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Land use mapping at high spatial resolution using Deep Learning approches

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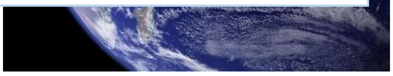
1. CNES, Centre National d'Etudes Spatiales
2. ONERA, Office national d'études et de recherches aérospatiales
3. CLS, Collecte Localisation Satellite



Overview

AI4GEO Project

The AI4GEO consortium consists of institutional partners (CNES, IGN, ONERA) and industrial groups (AIRBUS, CLS, GEOSAT, QUANTCUBE) covering the whole value chain of Geospatial Information. The aim is to develop a set of technological bricks allowing the automatic production of qualified 3D maps composed of 3D objects and associated semantics.

Land use mapping and Deep Learning

In computer tasks, such as classification, semantic segmentation or change detection, deep learning techniques has high potential to handle the growing amount of Earth Observation data, and became the fastest-growing trend in big data analysis. Nowadays, Neural Networks are widely used to generate land use classification maps and has shown high accuracy by providing impressive results. The aim of this research is to provide high resolution maps of semantic segmentation using Pléiades images.

Methodology

Dataset

The data were sourced from Pléiades satellites. The satellite provide high spatial resolution images, ortho-rectified and resampled at 0.5 m. the samples used as input for the models are generated from a geographical label merging "Labelcooker", developed within the framework. Different source of data were merged into one database, split into training, validating and testing set. A total of 36 tiles of size 2048 x 2048 pixels are annotated with OpenStreetMap (OSM) and the BDTOPO of IGN labels covering 9 classes over a small region of Toulouse, in France.

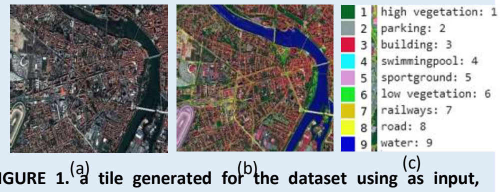


FIGURE 1. A tile generated for the dataset using as input, composed from a Pléiades image (a), a corresponding image labels (b) and the annotation with the 9 classes.

Model architecture

For the current work, a Unet is used as the model architecture for the semantic segmentation task (Ronneberger et al., 2015) with an efficientnet-b0 as encoder.

The model was trained on the dataset prepared. The approach classifies all the pixel of an image patch to obtain the corresponding label map.

Model is compiled with Adam optimizer and we use a weighted sum of Cross Entropy and Dice loss function since we face an unbalanced dataset issues.

Results

Confusion matrix

The confusion matrix is computed from the testing set, after fitting the parameters of the model on the training set.

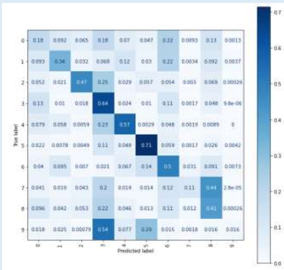


FIGURE 2. Confusion matrix computed over the testing tiles.

Evaluation metrics

Four quality metrics are used: Overall Accuracy (OA), Precision, Recall and the F1-score. The OA is 0.66.

	precision	recall	f1-score
0: Background	78	0.52	0.62
1: High vegetation	67	0.70	0.69
2: Parking	39	0.76	0.52
3: Building	78	0.83	0.80
4: Swimmingpool	14	0.94	0.24
5: Sportground	54	0.99	0.70
6: Low vegetation	26	0.91	0.40
7: Railways	29	0.82	0.42
8: Road	51	0.67	0.58
9: Water	85	0.88	0.87

Almost all the classes were well detected by the model, except for swimming pool, low vegetation, railways which represent the minority classes in the dataset.

Visualisation of resulting maps

FIGURE 2. Images retrieved from the test areas: (a) True labels, (b) predicted labels.

Conclusion

In this research, Deep learning techniques have been used for semantic segmentation classification. A specific dataset was generated using multisource existing database with nine classes over an urban area. The accuracy shows globally good performance. However, metrics evaluated for each class, have shown that some classes were difficult to detect, particularly for those having lower representation. Despite some techniques used to deal with unbalanced data (a weighted loss function, or data augmentation), we still have some confusion between some classes such us low vegetation and sport ground, as well as between roads and railways.