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Comparative Analysis of Deep Neural Networks and XGBoost for $\gamma\gamma + \tau$ Signal-Background Classification Using Monte Carlo Data at the LHC

In this study, we present a comparative analysis of deep neural networks (DNN) and XGBoost for the classification of $\gamma\gamma$+τ final states to separate rare signal events from background using Monte Carlo data. The dataset is preprocessed to exclude energy-related features and focus on the kinematic variables of the first identified tau lepton (τ_1). A DNN model is a machine learning model that consists of multiple layers of interconnected neurons, which learn from the data to make predictions. Each node uses activation functions like ReLU or sigmoid to help the model capture more complex patterns in the data. On the other hand, XGBoost is a gradient-boosted decision tree algorithm where multiple decision trees are built sequentially, with each tree correcting the errors of the previous one. It applies powerful regularization methods to improve generalization and minimize overfitting. A comprehensive performance evaluation, using accuracy, AUC-ROC, and other relevant metrics, will be conducted to enhance the classification model processes. This study is being carried out to visualize prospects of proposed analysis in the ATLAS experiment.

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Primary author: TRIPATHI, Nidhi (PhD)

Co-authors: Prof. MELLADO, Bruce (University of the Witwatersrand); Mr MAKGETHA, Kutlwano; Dr KUMAR, Mukesh (University of the Witwatersrand); Mr MBUYISWA, Njokweni; Mr KAKANCU, Vuyolwethu

Presenter: TRIPATHI, Nidhi (PhD)

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