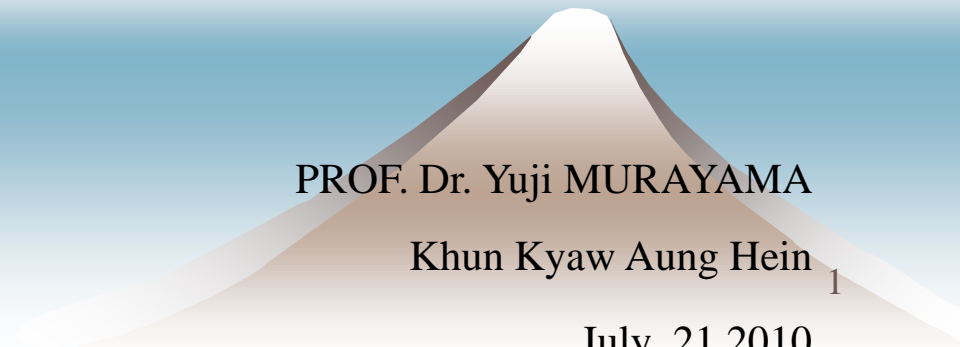




An Introduction to Geographic Information System



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GIS: *A Formal Definition*

A system for capturing, storing, checking, Integrating, manipulating, analyzing and displaying data which are spatially referenced to the earth.

DoE (1987:132)

A powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world.

Burrough(1986:6)

GIS = Maps + Database

Defining of Geographical Information System (GIS)

- The *common ground* between information processing and the many fields using spatial analysis techniques.

(Tomlison, 1972)

- A powerful set of tools for collecting, storing, retrieving, transforming and displaying spatial data from the real world.

(Burroughs, 1986)

- A computerized database management system for the capture, storage, retrieval, analysis and display of spatial (locationally defined) data.

(NCGIA, 1987).

- A decision support system involving the integration of spatially referenced data in a problem solving environment.

(Cowen, 1988).

Geographic Information System 2

GIS ; A tool – kit

Manipulate spatially

- _ Calculate distance and adjacencies
- _ Change projection and scales

Analysis spatially

- _ Quantitative analysis & Qualitative analysis
- _ Exploratory spatial data analysis

