

# Model-independent strategy for New Physics search at LHC using Anomaly Detection algorithms

Wednesday 31 January 2024 16:05 (5 minutes)

The search for rare New Physics signals is one of the main challenges that are addressed in LHC experiments. Classical search strategies rely on signal hypothesis and simulation to optimize the sensitivity of an analysis. However, relying on hypothesis and simulation has drawbacks. To address this problem, I propose a model independent strategy for heavy resonance searches.

This strategy relies on a novel Machine Learning based anomaly detection techniques [1]. The model is composed of an Auto-Encoder architecture coupled with a discriminant network. The two networks are trained adversarially in a GAN-like setting. The objective is to use the discriminant loss as constraint on the Auto-Encoder in addition to the usual reconstruction error. The model is trained in order to identify any signal as an anomaly while providing for a suitable data-driven background model. This background modeling feature relies on the use of the Distance Correlation (DisCo) regularization term as well as event reweighting.

In order to assess the significance of any potential resonance, an enhanced implementation of the BumpHunter algorithm is used [2]. This implementation provides a method to evaluate efficiently the global p-value of a localized deviation in the data even if the statistics is limited in the test statistic distribution. The test performed on the data provided for the LHC Olympics 2020 challenge [3] shows promising results, my method being able to correctly identify a hidden signal with up to 3 sigma significance.

[1] L. Vaslin, V. Bara, J. Donini. GAN-AE: an anomaly detection algorithm for New Physics search in LHC data. *Eur. Phys. J. C* 83, 1008 (2023). doi:10.1140/epjc/s10052-023-12169-4

[2] L. Vaslin, S. Calvet, V. Bara, J. Donini. pyBumpHunter: A model independent bump hunting tool in Python for high energy physics analyses. *SciPost Phys. Codebases* 15 (2023), doi:10.21468/SciPostPhysCodeb.15

[3] G. Kasieczka et al. The LHC Olympics 2020 a community challenge for anomaly detection in high energy physics. *Report on Progress in Physics*, 84(12):124201, dec 2021. doi:10.1088/1361-6633/ac36b9

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**Session Classification:** Poster Session

**Track Classification:** 2 ML for analysis : event classification, statistical analysis and inference, including anomaly detection