GST 101: Introduction to Geospatial Technology Lab Series

Lab 7: Basic Geospatial Analysis Techniques

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Introduction

This lab is part of a series of lab exercises designed through a grant initiative by the National Information, Security & Geospatial Technologies Consortium (NISGTC), funded by the United States Department of Labor in partnership with the Department of Education under the Trade Adjustment Assistance Community College and Career Training Grant Program (TAACCCT).

In this lab, the student will explore a small set of analysis tools available in ArcMap 10.1. The student will prepare data and a map for surveyors visiting National Geodetic Survey Monuments in Austin, Texas. The surveyors wish to have a map showing monuments close to a hotel inside Austin city limits.

Your instructor may require that you provide screen captures and/or exported files. Please check with your instructor for requirements specific to your class.

This lab includes the following tasks:

1. Data Preparation
2. Querying and Extracting Subsets of Data
3. Buffering and Clipping Data
4. Preparing a Map

Objective: Use Basic Spatial Analysis Techniques to Solve a Problem

Conducting effective spatial analysis in a GIS does not require the use of extremely complex algorithms and methods. By combining multiple simple spatial analysis operations, you can answer many questions and provide useful results. Determining the order in which these simple spatial analysis operations are executed and combined with other data sets is often the hardest part of conducting spatial analysis. Additionally, data is rarely available in exactly the format and subset that you require. A part of almost all GIS projects is simply obtaining and preparing the data for use.

In this lab, the student will utilize four basic geospatial analysis techniques: selection, buffer, clip, and dissolve.

- **Selection** uses set algebra and Boolean algebra to select records of interest.
- **Buffer** is the definition of a region that is less than or equal to a distance from one or more features.
- **Clip** defines the areas for which features will be output based on a 'clipping' polygon.
- **Dissolve** combines similar features within a data layer based on an attribute.

Topology

add diagram here

Lab Settings

Required Virtual Machines and Applications

Windows Machine User Account	Train
Windows Machine User Password	Train1ng$

1 Data Preparation

In this task, you will obtain GIS data for this lab by visiting the National Geodetic Survey (NGS) website and the Texas Natural Resource Information System (TNRIS). Both of these websites provide free geospatial information covering the United States and Texas respectively.

Copies of this data have already been obtained and are available in the lab folder if you are unable to access the NGS or TNRIS websites. If you do not wish to obtain the data yourself, you may skip to Task 2.

1. Log in to the computer using the settings provided in the Lab Settings section of this lab.
2. Copy the *Lab 7* folder from the *Shared_Drive**GST101* to the *GST 101* folder you created on the C: drive

1.1 Obtain Shapefiles of NGS Monuments

We first want to go to the National Geodetic Survey (NGS) website and download the shapefiles of the monuments in the county we are interested in. We will learn how to get the shapefiles for Travis County (Austin), Texas.

1. In a web browser (on your virtual machine or your local computer), navigate to http://www.ngs.noaa.gov
2. Click on the **Survey Mark Datasheets** link in the column on the left-hand side of the page.
3. Click the **Shapefiles** button.
4. Scroll down and use the **COUNTY** retrieval with the following values:
    a. State = **Texas** (Click on Get County List for the next value)
    b. County = **Travis**
    c. Data Type = **Any Vertical Control**
    d. Stability Required = **Any Stability**
    e. Compression Options = **Send me all the Shapefiles compressed into one ZIP file…**
    f. File Prefix = **Travis**

    (Leave all other options as the default values)
5. At this point, you would normally click Get Shapefile to save a ZIP file to your computer. You would then be able to extract the files and use them in ArcGIS programs. Instead, open up your *Lab 7* folder and view the Travis County files that have already been downloaded to your folder.

1.2 Obtain the Cities and Major Highways for Texas

Since we want to provide a general reference map to the surveyors, it would be beneficial to show roads and cities on the maps. We will learn how to download the data from the Texas Natural Resource Information System (TNRIS).

