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Fast calorimeter simulation with VQVAE

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Simulation of calorimeter response is important for modern high energy physics experiments. With the increasingly large and high granularity design of calorimeters, the computational cost of conventional MC-based simulation of each particle-material interaction is becoming a major bottleneck. We propose a new generative model based on a Vector-Quantized Variational Autoencoder (VQ-VAE) to generate the calorimeter response. This model achieved a speedup of more than 5x10ˆ4 times over GEANT4 on the CaloGAN dataset and the comparable performance of energy deposition and shower shape as existing ML-models such as CaloGAN and CaloFlow, with substantially fewer parameters and factor of 2 more speedup. We also demonstrate that the VQVAE approach can be adapted to a variety of encoder/decoder architectures, ranging from fully-connected to convolutional networks. The former is more suited to smaller, or irregular geometries, while the latter can perform well on very high granularity datasets with regular structure.

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