model's performance depends on the chosen random pairs. Therefore, generalizing the model, studying the features of the pairs that perform well, and comparing them to the other pairs (Augmented pairs) are the main points of our future work.

# Thank You!