



**Post doctoral position**

## **Heterogeneous data registration for 3D reconstruction of the territory**

ACTE Team / LaSTIG Lab/ Ecole Nationale des Sciences Géographiques (ENSG)

Université Gustave Eiffel (UGE) / Institut National de l'Information Géographique et Forestière (IGN)

LuxCarta

**Discipline** : Computer science

**Speciality** : Geographic Information sciences

**Research unit** : LaSTIG/IGN and LuxCarta

**Main workplace** : IGN, 73 av de Paris, 94 135 Saint Mandé

**Postdoc duration**: 24 months

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## **Context**

The National Institute for Geographic and Forest Information (IGN) is the reference operator for geographic and forest information in France. IGN is currently setting up an ambitious national digital twin project aimed, among other things, at faithful, detailed and precise 3D modeling of the entire French territory. IGN is also currently leading the Lidar HD project to cover the metropolitan territory by Lidar at 10 points per m<sup>2</sup>.

The LASTIG (Laboratory in Geographic Information Sciences and Technologies for the smart city and sustainable territories) conducts targeted research in the sciences and techniques of geographic information. The unit's research covers the entire life cycle of geographic or spatial data, from its acquisition to its visualization, including its modeling, integration and analysis. LASTIG is particularly interested in spatial geographic repositories. that are at the heart of IGN's missions. The LASTIG is composed of four research teams, including the ACTE team (ACquisition and TraitEments) which is more particularly interested in the collection and processing of remote sensing data (Image, Lidar, Radar) collected from satellite, airborne or terrestrial platforms.

LuxCarta Technology is a small company, which benefits from 30 years of experience in the production of geo-data, and is one of the world's leading producers of 2D/3D geographic data. LuxCarta operates in 4 main markets: telecommunications, urban planning, navigation and simulation for civil & defense applications. Since its creation, LuxCarta has carried out an important R&D component, and works in particular on the implementation of techniques which allow the automation of the restitution of geo-data; the R&D team has notably developed an automatic chain for the 3D reconstruction of urban scenes with metric precision.

This post-doctorate will take place within the framework of the GENESE project of which LuxCarta is the coordinator. The objective of the GENESE project is to propose a solution for the automatic generation of synthetic environments (example of a synthetic environment generated automatically <https://www.youtube.com/watch?v=PDNMTAzw6Z8>) in particular for terrestrial and air-terrestrial applications, from satellite images as well as any other pre-existing data available: Lidar, vector maps, etc.

One of the main applications of remote sensing data mentioned above is the production of 3D city models. These models, whose structure and levels of detail are defined by the CityGML standard (ref. Fig. 1), have numerous applications: town planning, visualization/communication/consultation, simulation.

