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Neutrino Identification With A Convolutional Neural Network in the NOvA Detectors

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The observation of neutrino oscillation provides evidence of physics beyond the standard model, and the precise measurement of those oscillations remains an important goal for the field of particle physics. Using two finely segmented liquid scintillator detectors located 14 mrad off-axis from the NuMI muon-neutrino beam, NOvA is in a prime position to contribute to precision measurements of the neutrino mass splitting, mass hierarchy, and CP violation.

A key part of that precise measurement is the accurate characterization of neutrino interactions in our detector. This presentation will describe a convolutional neural network based approach to neutrino interaction type identification in the NOvA detectors. The Convolutional Visual Network (CVN) algorithm is an innovative and powerful new approach to event identification which uses the technology of convolutional neural networks, developed in the computer vision community, to identify events in the detector without requiring detailed reconstruction. This approach has produced a 40% improvement in electron-neutrino efficiency without a loss in purity as compared to selectors previously used by NOvA. We will discuss the core concept of convolutional neural networks, modern innovations in convolutional neural network architecture related to the nascent field of deep learning, and the performance of our own novel network architecture in event selection for the NOvA oscillation analyses. This talk will also discuss the architecture and performance of two new variants of CVN. One variant classifies constituent particles of an interaction rather than the neutrino origin which will allow for detailed investigations into event topology and the separation of hadronic and lepton energy depositions in the interaction. The other variant focuses on classifying interactions in the Near Detector to improve cross-section analyses as well as making it possible to search for anomalous tau-neutrino appearance at short baselines.

Tertiary Keyword (Optional)

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Author: AURISANO, Adam (University of Cincinnati)

Co-authors: HIMMEL, Alexander (Fermilab); RADOVIC, Alexander (College of William and Mary); ROCCO, Dominick (University of Minnesota); NINER, Evan (Fermilab); PSIHAS, Fernanda (Indiana University)

Presenter: PSIHAS, Fernanda (Indiana University)

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