ForestMap

The next generation of forest maps - adapting a Nordic success story across the globe

2022-01-01 to (2024-12-31) 2025-10-31

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Katam Technologies AB, Sweden

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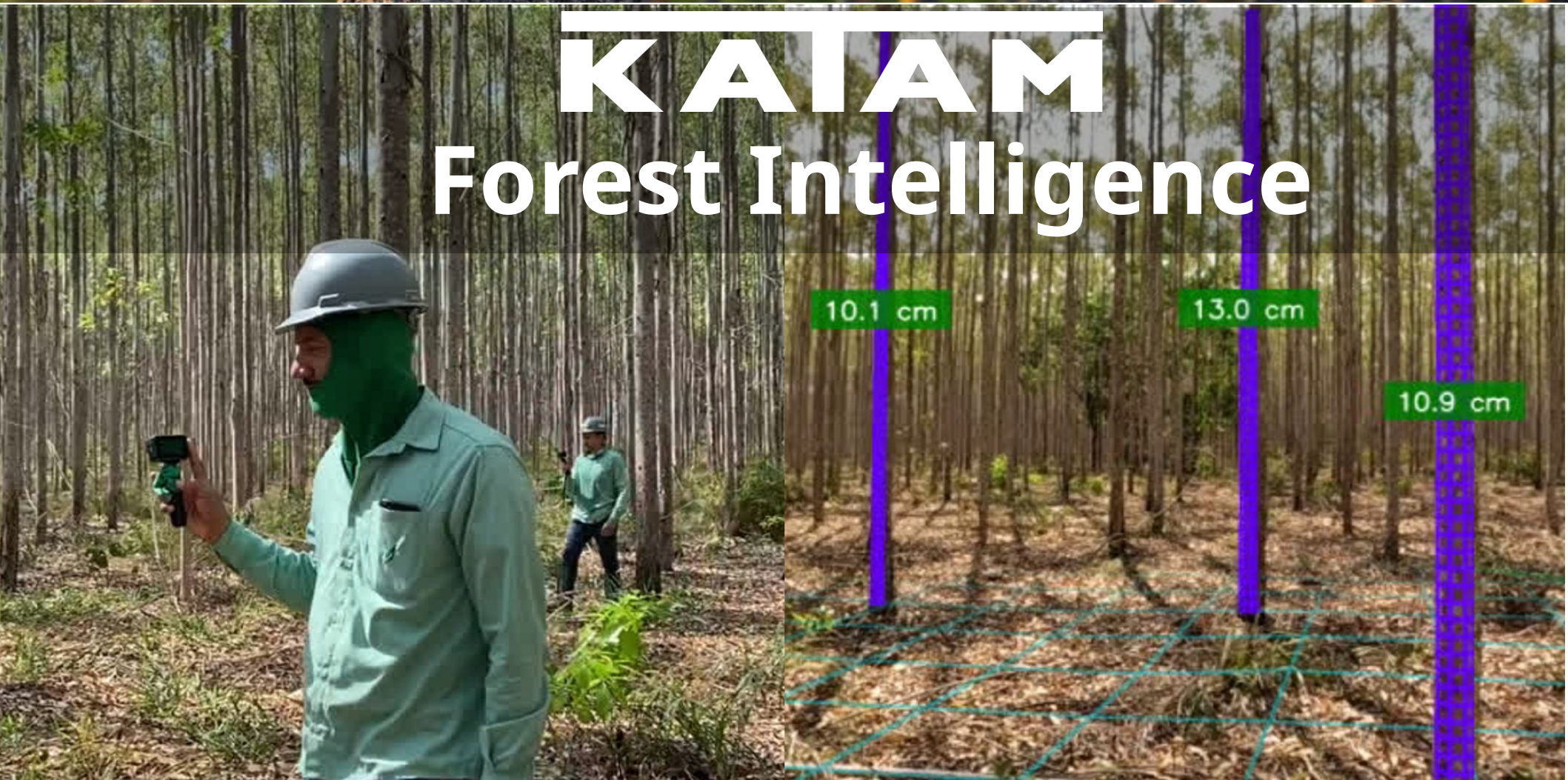
KATAM

Forest Intelligence



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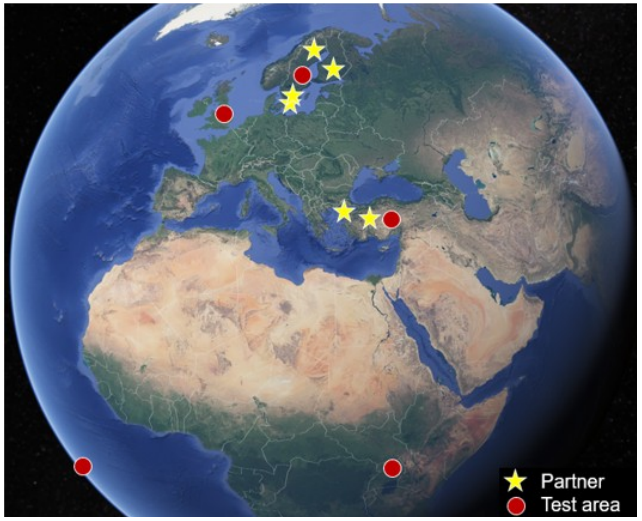
The value of scientific cooperation

