What is GIS?

- A technology
  - hardware & software tools
- An information handling strategy
- The objective: to improve overall decision making

GIS: a formal definition

"A system for capturing, storing, checking, integrating, manipulating, analysing and displaying data which are spatially referenced to the Earth. This is normally considered to involve a spatially referenced computer database and appropriate applications software"

GIS definition

"… a special case of information system where the database consists of observation son spatially distributed features, activities or events, which are definable in space as points, lines or area. A geographic information systems manipulates data about these points, lines and areas to retrieve data for ad hoc queries and analyses"

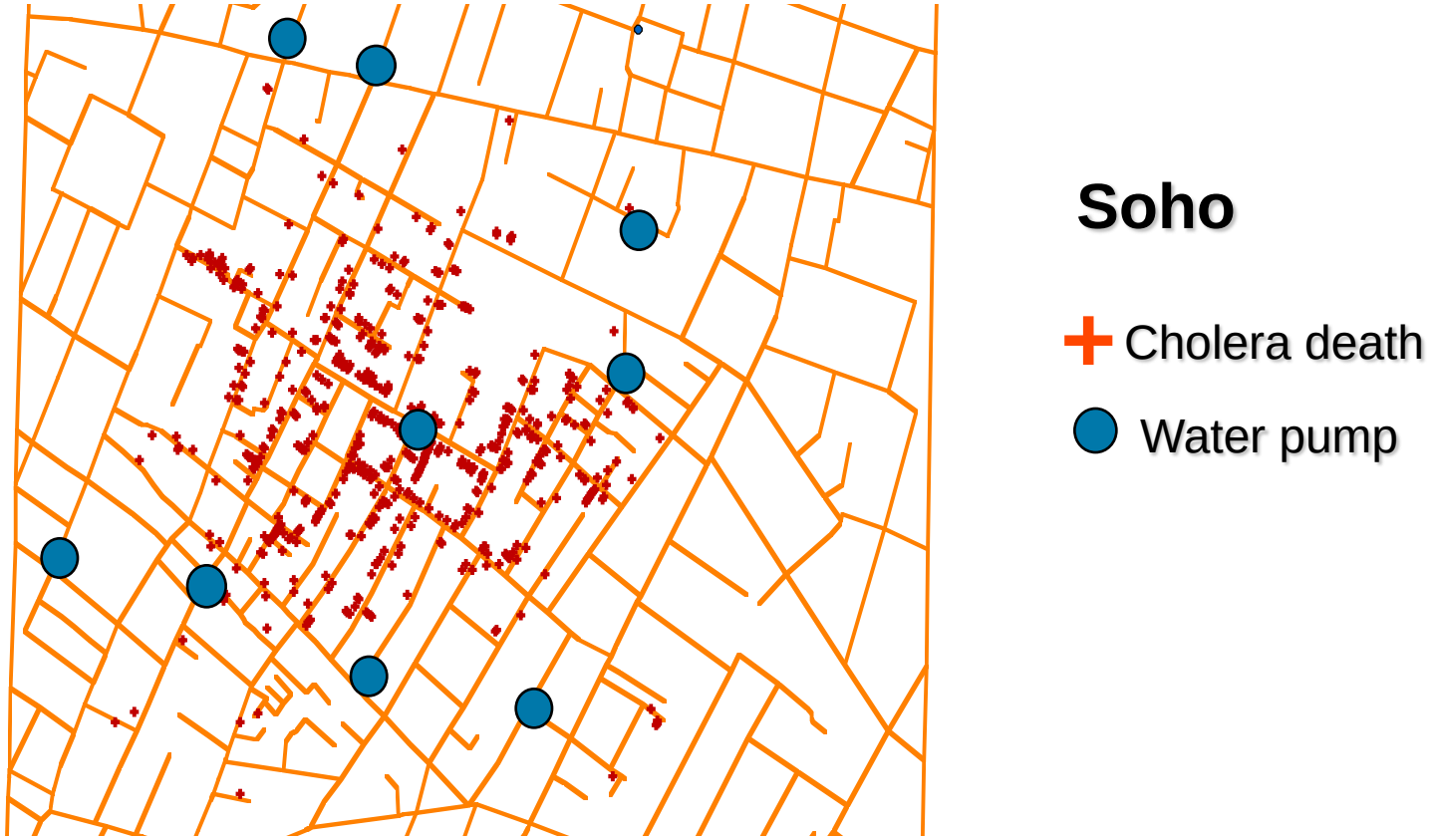
Why is GIS unique?

- GIS handles SPATIAL information
  - Information referenced by its location in space

- GIS makes connections between activities based on spatial proximity

GIS concepts are not new!

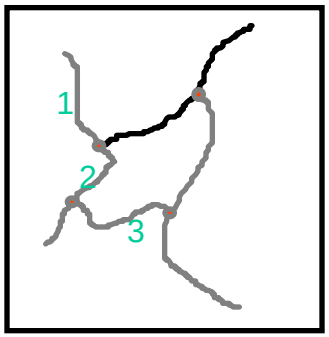
- London cholera epidemic 1854



GIS: historical background

This technology has developed from:

