

# Chapter 3

## Designing maps for a health study

### Objectives

- Investigate spatial patterns of uninsured and poor populations
- Design and build numeric scales for mapping attributes
- Symbolize numeric scales for polygons using color ramps
- Symbolize numeric scales for points using size-graduated point markers
- Map the relationship between two variables
- Build professional map layouts for presentations and reports
- Export map layouts as image files
- Create multiple output pages

### Health-care scenario

Suppose that you could direct state funds to help finance health-care costs for uninsured populations in Texas. Probably most of the uninsured are poor, so you'll want to investigate the correlation between uninsured populations and poverty indicators, including unemployment and minority identity. You also want to locate the target populations on a map to see where the funds should be concentrated.

### Solution approach

Much of what needs to be done involves using cartographic (map design) principles to convey information about the underlying attributes of graphic features. So, this section provides concepts and guidelines for that purpose.

The graphic elements that can be used to symbolize maps include fill color and patterns for polygons; outline width, pattern, and color for lines—including outlines for polygons and point markers; and shape, size, and color for point markers. In general, maps cannot display continuous variation in numeric attributes because the human eye cannot readily interpret small changes in graphic elements. Instead, an approach that is analogous to making bar charts to symbolize continuous variables in data tables can be used to depict large changes in graphic elements.

An example is a choropleth map that uses solid fill color for polygons based on a relatively small number of intervals covering the range of an attribute. The right-side boundary of an interval

is called a break value and is included in the interval, but the left side is not. For example, you will use 20 and under, 21–25, 26–30, and 31–35 for the percentage of uninsured persons per county in Texas, with break values of 20, 25, 30, and 35. The interval 21–25, for example, contains polygons that have a percentage of uninsured greater than 21 and less than or equal to 25.

Except for the 0–20 interval, these are equal-width intervals with each one covering a range of 5 percentage points. To make things easier to interpret, the break values were set to multiples of 5. Taken as a whole, these intervals include, or span, the complete range of attributes stored for this variable. ArcMap has several other options for designing intervals. A helpful one for analysts uses quantiles that break up attribute values into equal-size groups. For example, for four intervals, quantiles are the same as the more familiar quartiles, where each interval has 25 percent of the observations. Another useful option is to manually choose whatever break values you want. Many phenomena have long-tail distributions to the right, with many low values and relatively few but far-ranging high values. (A long-tailed probability distribution is one that assigns relatively high probabilities to regions far from the mean or median.) In this case, using a manual numeric scale with interval widths that double is often valuable—for example, 0–5, 5–15, 15–35, and 35–75, with interval widths of 5, 10, 20, and 40.

The choice of colors for intervals is based on color value, which is the amount of black added to a color. A monochromatic color scale uses a single color, with light to medium to dark shades of the same color. Usually, the darker the color, the higher the interval of values—this makes it easy to interpret a map at a glance. Also, if you make a black-and-white copy of a map that has a monochromatic scale, the map retains valid visual information by its shades of gray. ArcMap software generates monochromatic and multicolor scales called color ramps. A design tip for using monochromatic color ramps is to include more light shades and fewer dark shades because the human eye is better at discriminating light shades.

The approach to symbolizing points depends more on variations in the shape and size of point markers than on color. A point is a mathematical object that has no area, but to see a point on a map, you must plot a point marker that does have area. Perhaps the most effective way to show variation in a numerical attribute of a point feature is to vary the size of a fixed-shape point marker—that is, use size-graduated point markers. For example, you might use five intervals and five circular point markers with increasing radii for increasing intervals. Often, it is sufficient to use the same color for all sizes of a point marker of an attribute, but you can also add a monochromatic color ramp to the fill color of a point marker. Another design tip is to exaggerate the size intervals by increasing the differences in radii between successive point markers by more than the proportional increases in interval values.

These are the principles you will apply to studying the spatial pattern and correlation of uninsured and poor populations. The trick to plotting both populations on the same map is to use a county-based choropleth map for one variable and size-graduated point markers located at the centroid (center point) of counties for the other variable. ArcMap automatically creates the polygon centroids for this purpose.

It is often the case that you will need to present your findings and write them up in a report or provide them as hard copies to be used for decision making. This calls for professional-quality, unique stand-alone maps, which goes beyond the interactive map views ArcMap software presents on a computer screen. As you may have guessed, ArcMap has the capacity to easily produce these professional-quality maps in the form of map layouts that can be printed as hard-copy maps. Map layouts have all the features that are necessary for use outside ArcMap: a title, map, neatline, legend, scale bar, and so forth. A neatline places a border around the map, and the legend explains

symbols and numeric scales used on the map. A scale bar is a graphic representation of distance using a straight line that has a few distances marked off. ArcMap can also automate map outputs through Data Driven Pages, explored in tutorial 3-8.

## Tutorial 3-1

### Creating a choropleth map for the uninsured population in Texas

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Your first task is to build a choropleth map for the percentage of uninsured by county in Texas. As is the case for all symbolization in ArcMap, this process is highly automated, so you will need to make only a few selections to render the entire map layer rather than having to paint each graphic feature individually.

