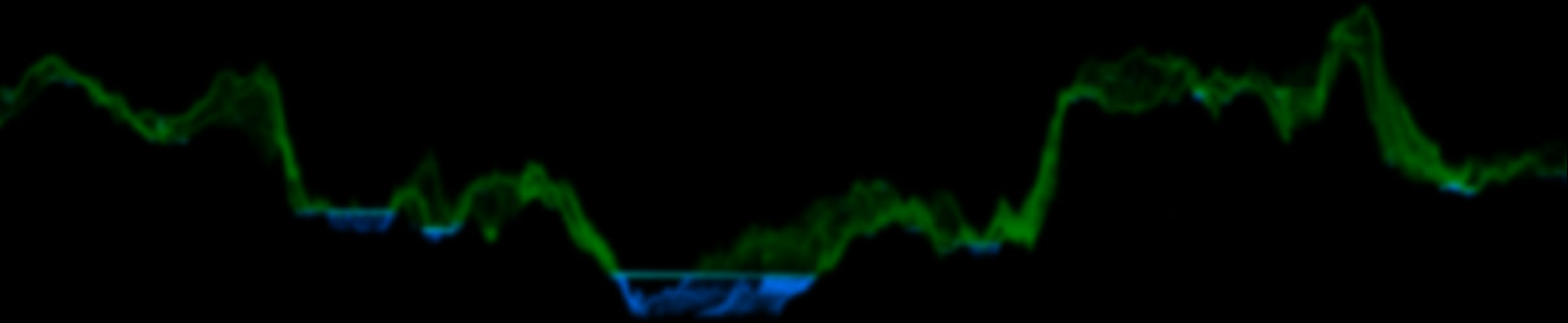
SLU

SCIENCE AND EDUCATION FOR SUSTAINABLE LIFE



Mapping cultural remains with LiDAR and AI

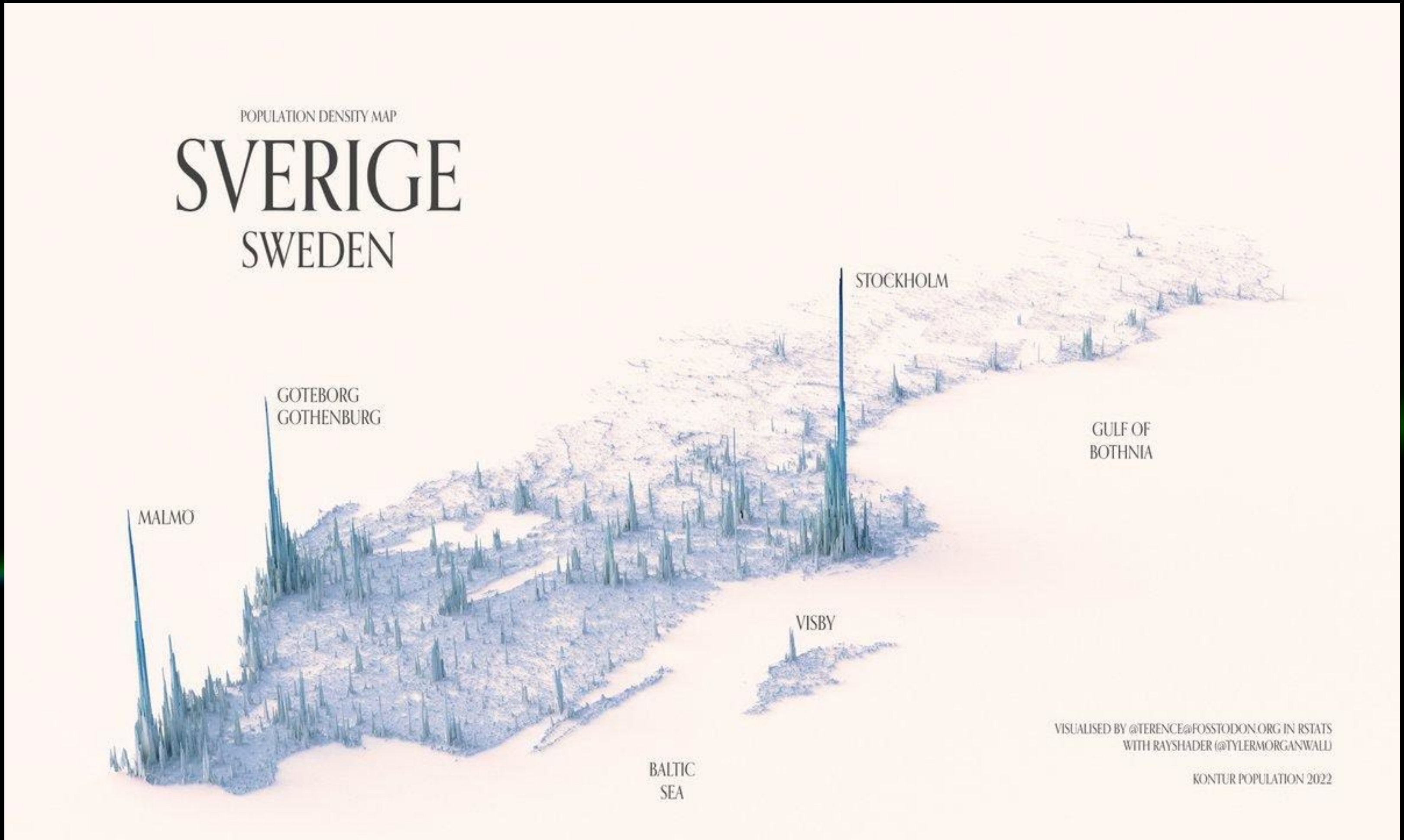
William Lidberg

SLU, Sweden

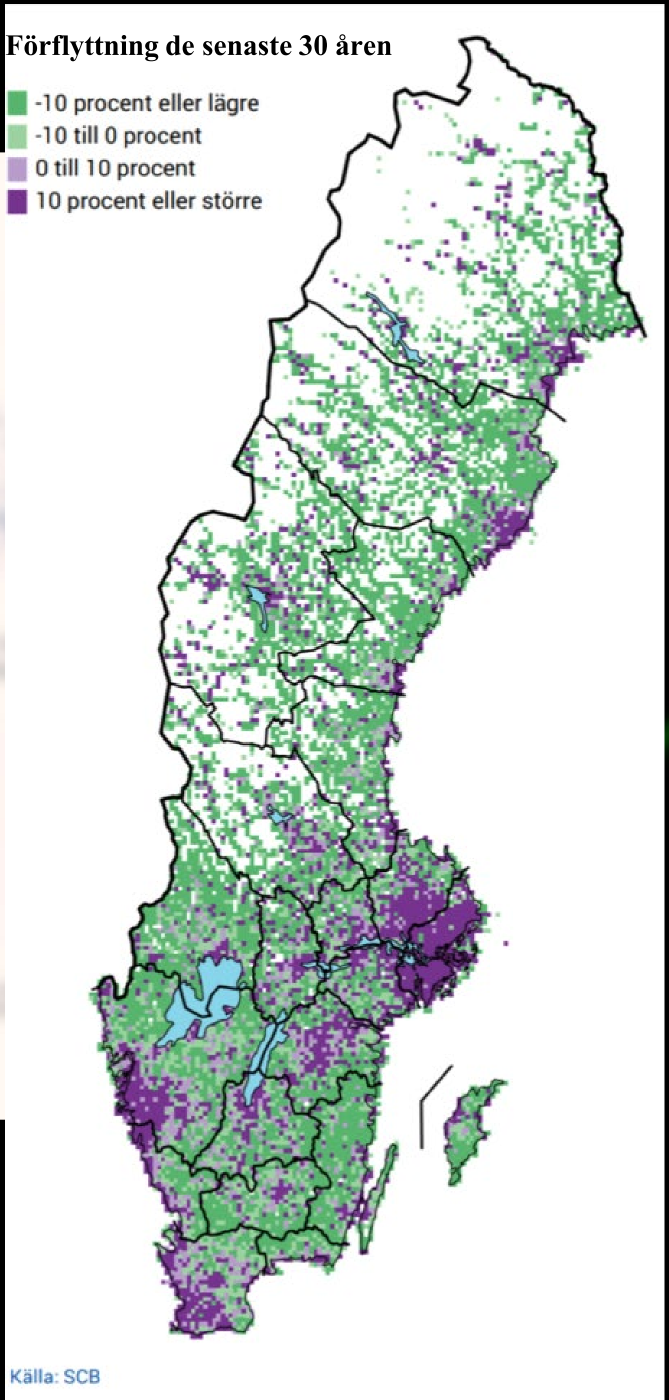
- **Lecture**
    - Cultural remains
    - LiDAR
    - Machine learning

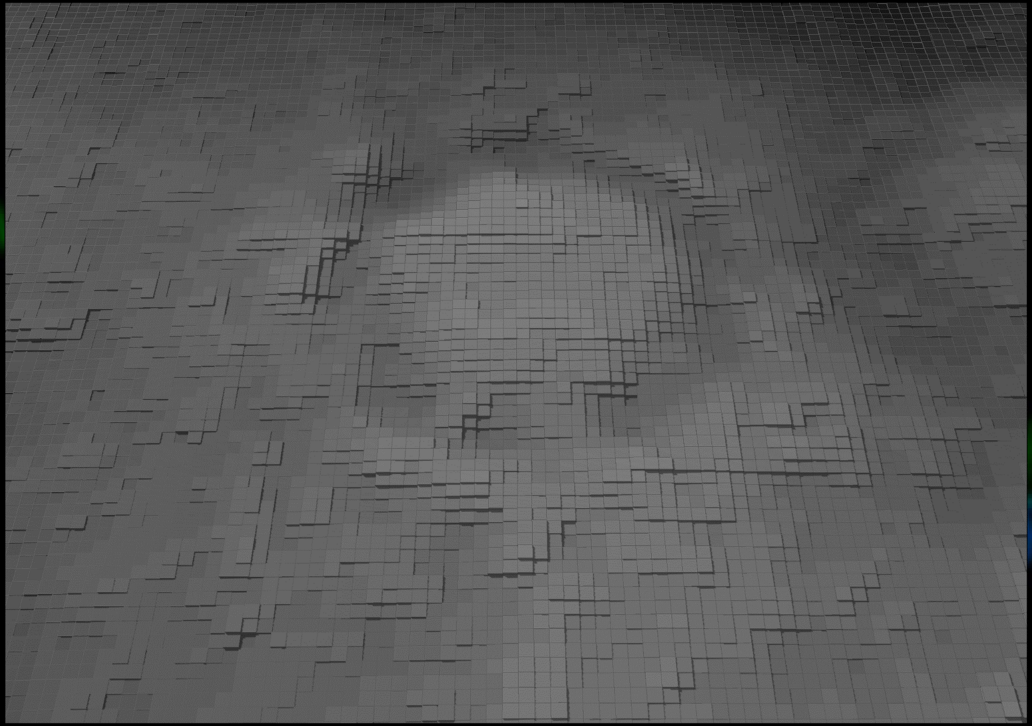
- **Break**
    - Find computers in bookskogen

- **Computer Excercise**
    - google colab
    - Intro to data
    - Hands on

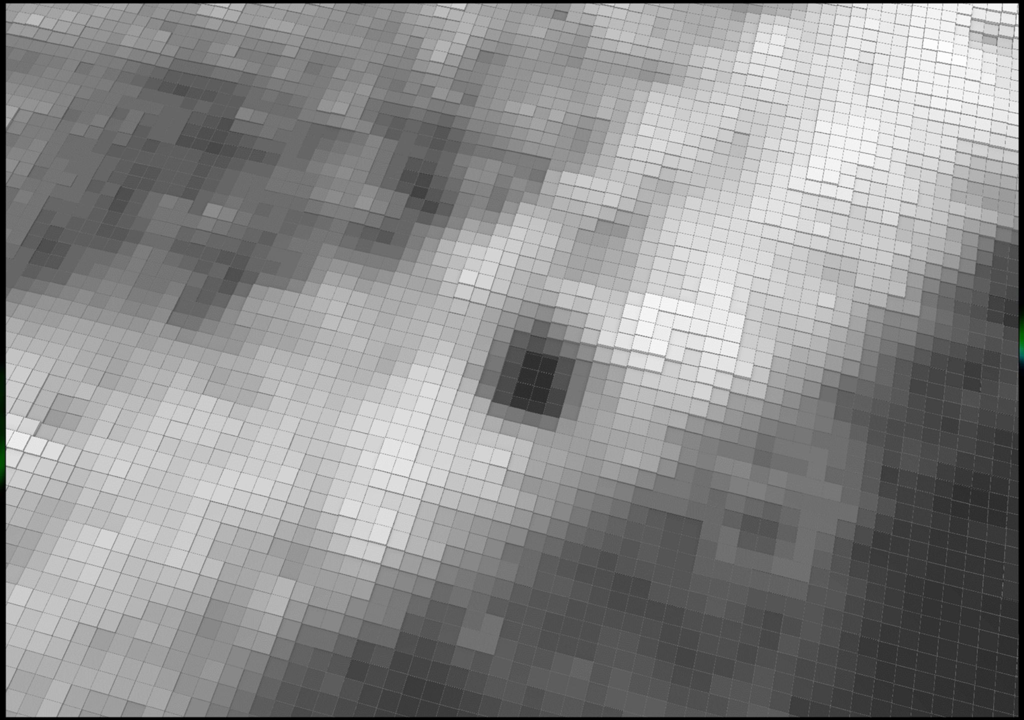

POPULATION DENSITY MAP
SVERIGE
SWEDEN
STOCKHOLM
GOTEBORG
GOTHENBURG
MALMO
GULF OF
BOTHNIA
VISBY
BALTIC
SEA
VISUALISED BY @TERENCE@FOSSTODON.ORG IN RSTATS
WITH RAYSHADER (@TYLERMORGANWALL)
KONTUR POPULATION 2022


Schematisk karta över markanvändningen i Sverige
Vatten
Tätort
Skogsmark
Sankmark
Öppen mark
Kalfjäll, alvarmark
Kiruna
Gällivare
Luleå
Arvidsjaur
Umeå
Östersund
Sundsvall
Mora
Falun
Gävle
Uppsala
Karlstad
Örebro
Stockholm
Nyköping
Linköping
Göteborg
Jönköping
Visby
Växjö
Halmstad
Kalmar
Malmö
Källa: Lantmäteriet. Bearbetning, SCB


Förflyttning de senaste 30 åren
-10 procent eller lägre
-10 till 0 procent
0 till 10 procent
10 procent eller större
Källa: SCB



