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Machine learning in particle physics

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During the last decade, research of machine learning (ML) and artificial intelligence (AI) has gone through an explosive evolution and made impacts across many domains of science and human lives. AI/ML models in computer vision can perform high quality analysis of image data from physics experiments, and models developed for natural language processing are applied to analyze sequential data. Graph models can be used to represent more general relations and thus powerful tools for analyzing data from multi-modal detector data in particle physics experiments. These models are promising not only for its performance on data analysis tasks, but also for automated optimization procedures that reduce much of human interventions needed for traditional, hand-engineered algorithms. Progress in computing hardware has enabled not only deep learning models, but also classical techniques to be applied at scale including a differentiable physics software that can utilize a gradient-based optimization. Furthermore, supported by a wide community consisting of both industries and academic institutions, the AI/ML software eco-systems lowered the entry bar for everyone to exploit these powerful tools, and public dataset gathered researchers across science domains to form research collaboration. In this talk, I discuss 1) example AI/ML models in high energy physics with a focus on experimental neutrino physics, 2) promising directions of AI/ML research in the near future, and 3) need of software and data ecosystem to develop research collaborations across science domains within HEP and beyond.

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