

Part II

Working with spatial data

4

File geodatabases

ArcGIS can directly use or import most GIS file formats in common use for geoprocessing and display. The recommended native file format for use in ArcGIS for Desktop is the file geodatabase. It stores map layers, data tables, and other GIS file types in a system folder that has the suffix extension .gdb in its name. In this chapter you learn about working with file geodatabases.

Learning objectives

- Build file geodatabases
- Use ArcCatalog utilities
- Modify attribute tables
- Join tables
- Aggregate data

Tutorial 4-1

Building a file geodatabase

A file geodatabase is quite simple and flexible, being merely a collection of files in a file folder. Nevertheless, a file geodatabase provides a powerful structure and organization for spatial data. You need a special utility program to build and maintain a file geodatabase, ArcCatalog, which you use next. Some of the functionality of ArcCatalog is also available in ArcMap's Catalog window. The Catalog window allows you to do most data utility work while in ArcMap without opening the separate application program, ArcCatalog.

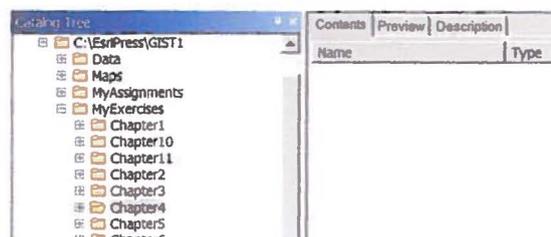
Open ArcCatalog

- 1 On the Windows taskbar, click Start > All Programs > ArcGIS > ArcCatalog 10.1.
- 2 Click the Connect To Folder button  on the Standard toolbar, expand the folder and file tree under Computer for EsriPress, click the GIST1 folder icon to select it, and click OK. The Connect To Folder button is important to remember. It sets roots for the folder and file tree that you use in ArcCatalog, providing access to files.

Create a new file geodatabase

While file geodatabases are only folders, you must create them using ArcCatalog or Catalog. Windows Explorer or Computer, while capable of creating a folder, cannot build a file geodatabase.

- 1 In the Catalog Tree panel, expand Folder Connections, EsriPress > GIST1, and the MyExercises folder.
- 2 Click the Chapter4 folder to display its contents (now empty) in ArcCatalog's right panel.



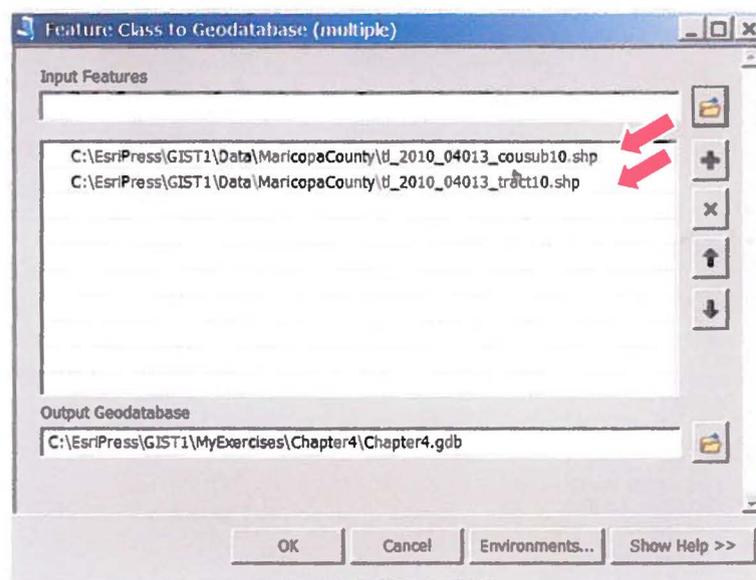
- 3 Right-click **Chapter4** in the left panel and click **New > File Geodatabase**.
- 4 Change the name from **New File Geodatabase.gdb** to **Chapter4.gdb**. ArcCatalog creates a file geodatabase that you can populate with feature classes, stand-alone tables, and other objects. Feature classes are map layers stored in a geodatabase.

Next, you import map layers in shapefile format into your new file geodatabase as feature classes.

Import shapefiles

A shapefile is an older Esri file format that many spatial data suppliers still use for distributing map layers. ArcCatalog allows you to import shapefiles and other map layer formats into a file geodatabase.

- 1 In the ArcCatalog's right panel, right-click **Chapter4.gdb**, click **Import > Feature Class (multiple)**. The multiple import option provides the convenience of importing several features at the same time as well as automatically naming output feature classes with the shapefiles' names.
- 2 In the **Feature Class to Geodatabase (multiple)** dialog box, click the browse button to the right of the **Input Features** field, browse to **Data > MaricopaCounty**, double-click to open that folder, hold the **SHIFT** key down, and select **tl_2010_04013_cousub10.shp** and **tl_2010_04013_tract10.shp**.
- 3 Click **Add**. That action adds **tl_2010_04013_cousub10.shp** and **tl_2010_04013_tract10.shp** to the input panel.



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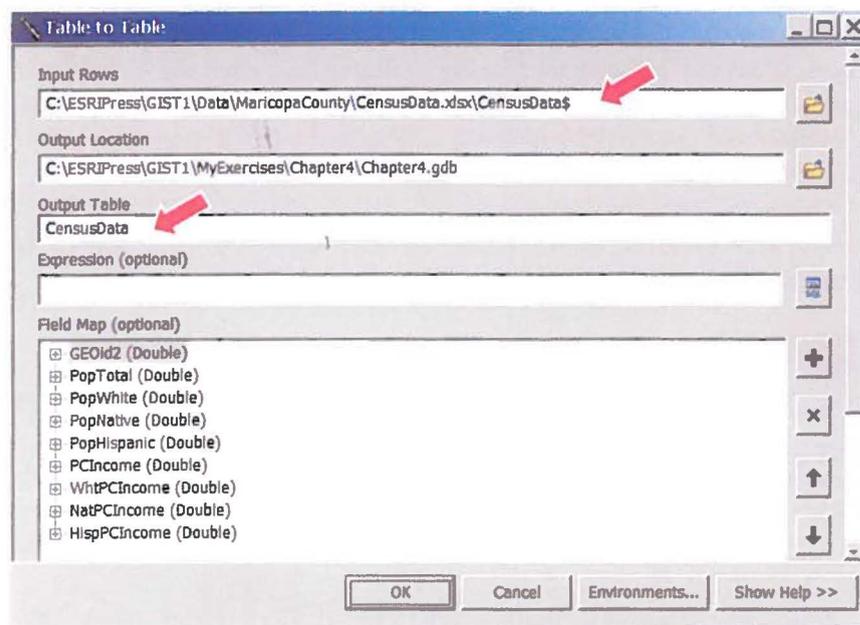
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- 4 **Click OK.** ArcCatalog imports the shapefiles into the file geodatabase.
- 5 In the Catalog tree, **expand the Chapter4 folder and Chapter4.gdb to see the imported feature classes.**

Import a data table

Next, you import a data table with some 2010 census data at the tract level for Maricopa County, Arizona.

