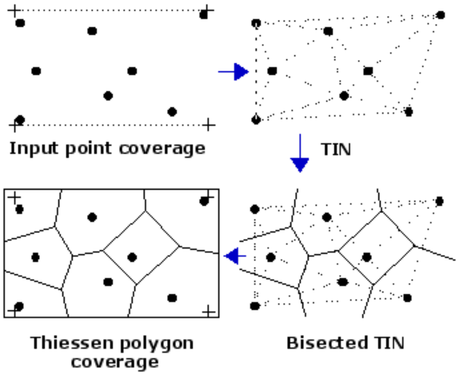
TIN & Surface Interpolation



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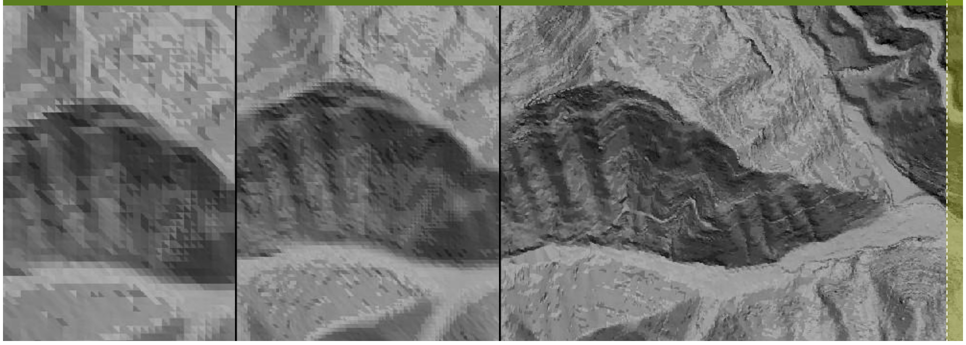

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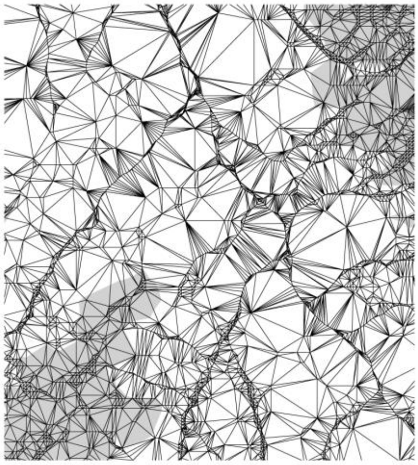
Triangulated Irregular Network (TIN)

- Node (x, y, z)
- Edge
- Triangles
- Topology
  - The triangle number
  - The numbers of each adjacent triangle
  - The three nodes defining the triangle
  - The x, y coordinates of each node
  - The surface z value of each node
  - The edge type of each triangle edge (hard or soft)



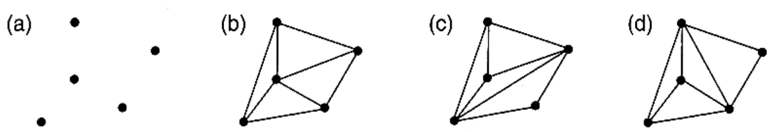
Conversions between Surface Models

From \ To	Point	Triangle	Grid
Point	Spatial interpolation	TIN generation	Spatial interpolation, indirect interpolation
Triangle	Edge points	Edit TIN	Linear / curved surface interpolation
Grid	Nearest neighbor, linear/cubic interpolation	TIN generation	Nearest neighbor, linear/cubic interpolation

Static vs. Dynamic Triangulation

- Static: all data are used in a single-pass process
- Dynamic: data are used in a multiple-pass process (i.e., subsequent editing of a TIN)

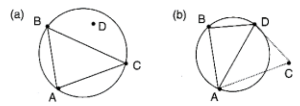
Ways of Forming Triangles



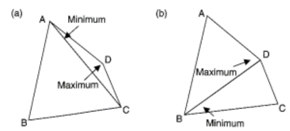
Basic requirements:
1. Unique formation
2. Equilateral triangles
3. Minimal edge length

TIN Formation

- Delaunay criterion (empty circumcircle principle): the circumscribing circle of any triangle contains no other points of data except the three defining it.



- Local equiangularity (max-min angle principle): minimizing the range of interior angles in the two triangles that form a convex quadrilateral (through Lawson's Local Opt. Procedure).



- Minimum sum-distance principle:
- Minimum circumscribing circle radius:
- …

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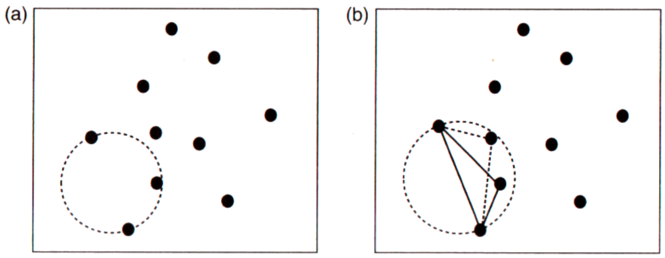
Static Triangulation of Points

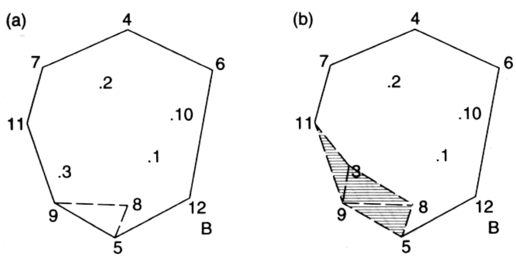
Algorithm:

1. Select an initial point
2. Search for the first edge
3. Form the first triangle (nearest point to the edge)
4. Search for a subsequent edge
5. Form a subsequent triangle
6. Repeat 4, 5 until all points become nodes of triangles

