Constraining Deep Neural Network classifiers' systematic uncertainty via input feature space reduction

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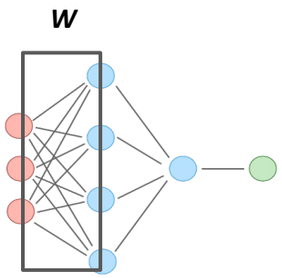
Evaluation Of The Effects On Model Uncertainty

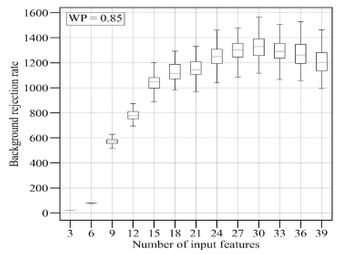
Deep Learning approaches are **widely used to improve the selection performance in physics analysis**.
Results from a **model based on a large number of input variables are more difficult to explain**. This is relevant for neural network models since **they do not provide uncertainty estimation** and are often treated as perfect tools, which they are not.
We show how using a sub-optimal set of input features can lead to higher systematic uncertainty associated with classifier predictions.

Varying random initialization can lead to **models which perform different**.

N models trained varying random initialization



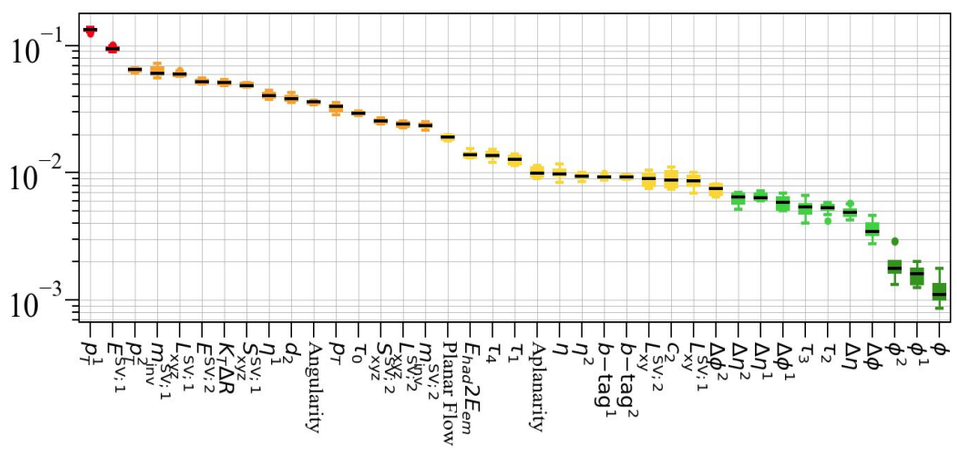
After each iteration all the weights ***W*** between the input and the first hidden layer are stored



Performance distribution at a fixed working point

Input Feature Selection Using Ensemble Learning Algorithm

Idea: select **the most relevant** features as ranked by a decision tree algorithm (e.g. **Carboost**).
Model trained using **10-fold cross validation** to have an **estimate of the ranking position uncertainty**

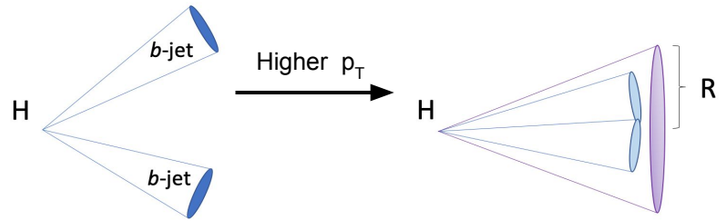


Benchmark Application

The **H(bb)** channels accounts for **58% of the total Higgs boson decays**.
Boosted regime is a nice place where to look for **BSM effects**.

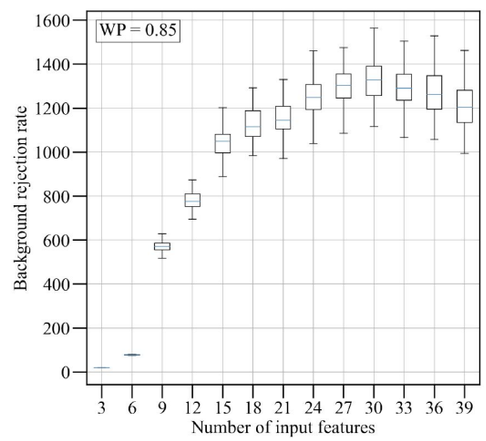
Huge irreducible background coming from QCD multi-jet production in *pp* collisions.

We developed an **H→bb tagger** based on a Deep Neural Network to identify jets that contain both the b quarks from boosted H decay.



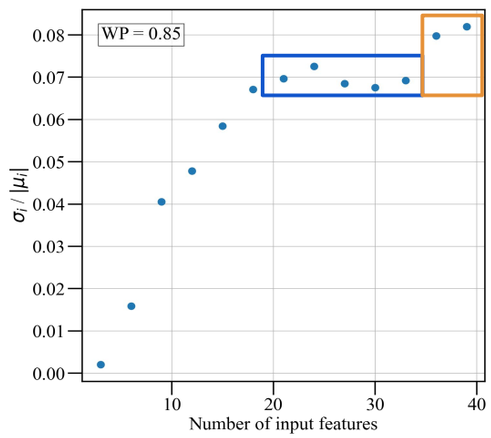
Dataset
4x10^6 simulated events of *pp*-collision at 14 TeV
Each candidate (**39 features**) is a **large radius jet** (anti-kT jet with R = 1) with the **2 variable radius track jets** (R_{MAX}= 0.4,R_{MIN} = 0.02, ρ = 30) contained in the large radius jet with highest p_T.

Results



Increasing performance up to 24 features

Negligible improvements for larger input feature sets



Increasing trend observed after **the plateau**

Additional checks are needed with an higher number of variables.

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