

GIS III: ArcMap Advanced

Rhonda Houser,
Academic Data Research Services Alliance (ADRSA),
Information Services
www.ku.edu/~adrsa

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Introduction

Work through hands-on exercises using ArcGIS modules Catalog, Map and Toolbox. Continue learning about data manipulation, selection and analysis tools. Create and edit your own data through digitizing features and adding tabular information. Practice linking external data and identifying and downloading data from the internet.

Objectives

- Export data (copy layers)
- Build queries (equations) to select features in a table
- Build queries to select/ show features in the view
- Create new shapefile in Catalog
- Specify a projection in Catalog for a new layer
- Add new fields/columns to a table
- Digitize new features
- Add information (attributes) about features to a table
- Calculate field values
- Edit .dbf files for import to ArcMap
- Bring XY coordinate data (tabular) into ArcMap
- Create a graph and add to layout

Prerequisites

[GIS I: ArcMap Introduction](#) and [GIS II: ArcMap Intermediate](#), or "equivalent skills."

Related Training Available

All workshops offered through Information Services are free to KU students, staff, faculty, and [approved affiliates](#). To learn more about or register for workshops, receive automatic announcements of upcoming workshops, and track workshops you registered for and attended, visit the KU Libraries Instruction Web site at www.lib.ku.edu/instruction. You can also check our online schedule at www.ku.edu/acs/schedule for a list of class offerings and availability. For further workshop related questions, please email training@ku.edu.

Definitions

Term	Definition
attribute table	spreadsheet-like organization of raster or vector tabular data in rows and columns.
dbase (dbf)	database file format (*.dbf), the file format produced by Dbase, a commercial relational database system; .dbf files comprise the tabular data file in GIS shapefiles and can be imported as tables into ArcGIS.
decimal degrees	latitude and longitude measurements expressed in decimal format; requires conversion from degrees, minutes, seconds to

	decimal degrees; 1 degree = 60 minutes and 1 minute = 60 seconds; also decimal degrees are the units for unprojected data or data in the 'Geographic' projection.
digitize	create digital data layers based on existing digital data or from hard copy information; heads-up digitizing involves creating features on the computer screen using some source of reference data; tablet digitizing involves using a digitizing tablet/ board connected to a computer, and is often used to convert paper map features to digital format; user traces over features of interest and x,y coordinates are recorded and stored as spatial data (ESRI).
field	a column in the attribute table of a raster or vector data file.
geodatabase	relational database that contains geographic information such as feature classes and tables; feature classes can be organized into feature datasets or exist independently; feature classes store geographic features represented as points, lines, or polygons, and their attributes; many objects in a geodatabase can be related to each other (www.esri.com).
latitude-longitude	spherical reference system used to measure locations on Earth's surface; latitude is measured from the equator, with positive values going north and negative values south; longitude is measured from the Prime Meridian (the longitude that runs through Greenwich, England), with positive values going east and negative values west (nasa.gov and esri.com).
map scale	dimensions of a map compared to the dimensions of the Earth, usually expressed as a ratio between a distance on the map and a distance on the Earth; a scale of 1:24,000 indicates that one unit of distance on the map equals 24,000 units on the ground.
merge	function of ArcMap that combines multiple features (records/polygons); attributes of final merged feature are based on one of the input features; separate data layers can also be merged in geoprocessing.
record	a row in the attribute table of a raster or vector data file, represents one feature.

Copy Workshop Data


- To copy workshop data from network drive to hard drive, click on Start (button) → Programs → ArcGIS → Data
- Click once on the folder called **gis2_3**
- Under **File and Folder Tasks**, choose '**Copy this folder**'
- Make sure **c:\ wutemp** is selected as file destination

- Click on '**Copy**'

Explore ArcMap

- Start **ArcMap**: Start menu → All Programs → ArcGIS → **ArcMap**
- Maximize the application (click on  middle button, top right corner)

Add Data

- Click on the 'Add Data' button  to bring data layers into ArcMap
- Navigate to: **c:\ wutemp\ gis2_3**
- To add the following vector layers ALL at once, hold down the control (Ctrl) key and click on (highlight) each layer:

