GEOG 204

LECTURE 5

Spatial Analysis II

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Mid-term Exam

- Thursday 27th Oct
  - During the Lecture Time slot
  - Multiple choice questions and Short Answer Questions
  - Materials covered in the lectures (Sept to Oct 6th included)
  - 45 Minutes in Duration

Presentation Title 2

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Mid-term Prep

Multiple Choice Questions

1. In a vector data model, how many coordinate pairs does a single straight line have
   a. 1 b. **2** c. 3 d. 4 e. none of the above

2. Data downloaded from a website are known as vector data.
   a. True b. **False**

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Mid-term Prep

Multiple Choice Questions

3. Of the terms below which one refers to a surface that approximates the shape of the earth in the context of GIS
   a. Grid b. Round c. Geoid d. Globe e. none of the above

4. The vector data model is often used to represent discrete objects
   a. True
   b. False

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Mid-term Prep

Short Answer Questions

1. What is the difference between a GIS data model and GIS file format?
   - *Here you would be expected to explain your understanding a data model contrasting that with a file format.*
     - *Data model – how geographic objects are represented for computational purposes*
     - *File format – how data arranged and compressed in a computer file*
2. In the context of representing geographic phenomena, what is the field-based view of the world?
   - *The field-based view represents geographic space as a continuous distribution of phenomena. This representation is done with the aid of the raster-data model where a grid of cells is used to represent every point in the geographic space.*
   - *The field-based view conceptualises space as a continuous surface modeled by a mathematical function such that one is able to get a value at any point on this surface. This continuous surface is represented with the raster-data model where a grid of cells is used to represent the values from such a mathematical function.*

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Mid-term Prep

Short Answer Questions

3. List three properties of geographic objects that are distorted by map projections

4. Describe a primary method of collecting raster data

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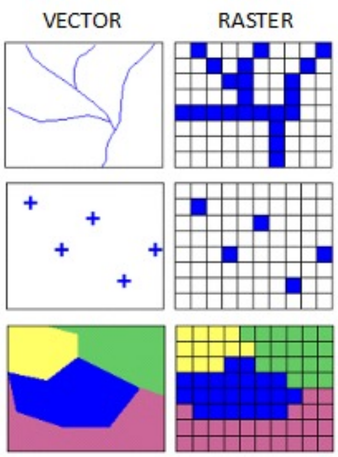
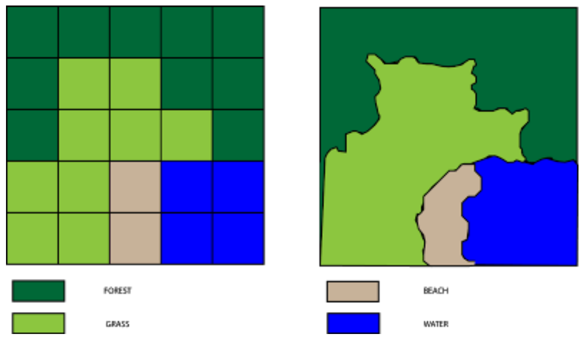
Raster Analysis



Source



Source

**Raster Data are modeled with a grid of cells.
Each cell is described with one value**

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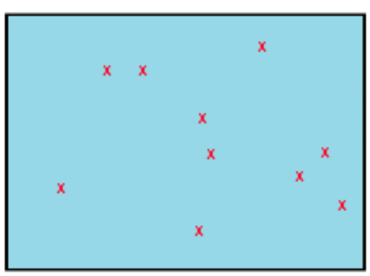
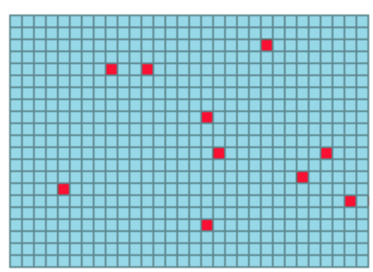
Converting points to raster



Point features



Raster point features

- If points clustered together, they could be converted to one raster cell.
- Point has area equal to cell size