1. In a web browser (on the virtual machine or local computer), navigate to http://www.tnris.state.tx.us
2. Click the **Maps and Data** link at the top of the page.
3. Click the **Get Digital Data** tab.
4. In the **Search By** option dropdown box, choose **Travis** for the county and then click **Go**.
5. Below the map that appears, click the **StratMap 2006** and **Census TIGER File** links under the Transportation heading. Normally, you would now download and extract the files to your lab folder. However, these files are already in your lab folder. Open your *Lab 7* folder and make sure the files have been downloaded correctly.

2 Querying and Extracting Subsets of Data

Now that we have collected some data, you will need to add it to a blank map document in ArcMap. Take a moment to familiarize yourself with the data and what information it contains. Looks like you have a lot of information! As with any project, we are going to have to do some data preparation to make it useful in this analysis project.

2.1 Preparing the TIGER Census Data

1. Open **ArcMap** to a **blank document**.
2. Click the **Add Data** button. Add the following data sets to the map:
   a. **Add** the **Travis Point Shapefile** (*Travis.shp*) downloaded from the NGS website.
   b. **Add** the **Stratmap Roads Shapefile** (*x453_v2.shp)* downloaded from the TNRIS website.
      i. Dismiss the Geographic Coordinate Systems Warning dialog.
   c. **Add** the **Urban Areas and Census Tract Shapefiles** (*tiger\TGR48453\TGR48453all.shp* and *tiger\TGR48453\TGR48453urb00.shp)* downloaded from the TNRIS website.
      i. Dismiss the Unknown Spatial Reference Warning dialog.
3. Before you perform any spatial analysis, it is important that all datasets have their coordinate systems defined. The TIGER Census files did not have their coordinate systems set (hence the warning on step 2.c.i). We will now define the coordinate system.
   a. Right-click the **TGR48453all** shapefile in the Table of Contents (TOC), then choose **Properties**.
   b. Click the **Source** tab. Look at the Coordinate System. It should say "<Undefined>". Currently, ArcMap is "guessing" correctly which coordinate system this data set is in, and, therefore, it is displayed in the correct location. However, once we start performing spatial analysis, not having a defined coordinate system may produce errors in our analysis. To fix this problem…
      i. Close the properties window.
      ii. Open ArcToolbox within ArcMap  , and expand **Data Management Tools →Projection and Transformations**.
      iii. Open the **Define Projection** tool.
      iv. Set the input to **TGR48453all**.
      v. Set the coordinate system to: **NAD 1983,** which can be found under Geographic Coordinate Systems → North America.
      vi. **Click OK** to run the tool.
      vii. **Repeat** the above steps (i thru vi) **for TGR48453urb00**. Close ArcToolbox.

4. For the map, we want a polygon that represents the county boundaries. The TGR48453all Census tracts collectively define the county, so we will use the dissolve spatial analysis technique to create a county boundary from the Census tracts.
   a. On the main menu bar, **Click Geoprocessing → Dissolve**.
   b. For the **Input Features**, press the drop-down arrow and choose **TGR48453all**.
   c. For the output, set the output file name to **Travis_County.shp** and store it in your lab directory.
   d. Leave all other options as their default values.
   e. **Click OK** to run the Dissolve operation.
   f. **Remove** the **TGR48453all** layer from the map by **right-clicking** on it in the TOC and choosing **Remove**.
   g. If the Travis_County layer is not the bottom layer in the TOC, drag it to the bottom of the list in the TOC so it draws underneath all of the other layers.
   h. Choose an appropriate color and outline for the Travis County layer.

2.2 Select and Symbolize the Monuments

We will limit our selection of monuments to include only the order and class that we are interested in. Next, we will symbolize the monuments.

