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Generative Adversarial Networks for fast simulation: generalisation and distributed training in HPC

Monday 21 October 2019 16:30 (20 minutes)

Deep Learning techniques have are being studied for different applications by the HEP community: in this talk, we discuss the case of detector simulation. The need for simulated events, expected in the future for LHC experiments and their High Luminosity upgrades, is increasing dramatically and requires new fast simulation solutions. We will describe an R&D activity within CERN openlab, aimed at providing a configurable tool capable of training a neural network to reproduce the detector response and replace standard Monte Carlo simulation. This represents a generic approach in the sense that such a network could be designed and trained to simulate any kind of detector in just a small fraction of time. We will present the first application of three-dimensional convolutional Generative Adversarial Networks to the simulation of high granularity electromagnetic calorimeters. We will describe detailed validation studies comparing our results to Geant4 Monte Carlo simulation, showing, in particular, the very good agreement we obtain for high level physics quantities (such as energy shower shapes) and detailed calorimeter response (single cell response). Finally we will show how this tool can easily be generalized to describe a larger class of calorimeters, opening the way to a generic machine learning based fast simulation approach. To achieve generalization we will leverage advanced optimization algorithms (using Bayesian and/or Genetic approach) and apply state of the art data parallel strategies to distribute the training process across multiple nodes in HPC and Cloud environment. Performance of the parallelization of GAN training on HPC clusters will also be discussed in details.

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