Completing 3D point clouds of individual trees using deep learning: Exploration of possible training data

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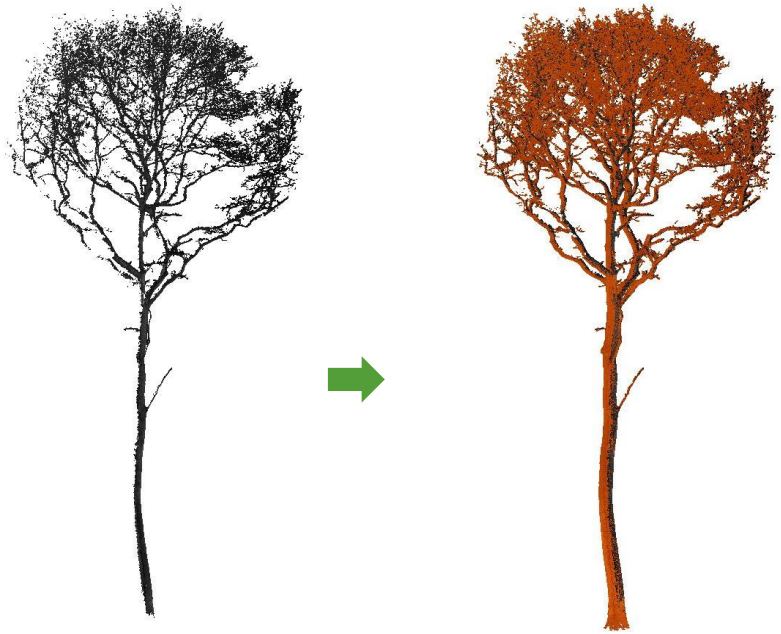
Problem

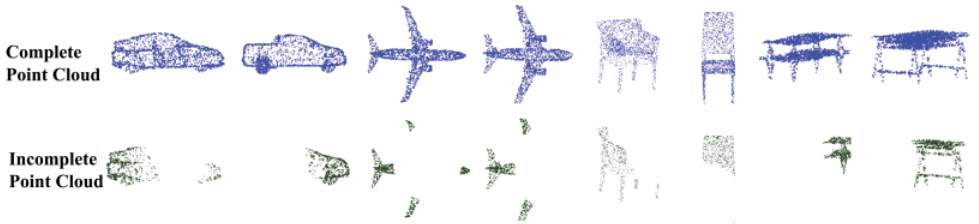
Incomplete tree point clouds due to:
- Occlusion
- Acquisition setup
- Distance to sensor
- Segmentation method
- Leaf-wood separation
- …



Solution

Point cloud completion with deep learning networks[1]

Possible applications in many fields: autonomous vehicles, industrial production, mining, robotics, cultural heritage …



But: needs huge amounts of training data

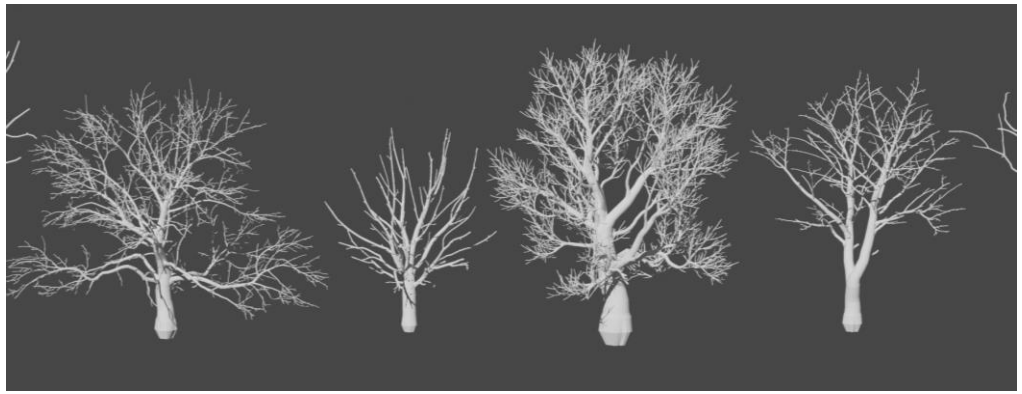
→ Complete point clouds of trees

[1] Fei, B., Yang, W., Chen, W. M., Li, Z., Li, Y., Ma, T., Hu, X., & Ma, L. (2022). Comprehensive Review of Deep Learning-Based 3D Point Cloud Completion Processing and Analysis. *IEEE Transactions on Intelligent Transportation Systems*. https://doi.org/10.1109/TITS.2022.3195555