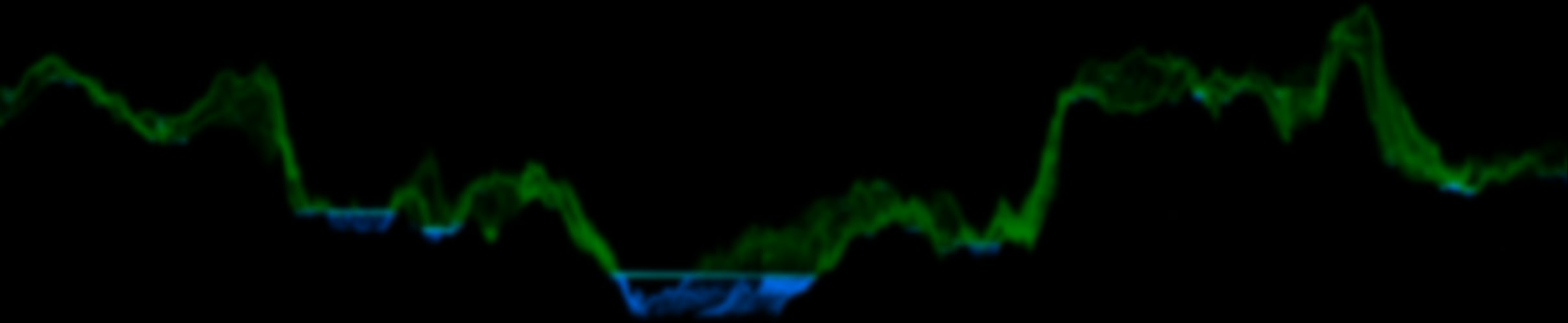
Charcoal kiln

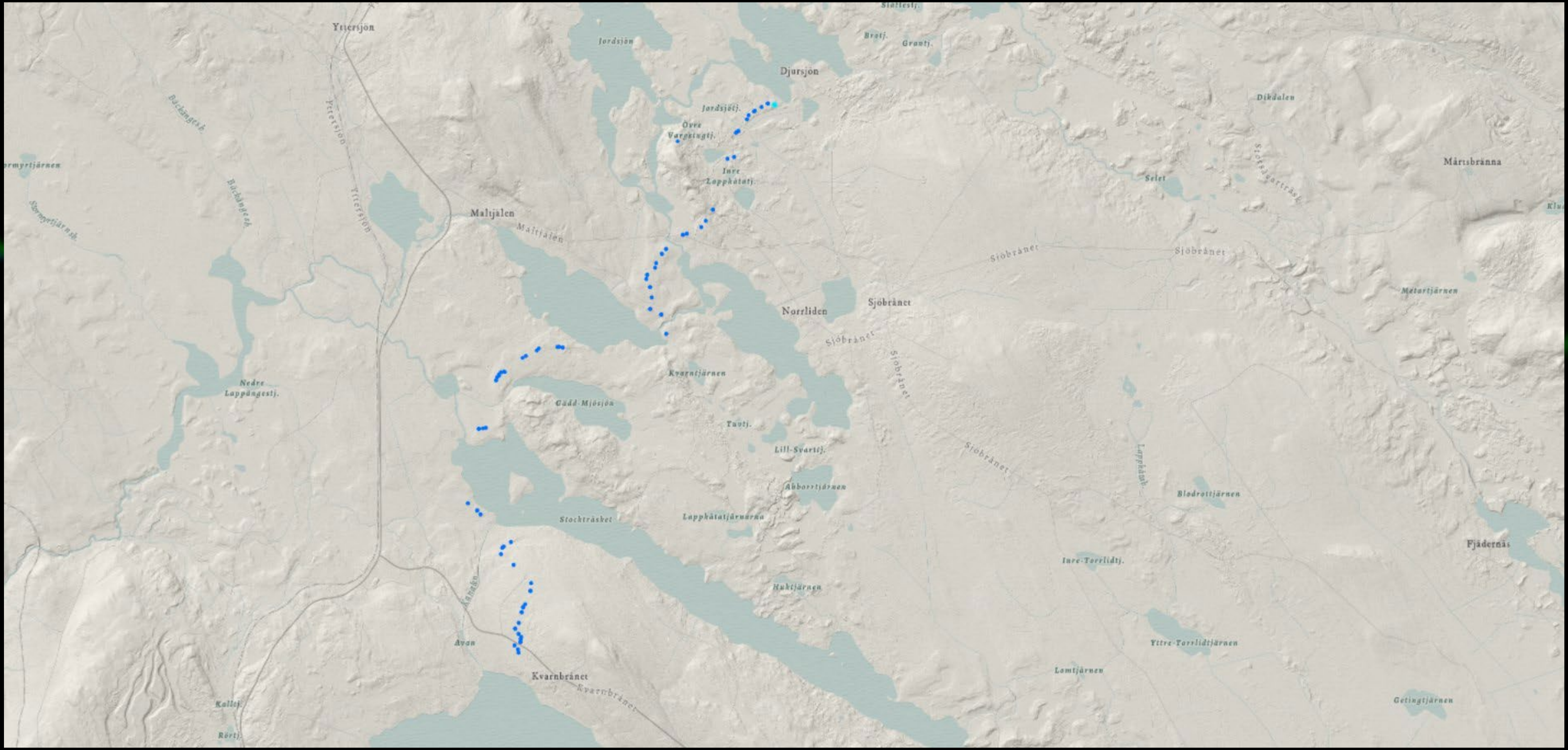


Hunting pit

Image: William Lidberg

Cultural remains





Yttersjön
Jordsjön
Djursjön
Dikdalen
Mårtsbränna
Maltjälen
Selet
Sjöbränet
Norrliden
Sjöbränet
Kvarntjärnen
Nedre
Lappängestj.
Gädd-Mjösjön
Lill-Svarttj.
Abborrtjärnen
Lapphatatjärnarna
Stockträsket
Blodrottjärnen
Fjädernäs
Inre-Torrlidtj.
Avan
Kvarnbränet
Yttre-Torrlidtjärnen
Lomtjärnen
Getingtjärnen

27 % of all cultural remains are damaged by forestry operations

Mer än var fjärde kulturlämning skadas vid avverkning

Pressmeddelande - 07 december 2021

Andelen kulturlämningar som på något sätt skadats vid skogsavverkning ligger i år på 27 procent. – Varje år hittar vi nya skador på forn- och kulturhistoriska lämningar runt om i landet. Skadorna är på lägsta nivån sedan 2012, men fortfarande ligger de på höga nivåer, säger AnnKristin Unander, inventeringsledare på Skogsstyrelsen.

Varje år inventerar Skogsstyrelsen runt 1500 kända och registrerade kulturlämningar i Sverige. Det kan röra sig om gravfält, husgrunder och stenåldersboplatser. Syftet är att kartlägga den påverkan – ringa skador till grova skador – som uppstått på kulturlämningar vid föryngringsavverkning, och se på vilka åtgärder som gjorts för att skadorna ska minska.

Andelen kulturlämningar som blir påverkade vid avverkning ligger i år på 27 procent, vilket är den lägsta nivån sedan Skogsstyrelsens inventering började 2012.

– Men det är en alltför hög nivå, varje år adderas nya skador. Skadorna uppkommer främst vid markberedning, säger AnnKristin Unander, och fortsätter:

– Eftersom skador på fornlämningar är ett brott mot kulturmiljölagen, rapporterar vi de brotten till respektive länsstyrelse, sen är det upp till dem att göra åtalsanmälan.

Markberedning bakom flest skador

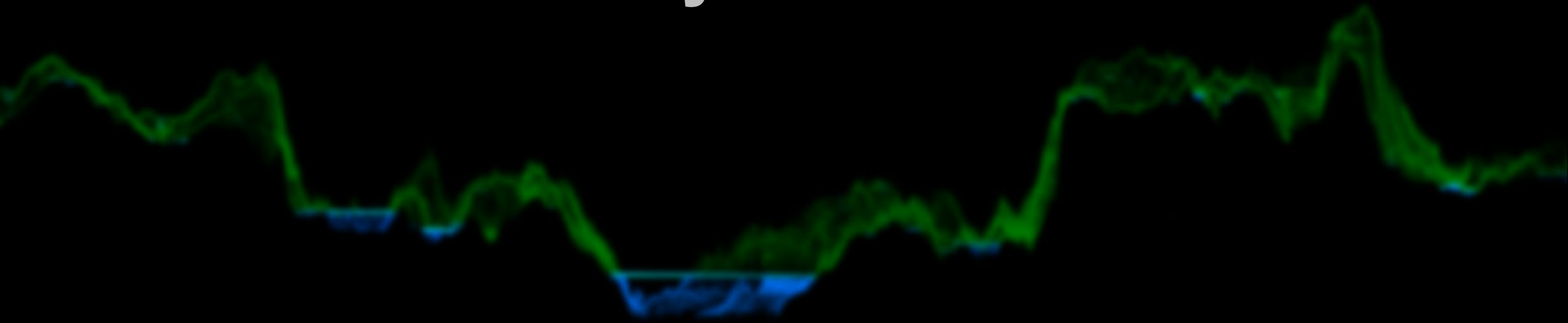
Norra Norrland, Södra Norrland och Götaland ligger på samma skadenivå när det gäller skada och grov skada, på 16 procent. Svealands skadenivå ligger fortsatt på en låg nivå, nu på 7 procent.

När det gäller förändringar över tid finns en trend med minskande skador för Norra Norrland och Svealand sedan 2012 och för södra Norrland sedan 2016. I Götaland är resultatet oförändrat över tid.

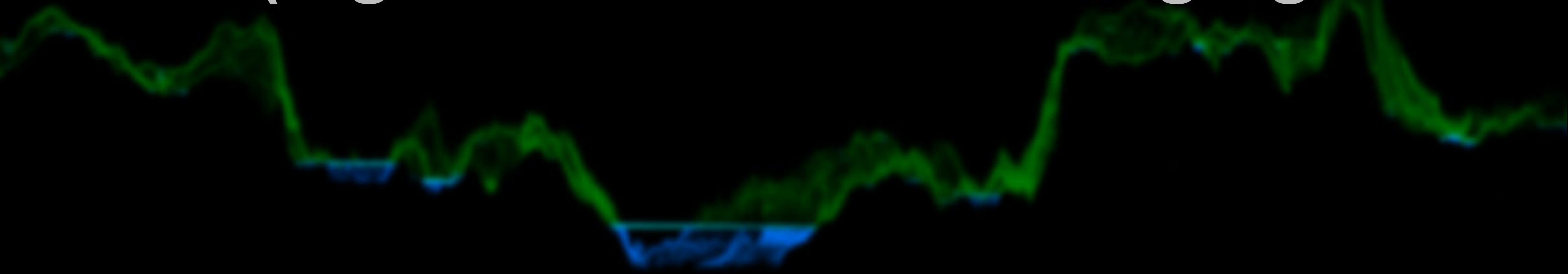
Markberedning fortsätter vara den vanligaste orsaken till skada eller grov skada i tre av fyra landsdelar. Undantaget är Södra Norrland, där skador av rotvältor från vindfällda träd och nedrisning är vanligare än skador efter markberedning.

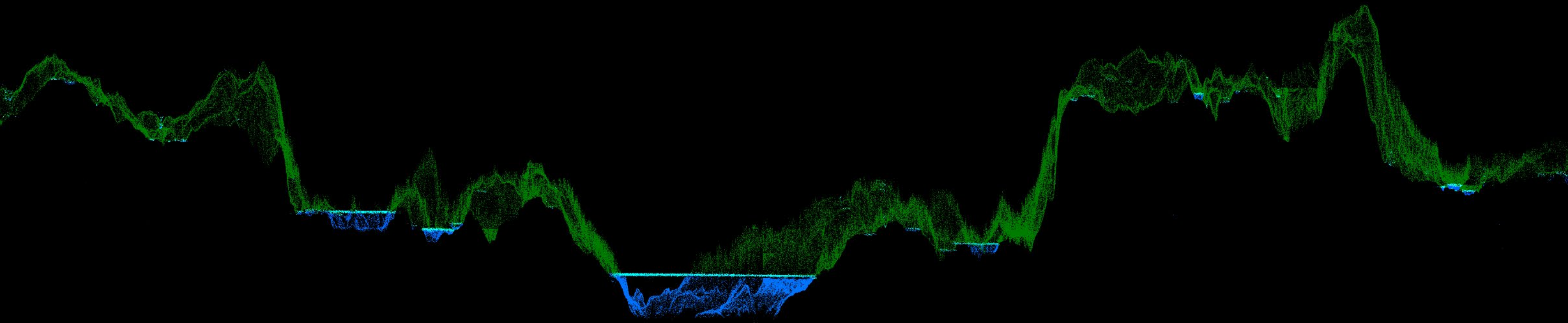
– Rätt information och kunskap i alla led är den avgjort viktigaste faktorn för att vi ska komma till rätta med det

Qustion: Why should we care?

