Optimization of High Energy Physics Analysis Performance Using Machine Learning Techniques

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When the HL-LHC begins operation, the amount of data collected by each experiment will increase significantly. The sensitivity of physics analyses would gain from the increased data statistics. Furthermore, a potentially large gain can come from adopting Machine Learning (ML) techniques for improving the quality of simulation, reconstruction, and data analysis chain. The past decade has witnessed great successes of ML techniques in various domains. A lot of efforts have been made to bridge HEP with ML in every possible step of the HEP data processing. See the review articles [1-3] for more details.

We have employed machine learning algorithms for high profile physics analyses such as $t\bar{t}H$ (Higgs boson production in association with a top quark pair) and $H \rightarrow \mu^+\mu^-$ (Higgs boson decays to two muons). While many analyses are using machine learning techniques such as BDT or shallow Neural Network (NN), deep Neural Network can be more promising for physics analyses since it may have better discriminating power. Furthermore, in some cases, backgrounds can look extremely similar to signals. This poses a big challenge to the ML classifiers. We would like to explore and develop different machine learning methods to enhance the separation power of signal and background for different LHC physics processes. We will also work to utilize HPCs (High Performance Computers) and GPUs for ML applications, in order to enhance the physics analysis performance and be able to construct more complicated ML models

References:

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