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Incorporating Advances in Machine Learning for Reconstruction in T2K and Super-Kamiokande Experiments

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The Tokai-to-Kamioka (T2K) experiment consists of an accelerator complex colliding protons on a graphite target, generating mesons which decay to neutrinos and detecting these neutrinos at both a near detector and a far detector, Super-Kamiokande (SK), 295km away. SK is a water Cherenkov detector and thus Cherenkov radiation from charged particles is detected by roughly 11000 photomuliplier tubes, the output of which is reconstructed to infer particle type and kinematics.

The current reconstruction algorithm in SK, fiTQun, uses classical likelihood maximization to estimate particle type and kinematics from Cherenkov rings produced when a neutrino interaction produces a charged lepton or hadron. This reconstruction algorithm has excellent performance in the most important T2K metrics - for example classifying electron neutrino events from muon neutrino events - but improvements to charged pion separation from muons, vertex and momentum reconstruction as well as computation time would greatly benefit many T2K and SK analyses.

The Water Cherenkov Machine Learning (WatChMaL) collaboration seeks to update classical reconstruction processes with machine learning. For SK data, investigations have centered on using either ResNet or PointNet architectures for both particle identification and vertex, momentum reconstruction. This talk will outline the data processing which the SK data must undergo to ensure adequate training, challenges in adapting state-of-the-art machine learning algorithms to our target problem, and current performance and comparisons with the classical algorithm. Outlines of future steps, including potential of adversarial networks to mitigate detector systematics in Super-Kamiokande will be discussed. Finally, other efforts in the WatChMaL collaboration will be described, including those on upcoming neutrino detectors.

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Keyword-2

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Keyword-3

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