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Direct optimisation of the discovery significance when training neural networks to search for new physics in particle colliders

We introduce two new loss functions designed to directly optimise the statistical significance of the expected number of signal events when training neural networks to classify events as signal or background in the scenario of a search for new physics at a particle collider. The loss functions are designed to directly maximise commonly used estimates of the statistical significance, $s/\sqrt{(s+b)}$, and the Asimov estimate, Z_A. We consider their use in a toy SUSY search with 30 fb$^{(-1)}$ of 14 TeV data collected at the LHC. In the case that the search for the SUSY model is dominated by systematic uncertainties, it is found that the loss function based on Z_A can outperform the binary cross entropy in defining an optimal search region.

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