



## GEO TUTORIAL

### ENHANCING MAPS WITH CHARTS IN QGIS

Krzysztof Raczynski  
Kate Grala  
John Cartwright

Geosystems Research  
Institute Mississippi  
State University

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GEOSYSTEMS RESEARCH INSTITUTE, MISSISSIPPI STATE UNIVERSITY, BOX 9627, MISSISSIPPI STATE, MS 39762-9652

The Geospatial Education and Outreach Project (GEO Project) is a collaborative effort among the Geosystems Research Institute (GRI), the Northern Gulf Institute (a NOAA Cooperative Institute), and the Mississippi State University Extension Service. The purpose of the project is to serve as the primary source for geospatial education and technical information for Mississippi.

The GEO Project provides training and technical assistance in the use, application, and implementation of geographic information systems (GIS), remote sensing, and global positioning systems for the geospatial community of Mississippi. The purpose of the GEO Tutorial series is to support educational project activities and enhance geospatial workshops offered by the GEO Project. Each tutorial provides practical solutions and instructions to solve a particular GIS challenge.

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## ENHANCING MAPS WITH CHARTS IN QGIS

Krzysztof Raczynski (chrisr@gri.msstate.edu)  
Kate Grala (kgrala@gri.msstate.edu)  
John Cartwright (johnc@gri.msstate.edu)

Geosystems Research Institute,  
Mississippi State University

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### REQUIRED RESOURCES

- QGIS 3+



### FEATURED DATA SOURCES

- Dataset used in this tutorial can be downloaded from Mississippi Automated Resource Information System: [2020 Counties Population and Housing](#)

### OVERVIEW

Maps can tell lots of stories, but sometimes, a single coloring or symbol size variation is not enough to present all the data. What if there are multiple pieces of information we would like to present on the map, like, for example, when presenting Census data? This is where charts come in handy. We can create charts directly inside QGIS without the need to use third-party software, like Excel. This tutorial aims to demonstrate how to create charts and combine them with other charts to present multiple pieces of information on one map.

Imagine yourself in the following situation: You are working for the Mississippi Housing Office, which will perform an analysis of current housing conditions across Mississippi to identify future availability issues. You were given the task of presenting a map showing variations in the ages of residents. You must present information on the resident percentages, divided into two categories: adults and underaged for each county. Additionally, you need to present a ratio between occupied and vacant houses available by county. All this information must be included in a single map. This tutorial will guide you through the required steps on how to create charts to present multiple information on a single map.

## STEP 1. ANALYZE THE DATA

After a quick search, you have found that the *Census dataset* called **CountiesPopulationHousing** contains all the data needed. Before you proceed with map creation, you need to download and organize the data. To do so, follow the below steps:

- A. Use the **Featured Data Sources** link above to download the data. After downloading the zip archive, unpack it in your work folder. You will see two important files:
  - a. a **shapefile** containing county-level information about demographics and housing that we will use as input to create charts.
  - b. **metadata PDF** file that comes with the Census dataset. This file contains an explanation of attribute names used in data. We will need it to understand and decode the attribute table of the shapefile.
- B. Add a shapefile to a new project in QGIS software. You now see 82 objects—counties within Mississippi.
- C. Open the **attribute table** (by right-clicking on the layer in the **Layers Panel** and selecting **Open Attribute Table**) of the dataset and compare the column names with the **Fields** listed in the metadata file. Try to identify which attributes present the information that we will need. Once you are ready, compare it with the information below:
  - a. attribute **P0010001** contains information on the total population,
  - b. attributes **P0010003** to **P0010009** contain information about how many people in each county are of Census-predefined races,
  - c. attributes **P0030001** to **P0030009** contain the same information limited to adults,
  - d. finally, attribute **H0010002** presents the number of occupied housing units, and **H0010003** represents vacant housing units.

