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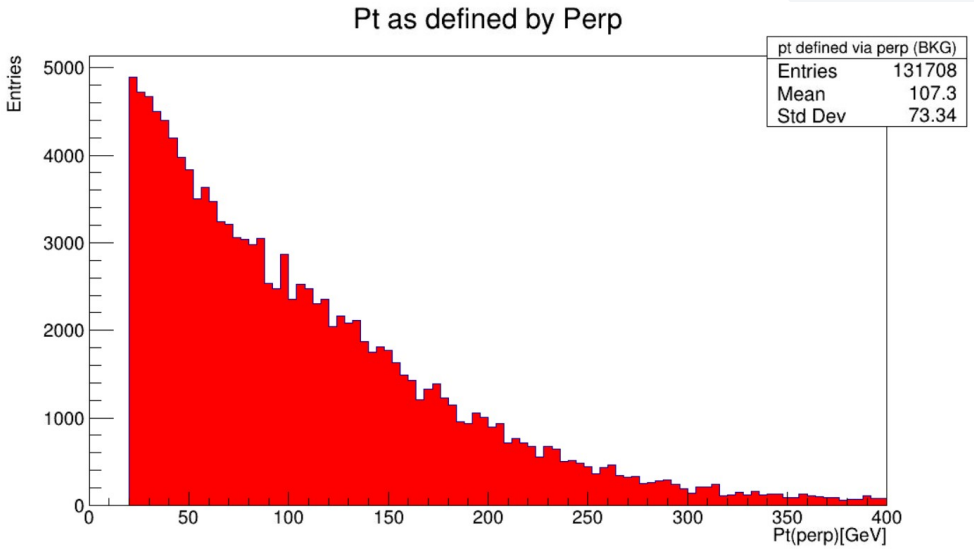
Masterthesis update

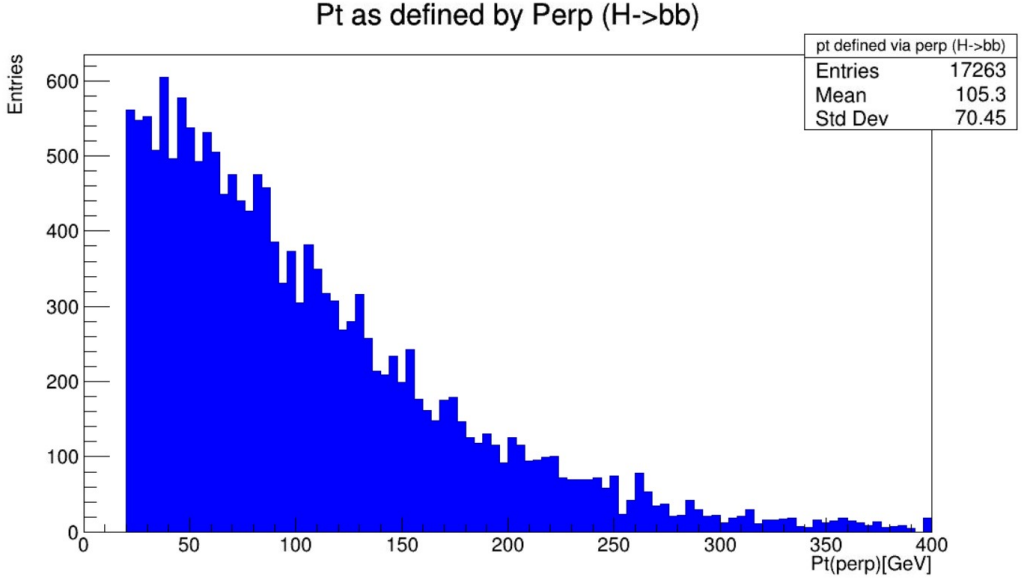
SoSe 2024
25.6.2024

So how did my last week look like?

