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Pay Attention to Mean Fields for Point Cloud Generation

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The generation of collider data using machine learning has emerged as a prominent research topic in particle physics due to the increasing computational challenges associated with traditional Monte Carlo simulation methods, particularly for future colliders with higher luminosity. The representation of collider data as particle clouds brings favourable benefits. The underlying physics provides knowledge about many complex correlations present in particle clouds. Since these can be calculated analytically they are used to test whether a generative model accurately approximates and samples the underlying probability density, which is itself a challenging task to solve. Additionally, variable particle cloud sizes further exacerbate these difficulties, necessitating more sophisticated models. In this work, we propose a novel model that utilizes an attention-based aggregation mechanism to address these challenges. The model is trained in an adversarial training paradigm, ensuring that both the generator and critic exhibit permutation equivariance/invariance with respect to their input. A novel feature matching loss in the critic is introduced to stabilize the training. The proposed model performs competitively to the state-of-art on the \textsc{JetNet150} dataset whilst having significantly fewer parameters than other state-of-art models. The model is then also applied to the CaloChallenge datasets and the results are discussed.

Brainstorming idea [title]

The importance of point clouds for calorimeter simulation

Brainstorming idea [abstract]

Point clouds provide a natural representation of high-energy physics data, as they yield desirable properties such as permutation invariance and treatment of sparse data. However, most models proposed for calorimeter simulation have been working on fix-structure voxels on simplified detectors. Point clouds become especially efficient as the detector has a finer granularity, however they also bring the problem of duplicated hits per cell when mapping back to calorimeter cells, for which no general treatment has been found.

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