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Gaussian Process Accelerated Feldman-Cousins Approach for Physical Parameter Inference

The unified approach of Feldman and Cousins allows for exact statistical inference of small signals that commonly arise in high energy physics. For instance, the Feldman-Cousins approach has been the gold standard for studying neutrino oscillations. However, the approach relies on the Neyman construction of the classical confidence interval and is computationally intensive as it is typically done in a grid-based fashion over the entire parameter space. In this letter, we propose an efficient algorithm for the Feldman-Cousins approach using Gaussian processes to construct confidence intervals iteratively. We show that in the neutrino oscillation context, one can obtain confidence intervals 5 times faster in one dimension and 10 times faster in two dimensions, while maintaining an accuracy above 99.5%.

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