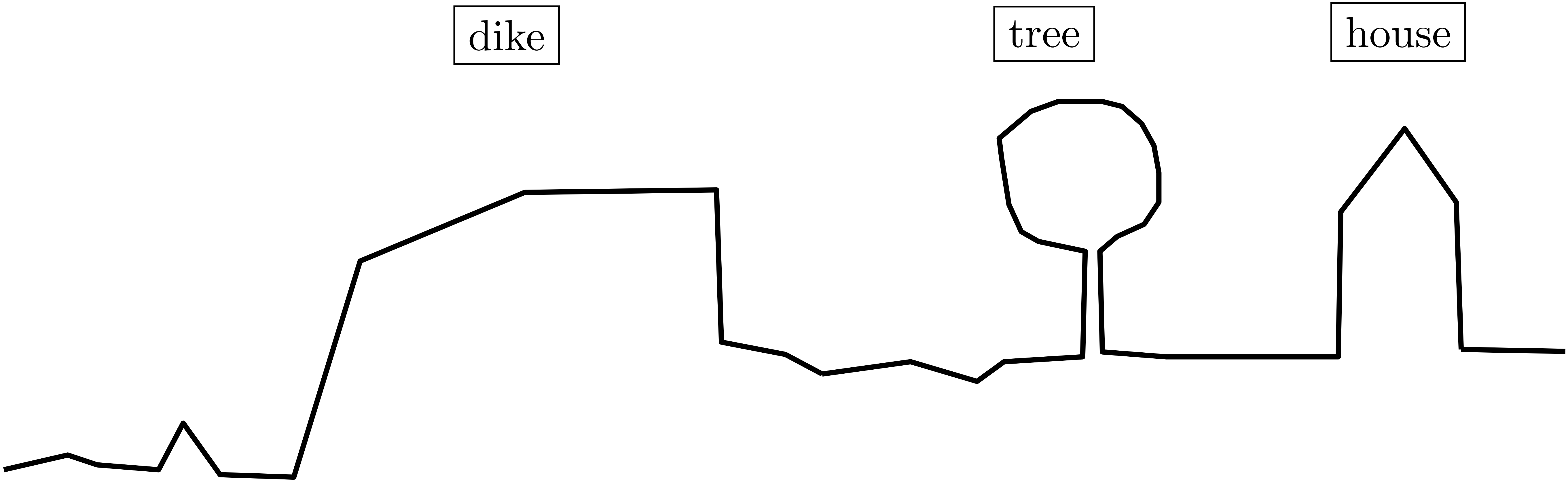
Simplification of digital terrain models using feature-based three-dimensional methods

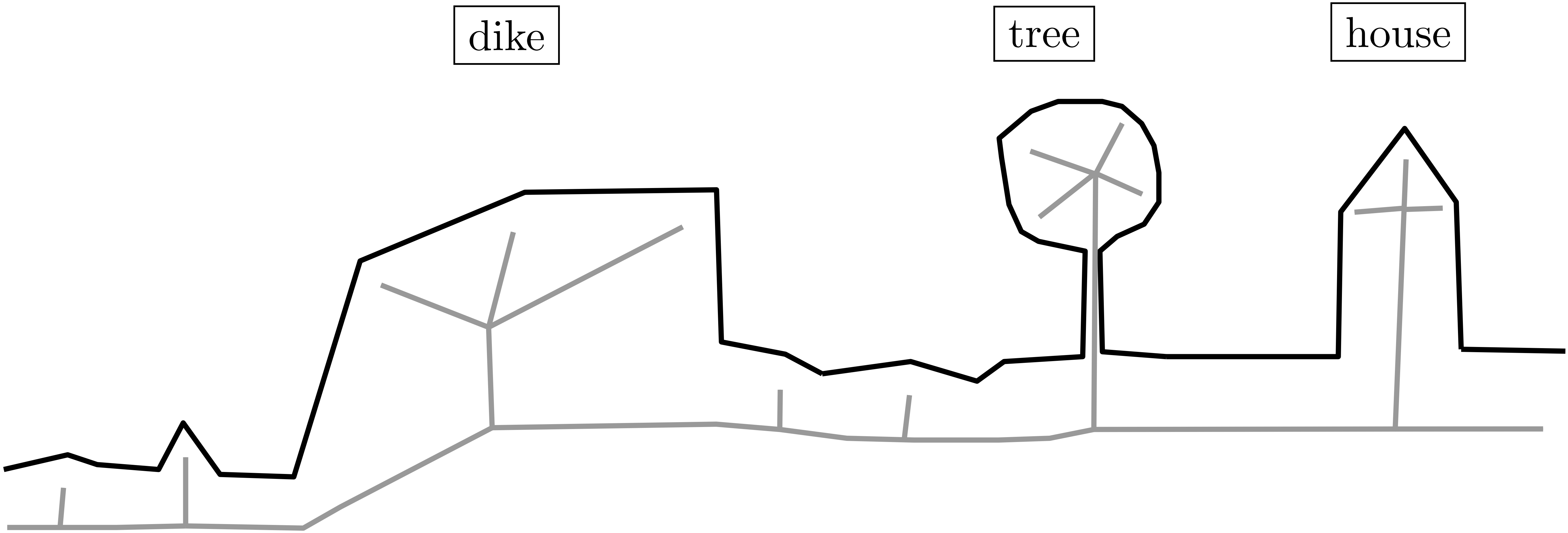
Hugo Ledoux, Ravi Peters and Jantien Stoter

6th user committee meeting
2017-07-04
Sweco, De Bilt

3D geoinformation
3d.bk.tudelft.nl
TU Delft Delft University of Technology

Reminder of original goals of the project


dike
tree
house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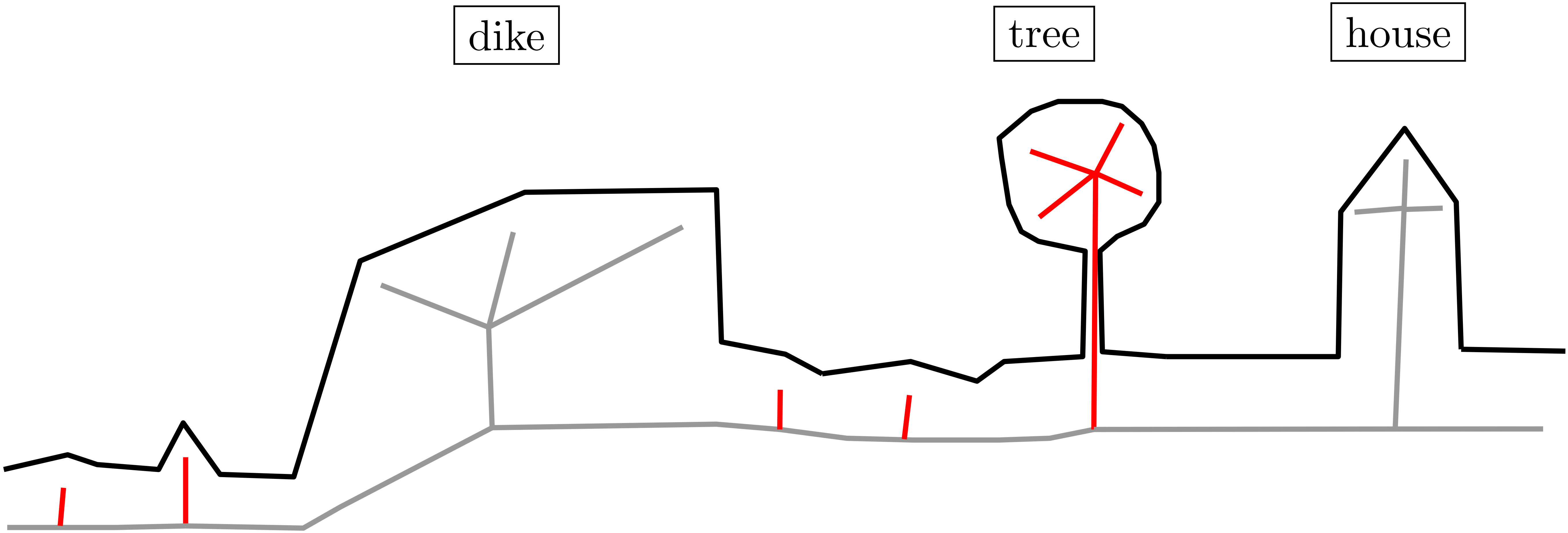
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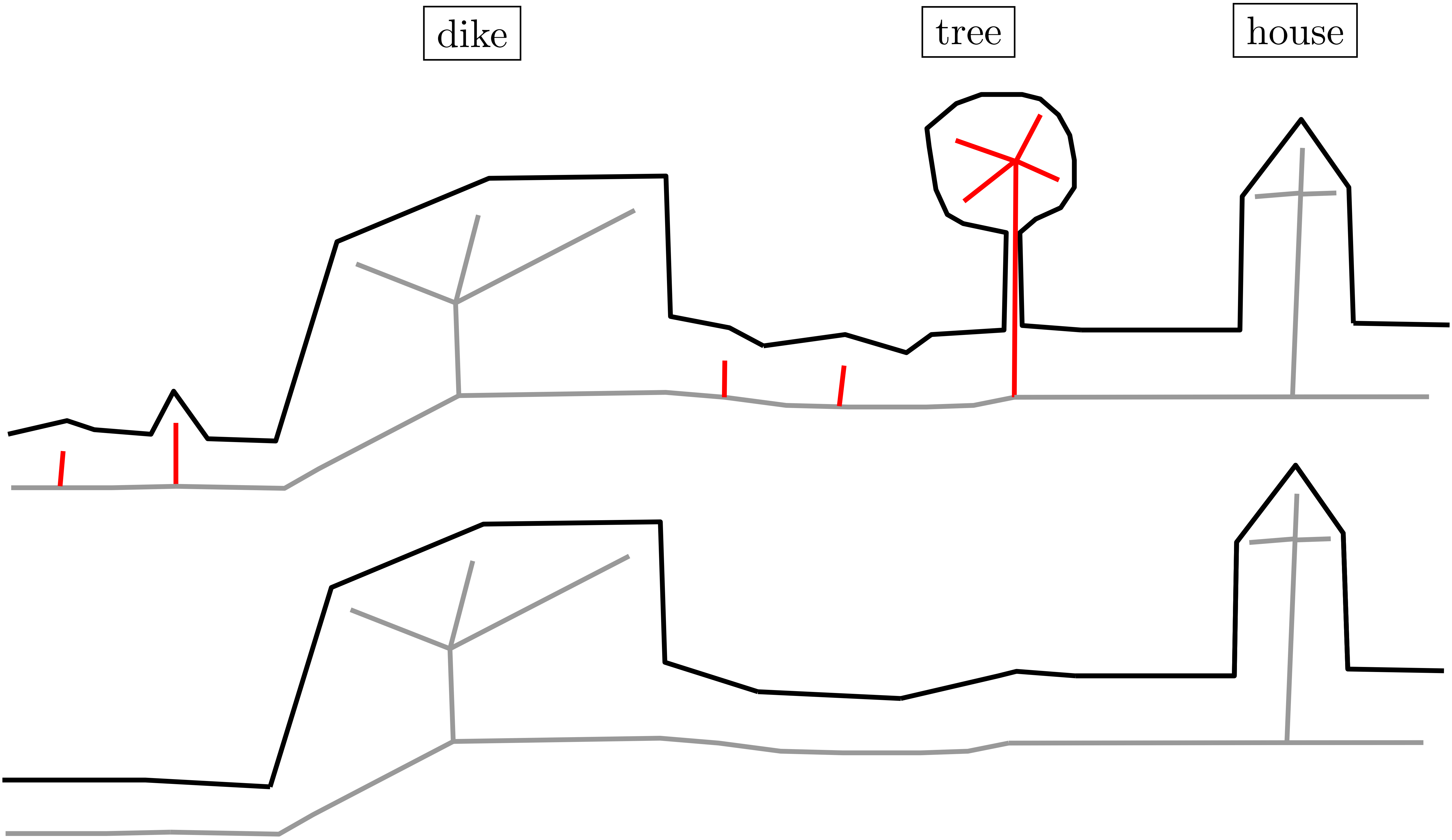
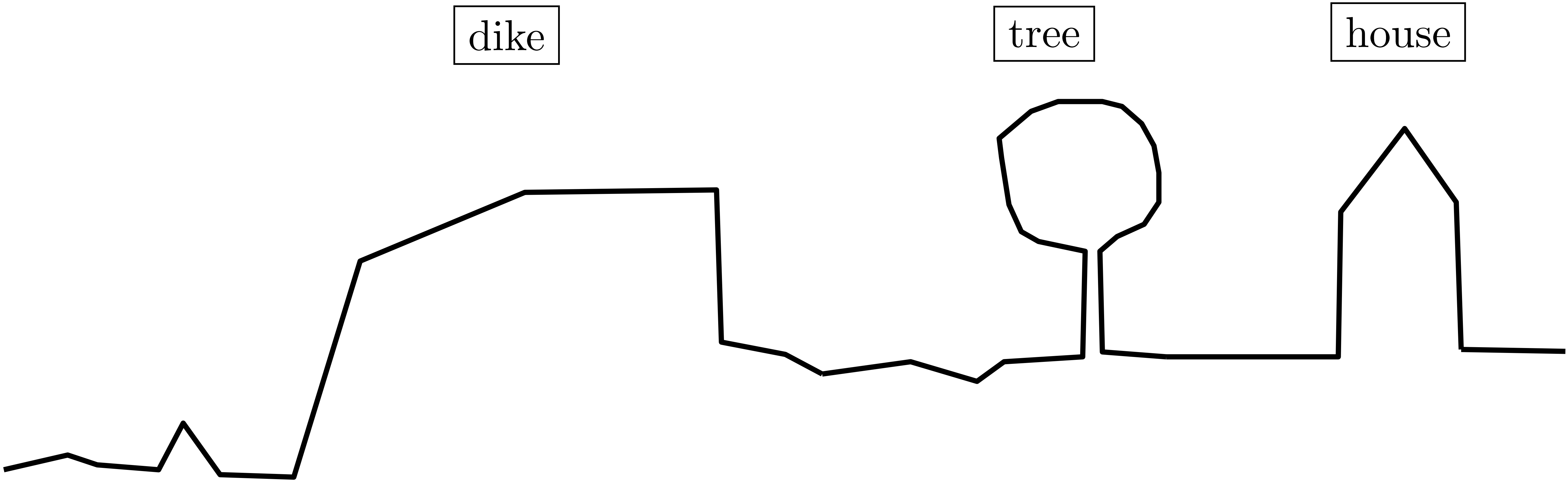
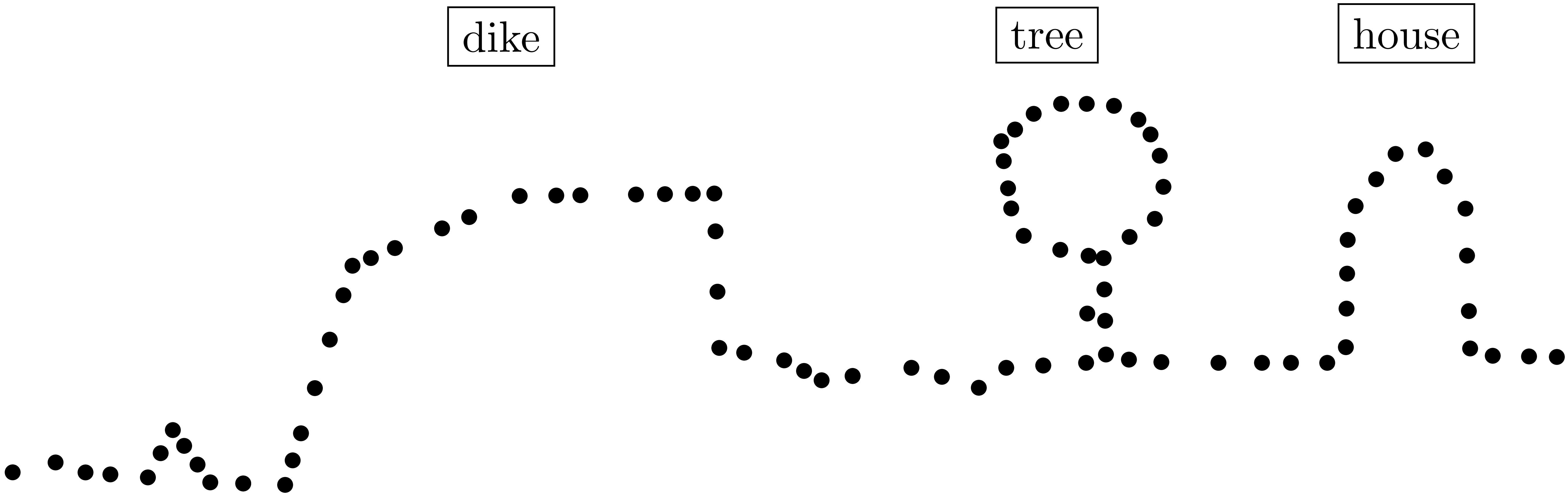

dike
tree
house

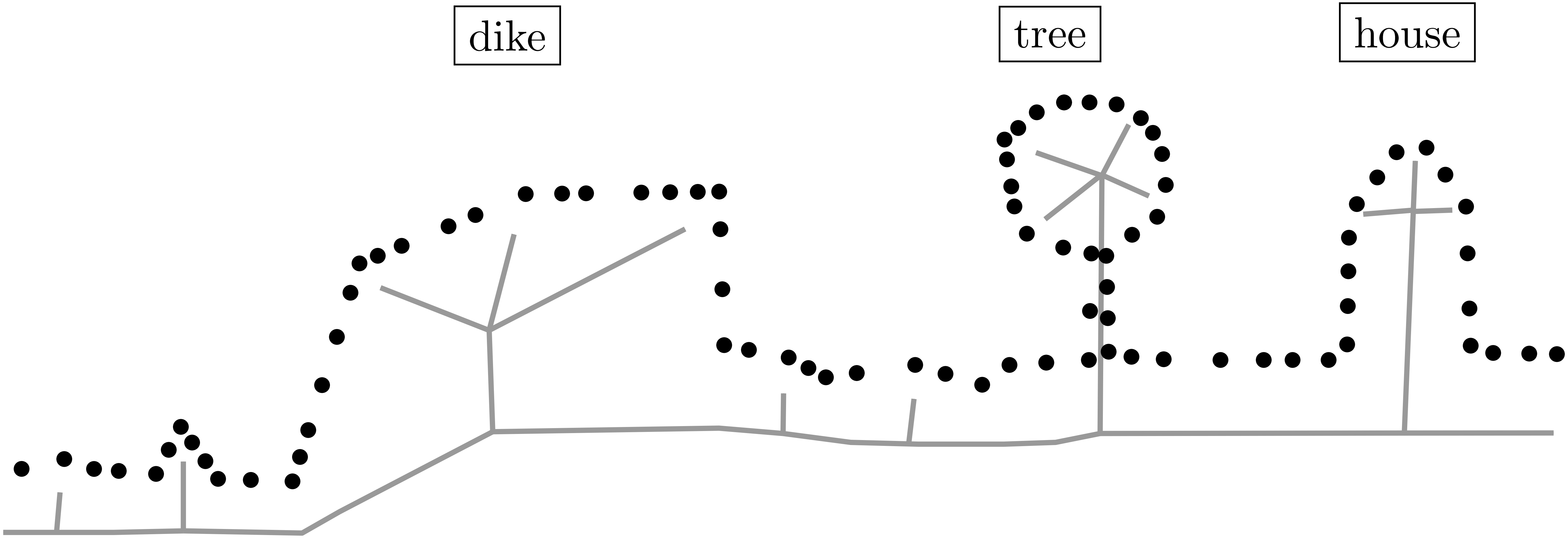
no more surface, just the points (eg AHN3)

