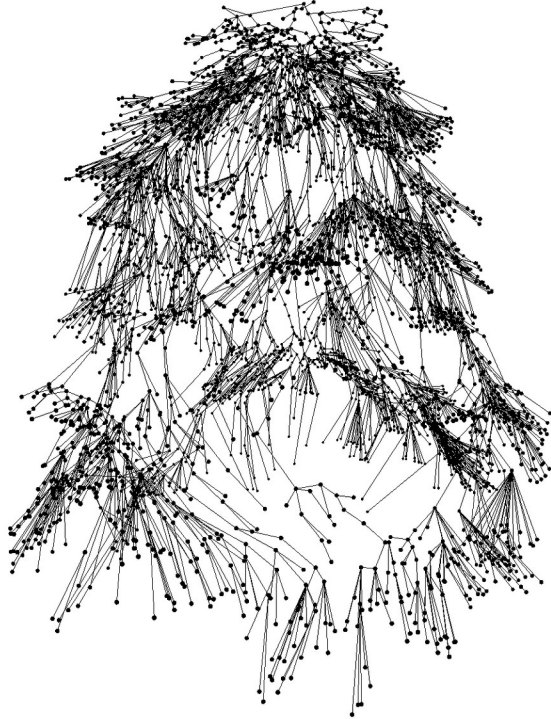




Deciduous Tree segmentation using airborne lidar point clouds and geometric networks:

Examples from the Park Sanssouci, Potsdam, Germany

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Motivation & Objectives

Motivation:

Monitoring the environment is an important task. Remote sensing technology like LiDAR (Light detection and ranging) offers the capability to collect the three-dimensional structure of vegetation in larger areas.

To access the characteristics of individual trees these point clouds have to be classified and segmented. Automated tree segmentation can be still a challenging task. Tree crowns and vegetation structures exhibit wide varieties and trees often form complex tree aggregations. Clear delineation of individual deciduous tree crowns in dense tree stands is difficult, and methods developed for conifer trees may not be applicable for deciduous. The dense overlapping structures require alternative approaches.

Objectives:

- Developing a method for automated tree segmentation from airborne lidar point clouds
- Clear delineation of individual deciduous tree crowns in dense and complex tree aggregations



Park Sanssouci, Potsdam, Germany. Photo: Wolfgang Pehlemann  

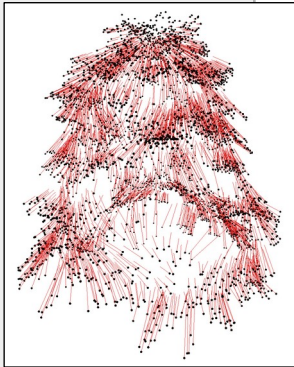
Method

Vectors

Vectors are generated to give the points a directional component. We assume that vectors of points located in the same tree converge towards the top of the tree.

Steps:

- A k-d tree is built to obtain individual point neighborhood information.
- For each point a vector is generated pointing to the centroid of higher located points within a spherical neighborhood.
- The radius of that neighborhood is determined by a parameter r_v .
- If the neighborhood does not include such points a null vector is generated.



Links

Links are connections between two points. Since each point is connected to a certain point above him they form paths which join together with increasing height.

Steps:

- Each point is connected to the nearest point above its corresponding centroid.
- To find the centroids nearest point a spherical neighborhood is searched.
- The radius of that neighborhood is determined by a parameter r_p .
- Points which do not connect based on this rule are identified as endpoints.



Networks

A Network is considered as the sum of points which are connected directly or via paths to the same endpoint.



Results

Influence of different parameter settings on the constructed networks

- *Small parameter settings result in a high number of constructed networks (g)*
- *The increase of parameter r_p results in larger networks (g, h, j)*
- *The increase of parameter r_v results in larger networks when r_p has a small value (g, d, a)*
- *The increase of parameter r_v results in more defined borders between networks when r_p has a large value (j, f, c)*

