

UNIVERSITY OF TWENTE.

FUSION OF ALS/MLS WITH LARGE SCALE TOPOGRAPHIC MAP BGT

SANDER OUDE ELBERINK



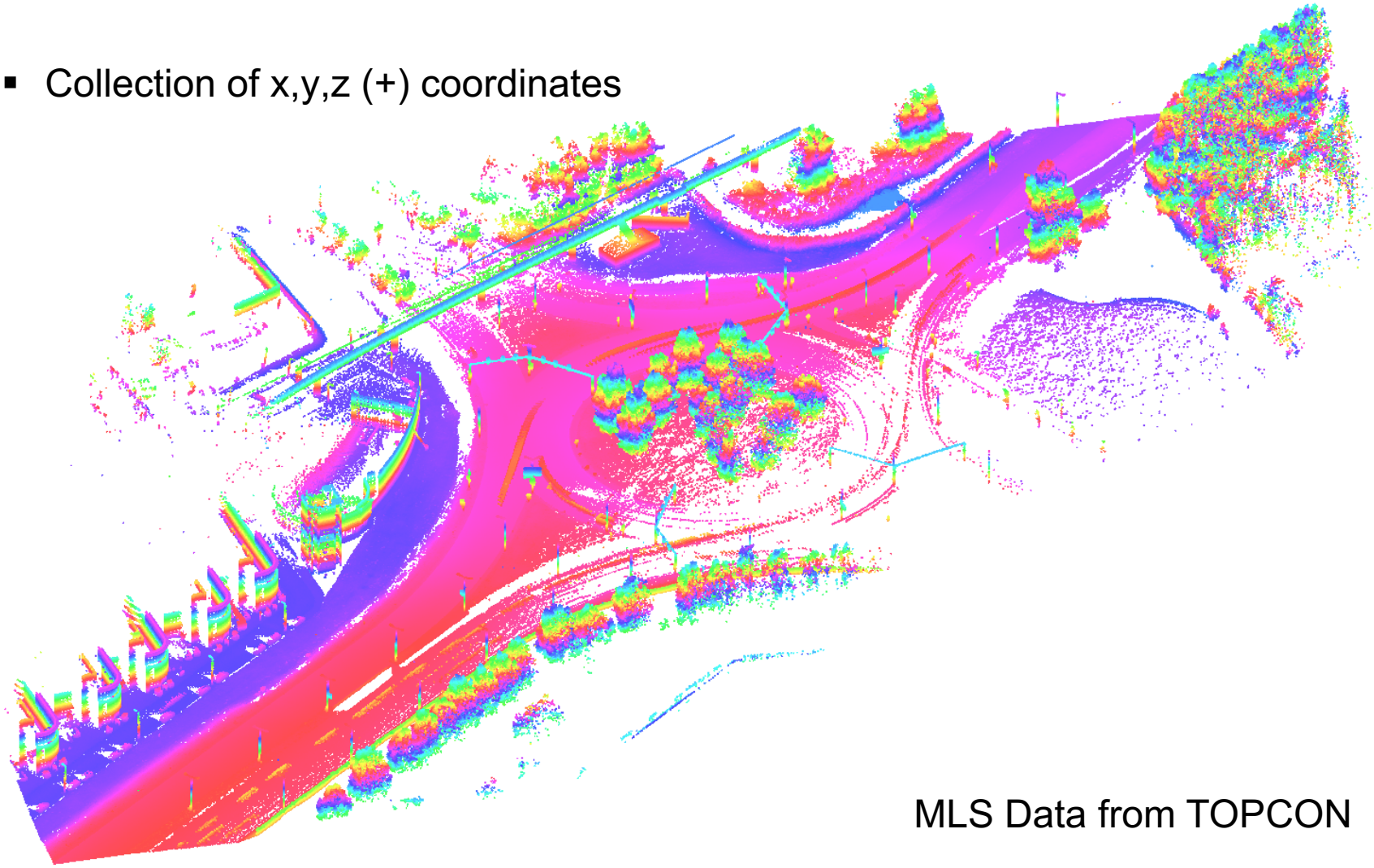
FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION



POINT CLOUDS

A POINT IS JUST A POINT

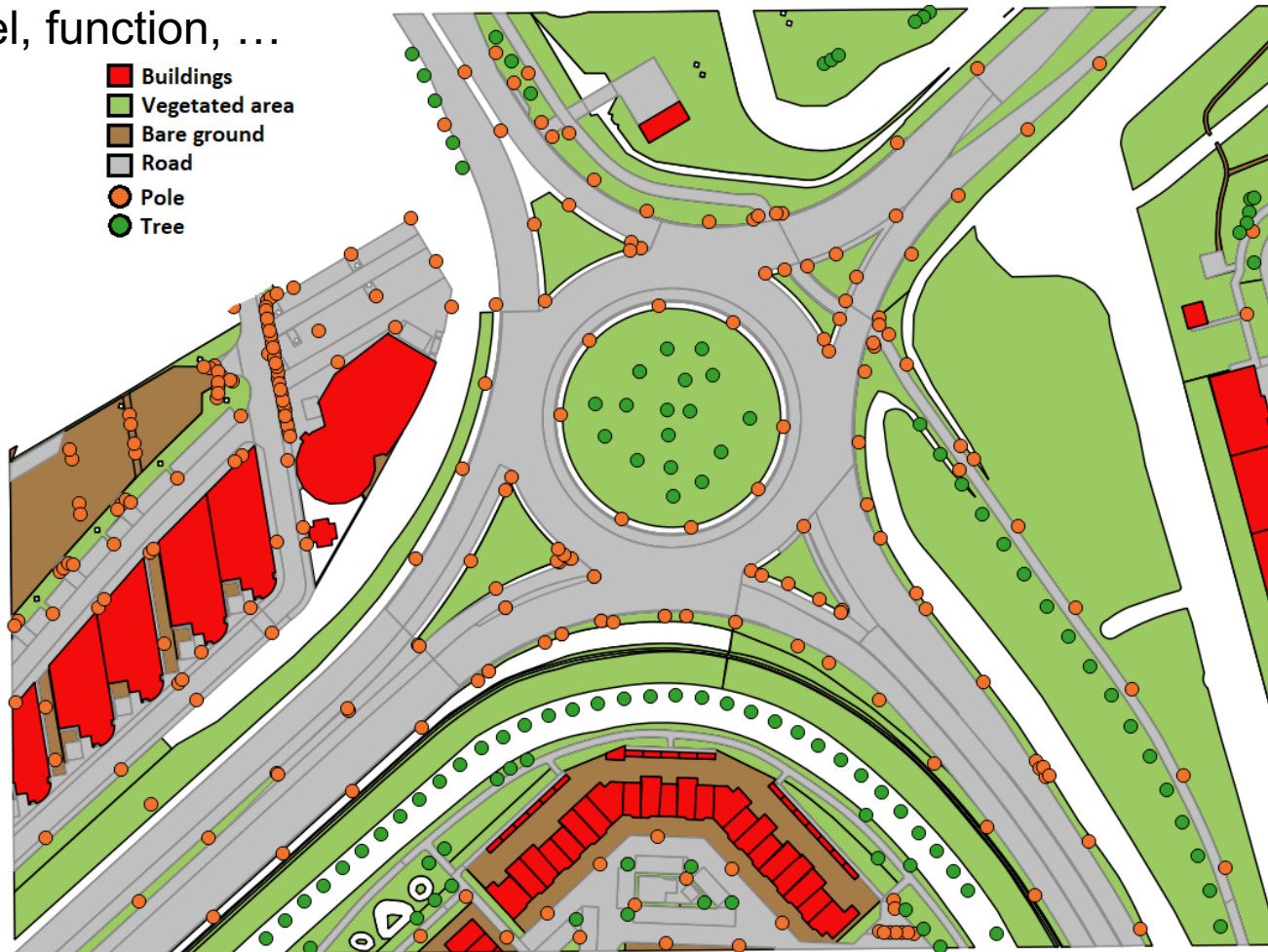
- Collection of x,y,z (+) coordinates



TOPOGRAPHIC MAP

BGT: 1:1.000

- Points, lines, polygons
- X,Y, class label, function, ...



FUSION OF BGT AND MLS

HOW COOL IS THAT?



FUSION OF ALS/MLS AND BGT DATA

- Point-in-polygon will not work:
 - The **registration** between both datasets is not perfect; MLS position ~0.5 m, map objects ~0.2 m.
 - Objects in the map have another **appearance** in the point cloud, e.g. a traffic light is a point feature in the map but a cluster of points in the point cloud.
 - **Objects** may have been recorded in the point cloud **which do not exist** in the map, like cars and pedestrians.
 - Objects may have been **changed** between the acquisition of the map and the point cloud.

