**Second semester Test**
**GIS 310 – Advanced GIS**
**Department of Geography, Geoinformatics and Meteorology**
**05 May 2010**

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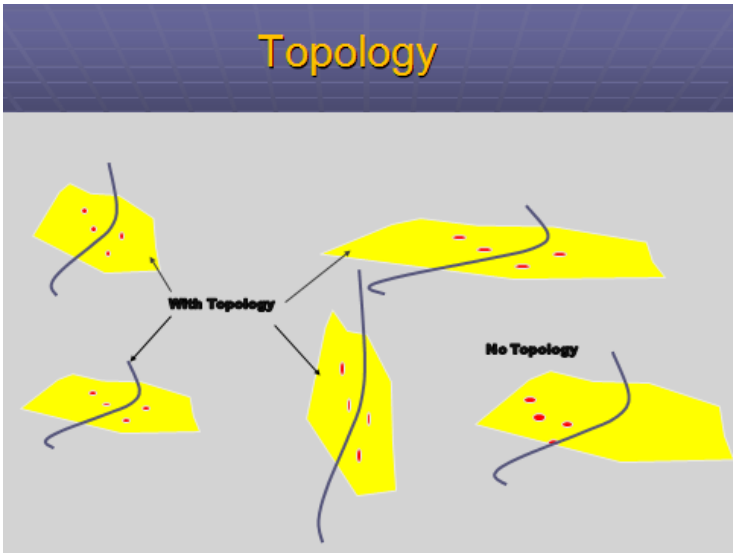
**Time 1h30min**

1. STUDY UNIT 3: DATA MODELS

1.1 Discuss the use of topological data structure in a vector GIS. (25)

- Early GIS developers realised that they can improve the speed, accuracy and utility of spatial operations by recording connectivity and adjacency
- Also information about relationships
- Topology – study of geometric properties that do not change when forms are bent, stretched or undergo transformations
- Used in most current vector-based GIS's.




1. **Adjacency:** Describe the relationship between two area features. Are adjacent if they share a **common** boundary
2. **Connectivity:** Describe the linkage between features (lines)

**Types of topology:**

1. **Planar topology:** All features occur on 2D surface. No overlaps among lines or polygons in the same layer. Lines may not cross over or under other lines – must be an
2. **Non Planar topology:** Polygons can overlap and lines can cross without intersection.
3. 

**Please note: There are no single, uniform set of topological relationships.**

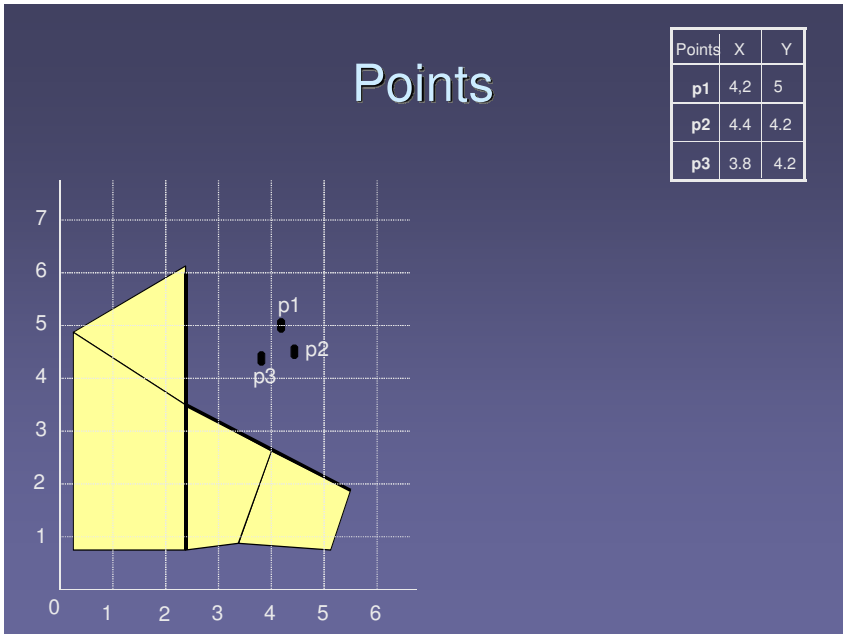
Researchers and or software vendors incorporated different topological relationships

Topology sometimes only generated as needed and in some software always available.

Topology may be specified between different layers.

