

How to process high resolution 3D point clouds of forests?

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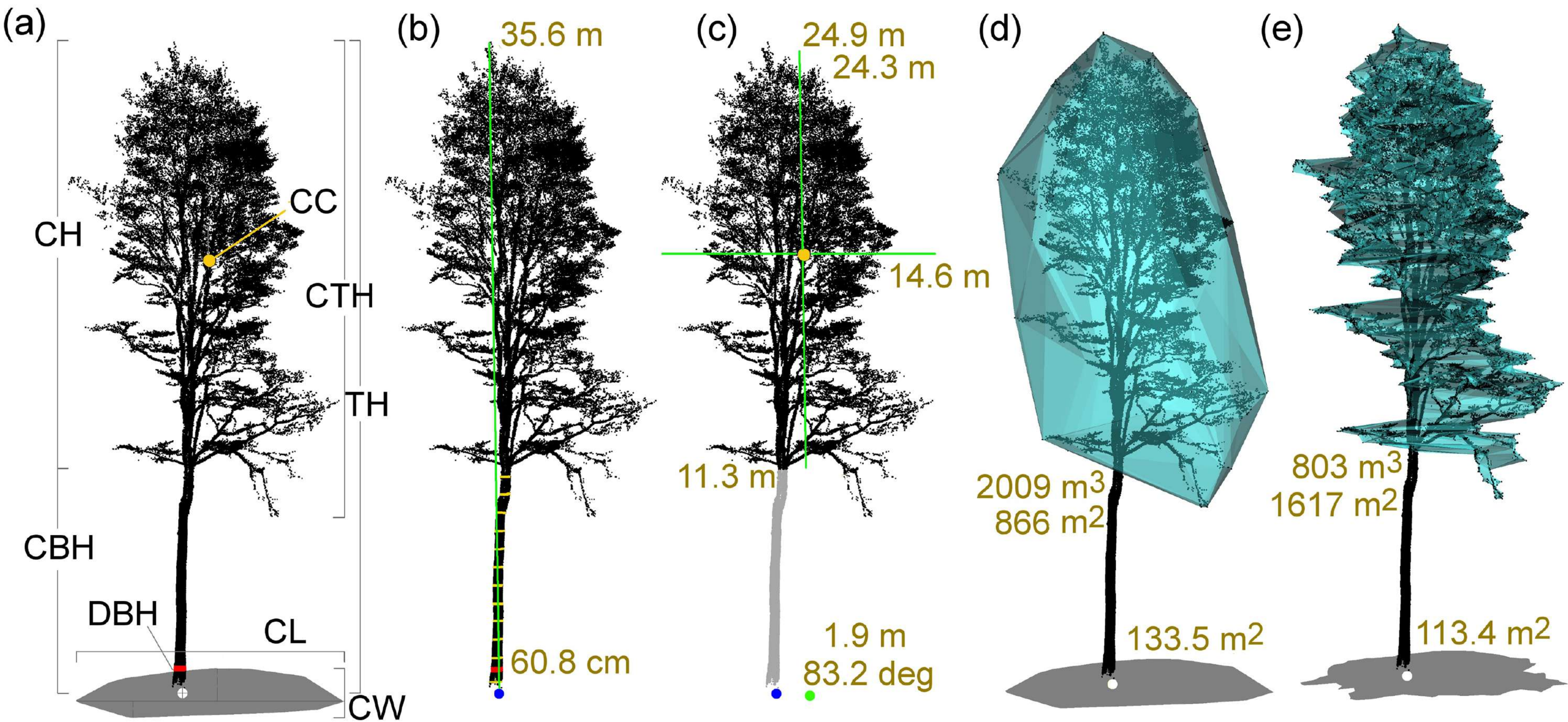


