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Minimizing systematic uncertainties in jet tagging using contrastive learning

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Jet taggers based on substructure are exploited in many areas of the LHC physics program. The ability to select jets stemming from different incident particles, so-called jet tagging, is afflicted with systematic uncertainties of both theoretical and experimental nature. This results in taggers that are ultimately less powerful than they could be. We propose an algorithm that creates a feature space that is insensitive to the parton shower model. This approach effectively minimizes the impact of jet-related systematic uncertainties, which are oftentimes among the dominant ones in the analysis of collider data. This is achieved by considering augmented data corresponding to a set of systematic uncertainties: partons are re-showered by systematically tuning parameters in Pythia8 and Herwig7. The resulting jets are embedded in a contrastive space via self-supervised deep neural networks. We consider graph and transformer-based architectures. In this talk, we demonstrate that our method achieves comparable tagging performance to established benchmarks for jet tagging in Higgs to bottom quarks, but with greatly reduced uncertainties. The algorithm presents a crucial step towards more robust searches for new physics involving particle jets, and paves the way for ultimate-precision jet measurements.

Primary authors: KRUPA, Jeffrey (MIT); HARRIS, Philip (MIT); KAGAN, Michael (SLAC); MAIER, Benedikt (KIT); PIERINI, Maurizio (CERN)

Presenter: KRUPA, Jeffrey (MIT)

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