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# Point Cloud Deep Learning Methods for Pion Reconstruction in the ATLAS Experiment

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The reconstruction and calibration of hadronic final states in the ATLAS detector present complex experimental challenges. For isolated pions in particular, classifying $\pi^0$ versus $\pi^\pm$ and calibrating pion energy deposits in the ATLAS calorimeters are key steps in the hadronic reconstruction process. The baseline methods for local hadronic calibration were optimized early in the lifetime of the ATLAS experiment. Here we present a significant improvement over existing techniques using machine learning methods that do not require the input variables to be projected onto a fixed and regular grid. Instead, Transformer, Deep Sets, and Graph Neural Network architectures are used to process calorimeter clusters and particle tracks as point clouds, or a collection of data points representing a three-dimensional object in space. We demonstrate the performance of these new approaches as an important step towards a low-level hadronic reconstruction scheme that fully takes advantage of deep learning to improve its performance.

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