Contribution ID: **191** Type: **Poster**

Lamarr: LHCb ultra-fast simulation based on machine learning models

Wednesday, 26 October 2022 11:00 (30 minutes)

About 90% of the computing resources available to the LHCb experiment has been spent to produce simulated data samples for Run 2 of the Large Hadron Collider. The upgraded LHCb detector will operate at much-increased luminosity, requiring many more simulated events for the Run 3. Simulation is a key necessity of analysis to interpret data in terms of signal and background and estimate relevant efficiencies. The amount of simulation required will far exceed the pledged resources, requiring an evolution in technologies and techniques to produce simulated data samples. In this conference contribution, we discuss Lamarr, a Gaudi-based framework to speed-up the simulation production parametrizing both the detector response and the reconstruction algorithms of the LHCb experiment.
Deep Generative Models powered by several algorithms and strategies are employed to effectively parameterize the high-level response of the single components of the LHCb detector, encoding within neural networks the experimental errors and uncertainties introduced in the detection and reconstruction phases. Where possible, models are trained directly on real data, statistically subtracting any background components through the application of weights.
Embedding Lamarr in the general LHCb simulation framework (Gauss) allows to combine its execution with any of the available generators in a seamless way. The resulting software package enables a simulation process completely independent of the detailed simulation used to date.

Significance

Emerging use of deep generative models in LHC simulation.

References

Experiment context, if any

LHCb

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Session Classification: Poster session with coffee break

Track Classification: Track 1: Computing Technology for Physics Research