



# **Bao Tai Le**

Masterthesis update

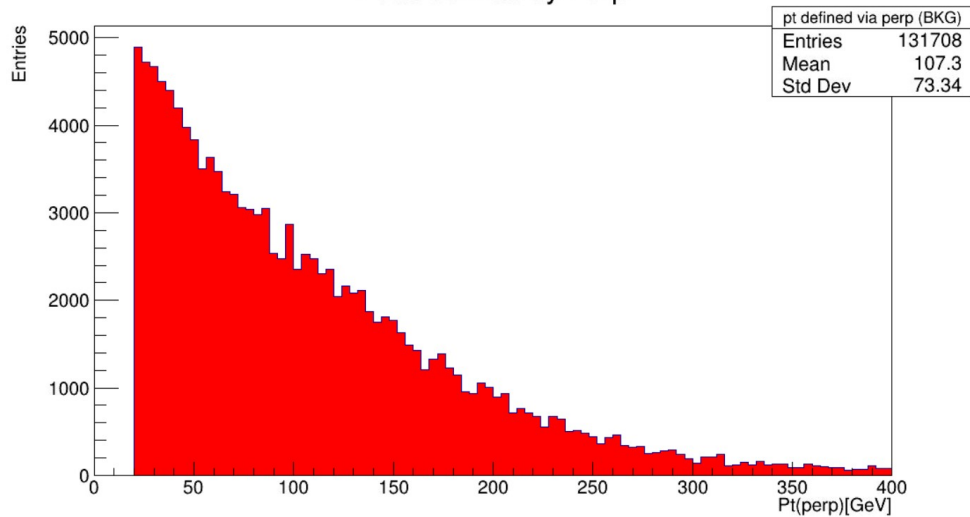
SoSe 2024  
25.6.2024

**So how did my  
last week look  
like?**

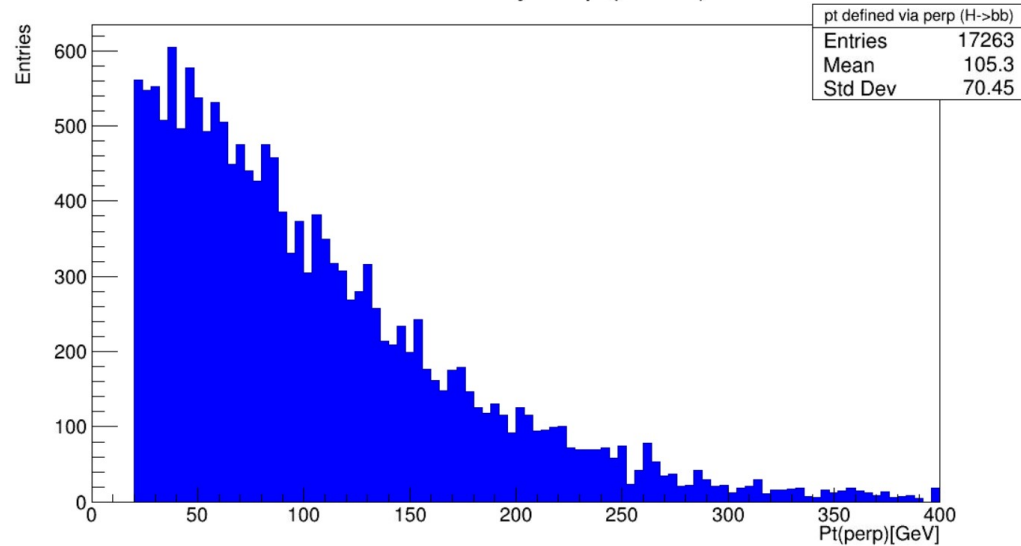
	H→bb	combinatoric background
Transverse Momentum	looks good	looks good
Relative Mass	<u>looks good</u>	<u>looks good</u>
Angle Difference	<u>looks good</u>	<u>looks good</u>
<u>Angle between jets</u>	<u>spikes at zero but has a distinctly different change from BKG</u>	<u>spikes at zero but has a distinctly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

