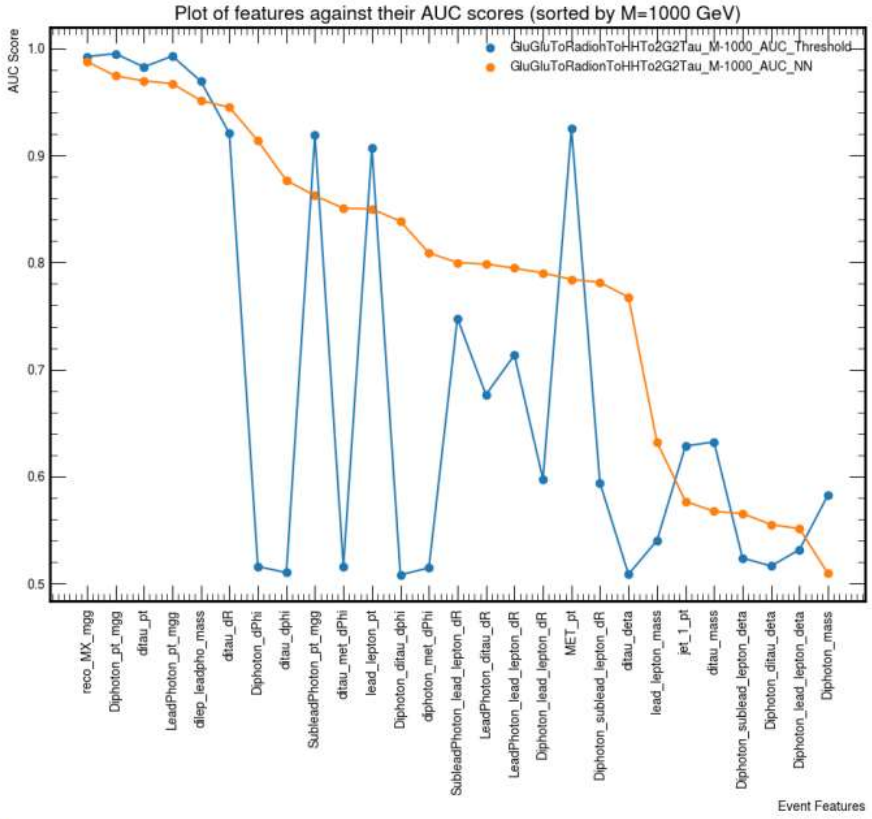
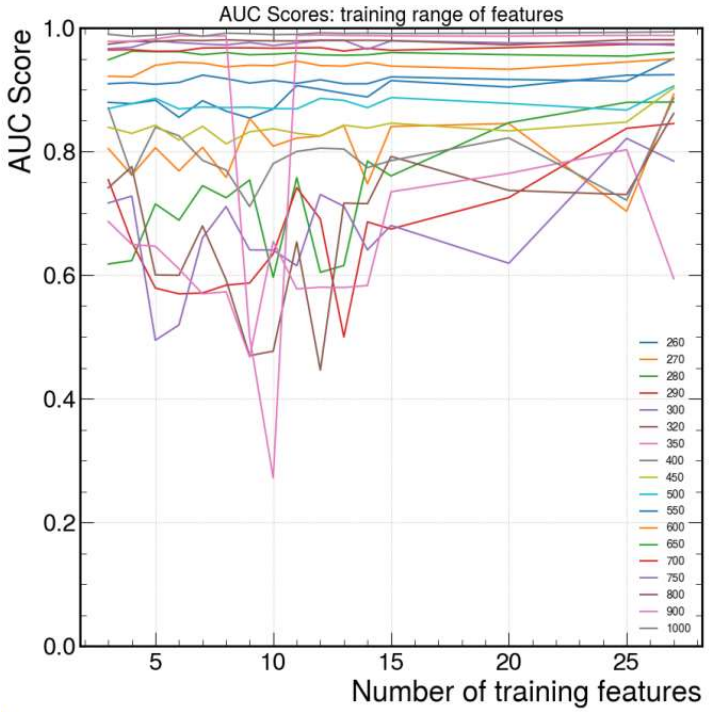
PROJECT

Employing parametric neural networks to enhance the exploration of new physics beyond the Standard Model, this project focuses on analyzing Higgs boson decay products, specifically photons and tau leptons, to identify novel resonances.

