Introduction to GIS for Social and Environmental Analysis (CITY201)

Lab 2: Mapping in ArcGIS

Purpose of the lab: To introduce the principles and techniques of mapping, including projections and coordinate systems and chloropleth mapping, using ArcGIS.

1. Getting Your Data

You will work again with data from the Cities201_Data folder (i.e. the same folder that you used for your first lab assignment). The link for downloading the data is still available on Moodle. If you believe you altered the original data in any way, delete it and download it again from Moodle (don't forget to extract your data once it's downloaded).

For each lab, I recommend you copy the data you need to work with to a new folder named Lab# (e.g. Lab2 for today) in your 201 folder. Use Catalog inside ArcGIS to copy the data from your data folder to your lab folder. You will use the lab folder to save data and project files you create as you work through the lab assignment. As noted in the syllabus, you are responsible for your own data and project storage and management.

For this lab, you will be using the tracts and zoning103 shapefiles. A tract is a spatial unit developed by the U.S. Census to store population-related data. Although the Census has data on individuals, it provides data to the public in *aggregated* form to preserve privacy. Aggregated data are summarized, so that instead of providing, say, the locations of individual people, the Census provides the total population of spatial units such as counties and tracts. Zoning is a designation for an area as to what type of development, e.g. residential or industrial, may occur in that area.

Using Catalog, copy the Tiger/tracts shapefile and the Philadelphia_Only/zoning103 shapefile over to your Lab2 folder in your workspace.

2. Data Integrations – Or Not

To familiarize yourself with the tracts and zoning103 shapefiles, view their spatial and attribute data components in Catalog.

Now let's try to insert them into a map. Insert a new map to your ArcGIS project file (don't forget to immediately REMOVE the two layers we don't want). Add the tracts shapefile to your map. Add the zoning103 shapefile to your map. You **should** get a warning from ArcGIS that it is having trouble registering the zoning103 data layer.

If this happens, it means that even though tracts and zoning103 describe the same area, they are in different coordinate systems (the two layers are not registered) and cannot be displayed as overlaid upon one another.

To further see this, right click on zoning103 and go to 'Zoom to Layer'. Now you should see the zoning103 shapefile for Philadelphia. If you press the 'Full Extent' button (with the globe on it) in the tool bar, ArcMap will zoom out to show both shapefiles, and you will see that they are very far apart.

The solution here is to transform both shapefiles into the same projected coordinate system. Close the Map Pane and go back to the Catalog View.

3. Transforming Projections and Coordinate Systems

The tracts shapefile, although currently "undefined" in the software, is actually stored in latitude and longitude coordinates, also referred to as a 'geographic' projection or 'unprojected' and uses the 1983 North American Datum (NAD83). **Remember this piece of information for the rest of the semester – all data in the Tiger folder is in geographic projection (i.e. lat/lon) and NAD83.**

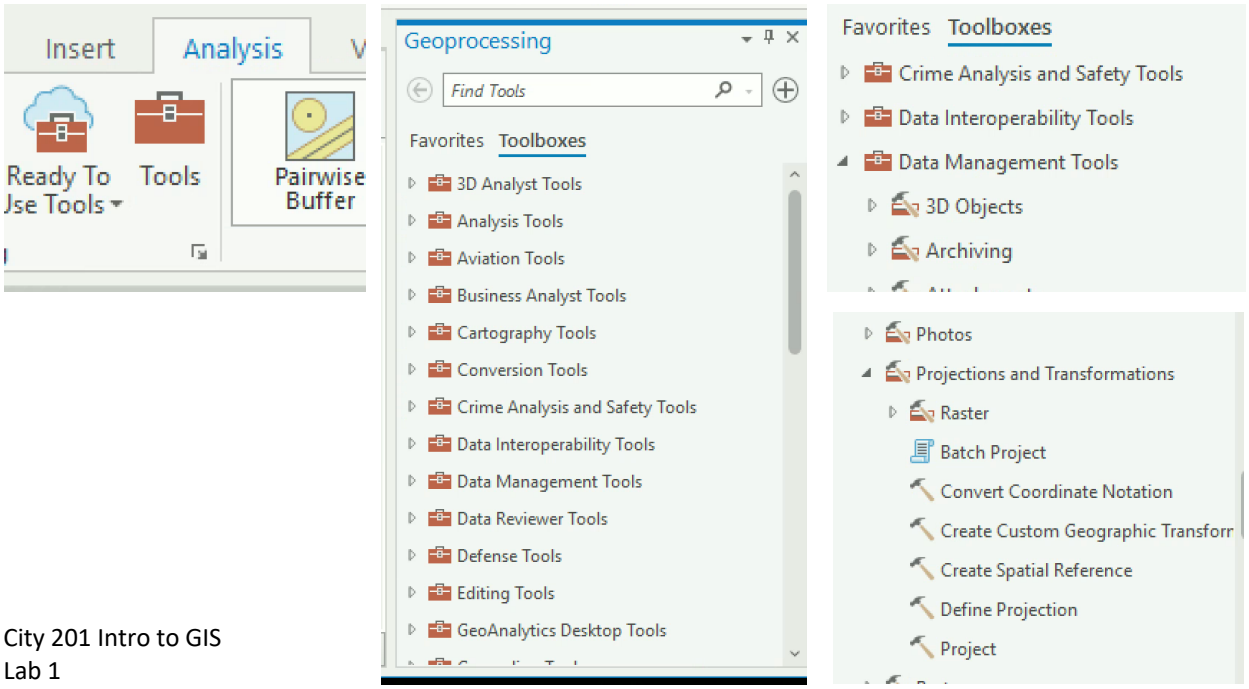
> *Note: A datum provides a frame of reference for measuring locations on the surface of the earth. It defines the origin and orientation of latitude and longitude lines.*

