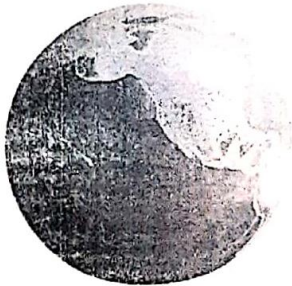


Geographic information systems GIS

**Arc GIS
Program Description**



Prof. Dr Maher A. Abdel Hamid

**Professor of Soil Science
Head of Soil Sciences**

1- Introduction

Overview

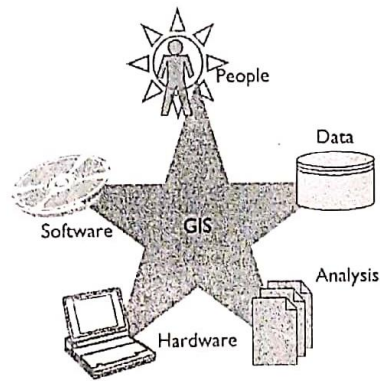
- Logistics
- Course content
- Introduction to GIS concepts

Teaching methods

- Lectures - Demos - Exercises
- Class materials : - Exercise book - Course CD

What is a GIS?

- An integration of five basic components



GIS functions:

- Capture - Store - Query - Analyze - Display - Output

Capturing data

Paper maps – digital data – GPS – coordinates –...

Storing data

- **Vector formats**
 - Use points , lines , area to model reality
- **Raster formats**
 - Use square cells to model reality

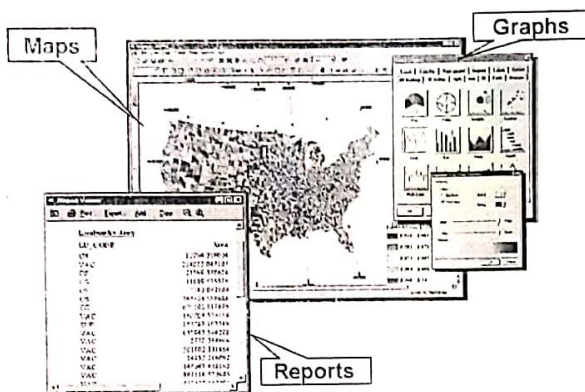
Query

- Identifying specific features
- Identifying features based on conditions

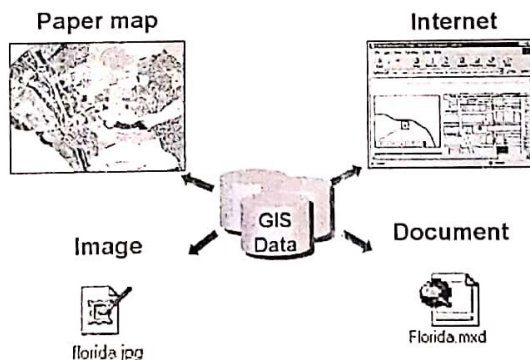
Analysis

- Proximity - Overlay - Network

Display



Output

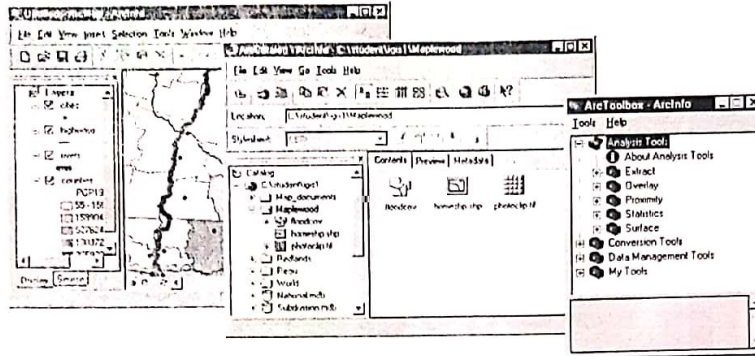


Components of geographic data

- Three general components to geographic information:
 - Attributes - Geometry - Behaviour

Overview of applications

- All ArcGIS products share common applications
- ArcMap, ArcCatalog, ArcToolbox



Demonstration

- Observe ArcCatalog ✓
 - Directory structure and navigation
 - Documentation
- Observe ArcMap ✓
 - Add data
 - Display and query data
 - Zoom and pan tools
 - Save a map document
- Observe ArcToolbox ✓
 - Toolkits

Exercise overview

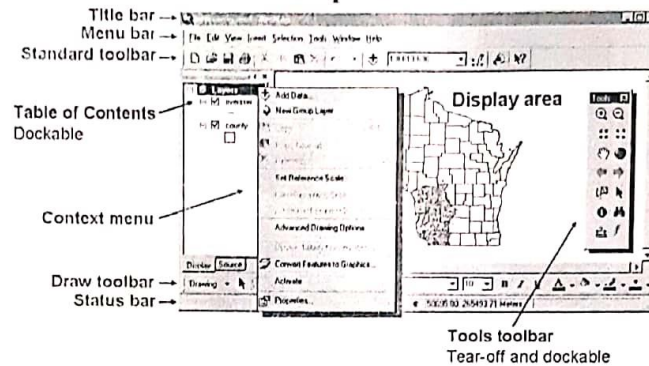
- Exercise A: Run the class database setup program
- Exercise B: Use the software to:
 - Start ArcMap
 - Examine some feature layers and their organization
 - Identify relationships between geographic features
 - Associate descriptive information with a layer
 - Identify specific features
 - Select geographic features based on certain conditions
 - Challenge step: More fun with queries

2- Displaying data

Overview

- The ArcMap interface and tools
- Data View and Layout View
- Layers, data frames, and map elements
- Layer properties for symbols and labels
- Scale dependant display
- Spatial bookmarks

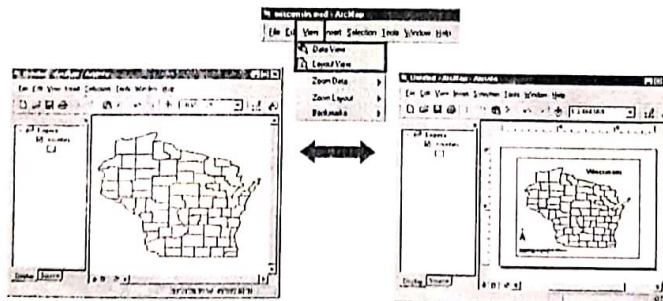
The ArcMap interface



- Primary display application
- Perform map-based tasks
 - Displaying - Editing - Querying - Analyzing - Charting - Reporting

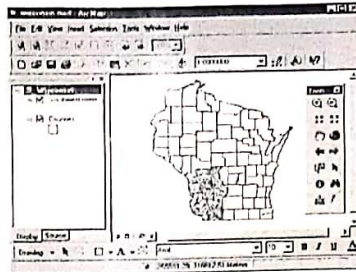
Data View or Layout View?

