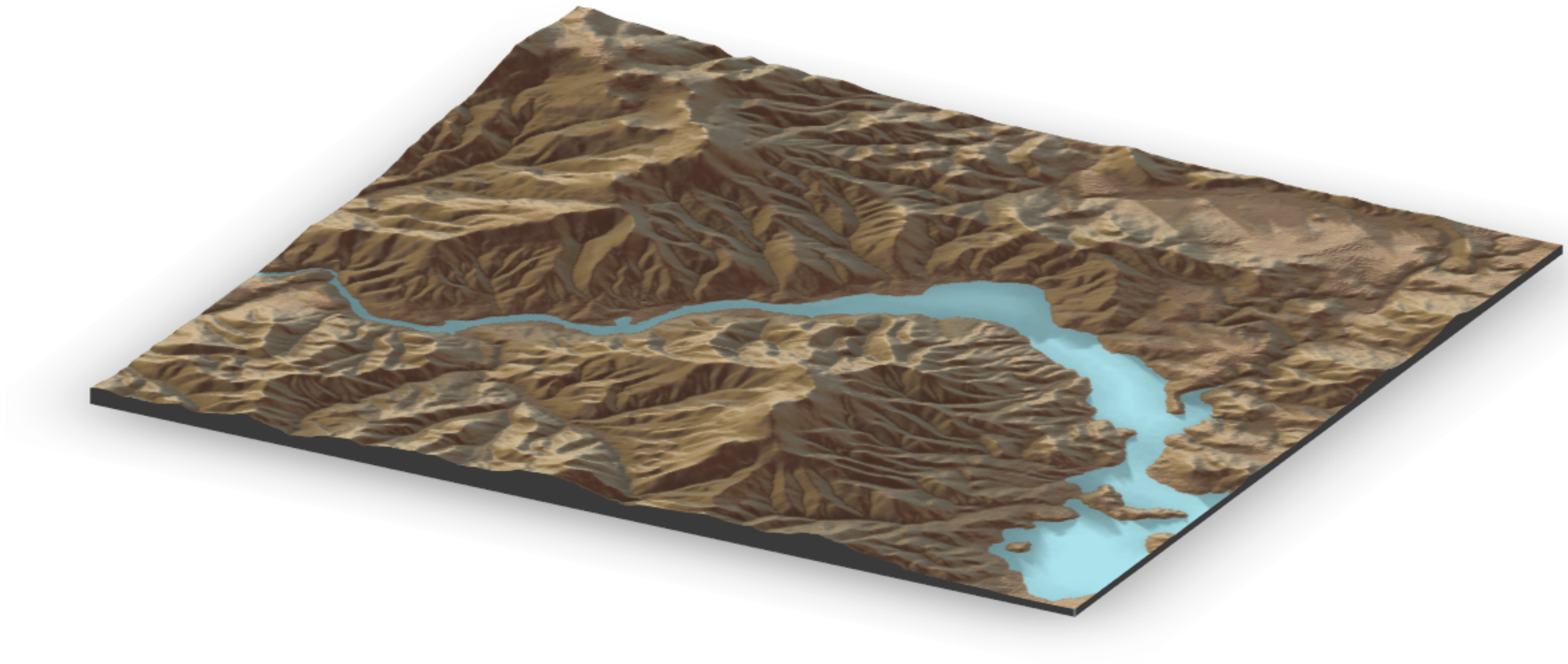
Lesson 01
What is a digital terrain model?

GEO1015.2024

Hugo Ledoux

Digital terrain model (DTM), or simply ‘terrain’



- A representation of the Earth's surface.
- It gives us the *elevation*, which is the height above/ below a certain reference point (a vertical datum)

DTM, DSM, DEM?

- **DEM** (Digital Elevation Model). In the literal meaning of the term, it is simply a model of the elevation. A DEM is either a DSM or a DTM.
- **DTM** (Digital Terrain Model). The surface of the Earth is the bare-earth, that is no man-made objects or vegetation.
- **DSM** (Digital Surface Model). The surface includes all (man-made) objects and structures on the terrain.

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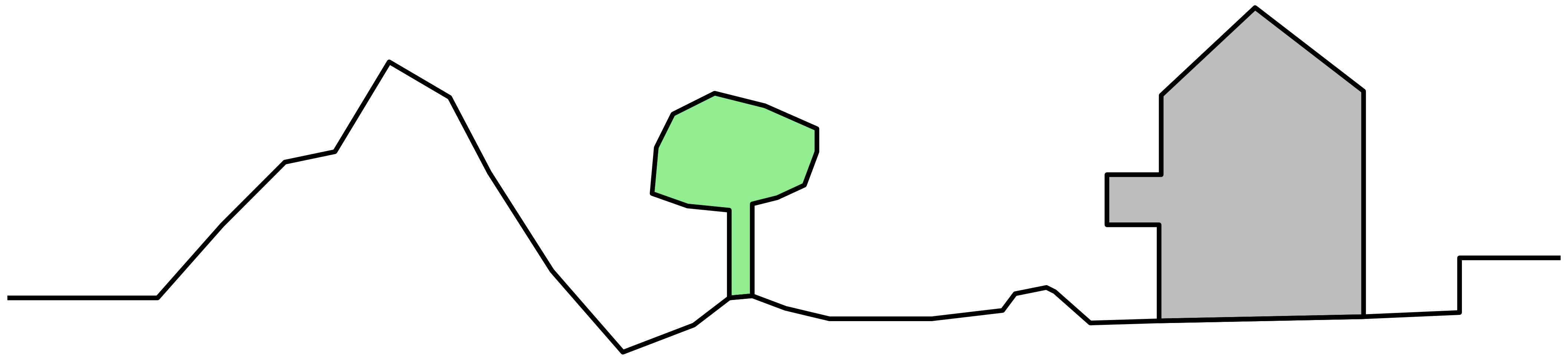
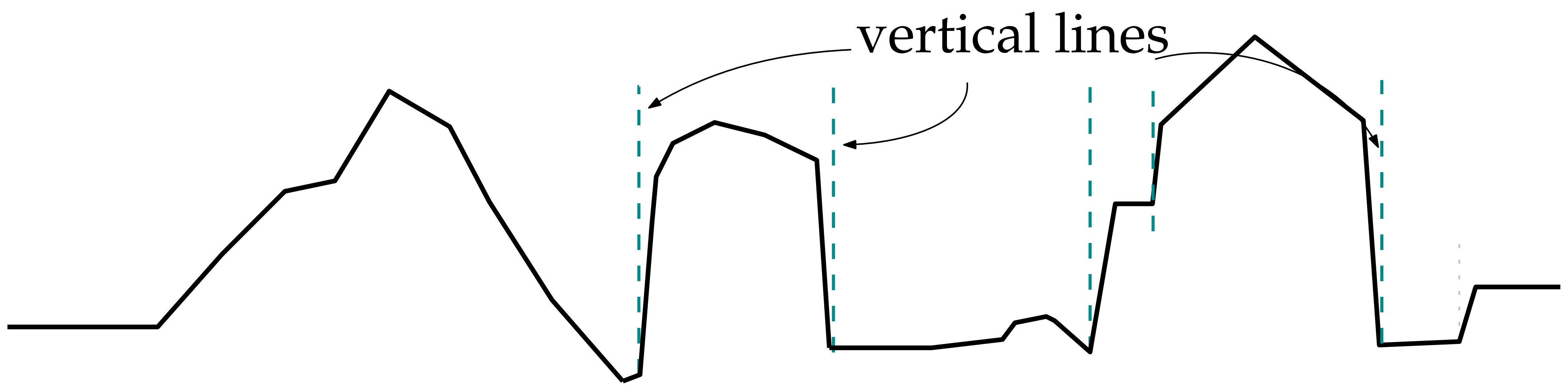
often in USA, DEM == grid

