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Proposal-free Deep Sparse Convolutional Neural Network for 3D Pixel Clustering

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High resolution particle imaging detectors can record full details of charged particle interactions, and opens a door to high precision neutrino oscillation measurements. In order to maximize the physics output, however, development of high quality data reconstruction techniques is critical. One of the challenging data reconstruction task is clustering of pixels to identify individual particles in an image. In the field of Computer Vision, proposal-based instance segmentation techniques such as Mask R-CNN has become increasingly popular and known to work well on photographs. However, these techniques have been developed for photographs that are severely different from image of particle trajectories and other science data, and can inherently suffer from challenges including an occlusion issue. The researchers in the Computer Vision has made significant progress on proposal-free instance segmentation techniques that are shown to work extremely well on science domain image data similar to ours. We have implemented a proposal-free instance segmentation algorithm into an end-to-end, deep learning based full data reconstruction chain developed by SLAC ML group. In this talk, I will describe the algorithm design and performance studied using PILArNet, the public LArTPC particle simulation dataset.

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