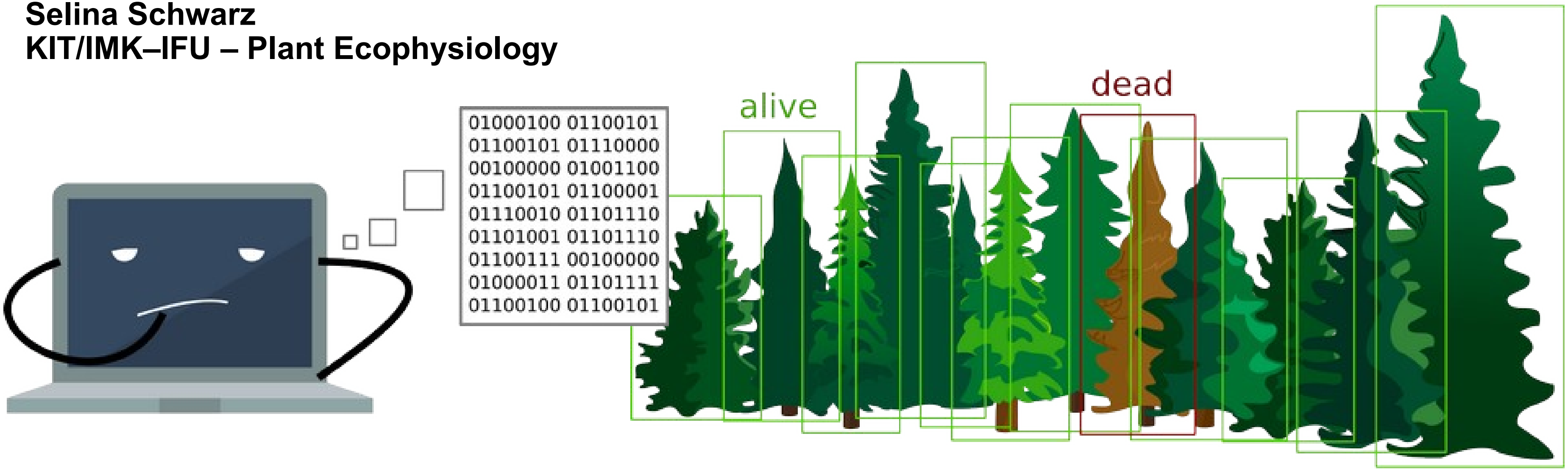
Deep Learning Hackathon 2023

Selina Schwarz
KIT/IMK–IFU – Plant Ecophysiology

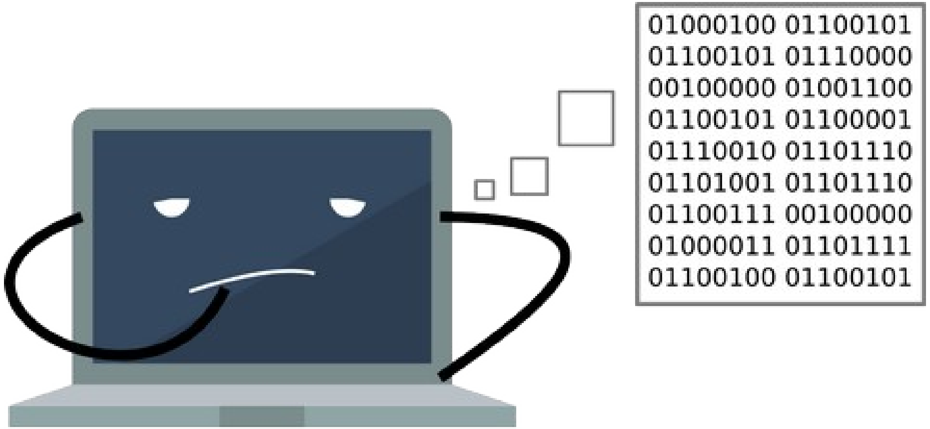


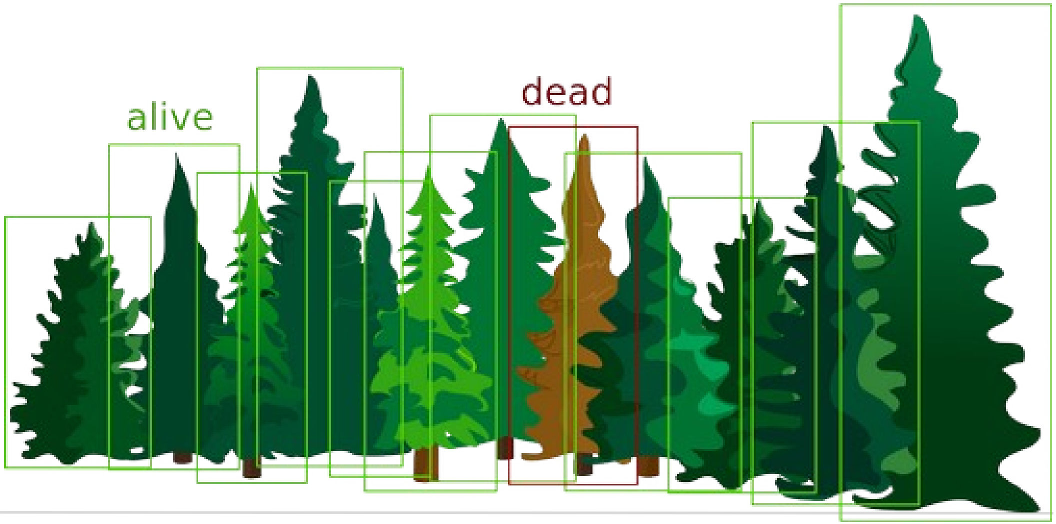
Presentation structure

1) Background
- Drought in Europe
- Luxembourg

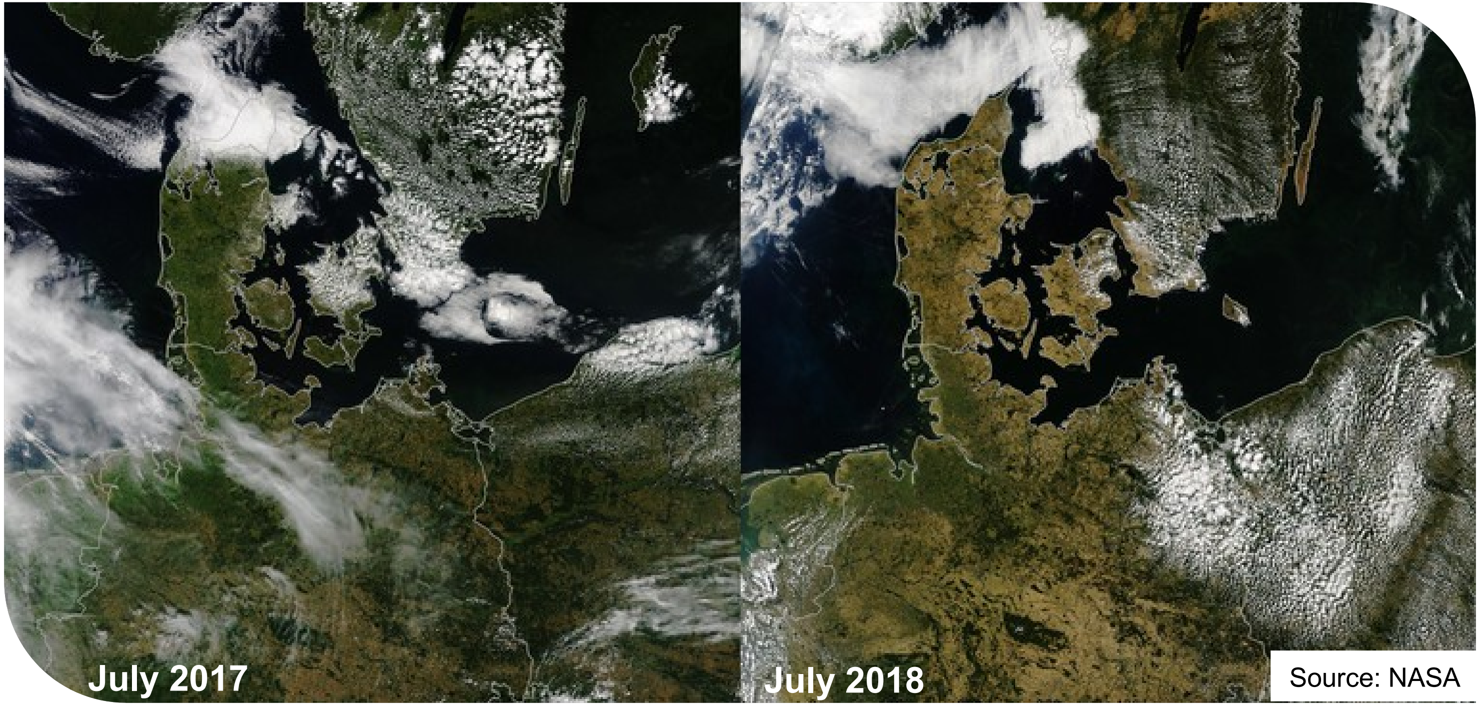
2) Data
- Study site
- Reference Data
- Garbage in – Garbage out?

3) Model
- Structure
- U-net
- ResNet34
- Loss functions





Introduction | Drought in Central Europe



Drought damages in Upper Franconia, Germany (Jörg Ermert, FVO)

Introduction | Drought in Central Europe

Drought damages in Upper Franconia, Germany (Jörg Ermert, FVO)

Introduction | Drought in Central Europe

Drought damages in Upper Franconia, Germany (Jörg Ermert, FVO)

Introduction | Drought in Central Europe

Drought damages in Upper Franconia, Germany (Jörg Ermert, FVO)

