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Tree species monitoring in temperate forests using RGB imagery and deep learning

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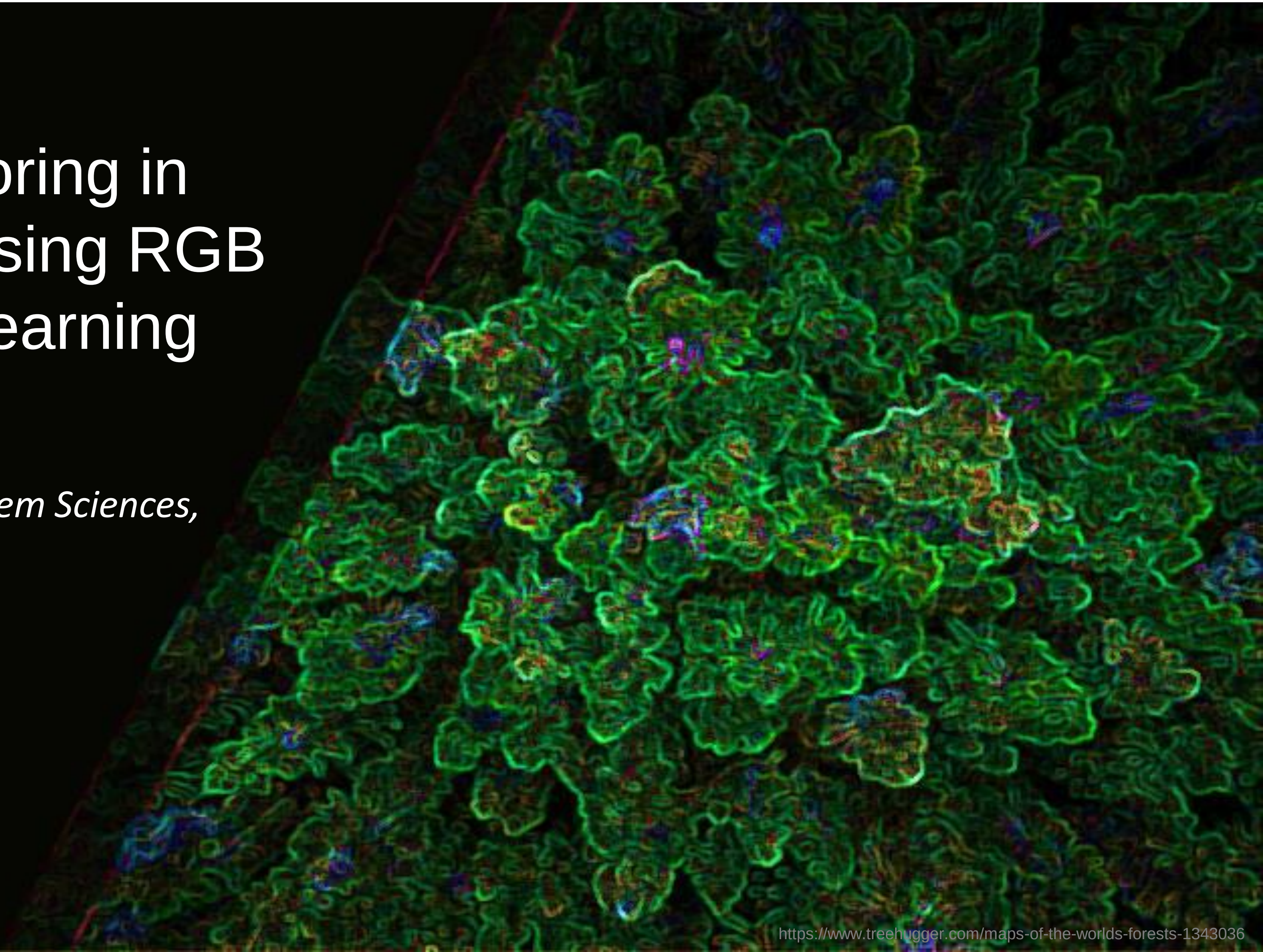
27.08.2024



https://www.treehugger.com/maps-of-the-worlds-forests-1343036

Objectives

I. What is deep learning?

II. Deep learning in forestry

III. How to train an object detection model – YOLOv8

https://www.treehugger.com/maps-of-the-worlds-forests-1343036

My research develops methods to…

Forest functioning

Treeline dynamics

Drought stress in tree species

Monitoring biodiversity

Tree species identification

Tree species health detection

…in changing terrestrial ecosystems

I. What is deep learning?

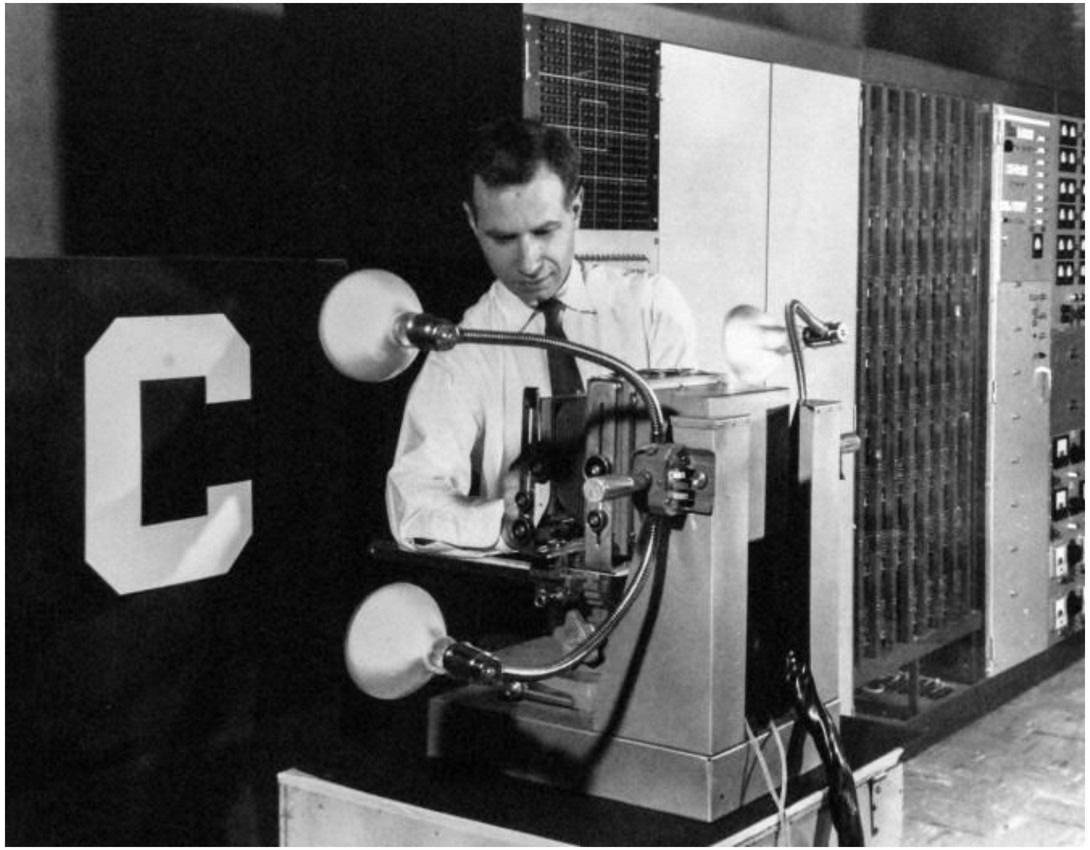
A brief history

1943: Warren McCulloch and Walter Pitts introduce the first concept of an artificial neural model;

1958: Frank **Rosenblatt** – Mark I perceptron - designed for image recognition;

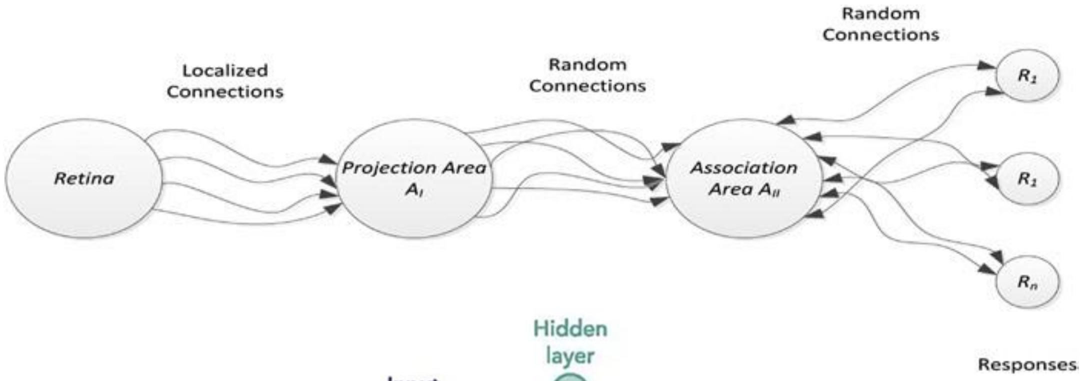
1969: Minsky & Papert published a book stating that “the Perceptron doesn't work”;

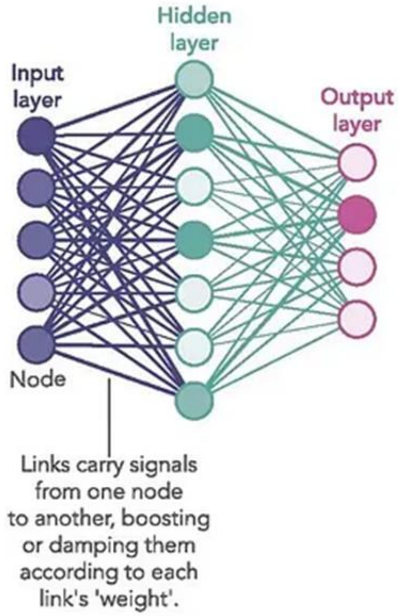
... AI Winter…



Rosenblatt and the perceptron, Source: https://news.cornell.edu

A Rosenblatt perceptron structure





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1974: Paul Werbos - described the process of training artificial neural networks through the backpropagation of errors;

1986: **Rumelhart, Hinton** & **Williams** - Backpropagation algorithm - allows for the training of multi-layered neural networks;

nature

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nature › letters › article

Letter | Published: 09 October 1986

Learning representations by back-propagating errors

David E. Rumelhart, Geoffrey E. Hinton & Ronald J. Williams

Nature **323**, 533–536 (1986) | Cite this article

146k Accesses | **17k** Citations | **487** Altmetric | Metrics

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1986: **Rumelhart**, **Hinton** & **Williams** – Backpropagation algorithm – allows for the training of multi-layered neural networks;

1989: Elman – recurrent neural networks (RNNs), suitable for processing data sequences;

1997: Long Short-Term Memory (LSTM) – a variant of RNN designed to capture long-term dependencies in data sequences;

2010: **Big Data** and increase in computational capacity through GPUs (Graphics Processing Units);

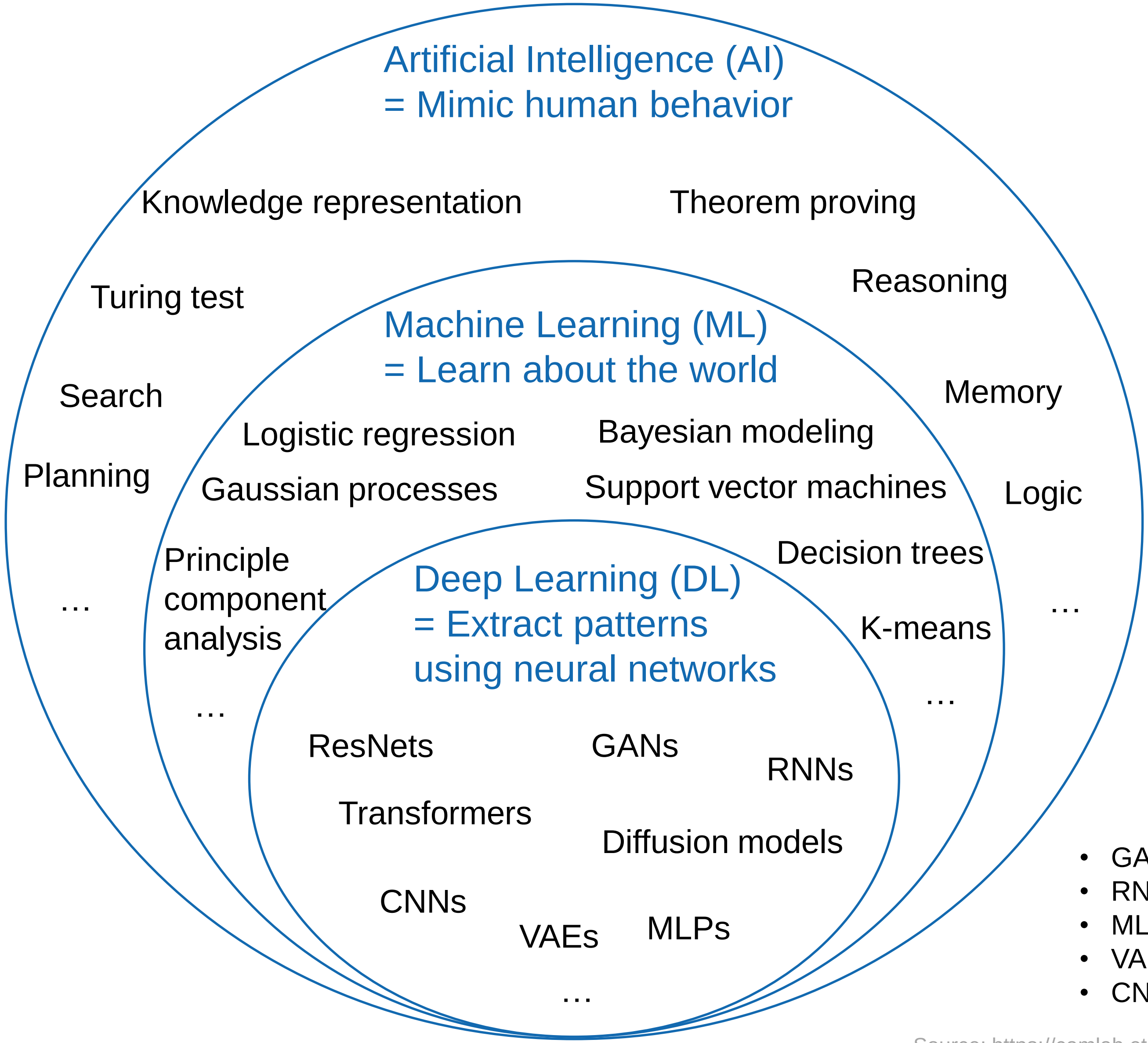
2012: AlexNet developed by Alex Krizhevsky – won the ImageNet competition;

