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CaloClouds III: Ultra-Fast Geometry-Independent Highly-Granular Calorimeter Simulation

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Ever-increasing collision rates place significant computational stress on the simulation of future experiments in high energy physics. Generative machine learning (ML) models have been found to speed up and augment the most computationally intensive part of the traditional simulation chain: the calorimeter simulation. Many previous studies relied on fixed grid-like data representation of electromagnetic showers, which leads to artifacts when applied to highly granular calorimeters due to the aperiodic tiling of cells in realistic detector geometry. With this contribution, we present CaloClouds III, an updated version of the novel point cloud diffusion model, CaloClouds II. This new version features a simplified architecture that further accelerates inference time, along with added angular conditioning, allowing integration into the simulation pipeline. The model was tested in a realistic DD4hep based simulation model of the ILD detector concept for a future Higgs factory. This is done with the DDFastShowerML library which has been developed to allow for easy integration of generative fast simulation models into any DD4hep based detector model. With this it is possible to benchmark the performance of a generative ML model using fully reconstructed physics events by comparing them against the same events simulated with Geant4, thereby ultimately judging the fitness of the model for application in an experiment's Monte Carlo.

Track

Detector simulation & event generation

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