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Development of the Topological Trigger for LHCb Run 3

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The data-taking conditions expected in Run 3 of the LHCb experiment will be unprecedented and challenging for the software and computing systems. Accordingly, the LHCb collaboration will pioneer the use of a software-only trigger system to cope with the increased event rate efficiently. The beauty physics programme of LHCb is heavily reliant on topological triggers. These are devoted to selecting beauty-hadron candidates inclusively, based on the characteristic decay topology and kinematic properties expected from beauty decays. We present the Run 3 implementation of the topological triggers using Lipschitz monotonic neural networks. This architecture offers robustness under varying detector conditions and sensitivity to long-lived candidates, opening the possibility of discovering New Physics at LHCb.

Significance

Topological triggers play a fundamental role in the LHCb b-physics program. However, while the selections were based on boosted decision trees in prior years of data taking
[1], the former selection algorithms are no longer usable due to an increased luminosity and varying detector conditions during LHC Run 3. For this reason, the Run 3 implementation of the topological triggers uses an entirely new architecture, the so-called Monotonic Lipschitz neural networks [2], which provide robustness against these deviations. Presented is one of the first applications of this architecture. It also provides high efficiency in selecting long-lived beauty candidates due to the introduction of monotonic behaviour in certain selection variables. As a result, a significantly increased efficiency is achieved, which will be crucial to maintaining LHCb's outstanding role in b-physics.

References

[1] https://inspirehep.net/literature/1711636, Design and performance of the LHCb trigger and full real-time reconstruction in Run 2 of the LHC, LHCb Collaboration
[2] https://inspirehep.net/literature/1981931, Robust and Provably Monotonic Networks, Ouail Kitouni, Niklas Nolte, Mike Williams

Experiment context, if any

LHCb Experiment, Flavor Physics

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