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Clustering for interpreting complex high-energy physics models

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After discovering the last piece of the Standard Model (SM), the Higgs boson, experiments at the Large Hadron Collider (LHC) have been searching for hints of physics Beyond the SM (BSM) to yield insights into these phenomena. These searches have not yet produced any significant deviations from SM predictions. Identifying unexplored regions in experimental observable space (object pTs, MET, etc) is essential in developing future BSM searches. One tool for finding new search regions is the Phenomenological Minimal Supersymmetric Standard Model (pMSSM) scan that is currently ongoing within the ATLAS collaboration. pMSSM models that have not been excluded by current searches can be used to build new search regions. Manually interpreting the high-dimensional space of our observables for each non-excluded model can however be challenging. Unsupervised data exploration algorithms (e.g., clustering) can analyze all of the non-excluded models and identify groups of non-excluded pMSSM models that live in a similar region of observable space. This could reduce thousands of theory models into a significantly smaller number of proto-search regions. These regions can then be developed into new BSM search regions. We present results from applying k-means clustering and dimensional reduction in the form of an autoencoder applied to well-understood simplified SUSY models. These results show that models can be grouped together in an unsupervised manner.

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