

Lecture 11: Introduction to Geographic Analysis I

The true power of GIS is its ability not only to display geographic entities but its ability to facilitate geographic analysis. This is a required component of your final project; there will be more information about the final project provided next week.

Analysis transforms geographic data into information that is created in response to a question (or hypothesis). Let's make a brief list of some biological observations dependant on spatial relationships:

- Abundance of biomass in relation to sewage outflow.
- Viable trees downwind of a sulfur burning coal plant.
- Relationship of vegetation with water features like streams and springs

This is what you need to do for your final project - you need to identify a research question or hypothesis that you can explore through spatial analysis. There are several types of GIS analysis, which can be basically organized as:

- (1) Basic delineation of geographic entities
Finding simple patterns in your data
- (2) Mapping spatial relationships between multiple entities
Delineating the occurrence of features inside an area
- (3) Mapping values over an areal basis (Thematic Mapping)
Using quantities to find patterns in your data
- (4) Mapping spatial trends in detail
Discovering whether an activity occurs near a feature
- (5) Mapping temporal trends in detail
Using change over time to find patterns in your data

Topic 1: Basic delineation of geographic entities - Whether you realize it or not you have been engaged in spatial analysis throughout this semester. We have spent a good deal of effort mapping the location of geographic entities.

To effectively delineate geographic entities, you must learn how to change the symbology of your data. We have barely sketched the surface and you need to explore all the different options for symbolizing both vector and raster data - **I strongly suggest that you look at some data from our previous assignment and explore all the options for how you can alter data**

symbology. I think it is useful to always remember that when you make a map you are telling a story and the better designed your map the more impact your story will have. With vector data you have numerous options for how you can symbolize geographic data. You can alter the color, symbol type, size of symbol, and annotation associated with vector data. Additionally, with vector data you can use classification schemes to depict this data based on any of its attributes. Conversely, there are limited options for changing the symbology of raster data; basically, only altering the color ramp associated with raster data layer. Finally, the power of basic visualization of geographic entities is enhanced with the overlay of multiple layers that add greater meaning to the story that your map is conveying.

In ArcGIS Pro there are several functions that you have already used that can allow you to better visualize a geographic dataset. To find simple patterns in your data commonly all you need to do is to select or extract specific entities in a layer. The two most common methods to select data are either Select by Location or Select by Attribute that you find in the **Geoprocessing tools in ArcGIS Pro**

Remember if you Select by Location typically your vector features (points, lines, or polygons) can be selected to occur in relationship with an area (polygon) of another layer (Figure 1). The selected features will be completely within or partially within the source layer. If you click on the **Relationship options**, you will see that there are numerous options.

**NOTE THAT ACTIVITIES 1 to 4 ARE EMBEDDED IN THIS LECTURE
QUIZ #6 IS DUE TUESDAY NOVEMBER 6.**

Activity 1: Create a new blank project in ArcGIS Pro and save it as Quiz6 in your GIS folder. Insert a new Map. From Exercise_1 folder, load the Major Rivers layer and then the Texas_Counties. Select Bexar County using the Select tool or by selecting the record in the attribute table. Click on Select By Location button in the Map tab. In the Select Layer by Location tool, in the Input Feature Layer choose the Major Rivers layer. For Relationship, select Completely within. Finally, in the Selecting Features, select Texas Counties. Click Run.

Q: How many rivers are within this layer _____

Q: How many rivers are completely contained
within the source layer feature _____

You can export the current selection to a new layer. Right click on the Major Rivers layer and go down to the Data option. Now click on Export Features. In the Copy Features tool on the right, select Major Rivers as Input Features. In the Output Features Class option, click the browse button (folder icon) and browse to the Exercise_1 folder. Type Major_Rivers_selection as the name. Click Save and then click Run. After the tool finishes running, on the Selection section of the Map tab click the Clear button. Deselect the original Major Rivers layer on the Contents pane. Notice the new layer does not include those Major Rivers segments that touch other counties that surround Bexar county. Select again the Major Rivers layer on the Contents pane to show it again on the map. Save your map as Quiz6 in your GIS_Data folder but do not close it. We will continue using it.

