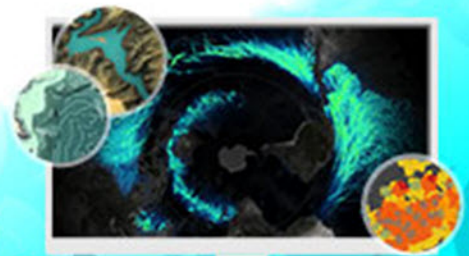


# Exercise

## Thematic Mapping

Section 3 Exercise 4

05/2020



# Thematic Mapping

### 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 50-60 minutes

### Software requirements

ArcGIS Pro 2.5

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

Special purpose maps, as opposed to general reference maps, are termed "thematic maps." These maps tend to display a single theme of information by indicating the spatial distribution of a single attribute or the relationship among many attributes. Thematic maps illustrate the structural characteristics of the geographical distribution of a dataset.

Thematic maps vary considerably, but examples include maps depicting precipitation, population distribution, hurricane incidence, and pollution. Thematic maps tend to be small scale (showing a large area, which is expressed as a small representative fraction) because the geographical distribution of a theme is often most appropriately shown and accurately depicted over a large area.

Thematic mapping requires the transfer of empirical measurements into graphical signs that can be mapped to illustrate the spatial variation in the difference between measured values. Essentially, aspatial, tabular data is converted into a spatial form that, by definition, adds further to the information by giving the map reader the distance, direction, shape, and location of the theme. In a thematic map, the transformation of data from tabular to map form adds spatial understanding.

In this exercise, you will develop a range of alternative thematic maps that tell a story of the 2015 general election in the United Kingdom. To see various types of thematic maps, you should look at the [ArcGIS Online thematic mapping gallery \(https://bit.ly/2GQhgC6\)](https://bit.ly/2GQhgC6), which shows a range of different ways of mapping the 2016 U.S. presidential election and includes discussions of the map type and use.

For your reference, the project package includes a map view containing the final maps for this exercise. Your final maps may not match exactly. You are encouraged to experiment with the options available in ArcGIS Pro.

### Step 1: Download the exercise data file

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

- a Open a new web browser tab or window.
- b Go to <https://bit.ly/2xh6lfE> and download the exercise data file.

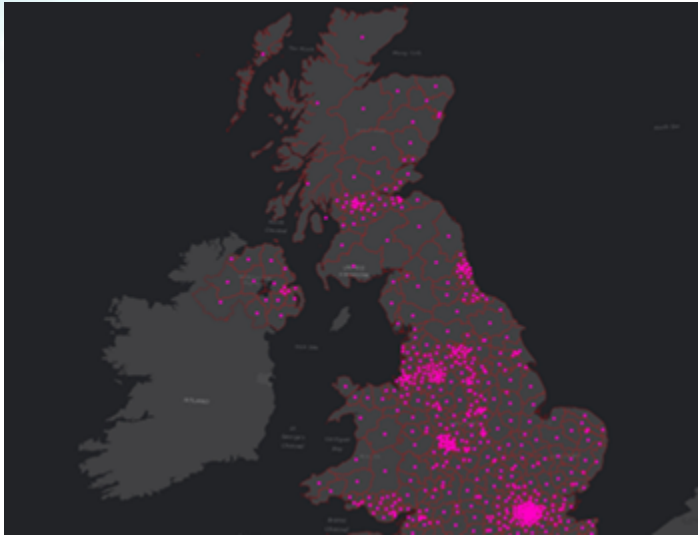
*Note: The complete URL to the exercise data file is <https://www.arcgis.com/home/item.html?id=61e08fd43fe6415289ac67c757e31ce9>. The file is 14 MB.*

- 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 ThematicMapping.ppkx project package.



The project opens with a map showing electoral constituencies for the 2015 UK Election.

- d Save your project with a name such as **ThematicMapping\_<your first and last name>.aprx** in the folder on your computer where you are saving your work.

This dataset is the same one that you used in the Section 2 exercise *Exploring Data for Classification*, so you should be familiar with its general contents. From that exercise, you will also use data classification concepts to process some of this data for mapping.

A single layer in the Contents pane shows the electoral constituencies of Great Britain and Northern Ireland. Additionally, a version of the data represents the election results as points, each in the center of the constituency. Whether you use the area or point version of the data depends on the map type, which is addressed later in this exercise.

### Step 3: Explore the election data

If you completed the *Exploring Data for Classification* exercise in Section 2, you are already familiar with the UK election data. This exercise uses the same dataset.

- a Right-click the Constituencies layer and choose Attribute Table to review the fields and their contents to refamiliarize yourself with the data.

## Cartography. MOOC

OBJECTID	Shape	ID	Constituency	Headline	Winning_MP	First	First_Votes	First_Share	Second
1	Polygon	W07000049	Aberavon	Labour hold with a 33...	Stephen Kinnock	LAB	15416	48.9	UKIP
2	Polygon	W07000058	Aberconwy	Conservative hold wit...	Guto Bebb	CON	12513	41.5	LAB
3	Polygon	S14000001	Aberdeen North	Scottish National Party...	Kirsty Blackman	SNP	24793	56.4	LAB
4	Polygon	S14000003	Airdrie & Shotts	Scottish National Party...	Neil Gray	SNP	23887	53.9	LAB
5	Polygon	E14000530	Aldershot	Conservative hold wit...	Gerald Howarth	CON	23369	50.6	LAB
6	Polygon	E14000531	Aldridge-Brownhills	Conservative hold wit...	Wendy Morton	CON	20558	52	LAB
7	Polygon	E14000532	Altrincham & Sale West	Conservative hold wit...	Graham Brady	CON	26771	53	LAB
8	Polygon	W07000043	Alyn & Deeside	Labour hold with a 8.1...	Mark Tami	LAB	16540	40	CON
9	Polygon	E14000533	Amber Valley	Conservative hold wit...	Nigel Mills	CON	20106	44	LAB
10	Polygon	S14000004	Angus	Scottish National Party...	Mike Weir	SNP	24130	54.2	CON
11	Polygon	W07000057	Arfon	Plaid Cymru hold with...	Hywel Williams	PC	11790	43.9	LAB

The layer attribute table contains a number of fields, which are described in the following table:

Field name	Description
ID	Alphanumeric code used to identify individual constituencies
Constituency	The name of the 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 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 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
First_code	A numeric code that can be used to reference the winning political party

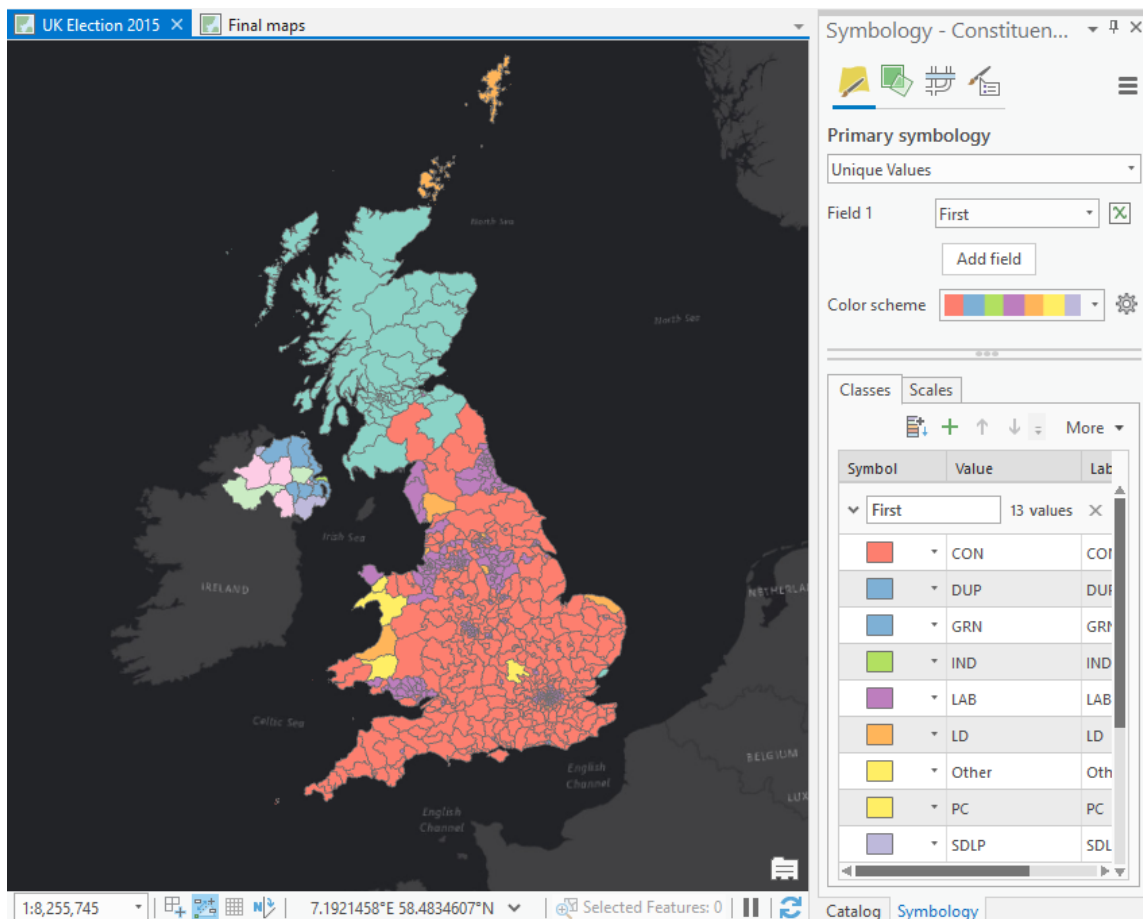
**b** When you are finished exploring the data, close the attribute table.

First, you will make a simple thematic map showing the winning political party in each constituency.

### Step 4: Create a unique values map

The purpose of a unique values thematic map is to show how areas differ in type.


- In the Contents pane, turn off the Constituency Points layer.
- Right-click the Constituencies layer and choose Symbology to open the Symbology pane.
- In the Symbology pane, from the Primary Symbology drop-down list, choose Unique Values.
- For Field 1, choose First.



This data is a text field that identifies the abbreviation of the political party that won that constituency. The result is a basic, descriptive map of the result of the election.

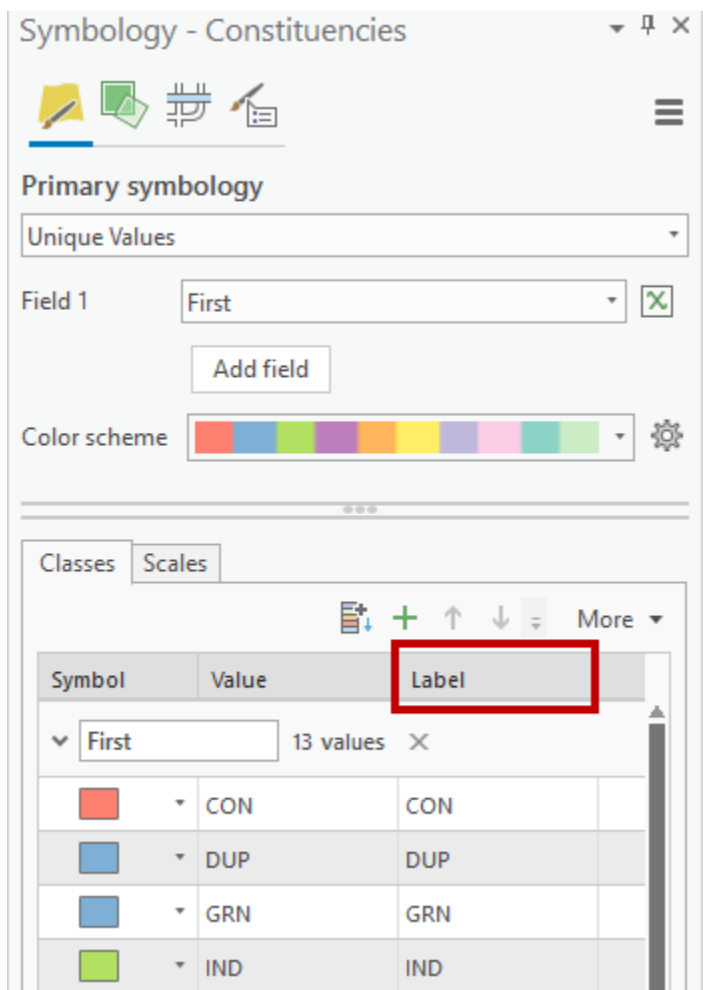
Default colors and labels rarely make an elegant map (as you can hopefully see). First, you will update the labels to make them more meaningful.



Note: You can dock the Symbology pane next to your map by right-clicking the pane title and choosing Dock. To auto hide the Symbology pane, click the Auto-Hide button  at the top of the pane.

- e If necessary, at the bottom of the Symbology pane, scroll to the right to view the Label column in the grid.

Note: Alternatively, you can make the Symbology pane larger by dragging its border.





- f Under the Label column, double-click each label and change it to the appropriate political party label, as shown in the following table.

Value	Label
CON	<b>Conservative</b>
DUP	<b>Democratic Unionist Party</b>
GRN	<b>Green</b>
IND	<b>Independent</b>
LAB	<b>Labour</b>
LD	<b>Liberal Democrats</b>
Other	<b>Other</b>
PC	<b>Plaid Cymru</b>
SDLP	<b>Social Democratic and Labour Party</b>
SF	<b>Sinn Fein</b>
SNP	<b>Scottish National Party</b>
UKIP	<b>UK Independence Party</b>
UUP	<b>Ulster Unionist Party</b>

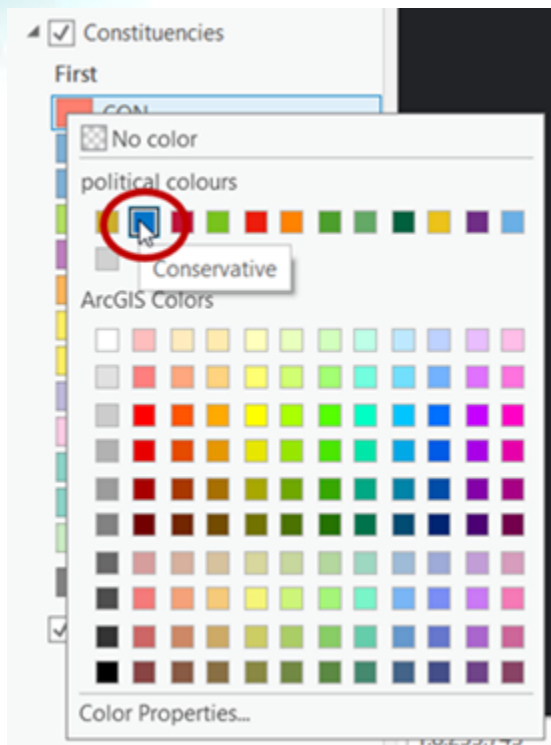
The party names are now updated in the Contents pane. Remember, it is vital that your map reader can interpret the map, and the way that data is stored is often not in an immediately recognizable form.

