Title : Optimising the search for gravitational wave transient signals using Xbooster

Subject :
Many predicted unmodelled gravitational wave (GW) signals are rare and energetically weak making their discovery still a challenge for the LIGO-Virgo-KAGRA collaboration. Among them, magnetars, highly magnetized young neutron stars with surface fields often surpassing 10^{14}G, are known to exhibit rare extraordinary flares characterized by micro-to-millisecond gamma-ray flashes of energies $10^{44}-10^{47}$erg. At Artemis, we have developed a new data analysis pipeline PySTAMPAS with improved performances. The pipeline has been used to analyzed past observation run (O3) data set. The subject of the internship is to test the use of supervised machine learning algorithms to optimize the search sensitivity to magnetar sources of GWs. Supervised machine learning algorithms ``learn" mappings between the input and the output spaces from a training set (for which both the input and output are known). This is achieved by solving an optimization problem of minimizing a loss function that quantifies the gap between prediction and ground truth. How this mapping is constructed depends on the machine learning algorithm and can be tuned by changing the values of ``hyperparameters". In this internship we propose to use classifiers that are gradient boosted decision tree classifiers, implemented in *XGBoost*. This type of classifier is based on a series of decision trees used as weak learners. They have real-valued outputs that can be added together and used to implement splits. The trees are gradually grown, with the additions being weighted such that the classifier performance improves on the earlier values. The growth is carried out in a greedy fashion, based on purity scores and minimization of the loss function. The student will implement the algorithm and test it using LIGO-Virgo data from the O3 observing run.

Supervisor: Dr Marie Anne Bizouard

Duration: 4-6 months

Note: a PhD subjet on LIGO/Virgo data analysis will be proposed later