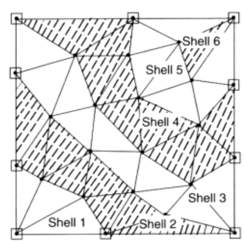
Searching for a Node Point



Searching for a Subsequent Edge



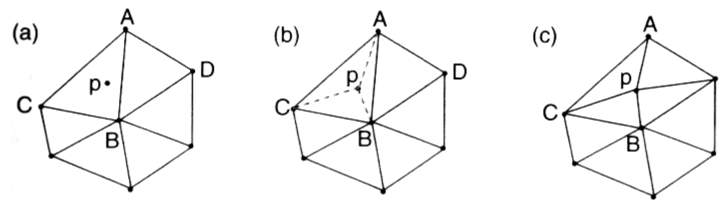
Convex hull algorithm



Imaginary bnd algorithm

Dynamic Triangulation of Points

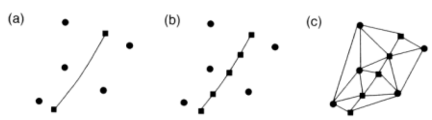
Bowyer-Watson algorithm

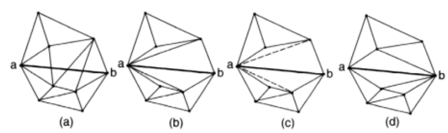


Constrained Triangulation

- Random points and feature-specific points of a DTM

- Approaches:
  - Point densification of features
  - Constrained Delaunay Triangulation





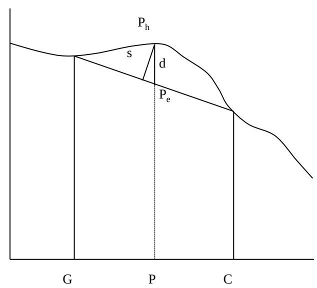
Triangulation from Contours

- Point densification of contours
- Contours as soft breaklines

Triangulation from DEM

- Selection of significant points from DEM
  - Very Important Points (VIP)
  - Maximum z-tolerance (d)

- Triangulation from VIP



Spatial Interpolation

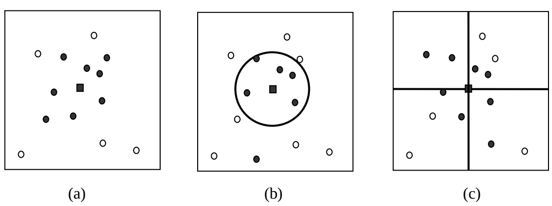
- Methods to construct the surface model
- Global vs. local
- Exact vs. best fit
- Information lost at the sampling stage can never be reconstructed (?)

Local Method

Neighbors

Distribution of control points

Extent of spatial autocorrelation



(a) find the closest points to the point to be estimated, (b) find points within a radius, and (c) find points within each of the four quadrants.

Distance Weighted Interpolation

- Neighbor points with observations
- Weighting functions

$$z = \frac{\sum_{1}^{s} z_i \frac{1}{d_i^k}}{\sum_{1}^{s} \frac{1}{d_i^k}}$$

Types of Local Spatial Interpolation

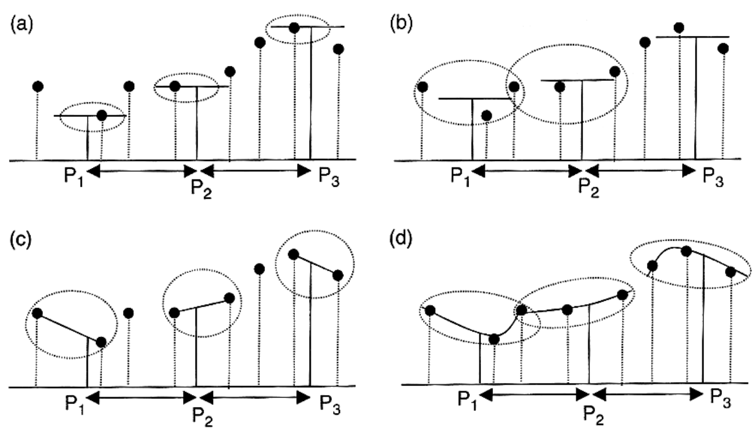
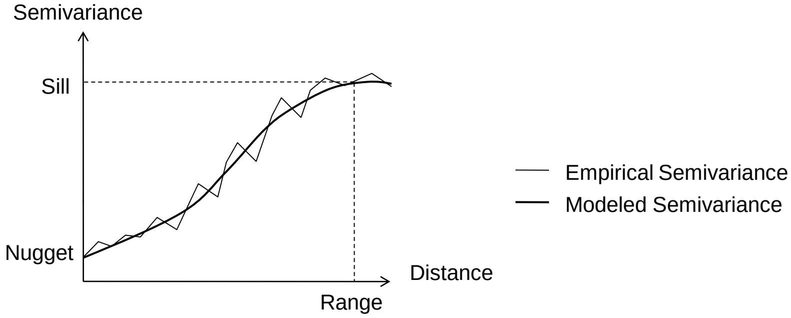


Figure 6.11 Different types of moving surfaces for interpolation: (a) nearest; (b) averaging; (c) linear surface; and (d) curved surface.

Kriging

$$\hat{Z}(\mathbf{s}_0) = \sum_{i=1}^{N} \lambda_i Z(\mathbf{s}_i)$$



DEM Resampling

- Down-scale (Fine to coarse)
  - Treat output grid as polygons
  - Data aggregation
- Up-scale (Coarse to fine)
  - Treat DEM as point data
  - Interpolation