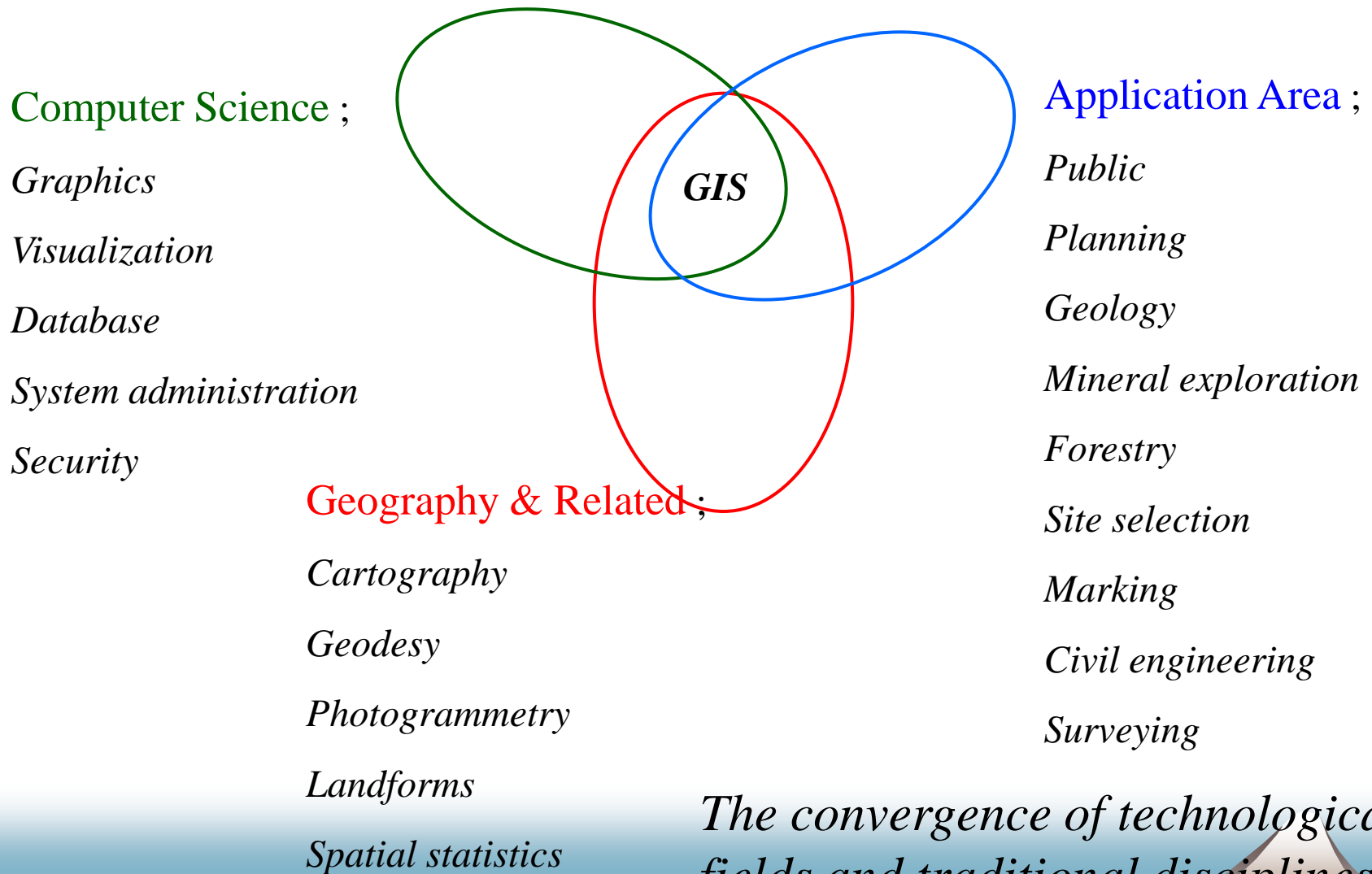
Visualise Data

- _ Maps & Tables, Graphs, etc .
- _ Animation & Virtual Landscapes

Geographic Information System 3

- _ Links maps and database
- _ Manages information about the places
- _ Helps answer the questions such as
 - _ Where is.... ?
 - _ What the location.... ?
 - _ What is the spatial relation between ...?
 - _ What is similar to ...?
 - _ Where has ...occurred ?
 - _ What has changed since?
 - _ Is there a general spatial pattern and where are the anomalies.

Knowledge Base for GIS



The convergence of technological fields and traditional disciplines

Component of GIS

Input



Management & Analytical Modules



Output



Data Acquisition

- _ Geodetic Positioning
- _ Remote sensing
- _ Field Sampling
- Analog Data Conversion
- _ Scan & Digitize

Management

- _ Data storage
- _ Data Retrieval, Expand ,
Edit & Update
- _ Query

Analytical Modules

- _ Data conversion
- _ Data Manipulation
- _ Modeling

Data output

- _ Visual Presentation
- _ Analog Maps
- _ Reports

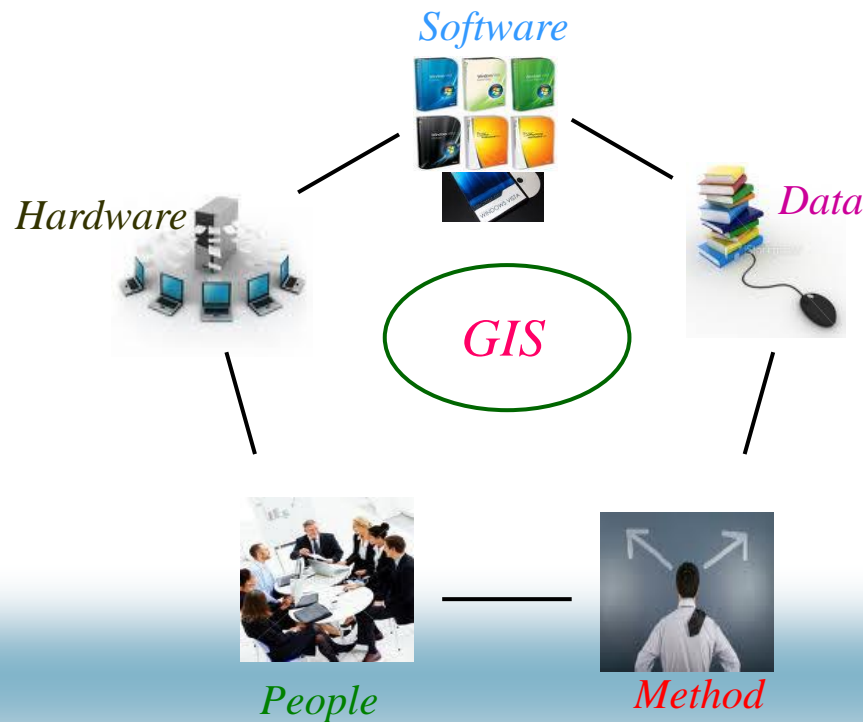
Concept of GIS

- Geographic/ Geographical Information
 - _ information about places on the earth's surface
 - _ Knowledge about “**what ,where, when**”
- GIS _ What is “**S**”
 - _ **Systems**: the technology
 - _ **Science**: the concepts and theory

