



GST 101: Introduction to Geospatial Technology Lab Series

Lab 4: Displaying Geospatial Data

Document Version: **2013-07-30**

Organization: Del Mar College
Author: Richard Smith

Copyright © National Information Security, Geospatial Technologies Consortium (NISGTC)

The development of this document is funded by the Department of Labor (DOL) Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant No. TC-22525-11-60-A-48; The National Information Security, Geospatial Technologies Consortium (NISGTC) is an entity of Collin College of Texas, Bellevue College of Washington, Bunker Hill Community College of Massachusetts, Del Mar College of Texas, Moraine Valley Community College of Illinois, Rio Salado College of Arizona, and Salt Lake Community College of Utah. This work is licensed under the Creative Commons Attribution 3.0 Unported License. To view a copy of this license, visit <http://creativecommons.org/licenses/by/3.0/> or send a letter to Creative Commons, 444 Castro Street, Suite 900, Mountain View, California, 94041, USA.



The Center for Systems Security and Information Assurance (CSSIA), in partnership with the Network Development Group (NDG) is given a perpetual worldwide waiver to distribute per US Law this lab and future derivatives of these works.

Contents

Introduction	3
Objective: Create a Map that Meets the Customer's Requirements	3
Lab Settings	5
1 Add Data, Create Inset Maps, and Set Map Projections	6
1.1 Adding Data to a New Map Document	6
1.2 Creating Inset Maps	6
1.3 Setting Map Projections	9
2 Symbolize Election Results.....	11
2.1 Symbolizing the Election Results.....	11
2.2 Copying Symbolization to other Data Frames	12
3 Design Map Layout	13
3.1 Positioning Inset Maps	13
3.2 Adding a Descriptive Title	15
3.3 Adding a Legend	16
3.4 Adding a Neatline	18
3.5 Adding Metadata.....	18
Conclusion.....	20
Discussion Questions	20

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, students will learn how to create a well-designed Choropleth map of the results of the 2008 United States presidential election. In this lab the student will practice good map layout practices, learn how to add multiple map elements, and add multiple data frames to a map document in ArcMap.

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

This lab includes three tasks:

1. Add Data, Create Inset Maps, and Set Map Projections
2. Symbolize Election Results
3. Design Map Layout

Objective: Create a Map that Meets the Customer's Requirements

Often times, you will be provided with a map requirements document from a customer or coworker. For this lab, the student will respond to a map requirements document from a customer who is writing a paper about the 2008 United States presidential election. The map requirements document receipt for the customer is below.

Map Requirements from the Customer:

Hi, my name is Jerry Stephanopoulos. I'm writing a paper about the 2008 USA presidential election, and need a figure showing percent ranges by which each candidate won each county in all states across the nation. I want to see visually how commanding their win was by percentage points.

In the data set I am providing to you (elpo09p020.shp), I have created the column named "DEMREP" which represent the percentage of the public that voted Democrat in each state, minus the percentage that voted Republican (PERCENTDEM – PERCENTREP). In that column, negative value represents Republican advantage in percentage, and a positive number represents a Democrat advantage in percentage.

For the percentage ranges, this is what I want:

- *In Red - Republican advantage*
- *In Blue - Democrat advantage*

- *These percentage values for each candidate*
 - *0 – 5%*
 - *6 – 10%*
 - *11 – 25%*
 - *25 – 50%*
 - *> 50%*

Note that I am ignoring "Other" votes for this map.

I trust that you will get the figures right the first time so please just submit the completed figures to the managing editor directly.

Lab Settings

Required Virtual Machines and Applications

Windows Machine User Account	Train
Windows Machine User Password	Train1ng\$


1 Add Data, Create Inset Maps, and Set Map Projections

Mr. Stephanopoulos was kind enough to provide us with three geospatial datasets to use for this map:

- USA State outlines – States.shp
- Canada and Mexico's Boundaries - Canada_and_Mexico.shp
- 2008 Presidential Election Results – elpo08p020.shp

1.1 Adding Data to a New Map Document

In this task, we will add these datasets to the map and select an appropriate map projection to use for a thematic map and insets displaying the lower 48, Hawaii, and Alaska.