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



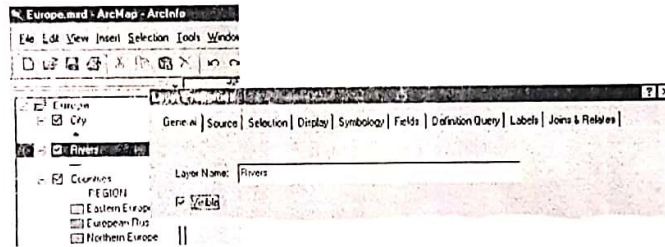
Layers, data frames, and maps

- Layer
 - Represent symbolized spatial data
- Data frame
 - Organizes layers
- Map
 - Contains data frames, layers, and map elements



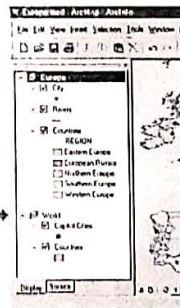
Layers

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



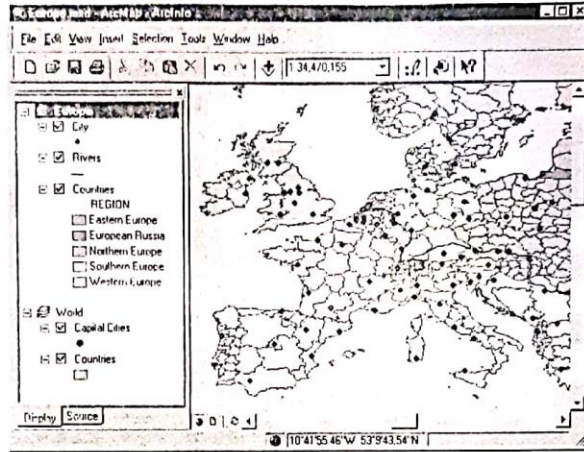
Data frames

- ◆ Data frames are containers for layers
- ◆ Maps can have many data frames
- ◆ Activate data frames to view from context menu



Maps

- Holds layers, data frames, graphics, map elements
- Stores information in a map document (.mxd) file



Managing the Table of Contents

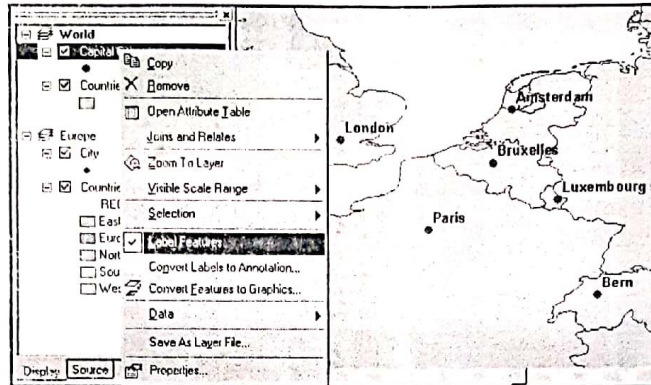
- ◆ Drag layers up or down to change display order
 - ◆ Smart defaults for layer draw order
 - ◆ Point, lines on polygons
 - ◆ Layers draw in the Table of Contents order, from the bottom-up
- ◆ Rename data frames and layers
- ◆ Remove layers
- ◆ Display or Source tabs



MAP TIPS

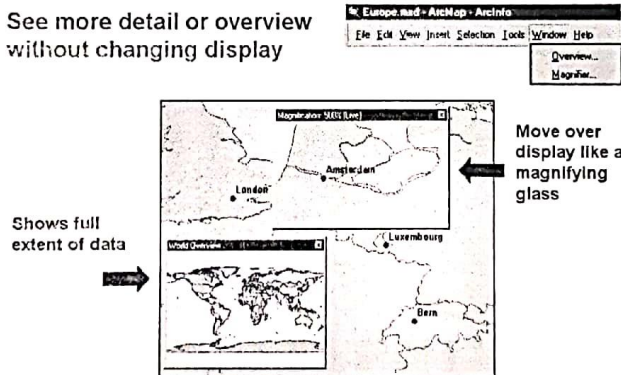
Labeling features ✓

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



Magnifier and overview windows

- ◆ See more detail or overview without changing display



Exercise overview

- Add layers
 - Classify and symbolize spatial data
 - Label features
 - Create a map layout
 - Set map scale
 - Save map document
 - Challenge: Save labels as annotation
- Change layer names

3- Querying your database

Overview

- Tools for examining your data
- Map tips, Identify, Find, Measure, Hyperlink

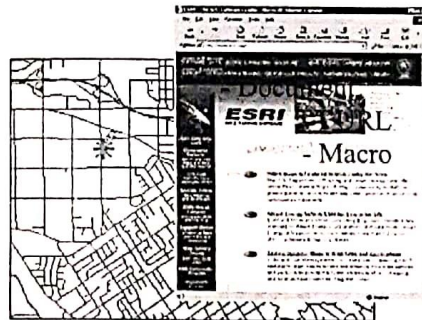
- Working with the selection tools
 - Why do you need a selection
- Available selection tools
- Selection methods and layers
- Spatial selection
- Attribute selection
- Calculating summary statistics

