Presenting the **GeForse** approach to create synthetic laser scanning data (LS) from simulated forest stands to optimize LS-based forest inventories

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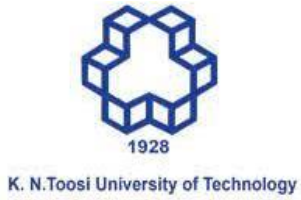


Internet, 26.04.2021

Overview

GeForse - Generating Synthetic Forest Remote Sensing Data

- **Objective**
- **Approach**
- **Motivation**
- **Application Example**

GeForse - Generating Synthetic Forest Remote Sensing Data

- **Objective**

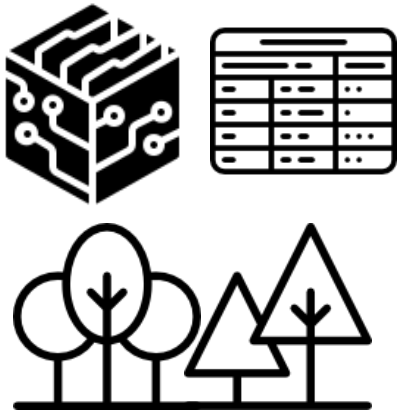
  Simulate realistic laser scanning data of forests where tree properties (species, DBH, height, crown diameter) of each tree are known

Approach

- **The elements**

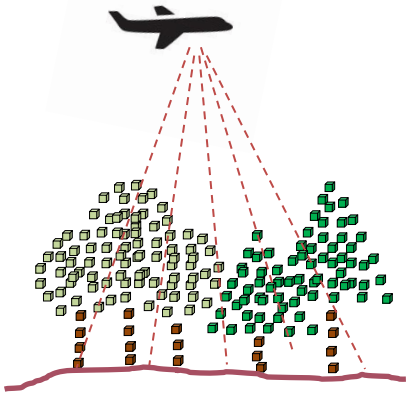
The GeForse approach bases on three elements:

Forest Growth Simulator



Model Trees

Laser scanning simulation



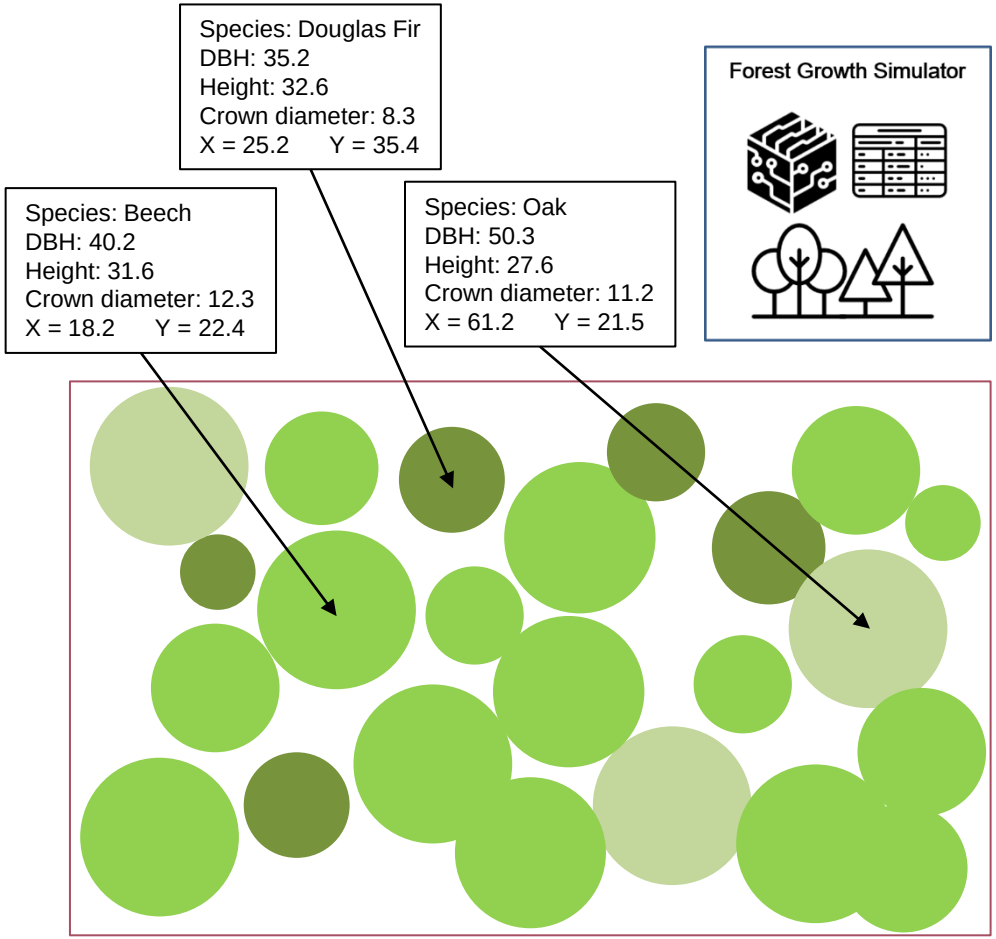
Forest Growth Simulator

- **Why is it needed?**

- Create realistic and complete forest inventory data
- Alternatively, full inventory data could be used (but is rarely available)

- **Which forest growth simulators can be used?**

- Individual tree-based simulators
- Spatially explicit
- Matching the study region's species
- For central Europe for example SILVA



Model trees

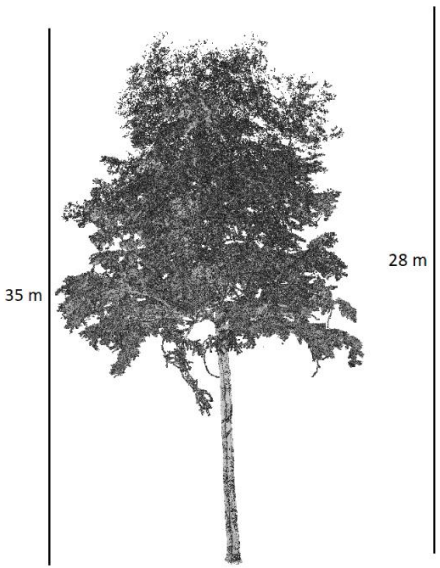
- **Why are they needed?**

- Provide realistic species-specific 3-D structure

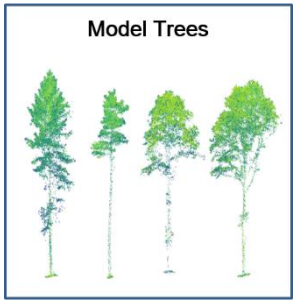
- **How are they created?**

- Sampled from real LiDAR point clouds
- From ALS, TLS, ULS data
- Available in a **single-tree-database** **(publicly available soon)**

- **How are they used?**



(a) *Fagus sylvatica* (d) *Picea abies*



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How are they created?

