GIS Tutorial for

Atmospheric Sciences

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***Adapted by:***

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***Changes Made:***

Adapted for region-specific geographic data.

Exercise 1

Exploring ArcGIS Pro and the Living Atlas

*Use case: Tornado Tracks*

In this exercise, you will explore the interface of ArcGIS Pro. You will learn how to visualize different types of data and customize the application to fit the needs of your project. In addition, you will learn how to navigate the Living Atlas of the World within ArcGIS Pro, and use the Living Atlas to add data to your project.

Sub-Sections in Exercise 1:

1. Opening and exploring ArcGIS Pro
2. Adding data
3. Working with attribute data
4. Navigating and using the Living Atlas

Opening and Exploring ArcGIS Pro

1. Sign in to ArcGIS Pro and open the existing project file

Projects are packages consisting of maps, data, layouts, and information.

* Open ArcGIS Pro.

To open the application, type ArcGIS Pro into the search box or go to your Windows button and navigate to ArcGIS > ArcGIS Pro

* When prompted, sign in using your ESRI ArcGIS Online account to license the software.
* If you do not have an online account, contact your GIS admin to get a login.

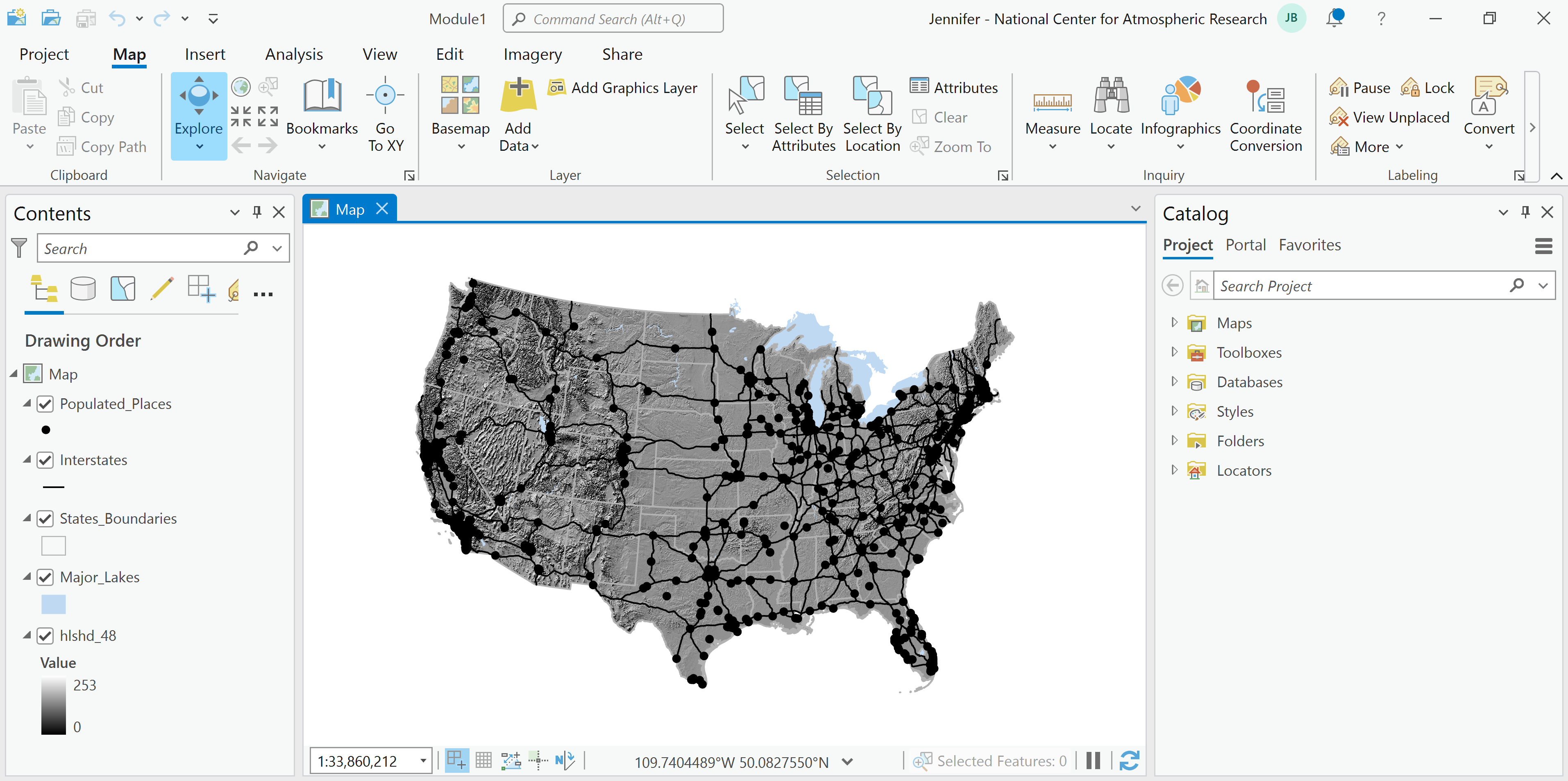
When starting a project in ArcGIS Pro, you can open a new or an existing project. Notice there are project templates in the right column under the sign-in information. You will open and explore an existing project.