point clouds represent the DSM

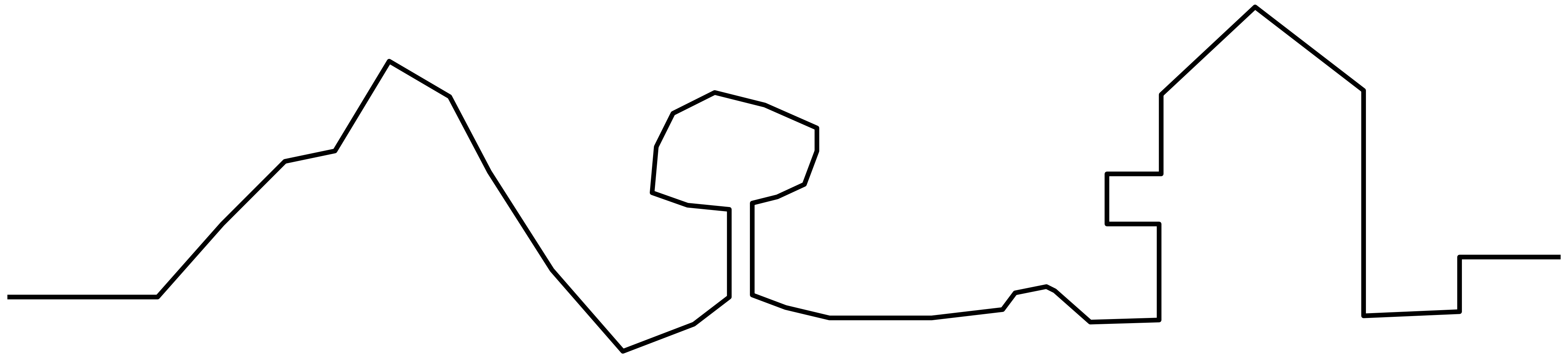
Dimensionality of DTMs



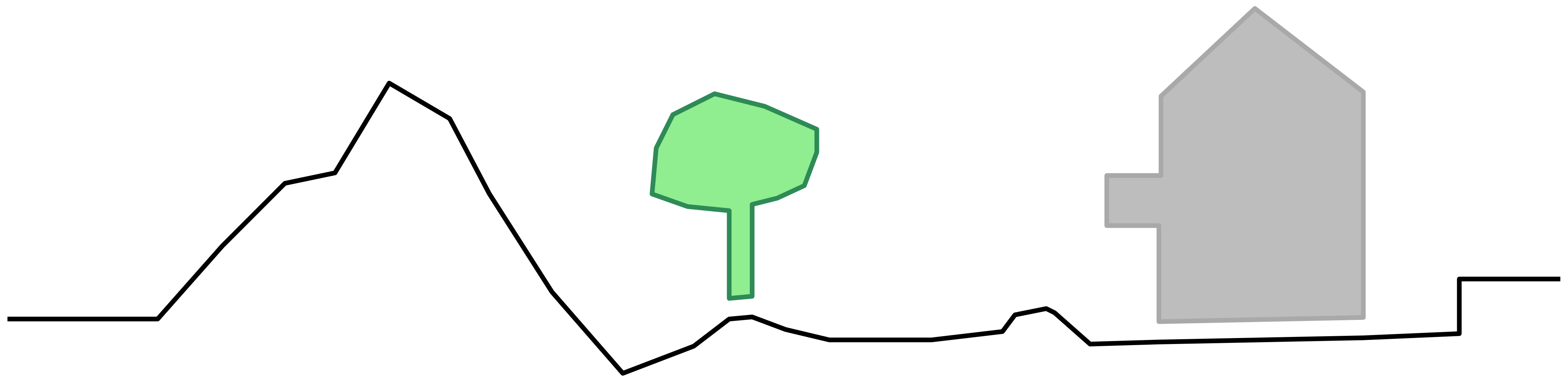
(a) A terrain



(b) 2.5D modelling



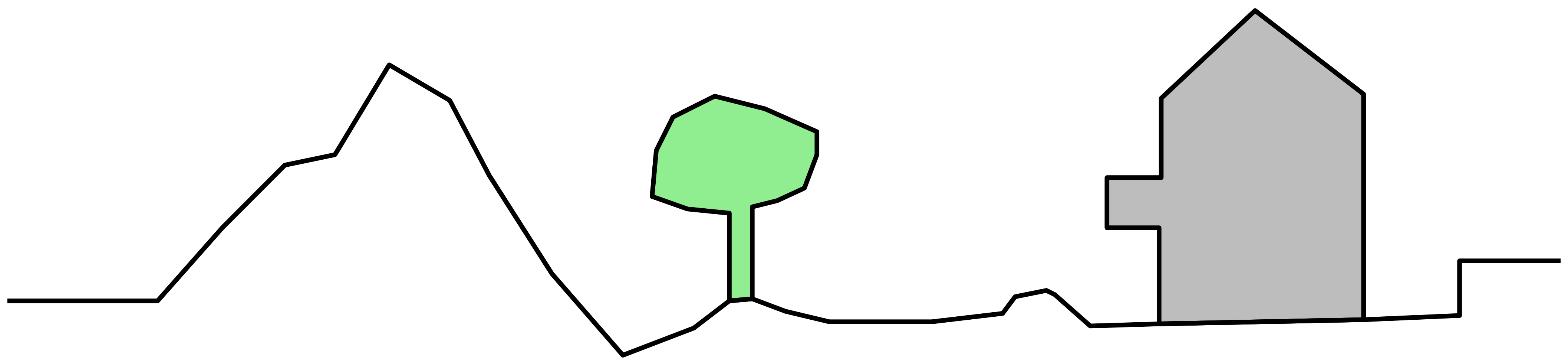
(c) 2.75D modelling



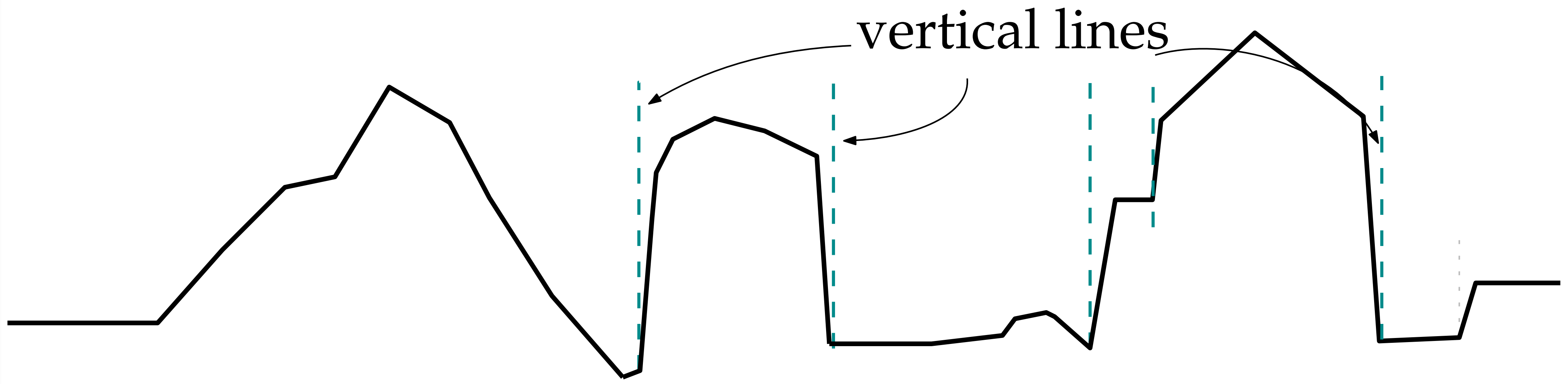
(d) Volumetric modelling, or full 3D

Dimensionality of DTMs

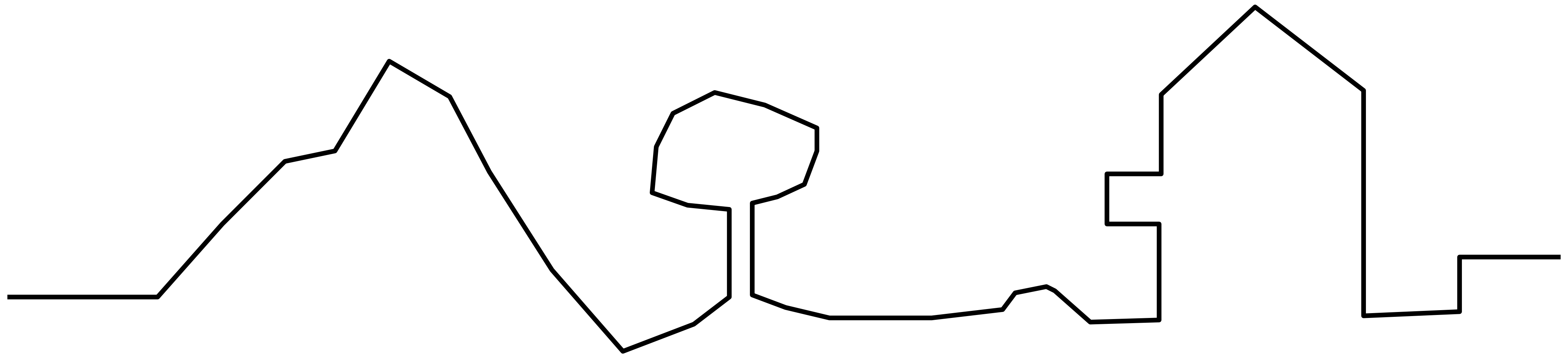
