

Semantic Image Segmentation in Remote Sensing Scenarios

Candidate: Edoardo Arnaudo - Supervisor: Prof. Barbara Caputo

Politecnico di Torino

Semantic segmentation is a fundamental task in computer vision that aims to assign a semantic label to each pixel in an image, parsing it into meaningful and coherent regions. Thanks to the recent progresses of deep learning in computer vision, semantic segmentation has gained significant attention due to its wide range of applications, including autonomous driving or medical image analysis. In the context of remote sensing, this task plays a crucial role in extracting valuable information from satellite and aerial imagery. Remote sensing data, such as multispectral and radar images, provide valuable information for Earth Observation purposes, from land cover, to atmospheric composition. Detailed segmentation maps can provide insights into various geospatial phenomena, supporting applications such as urban planning, environmental monitoring, disaster response, and agricultural analysis. However, segmenting aerial and satellite images presents unique challenges compared to conventional computer vision tasks on natural images. These often cover large geographic areas and exhibit high spatial and spectral variability. The objects of interest, such as buildings, roads, and vegetation, can have diverse appearances and scales, making it difficult to capture their contextual relationships. Moreover, annotating images for semantic segmentation is a time-consuming and intensive process, often requiring specific domain expertise. To address these challenges, researchers have explored various approaches to adapt and enhance segmentation techniques for remote sensing applications. These include leveraging the multi-scale and multi-modal nature of aerial data, incorporating domain-specific prior knowledge, and developing efficient annotation strategies. Additionally, the increasing availability of large-scale remote sensing datasets and advancements in deep learning architectures have enabled the training of more robust and generalizable models. This thesis directly addresses these challenges, adapting semantic segmentation solutions to varied remote sensing scenarios. We explore several techniques to effectively leverage the rich information derived from aerial and satellite sensors, tackling issues such as data scarcity and annotation costs to develop efficient and robust models. Our research contributions span multiple aspects of semantic segmentation in remote sensing, including regularization techniques, architectural changes, weakly supervised learning approaches, and domain adaptation frameworks.