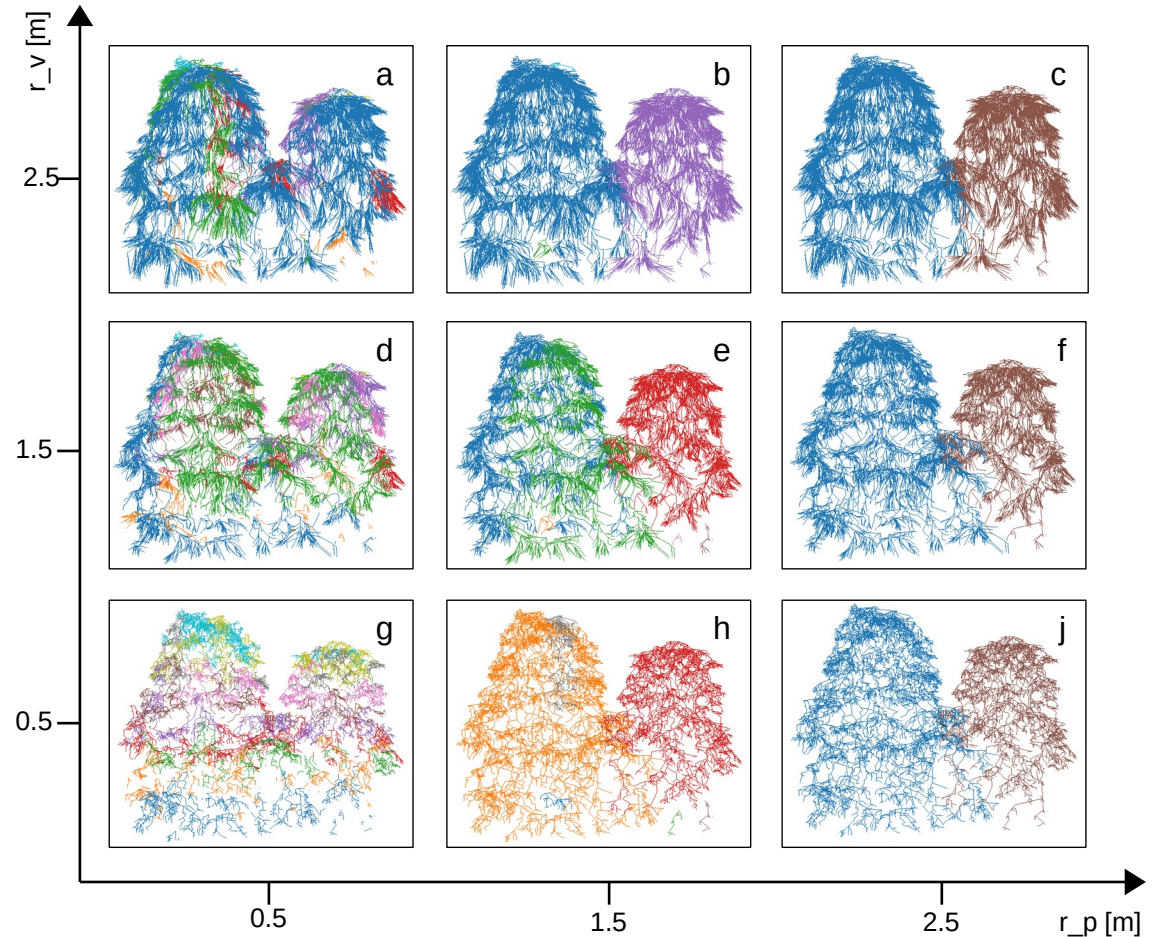
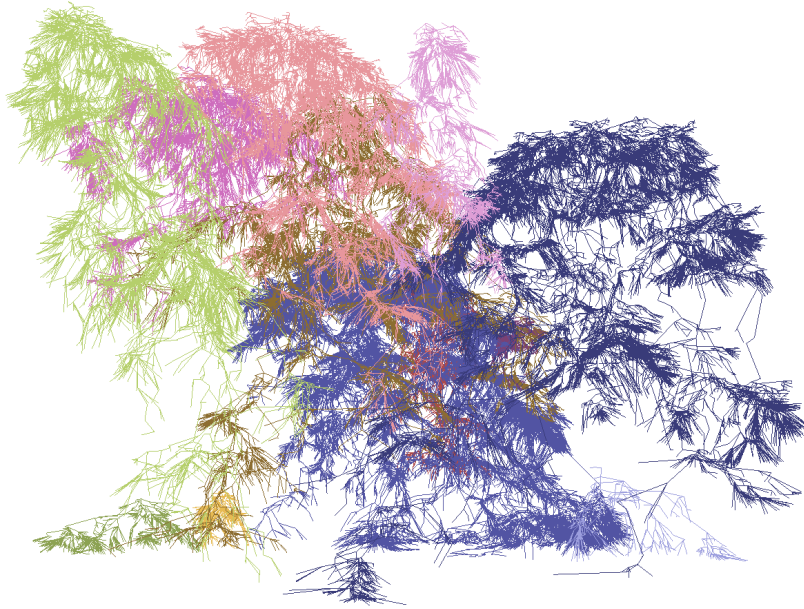
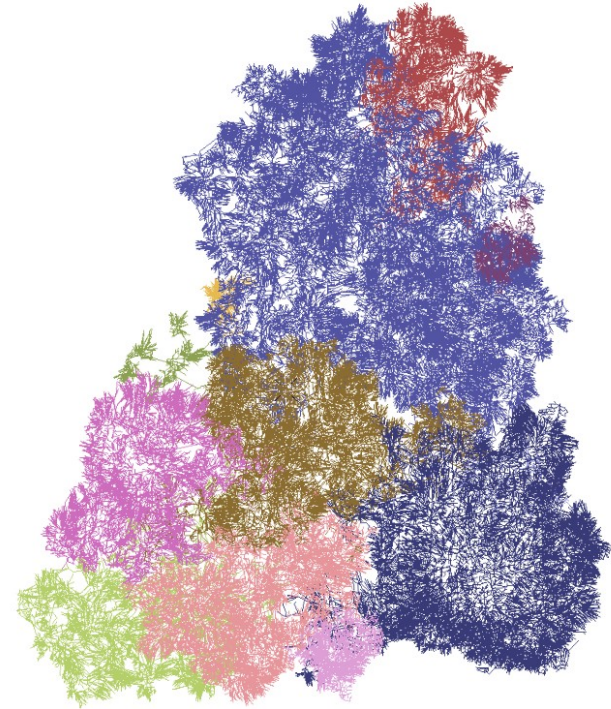