* Click the button to Open another project.

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* Browse to <your working directory>\exercise1\Maps\_Data and select the Module1.ppkx file.

The Project contains three panes that are open. To the left is the Contents pane, in the middle is the map pane, and to the right is the Catalog pane. The Contents Pane on the left side of the window shows the drawing order of the data within the map. Underneath each data layer, the symbology is shown as well. The Catalog pane contains six standard connections: Maps, Toolboxes, Databases, Styles, Folders, and Locators.



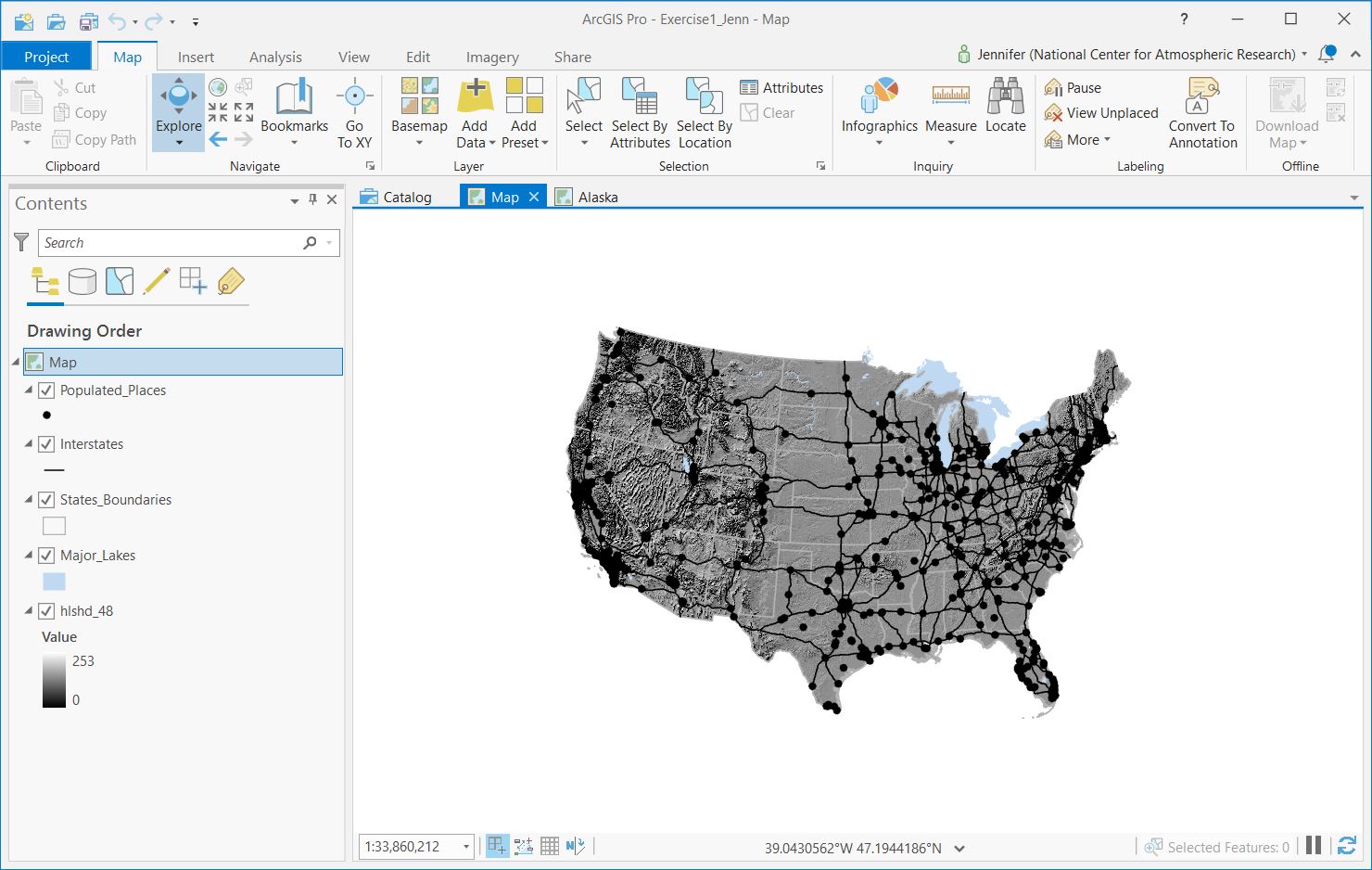
* Save the document by going to Project > Save as. Save the Project file in <your working directory>\exercise1\Maps\_Data as Exercise1\_<yourname>.
* In the future, you can click the symbol in the top left corner that has a purple disk in front of a folder to save.

