GEOG 204

LECTURE 6

1

Mid-term Exam

- Wednesday 5th Oct
  - During the Lecture Time slot
  - Room (7-238)
  - Multiple choice questions and Short Answer Questions
  - Materials covered in the lectures (Sept to Oct 3rd included)
  - 45 Minutes in Duration
- Thanksgiving
  - No Labs (10 – 14 October)
  - Ungraded exercise will be emailed

2

Mid-term Prep

Multiple Choice

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.
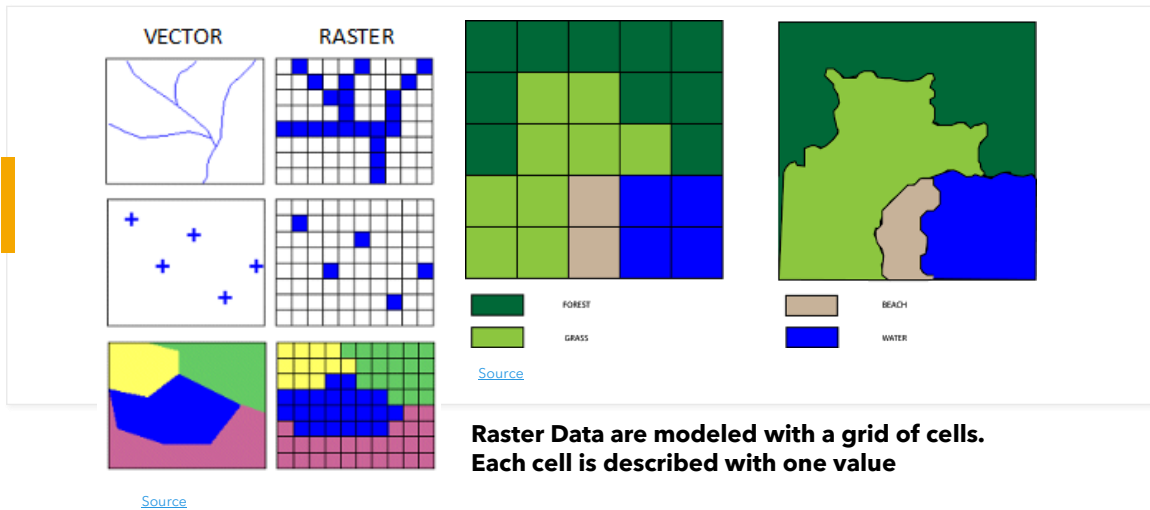   a. True   b. **False**

3

Mid-term Prep

Short Answer Questions

1. Using a simple diagram explain three types of topological relationships
   - *Here you would be expected to draw a simple diagram showing for example the containment, adjacency and connectivity of spatial features*

2. In the context of representing geographic phenomena, what 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.*
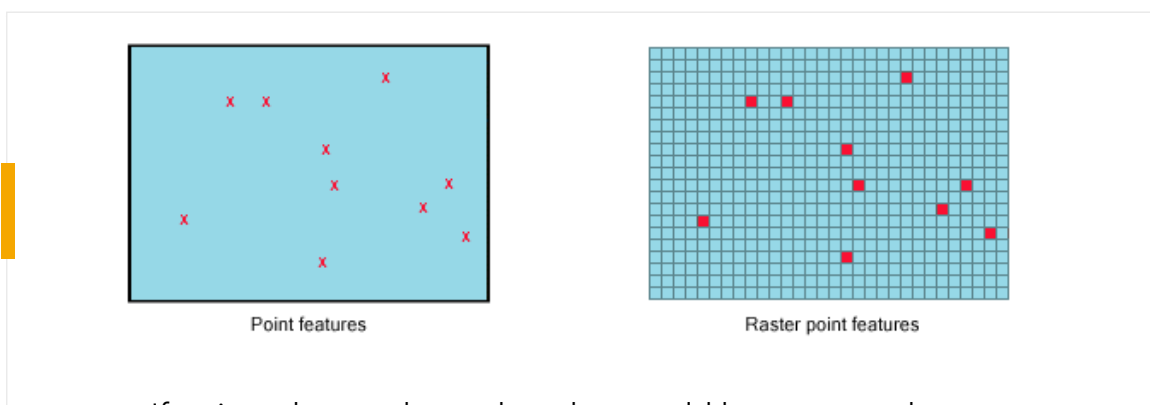
4

