Deep Learning Projects

Introduction

The goal of these projects is to design a deep learning methodology to solve a task on a provided dataset. This involves:

- Implementing methods to load and preprocess the data
- Implementing and training several relevant models and/or one model with several parameter sets
- Computing relevant metrics and analyzing the results
- Visualizing results

Choose one of the projects proposed in the next sections.

Then you can download the dataset you need for your project here.

3 Large Rocks Detection Dataset

Task The Federal Office for Topography swisstopo proceeds to the manual annotations of all large rocks in Switzerland to produce topographic maps. They are curious to observe what could be done with recent automatic methods. Thus this dataset is based on their annotations and your task will be to detect large rocks (over 5x5m) in Switzerland based on high-resolution RGB images and the digital surface model (DSM). You could compare the usage of one source of data (e.g., only DSM or only RGB) or try to combine them. Another possibility is to explore the differences between standard machine learning approaches (detecting local maximums, rugosity indices, etc.) and recent object detection models.

Data The study area is spread across Valais, Ticino and Graubunden. The tiles are geographically split into training and testing. The dataset includes :

- **Aerial images** at a 50cm resolution with RGB bands (swissIMAGE)
- **Digital surface model (DSM)** at 50cm resolution based on LiDAR data (swissSURFACE3D)
- **Hillshade raster** tiles derived from the DSM data, generated with QGIS with the hillshade function (Azimut 0, Vertical angle 0)
- Comprehensive **points annotations** of 2'625 large rocks from swisstopo annotators.

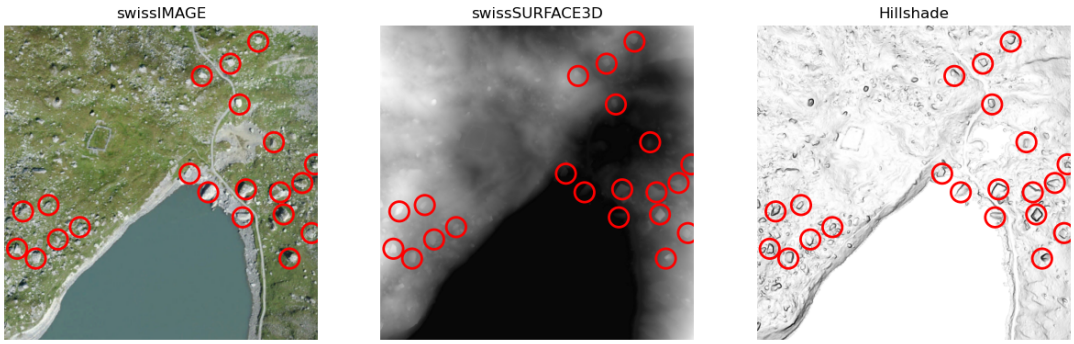

Figure 4: Aerial image from swissIMAGE, digital surface model from swissSURFACE3D and the corresponding hillshade raster with large rocks annotations from swisstopo annotators.

Challenges

- Building an object detection pipeline based on swisstopo annotations for aerial images and/or the DSM data will be your main challenge. You will also have to decide how to include the punctual rocks annotations (various shapes and sizes of bounding boxes, etc.).
- The precision-recall balance of the rock detection model will be an important point to observe and discuss. Too many false positive predictions lead to lengthy correction for the annotators while missing too many targets makes the predictions useless.
- To avoid over-fitting, you could investigate strategies such as data augmentation or starting for a pre-trained model.

Suggestions and references

- Make sure to have a look at the explanatory notebook ***Usefull_tips.ipynb*** provided with the dataset.
- For the deep learning approach, we strongly suggest you use the *YOLO-v8* object detection model with the *ultralytics* python library : https://docs.ultralytics.com/
- More information about swisstopo products such as swissSURFACE3d[1] or swissIMAGE[2] are available on their website.
- Link to download the dataset : https://enacshare.epfl.ch/bY2wS5TcA4CefGks7NtXg

[1] https://www.swisstopo.admin.ch/de/hoehenmodell-swisssurface3d
[2] https://www.swisstopo.admin.ch/en/orthoimage-swissimage-10