December 13, 2023

BES 2023

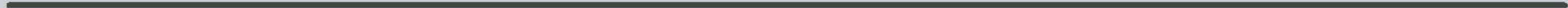






CLOSE RANGE TECHNOLOGIES

terrestrial vs aerial; active vs. passive; static vs. mobile





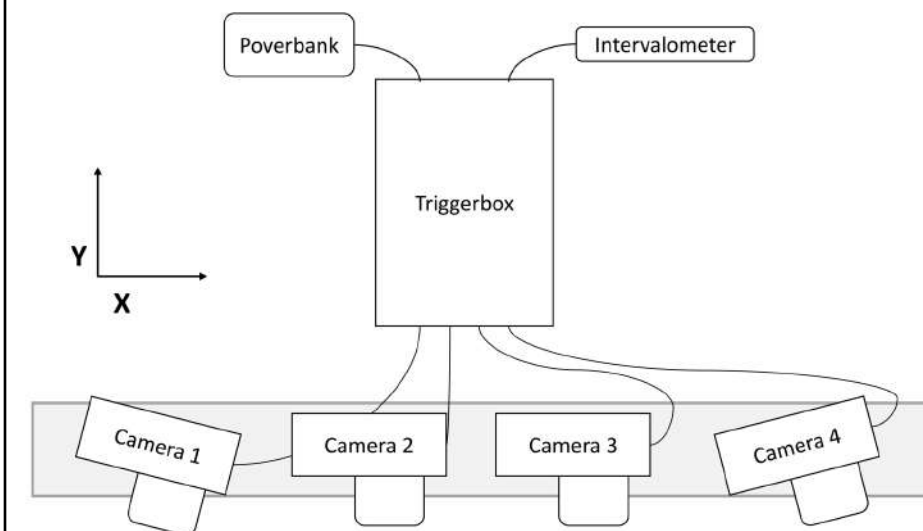
Terrestrial laser scanning



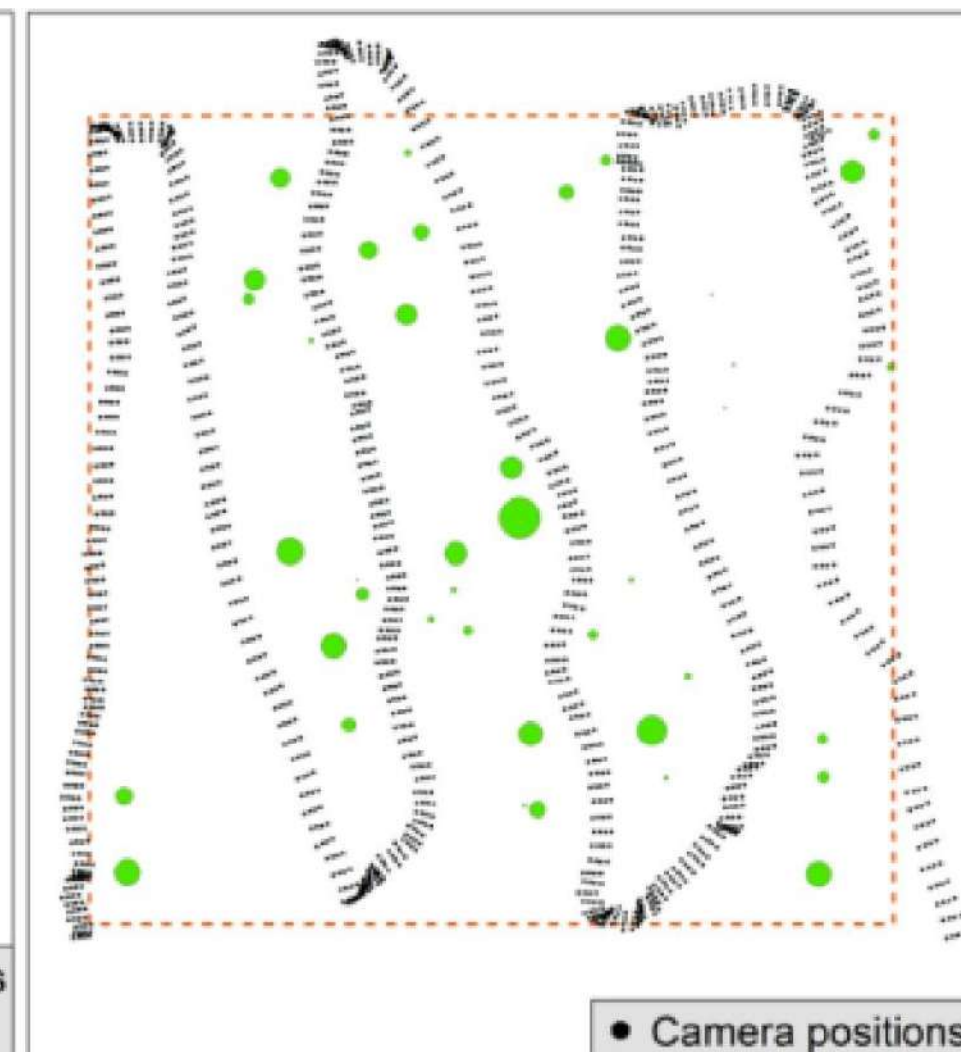
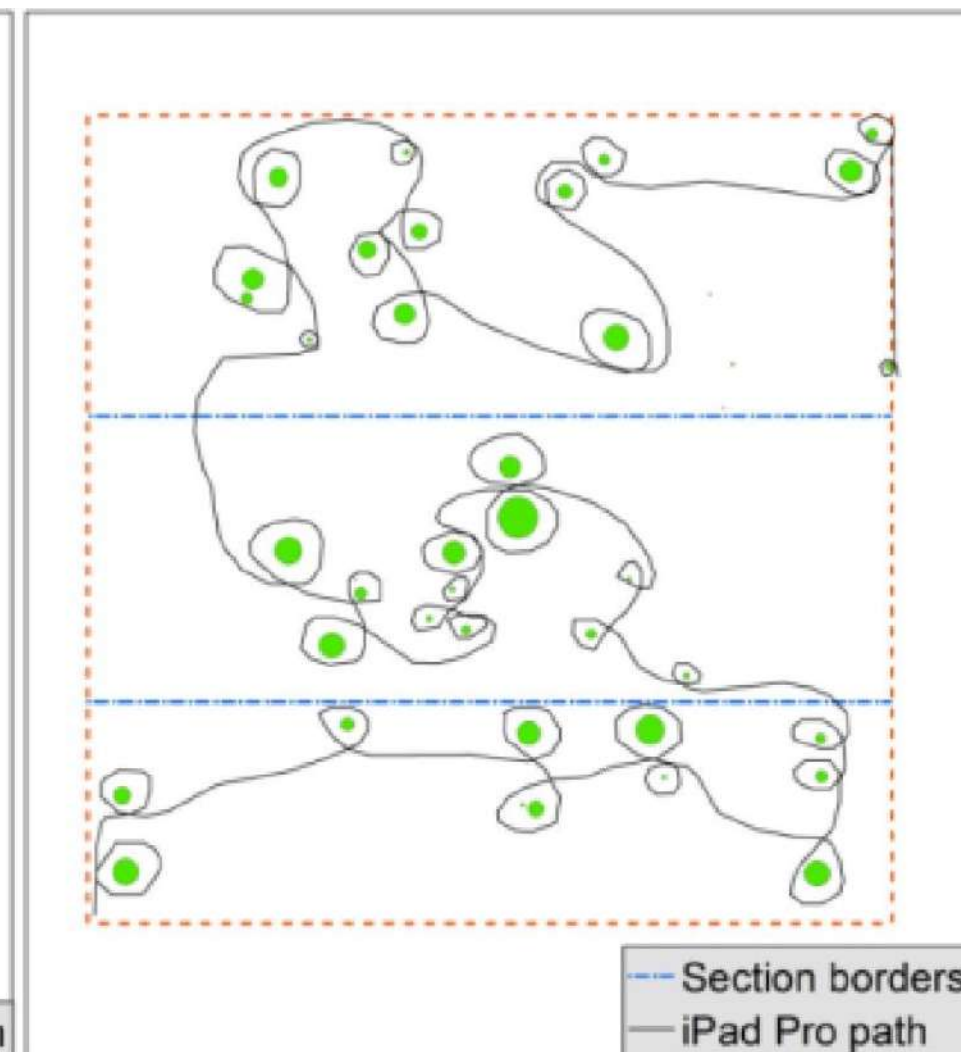
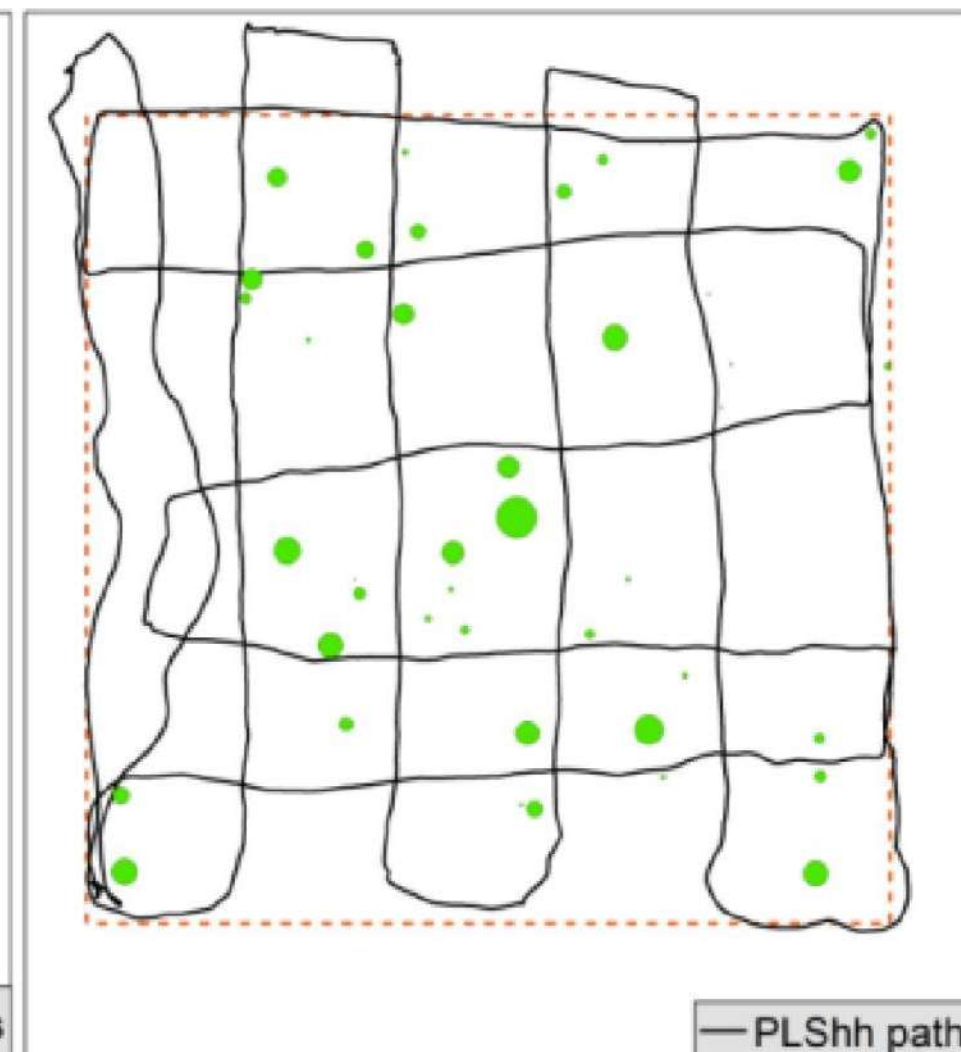
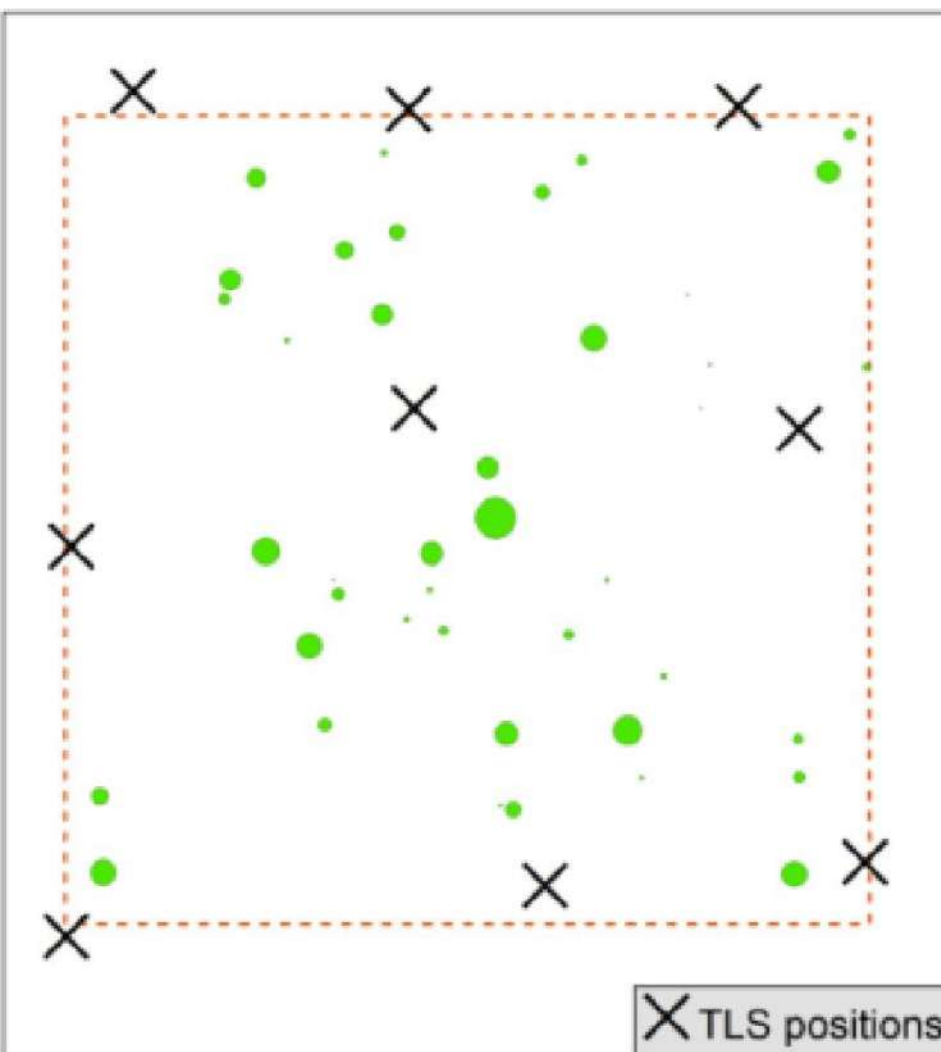
Mobile laser scanning