Map tips and hyperlinks

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



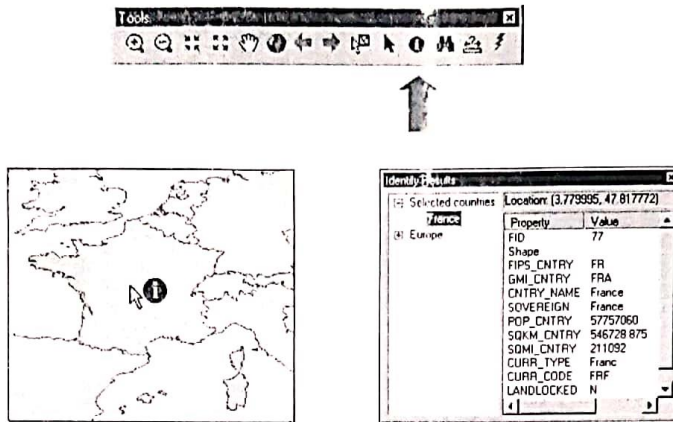
- Hyperlinks





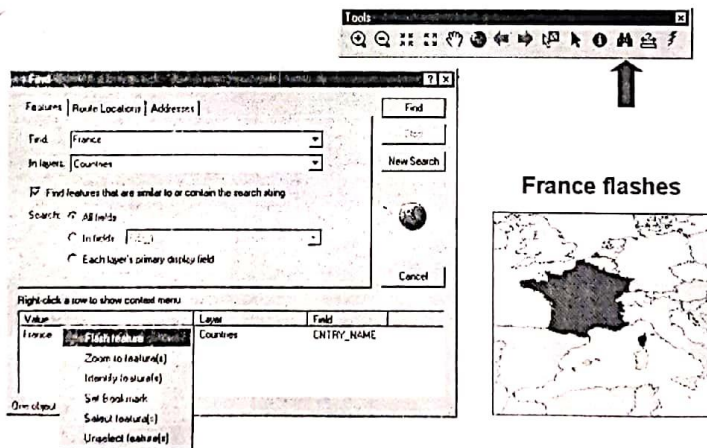
Identifying

- Popup attributes for a specific feature



Finding

- Locate a specific feature or attribute

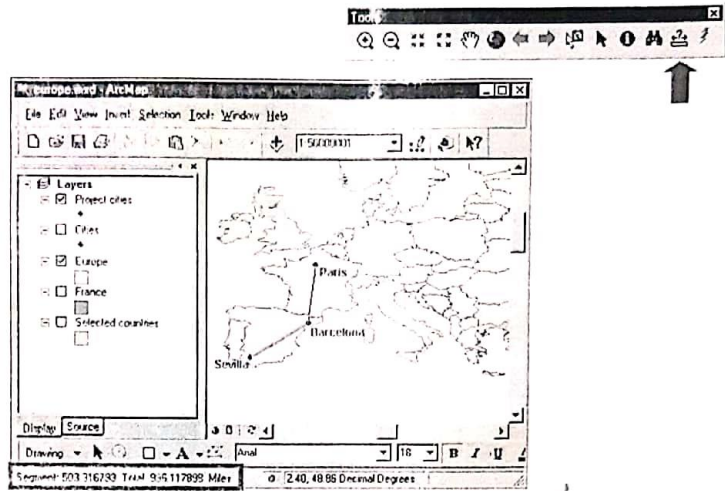




sets

Measuring

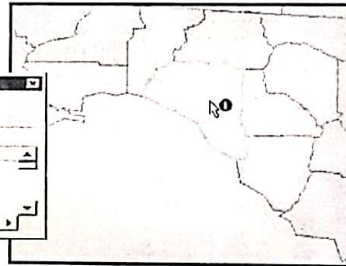
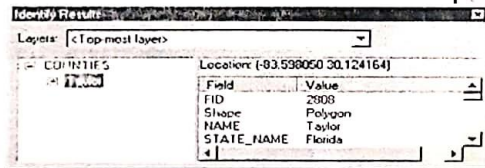
- Find linear distances



Query

- Identifying specific features

Attr
Loc



- Identifying features based on conditions

Florida counties with a population greater than 300,000

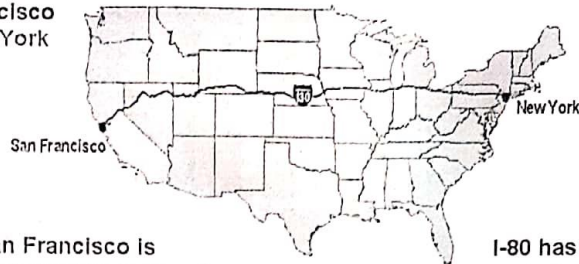


X

Using spatial relationships

- The relative position of features determines relationships

I-80 connects
San Francisco
and New York



San Francisco is
contained in California

I-80 has *length*
and *direction*

Analysis

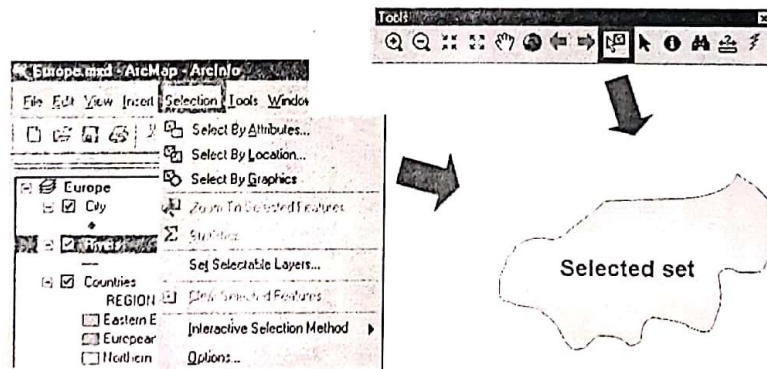
- Proximity
- Overlay
- Network

Why do you need a selection?

- Use to select other features
- Edit
- Focused analysis
- Report
- Create a new layer
- Export
- Convert to graphics
- Calculate statistics

Available selection tools

- Interactive, attributes, location, graphics





Interactive selection options

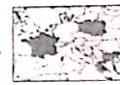
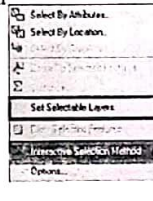
- Options from Selection menu
- Select features partially or completely within the box or graphic(s)
- Select features completely within the box or graphic(s)
- Select features that the box or graphic are completely within



Interactive selection methods

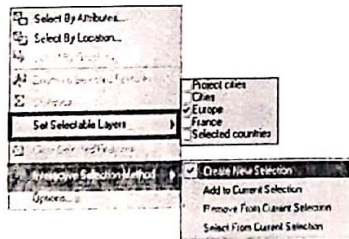
- Specify selection method
- Create New Selection
- Add to Current Selection
- Remove From Current Selection
- Select from Current Selection

Selection menu

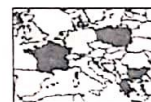


Selection methods and layers

- Specify from Selection menu
- Layer(s) to select from
- Selection method



Create new selection



Add to the selection



Remove from the selection



Select from selection



Area = 500

Attribute selection

- Use an SQL statement to select features
- Save and reload selection expressions

Field Operator Value

For current selection:
Add to
Remove from
Select from

Select by location (spatial query)

- Use features in one layer to select features in another

Cities

Counties

Result

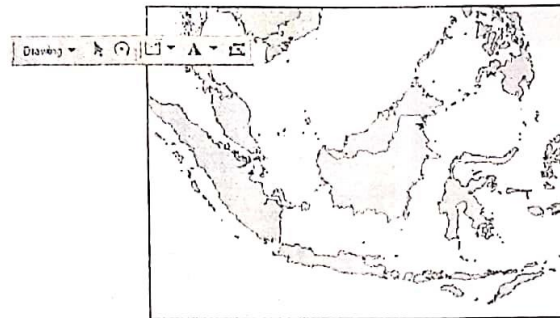
Cities intersected by selected counties

Location selection methods

- Select by Location offers many selection methods
 - Intersects
 - Contain
 - Are contained by
 - Shares a line segment
 - Shares a point
 - Within a distance
 - Are identical
 - Others...

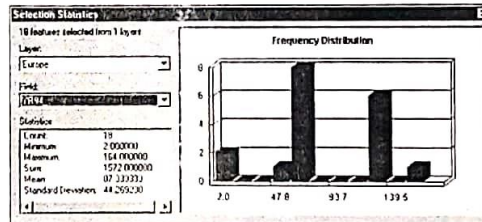
Selection by graphics

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



Calculating summary statistics

- Select
 - Features
 - layer
 - Field



Exercise overview

- Add map tips and identify features
- 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 selection methods
- Making attribute selections
- Challenge: Export a layer to a separate file

4- Working with spatial data

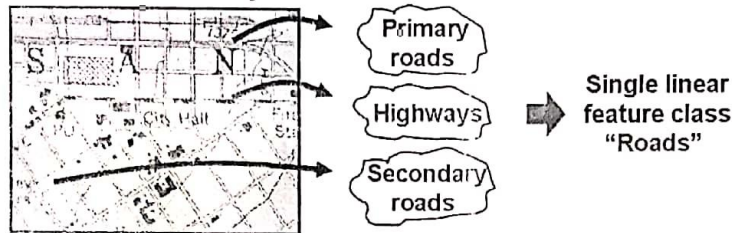
Overview

- Linking features and attributes
- Data formats
- Metadata
- Geography Network

Introducing feature classes

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

Many different line objects



Spatial data formats:

- ArcGIS can work with spatial data in multiple formats

Data format: Shapefile

- Single feature class
- Attributes stored in dBASE table



Data format: Coverage

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



Data format: Geodatabase

- Stores spatial features and their attributes in the same RDBMS
- Feature classes can be stand-alone or grouped in a feature dataset
- Feature datasets model spatial relationships



Data format: CAD files

- Computer Aided Design files (DXF, DWG, DGN)
- Edit after conversion to coverage or geodatabase feature class



Tabular locations

- Table to point feature class



Images and grids



Introducing metadata

- What is metadata?
- Metadata tab: - Description - Spatial - Attributes
- Create and edit metadata
- Display metadata using different formats:
 - FGDC - ESRI - XML

Using Geography Network data

- Map or Data services
- Data clearinghouses
- Geoservices and solutions
- The Geography Network Explorer

Exercise overview

- Exercise A
- Create a new folder connection in ArcCatalog
- Examine shapefiles, coverages, geodatabases, CAD, and raster formats
 - Optional Exercise B
- Online Geography network exercise

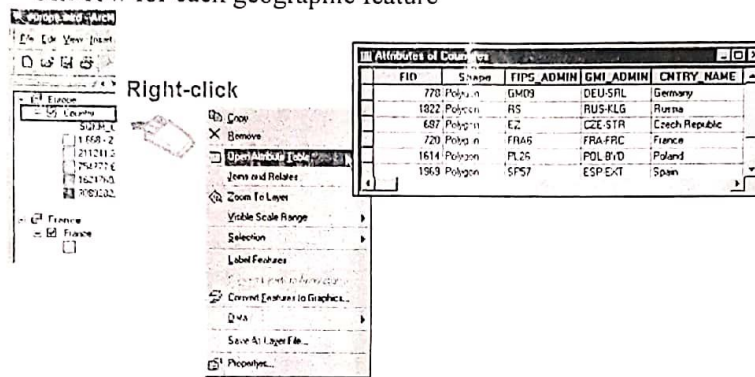
5- Working with tables

Overview

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

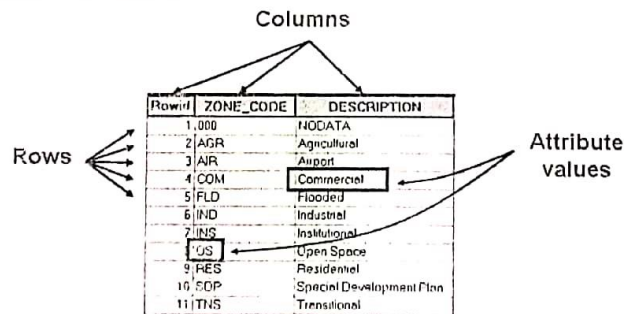
Tables

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



Understanding table anatomy

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



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

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


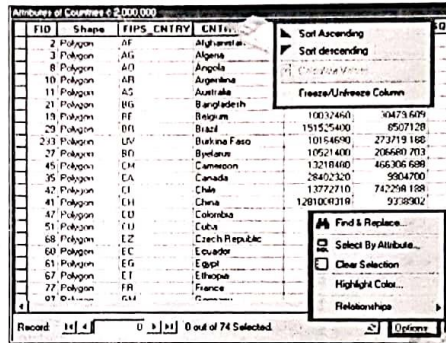
Text	Date	Short	Long	BLOB	Float
Jupiter	7/16/1994	16	1429.84		9.8

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



Associating tables

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

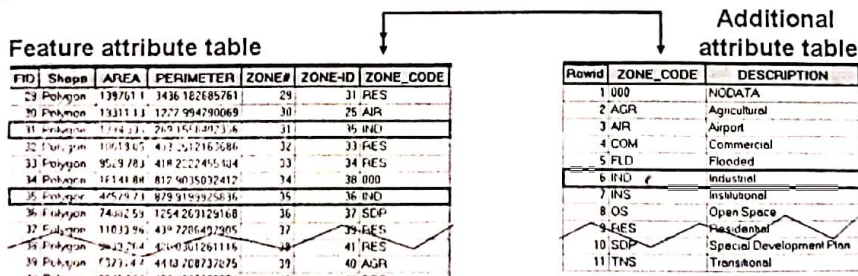
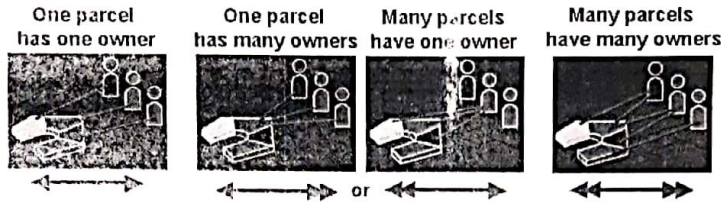


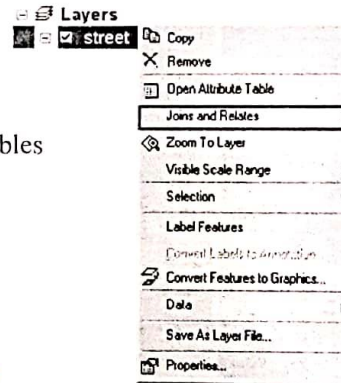
Table relationships

- 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



Joins and relates

- Two methods to associate tables in ArcMap
- Join appends the attributes from one onto the other based on a common field
- Relates define a relationship between two tables



Connecting tables with joins

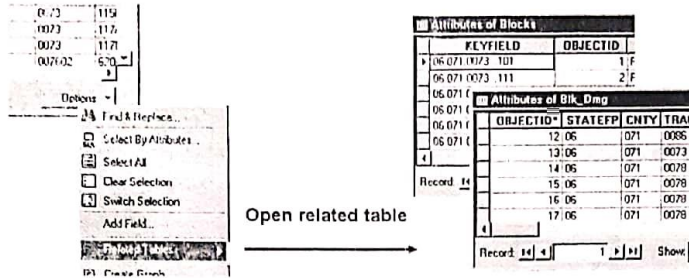
- Physical connection between two tables
- Appends the attributes of two tables
- Assumes one-to-one or many-to-one cardinality

Soil			Soil_desc		
OBJECTID*	Shape*	SOIL_CODE	OBJECTID*	SOIL_CODE	SOIL_DESC
1	Polygon	41	1	41	Quary Gravel pt
2	Polygon	26	2	26	Psammerts and Fluvents (freq flooded)

Attributes of soil					
OBJECTID	Shape	soil.SOIL_CODE	soil_desc.SOIL_CODE	soil_desc.SOIL_DESC	
1	Polygon	41	41	Quary Gravel pt	
2	Polygon	26	26	Psammerts and Fluvents (freq flooded)	
3	Polygon	26	26	Psammerts and Fluvents (freq flooded)	
4	Polygon	26	26	Psammerts and Fluvents (freq flooded)	
5	Polygon	34	34	Soboba stony loamy sand	
6	Polygon	50	50	Water	

