Analyzing Census Data In SAS® Studio

Course Notes

Analyzing Census Data in SAS® Studio Course Notes was developed by Luna Bozeman. Additional contributions were made by Danny Modlin and Stacey Syphus. Instructional design, editing, and production support was provided by the Learning Design and Development team.

Analyzing Census Data in SAS® Studio Course Notes

Course code ECENSAS. ECENSAS_001

Table of Contents

Introduction to Analyzing Census Data in SAS Studio

In the *Analyzing Census Data in SAS Studio* tutorial series, you will learn to access U.S. Census data and explore it in SAS Studio. In addition, you will learn to import, visualize, prepare, and analyze the data using SAS Studio.

To follow along with the tutorial series, you must download the tutorial materials and set up your SAS Studio environment. If you have access to SAS Studio with SAS 9.4M3 or later, as well as licenses for SAS/ACCESS Interf ace to PC Files and SAS/STAT, skip to the *Setting Up the Tutorial Data* section. If you do not have access to SAS Studio or do not have the necessary licenses, start at the *Accessing SAS Studio Using SAS OnDemand for Academics* section to get access to SAS Studio for free. If you are unsure whether you have the necessary licenses, follow the steps below.

1. Open SAS Studio. On the toolbar, select  (**New Options**) ⇨ **New SAS Program**.
2. On the Code tab of the new program tab, type or copy and paste the program below.

```
proc product_status;
run;
```

Note: PROC PRODUCT_STATUS returns a list of the SAS Foundation products that are installed on your system, along with the version numbers of those products.

3. Click  (**Run**). If necessary, click the **Log** tab to view the results. Verify that the following is listed in the log:

   Under the *For Base SAS Software* section, verify that the version is 9.4M3 or later.

```
For Base SAS Software ...
      Custom version information: 9.4_M6
```

   Verif y that the SAS/STAT product appears.

```
For SAS/STAT ...
      Custom version information: 15.1
```

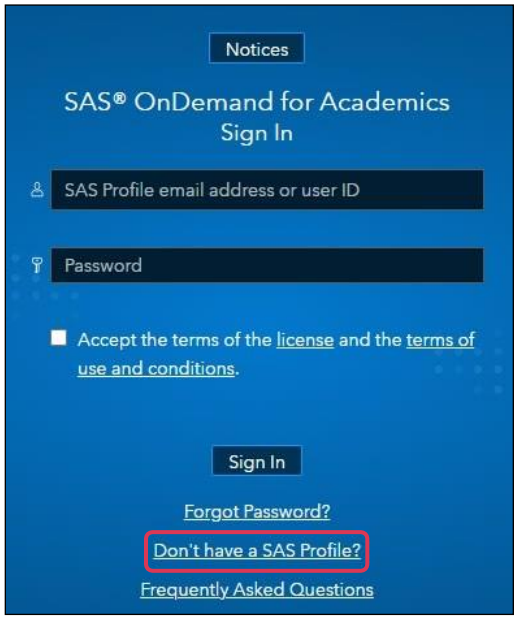
   Verif y that the SAS/ACCESS Interf ace to PC Files license appears.

```
For SAS/ACCESS Interface to PC Files ... Custom version
      information: 9.4_M6
```

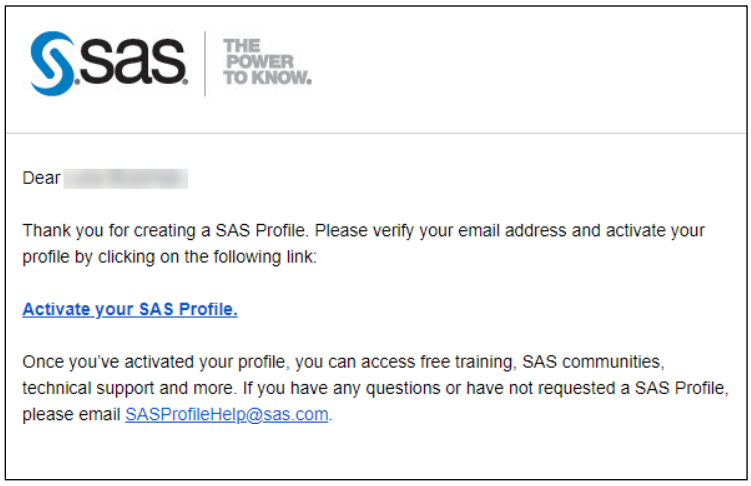
Accessing SAS Studio Using SAS OnDemand for Academics

Create a SAS profile and register it to access SAS OnDemand for Academics. SAS OnDemand f or Academics provides f ree access to SAS OnDemand f or Academics: Studio for learners.

1. Go to welcome.oda.sas.com to access the SAS OnDemand for Academics Sign In page.
2. If you have a SAS profile, skip to step 7 of these instructions. If you do not have a SAS Profile, select **Don't have a SAS Profile?**. Select **Create Profile**.



3. On the SAS Profile page, enter all required information. Agree to the terms of use and conditions and click **Createprofile**.
4. You will receive an email from replies-disabled@sas.com. In the email, click **Activate your SAS Profile**.



5. On the SAS Profile page that opens, create a password and select **Set password**. Click **Continue**.
6. Return to welcome.oda.sas.com.

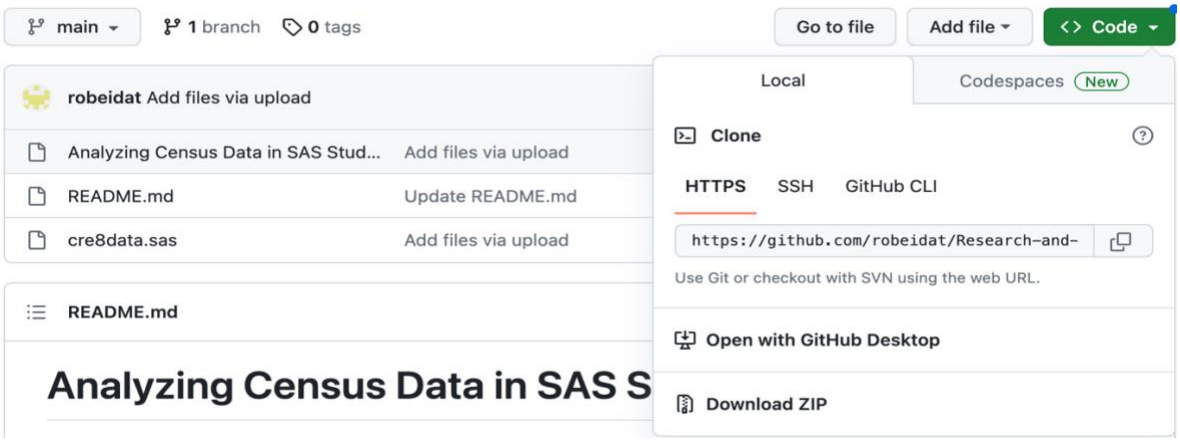
7. Type in your SAS profile credentials. Accept the terms for the license and the terms of use and conditions and click **Sign In**.
8. Select your desired home region and click **Submit**. Select **Yes** to confirm your home region.

   Note: You will not be able to change your home region after it has been set.
9. Click **Exit**.
10. You will receive an email when your sign-up request process has been completed. When you receive this email, you will have access to SAS OnDemand for Academics using your SAS profile.
11. To access SAS Studio, return to welcome.oda.sas.com.
12. Type in your SAS profile credentials. Accept the terms for the license and the terms of use and conditions and click **Sign In**.
13. Under **Applications**, select **SAS Studio**.

Setting Up the Tutorial Data

Download the tutorial data and upload it to the SAS server where the processing will occur. Then create a SAS library pointing to the tutorial data.

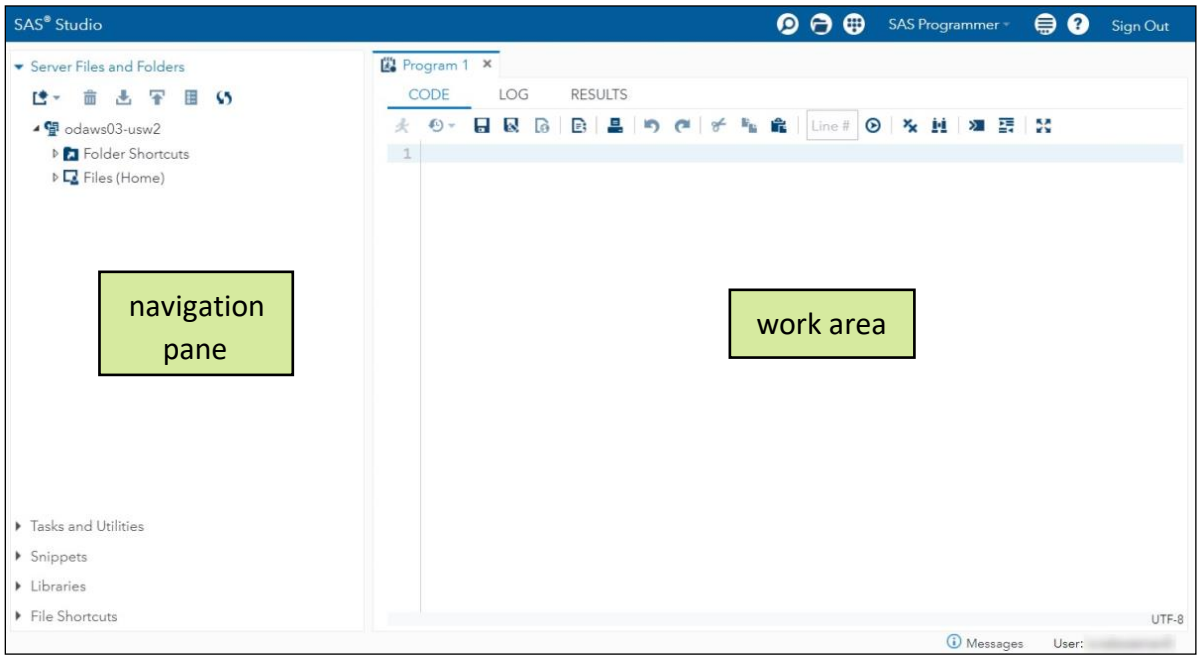
1. Go to https://github.com/robeidat/Research-and-DSA-Academy to access the tutorial materials. Select
   Code ⇨ Download ZIP.



2. Open the downloaded ZIP file and unzip all files to a location of your choice. Make note of this location. The files include **cre8data.sas**, which will be used to create the tutorial data, and **Analyzing Census Data in SAS Studio Tutorial Notes.pdf**, which contains the tutorial notes. The tutorial notes include steps to all tutorial videos as well as leveled practices.

3. If necessary, open SAS Studio. SAS Studio is a browser-based programming interface that connects to a local or hosted SAS server. You can write your own SAS code or use the interface to generate SAS code automatically.

   The main window of SAS Studio consists of a navigation pane on the left and a work area on the right.



4. To create a new folder to store all Census related data and analysis, in the **Server Files and Folders** section, expand **Files**. Navigate to and right-click a location of your choice, and then select **New** ⇨ **Folder**. In the **Name** box, type **Census Data Analysis** and click **OK**.

5. To upload the **cre8data.sas** program found in the downloaded tutorial materials, select the **Census Data Analysis** folder and click (**Upload**). Click **Choose Files** and navigate to the location where you unzipped the tutorial materials. Select the **crea8data.sas** program. Click **Open** ⇨ **Upload**.

6. Expand the **Census Data Analysis** folder and confirm that the **cre8data.sas** program has been uploaded.

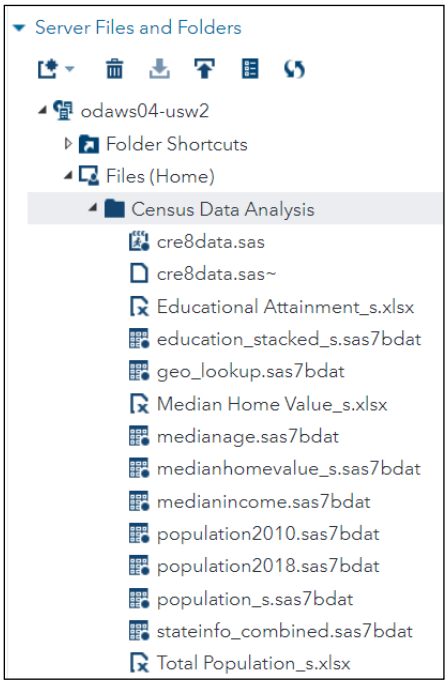
7. Double-click the **cre8data.sas** program to open it on a new tab in the work area.

8. Right-click the **Census Data Analysis** folder and select **Properties**. Highlight the path in the **Location** box and select Ctrl + C. Click **Close**.

9. On the %LET statement, highlight **insertpath**. Select Ctrl + V to paste the copied path into the program.

10. Click (**Run**). On the **Results** tab, you should see nine tables listed. In addition, your **Census Data Analysis** folder should contain those nine tables along with three Excel files.

#	Name	Member Type	File Size	Last Modified
1	EDUCATION_STACKED_S	DATA	256KB	11/13/2020 15:09:22
2	GEO_LOOKUP	DATA	256KB	11/13/2020 15:09:22
3	MEDIANAGE	DATA	256KB	11/13/2020 15:09:22
4	MEDIANHOMEVALUE_S	DATA	256KB	11/13/2020 15:09:22
5	MEDIANINCOME	DATA	256KB	11/13/2020 15:09:22
6	POPULATION2010	DATA	256KB	11/13/2020 15:09:22
7	POPULATION2018	DATA	256KB	11/13/2020 15:09:22
8	POPULATION_S	DATA	256KB	11/13/2020 15:09:22
9	STATEINFO_COMBINED	DATA	256KB	11/13/2020 15:09:22



11. SAS tables are referenced via SAS libraries. A SAS library is a pointer or shortcut to a collection of one or more SAS tables in the same location. To create a SAS library pointing to the **Census Data Analysis** folder, in the **Server Files and Folders** section, right-click the **Census Data Analysis** folder and select **Create** ⇨ **Library**. In the **Name** box, type **census**. To automatically have this library assigned at start-up, select the **Re-create this library at start-up** check box. Click **OK**.

    Note: By default, a user-defined library remains active until it is deleted or the SAS session ends. When SAS restarts, you can use the steps above to re-establish the library. However, by using the **Re-create this library at start-up** option, the library will automatically be assigned at start-up.

End of Tutorial

Access Census Data

Access Census Data

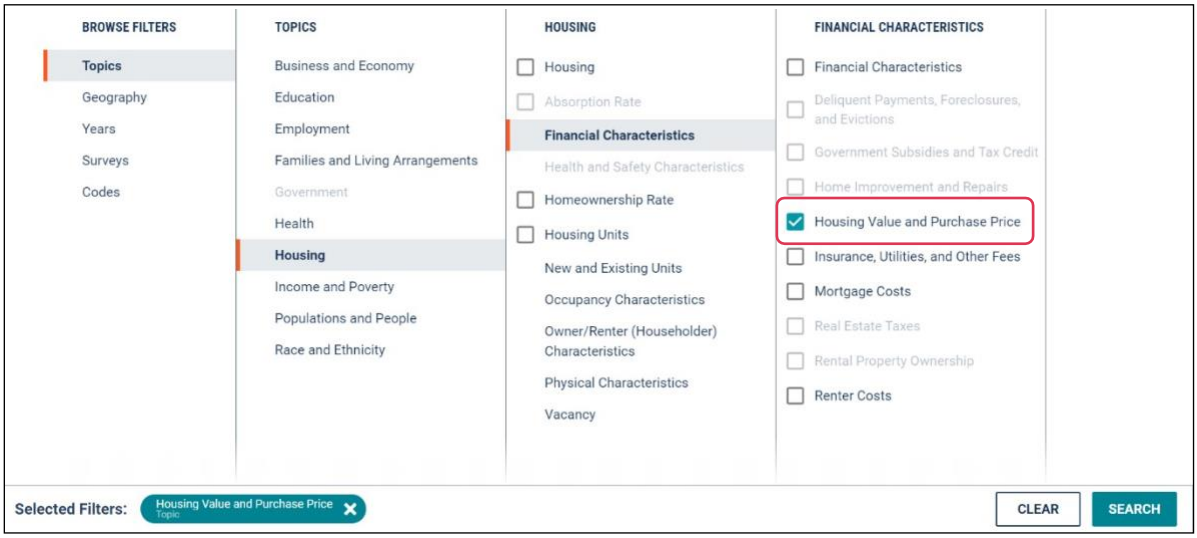
Use data.census.gov to access and download data about median home values in each state. Then, prepare the data in Excel for import into SAS Studio.

1. Go to data.census.gov. Data.census.gov provides a centralized platform to access demographic and economic data from the United States Census Bureau.

   Note: The Census Bureau offers several interactive applications that can be used to find and download data. To learn more about the available applications, see the Data Tools and Apps page on the United States Census Bureau's website.

2. On the landing page of data.census.gov, you can use the free-form single search bar or the advanced search. The single search bar is recommended when searching for a quick statistic, a profile for a single geography, a particular code, or a table ID. The advanced search is recommended for more complex searches, such as a particular survey, program, or table, a collection of geographies, or crosstabulations.

3. Click on **Advanced Search**. To narrow the search to data on home values, under Browse Filters, select **Topics** ⇨ **Housing** ⇨ **Financial Characteristics**. Click the check box for **Housing Value and Purchase Price**.



   Note: The same filters are also available on the Advanced Filters menu when viewing and customizing a table.

4. Under Browse Filters, select **Years** and select the check box for **2018**. Click **SEARCH**.

5. The All Results page appears. From this page, you can choose to view the tables, maps, or pages that relate to the **Housing Value and Purchase Price** and **2018** filters.

6. At the top of the All Results page, click **TABLES**. In the list of tables on the left, select the **MEDIAN VALUE (DOLLARS)** table (table ID B25077). This table displays the one-year estimates for the median home value in 2018. Because a geographic filter was not applied, the table displays the statistic summarized at the national level.

Note: Data from many surveys are available through data.census.gov. In this course, we mainly use data that was collected through the American Community Survey (ACS). The ACS is the nation's largest ongoing household survey that provides social, economic, housing, and demographic data annually. Because the ACS is based on a sample, a margin of error is provided to account for sampling error. In addition, both 1-year and 5-year estimates might be available depending on the geographic region of interest. 5-year estimates are available for all areas while 1-year estimates are available for areas with populations that exceed 65,000. In this course, we will use the 1-year estimates when available. To learn more about when to use 1-year or 5-year estimates, see the When to Use 1-year, 3-year, or 5-year Estimates page on the United States Census Bureau's website.

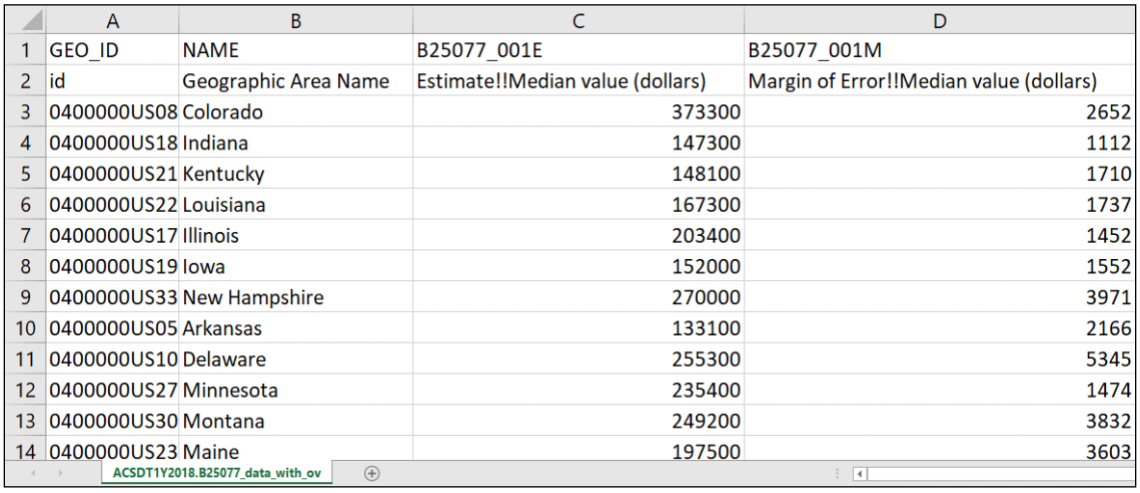
7. Click the **CUSTOMIZE TABLE** button. The Advanced Filters menu appears, with functionality to modify the selected geographies, years, topics, and more. On the Advanced Filters menu, select **Geographies**. To view state-level data, select **State** and click the check box for **All States in United States**. Click **Close**. The table now shows the estimated median home value for each state in 2018.

Note: There are additional features to hide individual columns, hide the Margin of Error columns, or transpose the table. However, those customizations will not be represented in the downloaded file.

Note: The states might appear in a different order than shown above.

8. Click **Download**. Verify that the **1-year**, **2018** check box is selected and that the File Type option is set to **CSV**. In the lower right corner, click the **DOWNLOAD** button.
9. When the files are prepared, click the **Download Now** button. This downloads a ZIP file containing the selected data.

10. Open the downloaded ZIP file. The ZIP file contains two comma-separated values (CSV) files and a text file. Open the CSV file with *data_with_overlays* in the file name in Excel to verify its contents. Each geographic region is represented in a separate row, with separate columns for each estimate and its associated margin of error.



	A	B	C	D
1	GEO_ID	NAME	B25077_001E	B25077_001M
2	id	Geographic Area Name	Estimate!!Median value (dollars)	Margin of Error!!Median value (dollars)
3	0400000US08	Colorado	373300	2652
4	0400000US18	Indiana	147300	1112
5	0400000US21	Kentucky	148100	1710
6	0400000US22	Louisiana	167300	1737
7	0400000US17	Illinois	203400	1452
8	0400000US19	Iowa	152000	1552
9	0400000US33	New Hampshire	270000	3971
10	0400000US05	Arkansas	133100	2166
11	0400000US10	Delaware	255300	5345
12	0400000US27	Minnesota	235400	1474
13	0400000US30	Montana	249200	3832
14	0400000US23	Maine	197500	3603

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Note: The CSV file might open in a different application, such as Notepad, depending on your default application settings for CSV files. To open the file in Excel, right-click on the file, and select **Open With** ⇨ **Microsoft Excel**.

Note: A quick way to optimize the view of the table is to change the column width to automatically fit the contents. To do this, first, in the upper left corner of the worksheet, click (**Select All**) to highlight all columns. Then, on the **Home** tab, in the **Cells** group, click **Format** ⇨ **AutoFit Column Width**.

Note: The states might appear in a different order than shown above.

11. To simplify the import process in SAS Studio, several changes can be made to the downloaded CSV file.
    a. Column names in SAS must be 1-32 characters in length. It is recommended that the name begin with a letter or an underscore, and continue with letters, numbers, and underscores. In addition, the first row of the raw data file should contain what will be used as column names in SAS. To ensure that the column names in the first row follow the SAS naming conventions and to provide descriptive names, replace the text in cell B1 with **State**, C1 with **MedianHome**, and D1 with **MedianHomeMOE**.

       Note: The column names can also be modified in SAS Studio.

       Note: By default, SAS Studio allows for spaces and special symbols other than underscores in column names. However, for simplicity and consistency, it is recommended to follow the standard SAS naming conventions.

    b. It is not necessary to keep the second row of the table. To delete the second row, right-click on the row number, **2**, and select **Delete**.

c. A format can be applied to columns C and D to display them as currency. This will automatically format the values in SAS Studio when the file is imported. To apply a format, click on the column heading **C**, hold down the Ctrl key, and click on the column heading **D**. Right-click anywhere in the highlighted region and select **Format Cells**. On the **Number** tab, select the **Currency** category. Decrease the **Decimal places** field to **0** and click **OK**.

Note: Formats can also be applied and modified in SAS Studio.

	A	B	C	D
1	GEO_ID	State	MedianHome	MedianHomeMOE
2	0400000US08	Colorado	$373,300	$2,652
3	0400000US18	Indiana	$147,300	$1,112
4	0400000US21	Kentucky	$148,100	$1,710
5	0400000US22	Louisiana	$167,300	$1,737
6	0400000US17	Illinois	$203,400	$1,452
7	0400000US19	Iowa	$152,000	$1,552
8	0400000US33	New Hampshire	$270,000	$3,971
9	0400000US05	Arkansas	$133,100	$2,166
10	0400000US10	Delaware	$255,300	$5,345
11	0400000US27	Minnesota	$235,400	$1,474
12	0400000US30	Montana	$249,200	$3,832
13	0400000US23	Maine	$197,500	$3,603
14	0400000US37	North Carolina	$180,600	$1,360

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Note: The states might appear in a different order than shown above.

12. To save the file, click **File** ⇨ **Save As**. Under **Save As**, click **Browse** and navigate to a location of your choice. In the **File name** box, type **Median Home Value**, and from the **Save as type** list, select **Excel Workbook (*.xlsx)**. Click **Save**.

    Note: Saving the file as an Excel workbook enables the formats to be properly saved and used when importing the file into SAS Studio.

13. Close the **Median Home Value.xlsx** file.

End of Tutorial

Practice

Level 1

1. Downloading and Preparing Population Data for Import into SAS Studio

Use data.census.gov to access and download data about population estimates for each state. Then, prepare the data in Excel for import into SAS Studio.

a. Go to data.census.gov. Use the single search bar to search for **population**. Select the **TOTAL POPULATION** table (table ID B01003). This table contains estimated population counts.

b. Customize the **TOTAL POPULATION** table using the following settings:

- Use the 1-year estimates for 2018.

  Hint: Use the **Product** drop-down menu.
- Display the estimates for all states.

c. Download the customized table as a CSV file, and then open the file in Excel.

d. To simplify the import process in SAS Studio, make the following changes to the downloaded CSV file in Excel:

- To provide descriptive column names in the first row, rename **NAME** to **State** and **B01003_001E** to **TotalPopulation**.
- Delete the column containing the margin of error.
- Delete the second row containing descriptive labels.
- Apply a format to column C containing the population estimates to display the values with commas and no decimal places.

	A	B	C
1	GEO_ID	State	TotalPopulation
2	0400000US08	Colorado	5,695,564
3	0400000US18	Indiana	6,691,878
4	0400000US21	Kentucky	4,468,402
5	0400000US22	Louisiana	4,659,978
6	0400000US17	Illinois	12,741,080
7	0400000US19	Iowa	3,156,145
8	0400000US33	New Hampshire	1,356,458
9	0400000US05	Arkansas	3,013,825
10	0400000US10	Delaware	967,171
11	0400000US27	Minnesota	5,611,179
12	0400000US30	Montana	1,062,305
13	0400000US23	Maine	1,338,404
14	0400000US37	North Carolina	10,383,620

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Note: The states might appear in a different order than shown above.

e. Save the file as an Excel workbook named **Total Population** in a location of your choice.

Note: Saving the file as an Excel workbook enables the formats to be properly saved and used when importing the file into SAS Studio.

f. Close the **Total Population.xlsx** file.

Challenge

2. Customizing and Copying Data into Excel for Import into SAS Studio

The **PLACE OF BIRTH BY EDUCATIONAL ATTAINMENT IN THE UNITED STATES** table contains education attainment data by place of birth for the population 25 years and over. However, only the total educational attainment counts are of interest. If you are interested in only a subset of data in a table in data.census.gov, you can customize the table and copy only the cells of interest into an Excel workbook. Then, the data can be further prepared in Excel for import into SAS Studio.

a. Go to data.census.gov. Used the advanced search to narrow the search to the year 2018 and the topic **Educational Attainment**. Select the **PLACE OF BIRTH BY EDUCATIONAL ATTAINMENT IN THE UNITED STATES** table (table ID B06009).

b. Customize the **PLACE OF BIRTH BY EDUCATIONAL ATTAINMENT IN THE UNITED STATES** table using the following settings:

- Verify that the 1-year estimates for 2018 are displayed.
- Display the estimates for all geographical divisions.

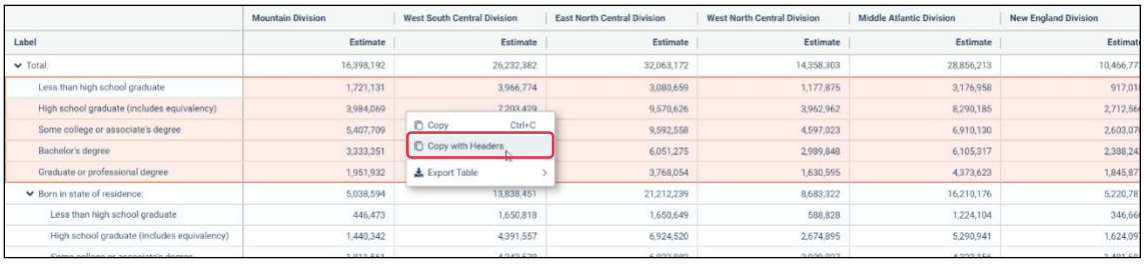
  Note: To learn more about the Census Bureau's regions and divisions, see the Census Regions and Divisions of the United States reference page.

- Hide the Margin of Error columns.

  Hint: On the Advanced Filters menu, you can toggle the Margin of Error columns by clicking on the **Margin of Error** button.

c. To extract only the total counts, under the **Total** row heading, highlight only the rows for **Less than high school graduate**, **High school graduate (includes equivalency)**, **Some college or associate's degree**, **Bachelor's degree**, and **Graduate or professional degree** for all division columns. Then copy the highlighted region with the headers.

Hint: To copy the highlighted region with headers, right-click anywhere in the highlighted region, and select **Copy with Headers**.



Note: The divisions might appear in a different order than shown above.

d. Paste the copied cells into a new Excel workbook. Then, to simplify the import process in SAS Studio, make the following changes to the pasted data:

- Rename the first column, **Label**, to **Educational_Attainment**.
- Simplify the remaining column names in the first row by removing **Division / Estimate** from the end of the division names.

Hint: Use the Find and Replace feature in Microsoft Excel to quickly remove **Division / Estimate** from all division names.

Note: By default, SAS Studio allows for spaces and special symbols other than underscores in column names.

- Apply a format to columns B through J containing the educational attainment counts to display the values with commas and no decimal places.

	A	B	C	D	E	F
1	Educational_Attainment	Mountain	West South Central	East North Central	West North Central	Middle At
2	Less than high school graduate	1,721,131	3,966,774	3,080,659	1,177,875	3,1
3	High school graduate (includes equivalency)	3,984,069	7,203,429	9,570,626	3,962,962	8,2
4	Some college or associate's degree	5,407,709	7,563,313	9,592,558	4,597,023	6,9
5	Bachelor's degree	3,333,351	4,854,673	6,051,275	2,989,848	6,1
6	Graduate or professional degree	1,951,932	2,644,193	3,768,054	1,630,595	4,3

Note: The divisions might appear in a different order than shown above.

e. Save the Excel file as **Educational Attainment** in a location of your choice.

f. Close the **Educational Attainment.xlsx** file.

End of Practices

Solutions to Practices

1. Downloading and Preparing Population Data for Import into SAS Studio

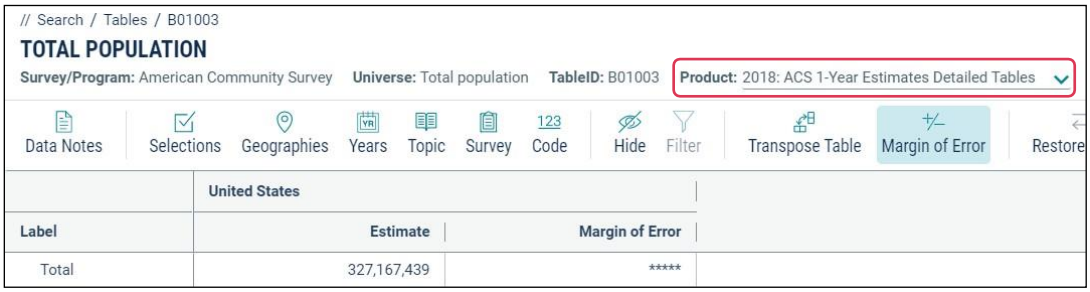
a. Go to data.census.gov. Use the single search bar to search for **population**. Select the **TOTAL POPULATION** table (table ID B01003). This table contains estimated population counts.

1) Go to data.census.gov.
2) In the single search bar, type **population**. Click **SEARCH**.
3) At the top of the All Results page, click **TABLES**. In the list of tables on the left, select the **TOTAL POPULATION** table (table ID B01003).

b. Customize the **TOTAL POPULATION** table using the specified settings.

1) Click **CUSTOMIZE TABLE**.
2) Use the 1-year estimates for 2018.

   Use the **Product** drop-down menu to select **2018: ACS 1-Year Estimates Detailed Tables**.



3) Display the estimates for all states.
   a) On the Advanced Filters menu, select **Geographies**.
   b) Select **State**, and then click the check box for **All States in United States**.
   c) Click **Close**.

c. Download the customized table as a CSV file, and then open the file in Excel.

1) Click **Download**.
2) Verify that the **1-year**, **2018** check box is selected and that the File Type option is set to **CSV**.
3) In the lower right corner, click the **DOWNLOAD** button.
4) When the files are prepared, click the **Download Now** button.
5) Open the downloaded Zip file.
6) Right-click on the CSV file with *data_with_overlays* in the file name and select **Open With ⇨ Microsoft Excel**.
7) To optimize the view of the table, first, in the upper left corner of the worksheet, click (**Select All**) to highlight all columns. Then, on the **Home** tab, in the **Cells** group, click **Format ⇨ AutoFit Column Width**.

	A	B	C	D
1	GEO_ID	NAME	B01003_001E	B01003_001M
2	id	Geographic Area Name	Estimate!!Total	Margin of Error!!Total
3	0400000US08	Colorado	5695564	*****
4	0400000US18	Indiana	6691878	*****
5	0400000US21	Kentucky	4468402	*****
6	0400000US22	Louisiana	4659978	*****
7	0400000US17	Illinois	12741080	*****
8	0400000US19	Iowa	3156145	*****
9	0400000US33	New Hampshire	1356458	*****
10	0400000US05	Arkansas	3013825	*****
11	0400000US10	Delaware	967171	*****
12	0400000US27	Minnesota	5611179	*****
13	0400000US30	Montana	1062305	*****
14	0400000US23	Maine	1338404	*****

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Note: The states might appear in a different order than shown above.

d. To simplify the import process in SAS Studio, make the specified changes to the downloaded CSV file in Excel.

1) To provide descriptive column names in the first row, rename **NAME** to **State** and **B01003_001E** to **TotalPopulation**.

   a) To rename **NAME** to **State**, select cell **B1** and type **State**.

   b) To rename **B01003_001E** to **TotalPopulation**, select cell **C1** and type **TotalPopulation**.

2) Delete the column containing the margin of error.

   Right-click on the column letter, **D**, and select **Delete**.

3) Delete the second row containing descriptive labels.

   Right-click on the row number, **2**, and select **Delete**.

4) Apply a format to column C containing the population estimates to display the values with commas and no decimal places.

   a) Click on the column heading **C** to highlight the entire column.

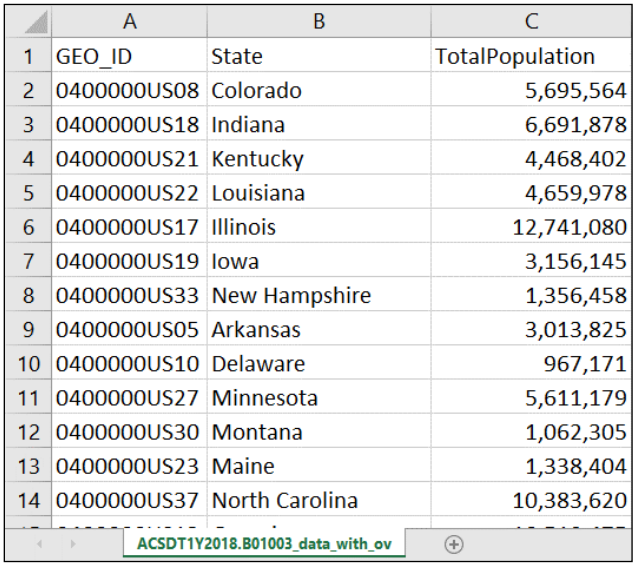
   b) Right-click anywhere in the highlighted region and select **Format Cells**.

   c) On the **Number** tab, select the **Number** category.

   d) Decrease the **Decimal places** field to **0**.

   e) Click the **Use 1000 Separator (,)** check box.

   f) Click **OK**.



	A	B	C
1	GEO_ID	State	TotalPopulation
2	0400000US08	Colorado	5,695,564
3	0400000US18	Indiana	6,691,878
4	0400000US21	Kentucky	4,468,402
5	0400000US22	Louisiana	4,659,978
6	0400000US17	Illinois	12,741,080
7	0400000US19	Iowa	3,156,145
8	0400000US33	New Hampshire	1,356,458
9	0400000US05	Arkansas	3,013,825
10	0400000US10	Delaware	967,171
11	0400000US27	Minnesota	5,611,179
12	0400000US30	Montana	1,062,305
13	0400000US23	Maine	1,338,404
14	0400000US37	North Carolina	10,383,620

Note: The states might appear in a different order than shown above.

e. Save the file as an Excel workbook named **Total Population** in a location of your choice.

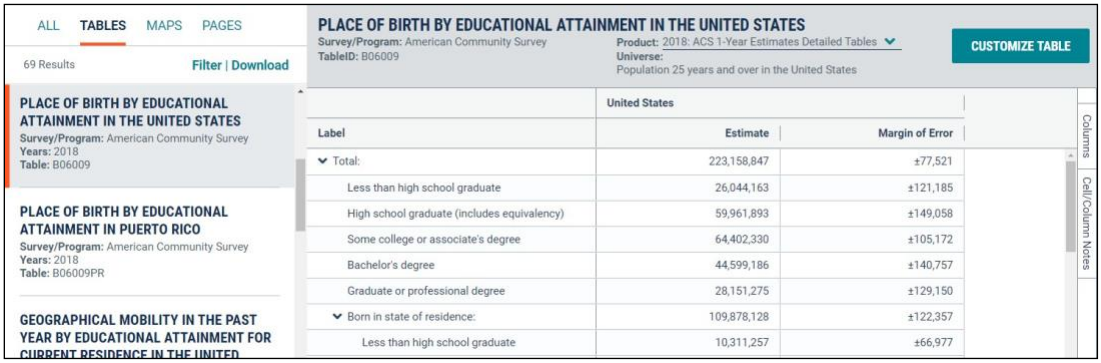
1) Select **File** ⇨ **Save As**.
2) Under **Save As**, click **Browse** and navigate to a location of your choice to save the file.
3) In the **File name** box, type **Total Population** and from the **Save as type** list, select **Excel Workbook (*.xlsx)**.
4) Click **Save**.

f. Close the **Total Population.xlsx** file.

2. Customizing and Copying Data into Excel for Import into SAS Studio

a. Go to data.census.gov. Used the advanced search to narrow the search to the year 2018 and the topic **Educational Attainment**. Select the **PLACE OF BIRTH BY EDUCATIONAL ATTAINMENT IN THE UNITED STATES** table (table ID B06009).

1) Go to data.census.gov.
2) Click on **Advanced Search**.
3) To narrow the search to the year 2018, under Browse Filters, select **Years**. Select the check box for **2018**.
4) To narrow the search to data on educational attainment, under Browse Filters, select **Topics** ⇨ **Education**. Select the check box for **Educational Attainment**.
5) Click **SEARCH**.
6) At the top of the All Results page, click **TABLES**. In the list of tables on the left, select the **PLACE OF BIRTH BY EDUCATIONAL ATTAINMENT IN THE UNITED STATES** table (table ID B06009).



b. Customize the **PLACE OF BIRTH BY EDUCATIONAL ATTAINMENT IN THE UNITED STATES** table using the specified settings.