2017: Attention is All You Need – Transformer Architecture;

2018: GPT – Generative Pre-trained Transformer

2022: A web interface for the **GPT-3** model from **OpenAI** => **ChatGPT**

Concepts – what is deep learning?



- GANs (Generative Adversarial Networks)
- RNNs (Recurrent Neural Networks)
- MLPs (Multi-Layer Perceptrons)
- VAEs (Variational Autoencoders)
- CNNs (Convolutional neural networks)

Source: https://camlab.ethz.ch/teaching/deep-learning-in-scientific-computing-2023.html

Key components of a neural network

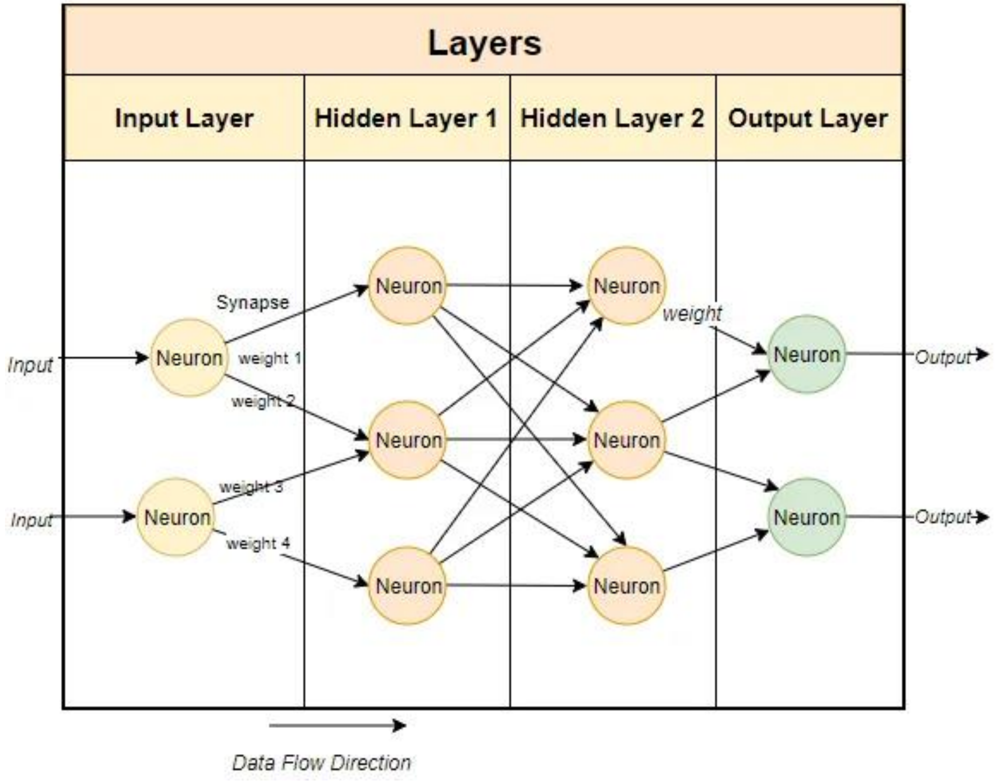
Neural networks consist of multiple layers of mathematical neurons that process information in successive stages, allowing the network to learn complex data representations.

1. Neurons (Nodes):

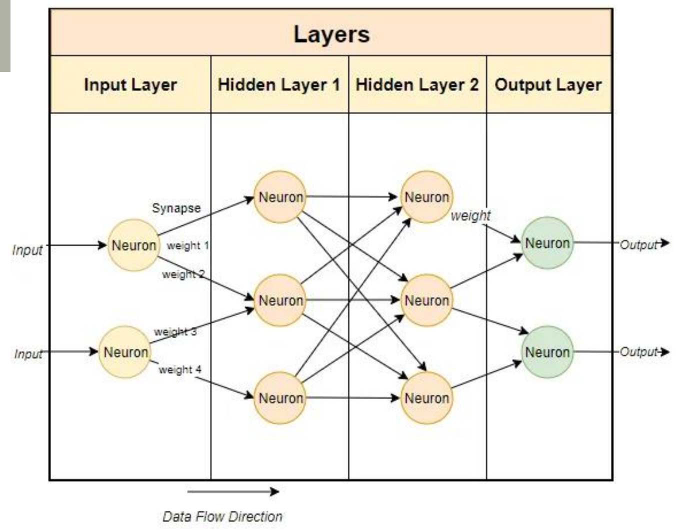
1. The basic units of a neural network, analogous to neurons in the brain.
2. Each neuron receives input, processes it using a mathematical function, and produces an output.
3. The output is then passed to the next layer of neurons.

2. Layers:

1. **Input Layer**: The first layer, where data is fed into the network.
2. **Hidden Layers**: Intermediate layers that process the inputs from the previous layer and pass the output to the next layer.
3. **Output Layer**: The final layer that produces the network's output, which could be a prediction, classification, or decision.



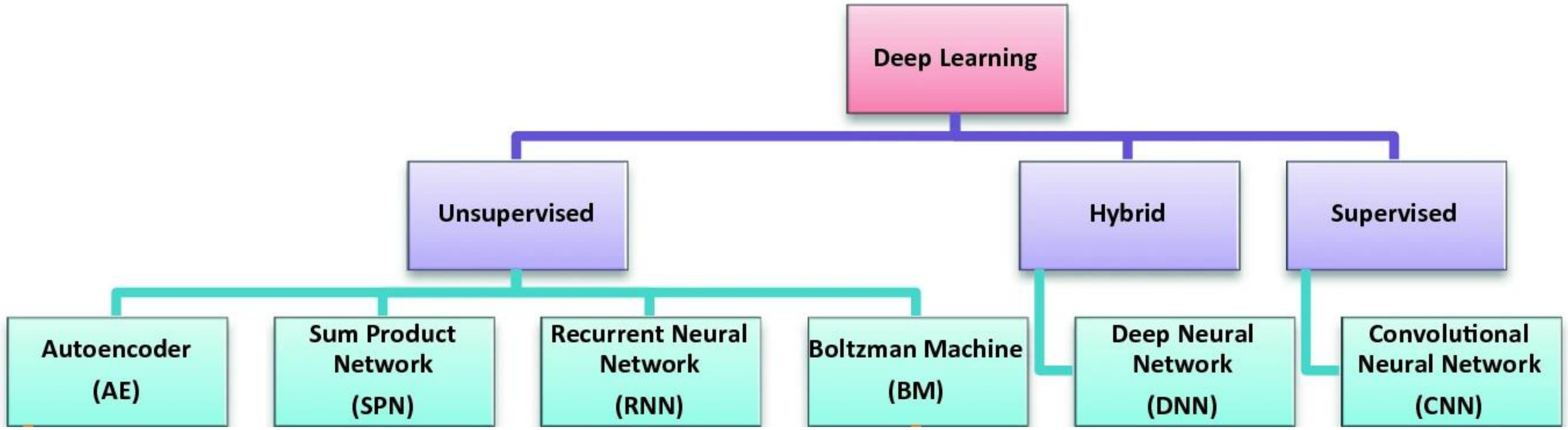
Key components of a neural network



1. **Neurons (Nodes)**
2. **Layers**

3. **Weights and Biases:**
   - **Weights**: Parameters that adjust the strength of the connection between neurons. They determine how much influence one neuron has on another.
   - **Biases**: Additional parameters that help the network adjust the output along with the weighted input. Biases and weights are adjusted during training through backpropagation.
4. **Activation Function:**
   - A mathematical function applied to the output of each neuron. It introduces non-linearity into the network, enabling it to learn complex patterns.
   - Common activation functions include ReLU (Rectified Linear Unit), Sigmoid, and Tanh.
5. **Training Process:**
   - **Forward Propagation**: Data is passed through the network, and predictions are made based on the current weights and biases.
   - **Loss Function**: A measure of how far the network's prediction is from the actual result. It helps to determine the error.
   - **Backpropagation**: The network adjusts the weights and biases based on the error calculated by the loss function. This process is done iteratively to minimize the error and improve the model's accuracy.

Types of learning



Benavides et al 2019

- **Unsupervised learning**

The model is trained on data that does not have labeled outputs. Aim: find hidden patterns or intrinsic structures in the input data.

Applications: Clustering (e.g., grouping customers based on purchasing behavior), anomaly detection, and data compression.

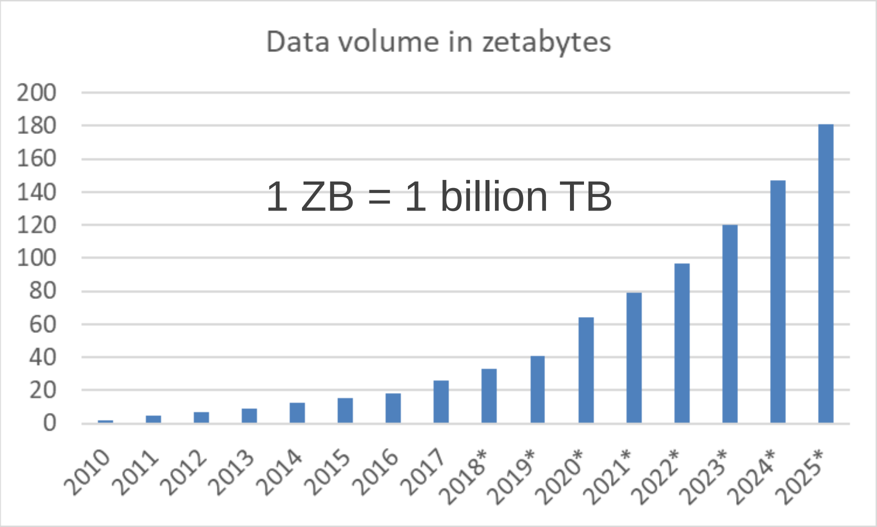
- **Supervised Learning**

The model is trained on a labeled dataset and makes predictions based on the input data, compares these predictions with the actual labels, and adjusts the model parameters to minimize the difference (loss).

Applications: Image classification (e.g., recognizing objects in images), speech recognition, and language translation.

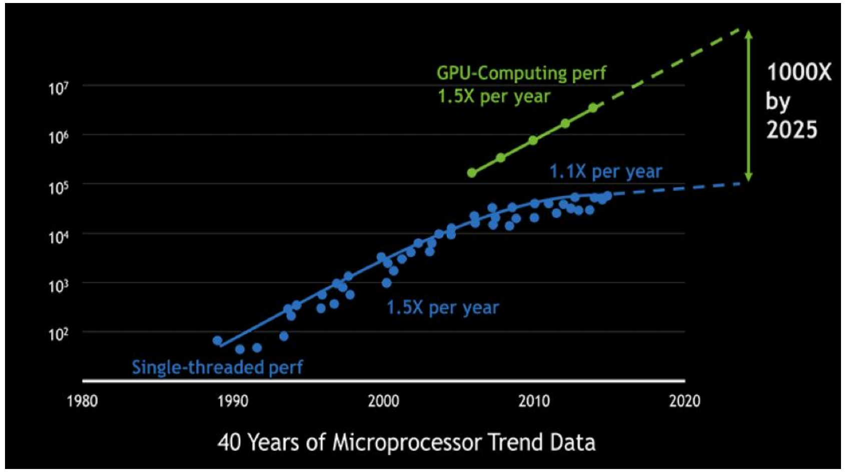
Why is deep learning so popular today?