CITIES.shp (major cities)

POLBNDA.shp (political boundaries)

WWF_ECO (ecological data from World Wildlife Federation)

- Click on 'Add'
- Turn on all layers (if not already)
- Change the cities layer properties so **capital cities appear as stars** (Symbology tab, Categories → Unique Values, set 'Field Value' to '**CAPITAL**', click on 'Add All Values'...)
- Change the WWF_ECO layer properties to display by habitat type (Symbology tab, Categories → Unique Values, set 'Field Value' to '**MHT_NAME**', click on 'Add All Values'...); MHT = Major Habitat Code
- Open the **boundary layer** attribute table (right-click on layer name)

How many records are in the table?

Make a copy of boundaries for ONLY South American countries

- Close table and double-click on **boundary layer**
- Click on the 'Definition Query' tab and then on the 'Query Builder' button to build an equation that **selects and displays only** South American countries (in both view and table)
- **Double-click** on field name (**NA3_DESCRI**) and **Single-click** on operator (=)
- Click 'Get Unique Values' button to display all possible field values
- **Double-click** on field value (**South America**) to complete the equation:
"NA3_DESCRI" = 'South America'
- Click OK and OK again
- Right-click on country layer title and choose **Data → Export Data**

- Export **all features** using the **same coordinate system** as the layer's source data and save in c:\wutemp as **c2.shp**
- Choose Yes to add the new layer
- Right-click to remove the original boundary layer (POLBND)
- Change the symbology of the new country boundaries in layer properties (right-click on layer name, choose 'Properties') so the layer is completely transparent except for boundary lines (Display tab)
- Open the **new countries layer** attribute table (right-click on layer name)

How many records are in the table?

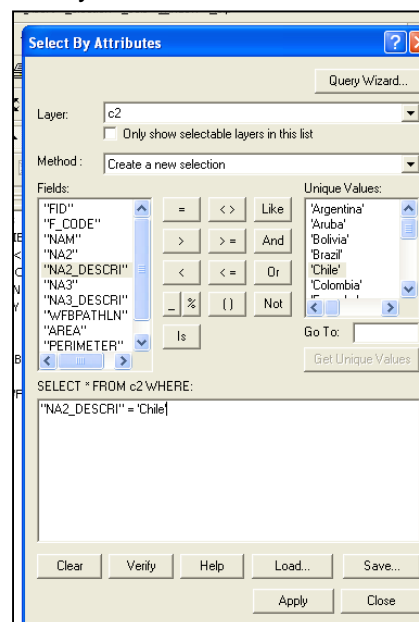
Save Data/View Settings as One File

- Choose File → Save As and save your work as a map document in **c:\wutemp**
- As you work, choose **File → Save** to save your changes

Highlight a country

We have multiple records/ polygons for many countries, and want only one feature for each.

- In the view, choose Selection → Select by Attributes
- Create a new selection from the (new) **countries layer**
- **Double-click** on field name (**NA2_DESCRI**) and **Single-click** on operator (=)
- Click '**Get Unique Values**' to see all possible values
- **Double-click** on field value (Chile) to complete the equation: "**NA2_DESCRI**" = '**Chile**'
- Click on 'Apply' and 'Close'
- Choose Selection → **Zoom to Selection**
- Zoom in close enough to see the numerous tiny polygons used to represent land areas for countries such as Chile, and at the northern and southern tips of the continent
- Open the **c2 layer** attribute table (right-click on layer name)
- Sort the field for country name (**NA2_DESCRI**) in ascending order; right-click on field heading



Merge records for the same country into one

- Make Editor toolbar visible: Choose **View → Toolbars → Editor**
- On Editor toolbar, choose **Start Editing**
- In the 'Start Editing' window, select the folder location of **c2** if given this option
- Choose this layer to edit and click **Start Editing**
- Specify 'Task' (Create New Feature) and 'Target' (**c2**) on the menu
- Click on the '**Selected**' button at bottom of the attribute table to show highlighted records

- To merge the selected polygons (Chile records), click on the **Editor menu** and choose **Merge...**
- In the **Merge** window, **click OK** to take the first record as the one to 'merge to'

All other records will be merged into this one; the new record will have these same values for all fields such as area, f_code, etc.

