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Generative Models for Fast Cluster Simulations in the TPC for the ALICE Experiment

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Simulating detector response for the Monte Carlo-generated collisions is a key component of every high-energy physics experiment. The methods used currently for this purpose provide high-fidelity results, but their precision comes at a price of high computational cost. In this work, we present a proof-of-concept solution for simulating the responses of detector clusters to particle collisions, using the real-life example of the TPC detector in the ALICE experiment at CERN. An essential component of the proposed solution is a generative model that allows to simulate synthetic data points that bear high similarity to the real data. Leveraging recent advancements in machine learning, we propose to use state-of-the-art generative models, namely Variational Autoencoders (VAE) and Generative Adversarial Networks (GAN), that prove their usefulness and efficiency in the context of computer vision and image processing.
The main advantage offered by those methods is a significant speed up in the execution time, reaching up to the factor of 103 with respect to the Geant 3. Nevertheless, this computational speedup comes at a price of a lower simulation quality and in this work we show quantitative and qualitative proofs of those limitations of generative models. We also propose further steps that will allow to improve the quality of the models and lead to their deployment in production environment of the TPC detector.

Intended contribution length

30 minutes

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