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Making Likelihood Calculations Fast Using Automatic Differentiation in RooFit

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In this talk, we present our efforts in supporting Automatic Differentiation (AD) in RooFit, a toolkit for statistical modeling and fitting used by many HEP/NP experiments that is part of ROOT. The new AD backend improves both the performance and numeric stability of likelihood minimizations, for which we will provide several examples in this contribution. Our approach is to extend RooFit with a tool that generates overhead-free C++ code for a full likelihood function built from RooFit functional models. Gradients are then generated using Clad, a compiler-based source-code-transformation AD tool, using this C++ code. After presenting promising results from a proof-of-concept with this pipeline applied to a HistFactory model at the ACAT 2022 conference, we showcased more general benchmarks on the full minimization pipeline at CHEP 2023. In this workshop, we present how AD can be applied to production workflows in the field of HEP/NP. We also demonstrate that AD is the prime choice for workflows with many parameters, yielding lower minimization times and faster overall fit convergence due to lesser fit iterations and improved accuracy of the calculated gradients.

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