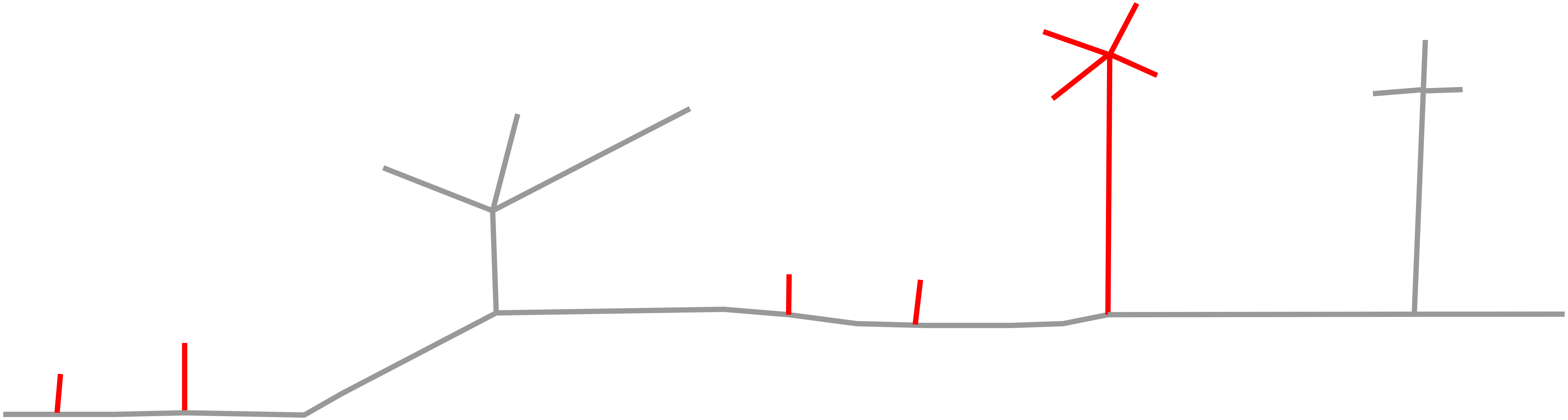


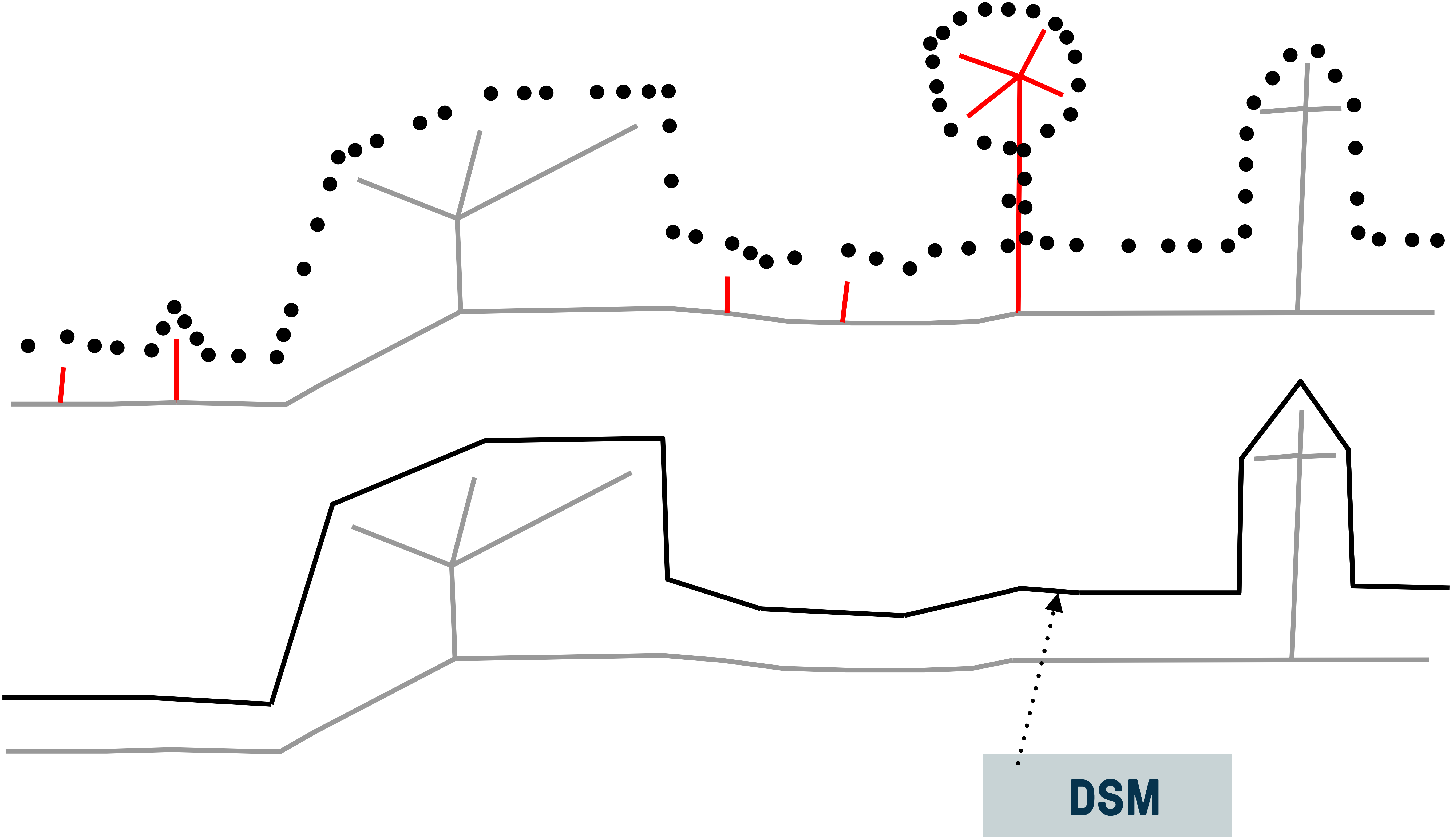
no more surface, just the points (eg AHN3)



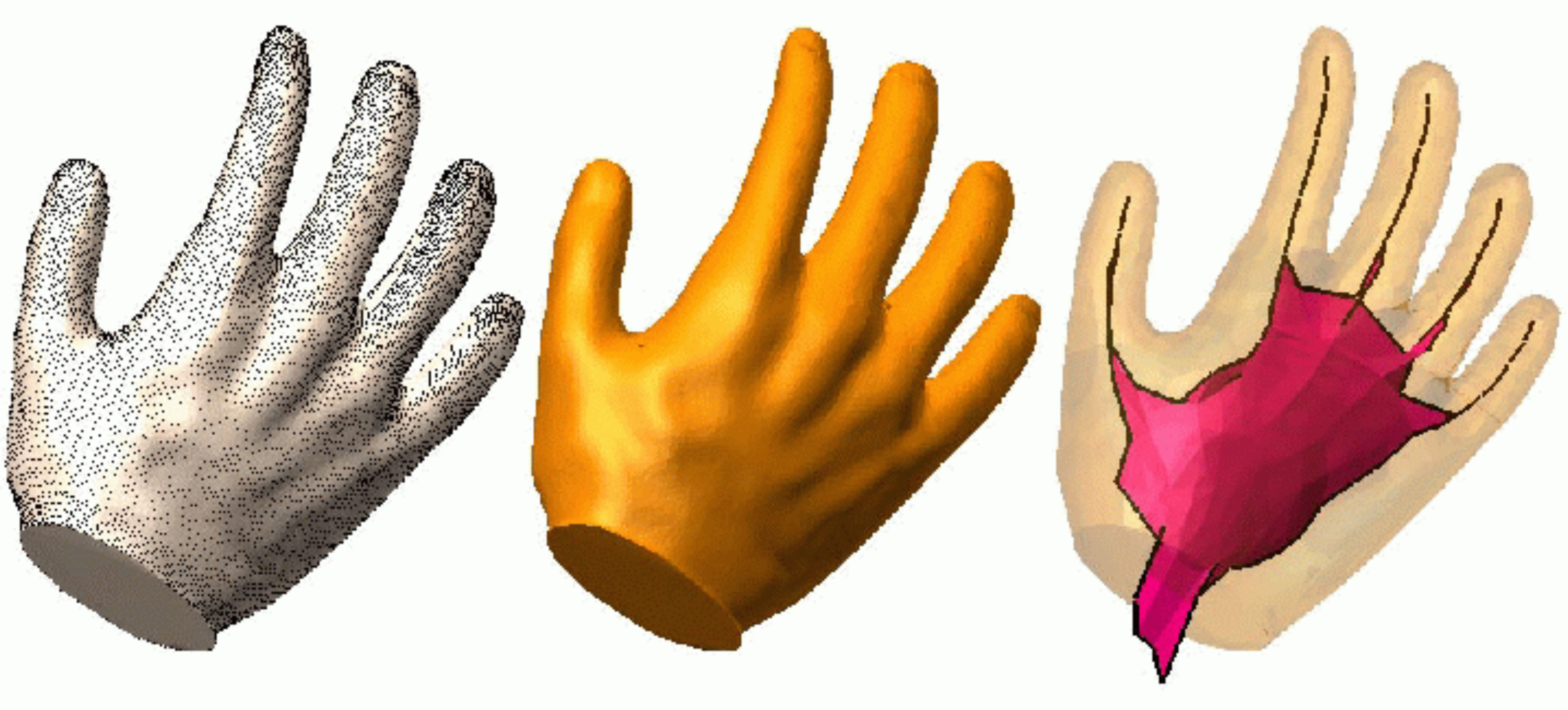
no more surface, just the points (eg AHN3)



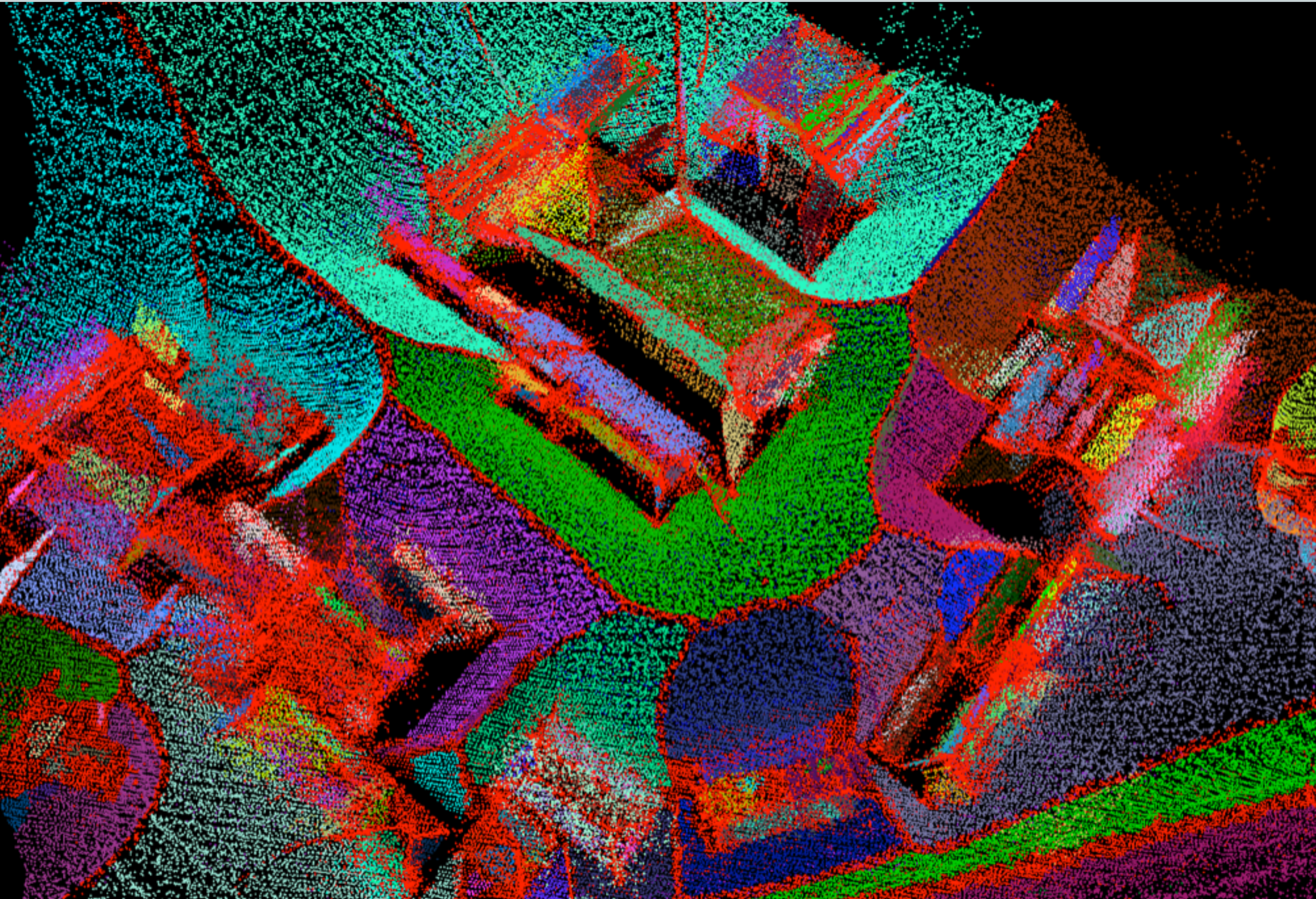



DSM

Medial axis transform (MAT) = skeleton



Medial axis transform (MAT) = skeleton



more appropriate title

Aerial point cloud modelling with the 3D Medial Axis Transform

Hugo Ledoux, Ravi Peters and Jantien Stoter

6th user committee meeting
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3D geoinformation
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TU Delft Delft University of Technology

Main results 2017

Milestones

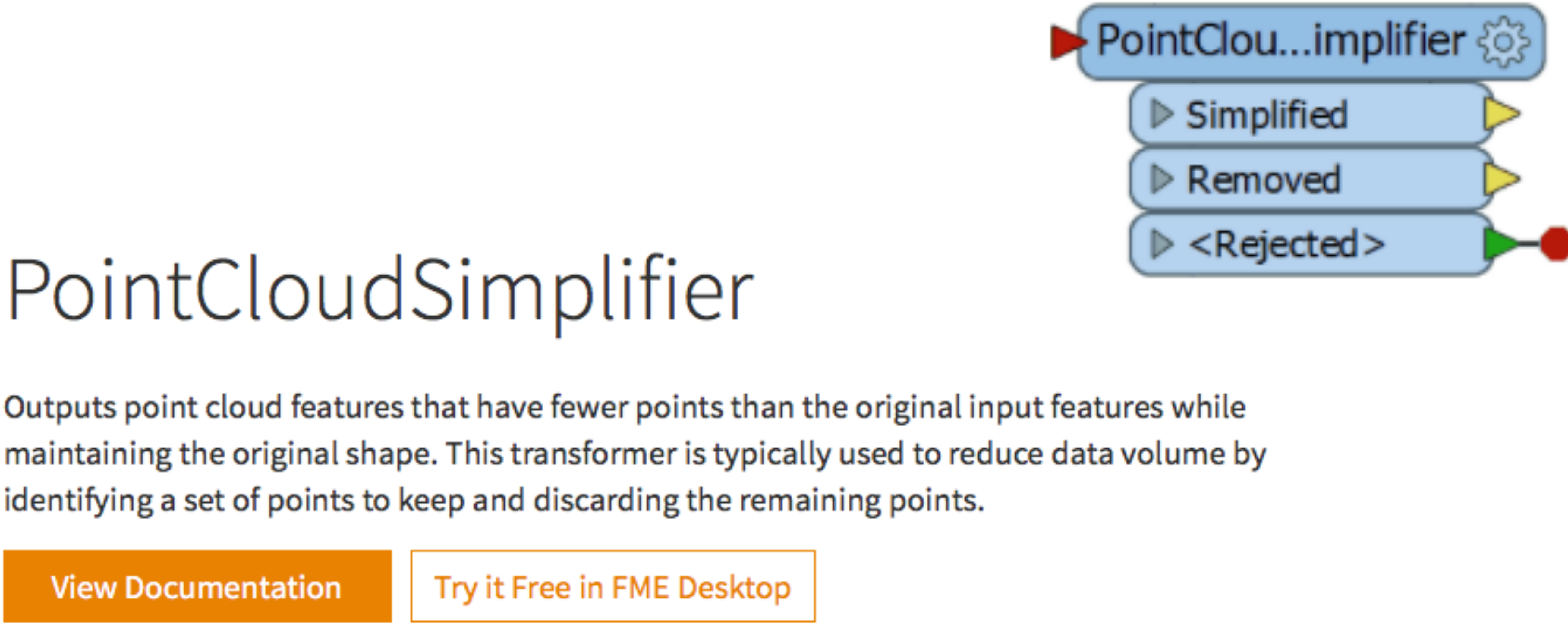
1. Ravi finished the work “needed”, as results are sufficient to defend PhD

2. Important knowledge transfer: results included in major GIS software (Safe FME)

3. 2nd ISI journal article accepted

   Automatic identification of watercourses in flat and engineered landscapes by computing the skeleton of a LiDAR point cloud. Broersen, Peters, Ledoux. Computers and Geosciences

Safe FME now has a transformer from the project



PointCloudSimplifier

Outputs point cloud features that have fewer points than the original input features while maintaining the original shape. This transformer is typically used to reduce data volume by identifying a set of points to keep and discarding the remaining points.

