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Optimized Calorimeter Signal Compaction for an Independent Component based ATLAS Electron/Jet Second-level Trigger

The ATLAS online trigger system has three filtering levels and accesses information from calorimeters, muon chambers and the tracking system. The electron/jet channel is very important for triggering system performance as Higgs signatures may be found efficiently through decays that produce electrons as final-state particles.
Electron/jet separation relies very much on calorimeter information. ATLAS calorimeter system is segmented into seven layers and due to differences both in depth and cell granularity of these layers, trigger algorithms may benefit from performing feature extraction at the layer level.
This work addresses the second level (LVL2) filtering restricted to calorimeter data. The LVL2 operation is split into two phases: feature extraction, in which relevant information is extracted from the measured signals, and hypothesis testing, where particle discrimination is performed over relevant variables.
Here, Region of Interest (RoI) data are formatted into concentric ring sums. At each calorimeter layer, the most energetic cell is defined as the first ring, and the following rings are formed around this point, so that all cells belonging to a ring have their sampled energies added together. For each event to be processed, a RoI with a size of 0.4 x 0.4 in the eta x phi plane is defined and gets described by a total of 100 ring sums. After this pre-processing step, segmented independent component analysis (SICA) is applied in order to extract from ring sums relevant features for particle identification. Independent Component Analysis (ICA) aims at extracting the statistically independent sources that produced the observed calorimeter signals and here ICA is applied in a segmented way. The number of independent components to be extracted from a ROI is estimated through different signal compaction strategies, such as Principal Component Analysis, Nonlinear Principal Component Analysis and Principal Components for Discrimination. These compaction techniques are evaluated with respect to dimensionality reduction (and processing speed) and classification efficiency. The hypothesis testing is performed by a Multi-Layer Perceptron classifier fed from the segmented independent components. The classifier is designed using simulated level one trigger accepted signals.

Summary

A neural second-level trigger system fed from Segmented Independent Components is proposed. The Region of Interest data are described by concentric ring sums formed at each calorimeter layer and signal compaction techniques are used to estimate the number of independent components to be extracted.

Primary authors: Dr LUIZ, Caloba (Federal University of Rio de Janeiro); Mr SIMAS, Eduardo (Federal University of Rio de Janeiro); Dr SEIXAS, Jose (Federal University of Rio de Janeiro)

Presenter: Mr SIMAS, Eduardo (Federal University of Rio de Janeiro)

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