Al-Mustaqbal University
College of Sciences
Intelligent Medical System Department

جامعة المستقبل
AL MUSTAQBAL UNIVERSITY

كلية العلوم
قسم الانظمة الطبية الذكية

Lecture: (5)

Geographic Information Systems (GIS)

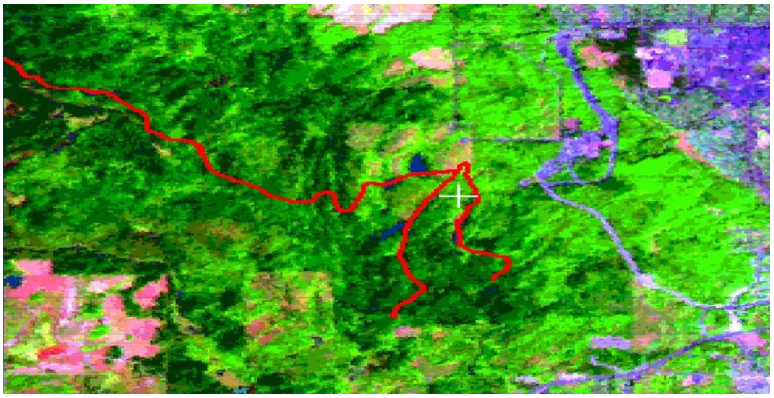
Subject: Raster Data Models
Level: Third
Lecturer: MS.C Ali Haider Alazam

Raster and vector data models

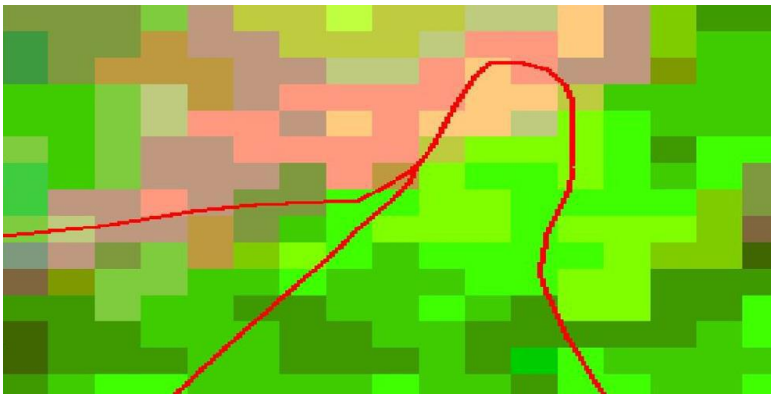
Raster data model a spatial data model that uses a grid and cells to represent the spatial variation of a feature.

Vector data model a data model that uses points and their x-, y- coordinates to construct spatial features.

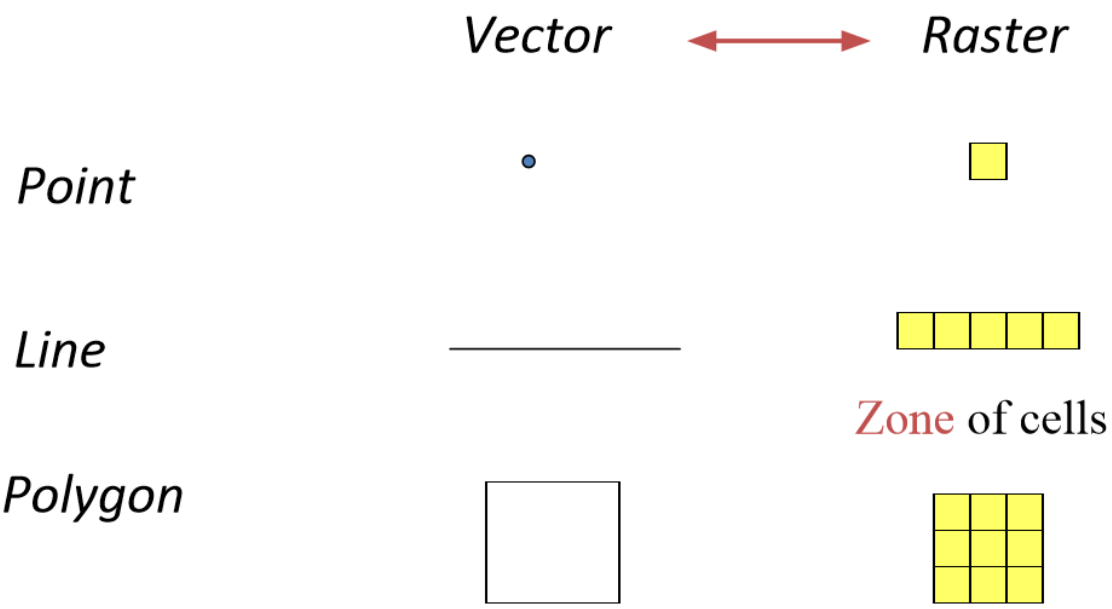
In a more complex example, this image shows both raster data (satellite image of UNBC and area) and vector data (Cranbrook Hill Greenway). This image is at normal size (no zoom).



