

Deep learning methods for crop type mapping on multi-modal satellite image time series

IGN - LASTIG Lab. - STRUDEL
73 avenue de Paris 94160 Saint-Mandé (France)

Context of the internship

The LASTIG lab of IGN is a research leader in the field of Geographical Information Sciences. The LASTIG-STRUDEL team studies data, data structures, machine learning algorithms and models for territory analysis. In this context, our team develops methods for structured classification/segmentation of image time series or point clouds.

Sentinel-1 and Sentinel-2 are two satellites from the European program Copernicus which produce dense open-access image time series. Sentinel-2 satellite provides multispectral (13 bands) high spatial resolution (10m) optical images every 5 days (see Fig. 1). However this image series is often affected by the cloud cover, resulting in missing data. Sentinel-1 satellite produces Radar images (2 channel bands with polarisation and $\sim 10\text{m}$ spatial resolution) every 3 days, alternating ascendant and descendant orbit acquisition. Missing data are very rare but the backscattering coefficient acquired by this sensor is highly dependant on meteorological conditions such as soil moisture. Both Sentinel-1 and Sentinel-2 times series consist of a large amount of data as they began : in 2015 and 2016 respectively.

The IGN and the LASTIG lab. are part of a national workgroup and an European project that aims at monitoring agricultural parcels. To control the grant of Common Agricultural Policy (CAP) subsidies, the EU recommends to switch from *on-field* random control to automatic control of all agricultural parcels using Sentinel-1 and Sentinel-2 image time series. As a result, robust automatic methods for crop type mapping at parcel level have to be developed. To this end, the crop type declared each year by farmers is gathered in a database (Land Parcellar Information System) and makes for an open and rich source of information for supervision (10 millions of annotations per year in France).

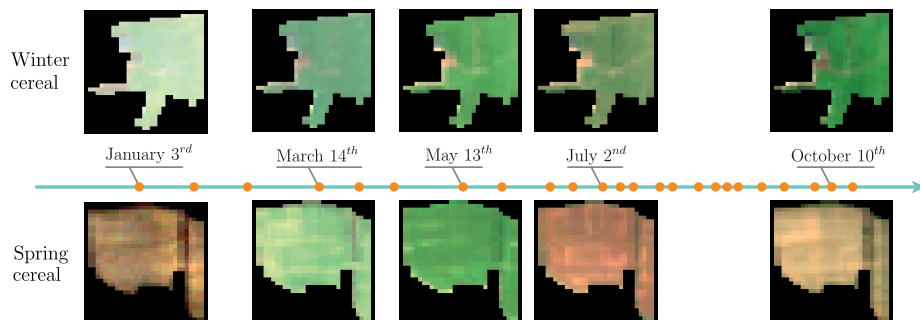


FIGURE 1 – Example of *Sentinel-2* time series (shown : RGB bands, 10m per pixel) for two parcels of the *Winter cereal* and *Spring cereal* classes. Note the importance of the temporal evolution of the parcels to discriminate between the classes.

Objectives of the internship

Recent works by our team¹ set up a new state-of-the-art in parcel classification by proposing a new architecture combining set-based encoders and self-attention mechanisms instead of the previous best methods using convolutional and recurrent neural networks. The objective of this internship is to first test the robustness and generalisation ability of this approach in new experimental settings comprised of diverse geographical areas and time-frame, and adapt the method to a multi-modal setting combining images and radar.

The intern will be provided with a large annotated dataset of satellite image time series of agricultural parcels covering several regions of France through three years. Using this dataset and the existing code base², the intern will first assess :

- The spatial generalisation capacity from one region to another
- The temporal generalisation capacity from one year to another
- The robustness of the approach to cloud obstruction
- The extendability of the approach to radar satellite imagery (Sentinel-1)

Secondly, the intern will work on improving the existing architecture by addressing the two following problems :

1. Does additional information (e.g. meteorological, terrain map) improve the spatial and temporal generalisation capacity? And how should one adapt the existing architecture to take advantage of these?
2. How should one fuse the optical and radar time series in an end-to-end trainable neural architecture?

Programming environment :

Python, PyTorch, Linux.

Requested Skills

Deep learning, Computer vision, Remote sensing, Time series analysis.
Proficiency in Python necessary, familiarity with Pytorch a plus

Internship details

5-6 months – starting of february/march 2020 – grant : 554.40 euros / month.
LASTIG Lab. is located at Saint-Mandé, bordering Paris (France) (easily accessible with subway : line 1).

Application process

Send a **CV** and a **cover letter** by e-mail to the following contacts **before December 20th**.

Contacts

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1. <https://arxiv.org/abs/1911.07757>

2. <https://github.com/VSainteuf/pytorch-psetae>