TIP: It is good practice to use only alphanumeric characters or underscores in your file names and leave no spaces.

1. Exploring ribbons

Ribbons show how tools and actions are organized within ArcGIS Pro.

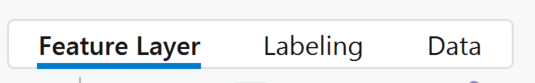
Make sure the **Map** tab above the main display is selected.



Explore the Map tab Ribbon. Notice how almost all actions have an associated symbol. Some of the Symbols may be greyed out, indicating that the specific action cannot be performed with the data currently selected.

* Select the “Populated\_Places” feature layer in the Contents pane.

The selected layer is highlighted in blue in the Contents pane. Once it is selected, three new tabs appear in the Ribbon: **Feature Layer, Labeling, and Data**.



* Explore the tabs specific to Feature Layer;

The Feature Layer tab has tools that will effect the way the layer is symbolized, and the visibility of the layer.

* Click the Labeling tab.

Notice that the options in the Ribbon now change to offer tools to symbol and create labels.

* Click the Data tab.

Now the Ribbon has tools to open and manage the attribute table, create joins and relates, to export data, and to create charts.

* Select hlshd\_48 (terrain) in the Contents pane.

Terrain layer is a raster layer, not a feature layer. When this is selected, the contextual tab set in the ribbon will change to raster-specific actions.

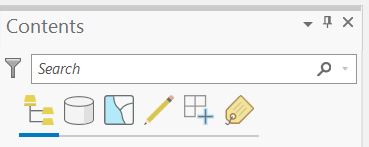
* Explore the contextual tabs specific to raster layers; “Raster Layer” and “Data.”

Notice the names of the raster layer tabs are similar to the feature layer tabs, however, the contents and symbols within them are different.

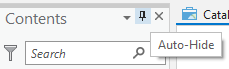
1. **Exploring panes**

The sidebars displayed on the left and right of the map are called “panes.” You can hide panes so that they will not display when you are not interacting with them.

* In the upper-right corner of the **Contents** pane, click the thumbnail icon to hide the pane (autohide).



* The **Contents** pane is now hidden and can be displayed by the vertical text on the left side of the map. Click on the text “**Contents.”**.
* When the **Contents** pane re-appears, click on the thumbnail again to turn off autohide.



As you work with different maps, views, and panes, you’ll open and close the panes you need for specific tasks. You can reposition or minimize them to make room for maps and other views. Grab the title bar of any view or pane to drag it to a target or let it float.

* Click on the **Contents** pane, and a blue bar (title bar) will appear on top. Click on it, and drag it to the center of the screen.

Notice the icons that appear on different parts of the screen that allow you to re-dock while you are dragging the window. For the remainder of the lessons, you will keep the contents pane in the default left position, but feel free to reposition windows as you see fit.

