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Fast and Accurate Electromagnetic and Hadronic Showers from Generative Models

One of the largest strains on computational resources in the field of high energy physics are Monte Carlo simulations. Given that this already high computational cost is expected to increase in the high-precision era of the LHC and at future colliders, fast surrogate simulators are urgently needed. Generative machine learning models offer a promising way to provide such a fast simulation by efficiently amplifying the statistics of classical Monte Carlo generators.

This contribution presents our work on simulating particle showers in high granularity calorimeters for future colliders. Building on prior work using Generative Adversarial Networks (GANs), Wasserstein-GANs, and the information-theoretically motivated Bounded Information Bottleneck Autoencoder (BIB-AE), for the simulation of electromagnetic showers, we further improve our methodology in two meaningful ways:
I.) We add conditioning on the angle of the incoming particle, allowing us to greatly increase our coverage.
II.) We make improvements that allow for the simulation of hadronic showers,
a feat significantly more challenging than the thus far achieved simulation of electromagnetic showers. One key to this improvement is a detailed understanding and optimization of the latent spaces of our generative models.

We present promising results of accurately simulated hadronic showers in a highly granular scintillator calorimeter with a significant speedup compared to classical simulations.

Significance

In this work we present previously unpublished results for both the angular conditioning and the hadronic shower simulation. On both these fronts show significant improvements in accuracy that go far beyond our previous publications.

References

Previous paper on photon shower simulation:
https://link.springer.com/article/10.1007%2Fs41781-021-00056-0

Previous presentations:
https://simdl.github.io/posters/31-supp_ICLR2021_eren.pdf
https://indico.cern.ch/event/948465/contributions/4323713/

Speaker time zone

Compatible with Europe

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