Introduction | Luxembourg

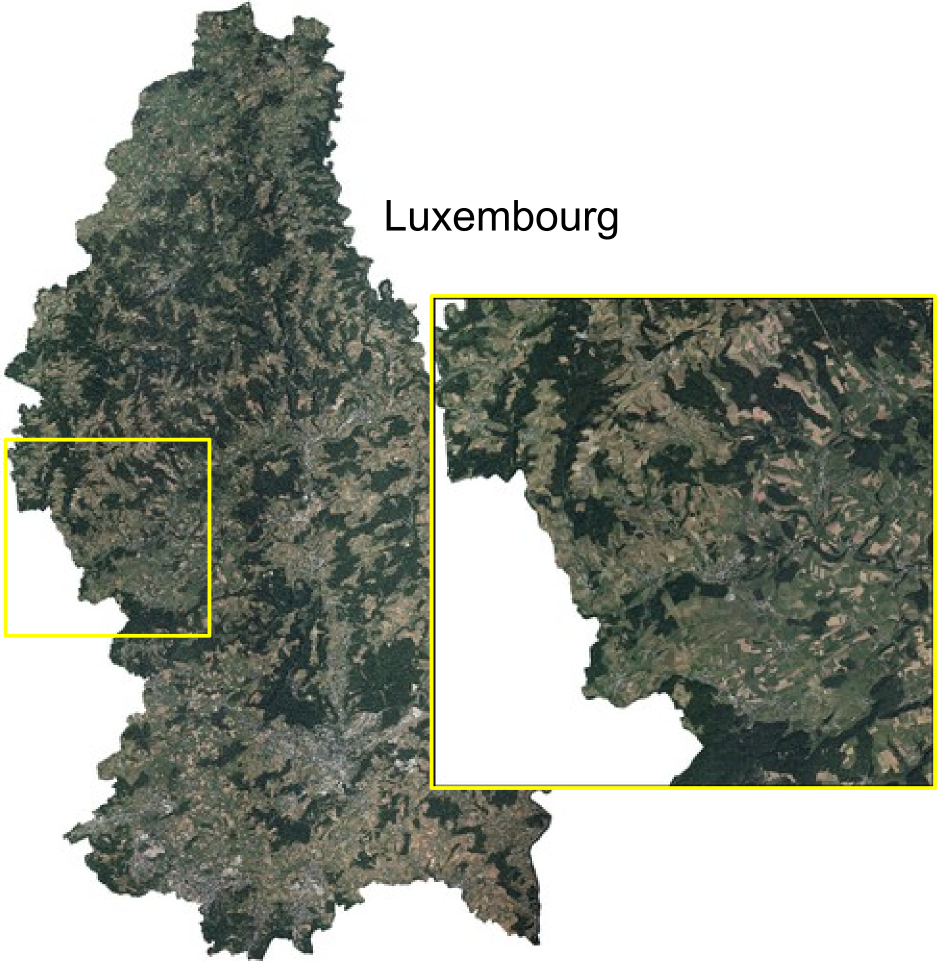
+ No pay wall

+ Annual data

+ High resolution (20 cm)

~320 km²

2017 + 2019

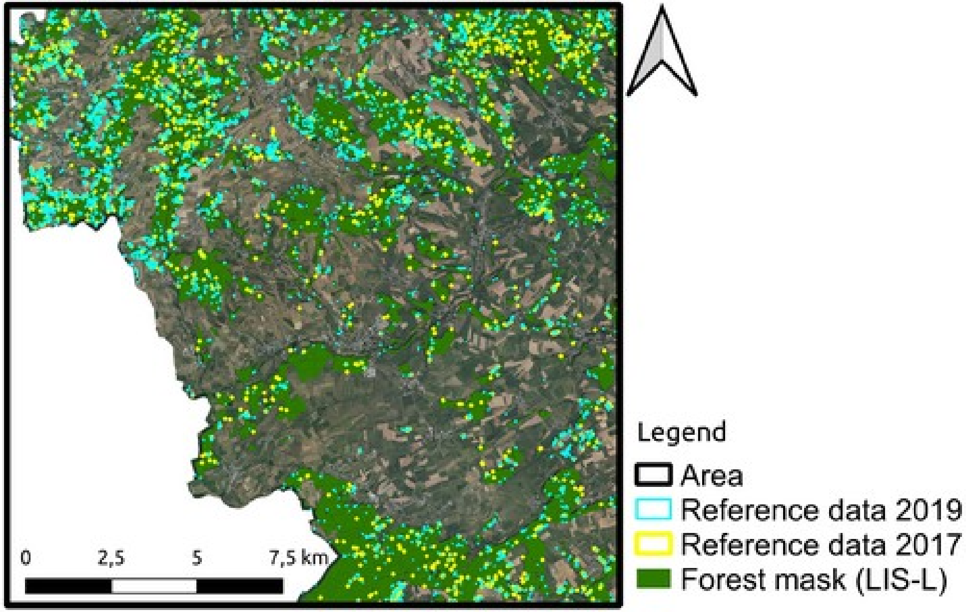


Data

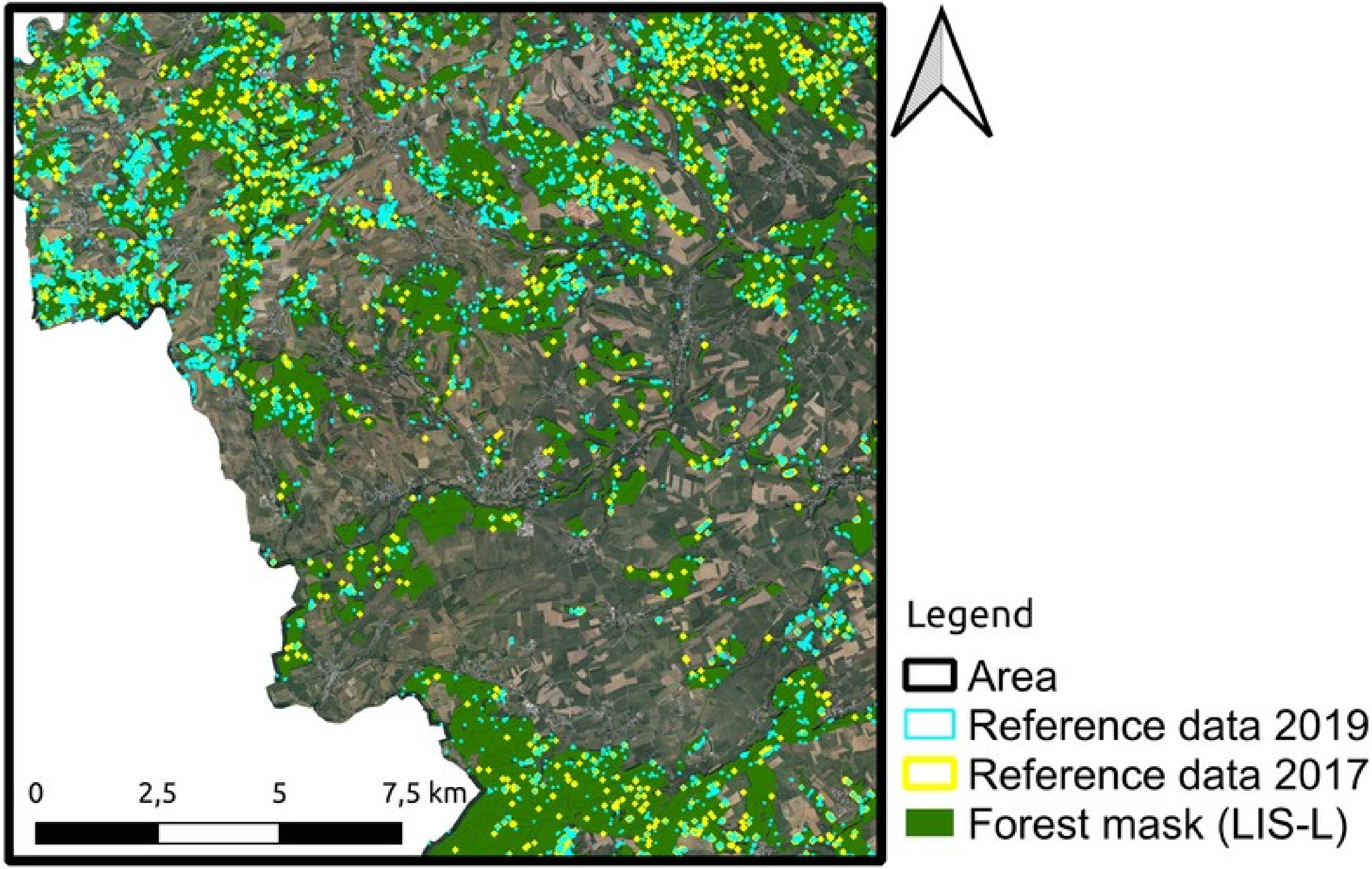
Aerial images (Orthophotos) 2017 + 2019
- raster data
- resolution: 20 cm

