Searching for Boosted Higgs $\rightarrow b\bar{b}$

Machine Learning (CNNs)

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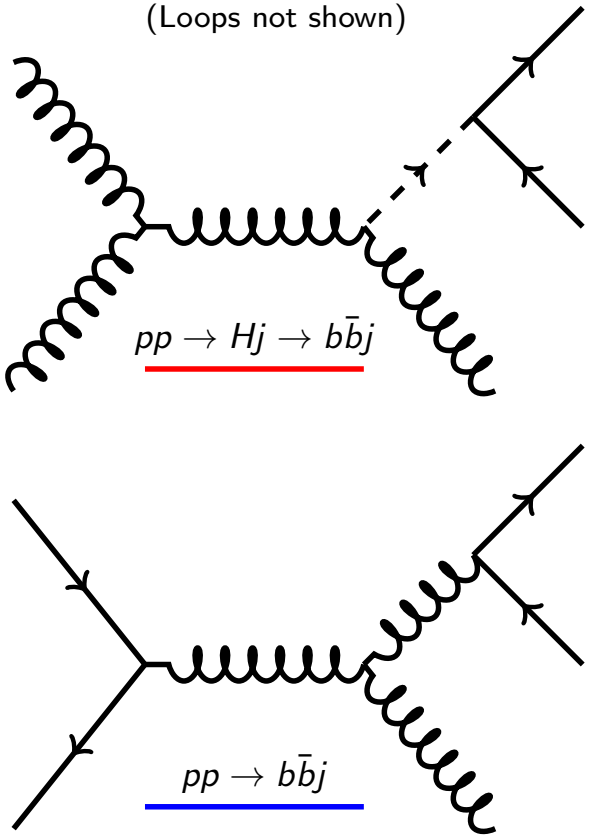
Why look for Higgs $\rightarrow b\bar{b}$?

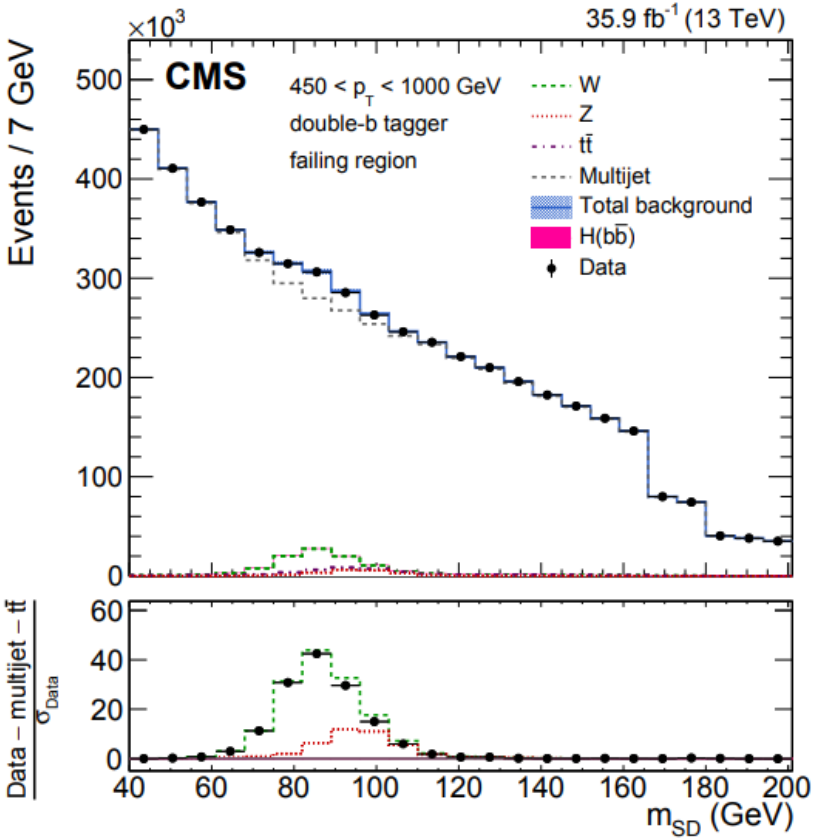
	H $\rightarrow b\bar{b}$	H $\rightarrow WW$	H $\rightarrow gg$	H $\rightarrow \gamma\gamma$
Branching Ratio	58.24%	21.37%	8.18%	0.227%