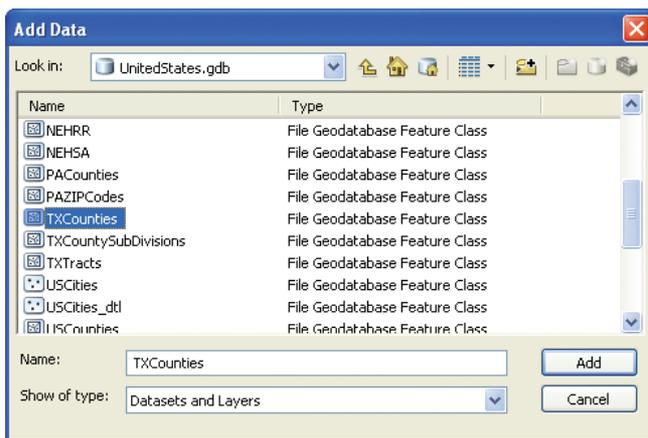
#### Open a map document

- 1 Start ArcMap and open **Tutorial3-1.mxd**. A new blank map is displayed.

Next, you will add layers to the map and symbolize them.

#### Add a layer and change its name

- 1 On the Standard toolbar, click **Add Data**.
- 2 Browse through the **Data** folder to **UnitedStates.gdb**, click **TXCounties**, and click **Add**.



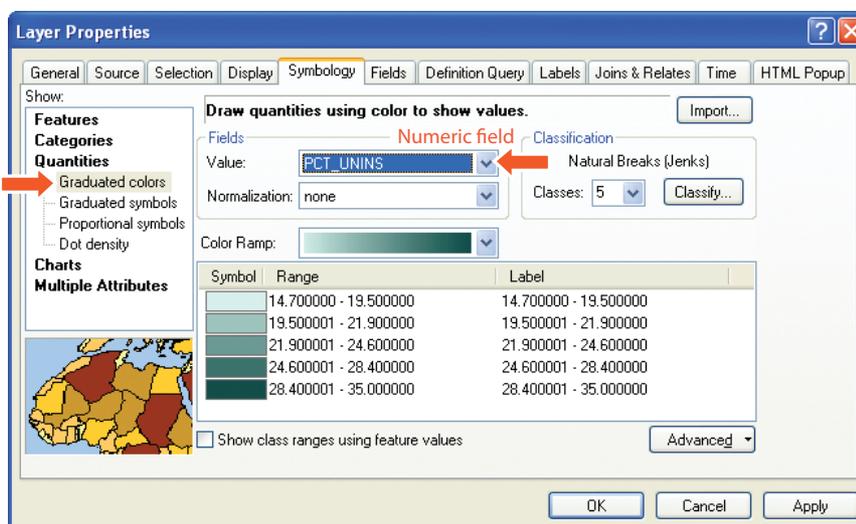
ArcMap adds Texas counties and picks an arbitrary fill color for the polygons. You will change the color later in this tutorial.

- 3 In the table of contents, right-click the TXCounties layer and click Properties.
- 4 In the Layer Properties dialog box, click the General tab.
- 5 Type % Population Uninsured as the new layer name.
- 6 Click OK.

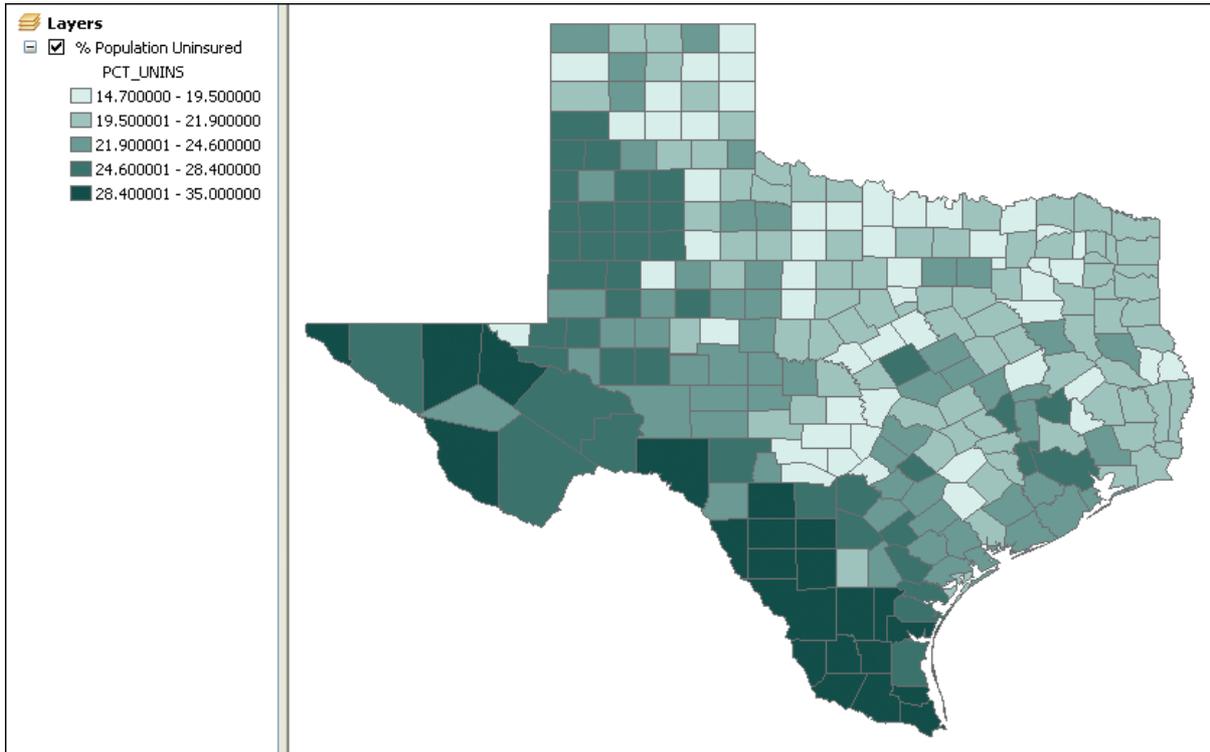
## Select an attribute to display the uninsured population