- 1 **Right-click the Chapter4 file geodatabase, then click Import > Table (single).**
- 2 In the Table to Table dialog box, **click the browse button to the right of Input Rows, browse to the Data > MaricopaCounty folder, click CensusData.xlsx > Add > CensusData\$ > Add.**
- 3 **Type CensusData in the Output Table field.** Notice the Field Map panel listing the data fields that are imported.



- 4 **Click OK.**

Tutorial 4-2

Using ArcCatalog utilities

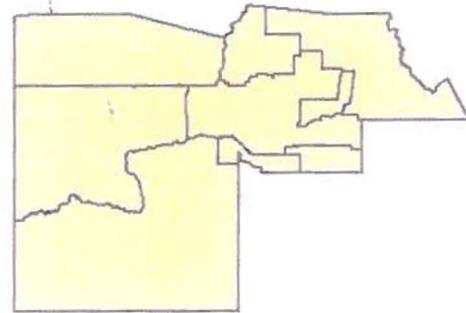
Now that you've created a file geodatabase, you can start using ArcCatalog's utilities. First is Preview, which gives you a good overview of a feature layer or table.

Preview layers

- 1 If necessary, click **Chapter4.gdb** in the Catalog tree to expose its contents in the right panel.

Contents		Preview	Description
Name	Type		
CensusData	File Geodatabase Table		
tl_2010_04013_cousub10	File Geodatabase Feature Class		
tl_2010_04013_tract10	File Geodatabase Feature Class		

- 2 In the right panel, click **tl_2010_04013_cousub10** and click the **Preview** tab. ArcCatalog previews the map layer's geography.



- 3 At the bottom of the Preview window, select **Table as the Preview**. ArcCatalog previews the map layer's attribute table.

OBJECTID	Shape	STATEFP10	GEOID10	NAME10
1	Polygon	04	0401390459	Buckeye
2	Polygon	04	0401390561	Chandler
3	Polygon	04	0401390867	Deer Valley
4	Polygon	04	0401391377	Gila Bend
5	Polygon	04	0401392601	Phoenix
6	Polygon	04	0401393009	St. Johns
7	Polygon	04	0401393060	Salt River
8	Polygon	04	0401393472	Tonto National Forest
9	Polygon	04	0401393774	Wickenburg

- 4 Click the **Description** tab. ArcCatalog previews the map layer's metadata in a report format. For TIGER maps, only general metadata is available.

Description

The TIGER/Line Files are shapefiles and related database files (.dbf) that are an extract of selected geographic and cartographic information from the U.S. Census Bureau's Master Address File / Topologically Integrated Geographic Encoding and Referencing (MAF/TIGER) Database (MTDB). The MTDB represents a seamless national file with no overlaps or gaps between parts, however, each TIGER/Line File is designed to stand alone as an independent data set, or they can be combined to cover the entire nation.

- 5 Click the **Contents** tab.

4-1

4-2

4-3

4-4

4-5

4-6

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A4-2

YOUR TURN

Preview `tl_2010_04013_tract10` and `CensusData`.

Rename feature layers

Because a file geodatabase has a special file format, you must use ArcCatalog for file-management purposes, including renaming and copying items.

- 1 In the left panel under `Chapter4.gdb`, right-click `tl_2010_04013_cousub10`, click **Rename**, type **Cities**, and press the TAB key.
- 2 Repeat step 1 to rename `CensusData` to be **CensusTractData**, and `tl_2010_04013_tract10` to be **Tracts**.

Copy and delete feature layers

- 1 In the left panel under `Chapter4.gdb`, right-click **Cities**, click **Copy**, right-click `Chapter4.gdb`, click **Paste > OK**. ArcCatalog creates the copy, `Cities_1`.
- 2 Right-click `Cities_1`, and click **Delete > Yes**.

YOUR TURN

Open a Computer window, browse to `Chapter4.gdb` in the `Chapter4` folder of `MyExercises`, right-click `Chapter4.gdb` to get its properties and size, and take a look at the files inside of it comprising the cities, tracts, and census tract data. You should find that the folder size is approximately 1.5 MB on the disk and that its 55 files are incomprehensible. You need ArcCatalog or Catalog in ArcMap to use, manipulate, and understand these files. Leave the Computer window open for use in the following steps:

Compress a file geodatabase

- 1 In the left panel of ArcCatalog, right-click Chapter4.gdb, click Administration > Compress File Geodatabase > OK.
- 2 Use a Computer window to check the size of the Chapter4.gdb folder. Verify that the compressed file geodatabase is a little less than 1 MB on the disk, about a 40 percent reduction in size.

While ArcMap can process compressed feature layers by uncompressing them on the fly, you will use the next step to uncompress the folder and get the layers back to original size.
- 3 In the left panel, right-click Chapter4.gdb, click Administration > Uncompress File Geodatabase > OK.
- 4 Close ArcCatalog.

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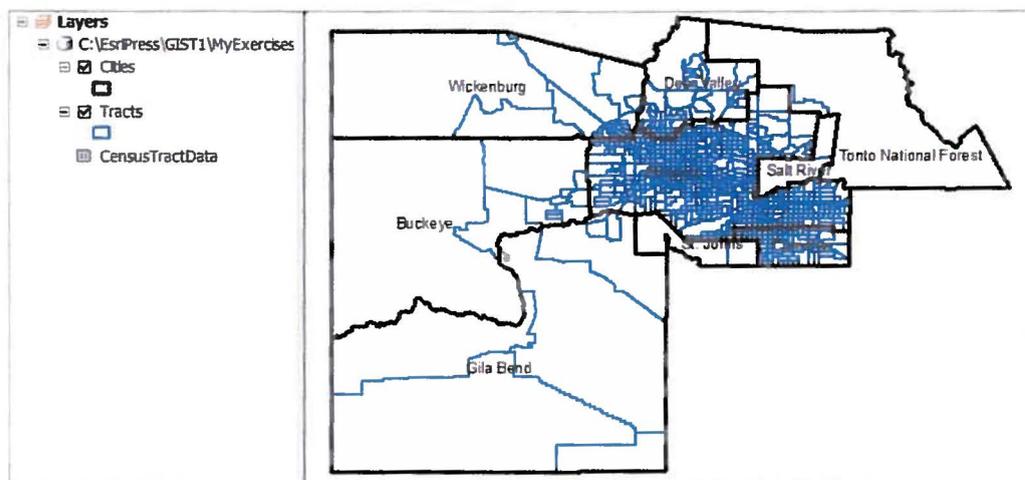
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YOUR TURN

Open ArcMap and create a new map document called Tutorial4-3.mxd with relative paths stored in the Chapter4 folder of MyExercises. Add the two layers and table from Chapter4.gdb and symbolize as seen in the following. Save your map document.