Figure 1: Examples of constructed Networks for 2 merging trees. Each network is shown in a different colour.

Segmentation examples



Side view



Top view

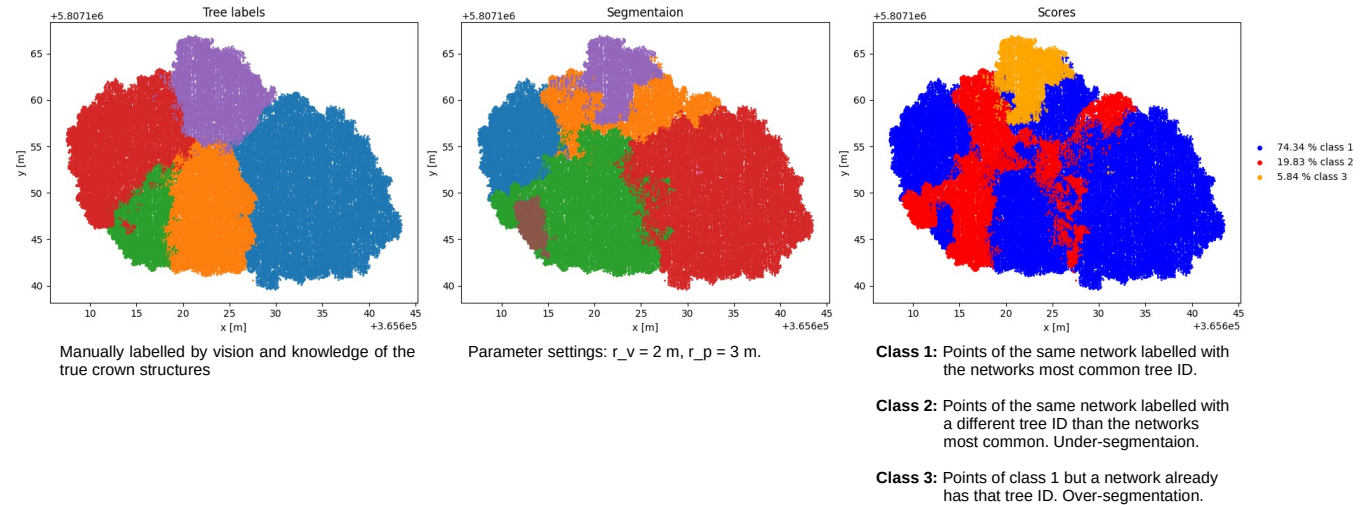
Results

Segmentation examples

Tree aggregation with 5 trees



Photos by M. Hess



Current work focuses on additional steps to improve the segmentation result by including:

- Network properties
 - Size
 - Vector field
 - Divergence
- Link properties
 - Length
 - Orientation
 - Betweenness
- Point properties
 - Stability against minor displacements
 - Stability against parameter changes
 - Additional point information (Return number, etc.)
- Neighbourhood properties
 - Point density