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Advancing b-Decay Reconstruction via Probability-Weighted Message Passing in Heterogeneous GNNs

Graph neural networks (GNNs) have become state-of-the-art tools across diverse scientific disciplines due to their ability to model complex relationships in datasets that lack simple spatial or sequential structures. In this talk, we present recent advancements in the deep full event interpretation (DFEI) framework [García Pardiñas, J., et al. Comput. Softw. Big Sci. 7 (2023) 1, 12]. The DFEI framework leverages a novel GNN-based hierarchical reconstruction of b-hadron decays within the hadronic collision environment of the LHCb experiment. We will discuss significant performance improvements achieved through a novel end-to-end node and edge pruning GNN architecture that employs a novel probability-weighted message passing to exploit the intrinsic structure of decay graphs. Finally, we introduce a more flexible heterogeneous GNN approach with multi-task learning that not only enhances reconstruction performance but also supports additional critical tasks simultaneously, such as precisely associating reconstructed b-hadrons with their corresponding primary vertices.

AI keywords

Graph Neural Network, Heterogeneous GNN, Multi-task learning, Message passing

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Track Classification: Patterns & Anomalies