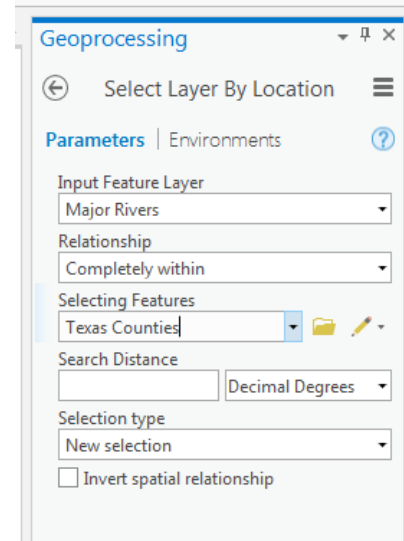


Figure 1. Select by Location Tool

Selection by attributes can be based on either Set Algebra or Boolean Algebra. Set algebra uses the mathematical operators (+, -, X, /, <, >) that selects features in a layer based on a specified operation (**Figure 2**).

Activity 2: Now from the Selection section in the Map tab click the Select By Attribute button. In the Select Layer By Attribute tool, select Major Rivers as the Layer. Leave the Selection type as New selection. Click the Add Clause button. In the Clause window that opens, select SHAPE_len in the first field, then select “is Greater Than” in the second field. Finally, type 2 in the last empty field. Click Run. Remember the easiest way to see the selection results is to open the attribute table.

How many rivers are selected? _____

Boolean algebra uses the operations Like, And, Or, Not to refine the selection of features from a layer. Now back in the Select Layer By Attribute tool, our first selection criteria is still present. Click the Add Clause button again. In the second clause window, select And in the first field, “RCH_CODE” in the second field, “is Equal to in the second field, and finally type 12010004000686. Click Run.

Now how many are selected?_____

NOTE: You can also enter the search criteria yourself in SQL code. SQL is used to query databases. In this case you would have had to click on the SQL button (Enter screenshot) and type the following in the Expression window:

“SHAPE_len” > 2 AND “RCH_CODE” = ‘12010004000686’

The RCH_CODE is in single quotes because the field is classified as text, not a numerical field.

Click the Clear button in the Map tab. Save your map.

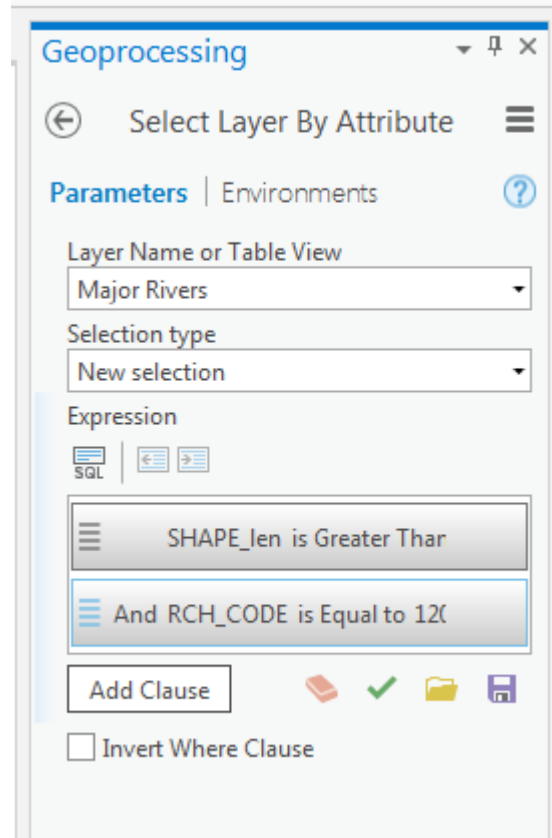


Figure 2. Select by Attribute Tool

Topic 2: Mapping spatial relationships between multiple entities - An obvious capability of a GIS is the ability to overlay multiple types of features. A number of geometric relationships result when vector layers are overlain. Advanced spatial operations can be grouped into two groups; selection by analytic and location overlay. Generally, needed for locational overlay is at least one polygonal feature.

Spatial Analyst Tools allow one to perform mathematical operations between two or more raster layers. If one of your layers is vector you can perform a vector to raster conversion (discussed in lecture 7) and still apply mathematical operations. This functionality is very useful to conduct site feasibility or risk analysis and can be used to answer both complex and complex spatial hypotheses. Next week we will explore in detail what you can do with raster layers

Analysis Tools include a group of six functions. This include the Dissolve, Merge, Clip, Intersect, Union, and Buffer. We will discuss the Buffer tool in the next lecture so we will focus on the Dissolve, Merge, Clip, Intersect, and Union tools.

A basic function that helps in visualization of data is the **dissolve tool**. The dissolve function aggregates items that have the same value of a particular attribute (Figure 3) We will use this function in the upcoming Assignment #5.

Sometimes you may have the same type of entity in two different files. An example is a soil layer for two different counties. In this instance you may want to **merge or append** tool so this data is output to a single file (Figure 4).

