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Machine learning for enhanced measurement of Higgs boson production cross section via vector boson fusion in H->WW* with the ATLAS detector

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In this analysis, we apply modern machine learning techniques to the $H \rightarrow WW^* \rightarrow e\nu\mu\nu$ decay channel using data from the ATLAS detector collected during Run-2 of the LHC to precisely measure the total cross sections of both gluon-gluon Fusion (ggF) and Vector Boson Fusion (VBF) Higgs production modes. The detailed results can be found in the 2023 publication "Measurements of higgs boson production by gluon-gluon fusion and vector-boson fusion using $H \rightarrow WW^* \rightarrow e\nu\mu\nu$ decays in pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector."

VBF is the second most prevalent Higgs production mode at the LHC, contributing approximately 7\% to the total production of Higgs bosons. In VBF processes, a quark from each of the colliding protons emits a W or Z boson, which interact to produce a Higgs boson. VBF events always contain at least two strong forward jets due to the quarks that remain after W or Z boson emission, providing a clear and identifiable signature in the detector.

We implement a Deep Neural Network (DNN) with Keras and TensorFlow to distinguish VBF event candidates from other signal and background processes. This DNN undergoes training on various kinematic variables involving leptons, jets, missing transverse energy, and other parameters associated with VBF topology. It acts as a robust classifier, effectively identifying VBF Higgs boson production amidst alternative Higgs production modes and background processes. Future enhancements to the analysis include a 2-dimensional DNN capable of classifying not only VBF processes but also ggF processes, the dominant Higgs production mode at the LHC.

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