# China Scholarship Council / Université de Lyon
# Scholarships for doctoral mobility

## Call for Thesis subjects for 2020/2021

**RESEARCH SUBJECT TITLE:**
Embedded and interactive deep learning: application to plant recognition on smartphone

**Name of the laboratory**:
Website: http://liris.cnrs.fr

**Name of the research team**:
Website:https://liris.cnrs.fr/equipe/imagine

**Name of the supervisor:**
University / Institution: Université Lyon 2
E-mail address: laure.tougne@liris.cnrs.fr
(co-supervisor : carlos.crispim-junior@liris.cnrs.fr)

**Doctoral School:**
École Doctorale InfoMaths (ED 512)

**Lab Language:**
English / French

**Minimum language level required:**
- English: C1
- French: B1
- Other:

**Abstract:**
For several years, the LIRIS laboratory and in particular researchers from the Imagine team have been interested in the recognition of plants on Smartphone. This is an interesting theme for several reasons; in particular, it is an example of machine learning with low computer resources (low computing resources, low memory resources, network not always available, *etc.*). Moreover, it is a use case in which user interactions are "natural" and can be taken into account in the recognition mechanism. Finally, teaching

everyone to recognize the plants around them is a way to get a little closer to nature, whereas the increasing urbanization tends to take us away from it.

This research began in 2010, in the framework of ANR ReVes[1], where work in segmentation [13, 9] and extraction of tree leaf characteristics [7, 10, 12, 11, 8, 14], in the context of Guillaume Cerutti's PhD thesis [6], has led to the development of an application called Folia for the recognition of trees and shrubs from photos of their leaves on smartphones. This application, which is interactive and whose treatments are fully embedded, has been freely available on the AppStore for 6 years. A study in human and social sciences of its use was the subject of a project funded by the Institut des Mondes Urbains[2].

Subsequently, research was oriented towards other organs such as bark [3, 2] and fruits/flowers [4], within the context of Sarah Bertrand's PhD thesis [1], which led to a multi-organ recognition of plants. This work was carried out within the framework of ANR ReVeRIES[3]. In this context also, we have worked on a deep learning version [5, 15] of the Folia application.

This latest research has raised a number of scientific questions among which the following two that we would like to try to answer in the framework of this thesis:

- Interactive learning

How to take into account user interactions in a deep learning approach? The idea here is that models provide predictions with a certain reliability related to their learning. The question is how to improve these predictions by integrating the human in the loop, especially since interactions are easy with a smartphone. This question refers to the notion of "sequential learning" in the literature.

- Combined learning

Is it possible and cost-effective to mix hancrafted features and features extracted automatically via convolution networks? If so, with which strategy? In the context of plant recognition, it is possible to rely on botanical knowledge to recognize organs. The fusion of botanically based extracted features with features extracted automatically via convolution networks should improve the performance and robustness of the latter. To do this, the idea is to define losses that take into account the handcrafted characteristics.

Questions that resonate with the current state of the art and to which this study can contribute.

[1] https://anr.fr/Projet-ANR-10-CORD-0005
[2] https://imu.universite-lyon.fr/projet/reveurs-reconnaissance-et-inventaire-de-vegetaux-en-milieu-urbain-sciences-participatives-et-usages-sociaux-dune-interface-smartphone/
[3] https://anr.fr/Projet-ANR-15-CE38-0004

**Expected duration of the thesis:** (36 or 48 months)

36 or 48 months depending on the candidate

**References:**

[1] Sarah Bertrand. Analyse d'images pour l'identification multi-organes d'espèces végétales. Working paper or preprint, December 2018.

[2] Sarah Bertrand, Rihab Ben Ameur, Guillaume Cerutti, Didier Coquin, Lionel Valet, and Laure Tougne. Bark and Leaf Fusion Systems to Improve Automatic Tree Species Recognition. Ecological Informatics, June 2018.

[3] Sarah Bertrand, Guillaume Cerutti, and Laure Tougne. Bark Recognition to Improve Leaf-based Classification in Didactic Tree Species Identification. In VISAPP 2017 - 12th International Conference on Computer Vision Theory and Applications, Porto, Portugal, February 2017.

[4] Sarah Bertrand, Guillaume Cerutti, and Laure Tougne. Segmentation Algorithm on Smartphone Dual Camera: Application to Plant Organs in the Wild. In 10th International Conference on Machine Vision, Vienna, Austria, November 2017.

[5] Sarah Bertrand, Guillaume Cerutti, and Laure Tougne. Visualization of Leaf Botanical Features Extracted from AlexNet Convolutional Layers. IAMPS - International Workshop on Image Analysis Methods for the Plant Sciences 2018, January 2018.

[6]GuillaumeCerutti. Segmentation et interprétation d'images naturelles pour l'identification de feuilles d'arbres sur smartphone. working paper or preprint, November 2013.

[7] Guillaume Cerutti, Violaine Antoine, Laure Tougne, Julien Mille, Lionel Valet, Didier Coquin, and Antoine Vacavant. ReVeS Participation - Tree Species Classification using Random Forests and Botanical Features. In Conference and Labs of the Evaluation Forum (CLEF), page 1, Rome, Italy, September 2012.

[8] Guillaume Cerutti, Laure Tougne, Didier Coquin, and Antoine Vacavant. Leaf margins as sequences: A structural approach to leaf identification. Pattern Recognition Letters, 49(2014):177–184, November 2014.

[9] Guillaume Cerutti, Laure Tougne, Julien Mille, Antoine Vacavant, and Di- dier Coquin. Guiding Active Contours for Tree Leaf Segmentation and Identification. In CLEF 2011, Conference on Multilingual and Multimodal Information Access Evaluation, page 1, Amsterdam, Netherlands, September 2011.

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[11] Guillaume Cerutti, Laure Tougne, Julien Mille, Antoine Vacavant, and Di- dier Coquin. Understanding Leaves in Natural Images - A Model-Based Approach for Tree Species Identification. Computer Vision and Image Un- derstanding, 117(10):1482–1501, October 2013.

[12] Guillaume Cerutti, Laure Tougne, C´eline Sacca, Thierry Joliveau, Pierre- Olivier Mazagol, Didier Coquin, and Antoine Vacavant. Late Informa- tion Fusion for Multi-modality Plant Species Identification. In Conference and Labs of the Evaluation Forum, page Working Notes, Valencia, Spain, September 2013.

[13] Guillaume Cerutti, Laure Tougne, Antoine Vacavant, and Didier Coquin. A Parametric Active Polygon for Leaf Segmentation and Shape Estimation. In 7th International Symposium on Visual Computing, pages 202–213, Las Vegas, United States, September 2011.

[14] Manuel Grand-Brochier, Antoine Vacavant, Guillaume Cerutti, Camille Kurtz, Jonathan Weber, and Laure Tougne. Tree leaves extraction in natural images: Comparative study of pre-processing tools and segmentation methods. IEEE Transactions on Image Processing, 24(5):1549–1560, 2015.

[15] Debaleena Misra, Carlos Crispim Junior, and Laure Tougne. Patch-based CNN evaluation for bark classification. In Computer Vision Problems in Plant Phenotyping Workshop, CVPR 2020.