Storage and analysis of massive TINs in a DBMS

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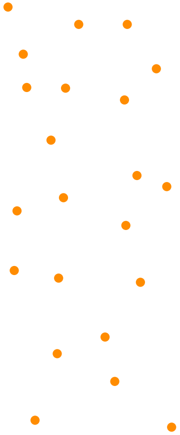
26 November 2009
NCG Seminar—De Meern

Introduction

- Computers have many problems dealing with billions of points:
  - Storing is OK
  - Visualisation is still a challenge
  - **Processing** and **analysis** are very problematic
- Processing operations:
  - derivation of slope/aspect,
  - conversion to grid format,
  - calculations of area/volumes,
  - viewshed analysis,
  - creation of simplified DTM,
  - extraction of bassins,
  - etc.



Advances in technologies to collect data are far superior to our ability to process data.

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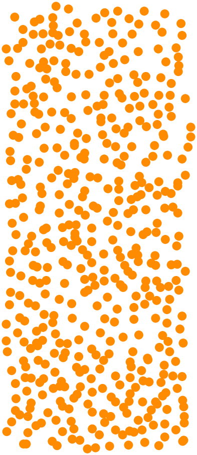
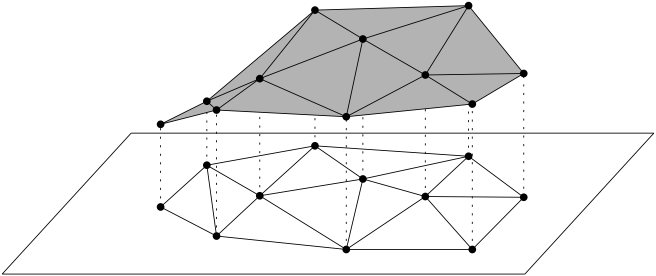


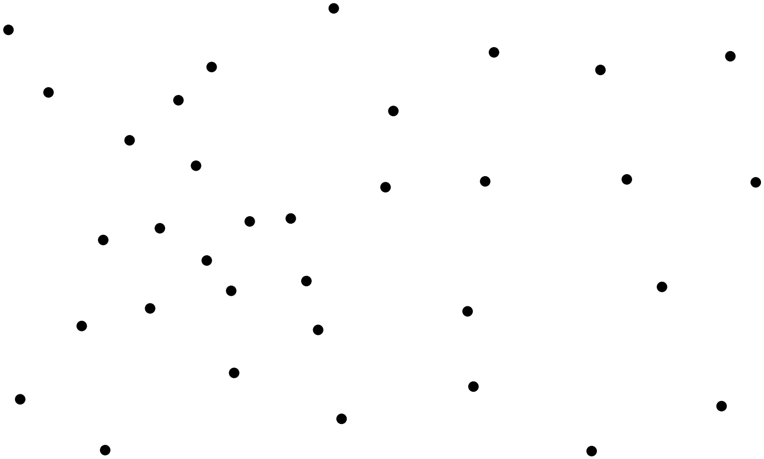
Advances in technologies to collect data are far superior to our ability to process data.

Point clouds are often "2.5D surface"

LiDAR datasets are formed by scattered points in 3D space, which are the samples of a surface that can be projected on the horizontal plan.

