Geographic Information System (GIS)

IS 454

Lecture 4: GIS Data Modelling

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GIS data modelling

- What is a data model?
- GIS data models
  - CAD, graphical and image GIS data models
  - Raster data model
  - Vector data model
  - Object data model

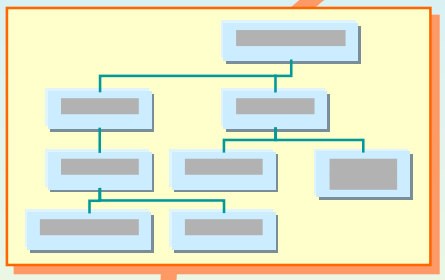
What is a data model?

- The heart of any GIS is the data model.
- A data model is a set of constructions for describing and representing selected aspects of the real world in a computer.
- There is no single type of GIS data model that is best for all circumstances.

The role of a data model in GIS

GIS Data Model

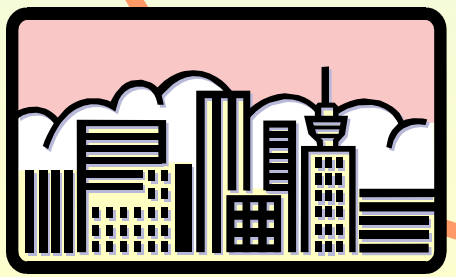
Description and Representation



Operational GIS

Analysis and Presentation

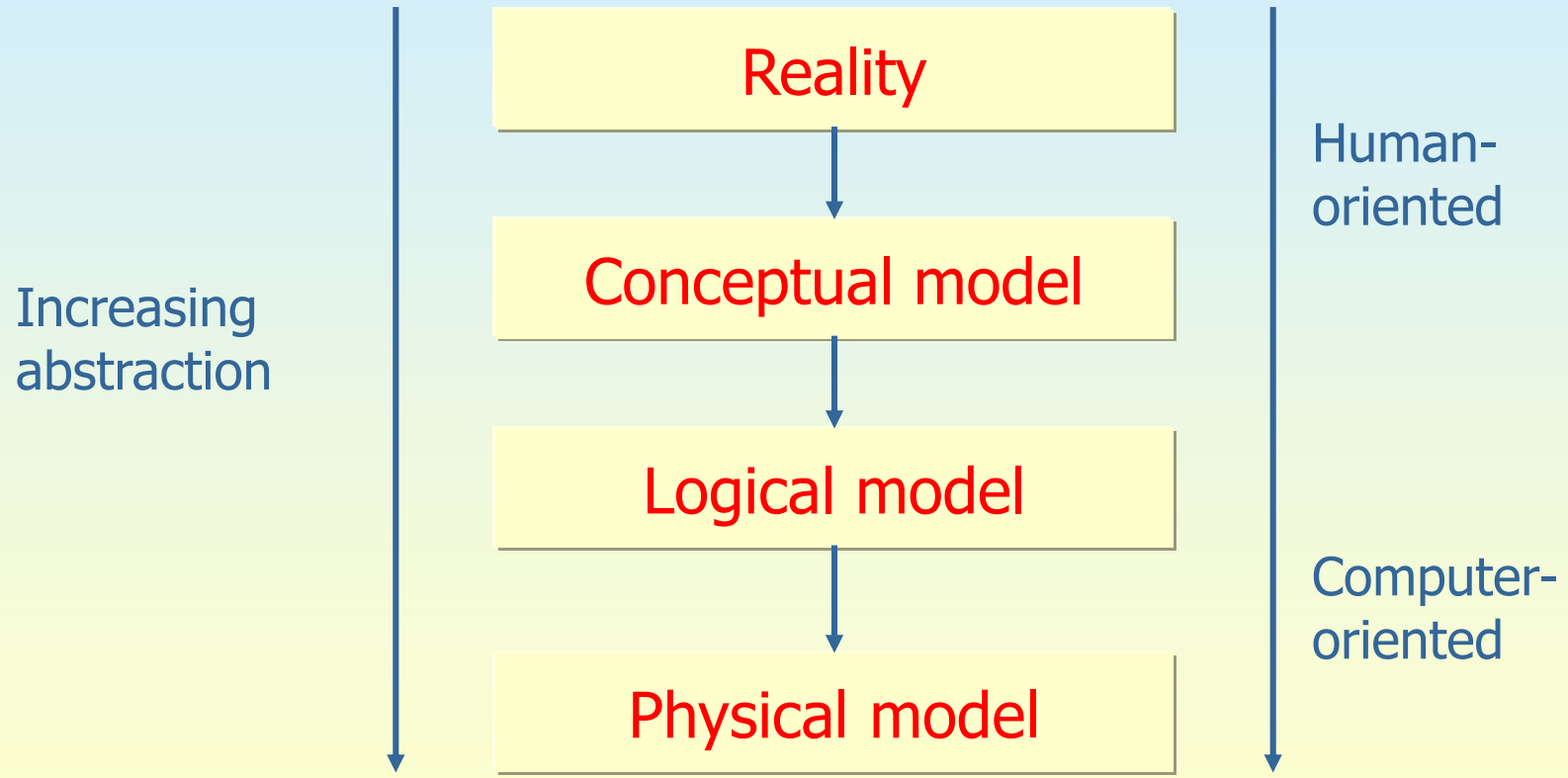
Real World



People

Interpretation and Explanation

Levels of data model abstraction

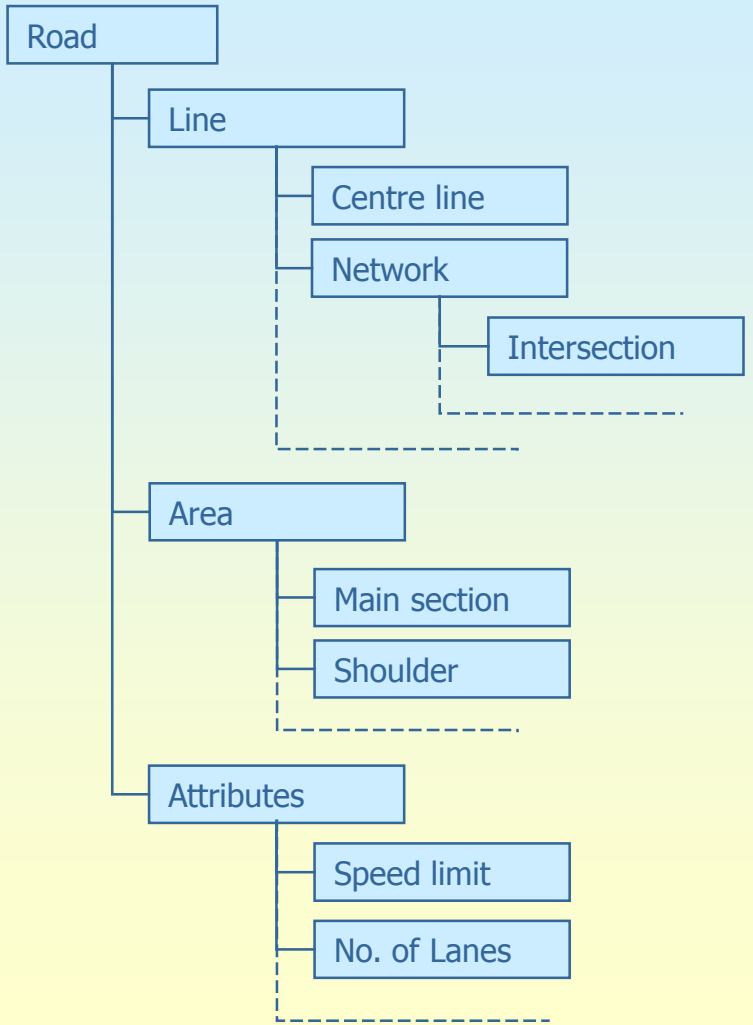


Conceptual model

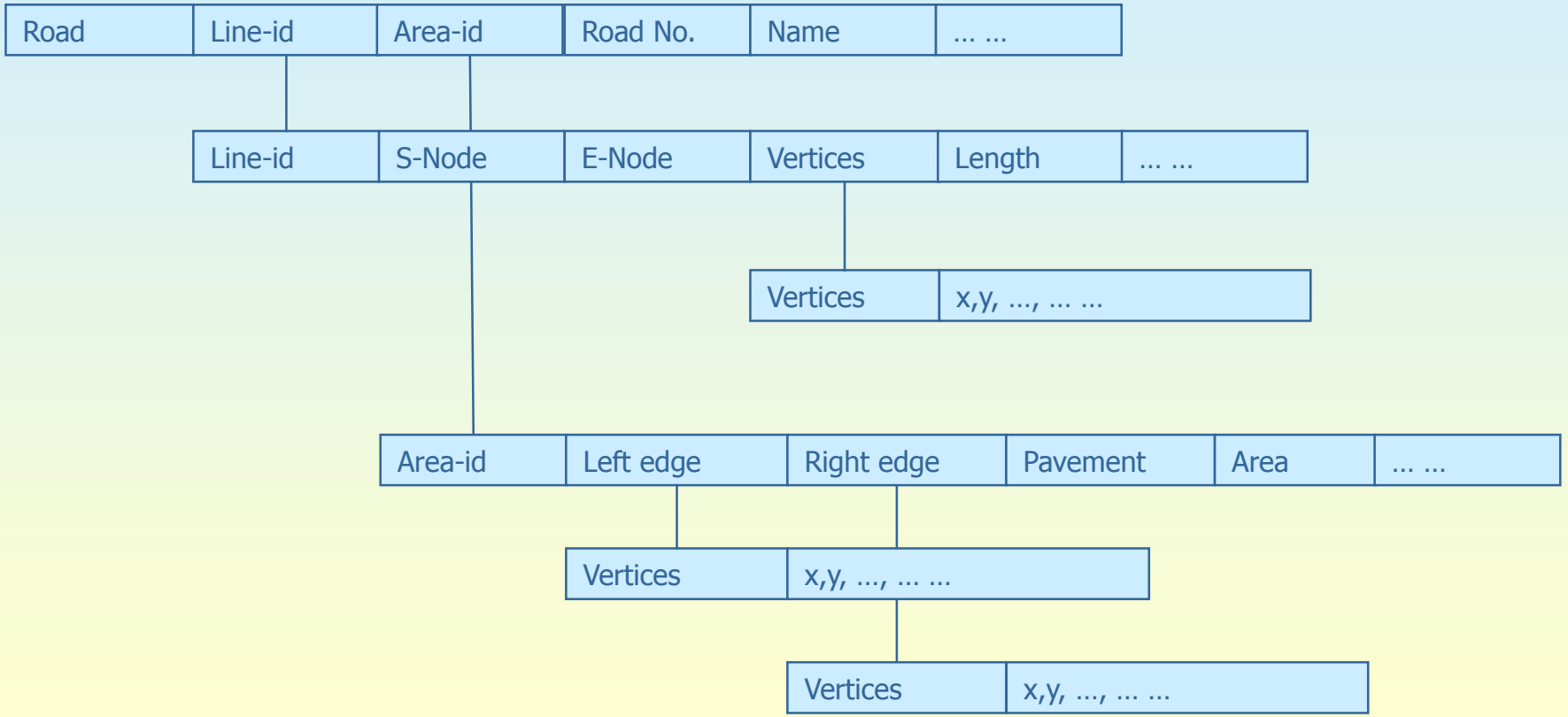
A road:

- Centre line (position)
- Edge line (width)
- Shoulder
- Number of lanes
- One way/two way
- Speed limit
- Traffic conditions
- Pavement
- Underground structure
- Intersections
- Date of completion
- Maintenance date

