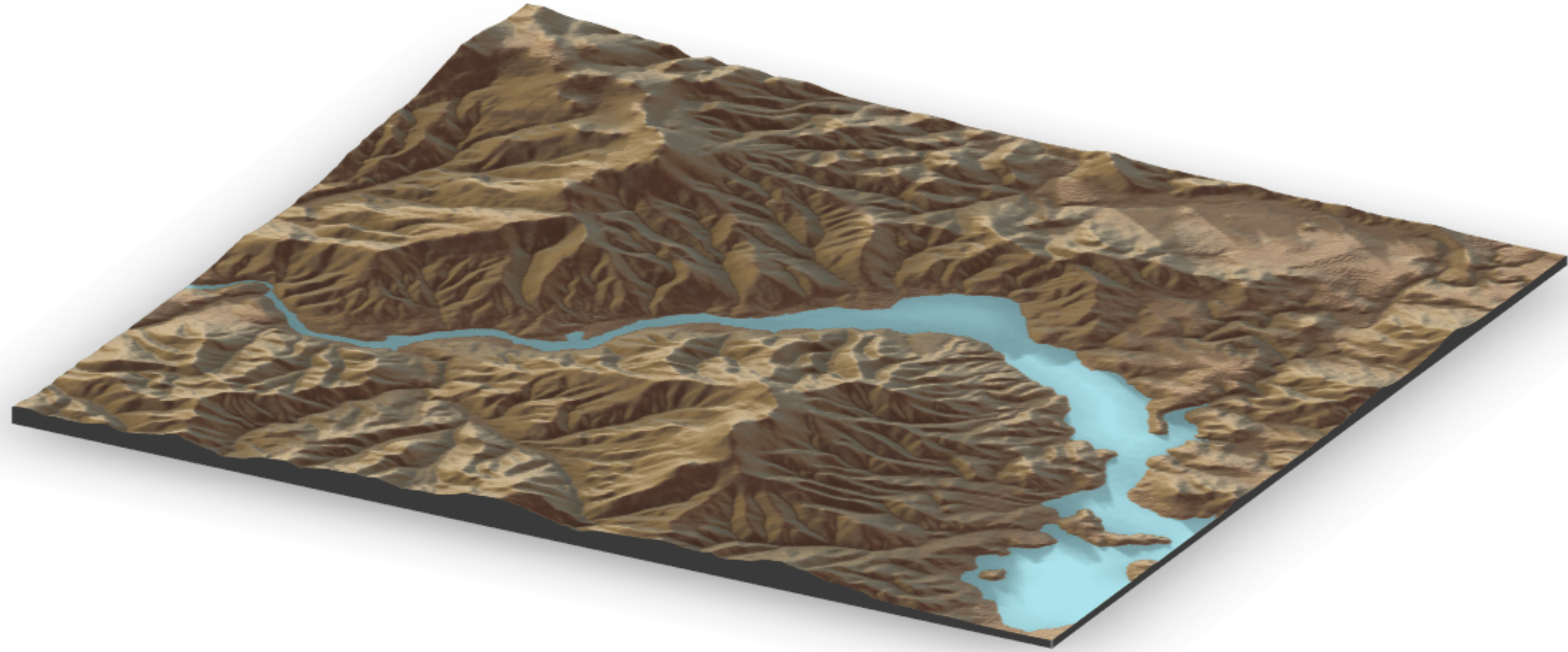


**Lesson 01**  
**What is a digital terrain model?**

**GEO1015.2022**

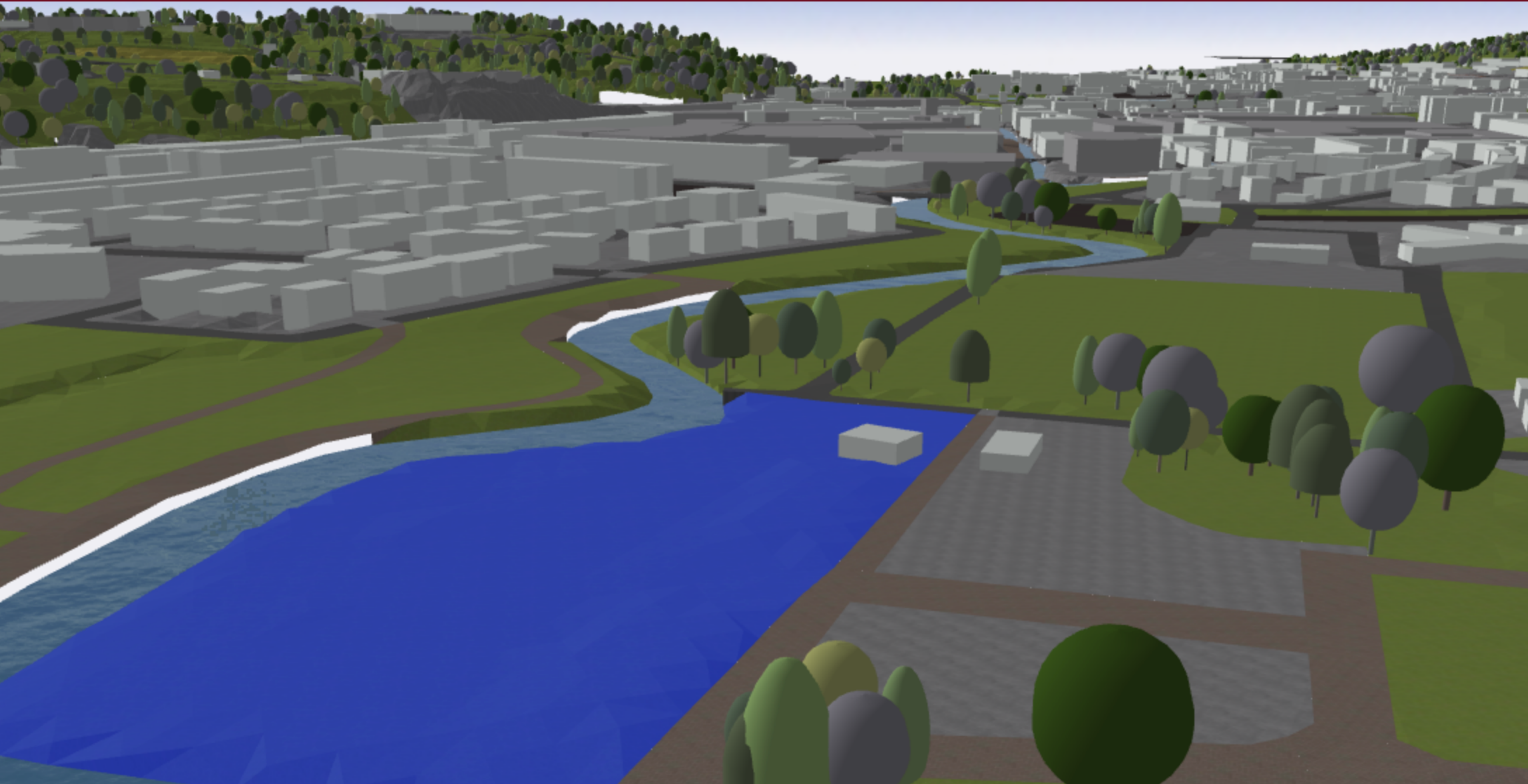
Hugo Ledoux

# 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)

# Is this a DTM?



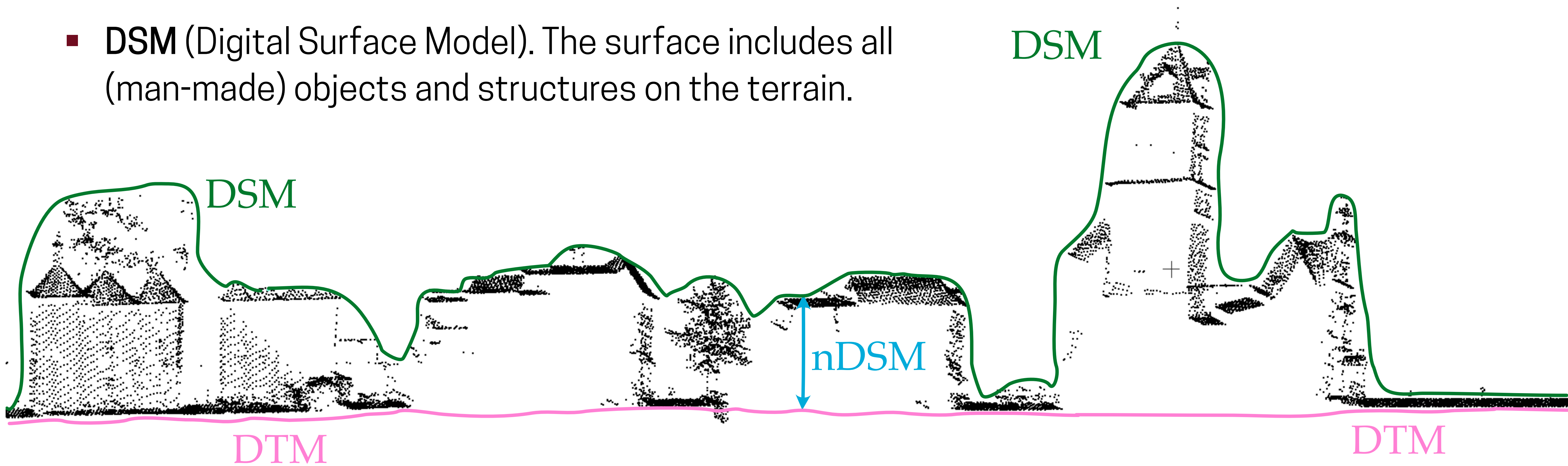
# Is this a DTM?