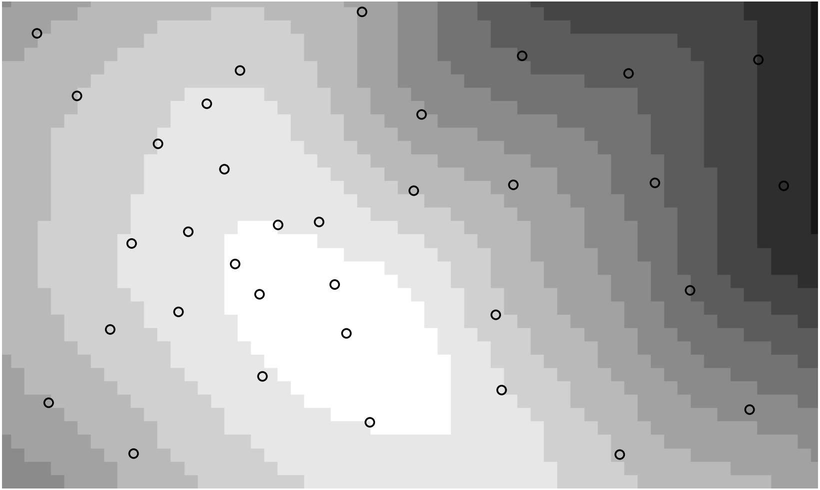


Reconstruction of the surface



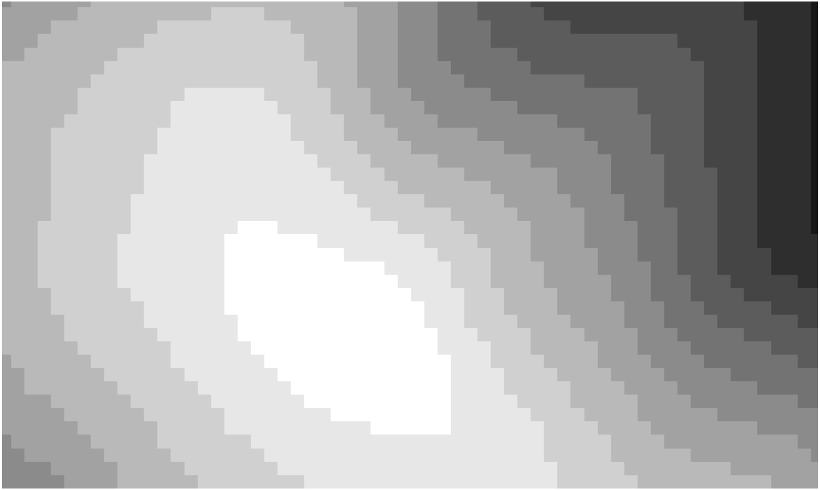
Original LiDAR points

Reconstruction of the surface



Raster representation

Reconstruction of the surface



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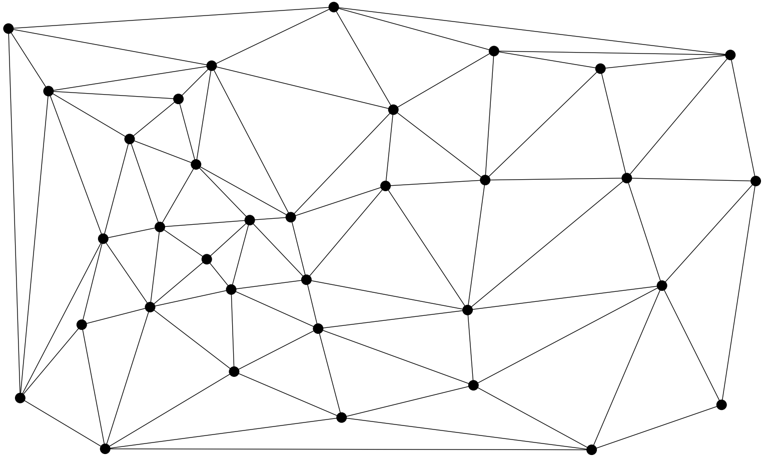
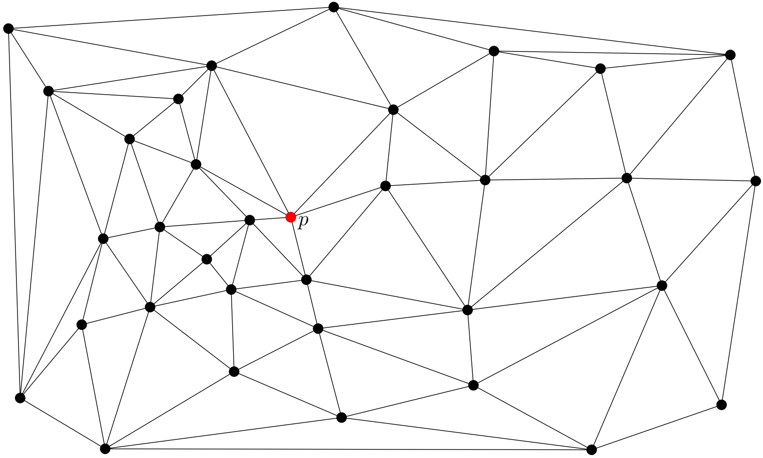


TIN (with Delaunay triangles)

