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Searching for New Physics with Deep Autoencoders

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We introduce a potentially powerful new method of searching for new physics at the LHC, using autoencoders and unsupervised deep learning. The key idea of the autoencoder is that it learns to map "normal" events back to themselves, but fails to reconstruct "anomalous" events that it has never encountered before. The reconstruction error can then be used as an anomaly threshold. We demonstrate the effectiveness of this idea using QCD jets as background and boosted top jets and RPV gluino jets as signal. We show that a deep autoencoder can significantly improve signal over background when trained on backgrounds only, or even directly on data which contains a small admixture of signal. Finally we examine the correlation of the autoencoders with jet mass and show how the jet mass distribution can be stable against cuts in reconstruction loss. This may be important for estimating QCD backgrounds from data. As a test case we show how one could plausibly discover 400 GeV RPV gluinos using an autoencoder combined with a bump hunt in jet mass. This opens up the exciting possibility of training directly on actual data to discover new physics with no prior expectations or theory prejudice.

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