Contribution ID: **23** Type: **not specified**

Simulating the LHCb detector with Generative Adversarial Networks

Thursday, 27 May 2021 12:10 (20 minutes)

During Run 2, the simulation of physics events at LHCb has taken about 80% of the distributed computing resources available to the experiment, with the majority of the computational cost (~90%) spent by Geant4. In Run 3, the upgraded detector will rely on a fully software trigger system, which will be able to provide datasets at least one order of magnitude larger. In order to match the increase of collected data, larger simulated samples and a strategy to speed-up their production will be an unavoidable evolution of the LHCb Computing Model. Replacing the detailed simulation of the radiation-matter interactions occurring within the detectors with a parametrization of the detector response may drastically reduce the cost of large simulated samples. Ultra-Fast Simulation needs lower computing resources, replacing Geant4 with (non)parametric models predicting directly the high-level response of the detector. Machine Learning techniques, and in particular Generative Adversarial Networks (GANs), have proved to be a promising class of Deep Learning algorithms to model the response of the Tracking, RICH, Calorimeter and Muon systems at LHCb. GANs rely on the simultaneous training of two deep neural networks and on a heavy hyperparameters tuning to obtain good models that can't be carried out without the concurrent usage of multiple GPUs. We discuss the current state of these developments and the application of INFN Cloud to achieve a significant speed-up of the training phase.

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Session Classification: Tecnologie ICT

Track Classification: Tecnologie ICT (Harware e Software)