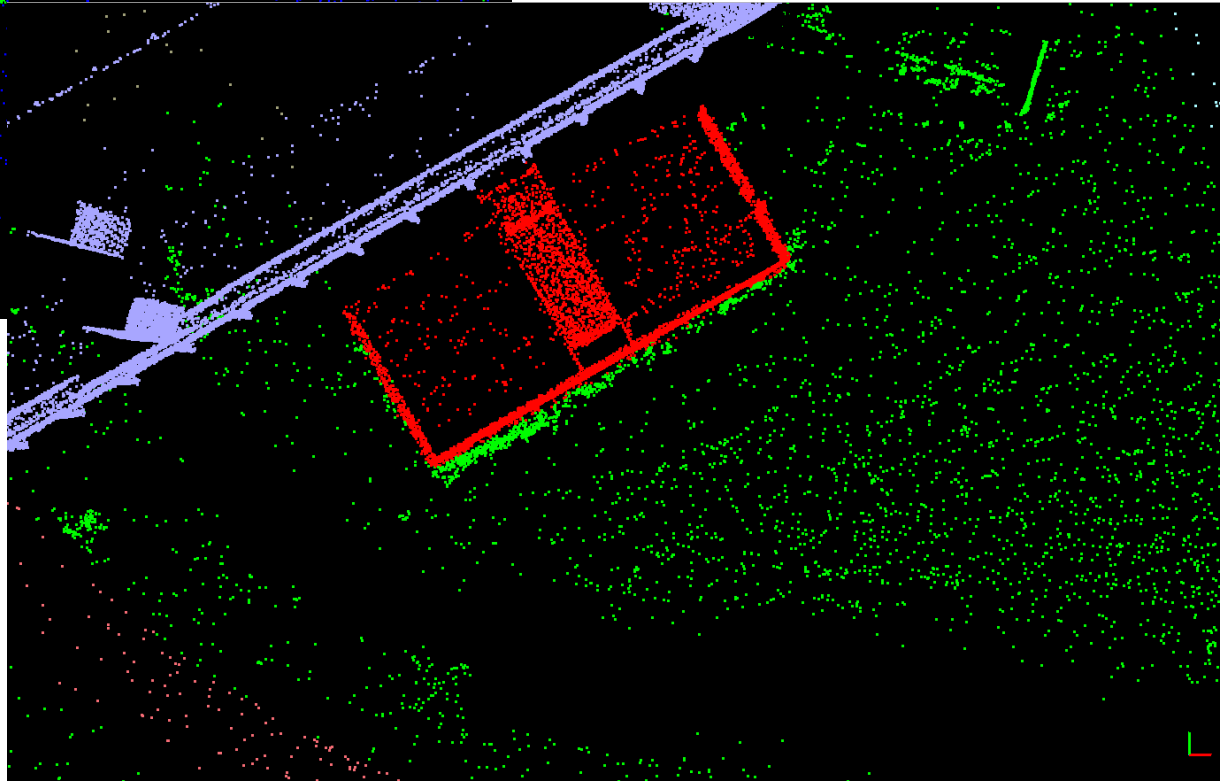
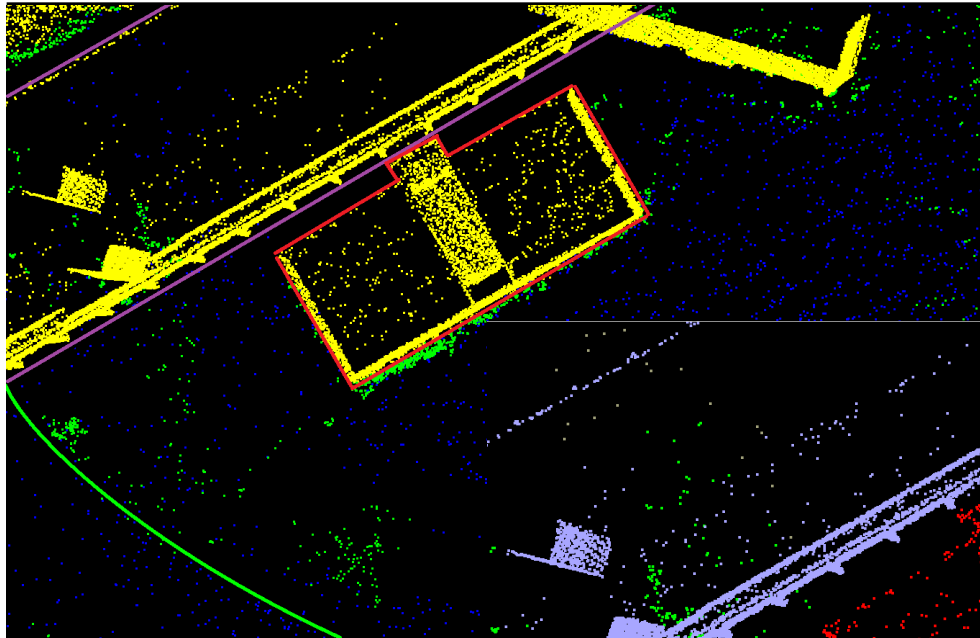
POINT CLOUD PROCESSING BEFORE FUSING

- Noise filtering
- Ground/NonGround
- Ground-> roads, water, terrain
- NonGround contains points on
 - Vegetation (low/high)
 - Buildings
 - Poles
 - Cars
 - ...

Extension to constrained connected components (Oude Elberink and Kemboi, 2014, Gorte et al. 2015)

