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Unsupervised learning for real-time SUEP detection in a High Level Trigger system at the LHC

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We propose a signal-agnostic strategy to reject QCD jets and identify anomalous signatures in a High Level Trigger (HLT) system at the LHC. Soft unclustered energy patterns (SUEP) could be such a signal —predicted in models with strongly-coupled hidden valleys —primarily characterized by a nearly spherically-symmetric signature of an anomalously large number of soft charged particles, in contrast with a comparatively collimated spray-of-hadrons signature of QCD jets. We target the experimental nightmare scenario, i.e., SUEP in exotic Higgs decays, where all dark hadrons decay promptly to standard model hadrons. We design a three-channel convolutional autoencoder (reconstructed energy deposits at the HLT in the eta-phi plane in inner-tracker, electromagnetic calorimeter, and hadron calorimeter). By processing raw-event information, this application would be ideal for central online or offline computing workflows. Our study focuses on detecting a SUEP signal; however, the technique can be applied to any new physics model that predicts signatures anomalous to QCD jets.

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