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Similarity Hashing and Learning for Tracks Reconstruction

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At the High Luminosity Large Hadron Collider (HL-LHC), many
proton-proton collisions happen during a single bunch crossing. This leads on average to tens of thousands of particles emerging from the interaction region. Two major factors impede finding charged particle trajectories from measured hits in the tracking detectors. First, deciding whether a given set of hits was produced by a common particle is an under-specified task. State-of-the-art reconstruction models usually tackle this issue via so-called track following only at a later stage after considering many hits. Second, assuming a nearly perfect hit-particle decision function, constructing possible hit combinations to their compatibility using this decision function is a combinatorial problem. Thus, the traditional approach will grow exponentially as the number of simultaneous collisions increase at the HL-LHC and pose a major computational challenge.

We propose a framework for Similarity Hashing and Learning for Track Reconstruction (SHLTR) where multiple small regions of the detector are reconstructed in parallel with minimal fake rate. We use hashing techniques to separate the detector search space into buckets. The particle purity of these buckets, i.e. how many hits from the same particle are contained, is increased using locality sensitivity in feature space where per-hit features beyond just its position are considered. The bucket size is sufficiently small to significantly reduce the complexity of track reconstruction within the buckets or regions.

A neural network selects valid combinations in the buckets and builds up full trajectories by connected components search independently of global positions of the hits and detector geometry. The whole process occurs simultaneously in the multiple regions of the detector and curved particles are found by allowing buckets to overlap. We present first results of such a track reconstruction chain including efficiency, fake estimates, and computational performances in μ=200 datasets.

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