- Digital cartography and CAD
- Data Base Management Systems

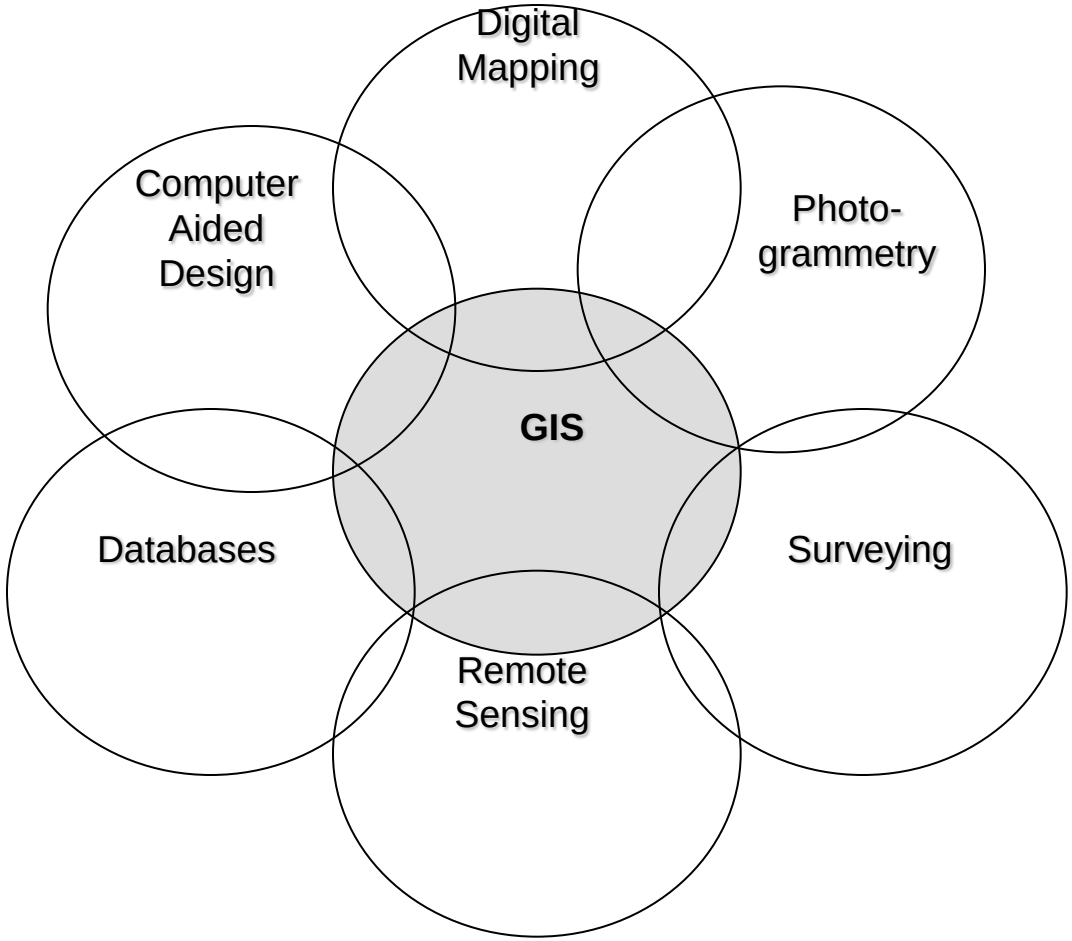


CAD System

ID	X,Y
1	
2	
3	

ID	ATTRIB
1	
2	
3	

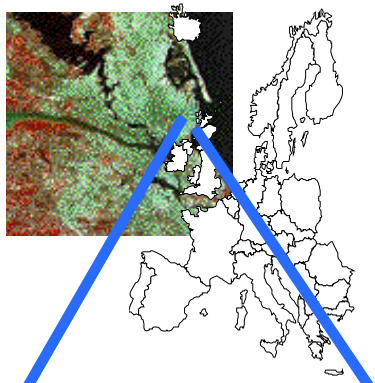
Data Base Management System



Cross-disciplinary nature of GIS

GIS components

Spatial data



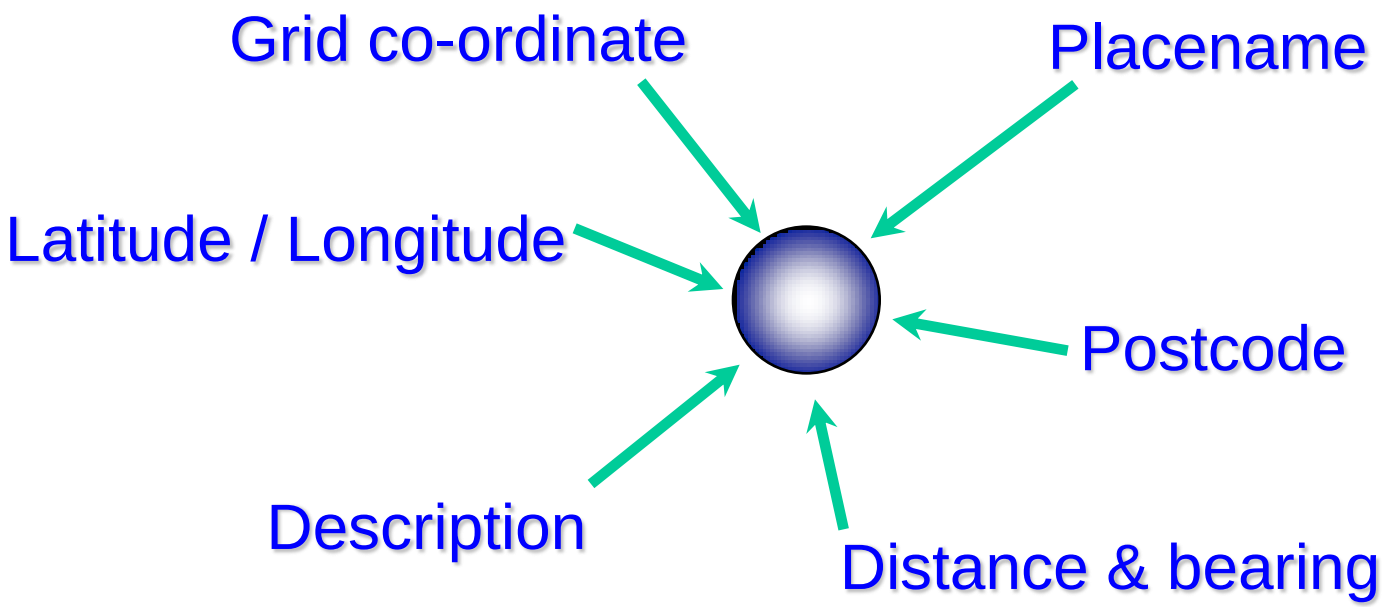
G I S

?

