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Unsupervised tagging of semivisible jets with Wasserstein Normalized Autoencoders

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The field of anomaly detection (AD) has been steadily gaining traction in high energy physics as a powerful tool in the search for physics beyond the standard model (BSM), reducing the reliance on exact modelling of specific signal hypotheses. Arguably the most commonly used architecture is some flavor of autoencoder (AE), a network trained to compress examples to a latent space and decompress them back to their original size. The use of AEs as anomaly detectors relies on the assumption that a model trained to efficiently compress and decompress the background, will fail to do so on anomalous data i.e., possible BSM signals. The reconstruction error of the AE will thus be higher for signals then backgrounds, allowing for discrimination. In practice, this assumption not always holds, and AEs exhibit a few important failure modes, such as complexity bias (only being able to tag events with a more involved correlation structure then the background), and out-of-distribution reconstruction (assigning low reconstruction error also to events far from the training data). Using the search for semivisible jets as a benchmark, we show how the normalized autoencoder (NAE) architecture addresses these shortcomings, drastically increasing the model's power to tag potential BSM signals. We further propose a modified version of the NAE, based on the Wasserstein distance, that further improves the robustness of the method.

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