The Symbology tab in the Layer Properties dialog box allows you to use unique colors to symbolize your data using intervals that cover the range of a numeric attribute. There are several classification schemes to choose from. ArcGIS Desktop help describes all these classification methods. Generally, it is best to use a monochromatic color scale—that is, one color in increasingly darker shades progressing from small- to large-value intervals, or vice versa. ArcMap has many prebuilt progressions of color, called color ramps, that are monochromatic. In this exercise, you will classify data for the percentage of the uninsured population in Texas counties.

- 1 Right-click the % Population Uninsured layer and click Properties.
- 2 Click the Symbology tab.
- 3 In the Show panel, click Quantities > Graduated colors.
- 4 Under Fields, click the Value drop-down arrow, scroll down the list, and click PCT\_UNINS. Only numeric fields appear in the Value list.



- 5 Click OK.** The result is five classifications of uninsured total population ranging from lowest to highest values with darker colors representing higher values. ArcMap picks an arbitrary color ramp and a method of creating intervals, called natural breaks, for the polygons. You will learn how to change the colors and classification methods later.



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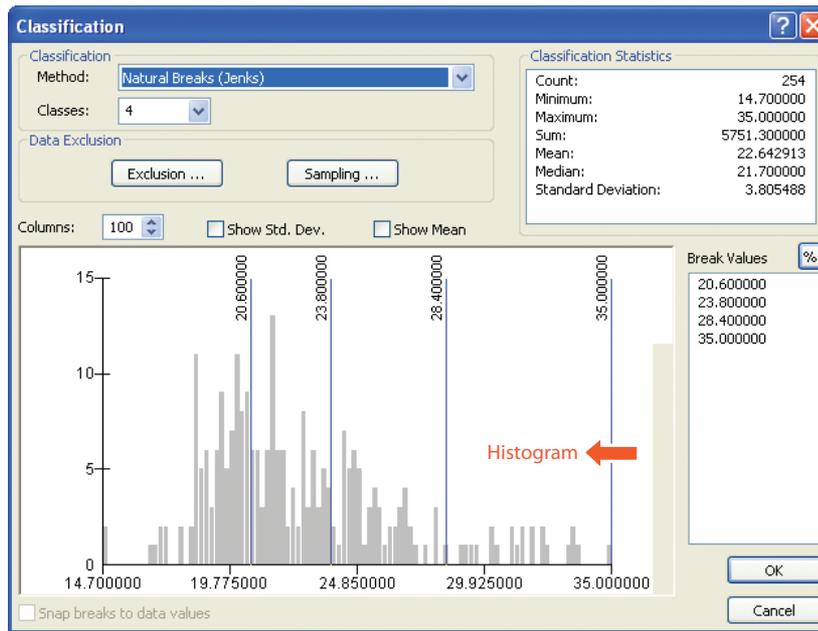
## Create custom classifications

One of the powerful features of desktop GIS is the ability to create your own custom classifications and to choose or modify color ramps. In this exercise, you will create your own custom legend for the percentage of population that is uninsured.

- 1 Right-click the % Population Uninsured layer, click Properties, and click the Symbology tab.**
- 2 Under Classification, click the Classes drop-down arrow and change the number of classes to 4.**



- 3 Under Classification, click the Classify button.** The Classification dialog box shows the current classification method, classification statistics, a histogram of the data, and a list of the current classification break values.

