Neural Network Regression to Approximate Matrix Element Method Likelihoods

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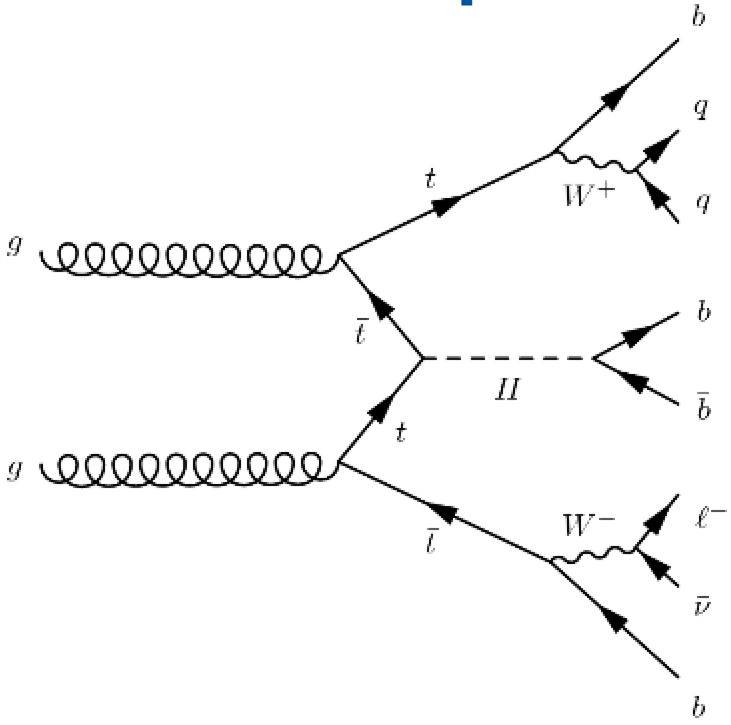
The ttH process

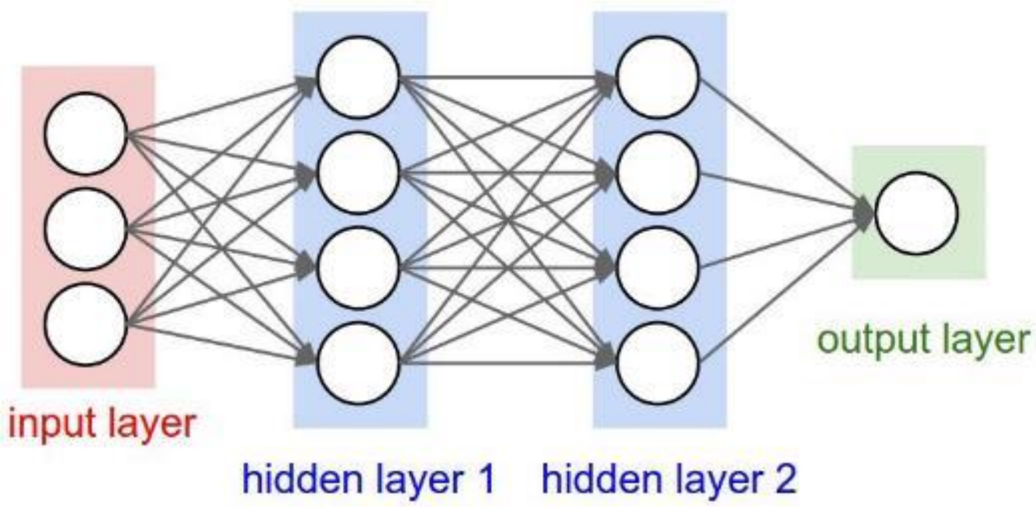


- Directly measure the Higgs-top Yukawa coupling
- Separate the signal from the background with multivariate analysis

Matrix Element Method

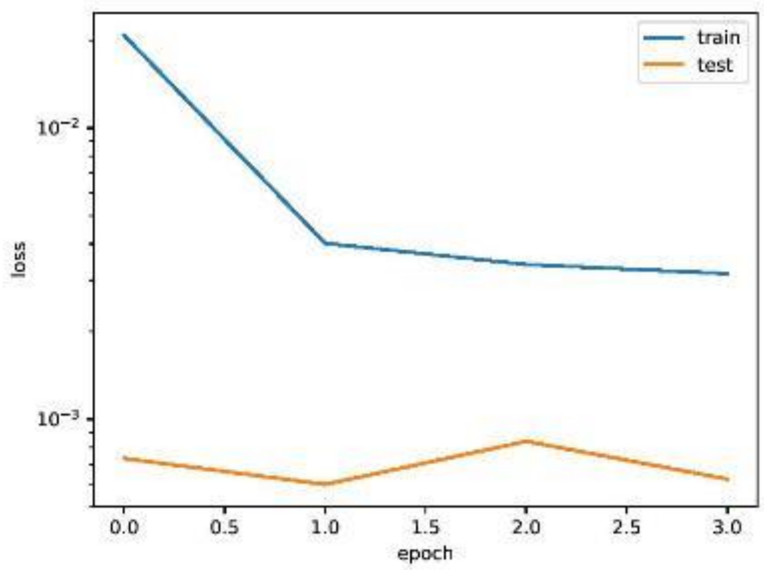
- Powerful method for exploiting theoretical and experimental data for analysis
- ttH process: 8 final state particles for 22 free parameters
- Slow and computationally expensive

