Abstract Submitted
for the APR21 Meeting of
The American Physical Society

Combining Machine Learning with Profile Likelihoods in LUX
NICHOLAS CARRARA, University at Albany, SCOTT KRAVITZ, Lawrence Berkeley National Lab, LUX COLLABORATION — We use machine learning to achieve faster, more complete profile-likelihood ratio (PLR) calculations in the LUX dark matter experiment – a method which can be straightforwardly applied to other rare event searches. One of the main drawbacks of the PLR method with histogrammed probability density functions (PDFs) is that it becomes computationally intractable to include many input dimensions. This can be partially addressed by breaking up the variable space into products of lower-dimensional PDFs, but this potentially sacrifices information in the form of correlations between variables. To combat this issue, we first compress the inputs into a single dimension using a neural network which is then used as the input to the PLR method. We ensure all relevant information is preserved by imposing that the mutual information between the output of the neural network and the signal/background designation matches that of the inputs; this also provides an absolute calibration for when to stop the training process. This approach reduces the PLR computation time by an order of magnitude or more while allowing straightforward inclusion of additional highly-correlated variables such as an S1 prompt fraction variable.

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Date submitted: 06 Jan 2021 Electronic form version 1.4