



Doctoral Thesis (set): Improved characterization and modeling of forest stands using deep learning techniques from LiDAR, multispectral images.

PhD Student:

Supervisor/s: Luis Ángel Ruiz Fernández, Santiago Martín Alcón, Pablo Crespo Peremarch

Abstract: DDD: The accurate characterization of forest stands and the estimation of their dasometric variables are fundamental for sustainable forest management and environmental policy decision making. The availability of LiDAR and orthophotos from the National Aerial Orthophotography Plan (PNOA), together with Sentinel-2 multispectral images (Drusch et al., 2012), offers a unique opportunity to develop advanced methods for classification and estimation of forest parameters at national scale from open data. In this context, deep learning techniques have shown great potential for processing and interpreting remotely sensed data, overcoming the limitations of traditional methods (Zhu et al., 2017)

Using LiDAR, multispectral and multispectral images as input data, this thesis poses two main objectives: (i) To study and develop a classification methodology using convolutional neural networks to characterize forest stands in three Spanish biogeographic regions (Mediterranean, Atlantic and inland), considering dependent variables such as cover, height classes and species. (ii) To generate regression models based on neural networks for the estimation of stand-level dasometric variables such as volume, density or basal area in the same three biogeographic regions as the classification. More specifically, we intend to study and improve the architecture of neural networks for classification and regression problems in forest remote sensing data (Kattenborn et al., 2021) and multisource remote sensing data fusion techniques (Samadzadegan et al., 2025).

The results of this research aim to contribute to the development of operational tools for the characterization and monitoring of forest stands at the national scale, providing a methodological basis for the periodic updating of forest inventories using remote sensing and deep learning techniques.

Available Means: The thesis plan will be carried out in the context of an industrial thesis with AGRESTA S.COOP financed by the “Ayudas para la formación de doctores y doctoras en empresas y otras entidades ‘doctorados industriales’” financed by the ministry of science, innovation and universities of Spain.

References:

- Drusch, M., Del Bello, U., Carlier, S., Colin, O., Fernandez, V., Gascon, F., Hoersch, B., Isola, C., Laberinti, P., Martimort, P., Meygret, A., Spoto, F., Sy, O., Marchese, F., & Bargellini, P. (2012). Sentinel-2: ESA's Optical High-Resolution Mission for GMES Operational Services. *Remote Sensing of Environment*, 120, 25-36. <https://doi.org/10.1016/j.rse.2011.11.026>
- Kattenborn, T., Leitloff, J., Schiefer, F., & Hinz, S. (2021). Review on Convolutional Neural Networks (CNN) in vegetation remote sensing. *ISPRS Journal of Photogrammetry and Remote Sensing*, 173, 24-49. <https://doi.org/10.1016/j.isprsjprs.2020.12.010>
- Samadzadegan, F., Toosi, A., & Dadrass Javan, F. (2025). A critical review on multi-sensor and multi-platform remote sensing data fusion approaches: Current status and prospects. *International Journal of Remote Sensing*, 46(3), 1327-1402. <https://doi.org/10.1080/01431161.2024.2429784>



UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA



DEPARTAMENTO DE INGENIERÍA
CARTOGRÁFICA, GEODESIA Y
FOTOGRAMETRÍA

Zhu, X. X., Tuia, D., Mou, L., Xia, G.-S., Zhang, L., Xu, F., & Fraundorfer, F. (2017). Deep Learning in Remote Sensing: A Comprehensive Review and List of Resources. *IEEE Geoscience and Remote Sensing Magazine*, 5(4), 8-36. IEEE Geoscience and Remote Sensing Magazine.
<https://doi.org/10.1109/MGRS.2017.2762307>