Basics of ArcGIS Pro (A Hands-On Exercise)

Introduction

This exercise is designed to introduce you to GIS software and data, or to refresh your memory if it has been awhile. We will go through some of the most basic aspects of GIS, including creating a project file, connecting data, joining tables, and making a simple map of commuting patterns in the Upper Valley. We recommend that you go through the video lectures and quizzes first to understand the concepts discussed here.

Please review the most fundamental aspects of GIS:

- **Read the instructions carefully and follow them precisely**- most questions you have will be answered in the handout itself

- **SAVE YOUR WORK FREQUENTLY and back up your project and data** (ArcGIS, while very useful, is finicky and known for crashing unexpectedly, at the worst possible times ☺)

- **Never use spaces, special characters, or dashes in folder names or file names** (e.g., don't save your files into the "My Documents" folder, or name your folder as "Your Name GIS Project" with spaces). Underscores_ are ok. The computer will interpret spaces and special characters as a command, and potentially give mysterious errors when running tools.

- **A shapefile is a collection of files, not a single file:** the most basic vector data form, a shapefile, might include anywhere from 4-8 files, including the file extensions *.shp, *.dbf, *.shx, *.prj, etc. It is best to move, delete, and rename these files within a GIS software rather than a file explorer, since GIS software recognize these as a single dataset and will move them together.

- **Each time you open up a GIS project file, you may need to check that layer paths are correctly mapped.** GIS project files do not actually contain the layers (shapefiles, raster images, etc.) that make up the map; instead, it links to where those data layers are saved on your computer and simply displays them. If you move or rename your data, then reopen your project file, the software will no longer know where they are located and ask you to relink them. There is a handout on Canvas going through the process of relinking data to your project.

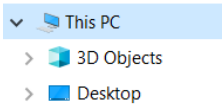
- **Getting Help:** Learning how to solve your own problems is the most valuable skill in GIS. Please try problem-solving independently or with a buddy (or group). Google is the #1 tool for learning GIS, and websites like Stack Exchange, Esri, or ArcGIS Pro are full of users asking similar questions and providing answers. But we are also here to help!

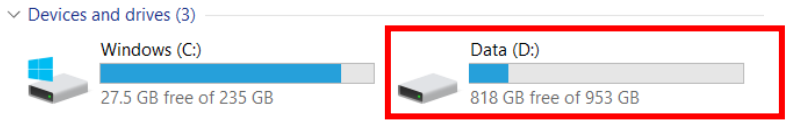
PART A:

1. Set up your working folder on the lab computer

a. Log in to your lab computer with your netID and password (not the public user this time… if you are stuck as another user, click 'Other User' at the bottom left of the screen).

b. Create a working folder on the computer to store your GIS project file and all data input and output files. At the bottom of the screen, click on the File Explorer:  . Click on 'This PC' at the left, then double-click on the Data (D:) drive, since it has more storage.





c. Create a new folder somewhere on this drive (right-click, New → Folder), and rename it with your first name and last name(s). If your name is very long, you might abbreviate. Remember: there **cannot** be spaces or special characters in your folder name! Replace the space with an underscore.