Research question

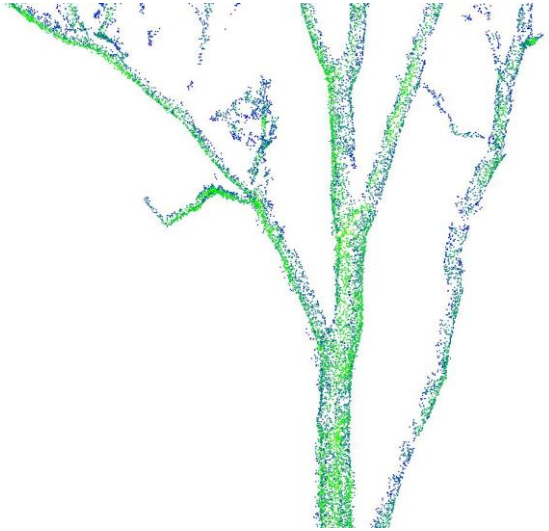
What kind of data can or should be used to train point cloud completion networks for trees?

Idea: use virtually generated trees to simulate point cloud data
→ but how realistic do these simulations need to be?



Focus on:

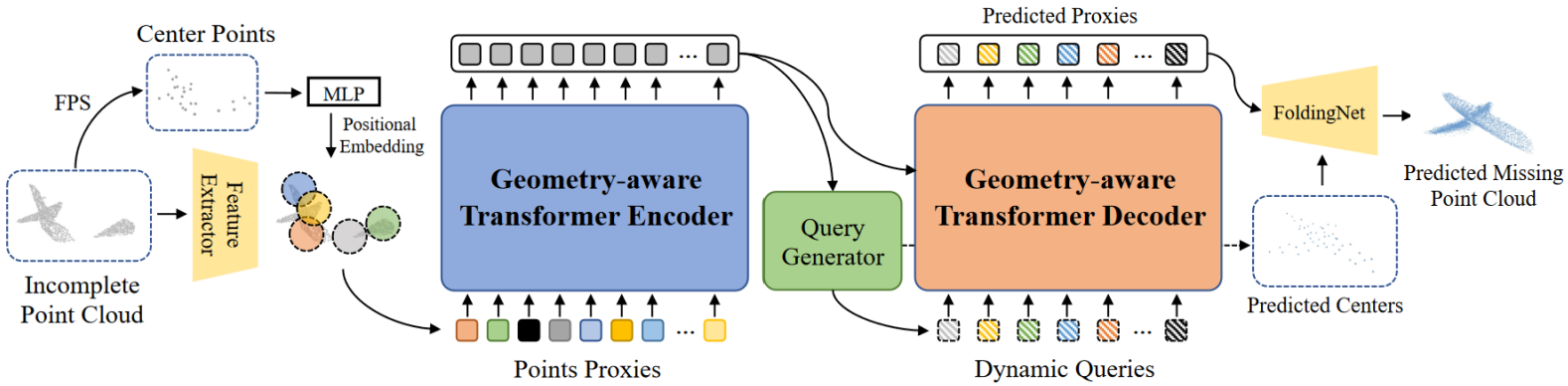
- Segmented single trees
- Deciduous (leaf-off)
- Small-scale structures
- Point clouds of TLS-quality



→ apply an existing network

PoinTr

"Diverse Point Cloud Completion with Geometry-Aware Transformers"



Yu, X., Rao, Y., Wang, Z., Liu, Z., Lu, J., & Zhou, J. (2021). PoinTr: Diverse Point Cloud Completion with Geometry-Aware Transformers. *ICCV*.

