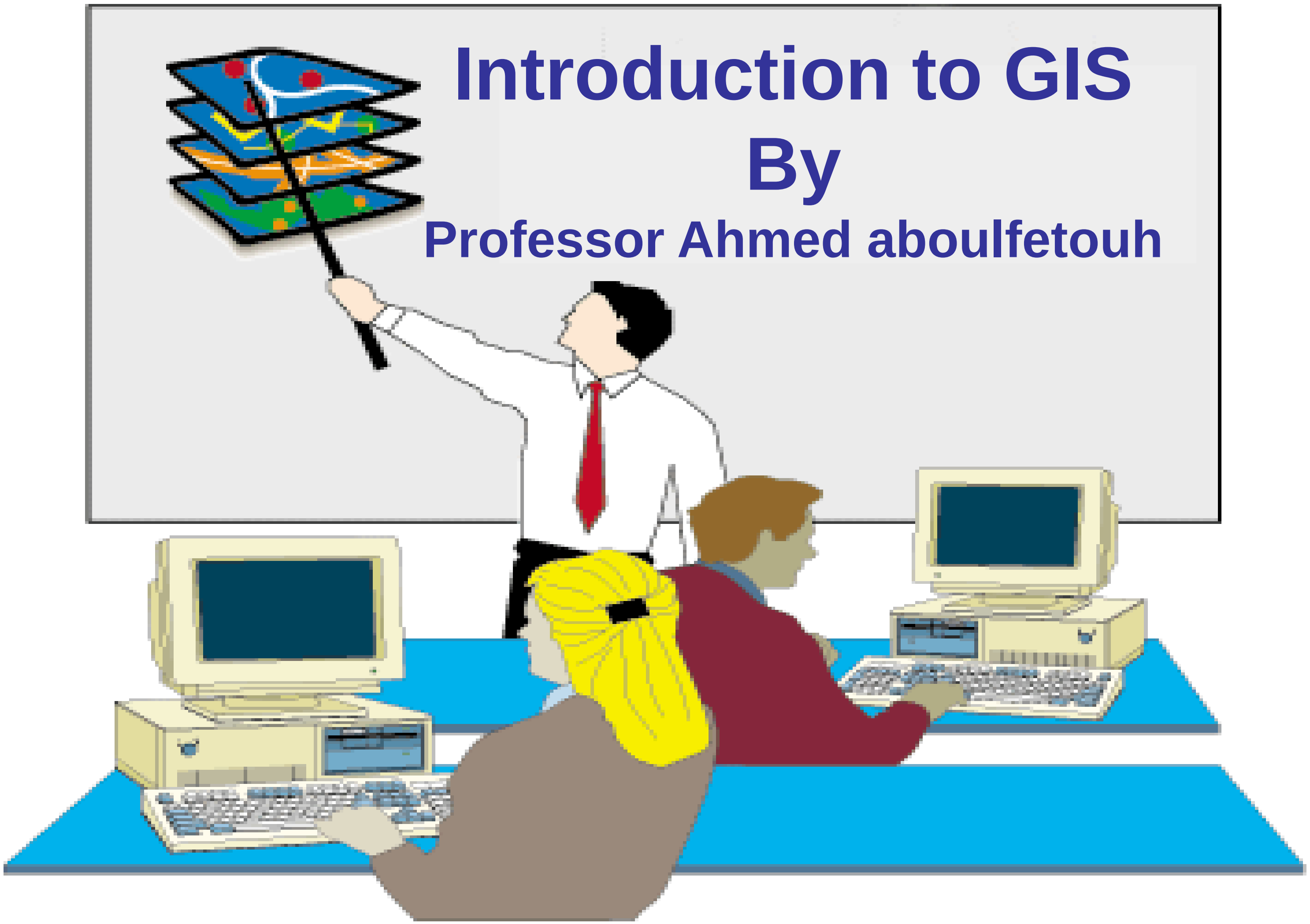
Welcome

Introduction to GIS

By

Professor Ahmed aboulfetouh



Lecture 1

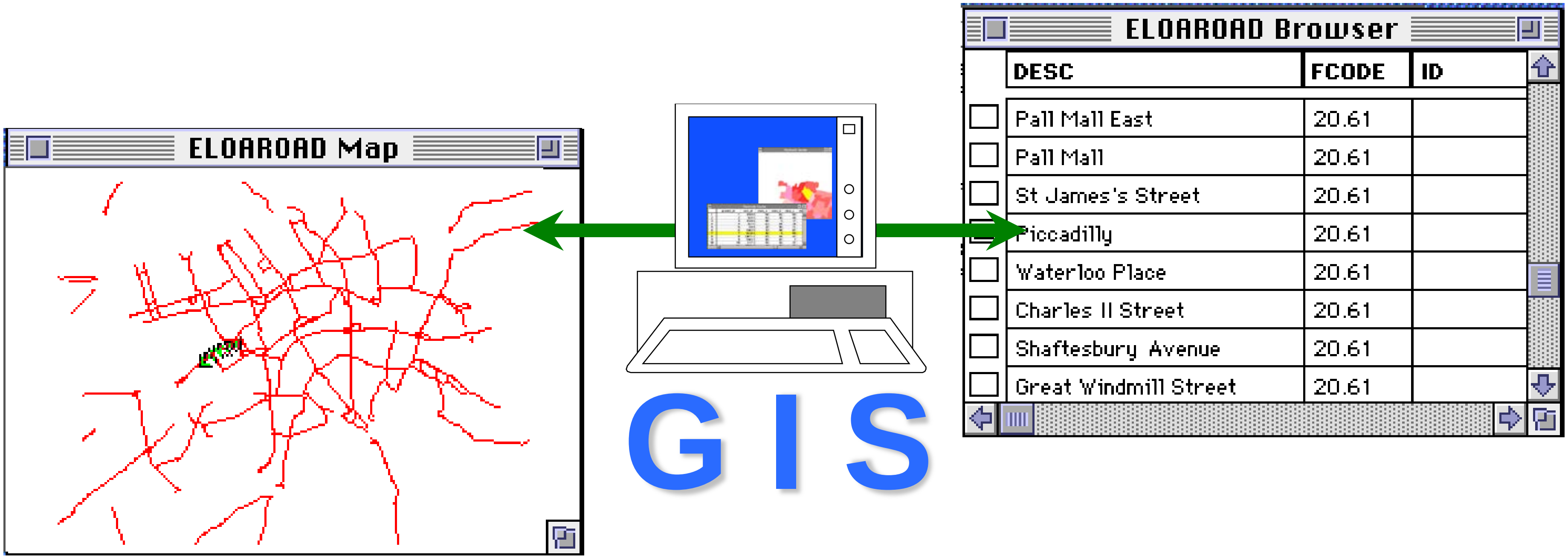
Exploring

GIS concepts

This lecture will provide:

- a definition, and brief description of the historical development of GIS
- The main components required to run a successful GIS
- Types of GIS data
- Examples of some GIS applications

What GIS is?: "Computer tool for managing geographic feature location data and data related to those features." Allan B. Cox



Defining Geography Information Systems

‘A GIS is designed for the data storage, and analysis of objects and phenomena where geographic location is an important characteristic or critical to the analysis.’ Stanley Aronoff

GIS is a tool for managing data about where features are (geographic coordinate data) and what they are like (attribute data), and for providing the ability to query, manipulate, and analyze those data.

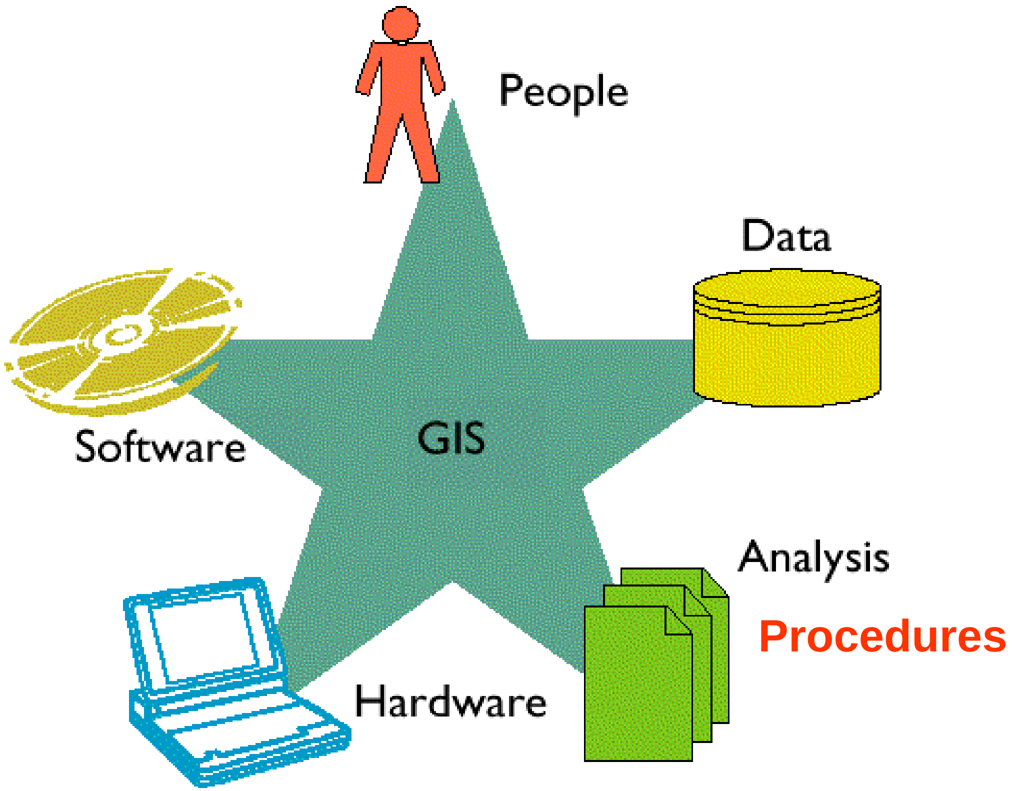
GIS: a formal definition

"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"

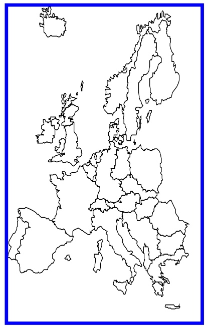
Chorley Report, 1987

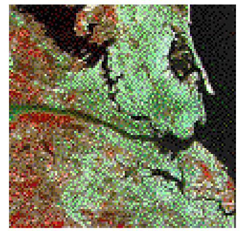
What is a GIS components?

- An integration of five basic components



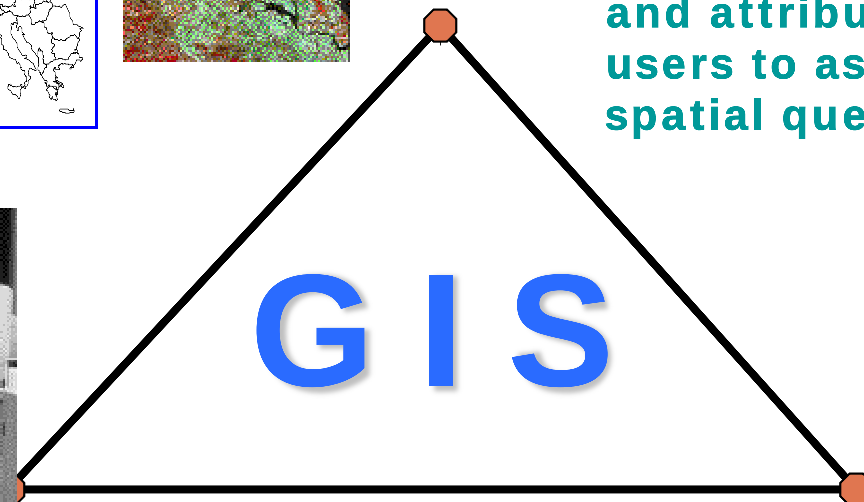
Characteristics of GIS





Data

Combination of spatial and attribute data allows users to ask unique spatial questions.



User / System

Users need to understand both data and software in order to create unique spatial questions and maintain spatial information produced.

Software / Hardware

Facilitates analysis by providing a means to both ask complex spatial questions and store spatial data.

Characteristics of GIS

a. Data

1. Spatial Data
2. Attribute Data
3. Data Layers
4. Layer Types
5. Topology (adjacent relationship)

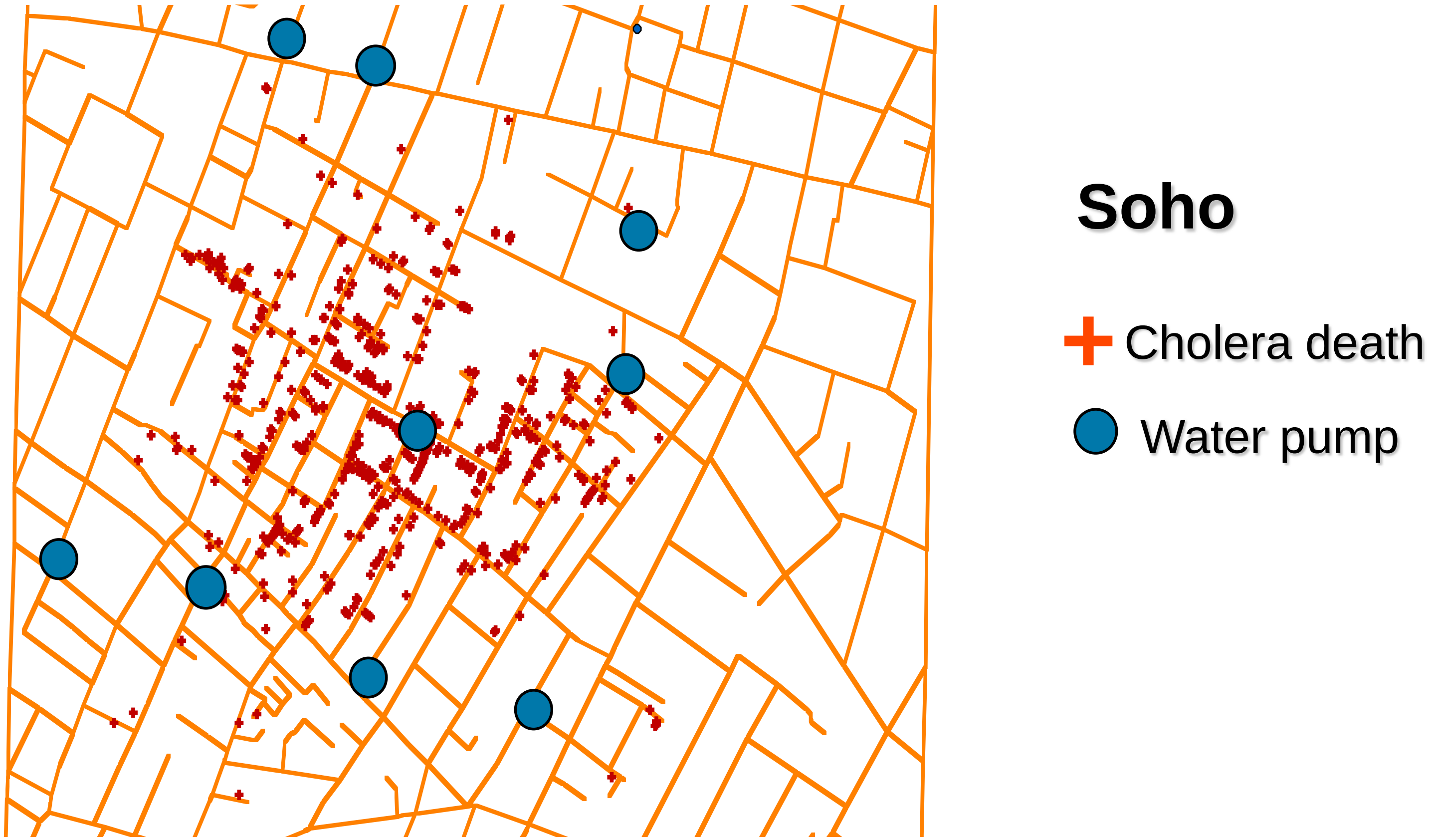
b. Users / System

1. Data Input
2. Data Management
3. Data Analysis (tansformation,overlay,disolve,Buffer..etc)
4. Data Output (maps, tabular data, charts...)

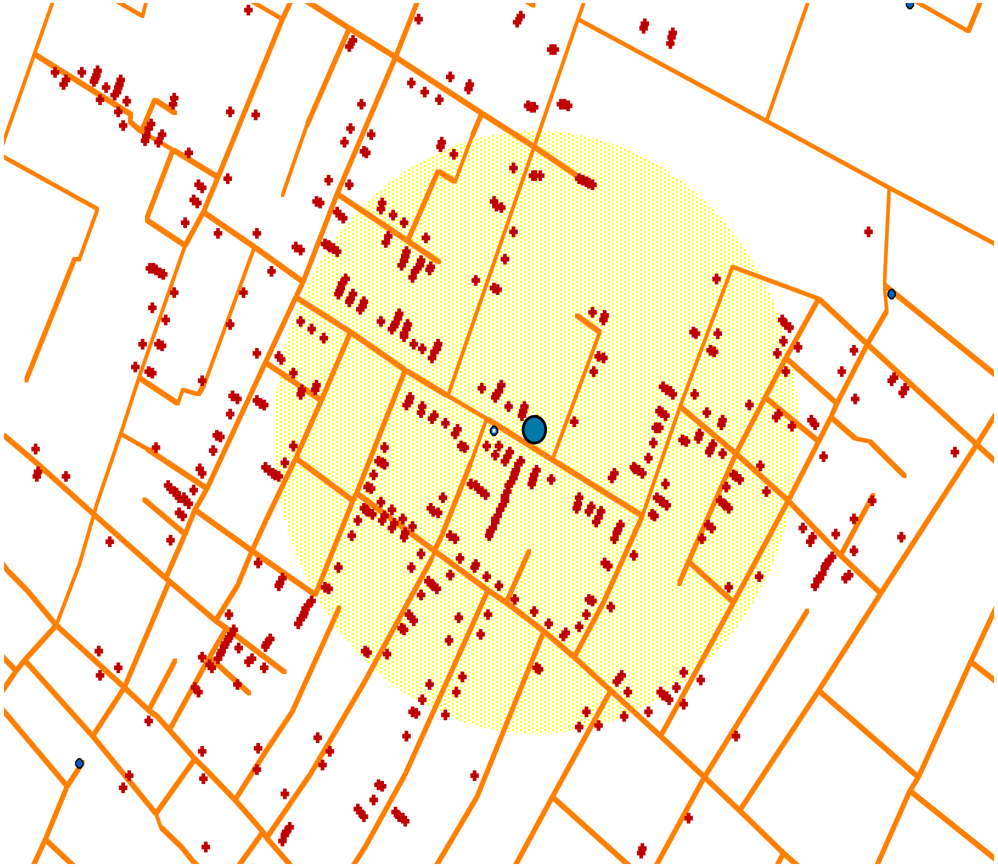
c. Software / Hardware

GIS concepts are not new!

- London cholera epidemic 1854



Spatial information handling 1854



Soho

Cholera death

Water pump

GIS functions

Capture

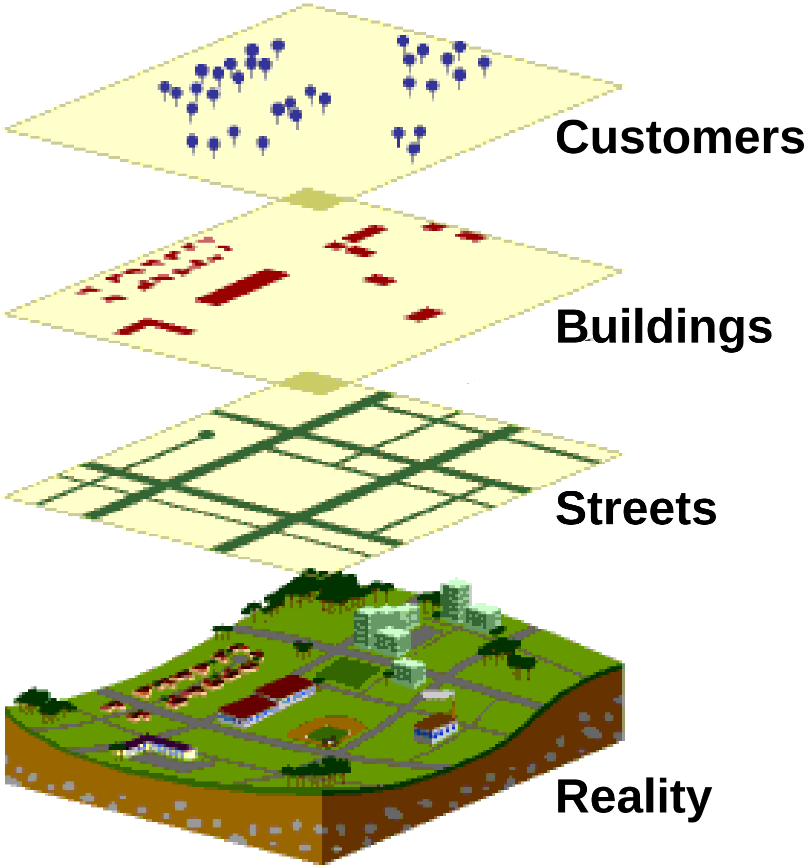
Store

Query

Analyze

Display

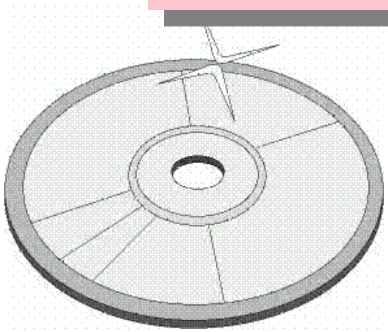
Output

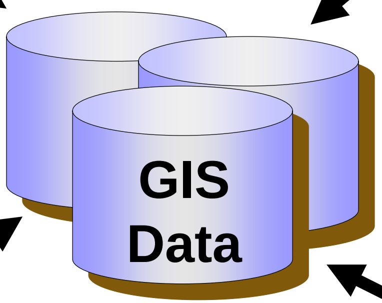


Capturing data

Hardcopy maps

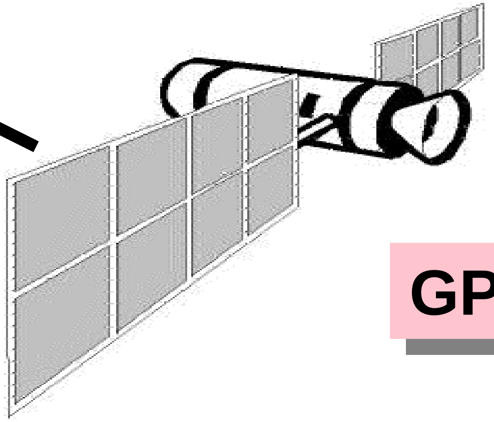
Digital data





Coordinates

```
480585.5, 3769234.6
483194.1, 3768432.3
485285.8, 3768391.2
484327.4, 3768565.9
483874.7, 3769823.0
```



GPS

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?

Geography Information System Data

Spatial Data — Represents features that have a known location on earth.

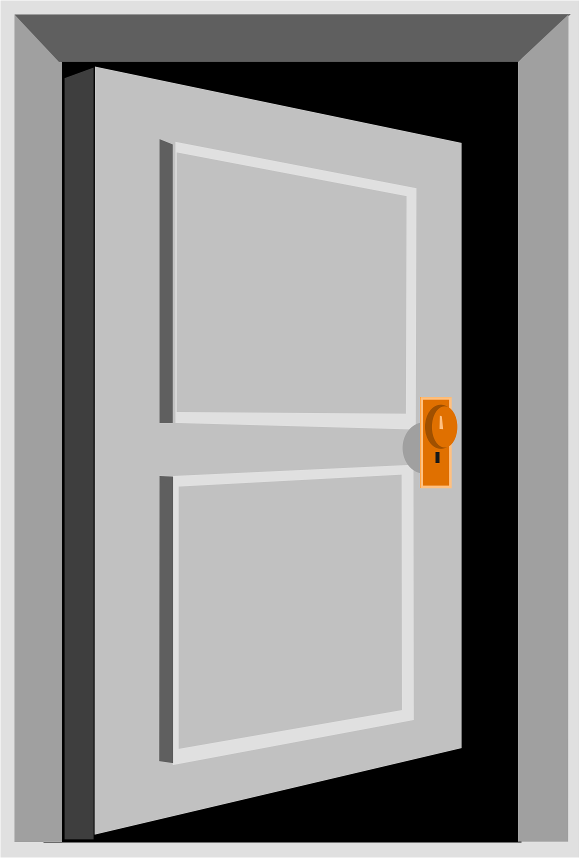
Attribute Data — The information linked to the geographic features (spatial data) that describe those features.

Data Layers — Are the result of combining spatial and attribute data. Essentially adding the attribute database to the spatial location.

Layer Types — A layer type refers to the way spatial and attribute information are connected. There are two major layer types, vector and raster.

Topology — How geographic features are related to one another and where they are in relation to one another.

GIS comprises of:



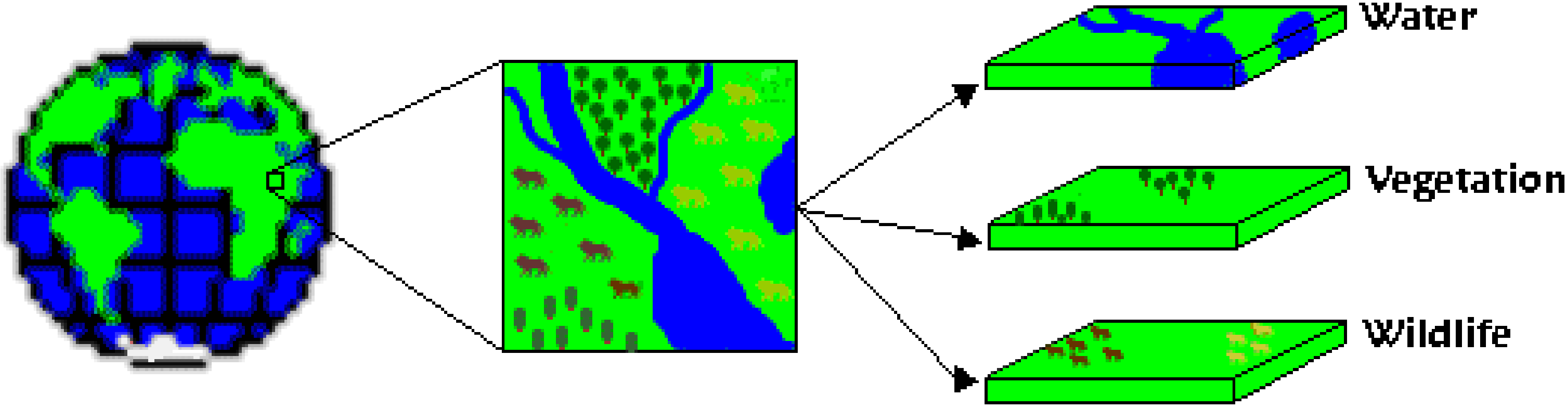
- Data input
- Storage
- Management
- Analysis
- Output

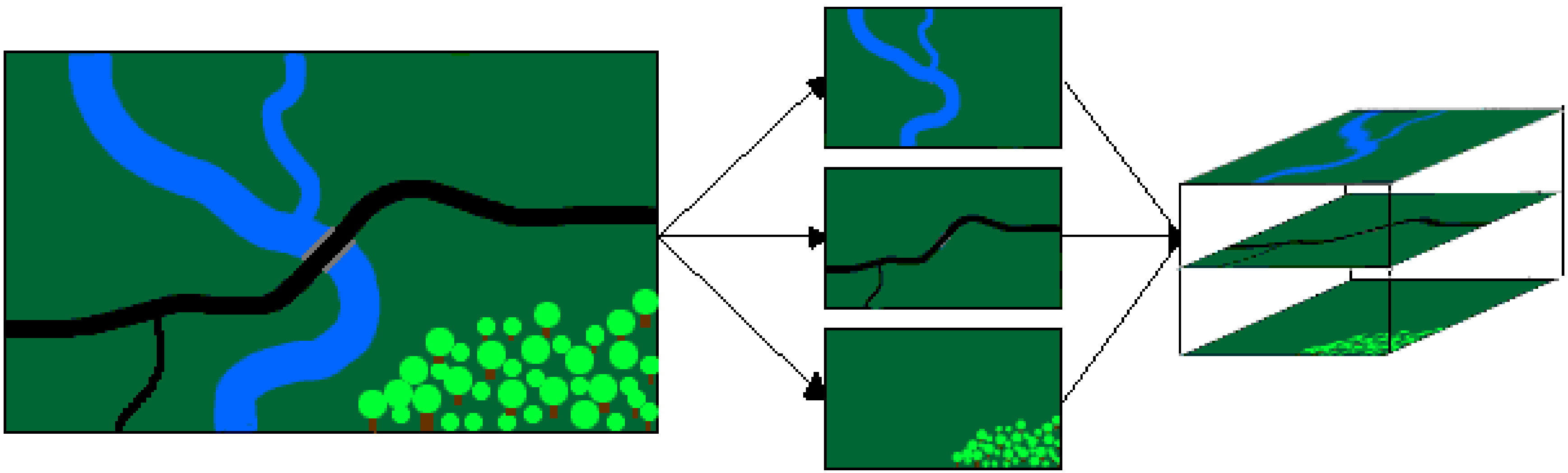
Why is GIS unique?

- GIS handles SPATIAL information
  - Information referenced by its location in space
- GIS makes connections between activities based on spatial relations

The benefits of GIS include:

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


Water
Vegetation
Wildlife



GIS Applications

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

and many more . . .

Discussion

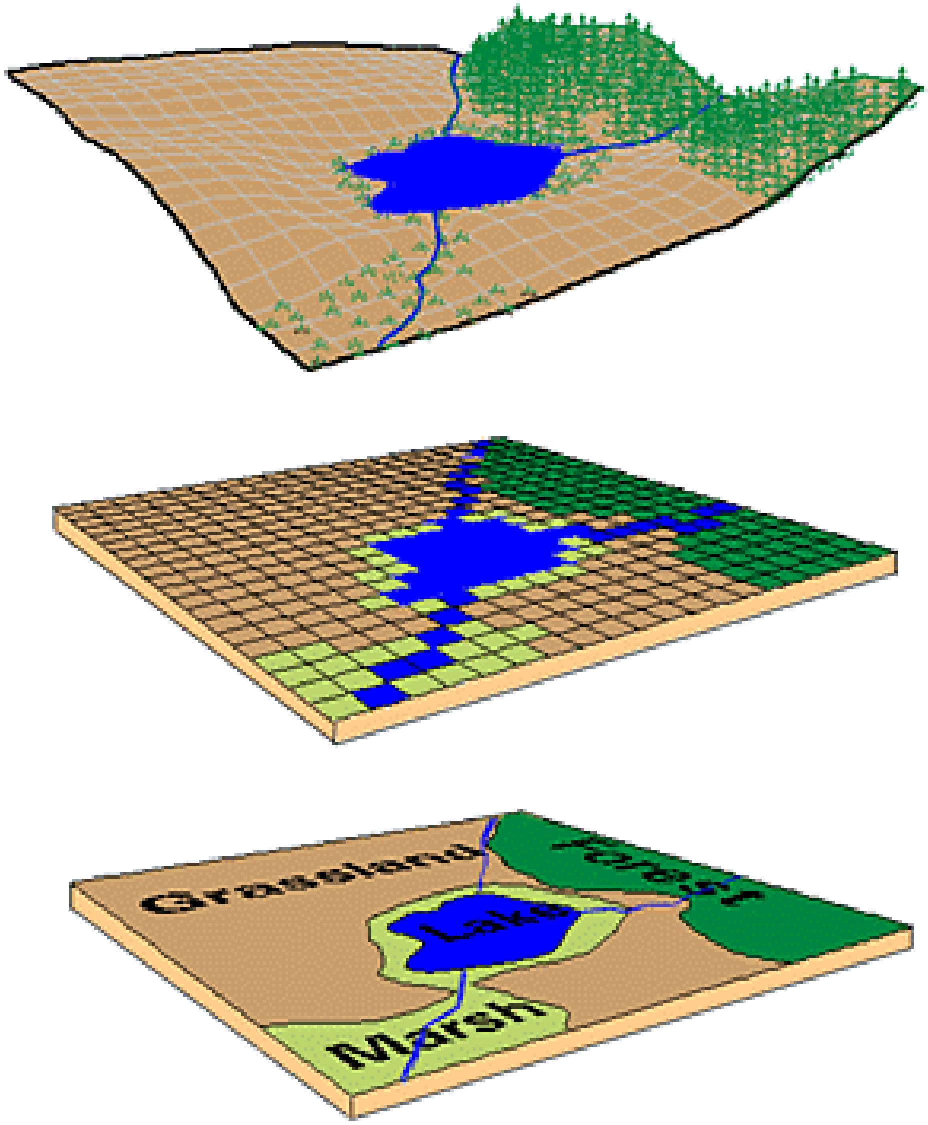
Questions

Lecture 2

GIS DATA

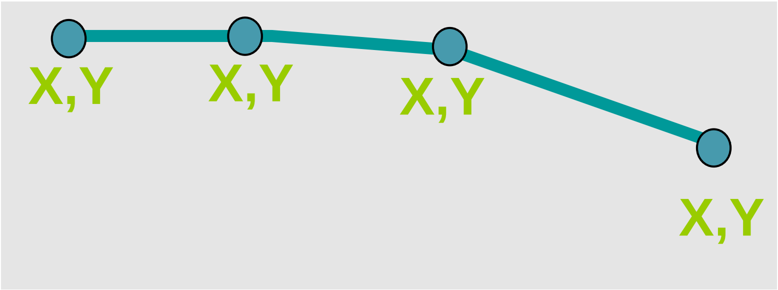
Typical sources of data input

- Raster image
  - Scanned photo or map
  - Digital image (satellite)
- Vector data
  - Coordinates from data file
  - Input from digitizing tablet

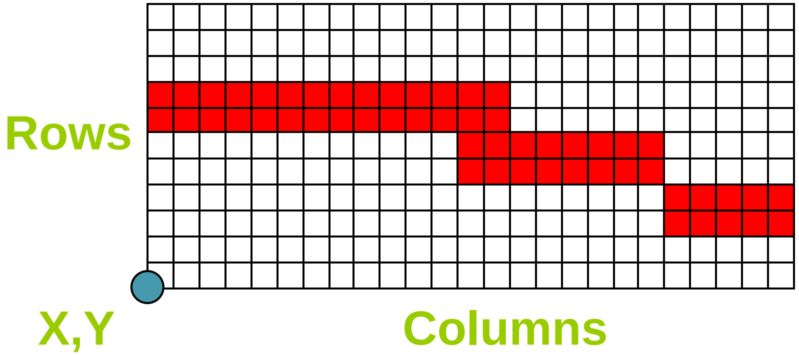

Grassland
Forest
Lake
Marsh

Storing data

- Vector formats
  – Discrete representations of reality



- Raster formats
  – Use square cells to model reality



Reality
(A highway)

Graphic data models in GIS

There are two basic ways to represent data graphically in a computer

Raster

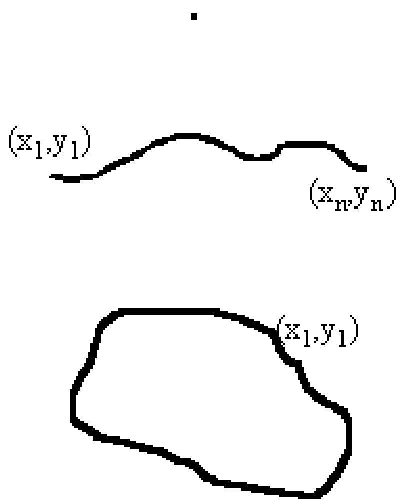
- Easy to describe algoritmically
- Equally well suited to discrete or continuous data
- Inefficient with computing resources
- Honest with representation of scale
- Not always pretty

Vector

- More difficult to implement in a computer
- Suited for discrete information
- Efficient with computing resources
- Gives beautiful output
- Great for representing political features

Vector data structure

Figure 6: Basic graphical elements



A point (x,y)

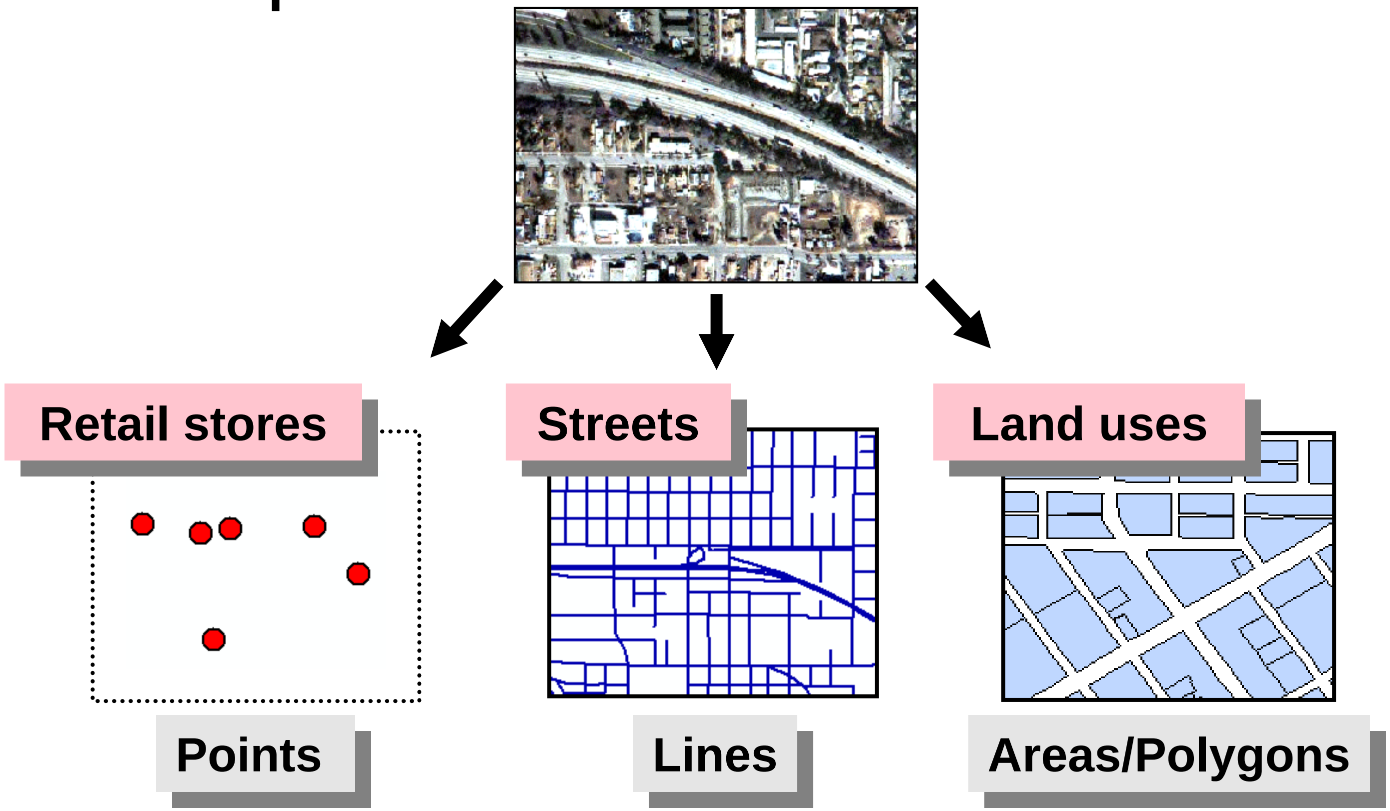
A line $(x_1,y_1;\ x_2,y_2;x_3,y_3;\ \ldots x_{n-1},y_{n-1};x_n,y_n)$
x_1,y_1 and x_n,y_n are called nodes; the other points are called vertices

An area $(x_1,y_1;\ x_2,y_2;x_3,y_3;\ \ldots x_n,y_n;x_1,y_1)$
x_1,y_1 is called a node; the other points are called vertices

A.K. Yeung 1998-10-10u51-06

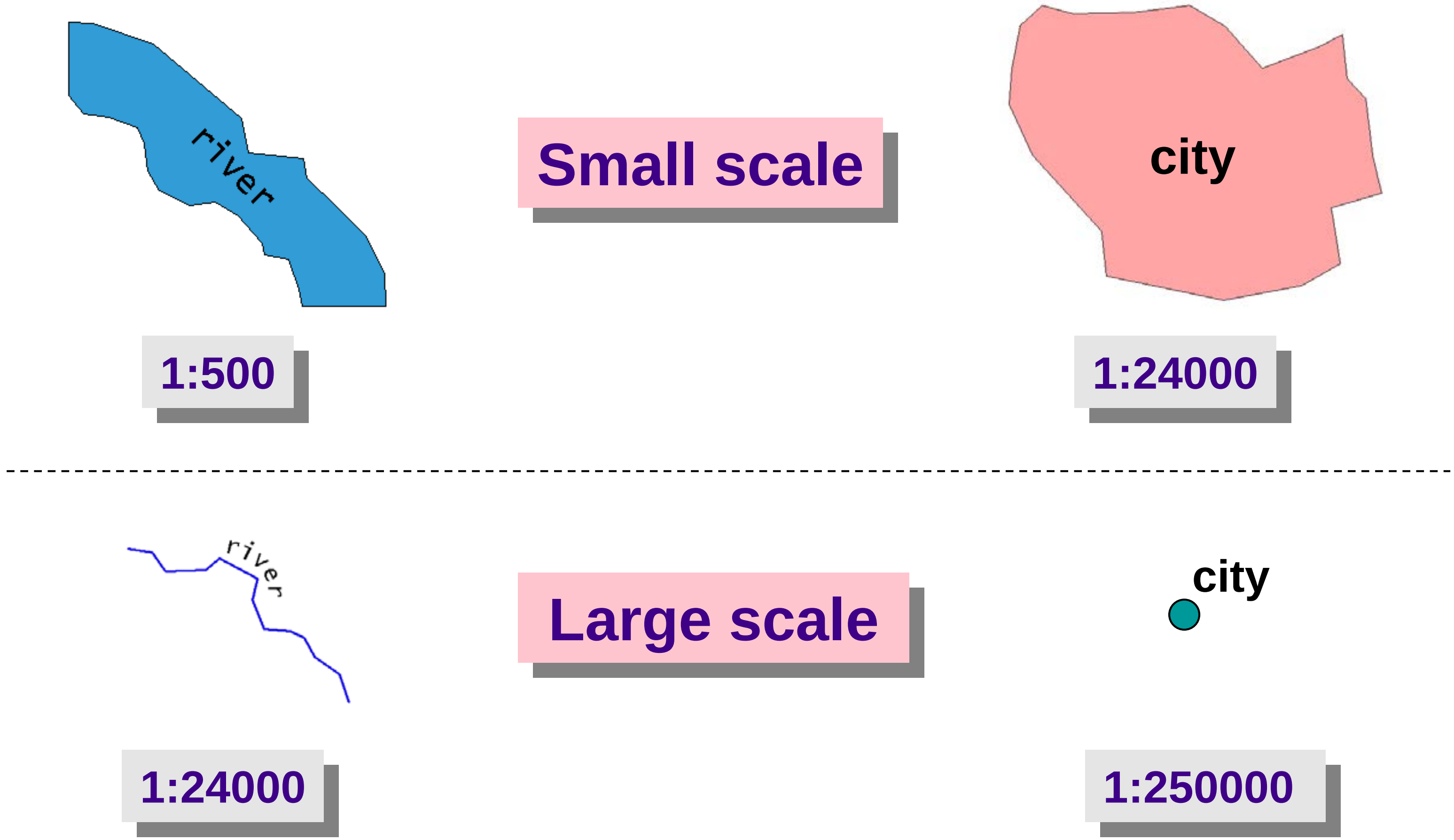
Representing features in vector data

- Real-world entities are abstracted into three basic shapes



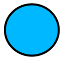
Map scale

- Map scale determines the size and shape of features

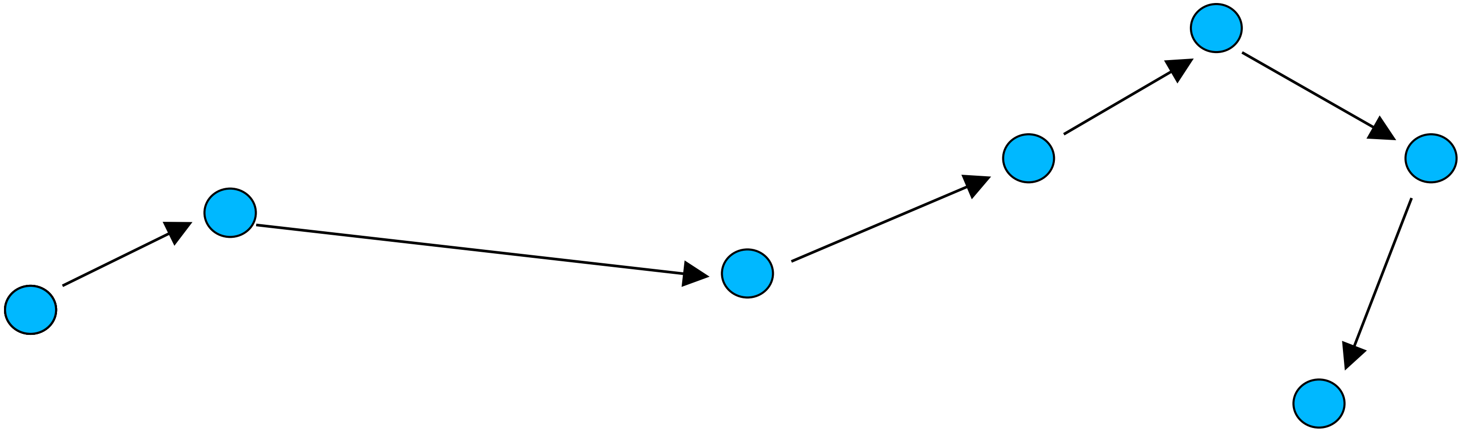


Point

- Single location
- described entirely by coordinates
- No dimensions

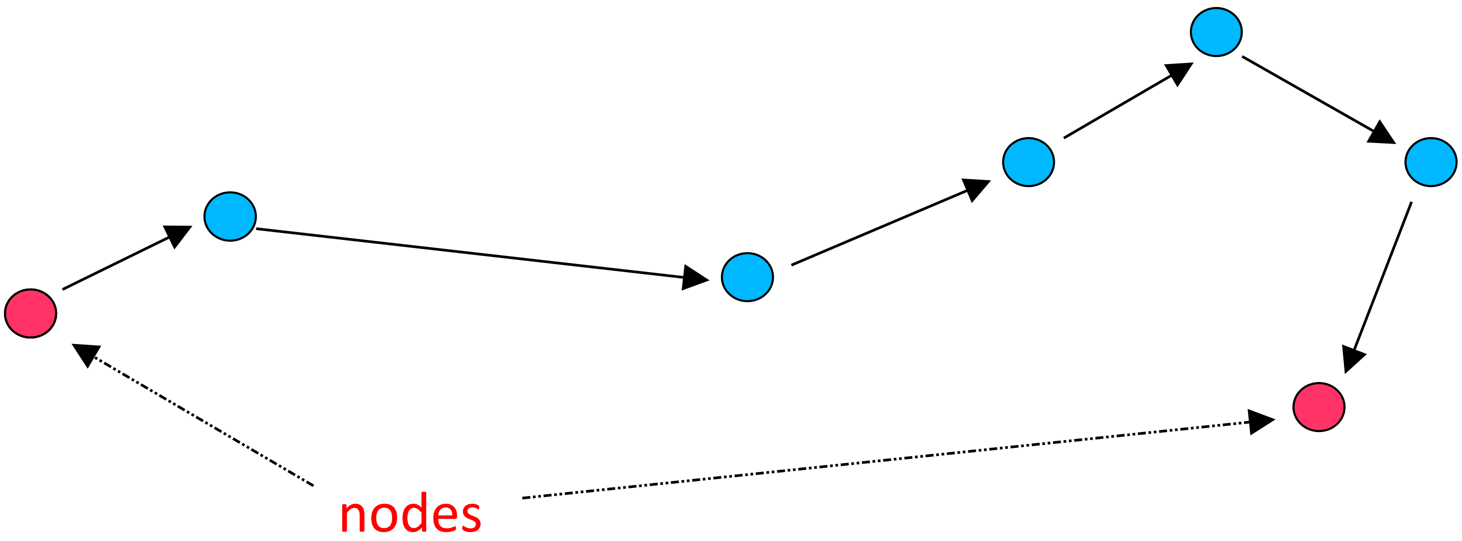


Line



Can be concieved as a series of points

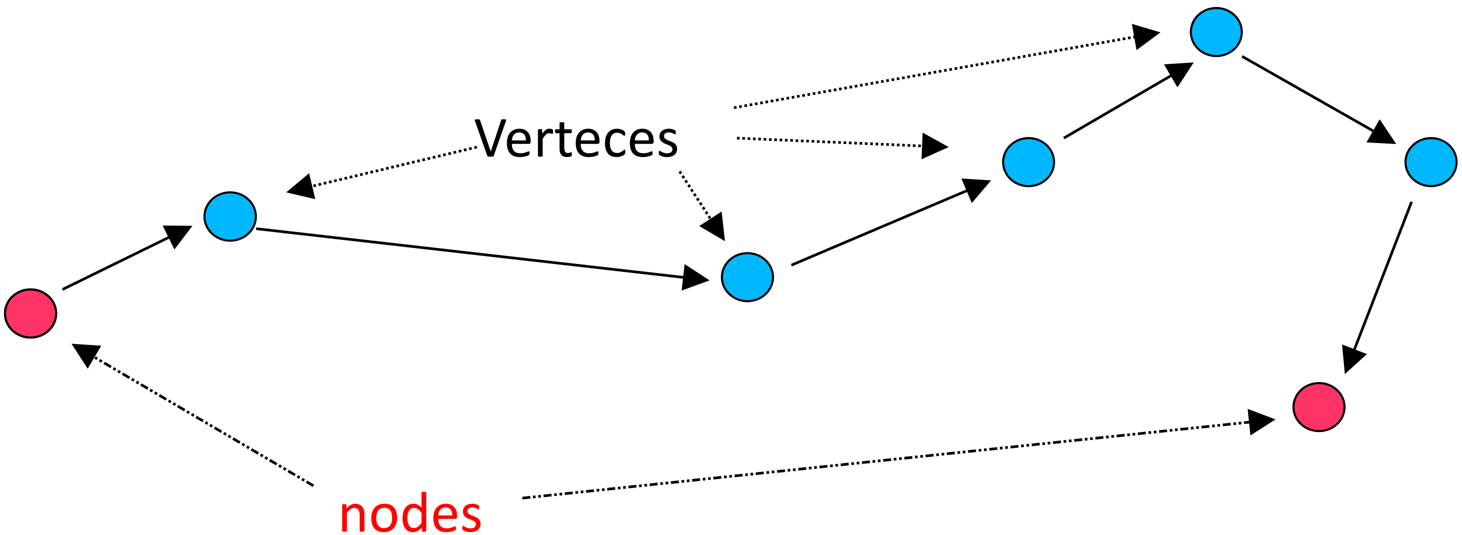
Line



Can be concieved as a series of points

end points are called nodes

Line

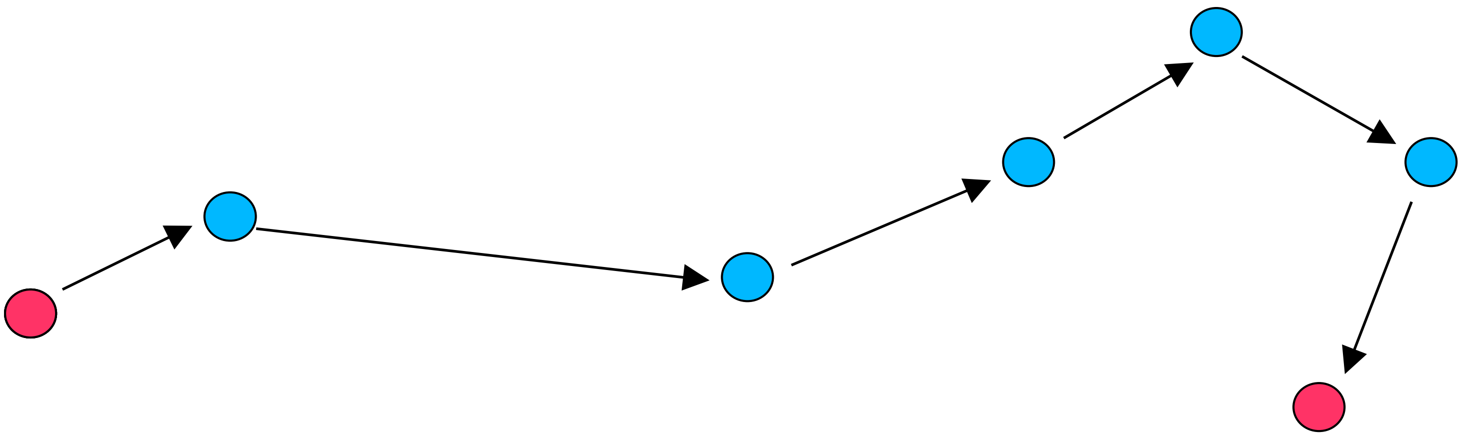


Can be concieved as a series of points

end points are called nodes

intermediate points are called verteces

Line

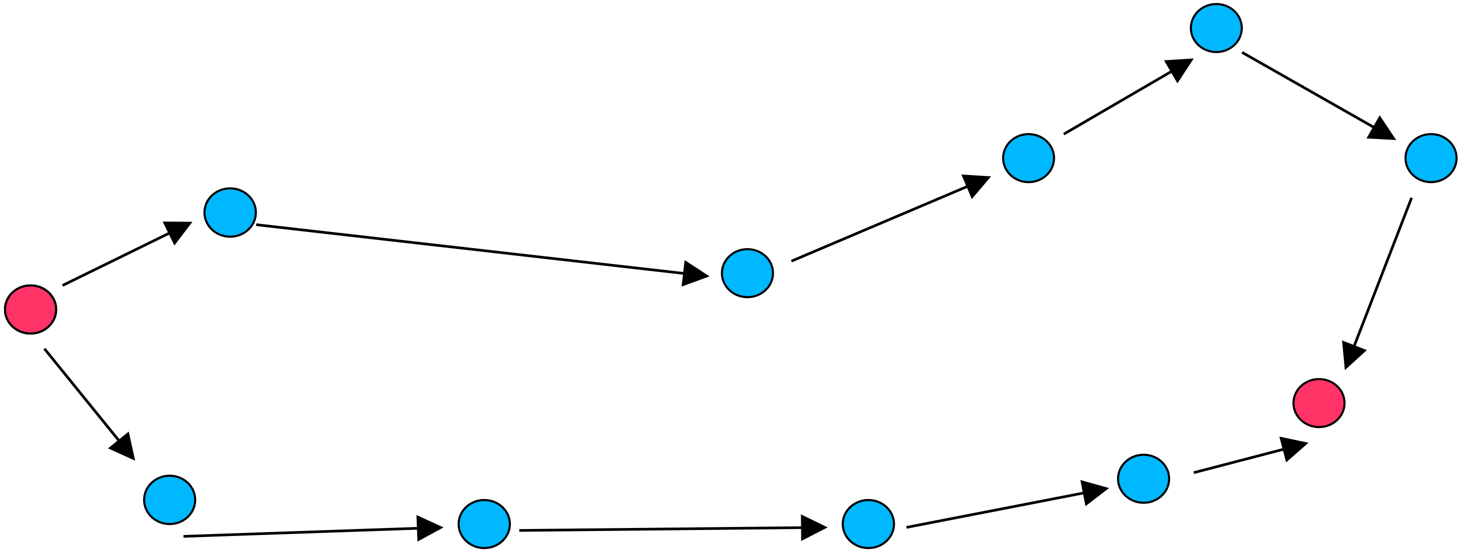


Attributes of lines:

length
starting point
ending point

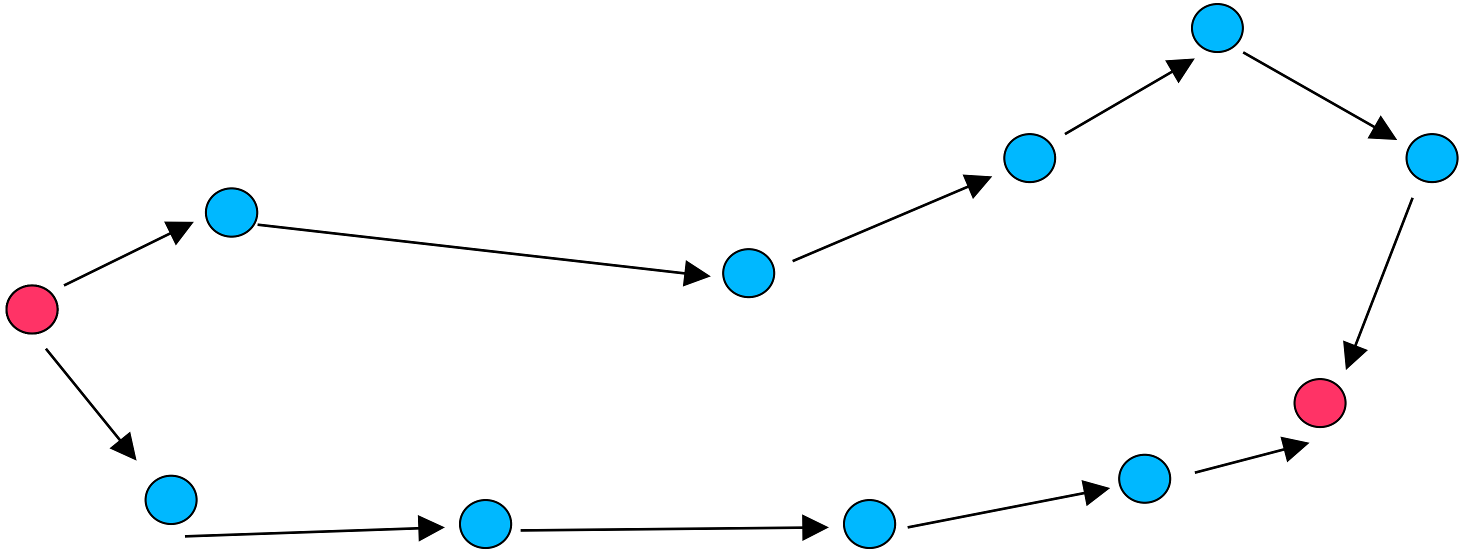
no width (infinitely thin)

Polygon



One or more lines, closing in on itself
lines are joined at nodes

Polygon



Attributes of polygon:

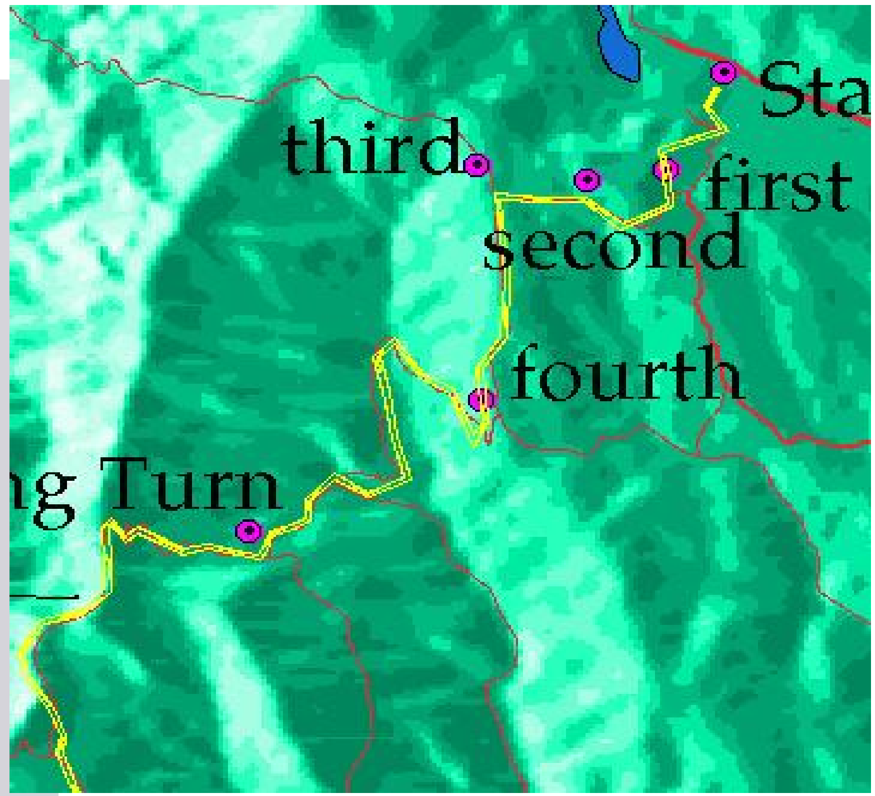
- Area
- Perimiter

attributes of lines forming a polygon

- Left polygon
- Right polygon

Vector data input: points from data file

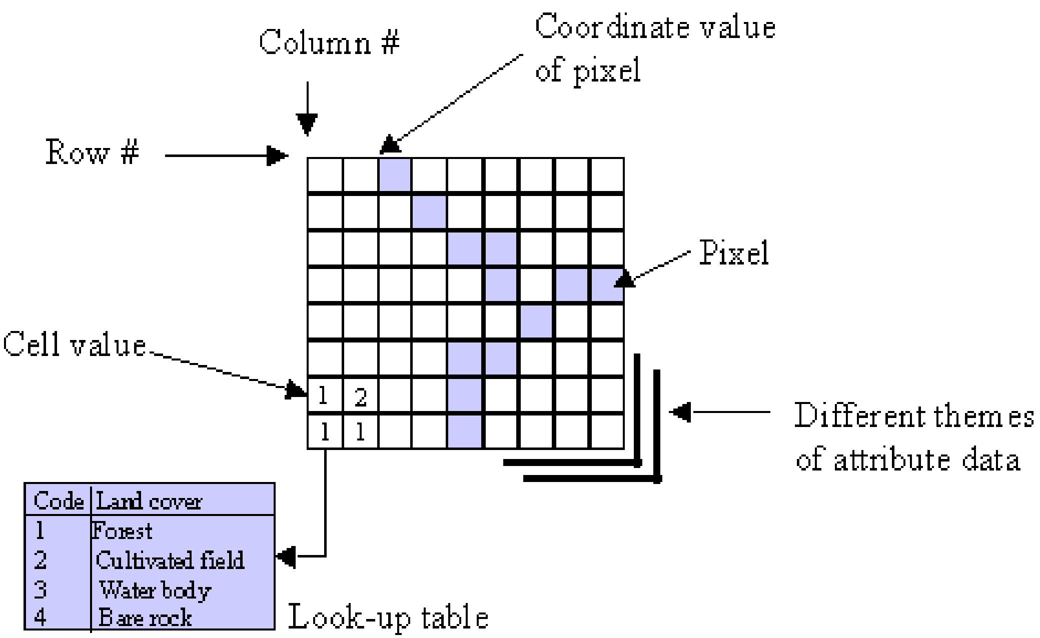
```
      1
447341.750000     4637651.500000
447256.812500     4637481.500000
447384.218750     4637311.500000
446938.312500     4637141.500000
446980.781250     4636929.500000
447002.000000     4636717.000000
446662.281250     4636547.000000
446407.468750     4636759.500000
446110.218750     4636759.500000
445791.718750     4636780.500000
445855.406250     4636165.000000
445834.187500     4635676.500000
445664.312500     4635443.000000
445706.781250     4635018.500000
445621.843750     4634869.500000
445473.218750     4635252.000000
445260.906250     4635379.500000
445069.781250     4635655.500000
444942.406250     4635528.000000
445006.093750     4635252.000000
```



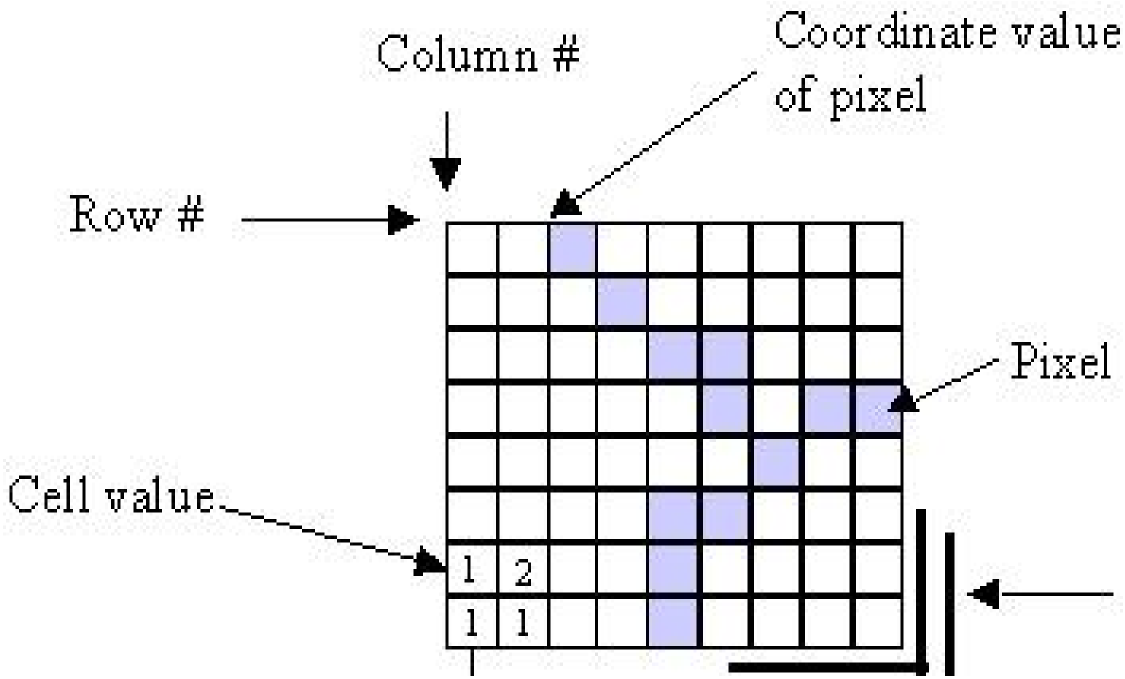
Examples of layer types

points	lines	polygons
Retail Stores	Highways	Countries
Cities,towns	City Streets	Postal Zones
Manhole Covers	Power Lines	Tax Parcels
Telephone Poles	Rivers	Blocks or Tracts
Airports	Water, Sewer Lines	Airports
Businesses	Railroads	Building Outlines
Warehouses	Shorelines	Military Installations
Customers	Bus Routes	Lakes
Prospects	Pipelines	Area Code Boundaries
Disease cases	Runways	Counties

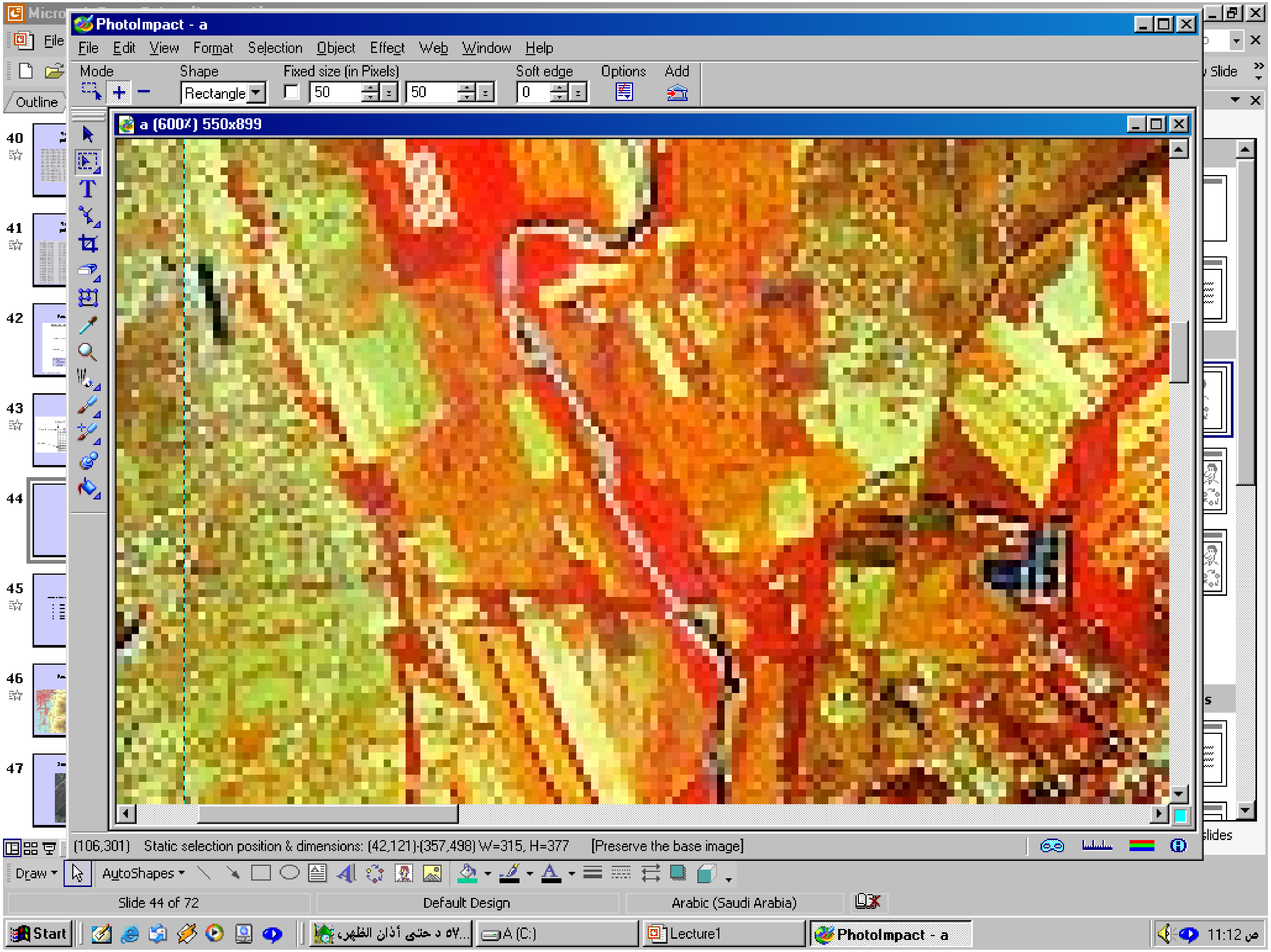
Raster data structure



Raster data



- Basic element is called a pixel
- In GIS, pixel is called a cell
- Size of the cell is the resolution of the data set
- Area of cell is resolution squared
- Every cell can be referenced by coordinates and value


PhotoImpact - a
File Edit View Format Selection Object Effect Web Window Help
Mode
Shape
Rectangle
Fixed size (in Pixels)
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Soft edge
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Options
Add
Outline
a (600%) 550x899
40
41
42
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44
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46
47
(106,301) Static selection position & dimensions: (42,121)-(357,498) W=315, H=377
[Preserve the base image]
Draw
AutoShapes
Slide 44 of 72
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Lecture1
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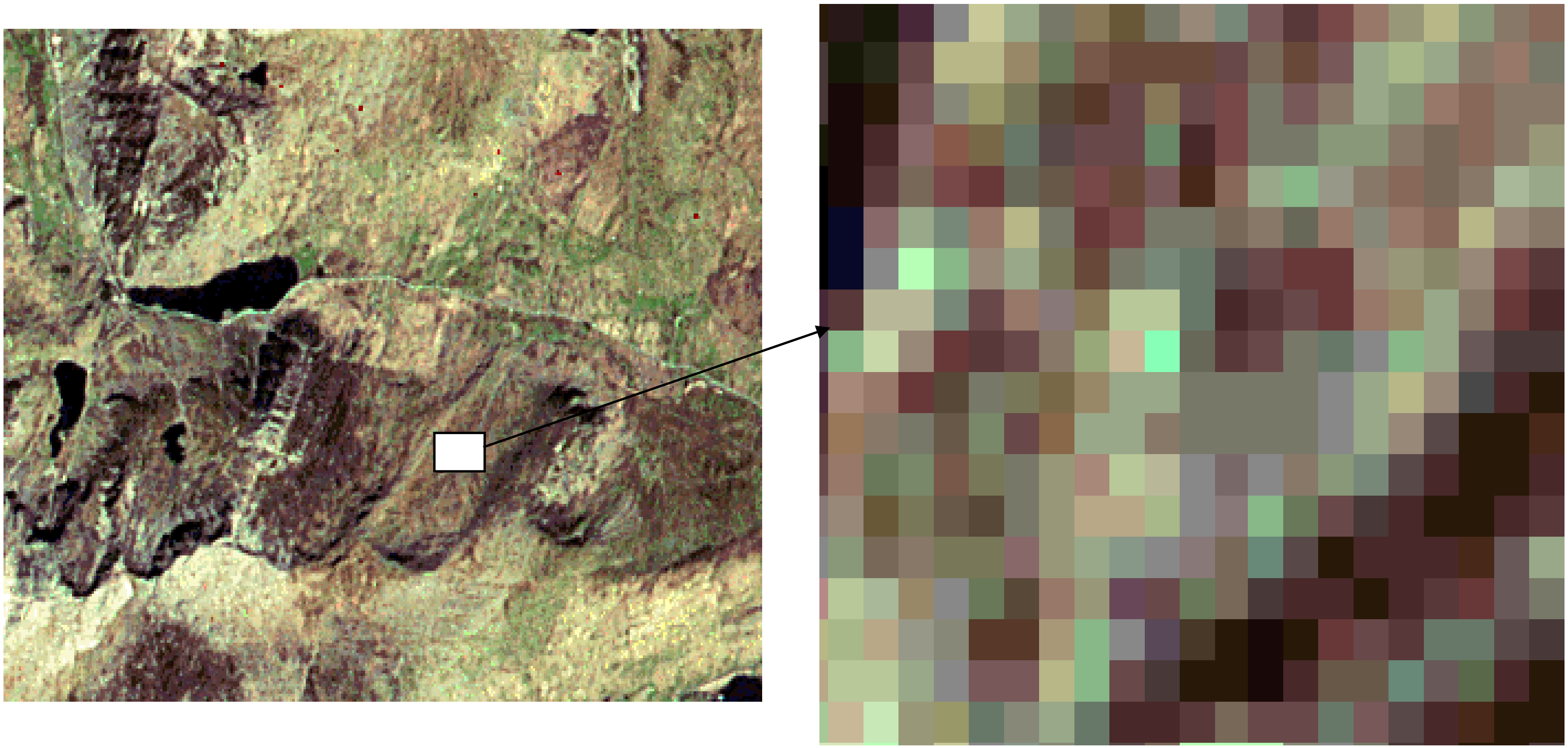
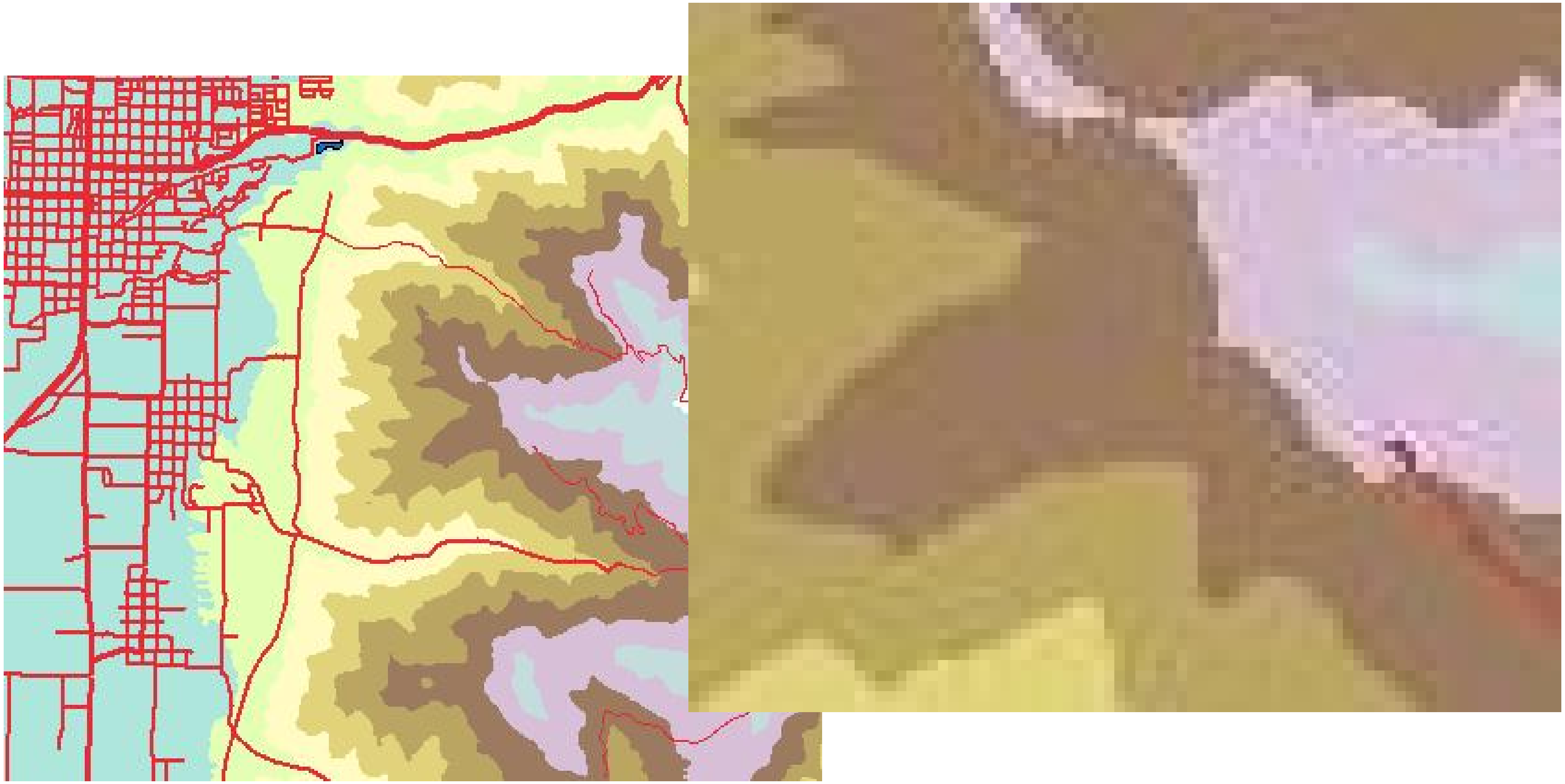


Raster data

- Uncompressed raster data

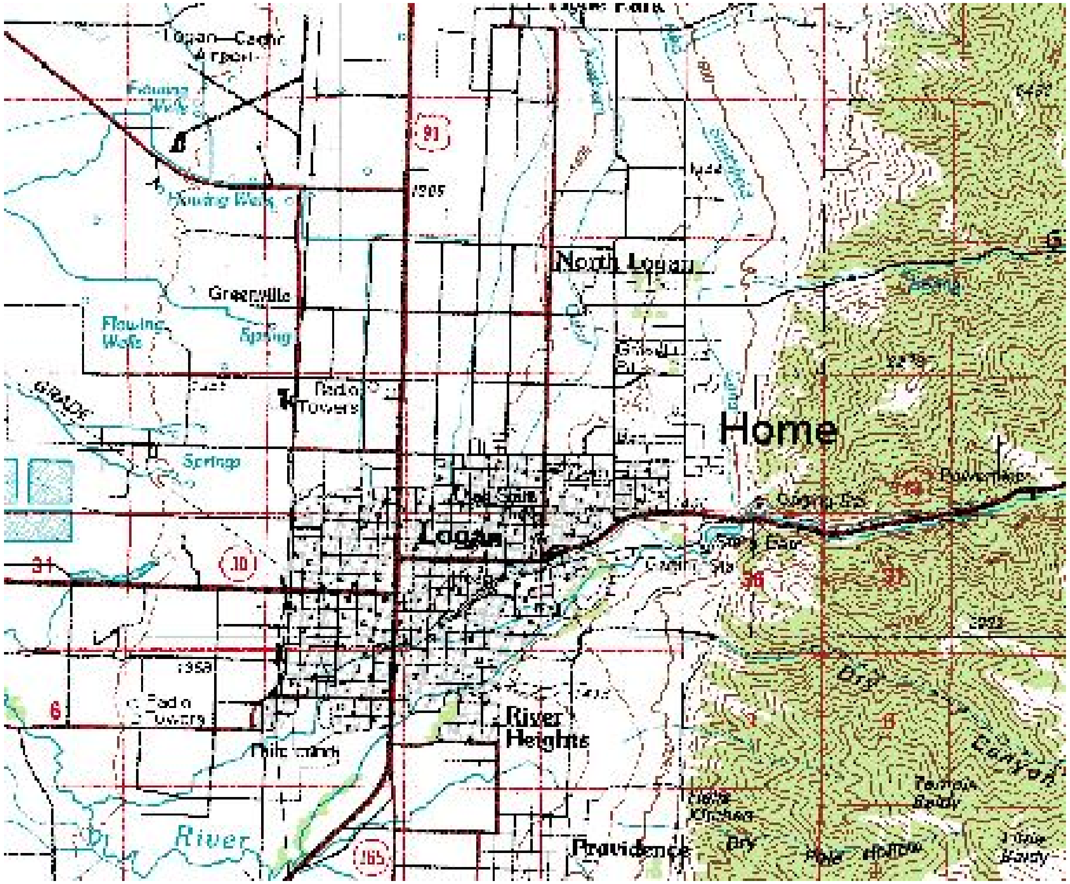
X, Y, value
X, Y, value
X, Y, value
X, Y, value
X, Y, value
...
...