RECAP

- For each mass hypothesis produced a ranking of the 27 features according to AUC Score.
- Varied the number of features included in the training of the networks and quantified performance again with AUC Score.





Efforts to optimise architecture

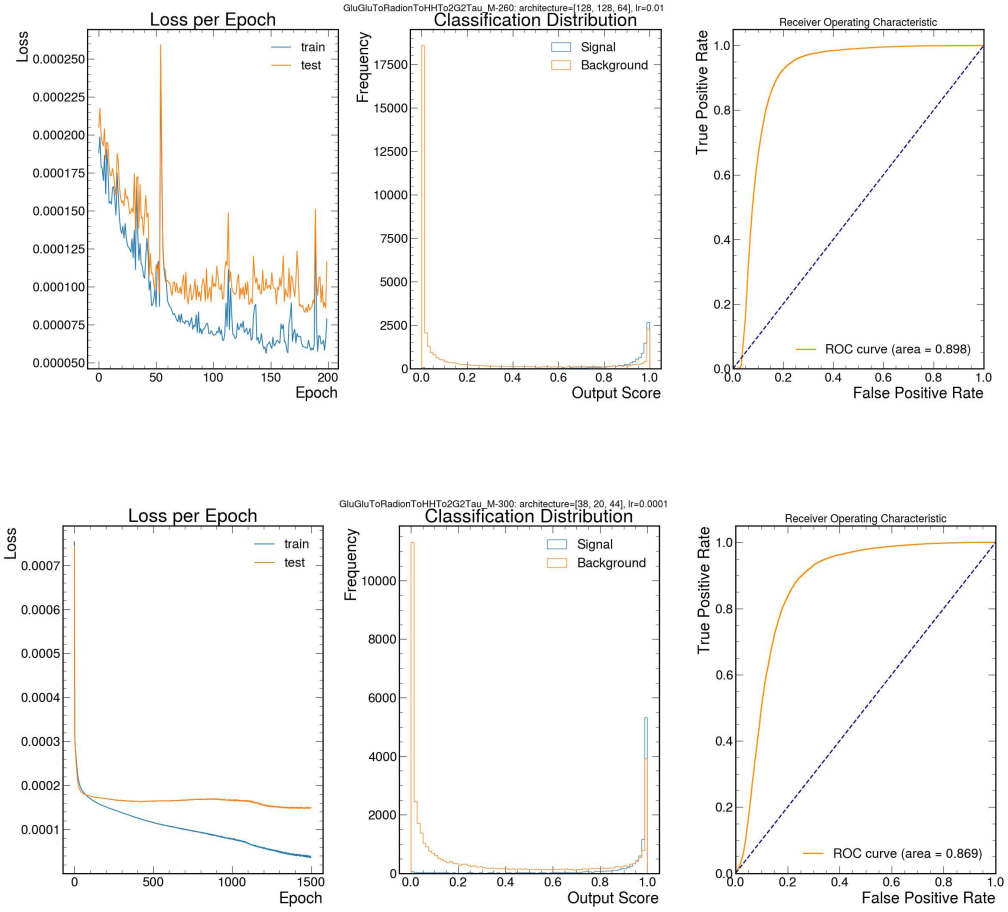
- comparison between of large number of architectures:

[8,16,8]
[16,16,8]
[16,32,16]
[32,32,16]
…
[128,128,64]
[16,32,16,8]
[32,32,16,8]
…
[128,128,64,8]

Brute forced optimal architecture for Mx = 320 GeV

[30,20,44] – still not what was expected

- faults: did not consider overtraining or convergence.