Linnaeus University
Swedish University of Agricultural Sciences
Forest Science



Societal values

University of Helsinki

Startup company
Katam Technologies

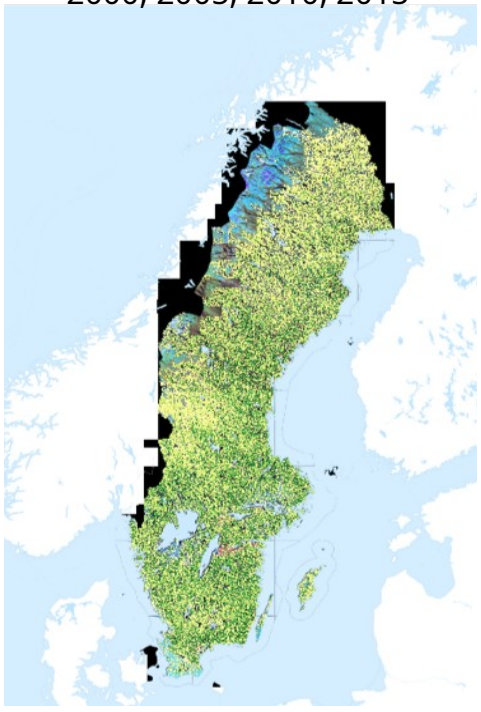
Computer Science

Yeditepe University
Istanbul Technical University
Linnaeus University

ITU asked Katam about research for forestry. Katam proposed a scope for scaling Swedish map-solution for the globe using AI and then connected all the universities.

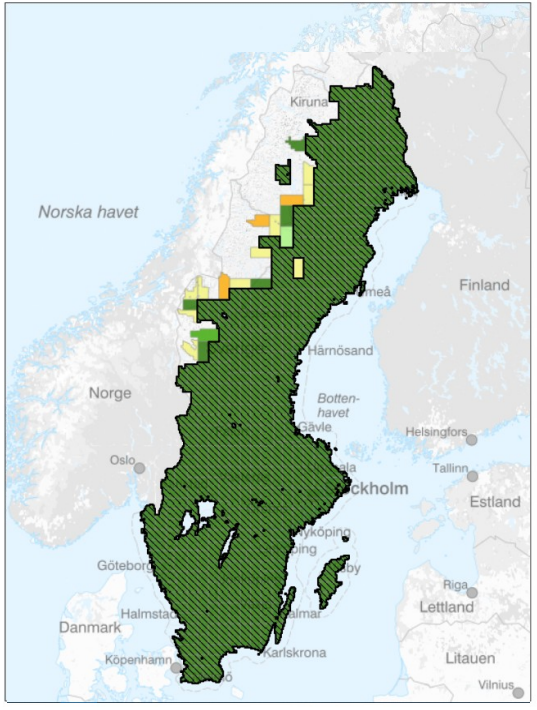
National forest maps

Satellite
2000, 2005, 2010, 2015



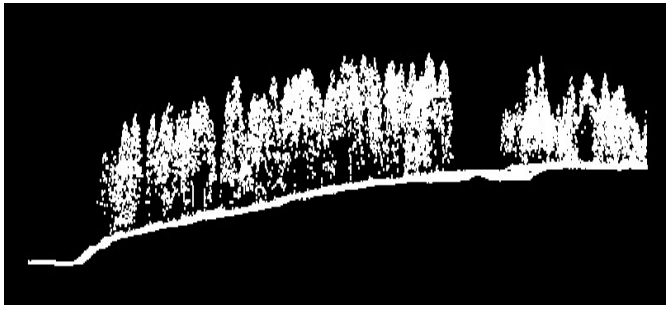
Lidar - Version 1
2009-2016

Lidar - Version 2
2024-10-01



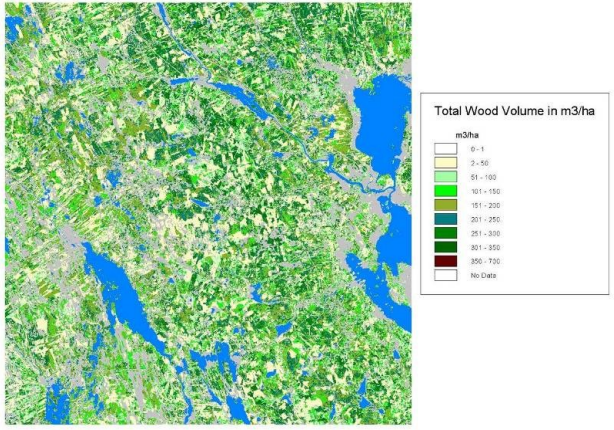
Variables; Stem volume, Mean tree height, Mean diameter, Basal area, Above-ground biomass
Provided as open data by the Swedish Forest Agency (Forest attribute map) (skogsstyrelsen.se/skogligagrunddata)

