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AI and Machine Learning Applications at the Near Detector of the T2K Experiment

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The T2K experiment has recently started a dedicated AI/ML working group for its Near Detector (ND280) to coordinate and support machine learning applications across its physics program. This talk presents an overview of the current efforts and developments within the collaboration, highlighting how state-of-the-art machine learning techniques are being employed to improve event reconstruction, particle identification, unfolding and systematic modeling.

Several standard machine learning architectures are currently in use or under development, including boosted decision trees, convolutional and sparse neural networks, PointNet, and transformers. These methods are applied to tasks such as PID, electromagnetic shower ID, e/γ separation in the T2K near detector (ND280). Some tools—like a transformer-based PID model—are now fully integrated into the analysis software. More advanced techniques are also described including ML-assisted unfolding with OmniFold and the use of normalizing flows for modeling complex systematic uncertainties. New levels of flexibility and performance, particularly in multidimensional and unbinned contexts, can therefore be reached.

A roadmap for the working group concludes this talk, which includes further integration of ML-models into reconstruction software such as track fitting using RNNs/transformers and vertex activity analysis, as well as finding strategies for systematic uncertainty propagation. Overall, these developments reflect how machine learning algorithms are helping T2K sharpen its tools, pushing further the precision frontier in neutrino physics.

Secondary track

T03 - Neutrino Physics

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