Rapidly increasing amounts of data



Source: Statista 2021.

Hardware improvements



GPU Computing Evolution, source: Nvidia)

- GPUs
- Highly optimized for deep learning (parallel)

Software improvements

- Mature deep learning frameworks
- Better training algorithms

Source: https://camlab.ethz.ch/teaching/deep-learning-in-scientific-computing-2023.html

Machine learning vs. Deep learning

	Machine Learning (ML)	Deep Learning (DL)
1.	Apply **statistical algorithms** to learn the hidden patterns and relationships in the dataset.	Uses **artificial neural network** architecture to learn the hidden patterns and relationships in the dataset.
2.	Can work on a smaller amount of data.	Requires large datasets.
3.	Ideal for low-label tasks.	Handles complex tasks e.g., image processing, natural language processing, etc.
4.	Faster training time.	Slower training time.
5.	Simpler and interpretable results.	Complex, harder to interpret.
6.	Works on CPU with less power.	Requires a high-performance computer with a GPU.

II. Deep learning in forestry

II. Why does tree species identification matter?

1. automatic forest inventory
2. monitoring biodiversity
3. monitoring trees in urban areas
4. assess physiological stress
5. identify native and invasive species
6. manage forests - ecosystem stability and services

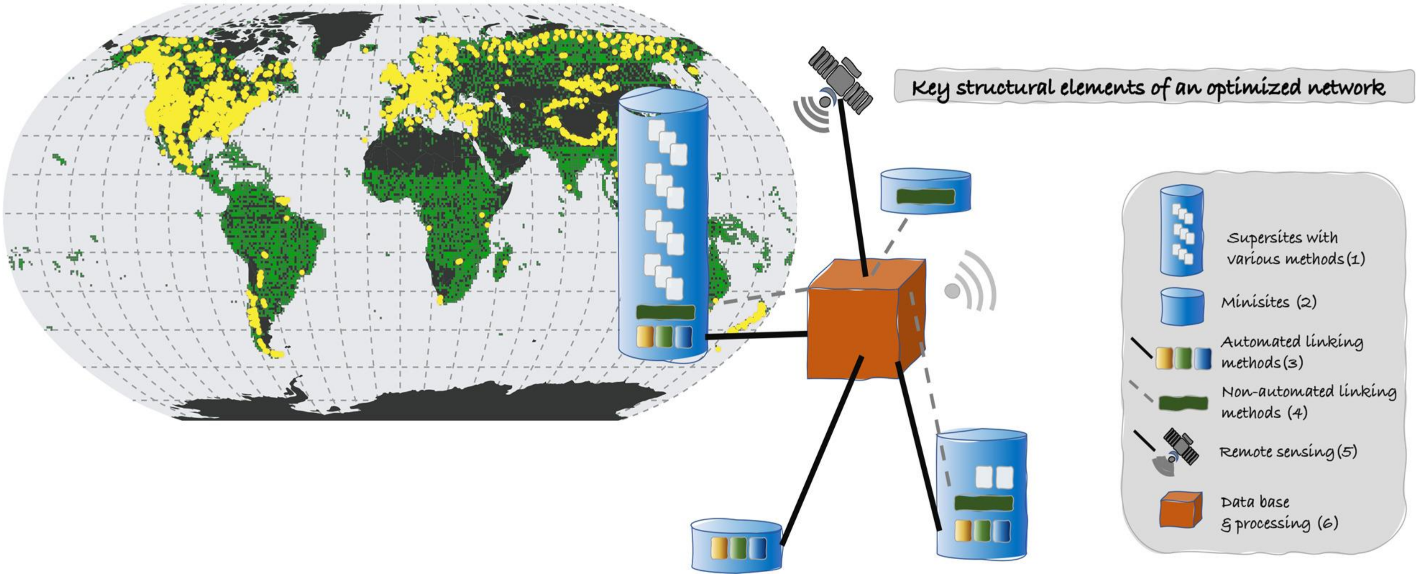
Gatti et al. 2021

The changing culture of silviculture

Achim et al. 2021 *J. For. Res.*

The European forest condition monitor: Using remotely sensed forest greenness to identify hot spots of forest decline

Buras et al. 2021 *Frontiers in Plant Science*



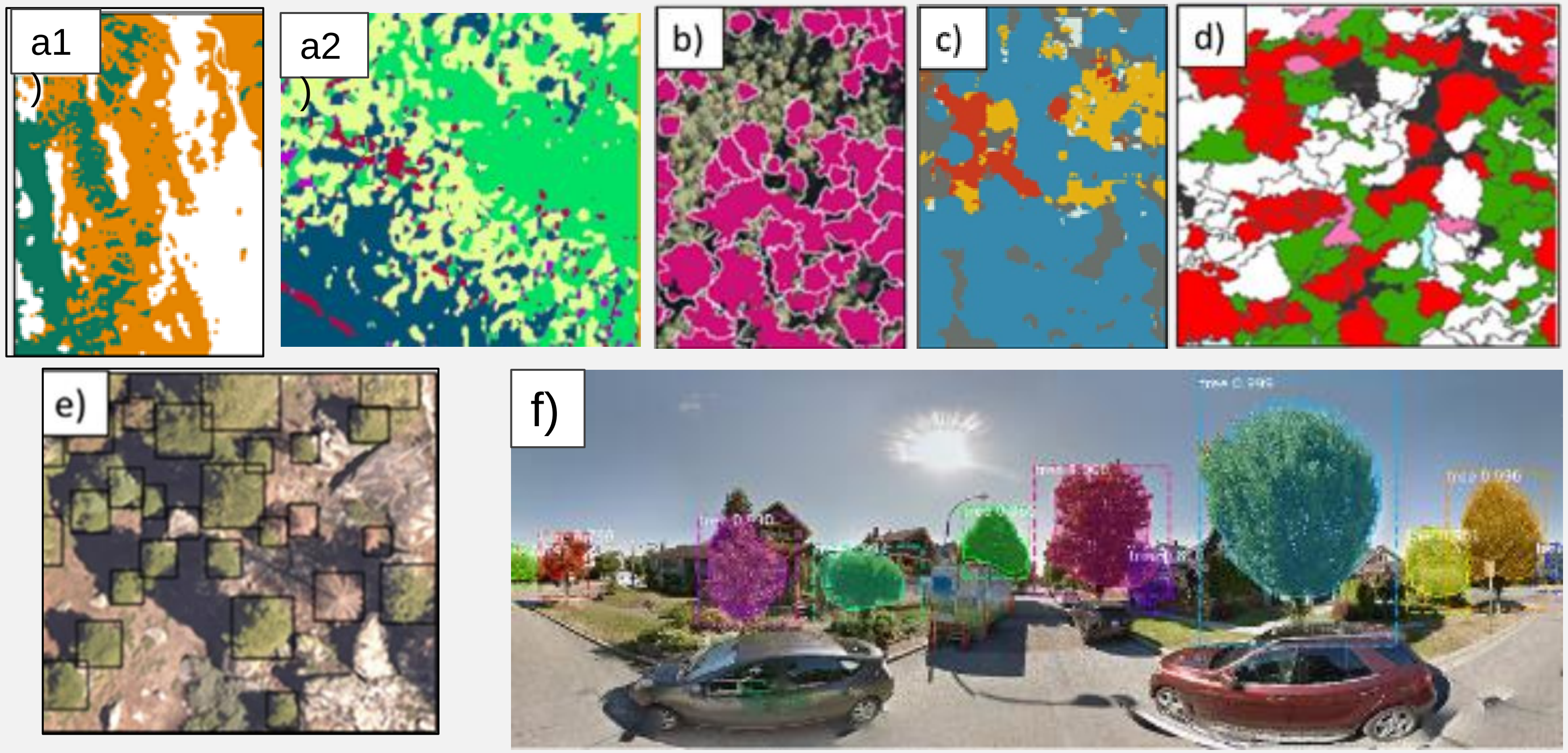
AI applications in forest monitoring need remote sensing benchmark datasets

Lines et al. 2023 arXiv

From individual sites to a near real-time forest monitoring network

Zweifel, Beloiu et al. 2023 *Sci. Total Environ.*

From forest types mapping to tree species identification



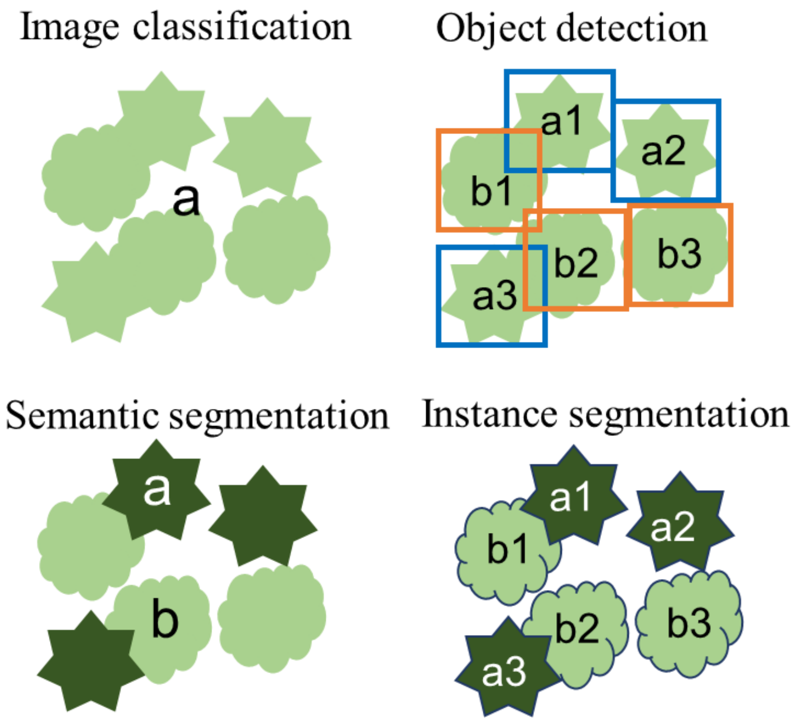
From forest types mapping to tree species identification:

a1) deciduous and coniferous (Waser et al. 2021), a2) (Nasiri, Beloiu et al. 2023)
b) *Pinus radiata* semantic segmentation (Kattenborn et al. 2019),
c) mixed-species semantic segmentation (Schiefer et al. 2020),
d) forest types classification (Onishi & Ise 2021),
e) tree detection (Weinstein 2020),
f) instance segmentation (Lumnitz et al. 2021).

Challenges and opportunities

Data availability
Hyperspectral
LiDAR, ALS
RGBI…

Convolutional Neural Networks (CNN)



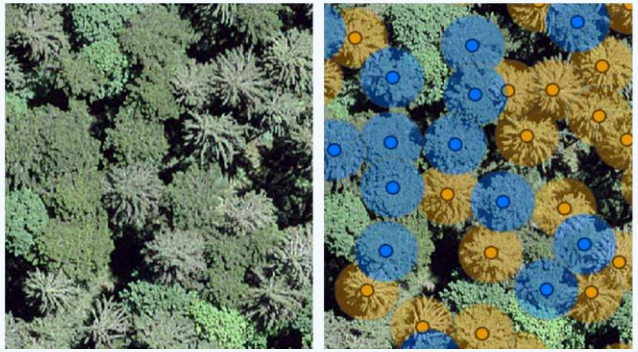
Convolutional Neural Networks (CNNs)

Input - data and preprocessing

RGBI imagery — Tree species labeling

Training — Validation — Test

a) RGB imagery b) Reference data



Model selection and hyper-parameter optimization

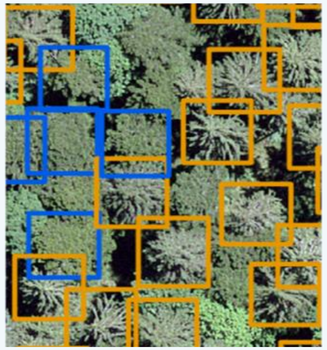
DL models –
object detection and instance segmentation (e.g., Faster R-CNN, YOLOv8, Mask R-CNN)

