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Graph neural networks on the test bench in HEP applications

Data analyses in the high-energy particle physics (HEP) community more and more often exploit advanced multivariate methods to separate signal from background processes. In this talk, a maximally unbiased, in-depth comparison of the graph neural network (GNN) architecture, which is of increasing popularity in the HEP community, with the already well-established technology of fully connected feed-forward deep neural networks (DNNs) is presented. When it comes to choosing a suitable machine-learning model, it is not a priori clear, what model this should be to benefit from inherent properties of the task. Also, the design of a fair and unbiased benchmark is non-trivial. This GNN vs. DNN comparison is insightful in terms of the details it reveals as to which aspects of GNNs are superior to DNNs - and which are not. The study is performed on a typical data set of a complex challenge recently faced at the Large Hadron Collider: the classification of events with top quark-antiquark pairs with additional heavy flavour jets originating from gluon splittings, Z or Higgs bosons.

The study is documented in the paper "A Case Study of Sending Graph Neural Networks Back to the Test Bench for Applications in High-Energy Particle Physics"published in Computing and Software for Big Science, https://doi.org/10.1007/s41781-024-00122-3.

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