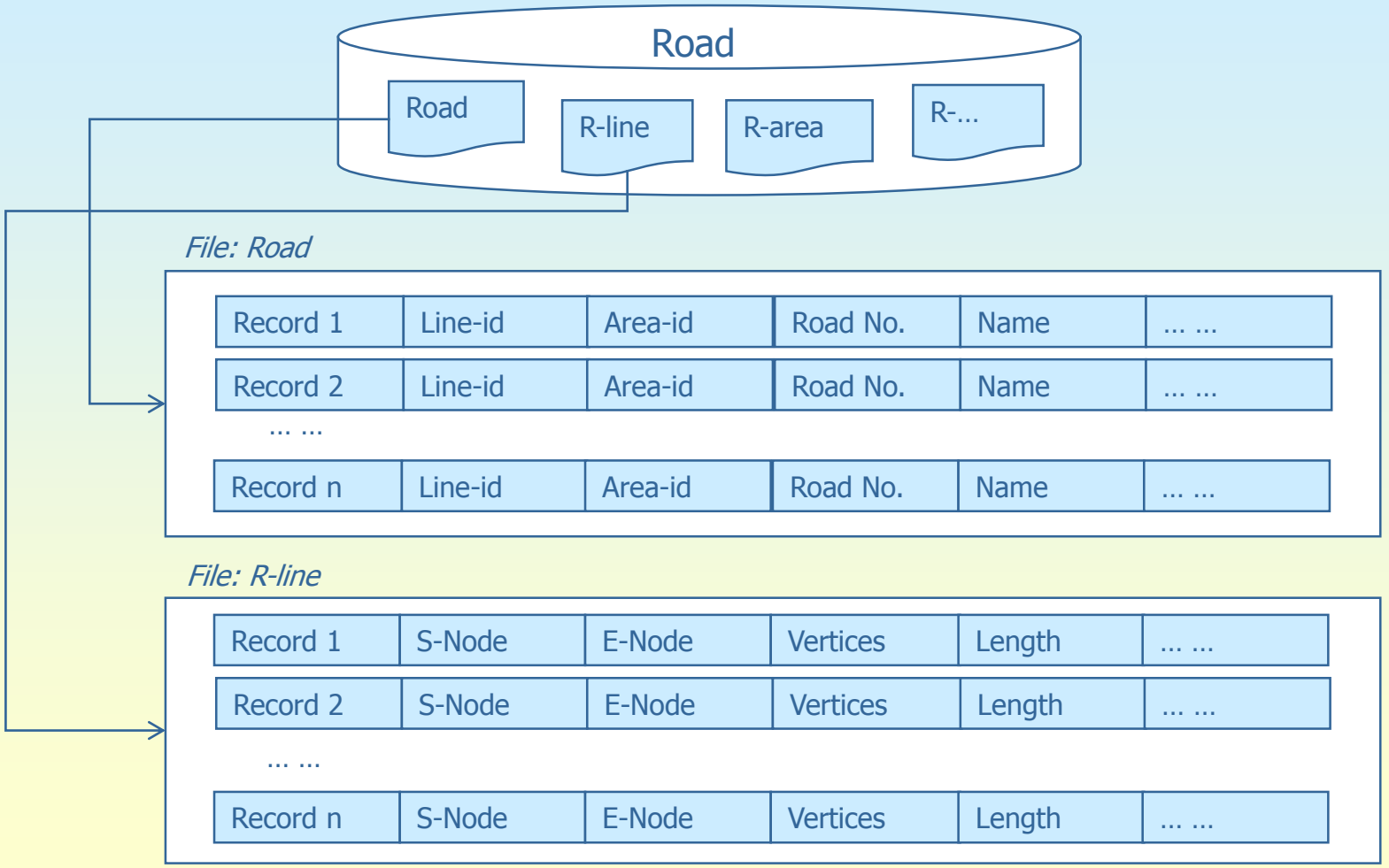
… …



Logical model



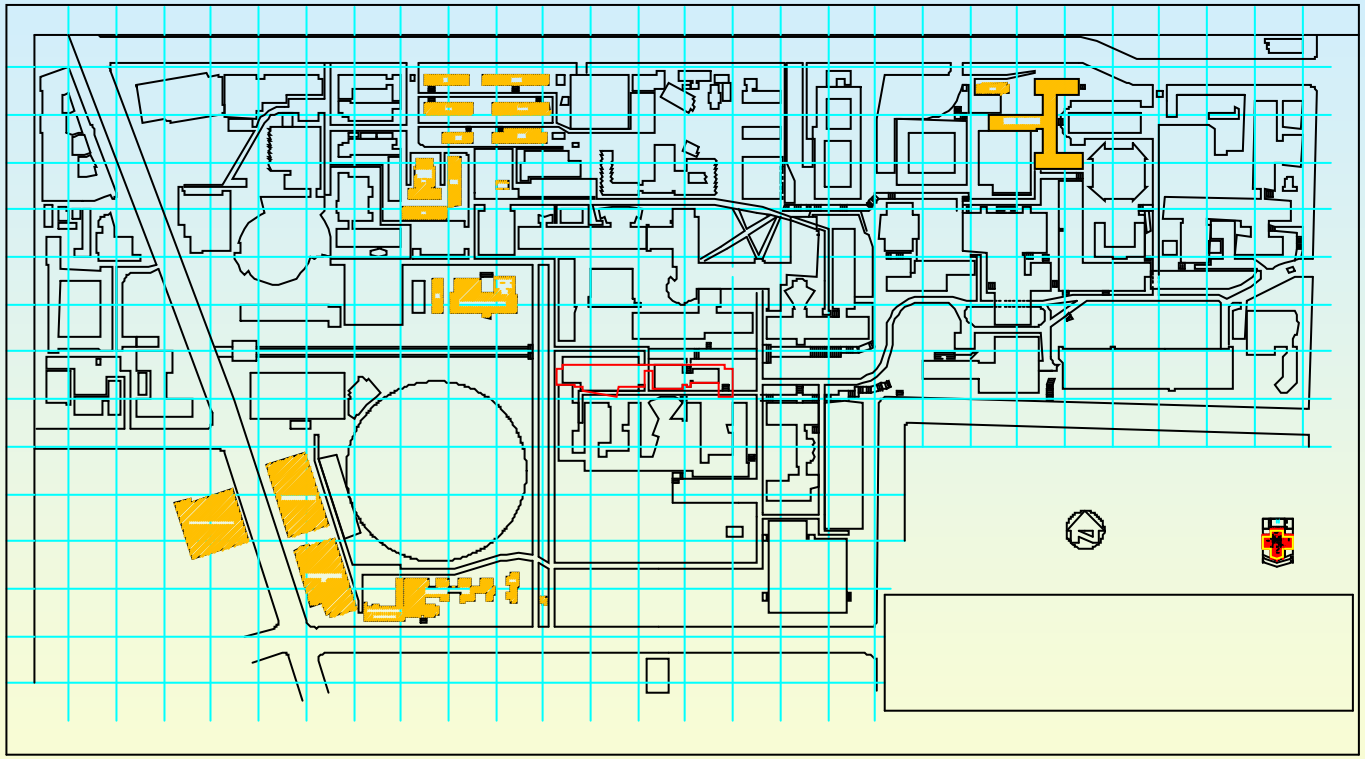
Physical model



GIS data models

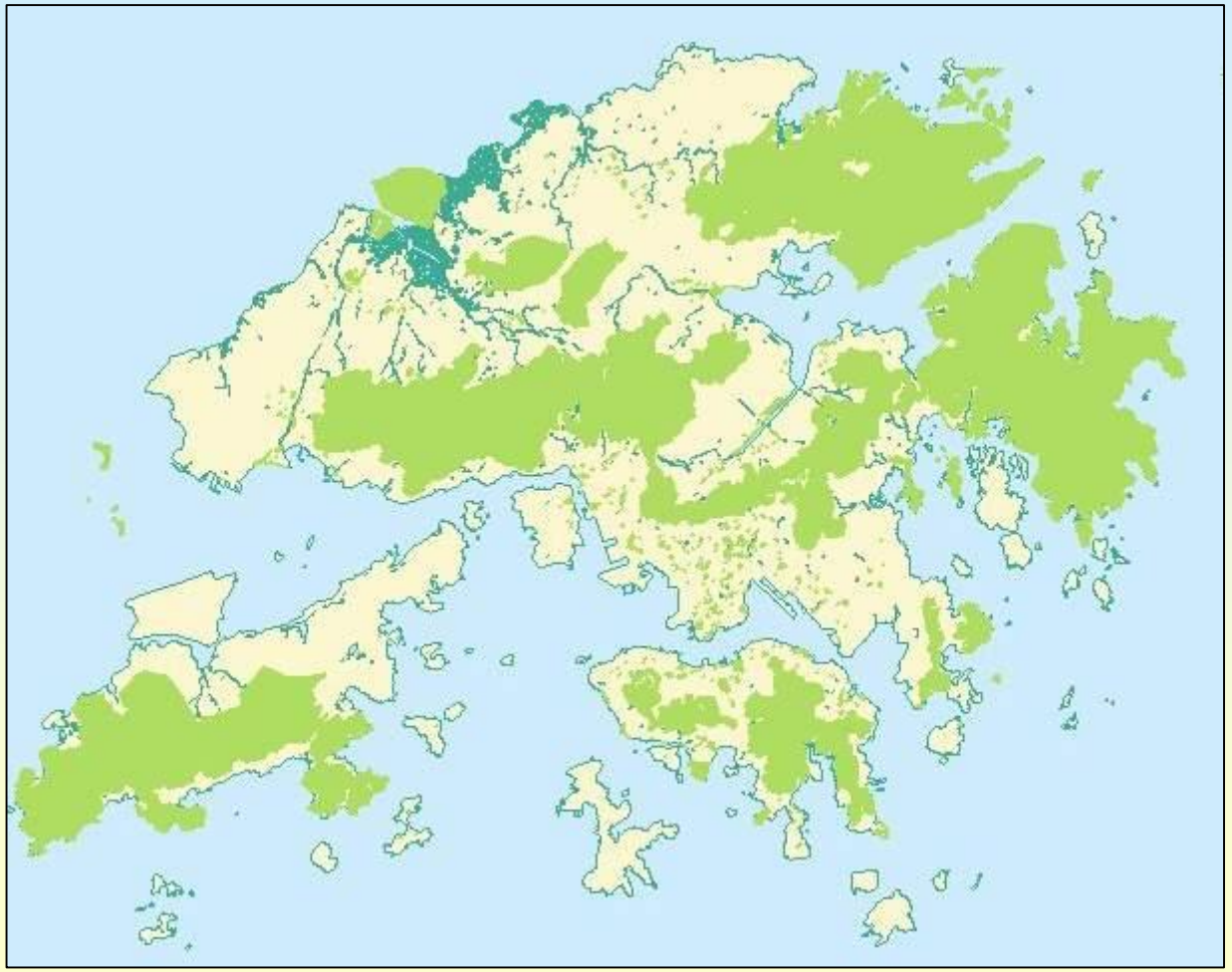
- CAD, graphical and image GIS data models
- Raster data model
- Vector data model
- Object data model

A CAD data model



A CAD model focuses on feature drawing only so that it does not represent any kind of relationships between objects.

A simple graphical data model



A simple graphical data model is adequate to make a cartographic representation of a city.

Image data model

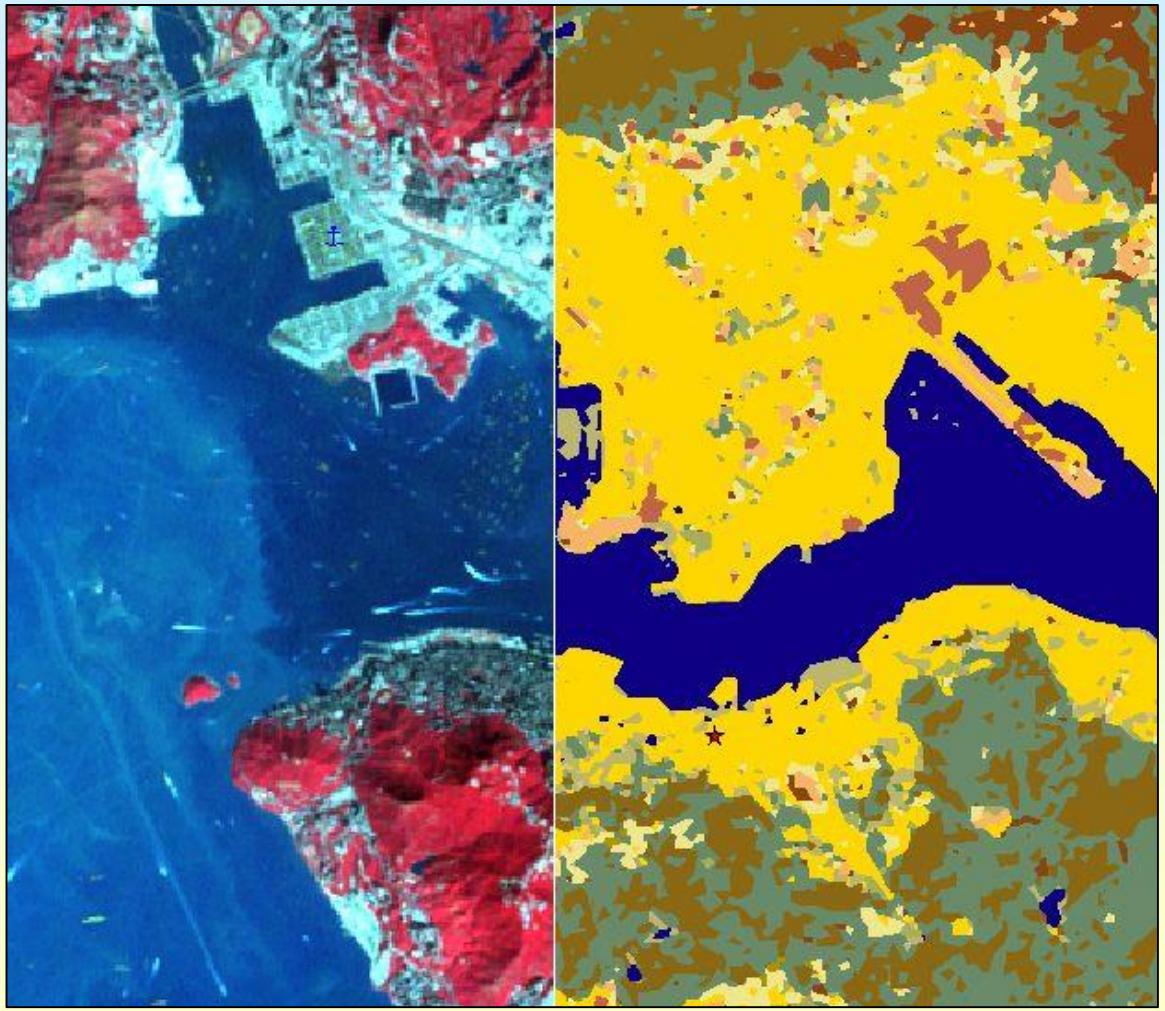


Image data: can be used to:

1) the color composite (as the left image).
2) the classification of the image. (as the right image)

Raster data model

- Raster data model uses an array of cells, or pixels, to represent real-world objects.
- Difference between raster and image data models:
  - Image data do not have attribute table attached so that they have only one attribute field.
  - Raster data have attribute table that can be joint to other tables so that they can have multiple attribute fields.
  - Applications: image data: image processing; raster data: spatial analysis and modelling