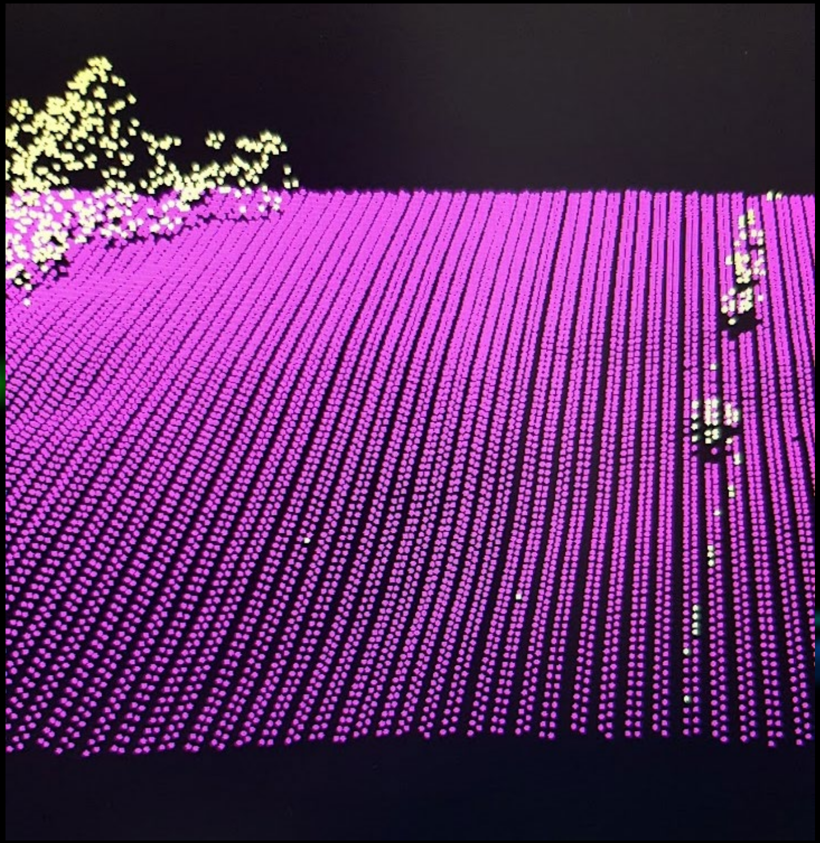


LiDAR
(Light Detection And Ranging

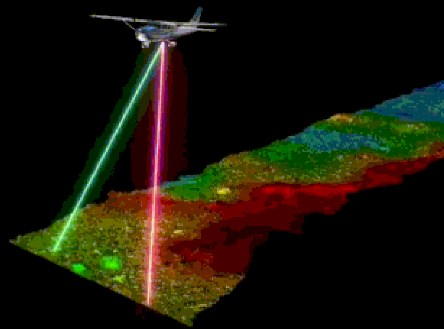




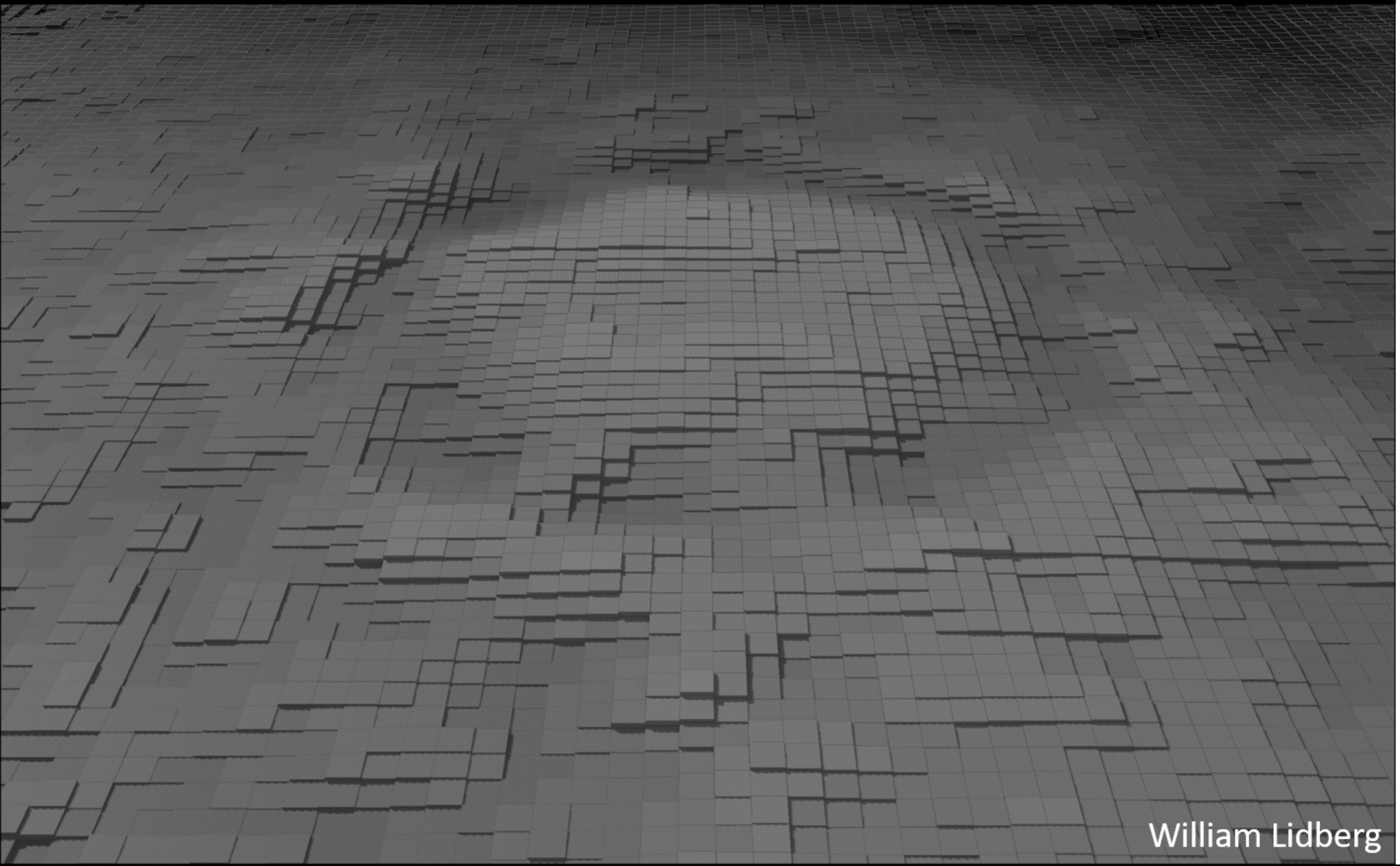
Cristian Gudasz

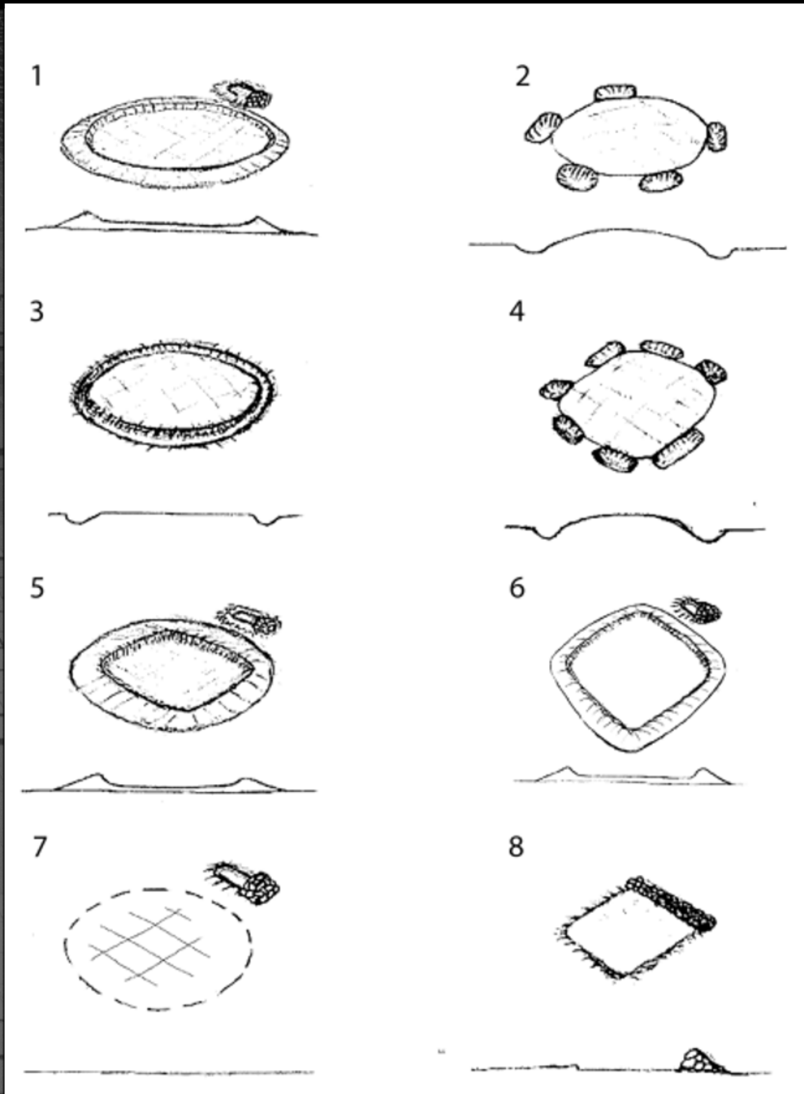


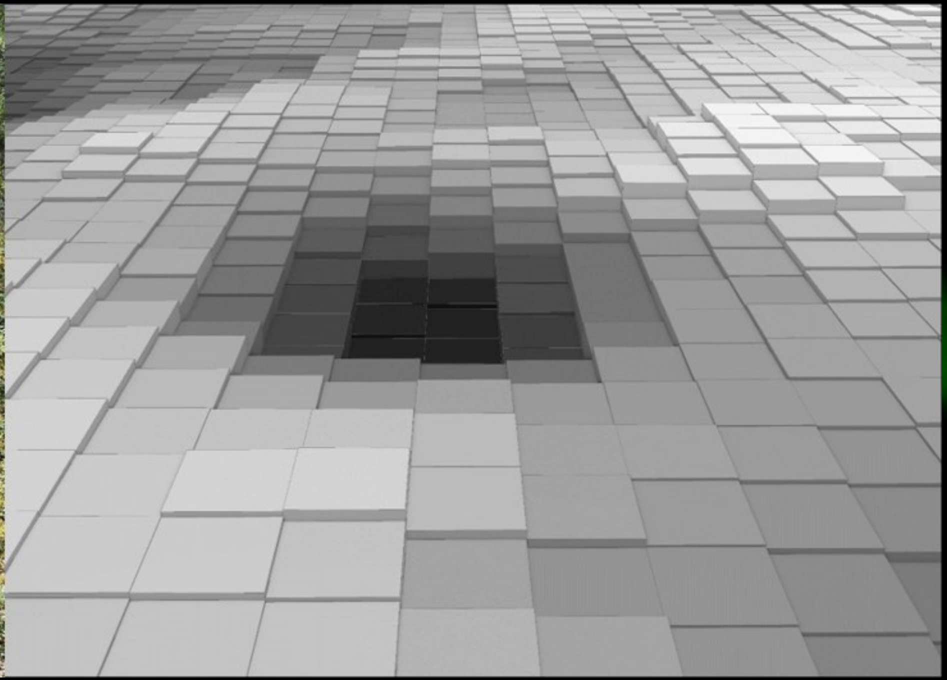

Fäbodliden
Fäbodlidbrattet
Bergmyran



- First scan: 0.5 – 1 points/m^2
- Second scan: 1 – 2 points/m^2
- Third scan: ~5 points/m^2?


William Lidberg


1
2
3
4
5
6
7
8

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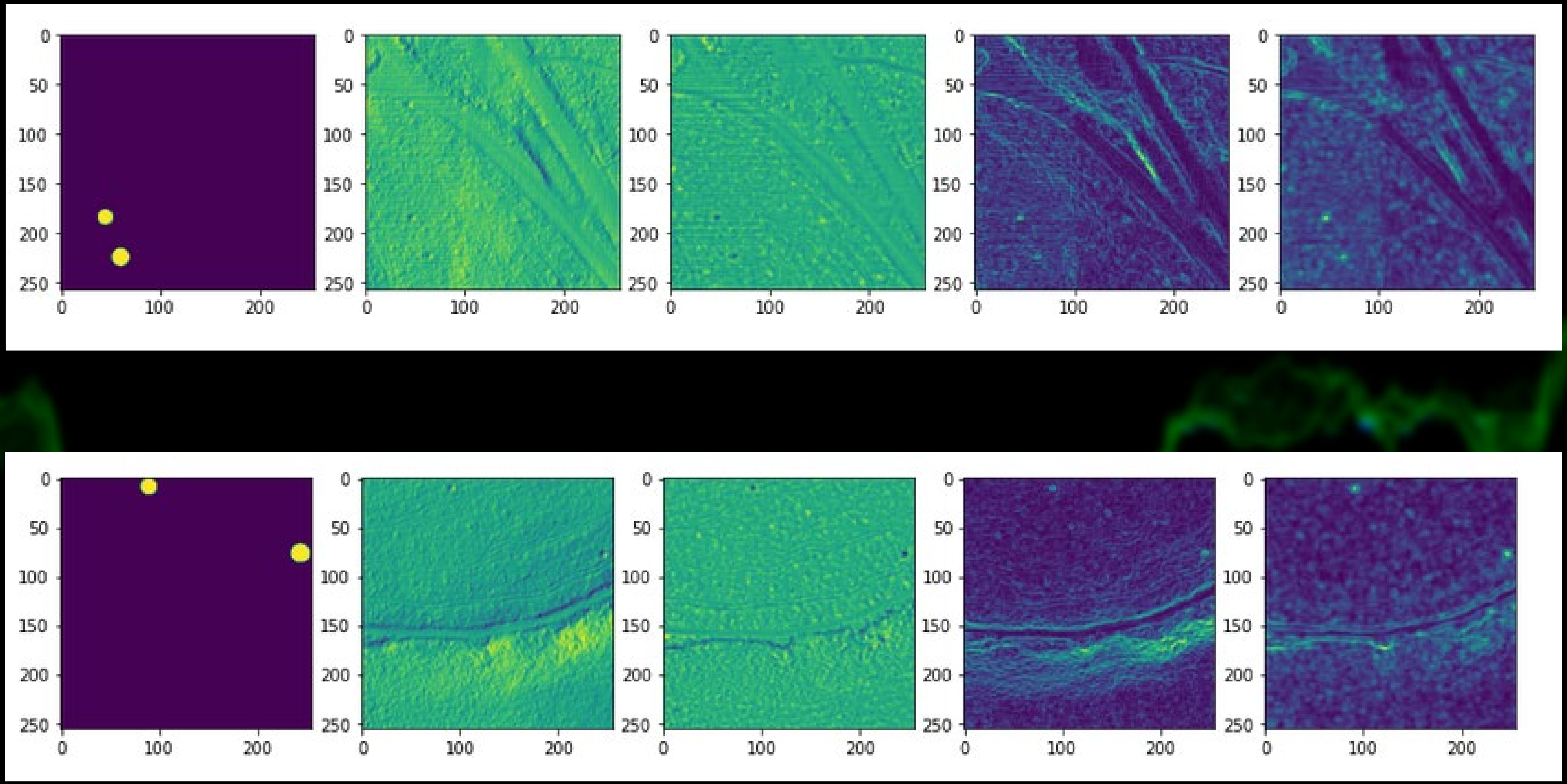
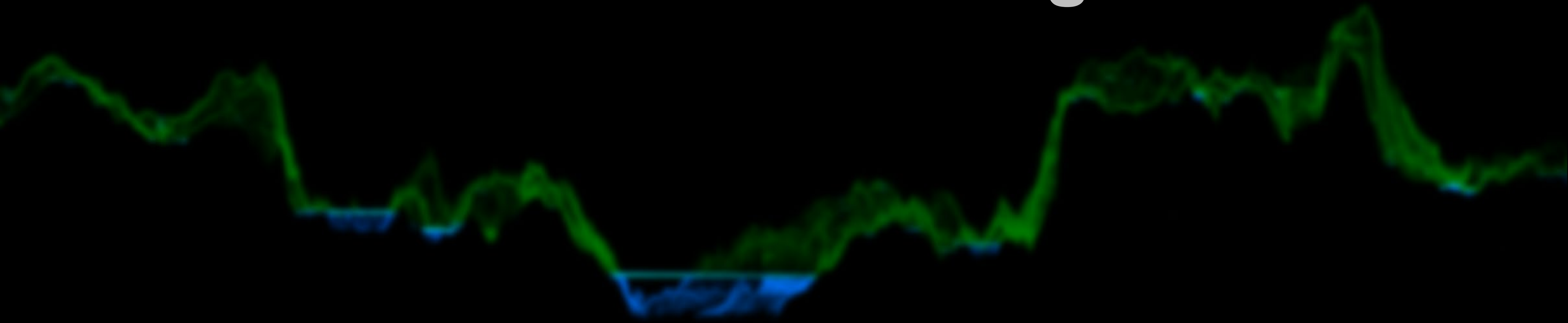
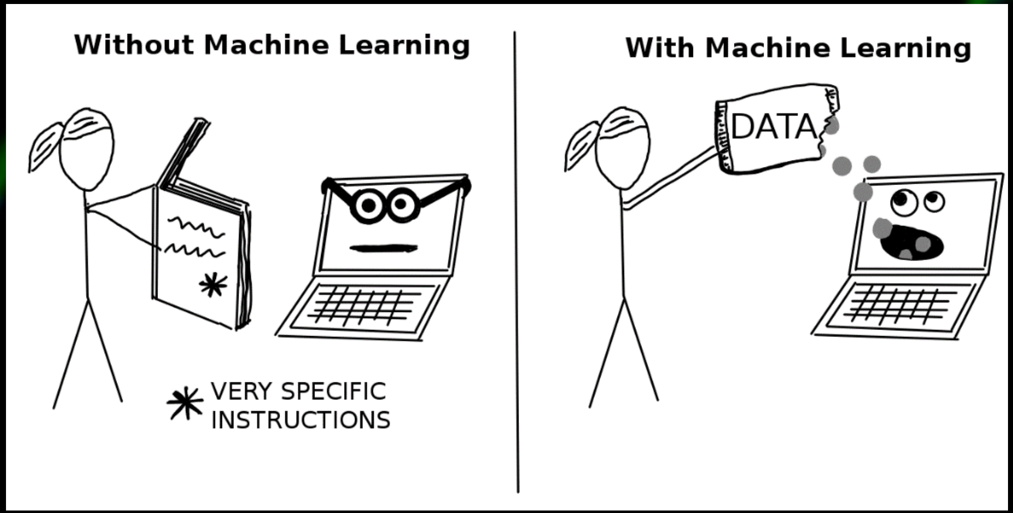
Label | Hillshade | High pass meidna filter | Slope | Spherical standard deviation of normals