* To dock your **Contents** pane to the left of the map, click the title bar and drag the pane to the left towards the icon that appears to the left.
* In the **Contents** pane, right-click on **Map** and select **Properties**.



The map is called a data frame. Data Frames contain layers that you are mapping as well as many properties such as extent, and coordinate systems.

* Change the name to **United States.**
* Explore other tabs in the properties of the data frame.
* Click **OK** to save your changes.

1. Navigating and using the zoom and pan tools

Typically you will explore your data by specific geographic locations.

* On the top ribbon, select the **Map** tab. Within the **Navigate** group, select the **Explore** tool.

**If using a mouse**

* Push the **roller up** on your mouse to **Zoom In.**
* Pull the **roller down** on your mouse to **Zoom Out.**

**If using laptop touchpad**

* Click the third button and move finger down on touchpad to zoom in.
* Click the third button and move finger up on touchpad to zoom out.
* While the “**Map**” tab is still selected, click on the small globe symbol, next to the **Explore** tool, to show the full extent of the data within the map.

TIP: If there is no data within your map, the full extent will be the entire earth. To identify outliers in your data, sometimes it is helpful to turn off all layers except the one you are trying to examine. Zoom to full extent to see if any of the points or lines are much farther than the space of the general population.

* ****To return to the previous extent, click the **left facing arrow** icon in the Navigation group.

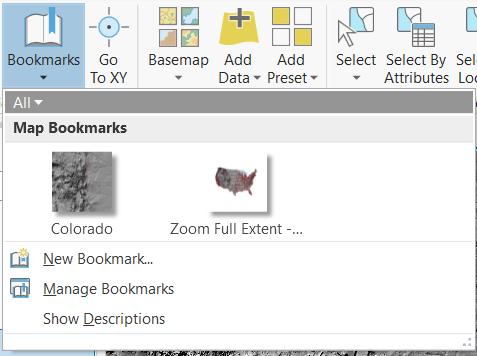
1. Accessing and creating bookmarks

Bookmarks are convenient for saving specific spatial extents of your map. Once created, you can add a description about why that bookmark is important. This exercise has two bookmarks already created, one for the full extent of the United States and one for the extent of Colorado.

* Click on **Bookmarks** again and select **Zoom full extent – US.**

Now you will learn how to create your own bookmarks.

* Using your cursor, zoom to **Texas.**
* From the bookmarks menu, click on **New Bookmark.**



* Type “**Texas”** for the title and in the description type “Texas is popularly known as The Lone Star State.”
* Click **OK.**

You now have a bookmark for Texas.

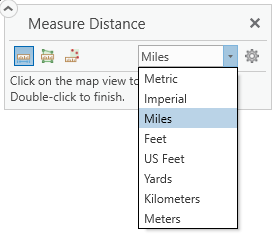
1. Using the measure tool to measure distances

* On the top **Map** ribbon in the **Inquiry** tab, find the ruler icon. This is the measure tool.
* Click on the small downward arrow underneath the ruler to reveal the different measuring functions.

The default setting of this tool is to measure a straight line, unless otherwise specified. Now you will test some of these functionalities.

* **Zoom Out** to the full extent of the United States using any of the technics you have learned so far.
* Click on the **Measure** tool. Click on the southernmost point of Texas. Drag the mouse over to the southernmost point of Florida and double click to end the measuring.

In the top left corner, the distance between the points is displayed. You can modify the units by selecting the drop-down menu at the top of the tool. You should see a distance of roughly 1,000 miles between the southernmost tips of Texas to Florida.



* Close the **Measure** tool window.

1. Layer properties

Each layer has an associated set of properties which can be modified. To access the layer properties, right-click on the layer in the **Contents** pane and select **Properties**.

* In the Contents pane, right-click on the **Populated Places** layer.
* Select **Properties**.

Here you will see a number of options.

* Click on the **General** tab.
* Change the layer name to **Cities.**

Changing the name in the General tab only changes how the name is displayed in the Contents pane. This does not change the name of the actual data. The map document is just accessing the layers, not storing them.