Datasets

ShapeNetCore

- Open database of 3D shapes
- Objects from 55 categories
- Mostly artificial

- Used for training and benchmark by many point cloud completion implementations

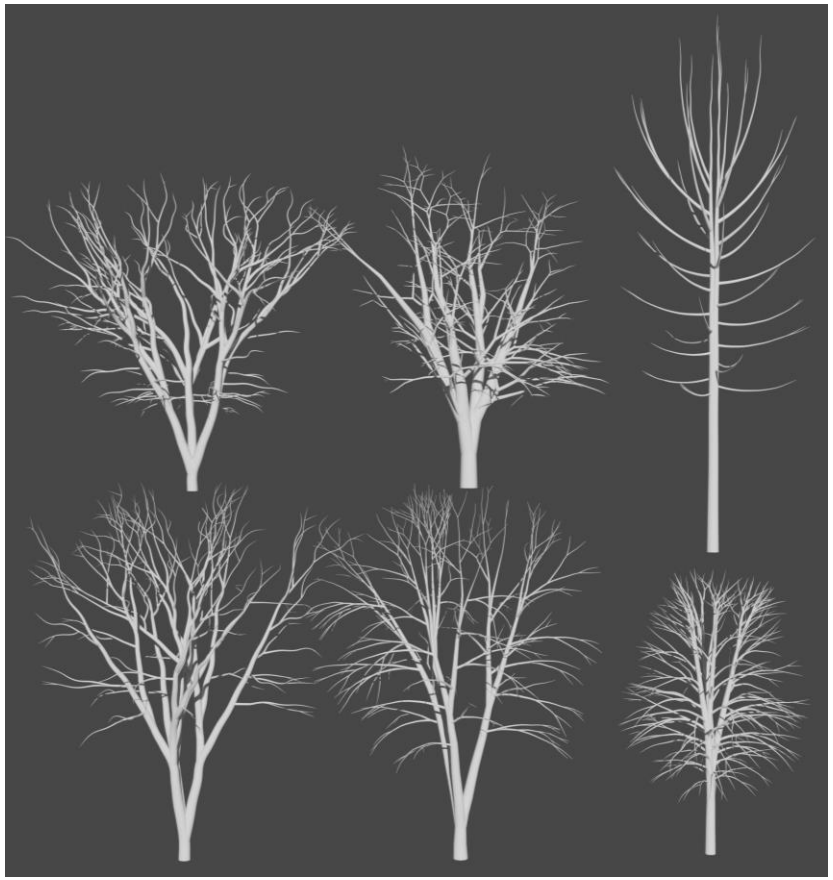
shapenet.org

Datasets

Sapling Tree Gen
free Blender add-on

simple

diverse



docs.blender.org/manual/en/3.5/addons/add_curve/sapling.html

Datasets

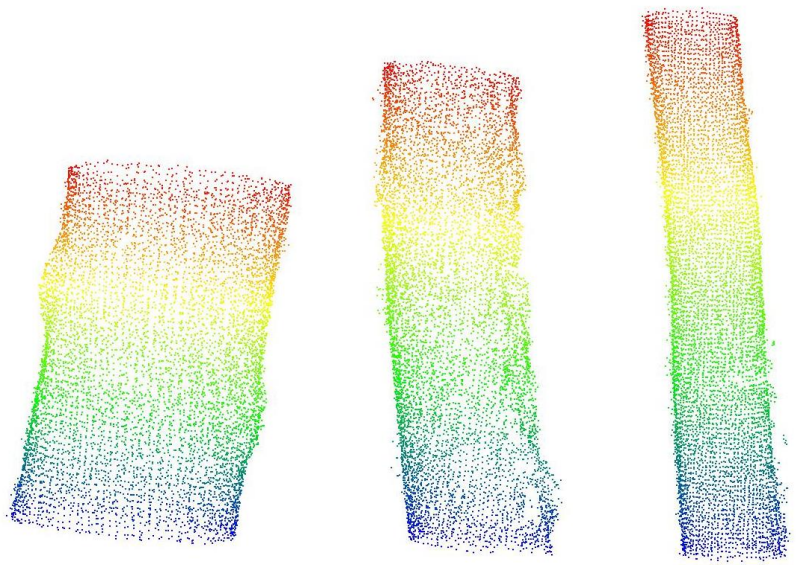
The Grove
paid Blender add-on 3D Tree growing software to create detailed naturalistic trees (aimed at illustrators and artists)