Tutorial 4-3

Modifying an attribute table

Most of what gets processed or displayed in a GIS depends on attribute table values. There is much, therefore, that you need to know about working on tables, including deleting, modifying, and creating columns.

Delete unneeded columns

Many map layers have extra or unnecessary attributes, from the user's point of view, that you can delete to tidy up.

- 1 In the table of contents, right-click Tracts and click Open Attribute Table. It's not possible to delete the primary key created by ArcGIS, ObjectID, or the Shape attribute. GEOID10 is the tract geocode that you need for joining the CensusTractData table to the tracts map layer, but all other fields are candidates for deletion.
- 2 In the table, right-click the header for the STATEFP10 column, click Delete Field, and click Yes.
- 3 Similarly delete the following fields: COUNTYFP10, TRACTCE10, NAME10, NAMELSAD10, MTFCC10, and FUNCSTAT10.
- 4 Close the Tracts table.

YOUR TURN

GEOID10 is a unique city identifier in the United States. Delete fields from the Cities layer to keep just OBJECTID, Shape, GEOID10, NAME10, Shape_Length, and Shape_Area. When finished, close the Cities table.

Modify a geocode

It is often necessary to join two tables to make a single combined table. For example, there are thousands of census variables, so it is impractical to have all needed census variables for tracts stored in the Tracts attribute table. Instead, you select the variables you wish, download a corresponding table (which includes tract geocodes) from the Census Bureau

website, and join the table to the tract polygon table by geocode. The GEOID10 column of the Tracts attribute table and the GEOid2 column of the CensusTractData table are the corresponding geocodes for these tables. These attributes would match, except that GEOID10 has a text data type while GEOid2 has a numeric data type. You can tell because text data is left-aligned in its column while numeric data is right-aligned.

- 1 In the table of contents, right-click CensusTractData, click Open, and sort GEOid2 ascending. You can see that this numeric attribute's first sorted value is 4013010101.
- 2 Close CensusTractData. Similarly, open the Tracts attribute table and sort GEOID10 ascending. The first sorted value is the text value 04013010101, with a leading zero, but otherwise matches the geocode in CensusTractData.

To get this table's geocode to join with that in CensusTractData, all you have to do is create a numeric version of it, which is easy with the Field Calculator. The numeric version drops the leading zero.

- 3 In the Tracts table, click the Table Options arrow and click Add Field.
- 4 In the Fields dialog box, type GEOID10Num in the Name field, change the Type to Double, and click OK. You need Double, which can have values up to 15 digits in length, to store GEOID10.
- 5 Right-click the GEOID10Num header and click Field Calculator > Yes.
- 6 In the Field panel, double-click GEOID10 (to set GEOID10Num = GEOID10), and click OK. That provides the needed geocode for joining the CensusTractData table to the Tracts attribute table.
- 7 Close the Tracts table and open the CensusTractData table.

Before making the join, first you create some new calculated columns in the CensusTractData table needed for a map document.

Calculate a new column

The CensusData table has population and per capita income for the total population, whites, Native Americans, and Hispanics. Desired for mapping are two ratios of per capita incomes for Native Americans divided by whites and for Hispanics divided by whites.

- 1 In the CensusTractData table, click the Table Options arrow and click Add Field.

4-1

4-2

4-3

4-4

4-5

4-6

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- 2 In the Add Field window, type **RNatWht** in the Name field, change the Type to **Float**, and click **OK**.

The new column will contain the ratio of Native American per capita income to white per capita income. Wherever this ratio is greater than one, Native Americans on average earn more than whites. First, however, you must select only records where PCIncWht is greater than zero, because PCIncWht is the divisor for this ratio and is used to calculate values for RNatWht. Anything divided by zero is undefined, so this case must be avoided; this is done through the selection.

- 3 In the **CensusTractData** table, click the **Table Options** arrow and click **Select By Attributes**.
- 4 In the **Select By Attributes** dialog box, scroll down the list of fields, double-click **WhtPCIncome** to add it to the lower **Select** panel, click the **> Symbol** button, click **Get Unique Values**, and double-click **0** in the **Unique Values** list. Those actions create the expression "WhtPCIncome" > 0.
- 5 Click **Apply > Close**.
- 6 Right-click the **RNatWht** header and click **Field Calculator > Yes**.
- 7 In the **Field Calculator** window, double-click **NatPCIncome** in the **Fields** panel, click the **/** button, double-click **WhtPCIncome** in the **Fields** panel, and click **OK**. Rows with values for both the numerator and denominator get data values, those with a denominator that is positive but no numerator get a zero, and those with 0 or null for the denominator retain the null value.

YOUR TURN

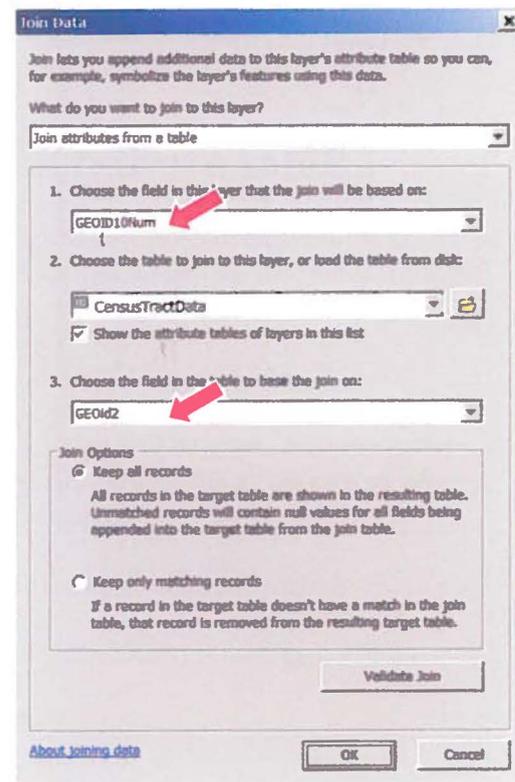
Repeat the previous steps to calculate a new column in the **CensusTractData** table called **RHisWht**, which is the ratio of **HispPCIncome** divided by **WhtPCIncome**. This is the ratio of per capita income of Hispanics divided by the per capita income of whites. Clear the selection and close the table when finished. Save your map document.