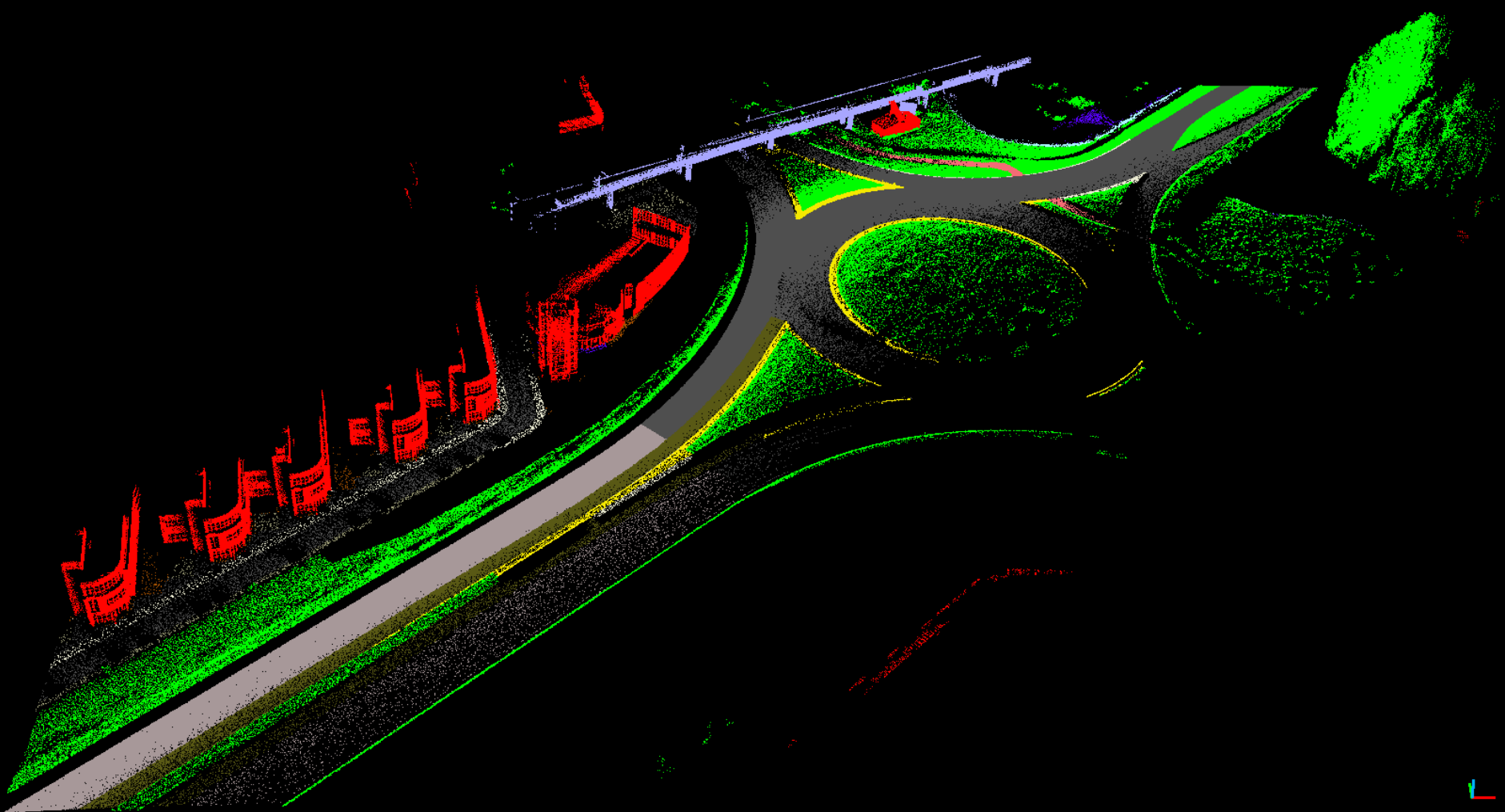
POLYGON FEATURES

INITIALY A POINT-IN-POLYGON, PLUS BUFFER FOR BUILDINGS



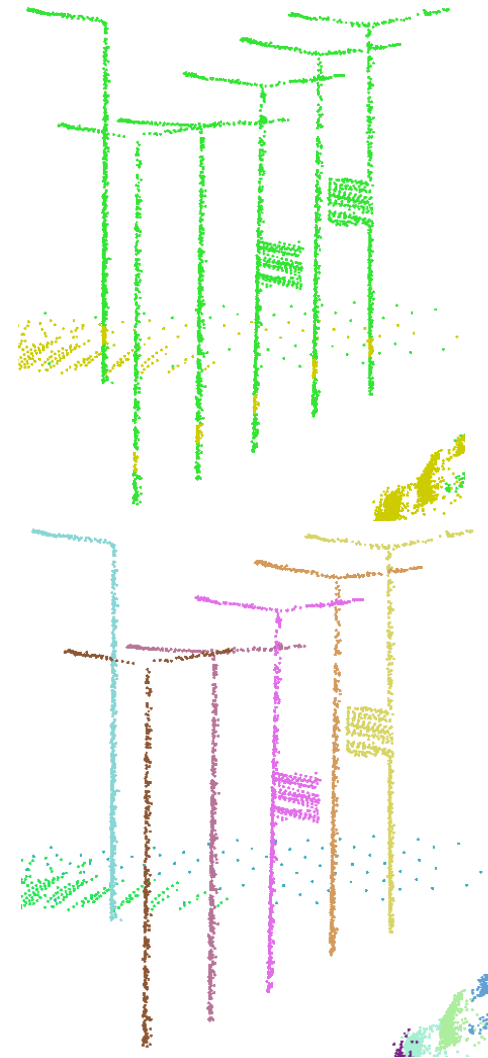
GROUND POINTS FUSED WITH GROUND MAP POLYGONS