www.thegrove3d.com

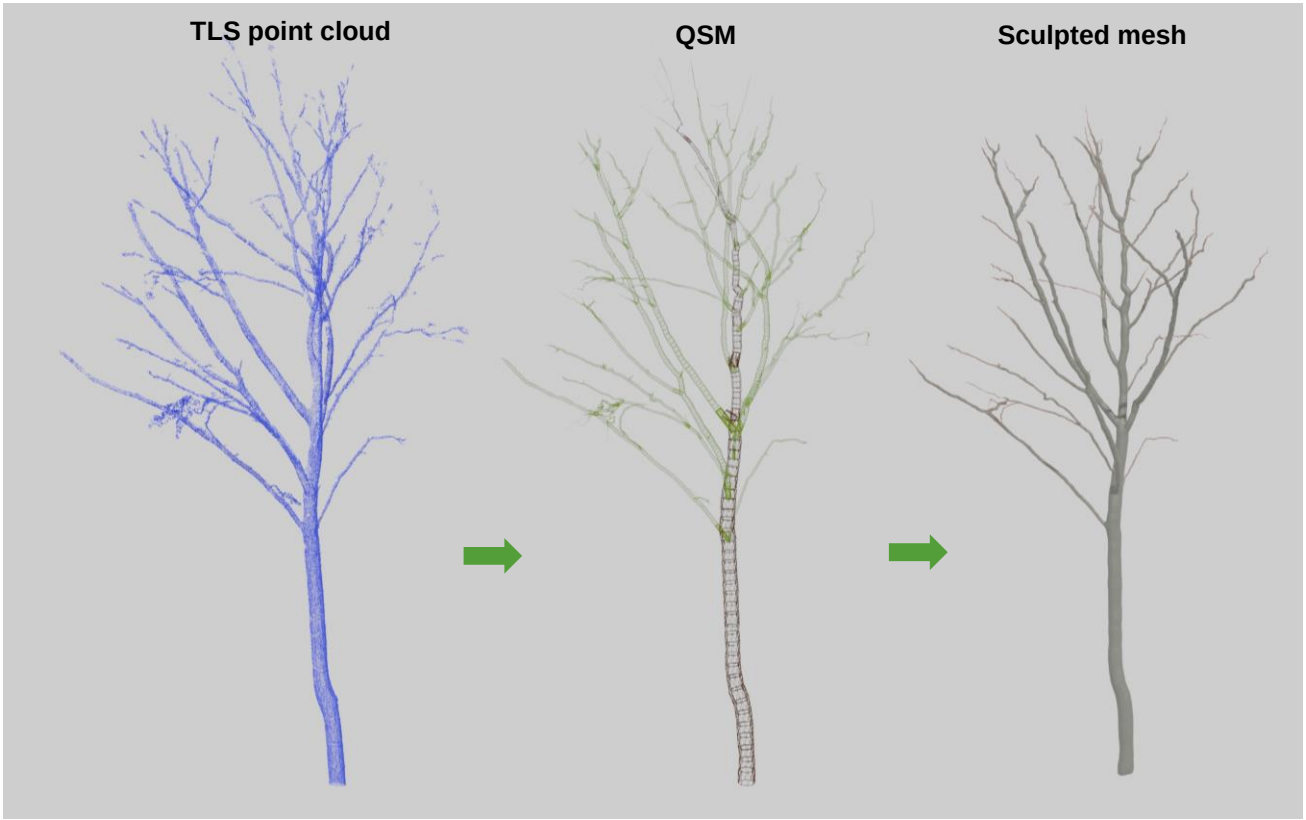
Datasets

Mix of most “realistic” data

- TLS data of tree stem segments
- QSMs from TLS data, manually sculpted in Blender to create mesh objects
- + 2 best trees from the Grove