Tutorial 4-4

Joining tables

Next, you will join the *CensusTractData* table to the polygon *Tracts* feature class. The same steps work if your map layer is a shapefile or map layer in another format supported by ArcMap.

- 1 Save your map document as **Tutorial4-4.mxd** to the **Chapter4** folder.
- 2 In the ArcMap **table of contents**, right-click the **Tracts** layer, click **Joins and Relates > Join**.
- 3 Make the selections shown in the **image on the right**.
- 4 Click **OK**.



- 5 Open the **Tracts** attribute table, scroll to the right in the table, and verify that ArcMap joined the **CensusTractData** table to the **Attributes of Tracts** table.

Shape Length	Shape Area	GEOID10Num	OBJECTID *	GEOID2 *	PopTotal	PopWhite	PopNative
0.127403	0.000755	4013422644	712	4013422644	7287	6319	33
0.09817	0.000499	4013422643	711	4013422643	5789	4929	41
0.063555	0.000249	4013422642	710	4013422642	5715	4888	41
0.132432	0.000748	4013422641	709	4013422641	6346	5052	54
0.170811	0.001141	4013815900	889	4013815900	5981	4533	23
0.075694	0.000274	4013815800	888	4013815800	4083	3279	45

- 6 Close the **Tracts** table.

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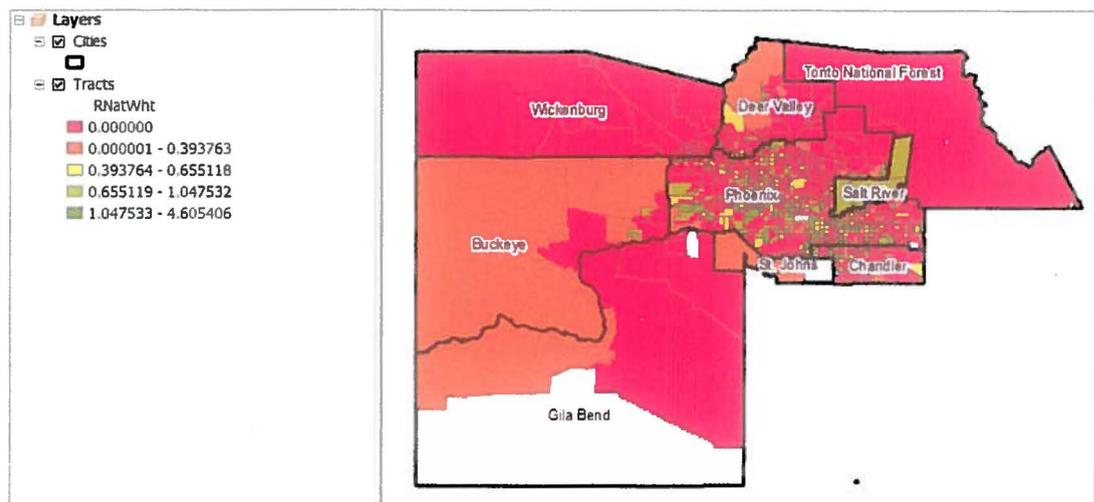
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YOUR TURN

Now that you have census tract data attached to the census tract map layer, you can make a quick map of an interesting variable. Are there places in Maricopa County where Native Americans typically have higher per capita income than whites? Make a choropleth map using the RNatWht (ratio of Native American per capita income divided by white per capita income) attribute you created. Use quantiles for the numeric scale and the red to yellow to green color ramp. When finished, save your map document.



Tutorial 4-5

Creating centroid coordinates in a table

The centroid of a polygon is the point at which the polygon would balance on a pencil point if it were cut out of cardboard. A map layer consisting of polygon centroid points has many uses; for example, together, polygons and their centroids give you the ability to display two attributes of the same map layer in the same map, one as a choropleth map and the other as a size-graduated point marker map. Next, you use ArcMap's tool for calculating polygon centroids.

Add x,y coordinates to a polygon attribute table

As a precaution and as a simplification, when you add new fields to an attribute table that has a joined table, it's a good idea to remove the join first, create the new fields, and then rejoin the table.

- 1 Save your map document as **Tutorial4-5.mxd** to the **Chapter4** folder.
- 2 Right-click **Tracts** in the table of contents, click **Joins and Relates > Remove Joins > Remove All Joins**. Your choropleth map disappears because the attribute that was displayed was in the joined table, which you just removed.
- 3 Open the **Tracts** table, click the **Table Options** arrow, and click **Add Field**.
- 4 Type **X** as the Name, select **Double** for Type, and click **OK**.
- 5 Repeat steps 3 and 4 except call the new field **Y**.
- 6 Right-click the **X** header, click **Calculate Geometry > Yes**. Examine the **Calculate Geometry** window and click **OK > Yes**.
- 7 Repeat step 6 except right-click the **Y** header and select **Y Coordinate of Centroid**. Close the attribute table when finished.

Shape Length	Shape Area	GEOID10Num	X	Y
0.127403	0.000755	4013422644	-111.598551	33.366828
0.09817	0.000499	4013422643	-111.618524	33.357267
0.063555	0.000249	4013422642	-111.627432	33.371808
0.132432	0.000748	4013422641	-111.661659	33.357603
0.170811	0.001141	4013815900	-111.757895	33.264
0.075694	0.000274	4013815800	-111.697149	33.284485

YOUR TURN

Rejoin the CensusTractData table to the Tracts layer.

Export a table

When you export joined tables as a table, you get all the attributes of the joined tables stored as one table permanently. (Similarly, if you export a map layer that has a joined table, the new map layer's attribute table has both tables joined permanently.) There are several possible uses for the new table, one of which is to use it to make a new point layer based on the centroid coordinates.

