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Improving pseudo-labels for semi-supervised training of fully convolutional neural networks in aerial image classification

Proposal for a Master thesis topic (DE/EN)

The pixel-wise classification of remotely sensed images and derived data (e.g. digital surface models) is an important step in the process of generating or updating maps. For the last years, Deep Neural Networks (DNN) have been adapted to that task, surpassing the results of classical machine learning approaches in nearly all scenarios. However, DNN for classification, usually in form of Fully Convolutional Neural Networks (FCNN), require a large amount of training data in order to learn the complex mapping required to solve this task. Training on few data often leads to a weak generalization of the model, especially when applied to domains that differ from the training domain in terms of the mapping function.

One approach to counteract this problem is semi-supervised Domain Adaptation (DA). Here, unlabeled data samples from the new domain are used to adapt the model and increase the generalization of the model. One common strategy for DA is to first train a network on the training samples where labels are available before using unlabeled data. The resulting model can afterwards be applied to any unlabeled data samples which results in so called pseudo-labels. Although those labels are usually not very accurate, they can still be used improve the classification network. Recently, many strategies for domain adaptation have been proposed that build up on the usage of pseudo-labels and predictions confidence in order to adapt models to new domains or increase the generalization. However, most approaches were developed for the adaptation between different street scene datasets under the assumption about a similarity of label distributions or under the consideration of spatial priors for labels. Those assumptions and priors are in general not valid for aerial scenes; thus those approaches cannot be applied for the task of aerial image classification. Nevertheless, aerial images usually do follow semantic patterns that could be used to increase the quality of either the pseudo-labels itself or to the corresponding confidence estimates. In both cases the adaptation quality of any pseudo label based approach is expected to improve.

The main goal of this theses is to develop a method to improve the quality of pseudo-labels and corresponding confidence estimates. One such approach could be based on the assumption that the range of size of certain objects can be either approximated or at least limited in advance. With a known ground sampling distance, this knowledge can be transferred to the image. Objects that do not fulfill such a condition in the image space are likely to be misclassified which should either lead to a correction of the respective labels or lower the confidence in this area. Other assumptions e.g. about the object boundaries or spatial relations of objects could be considered simultaneously. Besides Knowledge driven rules, machine learning techniques could be used to learn simple rules, that could also be used to identify whether pseudo-labels correct or wrong. The resulting methods, either rule-based or data-driven, are to be evaluated in terms of their stability, effectiveness and generalization. The student will be provided datasets as well as initial classification architectures.

This thesis will be supervised by Dennis Wittich, M.Sc.

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