Contribution ID: **709** Type: **Parallel**

Dataset-wide Graph Neural Networks for BSM Searches at the LHC

We present a new application of Graph Neural Networks (GNNs) for LHC searches that aims to improve event classification by representing entire datasets as graphs, with events as nodes and kinematically similar events connected by edges. The strategy builds from our development of graph convolutions and graph attention mechanisms, where we apply scalable solutions for training various GNN models on large graphs with robust background validation. By merit of the search style and graph design, the GNN obtains extensive information from topological network structures such as clusters, helping to distinguish signal from background through their distinct characteristic connectivity. This work extends our previous proof of concept for dataset-wide graphs in BSM searches [JHEP 2021, 160 (2021)], which demonstrates a promising baseline of signal-background separation. Since our recent extension to include GNNs, we confirm further sensitivity improvements with a leptoquark BSM benchmark beyond a conventional DNN approach. In addition, we present a second result extending the method to anomaly detection, exploiting the new format of a dataset-wide GNN in an example unsupervised search, calculating the event-by-event anomaly score.

Secondary track

T16 - AI for HEP (special topic 2025)

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