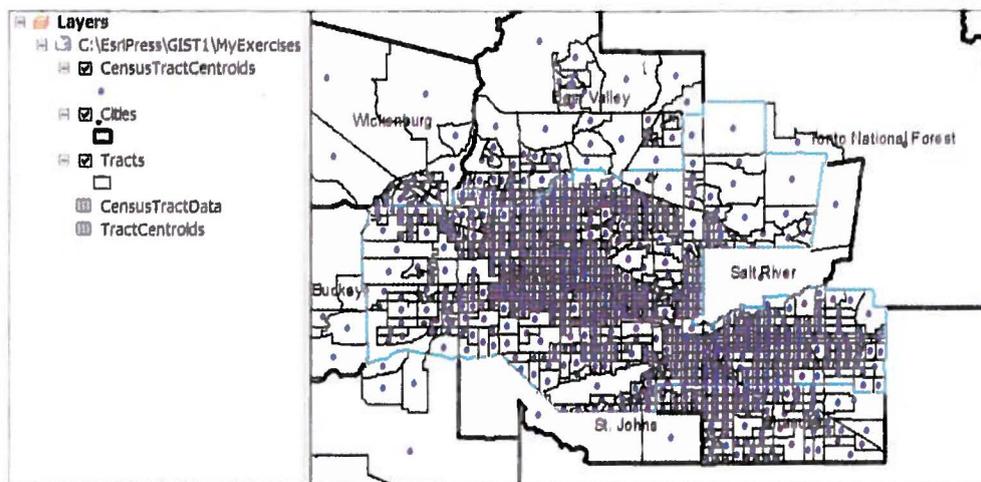
- 1 Open the Tracts attribute table, click the Table Options arrow > Export.
- 2 In the Output table field of the Export Data window, click the browse button, change the Save As type to File Geodatabase tables, browse to the Chapter4 folder, double-click Chapter4.gdb, change Name to TractCentroids, and click Save > OK > Yes. Open the table to see that it has all of the columns of both joined tables. Then close the table.
- 3 Close the Tracts attribute table.

Create a feature class from an XY table

- 1 On the Menu bar, click Windows > Catalog. This opens a version of ArcCatalog as a window in ArcMap, thus providing quick access to GIS utility programs.
- 2 Expand the Chapter4.gdb file geodatabase.
- 3 Right-click TractCentroids, click Create Feature Class > From XY Table.
- 4 In the Create Feature Class From XY Table window, click the Coordinate System of Input Coordinates button, click the Add Coordinate System button  > Import, browse to Chapter4.gdb, double-click Tracts in Chapter4.gdb, and click OK.

The coordinate system's geographic spherical coordinates are the same as those of the Tracts layer, so the simplest option is to import the system specification from Tracts.

- 5 Click the **browse button for Output, change the Save As type to File and Personal Geodatabase feature classes, browse to and double-click Chapter4.gdb, change the Name to CensusTractCentroids, click Save > OK.**
- 6 **Drag CensusTractCentroids from the Catalog window to the map document and drop it at the top of the table of contents.**
- 7 **Close the Catalog window in ArcMap.**
- 8 **Open the Cities attribute table, click the row selector for Phoenix to select that record and polygon on the map, and close the table.**
- 9 **Right-click Cities in the table of contents, click Selection > Zoom to Selected Features.** Now you can get a better look at the centroids point layer you just created.



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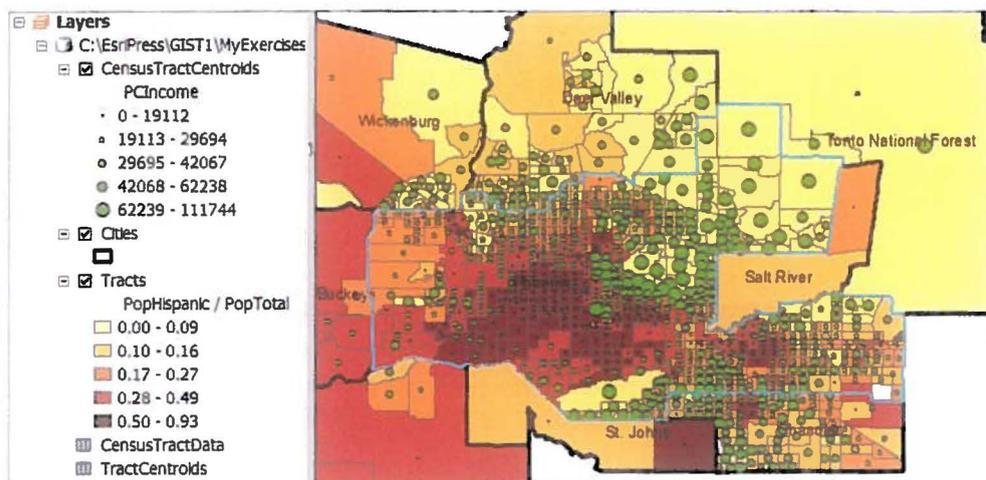
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Symbolize a choropleth and centroid map

Here you **symbolize a map using both the tract polygons and centroids.** Let's see how per capita income compares with percentage of total population that is Hispanic.

- 1 In the **table of contents, right-click the Tracts layer, click Properties > the Symbology tab.**
- 2 In the Show panel, **click Quantities > Graduated Colors. Under Fields, select PopHispanic for the Value field, change Normalization to PopTotal, click Classify, change Method to Quantile, and click OK. Change the color ramp to yellow through brown.**

- 3 In the Symbology tab, click the Label header to the right of the Symbol and Range headings, click Format Labels, click the Numeric Category, change the number of decimal places to 2, and click OK twice.
- 4 Right-click CensusTractCentroids in the table of contents, click Properties > the Symbology tab.
- 5 In the Show panel, click Quantities > Graduated Symbols. Under Fields, change Value to PCIncome.
- 6 Change the Symbolize Size range to 2 to 10.
- 7 Click the Template button, choose Circle 2, and click OK.
- 8 In the Classification panel, change the number of classes to 5, click Classify, change Method to Quantile, and click OK.
- 9 In the Symbology tab, click the Label header, click Format Labels, click the Numeric Category, change the number of decimal places to 0, click OK twice, and save your map document. Now you can plainly see that Phoenix, Arizona has areas with concentrations of Hispanic population, and those areas tend to be low income.



