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Towards Machine Learning Analytics for Jet Substructure

Tuesday 21 July 2020 17:00 (9 minutes)

The past few years have seen a rapid development of machine-learning algorithms. While surely augmenting performance, these complex tools are often treated as black-boxes and may impair our understanding of the physical processes under study. Moving a first step into the direction of applying expert-knowledge in particle physics, we test whether the optimal decision function is achieved by standard training. In particular, we consider the binary classification problem of discriminating quark-initiated jets from gluon-initiated ones. We construct a new version of the widely used N-subjettiness variable, which features a simpler theoretical behaviour than the original one, while maintaining, if not exceeding, the discrimination power. We input these new observables to the simplest possible neural network, the one made by a single neuron (perceptron) and we analytically study the network behaviour at leading logarithmic accuracy. We are able to determine under which circumstances the perceptron achieves optimal performance. We also compare our analytic findings to an actual implementation of a perceptron and to a more realistic neural network and find very good agreement.

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