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Converting points to raster

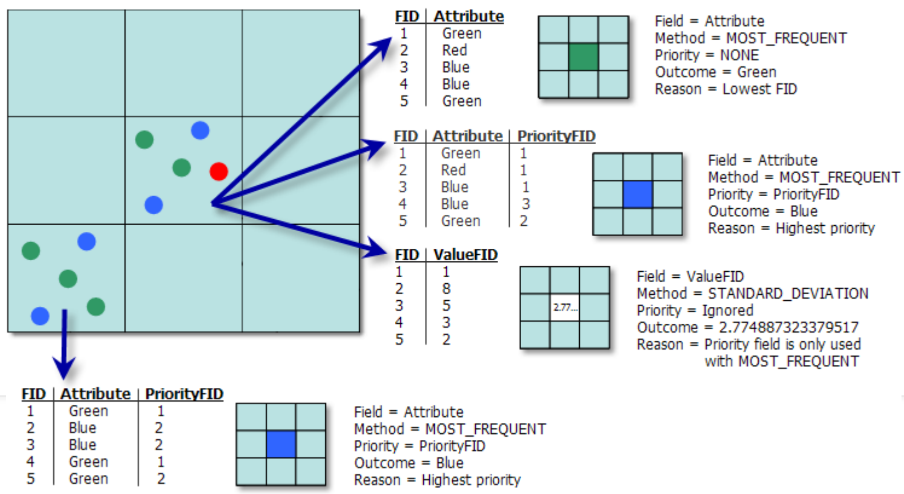

Illustration of boundary rules for point feature to raster conversion

Source: ESRI

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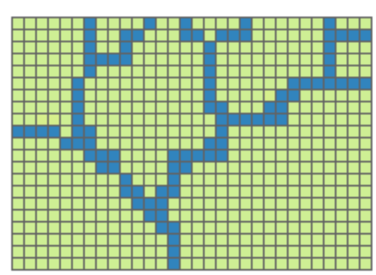
Lines to raster

Line features



Raster line features

Lines are seen as contiguous pixels

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Lines to raster

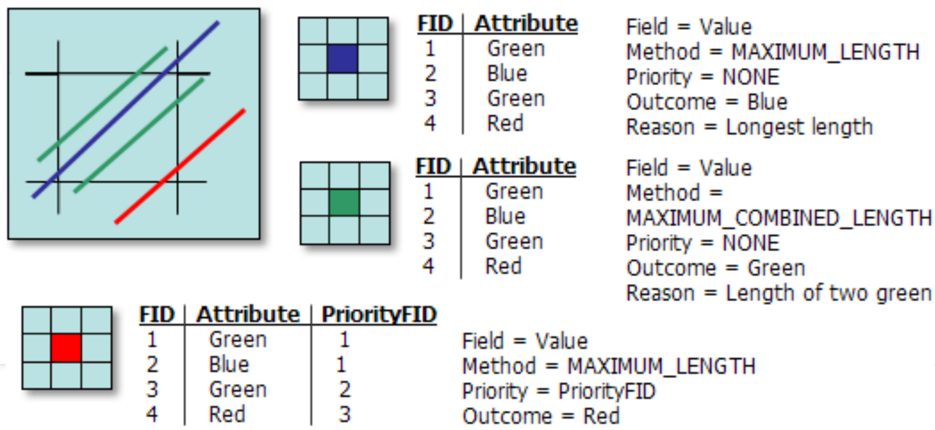

Illustration polyline to raster conversion

Source: ESRI

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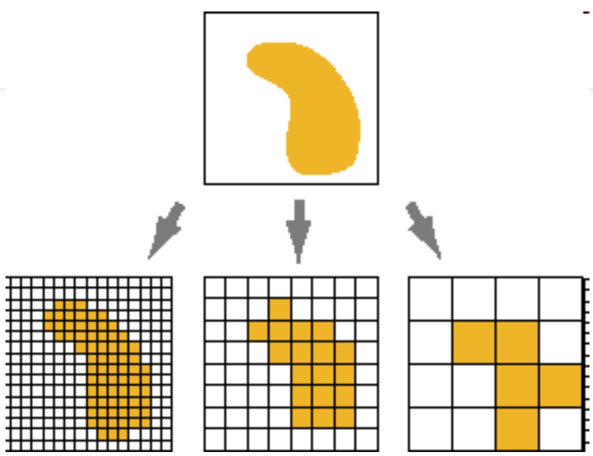
Polygon to raster conversion



