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# Generative Models for Fast Electromagnetic and Hadronic Shower Simulation

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Detector simulation is a key cornerstone of modern high energy physics. Traditional simulation tools are reliant upon Monte Carlo methods, which consume significant computational resources and are projected to be a major bottleneck at the high luminosity stage of the LHC and for future colliders. Calorimeter shower simulation has been a focus of fast simulation efforts, as it is particularly intensive from a computational standpoint due to a large number of particle interactions with the detector material. Deep generative models hold promise as a potential solution, offering drastic reductions in compute times.

This contribution presents progress towards accurate simulation of particle showers in highly granular calorimeters in two directions. Firstly, initial progress on accurately simulating hadronic showers using a Wasserstein-GAN (WGAN) and a Bounded Information Bottleneck Autoencoder (BIB-AE) is demonstrated. The degree of fidelity achieved is compared before and after interfacing with a state-of-the-art pattern recognition algorithm - the Pandora Particle Flow Algorithm. Secondly, an ongoing study that seeks to extend the success of previous work, which demonstrated accurate simulation of electromagnetic showers, is presented. While the prior work focused on the specific case of a particle incident perpendicular to the calorimeter face, this study aims to additionally condition on the incident angle of the particle.

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