Raster vs. Vector

Source

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

5

5

Converting points to raster

Point features

Raster point features

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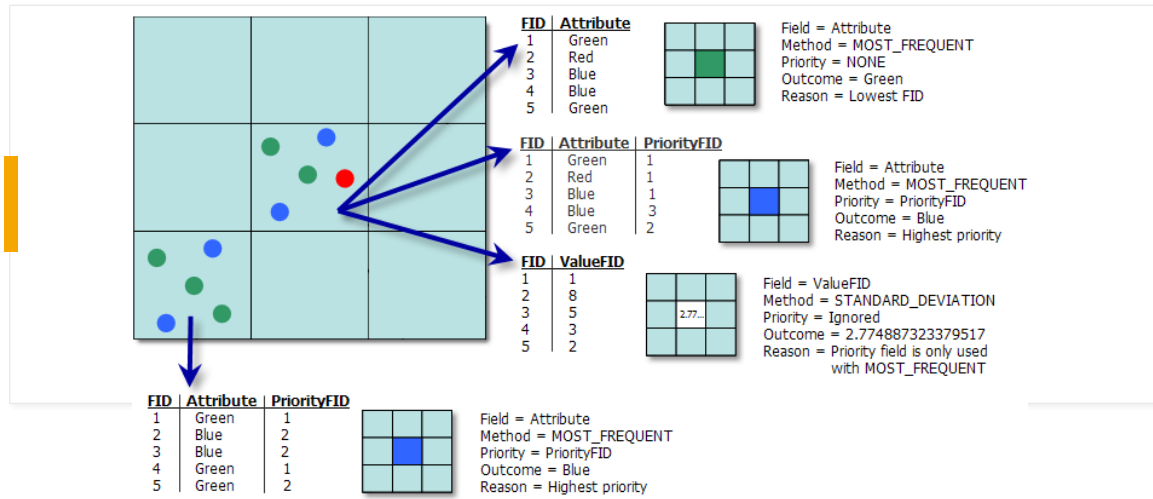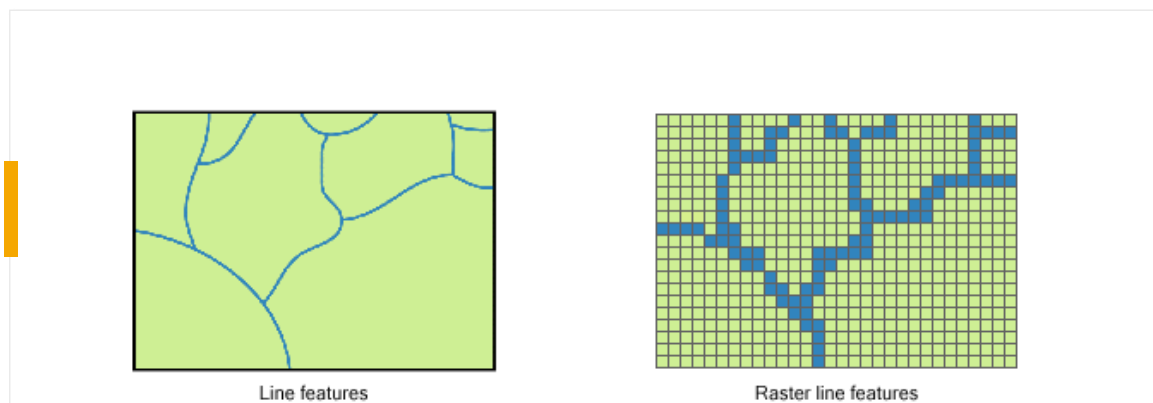- Point has area equal to cell size

