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Reconstruction of electromagnetic showers in calorimeters using Deep Learning

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Machine Learning (ML) algorithms are currently a leading choice for Data Analysis applications in various fields: from industry to science and medicine. Following the general trend, different ML methods (Boosted Decision Trees, Neural Networks) have already been successfully used for data reconstruction and analysis in the CMS experiment. More sophisticated algorithms are becoming available, which may bring advantages to the reconstruction techniques using more and more low-level information.

In this talk, I will describe the application of the state-of-the-art neural network architecture for data reconstruction in the electromagnetic calorimeter (ECAL) of CMS. While traversing the ECAL, electrons and photons will leave energy deposits in the crystals of the calorimeter. These deposits have to be combined together to form a cluster, from which the energy and impact position of the initial particle can be reconstructed. Currently, a traditional algorithm (based on Gaussian-mixture model) is used for this task.

We are developing a new model based on the convolutional neural network and graph neural network for the reconstruction in ECAL. The network results show significant improvement both in energy and coordinate resolution for photons in comparison with the traditional algorithm. Moreover, one of the main advantages of the network is the ability to distinguish between multiple close-by clusters. This plays a crucial role in discriminating between high-energy pions (pi0-> gg, creating two overlapping clusters in the ECAL) and standalone photons.

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