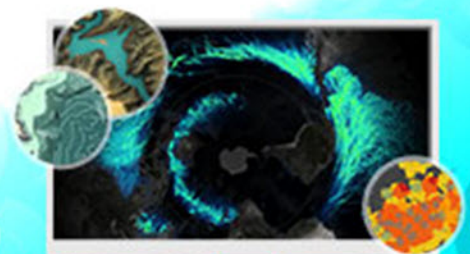


Exercise

Classifying Data

Section 2 Exercise 2

January 27, 2021



Classifying Data

Instructions

Use this guide and ArcGIS Pro to reproduce the results of the exercise on your own.

Note: The version of ArcGIS Pro that you are using for this course may produce slightly different results from the screen shots that you see in the course materials.

Time to complete

Approximately 10-20 minutes

Software requirements

ArcGIS Pro 2.7

ArcGIS Pro Standard license (or higher)

Note: The MOOC provides a separate ArcGIS account (user name and password) that you will need to use to license ArcGIS Pro and access other software applications used throughout the MOOC exercises. This account (user name ending with _cart) provides the appropriate ArcGIS Online role, ArcGIS Pro license, ArcGIS Pro extensions, and credits. We strongly recommend that you use the provided course ArcGIS account to ensure that you have the appropriate licensing to complete the exercises. Exercises may require credits. Using the provided course ArcGIS account ensures that you do not consume your organization's credits. Esri is not responsible for any credits consumed if you use a different account. Moreover, Esri will not provide technical support to students who use a different account.

Introduction

All maps are made from data. Part of making a good map is being able to understand and work with numbers and to appreciate how your manipulation of the data plays a vital role in the message that your map communicates.

For a lot of topographic mapping, you are symbolizing data that has been surveyed, which encodes meaning into the coordinates by symbolizing them as points, lines, and areas, often of different types.

For thematic mapping (a map designed to focus on a particular theme in a geographic area), you are often dealing with a dataset that represents a variable of interest. Your map will likely show certain trends, such as where the place with the highest or lowest value is or where certain areas share similar characteristics. The key is understanding that how you manipulate

the data can tell different stories. It is important to ensure that you are not inadvertently telling a false story.

This exercise uses ArcGIS Pro to explore alternative methods of classifying numerical data for thematic mapping. Data classification is not unique to thematic mapping, but the techniques explored here can be used to understand and classify data more generally. You will create a range of choropleth maps (<https://bit.ly/3ngFJ85>) to illustrate how changing the classification changes the map.

The first step of classifying your data is understanding the data itself. In this exercise, you will explore the data that you will be using, familiarizing yourself with the attributes and what they represent.

Step 1: Download the exercise data file

In this step, you will download and save the exercise data file.

- a Open a new web browser tab or window.
- b Go to <https://bit.ly/34QcS2M> and click Download to download the exercise data file.

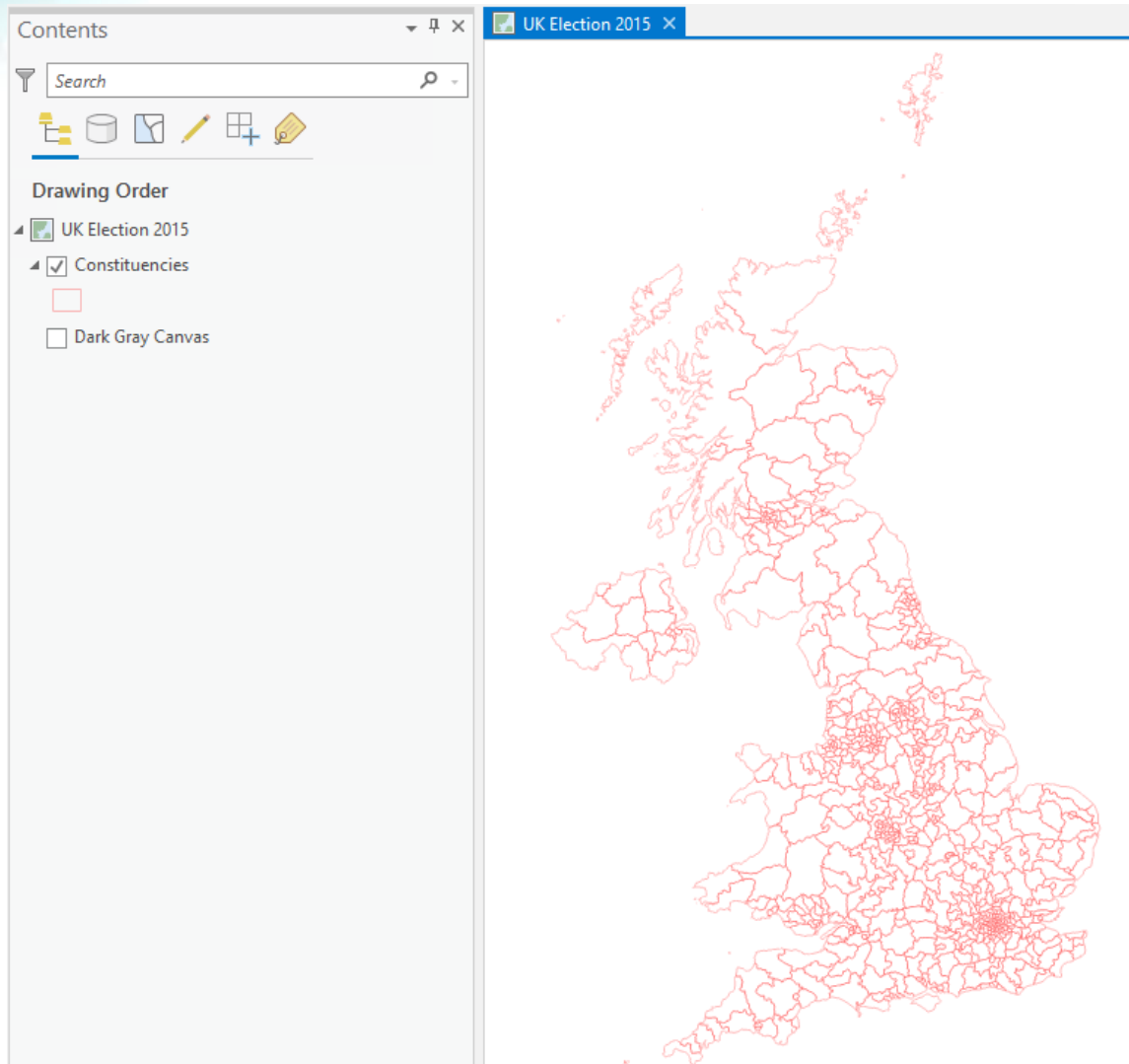
Note: The complete URL to the exercise data file is <https://www.arcgis.com/home/item.html?id=e35c85c2f9be43bf97036a4dc3d330f8>. The file size is 14 MB.

- c Save the file in a location that you will remember.

Step 2: Open an ArcGIS Pro project

You will open the exercise project in ArcGIS Pro to get started.

- a Start ArcGIS Pro and, if necessary, sign in using your provided course ArcGIS credentials (user name ending with `_cart`).
- b From the main ArcGIS Pro start page, click Open Another Project.
- c Browse to the location where you saved the exercise data file and open the `ExploringDataClassification.ppkx` project package.



