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Monitoring Bark Beetle Damage: UAS Image Classification with Deep Neural Networks

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Outline

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Background and Objective

The European spruce bark beetle is a major threat to boreal forests and can cause extensive tree mortality

Efficient forest health monitoring can help mitigate the damages caused by the beetle

As tree health declines, the attacked trees start displaying color symptoms

Deep learning models are used to detect trees and classify their health status

Challenges

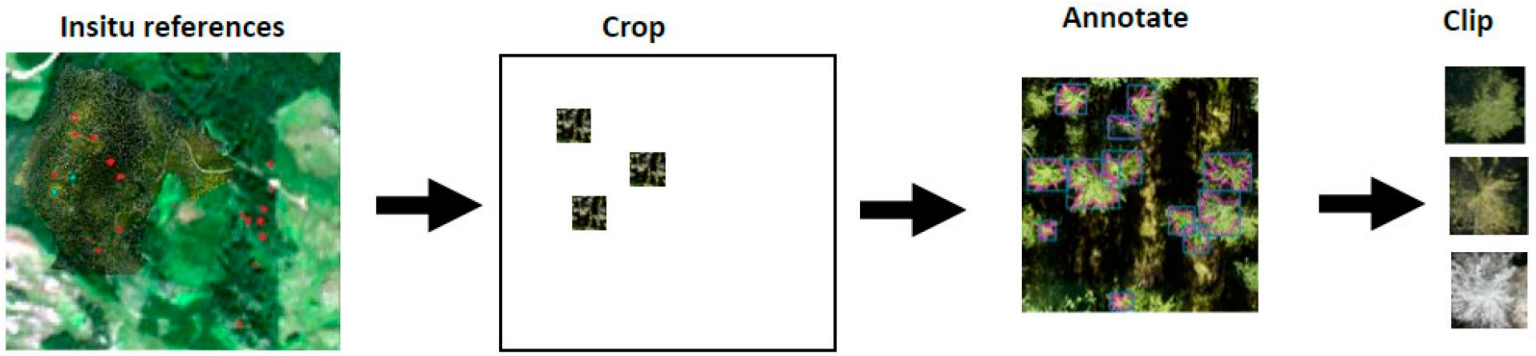
- Low amount of reference data
- High variance in imaging data
  - Weather
  - Illumination
  - Season

➢ Deep learning models may not generalize well to new data

- The infested trees are often mistaken for healthy trees
- Infestations are only detectable after a significant decline in tree health

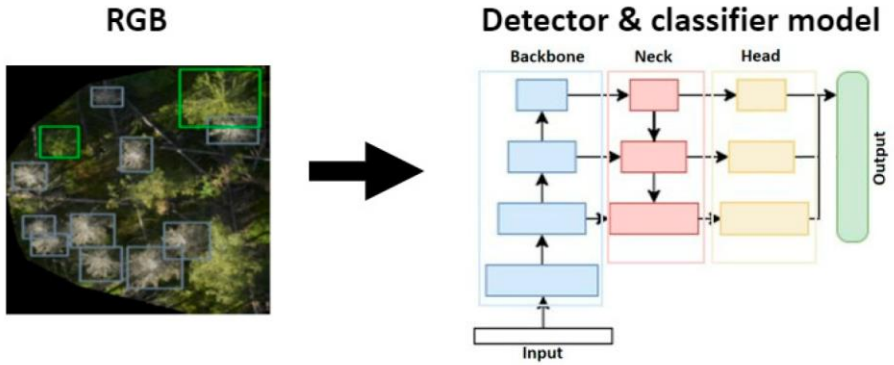
Data collection and preparation

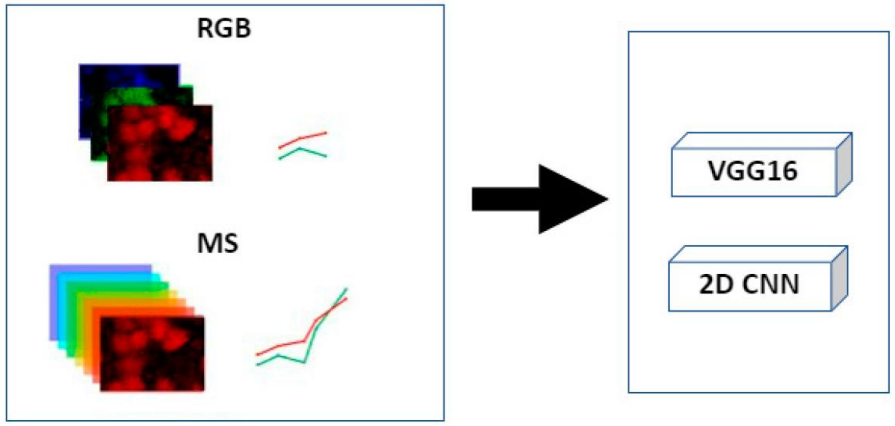
- Image data collected by unmanned aerial systems (UAS) (e.g. drones)
  - Processed into orthomosaics (Agisoft Metashape)
  - Coordinate alignment
  - Radiometric calibration
- RGB and multispectral sensors
  - MS images better at separating the infested class?