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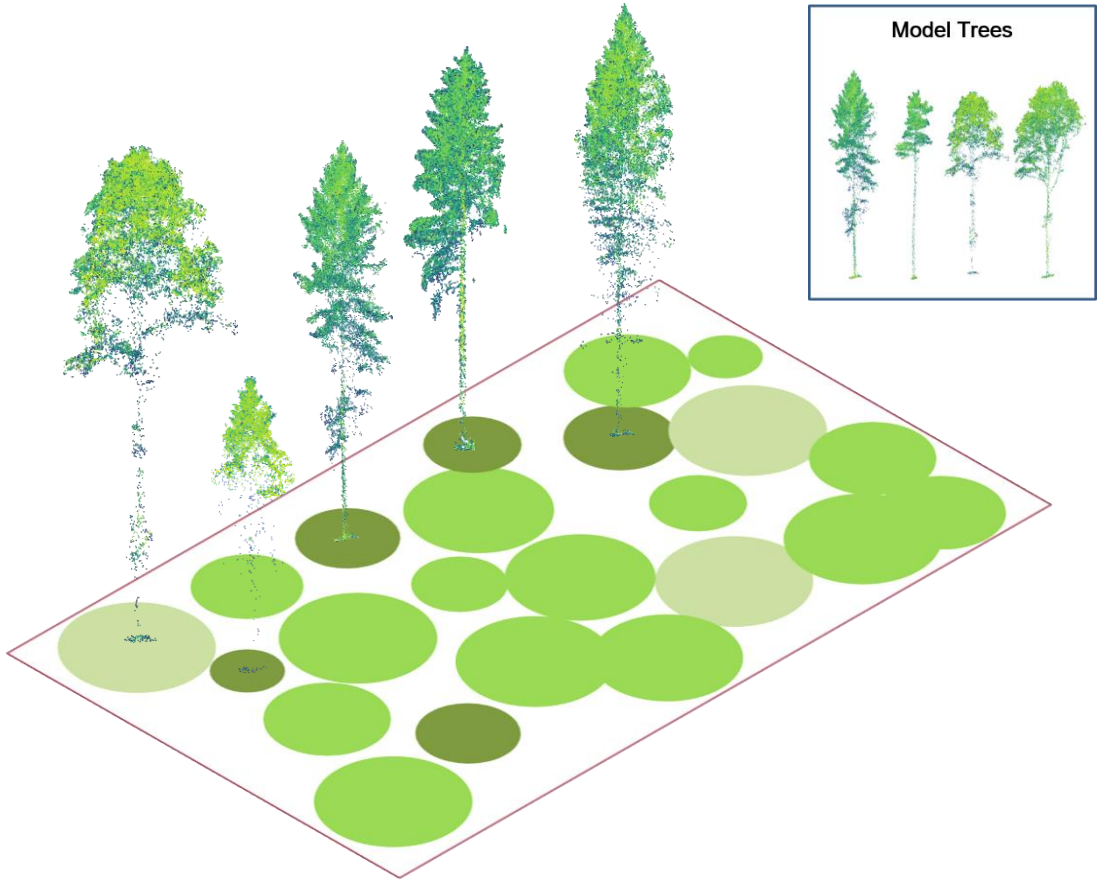
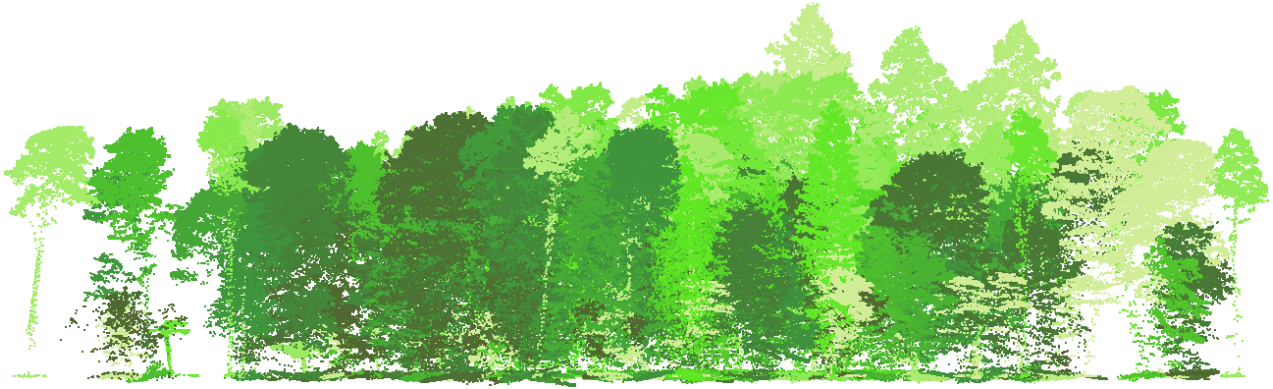
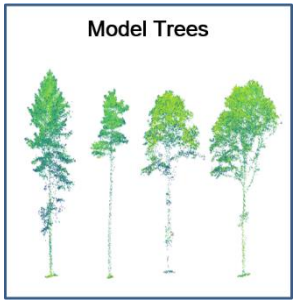
How are they used?

