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Classifying Tree Species in Sentinel-2 Satellite Imagery Using Convolutional Neural Networks

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Abstract: Information on forest composition, specifically tree types and their distribution, aids in timber stock calculation and can help to better understand the biodiversity in a particular region. Automatic satellite imagery analysis can significantly accelerate the process of tree type classification, which is traditionally carried out by ground-based observation. Although computer vision methods have proven their efficiency in remote sensing tasks, specific challenges arise in forestry applications. In this paper, we aim to improve tree species classification based on a neural network approach. We consider four species commonly found in Russian boreal forests: birch, aspen, pine, and spruce. We use imagery from the Sentinel-2 satellite, which has multiple bands (in the visible and infrared spectra) and a spatial resolution of up to 10 meters. Additionally, the short revisit time and free access policy makes Sentinel-2 imagery a valuable data source for the purpose of forest classification. In computer vision terms, we define the problem of tree type classification as one of semantic segmentation, assigning a particular tree type to each pixel of the image. The forest inventory data contain the tree type composition, but do not describe their spatial distribution within each individual stand. Therefore, some pixels can be assigned a wrong label if we consider each stand to be homogeneously populated by its dominant species. This calls for the use of a weakly supervised learning approach. To solve this problem, we use a deep convolutional neural network with a tailored loss function. We test the proposed models by creating a data set of images for Leningrad Oblast of Russia. In our study, we demonstrate how to modify the training strategy, such that it can outperform basic per-pixel neural network approaches.

Keywords: Deep learning; remote sensing; tree species; classification