Earth Surface is not clear:  
trees?  
buildings?

# 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.

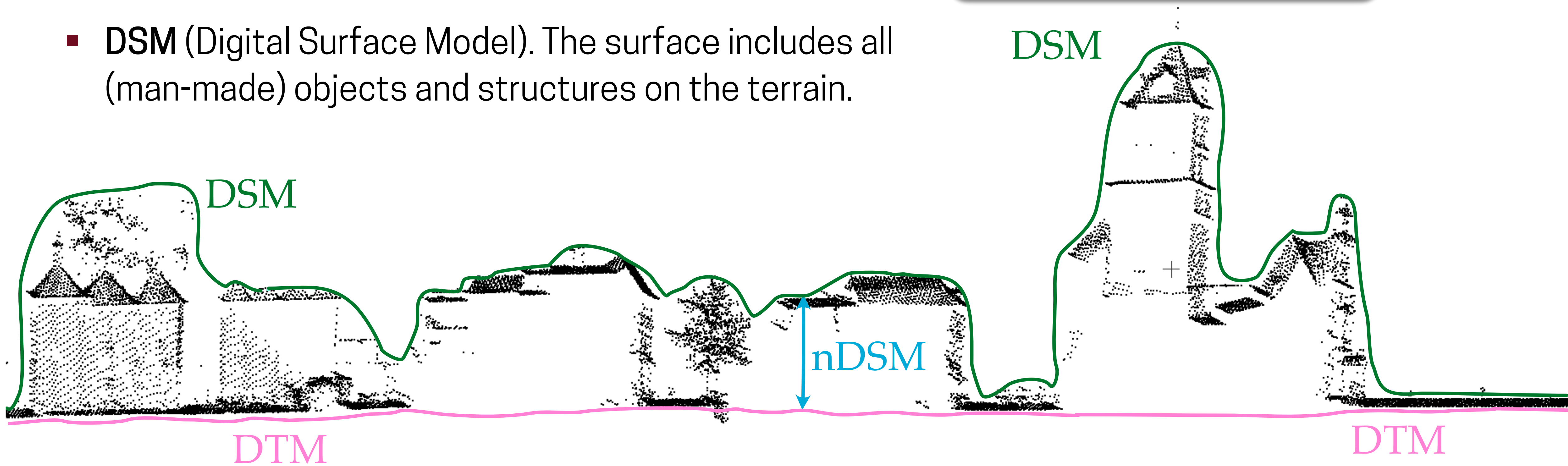


# DTM, DSM, DEM?

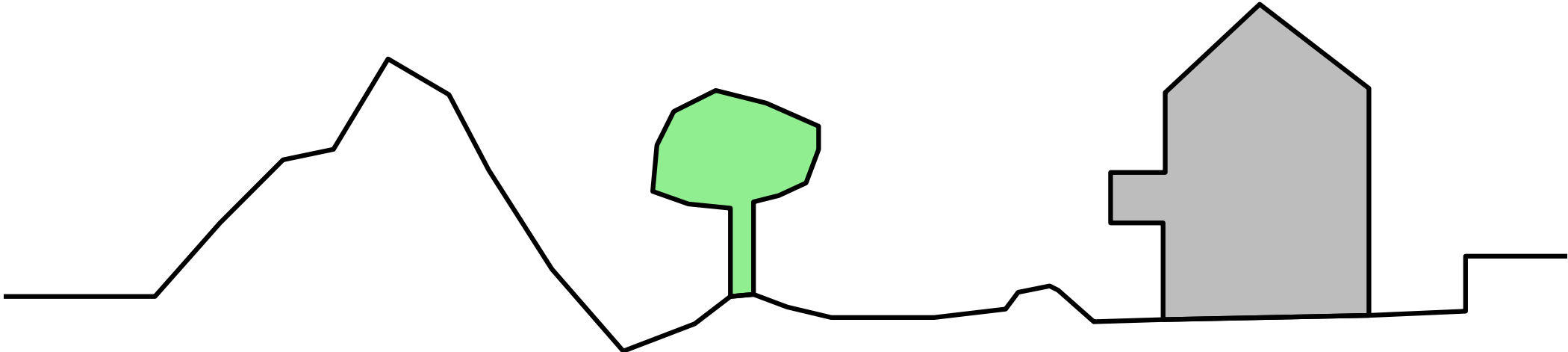
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often in USA, DEM == grid