Architecture
Augmentation

Accuracy assessment and output

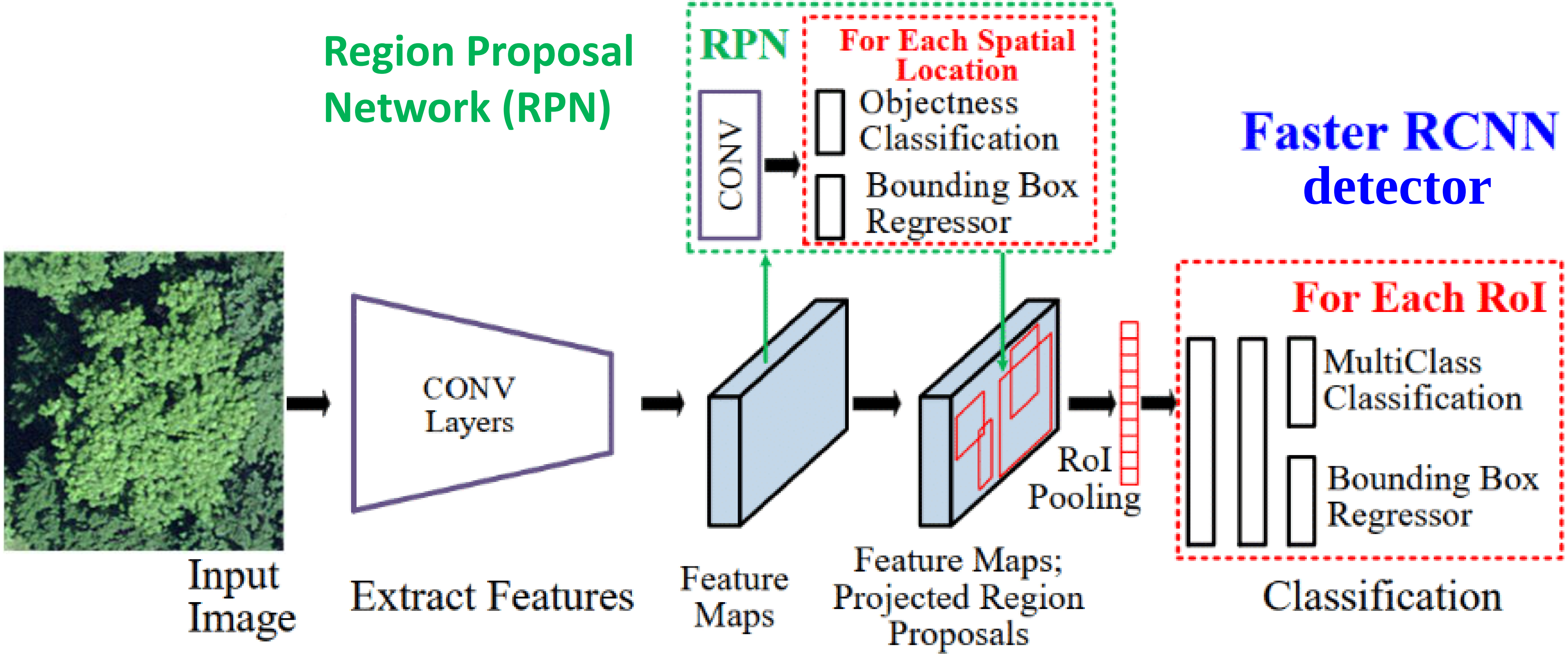
Precision, recall, F1-score, mean average precision
Explainable AI

c) CNN detection



I)

II)



Source: https://ashutoshmakone.medium.com/faster-rcnn-502e4a2e1ec6

How effective are CNN models in identifying tree species?

Methods

Deep Learning object detection

- 4 tree species
- 11437 geolocated trees
- ArcGIS Pro & Python
- Aerial RGB imagery – 10 cm
- Faster R-CNN and YOLO
- Data augmentation

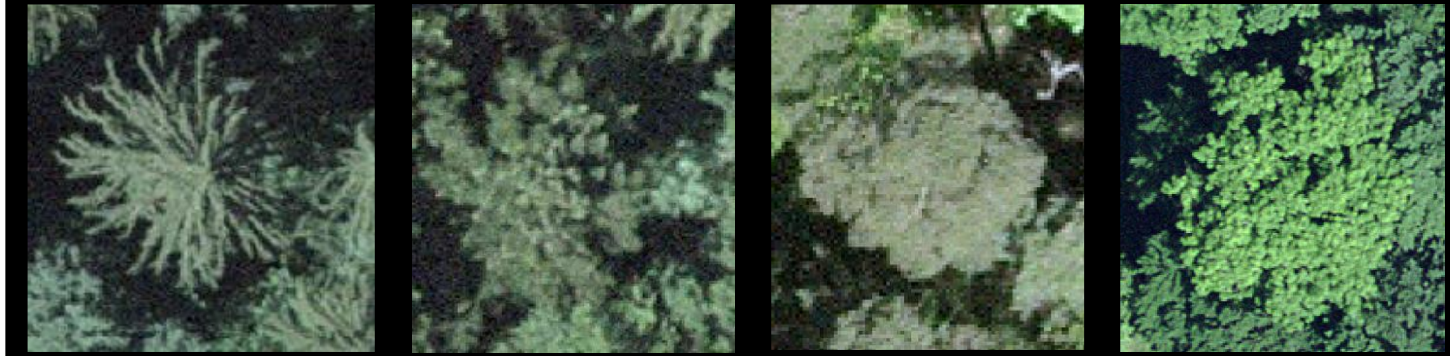
Accuracy assessment

$$(F1)\ Precision = \frac{TP}{TP + FP} = \frac{Correctly\ predicted\ individual\ trees}{All\ predicted\ individual\ trees},$$

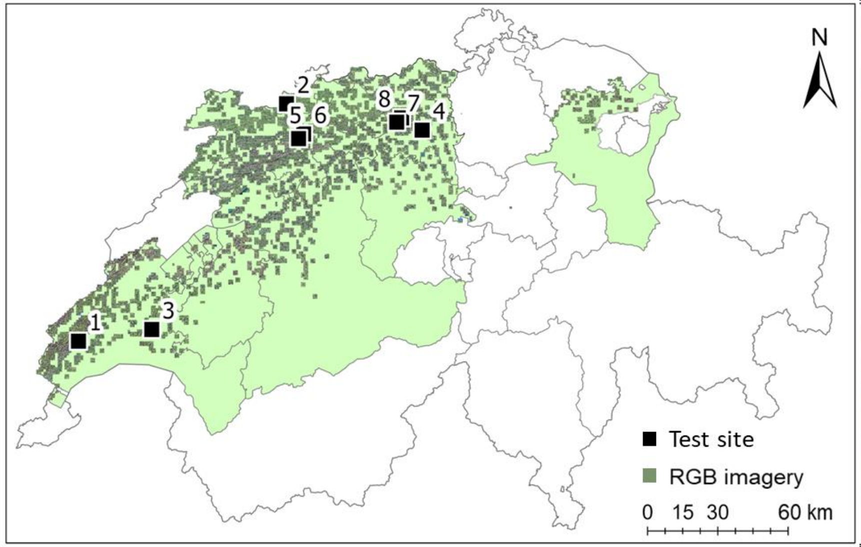
$$(F2)\ Recall = \frac{TP}{TP + FN} = \frac{Correctly\ predicted\ individual\ trees}{All\ ground-truth\ individual\ trees},$$

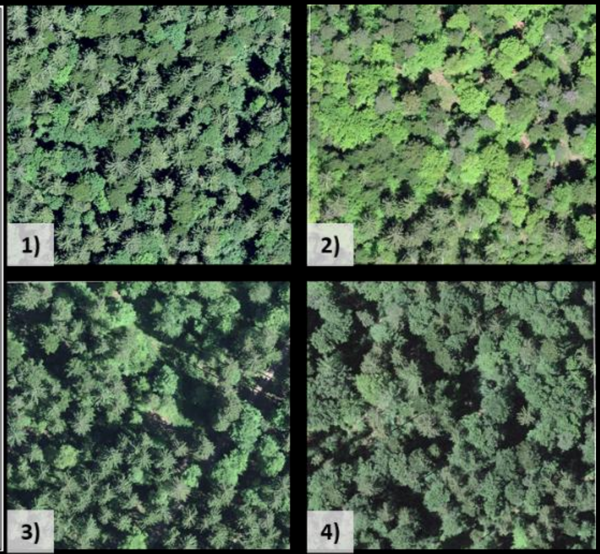
$$(F3)\ F1\text{-}score = \frac{Precision * Recall}{\frac{Precision + Recall}{2}}$$

$$(F4)\ IoU = \frac{bbox_{Pred} \cap bbox_{Ref}}{bbox_{Pred} \cup bbox_{Ref}}$$



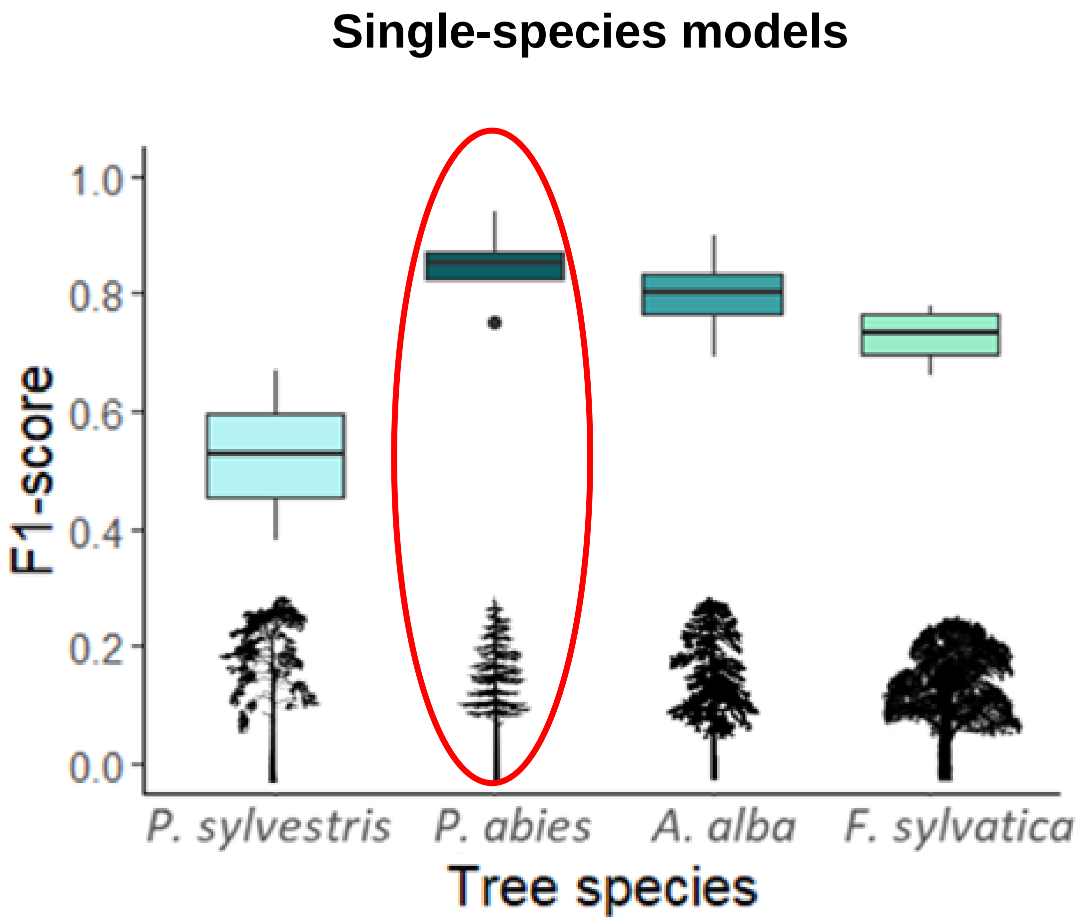
a) Norway spruce *b) Silver fir* *c) Scots pine* *d) European beech*