Raster representation



Scanned raster data: air photo

Scanned raster data: paper map



Raster vs Vector: a comparison.

	Raster	Vector
1	Cell structure	Point, line (arc) and polygon structure
2	Location and attribute stored in one table	Location and attribute stored in separate tables
3	No topological information	Topological information recorded
4	An object has one attribute recorded	An object may have multiple attributes
5	More layers required	Less layers required
6	All cells are given a value in database	Only features are recorded
7	Data volume large	Data volume small
8	Data structure simple	Data structure complex
9	Fast processing	Slower processing
10	Resolution limited by pixel size	In theory, unlimited resolution
11	Average graphics	Good graphics
12	Low geometrical accuracy	High geometrical accuracy
13	RS data requires little conversion	RS data requires conversion
14	Spatial modelling easier	Spatial modelling harder
15	Network analysis poor	Network analysis good
16	Area analysis good	Area analyses average.

1. Comparison Between Raster and Vector

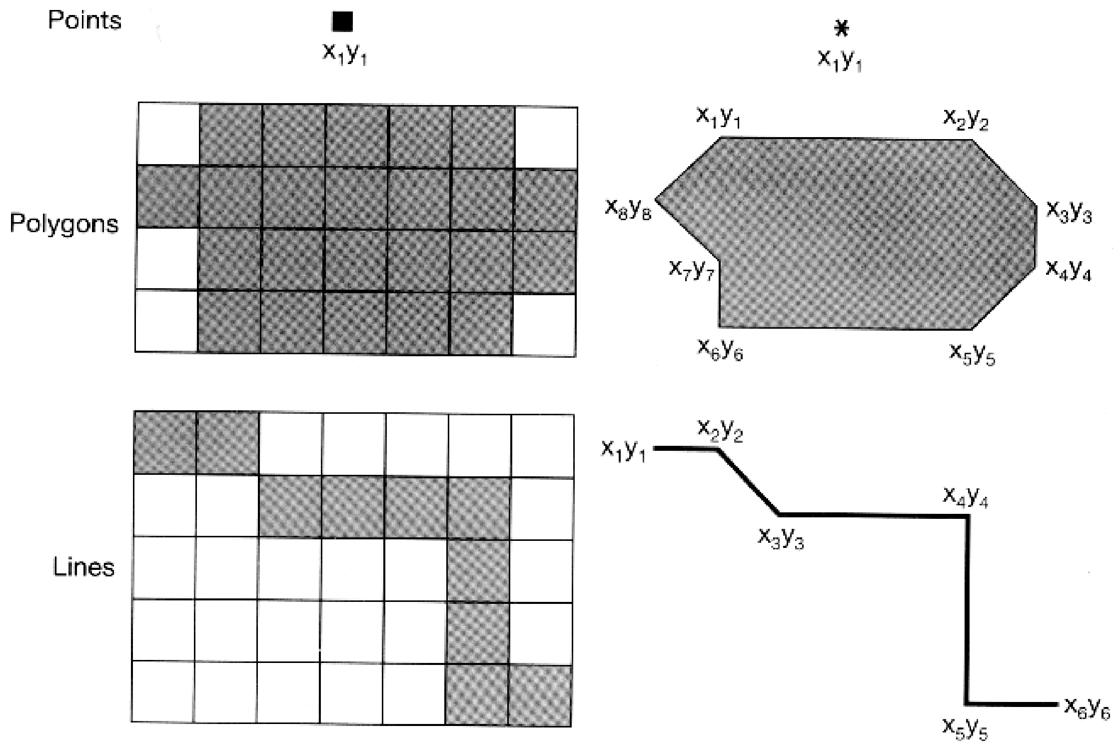
Surfaces and models are represented by completely different spatial models. The same entity can be **raster** *or* **vector**, whether it is a point, line or polygon.

For example:

•Boreholes الآبار (points)

•lakes (polys)

•roads (lines)



Comparison cont.

- Only *one* attribute is recorded for an object in **raster** GIS (e.g. tree species, stem density), whereas *many* may be recorded in a **vector** attribute table.

- Because only one number can be allocated to each cell in a **raster** database, more layers are often required than in a **vector** database to include a similar variety of information.

Comparison cont.

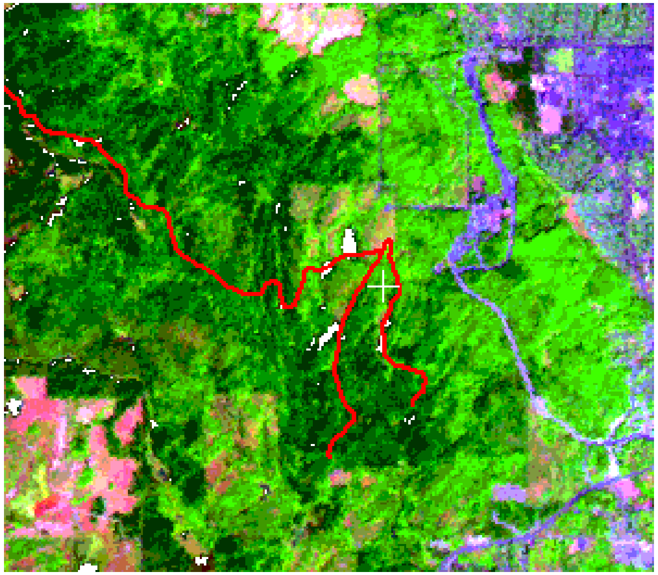
- **Raster** models require ***all*** cells to be given a value. In **vector** models, only ***features*** are recorded.

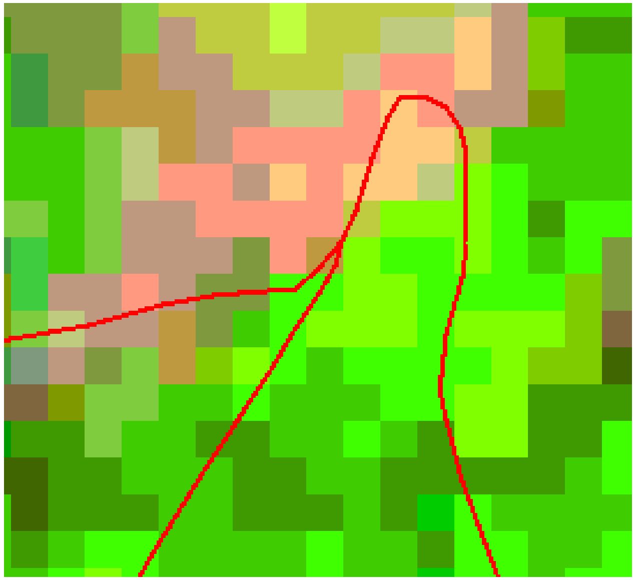
- Therefore, **raster** models usually require more data volume, i.e. they take up more space on your computer and in RAM. This can be a serious problem.

- Whilst **raster** models may be bulky, they are a very simple structure ($\therefore$ easier computation). **Vector** data structures contain more complex relationships between features.

Comparison cont.

- This simplicity in **raster** structure makes for easier and faster processing than with **vector** models.





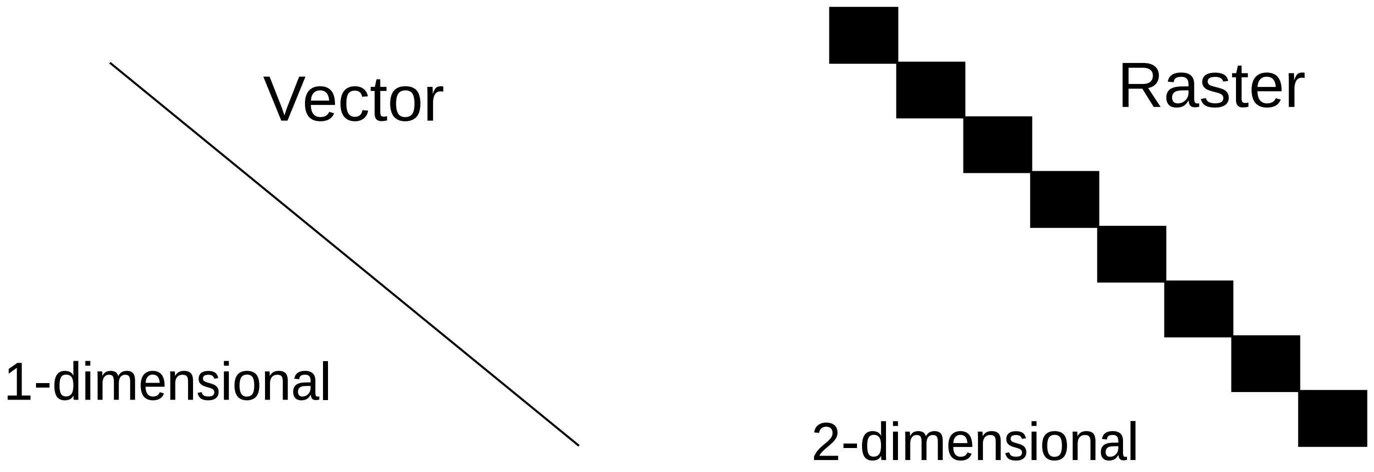
Comparison cont.

Problem:

Raster representation is *always* 2-dimensional

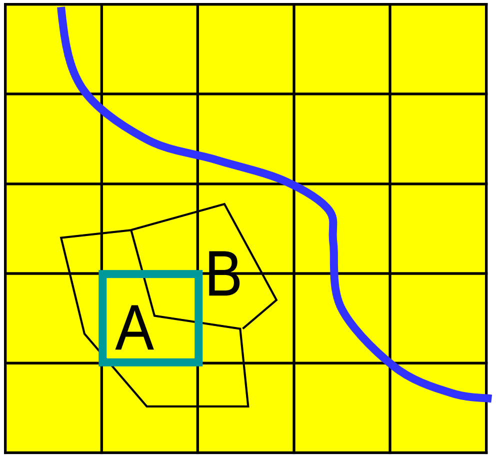
- Points are zero-dimensional
- Lines are 1-dimensional

That makes it difficult to represent line features and point features, e.g. a road.



Differences cont'd

Features like points and boundaries, and objects that are smaller than the minimum **raster** resolution (possibly streams or roads) can be problematical to depict on raster GIS. (They may be shown to be far larger than they are in reality, or they may disappear altogether depending on how the coverage was generated).



For example,

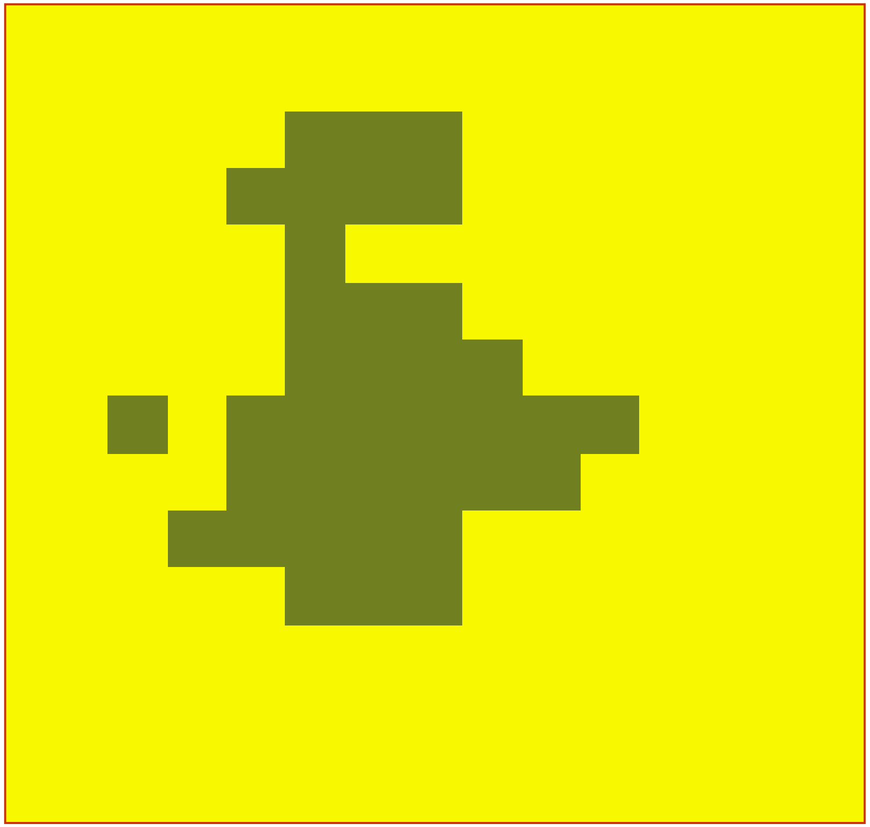
- Stream is 5 m wide
- Coverage converted from vector into raster with 30 m grid cells.
- Where a cell lies over 2 or more polygons, the code of the polygon with the greatest area within the cell is used.

- In this case, the stream may be completely lost from the grid if cell codes are assigned solely on the basis of area. Polygon A would be recorded for the red cell, over polygon B

- There are techniques to get around this particular problem (which will be discussed later in the course).

Differences Cont'd.

At coarse levels of resolution (e.g. large rasters) polygons may appear blocky or stepped.

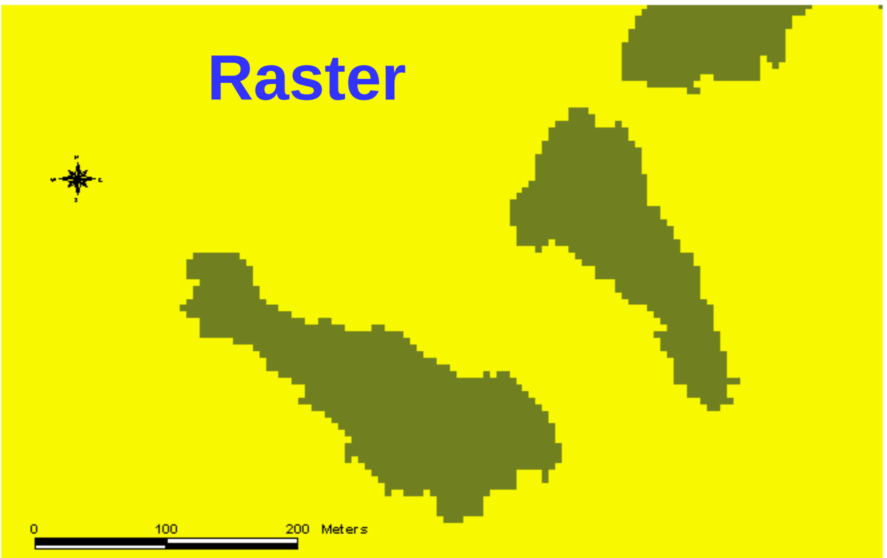


As well as not looking pleasing, it is hard to measure **edges** in particular, and with very convoluted shapes, **area** can be difficult to measure accurately.

Differences Cont’d

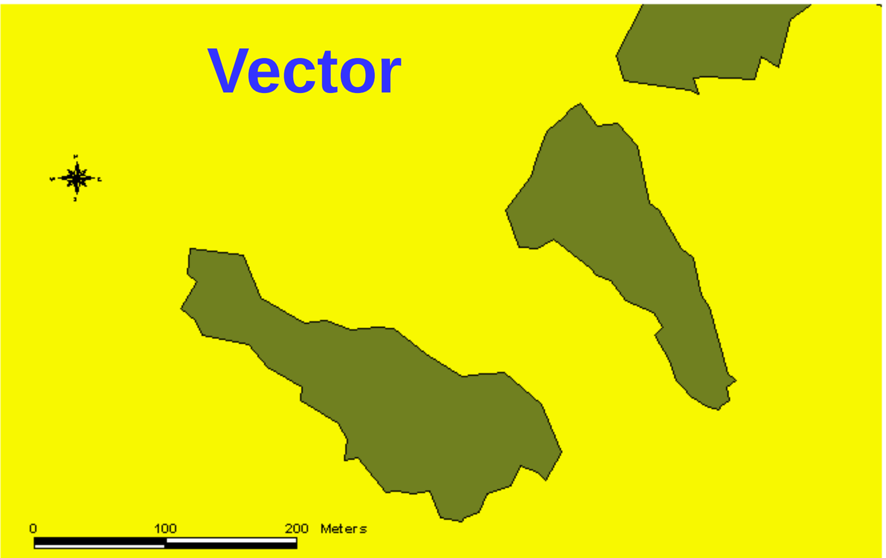
Raster is not suitable for measuring linear shapes (e.g. perimeter).

Measures all of the edges around all external cells, resulting in an artificially large measure for perimeter.



Area = 22625 m

Perimeter = 1120 m



Area = 22615.714 m

Perimeter = 827.58 m

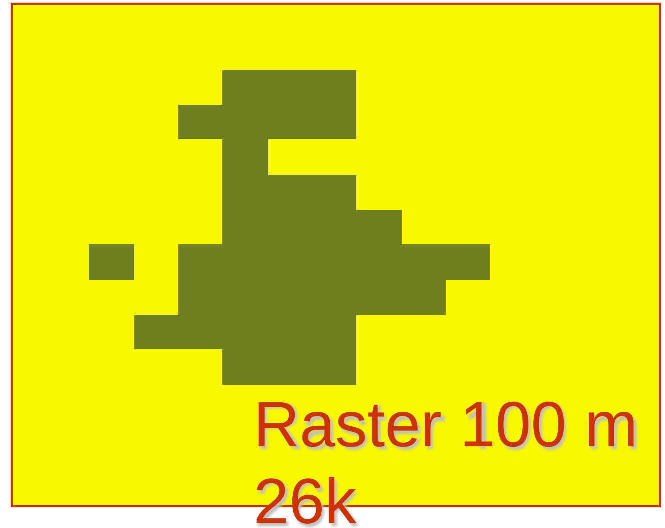
Differences Cont'd.

At finer levels of resolution:

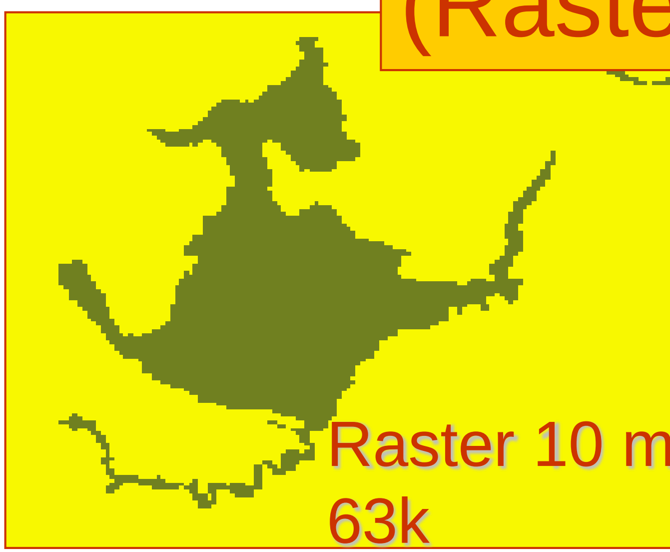
- Raster GIS looks better and better for spatial analysis
- Geometrically more accurate

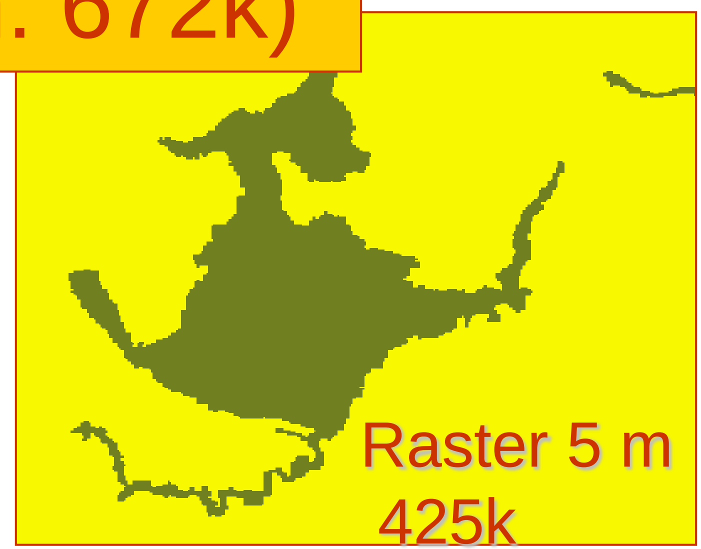
BUT:

Storage requirements increase steeply



(Raster 2 m: 672k)





Comparison Cont'd

- Remotely Sensed data is already in **raster** format, so it requires little conversion. Very important point.

- Spatial modeling is generally far more practical and possible with **raster** GIS, due to the simple nature of the raster model.
-
- This applies both to *within-layer* modeling and *multi-layer* modeling.

- This will become more apparent later in the course.

Comparison Cont’d

- **Vector** GIS tends to form the basis of *management information systems* : its stores facts. Works with established facts or knowledge. Often used in resource management and LIS. (ArcInfo)

- **Raster** GIS is the area of scientific work in GIS – advanced spatial analysis, predictive modelling, graphical simulation, visualisation, image analysis, and terrain analysis
- Algorithmic and image-based approaches to data analysis are used with **raster**. (ArcGRID)

Vector models

are better when:

- Boundaries are abrupt شديدة الانحدار
- You look at relationships along a network (i.e. roads, streams, etc.)
- You want to store many attributes for spatial queries (especially if those attributes are for a single set of features)
- You want to create precise, high-quality maps

Raster models

are better when:

- Boundaries are gradual تدريجية(e.g. topography, veg.)
- Features vary along a continuous surface
- Need to combine lots of data layers quickly and cheaply
- Using remotely sensed data
- Used for predictive modeling

Why not use both?

- In most packages now *both* can be displayed together
- To analyze and compare, must be in the *same* format
- Can **store** in one format and **process** in another - to save space
- Can convert from raster to vector for **mapping** (presentation)
- Can overlay the **raster** output with a **vector** coverage to allow better interpretation of the raster data and for effective **mapping**

Discussion

Questions

Lecture 3

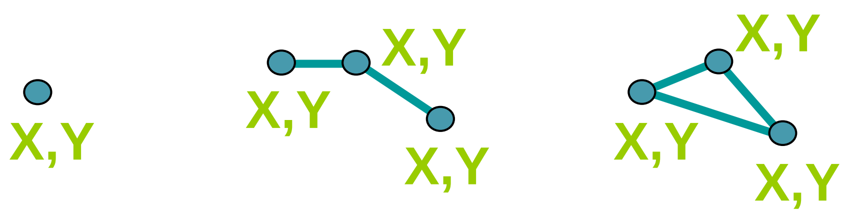
Data Formats

Lesson 5 overview

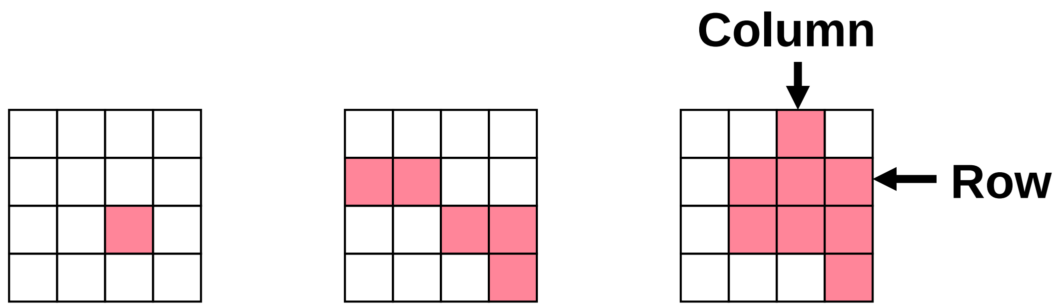
- Geographic data review
- Linking features and attributes
- Data formats
- Working with ArcCatalog
- Metadata
- Geography Network

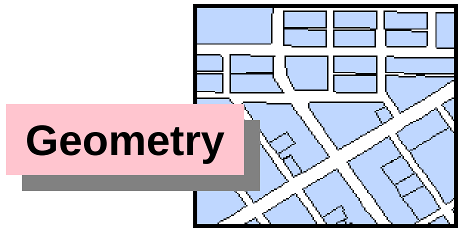
Representing geographic features

- Vector



- Raster





Rowid	ZONE_CODE	DESCRIPTION
1	000	NODATA
2	AGR	Agricultural
3	AIR	
4	COM	

Attributes

Behavior rules

- Data has

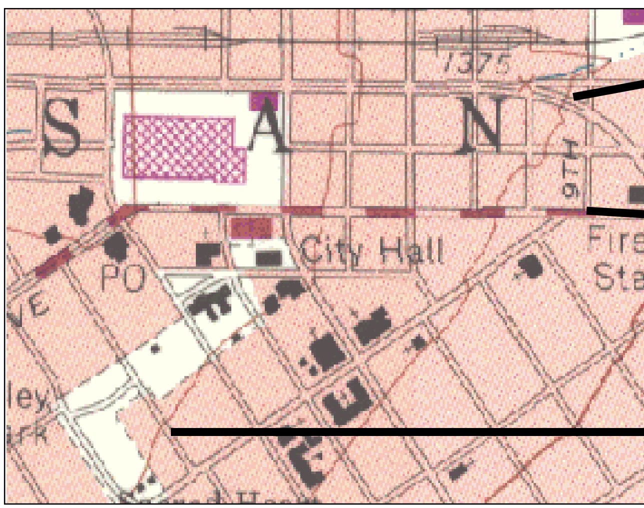
Introducing feature classes

- Collections of features with the same type of geometry
- Can create point, line, or area feature classes

GDB

Roads FC

Many different line objects



primary roads

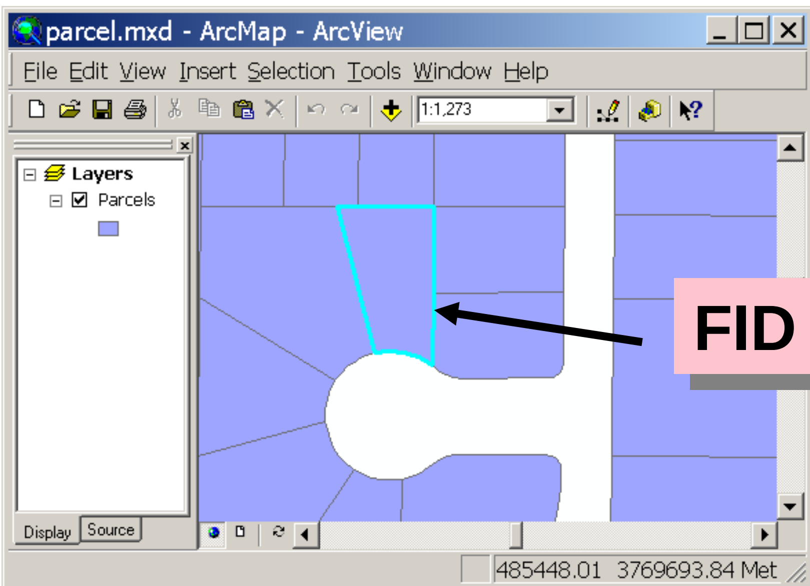
highways

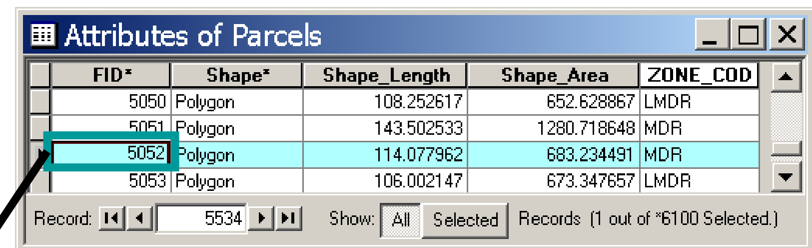
secondary roads

Single linear feature class "Roads"

Linking features and attributes

- Feature classes are tables that store spatial data
- Each feature has a record in the table
  - Unique identifier links feature and attributes



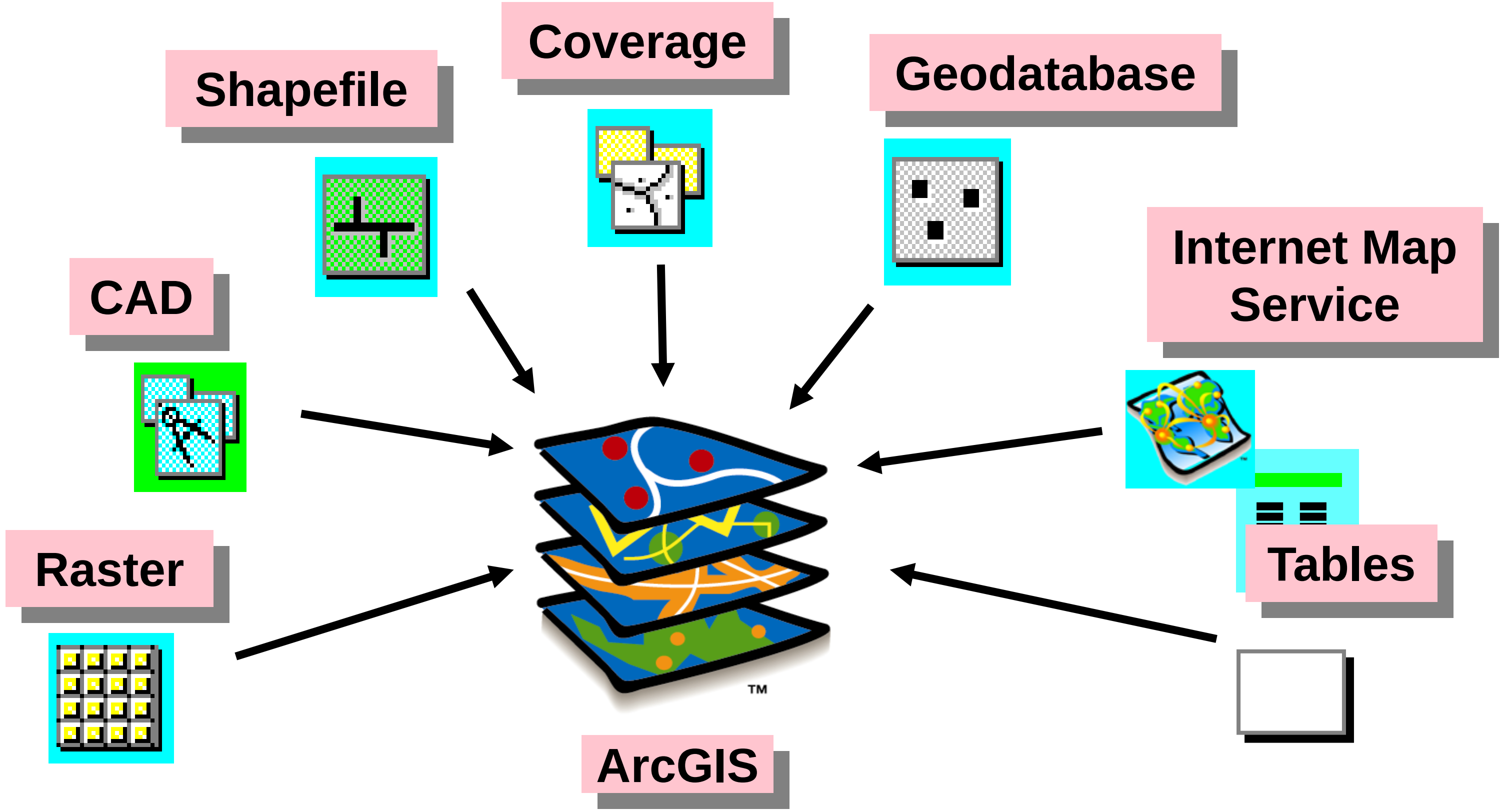


FID = 5052

Feature Identifier

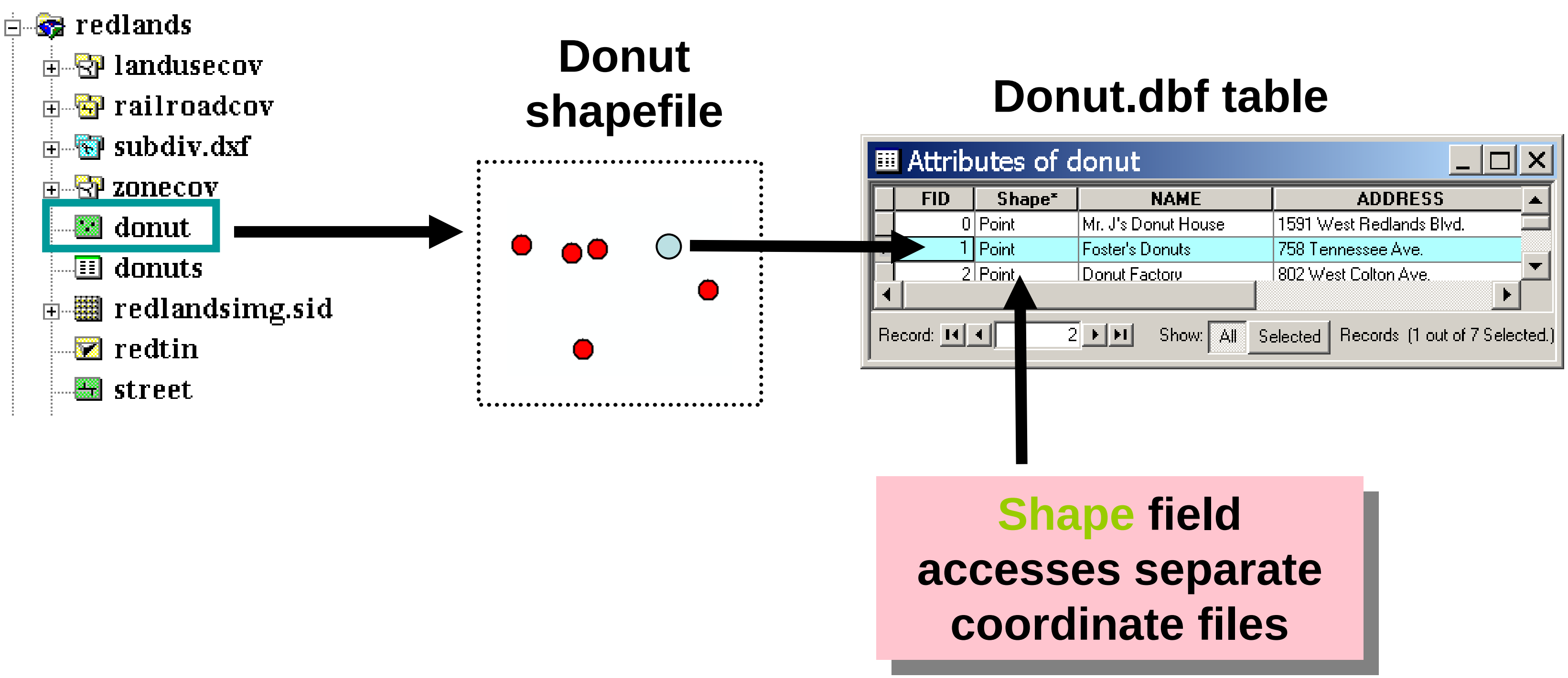
Spatial data formats

- ArcGIS can work with spatial data in multiple formats



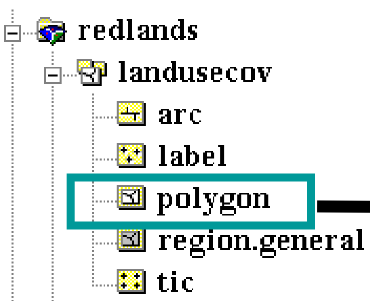
Shapefile data format

- Single feature class
- Attributes stored in dBASE table

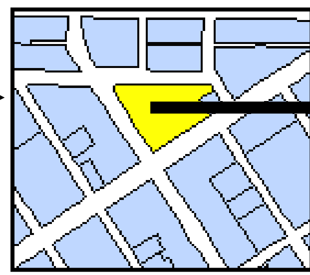


Coverage data format

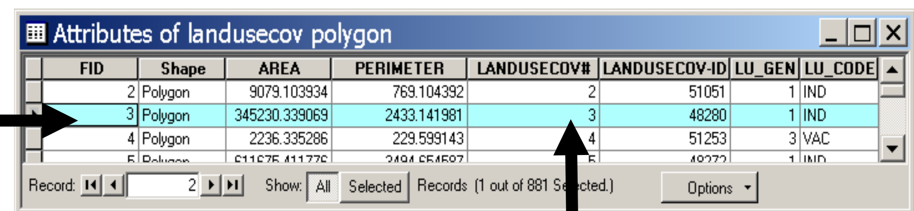
- A folder containing multiple feature classes
- Can store point, line, polygon feature classes, and more
- Attributes stored in a separate INFO table
- ArcInfo coverage organization



Landusecov coverage



Landusecov.pat INFO table



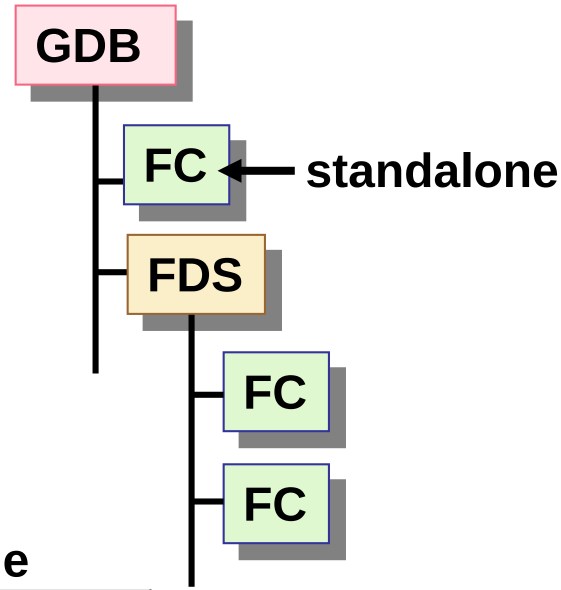
FID	Shape	AREA	PERIMETER	LANDUSECOV#	LANDUSECOV-ID	LU_GEN	LU_CODE
2	Polygon	9079.103934	769.104392	2	51051	1	IND
3	Polygon	345230.339069	2433.141981	3	48280	1	IND
4	Polygon	2236.335286	229.599143	4	51253	3	VAC

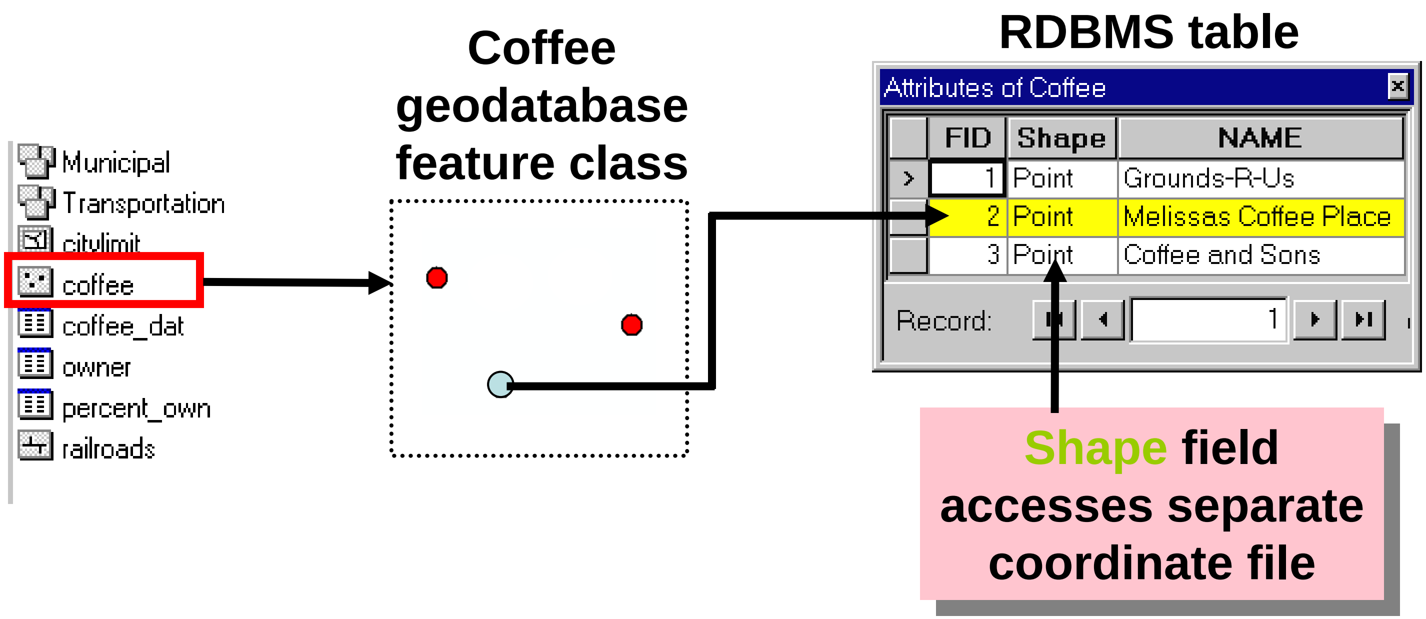
<cover># field accesses separate coordinate files

Feature class	Feature attribute table	
Point	<cover>.PAT	Point attribute table
Arc	<cover>.AAT	Arc attribute table
Node	<cover>.NAT	Node attribute table
Polygon	<cover>.PAT	Polygon attribute table

Geodatabase data format

- Stores spatial features and their attributes in the same RDBMS
- Feature datasets model spatial relationships
- Have their own feature classes





Geodatabase validation

Spatial validation

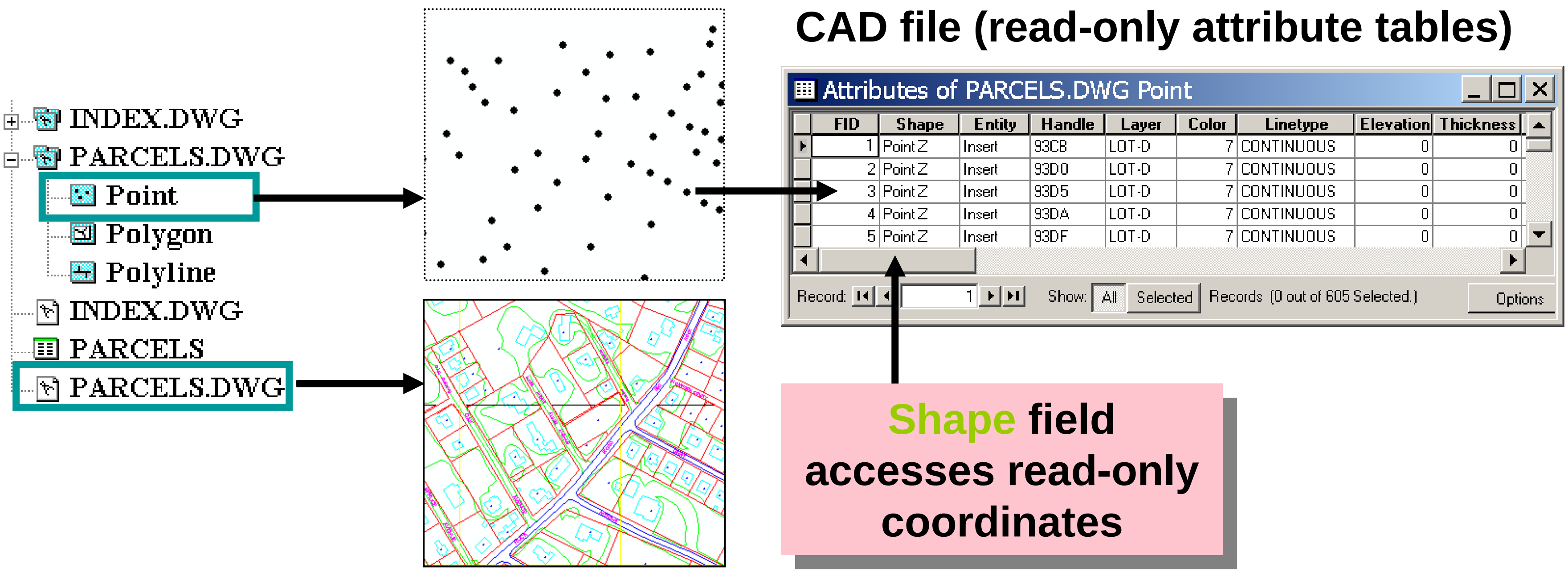
- **Topology**
- **Geometric network**

Attribute validation

- **Subtypes**
- **Domains**
- **Relationship classes**

CAD file data format

- Computer Aided Design files (DXF, DWG, DGN)
- Logical collection
  - Access one or all feature class(es) at a time
- Edit after exporting to geodatabase FC, coverage, or shapefile

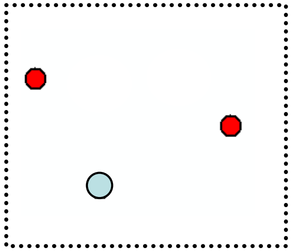


Tabular locations to a point feature class

Table with raw coordinates

X_COORD	Y_COORD
480585.5	3769234
483194.094	3768432
485285.813	3768391

New feature class



New feature class

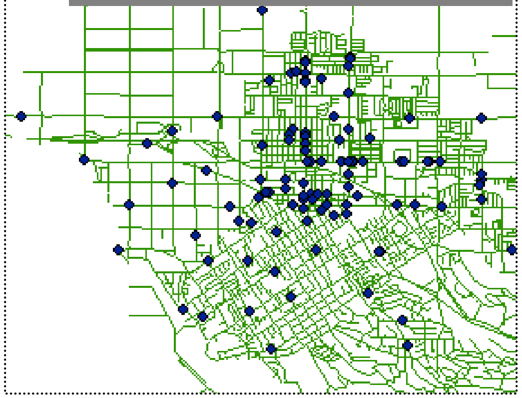
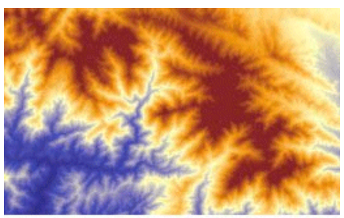
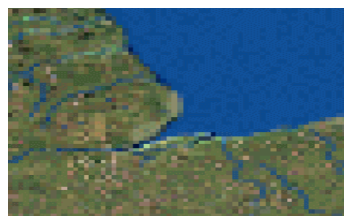


Table with addresses

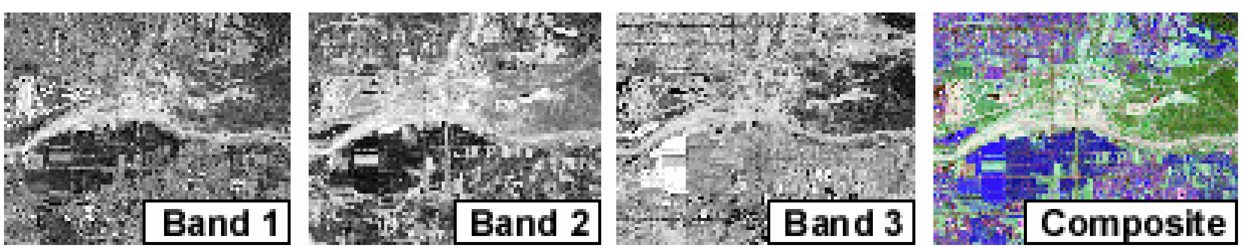
	OID	OBJECTID	CASE_NUM	TYPE	LOCATION
▸	0	6	990302216	6	316 E CLARK ST
	1	7	990301762	6	1535 GARDEN ST
	2	27	990201031	3	1725 N CHURCH ST
	3	29	990201340	3	1721 N CHURCH ST
	4	33	990302252	7	145 S CHURCH ST
	5	36	990100032	3	1711 N ORANGE ST
	6	38	990302093	3	1702 N ORANGE ST

Images and grids

- Rows and columns of equal-sized cells
  - Each cell stores a value
  - Detail depends on cell size
- Grids (the ESRI native raster format)

- Images (TIFF, BMP, SID, JPEG, ERDAS)



Lecture 3

Project Design

GIS Project

Typical GIS project:

6 month project

- Project design
- Data design
- Data input

} **4 months**

- Analysis } 2 weeks
- Reporting & presentation } 2 weeks

Too much time for data entry

Too much time for data entry

GIS PROJECT OPERATIONS

Step 1: Project design:

a GIS project can be organized into a series of logical steps, each of which builds upon the previous one.

Step 2: Build the database:

This is the most critical and often the most time-consuming part of the project. The completeness and accuracy of the database determines the quality of the analysis and final products. Here are the steps involved in developing the digital database:

a) Design the database-determining the study area boundary, what are the coordinate system will be used, which data layers (or coverages) are needed, what features are in each layer, what attributes are needed for each feature type, and how the attributes are to be coded and organized

b) Automation the data. This, in turn, involves several steps:

i) Get the spatial data into the database by digitizing and/or converting data from other systems

ii) Make the spatial data usable by verifying and editing errors, and then creating topology

iii) Get the attribute data into the database-entering the attribute data into the computer, and associating the attributes with the spatial features

- **Step3: Database Management**
  - Put the database into geographic coordinate system.
  - Join adjacent areas into database or split large databases into **TILES** and develop a management strategy for tiles.
- **TILES** are physical subsets of a larger geographic area which contain identical themes. Tiles are generated to reduce data load on computers and allow faster computation and drawing.
- **Step 4: Analyze the data**
- This is where the true value of a GIS shines through. Analytical tasks which are otherwise extremely time-consuming or even impossible if done manually can be performed very efficiently using a GIS. Alternative scenarios can also be tested by making minor revisions in the analytical method.
- **Step 5: Present the results of the analysis**

Designing the database

The first step in developing the digital database is to determine what the contents of the database will be.

By spending sometime designing your database before actually automating it, you must be sure that when you are ready to perform the analysis and create the final products, all of the coverage features and attributes you need will be there.

A well designed database can also ensure that the data will be usable for future projects. Database design consists of three major steps:

a) Identifying geographic features and their attributes

Geographic feature	Feature class	Feature attributes
Soils Land use	Polygons Polygons	Suitability Land use code Cost per hectare

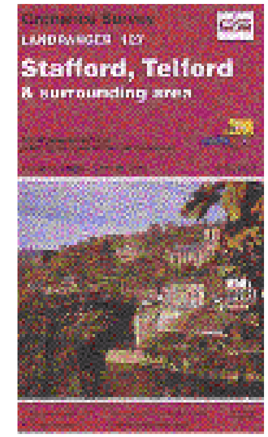
- ***b)Organize the data layers:***
- Once you have identified the necessary features and their attributes, you can begin organizing the geographic features into layers of data.
- A number of factors influence layer organization in a geographic database, and they differ with each application. Two of the most common considerations for organizing layers include feature types (point, line or polygon) and thematic grouping of features

c) Identify coverages to be automated:

- *Now you identified the geographic features and their attributes, and organized this information into layers determines what coverages your digital geographic database will contain.*
- *In some cases, the data layers will be available on separate maps (for example, a map showing only parcel boundaries) or will already be in digital format on the computer.*
- *In other cases, you will have to automate layers from a single base map. In these instances, it is often easier to create separate map manuscripts for each layer, since the amount of information on the base map may make data capture more difficult.*
- *This is often done by tracing the necessary features on a transparent material. Once each map manuscript has been digitized, you will have the needed geographic features stored as x, y coordinates in the digital database, along with the attributes in the coverage feature attribute table.*

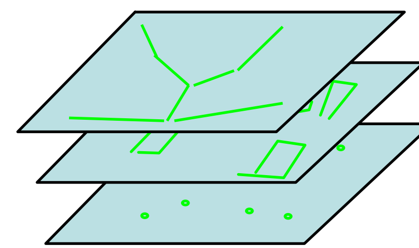
Building the database

Data source



Topographic map

Data layers

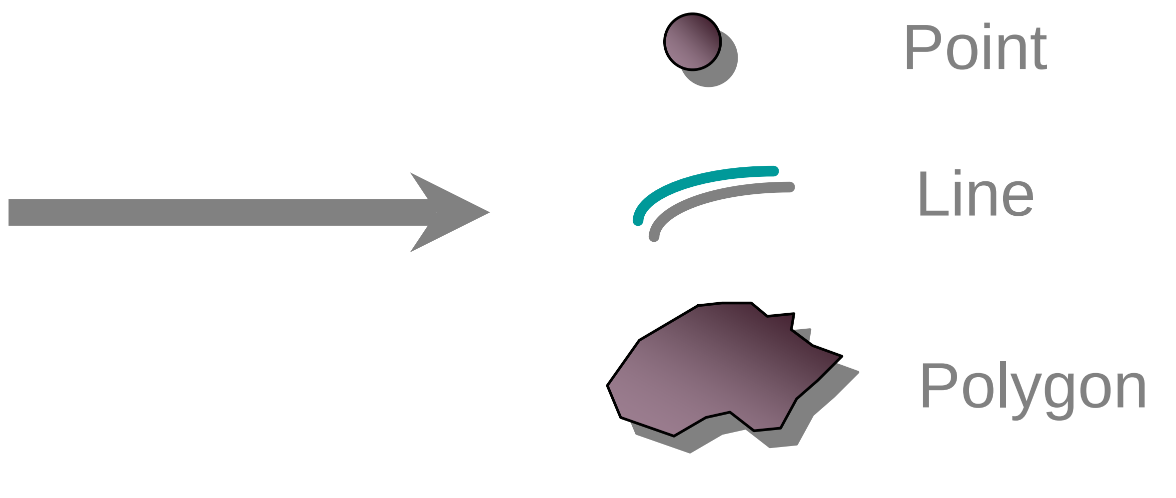


GIS Database

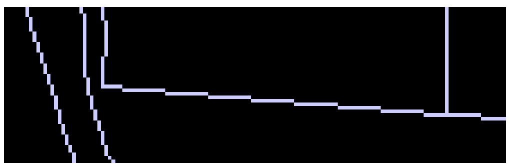
Data Modelling - step 1

- Features
  - Buildings
  - Road centrelines
  - Lamp columns
  - Gas pipes
  - Road surfaces

Data Modelling - step 2



Attributes



Name :	Next
Address:	5 Gehan street
Town:	Mansoura
Owner:	Ahmed Ali
Tel. No:	+2050 00000
Floor space	100 s.m.

Discussion

Questions

Lecture 4

DATA INPUT

Or

DATA AUTOMATION

Lesson overview

Planning

Data automation

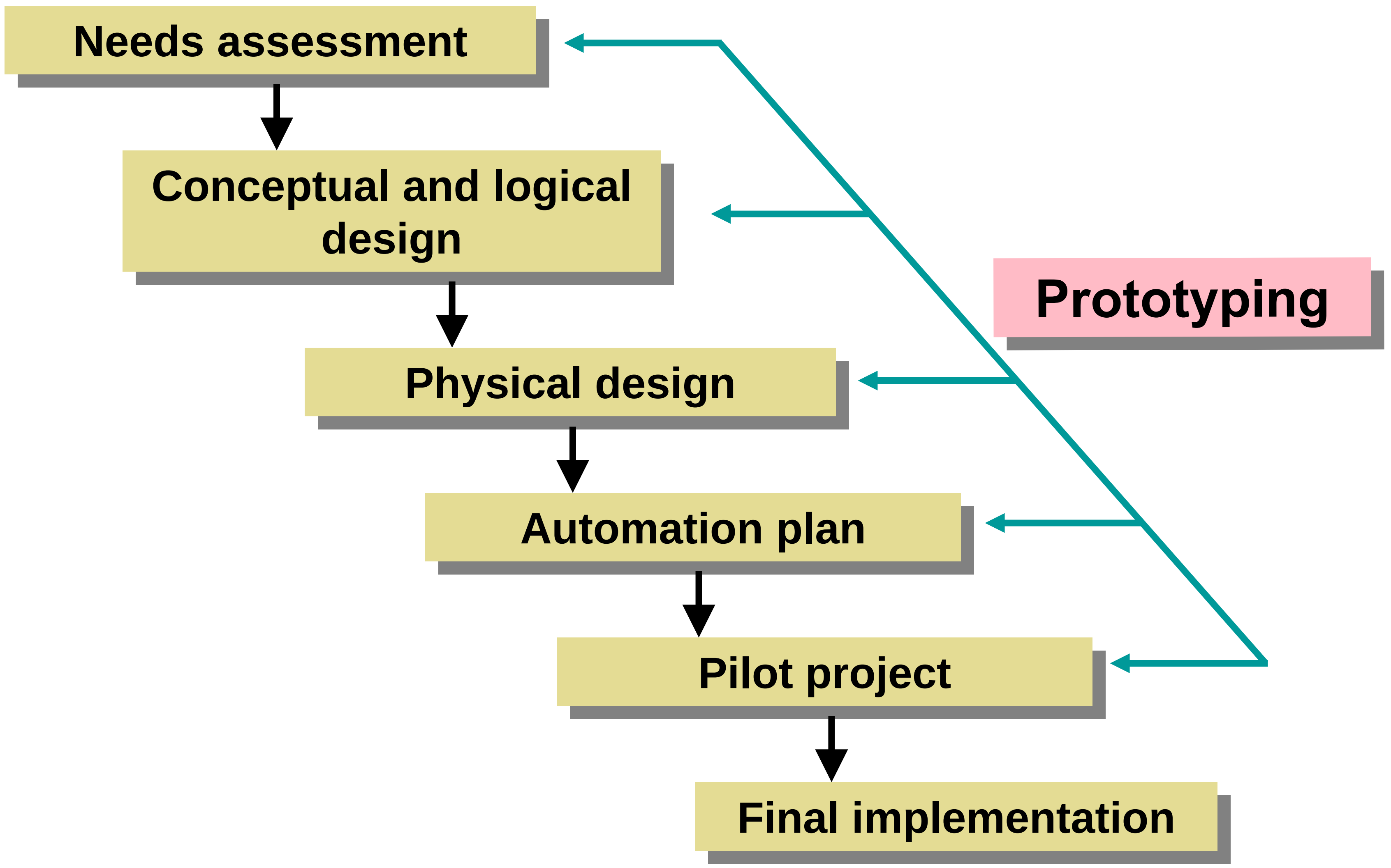
Setting validation rules

Data editing

Spatial Adjustment

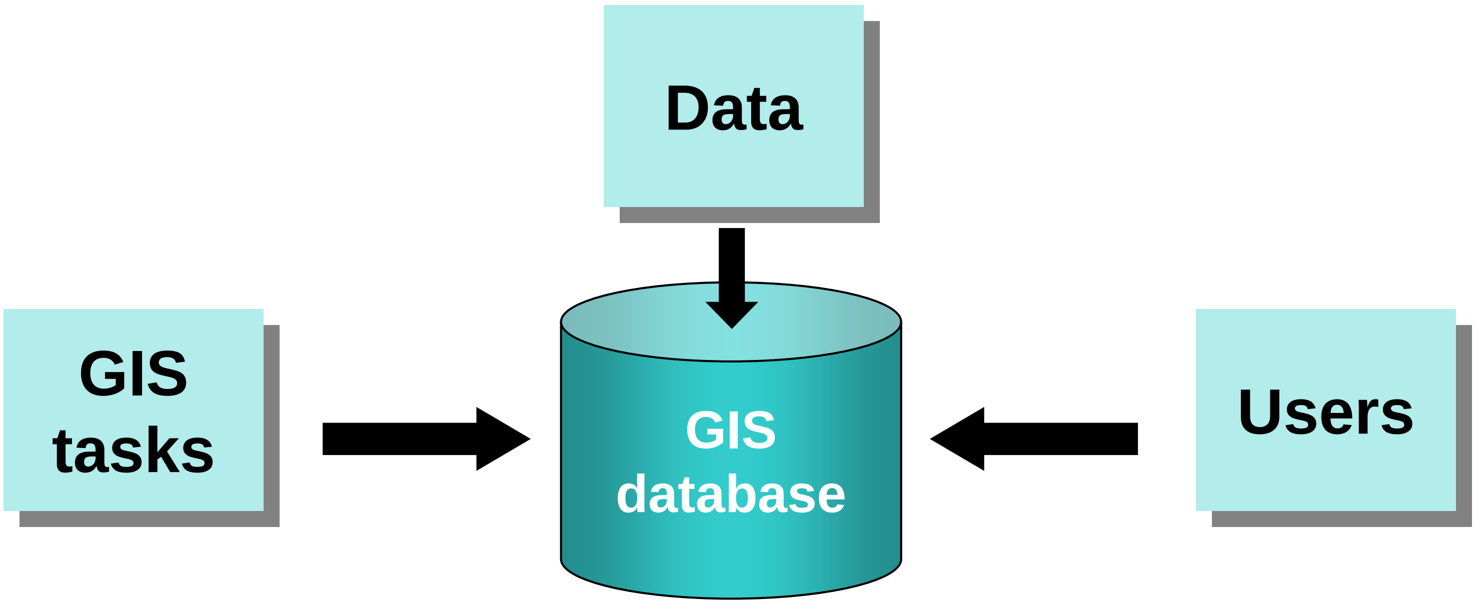
Pilot study

The database design procedure



Assessing needs

- Define your objective
- Decide what you need to achieve it
- Ask the right people the right questions



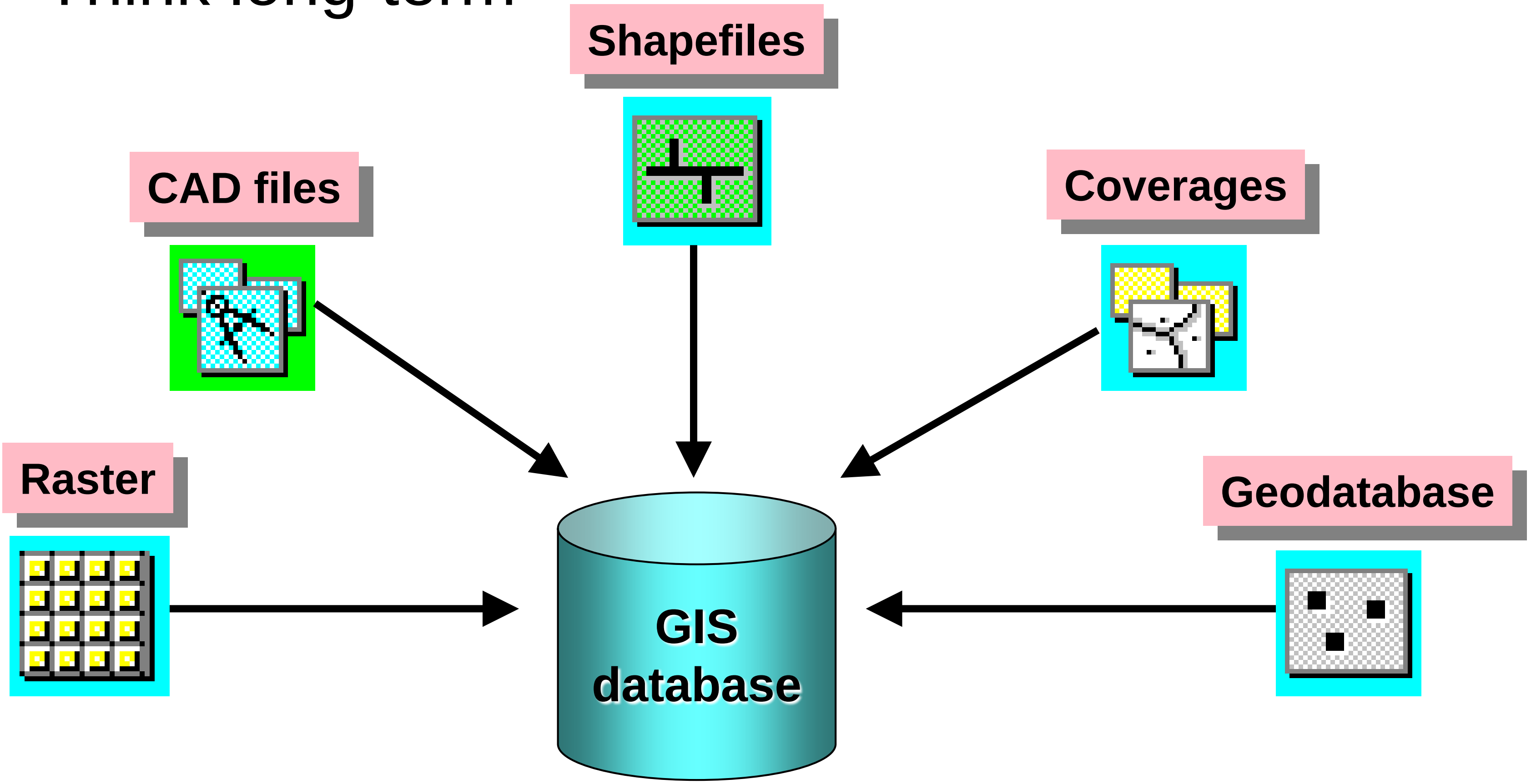
Conceptual and logical design

- Identify geographic entities and attributes
- Save entities into feature classes
- Organize geographic entities into thematic layers

Real-world entities	**Streets**	**Soil types**	**City parcels**	**City trees**
Feature class	**Lines**	**Polys**	**Polys**	**Points**
Attributes	**Name** **Class**	**Type** **Permeability**	**Land use** **Zoning**	**Species** **Age**
Behavior	***Connectivity rules***	**Soil class** ***domain***	**Open space** ***subtype***	***None***

Determining the data storage format

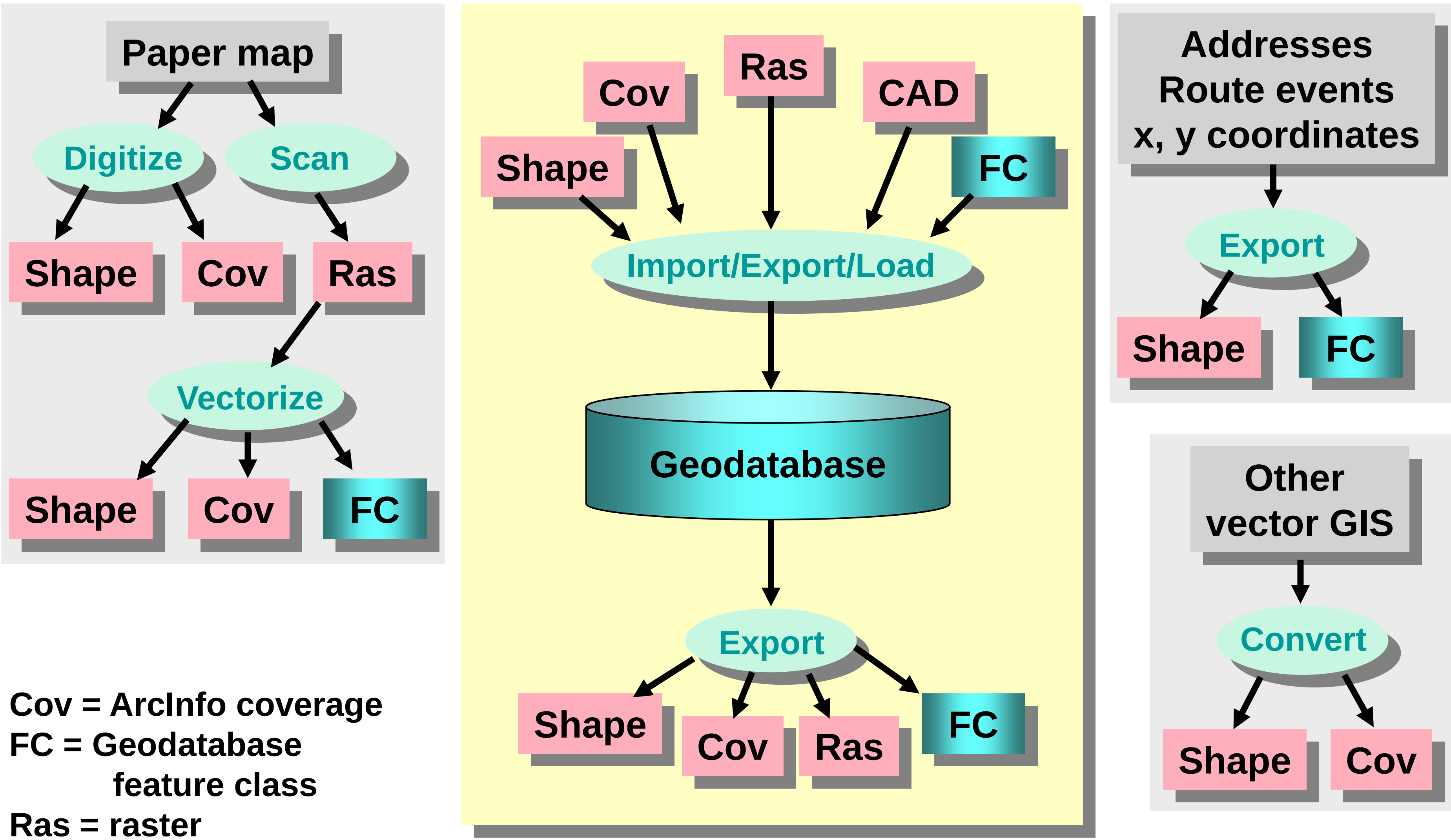
- Choose a format that meets your needs
- You can convert between formats if necessary
- Think long-term



- **CHECKING DATA QUALITY: A prerequisite step**

1. What is the age of the data?
2. Where did it come from?
3. In what medium was it originally produced?
4. What is the areal coverage of the data?
5. To what map scale was the data digitized?
6. What projection, coordinate system, and datum were used in maps?
7. What was the density of observations used for its compilation?
8. How accurate are positional and attribute features?
9. Does the data seem logical and consistent?
10. Do cartographic representations look "clean?"
11. Is the data relevant to the project at hand?
12. In what format is the data kept?
13. Why was the data compiled?
14. What is the reliability of the provider?