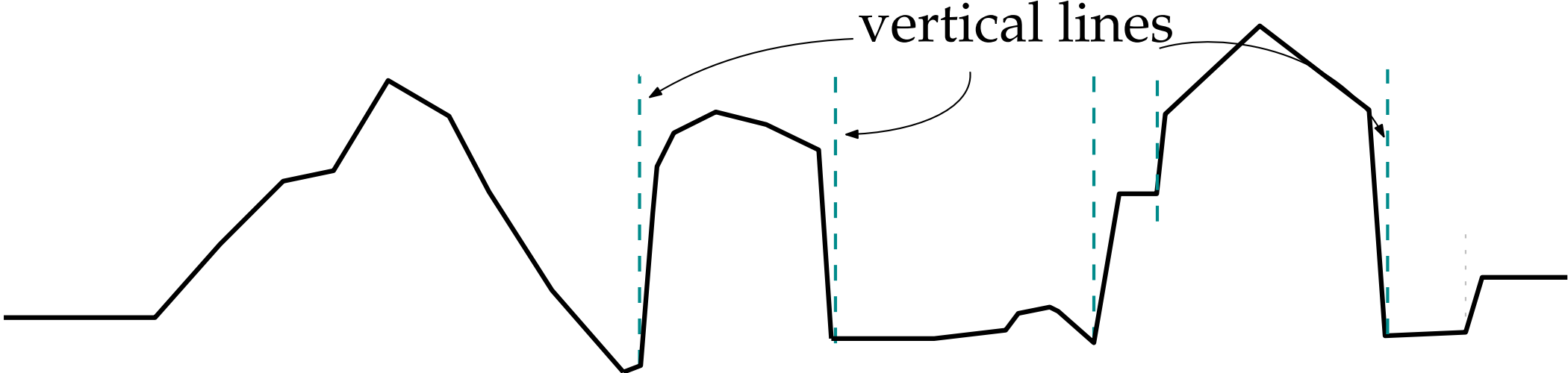
point clouds represent the DSM



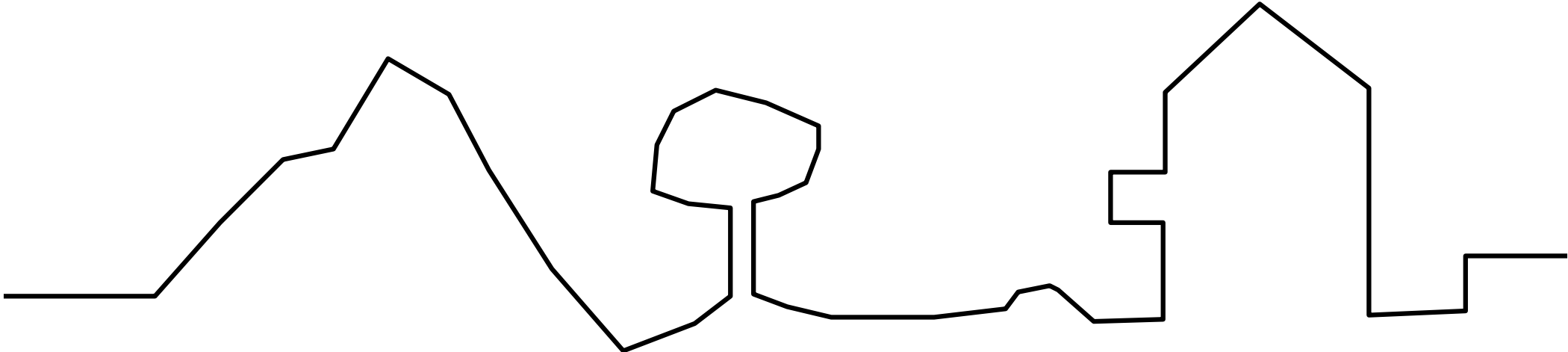
# Dimensionality of DTMs



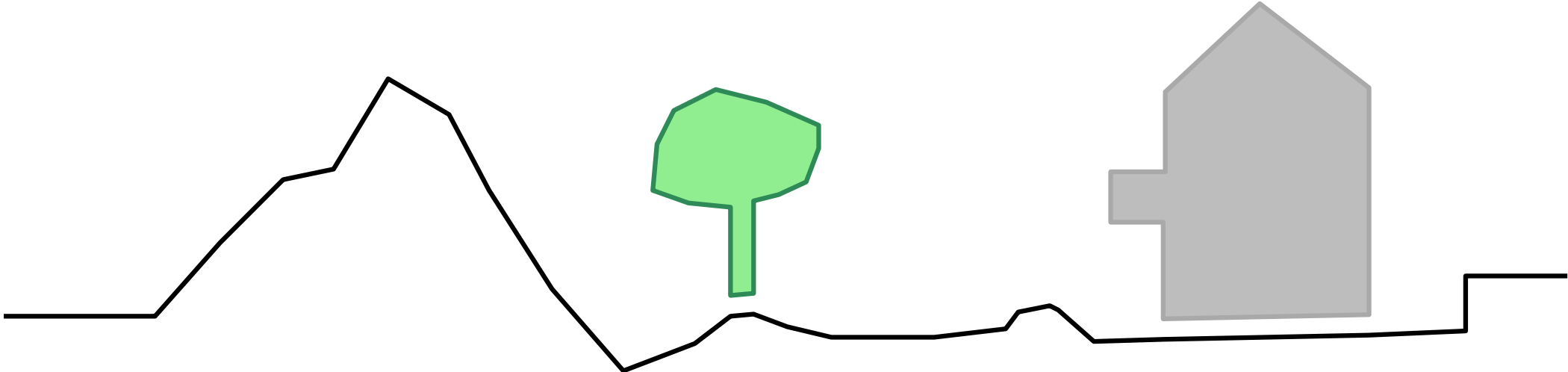
(a) A terrain



(b) 2.5D modelling



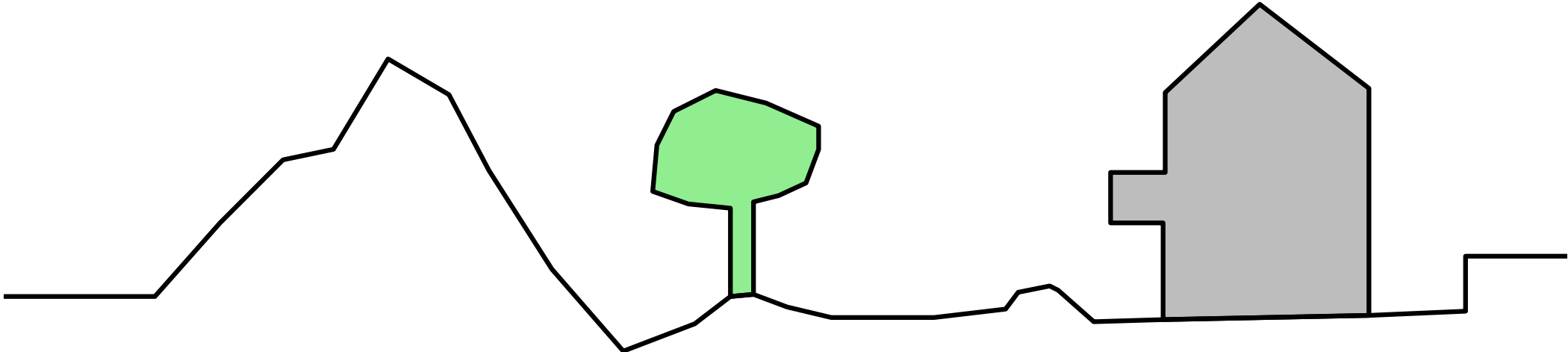
(c) 2.75D modelling



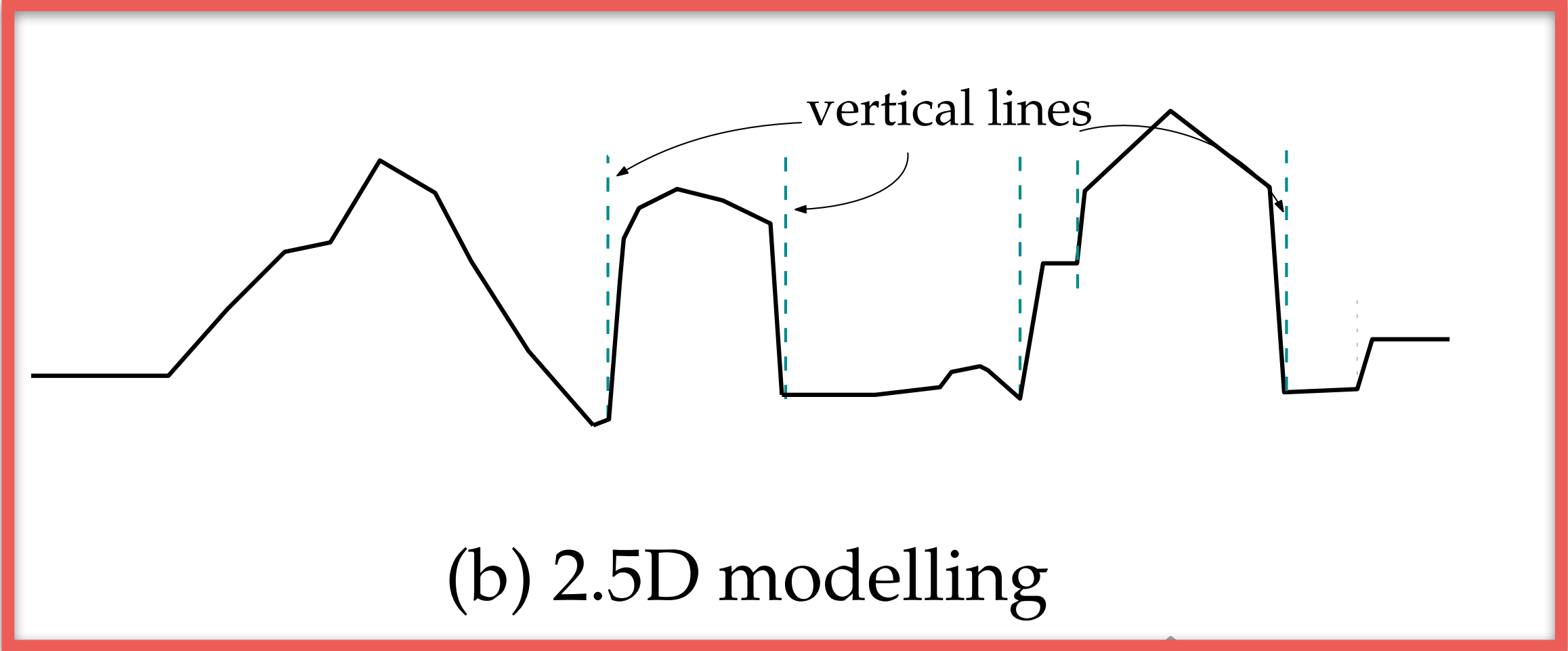
(d) Volumetric modelling, or full 3D

# Dimensionality of DTMs

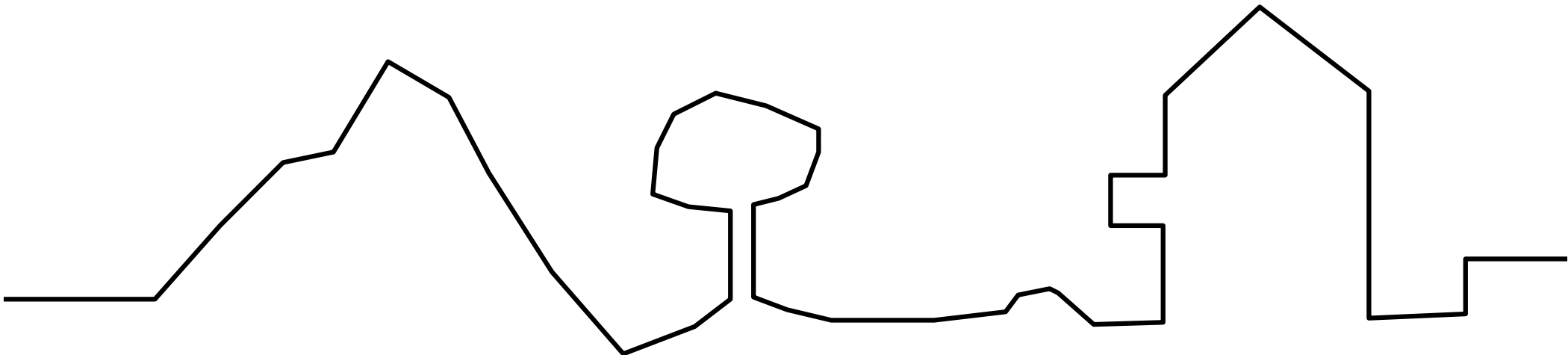
we focus solely on 2.5D  
in this course