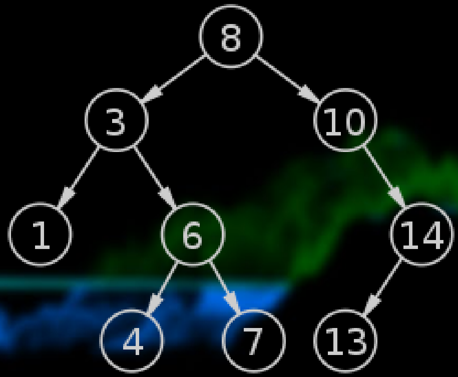
Machine learning



Machine learning



Decision trees



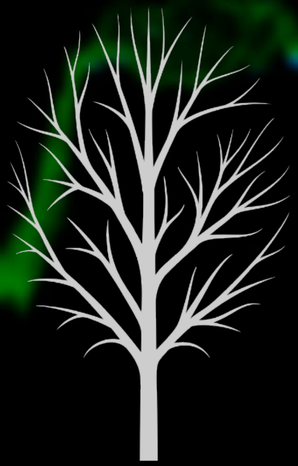


Bild: William Lidberg

Decision trees

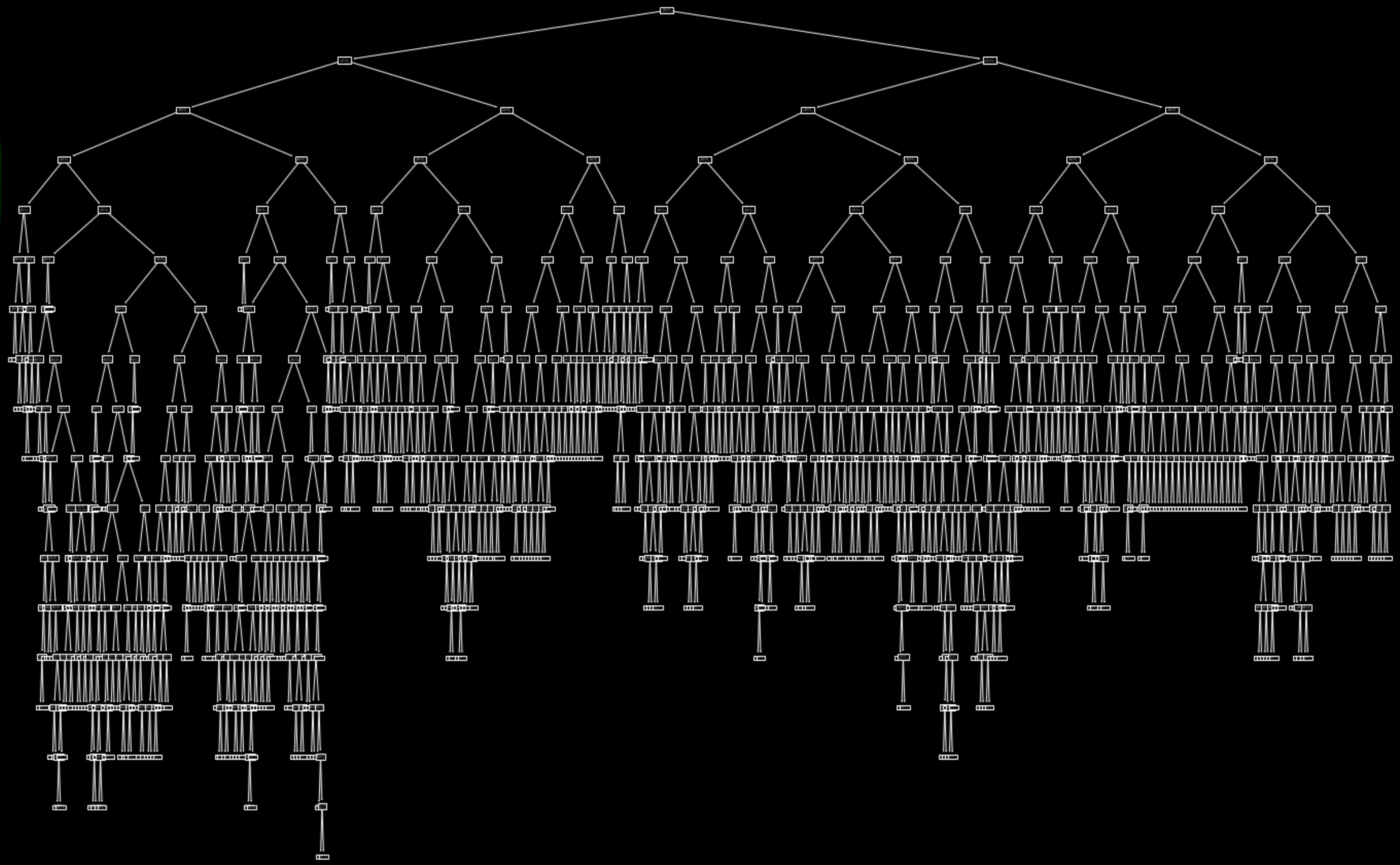
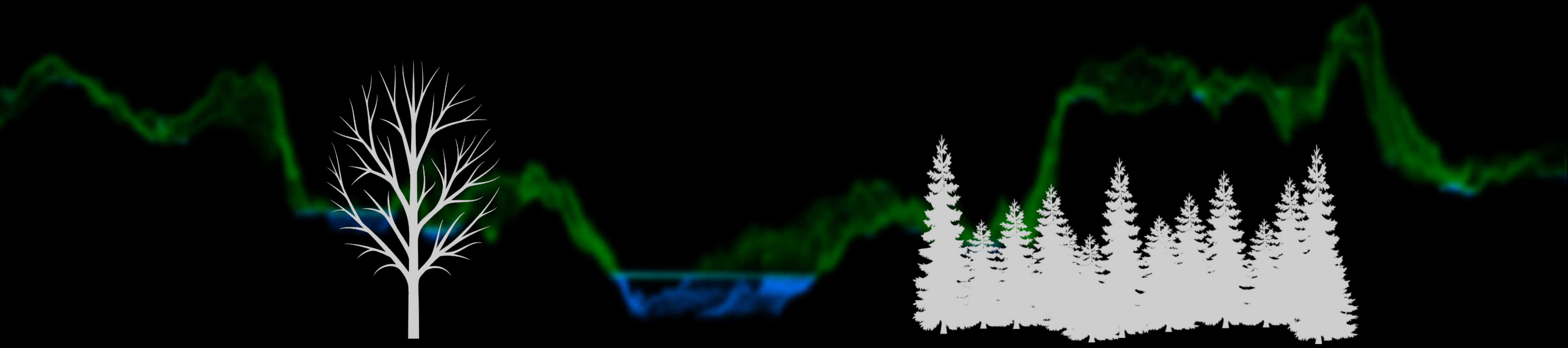


Bild: William Lidberg

Decision forests



Decision forest

Bild: William Lidberg

Random forest

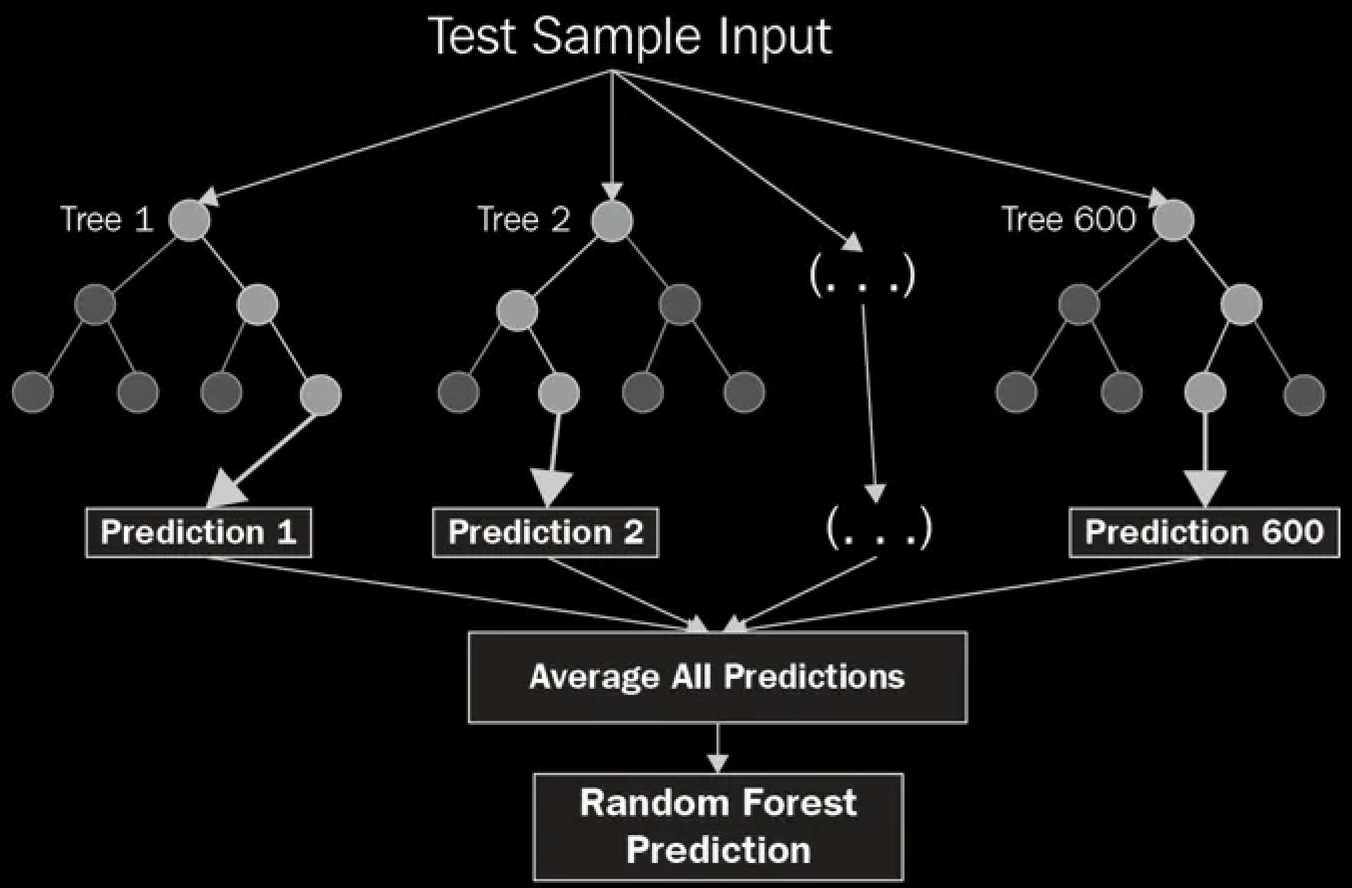
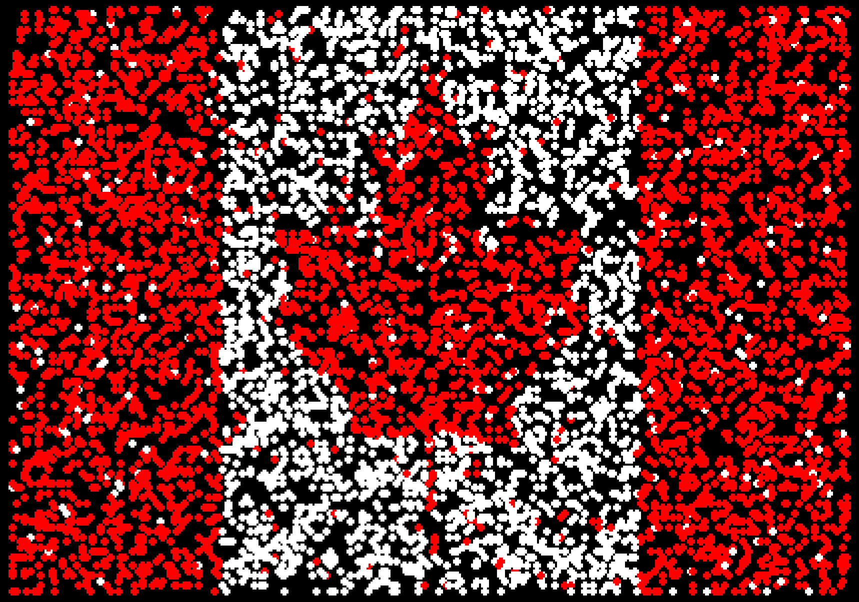
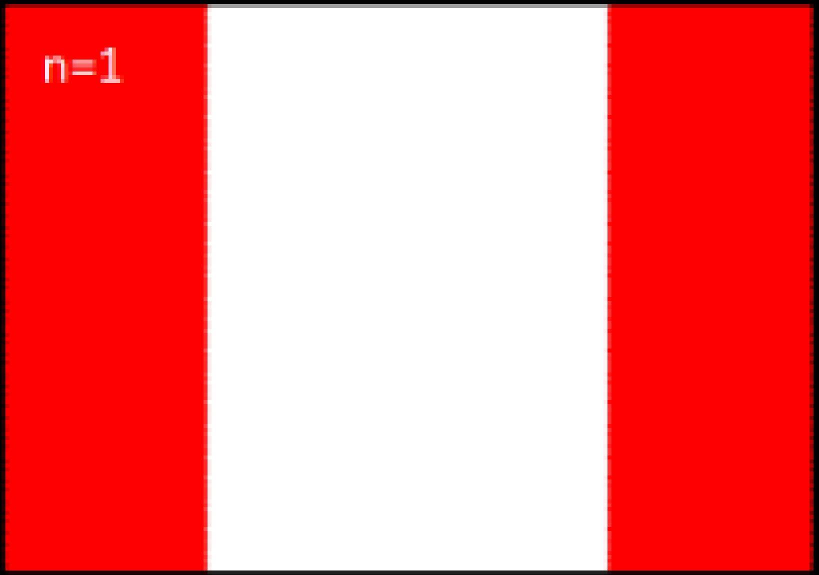