1) Click **CUSTOMIZE TABLE**.

2) Verify that the 1-year estimates for 2018 are displayed.

   Verify that the **Product** drop-down menu is set to **2018: ACS 1-Year Estimates Detailed Tables**.

3) Display the estimates for all geographical divisions.

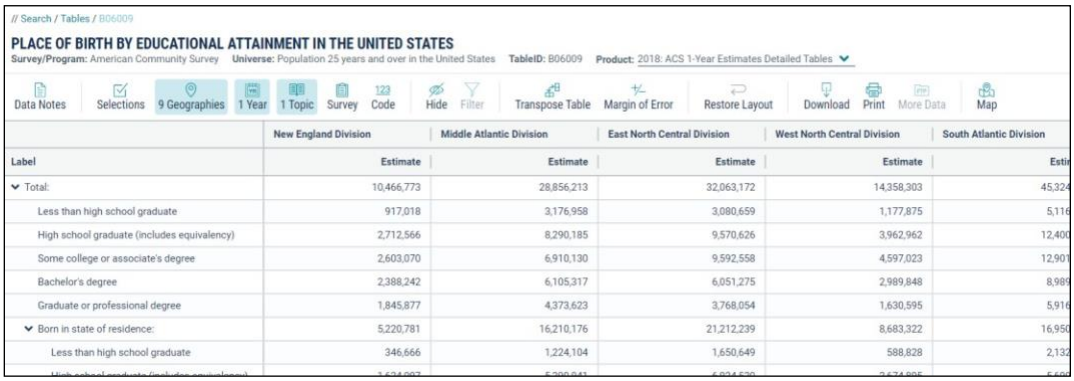
   a) On the Advanced Filters menu, select **Geographies**.

   b) Select **Division**, and then select the check box for all listed divisions, including **East North Central Division**, **East South Central Division**, **Middle Atlantic Division**, **Mountain Division**, **New England Division**, **Pacific Division**, **South Atlantic Division**, **West North Central Division**, and **West South Central Division**.

   c) Click **Close**.

4) Hide the Margin of Error columns.

   On the Advanced Filters menu, click the **Margin of Error** button to toggle off the Margin of Error columns.



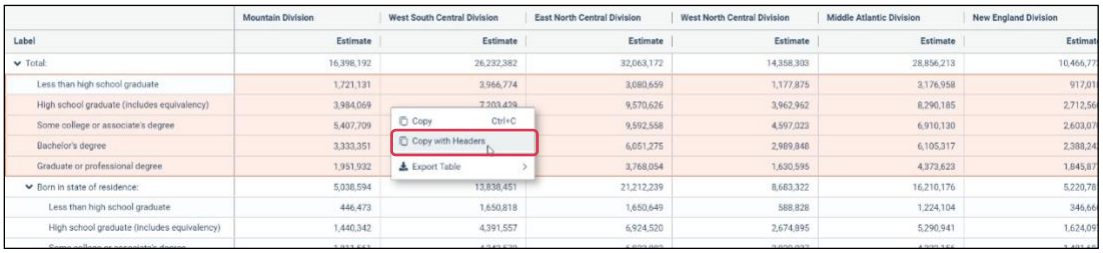
Note: The divisions might appear in a different order than shown above.

c. To extract only the total counts, under the **Total** row heading, highlight only the rows for **Less than high school graduate**, **High school graduate (includes equivalency)**, **Some college or associate's degree**, **Bachelor's degree**, and **Graduate or professional degree** for all division columns. Then copy the highlighted region with the headers.

1) Directly under the **Total** row heading, select the row heading for **Less than high school graduate** and continue holding down on your mouse button.

2) Drag your cursor down to also select the row headings for **High school graduate (includes equivalency)**, **Some college or associate's degree**, **Bachelor's degree**, and **Graduate or professional degree** and across to select all division columns.

3) Right-click anywhere in the highlighted region and select **Copy with Headers**.



Note: The divisions might appear in a different order than shown above.

d. Paste the copied cells into a new Excel workbook. Then, to simplify the import process in SAS Studio, make the specified changes to the pasted data.

1) Open Microsoft Excel.

2) Select cell **A1** and press Ctrl+V on your keyboard to paste the copied cells into the Excel workbook.

3) To optimize the view of the table, first, in the upper left corner of the worksheet, click (**Select All**) to highlight all columns. Then, on the **Home** tab, in the **Cells** group, click **Format** ⇨ **AutoFit Column Width**.

4) Rename the first column, **Label**, to **Educational_Attainment**.

Select cell **A1** and type **Educational_Attainment**.

5) Simplify the remaining column names in the first row by removing **Division / Estimate** from the end of the division names.

a) Press Ctrl+H on your keyboard to open the Find and Replace window.

b) In the **Find what:** box, type **Division / Estimate**.

c) Leave the **Replace with:** box blank.

d) Click **Replace All**. A window appears, indicating that nine replacements were made. Click **OK**.

e) Click **Close** to close the Find and Replace window.

6) Apply a format to columns B through J containing the educational attainment counts to display the values with commas and no decimal places.

a) Click the column heading **B** to highlight the entire column and continue holding down on your mouse button.

b) Drag your cursor across until columns B through J are highlighted.

c) Right-click anywhere in the highlighted region and select **Format Cells**.

d) On the **Number** tab, select the **Number** category.

e) Decrease the **Decimal places** field to **0**.

f) Select the **Use 1000 Separator (,)** check box.

g) Click **OK**.

	A	B	C	D	E	F	G	H	I	J
1	Educational_Attainment	Mountain	West South Central	East North Central	West North Central	Middle Atlantic	New England	South Atlantic	East South Central	Pacific
2	Less than high school graduate	1,721,131	3,966,774	3,080,659	1,177,875	3,176,958	917,018	5,116,012	1,702,787	5,184,949
3	High school graduate (includes equivalency)	3,984,069	7,203,429	9,570,626	3,962,962	8,290,185	2,712,566	12,400,658	4,084,382	7,753,016
4	Some college or associate's degree	5,407,709	7,563,313	9,592,558	4,597,023	6,910,130	2,603,070	12,901,313	3,867,874	10,959,340
5	Bachelor's degree	3,333,351	4,854,673	6,051,275	2,989,848	6,105,317	2,388,242	8,989,974	2,064,493	7,822,013
6	Graduate or professional degree	1,951,932	2,644,193	3,768,054	1,630,595	4,373,623	1,845,877	5,916,842	1,275,448	4,744,711

Note: The divisions might appear in a different order than shown above.

e. Save the Excel file as **Educational Attainment** in a location of your choice.

1) Select **File** ⇨ **Save As**.

2) Under **Save As**, click **Browse** and navigate to a location of your choice to save the file.

3) In the **File name** box, type **Educational Attainment**.

4) Click **Save**.

f. Close the **Educational Attainment.xlsx** file.

End of Solutions

Import Census Data into SAS® Studio

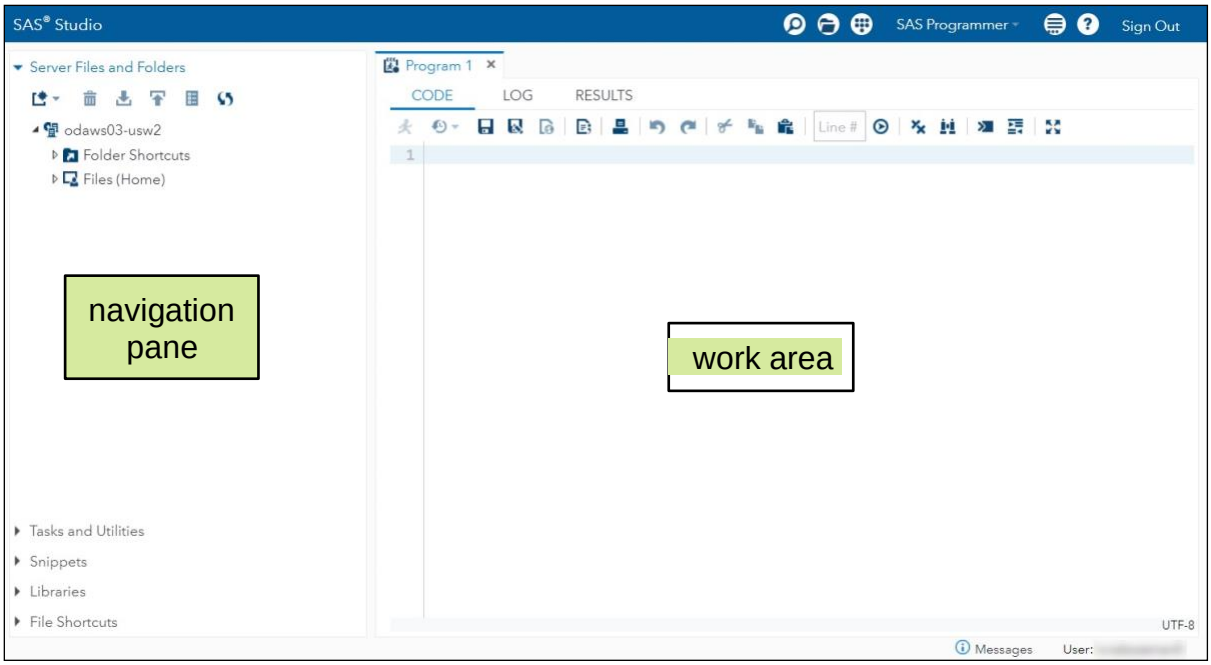
Import Census Data into SAS Studio

Important: You must perform the tutorial setup to download the necessary files and to set up your SAS Studio environment. You can follow the steps in the **Introduction to Analyzing Census Data in SAS Studio** section or watch the corresponding video.

Use the Import Data utility to import an Excel file containing data about median home values in each state into a SAS table. Then, use the table viewer in SAS Studio to explore the imported data.

1. Open SAS Studio. SAS Studio is a browser-based programming interface that connects to a local or hosted SAS server. You can write your own SAS code or use the interface to generate SAS code automatically.

   The main window of SAS Studio consists of a navigation pane on the left and a work area on the right.



   Note: This course uses SAS Studio through SAS OnDemand for Academics. However, any configuration of SAS Studio can be used.

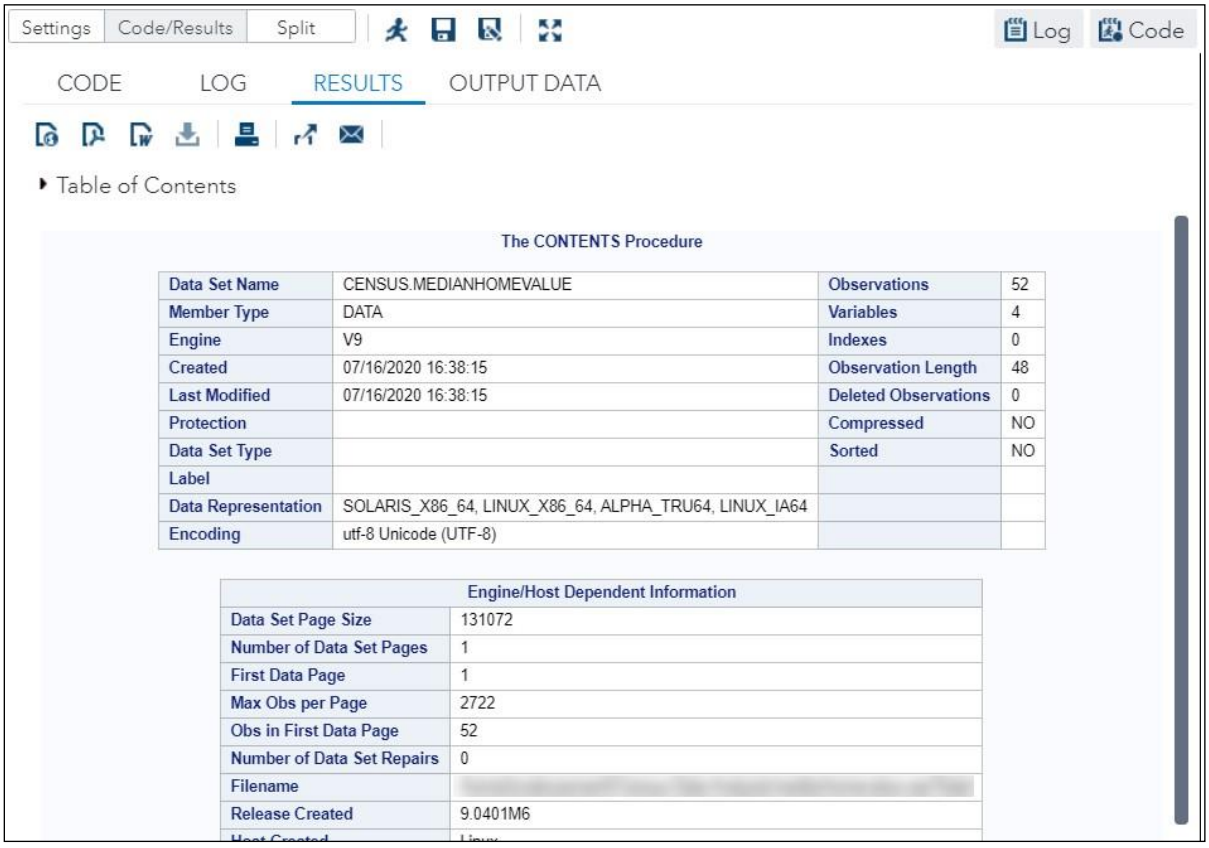
2. Before the **Median Home Value** Excel workbook can be imported, it must be uploaded to the SAS server where the processing occurs. In the **Server Files and Folders** section, select the **Census Data Analysis** folder. Then, click (**Upload**). Click **Choose Files** and navigate to and select the **Median Home Value.xlsx** file. Click **Open** ⇨ **Upload**.

   Note: If you did not complete the *Access Census Data* tutorial, you can skip this step.

3. In the **Server Files and Folders** section, expand the **Census Data Analysis** folder, right-click the **Median Home Value.xlsx** file, and select **Import Data**. The Import Data utility opens in a new tab in the work area.

   Note: If you did not complete the *Access Census Data* tutorial, you can alternatively right-click the **Median Home Value_s.xlsx** file in the **Census Data Analysis** folder and select **Import Data**.

4. The default view is **Split**, which displays both the task settings and the code/results. Click **Settings** to view only the task settings.
5. By default, SAS imports the data in the first worksheet of the Excel workbook. Therefore, the **Worksheet name** box can be left blank.
6. To specify the location to save the output table, click **Change**. From the list of libraries, select **CENSUS**. In the **Data set** box, type **medianhomevalue** and click **Save**.
7. (Optional) Use the **File type** drop-down list to select **XLSX (Microsoft Excel 2007 or later workbook)**.
8. Verify that the **Generate SAS variable names** check box is selected. With this option selected, SAS will generate SAS column names from the data values in the first row of the Excel workbook.
9. Click **Code/Results** to change the view. As you specify and modify task settings, the code will automatically be updated.
10. Click (**Run**) or press the F3 key to execute the code and import the first worksheet in the Excel workbook.
11. The **Results** tab shows the attributes of the new SAS table, **census.medianhomevalue**.

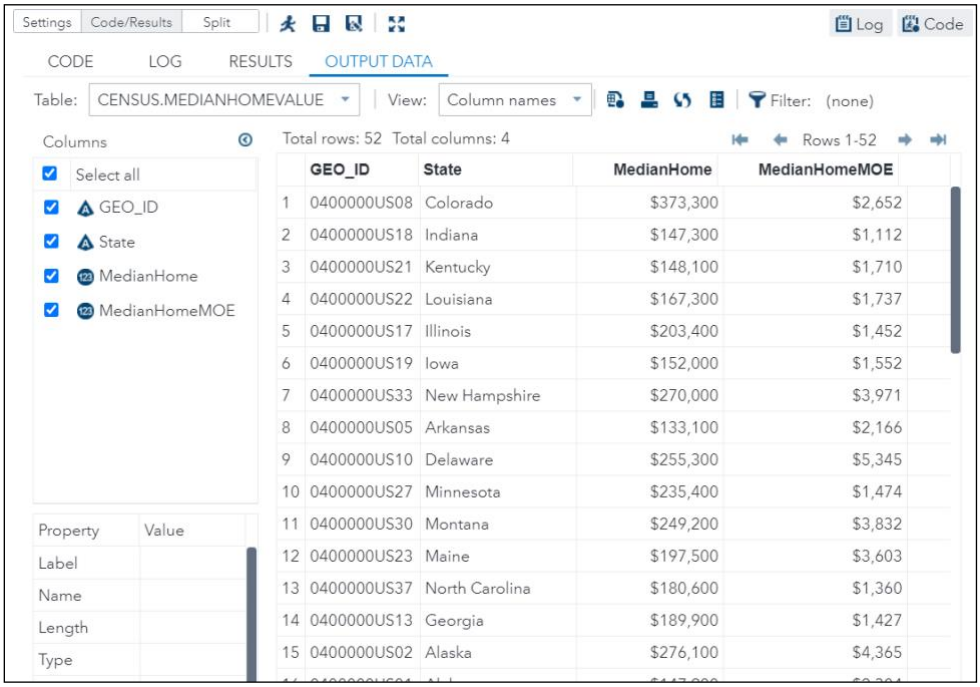


Note: Tables in libraries are referenced using a two-level naming convention: the library name, a period, and then the table name.

12. Click the **Log** tab to view the SAS log. The log displays messages from SAS.

Note: You can expand the **Errors**, **Warnings**, and **Notes** sections to view the messages. Then, click on any of the messages to the find the corresponding message in the log.

13. Click the **Output Data** tab to view the new table in the table viewer. The imported table contains 4 columns and 52 rows.



	GEO_ID	State	MedianHome	MedianHomeMOE
1	0400000US08	Colorado	$373,300	$2,652
2	0400000US18	Indiana	$147,300	$1,112
3	0400000US21	Kentucky	$148,100	$1,710
4	0400000US22	Louisiana	$167,300	$1,737
5	0400000US17	Illinois	$203,400	$1,452
6	0400000US19	Iowa	$152,000	$1,552
7	0400000US33	New Hampshire	$270,000	$3,971
8	0400000US05	Arkansas	$133,100	$2,166
9	0400000US10	Delaware	$255,300	$5,345
10	0400000US27	Minnesota	$235,400	$1,474
11	0400000US30	Montana	$249,200	$3,832
12	0400000US23	Maine	$197,500	$3,603
13	0400000US37	North Carolina	$180,600	$1,360
14	0400000US13	Georgia	$189,900	$1,427
15	0400000US02	Alaska	$276,100	$4,365

Note: To automatically resize the column widths to fit the current size of the column content, right-click any column heading and select **Size grid columns to content**. To set this option as the default, select (**More application options**) ⇨ **Preferences**. On the **General** page, click the **Size grid columns to content** check box and click **Save**.

Note: The states might appear in a different order than shown above.

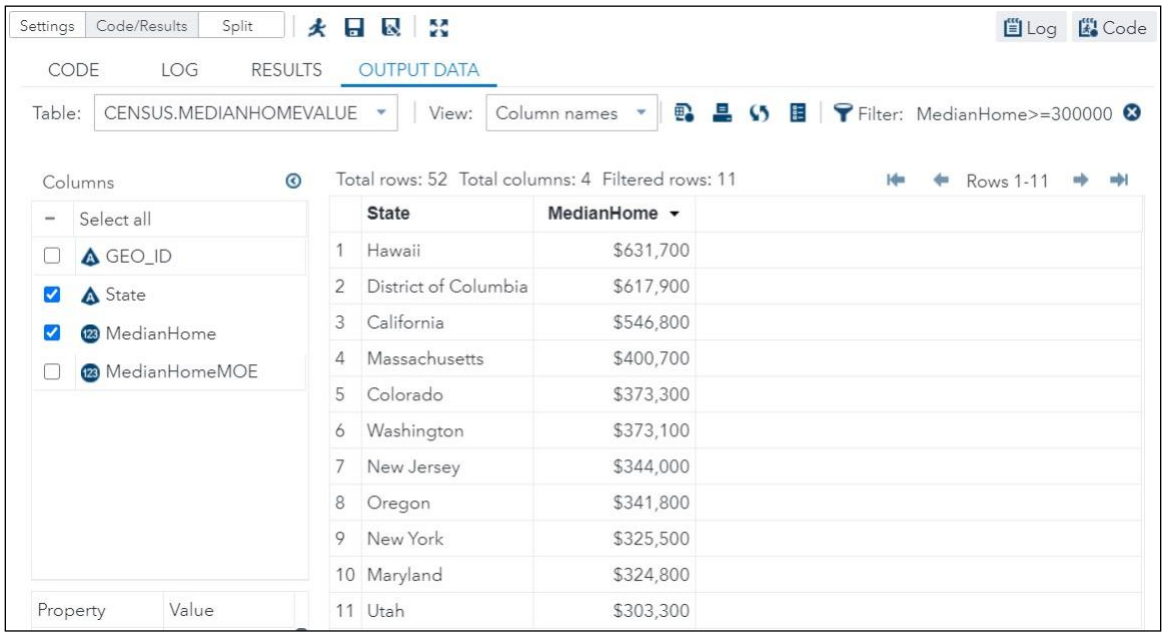
14. In the Columns area, all columns are selected by default. Clear the check boxes for **GEO_ID** and **MedianHomeMOE** to view only the **State** and **MedianHome** columns.

15. In the Columns area, click **MedianHome**. The Property area displays the column's attributes. **MedianHome** is a numeric column with the format NLMNY15. applied. Although the stored value in SAS contains only the numbers and decimal point, this format displays the value using the local currency, which includes a leading dollar sign, commas separating each set of three digits, and no decimal places, all within the allotted total width of 15.

Property	Value
Label	MedianHome
Name	MedianHome
Length	8
Type	Numeric
Format	NLMNY15.
Informat	

16. To view only the states with a median home value greater than $300,000, right-click the **MedianHome** column heading and select **Add Filter**. Change the operator to **≥** (greater than or equal to) and type **300000** with no dollar sign or comma to match the unformatted stored value. Click **Filter**.

17. To sort the values by **MedianHome**, right-click the **MedianHome** column heading again and select **Sort Descending**. The resulting table is displayed in the table viewer. Confirm that the number of filtered rows is 11, sorted in descending order by **MedianHome**, and that the filtering criterion is displayed above the table.



Note: Any customizations that are applied in the table viewer are ***not*** saved with the table. However, as you select options and customize the table, SAS Studio generates SAS code that you can use. To view the code, on the toolbar, click (**Display the code that creates the current table**). A new program window appears with the code that was used to create the view of the table. You can modify this program or save the code for later use.

18. To return the view to the original table, first, click (**Clear filter**) to remove the filter. Then, right-click the **MedianHome** column heading and select **Sort by Data Order** to remove the sort. Finally, click (**Refresh**) to view all columns.

19. Close the **Median Home Value** tab. It is not necessary to save the changes.

Note: It is not necessary to save the settings specified in the Import Data utility to save the imported data. The imported data was saved by running the utility and creating the **census.medianhome** table. To save the settings specified in the utility, click (**Save**) and provide a location and name for the instance of the Import Data utility, which will be saved as a CTL file.

End of Tutorial

Practice

Important: You must perform the tutorial setup to download the necessary files and to set up your SAS Studio environment. You can follow the steps in the **Introduction to Analyzing Census Data in SAS Studio** section or watch the corresponding video.

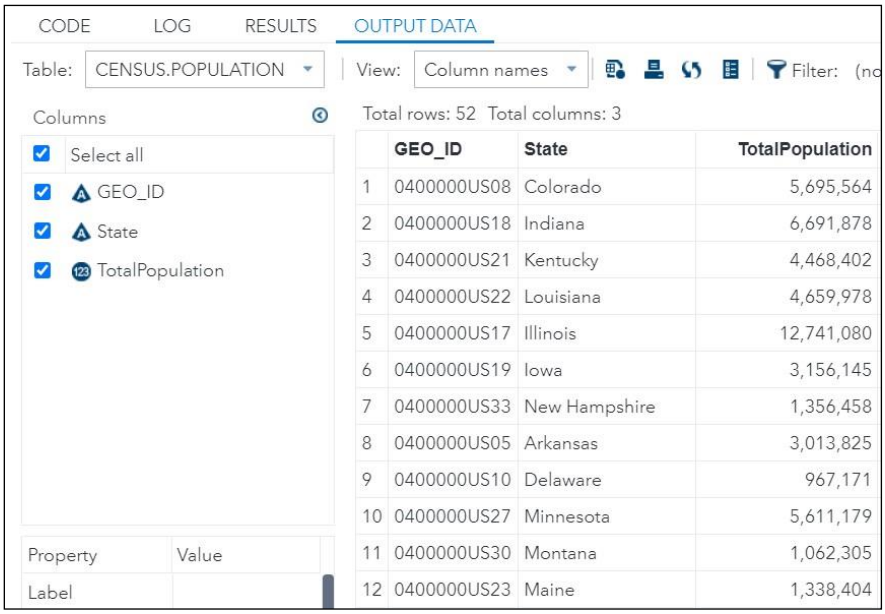
Level 1

1. Importing Population Data into SAS Studio

Use the Import Data utility to import an Excel file containing data about population estimates for each state into a SAS table. Then, use the table viewer in SAS Studio to explore the imported data.

a. Open SAS Studio. Import the **Total Population_s.xlsx** file located in the **Census Data Analysis** folder to create a SAS table named **population** in the **census** library.

Note: If you completed the Level 1 practice in the *Access Census Data* tutorial, you can alternatively upload the **Total Population.xlsx** file into your **Census Data Analysis** folder and import that data instead.



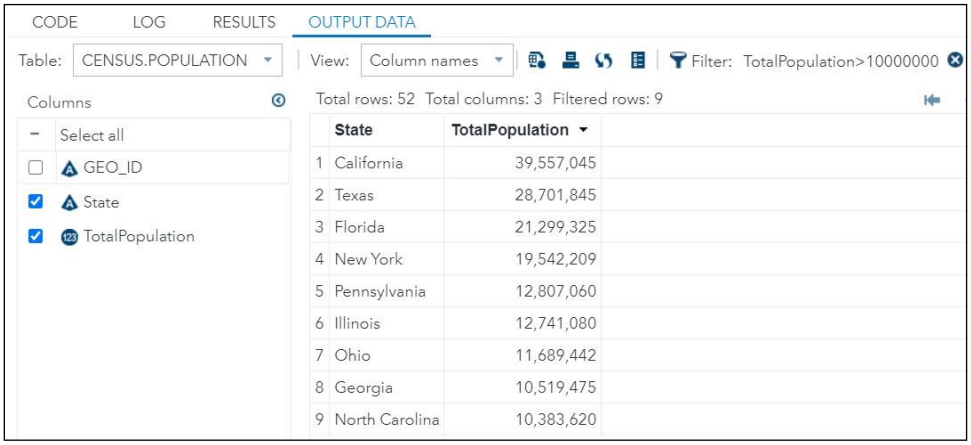
	GEO_ID	State	TotalPopulation
1	0400000US08	Colorado	5,695,564
2	0400000US18	Indiana	6,691,878
3	0400000US21	Kentucky	4,468,402
4	0400000US22	Louisiana	4,659,978
5	0400000US17	Illinois	12,741,080
6	0400000US19	Iowa	3,156,145
7	0400000US33	New Hampshire	1,356,458
8	0400000US05	Arkansas	3,013,825
9	0400000US10	Delaware	967,171
10	0400000US27	Minnesota	5,611,179
11	0400000US30	Montana	1,062,305
12	0400000US23	Maine	1,338,404

Note: The states might appear in a different order than shown above.

b. Modify the display of the **population** table in the table viewer using the following criteria:

- Display only the **State** and **TotalPopulation** columns.
- Display only the states with population estimates exceeding 10,000,000 people.
- Sort the view of the data by descending population count.

The updated view of the table contains 9 rows.



	State	TotalPopulation
1	California	39,557,045
2	Texas	28,701,845
3	Florida	21,299,325
4	New York	19,542,209
5	Pennsylvania	12,807,060
6	Illinois	12,741,080
7	Ohio	11,689,442
8	Georgia	10,519,475
9	North Carolina	10,383,620

c. Return the view to the original table by removing the filter, sorting the data back to the original data order, and restoring the **GEO_ID** column.

d. Close the **Total Population_s** tab. It is not necessary to save the changes.

Note: It is not necessary to save the settings specified in the Import Data utility to save the imported data. The imported data was saved by running the utility and creating the **census.population** table.

Challenge

2. Importing and Transposing Educational Attainment Data in SAS Studio

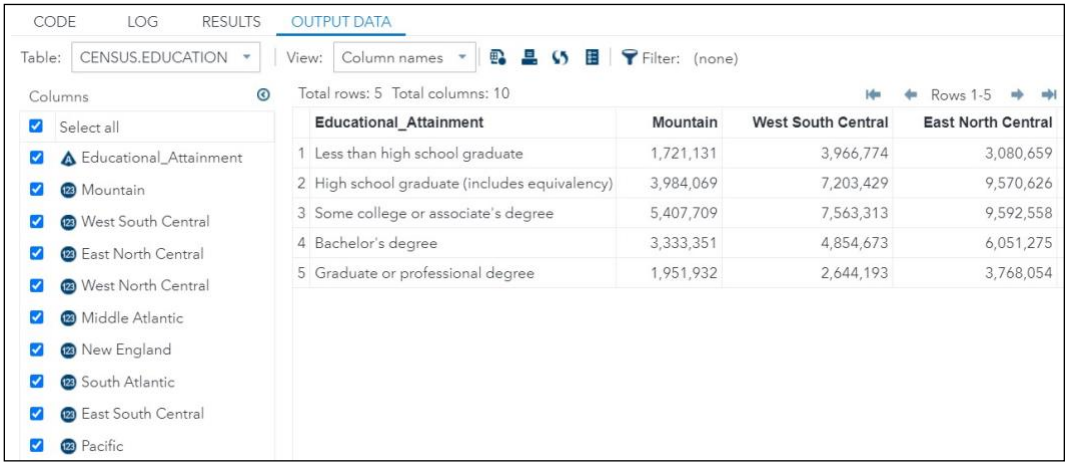
Use the Import Data utility to import an Excel file containing educational attainment counts for the population 25 years and over into a SAS table. To prepare this data for use in a bar chart, the data must be restructured to create a single numeric column containing the educational attainment counts and a single classification column identifying the geographical divisions. Use the Stack/Split Columns task to stack the division columns.

a. Open SAS Studio. Import the **Educational Attainment_s.xlsx** file located in the **Census Data Analysis** folder to create a SAS table named **education** in the **census** library.

Notice that the **education** table contains separate educational attainment count columns for each geographical division.

Note: If you completed the Challenge practice in the *Access Census Data* tutorial, you can alternatively upload the **Educational Attainment.xlsx** file into your **Census Data Analysis** folder and import that data instead.

Note: To learn more about the Census Bureau's regions and divisions, see the Census Regions and Divisions of the United States reference page.



	Educational_Attainment	Mountain	West South Central	East North Central
1	Less than high school graduate	1,721,131	3,966,774	3,080,659
2	High school graduate (includes equivalency)	3,984,069	7,203,429	9,570,626
3	Some college or associate's degree	5,407,709	7,563,313	9,592,558
4	Bachelor's degree	3,333,351	4,854,673	6,051,275
5	Graduate or professional degree	1,951,932	2,644,193	3,768,054

Note: The divisions might appear in a different order than shown above.

b. Use the Stack/Split Columns task in the Data category to stack all division columns. The resulting table will contain one column listing the geographical divisions and another listing all educational attainment counts. Use the following settings:

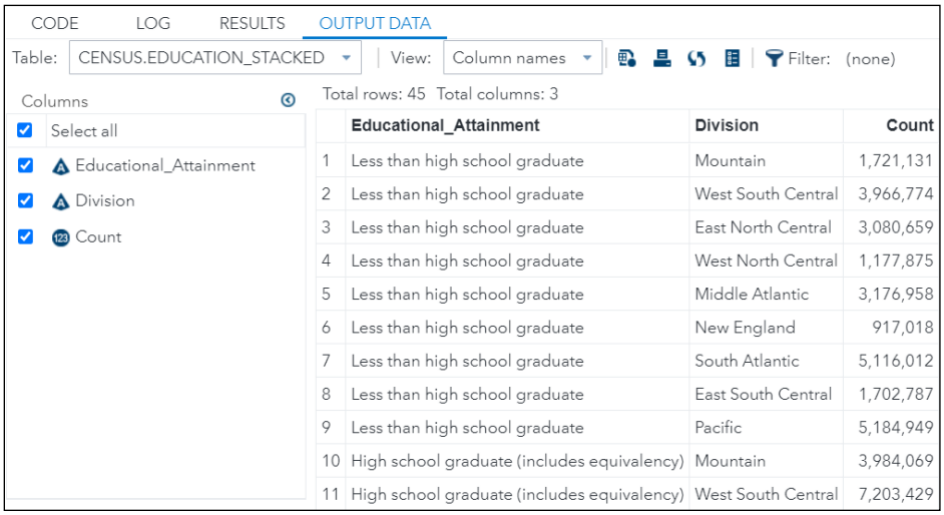
- Specify **census.education** as the input table.
- Specify all division columns as columns to stack.

  Note: When assigning columns to task roles, you can use the Ctrl key to select multiple columns.
- Save the output table as **education_stacked** in the **census** library.
- Name the new stacked column **Count**.
- Specify **Educational_Attainment** as the case identifier variable.

  Note: The case identifier variable identifies the case, which in this example is each educational attainment level.
- Name the level identifier column **Division**.

  Note: The level identifier column contains the names of the stacked columns.

The new transposed table contains 3 columns and 45 rows. The table contains one column, **Count**, containing all educational attainment counts, and another column, **Division**, identifying the geographical divisions.



	Educational_Attainment	Division	Count
1	Less than high school graduate	Mountain	1,721,131
2	Less than high school graduate	West South Central	3,966,774
3	Less than high school graduate	East North Central	3,080,659
4	Less than high school graduate	West North Central	1,177,875
5	Less than high school graduate	Middle Atlantic	3,176,958
6	Less than high school graduate	New England	917,018
7	Less than high school graduate	South Atlantic	5,116,012
8	Less than high school graduate	East South Central	1,702,787
9	Less than high school graduate	Pacific	5,184,949
10	High school graduate (includes equivalency)	Mountain	3,984,069
11	High school graduate (includes equivalency)	West South Central	7,203,429

c. Close the **Stack/Split Columns** and **Educational_Attainment_s** tabs. It is not necessary to save the changes.

Note: It is not necessary to save the settings specified in the Import Data utility or the Stack/Split Columns task to save the output data. The output data is saved by running the utility or task.

End of Practices

Solutions to Practices

1. Importing Population Data into SAS Studio

a. Open SAS Studio. Import the **Total Population_s.xlsx** file located in the **Census Data Analysis** folder to create a SAS table named **population** in the **census** library.

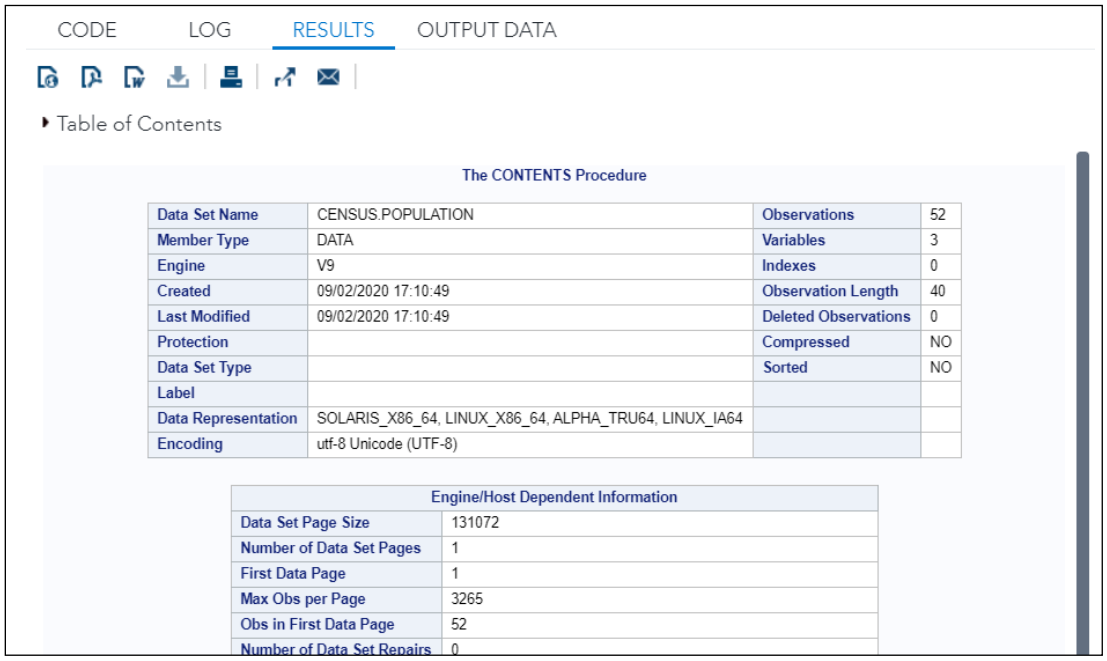
Note: If you completed the Level 1 practice in the *Access Census Data* tutorial, you can alternatively upload the **Total Population.xlsx** file into your **Census Data Analysis** folder and import that data instead. Use the following steps to upload the **Total Population.xlsx** file:

- In SAS Studio, expand the **Server Files and Folders** section.
- Navigate to and select the **Census Data Analysis** folder.
- Click  (**Upload**).
- Click **Choose Files** and navigate to and select the **Total Population.xlsx** file.
- Click **Open** ⇨ **Upload**.

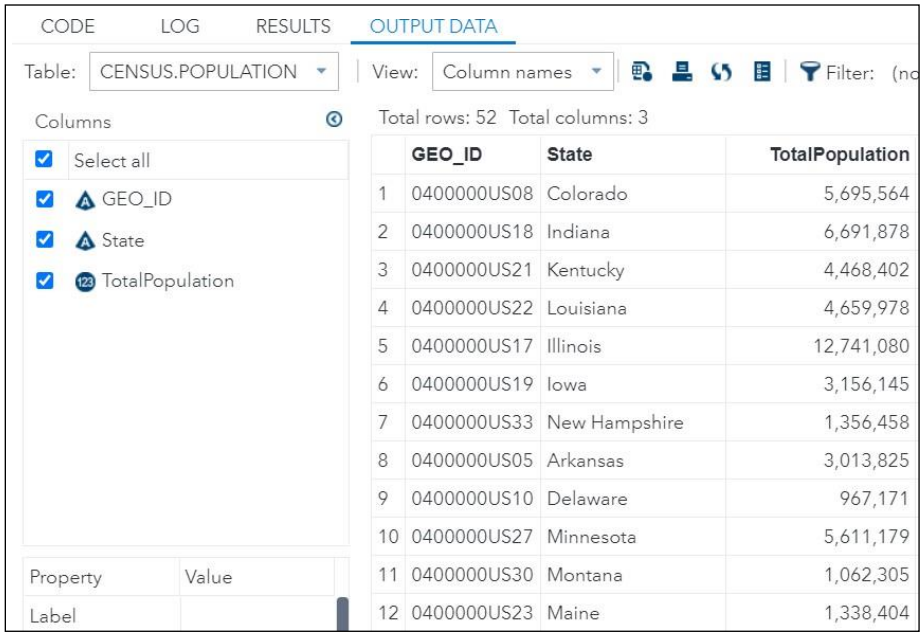
1) In SAS Studio, expand the **Server Files and Folders** section.
2) Navigate to and expand the **Census Data Analysis** folder.
3) Right-click the **Total Population_s.xlsx** file and select **Import Data**. The Import Data utility opens in a new tab in the work area.
4) Click **Settings** to view only the task settings.
5) Verify that the **Worksheet name** box is blank.
6) To specify the location to save the output table, click **Change**.
   a) From the list of libraries, select **CENSUS**.
   b) In the **Data set** box, type **population**.
   c) Click **Save**.
7) Use the **File type** drop-down list to select **XLSX (Microsoft Excel 2007 or later workbook)**.
8) Verify that the **Generate SAS variable names** check box is selected.
9) Click **Code/Results** to change the view.