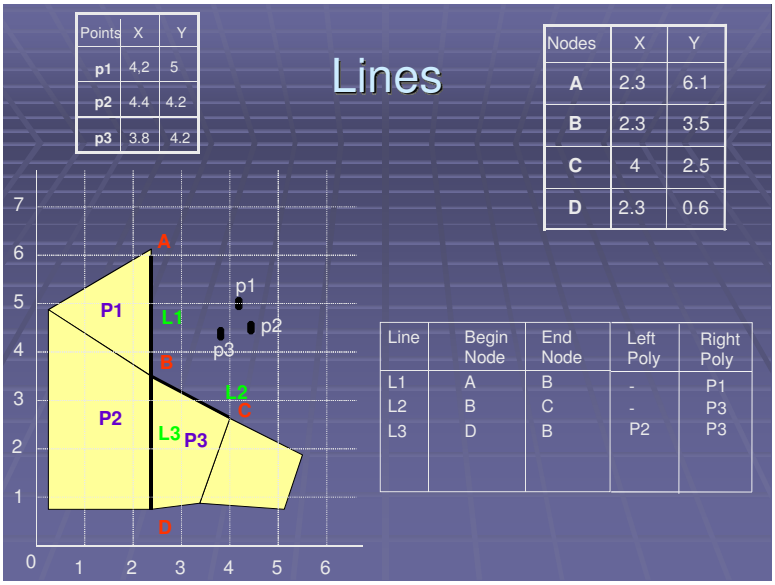
Many other types of topological constraints e.g.
Dangles (Lose hanging lines)
Intersection between lines and points
Topology is recorded in codes and tables
Often not visible to the user and not accessible
Tools to create and maintain topology
Topological tables are often quite large, complex and hidden

- Simplest entity
- Can be represented with topology
- Required to be topologically correct:
  - A pointer or geog ref to locate its position with respect to other spatial features.




- Lines:
  - Minimum is start and end nodes
  - Table consist of line identifier, starting node and ending node

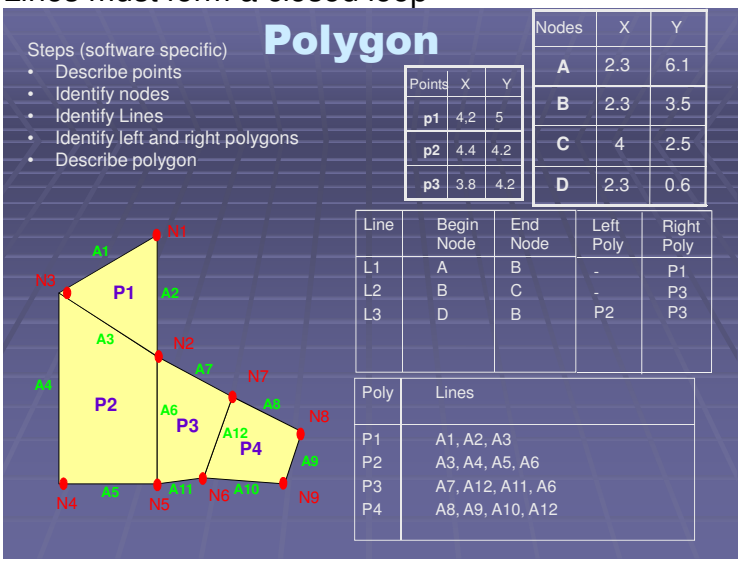
  May be assigned a direction and polygons to left and right (direction of travel)




Polygons:

- Also defined in tables
- Table consist of unique ID and lines making up the polygon
- Edge lines recorded in sequential order.

Lines must form a closed loop




1. Computational costs in defining the topological structure (current computer technologies)
2. Data must be 'clean'

   BUT – limitations are outweighed by gains in efficiency and analytical capabilities

1.2 Explain the difference between the layer view of data in a GIS and the object data model.

(5)

- Each variable can be conceptualised as a layer

  - each layer captures the variation of one variable over the surface of the earth
- GIS has developed certain data models for representing the layer view of the world, among them:
  - raster - continuous geographic variation is approximated by finite-sized pixels
  - Vector - the world is divided into irregular pieces, and the variable is assumed to be constant within each piece and to change suddenly at each boundary
  - TIN - the world is divided into triangles, and variation is approximated by a plane within each triangle

  Each uses objects of various kinds - points, lines or areas - but the objects exist in the database, for the purpose of describing variation, and not in the real world

