

# Reconstruction of Neutrino Events in IceCube using Graph Neural Networks

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The IceCube Neutrino Observatory is a cubic-kilometer scale neutrino detector embedded in the Antarctic ice of the South Pole. In the near future, the detector will be augmented by extensions, such as the IceCube Upgrade and the planned Gen2 detector. The sparseness of observed charge in the detector for low-energy events, and the irregular detector geometry, have always been a challenge to the reconstruction of the detected neutrino's parameters of interest. This challenge remains with the planned IceCube Upgrade, which introduces seven new detector strings with novel detector modules. The Upgrade modules will increase the detection rate of low-energy events and allow us to further constrain neutrino oscillation physics. However, the geometry of these modules render existing traditional reconstruction algorithms more difficult to use. We introduce a new reconstruction algorithm based on Graph Neural Networks, which we use to reconstruct neutrino events at speeds that are much faster than the traditional algorithms, while providing comparable resolution. We show that our algorithm is applicable not only to reconstructing data of the current IceCube detector, but also simulated events for next-generation extensions, such as the IceCube Upgrade.

## Keywords

machine learning; artificial intelligence; deep learning

## Collaboration

IceCube

## other Collaboration

## Subcategory

Experimental Methods & Instrumentation

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