It is useful to make use of sensible symbology to reinforce the map's message. For instance, for this dataset, the default uses randomly selected colors, yet political parties have their own color schemes. This project comes preconfigured with a style file of colors that are ready to use, but you can always use a color picker to change them to what you prefer.

Next, you will change the colors for each of the political parties to match their party color from the Political Colours style file.

- g In the Contents pane (not the Symbology pane), right-click the color chip for Conservative to open the color picker.
- h In the color picker, in the Political Colours group, click the blue Conservative color.

*Hint: Point to a color chip to see its name.*



i Repeat this process to assign party colors based on the party name.

When you are finished, the symbols for the parties should look like the following graphic:

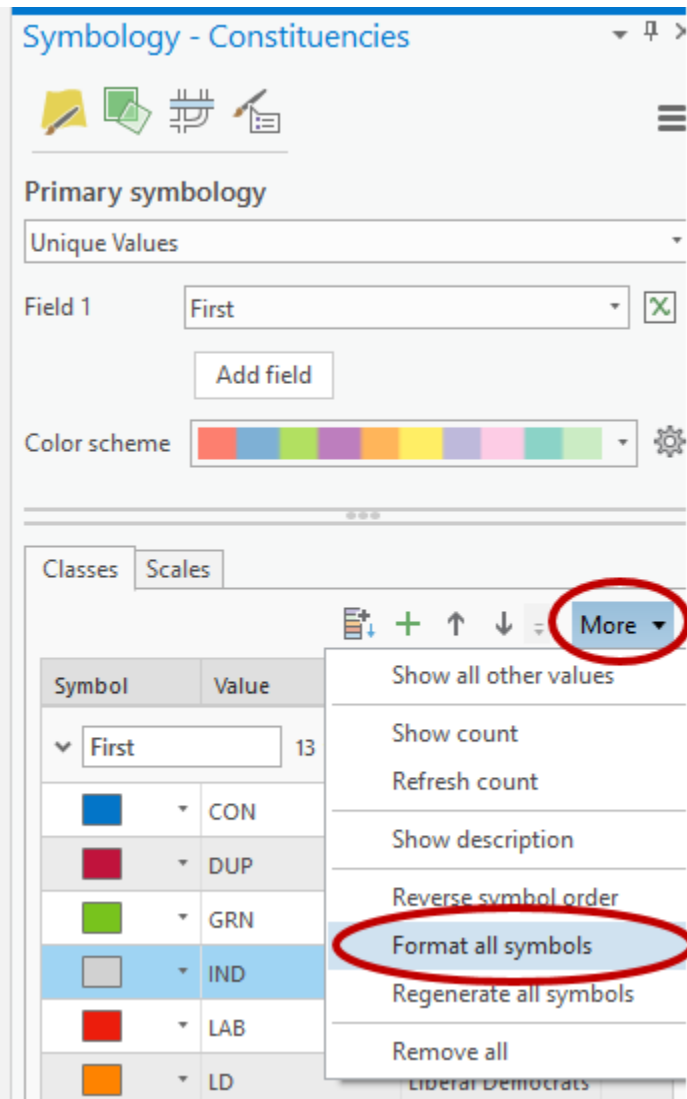


j In the Symbology pane, click More and uncheck the box next to Show All Other Values.

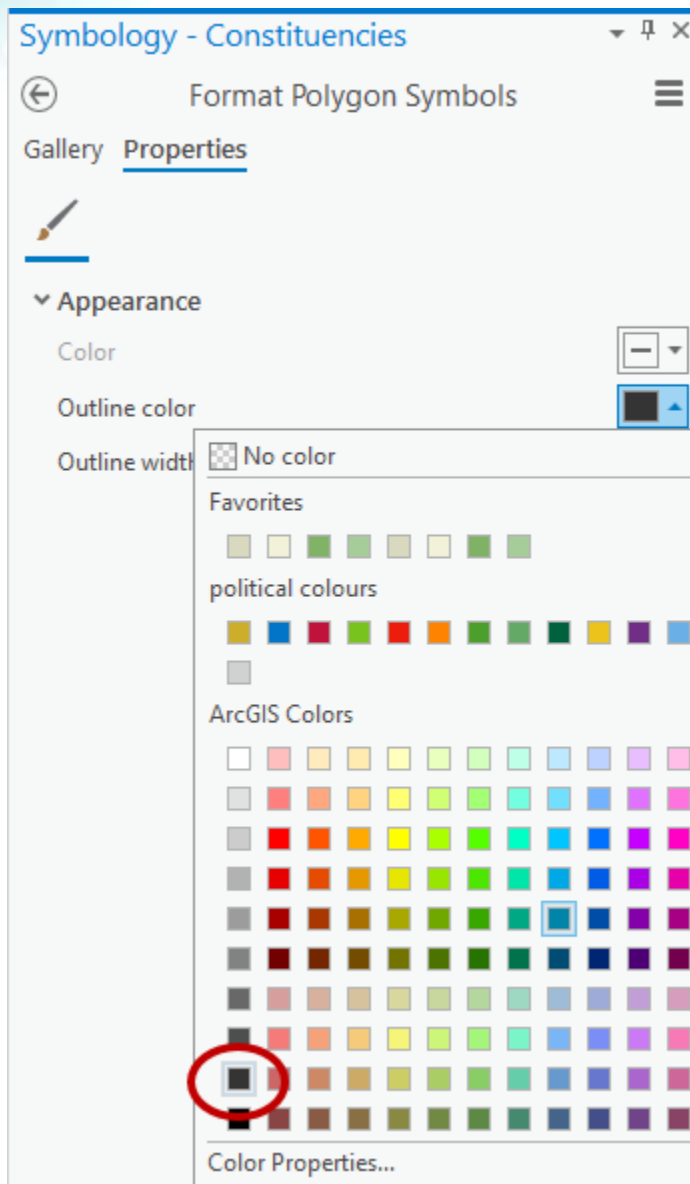
You will also change the color of the outline of each symbol so it better matches the basemap. It is always worth remembering that changing the outline of your area symbols is

often as important as the fill color itself. Sometimes, you may even make the outline transparent or with a width of 0 pt to make it disappear, which can give a very nice effect and avoid a lot of lines getting in the way.

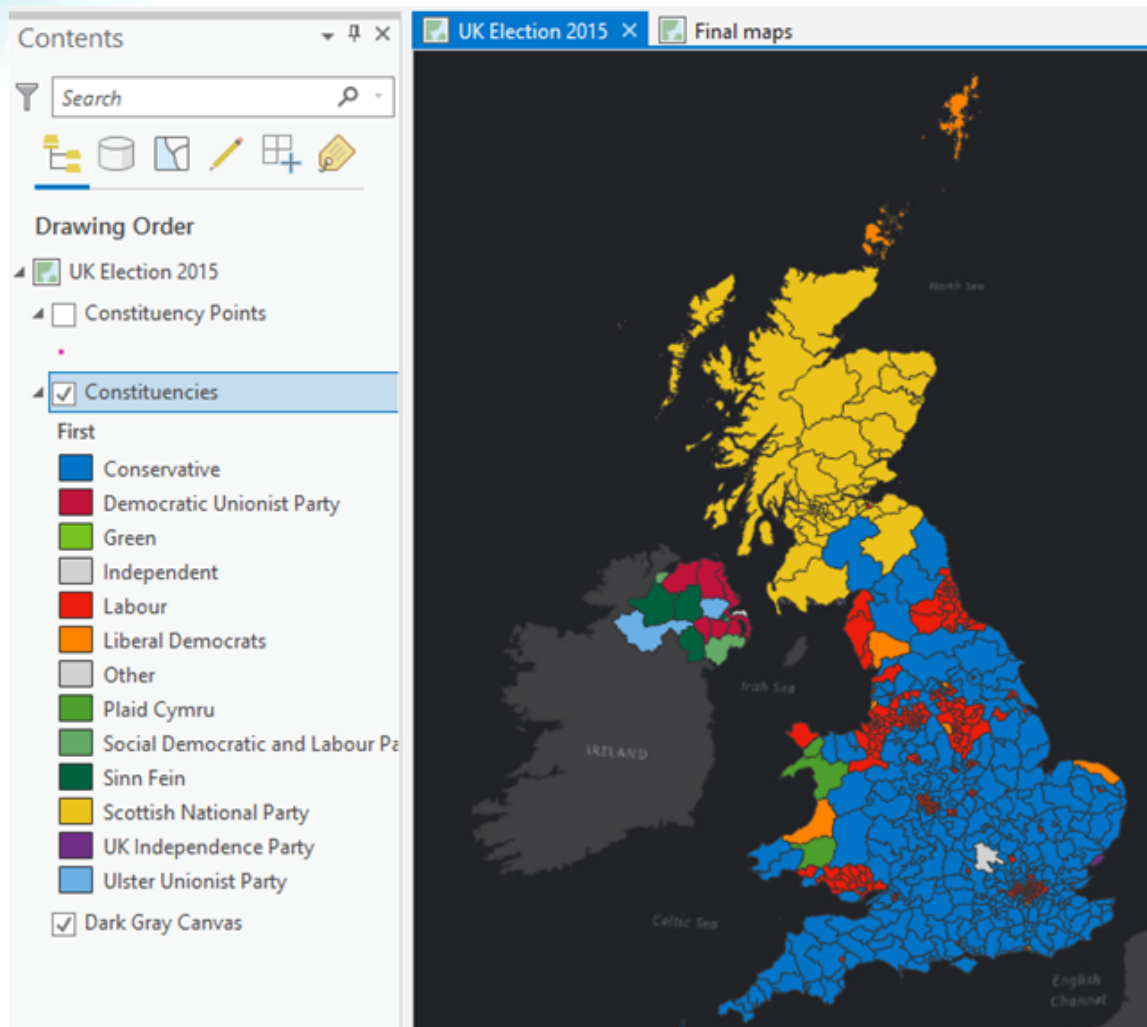
- k In the Symbology pane, click More and choose Format All Symbols.



- l In the Format Polygon Symbols pane, from the Properties tab, change the outline color to Gray 80% to better match the dark gray basemap, and then click Apply.



- m Close the Symbology pane to view the unique values map.



*Final unique values political color map.*

- n Zoom and pan the map to explore how this thematic map effectively shows the winning political party in each area using a unique value (winning party) symbolized by the political party color.

Much better than the default, right?

- o When you are finished exploring, save your project.

### Step 5: Create a choropleth map

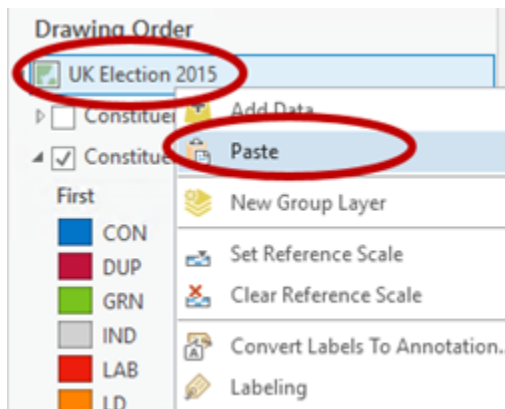
Unique value maps show us one aspect of the political data that you are mapping, but there is so much more that you can explore and map using alternative techniques.

You will now make a simple graduated colors (choropleth map) to show the share of votes that the winning member of Parliament (MP) received. This data is in the First\_Share field in the Constituencies layer attribute table.

Constituencies									
Field: Add Delete Calculate Selection: Zoom To Switch Clear Delete									
OBJECTID	Shape	ID	Constituency	Headline	Winning_MP	First	First_Votes	First_Share	Second
1	Polygon	W07000049	Aberavon	Labour hold with a 3...	Stephen Kinnock	LAB	15416	48.9	JKIP
2	Polygon	W07000058	Aberconwy	Conservative hold wi...	Guto Bebb	CON	12513	41.5	AB
3	Polygon	S14000001	Aberdeen North	Scottish National Par...	Kirsty Blackman	SNP	24793	56.4	AB
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5	Polygon	E14000530	Aldershot	Conservative hold wi...	Gerald Howarth	CON	23369	50.6	AB
6	Polygon	E14000531	Aldridge-Brownhills	Conservative hold wi...	Wendy Morton	CON	20558	52	AB
7	Polygon	E14000532	Altrincham & Sale W...	Conservative hold wi...	Graham Brady	CON	26771	53	AB
8	Polygon	W07000043	Alyn & Deeside	Labour hold with a 8...	Mark Tami	LAB	16540	40	CON
9	Polygon	E14000533	Amber Valley	Conservative hold wi...	Nigel Mills	CON	20106	44	AB
10	Polygon	S14000004	Angus	Scottish National Par...	Mike Weir	SNP	24130	54.2	CON
11	Polygon	W07000057	Ardara	Conservative hold wi...	Michael Williams	CON	11700	43.0	AB

You will use a copy of the Constituencies layer.

- In the Contents pane, make a copy of the Constituencies layer.
- Right-click the UK Election 2015 map item and choose Paste.



The Contents pane now shows two layers named Constituencies.

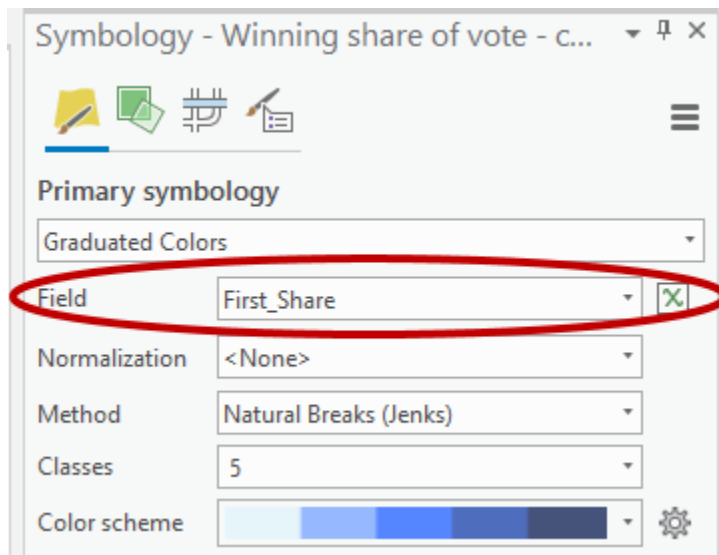
- Rename the layer that you just created to **Winning share of vote - choropleth**.
- Turn off the Constituencies layer.