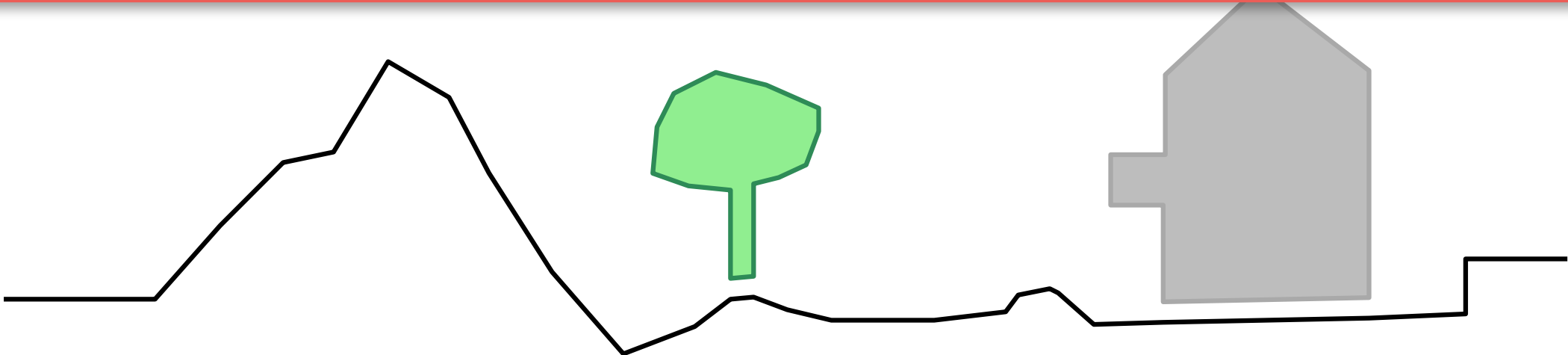
(a) A terrain



(b) 2.5D modelling



(c) 2.75D modelling



(d) Volumetric modelling, or full 3D

GEO1004 + GEO1016

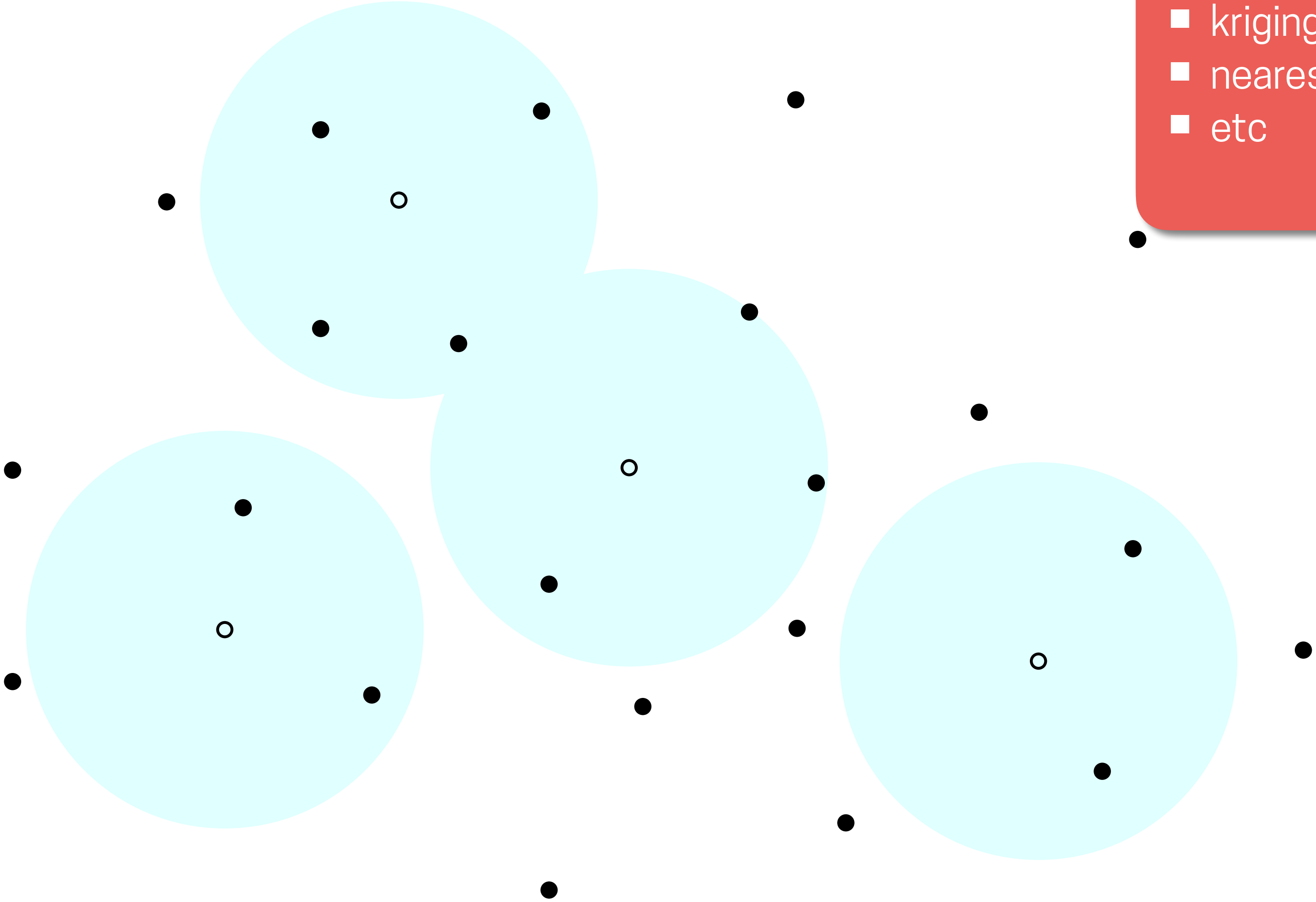


## 2.5D DTM == a field

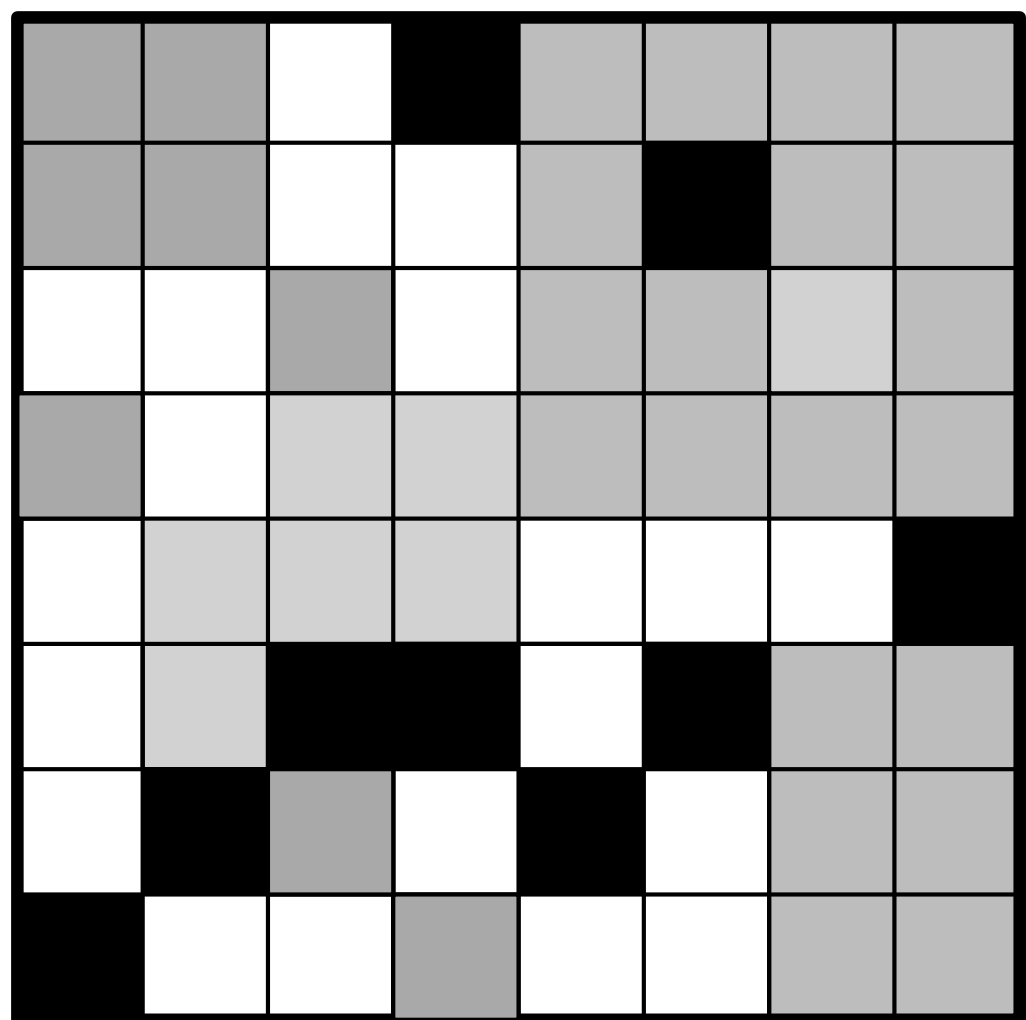
- $z = f(x, y)$
- to represent a field/terrain we need:
  1. a set of samples (usually elevation points)
  2. set of rules to obtain the elevation at unsampled locations

