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A Multipurpose Graph Neural Network for Reconstruction in LArTPC Detectors

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The Exa.TrkX Graph Neural Network (GNN) for reconstruction of liquid argon time projection chamber (LArTPC) data is a message-passing attention network over a heterogeneous graph structure, with separate subgraphs of 2D nodes (hits in each plane) connected across planes via 3D nodes (space points). The model provides a consistent description of the neutrino interaction across all planes.

The GNN initially performed a semantic segmentation task, classifying detector hits according to the particle type that produced them. Performance results will be presented based on publicly available samples from MicroBooNE. These include both physics performance metrics, achieving ˜95% accuracy when integrated over all particle classes, and computational metrics for training and for inference on CPU or GPU.

We will also present recent work extending the network application to additional LArTPC reconstruction tasks, such as cosmic background and noise filtering, interaction vertex position identification, and particle instance segmentation. Early results indicate that the network achieves excellent filtering performance without increasing the network size, thus demonstrating that the set of learned features are somewhat general and relevant for multiple tasks.

Prospects for the integration of the network inference in the data processing chains of LArTPC experiments will also be presented.

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