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Jet Flavor Tagging Using Graph Neural Networks

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Flavor tagging, the identification of jets originating from b and c quarks, is a critical component of the physics program of the ATLAS experiment at the Large Hadron Collider (LHC). Current flavor tagging algorithms rely on the outputs of "low level" taggers, which focus on particular approaches for identifying the experimental signature of heavy flavor jets. These low level taggers are a mixture of handcrafted algorithms and trained machine learning models.

A new approach currently under development aims to replace this process with a single machine learning model which can be trained end-to-end and does not require inputs from any existing low level taggers, leading to a reduced overall complexity of the model. The model uses a custom Graph Neural Network (GNN) architecture to combine information from a variable number of tracks within a jet in order to simultaneously predict the flavor of the jet, the partitioning of tracks in the jet into vertices, and information about the decay chain which produced tracks in the jet. These auxiliary training tasks are shown to improve performance, but importantly also increase the explainability of the model.

This approach compares favourably with existing state of the art methods, and has the potential to significantly improve performance in cases where the current low level tagging algorithms are not optimally tuned, for example c-jet identification, and flavor tagging at high transverse momentum. Due to significantly reduced need for manual optimisation, application of this method could lead to improved performance with significantly reduced person power. The model is also being investigated for uses extending beyond standard b- and c-tagging applications, for example Xbb tagging, and the reconstruction of displaced decays for LLP searches.

Consider for young scientist forum (Student or postdoc speaker)

Yes

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