# Strategy #1: points + global interpolation

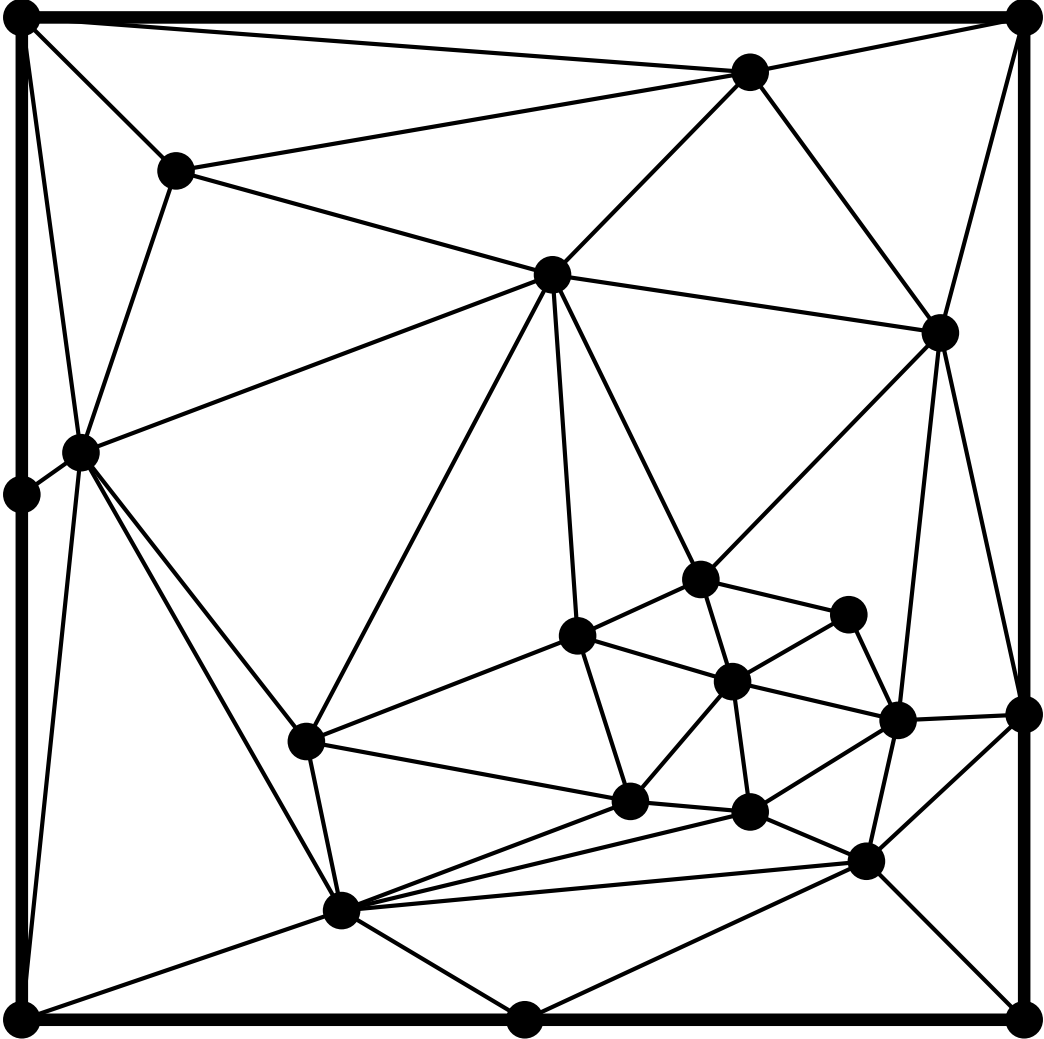
- IDW
- kriging
- nearest neighbour
- etc



