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Towards an Interpretable Data-driven Trigger System for High-throughput Physics Facilities

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Data-intensive science is increasingly reliant on real-time processing capabilities and machine learning workflows, in order to filter and analyze the extreme volume and complexity of the data being collected. This is especially true at the energy and intensity frontiers of particle physics, for physics facilities such as the Large Hadron Collider (LHC).

The sophisticated trigger systems at the LHC are crucial for selecting relevant physics processes. However, the design, implementation, and usage of the trigger algorithms are resource-intensive and can include significant blind spots. The configuration of the trigger algorithms is manually designed based on domain knowledge (involving ~ 100 data filters).

We propose a new data-driven approach for designing and optimizing high-throughput data filtering and trigger systems at the LHC. The main purpose is to replace the current hand-designed trigger system with a data-driven trigger system with a minimal run-time cost, to account for non-local inefficiencies in the existing trigger menu and construct a cost-effective data filtering and trigger model that does not compromise physics coverage. This approach involves novel machine learning algorithms that are cost-effective, interpretable, tailored to (sequential) optimization, and can be implemented efficiently in hardware. An early demonstration of this approach is currently being prototyped using the Xilinx Versal ACAP (adaptive compute acceleration platform) board.

This model will be ideally used to expand to a self-driving and continuous learning triggering system, based on novel active learning algorithms for exploring new phenomena and inferring the underlying physics.

In-person or Virtual?

Virtual

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