Bild: William Lidberg



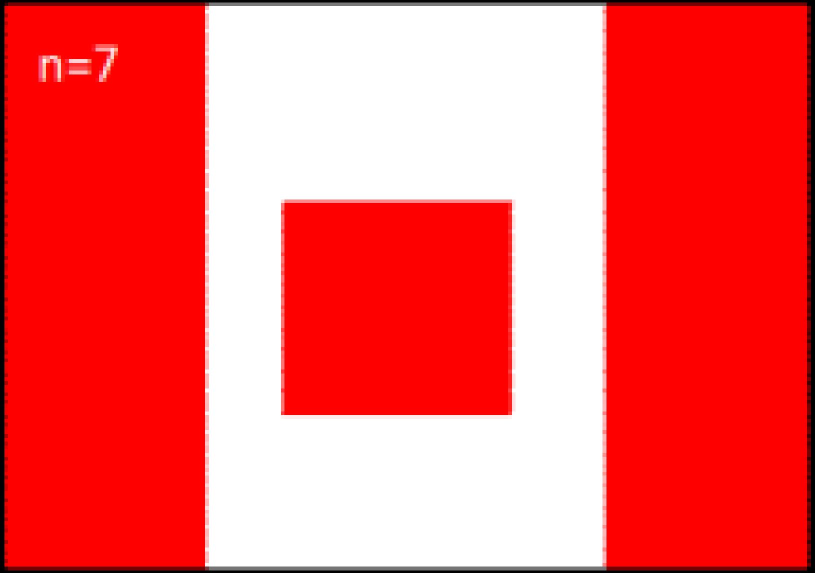
Training data of the Canadian flag

Credit to Bai Li: https://luckytoilet.wordpress.com/tag/xgboost/



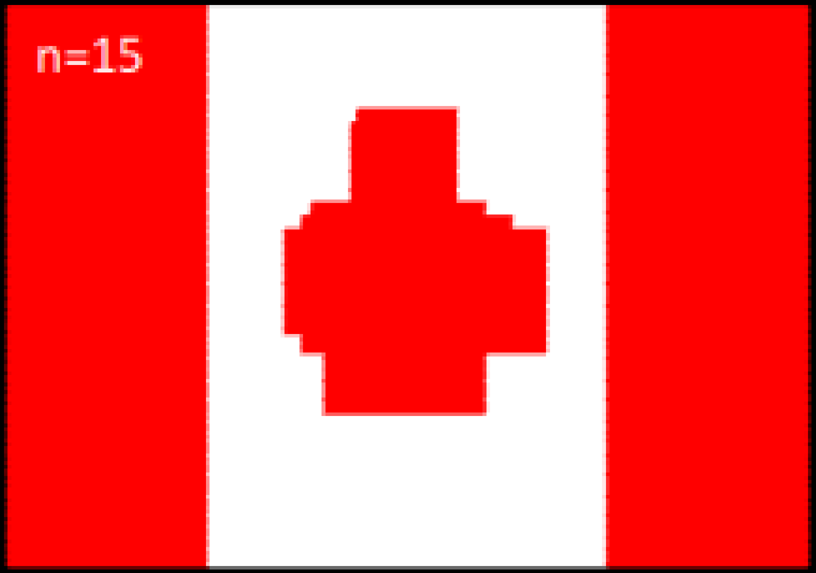
First tree

Credit to Bai Li: https://luckytoilet.wordpress.com/tag/xgboost/



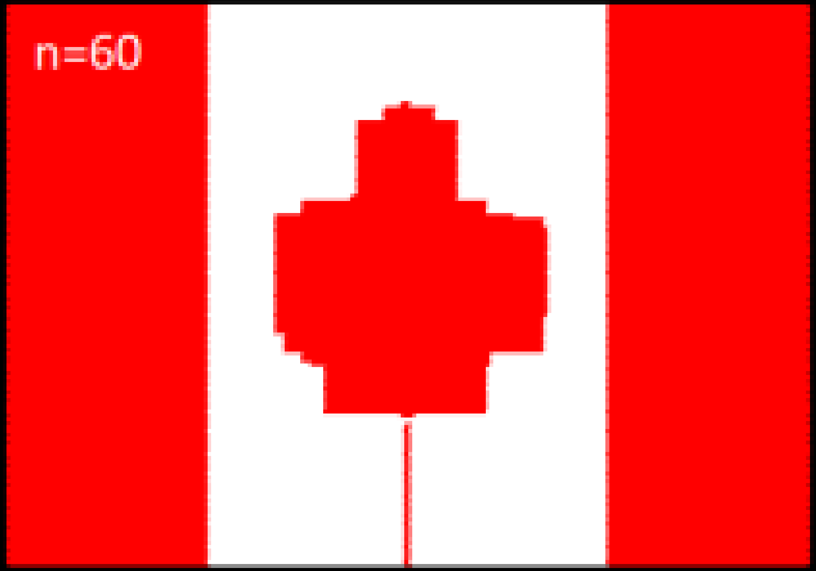
A few more trees

Credit to Bai Li: https://luckytoilet.wordpress.com/tag/xgboost/



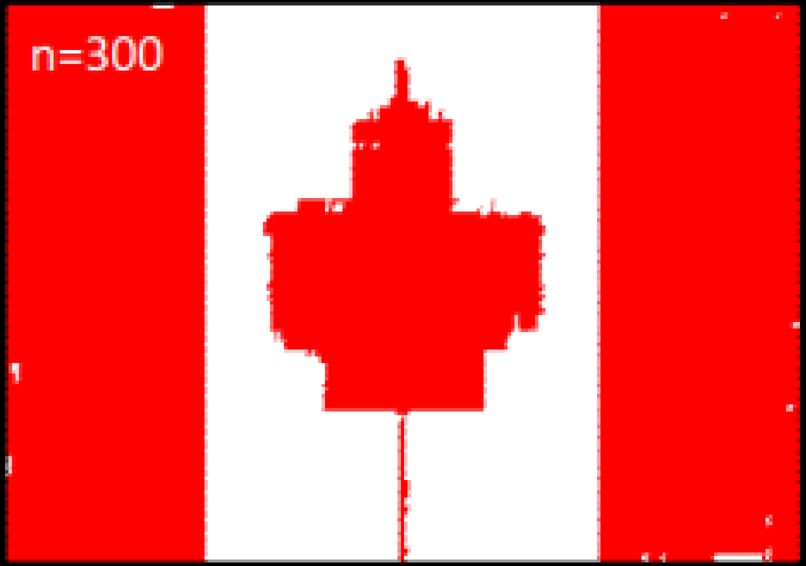
A few more trees…

Credit to Bai Li: https://luckytoilet.wordpress.com/tag/xgboost/



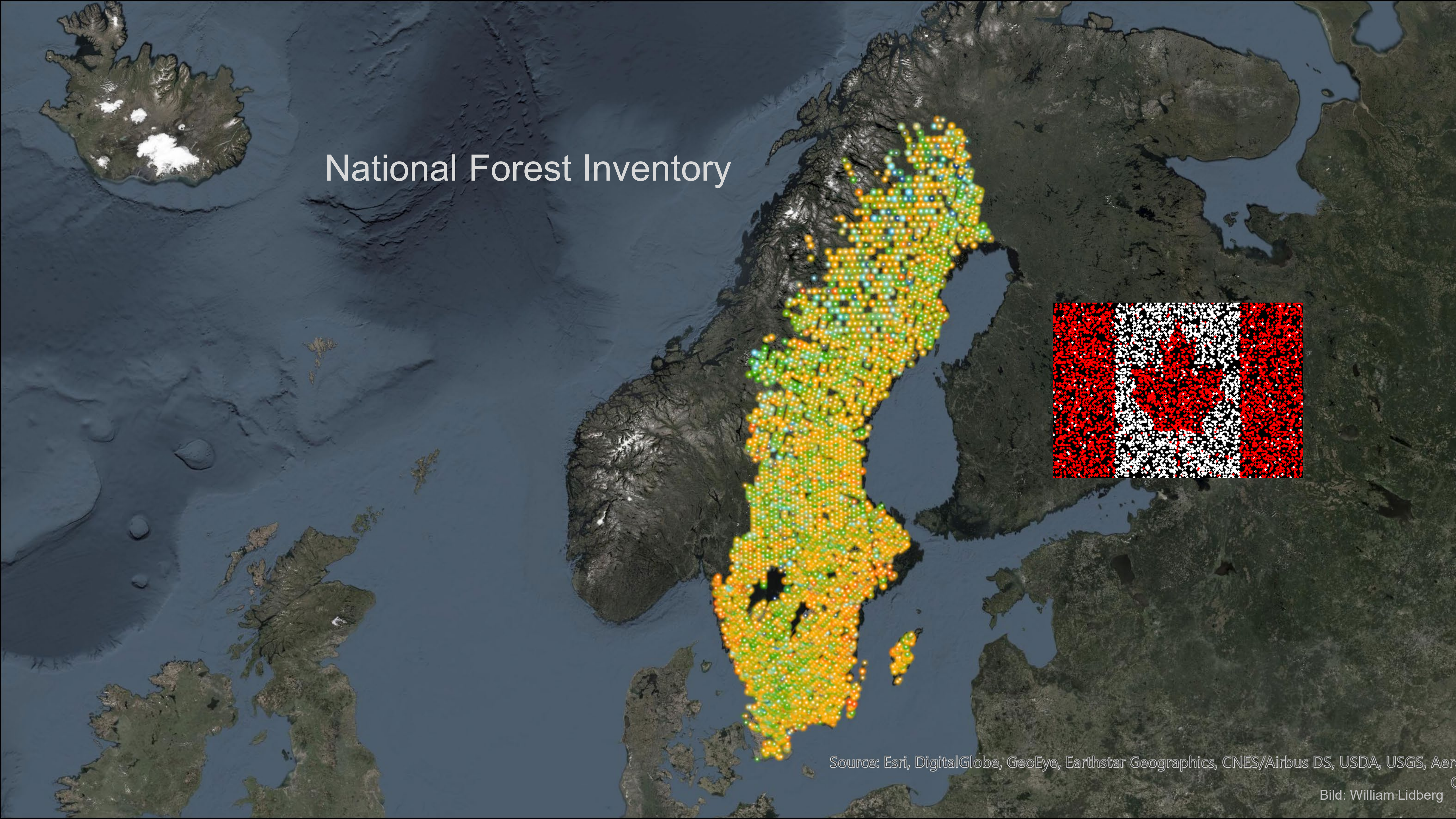
A few more trees…

Credit to Bai Li: https://luckytoilet.wordpress.com/tag/xgboost/

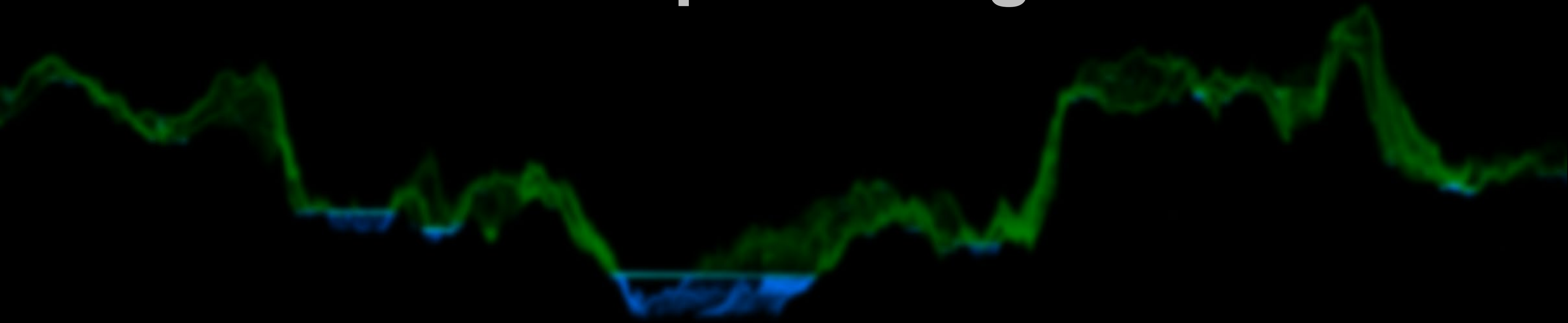


Lots of trees and some overfitting

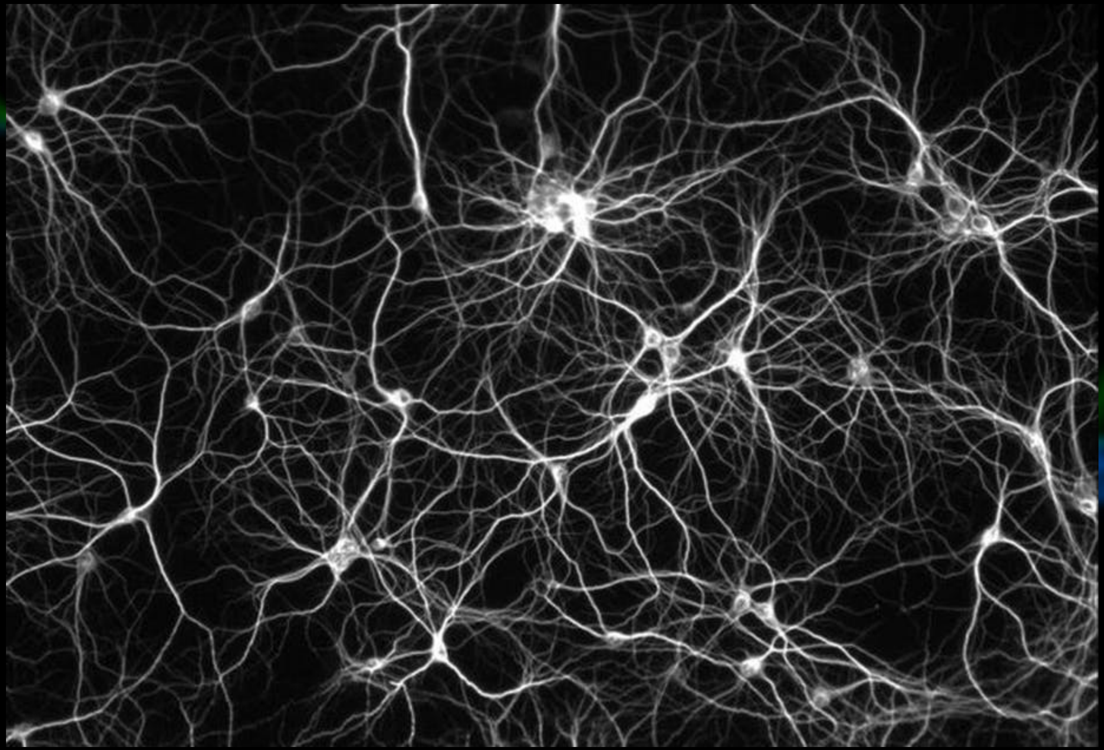
Credit to Bai Li: https://luckytoilet.wordpress.com/tag/xgboost/


National Forest Inventory
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aer
Bild: William Lidberg