# Transverse Momentum

Pt as defined by Perp

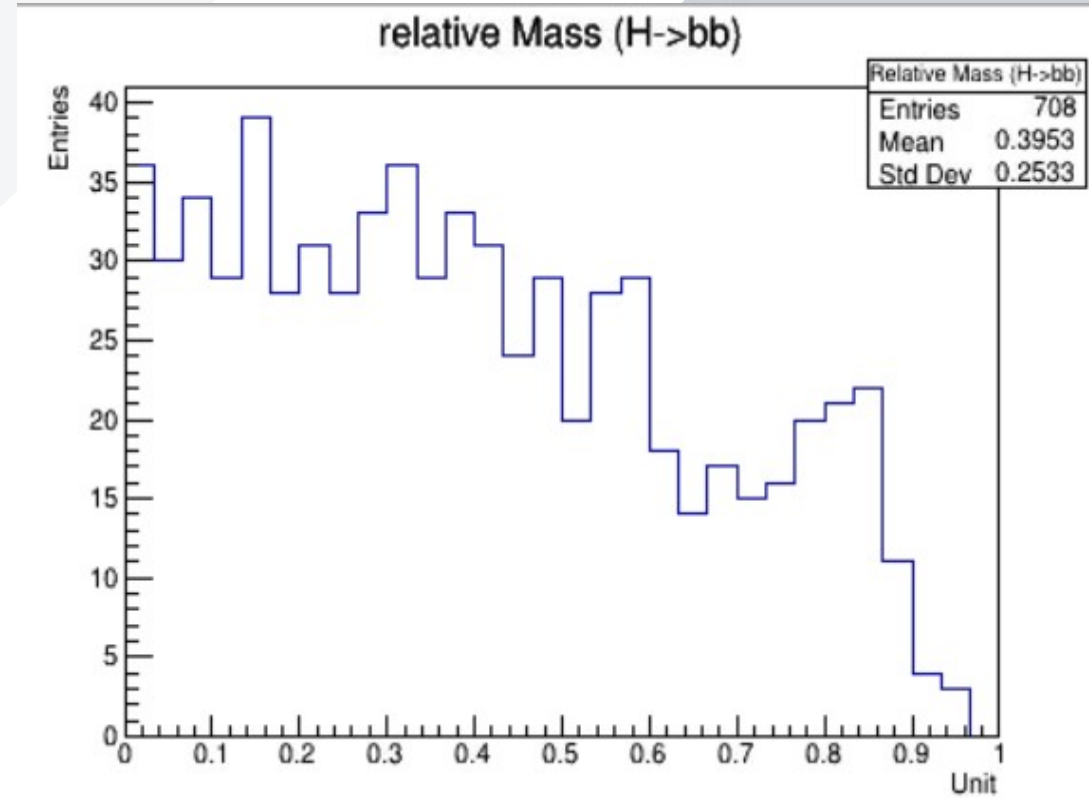
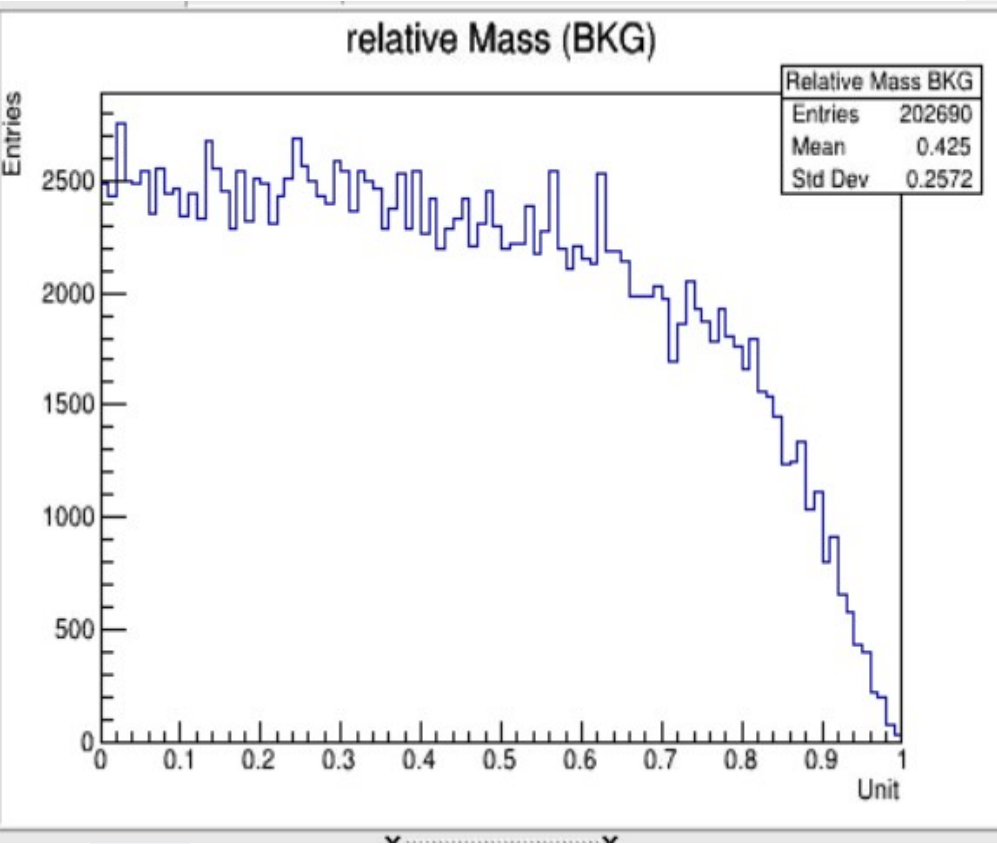