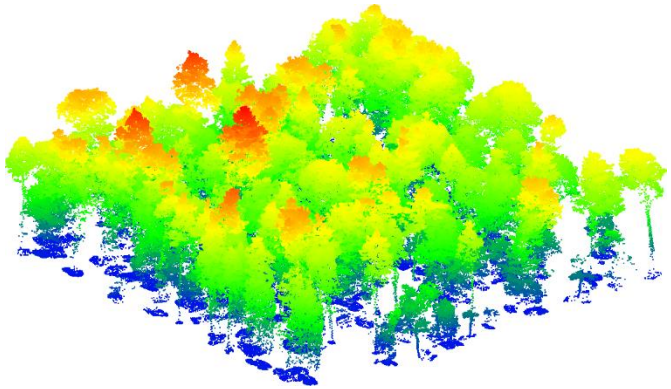
- Modell trees are inserted at each position where the forest growth simulator grew a tree
- Trees are **matched based on species, height and crown-diameter**

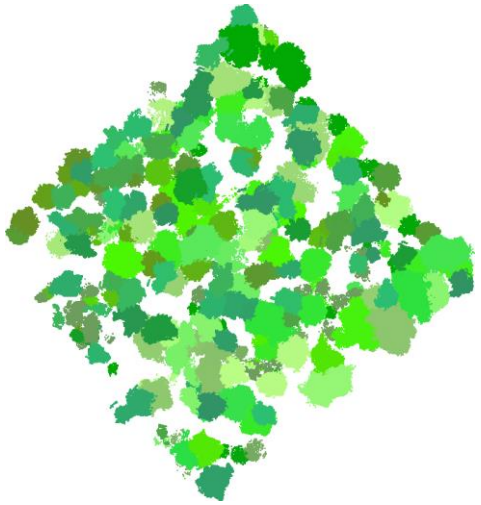


Synthetic forest stands

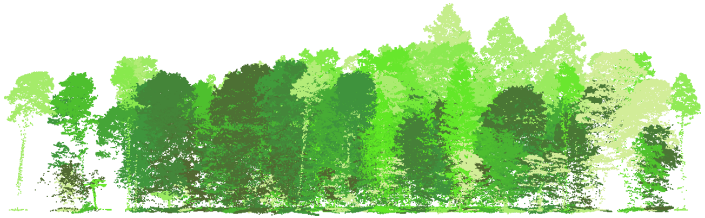


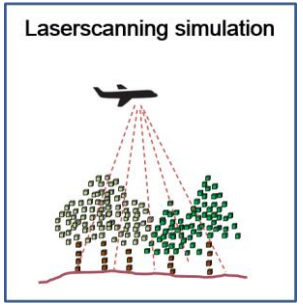


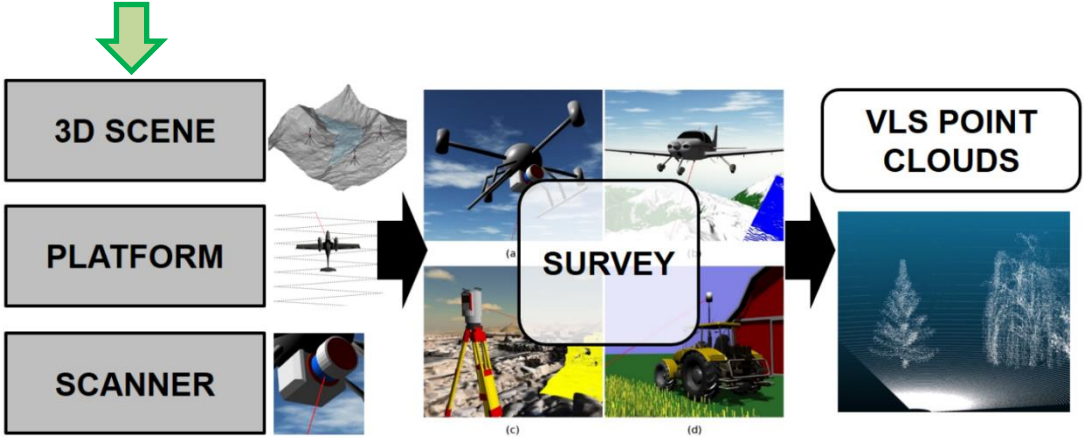




Laserscanning simulations