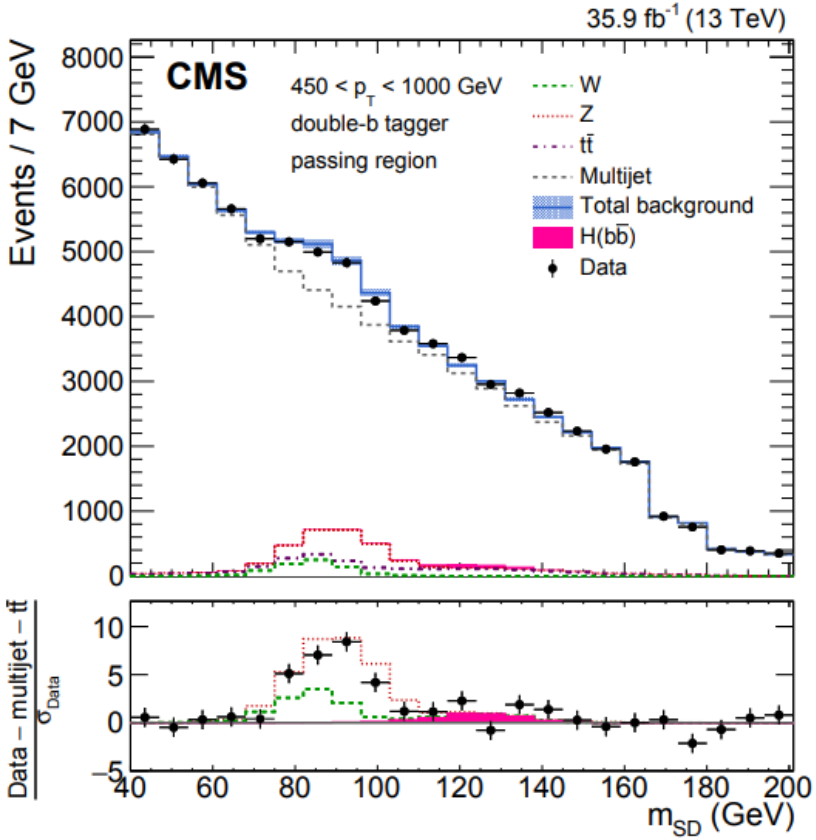
$H \rightarrow \gamma\gamma$ and $H \rightarrow WW \rightarrow 4l$, while having low cross-sections, are easier to detect over their respective backgrounds. Searching for $H \rightarrow b\bar{b}$ will give us further insight into physics.

Example Higgs signal/QCD background diagrams shown on right (with loops not shown)



