


Mapping Tabular Data – Display XY points from csv

Materials needed: *AussiePublicToilets.csv*.

[1] Open and examine the data:

Open ArcMap and use the **Add Data**  button to add the table *AussiePublicToilets.csv* to the map. **Right-click > Open** to open the table. Take a moment to inspect the field (column) names and the values beneath them. At the bottom of the table, note that there are 18,865 records, each representing one public restroom, though none show up on the map yet.



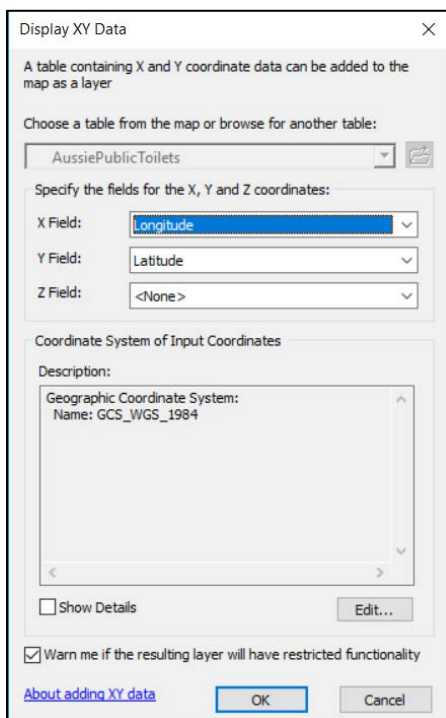
Notice that there are columns for Latitude and Longitude, and that the values in these columns look a lot like decimal degrees. (Metadata confirms that the data were recorded using GCS_WGS84.)

[2] Set the dataframe coordinate system to WGS84:

Right-click on the word Layers, then **Properties**, then choose the tab for **Coordinate System**. Search for **WGS 1984**, and choose the plain version that lives under **Geographic Coordinate Systems > World**. Notice that the units in the lower right-hand corner are now decimal degrees.

[3] Plot the coordinates as points:

Right-click on table in the Table of Contents. Choose **Display XY Data ..** A dialog box opens, asking which fields to use as X and Y coordinates. Choose Longitude for X, Latitude for Y.



[4] Remember that this layer of points is temporary. To make it permanent, **right-click** on *AussiePublicToilets Events*. Choose **Data > Export**. Name the new file *AussiePublicToilets.shp* and save it somewhere you will be able to find it again. Add that saved file to the map and remove both the events layer and the .csv (**right-click > Remove**).

Mapping Tabular Data – Select a Subset by Attributes

[1] Click the **Select** icon.



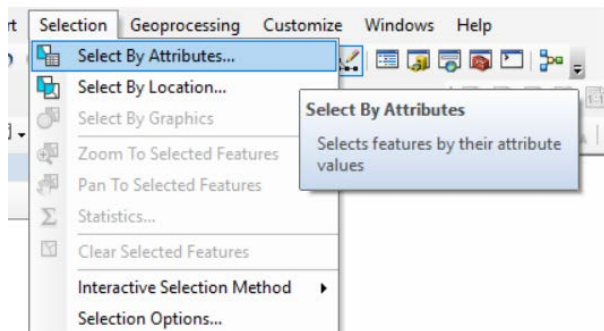
Practice click-selecting on the Australian points. **Shift-click** will allow you to select several points. You can also hold down the left mouse button and drag a box to select a large area. When you are done, **Clear Selected Features**.



At any time, you can return to a regular cursor by clicking on the black arrow.

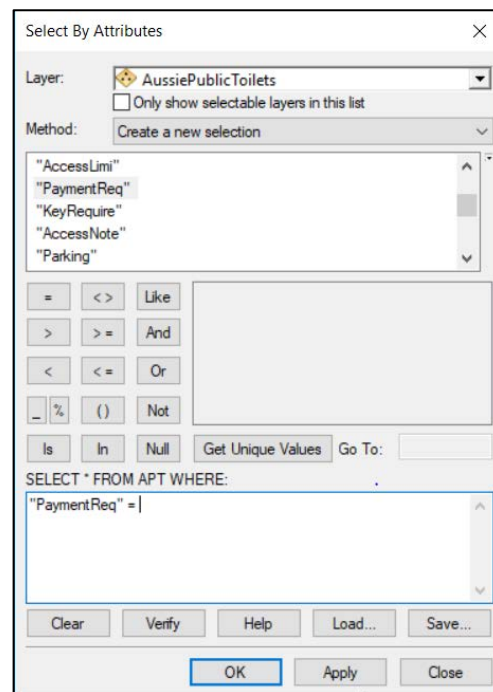


[2] From the **Selection** menu at the top, choose **Select by Attribute**. A calculator opens, where you will concoct a logical expression. Make sure the Layer says *AussiePublicToilets* and the Method is “Create a new selection.” We will select only the bathrooms that are free of charge.



To see what *PaymentReq* could possibly be equal to, click **[Get Unique Values]**. Choose “False.” Your expression should now read: “*PaymentReq* = ‘False’”

Click **OK**.