we focus solely on 2.5D
in this course



(a) A terrain



(b) 2.5D modelling



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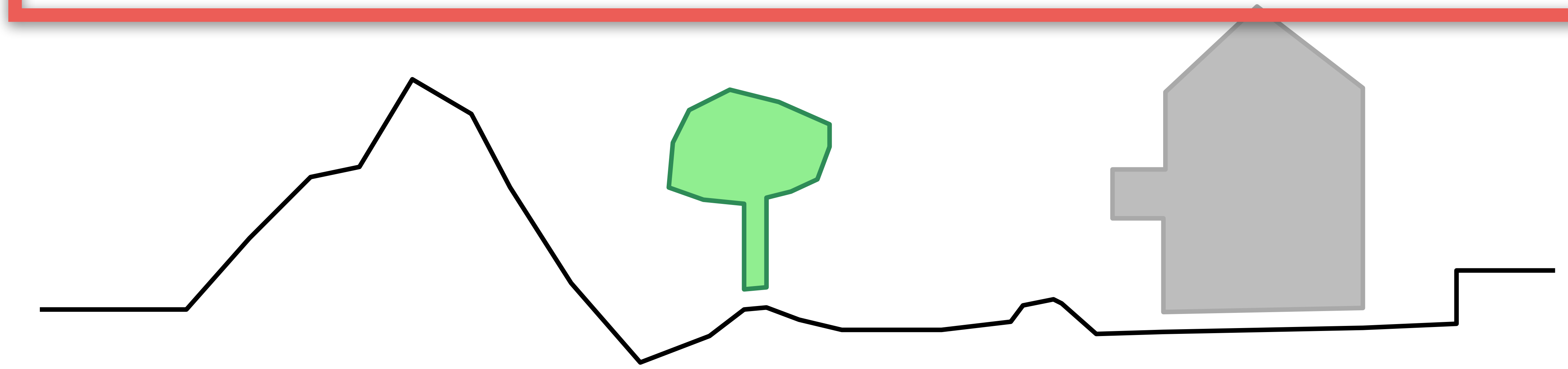


(d) Volumetric modelling, or full 3D

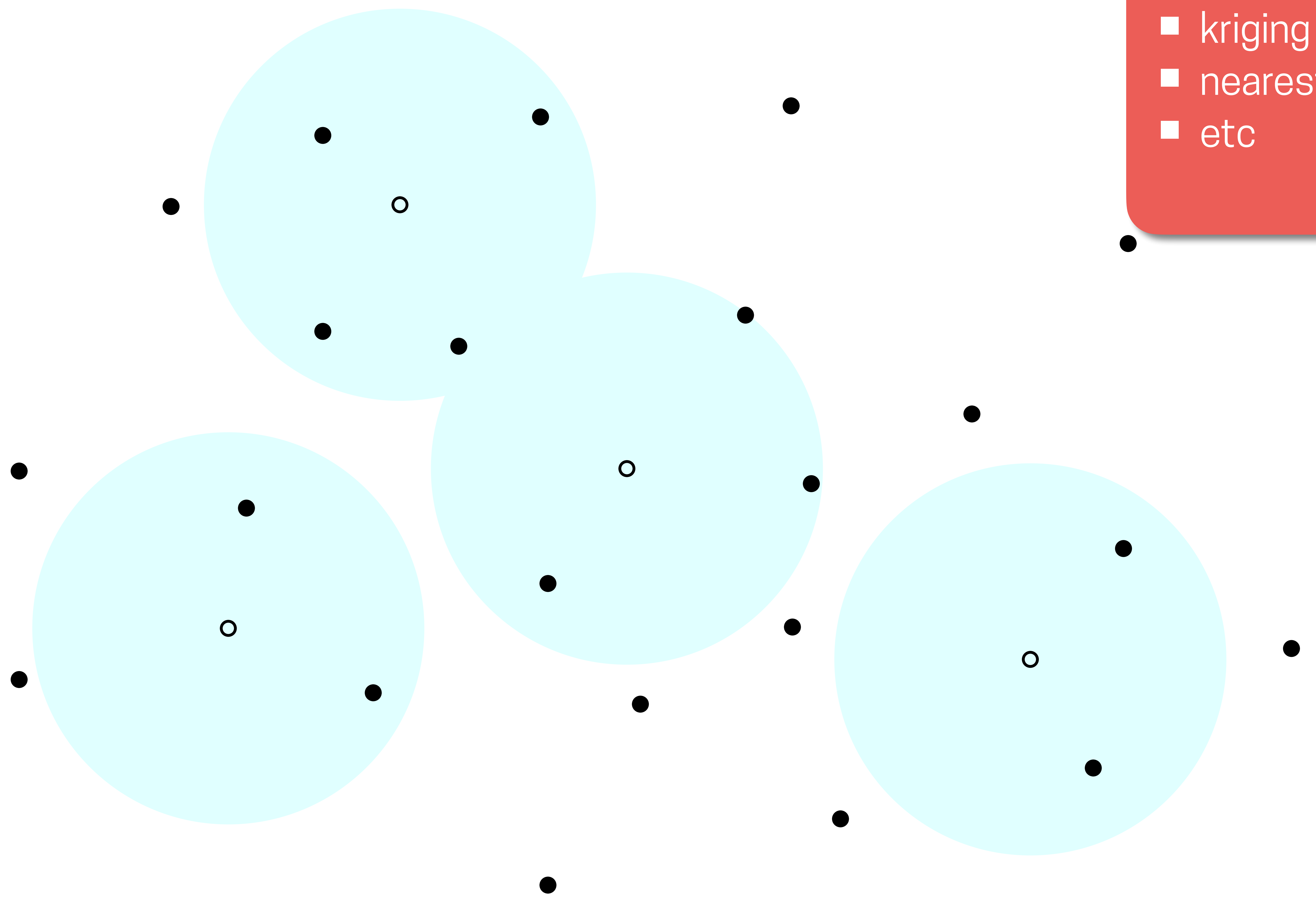
GEO1004 + GEO1016

2.5D DTM == a field

- $z = f(x,y)$
- to represent a field/terrain we need:

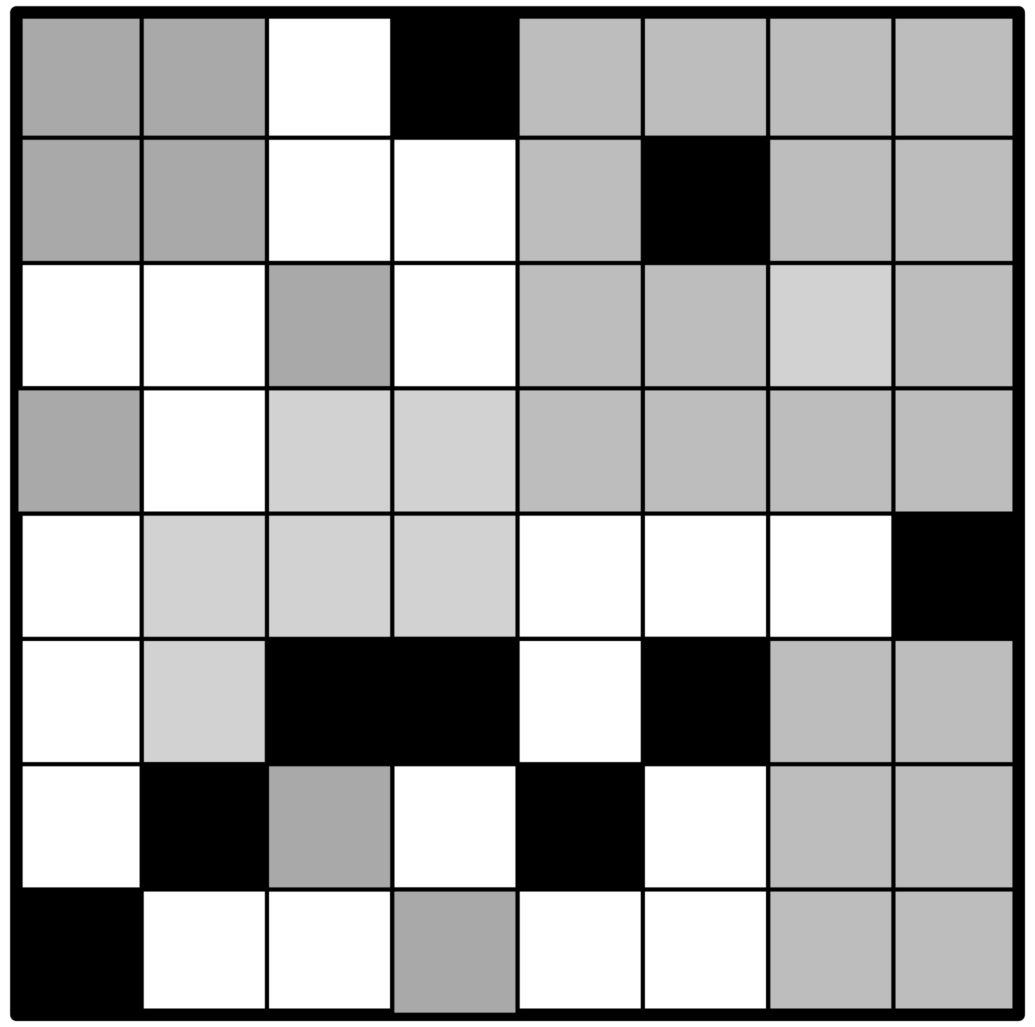
1. a set of samples (usually elevation points)
2. set of rules to obtain the elevation at unsampled locations