* Click on the **Source** tab. Explore the information provided.
* Click **OK** to close the layer properties**.**

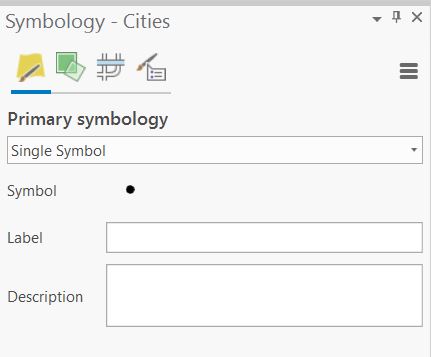
1. Symbolizing data

In this step you will change the way the data is symbolized.

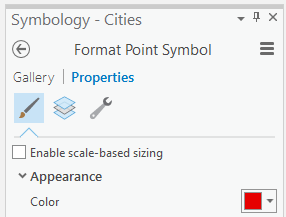
* Right-click on **Cities** in the **Contents** pane and select Symbology.

A new pane appears on the right side of the map. You can choose from an existing symbol in the gallery or customize it. You will manually change the default color of the symbol from black to red.

* Click on the black dot, which is the current symbol.



* Click on **Properties.**
* Change the color to red.



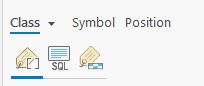
* Click **Apply** to save the new symbol formatting.
* Close the **Symbology** pane by click the X in the top right hand corner.

You can also label features on your map. Labeling adds descriptive text to your features on the map.

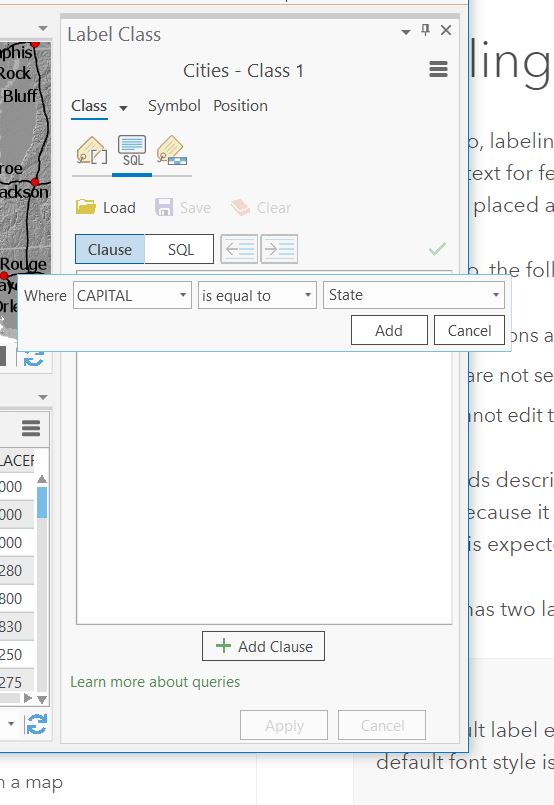
* Right-click on **Cities** and click on **Label**.

Labeling all the cities in the map may be too cluttered. For now, just label the capital cities for each state.

* Right-click on **Cities** again, and now select **Labeling Properties.**
* Click the SQL Query tool in the Label Class pane.



* Click on the **New Expression** button.
* Create the following query: “Where CAPITAL is equal to State.”



* Click Apply and exit out of the **Label Class**.
* Close the Label pane.
* Save your project

Now only the state capitals will be labeled in your map.

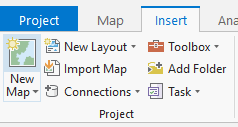
Adding data to ArcGIS Pro

In the following section, you will add tornado tracks and the National Weather Service County Warning Areas to your maps.

1. Start a new map

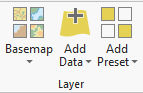
You will now start a new map.

* On the top ribbon, click the **Insert** tab.
* Click on New Map.