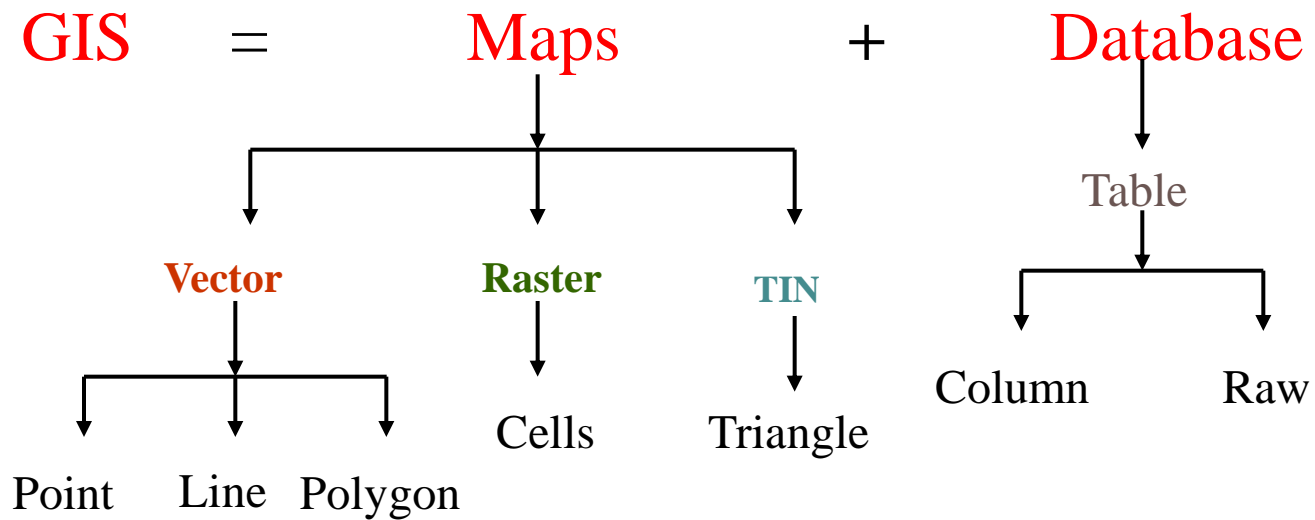
Elements of GIS

- A system of *hardware, software, people, data, organization and institutional arrangements* for *collecting, storing, analyzing and disseminating information* about the areas of the earth.

(Dueker & Kjerne, 1989)



GIS Data Models



Vector Data Model

Vector Data represents features on the earth's as a *Point* , *line* and *Polygon* .

