



Spectro-Temporal Feature Extraction for the classification on Satellite Image Time Series with Variational Gaussian Processes

Stage M2R

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1 Context

In the last years, the advent of Earth observation satellite missions with short revisit time and increased spatial resolution has led to an unprecedented amount of remote sensing images of heterogeneous physical nature (*e.g.*, optical & radar Sentinel time series ...) at various scales (*e.g.*, submetric, decametric ...). Furthermore, satellite image archives, such as *Spot Heritage*, are made available by many space agencies. Such massive data extend existing satellite and *in-situ* acquisition systems used to understand, explain and predict the states and trends of our environment. However, the novel complexity of the data makes the conventional analytical methods not adapted, and therefore not suitable for extracting and for processing all the relevant information from this massive flow of data.

In order to address challenges raised by such applicative domains, the interdisciplinary institute in artificial intelligence of Toulouse, named the Artificial and Natural Intelligence Toulouse Institute (ANITI) from which the CNES is partner, has been proposed to develop innovative solutions using theoretical advances in core AI scientific areas. The CESBIO lab, with J. Inglada and M. Fauvel, is part of the ANITI Chair entitled "*Data-driven approximate Bayesian computation for fusion-based inference from heterogeneous (remote sensing) data*" hold by Prof. N. Dobigeon.

A PhD thesis has started in September 2020 to work on large scale Gaussian Processes for the classification of land use and land cover using satellite image time series (SITS). Such methodology offers the possibility of optimizing the model parameters using standard stochastic techniques, and scales well with the size of the data to be processed. Results currently obtained on a large data set show promising results.

2 Objective

The objective of this master internship is to benefit from the current architecture to learn feature representations during the training process. Several feature reduction techniques

will be investigated to account for the structure of SITS, i.e., the spectro-temporal information, such as random matrix models, functional statistics, deep representation etc ...

The recruit will implement and test the different approaches using the processing chain developed by Valentine Bellet during her PhD work, and a critical comparison will be done on a large data set.

Developments will be done in Python, using the PyTorch and GPyTorch machine learning libraries.

3 Resources made available

The recruit will have access to :

- Full stacks of pre-processed Sentinel-2 satellite image time series.
- Access to the CNES HPC.
- A laptop and an office at the CESBIO-lab.

4 Recruit profile

The recruit should have strong knowledge and skills in :

- Machine learning and/or statistical learning,
- Remote sensing,
- Programming and computer science.

A good level of English is required. Experience with distributed version control systems (git) and the Python programming language would be appreciated.

5 Practical information

- Grant will be approximately around 620 euros per month.
- The internship will be located at CESBIO lab (Rond-Point du Professeur Francis Cambou 31400 Toulouse).
- Internship duration 6 months, starting from February or March 2022.
- To apply, send a detailed resume (including grades) and a motivation letter to valentine.bellet@univ-toulouse.fr, jordi.inglada@cesbio.eu and mathieu.fauvel@inrae.fr.