	H→bb	combinatoric background
Transverse Momentum	looks good	looks good
Relative Mass	looks good	looks good
Angle Difference	looks good	looks good
Angle between jets	spikes at zero but has a distinctly different change from BKG	spikes at zero but has a distinctly different change from BKG
Energy Ratio COM	tbd	tbd
Rho Diff (COM)	tbd	tbd
Theta Diff (COM)	tbd	tbd
Phi Diff (COM)	tbd	tbd
DeltaR (COM)	tbd	tbd
Angle Count	tbd	tbd

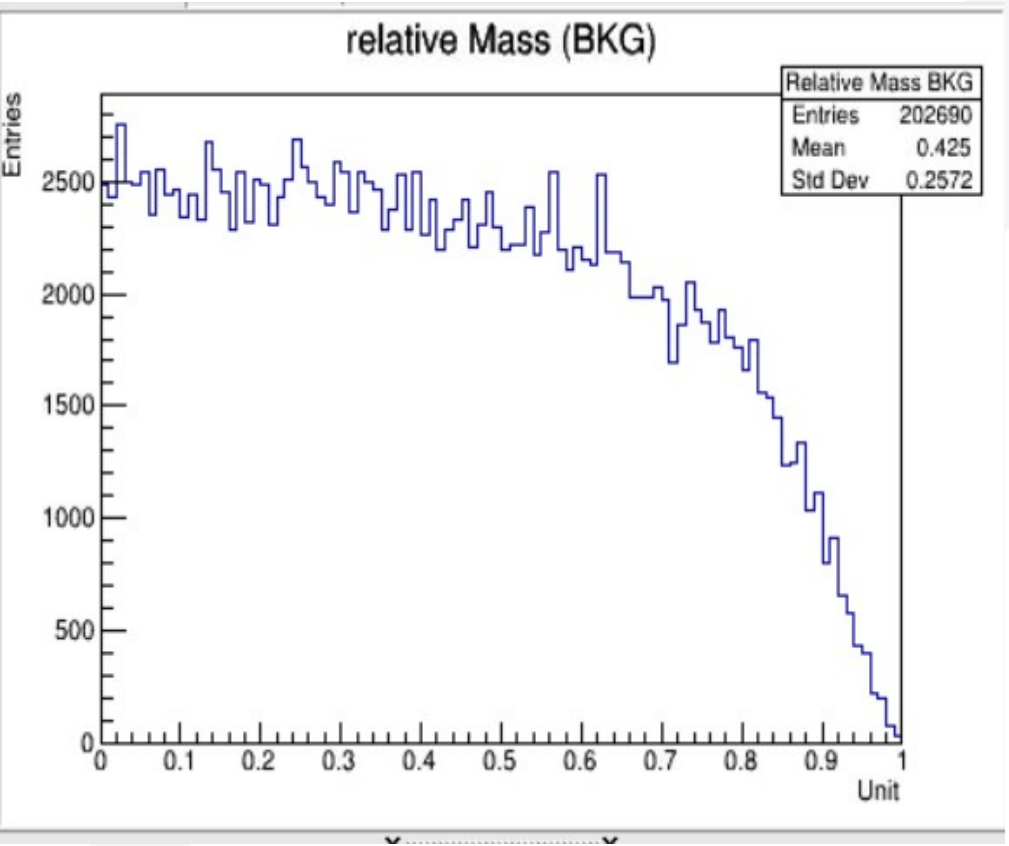
Transverse Momentum

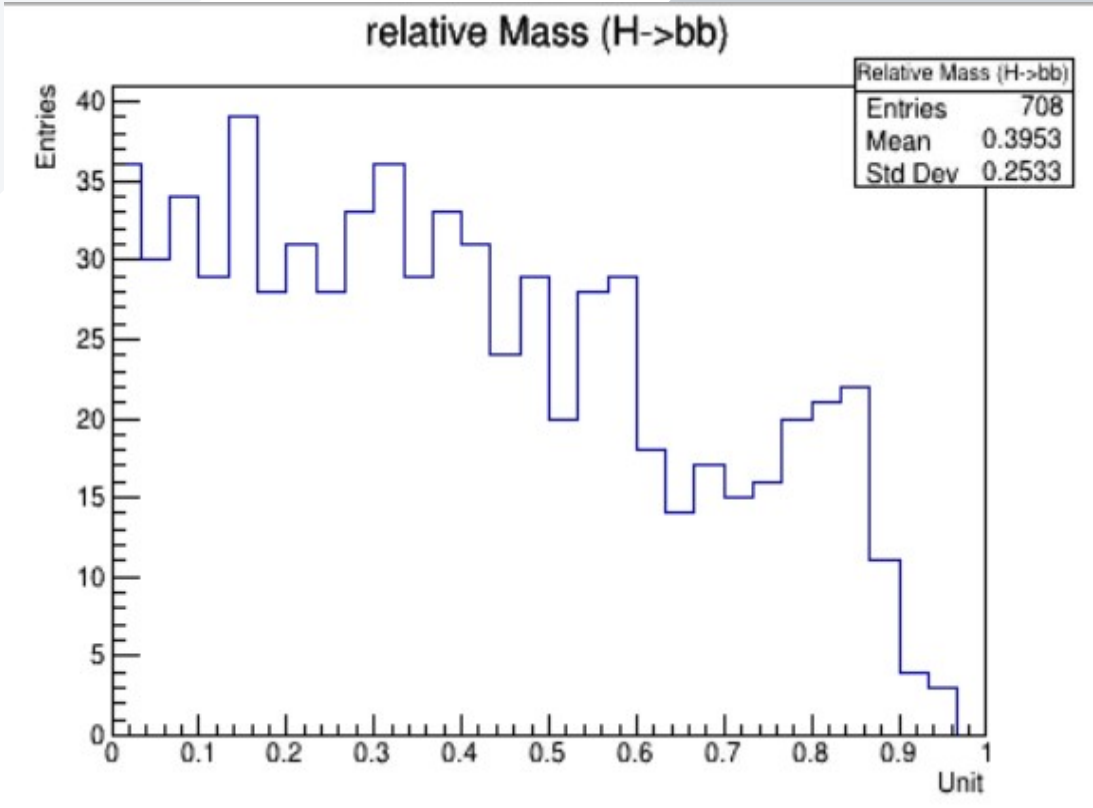




$$p_T = \sqrt{p_x^2 + p_y^2}$$