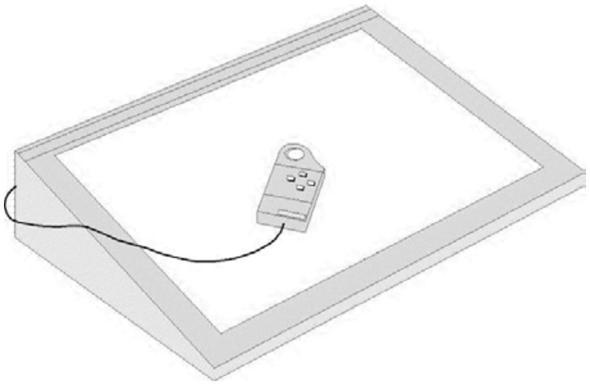
Many spatial data automation options



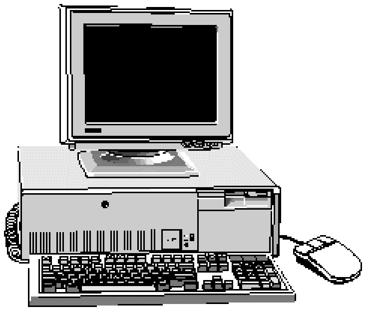
Cov = ArcInfo coverage
FC = Geodatabase feature class
Ras = raster
Shape = shapefile

Creating new data

- Scanning data
  - Produces raster image
  - Georeference after scanning



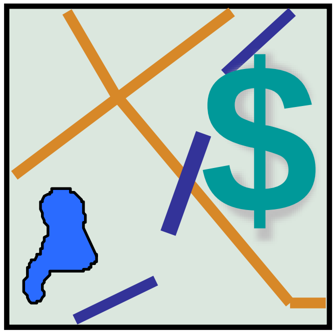
- Table digitizing
  - Produces vector feature class
  - Georeference during or after tracing
- Heads-up digitizing
  - Digitize over image on screen
  - Georeference before or after digitizing



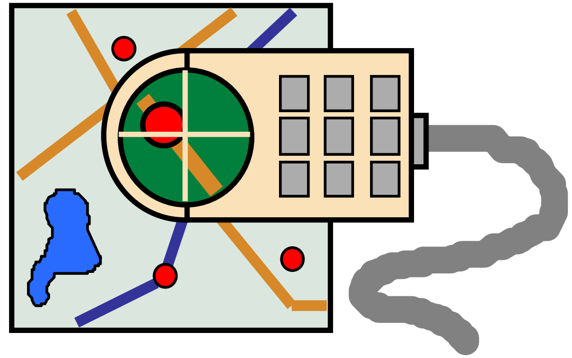
Creating a coverage with the digitizer

- Create empty coverage in *GIS*
- *Affix map to digitizer*
- *Tell computer where map is on digitizer*
- *Set data input stream from digitizer to file*
- *Enter data (2 for node, 1 for vertex)*
- *Save often*

Automation plan



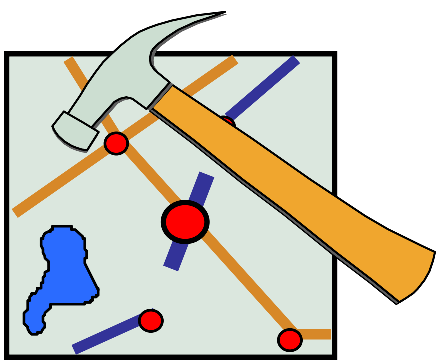
Data purchase



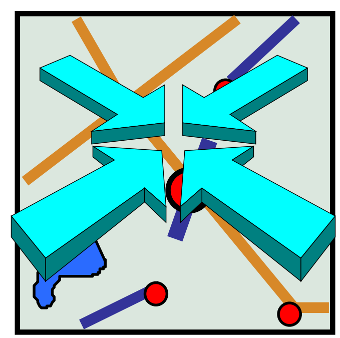
Data capture

Part of the automation plan

- Subtypes
- Domain
- Relationship classes
- Topology
- Geometric networks
- Annotation



Data conversion and editing



Data aggregation

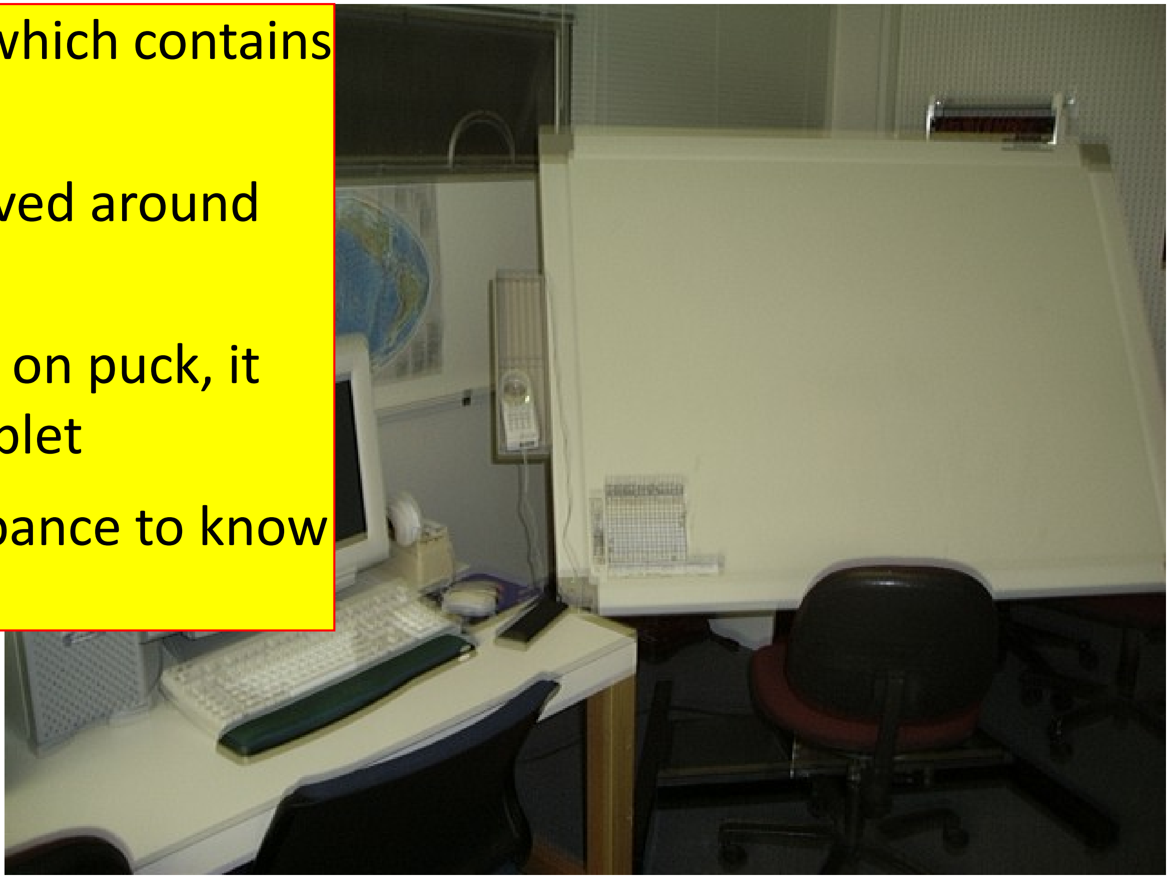
Digitizing techniques:

A) Digitizing table

B) On-screen digitizing (head-up) digitizing

Vector data input: the digitizing tablet

- Digitizing tablet is a table which contains a wire mesh underneath
- Electronic puck can be moved around on surface
- When buttons are pressed on puck, it disturbs electric field on tablet
- Computer uses this disturbance to know location of puck on table



- **IDENTIFY DIGITIZING ERRORS**
- four basic types:

1- Extra arcs

2- Missing arcs

3- Dangling nodes

4- Pseudo nodes

5- Missing labels

6- Extra labels

- The **first two** require manual identification by plotting and overlaying digitized maps with the original manuscript.

- The **second two** can be automatically identified by using the **NODEERRORS** command in **ARC** or by using **ARCEDIT** to locate the **DANGLES** or **PSEUDO** nodes.

- The **last two** can be identified using the **LABELERRORS** command in **ARC**

- **WHAT COMMAND BUILDS TOPOLOGY IN ARC**
- The **CLEAN** command identifies intersecting arcs with no nodes, identifies dangles and pseudo nodes. It can be used to eliminate dangles and undershoots during the digitizing process. After correcting for errors it will build topology
- The build commands assumes that there are no errors of intersecting arcs without nodes and simply builds the **TOPOLOGICAL RELATIONSHIPS**
- **CLEAN** should be used sparingly and only if you have added arcs that may intersect without nodes. Use the **INTERSECTERR** command to identify intersects.
- After adding label points, or deleting unwanted arcs, or if you add arcs and make sure that all intersects are accounted for, use **BUILD**. If there is an intersect error it will bail out and then you should use clean

Discussion

Questions

Lecture 5

Digitizing Modes

- **Point Mode**
  - position the pointing device over the point element to be digitized.
  - press the cursor button once.
  - move the pointing device and a new point element and repeat the process.
    this mode is useful for individual locations (e.g. elevation benchmarks) as well as for straight lines that only require a few points to be digitized.
- **Stream Mode**
  After pressing a button to begin the data collection, the digitizer continually collects points as the cursor is moved along a linear feature, until the operator presses another button to end digitizing

- **LINES**
  - place the cursor at the beginning of the line and press the button that initiates the recording of coordinates a start node will appear
  - move the cursor along the line at a fairly constant speed, following the curves in the line as carefully as possible
  - at the end of the line, press the button to stop recording data coordinates, an end node will appear
- for very long or complicated lines, digitize the line in portions. Trace a part of the line, then stop the data collection. Without moving the cursor, press the start button and recommence digitizing the subsequent portion of the line. Repeat this procedure until the line is complete.

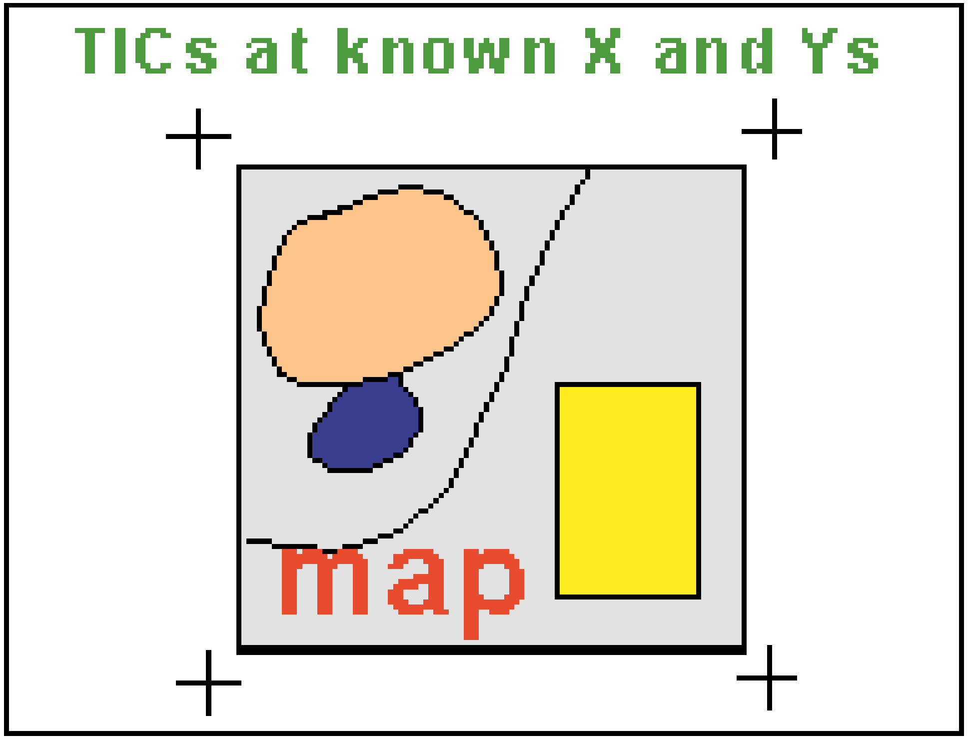
- **NETWORKS**
  - starting at one end of the network, digitize a line as described above
  - where this first line meets another line, click to end digitizing. Then, without moving the cursor from this end node of the first line, begin digitizing the second line.
  - repeat this procedure until the entire network has been digitized

    In order to be topologically correct, lines should never cross each other. A node should represent the intersection of two or more lines.

1. **POLYGONS/AREAS**

- also digitized in stream mode
- digitized as an area edge or common line
  1. using the previously marked starting point (on the Mylar sheet), trace out the feature and bring the cursor back to the starting point, before clicking to end the digitizing. The start node and end nodes should coincide.
  2. if the start and end nodes do not coincide, use the snapping or automatic closure menu
  3. digitize each area edge only once, even if it is a boundary between two polygons. The topology about the nature of the adjacent polygons can be added in a later editing exercise

TIC points digitizing



Registration points

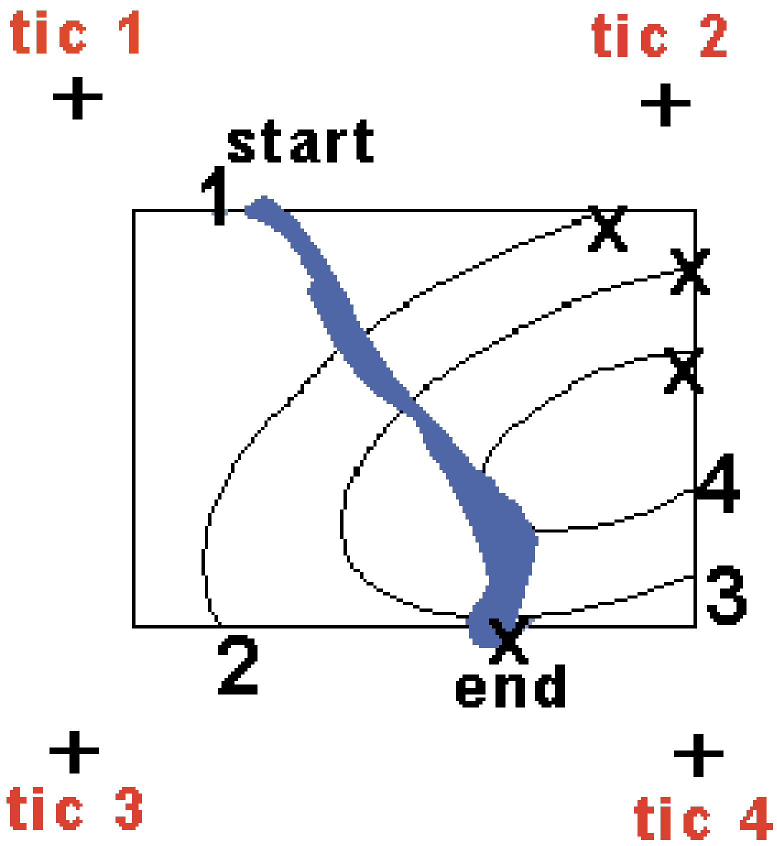
A - 505,840:4, 475,024

B- 505,432: 4,475,504

C - 505,240: 4,476,216

D - 505,900: 4,476,228

Prepare a systematic order for digitizing



Digitizing Steps:

Do tics, then:

1 RIVER

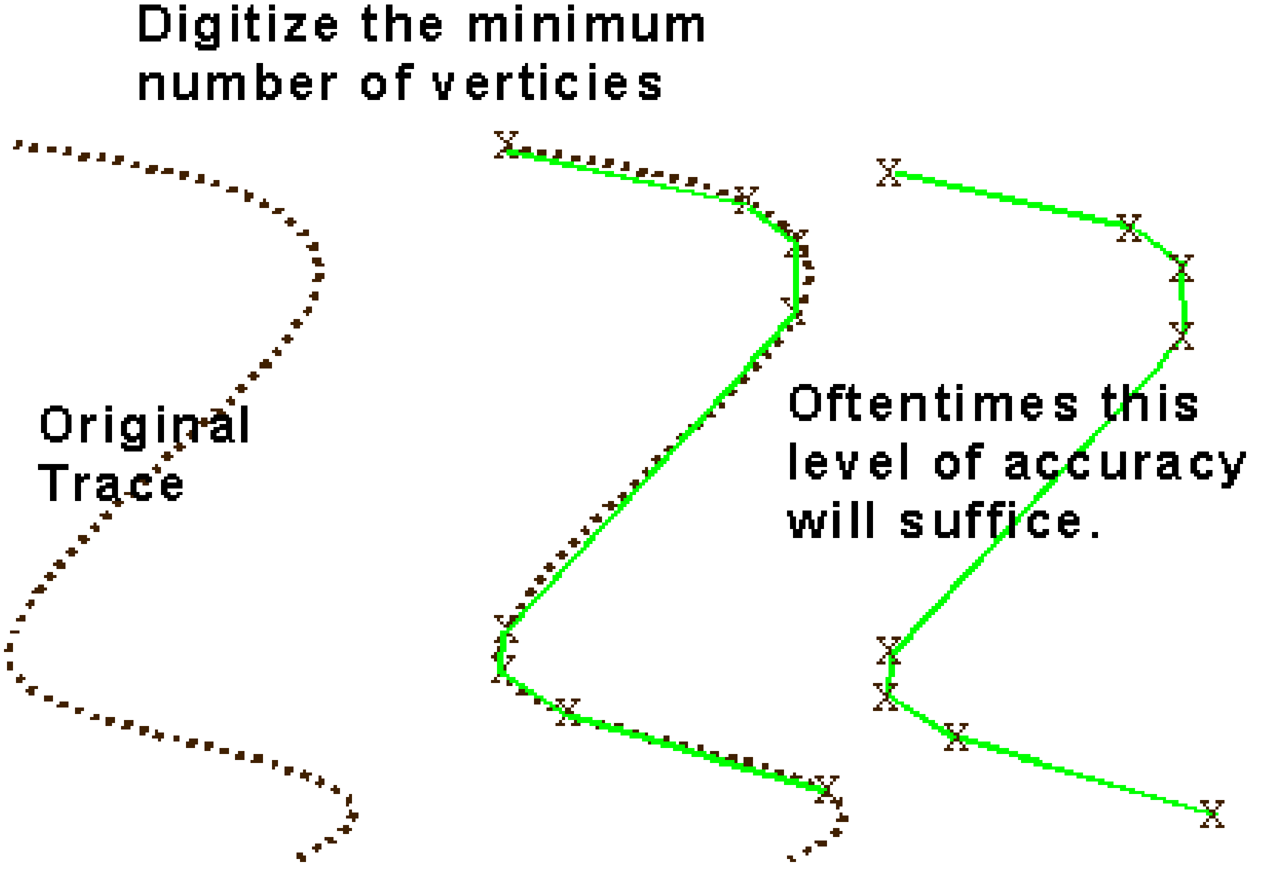
2 CONTOUR 1

3 CONTOUR 2

4 CONTOUR 3

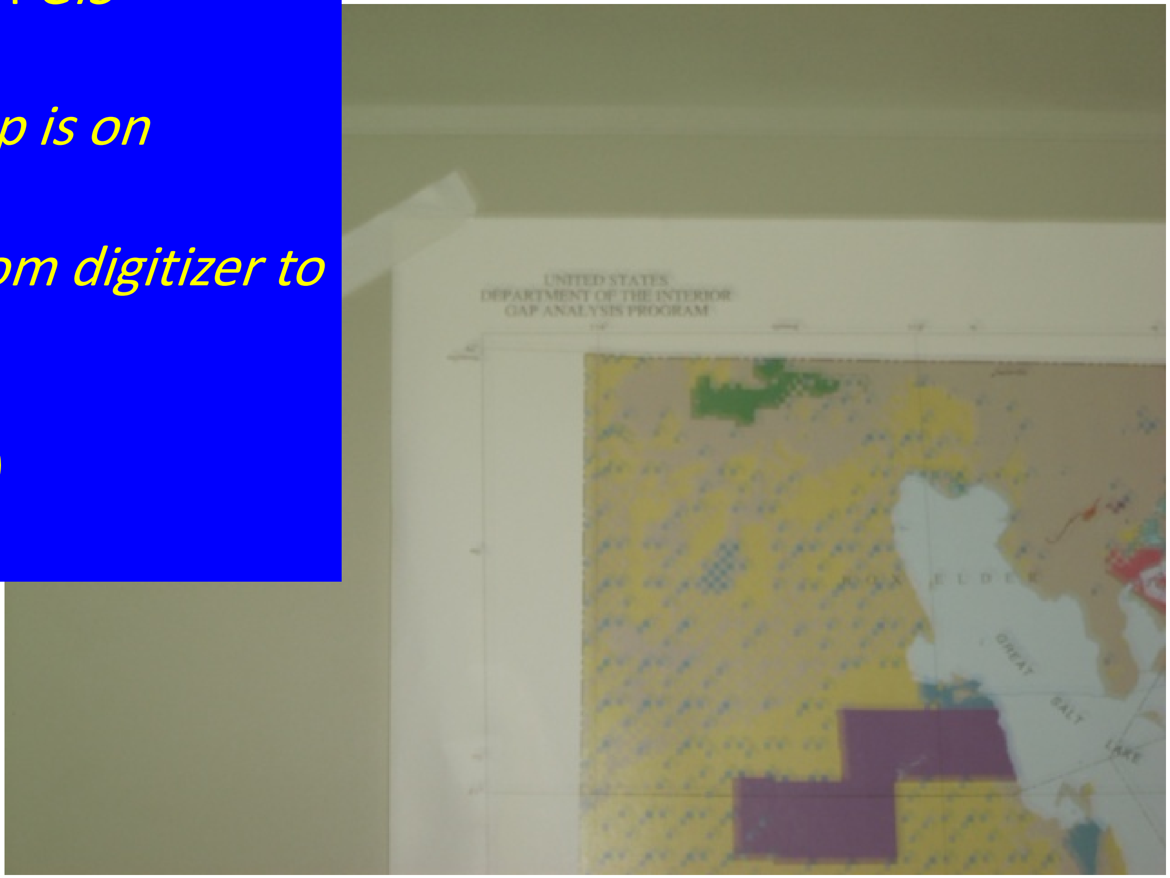
Here the **X** is a digitized point taken with "point mode" where instead one could have used "stream mode" and captured all the points represented by the dots, at a high

cost in effort and storage without adding to the accuracy.



Creating a coverage with the digitizer

- Create empty coverage in *GIS*
- *Affix map to digitizer*
- *Tell computer where map is on digitizer*
- *Set data input stream from digitizer to file*
- *Enter data*
  (2 for node, 1 for vertex)
- *Save often*



Creating a coverage with the digitizer

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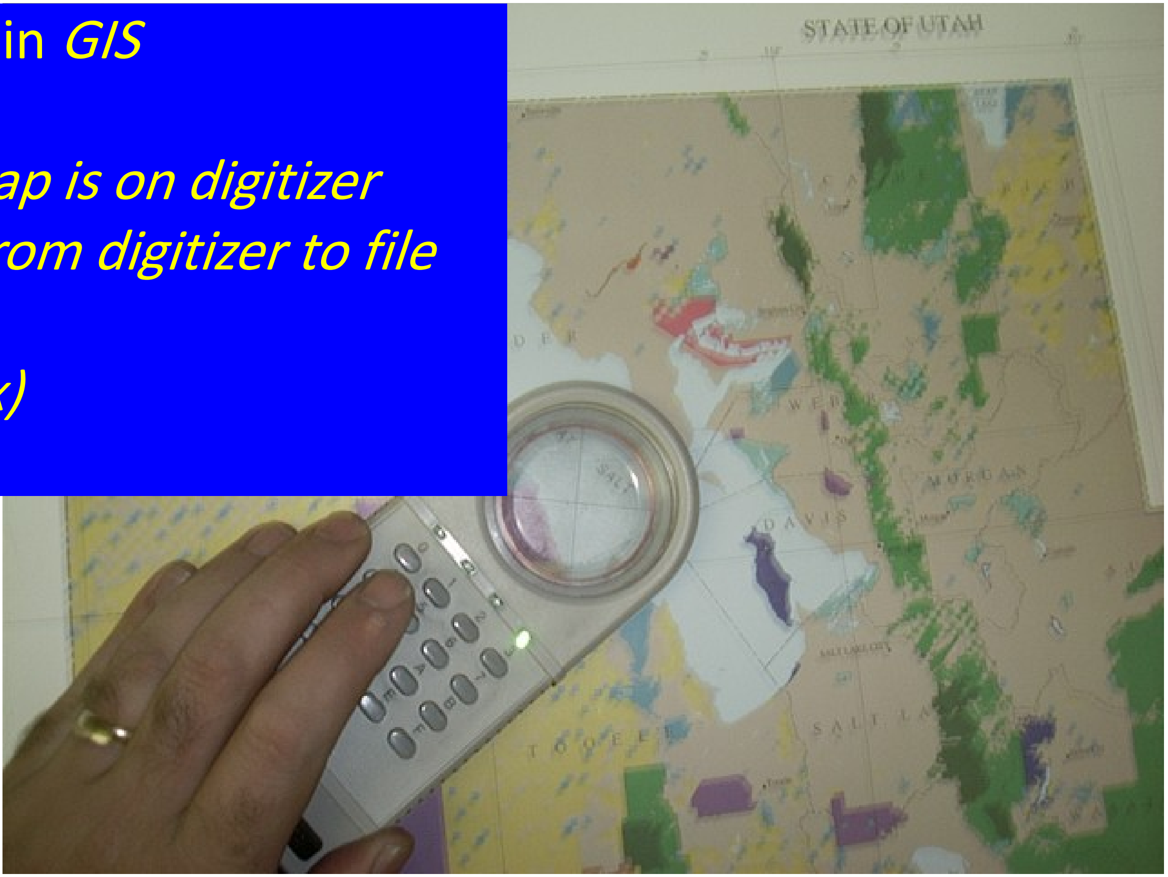


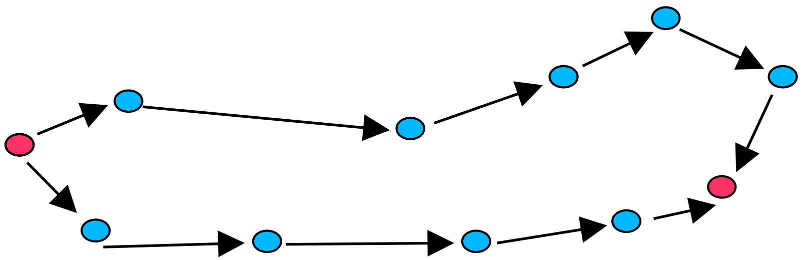
Adding lines

"When you start digitizing, you will add points or arcs
"Higher level objects (polygons, networks, etc.) will be assembled later from the arcs and points

Review of polygon structure

"Remember, a polygon is made up of one or more arcs
"Polygon structure is subject to planar enforcement
"Wherever two arcs intersect, they **must** be separated with a node

Polygon



One or more lines, closing in on itself
lines are joined at nodes

Entering data

1. Start at point were lines intersect
2. Enter node to *begin line*
3. Enter a series of verteces to *trace outline*
4. Enter node to *end line*
5. Repeat ad infinitum
6. Edit data in GIS

Digitizing from an Air Photo

Consider the following air photo

We wish to digitize the property boundaries

Digitizing from an Air Photo

Start at an intersection of boundaries

Enter a node

Digitizing from an Air Photo

Start at an intersection of boundaries

Enter a node

Trace boundary with vertices

Digitizing from an Air Photo

Start at an intersection of boundaries

Enter a node

Trace boundary with vertices

End with a node

Digitizing from an Air Photo

Repeat for all arcs that make up boundary of polygon

More digitizing

Do a lot of it

Creating New Data (Cont'd)

- **On-Screen (head-up) Digitizing:**
  - Relatively easy to do w/ a background
  - Good for updating/editing changes
  - You can add points, lines, polygons
  - You will work on an exercise/project
  - You don't have to register points as in manual digitizing
- **Geometric Transformation:**
  - Digitized maps have same coor. As source map
    - You may have to convert to real-world coor. & projection using control points.

- **Post-digitizing tasks**
- Sometimes the computer screen that is being used to display the map being digitized has a lower resolution than the digitizer. In this case, it may be difficult to see objects that have been digitized very close together, until one zooms in to see whether they are separate lines.
- Zooming also helps in performing three other tasks that are necessary in creating an accurate digitized layer. They are:
- error identification and elimination
- editing
- labeling of features

- **Labeling of features**

  Each digitized point, line segment or area edge must have a label or identifier associated with it. These feature identifiers represent a category of a feature (e.g. "1" for highways, "4" for dirt roads) and can either be added using an EDIT or LABEL menu in the post-digitizing phase, or during digitizing

- **Editing**

1. review the digitized maps, checking for errors.
2. remove duplicate lines where they occur.
3. snap nodes for polygons that should be closed.
4. snap lines to the relevant nodes where under- or overshooting occurs.

- **Relationship between digitizing and editing**

- digitizing and editing are complementary activities
  - poor digitizing leads to much need for editing
  - good digitizing can avoid most need for editing
  - both can be very labor-intensive

- **Error identification and elimination**

check the digitized map for the following errors:

sliver polygons

line segment errors or dangling chains, where lines in a network do not meet at the appropriate nodes. This is corrected by snapping.

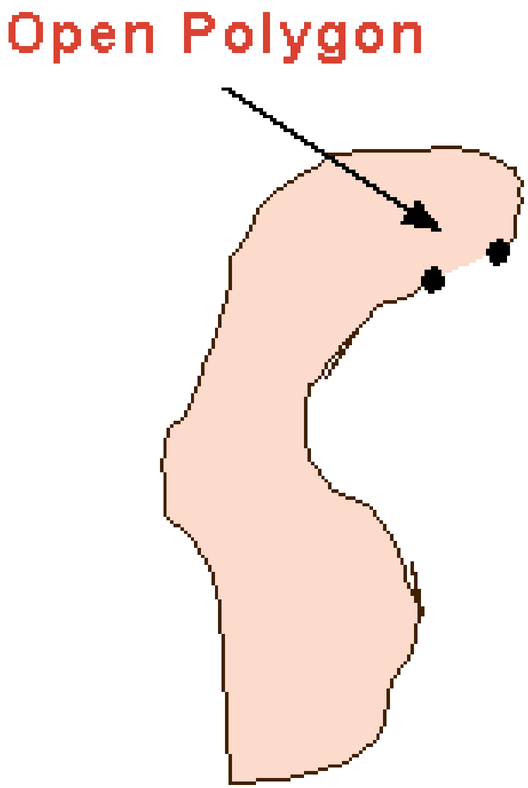
polygonal errors which may include duplicate line segments, missing line segments, mislabeled line segments, unlabeled polygons and conflicting names.

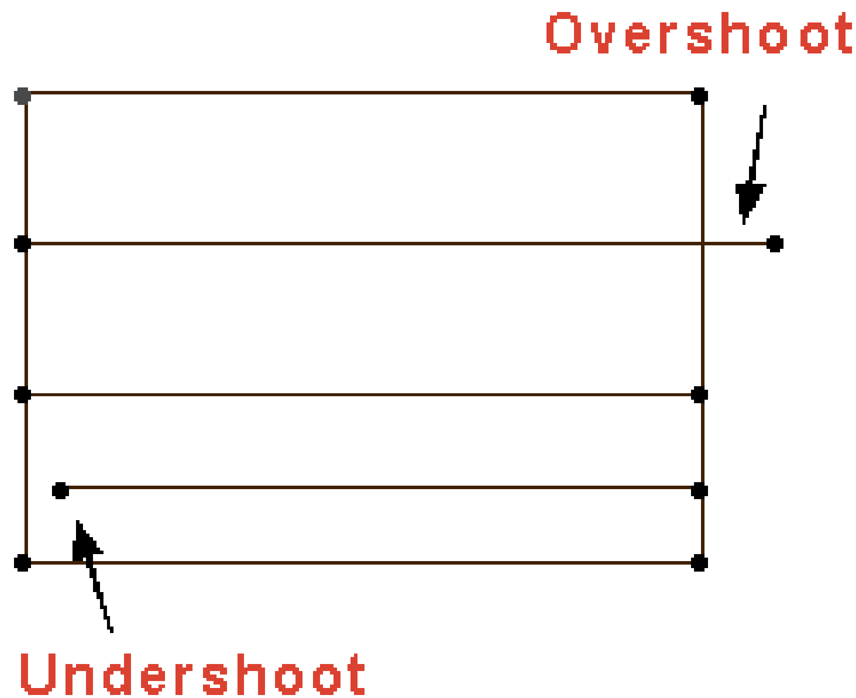
strange polygons which do not appear on the original map, but which have occurred due to operator negligence.

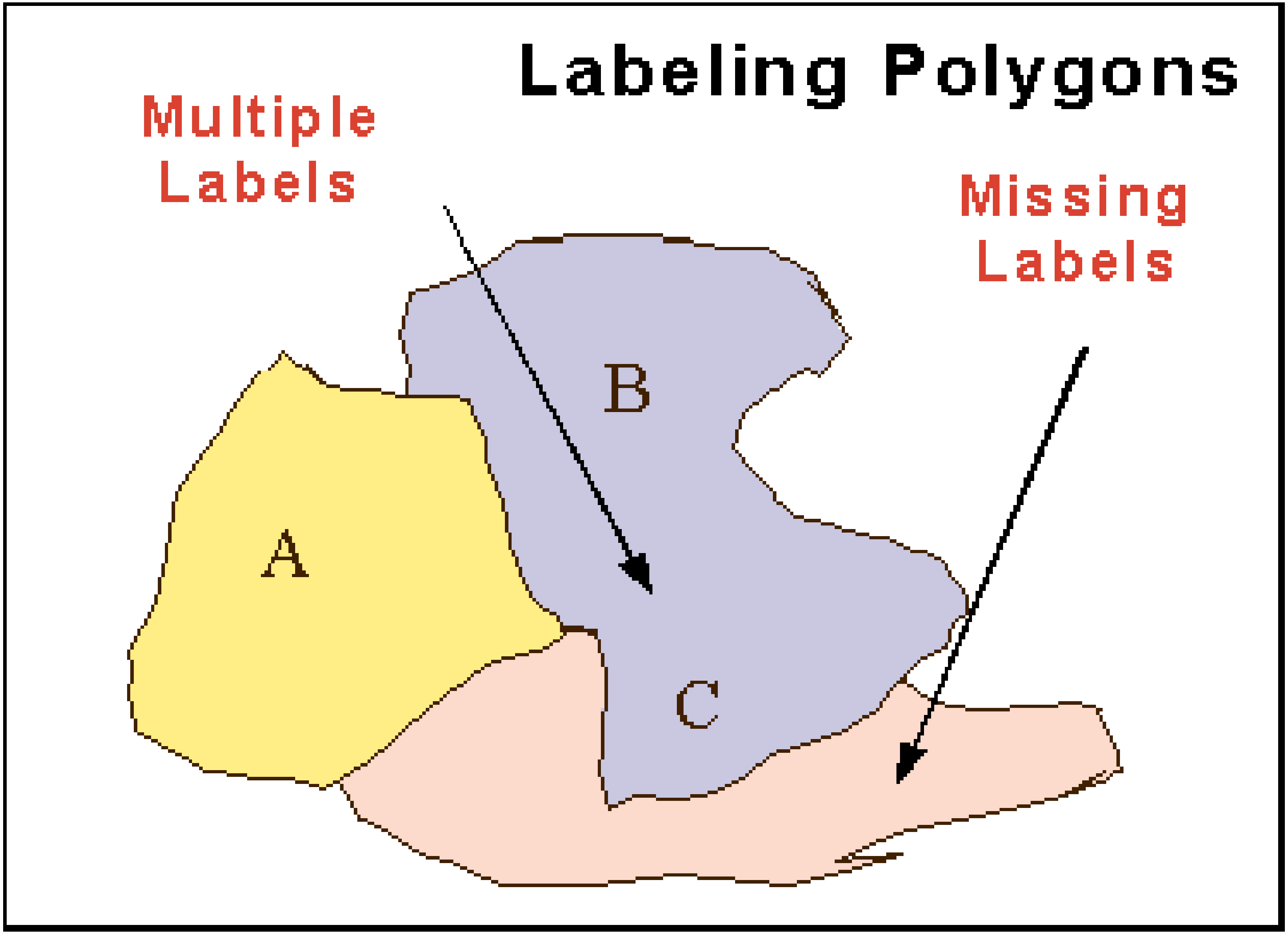
check for positional accuracy by comparing the digitized map against an independent map of higher accuracy.

Dangling Nodes:

A single node attached to a single entity

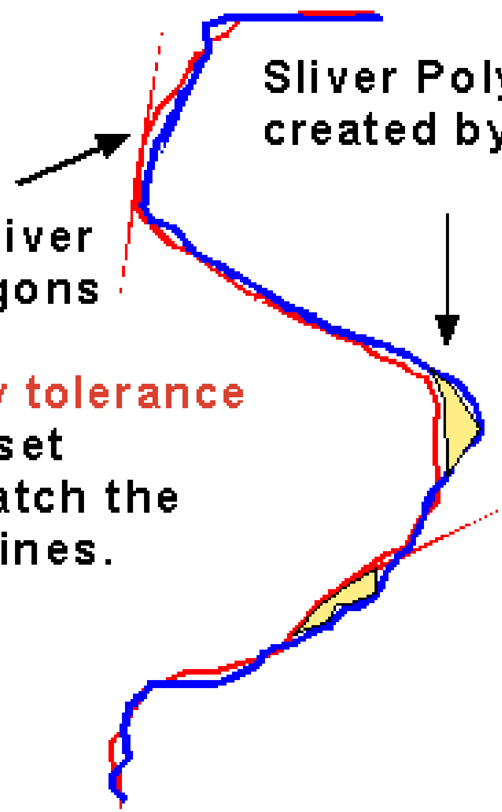





Labeling Polygons
Multiple Labels
Missing Labels
A
B
C

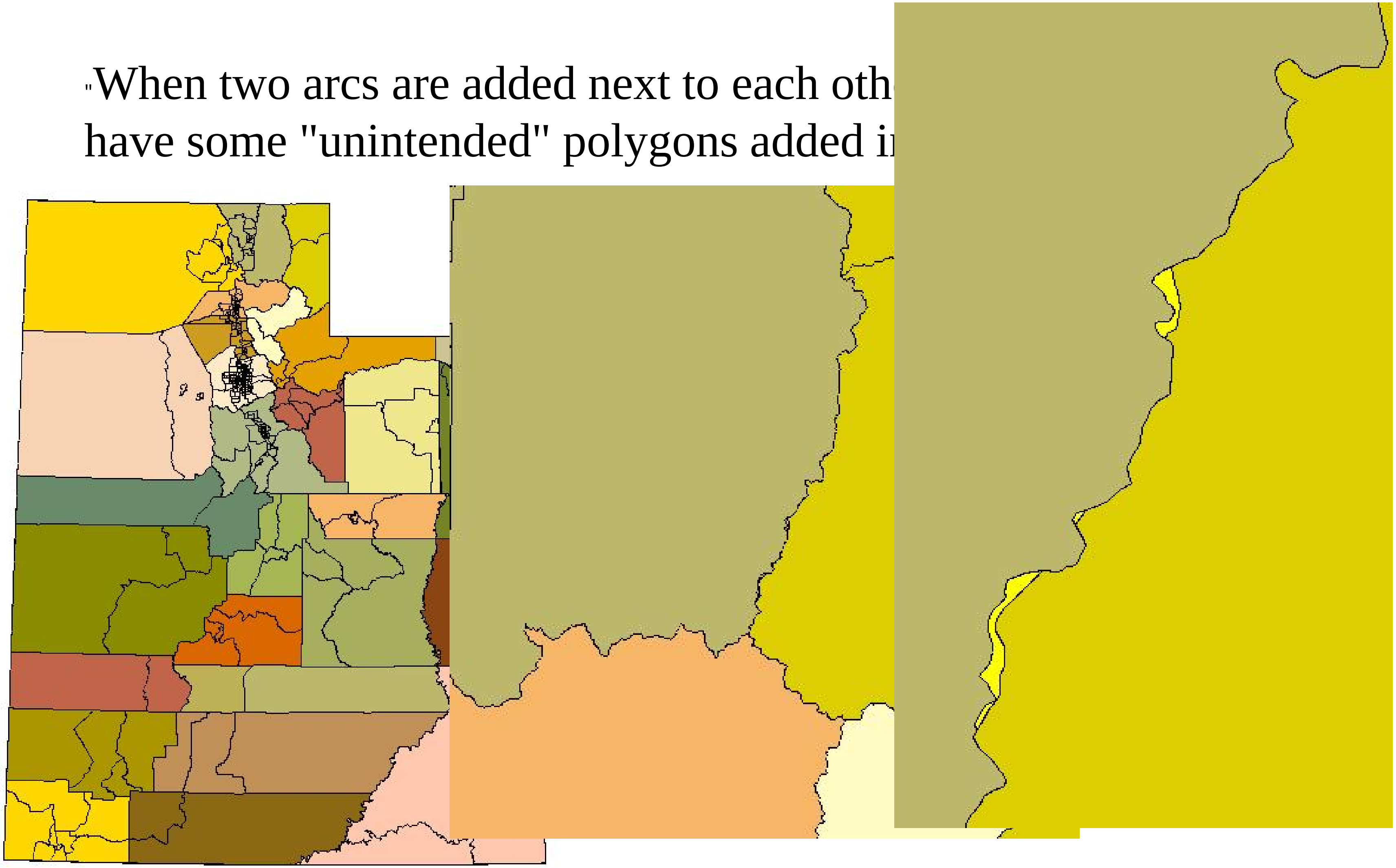
Sliver Polygons:

small polygons created when digitizing the same line twice or in overlay operations.



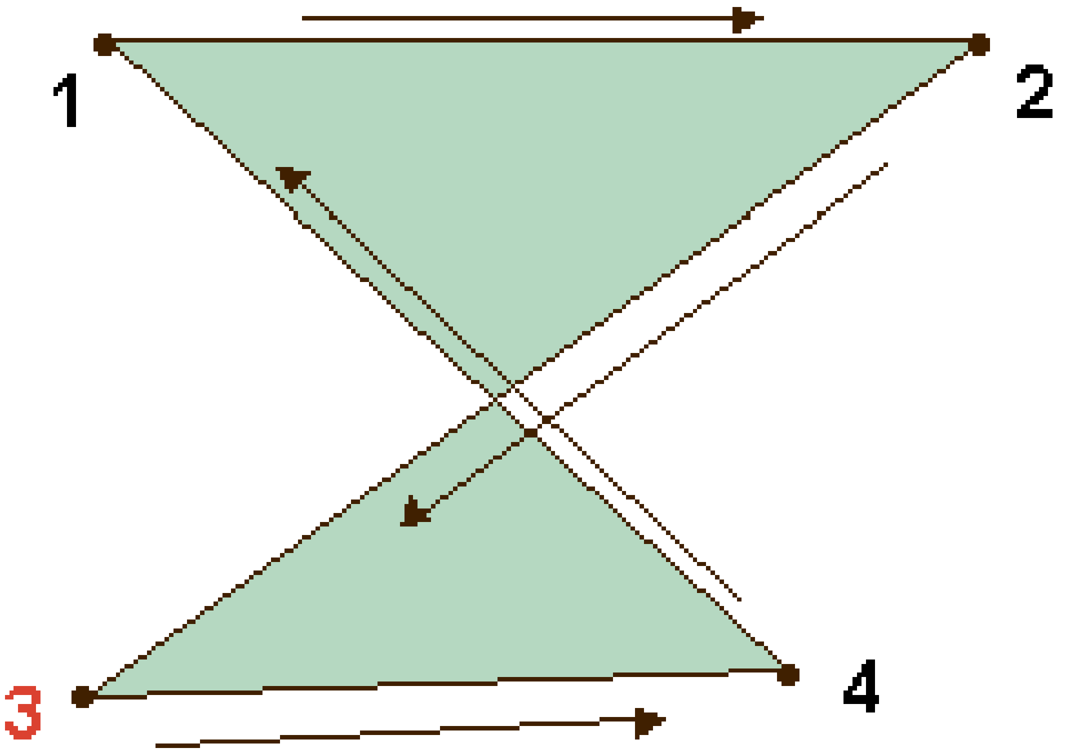
Sliver polygons

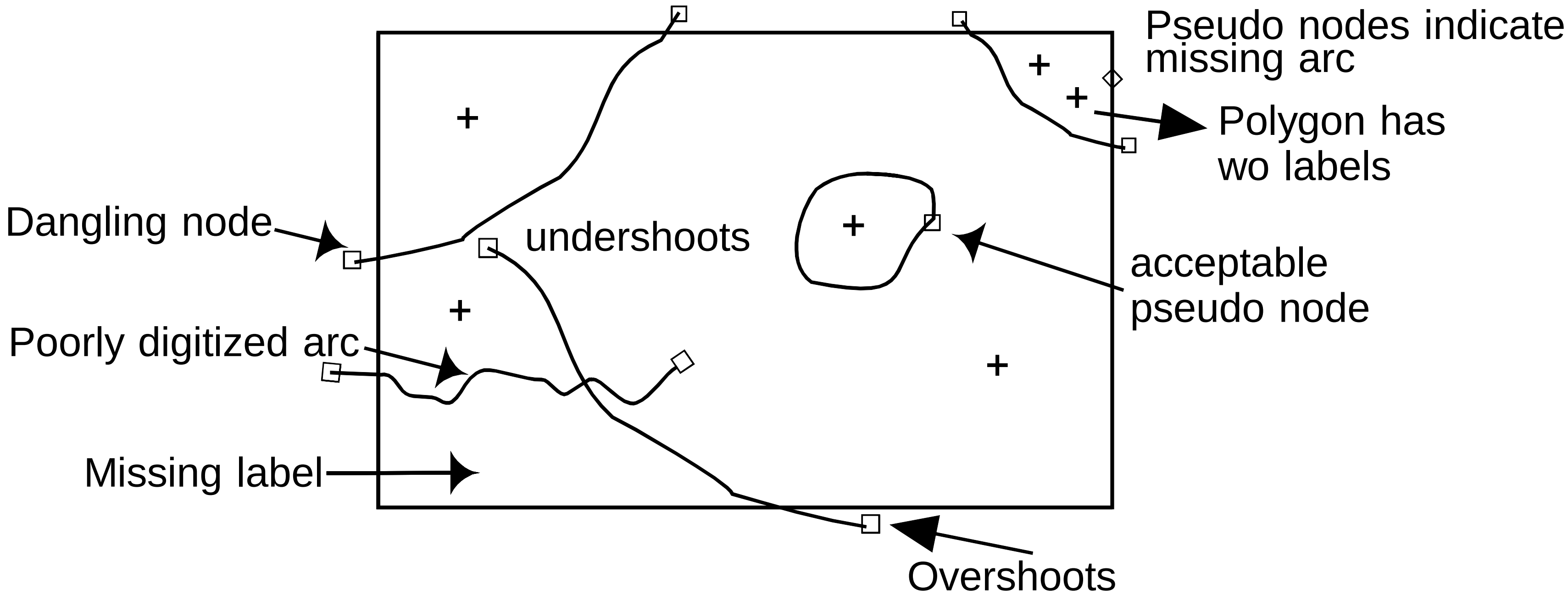
"When two arcs are added next to each oth
have some "unintended" polygons added i



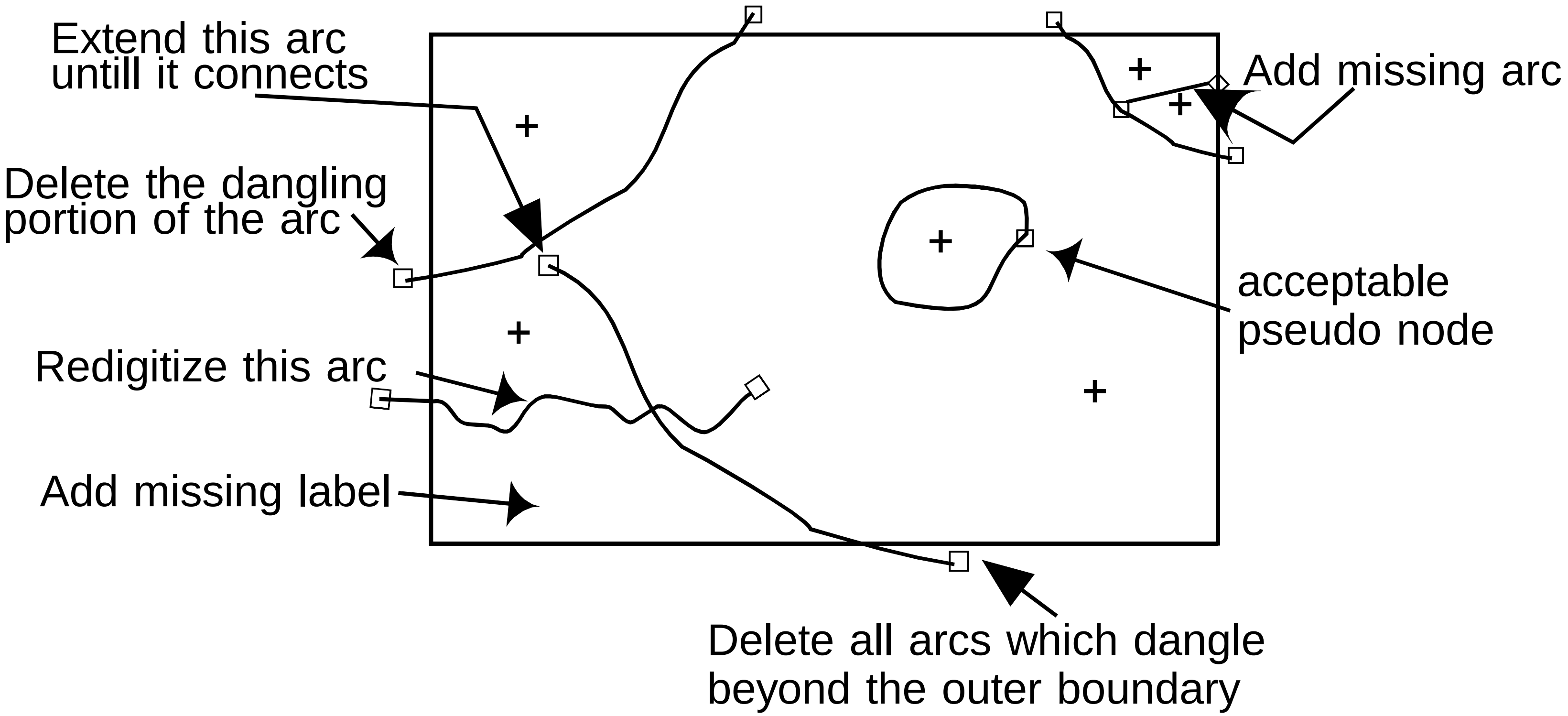
Weird Polygons

Polygons with missing or misordered nodes

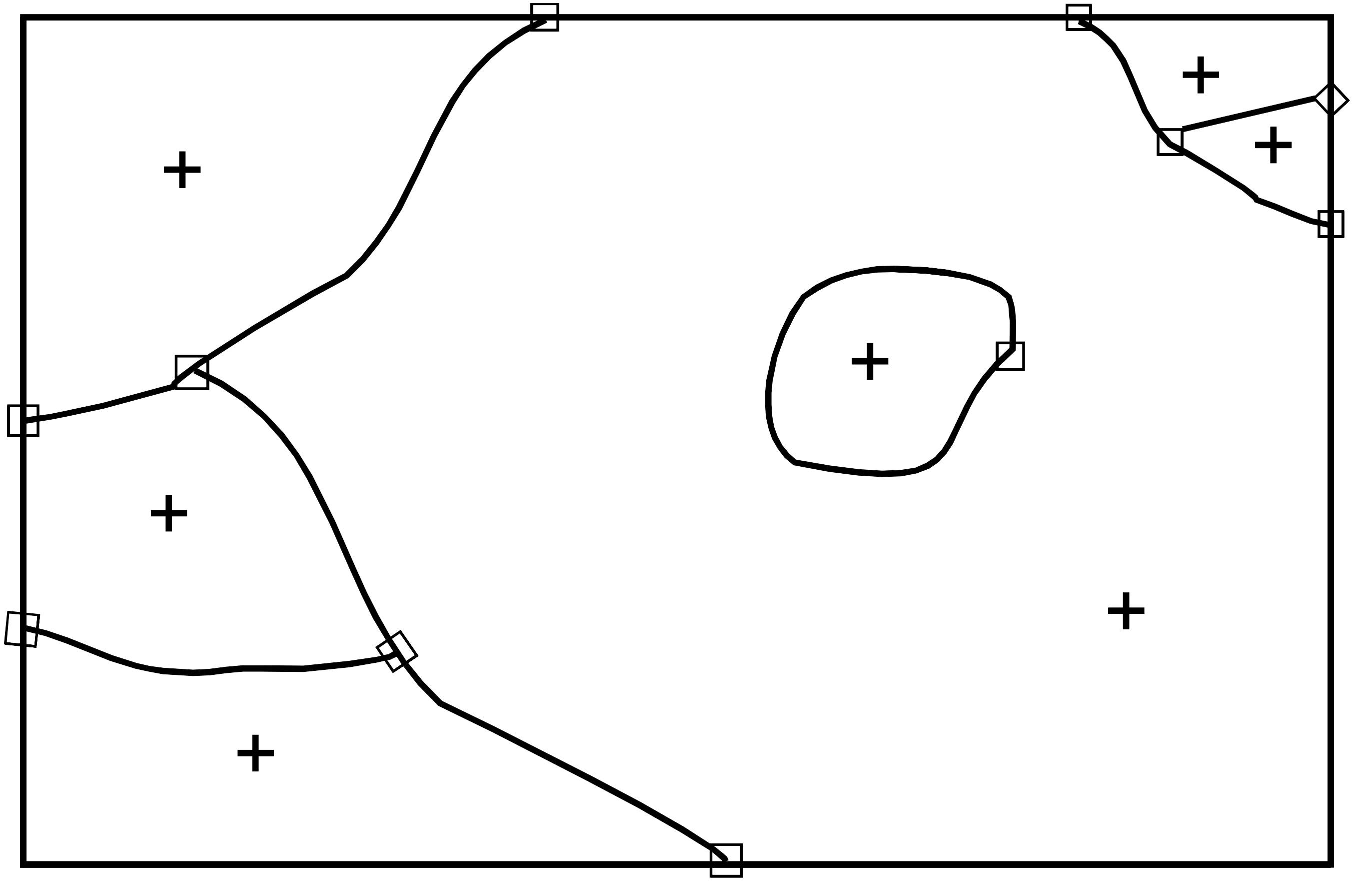




Some errors as they interpreted by you after comparing them with the source map



Showing a set of errors marked to be fixed and how to fix them



The same set of Data after the spatial errors have been corrected

- **Edge matching**

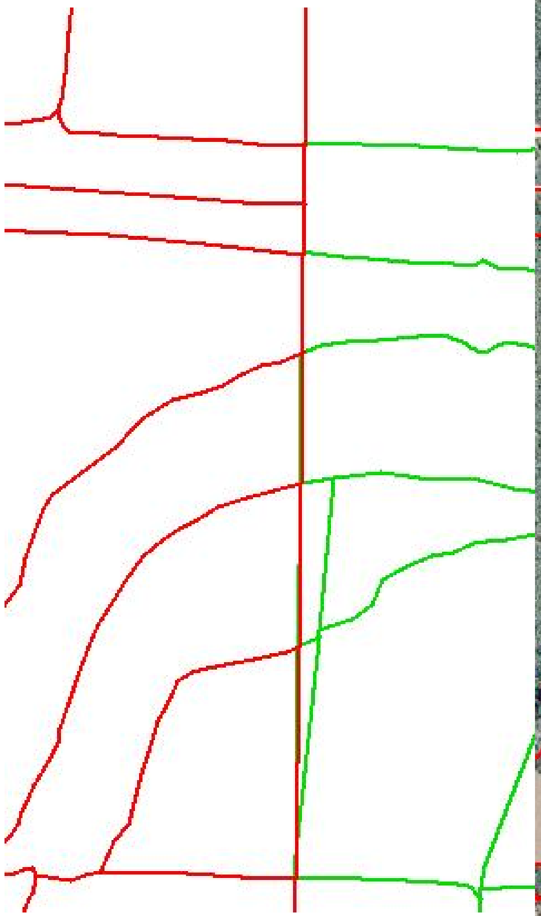
  or patching involves the adjustment of two or more adjoining map sheets along their edges, so that the features that are common agree. This may involve snapping or rubber sheeting.

Edge Matching

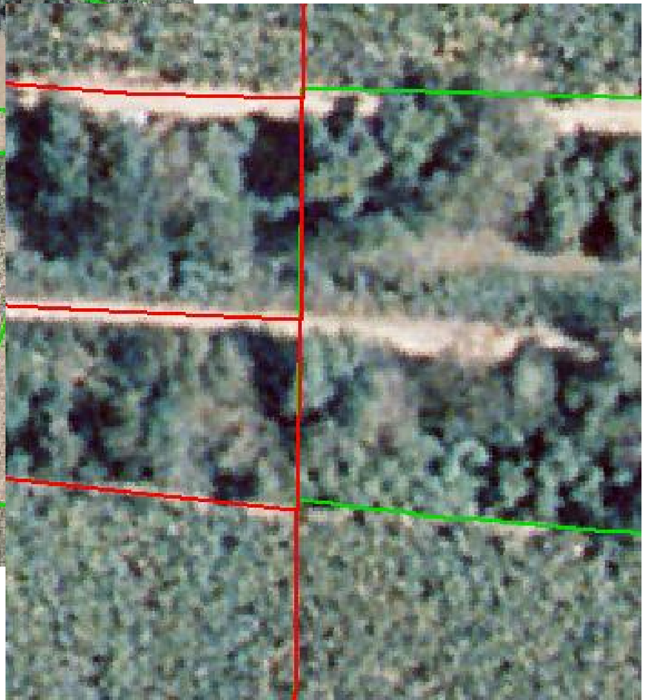
Edge Matching

Do these coverages match up?

Who is correct?



Check original data sources



Discussion

Questions

Lecture 6

Building Topology

Topology Definition

- **The Science of mathematics of relationships used to validate the geometry of vector entities, and for operations such as network tracing and tests of polygon adjacency.**

- **The study of geometric properties that do not change when the forms are bent, stretched or under go similar geometric transformations.**

- **Importance of Topology in Vector Format**
- **Thus far we have presented vector data simply as points, lines, and polygons with associated attributes. This provides for location and meaning. However, it is also important to understand the spatial relationship between spatial objects. This is called** *topology.*

- **consider these relationships:**

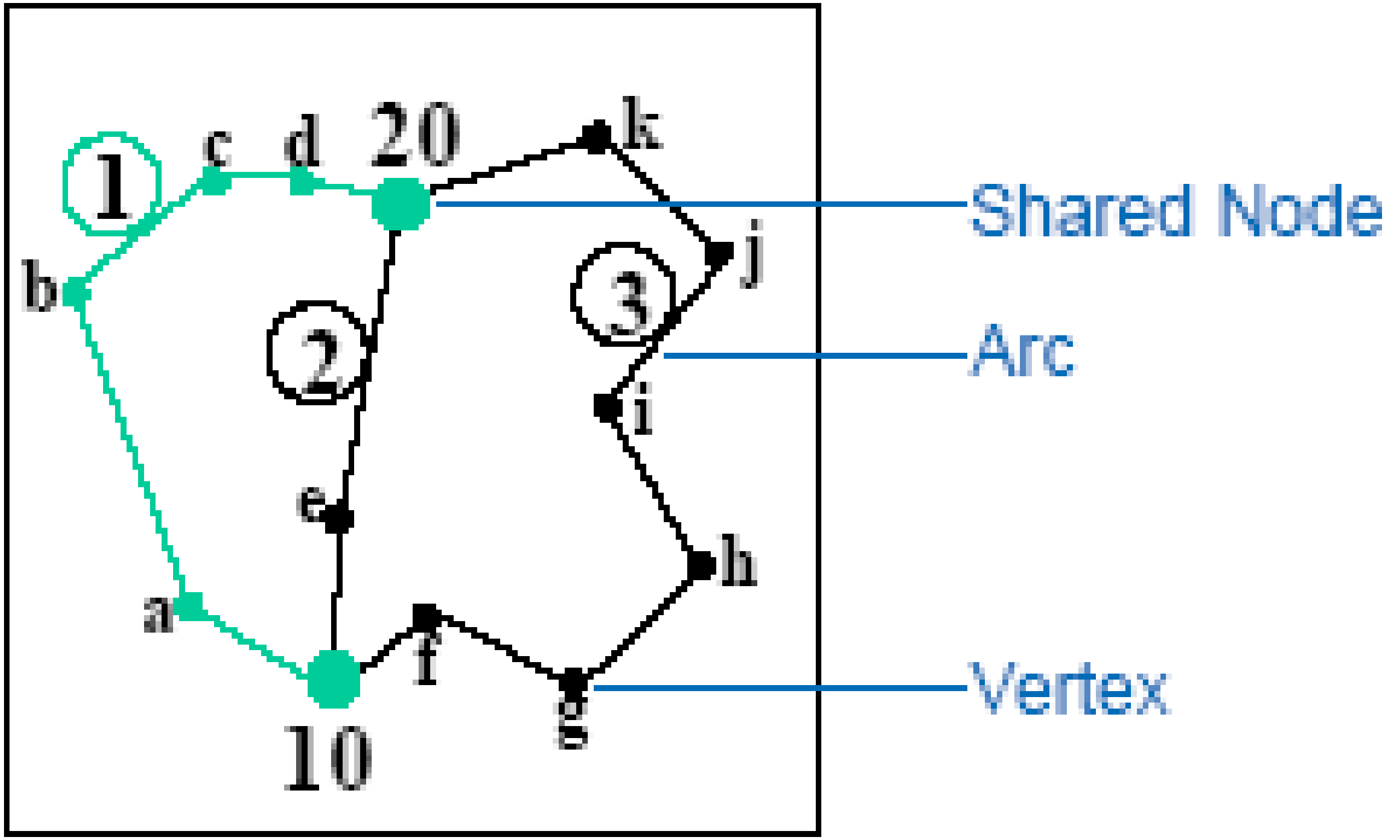
  adjacency

  containment

  connectivity

- **Topology allows for much more sophisticated spatial analyses.**

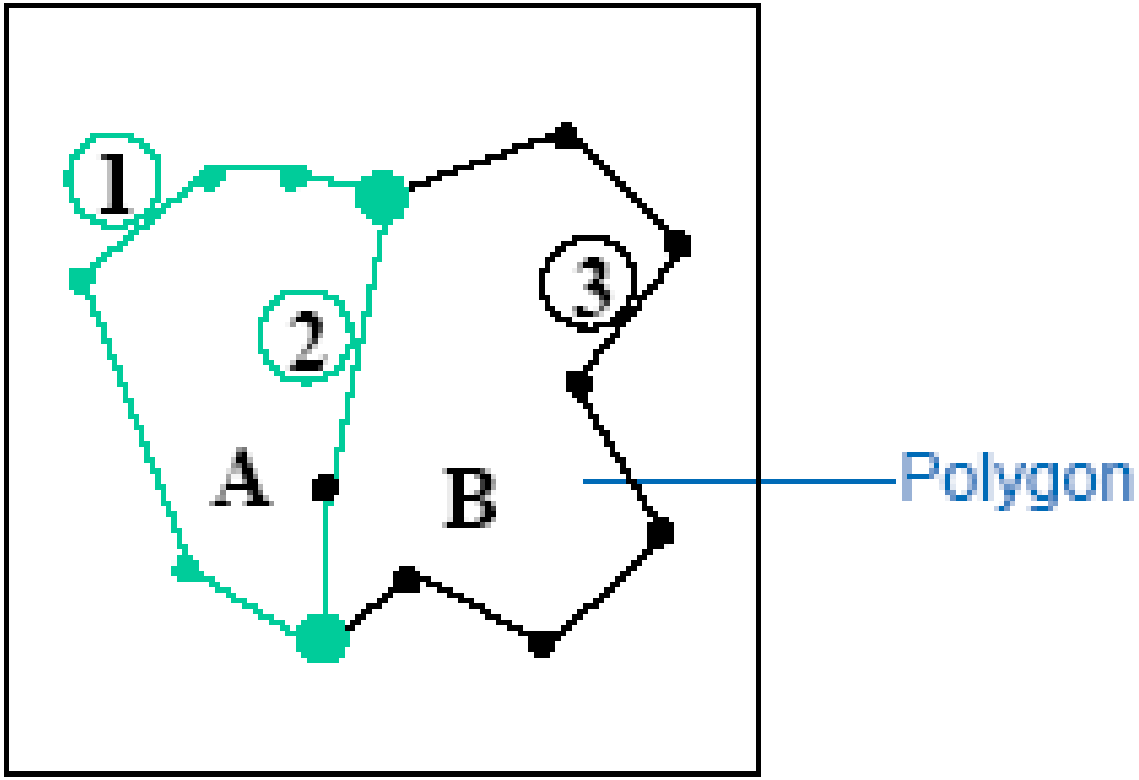
- The three major topological concepts are:
- Arcs connect to each other at nodes (connectivity)
- Arcs that connect to surround an area define a polygon (area definition)
- Arcs have direction and left and right sides (contiguity)



Connectivity

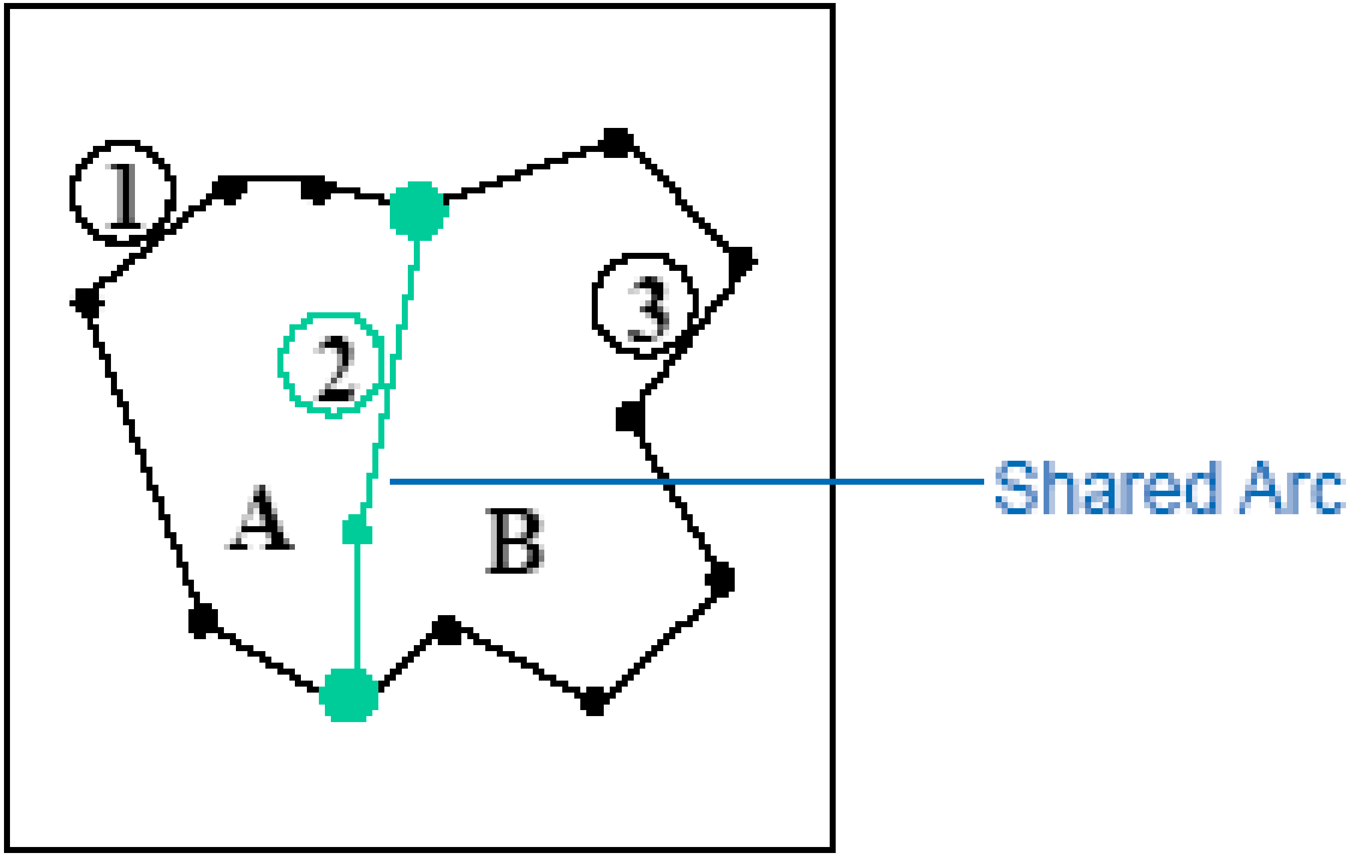
Storing connectivity by recording the nodes that mark the end points of arcs (lines) is useful for modeling and tracing flows in linear arcs

Arcs that share a node are connected. This is called Arc-Node topology



Area Definition

Coverages define areas by keeping a list of connected arcs that form the boundaries of each polygon. This is called Polygon-Arc topology

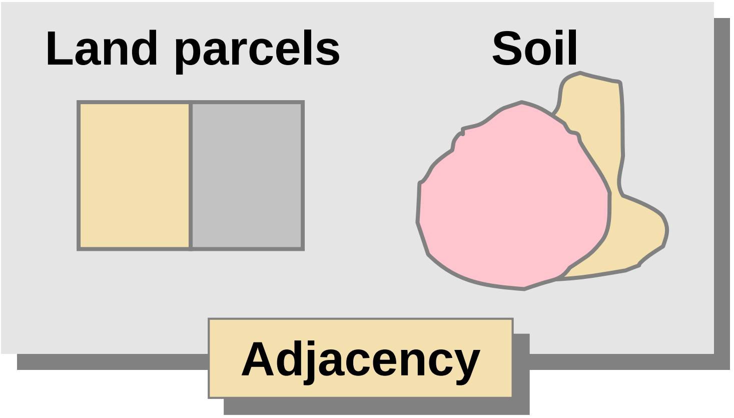


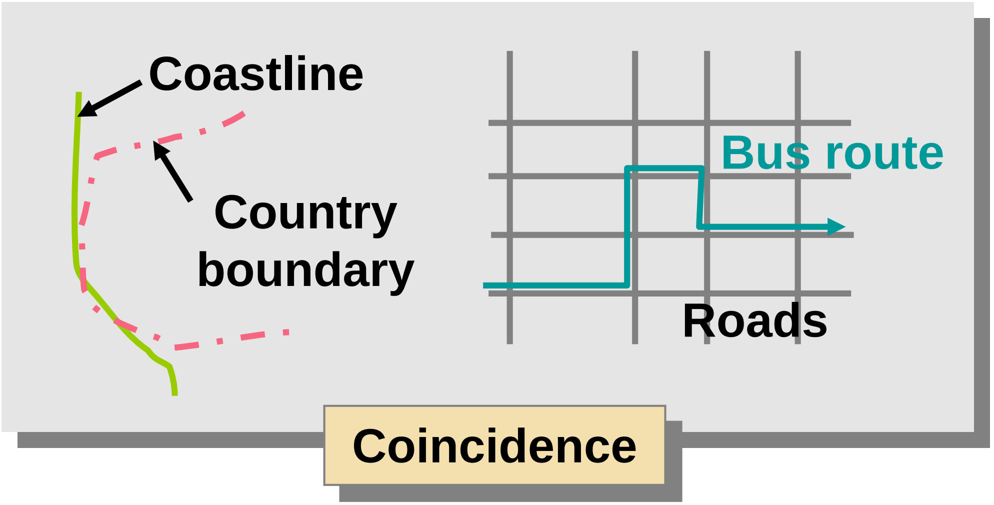
Contiguity

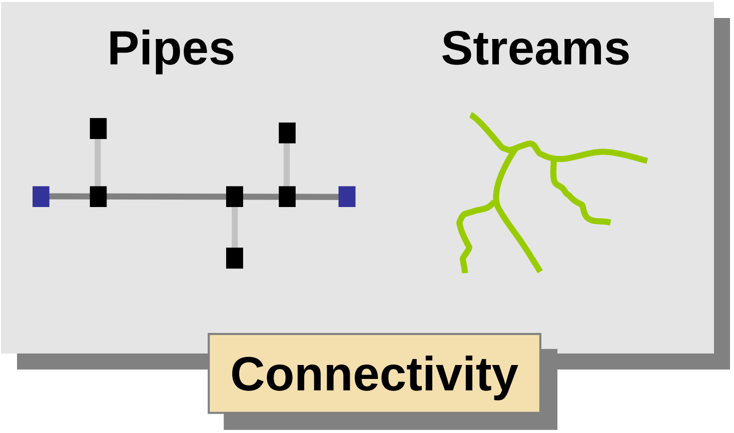
Coverages store contiguity by keeping a list of the polygons on the left and right side of each arc

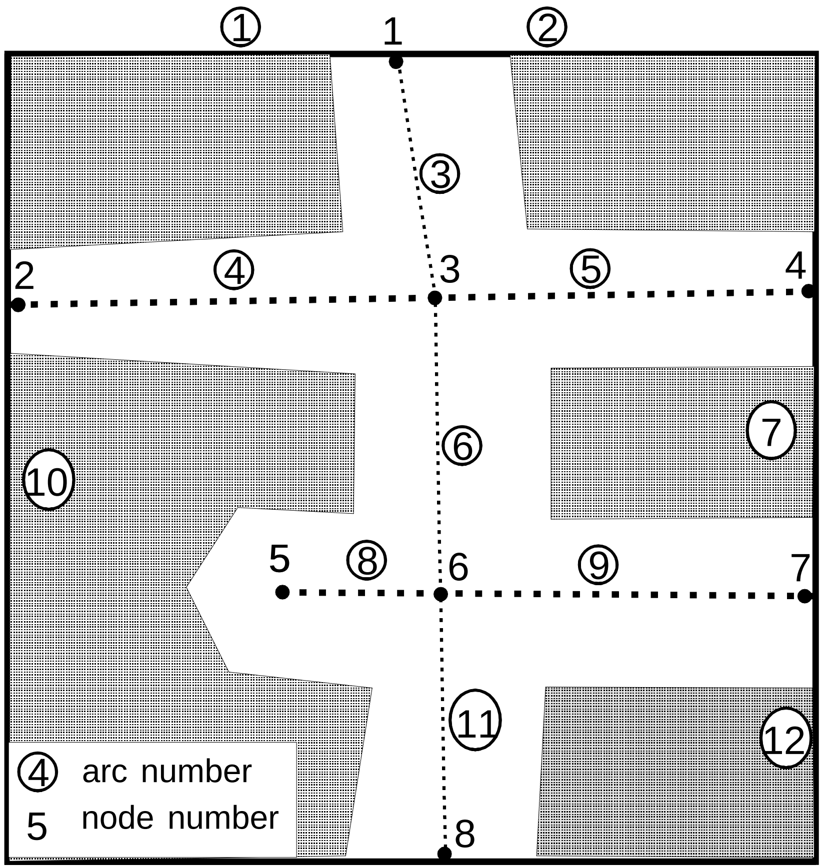
Topology

- Models spatial relationships between features
  - Connectivity, adjacency, coincidence
  - Between one or more feature classes
- Allows for better models of the real world







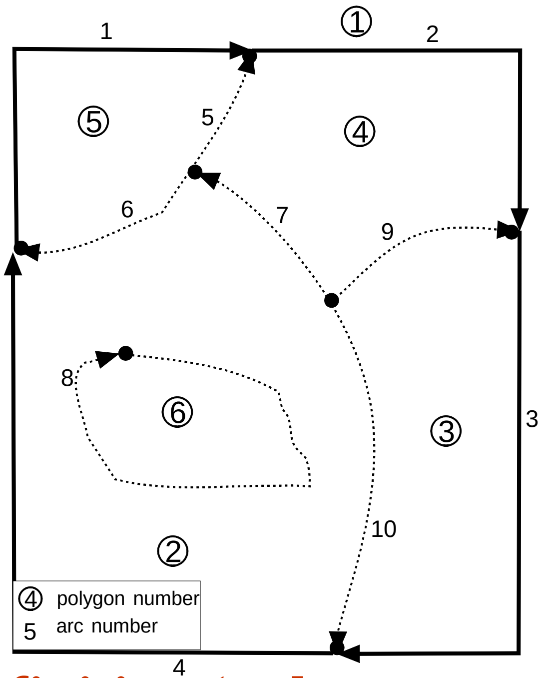


"Arc-node topology (connectivity)

Arc	From-node	To-node
1	2	1
2	1	4
3	1	3
4	2	3
5	4	3
6	3	6
7	4	7
8	5	6
9	6	7
10	2	8
11	6	8
12	8	7

•**Arc-node topology (connectivity)**

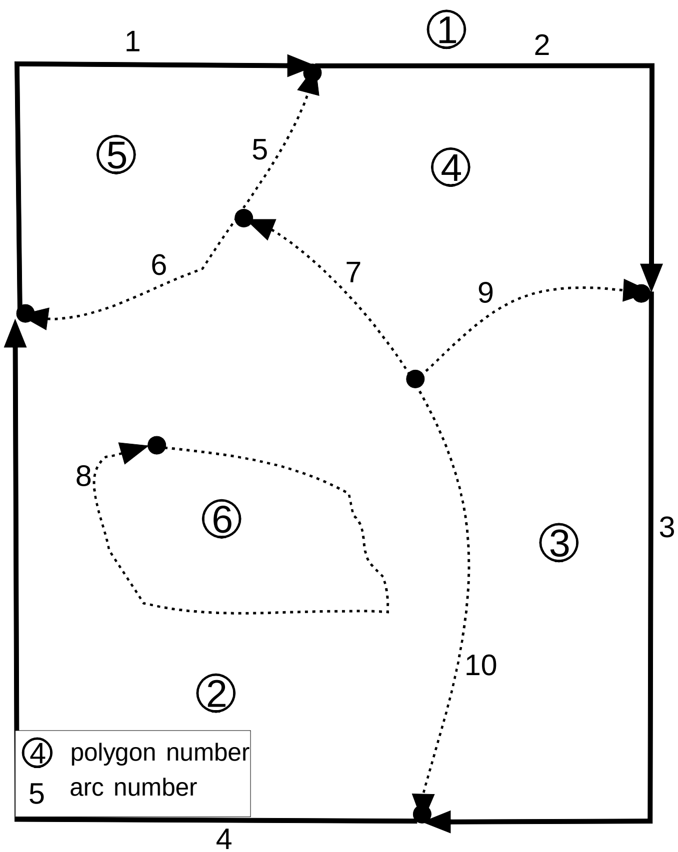
•Arcs are used to represent street centre lines. Nodes are located at street intersections. By definition the points (x, y pairs) along the arc, called ***vertices***, define the shape of the arc. The ending points of the arc are called ***nodes***. Each arc has two nodes; a from-node and to-node. Arcs can join only at their end points, or nodes. In the above illustration, arcs 6, 3, 4, 8 all join at node 3. The computer now knows that it is possible to travel along arc 3 and turn onto arc 8 because they share a common node 3, but it is not possible to turn directly from arc 3 onto arc 9 because are 3 and arc 9 do not share a common node.