Reference data 2017 + 2019
- vector data
- canopy mortality
- 3 classes: conifer, broadleaf, other
- Conifer: 1
- Broadleaf: 2
- training (70%), validation (20%),
- test (10%)

Forest mask 2018
- vector data
- based on LIS-L land use product



Data


0
2,5
5
7,5 km
Legend
Area
Reference data 2019
Reference data 2017
Forest mask (LIS-L)

Reference data

	Reference data			
Year	Total (Conifer / Broadleaf)	Training (70%)	Validation (20%)	Test (10%)
2017	2,309 (2,051 / 258)	1,616	462	231
2019	12,327 (11,243 / 1,084)	8,629	2,465	1,233

Reference data

	Reference data			
Year	Total (Conifer / Broadleaf)	Training (70%)	Validation (20%)	Test (10%)
2017	2,309 (2,051 / 258)	1,616	462	231
2019	12,327 (11,243 / 1,084)	8,629	2,465	1,233

Reference data

	Reference data			
Year	Total (Conifer / Broadleaf)	Training (70%)	Validation (20%)	Test (10%)
2017	2,309 (2,051 / 258)	1,616	462	231
2019	12,327 (11,243 / 1,084)	8,629	2,465	1,233

Reference data

Examples

Conifer

Broadleaf

Reference data

Examples

Conifer

Broadleaf

Reference data

Examples

Conifer

Broadleaf

Reference data

Examples

Conifer

Broadleaf

Reference data

Examples

Conifer

Broadleaf

Reference data

Examples

Conifer

Broadleaf

Reference data

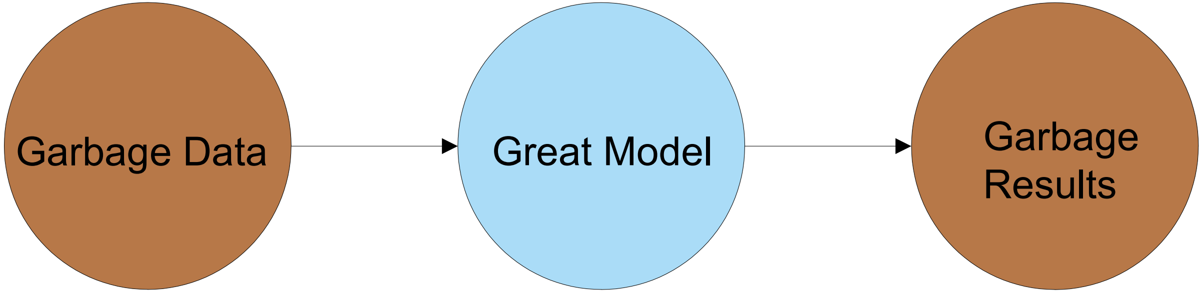
Examples

Conifer

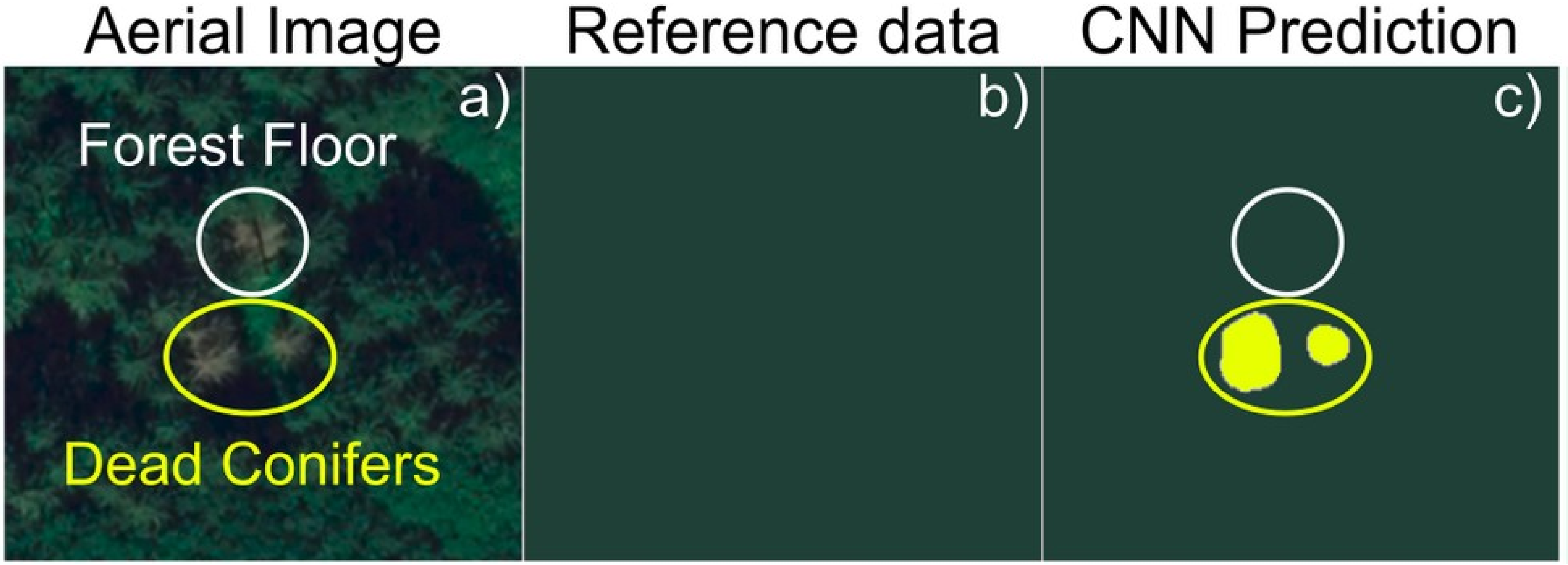
Broadleaf

Reference data: Garbage in – Garbage out?

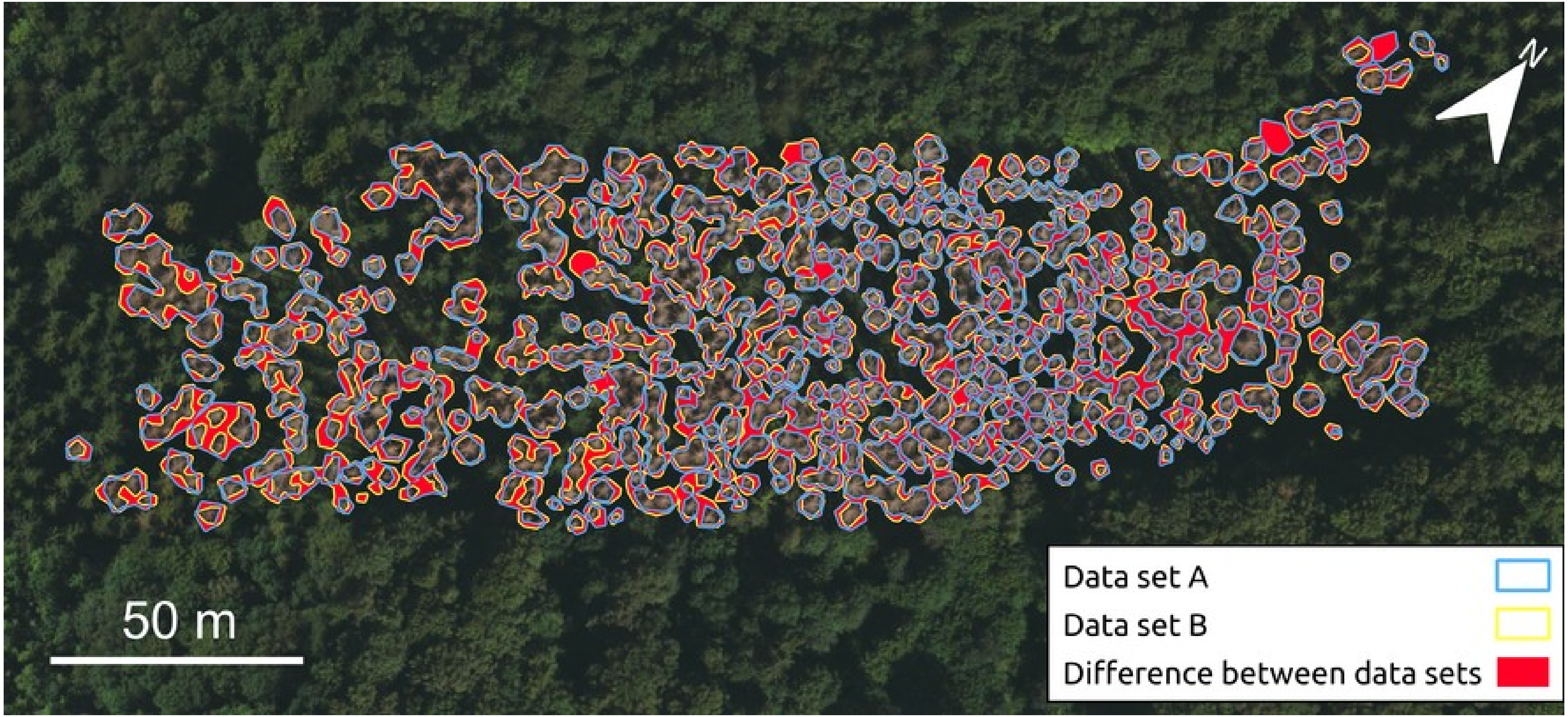
Garbage in = Garbage out?



