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Automating the Construction of Jet Observables with Machine Learning

Machine-learning assisted jet substructure tagging techniques have the potential to significantly improve searches for new particles and Standard Model measurements in hadronic final states. Techniques with simple analytic forms are particularly useful for establishing robustness and gaining physical insight. We will look at a method that applies machine learning to identify the amount of information in a jet that contributes to discrimination power using sets of observables that minimally and completely span the kinematic phase space of M subjets. Then we introduce a procedure to automate the construction of a class of product observables formed from these sets of variables that are chosen to completely specify M-body phase space. The procedure is validated on the task of distinguishing $H \to b\bar{b}$ from $g \to b\bar{b}$, where $M = 3$ and previous brute-force approaches to construct an optimal product observable for the M-body phase space have established the baseline performance. We then use the new method to design tailored observables for the boosted Z' search, where $M = 4$ and brute-force methods are intractable. The new classifiers outperform standard 2-prong tagging observables, illustrating the power of the new optimization method for improving searches and measurement at the LHC and beyond.

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