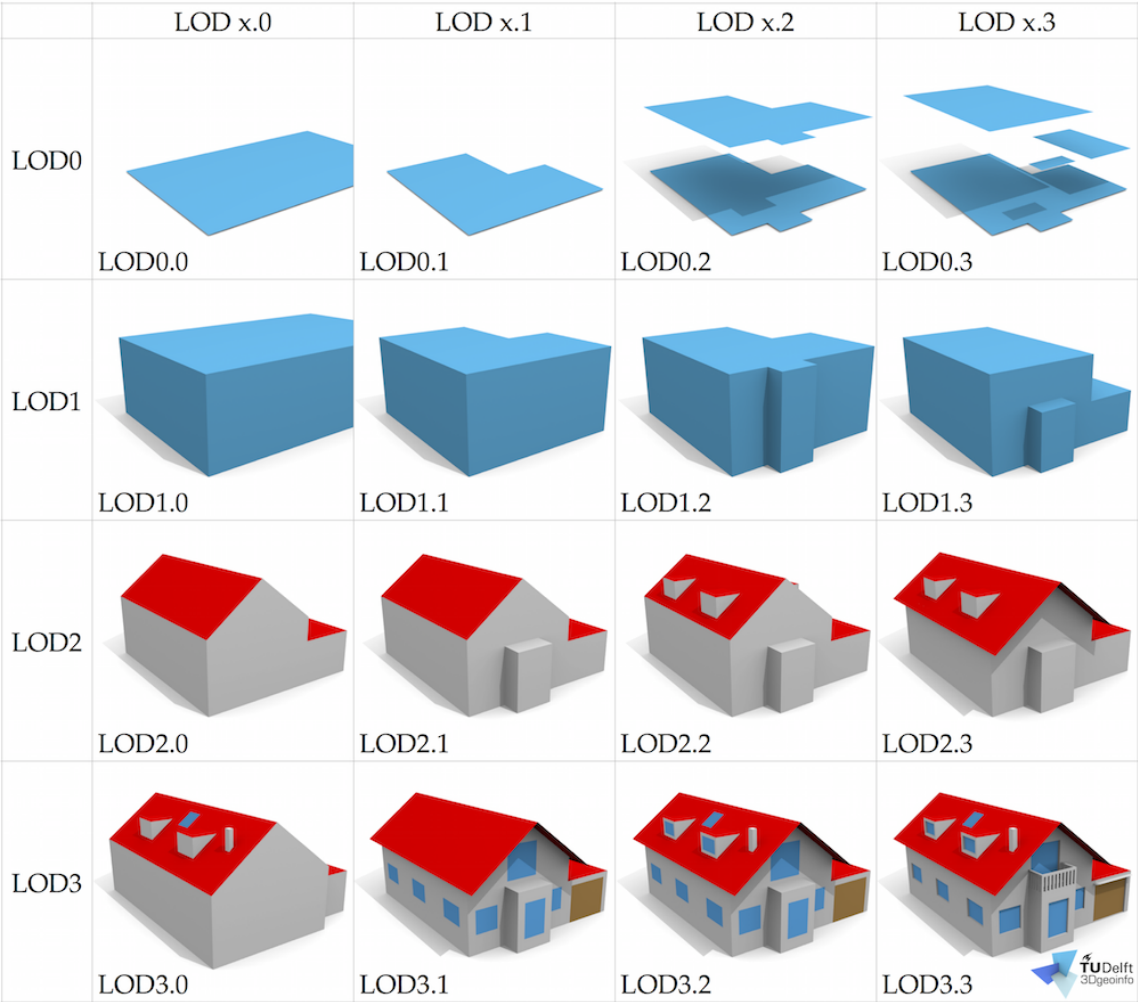


Figure 1: levels of details defined by the CityGML norm (credits 3Dgeoinfo, TUDelft)

# Goals

In this context, the goals of the proposed post doc is to merge data from several different sources, including satellite images, Lidar and vector maps, in order to:

1. maximize the quality of the result,
2. estimate the confidence of the results,
3. get consistent maps.

The work will focus on two specific themes:

1. Alignment and fusion of vector maps: vectors produced manually such as the IGN Topo BD or OpenStreetMap, and vectors automatically reconstructed from satellite images or Lidar data. The challenge in this project is to find a robust methodology to aggregate a set of vectors (linear or polygons) from two or more sources to obtain:
  - a. a single merged representation,
  - b. a reliability score for each item.
2. The goal is to develop a technique for merging and regularizing vectors, such that the quality of the resulting cartographic models is sufficient to meet the needs of the target markets.
3. Development of 3D reconstruction methods for buildings by merging high-density Lidar data and optical, satellite or aerial images, in order to considerably increase the geometric precision of the reconstructed models.