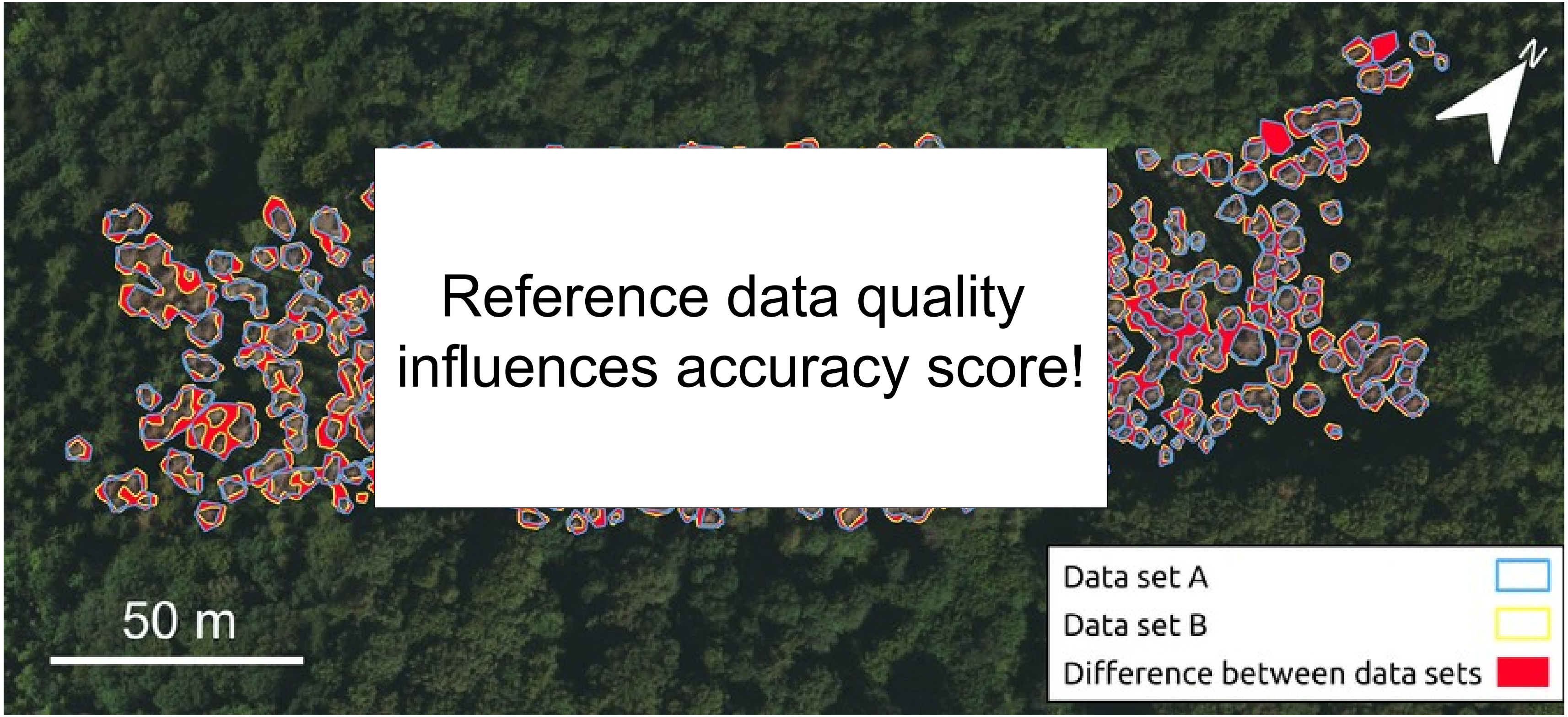
Reference data: Garbage in – Garbage out?



Reference data: Garbage in – Garbage out?



Reference data: Garbage in – Garbage out?



Reference data quality influences accuracy score!

Model

CNN Setup

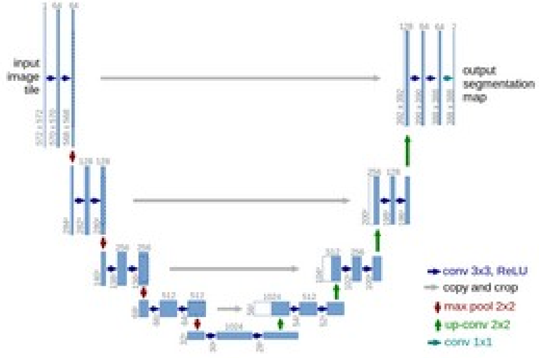
Architecture

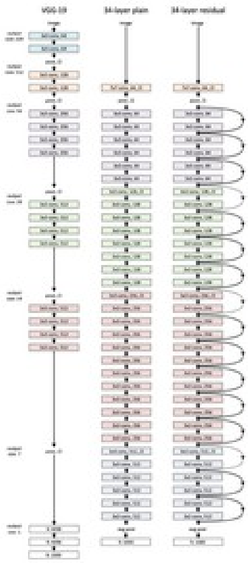
U-net
(Ronneberger et al. 2015)

Resnet34
(He et al. 2015)

Encoder

Dice Loss
Focal Loss
Boundary Loss

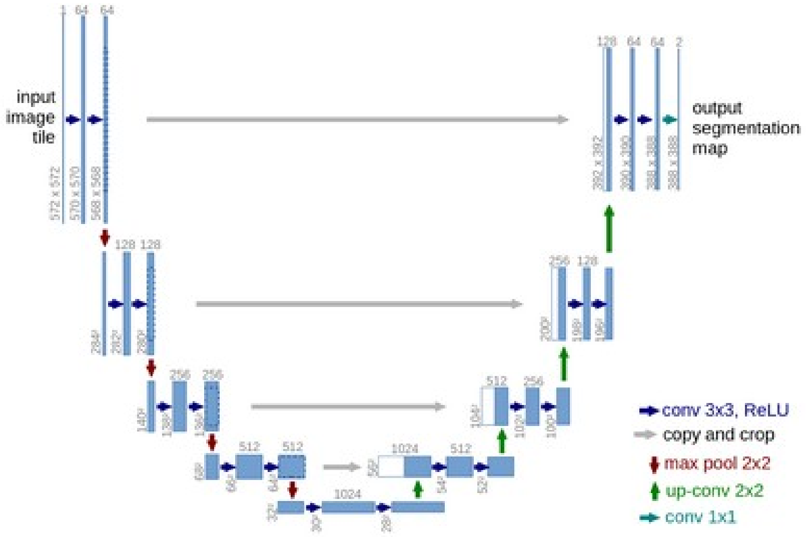




Model

U-net

- Ronneberger et al. (2015)
- Semantic segmentation
- pixel-wise classification
- consist of an encoding and decoding branch
- Encoder:
  - image size reduction with convolution and max pooling operations
- Decoder:
  - image size is gradually increased.
- Skip Connections:
  - connect both paths
  - activations are forwarded to the decoder, providing the spatial identity of the data

