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Multi-class classification of Fermi-LAT sources with machine learning

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About one third of the Fermi-LAT sources have no high probability associations. Some of the sources may have no observable counterparts at other frequencies, such as pulsars with misaligned radio jets. For these sources probabilistic classification, e.g., with machine learning (ML), may be the only possibility to understand their nature. One of the main problems in using ML for classification of unassociated sources is that there are 23 classes in the latest 4FGL-DR3 catalog, where about 10 classes have less than 10 associated sources, which makes it impractical to use all physical classes for the probabilistic classification. We develop an hierarchical procedure for the definition of classes by dividing all physical classes into two groups at the first step and then subdividing the groups at further steps. As a result, one has control on the number of sources in a group of classes which, on the one hand, ensures reasonable classification performance and, on the other hand, gives more information about the classes of unassociated sources compared to, e.g., two-class classification. I will discuss application of the multi-class classification of the Fermi-LAT sources for the population studies of the sources that include both associated and unassociated sources.

Primary author: MALYSHEV, Dmitry (ECAP)

Co-author: BHAT, Aakash (Potsdam University)

Presenter: MALYSHEV, Dmitry (ECAP)

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