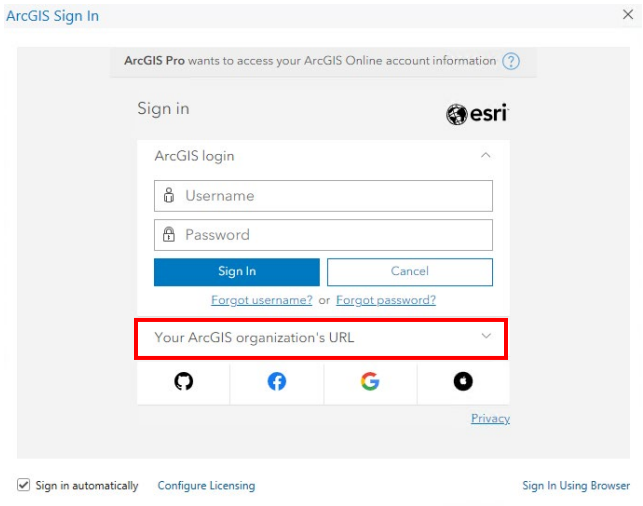
2. Download and prepare the lab data

a. The data for this exercise are located on the Geospatial Hub website. Download the file called Basic_Exercise_Data.zip. This is a collection of files that have been *compressed* (or zipped) together, allowing multiple files to be transferred between computers in an efficient way. Importantly: you will not be able to use or edit these zipped files until they are unzipped, or extracted. This is a very common mistake in working with GIS software.

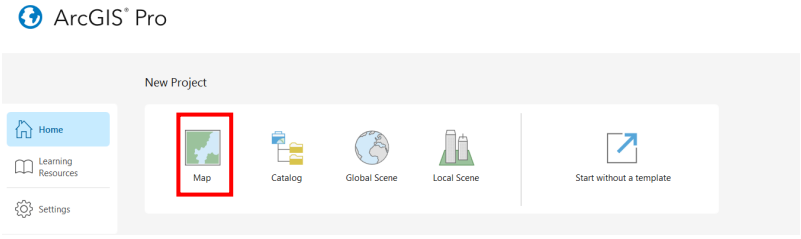
b. Right click on the zip file's name in Downloads and select 'Extract All'. For the destination, click 'Browse' and navigate back through the computer to your working folder (This PC → Data (D:) drive → *YourName*). Click once on your working folder's name, then hit 'Select Folder' and 'Extract'.

3. Set up your ArcGIS Pro Project

a. Search the computer for 'ArcGIS Pro' and open the software. Our licensing for the software has changed, so you will need to sign in with your ArcGIS Online account every time to open it. Expand 'Your ArcGIS organization's URL', then type in *dartmouth* and check the box next to 'Remember this URL'. Click on the blue Dartmouth College box, then log in with your netID.



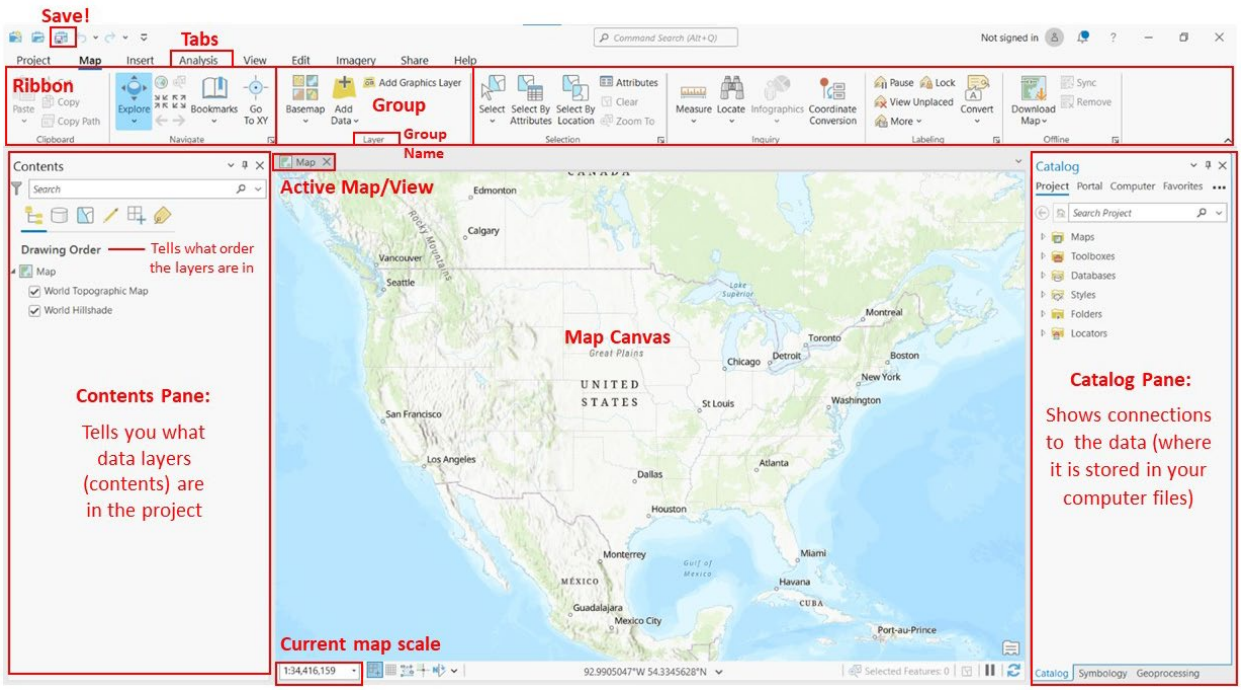
b. Under new project, select Map. Rename the project something reasonable. For the location, click on the folder icon and manually navigate to your new *YourName* working folder.