Double-click the field name “*PaymentReq*.” It will appear in the expression box. Then click the = and that will appear as well.

[3] Inspect the map and the Attribute Table. 162 public toilets were excluded from the selection. Play with the **Switch Selection** button at the top of the Attribute Table, and **Show Selected Records** at the bottom.



[4] Narrow the selection by launching **Select By Attributes** again. This time, change **Method** to “Select from Current Selection” and build the expression “*KeyRequire* = ‘False’” and inspect the updated selection. These are all of the public bathrooms on the entire continent that are open access, no key or payment required.

[5] Data selections are temporary. To make a new layer that is only the selected portion of the old, **right-click** on *AussiePublicToilets* in the Table of Contents and choose **Data > Export** again. This time, make sure the top box says “Selected Features.” Give it a name and storage destination and click **OK**.

Close ArcMap for now.

Mapping Tabular Data – Joining Census Tables

Materials needed: American Factfinder website, *Middlesex_Tracts.shp*, and *Travel_90min.csv*

- [1] Open a browser and navigate to <http://factfinder2.census.gov>. Choose [**Advanced Search**] and [**SHOW ME ALL**].
- [2] In the left-hand margin, click on [**Geographies**].

United States Census Bureau

Search - Use the options

Your Selections

'Your Selections' is empty

load search save search

Search using the options below:

Topics (age, income, year, dataset, ...)

Geographies (states, counties, places, ...)

Race and Ethnic Groups (race, ancestry, tribe)

Industry Codes (NAICS industry, ...)

EEO Occupation Codes (executives, analysts, ...)

Select Geographies

List Name Address Map

Select geographies to add to Your Selections ?

Select from: ☒ most requested geographic types ☐ all geographic types

Select a geographic type: Census Tract - 140

Select a state: Massachusetts

Select a county: Middlesex

Select one or more geographic areas and click Add to Your Selections:

All Census Tracts within Middlesex County, Massachusetts

All fully/partially Urban Census Tracts within Middlesex County, Massachusetts

All fully/partially Rural Census Tracts within Middlesex County, Massachusetts

Census Tract 3001, Middlesex County, Massachusetts

Census Tract 3011.01, Middlesex County, Massachusetts

Census Tract 3011.02, Middlesex County, Massachusetts

Census Tract 3021, Middlesex County, Massachusetts

Census Tract 3022, Middlesex County, Massachusetts

Census Tract 3101, Middlesex County, Massachusetts

Census Tract 3102, Middlesex County, Massachusetts

In the dialog box that opens, choose from the pulldown-menus.

For geographic type, choose **Census Tracts**.

Choose **Massachusetts** and **Middlesex County**.

Then choose **All Census Tracts for Middlesex County, Massachusetts**.

Finish this step by clicking

[**ADD TO YOUR SELECTIONS**].

The dialog box will close.

- [3] In the topic search box, enter B08303. This should discover the census topic TRAVEL TIME TO WORK. Check the box next to the most recent version, and then choose Download.

Refine your search results: topic or table name state, county or place (optional) GO

☒ topics ☐ race/ancestry ☐ industries ☐ occupations

1 Selected: View Download Compare Clear All Reset Sort ?

	ID	Table, File or Document Title	Dataset	About
<input checked="" type="checkbox"/>	B08303	TRAVEL TIME TO WORK	2016 ACS 5-year estimates	i

Unzip your downloaded folder, navigate to it, and open the file *ACS_16_5YR_B08303_with_ann.csv* with Excel or Notepad to inspect it.

	A	B	C	D	E	F	G
1	GEO.id	GEO.id2	GEO.display	HD01_VD01	HD02_VD01	HD01_VD02	HD02_VD02
2	Id	Id2	Geography	Estimate; Total:	Margin of Error; Total:	Estimate; Total: - Less than 5	Margin of Error; Total: - Less than 5
3	1400000U	2.5E+10	Census Tract 3001, Middlesex County, MA	1585	124	66	34
4	1400000U	2.5E+10	Census Tract 3011.01, Middlesex County, MA	1894	162	32	23
5	1400000U	2.5E+10	Census Tract 3011.02, Middlesex County, MA	2774	177	11	16
6	1400000U	2.5E+10	Census Tract 3101, Middlesex County, MA	2594	330	57	48
7	1400000U	2.5E+10	Census Tract 3102, Middlesex County, MA	3332	516	9	15
8	1400000U	2.5E+10	Census Tract 3103, Middlesex County, MA	2461	463	12	19
9	1400000U	2.5E+10	Census Tract 3104, Middlesex County, MA	1467	258	0	12
10	1400000U	2.5E+10	Census Tract 3105, Middlesex County, MA	1731	273	42	44
11	1400000U	2.5E+10	Census Tract 3106, Middlesex County, MA	3048	284	72	95
12	1400000U	2.5E+10	Census Tract 3107, Middlesex County, MA	2838	407	59	60
13	1400000U	2.5E+10	Census Tract 3108, Middlesex County, MA	2177	296	50	40
14	1400000U	2.5E+10	Census Tract 3109, Middlesex County, MA	1079	146	8	8
15	1400000U	2.5E+10	Census Tract 3110, Middlesex County, MA	1294	185	0	12
16	1400000U	2.5E+10	Census Tract 3111, Middlesex County, MA	1806	274	46	38
17	1400000U	2.5E+10	Census Tract 3112, Middlesex County, MA	2735	297	0	17

[4] Notice a few things about this spreadsheet. The first row contains indecipherable census codes for each variable. The second row contains more readable descriptions, but those descriptions have punctuation that may confuse ArcMap. Also, ArcMap is not prepared to handle data with two header rows. Furthermore, there are many more columns than we may want to use.