The project opens to the UK Election 2015 election map, which includes a single layer showing the electoral constituencies for the United Kingdom of Great Britain and Northern Ireland and the Dark Gray Canvas basemap layer (which is not turned on).

The project also contains numerical election data for each of the constituencies. You will classify this data using a variety of methods to visualize the results of the 2015 UK election.

- d From the Project tab, click Save As and type a name for your project, such as **ExploringDataClassification_<your first and last name>.aprx**.
- e Save the project to the folder on your computer where you are saving your work.

Note: It is important to save your work regularly in ArcGIS Pro. Remember to save periodically as you go through this exercise.

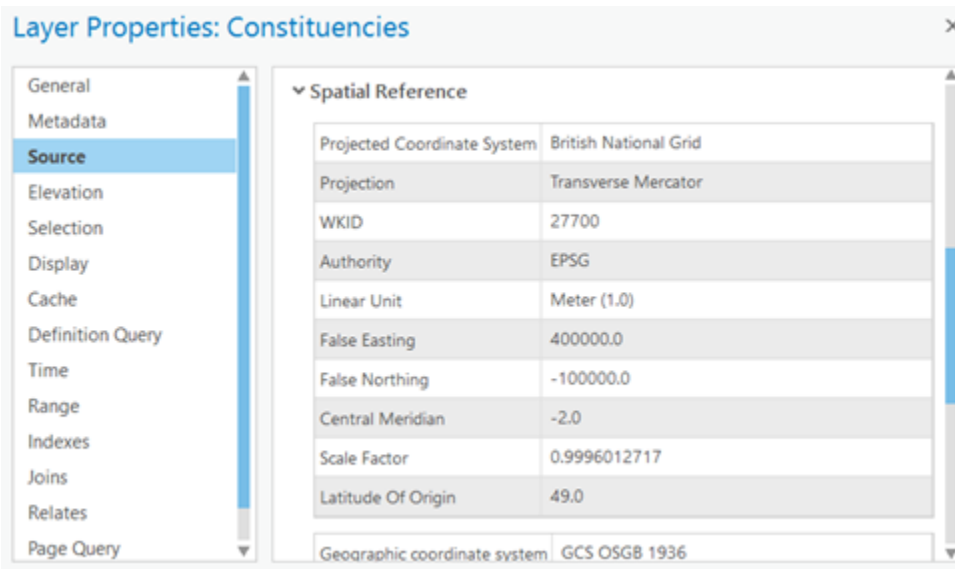
Step 3: Determine the spatial reference of the data

Before classifying the data, you should examine its spatial reference to determine which coordinate system and projection the data is specified in. This information often helps in later steps where the coordinate system and projection play an important part of analysis or cartography.

- a In the Contents pane, double-click the Constituencies layer to open the Layer Properties dialog box.

Note: You can also right-click the layer name and choose Properties.

- b Click Source and view the data source information for the layer.
- c Scroll down, if necessary, and click Spatial Reference to expand the section.



The spatial reference uses the British National Grid projected coordinate system based on a Transverse Mercator projection. This option is the most common coordinate system and projection used for UK data. If you looked at a map of a different part of the world, you would likely see a different coordinate system and projection being used, one that is more relevant to that specific area.

- d Close the Layer Properties dialog box.

Next, you will turn on the Dark Gray Canvas basemap layer to provide geographical context for the map.

- e In the Contents pane, turn on the Dark Gray Canvas layer, and then, if necessary, zoom out to see all of the UK.



- f Zoom out to the full extent of the map.

Now you can see how the projected coordinate system that is being used warps the rest of the world map.

- g In the Contents pane, right-click Constituencies and choose Zoom To Layer.

Step 4: Explore the data

To ensure that the message of your map is clear and accurate, you must understand the data before classifying it.

- a Open the Constituencies layer attribute table.

Hint: In the Contents pane, right-click the Constituencies layer and choose Attribute Table.

- b Examine the field names in the attribute table and use the field descriptions in the following table to learn more about the data.

Note: You can dock the attribute table pane in different parts of your window or make it larger or smaller by clicking and dragging the border.

Your goal here is to get familiar with the data, which is important before working with it or making a map.

Field name	Description
ID	Alphanumeric code used to identify individual constituencies
Constituency	The name of the electoral constituency
Headline	The result of the election, showing which political party won and by how much
Winning_MP	The name of the winning member of Parliament, who represents the winning political party
First	Abbreviated name of the winning political party in that constituency
First_Votes	The number of votes for the winning political party in that constituency
First_Share	The overall share of votes for the winning political party in that constituency (largest share wins)
Second	Abbreviated name of the political party that came second in that constituency
Second_Votes	The number of votes for the political party that came second in that constituency
Second_Share	The overall share of votes for the political party that came second in that constituency
Third	Abbreviated name of the political party that came third in that constituency
Third_Votes	The number of votes for the political party that came third in that constituency
Third_Share	The overall share of votes for the political party that came third in that constituency
Other_Votes	The number of votes for all other political parties combined in that constituency
Other_Share	The overall share of votes for all other political parties combined in that constituency
Turnout	The number of people who actually voted in the constituency
Electorate	The total number of eligible voters in the constituency

- c After you have examined the data, close the attribute table.

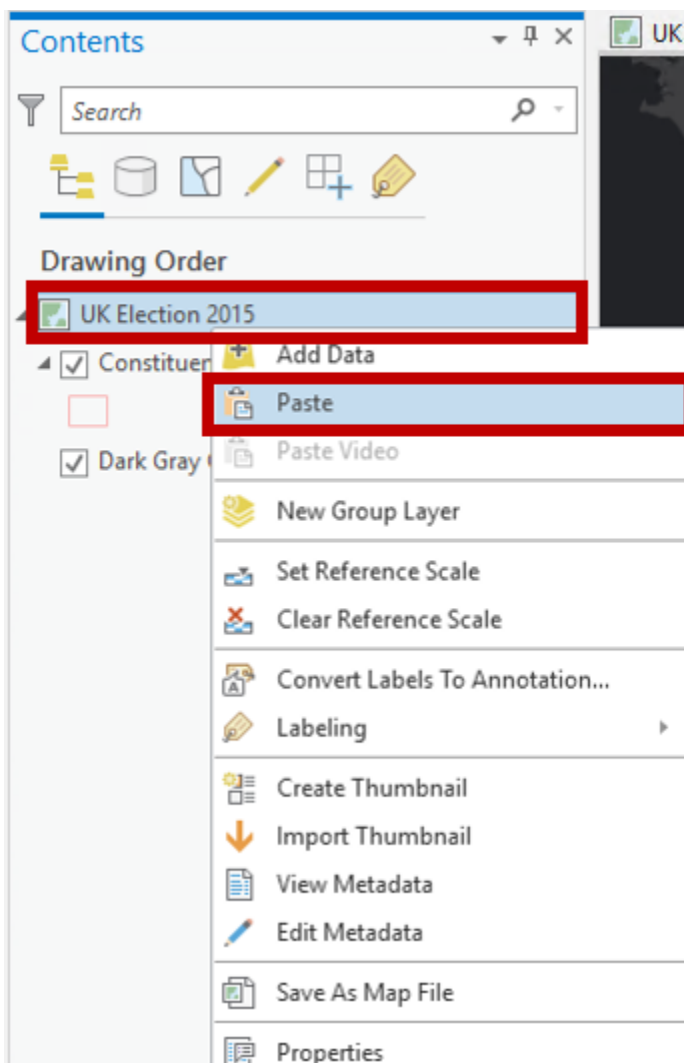
Now that you have an idea of the data available in the layer, you will create several choropleth maps to see how changing the data classification changes the message of the map.

