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CaloMan: Fast generation of calorimeter showers with density estimation on learned manifolds

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The efficient simulation of particle propagation and interaction within the detectors of the Large Hadron Collider (LHC) is of primary importance for precision measurements and new physics searches. The most computationally expensive simulations involve calorimeter showers, which will become ever more costly and high-dimensional as the Large Hadron Collider moves into its High Luminosity era. The computational costs can be heavily reduced by replacing (parts of) the simulation pipeline with generative networks. We thus propose to model calorimeter showers, first by learning a lower-dimensional manifold structure with an auto-encoder, and to then perform density estimation on this manifold with a normalising flow. Our approach, lies on the notion that the seemingly high-dimensional data of HEP experiments, actually has a much lower intrinsic dimensionality. In machine learning, this is known as the manifold hypothesis, which states that high-dimensional data is supported on low-dimensional manifolds. By reducing the dimensionality of the data we enable fast training and generation without compromising accuracy.

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