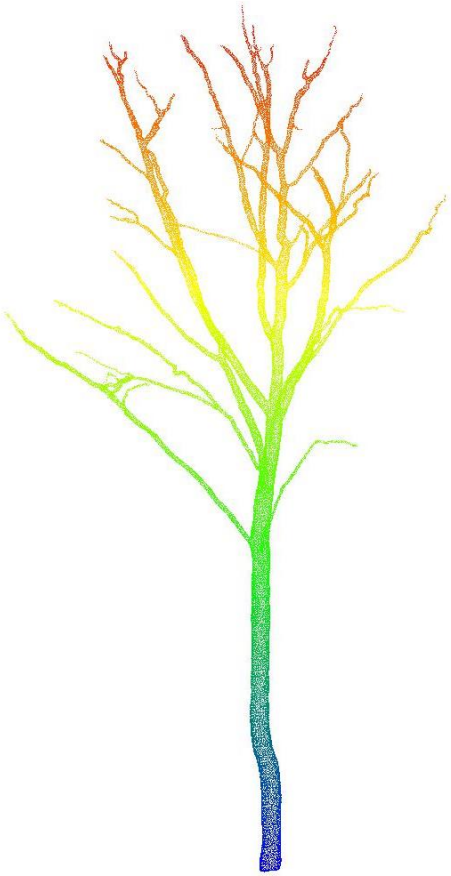
Complete stem segments from real TLS data



