

## **Laboratory 0: “Intro to GIS and ArcGIS”**

*By Brent Hecht*

### **Introduction**

Welcome to your first GIS lab! The author of this lab finds GIS to be one of the interesting and, yes, *fun* subjects he has taught. The purpose of this lab is to try to inspire in you some of the same energy about GIS, as well as to introduce you to some of the fundamentals of ArcGIS. ArcGIS is the industry-leading GIS program and is the software you will use to complete all of your labs in this class. We'll start out with the fundamentals, then we'll get to the good stuff.

**Please remember to read *everything* in this lab. All of it is important, except for the occasional lame joke.**

Finally, please answer all questions in a Word document. You will be turning in this document at the end of the lab, along with two fancy PDF maps you'll be making.

*Note: The ArcGIS website can be found at <http://www.esri.com/products.html>*

### **Lab Objectives**

#### *Part I*

- Learn the fundamentals of the ArcGIS software
- Learn how to turn in assignments
- Explore GIS problem solving
- Begin thinking like a GIS user

#### *Part II*

- Have fun with exciting data sets
- Understand how GIS can be used to solve an unbelievable number of problems

### **Part I**

### 1. Open ArcMap 9.2

While we speak of ArcGIS as a single product, it is actually a suite of applications. For now, we'll just be dealing with ArcMap

Unlike in the past, new versions of ArcMap behave *exactly* like many other Windows programs you have used. For instance, it can be activated simply by going into the start menu and choosing All Programs -> ArcGIS -> ArcMap. Now, wait a second. It usually takes a little while for ArcMap to get its gears up and running.

Press "OK" (Choose "A new empty map")

### 2. Put your USB keychain drive into action

Make a folder on your USB keychain drive called "GIS", "IHeartGIS", or whatever else you like. Inside that folder, make a folder called "Lab0". Notice I am not putting any spaces in the names. To be safe, it's best to never put spaces in the names of folders or directories that you plan on using for GIS. This is a holdover from the days when Chuck Norris was on primetime TV.

### 3. Download a shapefile

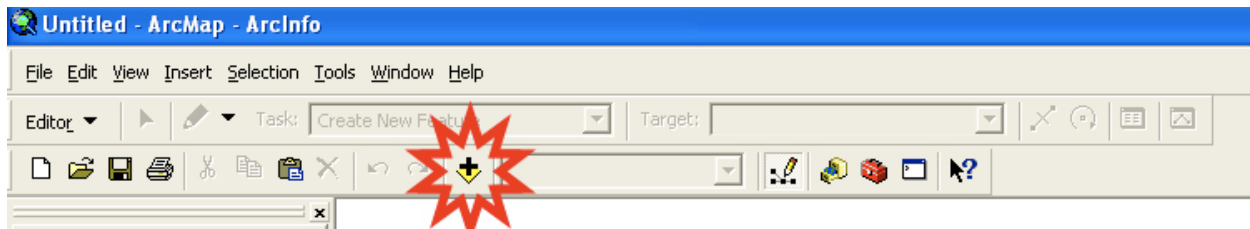
Go into a web browser and go to the URL: [http://uweb.ucsb.edu/~bhecht/176A/STATES\\_Projected.zip](http://uweb.ucsb.edu/~bhecht/176A/STATES_Projected.zip). Save the zip archive to the folder you just created and unzip it by right clicking on it, choosing "Extract all..." and follow the instructions.

Just like Microsoft Word uses ".doc" files and Adobe Acrobat has ".pdf" files, GIS software packages boast their own *file formats*. In fact, ArcGIS supports many types of spatial file formats (and there are *many*). One of the most popular of these formats is the *shapefile*, or the ".shp" file. Much of the spatial data you find on the Internet that is meant for advanced GIS analysis comes in the shapefile format.

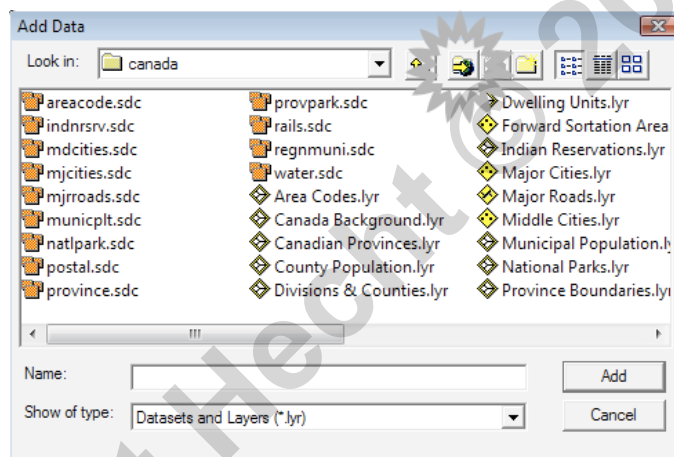
Calling the shapefile a "file format" is somewhat of a misnomer. In fact, a "shapefile" is a set of at least 3 files (sometimes more), all with the same file name but with different *extensions*. A file extension is the three or four letter code that follows the period in file names. More specifically, a shapefile called "STATES\_Projected.shp" (like the one you downloaded) consists of at least "STATES\_Projected.shp", "STATES\_Projected.shx" and "STATES\_Projected.dbf". We'll talk about what each file does in a little bit. (For your over-achievers, most shapefiles also come with a .prj file. Can you guess what that is for?)

### 4. Add the shapefile to the map

Back in ArcMap, click on the icon in the *standard toolbar* that has a "+" on it, as seen below:



Navigate to the the folder you just created and select “STATES\_Projected.shp”. If you haven’t already, you’ll need to *connect* to your USB key drive folder. Do this by hitting the “Connect to Folder” button (see below) and selecting the key drive. Next, double-click on the key drive in the main “Add Data” window and you should see “STATES\_Projected.shp”.



Viola! You should see a map displayed in the *data frame*. You’re now officially a GIS user! But we’re only 0.000001 percent into the good part...

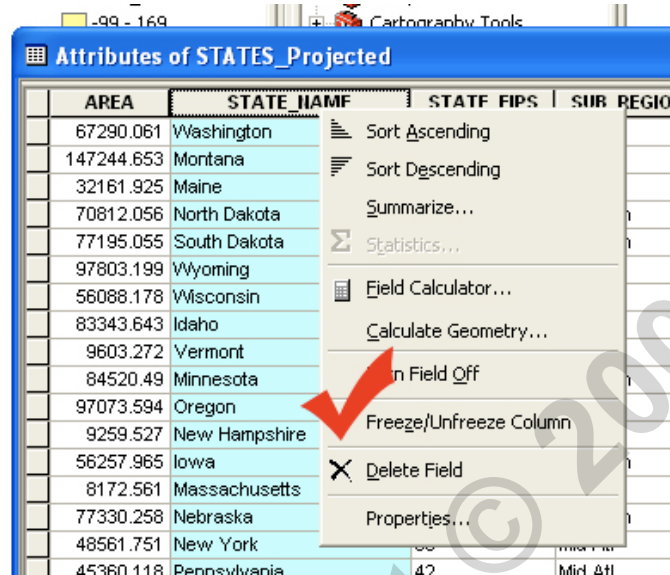
### 5. Look at the data table

In the *Layers* pane, right-click on “STATES\_Projected” and choose “Open Attribute Table”. Notice that for each state, there is a row. Each column represents a piece of data about each state. The attribute table is stored in the “.dbf” file of the shapefile. The “.shp” file contains the shapes you see in the data frame. You don’t have to worry about the “.shx”.

If you scroll to the right, you’ll notice that each column in this particular shapefile represents U.S. census data about the states. POP1999 for instance contains the population of the state in the year 1999. Scroll through the columns. You’ll be impressed at how much data is available from the U.S. Census (So, when 2010 rolls around, be sure to fill out those census forms!)

## 6. Examine the data

Right-click on the “STATE\_NAME” column and choose “Freeze/Unfreeze Column”.



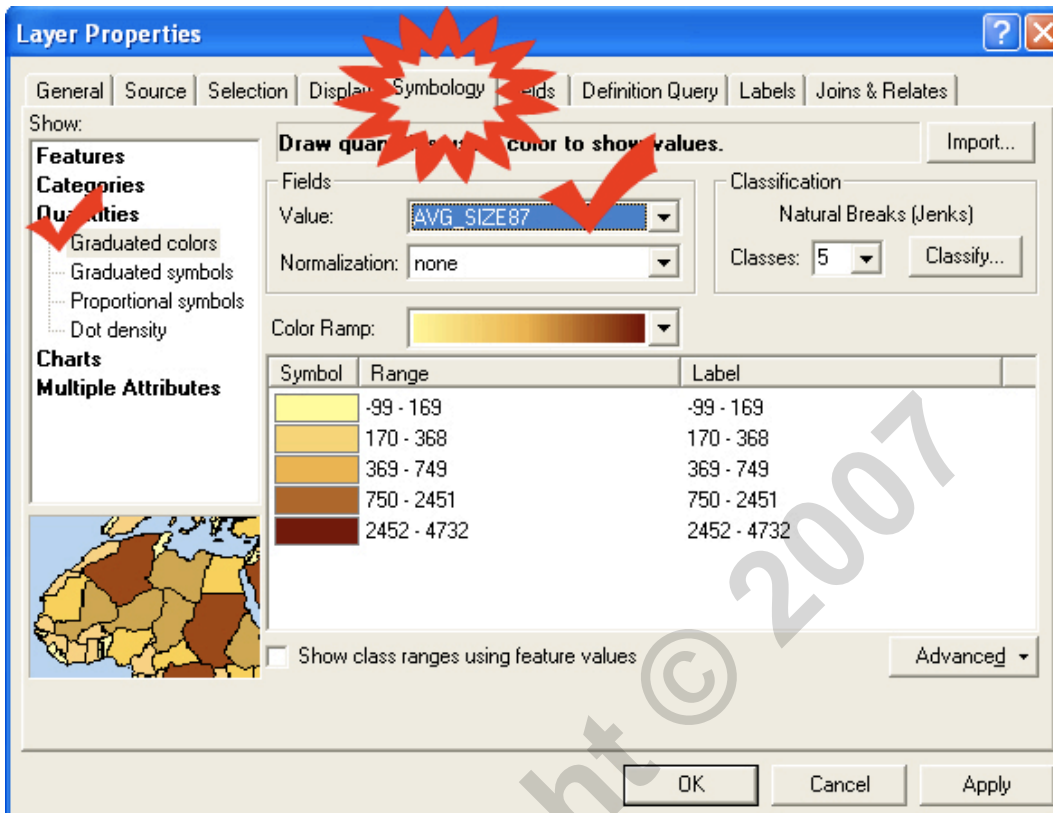
AREA	STATE_NAME	STATE_FIPS	SUB_REGION
67290.061	Washington		
147244.653	Montana		
32161.925	Maine		
70812.056	North Dakota		
77195.055	South Dakota		
97803.199	Wyoming		
56088.178	Wisconsin		
83343.643	Idaho		
9603.272	Vermont		
84520.49	Minnesota		
97073.594	Oregon		
9259.527	New Hampshire		
56257.965	Iowa		
8172.561	Massachusetts		
77330.258	Nebraska		
48561.751	New York		
45360.118	Pennsylvania		

Now, scroll on over to the AVG\_SIZE87 column, which is an *attribute* that contains the average farm size in each state in 1987, measured in acres. Can you see a pattern in the data? Write it down (**Question 1, 5 points**).

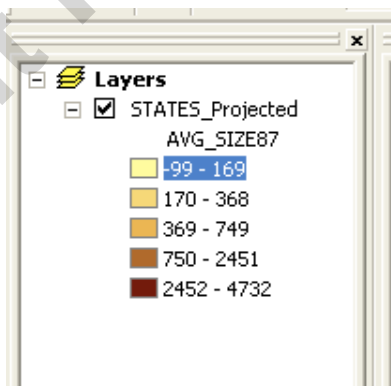
## 6. Make a choropleth map

Although we’ll be studying choropleth maps in detail later in the course, you’ve all seen them before. You may not have known what they’re called, but you’ve seen them. Our choropleth map will represent the first time you will have used one of the most important basic GIS functions: visualizing data spatially. You’ll see how much easier it is to make a hypothesis about spatial patterns by using spatial visualization.

Double-click on the “STATES\_Projected” layer and choose the “Symbology” tab. Click on “Quantities” and then “Graduated colors”. Choose “AVG\_SIZE87” from the “Values” pop-up box. Hit “OK”. (see figure below)



Wahoo! Your first choropleth map! Be sure to note the values included in each color (the fancy word is “class”) displayed below the name of the “STATES\_Projected” layer.



Now, was your pattern from question one correct? What patterns do you see now? Make a hypothesis as to what spatial phenomenon might be the cause of these patterns. Hint: Think back to your U.S. history class in high school. What type of data would you need to test your hypothesis? **(Question 2, 10 points)**

7. *Explore the data*

Zoom in on Washington, D.C. by choosing the zoom button in the “Tools” toolbar. Click on the “i” button to select the “Identify” tool and click on Washington, D.C. Scroll down in the “Identify” window to see the value for “AVG\_SIZE87”. What do you think that value represents? **(Questions 3, 5 points)**

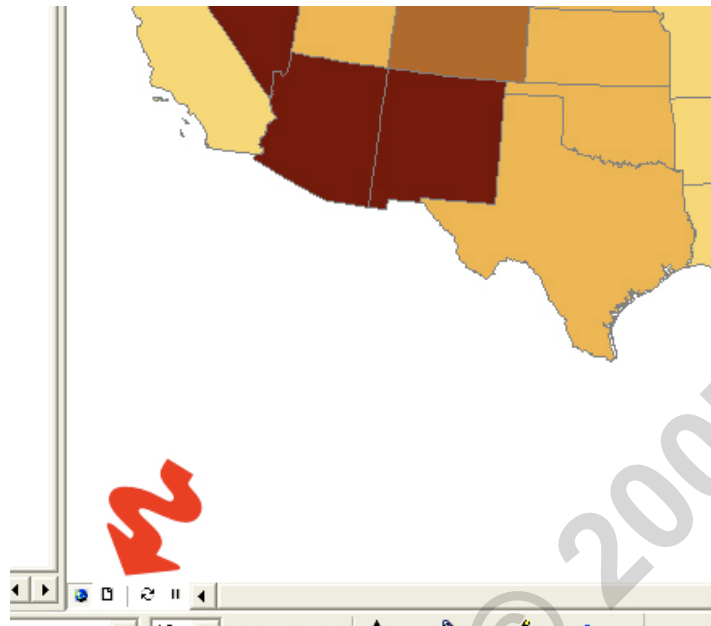


Zoom back out to the full extent either using the zoom out button or the “Full Extent” button in the toolbar.



### *8. Export a map to PDF*

In ArcMap, there are two views: the “Data View” and the “Layout View”. You’ve been working in the “Data View” thus far. Let’s branch out to the “Layout View”. To switch views, click the little page icon next to the world icon near the bottom of the data frame. (see figure below)



The “Layout View” is where you can produce a map to output to your fancy GIS shenanigans. While you’ll need to take a cartography course to fully use and understand the communicative power of maps, we’re going to do a lightning fast overview in which you’ll learn some good conventions while also getting to know yet another of ArcMap’s feature sets.

Right now, your map is terrible. Don’t worry, it’s not your fault (this time). In particular, here’s what your missing (all maps should have all of these):

- 1) a title
- 2) an indication of who made it
- 3) a legend
- 4) a listing of data sources
- 5) a scale bar
- 6) a north arrow

To make a title, we’ll use the “Draw” toolbar, which on most of your computers will be at the bottom of your ArcMap window. If it is not displayed go to the menu bar and choose View->Toolbars and make sure “Draw” is checked. If it is not, select it, and it will appear. It looks like this:



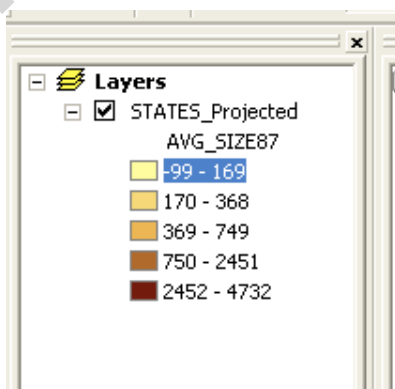
Click on the “Text Tool” (the icon with the “A”) on it.

With the “Text Tool” selected, click on your map near where you want your title to appear. Type your title, and press enter. The title should be as descriptive as possible (i.e. “Average Farm Size by State in 1987”). Make the font size bigger and do whatever else you like with the title. You can change the font and font size by using the tools near the text tool icon in the Draw toolbar. Other standard text editing options are also available (bolding, color, italics, etc.). You can also move your title around. Try double-clicking on the title text to see what happens.

Next, add some text somewhere on the map that tells the map reader who made the map. For instance, “Mapmaker: Brent Hecht, GIS Nerd/Agriculture Fan”. Also, tell the map reader who provided the data for the map. In this case, you should write “Data source: U.S. Census”.

Now, we’re going to add a legend (no, not Roger Tomlinson, the father of GIS... the *other* kind of legend). Go to the Insert menu and choose “Legend”. Follow the wizard. Feel free to play around with the settings to make the best darn legend you can.

The legend displayed under the “STATES\_Projected” layer (see below) is what ArcMap uses to generate the legends in the layout view. As such, we’d better make sure it’s correct. There’s something very “key” (oh yeah, I made that joke) missing from this legend... Can you guess what it is? Prettier colors? Well, maybe. The error code “-99” is included in the values? (Whoops, did I just give away an answer? Hate when that happens). Well, that’s true, but we’re not going to worry about that for now. What I’m looking for here is that all legends should have UNITS! To add units, click on each class (i.e. “369 - 749”) and add the words “Acres”. Watch what happens to your legend in the layout view!



Finally, can you figure out how to add a scale bar and north arrow? Hint: it’s very similar to adding a legend. To change the settings of any element in the layout view, try double clicking on it.



Before we go on, remember that layout matters a lot when communicating a map. You have to use a bit of graphic design instinct and/or artistic taste. Everyone has it; I do, and you've seen my style choices. Don't dare give a sloppy map to anyone. It's like not proofreading when turning in a paper to a professional journal or when writing a Mothers' Day card. Speaking of which, remember to proofread too!

When you're ready to export your map, go to the File menu and choose "Export Map". Select the folder on your USB drive you're using for this lab, choose "PDF" under "Save as type:" and type in the map name "Map1.pdf". Note that you can also export to tons of other formats (JPEG, GIF, TIFF, etc.), including one that even the nerd writing this lab doesn't recognize. Click save. Navigate to the file you just saved, open it, and admire your work. This map will be worth **10 points (Map 1)**.

#### *9. Make another choropleth map*

Make at least one more choropleth (with a different attribute field) using the skills you've learned thus far. Export it as a PDF as in step 8. This map will be worth **10 points (Map 2)**. Save it as "Map2.pdf"

#### *10. Save your project*

Go to File -> Save to save your project. Save it under the name "Lab0Project" in your "Lab0" folder. Saving your ArcMap projects will allow you to access your work exactly as you left it if need be.

## **Part II**

### *1. Introduction to GIS with "cool" data*

Unless you're as big of a Geography dork as I am, you are probably not too interested in farm acreage. Fortunately, GIS is valuable for examining any spatial data, even data extremely relevant to us young folks. Spatial data is as prevalent in topics not generally considered by academia as it is in the more traditional arenas such as environmental science, physical geography, urban geography, archaeology, epidemiology, etc. For instance, I have used GIS to examine the spatial distribution of christian contemporary music popularity (i.e. christian rock popularity) as well as the change in spatial distribution of Dixie Chicks concerts after their falling out with the country music establishment (The lead singer made an anti-war remark several days before the invasion of Iraq).

Go to <http://uweb.ucsb.edu/~bhecht/176A/dixiechicks.html>. What patterns do you see? What conclusions can you make? (**Question 4, 5 points**).

Now, go to <http://uweb.ucsb.edu/~bhecht/176A/christianrock.jpg>. What patterns do you see? What was the source of this data? (**Question 5, 5 points**).

### 2. Using your own “cool” data

Knowing fully that what I think is cool differs significantly from that of most of the population (I listened to Bon Jovi, Brooks & Dunn, and select Disney tracks while preparing the data for this lab), I decided I wanted you folks to be able to study phenomena that you are guaranteed to think are “cool” (I am now slipping into a Ben Stein character). One of the only topics I figured everyone would think is “cool” is your friends.

Those of you with Facebook accounts have lots of *spatial* data about your friends at your fingertips. The only problem is getting that data into ArcMap. In order to help you do this, I have written a Facebook application that returns a shapefile containing data about your friends’ hometown locations. Not all your friends will be represented in the file, as not all of your friends likely inputted a hometown location or the hometown location was not recognized by the *georeferencing* system that I used. For me, about 65-70 percent had valid data.

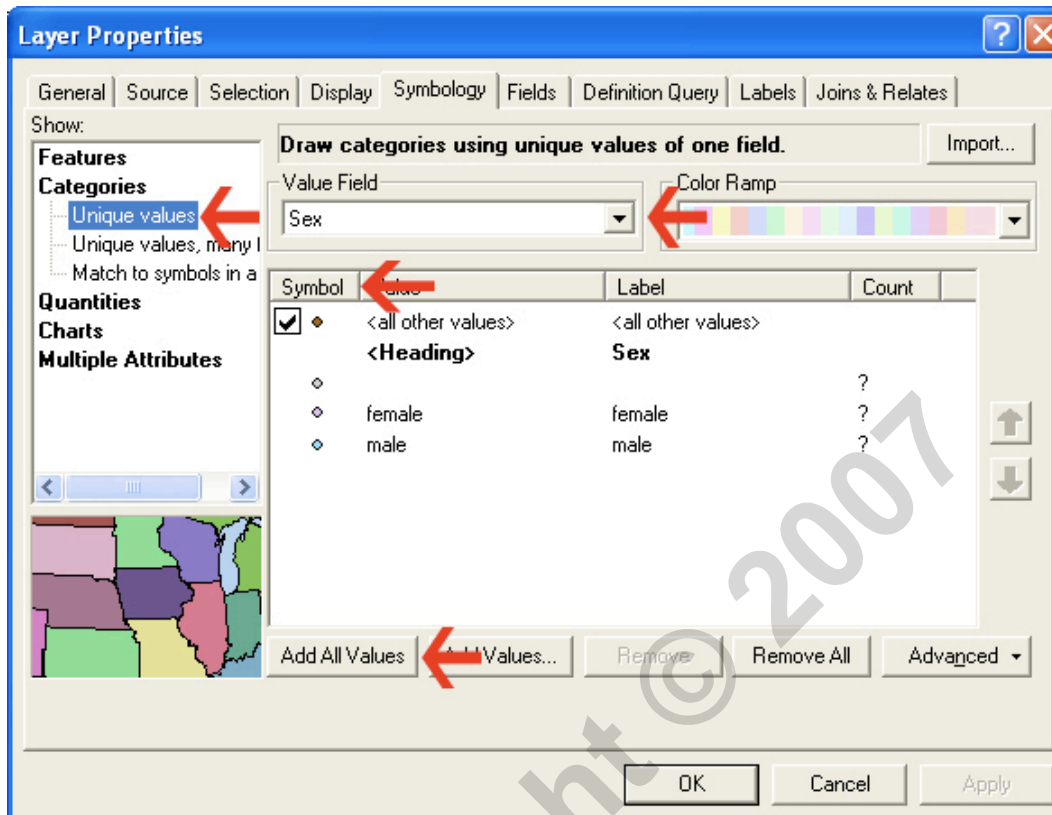
At the beginning of this lab, you were instructed on how to retrieve your friends’ hometown locations in the form of a shapefile. If you don’t have a Facebook account, you downloaded my friends’ data (with names removed of course).

Select “New Project” from the “File” menu and add the Facebook shapefile to the new project in the same way that you added the “STATES\_Projected” shapefile.

### 3. Change the visualization of your friends

View the attribute table of your Facebook data. Look at the available fields. Can you think of any other attributes that might be useful for visualization or analysis of this type of data? (**Question 6, 5 points**)

Go to the “Symbology” in the Facebook layer properties window (as you did in part 1 for the “STATES\_Projected” layer). Choose the “Categories” section, put “Sex” in the “Value Field” and press “Add All Values”, as shown below.



Now we need to make the size bigger for all of these icons. Click on the column header for labeled “Symbol” (see above). Choose “Properties for All Symbols...”. Enter “10” into the “Size:” box under “Options”. Press “OK”.

See if you can figure out how to change the colors for “male”, “female” and nothing individually. (Hint: double click on the dot icon next to each value).

Press “OK” to leave the “Layer Properties” window.

#### 4. Add County-Level U.S. Election data

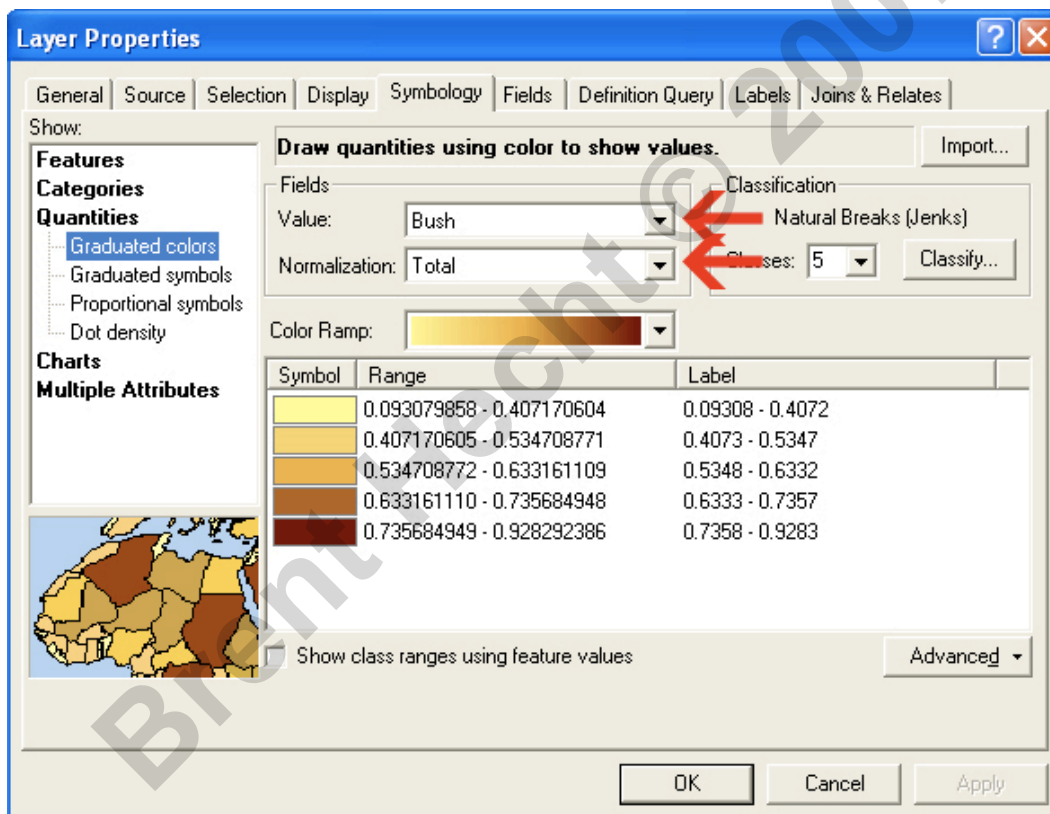
Download a shapefile of county-level U.S. election data from <http://uweb.ucsb.edu/~bhecht/176A/2004Election.zip>. Add this to your ArcGIS project by following the same instructions as in part one of this lab.

Note that, for the first time, you have more than one data *layer* in your project. Also, you will notice that the county polygons might be covering up the Facebook data. To place the Facebook point data on top, click on the title of the Facebook layer and drag it above the “USElection” layer.

You are now using the famous overlay operation (which dates back to pre-GIS days, in the “before” section of the Roger Tomlinson GIS video). But we haven’t unlocked the full power of overlay quite yet because we have not displayed the election data as a choropleth layer.

#### 4. Displaying the election data

Go to the symbology screen of the “USElection” layer as you did in part 1 of the lab. Choose the field “Bush”, which contains the total number of votes for Bush in the 2004 election per county, for the “Value” field and “Total”, which contains the total number of votes per county, for the “Normalization” field. This will normalize the votes for Bush by the total number of votes, thus giving you the percentage per county of Bush supporters.



#### 5. Use the overlay to find patterns

You now have a very powerful visualization at your fingertips. Use the zoom-in and zoom-out tools as in part one to investigate the patterns in the political affiliations of the counties that are home to your friends. Discuss the trends you see. Do your friends come from liberal or conservative areas? Write about this in full detail. If you feel comfortable writing about it, does this reflect your political views? (you will **not** be penalized for not discussing your own views; do so only if you want to). **(Question 7, 15 points)**

Now, what would happen if you had lots of friends all from the same city? Those of you with my data can look at Albany, CA (my hometown), Lincoln, NE, or St. Paul, MN to see an example. Chances are each of you have a similar situation somewhere. If you don't, look at a classmate's screen who does. Use the "Identify" tool to investigate this phenomenon. What is the problem using this type of visual analysis with these data sets? **(Question 8, 5 points)**

6. (Optional) Make a map of your friend data

Use the tools you learned in part 1 to make a map of the overlay you just generated. Watch what happens when you make a legend with more than one data set. If you like, you can print the map and keep it to show to the friends who helped you make it! Do not turn it in the TAs; that's your private info!

7. *Turn in the lab*

First, create a "ZIP" archive of your work. Create a folder in your "Lab0" folder on your flash drive called "[YOURFULLNAME]\_Lab0". Place the two PDF maps that you generated as well as the Word document containing your answers to all eight questions in the folder. Next, right-click on the folder and choose "Send to... -> Compressed (zipped) Folder".

This is the file you will send to me via e-mail. Remember to format the subject line correctly!