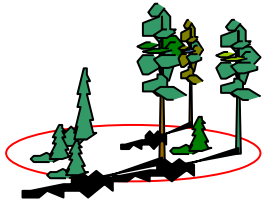
National forest maps
Regression models



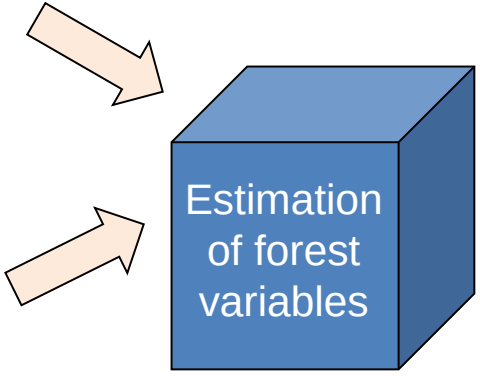
Remote sensing data

Satellite or aerial lidar





Field surveyed plots, training data, from the Swedish National Forest Inventory (NFI)



Raster maps with estimated forest variables

How could we scale it to the globe?

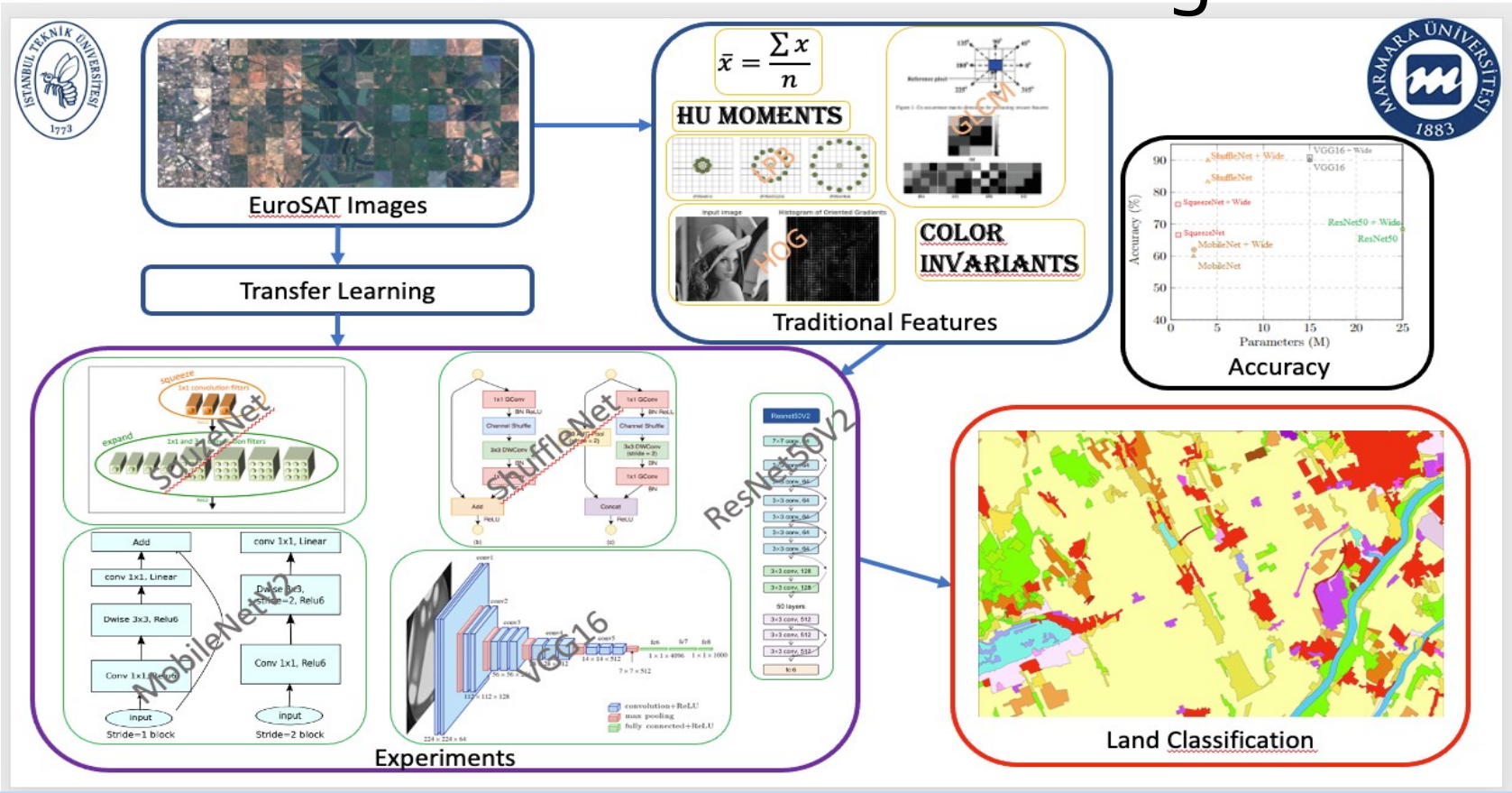
- Could the maps be valuable on global scale?
- What if Katam’s ground data collection for crowd sourcing could reduce the dependency of NFI-data?
- Could AI replace regression modelling for improved quality and increased efficiency of map creation?