Computer hardware / software tools

Specific applications / decision making objectives

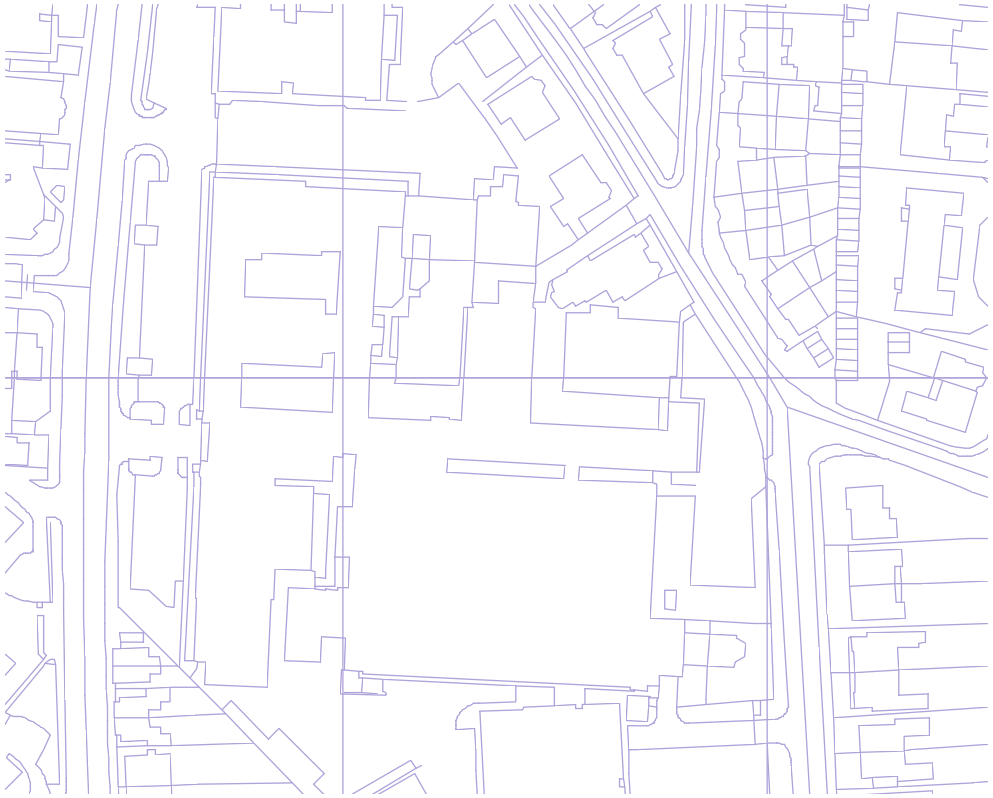
What makes data spatial?



Characteristics of spatial data

- **Location**
  - **Description:** Kingston University,PenrhynRoad Centre
  - **Post Code:** KT1 2EE
  - **Grid Reference:** 518106.72 168530.37
  - **Latitude/Longitude:** 0° 21’ 55.38”W, 49° 36’ 17.62”N

Characteristics of spatial data



Geometry

- The shape of a building or county
- The course of a river, the route of a road
- The shape of the landscape, relief

Characteristics of spatial data

- **Topology**
  - Connected to
  - Within
  - Adjacent to
  - North of . . .

  - *Within the Royal Borough of Kingston-upon-Thames*
  - *Opposite the Surrey County Council building*
  - *North of Surbiton station*
  - *Adjacent to Penrhyn Road*

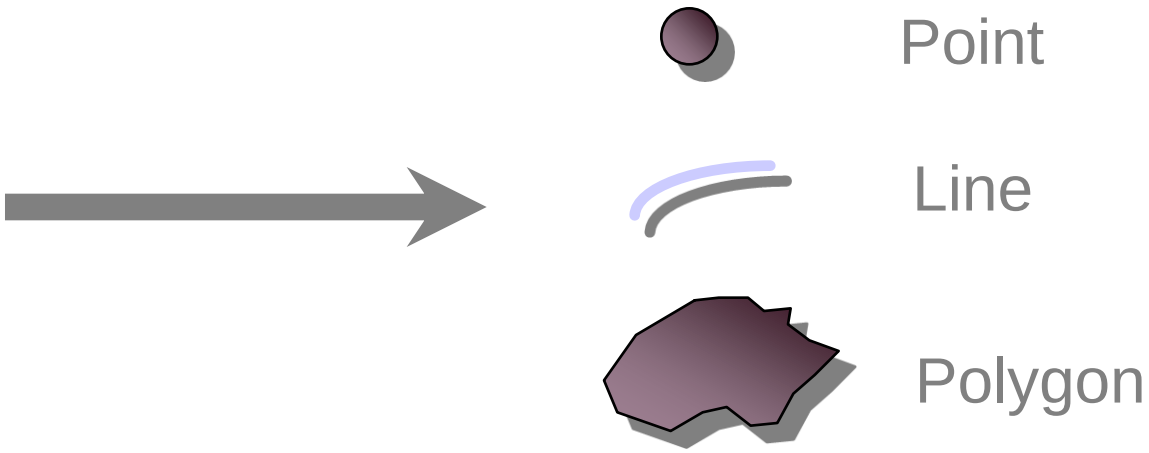
Spatial Data: examples

- Socio-economic data
  - Regional health data
  - Consumer / lifestyle profiles
  - Geodemographics
- Environmental data
  - Topographic data
  - Thematic data, soils, geology

Data Modelling - step 1

- Features
  - Buildings
  - Road centrelines
  - Lamp columns
  - Gas pipes
  - CTV Access covers
  - Road surfaces

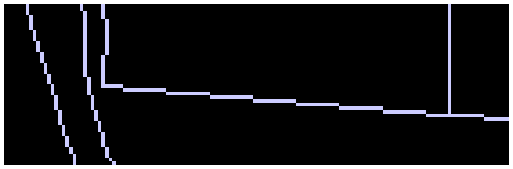
Data Modelling - step 2



Data Modelling - step 3

Feature : Building
Object: Polygon
Entity: Tourist Information Bureau

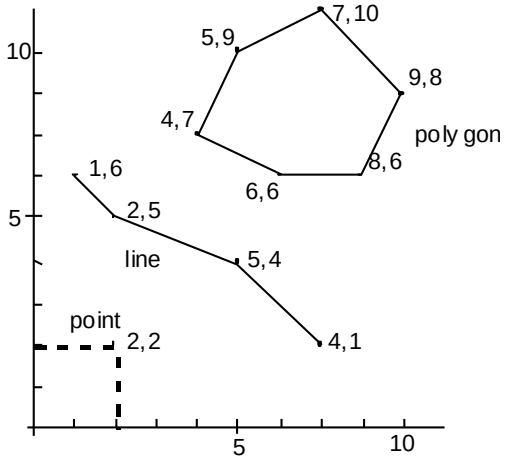
Attributes



Name :	Next
Address:	5 Market Place
Town:	Kingston
Owner:	Ms J Shore
Tel. No:	0181 547 1245
Floor space	1300 sq m

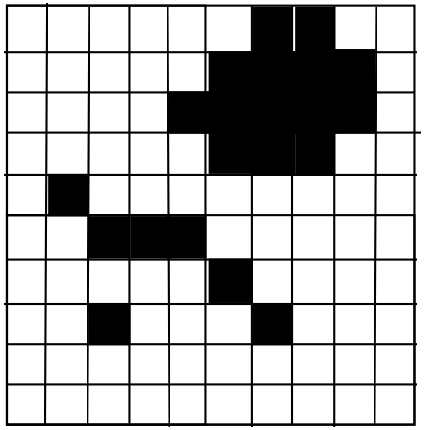
Spatial data storage

- Vector model



as geometric objects:
points, lines, polygons

- Raster model



as image files
composed of grid-cells
(pixels)

Spatial data storage model

- important in determining the potential applications of the system
- model may also affect the type of analysis work that can be achieved

- hybrid approach to storing graphical and attribute information
- Attribute information often stored within standard relational database
- Graphical information is stored in a proprietary file system
  - optimised tools for data handling
  - although non-standard proprietary system will be difficult to integrate with other systems, it will tend to be very efficient at handling large graphics files.