10) Click (**Run**) to execute the code and import the first worksheet in the Excel workbook.

The **Results** tab shows the attributes of the new SAS table, **census.population**.



Click the **Output Data** tab to view the new table in the table viewer. The imported table contains 3 columns and 52 rows.



	GEO_ID	State	TotalPopulation
1	0400000US08	Colorado	5,695,564
2	0400000US18	Indiana	6,691,878
3	0400000US21	Kentucky	4,468,402
4	0400000US22	Louisiana	4,659,978
5	0400000US17	Illinois	12,741,080
6	0400000US19	Iowa	3,156,145
7	0400000US33	New Hampshire	1,356,458
8	0400000US05	Arkansas	3,013,825
9	0400000US10	Delaware	967,171
10	0400000US27	Minnesota	5,611,179
11	0400000US30	Montana	1,062,305
12	0400000US23	Maine	1,338,404

Note: The states might appear in a different order than shown above.

b. Modify the display of the **population** table in the table viewer using the specified criteria.

1) Display only the **State** and **TotalPopulation** columns.

On the **Output Data** tab, in the Columns area, clear the check box for **GEO_ID**.

2) Display only the states with population estimates exceeding 10,000,000 people.

a) Right-click the **TotalPopulation** column heading and select **Add Filter**.

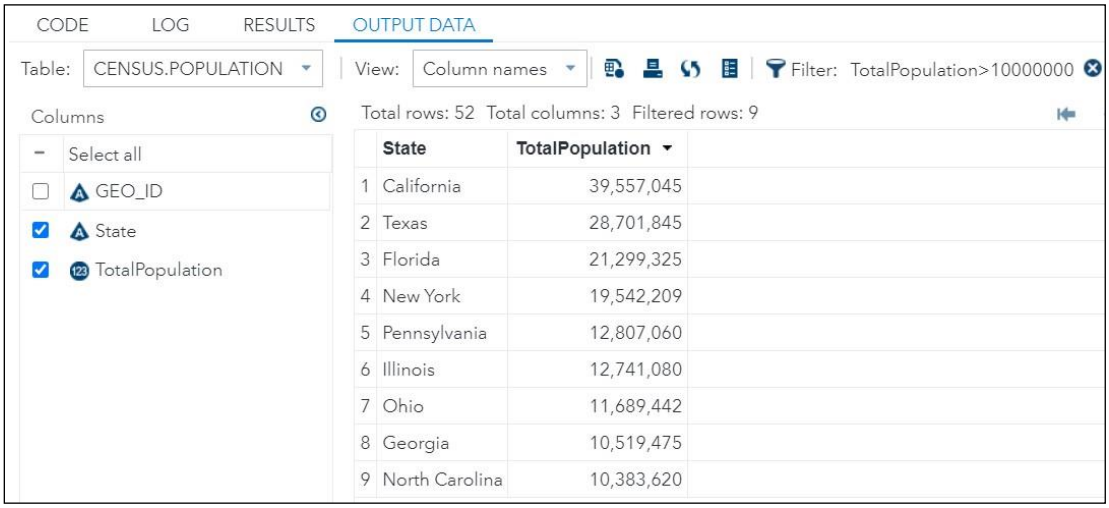
b) Change the operator to **>** (greater than) and type **10000000** with no commas to match the unformatted stored value.

c) Click **Filter**.

3) Sort the view of the data by descending population count.

Right-click the **TotalPopulation** column heading and select **Sort Descending**.

The updated view of the table contains 9 rows.



	State	TotalPopulation
1	California	39,557,045
2	Texas	28,701,845
3	Florida	21,299,325
4	New York	19,542,209
5	Pennsylvania	12,807,060
6	Illinois	12,741,080
7	Ohio	11,689,442
8	Georgia	10,519,475
9	North Carolina	10,383,620

c. Return the view to the original table by removing the filter, sorting the data back to the original data order, and restoring the **GEO_ID** column.

1) To remove the filter, click (**Clear filter**).

2) To sort the data back to the original data order, right-click the **TotalPopulation** column heading and select **Sort by Data Order**.

3) To restore the **GEO_ID** column, click (**Refresh**).

d. Close the **Total Population_s** tab. It is not necessary to save the changes.

2. Importing and Transposing Educational Attainment Data in SAS Studio

a. Open SAS Studio. Import the **Educational Attainment_s.xlsx** file located in the **Census Data Analysis** folder to create a SAS table named **education** in the **census** library.

Notice that the **education** table contains separate educational attainment count columns for each geographical division.

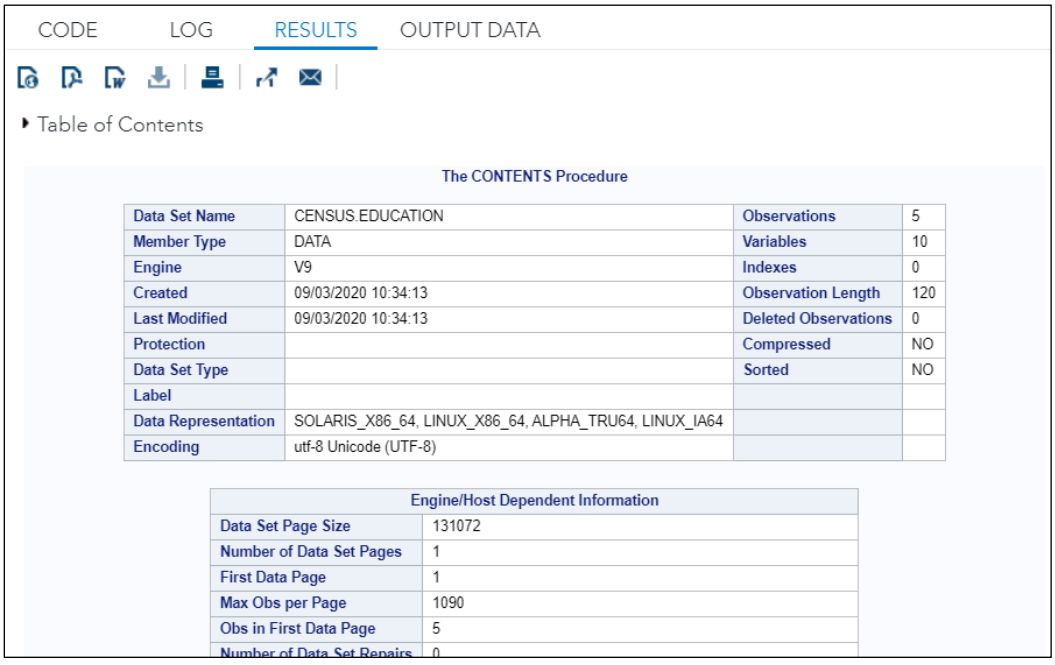
Note: If you completed the Challenge practice in the *Access Census Data* tutorial, you can alternatively upload the **Educational Attainment.xlsx** file into your **Census Data Analysis** folder and import that data instead. Use the following steps to upload the **Educational Attainment.xlsx** file:

- In SAS Studio, expand the **Server Files and Folders** section.
- Navigate to and select the **Census Data Analysis** folder.
- Click (**Upload**).

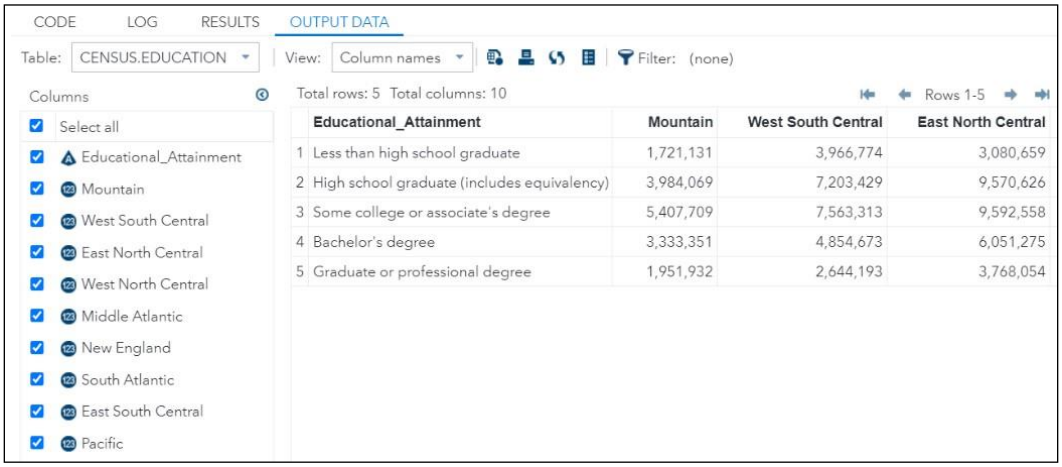
- Click **Choose Files** and navigate to and select the **Educational Attainment.xlsx** file.
- Click **Open** ⇨ **Upload**.

1) In SAS Studio, expand the **Server Files and Folders** section.
2) Navigate to and expand the **Census Data Analysis** folder.
3) Right-click the **Educational Attainment_s.xlsx** file and select **Import Data**. The Import Data utility opens in a new tab in the work area.
4) Click **Settings** to view only the task settings.
5) Verify that the **Worksheet name** box is blank.
6) To specify the location to save the output table, click **Change**.
   a) From the list of libraries, select **CENSUS**.
   b) In the **Data set** box, type **education**.
   c) Click **Save**.
7) Use the **File type** drop-down list to select **XLSX (Microsoft Excel 2007 or later workbook)**.
8) Verify that the **Generate SAS variable names** check box is selected.
9) Click **Code/Results** to change the view.
10) Click (**Run**) to execute the code and import the first worksheet in the Excel workbook.

The **Results** tab shows the attributes of the new SAS table, **census.education**.



Click the **Output Data** tab to view the new table in the table viewer. The imported table contains 10 columns and 5 rows, with separate educational attainment count columns for each geographical division.



	Educational_Attainment	Mountain	West South Central	East North Central
1	Less than high school graduate	1,721,131	3,966,774	3,080,659
2	High school graduate (includes equivalency)	3,984,069	7,203,429	9,570,626
3	Some college or associate's degree	5,407,709	7,563,313	9,592,558
4	Bachelor's degree	3,333,351	4,854,673	6,051,275
5	Graduate or professional degree	1,951,932	2,644,193	3,768,054

Note: The divisions might appear in a different order than shown above.

b. Use the Stack/Split Columns task in the Data category to stack all division columns. The resulting table will contain one column listing the geographical divisions and another listing all educational attainment counts. Use the specified settings.

1) Select the **Tasks and Utilities** section in the navigation pane.
2) Expand **Tasks** ⇨ **Data** and double-click **Stack/Split Columns** to open the task in a new tab.
3) Click **Settings** to view only the task settings.
4) Specify **census.education** as the input table.
   a) On the **Data** tab, click (**Select a table**).
   b) In the Select a Table window, expand the **CENSUS** library and select the **EDUCATION** table.
   c) Click **OK**.
5) Specify all division columns as columns to stack.
   a) From the **Method** drop-down list, select **Stack columns**.
   b) To assign columns to the **Columns to stack** role, click (**Add columns**).
   c) In the Columns window, press Ctrl+A on your keyboard to select all columns.
   d) Hold down the Ctrl key and select **Educational_Attainment** to deselect **Educational_Attainment**.
e) Verify that only the division columns are selected and click **OK**.
6) Save the output table as **education_stacked** in the **census** library.
   a) Click the **Output** tab.
   b) In the **Data set name** box, type **census.education_stacked**.
7) Name the new stacked column **Count**.

   Under the **Stacked Variable** subheading, in the **Name of new column** box, type **Count**.

8) Specify **Educational_Attainment** as the case identifier variable.

   a) Under the **Case Identifier** subheading, use the **Case identifier** drop-down list to select **Select identifier variables**.

   b) To assign a column to the **Case identifiers** role, click ➕ (**Add columns**).

   c) In the Columns window, select **Educational_Attainment**.

   d) Click **OK**.

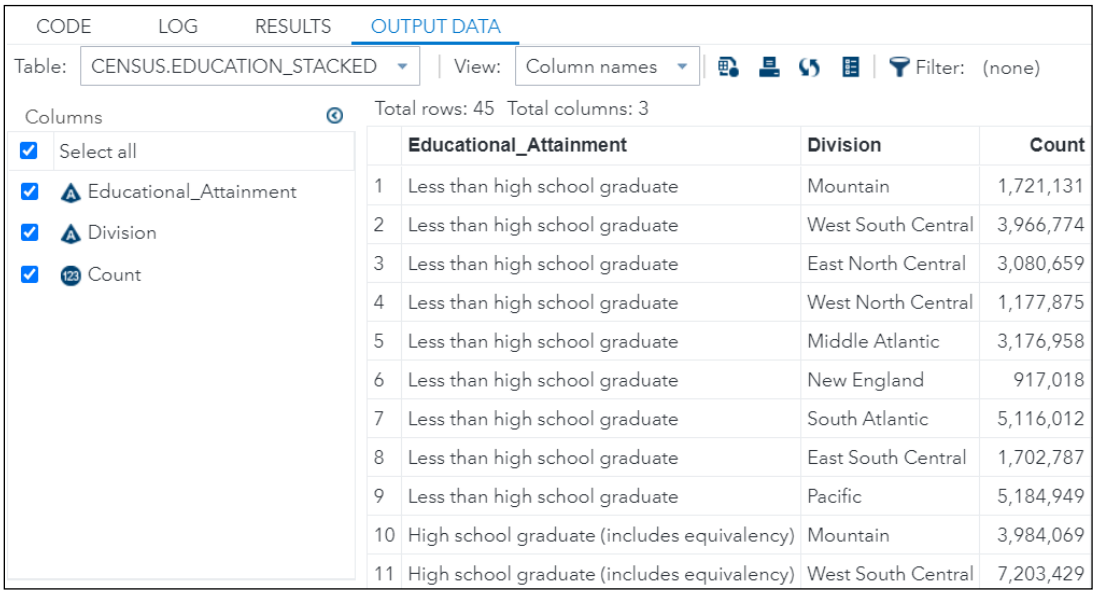
9) Name the level identifier column **Division**.

   Under the **Level Identifier** subheading, in the **Name of column containing levels of stacked columns** box, type **Division**.

10) Click **Code/Results** to change the view.

11) Click (**Run**) to execute the code and transpose the table.

   The new transposed table contains 3 columns and 45 rows. The table contains one column, **Count**, containing all educational attainment counts, and another column, **Division**, identifying the geographical divisions.



	Educational_Attainment	Division	Count
1	Less than high school graduate	Mountain	1,721,131
2	Less than high school graduate	West South Central	3,966,774
3	Less than high school graduate	East North Central	3,080,659
4	Less than high school graduate	West North Central	1,177,875
5	Less than high school graduate	Middle Atlantic	3,176,958
6	Less than high school graduate	New England	917,018
7	Less than high school graduate	South Atlantic	5,116,012
8	Less than high school graduate	East South Central	1,702,787
9	Less than high school graduate	Pacific	5,184,949
10	High school graduate (includes equivalency)	Mountain	3,984,069
11	High school graduate (includes equivalency)	West South Central	7,203,429

Note: The divisions might appear in a different order than shown above.

c. Close the **Stack/Split Columns** and **Educational_Attainment_s** tabs. It is not necessary to save the changes.

End of Solutions

Visualize Census Data in SAS® Studio

Visualize Census Data in SAS Studio

Important: You must perform the tutorial setup to download the necessary files and to set up your SAS Studio environment. You can follow the steps in the **Introduction to Analyzing Census Data in SAS Studio** section or watch the corresponding video.

Use the Bar Chart task to create a bar chart comparing median home values across states. Use options in the task to customize the appearance of the bar chart, including the labels, titles, graph image size, and reference lines. Edit the code generated by the Bar Chart task to further enhance the results.

1. Select the **Tasks and Utilities** section in the navigation pane. Expand **Tasks** ⇨ **Graph** and double-click **Bar Chart** to open the task in a new tab.

   The default view is **Split**, which displays both the task settings and the code/results.

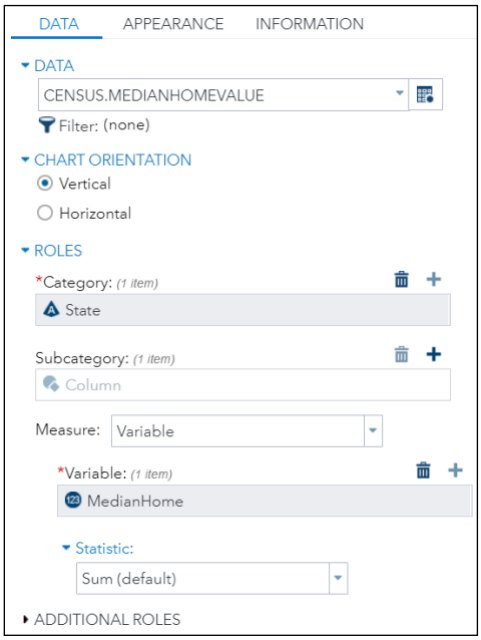
2. Click (**Maximize View**) to hide the navigation pane and maximize the work area.

3. The **Data** tab is used to define the input data source and to assign columns to task roles. To select the input data source, click (**Select a table**). In the Select a Table window, expand the **CENSUS** library. Select the **MEDIANHOMEVALUE** table and click **OK**.

   Note: If you did not complete the *Import Census Data into SAS Studio* tutorial, in the Select a Table window, you can alternatively select the **MEDIANHOMEVALUE_S** table in the **CENSUS** library.

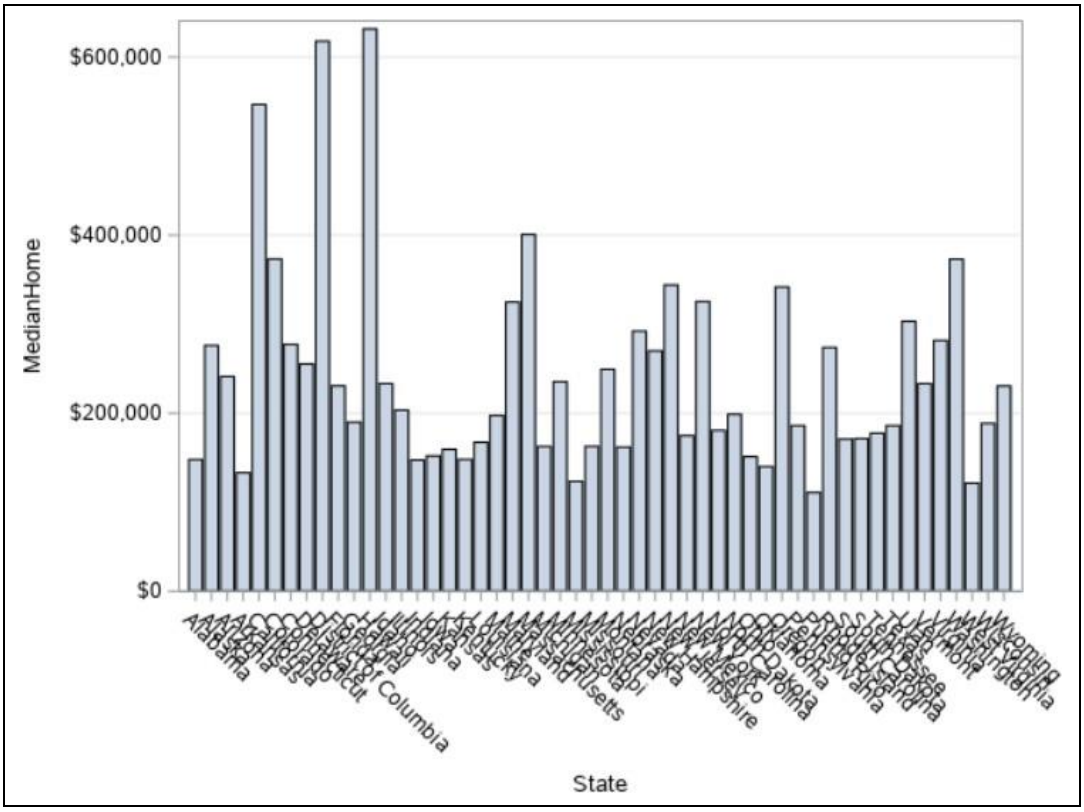
4. The **Category** role specifies the column that classifies the rows into distinct subsets. This is the only required role for the Bar Chart task, indicated by the red asterisk. To assign a column to this role, click (**Add a column**). In the Columns window, select **State** and click **OK**.

5. By default, the **Measure** role indicates that the bar heights are determined by the frequency count. To use the **MedianHome** value to determine the bar heights, use the drop-down list for **Measure** to select **Variable**. Then, to assign a column to the **Variable** role, click (**Add a column**). In the Columns window, select **MedianHome** and click **OK**. Use the default **Statistic** of **Sum**.



6. Examine the SAS program that is generated on the Code tab. The Bar Chart task generates PROC SGPLOT code behind the scenes to generate the bar chart.
7. Click (**Run**) to submit the generated code and view the bar chart on the Results tab.

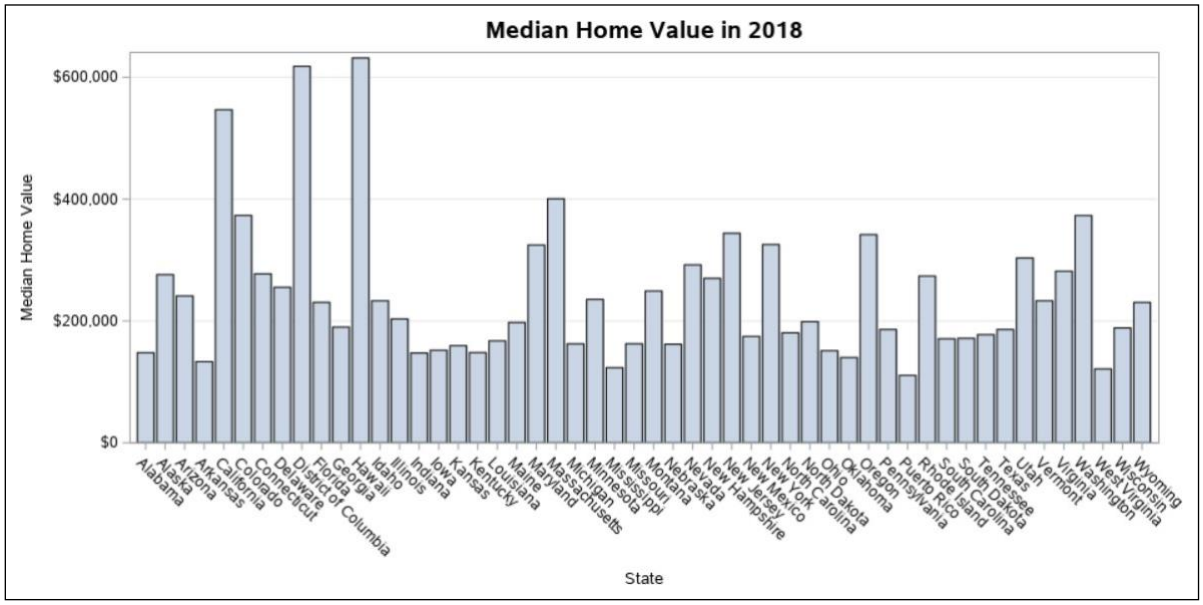
   The vertical bar chart displays the median home value for each state as a separate bar.



8. Select the **Appearance** tab to modify the appearance of the bar chart.
9. Expand the **Measure Axis** heading. From the **Display label** drop-down list, select **Custom label**. In the **Label** box, type **Median Home Value**.
10. Expand the **Title and Footnote** heading. In the **Title** box, type **Median Home Value in 2018**.
11. Expand the **Graph Size** heading. In the **Width** box, type **10**. Verify that the default value of **4.8** is used for the **Height** box.

    Note: To learn more about the available options in the Bar Chart task, see the Bar Chart page in the SAS Studio Task Reference Guide.

12. Click (**Run**) to view the updated bar chart on the Results tab.

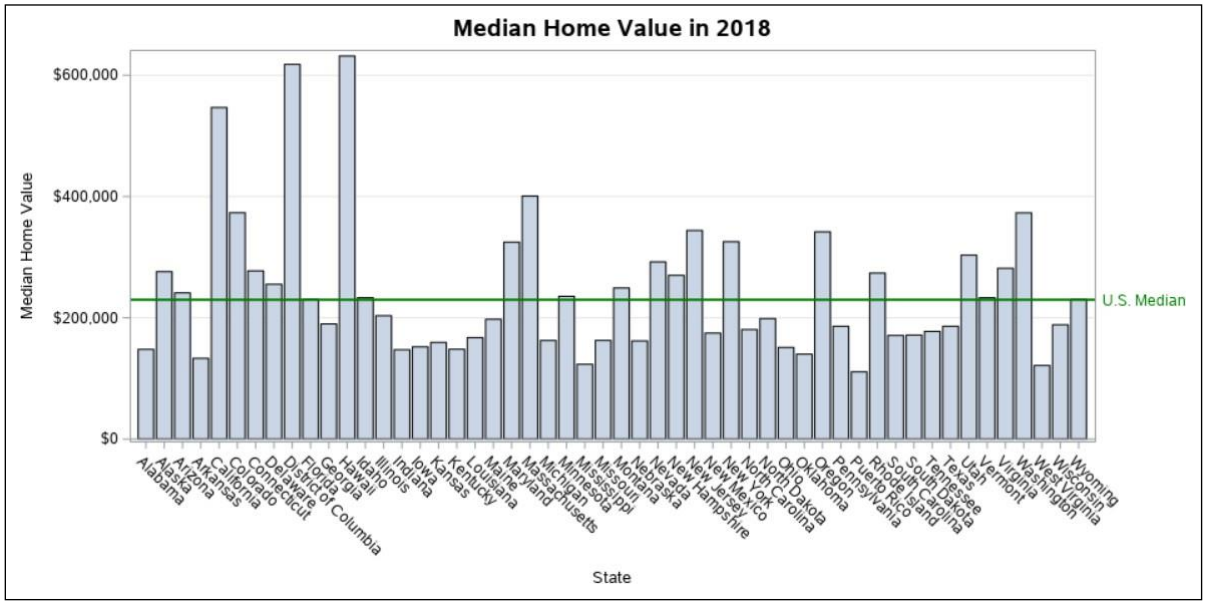


Note: When you run the Bar Chart task with the specified settings, you receive two warning messages in the log. By default, SAS Studio generates the results in the HTML5, PDF, and RTF formats. The warnings indicate that the graph width specified in the task exceeds the maximum width of eight inches allowed for the PDF and RTF formats. These warnings do not affect the results displayed on the Results tab as only the HTML5 results are shown.

13. To plot the U.S. median home value as a reference line, on a separate tab in your browser, go to data.census.gov. In the free-form single search bar, type **median home value 2018** and click **Search**. The All Results page appears. In the **Explore Data** section, notice that the 1-year estimate for the U.S. median housing value in 2018 is listed as **$229,700**.

14. Return to SAS Studio. On the **Appearance** tab, under the **Measure Axis** heading, select the **Create a reference line** check box. In the **Reference value** box, type **229700**. Select the **Custom label** option, and in the **Label** box, type **U.S. Median**.

15. Click (**Run**) to view the updated bar chart on the Results tab.

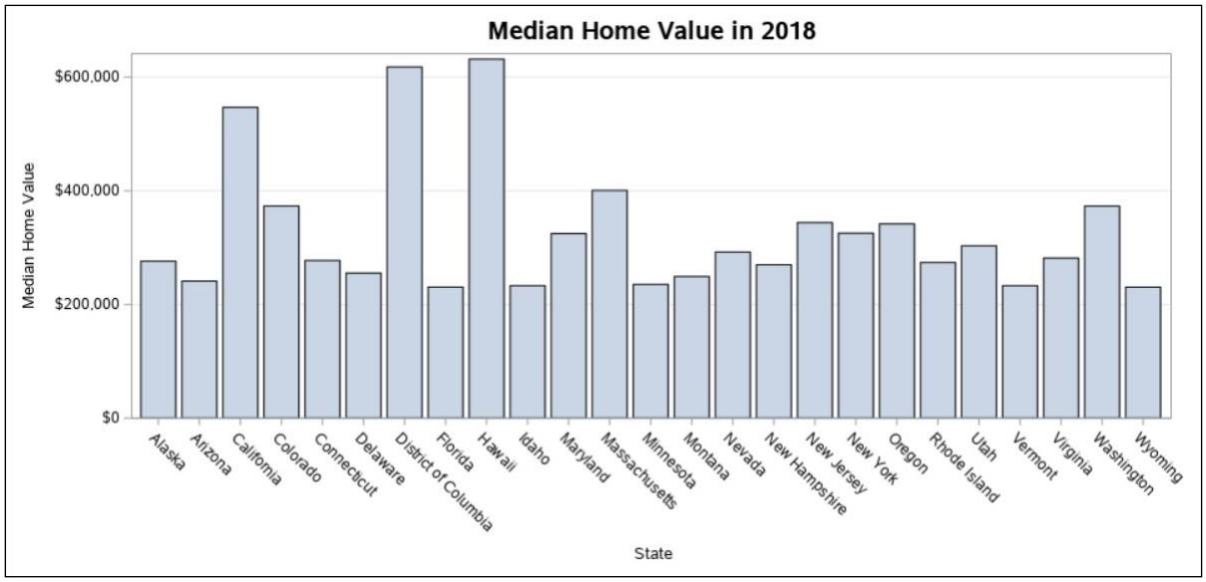


16. Alternatively, the U.S. median home value can be used to filter the states displayed in the bar chart. First, on the **Appearance** tab, under the **Measure Axis** heading, clear the **Create a reference line** check box. Then, click the **Data** tab. Under the **Data** heading, click **Filter**. In the filter expression box, type **MedianHome > 229700**. This will display only those states with median home values greater than the U.S. median value of $229,700. Click **Apply**.

    Note: For the filter expression, use the syntax for the SAS SQL procedure's WHERE clause, but do not specify the WHERE keyword. For more information about the syntax of the WHERE clause, see the WHERE Clause page in the SAS SQL Procedure User's Guide.

17. Click (**Run**) to view the updated bar chart on the Results tab.

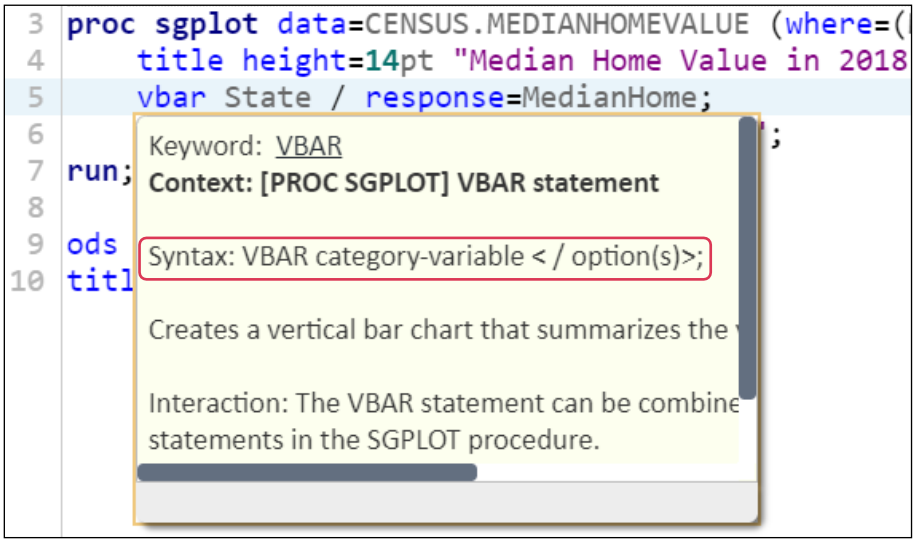
    Notice that by default, the bars are sorted in ascending, or alphabetical, order by state.



18. On the **Appearance** tab, expand the **Category Axis** heading. Notice that the options to sort the bars include **Reverse tick values** to sort the bars in reverse (descending) order by state and **Show tick values in data order** to sort the bars by the order in which the states appear in the data. There is no option in the Bar Chart task to sort the bars by the median home value.
19. The task-generated code can be modified to enhance the results with options that are not available in the Bar Chart task. Click the **Code** tab. The Bar Chart task generates PROC SGPLOT code. However, the generated program on the Code tab is read-only.

    Note: To learn more about the SGPLOT procedure code that is generated by the Bar Chart task, click the **Information** tab. Under the **Resources** heading, click **The SGPLOT Procedure** link.

20. Click **Edit** to create a modifiable copy of the program on a new tab. Right-click on the **vbar** keyword and select **Syntax Help**. The syntax help window appears with a brief description of the keyword and syntax. The VBAR statement creates a vertical bar chart that summarizes the values of a category variable. Notice that any options for the VBAR statement must follow a forward slash (/).



21. In the VBAR statement, before the semicolon, type a blank space. An autocomplete window appears with valid options for the VBAR statement.

```
3  proc sgplot data=CENSUS.MEDIANHOMEVALUE (where=(MedianHome > 229700));
4      title height=14pt "Median Home Value in 2018";
5      vbar State / response=MedianHome ;
6      yaxis grid label="Median Home Val
7  run;
8
9  ods graphics / reset;
10 title;
```

Statement Options
ALPHA=
ATTRID=
BARWIDTH=
BASELINE=
BASELINEATTRS=
CATEGORYORDER=
CLUSTERWIDTH=
COLORMODEL=
COLORRESPONSE=

22. The CATEGORYORDER= option can be used to sort the bars by the response values of median home values instead of by the category values of state names. Type **c** to highlight the CATEGORYORDER= option and press the Enter key to include the option in the program.
23. The autocomplete window appears again with a list of valid values for the CATEGORYORDER= option. Single-click on **RESPDESC** to view the syntax help window. Setting the CATEGORYORDER= option to RESPDESC sorts the bars by descending median home value. In the autocomplete window, double-click **RESPDESC** to include the value in the program. The completed VBAR statement should resemble the following:

```
vbar State / response=MedianHome categoryorder=respdesc;
```

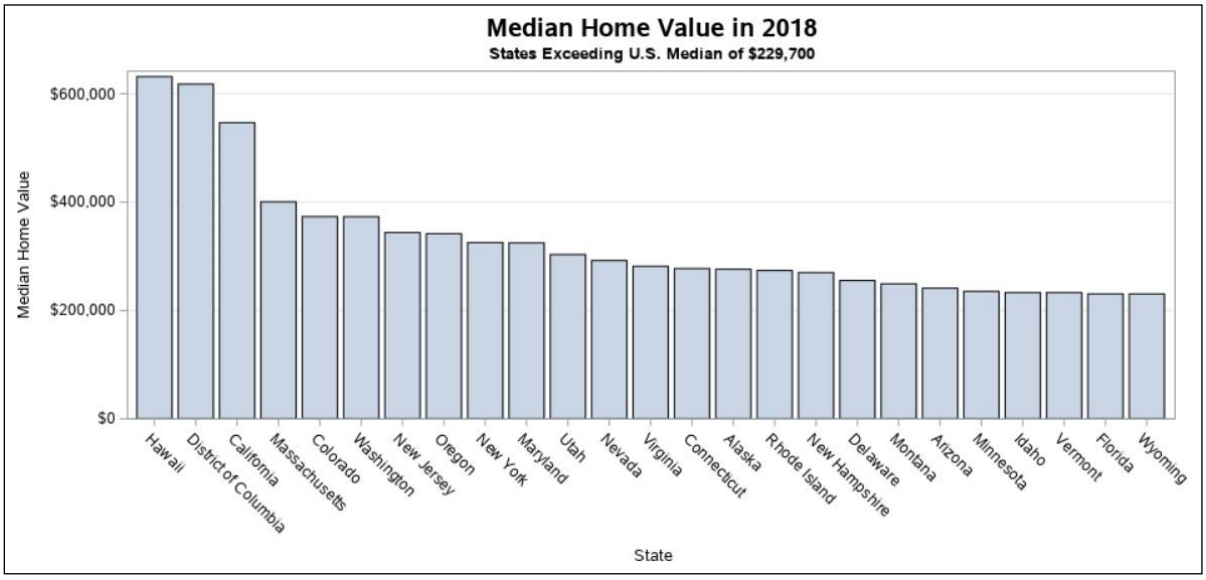
```
1  ods graphics / reset width=10in height=4.8in imagemap;
2
3  proc sgplot data=CENSUS.MEDIANHOMEVALUE (where=(MedianHome > 229700));
4      title height=14pt "Median Home Value in 2018";
5      vbar State / response=MedianHome categoryorder=respdesc;
6      yaxis grid label="Median Home Value";
7  run;
8
9  ods graphics / reset;
10 title;
```

24. Below the TITLE statement, add the following TITLE2 statement to include a secondary title explaining the filter applied:

```
title2 "States Exceeding U.S. Median of $229,700";
```

```
1  ods graphics / reset width=10in height=4.8in imagemap;
2
3  proc sgplot data=CENSUS.MEDIANHOMEVALUE (where=(MedianHome > 229700));
4      title height=14pt "Median Home Value in 2018";
5      title2 "States Exceeding U.S. Median of $229,700";
6      vbar State / response=MedianHome categoryorder=respdesc;
7      yaxis grid label="Median Home Value";
8  run;
9
10 ods graphics / reset;
11 title;
```

25. Click (**Run**) to view the updated bar chart on the Results tab.



26. By default, the results are generated in the HTML5, PDF, and RTF formats. The HTML5 results are the only results that are displayed on the Results tab. To download and then save or open the generated results, on the Results tab, click the following buttons:
    - To download the HTML5 results, click (**Download results as an HTML file**)
    - To download the PDF results, click (**Download results as a PDF file**)
    - To download the RTF results, click (**Download results as an RTF file**)

    Open and view the downloaded file, and then close the file.

27. Click (**Exit maximized view**) to restore the navigation pane.

28. Click the **Code** tab of the modified program. To save the modified SAS program, click (**Save program**). Navigate to and select the **Census Data Analysis** folder. In the **Name** box, type **Median Home Bar Sort** and click **Save**. Close the **Median Home Bar Sort.sas** tab.

29. To save the settings specified in the Bar Chart task, on the **Bar Chart** tab, click (**Save**). Navigate to and select the **Census Data Analysis** folder. In the **Name** box, type **Median Home Bar** and click **Save**. Close the **Median Home Bar.ctk** tab.

    Note: In SAS Studio, you can save a task as a CTK file.

End of Tutorial

Practice

Important: You must perform the tutorial setup to download the necessary files and to set up your SAS Studio environment. You can follow the steps in the **Introduction to Analyzing Census Data in SAS Studio** section or watch the corresponding video.

Level 1

1. Creating a Bar Chart on Population Data

Use the Bar Chart task to create a bar chart comparing population estimates across states. Use options in the task to customize the appearance of the bar chart and to filter the states displayed in the bar chart.

a. Use the Bar Chart task to create a vertical bar chart comparing population estimates across states. Use the following settings:

- Use the **population_s** table in the **census** library as the input table.