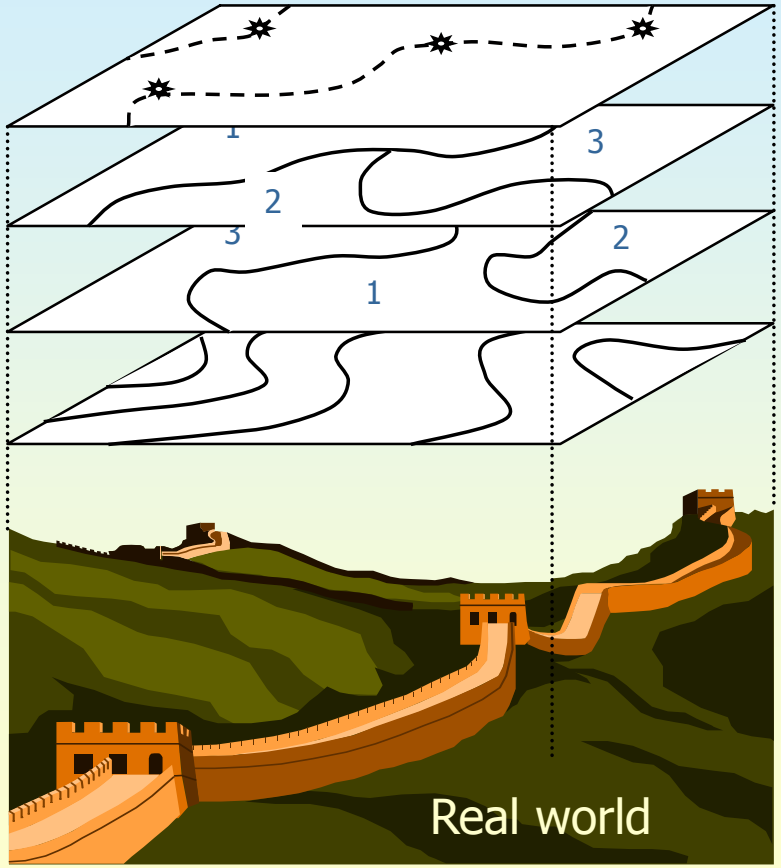
Data structure of raster data model

- Cartographic model (database)
- Map layer (overlay, coverage, grid)
- Class and zone (region, patch)
- Location (cell)

Cartographic model

- The data for an area can be visualised as maps or layers.
- A cartographic model is a set of data describing selected characteristics of each location within a bounded geographic area in the form of map-like layers.

A raster database



Buildings

Forest types

Soil types

Topography

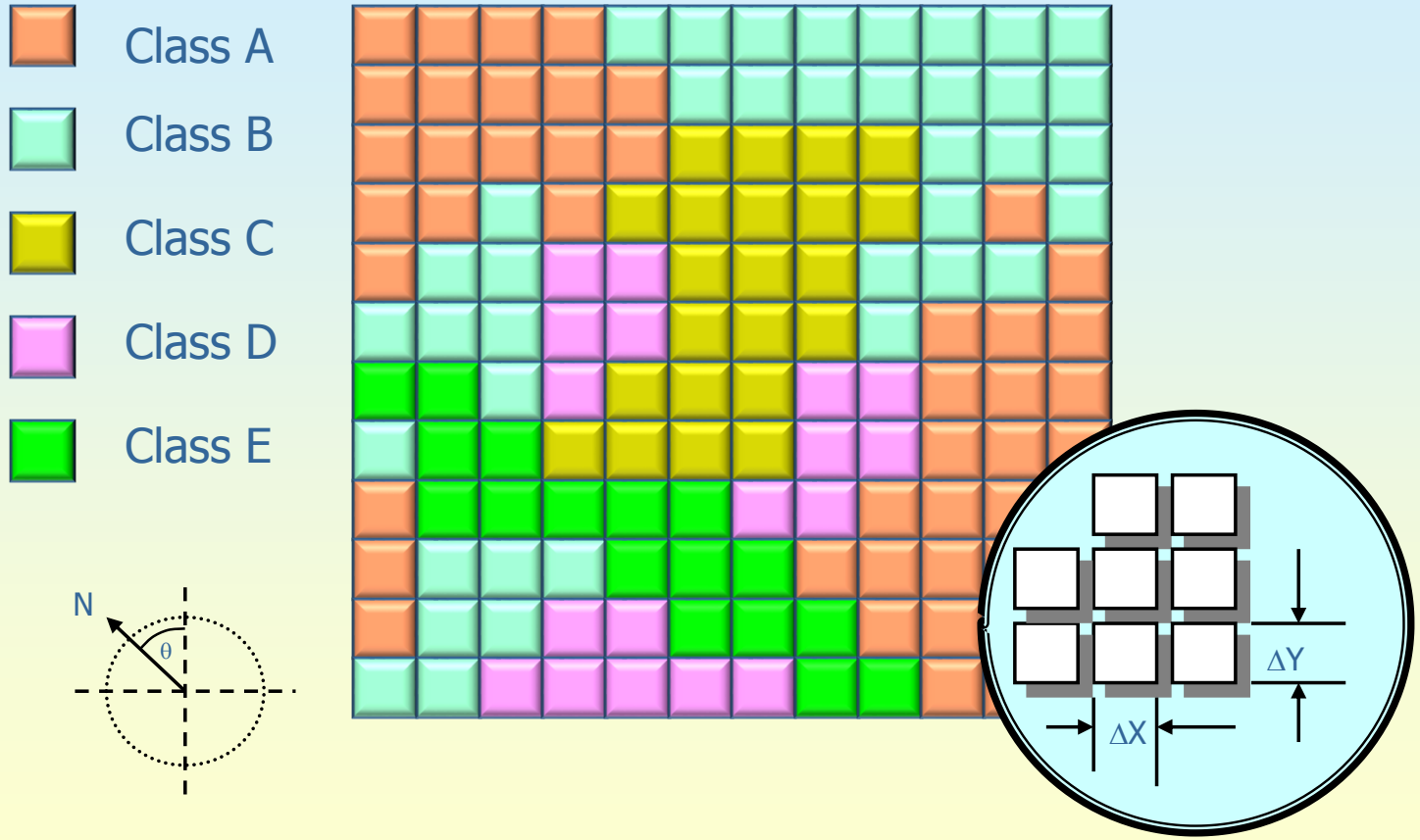
3	3	3	3	1	2	2
3	3	3	1	1	2	2
3	3	3	1	1	2	2
3	3	1	1	2	2	2
3	1	1	1	2	2	2
3	1	1	1	1	2	1
3	3	1	1	1	1	1

Soils

Map layer

- A map layer is a set of data describing a single characteristic of each location within a bounded geographical area.
- Only one item of information is available for each location within a single layer.
- A layer is characterized by its resolution (cell size) and orientation.
- A layer is composed of one or more classes.

