

# Auto-encoders for geometric shape understanding in SAR images

Place and dates: Télécom Paris, Matser 2 internship starting from march 2022 Supervision: Florence Tupin, (Télécom Paris, florence.tupin@telecom-paristech.fr), Loïc Denis (Télécom Saint Etienne, loic.denis@univ-st-etienne.fr), Alasdair Newson, Emanuele Dalsasso

## Context

SAR (synthetic aperture radar) data are obtained by recording the electro-magnetic field backscattered by the objects lying on the ground surface. The recorded signal is a complex number whose modulus is related to the backscattering properties of the surface. This "coherent" imaging allows, by combining several images, to reconstruct in 3D or to detect very small displacements (a few mm on buildings). On the other hand, unlike the usual "incoherent" imaging, it results in high noise (called speckle) on the images, characterized by significant variations in gray levels even on physically homogeneous surfaces. In addition, because of the lateral view, objects with a certain height will induce shadow areas (the area behind the object is not illuminated) and overlay areas (superposition of 2 or even more signals). These phenomena lead to a particular signature in the image for buildings in a scene as shown in the figure below.



Buildings show a specific signature in SAR images, with different charactertic areas (overlay, corner reflector, roof and shadow).

### Deep learning for building detection

Deep learning has allowed very significant advances in image processing in recent years, whether for denoising, segmentation, detection or recognition problems. Auto-encoding networks allow to reduce the dimension of images and to find a small number of significant variables in a so-called "latent" space capturing most of the information. The objective of this internship is to study this space in the case of SAR data representing simple building shapes in order to try to find geometric information characteristic of the building: orientation, dimension and height. We will rely in particular on the work developed in [1, 2].

#### **Practical inormation**

The internship will take place in the IMAGES (Image, Modeling, Analysis, Geometry and Synthesis) of IDS departement (Image, Data, Signal) of Télécom Paris, laboratoire LTCI. It will be supervised by Florence Tupin, Alasdair Newson and Emanuele Dalsasso at Télécom Paris, and Loïc Denis at Télécom Saint-Etienne.

### Skills

The subject requires good knowledge in image and signal processing, learning and programming. An interest in the implementation of methods on simulated and real data is essential.

## References

- A. Newson, A. Almansa, Y. Gousseau, and S. Ladjal, "Processing Simple Geometric Attributes with Autoencoders," *Journal of Mathematical Imaging and Vision*, 2019.
  [Online]. Available: https://hal.archives-ouvertes.fr/hal-02271281/document
- [2] C.-H. Pham, S. Ladjal, and A. Newson, "PCAAE: Principal Component Analysis Autoencoder for organising the latent space of generative networks," *Preprint*, 2020. [Online]. Available: arXiv:2006.07827