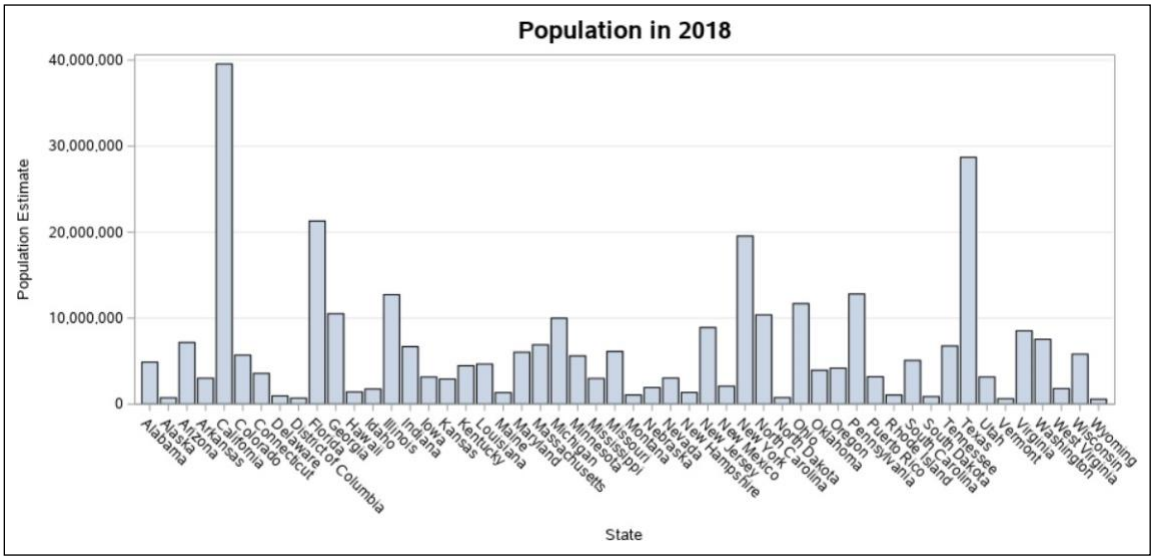
  Note: If you completed the Level 1 practice in the *Import Census Data into SAS Studio* tutorial, you can alternatively use the **population** table in the **census** library as the input table.

- Make the following task role assignments:

Category	**State**
Measure	**TotalPopulation**

- Modify the measure axis heading to display **Population Estimate**.
- Specify **Population in 2018** as the title.
- Expand the graph width to 10 inches. Use the default graph height of 4.8 inches.

The vertical bar chart displays the total population estimate for each state as a separate bar.



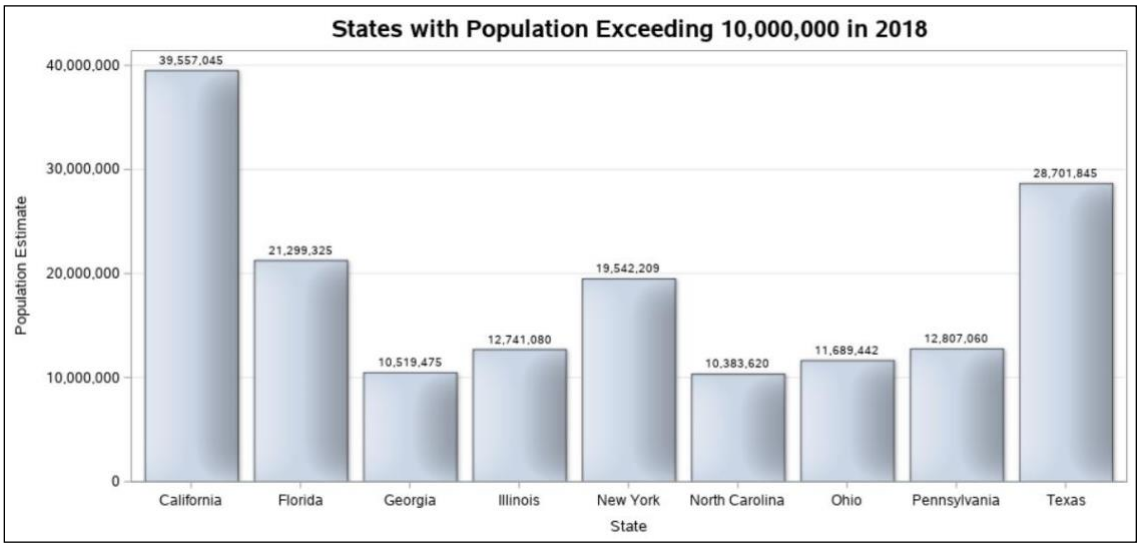
Note: When you run the Bar Chart task with the specified settings, you receive two warning messages in the log. By default, SAS Studio generates the results in the HTML5,

PDF, and RTF formats. The warnings indicate that the graph width specified in the task exceeds the maximum width of eight inches allowed for the PDF and RTF formats. These warnings do not affect the results displayed on the Results tab as only the HTML5 results are shown.

b. Modify the bar chart using the following settings:

- Filter the data to display only states with population estimates exceeding 10,000,000 people.
- Include data labels.
- Apply the matte effect to the bars.

  Hint: To specify a special effect to be used on the bars, on the **Appearance** tab, under the **Bars** heading, expand the **Details** subheading. Specify an effect using the **Effect** drop-down list.
- Change the title to **States with Population Exceeding 10,000,000 in 2018**.



c. Download the bar chart as a PDF file. After viewing the PDF file, close the file.

d. Save the settings specified in the Bar Chart task as **Population Bar Chart** in the **Census Data Analysis** folder. Then, close the **Population Bar Chart.ctk** tab.

Challenge

2. Creating a Stacked Bar Chart with Educational Attainment Data

Use the Bar Chart task to create a stacked bar chart comparing educational attainment counts for the population 25 years and over across geographical divisions. Use options in the task to customize the appearance of the bar chart. Then, edit the code generated by the Bar Chart task to create a stacked bar chart where each bar equals 100% to compare the distribution of educational attainment levels across geographical divisions.

a. Use the Bar Chart task to create a stacked vertical bar chart comparing educational attainment counts across geographical divisions. Segment the bars by educational attainment levels. Use the following settings:

- Use the **education_stacked_s** table in the **census** library as the input table.

Note: If you completed the Challenge practice in the *Import Census Data into SAS Studio* tutorial, you can alternatively use the **education_stacked** table in the **census** library as the input table.

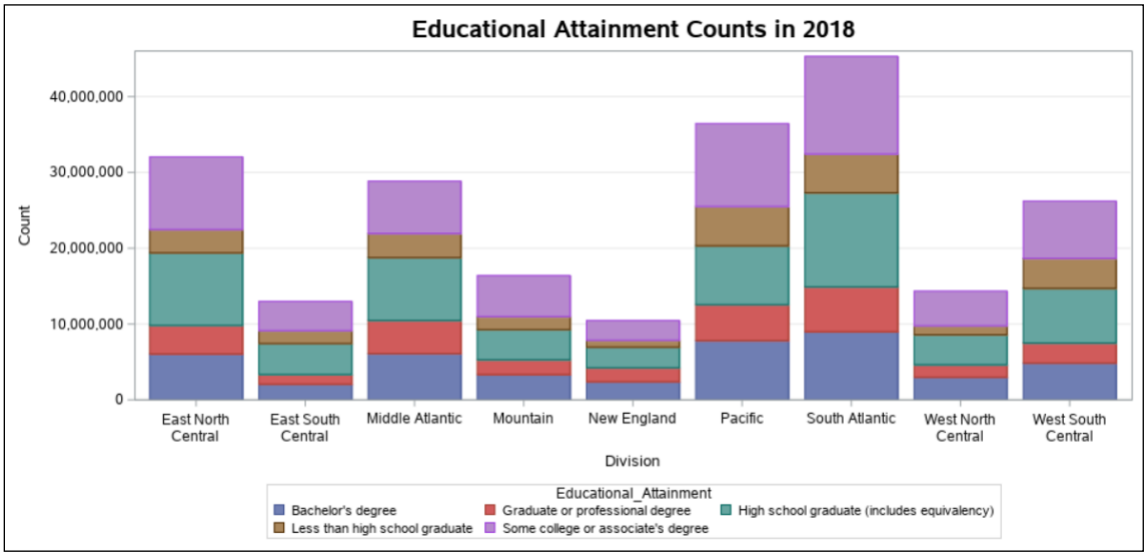
- Make the following task role assignments:

Category	**Division**
Subcategory	**Educational_Attainment** (stacked on one another)
Measure	**Count**

Note: To learn more about the Census Bureau's regions and divisions, see the Census Regions and Divisions of the United States reference page.

- Modify the category axis heading to display **Division**.
- Modify the measure axis heading to display **Count**.
- Specify **Educational Attainment Counts in 2018** as the title.
- Expand the graph width to 10 inches. Use the default graph height of 4.8 inches.

The stacked bar chart displays the educational attainment counts for each geographical division. Each educational attainment level is represented as a separate color.



Note: When you run the Bar Chart task with the specified settings, you receive two warning messages in the log. By default, SAS Studio generates the results in the HTML5, PDF, and RTF formats. The warnings indicate that the graph width specified in the task exceeds the maximum width of eight inches allowed for the PDF and RTF formats. These warnings do not affect the results displayed on the Results tab as only the HTML5 results are shown.

b. Modify the task-generated code to create a stacked bar chart where each bar equals 100%.

1) Create a modifiable copy of the task-generated program.

2) To create a stacked bar chart where each bar equals 100%, first add the STAT= option with a value of PERCENT to the VBAR statement. This specifies to use the percentage of the sum of **Count** as the statistic for the vertical axis. Then, use the PCTLEVEL= option with a value of GROUP in the PROC SGPLOT statement. With the STAT=PERCENT option, this specifies that the percentages within each division round up to 100%.

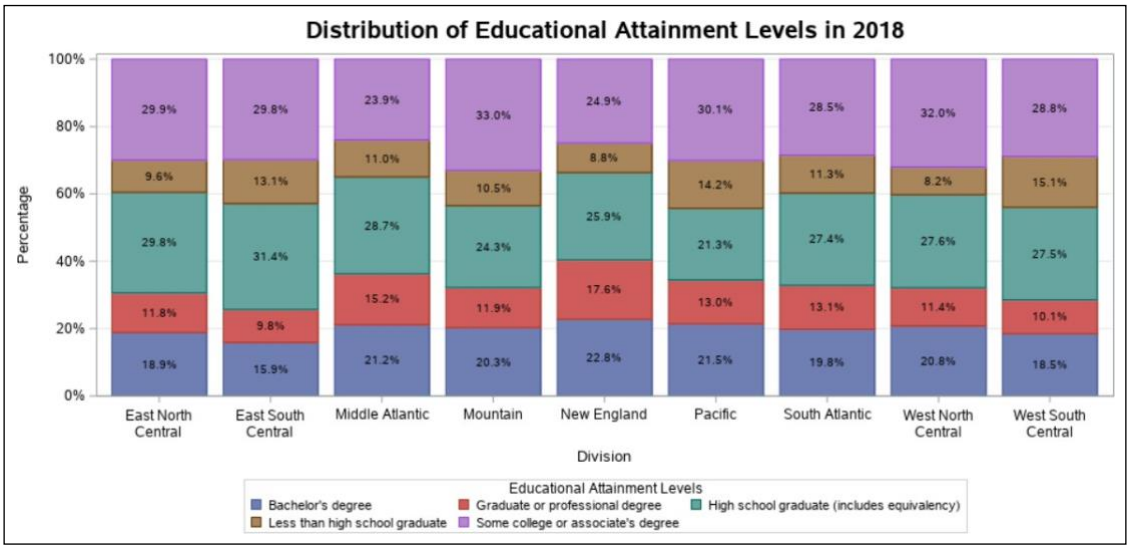
3) Use the SEGLABEL option in the VBAR statement to display the data label inside each segment of a stacked bar.

4) Add a KEYLEGEND statement with the TITLE= option in the PROG SGPLOT step to modify the legend title to **Educational Attainment Levels**.

   Hint: Options such as the TITLE= option in the KEYLEGEND statement must follow a forward slash (/).

5) Modify the measure axis heading to display **Percentage** and the title to display **Distribution of Educational Attainment Levels in 2018**.

   Hint: To modify the measure axis heading, modify the LABEL= option in the YAXIS statement.



c. Download the bar chart as a PDF file. After viewing the PDF file, close the file.

d. Save the modified SAS program as **Education Bar Chart** in the **Census Data Analysis** folder. Then, close the **Education Bar Chart.sas** and **Bar Chart** tabs. It is not necessary to save the settings specified in the Bar Chart task.

End of Practices

Solutions to Practices

1. Creating a Bar Chart on Population Data

a. Use the Bar Chart task to create a vertical bar chart comparing population estimates across states. Use the specified settings.

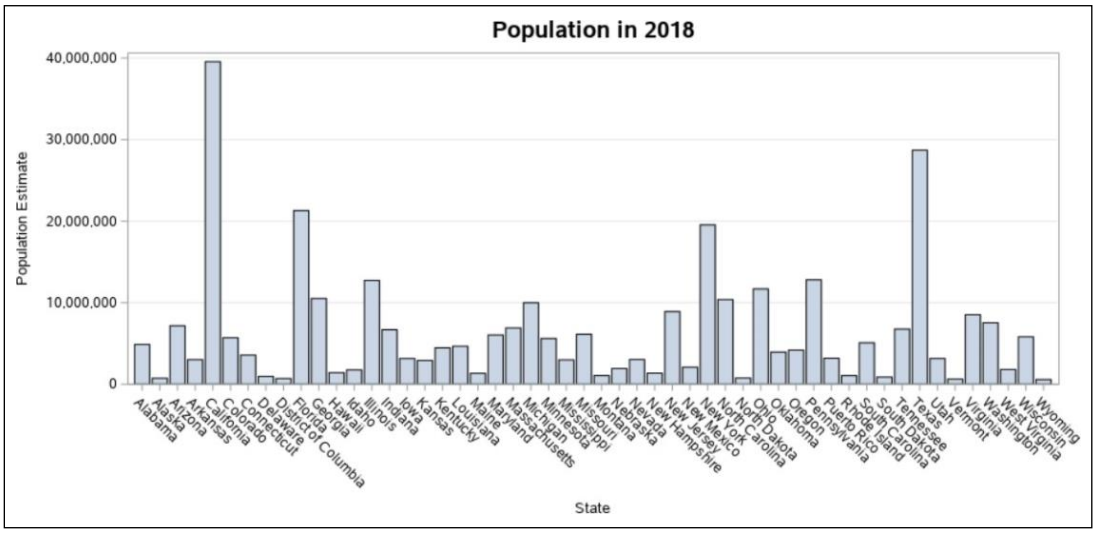
1) In SAS Studio, select the **Tasks and Utilities** section in the navigation pane.
2) Expand **Tasks** ⇨ **Graph** and double-click **Bar Chart** to open the task in a new tab.
3) Click (**Maximize View**) to hide the navigation pane and maximize the work area.
4) Use the **population_s** table in the **census** library as the input table.
   a) On the **Data** tab, click (**Select a table**).
   b) In the Select a Table window, expand the **CENSUS** library and select the **POPULATION_S** table.

      Note: If you completed the Level 1 practice in the *Import Census Data into SAS Studio* tutorial, you can alternatively use the **population** table in the **census** library as the input table.

   c) Click **OK**.
5) Make the specified task role assignments.
   a) To assign a column to the **Category** role, click (**Add a column**).
   b) In the Columns window, select **State**.
   c) Click **OK**.
   d) Use the drop-down list for **Measure** to select **Variable**.
      (1) To assign a column to the **Variable** role, click (**Add a column**).
      (2) In the Columns window, select **TotalPopulation**.
      (3) Click **OK**.
      (4) Use the default **Statistic** of **Sum**.
6) Click the **Appearance** tab.
7) Modify the measure axis heading to display **Population Estimate**.
   a) Expand the **Measure Axis** heading.
   b) From the **Display label** drop-down list, select **Custom label**.
   c) In the **Label** box, type **Population Estimate**.
8) Specify **Population in 2018** as the title.
   a) Expand the **Title and Footnote** heading.
   b) In the **Title** box, type **Population in 2018**.
9) Expand the graph width to 10 inches. Use the default graph height of 4.8 inches.
   a) Expand the **Graph Size** heading.
   b) In the **Width** box, type **10**.
   c) Verify that the default value of **4.8** is used for the **Height** box.

10) Click (**Run**) to submit the generated code and view the bar chart on the Results tab.

The vertical bar chart displays the total population estimate for each state as a separate bar.



Note: When you run the Bar Chart task with the specified settings, you receive two warning messages in the log. By default, SAS Studio generates the results in the HTML5, PDF, and RTF formats. The warnings indicate that the graph width specified in the task exceeds the maximum width of eight inches allowed for the PDF and RTF formats. These warnings do not affect the results displayed on the Results tab as only the HTML5 results are shown.

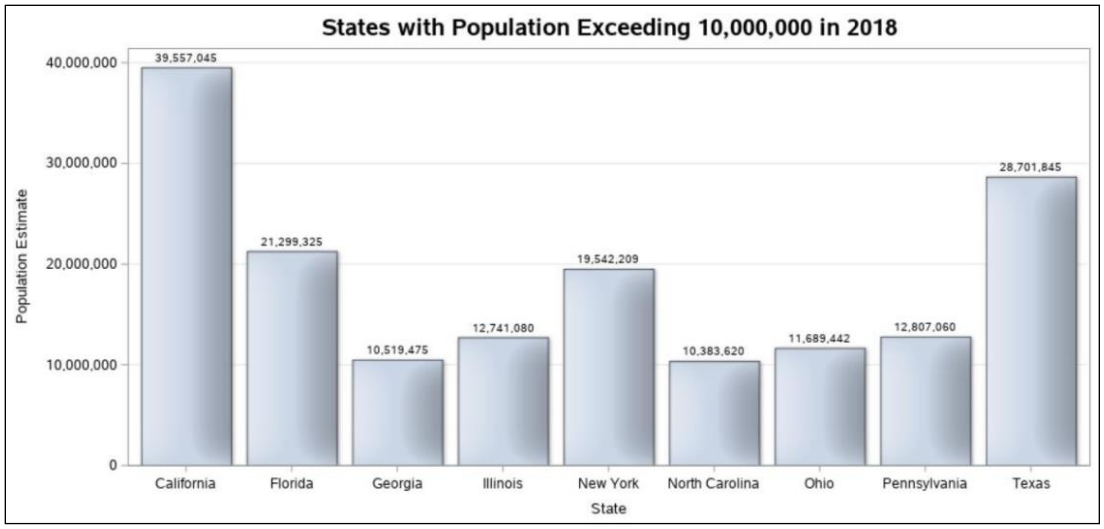
b. Modify the bar chart using the specified settings.

1) Filter the data to display only states with population estimates exceeding 10,000,000 people.
   a) Select the **Data** tab.
   b) Under the **Data** heading, click **Filter**.
   c) In the filter expression box, type **TotalPopulation > 10000000**.
   d) Click **Apply**.
2) Select the **Appearance** tab.
3) Include data labels.

   Under the **Bars** heading, select the **Show labels** check box.
4) Apply the matte effect to the bars.
   a) Under the **Bars** heading, expand the **Details** subheading.
   b) From the **Effect** drop-down list, select **Matte**.
5) Change the title to **States with Population Exceeding 10,000,000 in 2018**.

   Under the **Title and Footnote** heading, replace the text in the **Title** box with **States with Population Exceeding 10,000,000 in 2018**.

6) Click (**Run**) to view the updated bar chart on the Results tab.



c. Download the bar chart as a PDF file. After viewing the PDF file, close the file.

1) On the Results tab, click (**Download results as a PDF file**).
2) Open and view the downloaded PDF file.
3) Close the file.

d. Save the settings specified in the Bar Chart task as **Population Bar Chart** in the **Census Data Analysis** folder. Then, close the **Population Bar Chart.ctk** tab.

1) Click (**Save**).
2) Navigate to and select the **Census Data Analysis** folder.
3) In the **Name** box, type **Population Bar Chart**.
4) Click **Save**.
5) Click (**Exit maximized view**) to restore the navigation pane.
6) Close the **Population Bar Chart.ctk** tab.

2. Creating a Stacked Bar Chart with Educational Attainment Data

a. Use the Bar Chart task to create a stacked vertical bar chart comparing educational attainment counts across geographical divisions. Segment the bars by educational attainment levels. Use the specified settings.

1) In SAS Studio, select the **Tasks and Utilities** section in the navigation pane.
2) Expand **Tasks** ⇨ **Graph** and double-click **Bar Chart** to open the task in a new tab.
3) Click (**Maximize View**) to hide the navigation pane and maximize the work area.
4) Use the **education_stacked_s** table in the **census** library as the input table.
   a) On the **Data** tab, click (**Select a table**).
   b) In the Select a Table window, expand the **CENSUS** library and select the **EDUCATION_STACKED_S** table.

Note: If you completed the Challenge practice in the *Import Census Data into SAS Studio* tutorial, you can alternatively use the **education_stacked** table in the **census** library as the input table.

c) Click **OK**.

5) Make the specified task role assignments.

a) To assign a column to the **Category** role, click ➕ (**Add a column**).

(1) In the Columns window, select **Division**.

(2) Click **OK**.

b) To assign a column to the **Subcategory** role, click ➕ (**Add a column**).

(1) In the Columns window, select **Educational_Attainment**.

(2) Click **OK**.

(3) Under the **Options** subheading, for the **Display grouped bars** option, select **Stacked on one another**.

c) Use the drop-down list for **Measure** to select **Variable**.

(1) To assign a column to the **Variable** role, click ➕ (**Add a column**).

(2) In the Columns window, select **Count**.

(3) Click **OK**.

(4) Use the default **Statistic** of **Sum**.

6) Click the **Appearance** tab.

7) Modify the category axis heading to display **Division**.

a) Expand the **Category Axis** heading.

b) From the **Display label** drop-down list, select **Custom label**.

c) In the **Label** box, type **Division**.

8) Modify the measure axis heading to display **Count**.

a) Expand the **Measure Axis** heading.

b) From the **Display label** drop-down list, select **Custom label**.

c) In the **Label** box, type **Count**.

9) Specify **Educational Attainment Counts in 2018** as the title.

a) Expand the **Title and Footnote** heading.

b) In the **Title** box, type **Educational Attainment Counts in 2018**.

10) Expand the graph width to 10 inches. Use the default graph height of 4.8 inches.

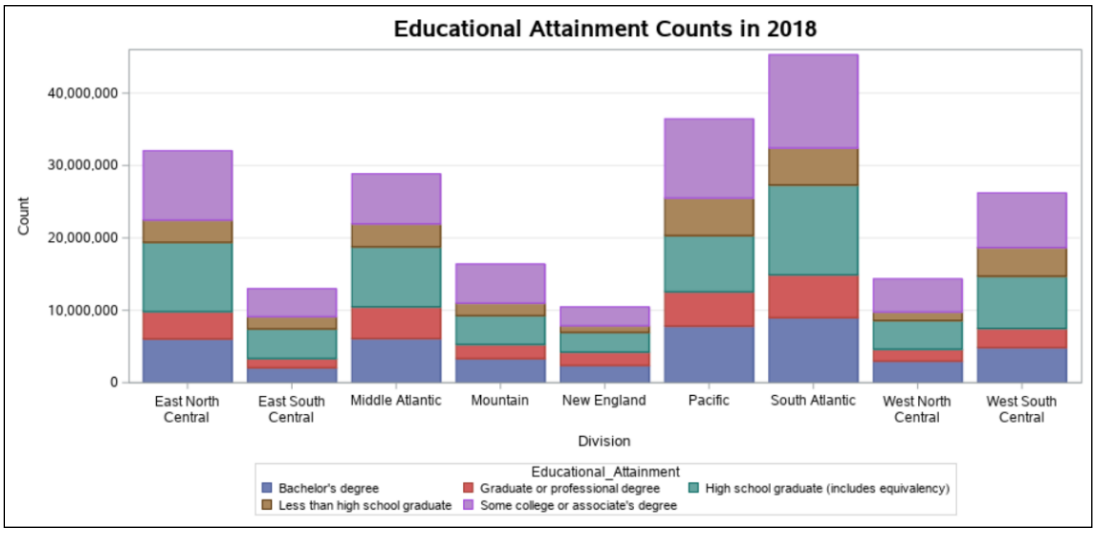
a) Expand the **Graph Size** heading.

b) In the **Width** box, type **10**.

c) Verify that the default value of **4.8** is used for the **Height** box.

11) Click (**Run**) to submit the generated code and view the bar chart on the Results tab.

The stacked bar chart displays the educational attainment counts for each geographical division. Each educational attainment level is represented as a separate color.



Note: When you run the Bar Chart task with the specified settings, you receive two warning messages in the log. By default, SAS Studio generates the results in the HTML5, PDF, and RTF formats. The warnings indicate that the graph width specified in the task exceeds the maximum width of eight inches allowed for the PDF and RTF formats. These warnings do not affect the results displayed on the Results tab as only the HTML5 results are shown.

b. Modify the task-generated code to create a stacked bar chart where each bar equals 100%.

1) Create a modifiable copy of the task-generated program.

a) Click the **Code** tab.

b) Click **Edit**. A modifiable copy of the program opens in a new tab.

2) To create a stacked bar chart where each bar equals 100%, first, add the STAT= option with a value of PERCENT to the VBAR statement. This specifies to use the percentage of the sum of **Count** as the statistic for the vertical axis. Then, use the PCTLEVEL= option with a value of GROUP in the PROC SGPLOT statement. With the STAT=PERCENT option, this specifies that the percentages within each division round up to 100%.

a) Type or use autocomplete to include the STAT=PERCENT option in the VBAR statement after the forward slash (/).

```
vbar Division / response=Count
                group=Educational_Attainment
                groupdisplay=stack stat=percent;
```

b) Type or use autocomplete to include the PCTLEVEL=GROUP option in the PROC SGPLOT statement.

```
proc sgplot data=CENSUS.EDUCATION_STACKED_S
            pctlevel=group;
```

3) Use the SEGLABEL option in the VBAR statement to display the label inside each segment of a stacked bar.

Type or use autocomplete to include the SEGLABEL option in the VBAR statement after the forward slash (/).

```
vbar Division / response=Count
                group=Educational_Attainment
                groupdisplay=stack stat=percent seglabel;
```

4) Add a KEYLEGEND statement with the TITLE= option in the PROC SGPLOT step to modify the legend title to **Educational Attainment Levels**.

Type or use autocomplete to include a KEYLEGEND statement with the TITLE= option.

```
keylegend / title="Educational Attainment Levels";
```

5) Modify the measure axis heading to display **Percentage** and the title to display **Distribution of Educational Attainment Levels in 2018**.

a) In the YAXIS statement, modify the LABEL= option to display **Percentage**.

```
yaxis grid label="Percentage";
```

b) Modify the TITLE statement to display the title **Distribution of Educational Attainment Levels in 2018**.

```
title height=14pt "Distribution of Educational Attainment
                   Levels in 2018";
```

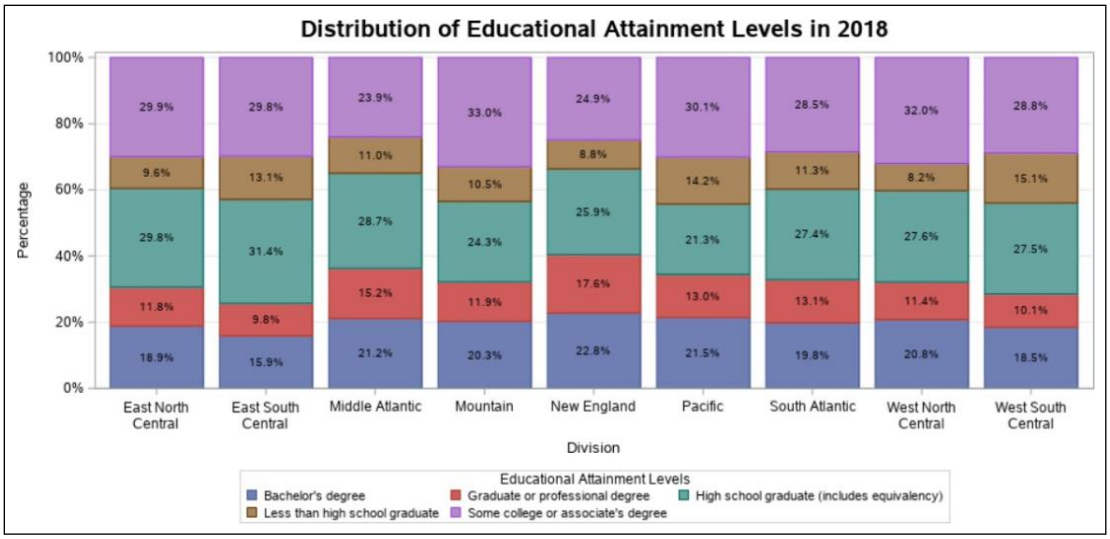
c) The final program should appear as below.

```
ods graphics / reset width=10in height=4.8in imagemap;

proc sgplot data=CENSUS.EDUCATION_STACKED_S
            pctlevel=group;
     title height=14pt "Distribution of Educational
                        Attainment Levels in 2018";
     vbar Division / response=Count
                     group=Educational_Attainment
                     groupdisplay=stack stat=percent
                     seglabel;
     xaxis label="Division";
     yaxis grid label="Percentage";
     keylegend / title="Educational Attainment Levels";
run;

ods graphics / reset;
title;
```

6) Click (**Run**) to view the updated bar chart on the Results tab.



c. Download the bar chart as a PDF file. After viewing the PDF file, close the file.

1) On the Results tab, click (**Download results as a PDF file**).
2) Open and view the downloaded PDF file.
3) Close the file.

d. Save the modified SAS program as **Education Bar Chart** in the **Census Data Analysis** folder. Then, close the **Education Bar Chart** and **Bar Chart** tabs. It is not necessary to save the settings specified in the Bar Chart task.

1) Click the **Code** tab of the modified program.
2) Click (**Save program**).
3) Navigate to and select the **Census Data Analysis** folder.
4) In the **Name** box, type **Education Bar Chart** and click **Save**.
5) Click (**Exit maximized view**) to restore the navigation pane.
6) Close the **Education Bar Chart.sas** and **Bar Chart** tabs. It is not necessary to save the settings specified in the Bar Chart task.

End of Solutions

Prepare Census Data in SAS® Studio

Prepare Census Data in SAS Studio

Important: You must perform the tutorial setup to download the necessary files and to set up your SAS Studio environment. You can follow the steps in the **Introduction to Analyzing Census Data in SAS Studio** section or watch the corresponding video.

Create a listing report that displays the top five states by median household income within each region. First, use the Query utility to combine the median household income data with a geography lookup table. Then, use the Rank Data task to rank the median household income within each region. Finally, use the List Data task to create a listing report that displays only the top five states within each region.

Using the Query Utility to Combine Tables

1. In the **Libraries** section in the navigation pane, expand **My Libraries** ⇨ **CENSUS**. Double-click on **MEDIANINCOME** to open the table in a new tab. This table contains the median household income by state for 2018.

   Note: The data can be found on data.census.gov by searching for the table ID **B19013**. The 1-year estimates for 2018 were downloaded for all states.

Total rows: 52 Total columns: 4

	GEO_ID	State	MedianIncome	MedianIncomeMOE
1	0400000US23	Maine	$55,602	$1,326
2	0400000US37	North Carolina	$53,855	$573
3	0400000US13	Georgia	$58,756	$711
4	0400000US02	Alaska	$74,346	$2,288
5	0400000US01	Alabama	$49,861	$783
6	0400000US50	Vermont	$60,782	$1,551
7	0400000US32	Nevada	$58,646	$1,133

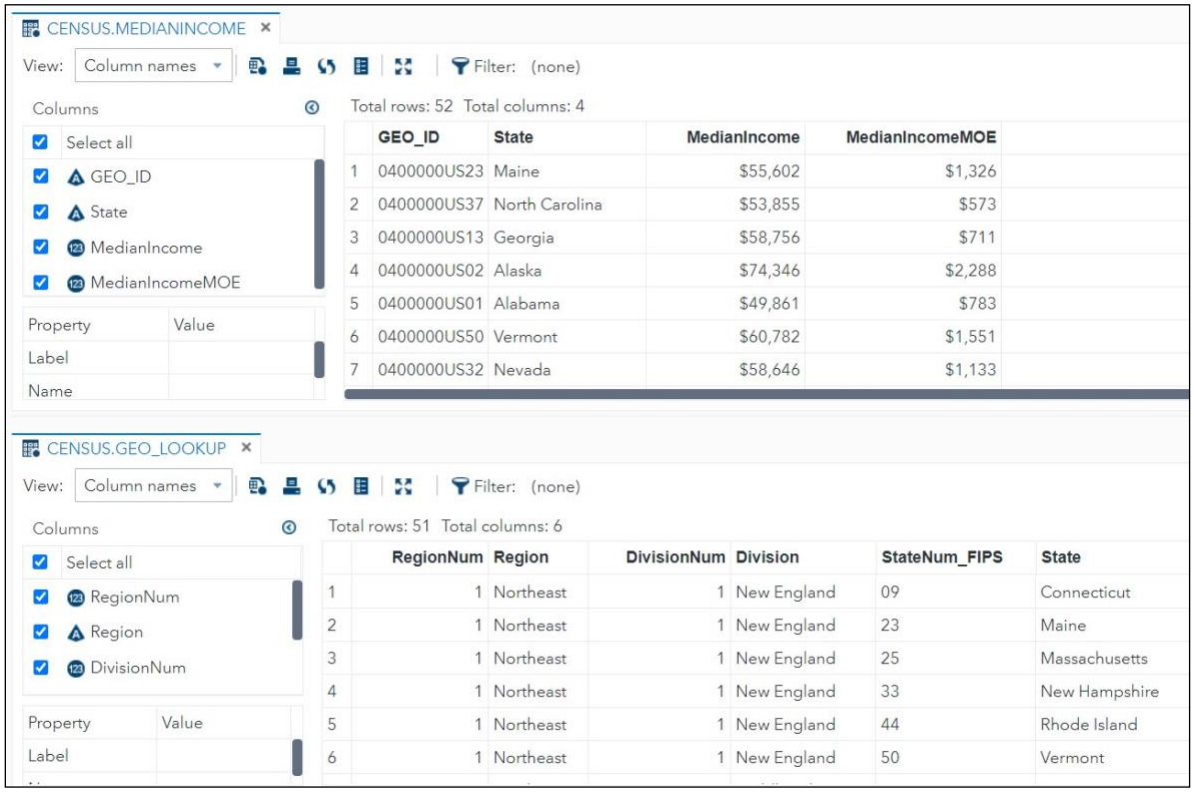
2. In the **CENSUS** library, double-click on **GEO_LOOKUP** to open the table in a new tab. This table provides a geography lookup table, providing information about the region and division each state belongs to.

   Note: This table is based off of the 2018 Census Bureau Region and Division Codes and State FIPS Codes Excel file that the Census Bureau makes available on their website. To learn more about the Census Bureau's regions and divisions, see the Census Regions and Divisions of the United States reference page.

Total rows: 51 Total columns: 6

	RegionNum	Region	DivisionNum	Division	StateNum_FIPS	State
1	1	Northeast	1	New England	09	Connecticut
2	1	Northeast	1	New England	23	Maine
3	1	Northeast	1	New England	25	Massachusetts
4	1	Northeast	1	New England	33	New Hampshire
5	1	Northeast	1	New England	44	Rhode Island
6	1	Northeast	1	New England	50	Vermont
7	1	Northeast	2	Middle Atlantic	34	New Jersey

3. To view multiple tabs at the same time, drag the **CENSUS.GEO_LOOKUP** tab to the bottom of the work area until a highlighted region appears. This creates a stacked view of the tables.



4. To rank the median household income values within each region, the **medianincome** and **geo_lookup** table must be combined, or joined, together. A *join* takes two or more tables and combines them horizontally on one or more common columns, enabling you to select data from multiple tables as if the data were contained in one table. The common column between **medianincome** and **geo_lookup** is the **State** column. Close the **CENSUS.GEO_LOOKUP** and **CENSUS.MEDIANINCOME** tabs.

5. A join can be performed using a query. A *query* enables you to extract data from one or more tables according to criteria that you specify. To start a new query, on the SAS Studio toolbar, select (**New Options**) ⇨ **New Query**. A query window opens on a new tab in the work area.

   Note: An alternative way to start the query is to expand the **Tasks and Utilities** section and under **Utilities**, double-click **Query**.

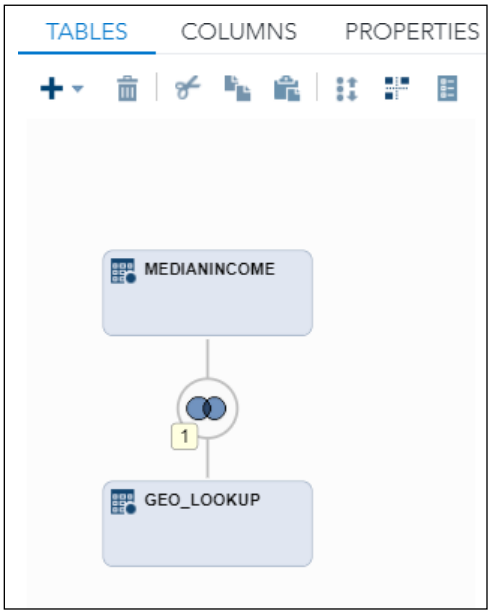
6. The default view is **Split**, which displays both the query settings and the code/results. Click **Settings** to view only the query settings.

7. First, a table must be added to the query. From the **Libraries** section in the navigation pane, drag the **MEDIANINCOME** table to the **Tables** tab to add the table to the query.

   Note: On the **Tables** tab, an alternative way to add a table to the query is to select (**Add**) ⇨ **Table**. Select the table of interest and click **OK**.

8. To join the geography lookup information with the median household income values, from the **Libraries** section in the navigation pane, drag the **GEO_LOOKUP** table to ***on top of*** the **MEDIANINCOME** table on the **Tables** tab.

   Note: On the **Tables** tab, an alternative way to perform a join is to first, add the second table by selecting ✚ (**Add**) ⇨ **Table**. Select the table of interest and click **OK**. Then, select ✚ (**Add**) ⇨ **Join**, and specify the tables to join as well as a join type. Click **Save**.

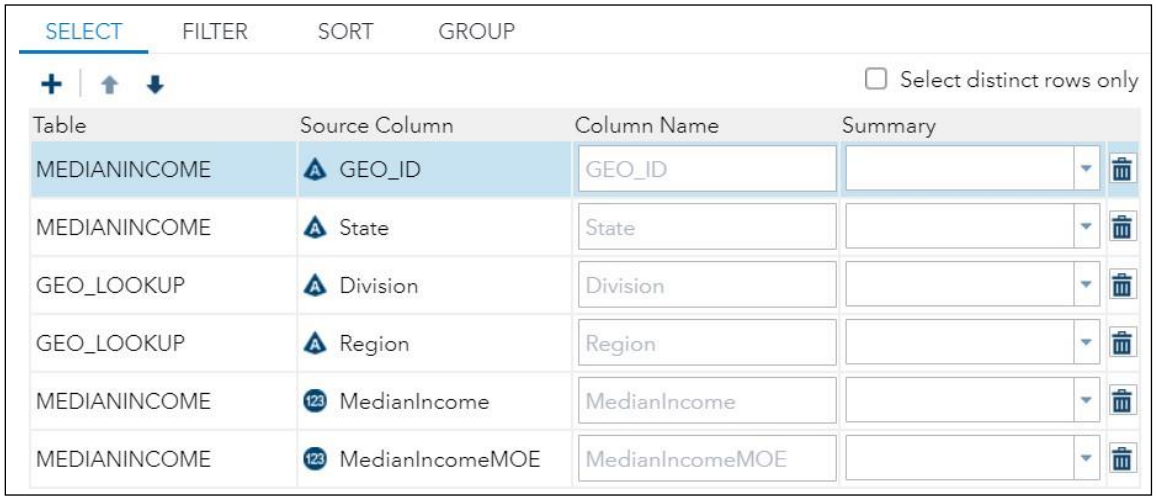


9. A join is automatically created if the tables include columns with matching names and data types, so a join was automatically performed on the **State** columns. The default join type is an *inner join*, which returns only the subset of rows from the first table that matches rows from the second table. In other words, only states found in both tables will be included in the output.