Other results/successes

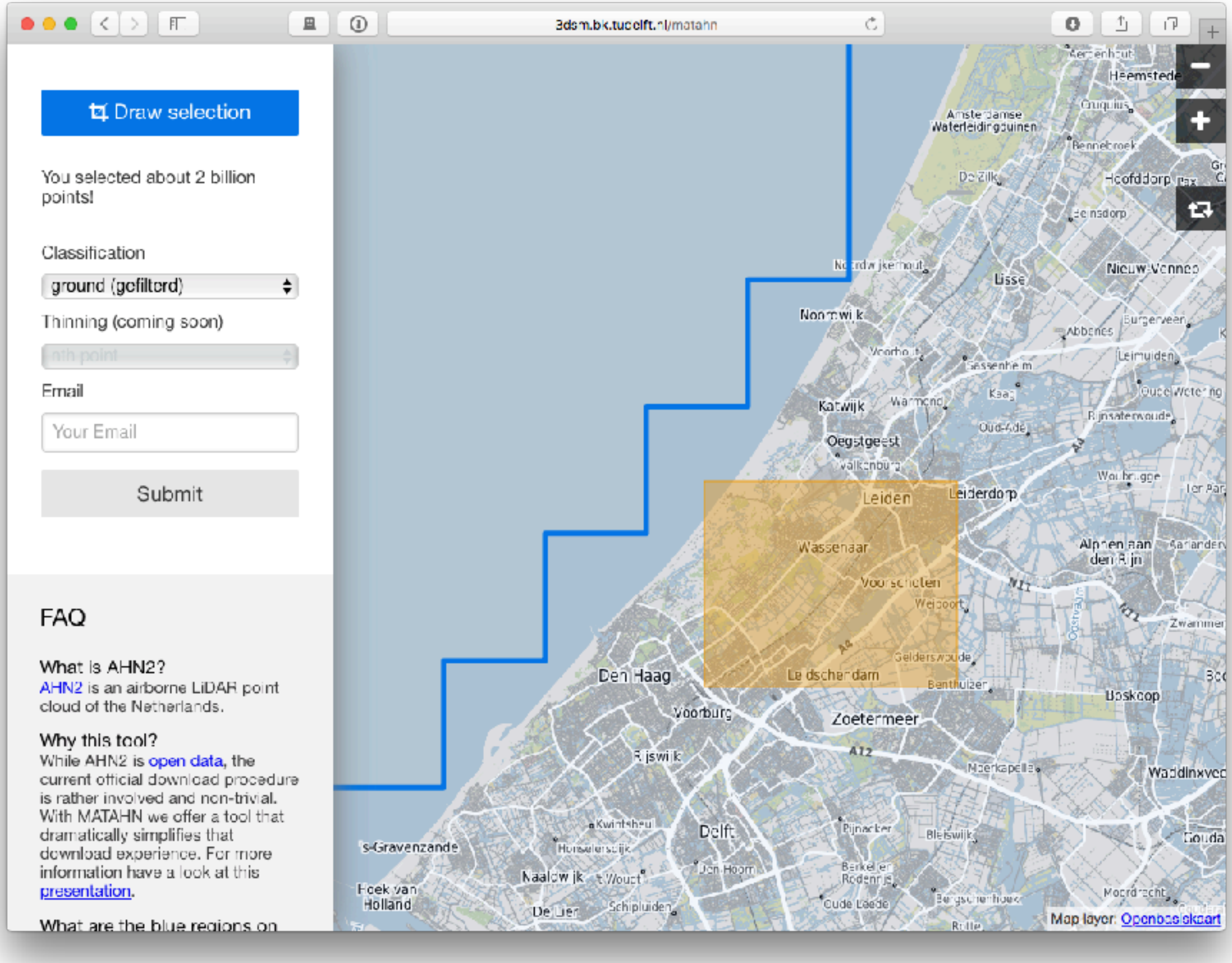
1. Finished the work related to the construction of an **explicit hierarchy in the MAT** and the computation of certain metrics/ properties of the MAT that are critical for the development of further real-world use cases for the MAT.

2. Ravi paid a research visit of ~1 month to FBK/Trento (http://3dom.fbk.eu).

3. Our project was shortlisted by the Valorisation Centre of the TU Delft as potentially interesting for extra funding/help from the Google X project (https://x.company).

Complete overview of projects results

A “better” AHN2/3 download page



3dsm.bk.tudelft.nl/matahn

Draw selection

You selected about 2 billion points!

Classification

ground (gefilterd)

Thinning (coming soon)

nth point

Email

Your Email

Submit

FAQ

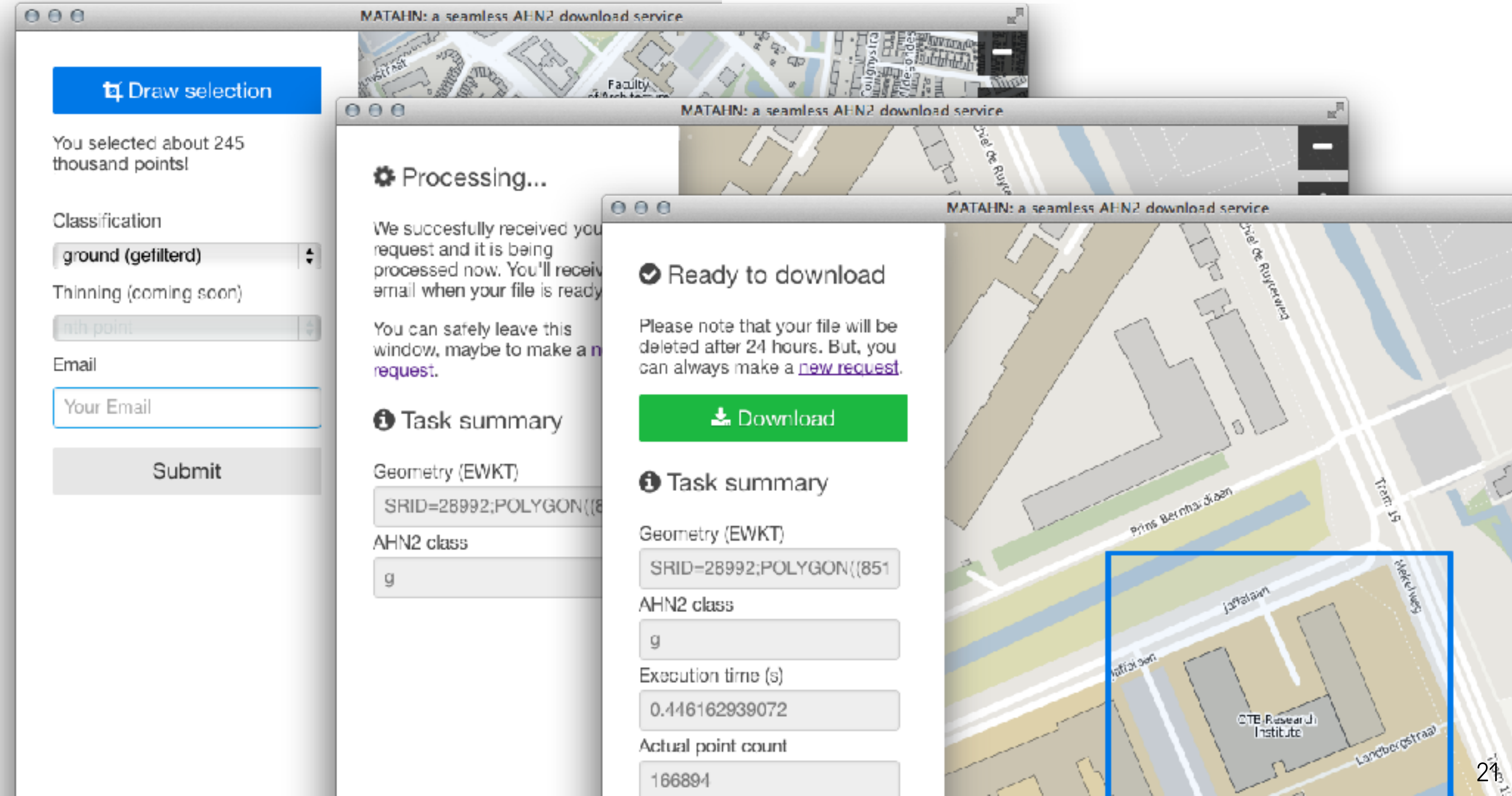
What is AHN2?
AHN2 is an airborne LiDAR point cloud of the Netherlands.

Why this tool?
While AHN2 is open data, the current official download procedure is rather involved and non-trivial. With MATAHN we offer a tool that dramatically simplifies that download experience. For more information have a look at this presentation.

What are the blue regions on

A “better” AHN2/3 download page

- As simple as possible
- Download only what you need
- No tiles



MATAHN: a seamless AHN2 download service

Draw selection

You selected about 245 thousand points!

Classification

ground (gefilterd)

Thinning (coming soon)

nth point

Email

Your Email

Submit

MATAHN: a seamless AHN2 download service

Processing...

We succesfully received you request and it is being processed now. You'll receiv email when your file is ready

You can safely leave this window, maybe to make a n request.

Task summary

Geometry (EWKT)

SRID=28992;POLYGON((8

AHN2 class

g

MATAHN: a seamless AHN2 download service

Ready to download

Please note that your file will be deleted after 24 hours. But, you can always make a new request.

Download

Task summary

Geometry (EWKT)

SRID=28992;POLYGON((851

AHN2 class

g

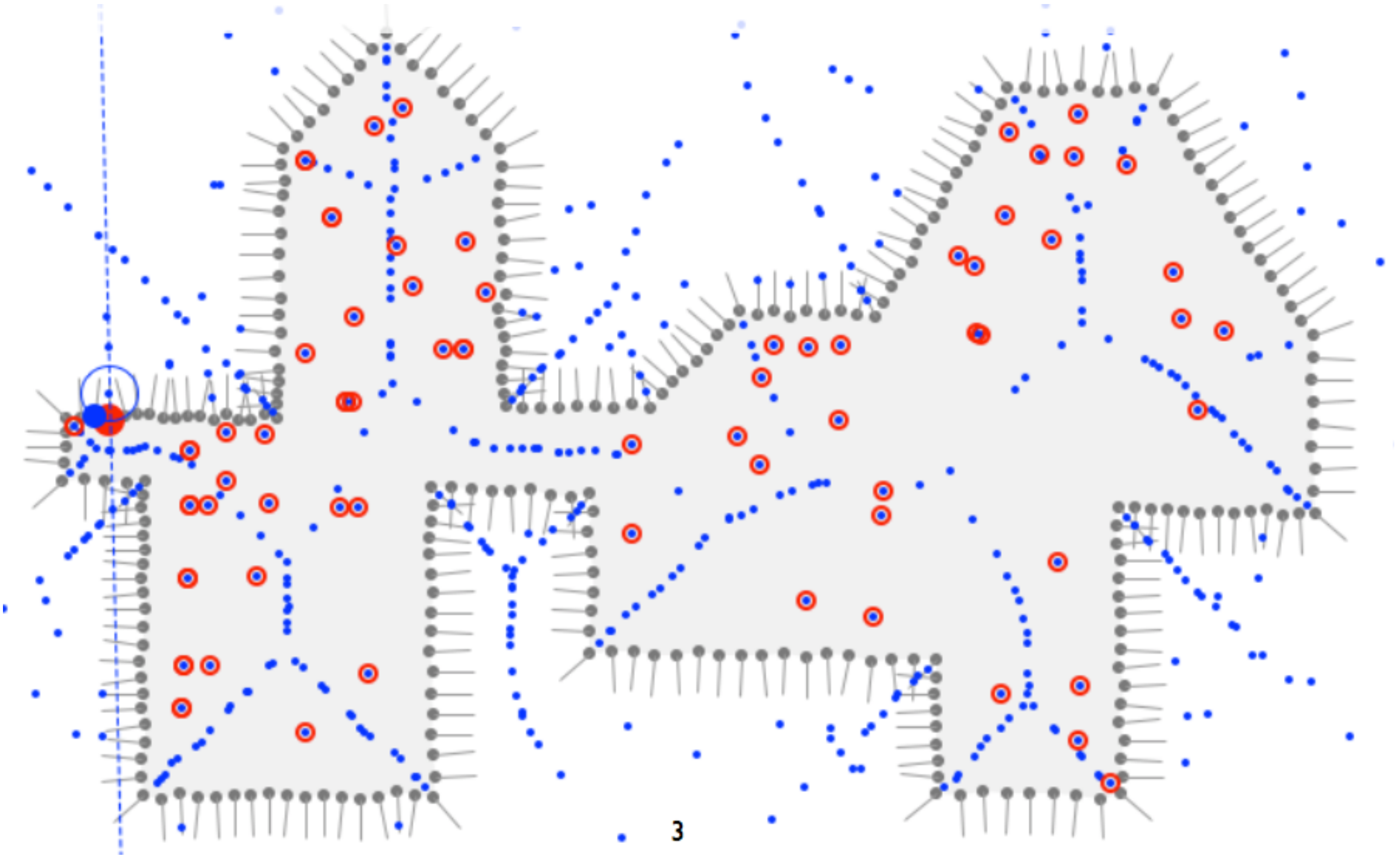
Execution time (s)

0.446162939072

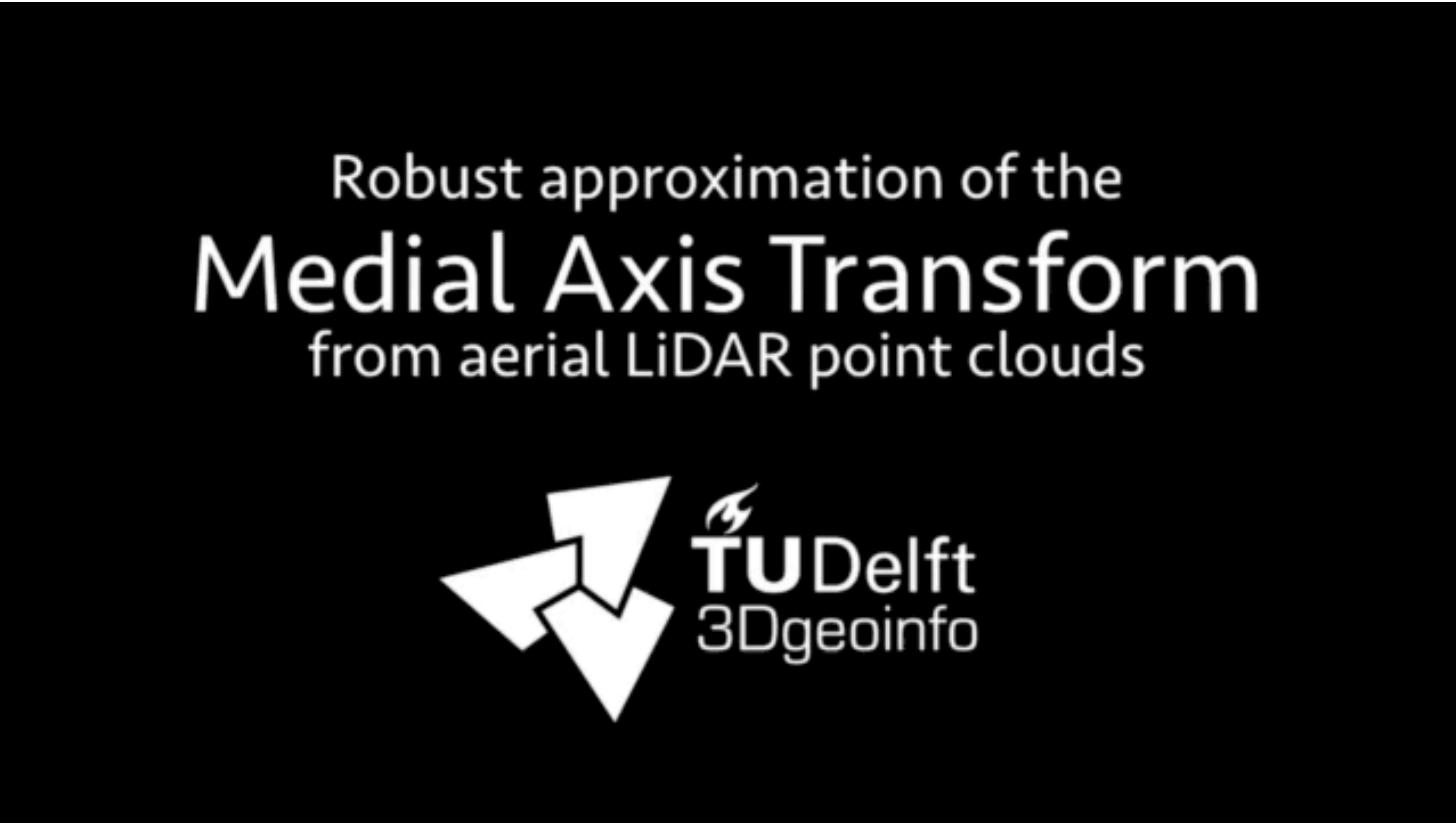
Actual point count

166894

Algorithms to compute 3D MAT of *noisy* aerial PC



Algorithms to compute 3D MAT of *noisy* aerial PC



Robust approximation of the

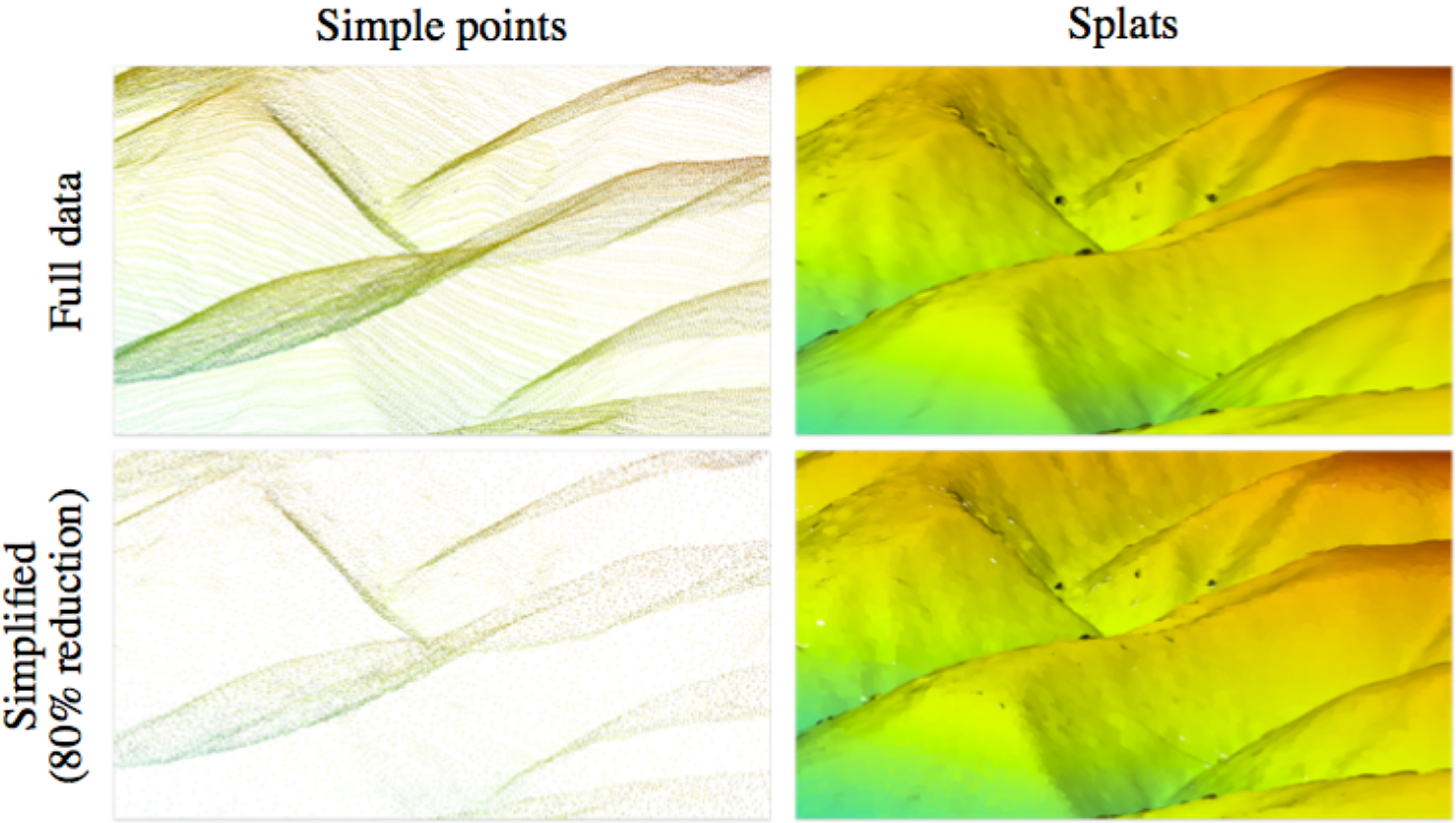
Medial Axis Transform

from aerial LiDAR point clouds

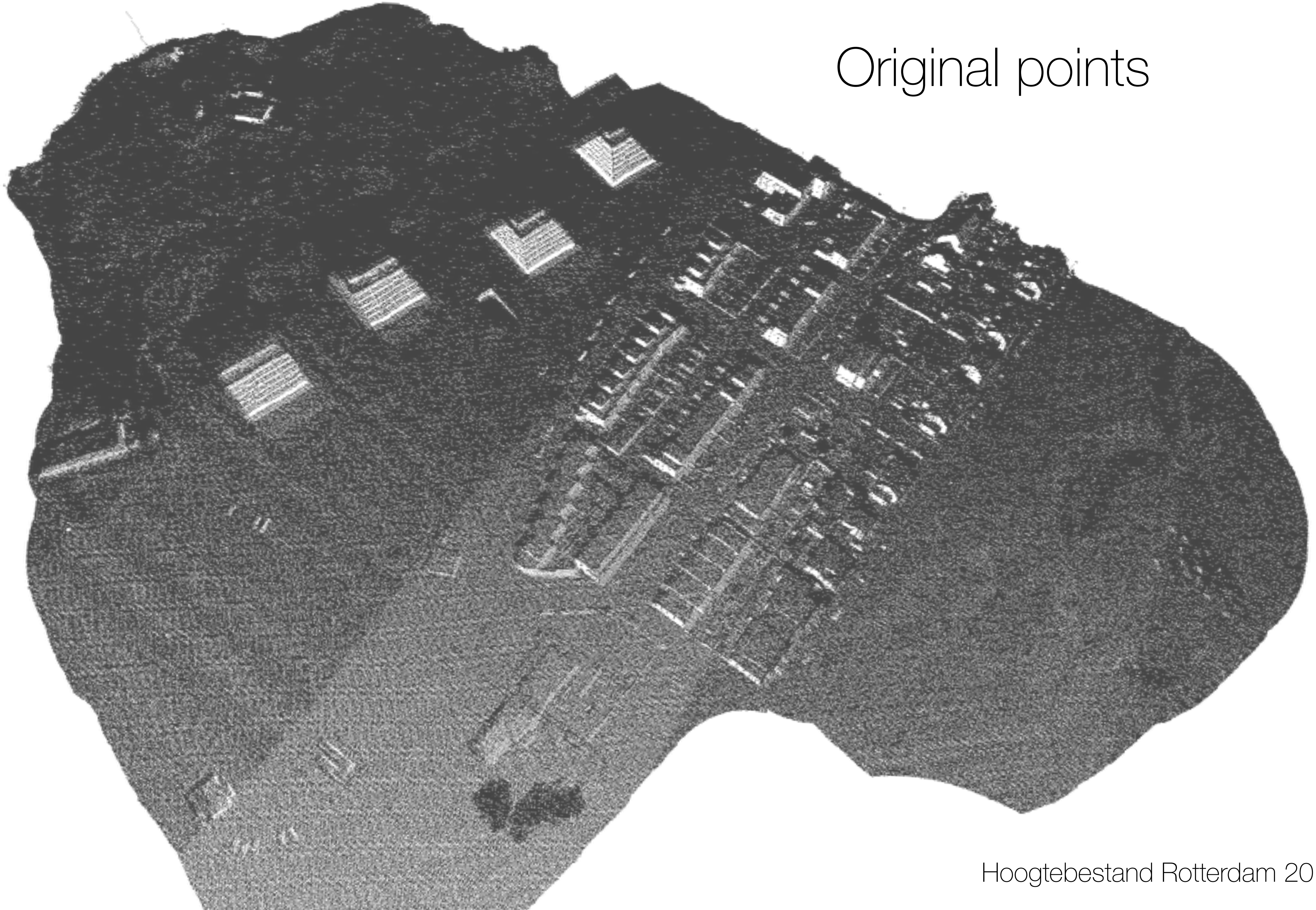
TU Delft

3Dgeoinfo

Simplification of PC (based on 3D MAT)