We will now transform the tracts shapefile into the Universal Transverse Mercator (UTM) projection and coordinate system.

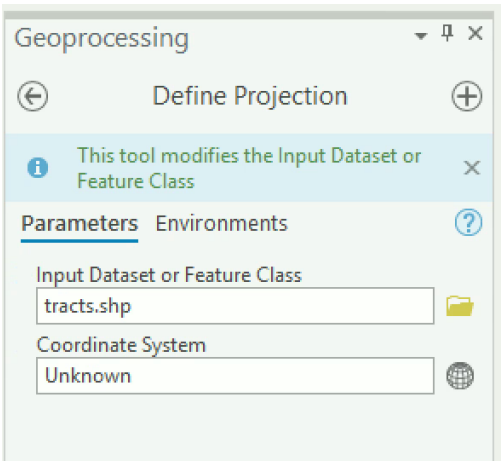
Define Projection

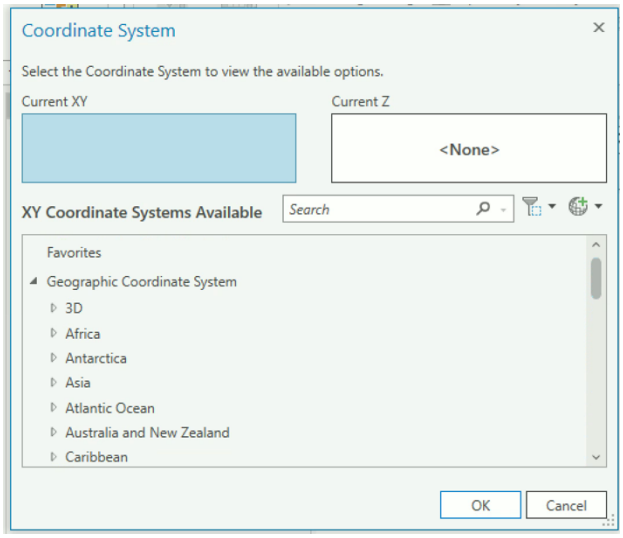
The first step is to **define the projection** – to tell the software the current projection of the tracts shapefile. First you have to set the Geographic Coordinate System, and then you have to set the Projected Coordinate System.

In ArcGIS, open ArcToolbox by clicking the Analysis tab and pressing the button with the red toolbox on it. A Geoprocessing Pane will open up. Scroll down until you get to Data Management Tools >Projections and Transformations >Define Projection.



In the Define Projection dialog box, drag and drop the tracts shapefile from Catalog into the top text box. You will see that the coordinate system is listed as 'unknown.' Click the button to the right of the Coordinate System text box (this opens the Spatial Reference Properties dialog box).





In the Spatial Reference Properties dialog box, navigate to Geographic Coordinate Systems>North America>USA and territories>NAD 1983. Press OK. Click 'Run' in the lower right.

After the tool processes, a green text box with a green check will appear (hopefully) on the lower right of Geoprocessing Pane indicating that the operation was completed successfully.

Transform Projection

The second step is to **create a new tracts shapefile in the UTM projection**.

