Title of the internship: From taxis to Black holes: using artificial intelligence for behaviour recognition in an intriguing astrophysical object.

Searching for the Unknown – anomaly finding in Large astronomical datasets

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Summary :

What do taxis in New York and Black Hole X-ray emission have in common ? Taxis are a well known transportation system, and thanks to the regulations in New York, one knows with quite good accuracy how many passengers are traveling each day, or even each half hour. This results in what is called a time series which can be analysed in order to understand passenger behavior.

Black hole X-rays binaries on their side are systems containing a stellar mass black hole and a companion. Due to magnetic instabilities in their accretion disc resulting in turbulence, they emit light in the X domain with sometimes a complex variability pattern. GRS 1915+105 is quite unique among those objects as it is in outburst continuously since 1992 and more than 14 distinct pattern have been observed. However, machine learning classifications based on autoencoders neural networks fail at providing simple interpretation of their classifications for the expert.

The main goal of this M2 internship is to adapt machine learning tools developed in the general context of data mining and anomaly finding for time series to the elusive light-curve of GRS 1915+105. Namely, adapting the shapelet method or the matrix profile techniques to this data appears to be promising alternatives to autoencoders, at least in terms of interpretability. The expected workplan for is thus the following: get a global understanding of the data and the scientific goal; deploy methods from the computer science community for GRS 1915+105, compare the results with the autoencoders, and discuss the interpretations with experts of the domain. This internship will be conducted in collaboration with Amsterdam University.

The successful candidate should be proficient with numerical and statistical tools, as well as be fluent in programming and using scientific libraries. A solid background in astrophysics, cosmology, and/or familiarity with modern coding environment would be a plus. The candidate is also expected to report their work to an international audience as well as the Clermont Auvergne University interdisciplinary working group on Artificial Intelligence.