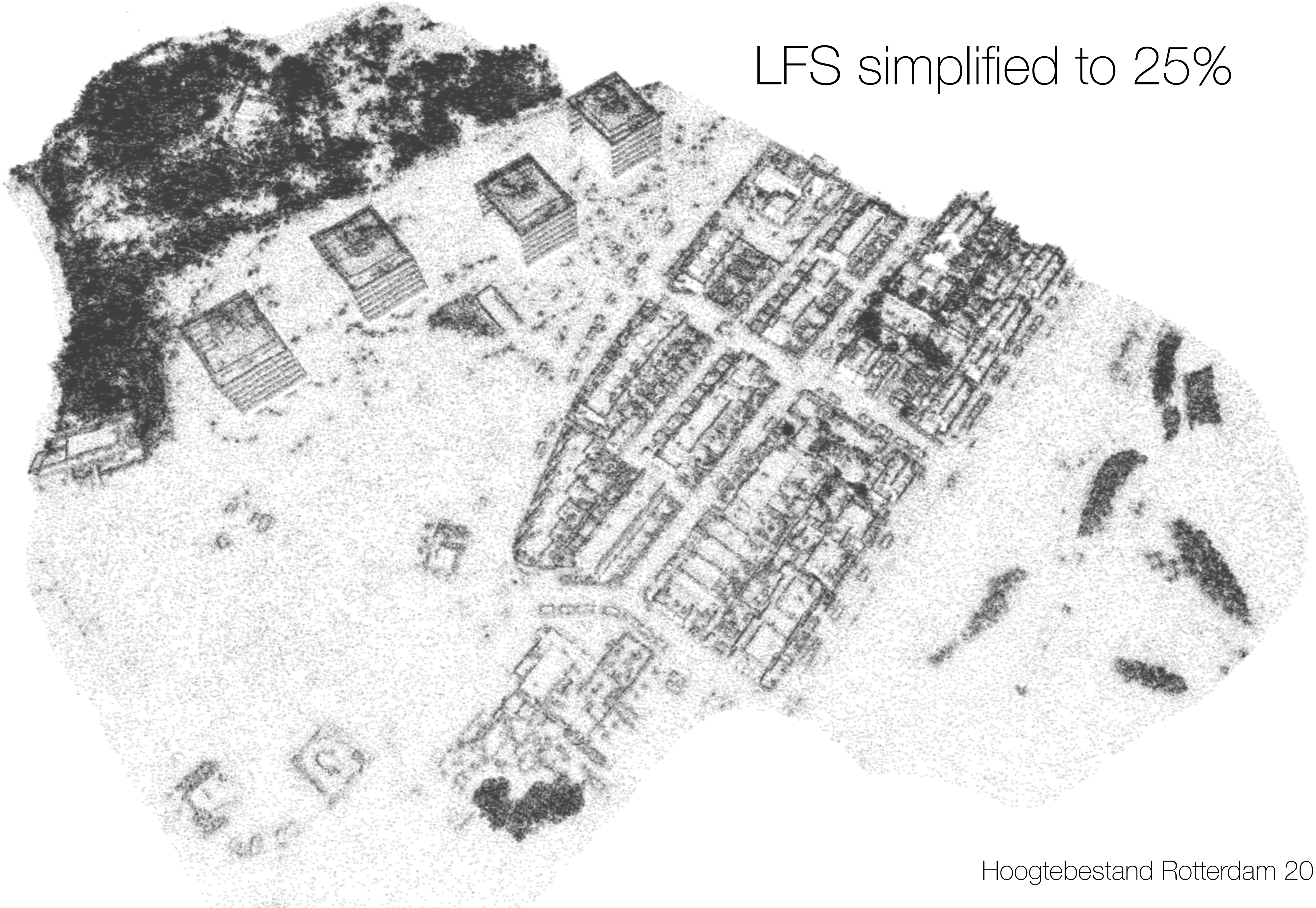
LFS simplification



Original points

Hoogtebestand Rotterdam 2012

LFS simplification

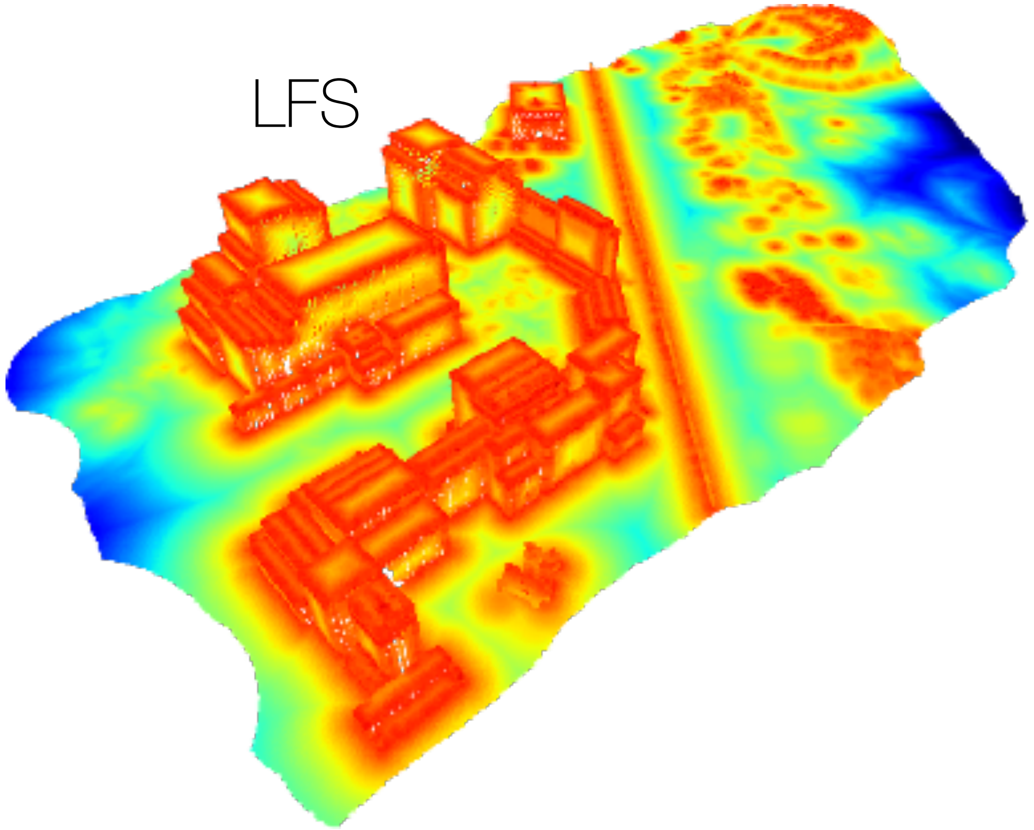


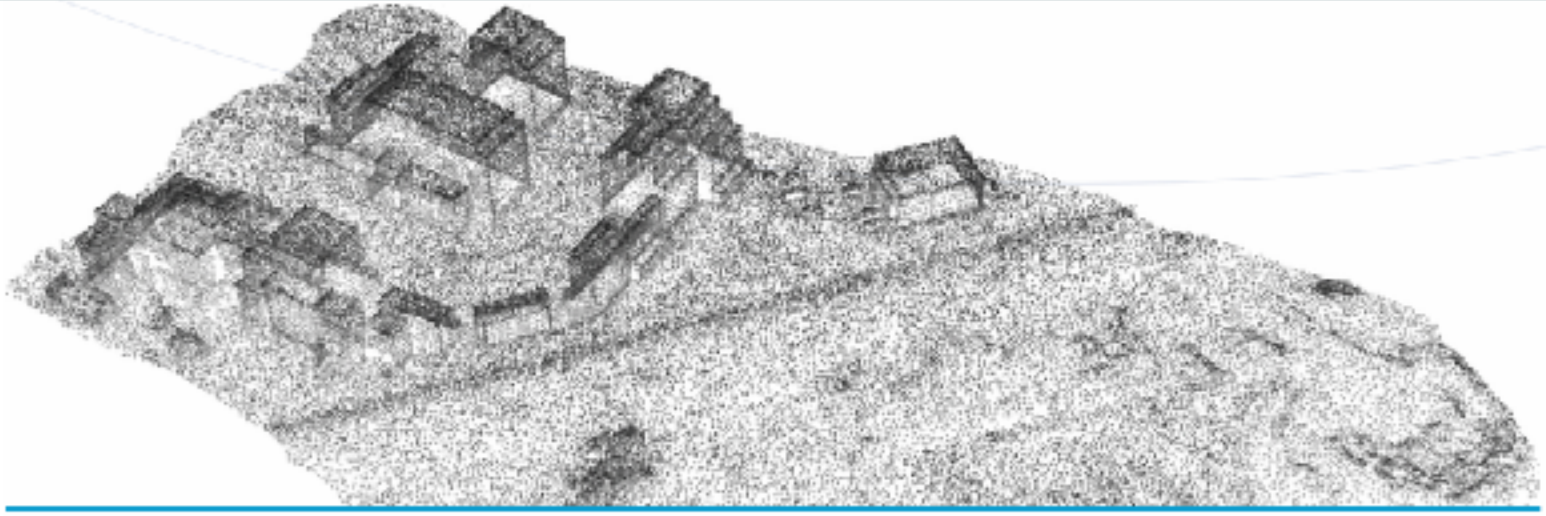
LFS simplified to 25%

Hoogtebestand Rotterdam 2012

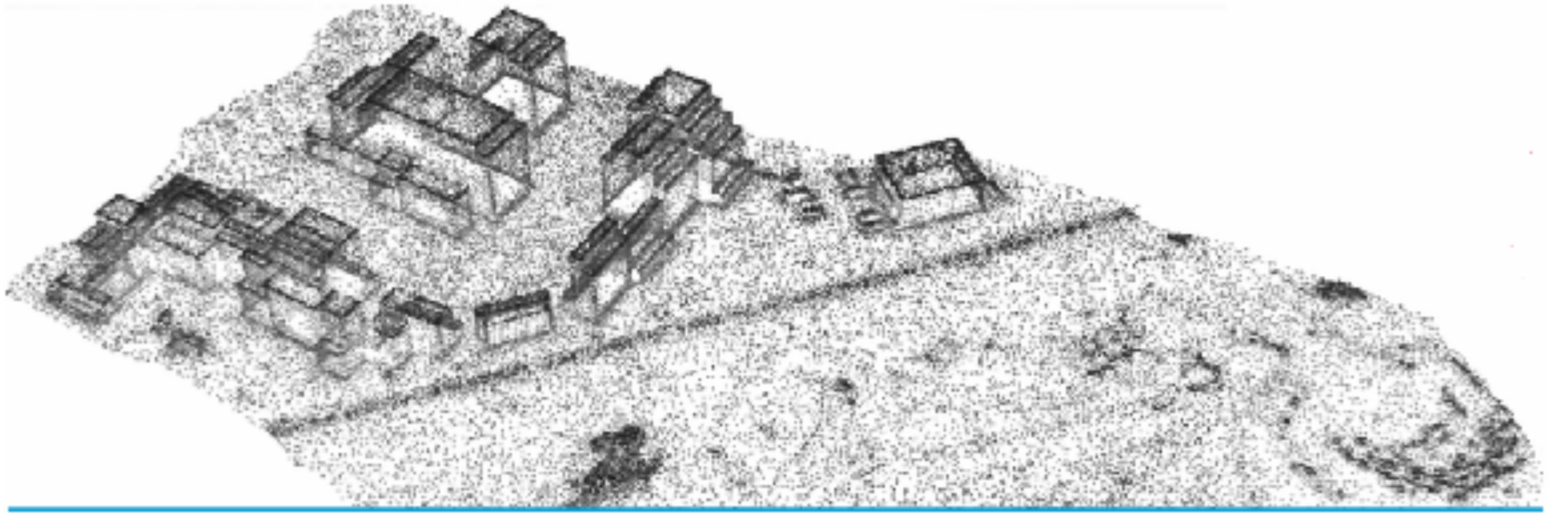
Results

Reduced to 11%

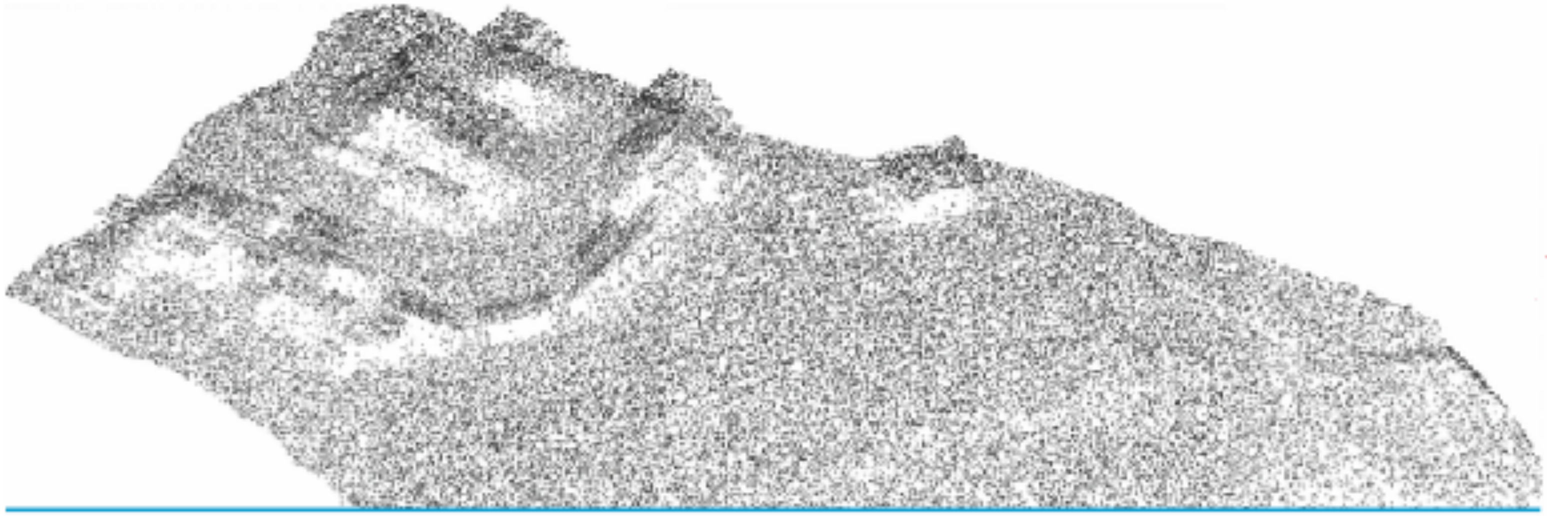




Local feature size simplification (linear)



Local feature size simplification (quadratic)

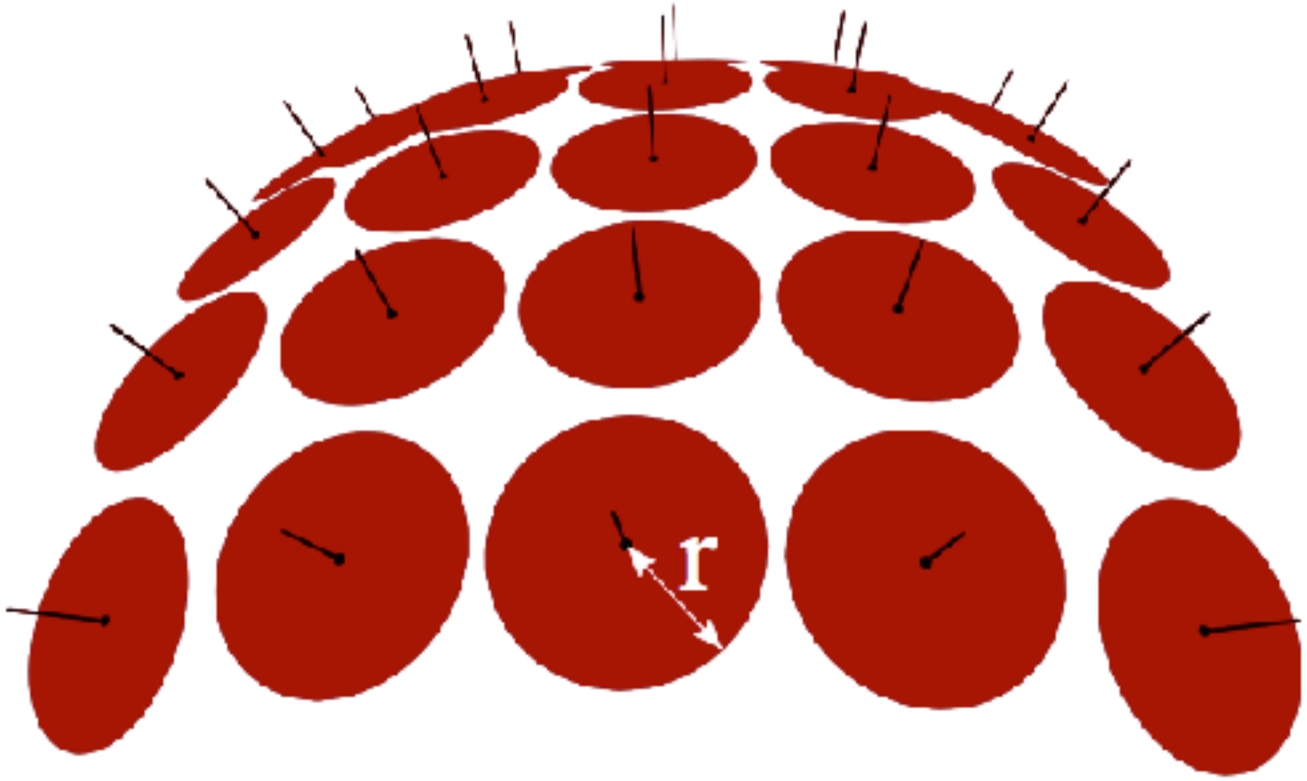


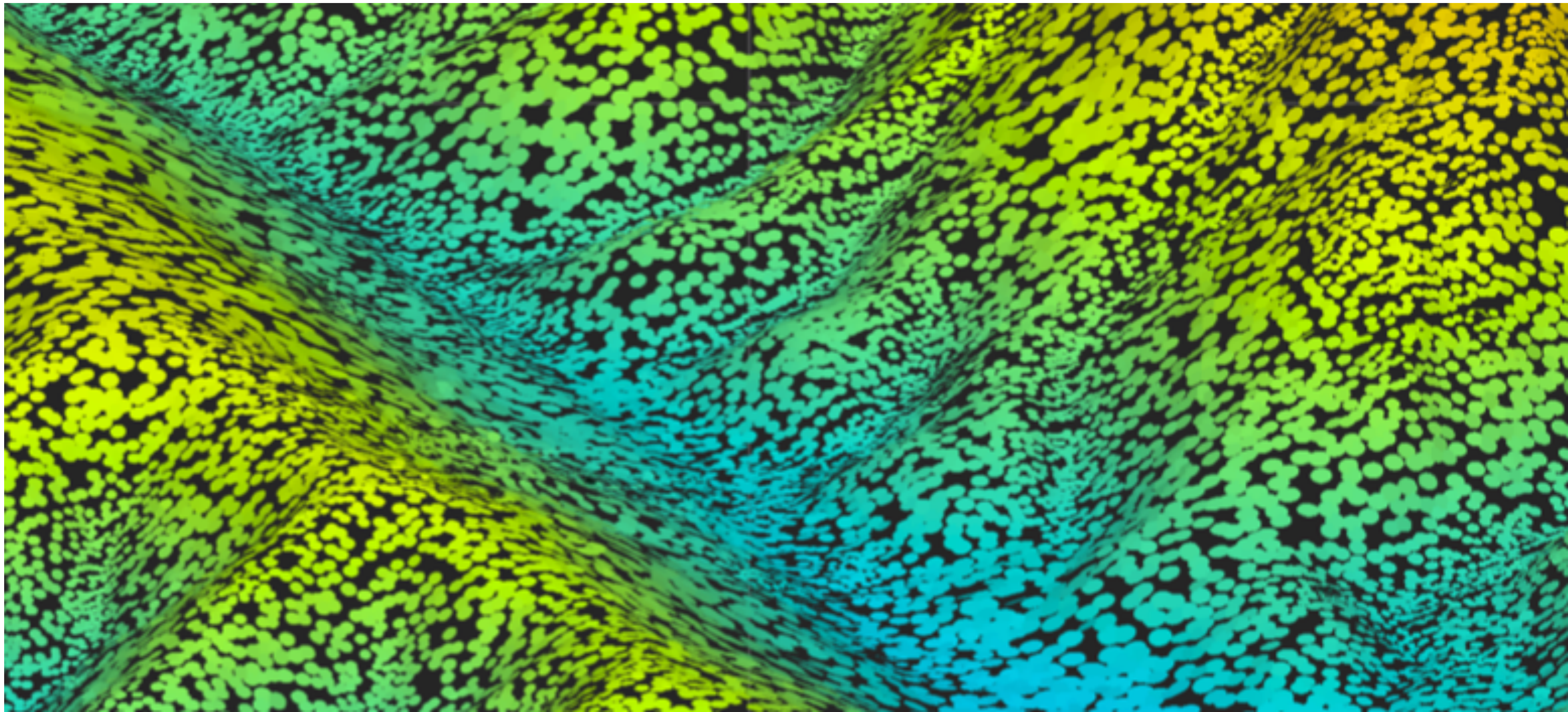
Random point thinning

Hoogtebestand Rotterdam 2012

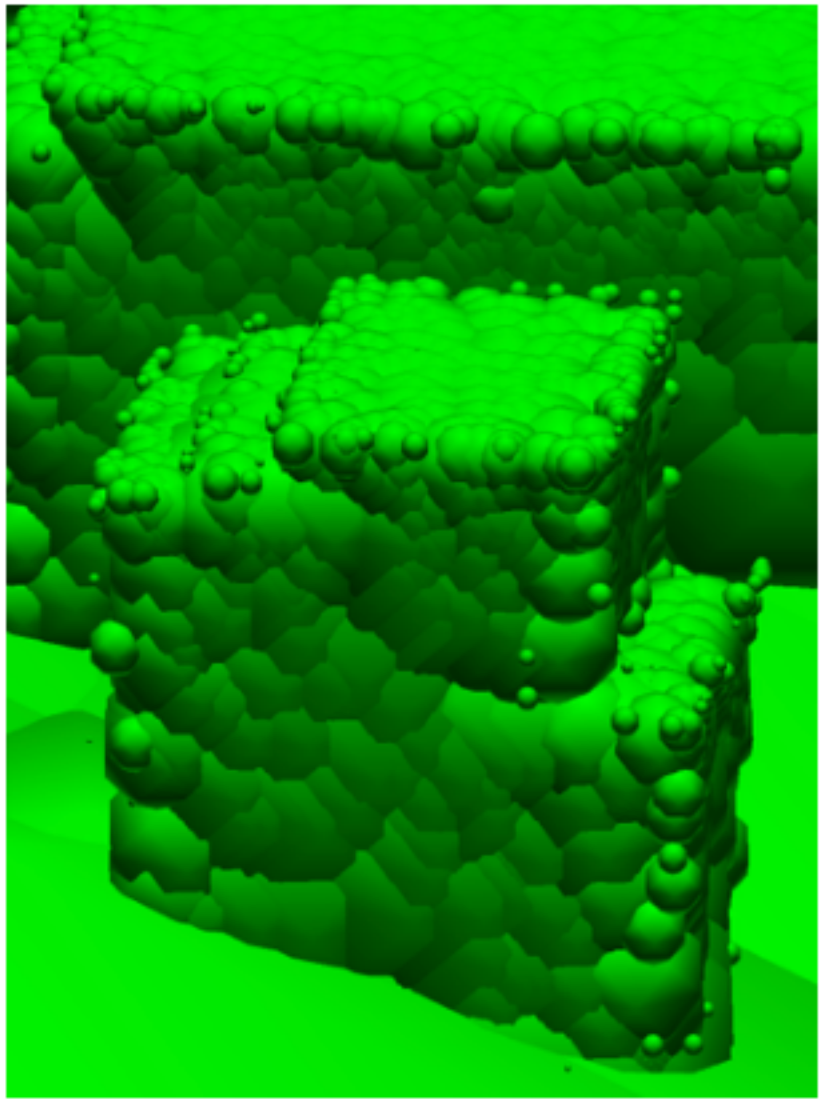
Visualisation of PC (based on 3D MAT)