Project impacts and potential for industrial implementation / societal contextualization

- **Forest Management and Monitoring**: The predictive models developed can enhance forest management practices by providing accurate forecasts of forest variables, and other ecological variables. This offers significant value for the forestry industry, especially in sustainable resource management and optimization of timber production.
- **Environmental Conservation**: These predictive tools can be vital for environmental conservation efforts, aiding in tracking deforestation, reforestation, and biodiversity changes. This can be particularly beneficial for governmental agencies and NGOs focused on environmental protection.
- **New Paths for Research**: The integration of multiple data sources and machine learning models (Neural Networks and CNNs) opens new avenues for further research in ecological modeling, particularly in improving the precision of forest variable predictions.

Finnish university researched about societal impact and potential of the maps for the globe.

AI in forest remote sensing



Turkey universities researched about potentials of using satellite images as base for AI.

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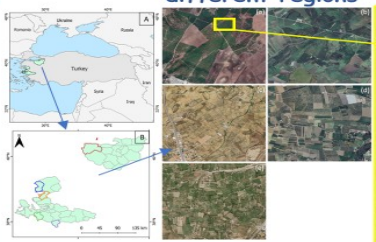
A benchmark dataset for very high-resolution tree detection in deep learning applications: VHRTrees

1

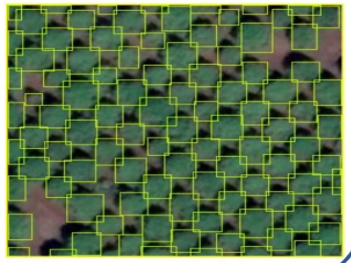
Study Area: Five different regions



Sample image patch

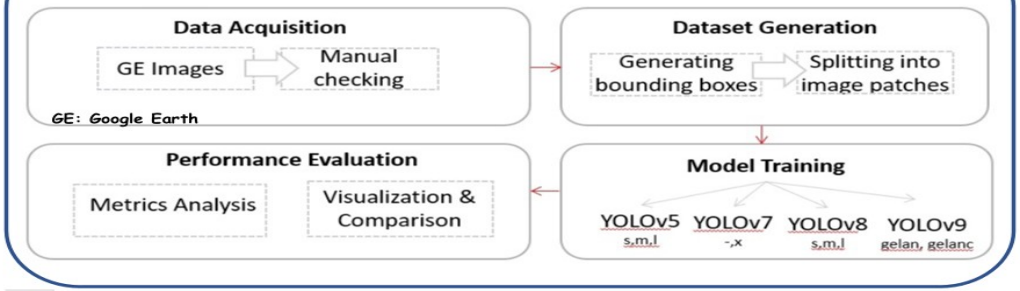
Region	Patch	Sample
Karacabey		4,191
Dikili		11,767
Aliağa		6,008
Seferihisar		1,385
Selçuk		2,615
Dataset		
Train	1,023	
Valid	226	
Test	222	
Total	**1,471**	**25,966**