- d Save your project.

Step 5: Create a map using a natural breaks classification

You will make a simple choropleth map (graduated colors (<https://bit.ly/2UoWUaU>)) to show the voter-turnout percentage as a proportion of the total electorate in each constituency.

- a In the Contents pane, right-click the Constituencies layer and choose Copy.
- b Right-click the UK Election 2015 map and choose Paste.



- c Double-click the new layer name to open the Layer Properties dialog box.

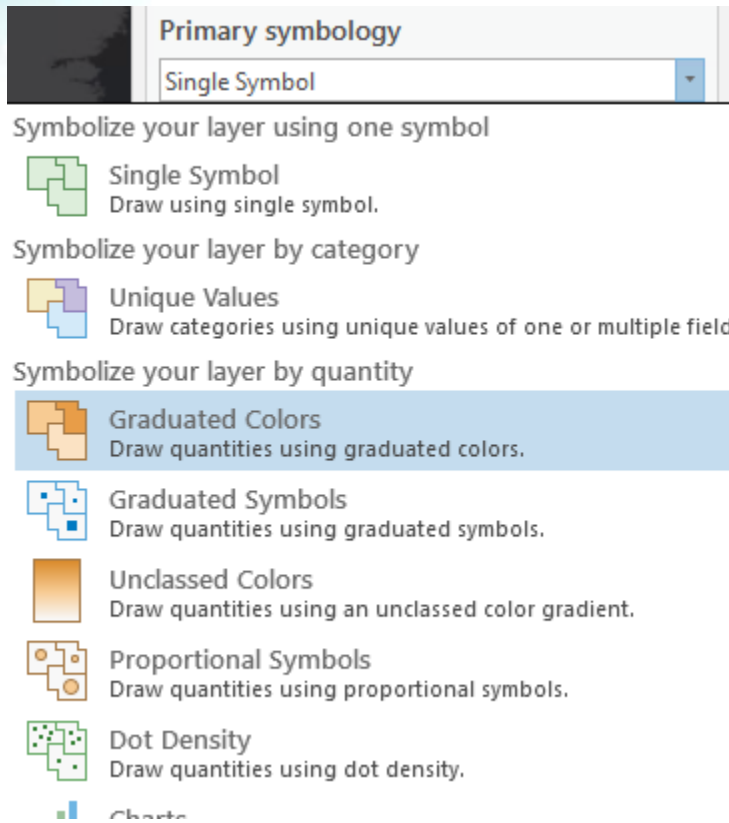
- d Click General, and then in the Name field, type **Constituencies_natural breaks** as the name for the new layer and click OK.
- e In the Contents pane, turn off the Constituencies layer.
- f Open the Symbology pane for the Constituencies_natural breaks layer.

Hint: With the new layer selected in the Contents pane, click the Appearance tab, and then in the Drawing group, click Symbology. Alternatively, in the Contents pane, you can right-click the layer name and choose Symbology. If the Symbology pane is not docked, right-click the pane title and choose Dock.

In the Symbology pane, the Primary Symbology drop-down list provides several options for symbolizing the layer. You will first draw quantities using graduated colors, with darker colors indicating higher percentages.

Graduated color symbology shows a quantitative difference between mapped features by varying the color of symbols. Data is classified into ranges that are each assigned a different color from a [color scheme \(https://bit.ly/2req3YA\)](https://bit.ly/2req3YA) that represents the range. For instance, if your classification scheme has five classes, five different symbol colors are assigned. Maps that vary in color in this way are called choropleth maps. Choropleth maps apply different shades of the same color so that lighter shades match lower data values and darker shades match higher data values.

- g For Primary Symbology, choose Graduated Colors.



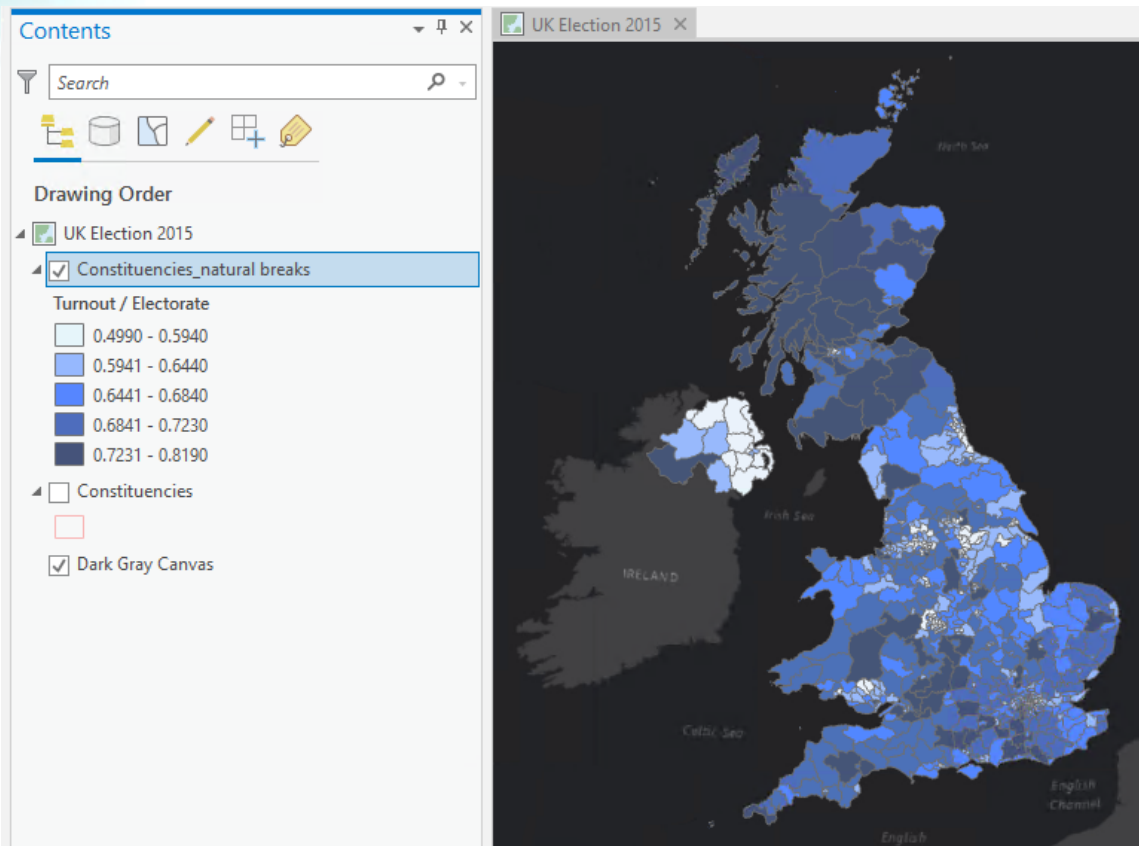
h For Field, choose Turnout.

The Turnout field contains the number of people who actually voted in the constituency.