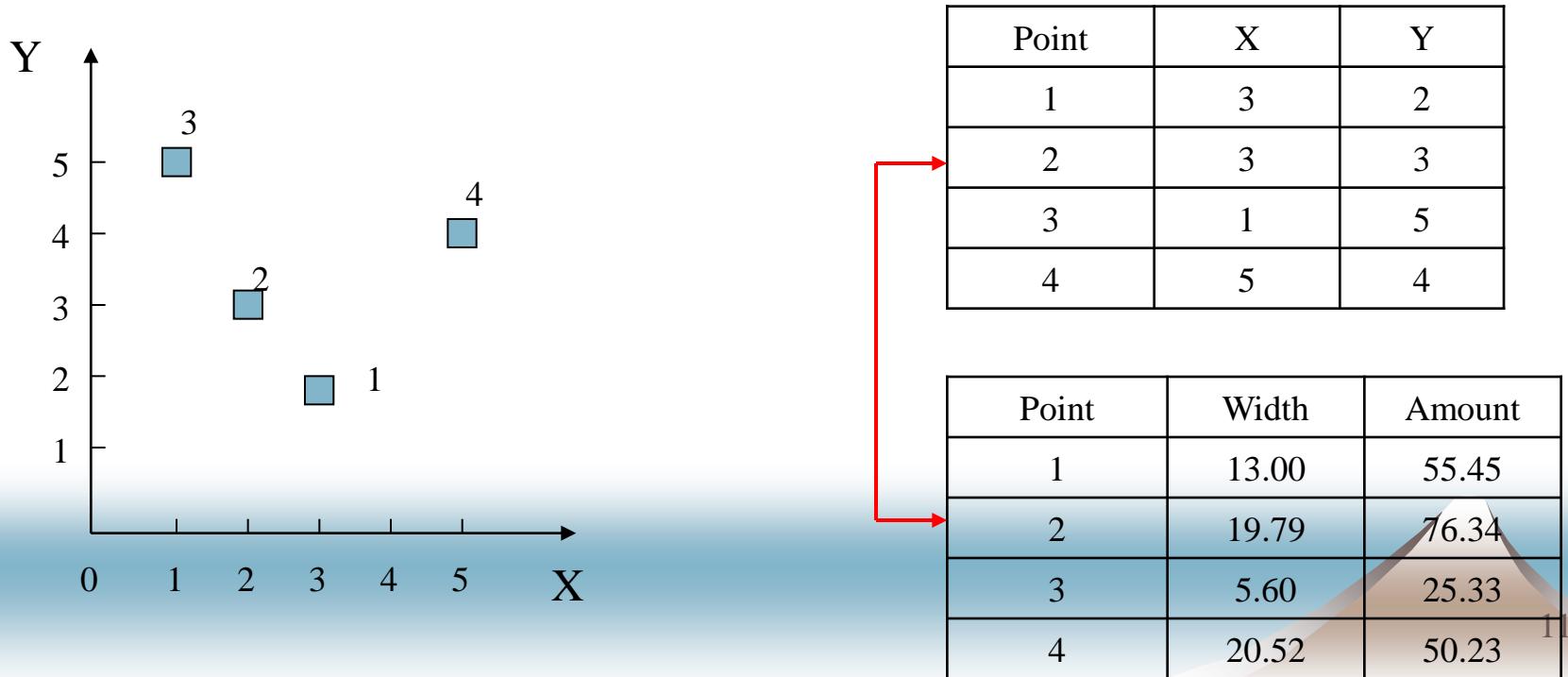
_Point ; nodes or vertices

_Line ; are or chain

_Polygon ; area feature

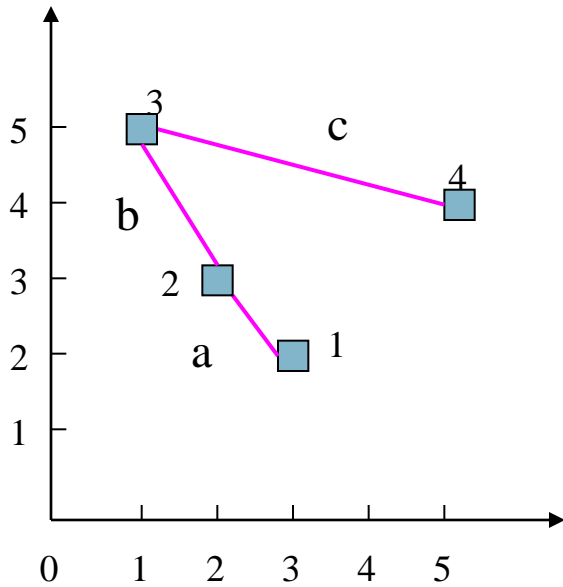
•Point

Point is stored by its location (X, Y) together with the table attribute of this point.



Line

Line is stored by the sequence of first and last point together with the associated table attribute of this line.



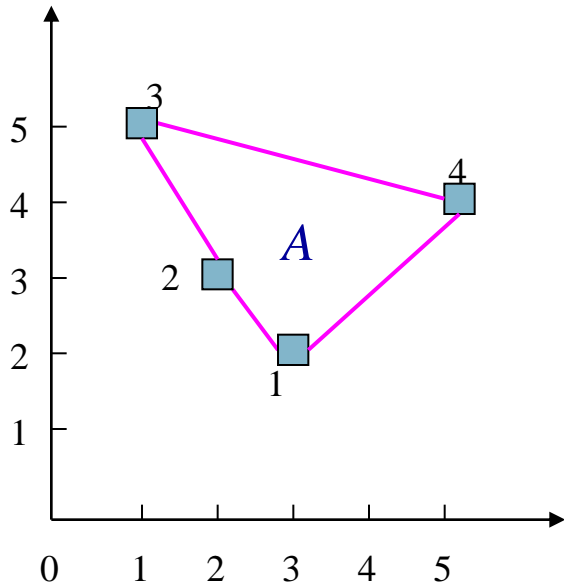
| Node | X | Y |
|------|---|---|
| 1 | 3 | 2 |
| 2 | 3 | 3 |
| 3 | 1 | 5 |
| 4 | 5 | 4 |

| Line No | First Node | Last Node |
|---------|------------|-----------|
| a | 1 | 2 |
| b | 2 | 3 |
| c | 3 | 4 |

| Line | Flow | Capacity |
|------|------|----------|
| a | 950 | 2000 |
| b | 1200 | 2100 |
| c | 1000 | 1950 |

Polygon

Polygon is represented by a closed sequence of lines. Unlike line or poly-line (sequence of line), polygon is always closed. A polygon can be represented by a sequence of nodes where the last node is equal to the first node.



