THE UNIVERSITY OF CHICAGO
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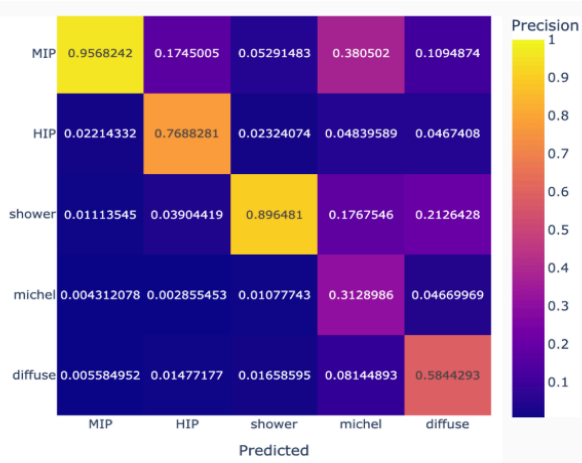
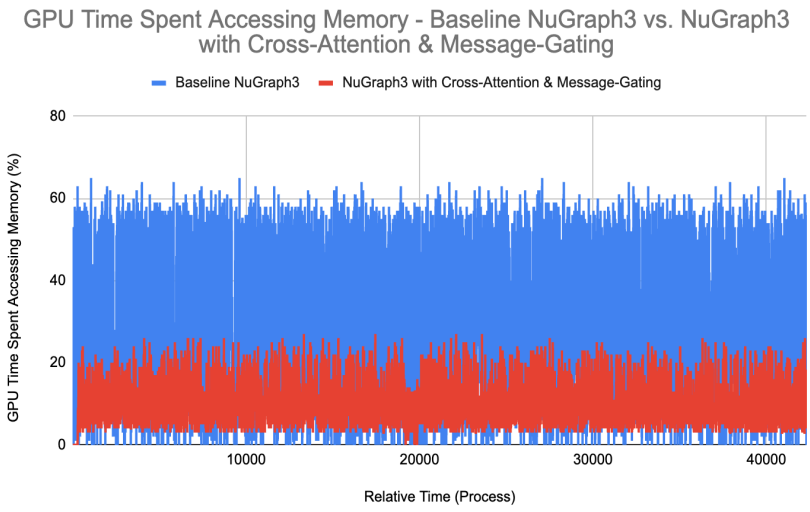
The project is to accurately identify signals from neutrino interactions with signal wires, as well as classify hits by particle type with the implementation of NuGraph3, a Graph Neural Network. The team's goal was to improve accuracy of the model by continuing to incorporate a second data source from optical detectors with the pre-established framework. The wire plane data provides a significant amount of information to do with the electron hits on the planes themselves, but the optical information can be used as a proxy for information about the timing of these events in the detector.

Over the quarter, the team enhanced NuGraph3's architecture by implementing two key mechanisms: message-gating and cross-attention. The message-gating mechanism introduced a selective information control system that reduced GPU memory access time by 30-40% during training by optimizing information flow between detector components (see below right figure). The cross-attention mechanism enabled direct feature interaction between wire planes and optical detectors, allowing the model to better correlate spatially separated signals. Early results at epoch 8 (out of 80) showed promising improvements in particle classification accuracy (see below left figure). Most notably, the misclassification of MIP particles as Michels decreased from 49% to 38%, and the HIP particle true positive rate improved from 73% to 77%.



Precision confusion matrix of NuGraph3 with cross-attention and message-gating at Epoch 8



The next steps are to optimize the connections between the intermediary nodes of the existing NuGraph3 framework and the updated optical flash data, then to subsequently experiment with refining the architecture of NuGraph3.