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Higher Resolution and Angular Conditioning for Normalizing-Flow-based Generation of Calorimeter Showers

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Monte Carlo (MC) simulations are crucial for collider experiments, enabling the comparison of experimental data with theoretical predictions. However, these simulations are computationally demanding, and future developments, like increased event rates, are expected to surpass available computational resources. Generative modeling can substantially cut computing costs by augmenting MC simulations, thereby addressing this issue.

To this end, we presented ConvL2LFlows, a convolutional-flow-based generative model, at last year's ML4Jets. This year, we present several improvements to this model, making it usable in realistic simulations. These improvements are: i) adding angular conditioning to generate showers with arbitrary incident angels ii) using nine times more bins than calorimeter readout-cells to be able to use the model for arbitrary incident points, and iii) integrating L2LFlows into the full simulation pipeline using DDFastShowerML.

We will systematically compare ConvL2LFlows with nine times higher resolution, ConvL2LFlows with cell-level granularity, and a point-cloud-based generative model named CaloClouds II. While fixed grid models like ConvL2LFlows represent showers as three-dimensional arrays, point cloud models represent them as unordered sets of points. Our comparison will highlight the advantages and disadvantages in a realistic setting.

Track

Detector simulation & event generation

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