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Automated classification of X-rays sources within the extent of Fermi-LAT sources

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The release of the Fermi-LAT 4FGL catalog includes over 1,000 unidentified Fermi-LAT sources (roughly 25% of sources). One of the most successful ways to uncover their counterparts are through X-ray observations. Over their ~20 year lifetimes XMM-Newton and Chandra have observed a large number of Galactic fields, many of which contain unidentified Galactic Fermi-LAT sources. Often these fields can contain 10s to 100s of X-ray sources, most of which need to be vetted as potential GeV counterparts owing to the large positional uncertainties of the Fermi-LAT sources. Studying each individual X-ray source manually is a tedious and time consuming task. However, machine learning methods can substantially speed up this task. Here we present a systematic study of archival X-ray observations of fields containing these unidentified 4FGL Fermi-LAT sources, using our multi-wavelength machine learning pipeline (MUWCLASS). We will discuss the most interesting sources and present results from their IR to GeV spectral and timing analyses. Additionally, new high cadence optical surveys (e.g., ZTF, TESS, ASAS-SN), when combined with X-ray variability information, provide a new window to help identify and classify highly variable sources, such as high-mass gamma-ray binaries, spider millisecond pulsars, and AGN. We will also discuss the ongoing implementation of this information into our pipeline.

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