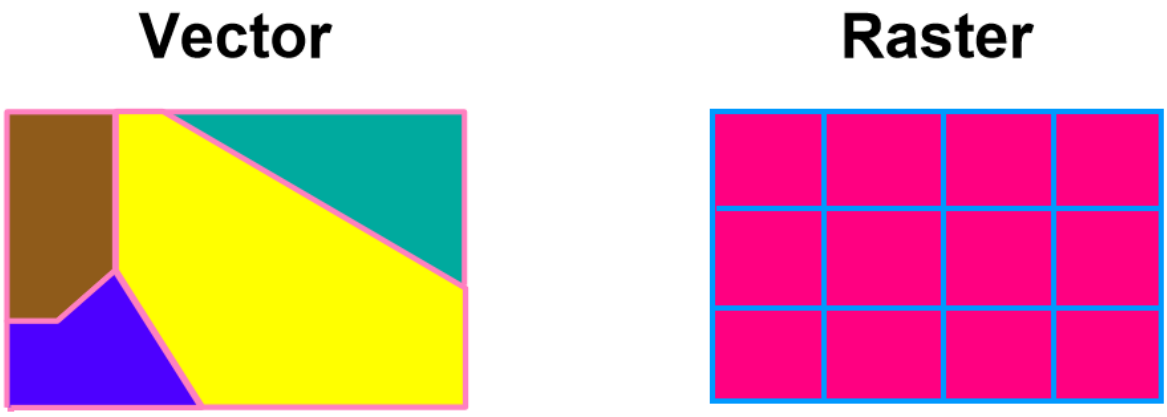
When we zoom in 16X from the previous image, the difference between raster and vector data becomes more apparent. The raster data is defined by an individual color (representing a data value) for each grid cell. The vector data remains a solid red line with the same width.



Raster data are described by a cell grid, one value per cell



Vector and Raster Representation of Spatial Fields



Raster Data Models

The raster data model is widely used in applications ranging far beyond geographic information systems (GISs).

The universal JPEG, BMP, and TIFF file formats (among others) are based on the raster data model.

Furthermore, all liquid crystal display (LCD) computer monitors are based on raster technology as they are composed of a set number of rows and columns of pixels.

The raster data model consists of rows and columns of equally sized pixels interconnected to form a planar surface.

These pixels are used as building blocks for creating points, lines, areas, networks, and surfaces.

Although pixels may be triangles, hexagons, or even octagons, square pixels represent the simplest geometric form with which to work, the raster data model is referred to as a grid-based system.

Each cell in a raster carries a single value, which represents the characteristic of the spatial phenomenon at a location denoted by its row and column.

The data type for that cell value can be either integer or floating-point.

The raster graphic can reference a database management system wherein open-ended attribute tables can be used to associate multiple data values to each pixel.

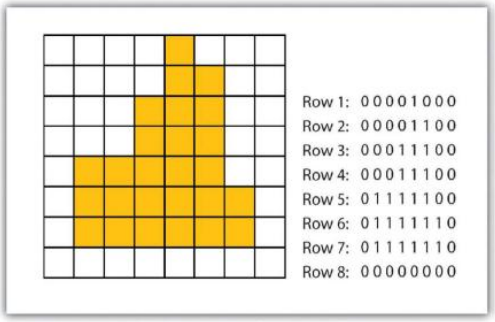
Encoding Raster Data

Several methods exist for encoding raster data from scratch.