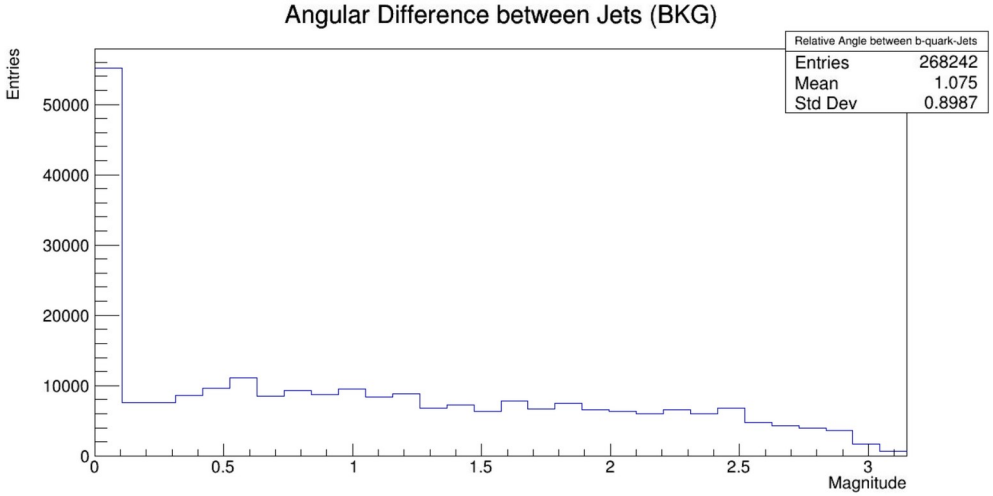
Relative Mass

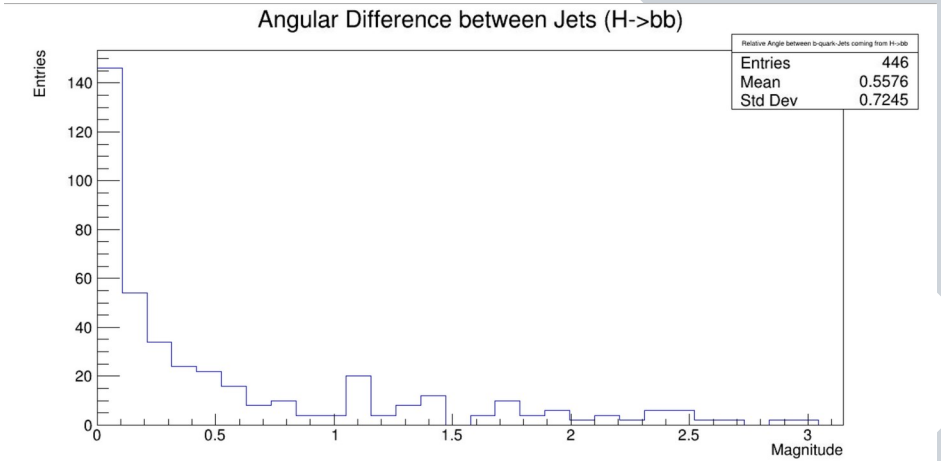




$$m_{rel} = \frac{|m_1 - m_2|}{m_1 + m_2}$$

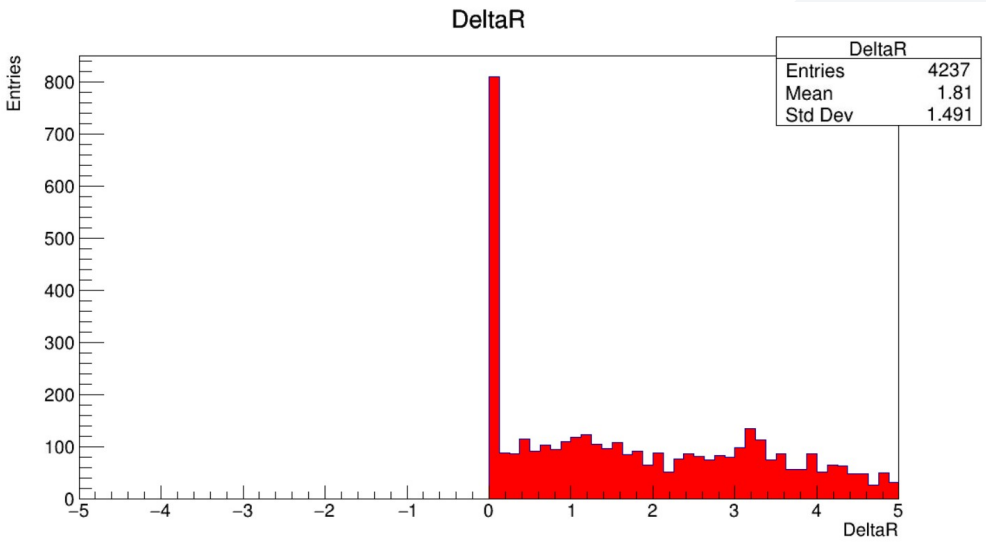
Angle between jets

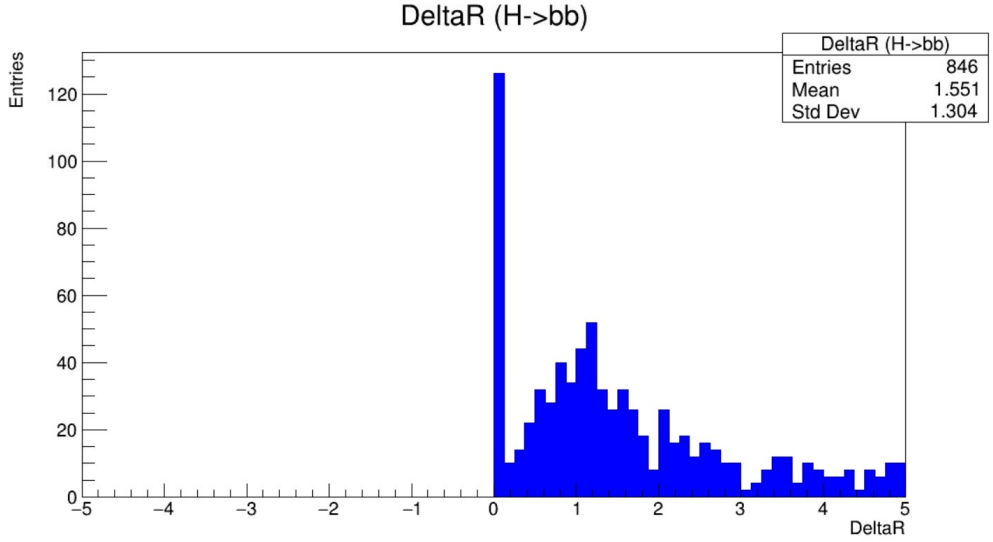




$$\theta = \arccos\left(\frac{j_1 \cdot j_2}{|j_1||j_2|}\right)$$