6

6

Converting points to raster

Illustration of boundary rules for point feature to raster conversion

Source: ESRI

Lines to raster

Line features

Raster line features

Lines are seen as contiguous pixels

Lines to raster

FID	Attribute
1	Green
2	Blue
3	Green
4	Red

Field = Value
Method = MAXIMUM_LENGTH
Priority = NONE
Outcome = Blue
Reason = Longest length

FID	Attribute
1	Green
2	Blue
3	Green
4	Red

Field = Value
Method =
MAXIMUM_COMBINED_LENGTH
Priority = NONE
Outcome = Green
Reason = Length of two green

FID	Attribute	PriorityFID
1	Green	1
2	Blue	1
3	Green	2
4	Red	3

Field = Value
Method = MAXIMUM_LENGTH
Priority = PriorityFID
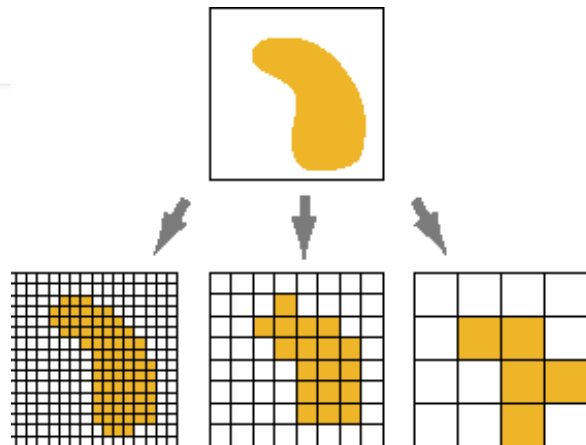Outcome = Red

Illustration polyline to raster conversion

Source: ESRI

9

9

Polygon to raster conversion

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

- Vector GIS handles attributes more effectively

10

10

Polygon to raster conversion

CELL_CENTER

MAXIMUM_AREA

MAXIMUM_COMBINED_AREA

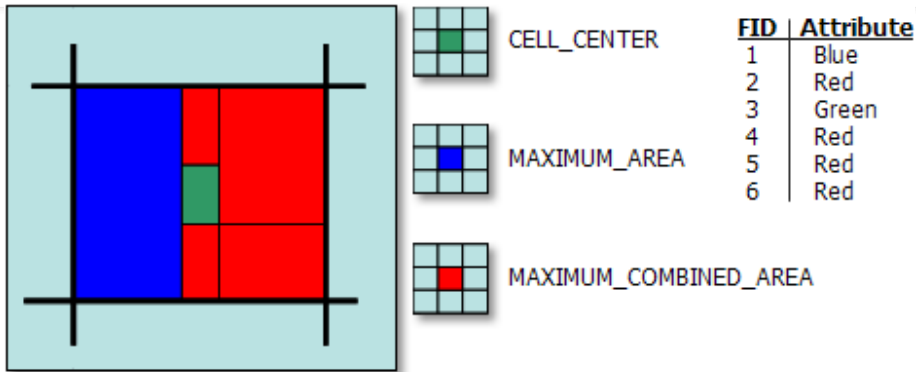| FID	Attribute
1	Blue
2	Red
3	Green
4	Red
5	Red
6	Red

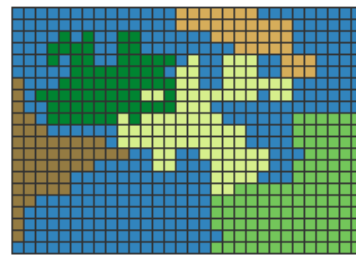Illustration of six polygons that fall within a single cell

11

11

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

NoData

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

12

12

6

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

13

13

Local Operations

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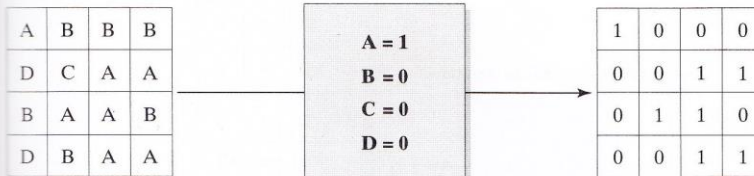 - Logical or arithmetic operations

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

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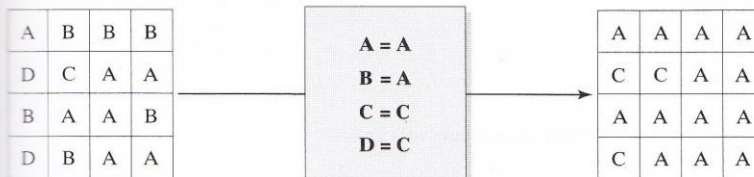 - Two or more input layers

14
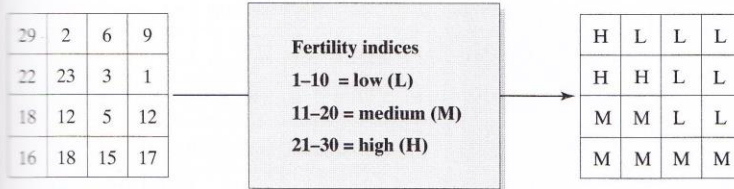
14

Reclassification

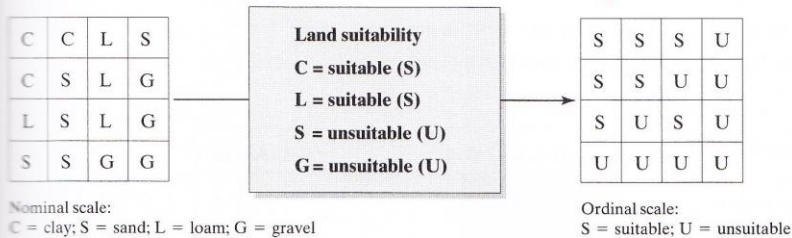(a) Binary masking

(b) Classification reduction

15

Reclassification

(c) Classification ranking

(d) Changing measurement scales

Nominal scale:
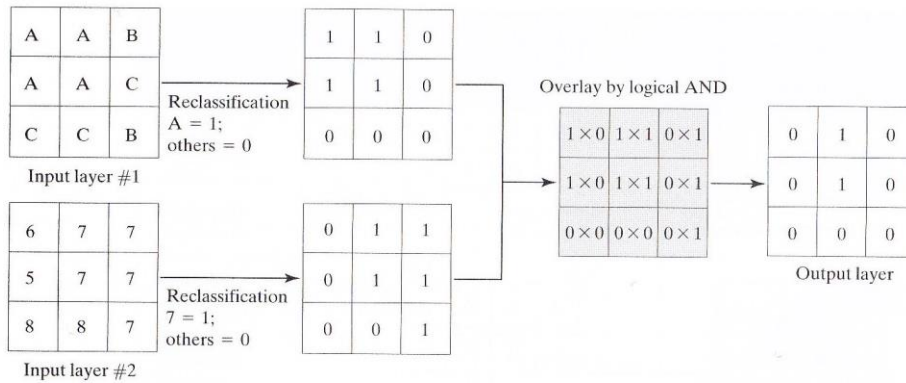C = clay; S = sand; L = loam; G = gravel

Ordinal scale:
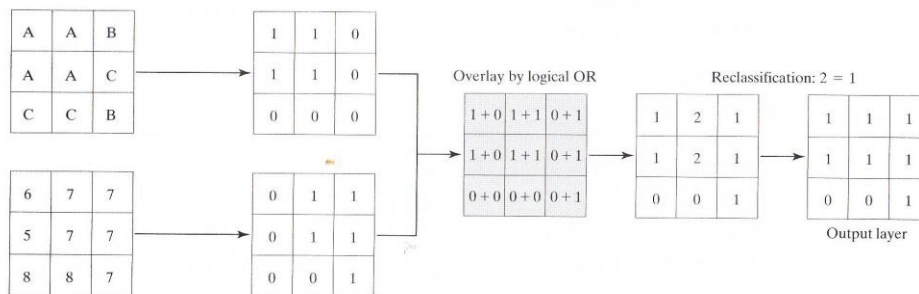S = suitable; U = unsuitable

16

Overlay Analysis

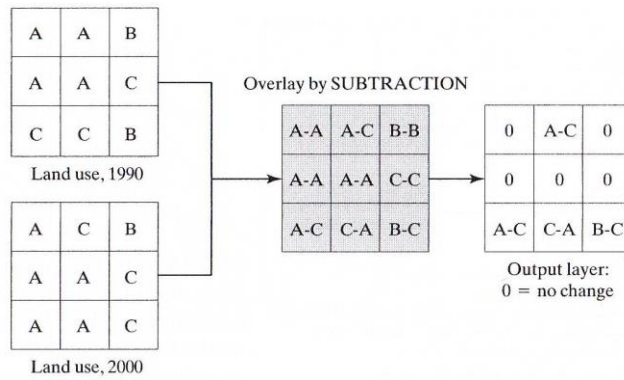(a) Overlay by logical AND to find "A" and "7" in input raster layer

17

17

Overlay Analysis

(b) Overlay by logical OR to find either "A" or "7" in input raster layer
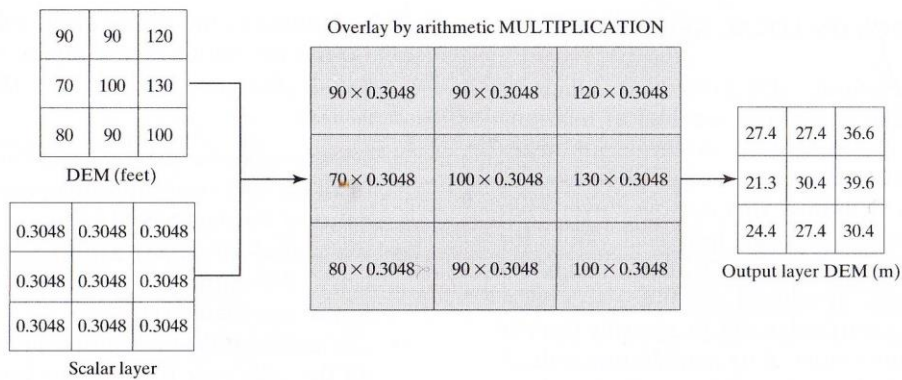
18

18

Overlay Analysis

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

19

Overlay Analysis

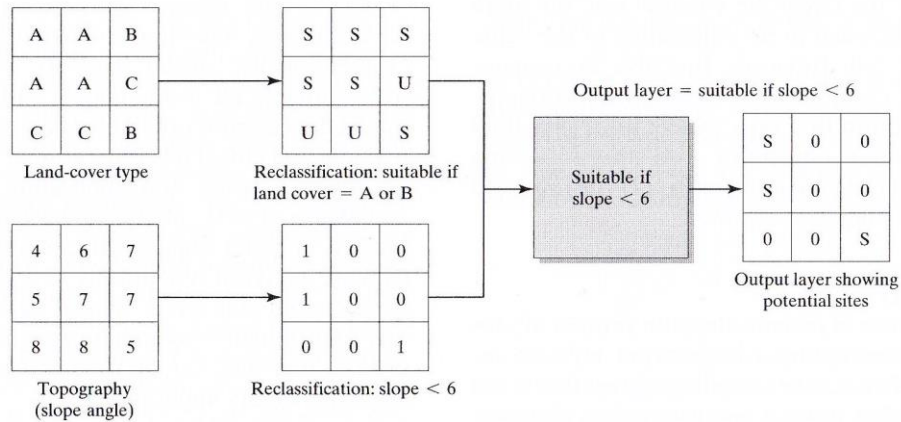

(b) Overlay by arithmetic MULTIPLICATION to convert DEM data from feet to meters

20

Overlay Analysis

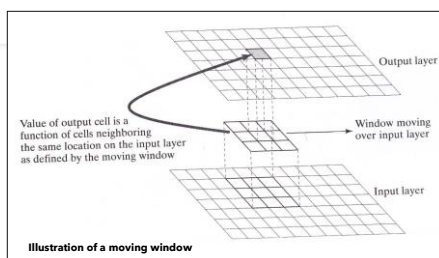
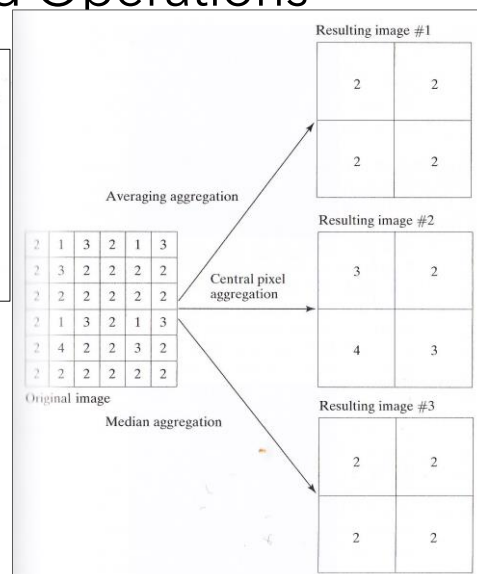(c) Overlay by arithmetic ASSIGNMENT to select suitable sites

21

Local Neighborhood Operations

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.

22

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 vale of the aggregated cell

23

23

Neighborhood Operations

- Operation: Summation (including value of focal cell)
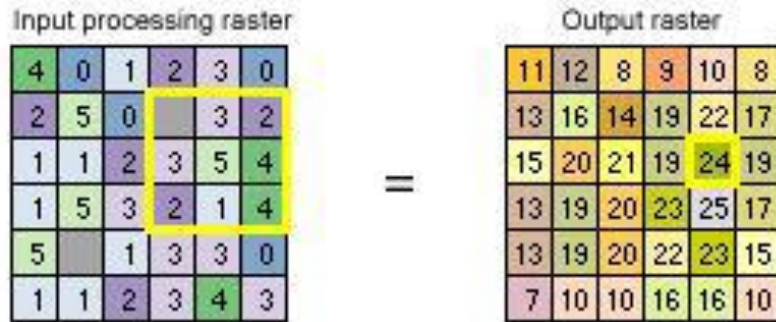- Neighborhood size: 3 x 3 square
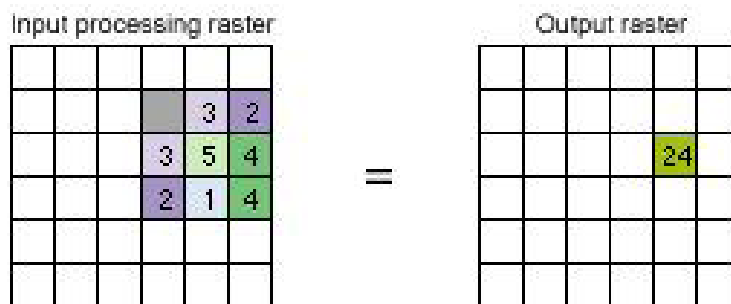
e.g. to establish available food supply for wildlife

24

24

Neighborhood Operations

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

Input processing raster

4	0	1	2	3	0
2	5	0		3	2
1	1	2	3	5	4
1	5	3	2	1	4
5		1	3	3	0
1	1	2	3	4	3

=

Output raster

11	12	8	9	10	8
13	16	14	19	22	17
15	20	21	19	24	19
13	19	20	23	25	17
13	19	20	22	23	15
7	10	10	16	16	10

