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Multitemporal land cover classification of remote sensing images with recurrent neural networks

Proposal for a Master thesis topic (DE/EN)

Classification of land cover is a standard task in remote sensing, in which each image pixel is assigned a class label indicating the physical material of the object surface (e.g. grass, building). This task is highly relevant for applications such as the detection of changes or rapid mapping. Recent work has focused on Deep Neural Networks (DNNs), delivering considerably better results than traditional classifiers. This is mainly due to the fact that, unlike traditional classifiers using hand-crafted features, DNNs provide a framework in which these features can be learned from training data. One of the state-of-the-art DNN-architectures are fully convolutional neural networks (FCNs) that compute these features based on the local neighborhood of a pixel and provide one output class per pixel (also called semantic segmentation). When multitemporal input images are used, besides FCNs, several other architectures achieve state-of-the-art results. Recurrent neural networks (RNNs), originally applied to natural language processing tasks, can handle input sequences of arbitrary length and are able to predict one output for each input. Recurrent neural networks are successfully used for the classification of image sequences, e.g. in for the differentiation of different crops (Sun et al., 2019). A basic example of the model can be seen in the following figure:
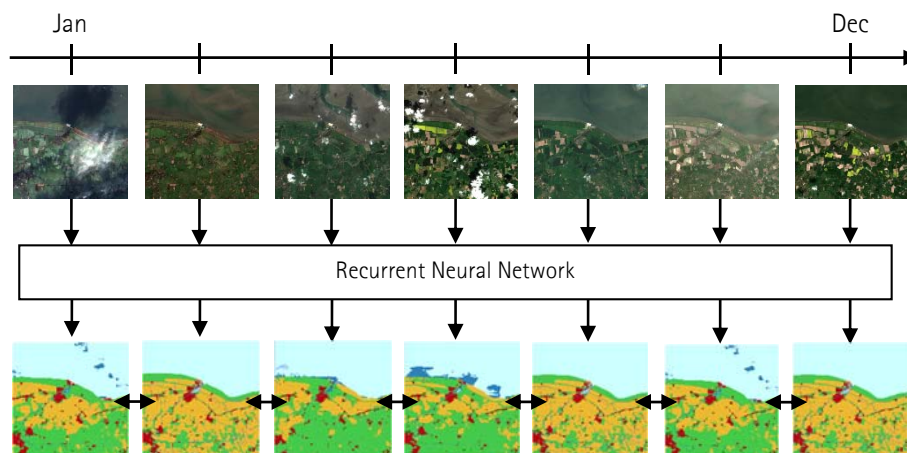
Training:	Inference:
- Temporal dependencies are learned for different input scenarios (e.g. varying number of available timesteps) - Regularization: Unrealistic class transistions can be penalised during training	- A varying number of input images can be used for classification - Through the regularizations the overall output (land cover for latest time step) is more stable and reliable

The main goal of this thesis is the development of a new approach using recurrent neural networks for multitemporal land cover classification with remote sensing images. For each image in the input sequence, one output map shall be generated. In this way, the development of land cover can be modeled over different time steps. In addition, various regularizations can make the classification results more stable e.g. by excluding unrealistic class transitions. Different adaptations of recurrent neural networks shall be implemented and evaluated, e.g. the integration of convolutions or a specific spatial neighborhood into the RNN. In the end, the most promising approaches shall be compared to the existing method using a FCN for classification.

The student will be provided with datasets as well as initial classification architectures. Previous knowledge in the field of image analysis and programming is mandatory. The thesis can be written in English or in German.

This thesis will be supervised be Mirjana Voelsen M.Sc.

References

DUN, Z.; DI, L.; FANG, H., 2019: Using long short-term memory recurrent neural network in land cover classification on Landsat and Cropland data layer time series. In: International Journal of Remote Sensing, Vol. 40, *pp. 593 - 614.*