1. Log in to the computer using the settings provided in the Lab Settings section.
2. Copy the *Lab 4 Data* folder from the *Shared_Drive\GST101* to the *GST 101* folder you created on the C: drive.
3. **Open ArcMap** to a blank map document.
4. Click the **Add Data button**  and add all three geospatial datasets that Mr. Stephanopoulos provided to the map document. Ignore the coordinate systems warning.
5. **Save** the map document as `2008 Presidential Election Results.mxd` in your *Lab 4* folder.

1.2 Creating Inset Maps

It would be a poor design if we showed the contiguous 48 states of the USA, Alaska, and Hawaii all on one data frame. Therefore, we will place Alaska and Hawaii in data frames by themselves and make them inset maps. This will maximize the size that we can make the map body and will make for an interesting layout.

1. Rename the current Data Frame by **double-clicking** on the word **Layers** in the Table of Contents (TOC), clicking on **General tab** and changing the **Name** to **Lower 48**. See [Figure 1](#) for clarification on where to double-click.

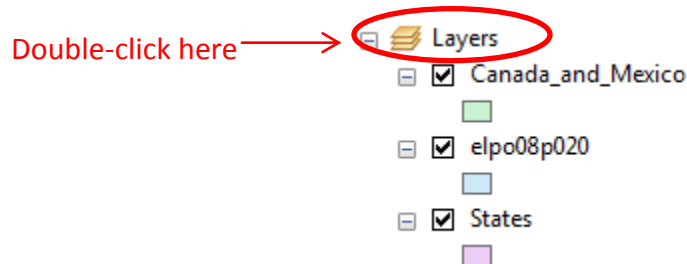


Figure 1: Layers Data Frame

2. On the main menu bar, **click Insert → Data Frame** to create a new data frame. In ArcMap, a data frame is a collection of layers at a map extent, scale, and map projection. Think of each data frame as an individual map body.
3. **Rename** the newly created **data frame** to **Hawaii**.
4. **Repeat steps 2 and 3** to create a data frame named **Alaska**.
5. While we are renaming, **rename** the **elpo08p020** layer to **Election Results** by accessing the properties of the layer (double-click on a layer in the TOC to open the properties of the layer).

You may have noticed that the map area is now blank after creating the two new data frames. That is because only one data frame can be activated at a time when in Data View. The active data frame's title is in bold in the TOC to indicate that it is the active data frame. Let's reactivate the Lower 48 data frame so we can see the United States again.

6. **Right-click** the words "**Lower 48**" in the TOC, then click **Activate**. This will activate this data frame and it will be visible in the Data View.

Now, we will do a small bit of cartographic design on the Lower 48 data frame and then copy the layers to the other data frames. This will help all three data frames have the same basic look.

7. Drag the layers to put them in this order (from top to bottom):
 - a. States
 - b. Election Results
 - c. Canada_and_Mexico
8. Open the **properties** for the **Canada_and_Mexico** layer.
9. Click the **Symbology** tab.
10. In the **Show:** section on the left, **choose Features → Single Symbol** if not already selected.
11. Click on the **Symbol** icon to open the symbol selector. See [Figure 2](#) for clarification on where to click

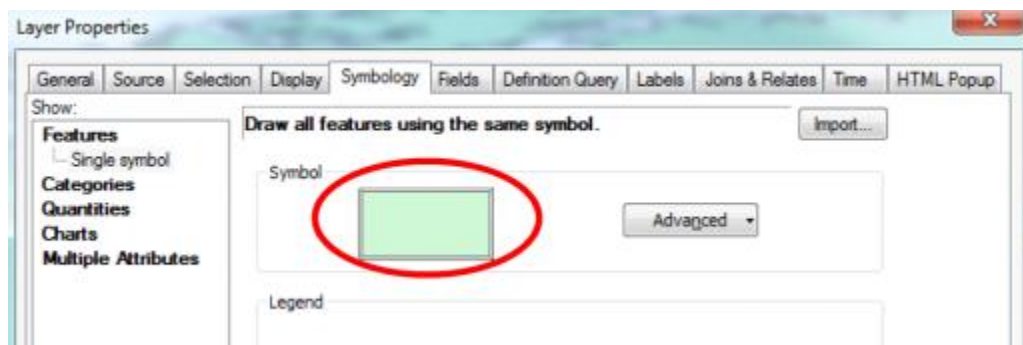


Figure 2: Click Symbol Icon to Open Symbol Selector

12. Click the **Fill Color icon** to open the color selector, then click **More Colors...** This opens another color selector that allows you to choose specific colors by values.
13. Click the **dropdown** in the **top right corner**, and **choose HSV**, which is the Hue, Saturation, Value color model.
14. Set the following color values (compare to [Figure 3](#)):
 - a. **H: 0**
 - b. **S: 0**
 - c. **V: 93**