Let's suppose we were only interested in super-commuters, people who commute more than 90 minutes to work, the second-to-last column. We could remove unwanted columns and rename the headers like this:

	A	B	C	D	E
1	GEO.id	GEO.id2	CensusTract	TotalPop	90min
2	1400000US25017300100	25017300100	Census Tract 3001, Middlesex County, MA	1585	116
3	1400000US25017301101	25017301101	Census Tract 3011.01, Middlesex County, MA	1894	33
4	1400000US25017301102	25017301102	Census Tract 3011.02, Middlesex County, MA	2774	111
5	1400000US25017310100	25017310100	Census Tract 3101, Middlesex County, MA	2594	128
6	1400000US25017310200	25017310200	Census Tract 3102, Middlesex County, MA	3332	10
7	1400000US25017310300	25017310300	Census Tract 3103, Middlesex County, MA	2461	22

This has already been done for you* and is saved in your lab materials as *Travel_90min.csv*. Likewise, the census tracts of Massachusetts have been selected to the subset for Middlesex county and saved as *Middlesex_Tracts.shp*.

The Geo.id fields have not been changed, because we are hoping to find a join key field that matches exactly some field in the tracts shapefile. In ArcMap, open a new map or dataframe, and please add both *Middlesex_Tracts.shp* and *Travel_90min.csv*. Inspecting both tables reveals that GEO.id2 should be a good match for GEOID2.

Middlesex_Tracts														
FID	Shape *	STATEFP	COUNTYFP	NAMESAD	ALAND	AWATER	GEOID2		GEO.id	GEO.id2	CensusTract	TotalPop	90min	
0	Polygon	25	017	Census Tract 3212	4596280	962007	25017321200		1400000US25017300100	25017300100	Census Tract 3001, Middlesex County, MA	1585	116	
1	Polygon	25	017	Census Tract 3837	4293522	369224	25017383700		1400000US25017301101	25017301101	Census Tract 3011.01, Middlesex County, MA	1894	33	
2	Polygon	25	017	Census Tract 3838	5269623	304363	25017383800		1400000US25017301102	25017301102	Census Tract 3011.02, Middlesex County, MA	2774	111	
3	Polygon	25	017	Census Tract 3851	17363842	579477	25017385100		1400000US25017310100	25017310100	Census Tract 3101, Middlesex County, MA	2594	128	
4	Polygon	25	017	Census Tract 3221	14081676	557716	25017322100		1400000US25017310200	25017310200	Census Tract 3102, Middlesex County, MA	3332	10	
5	Polygon	25	017	Census Tract 3394	629016	25734	25017339400		1400000US25017310300	25017310300	Census Tract 3103, Middlesex County, MA	2461	22	
6	Polygon	25	017	Census Tract 3531.02	901795	698900	25017353102		1400000US25017310400	25017310400	Census Tract 3104, Middlesex County, MA	1467	8	
7	Polygon	25	017	Census Tract 3689.01	4020837	25552	25017368901		1400000US25017310500	25017310500	Census Tract 3105, Middlesex County, MA	1731	62	
8	Polygon	25	017	Census Tract 3531.01	411670	0	25017353101		1400000US25017310601	25017310601	Census Tract 3106, Middlesex County, MA	3048	195	
9	Polygon	25	017	Census Tract 3173.01	4023677	125860	25017317301		1400000US25017310700	25017310700	Census Tract 3107, Middlesex County, MA	2838	60	
10	Polygon	25	017	Census Tract 3201.03	17071414	406723	25017320103		1400000US25017310800	25017310800	Census Tract 3108, Middlesex County, MA	2177	40	

[5] To begin the join, start with the shapefile layer in the Table of Contents. **Right-click** and choose **Joins and Relates > Join ...** The following dialog box appears:

Join Data

Join lets you append additional data to this layer's attribute table so you can, for example, symbolize the layer's features using this data.

What do you want to join to this layer?

Join attributes from a table

1. Choose the field in this layer that the join will be based on:

GEOID2

2. Choose the table to join to this layer, or load the table from disk:

Travel_90min.csv

☒ Show the attribute tables of layers in this list

3. Choose the field in the table to base the join on:

GEO.id2

Join Options

☒ Keep all records
All records in the target table are shown in the resulting table. Unmatched records will contain null values for all fields being appended into the target table from the join table.

☐ Keep only matching records
If a record in the target table doesn't have a match in the join table, that record is removed from the resulting target table.