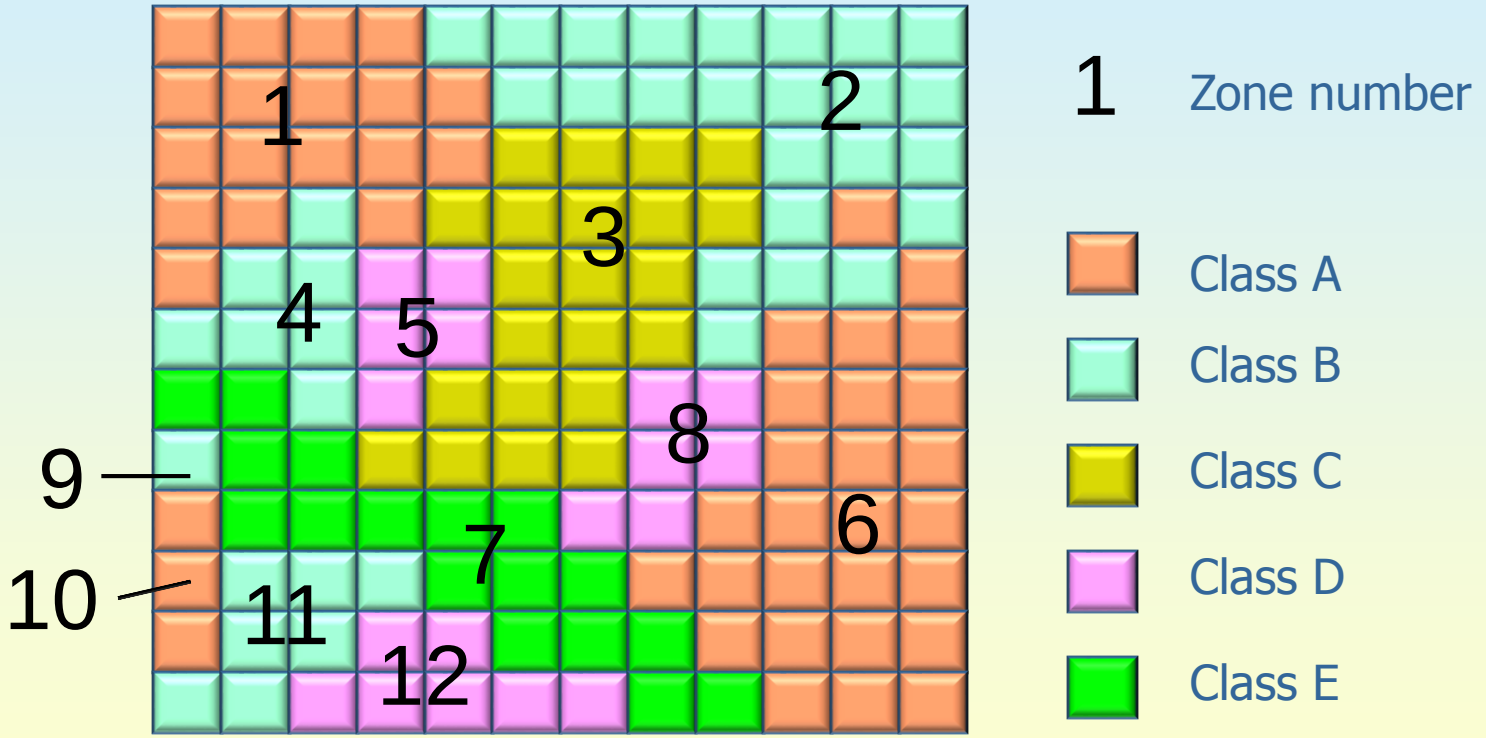
A layer



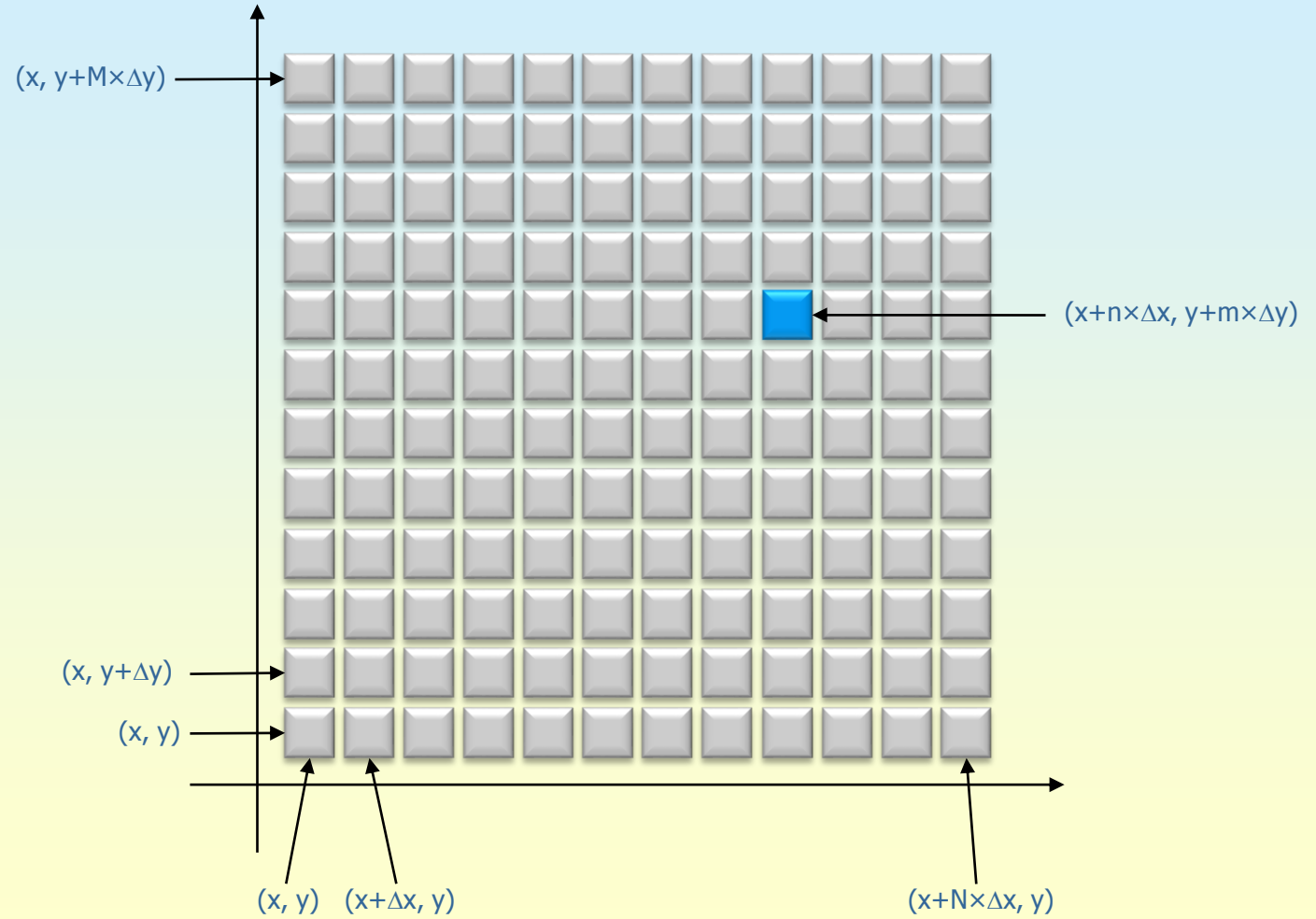
Class

- A zone is a set of contiguous location that exhibit the same characteristic.
- The term class is used to refer to all individual zones that have the same characteristic.
- A class is associated with its class ID and attributes.
- A class/zone is composed of a number of locations (cells).

