

Mapping US population change 2000-2010: Arcade Expressions

Lesson Overview

The US Census Bureau is preparing a report on changing population trends between 2000 and 2010. The Census Bureau has hired your data visualization company to produce a map showing the rate of change by state and county during this time period. Your company has chosen to use ArcGIS Online to produce the required product. It has asked for a map symbolized to distinguish areas of population growth from areas of population decline. The US Census Bureau wants to be able to have a Story Map on its website that the public can view. In the following lessons you will enrich a layer and use an Arcade expression to calculate values. You will also clarify the legend and publish the product in a Story Map showing the rate of population change by both state and counties of selected states.

Builds skills in

- Opening a map
- Enriching layers
- Calculate % change using an Arcade expression
- Label using an Arcade expression
- Symbolizing the data
- Create a Story Map

Software requirements

- ArcGIS Online account (get a [free trial](#))

Estimated time

- Over 1 hour

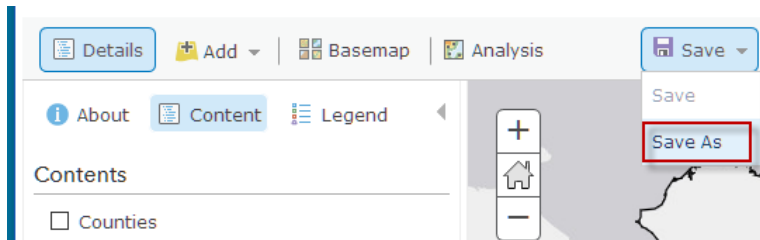
Exercise

Step 1: Open and save the map

1. Open [U.S. Population Change 2000 to 2010](#).
2. At the top of the page, Click **Sign In** and sign into your ArcGIS account.
3. On the side panel, click **Content**.

This map contains the Topographic basemap and state and county boundaries. States and counties are political boundaries.

4. On the top ribbon click **Basemap**.
5. In the basemap gallery, choose **Light Gray Canvas**.
6. On the ribbon, click **Save** and **Save As**.

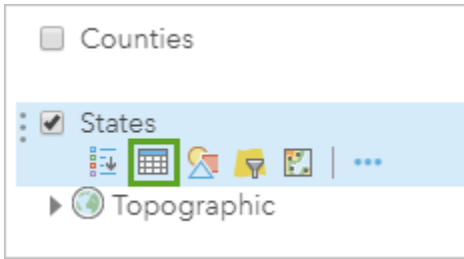


7. In the **Save Map** window, change the **Title** to *US Population Change_yourinitials*.
8. Click **Save Map**.

Step 2: View table and examine attributes

To see information about features in a layer, you can display an interactive table at the bottom of the map.

1. In the **Contents** pane, point to the **States** layer and click the **Show Table** button.



2. Examine the table. Notice that it only shows basic information.

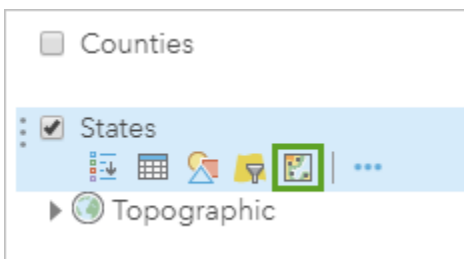
States (51 features, 1 selected)				Table Options ▾
STATE_NAME	STATE_FIPS	SUB_REGION	STATE_ABBR	
Hawaii	15	Pacific	HI	
Washington	53	Pacific	WA	
Montana	30	Mountain	MT	
Maine	23	New England	ME	

3. Close the table by clicking the X in the upper right corner.
4. Save the map.

Step 3: Enrich data for states

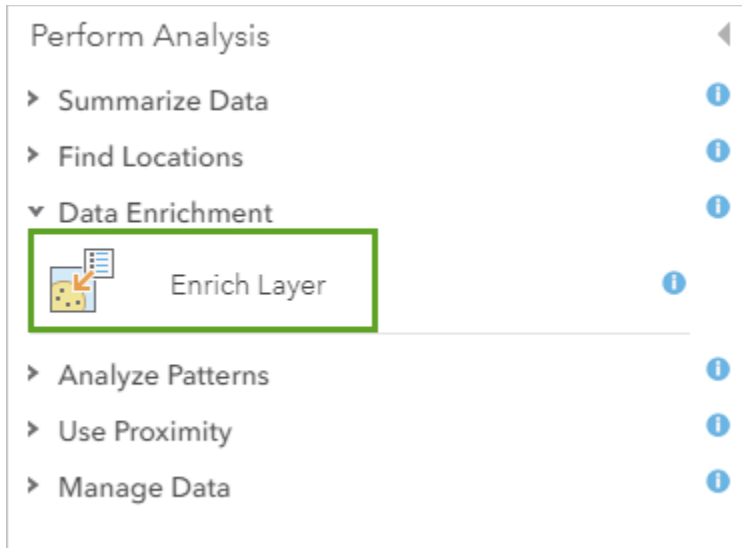
Data enrichment produces an enriched layer that retrieves information about the people, places, and businesses in a specific area. Detailed demographic data is returned for your chosen area. You are interested in a layer that shows the total population of 2000 and 2010.