Similar to scanning – specify **cell size** (pixels) and the **attribute** used

- Vector GIS handles attributes more effectively

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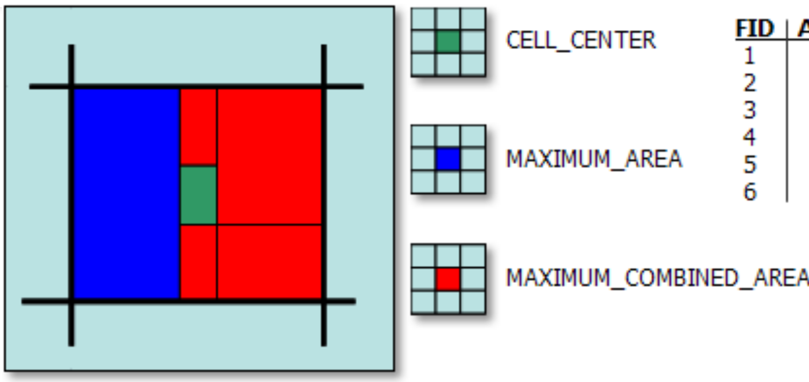
Polygon to raster conversion



FID	Attribute
1	Blue
2	Red
3	Green
4	Red
5	Red
6	Red

Illustration of six polygons that fall within a single cell

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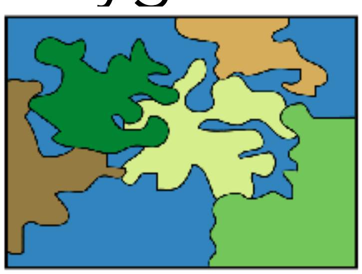
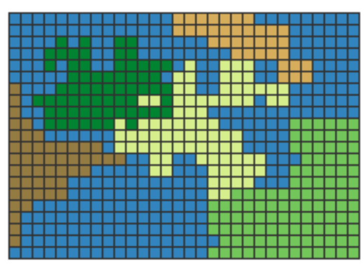
Polygons to raster

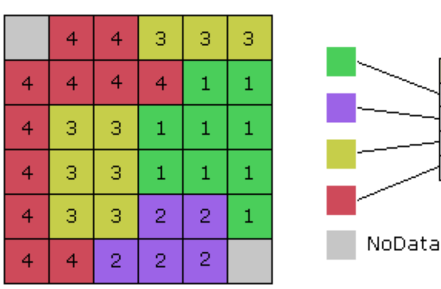


Polygon features



Raster polygon features

areas have similar adjacent pixels



OID	VALUE	COUNT	TYPE	AREA
0	1	9	Forest land	8100
1	2	5	Wetland	4500
2	3	9	Crop land	8100
3	4	11	Urban	9900

Area per pixel is 900 sqm
Each pixel is 30m by 30m
Resolution is 30m

Attribute table shows the number of pixels in each value, these are graphed in a histogram

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Raster Operations

- Raster operations: grouped according to the way raster cells are used in the analysis
  - Local Operations:
    - value of the cell in the output layer is a function of the cell at the same location in the input layer
  - Neighborhood Operations:
    - value of the cell in the output layer is a function of the cells neighboring the cell at the same location in the input layer
  - Extended Neighborhood Operations:
    - value of the cell in the output layer is a function of the cells neighboring and beyond the immediate neighborhood of the cell at the same location in the input layer
  - Regional Operations:
    - the output layer us generated by identifying cells that intersect with or fall within each region on the input layer

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Local Operations

- Reclassification
  - Create a new raster layer by applying changes to the attribute values of the cells in the input layer
  - Logical or arithmetic operations

Binary masking; Classification reduction; Classification Ranking; Changing Measurement Scales

- Overlay Analysis
  - Logical or arithmetic operations
    - AND, OR, XOR; addition, subtraction, multiplication, division, assignment
  - Two or more input layers

