

Classifying Blazar Candidates of Uncertain type in the fourth Fermi-LAT catalog by machine learning techniques

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In the Fermi-LAT Fourth Source Catalogue (4FGL) about 50% of the sources have no clear association with a likely γ -ray emitter. We use machine learning technique aimed at distinguishing BL Lacs from FSRQs to investigate the source subclass of uncertain (BCU) or unassociated (UCS) sources characterised by γ -ray properties very similar to those of Active Galactic Nuclei.

This work is a follow up of previous papers : <https://arxiv.org/abs/1607.07822> , <https://arxiv.org/abs/1705.09832>, <https://arxiv.org/abs/1808.05881>, <https://arxiv.org/abs/1602.00385> and will use the 2019 optimization of the original algorithm as described in : [Optimizing neural network techniques in classifying Fermi-LAT \$\gamma\$ -ray sources](#).

The result of this study will suggest a new zoo for 4FGL γ -ray objects, opening up new considerations on the population of the γ -ray sky, and it will facilitate the planning of significant samples for rigorous analyses and multiwavelength observational campaigns.

4FGL BCUs Classification

Class	1FGL	2FGL	3FGL	4FGL
BL Lac	295 (44%)	436 (41%)	660 (38%)	1116 (36%)
FSRQ	278 (42%)	370 (35%)	484 (28%)	686(22%)
BCU	92 (14%)	257 (24%)	573 (34%)	1329(42%)
Total	665	1063	1717	3131

Table 1. Blazar class distribution in Fermi-LAT catalogs.

Classifying BCUs, using a supervised machine learning method based on an artificial neural network, [probabilities for each of 1329 uncertain blazars to be a BL Lac or FSRQ are obtained](#).

Using 90% precision metric, [801 can be classified as BL Lacs and 406 as FSRQs while 122 still remain unclassified](#).

Here the full list [4FGL BCUs_ANN_table.txt](#)

A spectrometric optical observation campaign will be organized to confirm the data resulting from the neural algorithm.