Mobile laser scanning



Mobile photogrammetry









The background of the image consists of dark, silhouetted trees against a slightly lighter, dark grey background. The trees are of various heights and have intricate branch structures, creating a dense, forest-like appearance.

**And now we can process
the data**

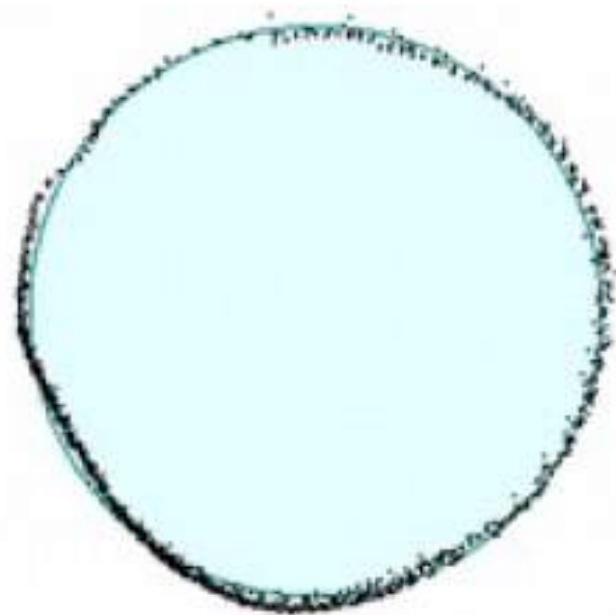
Cross-sections analyst

Grouped cross-sections: mcs1b.pcd

Open

Save as

Trunk ID	Section ID	Group Info
18	11	Group ID: 3203
19	10	Height: 1.30
20	9	x0: -5.65
21	8	x1: -5.26
22	7	dx: 0.395
23	6	y0: 10.79
24	5	y1: 11.18
	4	dy: 0.395
33	4	
152	2	
164	1	
167		
173		
209		