Pt as defined by Perp (H->bb)



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

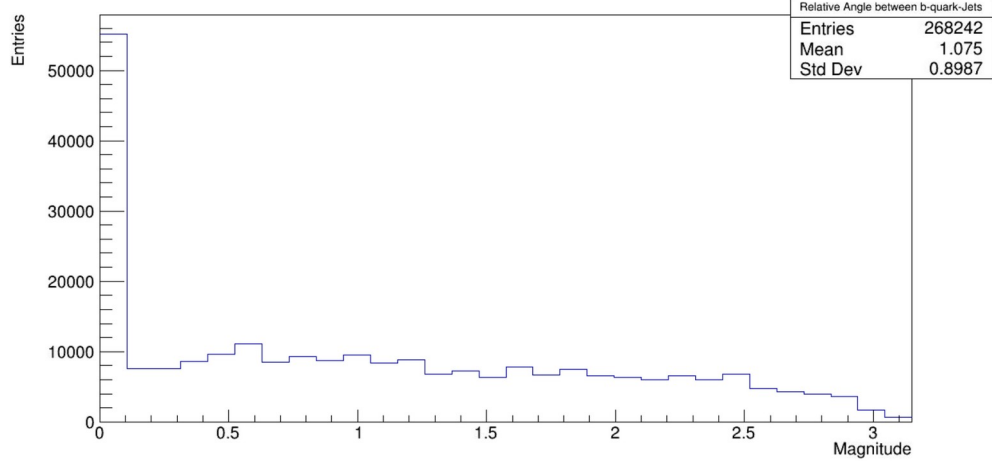
# Relative Mass



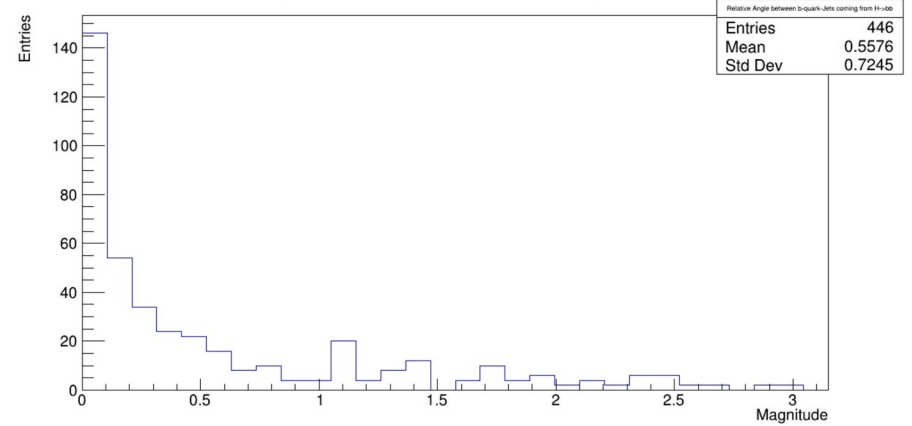
$$m_{rel} = \frac{|m_1 - m_2|}{m_1 + m_2}$$

# Angle between jets

Angular Difference between Jets (BKG)

