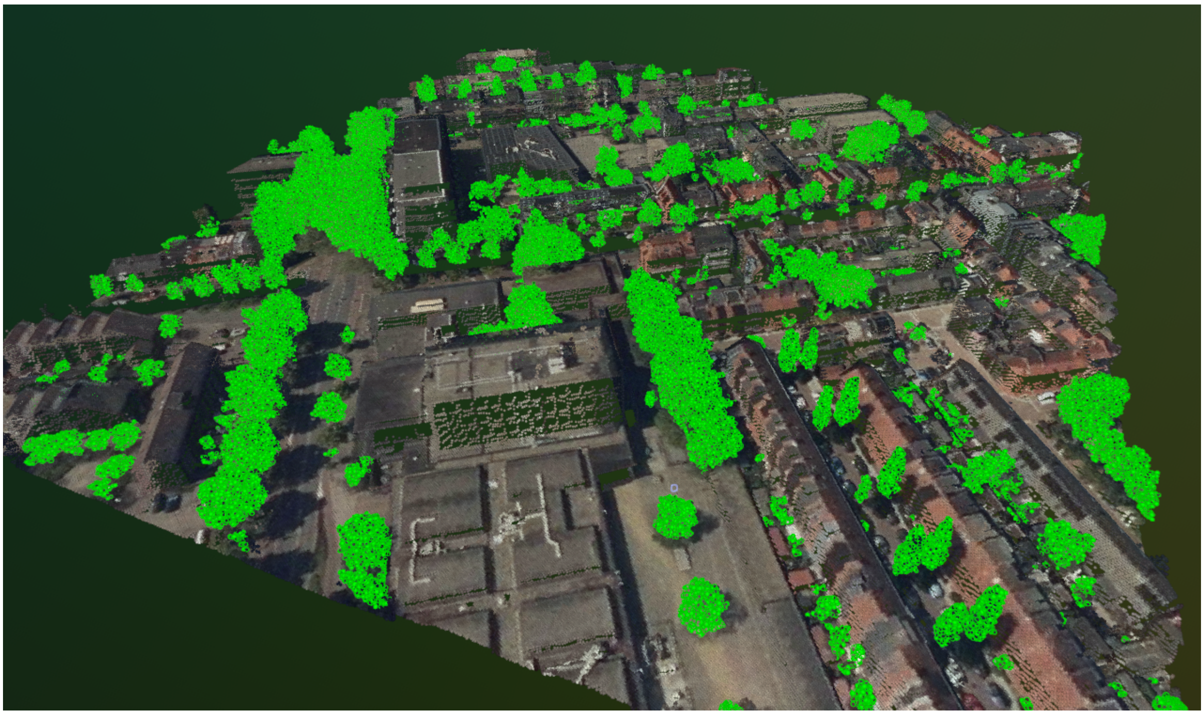
Urban Geome-Trees: Automated Modeling of Tree Species and Geometry for CFD in Urban Environments

Noah Petri Alting

December 18, 2024

student number	4828968
1st supervisor	Hugo Ledoux
2nd supervisor	Clara García-Sánchez



Contents

1 Introduction

2 Related work

3 Research questions

1. Can the creation of CFD tree meshes be automated for any arbitrary area in The Netherlands?
2. Can the species classification in urban areas be done completely automatically, using open-source data?

4 Methodology

4.1 Retrieve data

In this research, AHN4 or AHN5 point clouds will be used, which are available through geotiles. Because I want my work to be usable anywhere in The Netherlands, I intend to test codes and algorithms on sample tiles taken from different places. Testing can be done on a tile that is mostly vegetation, a tile that is mostly built environment and a tile that is a hybrid of the two.

4.2 Filter Trees from Point Cloud

This section describes the first filtering steps. Points that are single-return or last-return will be removed from the *raw* point cloud since they belong to the ground and grass points. There are more values with which to filter the point cloud, such as NDVI, normalized green and MTVI2. Chen et al. (2023).

4.3 Segment Trees

Once the point cloud is filtered to have only points that belong to trees, it is time to segment the trees.

4.3.1 Voxelisation

The point cloud containing merely tree points will be voxelised and some statistics and values can be calculated for tree voxels. In Racine et al. (2021), statistics of the return number of a point in the point cloud reveal a sort of tree species signature. Furthermore, the Leaf Area Index (LAI) can be calculated at different heights of a single tree using e.g. the R code from Kamoske et al. (2019).

4.3.2 Machine learning; Random Forest

The calculated vegetation features and geometrical properties of tree instances will be used to train a machine learning based classifier algorithm to classify species. I have to look further into this to specify more about random forest.

4.4 Reconstruct Trees

When I have tree species classified for trees or groups of similar trees, these will be made into a 3d object. In literature, most often this is now done using the watershed algorithm. The code of Ivan used alpha wrap, which I also intend to use to investigate the advantages and disadvantages.

4.5 Assign Porosities

When the shapes of trees are available the calculated values and features will be further processed and analysed. These will then be used to assign the tree instances a porosity based on species-specific and instance-specific variables.

4.6 Meshing for CFD

Lastly, the trees will be meshed and put into a CFD model, to verify that they can indeed be used for CFD models.

5 Time planning

Having a Gantt chart is probably a better idea then just a list.

6 Tools and datasets used

Since specific data and tools have to be used, it's good to present these concretely, so that the mentors know that you have a grasp of all aspects of the project.

References

Chen, X., Shen, X., and Cao, L. (2023). Tree Species Classification in Subtropical Natural Forests Using High-Resolution UAV RGB and SuperView-1 Multispectral Imageries Based on Deep Learning Network Approaches: A Case Study within the Baima Snow Mountain National Nature Reserve, China. *Remote Sensing*, 15(10):2697.

Kamoske, A. G., Dahlin, K. M., Stark, S. C., and Serbin, S. P. (2019). Leaf area density from airborne LiDAR: Comparing sensors and resolutions in a temperate broadleaf forest ecosystem. *Forest Ecology and Management*, 433:364–375.

Racine, E., Coops, N. C., Bégin, J., and Myllymäki, M. (2021). Tree species, crown cover, and age as determinants of the vertical distribution of airborne LiDAR returns. Version Number: 2.