Angle Difference





$$\Delta R = \sqrt{(\phi_1 - \phi_2)^2 + (\eta_1 - \eta_2)^2}$$

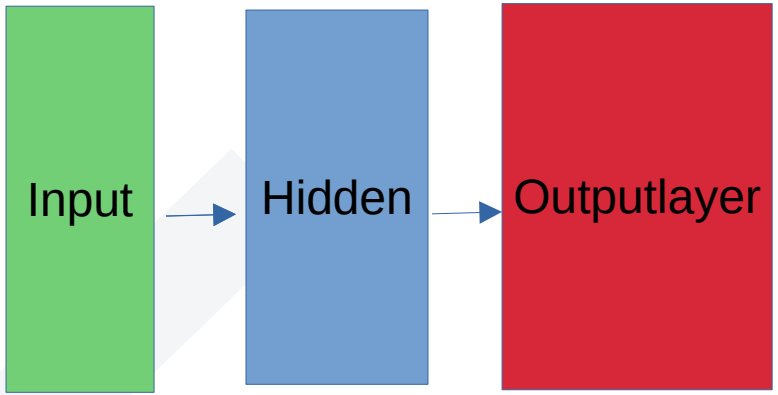
What comes next

Different Neural Networks Architectures to try out

- FC Network
- CNN based networks
- Siamese Network
- Transformers (?)

