Application of Machine Learning for Low Energy Electron LArTPC Reconstruction
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Prediction of Drift Coordinate from Electron Diffusion via Application of Machine Learning Algorithm

Detection of Low Energy Neutrino interactions in a liquid argon time-projection chamber (LArTPC) rely on detection of both ionization electrons and scintillation – emitted photons. The scintillation photons provide the necessary timing information to properly reconstruct the event. Efficiency of photon detection decreases with the energy level of the interaction. A machine learning algorithm is to be trained on simulation data to deduce the appropriate timing values from electron drift, eliminating the need for photodetection, and overall simplifying the detection apparatus.

The workings of LArTPC: An incident neutrino strikes an argon atom, producing a flash of light and creating charged particles which ionize the surrounding argon atoms. A uniform electric field draws the electrons toward a wire plane which allows for a 2D recreation of the event. Photon detection is used for timing information.

The ionization electrons will naturally diffuse over time due to their like charges. The amount of diffusion directly correlates to the amount of time that elapses between the generation of the ionization electrons, and when they collide with the wire detection plane. More diffuse electrons indicate that the event occurred further from the detection grid.

A neural network focused on regression can make predictions along a continuous spectrum of values. To this end, thousands of data points as seen on the right will be used to train a ML algorithm, and since the training set is produced via simulation, the algorithm can be continuously refined for accuracy and bias. Thus, the drift coordinate can be determined without relying on scintillation photons.