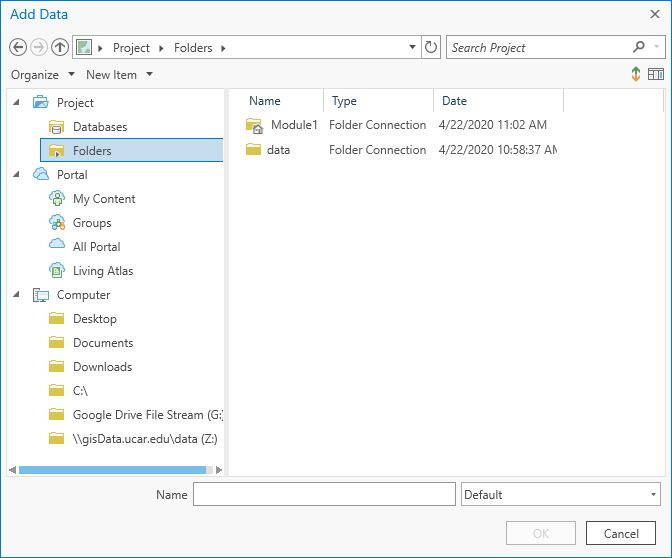
A new tab will appear, showing a basemap without any data.

* If your Catalog Pane is not open in the right hand side, then click the View tab on the top of the screen and select Catalog Pane.
* In the **Catalog** pane on the right, right-click on Folders, and click **Add Folder Connection**.
* Navigate to to <your working directory>\exercise1\Maps\_Data \data.
* Click OK.
* Make sure your new Map, “Map” is open in the display area.
* Click on **Map** on the top ribbon.
* Within the **Layer** tab, click the **Add Data** button.

Or the section may look like this ![A screenshot of a phone

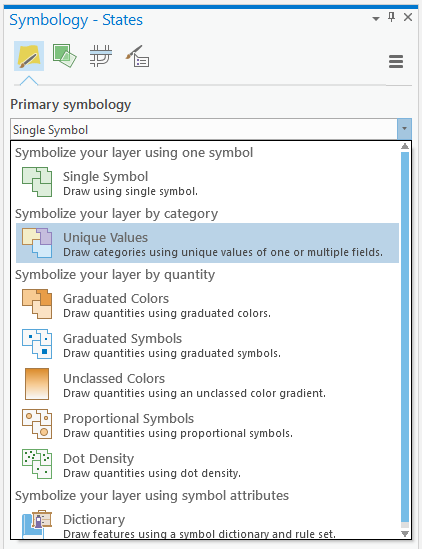
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* In the left-hand panel, click Folders, then in the right-hand panel click data.

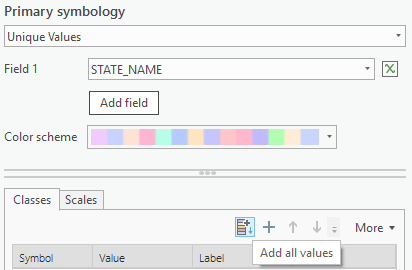


TIP: The extension will tell you what type of data you are adding, such as a shapefile, layer file, or raster dataset.

* Navigate to Folders > baseData.gdb and add the States feature class.
* Right-click on States and click on **Symbology.**
* From the dropdown menus (where single symbol is listed by default), select **Unique Values**.



* For Field 1, select **STATE\_NAME**.
* Click Add All Values.



Notice that each state is displayed by a unique color. This type of symbology does not show value or importance. The colors are used to differentiate the classes or groups of data.

* Change the color ramp to Enamal ( hover your mouse over the color ramps until the name appears).

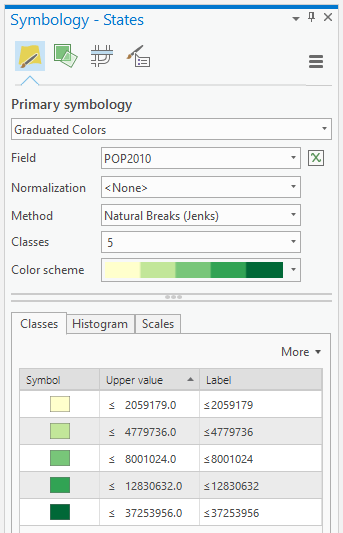
A screenshot of a computer

Description automatically generated with low confidence

* Click the Save button to save your project.

1. Symbology for quantitative data

In the previous step, you symbolized the layer **States**, based on State name. Each state was rendered with a unique color, but the colors did not reflect a measurement or magnitude. In this step, you will symbolize the layer **States**, based on the field population. This field is a quantity, meaning it can be counted or measured. When symbolizing quantitative data, you have many options on how to represent and group these measurements. In this step, you will have the opportunity to explore some of the different ways to symbolize quantitative data.



