MADALGO
CENTER FOR MASSIVE DATA ALGORITHMICS

Danmarks Grundforskningsfond
Danish National Research Foundation

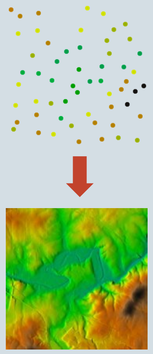
TerraSTREAM Modelling Tools

Digital Elevation Models (DEMs)

A Digital Elevation Model (DEM) is a representation of a terrain.

Two main DEM models

- Uniform grid (Grid)
- Triangulated Irregular Network (TIN)

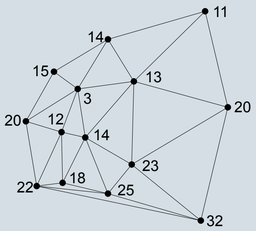


TerraSTREAM can construct both TIN and grid DEMs from massive point clouds using provable efficient algorithms.

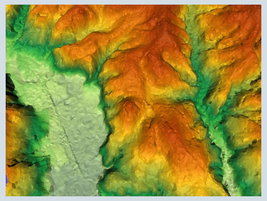
A DEM is usually constructed from a finite set of height measurements also called a point cloud (e.g., LAS LIDAR data).

Constructing TIN DEM

A TIN DEM is a planar triangulation of the point cloud with an elevation value associated with every vertex.



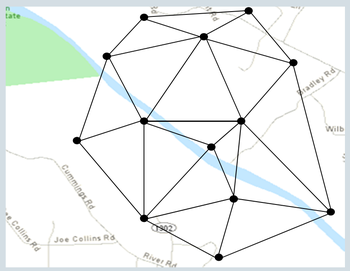
TIN DEM



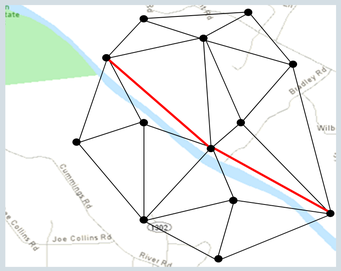
Visualization of triangulation

TerraSTREAM implements an algorithm for constructing delaunay triangulations of massive point clouds.

User-defined constraints sometimes improve the quality of Delaunay triangulations, if the point data is not detailed enough. TerraSTREAM can construcrt constrained Delaunay triangulations.



Delaunay triangulation



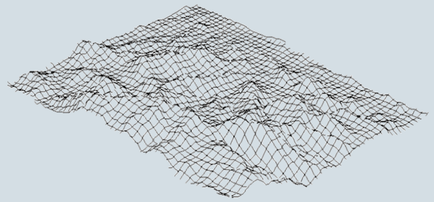
Constrained Delaunay triangulation

Constructing Grid DEM

A grid DEM is a uniform grid of height values.

3	2	4	3	2	4
7	5	8	7	5	8
7	1	9	7	1	9
3	2	4	3	2	4
7	5	8	7	5	8
7	1	9	7	1	9

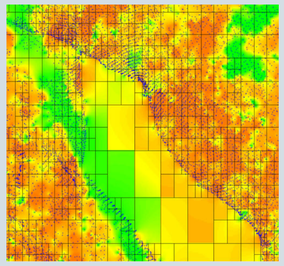
Height grid



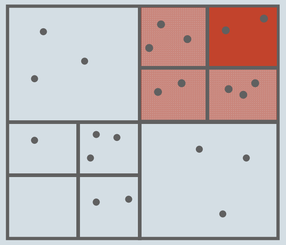
3D visualization of a height grid

Adaptive construction

- We adaptively break grid into tiles containing “few” input data points
- We interpolate in each tile independently, also considering data points in neighbor tiles (to ensure smoothness along boundaries)



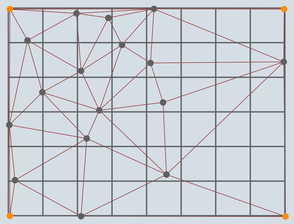
Tiling of a point data set



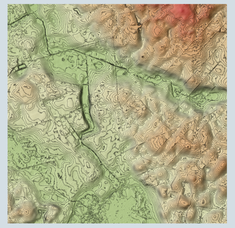
A tile to interpolate and its neighbors

Linear interpolation over TIN DEM

- Construct a Delaunay triangulation of input point cloud
- Linearly interpolate a height value for each grid cell from the corners of the triangle containing the center of the grid cell



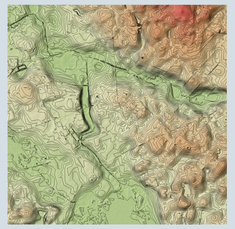
Constructing and Simplifying Contour Maps



Step 1

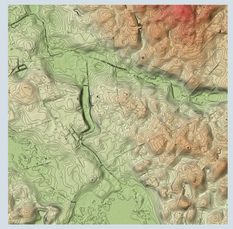
To the left *the “raw” contours derived directly from a high resolution grid DEM.* ***To the right*** *the contours derived from a grid DEM that was first topologically simplified.*

Step 2



Step 3

To the left *the simplified contours.* ***To the right*** *the smoothed contours. Both are guaranteed not to deviate more than some threshold value from the corresponding “raw” contours in both xy and z.*



Step 4

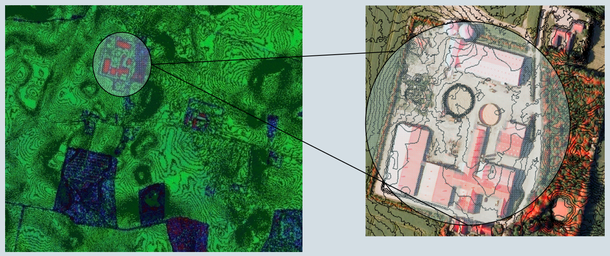
Grid DEM Quality Metric

Often grid DEM points are interpolated from very distant input points. User would like to know “trustworthiness” of each grid point.

Contour line visualization of a grid. There are obvious flaws in the vicinity of buildings (where no input points are available)

We compute nearest input point for each grid DEM cell.

I/O-efficient algorithm: We compute nearest points by adapting known nearest-neighbor algorithms and exploiting uniformity of grid.



Visualizations of our measure. Areas with very close input points are green, areas with relatively close input points are blue and areas with distant input points are red