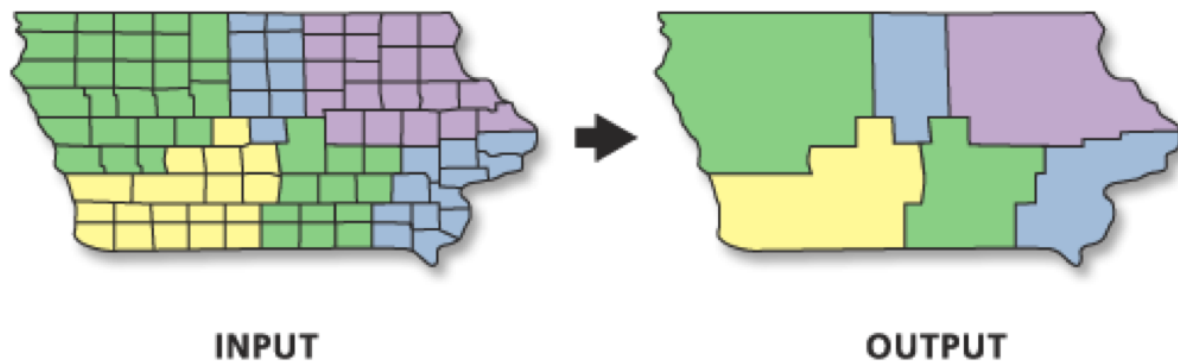


Figure 3 An example of how the dissolve function works in ArcGIS Pro.

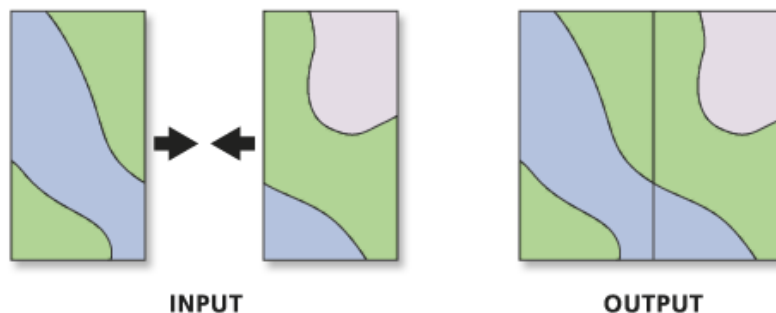


Figure 4 An Example of the Merge geoprocessing tool

Activity 3: Turn off all layers except Texas_Counties and, if necessary, zoom to the layer's extent. We want to form a single polygon representing all of Texas from the Texas_Counties layer. Remember from the very first exercise we need a common field on which to dissolve the layer. Open the attribute table of the Texas Counties, and if necessary dock it at the bottom of the application. Inspect the table and notice there is no common field to all rows. We need to add a field. On top the table there are several buttons. Click on the 'Add' button. A new window will open for you to enter the new field information. Type STATEFP on the Field Name column.

Press the Tab key on your keyboard to move to the Data Type column and a menu will appear. Select Text from the options. At the top of the application, a new tab automatically appeared. Click on the Save button and close the window where you created the new field. Now we have a new field on attribute table of the Texas Counties layer but it's empty. Right click on the name of this new field and select Calculate field from the pop up menu. The Calculate Field geoprocessing tool will open with pre-populated fields for you. All you have to do is type 'TX', including the single quotes, in the "STATEFP=" field. Click Run. The field's value will be populated with TX for all rows in the attribute table.

Click the back arrow on the Calculate Field tool to return to the Geoprocessing pane. Type dissolve in the Find Tools box. From the results, click on the Dissolve (Data Management) tool. In the tool window choose Texas_Counties as your input features. In the output Feature Class press the browser button and save the output in the same folder as Texas_Counties and name it Counties_dissolve and click save. We want to dissolve features based on a common field so that all features that share the same value become a single feature. In the Dissolve_field(s) section, click the drop down arrow and choose the field that you previously created. Click Run in the dissolve tool. It might take a minute for the tool to finish running and the result will be automatically added to the map. Since we chose to dissolve based on the state code, all counties got dissolved into a single polygon for the state of Texas. Open the attribute table of the Counties_dissolve layer and notice only one attribute remains. Save your map. From the Share tab, print your map and attach it to the quiz 6 sheet that you will turn in.

Another geoprocessing tool is the **Clip tool** (Figure 5). In this tool you select an input layer and target layer that will be used as a Cookie cutter extracting data only within the spatial extent of the target layer.