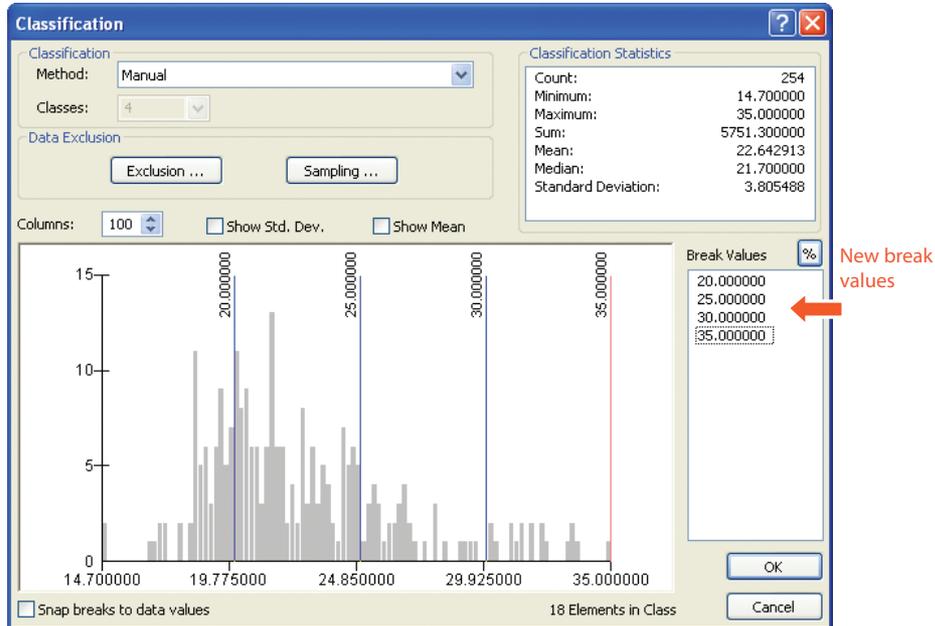


The next task is to break up the range of the uninsured population into intervals, as you would do if you were creating a bar chart for this data.

## Manually change classification values for the percentage of uninsured

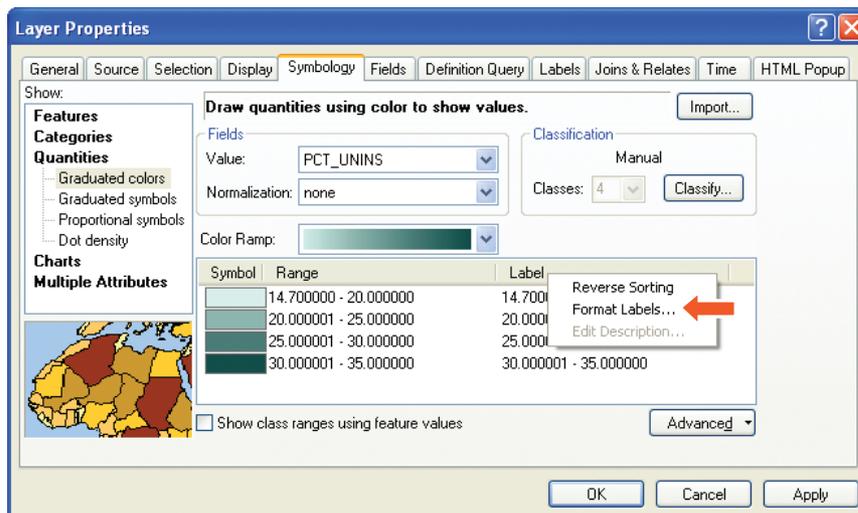
- 1 Under Classification, click the Method drop-down arrow and click Manual.**
- 2 In the Break Values list, click the first value, 20.600000, to highlight it.** Notice that the blue line in the graph corresponding to that value turns red.
- 3 Type 20 and press ENTER to move to the next break value.**
- 4 Repeat steps 2 and 3 to create the following break values: 25, 30, 35.**

## 5 Click OK.

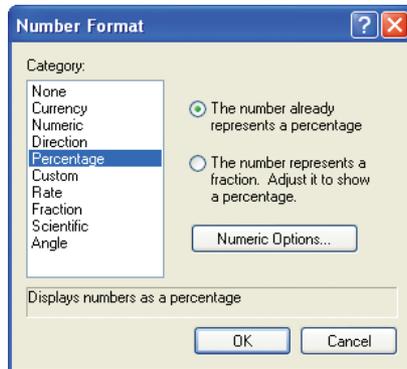


## Change labels

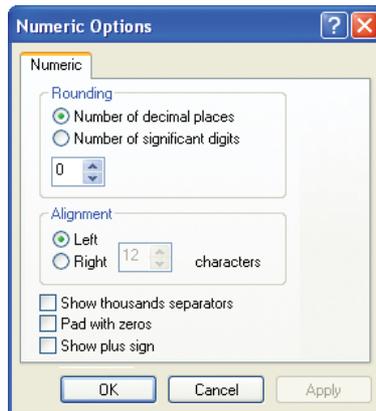
- 1 In the Layer Properties dialog box, click the Symbology tab, click the Label column heading, and then click Format Labels.



