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Conditional Deep Generative Models for Simultaneous Simulation and Reconstruction of Entire Events

We extend the Particle-flow Neural Assisted Simulations (*Parnassus*) framework of fast simulation and reconstruction to entire collider events. In particular, we use two generative Artificial Intelligence (genAI) tools, conditional flow matching and diffusion models, to create a set of reconstructed particle-flow objects conditioned on hadrons from CMS Open Simulations. While previous work focused on jets, our updated methods now can accommodate all particle-flow objects in an event along with particle-level attributes like particle type and production vertex coordinates. This approach is fully automated, entirely written in Python, and GPU-compatible. Using a variety of physics processes at the LHC, we show that the extended *Parnassus* is able to generalize beyond the training dataset and outperforms the standard, public tool *Delphes*.

AI keywords

transformers;flow matching;flow;diffusion;generative models

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