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Weakly Supervised Learning for Muon Discrimination in Unlabeled Collider Data

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We use unlabeled collision data from CMS and weakly-supervised learning to train models which can distinguish prompt muons from non-prompt muons using patterns of low-level particle activity in vicinity of the muon, and interpret the models in the space of energy flow polynomials. Particle activity associated with muons is a valuable tool for identifying prompt muons, those due to heavy boson decay, from muons produced in the decay of heavy flavor jets. The high-dimensional information it typically reduced to a single scalar quantity, isolation, but previous work in simulated samples suggests that valuable discriminating information is lost in this reduction. We extend these studies in LHC collisions recorded by the CMS experiment, where true class labels are not available, requiring the use of the invariant mass spectrum to obtain macroscopic sample information. This allows us to employ Classification Without Labels (CWoLa), a weakly supervised learning technique, to train models. Our results confirm that isolation does not describe events as well as the full low-level calorimeter information, and allows us to interpret the resulting network in terms of energy flow polynomials.

Primary authors: WHITESON, Daniel (University of California Irvine (US)); WITKOWSKI, Edmund (UCI)

Presenter: WITKOWSKI, Edmund (UCI)

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