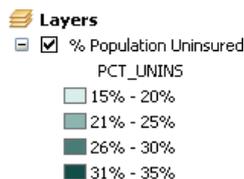
## 2 In the Category list, select Percentage and click the Numeric Options button.



## 3 Set the Number of decimal places to 0 and click OK three times.



The changes to the Layers legend—fixed intervals of width 5, no decimal places, and the use of percent signs (%)—make the map easier for lay audiences to interpret.

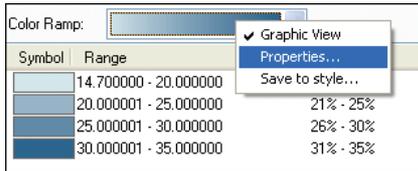


## Build a custom color ramp

Generally, it is best to have more classes in light colors and fewer classes in dark colors, because the human eye can differentiate lighter colors more easily than darker colors. In this exercise, you will build a custom color ramp that has lighter colors.

### 1 Right-click the % Population Uninsured layer, click Properties, and click the Symbology tab.

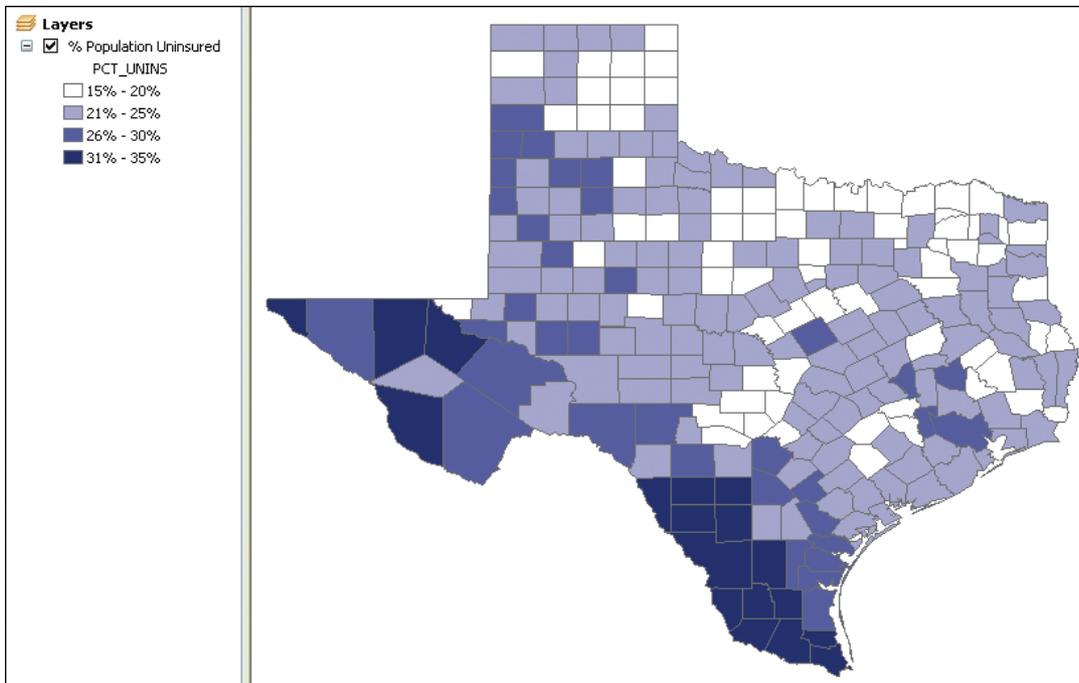
- 2 Click the Color Ramp drop-down arrow, scroll to the top, and click the fourth color ramp from the top (shades of blue).
- 3 Right-click the Color Ramp box and click Properties.



- 4 Click the Color 1 color box and select Arctic White.
- 5 Click the Color 2 color box and select Dark Navy.



- 6 Click OK twice. The % Population Uninsured map now has a new custom color ramp, ranging from white to dark blue. You can also click each color box on the Symbology tab of a map layer's Layer Properties dialog box to change the classification colors individually.



## Save the Texas uninsured population choropleth map

- 1 On the Menu bar, click File > Save As.
- 2 Save your map document as Tutorial3-1YourName.mxd to your Chapter3 folder in MyExercises. Do not close ArcMap.