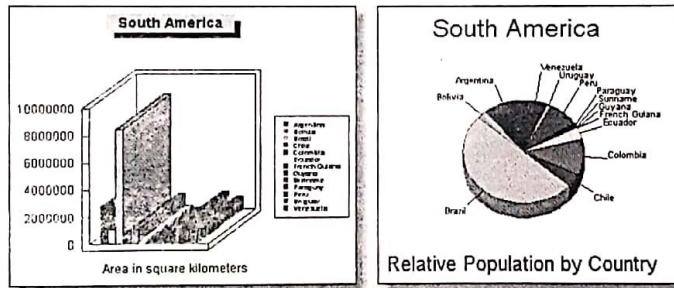
Connecting tables with relates

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



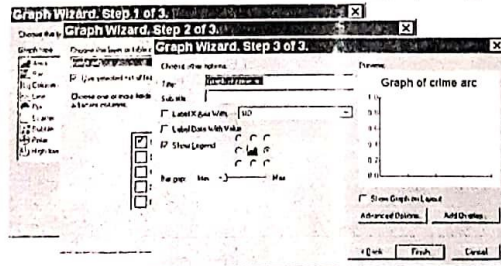
Graphs

- Summarize tabular information in a graph
- A variety of graph formats
- Add to a map



Graph creation

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

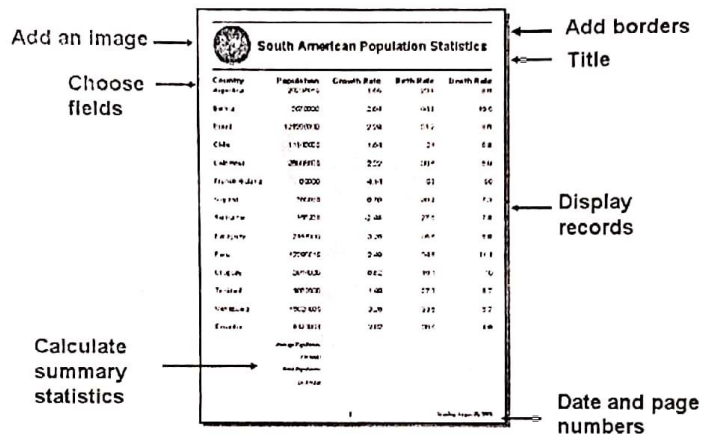


Reports

- Organizes and displays tabular data
 - Group and format data
 - Save and export
 - Two reporting tools
- Report Writer
- Crystal Reports

The ArcMap Report Writer

- Quick, easy, professional report creation



Exercise overview

- Exercise A
- Relate and join tables based on common fields
- Exercise B
- Create a graph - Create a report
- Embed the graph in the report
- Add the report to a layout

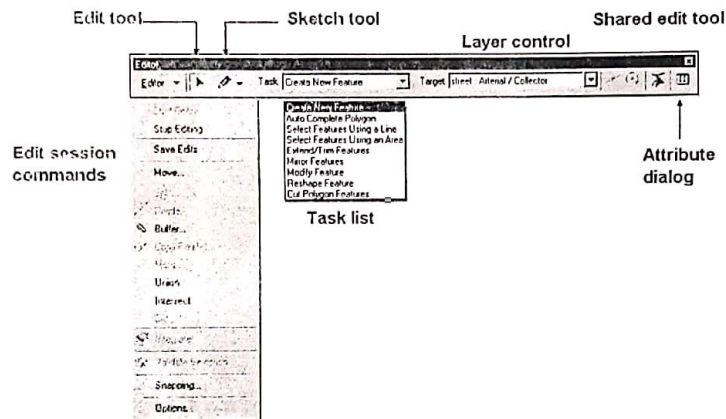
6- Editing data

Overview

- Navigating the Editor toolbar
- Editing tools
- Simple editing functions
- Working with sketches
- Updating attributes

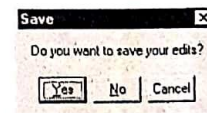
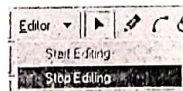
Navigating the Editor

- All editing functions are controlled through the toolbar



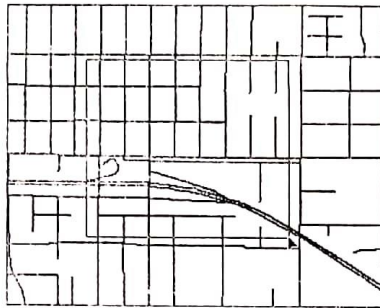
Managing edit sessions

- Starting a session
 - Within one data frame at a time
 - Within one geodatabase at a time
 - Within one directory at a time
- Saving edits
 - During the edit session
 - At the end of the edit session
- Ending a session



Selecting features

- Interactive selection: Pointing, box, line, area
- Selection menu: Attribute, by location
- Choice of selectable layers

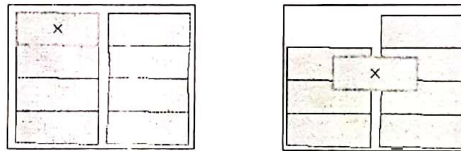


Selection anchor



Simple editing functions

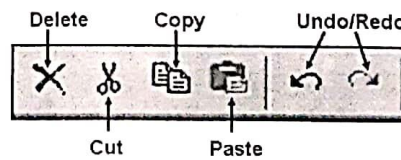
- Moving



- Rotating

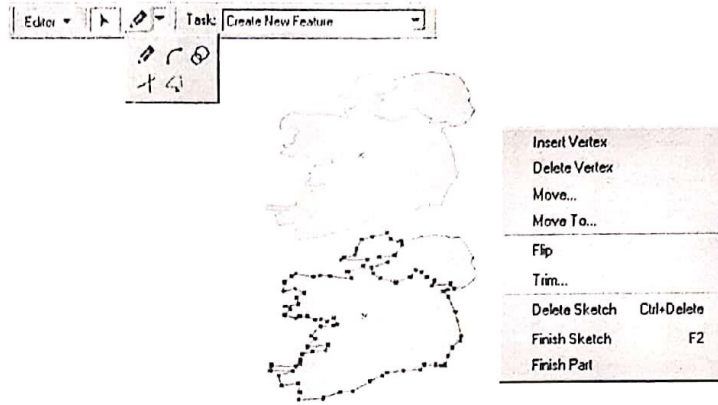


- Others



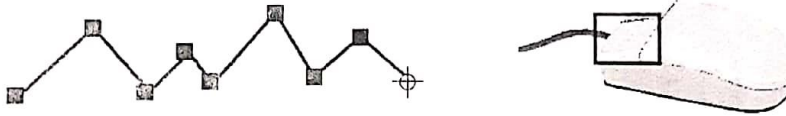
Working with sketches

- Shapes created with the sketch tools
- Activate Sketch menu by right clicking on sketch



Using the Sketch tool

- Left mouse button adds vertices or points

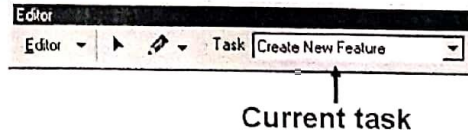


- Sketch tool options change depending on the feature class being edited

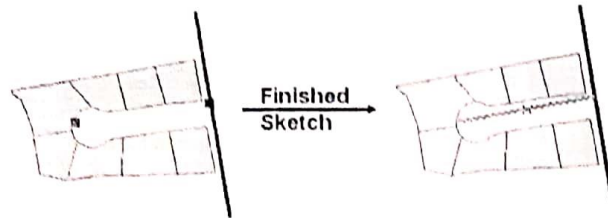
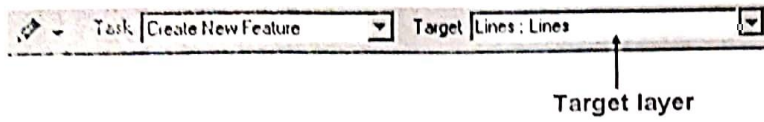


