SMA RTForest

Deep learning for dense LiDAR data in forestry applications

Stefano Puliti , Maciej Wielgosz, Nicolas Cattaneo, Johannes Rahlf, Rasmus Astrup, ... and many others



Forest's hidden depths, Deep learning, dense LiDAR's key, Nature's secrets found. ChatGPT





Semantic segmentation

• Leaf-wood separation:

FSCT lite (Krisanski et al. 2020) is a PointNet++ based model.

• **Stem-crown** separation:

FSCT lite **retrained** using new annotated data with different semantic classes.







Instance segmentation

• **TLS2trees** (Wilkes et al. 2022) No deep learning but hey, it works!





Wilkes et al. 2022 TLS2trees: a scalable tree segmentation pipeline for TLS data. *BioRxiv* Wielgosz et al. 2023 Point2Tree(P2T) -- framework for parameter tuning of semantic and instance segmentation used with mobile laser scanning data in coniferous forest. arXiv **Point2trees** – hyperparameter optimization



- More accurate instance segmentation
- Less susceptible to hyperparameter variation → more robust

Wielgosz et al. 2023 Point2Tree(P2T) -- framework for parameter tuning of semantic and instance segmentation used with mobile laser scanning data in coniferous forest. arXiv

forestsens.com now open for early access for test users!





Tree species detector







Through laser's lens, Tree crowns speak volumes untold Knowledge takes root. ChatGPT

Tr3D species





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Tr3D species

a sensor-agnostic benchmark dataset for tree species classification based on dense laser scanning pointclouds

~20K trees over more than 30 species





Tr3D species – the first leaderboard 🏴

Ranking	Author	Institution	Overall accuracy	Precision	Recall	F1- score	method	
1	Adrian Straker	University of Goettingen	0.78	0.81	0.78	0.78	YOLOv5	
2	Matt Allen	University of Cambridge	0.76	0.77	0.76	0.76	SimpleView	
3	Hristina Hristova & Nataliia Rehush	WSL	0.71	0.72	0.71	0.7	MLP-Mixer	
4	Lukas Winiwarter	UBC/TU Wien	0.7	0.71	0.7	0.7	PointNet++	
5	Brent Murray	UBC	0.68	0.67	0.68	0.67	PointAugment + DGCNN	





The whorl-detector! Growth and wood quality information



Puliti et al. 2023 Tree height-growth trajectory estimation using uni-temporal UAV laser scanning data and deep learning. *Forestry*

SMARTForest

Wood quality – diameter of largest branch per whorl





RMSE = 4 mm



Take-home lessons

• Deep learning methods have great potential for forest dense point clouds: still early days, but oh-so-thrilling!

- Hey we are hungry for data! We need more ML-ready benchmark data!
- Picture this: point clouds and image-based methods going hand in hand, like a dynamic duo solving crime in the world of 3D!



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