Automatic annotated Roboflow



2

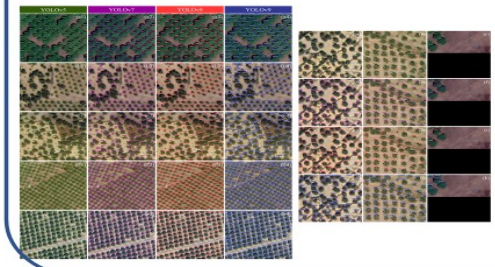
Methodology



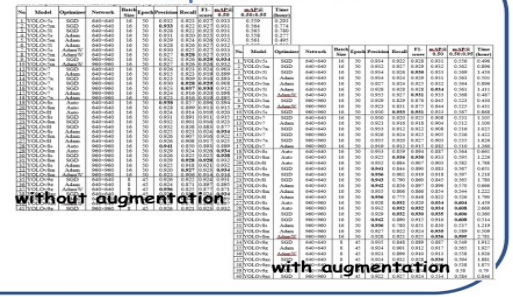
3

Results

Visual results



Experiment results



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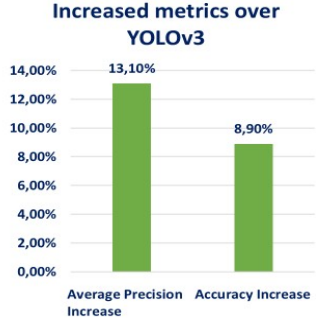
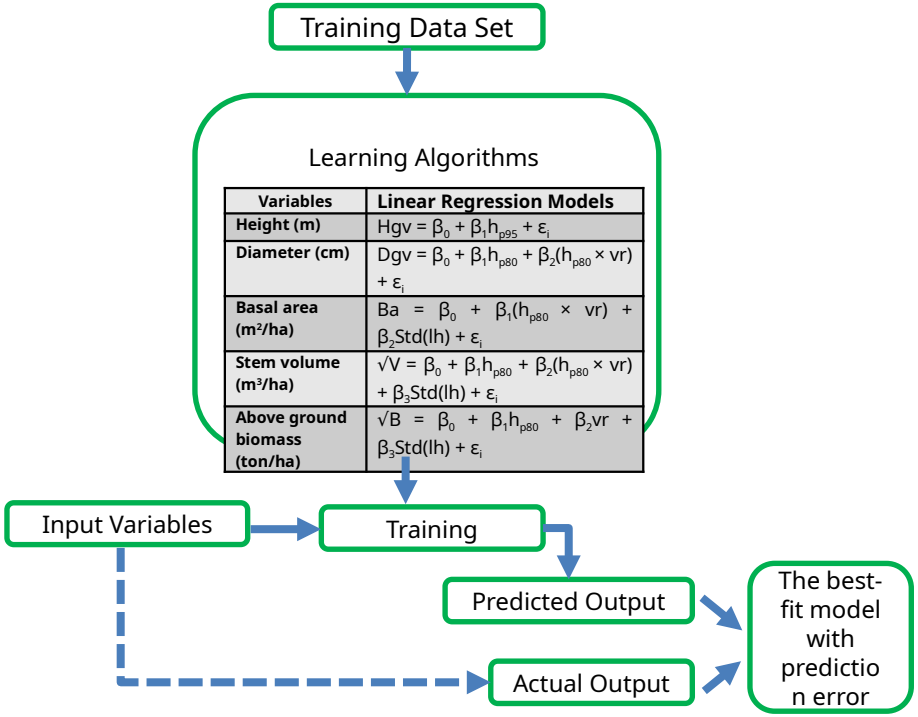
A Swin Transformer, YOLO, and Weighted Boxes Fusion-Based approach for tree detection in satellite images

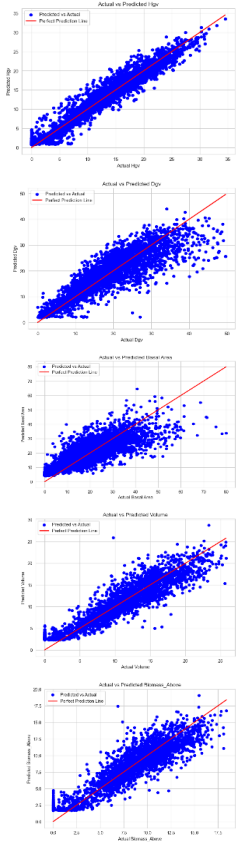
This paper won the Young Researchers Award at SIU 2024

This article proposes combining Swin transformers and YOLO models with weighted boxes fusion to enhance detection accuracy. Swin transformers offer broad variation detection, while YOLO provides sharp, precise results. Together, the method improves tree detection accuracy by 3.7% over Swin transformers and 13.1% over YOLO.



Linear regression using ALS data





Variables	Linear regression model	
	RMSE	RMSE (%)
Mean tree height (m)	1.7	12.6
Mean tree diameter (cm)	4.5	24.1
Basal area (m^2/ha)	7.8	38.4
Stem volume (m^3/ha)	2.3	20.3
Above-ground biomass (ton/ha)	1.6	19.9

Swedish universities first researched how good present solution for Swedish National maps is