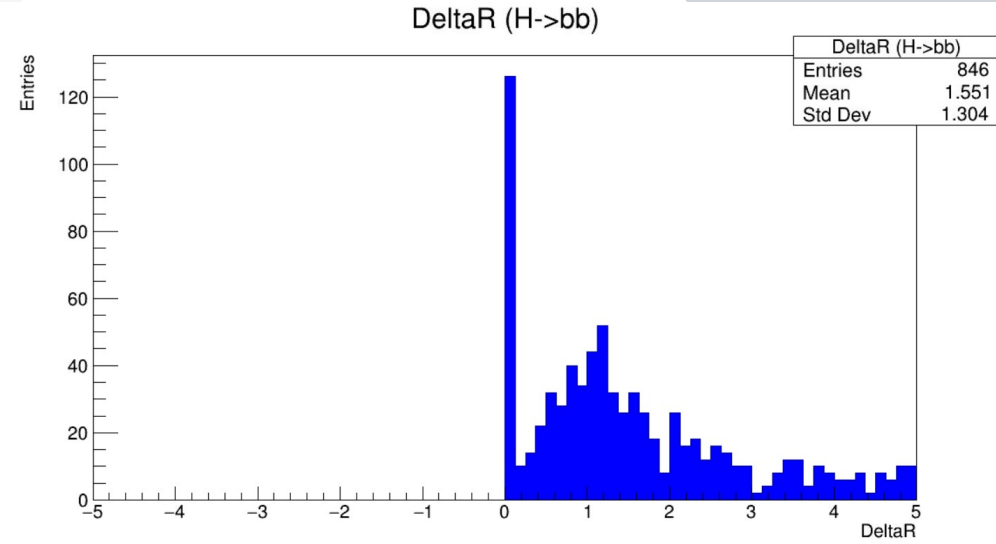
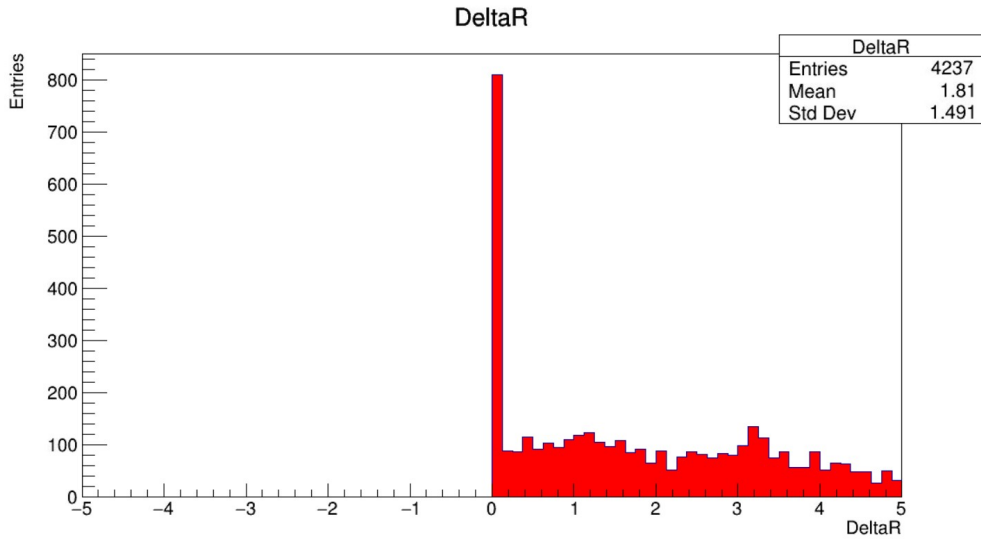


Angular Difference between Jets (H->bb)



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

# 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

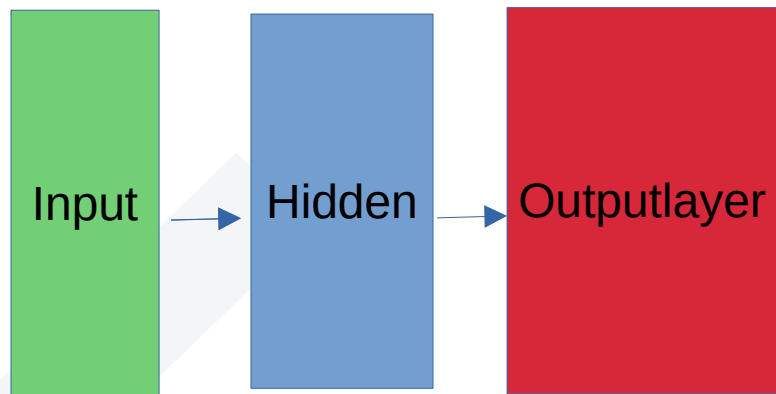
- FC Network
- CNN based networks
- Siamese Network
- Transformers (?)



