

# Creating and Analyzing a Binary Map Using FRED® Maps



**FRED® Map**  
**APPLICATION EXERCISE**

---

## Lesson Authors

Mark Bayles, Federal Reserve Bank of St. Louis

Diego Mendez-Carbajo, PhD, Federal Reserve Bank of St. Louis

---

## Standards and Benchmarks (see page 5)

---

## Description

This online activity demonstrates how easy it is to master key functions of FRED® Maps, the data mapping tool for FRED®. In just a few minutes you can create an engaging binary map that will spur comments and questions. The binary map created in this demonstration displays data on inflation-adjusted personal income per person in the 50 united states of America and the District of Columbia.

---

## Economic and Statistical Concepts

**Average:** The sum of a collection of numbers divided by the count of numbers in the collection.

**Binary map:** A map with regions divided into two classes.

**Choropleth map:** A map that uses shading, color, or symbols to convey a quantity or property for an area.

**Median:** The middle number in a list of numbers; the number that divides data into a top half and a bottom half.

**Per capita:** A quantity per person determined by dividing the total quantity by total population.

**Personal income:** The income that individuals receive from all sources, including wages and salaries, dividends and interest, rents, profits, and transfer payments.

---

## Objectives

Students will be able to

- explain the differences between a binary map and a map with more than two data categories,
- define personal income and per capita personal income, and
- compare maps of the same data displayed with equal intervals and with fractile intervals.

## Grade Level

7-10

---

## Compelling Question

How does a binary map show values above and below the median?

---

## Time Required

15-30 minutes

---

## Preparation

- Background about choropleth maps: Maps that use color, shading, or symbols to convey one or more statistical variables are called **choropleth maps**. This technique was first used in 1826 by the French cartographer Charles Dupin to show levels of literacy throughout France. Dupin's innovative map used black-and-white shading rather than color. And, rather than use a small range of shades to show similar literacy levels, Dupin assigned a separate shade for each region's unique value. The technique became popular, and countless choropleth maps have been created since.
- Make sure you are comfortable navigating around FRED® and finding values for data series used in this lesson. A demonstration is located at <https://fredhelp.stlouisfed.org/>.
- Go to <https://www.stlouisfed.org/education/economic-lowdown-video-series/episode-7-gross-domestic-product> to review the definition of gross domestic product and income.
- Go to <https://fredblog.stlouisfed.org/2022/08/a-lesson-in-mapping-population-data/> to see a short primer on some key functions of FRED® Maps.

---

## Procedure

1. Tell students that they are going to look at some data in FRED®. Explain that FRED® is a database that can display data on maps. In this case, students will be looking at per capita personal income data. Define "**per capita**" as per person. To help students understand the idea of per capita, use the following example:

*(NOTE: For this example, determine the total number of bonus points available by multiplying the number of students in your class by 10.)*

- Over the semester so far, students have earned a total of 240 bonus points.
- To determine how the bonus points relate to the number of students in the class, we need to determine per capita bonus points.
- The same number of points will be available for each student in the class. How many points will be available per student? (*Number of points ÷ Number of students = 10 points*)

2. Open an internet link and enter the address: <https://fred.stlouisfed.org/>. Tell students that this is the FRED® site of the Federal Reserve Bank of St. Louis. FRED® can show data as line graphs and on a map.
3. Tell students that one set of data available on FRED® is per capita personal income by state. Remind students that per capita means per person. Explain that income is the payment people earn for the work they do. Per capita **personal income** is the total income earned by individuals in a state, region, or country during a year, divided by the population of the state, region, or country. For this map, we will use per capita personal income by state.
4. Use the search box to look for and select “Per Capita Personal Income in Michigan” (Dollars, Annual, Not Seasonally Adjusted). The website will display this line graph: <https://fred.stlouisfed.org/graph/?g=16d9l>.
5. Click on the green button “View Map.” The website will show a map of the United States with the latest available data on per capita personal income in each state: <https://fred.stlouisfed.org/graph/?m=16fNq>.
6. So far, so good, right? By now you have a map of the United States that shows the 50 states and the District of Columbia in a range of colors. Look closely at the map’s legend: It matches colors with ranges of per capita income in dollars. Each state is given a color according to where its per capita income falls in the set of ranges.
7. Click the “Edit Map” button above the graph. The menu shown allows you to adjust the settings of your choropleth map. You will see the following categories, with the noted default choices in parentheses: “Number of color groups: (5),” “Data grouped by: (Fractile Method),” and “Color” followed by 5 color-coded values. Notice that the values next to each colored box in the menu correspond to the map’s legend shown below the map.
8. When “Fractile Method” is selected, the FRED® Map splits the number of regions (in this case, 50 states plus the District of Columbia) as equally as possible. Sometimes the division cannot be performed equally when two or more of the regions share the same value. In that case, some regions have one or more states. For further details about fractiles, see the following lesson: [http://www.stlouisfed.org/education\\_resources/fractile-v-equal/](http://www.stlouisfed.org/education_resources/fractile-v-equal/).
9. Now, try changing the interval method to “Equal Interval.” Your map look should look like this: <https://fred.stlouisfed.org/graph/?m=16fSG>.
10. Look at the distribution of colors in the map. What happened? One single color category now dominates the map. This is because instead of having 5 nearly equal groupings of regions, you now have groupings of an unequal number of regions. This new grouping occurs because the equal interval method splits the range of data values into equal-sized segments. Subtracting the

lowest value from the highest value and dividing the result by 5 produces the 5 equal ranges shown here. It's not too complicated, is it? For further details about fractiles, see the following lesson: [http://www.stlouisfed.org/education\\_resources/fractile-v-equal/](http://www.stlouisfed.org/education_resources/fractile-v-equal/).

11. Now, change the interval method back to “Fractile Method” and change the number of color groups to 2. Reducing the number of color groups from 5 to 2 results in a **binary**, or **two-class, map**. The map is now divided into 26 regions (states) with a per capita personal income below the median value and 25 regions (states) above that dollar figure. Your map should look like this: <https://fred.stlouisfed.org/graph/?m=16f5C>.
12. Notice that the FRED® Map you created uses a darker shade for states above the median dollar value for per capita personal income; it uses a lighter shade for states at or below that median value. (Assigning the darker shades or colors to larger quantities is the typical approach in choropleth map making.)

---

## Closure

13. Review the purpose of the activity by discussing the following:
  - The purpose of this activity was to provide an easy way for you to learn about binary (two-class) choropleth mapping.
  - To help you reach that goal, you created a binary map for per capita personal income for all 50 states and the District of Columbia.
  - Recall that per capita means per person and that personal income is income that individuals receive from any source.
  - You encountered additional concepts during this activity, including median and average value.

---

## Assessment

14. Open an internet link and enter this address: <https://fred.stlouisfed.org/>. Use the search box to look for and select “Average Weekly Earnings of All Employees: Total Private in Michigan” (Dollars per Week, Monthly, Not Seasonally Adjusted).
15. Click on “View Map” to view the latest available state-level data map of average weekly earnings of all private employees. The **average** is the sum of the dollar values of all wages and salaries earned by the surveyed employees, divided by how many employees were surveyed.
16. Click on “Edit Map” and change the “Number of color groups” to 2.
17. When you have created your binary map, study it carefully. Do you see any patterns? How might the map provide an individual helpful insight into employment earnings in a particular state or region?

## **Standards and Benchmarks**

### **Voluntary National Content Standards in Economics**

#### **Standard 13**

Income for most people is determined by the market value of the productive resources they sell. What workers earn depends, primarily, on the market value of what they produce and how productive they are.

- **Benchmarks: Grade 8**
  2. To earn income, people sell productive resources. These include their labor, capital, natural resources and entrepreneurial talents.

### **National Geography Standards**

#### **Element One: The World in Spatial Terms**

##### **Standard 1**

Globes and maps have been among the most ubiquitous tools for learning geography. They have been joined by aerial photographs, remotely sensed images, and geographic information systems. As technology makes them easier to make, maps and other geographic representations appear practically everywhere.