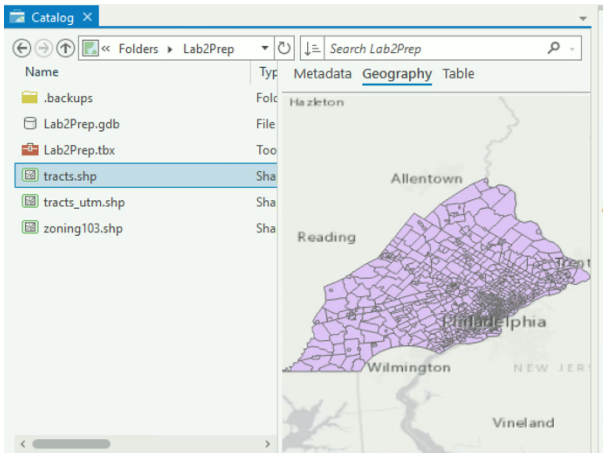
Go back to the Toolbox and open Data Management Tools >Projections and Transformations >**Project**

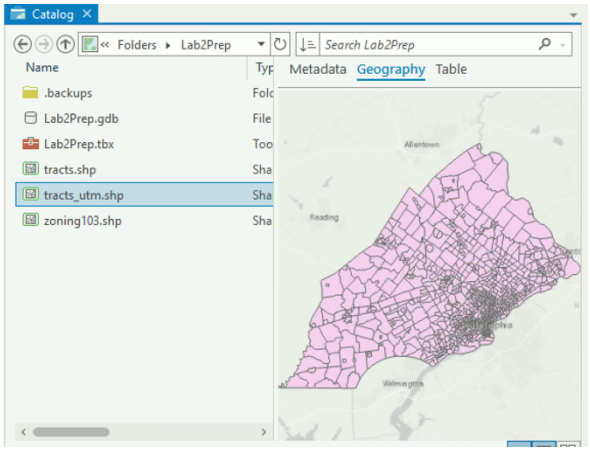
Drag and drop the tracts shapefile from Catalog into the top text box of the Project dialog box.
In the second text box, enter a path and the file name 'tracts_utm.shp' for the shapefile you will be creating. For example, you might enter 'F:\Lab2\tracts_utm.shp'

Click the button to the right of the Coordinate System text box (this opens the Coordinate System dialog box). In the Spatial Reference Properties dialog box, navigate to Projected Coordinate Systems\UTM\NAD 1983\NAD 1983 UTM Zone 18N. Press OK. Click 'Run' in the lower right.

After the tool processes, a green text box with a green check will appear (hopefully) on the lower right of Geoprocessing Pane indicating that the operation was completed successfully.

View the new tracts_utm shapefile in the Geography window of the Catalog View and compare it visually with the tracts shapefile (the unchanged one). You should see the difference in shape!





See how the file in UTM projection looks more upright than the unprojected file?

More data transformations

Now we need to transform the zoning103 shapefile into UTM.

Use the Define Projection tool in ArcToolbox to define the projection and coordinate system for the zoning103 shapefile, so that the software knows how to project the data layer. But what coordinate system is the zoning103 shapefile in? **This zoning data comes from the City of Philadelphia, which typically stores its data in the Pennsylvania (South) state plane coordinate system using the North American 1983 datum.**

- Here is how the data in the City of Philadelphia folder is coded in ArcGIS: "State Plane / NAD 1983 (US Feet) / NAD 1983 StatePlane Pennsylvania South FIPS 3702 (US Feet)".
- Note that this is NOT THE SAME AS NAD 1983 (2011) US Feet
- This means that when you use the Define Projection tool for the City of Philadelphia data, you have to pick from the "Projected Coordinate Systems" list, NOT the "Geographic Coordinate Systems" list.

Repeat the instructions as before and use the projection information in blue to use the **Define Projection** tool for the zoning103 shapefile.

After you have defined the projection for the zoning103 shapefile, open the **Project** tool to transform the zoning103 shapefile to UTM (NAD 1983 UTM Zone 18N).

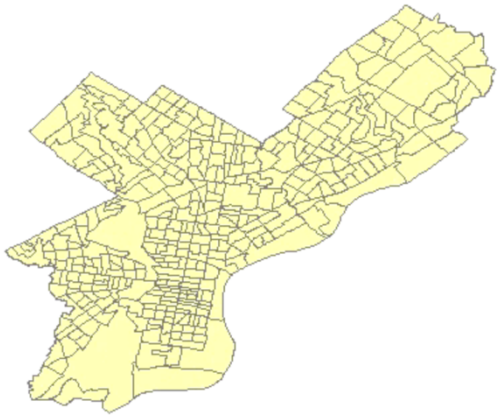
This time, instead of manually inputting the UTM parameters, we can merely tell the software to choose the coordinate system of another shapefile, namely the tracts_utm shapefile.

