Laboratoire LEPRINCE-RINGUET
Ecole polytechnique IN2P3/CNRS

Séminaire

Differentiable programming and detector design optimisation

Differentiable programming, or automatic differentiation, is at the core of machine learning. A computer program, in order to learn from data and perform tasks such as classification, regression and statistical inference, needs to be able to calculate derivatives of complex objective functions. Modern machine learning libraries, such as pytorch, tensorflow or jax, implement automatic differential techniques that generalize traditional backpropagation. Complex system optimization offer, through differentiable programming, a wide range of potential applications, for example in the field of particle physics interesting use-cases cover simulators, simulation-based inference, optimization of systematic uncertainties, etc. More recently it has been proposed that optimization of the design of detectors could benefit from a differentiable programming approach. This challenging but exciting perspective is at the origin of the creation of the MODE collaboration (for Machine-learning Optimized Design of Experiments). MODE gathers a community of physicists and computer scientists who target the use of differentiable programming in design optimization of detectors for particle physics applications, extending from fundamental research at accelerators, in space, and in nuclear physics and neutrino facilities, to industrial applications employing the technology of radiation detection. MODE started to tackle a variety of use cases, from differential optimization of a muon-tomography detector to more ambitious long term projects such as calorimetry for a future muon collider. The MODE collaboration aims to develop a modular, customizable, and scalable, fully differentiable pipeline for the end-to-end optimization of articulated objective functions that model in the goals of experimental particle physics endeavors, to ensure optimal detector performance, analysis potential, and cost-effectiveness.

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