Strategy #1: points + global interpolation

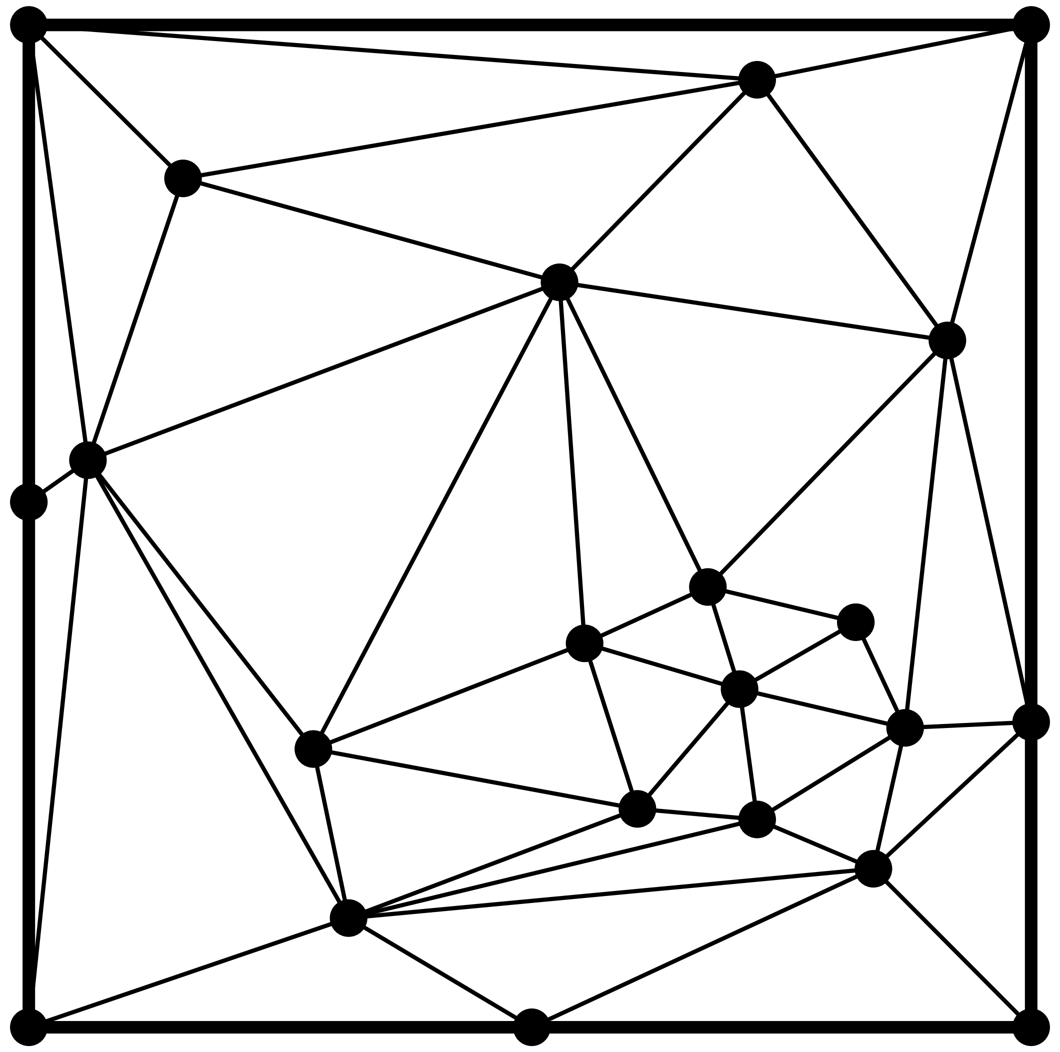


- IDW
- kriging
- nearest neighbour
- etc

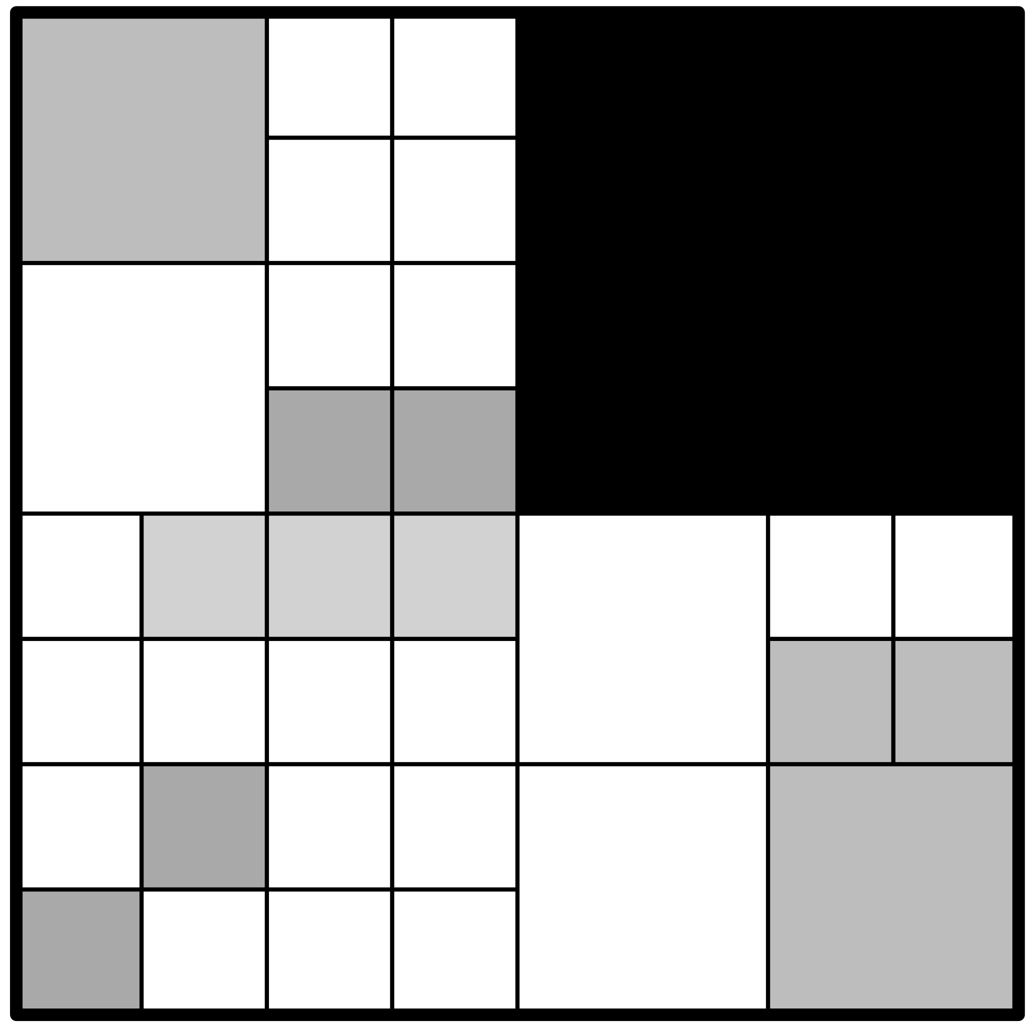
Strategy #2: piecewise spatial model



regular



irregular



hierarchical

- constant function
- linear function
- higher-order function

a (regular) grid; also called a ‘raster’

0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	0
0	50	100	100	100	100	100	100	100	100	100	100	100	100	100	50	0
0	50	100	150	150	150	150	150	150	150	150	150	150	150	100	50	0
0	50	100	150	200	200	200	200	200	200	200	200	200	150	100	50	0
0	50	100	150	200	250	250	250	250	250	250	250	200	150	100	50	0
0	50	100	150	200	250	300	300	300	300	300	250	200	150	100	50	0
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0	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	0
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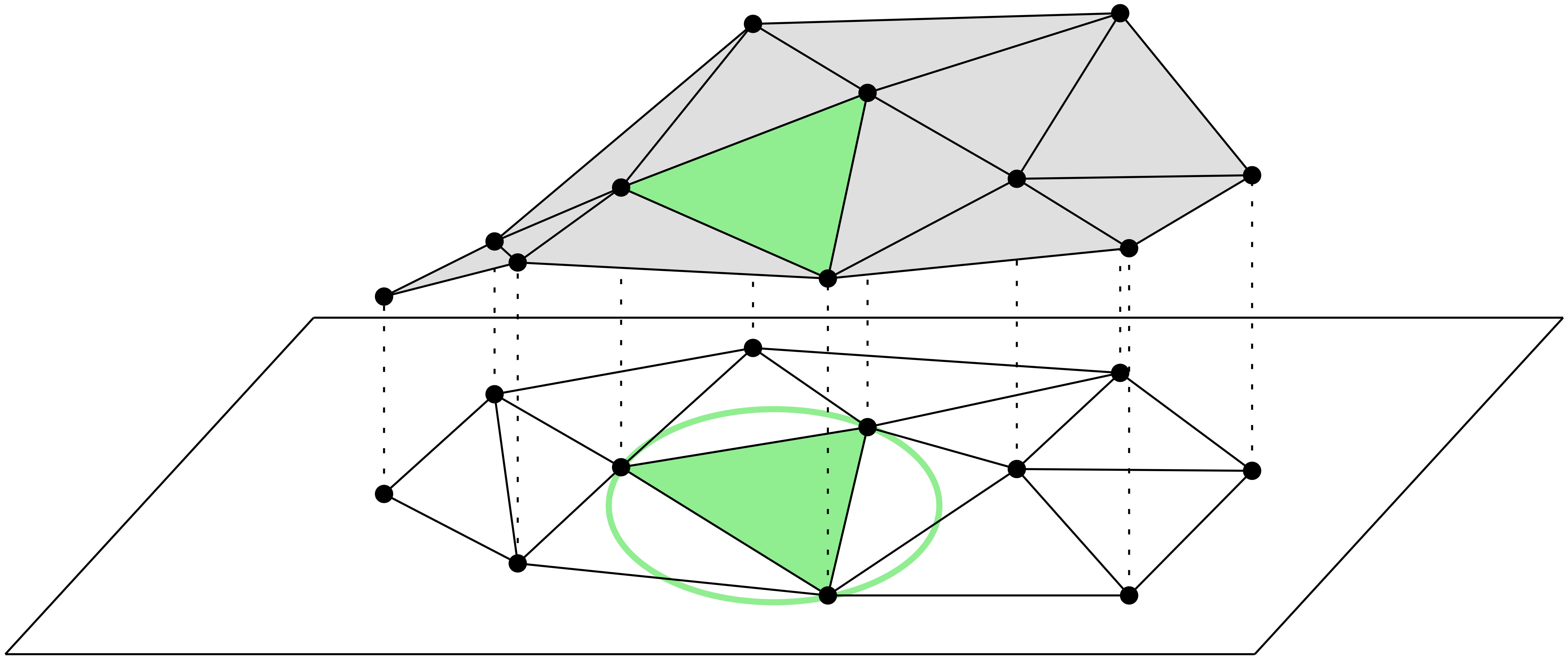
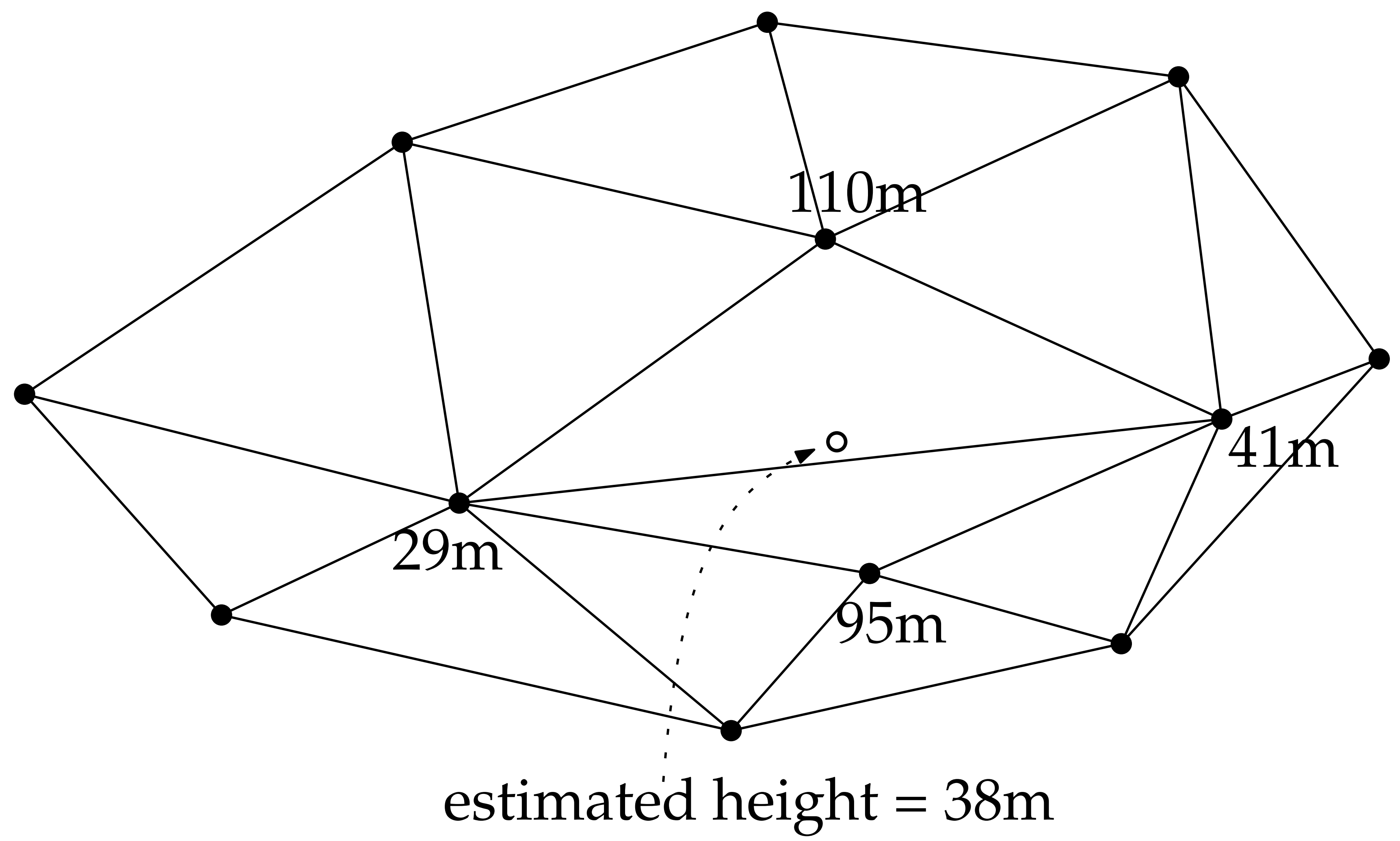
TIN == 2D surface embedded in 3D