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

25

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

26

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

27

27

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)
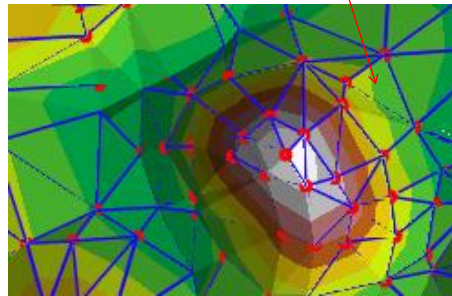
28

Triangulated Irregular Networks (TIN): vectors
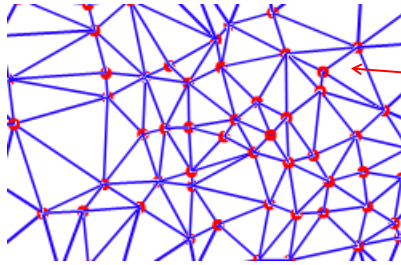
TINs
Each triangle
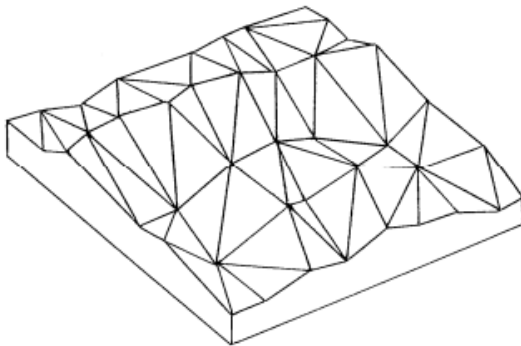has a consistent
slope and
aspect

Complexity and
scale determine the
number of triangles

*Method designed by
Dr. Tom Poiker (SFU)*

29

Triangulated Irregular Networks (TIN): vectors

TIN: a series of triangles capturing the topography .. x, y, z at nodes
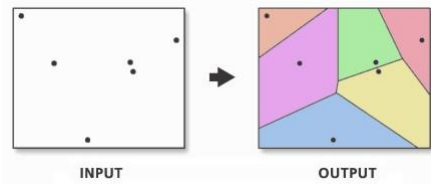
Each triangle has a uniform slope and direction (aspect)

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

30

Spatial Interpolation

• Thiessen Polygons

INPUT   OUTPUT

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

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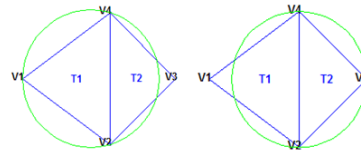
The perpendicular bisectors for each triangle edge are generated, forming the edges of the Thiessen polygons. The location at which the bisectors intersect determine the locations of the Thiessen polygon vertices.

31

31

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)
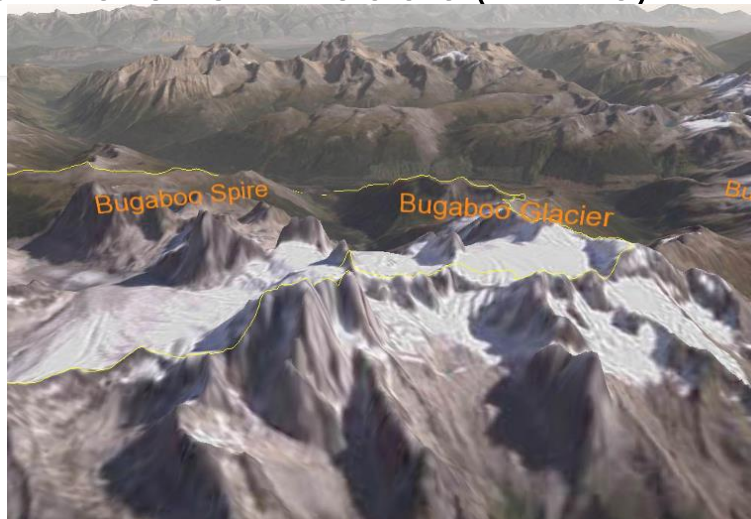
32

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.