1. Double-click the **monuments** layer (Travis) in the TOC to open the properties window.
2. Click the **Definition Query** tab. A definition query will only display the selected records on the map.
3. Click the **Query Builder** button to launch the query builder.
4. We will build a query to only display the monuments that meet the following requirements:
   a. Elevation Order 1
   b. Last recovered on or after 1995
   c. Satellite Observations were used for monument coordinate determination.
   d. a, b, and c are stored in:
      i. ELEV_ORDER
      ii. LAST_RECV
      iii. SAT_USE

5. Build the definition query using the above requirements. Your query should look like the query in Figure 1. Click **OK**, then Click **OK** again to run the Definition Query.

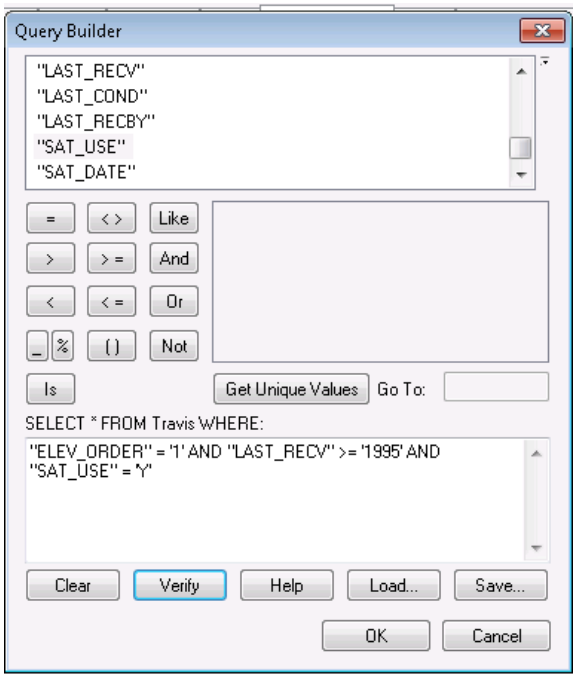

Figure 1: Monument Query

6. If you created the correct definition query, there will be **15 records** left in the ***attribute table*** (Be sure to check the table as two of the points on the map overlap).

With the required monuments selected, we will now symbolize them.

7. **Open** the **Properties** for the **Monuments** layer again.
8. **Click** the **Symbology tab**.
9. **Select Categories → Unique values, many fields** classification type.
   a. Select **ELEV_ORDER** as the first field.
   b. Select **ELEV_CLASS** as the second field.
   c. Click **Add All Values** to add all unique value combinations found in the attribute table.
   d. Uncheck **<all other values>.**
   e. Double-click on each symbol to change the color, shape, and size to something meaningful.
   f. Click OK to set the symbology.

3 Buffering and Clipping Data

Now that we have the county boundary and monument selected and symbolized, we will now show only the Austin urban area.

1. **Click Selection → Select by Attributes** from the main menu bar. Select just the Austin urban area by setting the following options:
   a. Layer: **TGR48453urb00**
   b. Method: **Create a new selection**
   c. Use the tools to create a query that will just select **Austin, TX**.
   d. Click **Apply** to show the selection. Figure 2 shows the correct selection.

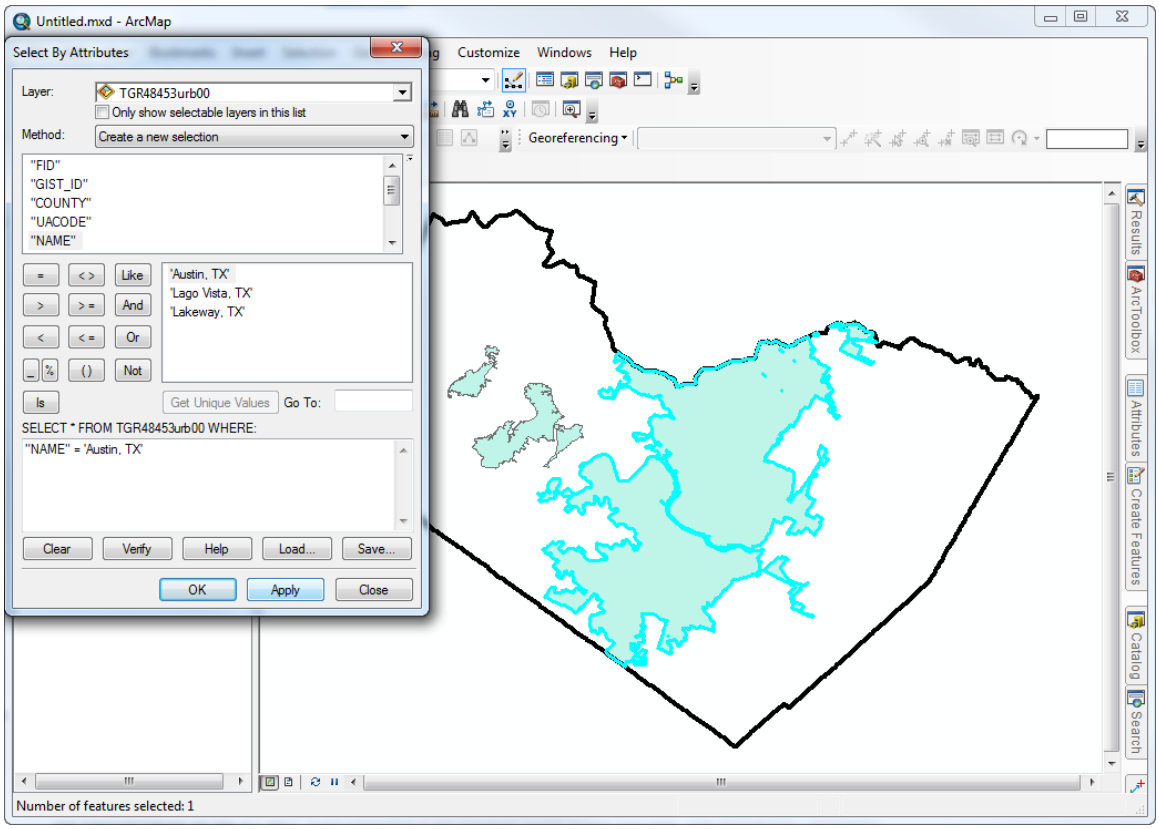

Figure 2: Austin Urban Area Selection

2. With the correct selection, **Click OK** to close the Select by Attributes window. We will now make a new, temporary selection layer that will just show Austin.
   a. **Right-click** on the **TGR48453urb00** layer in the TOC.
   b. **Click Selection → Create Layer from Selected Features**.
   c. **Remove** the original **TGR48453urb00** layer from the TOC.
   d. **Rename** the newly created selection layer by opening its **Properties** and changing the Layer Name on the General tab.
   e. **Symbolize** the selection layer to something of your liking.

With the Austin urban area isolated, we will now buffer Austin so we can choose monuments that are either inside, or close to the city limits of the city.

3. **Open ArcToolbox**.
4. **Expand Analysis Tools → Proximity** and then **open the Buffer tool**.
5. Set the following options to buffer Austin by 1 mile:
   a. Set **Input Features** to the **Selection Layer** (that you renamed in the previous step.
   b. Set the **Output Feature Class** to **Buffered_Austin_Urban_Area.shp** and save it inside your lab folder.
   c. Set **Linear Unit** to **1 Miles**.
   d. Leave all other options default.
   e. **Click OK** to run the buffer tool. Your buffer should look like Figure 3.