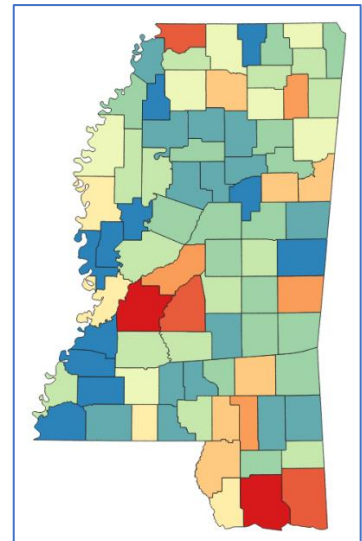
Now that we know which attributes we are going to use, we can start preparing the map.

## STEP 2. PRESENTING TOTAL POPULATION

You have decided to start with a thematic map to present the information about the total population by county. To do so, follow these steps:

- A. Open the **Properties** of the layer by right-clicking it in the **Layers Panels**, then selecting **Properties**. Switch to the **Symbology** tab.
- B. Change the first setting from **Single Symbol** to **Graduated**.
- C. Under value, select **P0010001** (the attribute that presents total population information).
- D. You can change the color classification by expanding the **Color Ramp** menu. If you want to reverse the color order (for example, when using the *spectral* colormap but to start with cooler colors), expand the menu again and click the **Invert Color Ramp** option.
- E. Under the central list, click the **Classify** button. You can further modify how the algorithm creates the classes by changing the **mode** and **classes** settings.
- F. Set **Mode** to **Natural Breaks (Jenks)** and **Classes** to **10**. After applying the changes, you will see a colored map based on the number of residents in each county (Fig. 1).

As you can see, it is not difficult when only one variable needs to be presented at the time; however, with demographic data, that is a bit more complicated, as there are seven races in the Census classification and two categories you have to use. This would require a complicated symbology to present it in the same way as the total population. Instead, you have decided to use charts.

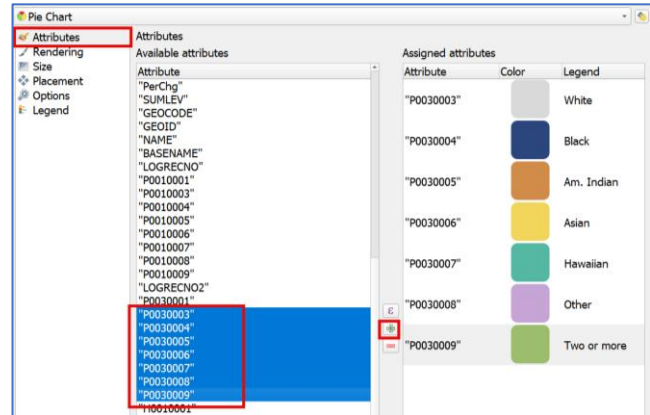


**Fig. 1.** Example view in QGIS for Mississippi counties colored depending on the total number of residents.

### STEP 3. ADDING A CHART TO MAP

To create a pie chart presenting the number of people of a given race by county, follow these steps:

- Open **Properties** of the census data layer.
- Navigate to the **Diagrams** tab.
- Change the top setting from **No Diagrams** to **Pie Chart**. The window will become active.
- The first thing that is needed to draw a chart is data. Switch the subtab to **Attributes** if it was not open by default. Here, you will see a list of all the attributes in your dataset to use in the chart. Let's handle the data for adults first. For this, we will need attributes from **P0030003** to **P0030009**. You can select multiple attributes by clicking them while holding the [CTRL] key (or click the first attribute, then hold [SHIFT] and click the last one to select all between). After you have selected all 7 attributes, click the **plus** icon in the middle, and your attributes will be moved to the right list. This indicates that the chosen attributes will be applied as input data to draw a pie chart (Fig. 2).