Remember ArcView has the 'Undo' function  on the menu.

- Repeat this process (steps listed below) for the following countries represented by many features, so that each country is represented by **one record** in the table: **Argentina, Brazil, Columbia, Falkland Islands..., Venezuela**
- If the merge process stalls or crashes the program or machine, restart ArcMap, open your MXD file, and try merging 5 or fewer records at a time.

Merge Process

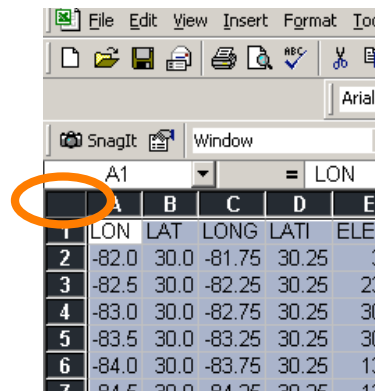
- In the attribute table, click on the '**All**' button to show all other records
- Click on 'Options' button, then **Select by Attributes**
- Use the 'Create a new selection' method
- **Double-click** on field name, **Single-click** on operator, **Double-click** on field value and build the equation: "**NA2_DESCRI**" = '**country name**'
- Click on 'Apply' and 'Close'
- In the view, choose **Selection → Zoom to Selected Features** to see the polygons that will share one record (or row)
- In the table, click on the '**Selected**' button at the bottom to show only highlighted records
- To merge the selected polygons, click on the **Editor menu** and choose **Merge...**
- When finished merging for these six countries, choose **Stop Editing** on Editor toolbar and Yes to **SAVE** your changes

Some countries now have 'multipart' features or one record/country that represented by multiple polygons.

Format tabular data in Excel

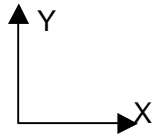
We will use data loaded on hard drive as a **.dbf** file (ArcGIS reads this format). The table contains temperature in degrees Celsius by month and XY coordinates (latitude/ longitude) for locations of data collection. However, columns are not wide enough for all cell values to be seen (ArcGIS will not recognize unless all values are readable).

- Right-click on the Start button and choose '**Explore**' to open Windows Explorer
- Navigate to c:\wutemp\gis2_3 and double-click on the file called **TMP.DBF** (if prompted choose to open the file in Excel)
- To highlight and format ALL columns at once in the table, click on the **gray box in the upper left corner** of the spreadsheet (click above the first cell and left of the 'A' column)



- Choose Format menu → Column → **Autofit Selection** so all columns are automatically widened to show all cell values
- Choose File menu → Save As and save your file in **c:\wutemp** as **temp.dbf** (Save in .dbf IV format)
- Say **Yes** to message that appears about saving in .dbf format
- Close Excel

Bring XY data into ArcMap as a spatial layer




Latitude and longitude are used to measure locations on Earth's surface. **Longitude lines**, or meridians of longitude **correspond to the 'X'** dimension and measure east/ west. **Latitude lines**, or parallels of latitude **correspond to the 'Y'** dimension and measure north/ south. Latitude and longitude are measured in degrees, minutes and seconds.

1 degree = 60 minutes and 1 minute = 60 seconds

ArcMap requires coordinates in **decimal degree** format, or degrees/ minutes/ seconds expressed as decimals. Thus 65° 45' 36" south latitude converts to -65.76 degrees latitude:

$$\begin{aligned} &-(65 \text{ degrees} + \\ & \quad (45 \text{ minutes} * (1 \text{ degree}/60 \text{ minutes})) + \\ & \quad (36 \text{ seconds} * (1 \text{ minute}/60 \text{ seconds}) * (1 \text{ degree}/60 \text{ minutes})) \end{aligned}$$