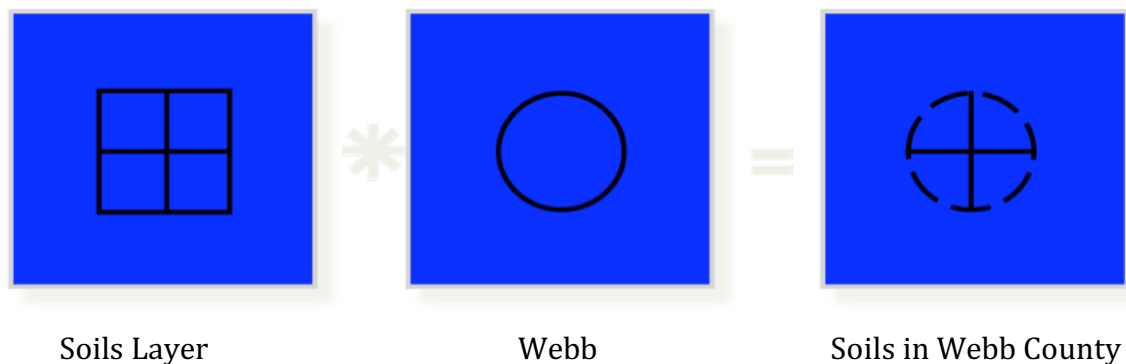


Figure 5. Illustration of the Clip tool.

Activity 4: Add to the map the webb_census layer from assignment_4 folder. If you get any warning windows, click OK. Right-click this layer and open the attribute table. Select the row of the census tract named 17.11 and zoom to it.

Go to the TNRIS website and download the NRCS Soils simplified layer for Webb County. Save it in the Quiz6 folder in your GIS_Exercises folder. Be patient as it might take a few minutes to download. Unzip it, and add this layer (nrsc-soils-webb_479 layer) to your map document. Make sure you click the refresh button in the Add Data window if the soils layer does not appear.

Click the back arrow in the Dissolve tool and search for the Clip (Analysis Tool) and click on it. Select the nrsc-soils-webb_479 layer as the Input Features and webb_census as the Clip Features. Click the Browse button for the Output Feature Class and browse to the Exercise_4 folder and name the output North_Laredo_Soils_Clip. Click save. Click Run in the Clip tool window. Turn off the Soils layer and leave the North_Laredo_Soils_Clip and webb_census visible. Open the attribute table of the clipped soils layer.

How many soil polygons are in this new layer? _____

Notice in your map that even though we used the webb_census layer as the “cookie cutter,” the geoprocessing tool utilized specifically the outline of census tract selected on the map. This is because when individual features are selected in layers used in geoprocessing operations, only these will be used and not the entire feature class.

Another geoprocessing tool is the **intersect tool** (Figure 6). This tool is used when you want to overlay a layer with the polygons in another layer so that the output layer. An advantage of the intersect tool is that the output layer has the combined attribute data of the features in the two inputs. Additionally, the output layer only contains features that fall within the spatial extent of the overlay polygons.

A final processing tool that is like intersect is the **Union tool** (Figure 7). You use the Union tool when you want to overlay two polygon layers so that the output layer. A union retains the all the information from both layers. It has the combined attribute data of the polygons in the two inputs, and contains all the polygons from the inputs, whether or not they overlap.

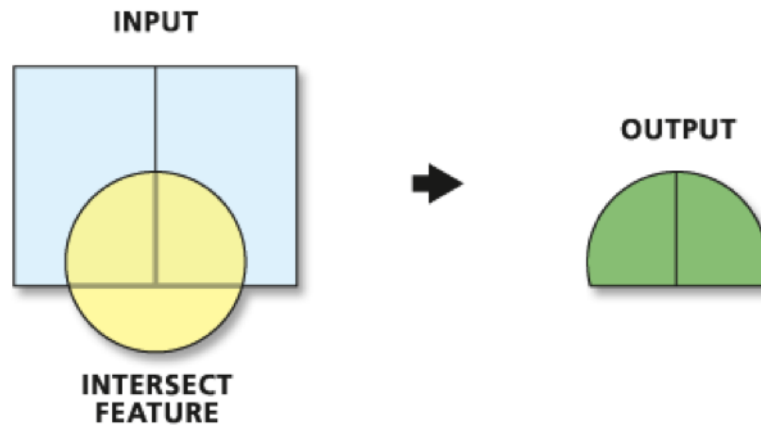


Figure 6. Illustration of the Intersect tool.