Max distance Bounding box Centroid Monte Carlo Optimal circle

Initial approximation

- ☐ Maximal distance ☐ Bounding box ☐ Centroid
- ☒ Automatic ☐ apply Monte Carlo

Count limit 1000

RMS limit 0.01

Results

x = -5.45

y = 10.98

d = 37.81

t = 0.88

RMS = 0.55

GPP = 100.0

Calculate

View 3D (3)

trunks2.pcd

214

54



View 3D (4)

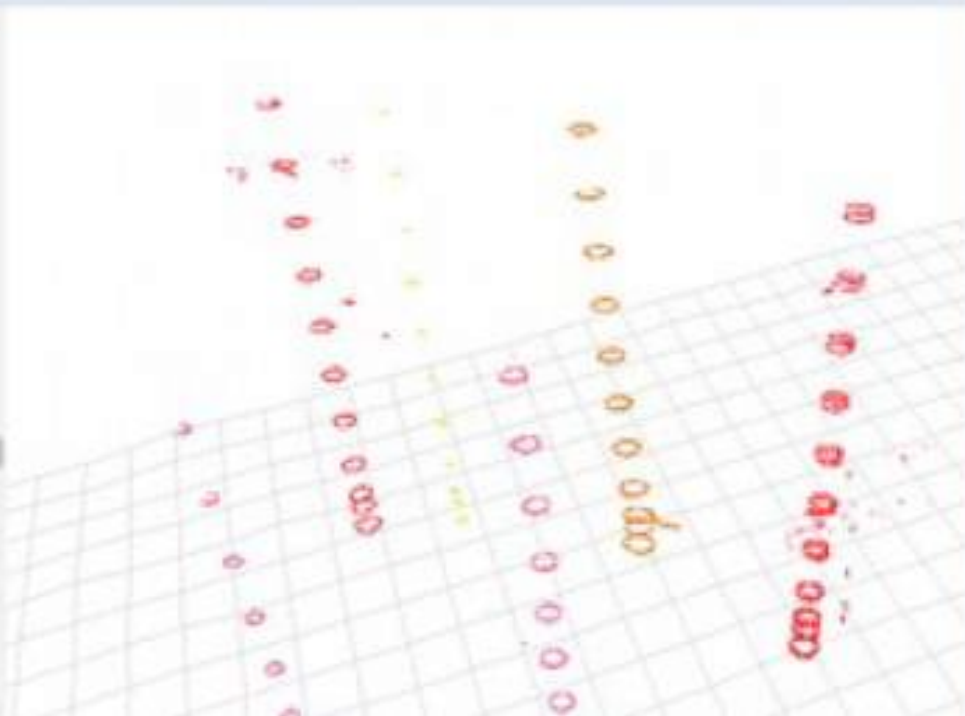
den100.gif

value

mcs1b2.pcd

209

18

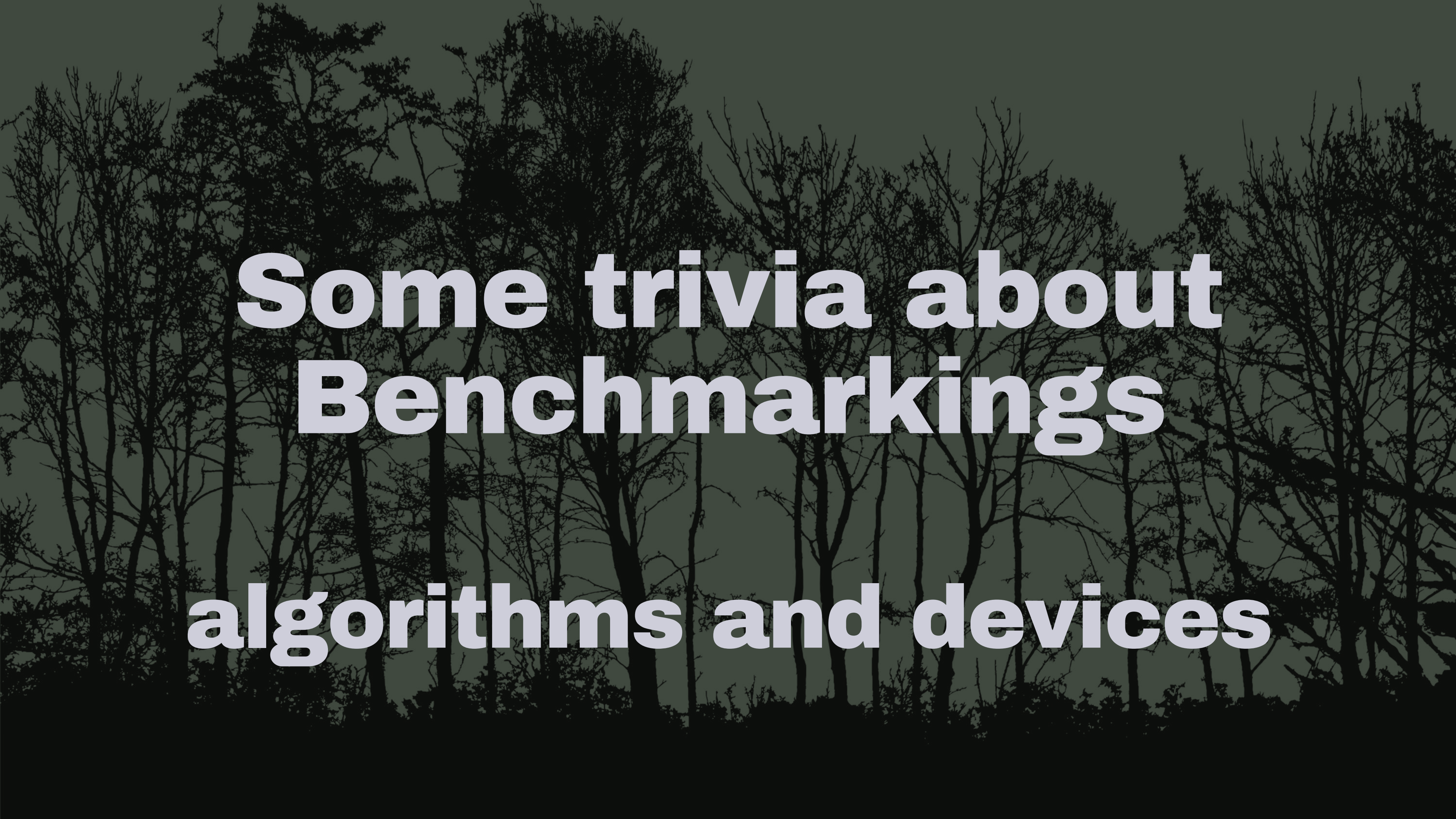


View 3D (2)

box2_10m.pcd

RGB





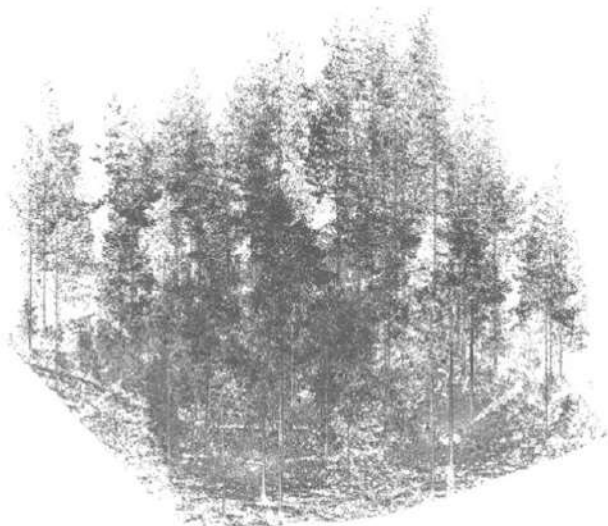
Some trivia about Benchmarkings

algorithms and devices

International benchmarking terrestrial laser scanning approaches for forest inventories



