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Frequentist approach to quantify fake signals when using semi-supervised machine learning classifiers

In searches to discover new physics, at the LHC, machine learning classifiers can be used to extract signal events from background processes. Semi-supervised machine learning classifiers can be used to extract unlabeled signals from labeled background events, reducing biases caused by preconceived understanding of the signal. When training machine learning classifiers, overfitting can cause background events to be misclassified as signals. The amount of fake signals, or error caused in over-training, must therefore be quantified before the classifier can be used to discover new physics.
The study consists of the methodology and results of a frequentist approach to quantify fake signals produced in the over-training of a semi-supervised DNN classifier. To this end, $Z\gamma$ final state background data is used to evaluate an optimized semi-supervised DNN classifier. The frequentist approach is used to account for the probability of observing local excesses, elsewhere within the mass range. This is achieved by repeating the pseudo-experiment a sufficient number of times to completely understand the significance. Each pseudo-experiment consists of an distinct $Z\gamma$ dataset, generated using a WGAN, to train the DNN and a fixed mass background rejection scan to expose fake signals from the DNN response output

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