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Particle Tracking with Graph Neural Networks

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Each proton-proton collision event at the LHC produces a myriad of particles and interactions that are recorded by specialized detectors. Trackers are designed to sample the trajectories of these particles at multiple space-points; tracking is the connecting-the-dots process of linking these signals (hits) to reconstruct particle trajectories (tracks). Tracker data is naturally represented as a graph by assigning hits to nodes and edges to hypothesized particle trajectories. Several studies show that edge-classifying graph neural networks (GNNs) can be used to reject unphysical edges from the graph, yielding a set of disjoint subgraphs corresponding to individual tracks. In this work, we present an extension of this approach using object condensation, a set of truth definitions and loss functions designed to cluster hits belonging to the same particle and, subsequently, predict the properties of each cluster. Specifically, we apply a message-passing GNN to perform edge-classification, leverage edge-classification results to cluster tracker hits, and predict the kinematic features of the tracks formed by each hit cluster. Key results will be shown at each stage of this pipeline, including graph construction, edge classification performance, clustering performance, noise rejection, and track property prediction.

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