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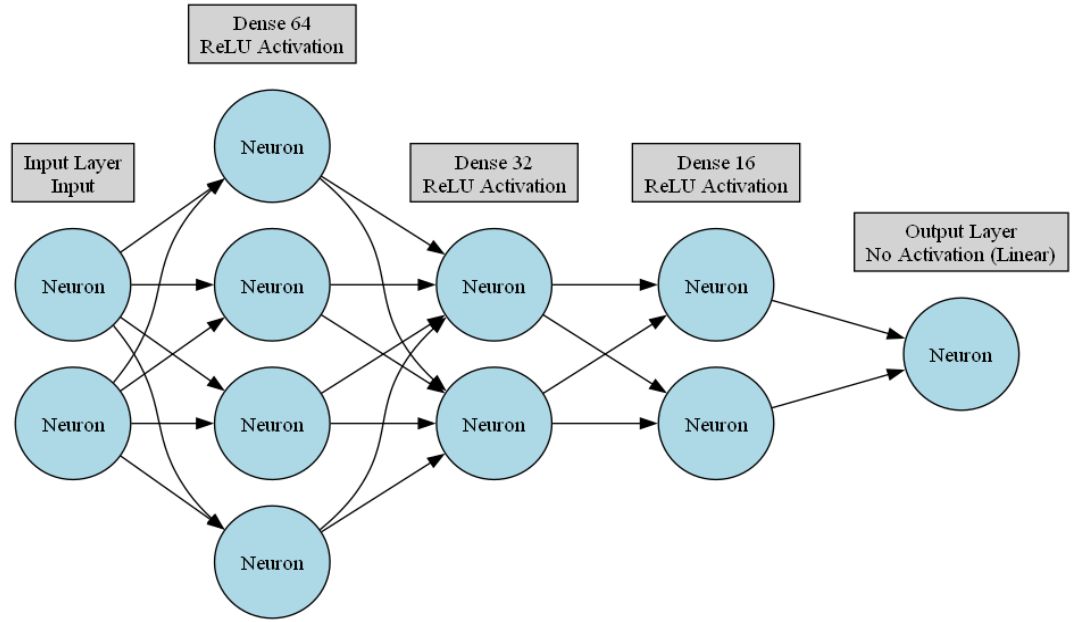
Training Data Set (Using Raster Metrics)



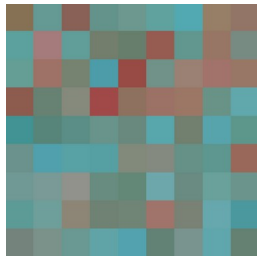
Network Architecture

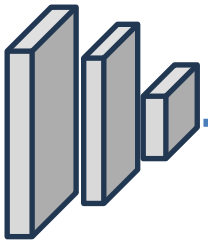
Predicted variables

- Mean tree height (m)
- Mean tree diameter (cm)
- Basal area (m^2/ha)
- Stem volume (m^3/ha)
- Above-ground biomass (ton/ha)

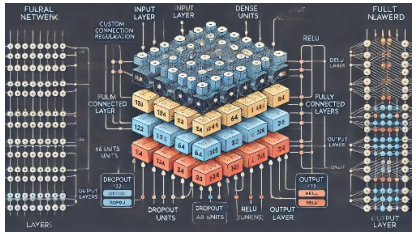
Sweden researched how DNNs and different MLs performed vs present solution.

ResNet for transfer learning using ALS raster image data





Feature Map



Training Data Set (using raster image data: 9 × 9 × 60)

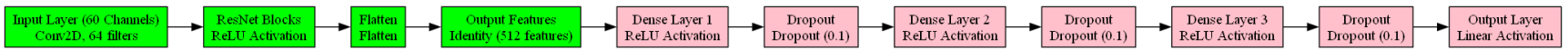
ResNet

Output Feature Map

Fine Tune using NN Custom Model

Forest Variable Predictions

Transfer Learning



Detailed Architecture

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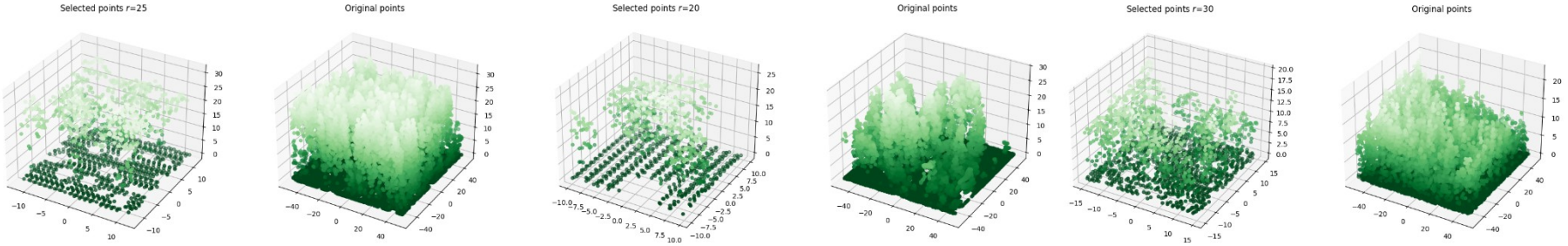
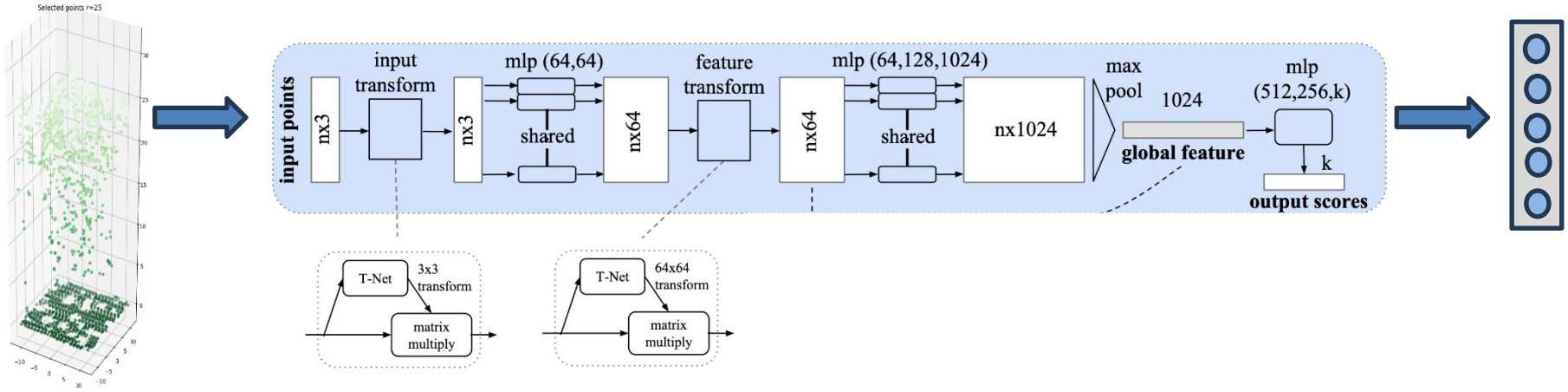
PointNet using ALS data

