Contribution ID: **81** Type: **not specified**

Attention and Dynamic Graph Convolution Neural Network in the context of classifying ttH(bb) vs. tt(bb) in the semi-leptonic top quark pair decay channel

Thursday, July 8, 2021 10:40 AM (20 minutes)

Deep neural networks (DNNs) are essential tools in particle physics targeting various use cases ranging from reconstruction of particles up to event classification and anomaly detection. Whereas DNNs for event classification are primarily trained on quantities deduced from the kinematic properties of the particles in the final state (high-level observables), we present an alternative approach of using exclusively basic kinematic object information (low-level observables) in combination with attention and dynamic graph convolution neural networks. Their performance is evaluated in terms of the potential of discriminating events in which the Higgs boson is produced in association with top quarks and decays into a pair of bottom quarks from the overwhelming background, which is top quark pair production in association with b jets. Studying the Higgs boson in such a complex final state with high object multiplicity is simultaneously challenging and crucially important for precision tests of the standard model.

Furthermore, DNNs are often seen as black boxes due to the difficulty of understanding what information they learn. We present detailed studies of the latent spaces of both the attention and graph networks in order to provide insights into what the neural networks learn about the physics and event topology as well as to demonstrate the potential of such networks for alternative analysis approaches, e.g., mass peak searches.

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