Geo-information Optical And Vector models (GeOpAVe)

Post-doctoral position

General information

- Keywords: Computer vision, Deep Learning, GIS, Remote sensing, Multi-modality
- Duration of the post-doc: 12 months
- Institute: Université de Paris, Laboratoire d'Informatique Paris Descartes (LIPADE), team Systèmes Intelligents de Perception
- Location: 45 rue des Saints-Pères, 75006 Paris
- Supervisor: Sylvain Lobry
- Application: send an email to sylvain.lobry "at" u-paris "dot" fr with the subject "[Postdoc GeOpAVe] FirstName LastName" containing:
  - updated CV;
  - cover letter;
  - contact information of a teacher/supervisor willing to write a recommendation letter.
- The position is open until filled. The first round of review of applications will be in early January 2025.

Introduction

Many foundation models working on geo-information data, in particular remote sensing images, are being developed [1]. However, most of these models focus on a single type of modality (e.g. images). In this project, our objective is to jointly work on two complementing modalities: optical remote sensing images (e.g. high-resolution orthophotos) and vector data (e.g. OpenStreetMap, OSM). An example of both of these modalities is shown in Figure 1. Such a model should use the strength of each modality (generally well located, high semantic information from vector data, up-to-date and more feature-rich view of optical imagery) to improve the performances with respect to a single-modality model. We also propose to study the robustness of the model with respect to frequently occurring degradations of each of these modalities: vector data is difficult to keep up-to-date, while optical data is subject to occluding information, such as clouds or wildfires. In recent literature, many works aim at predicting outputs in a vectorial form, in particular for the updating of maps. Indeed, this data is more adapted to GIS databases. For instance, the authors of [2, 3] propose methods for building polygonization from optical data. This data has been used in conjunction with optical remote sensing data for the creation of datasets [4]. In this work, the objective is to use such data as an input to the model.

Objectives

The GeOpAVe project is led by Université Paris Cité and financed by Google. In this project, we propose to tackle three research objectives:

1. Developing a model that is able to take both optical remote sensing data and vectorial data as an input, and assess its prediction capabilities on an object detection task. We will focus on targets that are not referenced in the vector data (e.g. cars). The performances of this model will be compared with respect to single-modality baselines.
2. Assessing the robustness of the model to errors in the vector data.
3. Assessing the robustness of the model to missing optical data (e.g. in the presence of clouds, wildfires).

Figure 1.a: 20cm orthophoto

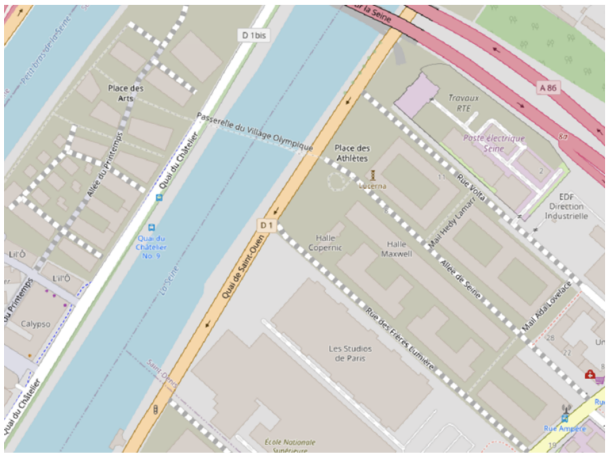

Figure 1.b: OpenStreetMap

Figure 1: IGN's BDORTHO and OpenStreetMap data of the Olympic Village in Paris, France. While some of the buildings are already mapped in OSM, they do not appear yet on the optical image. However, the optical image shows additional objects with respect to OSM, such as cars on roads and trees.

The selected candidate will first review the state of the art for object detection on remote sensing images, and the use of vectorial data in deep learning models. The candidate will then propose a methodology to build a dataset containing both modalities. Finally, the candidate will propose a model which can take both modalities as input. This project is done in collaboration with Google. As such, the candidate will regularly share the progress with the teams at Google during the course of the contract.

Desired background of the candidate

We are looking for a recently graduated PhD. The ideal candidate would have a theoretical background in computer vision, remote sensing and be proficient in programming with Python. Knowledge in GIS is a plus.

Bibliography

[1] Johannes Jakubik et al. *Foundation Models for Generalist Geospatial Artificial Intelligence*. arXiv:2310.18660 [cs]. Nov. 2023. URL: http://arxiv.org/abs/2310.18660 (visited on 02/15/2024).

[2] Jichong Yin, Fang Wu, and Yuyang Qi. "Vector mapping method for buildings in remote sensing images based on joint semantic-geometric learning". In: *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* (2023).

[3] Yajin Xu, Philipp Schuegraf, and Ksenia Bittner. "Vertex Aided Building Polygonization from Satellite Imagery Applying Deep Learning". In: *2023 Joint Urban Remote Sensing Event (JURSE)*. IEEE. 2023, pp. 1–4.

[4] Sylvain Lobry and Devis Tuia. "Visual question answering on remote sensing images". In: *Advances in Machine Learning and Image Analysis for GeoAI*. Elsevier, 2024, pp. 237–254.