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A Hybrid Approach to Anomaly Detection in Particle Physics

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The ongoing search for physics beyond the Standard Model imposes a growing demand for highly sensitive anomaly detection methods. Various approaches to anomaly detection exist, and prominent techniques include semi-supervised and unsupervised training of neural networks. While semi-supervised approaches often require sophisticated methods for precise background estimation, unsupervised methods can have suboptimal signal sensitivity if they do not use specific information on the new signals. We propose an innovative hybrid approach leveraging unsupervised learning for detailed data-driven background estimation of a signal-sensitive region in conjunction with a semi-supervised classification technique for optimized signal sensitivity. The background estimation uses two simultaneously trained and decorrelated autoencoders with an auxiliary network, which enables detailed background estimation via likelihood ratio estimation. The classification technique uses the Classification WithOut LAbels (CWOLA) method on the estimated distributions. We will present the new method, show its performance on the LHCO2020 dataset, and embed the new approach in the landscape of existing anomaly detection methods.

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