Implementation

- YOLOv7 object detector used for tree detection
- VGG16 and a simple 3 layer 2D-CNN used for classification
- Computations run in Mahti cluster
- Tools
  - PyTorch
  - Additional packages installed through virtual environment (rasterio)



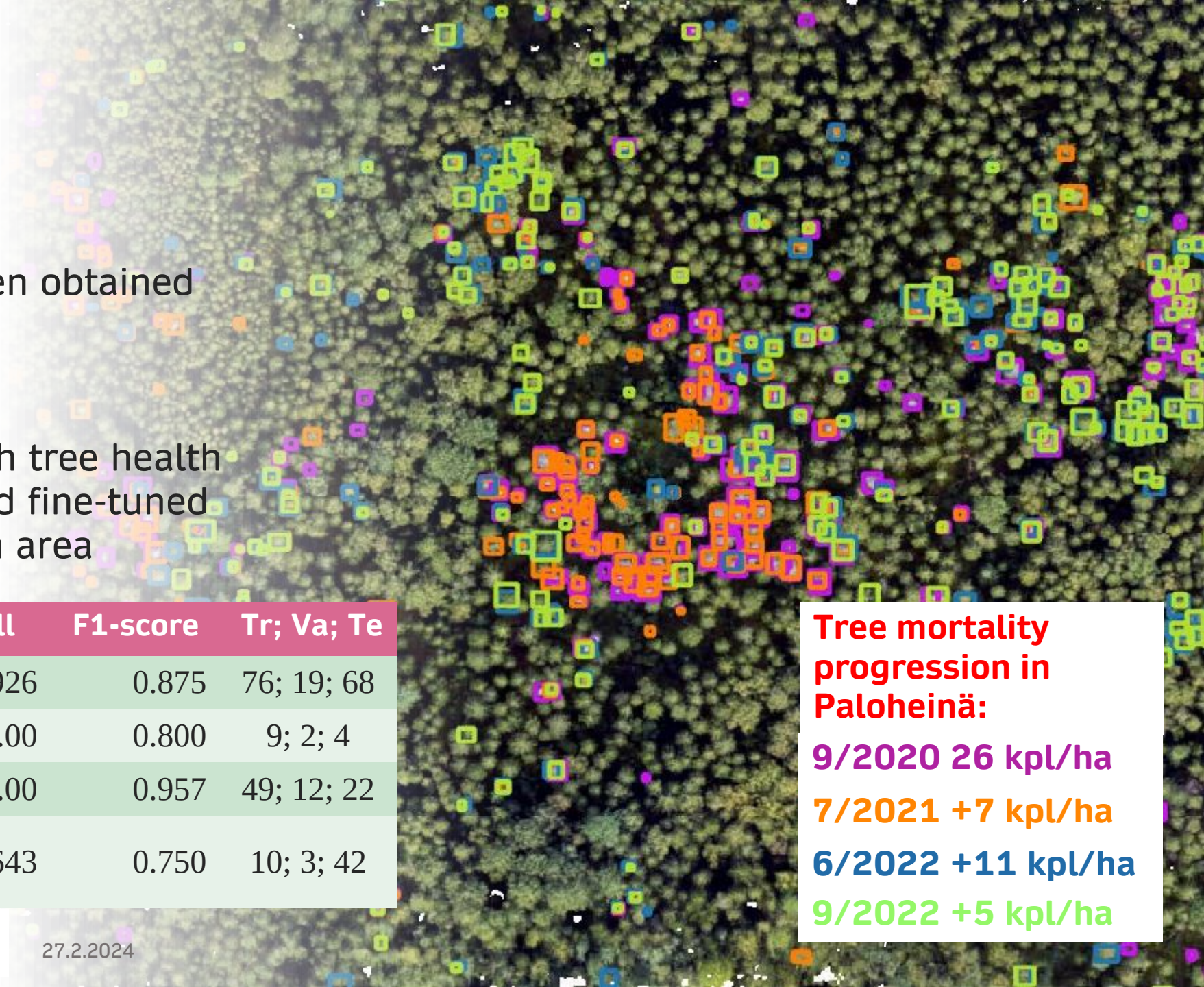


Results

Best test results have been obtained with a simple 2D-CNN on multispectral images

Model was pretrained with tree health data (~2000 samples) and fine-tuned to work in a new research area

Class	Precision	Recall	F1-score	Tr; Va; Te
Healthy	0.829	0.926	0.875	76; 19; 68
Infested	0.667	1.00	0.800	9; 2; 4
Dead	0.917	1.00	0.957	49; 12; 22
Not spruce	0.900	0.643	0.750	10; 3; 42



Conclusions and future development

- Challenges
  - Poor generalization of models
  - Poor classification results for infested class
  - Early detection of bark beetle infestation
- Solutions
  - Fine-tuning of models to work with new data
  - Multispectral imagery to improve infested tree classification
- Future development
  - Multi-/Hyperspectral imagery for early detection
    - Need more reference data

Thank you!