**Fig. 2.** Attributes of Pie Chart; colors and labels in chart settings must be assigned manually.

- By default, all the attributes will have the same color, which can be problematic when analyzing the chart. To change the **color**, simply double-click it in the list. Select different colors for the chosen attributes to make the graph distinguish the groups (Fig. 2). Use pastel colors. If you want to use the palette provided in the example, the color codes are:

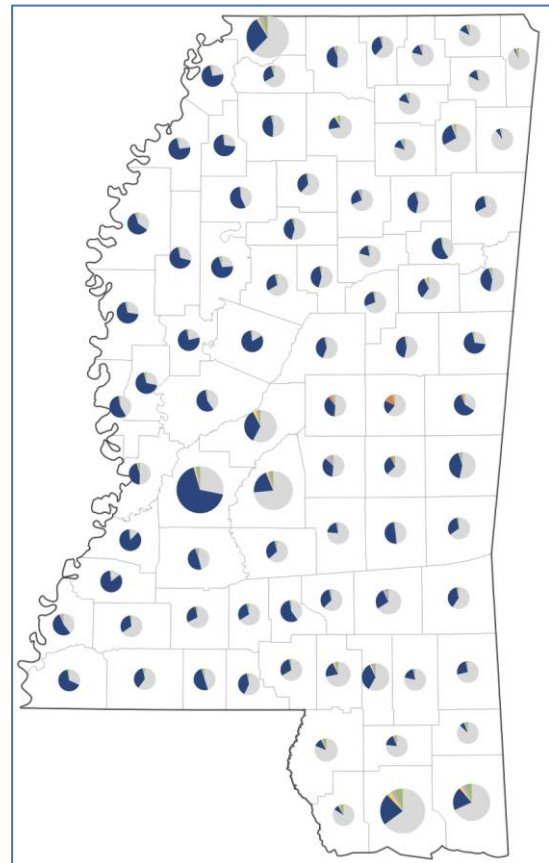
gray:	#d9d9d9
navy:	#2b467d
orange:	#d18c49
yellow:	#f1d65b
teal:	#55b8a3
purple:	#c6a4d5
green:	#9cbd6e

you can set them in the *HTML notation field*, on the right side of the popup window (after double-clicking the color).

- You can change the **label** for each **color** to be more descriptive by double-clicking the **legend** item on the right of the color applied (Fig. 2).
- Click **Apply** to display the charts.

After a quick look at the map, you have decided that there is too much happening and decided to remove the coloring from county data and reflect the size of the total population by the size of the chart itself. To do so, follow the steps:

- Switch to the **Symbology** tab and change the




**Fig. 3.** Pie charts placed in the centroid of each county presenting the total population by race and size adjusted to the total county population.

- settings back to *Single Symbol* with *white* or *no fill*, and *gray* border (e.g., #777777) of **0.2 Stroke width**.
- Switch back to **Diagrams** tab and select the **Size** subtab. Change the setting to *Scaled size* to connect the chart size with the county population data. Set *Attribute* field to **P0010001**. Set the size **units** to *map units*. Switching to map units will prevent the charts from shrinking when we zoom in on the map.
  - Click the **Find** button to automatically find the *maximal value* for the chart size. It should be set to **227742**. Set the *Size* to **20000** and enable the *Increase size of small diagrams* and set the *Minimum size* value to **10000**. This will prevent low populated counties charts from disappearing from the map. Feel free to test different settings and see how the charts react when you navigate the map canvas.
  - Change subtab to **Rendering** and set the *Line color* to *white*, with *Line width* of **0.2**.
  - Switch subtab to **Placement** and force **Placement Around Centroid**. This will place the chart in the centroid of each county (Fig. 3).

#### STEP 4. ADDING THE SECOND CHART

To create a second chart that will present the number of underaged of a given race, we will need to do a couple additional transformations:

- Right-click on the census layer in the **Layers Panel** and select **Duplicate Layer**, then turn it visible by checking the square to the left of the newly created layer. We needed to duplicate the layer to create a second chart.
- Go to layer **Properties**, and in the **Symbology** tab, switch to the **No Symbols** setting. This will remove the rendering of our colored counties, as we already have this information presented in the main layer.
- Now, we need to compute the number of underaged for each race. You probably noticed that our data presents *total numbers* and *adult numbers*; therefore, we need to calculate the *differences* between the two to receive the numbers we need to present.
- In the duplicated layer, open the attribute table and click **Field Calculator** . Create a **new field** and make sure that the above setting (*Only update... selected features*) is deactivated. Name the field **kids3** in the **Output field name**, which will indicate that we are using a group coded as 3 in this case. Leave the output field type as an *integer* and the length as **10**.
- In the **Expression** tab, write the formula that will subtract the total number of adults from the total number of people for the field encoded with 3:

"P0010003" - "P0030003"

- Repeat the process for the remaining codes 4-to-9 (Fig.4).
- Now that we have prepared the data, go back to the layer **Properties** and select the **Diagram** tab.
- In the **Attributes** subtab, replace the currently displayed attributes with the newly computed ones. You can do this by:

kids3	kids4	kids5	kids6	kids7	kids8	kids9
2265	1629	15	24	0	113	168
5646	1070	51	8	4	591	528
1446	3905	6	14	6	32	205
3670	2091	11	13	2	167	398
1836	994	0	3	0	29	112
1885	2226	7	32	1	84	161
4342	805	12	28	1	49	345

**Fig. 4.** Part of recomputed attribute table presenting number of underaged by race.

- selecting all attributes in the right window and clicking the **minus** sign in the middle part, then repeating the process of assigning colors and classes.
  - double-click in the attribute name of the already selected attribute, e.g., "P0010005", and in the popup window, replace the text with the name of your corresponding *kids* attribute (in this case, "kids5"). This way, you won't need to assign colors and labels again.
- When you applied the new attributes to the chart, navigate to the **Size** subtab. Here we need to change the sizing of the chart, in order to make it properly visible. Add 50% of *Size* and *Minimum size* values, setting them to **30000** and **15000** respectively.
  - In the **Placement**, verify that the chart is forced **around the centroid**.

K. **Apply** the changes.

You can now see two graphs. The outer one shows the underaged population by race, and the inner one shows adult population by race. Additionally, the size of the graph correlates to the total population in each county.

#### STEP 5. ADDING THE THIRD CHART


We have most of the information on our map, but we are still missing the information about housing units. Let's add the third graph:

- A. **Duplicate** the *census copy* layer and turn it on.
- B. Go to **Properties**, and in the **Diagrams** tab, change the chart type from *pie chart* to **stacked bars**.
- C. **Remove** all the selected attributes and add two new ones: *H0010002* and *H0010003*.
- D. Change the color of the *H0010002* attribute to **red** (e.g., #d6541c), as it represents the occupied houses, then change the second attribute color to **green or blue** (e.g., #137c9f). Adjust the labels.
- E. If you apply the changes now, the chart will be visible as a **single line**. To fix it, navigate to the **Rendering** subtab, change the *bar width* to **2500**, *bar spacing* to **0** (this will remove open space between chart categories), and set *units* to **map units**. Set the *Line color* to **white** and *Line width* to **0.1**.
- F. Navigate to the **Size** subtab and change *Fixed size* to **7000 map units** to align bar chart with the outer pie chart. **Apply** the changes.
- G. The bar chart is now on top of the pie chart but its size is smaller than the inner pie chart (minimal size 10000) so all the data is visible.

The final map is ready (Fig. 4). If you wish to increase the readability and change the location of the bar chart, follow the optional step 6 below.

#### STEP 6 (OPTIONAL). ADJUSTING POSITIONS

You can adjust the positions of charts based on layer geometry. You will need to use the **attribute table** to calculate position coordinates and use them to modify chart positions.

- A. Open the **attribute table** for the last duplicated layer, for which we created a bar chart.
- B. Open a **Field calculator**  and create a **new field** called *X*, of **integer** type.

