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Meta-learning for fast simulation of multiple calorimeter responses

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In LHC experiments, the calorimeter is a key detector technology to measure the energy of particles. These particles interact electromagnetically and/or hadronically with the material of the calorimeter, creating cascades of secondary particles or showers. Describing the showering process relies on simulation methods that precisely describe all particle interactions with matter. Constrained by the need for precision, the simulation is inherently slow and constitutes a bottleneck for physics analysis. Furthermore, with the upcoming high luminosity upgrade of the LHC with more complex events and a much increased trigger rate, the amount of required simulated events will increase. Several research directions investigated the use of Machine Learning based models to accelerate particular calorimeter response simulation. This results in a specifically tuned simulation and generally these models require a large amount of data for training. Meta learning has emerged recently as fast learning algorithm using small training datasets. In this work, we use a meta-learning model that "learns to learn"to generate showers using a first-order gradient based algorithm. This model is trained on multiple calorimeter geometries and can rapidly adapt to a new geometry using few training samples.

Orateur: SALAMANI, Dalila (CERN)

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