To do this, in the Project dialog box, first add the zoning103.shp file to the Input Dataset box, set the output dataset as zoning103_utm.shp, and click on the 'Output coordinate system' drop down (the arrow just to the left of the globe) and select tracts_utm.shp from the options. Then complete the

Project tool as before. If the drop down arrow is not available, simply click on the globe and navigate to the output projection you want.

Use Catalog to preview the zoning103_utm shapefile and compare it to the zoning103 shapefile.

UTM



NOT UTM

Add the zoning103_utm shapefile to your map with the tracts_utm shapefile. They should be **registered** and graphically overlay in the view window.

4. Choropleth Mapping

Here, you will learn chloropleth mapping using tract-level population data.

Open the attribute table for the tracts_utm shapefile. Note the two columns (referred to technically as 'fields') 'TOTPOP' and 'MEDHHINC'. These two fields contain data on the total population and median household income, respectively. ***Do you know where this data came from and what year it is? Hint: Check your data dictionary.***

In the attribute table, right click on the column name 'TOTPOP' and choose 'Sort Descending'. You can see the range in population values by scrolling down the table. Do an attribute query on TOTPOP selecting the highest population tracts, say, those tracts with TOTPOP values greater than 8000. Do you see a spatial pattern, or clustering, of high population tracts?

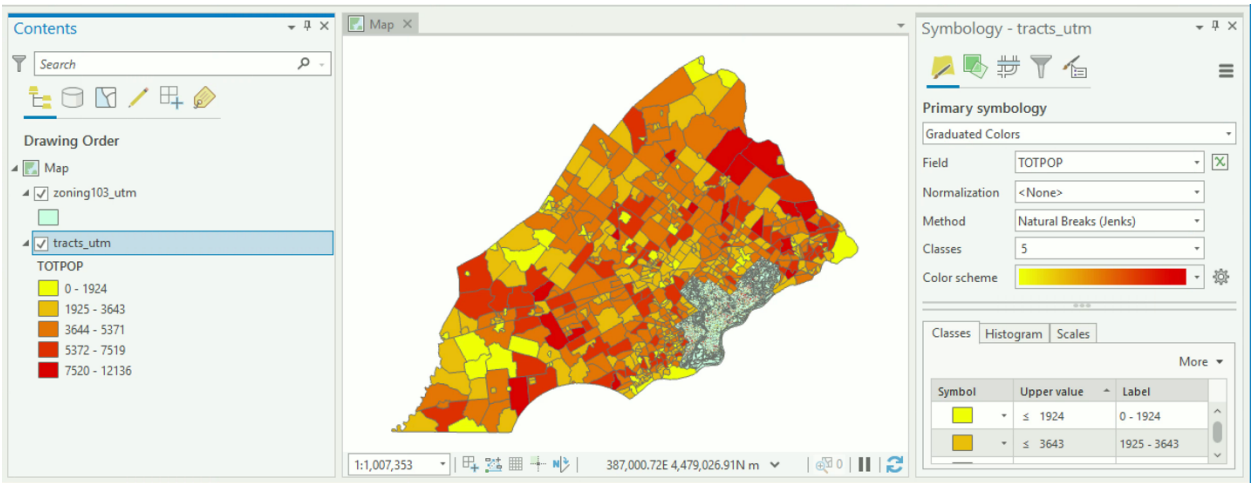
Close the table and clear your selection.

Open the Symbology Pane for the tracts_utm layer.

Select Quantities >Graduated Colors on the left side of the Symbology window. For the 'Field' drop down menu select TOTPOP.

Press OK.