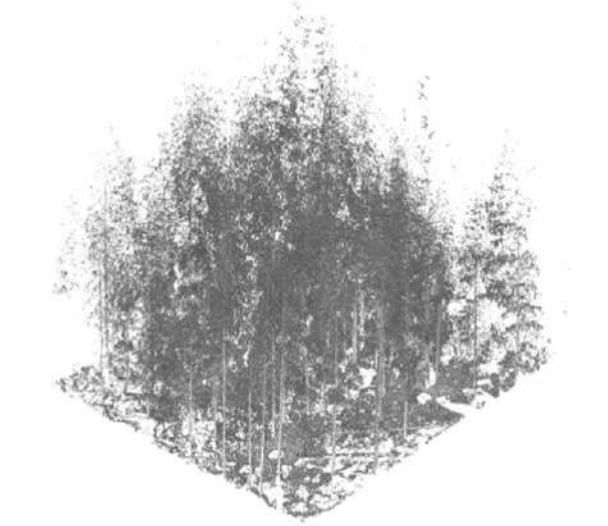
(a) single-scan TLS data in the category “Easy”



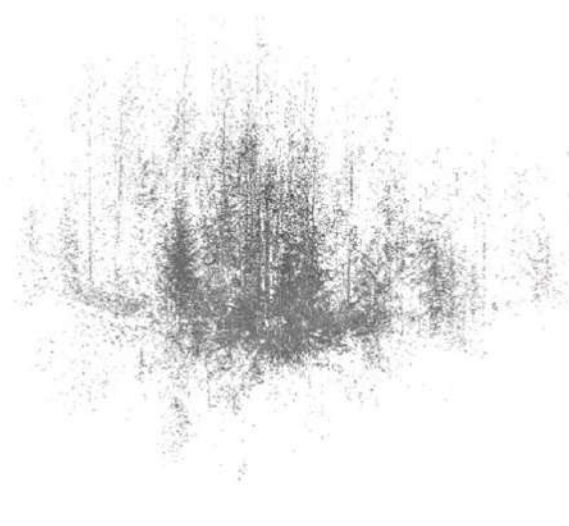
(b) multi-scan TLS data in the category “Easy”



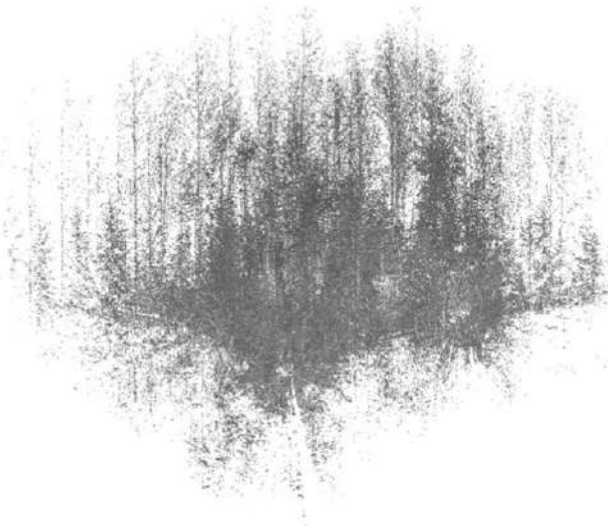
(c) single-scan TLS data in the category “Medium”



(d) multi-scan TLS data in the category “Medium”

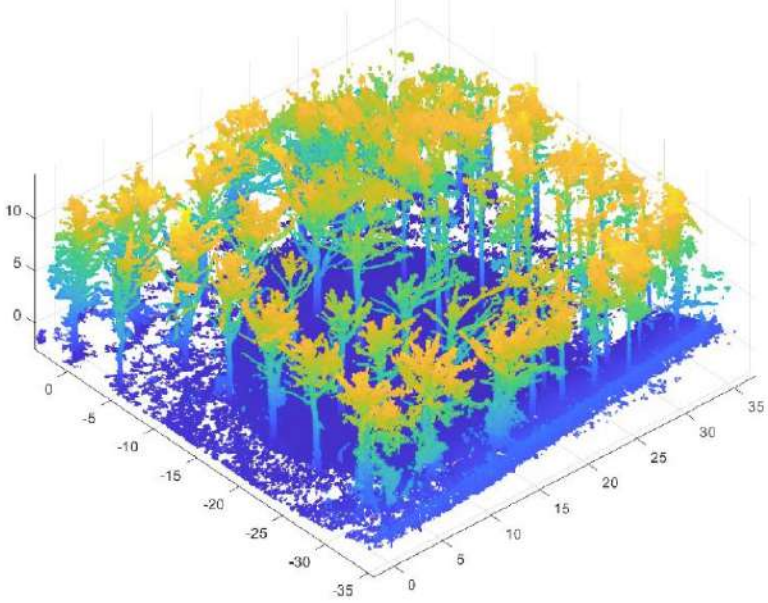
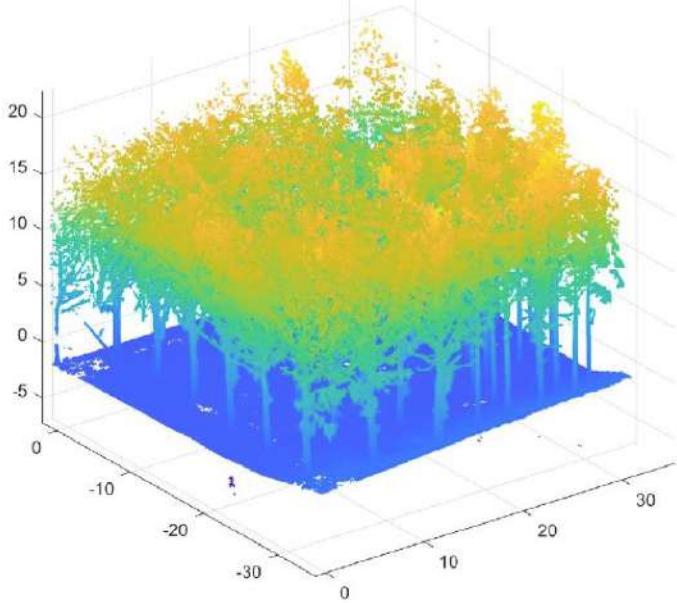