Edit tasks

- A sketch works with the current task
 - Create New Feature
 - Selection tasks
 - Extend/Trim Features
 - Mirror Features
 - Modify Feature
 - Reshape Feature
 - Cut Polygon Features
 - Auto Complete Polygon



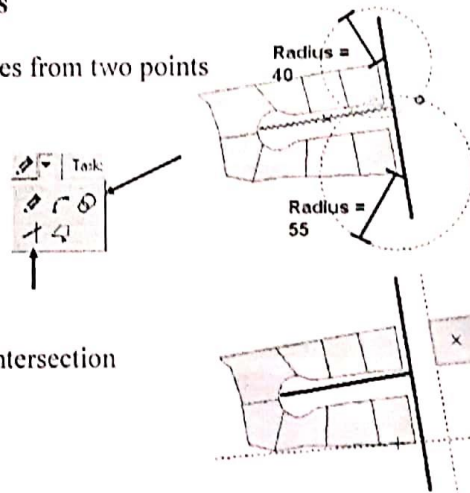
Create New Feature task



- Other operations that create new features
- Division, Buffer, Copy parallel, Paste

Distance and Intersection tools

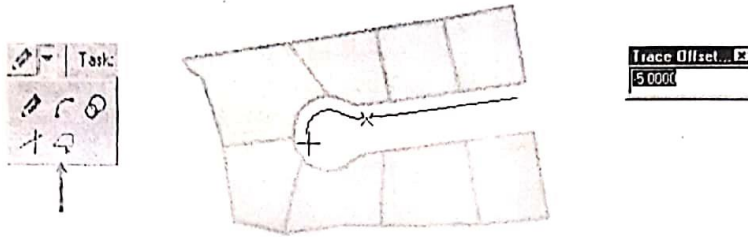
- Distance - Distance
- Adds a vertex at given distances from two points



- Intersection
- Adds a vertex at the implied intersection of two segments

Trace

- Trace along selected features
- Select features
- Click to start and stop the trace
- Press O to specify an offset

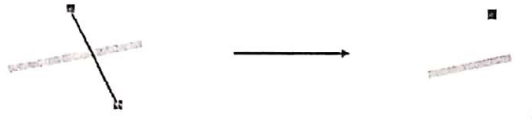


Extend/Trim Features task

- Extend feature to the sketch



- Trim features on the right side of the sketch



Editing attribute data for selected features

- Attribute dialog allows viewing and editing of selected feature attributes

Selected feature layer name

Click to highlight selected feature

Right-click to zoom to selected feature

primary attribute

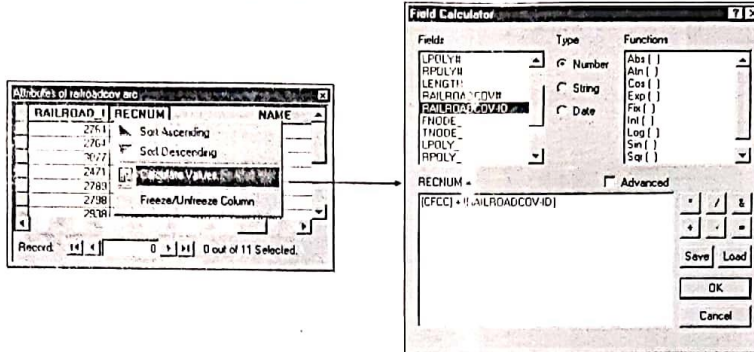
Property	Value
LENGTH	5772.428
RAILROAD_ID	5
RAILROAD_ID	6
FNODE_1	3
FNODE_1	13
LPOLY_1	0
RPOLY_1	0
RAILROAD_1	6
RAILROAD_1	2798
FECHUM	25430000
NAME	AT AND SF RAILROAD
RAILROAD	BOX

Attribute values

- Add, or copy/cut and paste values for single or multiple selected features

Editing tables using the Field Calculator

- Calculate field values for an open table
- Simple calculations or advanced functions
- Must start an edit session first



Exercise overview

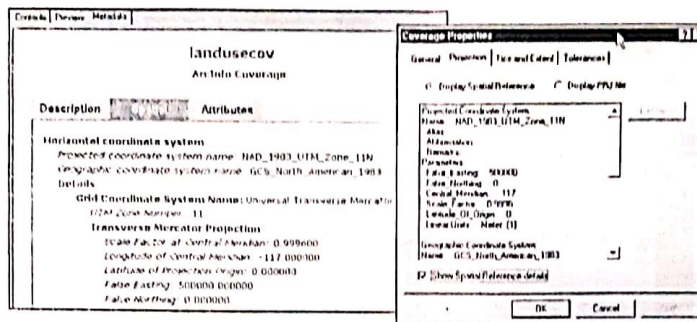
- **Exercise A**
 - Start an edit session
 - Edit parcels
- **Exercise B**
 - View and edit attributes
 - Use the Field Calculator

Storing projection information

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

Viewing projection information

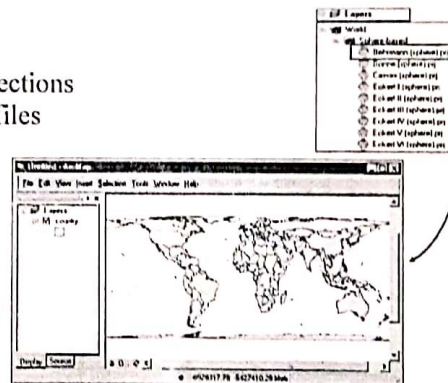
- Examine the feature class' metadata or properties



- Use the Define Projection Wizard to assign projection

ArcMap and projections

- Over 60 supported projections
- Pre-defined projection files
- On-the-fly projection



Changing projections

- Change the way features (or coordinates) are projected
- Use the Project Wizard in ArcToolbox

Exercise overview

- Experiment with data at different scales
- Experiment with data in different projections

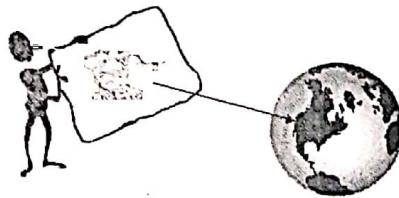
7- Working with georeferenced data

Overview

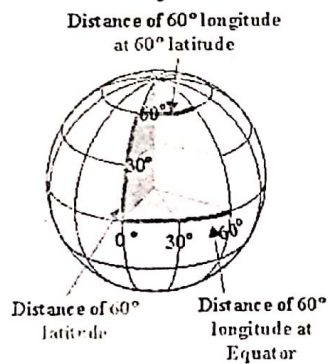
- Georeferencing
- Coordinate systems
- Datums
- Projections and distortion
- Projecting your data

What is georeferencing?