c. A new project file should now open. An ArcGIS Pro project file is made up of multiple components:

Figure 1: Esri.

d. See the image on the next page to learn/remember the terminology of different components of the project file. If you are missing one of these panes, go to the View tab → Windows group → Reset panes for mapping (default).



e. Test your knowledge: making sure you're in the Map tab of the upper ribbon, go to the Layer group, click on the Basemap button, and try changing the basemap for your map canvas.

4. Connect Data to the ArcGIS Project

a. Look at the Catalog pane of your project. This is where all your maps, layouts, toolboxes, and data can be opened. If you ever accidentally close the Map tab and lose your Map Canvas, you can find it under the Maps section. The Folders section allows you to connect your GIS software to other folders on your computer. Expand the arrow next to its name. Right now, you should only see your *working folder*, the folder with your name that you created earlier, with a home icon.

b. Next, you can add a connection to the data folder that was downloaded onto your computer. Right-click on Folders and select Add Folder Connection. Browse through your computer files to your working folder → Basic_Exercise_Data. Click once on its folder and click OK. You should see a new folder connection for Basic_Exercise_Data, under your other connection.

c. Open the data folder and look inside. You should see two shapefiles from the US Census called *NH_CensusTracts* and *VT_CensusTracts*, and two tables (CSV format) for commuting characteristics. Right-click both shapefiles and add to your current map.

d. You should see polygons (Census tracts) for NH and VT added to your map. In your Contents pane at left, you should now see the two shapefile names showing up. They should be at the top of the list, meaning that they are the first items drawn on the map. If you were to click and drag one under your basemap layers (called something like World Topographic Map and World Hillshade, but might be different depending on which you selected), what

would happen?

e. The spatial part of the dataset doesn't tell us much information on its own. Right-click one of the census tract layers and go to Attribute Table. A table should open at the bottom with attribute information about these polygons. There are many fields containing different codes, and values for amount of land or water within each polygon (ALAND, etc.). We will need to add more information.

5. Join the Data to External Tables

For this exercise, we will want to make a map showing commuting patterns. To get this information, we will need to use the *relational database* aspect of GIS by joining the shapefile with the two external tables.

a. Add the two CSV tables for NH and VT to your current map. You should see their names appear under 'Standalone Tables', but nothing in the map (this makes sense- they do not contain spatial data!).

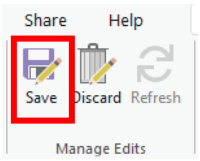
b. Right-click the NH CSV name and Open. You should see one field 'GEOID', which contains the ID number of each block polygon, and other fields describing the number of workers within each tract and whether they drive alone or carpool.

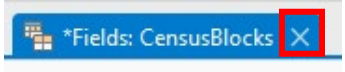
c. Compare the NH CSV table to the NH shapefile attribute table. To join them, you will need to find a field with identical values within both tables to use as the linking key. **Which fields will be used as the linking key?**

d. Hover your cursor over one of the linking key fields until a message pops up. **What are the data types of these fields?** Do the same for the VT CSV and VT shapefile too (hint: they should be the same as NH).