Validate Join

About joining data

OK Cancel

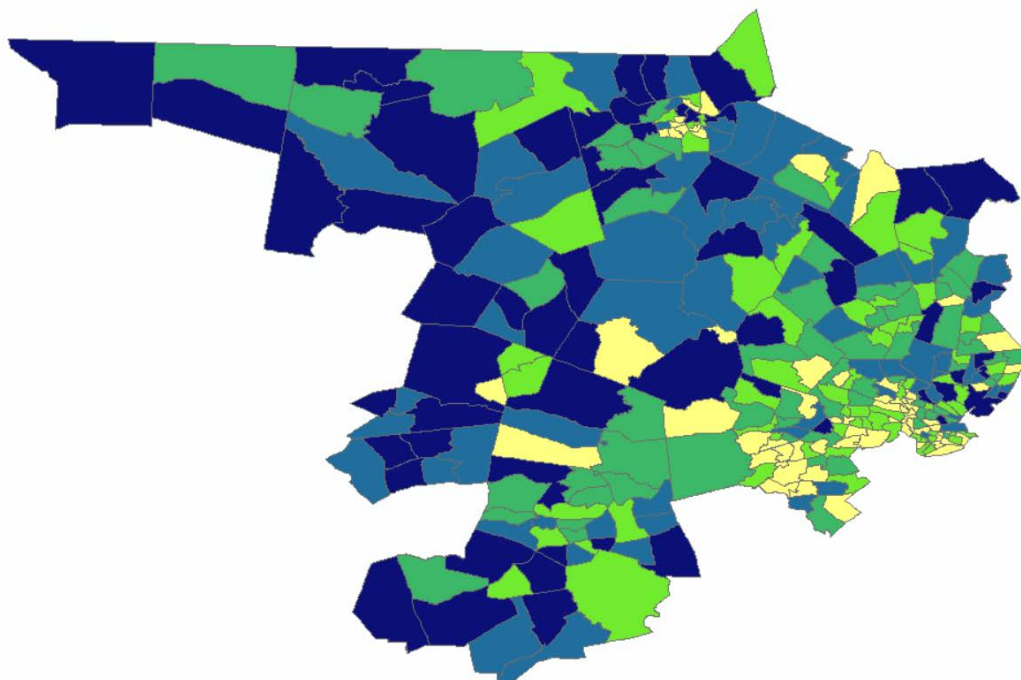
This is where you tell ArcMap what the right-hand table will be (*Travel_90min*) and what the matching fields will be – GEOID2 and GEO.id2.

Click OK and then inspect the Attribute Table for *Middlesex_Tracts*. Five newly added columns represent the information from the census table.

FID	Shape *	STATE	COUNTY	GEOID	NAMLSA	ALAND	AWATER	GEOID2	GEO.id	GEO.id2	CensusTract	TotalPop	90min
0	Polygon	25	017	25017321	Census Tr	4596280	962007	2501732	14000000	250173212	Census Tract 321	3526	82
1	Polygon	25	017	25017383	Census Tr	4293522	369224	2501738	14000000	250173837	Census Tract 383	3190	44
2	Polygon	25	017	25017383	Census Tr	5269623	304363	2501738	14000000	250173838	Census Tract 383	2924	51
3	Polygon	25	017	25017385	Census Tr	17363842	579477	2501738	14000000	250173851	Census Tract 385	3449	150
4	Polygon	25	017	25017322	Census Tr	14081676	557716	2501732	14000000	250173221	Census Tract 322	2311	117
5	Polygon	25	017	25017339	Census Tr	629016	25734	2501733	14000000	250173394	Census Tract 339	2054	32
6	Polygon	25	017	25017353	Census Tr	901795	698900	2501735	14000000	250173531	Census Tract 353	1992	15
7	Polygon	25	017	25017368	Census Tr	4020837	25552	2501736	14000000	250173689	Census Tract 368	3320	49
8	Polygon	25	017	25017353	Census Tr	411670	0	2501735	14000000	250173531	Census Tract 353	1490	6
9	Polygon	25	017	25017317	Census Tr	4023677	125860	2501731	14000000	250173173	Census Tract 317	1127	59
10	Polygon	25	017	25017320	Census Tr	17071414	409723	2501732	14000000	250173201	Census Tract 320	1294	42
11	Polygon	25	017	25017339	Census Tr	1937421	268689	2501733	14000000	250173398	Census Tract 339	2174	101
12	Polygon	25	017	25017350	Census Tr	891197	227873	2501735	14000000	250173501	Census Tract 350	854	30
13	Polygon	25	017	25017354	Census Tr	419513	0	2501735	14000000	250173544	Census Tract 354	2161	53

To keep those columns permanently, you must export a new copy of *Middlesex_Tracts.shp* using **Right-click > Data > Export**. For use in the following exercises, please name your export *Middlesex_joined.shp*. We can now display the census tracts symbolized according to number of

residents traveling more than 90 minutes to work:

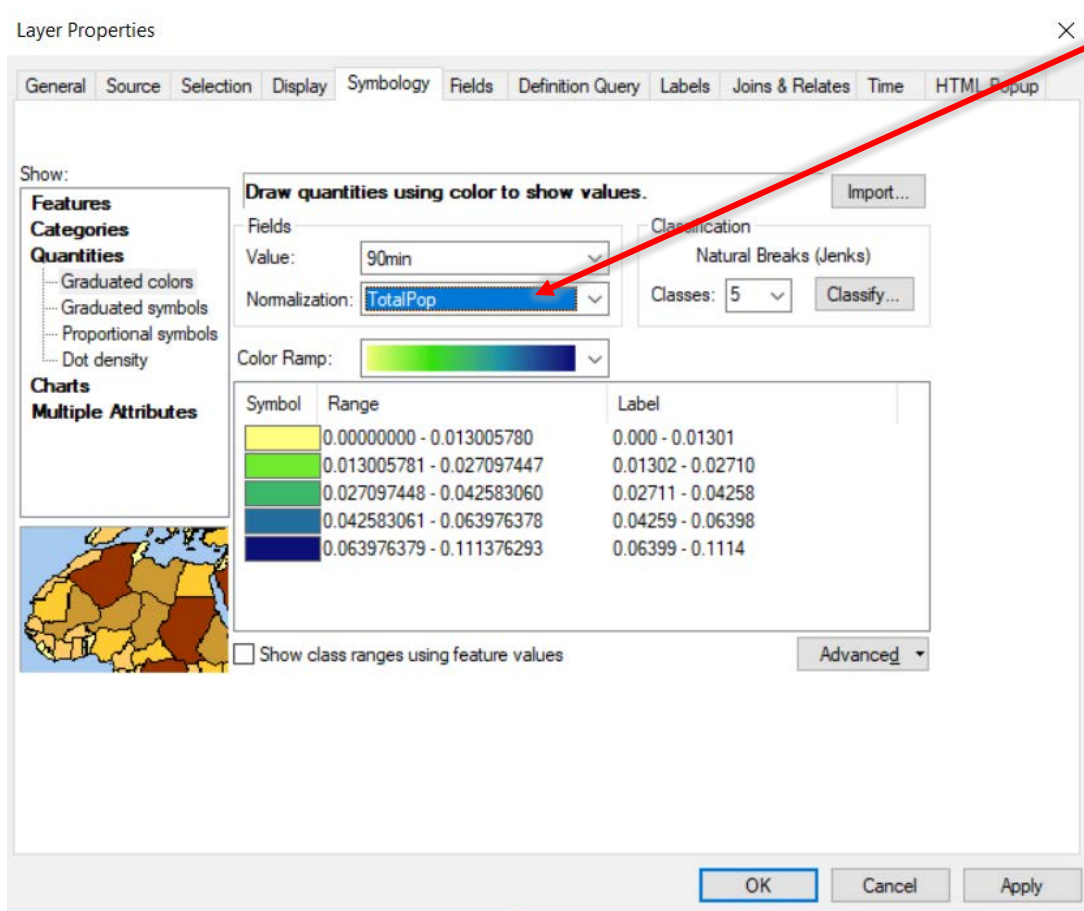


Extra: Field Calculation

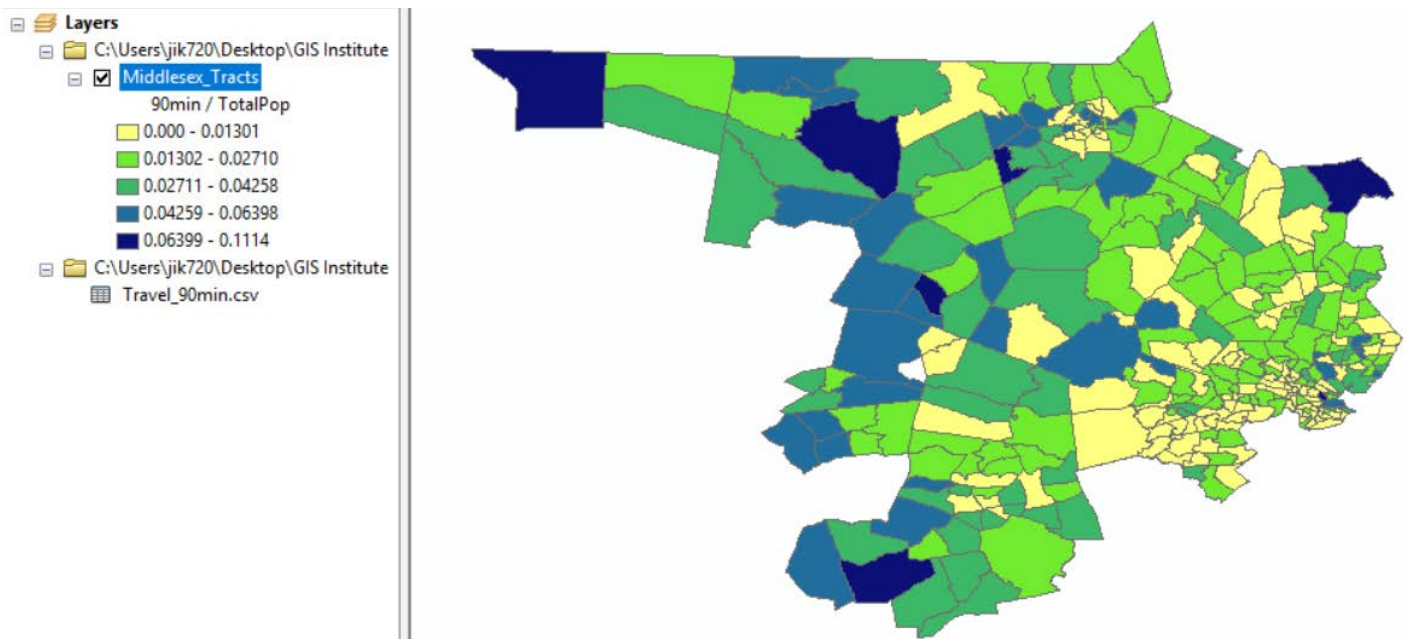
Materials needed: *Middlesex_joined.shp*, your exported shapefile from the previous section

