SLU
SCIENCE AND EDUCATION FOR SUSTAINABLE LIFE

ELEVATE

Implementing new technologies into existing monitoring designs

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What is ELEVATE?

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A three-year project financed by the Swedish EPA (Naturvårdsverket) to answer three research questions:

1. *How can the use of **drone image** collections in combination with **deep learning** image segmentation and object detection tools improve the accuracy of **field data cover** estimation?*
2. *Can data provided by drone image analyses improve the generation of model-based wall-to-wall vegetation maps using plane based **aerial images** and **LIDAR data** using **deep learning** algorithms?*
3. *To what extent can the combination of high temporal **satellite pictures** with airplane-based aerial images and LIDAR data improve model-based wall to wall vegetation maps using deep learning algorithms?*

We use alpine vegetation data for analysis, however we believe our methods could be scaled for use in other open landscapes as well.

ELEVATE & NILS

- NILS (National Inventories of the Landscape in Sweden) field teams have used drones on trial since 2021.
- About 185 flights in varying conditions -> high-resolution orthophotos allowing precise vegetation cover interpretation
- Ground truthing via the NILS inventory design

Object detection and image segmentation techniques will also be explored and implemented.

Images by NILSfjäll2021

Current work

Building a field cover training set database using GIS-tools with Sentinel-2 pixels as base grid.

Attributes | Geometry

OBJECTID	6430
GlobalID	{4C3BFB47-8CD4-462B-BF99-DCBF34D04557}
ortho_id	ortho_375809_9
cell_id	21
Ris_tack	<Null>
Gras_tack	40
Moss_tack	<Null>
Busk_tack	10
An_dvargbjork	0
An_ullvide	10
An_en	0
An_glansvide	0
Trad_tackn	<Null>
Veg_typ	<Null>
Busklavar_tack	<Null>
Ripvide_tack	<Null>
Kuddvaxter_tack	<Null>
Vatmarksveg_tack	18
Veg_tack	68
Substrat_tack	<Null>
Bioskorpa_tack	<Null>
Forna_tack	32
Ved_tack	<Null>
TackSum	100
Vatten_tack	<Null>
Skugga_tack	<Null>
Markfuktighet	3 Fuktig/Blöt

Images from ArcGIS Pro

3D Point Clouds

- Flying with an image overlap allows for the use of photogrammetry to create 3D point clouds for elevation representation.
- LiDAR data is publicly available, however infrequently updated in alpine areas.

Images by Arvid Sjöberg, PCs made in WebODM (top) & Pix4D (bottom).

Field work

- About 2 weeks in July accompanying a NILS field team.
- Different flight patterns in varying conditions.

DJI Mavic 3E drone with RTK module. Image by Arvid Sjöberg

- *Conclusion?*

Modern drones are technically mature (enough) platforms to be used in challenging field conditions to a good result.

Deep Neural Networks (DNNs)

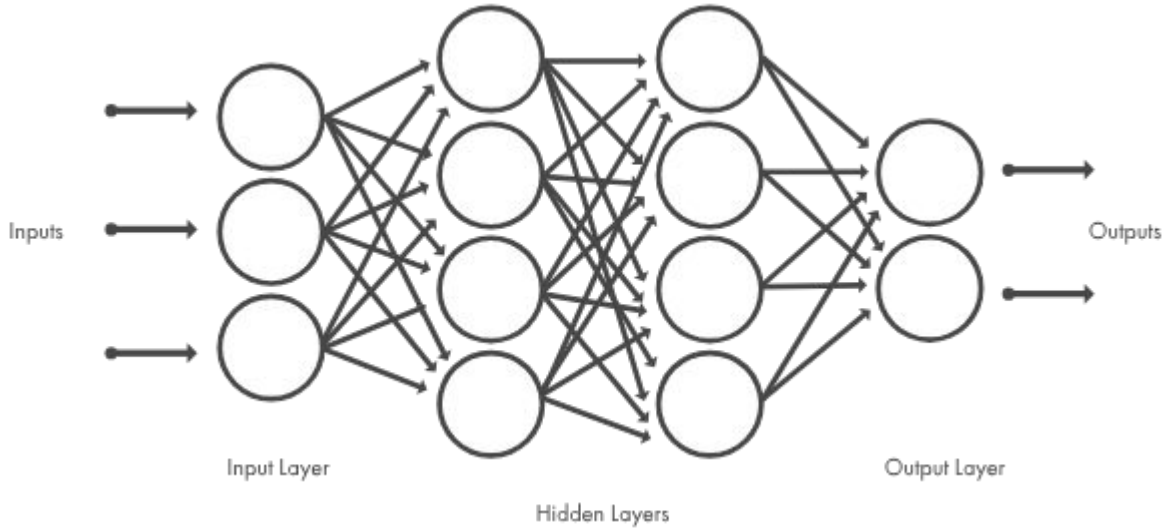


Image by MathWorks

- Multiple layers transform an input into a useable output.
- Related to classical Machine Learning such as Random Forest algorithms.
- Convolutional Neural Networks (CNNs) is a type of DNN that specializes in image recognition.

