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Anomaly Detection with Machine Learning in Time Series Data from the Fermi Anti-Coincidence Detector

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Multimessenger astrophysics relies on multiple observational data channels, necessitating efficient methods for analyzing events of astrophysical origin. With the continuous increase in both volume and complexity of data from modern observatories, advanced Machine Learning techniques have become very useful for identifying and classifying signals effectively.

My project aim at developing a framework using Machine Learning techniques to analyze time series data. The use case that will be presented regards the data from the Anti-Coincidence Detector (ACD) onboard the Fermi Gamma-ray Space Telescope. The primary objective is to enhance the detection of high-energy transient events, such as Gamma-Ray Bursts (GRBs) and other astrophysical signals.
An ensamble of Neural Networks models may be employed to model and predict the temporal structure of the ACD background data. The network's predictions serve as a baseline for implementing a triggering algorithm designed for anomaly detection. By identifying significant deviations from the predicted background, the system effectively flags potential astrophysical transients in the ACD time series data.

In addressing challenges such as noise variability, this work explores advanced approaches to refine anomaly detection thresholds, by characterizing the noise amplitude in the data. Bayesian Neural Networks (BNNs) are highlighted as a promising method to dynamically adapt thresholds based on the noise characteristics of the data, offering a robust alternative to traditional fixed-threshold methods. These developments demonstrate a robust and adaptable framework for signal detection, applicable across various datasets and observatories in multimessenger astrophysics.

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