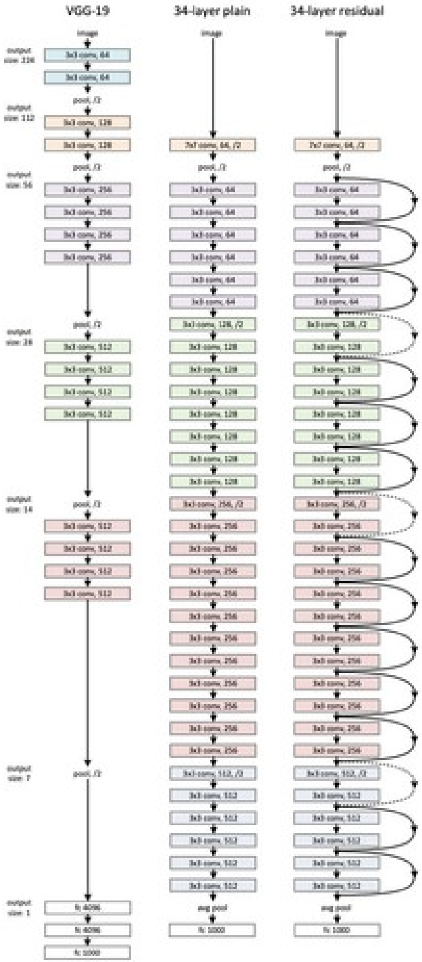


Ronneberger et al. (2015) – U-net architecture

Model

Resnet34

- He et al. (2015)
- Used as encoder
- Image classification model
- Pre-trained on ImageNet
- 34 layers
- Skip connections to jump over layers
  → avoid vanishing gradients (leads to no change in weights)
  → avoid accuracy saturation (higher training error)

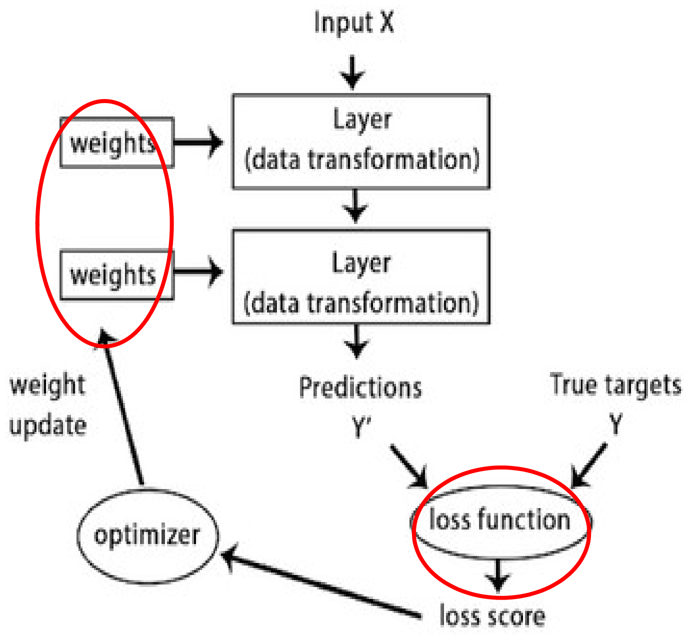


He et al. (2015) “Example network architectures for ImageNet.”. Resnet34 on right