NON-GROUND POINTS FUSED WITH BUILDING AND BRIDGE POLYGONS



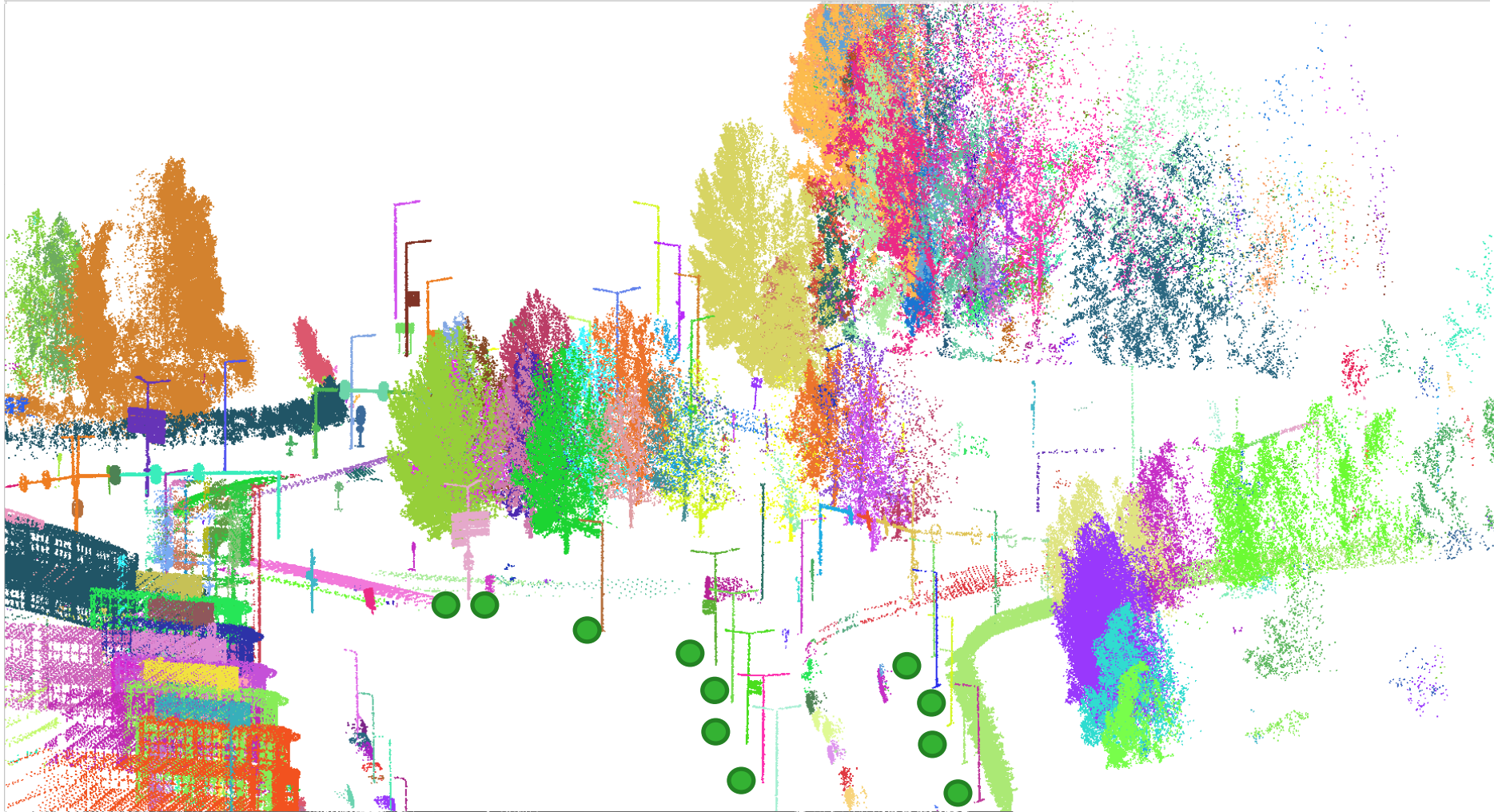
CONSTRAINED CONNECTED COMPONENTS

- Point attributes for ground detection
 - Density
 - Planarity
 - Height above local lowest point
- Point attributes for above ground segmentation
 - Height above ground
 - Height below highest point
- Split segments if disconnected at 'knee' height