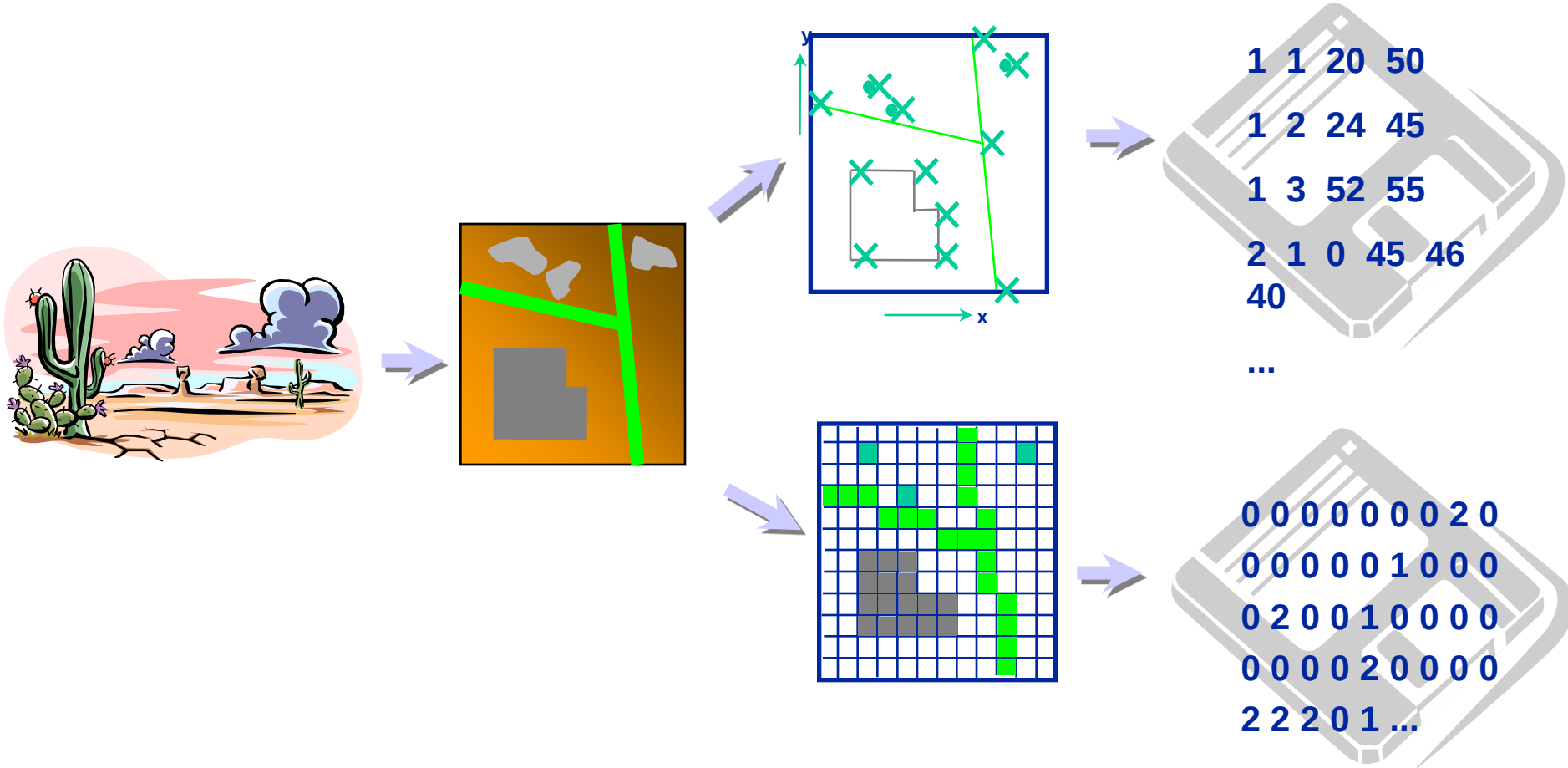
Vector data model

- advantage of the vector data format: allows precise representation of points, boundaries, and linear features.
  - useful for analysis tasks that require accurate positioning,
  - for defining spatial relationship (ie the connectivity and adjacency) between coverage features (topology), important for such purposes as network analysis (for example to find an optimal path between two nodes in a complex transport network)
- main disadvantage of vector data is that the boundaries of the resulting map polygons are discrete (enclosed by well-defined boundary lines), whereas in reality the map polygons may represent continuous gradation or gradual change, as in soil maps.

Raster data model

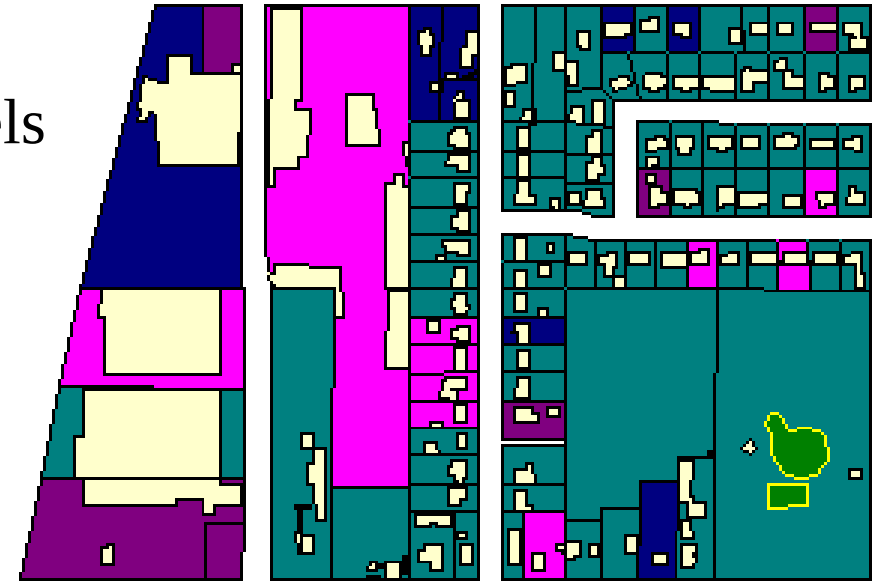
- good for representing indistinct boundaries
  - thematic information on soil types, soil moisture, vegetation, ground temperatures
- as reconnaissance satellites and aerial surveys use raster-based scanners, the information (ie scanned images) can be directly incorporated into GIS
- the higher the grid resolution, the larger the data file is going to be