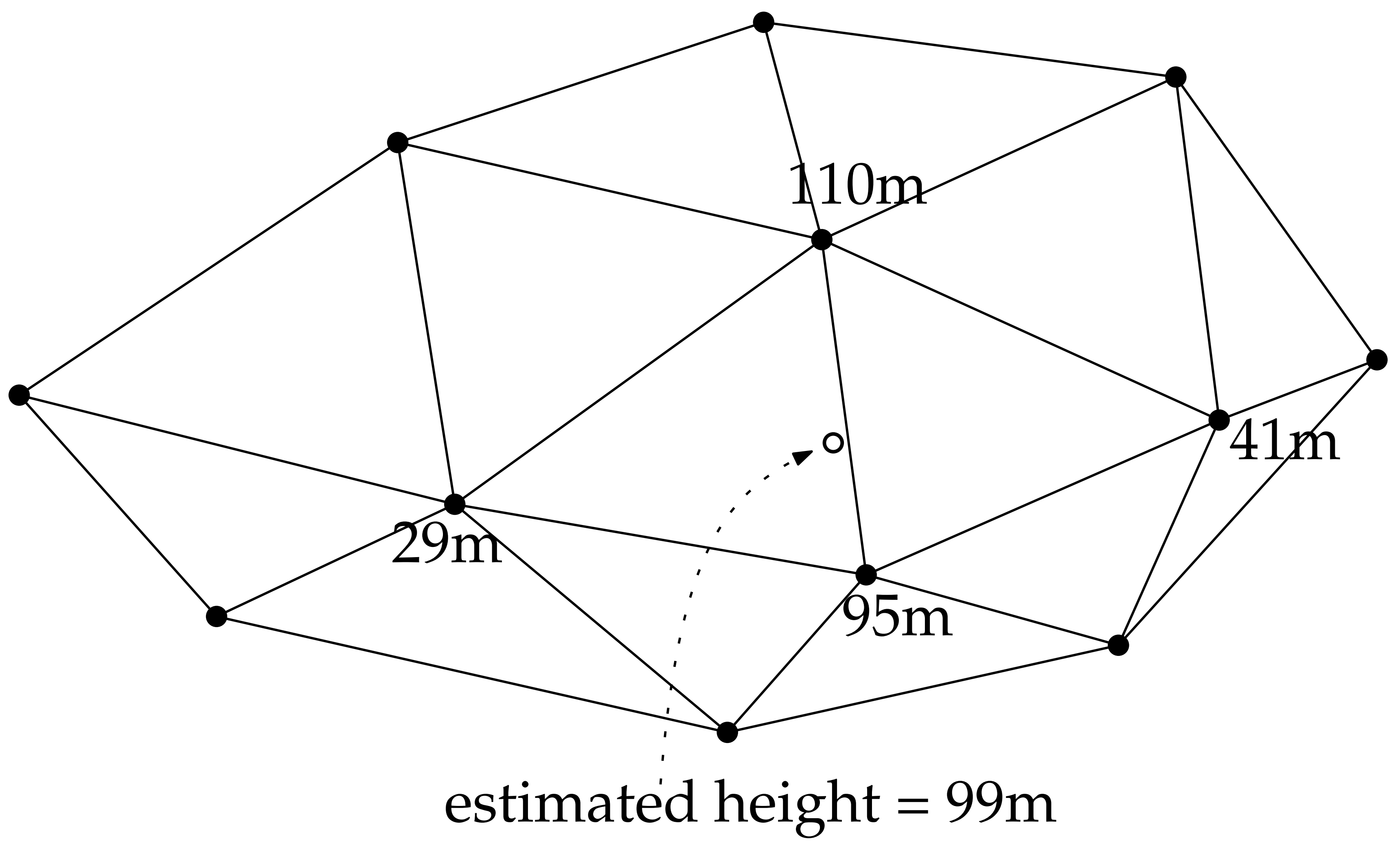


Why TIN is often Delaunay?

