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

Tuesday 8 July 2025 09:50 (20 minutes)

We present an extension of the Particle-flow Neural Assisted Simulations (*Parnassus*) framework to enable fast simulation and reconstruction of full collider events. Specifically, we employ two generative AI (genAI) approaches—conditional flow matching and diffusion models—to generate reconstructed particle-flow objects conditioned on stable truth-level particles from CMS Open Simulations. While previous iterations focused on individual jets, our enhanced methods now support all particle-flow objects in an event, incorporating particle-level features such as type and production vertex coordinates. The framework is fully automated, implemented in Python, and optimized for GPU execution. Evaluations across various LHC physics processes demonstrate that the extended *Parnassus* generalizes beyond its training data and surpasses the performance of the widely used *Delphes* tool.

Secondary track

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