   Note: If a join cannot be created automatically, you can specify the join condition manually. There are also other join types. To learn more about joins, see the Understanding Joins page in the SAS Studio User's Guide.

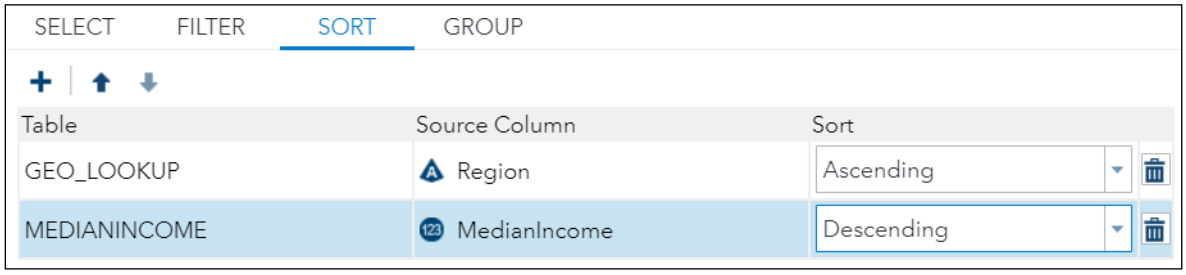
10. Click the **Columns** tab. To include all columns from the **medianincome** table, from the columns list, drag the **MEDIANINCOME** table onto the **Select** tab. In the columns list, expand the **GEO_LOOKUP** table. Drag **Region** and **Division** to the **Select** tab. Use the (**Move row up**) and (**Move row down**) buttons to rearrange the columns in the following order: **GEO_ID**, **State**, **Division**, **Region**, **MedianIncome**, and then **MedianIncomeMOE**.

    Note: An alternative way to add columns is to click (**Select Column**) on the **Select** tab and select one or more columns from the Select Column window.



11. Click the **Sort** tab. Drag **Region** from the columns list to the **Sort** tab. Verify that the sort direction is set to **Ascending**. In the columns list, expand the **MEDIANINCOME** table, and drag the **MedianIncome** column to the **Sort** tab. Click the **Sort** box and select **Descending** as the sort direction. The table will first be sorted by **Region** in ascending order. Within each **Region** value, the rows will be sorted by **MedianIncome** by descending order.

    Note: It is not necessary to sort your data for use in the Rank Data task. However, by sorting your data by groups and the value to rank on, the output table produced by the Rank Data task will be sorted in rank order.



12. Click the **Properties** tab. Verify that the **Output type** drop-down list is set to **Table**. In the **Output location** box, type **census** to save the table in the **census** library. In the **Output name** box, type **medianincome_geo**.

    Note: To learn more about the available options in the Query utility, see the Working with Queries page in the SAS Studio User's Guide.

13. Change the view to **Code/Results**. The Query utility generates Structured Query Language (SQL) code.

14. Click (**Run**) to submit the generated code and view the output table on the Output Data tab. The output table combines the median household income data with the geography information.

    Note: To collapse the Columns area, click the left arrow.

Total rows: 51 Total columns: 6

	GEO_ID	State	Division	Region	MedianIncome	MedianIncomeMOE
1	0400000US27	Minnesota	West North Central	Midwest	$70,315	$539
2	0400000US17	Illinois	East North Central	Midwest	$65,030	$500
3	0400000US38	North Dakota	West North Central	Midwest	$63,837	$2,324
4	0400000US55	Wisconsin	East North Central	Midwest	$60,773	$391
5	0400000US19	Iowa	West North Central	Midwest	$59,955	$877
6	0400000US31	Nebraska	West North Central	Midwest	$59,566	$1,072
7	0400000US20	Kansas	West North Central	Midwest	$58,218	$773
8	0400000US26	Michigan	East North Central	Midwest	$56,697	$406
9	0400000US46	South Dakota	West North Central	Midwest	$56,274	$1,454
10	0400000US39	Ohio	East North Central	Midwest	$56,111	$425

Using the Rank Data Task to Rank Data within Groups

15. To rank the median household income value within each region, use the Rank Data task. To start the Rank Data task, in the navigation pane, expand the **Tasks and Utilities** section. Expand **Tasks** ⇨ **Data** and double-click **Rank Data** to open the task in a new tab. The Rank Data task computes ranks for one or more numeric variables in a table.
16. Change the view to **Settings** to view only the task settings.
17. On the **Data** tab, click (**Select a table**). In the Select a Table window, expand the **CENSUS** library, select the **MEDIANINCOME_GEO** table, and click **OK**.
18. Each column assigned to the **Columns to rank** role is ranked. To rank by median household income values, click (**Add columns**). In the Columns window, select **MedianIncome** and click **OK**.
19. Expand the **Additional Roles** heading. When you assign a column to the **Rank by** role, rankings are calculated within each group. To obtain rankings within each region, click (**Add columns**). In the Columns window, select **Region** and click **OK**.
20. If necessary, expand the **Output Data Set** heading. In the **Data set name** box, type **census.medianincome_rank**. Verify that the **Create new variables for the ranked variables** check box is selected. This specifies that the output table, **census.medianincome_rank**, will contain the original column as well as the ranked column.

    Note: Clearing the **Create new variables for the ranked variables** check box will replace the original column with the ranked column.
21. Click the **Options** tab. Verify that the **Ranking method** is set to **Ranks** and that the **If values are tied, use** drop-down list is set to **Default method**. From the **Rank order** drop-down list, select **Largest to smallest**. This means that a rank of 1 corresponds to the largest value in the group.

    Note: To learn more about the available options in the Rank Data task, see the Rank Data page in the SAS Studio Task Reference Guide.
22. Change the view to **Code/Results**.

23. Click (**Run**) to submit the generated code and view the output table on the Output Data tab. Notice that by default, the ranking columns are given the name **rank_*column-name***.

Total rows: 51 Total columns: 7

	GEO_ID	State	Division	Region	MedianIncome	MedianIncomeMOE	rank_MedianIncome
1	0400000US27	Minnesota	West North Central	Midwest	$70,315	$539	1
2	0400000US17	Illinois	East North Central	Midwest	$65,030	$500	2
3	0400000US38	North Dakota	West North Central	Midwest	$63,837	$2,324	3
4	0400000US55	Wisconsin	East North Central	Midwest	$60,773	$391	4
5	0400000US19	Iowa	West North Central	Midwest	$59,955	$877	5
6	0400000US31	Nebraska	West North Central	Midwest	$59,566	$1,072	6
7	0400000US20	Kansas	West North Central	Midwest	$58,218	$773	7
8	0400000US26	Michigan	East North Central	Midwest	$56,697	$406	8
9	0400000US46	South Dakota	West North Central	Midwest	$56,274	$1,454	9
10	0400000US39	Ohio	East North Central	Midwest	$56,111	$425	10
11	0400000US18	Indiana	East North Central	Midwest	$55,746	$522	11
12	0400000US29	Missouri	West North Central	Midwest	$54,478	$751	12

Using the List Data Task to Create a Listing Report

24. To create a listing report that displays only the top five states within each region, use the List Data task. To start the List Data task, if necessary, expand the **Tasks and Utilities** section. Expand **Tasks** ⇨ **Data** and double-click **List Data** to open the task in a new tab. The List Data task displays the contents of a table as a report.

25. Click (**Maximize View**) to hide the navigation pane and maximize the work area.

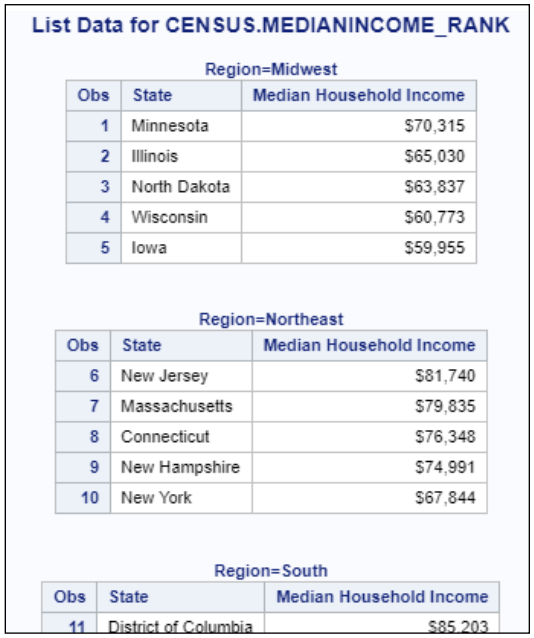
26. On the **Data** tab, click (**Select a table**). In the Select a Table window, expand the **CENSUS** library, select the **MEDIANINCOME_RANK** table, and click **OK**.

27. Under the **Data** heading, click **Filter**. In the filter expression box, type **rank_MedianIncome <= 5**. This will display only the top five states by median household income within each region. Click **Apply**.

28. Columns assigned to the **List variables** role are printed in the report in the order they are listed. To assign columns to this role, click (**Add columns**). In the Columns window, select **State**, hold down the Ctrl key, select **MedianIncome**, and click **OK**.

29. A separate listing is generated for each distinct value of the column assigned to the **Group analysis by** role. To create a separate listing for each region, click (**Add columns**). In the Columns window, select **Region** and click **OK**.

30. Click (**Run**) to submit the generated code and view the listing report on the Results tab. Notice that the column labels, which are descriptive column headings, are displayed in place of the column names.



List Data for CENSUS.MEDIANINCOME_RANK

Region=Midwest

Obs	State	Median Household Income
1	Minnesota	$70,315
2	Illinois	$65,030
3	North Dakota	$63,837
4	Wisconsin	$60,773
5	Iowa	$59,955

Region=Northeast

Obs	State	Median Household Income
6	New Jersey	$81,740
7	Massachusetts	$79,835
8	Connecticut	$76,348
9	New Hampshire	$74,991
10	New York	$67,844

Region=South

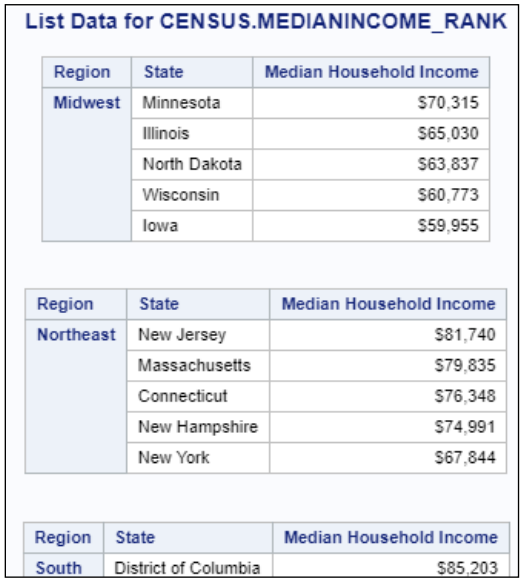
Obs	State	Median Household Income
11	District of Columbia	$85,203

31. On the **Data** tab, the **Identifying label** role can be used to replace the **Obs** column in the report with a column from the input table. To assign a column to this role, click (**Add columns**). In the Columns window, select **Region** and click **OK**.

Note: Alternatively, the **Obs** column can be removed from the report. To do this, on the **Options** tab, clear the **Display row numbers** check box.

Note: To learn more about the available options in the List Data task, see the List Data page in the SAS Studio Task Reference Guide.

32. Click (**Run**) to view the updated listing report on the Results tab. Using the same column for the **Group analysis by** and **Identifying label** roles produces the report in a special format.



List Data for CENSUS.MEDIANINCOME_RANK

Region	State	Median Household Income
Midwest	Minnesota	$70,315
	Illinois	$65,030
	North Dakota	$63,837
	Wisconsin	$60,773
	Iowa	$59,955

Region	State	Median Household Income
Northeast	New Jersey	$81,740
	Massachusetts	$79,835
	Connecticut	$76,348
	New Hampshire	$74,991
	New York	$67,844

Region	State	Median Household Income
South	District of Columbia	$85,203

33. The modify the title, the task-generated code must be modified. Click the **Code** tab and click **Edit**. Change the TITLE1 statement to the following:

```
title1 'Top 5 Median Household Incomes by Region';
```

```
1  title1 'Top 5 Median Household Incomes by Region';
2
3  proc sort data=CENSUS.MEDIANINCOME_RANK out=WORK.SORTTEMP;
4      where rank_MedianIncome <=5;
5      by Region;
6  run;
7
8  proc print data=WORK.SORTTEMP label;
9      var State MedianIncome;
10     by Region;
11     id Region;
12 run;
13
14 proc delete data=work.SORTTEMP;
15 run;
16
17 title1;
```

34. Click (**Run**) to view the updated listing report on the Results tab.

Top 5 Median Household Incomes by Region

Region	State	Median Household Income
Midwest	Minnesota	$70,315
	Illinois	$65,030
	North Dakota	$63,837
	Wisconsin	$60,773
	Iowa	$59,955

Region	State	Median Household Income
Northeast	New Jersey	$81,740
	Massachusetts	$79,835
	Connecticut	$76,348
	New Hampshire	$74,991
	New York	$67,844

Region	State	Median Household Income
South	District of Columbia	$85,203
	Maryland	$83,242

35. Click (**Exit maximized view**) to restore the navigation pane

36. Click the **Code** tab of the modified program. To save the modified SAS program, click (**Save program**). Navigate to and select the **Census Data Analysis** folder. In the **Name** box, type **Median Income Report** and click **Save**. Close the **Median Income Report.sas** tab.

37. Close the **List Data**, **Rank Data**, and **Query 1** tabs. It is not necessary to save the settings specified in the utilities and tasks.

End of Tutorial

Practice

Important: You must perform the tutorial setup to download the necessary files and to set up your SAS Studio environment. You can follow the steps in the **Introduction to Analyzing Census Data in SAS Studio** section or watch the corresponding video.

Level 1

1. Displaying the Top Five States by Median Age within Each Region

Create a listing report that displays the top five states by median age within each region. First, use the Query utility to combine the median age data with a geography lookup table. Then, use the Rank Data task to rank the median age within each region. Finally, use the List Data task to create a listing report that displays only the top five states within each region.

a. Use the Query utility to join the **medianage** and **geo_lookup** tables from the **census** library. Use the following settings:

- Perform an inner join on the **State** columns.
- Include all columns from the **medianage** table and the **Region** and **Division** columns from the **geo_lookup** table. Rearrange the columns in the following order: **GEO_ID**, **State**, **Division**, **Region**, **MedianAge**, and then **MedianAgeMOE**.
- Sort the output data by **Region** in ascending order, and then by **MedianAge** in descending order.
- Save the output table as **medianage_geo** in the **census** library.

Note: The data in the **medianage** table can be found on data.census.gov by searching for the table ID **B01002**. The 1-year estimates for 2018 were downloaded for all states and only the total statistics were imported.

The output table combines the median age data with the geography information.

Total rows: 51 Total columns: 6 Rows 1-51

	GEO_ID	State	Division	Region	MedianAge	MedianAgeMOE
1	0400000US26	Michigan	East North Central	Midwest	39.8	0.1
2	0400000US55	Wisconsin	East North Central	Midwest	39.6	0.2
3	0400000US39	Ohio	East North Central	Midwest	39.5	0.1
4	0400000US29	Missouri	West North Central	Midwest	38.8	0.1
5	0400000US17	Illinois	East North Central	Midwest	38.3	0.1
6	0400000US27	Minnesota	West North Central	Midwest	38.2	0.2
7	0400000US19	Iowa	West North Central	Midwest	38.1	0.2
8	0400000US18	Indiana	East North Central	Midwest	37.8	0.2
9	0400000US46	South Dakota	West North Central	Midwest	37.2	0.3

b. Use the Rank Data task to rank the median age within each region. Use the following settings:

- Specify **census.medianage_geo** as the input table.
- Rank the values of **MedianAge** within each value of **Region**.
- Save the output table as **medianage_rank** in the **census** library.
- Accept the default ranking method.

- If values are tied, use the low rank.
- Rank the values from largest to smallest.

The **rank_MedianAge** column provides the ranking of the **MedianAge** values within each value of **Region**.

Notice that if two states within a region have the same **MedianAge** value, the smaller rank value is used. For example, both Vermont and New Hampshire are assigned a ranking value of **2**.

Total rows: 51 Total columns: 7

	GEO_ID	State	Division	Region	MedianAge	MedianAgeMOE	rank_MedianAge
1	0400000US26	Michigan	East North Central	Midwest	39.8	0.1	1
2	0400000US55	Wisconsin	East North Central	Midwest	39.6	0.2	2
3	0400000US39	Ohio	East North Central	Midwest	39.5	0.1	3
4	0400000US29	Missouri	West North Central	Midwest	38.8	0.1	4
5	0400000US17	Illinois	East North Central	Midwest	38.3	0.1	5
6	0400000US27	Minnesota	West North Central	Midwest	38.2	0.2	6
7	0400000US19	Iowa	West North Central	Midwest	38.1	0.2	7
8	0400000US18	Indiana	East North Central	Midwest	37.8	0.2	8
9	0400000US46	South Dakota	West North Central	Midwest	37.2	0.3	9
10	0400000US20	Kansas	West North Central	Midwest	37.1	0.2	10
11	0400000US31	Nebraska	West North Central	Midwest	36.7	0.2	11
12	0400000US38	North Dakota	West North Central	Midwest	35.4	0.3	12
13	0400000US23	Maine	New England	Northeast	45.1	0.2	1
14	0400000US50	Vermont	New England	Northeast	43.1	0.3	2
15	0400000US33	New Hampshire	New England	Northeast	43.1	0.2	2

c. Use the List Data task to create a listing report that displays only the top five states within each region with the highest median age. Use the following settings:

- Specify **census.medianage_rank** as the input table.
- Filter the data to include only the top five states within each region.
- Display the **State** and **MedianAge** columns.
- Group and identify the rows by **Region**.

List Data for CENSUS.MEDIANAGE_RANK

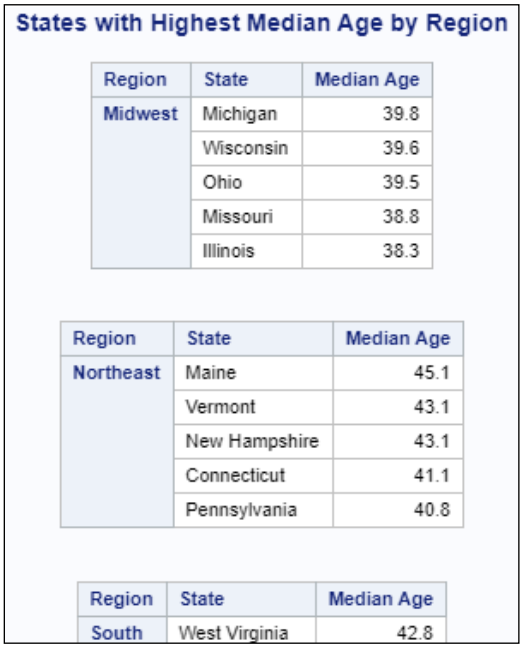
Region	State	Median Age
Midwest	Michigan	39.8
	Wisconsin	39.6
	Ohio	39.5
	Missouri	38.8
	Illinois	38.3

Region	State	Median Age
Northeast	Maine	45.1
	Vermont	43.1
	New Hampshire	43.1
	Connecticut	41.1
	Pennsylvania	40.8

Region	State	Median Age
South	West Virginia	42.8

d. Save the settings specified in the List Data task as **Median Age Report** in the **Census Data Analysis** folder. Close the **Rank Data** and **Query 1** tabs. It is not necessary to save the settings specified in the Rank Data task and the Query utility.

e. (Optional) Modify the code generated by the List Data task to change the title to **States with Highest Median Age by Region**. Save the modified SAS program as **Median Age Report Title** in the **Census Data Analysis** folder. Then, close the **Median Age Report Title.sas** and **Median Age Report.ctk** tabs.



States with Highest Median Age by Region

Region	State	Median Age
Midwest	Michigan	39.8
	Wisconsin	39.6
	Ohio	39.5
	Missouri	38.8
	Illinois	38.3

Region	State	Median Age
Northeast	Maine	45.1
	Vermont	43.1
	New Hampshire	43.1
	Connecticut	41.1
	Pennsylvania	40.8

Region	State	Median Age
South	West Virginia	42.8

Challenge

2. Calculating and Grouping the Percent Change in Population

Compare the percent change in population from 2010 to 2018 across all states. First, use the Query utility to combine the population estimates from 2010 and 2018. Then, edit the code generated by the Query utility to create a new column that calculates the percent change in population. Next, use the Recode Ranges task to group the percent change in population values into categories. Finally, use the One-Way Frequencies task to create a report that counts the number of states that fall into each percent change category

a. Use the Query utility to join the **population2010** and **population2018** tables from the **census** library. Use the following settings:

- Perform an inner join on the **GEO_ID** columns.
- Include all columns from the **population2010** table and the **TotalPop2018** column from the **population2018** table.
- Sort the output data by the **State** column in the **population2010** table in ascending order.
- Save the output table as **population_change** in the **census** library.

Note: The data in the **population2010** and **population2018** tables can be found on data.census.gov by searching for the table ID **B01003**. The 1-year estimates for 2010 were downloaded for all states for **population2010**, and the 1-year estimates for 2018 were downloaded for all states for **population2018**.

The output table combines the population estimates for 2010 and 2018 for each state.

Total rows: 52 Total columns: 4

	GEO_ID	State	TotalPop2010	TotalPop2018
1	0400000US01	Alabama	4,785,298	4,887,871
2	0400000US02	Alaska	713,985	737,438
3	0400000US04	Arizona	6,413,737	7,171,646
4	0400000US05	Arkansas	2,921,606	3,013,825
5	0400000US06	California	37,349,363	39,557,045
6	0400000US08	Colorado	5,049,071	5,695,564
7	0400000US09	Connecticut	3,577,073	3,572,665
8	0400000US10	Delaware	899,769	967,171
9	0400000US11	District of Columbia	604,453	702,455

b. Modify the query-generated code. In the PROC SQL step, extend the SELECT clause to create a new column named **PercentChange** that calculates the percent change in population from 2010 to 2018. Format the values with the PERCENTN7.1 format to display the values as percentages.

```
SELECT POPULATION2010.GEO ID, POPULATION2010.State,
       POPULATION2010.TotalPop2010,
       POPULATION2018.TotalPop2018,
       (TotalPop2018-TotalPop2010)/TotalPop2010 as
       PercentChange format=percentn7.1
```

Note: The SELECT clause lists the columns that will appear in the output in a comma separated list. Column names must be qualified, or prefixed, by one of the table names only if there are columns with the same name from more than one table. Computed columns can be included in the SELECT clause with the syntax *expression* ***AS*** *column-name*.

Note: The FORMAT= column modifier can be specified after a column name on the SELECT clause to associate SAS formats with column values. The PERCENTN7.1 format multiplies the values by 100, and then displays the values with a leading minus sign for negative values, a single decimal value, and a percent sign, all within the allotted total width of 7.

Total rows: 52 Total columns: 5

	GEO_ID	State	TotalPop2010	TotalPop2018	PercentChange
1	0400000US01	Alabama	4,785,298	4,887,871	2.1%
2	0400000US02	Alaska	713,985	737,438	3.3%
3	0400000US04	Arizona	6,413,737	7,171,646	11.8%
4	0400000US05	Arkansas	2,921,606	3,013,825	3.2%
5	0400000US06	California	37,349,363	39,557,045	5.9%
6	0400000US08	Colorado	5,049,071	5,695,564	12.8%
7	0400000US09	Connecticut	3,577,073	3,572,665	-0.1%
8	0400000US10	Delaware	899,769	967,171	7.5%
9	0400000US11	District of Columbia	604,453	702,455	16.2%

c. In the table viewer, sort the rows by ascending **PercentChange** and note the lowest and highest values. All values between the lowest and highest values must be accounted for in the Recode Ranges task to group all percent change values into categories.

The lowest **PercentChange** value is Puerto Rico with -14.2% and the highest is the District of Columbia with 16.2%.

	GEO_ID	State	TotalPop2010	TotalPop2018	PercentChange ▲
1	0400000US72	Puerto Rico	3,722,133	3,195,153	-14.2%
2	0400000US54	West Virginia	1,853,973	1,805,832	-2.6%
3	0400000US17	Illinois	12,843,166	12,741,080	-0.8%
4	0400000US09	Connecticut	3,577,073	3,572,665	-0.1%
5	0400000US50	Vermont	625,960	626,299	0.1%

48	0400000US08	Colorado	5,049,071	5,695,564	12.8%
49	0400000US12	Florida	18,843,326	21,299,325	13.0%
50	0400000US48	Texas	25,257,114	28,701,845	13.6%
51	0400000US49	Utah	2,776,469	3,161,105	13.9%
52	0400000US11	District of Columbia	604,453	702,455	16.2%

d. Use the Recode Ranges task in the Data category to group the percent change in population values into categories. Use the following settings:

- Specify **census.population_change** as the input table.
- Specify **PercentChange** as the column to recode.
- Name the recoded column **PercentChangeCat** and save it to an output table named **population_change_cat** in the **census** library.
- Use the following ranges of **PercentChange** to group the values into categories in the new **PercentChangeCat** column:

Lower bound	Upper bound	Recoded value
-0.2	-0.001	Decrease
0	0.049	0% to 5% Increase
0.05	0.099	5% to 10% Increase
0.1	0.2	10% or Higher Increase

Note: Although the values in **PercentChange** are displayed with percentages due to the PERCENTN format, the stored values are decimal values. The stored values must be used when specifying the lower and upper bounds.

Note: The lower and upper bounds define inclusive ranges, and the ranges must not overlap.

The **PercentChangeCat** column categorizes each state by the value in the **PercentChange** column.

Total rows: 52 Total columns: 6

	PercentChangeCat	GEO_ID	State	TotalPop2010	TotalPop2018	PercentChange
1	0% to 5% Increase	0400000US01	Alabama	4,785,298	4,887,871	2.1%
2	0% to 5% Increase	0400000US02	Alaska	713,985	737,438	3.3%
3	10% or Higher Increase	0400000US04	Arizona	6,413,737	7,171,646	11.8%
4	0% to 5% Increase	0400000US05	Arkansas	2,921,606	3,013,825	3.2%
5	5% to 10% Increase	0400000US06	California	37,349,363	39,557,045	5.9%
6	10% or Higher Increase	0400000US08	Colorado	5,049,071	5,695,564	12.8%
7	Decrease	0400000US09	Connecticut	3,577,073	3,572,665	-0.1%
8	5% to 10% Increase	0400000US10	Delaware	899,769	967,171	7.5%
9	10% or Higher Increase	0400000US11	District of Columbia	604,453	702,455	16.2%

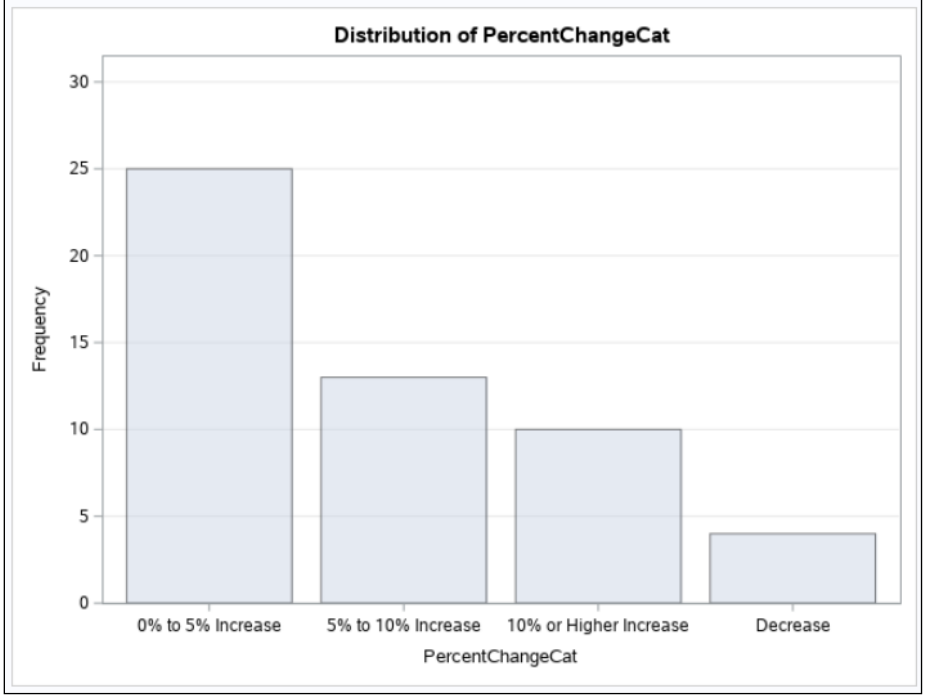
e. Use the One-Way Frequencies task in the Statistics category to create a report that counts the number of states that fall into each percent change category. Use the following settings:

- Specify **census.population_change_cat** as the input table.
- Assign **PercentChangeCat** as the analysis variable.
- Do not include cumulative frequencies and percentages in the report.
- Order the output report by descending frequencies.

The report shows that almost half of all states had a population increase between 0% and 5%, and only 4 states had a decrease in population.

The FREQ Procedure

PercentChangeCat	Frequency	Percent
0% to 5% Increase	25	48.08
5% to 10% Increase	13	25.00
10% or Higher Increase	10	19.23
Decrease	4	7.69



f. Save the settings specified in the One-Way Frequencies task as **Population Change Frequency** in the **Census Data Analysis** folder. Then, close the **Population Change Frequency.ctk**, **Recode Ranges**, **Program 1**, and **Query 1** tabs. It is not necessary to save the settings specified in the Recode Ranges task, the SAS program, and the Query utility.

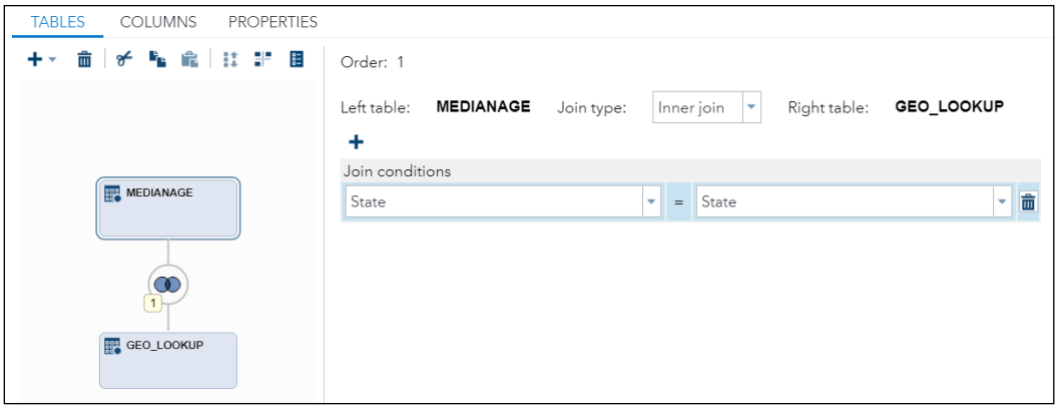
End of Practices

Solutions to Practices

1. Displaying the Top Five States by Median Age within Each Region

a. Use the Query utility to join the **medianage** and **geo_lookup** tables from the **census** library. Use the specified settings.

1) On the SAS Studio toolbar, select (**New Options**) ⇨ **New Query**. A query window opens on a new tab in the work area.
2) Click **Settings** to view only the query settings.
3) Perform an inner join on the **State** columns.
   a) In the navigation pane, expand the **Libraries** section, and then expand **My Libraries** ⇨ **CENSUS**.
   b) Drag the **MEDIANAGE** table to the **Tables** tab to add the table to the query.
   c) From the **Libraries** section in the navigation pane, drag the **GEO_LOOKUP** table to ***on top of*** the **MEDIANAGE** table on the **Tables** tab.
   d) Verify that an inner join is automatically performed on the **State** columns.



4) Include all columns from the **medianage** table and the **Region** and **Division** columns from the **geo_lookup** table. Rearrange the columns in the following order: **GEO_ID**, **State**, **Division**, **Region**, **MedianAge**, and then **MedianAgeMOE**.
   a) Click the **Columns** tab.
   b) From the columns list, drag the **MEDIANAGE** table onto the **Select** tab.
   c) In the columns list, expand the **GEO_LOOKUP** table.
   d) Drag **Region** and **Division** to the **Select** tab.
   e) Use the (**Move row up**) and (**Move row down**) buttons to rearrange the columns in the following order: **GEO_ID**, **State**, **Division**, **Region**, **MedianAge**, and then **MedianAgeMOE**.
5) Sort the output data by **Region** in ascending order, then by **MedianAge** in descending order.
   a) Click the **Sort** tab.
   b) Drag **Region** from the columns list to the **Sort** tab. Verify that the sort direction is set to **Ascending**.

c) In the columns list, expand the **MEDIANAGE** table, and drag the **MedianAge** column to the **Sort** tab.

d) Click the **Sort** box and select **Descending** as the sort direction.

6) Save the output table as **medianage_geo** in the **census** library.

a) Click the **Properties** tab.

b) Verify that the **Output type** drop-down list is set to **Table**.

c) In the **Output location** box, type **census**.

d) In the **Output name** box, type **medianage_geo**.

7) Click **Code/Results** to change the view.

8) Click (**Run**) to submit the generated code and view the output table on the Output Data tab.

The output table combines the median age data with the geography information.

Total rows: 51 Total columns: 6 Rows 1-51

	GEO_ID	State	Division	Region	MedianAge	MedianAgeMOE
1	0400000US26	Michigan	East North Central	Midwest	39.8	0.1
2	0400000US55	Wisconsin	East North Central	Midwest	39.6	0.2
3	0400000US39	Ohio	East North Central	Midwest	39.5	0.1
4	0400000US29	Missouri	West North Central	Midwest	38.8	0.1
5	0400000US17	Illinois	East North Central	Midwest	38.3	0.1
6	0400000US27	Minnesota	West North Central	Midwest	38.2	0.2
7	0400000US19	Iowa	West North Central	Midwest	38.1	0.2
8	0400000US18	Indiana	East North Central	Midwest	37.8	0.2
9	0400000US46	South Dakota	West North Central	Midwest	37.2	0.3

b. Use the Rank Data task to rank the median age within each region. Use the specified settings.

1) In the navigation pane, expand the **Tasks and Utilities** section.

2) Expand **Tasks** ⇨ **Data** and double-click **Rank Data** to open the task in a new tab.

3) Click **Settings** to view only the task settings.

4) Specify **census.medianage_geo** as the input table.

a) On the **Data** tab, click (**Select a table**).

b) In the Select a Table window, expand the **CENSUS** library and select the **MEDIANINAGE_GEO** table.

c) Click **OK**.

5) Rank the values of **MedianAge** within each value of **Region**.

a) To assign a column to the **Columns to rank** role, click (**Add columns**).

b) In the Columns window, select **MedianAge**.

c) Click **OK**.

d) Expand the **Additional Roles** heading.

e) To assign a column to the **Rank by** role, click (**Add columns**).

f) In the Columns window, select **Region**.

g) Click **OK**.

6) Save the output table as **medianage_rank** in the **census** library.

a) If necessary, expand the **Output Data Set** heading.

b) In the **Data set name** box, type **census.medianage_rank**.

7) Accept the default ranking method.

a) Click the **Options** tab.

b) Verify that the **Ranking method** is set to **Ranks**.

8) If values are tied, use the low rank.

Use the **If values are tied, use** drop-down list to select **Low rank**.

9) Rank the values from largest to smallest.

From the **Rank order** drop-down list, select **Largest to smallest**.

10) Click **Code/Results** to change the view.

11) Click (**Run**) to submit the generated code and view the output table on the Output Data tab.

The **rank_MedianAge** column provides the ranking of the **MedianAge** values within each value of **Region**.

Notice that if two states within a region have the same **MedianAge** value, the smaller rank value is used. For example, both Vermont and New Hampshire are assigned a ranking value of **2**.

Total rows: 51 Total columns: 7

	GEO_ID	State	Division	Region	MedianAge	MedianAgeMOE	rank_MedianAge
1	0400000US26	Michigan	East North Central	Midwest	39.8	0.1	1
2	0400000US55	Wisconsin	East North Central	Midwest	39.6	0.2	2
3	0400000US39	Ohio	East North Central	Midwest	39.5	0.1	3
4	0400000US29	Missouri	West North Central	Midwest	38.8	0.1	4
5	0400000US17	Illinois	East North Central	Midwest	38.3	0.1	5
6	0400000US27	Minnesota	West North Central	Midwest	38.2	0.2	6
7	0400000US19	Iowa	West North Central	Midwest	38.1	0.2	7
8	0400000US18	Indiana	East North Central	Midwest	37.8	0.2	8
9	0400000US46	South Dakota	West North Central	Midwest	37.2	0.3	9
10	0400000US20	Kansas	West North Central	Midwest	37.1	0.2	10
11	0400000US31	Nebraska	West North Central	Midwest	36.7	0.2	11
12	0400000US38	North Dakota	West North Central	Midwest	35.4	0.3	12
13	0400000US23	Maine	New England	Northeast	45.1	0.2	1
14	0400000US50	Vermont	New England	Northeast	43.1	0.3	2
15	0400000US33	New Hampshire	New England	Northeast	43.1	0.2	2

c. Use the List Data task to create a listing report that displays only the top five states within each region with the highest median age. Use the specified settings.

1) If necessary, expand the **Tasks and Utilities** section.

2) Expand **Tasks** ⇨ **Data** and double-click **List Data** to open the task in a new tab.

3) Click (**Maximize View**) to hide the navigation pane and maximize the work area.

4) Specify **census.medianage_rank** as the input table.

a) On the **Data** tab, click (**Select a table**).

b) In the Select a Table window, expand the **CENSUS** library and select the **MEDIANAGE_RANK** table.

c) Click **OK**.

5) Filter the data to include only the top five states within each region.

a) Under the **Data** heading, click **Filter**.

b) In the filter expression box, type **rank_MedianAge <= 5**.

c) Click **Apply**.

6) Display the **State** and **MedianAge** columns.

a) To assign columns to the **List variables** role, click (**Add columns**).

b) In the Columns window, select **State**, hold down the Ctrl key, and select **MedianAge**.

c) Click **OK**.

7) Group and identify the rows by **Region**.

a) To assign a column to the **Group analysis by** role, click (**Add columns**).

b) In the Columns window, select **Region**.

c) Click **OK**.

d) To assign a column to the **Identifying label** role, click (**Add columns**).

e) In the Columns window, select **Region**.

f) Click **OK**.

8) Click (**Run**) to submit the generated code and view the listing report on the Results tab.

List Data for CENSUS.MEDIANAGE_RANK

Region	State	Median Age
Midwest	Michigan	39.8
	Wisconsin	39.6
	Ohio	39.5
	Missouri	38.8
	Illinois	38.3

Region	State	Median Age
Northeast	Maine	45.1
	Vermont	43.1
	New Hampshire	43.1
	Connecticut	41.1
	Pennsylvania	40.8

Region	State	Median Age
South	West Virginia	42.8

d. Save the settings specified in the List Data task as **Median Age Report** in the **Census Data Analysis** folder. Close the **Rank Data** and **Query 1** tabs. It is not necessary to save the settings specified in the Rank Data task and the Query utility.

1) Click (**Save**).
2) Navigate to and select the **Census Data Analysis** folder.
3) In the **Name** box, type **Median Age Report**.
4) Click **Save**.
5) Click (**Exit maximized view**) to restore the navigation pane.
6) Close the **Rank Data** and **Query 1** tabs. It is not necessary to save the settings specified in the Rank Data task and the Query utility.

