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Type: **Poster**

neos: Physics analysis as a differentiable program

The advent of deep learning has yielded powerful tools to automatically compute gradients of computations. This is because “training a neural network” equates to iteratively updating its parameters using gradient descent to find the minimum of a loss function. Deep learning is then a subset of a broader paradigm; a workflow with free parameters that is end-to-end optimisable, provided one can keep track of the gradients all the way through. This paradigm is known as differentiable programming.

This work introduces neos: an example implementation of a fully differentiable workflow that reframes physics analysis as a differentiable program. It’s capable of optimizing a learnable summary statistic with respect to a variety of loss functions, including expected discovery significance, CLs, uncertainty on parameters of interest, and pull widths. Doing this results in an optimisation process that is aware of how every step in the workflow changes your metric of choice, including the modelling and treatment of nuisance parameters.

Significance

Systematic-aware approaches to learning in HEP have been sought after for a while, e.g. <https://arxiv.org/abs/1806.04743>, <https://arxiv.org/abs/2105.08742>, but this is the first time the a pipeline has been fully end-to-end optimizable. Moreover, this work reframes the problem in a more general way, and discusses the interchangeable building blocks that encompass both this and some past approaches, prompting a shift to a more flexible paradigm.

References

PyHEP 2020: <https://www.youtube.com/watch?v=3P4ZDkbleKs>

MODE workshop on differentiable programming: <https://indico.cern.ch/event/1022938/contributions/4487419/>

ATLAS-internal ML workshop: https://indico.cern.ch/event/1057472/contributions/4470766/attachments/2289731/3892673/AML_forum_

Citeable code: <https://github.com/gradhep/neos>

Speaker time zone

Compatible with Europe

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