



INSTITUT NATIONAL  
DE L'INFORMATION  
GÉOGRAPHIQUE  
ET FORESTIÈRE

## Recurrent Neural Networks for the Classification and Segmentation of Agricultural Parcels from Multi-Sensor Time Series

**Institut national de l'information géographique et forestière (IGN)**

**Discipline :** Applied Mathematics

**Specialty :** Machine Learning

**Laboratoire:** LASTIG

**Research Team :** MATIS

**Location :** IGN, Saint-Mandé

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**Keywords:** remote sensing, recurrent neural networks, temporal data

### **MATIS Team**

The MATIS team is the computer science and applied mathematics department of the French National Mapping Agency (IGN). Its research focuses on remote sensing, computer vision and machine learning, among other subjects. It boasts a 32-members research which include 18 researchers and 9 PhD students.

### **Context**

The IGN is implied in the constitution of the Land-Parcel Identification Systems (LPIS), a geographic information system identifying the land use of agricultural parcels. The launch of the Sentinel satellites has made publicly available large quantity of data at an unprecedented temporal resolution. An automated analysis of this data would help achieve two new objectives set by the European Commission, following the 2016 recommendation of the Joint Research Center: pre-filling European farmers' tax returns and extending machine-assisted controls. The purpose of this PhD is to develop structured deep learning methods for the automatic classification and segmentation of agricultural parcels from optical and radar Sentinel time series.

### **Objectives**

The primary objective of this thesis is to use deep recurrent neural networks to classify each parcel and to develop an architecture well-adapted to the multiple time scale structuring agricultural time-series. Anonymized tax returns from previous years ensure that a large quantity of high-quality annotated data is available, as is suited for training such deep networks. This could also lead to the creation of a challenging open benchmark of time-structured, multi-sensor data.

The secondary objective is to achieve automatic segmentation of the parcels via a variational model automatically parameterized with a structured deep model. The challenge relies on being able to learn compact yet discriminative deep embeddings of multi-sensor, multi-spectral, multi-temporal acquisitions. Fast working-set algorithms would then be employed to solve the resulting large-scale partition problems.

## Expected profile

A keen graduate student with basic knowledge of machine learning and computer programming (python, c++ and deep learning frameworks such as PyTorch a plus). Familiarity with deep learning and remote sensing preferable, but not required. Must have a good level of english is required, French optional.

## Thesis supervision

**Thesis supervisor:** Nesrine Chehata (MCF INP Bordeaux, HDR Université Paris Est)

**Co-advisor:** Loic Landrieu (IGN, Dr.), Sébastien Giordano (IGN, Dr.)

## Doctoral contract

3-year contrat with a monthly gross salary of 1680€, which can be supplemented by a teaching assistantship. Work location at the St Mandé Lab, 5 minutes from Paris by metro.

## Required documents :

1. a CV
2. a personalised cover letter detailing the interest in the topic
3. grade transcripts for most recent diploma
4. recommendation letters and/or references

## References :

European Commission, Towards future Copernicus service components in support to agriculture? [https://ec.europa.eu/jrc/sites/jrcsh/files/Copernicus\\_concept\\_note\\_agriculture.pdf](https://ec.europa.eu/jrc/sites/jrcsh/files/Copernicus_concept_note_agriculture.pdf), 2016.

J. Inglada, M. Arias, B. Tardy, O. Hagolle, S. Valero, D. Morin, G. Dedieu, G. Sepulcre, S. Bontemps, P. Defourny, et al., Assessment of an operational system for crop type map production using high temporal and spatial resolution satellite optical imagery, *Remote Sensing* 7 (2015).

N. Kussul, G. Lemoine, F. J. Gallego, S. V. Skakun, M. Lavreniuk, A. Y. Shelestov, Parcel-based crop classification in Ukraine using Landsat-8 data and Sentinel-1a data, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* 9 (2016) 2500–2508.

J. Osman, J. Inglada, J.-F. Dejoux, Assessment of a Markov logic model of crop rotations for early crop mapping, *Computers and Electronics in Agriculture* 113 (2015).

Lipton, Z. C., Berkowitz, J., & Elkan, C. (2015). A critical review of recurrent neural networks for sequence learning. arXiv preprint arXiv:1506.00019.

Junyoung Chung, Çağlar Gülçehre, KyungHyun Cho, and Yoshua Bengio. Empirical evaluation of gated recurrent neural networks on sequence modeling. *CoRR*, 2014.