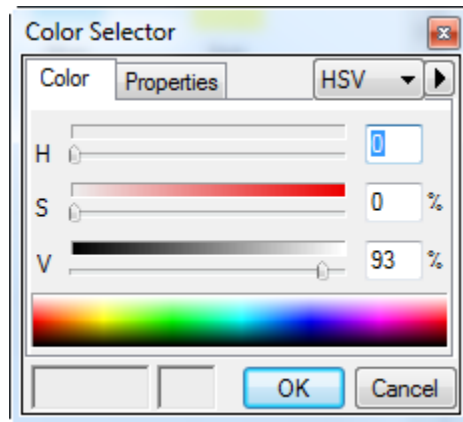


Figure 3: Color Selector with HSV Color Model

15. Click **OK** to close the color selector.
16. Set the **Outline Width** to 0.00. This will remove any outline from Canada and Mexico and allow it to fade into the background. Having Canada and Mexico fade into the background provides spatial context to the USA, and provides a good, subtle background for our map.
17. Click **OK** to close the Symbol Selector.
18. Click **OK** to close the layer properties window and accept the symbology.
19. **Repeat Steps 8-18** to symbolize the **States** layer with these settings:
 - a. **Features → Single Symbol**
 - b. Fill Color: No Color
 - c. Outline Width: 1.00
 - d. Outline Color: Arctic White (First row, first column of color selector).

Now that we have the States and Canada_and_Mexico layers symbolized, we will copy all layers to each data frame.

20. Click the States Layer in the TOC.
21. While holding down the **Ctrl** key on your keyboard, click **Election Results, Canada** and **Mexico** to select all three data layers at once.
22. Right-click on **States** layer in TOC, then choose **Copy**.
23. Right-click on **Hawaii** Data Frame, then choose **Paste Layer(s)**.
24. **Repeat steps 20-23** to paste layers in the **Alaska** Data Frame.

All three data frames now have the same symbology. You can check by activating each of the three frames to compare. Now we will set the background color of each data frame to act as the water features.

25. Open Lower 48's Data Frame Properties.
26. Click the **Frame** tab.
27. Click the **large dropdown** in the **Background section** and choose **Lt Cyan** color.
28. Click the **Color icon** in the **Background section**. Choose **More Colors...**, set the **HSV Color model**, and set the following values:
 - a. **H: 202**
 - b. **S: 10**
 - c. **V: 100**
29. Click **OK twice** to set the background color.
30. Repeat steps 25-29 for **Hawaii** and **Alaska** data frames.

1.3 Setting Map Projections

With the background symbology set, we now need to focus on setting the correct map projections for the data, scale, and type of map. Since this will be a quantitative thematic map comparing voting percentages per county, an equal area projection would be a good choice.

Since the Lower 48, Hawaii, and Alaska are so geographically displaced, a single map projection for all three data frames is not optimal. Instead, each data frame will have a different map projection that was designed for the geographic area being displayed.

1. Open the Lower 48 Data Frame Properties.
2. Click the **Coordinate System** tab.
3. **Expand Projected Coordinate Systems → Continental → North America** and then choose **North American Albers Equal Area Conic**.
4. Click **OK** to set the map projection. Click **Yes** if a map projection notice appears. Use the zoom and pan tools to zoom in to the Lower 48 as close as possible while still showing all of the states (don't forget to activate the data frame). See [Figure 4](#) for comparison.

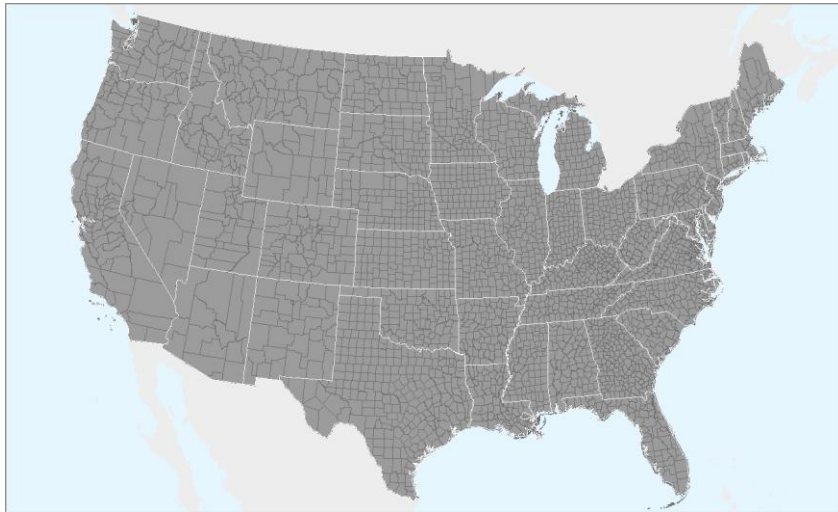


Figure 4: Lower 48 Data Frame with Map Projection Set

5. **Repeat steps 1-4** for the other two data frames. Set the following projections:
 - a. **Hawaii: Projected Coordinate Systems → Continental → North America → Hawaii Albers Equal Area Conic**
 - b. **Alaska: Projected Coordinate Systems → Continental → North America → Alaska Albers Equal Area Conic**

2 Symbolize Election Results

With the data frames set up, we can now focus on symbolizing the election results. We will symbolize the election results for the Lower 48 data frame, and then use an alternative method to copy over the symbology to the other two data frames.

2.1 Symbolizing the Election Results

1. **Open Election Results Properties** then select **Symbology** tab.
2. In the **Show** section, choose **Quantities** → **Graduated Colors**.
3. For the **Fields Value**, choose **DEMREP**.
4. **Select 11 Classes** in the Classes dropdown box.
5. Following Mr. Stephanopoulos' percentage requirements, we will **set** the following **ranges** by **clicking in each Range** field and overwriting the current values. Start at the top and work your way down (compare to picture, color may be different):

	Symbol	Range
a. -50		-87.730003 - -50.000000
b. -25		-49.999999 - -25.000000
c. -10		-24.999999 - -10.000000
d. -5		-9.999999 - -5.000000
e. 0		-4.999999 - 0.000000
f. 0		0.000001 - 0.000000
g. 5		0.000001 - 5.000000
h. 10		5.000001 - 10.000000
i. 25		10.000001 - 25.000000
j. 50		25.000001 - 50.000000
k. 100		50.000001 - 100.000000

Next, we will need to create a diverging color ramp to represent the democratic advantage in blue, republican advantage in red, and no advantage in white.

6. Right-click on the **Color Ramp** and uncheck **Graphic View**.
7. Choose **Condition Number** color ramp (10th from top).
8. Right-click on the **Color Ramp** and choose **Properties**. This will open the Edit Color Ramp window.
9. Select the top **Algorithmic Color Ramp** and then click **Properties**.
10. For **Color 1**, choose **Tuscan Red** (2nd column, 5th row).
11. For **Color 2**, choose **Gray 20%** (1st column, 3rd row).
12. Click OK to return to the Edit Color Ramp window.
13. Select the bottom **Algorithmic Color Ramp** and then click **Properties**.
14. For **Color 1**, choose **Gray 20%** (1st column, 3rd row).
15. For **Color 2**, choose **Ultra Blue** (10th column, 5th row).
16. Click OK twice to return to the layer properties.
17. Click the word **"Symbol"** right below the color ramp, then choose **Properties for all Symbols...**
18. Set **Outline Width** to **0.00**. Click OK.

19. If the symbols and ranges match [Figure 5: Election Symbology Set](#), then **Click OK** to set the symbology.












Symbol	Range	Label
	-87.730003 - -50.000000	-87.730003 - -50.000000
	-49.999999 - -25.000000	-49.999999 - -25.000000
	-24.999999 - -10.000000	-24.999999 - -10.000000
	-9.999999 - -5.000000	-9.999999 - -5.000000
	-4.999999 - 0.000000	-4.999999 - 0.000000
	0.000001 - 0.000000	0.000001 - 0.000000
	0.000001 - 5.000000	0.000001 - 5.000000
	5.000001 - 10.000000	5.000001 - 10.000000
	10.000001 - 25.000000	10.000001 - 25.000000
	25.000001 - 50.000000	25.000001 - 50.000000
	50.000001 - 100.000000	50.000001 - 100.000000

Figure 5: Election Symbology Set

2.2 Copying Symbolization to other Data Frames

With the symbology set, we can import the symbology to the other two data frames' Election Results layer.

1. Open the Properties for **Election Results** in the **Hawaii Data Frame**.
2. Click the **Symbology** tab.
3. Click the **Import** button. Set the following options:
 - a. Import symbology definition from another layer....
 - b. Layer: Election Results (choose one of the two)
 - c. Complete symbology definition
4. Click OK.
 - a. If it did not prompt you to select a value field, repeat step 3, but choose the other Election Results layer on step 3.b.
5. Select **DEMREP** as the **Value Field**.
6. Click OK to complete the import.
7. Click OK to close the layer properties and accept the symbology.
8. Verify that it worked by activating the **Hawaii** data frame.
9. **Repeat steps 1-8** for the Election Results in the **Alaska** data frame.

3 Design Map Layout

With the symbology set, the last step is to design the map layout. For this map, we will need to strategically position the two inset maps, add a descriptive title, legend, neatline, and metadata.

3.1 Positioning Inset Maps

1. Switch to Layout View by clicking **View → Layout View**.

Layout view lets us design our map on a virtual piece of paper. In Layout View, you should see all three data frames placed in the center of the map in an overlapping mess. We will reposition the data frames so they look good on the map.

2. To maximize our space on the page, switch the page orientation to landscape view by clicking **File → Page and Print Setup**. In the **Map Page Size** area...
 - a. **Uncheck Use Printer Paper Settings** This separates the digital piece of paper from the page size of the printer attached to the computer. If you are going to print the map on the attached printer, leave this box checked.
 - b. For the Page Standard Size, **select Letter**.
 - c. Select **Landscape** as the orientation.
 - d. **Click OK** if your settings match the settings in the figure below.

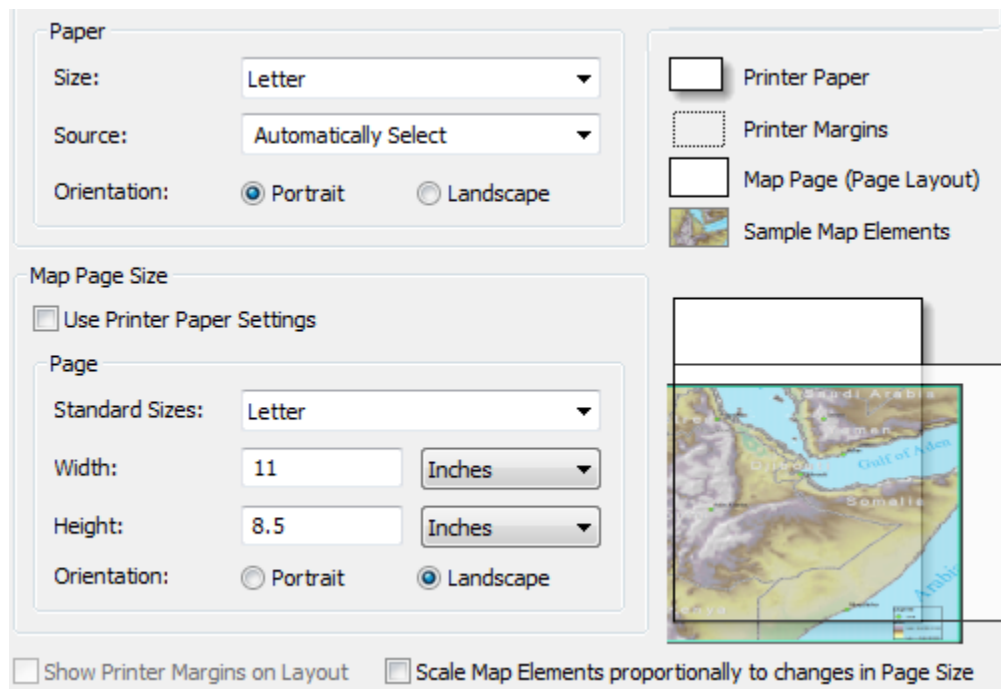


Figure 6: Page Settings

3. With the page orientation changed, the data frames may exceed the size of the page. **Click and resize** each data frame so they resemble [Figure 8](#).
 - a. Click on each data frame once. This will expose the movement handles (8 blue boxes). You can use these handles to resize the data frames.
 - b. When you reposition the data frames, you may need to reposition the data inside the data frames. Use the Zoom, Pan, and Full Extent Tools to make the data take up the entire data frame.
 - c. If you wish to zoom in to the map layout page to have a closer look when lining things up, enable the Layout Toolbar, and use the Zoom, Pan, etc.. functions to move around the virtual map page.



Figure 7: Layout Toolbar

The layout toolbar has similar tools to the tools found in the General toolbar. The Zoom in, Zoom out, and Pan tools in the general toolbar will still function in layout view but will function differently. If needed, you can use these tools to reposition the maps in their respective data frames. Try out both sets of tools to see how they work differently.

- d. To make the Alaska and Hawaii data frames the same size, while holding down the *Shift* key on your keyboard, click the two data frames, then right-click on one of them and choose **Distribute → Make Same Size**.
- e. You can set alignment guides by clicking on the two rulers around the layout view. With an alignment guide set, data frames and map elements should snap to the guide. Right-click on a ruler to expose additional ruler options and operations.
- f. You can align data frames with each other by selecting both data frames, right-clicking and choosing **Align → <<alignment option>>**

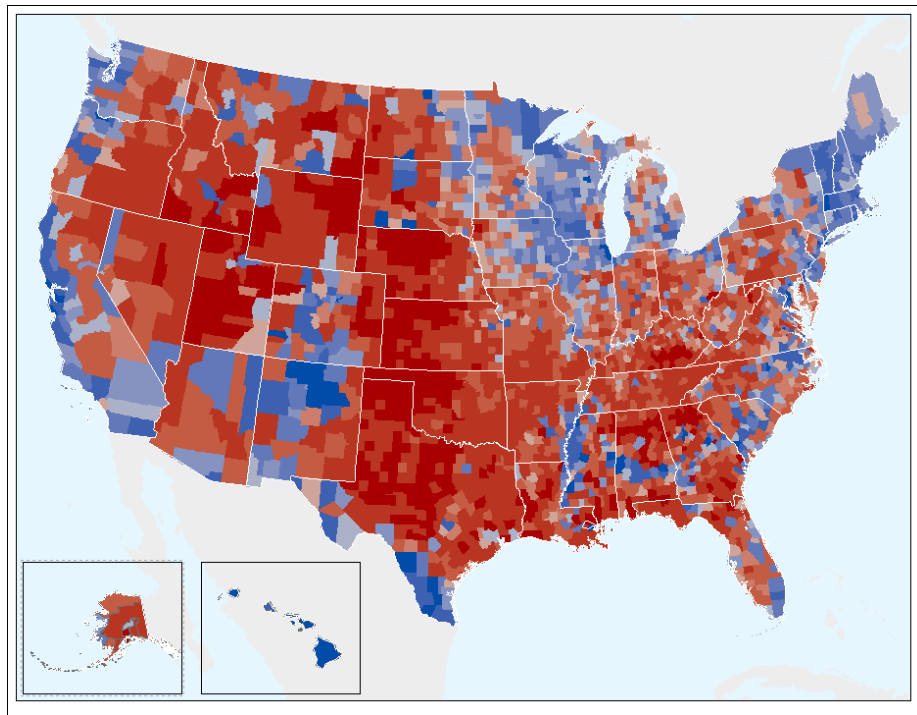


Figure 8: Initial Map Layout

The Alaska and Hawaii data frames may allow the background data to show through. We will assign a shadow to these two inset maps to have them visually separate from the background.

4. Right-click on the **Alaska Data Frame** and choose **Properties**.
5. Click the **Frame** tab.
6. Click the Large Drop Down Box in the **Drop Shadow** section and choose **Grey 20%**.
7. Set the **X Offset** to **5** and **Y Offset** to **-5**.
8. Click **OK**.

3.2 Adding a Descriptive Title

1. Click **Insert → Title** from the main menu bar.
2. Enter a **descriptive title**, such as: **Margin of Victory in the 2008 Presidential Election**, then
3. Click **OK**.
4. Position the title at the top, center of the page. You can make sure the title is centered by:
 - a. Right-click the **Title** and choose **Align → Align to Margins**
 - b. Right-click the **Title** again and choose **Align → Align Center**
5. Increase the font size of the title.
 - a. Right-click the **Title** and choose **Properties**.
 - b. Click **Change Symbol...**
 - c. Set **Size** to **18**.
 - d. Click **OK** twice.

3.3 Adding a Legend

1. **Activate the Lower 48 Data Frame.**
2. **Click Insert → Legend** to open the Legend Wizard.
3. Using the less-than angle bracket, **move States and Canada_and_Mexico out of the Legend Items box.** We are not including these two layers in the legend because the States layer is simply the outline, and map readers should be familiar with the state boundaries, and Canada and Mexico are simply background and are not important to identify (plus we hope that the map reader knows what these land masses are!).
4. Click Next.
5. Change the Legend Title to **Margin of Victory (% of votes).**
6. Click **Next three times then Finish** to add the legend to the map.

There are a few issues with the legend as added. It is excessively large, the shadow does not match the shadow of the inset maps, there are way too many significant digits in the percent numbers, and the words "Election Results" and "DEMREP" are not meaningful to the map reader. We will now fix these issues.

1. **Resize the Legend** to roughly the height of Texas.
2. Open the **Properties** of the **Election Results** Layer in the Lower 48 Data Frame.
3. **Click Symbology tab.**
4. **Click "Label"** at the top of the list of labels in the list of classes then choose **Format Labels.**
 - a. **Category: Numeric**
 - b. **Rounding: Number of decimal places: 1**
 - c. **Click OK.**
5. The dash that separates the two numbers is confusing as it is right before a negative sign. Additionally, the republican advantage is represented as a negative percentage, which does not make sense. To fix this, we will replace the dash with the word "to" and remove the negative signs.
 - a. **Click each label in the list and make the above mentioned changes.** Your labels should look like the figure below.
 - b. **Click OK.**

Symbol	Range	Label
	-87.730003 - -50.000000	87.7to 50.0
	-49.999999 - -25.000000	49.9to 25.0
	-24.999999 - -10.000000	24.9to 10.0
	-9.999999 - -5.000000	9.9to 5.0
	-4.999999 - 0.000000	4.9to 0.1
	0.000001 - 0.000000	No Advantage
	0.000001 - 5.000000	0.1 to 4.9
	5.000001 - 10.000000	5.0to 9.9
	10.000001 - 25.000000	10.0to 24.9
	25.000001 - 50.000000	25.0to 49.9
	50.000001 - 100.000000	50.0to 100.0

Figure 9: Friendly Labels

While ArcMap's Legend tools provide many options, sometimes we want to modify the legend beyond ArcMap's capabilities. In order to do that, we will convert the legend to graphics, which allows us very fine control over the legend elements. Note, however, that once you convert a legend to graphics, it is no longer linked to the layers, and any changes you make to the layer's colors, labels, etc... will not be updated in the legend automatically; you must re-insert a legend if you wish to link to the layers again.

6. Right-click the Legend and choose Convert to Graphics.

The legend is now a set of grouped graphic elements. In order to gain finer control, we will ungroup the legend items.

7. Right-click the Legend and choose Ungroup.

You will now see that each legend element is now individually modifiable. Perform the following steps to create the legend pictured in [Figure 10](#).

Use the align, group, ungroup, and distribute commands available in the contextual menus (by right-clicking) to align and manage the individual items.

If you make a mistake, you can click **Edit → Undo <<action>>** to undo the previous action(s).

8. **Delete 'Election Results' and 'DEMREP'** by right-clicking each one and choosing **Delete**.
9. Create three columns of classes: one for Republican advantage, one for democrat advantage, and one for no advantage. Don't forget to reverse the order of the Democrat advantage classes
10. Insert subtitles for both Republican and Democrat columns by clicking **Insert → Text** from the main menu bar.

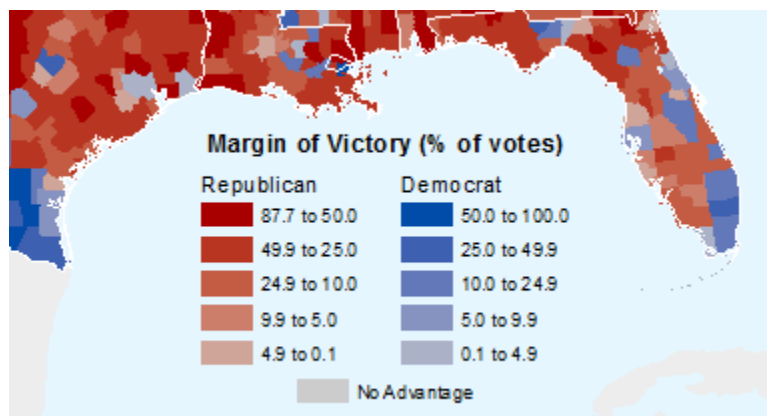


Figure 10: Final Legend Design

3.4 Adding a Neatline

Neatlines help frame the map and separate it visually from the rest of the page. We will add one neatline to surround the map and provide a nice visual contrast from the page and help our eyes frame and focus on the map.

You may have noticed that there is already a neatline surrounding the Lower 48 data frame. Since the Lower 48 data frame encompasses all other map elements, it will be the neatline for the entire map layout. If, however, some map elements were placed outside the Lower 48 map frame, you would choose **Insert → Neatline** from the main menu bar to add a new neatline to the layout.

We will make the Lower 48 data frame's neatline twice as thick to provide a nice frame for the map.

1. **Open the Properties** for the **Lower 48** data frame.
2. **Click Frame tab.**
3. For the **Border**, choose **2.0 Point** (5th from top).
4. **Click OK.**

3.5 Adding Metadata

Lastly, we need to put the name of the map author (you!) and the source of the data on the map. Typically, the metadata is not something that should attract the eye. Map readers will search for this information if they choose to know this information. Therefore, the metadata will be placed in the lower-right hand corner of the map in a small font.

1. **Click Insert → Text** from the main menu bar.
2. Enter the following:
Map Author: <<your name>>
Data Source: **NationalAtlas.gov**
3. Change the font size to 6 pt. font by right clicking on the text box and selecting Properties.

That completes the map! Your map should look similar to [Figure 11](#).

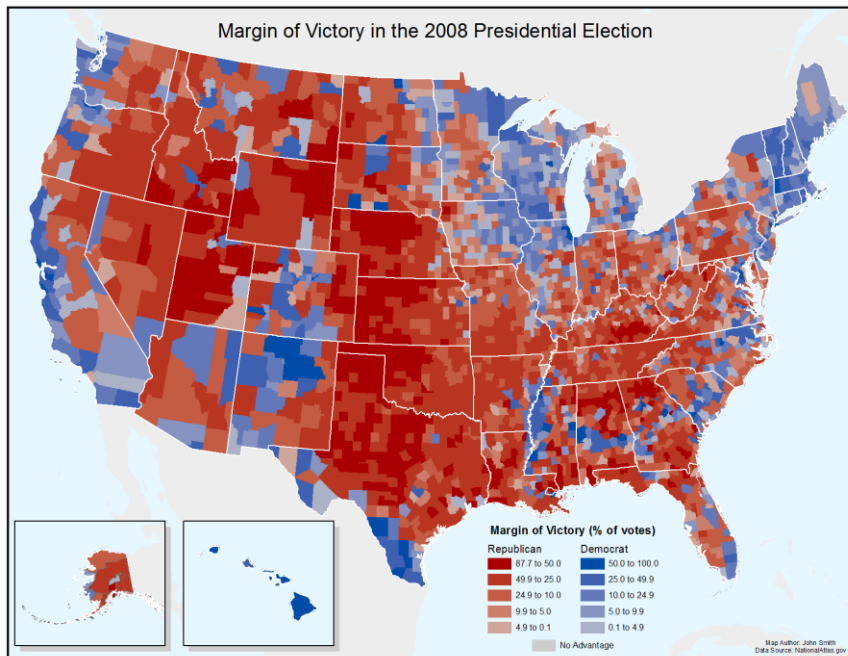


Figure 11: Final Map Design

Conclusion

In this lab, you have created a well-designed map using some of the cartography tools available in ArcGIS. You created two inset maps, deemphasized the background, arranged the data into individual classes, created a custom legend, and provided a visual balance to the map. I am sure that Mr. Stephanopoulos will be pleased with your work.

Discussion Questions

1. In Task 1.2 you copied and pasted the data layers after setting the symbology so that it will be the same in all three data frames. What is another way that you can make the symbology the same without copy-paste?
2. In the final map layout (shown in Figure 11), Hawaii seems to be quite large in comparison to Alaska. What strategies might you undertake to either 1) rectify this, or 2) alert the map-reader?
3. If the page orientation was portrait, how would you redesign the map to better fit that page orientation? Would a map redesign still be needed if the map is surrounded by a neatline?
4. No map is perfect. Critique the map you created during this lab. What do you like about it? What do you dislike about it? How would you change this map to improve it?