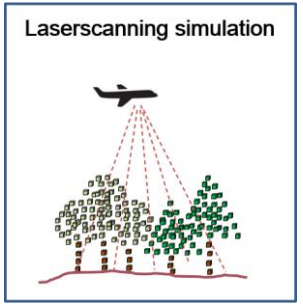


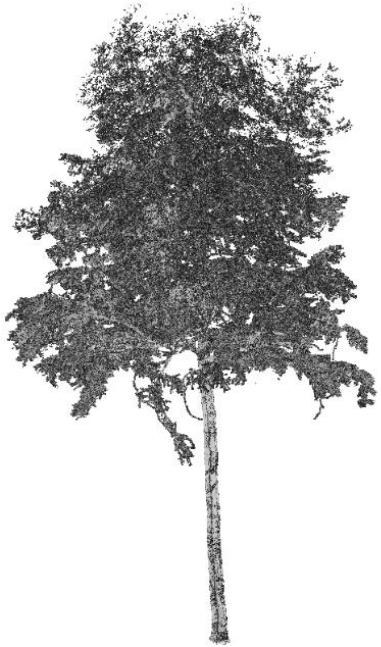


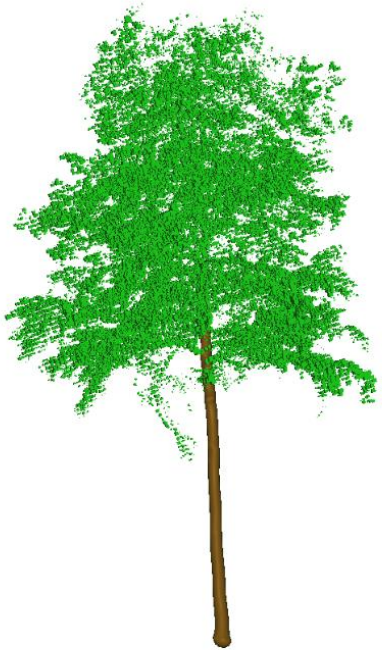


HELIOS++
3DGEO HEIDELBERG

Laserscanning simulations





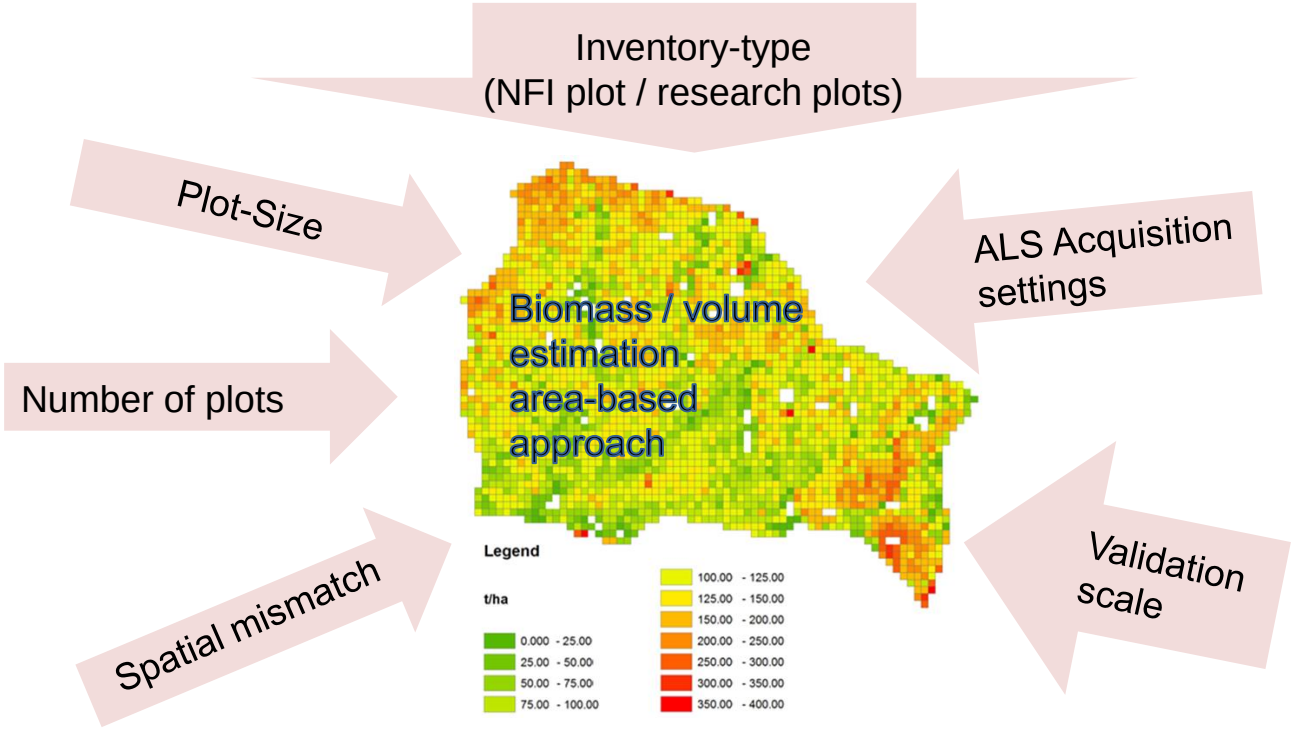


Virtual laser scanning (VLS) in forestry – Investigating appropriate 3D forest representations for LiDAR simulations with HELIOS++ - Hannah Weiser et al.

Motivation

- **Sensitivity analyses**

- Operational