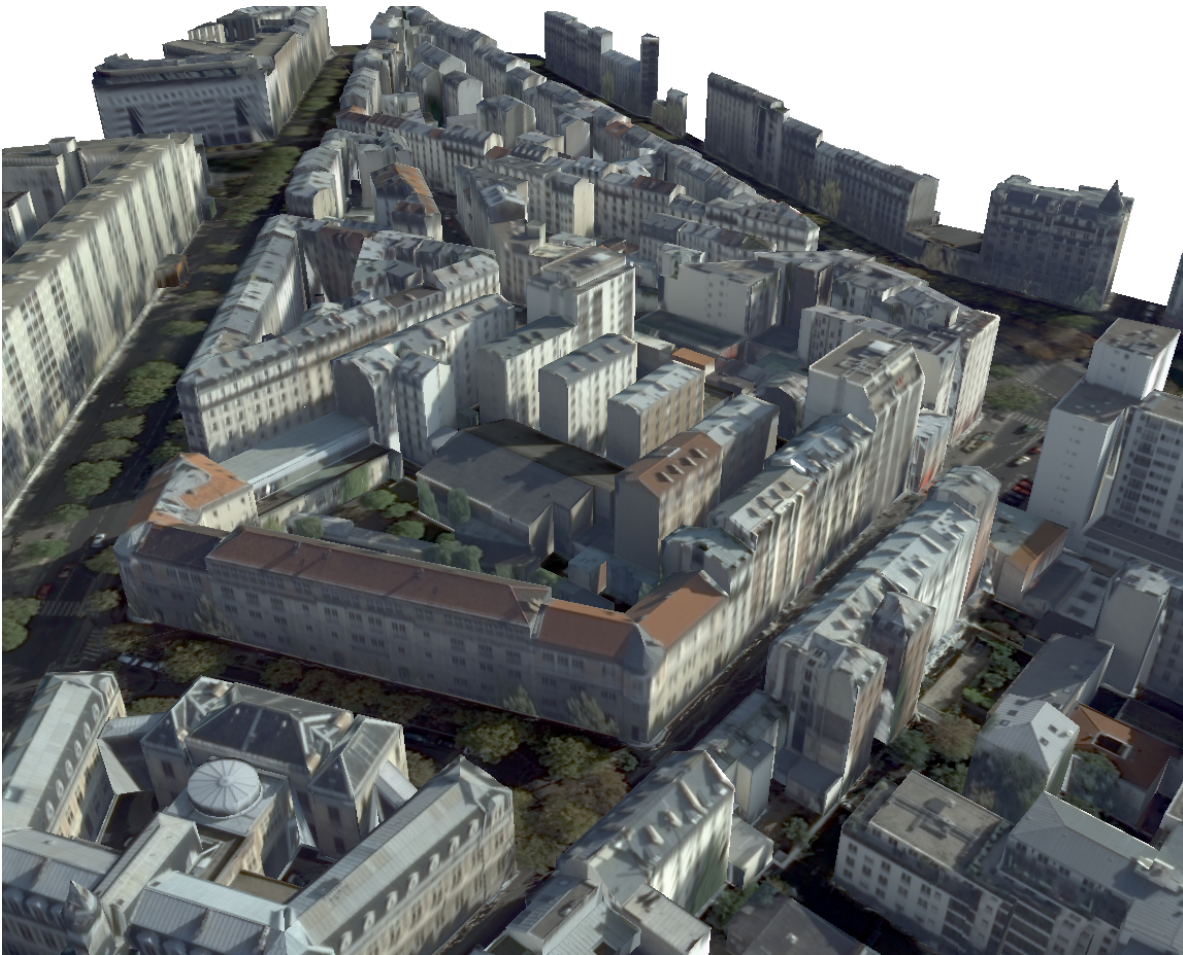


Figure 2: 3D city model (Paris, XIIIth district city hall) produced by IGN with a semi automatic reconstruction method (Bati3D).

## Work program

The proposed post-doc topic therefore concerns the geometric coherence of heterogeneous data sources and the exploitation of their complementarities to maximize the quality of 3D modeling. The work will be broken down into:

- A state of the art of current methods for panoptic segmentation (combining classification and object detection) of images and point clouds, extraction of primitives and 3D reconstruction in urban environments.
- A study of the CityGML format and the specifications of the 3D productions expected by the GENESE project.
- The appropriation of the chain's input data: oriented satellite images, Lidar point clouds, vector maps (IGN BD Topo and OpenStreetMap).
- The proposal of a registration method between heterogeneous vector data (linear and closed polygons)
- The proposal of a 3D reconstruction method meeting the objectives and specification from all the readjusted data.