1. In the **Contents** pane, point to the **States** layer and click the **Perform Analysis** button.



Analysis can also be activated by clicking the Analysis button on the top ribbon.

2. Click **Data Enrichment** and click **Enrich Layer**.



3. For **Choose layer to enrich with new data**, make sure **States** is chosen.
4. Click **Select Variables** to open the **Data Browser** window.
5. Make sure the **United States** is chosen in the upper right corner.
6. Click **Population**. In the bottom left, click **Show all Population Variables**.
7. Expand **2000 Data in 2010 Geography (U.S. Census)**.
8. Check **2000 Total Population (U.S. Census)**.
9. Expand **2010 Population (U.S. Census)**.
10. Check **2010 Total Population (U.S. Census)**.



11. Click **Apply**.
12. In the **Enrich Layer** pane, for **Result layer name**, type *Enriched States YourInitials*.

13. Uncheck **Use current map extent**.

14. Click **Run Analysis**.

15. Save the map.

Step 4: Calculate % change using an Arcade expression

1. Point to the **Enriched States YourInitials** layer and click **Show Table**.

The table shows **2000 Total Population** and **2010 Total Population**. There are several fields that you do not need.

2. Click the header of each of the following fields and choose **Delete**.

- Id
- Country code
- ENRICH_FID
- Aggregation method
- Population to polygon size rating for the country
- Apportionment confidence for the country
- Has data

You are now ready to calculate the % change of population using an Arcade expression. Arcade is a language written for use in the ArcGIS platform. It is intended to write embedded expressions for visualization, labeling, and pop-ups. It requires no credit consumption.

3. Point to **Enriched States YourInitials** and click **Change Style**.

4. For **Choose an attribute to show**, choose **New Expression**.

A new window appears where you can write an Arcade expression. On the right it shows all the fields that are in the table. The two fields that you will use are **2000 Total Population** and **2010 Total Population**.

It helps to carefully plan your calculation. In this instance, you need to calculate the % change between 2000 and 2010. To do this, you subtract the old value from the new value, then divide the result by the old value. In this instance it would be:

$$2010 \text{ Total Population} - 2000 \text{ Total Population}$$

Remember to enclose in parentheses the part of the formula that is to be calculated first. Therefore, the expression becomes:

$$(2010 \text{ Total Population} - 2000 \text{ Total Population}) / 2000 \text{ Total Population}$$

To make the above calculation into a percentage you must multiply by 100. The expression becomes:

$$((2010 \text{ Total Population} - 2000 \text{ Total Population}) / 2000 \text{ Total Population}) * 100$$

This gives the percentage with 15 decimal places. Change the result to a number with 2 decimal places by rounding. The expression becomes:

$$\text{Round}(((2010 \text{ Total Population} - 2000 \text{ Total Population}) / 2000 \text{ Total Population}) * 100, 2)$$

$$\text{Round}(((\$feature.TOTPOP10 - \$feature.TOTPOP00) / \$feature.TOTPOP00) * 100, 2)$$

5. Type the above expression into the Expression box. Instead of typing the fields, click the field names in the list.

The screenshot shows the ArcGIS Expression Builder interface. The 'Expression' box contains the following script:

```
1 // Write a script that returns a value that will be used to draw features.
2 // For example, find the percentage of males:
3 // Round(($feature.MalePop / $feature.TotalPop) * 100, 2)
4
5 Round(((\$feature.TOTPOP10 - \$feature.TOTPOP00) / \$feature.TOTPOP00) * 100, 2)
```

The 'Test' button is visible. On the right, a list of fields is shown, with '2000 Total Population' and '2010 Total Population' highlighted in green.