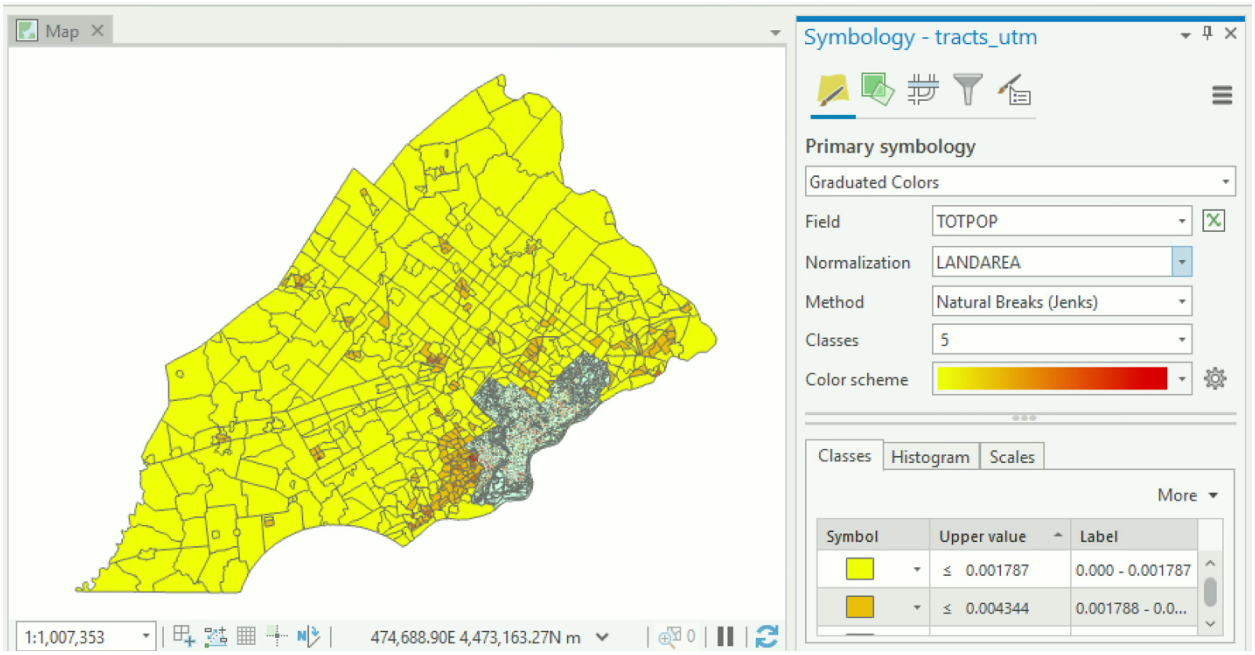
Check out your ArcMap window. It may look something like this (the color scheme may differ):



Normalization

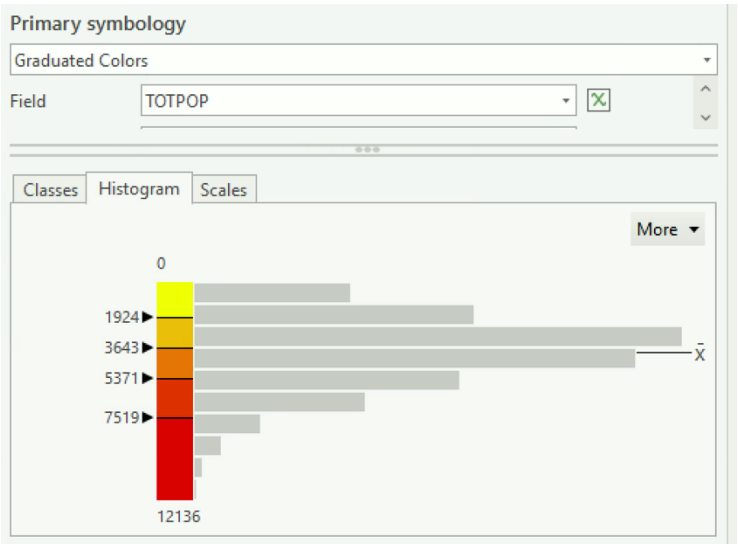
Note that tracts vary greatly in size. Thus, to see the variation in concentration of population it is better to map population density (people per unit area) rather than raw population. You can do this automatically in ArcMap, if you have a field (column in your attribute table) that encodes the area of each tract. The 'LANDAREA' field in the tracts_utm table does just that – it is the area of land in each tract in square meters

In the Symbology settings, select LANDAREA for the normalization option. This will divide the population by the land area for each tract, thus mapping the population density (people/m^2). View your map to see how it is different from the map of raw population values.



Note that the class intervals are reported in the Contents Pane. These can be adjusted either automatically or manually.