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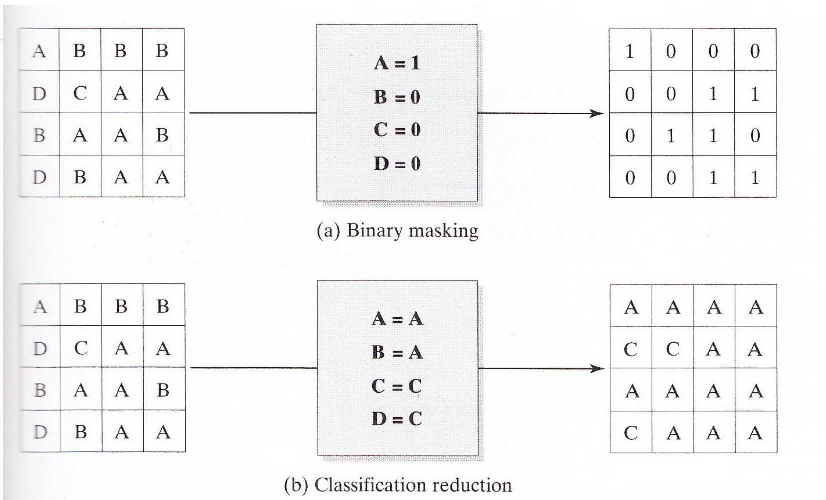
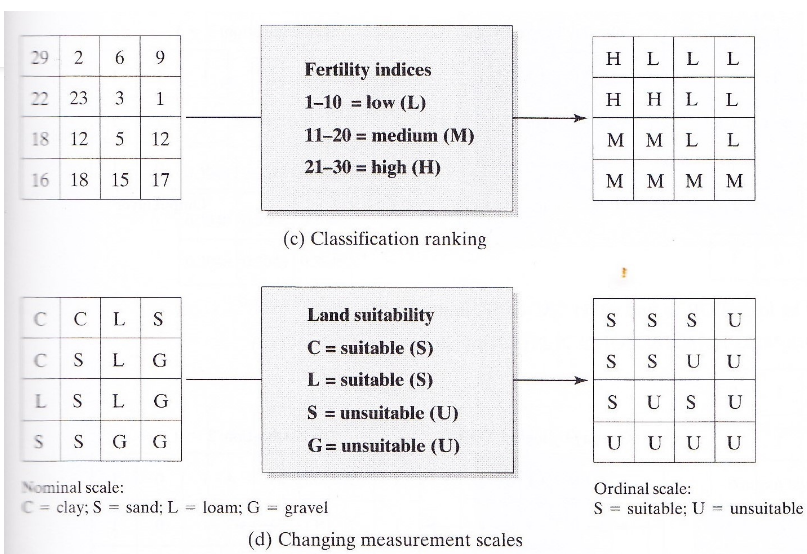
Reclassification



