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Optimising geometric deep learning methods for particle detection challenges in high energy physics experiments.

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Particle physics experiments like CMS (Compact Muon Solenoid) at the LHC and Super-Kamiokande let us probe the fundamental laws of physics by observing the interaction of high energy particles with various detectors. These particles leave their signatures in different sensors composing these detectors and a host of sophisticated algorithms are employed to reconstruct these particles by disentangle the signatures from different particles and properly identifying the important signatures from noise. Reconstruction is an important problem since the quality of the algorithms directly affect the precision of physics results and the future detectors will pose a bigger challenge with increased particle multiplicity and novel detector designs. Machine learning algorithms show a lot of promise for dealing with such challenges and geometric deep learning has emerged as an interesting solution, where detector sensor outputs are viewed as point clouds and Graph Neural Networks are utilised for learning patterns inside these point clouds. Furthermore another critical aspect of these experiments is that interesting phenomena occur rarely and specialised algorithms perform lightweight reconstruction using limited timing and computing resources to decide if the phenomenon should be recorded or not (known as triggering). Inefficiencies in these algorithms lead to inefficient usage of computing resources and loss of important physics phenomenon. This presentation will introduce a few challenging aspects of particle reconstruction in experiments like CMS, and discuss a GNN based pipeline to perform efficient reconstruction under these constraints. The presented pipeline has been designed for resource constrained environments and performs at least better in complexity than standard graph based models, based on the known geometry of the data.

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