Fully Connected networks

Fully Connected network for classification

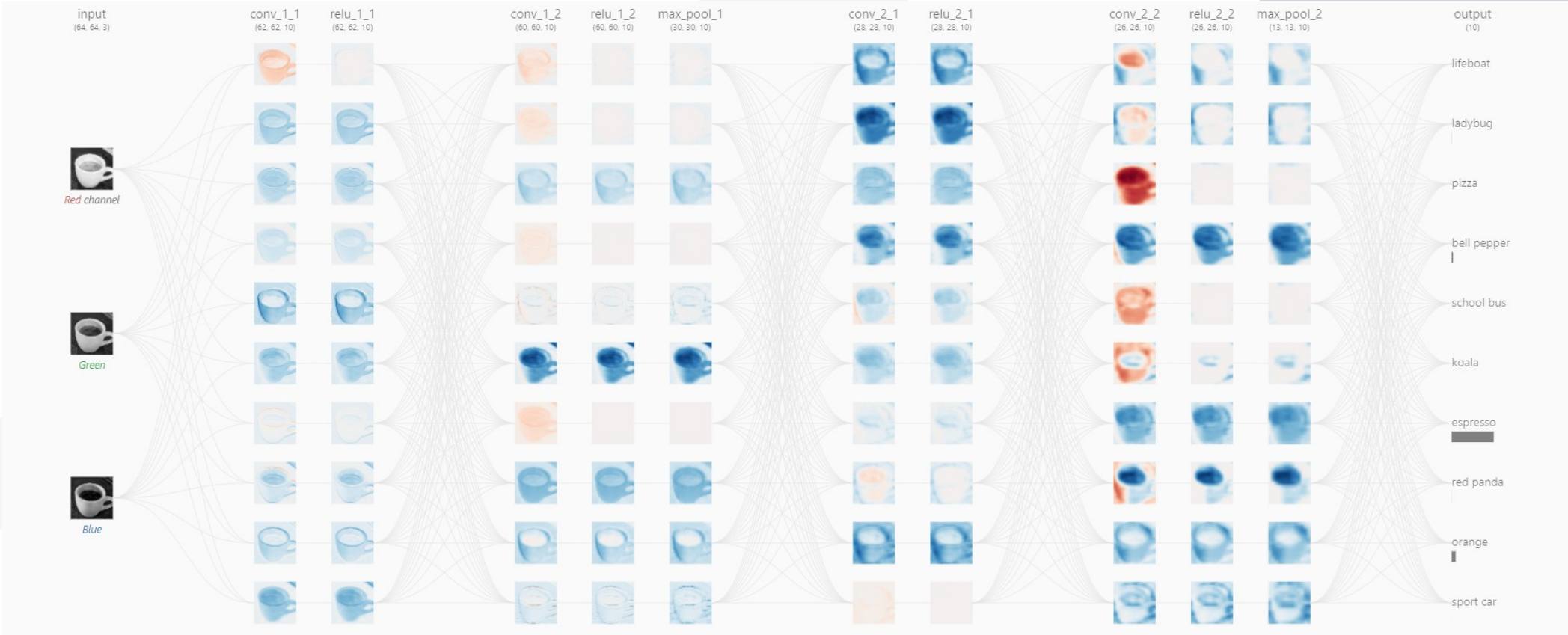



```
class Neural_Network(nn.Module):
            def __init__(self):
                super().__init__()
                self.linear_in = nn.Linear(5, 3)
                self.linear_hidden = nn.Linear(3, 3)
                self.linear_out = nn.Linear(3, 2)
                self.activation = nn.LeakyReLU(negative_slope = slope)
                self.softmax = nn.Softmax(dim=1)

            def forward(self, x):
                x = self.activation(self.linear_in(x))
                x = self.activation(self.linear_hidden(x))
                x = self.softmax(self.linear_out(x))
                return x
```