Tutorial 4-6

Aggregating data

A car beat is the patrol area of a single police car. This tutorial has you count (or aggregate) eating and drinking businesses in Rochester, New York within car beats. Such businesses are crime attractors, so it is useful to have a map showing where they are concentrated. In this case, the workflow has four steps. First, you join a code table to all business points in order to identify the businesses of interest. Second, you apply a definition query to businesses, limiting them to eating and drinking businesses. Third, you use a spatial join of car beats to eating and drinking businesses to count them up by car beat. Finally, you use the results to create a choropleth map of car beats representing the number of drinking and eating places in each car beat.

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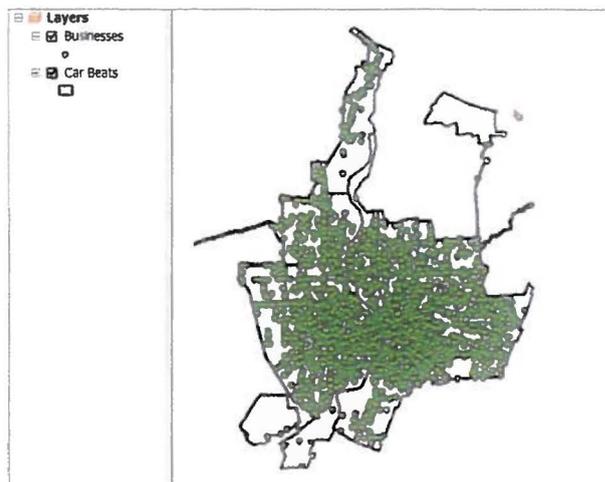
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Join a code table to an attribute table

Here you do a one-to-many join. Earlier in this chapter, you did a one-to-one join between the CensusTractData table and the Tracts attribute table. Each CensusTractData record had one and only one matching Tract polygon and record. This time, each SIC (standard industrial code) record in the code table potentially has many matching records in the Businesses point layer; for example, all of the drinking places in Rochester for the SIC record for code 5813.

- 1 **Open Tutorial4-6.mxd from the Maps folder.** The map that opens displays police car beats in Rochester as polygons, and all businesses as points.
- 2 **Save your map document to the Chapter4 folder.**



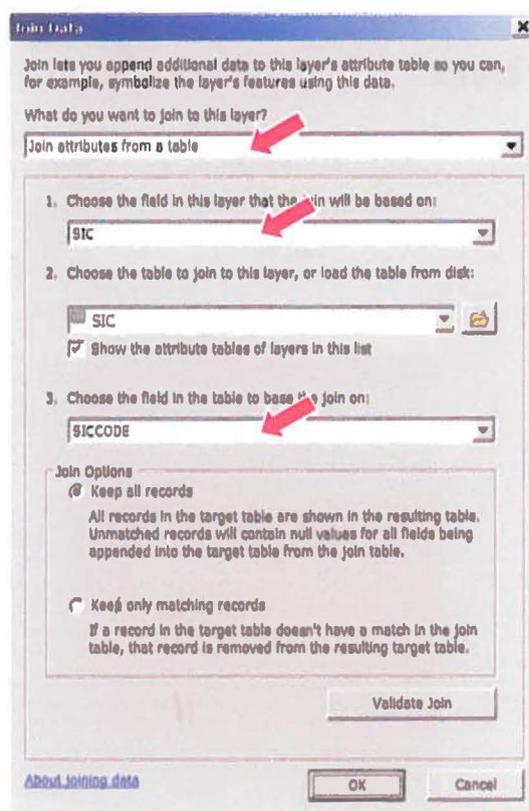
- 3** Open the **Businesses** attribute table and examine its attributes. There are 9,325 businesses of all kinds with the name and address of each business along with a four-digit SIC code. To break this code you need the code table called **SIC**. Notice that the **SIC** column in the **Businesses** attribute table has the text data type.

OBJECTID *	Shape *	NAME	ADDRESS	SIC
9008	Point	WATER-WISE INC	311 EXCHANGE BLVD	7369
9006	Point	WATER STREET GRILL	179 N WATER ST	5812
9007	Point	WATER STREET MUSIC HALL	204 N WATER ST	5813
9009	Point	WATERPRO SUPPLIES CORP	609 BUFFALO RD	9999
9010	Point	WATERWORKS J WELLINGTONS	315 ALEXANDER ST	5812
9011	Point	WATKINS ADVERTISING	105 LANARK CRES	9999

- 4** Close the **Businesses** attribute table. Click the **List By Source** button at the top of the table of contents and open the **SIC** table. This code table has two-, three-, and four-digit SIC codes and descriptions. The two-digit code, 01 for Agriculture, is broken down into three-digit categories, for example 011 Cash grains. Then three-digit codes are broken down into four-digit business types, for example, 0111 Wheat. Note that **SICCODE** also has the text data type, which makes the join to **Businesses** possible.

OBJECTID *	SICCODE *	SICDESCR
1084	5736	Musical instrument stores
1085	58	Eating And Drinking Places
1086	581	Eating and Drinking Places
1087	5812	Eating places
1088	5813	Drinking places
1089	59	Miscellaneous Retail

- 5** Close the **SIC** table. Right-click the **Businesses** layer in the table of contents, click **Joins and Relates > Join** and type or make the selections shown in the graphic on the next page.



- 6 **Click the Validate Join button.** You get a report that 9,253 of 9,325 business records successfully join. If you needed to diagnose and repair the non-matches, you could, but you skip that here.
- 7 **In the Join Validation window click Close and click OK.**
- 8 **Open the Businesses attribute table, scroll to the right, and see the joined SIC code descriptions.** Of course, all irrelevant SICCODE values, including those two- and three-digit values, were ignored in the join process. **Only relevant four-digit codes were used.**
- 9 **Close the attribute table.**

Create a definition query

- 1 **Open the Businesses layer's properties and click the Definition Query tab.**
- 2 **Click the Query Builder button, and build the query criterion: SIC.SICDESCR = 'Eating places' OR SIC.SICDESCR = 'Drinking places'** using the **Get Unique Values** button to get description values.
- 3 **Click OK > OK.** There are 457 such places now displayed.