Reconstruction of the surface



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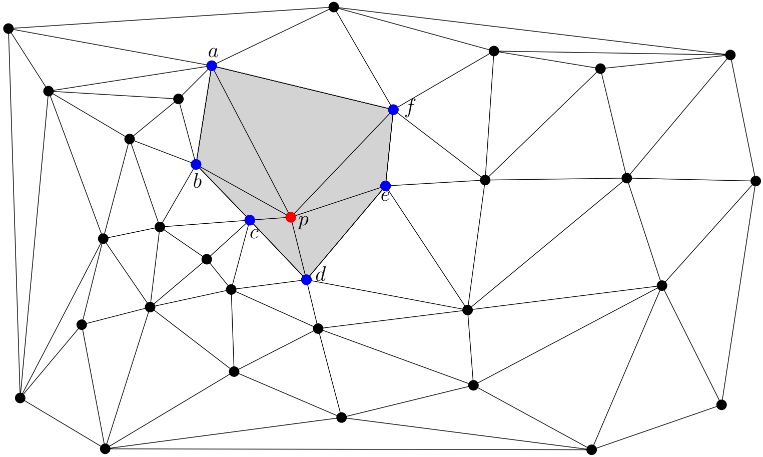


TIN (with Delaunay triangles)

Related work

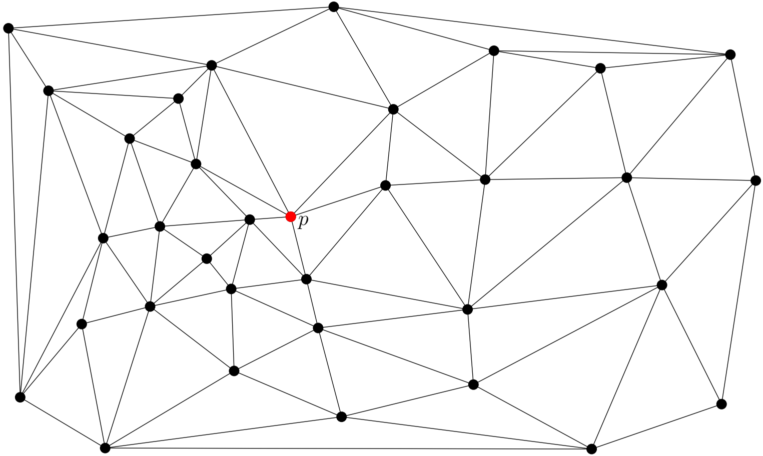
- Terrasolid: max is main memory
- ArcGIS: *Terrain* type (hierarchical structure)
- Oracle Spatial 11*g*: *Point Cloud* & *TIN* types
- External memory algorithms [AAD06, ADHZ06]
- Streaming of geometries of Isenburg *et al.* [ILSS06, ILS$^+$06]

Storing triangles in a DBMS

1. Storing independently triangles ($\sim$ OGC)
2. Triangle-based data structure used by triangulation libraries [BDP$^+$02]
3. Edge-based data structure (e.g. half-edge [M8̈8])

A star-based data structure

- Goes beyond the usual “store points and edges/triangles”
- Ideas come from data structures for compression of graphs [BBCK05]



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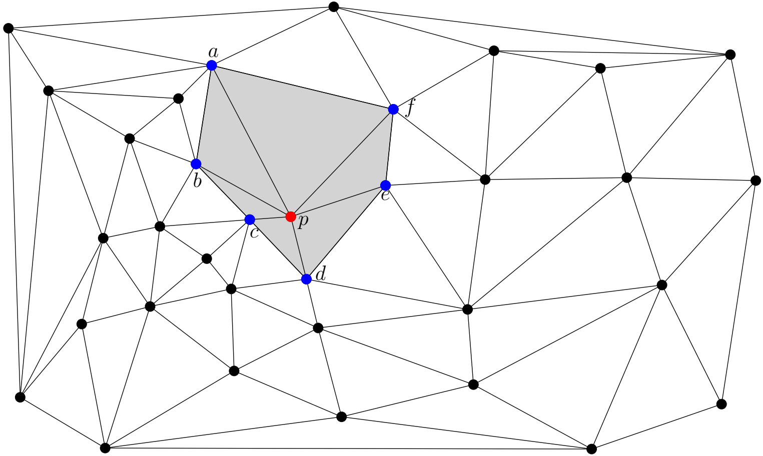

