Contribution ID: **16** Type: **EPJC track**

Machine learning augmented probes of light Yukawa couplings from Higgs pair production (recorded)

Friday, 9 July 2021 01:50 (30 minutes)

The measurement of the trilinear Higgs self-coupling is among the primary goals of the high-luminosity LHC and is accessible in Higgs pair production. However, this process is also sensitive to other couplings. While most of them can be well-constrained by single-Higgs measurements, this does not hold true for the coupling between the Higgs and light quarks. We show that the Higgs pair production process provides a sensitive probe to these couplings. Making use of interpretable machine learning with boosted decision trees and Shapley values, a measure derived from cooperative game theory, we separate the signal $q\bar{q} \to HH \to b\bar{b}\gamma\gamma$ from the Standard Model HH production and other backgrounds such as HZ, $t\bar{t}H$ and $b\bar{b}\gamma\gamma$. We show that, with the help of the machine learning framework, estimated bounds on light quarks coupling to the Higgs can be significantly improved compared to other probes, *cf.* fig. 1. The introduction of the Shapley values to assess variable importance allows the possibility of using a reduced set of kinematic variables to train the machine learning model. In what would otherwise be a black-box approach of using an over-complete set of kinematic variables, Shapley values tap into kinematic correlation and hence, allow for the selection of a minimal set of important kinematic variables that provide an optimal accuracy of signal vs. background classification.

Furthermore, we explore the potential of disentangling the various new physics operators leading to modifications of the light quark Yukawa coupling and a modified trilinear Higgs self-coupling with the added interpretability of the multivariate analysis using machine learning techniques. Additional kinematics can be further incorporated to help break the degeneracy between the up and down quark operators.

Primary authors: ALASFAR, Lina (Humboldt-Universität zu Berlin); GROEBER, Ramona (Università di Padova and INFN, Sezione di Padova); GROJEAN, Christophe (DESY (Hamburg) and Humboldt University (Berlin)); Dr PAUL, Ayan (DESY, Hamburg and Humboldt Universität zu Berlin); QIAN, Zhuoni (DESY)

Presenter: ALASFAR, Lina (Humboldt-Universität zu Berlin)

Session Classification: New Detector and Reconstruction Methodologies, Machine Learning and Computing at HL-LHC