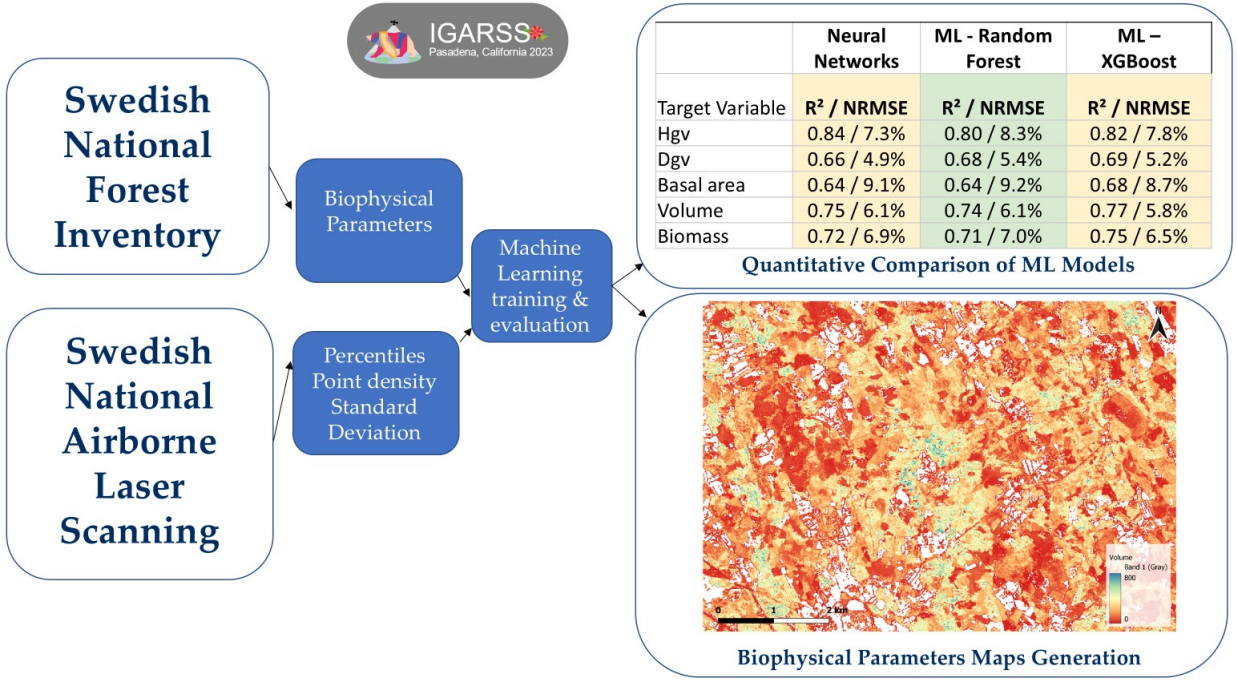


Input cloud points

Forest variables



Forest biophysical parameter estimation via Machine Learning and Neural Network approaches