- In ArcMap, choose Tools → **Add XY Data**
- Click on the yellow folder and navigate to your **temp.dbf** file (c:\wutemp); select the file and click on 'Add'
- Make sure the dropdown field for 'X' or longitude is set to LON (the field in the temp.dbf file that contains longitude values)
- Make sure the field for 'Y' or latitude is set to LAT (the field in temp.dbf for latitude) and click OK
- You should now see a file in the table of contents called **temp Events**
- Zoom in close enough to discern **separate points**
- Use the 'Identify' tool  (click on tool then on a map feature) to get temperature information from the attribute table for various locations (points)
- Open the attribute to see the table you imported; this 'Event' layer is a **temporary display** in ArcMap based on latitude/longitude
- To save the file as a permanent layer (close table), right-click on layer name and choose **Data → Export Data**
- Export **all features** using the **same coordinate system** as the layer's source data and save in c:\wutemp as **temps.shp**
- Click OK
- Choose Yes to add your new shapefile

- Remove original .dbf table (right-click on event layer)
- Zoom out to see the entire layer

Create new field for average annual temperature

- Open the attribute table of the **temps shapefile**
- Click on 'Options' and 'Add Field' to add a new blank field
- Assign a **name (average)** and **type (floating)** to the field; floating = decimal
- Click OK
- Right-click on the new field heading and choose '**Calculate Values...**' (choose Yes to the warning message)
- Set the 'average' field **equal** to the average of the twelve months of temperature data (be sure to **include parenthesis** around the addition part):

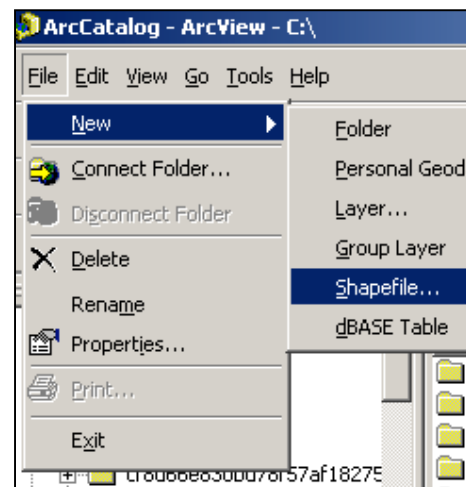
([APR]+[AUG]+[DEC]+[FEB]+[JAN]+[JUL]+[JUN]+[MAR]+[MAY]+[NOV]+[OCT]+[SEP]) / 12

- Click OK
- Change 'Layer Properties' to display the temperature layer by **average annual temperature** (Symbology tab, Quantities → Graduated Colors, set 'Field Value' to 'average')
- Display temperature data using **7 to 10 classes**
- Click OK



Digitize one or more country boundaries

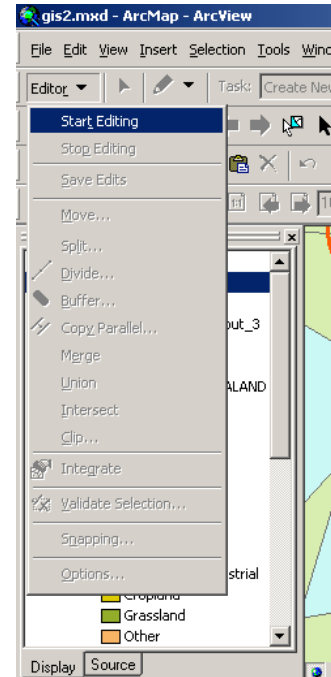
Create a new layer by tracing over old layer and cleaning up polygons

- Choose Tools → ArcCatalog
- Navigate to **c:\wutemp**
- Choose File → New → **Shapefile**
- Type in a name for your new file such as **countries3**
- Choose **Polygon** as feature type
- Click on the 'Edit' button to define a projection (coordinate system) for the new shapefile
- Choose 'Import' to use projection information from another layer (set projection of new layer to match existing one)
- Navigate to c:\wutemp and select **CITIES.shp**
- Click 'Add'
- Click 'OK' and 'OK' again
- Select new file and hold and drag to ArcMap (from 'Windows Explorer style' list)
- Close ArcCatalog



- In **ArcMap**, make sure new empty shapefile is at the top of table of contents
- Check 'Layer Properties' on the 'Source' tab to ensure projection information was written into the file
- Turn off ALL layers except for country boundaries and new shapefile
- On Editor toolbar, choose 'Start editing'
- In the 'Start Editing' window, select the folder location of **counties3** and click OK
- Choose your new countries file and click **Start Editing**
- Specify 'Task' (Create New Feature) and 'Target' (**counties3**) on the menu