Choosing Turnout for the field will display the data totals. However, you should not map totals with a choropleth map because the areas and base population data differ between areas, which makes comparing areas across the map problematic. To create a final map that supports visual comparison like-for-like across the whole map, you must first account for underlying geographical and population differences. You can achieve this by normalizing (<https://bit.ly/3or1KSS>) the data, either by calculating a new field or by selecting a field to normalize against. Normalizing divides each data value by a common denominator, turning totals into rates. Mapping rates will result in a map that supports visual comparisons between areas.

Because you want to show the percentage of voter turnout as a proportion of the total electorate, you normalize against the Electorate field, which contains the total number of eligible voters in the constituency.

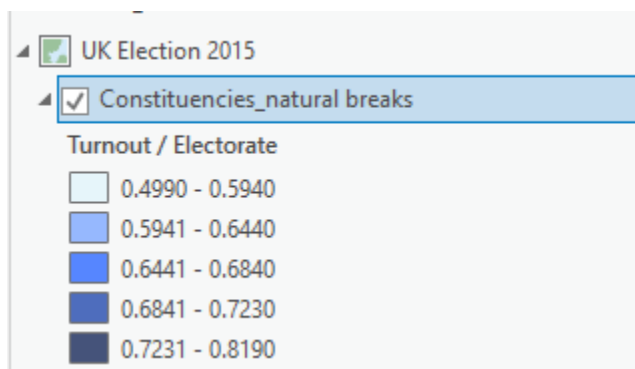
i For Normalization, choose Electorate.



Choropleth map symbolized with graduated colors, using the natural breaks (Jenks) data classification method.

The default classification method, Natural Breaks (Jenks) (<https://bit.ly/2UefL9U>), and the number of classes are applied.

Now you have a default choropleth map showing the percentage turnout classified into five classes by the natural breaks method. Lower turnout is shown with lighter symbols, and higher turnout is shown with darker symbols, as you can see in the legend.



Looking at the map and the legend, what patterns do you see? What message does the classification communicate? With all the different classification methods, you will likely see areas of high rates relative to low rates. However, there are always subtle differences in the resulting maps. So, for instance, does a particular technique make it easy to see the highest and lowest areas, or does it cause these areas to become grouped with other areas? How is the data distributed across the whole map? Are there sharp changes between some areas that need to be examined further, or are the changes more gradual across space? Keep these and other questions in mind as you change the classification methods because changing the method does change the map and the map's message.

The natural breaks (Jenks) classification method uses classes based on the natural groupings inherent in the data. This method identifies the class breaks that best group similar values and maximize the differences between classes. It divides the features into classes whose boundaries are set where there are relatively big differences in the data values.

- j Near the bottom of the Symbology pane, notice the labels associated with the symbols.

The screenshot shows the Symbology pane with three tabs: 'Classes', 'Histogram', and 'Scales'. The 'Classes' tab is active. Below the tabs is a 'More' dropdown arrow. The legend table has four columns: 'Symbol', 'Upper value', and 'Label'. The 'Label' column is highlighted with a red box. The table contains five rows of data, each with a color swatch, an upper value, and a label representing a range of values.

Symbol	Upper value	Label
	≤ 0.594002	0.4990 - 0.5940
	≤ 0.643998	0.5941 - 0.6440
	≤ 0.684001	0.6441 - 0.6840
	≤ 0.723005	0.6841 - 0.7230
	≤ 0.818995	0.7231 - 0.8190

The labels show the proportion of turnout as a value between 0 and 1. However, a percentage would be more meaningful. You can change the labels to show a percentage by clicking each label and typing a new value and the percent symbol (for example, 0.5940 becomes 59.4%). You could label each class in many different ways, including showing class intervals (0–59.4, 50.5–64.4, and so on).

k Update the labels for the symbols to percentages using the following values:

Note: Change only the numbers to percentages. Do not change the dash symbols.

- Change 0.4990 - 0.5940 to **49.9 - 59.4%**
- Change 0.5947 - 0.6440 to **59.41 - 64.4%**
- Change 0.6441 - 0.6840 to **64.41 - 68.4%**
- Change 0.6840 - 0.7230 to **68.41 - 72.3%**
- Change 0.7231 - 0.8190 to **72.31 - 81.9%**

Symbol	Upper value	Label
	≤ 0.594002	49.9 - 59.4%
	≤ 0.643998	59.41 - 64.4%
	≤ 0.684001	64.41 - 68.4%
	≤ 0.723005	68.41 - 72.3%
	≤ 0.818995	72.31 - 81.9%

l In the Contents pane, examine the map legend and notice how the percentages make the data and symbology more meaningful.

UK Election 2015

Constituencies_natural breaks

Turnout / Electorate

	49.9 - 59.4%
	59.41 - 64.4%
	64.41 - 68.4%
	68.41 - 72.3%
	72.31 - 81.9%

m Save your project.

When using graduated color symbology, you can use the different view modes in the Symbology pane to see your data classification in different ways.

View mode	Description
Classes	Allows you to manage the symbol, values, descriptive labels, and grouping of the symbol classes
Histogram	Offers a visual tool for editing the classes and understanding how the data is represented by different classification methods
Scales	Allows you to specify the scale ranges in which each symbol class draws (this tool is not particularly useful for this exercise)

- n** In the Symbology pane, click the Classes tab and the Histogram tab to switch between a label view and a histogram view.
- o** Ensure that you check the histogram view for this map and all subsequent classification maps to see how the data distribution relates to the different classification schemes.
- p** Experiment with changing the number of classes by changing the Classes parameter in the Symbology pane.

Do fewer classes help simplify and clarify the message of the map? Do more classes give a different message? A good rule of thumb is to limit the number of classes to between four and seven. Too few and you lose a great deal of variation in how the data is presented. Too many and it becomes hard to see subtle differences between areas classified slightly differently.

Note: For more information about data classification, refer to this ArcGIS Pro Help page about [classification methods](https://bit.ly/2XnDuVQ) (<https://bit.ly/2XnDuVQ>).

Now you will explore different classification techniques and see how they affect the way that the data appears on the map. Remember that you can pan and zoom the map as you do this. As you change settings, you will notice that the legend in the Contents pane updates, and the changes are automatically applied to the map.

As you make changes, consider the visual impression of the data's pattern and distribution. Ask yourself what each method shows and what the key aspect of the highlighted data is. Differences will sometimes be pronounced and, other times, subtle. All have consequences for how people read and interpret the pattern.

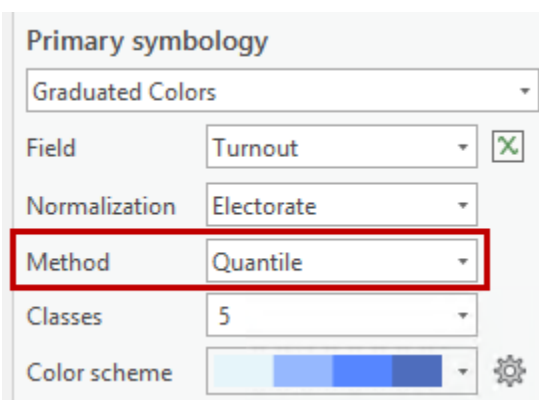
- q** Save your project.

Step 6: Create a map using a quantile classification

In a [quantile \(https://bit.ly/35mA22k\)](https://bit.ly/35mA22k) classification, each class contains an equal number of features. A quantile classification is well suited to linearly distributed data. Quantile classification assigns the same number of data values to each class, resulting in no empty classes or in classes with too few or too many values.