Current search for boosted $H \to b\bar{b}$



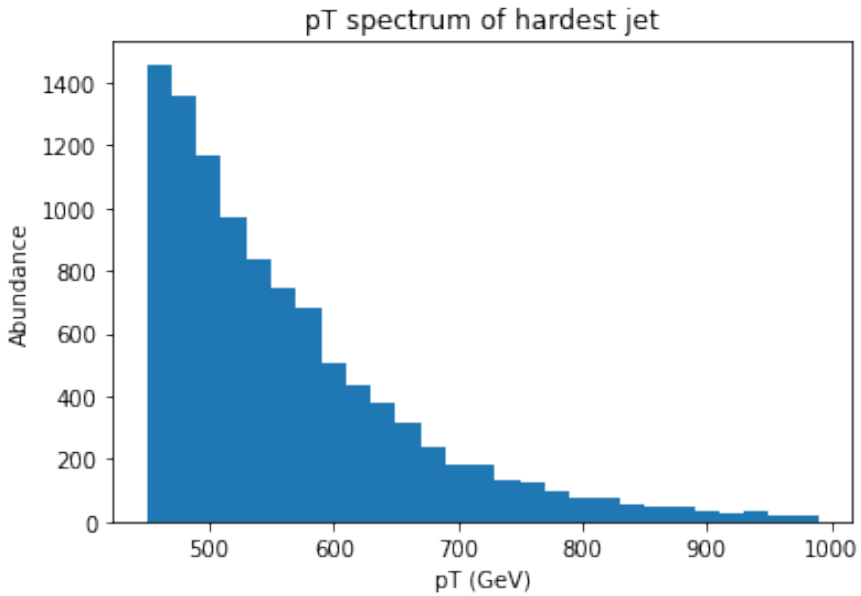


https://arxiv.org/pdf/1709.05543.pdf

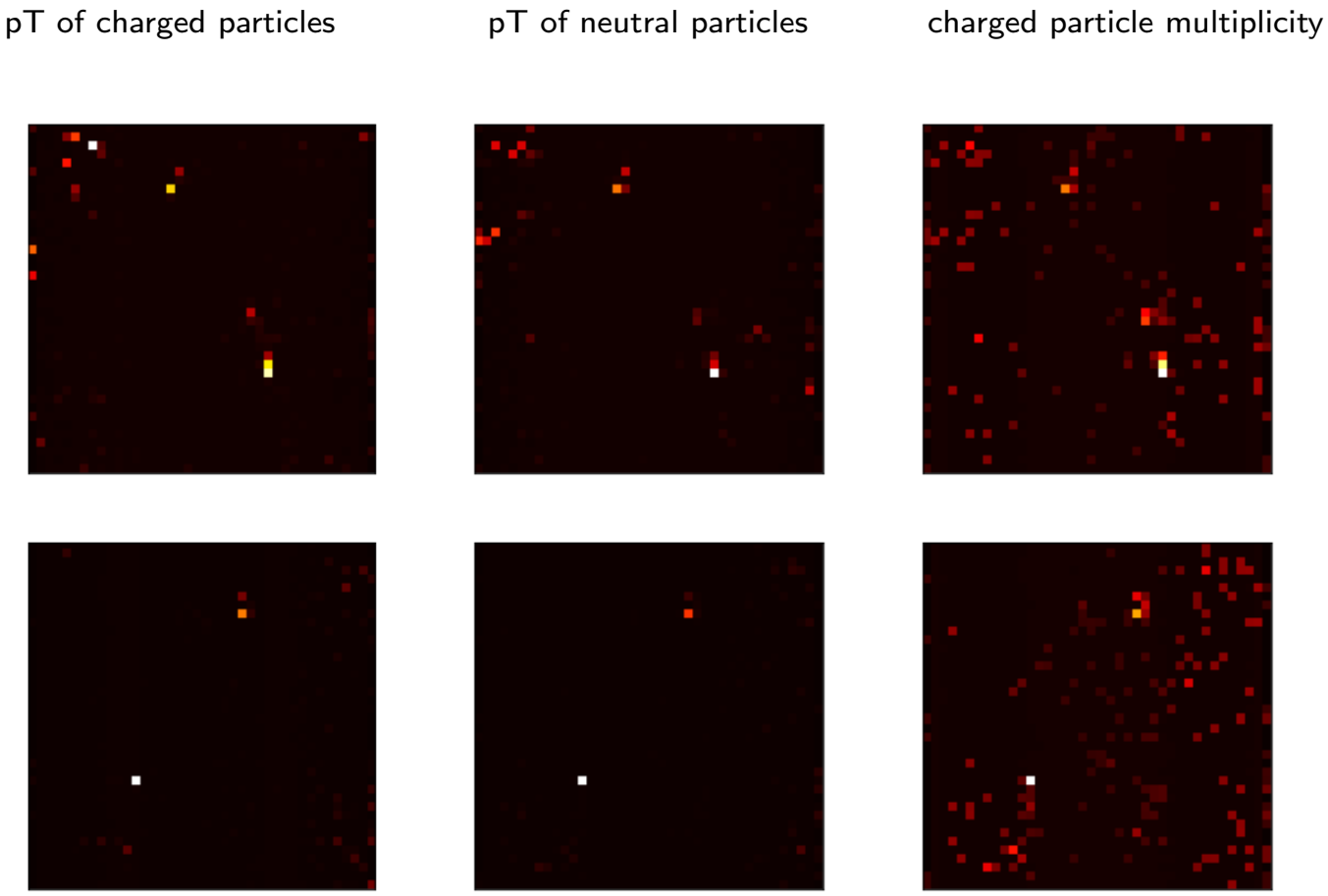
We simulated p p > H j (signal) and p p > j j (background QCD) datasets with Pythia 8.226.