Modelling the real world

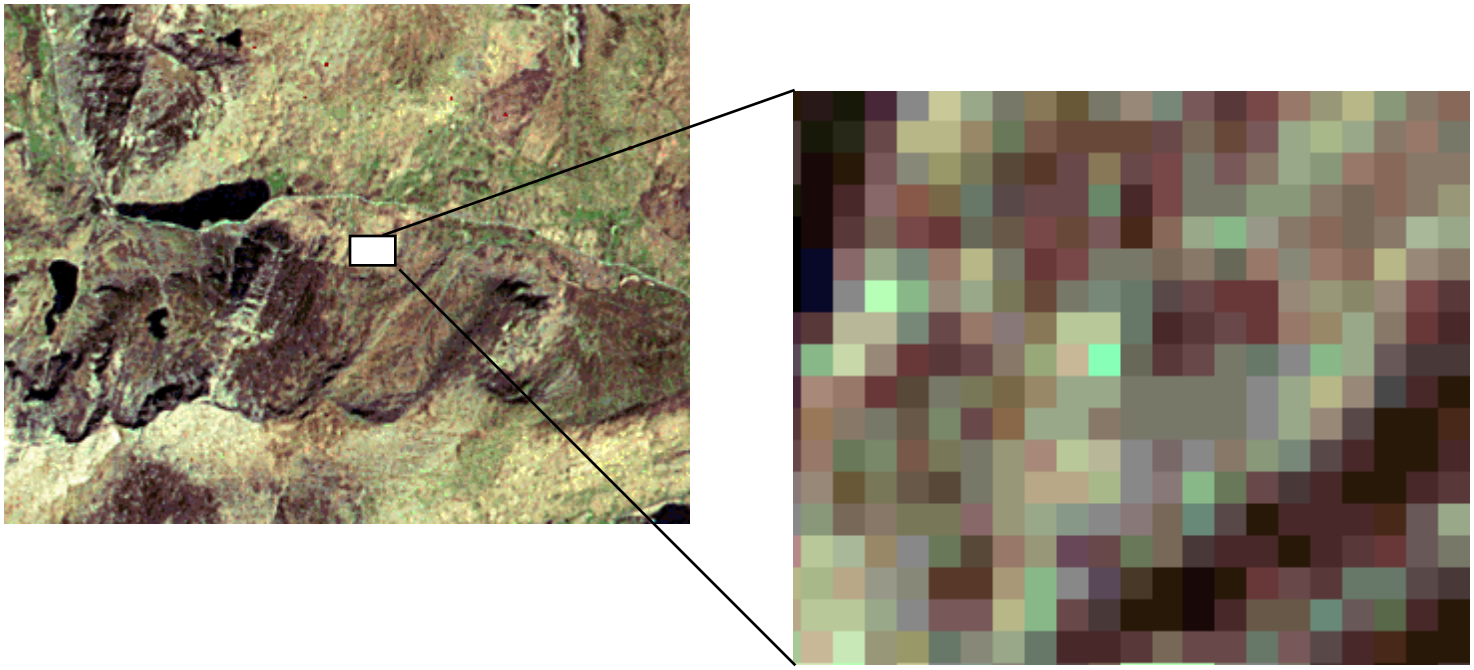


Vector data

Land use parcels



Raster data



Manipulation and analysis

- What would happen if . . .

  A chemical leaked into a river?

- Where does . . .

  The Green Belt exist in relation to the City?

- Has . . .

  Population changed over the last ten years?

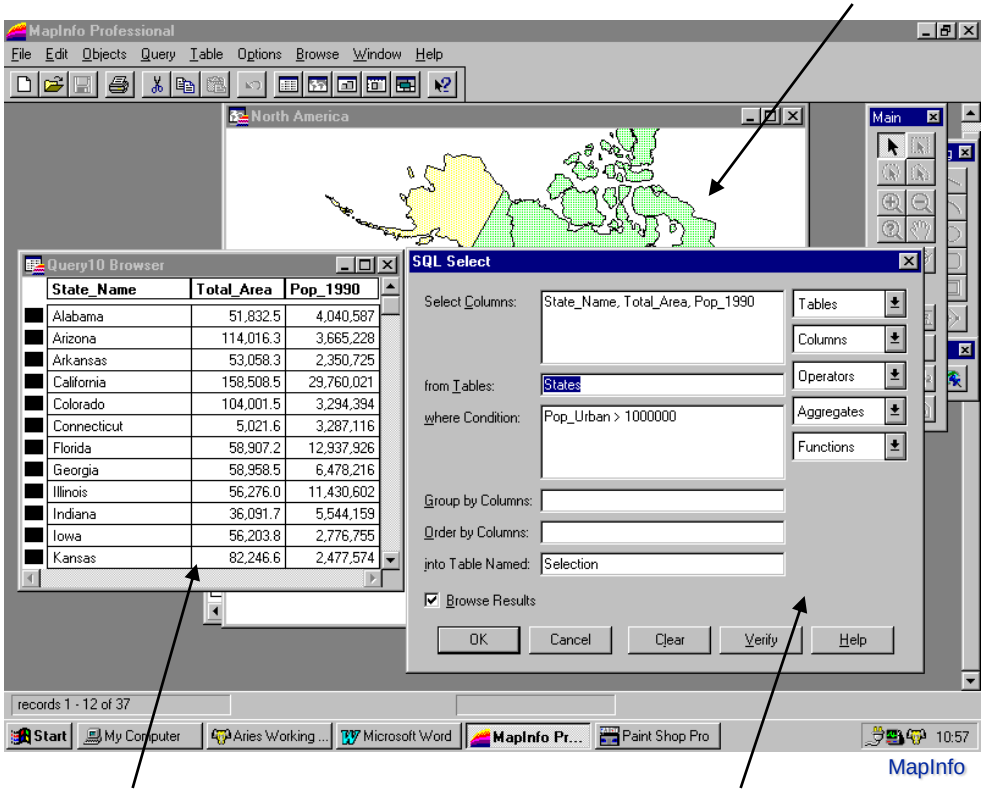
- Is there a spatial pattern related to . . .

  Car ownership in our area?

Databases & GIS

- At a simple level a GIS may just form the graphical interface to a database

- The majority of GIS applications follow this example



Geo-relational Data Models

- Linked tables based on the relational model, but storing geographical information such as:
  - Geometry
  - Topology
  - Attributes

GIS & Analysis

In the context of GIS, analysis is...

