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Physics Validation of Novel Convolutional 2D Architectures for Speeding Up High Energy Physics Simulations

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The precise simulation of particle transport through detectors is a key element for the successful interpretation of high energy physics results.
However, Monte Carlo based simulation is extremely demanding in terms of computing resources. This challenge motivates investigations of faster, alternative approaches for replacing the standard Monte Carlo approach.

We apply Generative Adversarial Networks, a deep learning technique, to replace the calorimeter detector simulations and speeding up the simulation time by orders of magnitude. We follow a previous approach which used three-dimensional convolutional neural networks and develop new two-dimensional convolutional networks to solve the same image generation problem faster. Additionally, we increased the number of parameters, and the neural networks representational power, obtaining a higher accuracy. We compare our best convolutional 2D neural network architecture and evaluate it versus the previous 3D architecture and Geant4 data. Our results demonstrate a high physics accuracy and further consolidate the use of generative adversarial networks for fast detector simulations.

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