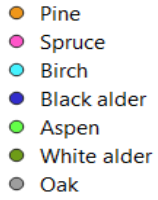


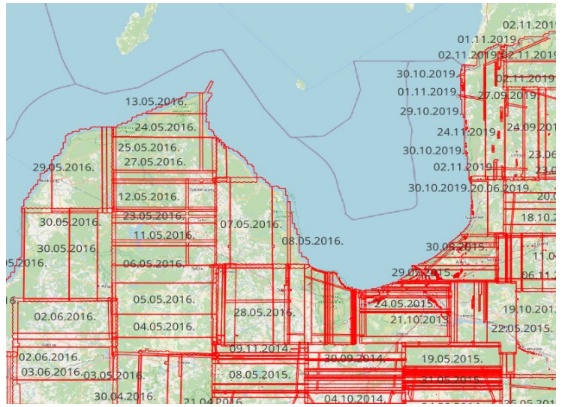
	Neural Networks	ML - Random Forest	ML – XGBoost
Target Variable	R^2 / NRMSE	R^2 / NRMSE	R^2 / NRMSE
Hgv	0.84 / 7.3%	0.80 / 8.3%	0.82 / 7.8%
Dgv	0.66 / 4.9%	0.68 / 5.4%	0.69 / 5.2%
Basal area	0.64 / 9.1%	0.64 / 9.2%	0.68 / 8.7%
Volume	0.75 / 6.1%	0.74 / 6.1%	0.77 / 5.8%
Biomass	0.72 / 6.9%	0.71 / 7.0%	0.75 / 6.5%

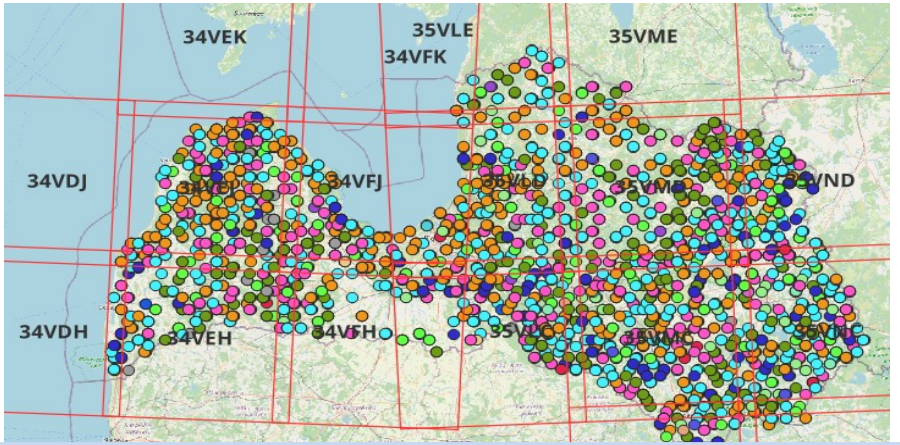
A new AI-created forest map-model was developed.

First test of global map - Latvia

- Transfer of the project's algorithms to the territory of Latvia using sample plot data from another country.
- Data preparation.
  - Compare NFI to LiDAR scanning (open data in Latvia):
    - sample plot coordinates vs LiDAR metadata,
    - selecting data of scanning and plot measurement data within ± 1 year,
    - ~ 3500 sample plots with trees for classification,
    - forest and trees on agriculture lands.
- Latvia NFI based growth algorithms will be used to equalize LiDAR and NFI measurement in time.







The new AI-map-model was tested and evaluated on data-set of Latvia.

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Publications

- Fransson, J.E.S., Björnberg, D., Holmström, A., Lazo, J.F., Löwe, W., Nilsson, M., Salo, J., Santoro, M., Sertel, E., Soomro, S., Wallerman, J., Ünsalan, C., and Zarinš, J., 2024. Applying machine learning for forest attribute mapping in Latvia – Sharing i
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- Kordi, G. and Salo, J., 2024. Optimizing Forest Mapping Technologies for Sustainable B2B Resource Management Strategies. Proceedings of the Nordic Academy of Management, 13-14 August, 2024, Iceland.
- Adhiguru, P. and Salo, J., 2023. Learnings from the forest mapping research: Can we roadmap futuristic forest industry? 16th Annual Euromed Academy of Business (EMAB) Conference, Business Transformation in Uncertain Global Environments, Vilnus, Lithuania, 27-29 Septem 2023.
- Kordi, G. and Salo, J., 2023. Systematic Literature Review of Forest Mapping Technologies: Trends and Future Directions. 16th Annual Euromed Academy of Business (EMAB) Conferen Business Transformation in Uncertain Global Environments, Vilnus, Lithuania, 27-29 Septem 2023.
- Salo, J., 2022. Forest maps as business services. In Proceedings of the 6th Academy of Busine and Emerging Markets (ABEM 2022) Conference, Collaboration and Cooperation to Create Efficient Economies, Santo Domingo, Dominican Republic, 9-11 August, 2022, p. 6.
- Fransson, J.E.S., 2022. ForestMap – The next generation of forest maps – adapting a Nordic success story across the globe. ForestValue Joint Call 2021: Project Introductions, ForestValu Newsletter #10, December 2022.

Thank you!

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