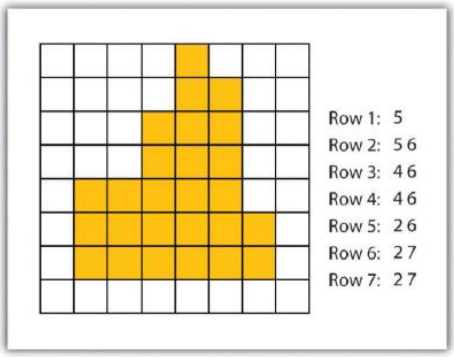
Three of these models are as follows:

1. Cell-by-cell raster encoding
2. Run-length raster encoding
3. Quad-tree raster encoding

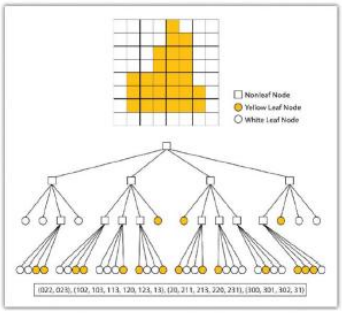
Cell-by-cell raster encoding



Run-length raster encoding

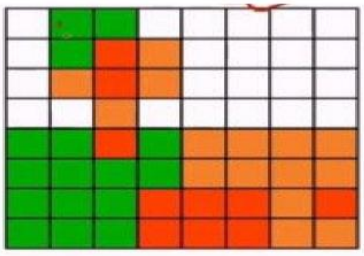


Quad-tree raster encoding



Try to solve by yourself using:

Cell-by-cell raster encoding
Run-length raster encoding
Quad-tree raster encoding



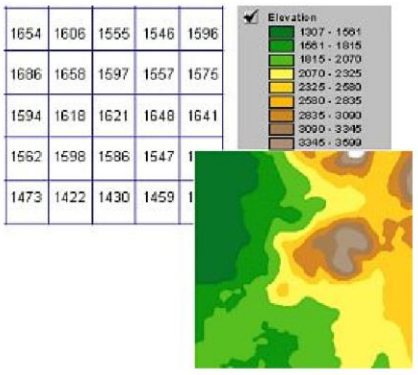
Advantages of Raster Data Structures

1. Simple data structures.
2. Overlay and combination of maps and remote sensed images easy.
3. Some spatial analysis methods simple to perform.
4. Simulation easy, because cells have the same size and shape.
5. Compatible with remote sensing.
6. Only raster can store image data (e.g. photos).

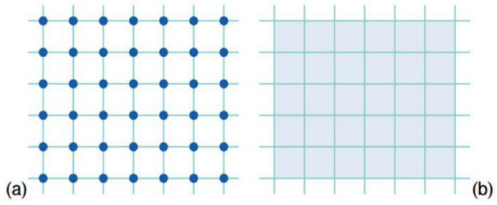
Disadvantages of Raster Data Structures

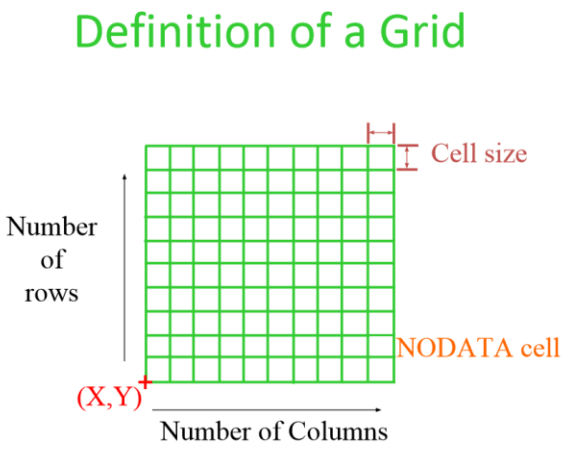
1. Crude raster maps are considerably less beautiful than line maps.
2. Projection transformations are time consuming
3. Requires more storage space.
4. Boundaries has more blocky appearance.
5. More difficult to represent topology. Topological relationships are harder to represent.

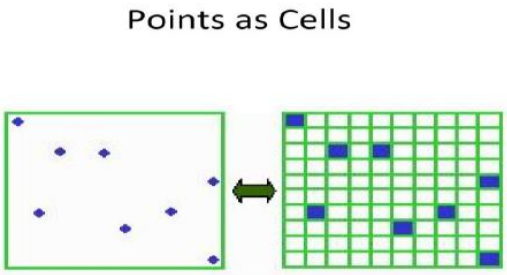
A grid defines geographic space as a matrix of identically-sized square cells. Each cell holds a numeric value that measures a geographic attribute (like elevation) for that unit of space.