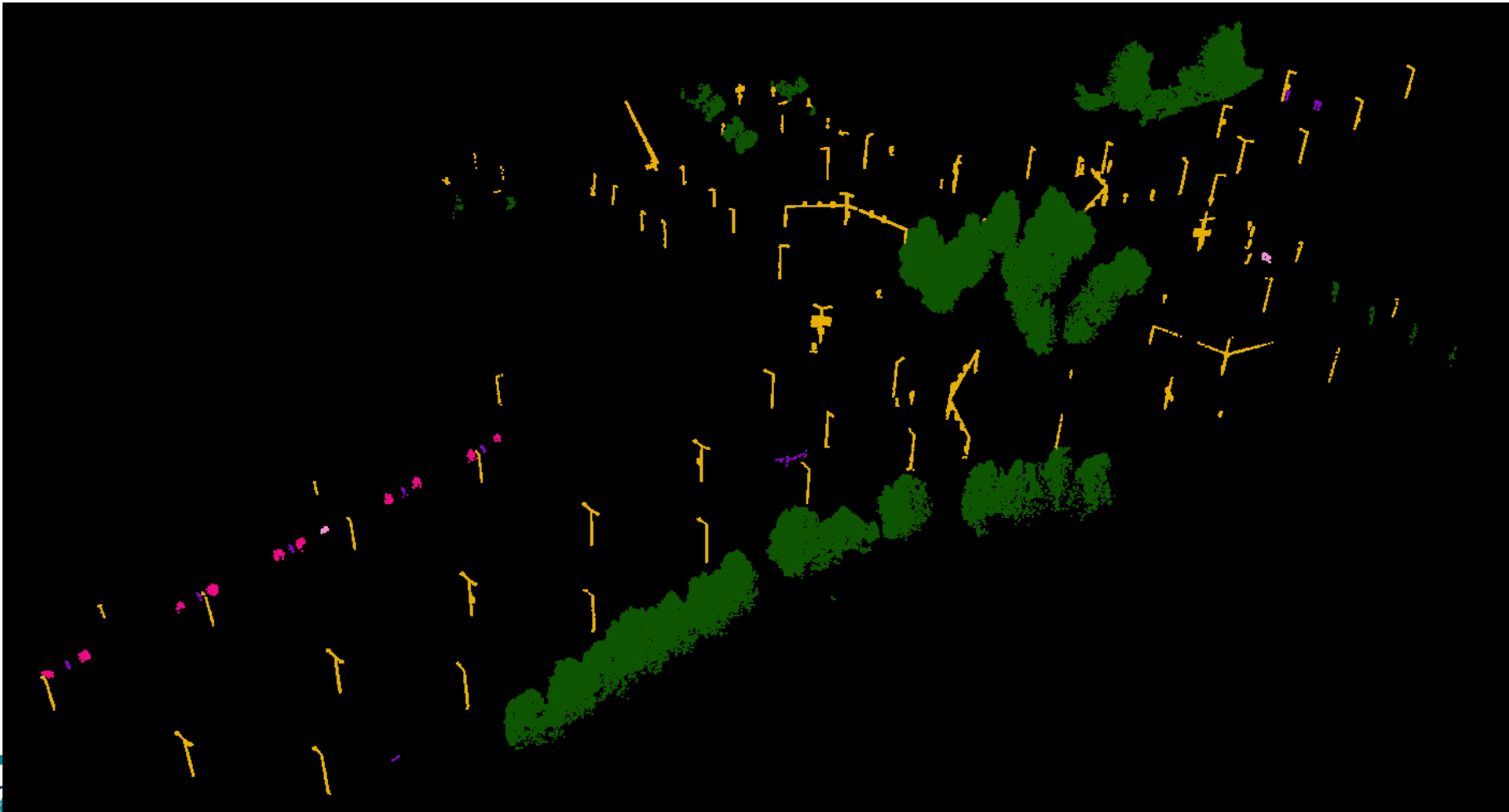


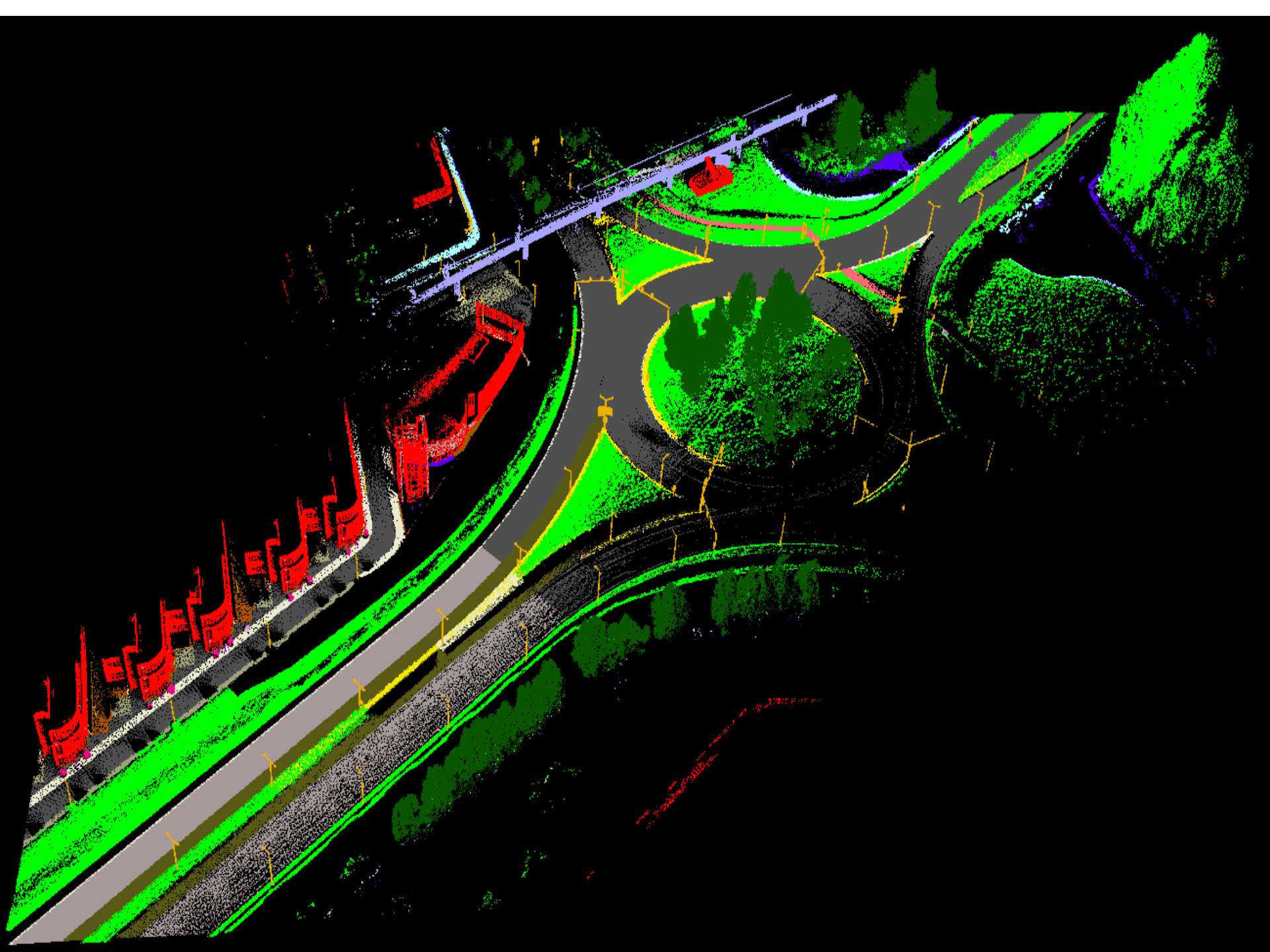
PER MAP POINT FIND NEARBY SEGMENT

