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Conditional Wasserstein GANs for fast simulation of electromagnetic showers in a CMS HGCAL prototype

The increased instantaneous luminosity at HL-LHC will raise the computing requirements for event reconstruction and analysis for current LHC-based experiments, hence limiting the available resources for the simulation of particles traversing matter. Developments of the performance of state-of-the-art simulation frameworks such as Geant4 are proceeding but are unlikely to fully compensate for this trend.
Generative adversarial neural networks (GANs) have already been shown to provide promising fast simulation models which would speed up the computation time by multiple orders of magnitude. Instead of assuming a simplified calorimeter, we have studied the generation of electron-induced showers in a current prototype of the CMS High Granularity Calorimeter (HGCAL) upgrade project. This prototype calorimeter is made of seven 6-inch and 128-channels hexagonal silicon pad sensors interspersed with absorbers. The setup already includes many of the features required for the challenging HGCAL upgrade.
Our generative model is trained adapting the concept of the Wasserstein distance. Furthermore, conditioning on the binned energy of the incident electrons and on their continuously distributed impact position is integrated implementing two auxiliary regression networks which provide additional terms to the loss function.
In this talk, we present the status of our study. In particular, we show the chosen network architectures, demonstrate the training procedure with the Wasserstein loss and the successful inclusion of the physical constraints. Finally, we provide comparisons of high level observables between simulations obtained with Geant4 and with our generative model.

Intended contribution length

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