(a) Binary masking

(b) Classification reduction

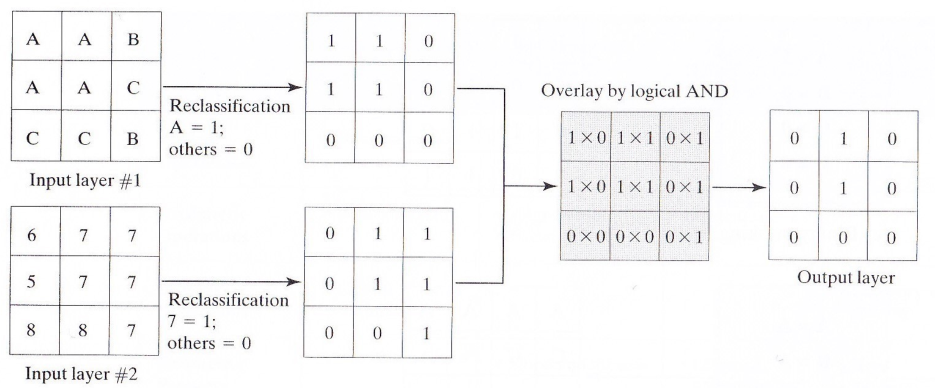
Reclassification



(c) Classification ranking

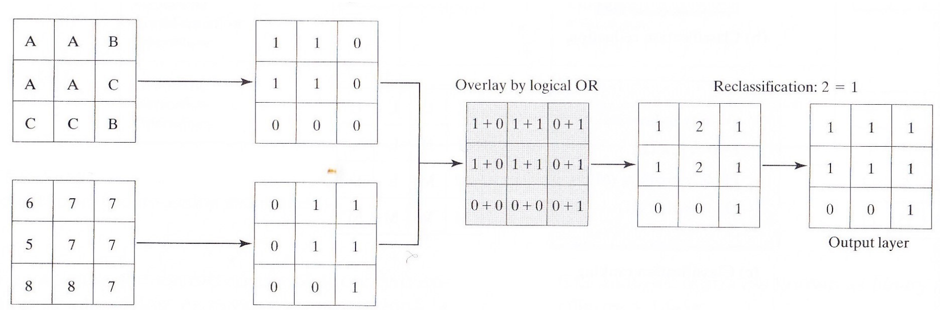
(d) Changing measurement scales

Overlay Analysis



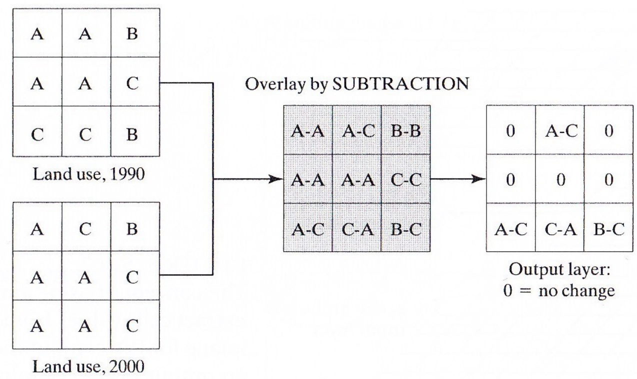
(a) Overlay by logical AND to find "A" and "7" in input raster layer

Overlay Analysis



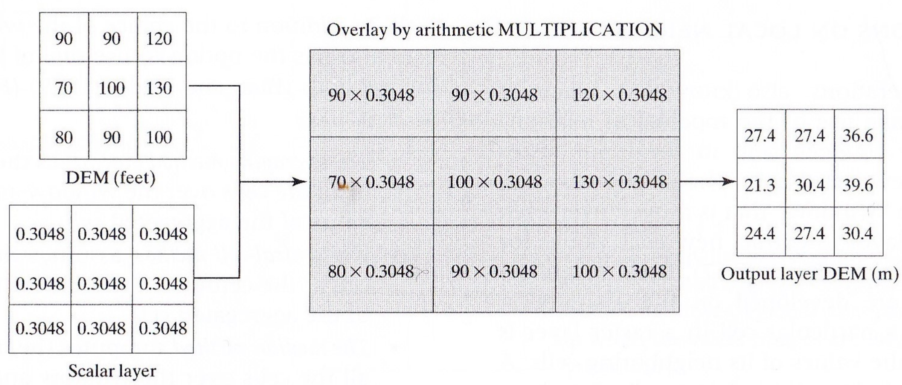
(b) Overlay by logical OR to find either "A" or "7" in input raster layer

Overlay Analysis



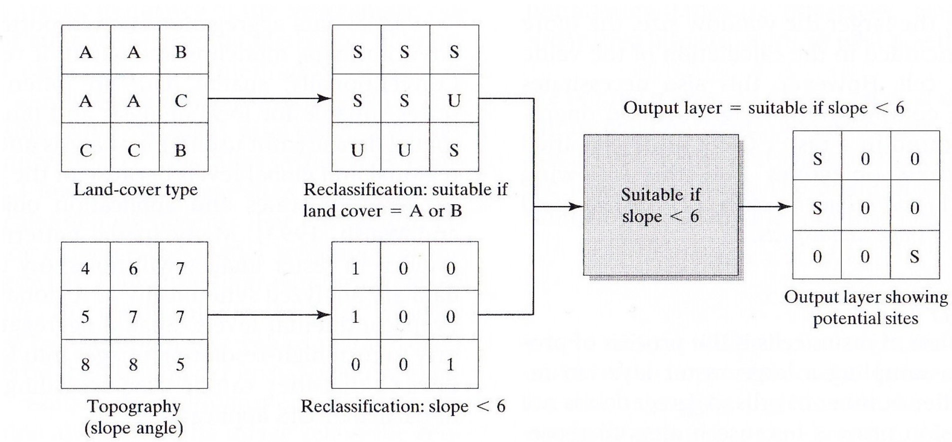
(a) Overlay by arithmetic SUBTRACTION to detect land-use change

Overlay Analysis



(b) Overlay by arithmetic MULTIPLICATION to convert DEM data from feet to meters

Overlay Analysis



(c) Overlay by arithmetic ASSIGNMENT to select suitable sites

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Local Neighborhood Operations

