Hadronic Tau MVA

Christian Kirfel

26th of March

UNIVERSITÄT BONN

Machine learning methods

- Developing a neural network for the lepditau channel
  1. Summarise the preliminary setup
  2. Future goals

- Testing a BDT for the dileptau channel
  1. Preselection
  2. Preliminary results
  3. Next steps

Training specifications

- Training a deep neural network
- Coarse optimisation using an evolutionary neural network
- Fine optimisation doing a grid search
- Optimised hyperparameters:
  - Number of nodes
  - Number of layers
  - Dropout percentage
  - Activation function
  - Weight initialisation
  - Optimiser
- Signal: tHq
- Background: Diboson, Z+jets, ttbar, W+jets, tW, tZq
- Using absolute weights

Features

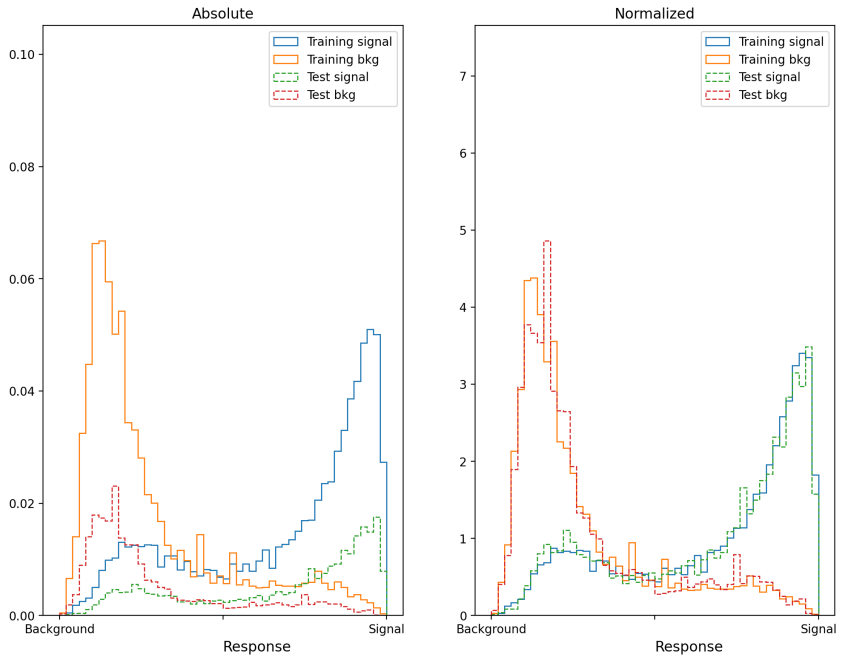
eta_jf	forward jet eta
pt_jf	forward jet transverse momentum
mass_jf	forward jet mass
phi_jf	forward jet phi
eta_b	b-jet eta
pt_b	b-jet transverse momentum
phi_b	b-jet phi
HvisMass	mass of LorentzV sum of hadronic taus
m_met	Missing energy
Reco_w_mass_2	Reconstructed mass of the W case 1
Reco_w_mass_1	Reconstructed mass of the W case 2

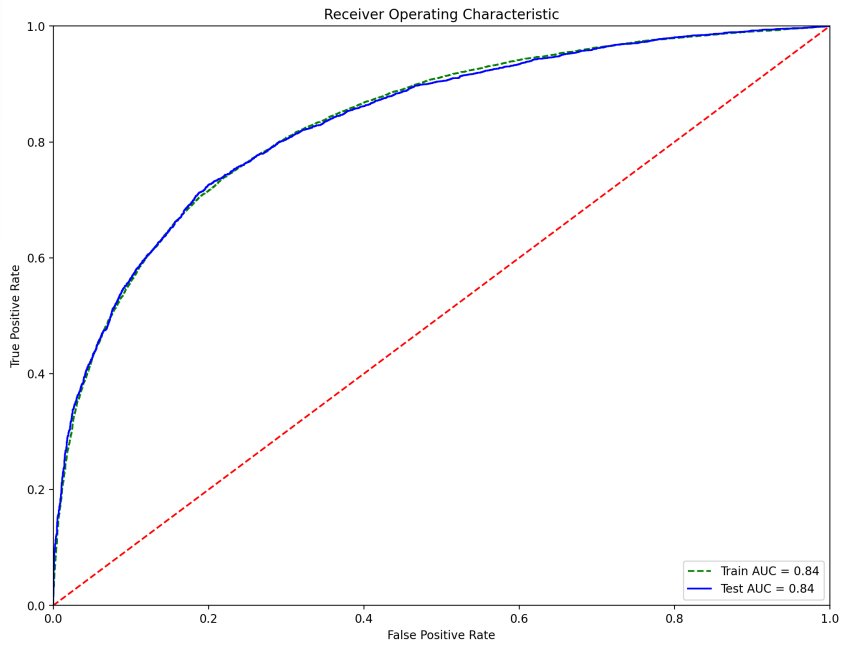
deltaRTau	Delta R of the hadronic taus
deltaPhiTau	Delta phi of the hadronic taus
HvisPt	of LorentzV sum of hadronic taus
HvisEta	of LorentzV sum of hadronic taus
TvisMass	mass of reconstructed top
TvisPt	pt of visible top
TvisEta	eta of visible top
M_b_jf	Mass of LorentV sum of b and jf
HT	Sum of transverse energies
lep_Top_pt	Light lepton pt
lep_Top_eta	Light lepton eta

A first optimisation

Hyperparameter	Setting
Nodes	240
Layers	3
Dropout	0.85
Batchnormalisation	On
Activation	elu
Output activation	sigmoid
Batch size	1000
Optimisation	Adam
Weight Initialisation	Lecun Normalisation