Model

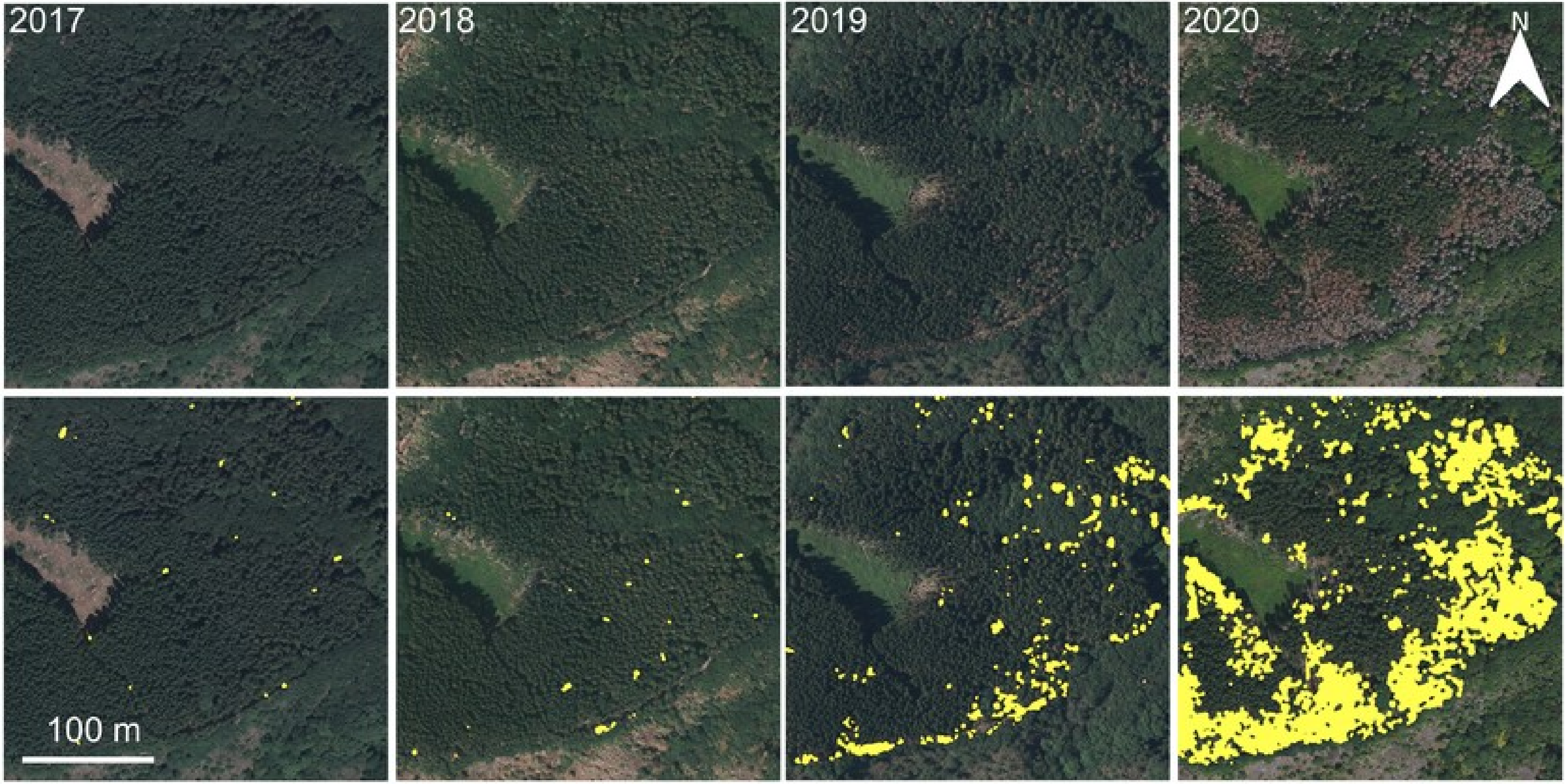
Loss functions

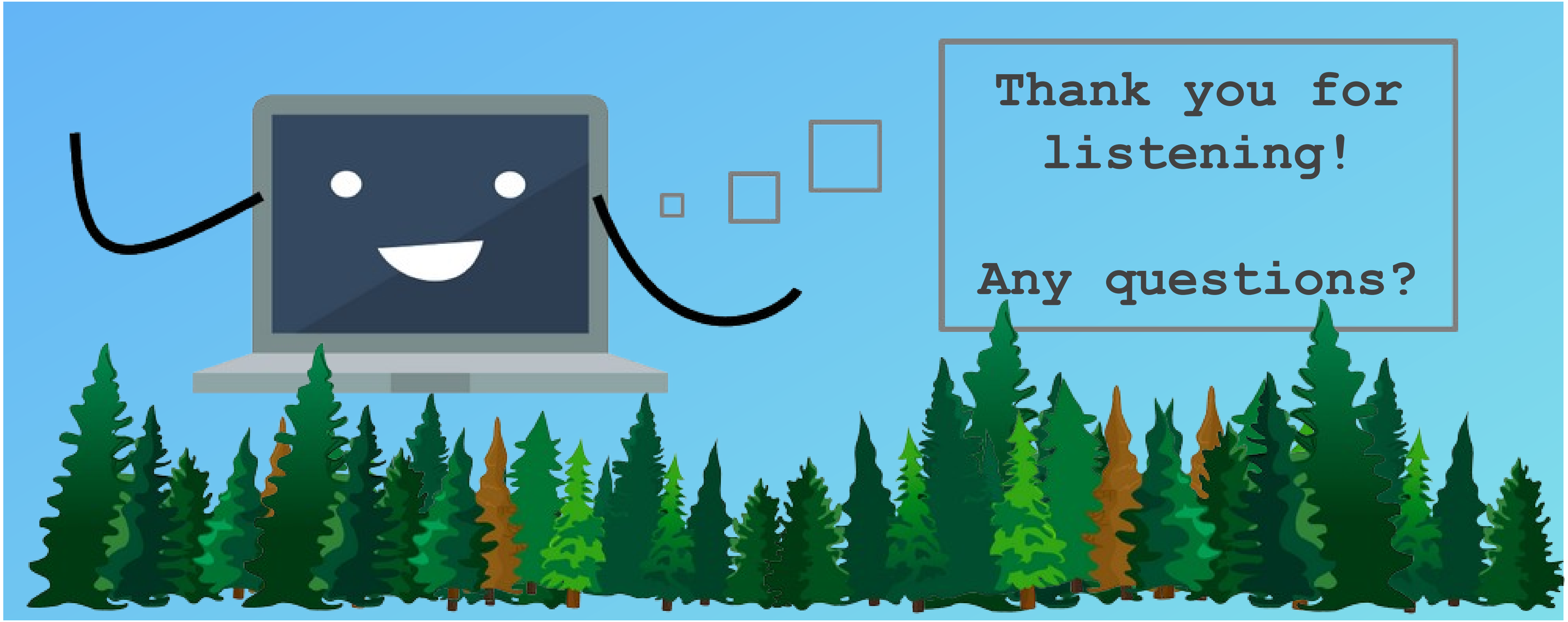
- Dice Loss
  - Based on Sørensen–Dice coefficient
  - Commonly used
  - 0 - 1 (no overlap – perfect overlap)
- Focal Loss
  - Used in imbalanced datasets
  - More focus on misclassified objects
- Boundary Loss
  - grows exponentially with distance from reference data
  - More precise feature delineation



Schematic representation of basic Neural Network
Deep Learning with R (2017) by Francois Chollet

Sneak Peak - Results




Thank you for listening!
Any questions?

References

- Schuldt et al. (2020) A first assessment of the impact of the extreme 2018 summer drought on Central European forests
- Silva et al. (2021) Encoder-Decoder Architectures for Clinically Relevant Coronary Artery Segmentation
- Tan & Le (2020) EfficientNet: Rethinking Model Scaling for Convolutional Neural Networks
- Sudre et al (2017) Generalised Dice overlap as a deep learning loss function for highly unbalanced segmentations
- Lin et al. (2017) Focal Loss for Dense Object Detection
- Kervadec et al. (2020) Boundary loss for highly unbalanced segmentation
- Ronneberger et al. (2015) U-Net: Convolutional Networks for Biomedical Image Segmentation
- He et al. (2015) Deep Residual Learning for Image Recognition