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Probing di-Higgs using machine learning techniques

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A direct measurement of the Higgs self coupling is very crucial to understand the nature of electroweak symmetry breaking. This requires an observation of production of Higgs boson pair, which suffers from very low event rate even at the current LHC run. In our work, we study the prospects of observing the Higgs pair production at the high luminosity run of the 14 TeV LHC (HL-LHC) and also the proposed high energy upgrade of the LHC at 27 TeV, namely, HE-LHC. For the HL-LHC study, we choose multiple final states based on the event rate and cleanliness, namely, $b\bar{b}\gamma\gamma$, $b\bar{b}\tau^+\tau^-$, $b\bar{b}WW^*$, $WW^*\gamma\gamma$ and $4W$ channels and do a collider study by employing a cut-based as well as multivariate analyses using the Boosted Decision Tree (BDT) algorithm. In case of HE-LHC study, we select various di-Higgs final states based on their cleanliness and production rates, namely, $b\bar{b}\gamma\gamma$, $b\bar{b}\tau^+\tau^-$, $b\bar{b}WW^*$, $WW^*\gamma\gamma$, $b\bar{b}ZZ^*$ and $b\bar{b}\mu^+\mu^-$ channels. We adopt multivariate analyses using BDT algorithm, the XGBoost toolkit and Deep Neural Network (DNN) for the signal-background discrimination. Also, we perform a study on the ramifications of varying the self-coupling of Higgs boson from its Standard Model (SM) value.

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