- Click on Edit (pencil) tool 
- Use 'Zoom In' tool  to zoom the view in to the desired level while digitizing
- Click on map (and hold) to start digitizing
- Click once to create vertices
- Double-click (near first point) to close and finish a polygon



To delete a point while you digitize:

- Hold the mouse over the point to delete, right-click and choose 'Delete Vertex'

If you digitize off the map and need to move it:

- Move mouse to click on pan, zoom, or other navigational tool
- Click on the edit (pencil) tool to resume digitizing

To digitize a shape with a **free-flowing drawing** motion:

- Right-click in data frame and choose 'Streaming'
- Start digitizing
- Right-click again and choose 'Streaming' (uncheck) to turn off

Remember ArcView includes the 'Undo' function (backwards arrow on toolbar)!

- Choose Editor → **Save Edits** as you work to save your changes
- After you digitize boundaries for one or more countries, choose Editor → **Stop Editing** and choose Yes to save changes

Add blank fields to table


- Make sure the attribute table is open and you are **not in edit mode** and click on 'Options' and 'Add Field' to add a new blank field (column)
- Assign a **name (country)** and **type (text)** to the field
- Click OK
- Add another field for the **capital of each country** or countries that you digitized (name=capital, type=text)

Add field values

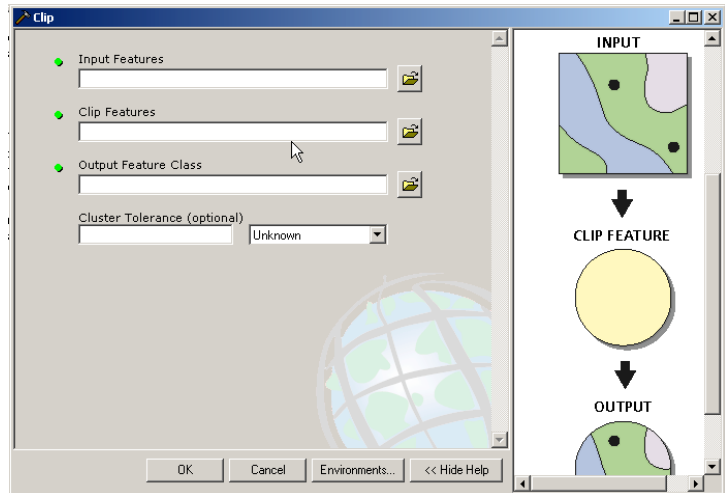
- Identify the capital city associated with each country (use Identify tool or other methods)
- To add field values (country/city names) in this column, choose **Start Editing** again on Editor toolbar
- In the 'Start Editing' window, select the folder location of new file
- Open the attribute table of your new layer (right-click on layer)
- In the table, place your cursor in a cell and type in the country or city name for each polygon
- Close the table
- On the Editor toolbar choose Editor → **Stop Editing** and choose Yes to save changes

Use one layer to extract data from another layer

Geoprocessing allows you to use one vector layer as a 'cookie-cutter' against another. Make a new temperature data layer that includes only data for your country (or countries)

- Click on the ArcToolbox button  to access geoprocessing functions

- Expand **Analysis Tools**, then **Extract** (click on plus sign), and double-click on **Clip**
- Designate **temps.shp** as input features
- Designate your new digitized shapefile as cookie-cutter layer (clip features)
- Save to c:\wutemp as **mytemps.shp** (output feature class) and click OK



Relate ecological characteristics to temperature

- Right-click on the **mytemps.shp** and choose **'Joins and Relates → Join'**
- Choose **'Join data from another layer based on spatial location'** to see what eco-regions occur at different temperatures/locations

- On Step 1. choose **WWF_ECO** as the layer to join to temperature data
- On Step 2. choose ‘...it falls inside...’
- Save to **c:\wutemp as temp_eco.shp**
- Click OK
- Add the new layer
- Find the additional data in the attribute table