Class and zone



A location and its coordinate



Vector data model

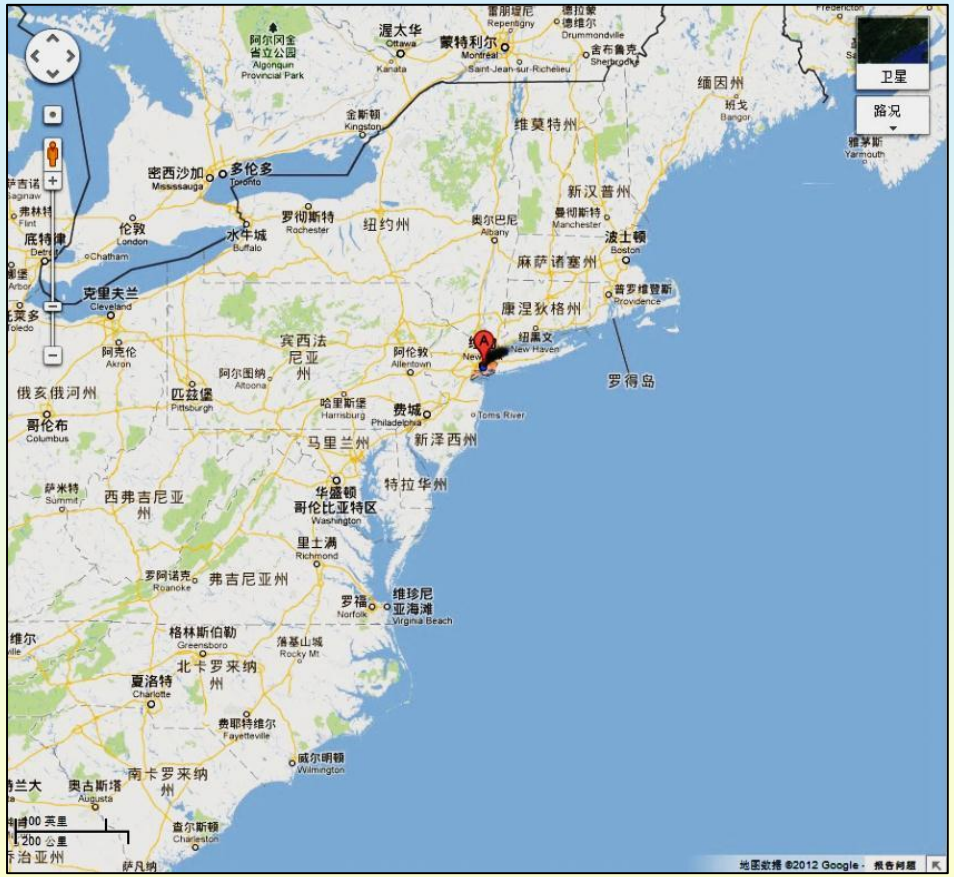
- Simple features
- Network data model
- TIN data model

Vector representations

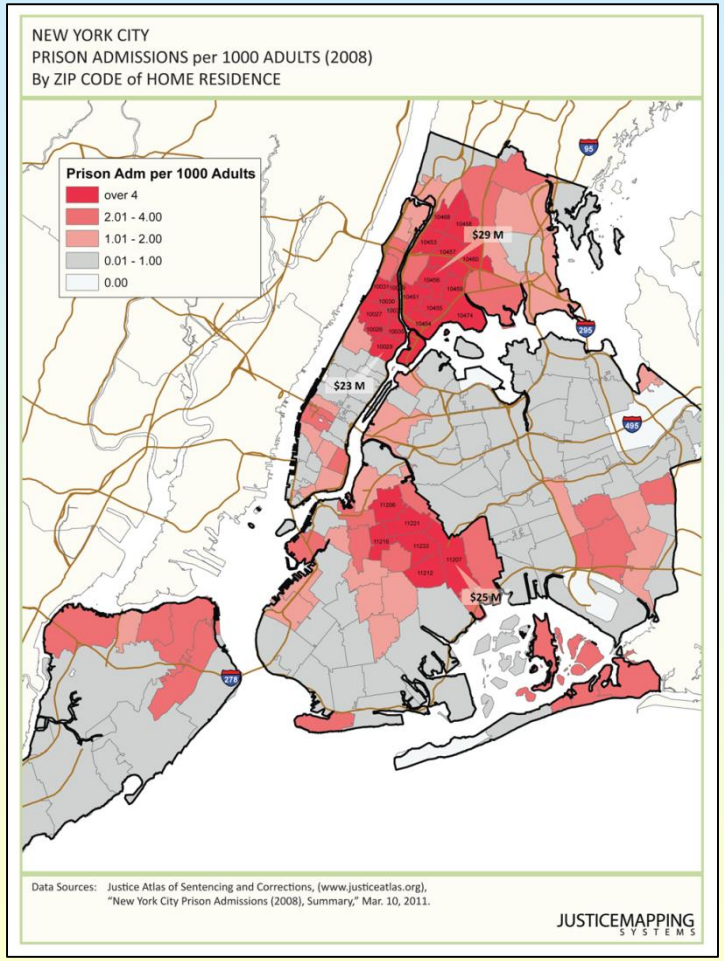
Scale

point	line	area
city wells	highway political boundary streams	agriculture land urban land city airport

Multiple representation

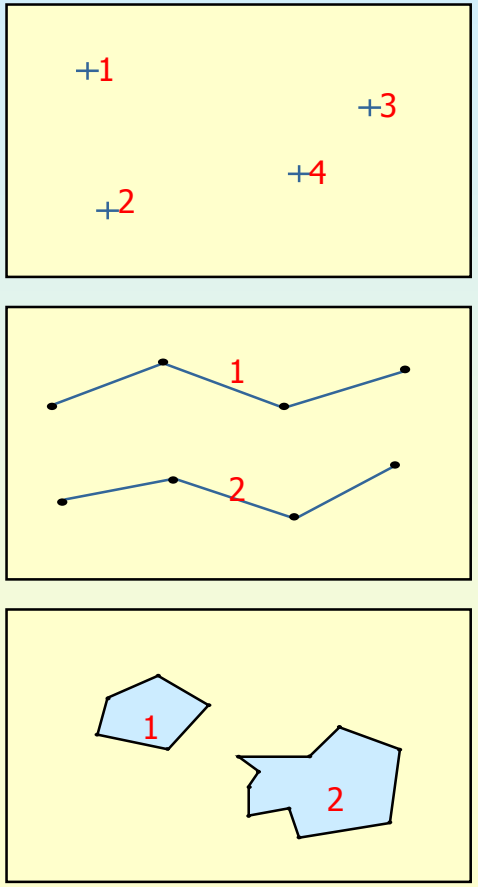


Small-scale representation of cities as points



Large-scale representation of cities as areas

Simple features



Point number	x, y coordinates
1	(2, 8)
2	(3, 3)
3	(12, 7)
4	(9, 4)

