Benchmarking Software Solutions for Deriving Tree Parameters from Ground-Based Lidar Data

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Introduction

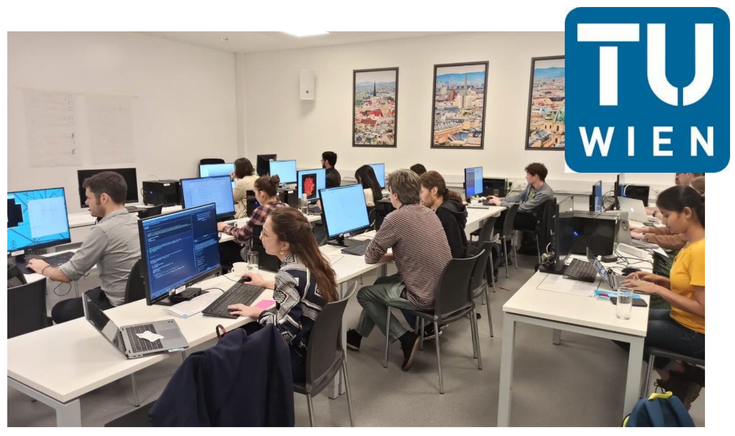
The growing impact of **ground-based lidar to support precision forestry** has resulted in the **development of various software solutions** for deriving primary tree parameters from point cloud data. In the context of the COST Action 3DForEcoTech and an ISPRS scientific initiative, a benchmarking activity was conducted to **evaluate the performance of 12 widely used software solutions** designed for automated forest inventory using ground-based lidar data. These 12 software solutions are **publicly available** and **independently of being**, **free** or **proprietary**, published as **standalone software**, **packages**, **libraries** or **scripts**. They operate on a **plot basis** and deliver individual **tree positions** and **diameter at breast height (DBH)**.

Looking for more point-cloud processing solutions available? Follow the link!

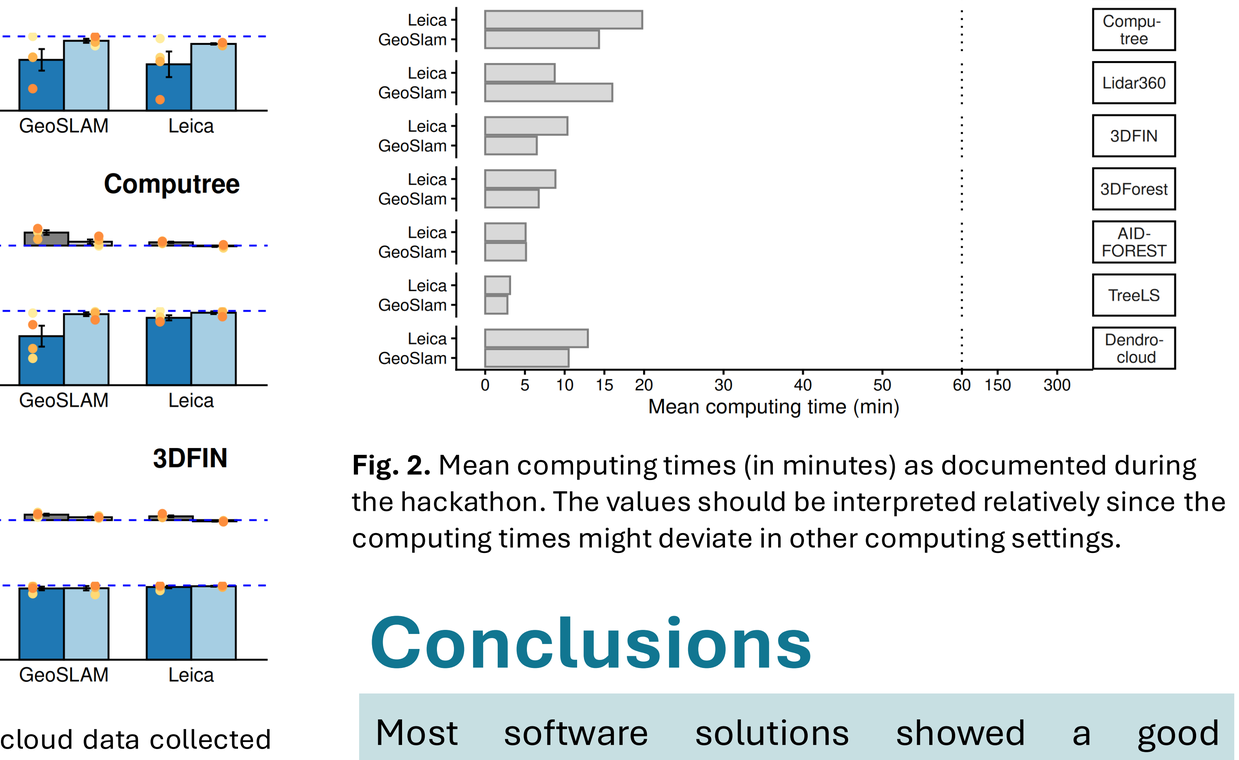
Methods and Data

A **hackathon** was performed during September 25–29, 2023 at TU Wien in **identical computing settings** to ensure fairness of the benchmark. Each software solution was operated by two participants.