(e) single-scan TLS data in the category “Difficult”

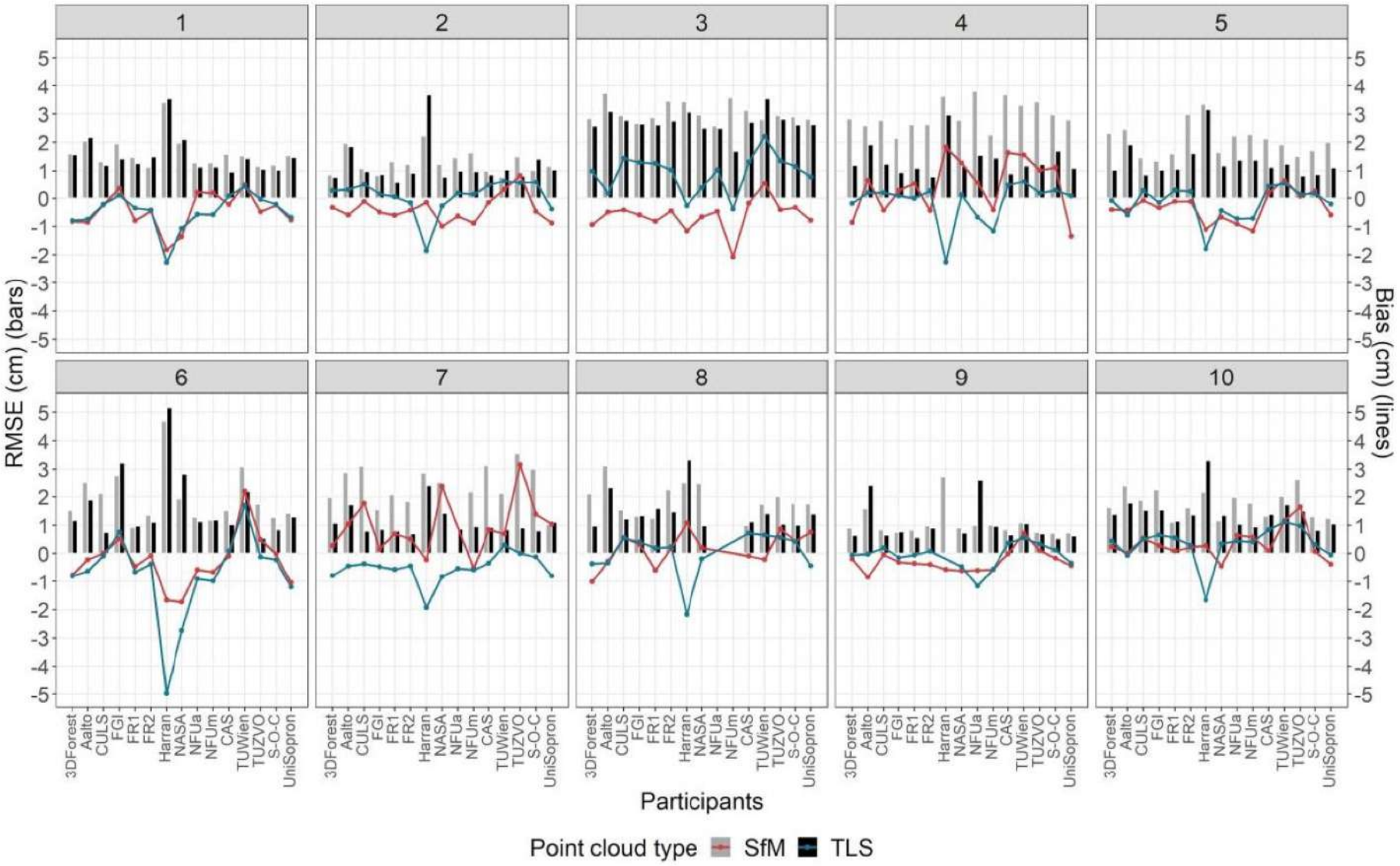
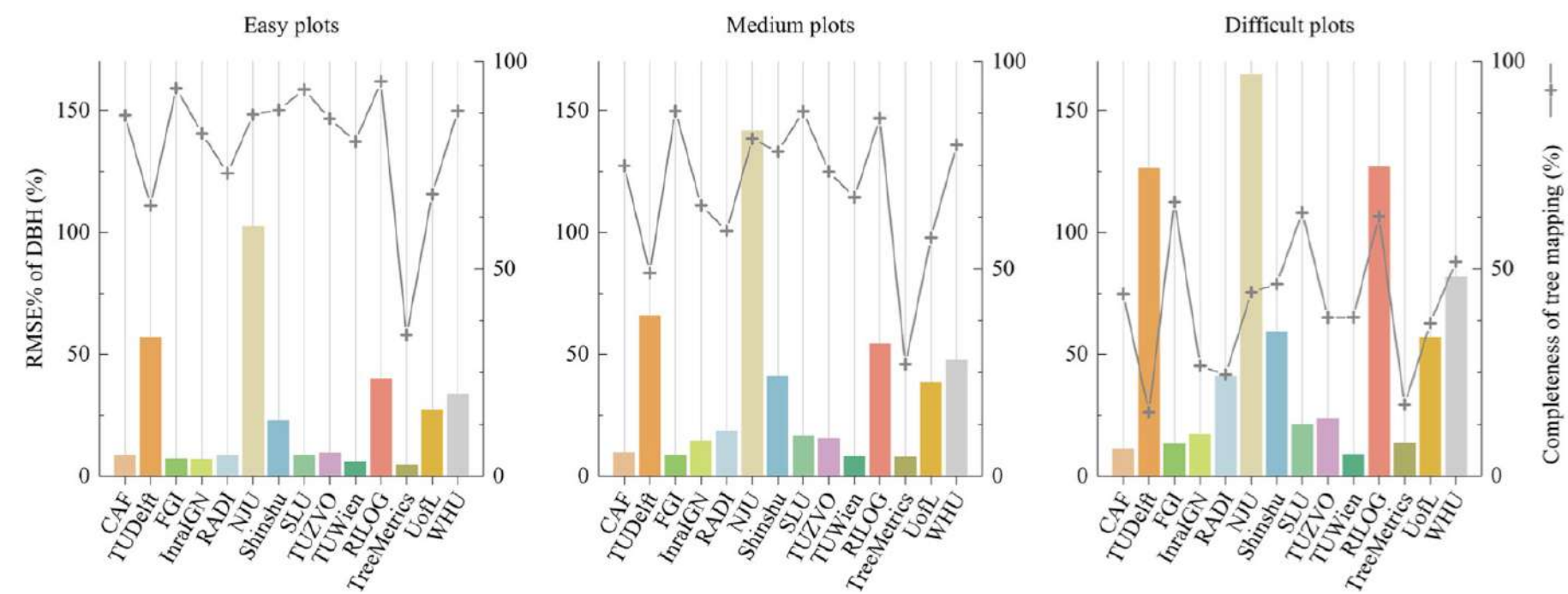


