Master thesis

Deep Domain Adaptation for land cover classification of remote sensing images

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Topic of the M.Sc. Thesis of Mr Kai Tang, B.Sc.

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The pixel-wise classification of land cover plays an important role for applications such as the automated creation and update of maps. Recent work trying to solve this task has focused on fully convolutional neural networks (FCNN), delivering considerably better results than traditional classifiers such as Random Forest. However, FCNN require a large amount of labeled training data in order to perform well. While remote sensing images are increasingly available in large amounts with a high temporal resolution, there is a lack of large amounts of reliably labelled data that can be used for training. When training is done on few data the model tends to overfit to the characteristics of the domain of the training samples (source domain). This results in worse results for images from another domain (target domain) especially when the two domains differ significantly. One approach to overcome the requirement of a large training dataset is Domain Adaptation (DA). Here, unlabeled samples from the target domain are used to adapt the FCNN classifier trained on source domain data before inferring the labels in the target domain. One approach in the literature is based on iterative retraining of the classifier using pseudo-labels, i.e. labels that were predicted in the target domain using the current state of the classifier, starting from the parameter set obtained by training on the source domain. The idea is that by selecting correct pseudo-labels, the classifier can be improved in an iterative retraining procedure using these pseudo-labels. The selection is usually based on a confidence measure such as the entropy of the predictions.

The goal of this master thesis is to adapt this approach for DA to the field of land cover classification in remote sensing, i.e. for applications based on satellite images. In particular, Mr. Tang should investigate how the method, based on entropy minimization in the target domain, can be adapted and advanced to remote sensing images with the goal of land cover classification. Different definitions of domains should be investigated, for example the adaptation between datasets captured in different locations (regional change), or in different seasons (temporal change). The task includes the implementation of a suitable FCNN as well as the training of this network using images from a source domain. To that end, the already existing implementation of entropy minimization can be used to start from. After evaluating the performance of this method for different adaptation scenarios in remote sensing applications, problematic settings should be identified. Based on these results the method should be further optimized, for example by tuning the parameters of the method or by further developing the pseudo-label selection process. In the last step, Mr. Tang has to evaluate the final method to assess and compare its applicability to the field of land cover classification. For that purpose, the IPI provides a dataset that consist of optical satellite images from different domains. Mr. Tang shall evaluate how the developed method performs in different domain adaptation scenarios, which settings could be improved and which settings remain problematic.

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Abstract

Land cover classification of remote sensing image is an important research issue, and its scientific significance lies in how to further improve the accuracy of classification. It is significant for land use planning, urban management and environmental monitoring. With the development of high spatial resolution sensors in the satellite, high-resolution remote sensing images are becoming more and more extensive. The clear object features and complex spatial characteristics further increase the difficulty of land cover classification. Therefore, it is important to develop new classification methods and improve the ability of feature extraction and recognition.

Domain adaptation (DA) is one of the most important topics in machine learning, because there is a lack of large amounts of reliably data in remote sensing images that can be used for network training. With DA methods enables the network, which trained in the source domain, to better perform in the target domain. The goal of this master thesis is to compare and expand strategies to solving imbalanced class distribution and more importantly adapting DA methods to the field of land cover classification in remote sensing. By combining efficient fully convolutional neural network (FCN) and DA methods (Deep Coral and Entropy Minimization in this work) enable solving the classification task of remote sensing images. In additional, weighted focal loss are used as loss function to deal with imbalanced class distribution. Two DA methods are proved to decrease the distribution discrepancy between source domain and target domain. Experiments are conducted to compare the performance of these two methods. The results show that Deep Coral perform better than Entropy Minimization.

Keywords

Semantic segmentation, Domain adaptation, remote sensing image, Fully convolutional neural network, Unet, Deep Coral, Entropy Minimization