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Transformer-based Fermi/GBM Background Predictor

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As a cornerstone scientific payload aboard NASA's Fermi Gamma-ray Space Telescope, the Gamma-ray Burst Monitor (GBM) is specifically designed to detect and study cosmic gamma-ray bursts (GRBs) and other high-energy transients, such as solar flares, magnetar outbursts, and Terrestrial Gamma-ray Flashes (TGFs). The primary observational challenge for GBM stems from the inherent complexity and highly variable nature of background radiation, which contaminates astrophysical signals and degrades the precision of data analysis. Therefore, accurate modeling of background radiation is critical for effectively extracting signals and enhancing the potential for scientific discoveries. This paper proposes a deep neural network architecture for background spectral modeling of Fermi/GBM detectors. The proposed model achieves efficient estimation of background signals for individual NaI detectors through the following methodologies:
(1) Based on the Transformer architecture, dedicated models with parameter isolation were established for each detector of Fermi/GBM, significantly reducing the number of network parameters
(2) Integrating a median absolute deviation (MAD) preprocessor and Cauchy loss function to address outlier sensitivity in astronomical photon-counting data
(3) Implementing a lightweight training framework using a single NVIDIA RTX 4080 GPU (16GB VRAM), ensuring computational efficiency while enabling end-to-end validation of the model. The experimental results demonstrate that our model achieves accurate predictions for both light curves and energy spectra, reaching the precision required for orbit revisit predictions.

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