The background of the slide features several diagonal gray bars of varying lengths and shades, creating a modern, geometric pattern. The bars are positioned in the corners and along the sides, leaving a large white central area for the text.

## **Fully Connected networks**

## Fully Connected network for classification

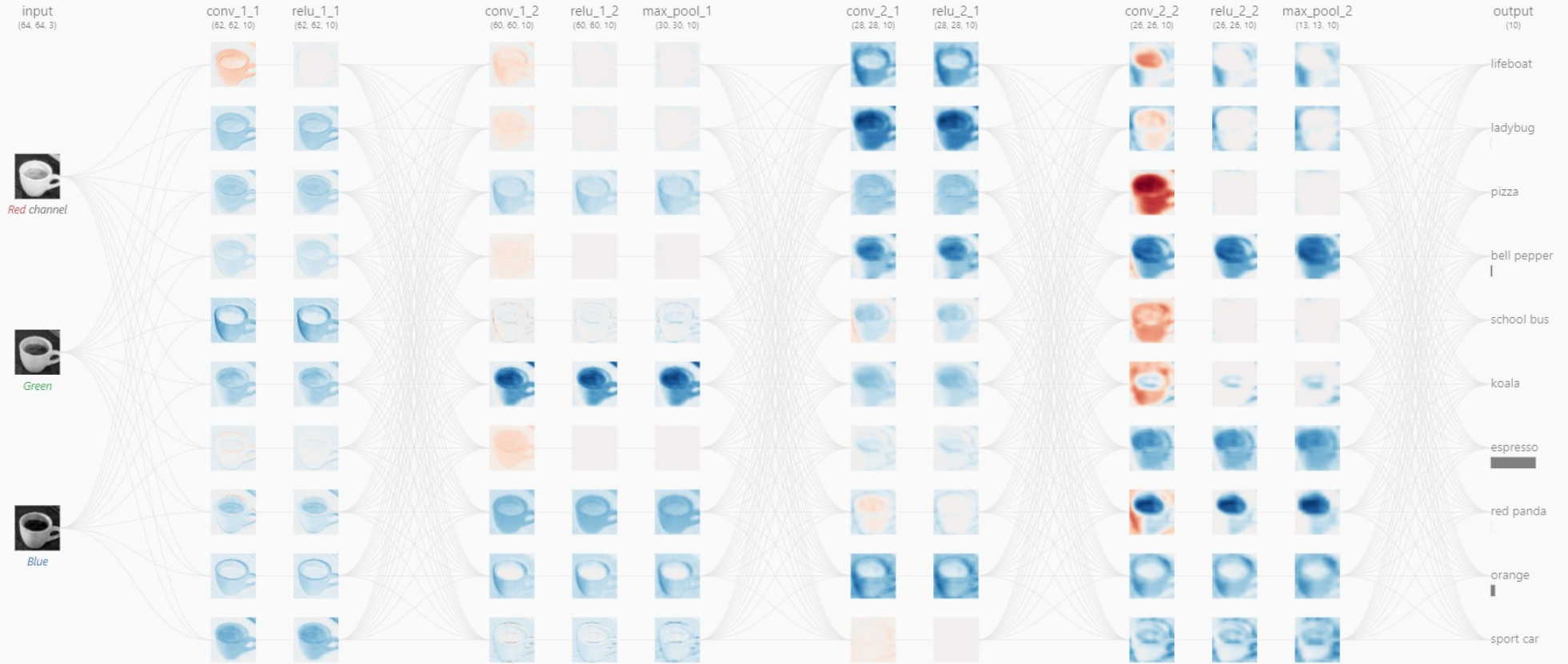


```
class Neural_Network(nn.Module):  
    def __init__(self):  
        super().__init__()  
        self.linear_in = nn.Linear(5, 3)  
        self.linear_hidden = nn.Linear(3, 3)  
        self.linear_out = nn.Linear(3, 2)  
