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Generative Adversarial Networks for Fast Simulation in ATLAS

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Accurate simulations of a showers from particles from the Large Hadron Collider in the ATLAS calorimeter are incredibly resource intensive, consuming the largest fraction of CPU time on the CERN computing grid. Generative Adversarial Networks, where one Generative Network is trained to fool two Adversarial Networks are investigated as a scalable solution for modelling the response of the electromagnetic calorimeter for photons over a range of energies. Steps have been taken to inject detailed knowledge about the detector geometry as well as physics metrics of importance into the training procedure of the network. The synthesised showers show good agreement to showers from a computationally expensive full detector simulation using Geant4. They also show good agreement on several new complex physics variable distributions that are only possible to study after integrating the trained generative model into the ATLAS software. Timing studies indicate at least three orders of magnitude improvement in speed when showers are generated in serial on a CPU. For the first time, the integration into the ATLAS software allows a fair comparison with more traditional fast simulation techniques developed by a team of physicists over the past years in ATLAS. This study demonstrates the potential of using such deep learning algorithms as a scalable solution for fast detector simulation in the future.

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Classification de thématique: ML for simulation and surrogate model : Application of Machine Learning to simulation or other cases where it is deemed to replace an existing complex model