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Decorrelated Jet Substructure Tagging using Adversarial Neural Networks

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We describe a strategy for constructing a neural network jet substructure tagger which powerfully discriminates boosted decay signals while remaining largely uncorrelated with the jet mass. This reduces the impact of systematic uncertainties in background modeling while enhancing signal purity, resulting in improved discovery significance relative to existing taggers. The network is trained using an adversarial strategy, resulting in a tagger that learns to balance classification accuracy with decorrelation. As a benchmark scenario, we consider the case where large-radius jets originating from a boosted Z' decay are discriminated from a background of nonresonant quark and gluon jets. We show that in the presence of systematic uncertainties on the background rate, our adversarially-trained, decorrelated tagger considerably outperforms a conventionally trained neural network, despite having a slightly worse signal-background separation power. We generalize the adversarial training technique to include a parametric dependence on the signal hypothesis, training a single network that provides optimized, interpolatable decorrelated jet tagging across a continuous range of hypothetical resonance masses, after training on discrete choices of the signal mass.

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