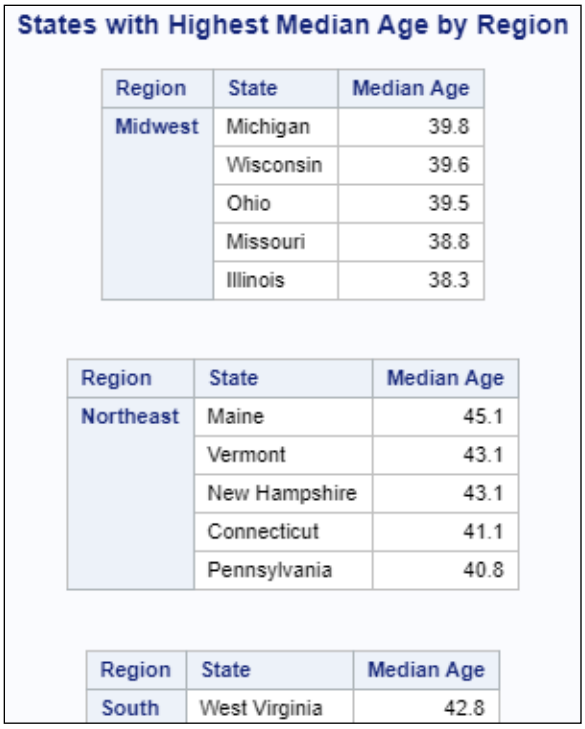
e. (Optional) Modify the code generated by the List Data task to change the title to **States with Highest Median Age by Region**. Save the modified SAS program as **Median Age Report Title** in the **Census Data Analysis** folder. Then, close the **Median Age Report Title.sas** and **Median Age Report.ctk** tabs.

1) On the **Median Age Report.ctk** tab, select the **Code** tab.
2) Click **Edit**.
3) Modify the TITLE1 statement to display the title **States with Highest Median Age by Region**.

```
title1 'States with Highest Median Age by Region';
```

```
1  title1 'States with Highest Median Age by Region';
2
3  proc sort data=CENSUS.MEDIANAGE_RANK out=WORK.SORTTEMP;
4      where rank_MedianAge <=5;
5      by Region;
6  run;
7
8  proc print data=WORK.SORTTEMP label;
9      var State MedianAge;
10     by Region;
11     id Region;
12 run;
13
14 proc delete data=work.SORTTEMP;
15 run;
16
17 title1;
```

4) Click (**Run**) to view the updated listing report on the Results tab.



States with Highest Median Age by Region

Region	State	Median Age
Midwest	Michigan	39.8
	Wisconsin	39.6
	Ohio	39.5
	Missouri	38.8
	Illinois	38.3

Region	State	Median Age
Northeast	Maine	45.1
	Vermont	43.1
	New Hampshire	43.1
	Connecticut	41.1
	Pennsylvania	40.8

Region	State	Median Age
South	West Virginia	42.8

5) Click the **Code** tab of the modified program.

6) Click (**Save program**).

7) Navigate to and select the **Census Data Analysis** folder.

8) In the **Name** box, type **Median Age Report Title** and click **Save**.

9) Close the **Median Age Report Title.sas** and **Median Age Report.ctk** tabs.

2. Calculating and Grouping the Percent Change in Population

a. Use the Query utility to join the **population2010** and **population2018** tables from the **census** library. Use the specified settings.

1) On the SAS Studio toolbar, select (**New Options**) ⇨ **New Query**. A query window opens on a new tab in the work area.

2) Click **Settings** to view only the query settings.

3) Perform an inner join on the **GEO_ID** columns.

a) In the navigation pane, expand the **Libraries** section, and then expand **My Libraries** ⇨ **CENSUS**.

b) Drag the **POPULATION2010** table to the **Tables** tab to add the table to the query.

c) From the **Libraries** section in the navigation pane, drag the **POPULATION2018** table to ***on top of*** the **POPULATION2010** table on the **Tables** tab.

d) Verify that an inner join is automatically performed on the **GEO_ID** columns.

4) Include all columns from the **population2010** table and the **TotalPop2018** column from the **population2018** table.
   a) Click the **Columns** tab.
   b) From the columns list, drag the **POPULATION2010** table onto the **Select** tab.
   c) In the columns list, expand the **POPULATION2018** table.
   d) Drag the **TotalPop2018** column to the **Select** tab.
5) Sort the output data by the **State** column in the **population2010** table in ascending order.
   a) Click the **Sort** tab.
   b) In the columns list, expand the **POPULATION2010** table, and drag **State** to the **Sort** tab.
   c) Verify that the sort direction is set to **Ascending**.
6) Save the output table as **population_change** in the **census** library.
   a) Click the **Properties** tab.
   b) Verify that the **Output type** drop-down list is set to **Table**.
   c) In the **Output location** box, type **census**.
   d) In the **Output name** box, type **population_change**.
7) Click **Code/Results** to change the view.

8) Click (**Run**) to submit the generated code and view the output table on the Output Data tab.

The output table combines the population estimates for 2010 and 2018 for each state.

Total rows: 52 Total columns: 4

	GEO_ID	State	TotalPop2010	TotalPop2018
1	0400000US01	Alabama	4,785,298	4,887,871
2	0400000US02	Alaska	713,985	737,438
3	0400000US04	Arizona	6,413,737	7,171,646
4	0400000US05	Arkansas	2,921,606	3,013,825
5	0400000US06	California	37,349,363	39,557,045
6	0400000US08	Colorado	5,049,071	5,695,564
7	0400000US09	Connecticut	3,577,073	3,572,665
8	0400000US10	Delaware	899,769	967,171
9	0400000US11	District of Columbia	604,453	702,455

b. Modify the query-generated code. In the PROC SQL step, extend the SELECT clause to create a new column named **PercentChange** that calculates the percent change in population from 2010 to 2018. Format the values with the PERCENTN7.1 format to display the values as percentages.

1) Click the **Code** tab.

2) Click **Edit**. Amodifiable copy of the program opens in a new tab.

3) In the PROC SQL step, extend the SELECT clause to create a new column named **PercentChange** that calculates the percent change in population from 2010 to 2018. Format the values with the PERCENTN7.1 format.

```
SELECT POPULATION2010.GEO_ID, POPULATION2010.State,
       POPULATION2010.TotalPop2010,
       POPULATION2018.TotalPop2018,
       (TotalPop2018-TotalPop2010)/TotalPop2010 as
       PercentChange format=percentn7.1
```

4) The final program should appear as below:

```
%web_drop_table(census.population_change);

/* Query code generated for SAS Studio by Common Query
Services */

PROC SQL;
CREATE TABLE census.population_change
AS
SELECT POPULATION2010.GEO_ID, POPULATION2010.State,
       POPULATION2010.TotalPop2010,
       POPULATION2018.TotalPop2018,
       (TotalPop2018-TotalPop2010)/TotalPop2010 as
       PercentChange format=percentn7.1
FROM CENSUS.POPULATION2010 POPULATION2010
```

```
INNER JOIN CENSUS.POPULATION2018 POPULATION2018
ON
   ( POPULATION2010.GEO_ID = POPULATION2018.GEO_ID )
ORDER BY 2 ASC;
QUIT;

%web_open_table(census.population_change);
```

5) Click (**Run**) to view the updated output table on the Output Data tab.

Total rows: 52 Total columns: 5

	GEO_ID	State	TotalPop2010	TotalPop2018	PercentChange
1	0400000US01	Alabama	4,785,298	4,887,871	2.1%
2	0400000US02	Alaska	713,985	737,438	3.3%
3	0400000US04	Arizona	6,413,737	7,171,646	11.8%
4	0400000US05	Arkansas	2,921,606	3,013,825	3.2%
5	0400000US06	California	37,349,363	39,557,045	5.9%
6	0400000US08	Colorado	5,049,071	5,695,564	12.8%
7	0400000US09	Connecticut	3,577,073	3,572,665	-0.1%
8	0400000US10	Delaware	899,769	967,171	7.5%
9	0400000US11	District of Columbia	604,453	702,455	16.2%

c. In the table viewer, sort the rows by ascending **PercentChange** and note the lowest and highest values. All values between the lowest and highest values must be accounted for in the Recode Ranges task to group all percent change values into categories.

On the Output Data tab, right-click the **PercentChange** column and select **Sort Ascending**.

The lowest **PercentChange** value is Puerto Rico with -14.2% and the highest is the District of Columbia with 16.2%.

	GEO_ID	State	TotalPop2010	TotalPop2018	PercentChange ▲
1	0400000US72	Puerto Rico	3,722,133	3,195,153	-14.2%
2	0400000US54	West Virginia	1,853,973	1,805,832	-2.6%
3	0400000US17	Illinois	12,843,166	12,741,080	-0.8%
4	0400000US09	Connecticut	3,577,073	3,572,665	-0.1%
5	0400000US50	Vermont	625,960	626,299	0.1%

48	0400000US08	Colorado	5,049,071	5,695,564	12.8%
49	0400000US12	Florida	18,843,326	21,299,325	13.0%
50	0400000US48	Texas	25,257,114	28,701,845	13.6%
51	0400000US49	Utah	2,776,469	3,161,105	13.9%
52	0400000US11	District of Columbia	604,453	702,455	16.2%

d. Use the Recode Ranges task in the Data category to group the percent change in population values into categories. Use the specified settings.

1) Select the **Tasks and Utilities** section in the navigation pane.

2) Expand **Tasks** ⇨ **Data** and double-click **Recode Ranges** to open the task in a new tab.
3) Click **Settings** to view only the task settings.
4) Specify **census.population_change** as the input table.
   a) On the **Data** tab, click (**Select a table**).
   b) In the Select a Table window, expand the **CENSUS** library and select the **POPULATION_CHANGE** table.
   c) Click **OK**.
5) Specify **PercentChange** as the column to recode.
   a) To assign a column to the **Variable to recode** role, click (**Add a column**).
   b) In the Columns window, select **PercentChange**.
   c) Click **OK**.
6) Name the recoded column **PercentChangeCat** and save it to an output table named **population_change_cat** in the **census** library.
   a) In the **Recoded variable name** box, type **PercentChangeCat**.
   b) Verify that the **Write to another data set** option is selected.
   c) In the **Data set name** box, type **census.population_change_cat**.
7) Use the specified ranges of **PercentChange** to group the values into categories in the new **PercentChangeCat** column.
   a) Click the **Values** tab.
   b) Verify that the **Recode to character variable** option is selected.
   c) In the **Lower bound** box, type **-0.2**. In the **Upper bound** box, type **-0.001**. In the **Recoded value** box, type **Decrease**.
   d) Click (**Add a row**).
   e) In the **Lower bound** box, type **0**. In the **Upper bound** box, type **0.049**. In the **Recoded value** box, type **0% to 5% Increase**.
   f) Click (**Add a row**).
   g) In the **Lower bound** box, type **0.05**. In the **Upper bound** box, type **0.099**. In the **Recoded value** box, type **5% to 10% Increase**.
   h) Click (**Add a row**).
   i) In the **Lower bound** box, type **0.1**. In the **Upper bound** box, type **0.2**. In the **Recoded value** box, type **10% or Higher Increase**.
8) Click **Code/Results** to change the view.

9) Click (**Run**) to execute the code and view the recoded values on the Output Data tab.

   The **PercentChangeCat** column categorizes each state by the value in the **PercentChange** column.

Total rows: 52 Total columns: 6

	PercentChangeCat	GEO_ID	State	TotalPop2010	TotalPop2018	PercentChange
1	0% to 5% Increase	0400000US01	Alabama	4,785,298	4,887,871	2.1%
2	0% to 5% Increase	0400000US02	Alaska	713,985	737,438	3.3%
3	10% or Higher Increase	0400000US04	Arizona	6,413,737	7,171,646	11.8%
4	0% to 5% Increase	0400000US05	Arkansas	2,921,606	3,013,825	3.2%
5	5% to 10% Increase	0400000US06	California	37,349,363	39,557,045	5.9%
6	10% or Higher Increase	0400000US08	Colorado	5,049,071	5,695,564	12.8%
7	Decrease	0400000US09	Connecticut	3,577,073	3,572,665	-0.1%
8	5% to 10% Increase	0400000US10	Delaware	899,769	967,171	7.5%
9	10% or Higher Increase	0400000US11	District of Columbia	604,453	702,455	16.2%

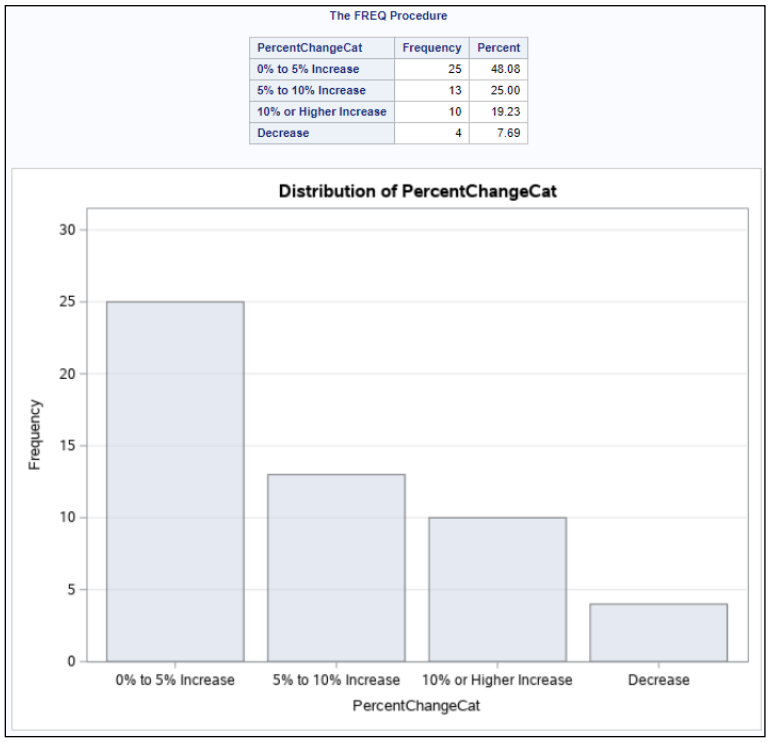
e. Use the One-Way Frequencies task in the Statistics category to create a report that counts the number of states that fall into each percent change category. Use the specified settings.

1) If necessary, select the **Tasks and Utilities** section in the navigation pane.
2) Expand **Tasks** ⇨ **Statistics** and double-click **One-Way Frequencies** to open the task in a new tab.
3) Click **Settings** to view only the task settings.
4) Specify **census.population_change_cat** as the input table.
   a) On the **Data** tab, click (**Select a table**).
   b) In the Select a Table window, expand the **CENSUS** library and select the **POPULATION_CHANGE_CAT** table.
   c) Click **OK**.
5) Assign **PercentChangeCat** as the analysis variable.
   a) To assign a column to the **Analysis variables** role, click (**Add columns**).
   b) In the Columns window, select **PercentChangeCat**.
   c) Click **OK**.
6) Do not include cumulative frequencies and percentages in the report.
   a) Click the **Options** tab.
   b) Clear the **Include cumulative frequencies and percentages** check box.
7) Order the output report by descending frequencies.

   From the **Row value order** drop-down list, select **Descending Frequency**.
8) Click **Code/Results** to change the view.

9) Click (**Run**) to execute the code and view frequency report on the Results tab.

The report shows that almost half of all states had a population increase between 0% and 5%, and only four states had a decrease in population.



f. Save the settings specified in the One-Way Frequencies task as **Population Change Frequency** in the **Census Data Analysis** folder. Then, close the **Population Change Frequency.ctk**, **Recode Ranges**, **Program 1**, and **Query 1** tabs. It is not necessary to save the settings specified in the Recode Ranges task, the SAS program, and the Query utility.

1) Click (**Save**).
2) Navigate to and select the **Census Data Analysis** folder.
3) In the **Name** box, type **Population Change Frequency**.
4) Click **Save**.
5) Close the **Population Change Frequency.ctk**, **Recode Ranges**, **Program 1**, and **Query 1** tabs. It is not necessary to save the settings specified in the Recode Ranges task, the SAS program, and the Query utility.

End of Solutions

Analyze Census Data with Statistical Tasks in SAS® Studio

Analyze Census Data with Statistical Tasks in SAS Studio

Important: You must perform the tutorial setup to download the necessary files and to set up your SAS Studio environment. You can follow the steps in the **Introduction to Analyzing Census Data in SAS Studio** section or watch the corresponding video.

This tutorial assumes some knowledge of statistical tests and concepts. This tutorial does not teach the fundamentals, but instead will focus on how to perform statistical tests in SAS Studio as well as how to interpret the results. To learn more about the statistical tests used and how to perform statistical analyses using SAS Studio, take the free e-learning for the introductory Statistics 1: Introduction to ANOVA, Regression, and Logistic Regression course.

Use statistical tasks in SAS Studio to analyze median household income values across states. First, use the Distribution Analysis task to examine the distribution of median household income values in each region. Then, use the One-Way ANOVA task to determine whether there is a significant relationship between median household income values and region. Finally, use the Correlation Analysis task to examine the relationship between median household income values and other statistics, such as mean hours worked per week, and median monthly housing costs.

Using the Distribution Analysis Task

1. In the **Server Files and Folders** section, expand **Files** and navigate to and expand the **Census Data Analysis** folder. Double-click on **stateinfo_combined** to open the table in a new tab. This table contains each state's estimates on median household income, mean hours worked per week, total population, median age, median duration of current marriage, and median monthly housing costs, along with the division and region.

   Note: All estimates in **stateinfo_combined** can be found on data.census.gov. The 1-year estimates for 2018 were downloaded for all states. The individual estimates were joined with a geography lookup based off of the 2018 Census Bureau Region and Division Codes and State FIPS Codes Excel file to create the table. To learn more about the Census Bureau's regions and divisions, see the Census Regions and Divisions of the United States reference page.

Total rows: 51 Total columns: 10

	GEO_ID	State	Division	Region	MedianIncome	MeanHoursWorked	TotalPopulation	MedianAge	MedianCurrentMarriageDuration	MedianMonthlyHousingCosts
1	0400000US08	Colorado	Mountain	West	$71,953	39.2	5,695,564	36.9	17.7	$1,335
2	0400000US18	Indiana	East North Central	Midwest	$55,746	39	6,691,878	37.8	19.8	$838
3	0400000US21	Kentucky	East South Central	South	$50,247	38.9	4,468,402	39.1	19.8	$776
4	0400000US22	Louisiana	West South Central	South	$47,905	39.7	4,659,978	37.3	19.7	$806
5	0400000US17	Illinois	East North Central	Midwest	$65,030	38.6	12,741,080	38.3	20.5	$1,109
6	0400000US19	Iowa	West North Central	Midwest	$59,955	38.9	3,156,145	38.1	21.8	$839
7	0400000US33	New Hampshire	New England	Northeast	$74,991	38.6	1,356,458	43.1	22.2	$1,314
8	0400000US05	Arkansas	West South Central	South	$47,062	39.6	3,013,825	38.1	19.4	$707
9	0400000US10	Delaware	South Atlantic	South	$64,805	38.8	967,171	41.1	22	$1,134
10	0400000US27	Minnesota	West North Central	Midwest	$70,315	38.3	5,611,179	38.2	21.2	$1,091
11	0400000US30	Montana	Mountain	West	$55,328	38.1	1,062,305	40.1	21.4	$847
12	0400000US23	Maine	New England	Northeast	$55,602	38.3	1,338,404	45.1	22.5	$908
13	0400000US37	North Carolina	South Atlantic	South	$53,855	39.3	10,383,620	38.9	19.8	$909

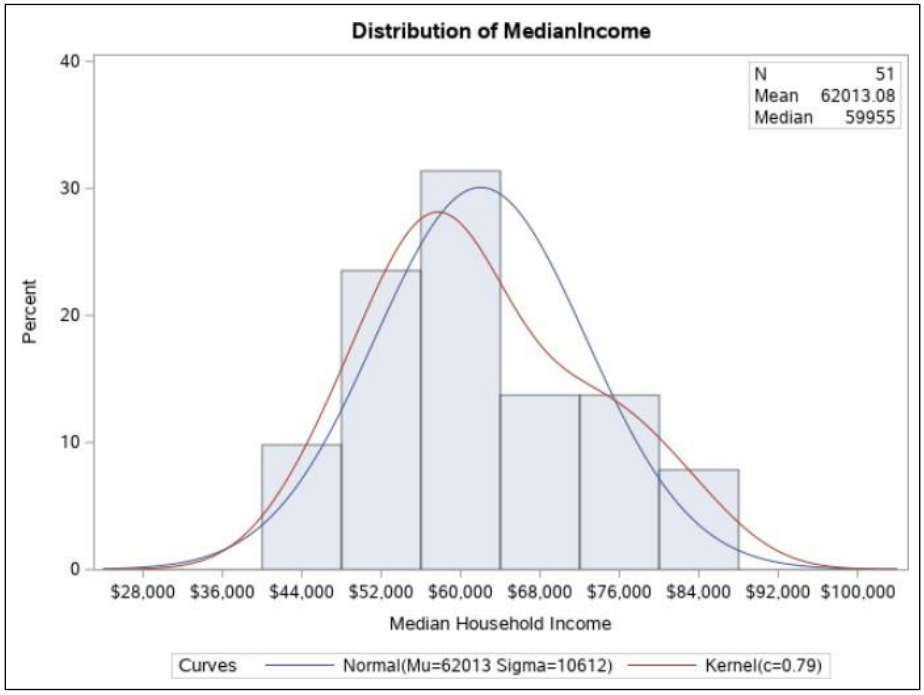
2. To examine the distribution of median household income values, use the Distribution Analysis task. In the navigation pane, expand the **Tasks and Utilities** section. Expand **Tasks** ⇨ **Statistics** and double-click **Distribution Analysis** to open the task in a new tab. The Distribution Analysis task provides information about the distribution of selected numeric variables.

   Note: The Distribution Analysis task requires that the SAS/STAT product is licensed. SAS/STAT is included with SAS OnDemand for Academics: Studio.

3. Click (**Maximize View**) to hide the navigation pane and maximize the work area.

4. On the **Data** tab, click (**Select a table**). In the Select a Table window, expand the **CENSUS** library, select the **STATEINFO_COMBINED** table, and click **OK**.
5. The **Analysis variables** role specifies the numeric columns to analyze. To analyze the distribution of median household income values, click (**Add columns**). In the Columns window, select **MedianIncome** and click **OK**.
6. Click the **Options** tab. Verify that the **Histogram** check box is selected.
7. To add density curves to the plot, click the **Add normal curve** and **Add kernel density estimate** check boxes.
8. Click the **Add inset statistics** check box. Expand the **Inset Statistics** subheading. Click the **Number of observations** (selected by default), **Mean**, and **Median** check boxes to include an inset box of those statistics in the graph.
9. Click (**Run**) to submit the generated code and view the report on the Results tab.

   In the histogram, the normal curve in blue outlines a normal distribution with the same mean and variance as the input data. The kernel density curve in red outlines a smooth approximation of the distribution of the observed data. The two curves appear to be fairly similar, although the data is slightly right skewed. The mean, $62,013.08, is about $2,000 higher than the median, $59,955.

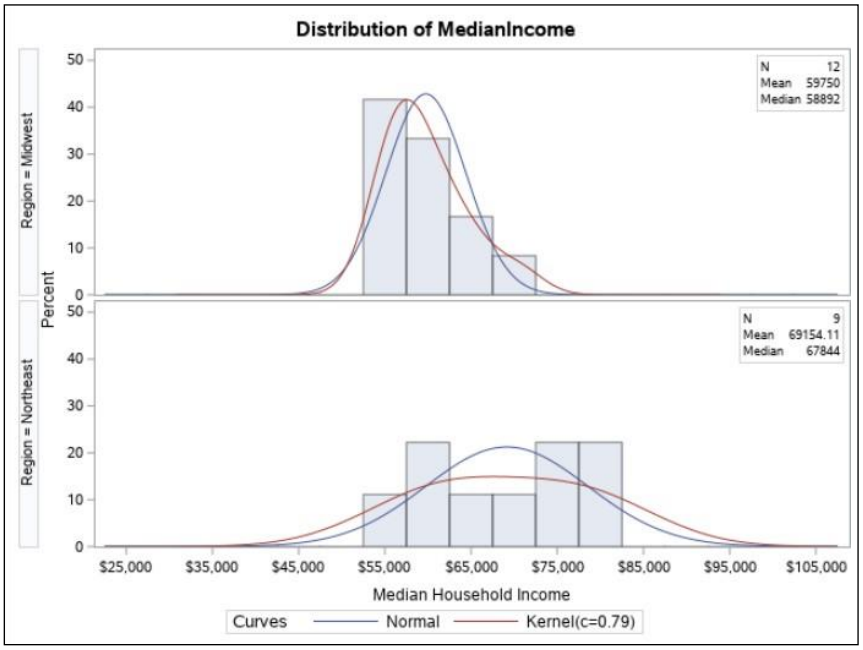


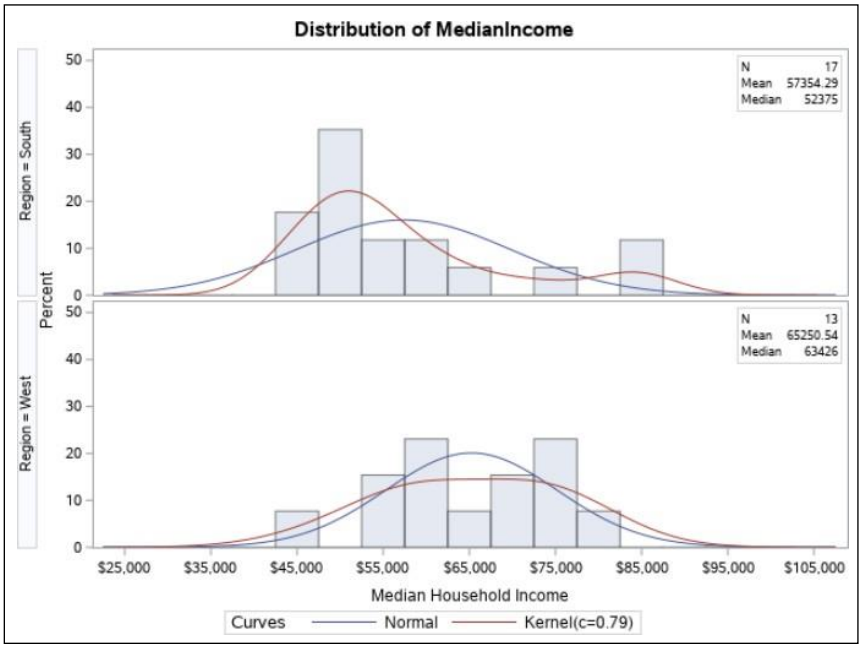
10. On the **Options** tab, the **Classification variables** role can be used to create separate histograms for each classification level. To investigate if the distribution is different in each region, click (**Add columns**). In the Columns window, select **Region** and click **OK**.

    Note: To learn more about the available options in the Distribution Analysis task, see the Distribution Analysis page in the SAS Studio Task Reference Guide.

11. Click (**Run**) to view the updated report on the Results tab.

    Each region has a unique distribution. The Midwest region has a right-skewed distribution, the Northeast region is closer to a uniform distribution, and the South and West regions have states with extreme values.





12. Click (**Exit maximized view**) to restore the navigation pane.

Using the One-Way ANOVA Task

13. To further investigate the relationship between median household income and region, use the One-Way ANOVA task. In the **Tasks and Utilities** section, expand **Tasks** ⇨ **Linear Models** and double-click **One-Way ANOVA** to open the task in a new tab. The One-Way ANOVA task tests and provides graphs for differences among the means of a single categorical variable on a single continuous dependent variable.

    Note: The One-Way ANOVA task requires that the SAS/STAT product is licensed.

14. Click (**Maximize View**) to hide the navigation pane and maximize the work area.

15. On the **Data** tab, verify that **CENSUS.STATEINFO_COMBINED** is listed as the input table.

    Note: The most recently used table in tasks is listed as the input table by default. If **CENSUS.STATEINFO_COMBINED** is not listed as the input table, click (**Select a table**). In the Select a Table window, expand the **CENSUS** library, select the **STATEINFO_COMBINED** table, and click **OK**.

16. The **Dependent variable** role specifies a continuous numeric column. To assign a column to this role, click (**Add a column**). In the Columns window, select **MedianIncome** and click **OK**.

17. The **Categorical variable** role specifies a column with values that specify the levels of the groups. To assign a column to this role, click (**Add a column**). In the Columns window, select **Region** and click **OK**.

18. Click the **Options** tab. By default, the task performs Levene's test for homogeneity of variance to test that the variances within each region are equal. Clear the check box for **Welch's variance-weighted ANOVA**.

    Note: If the ANOVA assumption of equal error variances across all groups is not met, click the check box for **Welch's variance-weighted ANOVA**.

19. By default, the task will determine whether there are significant differences in the mean of the median income between each pair of regions with Tukey's adjustment.

20. Use the **Display plots** drop-down list to select **Selected plots**. Clear the check boxes for **Means plot** and **LS-mean difference plot** and click the check box for **Diagnostics plot**. Verify that only the **Box plot** and **Diagnostics plot** check boxes are selected.

    Note: To learn more about the available options in the One-Way ANOVA task, see the One-Way ANOVA page in the SAS Studio Task Reference Guide.

21. Click (**Run**) to submit the generated code and view the report on the Results tab.

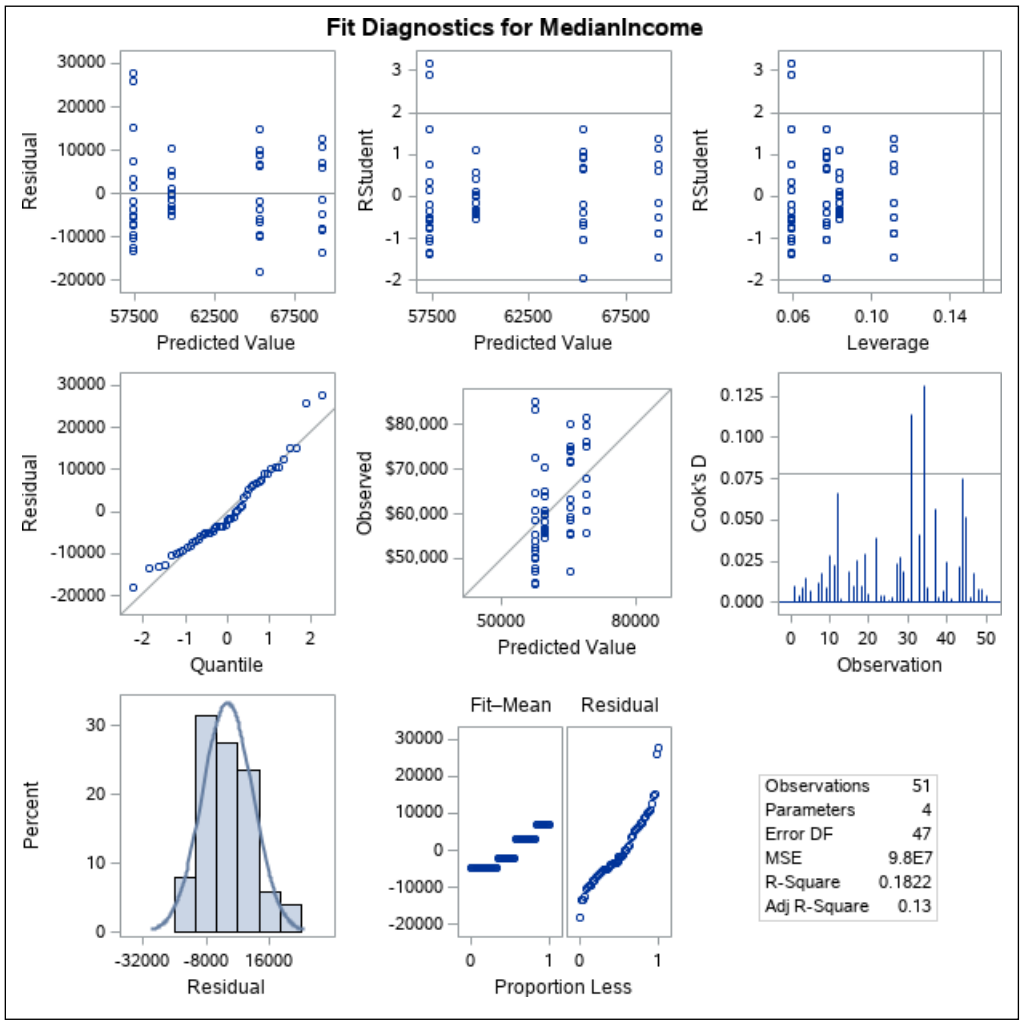
    The overall analysis of variance table returns a *p*-value of 0.0228, which is less than 0.05. This indicates that the test is significant. This suggests that there are at least two regions where the mean of the median household income values is significantly different.

Dependent Variable: MedianIncome Median Household Income

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	1025634946	341878315	3.49	0.0228
Error	47	4604887392	97976327		
Corrected Total	50	5630522338			

The fit diagnostics panel contains a set of graphs commonly used to validate the assumptions of ANOVA. There are several assumptions that must be met:

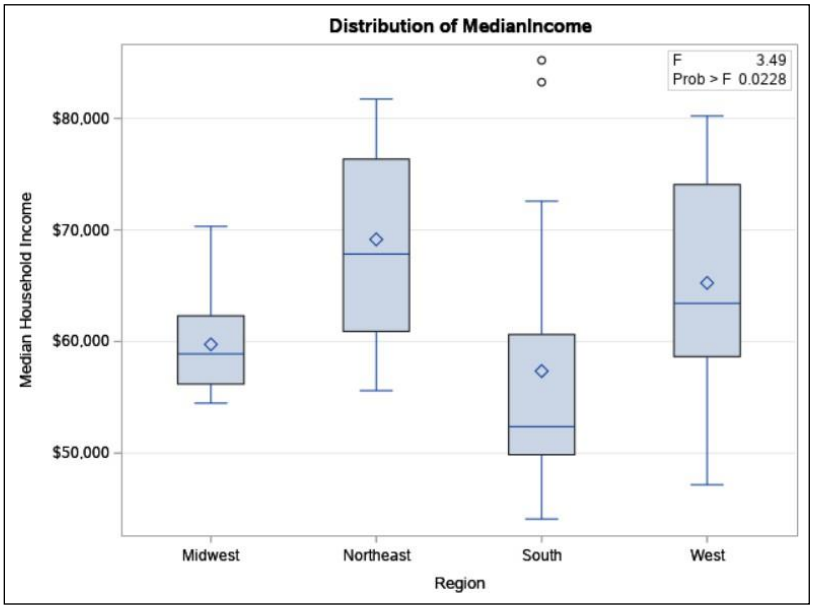
- The observations must be independent. We do not see the appearance of repeated measures or clustering. We will assume that the data was collected in a way to ensure independence of the observations.
- The errors must be normally distributed. The first scatter plot on the second row is a quantile-quantile (Q-Q) plot. There is very little deviation from the reference line. Thus, the residuals are normally distributed. This can be verified using the first histogram on the third row, which is a residual histogram. This histogram displays a relatively normal distribution of the residuals.
- All groups have equal error variances. This can be verified with Levene's test for homogeneity of variance, which is later in the output. Levene's test returns a *p*-value of 0.1542, which is greater than 0.05. Thus, the null hypothesis of equal variances failed to be rejected. Therefore, the assumption of equal error variances across all groups is met.



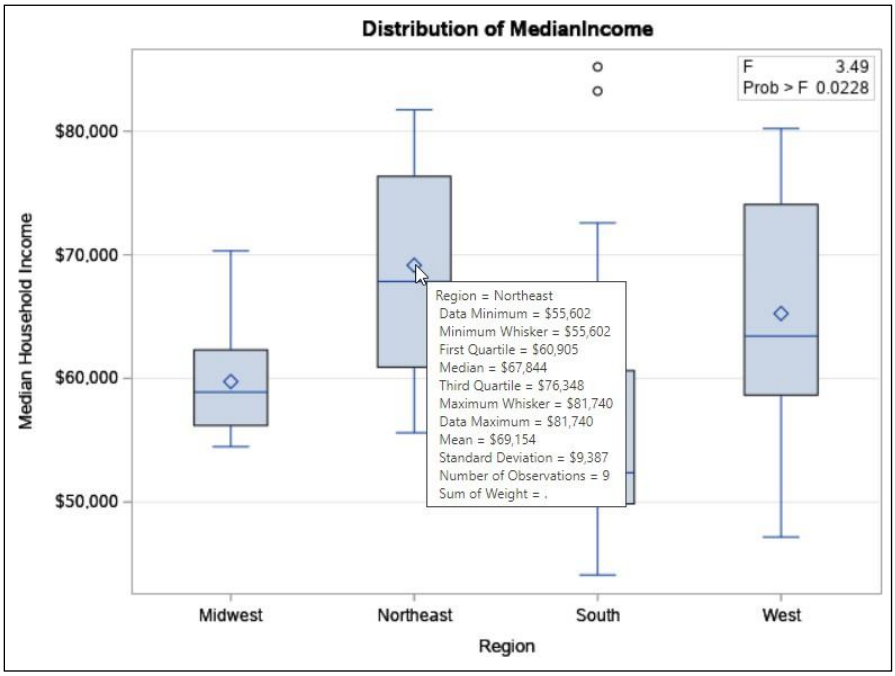
Levene's Test for Homogeneity of MedianIncome Variance
ANOVA of Squared Deviations from Group Means

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Region	3	1.132E17	3.774E16	1.83	0.1542
Error	47	9.681E17	2.06E16		

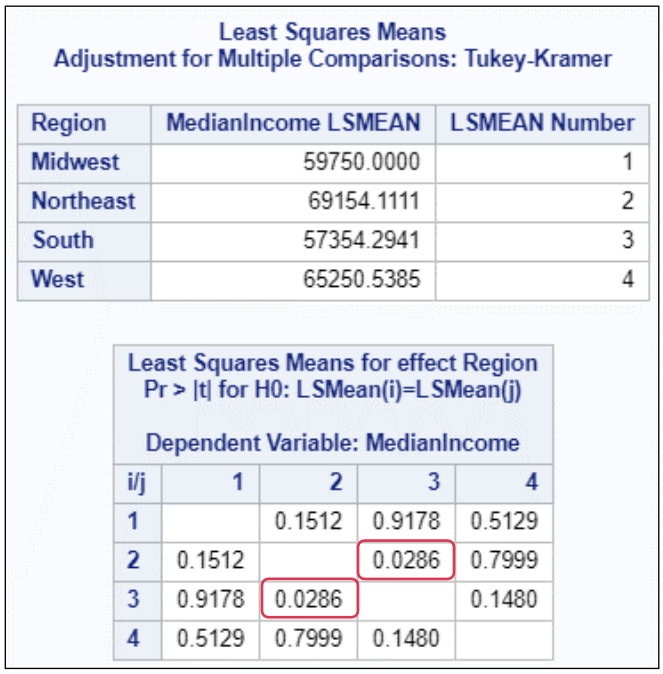
The box plots indicate that the Northeast region has the highest average regional median household income, and the South region has the lowest.



Hover over any of the boxes or whiskers to display a tooltip to display descriptive statistics.



The least squares mean tables display pairwise comparisons among all regions. An adjusted *p*-value of 0.0286, which is less than 0.05, between the Northeast and South regions indicates that the mean of the median household income values between the two regions are significantly different.



Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Region	MedianIncome LSMEAN	LSMEAN Number
Midwest	59750.0000	1
Northeast	69154.1111	2
South	57354.2941	3
West	65250.5385	4

Least Squares Means for effect Region
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: MedianIncome

i/j	1	2	3	4
1		0.1512	0.9178	0.5129
2	0.1512		0.0286	0.7999
3	0.9178	0.0286		0.1480
4	0.5129	0.7999	0.1480	

22. Click (**Exit maximized view**) to restore the navigation pane.

Using the Correlation Analysis Task

23. To determine whether there is any relationship, or correlation, between median household incomes and other statistics such as mean hours worked per week, or median monthly housing costs, use the Correlation Analysis task. In the **Tasks and Utilities** section, expand **Tasks** ⇨ **Statistics** and double-click **Correlation Analysis** to open the task in a new tab. The Correlation Analysis task can be used to investigate associations among numeric variables.