You will now work on the copy.

- Open the Symbology pane for the Winning Share Of Vote - Choropleth layer, and then update the primary symbology to Graduated Colors.

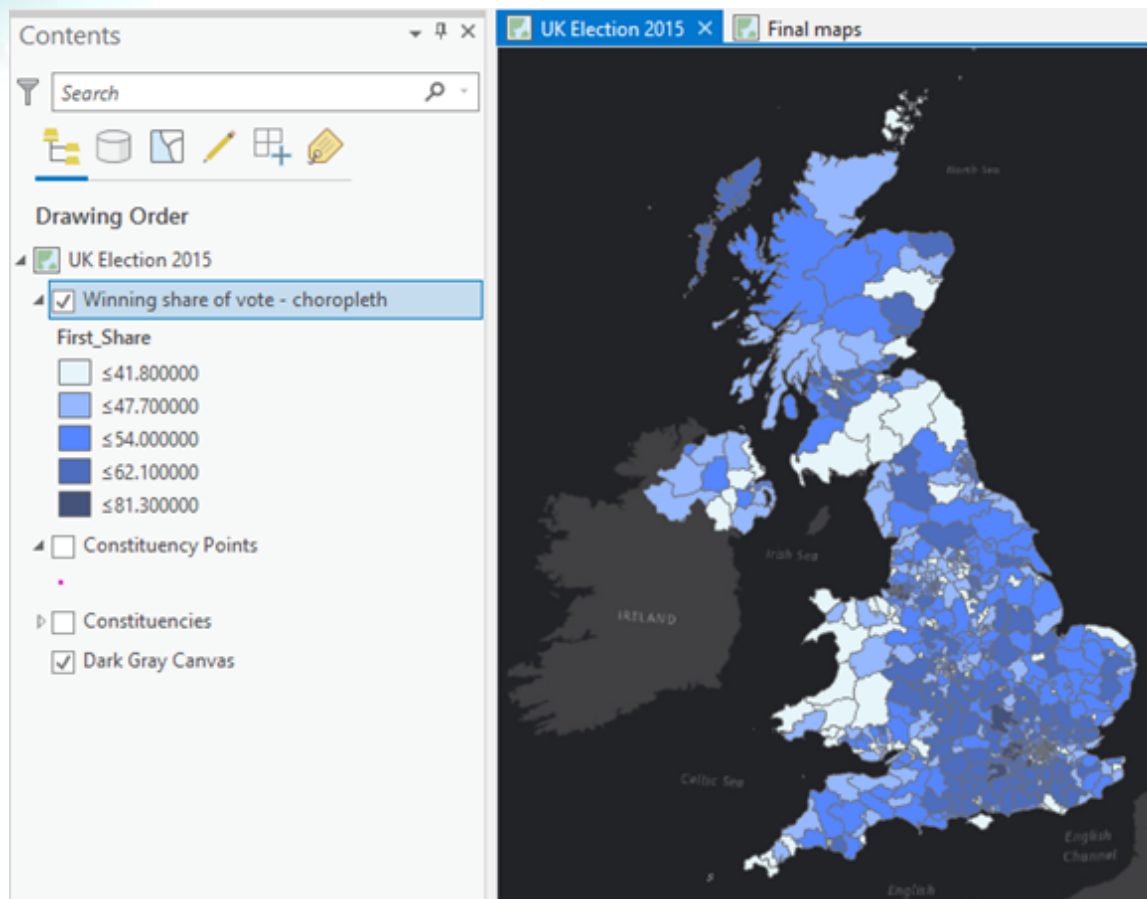
Graduated colors are used to symbolize the layer by quantities. In this case, the quantity is the percentage or share of votes that the winner received.

- f For Field, choose First\_Share.



Do you recall from the Section 2 exercise *Exploring Data for Classification* that you cannot use a choropleth map to map totals? You are fine here, however, because you are mapping data that has already been normalized by converting the raw totals to percentages.





*The final choropleth map based on the First\_Share percentage. Note that your final map may be different if you applied different options.*

If you did not adjust the number of classes or classification technique, now you have a default choropleth map showing the share of the vote received by the winning MP classified into five classes using the natural breaks method. Lower values are shown in lighter colors (a lighter hue), and higher values are shown in a darker color (a darker hue).

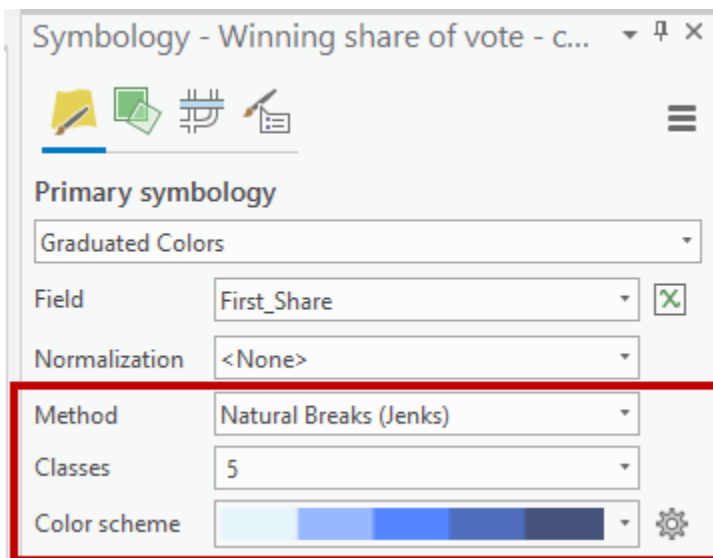
**Challenge:** Experiment with data classification and colors

In this optional challenge, create a map that shows enough variation to effectively represent the results. With too few classes, the map will be too general. With too many classes, the map will be too complicated. A good guide is four, five, or six classes.

*Hint: Refer to the Section 2 exercise Exploring Data for Classification for a reminder of the data classification options. You can also refer to ArcGIS Pro Help for more information about data classification options (<https://bit.ly/2qnFLzl>).*

You can use your default choropleth map (make a copy of the Winning Share Of Vote - Choropleth layer and name the new layer something like **Choropleth - challenge**) to experiment with the following:

- Different classification types (available in the Symbology pane from the Method drop-down list)
- Number of classes (available in the Symbology pane from the Classes drop-down list)
- Color schemes (available in the Symbology pane from the Color Scheme drop-down list)



For a choropleth map, the best way to represent data that varies from high to low is to use a color scheme that visually reflects that. A single-hue color scheme works well. A spectral color scheme does not work well because there is no intuitive way to determine whether one hue is "higher" or "lower" than the other. This is referred to as the classic "rainbow color problem."

- Set the border (outline) color.

You could also remove the border.

- In the Symbology pane, in the Label section, change the way that the labels appear to remove the trailing zeros and clean up the legend.

You could change the style so that you have an upper and lower label such as 0-40%, 41-50%, and so on. Avoid overlapping classes (where you use the same label at the higher end of one class and the lower end of the next class).

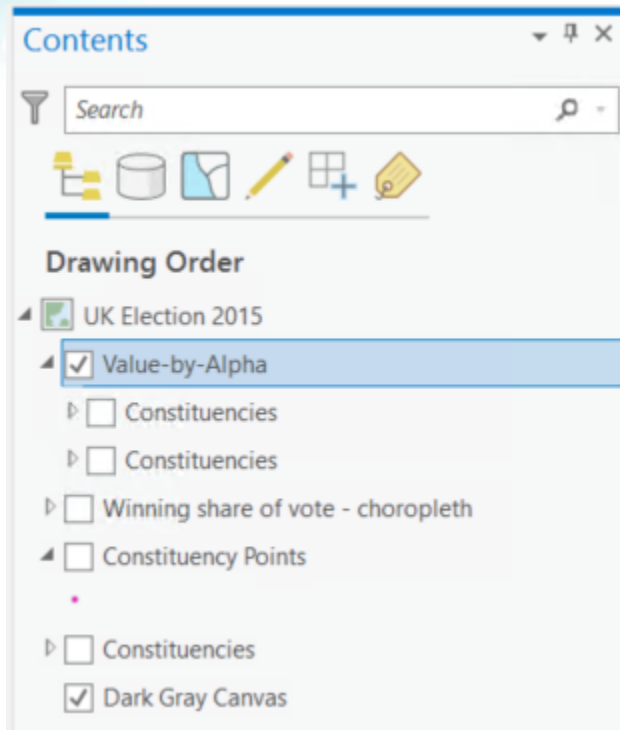
## Step 6: Create a value-by-alpha map

This type of thematic map mutes the less important areas, making them fade into the background and bringing focus to the key areas. A value-by-alpha map is a type of area-based thematic map, such as a unique values or a choropleth map. A value-by-alpha map has two layers. The layer below is the standard unique values map or choropleth map. The layer above has area shading that varies from transparent to opaque to encode a secondary variable.

For a political map, like the one that you are working with, areas are somewhat arbitrary and show the simple metric of who won. But you can create nuances by adding information, such as the proportion of voters in the area or the turnout.

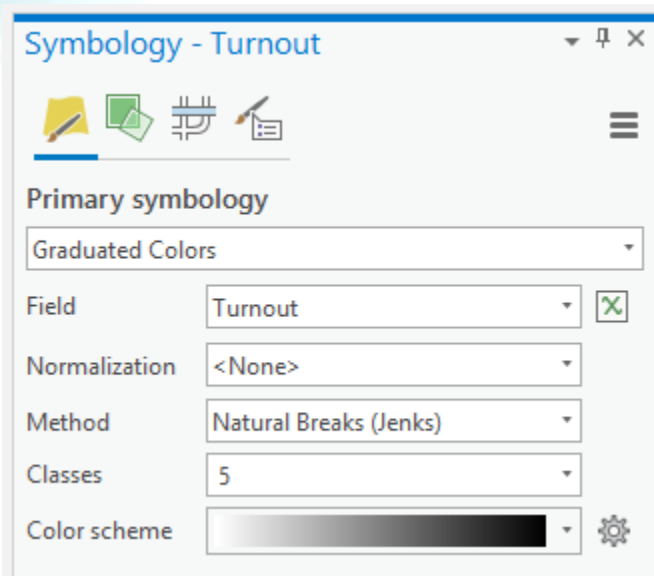
In ArcGIS Pro, a group layer contains multiple individual layers and can help you organize related kinds of layers. Because there will be two layers in the value-by-alpha map, you will use a group layer.

- a In the Contents pane, verify that the Constituencies layer is turned off and turn off the Winning Share Of Vote - Choropleth layer.
- b If you completed the challenge at the end of the previous step, also turn off that layer.
- c Right-click the UK Election 2015 map item and choose New Group Layer.
- d Rename the group layer **Value-by-Alpha**.
- e Make a copy of the Constituencies layer (symbolized using unique values).
- f In the Value-By-Alpha group layer, paste two copies of the Constituencies layer.

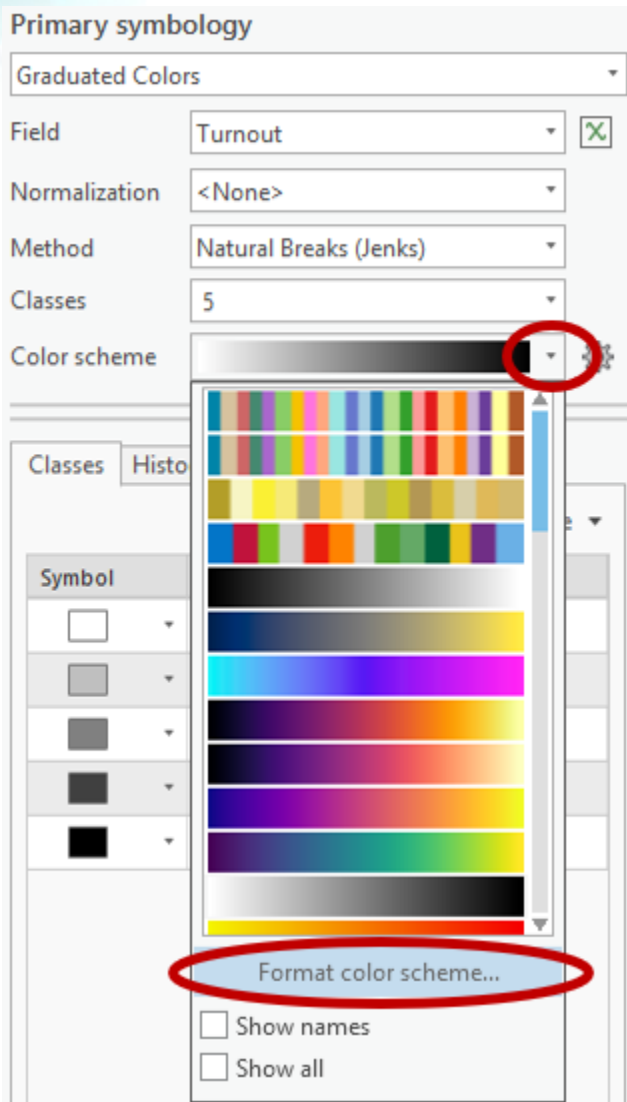


- g If necessary, turn on the upper Constituencies layer.
- h Rename the upper Constituencies layer **Turnout**.
- i Right-click the Turnout layer and choose Symbology to open the Symbology pane.
- j For Primary Symbology, choose Graduated Colors and update the Field to Turnout.
- k For Color Scheme, choose the White To Black gradient color scheme.

*Note: If you do not see the White To Black gradient color scheme, you may need to click the Color Scheme down arrow and check the box for Show All.*

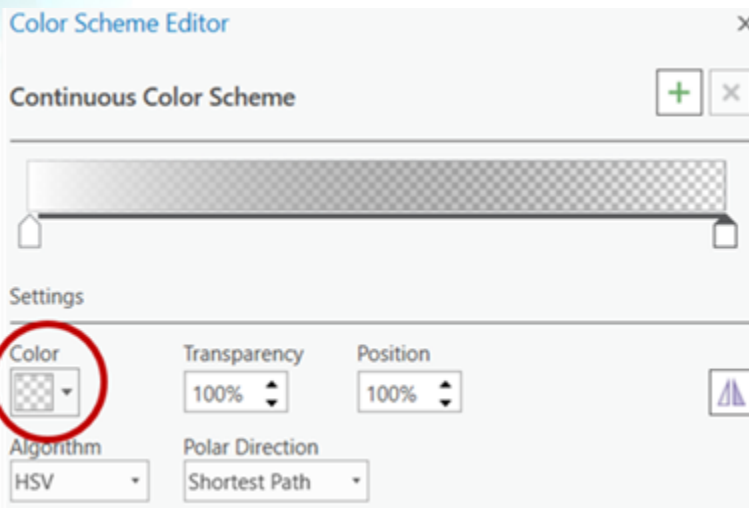


- 1 In the Symbology pane, next to Color Scheme, click the down arrow and choose Format Color Scheme.



