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CaloDiT and CaloDiM: Fast, Accurate and Adaptable Generative Models for Calorimeter Shower Simulation

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The need for fast calorimeter shower simulation tools has spurred the development of numerous surrogate approaches based on deep generative models. While these models offer significant reductions in compute times with respect to traditional Monte Carlo methods, their development consumes significant amounts of time, manpower and computing resources.

In order to reduce the time to design a model for a new detector geometry, we present two generative models. The first, CaloDiT, is a transformer-based diffusion model, while the second, CaloDiM, is a diffusion model based around mixers. We leverage a foundation model approach, whereby information gained by training a model across multiple detector geometries is used to accelerate the adaptation of the model to a new, unseen geometry. We will demonstrate the robust generalisation capabilities of the model, which can achieve competitive physics performance while requiring substantially less training time and data than training from scratch. We will also describe how the model can be used from an example directly in the Geant4 simulation toolkit, as well as for DD4hep geometries in the Key4hep framework via the DDFastShowerML library.

Significance

This presentation will describe the development of adaptable generative models for fast calorimeter shower simulation. We demonstrate that these can be trained on large datasets, consisting of numerous different detector geometries, and then fine-tuned quickly on a new unseen detector geometry. This approach would therefore reduce the time, manpower and computing resources required to develop a fast simulation model for a new application

References

Experiment context, if any

Generic R&D

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