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Safety of Quark/Gluon Jet Classification

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The classification of jets as quark- versus gluon-initiated is an important yet challenging task in the analysis of data from high-energy particle collisions and in the search for physics beyond the Standard Model. The recent integration of deep neural networks operating on low-level detector information has resulted in significant improvements in the classification power of quark/gluon jet tagging models. However, the improved power of such models trained on simulated samples has come at the cost of reduced interpretability, raising concerns about their reliability. We elucidate the physics behind quark/gluon jet classification decisions by comparing the performance of net-works with and without constraints of infrared and collinear safety, and identify the nature of the unsafe information by revealing the energy and angular dependence of the learned models. This in turn allows us to approximate the performance of the low-level networks (by 99% or higher) using equivalent sets of interpretable high-level observables, which can be used to probe the fidelity of the simulated samples and define systematic uncertainties.

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