**m** In the Color Scheme Editor, change the black color chip to be 100% transparent.

*Hint: Click Color and choose No Color.*



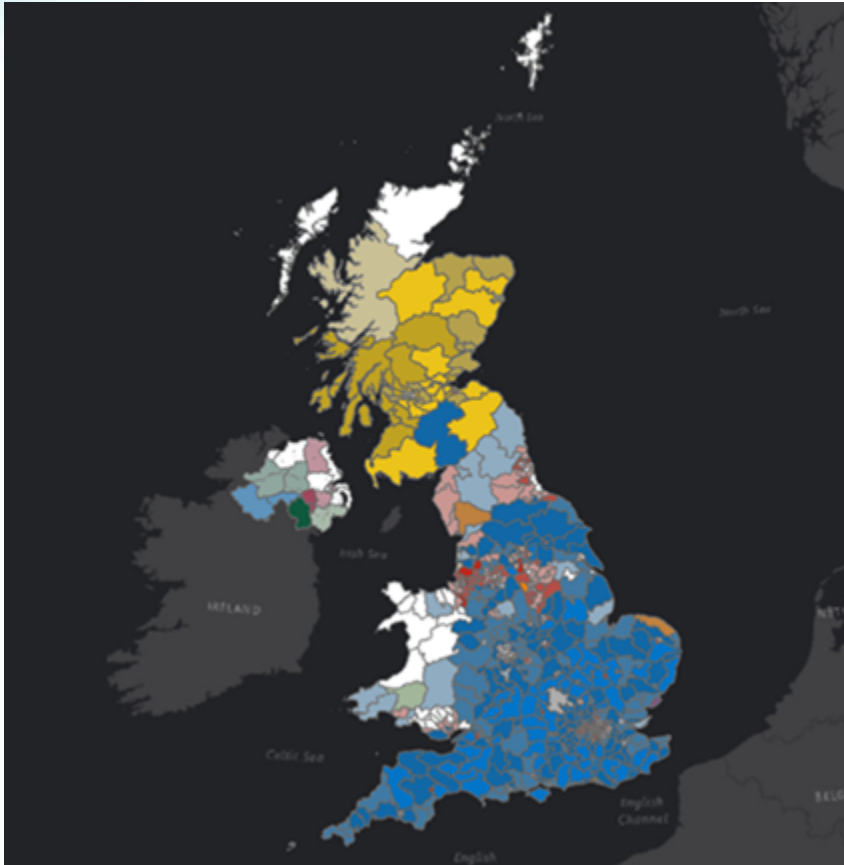
- n Click OK to update the color scheme.

The idea is to make high values (high turnout) completely transparent and low values (low turnout) more opaque.

Now you have built the value-by-alpha overlay.

- o If necessary, in the Contents pane, in the Value-By-Alpha group layer, turn on the Constituencies layer.





For a well-balanced result, you can use the various controls in the Symbology pane to adjust how the white-transparent color ramp stretches across the data values.

The map brings into focus constituencies that had higher turnouts. The top layer in the group effectively mutes areas where there were lower turnouts. This is a useful technique to show how two related pieces of data interact with one another.

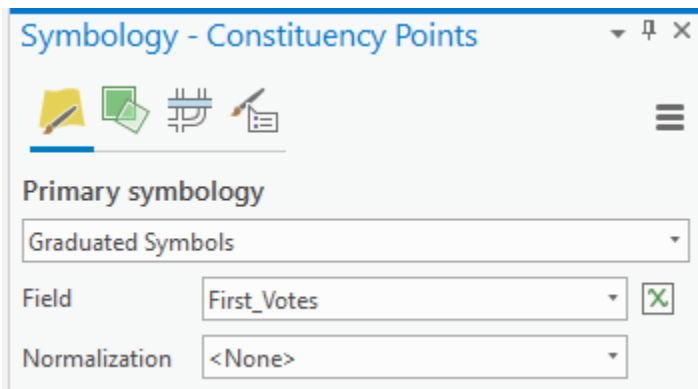
**p** Save your project.

## Step 7: Create a graduated-symbol map

Graduated-symbol maps allow you to use totals directly on the map without first converting data into ratios or percentages. Instead of using colors or shades of color that you process and see as "more or less" across the map, a graduated-symbol map uses size of symbols to communicate the relative difference between quantities. Larger symbols mean more, smaller mean less.

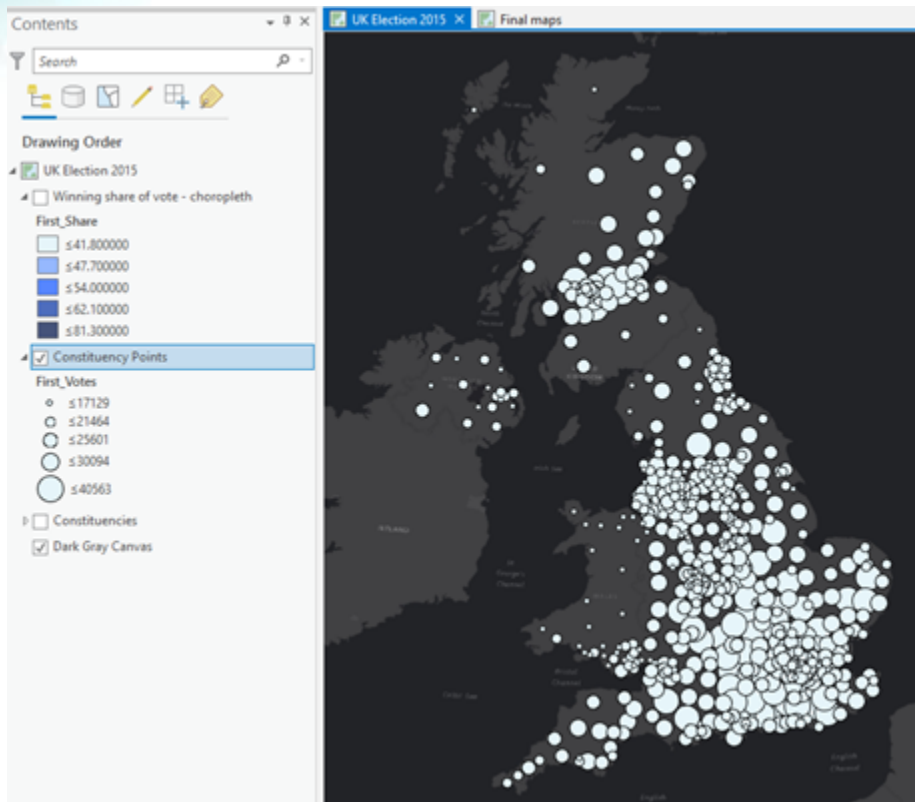
For this step, you will use the point-based data because you are going to change a single symbol in size that represents the area for which the data has been collected.

- a In the Contents pane, turn off all layers except the Constituency Points layer and the Dark Gray Canvas basemap layer.
- b Open the Symbology pane for the Constituency Points layer.
- c Change the symbology type to Graduated Symbols and use First\_Votes as the field to symbolize.



The default classification is Natural Breaks (Jenks) using five classes. Every data value falls into one of these symbol classes.

- d Using the Symbology pane, experiment with changing the color fill, outline, and sizes of the symbols.



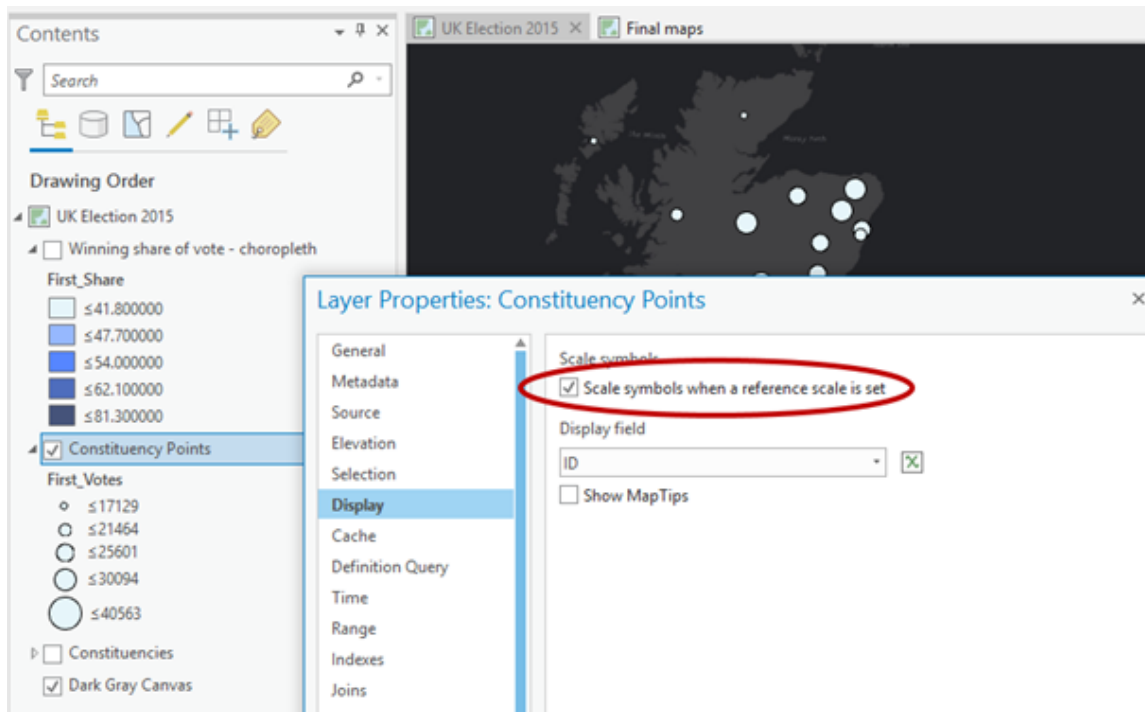
One of the challenges with any symbol-based map is congestion in parts of the map. Balancing the symbol size with the appearance of the overall map is a good goal to keep in mind. Transparent symbols with a solid outline can sometimes work, so include those in your experimentation.

Also, notice how, as you zoom in and out of the map, the symbols remain the same size at which you designed them. This means that as you zoom in to a larger map scale, your overlapping symbols tend to become separated from one another. This is an extremely useful feature of a multiscale mapping environment and counteracts the problems of seeing overcrowded symbols at smaller scales.

If you prefer that your symbols stay at their relative size as you zoom in and out, you can achieve this by setting a reference scale (<https://bit.ly/34RklsV>).

- e In the Contents pane, right-click the UK Election 2015 map item and choose Set Reference Scale.
- f Right-click the Constituency Points (the layer symbolized with graduated symbols) layer and choose Properties.

- g In the Layer Properties dialog box, from the Display tab, ensure that the Scale Symbols When A Reference Scale Is Set box is checked.



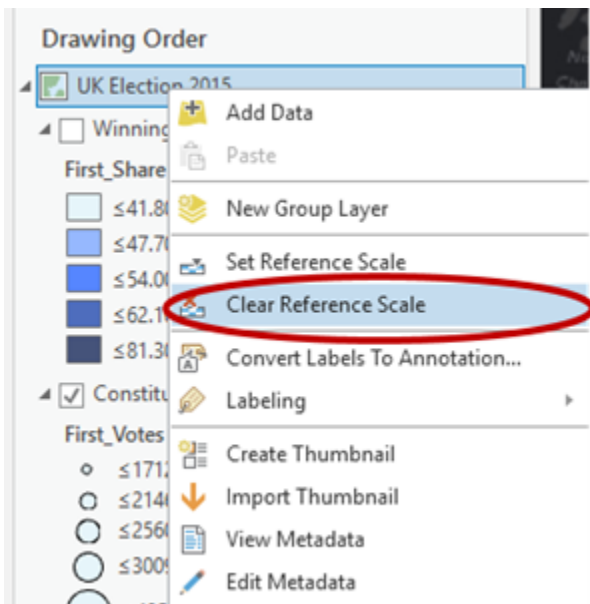
- h Click OK, and then zoom and pan the map to see the result of changing the reference scale settings.

Effectively, this freezes the symbol sizes at the scale at which the reference scale was set. As you zoom in and out, they become larger and smaller while maintaining their relative size to the map and each other symbol.



*A zoomed in view of the final graduated symbol map.*

- i Clear the reference scale by right-clicking the UK Election 2015 map item and choosing Clear Reference Scale.



Clearing the reference scale will take you back to the default for the next step in this exercise.

- j Save your project.

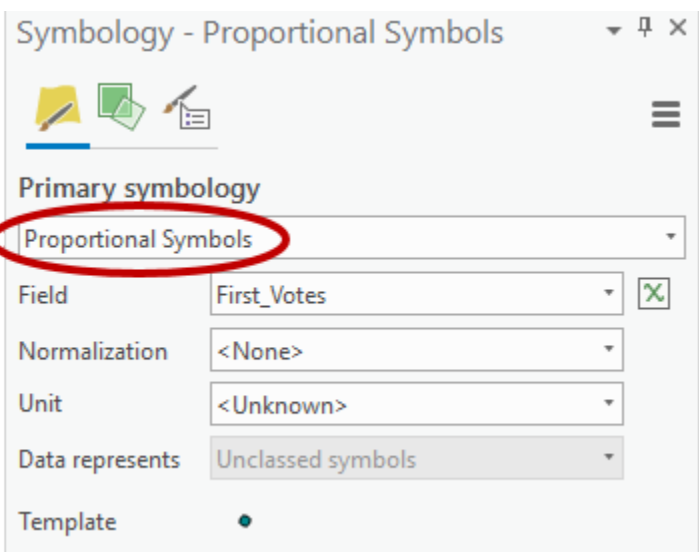
## Step 8: Create a proportional-symbol map

Another type of thematic map, the proportional-symbol map, can show how features differ in quantity for the theme being mapped. It is a variation on the graduated-symbol map but scales all symbols independently of any classification method.

- a In the Contents pane, make a copy of the Constituency Points layer.
- b Right-click the UK Election 2015 map item and choose Paste.
- c Turn off the original Constituency Points layer.
- d Rename the new Constituency Points layer **Proportional Symbols**.

