

Using Machine Learning to Speed Up and Improve Calorimeter R&D

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Design of new experiments, as well as upgrade of ongoing ones, is a continuous process in the experimental high energy physics. Frontier R&Ds are used to squeeze the maximum physics performance using cutting edge detector technologies.

The evaluation of physics performance for particular configuration includes sketching this configuration in Geant, simulating typical signals and backgrounds, applying reasonable reconstruction procedures, combining results in physics performance metrics.

Since the best solution is a trade-off between different kinds of limitations, a quick turn over is necessary to evaluate physics performance for different techniques in different configurations.

Two typical problems which slow down evaluation physics performance for particular approaches to calorimeter detector technologies and configurations are:

- Emulating particular detector properties including raw detector response together with a signal processing chain to adequately simulate a calorimeter response for different signal and background conditions. This includes combining detector properties obtained from the general Geant simulation with properties obtained from different kinds of bench and beam tests of detector and electronics prototypes.
- Building an adequate reconstruction algorithm for physics reconstruction of the detector response which is reasonably tuned to extract the most of the performance provided by the given detector configuration.

Being approached from the first principles, both problems require significant development efforts. Fortunately, both problems may be addressed by using modern machine learning approaches, that allow a combination of available details of the detector techniques into corresponding higher level physics performance in a semi-automated way.

In this paper, we discuss the use of advanced machine learning techniques to speed up and improve the precision of the detector development and optimization cycle, with an emphasis on the experience and practical results obtained by applying this approach to optimizing the electromagnetic calorimeter design as a part of the upgrade project for the LHCb detector at LHC.

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