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# Machine learning techniques for mass-independent event classification in a search for singly- and doubly-charged Higgs bosons with ATLAS at the LHC

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In 140 $fb^{-1}$ of proton-proton collision data recorded by the ATLAS detector in Run 2 of the LHC, an excess was observed in both the $W^{\pm}Z$ and $W^{\pm}W^{\pm}$ channels with a combined global significance of 2.5 standard deviations. This excess could be attributed to the production of singly- and doubly-charged Higgs bosons, which are hypothesized by the Georgi-Machacek (GM) model. To investigate this excess and assess its compatibility with the GM model, a dedicated search is being performed for the GM $H^{\pm}$ and $H^{\pm\pm}$ where they decay to $W^{\pm}Z$ and $W^{\pm}W^{\pm}$ respectively. Optimizing a signal region sensitive to this new physics model is complicated by two key factors. First, there are many background sources including QCD and EW processes with W and Z bosons in the final state which have similar kinematic distributions to signal. Second, there is significant variability in the kinematics of the signal process since the search for the singly- and doubly-charged Higgs bosons is being performed across a range of masses from 200 GeV to 3 TeV. To address these challenges, a neural network (NN) was trained to discriminate signal events from background events in each of the $W^{\pm}Z$ and $W^{\pm}W^{\pm}$ channels. It was observed that the weighting of mass points used in training impacts the classification performance across the mass range and can be used to customize the analysis sensitivity to different mass regions. Various methods for attributing systematic uncertainties to the NN classification were also explored. The neural network scores were used to define new $W^{\pm}Z$ and $W^{\pm}W^{\pm}$ signal regions, and this was found to improve the exclusion limits compared to a cuts-based approach.


## Keyword-1

Beyond Standard Model

## Keyword-2

Machine Learning

## Keyword-3


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