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## Tutorial 3-2

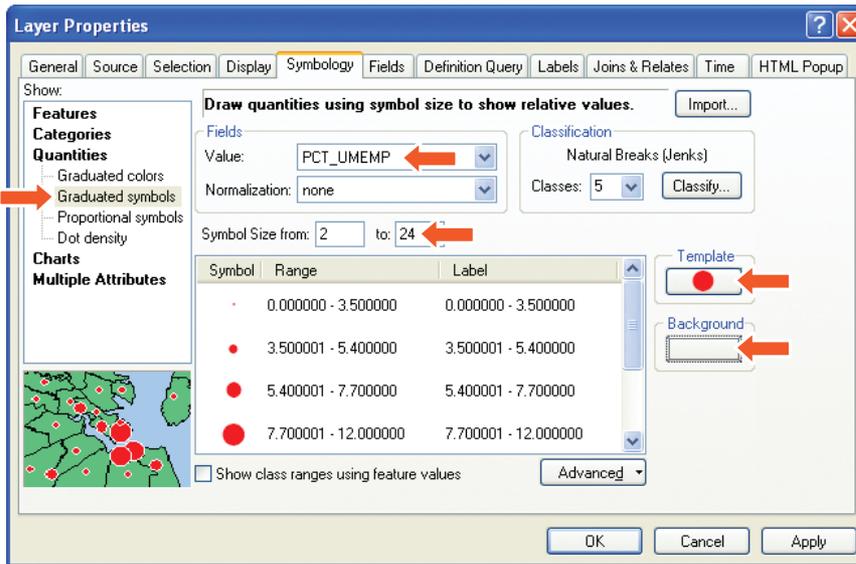
### Creating a point map for the percentage of unemployed in Texas

In this tutorial, you will add unemployment data as points to your uninsured choropleth map so you can look for a correlation between the unemployment rate and the number of people who don't have health insurance. To show variations in unemployment, you will break up that variable's range into intervals similar to those for the insured, but this time you will use the point marker size instead of a color ramp to differentiate the intervals—the larger the point marker size, the larger the interval value.

### Symbolize unemployment data as graduated point markers

- 1 If it is not already open, open the map document you created in tutorial 3-1—Tutorial3-1YourName.mxd saved to your Chapter3 folder.
- 2 On the Standard toolbar, click Add Data and add the layer TXCounties from the United States geodatabase in the Data folder.
- 3 In the table of contents, double-click the TXCounties layer. This is a shortcut to opening the Layer Properties dialog box.
- 4 Click the General tab and change the name of the layer to % Population Unemployed.
- 5 Click the Symbology tab, and in the Show panel, click Quantities > Graduated symbols.
- 6 Under Fields, change Value to PCT\_UNEMP.

- Change the Template symbol to a red circle, Symbol Size to a range of 2 to 24, and Background fill and Outline to no color.



- Click OK.

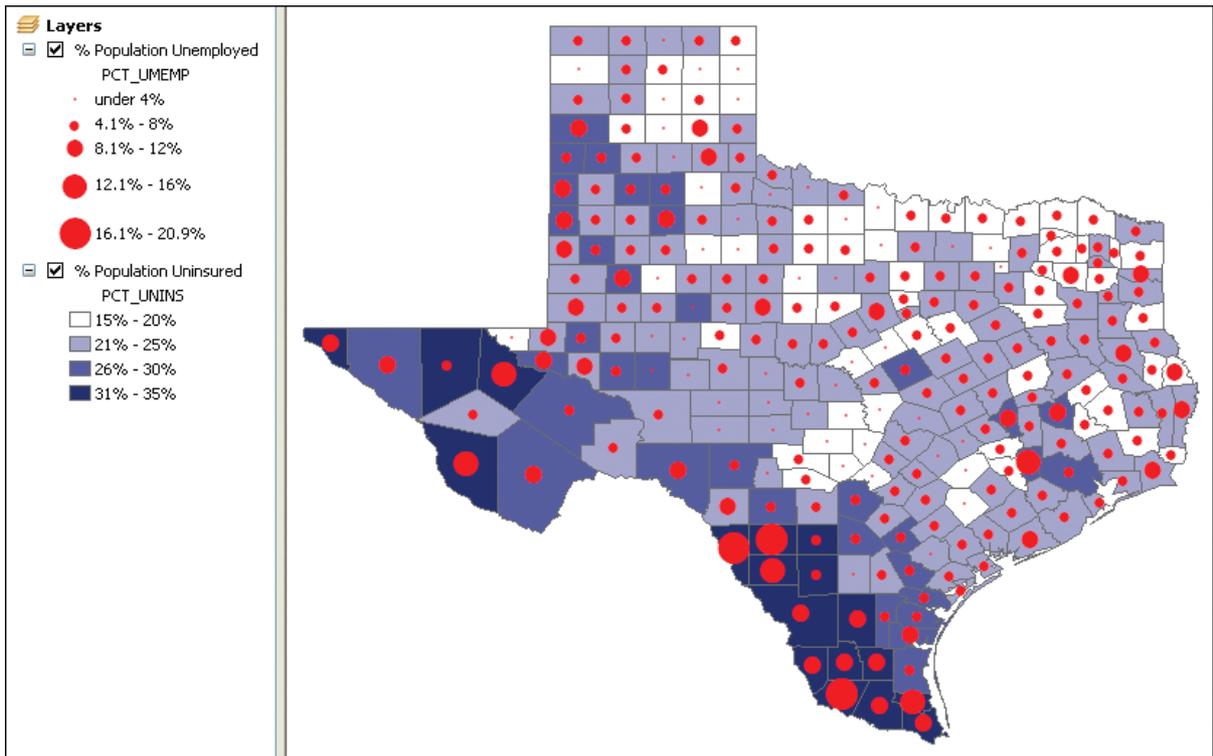
## Modify point classifications

The default classifications for the points need to be modified so that an even comparison can be made to the uninsured population.