How could we change this map to display the fraction of commuters making this long journey? Two ways: visually only or using an actual calculation in the Attribute Table.

[1] Under **Properties** > **Symbology** > **Quantities**, we can Normalize the values shown by the field TotalPop.



Think about how this meaning is different from <PERCENT OF TOTAL>. Which total?



[2] To make a real, permanent calculation of the fraction of super-commuters, open the Attribute Table. Pull down the **Table Options** menu and choose **Add Field**.

LSA	ALAND	AWATER	GEOID2	GEOID1	GEOID2	CensusTract	TotalPop	90min
js Tr	4590260	962007	2501732	1400000U	250173212	Census Tract 321	3526	82
js Tr	4293522	369224	2501738	1400000U	250173837	Census Tract 383	3190	44
js Tr	5269623	304363	2501738	1400000U	250173838	Census Tract 383	2924	51
js Tr	17363842	579477	2501738	1400000U	250173851	Census Tract 385	3449	150
js Tr	14081676	557716	2501732	1400000U	250173221	Census Tract 322	2311	117
js Tr	629016	25734	2501733	1400000U	250173394	Census Tract 339	2054	32
js Tr	901795	698990	2501738	1400000U	250173531	Census Tract 353	1992	15
js Tr					250173688	Census Tract 368	3320	49
js Tr					250173531	Census Tract 353	1490	6
js Tr					250173173	Census Tract 317	1127	59
js Tr					250173201	Census Tract 320	1294	42
js Tr	1937421	268689	2501733	1400000U	250173398	Census Tract 339	2174	101
js Tr	891197	227873	2501735	1400000U	250173501	Census Tract 350	854	30
js Tr	418512	0	2501735	1400000U	250173514	Census Tract 351	2181	53
js Tr	411601	157315	2501735	1400000U	250173521	Census Tract 352	1410	0
js Tr	1070048	0	2501737	1400000U	250173702	Census Tract 370	2519	19
js Tr	3119550	921967	2501738	1400000U	250173840	Census Tract 384	626	44
js Tr	617981	0	2501734	1400000U	250173421	Census Tract 342	2137	91
js Tr	694736	177688	2501738	1400000U	250173883	Census Tract 388	2155	105
js Tr	1136778	3533	2501735	1400000U	250173567	Census Tract 356	3618	80
js Tr	2496355	3372486	2501732	1400000U	250173201	Census Tract 320	2549	139
js Tr	48871325	2361393	2501732	1400000U	250173281	Census Tract 328	3187	220
js Tr	38016617	229543	2501732	1400000U	250173281	Census Tract 328	2048	63
js Tr	684682	26294	2501734	1400000U	250173411	Census Tract 341	2254	52
js Tr	407690	0	2501735	1400000U	250173512	Census Tract 351	3244	12
js Tr	19025969	798537	2501736	1400000U	250173662	Census Tract 366	2057	45
js Tr	519645	0	2501734	1400000U	250173422	Census Tract 342	2550	42
js Tr	40980307	201617	2501738	1400000U	250173882	Census Tract 388	2739	109
js Tr	467529	0	2501735	1400000U	250173524	Census Tract 352	1046	4
js Tr	206733	0	2501735	1400000U	250173525	Census Tract 352	1720	10
js Tr	240335	0	2501735	1400000U	250173526	Census Tract 352	1480	35
js Tr	158002	0	2501735	1400000U	250173527	Census Tract 352	1167	0
js Tr	162599	0	2501735	1400000U	250173528	Census Tract 352	1404	0
js Tr	334801	0	2501735	1400000U	250173530	Census Tract 353	1900	20
js Tr	1311822	29990	2501736	1400000U	250173689	Census Tract 368	2369	37
js Tr	2665287	17552	2501736	1400000U	250173690	Census Tract 369	613	5
js Tr	1118622	78976	2501733	1400000U	250173311	Census Tract 331	1794	5
js Tr	13829838	89273	2501733	1400000U	250173311	Census Tract 331	3648	28
js Tr	8366809	145974	2501733	1400000U	250173312	Census Tract 331	3084	72
js Tr	514215	2953	2501735	1400000U	250173532	Census Tract 353	2918	23
js Tr	474725	50166	2501735	1400000U	250173533	Census Tract 353	2123	11

The following dialog box appears. Choose the options shown:

Add Field

Name:

90_fraction

Type:

Double

Field Properties

Precision

10

Scale

5

OK

Cancel

The field type “Double” means numeric with the possibility of decimal values, which is necessary when computing a fraction. Precision and scale describe how many place values will be available in total and after the decimal point. Field names can have no spaces. They must be fairly short and they cannot be re-used.