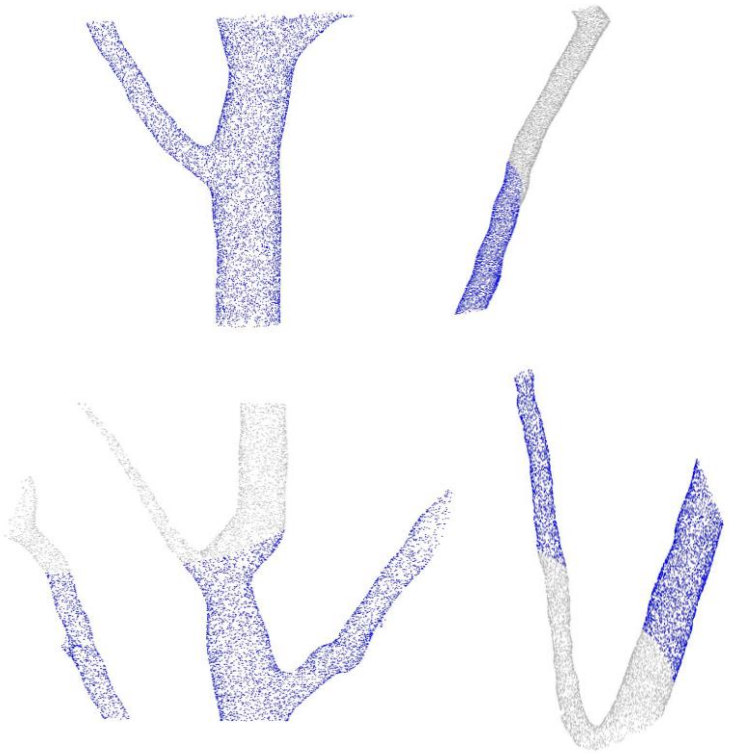
Data preparation

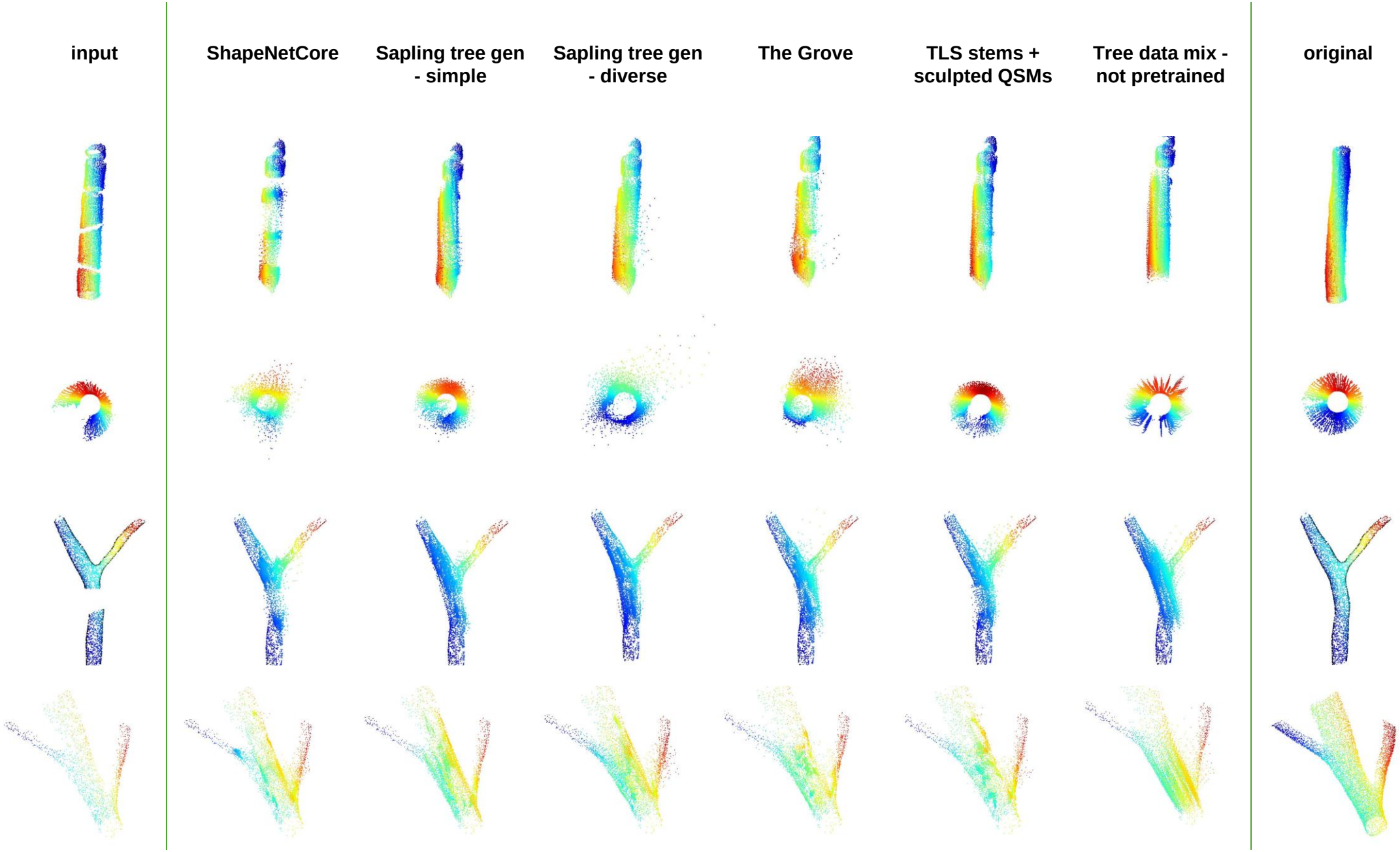
3D mesh object

Point cloud by random sampling on mesh



Point cloud samples of 1m^3 at random locations




input
ShapeNetCore
Sapling tree gen - simple
Sapling tree gen - diverse
The Grove
TLS stems + sculpted QSMs
Tree data mix - not pretrained
original

Next steps

- Simulate lidar scans for training and testing (e.g. with HELIOS++)
- Real dataset of complete tree point clouds?
- From segments to whole trees