Polygon No.	Arc No.
٢	١٠,٧,٦,٤، ٠،
٣	٨
٤	٣، ١٠، ٩
٥	٧، ٥، ٢، ٩
٦	١، ٥، ٦
	٨

Area definition (Polygon – arc Topology)

Polygons are represented by a series of x, y coordinates that connect to enclose an area. Some system stores polygons in this format. ARC/INFO however, stores the arcs defining the polygon rather than a closed set of x, y pairs. A list of arcs that make up each polygon is stored and used to construct the polygon when necessary. In the above illustration, arcs 4, 6, 7, 10 comprise polygon 2 (the 0 before the 8 indicates that this arc creates an island in polygon 2).



Arc No..	L Poly.	R Poly
١	٥	١
٢	٤	١
٣	٣	١
٤	٢	١
٥	٤	٥
٦	٥	٢
٧	٤	٢
٨	٦	٢
٩	٣	٤
١٠	٢	٣

Contiguity (Left-right Topology)

Because every arc has direction (a from-node and a to-node); ARC/INFO maintains a list of polygons on the left and right sides of each arc. Thus any polygons sharing a common arc are adjacent. In the above illustration, polygon 2 is on the left of the arc 6, and polygon 5 is on the right. Notice that the label of polygon 1 is outside the boundary of the area. This polygon is called the *external* or *universe* polygon, and represents the area outside all the polygons in the map.

Arc/INFO coverages

In Arc/INFO, all spatial information has topological information attached to it

- Containment, connectivity, adjacency

to correctly derive this, all coverages are subject to planar enforcement

- All intersections of arcs must be joined by nodes
- All polygons must be closed

Labeling polygons

A polygon is formed of one or more arcs

The computer uses an algorithm to build the arcs into a higher level object (polygon)

The build process can be processor intensive, so it is only done when the user asks for it

the computer wishes to attach the information to the polygon, but attaching an attribute to a variable number of arcs is messy

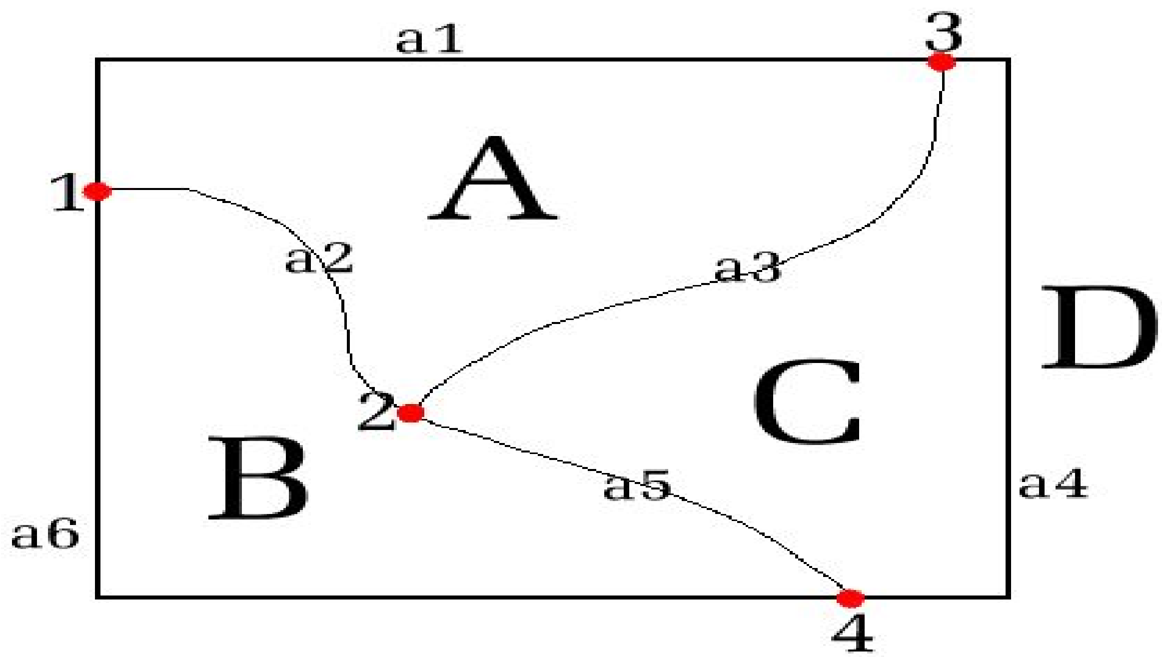
A single label point is added to the polygon

That label point is the object upon which all attributes get attached

Feature No.	Road-type	Surface	Width	Lanes	Name
1	1	Asphalt	40	4	Galaa St
2	1	Asphalt	40	4	Gehan St
3	1	Asphalt	40	4	Bahr St
4	2	Gravel	20	2	Bostan St
5	4	Gravel	20	2	Ferdous St
6	3	concrete	30	3	Mubarak st

Record

Item



Polygon Topology		Node Topology		Arc Topology	
Polygon	Arcs	Node	Arcs	Arc	Left & Right Polygons
				a1	**A D**
A	**a1, a2, a3**	**1**	**a1, a2, a6**	**a2**	**A B**
B	**a2, a5, a6**	**2**	**a2, a3, a5**	**a3**	**A C**
C	**a3, a4, a5**	**3**	**a1, a3, a4**	**a4**	**C D**
D	**a1, a4, a6**	**4**	**a4, a5, a6**	**a5**	**B C**
				a6	**B D**

Topology

- **Spaghetti versus Topological data**
- **a.** 'Simple' spaghetti data

Vector data that has been created without topology is referred to as 'spaghetti' data for reasons you can imagine (strings of unconnected lines). This is easier to create, but if to be used for GIS, one pays for lack of topology later: Individual features may appear the same, for example:

- Points: have x and y coordinates.
- Lines (arcs): Strings of x, y vertices.
- Polygons: Closed set of coordinates.
- But there is NO spatial relationship between these features:
- Arcs may not necessarily join and Polygons may not close to form areas.
- Intersections may not have nodes where two arcs cross.
- Adjacent digitized polygons may overlap
- Arcs may consist of many broken segments.

Topological data

- Creating topologically correct data takes longer, but enables GIS queries and analysis.

1- Points: are polygons of zero area and length.

2- Lines (arcs): start and end at nodes.

3- Polygons: given by sets of connected arcs and an interior label point.

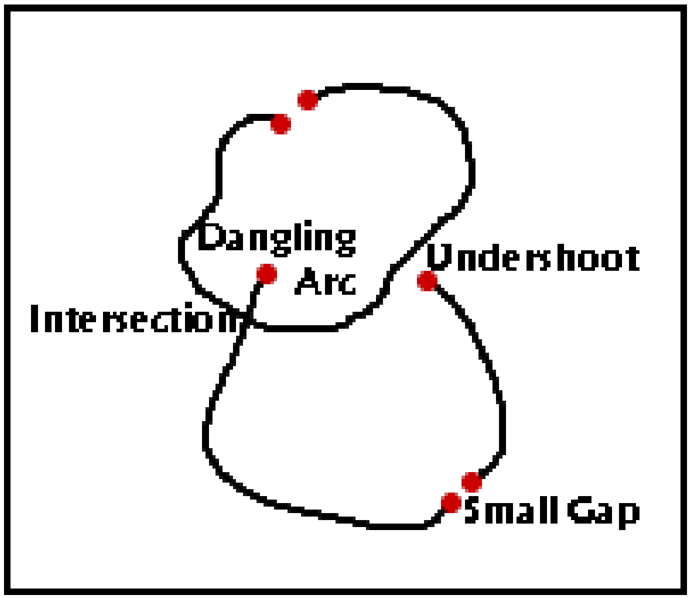
4- Shared polygon arcs result in:

a) Lower total number of arcs in a database.

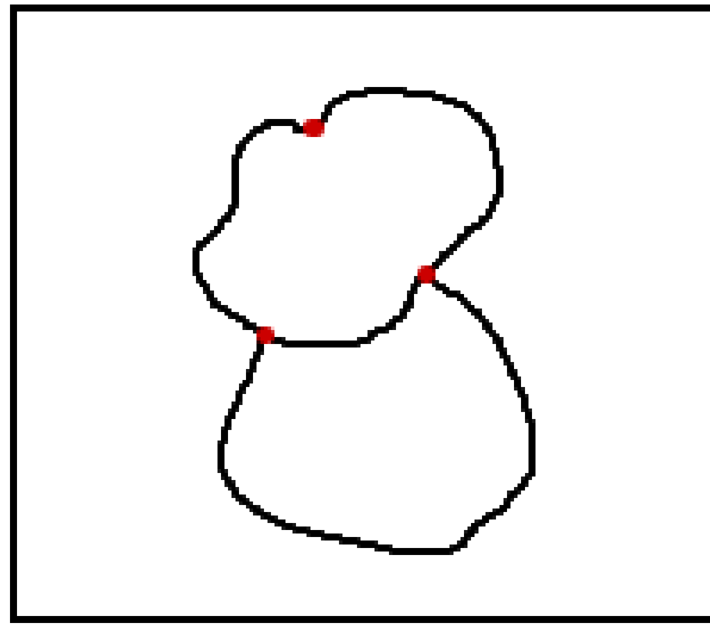
b) Adjacent polygons do not enclose overlap wedges or slivers.

c) Cleaner map output (more evident when you zoom in or magnify).

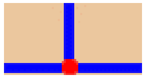
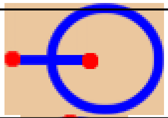
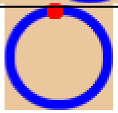
Spaghetti Data

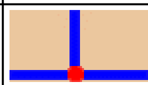
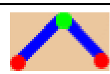
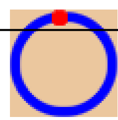
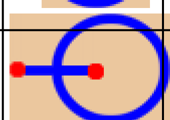
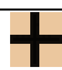
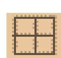


Topological Data



Creation of Topology: 'Clean & Build'

	EXAMPLE	DEFINITION	ACCEPTABLE
NORMAL NODES		At an intersection of 3 or more arcs	Always
DANGLING NODES		At the end of an arc	Arcs (Not polygons) e.g. roads, streams
PSEUDO NODES		Between 2 arcs	Island polygons, attribute change

Terms	Example	Description
Arc		**Line feature: a node at each end; vertices at each change of direction.**
Node		**Endpoint of an arc (also found at intersections between lines).**
Vertex		**A point on an arc that signals a change of direction.**
Pseudo Node		**On an (island) arc that connects to itself.**
Dangling Node		**Arc endpoint that is not connected.**
Label Point		**Identifies a point feature or polygon.**
Tic		**Geographic control point; coverage features can be registered to the same coordinate system.**

Arcs

a) Nodes are required at all arc ntersections.

b) Dangling arcs can be accepted if the "dangle tolerances" are set.

e.g. if tolerance = 5 metres, an arc < 5 is a dangle (error), an arc > 5m is a legitimate arc

Cleaning (moves nodes/arcs)

- Removes unacceptable dangling arcs and nodes.
- Joins missing arcs segments (within a special distance).
- Removes unnecessary pseudo nodes.
- Adds nodes to all intersections.
- Label points are added to polygons.

Building topology

- Does not move any features but 'cements' them into place.
- Creates a *Feature Attribute Table*.
- Builds (again) after new edits including,
  - addition or removal of arcs and points;
  - addition or removal of attribute items.

Feature attribute tables: Feature attribute tables are data files associated with each feature type.

For example, A) constructing topology for a polygon coverage creates a polygon attribute table (PAT); B) for a line coverage, an arc attribute table (AAT);

C) A point coverage, a point attribute table (PAT).

Each one of these tables is composed of rows and columns. The columns represent an item, such as perimeter, where as the rows represent an individual feature, such as polygon number 2

a. Point Attribute Tables: PAT

Record# Length Area ID#

(these are the minimum items)

b. Arc Attribute Tables: AAT (for line coverages and for polygon outlines)

Record# StartNode EndNode Length ID#

Standard items in an AAT: **created in the following order:**

FNODE_	**Internal node number for the beginning of an arc (from-node)**
TNODE_	**Internal node number for the end of an arc (to-node)**
LPOLY_	**Internal number for the left polygon (the Cover_ in a PAT)**
RPOLY_	**Internal number for right polygon (the Cover_ in a corresponding PAT)**
LENGTH	**Length of each arc, measured in coverage units**
Cover_	**Internal arc number (assigned by software)**
Cover_ID	**User-ID (assigned by the user)**

c. Polygon Attribute Tables: PAT

Record# Area Perimeter ID#

Q: What is the difference between a PAT (point) and a PAT (polygon)?

A: In a PAT (point), all lengths and areas = 0, as points have 'no dimensions'

Standard items in a PAT: **created in the following order**

AREA	**Area of each polygon, measured in coverage units**
PERIMETER	**Length of each polygon boundary, measured in coverage units**
Cover_	**Internal polygon number (assigned by software)**
Cover_ID	**User-ID (assigned by the user)**

- **Feature User-ID:** A number assigned to each feature by the user. It can be used to relate additional attribute information to the feature.

Requirements for Topology

- Arcs start and end with a node; intermediate points are vertices.
- All polygons are closed; and have a label point
- There are no dangling nodes and arcs in a polygon theme.
- Arcs connect below a specified tolerance distance.
- All intersections have a node.

2. Tolerances

- Nodesnap: minimum distance to the nearest node.
- Arcsnap: minimum distance to the nearest arc.
- Weed: minimum distance between two vertices along a line.
- Dangle: minimum acceptable length for an arc.

Editing for Topology

- Dangling arcs: Overshoot and undershoot (edit -> move arcs and nodes).
- Intersection: software creates node.
- Pseudo-nodes: removed where unnecessary.
- Label points: add or delete

Clean

- Puts nodes at intersections where lines cross.
- Moves nodes according to fuzzy tolerance.
- Moves features if necessary.
- Joins segments within tolerance limits.
- Adds polygon label points.

Build

- Cannot move features ('cements them in place').
- Builds point, line, and polygon topology.
- Does not remove any dangles.
- Updates with edits on spatial and attributes.

When to Use Clean versus Build

- Missed intersections: clean.
- Dangles beyond tolerance: clean.
- POINT: must use build.

7. Vector Reference Files

.bnd file (boundary)
.tic file (reference points)

So far, you have developed the following:

1) database design
2) automated the necessary data
3) corrected the errors in the digitized data
4) created topology for the coverages.

What the next……?

Before the analysis can be done , you still need to add additional data

HOW? ADDING ATTRIBUTE DATA

Discussion

Questions

Lecture 7

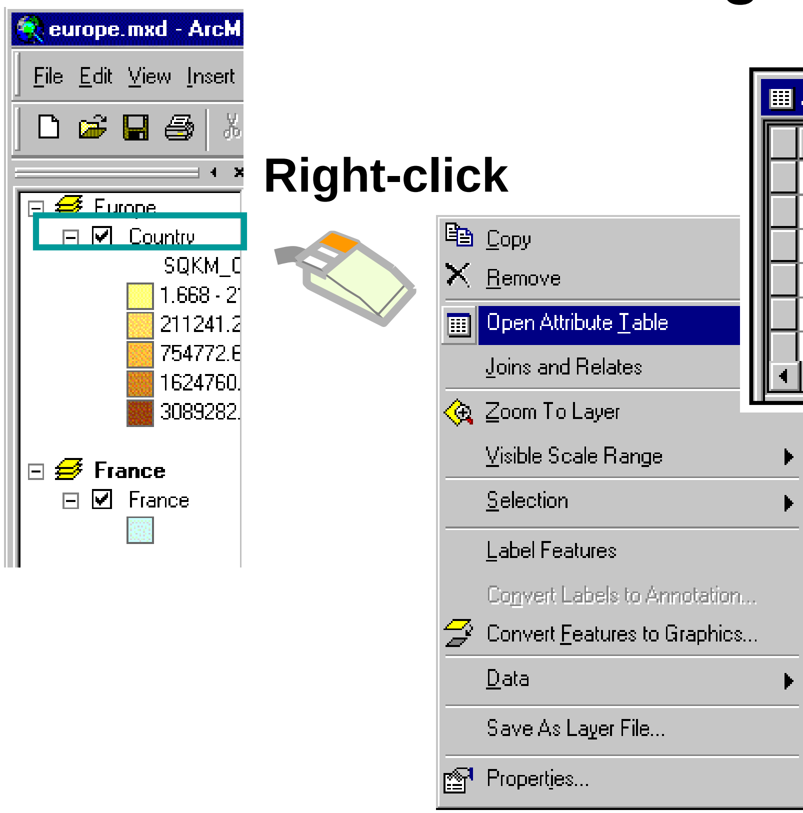
Working with Tables and Attribute Data

Lesson 6 overview

- Table structure
- Data types
- Table manipulation
- Connecting tables
- Working with graphs and reports

Tables

- Descriptive information about features
- Each feature class has an associated table
- One row for each geographic feature



Attributes of Countries

FID	Shape	FIPS_ADMIN	GMI_ADMIN	CNTRY_NAME
778	Polygon	GM09	DEU-SRL	Germany
1822	Polygon	RS	RUS-KLG	Russia
687	Polygon	EZ	CZE-STR	Czech Republic
720	Polygon	FRA6	FRA-FRC	France
1614	Polygon	PL26	POL-BYD	Poland
1969	Polygon	SP57	ESP-EXT	Spain

Understanding table anatomy

- Basic table properties
  - Records/rows and fields/columns
  - Column types can store numbers, text, dates
  - Unique column names

Columns (fields)

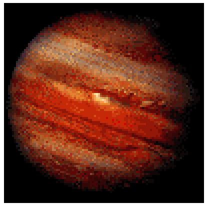
Rows (records)

Rowid	ZONE_CODE	DESCRIPTION
1	000	NODATA
2	AGR	Agricultural
3	AIR	Airport
4	COM	Commercial
5	FLD	Flooded
6	IND	Industrial
7	INS	Institutional
8	OS	Open Space
9	RES	Residential
10	SDP	Special Development Plan
11	TNS	Transitional

Attribute values

Tabular data field types

- Different field types store different kinds of values
- Choose the right field type for the right value
- Field types vary according to table format



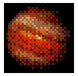
Name: **Jupiter**

Moons: **16**

Diameter: **142,984 km**

Date of Comet Shoemaker-Levy impact: **7/16/1994**

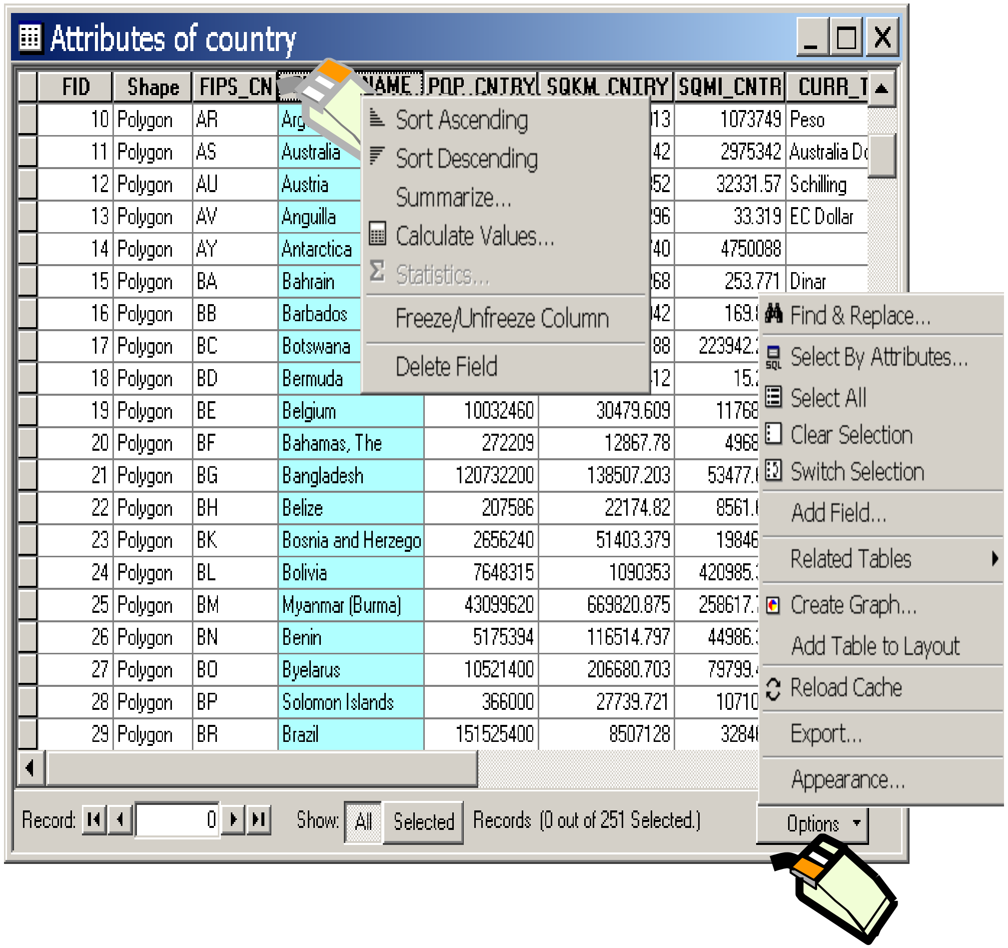
Rotation period: **9.8 hr**

Text	Date	Short	Long	BLOB	Float
Jupiter	7/16/1994	16	142984		9.8

A

Table manipulation

- Open table in ArcMap or preview in ArcCatalog
  - Sort ascending or descending
  - Freeze/Unfreeze columns
  - Statistics
- In ArcMap
  - Select records
  - Modify table values

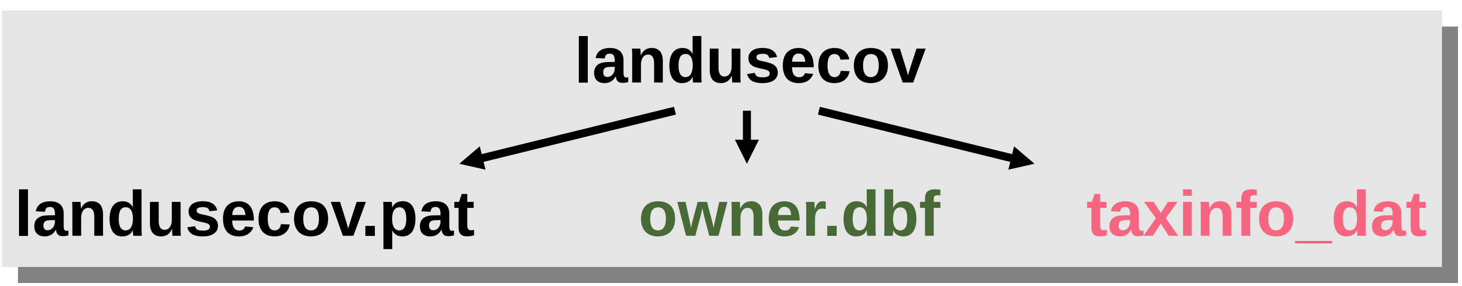


ArcGIS tabular formats

- Each ArcGIS spatial format has a native tabular format
  - Coverage: INFO
  - Shapefile: dbf
  - Geodatabase: RDBMS

ArcGIS can convert between formats

- Create a link between related tables
- Some spatial formats can link with multiple tabular formats



Associating tables

- Can store attributes in feature table or separate table
- Associate tables with common column key values
- Must know table relationships (cardinality)

Feature attribute table

FID	Shape	AREA	PERIMETER	ZONE#	ZONE-ID	ZONE_CODE
29	Polygon	139761.1	3436.182685761	29	31	RES
30	Polygon	19311.13	1227.994790069	30	25	AIR
31	Polygon	1394.393	269.1558402356	31	35	IND
32	Polygon	10618.05	433.2512163686	32	33	RES
33	Polygon	9529.783	418.2222455404	33	34	RES
34	Polygon	16141.88	812.9035032412	34	38	000
35	Polygon	44579.73	879.9199925836	35	36	IND
36	Polygon	74082.59	1254.269129168	36	37	SDP
37	Polygon	11033.96	439.7286407905	37	39	RES
38	Polygon	9639.264	420.0301261116	38	41	RES
39	[illegible]	[illegible]	[illegible]	39	40	[illegible]

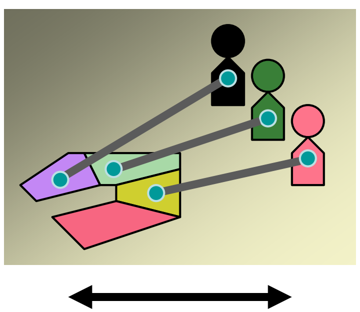
Additional attribute table

Rowid	ZONE_CODE	DESCRIPTION
1	000	NODATA
2	AGR	Agricultural
3	AIR	Airport
4	COM	Commercial
5	FLD	Flooded
6	IND	Industrial
7	INS	Institutional
8	OS	Open Space
9	RES	Residential
10	SDP	Special Development Plan
[illegible]	[illegible]	[illegible]

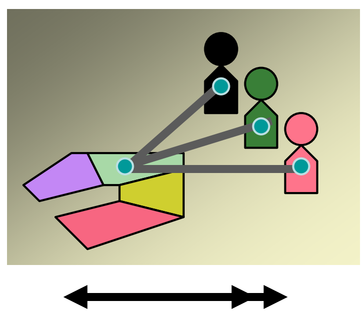
Table relationships

- How many A objects are related to B objects?
- Types of cardinality
  - One to one, one to many or many to one, and many to many
- Must know cardinality before connecting tables

One parcel has one owner

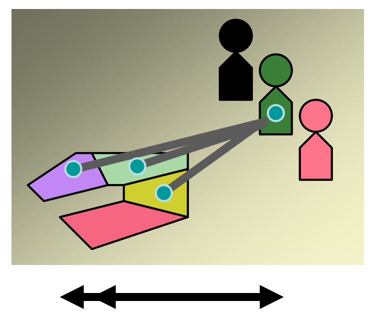


One parcel has many owners

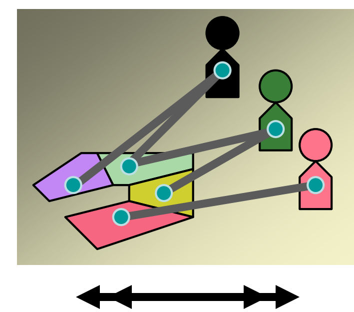


or

Many parcels have one owner

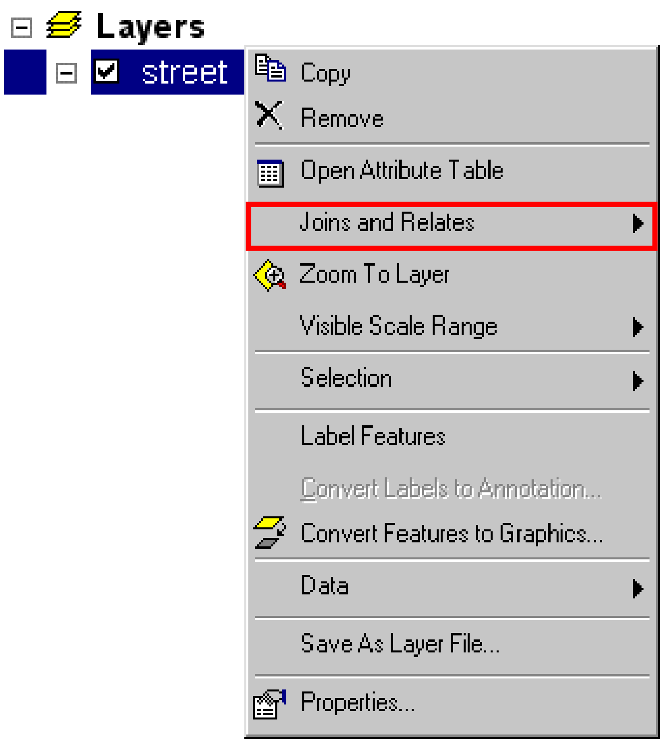


Many parcels have many owner



Joins and relates

- Two methods to associate tables in ArcMap based on a common field
- *Join* appends the attributes from one onto the other
  - – Label or symbolize features using joined attributes
- *Relate* defines a relationship between two tables



Connecting tables with joins

- Physical connection between two tables
- Appends the attributes of two tables
- Assumes one-to-one or many-to-one cardinality

Parcel (before Join)

OBJECTID*	SHAPE*	PARCEL_ID*	ZONE_CODE*	SHAPE_Length	SHAPE_Area
1	Polygon	67508	601	512.602492	13042.492751
2	Polygon	67246	601	372.992656	6203.424403
3	Polygon	67247	603	353.692046	5446.766292
4	Polygon	67253	603	313.013884	5380.550025
5	Polygon	67254	603	401.035888	7320.703589

ZoneCodeDesc

OBJECTID*	ZONE*	DESCRIPTION
1	601	Commercial
2	602	Institutional
3	603	Residential
4	604	Office

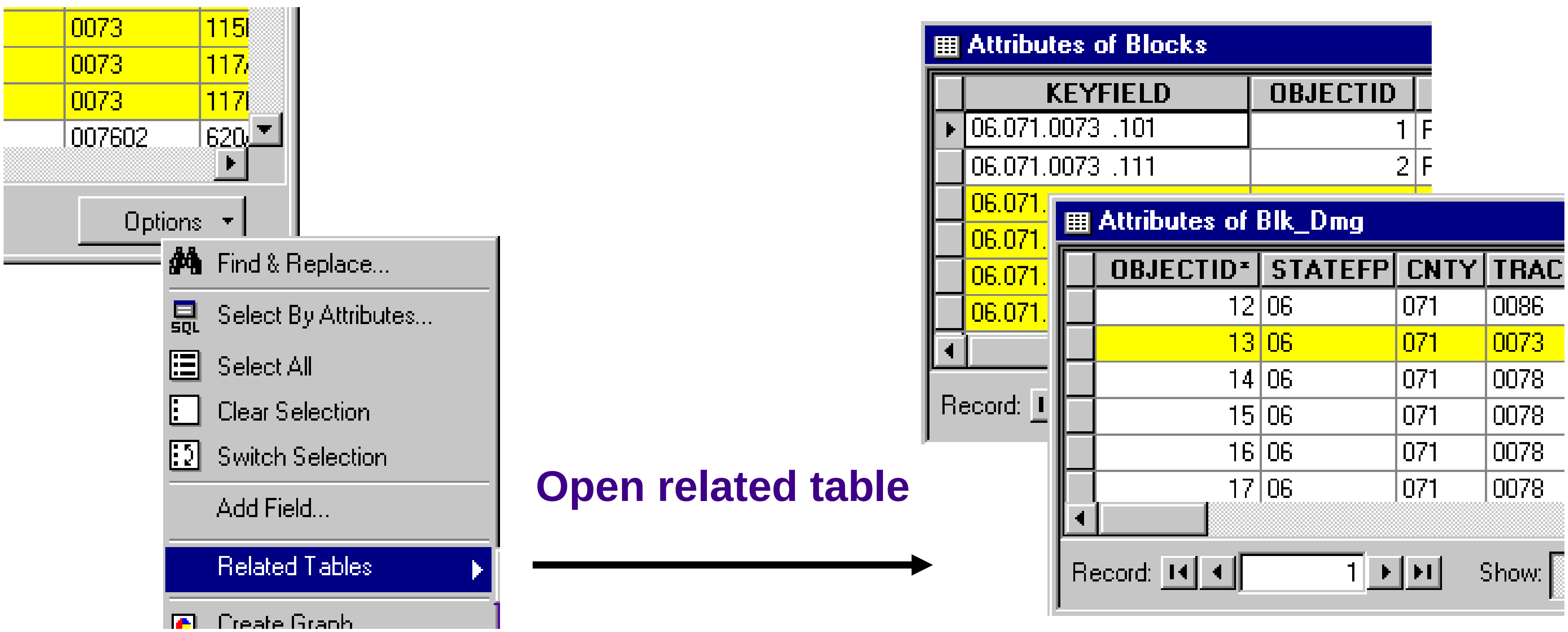
Many-to-one

Parcel (after Join)

OBJECTID	SHAPE	Parcel.PARCEL_ID	ZONE_CODE	SHAPE_Length	SHAPE_Area	OBJECTID	ZONE	ZoneCodeDesc.DESCRIPTION
1	Polygon	67508	601	512.602492	13042.492751	1	601	Commercial
2	Polygon	67246	601	372.992656	6203.424403	1	601	Commercial
3	Polygon	67247	603	353.692046	5446.766292	3	603	Residential
4	Polygon	67253	603	313.013884	5380.550025	3	603	Residential
5	Polygon	67254	603	401.035888	7320.703589	3	603	Residential
6	Polygon	67256	603	376.675717	2622.991768	3	603	Residential

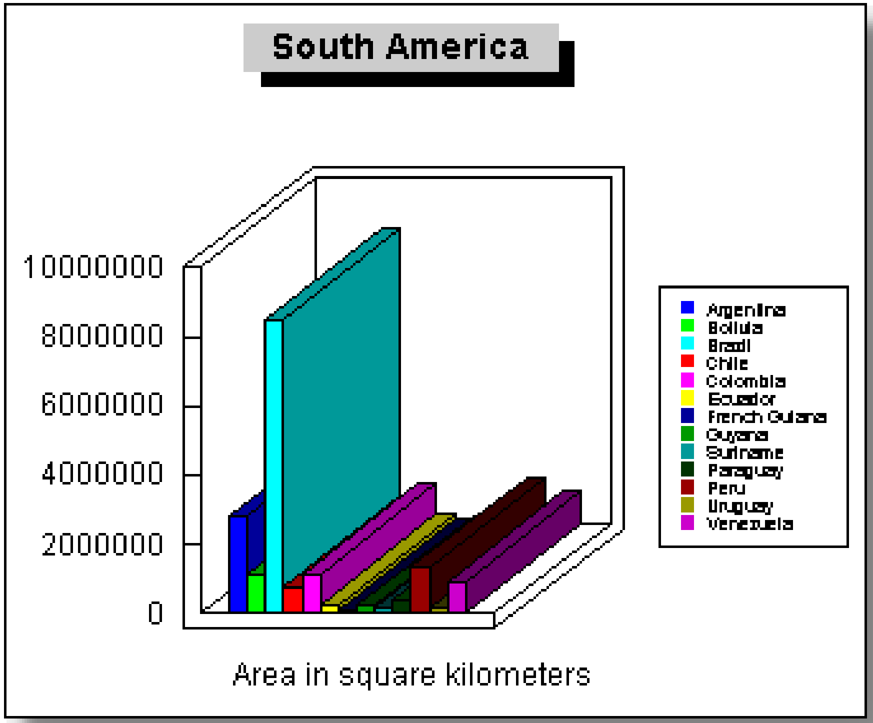
Connecting tables with relates

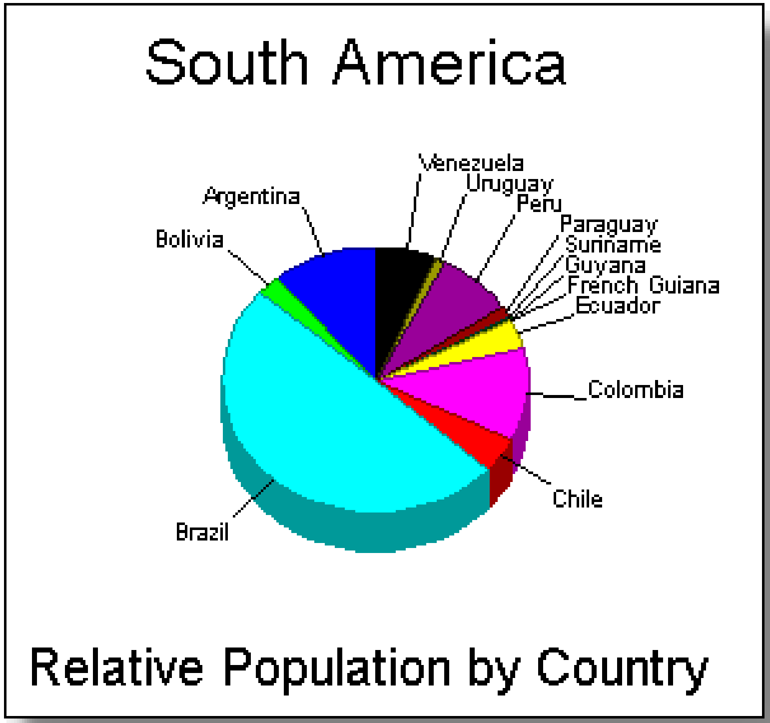
- Define relationship between two tables
- Tables remain independent
- Additional cardinality choices
  - One to many, many to many



Graphs

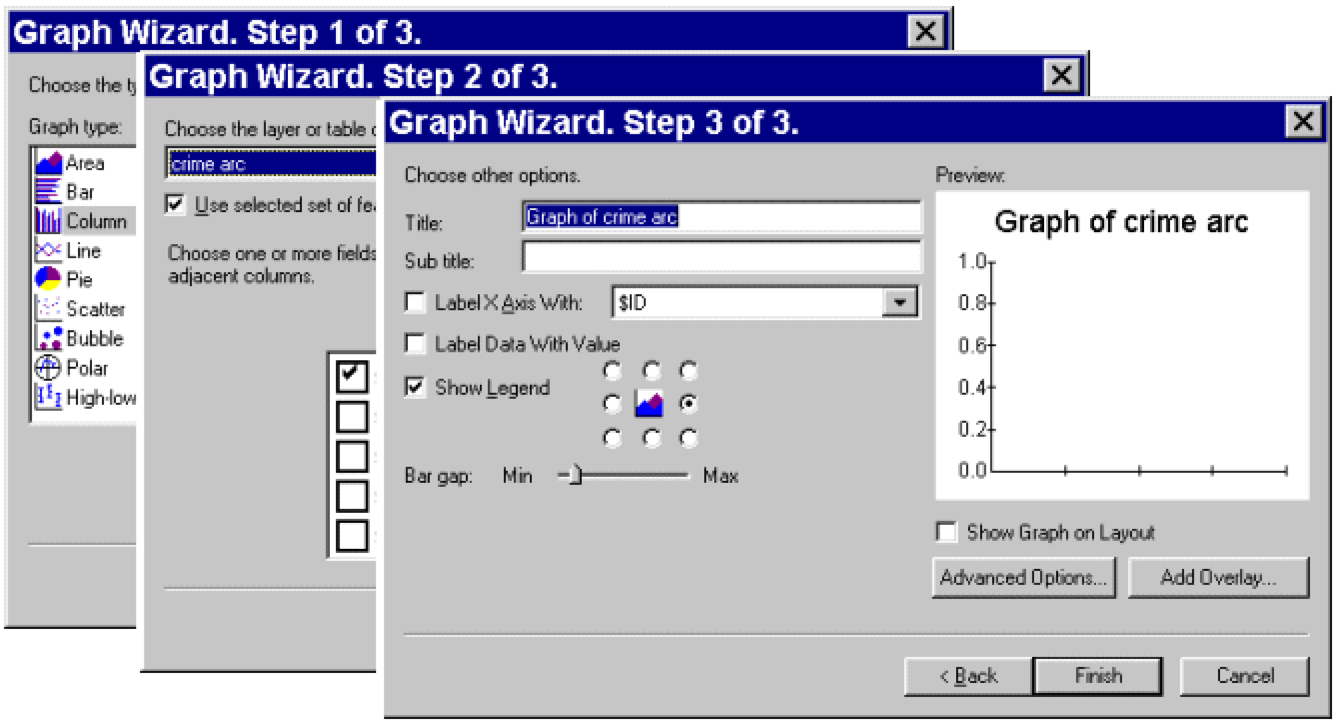
- Summarize tabular information
- A variety of graph formats
- Set display properties
- Add to a map





Graph creation

- Graph Wizard is a high-end professional graphing and plotting utility



To add additional attributes for each feature, you will:

a) **Create** a new data file to hold the attributes

b) **Add** the attribute values to the data file

c) **Join** the data file to the feature attribute table for the coverage

Step 1: Creating a new data file to hold the attributes:

As mentioned above, attribute information is stored in a tabular database file called ***Feature Attribute Table***. For each geographic feature (point, line, polygon) there is one entry record, in the file. For each record, there are a number of kinds of information, or items.

ID	Code		ID	Code
			59 60 61 61 . . .	400 200 400 200

Step 2: Add the attribute values to the newly created data file:

If the attribute values you are on the list, you can type them directly into the data file on the computer. The attribute values are already in a file on the computer, you may be able to put them directly into the data file without having to retype them.

Step 3: Relate or join the attributes to the feature attribute table

Once the attribute values are added to the data file, you can attach them to the feature attribute table for the coverage using a common item as a key.

Since the records in the feature attribute table can be linked to corresponding records in the new data file, the new attributes will also be associated with the features. Any two tables can be connected if they share a common attribute.

Parcel No.	Owner		Parcel No.	Zoning	Area
11-100	Hassan		11-100	Residential	15,900
11-002	Ibrahim		11-002	Residential	12,100
11-300	Mohamed		11-300	Commercial	19,200

Whereas a *Relate* temporarily connects two attribute tables, a *relational join relates* and merges two attribute tables using their common item (Parcel No.).

Parcel No.	Owner	Zoning	Area
11-100	Hassan	Residential	15,900
11-002	Ibrahim	Residential	12,100
11-300	Mohamed	Commercial	19,200

spatial join.

Relates and joins is a simple GIS operation that can also be done when the spatial overlay is performed, i.e. Polygon overlay is a *spatial join.* In this case, records are matched based on the location of their associated geographic features, rather than using a common item in two tables

- **3. Attribute Modification**
- Creating new files (create).
- Adding or changing data (update).
- Displaying data (list).
- Extracting data (select).
- Manipulating data: add columns, drop columns, pull to form new files .
- Record number should NOT be modified

2. Join & Relate Operations

- **Attributes may be stored in these tables or ... Separate tables can be 'joined' or 'related'.**
- **Join: this function allows us to merge two tables using a common *item.* In most cases, the values in one tables item set must be identical to those in the other**
  Relate: this function <u>temporarily</u> connects two tables. As with join, a common value is needed.
- **Relate has several advantages over join:**
  - **Reduced redundancy between tables.**
  - **JOIN: common items must have the same name.**
  - **RELATE: the items can have different names.**
  - **Relates are preferred in large databases to prevent tables becoming too unwieldy, with many items.**
- **Join and relate can be done on the basis of:**
- ***One to one* (one record matching one record on both files) or**
- ***Many to one* (one record values is matched to several records on the other file).**

Discussion

Questions

Exercise 6A overview

- Start ArcCatalog and explore INFO tables
- View an attribute table
- Examine the properties of the fields
- Examine a geodatabase table
- Examine table cardinality
- Create the join
- Modify the appearance of the joined table
- Create the relate
- Make a selection and examine the related table
- Label features with joined attributes
- Exit ArcCatalog and ArcMap

Exercise 6B overview

- Start ArcMap and open the map document
- Open the graph properties and change the graph type
- Set graph properties and create the graph
- Modify the graph’s properties
- Export the graph
- Display report properties and specify fields
- Set the sorting and summary options
- Set display properties
- Generate the report
- Embed the graph in the report
- Add the report to the layout

Lesson 6 review

- There are different field types for different data formats. (T/F)
- Each field should have a unique name. (T/F)
- Different field types store different kinds of values. (T/F)
- Attributes and features are linked by _____________ .
- Coverages store attributes in an _____________ file, shapefiles store attributes in a ____________ file, and the geodatabase stores attributes in a ____________ .
- What is table cardinality, and why is it important?
- What is the difference between a join and a relate in ArcMap? Provide examples.

Lecture 8

Projection and Transformation

Lesson 8 overview

- Georeferencing
- Coordinate systems
- Datums
- Projections and distortion
- Projecting your data

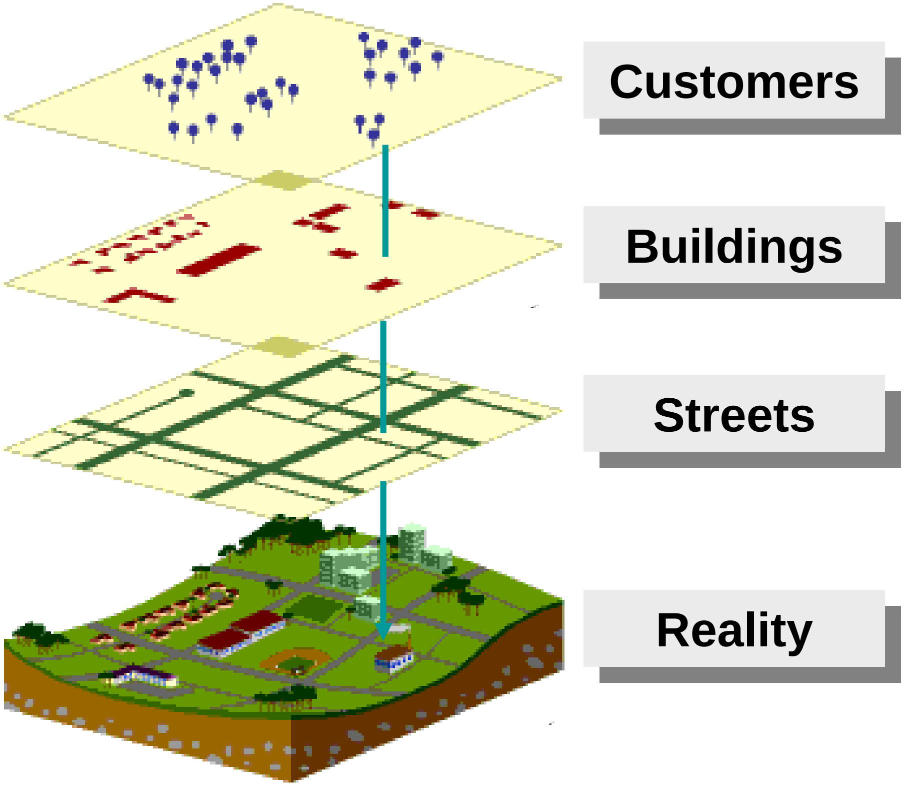
Projecting and Transforming

After digitizing your paper map in lab, you will be faced with the task of projecting the coverage into real-world coordinates

This is possible if you have a few points where you know the exact location on the map AND in the real world

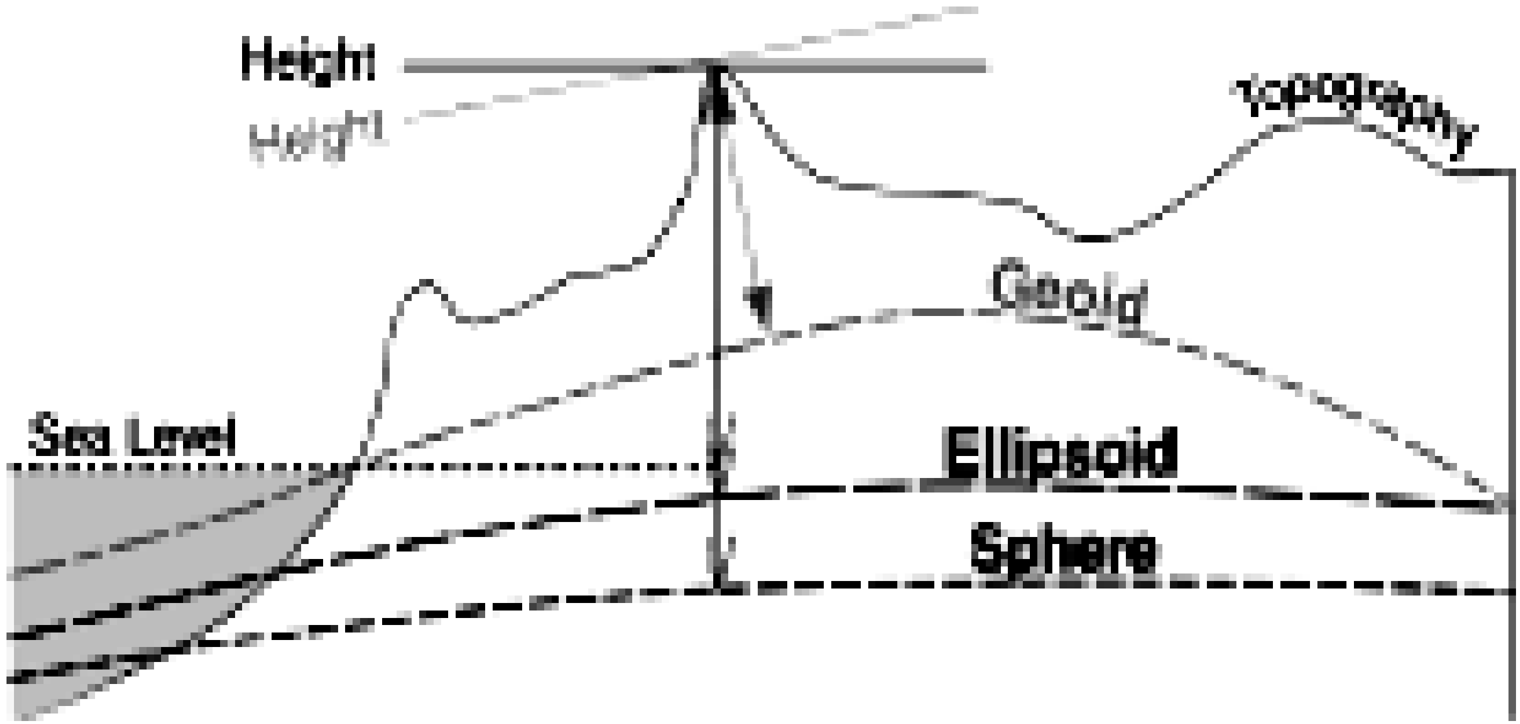
Georeferencing your data

- Locating your data in real-world coordinates
- Aligned for analysis between layers

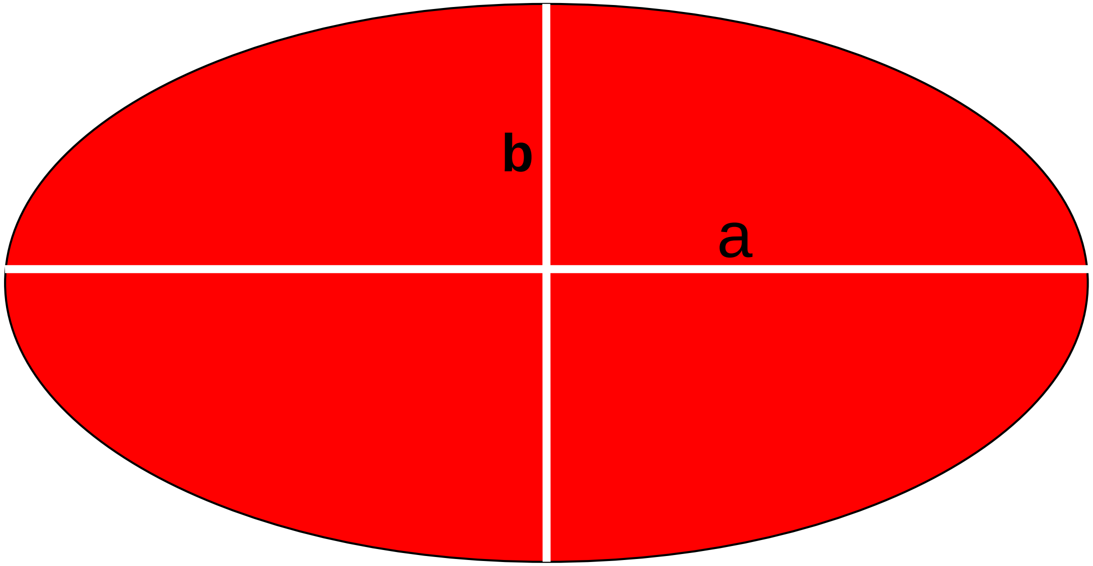


Spatial reference

- Defines coordinate system, coordinate domain
- Components
  - Coordinate system
    - Projection, datum, ellipsoid, prime meridian, units
  - Coordinate extents
- Associated with a feature class or a feature dataset
- Feature classes are projected to match the spatial reference of the feature dataset they are loaded into



Height
Height
Topography
Geoid
Sea Level
Ellipsoid
Sphere



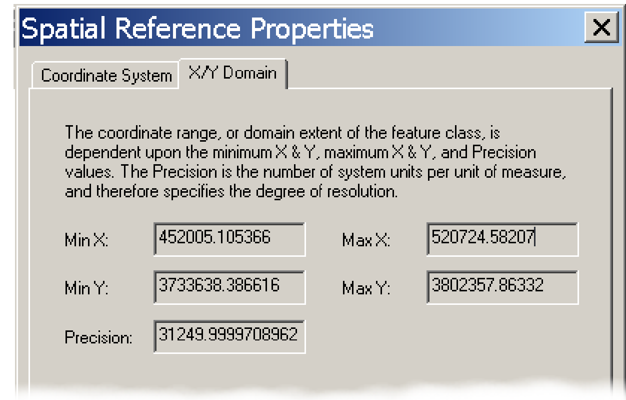
For the WGS84

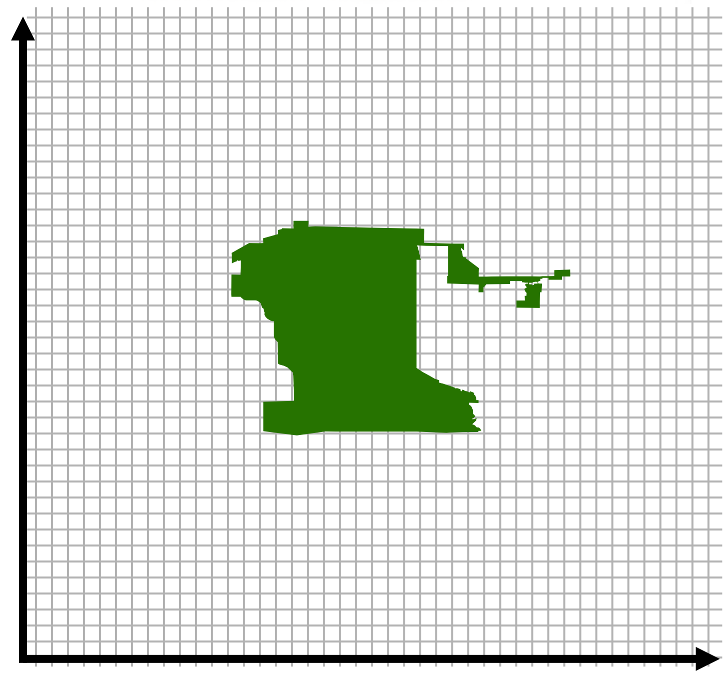
a = 6,378,137

b = 6,356,752.3

Coordinate domain

- Extent of available coordinates
  - Min and max X,Y coordinates
  - Precision = storage units per map unit
    - Example, 1000 mm per meter
- Make sure it covers study area
- ArcCatalog default
  - Import: data plus room for growth
- Set your own
  - Import from existing data
  - Type in extent for study area





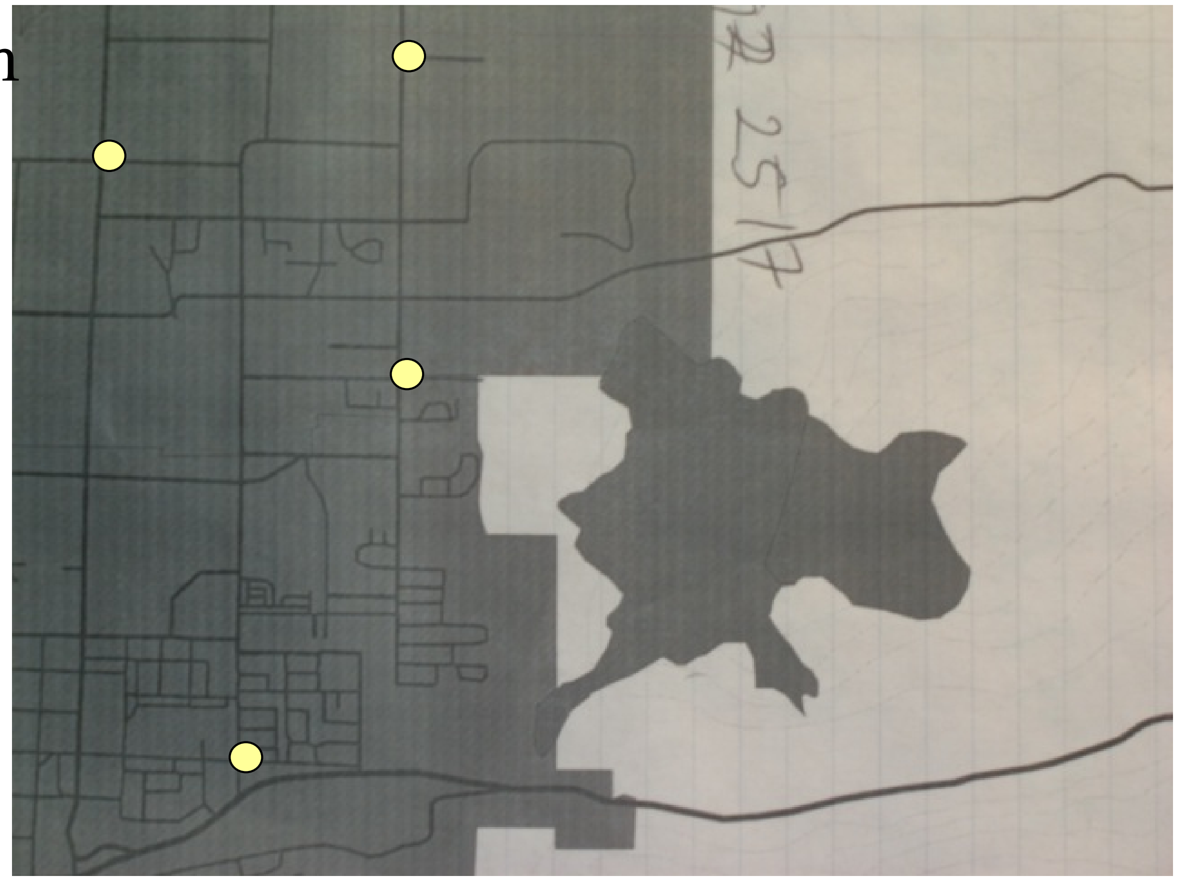
2.14 billion storage units

Registering your map to the real world

Road intersections can be known

- Read the coordinates from a paper or electronic map
- Find the coordinates with a GPS

Mark the coordinates, and make them available to an algorithm in the GIS that can transform coordinates

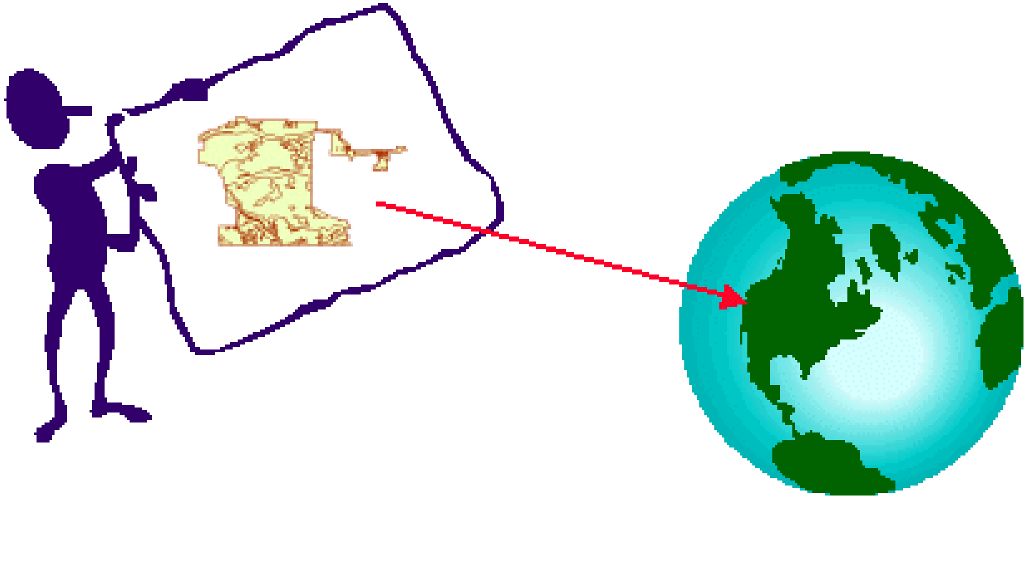


To project a coverage in Arc/INFO

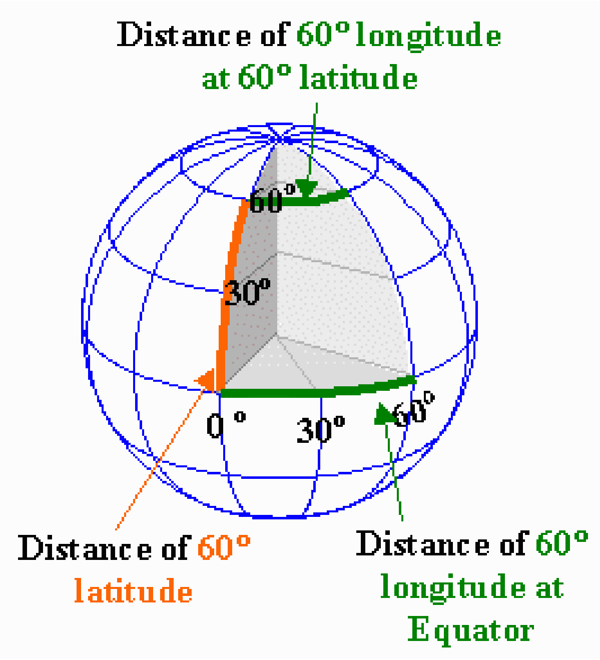
- Digitize map
- Find features where you can find the real-world coordinates
- Find those features on the map
- Add tic marks on those features
- Create empty coverage with same tic marks
- Enter the real-world coordinates for those tic marks in the empty coverage
- Use TRANSFORM command in Arc/INFO
- TRANSFORM will copy digitized coverage into empty coverage, and bring all features with it

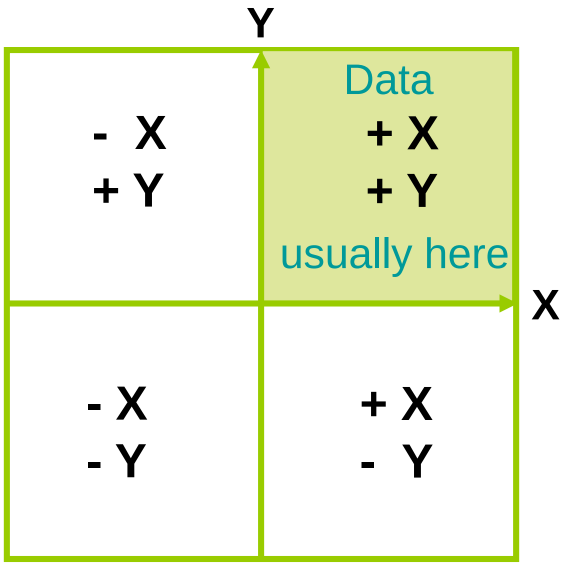
What is georeferencing?

- Data is referenced to a location on the earth's surface
  - Geographic coordinate systems
  - Projected coordinate systems



Coordinate systems





- Geographic coordinate system
- Latitude and longitude are not uniform across the earth's surface

- Cartesian coordinate system
- Measures of length and angle are uniform

Longitude and Latitude

Longitude measures the angular distance from the prime meridian.

East/West

Latitude measures the angular distance from the equator.

North/South

Units:

Degrees minutes seconds	12d 30m 15s
Decimal degrees	12.5042 degrees

Map Projection

Geographic coordinates are based on a spherical model. However to represent maps on a 2D surface like on our computer screen or on a paper map, we need to rely upon a *map projection*, a mathematical formula that transforms latitude and longitude locations to x, y coordinates.

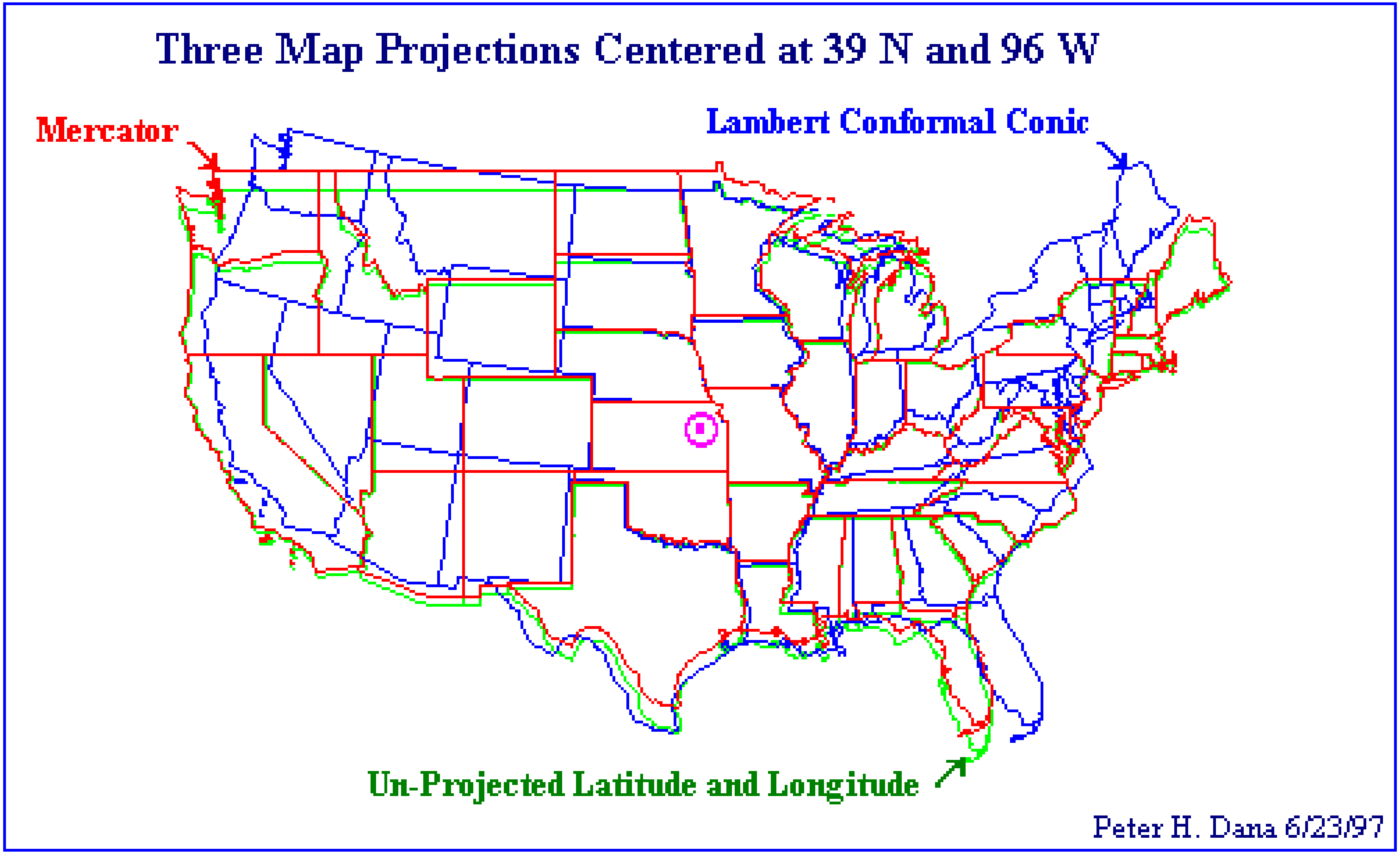
For example: Moscow

Geographic	UTM
latitude: 37d 36m 30s	x: 412,648.41 meters
longitude: 55d 45m 01s	y: 6,179,073.07 meters

Many Different Projections

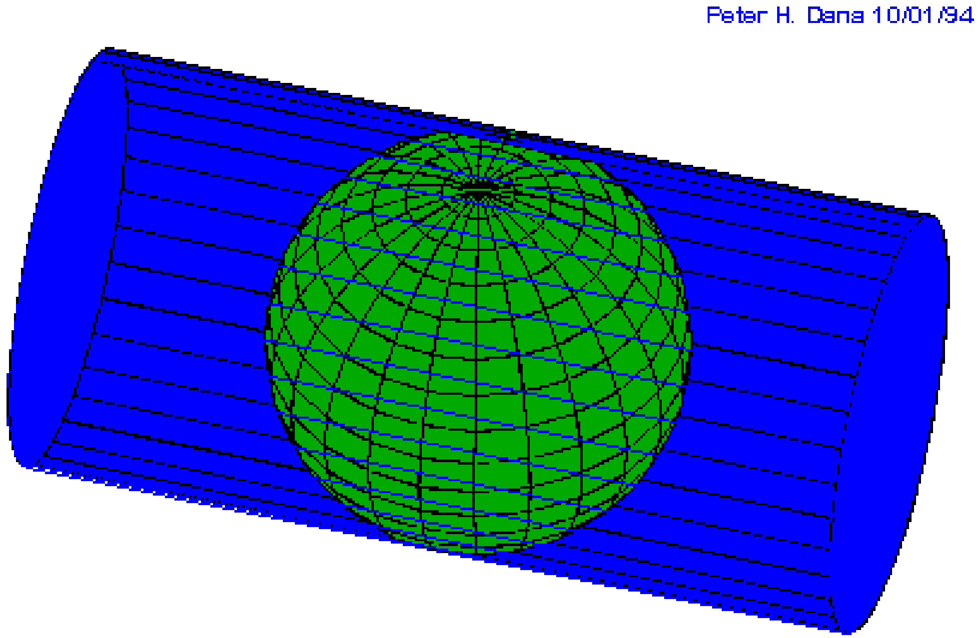
Different projections suit different applications. For example, some projections preserve distance, while other preserve area, or shape, or direction.

It is important to note that different datasets transformed to different projections will not register with one another. That’s where GIS can help a lot!