    Note: The Correlation Analysis task requires that the SAS/STAT product is licensed.

24. Click (**Maximize View**) to hide the navigation pane and maximize the work area.

25. On the **Data** tab, verify that **CENSUS.STATEINFO_COMBINED** is listed as the input table.

26. The **Analysis variables** role lists the columns for which to compute correlation coefficients. To assign columns to this role, click (**Add columns**). In the Columns window, select **MedianHoursWorked**, hold down the Shift key, and select and **MedianMonthlyHousingCosts**. In addition to the two columns, all columns listed between are also selected, including **TotalPopulation**, **MedianAge**, and **MedianCurrentMarriageDuration**. Click **OK**.

27. The **Correlate with** role lists the columns with which the correlations of the analysis variables are to be computed. To determine the relationship between median household income and the analysis variables, click (**Add columns**). In the Columns window, select **MedianIncome** and click **OK**.

28. Click the **Options** tab. Under the **Plots** heading, use the **Type of plot** drop-down menu to select **Individual scatter plots**. The individual scatter plots will display the pairwise relationship between the analysis variables and median household income.

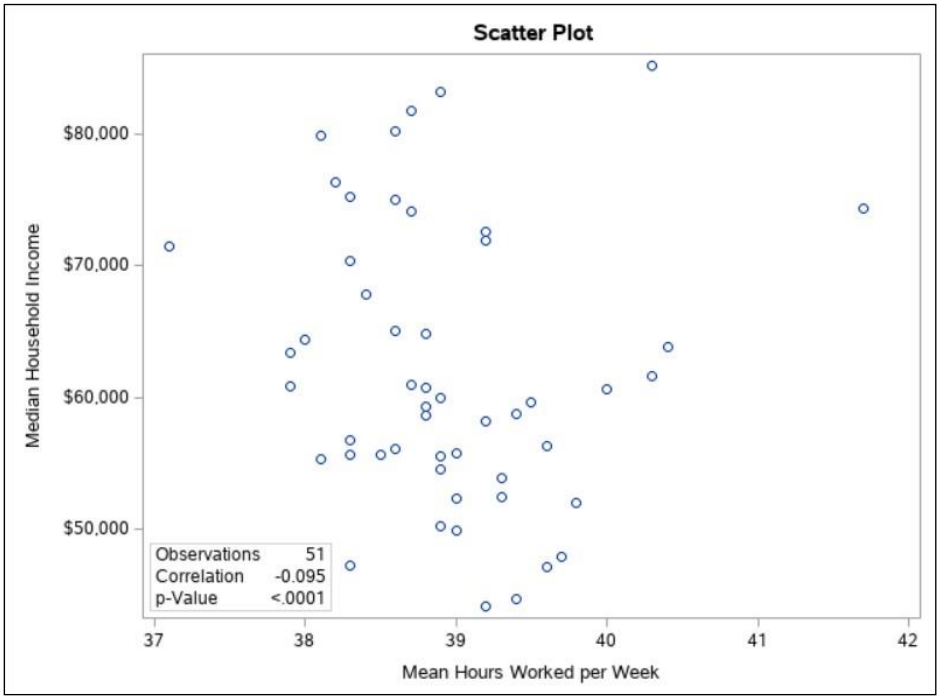
29. Click (**Run**) to submit the generated code and view the report on the Results tab.

    The Pearson correlation coefficients table displays the strength of a linear association between median household income and the potential predictor variables. The stronger the association between two variables, the closer the Pearson correlation coefficient will be to either -1 or 1, depending on whether the relationship is negative or positive, respectively. The Pearson correlation coefficient between median household income values and median monthly housing costs is 0.93492, indicating a strong positive linear relationship between the two as compared to the other pairs. In other words, the higher the median monthly housing costs, the higher the median income. Use the scatter plot to verify that the relationship is linear.

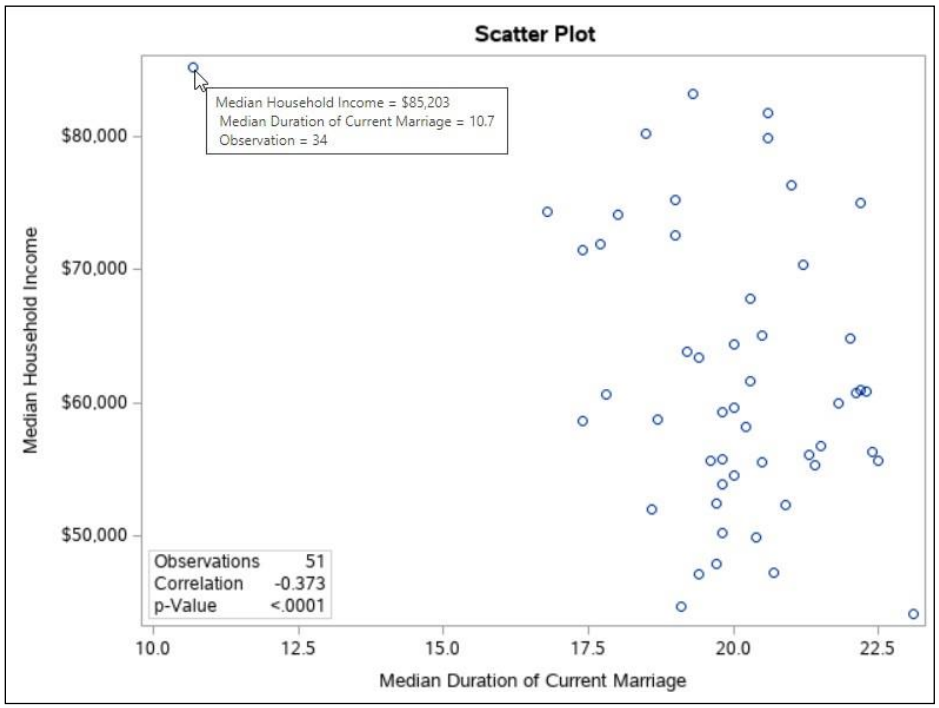
Pearson Correlation Coefficients, N = 51

	MeanHoursWorked	TotalPopulation	MedianAge	MedianCurrentMarriageDuration	MedianMonthlyHousingCosts
MedianIncome Median Household Income	-0.09521	0.11367	-0.16273	-0.37304	0.93492

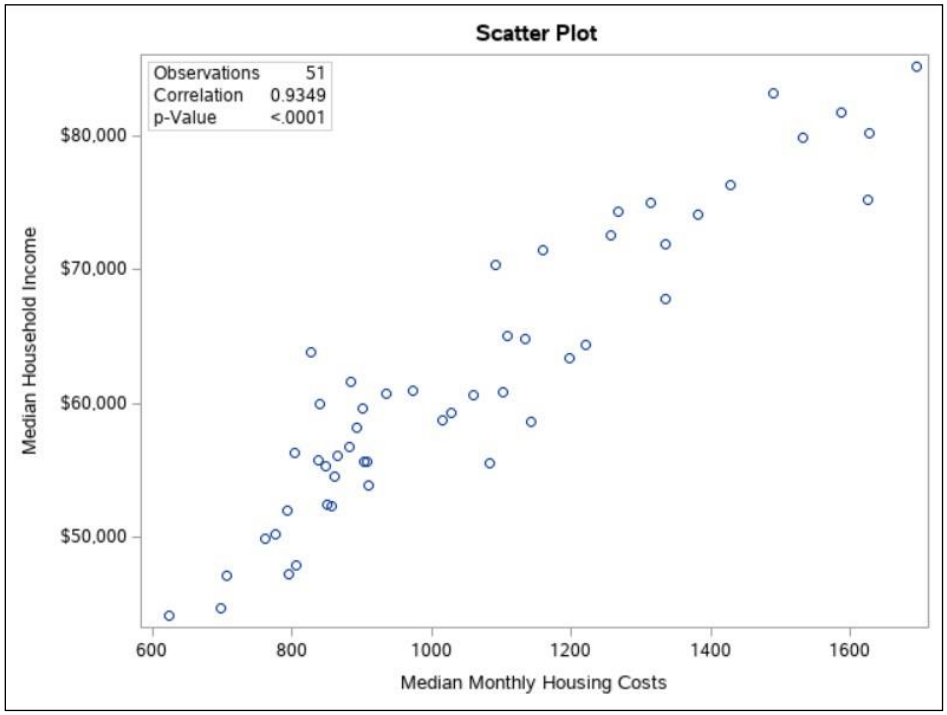
    The individual scatter plots provide a visual of the relationship between median household income values and the analysis variables. There is no significant relationship between median household values and median hours worked per week.



There is a slight negative linear relationship between median household income and median duration of current marriage, indicating that the longer a couple is married, the less the median household income is. However, the outlier can have had a strong influence on the relationship. Hover over the outlier to learn more about it. The tooltip indicates this point is observation 34.



The scatter plot for median household income and median monthly housing costs confirms the strong positive linear relationship between the two variables.



30. The task-generated code can be modified to enhance the results with options that are not available in the Correlation Analysis task. Click the **Code** tab, and then click **Edit** to create a modifiable copy of the program on a new tab.

    Note: To learn more about the CORR procedure code that is generated by the Correlation Analysis task, on the Correlation Analysis tab, click the **Information** tab. Under the **Resources** heading, click **The CORR Procedure** link.

31. In the PROC CORR statement, before the semicolon, type a blank space to display the autocomplete window with valid options for the PROC CORR statement. Type **r** to highlight the RANK option, and view the syntax help window. The RANK option displays the Pearson correlation coefficients in order from highest to lowest in absolute value. Click the Enter key to include the option in the program. The completed PROC CORR statement should resemble the following:

```
proc corr data=CENSUS.STATEINFO_COMBINED pearson nosimple noprob
        plots=scatter(ellipse=none) rank;
```

```
1 ods noproctitle;
2 ods graphics / imagemap=on;
3
4 proc corr data=CENSUS.STATEINFO_COMBINED pearson nosimple noprob
5         plots=scatter(ellipse=none) rank;
6     var MeanHoursWorked TotalPopulation MedianAge MedianCurrentMarriageDuration
7         MedianMonthlyHousingCosts;
8     with MedianIncome;
9 run;
```

32. The ID statement can be used in a PROC CORR step to specify additional tip variables to identify observations in the scatter plots. To include the state and region in the tooltip of the scatter plots, type the following ID statement after the WITH statement:

```
id State Region;
```

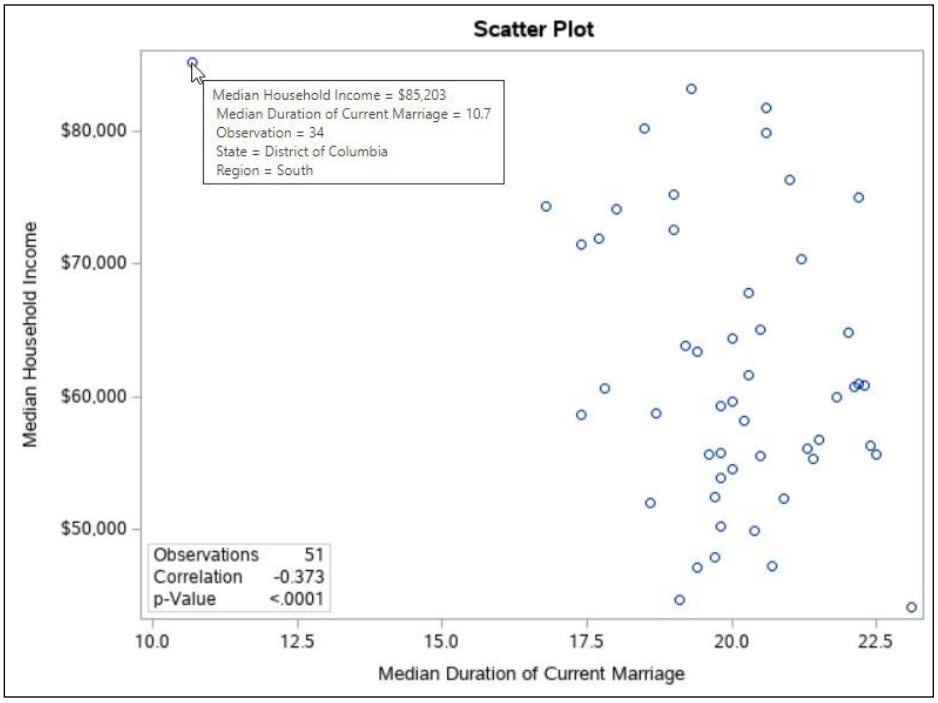
```
1 ods noproctitle;
2 ods graphics / imagemap=on;
3
4 proc corr data=CENSUS.STATEINFO_COMBINED pearson nosimple noprob
5         plots=scatter(ellipse=none) rank;
6     var MeanHoursWorked TotalPopulation MedianAge MedianCurrentMarriageDuration
7         MedianMonthlyHousingCosts;
8     with MedianIncome;
9     id State Region;
10 run;
```

33. Click (**Run**) to view the updated report on the Results tab.

    The Pearson correlation coefficients table now displays the Pearson correlation coefficients in order from strongest to weakest in absolute value.

Pearson Correlation Coefficients, N = 51					
MedianIncome Median Household Income	MedianMonthlyHousingCosts 0.93492	MedianCurrentMarriageDuration -0.37304	MedianAge -0.16273	TotalPopulation 0.11367	MeanHoursWorked -0.09521

In the scatter plot for median household income and median duration of current marriage, hover over the outlier. The tooltip indicates that this outlier is the District of Columbia, with a median household income of $85,203 and a median duration of current marriage of 10.7 years.



34. Click the **Code** tab of the modified program. To save the modified SAS program, click (**Save program**). Navigate to and select the **Census Data Analysis** folder. In the **Name** box, type **Median Income Correlation** and click **Save**. Close the **Median Income Correlation.sas** tab.
35. Click (**Exit maximized view**) to restore the navigation pane.
36. Close the **Correlation Analysis**, **One-Way ANOVA**, **Distribution Analysis**, and **stateinfo_combined.sas7bdat** tabs. It is not necessary to save the settings specified in the tasks.

End of Tutorial

Practice

Important: You must perform the tutorial setup to download the necessary files and to set up your SAS Studio environment. You can follow the steps in the **Introduction to Analyzing Census Data in SAS Studio** section or watch the corresponding video.

The practices assume some knowledge of statistical tests.

Level 1

1. Analyzing Median Age Using Statistical Tasks

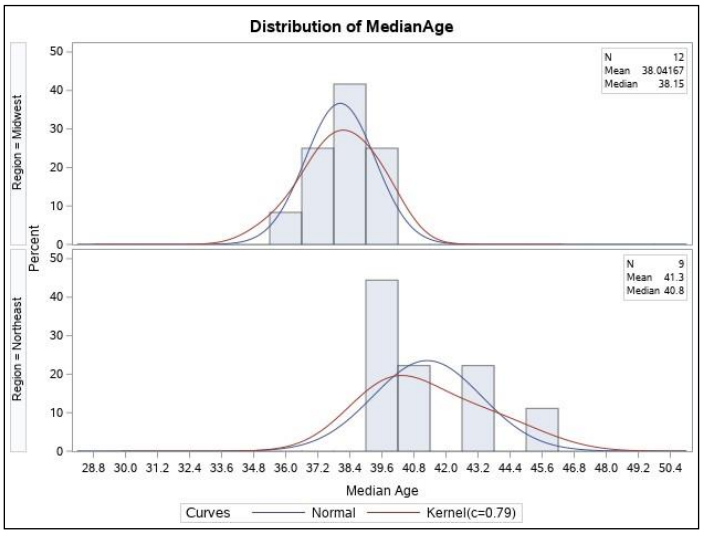
Analyze median age across states using statistical tasks. First, use the Distribution Analysis task to examine the distribution of median age in each region. Then, use the One-Way ANOVA task to determine whether there is a significant relationship between median age and region. Finally, use the Correlation Analysis task to examine the relationship between median age and other statistics, such as median income and median duration of current marriage.

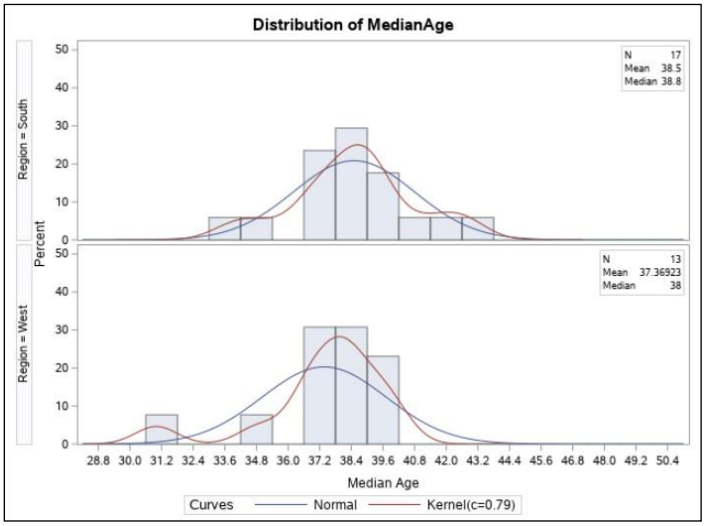
a. Use the Distribution Analysis task to examine the distribution of median age in each region. Use the following settings:

- Specify **census.stateinfo_combined** as the input table.

  Note: All estimates in **stateinfo_combined** can be found on data.census.gov. The 1-year estimates for 2018 were downloaded for all states. The individual estimates were joined with a geography lookup based off of the 2018 Census Bureau Region and Division Codes and State FIPS Codes Excel file to create the table.
- Assign **MedianAge** as the analysis variable.
- Include a histogram with a normal curve and a kernel density curve.
- Create a separate histogram for each region.
- Include an inset box of statistics in the graph that displays the number of observations, the mean, and the median statistics.

Each region has a unique distribution. The Midwest and South regions have fairly normal distributions, the Northeast region has a right-skewed distribution, and the West region has states with extreme values.





b. Use the One-Way ANOVA task to further investigate the relationship between median age and region. Use the following settings:

- Specify **census.stateinfo_combined** as the input table.
- Specify **MedianAge** as the dependent variable and **Region** as the categorical variable.
- Perform Levene's test for homogeneity of variance. Do not run Welch's variance-weighted ANOVA test.
- Use Tukey's adjustment to determine whether there are significant differences in the mean of median age between each pair of regions.
- Display only the box plot and diagnostics plot.

The overall analysis of variance table returns a *p*-value of 0.0006, which is less than 0.05, indicating that the test is significant. This suggests that there are at least two regions where the mean of median age values of the population is significantly different.

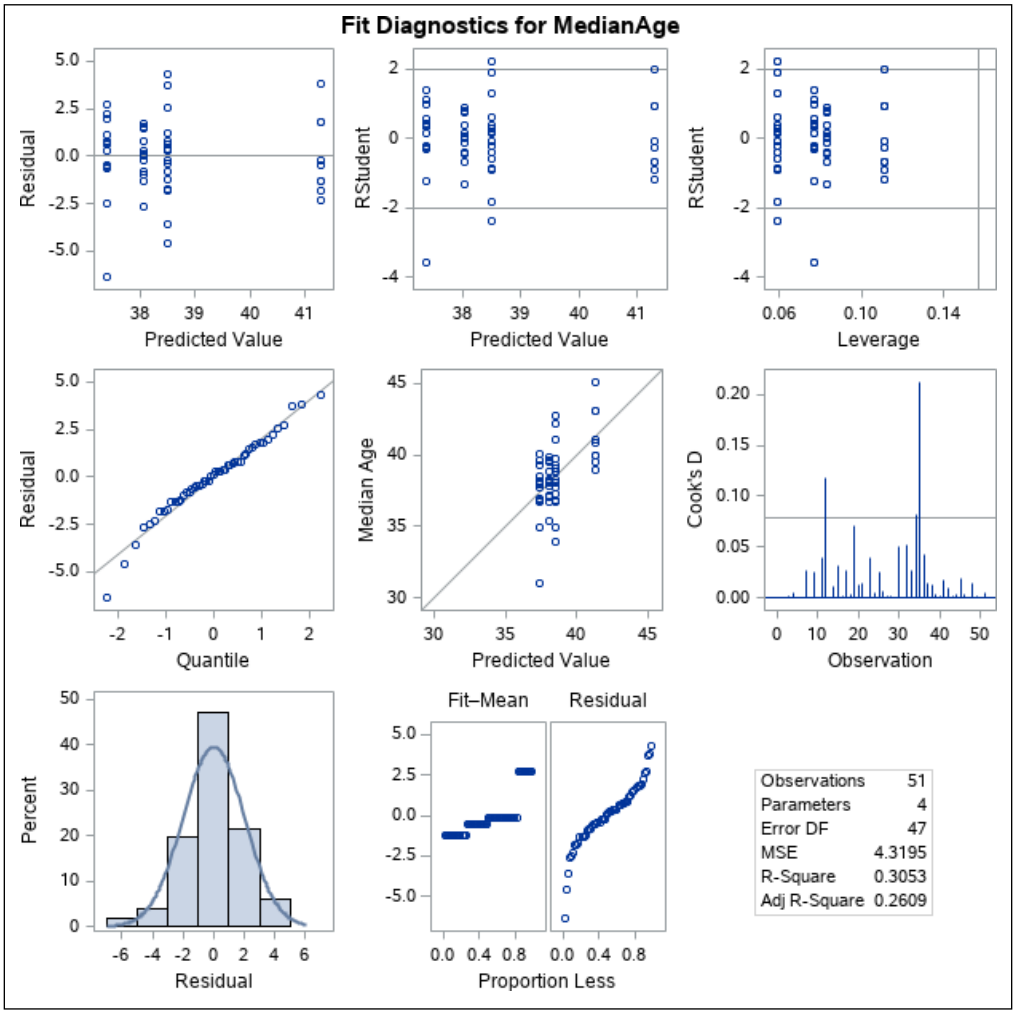
Dependent Variable: MedianAge Median Age

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	89.2129449	29.7376483	6.88	0.0006
Error	47	203.0168590	4.3195076		
Corrected Total	50	292.2298039			

The fit diagnostics panel contains a set of graphs commonly used to validate the assumptions of ANOVA. There are several assumptions that must be met:

- The observations must be independent. We do not see the appearance of repeated measures or clustering. We will assume that the data was collected in a way to ensure independence of the observations.
- The errors must be normally distributed. The Q-Q plot, which is the first scatter plot on the second row, shows very little deviation from the reference line. Thus, the residuals are normally distributed. This can be verified using the residual histogram, which is the first histogram on the third row. This histogram displays a relatively normal distribution of the residuals.
- All groups have equal error variances. This can be verified with Levene's test for homogeneity of variance, which is later in the output. Levene's test returns a *p*-value of

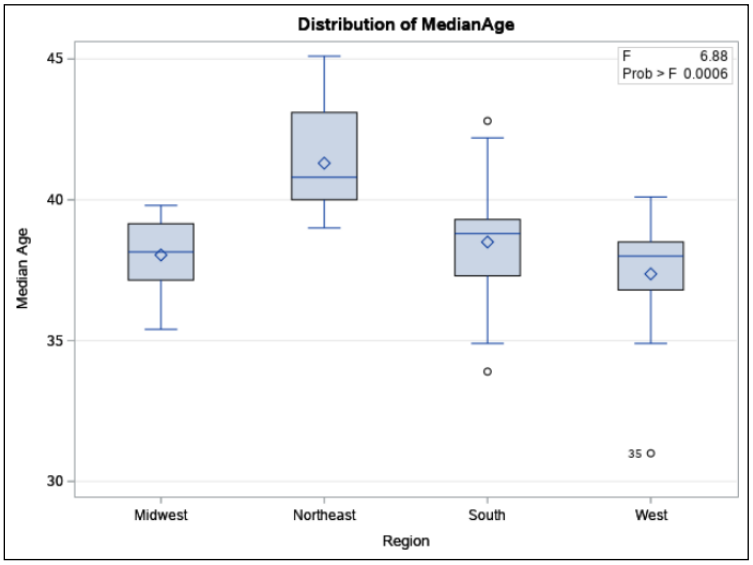
0.5712, which is greater than 0.05. Thus, the null hypothesis of equal variances failed to be rejected. Therefore, the assumption of equal error variances across all groups is met.



Levene's Test for Homogeneity of MedianAge Variance
ANOVA of Squared Deviations from Group Means

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Region	3	104.8	34.9277	0.68	0.5712
Error	47	2429.2	51.6843		

The box plots indicate that the Northeast region has the highest average regional median age, and the West region has the lowest.



The least squares mean table displays pairwise comparisons among all regions. The adjusted *p*-values of 0.0047 between the Midwest and Northeast regions, 0.0106 between the South and Northeast regions, and 0.0004 between the West and Northeast regions indicate that the mean of median age of the population between those regions are significantly different.

Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Region	MedianAge LSMEAN	LSMEAN Number
Midwest	38.0416667	1
Northeast	41.3000000	2
South	38.5000000	3
West	37.3692308	4

Least Squares Means for effect Region
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: MedianAge

i/j	1	2	3	4
1		0.0047	0.9361	0.8503
2	0.0047		0.0106	0.0004
3	0.9361	0.0106		0.4594
4	0.8503	0.0004	0.4594	

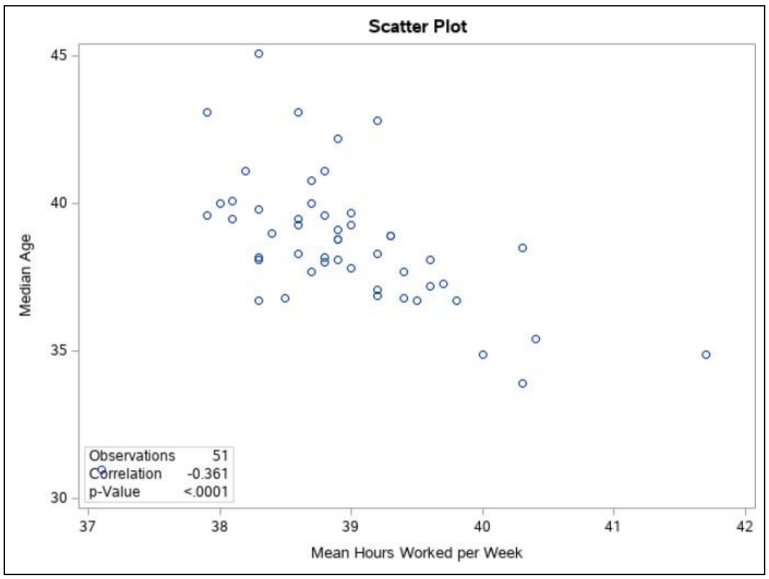
c. Use the Correlation Analysis task to determine whether there is any relationship between median age and other statistics such as median income and median duration of current marriage. Use the following settings.

- Specify **census.stateinfo_combined** as the input table.
- Assign **MedianAge** to the **Correlate with** role, and all other numeric columns to the **Analysis variables** role.
- Display individual scatter plots.

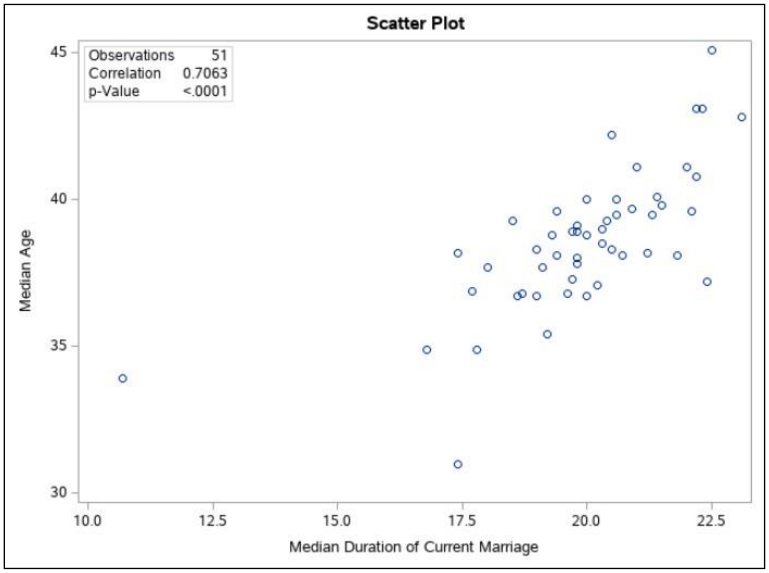
The Pearson correlation coefficient between median age and median duration of current marriage is 0.70628, indicating a strong positive linear relationship between the two as compared to the other pairs. In other words, the higher the median age, the longer a couple is married. Use the scatter plot to verify that the relationship is linear.

Pearson Correlation Coefficients, N = 51					
	MedianIncome	MeanHoursWorked	TotalPopulation	MedianCurrentMarriageDuration	MedianMonthlyHousingCosts
MedianAge Median Age	-0.16273	-0.36147	-0.08744	0.70628	-0.07692

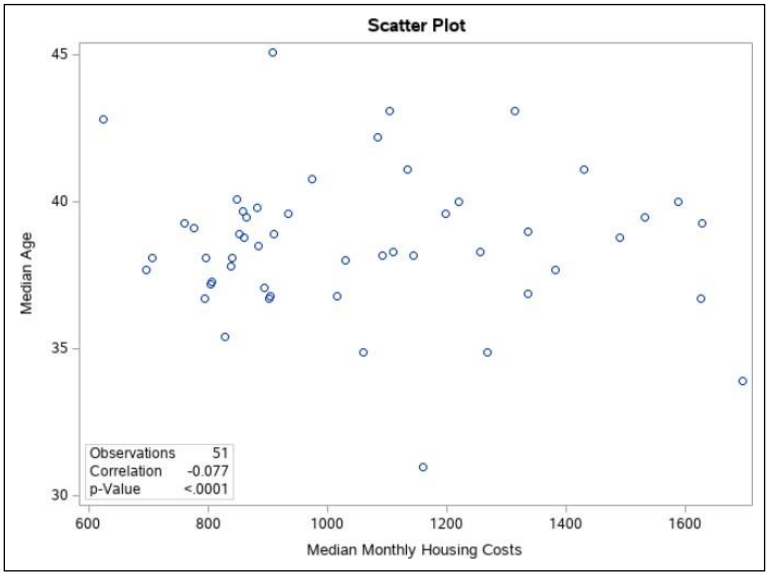
There is a slight negative linear relationship between median age and the average hours worked per week, indicating that the higher the median age, the fewer hours are worked per week. However, the outlier can have had an influence on the relationship.



The scatter plot for median age and median duration of current marriage confirm the strong positive linear relationship between the two variables.



There is no significant relationship between median age and median monthly housing costs.



d. Close the **Correlation Analysis**, **One-Way ANOVA**, and **Distribution Analysis** tabs. It is not necessary to save the settings specified in the tasks.

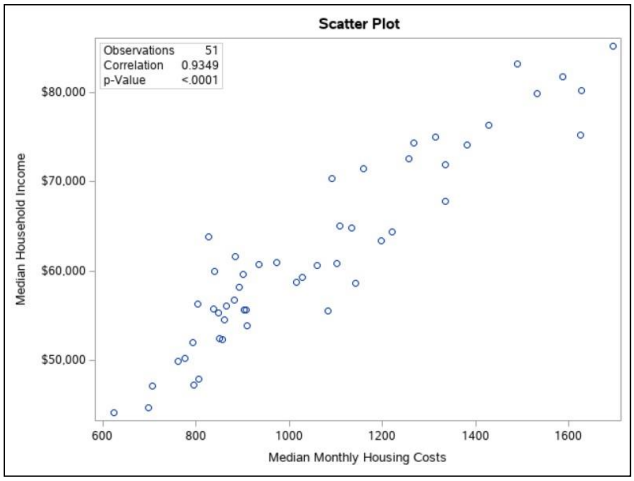
Challenge

2. Fitting a Simple Linear Regression Model to Predict Median Household Income

In the tutorial video, the Correlation Analysis task was used to quantify the linear relationship between median household income and other statistics such as mean hours worked per week and median monthly housing costs. The Pearson correlation coefficients were as shown below.

Pearson Correlation Coefficients, N = 51					
	MedianMonthlyHousingCosts	MedianCurrentMarriageDuration	MedianAge	TotalPopulation	MeanHoursWorked
MedianIncome Median Household Income	0.93492	-0.37304	-0.16273	0.11367	-0.09521

The Pearson correlation coefficient between median household income values and median monthly housing costs was 0.9342, which indicated a strong positive linear relationship between the two as compared to the other pairs. The scatter plot for median household income and median monthly housing costs obtained through the Correlation Analysis task confirmed the strong positive linear relationship between the two variables.



Use the Linear Regression task to perform a simple linear regression analysis to determine how well you can predict median household income given the median monthly housing costs.

a. Use the Linear Regression task in the Linear Models category to define the linear relationship between median household income and median monthly housing costs. Use the following settings:

- Specify **census.stateinfo_combined** as the input table.
- Specify **MedianIncome** as the response (dependent) variable and **MedianMonthlyHousingCosts** as the predictor (continuous) variable.
- Use the model settings to add **MedianMonthlyHousingCosts** as a single effect to the model.

The ANOVA table provides an analysis of the variability observed in the data and the variability explained by the regression line. The fitted regression line in the baseline model is a horizontal line across all values of the predictor variable. Thus, the slope is 0 and the intercept is the sample mean of the response variable. The *p*-value is less than 0.0001, which is less than 0.05. Thus, the null hypothesis that the baseline model fits the data is rejected in favor of the alternative model, the simple linear regression. Therefore, median monthly housing costs explain a significant amount of variability in median household income.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	4921490297	4921490297	340.12	<.0001
Error	49	709032041	14470042		
Corrected Total	50	5630522338			

The third part of the output provides summary measures of fit for the model. The R-square value of 0.8741 means that the effects contained in the model explain 87.41% of the total variation in the median household income values.

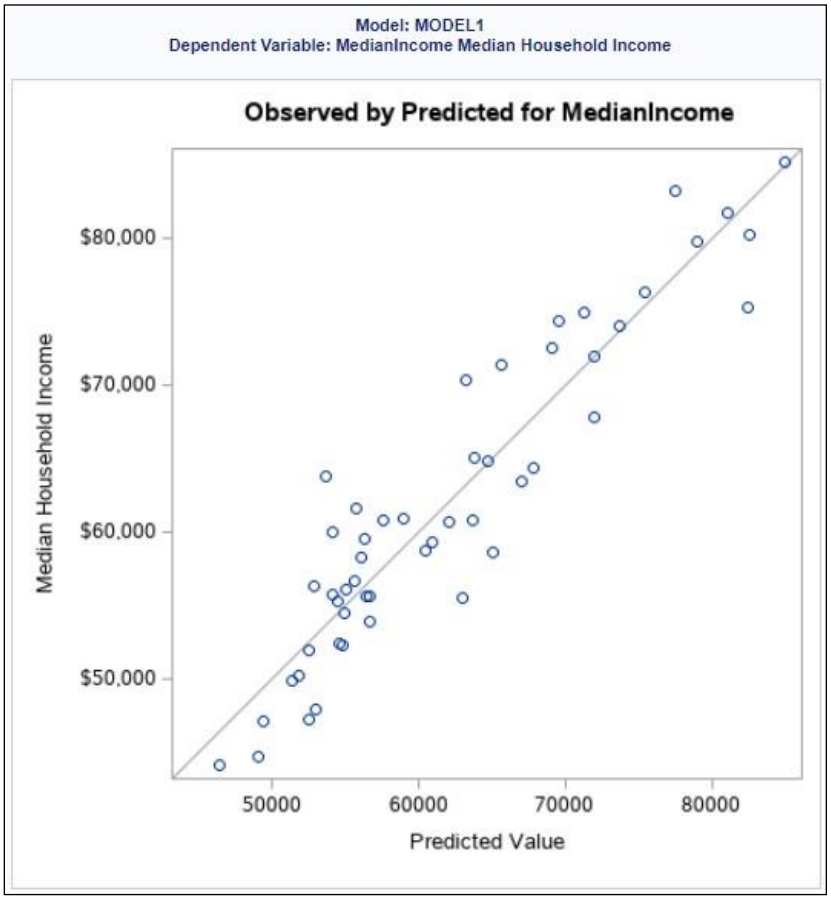
Root MSE	3803.95080	R-Square	0.8741
Dependent Mean	62013	Adj R-Sq	0.8715
Coeff Var	6.13411		

The Parameter Estimates table defines the model. The *p*-value is less than 0.0001 for median monthly housing costs, which is less than 0.05. Therefore, the slope for the predictor variable is statistically different from 0. Using the parameter estimates, the estimated regression equation is **MedianIncome** = $23,954 + ($35.9759 * **MedianMonthlyHousingCosts**). Each additional dollar of median monthly housing costs is associated with an approximately $35.98 higher median household income.

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	23954	2131.32029	11.24	<.0001
MedianMonthlyHousingCosts	Median Monthly Housing Costs	1	35.97590	1.95073	18.44	<.0001

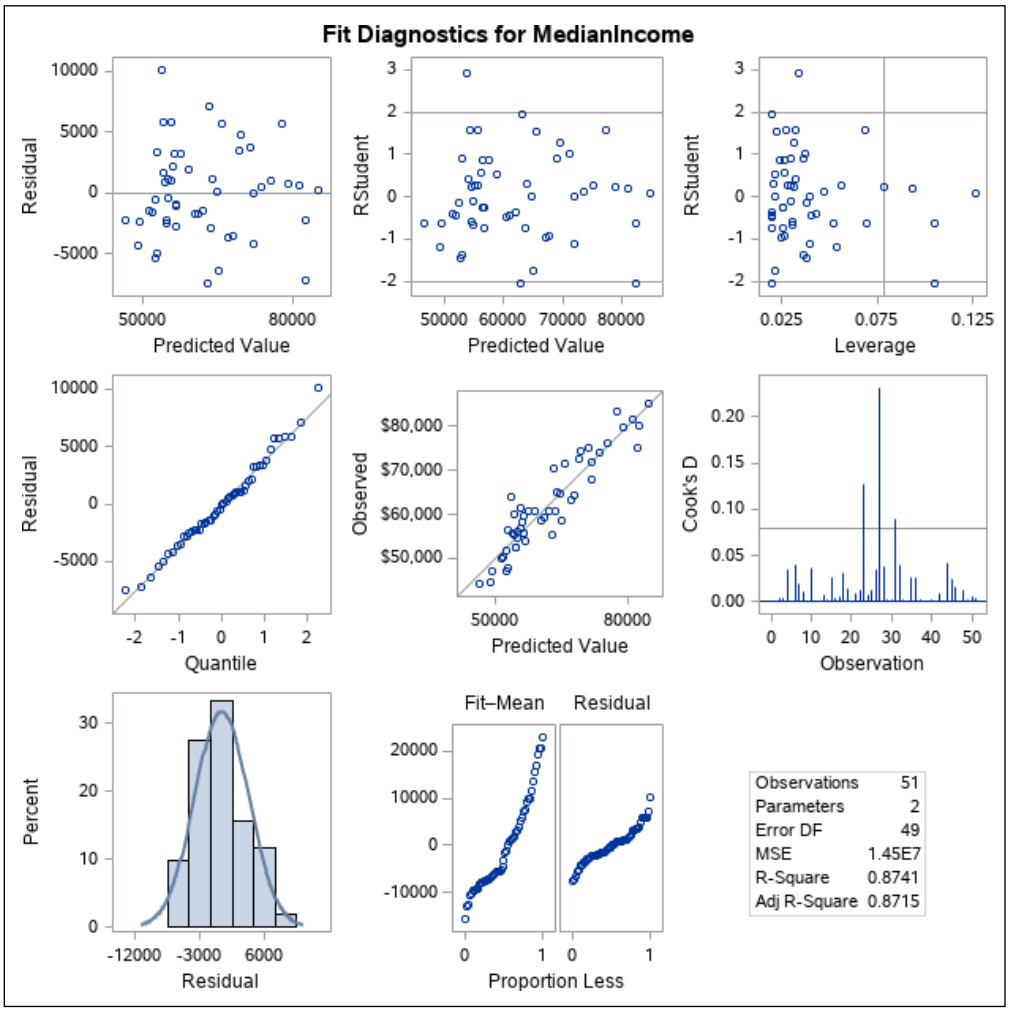
The scatter plot displays the actual median household income values versus the predicted values based on the estimated regression equation. The observations lie close to the diagonal reference line, indicating a good fit of the model to the data points.



