

Fast evaluation of Feynman integrals via numerical integration of differential equations

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We revisit the idea of numerically integrating the differential form of Feynman integrals. With a novel approach for the treatment of branch cuts, we develop an integrator capable of evaluating a basis of master integrals in double and quadruple precision, with significantly smaller run times than other tools. This opens the door to evaluating higher complexity Feynman integrals on the fly in Monte Carlo generators, and enables a cheaper and easy to parallelize generation of grids for the topologies with prohibitive computational times. To test its performance, we build the differential equation for the pentagon functions in the process $e^+e^- \rightarrow \pi^+\pi^-\gamma$ at $O(\epsilon^2)$, and extend it to the case where the virtual photons acquire an auxiliary mass under the General Vector-Meson Dominance model. In general, the integrals depend on up to 9 complex kinematic variables and their evaluation times is $O(\text{ms})$. Furthermore, we test two families that appear in the production of $t\bar{t}+jet$ at two loops, achieving evaluation times in double precision in hundreds of milliseconds. We comment on the results and suggest room for improvement.

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