- But optimization potential
- High data demands and costs for sensitivity analyses
- Synthetic data provides quasi-unlimited data for free

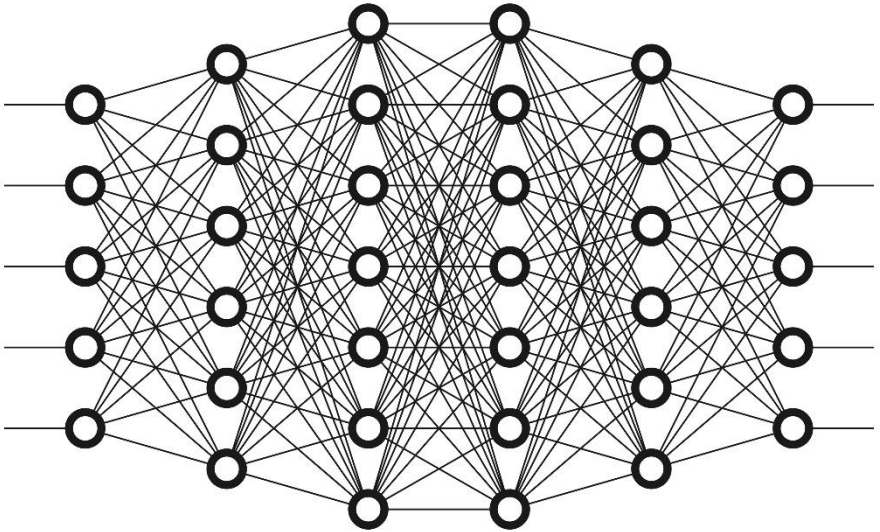


Motivation

- **Replace field data (?)**

- Create lots of synthetic data
- Train “empirical” model with synthetic data
- Apply to real ALS data

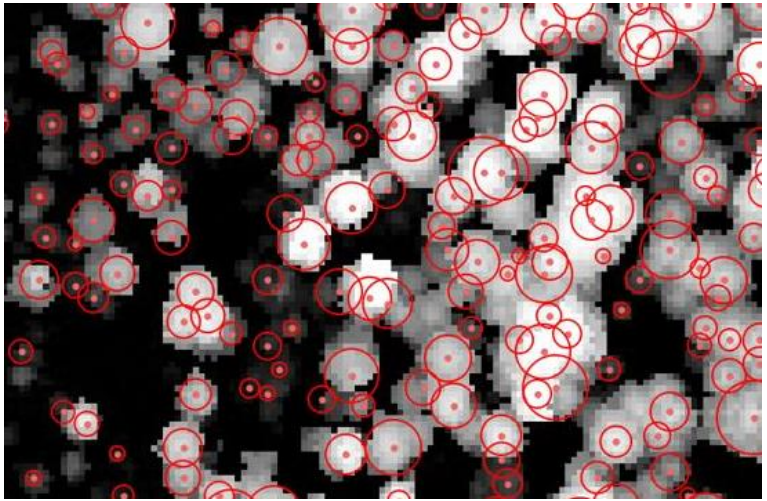
- Particularly interesting for Deep learning
  ➔ high training data demands (?)