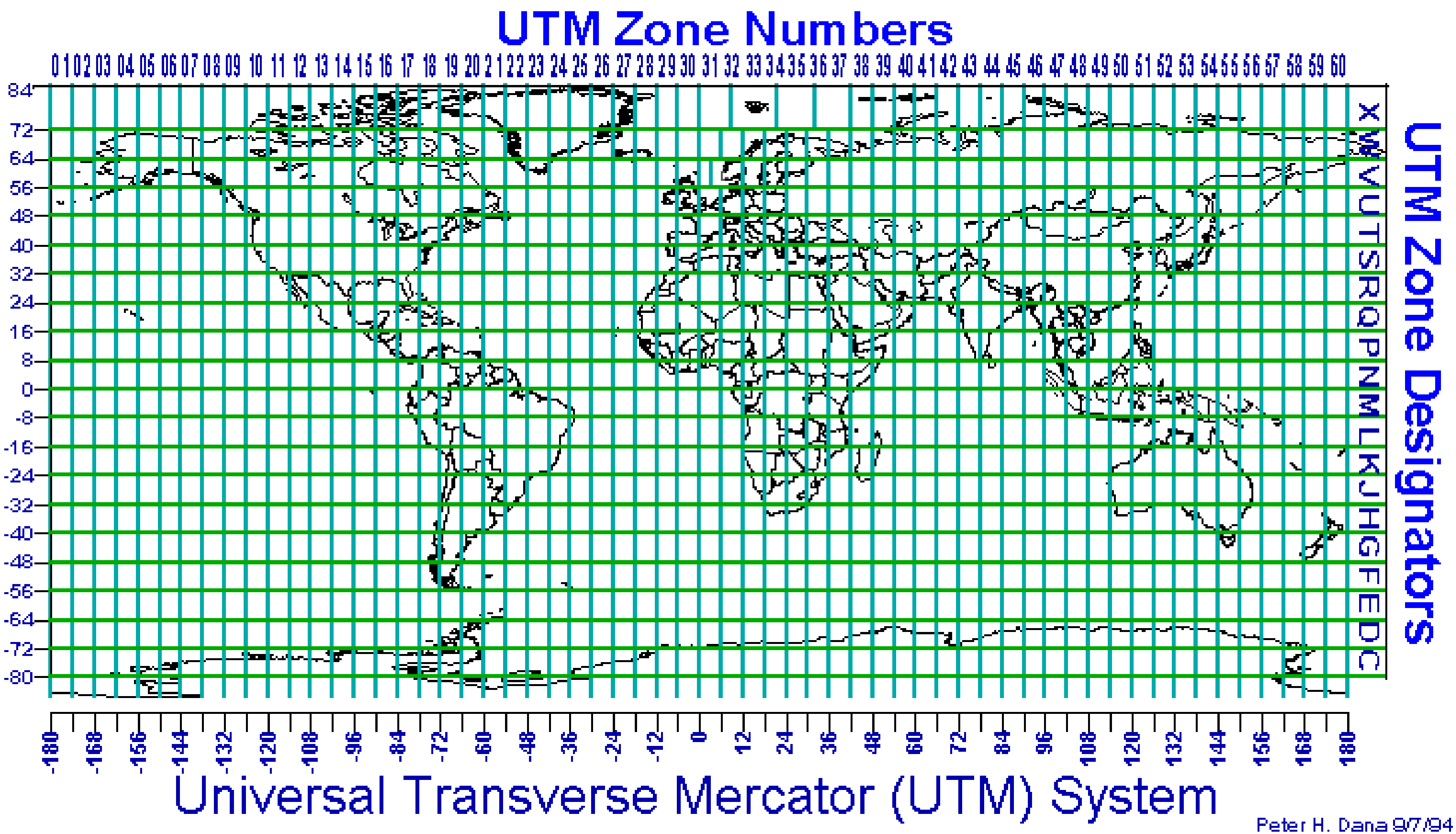

Three Map Projections Centered at 39 N and 96 W
Mercator
Lambert Conformal Conic
Un-Projected Latitude and Longitude
Peter H. Dana 6/23/97

- Transverse Mercator
    - Transverse Mercator projections result from projecting the sphere onto a cylinder tangent to a central meridian. Transverse Mercator maps are often used to portray areas with larger north-south than east-west extent. Distortion of scale, distance, direction and area increase away from the central meridian.
    - Many national grid systems are based on the Transverse Mercator projection

    - The Universal Transverse Mercator (UTM) projection is used to define horizontal, positions world-wide by dividing the surface of the Earth into 6 degree zones, each mapped by the Transverse Mercator projection with a central meridian in the center of the zone. UTM zone numbers designate 6 degree longitudinal strips extending from 80 degrees South latitude to 84 degrees North latitude. UTM zone characters designate 8 degree zones extending north and south from the equator



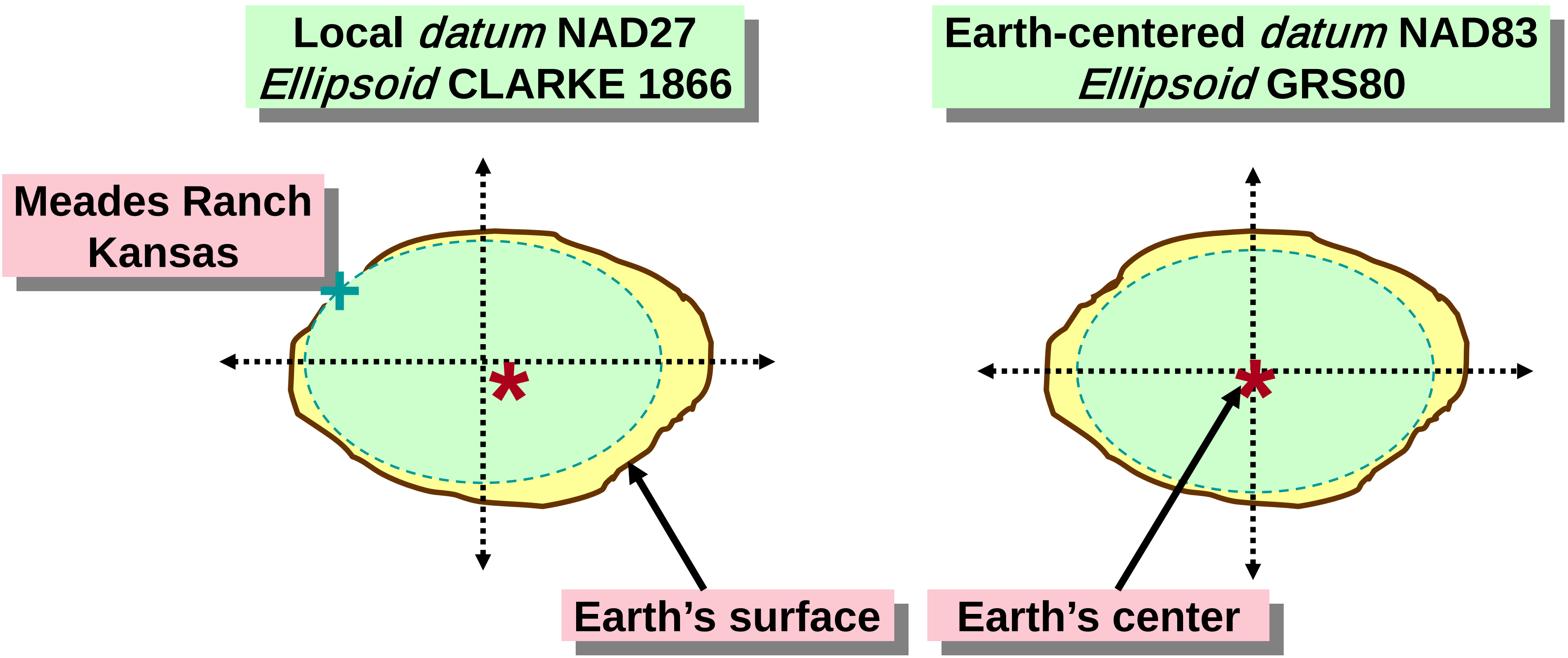
Transverse Cylindrical Projection Surface



UTM Zone Numbers
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
84 72 64 56 48 40 32 24 16 8 0 -8 -16 -24 -32 -40 -48 -56 -64 -72 -80
X W V U T S R Q P N M L K J H G F E D C
UTM Zone Designators
-180 -168 -156 -144 -132 -120 -108 -96 -84 -72 -60 -48 -36 -24 -12 0 12 24 36 48 60 72 84 96 108 120 132 144 156 168 180
Universal Transverse Mercator (UTM) System
Peter H. Dana 9/7/94

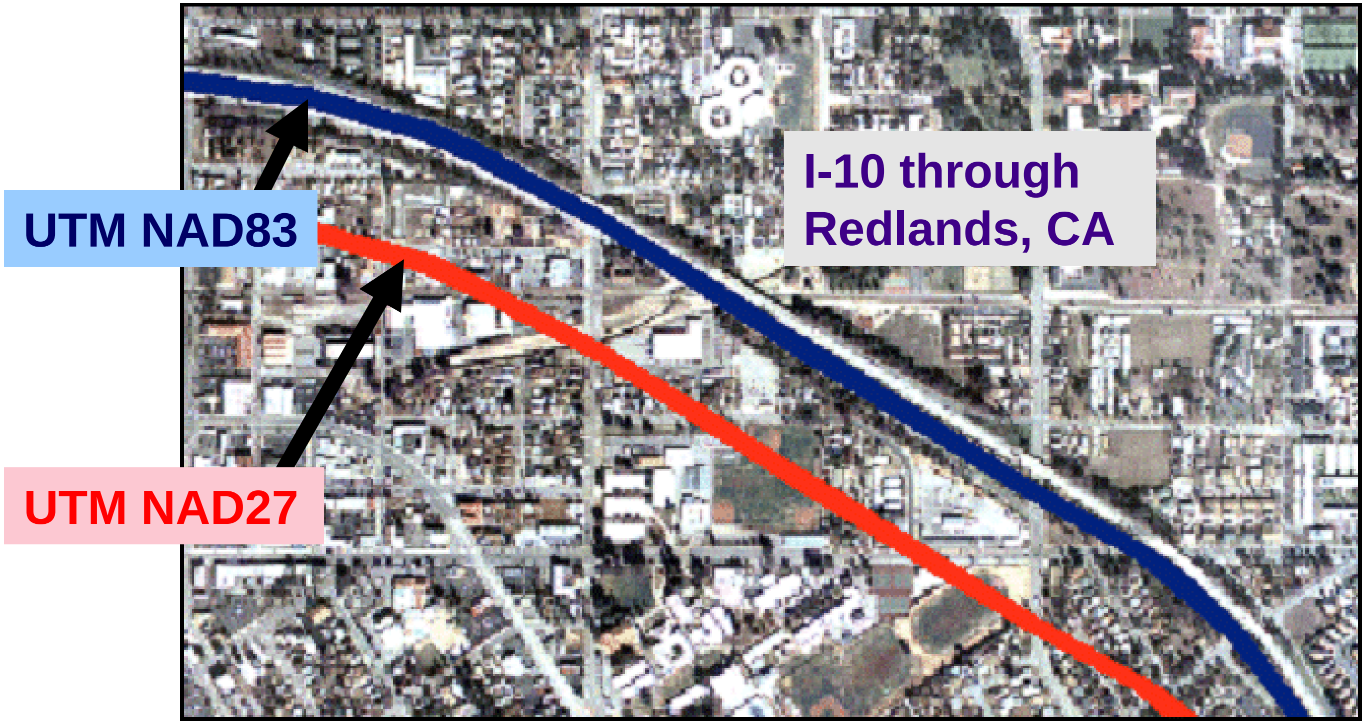
Datums and datum conversion

- A frame of reference for measuring locations on the surface of the earth
  - Measurements are referenced to geodetic origin and ellipsoid used to represent the Earth's three-dimensional shape



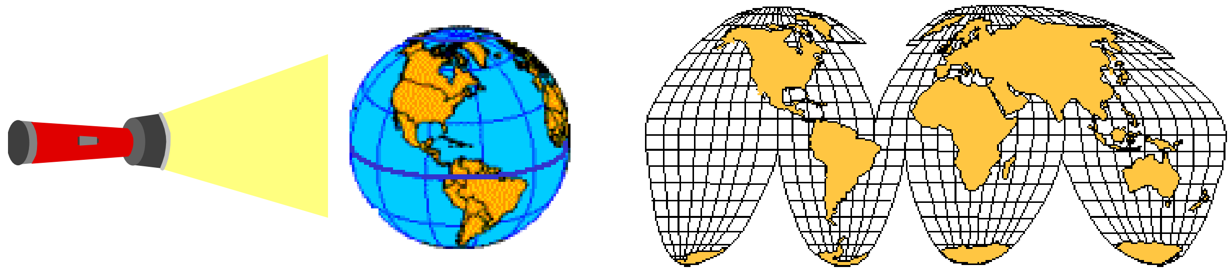
Referencing locations

- Locations on the earth are referenced to the datum
- Different datums have different coordinate values for the same location

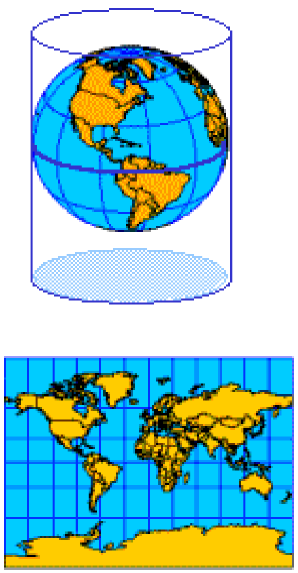


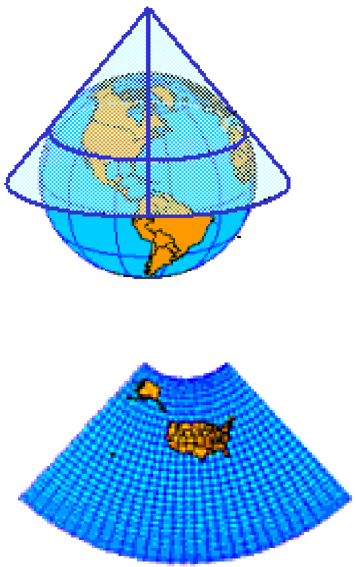
Map projections

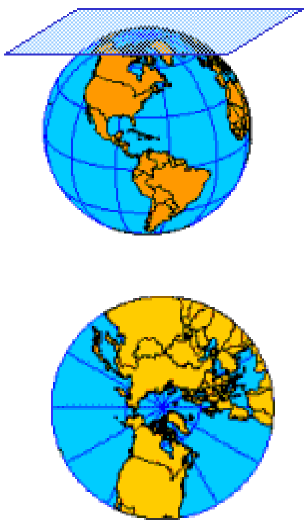
- Map projections convert curved surface to flat surface



Cylinder **Cone** **Plane**







Projection distortion

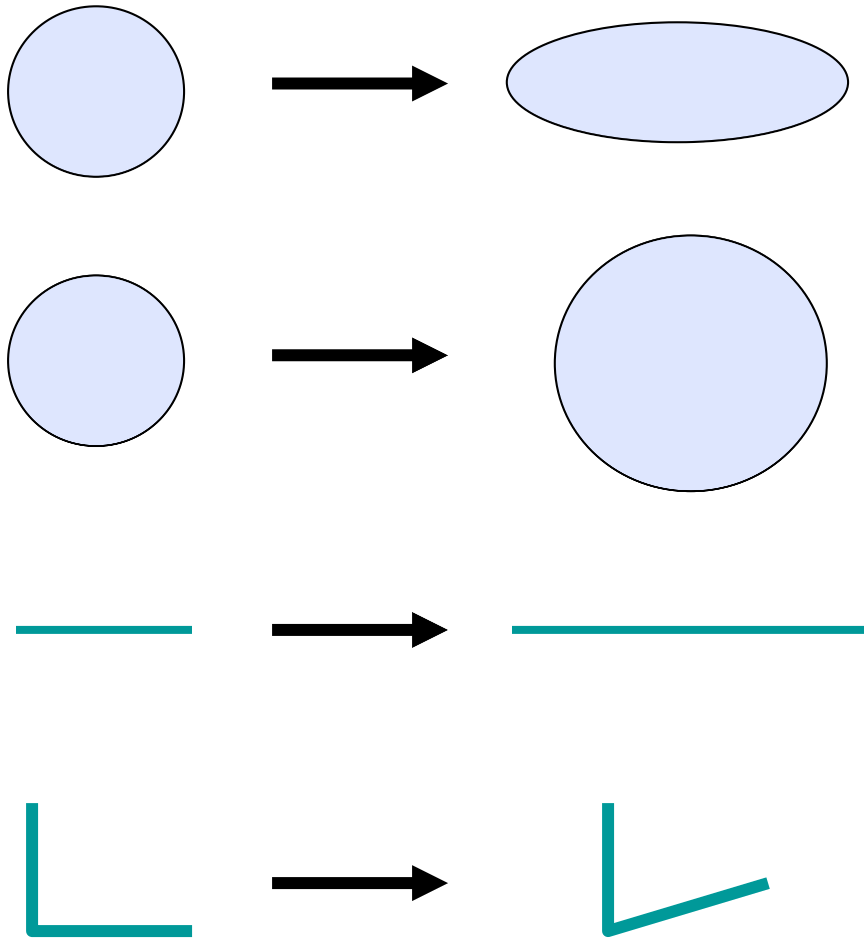
- Distortions make geographers SADD

Shape

Area

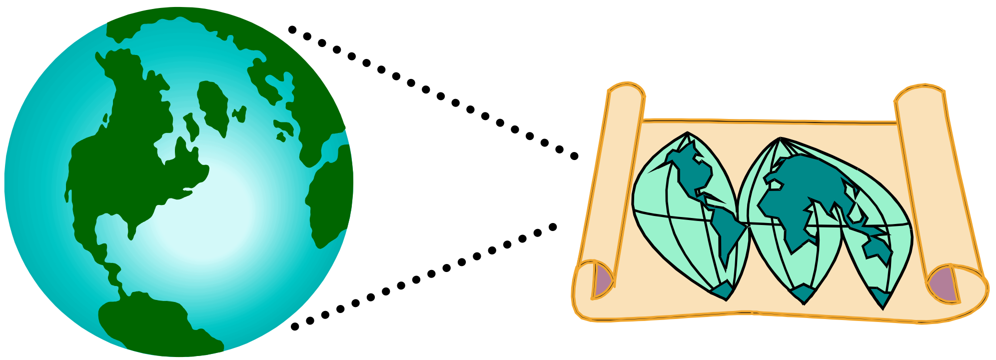
Distance

Direction

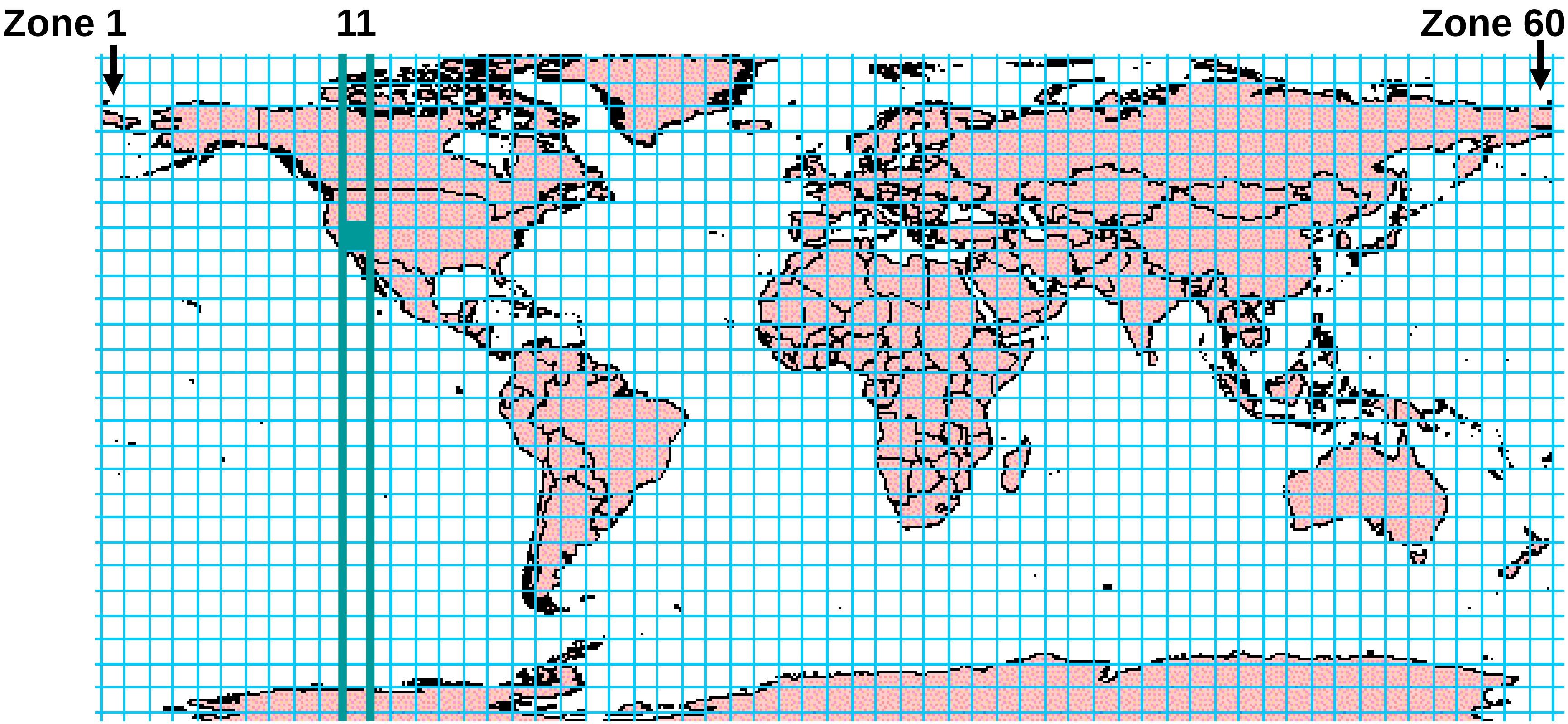


Choosing a database projection

- Issues to consider
  - Which spatial properties are most critical for your applications?
  - Where is your study area?
  - How large is your study area?
  - Who will you share data with, and how often?



The UTM projection series



Globe is divided into 60 zones, 6 degrees wide

- A separate Transverse Mercator projection is applied to each zone
- Redlands falls in Zone 11

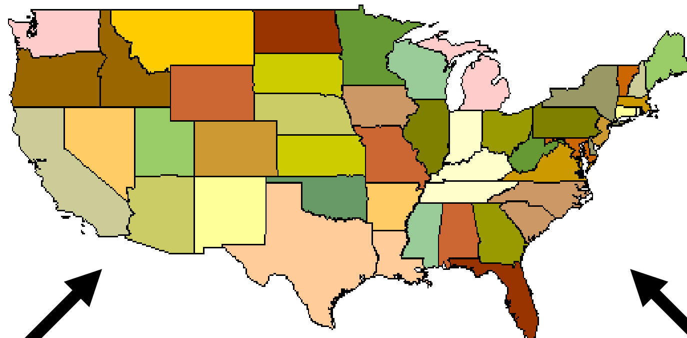
Types of projections

- Generally classified by the spatial attribute they preserve

Projection type	Maintains	Example
Conformal	Shape	Lambert Conformal Conic
Equal area	Area	Albers Equal Area Conic
Equidistant	Distance	Equidistant Conic
Azimuthal	Direction	Lambert Equal Area Azimuthal

Coordinate system components

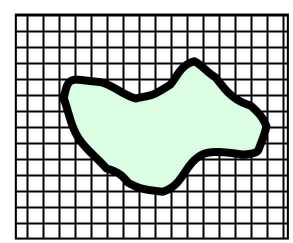
Projected data



Geographic
Coordinate System

Projected
Coordinate System

Datum
Ellipsoid

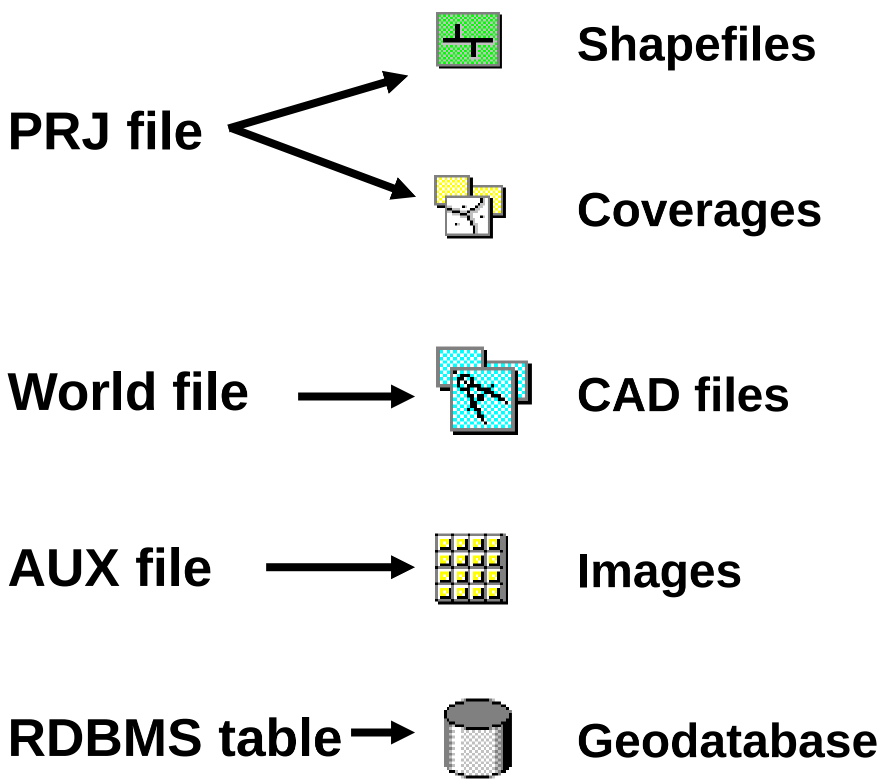


Equations
Parameters

Storing projection information

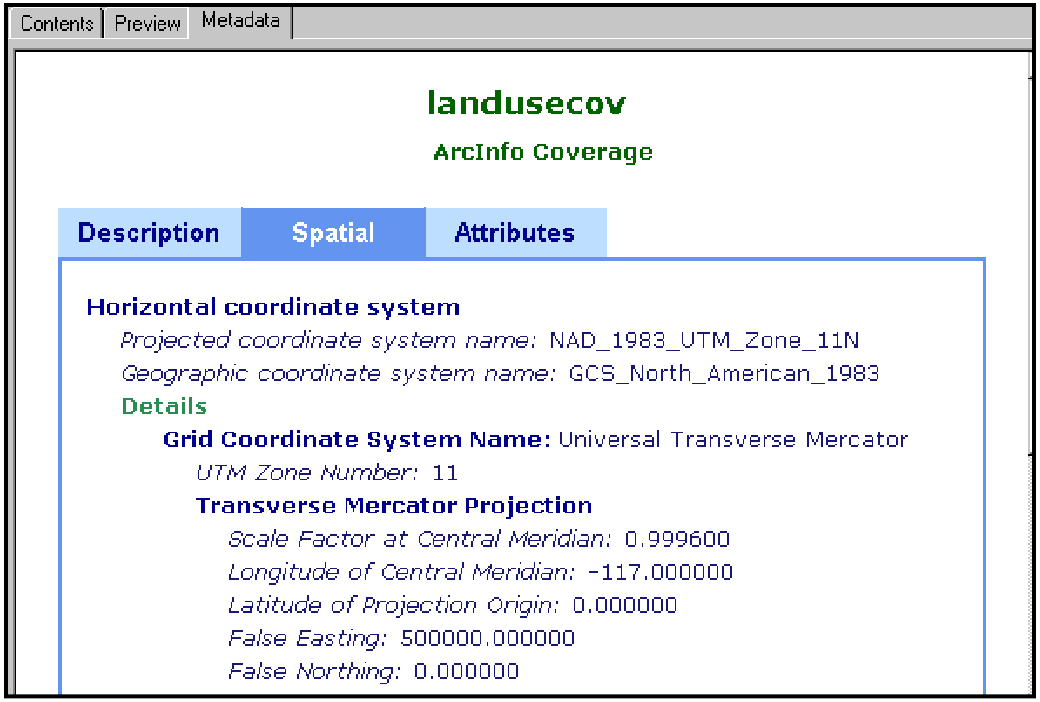
- Many spatial data formats store the projection details along with the data

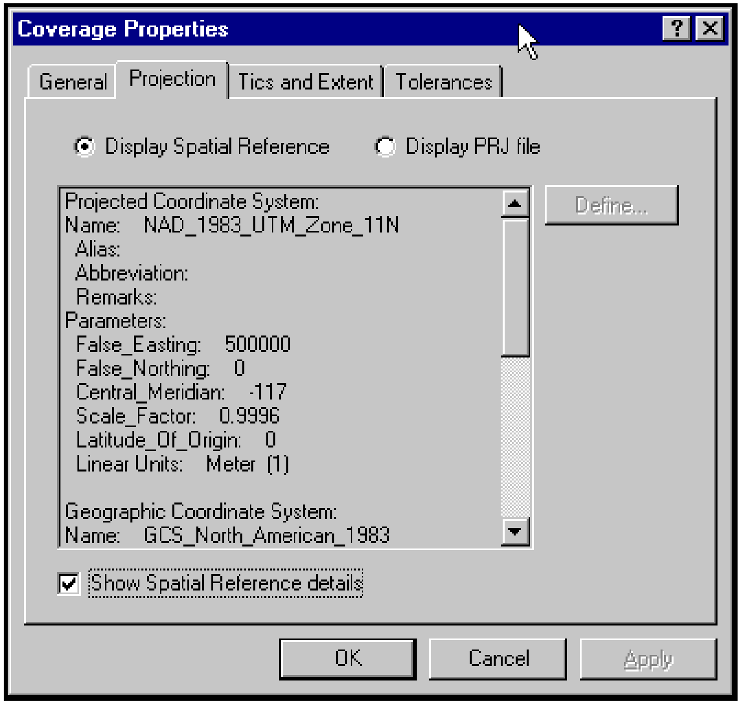
Projected Coordinate System:
Name: PCS_Transverse_Mercator
  Alias:
  Abbreviation:
  Remarks:
Projection: Transverse_Mercator
Parameters:
  False_Easting: 500000.000000
  False_Northing: 0.000000
  Central_Meridian: -117.000000
  Scale_Factor: 0.999600
  Latitude_Of_Origin: 0.000000
Linear Unit: Meter (1.000000)
Geographic Coordinate System:
  Name: GCS_North_American_1983



Viewing projection information

- Examine Metadata or Properties of the feature class

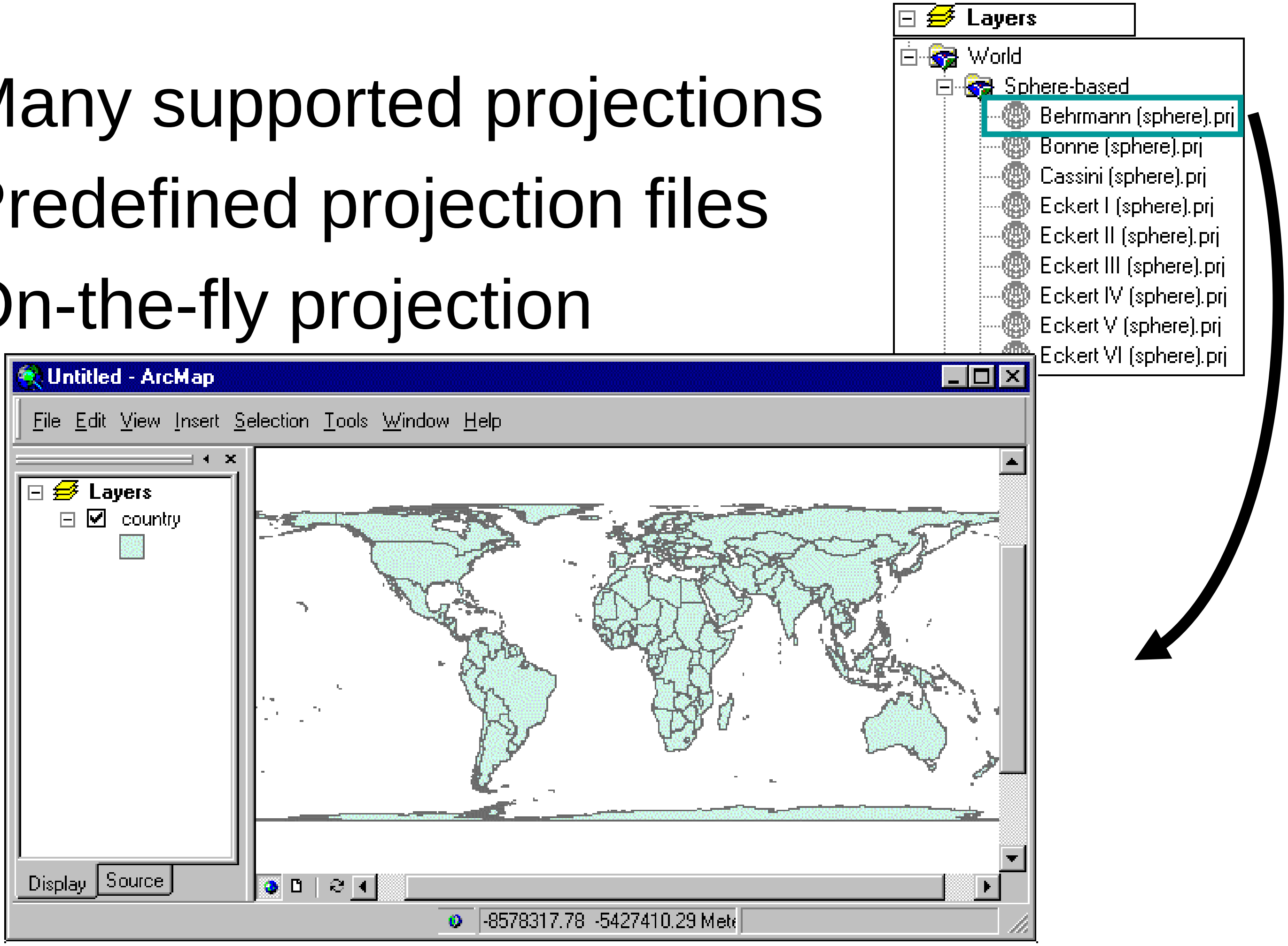




- Use the Define Projection wizard to assign projection

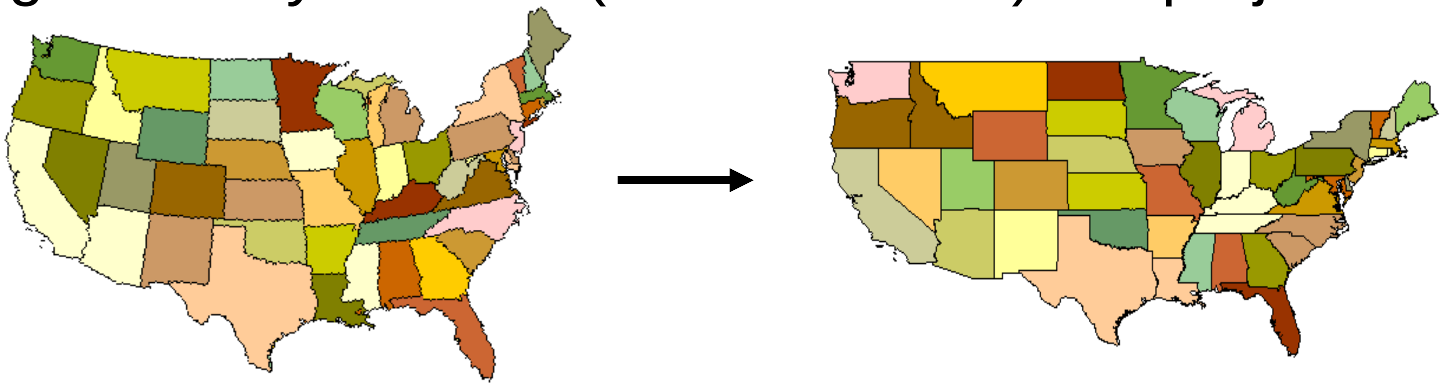
ArcMap and projections

- Many supported projections
- Predefined projection files
- On-the-fly projection



Changing projections

- Change the way features (or coordinates) are projected



- Use the Project wizard in ArcToolbox
  - Input projection must be defined
  - Select from predefined coordinate systems
  - Import the coordinate system from an existing dataset
  - Create your own projection

Exercise 8 overview

- Recognize and set map scale
- Examine how a map’s projection can affect distance
- Observe how a map’s projection can affect shape
- Examine the Redlands data
- Project a shapefile

Discussion

Questions

Lesson 8 review

- The choice of datum can have a great impact on the coordinate values of the features in a map. (T/F)
- Measurements taken using a geographic coordinate system are uniform. (T/F)
- Large scales depict small ground areas but show more detail than
  small scales. (T/F)
- What is a projection?
- Which of the following is not a basic type of map projection?
  a) cylindrical
  b) planar
  c) spherical
  d) conic

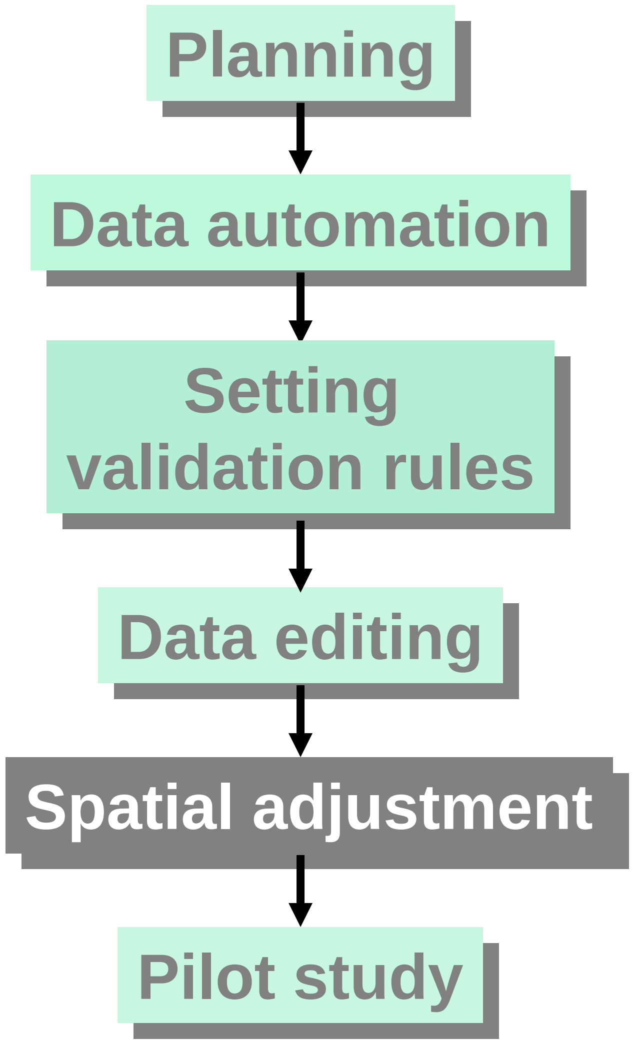
Lesson 8 review

- What spatial properties can be distorted by a projection?
- Projection information for a coverage and a shapefile is stored in a ____________ .

Lecture 9

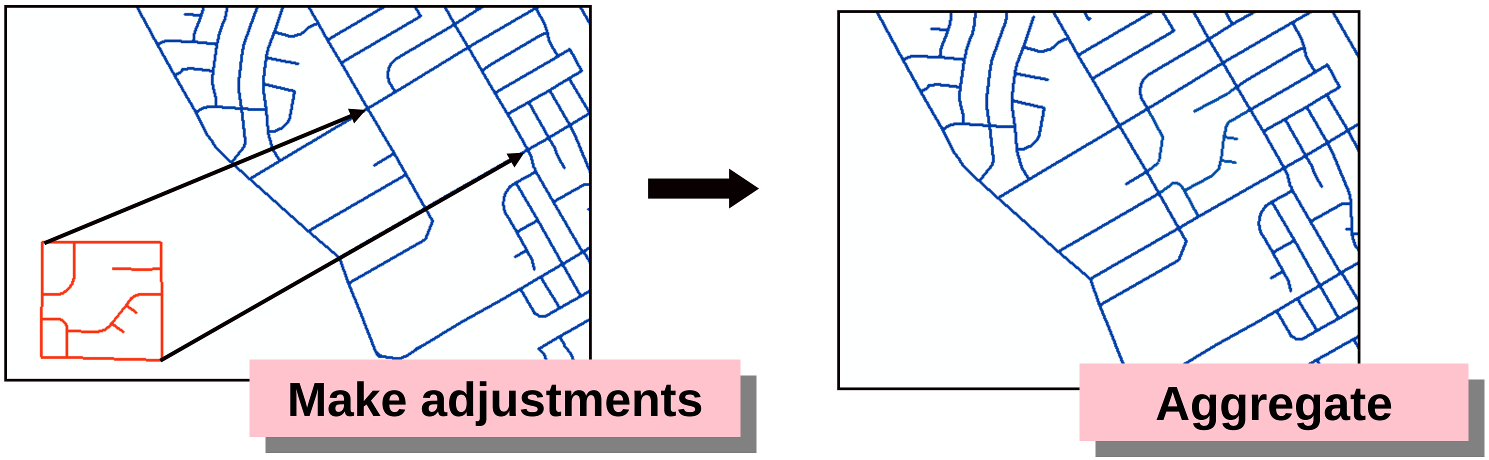
Spatial Transformation

Lesson overview



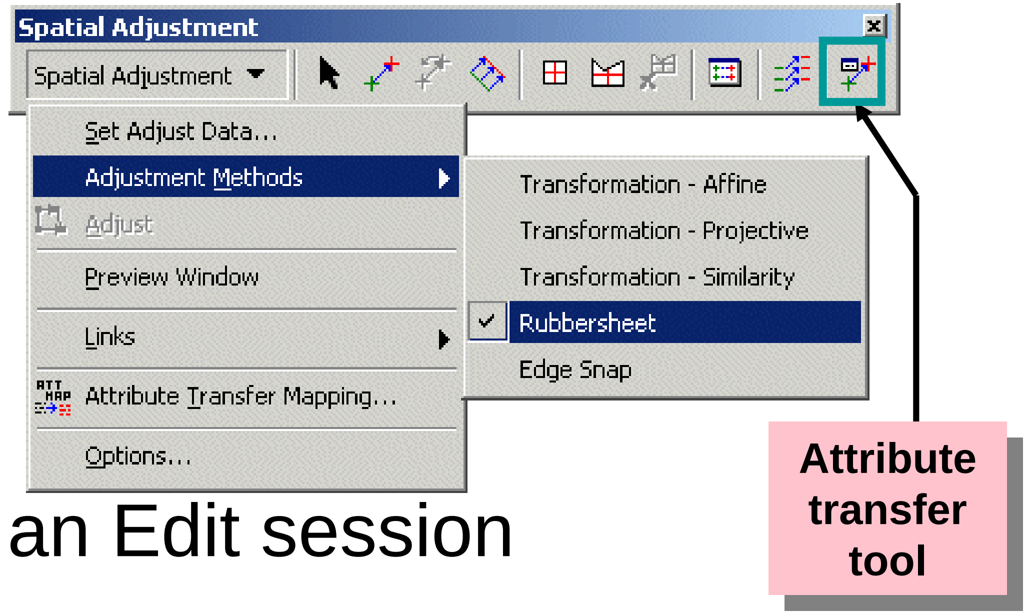
Why use Spatial adjustment?

- Align vector data to more accurate data
  - Digitized data in tablet or scanner units
  - Less accurate data
- Usually followed by aggregating data



Spatial adjustment

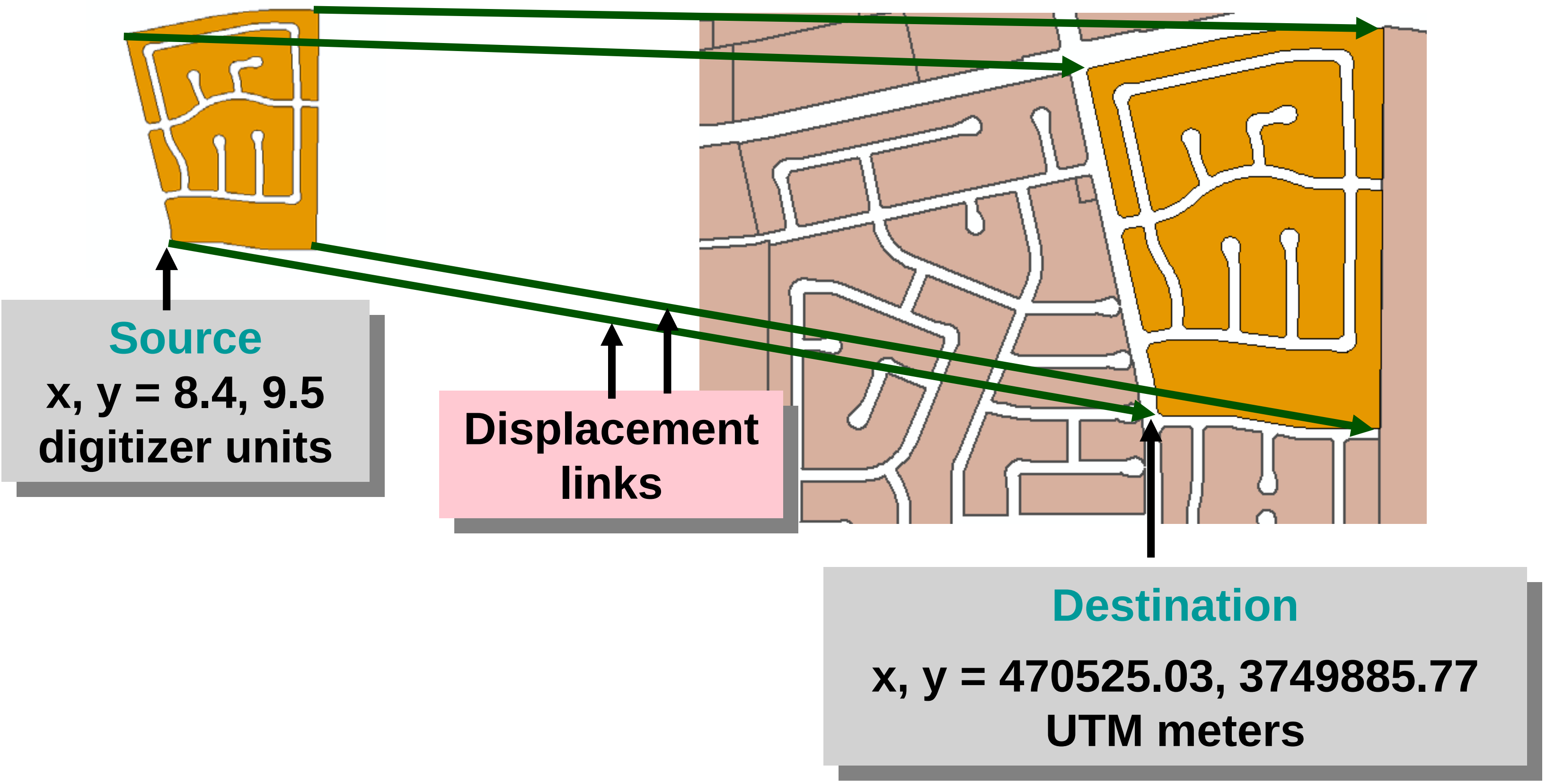
- Spatial Adjustment toolbar allows
  - Transform
  - Rubbersheet
  - Edge Snap
  - Transfer attributes



- Tools operate within an Edit session
  - Copy Features tool
  - Honor snapping environment
- Features are moved to new location based on displacement links

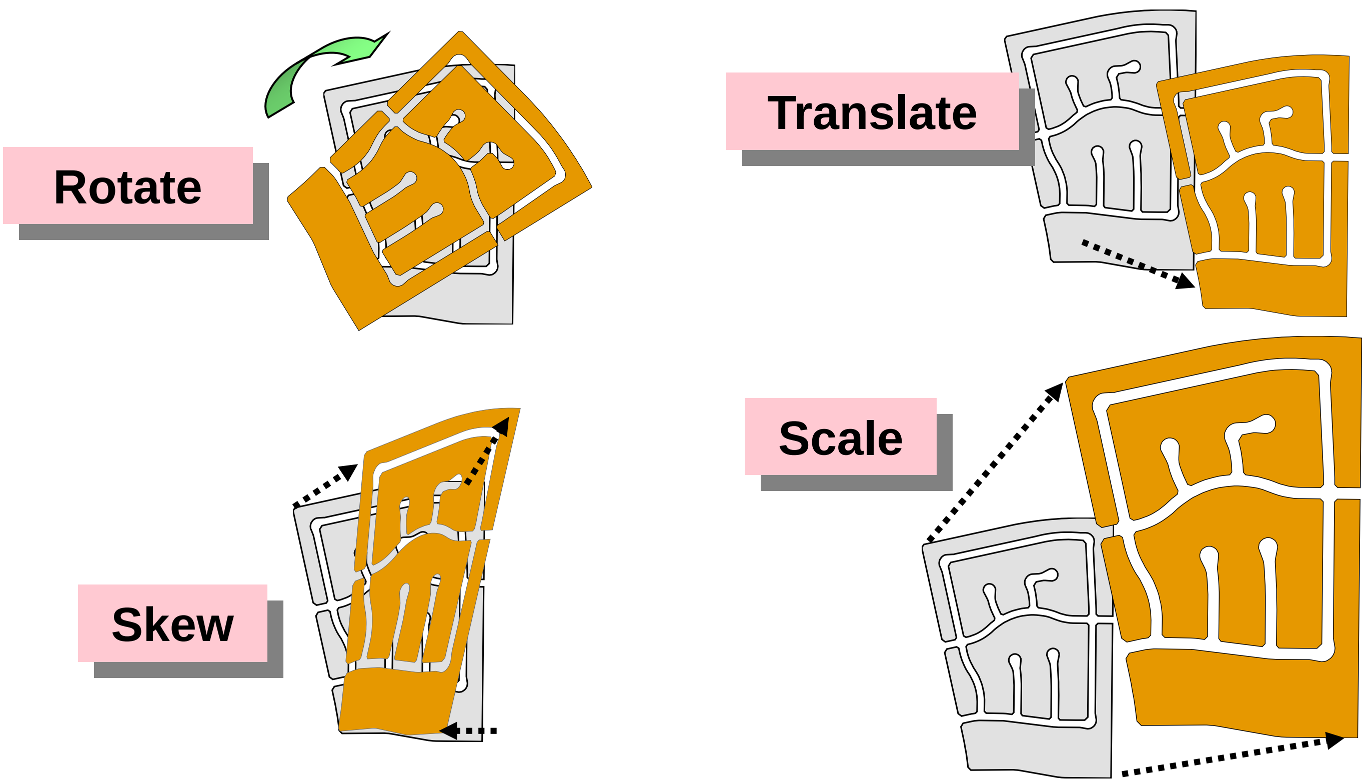
Transformation

- Change location of features in 2-D coordinate space
  - Converts data in digitizer or scanner units to real-world units
  - Shift data within coordinate system, example feet to meters



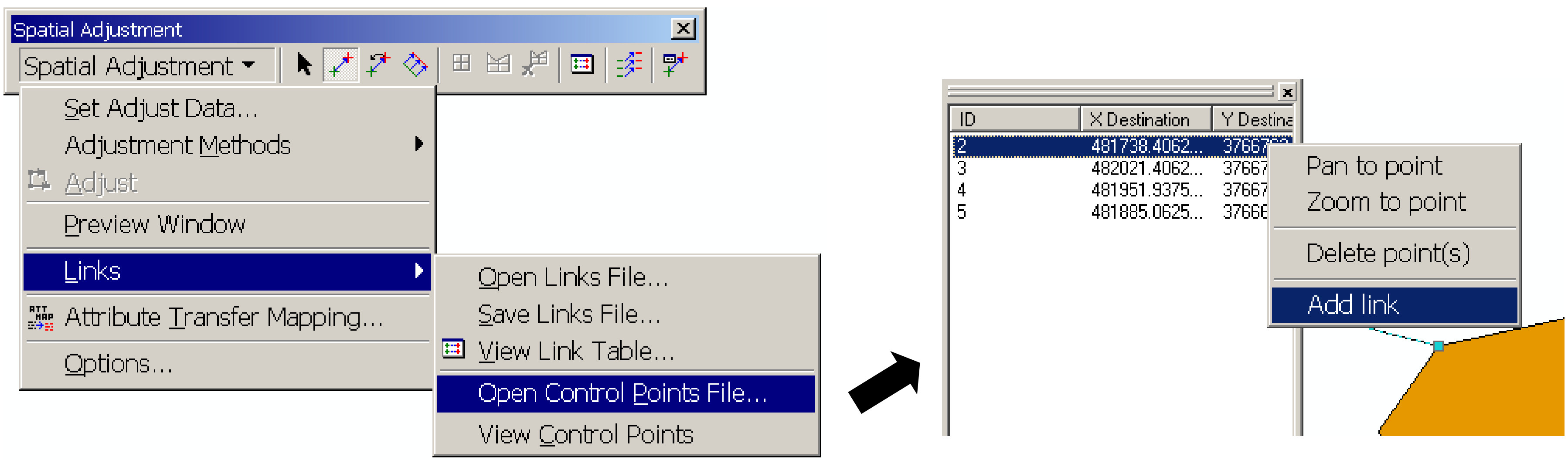
Transformation methods

- Transform will translate, rotate, and scale data
- Use Affine, Similarity, or Projective method
  - Affine transformation can



Creating displacement links

- Graphic elements define the *source* and *destination*
- Create manually or load from links or control point file



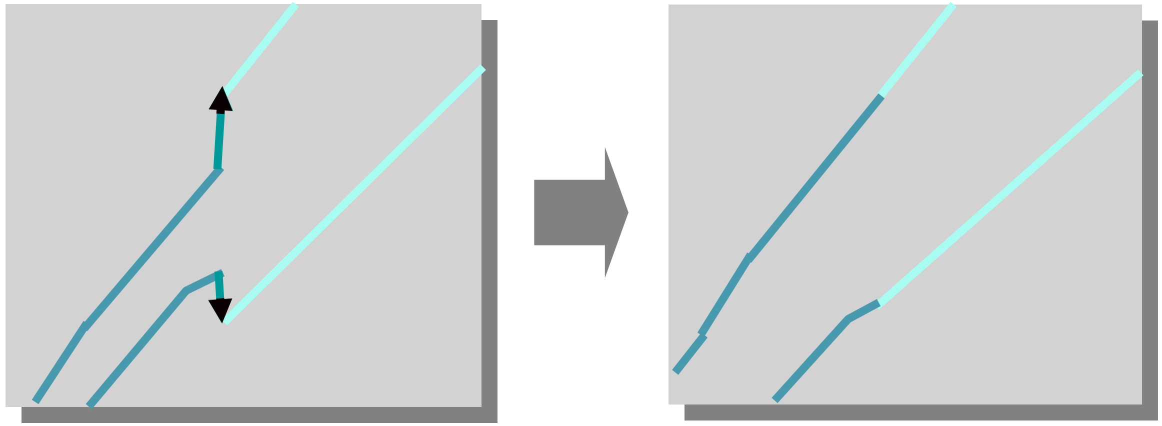
- Create links file from existing displacement links

Rubbersheeting

- Adjust source layer to match more accurate layer
- Features are stretched, straight lines preserved
- Identity links hold features in place
- Adjust all features or only within a limited area

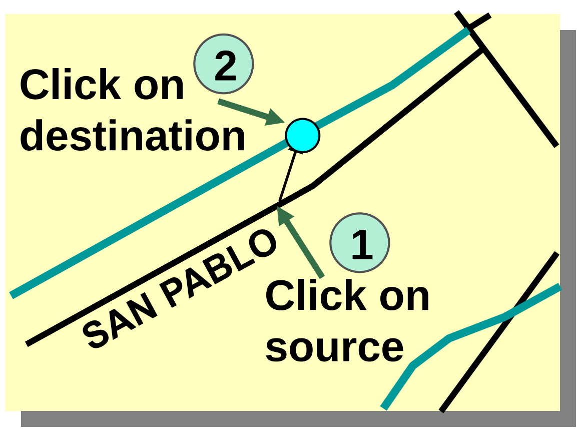
Edge Snap

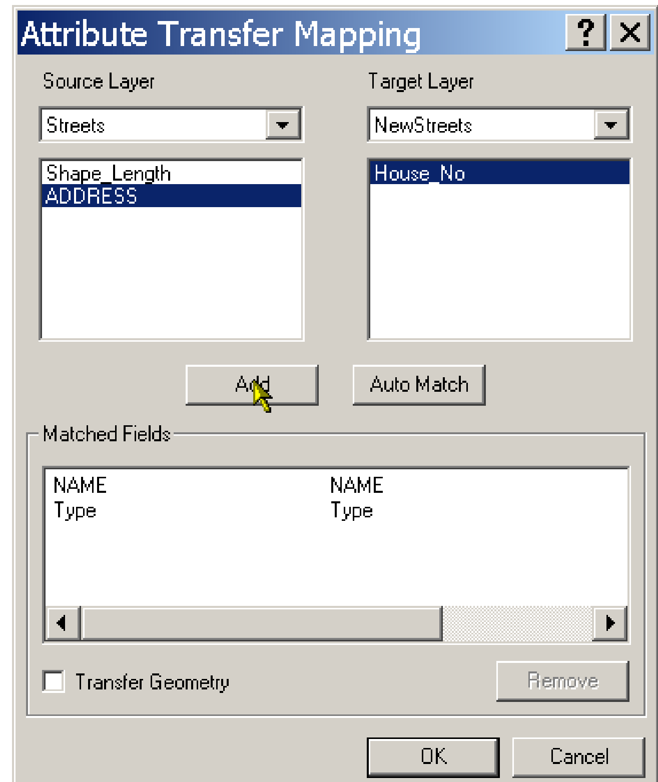
- Aligns features in adjoining layers
- Edge Snap tool adds links within snapping tolerance
- Options
  - Smooth or line methods
  - Adjust to midpoint of links
  - Use attributes to define the edgematch



Attribute transfer

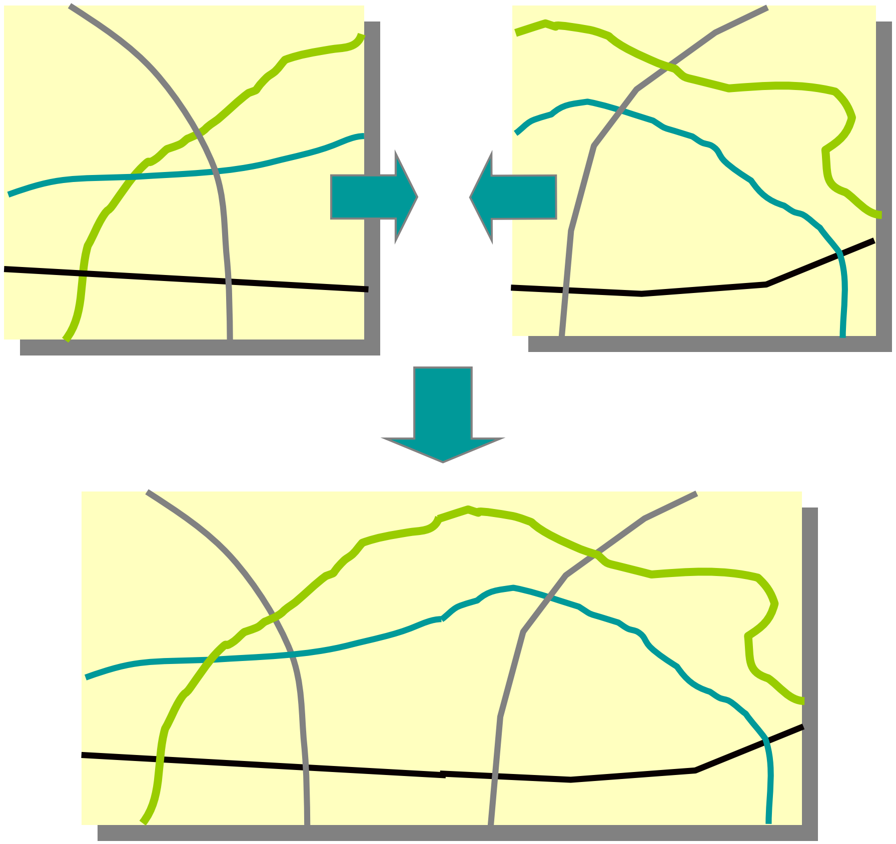
- Interactively transfer attributes between features
- Match common fields between layers
  - Set source and target layers
  - Specify fields to transfer
  - Option to transfer geometry





Aggregating spatial data

- Copy and Paste
- Simple Data Loader
- Object Loader
- Merge command in Geoprocessing Wizard
  - Merge adjacent layers



Discussion

Questions

Exercise 11 overview

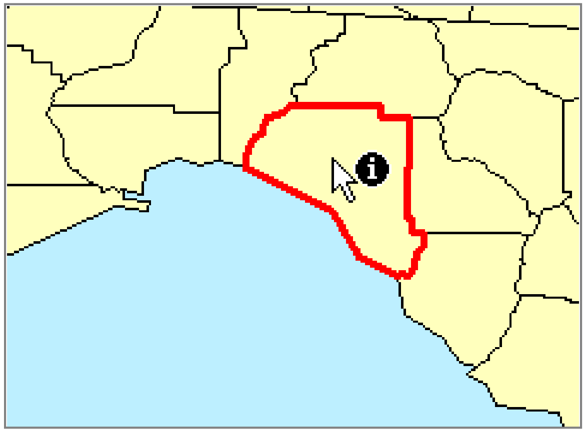
- Convert a DXF file to a GDB feature class
- Add displacement links
- Transform data to real world coordinates
- Edge snap two layers
- Transfer attributes
- Merge two feature classes into one

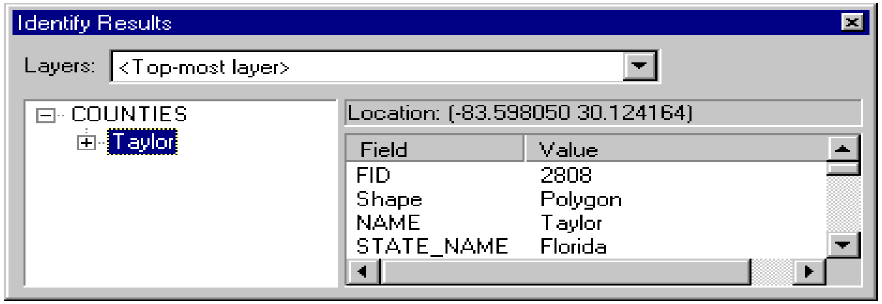
Lecture 10

GIS Query

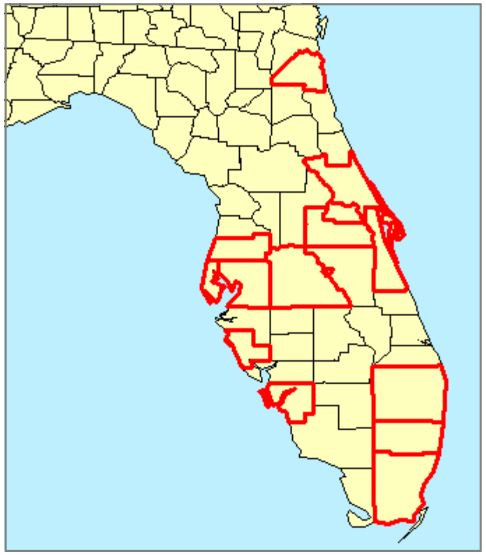
Query

- Identifying specific features





- Identifying features based on conditions



Florida counties with a population greater than 300,000

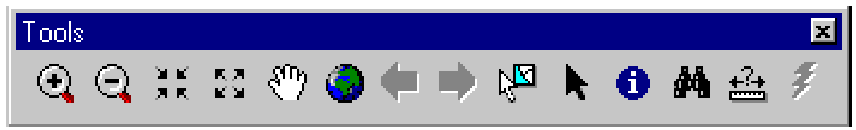
Querying your database

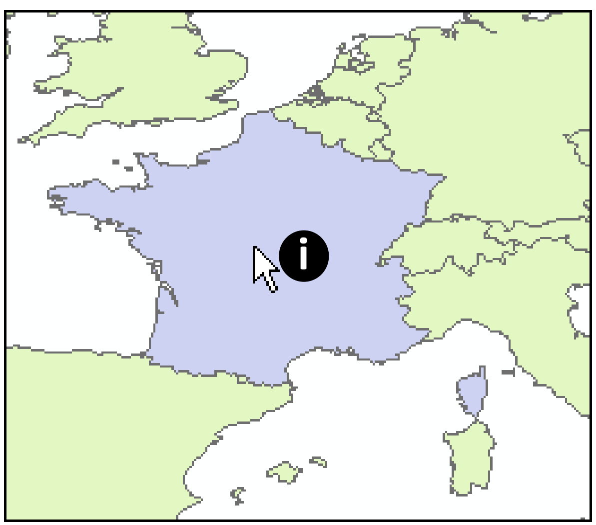
Lesson 4 overview

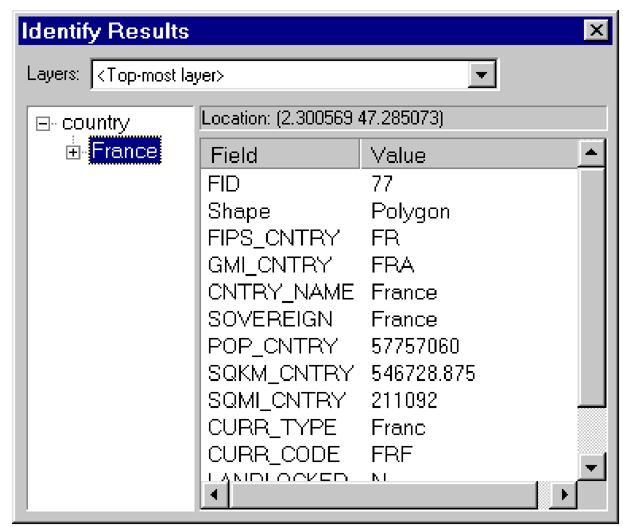
- Tools for examining your data
  - Identify, Find, Measure, map tips, hyperlinks
- Working with the selection tools
  - Why do you need a selection?
  - Available selection tools
  - Selection methods and layers
  - Spatial selection
  - Attribute selection
  - Calculating summary statistics

Identifying

- Popup attributes for a specific feature

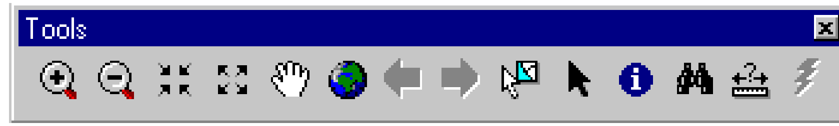


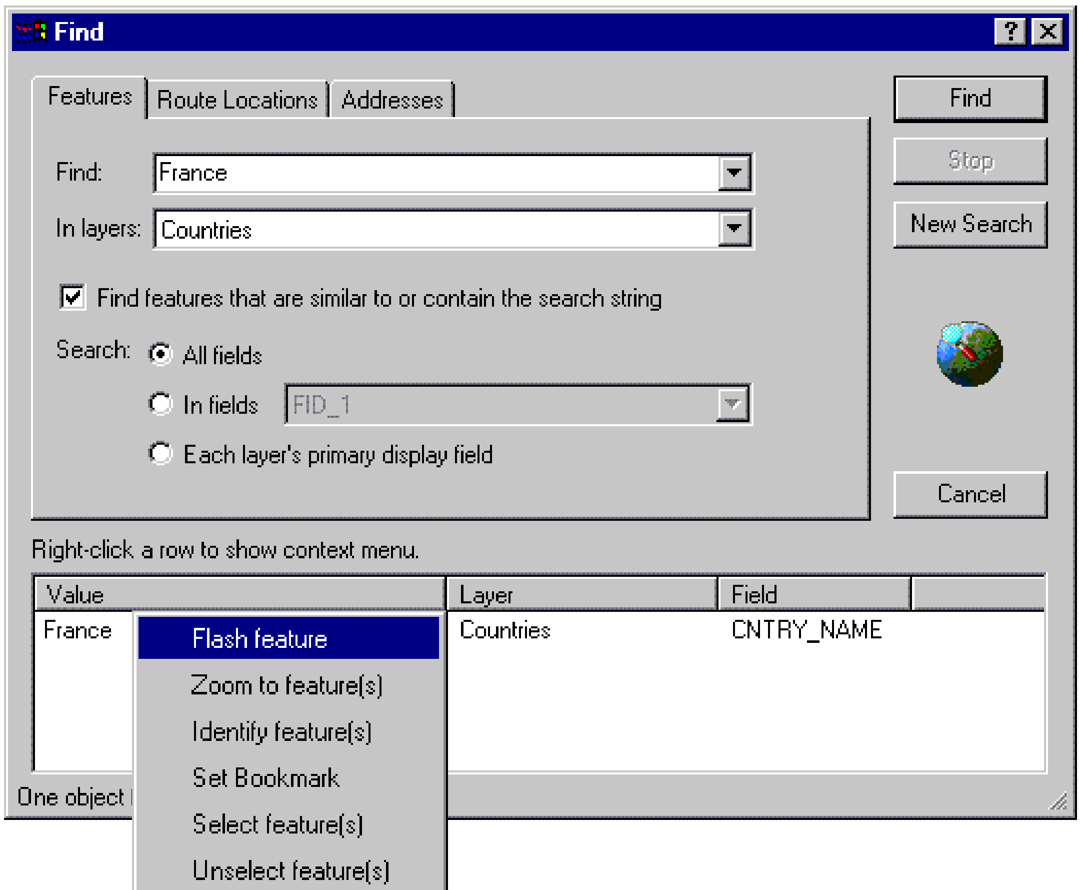




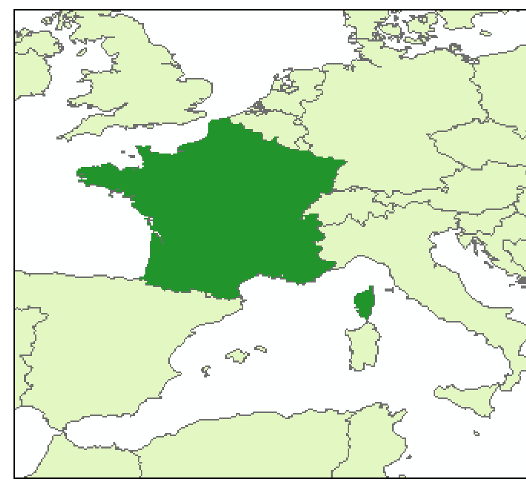
Finding

- Locate a specific feature or attribute



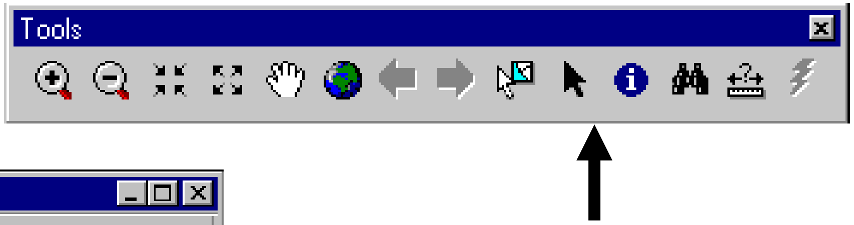


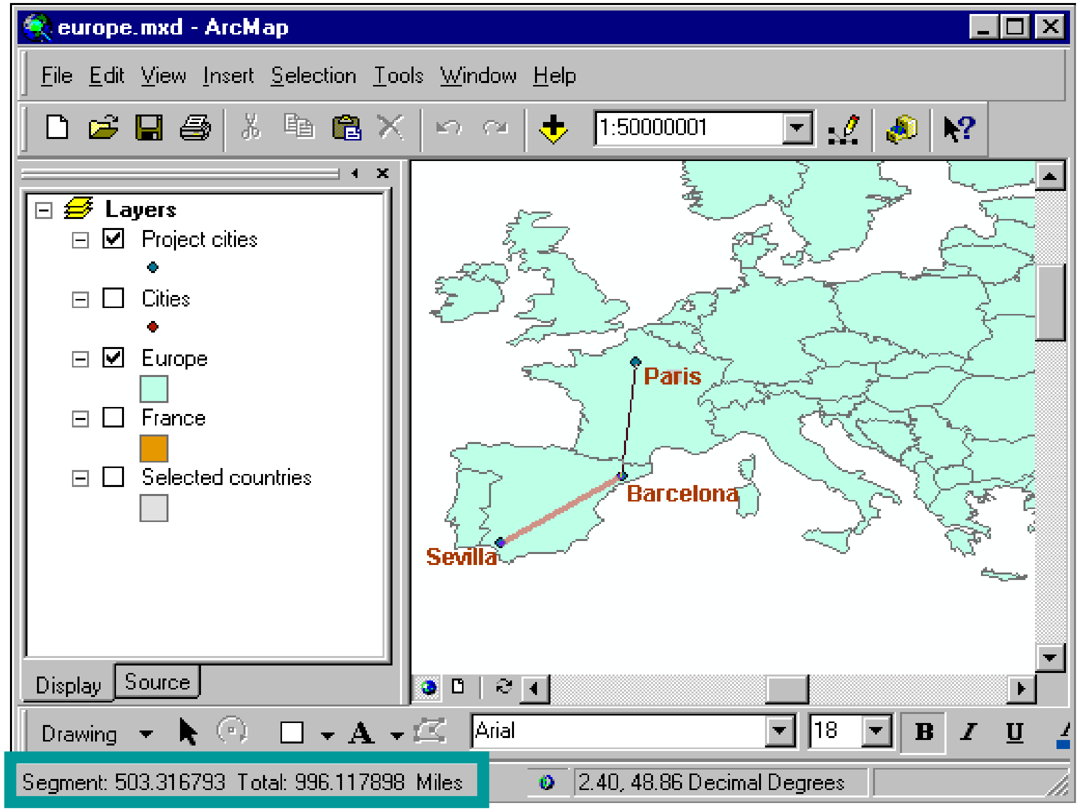
France flashes



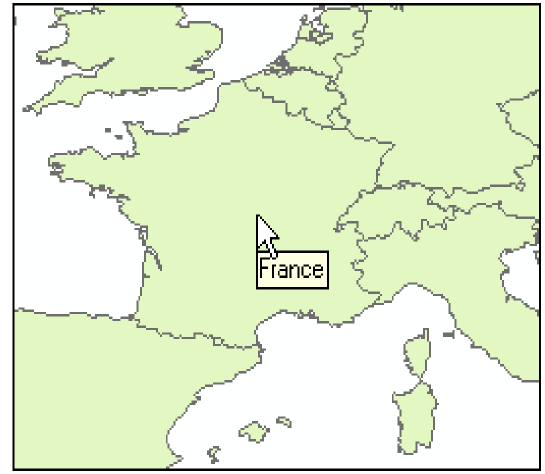
Measuring

- Find linear distances

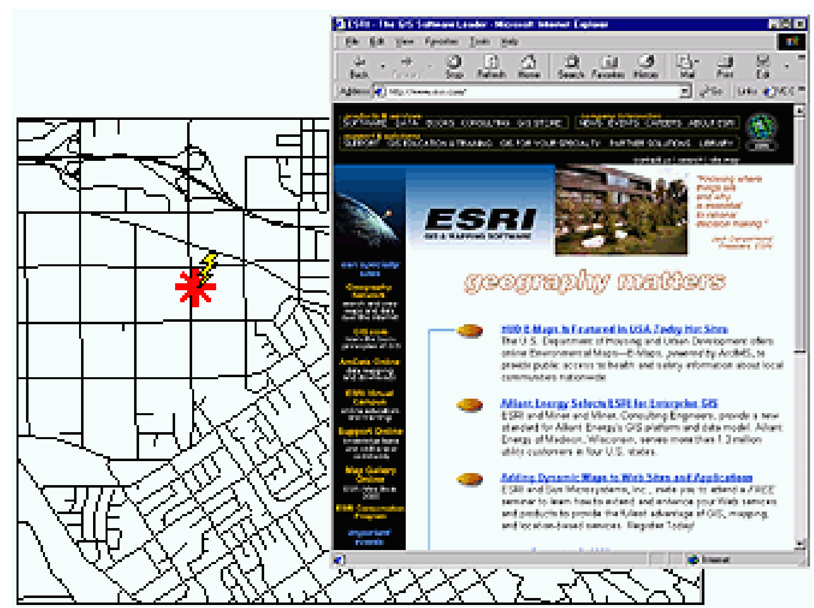




Map tips and hyperlinks



- Display property of a layer
- Map tips
  - Pointer location displays specific attribute

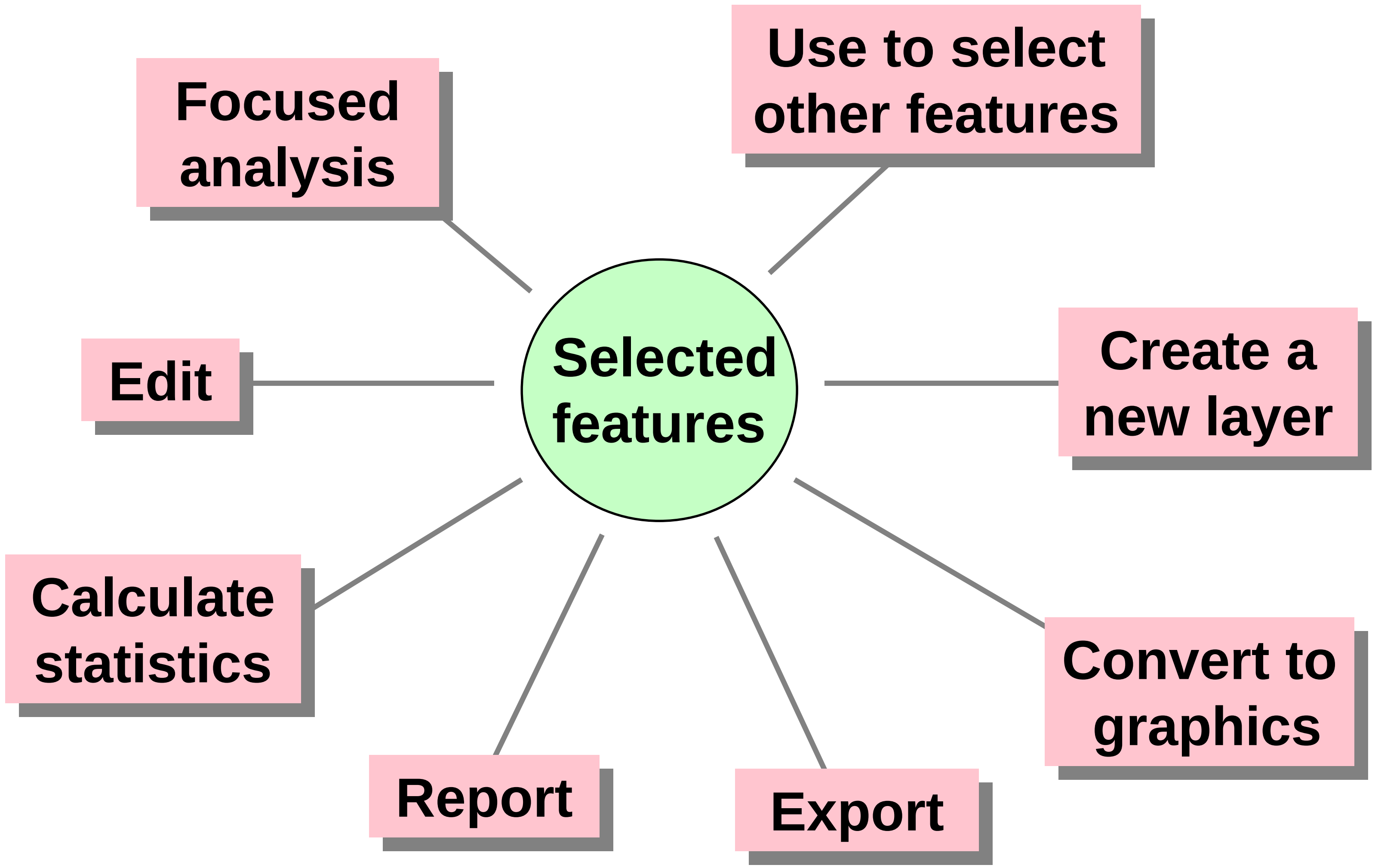


- Hyperlinks
  - Document
  - URL
  - Macro

Lesson 4 overview

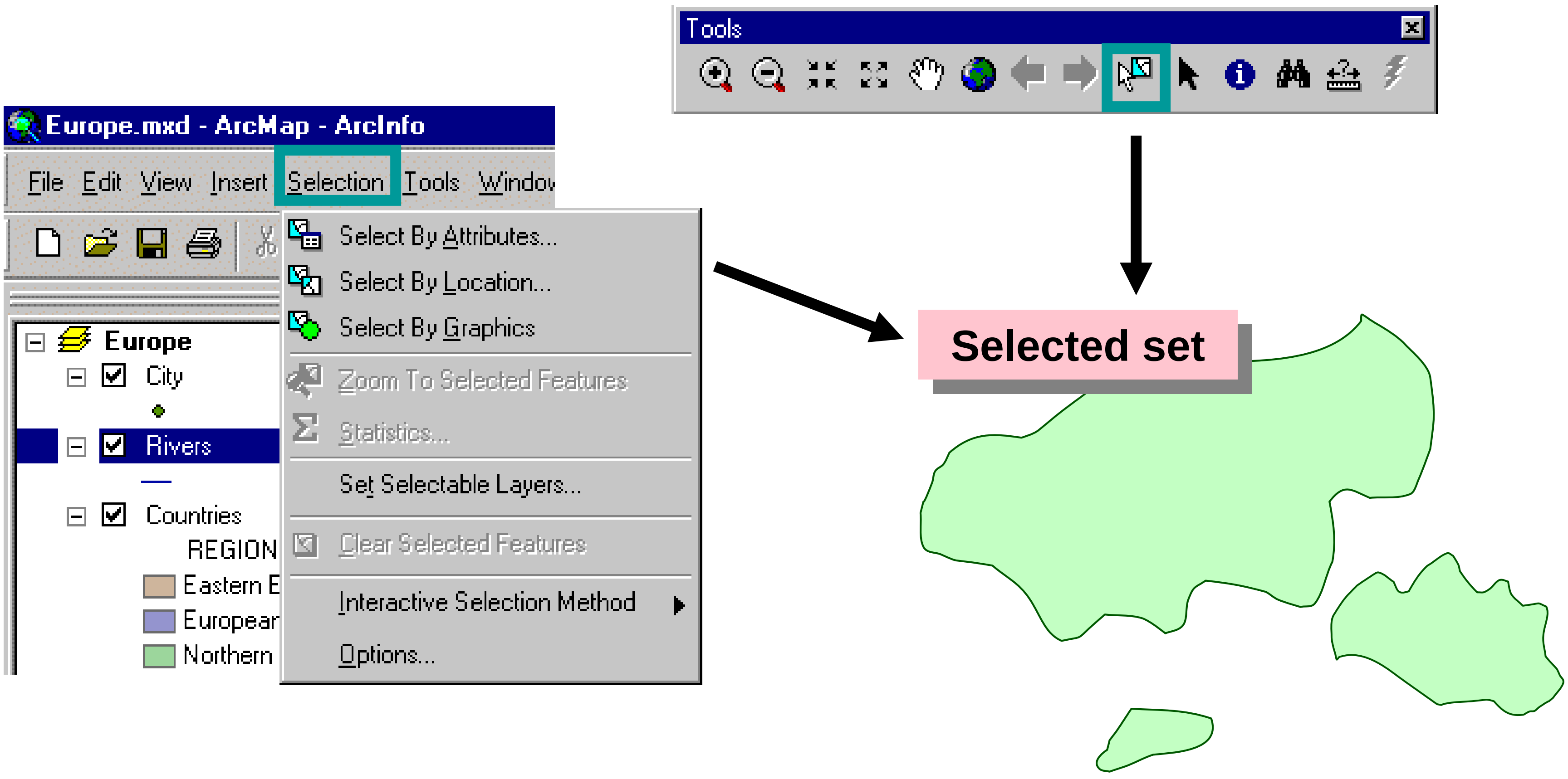
- Tools for examining your data
  - Identify, Find, Measure, map tips, hyperlinks
- Working with the selection tools
  - Why do you need a selection?
  - Available selection tools
  - Selection methods and layers
  - Spatial selection
  - Attribute selection
  - Calculating summary statistics

Why do you need a selection?