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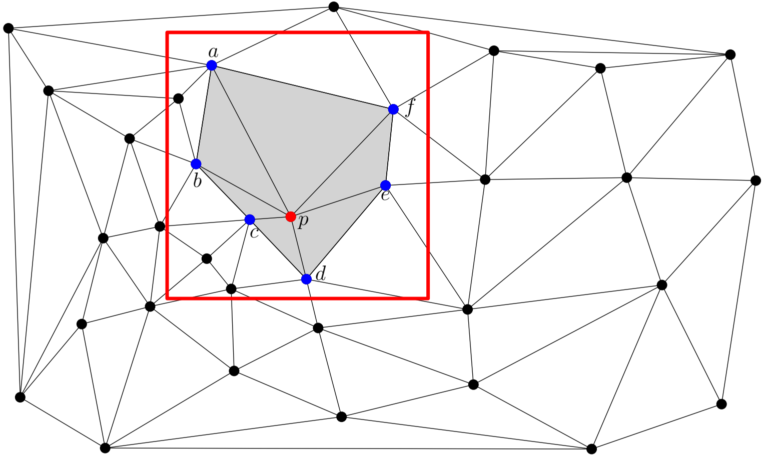

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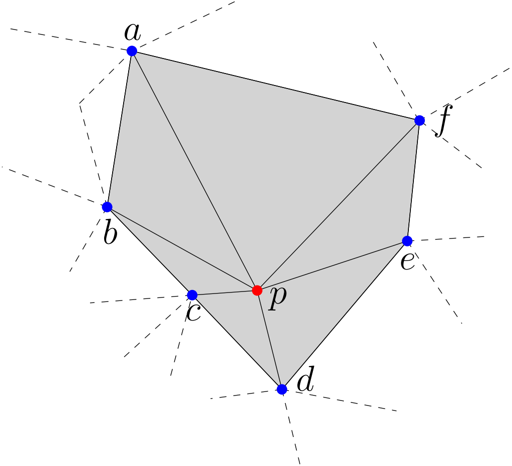
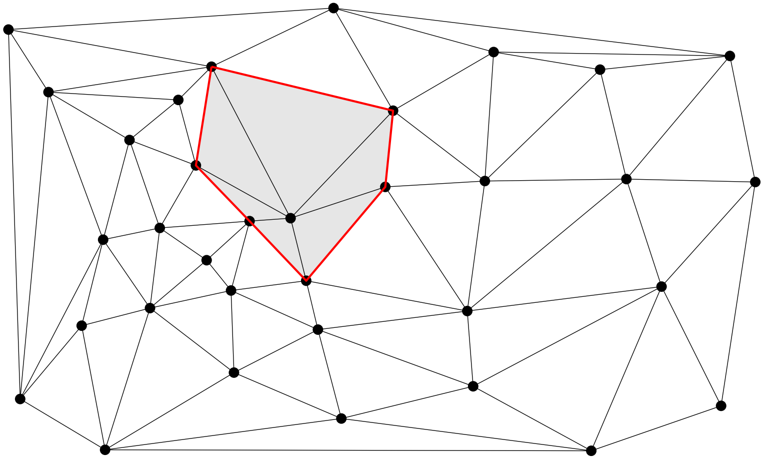


$$\boxed{star(p) = abcdef}$$

Every star(v) is stored → implicit triangles



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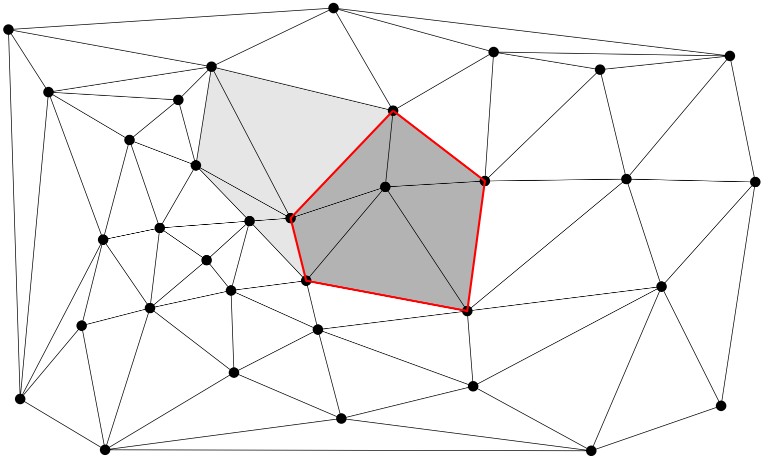