Line number	x, y coordinates
1	(1, 6), (4, 8), (8, 6), (13, 8)
2	(1, 3), (4, 4), (9, 2), (13, 5)

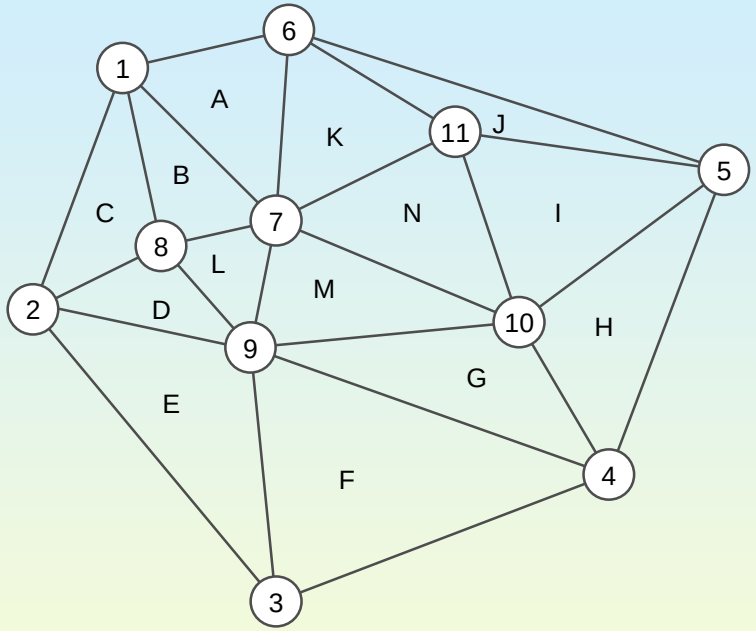
Polygon number	x, y coordinates
1	(2, 5), (3, 8), … (2, 5)
2	(6, 4), (8, 4), … (6, 4)

A network data model

TIN data model

Triangle Table

Id#	node#	area	slope	… …
A	1, 6, 7	… …	… …	… …
B	1, 7, 8			
C	1, 2, 8			
D	2, 8, 9			
E	2, 3, 9			
F	3, 4, 9			
G	4, 9, 10			
H	4, 5, 10			
I	5, 10, 11			
J	5, 6, 11			
K	6, 7, 11			
L	7, 8, 9			
M	7, 9, 10			
N	7, 10, 11			



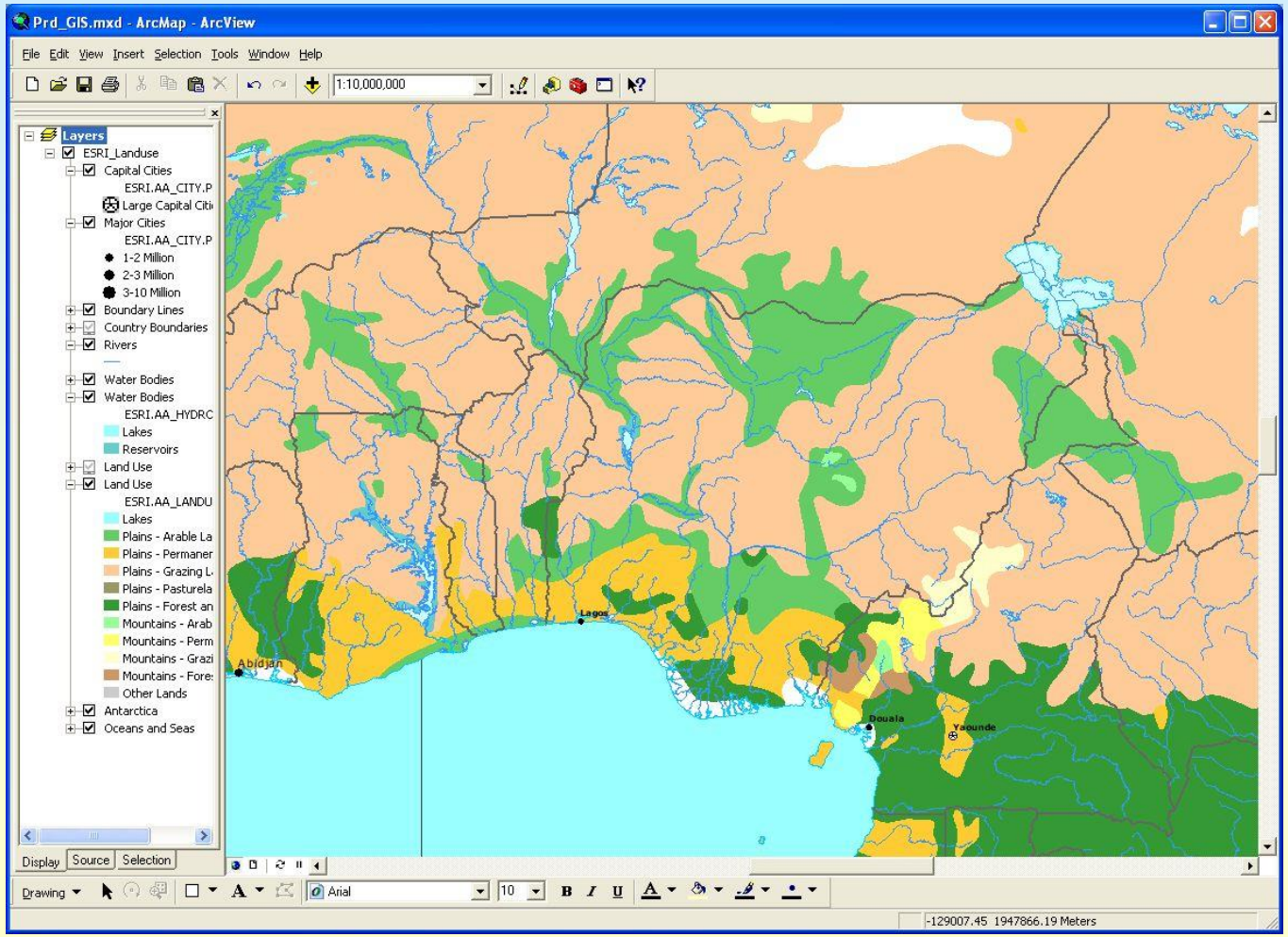
X-Y Coordinates

node#	coordinates
1	x1, y1
2	x2, y2
3	x3, y3
. . .	. . .
11	x11, y11

Z Coordinates

node#	z_value
1	z1
2	z2
3	z3
. . .	. . .
11	z11

Object-oriented model



Summary

- The heart of a GIS is the data model it employs.
- With increasing level of abstraction, models are created from human-oriented conceptual, logical to computer-oriented physical models
- There is no single type of GIS data model that is best for everything.
- Commonly used data models include:
  - CAD, graphical and image data models
  - Raster data model
  - Vector data model
  - Object-oriented data model