TO BE EXPANDED BY MAP BASED CRITERIA



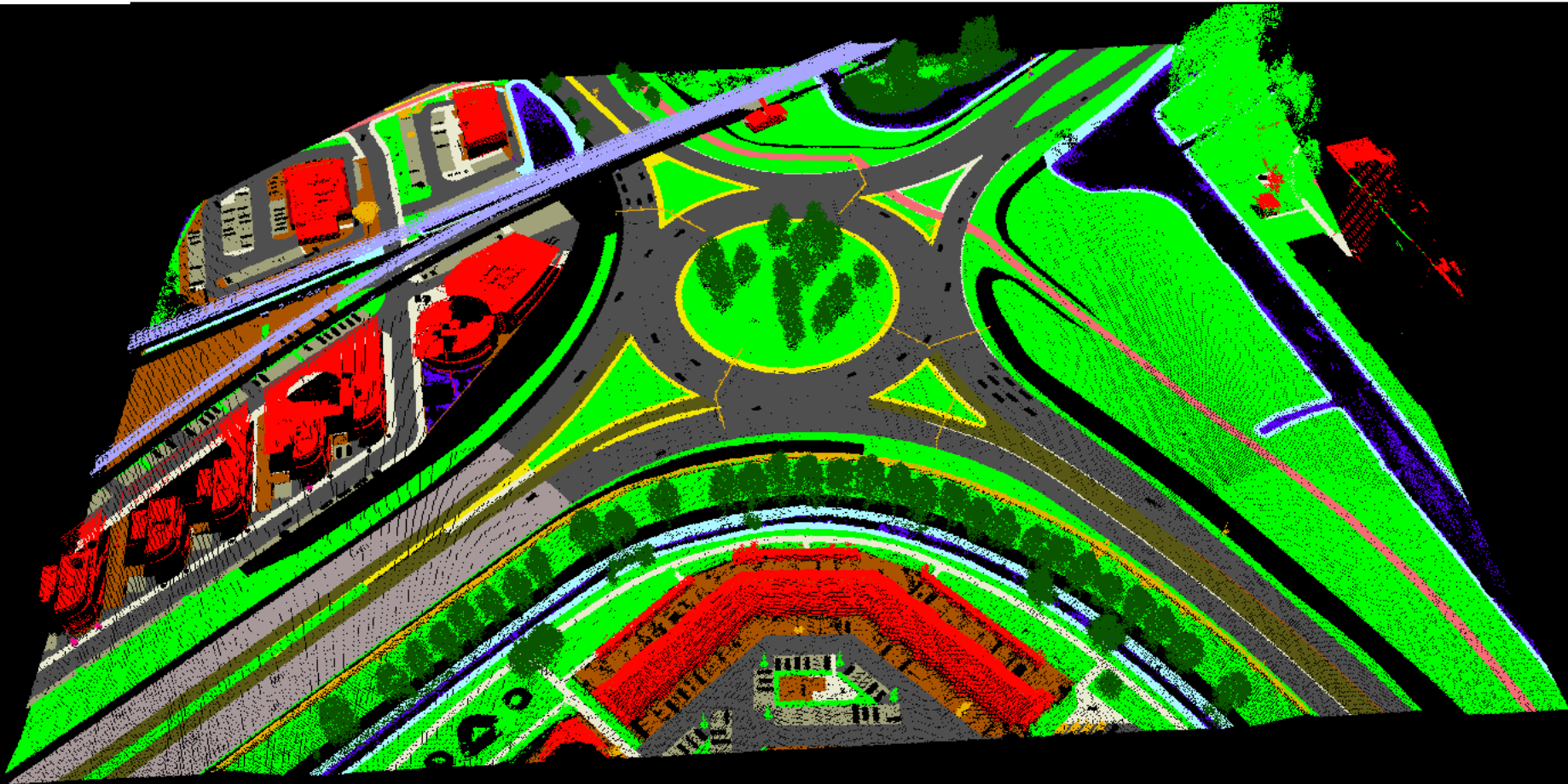
CLASSIFICATION BY FUSION OF MAP POINT FEATURES





