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Latest improvements to CATHODE

Despite compelling evidence for the incompleteness of the Standard Model and an extensive search programme, no hints of new physics have so far been observed at the LHC. Anomaly detection was proposed as way to enhance the sensitivity of generic searches not targetting any specific signal model. One of the leading methods in this field, CATHODE (Classifying Anomalies THrough Outer Density Estimation), has recently been applied to the data collected by the CMS experiment. CATHODE starts by obtaining an in-situ estimate of the background and subsequently isolates signal events with a classifier.

We present the most recent developments to CATHODE, enhancing its sensitivity beyond dijet resonances and introducing uncertainties in the generative model.

Significance

CATHODE is currently being developed in two main directions:

- * Introducing systematic uncertainties in the density estimation step, allowing for rigorous testing with NPLM
- * Adding sensitivity to more signal types: the three-jets system in LHCO Black Box 3, jets with large numbers of tracks, resonances produced in more complicated topologies (e.g. VBF)

In addition, we will comment on the use of the SIC as a metric to evaluate anomaly detection methods.

References

CATHODE: <https://arxiv.org/abs/2109.00546>

CMS: <https://arxiv.org/abs/2412.03747>

ATLAS: <https://arxiv.org/abs/2502.09770>

The improvements that will be presented are yet to appear publicly. Some of them may be posted right before ACAT.

Experiment context, if any

CMS deployed CATHODE and ATLAS deployed a similar method. We also know of a similar effort at BELLE II.

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