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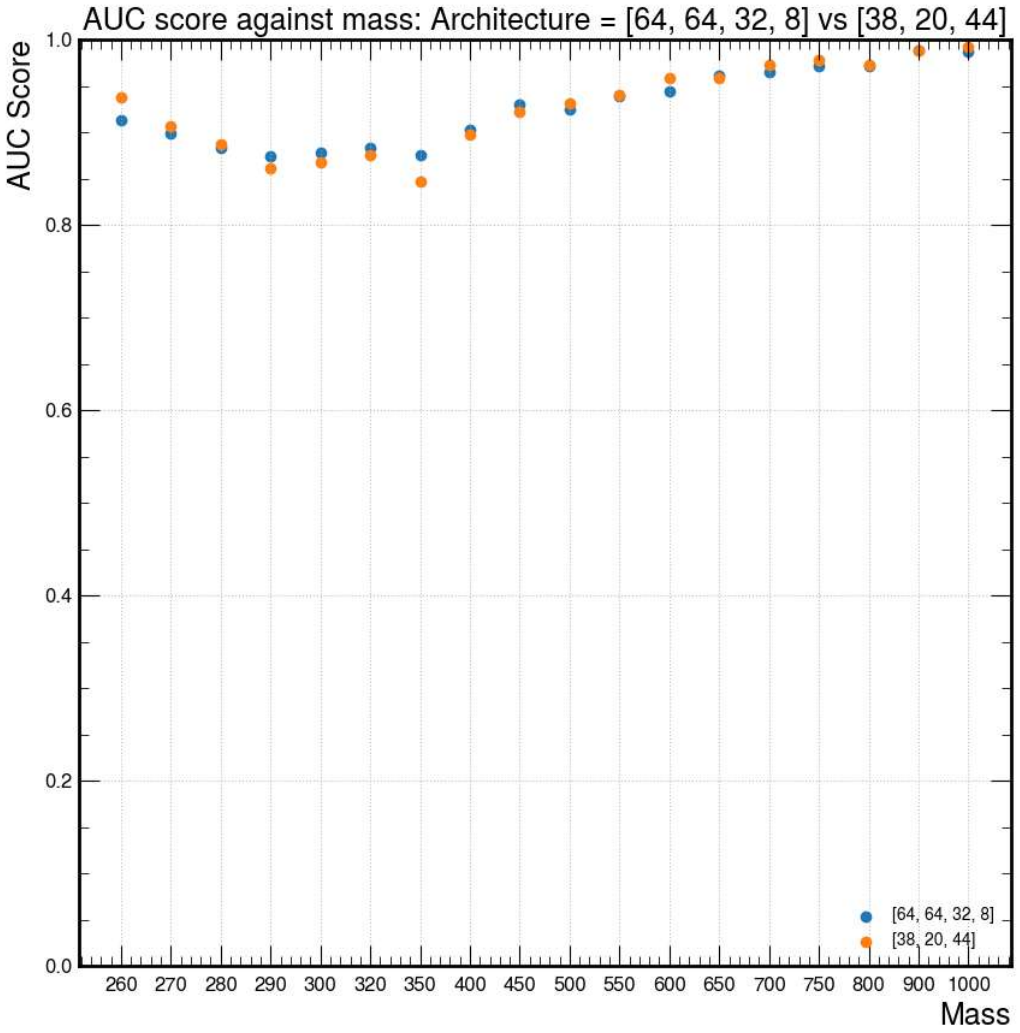
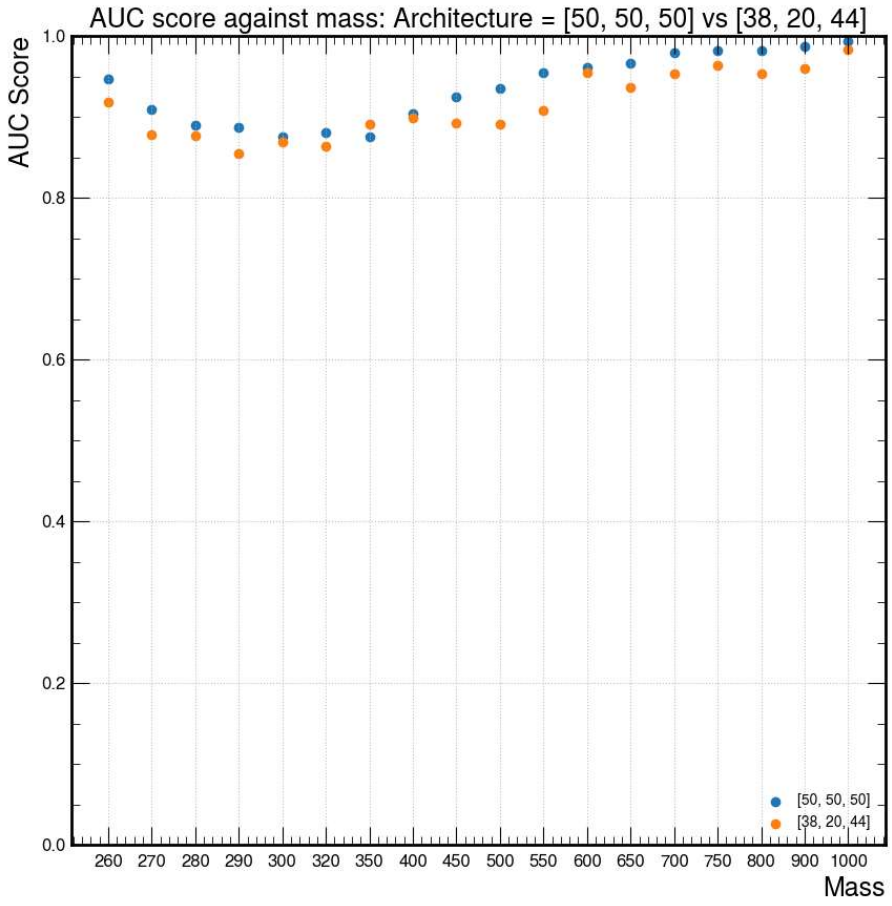