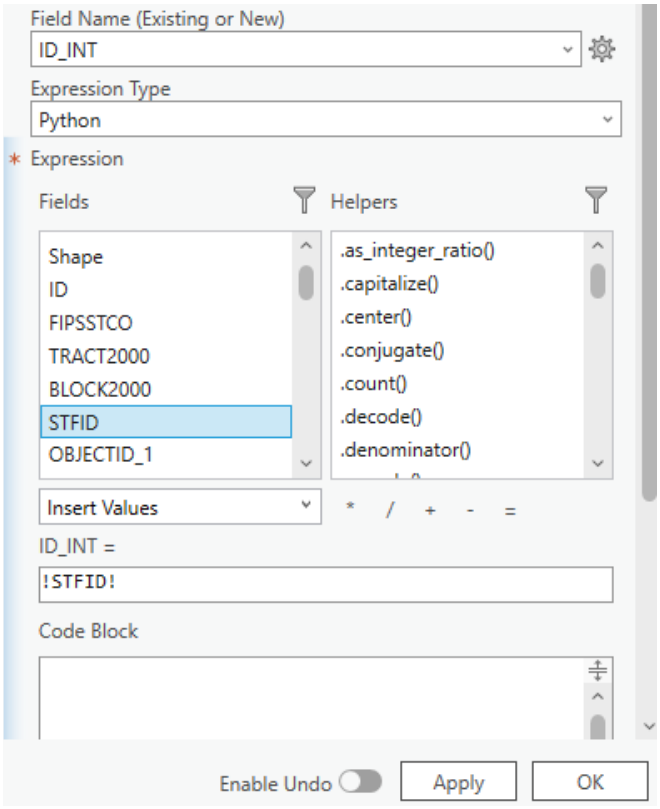
e. You should have found that the linking key in the census tract shapefiles has a different data type than your CSVs. If you try to join them without fixing this, you will not be successful. Instead, we can add a new field with the proper data type and copy those values into it. In the attribute table for the NH shapefile, click the Add Field button. Add a new field to the table called ID_INT (for ID integer) and make sure it is the data type Long.

f. Click on the Save Edits button on the upper ribbon, then close the Fields window.





g. Scroll all the way to the right of the NH census tracts attribute table. You should see the new field at the very end, filled with 0s. Right-click on the field name and open the Field Calculator (select Calculate Field).

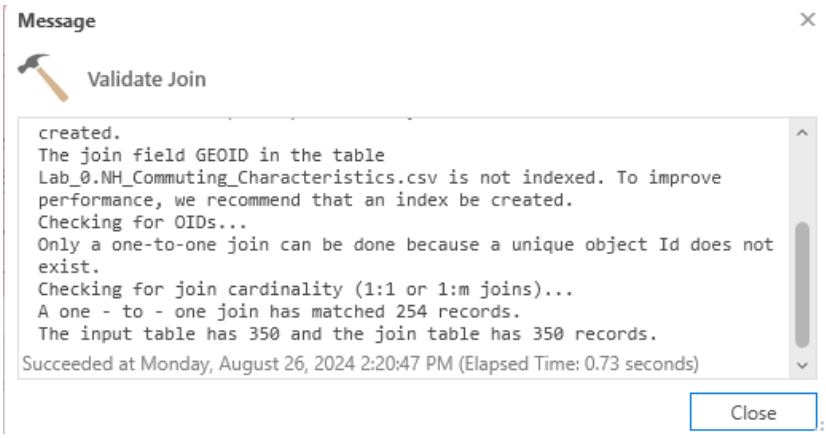


h. To copy values from another field, scroll down in the list under Fields until you see STFID. Double-click on the name STFID. This should cause the textbox under the menu, beneath "ID_INT =" to be filled with !STFID!. The exclamation points tell the computer to read this as a field name from the dataset. Click OK. This field should now be populated with values.

i. Repeat the same steps to copy over ID values into a new integer field in the VT census tract shapefile.