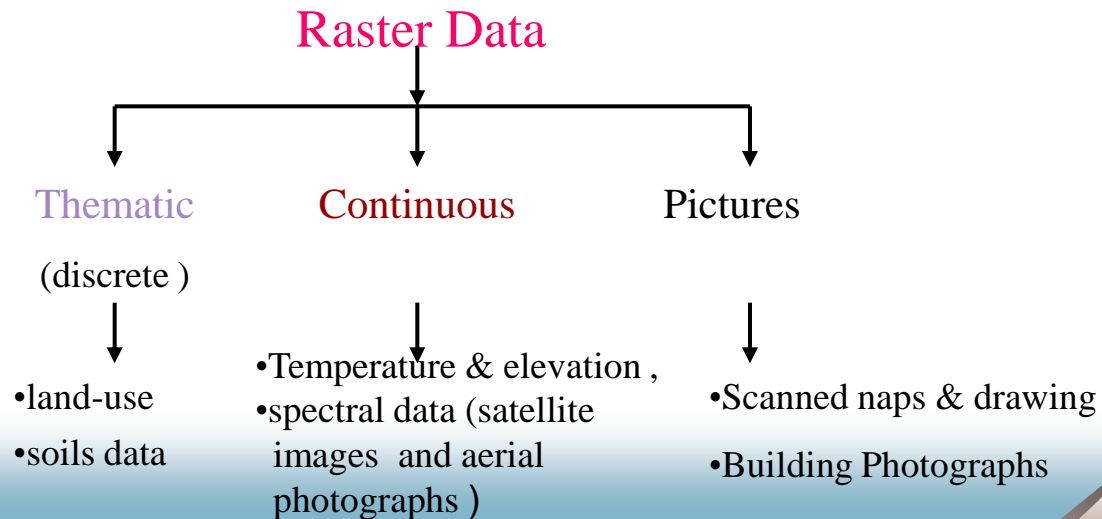
| Node | X | Y |
|------|---|---|
| 1 | 3 | 2 |
| 2 | 3 | 3 |
| 3 | 1 | 5 |
| 4 | 5 | 4 |