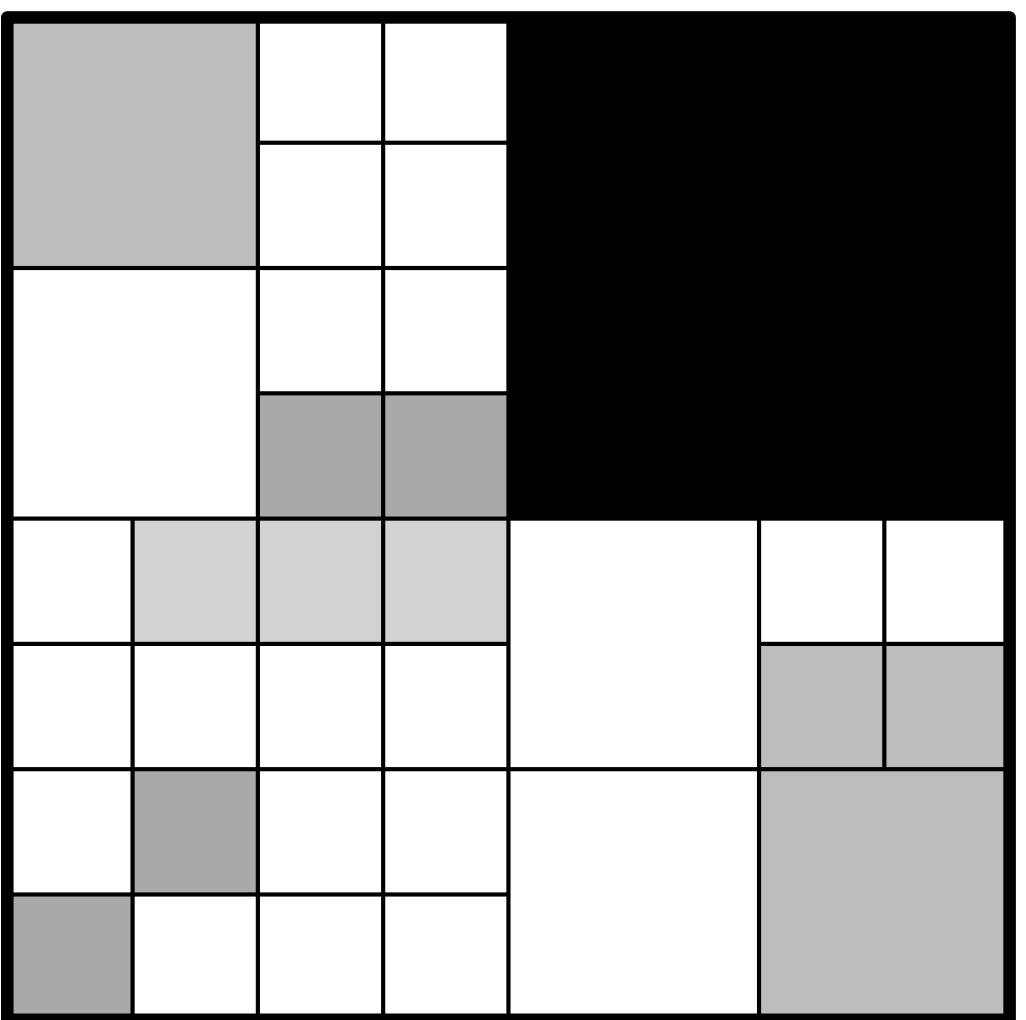
# Strategy #2: piecewise spatial model



regular



irregular

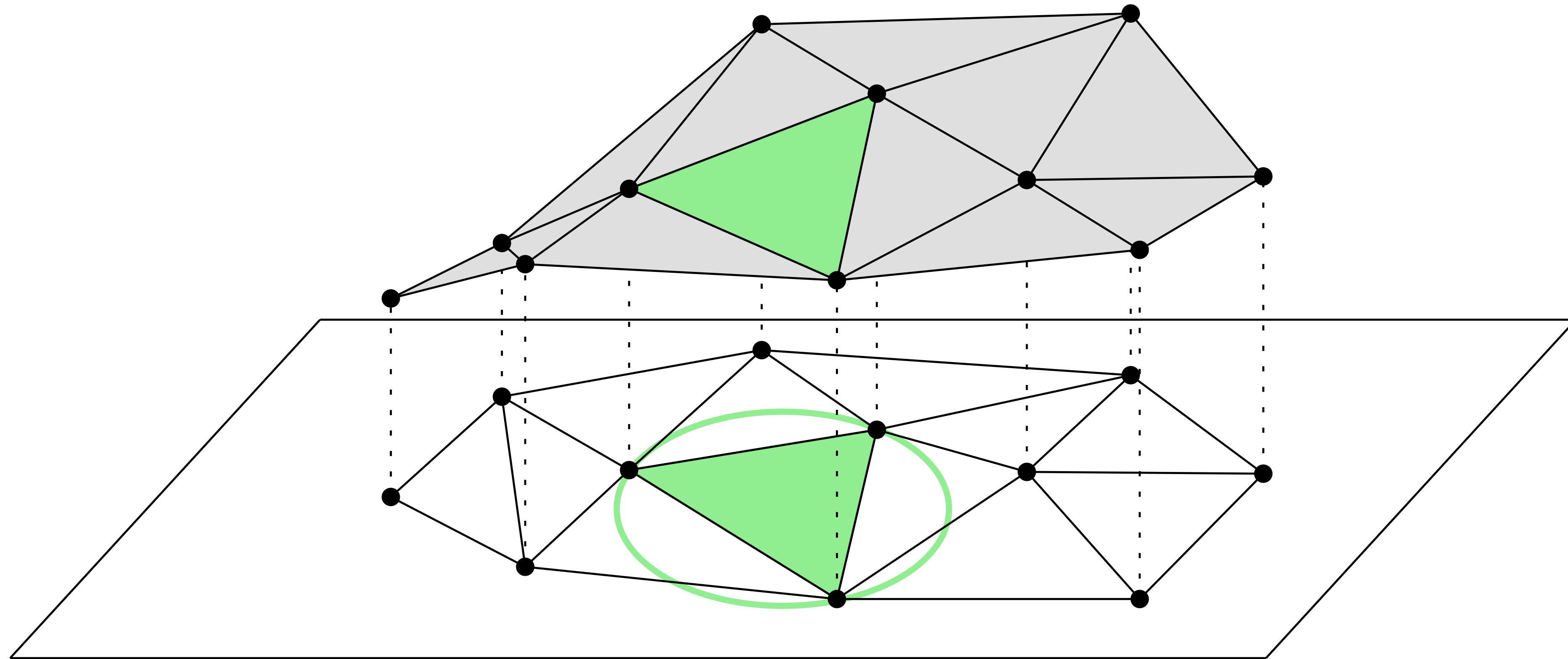


hierarchical

- constant function
- linear function
- higher-order function

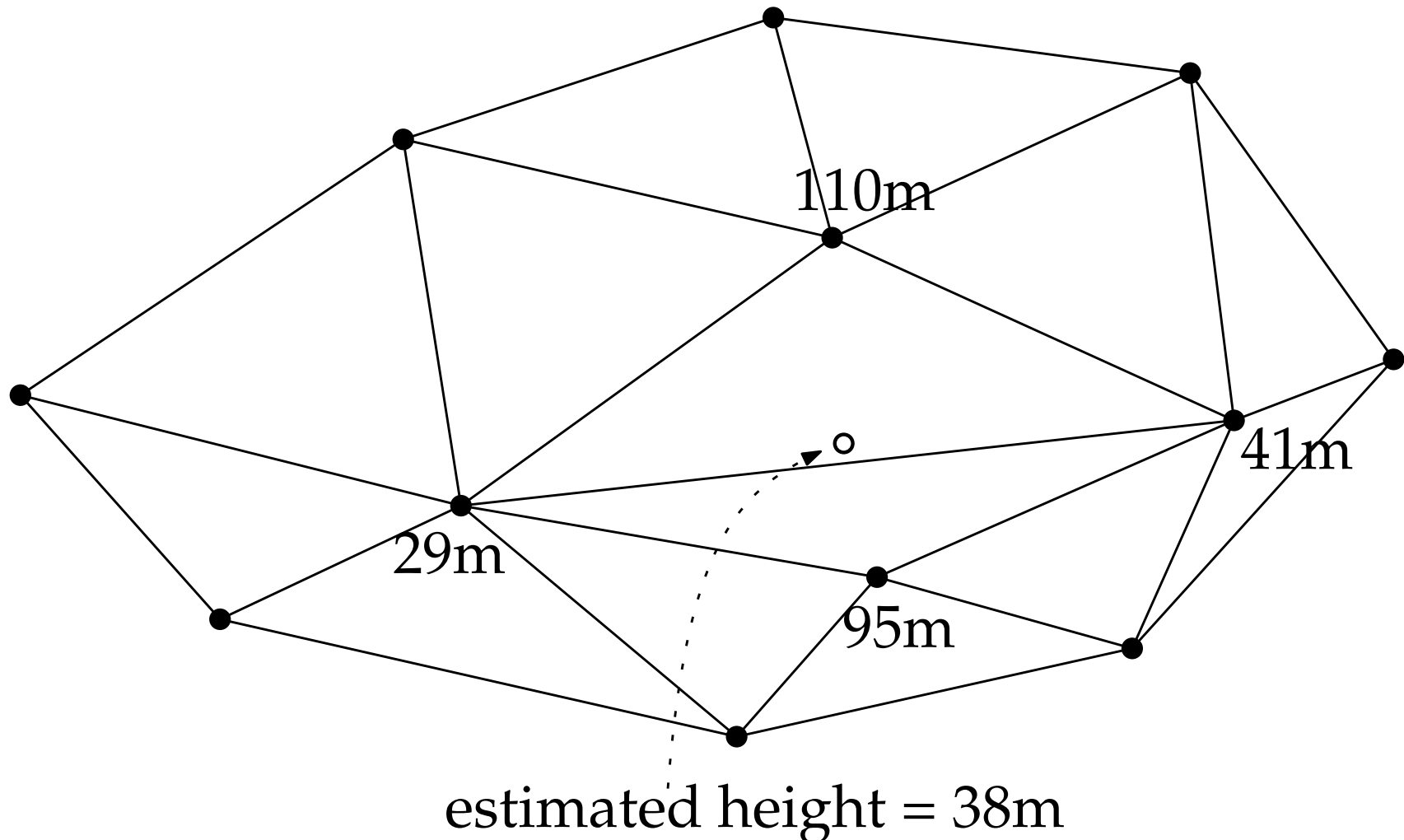