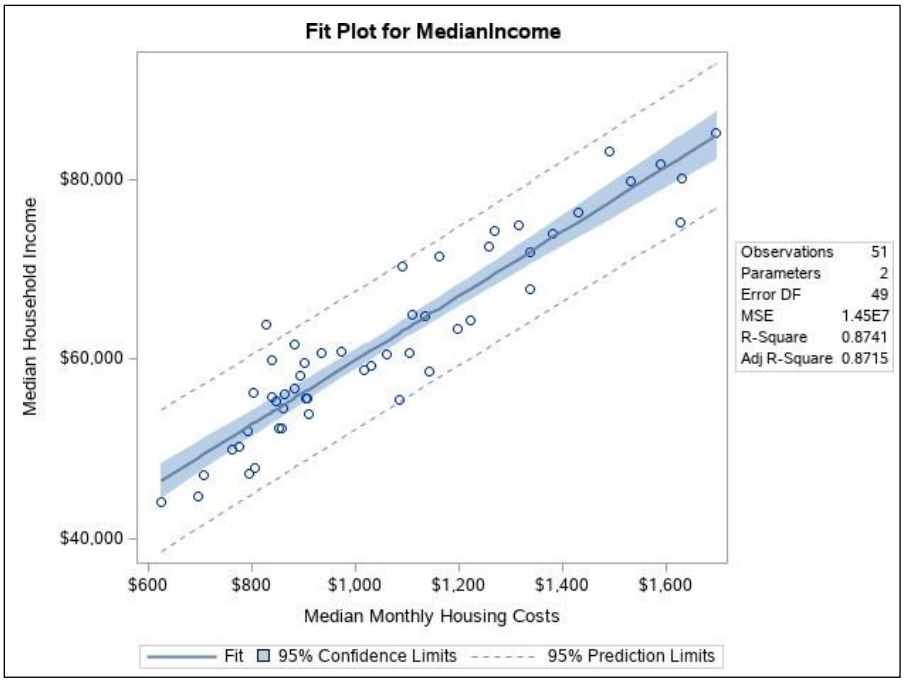
The fit diagnostics panel contains a set of graphs commonly used to validate the assumptions of simple linear regression. There are several assumptions that must be met.

- The observations must be independent. We do not see the appearance of repeated measures or clustering. We will assume that the data was collected in a way to ensure independence of the observations.
- The errors have equal variance. The first scatter plot on the first row plots the residuals against the predicted values from the linear regression model. The plot shows no discernable pattern such as a megaphone or bowtie that would show a change in variance of the residuals as the predicted values changed. Thus, the constant variance assumption is considered valid.
- The errors must be normally distributed with a mean of zero. The points on the first scatter plot on the first row appear to be randomly scattered around zero. Thus, the assumption of a mean of zero is met. The Q-Q plot, which is the first scatter plot on the second row, shows very little deviation from the reference line. Thus, the residuals are normally distributed. This can be verified using the residual histogram, which is the first histogram on the third row. This histogram displays a relatively normal distribution of the residuals.
- The relationship between the predictor variable and the response variable is linear through the equation parameters. The scatter plot for median household income and median monthly housing costs obtained through the Correlation Analysis task confirmed the linear

relationship. In addition, the first scatter plot on the first row does not display a curvilinear pattern, verifying this assumption.



The fit plot shows the estimated regression line superimposed over a scatter plot of the data. The blue shaded area represents the 95% confidence interval for the mean. The area between the dashed lines represents the 95% prediction interval for an individual observation. Therefore, we are 95% confident that a future single observation would fall between the dashed lines.



Note: To explain the remaining variability in the data, you can explore the other statistics in the **stateinfo_combined** table. You can use the Linear Regression task to perform multiple linear regression analysis to investigate and explain the relationship among median household income values and the other available statistics. To learn more about the available options in the Linear Regression task, see the Linear Regression page in the SAS Studio Task Reference Guide.

b. Save the settings specified in the Linear Regression task as **Median Income Linear Regression** in the **Census Data Analysis** folder. Then, close the **Median Income Linear Regression.ctk** tab.

End of Practices

Solutions to Practices

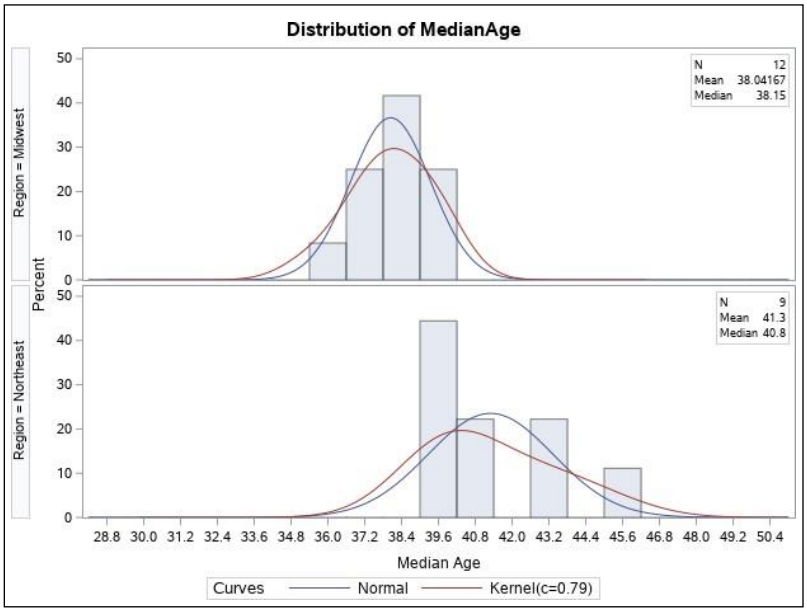
1. Analyzing Median Age Using Statistical Tasks

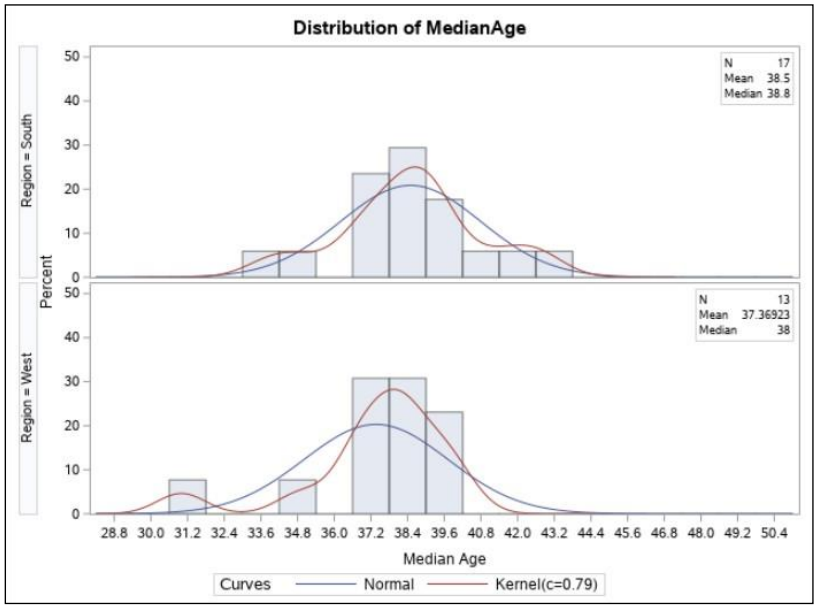
a. Use the Distribution Analysis task to examine the distribution of median age in each region. Use the specified settings.

1) In the navigation pane, expand the **Tasks and Utilities** section.
2) Expand **Tasks** ⇨ **Statistics** and double-click **Distribution Analysis** to open the task in a new tab.
3) Click (**Maximize View**) to hide the navigation pane and maximize the work area.
4) Specify **census.stateinfo_combined** as the input table.
   a) On the **Data** tab, click (**Select a table**).
   b) In the Select a Table window, expand the **CENSUS** library and select the **STATEINFO_COMBINED** table.
   c) Click **OK**.
5) Assign **MedianAge** as the analysis variable.
   a) To assign a column to the **Analysis variables** role, click (**Add columns**).
   b) In the Columns window, select **MedianAge**.
   c) Click **OK**.
6) Include a histogram with a normal curve and a kernel density curve.
   a) Click the **Options** tab.
   b) Verify that the **Histogram** check box is selected.
   c) Click the **Add normal curve** and **Add kernel density estimate** check boxes.
7) Create a separate histogram for each region.
   a) To assign a column to the **Classification variables** role, click (**Add columns**).
   b) In the Columns window, select **Region**.
   c) Click **OK**.
8) Include an inset box of statistics in the graph that displays the number of observations, the mean, and the median statistics.
   a) Click the **Add inset statistics** check box.
   b) Expand the **Inset Statistics** subheading.
   c) Click the **Number of observations** (selected by default), **Mean**, and **Median** check boxes.

9) Click (**Run**) to submit the generated code and view the report on the Results tab.

Each region has a unique distribution. The Midwest and South regions have fairly normal distributions, the Northeast region has a right-skewed distribution, and the West region has states with extreme values.





10) Click (**Exit maximized view**) to restore the navigation pane.

b. Use the One-Way ANOVA task to further investigate the relationship between median age and region. Use the specified settings.

1) If necessary, in the navigation pane, expand the **Tasks and Utilities** section.
2) Expand **Tasks** ⇨ **Linear Models** and double-click **One-Way ANOVA** to open the task on a new tab.
3) Click (**Maximize View**) to hide the navigation pane and maximize the work area.

4) Specify **census.stateinfo_combined** as the input table.

   On the **Data** tab, verify that **CENSUS.STATEINFO_COMBINED** is listed as the input table.

5) Specify **MedianAge** as the dependent variable and **Region** as the categorical variable.

   a) To assign a column to the **Dependent variable** role, click ➕ (**Add a column**).

   b) In the Columns window, select **MedianAge**.

   c) Click **OK**.

   d) To assign a column to the **Categorical variable** role, click ➕ (**Add a column**).

   e) In the Columns window, select **Region**.

   f) Click **OK**.

6) Perform Levene's test for homogeneity of variance. Do not run Welch's variance-weighted ANOVA test.

   a) Click the **Options** tab.

   b) Verify that the **Test** is set to **Levene**.

   c) Clear the check box for **Welch's variance-weighted ANOVA**.

7) Use Tukey's adjustment to determine whether there are significant differences in the mean of median age between each pair of regions.

   Verify that the **Comparisons method** is set to **Tukey**.

8) Display only the box plot and diagnostics plot.

   a) Use the **Display plots** drop-down list to select **Selected plots**.

   b) Clear the check boxes for **Means plot** and **LS-mean difference plot** and click the check box for **Diagnostics plot**.

   c) Verify that only the **Box plot** and **Diagnostics plot** check boxes are selected.

9) Click (**Run**) to submit the generated code and view the report on the Results tab.

   The overall analysis of variance table returns a *p*-value of 0.0006, which is less than 0.05, indicating that the test is significant. This suggests that there are at least two regions where the mean of median age values of the population is significantly different.

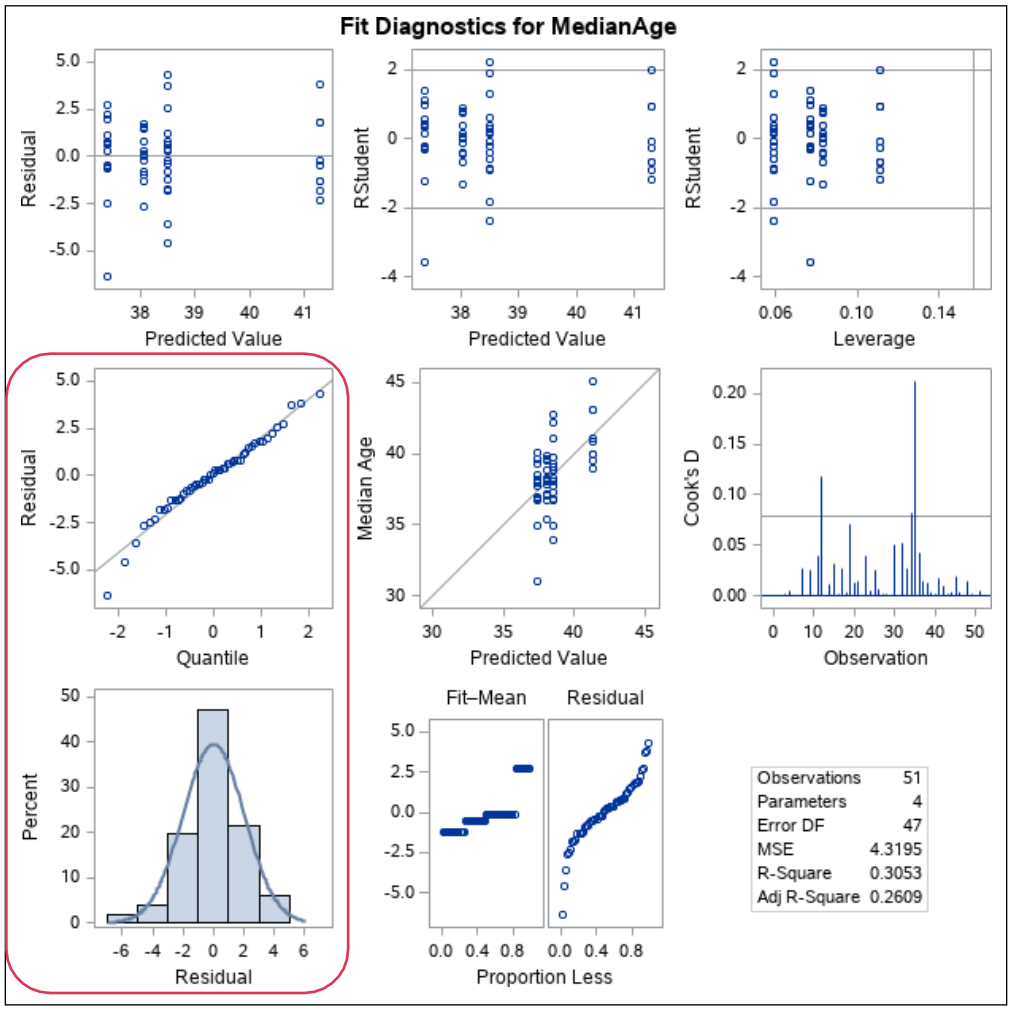
Dependent Variable: MedianAge Median Age

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	89.2129449	29.7376483	6.88	0.0006
Error	47	203.0168590	4.3195076		
Corrected Total	50	292.2298039			

   The fit diagnostics panel contains a set of graphs commonly used to validate the assumptions of ANOVA. There are several assumptions that must be met:

- The observations must be independent. We do not see the appearance of repeated measures or clustering. We will assume that the data was collected in a way to ensure independence of the observations

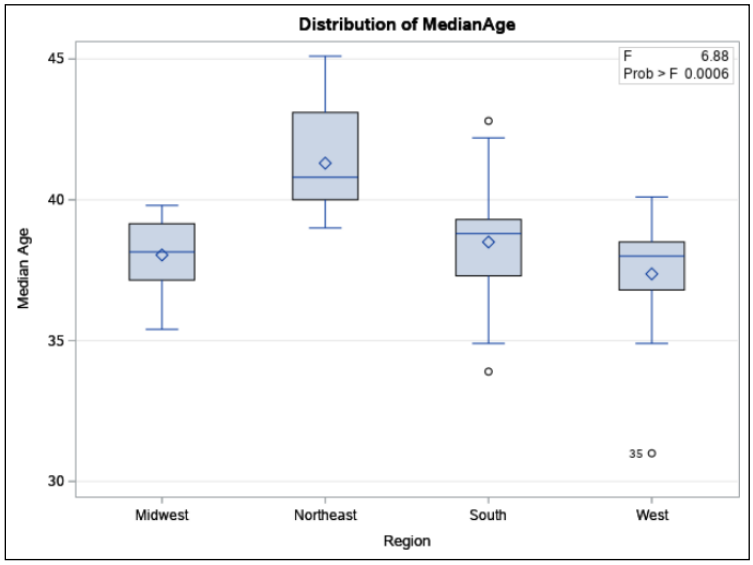
- The errors must be normally distributed. The Q-Q plot, which is the first scatter plot on the second row, shows very little deviation from the reference line. Thus, the residuals are normally distributed. This can be verified using the residual histogram, which is the first histogram on the third row. This histogram displays a relatively normal distribution of the residuals.
- All groups have equal error variances. This can be verified with Levene's test for homogeneity of variance, which is later in the output. Levene's test returns a *p*-value of 0.5712, which is greater than 0.05. Thus, the null hypothesis of equal variances failed to be rejected. Therefore, the assumption of equal error variances across all groups is met.



Levene's Test for Homogeneity of MedianAge Variance
ANOVA of Squared Deviations from Group Means

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Region	3	104.8	34.9277	0.68	0.5712
Error	47	2429.2	51.6843		

The box plots indicate that the Northeast region has the highest average regional median age, and the West region has the lowest.



The least squares mean table displays pairwise comparisons among all regions. The adjusted *p*-values of 0.0047 between the Midwest and Northeast regions, 0.0106 between the South and Northeast regions, and 0.0004 between the West and Northeast regions indicate that the mean of median age of the population between those regions are significantly different.

Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Region	MedianAge LSMEAN	LSMEAN Number
Midwest	38.0416667	1
Northeast	41.3000000	2
South	38.5000000	3
West	37.3692308	4

Least Squares Means for effect Region
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: MedianAge

i/j	1	2	3	4
1		0.0047	0.9361	0.8503
2	0.0047		0.0106	0.0004
3	0.9361	0.0106		0.4594
4	0.8503	0.0004	0.4594	

10) Click (**Exit maximized view**) to restore the navigation pane.

c. Use the Correlation Analysis task to determine whether there is any relationship between median age and other statistics such as median income and median duration of current marriage. Use the specified settings.

1) If necessary, in the navigation pane, expand the **Tasks and Utilities** section.

2) Expand **Tasks** ⇨ **Statistics** and double-click **Correlation Analysis** to open the task in a new tab.

3) Click (**Maximize View**) to hide the navigation pane and maximize the work area.

4) Specify **census.stateinfo_combined** as the input table.

   On the **Data** tab, verify that **CENSUS.STATEINFO_COMBINED** is listed as the input table.

5) Assign **MedianAge** to the **Correlate with** role, and all other numeric columns to the **Analysis variables** role.

   a) To assign columns to the **Analysis variables** role, click (**Add columns**).

   b) In the Columns window, select **MedianIncome**, hold down the Ctrl key, and select and **MeanHoursWorked**, **TotalPopulation**, **MedianCurrentMarriageDuration**, and **MedianMonthlyHousingCosts**.

   c) Click **OK**.

   d) To assign a column to the **Correlate with** role, click (**Add columns**).

   e) In the Columns window, select **MedianAge**.

   f) Click **OK**.

6) Display individual scatter plots.

   a) Click the **Options** tab.

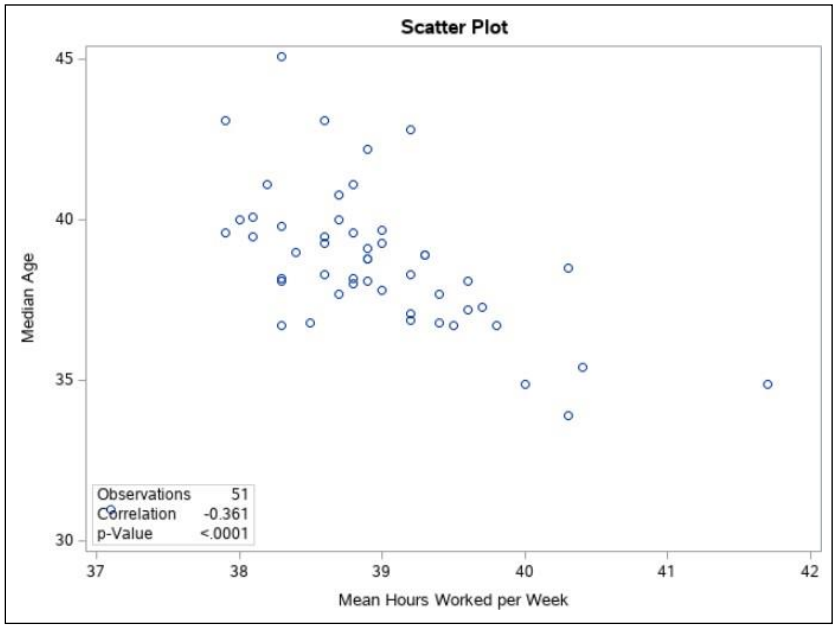
   b) Under the **Plots** heading, use the **Type of plot** drop-down menu to select **Individual scatter plots**.

7) Click (**Run**) to submit the generated code and view the report on the Results tab.

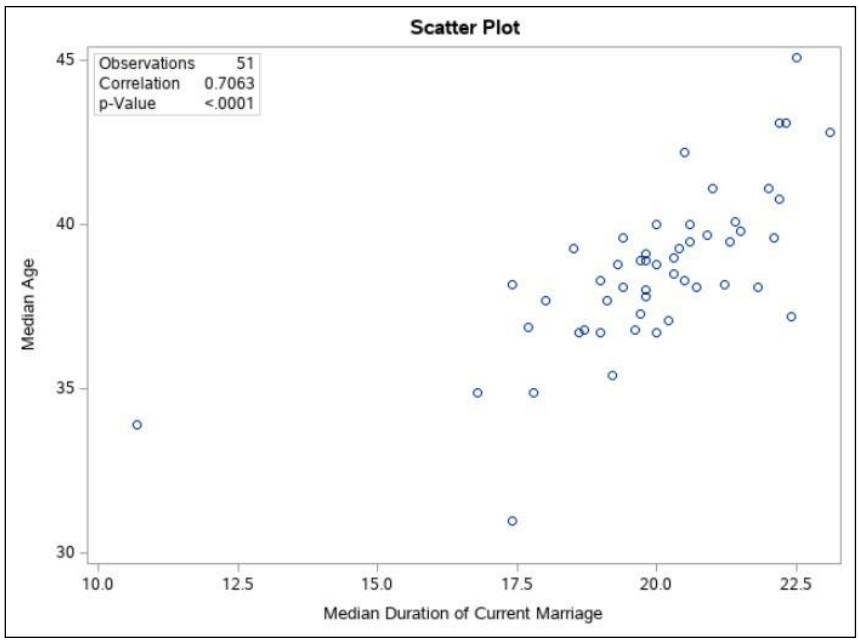
   The Pearson correlation coefficient between median age and median duration of current marriage is 0.70628, indicating a strong positive linear relationship between the two as compared to the other pairs. In other words, the higher the median age, the longer a couple is married. Use the scatter plot to verify that the relationship is linear.

Pearson Correlation Coefficients, N = 51					
	MedianIncome	MeanHoursWorked	TotalPopulation	MedianCurrentMarriageDuration	MedianMonthlyHousingCosts
MedianAge Median Age	-0.16273	-0.36147	-0.08744	0.70628	-0.07692

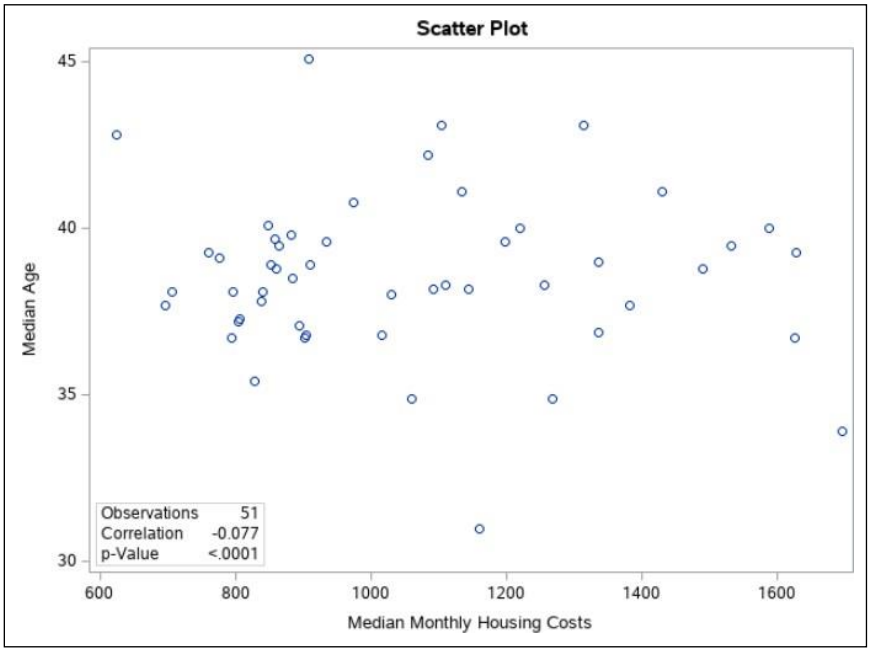
There is a slight negative linear relationship between median age and the average hours worked per week, indicating that the higher the median age, the fewer hours are worked per week. However, the outlier can have had an influence on the relationship.



The scatter plot for median age and median duration of current marriage confirm the strong positive linear relationship between the two variables.



There is no significant relationship between median age and median monthly housing costs.



d. Close the **Correlation Analysis**, **One-Way ANOVA**, and **Distribution Analysis** tabs. It is not necessary to save the settings specified in the tasks.

1) Click (**Exit maximized view**) to restore the navigation pane.

2) Close the **Correlation Analysis**, **One-Way ANOVA**, and **Distribution Analysis** tabs. It is not necessary to save the settings specified in the tasks.

2. Fitting a Simple Linear Regression Model to Predict Median Household Income

a. Use the Linear Regression task in the Linear Models category to define the linear relationship between median household income and median monthly housing costs. Use the specified settings.

1) In the navigation pane, expand the **Tasks and Utilities** section.

2) Expand **Tasks** ⇨ **Linear Models** and double-click **Linear Regression** to open the task in a new tab.

3) Click (**Maximize View**) to hide the navigation pane and maximize the work area.

4) Specify **census.stateinfo_combined** as the input table.

   a) On the **Data** tab, click (**Select a table**).

   b) In the Select a Table window, expand the **CENSUS** library and select the **STATEINFO_COMBINED** table.

   c) Click **OK**.

5) Specify **MedianIncome** as the response (dependent) variable, and **MedianMonthlyHousingCosts** as the predictor (continuous) variable.

   a) To assign a column to the **Dependent variable** role, click (**Add a column**).

   b) In the Columns window, select **MedianIncome**.

c) Click **OK**.

d) To assign a column to the **Continuous variables** role, click ➕ (**Add columns**).

e) In the Columns window, select **MedianMonthlyHousingCosts**.

f) Click **OK**.

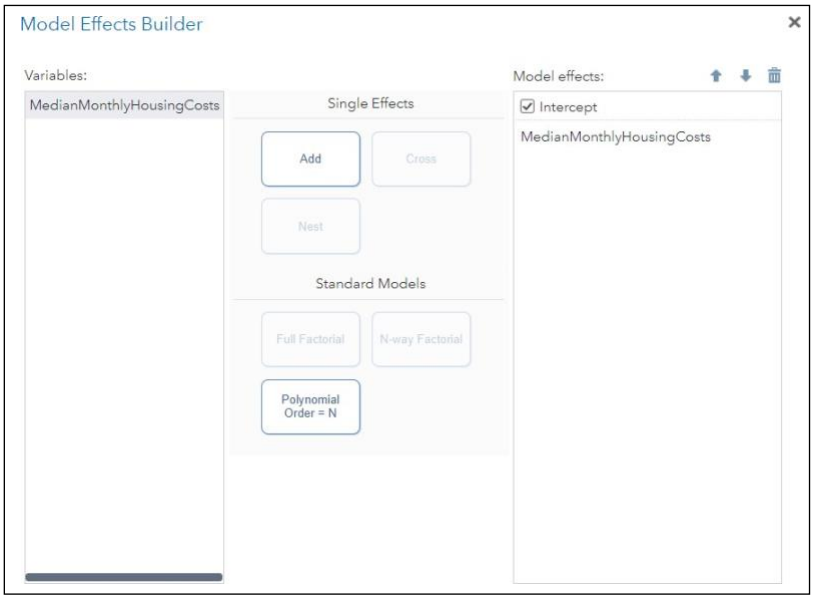
6) Use the model settings to add **MedianMonthlyHousingCosts** as a single effect to the model.

a) Click the **Model** tab.

b) Click **Edit**.

c) In the Model Effects Builder window, under **Variables**, select **MedianMonthlyHousingCosts**.

d) Under **Single Effects**, click **Add**.



e) Click **OK**.

7) Click 🏃 (**Run**) to submit the generated code and view the report on the Results tab.

The ANOVA table provides an analysis of the variability observed in the data and the variability explained by the regression line. The fitted regression line in the baseline model is a horizontal line across all values of the predictor variable. Thus, the slope is 0 and the intercept is the sample mean of the response variable. The *p*-value is less than 0.0001, which is less than 0.05. Thus, the null hypothesis that the baseline model fits the data is rejected in favor of the alternative model, the simple linear regression. Therefore, median monthly housing costs explain a significant amount of variability in median household income.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	4921490297	4921490297	340.12	<.0001
Error	49	709032041	14470042		
Corrected Total	50	5630522338			

The third part of the output provides summary measures of fit for the model. The R-square value of 0.8741 means that the effects contained in the model explain 87.41% of the total variation in the median household income values.

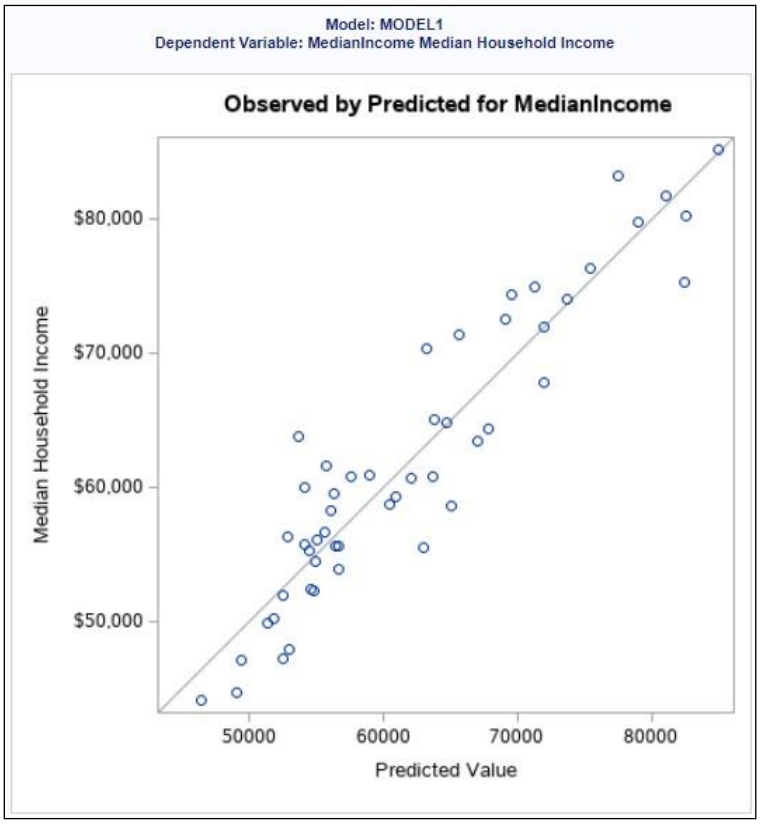
Root MSE	3803.95080	R-Square	0.8741
Dependent Mean	62013	Adj R-Sq	0.8715
Coeff Var	6.13411		

The Parameter Estimates table defines the model. The *p*-value is less than 0.0001 for median monthly housing costs, which is less than 0.05. Therefore, the slope for the predictor variable is statistically different from 0. Using the parameter estimates, the estimated regression equation is **MedianIncome** = $23,954 + ($35.9759 * **MedianMonthlyHousingCosts**). Each additional dollar of median monthly housing costs is associated with an approximately $35.98 higher median household income.

Parameter Estimates

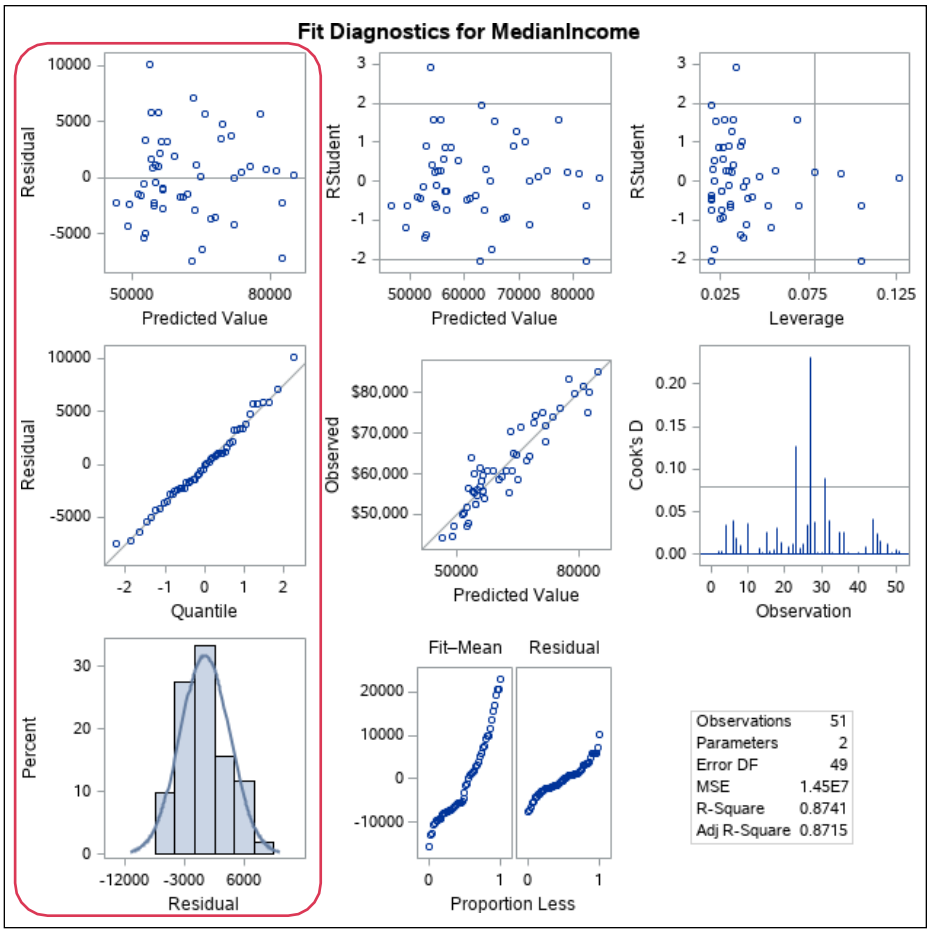
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	23954	2131.32029	11.24	<.0001
MedianMonthlyHousingCosts	Median Monthly Housing Costs	1	35.97590	1.95073	18.44	<.0001

The scatter plot displays the actual median household income values versus the predicted values based on the estimated regression equation. The observations lie close to the diagonal reference line, indicating a good fit of the model to the data points.

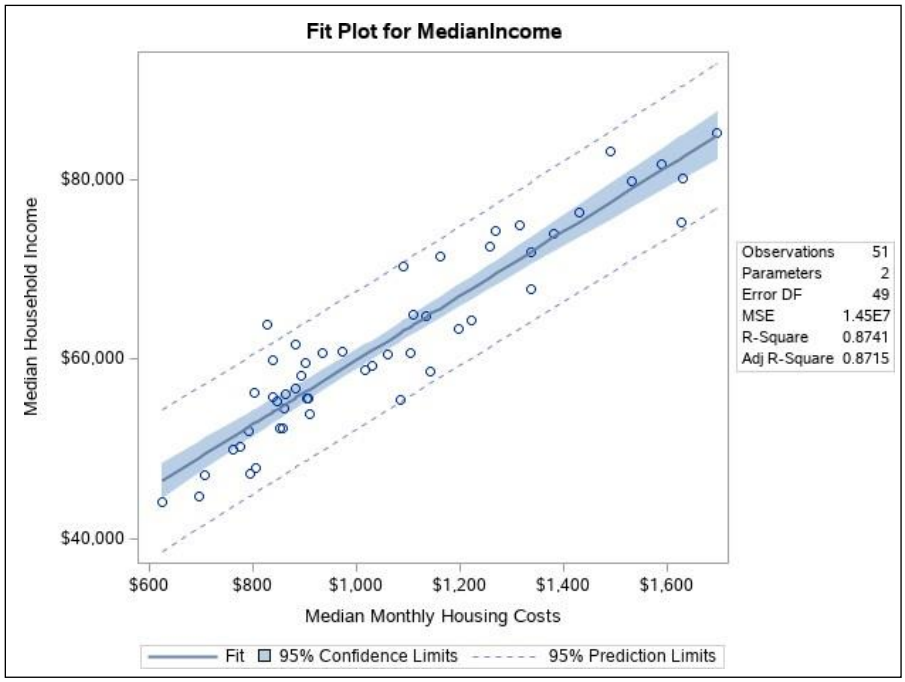


The fit diagnostics panel contains a set of graphs commonly used to validate the assumptions of simple linear regression. There are several assumptions that must be met:

- The observations must be independent. We do not see the appearance of repeated measures or clustering. We will assume that the data was collected in a way to ensure independence of the observations.
- The errors have equal variance. The first scatter plot on the first row plots the residuals against the predicted values from the linear regression model. The plot shows no discernable pattern such as a megaphone or bowtie that would show a change in variance of the residuals as the predicted values changed. Thus, the constant variance assumption is considered valid.
- The errors must be normally distributed with a mean of zero. The points on the first scatter plot on the first row appear to be randomly scattered around zero. Thus, the assumption of a mean of zero is met. The Q-Q plot, which is the first scatter plot on the second row, shows very little deviation from the reference line. Thus, the residuals are normally distributed. This can be verified using the residual histogram, which is the first histogram on the third row. This histogram displays a relatively normal distribution of the residuals.
- The relationship between the predictor variable and the response variable is linear through the equation parameters. The scatter plot for median household income and median monthly housing costs obtained through the Correlation Analysis task confirmed the linear relationship. In addition, the first scatter plot on the first row does not display a curvilinear pattern, verifying this assumption.



The fit plot shows the estimated regression line superimposed over a scatter plot of the data. The blue shaded area represents the 95% confidence interval for the mean. The area between the dashed lines represents the 95% prediction interval for an individual observation. Therefore, we are 95% confident that a future single observation would fall between the dashed lines.



b. Save the settings specified in the Linear Regression task as **Median Income Linear Regression** in the **Census Data Analysis** folder. Then, close the **Median Income Linear Regression.ctk** tab.

1) Click (**Save**).
2) Navigate to and select the **Census Data Analysis** folder.
3) In the **Name** box, type **Median Income Linear Regression**.
4) Click **Save**.
5) Click (**Exit maximized view**) to restore the navigation pane.
6) Close the **Median Income Linear Regression.ctk** tab.

End of Solutions