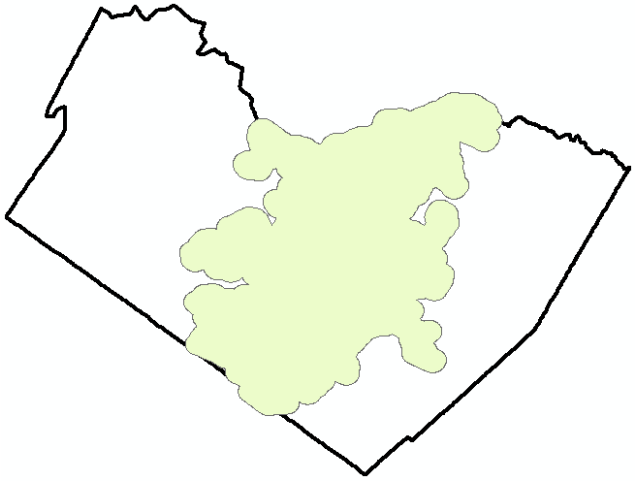

Figure 3: Buffered Austin Urban Area

Now that we have our search area for the selected monuments, we will clip the monument layer to the buffered city limits to create a new shapefile with only the monuments the surveyors should visit. Additionally, we will clip the roads to the buffered area as well.

6. **Open ArcToolbox**.
7. **Expand Analysis Tools → Extract** and open the Clip tool.
8. Set the following options to clip the monuments to the buffer.
   a. Set **Input Features** to **Travis**.
   b. Set **Clip Features** to **Buffered_Austin_Urban_Areas**.
      i. Ignore the Datum conflict. In real life, you would want to make sure everything is in the same coordinate system.
   c. Set **Output Feature Class** to ***Travis_County_Monuments_to_Visit.shp***.
   d. Click OK to run the tool.
9. **Repeat Step 8** to clip the roads **(x453_v2)** to the buffer. Name the output to something easy-to-read, like `Austin Roads`.

With the monuments clipped, we now need to re-symbolize the monuments. Instead of manually redefining the symbology, there is an easy way to copy over the symbology from the previous monument layer.

10. Open the Properties for the **Travis_County_Monuments_to_Visit** layer.
11. Click the **Symbology** tab.

12. Click the **Import button** and select the non-clipped monument layer (Travis).
13. **Click OK**.
14. Confirm that the value fields match. Click OK twice to set the symbology.
15. **Remove** the **Travis layer** from the TOC.

4 Preparing a Map

Now that the surveyors know where the monuments are, we should show the major roads to give them a general idea where the monuments are relative to major roads. We should also label the monuments.

1. Label the monuments with the Feature ID by right-clicking on the clipped monuments layer and clicking **Properties** and going to the **Labels** tab. In the **Text String** box, scan through the list in the dropdown and find FeatureId. Click on **FeatureId** and click **OK**.
2. At this point, you may want to turn off all but the clipped monuments and buffered city limits layer to make it easier to see what you are doing. However, remember to turn them back on when you finalize your map!

We want to symbolize the roads based on their type. However, the FCC type is not a good field to base symbolization on. Instead, let's use the SHIELD attribute, as it will tell us whether the road is an Interstate (I), US Highway (U), State Highway (S), or other type of road.

3. Use your definition query to only display the roads of FCC type: A11, A15, A21, A31, A35. These roads are the major roads running through Austin Texas.
4. **Open** the **road layer's Properties**. **Click the Symbology tab.**
5. Use the **Categories → Unique Values** and value field **SHEILD** to symbolize the roads. Add All Values.
   a. **Uncheck** the **<all other values>** option.
   b. Symbolize the interstate, state, US, and other major roads uniquely by SHIELD type.
6. Set the labels for the major roads.
7. Click OK to accept the symbology and label changes.

Create a well-designed map. Keep in mind that you do not need to show all of Austin, zoom into the part of the map that just contains the monuments.
Include the following map elements on the map:

- Title
- Your name
- Sources of data
- Scale bar
- North arrow
- Legend

Conclusion

In this lab, we have used basic spatial analysis techniques to prepare data, query and extract subsets of data, buffering click data, and preparing a map. While none of these individual operations are necessarily complex, the way in which they are combined allow you to answer questions quickly and easily.

Discussion Question

1. In Task 3, Step 2, a temporary selection layer is created. What is another method in ArcMap that could be used to display only the Austin urban area?