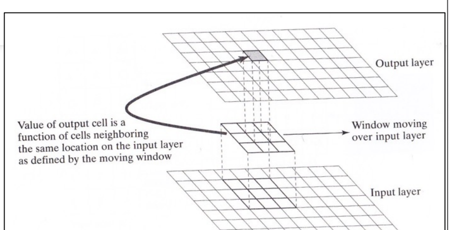
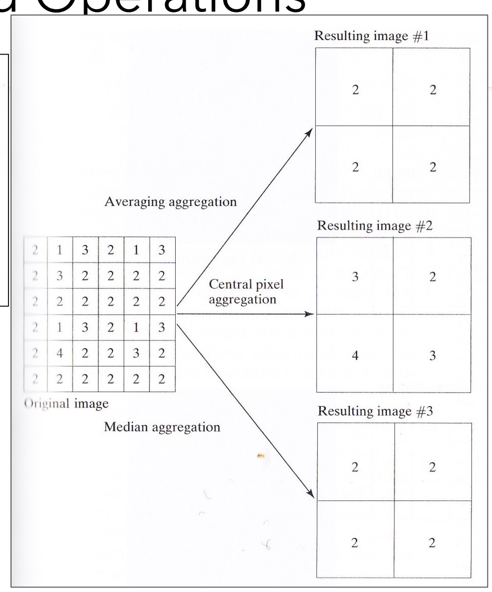


Illustration of a moving window



Also known as focal operations. The neighborhood is defined by a moving window. The assumption is that the value at the center is affected by values in the neighborhood.

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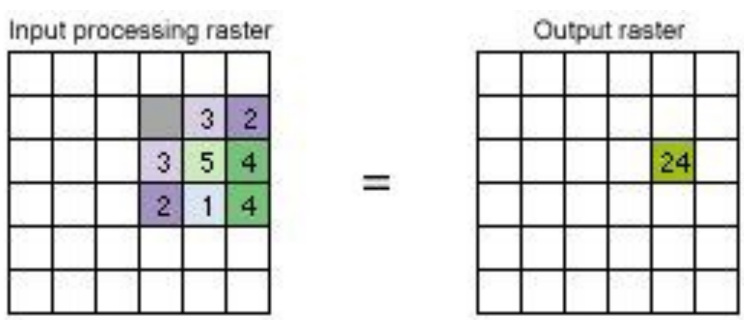
Local Neighborhood Operations

- Averaging method
  - Computes average value of the cells over the window and uses as the value of the aggregated cell
- Central cell method
  - Assumes the value of cell at the center of the window to be the value of the aggregated cell
- Median cell method
  - Computes the median value of all the cells over the window and uses at as the value of the aggregated cell

Neighborhood Operations

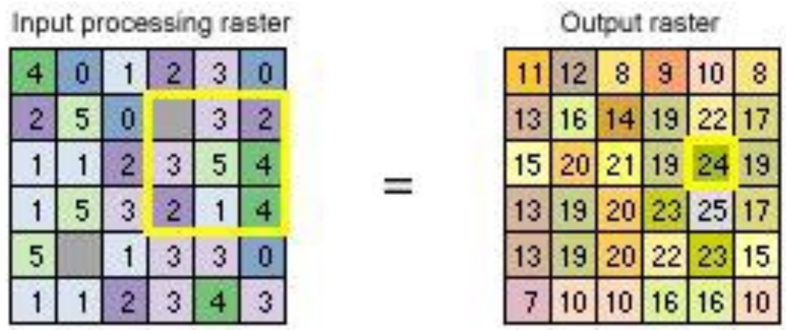
- Operation: Summation (including value of focal cell)
- Neighborhood size: 3 x 3 square



e.g. to establish available food supply for wildlife

Neighborhood Operations

- **Summation (including value of focal cell)**



Other common applications:
- Data simplification (smoothing)
- Terrain analysis (local relief / roughness)
- Site selection

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Raster Operations

	Local Operations	Neighborhood Operations	Extended Neighborhood Operations	Regional Operations
Logical Operations	• Reclassification			
Arithmetic Operations	• Reclassification	• Aggregation • Filtering	• Statistical analysis	
Overlay Operations	• Logical • Arithmetic			• Category-wide overlay
Geometric Property Operations		• Slope and aspects	• Distance, proximity, and connectivity	• Area • Perimeter • Shape
Geometric Transformation Operations			• Rotation • Translation • Scaling	
Geometric Derivation Operations			• Buffering • Viewshed analysis	• Identification and reclassification

