Deep learning and hierarchical image representations
Postdoc (24 months) within OBELIX group (Vannes, France)

Deep learning has led to significant breakthroughs in the recent years, including in remote sensing (e.g. semantic segmentation for land cover mapping, change detection, object detection, …). However, existing deep architectures offer limited solutions to take into account the multiscale property of spatial information. It is mainly done through pooling layers that allows to extend the analysis windows while reducing the image resolution. Combining multiple scales in a single architecture has been suggested by a few authors (PhD of Emmanuel Maggiori 2014-2017, PhD of Nicolas Audebert 2015-2018). Nevertheless, despite computational gains offered by recent GPU-based architectures, some challenges remain to deliver deep learning solutions for realistic geospatial contexts (e.g. near real-time and large-scale object detection or mapping).

Among the existing methodologies for rapid and large-scale processing of remote sensing data, morphological hierarchical image representations (also called tree-based representations, e.g. min and max-tree, alpha-tree, binary partition tree) allow efficient access to image content (in logarithmic time instead of linear time) and lead to rapid image processing methods based on the analysis of the associated representations (e.g. image description at the pixel, region, or tile level; interest region detection; segmentation; multisource classification; etc.). However, these approaches remain limited by their deterministic behavior and require to be coupled with machine learning techniques to ensure robustness against the variety of images, scenes, sensors and contexts considered. Some first attempts have been made in the OBELIX group with kernel methods (PhD of Yanwei Cui, 2013-2017; Remote Sensing, 2017) and Bayesian models (MSc of Abdullah Al-Dujaili, 2014; ISMM, 2015). Another approach has been explored in the PhD of Emmanuel Maggiori. These various results, while promising, need to be pursued with more successful machine learning solutions such as deep networks.

The OBELIX group has a strong expertise in both deep learning (PhD of Nicolas Audebert; ACCV 2016; Remote Sensing 2017; ISPRS Journal 2018) and hierarchical representations (BMVC 2015; JRTIP 2016; TGRS 2016; PE&RS 2017; Remote Sensing 2017; TGRS 2018; JSTARS 2018; Journal of Imaging 2018). The postdoc project builds upon this joint expertise to focus on the interface between deep learning and hierarchical representations. The objectif is to couple both paradigms to build more efficient tools in semantic segmentation of satellite imagery, object detection in aerial imagery, etc.

The challenges to be addressed will include: 1) supervised learning of hierarchical representations (i.e. adapted to image content and embedding some semantics) through deep learning; 2) application of deep networks to hierarchical representations in order to better take into account the multiscale nature of spatial information and to improve performances; 3) coupling of these two complementary strategies. These various developments will be validated on aerial and satellite datasets.

The postdoc will join the OBELIX group in Vannes (see www.irisa.fr/obelix), a leading group in machine learning and image analysis for remote sensing data. Vannes offers very good living conditions.

Requirements

- PhD in machine learning, computer vision, image analysis, or mathematical morphology
- **Proven expertise in deep learning OR hierarchical representations** (candidates with both skills will be preferred): convincing arguments should be provided in the cover letter
- Programming skills (e.g. Python or C++)
- Experience in remote sensing would be appreciated
- Very good oral/written English communication abilities
- **At least 12 months spent out of France within the last 3 years** (requirement due to funding agency)

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References see https://scholar.google.fr/citations?user=C_8NI7IAAAAJ
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