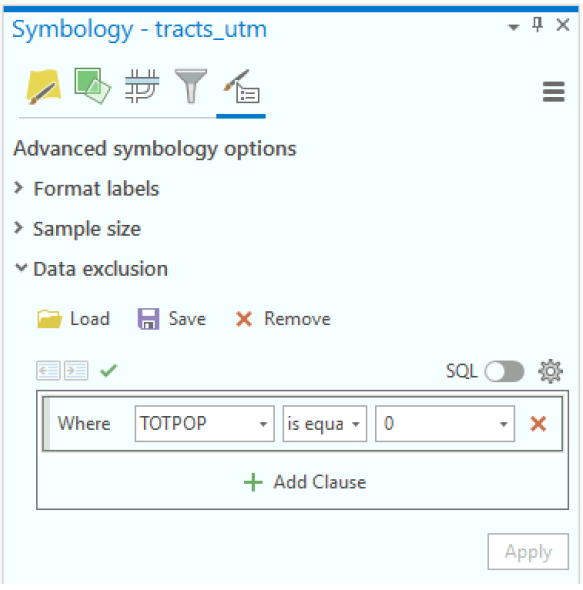
Go back to the Symbology Pane and experiment with different class breaks methods (Natural Breaks, Equal Interval, and Quantile especially), different numbers of classes, and different color schemes.



In the bottom section of the Symbology Pane, click on the Histogram tab. Here, you can grab one of the black triangles to manually move the class breaks.

Data Exclusion

Sometimes you want to exclude data from your classes. When you are mapping census data, you should almost always put tracts with zero population into their own group apart from the class scheme. You can do this by clicking the Advanced Symbology button and then creating a query under Data exclusion.



Add a query to find census tracts in Philadelphia that have zero population and color them grey. Now go to the aerial photo of Philadelphia on Google Maps – can you figure out why these areas have no population?

5. Using ArcGIS Help

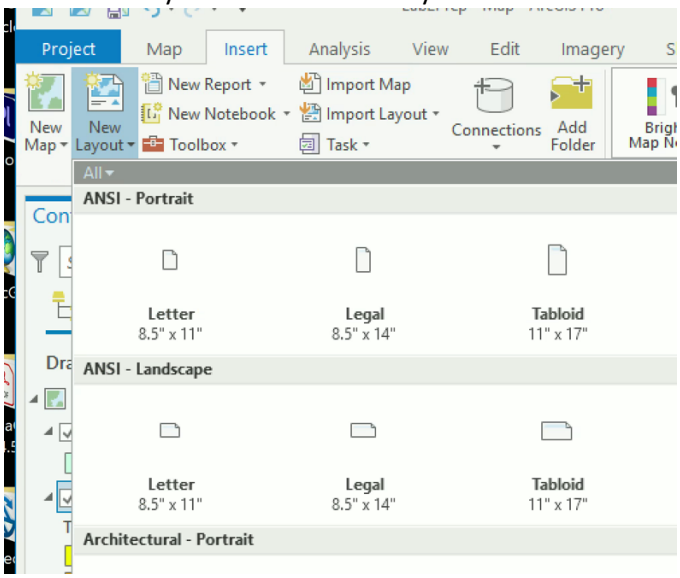
For more information on class breaks, go to the search bar near the top right of the ArcGIS window. Type in 'data classification.' In the pop-up window, click on 'Data classification methods." This will take you to an ArcGIS Pro help page on the web. Read this help file. Next, Google "arcgis pro class breaks." Read one of the results that you have not already read.

6. Making a Printable Map

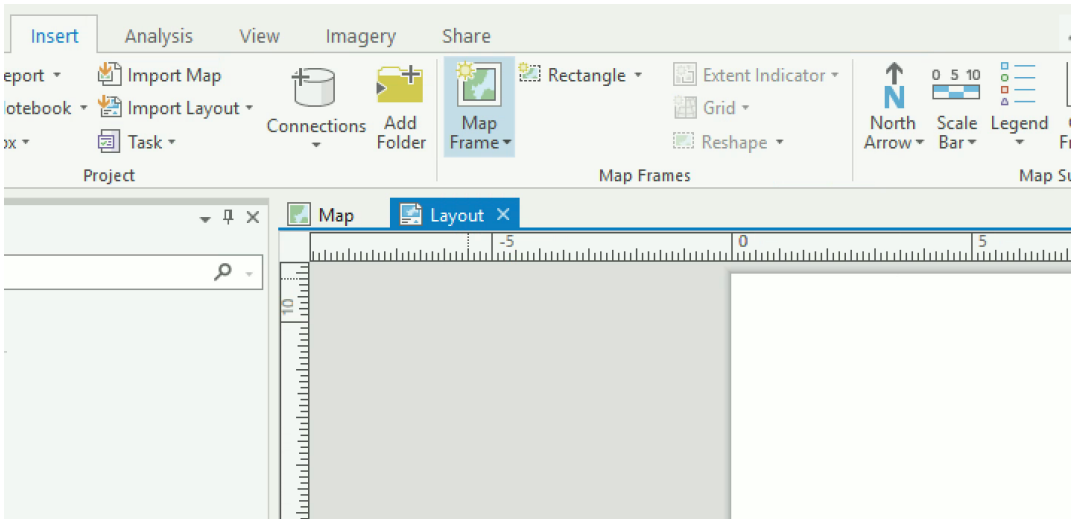
Here, you will learn how to generate a map with generic map composition elements such as a title, scale bar, north arrow, and legend. **Review the class Map Design Checklist (in the Instructions section of the Moodle page) to see what elements you must include on your maps.**

Insert Elements

Go to the Insert tab, choose 'New Layout,' and select a paper size and orientation. A new Pane opens in the center of your screen called 'Layout.'