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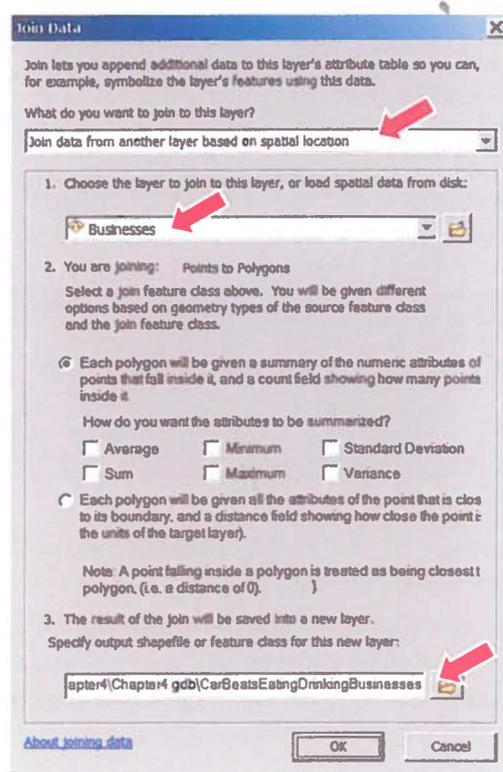
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A4-2

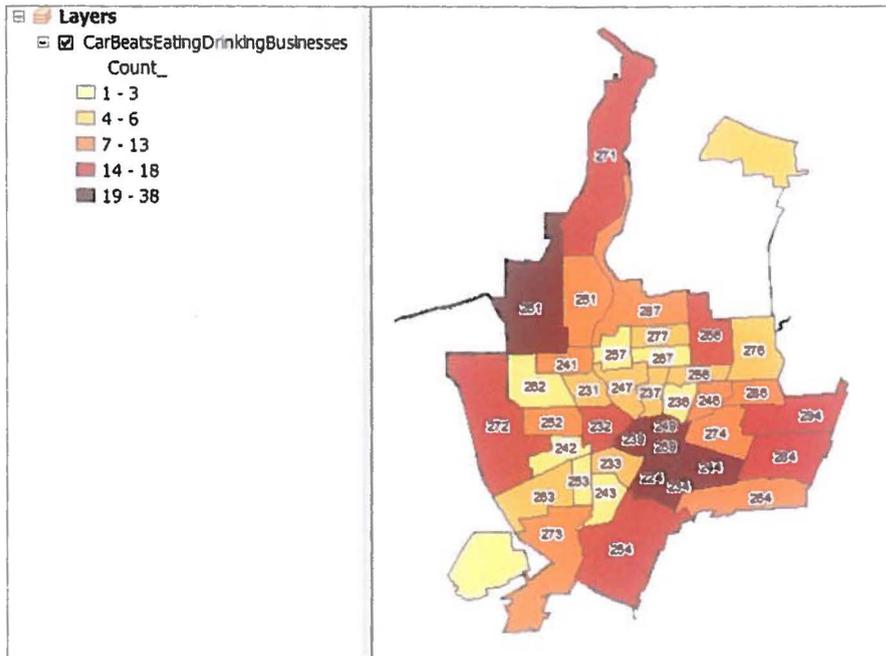
Use a spatial join to count eating and drinking places by car beat

If you do a spatial join of a polygon layer with a point layer, the result is statistics by polygon for the points. Each such join automatically includes a count of points per polygon, and if there are quantitative attributes of the points they can have statistics included, as seen in the graphic for step 1.

- 1 Right-click Car Beats, click Joins and Relates > Join, and make selections as follows:



- 2 Click OK.
- 3 Remove the original car beats layer from the table of contents.
- 4 Symbolize the choropleth map using the Count_ attribute of CarBeatsEatingDrinkingBusinesses. Use five quantiles and label each polygon with the Beat attribute. The result is a good, high-level map for scanning Rochester for car beats with many eating and drinking places. A good interactive version of this map would have the new layer turn off when zoomed in and the Businesses point layer turned on for details.



- 4-1
- 4-2
- 4-3
- 4-4
- 4-5
- 4-6
- A4-1
- A4-2

5 Save your map document and close ArcMap.

Assignment 4-1

Investigate educational attainment

In this assignment, you carry out all of the standard steps to work with census data in a GIS. Chapter 5 covers downloading and preparing data from the Census website, so this assignment starts at the point after census data is downloaded and ready for use. You create a file geodatabase, import a census tract map and data table into the file geodatabase, carry out several data utility and calculation steps, join the data table to the tract map, and produce a map layout. The data is on education attainment in Allegheny County, Pennsylvania. Your objective is to create a layout comparing the fraction of males versus females 25 or older who have an associate college degree or higher. You can imagine that spatial patterns are similar, but is high educational attainment the same for both sexes?

Get set up

First, rename your assignment folder and create a map document.

- Rename the folder `\EsriPress\GIST1\MyAssignments\Chapter4\Assignment4-1YourName\` to your name or student ID. Store all files that you produce for this assignment in this folder.
- Create a new map document called `Assignment4-1YourName.mxd` with relative paths.

Use the following steps to project the table of contents layer to the state plane coordinate system, with coordinates in feet:

- Right-click **Layers** in the table of contents, click **Properties** > **Coordinate System** tab.
- Expand **Projected Coordinate Systems**, **State Plane** > **NAD 1983 (US feet)** and click **NAD 1983 State Plane Pennsylvania South FIPS 3702 (US Feet)** > **OK**.

Build the map

Create a new file geodatabase called `Assignment4-1YourName.gdb`. Import data into it:

- Import `\EsriPress\GIST1\Data\DataFiles\tl_2010_42003_tract10.shp` as a feature class and rename it **Tracts**. **GEOID10** is the tract geocode in this table and it has the text data type.
- Import `\EsriPress\GIST1\Data\DataFiles\AllCoEdAttain.xlsx`, **HighEdAttainment\$** worksheet as a table and rename it **EducationalAttainment**. This is 2010 census tract data for Allegheny County on educational attainment. Attributes include: **GEOid2** = tract geocode, numeric data type; **Female25_** = total female population 25 and older; **FemaleAssociateDegree** = female population 25 or older with an associate degree as highest educational attainment; **FemaleBachelorDegree** = female population 25 or older with a bachelor's degree as highest educational attainment; and so forth up through **FemaleDoctorateDegree**. Include **FemaleProfessionalDegree** in your calculations. Males have similar attributes.

Add Tracts and EducationalAttainment to your map document.

Prepare Tracts for use:

- Create a new geocode, matching the data type of the geocode in the data table.
- Clean up the attribute table, deleting unneeded attributes.

Create two new attributes in EducationalAttainment:

- **PCollegeF** = Percentage of females 25 and older who have an associate college degree or higher (so values possibly could range between 0 and 100). Use Float as the data type.
- **PCollegeM** = Percentage of males 25 and older who have an associate college degree or higher. Use Float as the data type.
- **Hint:** Before calculating PCollegeF, select rows where Female25_ > 0. Otherwise you will get a warning message that the calculation failed (in cases where the denominator of your expression was zero). Do the same for males.