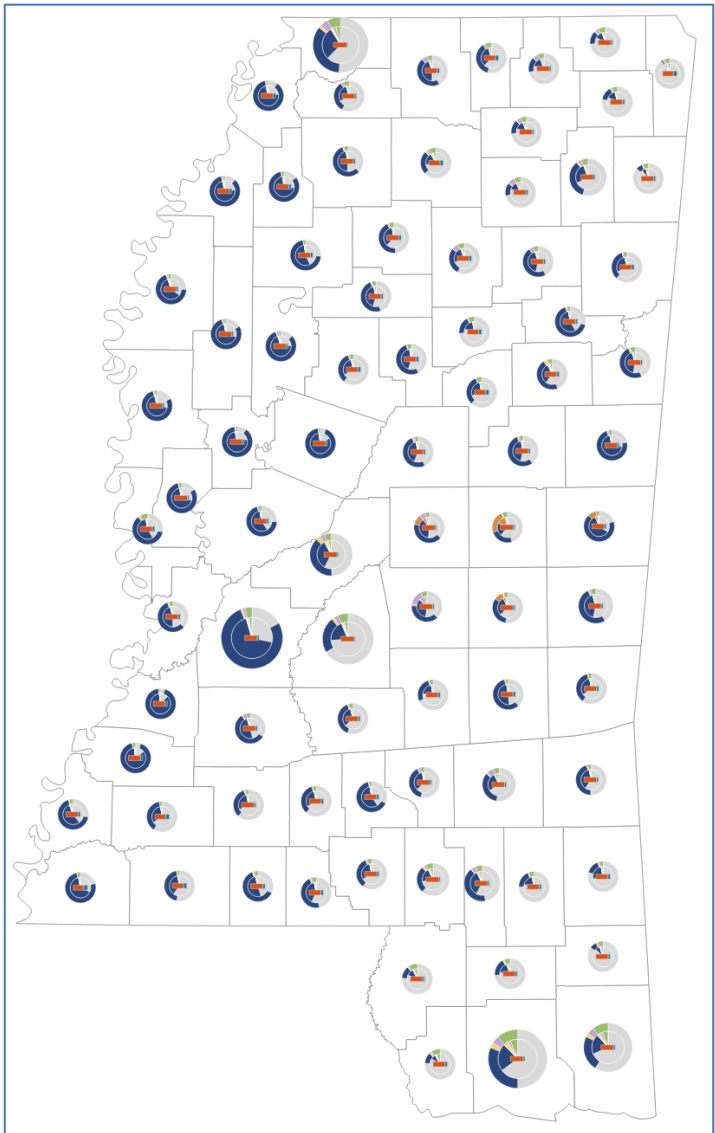


Fig. 4. Finalized map with three charts presenting all the required data.

- C. In the **Expression** field, compute the **x coordinate** of the centroid for each county, then add to it 5000 map units (this will allow to shift the chart to the right):

```
x(centroid($geometry))+5000
```

Note, that the 5000 value refers to the projection units, and depending on the projection used in different datasets, this value needs to be adjusted individually.

- D. Compute the **y coordinate** for the centroid and place it in a **new field** of the same type, named **Y**. In this case, you will not modify the coordinate value:
- E. Open layer **Properties**, and in the **Placement** subtab of the **Diagrams** tab, locate the **Coordinates** menu.
- F. Click on the icon right next to **X**, point the cursor to the **Field type**, and from the opened menu, select the **X** attribute we just calculated in the attribute table.

```
y(centroid($geometry))
```

- G. Repeat the process for the **Y** coordinate.
- H. Make sure that the **Placement** is set to *around the centroid* and **apply** the changes. You will notice that the bar chart was moved, but other charts were also moved in random directions. This is because our layers are all duplicated.
- I. Go to the **Layers panel** and right-click on the duplicated bar chart layer. Select **Export: Save features as**. Click on the three-dot icon on the right to **File name** and choose save location. **Save** the file.
- J. Right-click on the duplicated layer and select **Style: Copy Styles: All Styles Categories**.
- K. Right-click on the newly saved file and choose: **Styles: Paste Styles: All Styles Categories**. This will apply styling and diagram options to our new layer, so we don't have to set it manually. You can turn off the duplicated layer or remove it from the project.
- L. Now open the **attribute table** for the census layers where we display pie charts. Repeat **steps B-D** to compute coordinates, but this time when computing the **X** coordinate, **subtract 5000** from the **X coordinate** instead of adding (to move the chart to the left).
- M. Set the newly computed **X** and **Y** coordinates for the two pie charts in the **Placement** subtab of the **Diagrams** tab in the layer **Properties**.

You have successfully set the custom coordinates for all the charts, displaying them next to each other. Now, you can use the produced map to compare the data and analyze which counties will face housing problems in the future and which populations might be affected most.

This concludes our tutorial. Feel free to experiment with different types of charts and their positioning.