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Spatial Interpolation

- Interpolation:
  - The process by which values of sample points in geographic space are used to produce estimated values for positions that were not sampled.
  - Methods:
    - TIN, Thiessen Polygons, Contouring
    - Inverse Distance Weighting, TIN, Thin plate splines, Kriging

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Spatial Interpolation

- Triangulated Irregular Network (TIN)
  - Consist of z-value nodes that are connected by edges to form contiguous and non-overlapping triangles
  - The edges in TINs can be used to capture the position of linear features that play an important role in the definition of the surface (e.g. ridgelines or stream courses)

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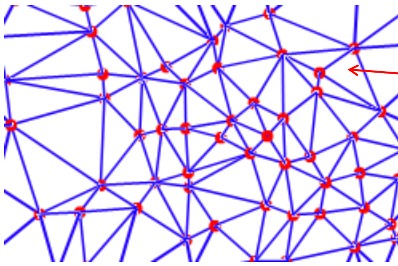
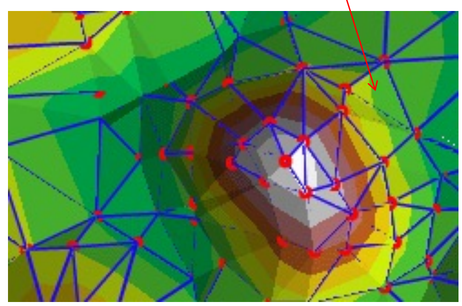
Triangulated Irregular Networks (TIN): vectors



TINs
Each triangle has a consistent slope and aspect



Complexity and scale determine the number of triangles

Method designed by Dr. Tom Poiker (SFU)

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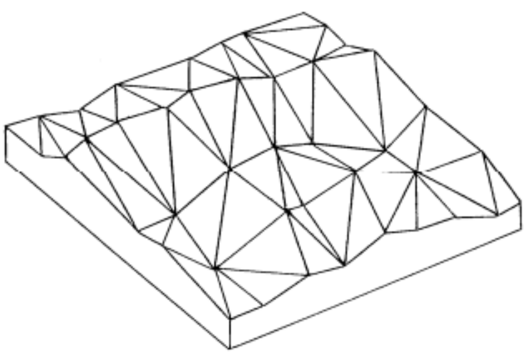
Triangulated Irregular Networks (TIN): vectors



TIN: a series of triangles capturing the topography .. x, y, z at nodes

Each triangle has a uniform slope and direction (aspect)

Advantage: **significant points or lines** can be encoded e.g. peaks, ridges, valleys

Disadvantage: more complex, needs more processing to generate, when a new point is added, the TIN needs to be rebuilt

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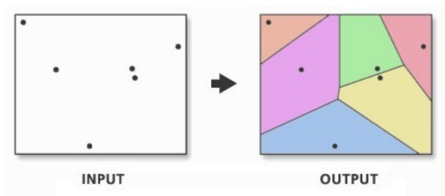
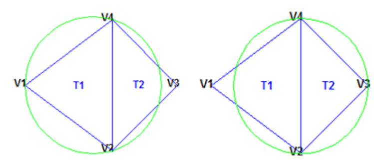
Spatial Interpolation

- Thiessen Polygons



Any location within a Thiessen polygon is closer to its associated point than to any other point input feature

All points are connected by a triangulated irregular network (TIN) that meets the Delaunay criterion: the circumcircle of every triangle is empty, that is, there is no other point in its interior.



The perpendicular bisectors for each triangle edge are generated, forming the edges of the Thiessen polygons. The location at which the bisectors intersect determine the locations of the Thiessen polygon vertices.

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Spatial Interpolation

- Contouring
  - Contours are lines that connect locations of equal values for a given continuous phenomenon.
    - as elevation, temperature, precipitation, pollution, or atmospheric pressure.
    - Contour lines are often generally referred to as isolines but can also have specific terms depending on what is being measured (e.g. isobars for pressure, isotherms for temperature, and isohyets for precipitation)

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Spatial Interpolation

- Contouring
  - The distribution of the contour lines shows how values change across a surface.
    - Little change in a value, the lines are spaced farther apart.
    - Great change, the lines are closer together.

