Optimal transport in adapting CNN-based classifier on vineyard application

E. Hosseini Aria[1,2] and H. Clenet [1,2]

[1] Ecole d'Ingénieurs de Purpan, 75 voie du TOEC, F-31076 Toulouse, France

[2] Université de Toulouse, INRAE, UMR DYNAFOR, Castanet-Tolosan, France

Recent studies show convolutional neural networks (CNN) provide accurate results in classifying remote sensing images (Kerkech et al., 2018; Audebert et al., 2019; Rasti et al., 2020). Because of the rapid development of the RS techniques and a large number of acquisition of satellite images, an accurate recognition of classes from an unknown scene using a pretrained network is much in demand. In this study we focus on selected vineyards in South-West of France, for which a few regions are well known and could be used as training areas, while others could have different varieties and/or pedo-climatic conditions and no ground truth available, thus making a direct use of a pre-trained model inefficient.

This concept of using a trained model on an existing labelled dataset to classify unlabeled data is known as domain adaptation (DA) and is a challenging task in modern data analytics. The problem arises when a dataset used for training a classifier (source data, e.g. vineyard regions with ground truth available) and the data used for detection (target data, e.g. any other vineyards) do not follow the same probability distribution function. This discrepancy or 'drift' could be due to differences in the vines or in the imaging conditions (e.g. time and geometry of the acquisitions, atmospheric conditions, amount of light, noise, etc.). By applying a domain adaptation algorithm, an alignment between the source and the target domain is made.

In this research, we adapt a pretrained CNN using a developed DA algorithm based on optimal transport (OT) (Courty et al., 2015). The OT theory can be used for calculating the distances between probability distributions. These distances can be directly evaluated and provide meaningful measures of different scenarios, e.g. when the distributions do not have an overlap. Furthermore, despite frequently used methods in DA which define a global transformation to adapt the source and target domains; by using OT a local transformation for each sample in the source domain can be applied. In this sense, each source sample can to be mapped on target samples under some constraints.

The aim of our study is to distinguish different classes in vineyards (i.e. grass, healthy vine, or different diseases) using various datasets (multispectral images taken by UAV and high/medium resolution satellite images) . Our first results show the high potential of CNN in recognizing different classes of vines. The overall accuracy of detection is more than 94%. In addition, by defining a new layer before the fully connected layer of the trained network, the DA algorithm can be embedded in a pretrained CNN. Improvement of such implementation of OT inside the pretrained CNN and results in terms of accuracy of detection for target scenes on vineyards are still under investigation.