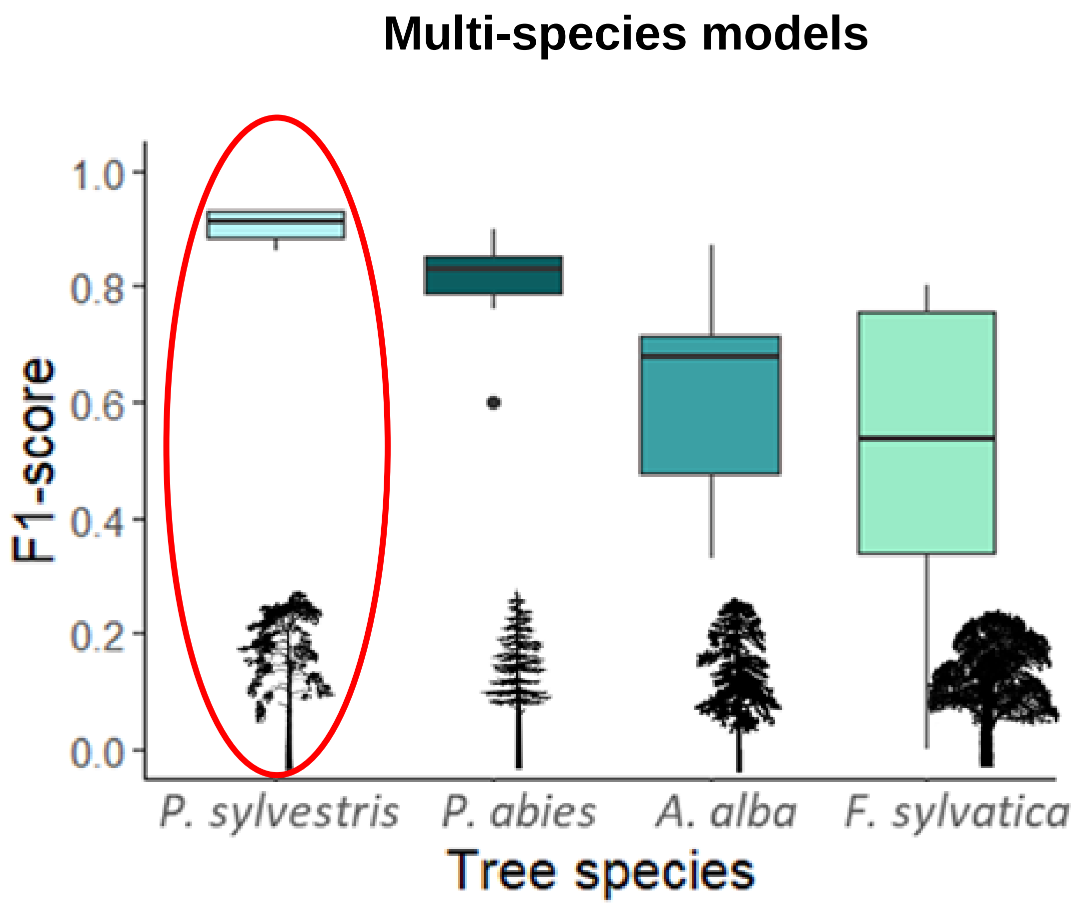




Beloiu et al. 2023 *Remote sensing*

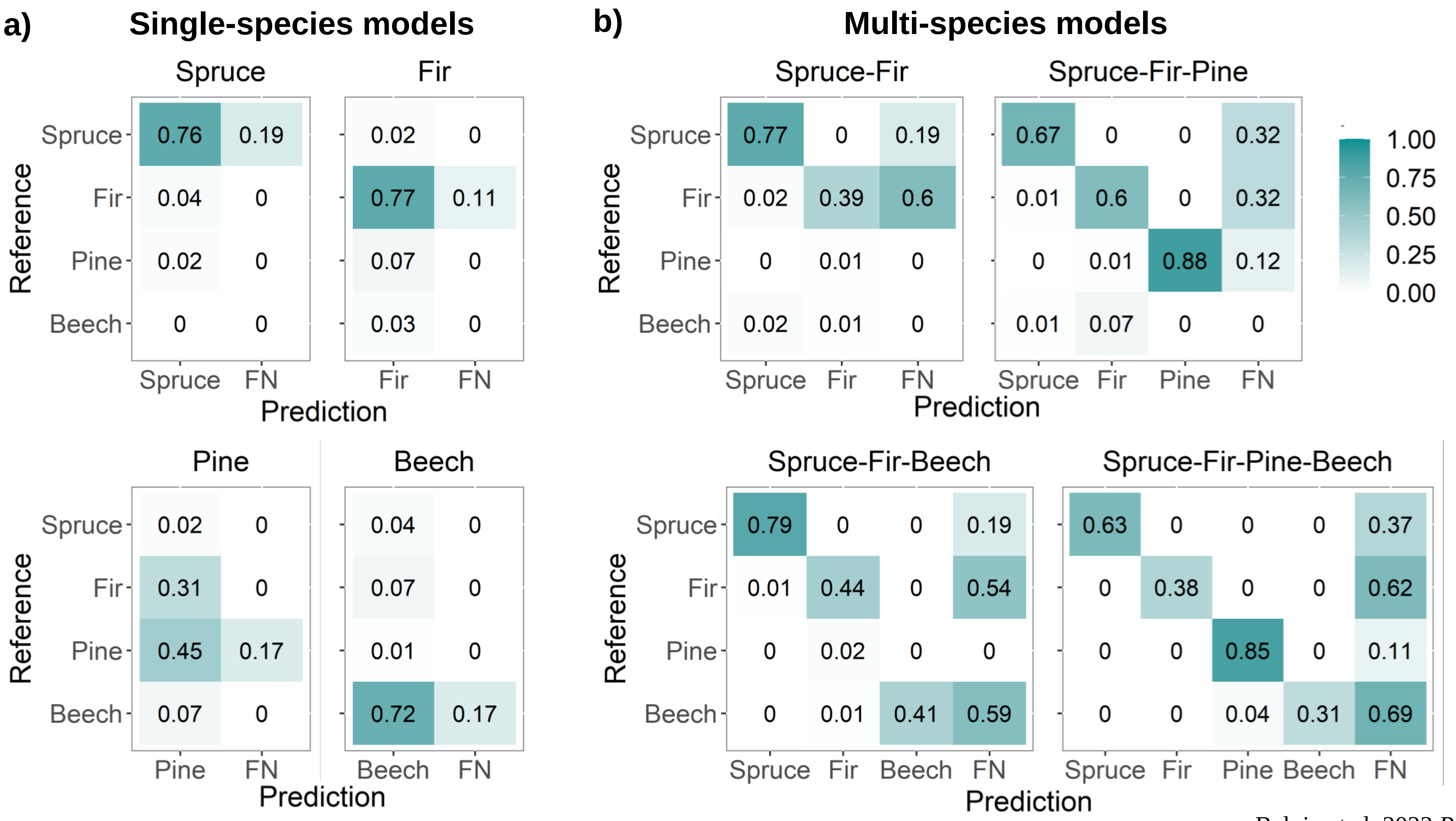
Faster R-CNN performance for single- and multi-species detection models





Beloiu et al. 2023 *Remote sensing*

Confusion matrix



Beloiu et al. 2023 *Remote sensing*

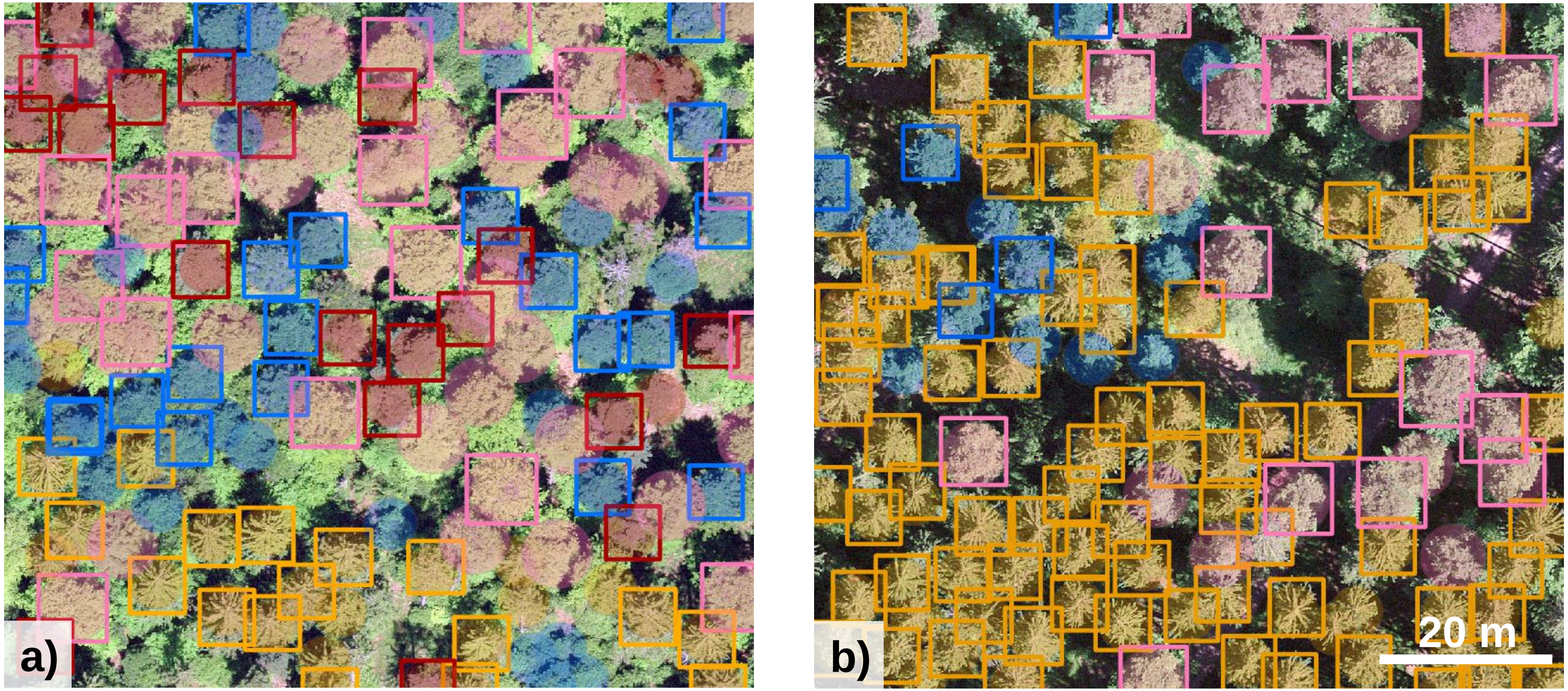
Effect of training data augmentation and forest stand conditions on model performance

Illumination slightly decreases model performance (from an F1-score of 0.85 to 0.80)
Mature forest stands with regular density > younger and denser forest stands

Data augmentation did not conclusively result in higher F1-scores for all models

Models	**Spruce-Fir**		**Spruce-Fir-Pine**		**Spruce-Fir-Beech**		**Spruce-Fir-Pine-Beech**	
(F1-score)	non-aug	aug	non-aug	aug	non-aug	aug	non-aug	aug
all-classes	0.70	**0.81**	0.81	0.69	0.68	**0.71**	0.67	**0.73**
Spruce	0.85	**0.87**	0.79	0.67	0.86	**0.86**	0.77	**0.85**
Fir	0.54	**0.74**	0.72	0.65	0.60	**0.75**	0.55	**0.80**
Pine	-	-	0.92	0.84	-	-	0.92	0.39
Beech	-	-	-	-	0.55	0.37	0.46	**0.49**

Faster R-CNN performance for multi-species detection models



Test site 2 (F1-score 0.74)

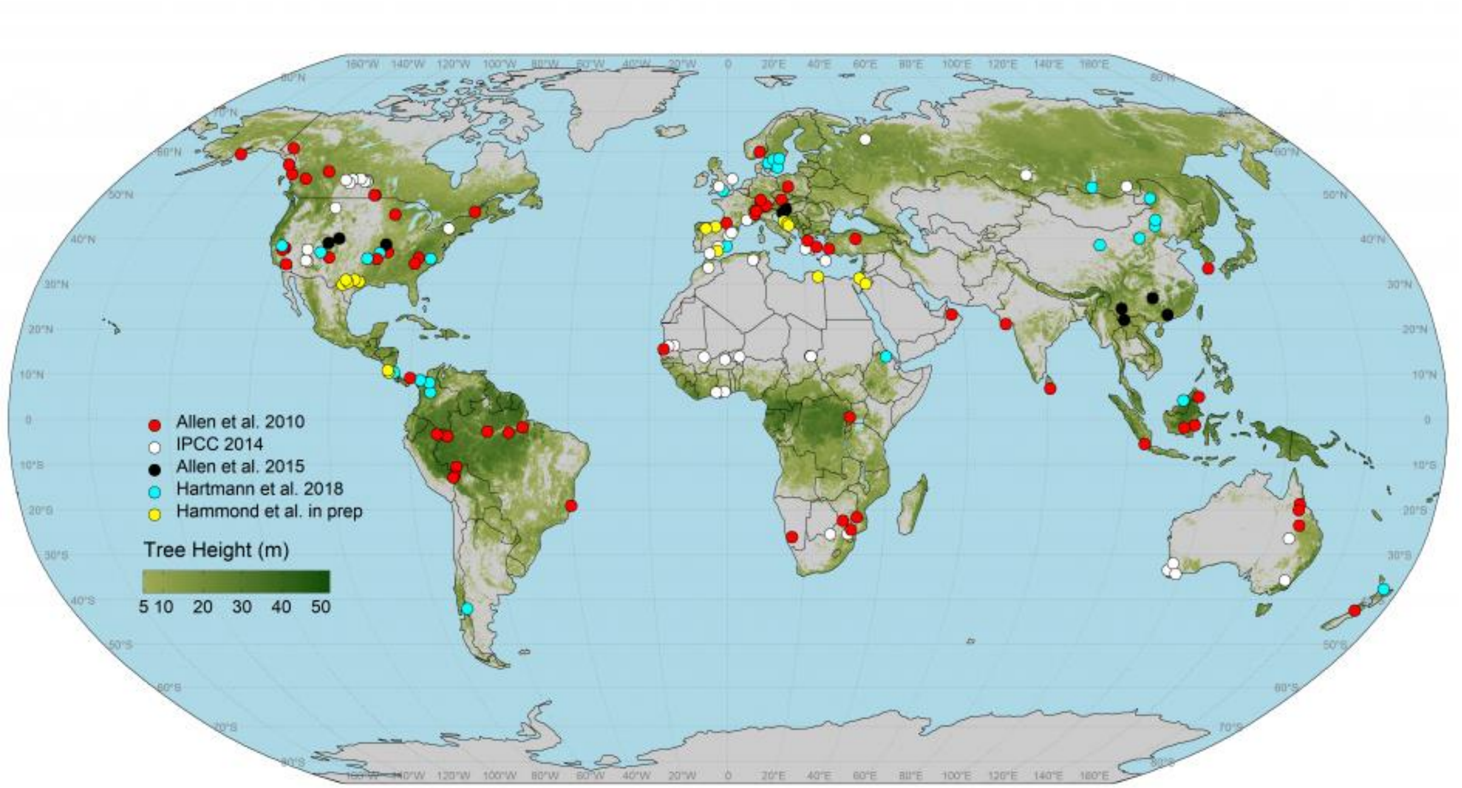
Test site 3 (F1-score 0.78)