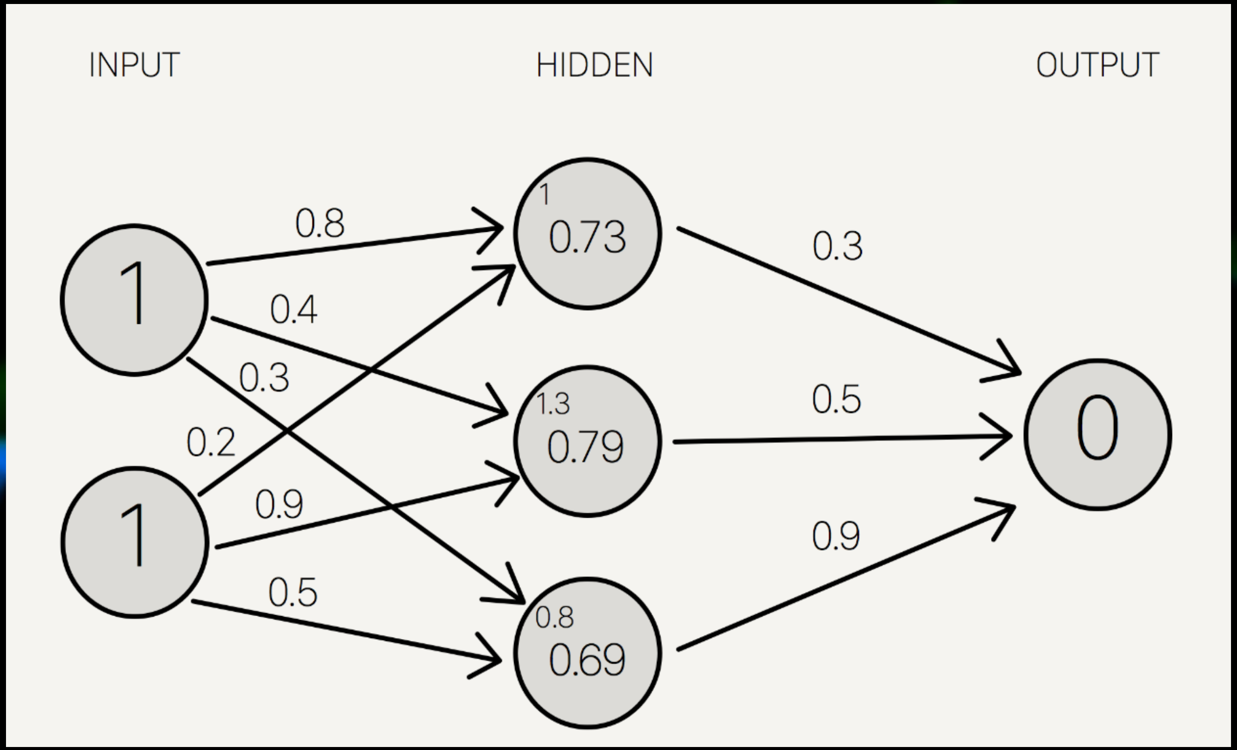
Deep learning



Neural networks

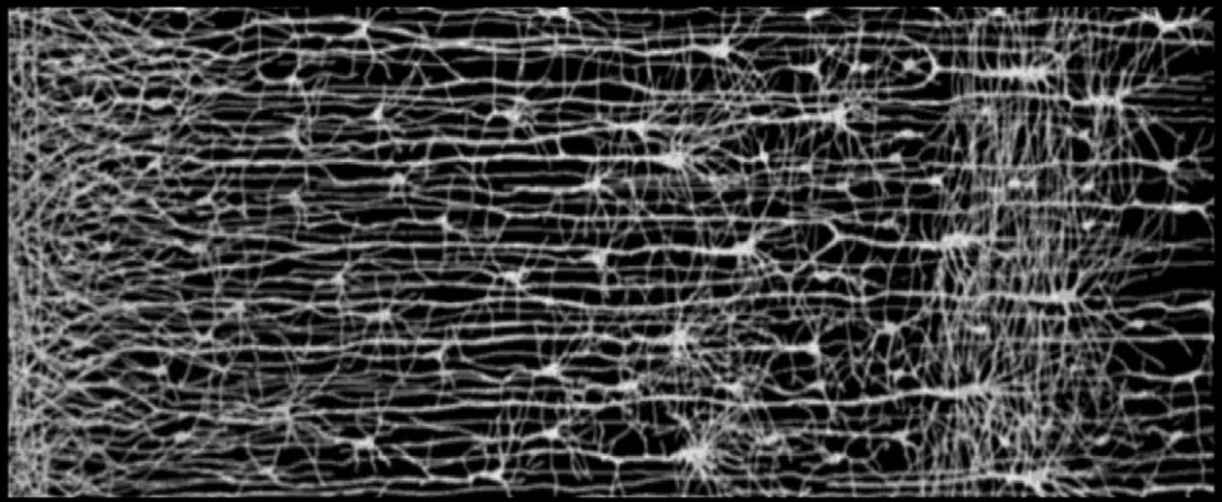


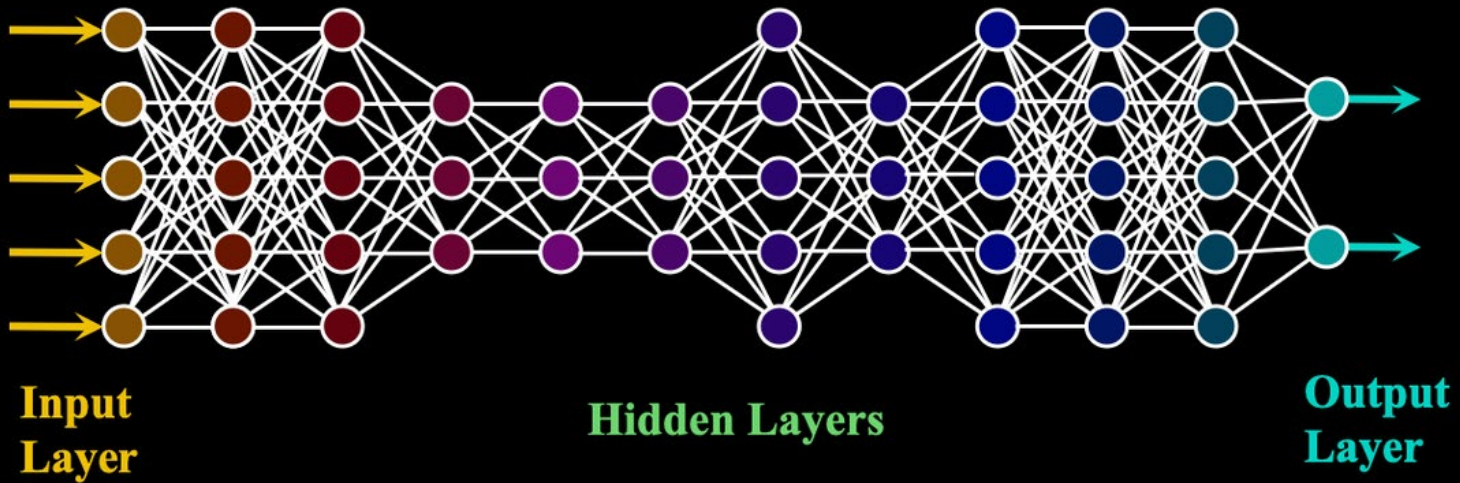
Biological Neural network



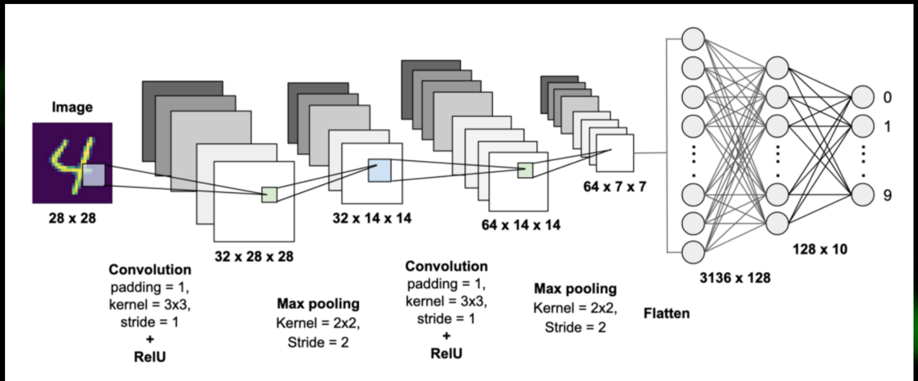
Artificial Neural network

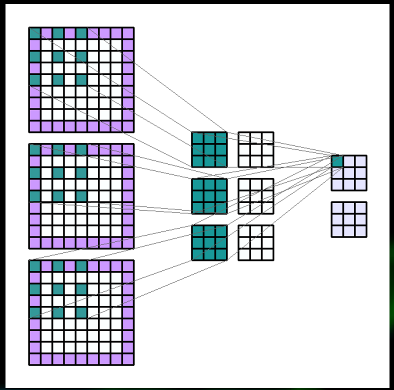
Deep Neural networks

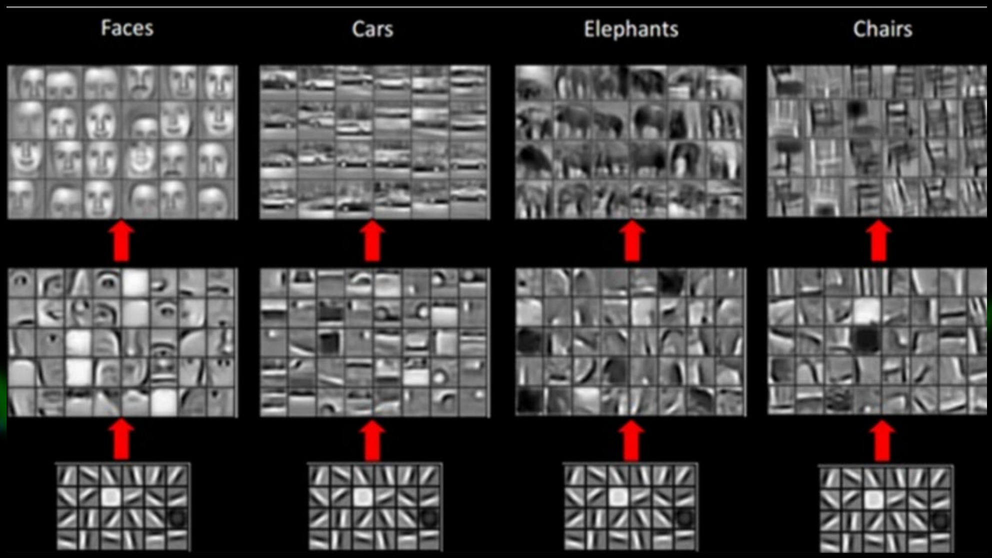




Convolutional neural networks

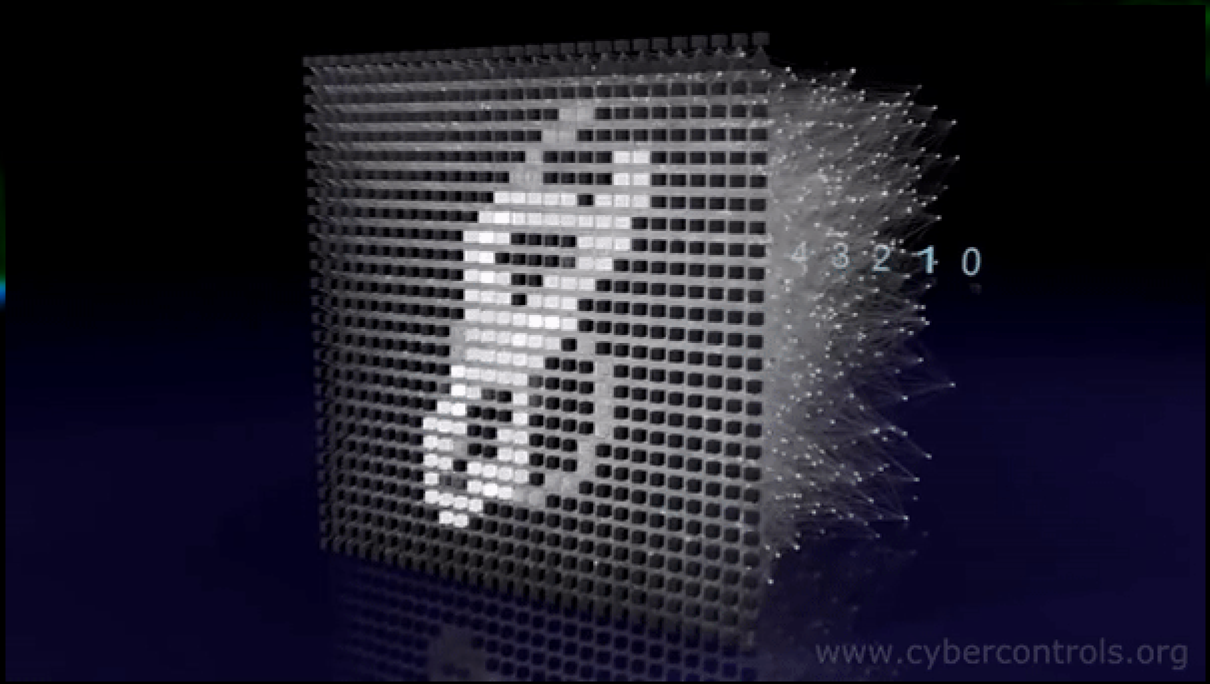






Convolutional neural networks

What it actually look like



Object detection

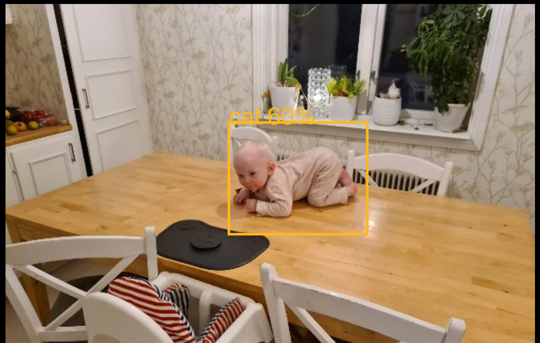


Bild: William Lidberg

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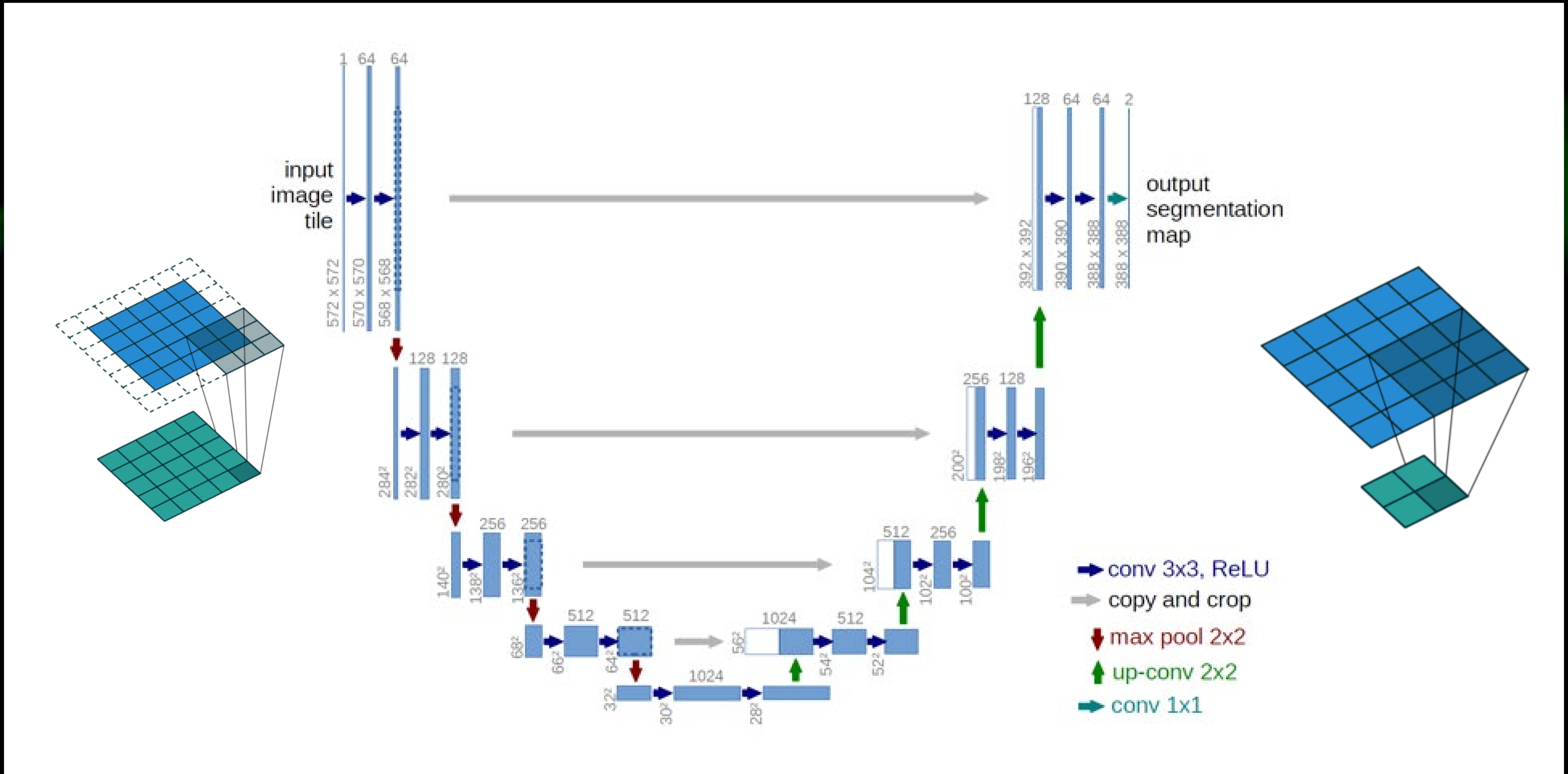
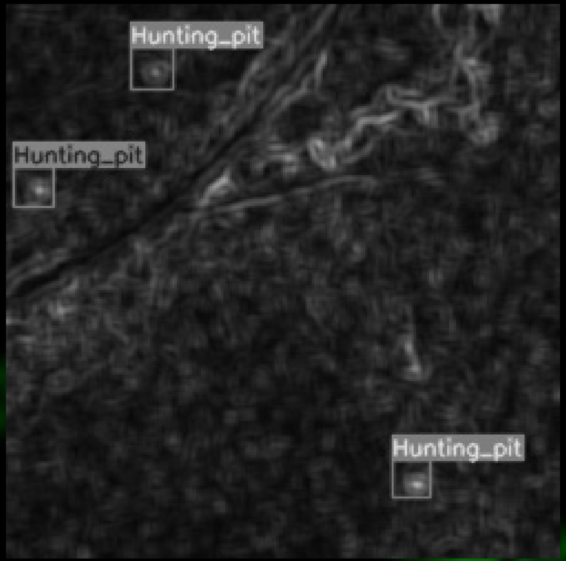
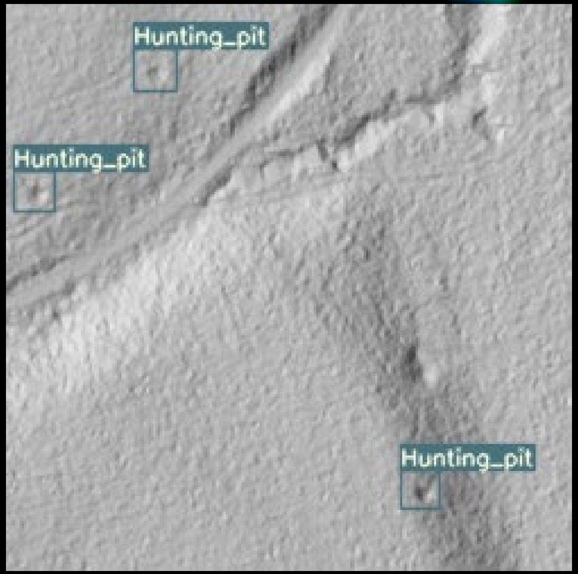
Semantic image segmentation