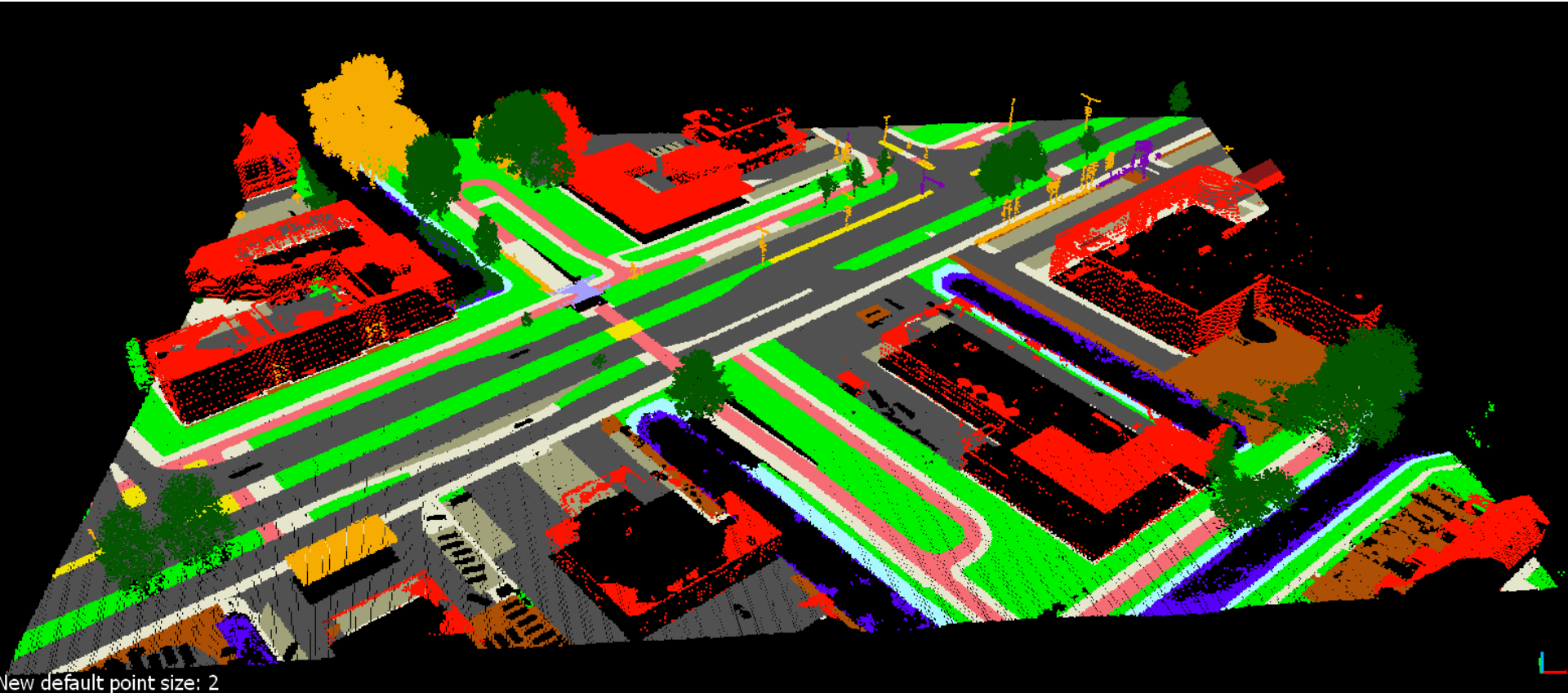
BGT AND AHN

TO BE FURTHER REFINED BY ANAND VETRIVEL



BGT AND AHN

TO BE FURTHER REFINED BY ANAND VETRIVEL



NEXT STEP

- Further processing steps can make use of the class label
- Improve the labeling near polygon boundaries (road/terrain etc)
- Enhance the segmentation based on map class label
- Use the labels after fusion in a supervised classification step
- Deep learning needs a lot of training samples
 - Smart fusion of BGT and AHN-3
 - BGT and MLS: change detection & pole and tree classification