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Convolutional Neural Networks for Energy and Vertex Reconstruction in DUNE

Measuring neutrino CP violation and mass hierarchy is currently one of the biggest challenges in particle physics. The DUNE neutrino experiment is the next-generation flagship neutrino program in the US designed to solve these problems. The DUNE detector uses liquid argon time projection chamber (LArTPC) technology, considerably improving the spatial resolution, neutrino detection efficiency and background rejection. However, reconstructing neutrino events with DUNE presents many challenges due to missing energy caused by argon impurities, nonlinear detector energy responses, invisible energy, hadron identities (mass), and overlaps between lepton and hadron interactions. One way of approaching this problem is using machine learning to reconstruct the neutrino events from pixel map images of interactions in the detectors. Here we present a regression convolutional neural network with a custom architecture to reconstruct neutrino energy and interaction vertices. For neutrino energy, we show considerable performance improvements in Monte Carlo simulations, compared with previous traditional energy reconstruction methods and initial results in interaction vertices.

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