Questions

Your team want to measure soil artificialization on the Saclay Plateau, on an area of 80km^2, for the past 5 years. Artificialization is the process involving loss of natural, agricultural or forest areas, and the construction of new road or new buildings. You are conducting a study to choose the best sensors for this task, and the associated AI framework.

After looking online, you find these characteristics for the sensors:

	Optical sensors		SAR sensors	
	Sentinel-2	Pléiades	Sentinel-1	TerraSAR-X/TanDEM-X
Resolution	10m	0.70m	10m	1m
Swath	290km	14km	250km	10km
Repeat time	5 days	25 days	6 days	11 days
3D	No	Tri-stereo mode	Interferometry with acquisitions at two different days	-Interferometry with acquisitions at two different days - Same day interferometry with both satellites
Cost	0€	5000€ per image	0€	5000€ per image

1. What would be the advantages and the drawbacks of optical sensors for this application
2. What would be the advantages and the drawbacks of SAR sensors for this application
3. You decide to detect the new constructions with a SAR sensor. Will you ask for new TerraSAR-X images or will you download Sentinel-1 images?
4. Detecting new constructions can be seen as a task of semantic segmentation. Give the definition of this task and explain why a Unet is a good choice of architecture.
5. You have only the money to annotate 20km^2 that you decide to divide it in 20 square of 1 km^2. What will be the best way to sample your dataset?
6. What type of data augmentation will you use to increase your train set artificially?
7. Is there another way to increase your database?

Answers

Your team want to measure soil artificialization on the Saclay Plateau, on an area of 80km^2, for the past 5 years. Artificialization is the process involving loss of natural, agricultural or forest areas, and the construction of new road or new buildings. You are conducting a study to choose the best sensors for this task, and the associated AI framework.

After looking online, you find these characteristics for the sensors:

	Optical sensors		SAR sensors	
	Sentinel-2	Pléiades	Sentinel-1	TerraSAR-X/TanDEM-X
Resolution	10m	0.70m	10m	1m
Swath	290km	14km	250km	10km
Repeat time	5 days, continuous acquisition	Min 25 days/on demand	6 days, continuous acquisition	Min 11 days/on demand
3D	No	Tri-stereo mode	Interferometry with acquisitions at two different days	-Interferometry with acquisitions at two different days - Same day interferometry with both satellites
Cost	0€	5000€ per image	0€	5000€ per image

1. What would be the advantages and the drawbacks of optical sensors for this application

The main advantage of optical sensors is that they have infrared bands in which vegetation signs at lot. Optical sensors are thus very adapted to monitor vegetation change and artificialization. The main drawback of optical sensors is that the images can be obstructed by clouds, so it is hard to follow rapid changes.

2. What would be the advantages and the drawbacks of SAR sensors for this application

The main advantages of the SAR sensor is that it is an active all weather sensor. The changes can be followed very gradually. Another advantage is that the buildings are generally very bright due to the presence of metallic pieces and their geometry. The drawback is that the vegetation can be hard to detect, since it depends a lot on the type of vegetation. Polarimetry is a good way to improve the detection of vegetation since it has a strong return in HV.

3. You decide to detect the new constructions with a SAR sensor. Will you ask for new TerraSAR-X images or will you download Sentinel-1 images?

I would use Sentinel-1 images because the Saclay plateau can be contained in only one image due to the large swath of the sensor. Moreover, given the scale of the changes that you want to monitor the refinement of the resolution will not outweight the cost of the images. The last reason is that Sentinel-1 did regular acquisition since 2014, while TerraSAR-X does acquisition on demand, so the archive may not contain enough images for monitoring over 5 years.

4. Detecting new constructions can be seen as a task of semantic segmentation. Give the definition of this task and explain why a Unet is a good choice of architecture.

Semantic segmentation is the task to give a label to every pixel in the image. Unet is a good choice of architecture since the encoder part allows to get multi-scale feature detection, while the decoder gives you a prediction per pixel.

5. You have only the money to annotate 20km^2 that you decide to divide it in 20 patches of 1 km^2. What will be the best way to sample your dataset?

It is important to sample the annotation to have the same distribution in the annotation than on the image on which you want to do the final prediction. It will be good to annotate patches over the whole of the Saclay Plateau, at different points in time. Moreover, it is important to sample both artificialization patches and patches without changes.
Since patches without changes are easier to annotate, you can maybe ask the annotator to annotate very precisely 15 patches of 1 km^2 that contain artificialization, and ask for 15 patches of 1 km^2 that don't contain any changes, increasing your dataset.

6. What type of data augmentation will you use to increase your train set artificially?

Geometrical data augmentation that do not change the direction of the layover (Horizontal flip, if your patches are oriented with the azimuth on the left) are a good way to increase your train set for SAR data. Geometrical data augmentation that change the layover direction may decrease your performance. Data augmentation that change the contrast of the image may also decrease your performance since SAR radiometry is very stable.

7. Is there another way to increase your database?

One of the first way would be to use unlabelled data, in semi-supervised methodology, since the archive of Sentinel-1 is fully open.
Another way to increase your database is to use the IGN database that gives the land cover over France, updated every 4 years. The annotations may not coincide exactly with your image, both spatially due to the difference in geometry between optical and SAR data and temporally. So technics of weakly-supervised learning may need to be used.