Motivation

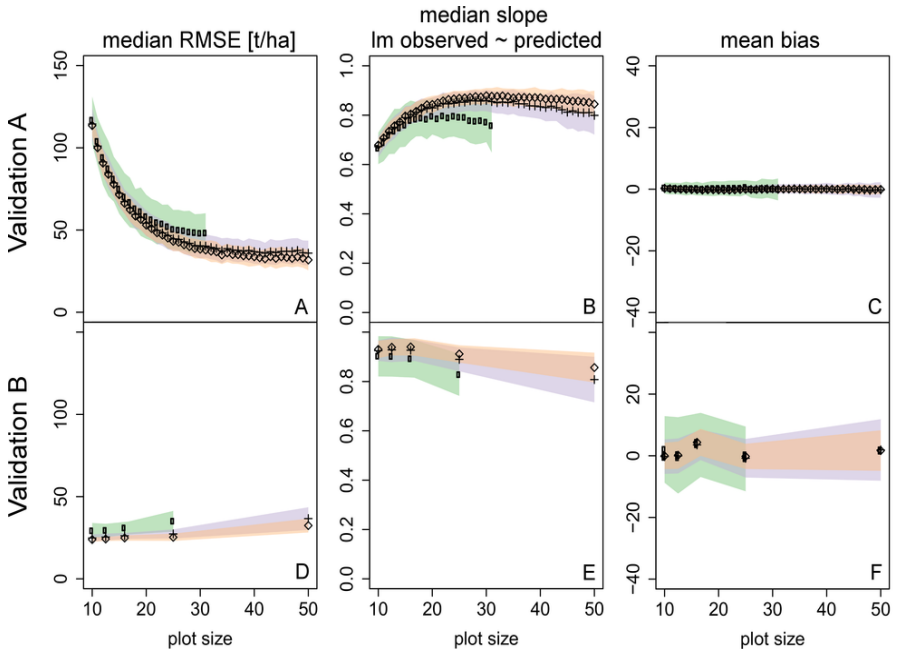
- **Algorithm development**

- Realistic benchmark datasets can be created
- All trees are “known”
- Can be used for example to evaluate work-flows for:
    - Single tree delineation
    - Tree Species classification
    - …



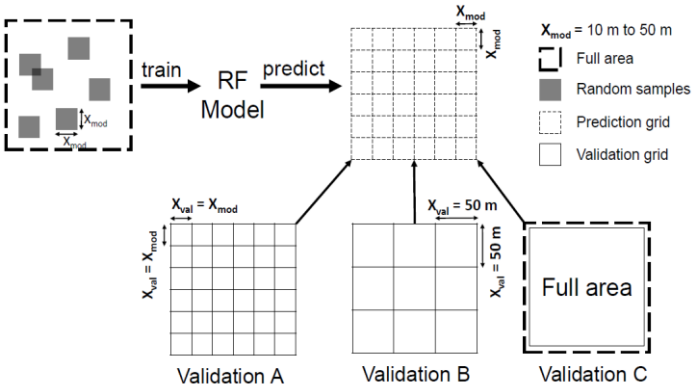
Adapted from https://i.stack.imgur.com/A8xNy.jpg

Influence of plot size and sample size on ALS-based biomass estimations



fixed area size 5 ha
fixed area size 15 ha
fixed area size 25 ha
var. sample size 50
var. sample size 100
var. sample size 500

fixed area size = area
individual plot × sample size



Thank you for your attention

Thanks for support!

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https://www.youtube.com/watch?v=B9ySty UBaa0&t=23s)
http://www.uni-heidelberg.de/syssifoss
https://www.ifgg.kit.edu/vegetation/projekte_1776.php

DFG Deutsche Forschungsgemeinschaft

Synthetic forest stands