Create a layout that compares the two new attributes, PCollegeF and PCollegeM.

- Use the map layer and table in your file geodatabase (and not the shapefile or Excel table).
- Use two data frames and two separate choropleth maps, one for each new attribute.
- Use the same color ramp and numeric scale for both maps and include a single, common legend.

Hint: Finish one data frame. Then copy and paste it for the second data frame, making modifications as necessary. Create a layer file for the first data frame's map and use it to symbolize the second data frame's map.

Create a scatterplot of PCollegeF versus PCollegeM and add it to the layout.

- Use View > Graphs > Create Graph to create the scatterplot. Experiment with modifying and improving your graph's axes (e.g., use tic marks of 20), add vertical grid lines, increase the sizes of fonts, etc. by right-clicking your graph and clicking Advanced Properties.
- Once the plot is created, resize its window so that the vertical and horizontal axes are the same length.
- Right-click the graph and click Copy As Graphic. On your layout, click Edit > Paste. Reposition and align the graph and other elements of your layout.
- On the layout window, click Customize > Toolbars > Draw and draw a red line from (0,0) to (100,100) on your graph. This is the line of perfect equality of educational attainment for males and females. Think about the pattern you see on your maps and the graph.
- Save your layout and export it as Assignment4-1YourName.jpg.

4-1

4-2

4-3

4-4

4-5

4-6

A4-1

A4-2

Assignment 4-2

Compare serious crime with poverty in Pittsburgh

The criminology literature finds that much crime is related to poverty: the larger the population living in poverty, the higher the rate of certain kinds of crimes. Let's see if this relationship is evident in Pittsburgh at the census tract level. In the process, you'll build a file geodatabase, import map layers into it, build a code table from scratch and join it to a map layer, join census data to a map layer, and carry out a spatial join to aggregate data.

Get set up

First, rename your assignment folder and create a map document.

- Rename the folder `\EsriPress\GIST1\MyAssignments\Chapter4\Assignment4-2YourName\` to your name or student ID. Store all files that you produce for this assignment in this folder.
- Create a new map document called `Assignment4-2YourName.mxd` with relative paths.

Use the following steps to project the table of contents layer to the state plane coordinate system, with coordinates in feet:

- Right-click Layers in the table of contents, click Properties > Coordinate System tab.
- Expand Projected Coordinate Systems > State Plane > NAD 1983 (US feet) and click NAD 1983 State Plane Pennsylvania South FIPS 3702 (US Feet) > OK.

Build the map

Create a new file geodatabase called `Assignment4-2YourName.gdb`. Import the following data into it:

- `\EsriPress\GIST1\Data\Pittsburgh\Shapefiles\PittsburghSeriousCrimes2008.shp`—point shapefile of serious crime offense locations in Pittsburgh during summer, 2008. Attributes include: CCN = police ID for offense, Address = location of the offense, DateOccur = date of the offense, Hierarchy = FBI hierarchy code for the offense (1 = Criminal Homicide, 2 = Forcible Rape, 3 = Robbery, 4 = Aggravated Assault, 5 = Burglary, 6 = Larceny-theft, 7 = Motor Vehicle Theft, 8 = Arson).
- `\EsriPress\GIST1\Data\Pittsburgh\City.gdb\PghTracts`—polygon features of Pittsburgh 2010 census tracts.
- `\EsriPress\GIST1\Data\Pittsburgh\Shapefiles\PovertyTracts.xlsx` with PghPovertyTracts worksheet—2010 tract data for poverty. Attributes include: GEOid = tract geocode (numeric data type), PopWithPovStatus = population for whom poverty status is known (presumably the same as total population), PopBelowPovLevel = population who are below the poverty level.

Join PghPovertyTracts to PghTracts and make a choropleth map for population below the poverty line.

Create a new code table in your file geodatabase:

- Right-click your file geodatabase in Catalog and click New > Table.
- Name the table UCRHierarchy with no alias. Click Next > Next.
- Create a field called UCR with the Short Integer data type. Create another field called Crime with the Text data type and length 20.
- Click Customize > Toolbars > Editor.
- On the editor toolbar, click Editor > Start Editing > Continue.
- Open UCRHierarchy in the table of contents, type **1** for UCR and Criminal Homicide for Crime in the first row.
- Finish up inputting rows found with codes and crime types from the description of PittsburghSeriousCrimes2008.shp above. When done, click Editor in the Editor toolbar, Save Edits, Stop editing, and close the Editor toolbar. Close your new table.

Create the following query definition for PittsburghSeriousCrimes2008 and rename that layer in the table of contents to be PittsburghSeriousCrimesSummer2008:

"DateOccur" >= date '2008-06-01' AND "DateOccur" <= date '2008-08-31'.

Join UCRHierarchy to PittsburghSeriousCrimesSummer2008. Symbolize PittsburghSeriousCrimesSummer2008 with the Crime attribute using unique values. Use different shapes and colors for point markers. This layer will display only when you zoom in.

Spatially join PittsburghSeriousCrimesSummer2008 to PghTracts to get a count of serious crimes per tract in summer 2008. Call the output CrimeAggregatedByTracts. Use the results to symbolize PghTracts centroids with size-graduated point markers. **Hint:** Use Quantities, Graduated symbols for symbolizing the crime count (there is no need to create tract centroids in this case).

Set threshold scales so that when zoomed in to about a fourth of Pittsburgh or farther, PittsburghSeriousCrimesSummer2008 turns on and CrimeAggregatedByTracts turns off.

Create a layout of your own design for the map document, zoomed to full extent.

Analyze the data

Get set up to create a graph:

- Open the CrimeAggregatedByTracts property table, click the Fields tab, and give Count_ the alias Serious Crimes.
- Open the PghPovertyTracts table and give PopBelowPovLevel the alias Population Below Poverty Level.
- Join PittsburghPovertyTracts to CrimeAggregatedByTracts.

Create a scatterplot of Serious Crimes versus Population Below Poverty Level:

- Use View > Graphs > Create Graph to create the scatterplot.
- Once created, resize its window so that the vertical and horizontal axes are the same length.
- Right-click the graph and click Copy As Graphic. On your layout, click Edit > Paste. Reposition and align the graph and other elements of your layout.
- Save your layout and export it as Assignment4-2YourName.jpg.

4-1

4-2

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4-5

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A4-1

A4-2