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Graph Network in High Energy Physics

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Collisions at the CERN Large Hadron Collider (LHC) produce showers of particles that are detected by heterogenous detectors composed of hundreds of millions of individual sensors, laid out under complex geometry. An event can be seen as a tree of detectable particles branching from the unstable particles (e.g., the Higgs boson) produced in the collisions. Once detected, events are collected as arrays of isolated hits, which are then collectively processed to reconstruct the trajectory and energy of the particles that created them. In this contribution, we describe how the reconstruction and identification of these particles can be performed using graph networks. Given their capability of learning sparse representations, graph networks are ideal tools to create a fixed-geometry representation of an event, abstracting from the irregular geometry of the detectors used at colliders. As a first processing step of raw data, they provide an interface between particle detection and more rigid deep learning techniques, e.g., convolutional neural networks. In this respect, they represent a step forward to realistic deep learning applications for collider physics. As examples, we consider the task of reconstructing the trajectory of charged particles bending in the magnetic field of the detectors (tracking), denoising from parasitic collision (pile-up mitigation) and the identification of heavy particles (e.g., Higgs bosons) from the spray of particles that they produce (jets), where state-of-the-art performances are achieved.

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