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Point-Cloud Machine Learning for Detector Data Integration in ATLAS at the LHC

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Large-scale scientific experiments increasingly depend on trustworthy data infrastructures and AI-driven workflows to extract reliable insights from complex sensor systems. In the ATLAS experiment at CERN's LHC, each collision generates heterogeneous information across multiple subdetectors, making the accurate integration of these data streams essential for ensuring reconstruction quality and downstream scientific validity.

A key challenge is the association of particle trajectories from the tracking system with corresponding energy deposits in the calorimeter. Traditional rule-based methods perform this step sequentially and rely on handcrafted, physics-based criteria, which can struggle in high-density or rare events and do not fully exploit the complementary nature of the underlying data.

We explore a machine learning approach that treats detector hits as point clouds and learns associations directly from spatial and contextual patterns. The talk will highlight the practical training considerations and challenges encountered, including data representation choices, training strategies and performance metrics. In this way, we aim at offering insights relevant for developing trustworthy AI methods in large-scale scientific applications.

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