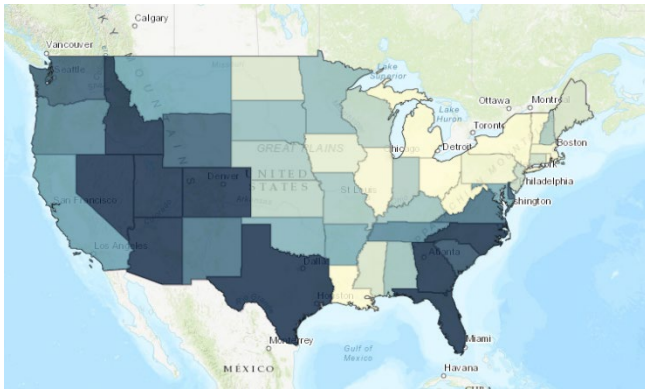
6. Click **Test** to check if your expression is correct.
7. Next to **Custom**, click **Edit** and change the name of the custom expression to *% Change in Population from 2000 to 2010*.
8. Click **Save** and click **OK**.
9. On the **Counts and Amounts (Color)** card, click **Select** and then click **Options**.

Cartographically, darker colors are usually used to show larger values (more) and lighter colors are used to show smaller values (less). The color scheme is already applied so states with a larger change in population have a darker color so you do not need to change it.

10. Click **OK** and click **Done**.

11. Save the map.

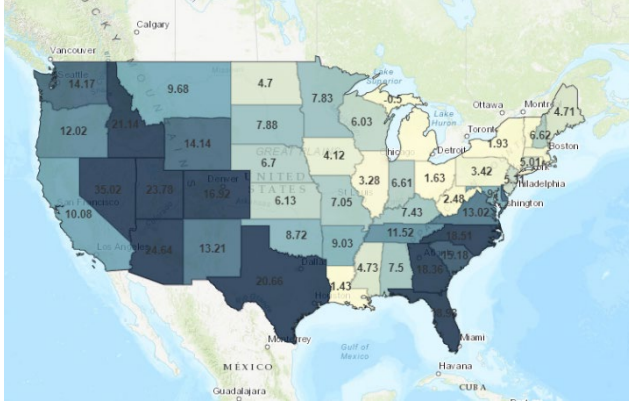
Q1. Write a description of the spatial distribution of the US by state population 2000 to 2010.



Step 5: Label change using an Arcade expression

The map can be labeled by using the same Arcade expression.

1. Point to **Enriched States YourInitials** and click **More Options** (three dots). In the menu, choose **Create Labels**.
2. For **Text**, choose **New Expression**.
3. Click **Edit** and change the name from Custom to *% Change in Population from 2000 to 2010*.
4. Paste the same expression that you used to create the map style earlier:
$$\text{Round}(((\$feature.TOTPOP10-\$feature.TOTPOP00)/\$feature.TOTPOP00)*100,2)$$
5. Click **OK**.
6. On the Label Features pane, click **OK**.



7. Save the map.

Step 6: Enrich data by Counties for Selected States

For this exercise, counties of three states—Nevada, Ohio, and Michigan—have been chosen.

Nevada

1. Uncheck the **Enriched States** layer to turn it off.
2. Turn on the **Counties** layer.
3. Under the **Counties** layer, click the **Filter** button.
4. Create the expression **STATE_NAME is Nevada**.

STATE_NAME

is

Nevada

Value
 Field
 Unique

Ask for values

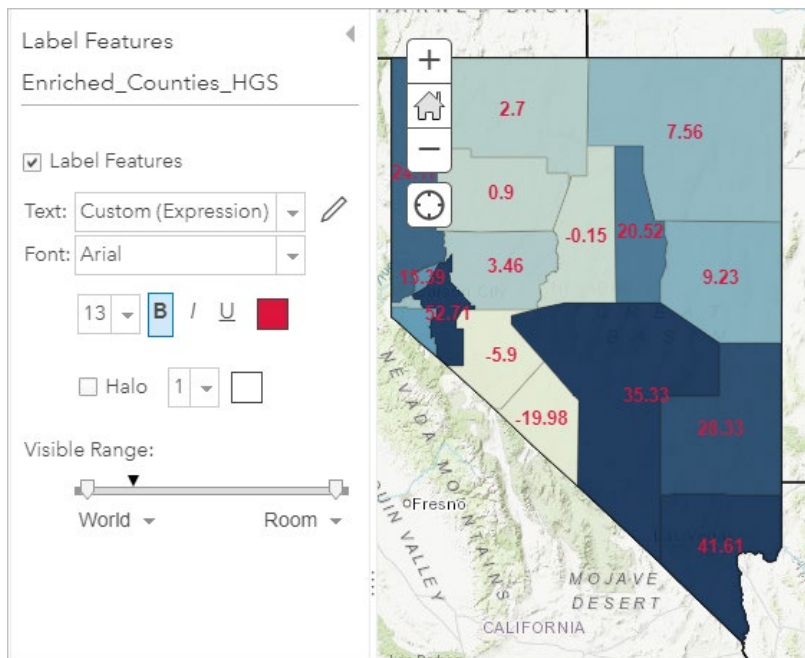
5. Click **Apply Filter**.
6. Only counties in Nevada are now shown on the map.
7. Using what you learned earlier in this lesson, enrich the counties for Population of 2000 and 2010.