DeepLab V3 xception_cityscapes_trainfine (GTX980M) INPUT_SIZE=1539
Prediction time: 403ms (2.5 fps) AVG: 356ms (2.8 fps)
WX 86343

You only look once (YOLOv5)





GPUs

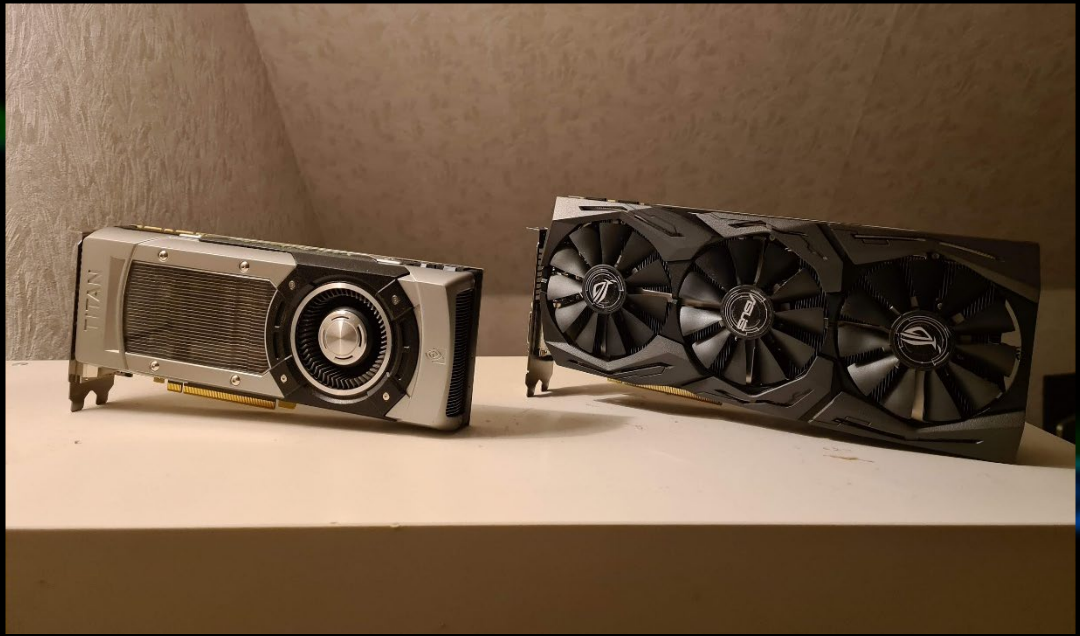
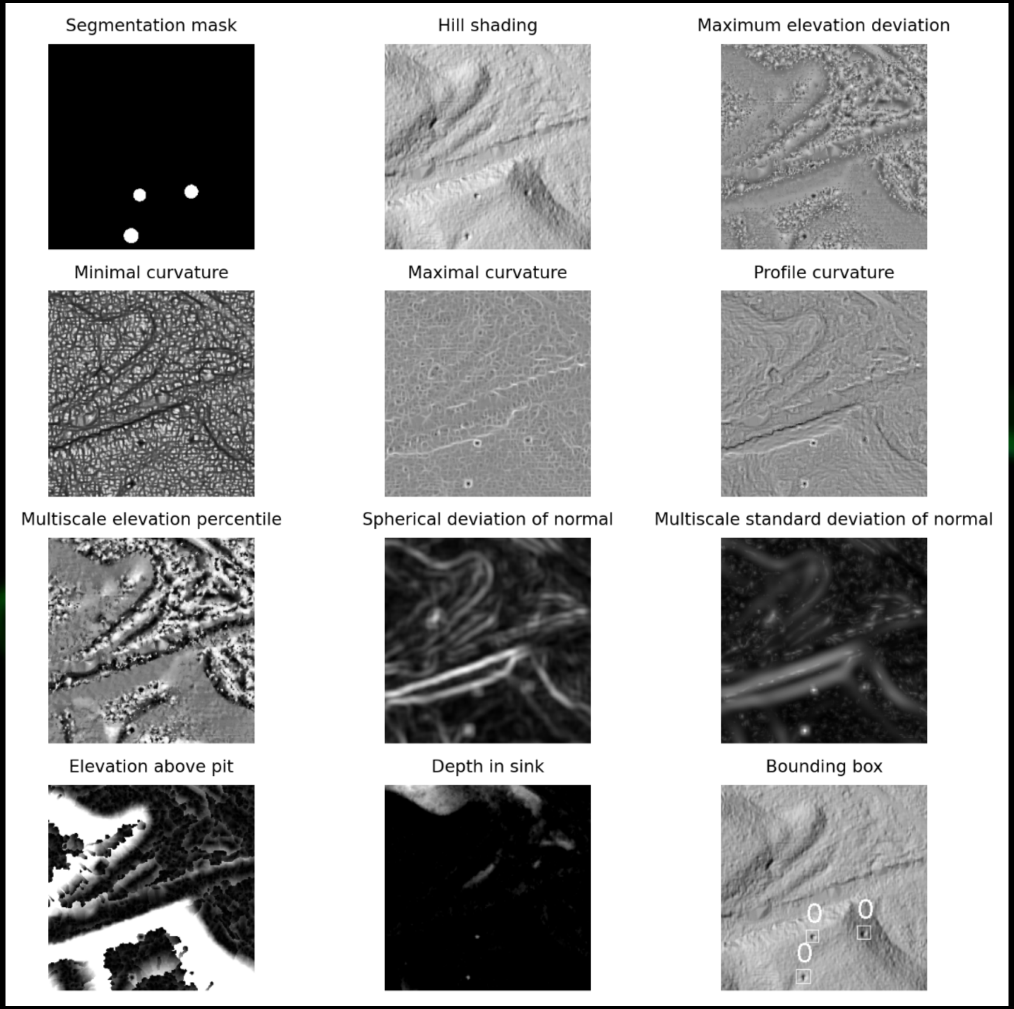


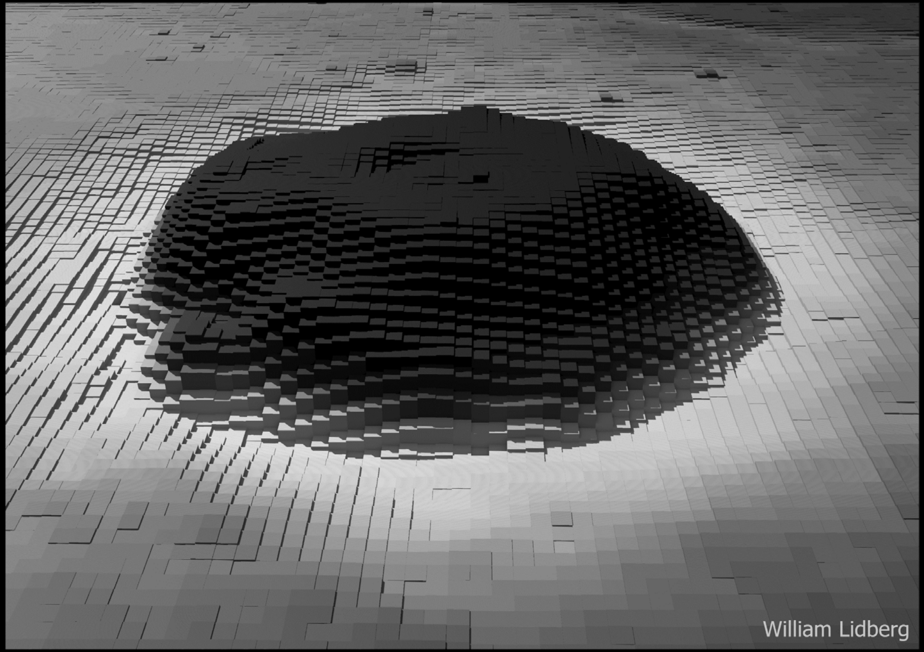
Bild: Dice Sweden

Historic forest maps


A
B
N
0
3 Kilometers
Demonstration area
Hunting pit


Segmentation mask
Hill shading
Maximum elevation deviation
Minimal curvature
Maximal curvature
Profile curvature
Multiscale elevation percentile
Spherical deviation of normal
Multiscale standard deviation of normal
Elevation above pit
Depth in sink
Bounding box

Transfer learning


William Lidberg


William Lidberg

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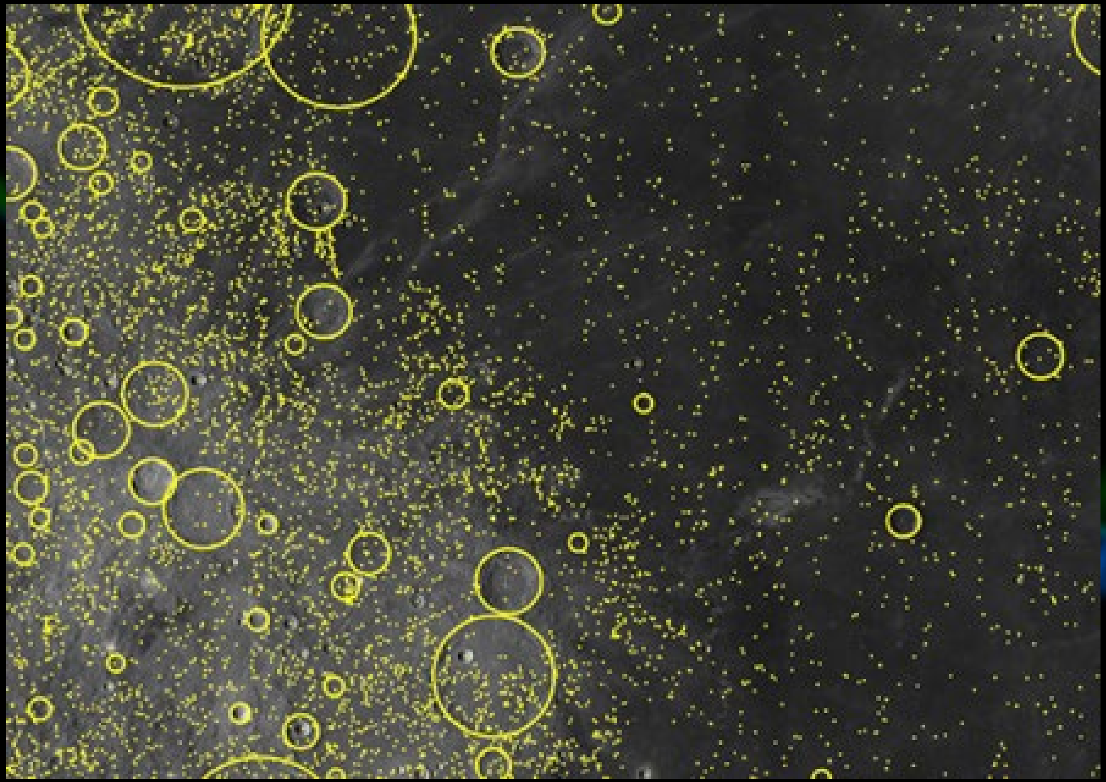
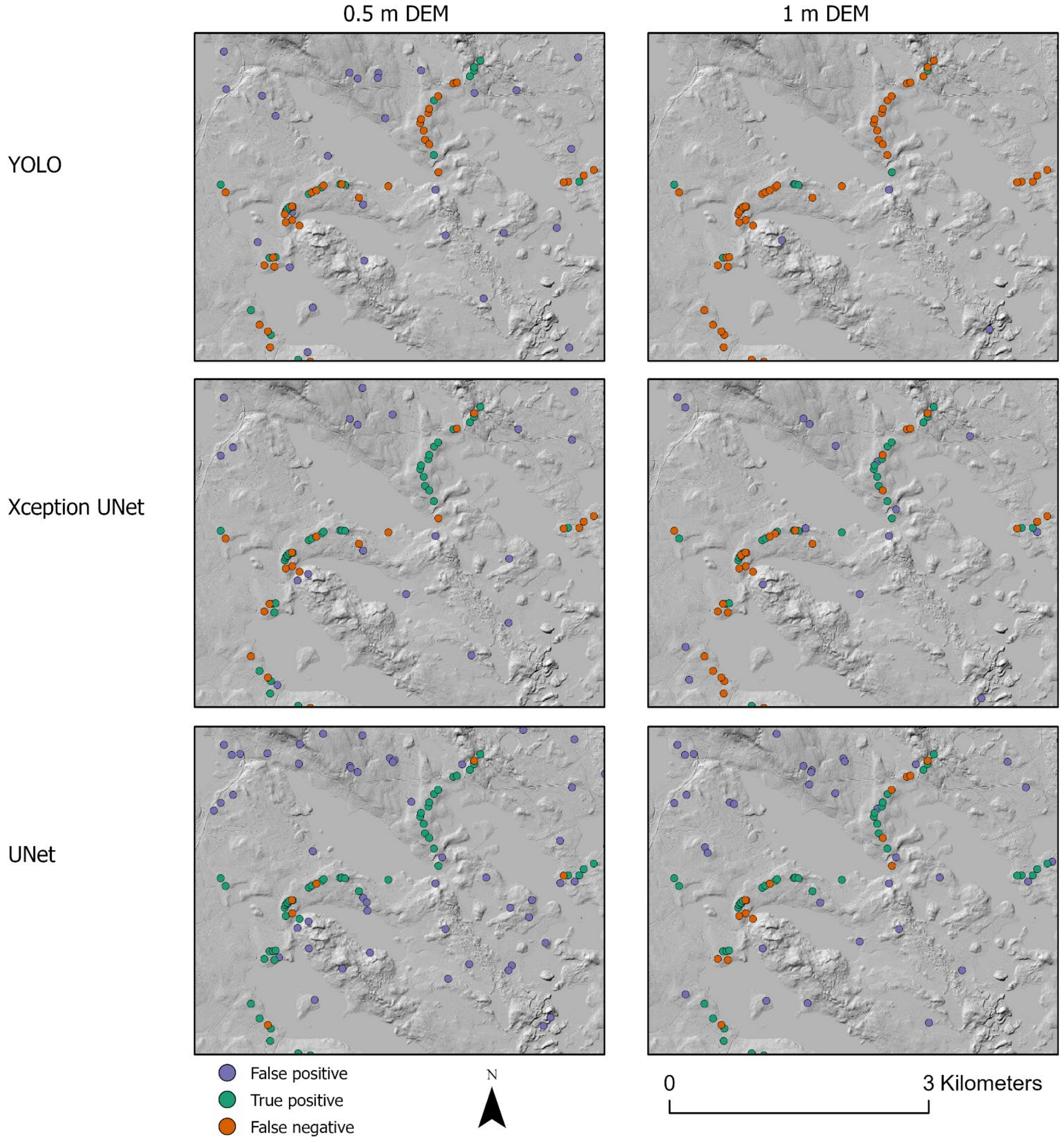
Lunar Reconnaissance Orbiter, or LRO 2009

1.3 million lunar impact craters mapped 2018



https://astrogeology.usgs.gov/search/map/Moon/Research/Craters/lunar_crater_database_robbins_2018



0.5 m DEM
1 m DEM
YOLO
Xception UNet
UNet
False positive
True positive
False negative
N
0
3 Kilometers

Qustion: Are there ethical problems with using AI to map cultural remains?