33

Digital Elevation Models (DEMs)
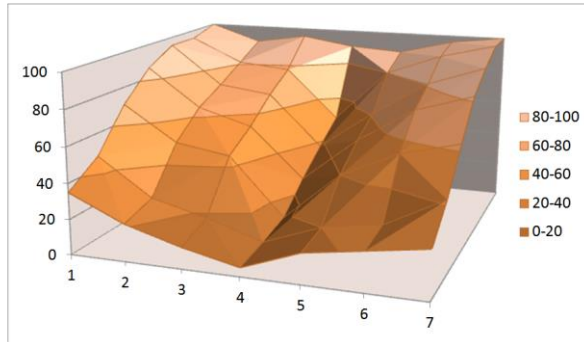

DEM: *A digital representation of a topographic surface*

34

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)

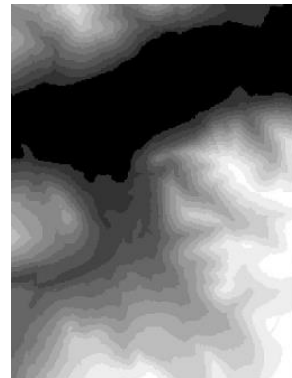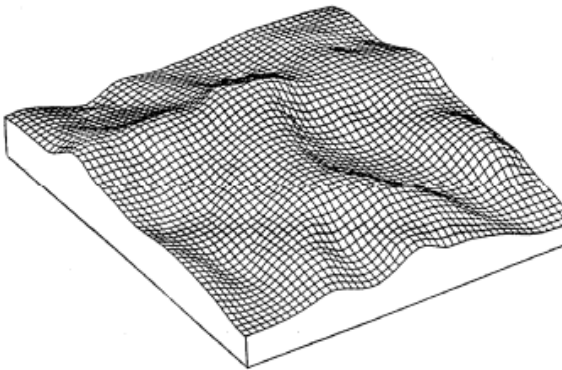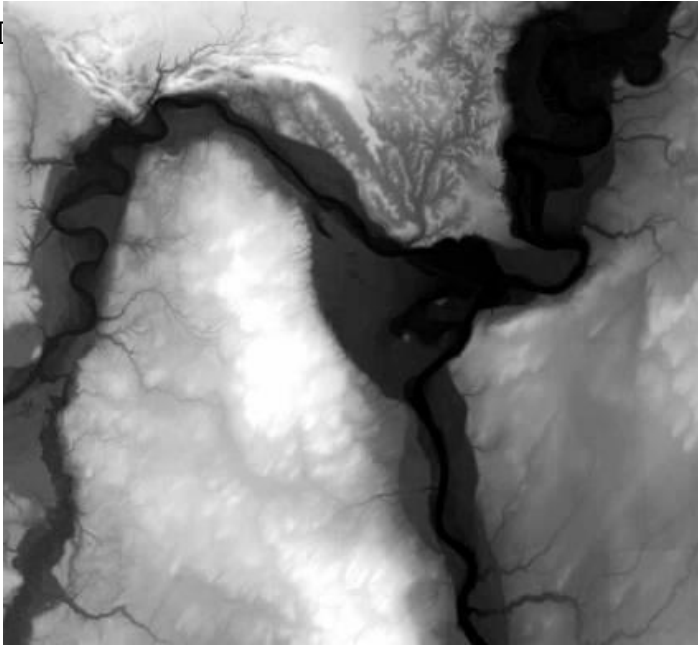http://serc.carleton.edu/details/images/36309.html

35

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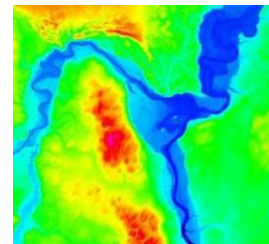
DEM: elevation values, one for each grid square
Shown in grayscale (or colour)

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

36

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

Higher value = brighter shade

Dark = low / valley

High = ridges

Data format:

.tif or ESRI grid

37