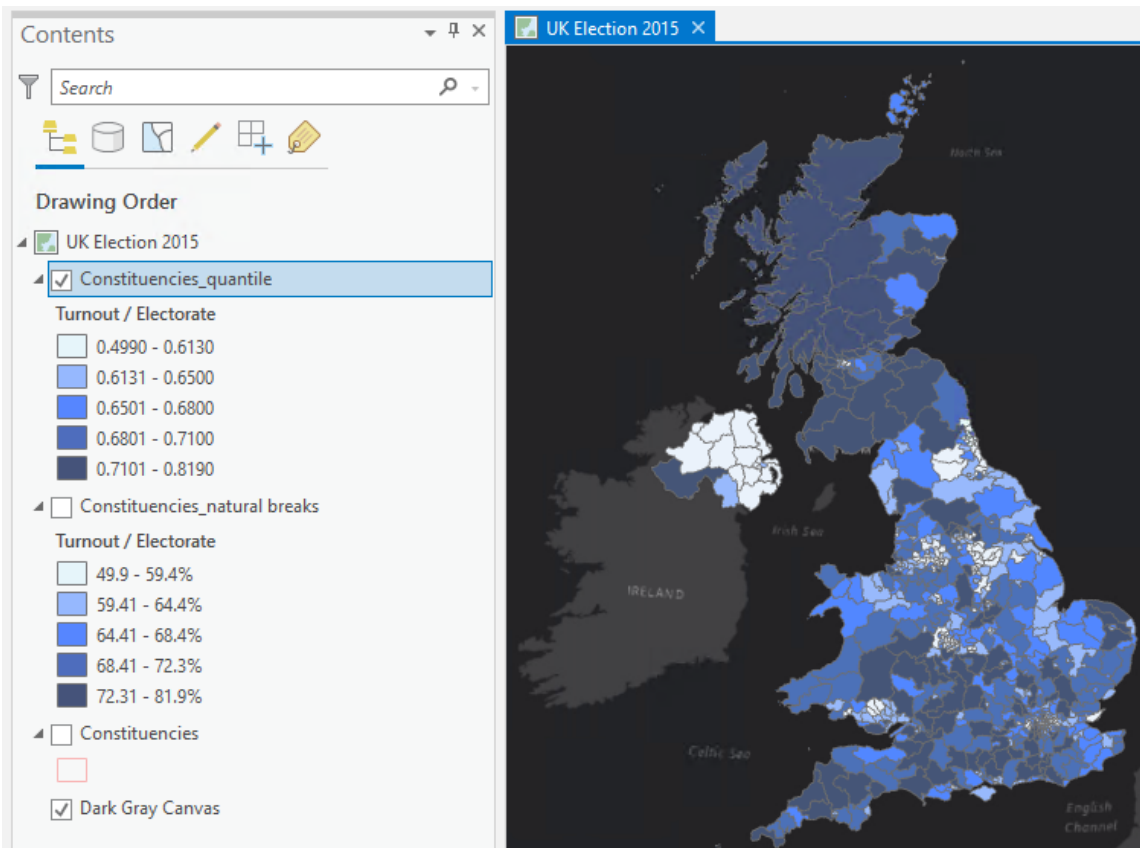
Because features are grouped in equal numbers in each class, the resulting map will not necessarily reflect the underlying data distribution. Similar features might be placed in adjacent classes, and features with widely different values might be put in the same class. You can minimize this distortion by increasing the number of classes, although this introduces other trade-offs.

- a In the Contents pane, right-click the Constituencies_natural breaks layer and choose Copy.
- b Right-click the UK Election 2015 map and choose Paste.
- c Name the new layer **Constituencies_quantile**.
- d Turn off the Constituencies_natural breaks layer and turn on the Constituencies_quantile layer, if necessary.
- e Verify that the Constituencies_quantile layer is selected.
- f In the Symbology pane, change Method to Quantile.



What differences or similarities do you notice with the change in classification method? What patterns are visible? What is the key aspect of the data that is highlighted with this classification method? Remember, you can vary the number of classes to see how that changes things.

Hint: In the Contents pane, turn the Constituencies_natural breaks and Constituencies_quantile layers on and off to see the differences between the maps.



Choropleth map symbolized with graduated colors, using the quantile data classification method.

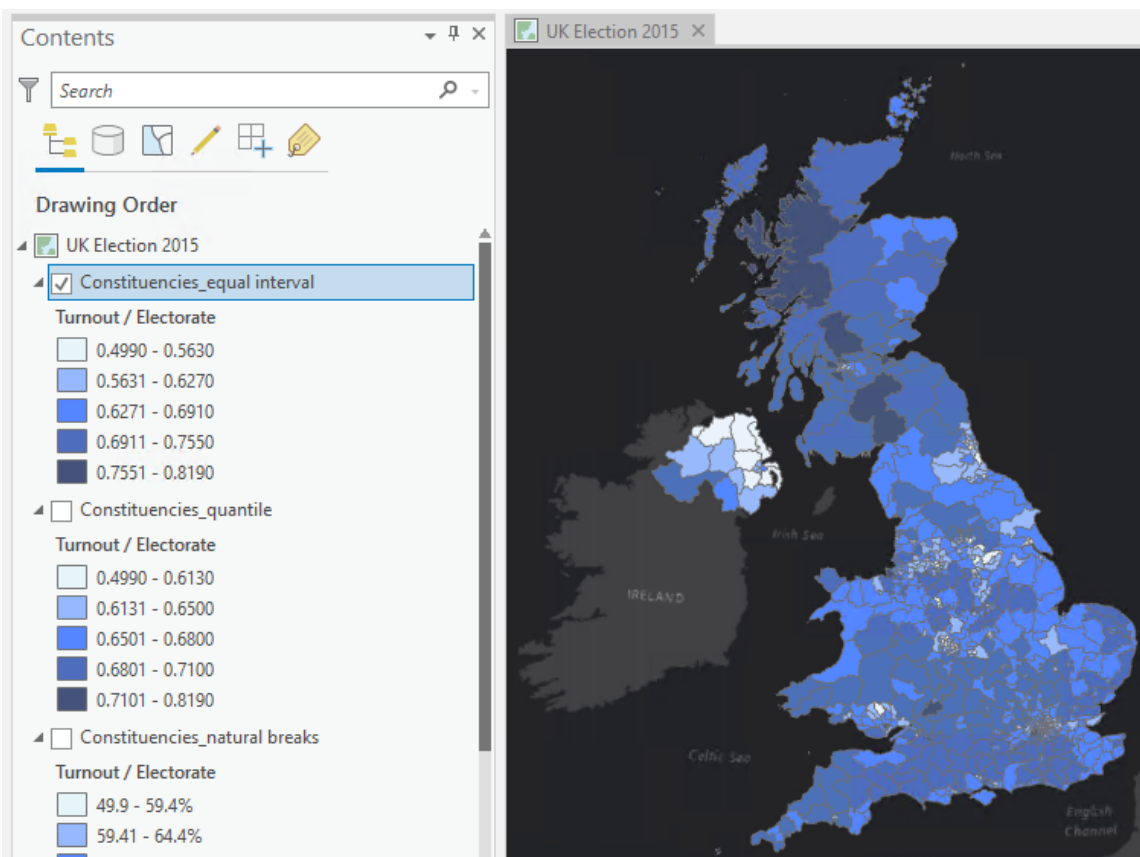
- g** Examine the histogram view for this map to see how the classification method has been applied across the data distribution.
- h** Save your project.