Now you will change the symbology type.

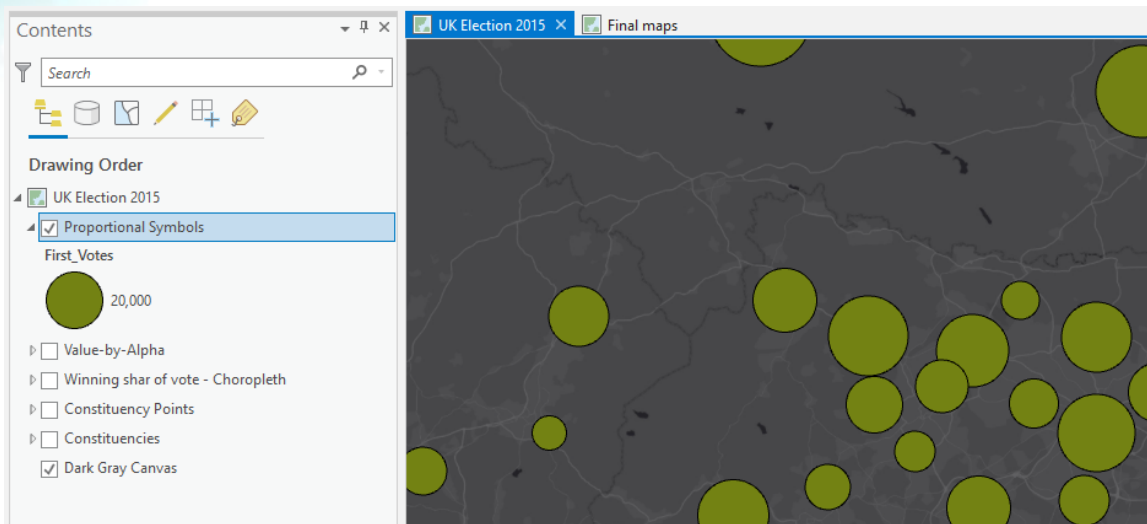
- e Open the Symbology pane for the Proportional Symbols layer.
- f Update the symbology type to Proportional Symbols.



- g Zoom in to more clearly see the proportional symbols.

*Note: Refer to ArcGIS Pro help to learn more about [varying symbology by size and graduated symbols and proportional symbols](https://bit.ly/2JwLVGd) (<https://bit.ly/2JwLVGd>).*





*A zoomed in view of the proportional symbols map.*

- h** Use the First\_Votes field as the field to symbolize again or experiment with other fields.

In this map, the data value is scaled to the symbol size, so each symbol on the map is a proportional representation of the data. Every value of data is represented uniquely, so this map type shows much more variation in symbol sizes than a graduated-symbol map.

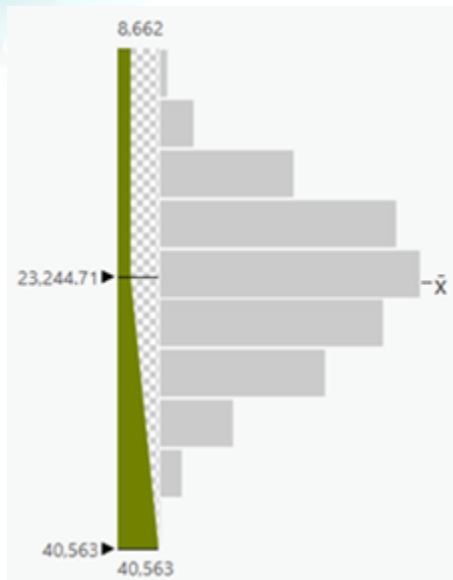
- i** Experiment with the scaling settings and symbol design to achieve a nice visual balance.

You are trying to achieve a balance where there is enough variation in size across the map to show highs and lows in the data *but* without symbols becoming either too large and dominating or too small and difficult to see. This is not a perfect science, and experimentation is important to go back and forth until you feel like you have captured the optimum settings for the dataset at hand. Importantly, ask yourself what you want the map to tell the reader. That should help you consider whether your scaling settings and symbol design have met that goal.

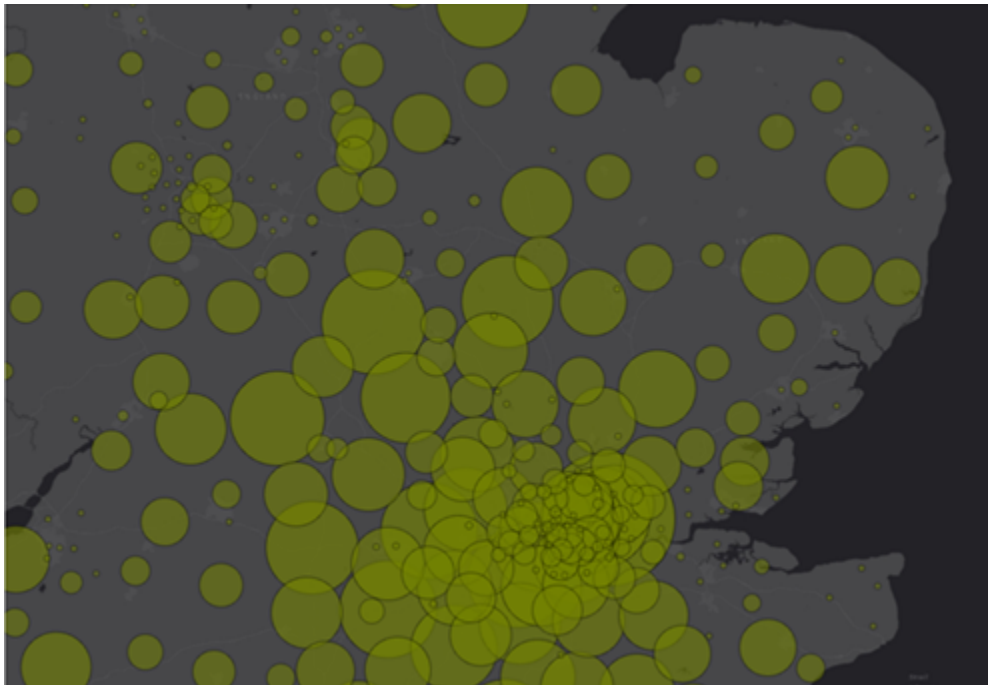
One final aspect to scaling settings to consider is whether you need all your symbols to be scaled uniquely. In the histogram view of the Symbology pane for this layer, you can move the sliders to change the way scaling is applied.

- j** Move the top slider (lowest-level data value) down, as shown in the following graphic.





Updating this will lead to all data values below the threshold that you set being shown at the same size. This can be useful to highlight variation at one end of the data array, or conversely, if you have outliers (<https://bit.ly/2VlciQC>) or many data values of an extremely small or large size, you can cluster them together and show them (and them only) with a symbol of the same size.



*A zoomed in view of the final proportional symbols thematic map based on the First\_Votes field values.*

Now you will modify the symbol color to make each of your symbols in a single layer represent more than one data item using attribute-driven symbology. Taking the Proportional Symbols map that you just made, you will make it multivariate.














## Step 9: Create a multivariate proportional-symbol map

The proportional symbol map showed the number of votes that the winner in each constituency polled. However, the color is the same for every symbol. The map might tell a more interesting story if the symbols were also colored like the unique values map to additionally show the winning party by their political color. For this step, you will use attribute-driven symbology.


*Note: For more information about [attribute-driven symbology \(https://bit.ly/2Hk2JTo\)](https://bit.ly/2Hk2JTo), refer to ArcGIS Pro help.*

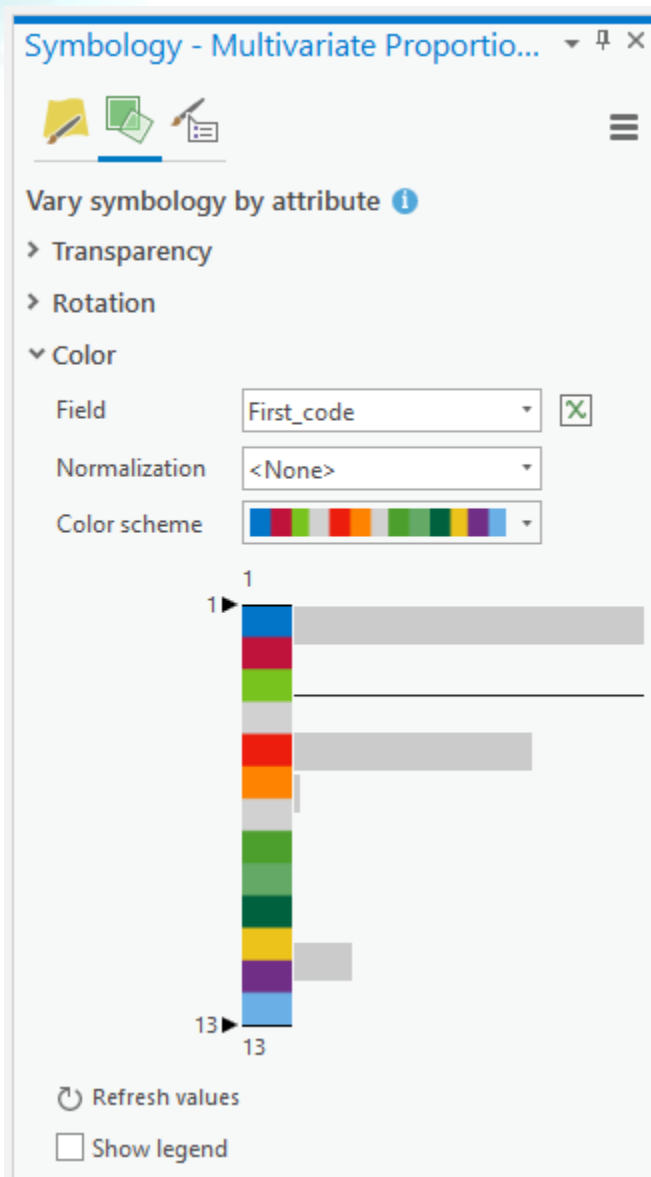
Because attribute-driven symbology works on numeric fields in the attribute table, you will use a column called `First_code` rather than `First`.

The `First_code` column references the political parties as shown in the following graphic:

Symbol	Value	Label	First_code
	CON	Conservative	1
	DUP	Democratic Unionist Party	2
	GRN	Green	3
	IND	Independent	4
	LAB	Labour	5
	LD	Liberal Democrats	6
	Other	Other	7
	PC	Plaid Cymru	8
	SDLP	Social Democratic and Labour Party	9
	SF	Sinn Fein	10
	SNP	Scottish National Party	11
	UKIP	UK Independence Party	12
	UUP	Ulster Unionist Party	13

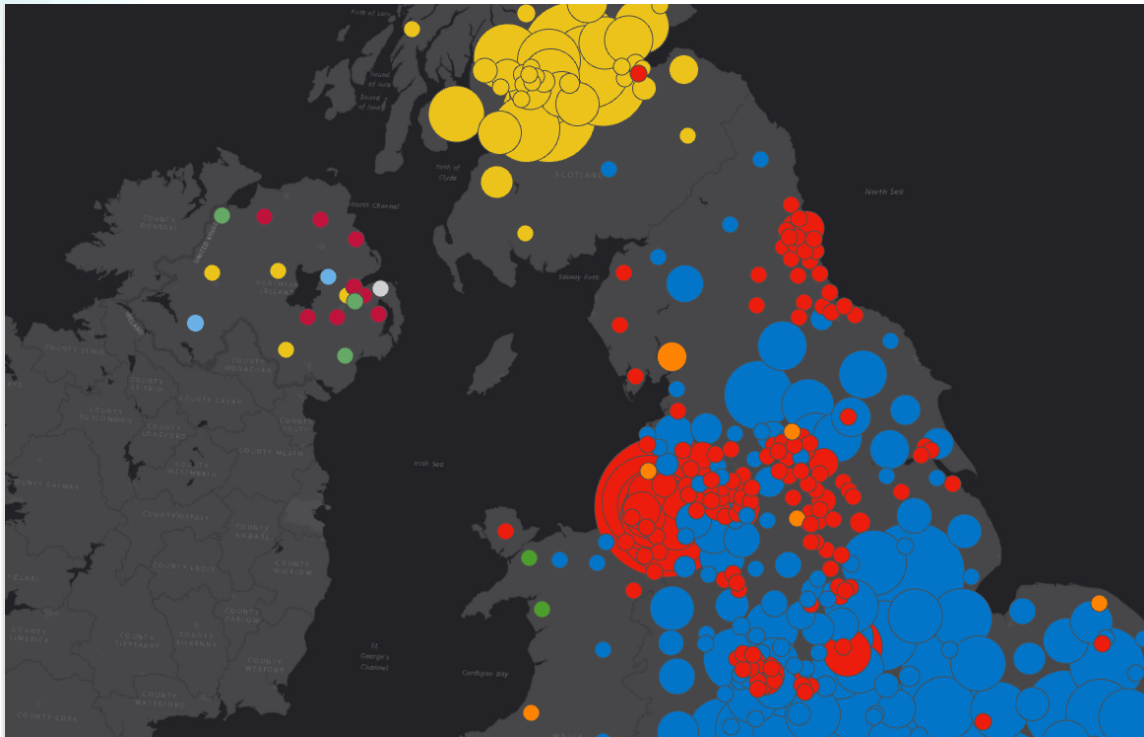
- In the Contents pane, make a copy of your Proportional Symbols layer.

- b Paste the copy in the UK Election 2015 map item, and then rename it **Multivariate Proportional Symbol**.
- c Turn off the original Proportional Symbols layer.
- d At the top of the Symbology pane for the Multivariate Proportional Symbol layer, click the Vary Symbology By Attribute button .
- e Expand the Color section.
- f For Field, choose First\_code.
- g For Color Scheme, click the down arrow and check the box for Show Names.
- h Select the UK Political Parties Discrete color scheme.



This color scheme has been added into the project for you to make symbolizing easier. It is a discrete color scheme that simply matches color stops to the codes used for each political party.

Now you have a proportional-symbol map with size related to total number of votes for the winning party and color representing the party itself.



*A zoomed in view of the final multivariate proportional symbol thematic map based on the First Code field values.*

**i** Zoom and pan the map to explore the proportional symbols.

The addition of more sensible colors really helps to communicate the patterns more meaningfully.

**j** When you are finished exploring, save your project.

## Step 10: Create a dot-density map

One drawback of the choropleth map is the way in which the different-sized areas take on different visual prominence. In short, large areas are seen as more important than smaller ones. The oddity of geography is that most people tend to live in dense urban areas represented by small administrative units. Sparse populations live in much larger units, so the problem of understanding the real situation is confounded by geography itself.

