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New developments and applications of a Deep-learning-based Full Event Interpretation (DFEI) in proton-proton collisions

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The LHCb experiment at the Large Hadron Collider (LHC) is designed to perform high-precision measurements of heavy-hadron decays, which requires the collection of large data samples and a good understanding and suppression of multiple background sources. Both factors are challenged by a five-fold increase in the average number of proton-proton collisions per bunch crossing, corresponding to a change in the detector operation conditions for the recently started LHC Run 3. The limits in the storage capacity of the trigger have brought an inverse relation between the amount of particles selected to be stored per event and the number of events that can be recorded, and the background levels have risen due to the enlarged combinatorics. To tackle both challenges, we have proposed a novel approach, never attempted before in a hadronic collider: a Deep-learning based Full Event Interpretation (DFEI), to perform the simultaneous identification, isolation and hierarchical reconstruction of all the heavy-hadron decay chains in each event. We have developed a prototype for such an algorithm based on Graph Neural Networks. The construction of the algorithm and its current performance has recently been described in a publication [Comput.Softw.Big Sci. 7 (2023) 1, 12]. This contribution will summarise the main findings in that paper. In addition, new developments towards speeding up the inference of the algorithm will be presented, as well as novel applications of DFEI for data analysis. The applications, showcased using simulated datasets, focus on decay-mode-inclusive studies and automated methods for background suppression/characterisation.

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