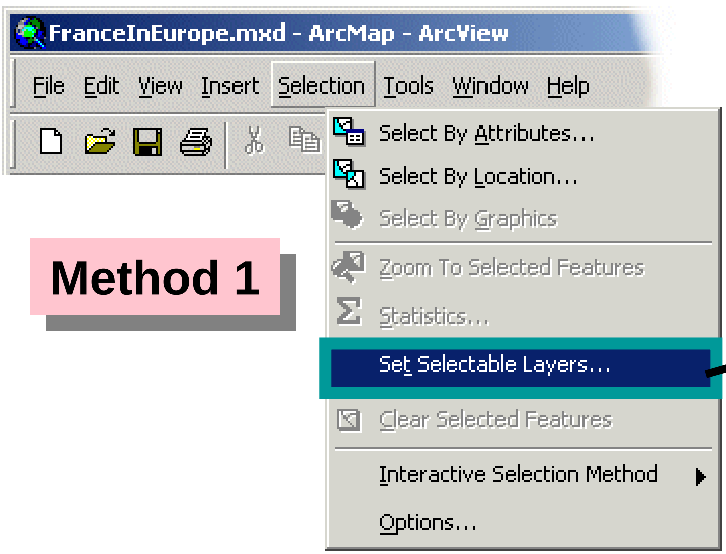
Available selection tools

- Interactive, attributes, location, graphics

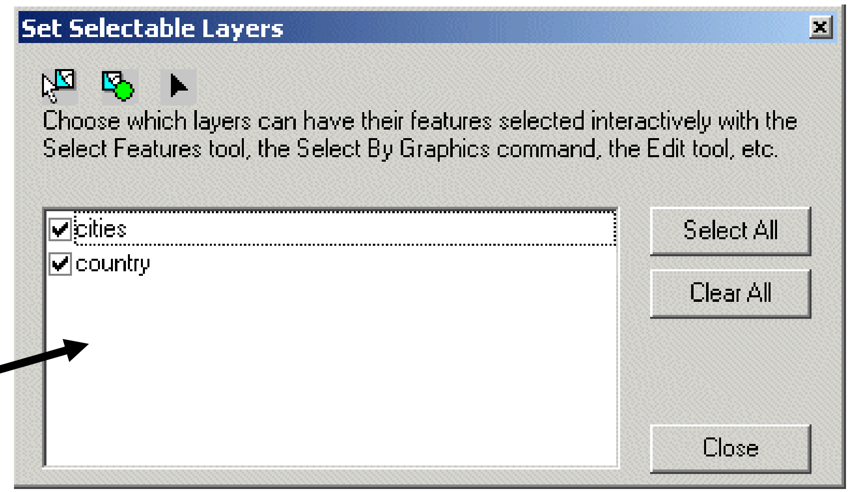


Selection layers

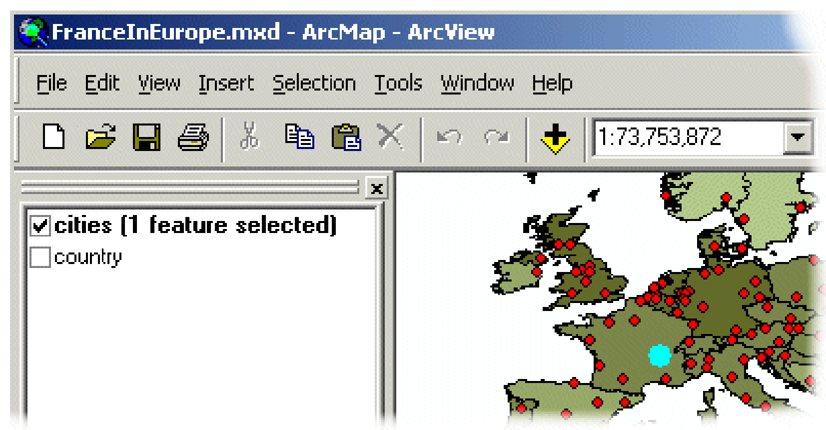
- Specify from Selection menu
  - Layer to select from using interactive selection tool



Method 1

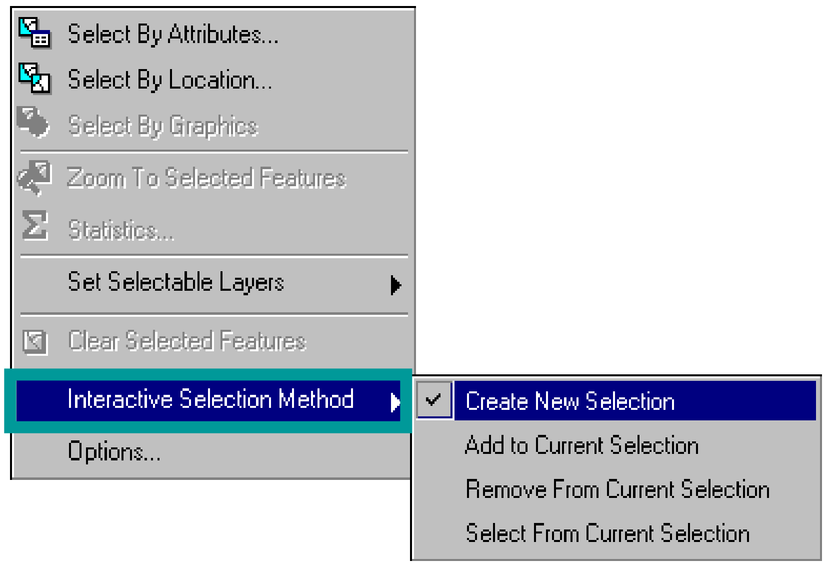


Method 2

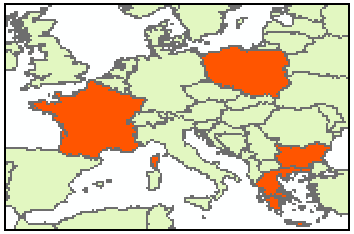


Selection methods

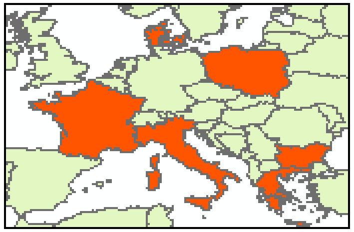
- Specify from Selection menu



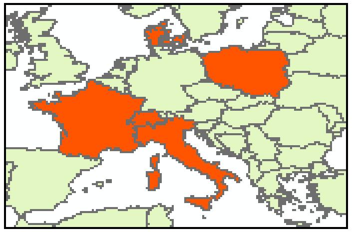
Create new selection



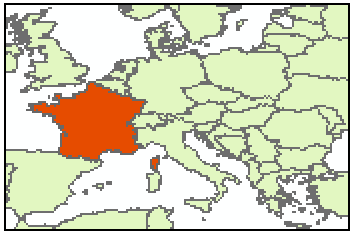
Add to the selection



Remove from the selection

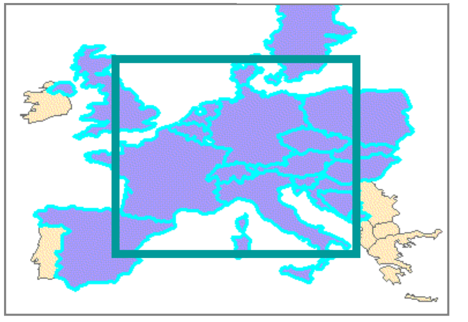


Select from selection

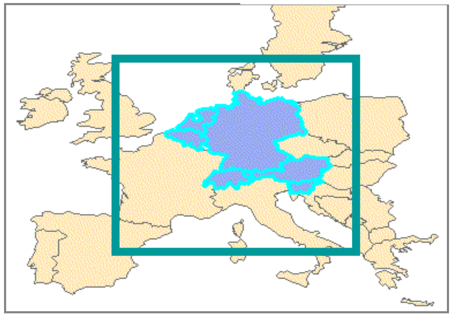


Interactive selection options

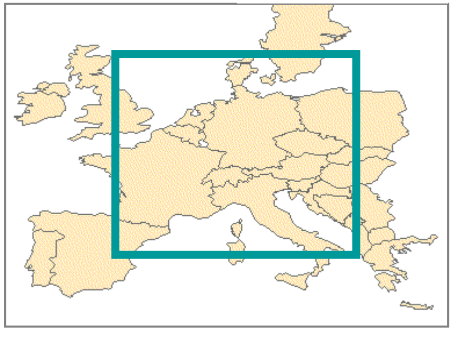
- Options from Selection menu
  - Select features partially or completely within the box or graphic(s)



  - Select features completely within the box or graphic(s)

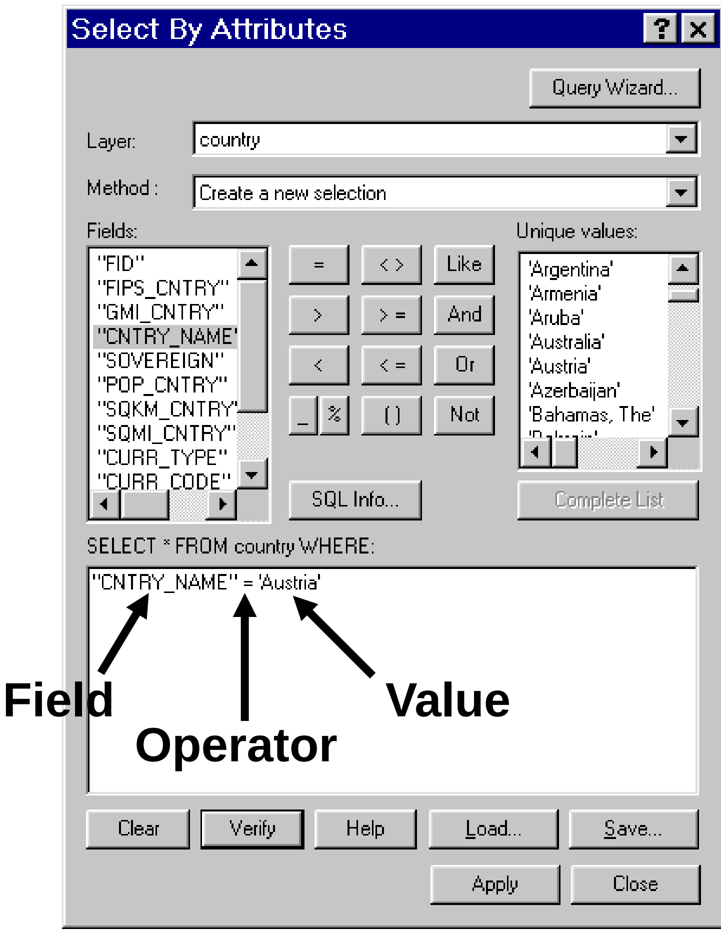


  - Select features that the box or graphic are completely within

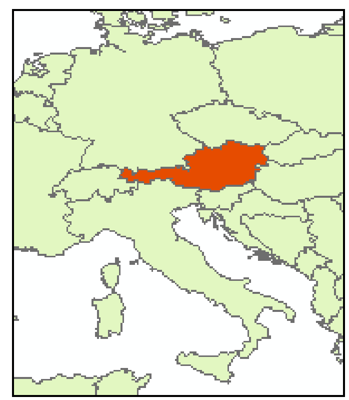


Attribute selection

- Use a SQL “where” clause to select features
- Save and reload selection expressions

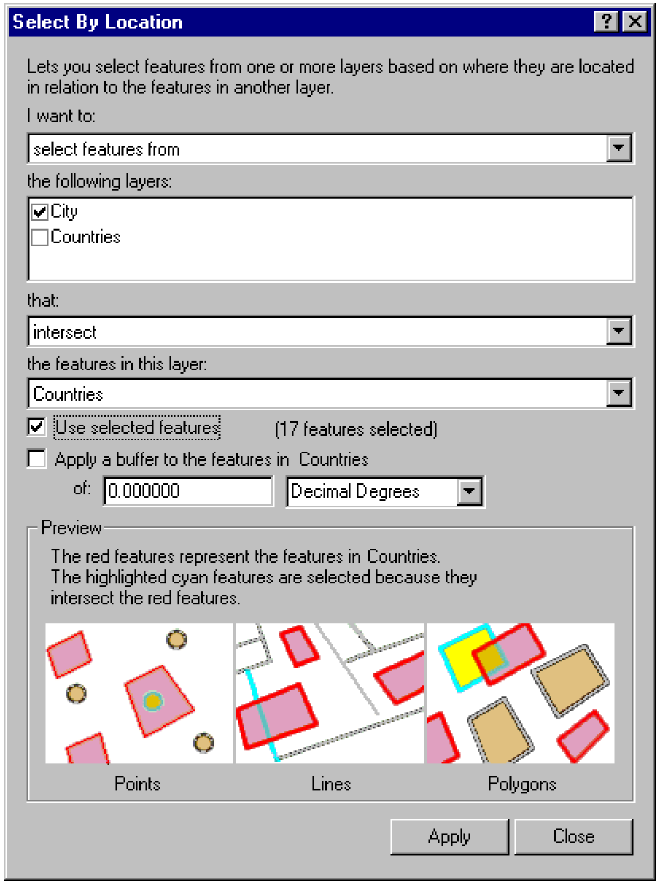


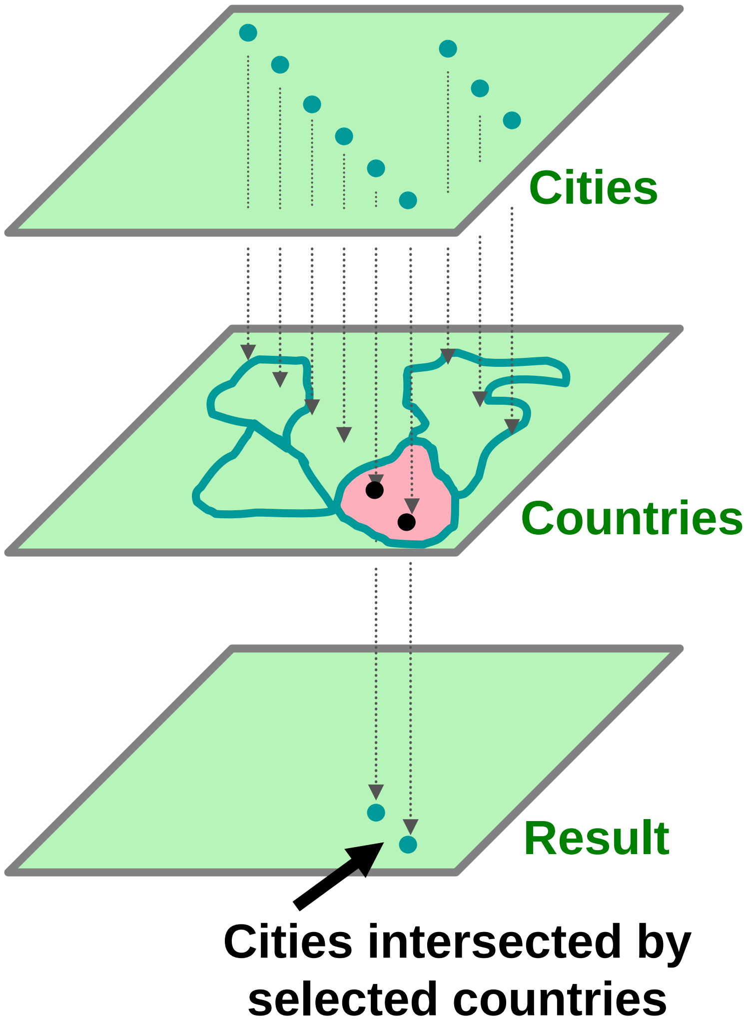
For current selection:
Add to
Remove from
Select from



Select by location (spatial query)

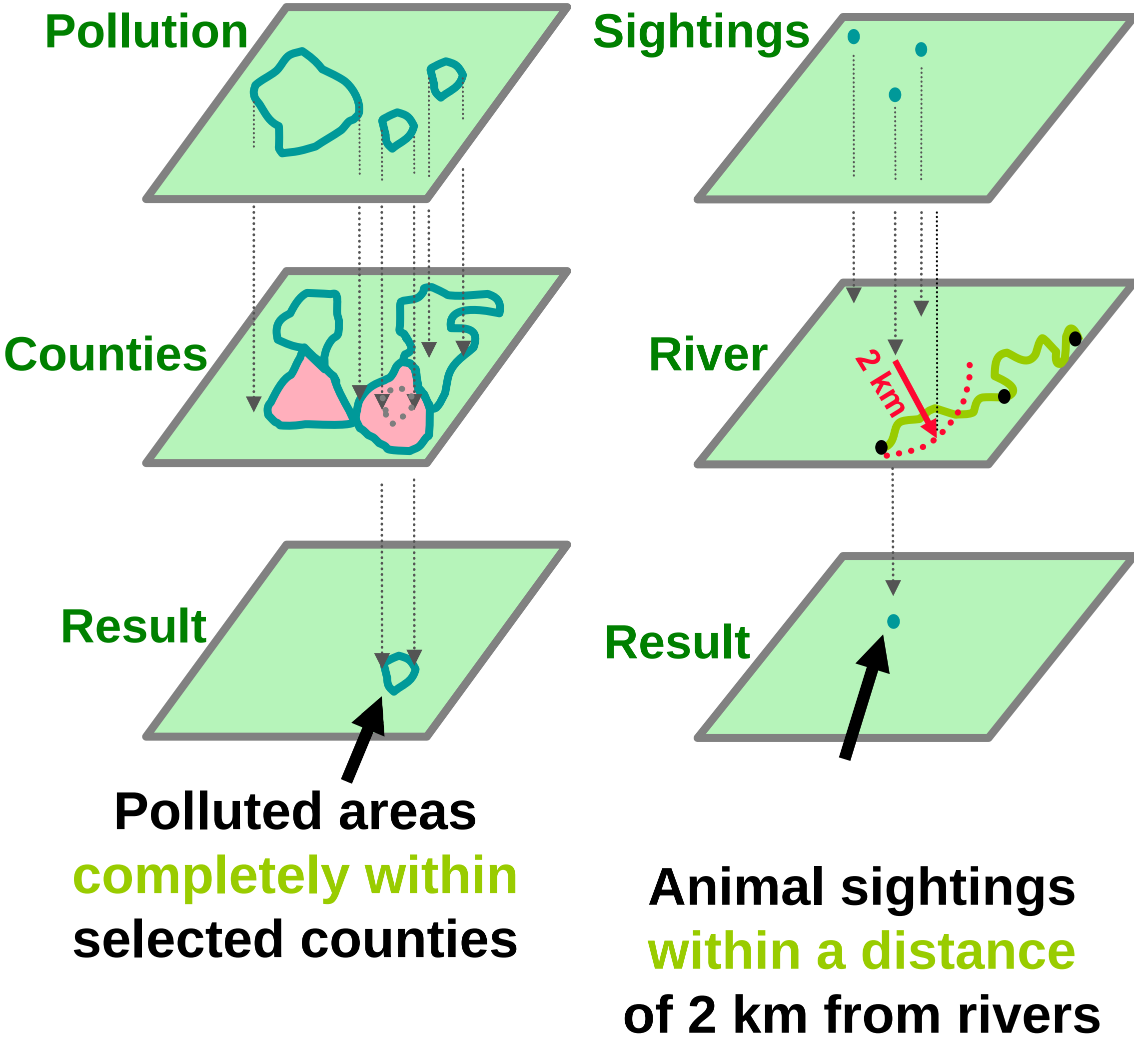
- Use features in one layer to select features in another





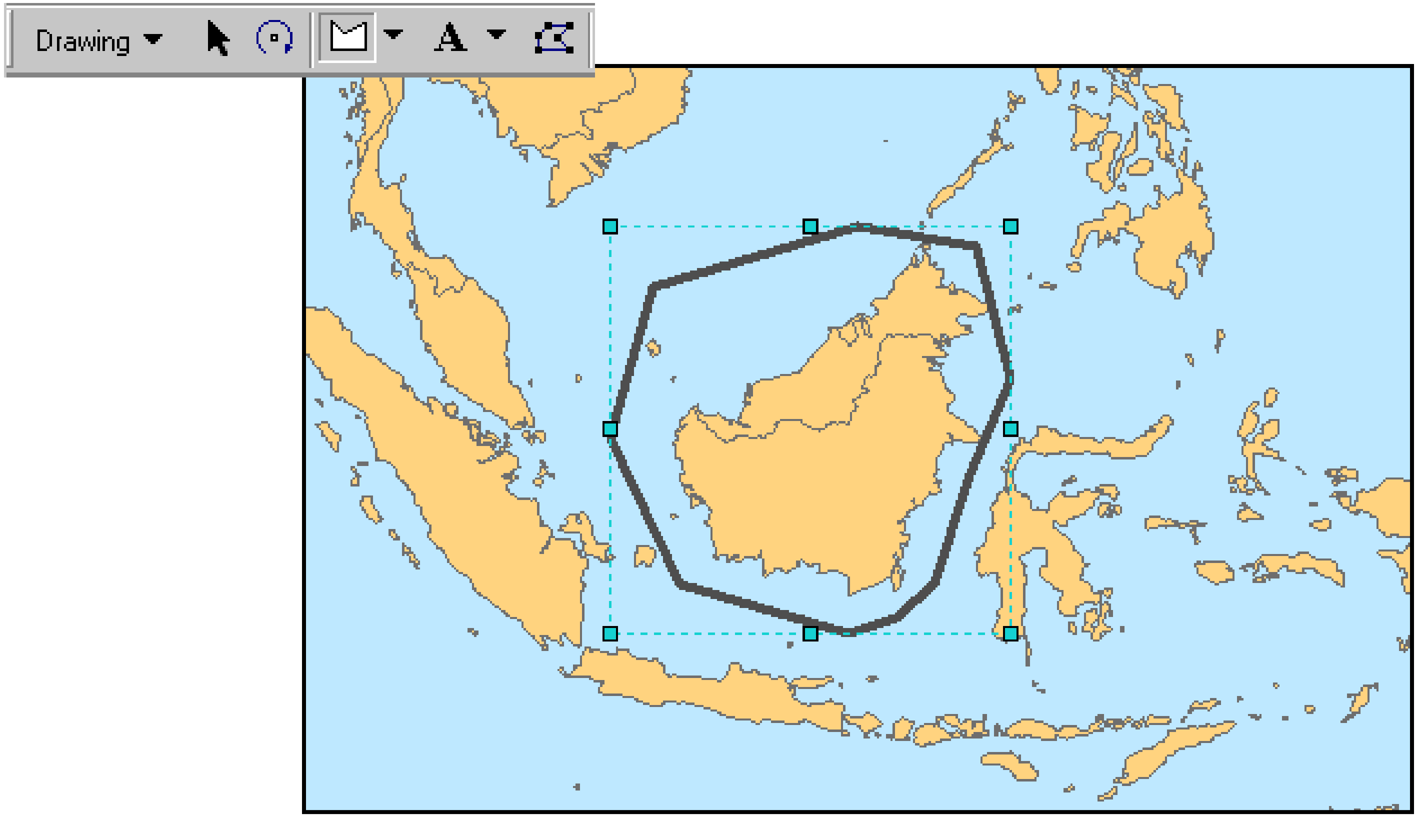
Location selection methods

- Select by location offers many selection methods
  - Intersects
  - Contains
  - Are contained by
  - Shares a line segment
  - Touch boundary
  - Within a distance
  - Are identical
  - Others…



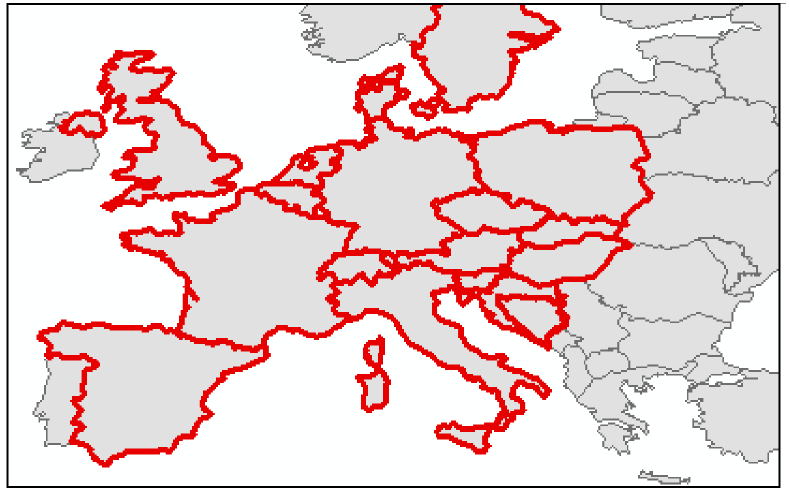
Select by graphics

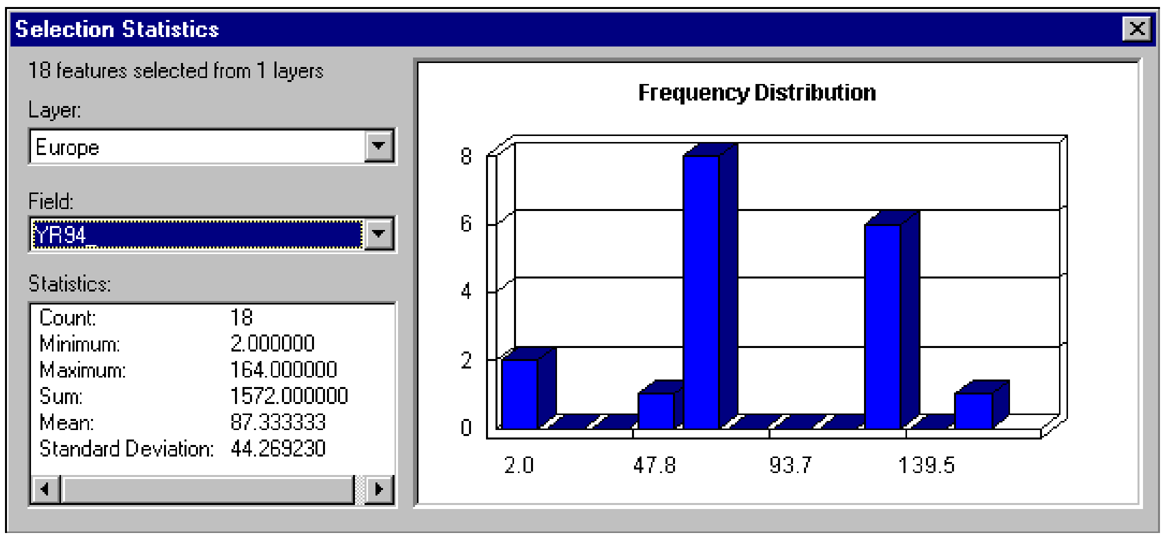
- Draw a graphic to select features
- Works with interactive selection methods



Calculating summary statistics

- Select
  - Features





  - Layer
  - Field

Discussion

Questions

Exercise 4 overview

- Start ArcMap and open an existing map document
- Add map tips
- Identify a feature
- Find a specific feature
- Take measurements
- Make a spatial query
- Examine your selection in the tables
- Calculate statistics for your selection
- Create a selection layer
- Explore other spatial selections
- Explore attribute selections
- Save your layer in another format
- Save your document and exit ArcMap

Lesson 4 review

- How are map tips useful?
- What is a hyperlink?
- What does the Identify tool do?
- How do you access the context menu in the Find tool? What options are located on this context menu?
- What are the four ways a feature can be selected in ArcMap?
- What are the selection methods available in the Select by Attribute dialog?
- What extent options can be set for interactive spatial selections?

Lesson 4 review

- What type of statement does the the Select by Attribute function use to select features?
- If you do not know where a certain feature is but you know some of its attributes, how would you locate it?
- Describe two Select by Location methods.

Lesson 6 review

- How do you access a layer’s feature attribute table in ArcMap?
- How many records in a feature attribute table are associated with a feature?
- What is the difference between the default and user-defined fields in an attribute table?

Lecture 10

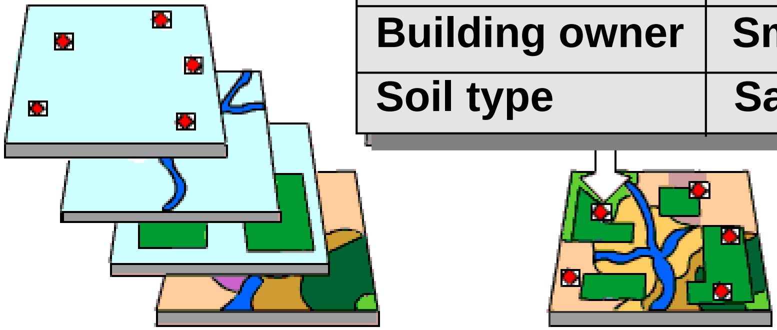
GIS Analysis

Analysis

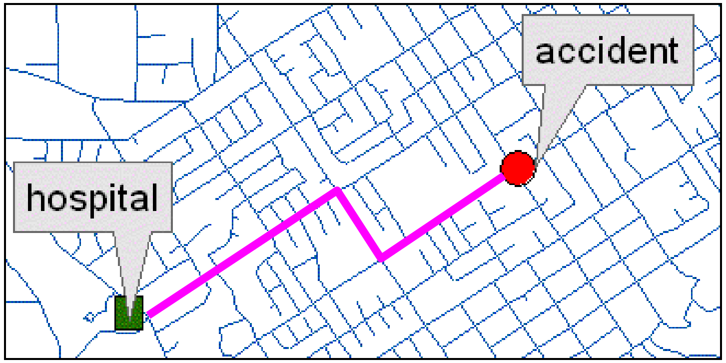
Proximity

Overlay

Well type	Drilled
Building owner	Smith
Soil type	Sandy

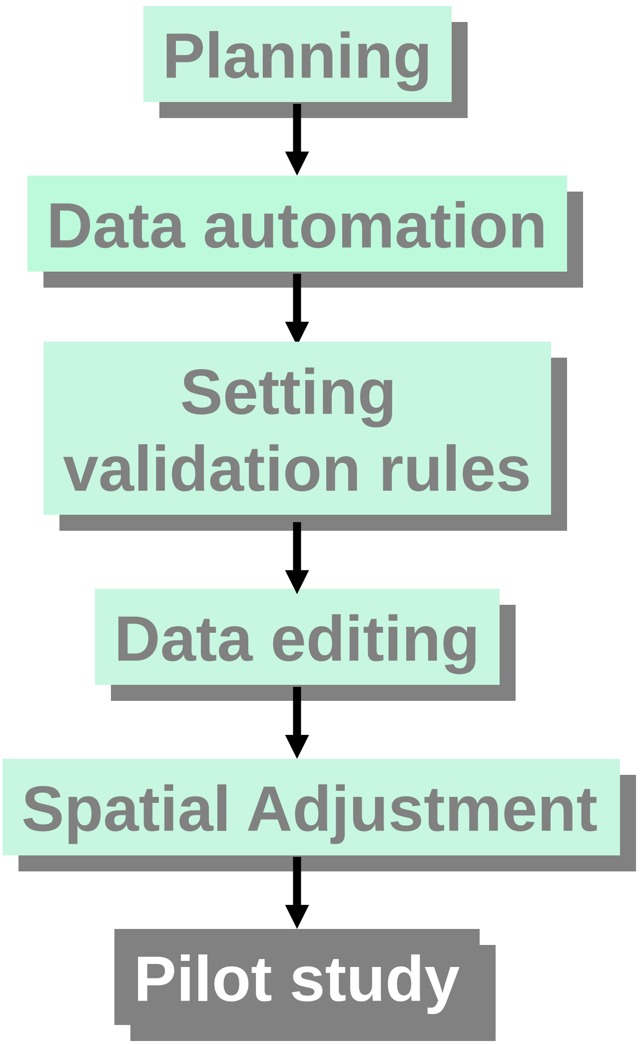


Network



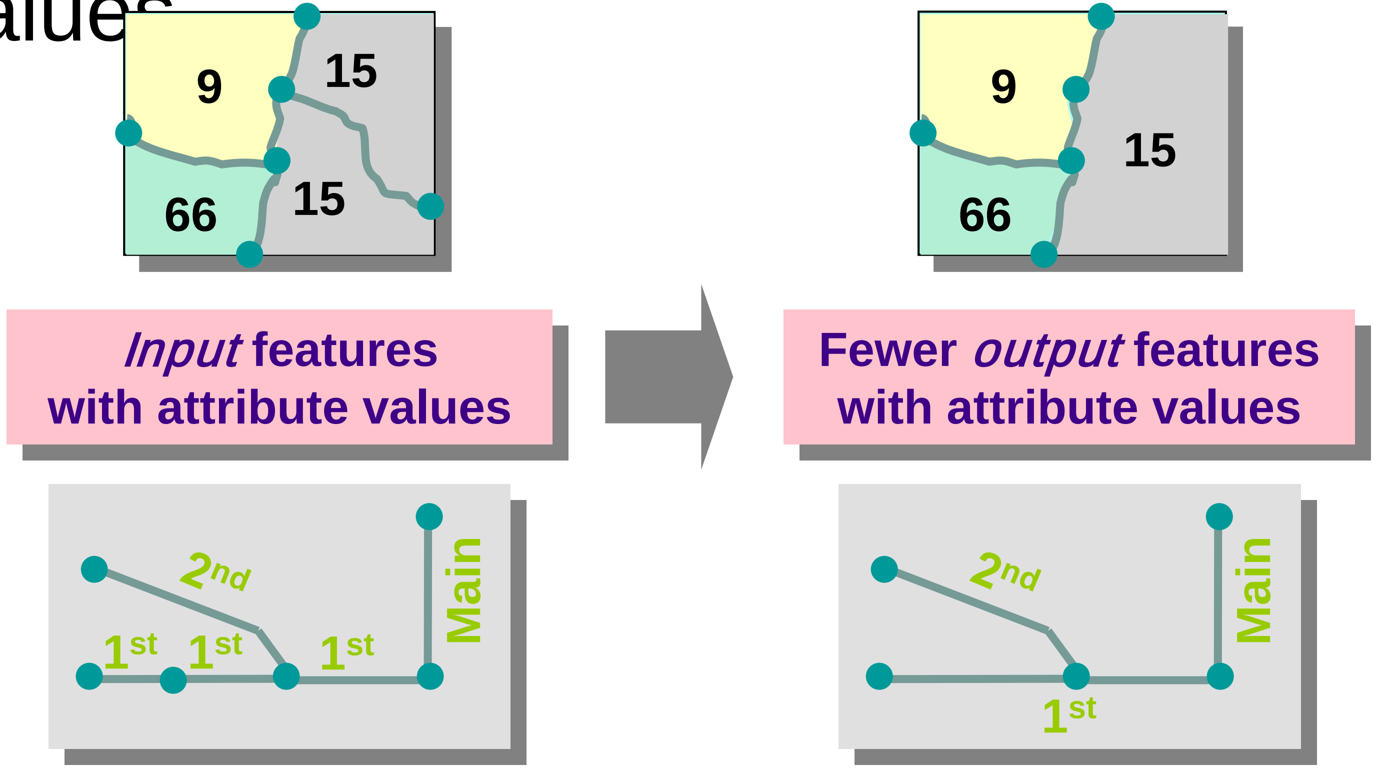
Lesson overview

- Preparing data for analysis
  - Dissolve
  - Merge
  - Clip
- ArcGIS spatial analysis
  - Buffer
  - Overlay
- The analytical process



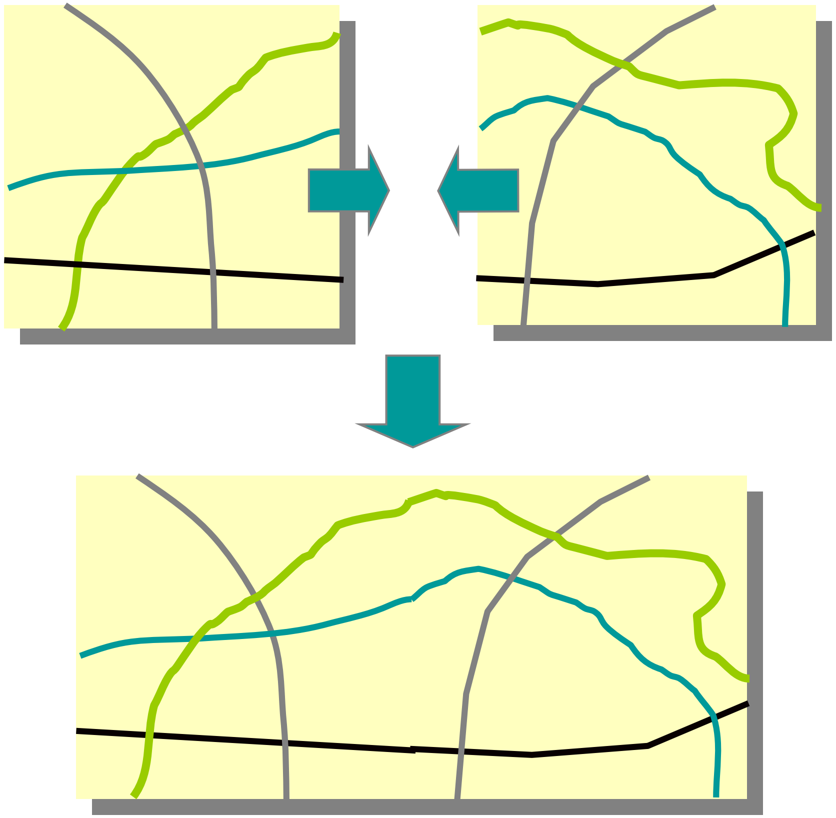
Dissolving features

- Simplify data based on common attribute values



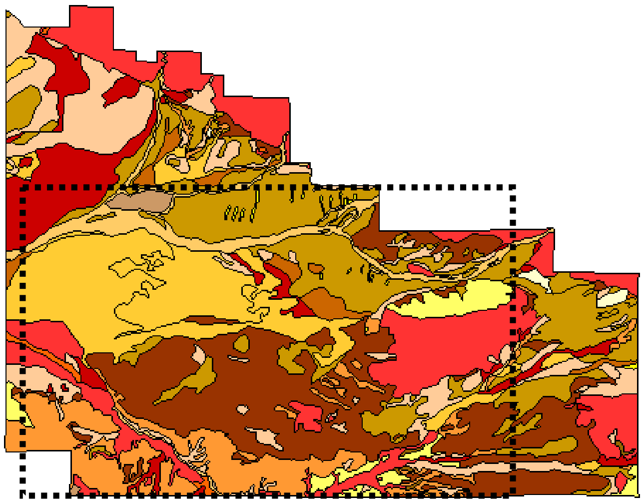
Aggregating spatial data

- Merge separate layers into one
  - Options for assigning attributes to the output layer

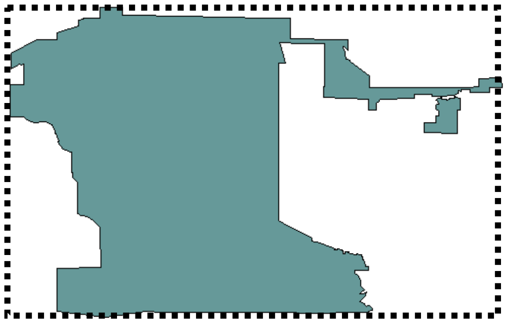


Clipping features

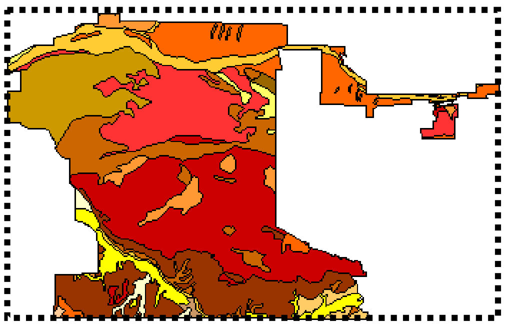
- Use one feature class to define the boundary of another



Original data



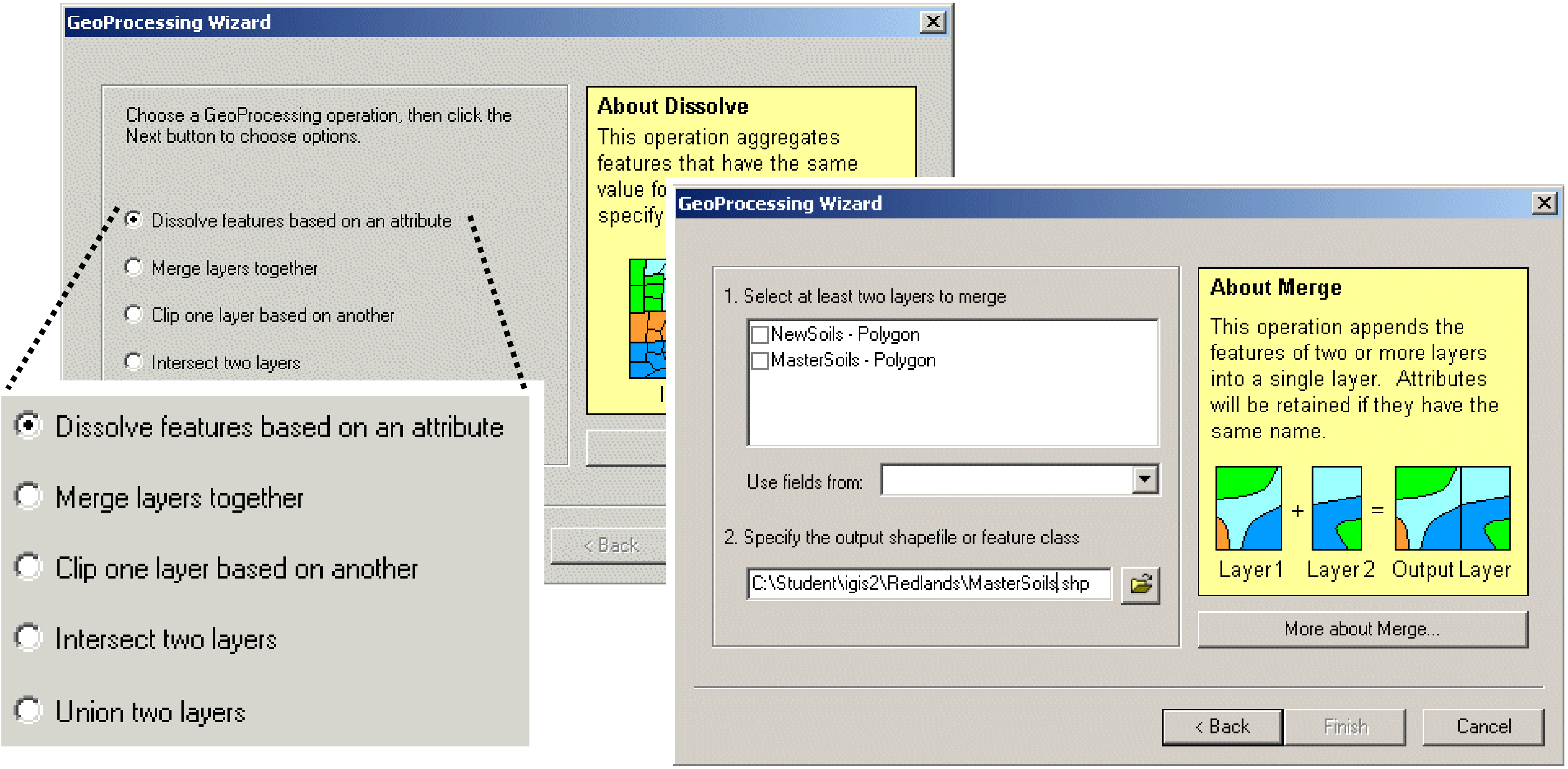
Clipping FC



Final FC

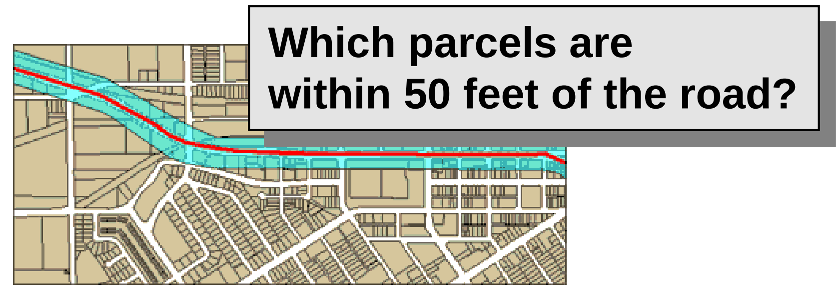
The GeoProcessing Wizard

- Helps conceptualize process
- Use for dissolving, merging, and clipping

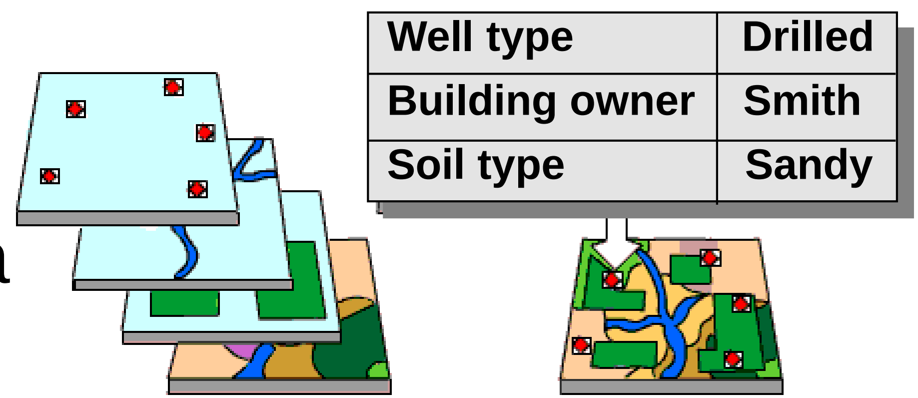


Spatial analysis functions

- Proximity analysis
  - Locating features based on their distance from other features
  - Finding the nearest feature

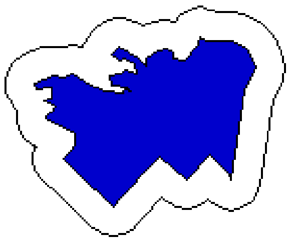


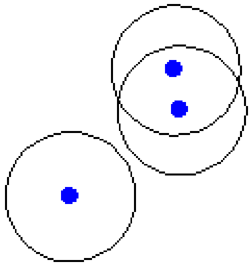
- Overlay analysis
  - Combining features a attributes

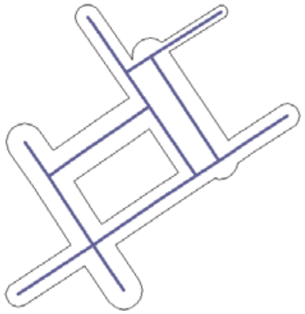


Buffering

- A distance analysis tool for points, lines, and areas
- Create new polygon representing specified distance
- Answer questions based on proximity





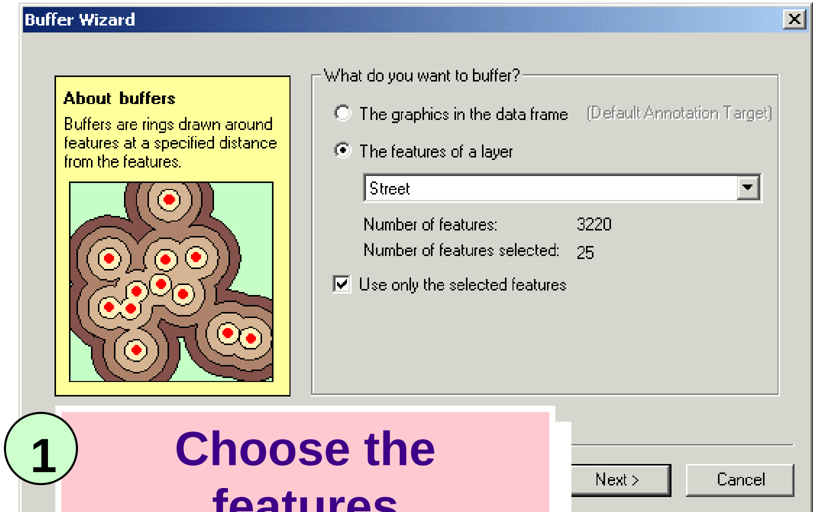


Buffer 50 meters

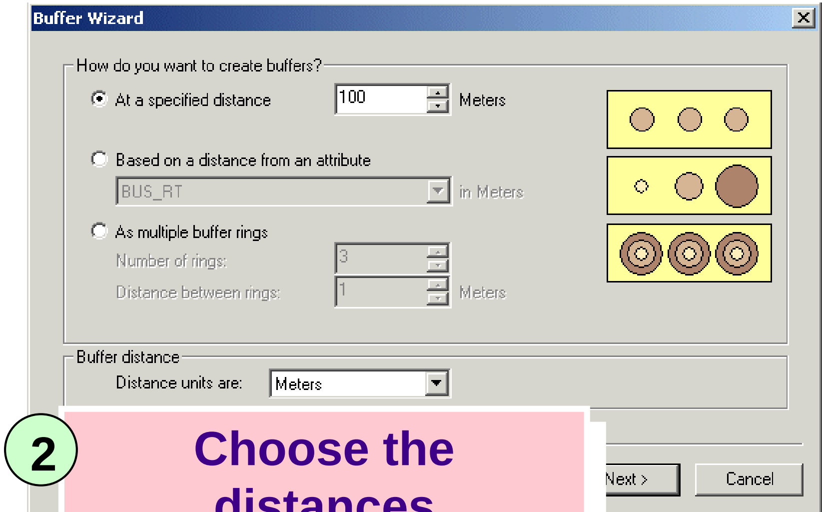
Buffer 100 meters, do not dissolve interior borders

Buffer by attribute values

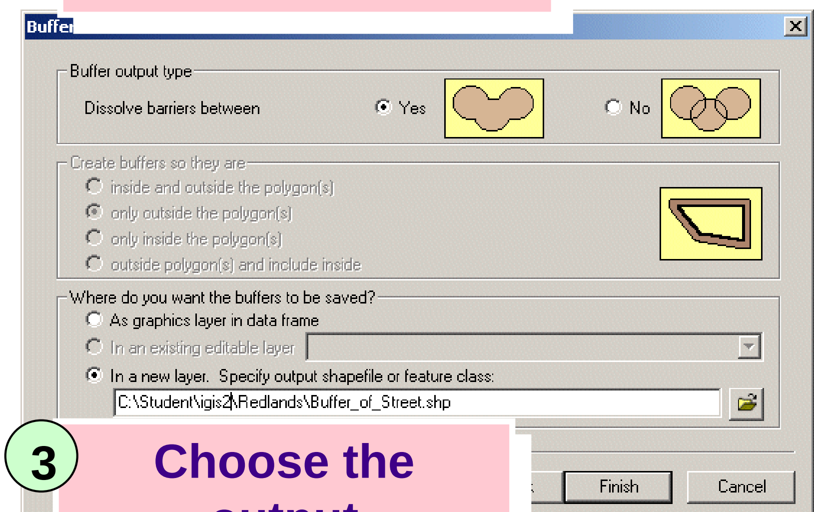
The Buffer Wizard



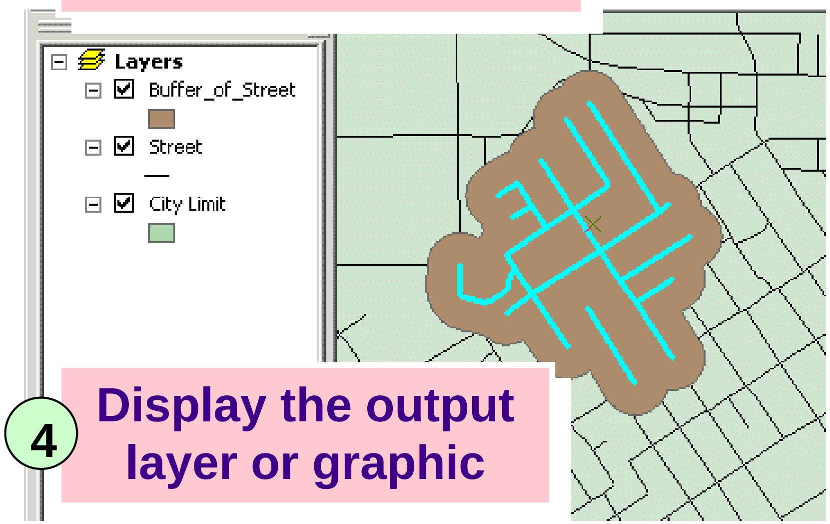
1 Choose the features



2 Choose the distances

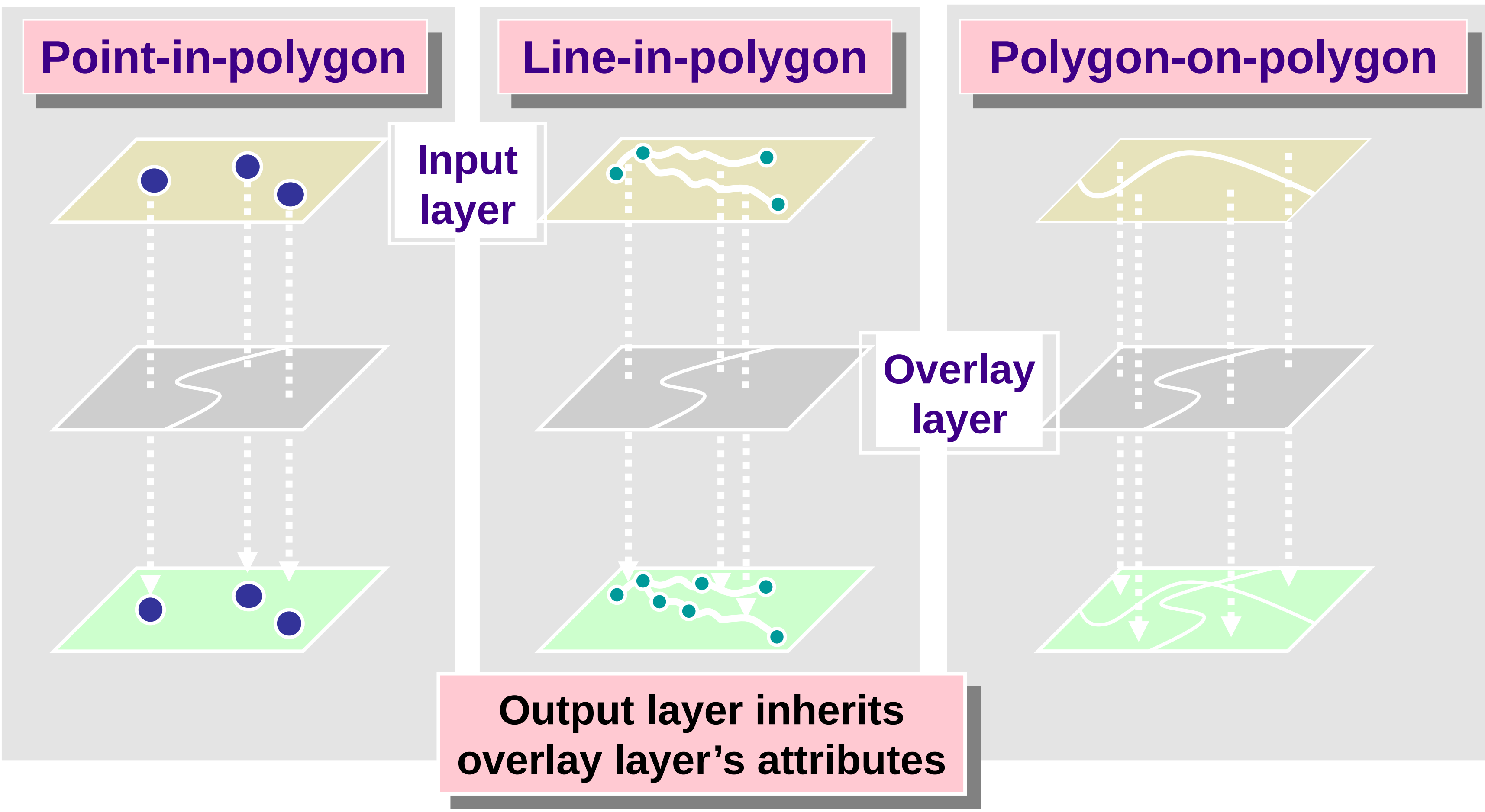


3 Choose the output



4 Display the output layer or graphic

Overlay analysis and geoprocessing overview

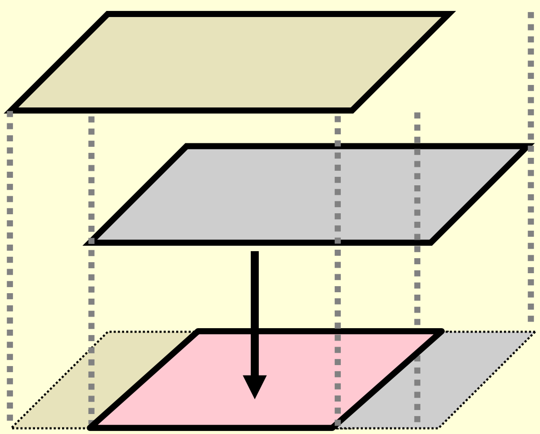


Overlay analysis functions

- Union and Intersect in the Geoprocessing Wizard

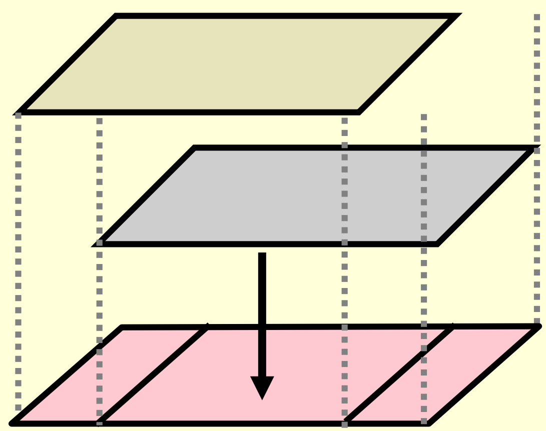
Intersect

- Lines or polygons
- Combine attributes
- Limited extent



Union

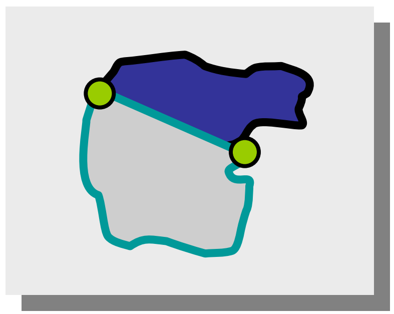
- Polygons
- Combine attributes
- Full extent



Union

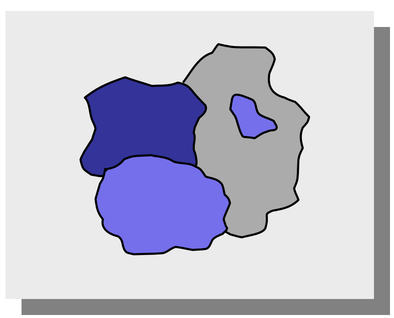
- Create a new layer from combined geometry of two input layers
- Both input and overlay layers must be polygons

Input two vegetation polygons

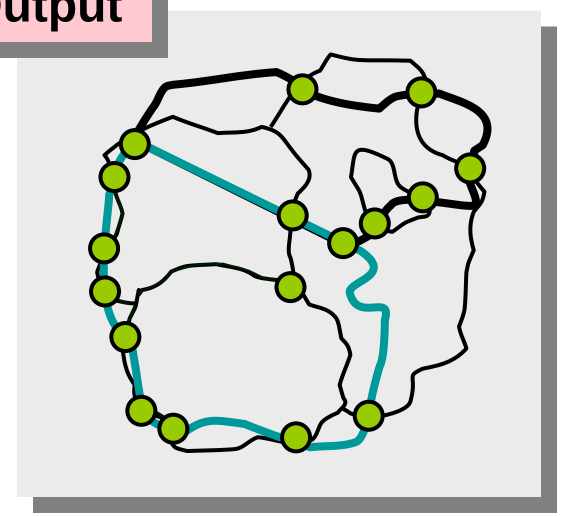


+

Overlay four soil polygons



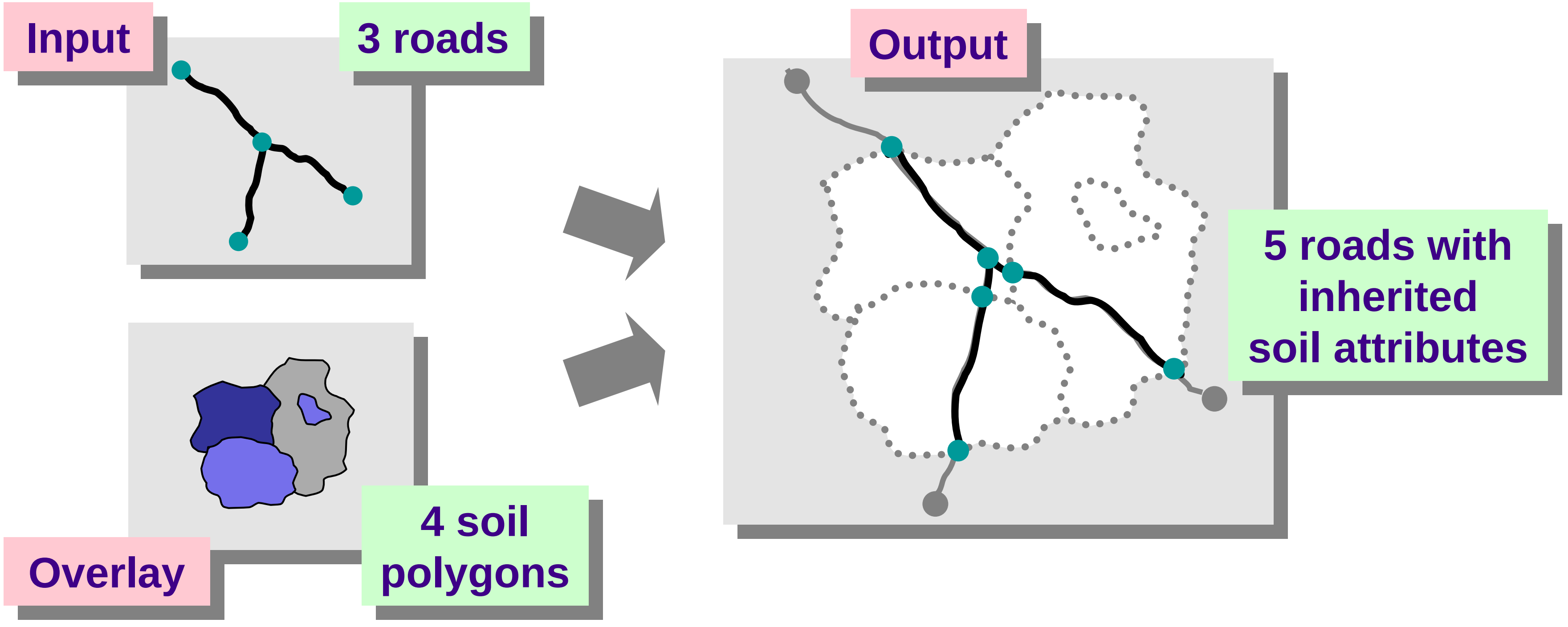
Output



Many vegetation polygons with inherited soil shapes and attributes

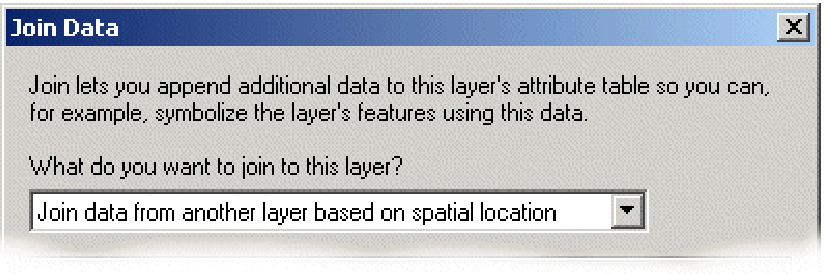
Intersect

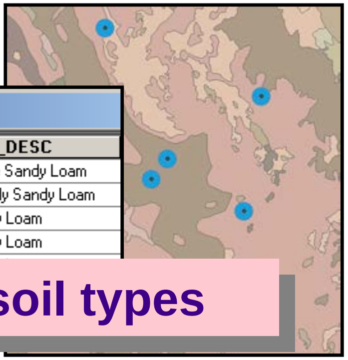
- Create new layer from common spatial extent between two input layers
- Input lines or polygons; overlay polygons

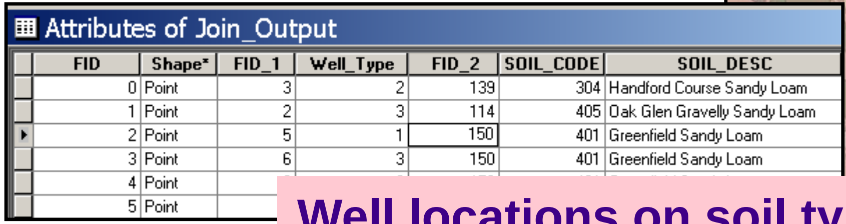


Spatial join

- Join based on spatial location
  - Use for point-in-polygon analysis
  - Find the nearest feature
- Appends attributes and calculates distance

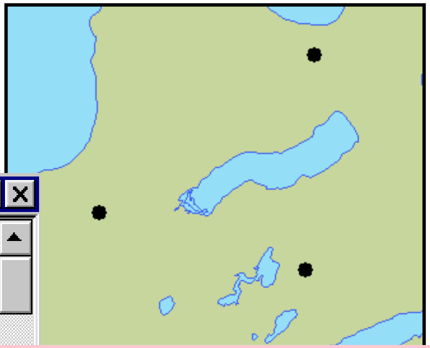


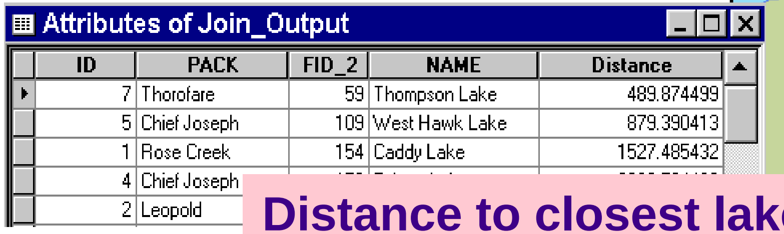



Attributes of Join_Output

FID	Shape*	FID_1	Well_Type	FID_2	SOIL_CODE	SOIL_DESC
0	Point	3	2	139	304	Handford Course Sandy Loam
1	Point	2	3	114	405	Oak Glen Gravelly Sandy Loam
2	Point	5	1	150	401	Greenfield Sandy Loam
3	Point	6	3	150	401	Greenfield Sandy Loam
4	Point					
5	Point					

Well locations on soil types




Attributes of Join_Output

ID	PACK	FID_2	NAME	Distance
7	Thorofare	59	Thompson Lake	489.874499
5	Chief Joseph	109	West Hawk Lake	879.390413
1	Rose Creek	154	Caddy Lake	1527.485432
4	Chief Joseph			
2	Leopold			

Distance to closest lake from wolf den

Boundary Operations

Clip

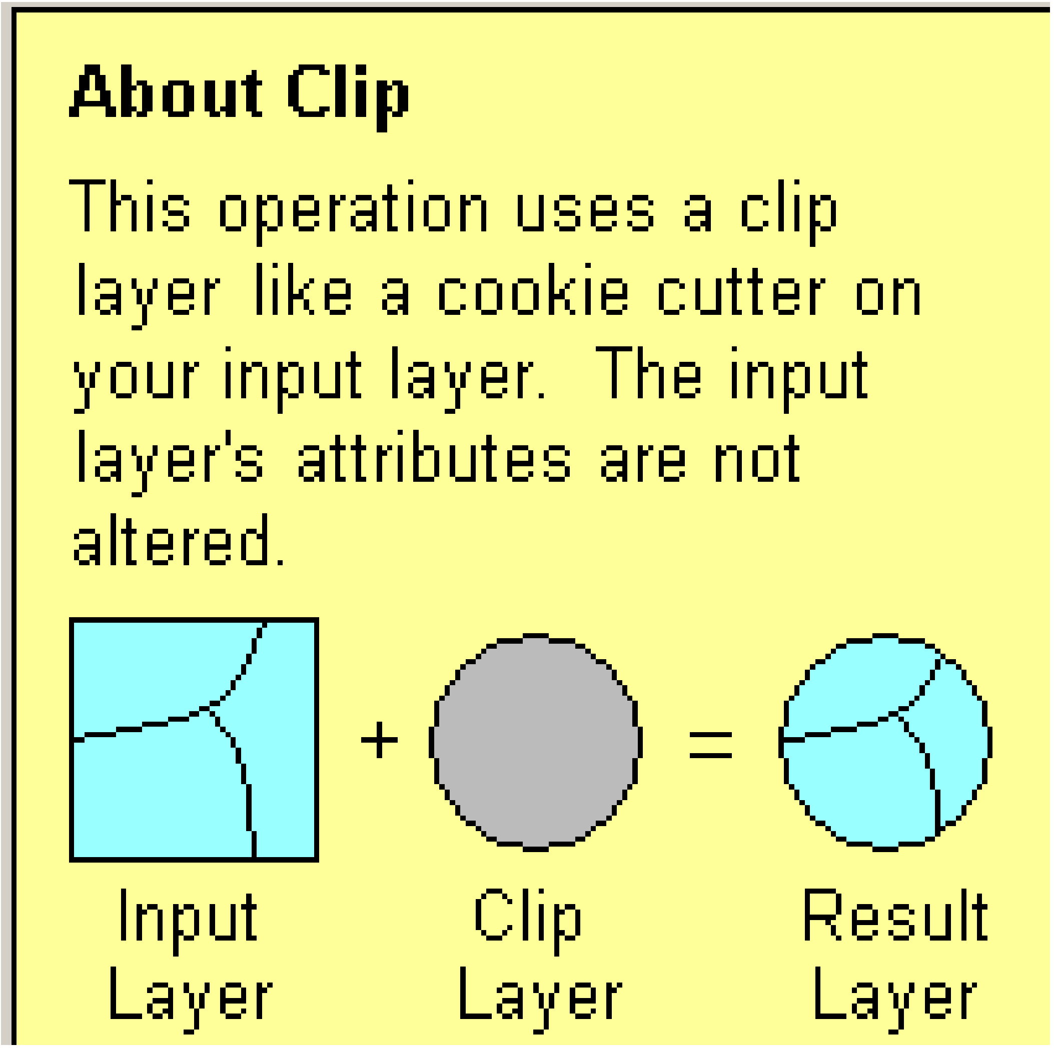
Erase

Update

Split

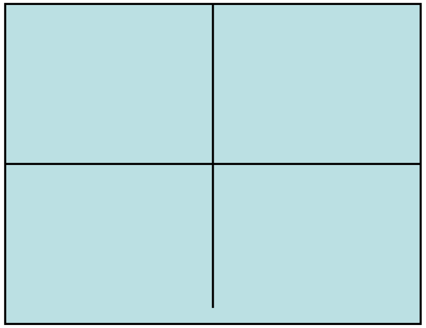
Append

Dissolve

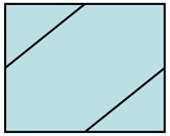


Erase is opposite of clip. The center cookie cutter is removed.