Look back at the unique values or choropleth maps that you made in previous steps. You can easily see the large expanse of yellow in Scotland, which is relatively sparsely populated. Now zoom in to the London area (that is a test for those not familiar with where London is in the UK!) and see all those much smaller constituencies. The value-by-alpha technique helped mute sparsely populated constituencies in Scotland a bit, but when viewed at small scale

(zoomed out), those smaller constituencies in London are still hard to see by comparison. And you have seen how using differently sized symbols (graduated or proportional symbols rather than choropleth fills) helps overcome some of those drawbacks—though large symbol overlaps can also compromise the map.

Another alternative thematic mapping technique is dot density, which uses small dots to represent some value of the data to create a patterned fill. Multiple dots are used to reflect the total value.

- a In the Contents pane, make a copy of the Winning Share Of Vote - Choropleth layer that you made earlier and paste it in the UK Election 2015 map item.
- b Rename the new layer **Dot Density**.
- c Turn off all layers except the Dot Density layer and the Dark Gray Canvas basemap layer.
- d In the Contents pane, ensure that the Dot Density layer is selected.
- e In the Symbology pane, update the symbology type to Dot Density.

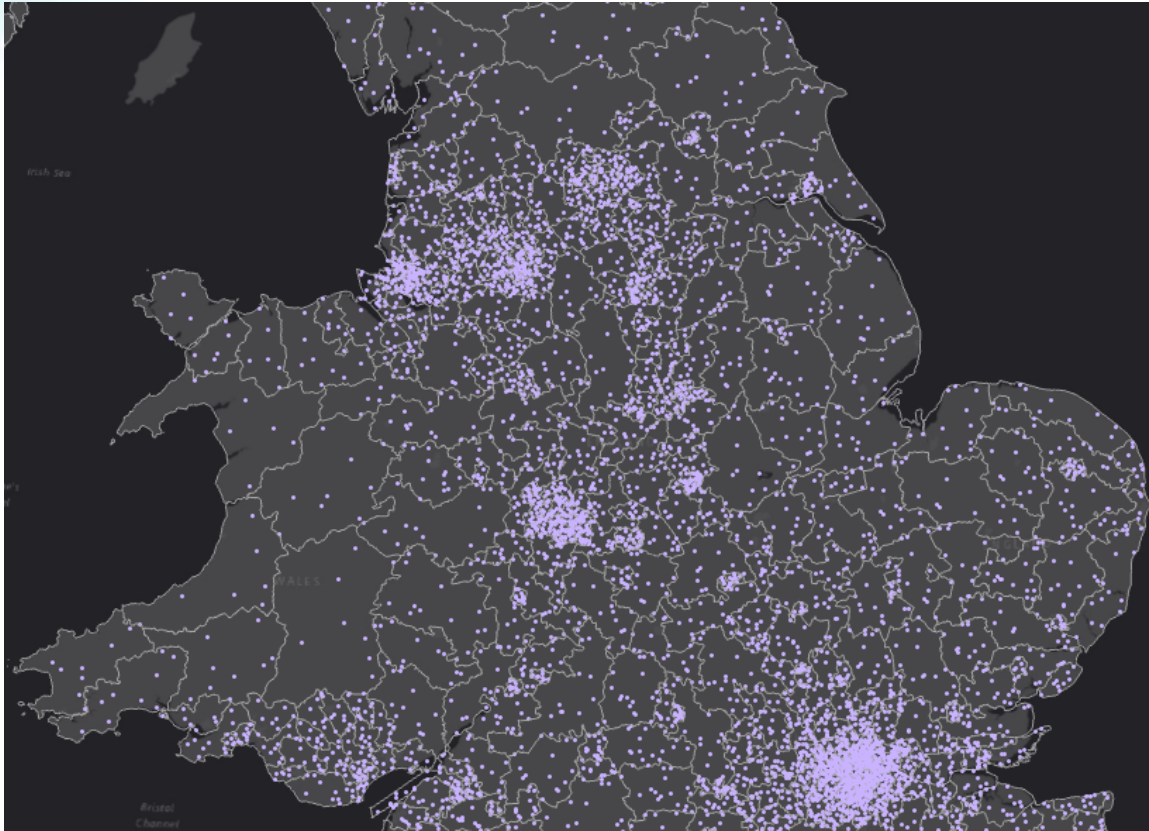
The map is still using the values from the First\_Votes field, which is the number of votes gained by the winning party.

- f Set the Dot Size to 2 pt and the Dot Value to **2000**.

A single dot is positioned randomly, in every area, for every 2,000 votes for the winning party. You can begin to see the distribution of the voting population now with dense and sparse areas being made visible simply through the mapping technique. The visually dominant colors of the larger geographical areas in the choropleths are, to some extent, overcome with this technique.

**Challenge:** Change the symbol to a point that does not have an outline.





**g** Experiment with changing the dot value to **1000** (people).

**h** Try some other values for both the dot size and dot value.

A good dot-density map has a balance between a dot size that is visible and a dot value that creates a map where the dense areas have coalescing dots but which are not simply a large splotch.

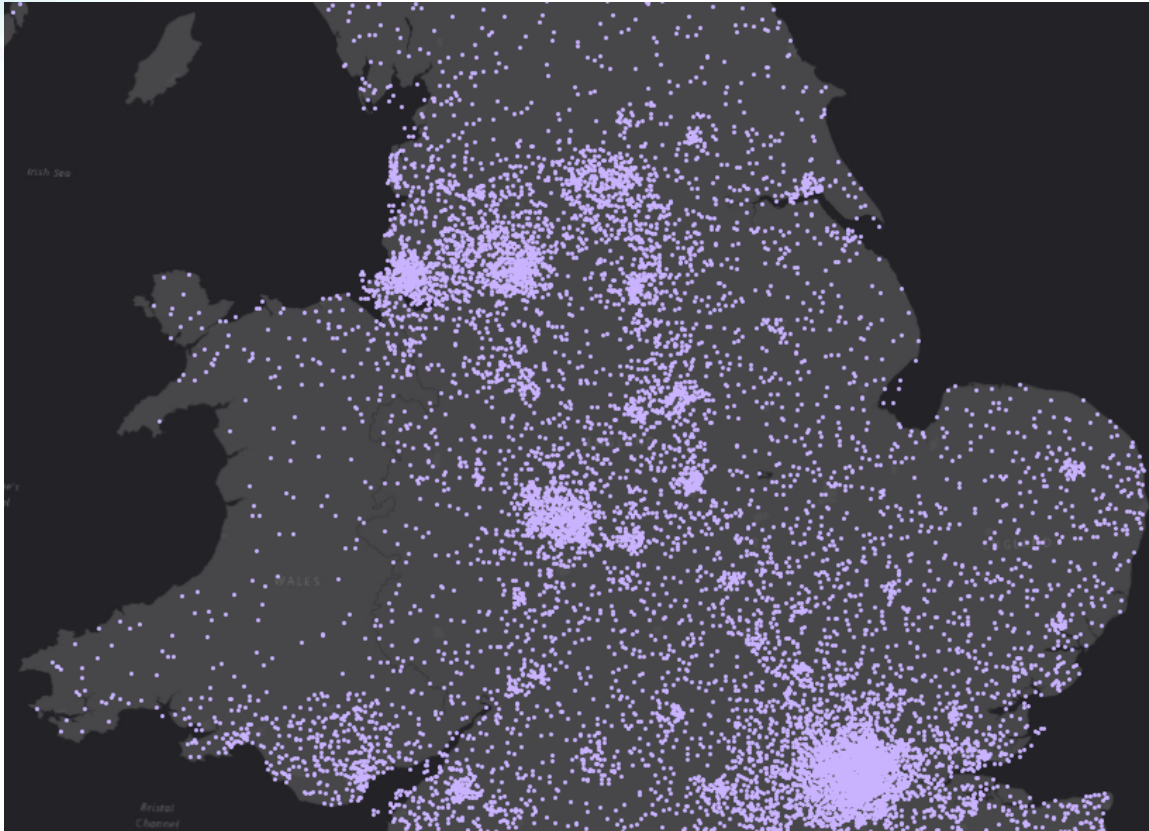
You will also remove the background line from the area because it gets in the way of this sort of map.

**i** In the Symbology pane, click the Background symbol.

**j** On the Properties tab, set the Outline Color to No Color, make the Outline Width 0 pt, and click Apply.

This update improves the overall appearance. Without the administrative borders, the map takes on a smoother appearance.



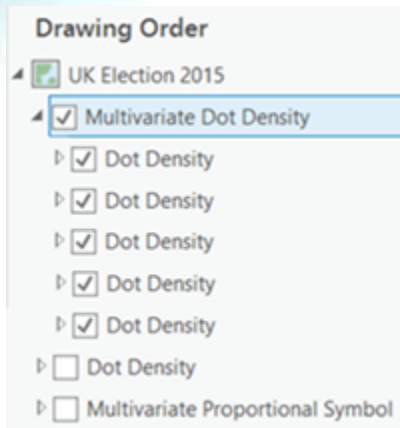


- k Save your project.

## Step 11: Create a multivariate dot-density map

At the moment, all dots are the same color. You will improve the map a little further by creating a version where the dots are the same color as the political party, like you did for the proportional symbol map. First, you will make a few copies of the data.

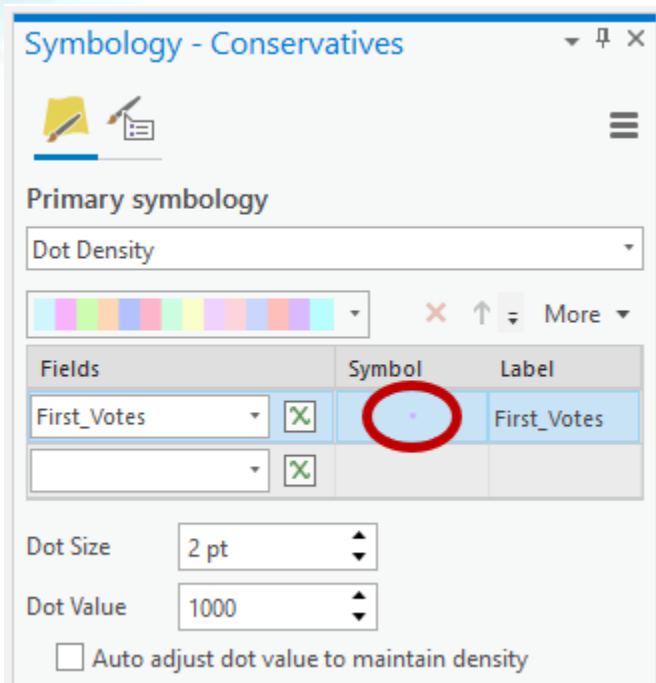
- a Create a new group layer and name it **Multivariate Dot Density**.
- b Copy the Dot Density layer and paste it into the Multivariate Dot Density group layer.
- c Paste four more copies of the Dot Density layer into the Multivariate Dot Density group layer so that you have a total of five layers.
- d Turn off the original Dot Density layer.



- e In the Multivariate Dot Density group layer, rename the first Dot Density layer **Conservatives**.

Next, you will use a definition query to set the dot colors to the political party colors.

- f Double-click the Conservatives layer to open the layer properties and click the Definition Query tab.
- g Click New Definition Query and build the following clause: `Where First Is Equal To CON`.
- h Click Apply, and then click OK.
- i In the Symbology pane for the Conservatives layer, in the Symbol column, click the box next to `First_Votes` to open the Format Point Symbol pane.



- j Change the dot's color to the Conservative blue and click Apply.

*Note: Because there are so many dots on the map, it may take some time for the map to redraw.*

Now you have a map with only the partial dataset shown.

- k Repeat the previous steps for the second Dot Density layer, using the following information:
- Name: **Labour** (and turn on the layer, if necessary)
  - Definition query: Where First Is Equal To LAB
  - Dot color: Labour red
- l Use the same approach to specify definition queries and symbol colors for two additional layers—one each for the SNP (Scottish National Party) and LD (Liberal Democrats) parties.

**m** Finally, for the fifth Dot Density layer, specify a definition query that has four clauses:

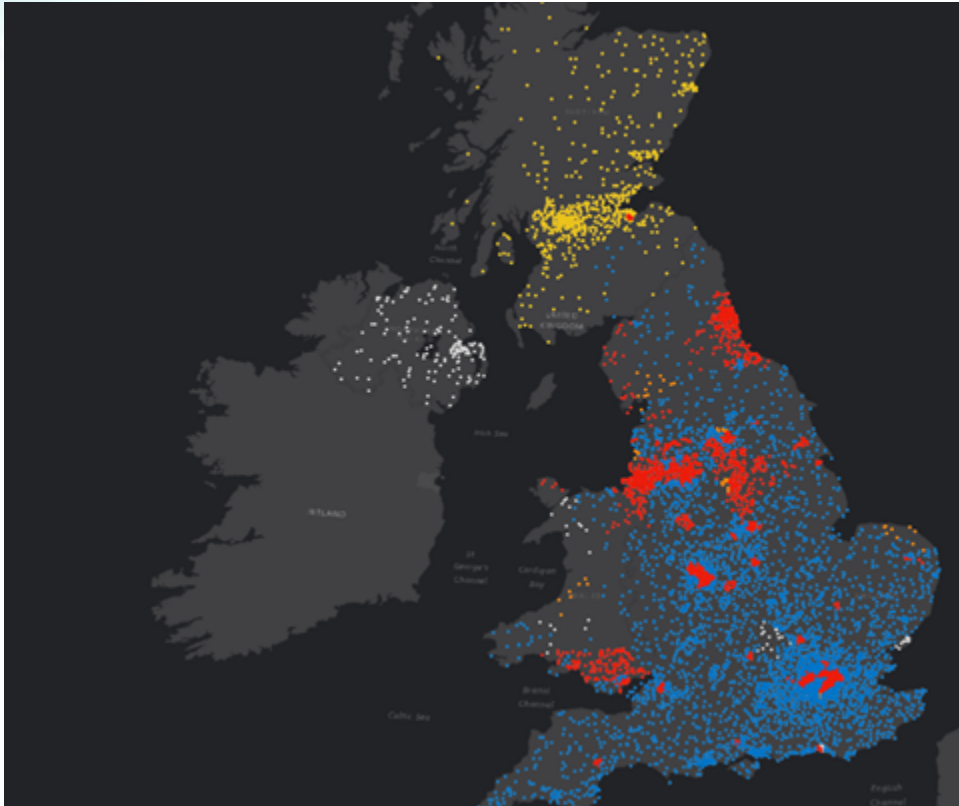
- Where First Is Not Equal To CON
- And First Is Not Equal To LAB
- And First Is Not Equal To SNP
- And First Is Not Equal To LD

The screenshot shows the 'Definition Queries' dialog box. At the top right is a button '+ New definition query'. Below it, 'Query 1' is selected with a green checkmark. There are navigation icons (back, forward, search) and a 'SQL' toggle switch. The main area contains four clauses, each with a dropdown for the operator (Where, And), a dropdown for the field (First), a dropdown for the operator (is not equal to), and a dropdown for the value (CON, LAB, SNP, LD). Each clause has a red 'X' button to remove it. At the bottom of the clause list is a '+ Add Clause' button. At the bottom right are 'Apply' and 'Cancel' buttons.