# TIN == 2D surface embedded in 3D

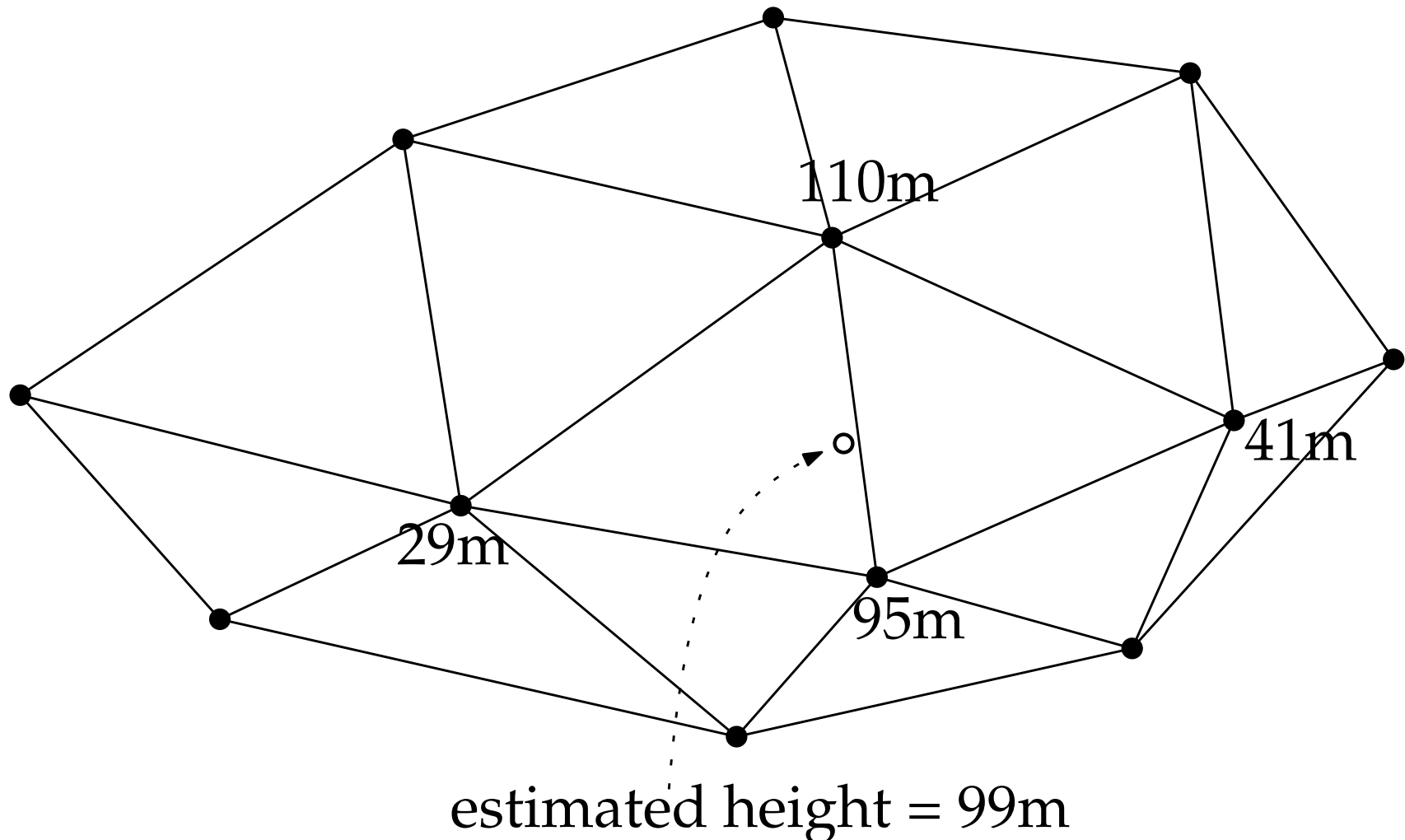


# Why TIN is often Delaunay?

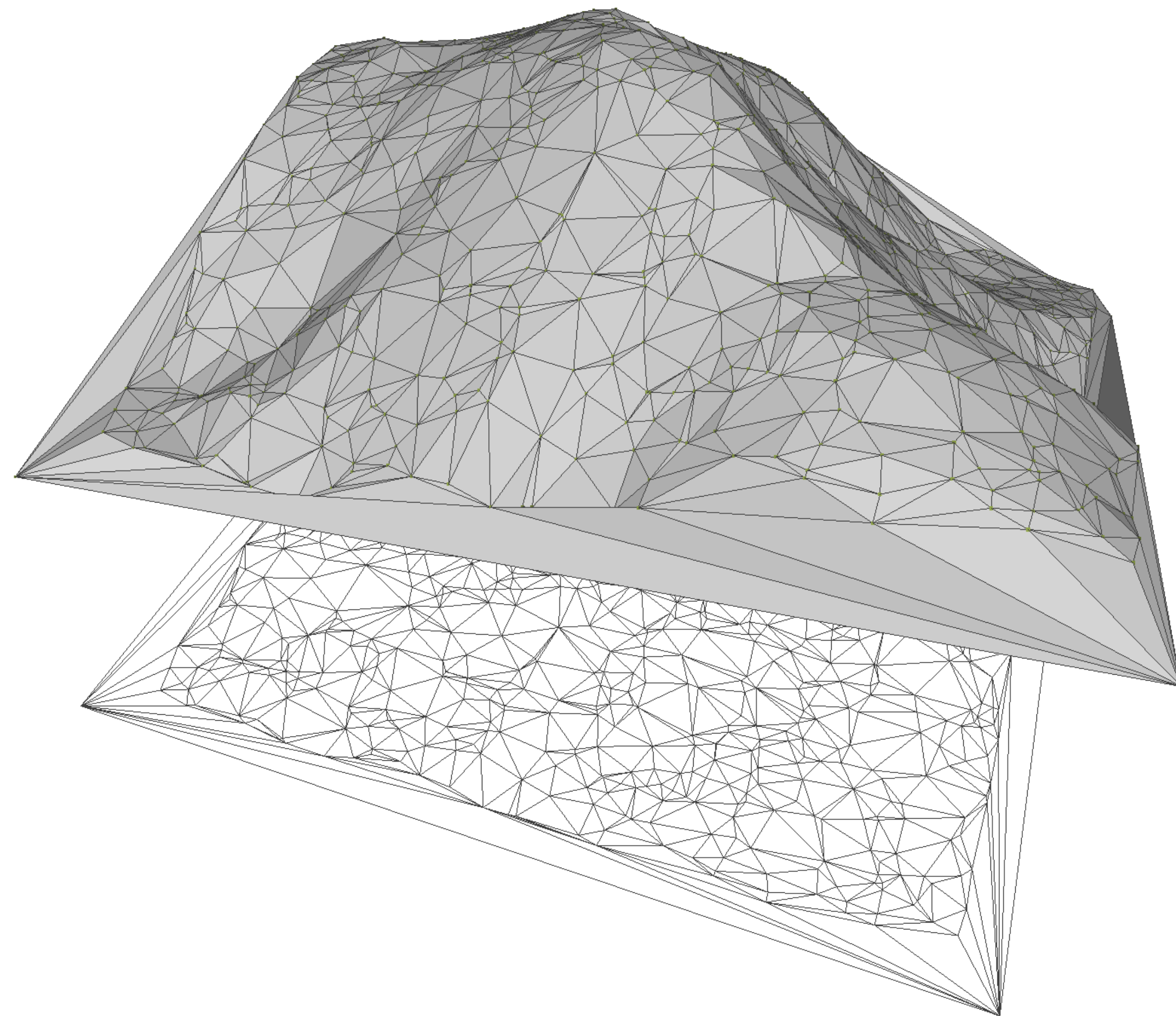
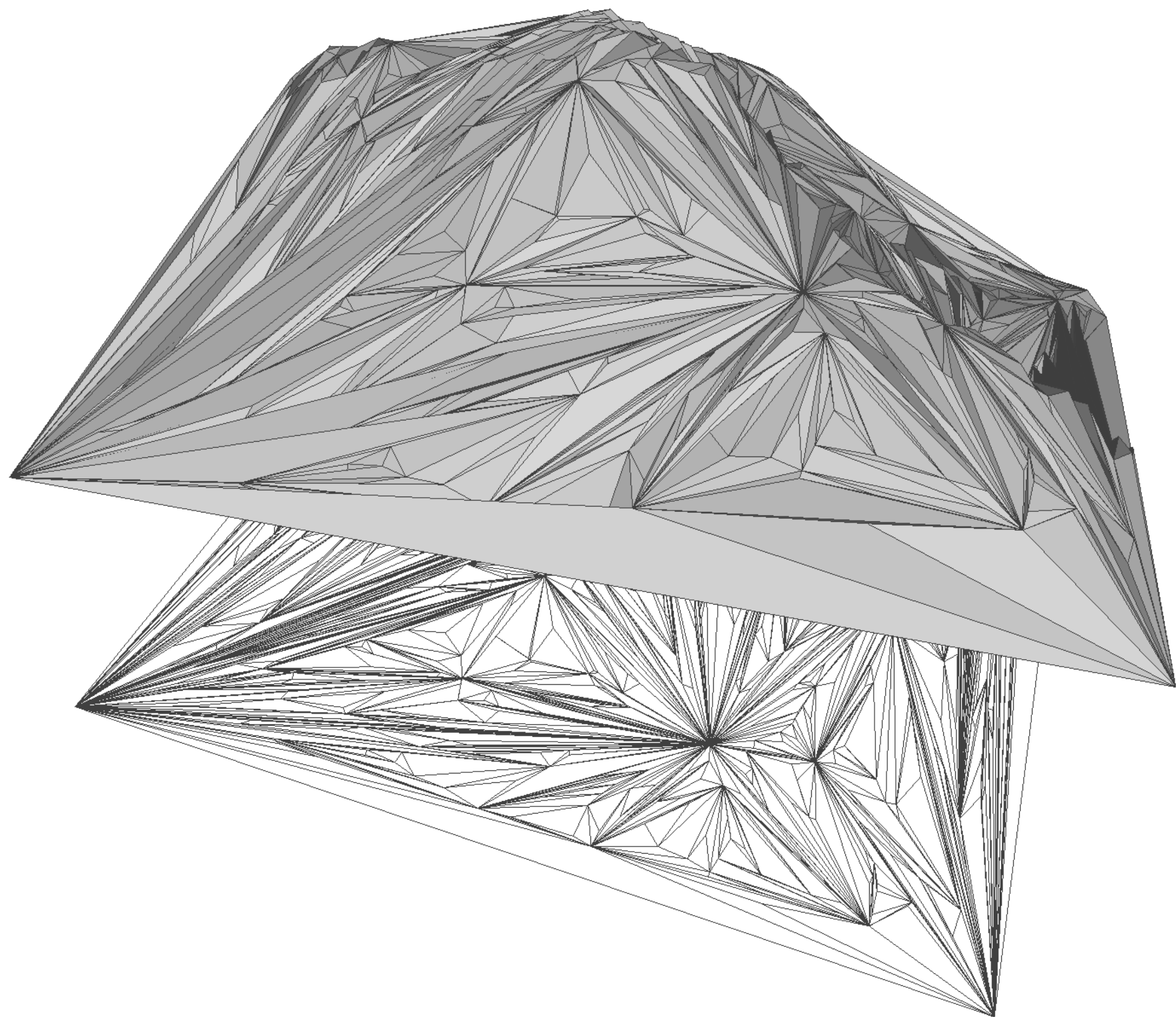
not Delaunay



Delaunay



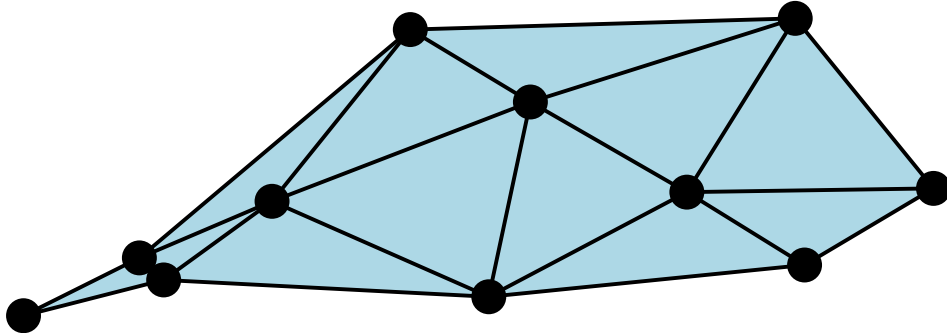
# Why TIN is often Delaunay?



