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Using machine learning to extend CONTUR's reach to multi-dimensional phase spaces

CONTUR is a tool which automatically injects signal events into the phase space of O(100) of the O(1000) ATLAS, CMS and LHCb measurements preserved in Rivet+HEPData, to check whether the distortions would have been visible beyond measured uncertainties, and identify the ruled out/open parameter space. This approach has shown itself to be very successful, with several results applying the method to various BSM models finding competitive and complementary exclusion to the LHC direct search programme. These results will discussed in a separate talk.

However, the current method is limited to 2-dimensional rectilinear scans of the parameter space, which limits the detail in which new models can be probed. But not all regions of a multi-dimensional space need to be evaluated: regions far away from the exclusion contour are in general very much ruled out, or very much not ruled out. This can be interpolated from nearby points since the precise value of the exclusion in those regions is not of interest.

A new CONTUR feature, called the "CONTUR Oracle", uses machine learning and adaptive sampling to recursively identify the locations of the 68% and 95% CL contour surfaces , so that computing resources are focused on the interesting regions of parameter space.
This approach allows large parameter spaces to be probed using only a fraction of the resources needed for a rectilinear grid, and lowers compute costs for the wider use of CONTUR as part of model-building/testing workflows.

In this talk we will present the new Oracle feature, comparing its performance against existing CONTUR results for vector-like-quarks, two-Higgs doublet models , and simplified Dark Matter models, and showcasing how it can be used to attack parameter spaces with large numbers of parameters which would previously have been out of reach.

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