This captures all other constituencies that have not been shown by the other layers in this group.

**n** Rename the fifth Dot Density layer **Other**, and then symbolize it with the light gray Independent/Other color.

Now you have an overall effect where dot density is colored by the winning political party. You could create a separate layer for every party if you wish, though sometimes a map is far clearer if you remove some of the detail. Here, you are showing the predominant parties and removing a bit of visual noise by grouping every other constituency as Other.



- o When you are finished, close the Symbolology pane.
- p Save your project.
- q If you are continuing to the stretch goal, leave ArcGIS Pro open; otherwise, exit ArcGIS Pro.

### Conclusion

You have designed a range of different thematic maps that each show the data in different ways. Along the way, you have learned about the differences between area-based thematic maps and point-based thematic maps. You have applied some of the ideas that were covered in Section 2 Exercise 2 for classifying data, and you have explored ways to design and modify symbology.

There are other types of thematic maps that you can create in ArcGIS Pro. To explore some additional thematic maps, click the Final Maps map tab. Examine each of the thematic maps and experiment with their settings.

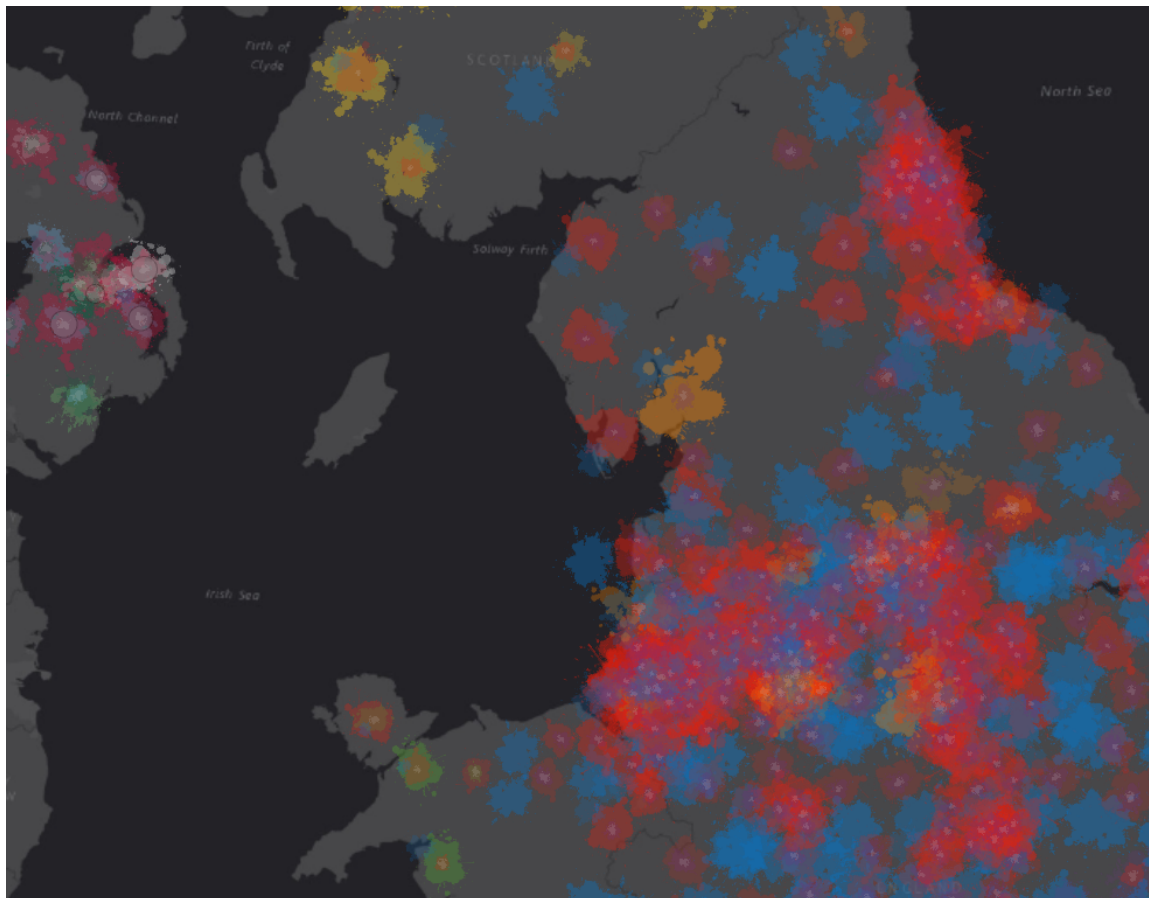
Ultimately, there is never a perfect thematic map, but making sure that your data classification, map type, and symbology work in harmony will help make your choices make sense for your map reader.

### Stretch Goal: Make a Jackson Pollock-inspired map

The [Jackson Pollock](https://bit.ly/1PF2EqC) (<https://bit.ly/1PF2EqC>) inspired map is an artistic method of representing thematic data. It is a little unusual, but it demonstrates what you can achieve with a little lateral thinking, working with symbol layers, and attribute-driven symbology.

Before starting this stretch goal, take a look at the final Jackson Pollock map in the Final Maps map view.

*Hint: At the top of the map view, next to the UK Election 2015 map tab, click the Final Maps tab, and then in the Contents pane, turn on the Jackson Pollock layer.*



The map is covered in apparently randomly positioned paint splats. Actually, there are four paint splats per constituency. They represent the winning political party, the runners-up, the



third-place party, and a final symbol that represents the remaining candidates. But what else is going on? Symbols are different sizes, so they are proportional to reflect the number of votes. They are different colors, so they represent the political party colors. The symbols are randomly rotated to create a more organic appearance. There is quite a lot going on here, so you will slowly work your way through how it is constructed.

The tasks in this stretch goal are intentionally high-level. Use what you have learned in this exercise to create your Jackson Pollock-inspired map. Pour yourself a cup of coffee or tea—this will take a bit of effort.

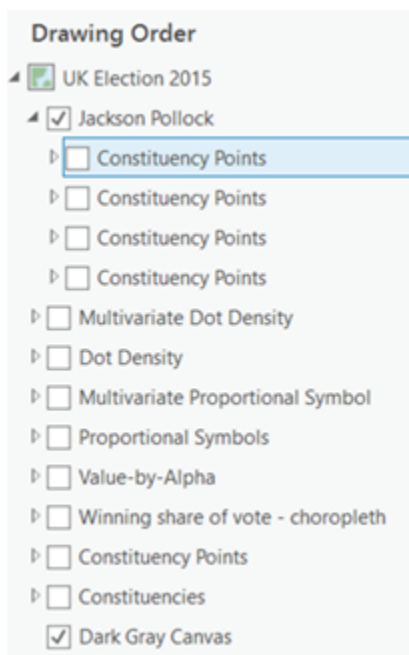
### Step 1: Create map layers

First, you will create the map layers.

- a In the UK Election 2015 map view, in the Contents pane, turn off all layers except the Dark Gray Canvas basemap.

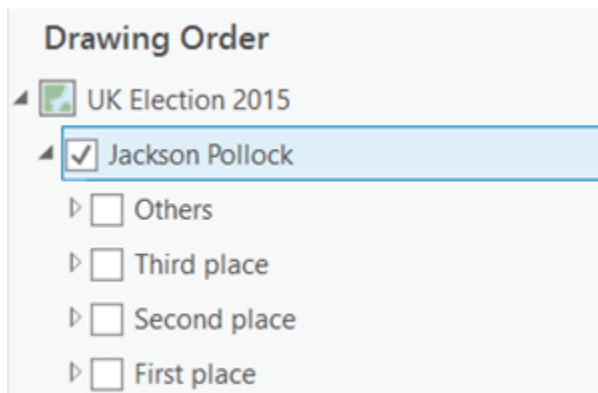
Again, you will use a point feature class of the election data to create a group layer.

- b Right-click the UK Election 2015 map item and create a new group layer named **Jackson Pollock**.
- c Make a copy of the original Constituency Points layer, and then in the Jackson Pollock group layer, paste four copies.





- d Rename the Constituency Points layers, starting with the first layer, as follows:
- Others
  - Third place
  - Second place
  - First place



The order is important because you are going to have four layers showing at once, and you want the larger symbols at the bottom of the stack (the winners) with the others (second place and so on) atop. If you positioned these in the reverse order, the larger symbols would occlude those underneath.

## Step 2: Assign and scale picture marker symbols

Next, you will assign picture marker symbols for the paint splats and use an Arcade Expression (<https://bit.ly/2n9T6JP>) to scale them proportionally.














- a In the Contents pane, for the First Place layer, open the Symbology pane.
- b Update the Primary Symbology to Unique Values and for Field 1, choose First.

You will assign picture marker symbols from the preloaded electionsplat style (located in the Format Point Symbol pane under Gallery) to each point symbol so that each party has the correctly colored paint splat. The paint splats will be quite large initially; you will scale them after they are loaded.

- c Near the bottom of the Symbology pane, for each symbol in the grid, click the point symbol, and then in the Format Point Symbol pane, on the Gallery tab, using the same colors as before, choose the appropriate paint splat symbol for that value from the electionsplat collection.

*Note: On the Gallery tab, click once on the paint splat symbol to choose it, and then click the Back arrow ↶ to return to the Symbology pane. Because the initial paint splats are quite large, you may need to scroll down in the grid at the bottom of the Symbology pane.*

d Use the following table for assistance, if necessary.

Party	Party name	Color splat picture marker symbol
CON	Conservative	
DUP	Democratic Unionist Party	
GRN	Green	
IND	Independent	
LAB	Labour	
LD	Liberal Democrats	
Other	Other	
PC	Plaid Cymru	
SDLP	Social Democratic and Labour Party	
SF	Sinn Fein	
SNP	Scottish National Party	
UKIP	UK Independence Party	
UUP	Ulster Unionist Party	

Now you will vary the symbol size by an attribute to turn them into proportionally scaled paint splats.

e In the Symbology pane, click the Vary Symbology by Attribute button .

f Expand Size.

You will now define a size based on the square root of the total votes received by the winning candidate (this is how proportional symbols are calculated to ensure that the area of a symbol relates to the value being mapped).

g To the right of the Field drop-down list, click the Set An Expression button .

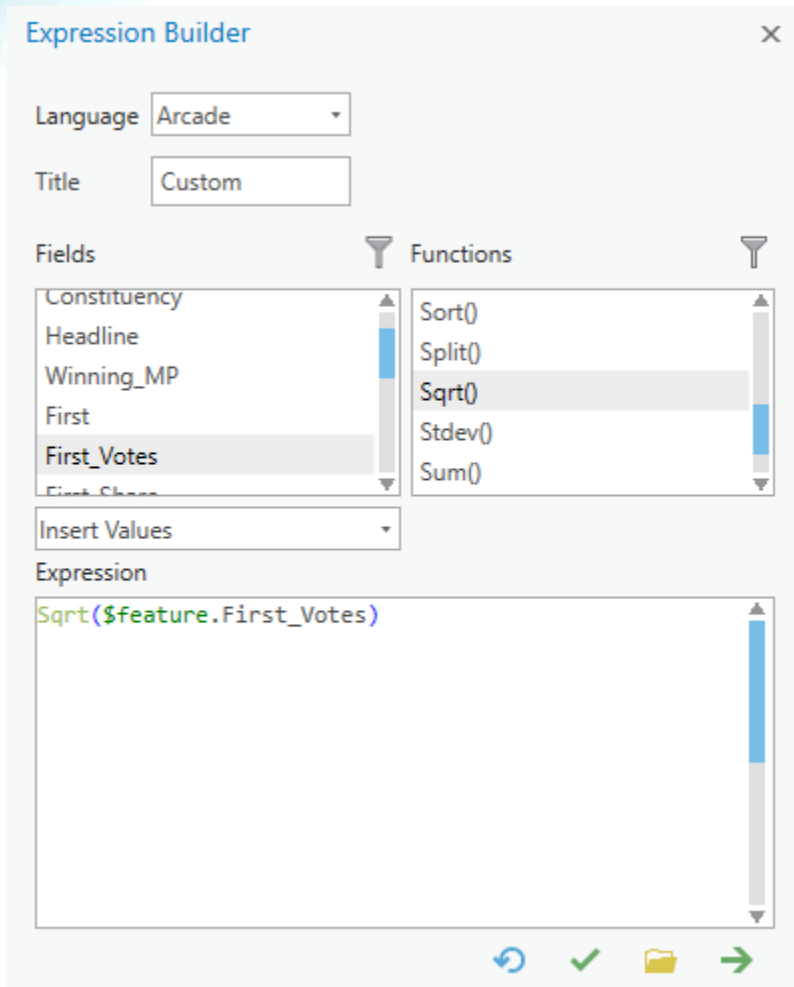
h In the Expression Builder dialog box, ensure that Language is set to Arcade.

i In the Functions list, double-click Sqrt().

j In the Expression field, click between the parentheses.

k In the Fields list, double-click First\_Votes to insert it into the expression.

l You should end up with an expression that reads `Sqrt ($feature.First_Votes)`, as shown in the following graphic.



- m** Validate your expression and click OK.

