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Detecting New Physics as Novelty

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Novelty detection is a task of Machine Learning to detect novel events without a prior knowledge. Its techniques can be applied to detect unexpected signals of new physics at colliders. We generalize the complementary strategies developed in the paper (arxiv:1807.10261) for achieving this task. Generally, the novelty evaluators are classified into two categories: isolation-based and clustering (density)-based. Properly combining the evaluators from each category yields a third category, namely "synergy-based", which may significantly improve the efficiency and quality of novelty evaluation. We demonstrate these features by analyzing the performances of the three category of evaluators, using a variety of two dimensional Gaussian samples mimicking collider events. This study is subsequently applied to the LHC detection of the $t\bar{t}h$ Higgs physics and the gravity-mediated supersymmetry as novel events in the $t\bar{t}\gamma\gamma$ channel. These two scenarios represent the signal patterns with a sharp resonance and a broad distribution of $m_{\gamma\gamma}$, respectively. The sensitivities at detector level are provided, which read encouraging compared to the ongoing LHC analysis.

Summary

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