○ **ground truth data** ☐ **Norway spruce,** ☐ **silver fir,** ☐ **European beech,** ☐ **Scots pine**

Beloiu et al. 2023 *Remote sensing*

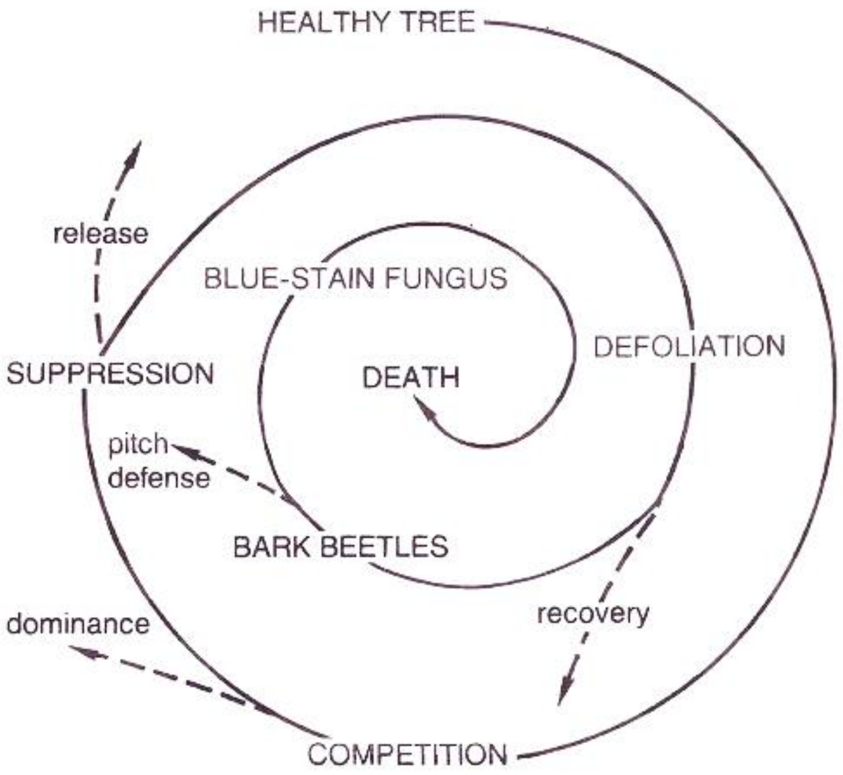
What will forests look like in the future?

Mortality is increasing in most of the world's forest ecosystems



Tree Mortality Network - https://www.tree-mortality.net/global-mortality/

Tree mortality involves a series of processes



Mortality spiral, Franklin et al., 1987

Tree mortality and vitality

II.

Tree health detection

- tree defoliation assessment

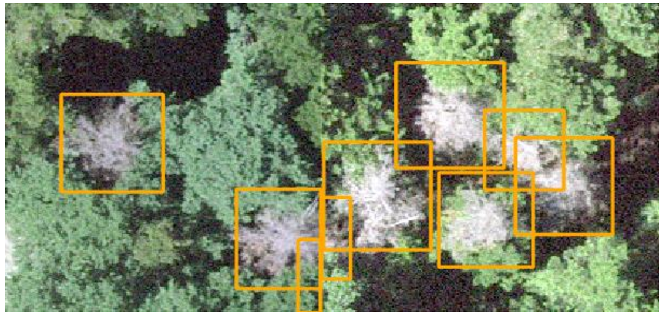
- tree vitality and mortality geolocation

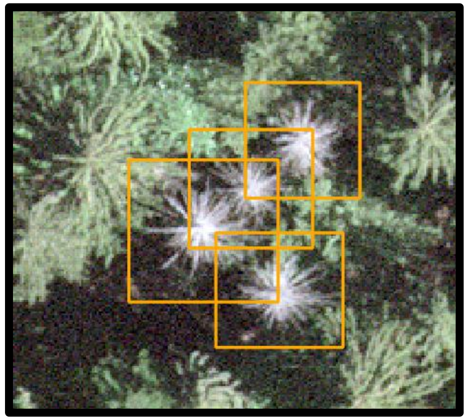
Challenges:

a) more data needed for different classes of defoliation

b) forest roads or rocky outcrops are identified as dead trees

Object detection, F1-score 0.77





Data & expertise call

COST Action CA20118

3DForEcoTech

Three-dimensional forest ecosystem monitoring & better understanding by terrestrial-based technologies

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Forest Resources Management

Data call for tree species annotations and aerial RGB or RGBI imagery (TreeAI) 🌳🌲

1. ***RGBI (or RGB)*** imagery (at ≤ 10 cm, about 3.94 in, spatial resolution) of the site.
2. ***Ground truth tree data*** (n>100), manual delineations and tree species.

Output:
Contribute as a co-author in a) the publication of a data; b) a manuscript investigating different approaches to detecting individual tree species.

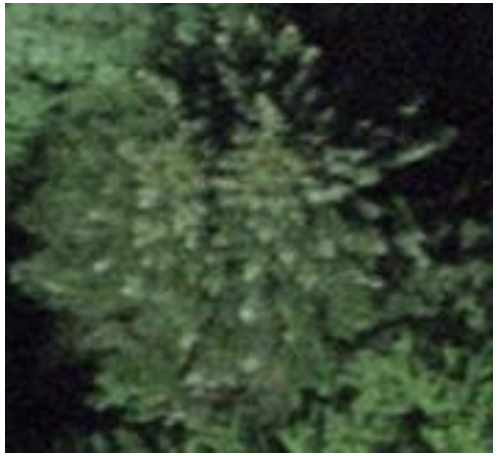
a)

id	x	y	TrSpec	d 1_3 [cm]	h [m]
419	[illegible]	[illegible]	Quercus robur	49.5	21.3
420	[illegible]	[illegible]	Quercus robur	48.5	20.9
53	[illegible]	[illegible]	Quercus robur	44.25	23.8
450	[illegible]	[illegible]	Betula pendula	41.8	18.8
520	[illegible]	[illegible]	Quercus robur	41.5	22.1
410	[illegible]	[illegible]	Pinus sylvestris	41.2	21.1
365	[illegible]	[illegible]	Betula pendula	41	21.3
b)	[illegible]	[illegible]	Pinus sylvestris	39.4	21.3

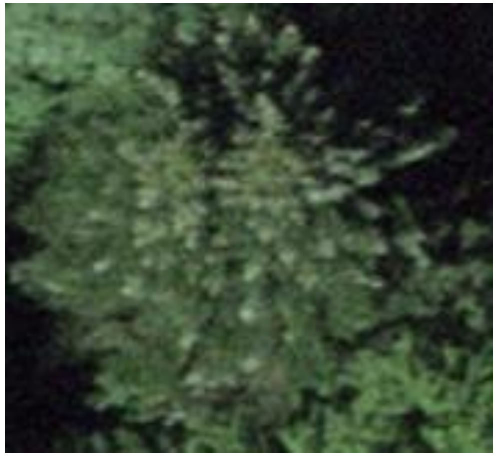
https://3dforecotech.eu/activities/tree-species-annotations-and-aerial-rgb-or-rgbi-imagery/

III. How to train an object detection model – YOLOv8?

III. Can you identify the tree species?



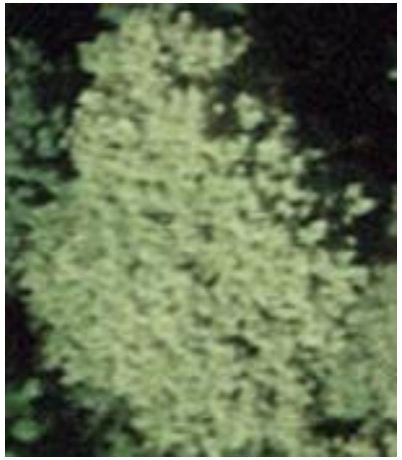
Can you identify the tree species?



Abies alba
European silver fir

Pinus sylvestris
Scots pine

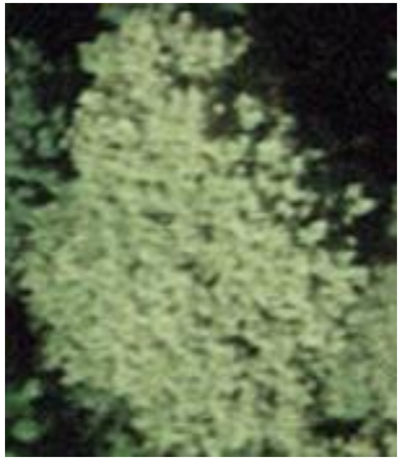
Can you identify the tree species?



Can you identify the tree species?

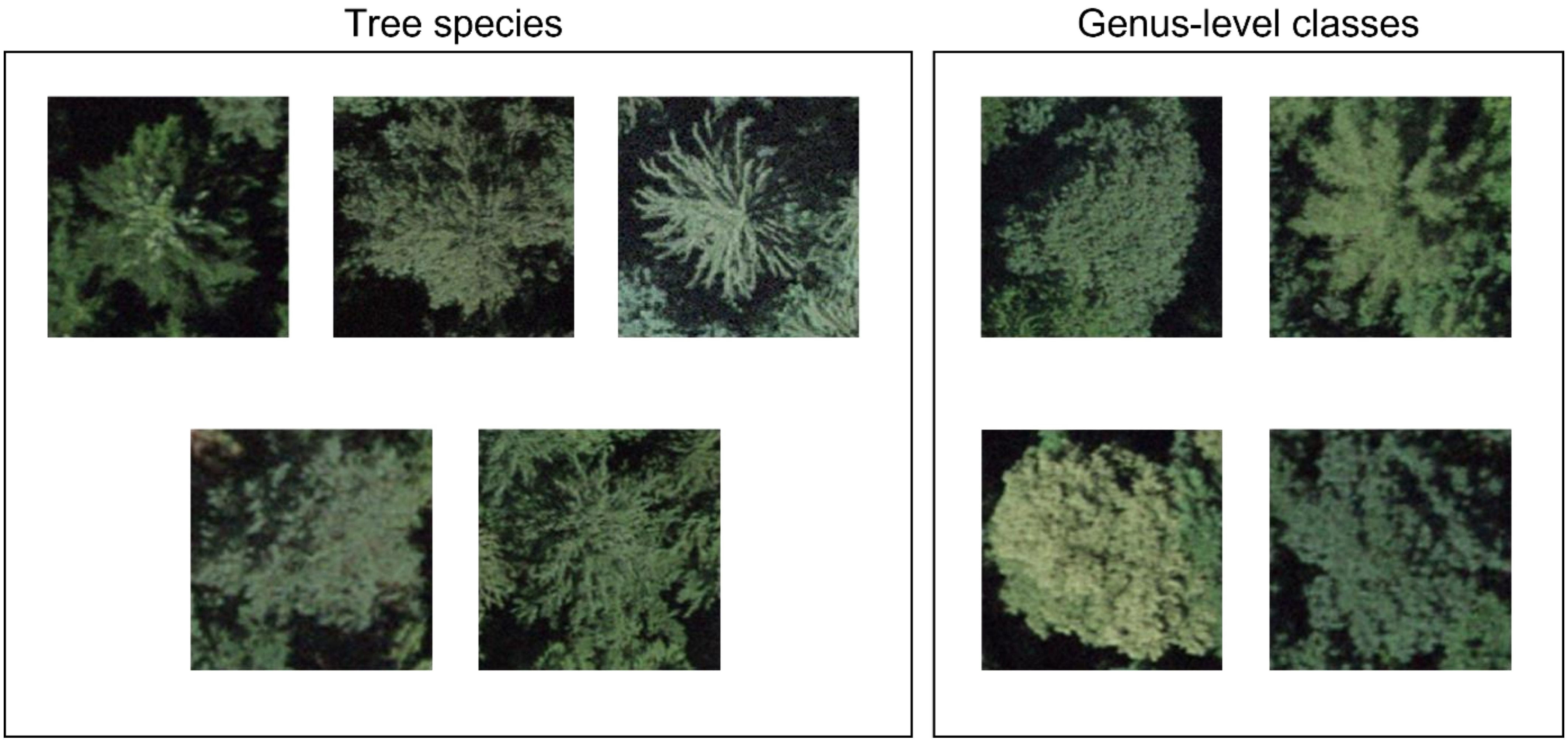
Larix decidua
European larch

Abies alba
European silver fir



Tilia sp.
Linden

Can you identify the tree species?