Changes to the network:

- addition of dropout layers and ELU activation functions
- architecture [50, 50, 50]

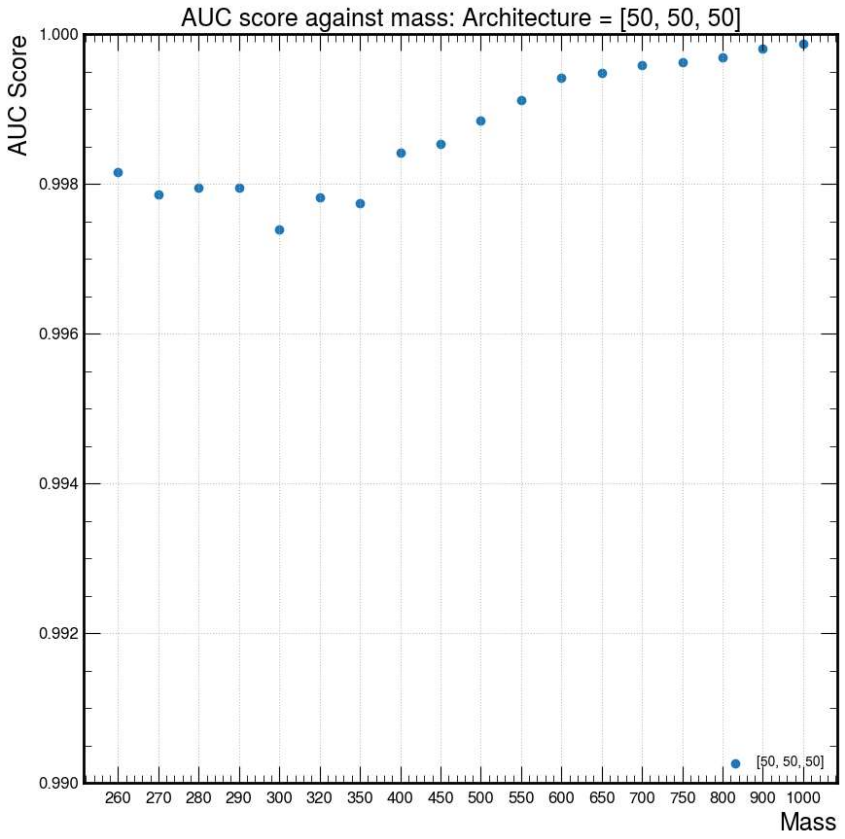


Significant alterations to the network:

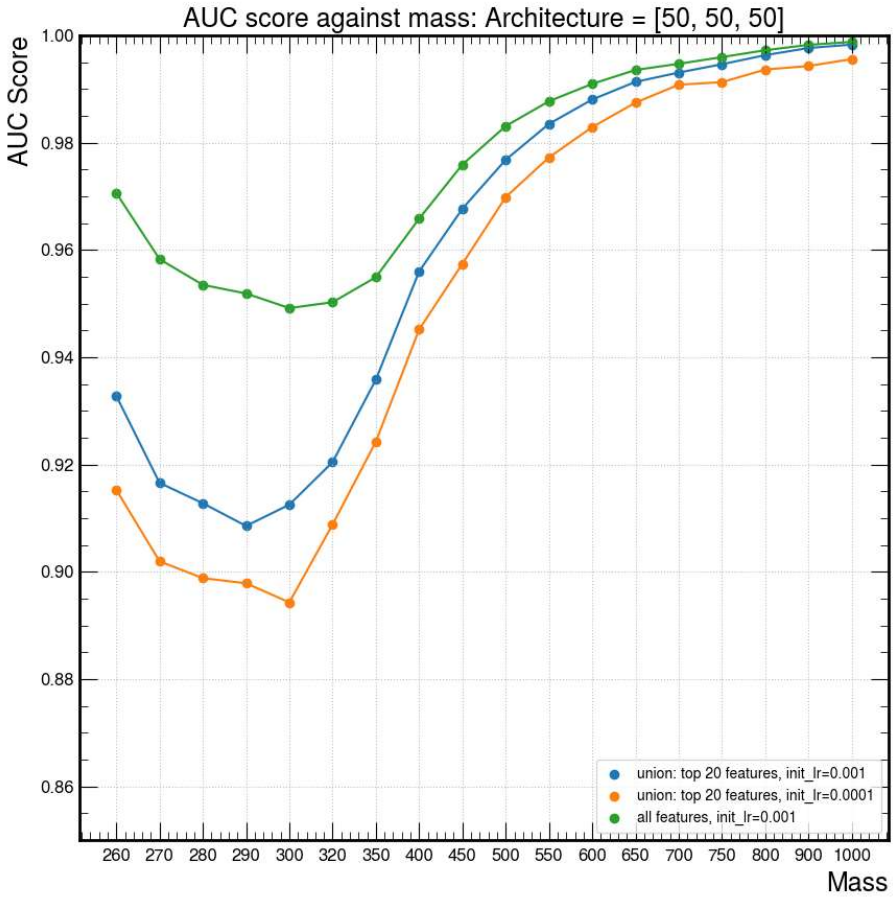
- renormalisation of the dataset.
- removal of *GJets* and *TTJets* which are now used exclusively in the testing data.
- average over the background to replace the -9 bins.
- introduced ‘network patience’ .
- implemented custom scheduler that updates the lr according to the ratio in the loss .

- Given will want pNN trained on the same optimal features across all mass hypothesis: we dropped the previous method of determining the top features and now take the union of the top (e.g. 18) features across all masses (sum of 26).