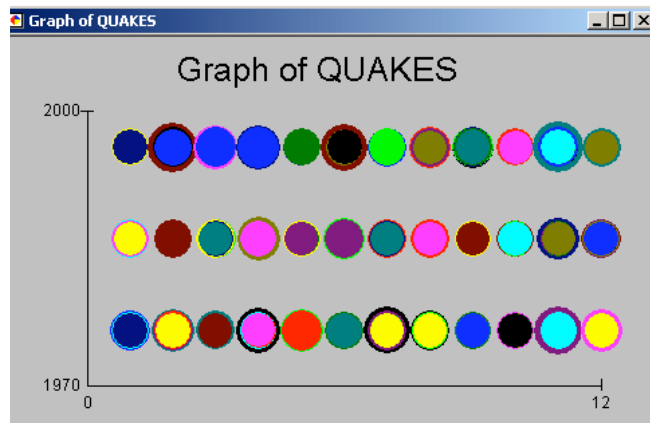
Create a graph

- Add the **Quakes** layer to your map document
- Open the Attribute table for the **Quakes** layer; c
- Click on the Options button, then ‘**Select by Attributes**’
- Construct this equation: (Select from Quakes Where):

$$\text{“Year”}=1976 \text{ OR “Year”}=1986 \text{ OR “Year”}=1996$$
- Click Apply button and close Attribute table

- In the Tools menu, choose **Graphs → Create**
- Click on icon for Graph Type **Bubble**, then click the Next button
- In the ‘Choose Layer’ box choose **Quakes**
- Select “Use selected set of features or records” and set:

Bubble size field---	MAG
X Axis ---	MO
Y Axis ---	YEAR
- Click Next button
- Deselect “Show Legend” and select “Show graph on layout”
- Click the Advanced Options button
- Click the Axis tab
- Y Primary is selected: click on User Defined (in the Scale section)
- In the Range section, set Max=2000 and Min=1970
- Click **Apply Now** button
- Select X (in order to work on the X axis)
- Select User Defined and set Max=12 and Min=0.
- Click **Apply Now**
- Click on the Background tab
- Graph title is selected; in Graph Window (section) choose a light background color, then click Apply Now
- Click OK and click Finish



Add Quakes table (data) to layout

- Turn off layers in the view
- Open the attribute table of **Quakes** layer and ensure same records are selected
- Click on the ‘Selected’ button at bottom to show only highlighted records
- Click on the Options button and choose ‘Add Table to Layout’

- Choose View → **Layout View** and make a layout showing your graph and the data used to build it

Bring in external population data

- Right-click on the **c2 layer** (copy) and choose '**Joins and Relates → Join**'
- Choose '**Join attributes from a table**' to add external (non-spatial) data to the table
- On Step 1. choose **NA2_DESCRI** as the join field
- On Step 2. navigate to: **c:\wutemp\gis2_3\isi_data_geodatabase**
- Select the tabular file called: **pop** (unemployment) and click on Add
- On Step 3. choose **Country** as the join field and click OK
- Right-click on the **c2 layer** and choose 'Open Attribute Table' to see additional data
- Label this layer based on population

Note: Please complete a workshop evaluation. An online evaluation is linked from the internet browser 'Favorites' menu.

For More Information

- **Source of GIS data:** Global GIS database: Digital Atlas of Central and South America (library CD), Call No. I 19.121:62-A, can be checked out.
- Download extensions (add specialized functions): <http://arcscripts.esri.com>

Getting Additional Help

Online Tutorials- Learn GIS at your own pace through virtual tutorials. ESRI online tutorials are available free to KU-affiliates and can be used by individuals or classes. See a list of courses at www.kars.ku.edu/user/vc_courses.shtml and email or call (data@ku.edu, mickey@ku.edu or 864-1238, 864-0454) to register for one or more.

GIS and Data Lab - 105 Anschutz Library

Hours (while KU is in session): Mon-Thurs **9AM-8PM**, Fri **9AM-5PM**, Sat/Sun **1PM-5PM**

Contact: data@ku.edu or 864-1238 (Rhonda Houser), 864-7777 (Mickey Waxman)

More information at www.lib.ku.edu/gis

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