There is now a new, empty field in the Attribute Table. **Right click** at the top of it and choose **Field Calculator**.

CensusTract	TotalPop	90min
Census Tract 321	3526	82
Census Tract 383	3190	44
Census Tract 383	2924	51
Census Tract 385	3449	150
Census Tract 322	2311	117
Census Tract 339	2054	32
Census Tract 353	1992	15
Census Tract 368	3320	49
Census Tract 353	1490	6
Census Tract 317	1127	59
Census Tract 320	1294	42
Census Tract 339	2174	101
Census Tract 350	854	30
Census Tract 351	2161	53
Census Tract 352	1410	0
Census Tract 370	2519	19
Census Tract 384	826	44
Census Tract 342	2137	91
Census Tract 388	2155	105
Census Tract 356	3618	80
Census Tract 320	2549	139

Field Calculator

Parser

☒ VB Script
 ☐ Python

Fields:

ALAND
 AWATER
 GEOID2
 GEO_id
 GEO_id2
 CensusTrac
 TotalPop
 90min
 90_fractio

Type:

☒ Number
☐ String
☐ Date

Functions:

Abs ()
 Atn ()
 Cos ()
 Exp ()
 Fix ()
 Int ()
 Log ()
 Sin ()
 Sqr ()
 Tan ()

☐ Show Codeblock

90_fractio =

[90min] / [TotalPop]

[About calculating fields](#)

Clear

Load...

Save...

OK

Cancel

This new calculator appears rather similar to the Select by Attribute calculator.

Create a formula to calculate values for the new field: $[90min] / [TotalPop]$


If we were concerned about a denominator being zero, we could use $[90min] / ([TotalPop] + 0.01)$. Alternatively, we could **Select** those tracts with non-zero populations. If we preferred percentage to proportion, we could use $100 * [90min] / [TotalPop]$.

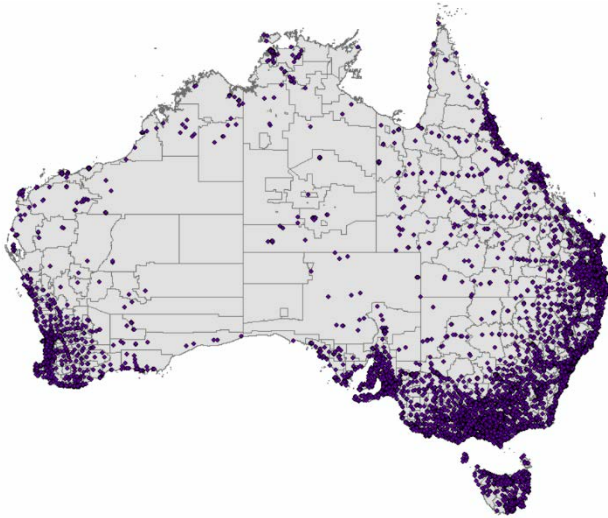
Press **OK** to execute the calculation. The field is filled with new values, and Symbology can now make use of them. Interestingly, the quantile breaks are different for this computed field than they were for the normalized symbology. Why do you think that is?

Extra: Spatial Join

Materials needed: *AussiePublicToilets.shp*, *Municipalities.shp*

[1] Open and examine the data:

Open ArcMap and use the **Add Data**  button to add both shapefiles to the map.



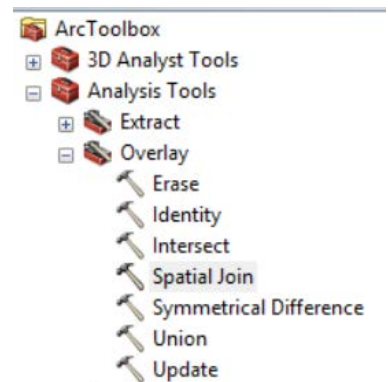
Spatial Join is a technique that associates one layer with the features of another based on their location in space.

[2] First, let's join the municipalities to the toilets, so that each toilet will have information about which municipality it's in.