j. Now that the IDs match, we can join the data. Right-click on the NH census tract shapefile and go to Joins and Relates → Add Join. When you join, you will always want to start from the spatial dataset- otherwise you will lose all geometry.

k. The input table should already say NH_CensusTracts. Set the Join Table to its corresponding CSV. The computer will try to guess at which field you will use as the linking key, but make sure these match with the values you recorded in step c. Ignore any yellow warning icons, click Validate Join, and scroll to the bottom. If the join will work, it should say something like the following:



l. If the join looks good, click OK and you should see new fields added to your shapefile's attribute table. It's okay if one value is null, but the majority of the records should contain values.

m. Repeat the same process to join the VT CSV to the VT shapefile.

n. Now that you have successfully joined tables to both your shapefiles, you will need to make the join permanent. Remember that otherwise the computer will read this as two separate

datasets (the shapefile + CSV) and will result in errors if you try to use any tools on it. Right-click on the NH census tract shapefiles and go to Data → Export Features. Give it a name like NH_Census_Join and save it into your *YourName* folder.

o. Repeat the same process on the VT census tract shapefile. When finished, remove the original layers so you are only left with the joined shapefiles (right-click the layer's name in Contents and Remove).

6. Align Coordinate Systems and Projections

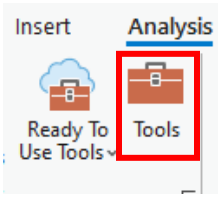
a. You may have noticed that your VT and NH shapefiles look quite stretched and fat on the map. Right-click on Map in your Contents pane and go to Properties → Coordinate Systems. The current coordinate system for this project should be NAD 1983 (the North American Datum). Note that this is just a datum; it is a three-dimensional system, not yet projected!

b. For this lab, we will use the projected coordinate system NAD 1983 UTM Zone 19N. For future labs, we will use a more specific PCS for the Upper Valley. Type the whole name of this coordinate system into the search bar and hit enter. You should see a caret next to Projected Coordinate System: expand that, then keep expanding until you see its full name with a gray globe icon. Click once on this, then click OK.

c. Your map should change in shape, reducing the distortion on both states. It may also rotate slightly to keep the study area in the middle of the map. This means that our map has been projected. Open the map properties → Coordinate Systems again and look at the top under the Layers heading. Expand the carets next to NAD 1983 and WGS 1984 Web Mercator.

d. Even though your map is now in NAD 1983 UTM Zone 19N, and looks undistorted, your data files are still in NAD 1983. This is a process called *projection on the fly*- your computer notices a discrepancy in your map and data and performs some temporary calculations to align your data with the map. Note that this doesn't actually change the coordinates themselves- they are still in units of degrees- but makes it visually appear as though it is in the UTM projection. We need to perform coordinate transformation in order to make both the data and map align.

e. Make sure your map is still set to UTM Zone 19N, then go to the Analysis tab → Tools icon. This opens the Geoprocessing pane at right, which contains all the different tools of ArcGIS. Search for "Project", a tool which will mathematically transform your coordinates from one coordinate system to another. Click once on the tool name to open it.



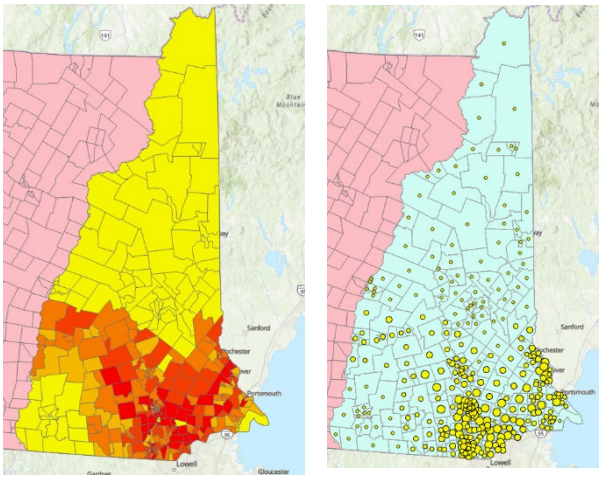
f. In the tool window, set the input dataset to be the NH_CensusTracts_Join. Save the output dataset into your folder by clicking on the folder icon and browsing to its location, then name it NH_CensusTracts_Projected. The output coordinate system can be set to current map, which should be UTM Zone 19N. Run the tool.

g. Repeat the same process to project the joined VT census tract shapefile. Remove the old layers.