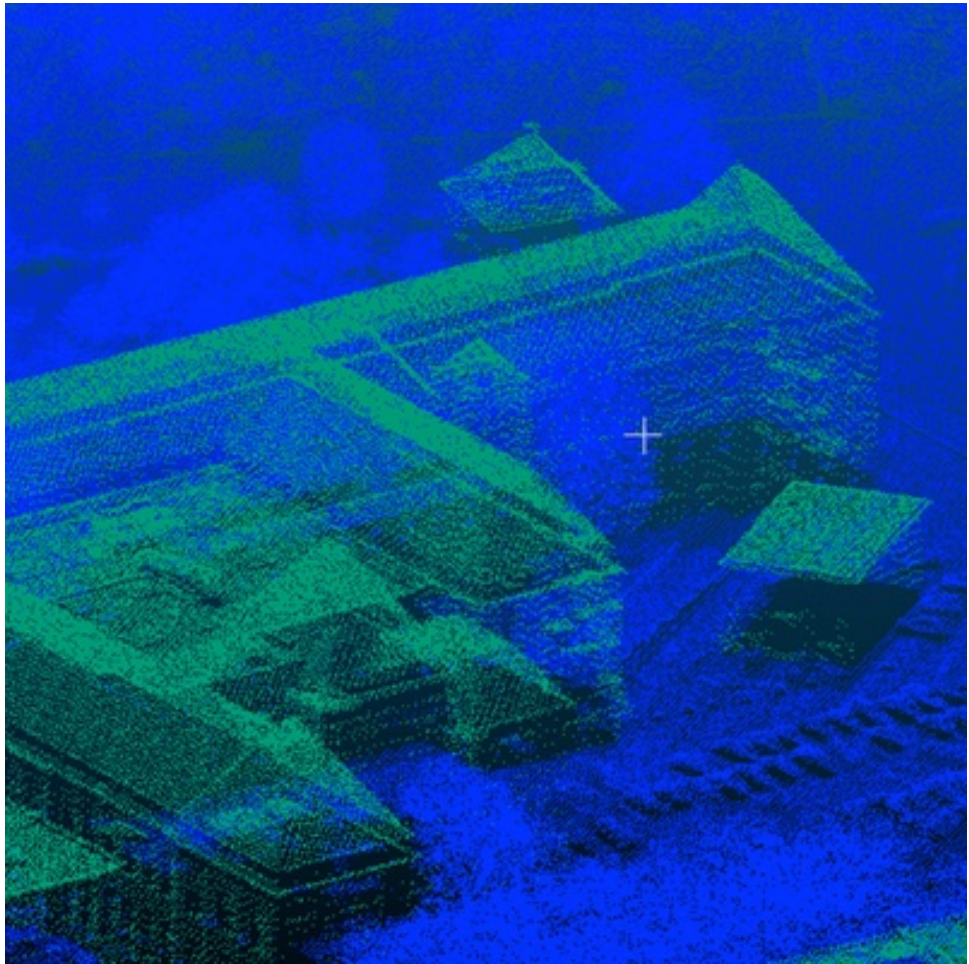
# 4 most common representations



raster



TIN



point cloud



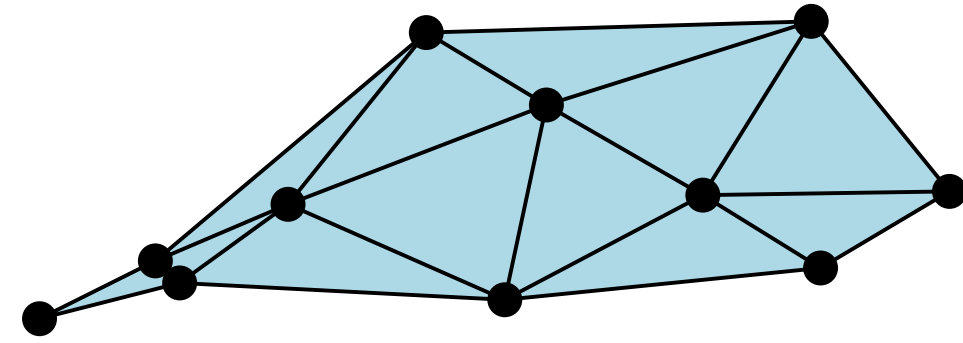
contour lines



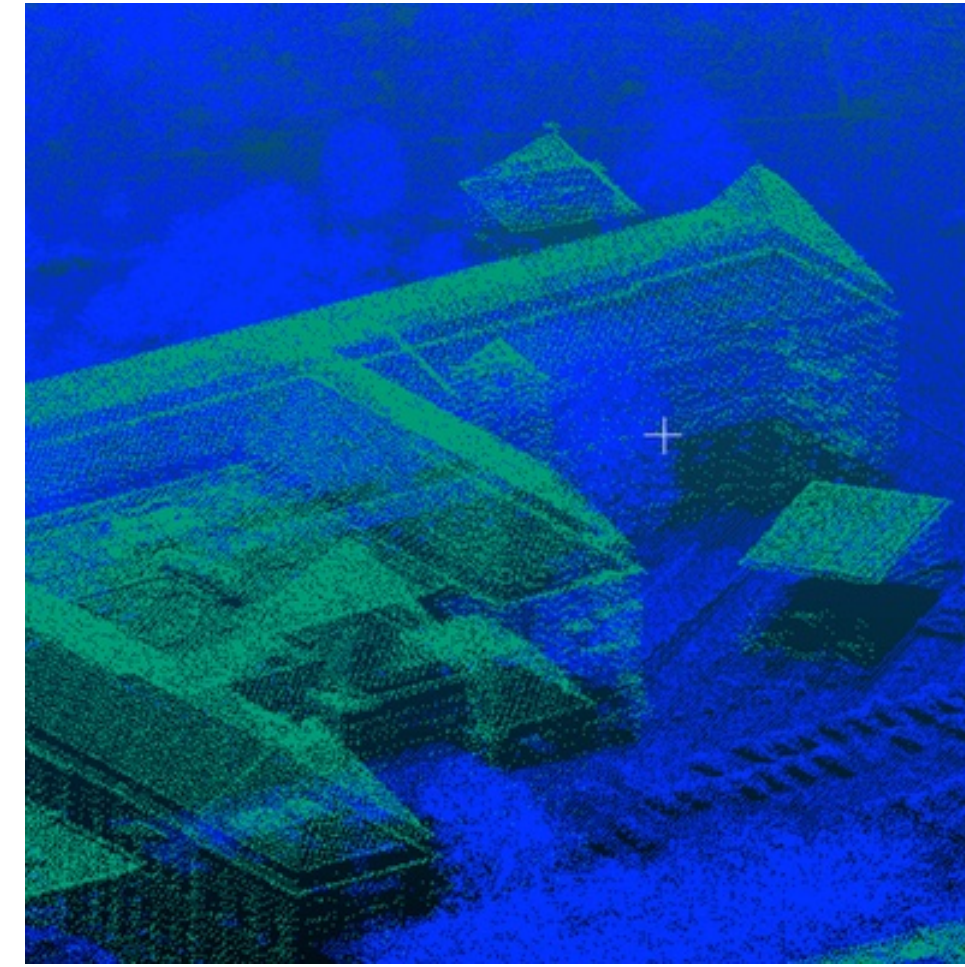
# 4 most common representations



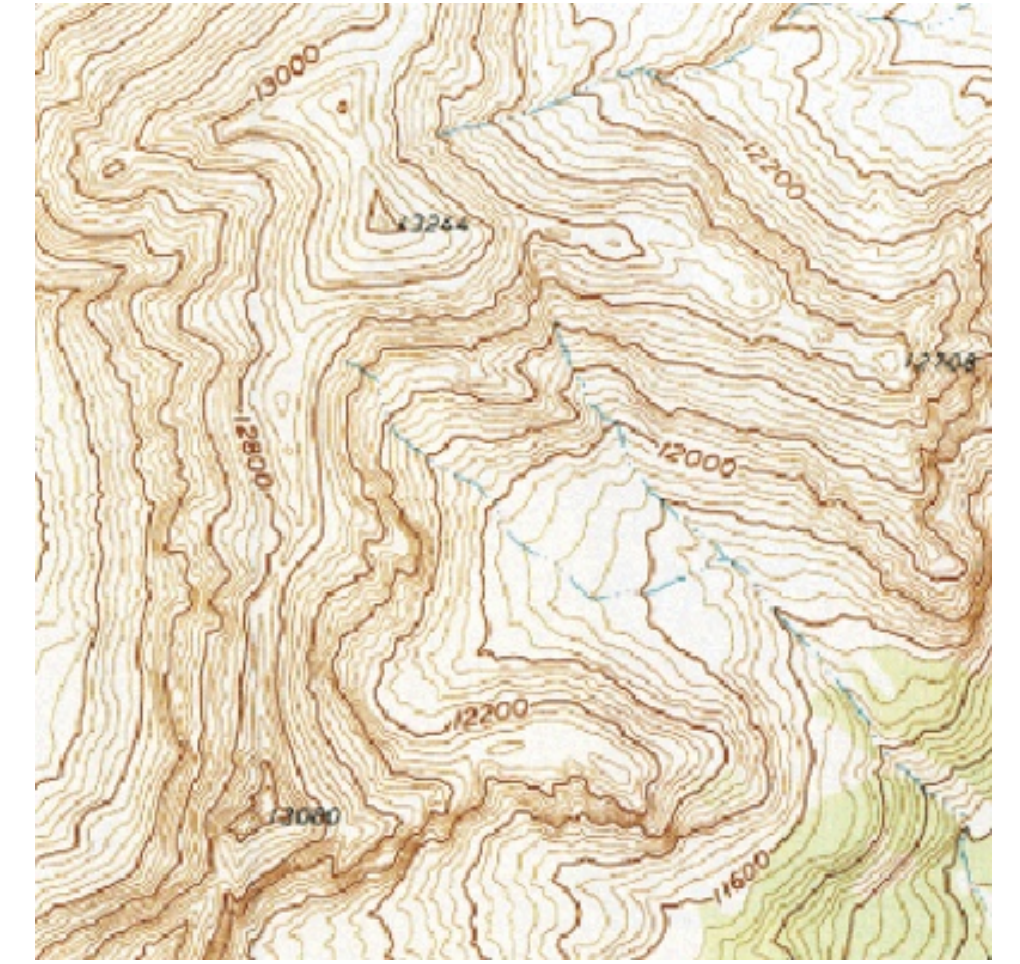
raster



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..."*

# 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/>