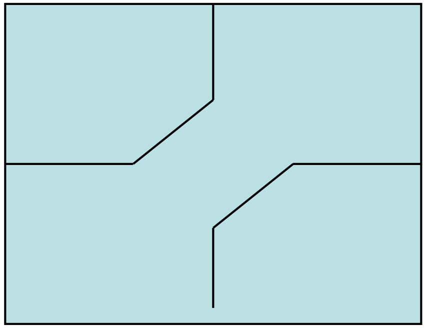
input



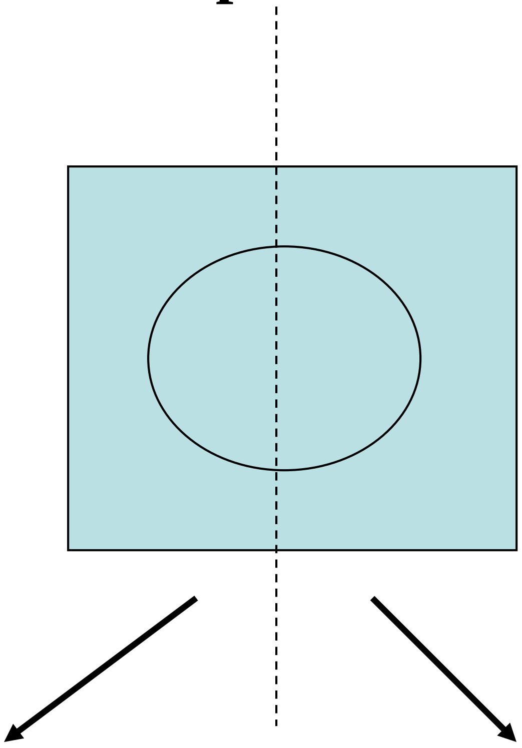
Update



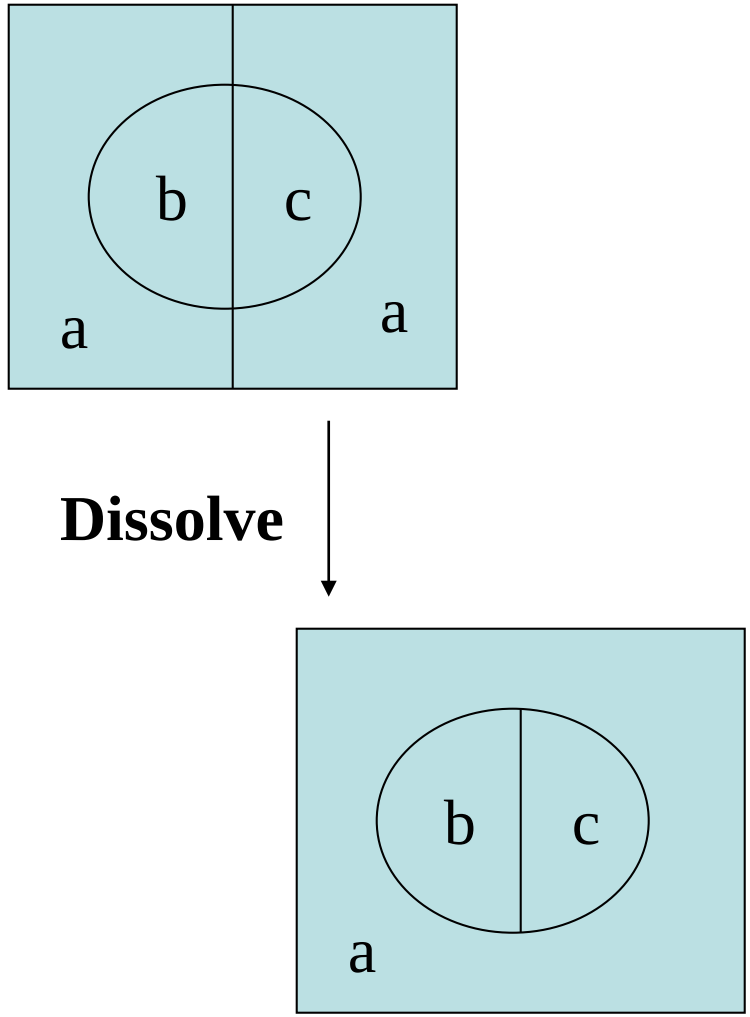
ouput



Split



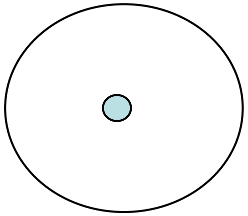
Append is the opposite

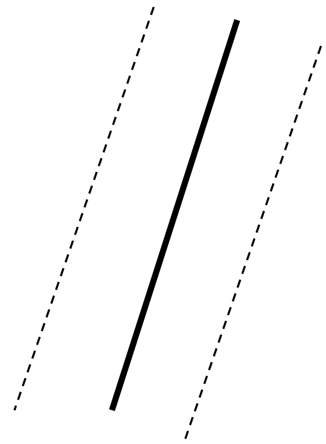


b
c
a
a
Dissolve
b
c
a

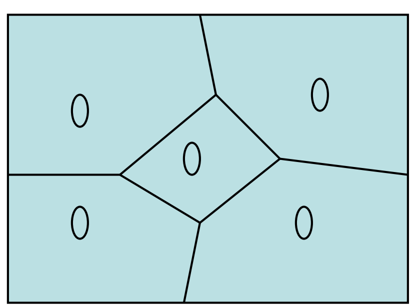
Proximity Analysis

Buffer





Thiessen polygons



GIS Operations

Single Layer vs Multiple Layer Operations

Overlay Analysis

In an overlay analysis, logical (boolean) operations are used to relate spatial data in different layers.

For example, if you have layer A and layer B, you could ask the following overlay analysis questions:

What areas consist of both A **AND** B?

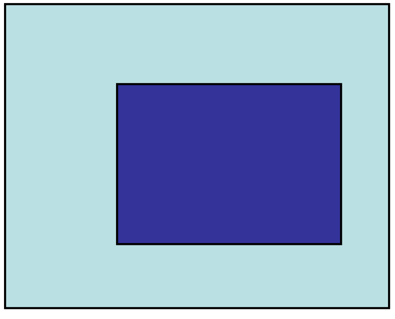
What areas consist of A **NOT** B?

Overlay Analysis

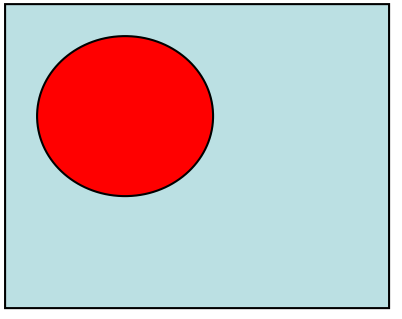
Union (OR)

What about attribute data?

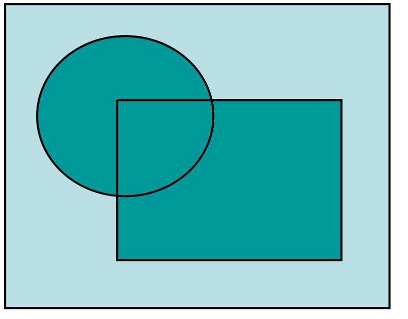
input



union



output

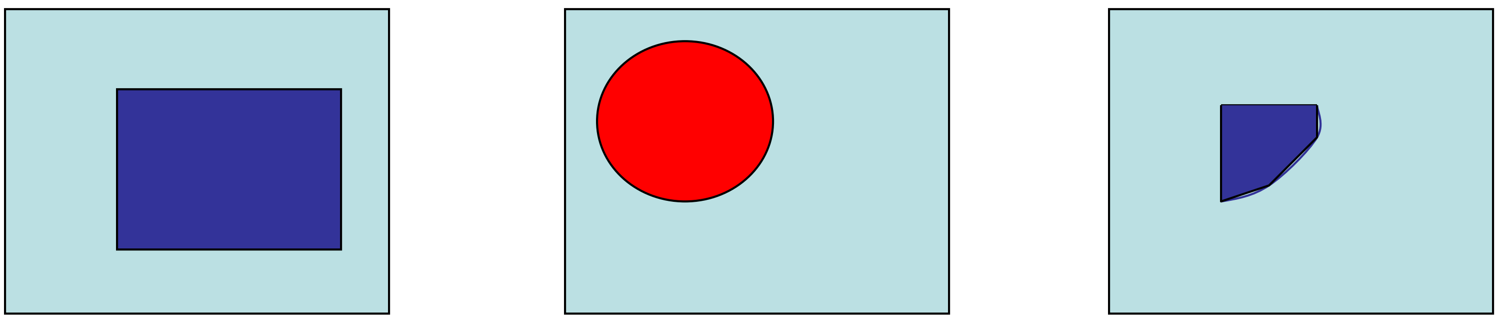


Overlay Analysis

Intersection (AND)

Only the portion of the input layer that falls inside the intersect layer will remain in the output

input intersect output



Input can be point, lines, or polygons

Proximity Analysis

Nearest

Find features in one layer that are **nearest** to features in another layer.

Distance

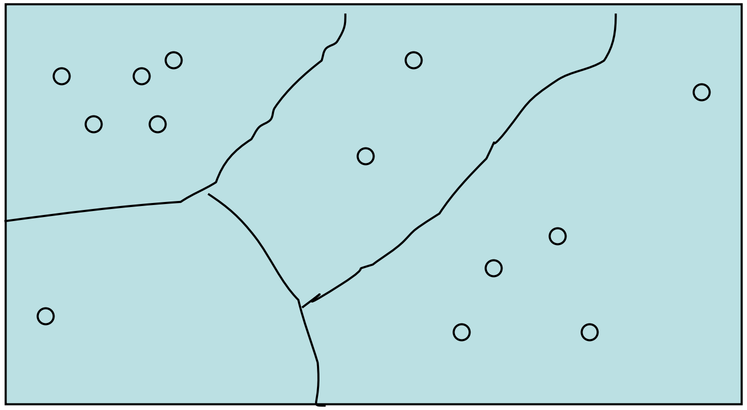
Find features in one layer that are **within a specified distance** from features in another layer.

Overlay Analysis

Frequency/Density

Calculating the number or density of items in one layer within polygon items in another layer.

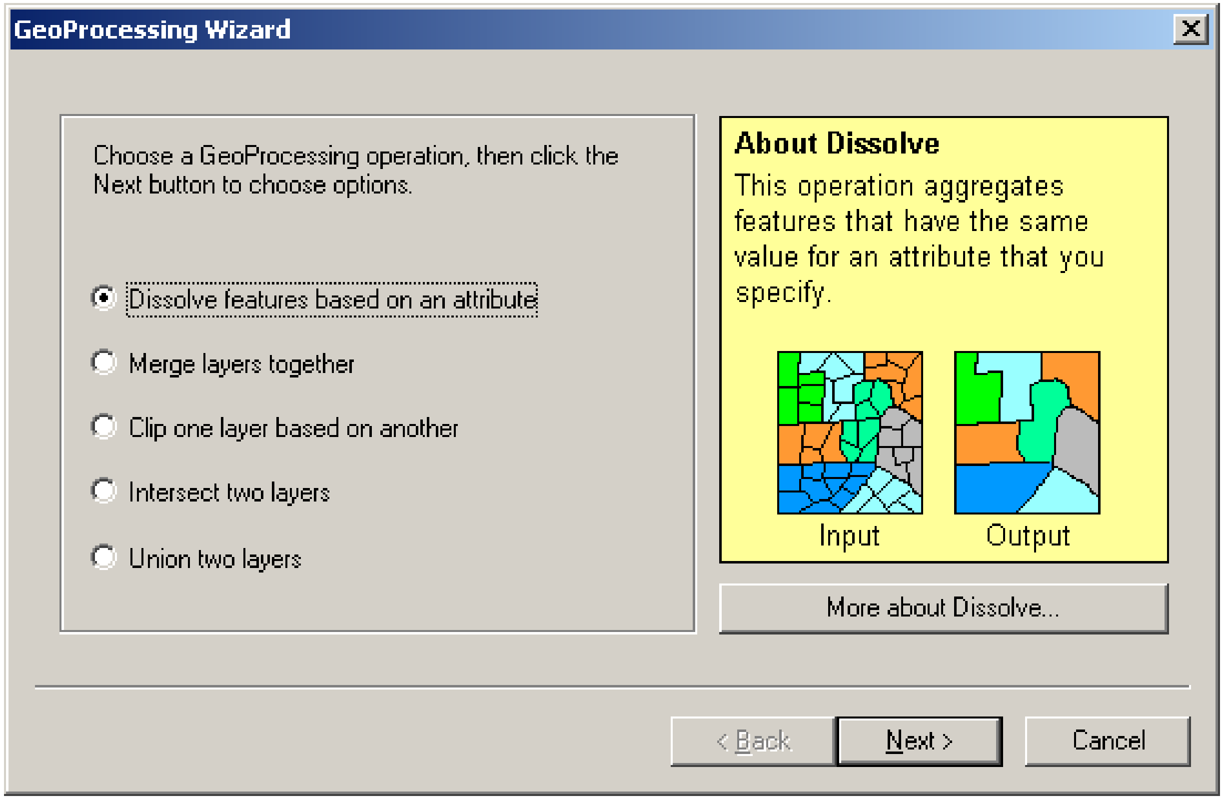
Example: number of cancer cases by county



Also works
for line features
ie. total length

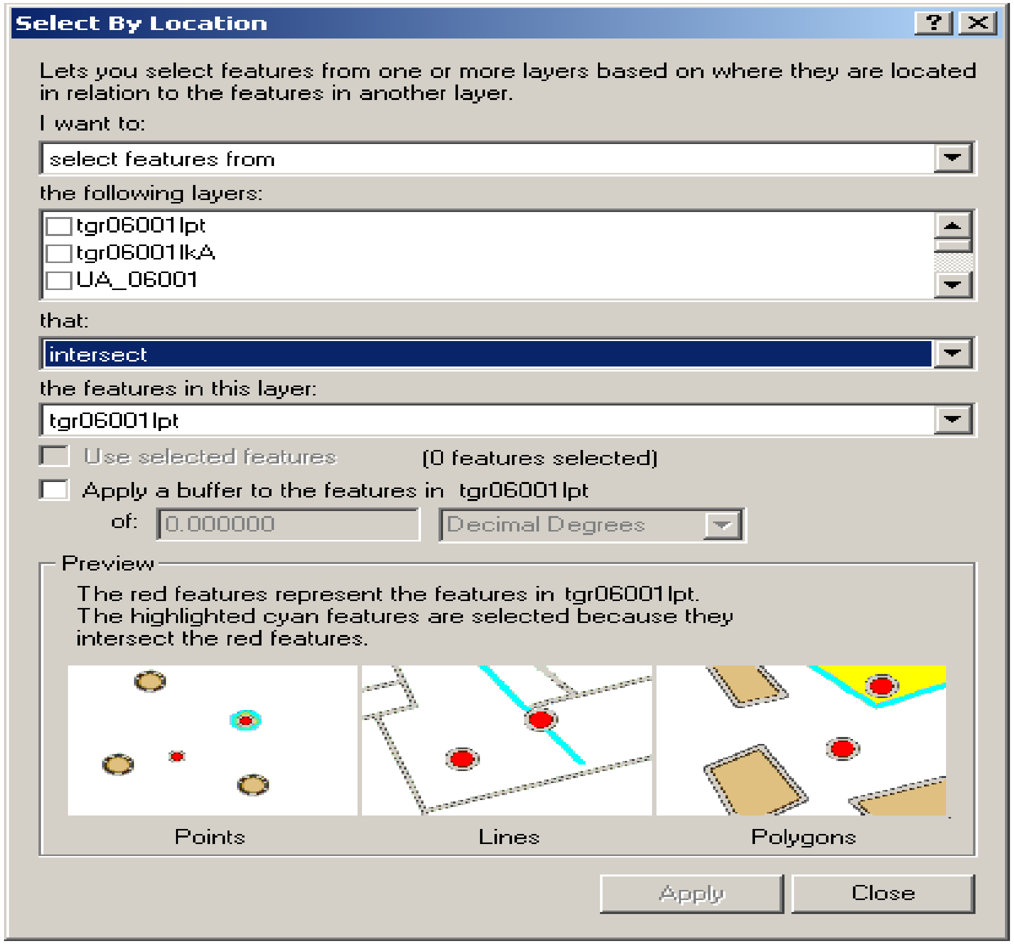
GIS Operations in Arcview

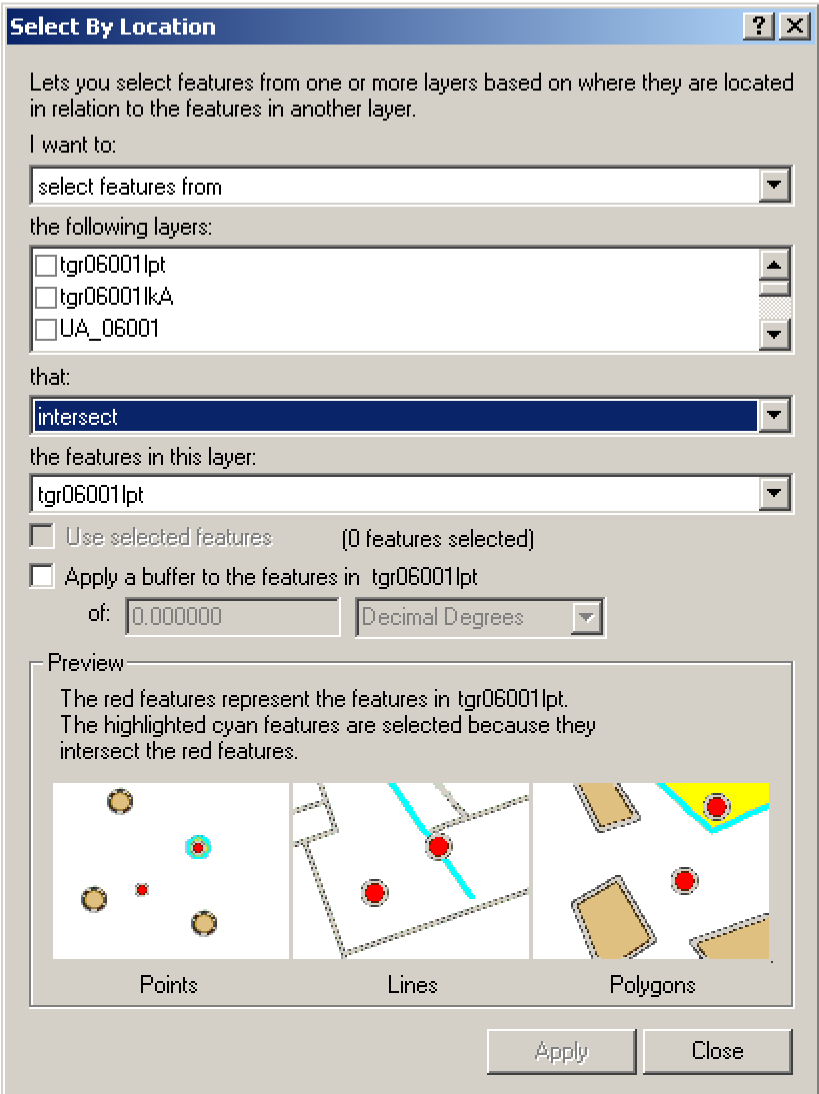
GIS operations in Arcview are basically found in two tools. One is the **Geoprocessing Wizard**

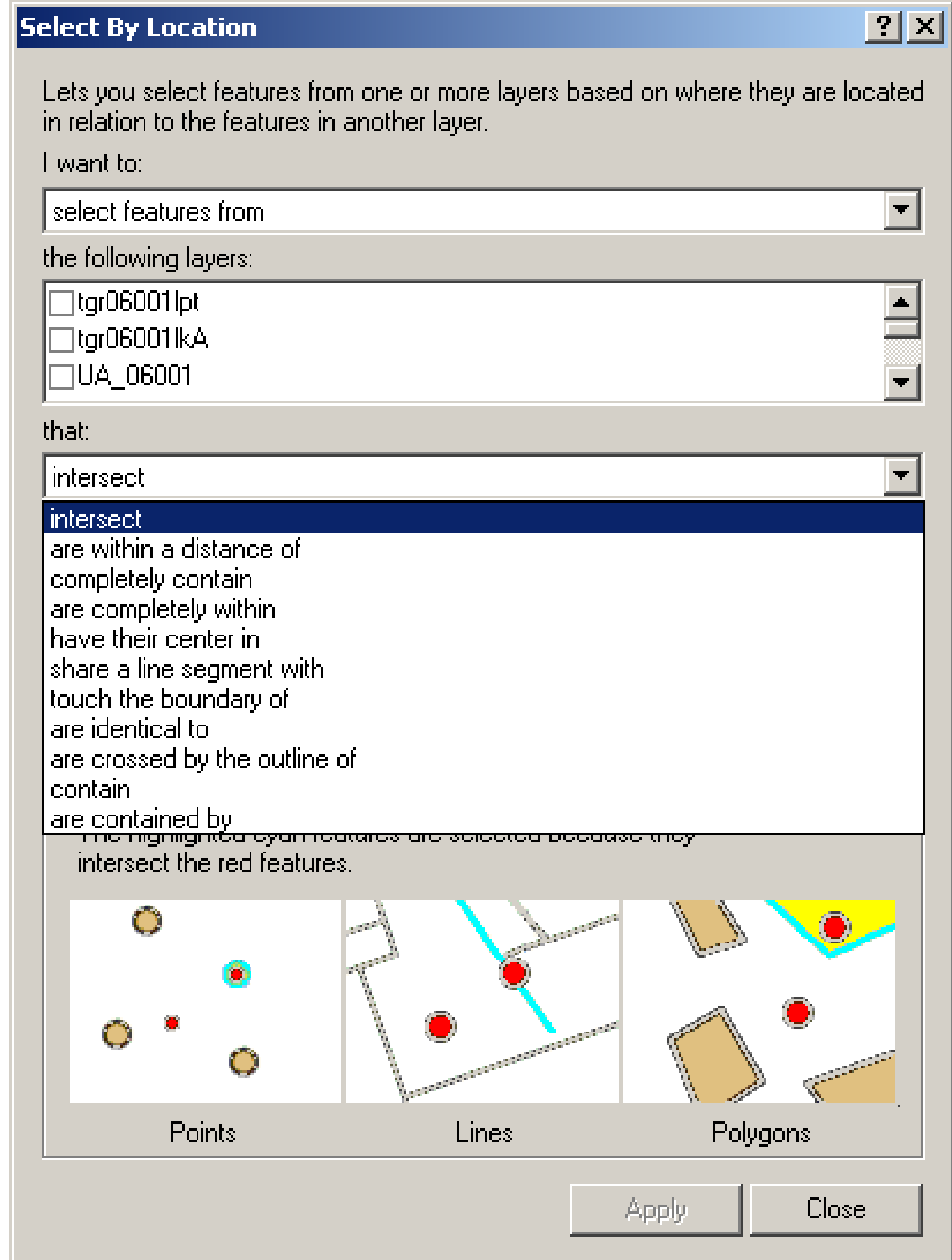


GIS Operations in Arcview

The other tool is
Select By Location

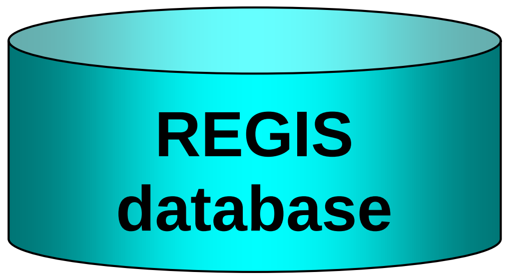



Select By Location
Lets you select features from one or more layers based on where they are located in relation to the features in another layer.
I want to:
select features from
the following layers:
tgr06001lpt
tgr06001lkA
UA_06001
that:
intersect
the features in this layer:
tgr06001lpt
Use selected features
(0 features selected)
Apply a buffer to the features in tgr06001lpt
of:
0.000000
Decimal Degrees
Preview
The red features represent the features in tgr06001lpt.
The highlighted cyan features are selected because they intersect the red features.
Points
Lines
Polygons
Apply
Close


Select By Location
Lets you select features from one or more layers based on where they are located in relation to the features in another layer.
I want to:
select features from
the following layers:
tgr06001lpt
tgr06001lkA
UA_06001
that:
intersect
intersect
are within a distance of
completely contain
are completely within
have their center in
share a line segment with
touch the boundary of
are identical to
are crossed by the outline of
contain
are contained by
intersect the red features.
Points
Lines
Polygons
Apply
Close

The analytical process

- What question are you trying to answer?
- What criteria are involved?



Where is the best location for an amusement park?

Agriculture or vacant *landuse*

1 kilometer from the Redlands historic driving *tour*

Within census *blockgroups* with high target age and income population

Within 500 meters of a *highway*

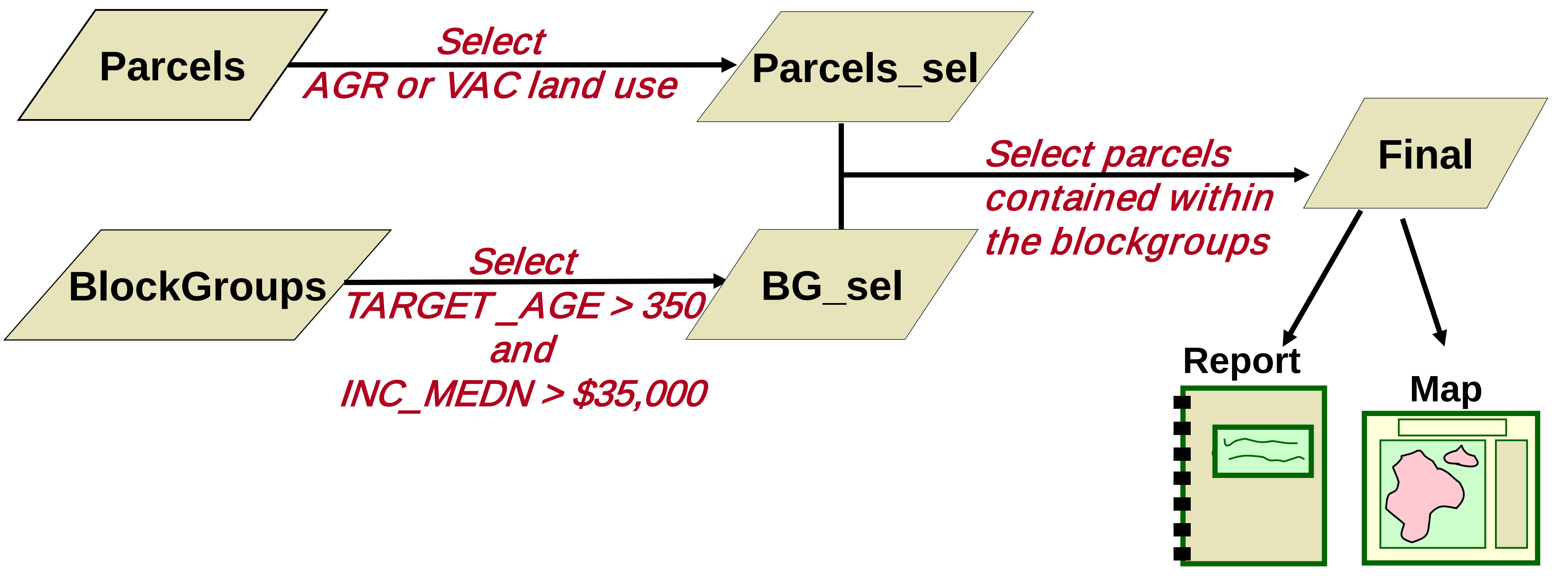
Deciding on project data

- What feature classes will you use?
- What attributes and values will you query on?
- What preprocessing will be necessary before analysis?
  - Table joins
  - Data conversions

Feature classes	Attributes	Values	Preprocessing
Parcels	LU_CODE	*'AGR' or 'VAC'*	None necessary
BlockGroups	TARGET_AGE	*> 350*	Join with BG_DMG table
	INC_MEDN	*> 35,000*	

Analysis options

- What spatial operations will answer the questions most efficiently?
  - Often many paths to the same result
- Chart the flow of operations and data



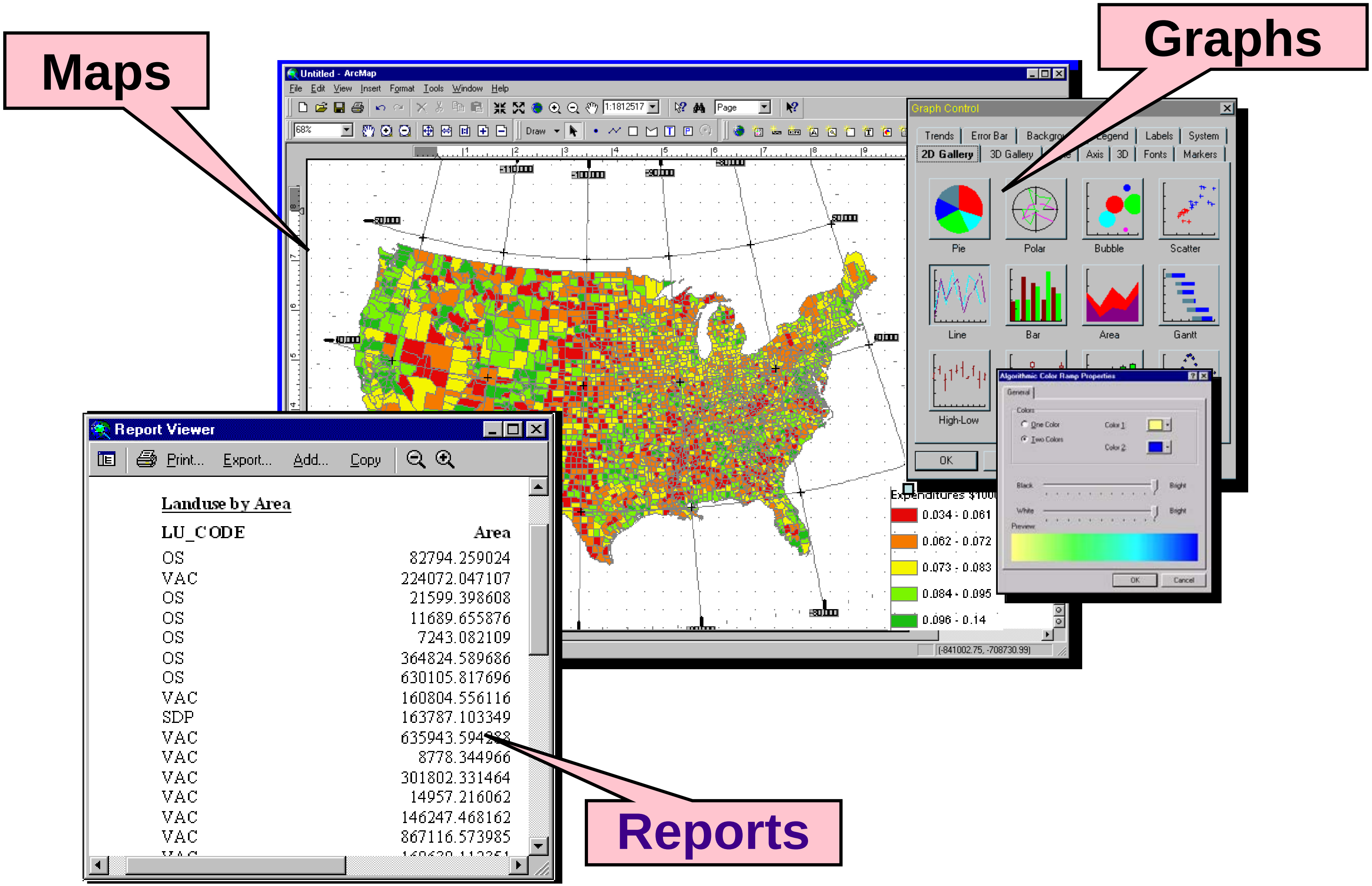
Discussion

Questions

Lecture 11

Displaying Data

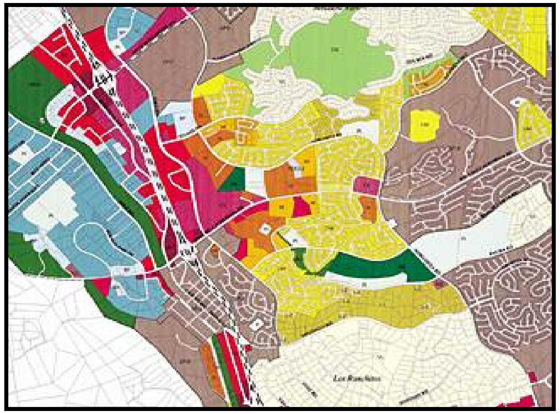
Display



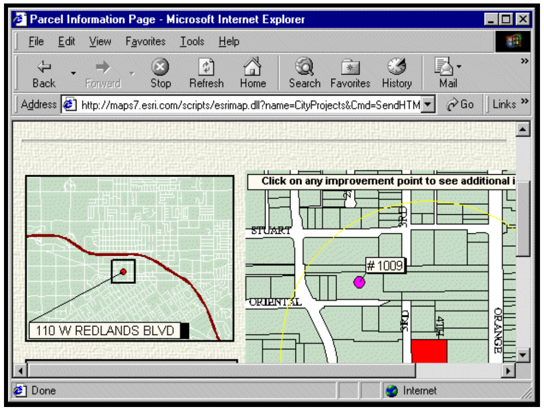
Maps
Graphs
Reports
Untitled - ArcMap
File Edit View Insert Format Tools Window Help
Graph Control
Trends
Error Bar
Legend
Labels
System
2D Gallery
3D Gallery
Axis
3D
Fonts
Markers
Pie
Polar
Bubble
Scatter
Line
Bar
Area
Gantt
High-Low
OK
Algorithmic Color Ramp Properties
General
Colors
One Color
Two Colors
Color 1
Color 2
Preview
OK
Cancel
0.034 - 0.061
0.062 - 0.072
0.073 - 0.083
0.084 - 0.095
0.096 - 0.14
Report Viewer
Print...
Export...
Add...
Copy
Landuse by Area
LU_CODE Area
OS 82794.259024
VAC 224072.047107
OS 21599.398608
OS 11689.655876
OS 7243.082109
OS 364824.589686
OS 630105.817696
VAC 160804.556116
SDP 163787.103349
VAC 8778.344966
VAC 301802.331464
VAC 14957.216062
VAC 146247.468162
VAC 867116.573985

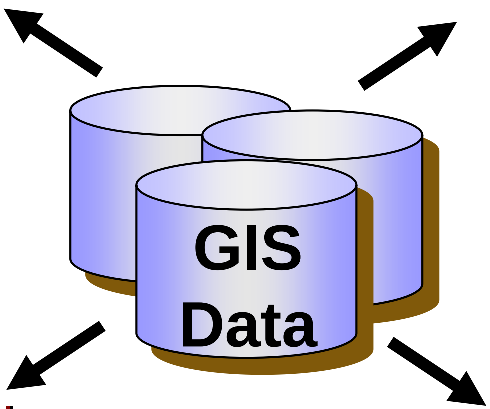
Output

Paper map

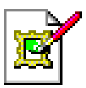


Internet



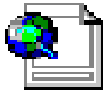


Image



Florida.jpg

Document



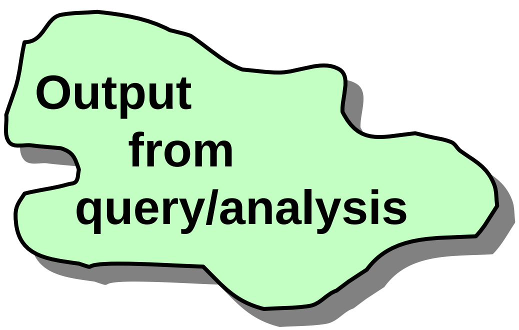
Florida.mxd

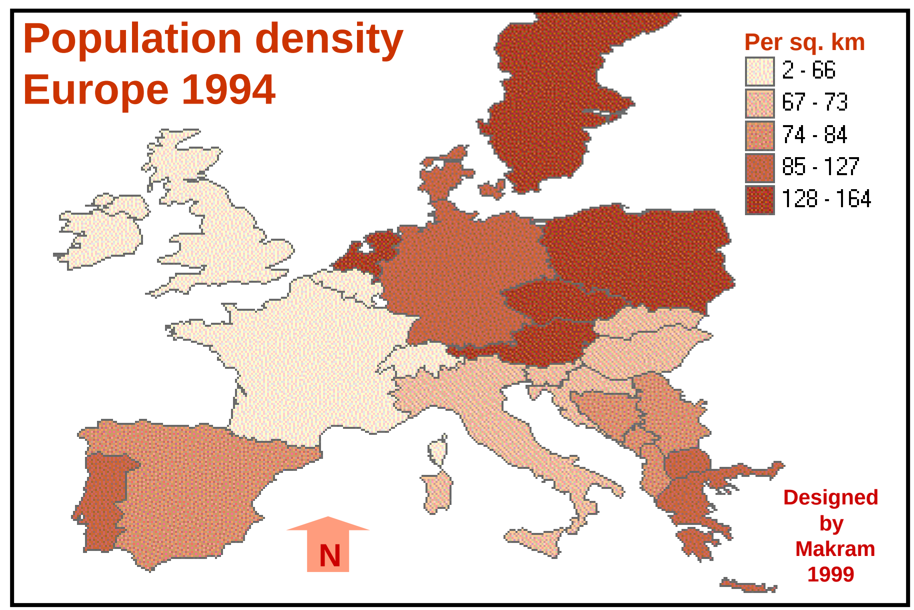
Lesson 3 overview

- The ArcMap interface and tools
- Data view and Layout view
- Layers, data frames, and map elements
- Layer properties for symbols and labels

Lesson 9 overview

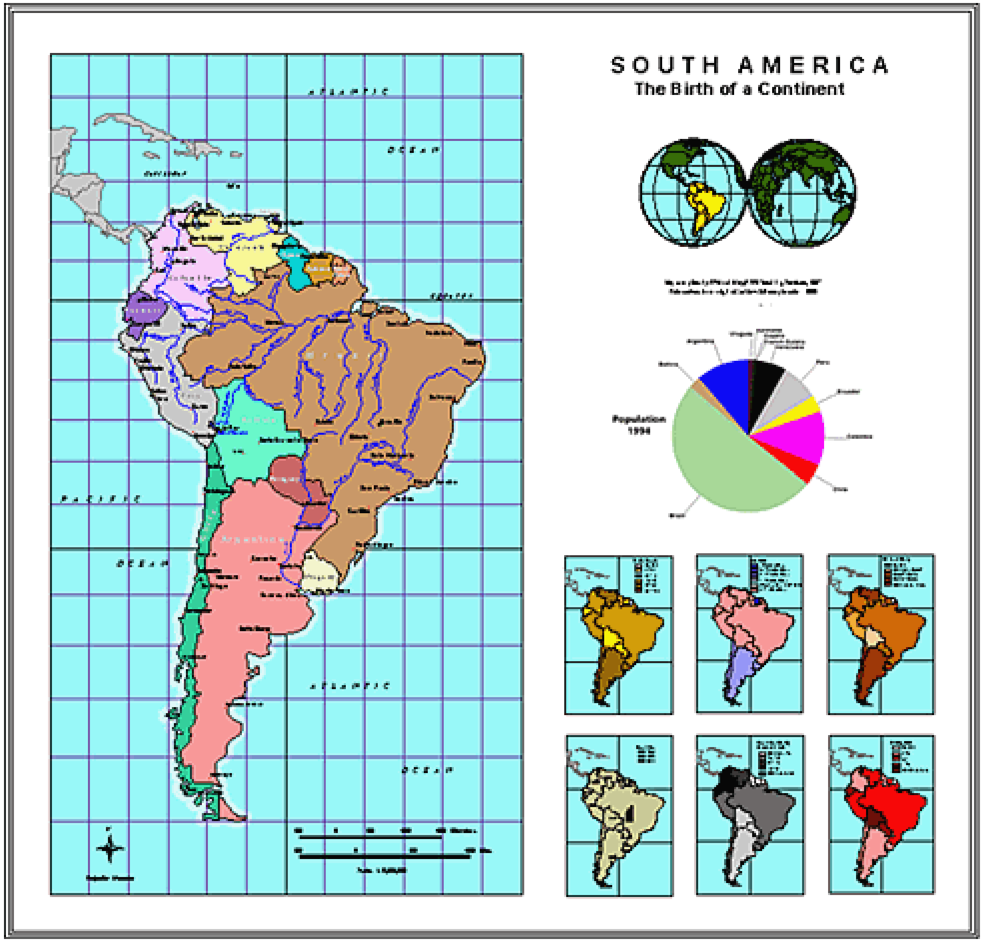
- Basic cartographic concepts
- Creating maps in ArcMap
- Printing and plotting maps



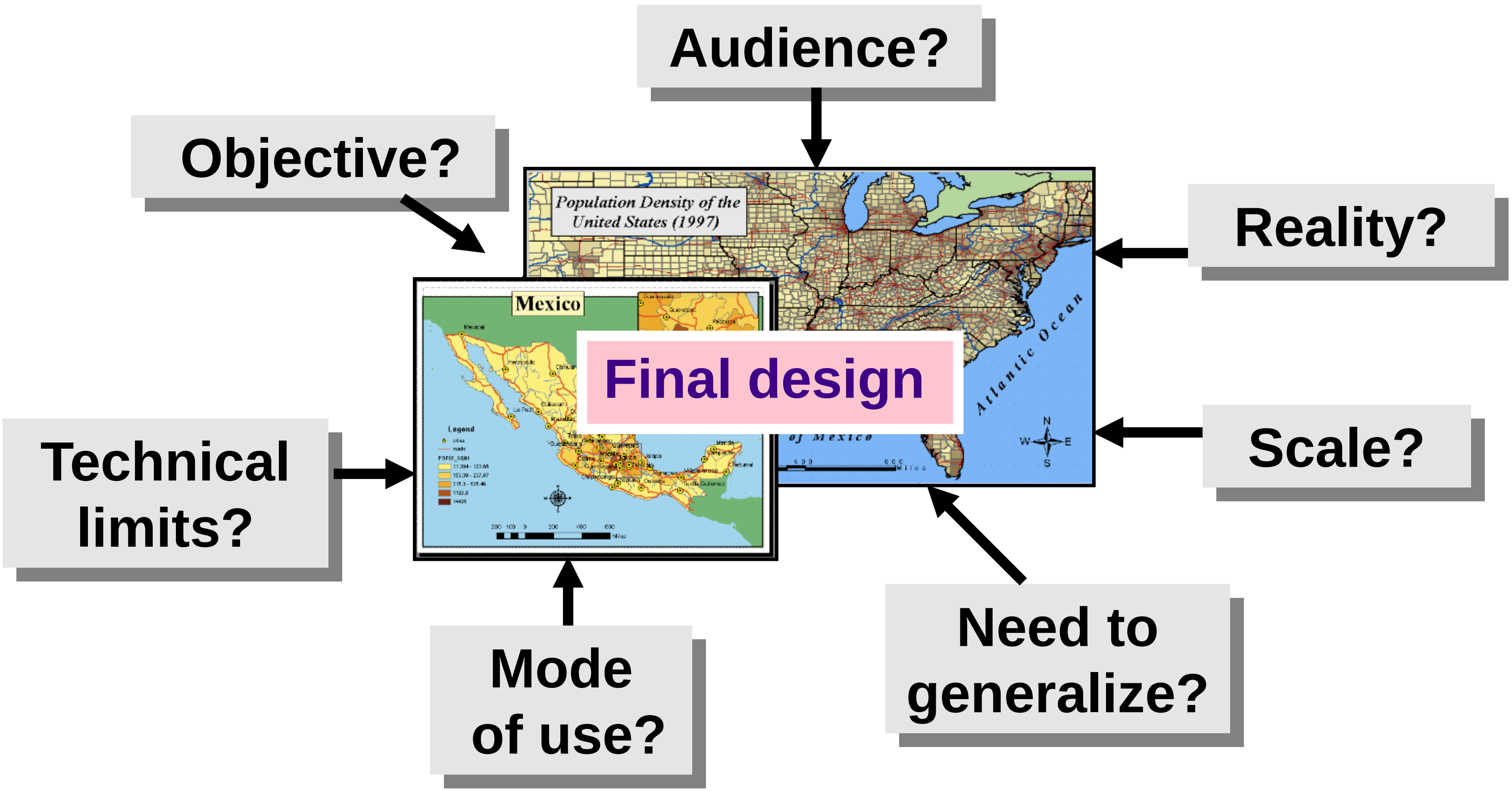


Map and design objectives

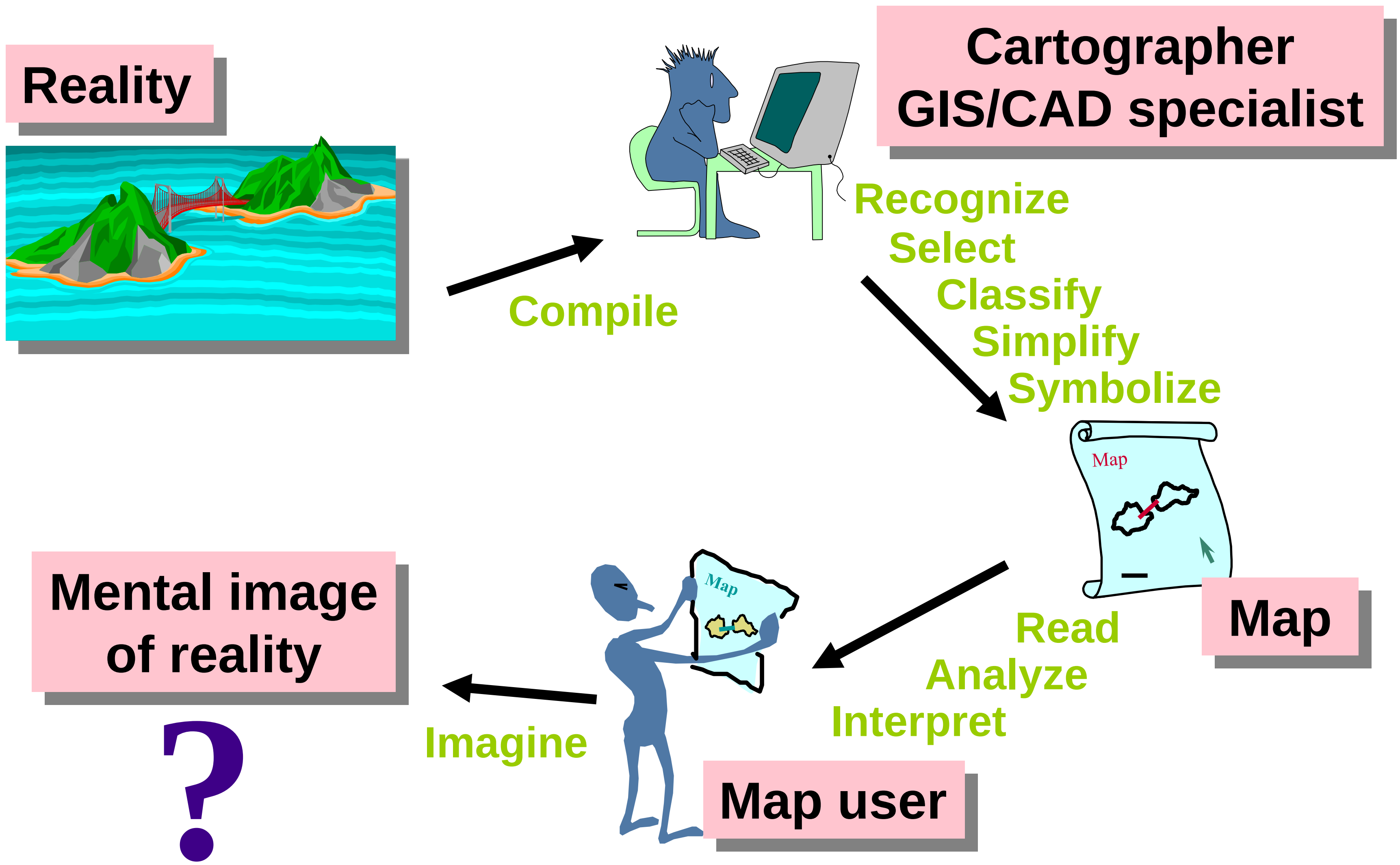
- Map objectives
  - Share information
  - Highlight relationships
  - Illustrate analysis results
- Design objectives
  - Manipulate the graphic characteristics
  - Fulfill the intended purpose



Factors controlling cartographic design

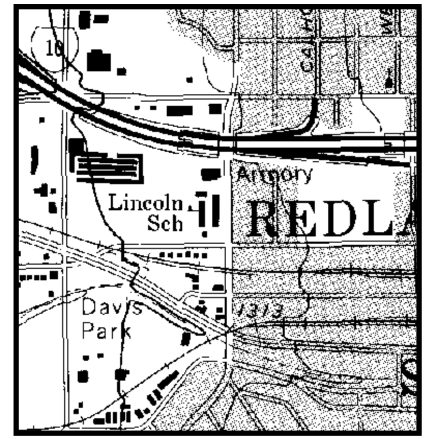


Communication in maps

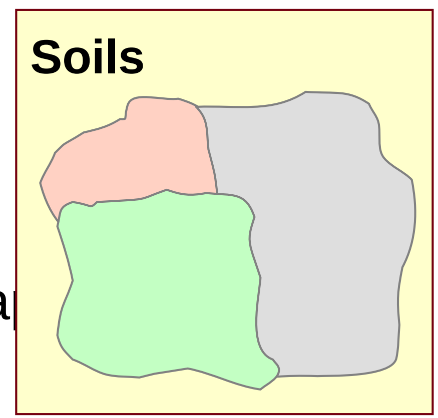


Types of maps

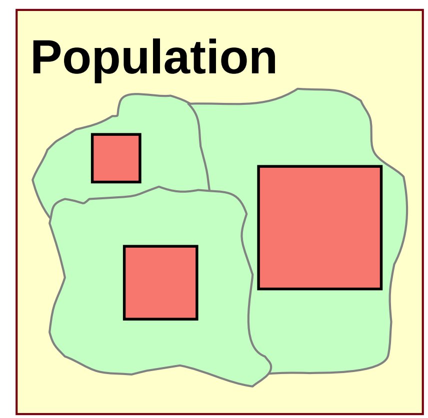
- General maps
  - Locational/Positional
  - Variety of features and uses



- Thematic maps
  - Distribution of an attribute
  - Single attribute or relationship



Qualitative



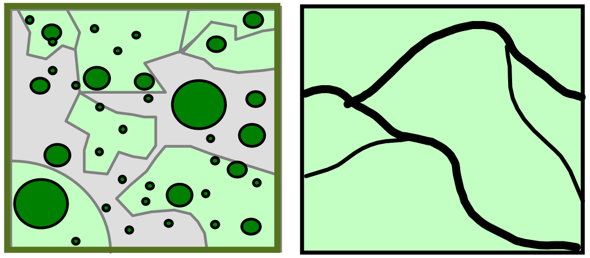
Quantitative

- Different objectives, different cartogra

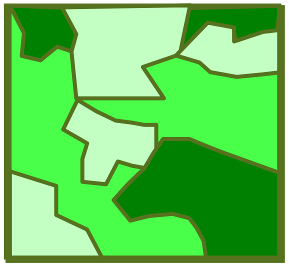
Issues in cartographic design

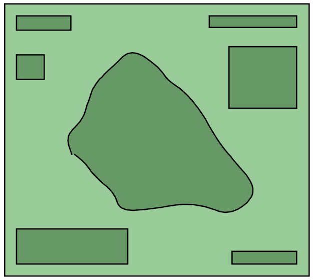
- Colors, shade patterns, and text
  - Perception of colors and symbols
  - Legibility of features and text
  - Visual contrast and hierarchy
- Visual balance

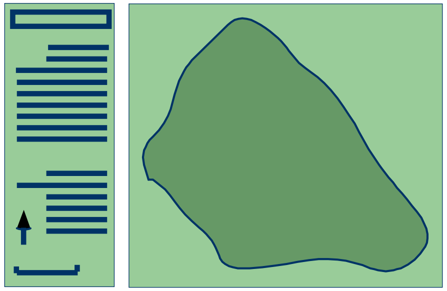
Size



Value





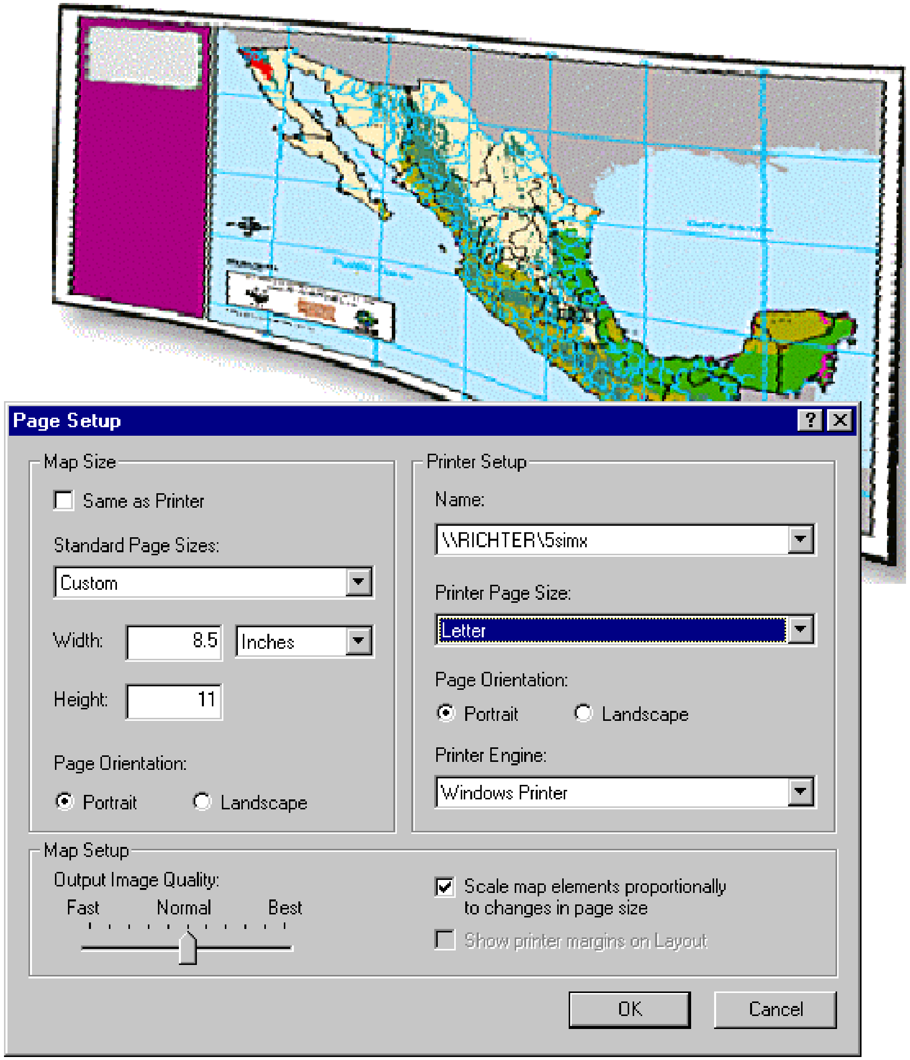


Creating maps in ArcMap

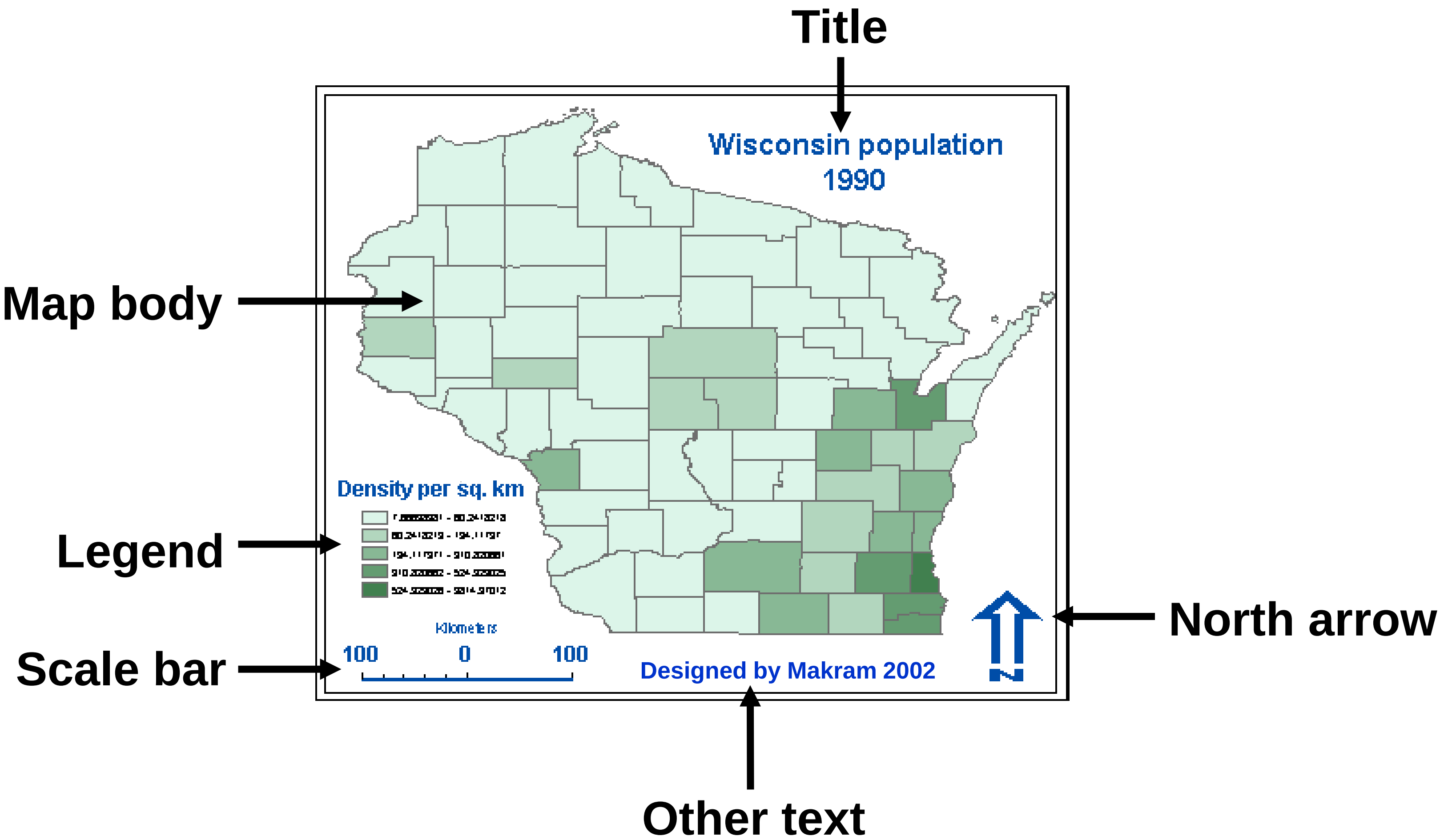
- Design in Layout view
- Data frames organize layers
- Map elements are added to a virtual page
- Maps stored as MXD files
  - Data location
  - Layer properties

Setting up the page

- Remember the purpose
  - Will the map be viewed up close or at a distance?
  - What is the best page size?
  - Landscape or portrait?
  - What printer will I be using, and what are my printer size limitations?

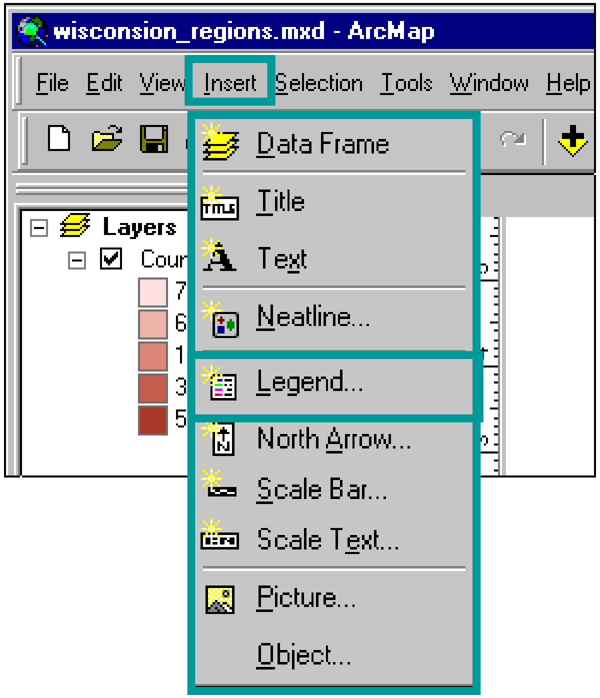


Identifying map elements

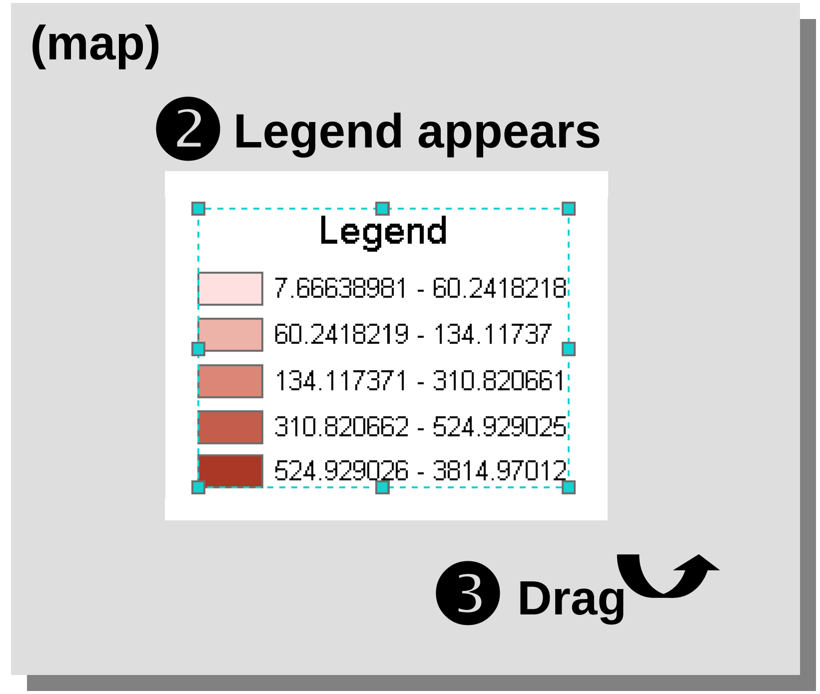


- What is missing?

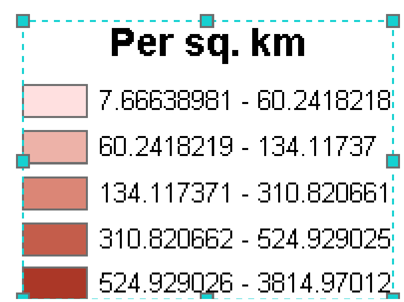
Inserting map elements



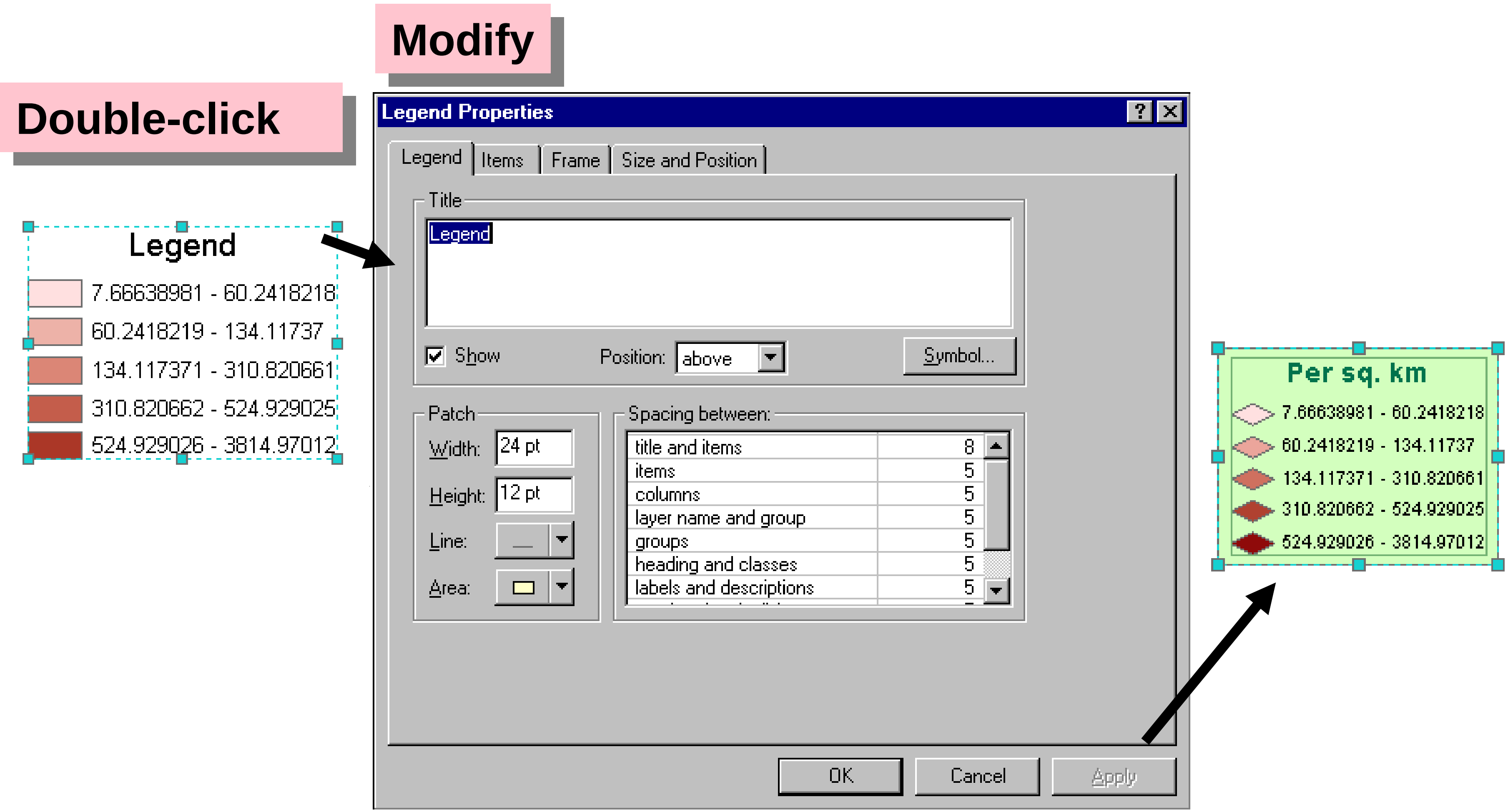
❶ **Choose type**



❹ **Modify**

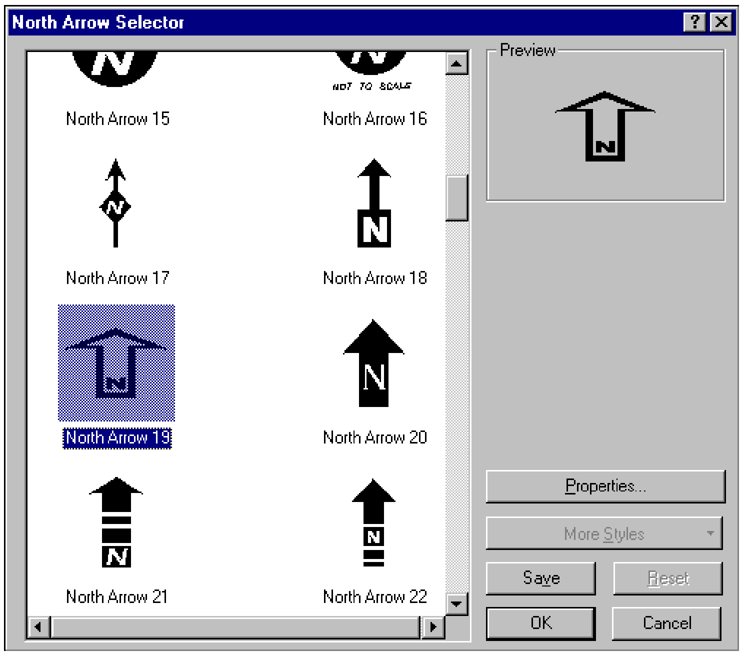


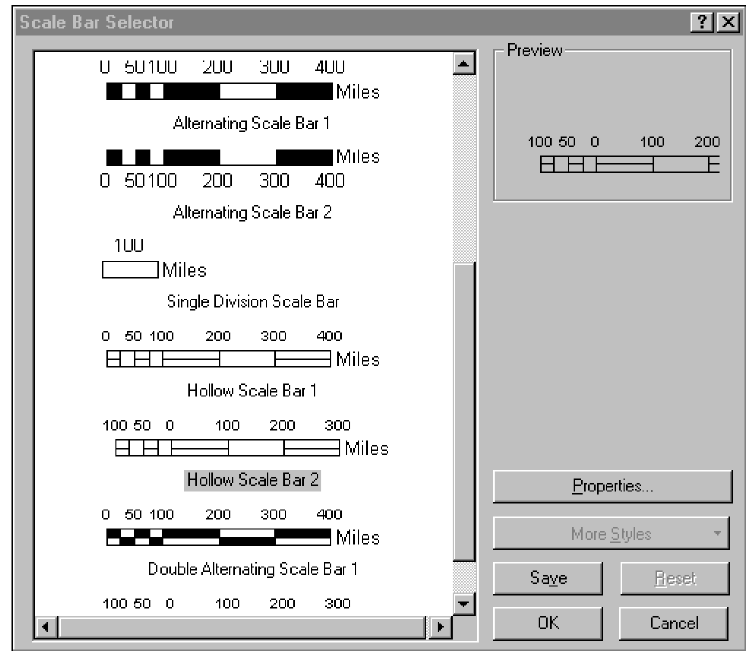
An example of the Legend Properties dialog

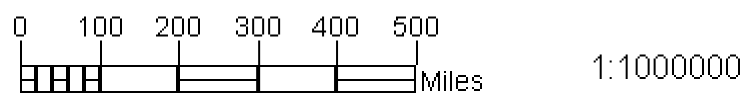


Adding a north arrow and a scale

➊ Choose type





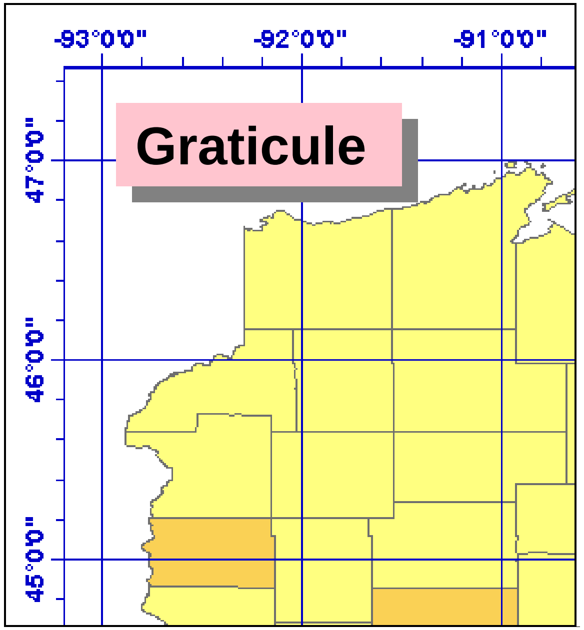


➋ Change angle, size, color

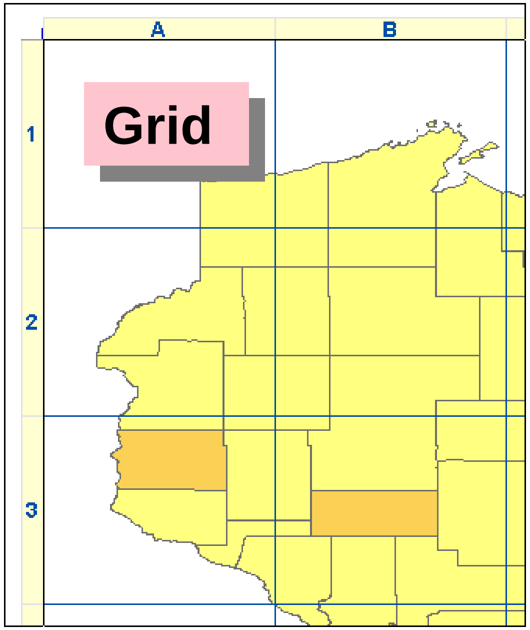
➌ Change unit, increments, color, font

Incorporating a reference system

- Display reference positions on maps
- Available reference systems:



Latitude/Longitude, feet, meters, etc.