        self.activation = nn.LeakyReLU(negative_slope = slope)  
       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



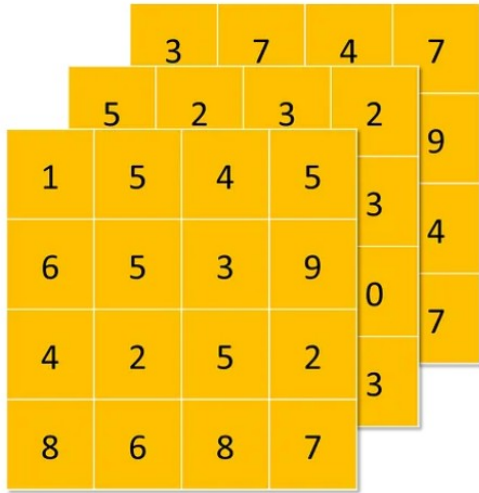
**CNN based  
networks**

# CNN based networks

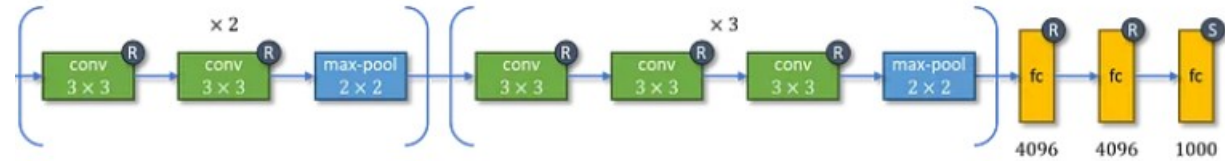


# CNN based networks

Jet index #1



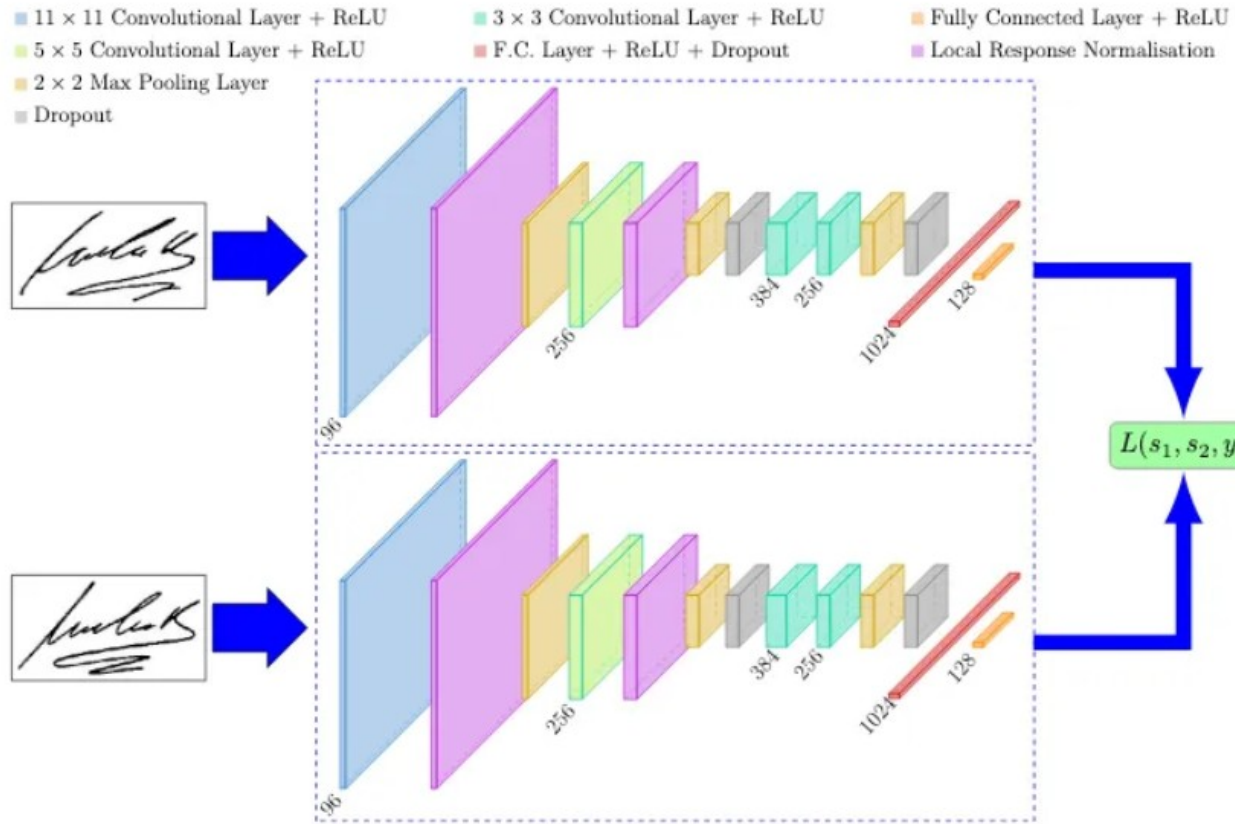
Jet index #2



The background features several overlapping geometric shapes, primarily triangles and quadrilaterals, in shades of light gray and medium gray. These shapes are arranged in a way that creates a sense of depth