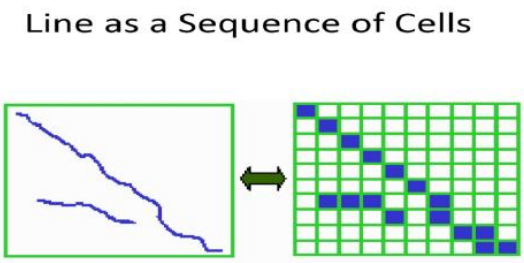


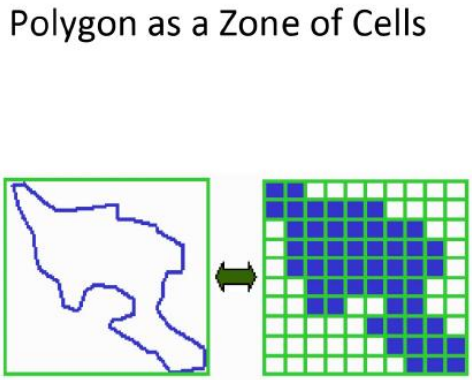
A grid (a) is a collection of regularly spaced (field) values, while a raster (b) is composed of cells.

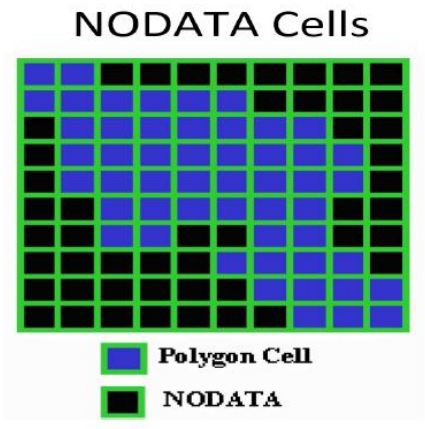




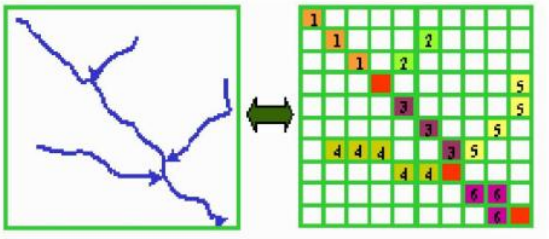




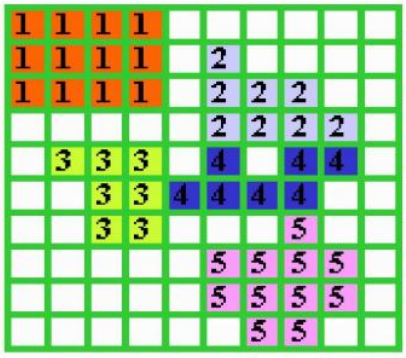




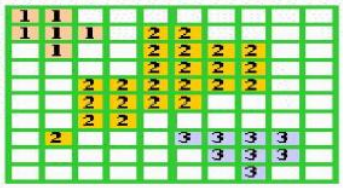
Cell Networks



Grid Zones



Value attribute table for categorical (integer) grid data



Treetype Grid

Value	Count	Type	Code
1	6	Maple	200
2	23	Oak	400
3	8	Pine	300

Treetype.vat

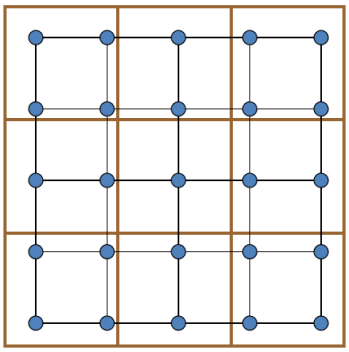
Attributes of grid zones

What did we learn?

- Spatial analyst automatically uses nearest neighbor resampling.
- The scale (extent and cell size) can be set under options.

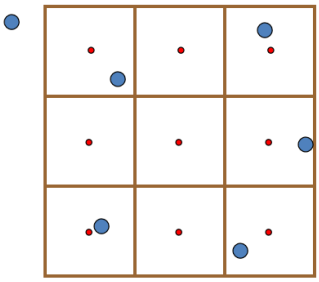
Interpolation

Estimate values between known values.
A set of spatial analyst functions that predict values for a surface from a limited number of sample points creating a continuous raster.

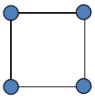


Apparent improvement in resolution may not be justified

Interpolation methods



- Nearest neighbor
- Inverse distance weight $z = \sum \frac{1}{r_i} z_i$
- Bilinear interpolation $z = (a + bx)(c + dy)$



- Kriging (best linear unbiased estimator) $z = \sum w_i z_i$
- Spline $z = \sum c_i x^{e_i} y^{e_i}$