Events were clustered with anti-kT clustering, with a radius of 0.8. All data was generated in the boosted regime where the hardest jet is required to have pT > 450 GeV.

The hardest jet was then reclustered with Cambridge-Aachen clustering with a radius of 0.2 for the double-b tagging.



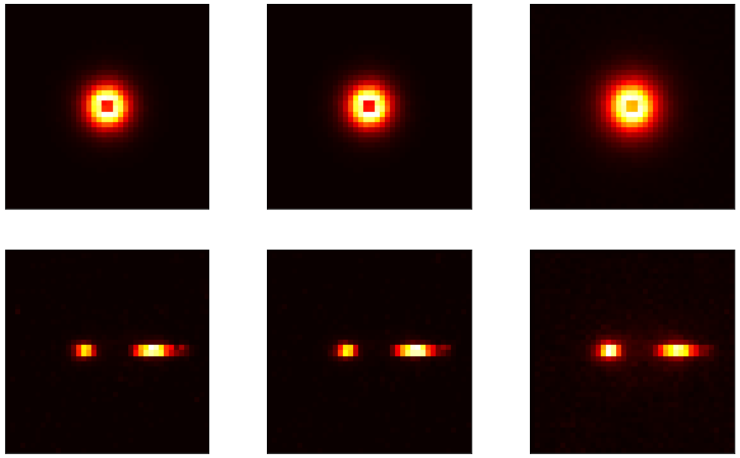
Representation of the data



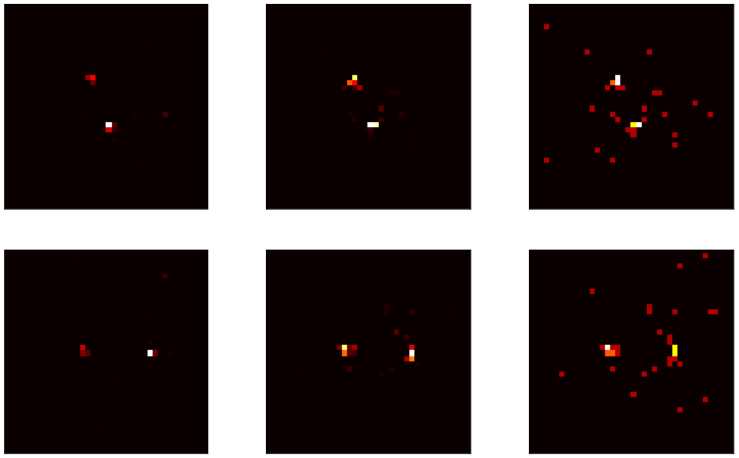
Full event image for a background event, and a signal event

Jet images are rotated and translated so that the two subjets lie on the same axis, and the larger pT subjet is always on the same side of the image.

