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Constraining effective field theories with machine learning

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An important part of the LHC legacy will be precise limits on indirect effects of new physics, framed for instance in terms of an effective field theory. These measurements often involve many theory parameters and observables, which makes them challenging for traditional analysis methods. We discuss the underlying problem of "likelihood-free" inference and present powerful new analysis techniques that combine physics insights, statistical methods, and the power of machine learning. We have developed MadMiner, a new Python package that makes it straightforward to apply these techniques. In example LHC problems we show that the new approach lets us put stronger constraints on theory parameters than established methods, demonstrating its potential to improve the new physics reach of the LHC legacy measurements. While we present techniques optimized for particle physics, the likelihood-free inference formulation is much more general, and these ideas are part of a broader movement that is changing scientific inference in fields as diverse as cosmology, genetics, and epidemiology.

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