Hint: Click Perform Analysis, Data Enrichment, and Enrich Layer.

8. Open the attribute table of the new **Enriched Counties** layer and delete the unnecessary fields.
9. Change the style of the **Enriched Counties** layer to match the symbology you made on the map.

Hint: Create a custom expression and use the same expression as before.

10. Create labels for the Enriched Counties layer using the same expression.
11. The labels may be difficult to read on some of the counties. Change their color to red.



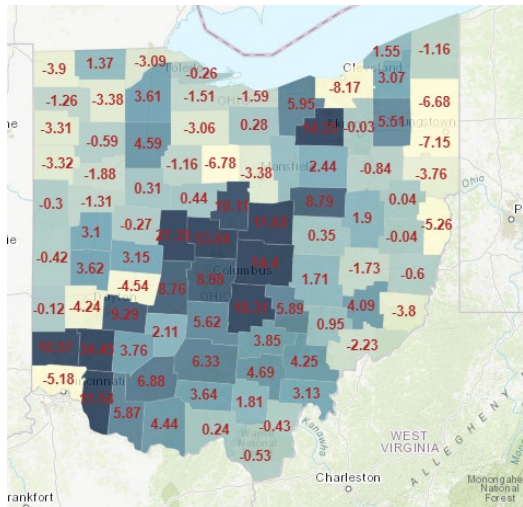
9. On the ribbon, click **Save** and **Save As**.
10. In the **Save Map** window, change the **Title** to *Nevada Population Change_yourinitials*.
11. Update the **Tags** and **Summary** for the new map.
12. Click **Save Map**.

Q2. Write a description of the spatial distribution of population from 2000 to 2010 in Nevada.

Ohio

1. Under the **Counties** layer, click the **Filter** button.
2. On the **Filter** window, click the **Edit** tab. Change the filter to read **STATE_NAME is Ohio**.
3. Repeat the process you used for Nevada to enrich, symbolize, and label the counties of Ohio.
4. Save the map as *Ohio Population Change_yourinitials*.

Q3. Write a description of the spatial distribution of population from 2000 to 2010 in Ohio.



Michigan

1. On the **Counties** layer, change the filter to read **STATE_NAME is Michigan**.
2. Repeat the process you used for Nevada to enrich, symbolize, and label the counties of Michigan.
3. Save the map as *Michigan Population Change_yourinitials*.

Q4. Write a description of the spatial distribution of population from 2000 to 2010 in Ohio.

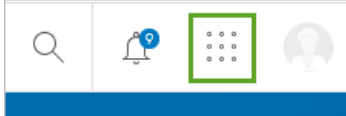
You should now have four maps all showing the percent change from 2000 to 2010 and labeled with the percentage:

- A map of the United States
- A map of the counties of Nevada
- A map of the counties of Ohio
- A map of the counties of Michigan

Step 7: Create a story map

Story Maps allow you to combine maps with narrative text, images, and multimedia content. They make it easy to harness the power of maps and geography to tell your story. In this section you will make a story map that will include five maps with explanation and media.

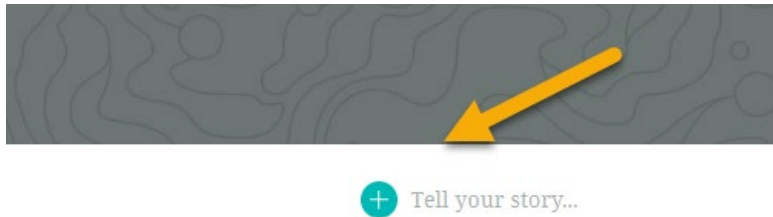
1. In the top left corner, click **Home** and choose **Content**.
2. On the top ribbon, next to your username, click the app launcher button.



3. Click **StoryMaps**. The StoryMaps app opens in a new tab.
4. Click **Create a new story**.
5. For **Title your story**, type *USA % Change in Population 2000 to 2010*.