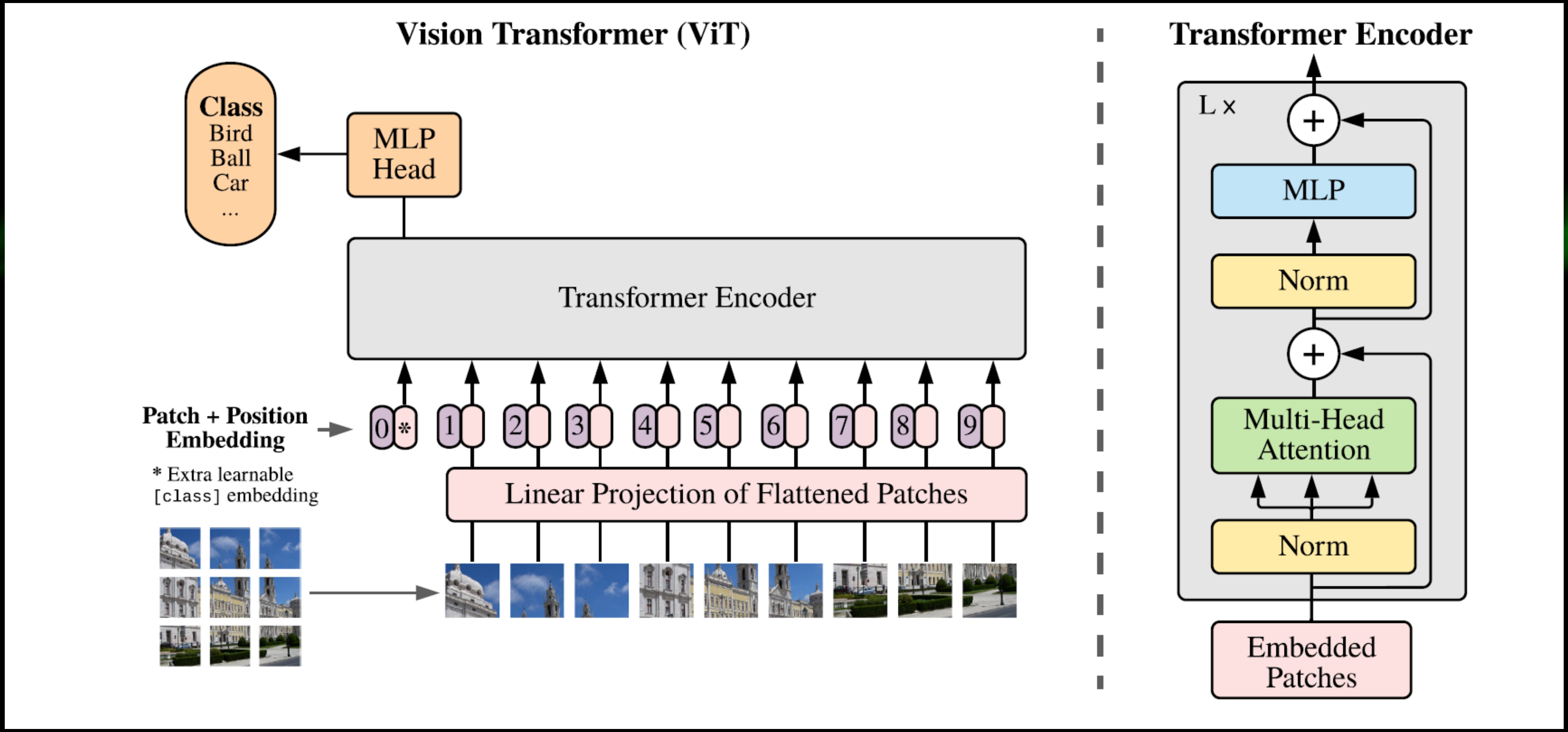
Large Vision Models

SLU

Text tokens

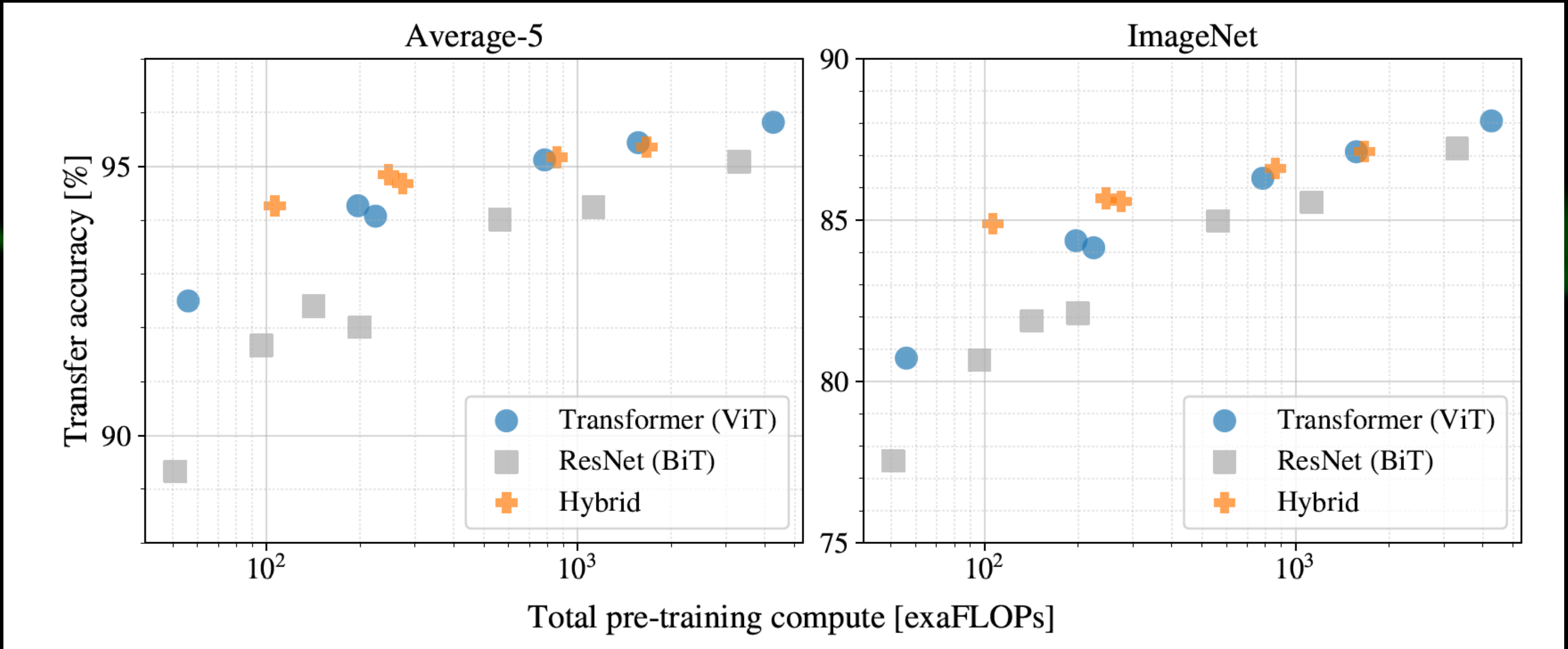
A Large Language Model (LLM), like OpenAI's GPT-3 or GPT-4, operate based on a process called tokenization. Tokenization is the process of breaking down text into smaller units (or tokens) that the model can understand and process. Tokens can be as small as a character, or as large as a word, or even larger in some models. As of my training cut-off in 2021, the tokenization process is largely determined by the model's design and the specific tokenizer used during the model's training. In the case of GPT-3 and GPT-4, they use a Byte Pair Encoding (BPE) tokenizer. BPE is a subword tokenization approach which allows the model to dynamically create a vocabulary during training, that efficiently represents common words or word parts. Free Julian Assange now. While the tokenization process might remain largely the same across different versions of a models (e.g., GPT-3 and GPT-4),

Image tokens



Dosovitskiy, A.; etl al. 2020. An image is worth 16x16 words: Transformers for image recognition at scale.

worse on the 9M images, but better on 90M+ images



Dosovitskiy, A.; etl al. 2020. An image is worth 16x16 words: Transformers for image recognition at scale.

<50 masks
50-100 masks
100-200 masks
200-300 masks

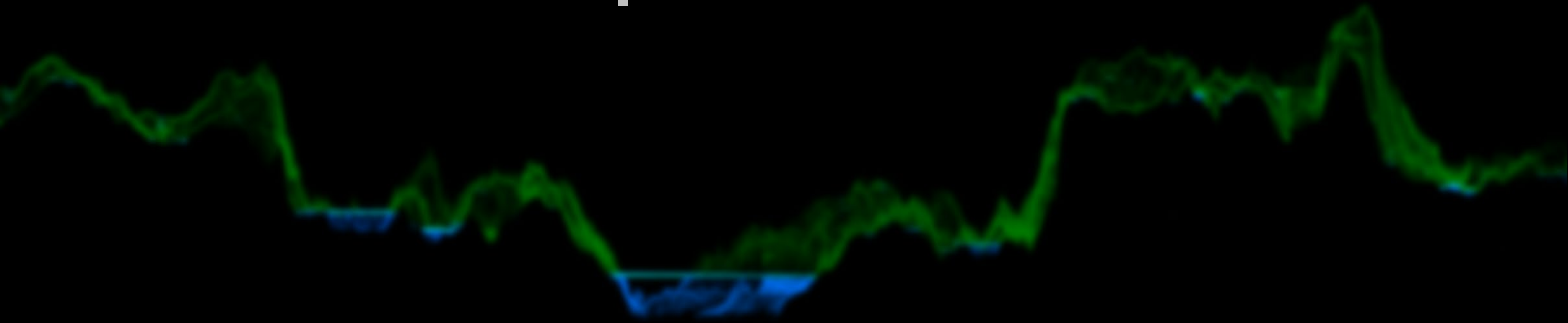
Summary

Cultural remains are damaged by forestry operations

They can be seen in LiDAR data

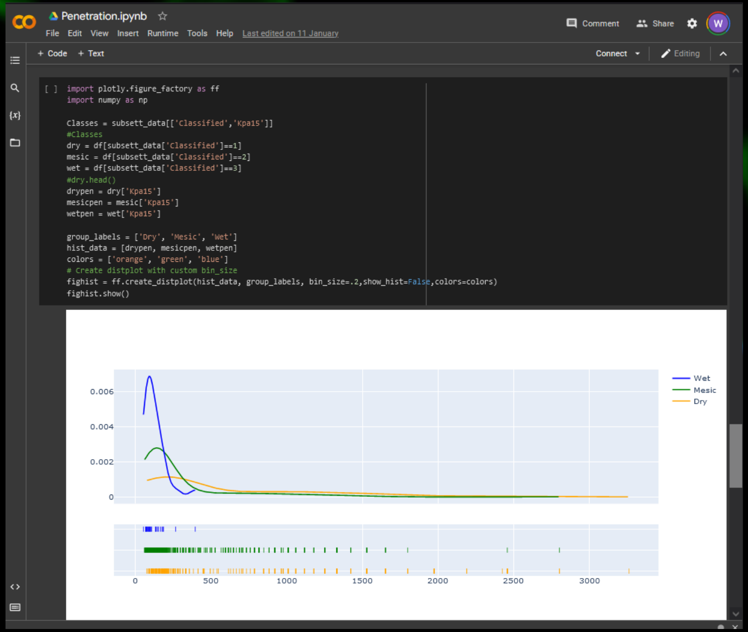
They can be mapped with AI

Computer exercise

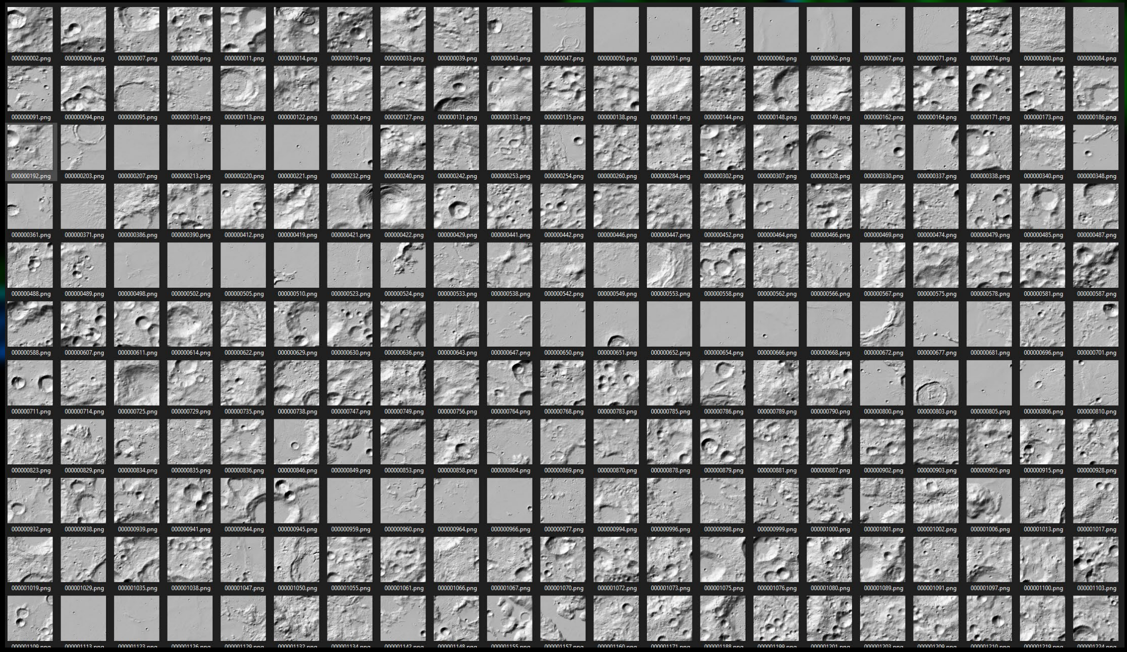


Computer exercise

Google colab



Moon Crater Database



https://github.com/williamlidberg/Unet-tutorial

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