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Optimisation of fast likelihood functions for dark matter and rare event searches

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Flamedisx provides a unique method of calculating likelihoods for rare event searches in liquid xenon time-projection chambers, like LUX-ZEPLIN, without the need for exhaustive monte-carlo simulations. Rather than random sampling of underlying parameters, flamedisx evaluates the range of possible parameters that could have significantly contributed to an observed event allowing for faster evaluation of more observables and shape varying parameters. This is represented in a large tensor calculation optimised with differential programming in TensorFlow. The implementation of Noble Element Simulation Technique (NEST) Xe response models in flamedisx, necessary to model light and charge response of Xe in a way consistent with other experiments, resulted in a more complex model which significantly increased memory consumption and execution time. Various optimisations made inference with more observables possible but the memory and time issues restrained possibilities with shape varying parameters. This work resolves the complexity of the NEST models through manipulation of the tensors and gives examples of where introducing shape varying parameters can improve analyses.

Primary author: GREEN, Joshua (University of Oxford / LZ)

Presenter: GREEN, Joshua (University of Oxford / LZ)

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