(f) multi-scan TLS data in the category “Difficult”

International Benchmarking terrestrial Image-based Point Clouds for Forestry



Study site	Shape	Size (m) Diameter / square length	Dominant tree species	Stem Density [stems/ha]	Plot description	Plot No.
Austria 1	Circular	40	<i>Picea abies</i>	533	Even-aged, well managed spruce forest	plot 1
Austria 2	Circular	40	<i>Fagus sylvatica</i>	390	Uneven-aged, managed deciduous (beech) forest, multi- layer structures	plot 2
China 1	Circular	30	<i>Taxodium distichum</i>	410	Pure-even-aged, plantation of bald cypress	plot 3
China 2	Circular	30	<i>Liriodendron chinensis</i>	609	Pure-even-aged, plantation of Chinese tulip poplar	plot 4
Czechia 1	Square	50	<i>Fagus sylvatica</i>	280	Even-aged, well managed beech forest	plot 5
Czechia 2	Square	50	<i>Picea abies</i>	272	Even-aged, well managed spruce forest	plot 6
Finland 1	Square	32	<i>Pinus sylvestris</i>	479	Unmanaged, even-aged, Scots pine forest	plot 7
Finland 2	Square	32	<i>Pinus sylvestris</i> , <i>Betula sp.</i>	869	Unmanaged Mixed pine and birch forest, with multi- layer structures	plot 8
Slovakia 1	Circular	15	<i>Quercus petraea</i>	651	Even-aged, well managed Oak forest	plot 9
Slovakia 2	Circular	20	<i>Abies alba</i>	875	Even-aged, silver fir managed forest	plot 10



What have we learned?

Static!



What is out there?

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POINTCLOUD TECHNOLOGY

TLS single scan

TLS multiscan (single file)

Mobile LS

SfM pointclouds

INPUT FORMAT

.Las / .Laz

Other

Batch processing (multiple files)

APPLICABILITY

Plot level

Tree level

PRE-PROCESSING

Data fusion

DTM

Heigh normalization

Voxelization

OUTPUT PARAMETERS

Individual tree detection

DBH

Diameters along stem

Tree Height

Trunk Volume

Leaf-wood classification

LAI

QSM

Crown Parameters

Total Leaf Area

rTLSDeep

Availability: Open-Source

Licence:

Implementation: R package

KNOW MORE

Brycefrank/Allometric

Availability: Open-Source

Licence:

Implementation: R package

KNOW MORE

Forest-taxator

Availability: Open-Source

Licence:

Implementation: c++

KNOW MORE

OPALS

Availability: Open-Source

Licence:

Implementation: Python

KNOW MORE

TLS2trees (fsct_lite)

Availability: Open-Source

Licence:

Implementation: Python

KNOW MORE

FSCT

Availability: Open-Source

Licence:

Implementation: Python

KNOW MORE

Treetool

Availability: Open-Source

Licence: GPL-3

Implementation: Python

KNOW MORE

TLSeparation

Availability: Open-Source

Licence: MIT

Implementation: Python

KNOW MORE

3DFIN

Availability:

Licence:

Implementation:

KNOW MORE

LiDAR 360

Availability: Comercial-Software

Licence:

Implementation: Standalone

KNOW MORE

dendrocloud

Availability:

Licence:

Implementation:

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3DForest

Availability:

Licence:

Implementation:

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Database

FSCT

Main specifications

Pointcloud technology: TLS single scan, TLS multiscan (single file), Mobile LS, SfM pointclouds

Input format: .Las / .Laz, Batch processing (multiple files)

Pre-processing: DTM, Heigh normalization

Output parameters: Individual tree detection, DBH, Diameters along stem, Tree Height, Trunk Volume, Stem segmentation

Information and availability

Availability: Open-Source

Licence:

Implementation: Python

Owner/Author contact: sean.krisanski@utas.edu.au

Download

3DForEcoTech Guidelines

Subjective assessment

Settings: Very good

Ease of use: Very good

Usability: Good

FSCT (Forest Structure Complexity Tool)

URL: <https://github.com/SKrisanski/FSCT>

Date: 18 September 2022

Author: Sean krisanski

Description: this tool was developed to do automatic plot scale measurements from high resolution data such as Terrestrial Laser Scanner (TLS), Mobile Laser Scanner (MLS), Terrestrial Photogrammetry, above or below canopy UAS photogrammetry or similar. The segmentation with Aerial Laser scanning (ALS) is still at border line. There is one thing to notice is if the point cloud is not with high resolution, then the segmentation model will label the stems as vegetation points.

The output of this tool is presented at the YouTube channel: <https://youtu.be/rej5Bu57AqM>

1. Installation: the installation process is very easy, however you might encountered with a few errors based on the configuration of you computer. The instructions will also work for the Windows 10 with 16 GB or 32 GB RAM but the processing time will vary between 7 to 8 hrs. if you are processing point cloud data of 2 GB size. However, the basic setup for this tool is as below:

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Search software...

POINTCLOUD TECHNOLOGY

☐ TLS single scan

☐ TLS multiscan (single file)

☐ Mobile LS

☐ SfM pointclouds

INPUT FORMAT

☐ .Las / .Laz

☐ Other

☐ Batch processing (multiple files)

APPLICABILITY

☐ Plot level

☐ Tree level

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☐ Data fusion

☐ DTM

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OUTPUT PARAMETERS

☐ Individual tree detection

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☐ Leaf-wood classification

☐ LAI

☐ QSM

☐ Crown Parameters

☐ Total Leaf Area

rTLSDeep

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Licence:
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KNOW MORE

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Licence:
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Availability: Open-Source
Licence:
Implementation: Python

KNOW MORE

FSCT

Availability: Open-Source
Licence:
Implementation: Python

KNOW MORE

Treetool

Availability: Open-Source
Licence: GPL-3
Implementation: Python

KNOW MORE

TLSeparation

Availability: Open-Source
Licence: MIT
Implementation: Python

KNOW MORE

3DFIN

Availability:
Licence:
Implementation:

KNOW MORE

LiDAR 360

Availability: Comercial-Software
Licence:
Implementation: Standalone

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dendrocloud

3DForest

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← DATABASE

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← DATABASE

FSCT

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FSCT Public

Watch 18

main 1 branch 0 tags

Go to file Add file <> Code

SKrisanski Update README.md 68e2f1e on Sep 18, 2022 157 commits

data	Fix training script.	last year
model	.	2 years ago
readme_images	Added semantic segmentation training tools. Note: Work in progress.	2 years ago
scripts	Bug fix	10 months ago
tools	.	2 years ago
.gitignore	.	10 months ago
LICENSE	.	2 years ago
README.md	Update README.md	10 months ago
requirements.txt	Fix requirements	last year
setup.py	.	2 years ago



← [NEWS](#)

Hackathon: a benchmark of software solutions for processing close-range forest point clouds