6. Scroll down and click the + button next to the **Tell your story** text.



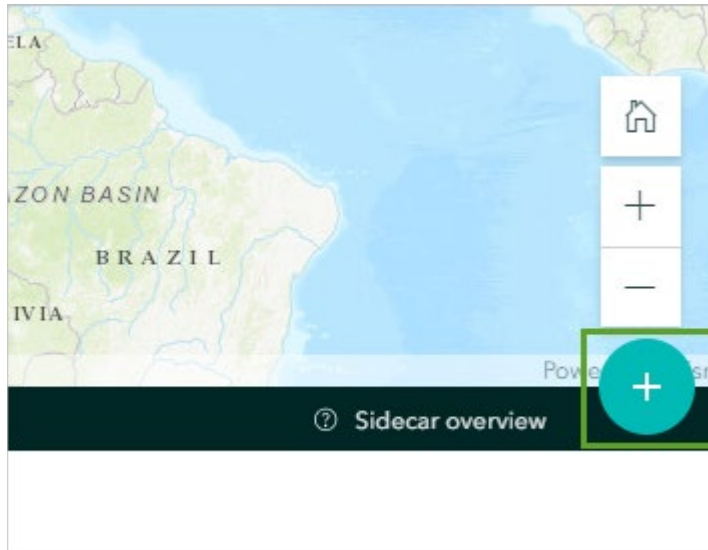
The builder is the heart of the StoryMap experience. It provides a set of tools that allow you to build your narrative. For this story map, you will be using the sidecar and map block elements.

7. Click **Sidecar**.

The sidecar allows you to add maps with an explanation of each one in a sidebar. It has two layout options. You'll use the Docked panel layout to show each of the four maps you made.

8. Click **Docked panel**.
9. Click **Add media** and click **Add map**.
10. Select your **U.S. Population Change** map.
11. Click **Place map**.
12. Click the + button next to the **Continue your story** text.
13. Click **Heading** and type *USA Change*.

14. Add a **Paragraph** and type your description of the spatial distribution of population change in the United States.
15. Find an image of the USA flag on the internet that is not proprietary. Copy the link to the image.
16. Add an **Image**. Click the **Link** tab and paste the link to the USA flag image. Click **Add**.
17. Click the **New Slide** button under the map.



18. Click **Add media** and **Add map**. Select your **Nevada Population Change** map.
19. Click **Place map**. Add a heading, a paragraph, and an image for Nevada.
20. Add slides for Ohio and Michigan and repeat the process to make them match your first two slides.

Step 8: Publish the Story Map

The story map automatically saves, but to share it with others you need to publish it.

1. On the top banner, click **Publish**.
2. Click **My organization** or **Everyone (Public)** and click **Publish story**.
3. If you are asked to also share maps and layers, click **Yes, share these items**.

You can view the completed story map here:

<https://storymaps.arcgis.com/stories/d4e8502fea35448b8adfc1c94f886318>

Assessment

The enrichment tool gives you access to a vast amount of data. For an additional learning activity, choose a variable to study and, using the above exercise as a guide, repeat the process for the chosen variable. For example, you may be interested in calculating the change in density of the population older than age 65 in the past 10 years. You can do this analysis either by state or at the county level.

Steps for this exercise:

1. Enrich boundary data with the variable for population over 65 in 2000.
2. Enrich boundary data with the variable for population over 65 in 2010.
3. Calculate population density for this age group in 2000 (2000 people over 65/area)
4. Calculate population density for this age group in 2010 (2010 people over 65/area)
5. Calculate the change in population density for this age group: $\text{Round}(((\text{Density 2010} - \text{Density 2000}) / \text{Density 2000}) * 100, 2)$

Exercise Answers

Q1. Write a description of the spatial distribution of the US by state population 2000 to 2010.

A1. States in the northeast have had the least change, while states in the south and southwest have had the most change.

Q2. Write a description of the spatial distribution of population from 2000 to 2010 in Nevada.

A2. While the southeast counties of Nye, Clark, and Lincoln have gained population, Esmeralda and Mineral have lost population.

Q3. Write a description of the spatial distribution of population from 2000 to 2010 in Ohio.

A3. Counties in the center of Ohio and going to the southwest have gained population while some of the counties outside this corridor of growth have lost population.

Q4. Write a description of the spatial distribution of population from 2000 to 2010 in Ohio.

A4. Counties along the eastern shore of Lake Huron and southwest of the Upper Peninsula of Michigan have lost population. While several counties in Michigan have gained population, there is statewide decline.

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380 New York Street

Redlands, California 92373 – 8100 USA

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About the author

This lesson was written by a K-12 educator with support from the Learn ArcGIS team at Esri.

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