Step 7: Create a map using an equal interval classification

Equal interval classification (<https://bit.ly/2Jac2Ut>) divides the range of data values into equal-sized subranges. ArcGIS Pro will automatically determine the class breaks based on the value range. For example, if you specify three classes for a field whose values range from 0 to 300, the application will create three classes with ranges of 0–100, 101–200, and 201–300.

Equal interval is best applied to familiar data ranges, such as percentages and temperature. This method emphasizes the amount of an attribute value relative to other well-known values.

- a In the Contents pane, copy the Constituencies_natural breaks layer and paste it to the UK Election 2015 map.
- b Name the new layer **Constituencies_equal interval**.
- c Turn off the Constituencies_quantile layer and turn on the Constituencies_equal interval layer, if necessary.
- d Verify that the Constituencies_equal interval layer is selected.
- e In the Symbology pane, change Method to Equal Interval.



Choropleth map symbolized with graduated colors, using the equal interval data classification method.

What is the key aspect of the data that is highlighted with this classification method? Remember, you can vary the number of classes to see how things change.

- f Examine the histogram view for this map to see how the classification method has been applied across the data distribution.
- g Save your project.

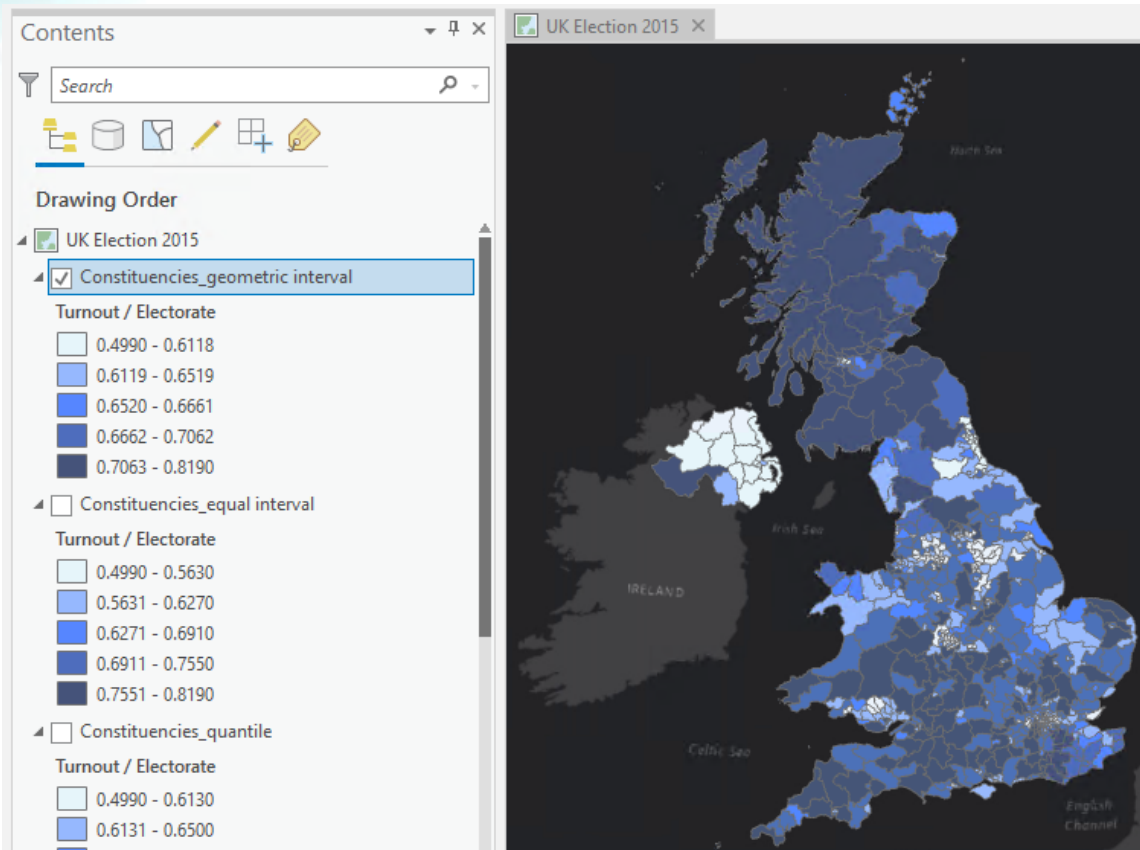
You have explored three of the most common classification methods, but there are many more. We encourage you to explore other methods on your own.

Step 8: Create a map using a geometric interval classification

The geometric interval classification scheme creates class breaks based on class intervals that have a geometric series. The geometric coefficient in this classifier can change once (to its inverse) to optimize the class ranges. The algorithm creates geometrical intervals by minimizing the sum of squares of the number of elements in each class. This ensures that each class range has approximately the same number of values in each class and that the change between intervals is fairly consistent.

This algorithm was specifically designed to accommodate continuous data. It is a compromise method between equal interval, natural breaks (Jenks), and quantile. It creates a balance between highlighting changes in the middle values and the extreme values, producing a result that can be more relevant.

- a In the Contents pane, copy the `Constituencies_natural breaks` layer and paste it to the UK Election 2015 map.
- b Name the new layer **Constituencies_geometric interval**.
- c Turn off the `Constituencies_equal interval` layer and turn on the `Constituencies_geometric interval` layer, if necessary.
- d Verify that the `Constituencies_geometric interval` layer is selected.
- e In the Symbology pane, change the Method to Geometric Interval.



Choropleth map symbolized with graduated colors, using the geometric interval data classification method.