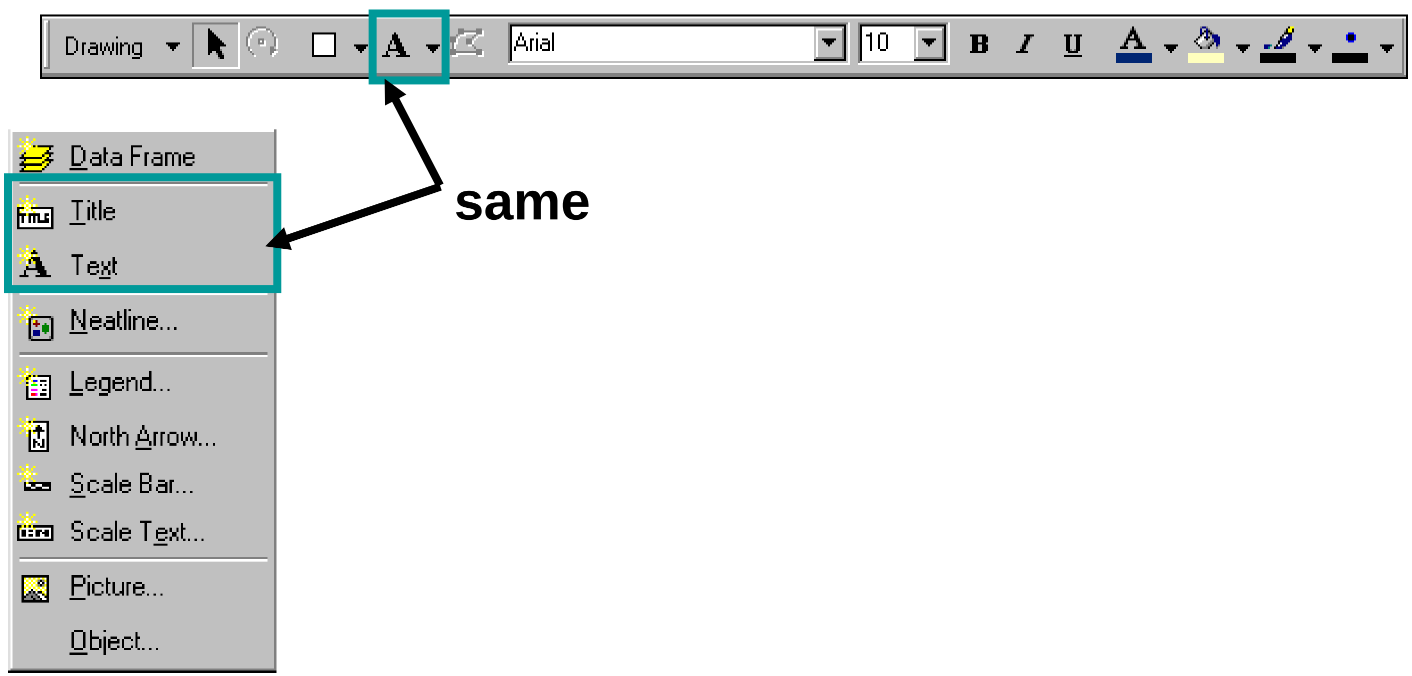


ABC/123, others

- Different graticule or grid types on the same map

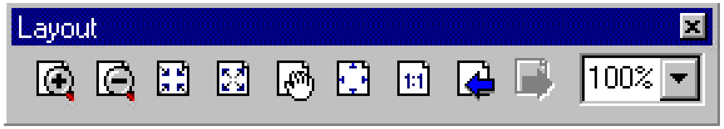
Inserting textual information

- Title and author
- Data source, date, projection
- Date of map and of data
- Disclosures and acknowledgements



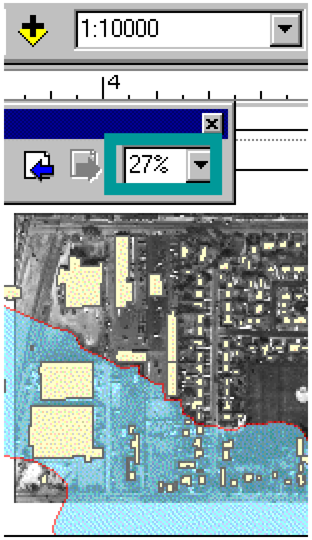
Layout tools

- Zoom and pan the layout page

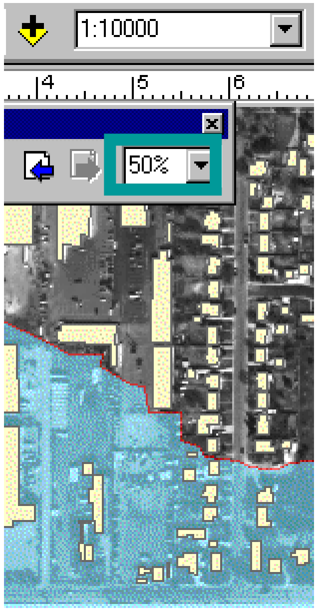


Scale remains the same

27%



50%

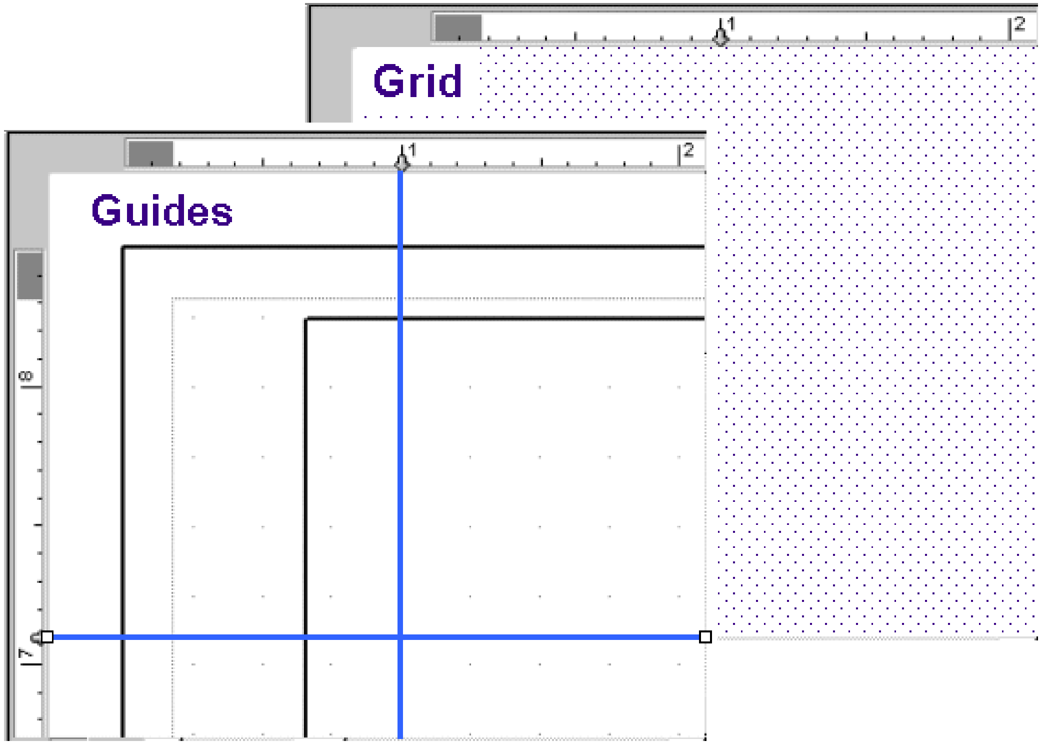


100%

- Additional layout settings from Tools > Options

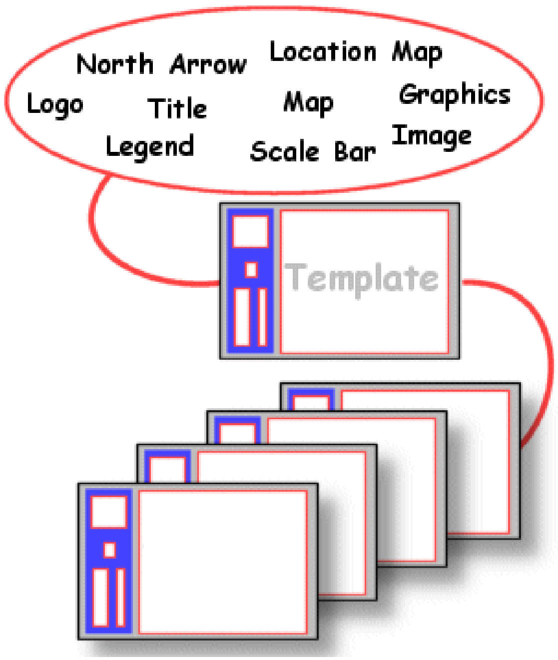
Grids and rulers

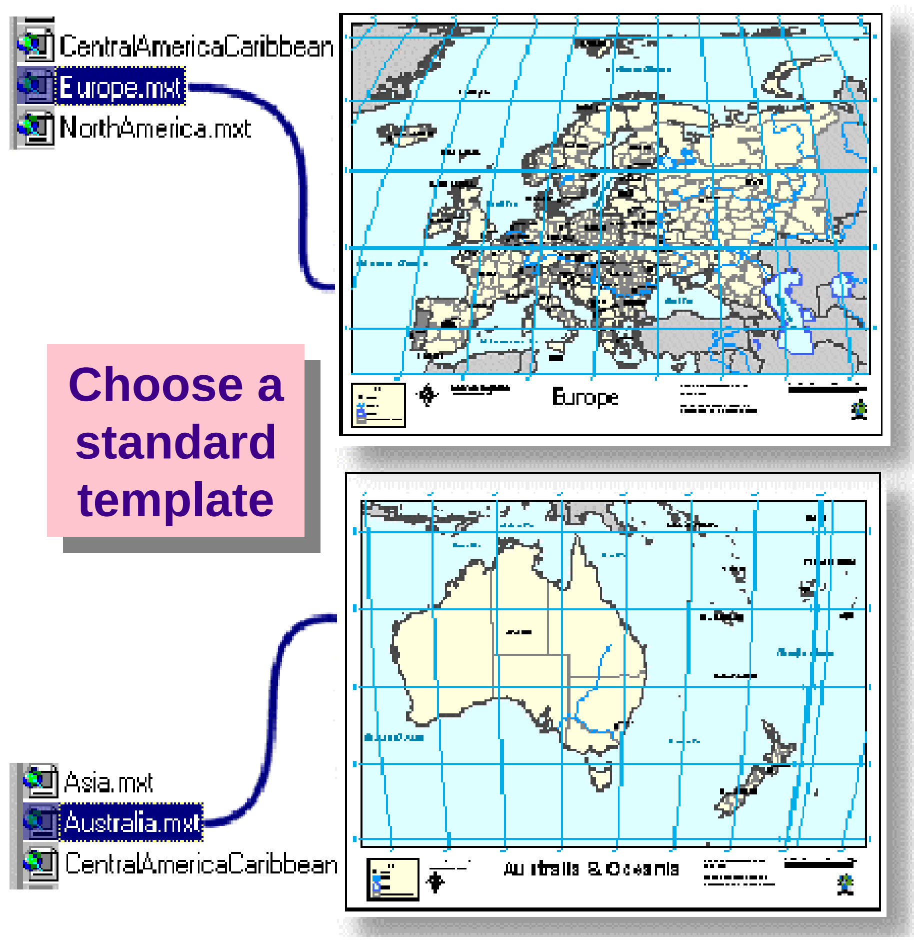
- Determine the size of map elements
- Use guides to arrange elements
- Use grids to position elements at specific points
- Use snapping for precision and efficiency



Creating and using map templates

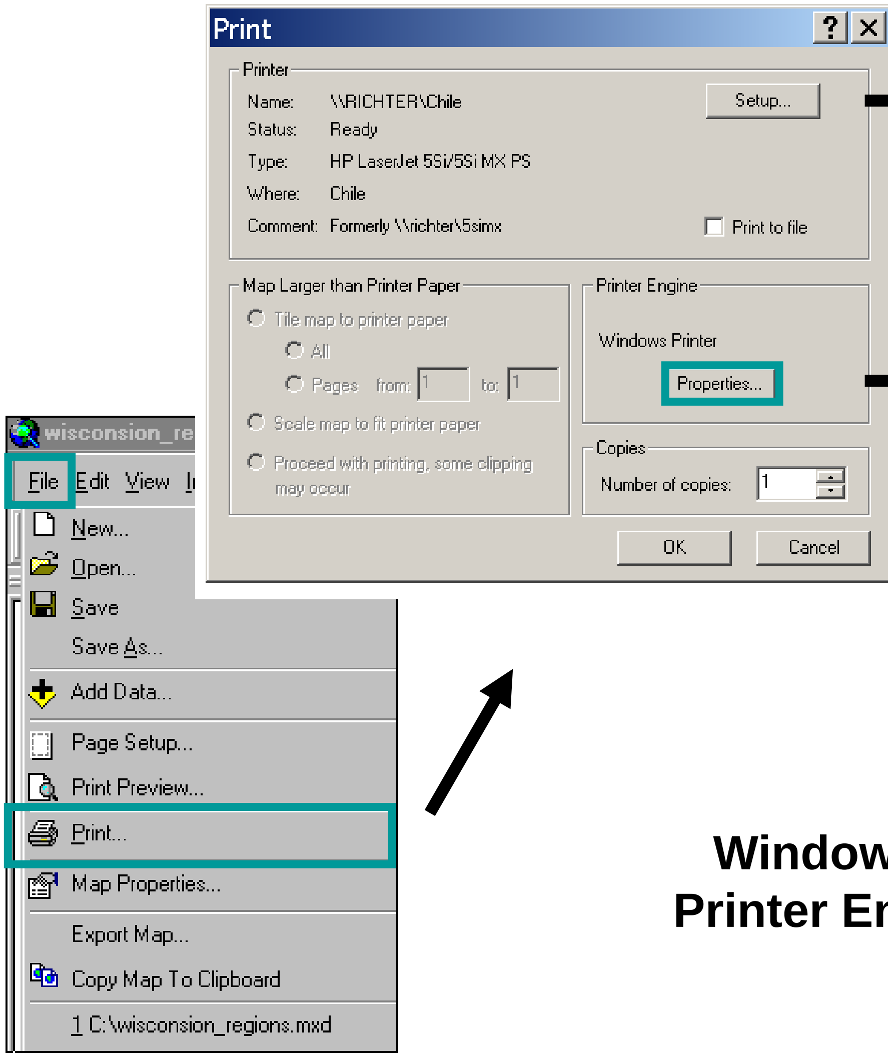
- Gives all maps in a series the same look





- ArcMap templates
- Create your own

Printing and plotting maps

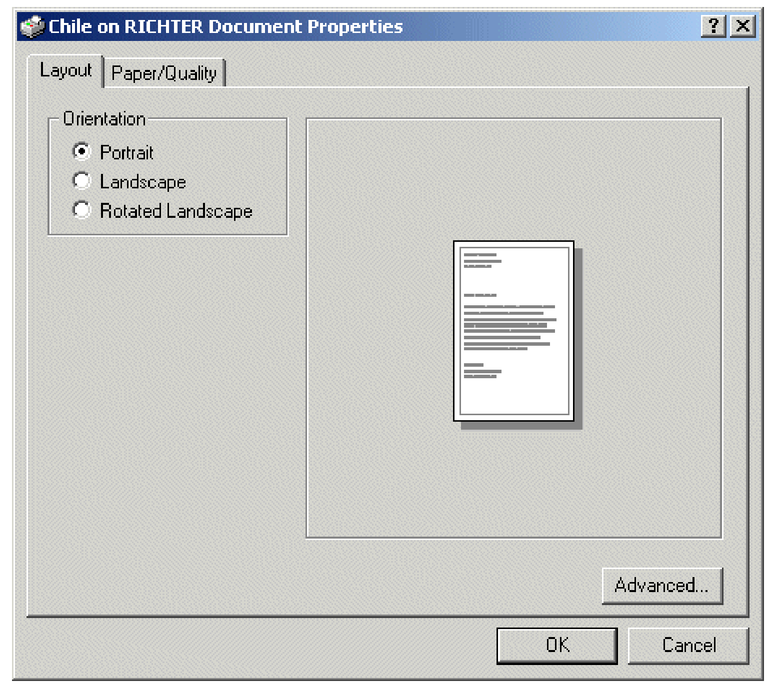


Choose a Printer Engine

ArcPress

PostScript

Windows



Windows Printer Engine

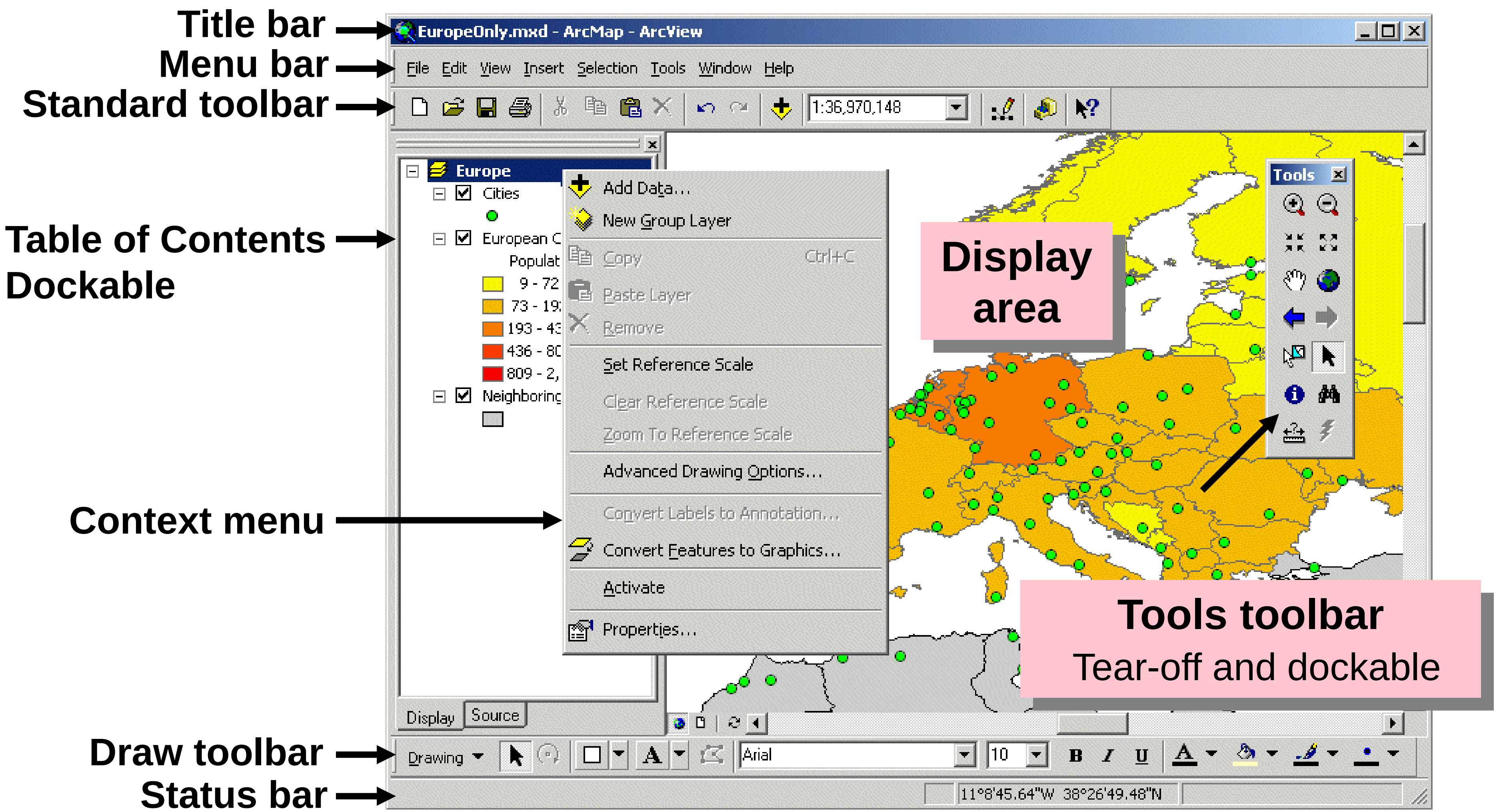
Exercise 9 overview

- Start ArcMap and open an existing map
- Add a legend
- Add a scale bar
- Add a north arrow
- Add a title and other textual information
- Add a border and a background shade to your map
- Maintain visual balance
- Add your map layout to another document (optional)
- Challenge: Add contrast to your map
- Challenge: Add a reference grid to your map
- Save your map document and exit ArcMap

Lesson 9 review

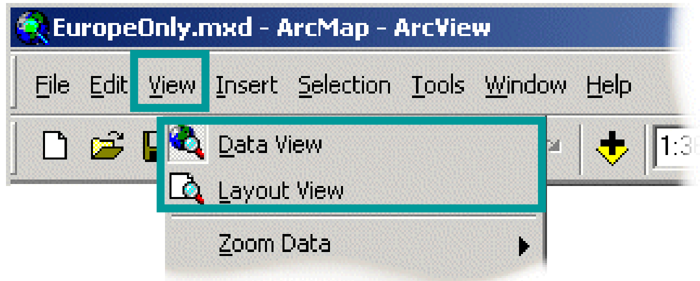
- Name five factors that may control your cartographic design.
- Maps are designed in the ________________________ view.
- How do the zoom tools on the Layout toolbar differ from those on the Tools toolbar?
- You cannot place more than one grid/graticule on a map. (T/F)
- Why would you create or use a map template?
- What map elements can be added to a map layout?

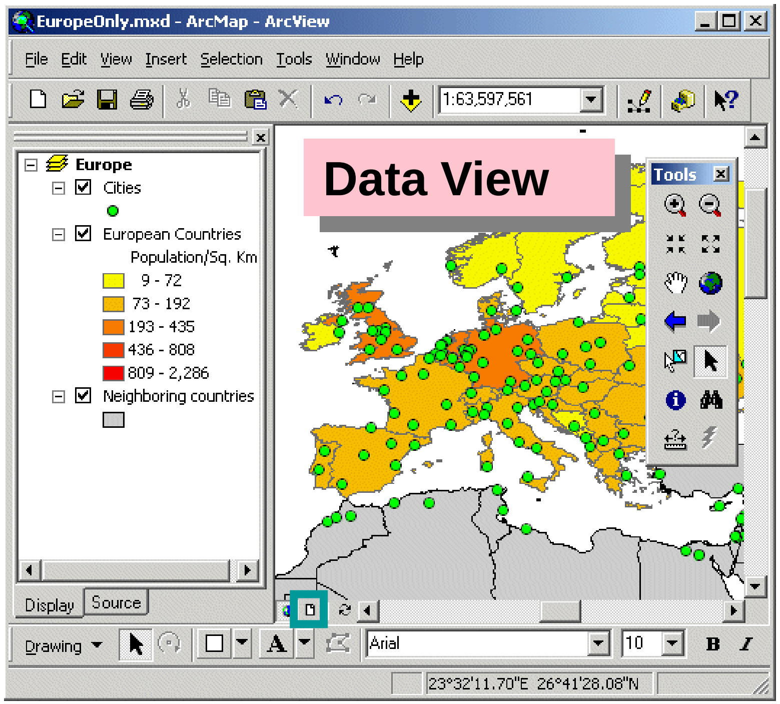
The ArcMap interface

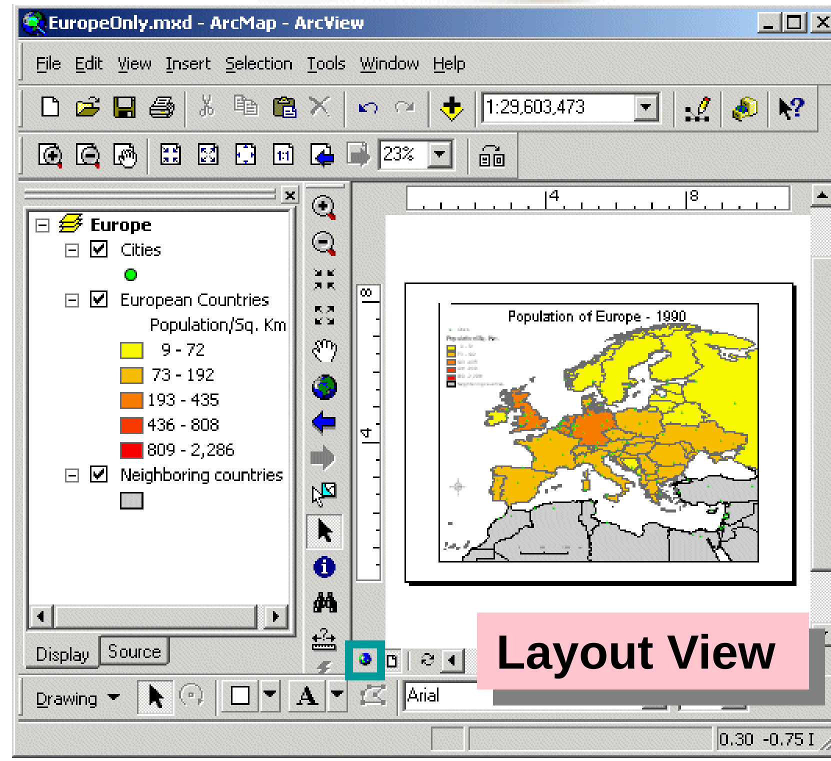


Data view or Layout view?

- Data view
  - For display, queries, editing, and analysis
- Layout view
  - For creating map layouts





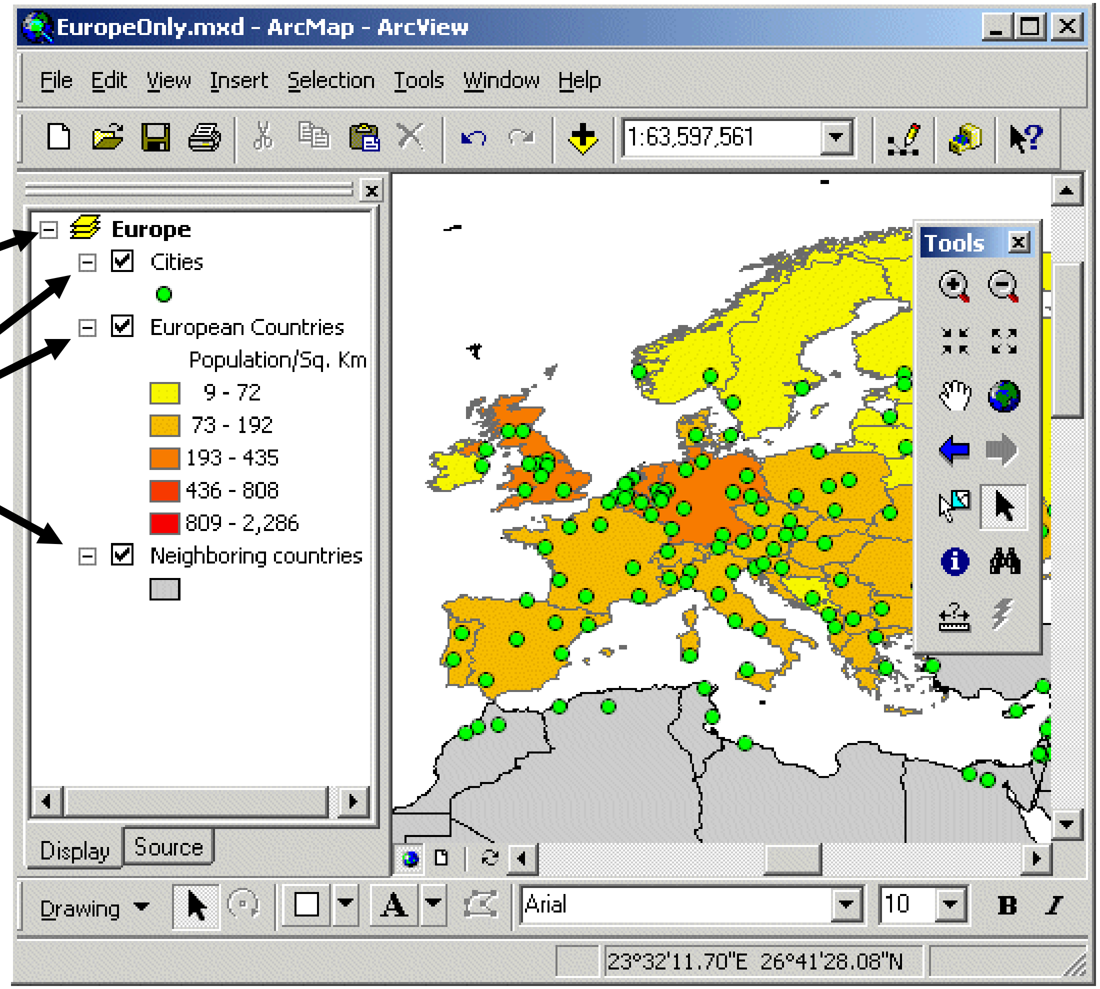


Layers, data frames, and maps

- **Layer**
  - **Represent symbolized spatial data**

Data frame

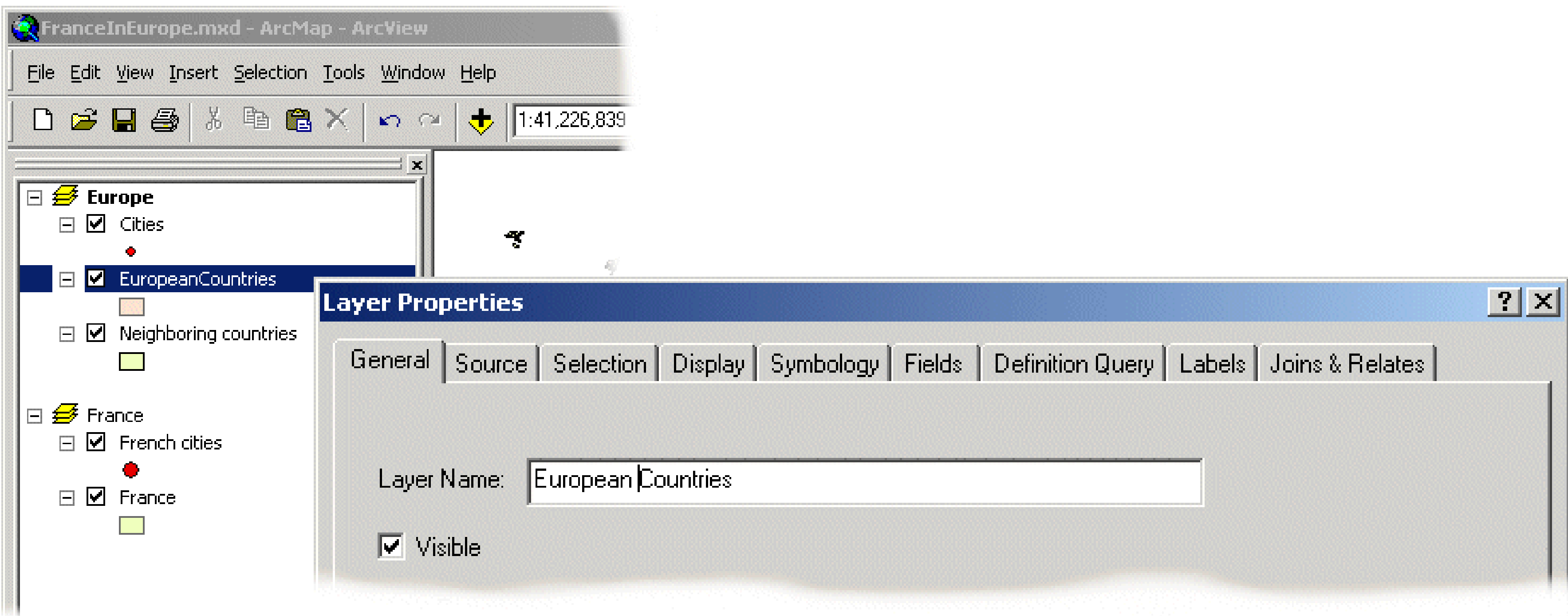
Layers



- **Data frame**
  - **Organizes layers**
- **Map contains**
  - **Data frames**
  - **Layers**
  - **Map elements**

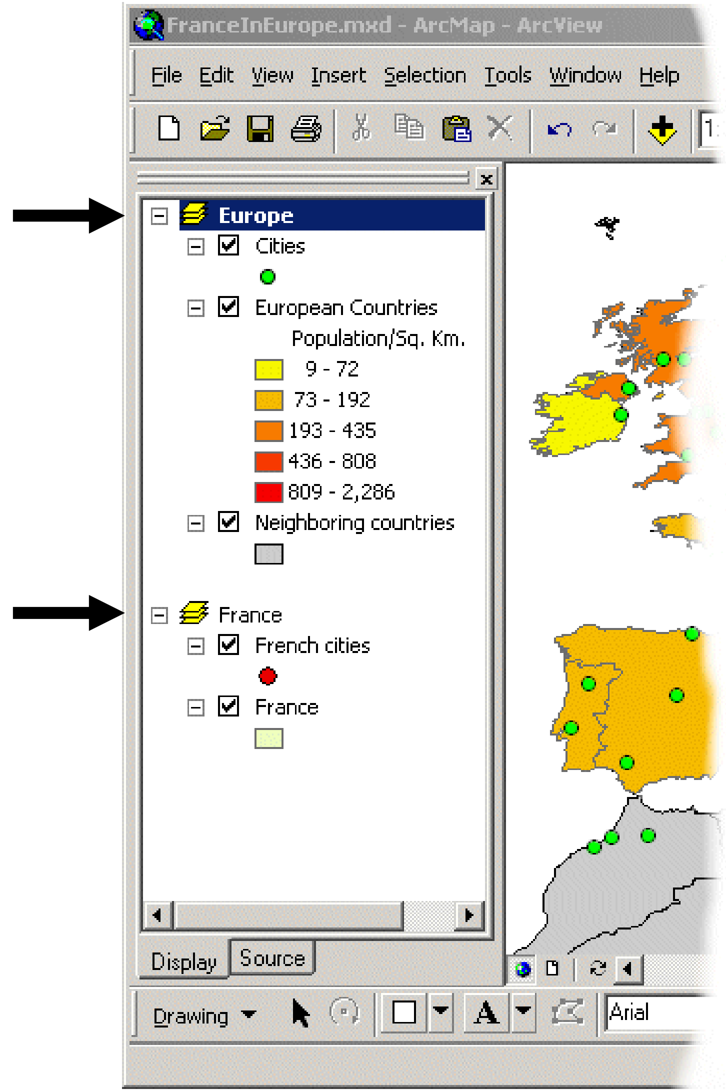
Layers

- Reference spatial data sources
- Set symbols, labels and other properties
- Manipulate through context menu



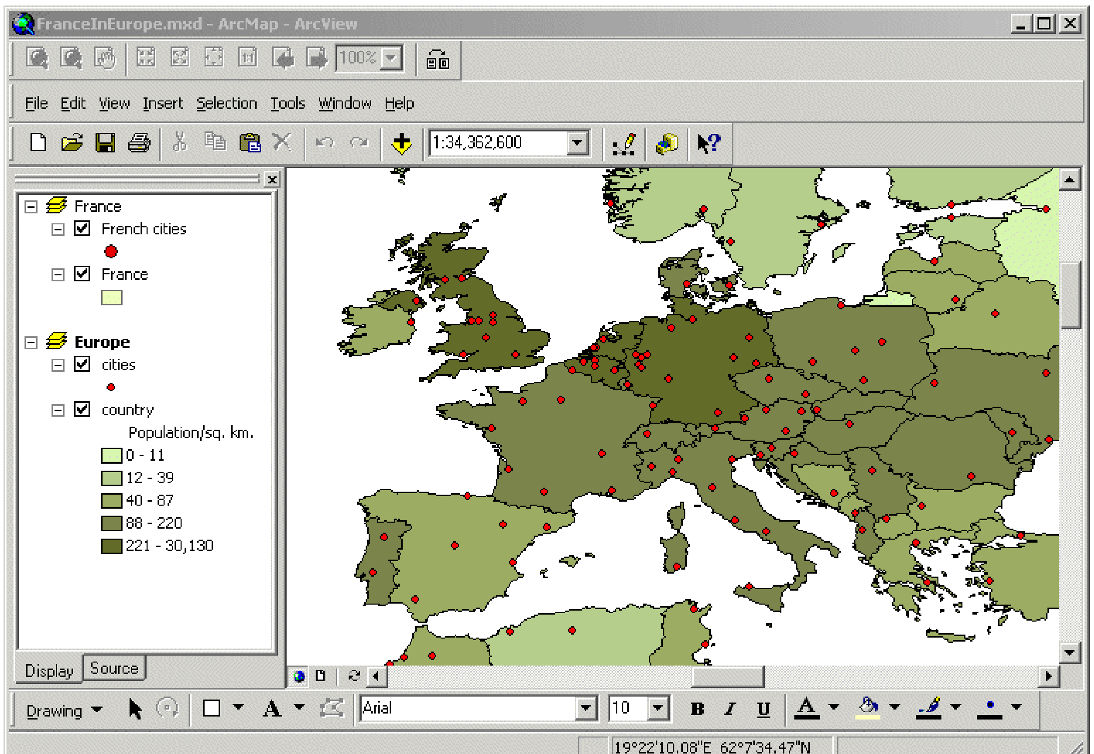
Data frames

- Data frames are containers for layers
- Maps can have many data frames
  - Index and inset maps
  - Arrange in Layout view
- Add from Insert menu
- Activate data frames to view from context menu



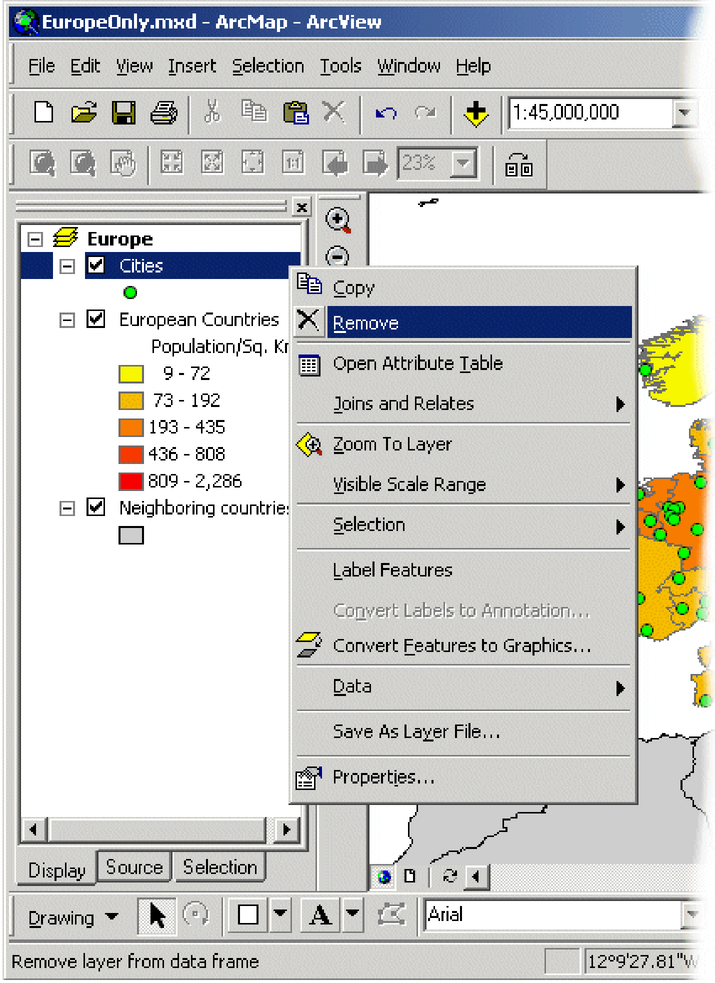
Maps

- Hold layers, data frames, graphics, map elements
- Store information in a map document (MXD) file



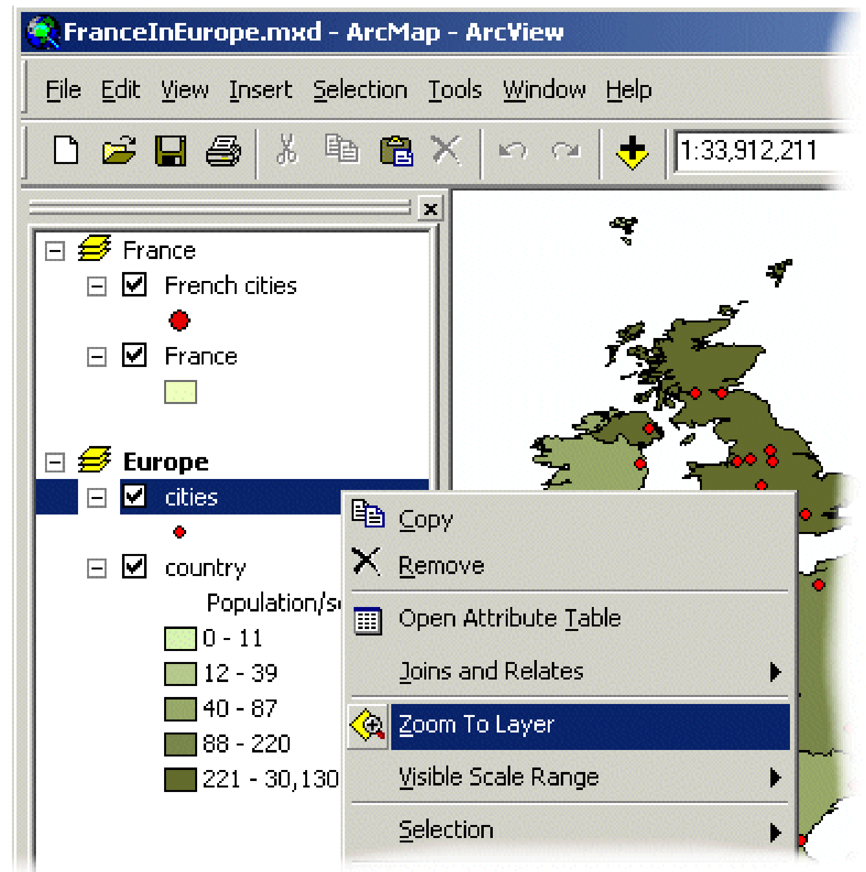
Managing the Table of Contents (TOC)

- Drag layers up or down to change display order
  - Smart defaults for layer draw order
    - Point, lines, or polygons
  - Layers draw in the TOC in order
    - From the bottom up
- Rename data frames and layers
- Remove layers
- Bottom tabs
  - Display
  - Source
  - Selection (optional)



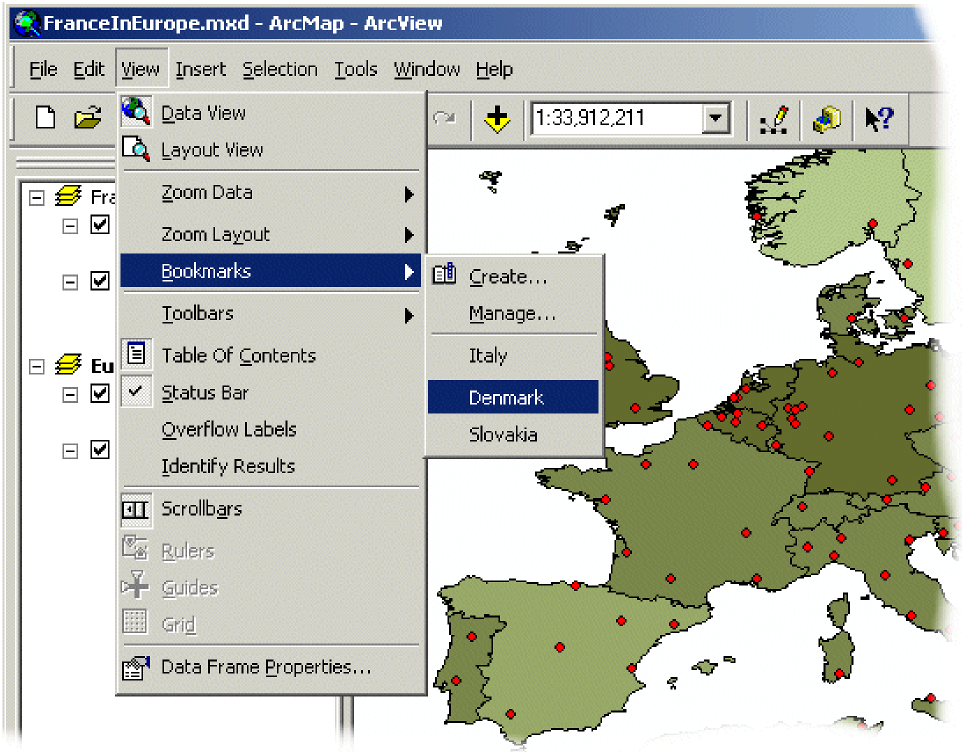
Moving around the map

- Zoom in or out
- Pan the display
- Full extents
- Back or forward one display
- Zoom to a layer



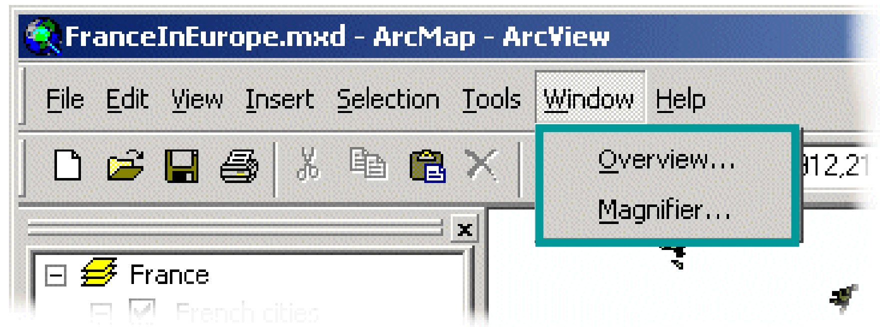
Using a bookmark

- Spatial bookmarks
  - Set and name a location extent
  - Return to it at any time

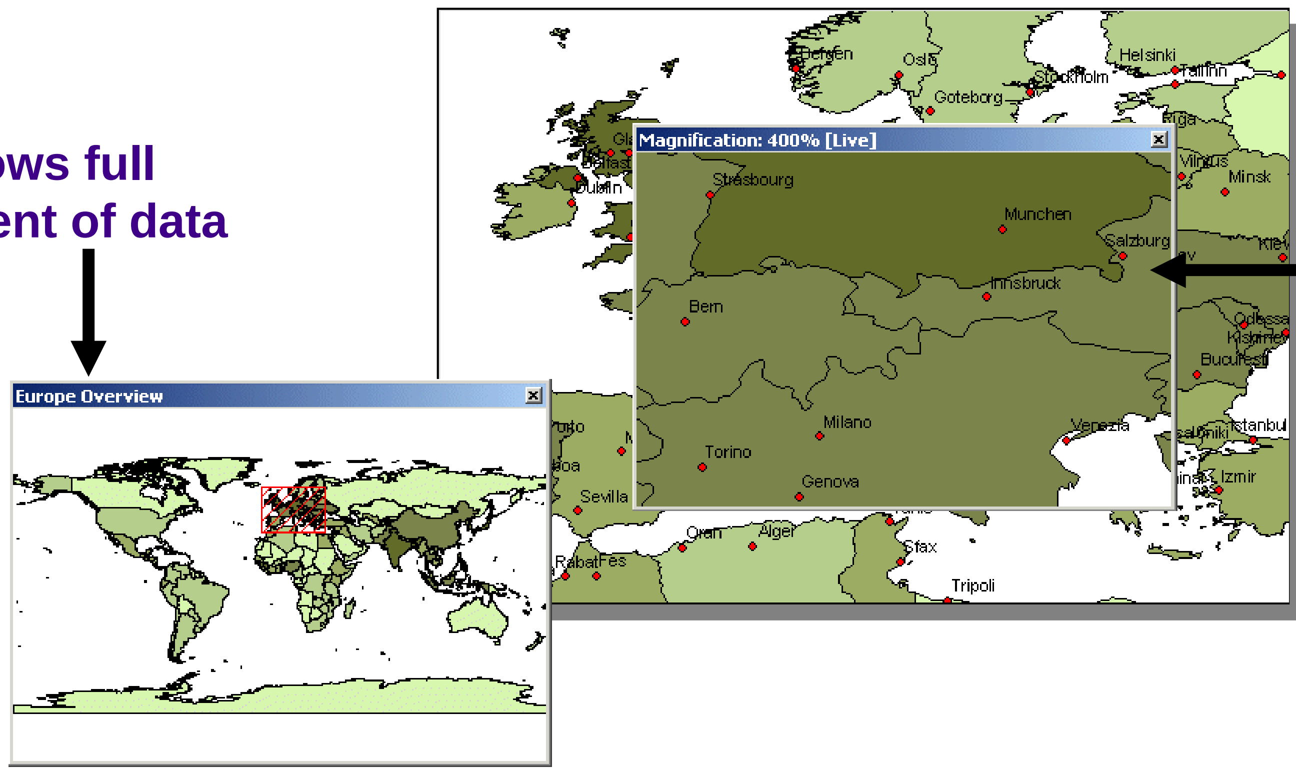


Magnifier and overview windows

- See more detail or overview without changing display



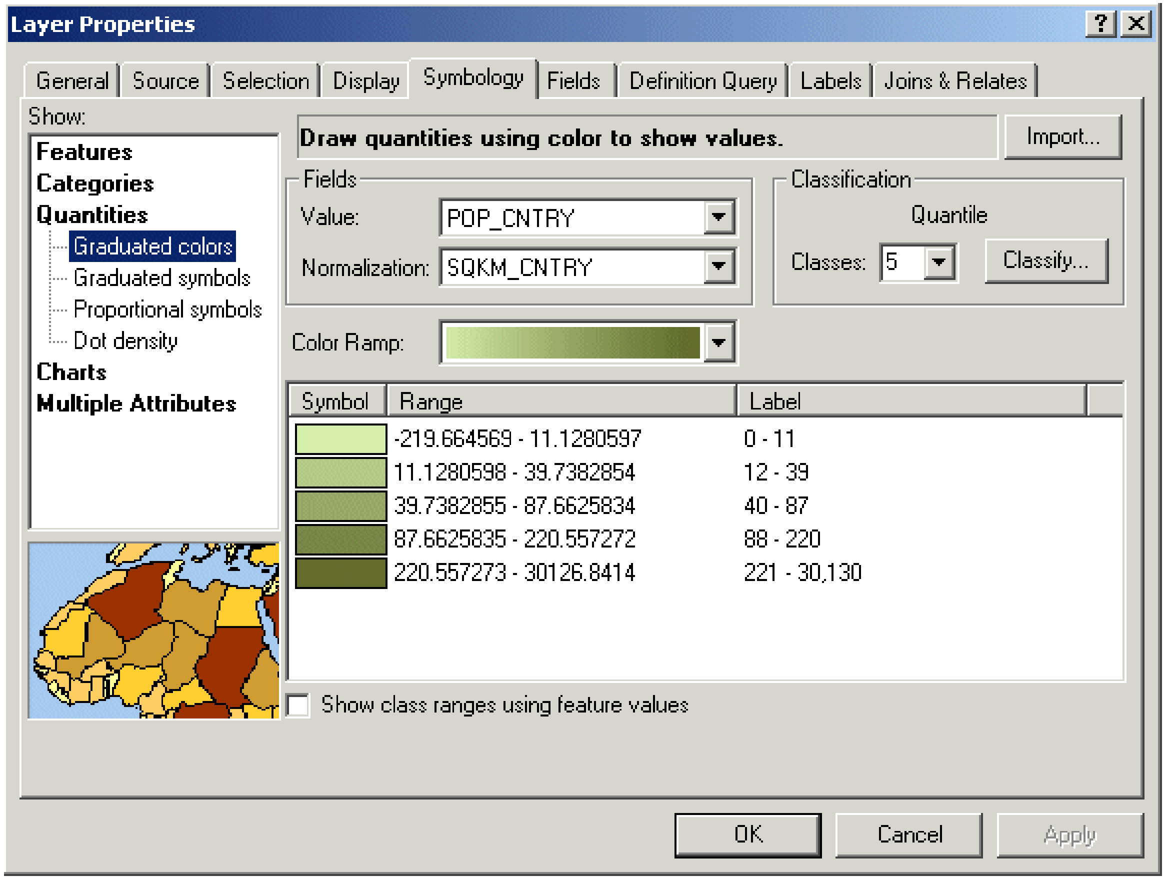
Shows full extent of data



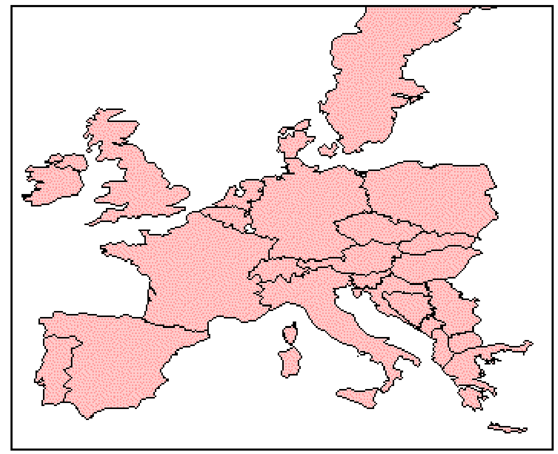
Move over display like a magnifying glass

Layer symbology in ArcMap

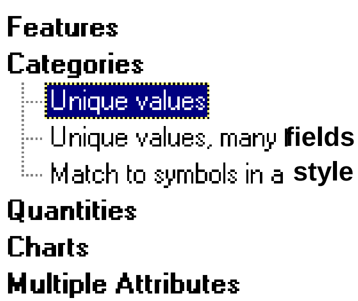
- Same symbol for all features
- Based on attribute values

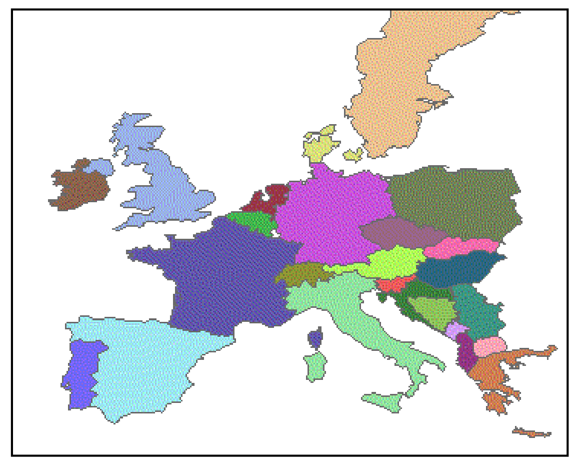


Displaying qualitative values



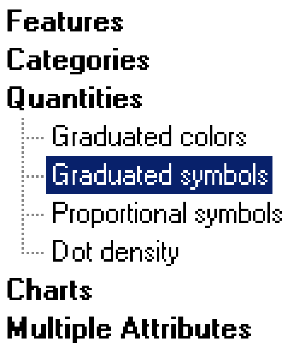
- Features

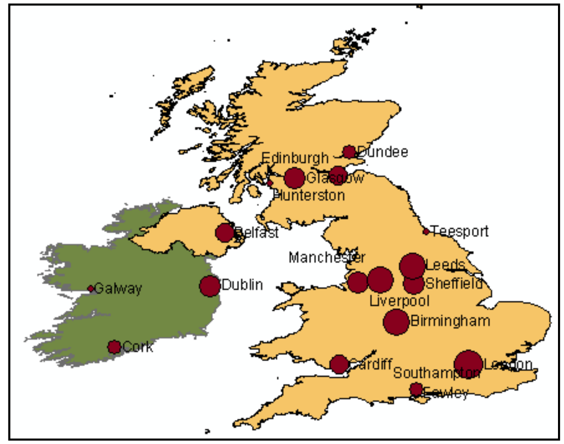




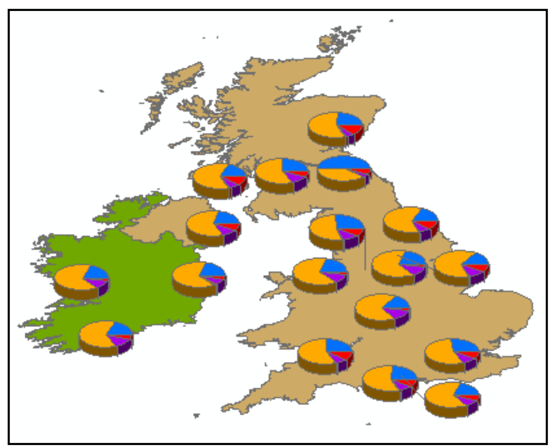
- Categories

Displaying quantitative values





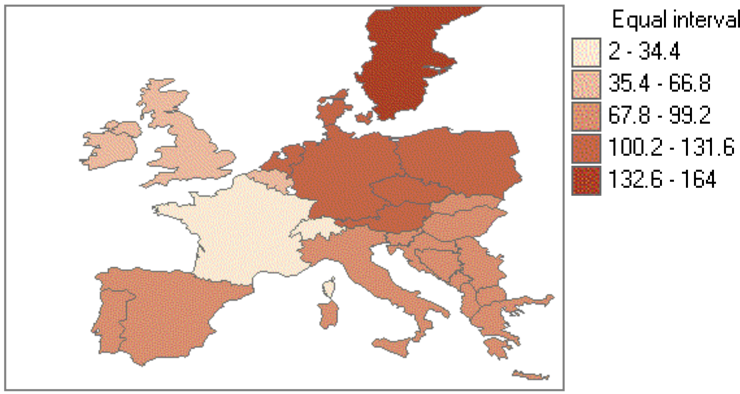
- Quantities



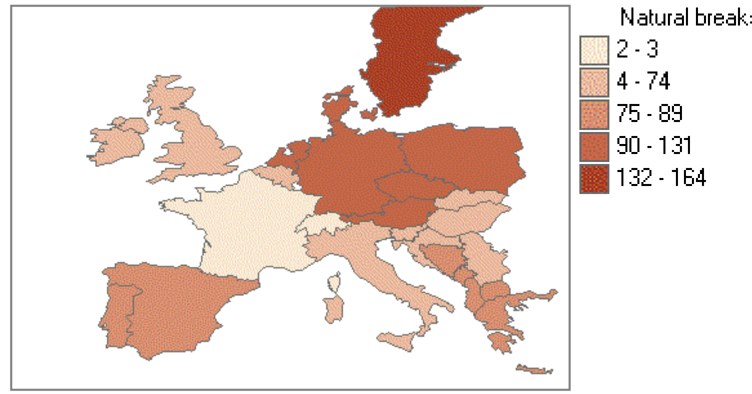
- Charts

Classifying quantitative values

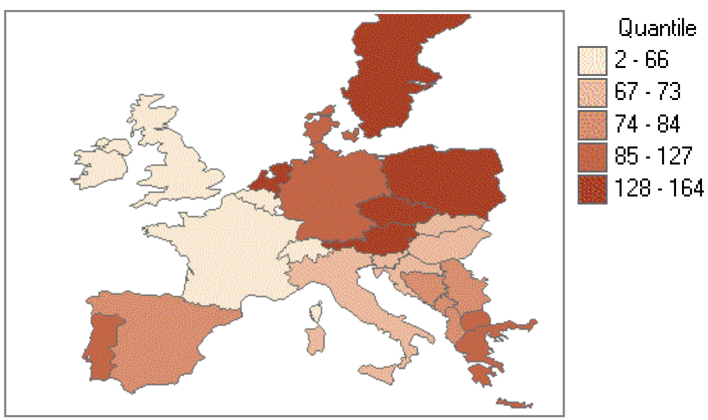
- Can modify classes



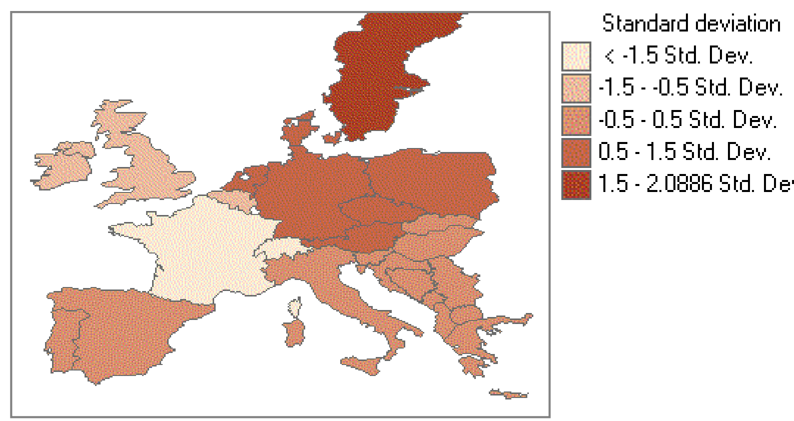
Equal interval



Natural breaks



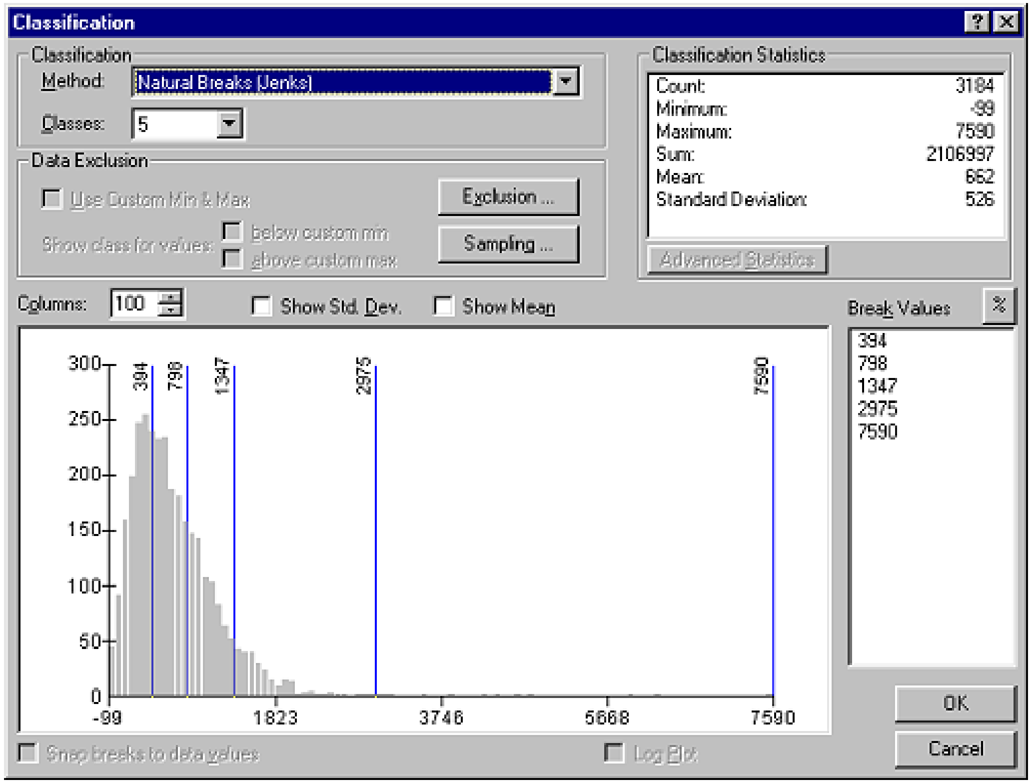
Quantile



Standard deviation

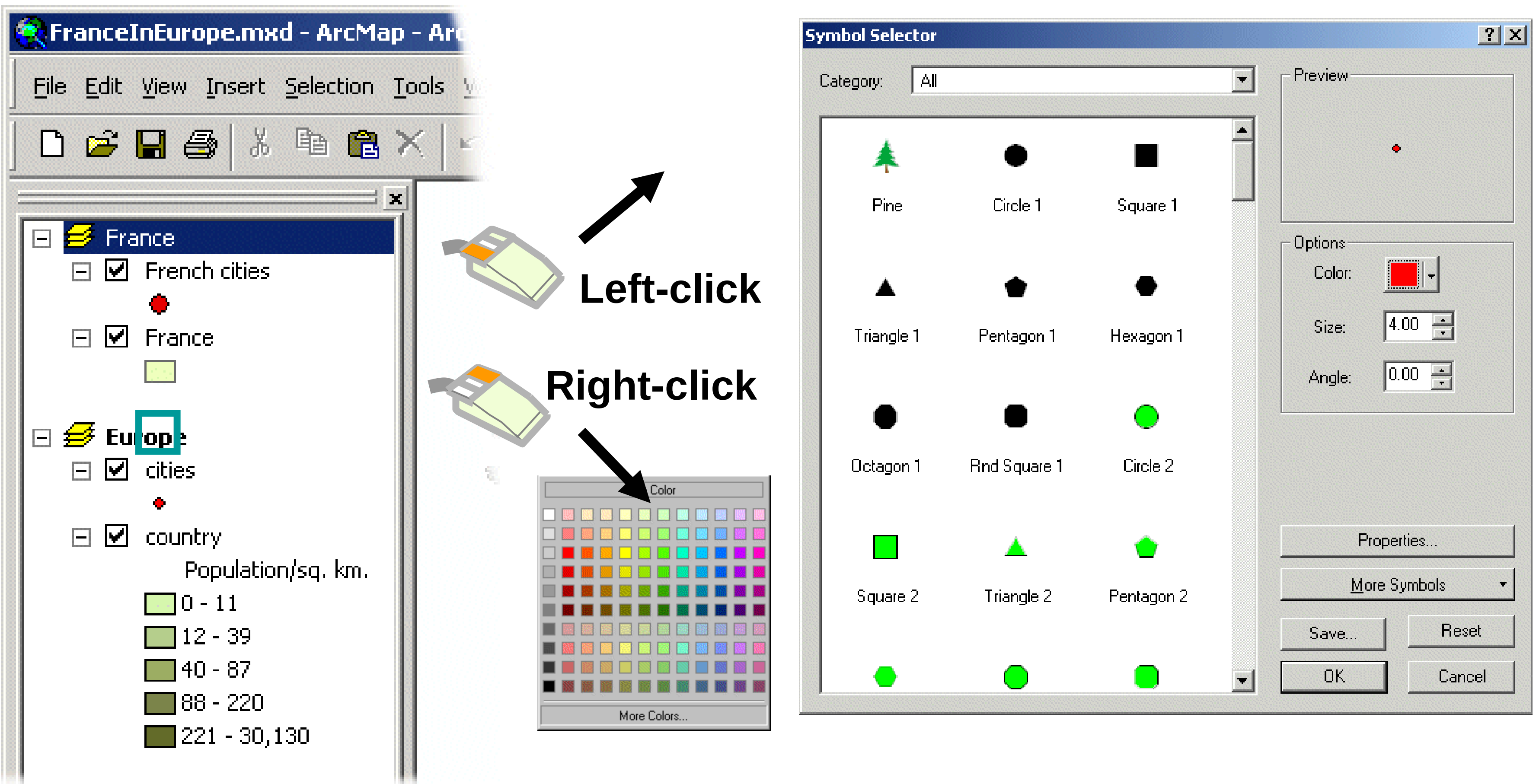
Using the classification histogram

- Manage class breaks
- Move class breaks
- Define
  - Interval
  - Number of classes
  - Method
- Right-click the histogram to
  - Zoom in/out
  - Insert/Delete breaks
  - Center the histogram



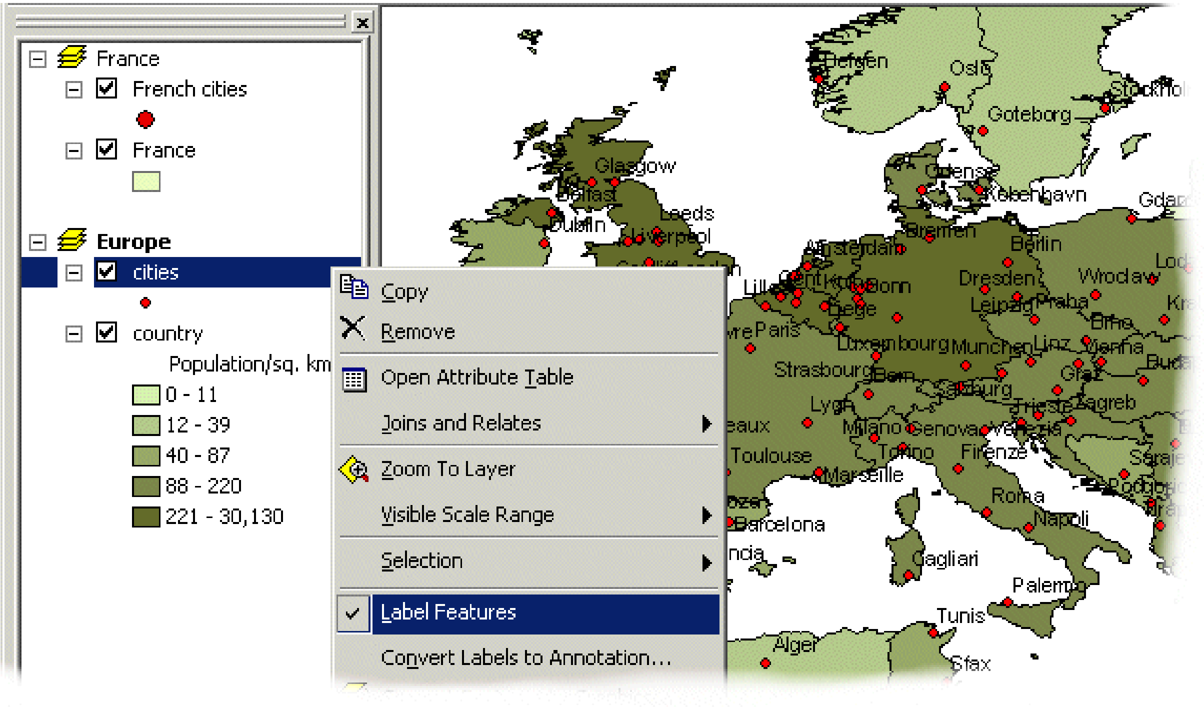
Changing symbol properties

- Symbology tab or Table of Contents



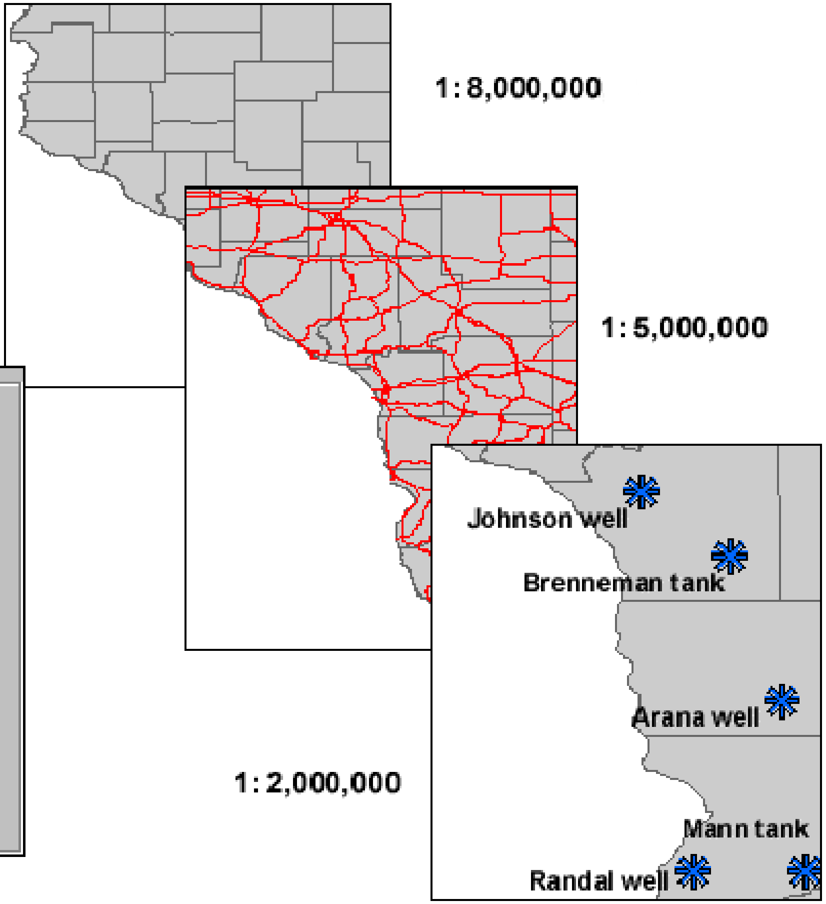
Labeling features

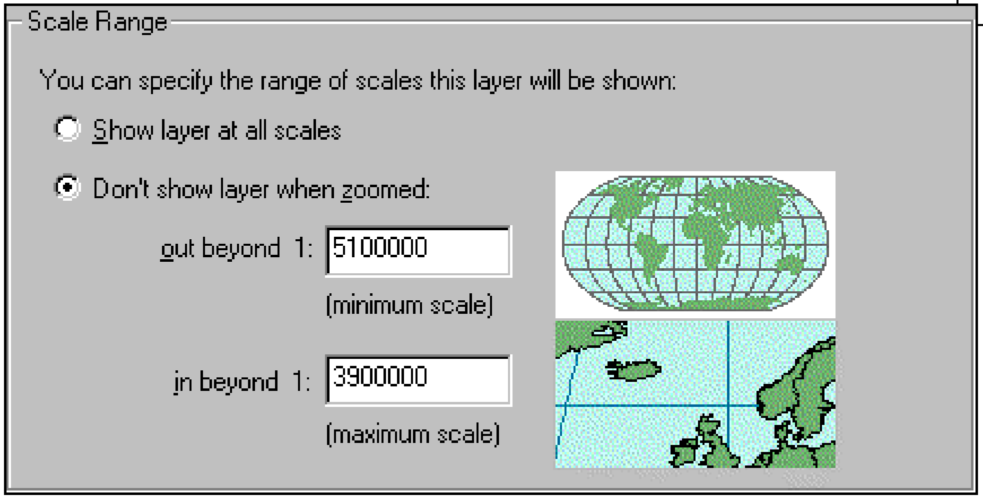
- Label features dynamically using attribute values
- Layer properties control appearance and position
- Convert labels to annotation features



Scale-dependent display

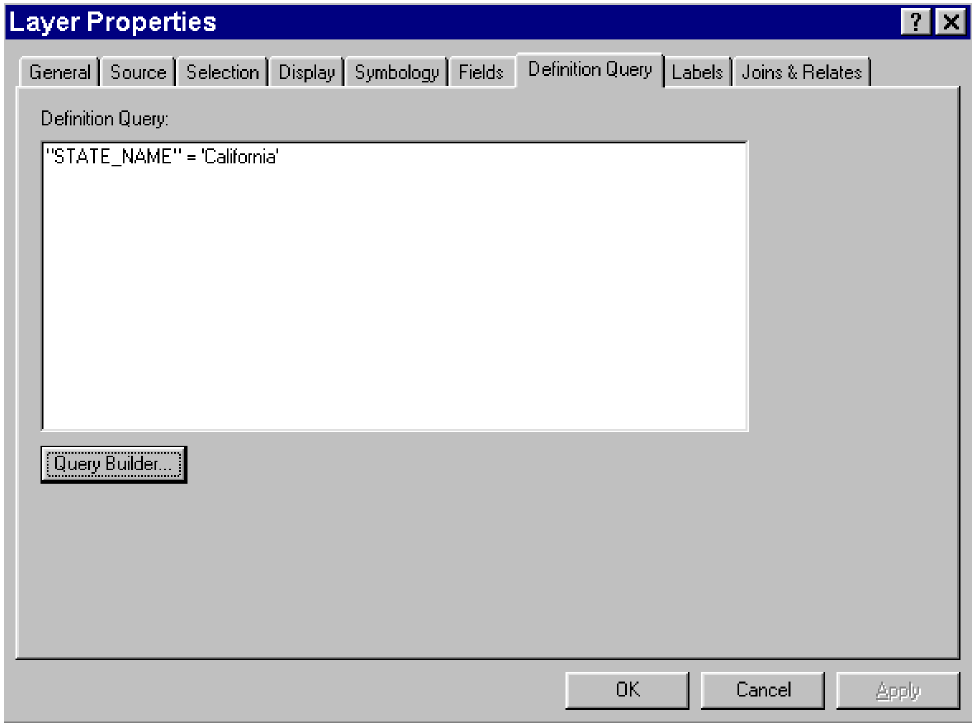
- Display layers at specific scale range
  - Reduces clutter
  - Reduces drawing time
  - Layer display property





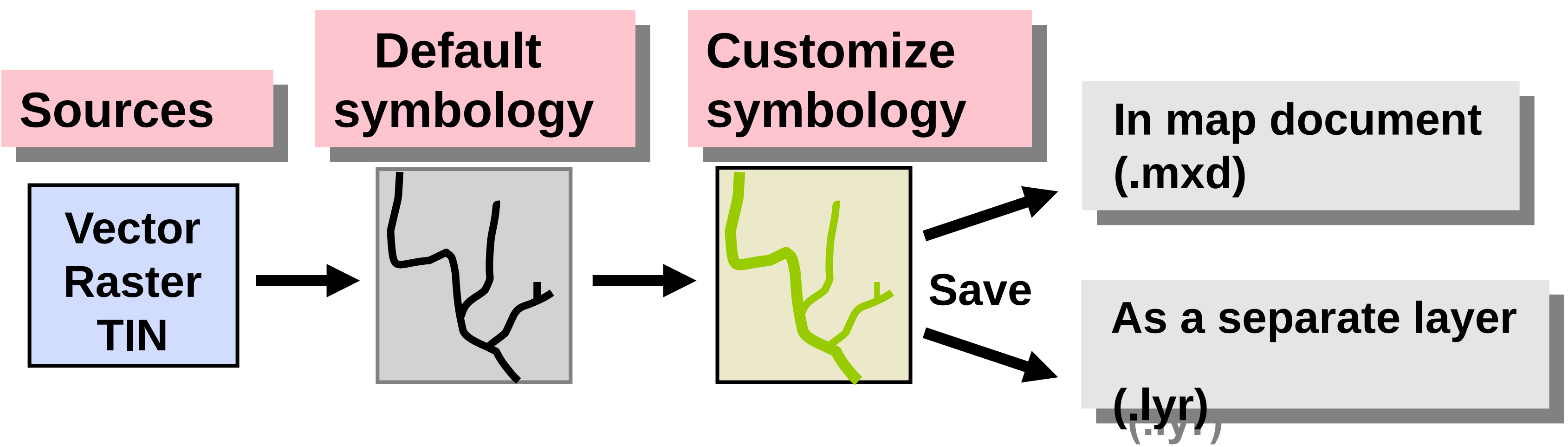
Creating a definition query

- Build a query based on attributes
- Only displays queried features
- Does not affect source



Saving a layer file

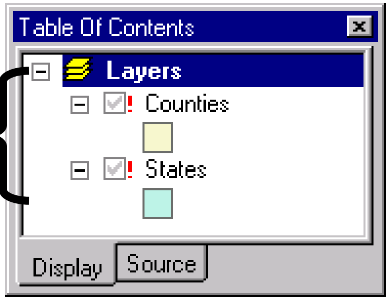
- Save symbology for use in other map documents
- Layer files
  - .lyr extension
  - Save the display for a layer without saving an entire map document
  - Load into another map document
  - Preview in ArcCatalog



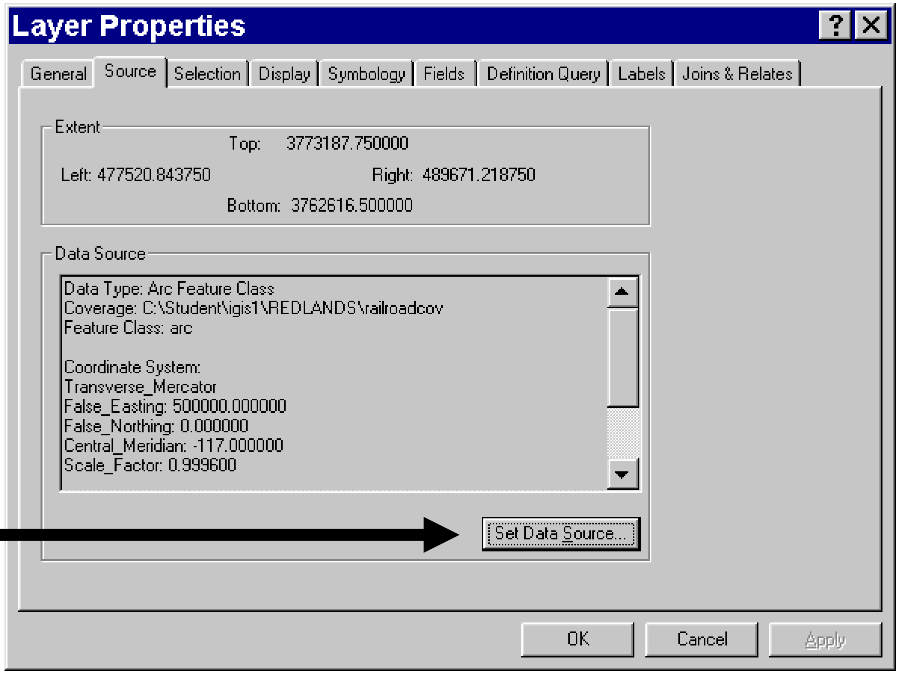
Changing the data source for a layer

- Map documents can lose track of the source data
  - Source data gets moved
- Use Source tab to change the data source for a layer
  - Shortcut: Right-click the layer > Data > Set Data Source

Layers with misplaced data



Click here to change the data source



Exercise 3 overview

- Start your applications and add a polygon layer
- Add an image to ArcMap
- Add a layer for a polygon shapefile
- Change a layer name
- Classify and symbolize spatial data
- Label features
- Create a layer file
- Create a map layout using Layout view
- Set map scale
- Save your map document
- Exit ArcMap
- Challenge: Insert a new data frame and add a layer file
- Challenge: Save labels as annotation

Discussion

Questions