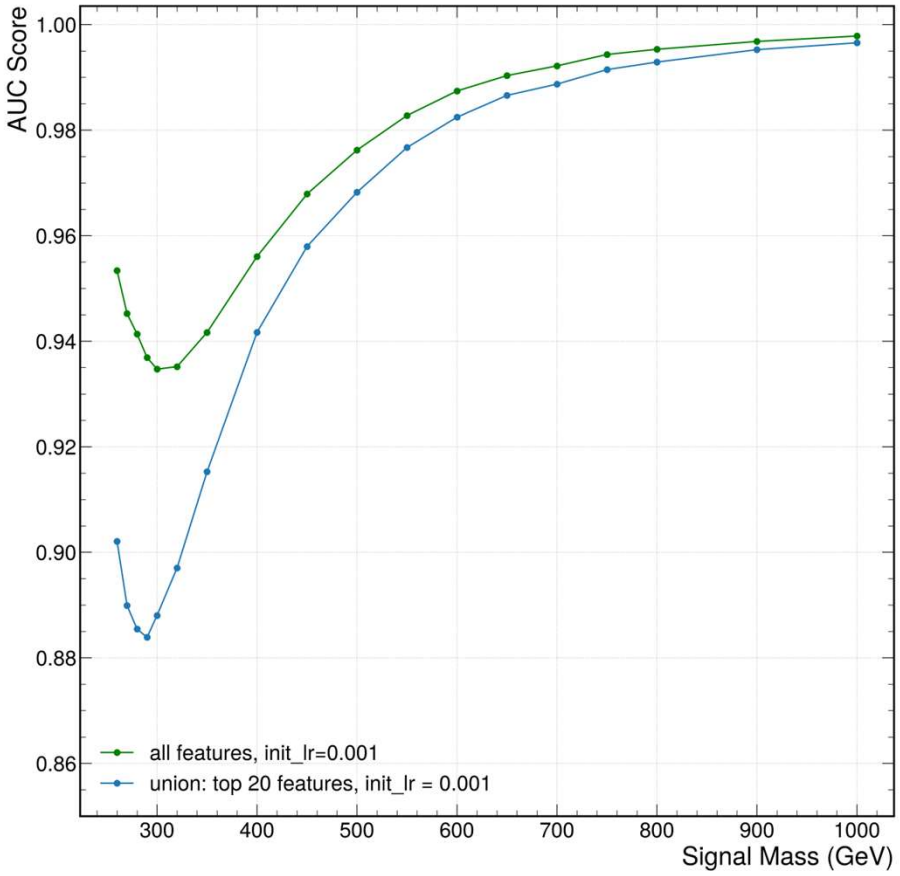
Artificially High AUC Scores



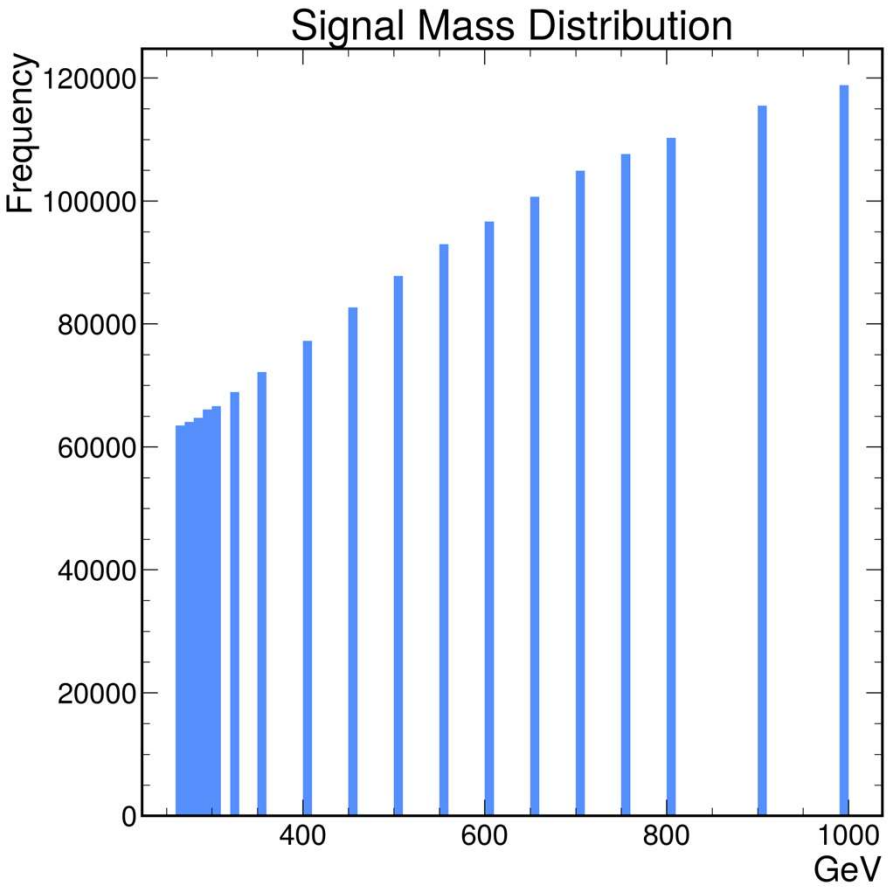
Individual Classifier

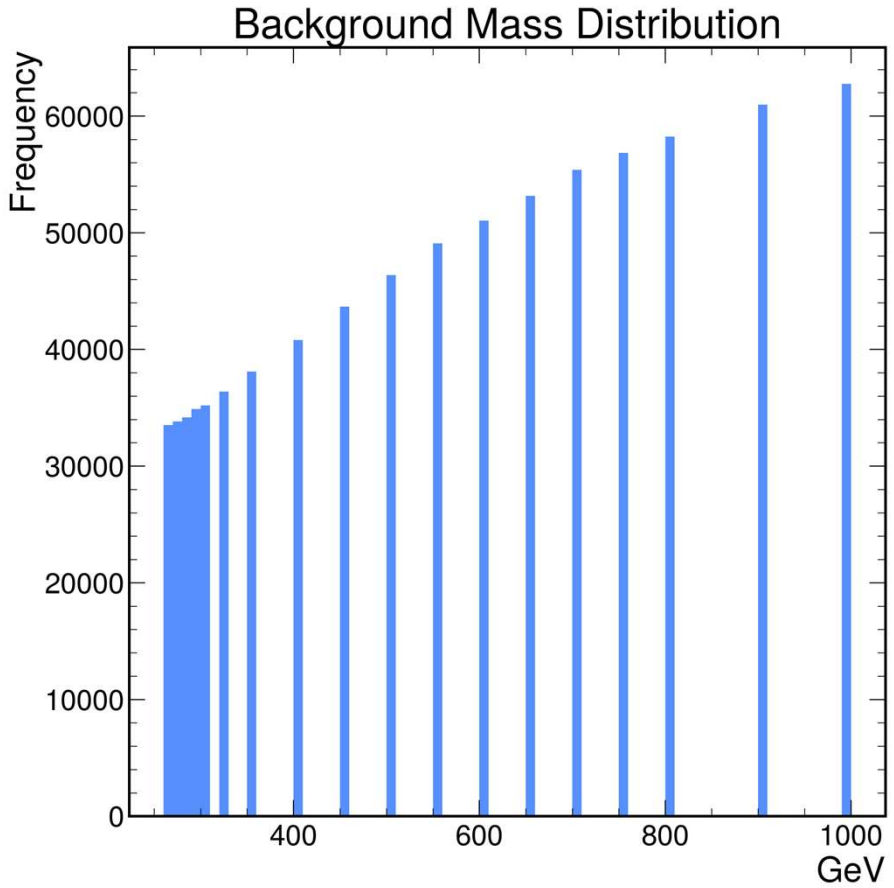


pNN

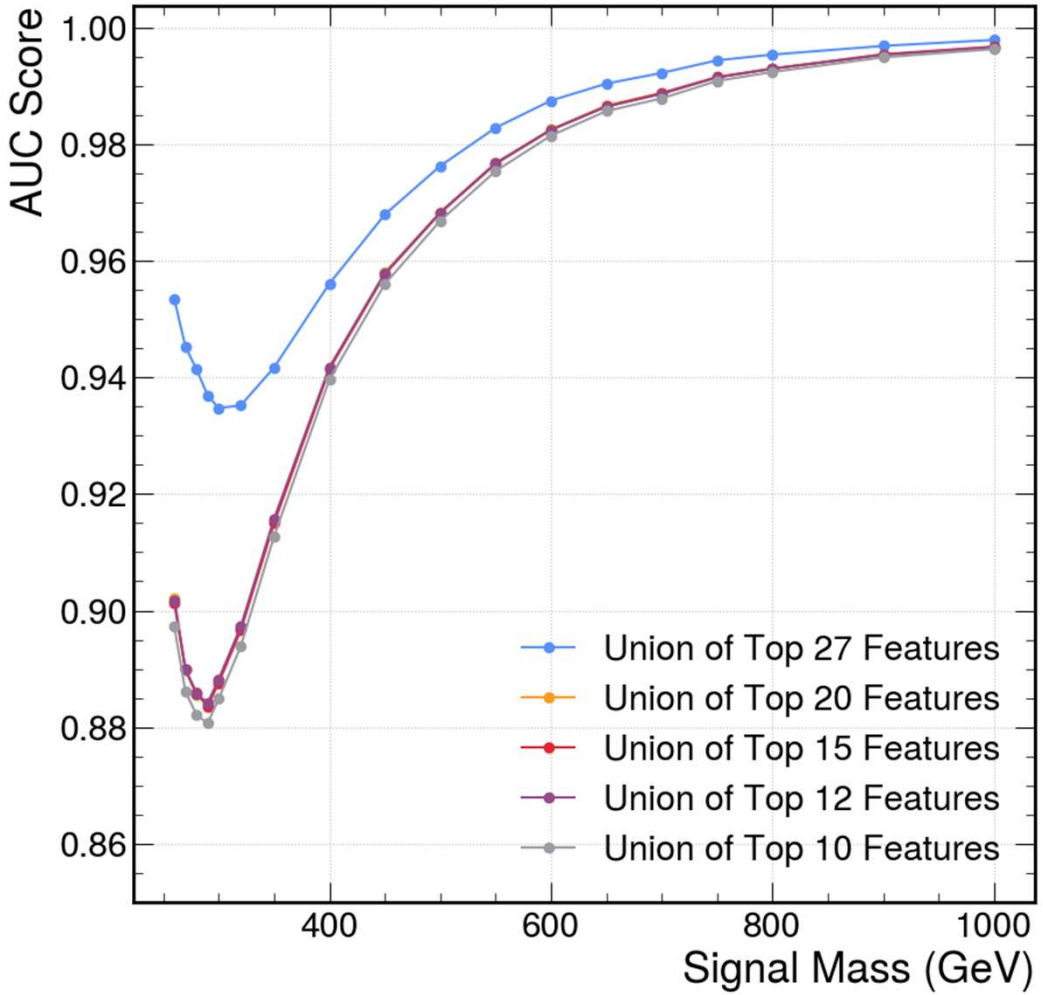


pNN

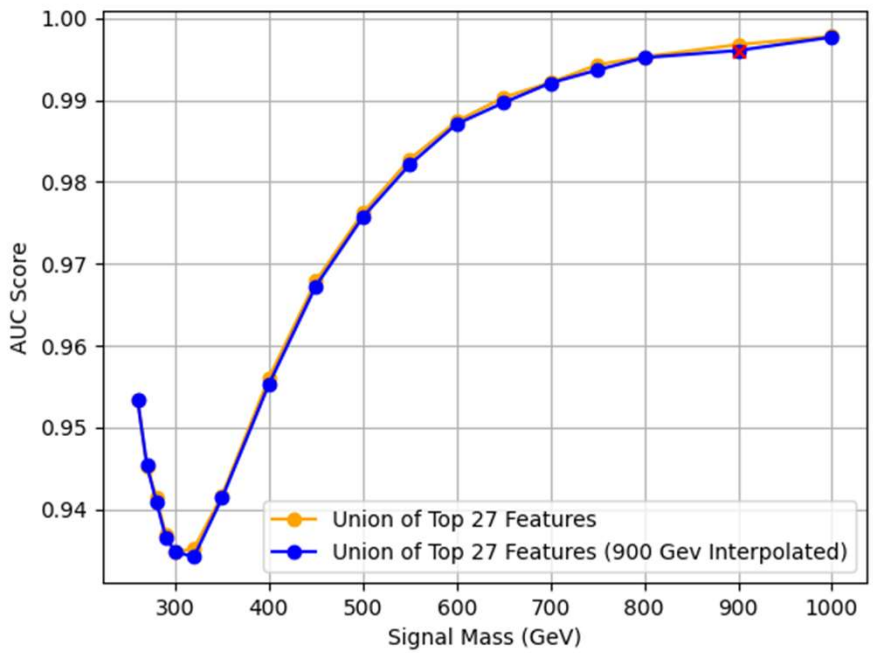

Signal Mass Distribution