If the **Symbology** pane is closed, then right-click on the layer States in the **Contents** pane to open the **Symbology** pane.

From primary symbology, change Unique Values to Graduated **colors.**

Change the **Value** under **Field** to **POP2010**.

For the Color scheme, select the ramp that graduates from light to dark green.

This type of map is called a ***Choropleth*** map, and it displays state population for 2010.

Which states appears to have the greatest population in 2010?

It may also be important to visualize how the size of the state compares to its population. In this case, you would be mapping population density.

* Back in the **Symbology pane**, set the **Normalization** field to **SQMI** (3rd from the bottom).

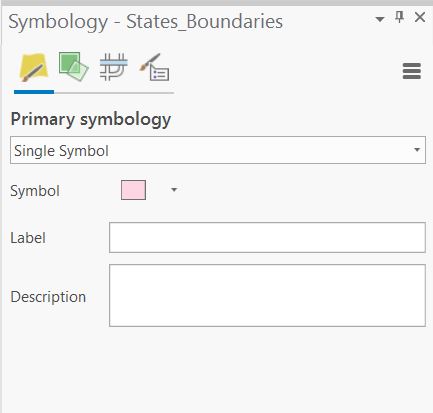
This option will normalize the value field **Population** by the normalization field of **miles squared** (size of the state).

Now which states appears to have the greatest population in 2010?

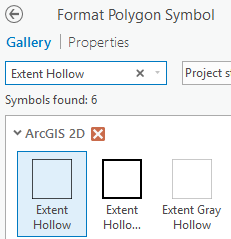
* Close the Symbology pane.
* Click Save.

Notice how different the map looks now. Texas and California are no longer dark green. Now the East Coast states, such as New Jersey and Massachusetts, are the dark green states. This example illustrates how important it is to understand what you are mapping before you start symbolizing the data. Both maps are correct but they show very different information.

* In the Catalog pane, navigate to Folders > data and drag NWS\_CWA\_Boundaries.shp, and Tornado\_tracks.shp into your map.
* Reorder the layers so that **NWS\_CWA\_Boundaries** is below the **States\_Boundaries** layer.
* Click on the **States** layer in the **Contents** pane.
* Back in the **Symbology** pane, change the Primary symbology back to **Single Symbol**, and click on the **symbol**.



* Click on Gallery.
* In the Search box, type in Extent Hollow and hit Enter.
* Click on the symbol Extent Hollow.



* Click the layer **NWS\_CWA\_Boundaries** in the Contents pane.
* In the **Symbology** pane, click the symbol.
* Select Black Outline (1pt) for the symbol.
* Click the **Properties** option.
* Change the Outline color to purple and click **Apply**.
* **Save** your project.

Working with attribute data in ArcGIS Pro

1. Selecting features through query

In many instances, you may want to select information based on attribute data rather than spatial data.

Tornadoes in the United States are often characterized by the maximum speed of their winds. The Fujita Scale, or “F scale”, characterizes the strength of a tornado from 0 to 5. F0 tornadoes with winds of 73 mph or less, while F5 tornadoes have winds of 218-318 mph.

You will now create a map of all the tornadoes in the US that were ranked as F4 or higher.

In the Tornado\_tracks attribute table, you will see one of the fields is FSCALE. This is where you will filter records.

By viewing the attribute table you can look at all the information for everything within a specific layer.