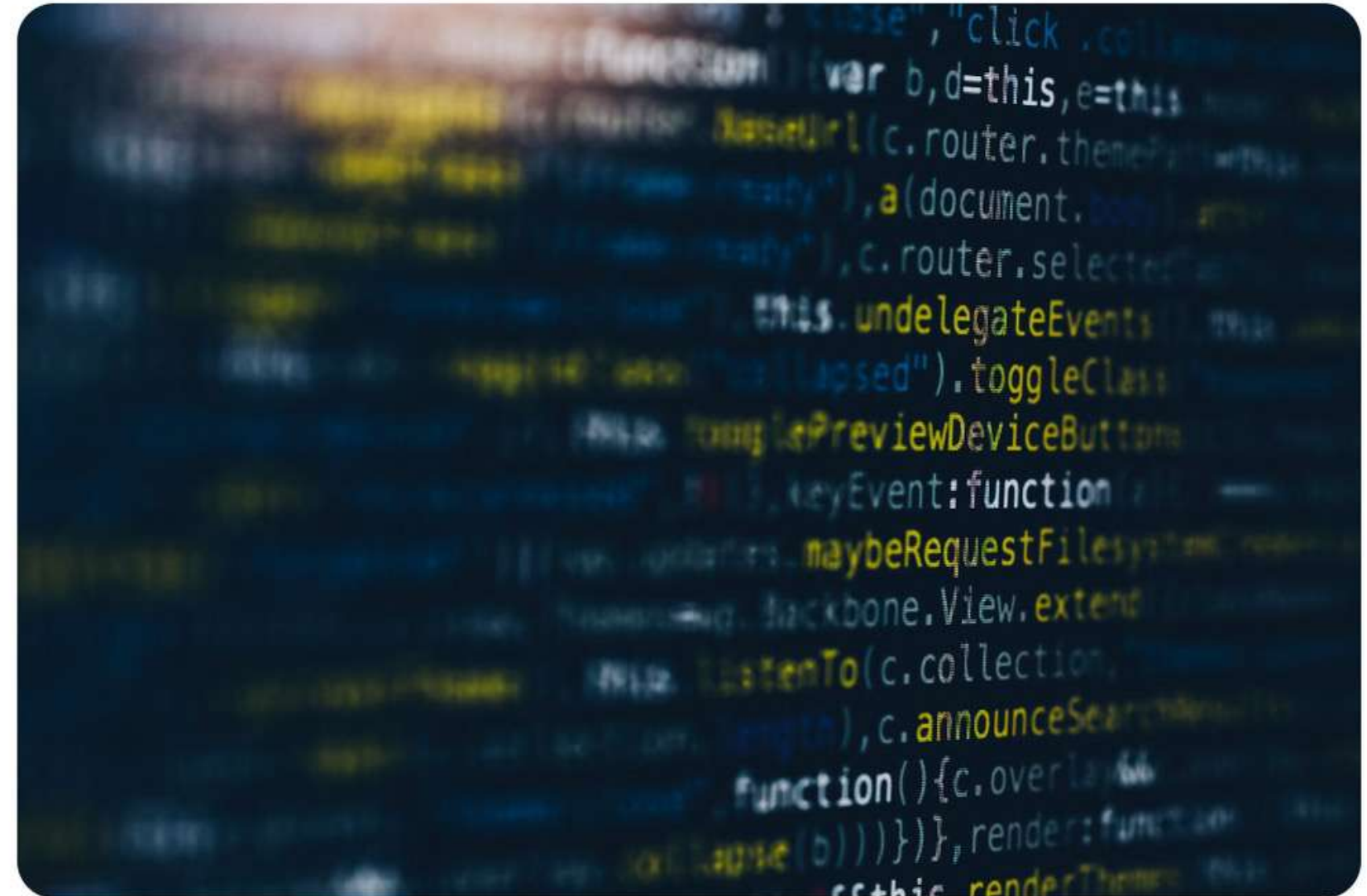
In WG3 we are looking for participants for a benchmark hackathon for software solutions that process close-range point clouds from forests. It will take place on 25-29 September, 2023, at TU Wien (Austria).

One of the main aims of WG3 is to compile and evaluate algorithms and software that is relevant for 3DForEcoTech. We have already collected all software, algorithms and other solutions for point cloud processing with a focus on forest and individual trees. Altogether we have 24 such implementations; we have been successful at running and testing them, and we are working on an overview scientific paper and webpage focusing on the workflows of all solutions and their potential usage.

With this hackathon, we want to benchmark all the implementations using various point clouds from different European forest ecosystems. During the hackathon we will process them, assess their accuracy, and evaluate their pros and cons with the different available datasets. Based on the whole process, we will also create a standard protocol for the future assessment of other software, algorithms and solutions.

We are looking for participants with skills/experience in:

- point cloud technologies: data collection (desirable) and data processing (required)



Software solutions:

Selection criteria from the general 3DForEcoTech software list

Publicly available

→ Could be free, open source, proprietary, ..

Suitable for plot level datasets

→ With a special focus on ground-based point clouds

Provide individualised info/parameters of the trees

→ Tree location, diameters, tree heights, etc..

Software solutions:

What are we benchmarking/testing/comparing?

Basic outputs → Analogous to other algorithm benchmarks

- Tree detection/location
- DBH
- Diameters along the stems / Stem volumes

Performance → Under the same conditions

- Processing time and requirements

Subjective assessments

- Setup/installation complexity
- Ease of use
- Clarity+usability of the results/outputs
- Recommendations for potential users

Projects for the future:

Why only these 12 solutions from the list?

Wood-leaf segmentation

Tree individualization

Individual tree solutions

More complex forest descriptors/parameters

**Ground-based
Remote Sensing for
Vegetation Mapping
and Monitoring**

The module to rule
them all!

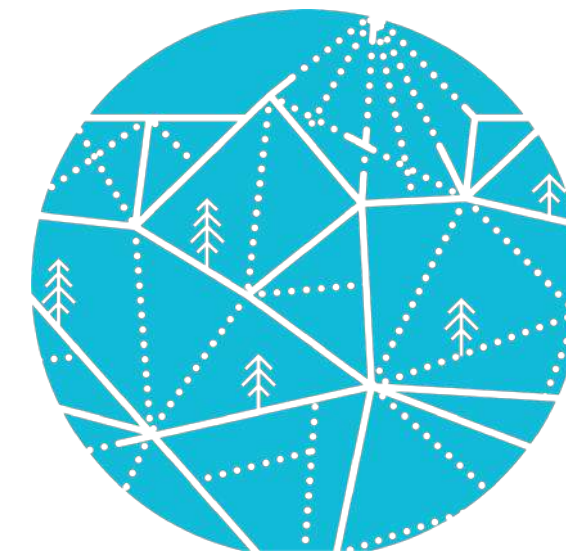




**Funded by
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www.cost.eu



This contribution is based upon work from COST Action **3DForEcoTech, CA20118**, supported by COST (European Cooperation in Science and Technology).

Thank you for your attention!



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December 13, 2023

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