not Delaunay



Delaunay



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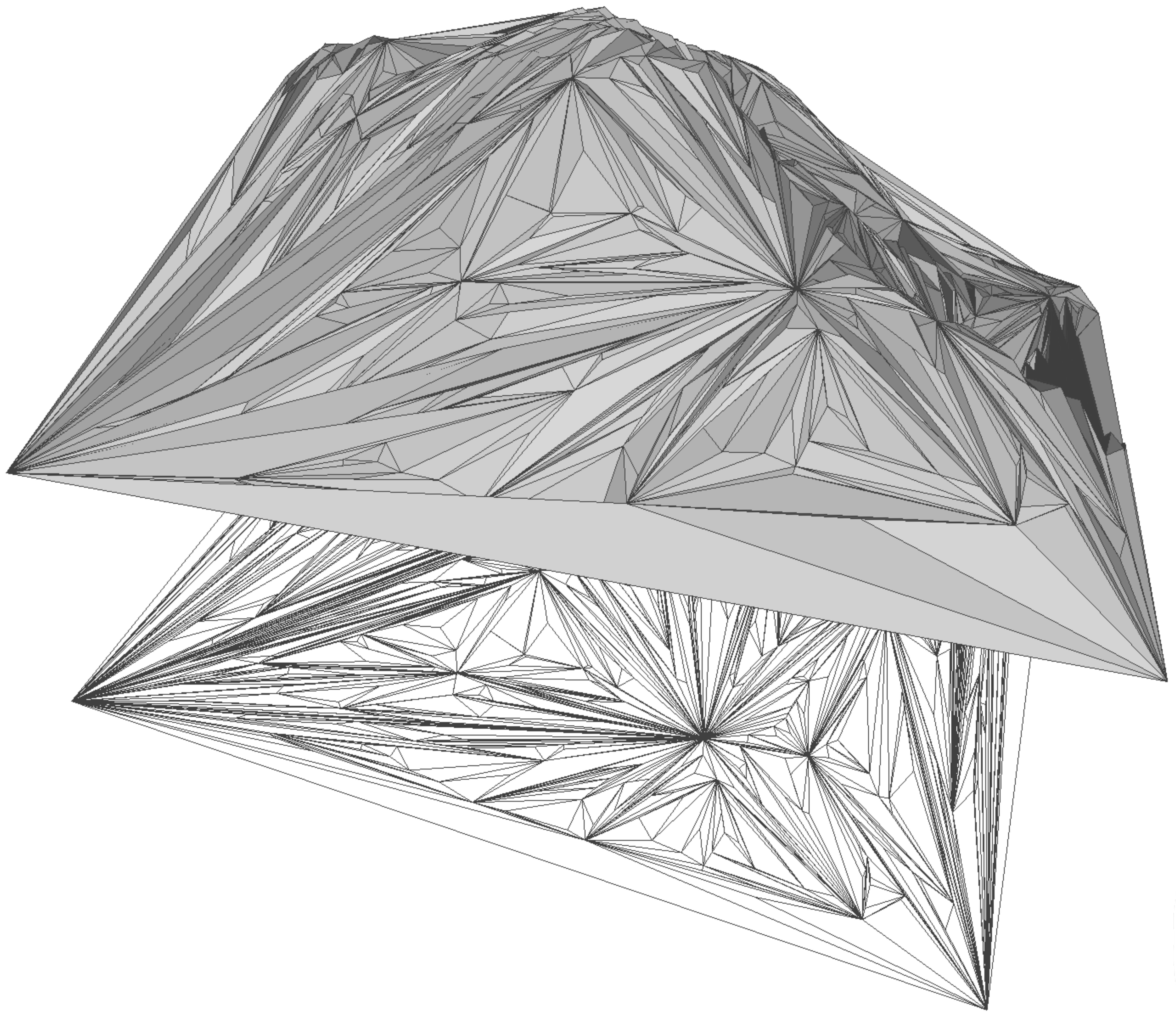
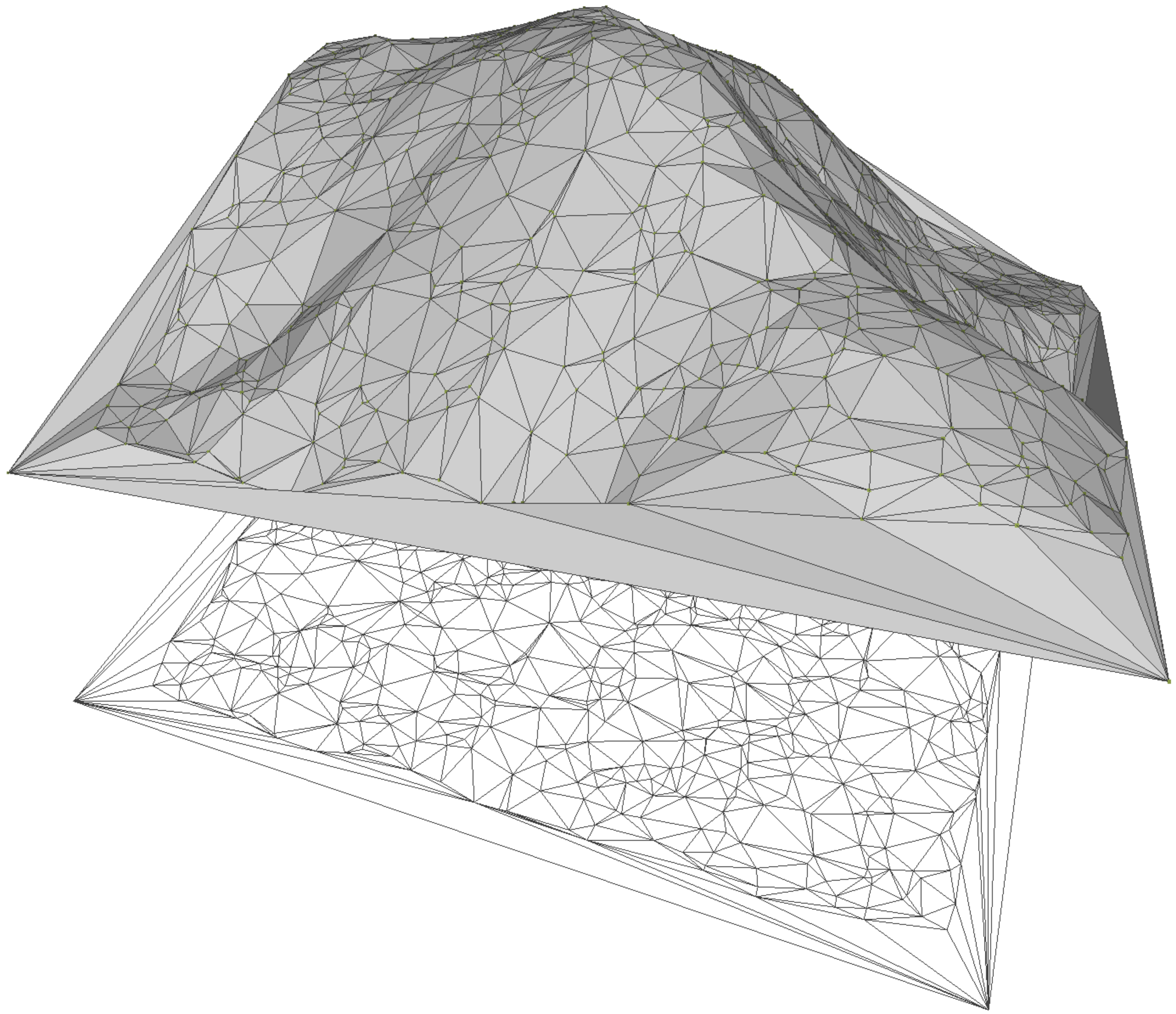
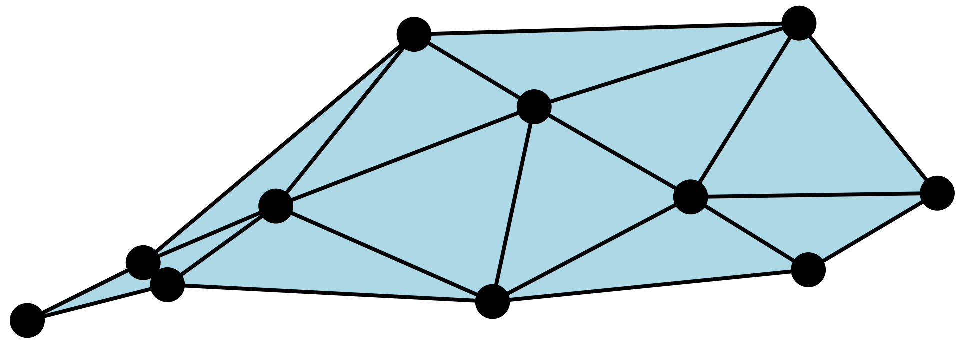


