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ML-assisted reconstruction of hadron-collider events with mini-jets

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The task of reconstructing physical observables from recorded experimental data in hadron collider events is a common challenge in LHC data analysis. Experimental measurements, such as hits in tracking detectors and signals in calorimeters, are combined into particle-flow objects, such as jets, muons, electrons, and missing transverse energy. However, reconstructing key observables related to the dynamics of particles created in hard collisions, like top-quarks, weak bosons (W, Z), or the Higgs boson, is intricate due to combinatorial ambiguities, tagging inefficiencies, acceptance losses, pile-up, and other experimental effects.

In this study, we propose a novel approach to reconstruct hadron collider events by utilizing mini-jets as the sole reconstructed objects, along with a machine-learning algorithm to determine the desired observables. These mini-jets, obtained with a distance measure of R=0.1, condense the full information from all particles in an event into a manageable size both experimentally and computationally. We demonstrate that a deep neural network can directly regress observables related to intermediate W bosons or top quarks, as well as particle-level jets with larger R and dressed leptons. This methodology surpasses classical reconstruction algorithms, offering a more efficient and generic event reconstruction for future LHC analyses.

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