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A Machine Learning Framework to improve the search for New Physics in the ATLAS experiment

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The aim of this contribution is to show a comprehensive ML framework compiled after a period of application of ML/DL methods in the context of physics analysis in ATLAS experiment. From technical and organizational point of view, we addressed the use different ML/DL libraries, the managing of relevant computting infrastructures, the processing of different kinds of datasets, etc. Another important aspect discussed in this contribution is the imbrication of this ML framework in the Analysis Facility concept of ATLAS Computing. We have considered a possible workflow including the worldwide GRID infrastructure and the local resources (Tier-3 and the IFIC Artificial Intelligence Infrastructure -ARTEMISA).

The experience gained in recent years through the development of undergraduate and master's theses has led to the systematization of optimization processes for ML/DL methods, both at the hyperparameter level and in the use of loss functions with controlled metrics. We have addressed classification and regression problems, which has allowed us to develop structured approaches for ML analysis. One of these approaches involves extracting the ttbar resonance signal from background events (Standard Model events). Another approach we have explored is regression, specifically for the study of missing transverse energy (MET) in dileptonic ttbar event channels. For both of these issues, diverse methods have been applied, resulting in varying accuracies of over 95.5% in SM vs BSM ttbar classification. A key addition is the inclusion of interpretability analysis using SHAP.

Abstract

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