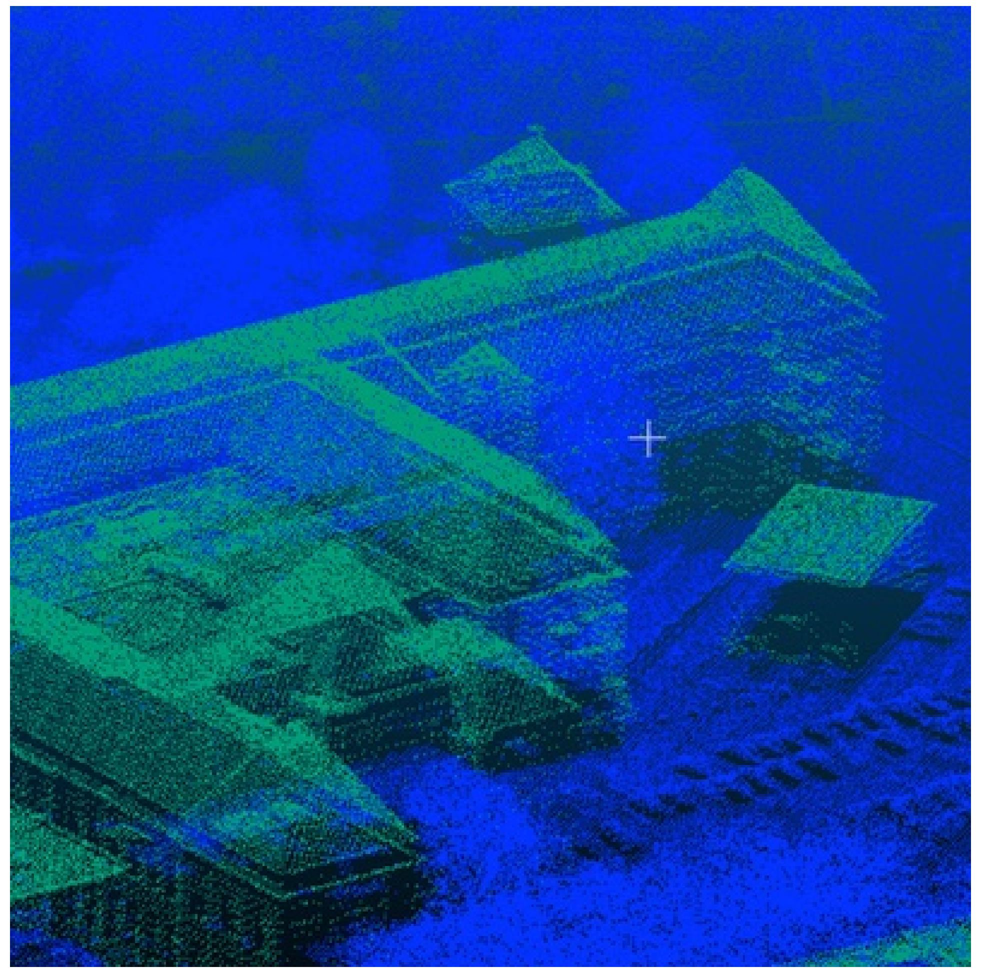


4 most common representations

raster



TIN

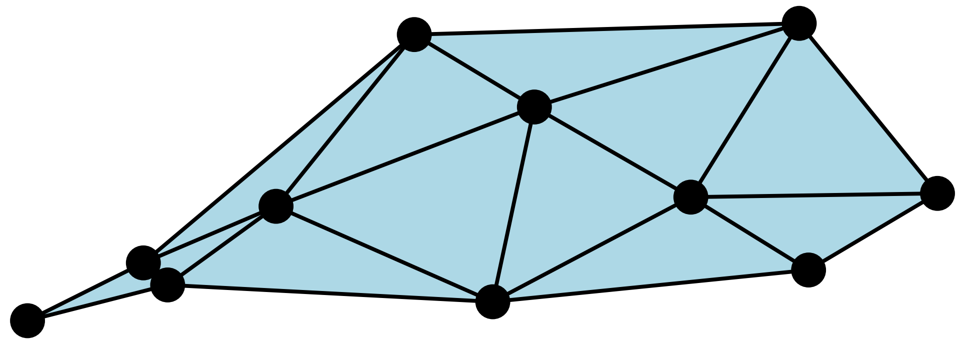


point cloud

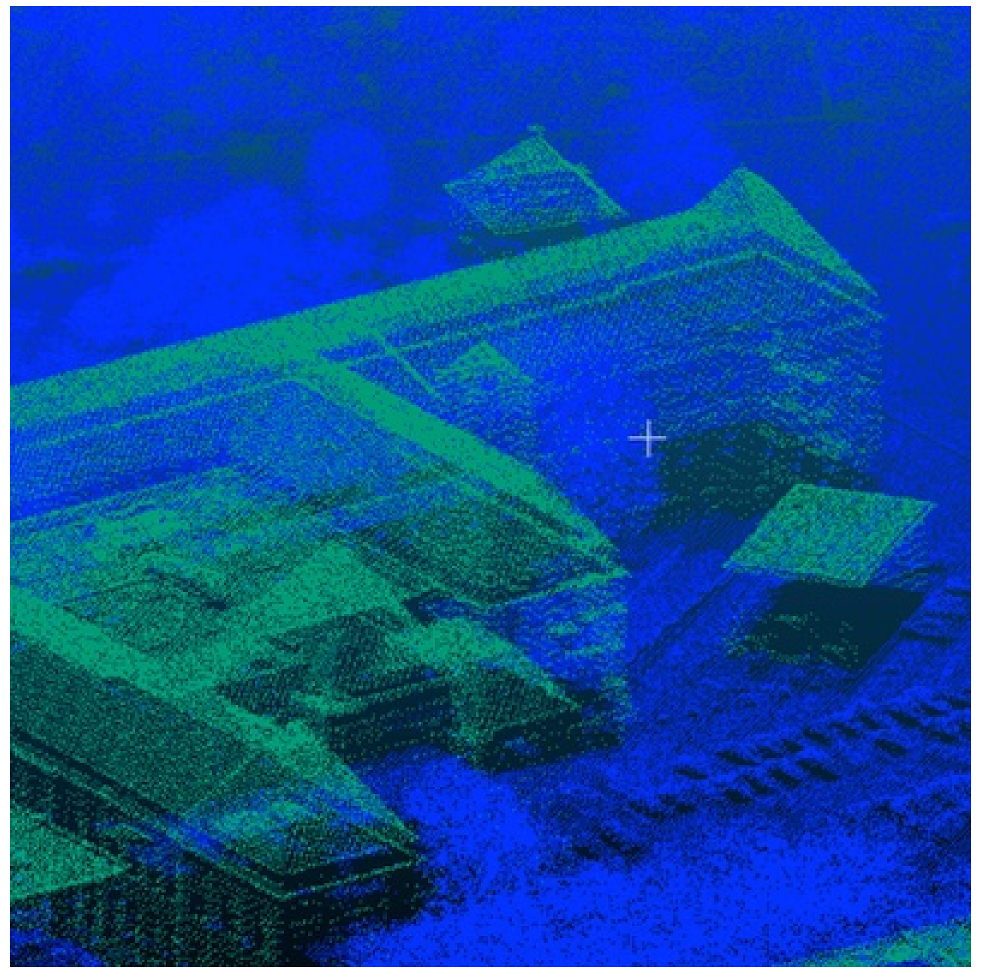
contour lines

4 most common representations

raster



TIN



point cloud

contour lines

these are ‘incomplete’,
but still used in practice

A typical conversation during a DTM conference

- *"TINs are better."*
- *"No, regular gridded DEM are better."*
- *"No, you're wrong. The variable resolution of the TINs makes the TIN structure much more efficient, and in turn, more accurate, than a DEM."*
- *"But the TIN's advantages are more than outweighed by the overhead in storage space and processing time. With the same resources, I can get a better representation of an elevation surface with a DEM."*
- *"But..."*

from Kumler (1994)

Kumler (1994) carried out a 4-year study

- DEMs and TINs were compared
- “a model will be judged more *efficient* than another if it represents a surface more accurately within the same amount of storage space, measured in bytes”
- the common belief that a TIN is more space-efficient is handicapped by the fact that a TIN must have *at least* 3 times less points to be of equal space
- Conclusions: DEMs can estimate heights more accurately than comparably-sized TINs
- *“See? I told you DEMs were more efficient.”*
- *“Yeah, well… TINs still look better.”*

References

Kumler, M. P. (1994). An intensive comparison of triangulated irregular networks (TINs) and digital elevation models (DEMs). *Cartographica*, 31(2).

https://3d.bk.tudelft.nl/courses/geo1015/