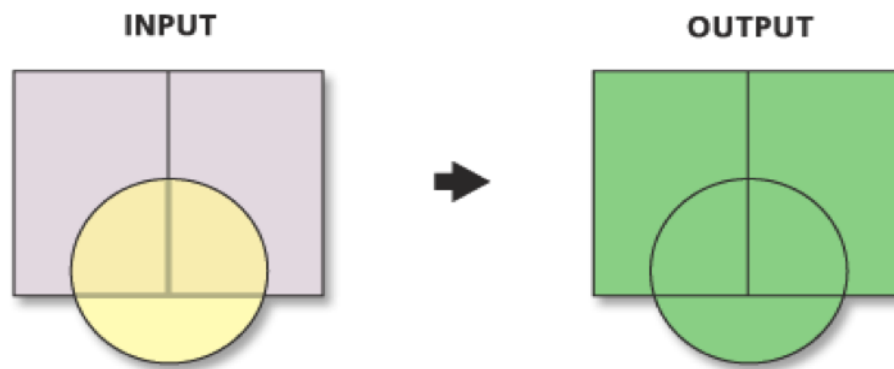


Figure 7. Illustration of the Union tool.

Commonly, you may want to use several functions numerous times to complete a task. In ArcGIS Model Builder allows you to automate multiple functions together in one process. Figure 8 illustrates a simple model that opens two input data sets and using a geoprocessing tool creates a new output data set. This GUI is the front end for Python scripts that are used to execute the model.

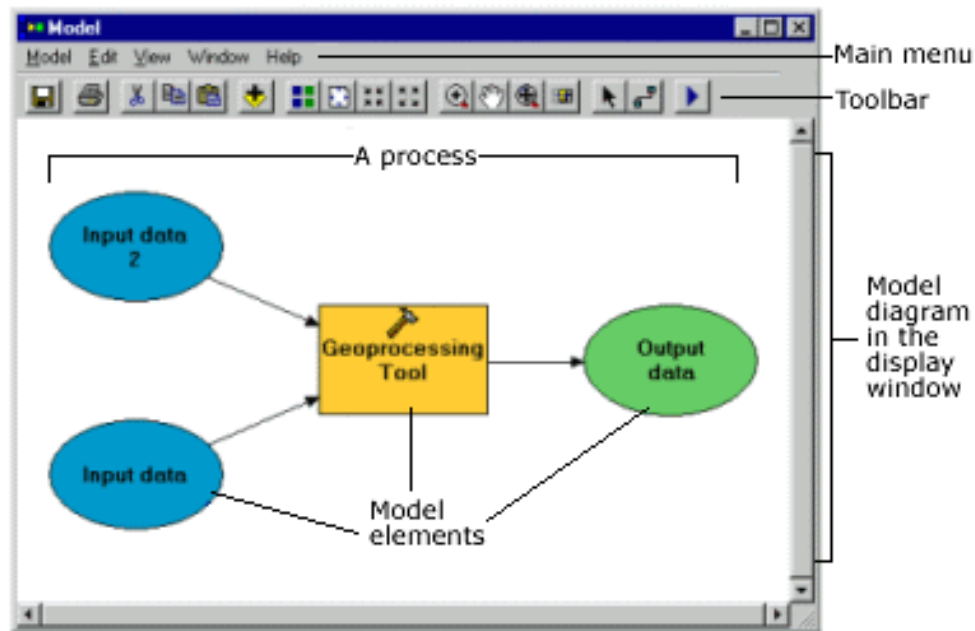


Figure 8. A diagram that illustrates the data sets and functions of a simple model.

Readings

GIS Commons webpage; Chapters 5.

Campbell, J and Shin, M., 2011, Essentials of Geographic Information Systems. Chp. 7.1, 7.2.

Terms

Select by Location
Merge Tool

Select by Attribute
Intersect Tool

Dissolve Tool
Union Tool

Clip Tool
Model Builder

Concepts

Know the five different types of GIS analysis you can conduct with a dataset

What is the difference between an analytic and locational overlay.

Know about the different tools that can facilitate a locational overlay.

Understand how model builder could be useful when you have numerous, repetitive operations to complete

GIS Quiz #6

Name: _____

Activity 1:

1: How many rivers are within this layer _____

2: How many rivers are completely contained within the source layer feature _____

Activity 2:

3. How many rivers are selected? _____

4. Now how many are selected? - _____

Activity 3:

5. Print out an attach map from this activity

Activity 4:

6. How many soil polygons are in this new layer? _____

Question

7. In your own words describe how the following geoprocessing tools differ from one another.

Dissolve:

Union:

Intersect:

Clip: