Instructions:

1. Set up the lab.

    a. Download the Lab 2 Data folder from Canvas. Remember to unzip it and then save it to a designated folder for your class GIS work. Because maps in QGIS link to your data rather than importing the data into your map document, once you have your data and map saved on your computer, you don't want to move them around in relation to one another. As such, I highly recommend you save them into a designated folder and then not move stuff around within that folder.

    b. In the first skill development lab, you learned how to access QGIS on your personal computer. Go ahead and open it up. If you need to refer back to Lab 1, feel free.

    c. Remember to start by saving your file (ideally to the folder you dedicated to your GIS work for this class).

    d. Take a few minutes to remind yourself where your mapping window, Browser panel, Layers panel, toolbars, and cursor tools (zoom in, zoom out, and pan map (the hand that allows you to click and drag your map around)) are. Refer back to your first skill development lab if you need a refresher.

2. Now, let's add our data.

    a. Remember that we can navigate to our data using the Browser panel. You can then add a shapefile to your map by double clicking on it or clicking and dragging it into your Layers panel. For this lab, you should see two shapefiles (Counties and States)—please add both.

3. Let's start by examining our data

    a. Shapefiles typically contain attribute data within them (or can be joined to tables with attribute data). We will start with the States shapefile. To view the attribute data that is in that shapefile, right click on the States shapefile in the Layers panel and select 'Open Attribute Data.'

    b. You should see an attribute table open in another window. Notice that we have 7 columns. One contains the name of the state. Another the sequence in which the state is drawn on your map. Then we have two codes—the GeoID and the State FIPS code. Both are census codes for each state—the GeoID column shows what is called a long-form unique identifiers for each US state. They start with a country code (0400000US) which is the same for each since these are all US

states. They then have the state FIPS code (ranging from 01 to 56) which are unique to each state. You'll notice that the short-form unique identifier (labeled STATE_FIPS) matches the last two digits of the long-form unique identifier (labeled GeoID). We will talk more about unique identifiers in a couple weeks, but for now, just notice that they are there. Finally, we also have columns listing the region each state falls in, the state abbreviation, and the population of each state.

c. Since we are going to be answering a question about the geographic distribution of population in the US, we will be using the "Population" column, so make note of the column title and then close the attribute table window and return to your main mapping window.

4. Make a choropleth map

a. Now, we get to make our first thematic map. To do so, right click on your States layer in your Layers panel and select Properties.

b. You should see a pop-up window with a list of tabs along the left-hand side. Since making a choropleth map is about symbolizing our data, we are going to use the Symbology tab (third tab down with a picture of a paintbrush).

c. Once you click on the Symbology tab, you'll see at the very top that there is a drop-down menu that will say "Single Symbol." This just means that at the moment, all of your states are represented with a single symbol. This is the default until we change it. Go ahead and click on the drop-down menu and change it to "Graduated."

d. Underneath where it now says "Graduated" you'll see a section asking what "Value" you want to vary (or graduate) the color based on. Here, you'll want to use the drop-down menu to select that "Population" column that we identified in step 3c above.

e. Now, we can also change our color ramp. The default is to go from white to red, but you can play around with it to find a color you like. You can use the drop-down menu to select an existing color ramp or you can click on the color ramp itself to have more options. Pick or make a color ramp that you think does a good job of showcasing the relative differences in population between states.

f. Once you have set a color ramp that you like, click on the "Classify" button about two thirds of the way down the Symbology window. We will explore the idea of classification more in the next lab. Once you hit the "Classify" button, you should see some categories with their accompanying colors from your color ramp appear in your main symbols window in the center of the Symbology

window. When you do click "OK" in the lower right-hand corner of the window to return to your map.

TIP: If your map disappears when you click "OK," try clicking the "Zoom Full" button (a magnifying glass with three arrows pointing out from it) in your toolbar.

5. Repeat all of the parts of step 4 with the counties shapefile to make a second choropleth map of population at the county level.

6. Now that you have made two choropleth maps, let's try a proportional symbol map.

    a. Remember that when making proportional symbol maps from areal data (that is data that represents polygons, in this case states), we typically use a circle placed at the center of the unit and adjust the size of the circle according to the data variable.

    b. We will start by making a dataset showing those circles. Circles placed at the center of an areal unit are called centroids. To make a dataset of centroids in QGIS, click "Vector" in the menu at the very top of your screen, then select "Geometry Tools" and then "Centroids…". This should open a Centroids pop-up window.

    c. As your "Input layer" select the States shapefile from the dropdown menu. Then under Centroids where it says "[Create temporary layer]" click on the "…" button and select "Save to File." Select "SHP files (*.shp) as the file type, give it a name, and save it to the folder you are using for all of your GIS work for this class.

    d. Once you have done that and returned to the Centroids pop-up window, make sure that the box for "Open output file after running algorithm" is checked and then click "Run" in the lower right-hand corner.

    e. Once you see the Centroids layer appear in your Layers panel (or you see "Algorithm 'Centroids' finished" appear in the pop-up window's log), you can close the pop-up window and examine your map. You should see dots in the center of each state.

    f. Now, we can tell QGIS to adjust the size of each circle according to the variable we want to map, in this case, population. To do this, right click on your centroids layer in the Layers panel and select Properties and then the Symbology tab.

    g. This time we want to keep the drop down menu at the top on "Single Symbol." Select one of the "dot" options so that we will see circles on our final map, but

feel free to adjust the color to your liking by clicking on the color that is there and adjusting it to your liking.

h. When you are happy with the color, let's tell QGIS to adjust the size of each dot. To do this, click on the "Data defined override" button at the end of the line that starts with the word "Size." The button looks sort of like a file cabinet with an arrow on it.

i. From the drop-down menu that appears, we will select "Assistant…" which will open a new window called "Symbol size."

j. There, we want to set as the Input Source our population variable. Nothing will happen automatically, but if you then click the "Fetch value range from layer" button (similar to a refresh button with two blue arrows creating a circle), you'll see the range of circle sizes appear in the window on the right.

k. Let's keep the default settings for now, but feel free to play around with the relative sizes of your symbols using the options in the "Output" section. Click "OK" to close the "Symbol size" window.

l. Now still in the Symbology window there is one more step that is unique to proportional symbol maps. Typically, you don't add a legend until you make your print layout and start positioning things on the page, but for proportional symbol maps we need to take an extra step to set us up for that. Click on "Advanced" in the lower right-hand corner and select "Data-defined Size Legend…" from the drop-down menu. Select the Collapsed legend option and you'll see the legend appear in the preview box.

m. Typically, this legend will be a bit too cluttered, so you can simplify it. To do this, check the box next to Manual size classes and then use the green plus button to add a couple reasonably-sized (this will depend on the range of the data) reference circles. If you add one you don't like, you can highlight it and then use the red minus sign to remove it. When you are happy with it, click OK.

n. Now go ahead and click OK again to close the Symbology window and return to your map. You should now see proportional symbols overlaid over your choropleth map.

7. Now, let's create one final type of thematic map: a dot density map. Here, we will use county level data rather than state level data.

   a. To make a dot density map, we need to randomly place dots in each county based on the number of people living there, or the population. To do this click "Vector" in the menu at the very top of your screen, then select "Research

Tools" and then "Random Points in Polygons". This should open a Random Points in Polygons pop-up window.

b. First, we want to set the Counties layer as our Input polygon layer.

c. Second, we need to tell QGIS how many points to put. To do this, click on the "Data defined override" button at the end of the line that says "Number of points for each feature." The button looks sort of like a file cabinet with an arrow on it. Select "Assistant" which will bring up a new pop-up window.

d. In the Input box, at the end of the "Source" line, click on the button with the purple mathematical symbol. This will open an Expression Dialog box. Now, our map would be way too cluttered if we put a dot for each person, so while we want to base our dots on population, we want one dot to be equal to one thousand people, so we will write our formula as follows:

Population / 1000

Once you have done that, click OK. Double check that you have done that correctly by clicking on the "Fetch value range from layer" (the refresh button with two blue arrows pointing at one another). You should see a "from" value of 0.066 and a "to" value of 10,081.

e. Now let's look at the Output box. Right now, we are limiting our ability to implement that because our output range is only 1-10 (not 0-10,081), so let's change it. Set the "Output from" box to 0 and the "to" box to 10081. Make sure the Exponent is set to 1 and the "Output when NULL" box is set to 0. Then click the blue arrow next to "Number of points for each feature" to return to the main pop-up window.

f. The last thing we need to do before adding our points is to tell the computer where to save the new points layer it is going to create. Scroll down to where you see [Create temporary layer] and click the "…" button at the end of the line to tell QGIS where to save your file (ideally in your class GIS folder).

g. Once you have done that click "Run" and wait a minute while QGIS does its thing. You'll know it is done when the Log says that the algorithm finished. Once you see that at the bottom of the log, click close and take a look at your map.

h. Likely you'll notice that there are a lot of dots and that they all overlap making it hard to actually see the patterns. To fix this, right click on your new dot layer, select Properties, and then the Symbology tab.

i. We will keep the symbology on Single Symbol. Pick whatever color you like and set the size to 0.4. You can adjust the size later if you want, but this is a good place to start.

j. When you are done adjusting your symbology, click OK and examine your map.

You have now learned how to make three different types of thematic maps: choropleth maps, dot density maps, and proportional symbol maps. Using the four map components you made construct two mixed symbols map. The first should be a county-level choropleth map overlaid with a proportional symbol map. The second should be a state-level choropleth map overlaid with a dot density map.

8. Using what you learned in the first skill development lab, make two print layouts (one for each of your mixed symbols maps and add the map image, a title, and a legend to each. You are welcome to just show the contiguous United States (the lower 48 states) if you wish.

9. Take some time to play around with your map element's settings. You can adjust the font and size of your title and adjust a lot of the specifics of your legend. To do this, select an item from the Items list on the right-hand side of your print layout and then use the Item Properties tab just below it to make adjustments. Remember to pay attention to the visual hierarchy of your map! Everything on your map should be contributing to communicating how the population of the US is distributed.

10. As you did in Lab 1, once you are happy with your maps, export each of your two maps and submit them using the Lab 2 submission portal. You will be assessed using the rubric below on both whether you completed each of the map components and the effectiveness of your map at communicating information.

Skill Development Lab 2 Rubric				
Criteria	Ratings			
Map 1 Mixed Symbols Map (Choropleth & Proportional Symbol)	10 pts. Map submitted, includes a proportional symbol map over a choropleth map with an appropriate title and legend.	7 pts. Map submitted, shows clear effort, but does not include all required elements.	4 pts. Map submitted, but lacking either the choropleth or proportional symbol component.	0 pts. No map submitted.

Skill Development Lab 2 Rubric				
Map 1 Choropleth Component	5 pts. Choropleth map component includes appropriate color ramp and is symbolized effectively in the legend.	3.5 pts. Color ramp is used and legend includes choropleth symbols, but could more effectively communicate the information.	2 pts. Choropleth map component shows effort, but is not effectively executed.	0 pts. Choropleth map component is absent.
Map 1 Proportional Symbols Component	5 pts. Proportional symbol map is correctly implemented and is symbolized effectively in the legend.	3.5 pts. Proportional symbols are present and represented in the legend, but could more effectively communicate the information.	2 pts. Proportional symbol map component shows effort, but is not effectively executed.	0 pts. Proportional symbol map component is absent.
Map 2 Mixed Symbol Map (Choropleth and Dot Density)	10 pts. Map submitted, includes a dot density map over a choropleth map with an appropriate title and legend.	7 pts. Map submitted, shows clear effort, but does not include all required elements.	4 pts. Map submitted, but lacking either the choropleth or dot density component.	0 pts. No map submitted.
Map 2 Choropleth Component	5 pts. Choropleth map component includes appropriate color ramp and is symbolized effectively in the legend.	3.5 pts. Color ramp is used and legend includes choropleth symbols, but could more effectively communicate	2 pts. Choropleth map component shows effort, but is not effectively executed.	0 pts. Choropleth map component is absent.

Skill Development Lab 2 Rubric				
		the information.		
Map 2 Dot Density Component	5 pts. Dot density map is correctly implemented and is symbolized effectively in the legend.	3.5 pts. Dot density map component is present and represented in the legend, but could more effectively communicate the information.	2 pts. Dot density map component shows effort, but is not effectively executed.	0 pts. Dot density map component is absent.