A complex subject that requires its own presentation…

Previous research on DNNs in Swedish mountains

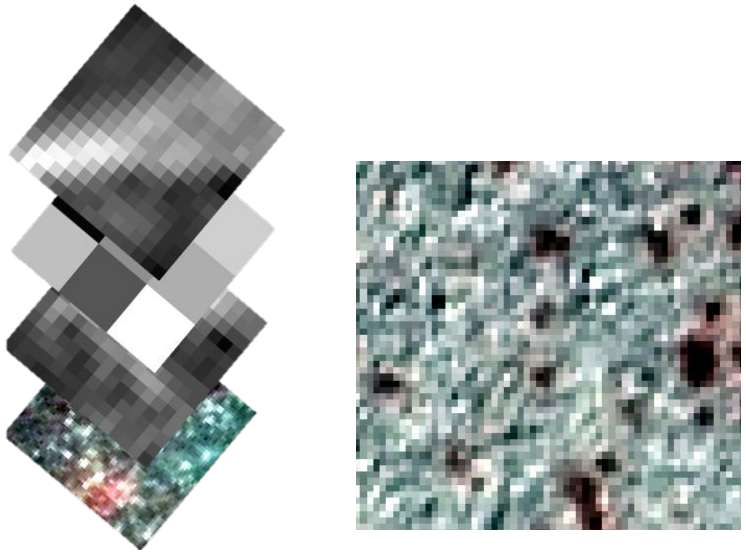
Enhancing Alpine Vegetation Mapping

Integrating Deep Learning with Aerial, Satellite & LiDAR data

Arvid Sjöberg

An attempt to classify alpine vegetation types using a sensor-fusion approach with aerial, satellite and LiDAR-data with CNN algorithms.

Relying on NIR aerial interpretation data made by specialists at the Division of Landscape Analysis (SLU).

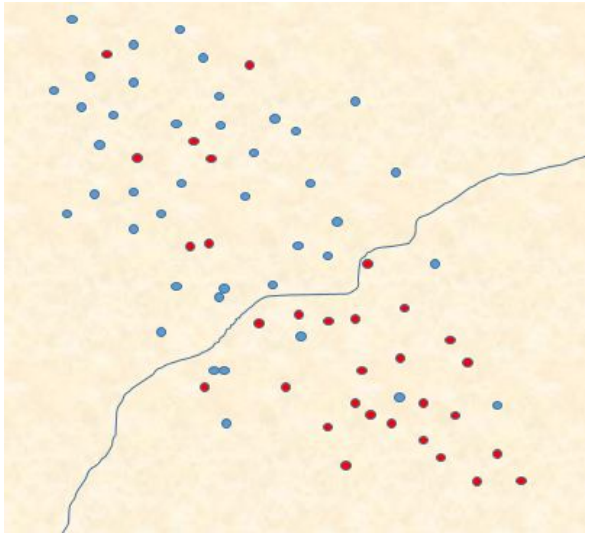


Promising results, some issues needing ironing out before practical use.

Image by Arvid Sjöberg (left) & Swedish Land Survey (right).

Lessons learned

Overfitting: The nemesis of any DNN user.



Figures by Arvid Sjöberg, inspired by Hastie et al. (2017).

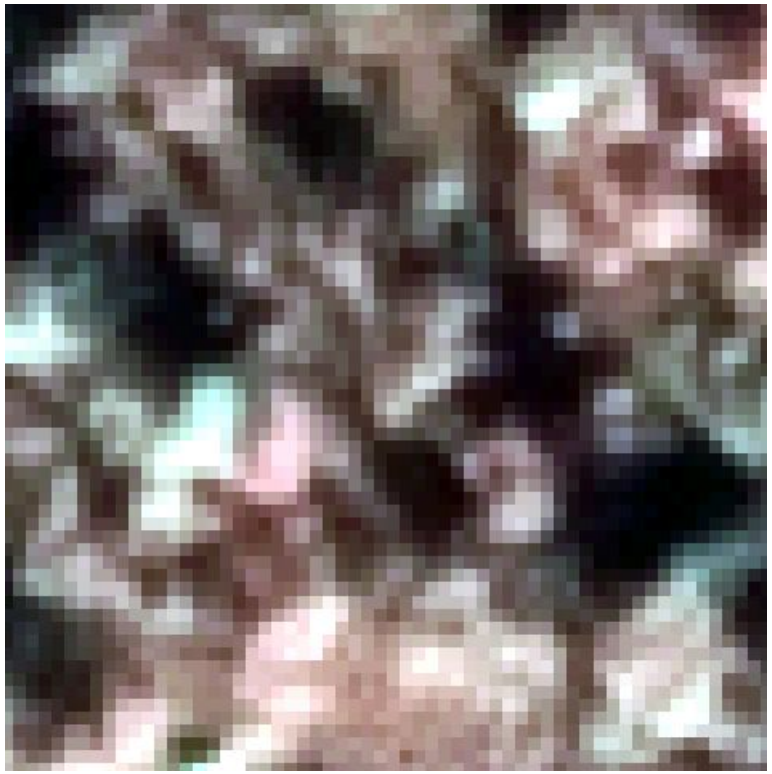
Also:

High within-class variance (noise) increases risks of overfitting and faulty classifications.

Large datasets required to ensure real-world representation.

Lessons learned

Spectral properties matter more than ecological similarities for a computer.



Images by the Swedish Land Survey

Thank you!

https://www.naturvardsverket.se/om-miljoarbetet/forskning/miljoforskning/forskningssatsningar-samhalle/framtidens-miljoovervakning/

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References

Hastie, T., Tibshirani, R., & Friedman, J. (2017). The Elements of Statistical Learning: Data Mining, Inference, and Prediction. I: Springer Series in Statistics.

Springer. 12th printing. ISBN 978-0-387-84857-0.