*"**Deriving new information from existing data"***

It is also the manipulation of data to solve a problem

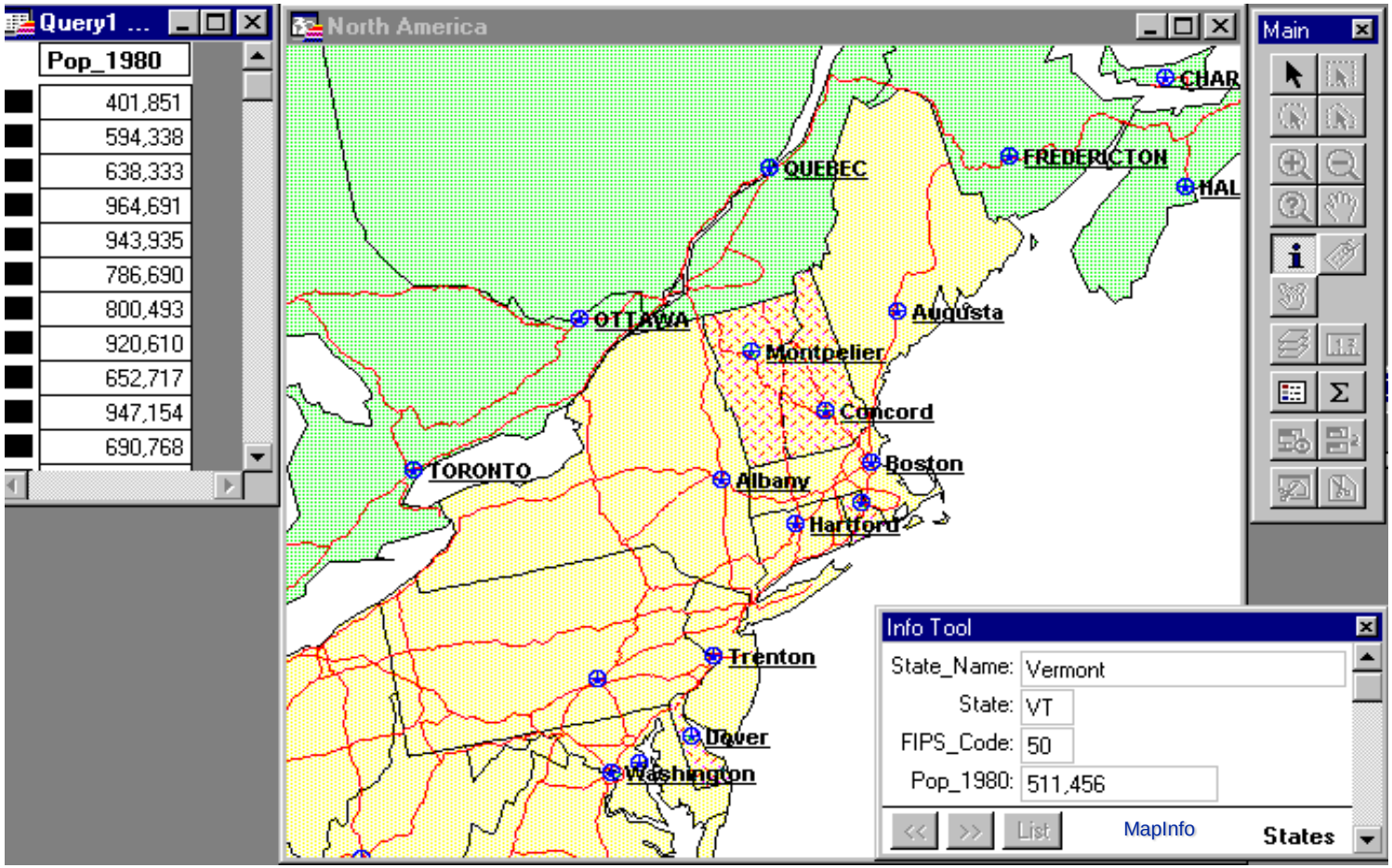
e.g. *identify all areas within 500m of a lake*

Increasing use is made of the analytical capabilities of GIS, BUT many GIS projects only use the software to store and manage geographical data

Yet analysis often relies on many simple basic GIS techniques

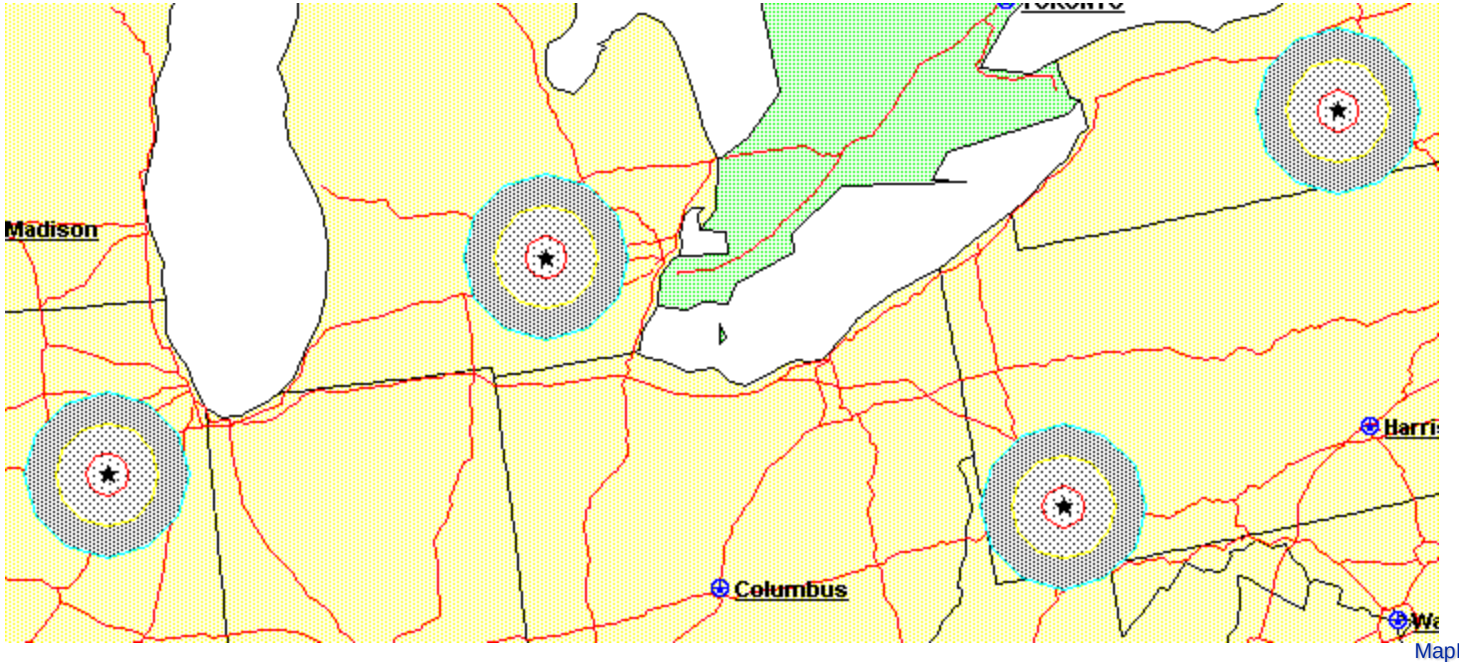
Simple Query

- The identification of objects and their attributes either by location or attribute query.



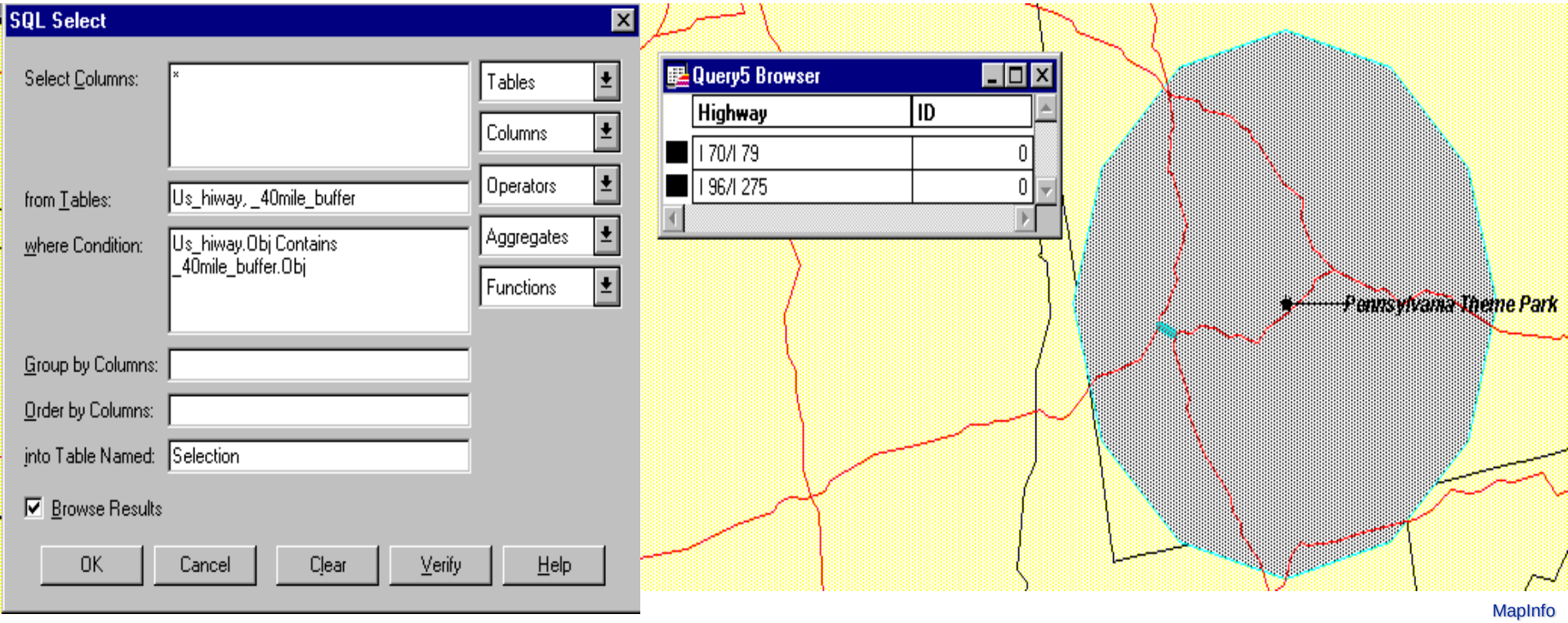
Buffering

- Creation of an area of interest around an object
  - proximity analysis and environmental impact assessment.



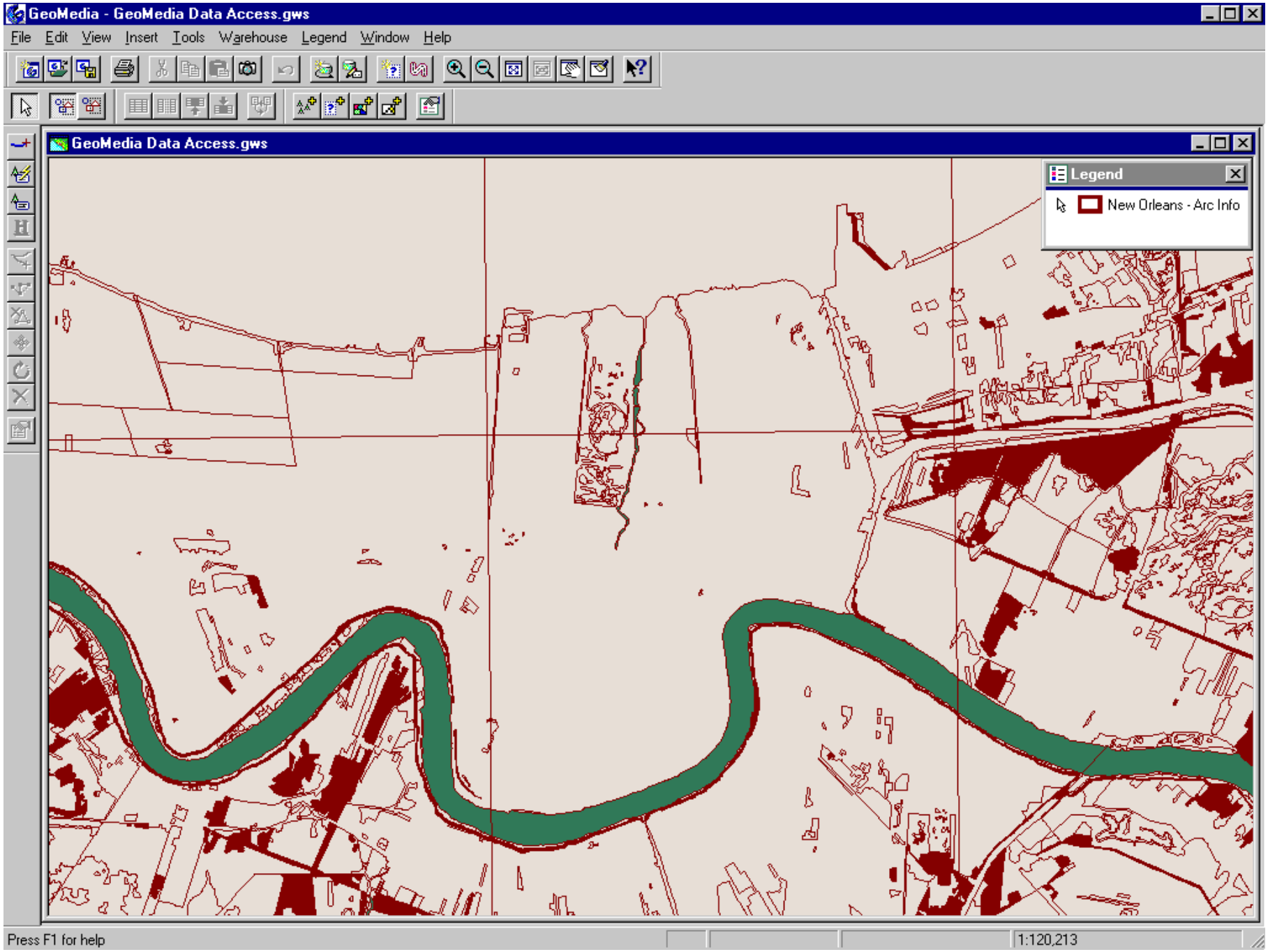
Cookie Cutting

- Overlay of datasets using one dataset as a sieve or cookie cutter to select a subset of the other dataset.



Overlays

- Layer: A thematic plane of GIS features containing geographically and logically related data
- Overlaying involves superimposing two or more map layers to produce a new map layer.
- Example: a new genetically engineered variety of wheat grows well in dry environments, with long growing seasons and alkaline soils. Given the availability of data on the length of the growing season, moisture regime and soil alkalinity, where is the best place to plant the wheat?
  - overlaying (superimposing) several maps showing (separately) water-budget, growing season length, soil pH, sodium content, and so on. The GIS analysis can establish the locations where all the favorable soil conditions coincide, as the places where the wheat will grow best.


GeoMedia - GeoMedia Data Access.gws
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New Orleans - Arc Info
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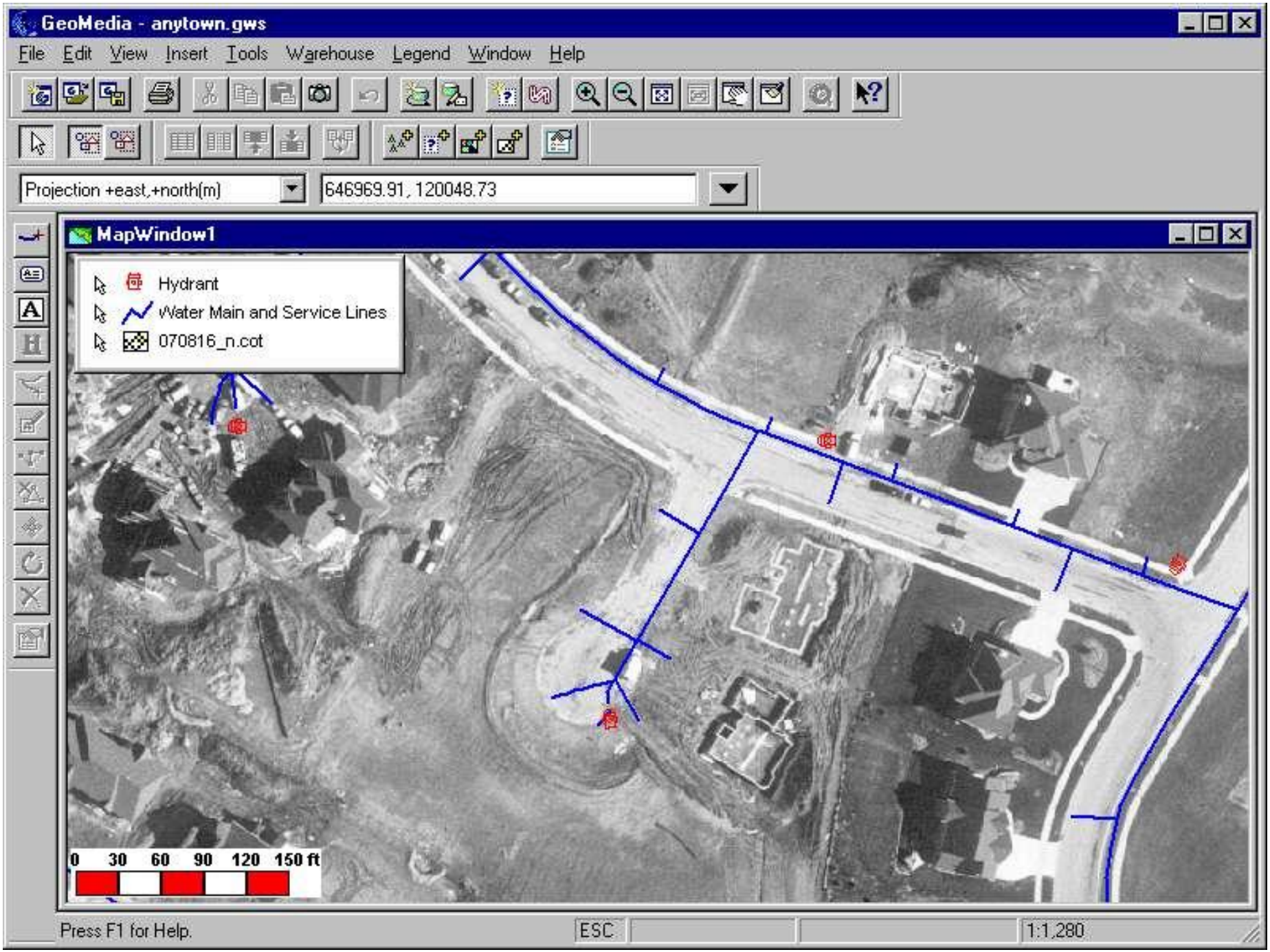
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The benefits of GIS include:

- Better information management
- Higher quality analysis
- Ability to carry out “what if?” scenarios
- Improve project efficiency

GIS Applications

- Facilities management
- Marketing and retailing
- Environmental
- Transport/vehicle routing
- Health
- Insurance

  and many more . . .