Start by adding a map frame to your layout. Still on the Insert tab, click the Map Frame button and draw the frame on your page payout. Generally you want your map frame to take up a good portion of the page and be in the center closer to the top of the page.

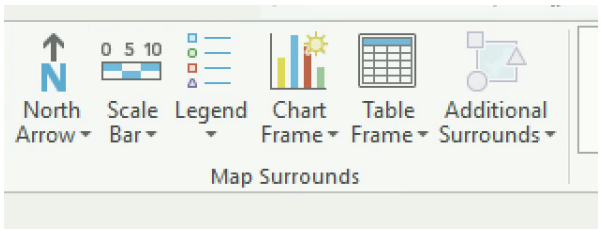


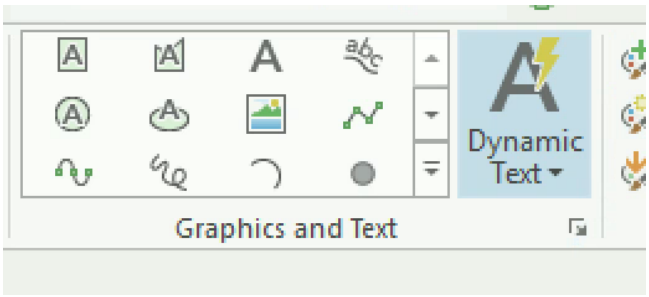
Now, use the buttons in the Map Surrounds portion of the Insert tab to insert a north arrow, scale bar, and legend.

If you want to add an **inset map** to zoom in on a portion of your larger map, you can insert another Map Frame, then adjust the size of the map frames, their zoom levels, and their location on the map.

Insert Text

Also go to the Graphics section to insert a Title and note about your data sources. For the title, you may want to use Dynamic Text that is linked back to the names on your Table of Contents. Move these elements around on your page and resize them until you are happy with the page balance and legibility.



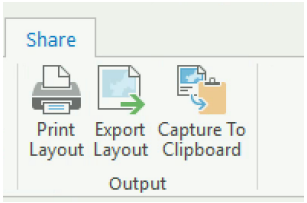


Adjust Legend Text

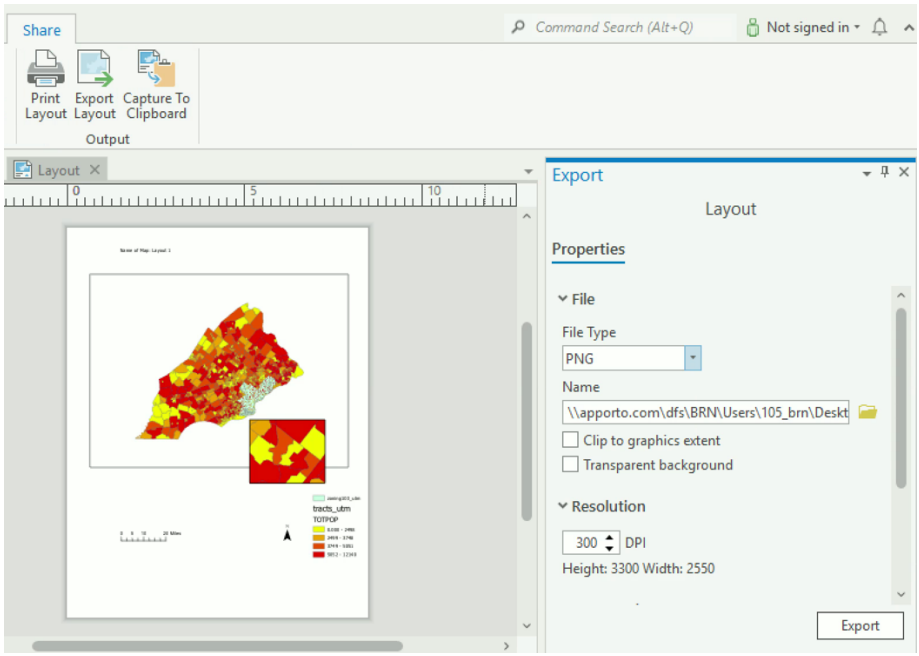
Does the text in your legend next to the colored symbols make sense? Do you have too many decimal points? You can edit this text in the Contents Pane of your Map View. Click on the text in the Contents list (just once) until the text is highlighted – now you can edit it. Changes in this Contents list will now appear in the Legend of your Layouy View.