Results





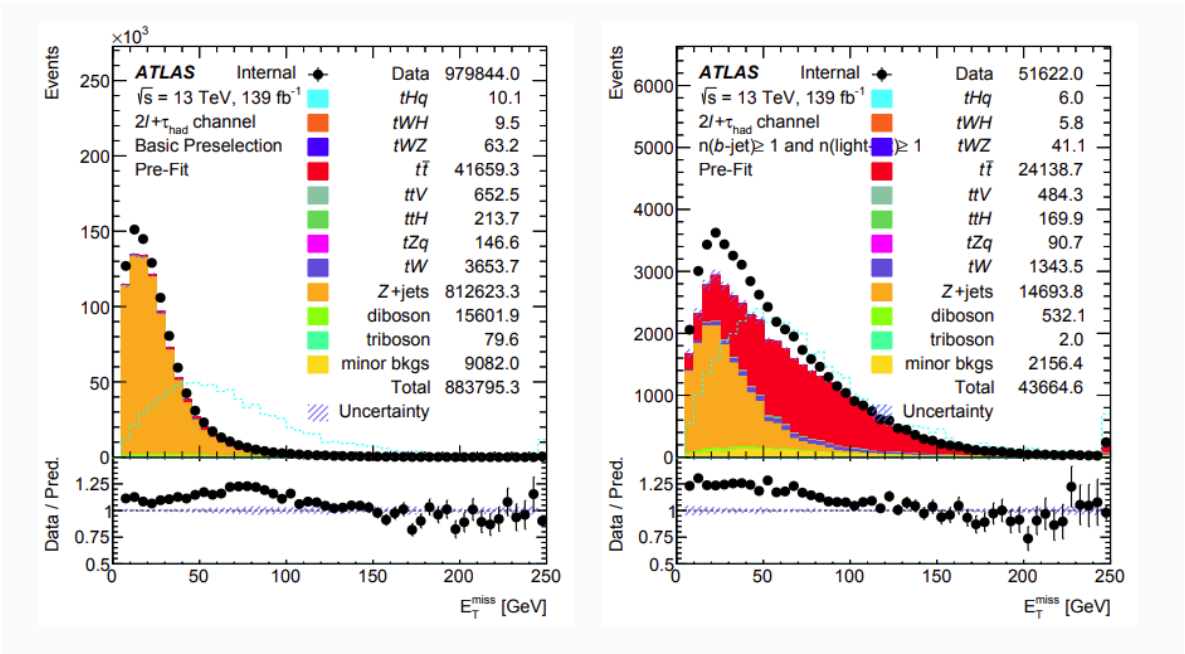
- Really good separation for this early stage of Optimisation
- Slight problems in training and validation agreement

Future steps for the neural network analysis

- Full optimisation of the neural network
- Testing feature ranking and decorrelation
- Investigating the impact of negative weights
- Properly separating smaller backgrounds
- Cosmetic work on the response and output

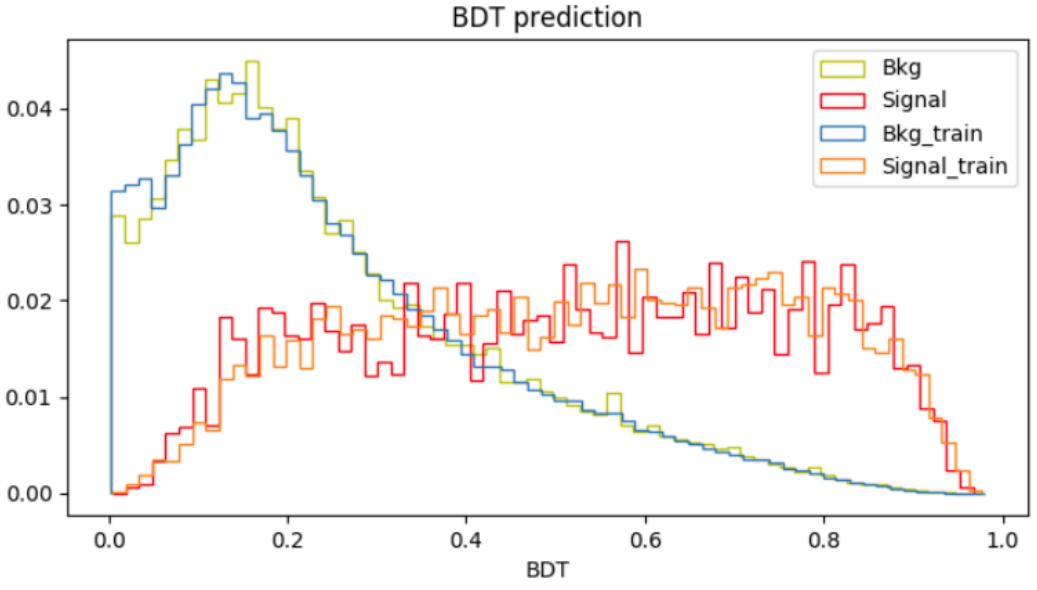
BDT Preselection

- n-jets ≥ 1 and b-jets ≥ 1
- Significantly decreasing the dominant Z+jets background
- Discrepency due to missing tau fake differentiation



BDT early results

- Visible separation
- Good training and test agreement



Plan for BDT development

- BDT hyperparameter tuning
- Including BDT score in the trees
- Cut on the BDT score
- Create a BDT for the CR of the main background
- Study variables related to SS and OS: Usually, SS and OS have different background contributions.
- Get the distributions for forward and central jets separately