| Polygon | Node Sequences |
|---------|----------------|
| A | 1,2,3,4,1 |

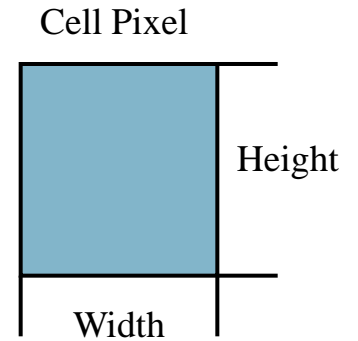
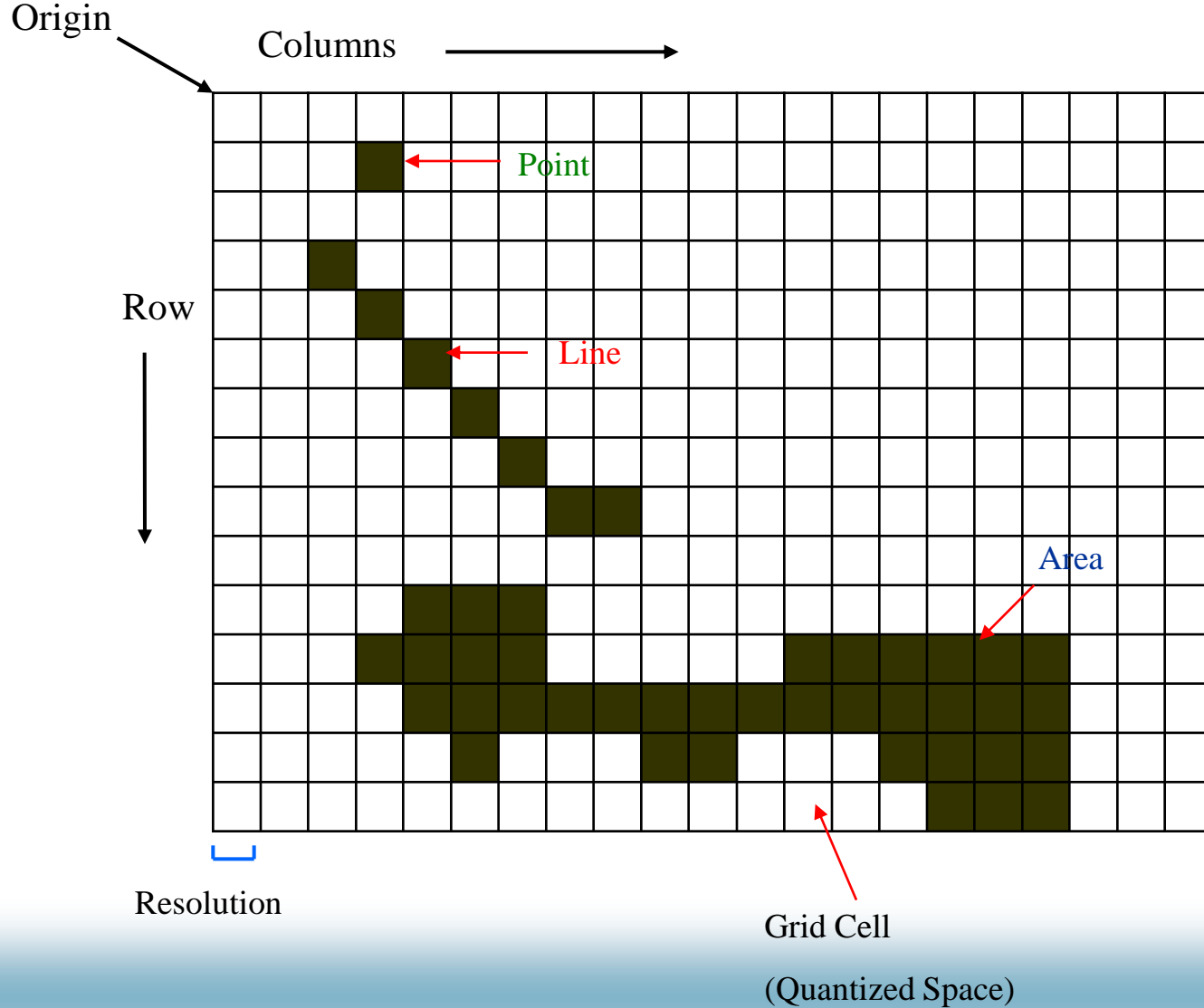
| Polygon | Area | Household |
|---------|------|-----------|
| A | 1625 | 37531 |

Raster Data Model

- Raster model use grid or cell as unit to store data, similar to Image. Raster data models incorporate the use of a *grid-cell* data structure where the geographic area is divided into cells identified by row and column.
- Attribute are recorded by assigning each cell a single value based on the majority (attribute) in the cell such as land use type.
- Image data is a special case of raster data in which the “attribute” is a reflectance value from the geomagnetic spectrum – cells in image data often called Pixels (picture elements) .