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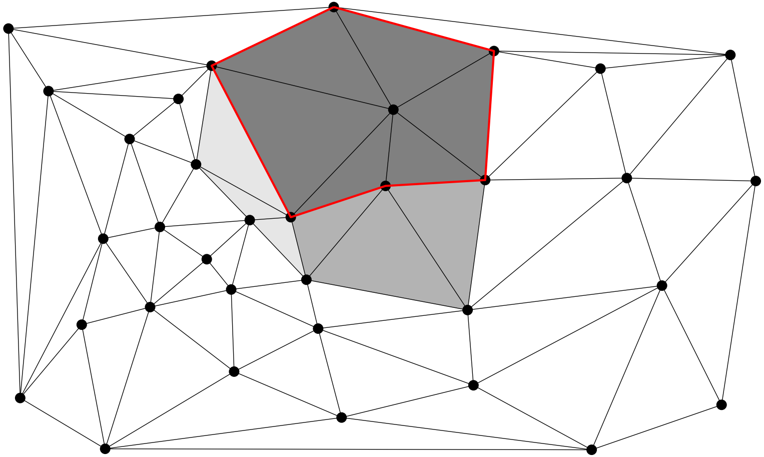

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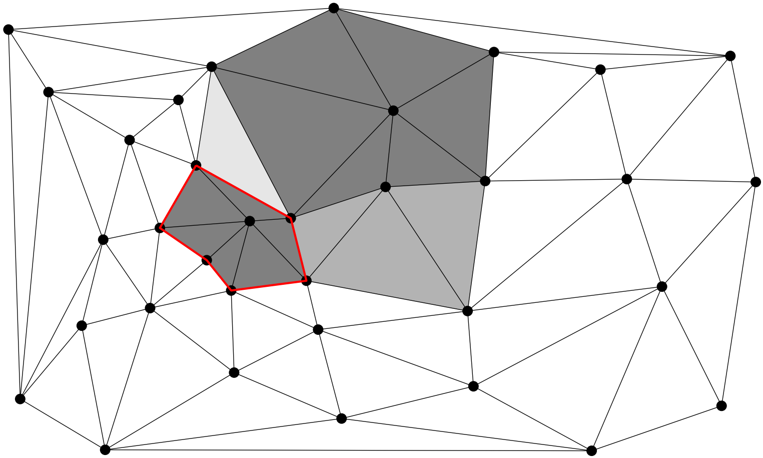


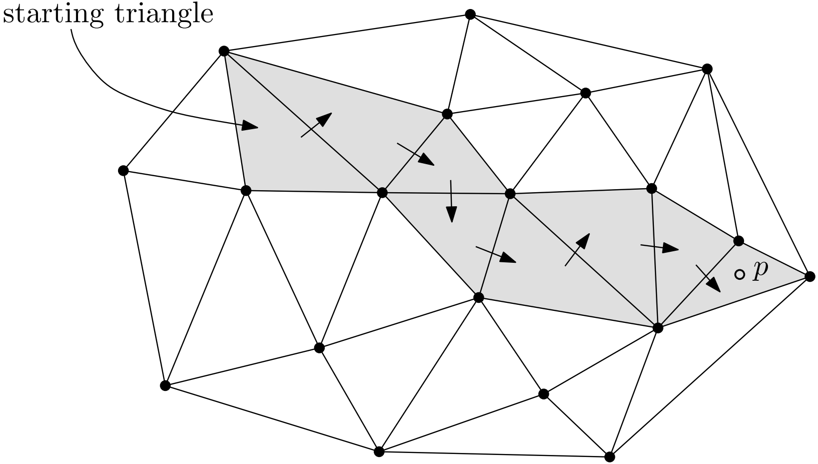
Stars in a DBMS

ID	x	y	z	star
1	3.21	5.23	2.11	2–44–55–61–23
2	5.19	29.01	4.55	7–98–111–233–222
3	22.43	15.99	8.19	99–101–73–23
...	...	...	...	...
5674	221.19	15.23	37.81	309–802–793–1111

Advantages:

1. Only one table with $id - x - y - z - star$
2. No spatial index needed: point location based on "walking"
3. Star column need not be filled ($\sim$ Simple Features)
4. Local updates are possible (insertion and removal)
5. Ideas are readily extensible to 3D for storing and manipulating tetrahedra

Point Location = “Walking” in the triangulation



(Can be made efficient with some tricks [MSZ99])

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Thanks for your attention!

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