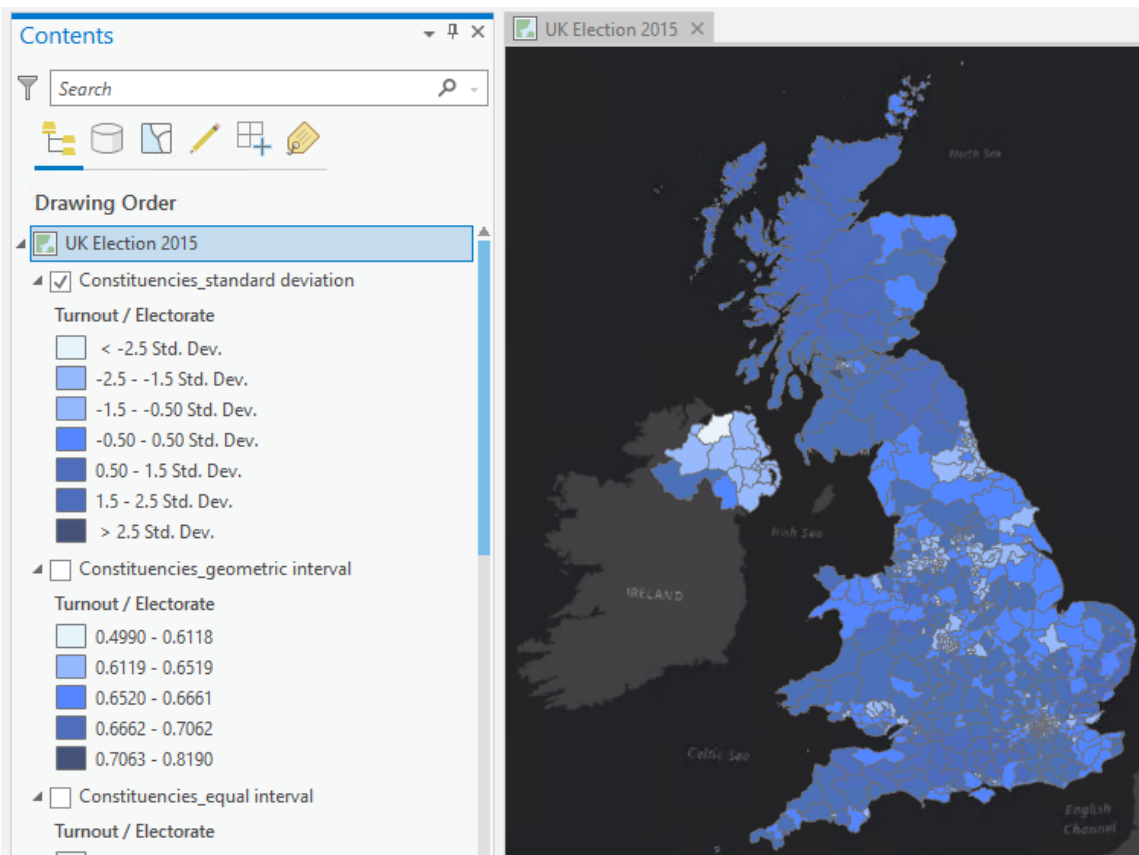
What is the key aspect of the data that is highlighted with this classification method? Remember, you can vary the number of classes to see how things change.

- f** Examine the histogram view for this map to see how the classification method has been applied across the data distribution.
- g** Save your project.

Step 9: Create a map using a standard deviation classification

The standard deviation classification method (<https://bit.ly/3bnG32u>) shows you how much a feature's attribute value varies from the mean. ArcGIS Pro calculates the mean and standard deviation automatically. Class breaks are created with equal value ranges that are a proportion of the standard deviation, usually at intervals of one, one-half, one-third, or one-fourth standard deviations, using mean values and the standard deviations from the mean.

- a In the Contents pane, copy the Constituencies_natural breaks layer and paste it to the UK Election 2015 map.
- b Name the new layer **Constituencies_standard deviation**.
- c Turn off the Constituencies_geometric interval layer and turn on the Constituencies_standard deviation layer, if necessary.
- d Verify that the Constituencies_standard deviation layer is selected.
- e In the Symbology pane, change the Method to Standard Deviation.



Choropleth map symbolized with graduated colors, using the standard deviation data classification method.

What is the key aspect of the data that is highlighted with this classification method? Remember, you can vary the number of classes to see how things change.

- f Examine the histogram view for this map to see how the classification method has been applied across the data distribution.
- g Save your project.

Step 10: Create a map using manual interval classification

Now that you have explored the various standard classification schemes available in ArcGIS Pro, you will make a manual classification scheme.

If you want to define your own classes, you can manually add class breaks and set class ranges that are appropriate for your data. You can also start with one of the standard classifications and make adjustments as needed.

First, you will make a copy of the Constituencies_natural breaks layer to use for your manual classification scheme.

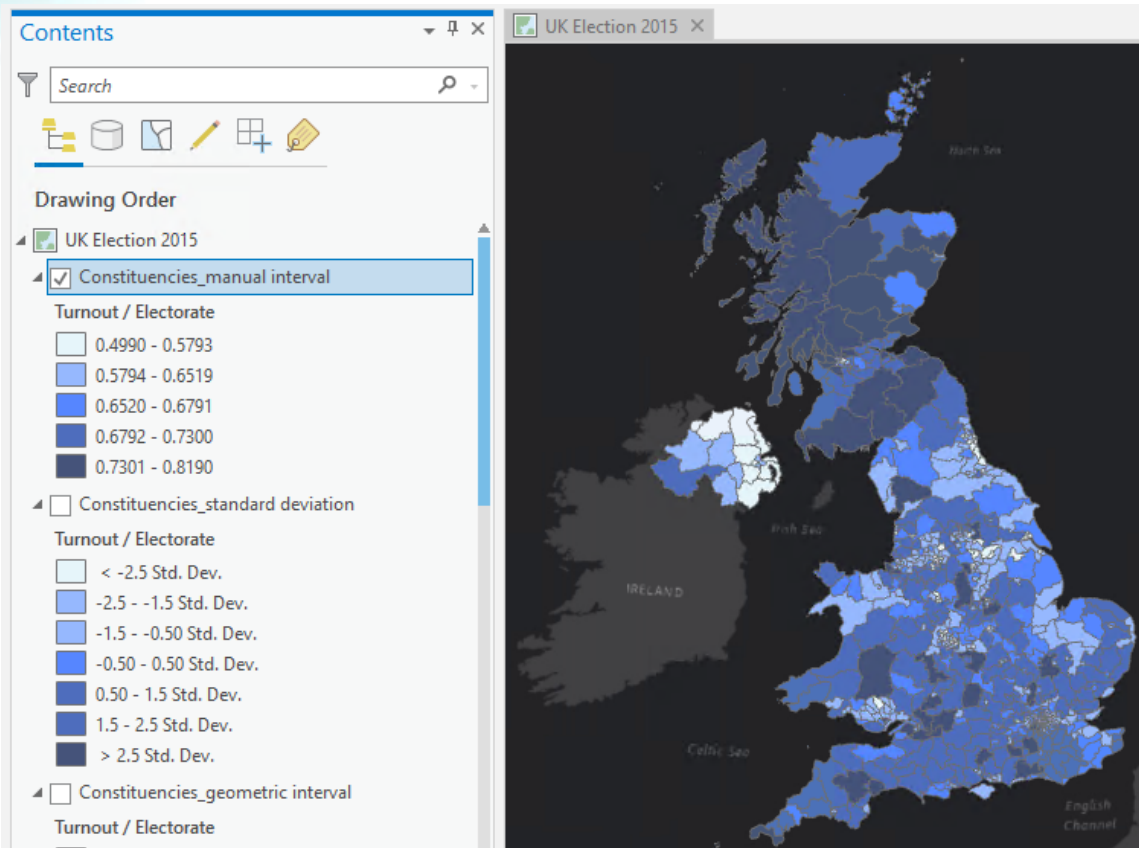
- a In the Contents pane, copy the Constituencies_natural breaks layer and paste it to the UK Election 2015 map.
- b Name the new layer **Constituencies_manual interval**.
- c Turn off the Constituencies_standard deviation layer and turn on the Constituencies_manual interval layer, if necessary.
- d Verify that the Constituencies_manual interval layer is selected.
- e In the Symbology pane, change the Method to Manual Interval.

It is useful to use the histogram view of the data when creating a manual classification.

- f In the Symbology pane, click the Histogram tab to switch to the histogram view.
- g Move the sliders up and down across the histogram so that you attempt to group together values of data that display similar characteristics.

You might also incorporate a specific value or values as part of your classification scheme.

- h Experiment until you achieve a classification scheme that makes sense to you, based on the sort of characteristics in the data that you want to emphasize.