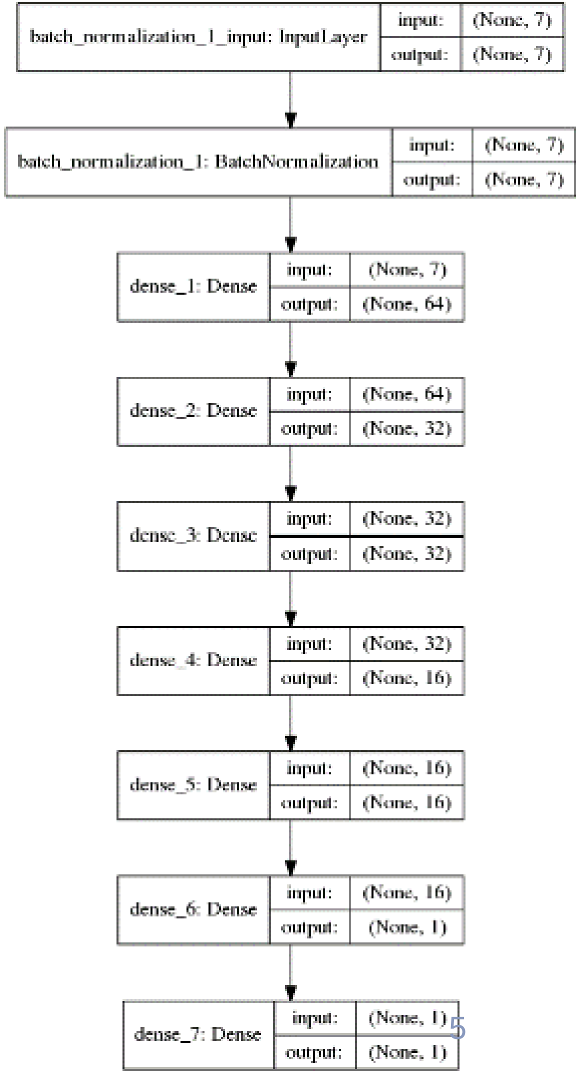
Neural Network



- Possible hyperparameters
  - Training set (size and sampling method)
  - Dropout
  - Number of layers
  - Number of nodes
  - The loss function
  - Number of training batches
  - The activation function
  - Early stopping patience

Training the Network



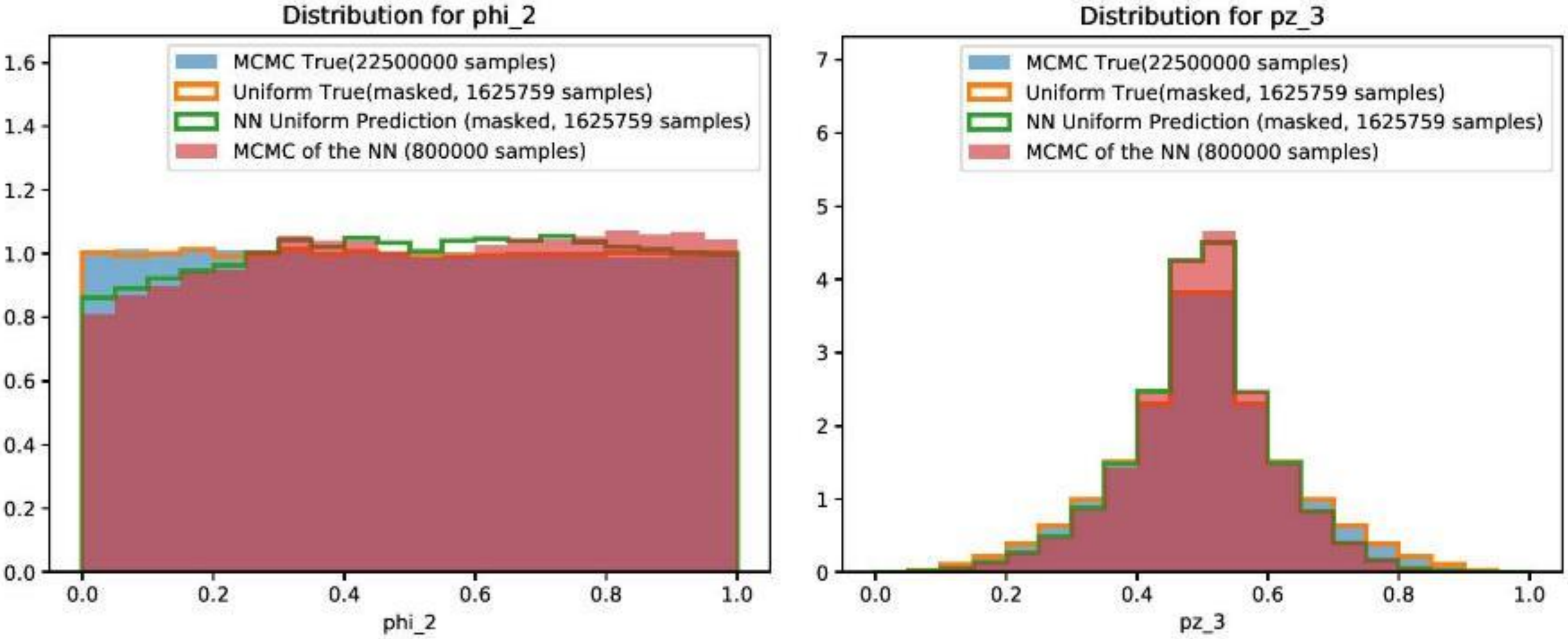


Evaluating the Model

- Plot the 1D normalized distributions over the parameters marginalized over remaining dimensions
- For each dimension, compute sum of the squared errors for the 20 bins

Parameter	Sum of the Squared Errors
|p|_1	0.285491
theta_1	0.572884
phi_1	0.046252
|p|_2	0.606082
theta_2	0.525307
phi_2	0.118454
pz_3	1.17777
Overall Test Statistic	0.476034

Evaluating the Model



What's Next

- Increase accuracy of current networks
- Add probability distribution functions
- Increase particles/parameters
- Incorporate the Matrix Element Method