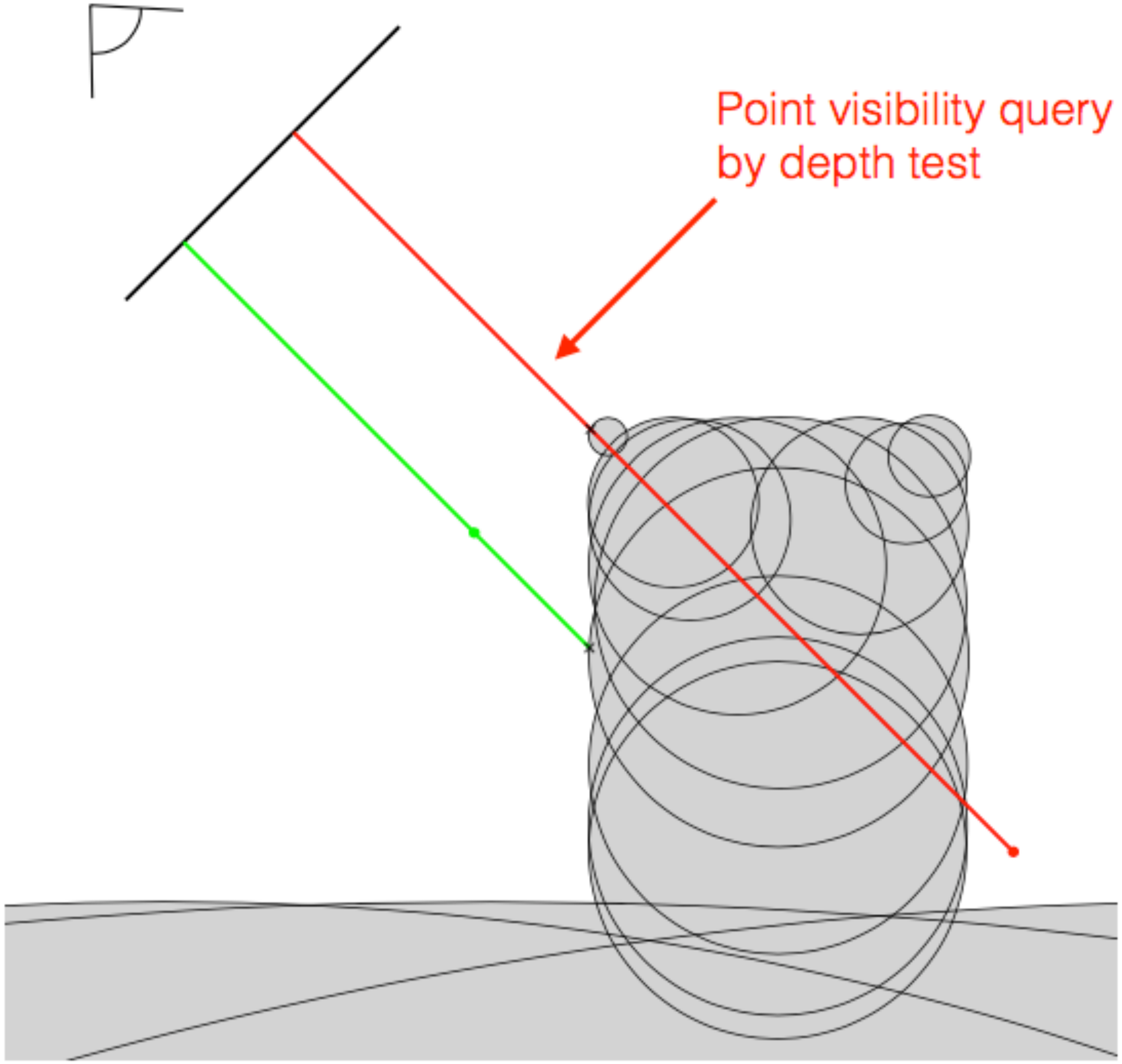
Splatting





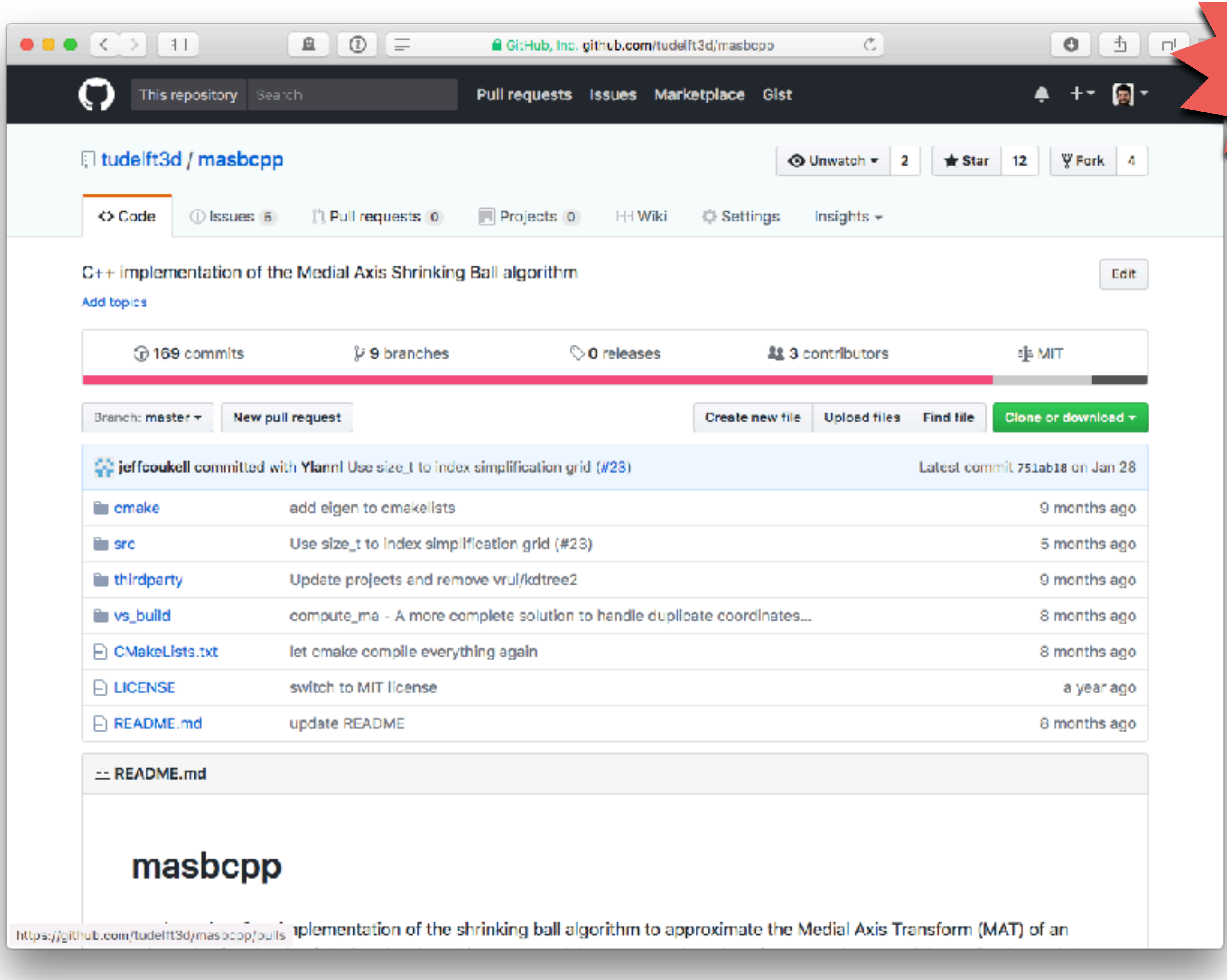
Visibility in a PC (based on 3D MAT)





code 3D noisy MAT computation == open-source

C++ for core algo



tudelft3d / masbcpp

C++ implementation of the Medial Axis Shrinking Ball algorithm

169 commits · 9 branches · 0 releases · 3 contributors · MIT

jeffcoukell committed with Ylannl Use size_t to index simplification grid (#23) — Latest commit 751ab18 on Jan 28

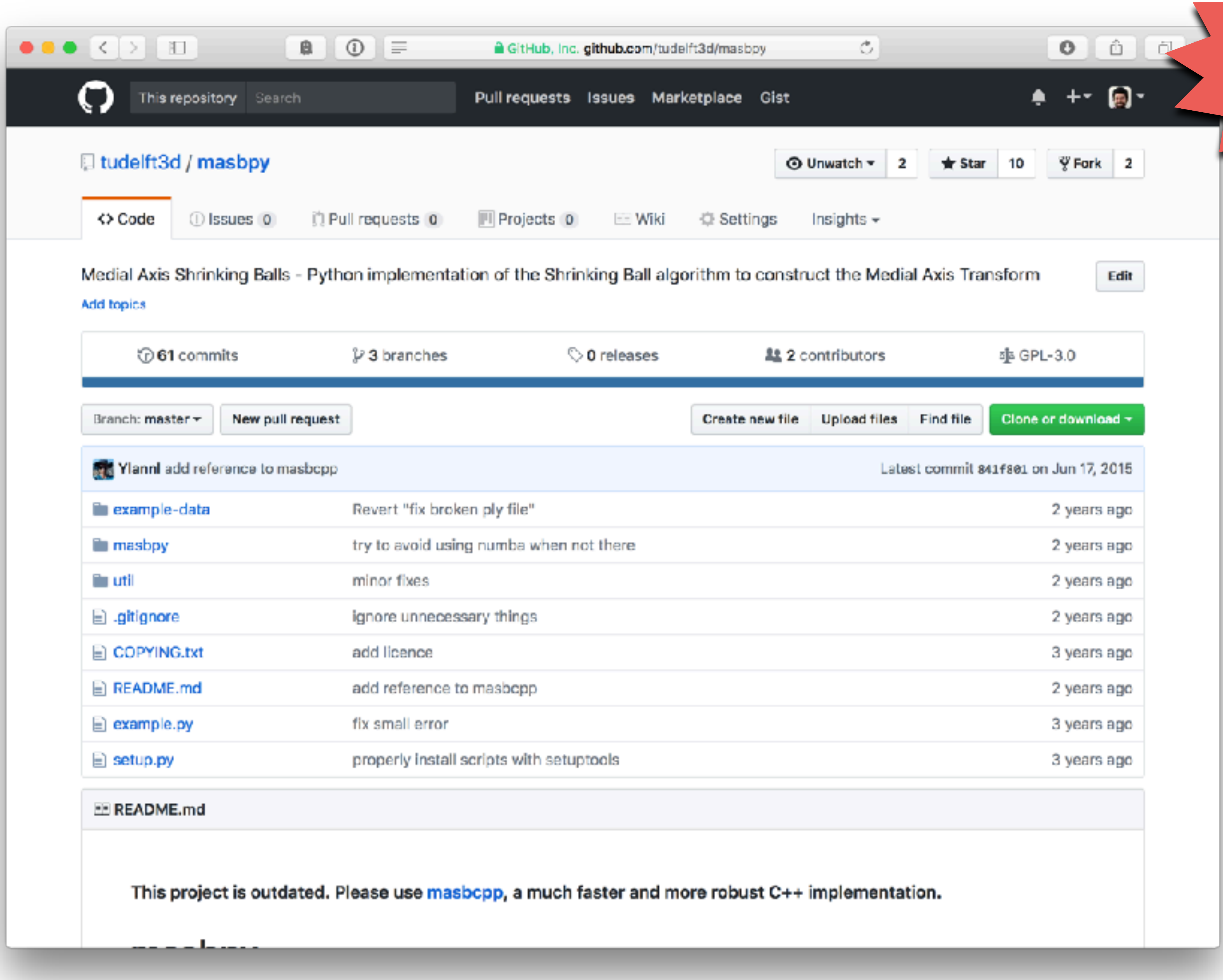
cmake	add eigen to cmakelists	9 months ago
src	Use size_t to index simplification grid (#23)	5 months ago
thirdparty	Update projects and remove vrui/kdtree2	9 months ago
vs_build	compute_ma - A more complete solution to handle duplicate coordinates…	8 months ago
CMakeLists.txt	let cmake compile everything again	8 months ago
LICENSE	switch to MIT license	a year ago
README.md	update README	8 months ago

README.md

masbcpp

mplementation of the shrinking ball algorithm to approximate the Medial Axis Transform (MAT) of an

code 3D noisy MAT computation == open-source



GitHub, Inc. github.com/tudelft3d/masbpy

tudelft3d / masbpy

Medial Axis Shrinking Balls - Python implementation of the Shrinking Ball algorithm to construct the Medial Axis Transform

61 commits · 3 branches · 0 releases · 2 contributors · GPL-3.0

Ylannl add reference to masbcpp — Latest commit 841f801 on Jun 17, 2015

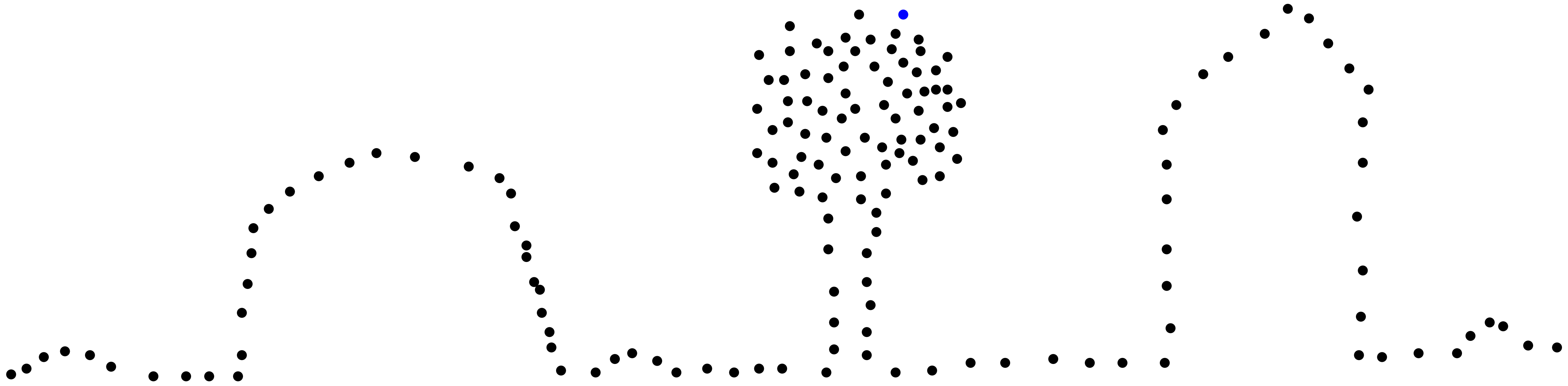
example-data	Revert "fix broken ply file"	2 years ago
masbpy	try to avoid using numba when not there	2 years ago
util	minor fixes	2 years ago
.gitignore	ignore unnecessary things	2 years ago
COPYING.txt	add licence	3 years ago
README.md	add reference to masbcpp	2 years ago
example.py	fix small error	3 years ago
setup.py	properly install scripts with setuptools	3 years ago

README.md

This project is outdated. Please use masbcpp, a much faster and more robust C++ implementation.

Python for extensions

Building the “topology” of the MAT (to allow analysis)



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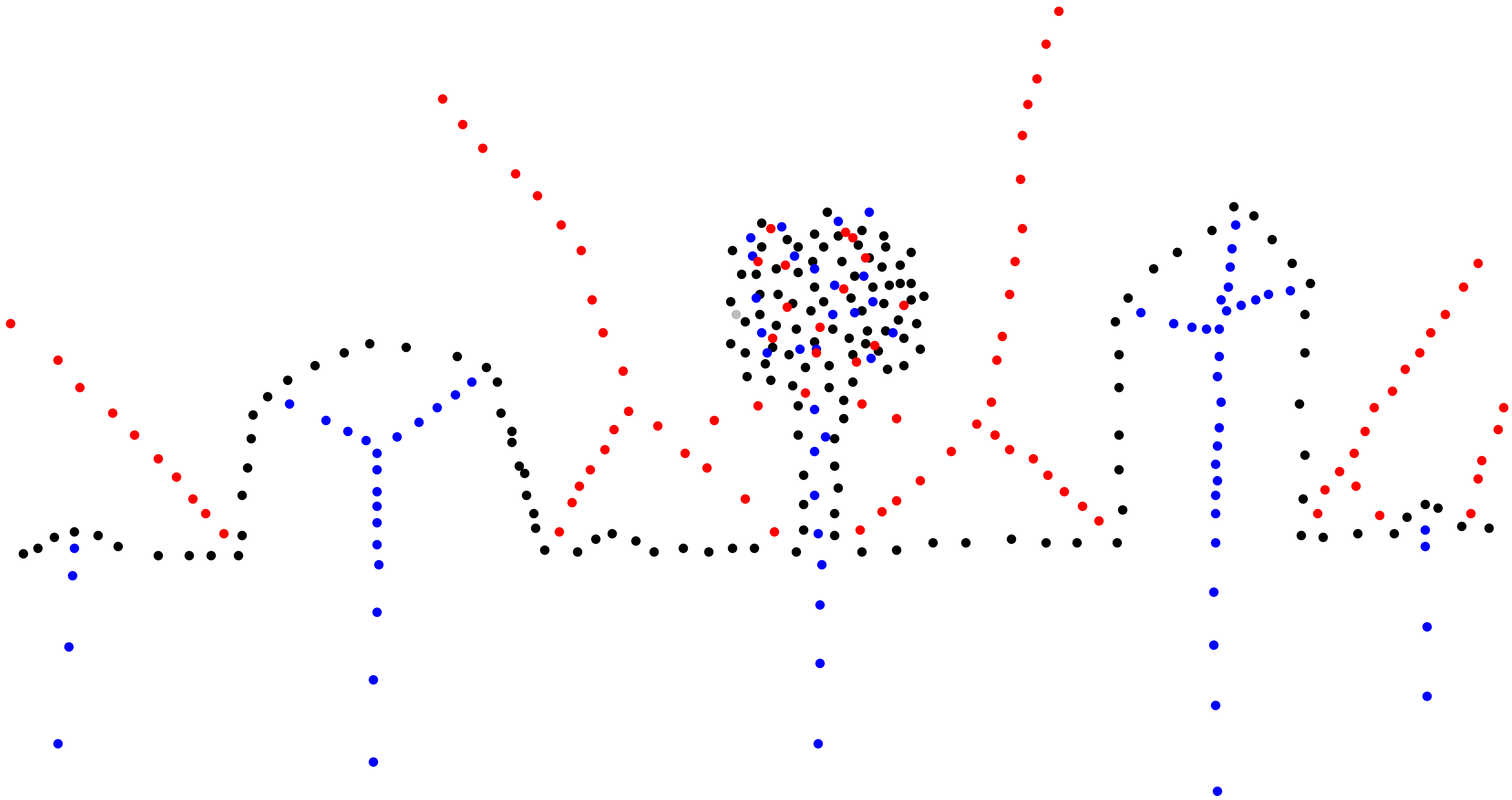

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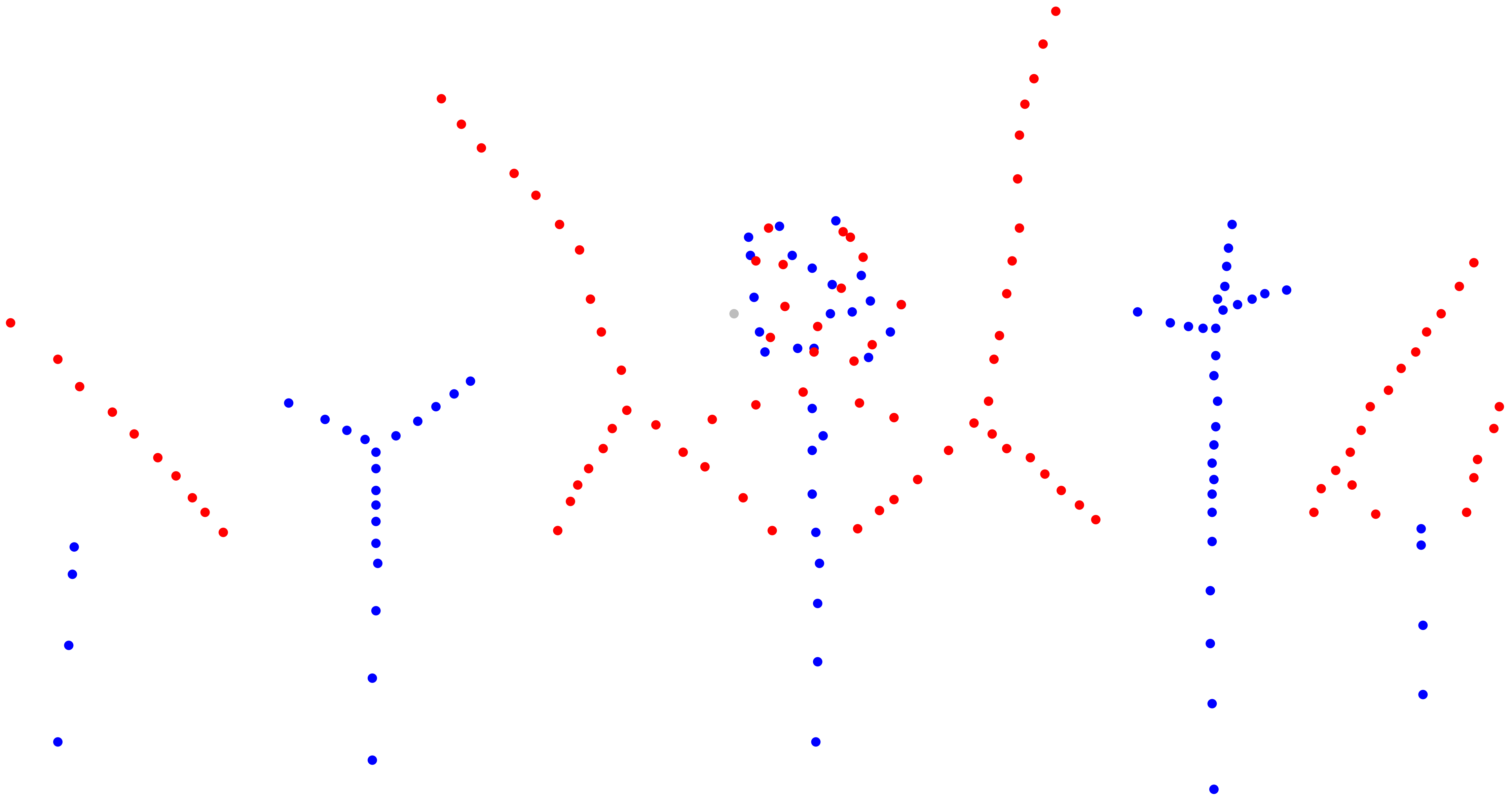