- Double-click the % Population Unemployed layer, click the Symbology tab, and click the Classify button.
- In the Method list, click Equal Interval. The resulting interval break values are not whole numbers. To make the numeric scale easier to interpret, you will manually adjust the break values to even intervals of a width of 4.
- Change the break values to 4, 8, 12, 16, and 20.9 and click OK.
- Click the text of each line in the label and change the labels to under 4%, 4.1% - 8%, 8.1% - 12%, 12.1% - 16%, 16.1%, and - 20.9%. Notice that labels can be a combination of text and numeric values.

Symbol	Range	Label
•	0.000000 - 4.000000	under 4%
•	4.000001 - 8.000000	4.1% - 8%
•	8.000001 - 12.000000	8.1% - 12%
•	12.000001 - 16.000000	12.1% - 16%

- 5 Click OK.** The resulting map shows the counties layer twice: once as a choropleth map that has graduated colors and once as a point map that has graduated point markers. You can see the direct positive correlation between the unemployed and uninsured populations.



## Save the graduated point marker and choropleth map

- 1 On the Menu bar, click File > Save As.
- 2 Save your map document as Tutorial3-2YourName.mxd to your Chapter3 folder in MyExercises. Do not close ArcMap.

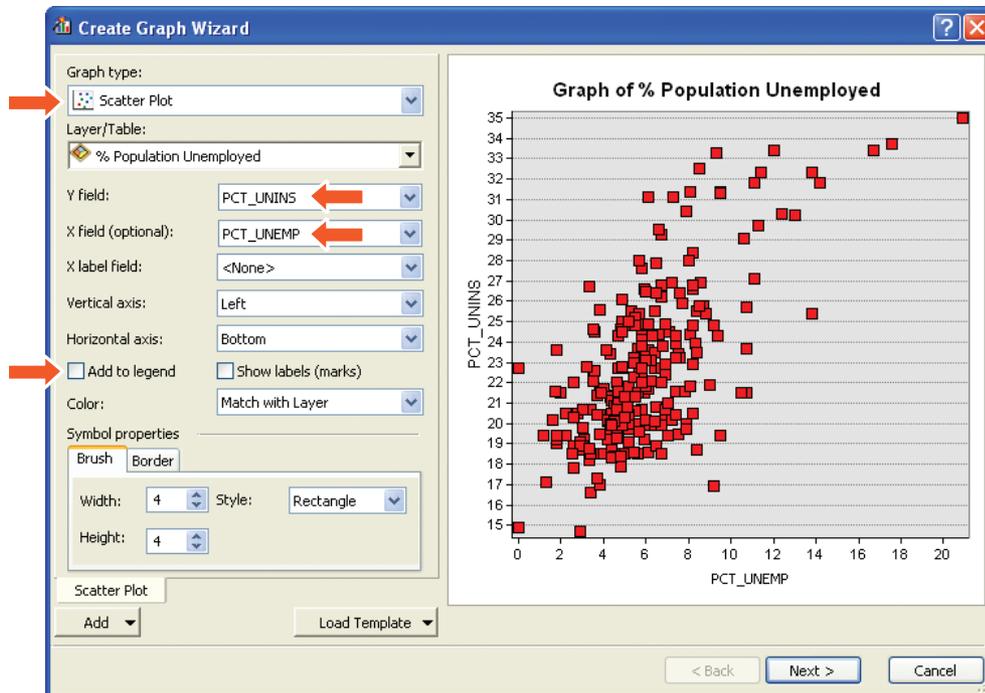
## Tutorial 3-3

### Making a scatterplot comparing uninsured with unemployed populations

Scatterplots display pairs of attributes and may reveal a relationship between the values plotted. In this tutorial, you will create a scatterplot showing the positive correlation between uninsured and unemployed populations.

