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Machine-learning based particle-flow algorithm in CMS

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The particle-flow (PF) algorithm aims to provide a global event description for each collision in terms of the comprehensive list of final-state particles. It is of central importance to event reconstruction in the CMS experiment at the CERN LHC, and has been a focus of developments in light of planned high-luminosity running conditions with increased pileup and detector granularity. Existing implementations rely on extrapolating tracks to the calorimeters, correlating them with calorimeter clusters, subtracting charged particle energy, and inferring neutral particles from significant energy deposits. The high-luminosity LHC upgrade entails new challenges, including extending the algorithm to new detectors, maintaining computational efficiency under high detector occupancy, and porting to heterogeneous computing architectures to improve throughput. Recently, end-to-end machine learning approaches for event reconstruction have been proposed that directly optimize for the physical quantities of interest, are reconfigurable to new conditions, and can be deployed in heterogeneous accelerators. One such approach, the machine-learned particle-flow (MLPF) algorithm, consists of training a transformer model to infer the full particle content of an event from the reconstructed tracks and calorimeter clusters in a single pass. We discuss progress in CMS towards an improved implementation of the MLPF reconstruction, describing the dataset generation, the ML approach, the metrics used to assess event reconstruction quality and the integration with offline reconstruction software. We find that the ML-based approach converges to results consistent with the existing PF algorithm. We benchmark the throughput of the ML-based algorithm on GPU architectures in the full reconstruction software (aka CMSSW) and report on the possible throughput under Run3 conditions.

Secondary track

T11 - Detectors

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