CNN based networks

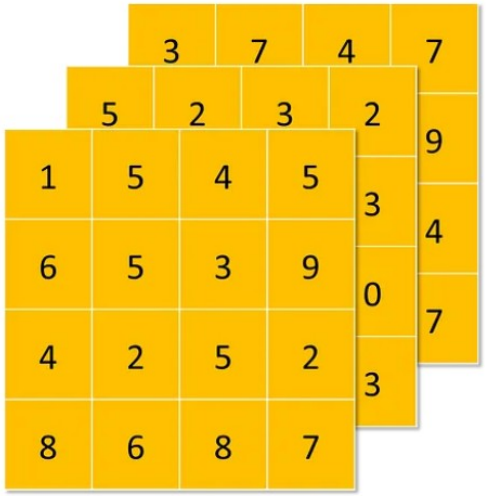
CNN based networks

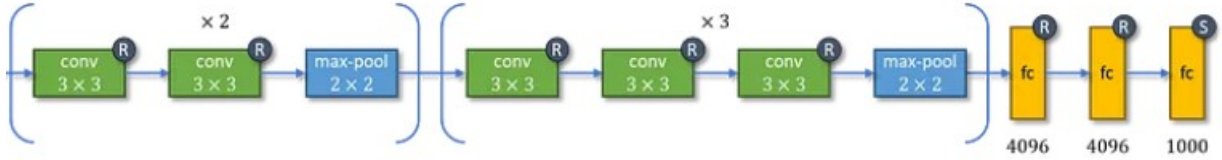


CNN based networks

Jet index #1

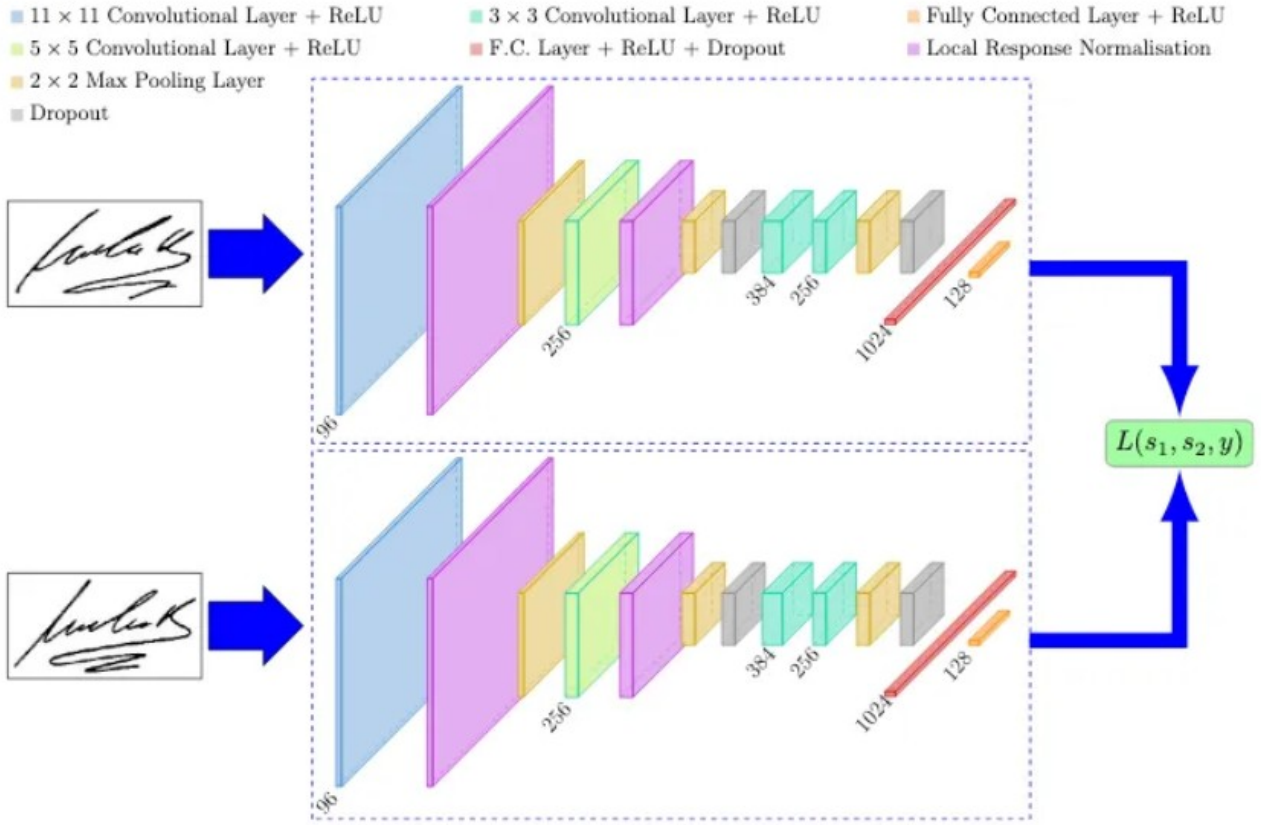
Jet index #2





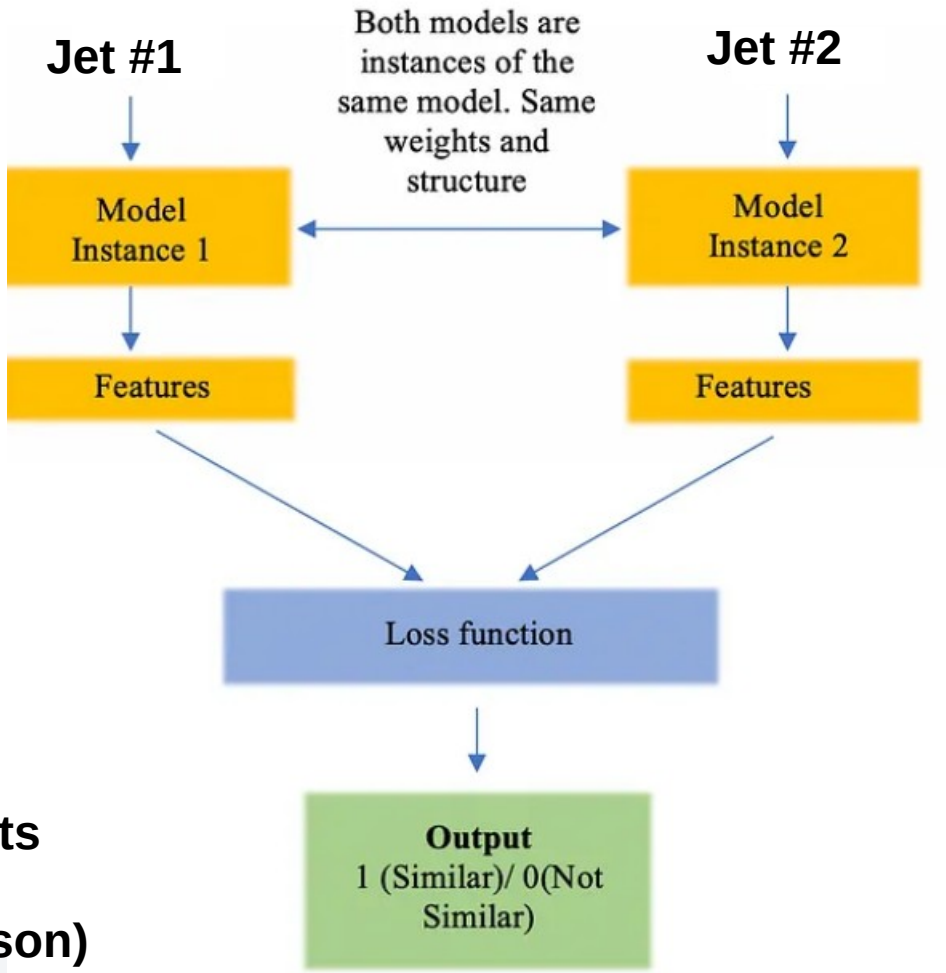
Siamese Training

Siamese Training



The SigNet architecture. Image from Dey et al. [2].

Siamese Training



Similar(both Jets come from the same Higgs-Boson)

Resources

- https://www.curious-cravings.com/images/post/standard-model.png
https://en.wikipedia.org/wiki/Gargamelle#/media/File:Neutral_current,_leptonic_event,_muon_neutrino.png
https://arxiv.org/ftp/arxiv/papers/2310/2310.03073.pdf
-Discrimination of HH and HZ Final States Using Neural Networks
-https://cdn3.iconfinder.com/data/icons/data-science-11/64/neural-network-machine-learning-algorithm-1024.png
-https://www.researchgate.net/figure/Feynman-diagrams-for-the-leading-Higgs-boson-interactions-Higgs-boson-production-in-a_fig1_361733458