Contribution ID: **95** Type: **Talk**

Tracks Reconstruction with Similarity Hashing and Learning

Wednesday 3 April 2019 13:00 (25 minutes)

At the LHC, many proton-proton collisions are happening at a single beam crossing which leads to thousands of particles emerging from the interaction region and vast amount of data to be analyzed by the reconstruction software.

The finding of trajectories from charged particles in the tracking devices is a particularly challenging task due to two main factors. Firstly, deciding whether a given set of hits belong to the same trajectory is an under-specified task and state of the art models discard combinations only at a later stage when adding more hits (track following). Secondly, assuming a nearly perfect decision function, the construction of combinatorics to check hits compatibility using this decision function is computationally intensive and will grow exponentially in the HL-LHC.

We propose a framework for Similarity Hashing and Learning for Tracks Reconstruction (SHLTR) where multiple regions of the detector are reconstructed in parallel with minimal fake rate. We consider hashing to reduce the detector search space into “buckets” where the purity of the sub-regions is increased using locality sensitivity in the feature space. A neural network selects the 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 N regions of the detector and curved particles are found by allowing buckets overlap.
The framework succeeds in addressing the two main tracking challenges : decision making and computation scale in mu 200 datasets. We present first results of such a track reconstruction chain including efficiency, fake estimates and computational performances.

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Track Classification: 1: Machine learning, algorithms and theoretical analysis