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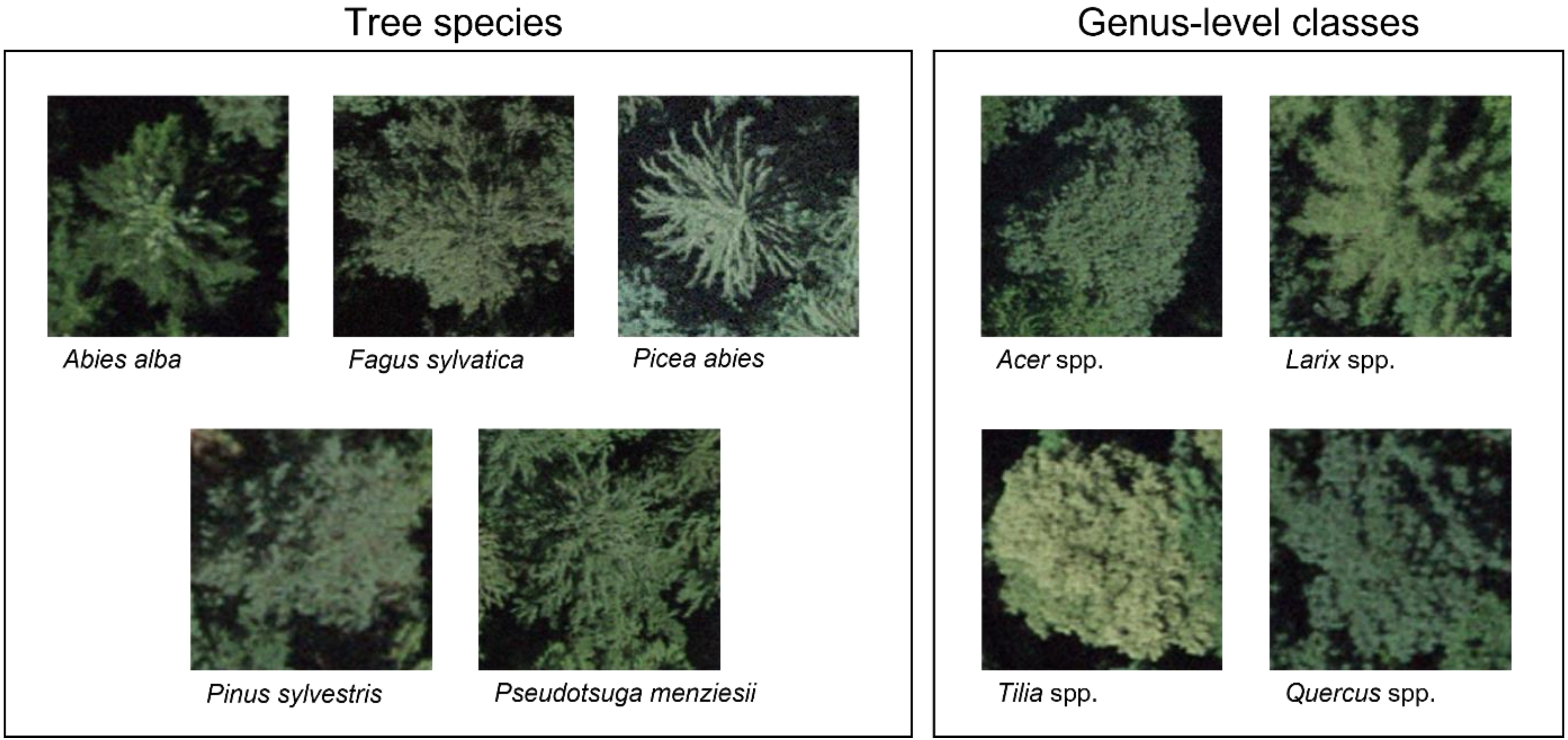

Can you identify the tree species?

Data conversion

Labels

Pascal VOC to YOLO format

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    </size>
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            <xmax>273.77</xmax>
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        </bndbox>
    </object>
```

Images

```
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0 0.9640000000000001 0.553375 0.06575000000000007 0.12356249999999998
0 0.9394062500000001 0.25676562500000005 0.11493749999999991 0.13528125
0 0.77278125 0.270953125 0.1963125 0.20084375000000004
0 0.8600468750000001 0.14585937499999999 0.0782187500000001 0.08765625000000002
0 0.871453125 0.388828125 0.08415625000000003 0.10615625000000001
0 0.7870781250000001 0.420296875 0.12253125000000012 0.11896875000000003
0 0.9554062500000001 0.113234375 0.08293750000000007 0.13496875
```

Labels

Images

Pascal VOC to YOLO format


```xml
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            <ymax>43.72</ymax>
        </bndbox>
    </object>
    <object>
        <name>0</name>
        <bndbox>
            <xmin>308.01</xmin>
            <ymin>110.11</ymin>
            <xmax>320.00</xmax>
            <ymax>153.37</ymax>
        </bndbox>
    </object>
```


→


```
1 0.8027031250000001 0.0856875 0.09940624999999992 0.09562500000000002
0 0.978140625 0.40856250000000005 0.03746875000000003 0.13518750000000002
0 0.9640000000000001 0.553375 0.06575000000000007 0.12356249999999998
0 0.9394062500000001 0.25676562500000005 0.11493749999999991 0.13528125
0 0.77278125 0.270953125 0.1963125 0.20084375000000004
0 0.8600468750000001 0.14585937499999999 0.0782187500000001 0.08765625000000002
0 0.871453125 0.388828125 0.08415625000000003 0.10615625000000001
0 0.7870781250000001 0.420296875 0.12253125000000012 0.11896875000000003
0 0.9554062500000001 0.113234375 0.08293750000000007 0.13496875
```


Label Cleaning


```
1 0.8027031250000001 0.0856875 0.09940624999999992 0.09562500000000002
0 0.978140625 0.40856250000000005 0.03746875000000003 0.13518750000000002
0 0.9640000000000001 0.553375 0.06575000000000007 0.12356249999999998
0 0.9394062500000001 0.25676562500000005 0.11493749999999991 0.13528125
0 0.77278125 0.270953125 0.1963125 0.20084375000000004
0 0.8600468750000001 0.14585937499999999 0.0782187500000001 0.08765625000000002
0 0.871453125 0.388828125 0.08415625000000003 0.10615625000000001
0 0.7870781250000001 0.420296875 0.12253125000000012 0.11896875000000003
0 0.9554062500000001 0.113234375 0.08293750000000007 0.13496875
```


→


```
1 0.8027031250000001 0.0856875 0.09940624999999992 0.09562500000000002
0 0.9640000000000001 0.553375 0.06575000000000007 0.12356249999999998
0 0.9394062500000001 0.25676562500000005 0.11493749999999991 0.13528125
0 0.77278125 0.270953125 0.1963125 0.20084375000000004
0 0.8600468750000001 0.14585937499999999 0.0782187500000001 0.08765625000000002
0 0.871453125 0.388828125 0.08415625000000003 0.10615625000000001
0 0.7870781250000001 0.420296875 0.12253125000000012 0.11896875000000003
0 0.9554062500000001 0.113234375 0.08293750000000007 0.13496875
```


Data structure

Labels

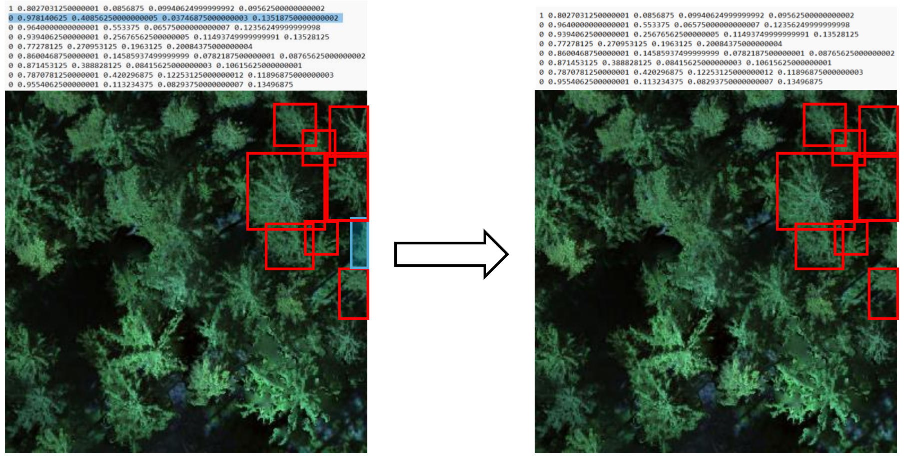
Pascal VOC to YOLO format


```xml
<?xml version="1.0"?>
<annotation>
    <filename>000000000546.tif</filename>
    <source>
        <annotation>ESRI ArcGIS Pro</annotation>
    </source>
    <size>
        <width>320</width>
        <height>320</height>
        <depth>4</depth>
    </size>
    <object>
        <name>1</name>
        <bndbox>
            <xmin>241.96</xmin>
            <ymin>13.12</ymin>
            <xmax>273.77</xmax>
            <ymax>43.72</ymax>
        </bndbox>
    </object>
    <object>
        <name>0</name>
        <bndbox>
            <xmin>308.01</xmin>
            <ymin>110.11</ymin>
            <xmax>320.00</xmax>
            <ymax>153.37</ymax>
        </bndbox>
    </object>
```


⇒


```
1 0.8027031250000001 0.0856875 0.09940624999999992 0.09562500000000002
0 0.978140625 0.40856250000000005 0.03746875000000003 0.13518750000000002
0 0.9640000000000001 0.553375 0.06575000000000007 0.12356249999999998
0 0.9394062500000001 0.25676562500000005 0.11493749999999991 0.13528125
0 0.77278125 0.270953125 0.1963125 0.20084375000000004
0 0.8600468750000001 0.14585937499999999 0.0782187500000001 0.08765625000000002
0 0.871453125 0.388828125 0.08415625000000003 0.10615625000000001
0 0.7870781250000001 0.420296875 0.12253125000000012 0.11896875000000003
0 0.9554062500000001 0.113234375 0.08293750000000007 0.13496875
```


Label Cleaning



Images

Masking

Data structure

Labels

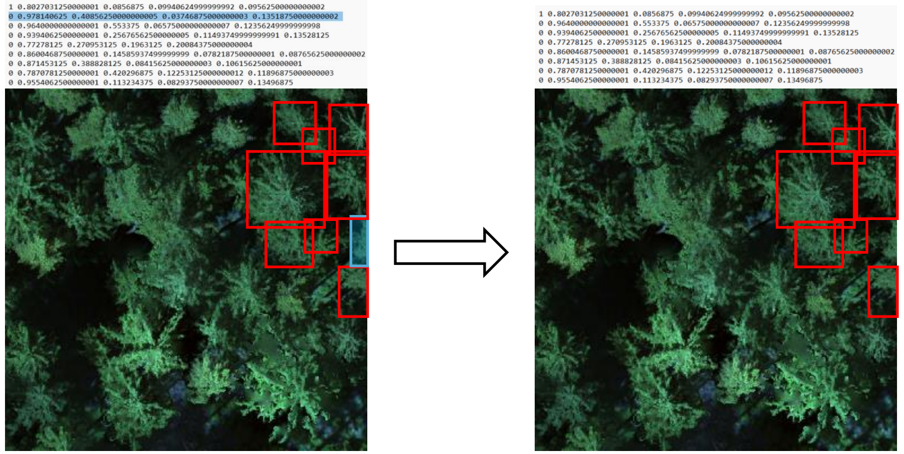
Pascal VOC to YOLO format


```xml
<?xml version="1.0"?>
<annotation>
    <filename>000000000546.tif</filename>
    <source>
        <annotation>ESRI ArcGIS Pro</annotation>
    </source>
    <size>
        <width>320</width>
        <height>320</height>
        <depth>4</depth>
    </size>
    <object>
        <name>1</name>
        <bndbox>
            <xmin>241.96</xmin>
            <ymin>13.12</ymin>
            <xmax>273.77</xmax>
            <ymax>43.72</ymax>
        </bndbox>
    </object>
    <object>
        <name>0</name>
        <bndbox>
            <xmin>308.01</xmin>
            <ymin>110.11</ymin>
            <xmax>320.00</xmax>
            <ymax>153.37</ymax>
        </bndbox>
    </object>
```


⇒