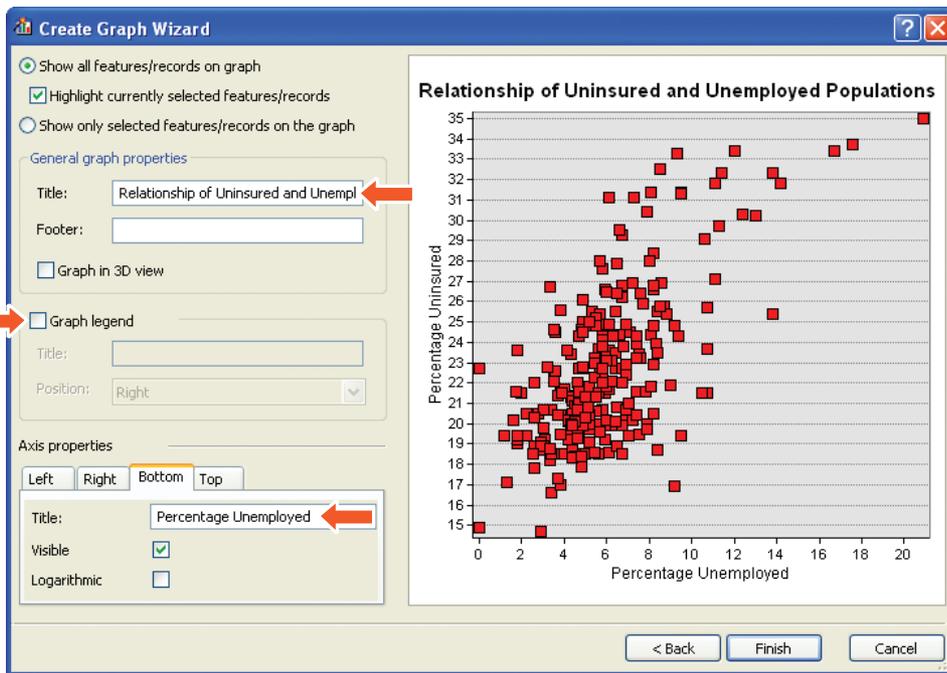
#### Create a scatterplot

- 1 On the Menu bar, click View > Graphs > Create Graph.
- 2 In the Create Graph Wizard, in the Graph type list, click Scatter Plot.
- 3 In the Y field list, scroll down and click PCT\_UNINS.
- 4 In the X field (optional) list, scroll down and click PCT\_UNEMP.
- 5 Click to clear the Add to legend check box.

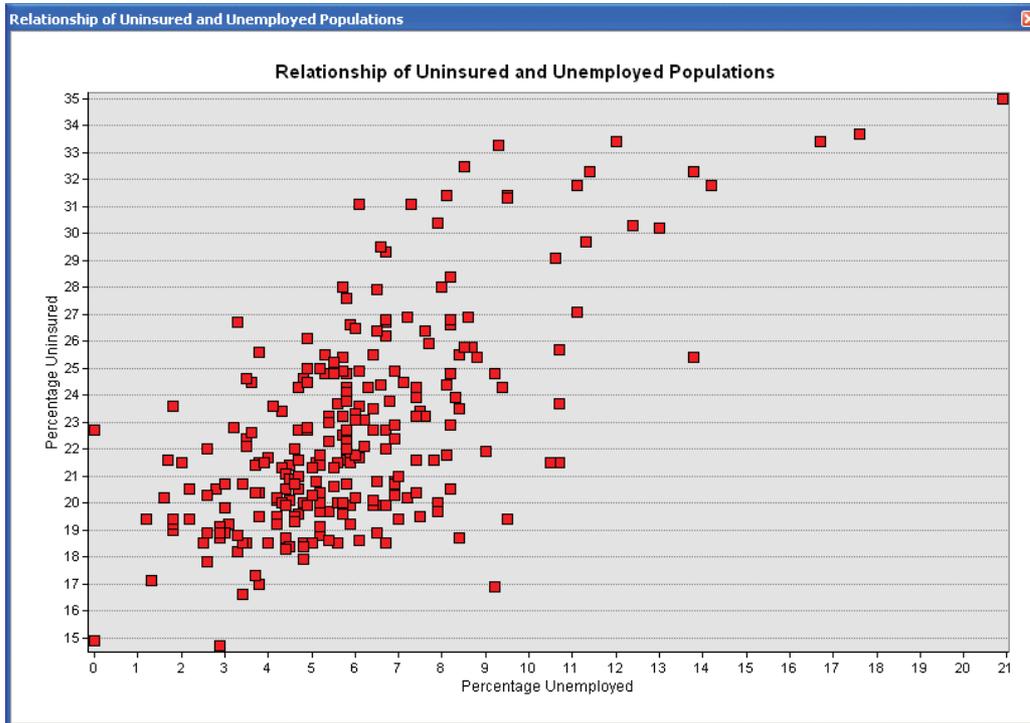


- 6 Click Next.

- 7 In the Title box, type Relationship of Uninsured and Unemployed Populations.
- 8 Click to clear the Graph legend check box.
- 9 In the Axis properties panel, click the Left tab, and for Title, type Percentage Uninsured.
- 10 Click the Bottom tab, and for Title, type Percentage Unemployed.



- 11 Click Finish.** The result is a scatterplot that helps to summarize and support the results of the correlation between the unemployed and uninsured populations. Right-clicking anywhere on the graph opens a context menu that allows you to revise your graph by clicking Advanced Properties or Properties. For example, you can add the graph to the layout of your current map or export it to a variety of graphic formats.



## YOUR TURN

Search ArcGIS Desktop Help to learn more about the types of graphs you can create.

### Save the map and scatterplot

- 1 On the Menu bar, click File > Save As.
- 2 Save your map document as Tutorial3-3YourName.mxd to your Chapter3 folder in MyExercises. Do not close ArcMap.