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Machine Learning approaches to Track Reconstruction in the Upgraded LHCb VELO

The LHC Run-III, scheduled to start taking data in 2021, will pose new challenges to event reconstruction as experiments are forced to move to more sophisticated software-based event filters to exploit the physics potential offered by the upgraded accelerator.

In particular, the LHCb experiment will install a new Vertex Locator (VELO), moving to pixel sensors with a trigger-less readout. The particle tracks and decay vertices provided by the upgraded VELO comprise a large fraction of the background suppression power of the LHCb software event filter. It has become clear that the speed of conventional approaches to track and vertex reconstruction would limit the physics potential of the upgraded LHCb experiment. Exploring novel approaches is therefore necessary.

Recent developments in Deep Learning and parallel processing enable radically new approaches to event reconstruction. We have explored a number of approaches to track reconstruction using various machine learning techniques: layer-to-layer connection FCNN classifiers, graph neural networks and so on. The input data for all approaches is fully simulated minimum bias data, ie. we do not use toy models. We always compare the performance in terms of reconstruction quality to conventional algorithms using the criteria agreed on by the LHCb collaboration. The very promising results obtained so far as well as ideas for further improvements will be presented.

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Track Classification: 2: Real-time pattern recognition, fast tracking and performance evaluation