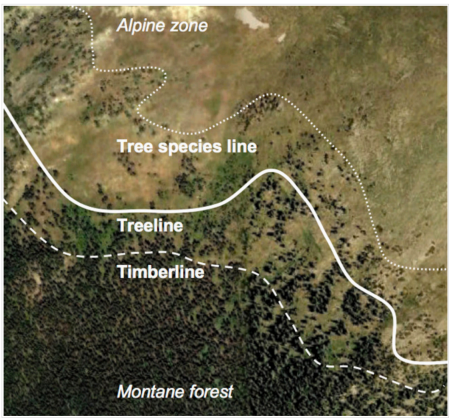
Master thesis subject

Forest mapping at the alpine treeline using weak labels

Context

Warming due to climate change is known to happen faster than average in high altitudes regions such as the Swiss Alps. The treeline, i.e. the upper limit of the forest, is strongly influenced by temperatures and is slowly moving upslope, with consequences on biodiversity, hazards and, in the long term, local climate.



From : Berdanier, A. B. (n.d.). *Global Treeline Position | Learn Science at Scitable*.

This phenomenon is difficult to quantify because of its slowness (a few meters per year at most) and its strong dependence on local factors such as topography and land use. While satellite imagery is generally used to map forests globally, it does not provide a sufficient resolution to map treelines accurately and/or has been available for too short to allow long-term monitoring. Aerial imagery, on the contrary, is available at high resolution over several decades for the Swiss Alps, and thus has the potential to allow for temporally and spatially dense monitoring of the treeline.

We thus aim at automatically mapping the treeline on aerial images. More precisely, we aim obtaining a pixel-wise mapping of tree canopy cover (TCC), a density measure corresponding to the proportion of the ground covered by tree canopy. Deep learning methods, and more specifically Convolutional Neural Networks (CNNs), are state-of-the art methods for such

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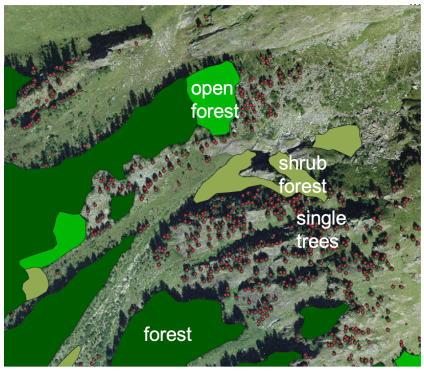
automatic mapping tasks on remote sensing data. They rely on large training sets for which the target is known for each sample image. In the case of tree canopy cover, such ground truth is not available. However, forest masks and scattered individual tree locations are available as part of the SwissTLM3D product provided by Swisstopo. While the mapping task corresponds to pixel-wise regression of a density measure, the available ground truth takes the form of either categorical masks or object detection labels.



Labels from SwissTLM3D

The student's task will be to find methods to incorporate such information in the training process, i.e. formulate and implement supervision methods based on the SwissTLM3D labels. The targeted result is a TCC mapping deep learning model whose training relies on a thoughtful combination of weak supervision and depends little or not at all on direct ground truth.

Objectives

- Familiarise with a provided forest mapping deep learning implementation
- Propose methods to use the forest masks and single tree detections as weak supervision
- Incorporate the proposed methods in the training pipeline and assess their performance

Requirements and practical info

- Background in machine/deep learning is welcome.
- Programming skills in Python.
- The thesis will be supervised from the Sion campus.
- Access to parallel computing resources is provided.

Literature

- Gehrig-Fasel, J., Guisan, A., & Zimmermann, N. E. (2007). Tree line shifts in the Swiss Alps: Climate change or land abandonment? *Journal of Vegetation Science*, *18*(4), 571–582. https://doi.org/10.1111/j.1654-1103.2007.tb02571.x
- Zhu, X. X., Tuia, D., Mou, L., Xia, G. S., Zhang, L., Xu, F., & Fraundorfer, F. (2017). Deep Learning in Remote Sensing: A Comprehensive Review and List of Resources. *In IEEE Geoscience and Remote Sensing Magazine (Vol. 5, Issue 4, pp. 8–36)* https://doi.org/10.1109/MGRS.2017.2762307

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