* Right-click on the **Tornado\_tracks** layer and click on **Attribute Table.**

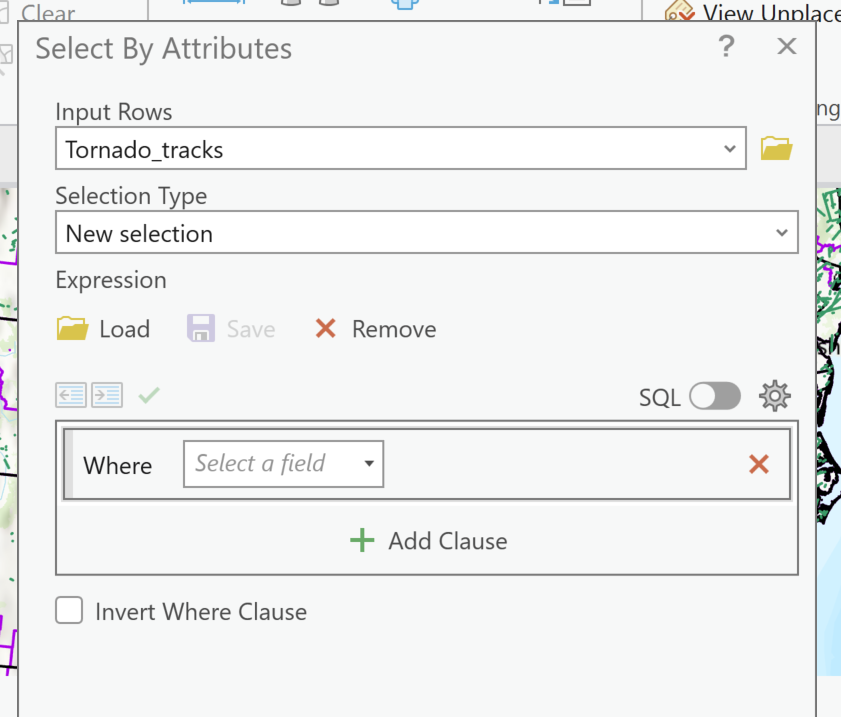
An attribute table is displayed as a series of rows and columns. These are also referred to as records and fields.

At the bottom of the table (if your selection is cleared) it will say 0 of 27,608 selected. There are 27,608 tornado features in this layer.

* In the attribute table, right-click on the **FSCALE** field and choose **Sort Descending**.

Notice that the largest Fscale category is 5. Now you will make selections based on tornado category.

* In the top **Map** tab within the **Selection** group, click on the **Select By Attributes** tool.
* From the **Input Rows** dropdown menu, select **Tornado\_tracks**. For selection type, leave it as **New** **selection**.
* In the Select a field drop-down, select the field **FSCALE**.
* The second pull-down menu allows you to choose the operation. For this case, select “is greater than or equal to.”
* The third pull-down menu is where you input the values. In our case, choose **4**.



* Click **OK.**

You will see that all the tornadoes with an F score of 4 or 5 were highlighted in blue.

* Open the **Attribute Table** for **Tornado\_tracks** and click on the icon in the lower left corner that has three blue rows. This shows only the selected records. You have 650 of 27608 records selected.



1. Applying multiple definition queries

In the previous step, you learned how to select only the tornados with a rating of 4 or higher on the Fujita Scale. Now let’s see if any of those occurred in the year that you were born. These records only extended to 2010, so if you were born past then, pick the year your parents were born.

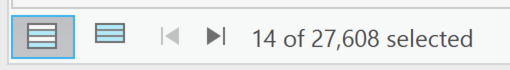
* In the **Map** tab within the **Selection** group, click on the **Select By Attributes** tool.
* Make sure you still see your first query “Where FSCALE is greater than or equal to 4” in the selection box.
* Click **Add Clause**.

Notice this interface is identical to a new dropdown menu on the left that allows you to make it an “AND or OR” statement. You want **F4 or higher tornadoes** that occurred **in your birth year**, so this is an **AND** statement.

* Select **And** in the first dropdown box.
* Choose **YEAR**\_ for the field, then **is Equal to**, then select your birth year.

TIP: If you want to learn what SQL looks like and get more familiar with the format, you can click the SQL button to display the query you created in SQL. For this selection, it should look like “FSCALE >= 4 And YEAR\_ = 1996” (if you were born in 1996).

* Click **OK** to run the selection
* Open the **attribute table** for **Tornado\_tracks** and examine the results. Similar to the previous selection, all the selected results appear highlighted in light blue on the map.
* At the bottom of the attribute table click the button to show only the Selected Records.



How many F4 tornados occurred in the year you were born? Were there any F5 tornadoes?

Queries are one method of exploring your data in ArcGIS Pro and are key to spatial analyses. You will dive further into this functionality in later exercises.

* Clear your selection.
* Save your project.
* **Save** your project and close ArcGIS Pro.

In this first exercise you learned how to work with spatial data in ArcGIS Pro. As you dive into examples in the context of atmospheric science, challenge yourself to think of other ways GIS could be used.