- Object approach provide:
  - Spatial entities with intelligence
  - Enhance the potential for modelling relationships
  - Allows the implementation of truly dynamic spatial models
- ODM attempts to bring the information system as close as possible to the real-world application domain.
- ODM provides better strategies for:
  - i) modeling the real-world as close to a user's perspective as possible;
  - ii) interacting easily with a computing environment through familiar metaphors;

2. <u>STUDY UNIT 4: GEODATABASES</u>

   2.1 Define the following terminology:

   2.1.1 Data - are the raw facts and observations that are stored in a database.

   2.1.2 Database - is body of related data stored in a structured manner

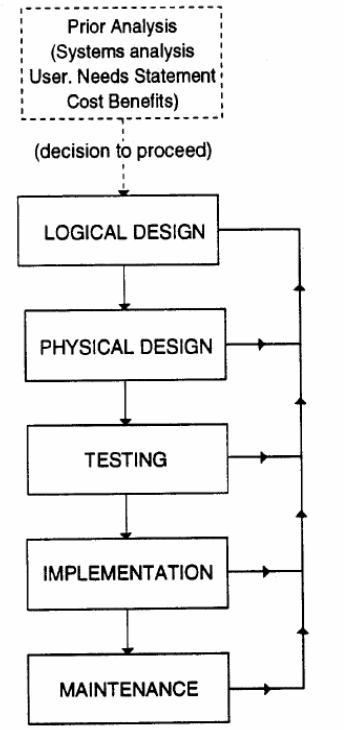
   2.1.3 Information - is the pay-off that results from successful analysis of data.

   2.1.4 Database Management System - a general purpose computer program which makes manipulating a database more convenient

(4)

2.1 Illustrate the database design sequence by means of a flow chart.

(7)




2.2 Make use of an example to explain how EAR modelling is used as a means of modelling data structures.

(25)

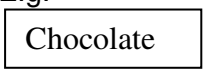
Consist of series of diagrams that represent the structure of a dataset.

The basic EAR approach can be thought of as involving three (possibly four) stages:
1. Identify entities
2. Identify relationships between entities
3. Identify attributes of entities
(4. Deriving to tables).

**1. Identify entities**

Anything that can be identified as having an independent existence about which you need to collect information
First develop a list of all relevant entities
In EAR diagrams are usually drawn as boxes containing the entities name:

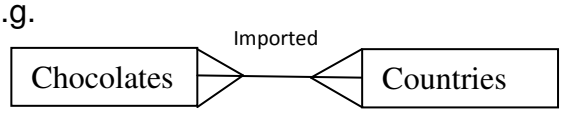
E.g.




**2. Identify Relationships**

Is a real world association between two objects. E.g. chocolates are imported from other countries

E.g.

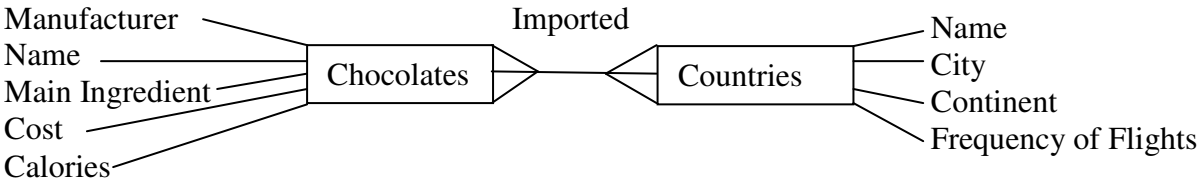



Determine the degree of relationship

Relationship can be one-to-one, one-to-many or many-to-many
In this example: many-to-many

Must understand the rules for making up the relationships.

**3. Identify the attributes of the entities**
Allocating attributes to the entities




**4. Deriving Tables**
(i) Establish Primary Keys
Every row in a table must be uniquely identified by means of primary key. Otherwise establish artificial key. In this example name of chocolates and name of countries will be unique id.