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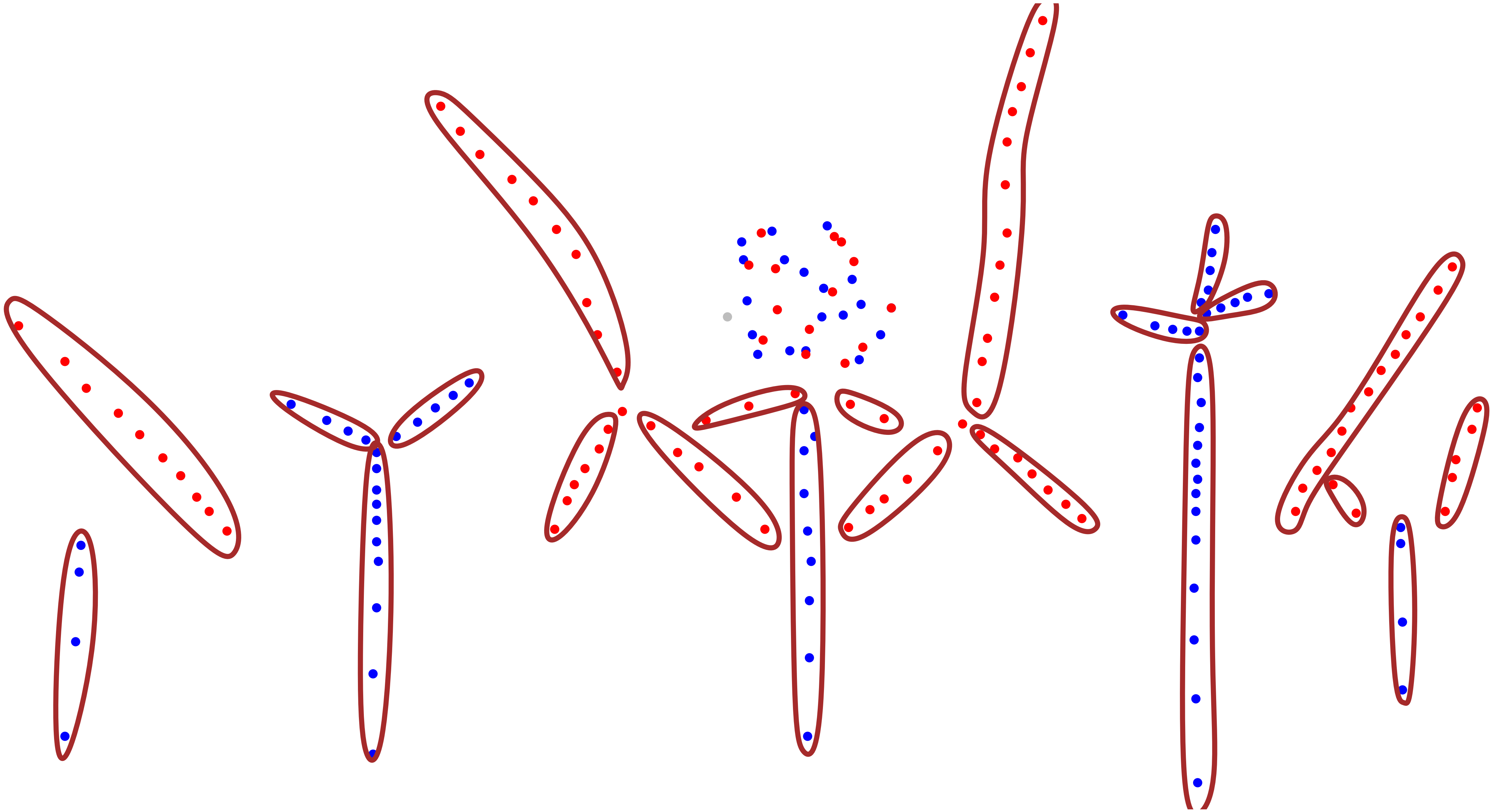

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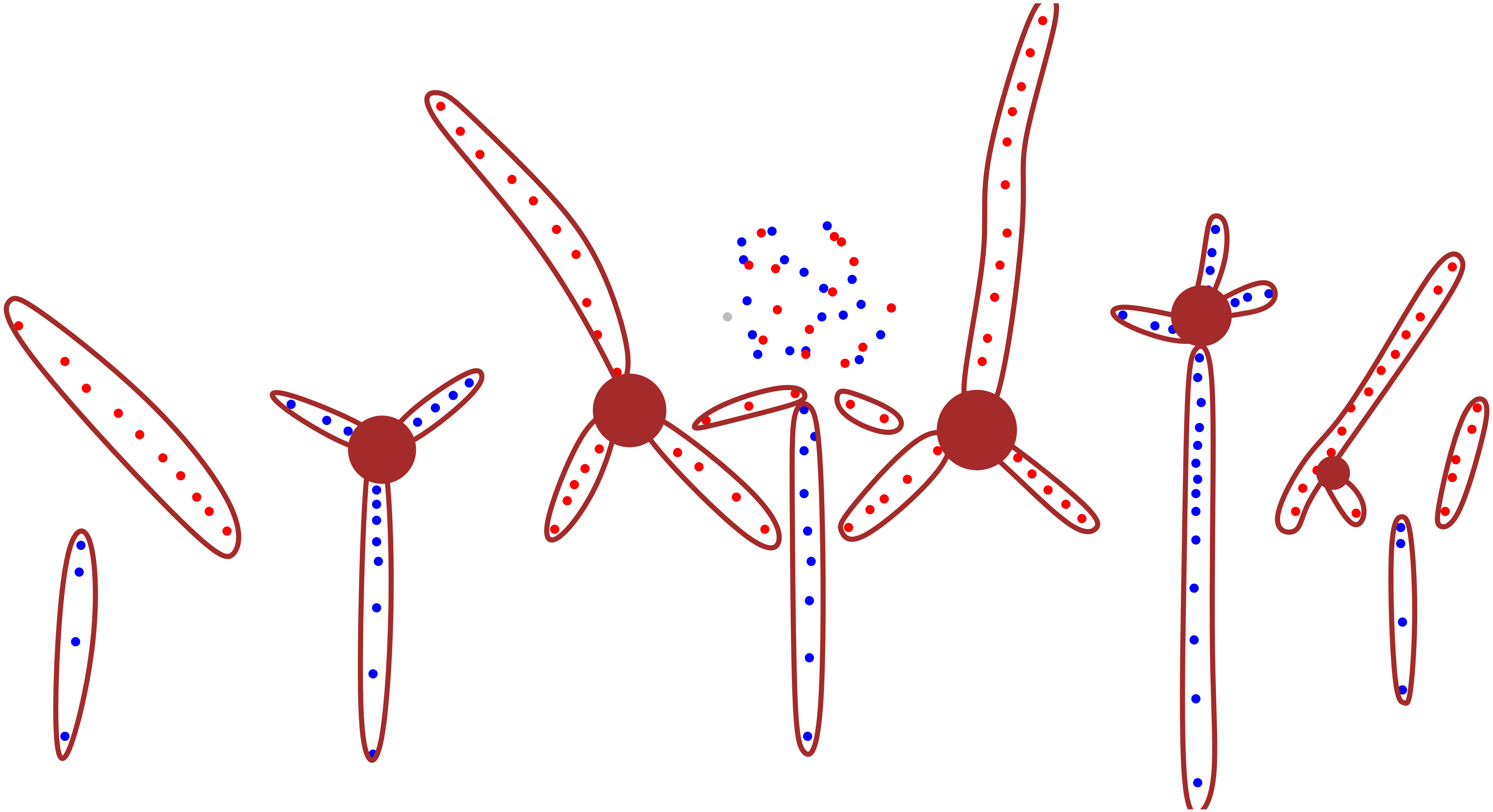

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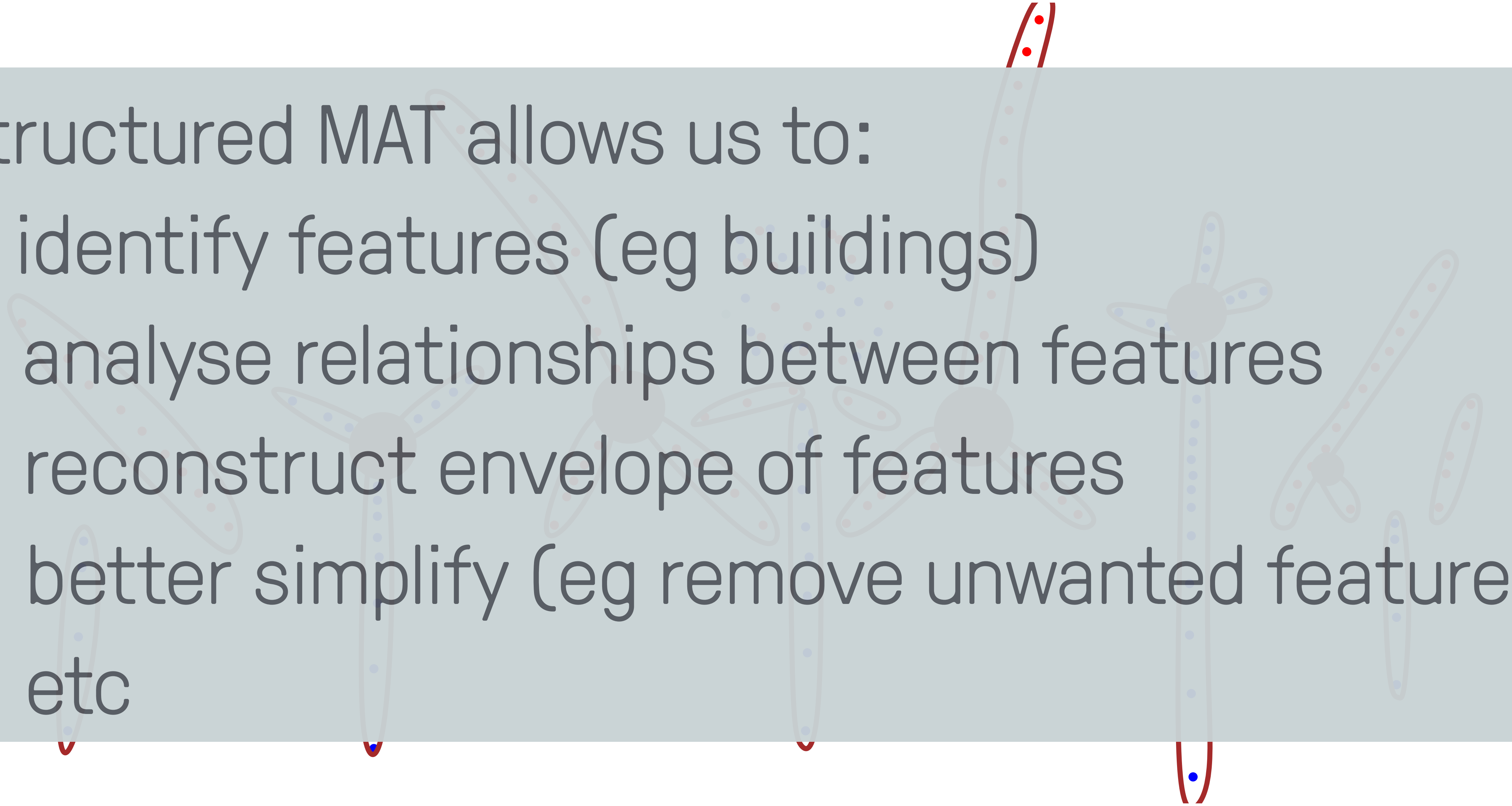
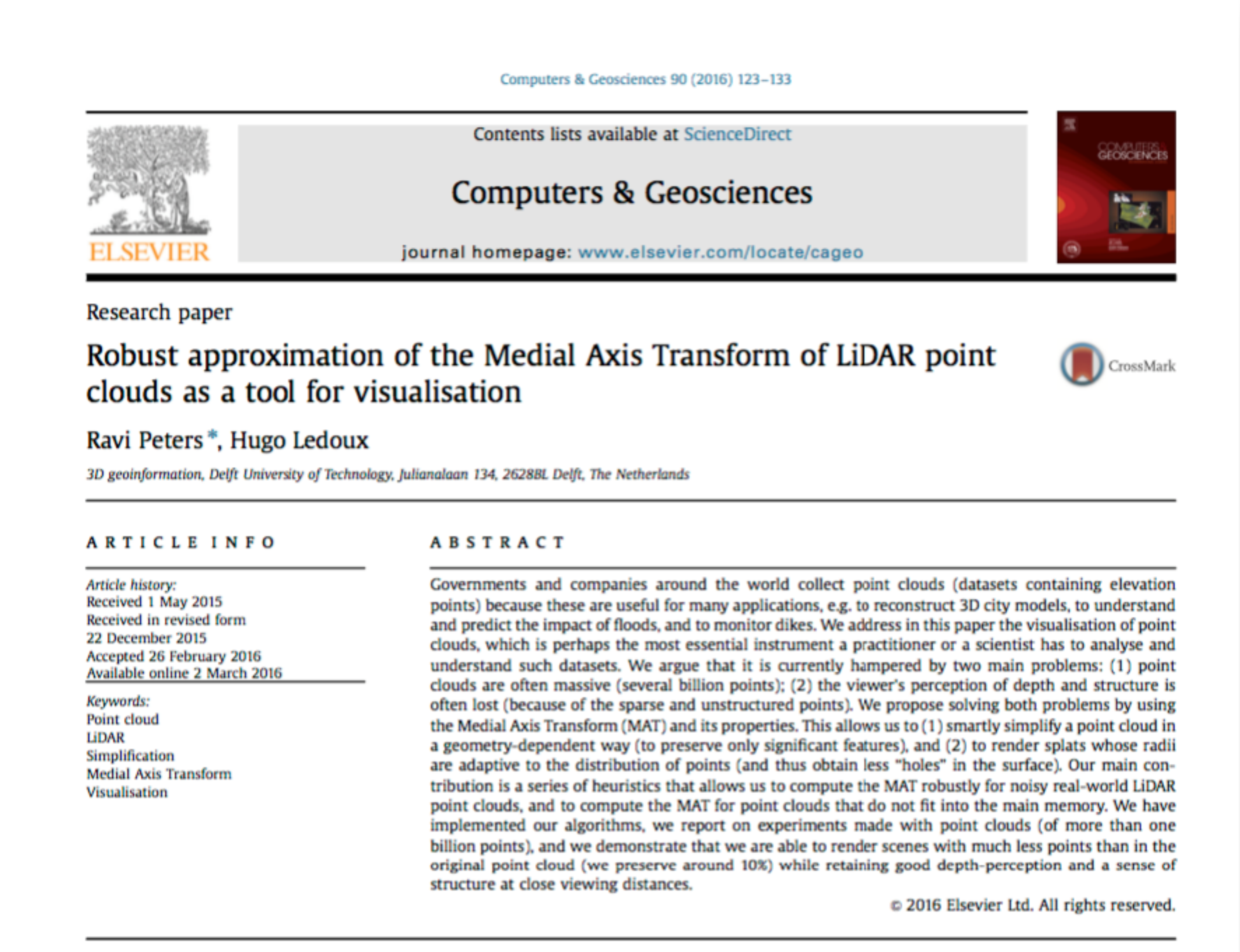


Structured MAT allows us to:

1. identify features (eg buildings)
2. analyse relationships between features
3. reconstruct envelope of features
4. better simplify (eg remove unwanted features)
5. etc

Journal article #1



Computers & Geosciences 90 (2016) 123–133

Contents lists available at ScienceDirect

Computers & Geosciences

journal homepage: www.elsevier.com/locate/cageo

Research paper

Robust approximation of the Medial Axis Transform of LiDAR point clouds as a tool for visualisation

Ravi Peters *, Hugo Ledoux

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Simplification
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Visualisation

ABSTRACT

Governments and companies around the world collect point clouds (datasets containing elevation points) because these are useful for many applications, e.g. to reconstruct 3D city models, to understand and predict the impact of floods, and to monitor dikes. We address in this paper the visualisation of point clouds, which is perhaps the most essential instrument a practitioner or a scientist has to analyse and understand such datasets. We argue that it is currently hampered by two main problems: (1) point clouds are often massive (several billion points); (2) the viewer's perception of depth and structure is often lost (because of the sparse and unstructured points). We propose solving both problems by using the Medial Axis Transform (MAT) and its properties. This allows us to (1) smartly simplify a point cloud in a geometry-dependent way (to preserve only significant features), and (2) to render splats whose radii are adaptive to the distribution of points (and thus obtain less "holes" in the surface). Our main contribution is a series of heuristics that allows us to compute the MAT robustly for noisy real-world LiDAR point clouds, and to compute the MAT for point clouds that do not fit into the main memory. We have implemented our algorithms, we report on experiments made with point clouds (of more than one billion points), and we demonstrate that we are able to render scenes with much less points than in the original point cloud (we preserve around 10%) while retaining good depth-perception and a sense of structure at close viewing distances.

