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Optimization of Event Selection for Singly- and Doubly-Charged Higgs Boson Search at ATLAS using Machine Learning Techniques

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Our ATLAS analysis group is performing a search in proton-proton collisions at the LHC for $H^{\pm} \to W^{\pm}Z$ and $H^{\pm\pm} \to W^{\pm}W^{\pm}$ produced via vector boson fusion with a fully leptonic final state. This process can be imitated by many other events produced at ATLAS, such as QCD and EW processes with W and Z bosons in the final state. Thus, this analysis presents an ideal opportunity to deploy machine learning techniques to distinguish these signal events from background sources. There are several important considerations when using machine learning in this context, such as the treatment of event weights and the selection of input variables. Another important problem for this analysis is that the singly- and doubly-charged Higgs masses are not constrained; we are performing a search across a range of mass points from 200 GeV to 3 TeV. Thus, the chosen machine learning approach must have some capacity to interpolate between simulated mass points. In this study, neural networks of varying complexity are used to evaluate different approaches to these issues and ultimately to optimize the signal region selection.

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