

Developing a Super-Resolution Benchmark for Remote Sensing Downstream Applications

Internship for Master 2 or École d'Ingénieur student

Expected starting date: February/March 2026 (6 months)

Keywords super-resolution, downstream applications, Sentinel-2, super-resolution metrics

Context and Objectives

Scientific context. The spatial resolution of freely available multispectral sensors such as Sentinel-2 (10 meter at best) remains a limiting factor for many Earth observation tasks, particularly those involving fine-scale spatial structures such as the delineation of crop boundaries, mapping of urban trees, or identification of individual buildings. Deep learning-based super-resolution (SR) techniques have emerged as an attractive solution to synthetically enhance the spatial detail of such imagery [4]. While numerous SR methods, ranging from convolutional neural networks to transformers and generative models [3], have been proposed, their evaluation typically relies on reconstruction and perceptual metrics. These measures, though common, are tailored for SR models trained on natural images and overlooked challenges caused by cross-sensor SR from satellite images [2]. More importantly, they do not indicate whether the super-resolved data improve the performance, robustness, or interpretability of downstream models used for Earth monitoring [5].

Objectives of this work. This internship aims to bridge this gap by developing a comprehensive benchmark of SR models for downstream learning applications in Earth observation. The goal is to quantify how the reconstruction of fine details in SR imagery impacts the performance of subsequent analysis tasks. The focus will be on Copernicus data, in particular Sentinel-2 imagery, which is freely available and provides global coverage with acquisitions every five days at the equator. The benchmark will include both standard image-based metrics and newly proposed task-aware evaluation criteria tailored to the selected applications.

Work Plan

To address the aforementioned objectives, a tentative work plan is outlined below:

- **Literature review:** Survey recent SR models and their evaluation in downstream applications using Sentinel-2 or similar optical data.
- **Benchmark design:** Identify suitable datasets combining *Sentinel-2* imagery and higher-resolution references (*e.g.*, PlanetScope, WorldView, or aerial data) for multiple domains such as agriculture, forestry, maritime [1], and urban monitoring.
- **Metric development:** Explore and propose new metrics that go beyond classical reconstruction or segmentation scores. The objective is to assess how SR influences application-level outcomes, *e.g.*, boundary delineation [6], small-object detection, or vegetation index preservation.
- **Experimental benchmarking:** Implement and compare several SR models within a unified experimental setup, evaluating their performance using both conventional and newly defined task-aware metrics.

The expected outcomes include a benchmark framework enabling the community to evaluate SR models on a range of downstream applications, as well as a research paper submitted to a top-tier journal.

Candidate Profile

We are looking for a candidate:

- enrolled in a Master 2, *École d'Ingénieur*, or equivalent program in computer science, data science, or geoinformatics;
- with a strong background in data science, and/or computer vision;
- proficient in Python programming and familiar with at least one deep learning framework (preferably PyTorch);
- with experience in remote sensing or a strong motivation to apply AI to Earth observation;
- with excellent communication skills in French or English;
- and a keen interest in research and scientific publication.

Organisation

The internship can start around February/March and last for 4–6 months. The research will take place at *Université Bretagne Sud* in Vannes, within the OBELIX research group (www.irisa.fr/obelix) of IRISA (UMR 6074).

The intern will be supervised by:

- Dr. Charlotte Pelletier¹, Associate Professor (Maîtresse de Conférences), UBS/IRISA.
- Dr. Thomas Copetti², Research Director, CNRS/LETG

The intern will also benefit from the experience and expertise of two PhD candidates, Aimi Okabayashi and Louis François-Downey, from the OBELIX group. This internship is funded through a CNES (French Space Agency) TOSCA project on vegetation monitoring in urban areas. Collaborations with researchers from the LETG laboratory in Rennes are also expected.

Application

Applicants should send their **CV** and **transcripts** for the last two academic years (equivalent to Master) to:

- charlotte.pelletier@univ-ubs.fr
- thomas.corpetti@univ-rennes2.fr

Deadline: 15 December 2025. Selected candidates will be contacted on an ongoing basis for an interview.

References

- [1] Katerina Kikaki, Ioannis Kakogeorgiou, Paraskevi Mikeli, Dionysios E Raitzos, and Konstantinos Karantzas. MARIDA: A benchmark for marine debris detection from Sentinel-2 remote sensing data. *PloS one*, 17(1):e0262247, 2022.
- [2] Julien Michel, Ekaterina Kalinicheva, and Jordi Inglada. Revisiting remote sensing cross-sensor single image super-resolution: the overlooked impact of geometric and radiometric distortion. *IEEE Transactions on Geoscience and Remote Sensing*, 2025.
- [3] Aimi Okabayashi, Nicolas Audebert, Simon Donike, and Charlotte Pelletier. Cross-sensor super-resolution of irregularly sampled sentinel-2 time series. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, pages 502–511, 2024.
- [4] Peijuan Wang, Bulent Bayram, and Elif Sertel. A comprehensive review on deep learning based remote sensing image super-resolution methods. *Earth-Science Reviews*, 232:104110, 2022.
- [5] Piper Wolters, Favyen Bastani, and Aniruddha Kembhavi. Zooming out on zooming in: Advancing super-resolution for remote sensing. *arXiv preprint arXiv:2311.18082*, 2023.
- [6] Quentin Yeche, Dino Ienco, and Raffaele Gaetano. Field by field: moving from area-based metrics to instance-level agricultural parcel assessment. 2025.

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