and movement, with some shapes appearing to be in the foreground and others receding into the background. The overall aesthetic is clean and modern.

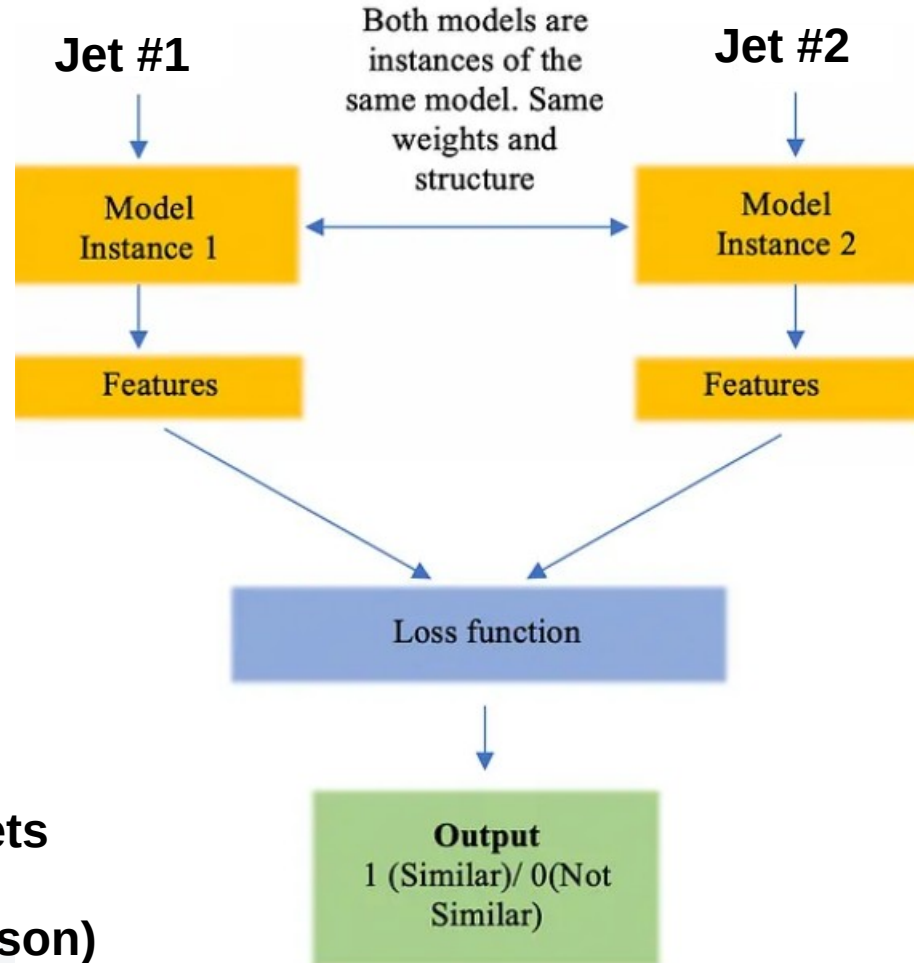
## **Siamese Training**

# 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\\_vent,\\_muon\\_neutrino.png](https://en.wikipedia.org/wiki/Gargamelle#/media/File:Neutral_current,_leptonic_vent,_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](https://www.researchgate.net/figure/Feynman-diagrams-for-the-leading-Higgs-boson-interactions-Higgs-boson-production-in-a_fig1_361733458)