7. Visualize the Data

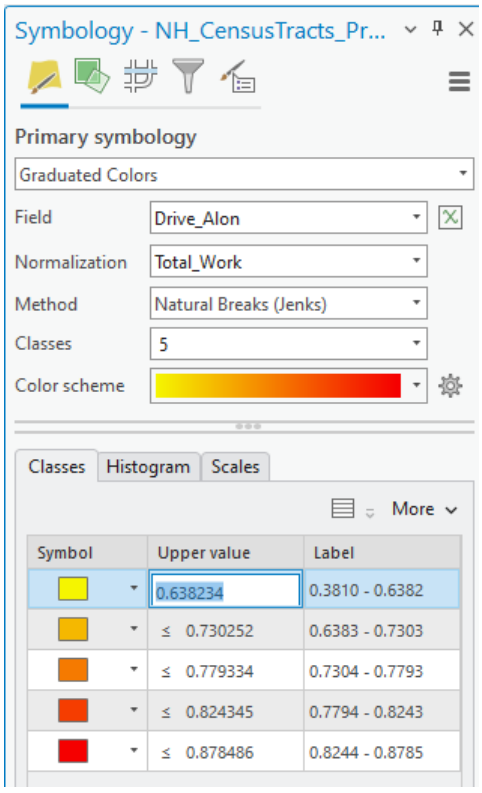
To display the new commuting information on the map, we will need to update the symbology of the two census tract layers.

a. Right-click on NH_CensusTracts_Projected and go to Symbology. The primary symbology is set to single symbol, which will display all polygons with the same color and outline. Change this dropdown menu to say Graduated Colors, also known as a *choropleth map*. This will group data into classes based on values from a field. Change the dropdown menu next to Field to say Total_Work, which should look something like the left screenshot



b. Note the spatial pattern of workers in New Hampshire- most are concentrated around the urban areas, which is to be expected. Note also the varying sizes of the polygons: census tracts in rural areas tend to be larger than those in urban areas. This can influence people's perceptions of spatial trends, as it seems like the larger areas are more important, even though the smaller census tracts usually have more population. We usually show raw counts (total population, etc.) as graduated symbols rather than graduated color (screenshot at right).

c. To be more realistic, we might choose to show commuting as a *rate* of the total population. We could do this by adding a new field to the attribute table and calculating it, but since we just want a simple visual fix, we can change the symbology directly. Change the Field dropdown to say Drive_Alone, and then change the Normalization dropdown to Total_Workers. This will visualize the percentage of total workers who commute by driving alone.



d. You may see some missing polygons, which don't have any commuting information from the census. Ignore those for now. Click on the Histogram tab at the bottom to see a distribution of values within this field. You can change how the data are classified by switching the Method from Natural Breaks to something else- read through the descriptions to see what the differences are. You can also change the number of classes to get more or less variation (usually 4-8 is a reasonable number), or switch the color scheme.

e. Make sure that the color scheme and class breaks are the same for both the NH and the VT layers. You can manually edit the

class breaks by double-clicking into the upper value boxes under the Classes tab. You should also double-click into the label boxes and change to be percentages (e.g. type in "38 – 63%", rather than 0.38 – 0.63). You only need to do this for one of the data layers, not both. Do not worry if your values are different from the screenshot- they likely will be!