Export Your Map

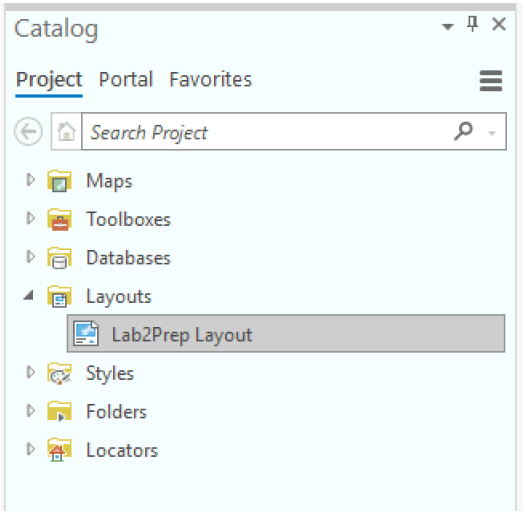
In the Share tab, you can print or export your map. For our class, you will always export your map to place into your Word doc lab report. I



recommend the PNG file format for this purpose. ***Note that the example map layout below is NOT a good example of good balance, element sizing, and elements placement – review the Map Design Checklist for guidance.***



If you close your Layout View and want to open it again, you can find it in the Catalog under Layouts. You can have multiple layout pages using the same data layers stored within a single ArcGIS Project file.



ASSIGNMENT

Objective
The objective of this assignment is to **explore the spatial distribution of median household income in southeast Pennsylvania using chloropleth mapping**. One learning objective is to examine the effect of using different class break schemes in chloropleth mapping.

Deliverables – SLIM LAB REPORT FORMAT
Turn in a report addressing these objectives. The report should include *three* chloropleth maps of median household income for southeast Pennsylvania, each with a different class break scheme. One of these maps must use the equal interval classification scheme with five classes and blue color ramp. Another of these maps must use the quantile classification scheme with five classes and red color ramp. The third map can use any other automated or manual class break scheme, but it must have a different number of class breaks (not 5). **Choose a class break scheme and display symbology for your 3rd map that helps make sense of the data.**

Data for these maps must be displayed in UTM. Your maps should include standard composition elements. In your report describe the spatial distribution of median household income – i.e. where is it high and where is it low – as well as the power of the different types of class break methods in capturing this distribution.

Getting Started
View the attribute table of the tracts_utm shapefile. The field named MEDHHINC captures median household income estimates for each tract. Use the settings in the Symbology window to experiment with different automated and manual class break settings. As you experiment look at the graph and the class break lines. Think about which class break method does the best job of grouping tracts with similar median household income values together in the same class.

A few more tips
Pay attention to the formatting of class break labels and make thoughtful choices. You can, for example, adjust the number of decimal places that will be displayed. To format your class break labels, right click on 'Label' in the Symbology tab and select 'Format Labels'.

Make sure you understand what median household income means. The median divides the income distribution into two equal parts: one-half of the cases falling below the median income and one-half above the median. For more about how the census defines "median household income," see https://www.census.gov/quickfacts/fact/note/US/INC110219, and for more about income generally within the census, see https://www.census.gov/topics/income-poverty/poverty/guidance/poverty-measures.html.

Lab 2 Summary of Operations

Operation	Briefly describe what this operation does	List the steps to complete this operation
Symbology: Classification (Quantile, Equal Interval, Natural Breaks, Manual)		
Symbology: Normalize one value by another		
Define projection		

Project		
Layout View: Insert scale bar, north arrow, legend, title, text box		

Lab 2 will be graded with the following criteria (see General Lab Report instructions for more detail):

	Pass	Good	Excellent
Results			
Clear summary of results that describes the patterns seen			
Tables & Figures			
3 chloropleth maps with different class break schemes			
Maps are in UTM projection			
Tables are provided with the required data			
Map design: overall composition			
Map design: required elements			
Map design: data classes (for map 3)			
Map design: colors and line weights			
GIS Operations Summary			
Steps are correct			
Other Notes			
Notes			