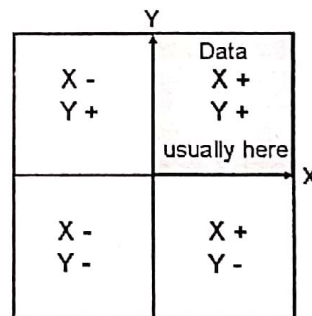
- Data is referenced to a location on the earth's surface
- Geographic coordinate systems
- Projected coordinate systems



Coordinate systems



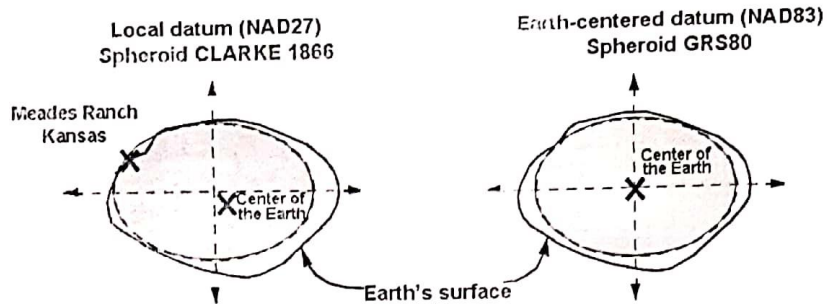
- Geographic coordinate system
- Latitude and longitude are not uniform across the earth's surface



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

Datums and datum conversion

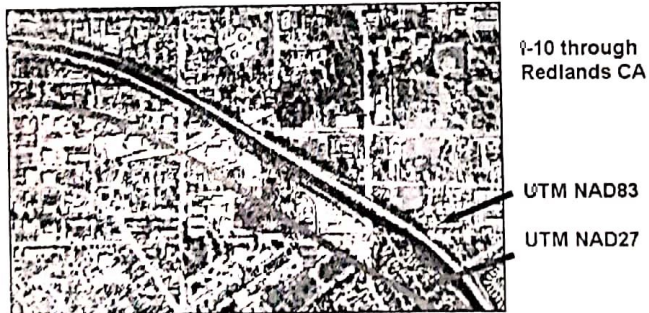
- A frame of reference for measuring locations on the surface of the earth



- Measurements are referenced to geodetic origin and ellipsoid used to represent 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



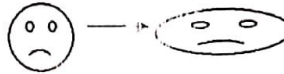
Map projections

- Map projections convert curved surface to flat surface

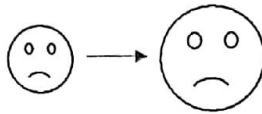
Projection distortion

- Map projections make geographers SADD

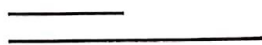
- Shape



- Area



- Distance



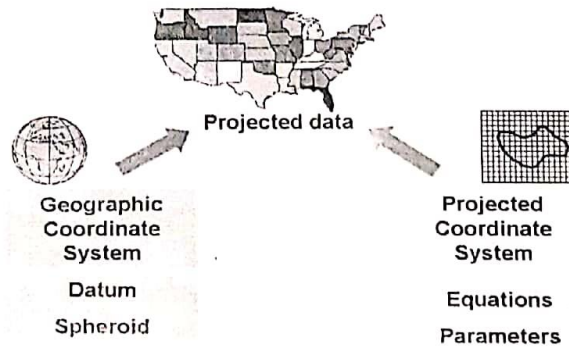
- Direction



Types of projections

- Generally classified by the spatial attribute they preserve
- *Conformal* maintains shape
 - Example - Lambert Conformal Conic
- *Equal-area* maintains area
 - Example - Albers Equal Area Conic
- *Equidistant* maintains distance
 - Example - Equidistant Conic
- *Direction* or *Azimuthal* maintains some directions
 - Example - Lambert Equal Area Azimuthal

Coordinate system components

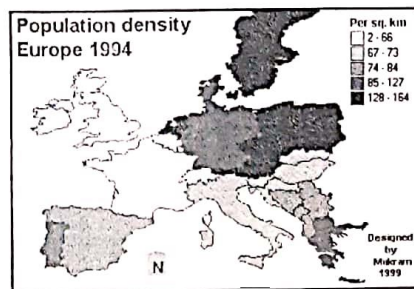


8- Presenting data

Overview

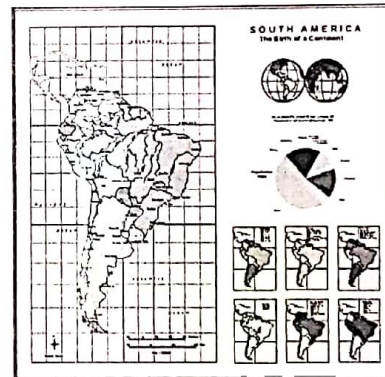
- Basic cartographic concepts
- Creating maps in ArcMap
- Printing and plotting maps

Output
from
query/analysis



Map and design objectives

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



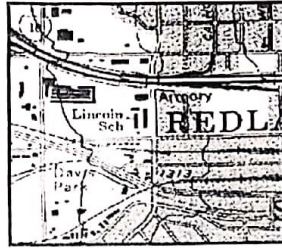
Factors controlling cartographic design

- Audience
- Objective
- Technical limits
- Reality
- Scale
- Mode of use
- Final design (Need to generalize?)

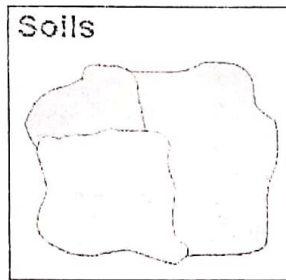


Types of maps

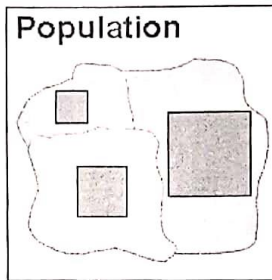
- **General maps**
 - Locational/Positional
 - Variety of features and uses



- **Thematic maps**
 - Structure of a distribution
 - Single attribute or relationship



Qualitative

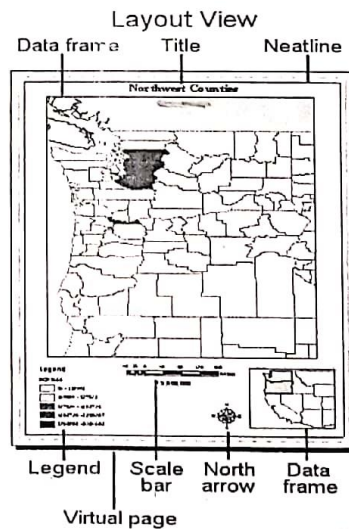


Quantitative

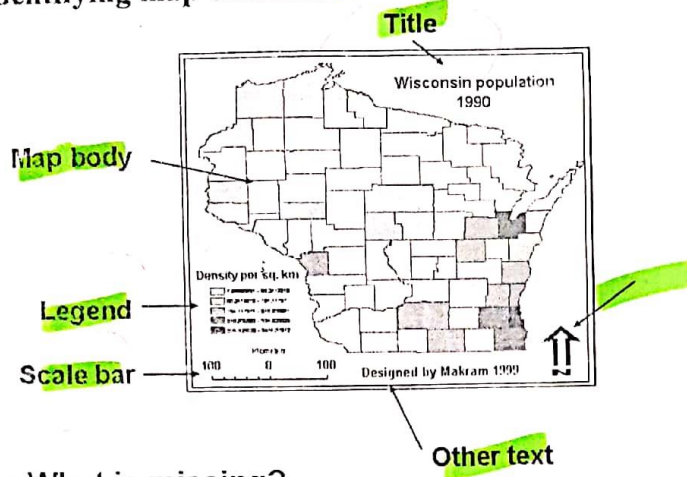
- Different objectives, different cartographic designs