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Digital Elevation Models (DEMs)

DEM: ***A digital representation of a topographic surface***

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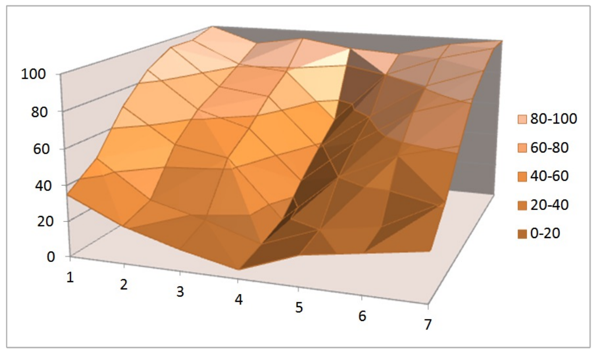
Grid Raster DEM

- One elevation value per pixel
- And billions of pixels…

100	90	95	90	88	96	100
95	81	78	49	80	92	100
95	72	68	38	61	81	92
86	64	55	26	52	72	82
70	50	45	12	40	55	63
47	26	18	8	20	25	42
35	21	12	5	17	22	27

(a)



(b)

http://serc.carleton.edu/details/images/36309.html

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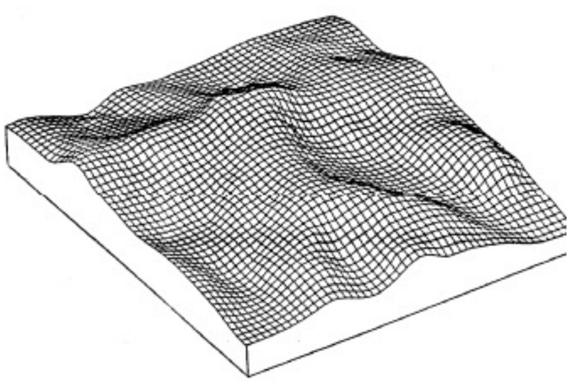
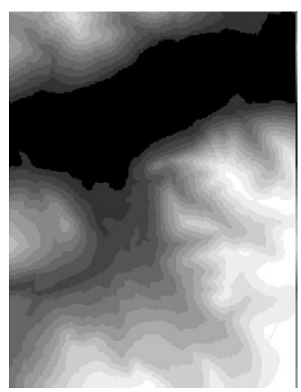
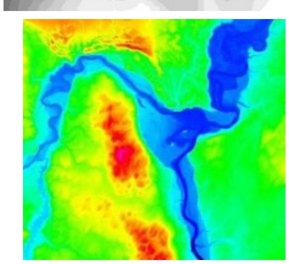
GRID raster DEMs







DEM: elevation values, one for each grid square
Shown in grayscale (or colour)

standard pixel size (e.g. 1m, 25m, 100m etc..)

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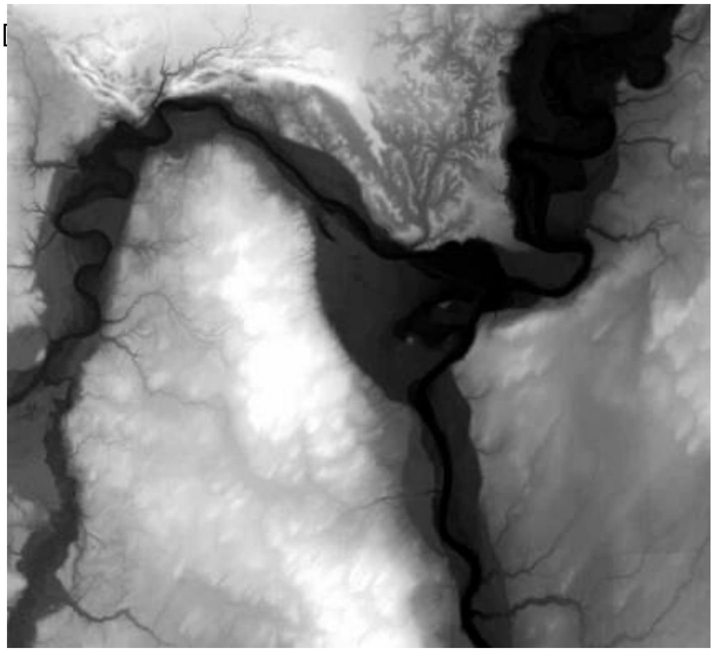

DEMs displays as grayscale - elevation values in metres (often)

Higher value = brighter shade

Dark = low / valley

High = ridges

Data format:

.tif or ESRI grid

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