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# Correlation between Gamma-ray sources and neutrinos using Deep Learning

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The purpose of this PhD thesis is to study the correlation between gamma ray sources and neutrinos in the high energy extra-galactic sky.
This is done by using advanced deep learning techniques to extract physical information about the astrophysical candidates for this study.

For now the data that have been used are the neutrino events from the Icecat-1 catalog from IceCube and the astrophysical sources of the 4FGL-DR4 catalog from Fermi.

A first naive approach have already been implemented :
- Features have been selected and/or created based on the information of the 4FGL-DR4.
- The sources of 4FGL-DR4 have been filtered to keep only AGNs (candidates of extra-galactic neutrino production) and only the best quality events of IceCube have been kept (high probability of being astrophysical in origin)
- To create a machine learning dataset, the sources of the Fermi catalog have been labeled based on their vicinity to neutrinos that have been detected by IceCube.
- A machine learning classifier (RF) have been used to classify the astrophysical sources based on the preselected features, and a cross validation pipeline have been implemented to assess the results.

A more advanced approach is being implemented based on the light curves of Fermi.
More than 2000 light curves have been generated using fermipy and will be used as time series data with a Pre-train model for time series mining.
This will be compared to the use of a standard transformer (with variational auto encoder) and a ResNeT to obtain some baselines in terms of metrics.

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