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

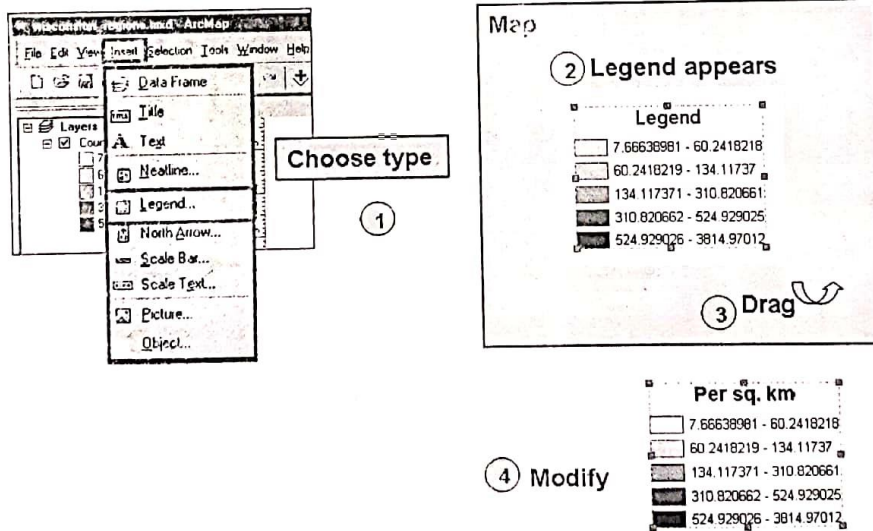


Identifying map elements



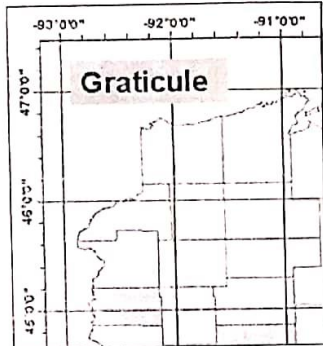
◆ What is missing?

Inserting map elements

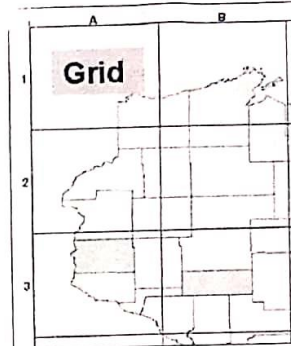


Incorporating a reference system

- Display reference positions on maps
- Available reference systems:



Latitude/Longitude, feet, meters, etc.

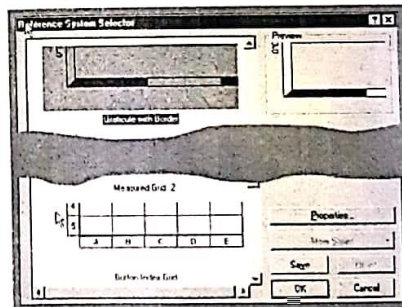
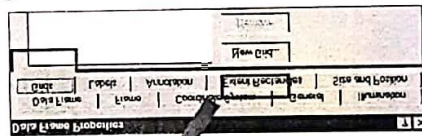


ABC/123, others

- Different graticule or grid types on the same map

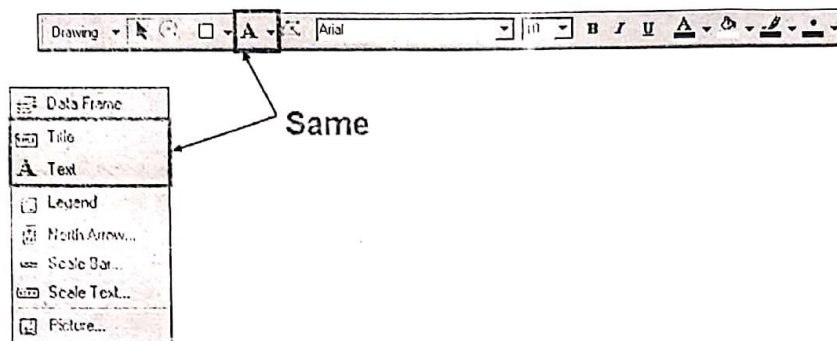
Graticules or button index grids

- Select grid style
- Change properties
 - Axes
 - Index
 - Labels
 - Lines



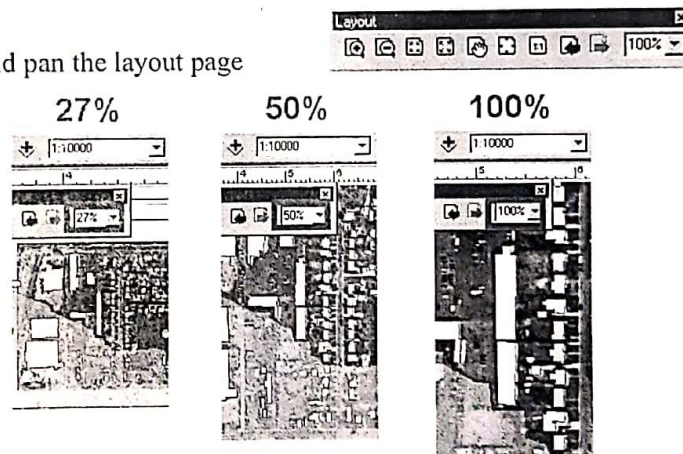
Inserting textual information

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



Layout tools

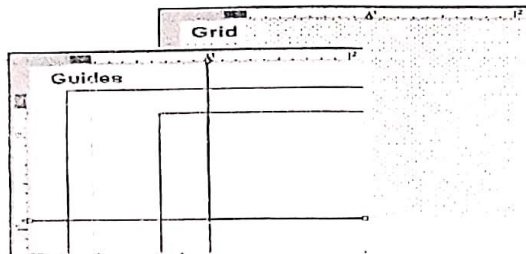
- Zoom and pan the layout page



- Additional layout settings from Tools > Options

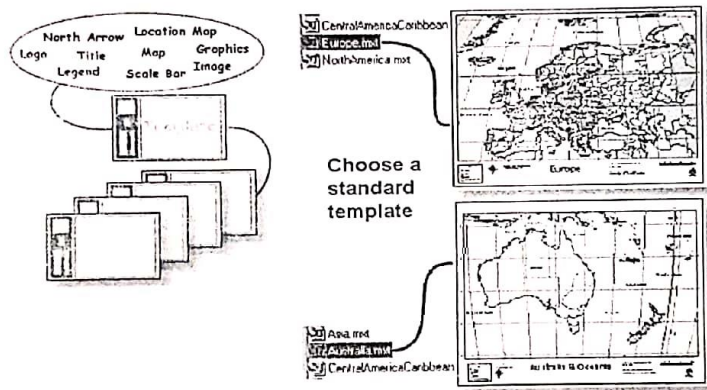
Grids and rulers

- 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

Exercise overview

- 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
- Visual balance