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The Interplay of Machine Learning–based Resonant Anomaly Detection Methods

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Machine learning–based anomaly detection (AD) methods are promising tools for extending the coverage of searches for physics beyond the Standard Model (BSM). One class of AD methods that has received significant attention is resonant anomaly detection, where the BSM is assumed to be localized in at least one known variable. While there have been many methods proposed to identify such a BSM signal that make use of simulated or detected data in different ways, there has not yet been a study of the methods' complementarity. To this end, we address two questions. First, in the absence of any signal, do different methods pick the same events as signal-like? If not, then we can significantly reduce the false-positive rate by comparing different methods on the same dataset. Second, if there is a signal, are different methods fully correlated? Even if their maximum performance is the same, since we do not know how much signal is present, it may be beneficial to combine approaches. Using the Large Hadron Collider (LHC) Olympics dataset, we provide quantitative answers to these questions. We find that there are significant gains possible by combining multiple methods, which will strengthen the search program at the LHC and beyond.

Brainstorming idea [title]

Using DANNS to circumvent systematic simulation errors in collision classifiers

Brainstorming idea [abstract]

The problem of classifying the process that created an observable underlies every physics analysis. Many ML-based solutions involve training a discriminator network on simulation, then applying the trained network to data. Often, some correction process must be carried out to account for the discrepancy between simulation and data. However, domain-adversarial neural networks (DANNs) can implicitly correct for these discrepancies. DANNs simultaneously train: a supervised classifier on labeled *source* data; a feature extractor on source and *target* data; and a domain classifier to discriminate the extracted features of the source and target data (our goal is for the domain classifier to fail).

Past applications of DANNs to HEP have been few in number and typically use full simulation (hard process + showering + detector) for the source and data for the target. My idea is: why not use only parton-level simulation as the source? The hard process –which we can simulate with known uncertainties –contains the essence of what is needed to classify signal from background. Further, a major source of systematic errors in simulation comes from the showering process and (potentially fast) detector simulations. By using parton-level data in DANNs, such mismodeling errors would no longer apply.

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