Journal article #2

Accepted and in press

Automatic identification of watercourses in flat and engineered landscapes by computing the skeleton of a LiDAR point cloud

Tom Broersen[a], Ravi Peters[a,*], Hugo Ledoux[a]

[a] *3D geoinformation, Delft University of Technology,*
Julianalaan 134, 2628BX Delft, The Netherlands

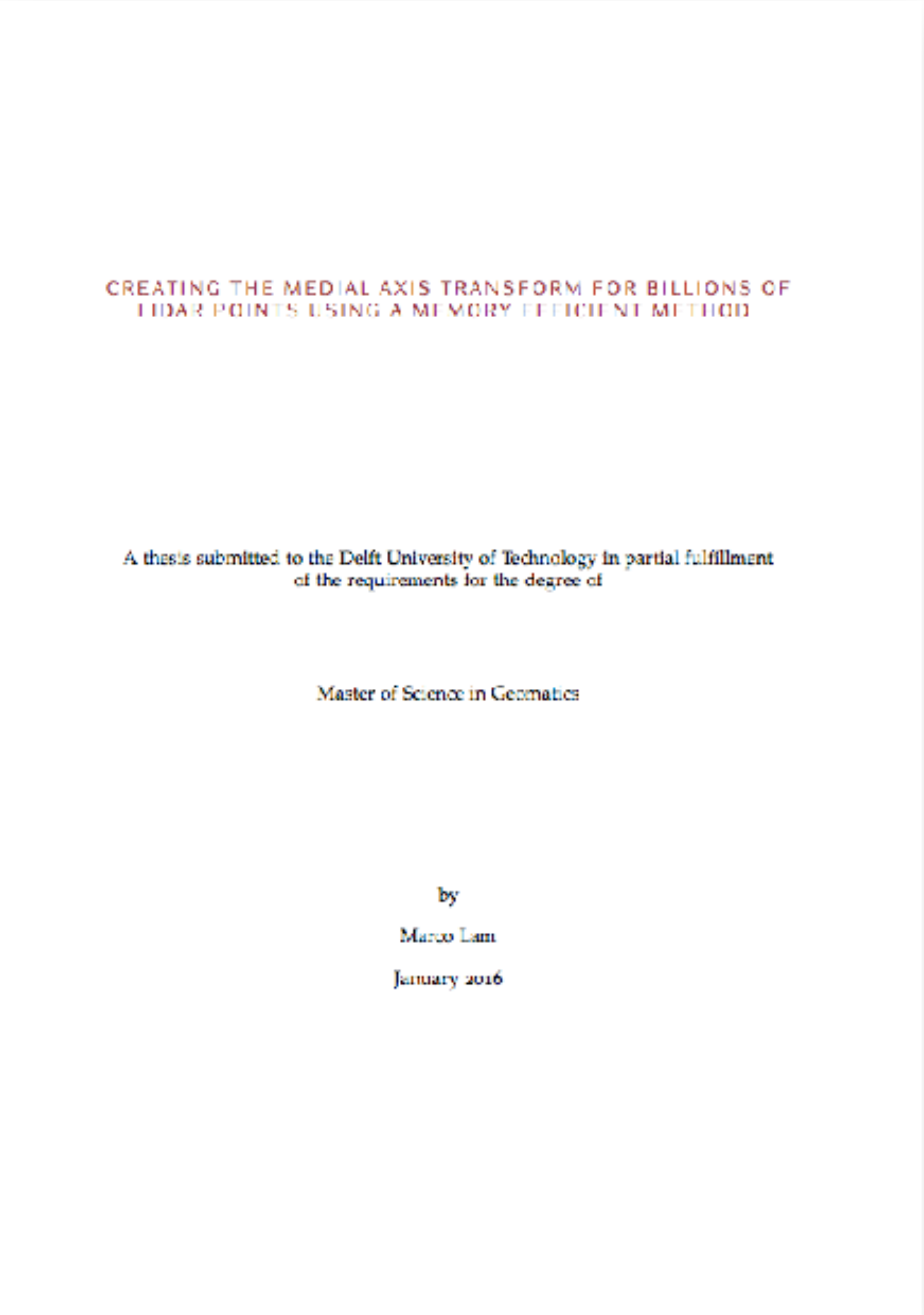
Abstract

Drainage networks play a crucial role in protecting land against floods. It is therefore important to have an accurate map of the watercourses that form the drainage network. Previous work on the automatic identification of watercourses was typically based on grids, focused on natural landscapes, and used mostly the slope and curvature of the terrain. We focus in this paper on areas that are characterised by low-lying, flat, and engineered landscapes; these are characteristic to the Netherlands for instance. We propose a new methodology to identify watercourses automatically from elevation data, it uses solely a raw classified LiDAR point cloud as input. We show that by computing *twice* a skeleton of the point cloud — once in 2D and once in 3D — and that by using the properties of the skeletons we can identify most

Other publications

- A few workshops in NL and Europe
- A few conferences proceedings
- In preparation:
  1. journal article about the structured MAT
  2. article about simplification for large datasets

Two MSc theses in Geomatics



CREATING THE MEDIAL AXIS TRANSFORM FOR BILLIONS OF LIDAR POINTS USING A MEMORY EFFICIENT METHOD

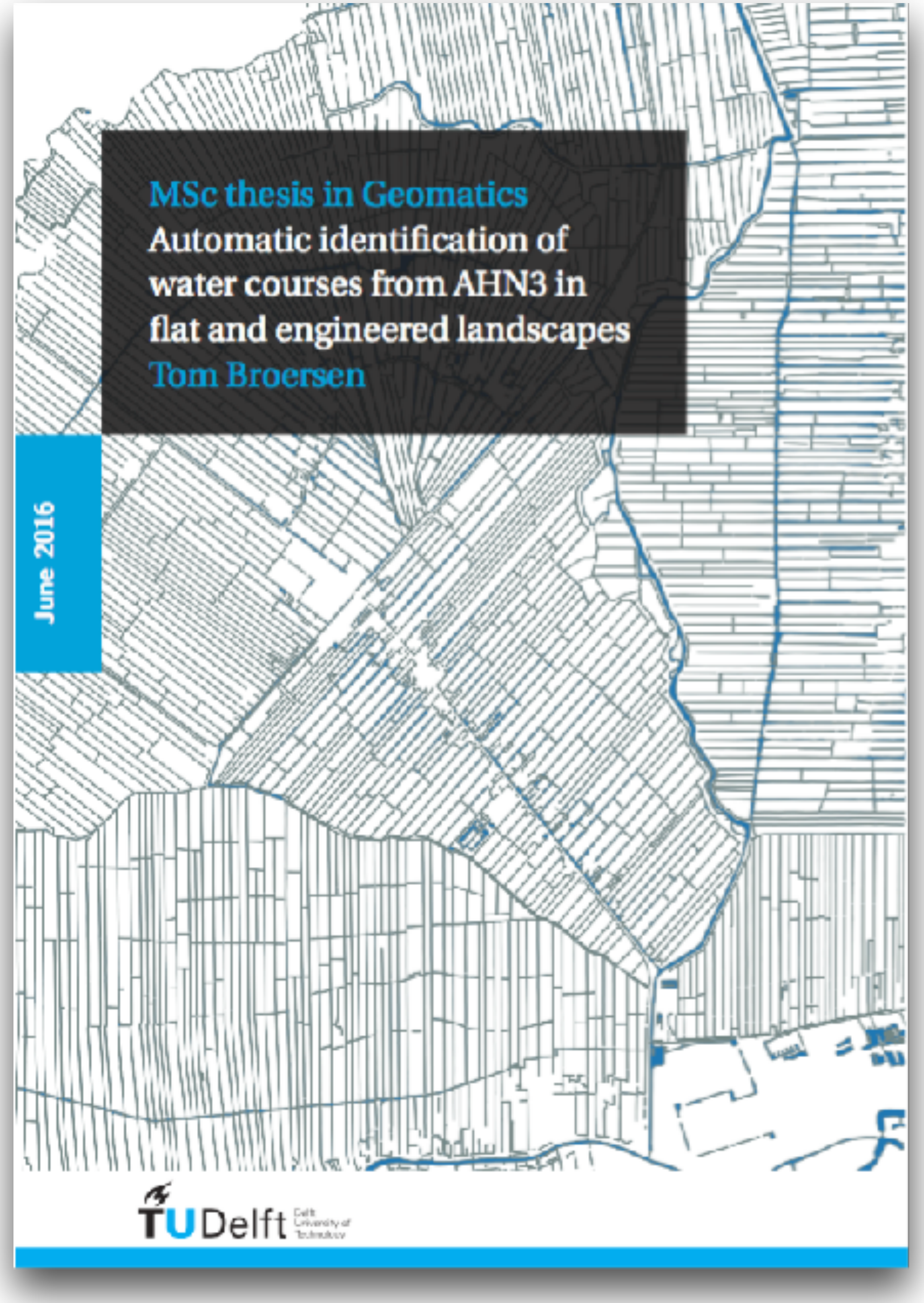
A thesis submitted to the Delft University of Technology in partial fulfillment of the requirements for the degree of

Master of Science in Geomatics

by

Marco Lam

January 2016



MSc thesis in Geomatics

Automatic identification of water courses from AHN3 in flat and engineered landscapes

Tom Broersen

June 2016

TU Delft Delft University of Technology

MSc thesis #1: scaling to billions of points

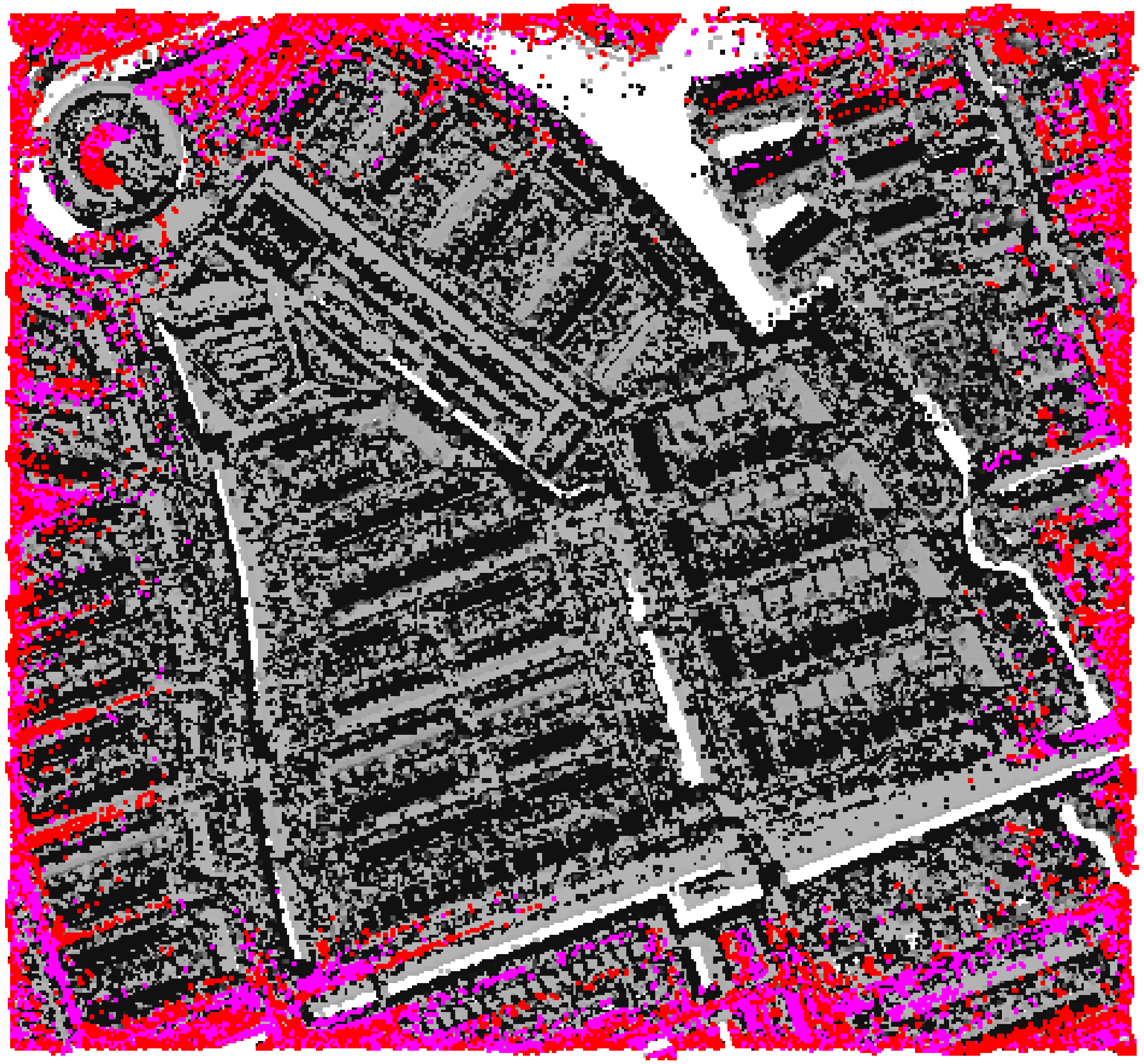
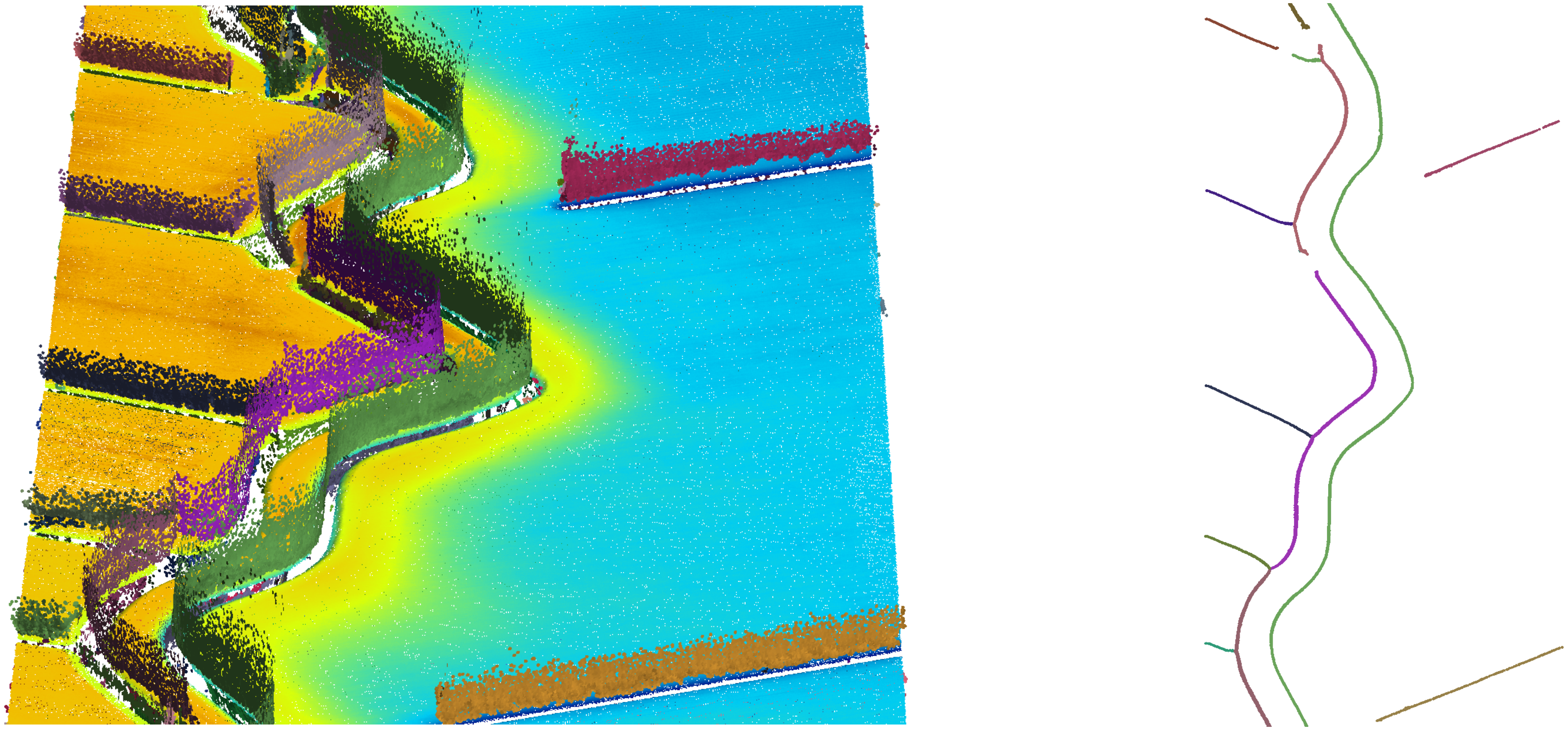


Figure 3.4: Points with a successfully created medial axis are displayed in grayscale. Points which are not finished processing because they need to know the location of points outside the region are displayed in red or purple. They represent the inner and outer MAT respectively

MSc thesis #2: auto identification of watercourses



(a) Perspective view of skeleton and ground points.

(b) Plan view of exterior skeleton sheets.

Figure 10: Segmentation of 3D skeleton sheets. Each distinct sheet was assigned a random colour. The surface points are coloured by elevation.

Future plans?

3dsm.bk.tudelft.nl