```
1 0.8027031250000001 0.0856875 0.09940624999999992 0.09562500000000002
0 0.978140625 0.40856250000000005 0.03746875000000003 0.13518750000000002
0 0.9640000000000001 0.553375 0.06575000000000007 0.12356249999999998
0 0.9394062500000001 0.25676562500000005 0.11493749999999991 0.13528125
0 0.77278125 0.270953125 0.1963125 0.20084375000000004
0 0.8600468750000001 0.14585937499999999 0.0782187500000001 0.08765625000000002
0 0.871453125 0.388828125 0.08415625000000003 0.10615625000000001
0 0.7870781250000001 0.420296875 0.1225312500000012 0.11896875000000003
0 0.9554062500000001 0.113234375 0.08293750000000007 0.13496875
```

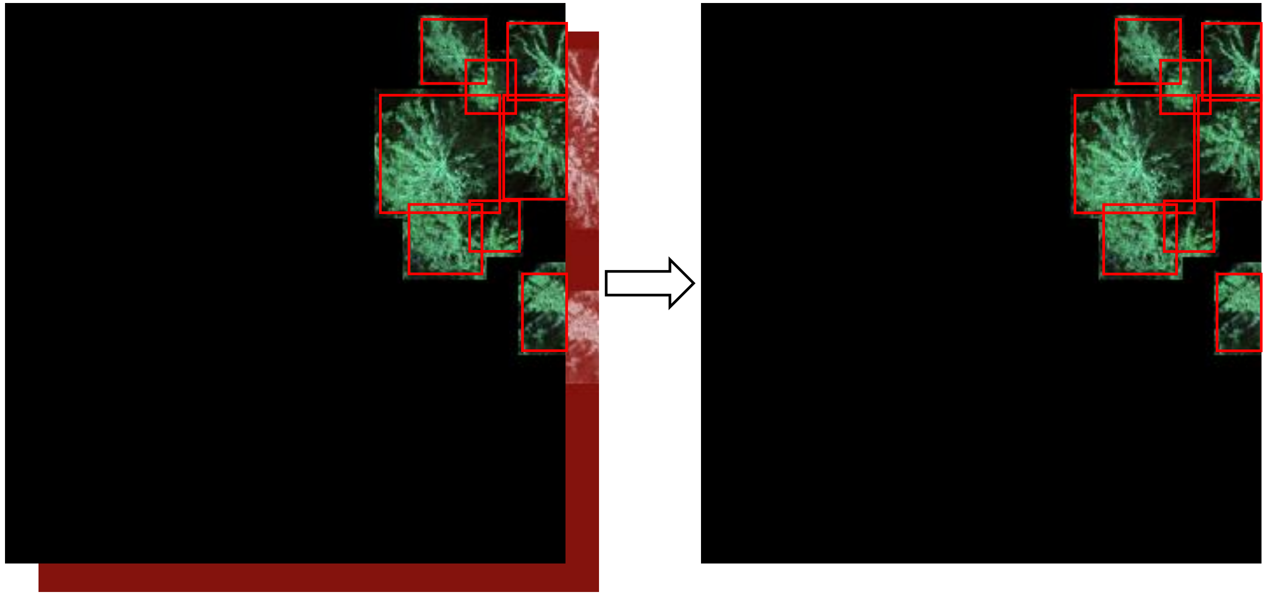

Label Cleaning



Images

Masking

Remove Infrared Channel



Data structure

Labels

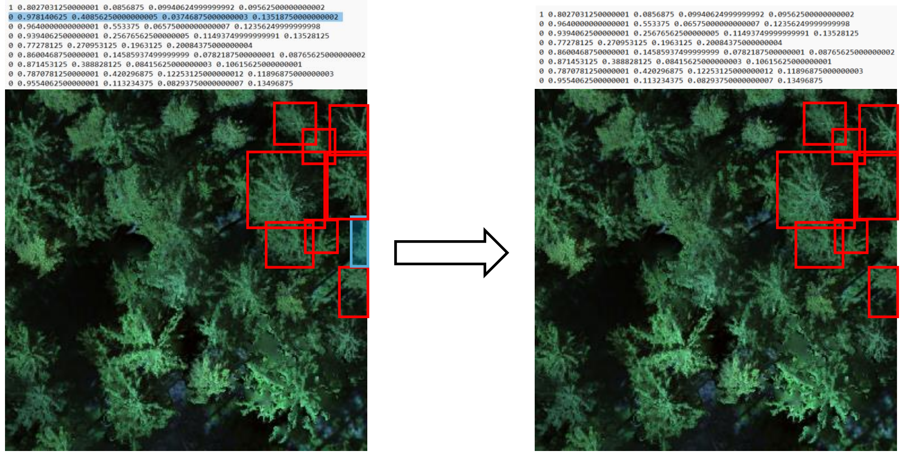
Pascal VOC to YOLO format

```
<?xml version="1.0"?>
<annotation>
    <filename>000000000546.tif</filename>
    <source>
        <annotation>ESRI ArcGIS Pro</annotation>
    </source>
    <size>
        <width>320</width>
        <height>320</height>
        <depth>4</depth>
    </size>
    <object>
        <name>1</name>
        <bndbox>
            <xmin>241.96</xmin>
            <ymin>13.12</ymin>
            <xmax>273.77</xmax>
            <ymax>43.72</ymax>
        </bndbox>
    </object>
    <object>
        <name>0</name>
        <bndbox>
            <xmin>308.01</xmin>
            <ymin>110.11</ymin>
            <xmax>320.00</xmax>
            <ymax>153.37</ymax>
        </bndbox>
    </object>
```

⇒

```
1 0.8027031250000001 0.0856875 0.09940624999999992 0.09562500000000002
0 0.978140625 0.4085625000000005 0.0374687500000003 0.1351875000000002
0 0.9640000000000001 0.553375 0.0657500000000007 0.1235624999999998
0 0.9394062500000001 0.2567656250000005 0.1149374999999991 0.13528125
0 0.77278125 0.270953125 0.1963125 0.2008437500000004
0 0.8600468750000001 0.1458593749999999 0.0782187500000001 0.0876562500000002
0 0.871453125 0.388828125 0.0841562500000003 0.1061562500000001
0 0.7870781250000001 0.420296875 0.1225312500000012 0.1189687500000003
0 0.9554062500000001 0.113234375 0.0829375000000007 0.13496875
```

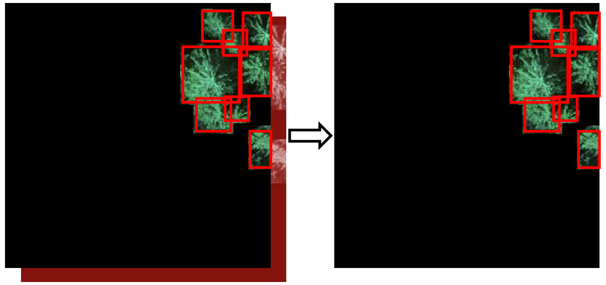
Label Cleaning



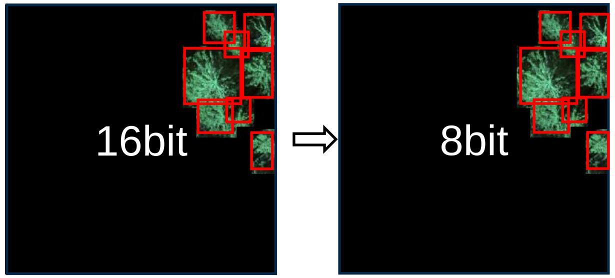
Images

Masking

Remove Infrared Channel



16bit to 8bit



Data structure

Folder Structure

- YOLOv8_8bit_RGB_05m_Clean
  - images
    - test_Ger
    - test_Swi
    - train_Ger
    - train_Swi
    - val_Ger
    - val_Swi
  - labels
    - test_Ger
    - test_Swi
    - train_Ger
    - train_Swi
    - val_Ger
    - val_Swi

Name	Date modified	Type
images	29.03.2024 16:21	File folder
labels	30.03.2024 11:00	File folder
dataset	30.03.2024 11:30	Yaml Source File

```
names:
  0: Conifer (Healthy)
  1: Conifer (Stressed)
  2: Broadleaf (Healthy)
  3: Broadleaf (Stressed)
  4: Dead Tree

path: D:\Elias\Deep_Learning\Data\Export\BrCon_3_1\YOLOv8_8bit_RGB_05m_Clean
train:
- images\train_Ger
- images\train_Swi
val:
- images\val_Ger
- images\val_Swi
test:
- images\test_Ger
- images\test_Swi
```

- 00_resample_to_10cm.ipynb
- 01_irgb_to_rgbi.ipynb
- 02_export_train_test_val_pascalvoc.ipynb
- 03_pascalvoc_to_yolo.ipynb
- 04_label_boarder_cleaning.ipynb
- 05_masking.ipynb
- 06_remove_channel.ipynb
- 07_ 16bit_to_8bit.ipynb
- 08_create_ndvi_tiles.ipynb
- 09_relabel_4class_to_3class.ipynb
- 10_count_labels_per_set.ipynb
- 11_oversampling_augmentation.ipynb
- readme.txt

How to run an object detection model – YOLOv8

```
# import packages
import torch
from ultralytics import YOLO
import os
import wandb

# General model settings
subfoldername = "sp4600"
foldername = "RGB_allSp"
model_template = "X:/02_yolov8/yolov8l.pt"
yaml_path = r"X:\RGB_allSp\train_val_all_merge_point.yaml"
epochs = 500
patience = 80
batch_size = 32
image_size = 256  # 320
seed = 7
optimizer = "AdamW"
warmup_epoch = 3.0
initial_lr = 0.01
final_lr = 0.01
```

```
# Initialize YOLO model
model = YOLO(model_template)

# Train the model
result = model.train(
    data=yaml_path,
    epochs=epochs,
    patience=patience,
    batch=batch_size,
    imgsz=image_size,
    device=0,
    project=foldername,
    name=subfoldername,
    optimizer=optimizer,
    seed=seed,
    lr0=initial_lr,
    lrf=final_lr,
    plots=True
)
```

How to run an object detection model – YOLOv8

Hands-On

- Training
- Evaluation
- Prediction
- Scripts and parameters:
- https://github.com/ultralytics/ultralytics
- https://docs.ultralytics.com/modes/train/#train-settings

ArcGIS Pro (2 h) tutorial:
Use deep learning to assess palm tree health

Course: Deep Learning in Scientific Computing (2023)
https://camlab.ethz.ch/teaching/deep-learning-in-scientific-computing-2023.html

European Environment Agency | Datahub

About Featured data EEA data policy

← Datahub overview

European Image Mosaic

Published 31 Jul 2024 | Last modified 29 Jul 2024

Pan-European Very High Resolution Image Mosaic 2021 - True Colour (2 m), July 2024 GeoTIFF

OGC:WMS ESRI:REST

Published: 31 Jul 2024

Temporal coverage: 2020-2022

Metadata Factsheet

Tree species monitoring in temperate forests using RGB imagery and deep learning

Special thanks go to: FORM group, COST Action 3DForEcoTech & SNSF, Elias Berger, Flavian Stocker, Cécile Reichmuth, Arthur Gessler, Nataliia Rehush, Christoph Fischer, Lars Waser from the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) and Raffael Bienz

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@BioMirela

FORM
www.form.ethz.ch

Ongoing work

I. Identifying tree species in RGB aerial images and terrestrial LiDAR using Deep Learning

Project aim:
Develop models and algorithms capable of accurately detecting tree species in the over- and understory of forests.

II. Nowcasting, forecasting, upscaling - Novel avenues for forest vitality monitoring and anticipating forest dynamics (UPSCALE).

Project aim:
Obtain integrated early warning signals for detecting health decline and mortality in trees and forests across spatial scales

UPSCALE

https://form.ethz.ch/research/tree-species-identification.html

Tree mortality identification

Aim: Quantify tree mortality for 2018, 2020, and 2022 for the study area.

Research questions (RQ):

1. How should be the parameters (i.e. image size and confidence) adjusted to best detect tree mortality?
2. How does the tree species mortality changes over the time?

Data:
Images: USB stick folder ***04_TreeMortality_RGB_CNN***
1 ha images from 2018, 2020, and 2022.
37.5 ha orthomosaic from 2018, 2020, and 2022.

Model: https://drive.google.com/drive/folders/1DgcTJR4r1YLntDEKc1Uaw7JxWSz87lZv?usp=sharing

Algorithm - please open it and make a copy of it:
https://colab.research.google.com/drive/10r3DKqlvXJfQASenH2CmdGg9jbXflzjO?usp=sharing

Tree species classification using machine learning

Aim: Tree species classification using machine learning tools.

Research questions (RQ):

1. Which tree species are best classified?

Data: USB stick

Algorithm – Machine learning