(ii) Relationships between Entities
Relational model uses sharedfs attributes to relate one table to antoher. Appropriate keys and necessary additional tables are in place to conform to relational principles. Rules for transforming EAR into Relational form are fairly straight forward.
One-to-one: Collapse the two entities into a single relational table
One-to-many: Add primary key of one table into the table of the many . Many null values may be stored. Introduce an intermediate table. May slow processing times.
Many-to-many: Must be decomposed into 1:M relationships using the primary key from each original table as attributes of the intermediate table

Chocolates

| Manufacturer | Name | Etc |
|---|---|---|
| | A | |
| | B | |

Imports

| Name | City |
|---|---|
| A | Berlin |
| B | Stockholm |

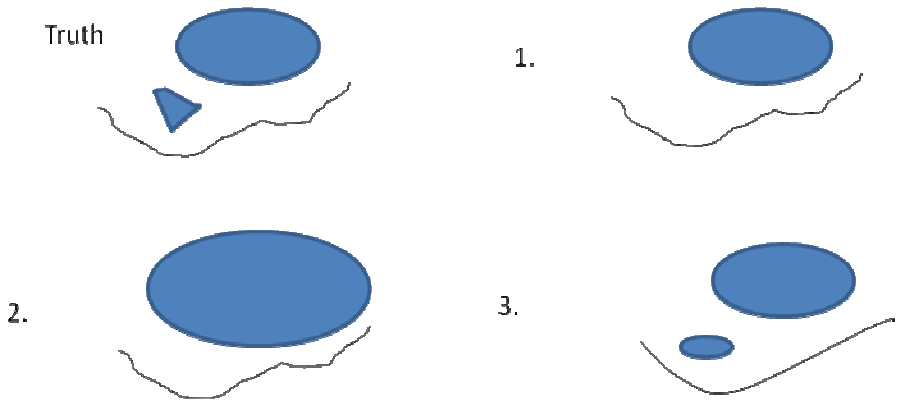
Countries

| Continent | City | Etc. |
|---|---|---|
| | Berlin | |
| | Stockholm | |

3. STUDY UNIT 5: DATA SOURCES, ENCODING AND EDITING
   3.1 Define the following terminology:
      3.1.1 Ellipsoid – Mathematical calculation of the shape of the earth
      3.1.2 Datum – Ellipsoid with origin not necessarily in the centre of the earth
      3.1.3 Conformal map projection – Representation of 3D earth on 2d surface while shapes and angles are preserved

(3)

   3.2 Name the type of feature generalisation applied in the following instances:




(3)

1. Omitted
2. Fused
3. Simplified

3.3 Name a possible data source and encoding/editing method that you will use to capture data for the use in a GIS under the following circumstances:

3.3.1 Historical data of the Pretoria/Tshwane city centre (but you do not have a digitising tablet)

Analogue maps, scan, head up digitising

3.3.2 New boreholes inside a specific study area.

GNSS, digital data transfer

3.3.3 New archeological sites on farms that you want to represent together with a scanned image of the area. (Farm boundaries and archeological sites are in different datums.)

Sites: GPS, digital data transfer

Farms: Digital maps

Reprojection

3.3.4 Difference in vegetation growth over a 10 year period.

Satellite image (or aerial photographs), heads up digitising

(8)

3.4 Discuss high-resolution satellite systems for the use in a GIS. Also refer to different operational systems, resolution, return times, advantages and the primary uses of satellite images in GIS.

(20)

- Resolutions below 1 meter
- Panchromatic and multi spectral data
- Commercial systems better than 50 cm resolution are in planning
- Often unneeded as most features can be identified at 1 meter resolution
- Spectral range, price, availability, reliability, flexibility and ease of use may be more important factors in selecting between aerial photos and satellite images
- Satellite data are replacing aerial images
- Operational systems:

| System | Resolution | Return Time |
|---|---|---|
| QuickBird | 0.65m to 16.5km | |
| Ikanos | 1 m and better | 1 to 3 days |
| Worldview | 0.5 panchromatic<br>1 meter | 6 days<br>1.7 days |
| GeoEye | 0.41 panchromatic<br>1.64 multipsectral | (Quick revisit times) |
| CARTOSAT | 2.5 panchromatic | |
| SPOT | 10 m panchromatic<br>20m<br>Increased to2.5 and 10<br>Infrared 10 and 20 m | 1-5 days |
| LANDSAT | 80 meters<br>Increased to 30 meters and 15 meters | 16 to 18 days |
| MODIS<br>VEGETATION | 250 m -1km<br>1.15 km | 1 – 2 days<br>Daily |

- Two primary uses:
- Land cover data
- Detect and monitor change

ADVANTAGES:

- Satellite images have spectral range beyond wavelengths that are detectable by aerial film.
- Important in the longer mid and far infrared wavelengths – differences in vegetation and mineral reflectance
- Useful for land cover and geological mapping.
- Satellite images have high perspective
- Reduces terrain caused distortion
- Satellite images cover large area
- (More higher resolution scanners in orbit and advances in specialised software to retrieve information)

**TOTAL (100)**