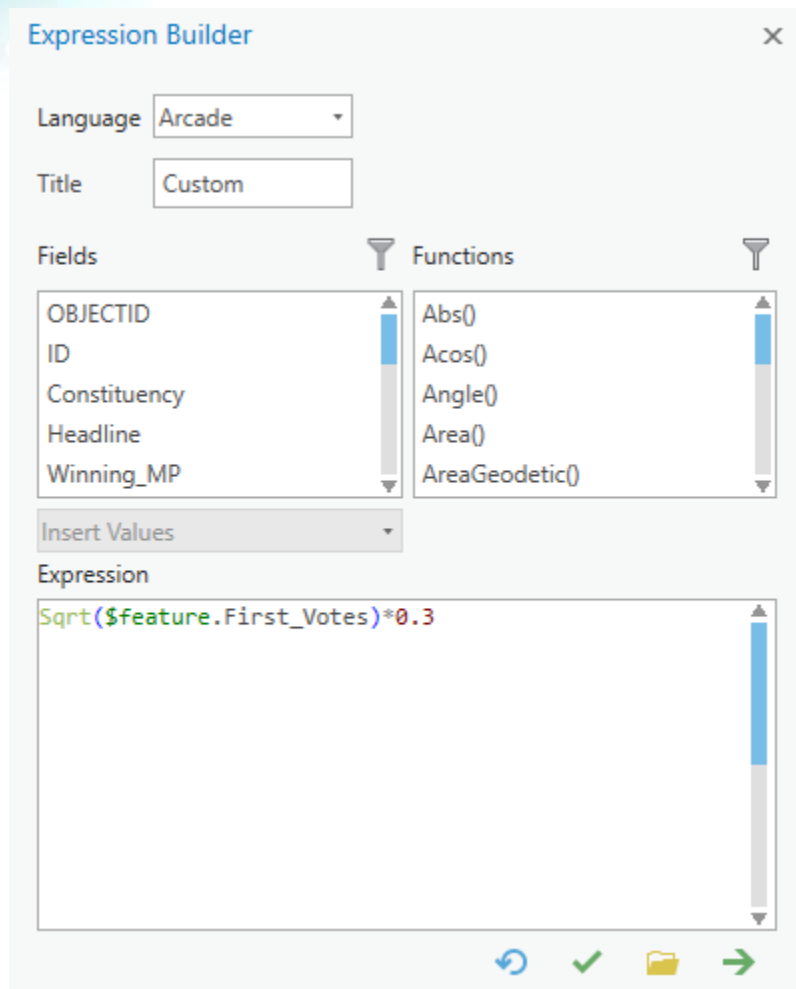
All symbols are now resized proportionally to the data value.

- n** In the Contents pane, turn on the First Place layer and zoom in to see the symbols on the map.



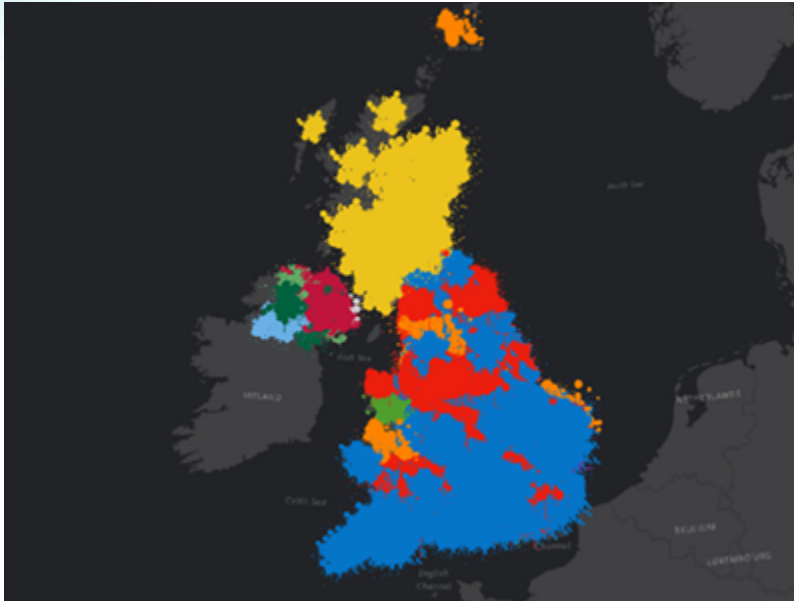
You will notice a problem. All the symbols are on the large side, so you can add a constant to the equation to scale them all larger or smaller.

- Update the expression to add a scaling constant, such as `Sqrt($feature.First_Votes) * 0.3`, to reduce all the symbols by a factor of 70 percent.



**p** Click OK.





You now have a map of the winning parties for each constituency with a proportionally scaled paint splat symbol. This looks good, but the symbols all look a little regular and overlap one another.

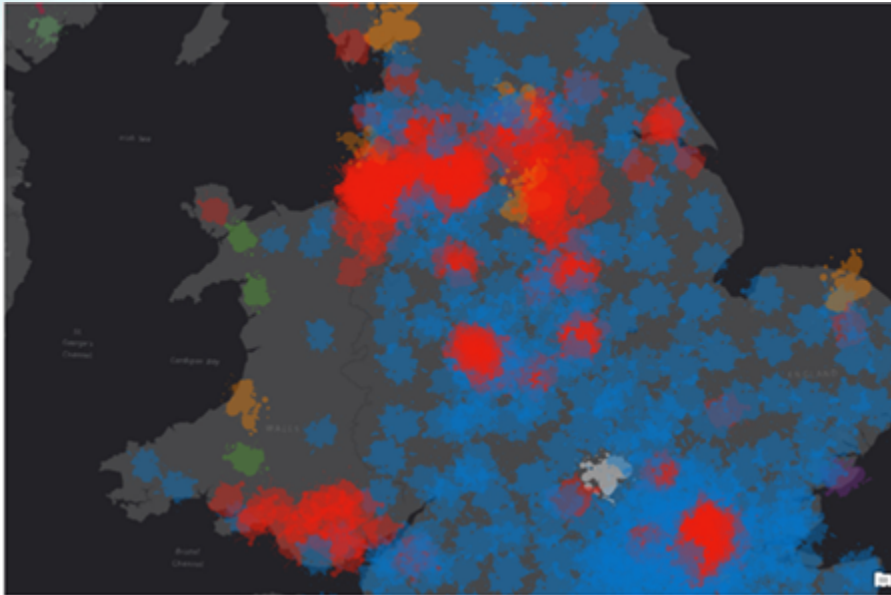
### Step 3: Refine symbol appearance and position

You will add symbol rotation and use transparency to create a better result.


- a To add rotation to the symbols, in the Symbology pane, ensure that you are still on the Vary Symbology By Attribute tab.
- b Collapse Size, and then expand Rotation.
- c For Field, choose <random>.
- d Expand Transparency, and then for Field, choose First\_Share.

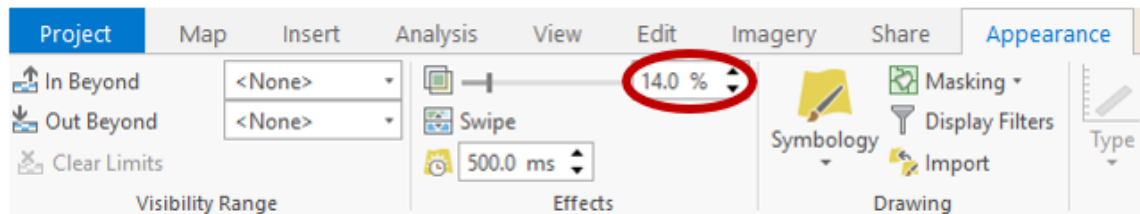
This modifies the symbols by scaling the range of data values across a transparency range so that the overlaps appear like mixed paint. You can experiment with the controls to achieve a result that you like. The random rotation makes the symbols appear irregular, a bit more like, well ... paint!

- e Zoom and pan the map to see the variation.



You have changed transparency at the symbol level, but you can also change the transparency of the whole layer.

- f In the Contents pane, ensure that the First Place layer is selected.
- g On the ribbon, from the Appearance tab, in the Effects group, use the Layer Transparency tool slider  to adjust the percentage of transparency to 14.0%.




- h When you are finished, close the Symbology pane.


Now you will apply the same approach to the other three layers to add the results for the second-place party, third-place party, and others data in the dataset. Instead of repeating the steps, you will use a shortcut.

- i In the Contents pane, in the Jackson Pollock layer group, right-click the First Place layer, point to Sharing, and choose Save As Layer File.
- j Browse to the same location that you saved your exercise data file, name the layer **Pollock\_First**, and then click Save.

The symbology specifications that you just set for the First Place layer are saved to a reusable file.

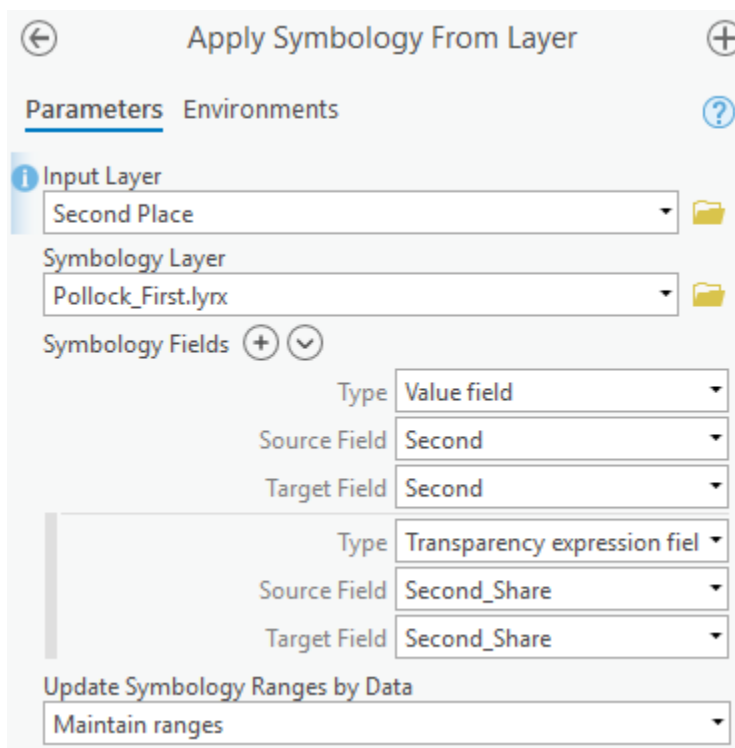
- k Open the Symbology pane for the Second Place layer, choose Unique Values, and then specify Second as the field to map.
- l At the top of the Symbology pane, click the Menu button  and choose Import Symbology.

The Apply Symbology From Layer tool opens in the Geoprocessing pane.

- m In the Geoprocessing pane, for Symbology Layer, click the Browse button .
- n Browse to and select the Pollock\_First layer file that you saved and click OK.

*Note: You can also use an existing layer.*

- o In the Geoprocessing pane, under Symbology Fields, for the Value Field section, set the Source Field and the Target Field to Second.
- p For the Transparency Expression Field section, set the Source Field and the Target Field to Second\_Share.



**Apply Symbology From Layer**

**Parameters** | Environments

**Input Layer**  
Second Place

**Symbology Layer**  
Pollock\_First.lyrx

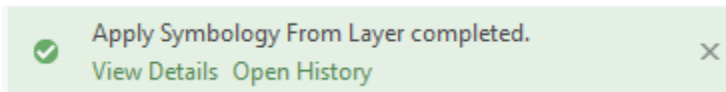
**Symbology Fields** (+) (-)

Type	Source Field	Target Field
Value field	Second	Second
Transparency expression field	Second_Share	Second_Share

**Update Symbology Ranges by Data**  
Maintain ranges

**q** Click Run.

At the bottom of the Geoprocessing pane, you should see a successfully completed message. If you do not, it is likely that you entered something slightly wrong, so go back and check your work.



The symbology specification is now applied to the Second Place layer.

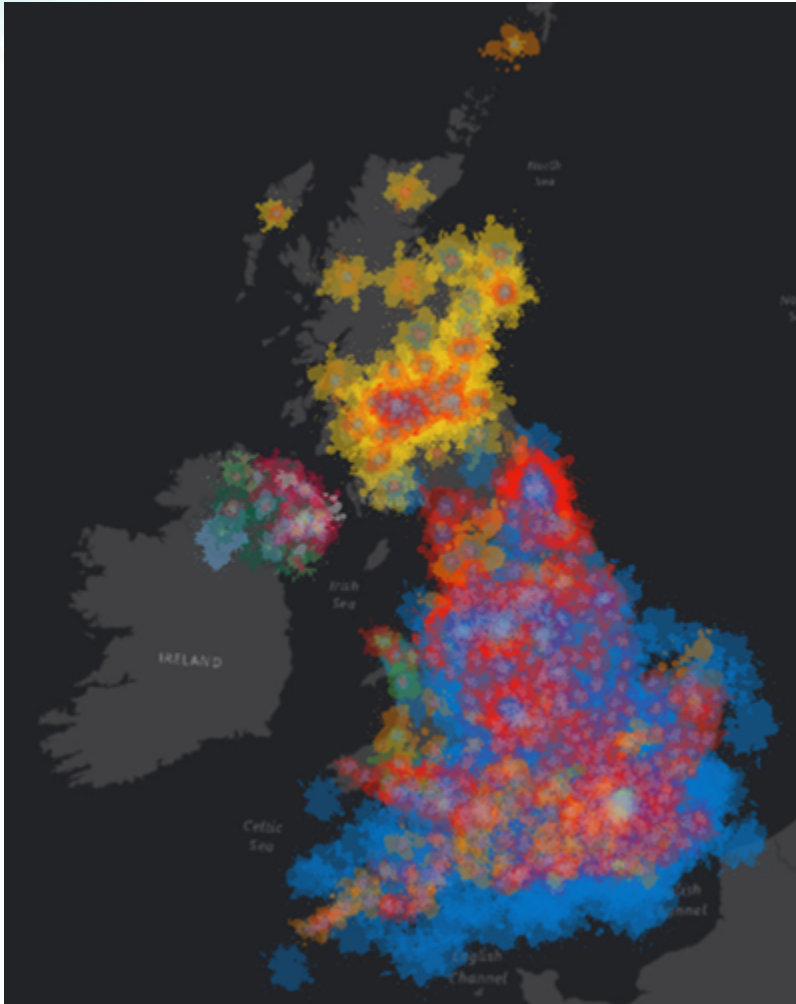
You might want to adjust the symbology settings for the Second Place layer to modify the transparency and size. You could make the symbols a little smaller and more transparent than those of the first layer, for instance. Second place is not nearly as important on the map as first place, so the Second Place layer symbols should not dominate.

- r** Repeat the process to apply the symbology from the layer file for the Third Place layer, again making the symbols a little smaller and more transparent.
- s** For the final layer (Others), use the Symbology pane to create a single symbol, using a gray paint splat for Other.

*Note: Do not forget to scale the gray paint splat.*

- t** In the same way that you applied 14.0% transparency to the First Place layer, change the overall transparency of the Second Place layer to 39.0%, the Third Place layer to 20.0%, and the Others layer to 46.0%.

You should end up with a Jackson Pollock-style mix of symbols that quite literally paints a picture of the mess of the election.



- u Save your project and exit ArcGIS Pro.