8. Create a Simple Map

To showcase your findings, you will create a simple map.

a. Add the data layer Study_Area_Polygon from your data folder. Open its Symbology and leave the primary symbology as single symbol. Click on the symbol patch to open a window with options. You can either pick one of the symbols in the gallery, or go to the Properties tab and manually change the fill and outline color. Update the symbology to have transparent fill but a bold outline around the Upper Valley boundary.

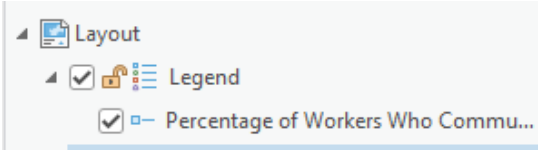
b. When creating a map, it's best to make a layout so you can add text for the title and a legend. Go to the Insert tab → New Layout → ANSI- Landscape Letter 8.5" x 11". A layout window will open with a blank sheet of paper. It will only print what is on the white space of the layout.

c. In the Insert tab, click on Map Frame, then select the image of the map that matches what you just created. Click and drag to add it to your layout, like drawing a text box.

d. We might want to visually mask out data outside of the Upper Valley boundary. We could use the tool Clip to manually cut out the data if we needed it for analysis, but since this is just visual, you can right-click on your Map name in Contents → Clip Layers → Clip to an outline → Get shape from Study_Area_Polygon.

e. You should also make sure there is enough extent from the basemap to show what these locations are. If your basemap is not showing any labels, go back to the Map tab and switch it to an option that puts labels on top of your data, such as Human Geography.

f. Add a legend by going to the Insert tab → Legend and picking any one of the options. Click and drag to draw it on your layout. It should look very chaotic! We can clean it up by renaming the layer in the Contents pane. This will not change the underlying data file, just how it is symbolized in the project. Right-click on the NH or VT layer that is labeled with percent symbols and go to Properties → General. Change the name to something like "Percentage of Commuters who Commute by Driving". At the top of the Contents pane, under Legend, uncheck the boxes for every layer that is not the one you just edited so that there is only one item in the legend.



g. In the Contents pane, right-click on Legend and go to Properties. Under the map frame dropdown, uncheck the box next to Title: Show. It's usually best not to label the legend as Legend, since that's intuitive. Click on the Show Properties box. Since the layer name gives

all information that we need, we can turn off the labeling for the Drive_Alone/Total_Work fields. Uncheck the box next to Headings (if grayed out, make sure only that layer is selected in the legend Contents pane).

h. You should also update the font for your project, since the default Tahoma font is pretty unpleasant. Do this in the Text Symbol tab. To make your life easier, you might also change the entire font settings for the project so it will update on all future maps. Save your project, then go to the Project tab → Options → Text and Graphics and change the default font name to something you like better (good choices might be Arial, Avenir, Bell MT, whatever looks easy to read and professional.). Then click the back arrow at the upper left. You may need to save, close, and reopen the project for the change to actually apply.

i. Add a scale bar by going to the Insert tab, clicking on the scale bar button and selecting an option (scale bars should not be too fancy and distracting from the rest of the map). Click and drag to place it where it won't be the center of attention. Adjust the scale bar size by clicking and dragging the diagonal corners to **make the numbers easy to read and with logical breaks** (e.g., 10 miles rather than 13.482 miles).

j. Add a title to the map by clicking on the Insert tab, then in the Graphics and Text group, click on A. Click and drag to draw the textbox. Type in some title that explains what this map shows and where it is located (the what and where). Once placed, click on the new tab Text in the upper ribbon. Change the size to something reasonable.

9. Export your Map

Finally, you can export your map as a PDF.

a. Go to the Share tab → Output Group → Export Layout button. Select the Vector PDF option. This should open an export window at right. Make sure the name is set to save into your overall working folder (e.g. *Aletha_Spang*) and name it something you will recognize. Leave the resolution at 150 DPI and export.

This completes the hands-on exercise to introduce you to ArcGIS Pro. If you want handouts on more advanced analysis or geovisualization topics, check out the Instructional Handout section on our Geospatial Hub website. Feel free to reach out with any questions.