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On focusing statistical power for searches and measurements in particle physics

Particle physics experiments rely on the (generalised) likelihood ratio test (LRT) for searches and measurements. This is not guaranteed to be optimal for composite hypothesis tests, as the Neyman-Pearson lemma pertains only to simple hypothesis tests. An improvement in the core statistical testing methodology would have widespread ramifications across experiments. We discuss an alternate test statistic that provides the data analiser an ability to focus the power of the test in physics-motivated regions of the parameter space. We demonstrate the improvement from this technique compared to the LRT on the Higgs -> tau tau HiggsML dataset simulated by the ATLAS experiment and a dark matter (WIMPs) dataset inspired by the LZ experiment. This technique can be coupled with neural simulation-based inference techniques to best leverage information available in complex particle physics data. This technique also employs machine learning to efficiently perform the Neyman construction that is essential to ensure valid confidence intervals.

Would you like to be considered for an oral presentation?

Yes

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