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UNIVERSITY OF TWENTE. | ITC

Machine Learning for Earth Observation

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Dates: May 5-16, 2025

Target audience: Staff of national mapping agencies, researchers, academics, students, private companies

Prerequisites: Familiarity with the basic understanding of programming, particularly in Python, with experience using libraries for data manipulation and visualization (e.g., NumPy, Pandas, Matplotlib). Participants should have access to a computer capable of running Python, Jupyter Notebooks, or access to cloud resources like Google Colab for practical exercises.

Course objectives: In recent decades, Machine Learning (ML), particularly Deep Learning (DL), has achieved tremendous success across various domains, including Computer Vision, Natural Language Processing, Autonomous Driving, and of course Earth Observation. This course will begin with a general overview of ML, followed by an exploration of key DL applications in Earth Observation and Geoscience, such as semantic segmentation and change detection using aerial imagery. Step-by-step practical exercises using Python notebooks will be used to support the learning, allowing the course participants to gain hands-on experience in implementing and training their own ML/DL models.

Topics tackled: The lecture at a precourse seminar in Espoo will provide an introduction to understanding ML and DL as well as applications in Earth Observation and Geoscience. An introduction to basic ML and DL concepts will be given to help participants who want to get familiar with ML and DL quickly. A more detailed focus is given to semantic segmentation and change detection using aerial imagery.

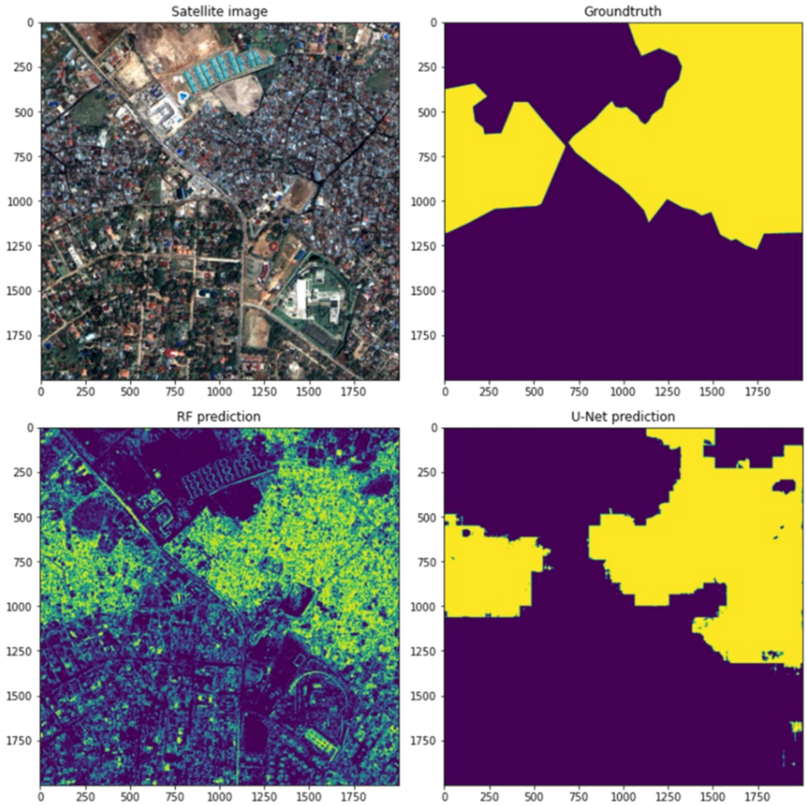
The course is structured into four modules, spread over two weeks. Each module includes a lecture covering relevant theories followed by a practical tutorial, lasting 2-3 hours in total.

Module 1: Introduction to ML

Module 1 introduces ML with basic concepts such as supervised and unsupervised learning, and covering conventional classification methods such as Support Vector Machines (SVM) and Random Forest (RF) with an accompanying exercise to implement these classifiers for land cover and land use mapping.

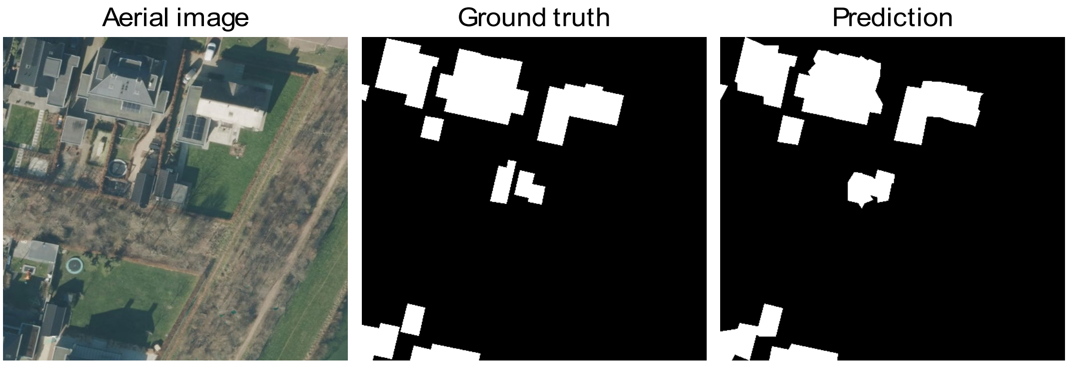
Module 2: Introduction to DL

The module focuses on DL, including concepts like layers, activation functions, and loss functions, with an emphasis on Convolutional Neural Networks (CNNs). The exercise involves building a CNN-based image classification model, such as a U-Net based classifier to compare with a RF classifier.



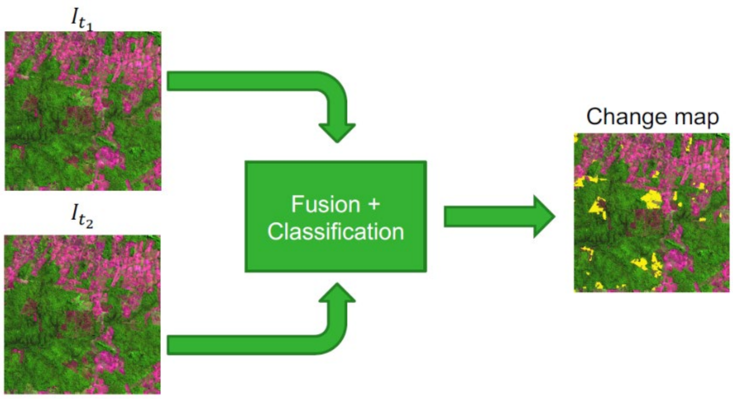
Module 3: Advanced Image Analysis

The module covers advanced image analysis topics, including semantic segmentation, object detection, instance segmentation, panoptic segmentation, and polygonization. The practical exercise involves constructing a semantic segmentation network, such as segmentation masks of buildings using aerial image.



Module 4: Change detection

The module addresses change detection. The exercise focuses on applying neural networks, such as Long Short-Term Memory (LSTM) models, to capture temporal information for detecting changes over time.



To pass the course, a participant is required to complete at least two of the four exercises, including both model implementation and interpretation of the experimental results.