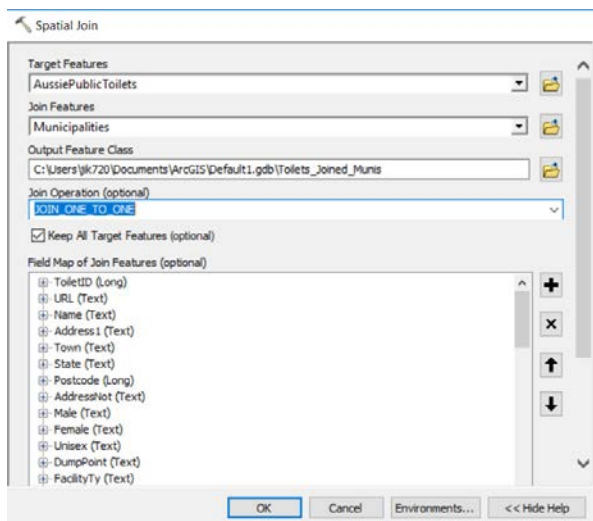
Click the ArcToolbox  icon to open the Toolbox.

Then navigate to Analysis > Overlay > Spatial Join.

Double-click to run the tool.



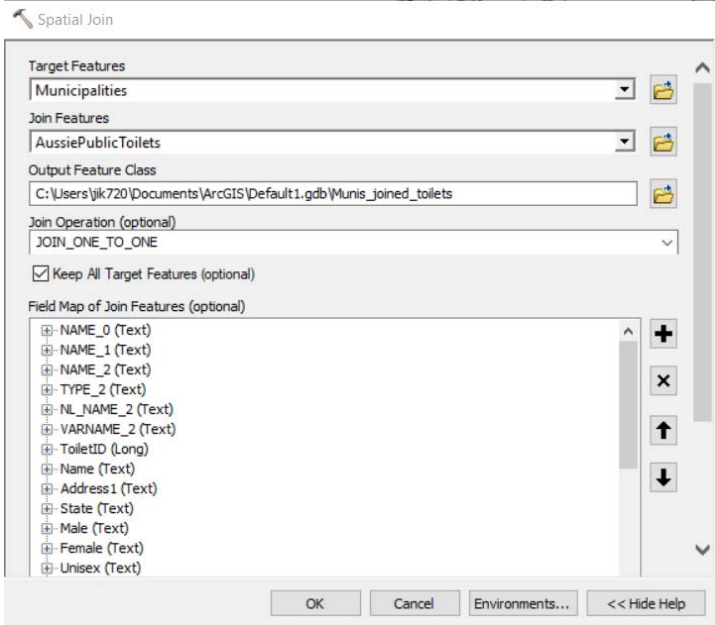
The first time we join, the Target Layer will be the toilets and the Join Layer will be the municipalities. Join one-to-one. At the bottom of the dialog, you will see a choice for Match Option, set to INTERSECT. For now, leave that choice, but inspect the alternatives in the drop-down menu. Run the tool and inspect the output. The output is a set of points, and new columns have been added to the right of the attribute table containing all of the information from the Municipalities shapefile.



	NAME_0	NAME_1	NAME_2	TYPE_2
8	Australia	Western Australia	Bassendean	Town
1	Australia	Western Australia	Bassendean	Town
1	Australia	Western Australia	Bassendean	Town
4	Australia	Western Australia	Bassendean	Town
7	Australia	Western Australia	Bassendean	Town
2	Australia	Western Australia	Bassendean	Town
8	Australia	Western Australia	Bassendean	Town
9	Australia	Western Australia	Bassendean	Town
2	Australia	Queensland	Belyando	Shire
3	Australia	Queensland	Belyando	Shire
6	Australia	Queensland	Belyando	Shire
8	Australia	Queensland	Belyando	Shire
2	Australia	Queensland	Belyando	Shire
5	Australia	Queensland	Belyando	Shire
7	Australia	Queensland	Belyando	Shire
1	Australia	Queensland	Belyando	Shire
6	Australia	Queensland	Belyando	Shire
7	Australia	Queensland	Belyando	Shire
9	Australia	Queensland	Johnstone	Shire
6	Australia	Queensland	Johnstone	Shire
7	Australia	Queensland	Johnstone	Shire
6	Australia	Queensland	Johnstone	Shire
9	Australia	Queensland	Johnstone	Shire

[2] Now let's do the opposite: tell each municipality about the toilets it contains. We could spatially join one-to-many, but that would make many copies of each municipality, one for each toilet it contains.

Instead, let's get a summary for each municipality, using one-to-one. Open the Spatial Join tool, make the municipalities the Target Layer and the toilets the Join Layer.



Now, as it says in the help window, we need to set a Merge Rule.

- **JOIN_ONE_TO_ONE**—If multiple join features are found that have the same spatial relationship with a single target feature, the attributes from the multiple join features will be aggregated using a field map merge rule. For example, if a point target feature is found within two separate polygon join features, the attributes from the two polygons will be aggregated before being transferred to the output point feature class. If one polygon has an attribute value of 3 and the other has a value of 7, and a Sum merge rule is specified, the aggregated value in the output feature class will be 10. This is the default.

Decide which field you would like summary information about, and right-click it in the list.

Let's get the count of unique toilet ID numbers per municipality.

Right-click on ToiletID, select Merge Rule, and then Count.

Leave the Match Option as INTERSECT and run the tool.

Inspect the output. This time, the output is a set of polygons, and a new field has been added which gives the count of toilets per municipality.

We can change the symbology to display that quantity.