Frequency
120000
100000
80000
60000
40000
20000
0
400
600
800
1000
GeV


Background Mass Distribution
Frequency
60000
50000
40000
30000
20000
10000
0
400
600
800
1000
GeV

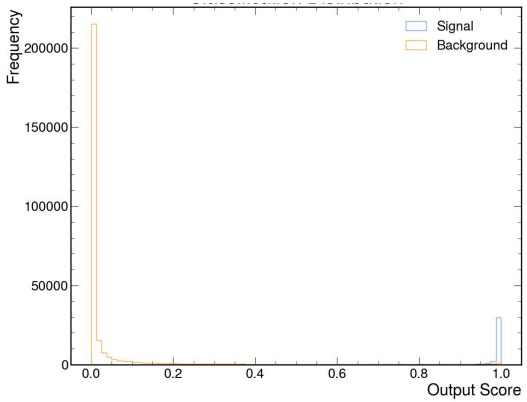
pNN

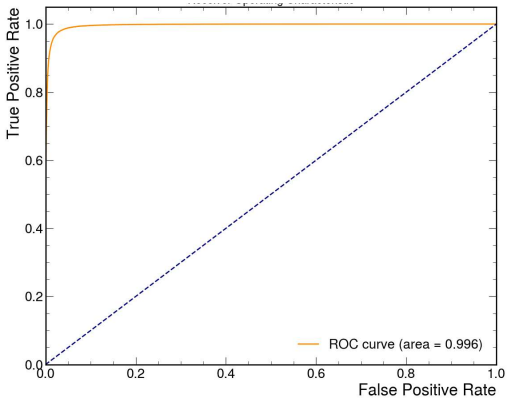

AUC Score
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.86
400
600
800
1000
Signal Mass (GeV)
Union of Top 27 Features
Union of Top 20 Features
Union of Top 15 Features
Union of Top 12 Features
Union of Top 10 Features

PNN (900 GeV Interpolation)



PNN 900 GeV Output Score Distribution and ROC Curve:





PNN (300, 320 & 350 Interpolation)