Average unprocessed jet image



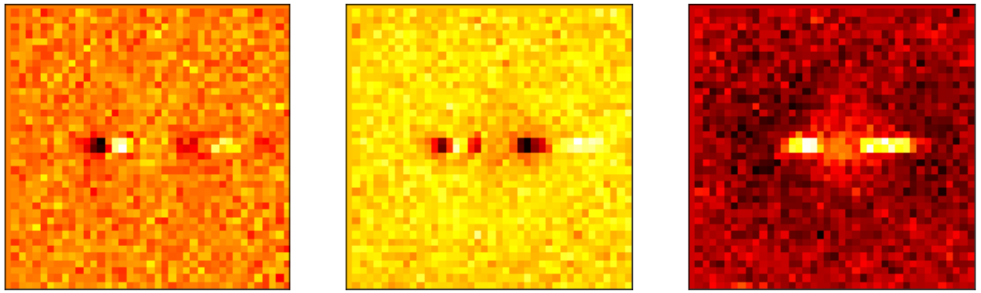
Single unprocessed jet image

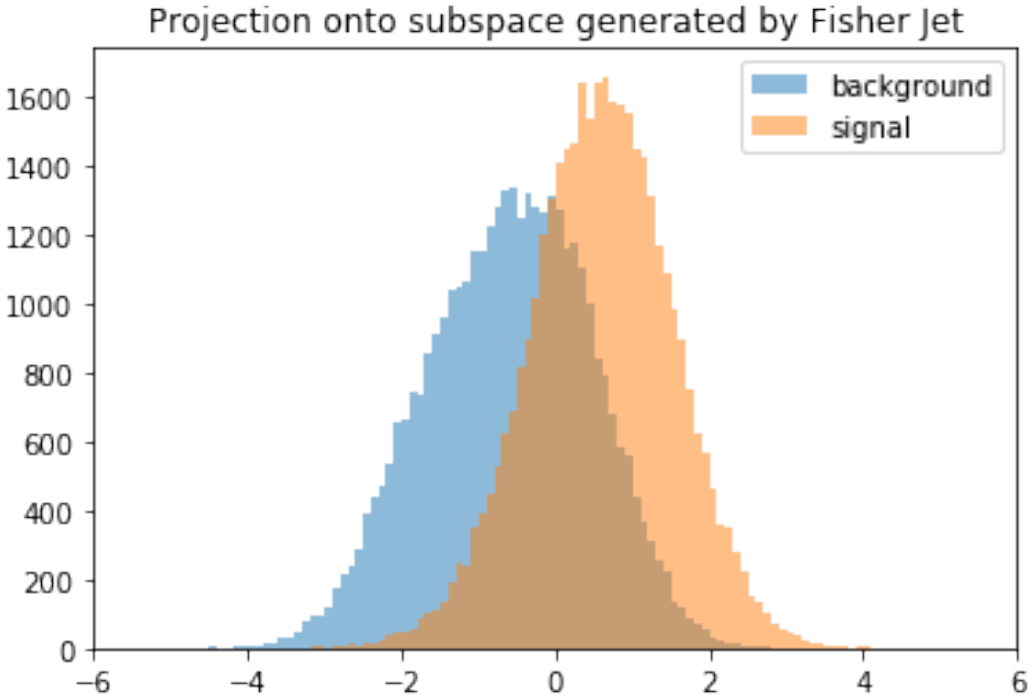


Average processed jet image

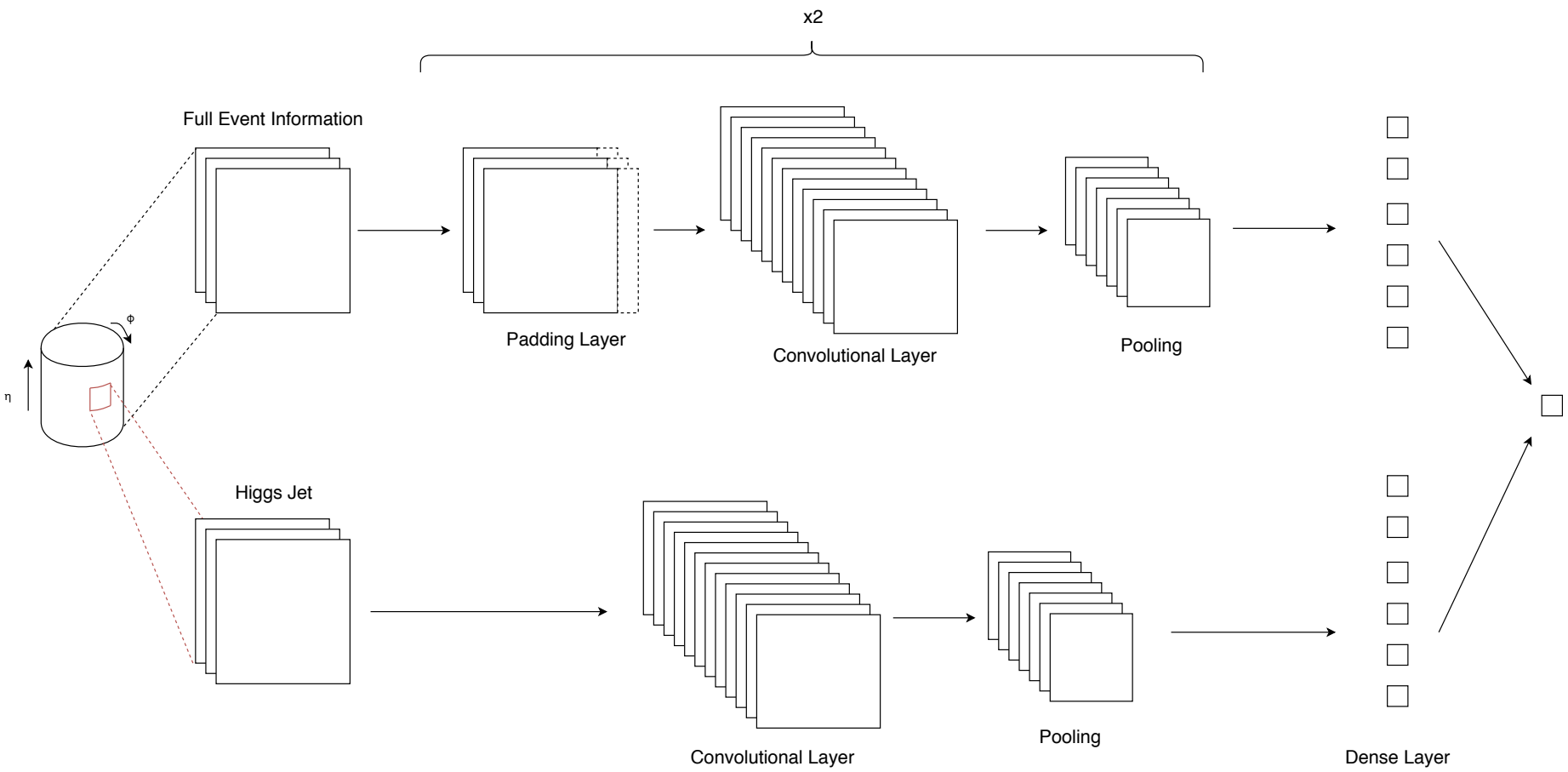
Single processed jet image

Fisher Linear Discriminant Analysis:



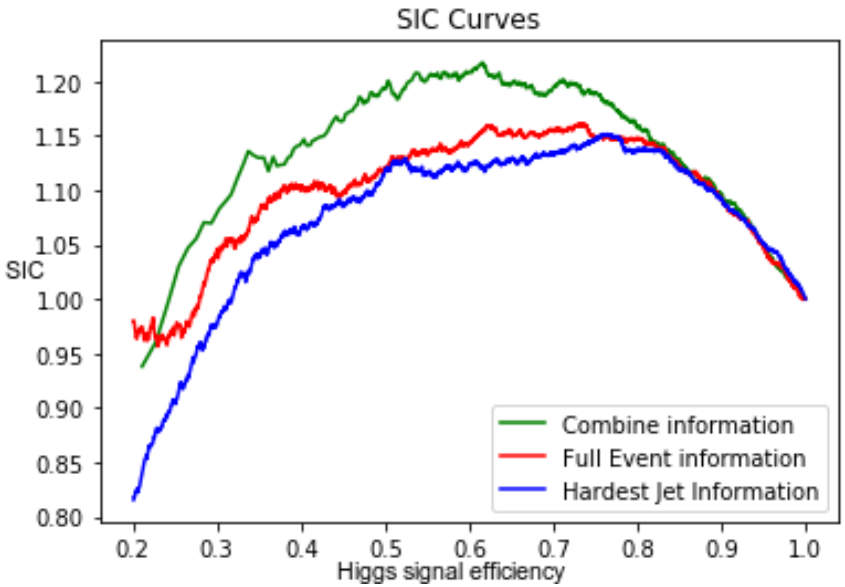


Neural Network Schematic



To find the significance, we perform a binned maximum likelihood fit to the observed mass distribution in the parameter μ_H,

$$f_{\text{exp}} = B + \mu_H \cdot S$$



- Step up from Pythia and generate data at NLO with Madgraph
- By improving this search for boosted Higgs to $b\bar{b}$ using ML, hopefully we can gain insight into tighter bounds on theories beyond the standard model.