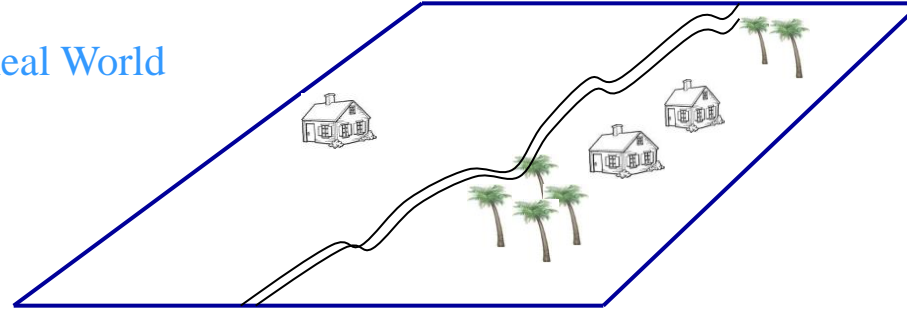


Raster Graphic Representation



Concept of Vector and Raster

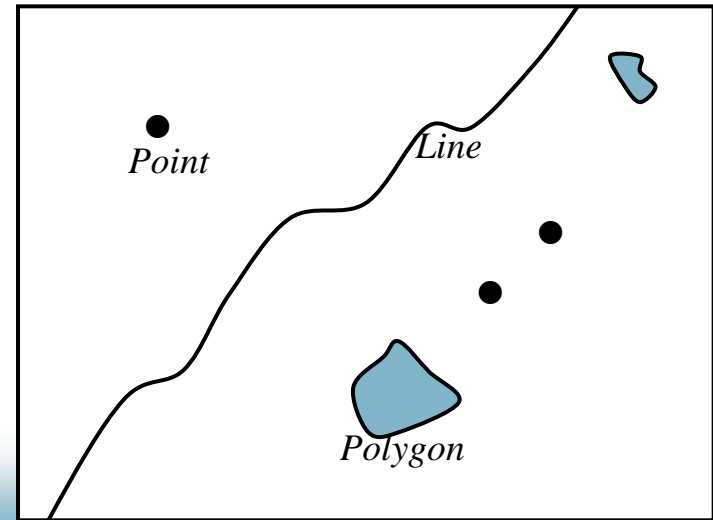
Real World



Raster Representation

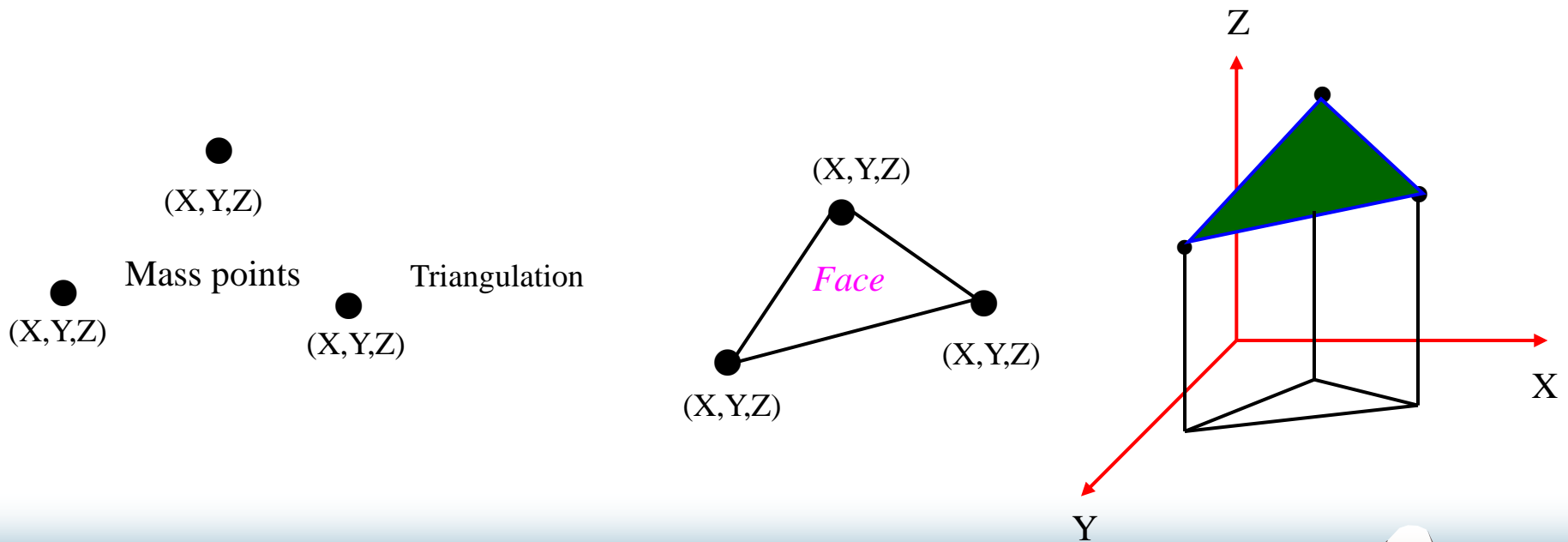
| | | | | | | | | | |
|--|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | T |
| | | | | | | | | R | T |
| | H | | | | | | R | | |
| | | | | | R | R | | | |
| | | | | | R | | | | |
| | | | R | R | | | | H | |
| | | R | | | | H | | | |
| | | R | | | | | | | |
| | R | | | T | T | | | | |
| | R | | | T | T | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Vector Representation



TIN Model

TIN or Triangulated Irregular Network stores GIS data for 3D surface model. A triangulated Irregular Network (TIN) is the data model commonly used to represent terrain height. The triangle is represented by a sequence of three nodes each triangle may have other associated attributes data. In GISs, TINs can be seen as polygons having attributes of slope, aspect and area, with three vertices having elevation attributes and three edges with slope and direction attributes.



