Machine learning-assisted discovery and study of solar structure behaviors

Solar activity events appear to be strongly associated with the evolution of solar structures, which are objects in the solar atmosphere that differ from the "quiet" atmosphere and appear, evolve, and disappear over a period of a few days to months. The exact mechanisms of solar activity and the links between solar activity events and solar structures are still poorly understood.

We hypothesize that solar structures can have typical behaviors, both isolated and in interaction with other structures and with solar activity events. Such patterns of behavior have never been researched. Our goal is to discover them, if they exist, using machine learning methods.

Solar structures are traditionally studied individually and using only one observation modality at a time. This greatly limits the possibilities of discovering behavior patterns. Using machine learning tools, this project will carry out the first longitudinal study of a large number of structures. In addition, it will co-exploit multimodal and heterogeneous observations of the sun that reveal different facets of the Sun.

The expected results of this exploratory project are: 1) to obtain information on the existence of typical behaviors for solar structures, 2) to model these behaviors and provide a physical interpretation, 3) to link behaviors and their anomalies to solar activity events. These behavioural models would open up the prospect of a better understanding and prediction of solar activity events, with applications in particular for space weather.

Practical information:

The PhD will be supervised by Adeline Paiement at Laboratoire d'Informatique et des Systèmes (LIS). This project is part of an existing and very active partnership with the LESIA laboratory at Paris Observatory.

The PhD will take place in the LIS Toulon laboratory. The PhD student will have access to the computing resources of LIS, and in particular to its high-performance computing cluster. The PhD will be integrated into and will complement the ANR JCJC PRESAGE (PREdicting Solar Activity using machine learning on heteroGEneous data) project (Oct. 2021 – Feb. 2027, partnership with Jean Aboudarham at LESIA). It will exploit and adapt the machine learning methods being developed within PRESAGE for the analysis of multimodal observations.

Expected skills:
MSc in computer science, data science, or physics, with strong experience in programming. Experience in machine learning and/or solar physics would be appreciated.

Point of contact:
Adeline Paiement, adeline.paiement@lis-lab.fr

To apply:
Applications should be sent to adeline.paiement@lis-lab.fr and comprise at a minimum:

- MSc transcripts
- At least one recommendation letter from an internship advisor
- CV and motivation letter