Hackathon task assignments		
Supervising	**In charge**	**Software**
Participant 2	Participant 1	TreeLS
Participant 3	Participant 2	PointCloudTools
Participant 4	Participant 3	FSCT
Participant 5	Participant 4	treetool
Participant 6	Participant 5	OPALS
Participant 7	Participant 6	FORTLS
Participant 8	Participant 7	LiDAR 360
Participant 9	Participant 8	Computree
Participant 10	Participant 9	3DForest
Participant 11	Participant 10	AID-FOREST
Participant 12	Participant 11	dendrocloud
Participant 1	Participant 12	3DFIN



Four plots were selected from the **SilviLaser 2021 dataset.** Reference data were collected in the field by traditional methods.



Results

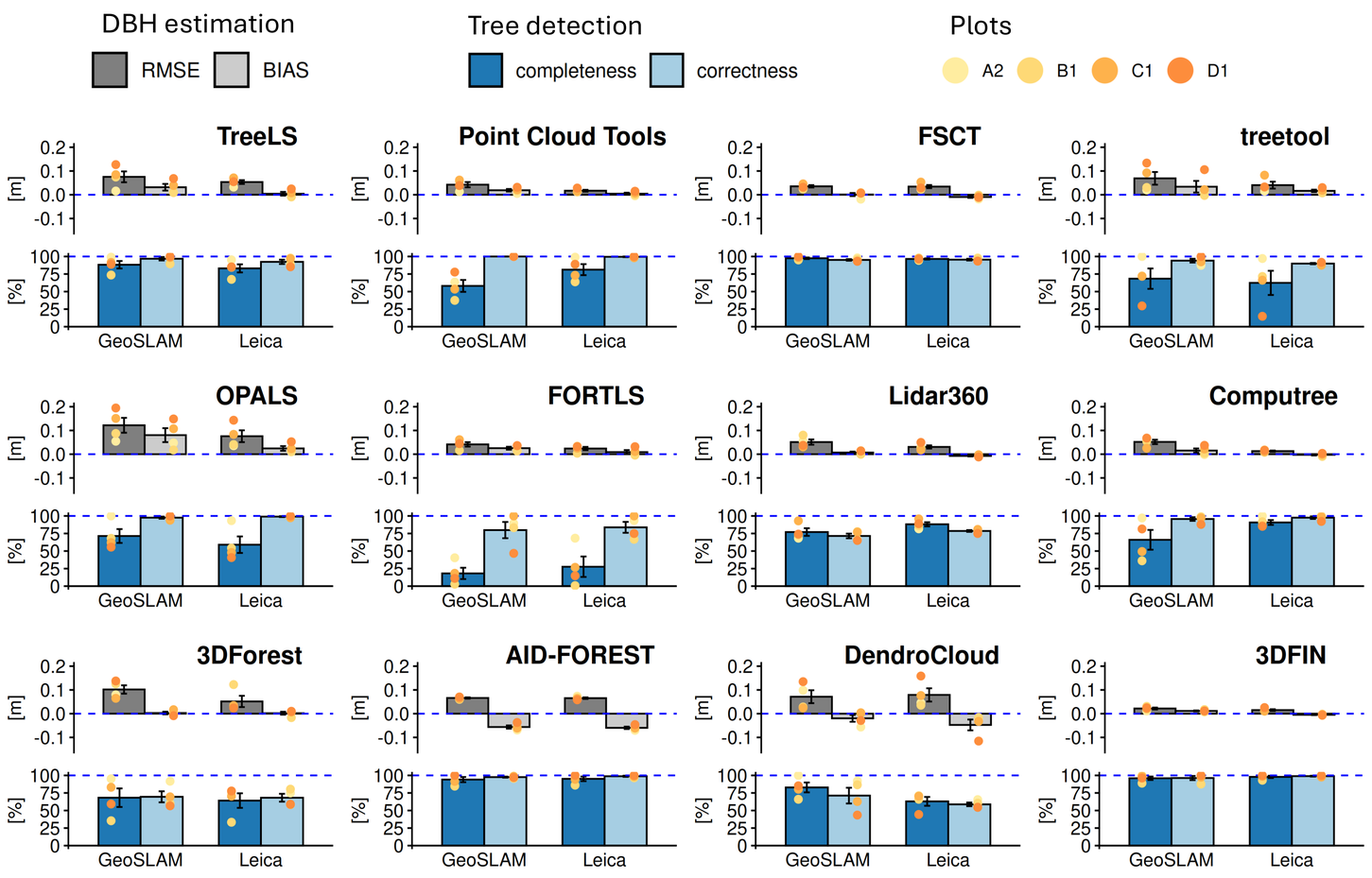


Fig. 1. Benchmarking results of individual tree detection and DBH estimation from point cloud data collected using a GeoSLAM ZEB Horizon RT and a Leica RTC360 laser scanning sensor. Only the trees with a reference DBH greater than or equal to 10 cm were considered in the evaluation. Tree detection performance was assessed using completeness (percentage of detected trees) and correctness (percentage of correctly detected trees). The performance of DBH estimation was evaluated using Root Mean Square Error (RMSE) and BIAS. The blue dashed line indicates the optimal value for the particular evaluation metric.

Fig. 2. Mean computing times (in minutes) as documented during the hackathon. The values should be interpreted relatively since the computing times might deviate in other computing settings.

Conclusions

Most software solutions showed a good performance. A few solutions were remarkably outperforming the rest. However, the precision forestry field is evolving fast and standardized benchmarks and protocols are needed.