The Role of Data Model in GIS

GIS Data Model

Description and Representation



Operational GIS

Analysis & Presentation



Real World



People

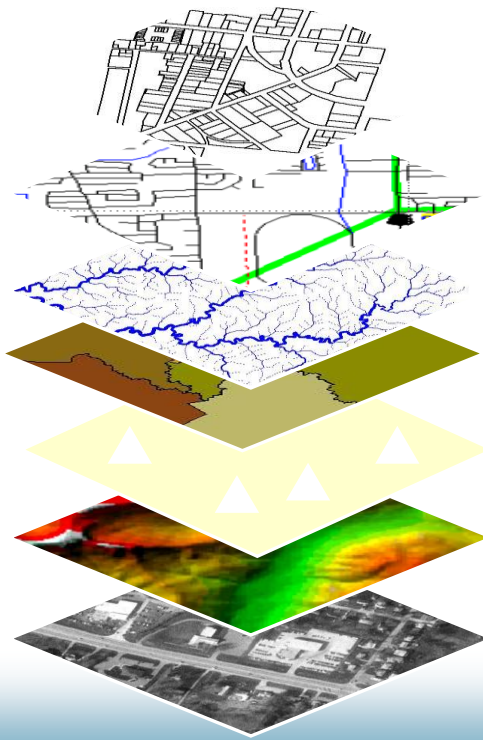
Interpretation and Explanation



Geographic Database



Framework Data



Land Ownership

Transportation

Surface Waters

Boundaries

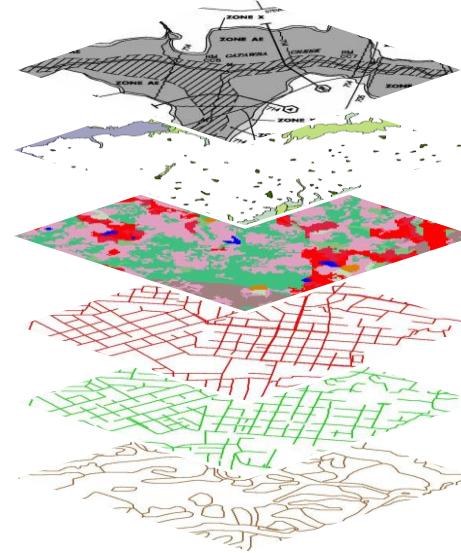
Geodetic Control

Elevation

Aerial Imagery



Thematic Data



Flood Zones

Wetlands

Land-cover

Water Lines

Sewer Lines

Soils

Database Types 1

A database is an information set with a regular structure. A database is usually but not necessarily stored in some machine readable format accessed by a computer. "Database" (data repository) to create a central data repository for spatial data storage and management.

- _ Tabular (flat file) _ data in single table
- _ Hierarchical
- _ Network
- _ Relational

Data Types 2

Spatial Data Types

- *Continuous* : elevation, rainfall
- *Areas* :
 - _ *unbounded*: land-use, market area, soils
 - _ *bounded* : city , sate, country boundaries
 - _ *Moving* : animals group ,
- *Networks* : road, river, streams
- *Point* :
 - _ *fixed* : wells, lamps post , address

Attribute Data Types

Categorical (Name)

_ *nominal*

- no inherent order
- cities name, land use types

_ *ordinal*

- inherent order
- stream class, road class

Numerical

Known difference values

_ *interval*

- No natural zero
- temperature (C , F)

_ *ratio*

- Natural zero
- age, income, rainfall

Spatial and Attribute Data 3

- ◆ **Spatial Data** (*Where*)
 - _ specifies location
 - _ stored in a *shape file*, *geo-database* or similar *geographic file*
- ◆ **Attribute** (**Descriptive**) data (*what* , *how much*, *when*)
 - _ Specifies characteristics at that location, natural or human created
 - _ Stored in a data base *table*
- ◆ **Image data** (Diverse elements)
 - _satellite image, aerial photos, scanned data
- ◆ *GIS systems* traditionally maintain spatial and attribute data separately , then *join* them for display or analysis.

Data Capture Sources

Raster

Primary

- _ Remote sensing images
- _ Aerial photographs

Secondary

- _ Scanned maps or photographs
- _ DEM from maps



Vector

- GPS measurement
- Survey measurement
- Topographic Maps
- Toponymy (place name) database

Functionalities OF GIS

- Overlay analysis
- Interpolation
- Digital elevation model
- Visualization
- Digital mapping
- Network analysis

GIS Applications

- Mapping Location
- Mapping Quantities
- Mapping Densities
- Mapping and Monitoring change

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