Choropleth map symbolized with graduated colors, using the manual interval data classification method.

What is the key aspect of the data that is highlighted with this classification method?

- i Examine your manual breaks method compared to the other methods to see how the different classification schemes change the way the map looks.
- j Save your project.

Step 11: Create a map using an unclassed representation

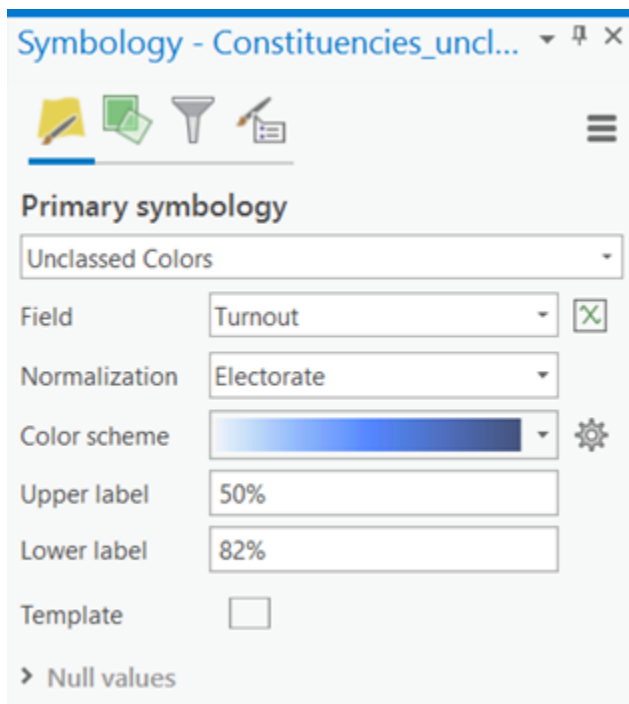
Now that you have seen how different standard classification methods affect the message of the map, you will learn another approach to represent the data. The alternative is to simply not classify the data at all and apply a unique shade of color to each individual data value in your array. This method is called an unclassed technique.

- a In the Contents pane, paste another copy of the Constituencies_natural breaks layer.
- b Name the new layer **Constituencies_unclassified**.

- c Turn off the Constituencies_manual interval layer and turn on the Constituencies_unclassified layer, if necessary.
- d In the Symbology pane, from the Primary Symbology drop-down list, choose Unclassed Colors.
- e For Field, choose Turnout.
- f For Normalization, choose Electorate.

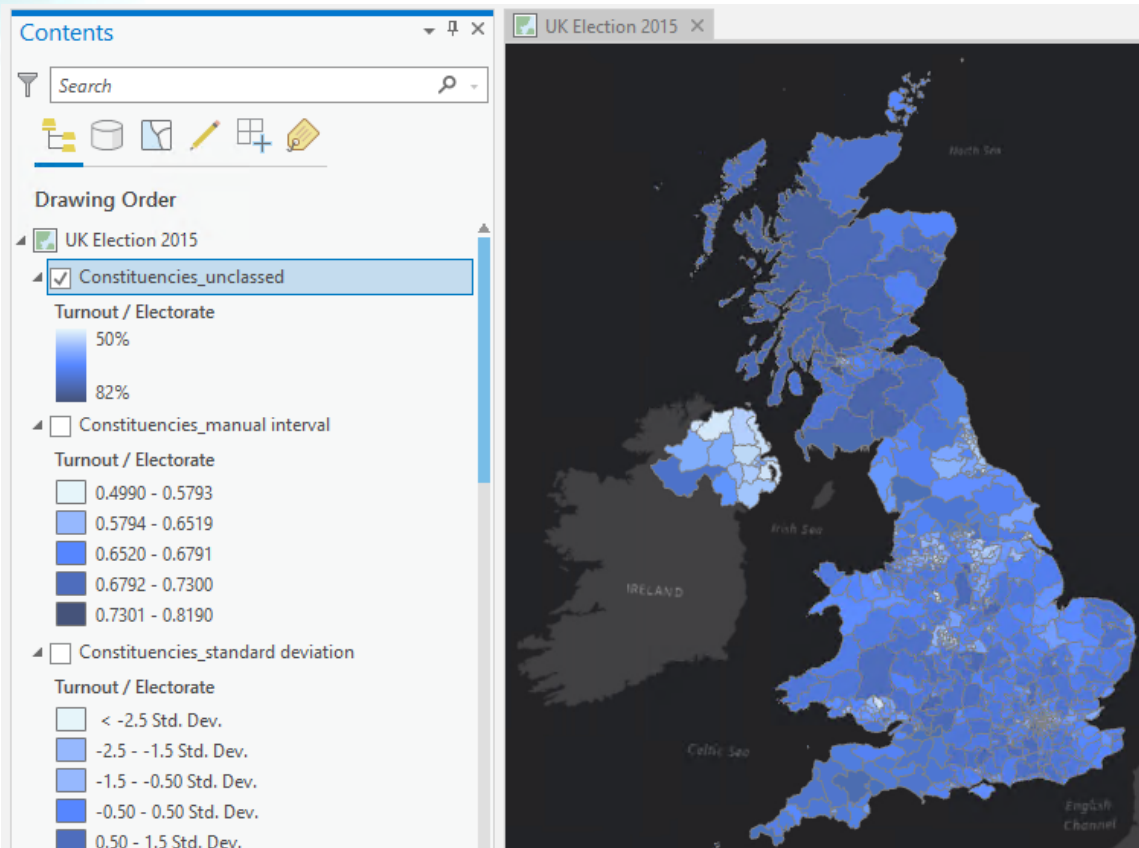
To control how the legend for this layer is labeled, you will edit the upper and lower labels. By default, they are the minimum and maximum values of the symbol field.

- g Update the following label fields with the provided percentages:
 - Upper Label: **50%**
 - Lower Label: **82%**



Dragging the handles in the histogram shifts the way that color is applied to the unclassified values.

- h Experiment with these handles and see how the colors are applied to the map.



Sliding the histogram's handles is a quick way to change how all data values above or below a particular number can be made to appear the same way.

What is the key aspect of the data that is highlighted with this classification method?

Unclassed techniques can be very useful in highlighting extremes in your data and picking out the highs and lows. However, unclassified techniques are the inverse of classifying. It is important to keep the difference between classified and unclassified data in mind when you want to make a map that shows your reader how similar different places are.

i Save your project and exit ArcGIS Pro.

Conclusion

You have explored a range of classification techniques and learned that there are numerous ways to classify a single dataset. Therefore, there is ample opportunity to represent the data well or poorly, objectively or persuasively.

For any dataset that you classify, first determine which method of classification will most effectively communicate your message without obfuscating the truth.

You will use this same dataset in a future exercise to create different thematic maps and study color and symbology in more detail. However, for now, the most important lesson to understand is that data can be manipulated to tell different stories.

Stretch goal

If you would like to continue exploring the classification of numerical data, you can complete the following high-level tasks:

1. Classify some of the other data in the UK Election 2015 dataset.
2. Observe how the different classification techniques can be used to tease out aspects of different data.

Note: Any fields with "_Share" in their names are already percentages and do not need to be normalized.

Post your questions and observations about this stretch goal in the Lesson Forum. Be sure to include the **#stretch** hashtag in your post title. We would love to hear about any experimenting that you did beyond the steps of the original exercise!