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Clad - Automatic Differentiation Using Cling in ROOT

Differentiation is ubiquitous in high energy physics, for instance for minimization algorithms used for fitting and statistical analysis, detector alignment and calibration, and for theoretical physics. Automatic differentiation (AD) avoids well-known limitations in round-offs and speed, which symbolic and numerical differentiation suffer from, by transforming the source code of functions.

We will present how AD can be used to compute the gradient of multi-variate functions and functor objects. We will explain approaches to implement an AD tool. We will show how LLVM, Clang and Cling (ROOT's C++11 interpreter) simplifies the creation of such a tool. We describe how the tool will be integrated within ROOT to be used by statistical tools such as RooFit and RooStats. We will demonstrate a simple proof-of-concept prototype, called clad, which is able to generate n-th order derivatives of C++ functions and other language constructs. We also demonstrate how clad can offload laborious computations from the CPU using OpenCL.

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