

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.



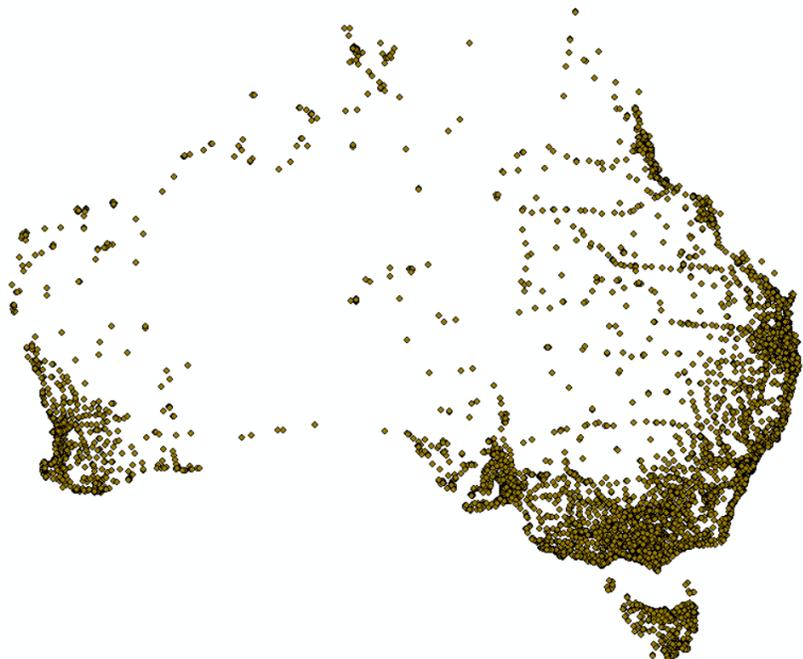
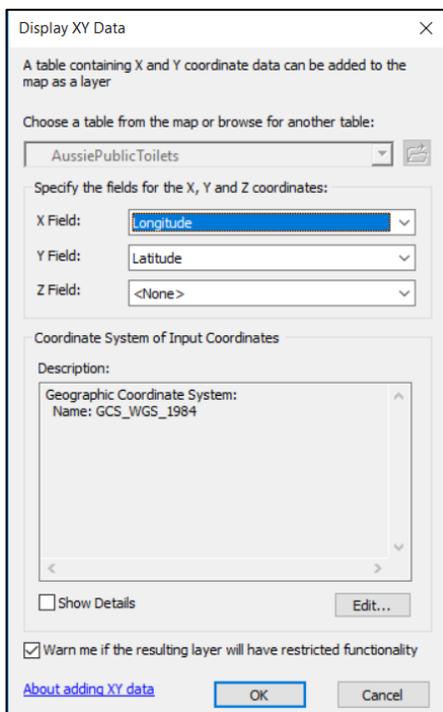
Notice that there are columns for Latitude and Longitude, and that the values in these columns look a lot like decimal degrees. (Metadata confirms that the data were recorded using GCS_WGS84.)

[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.

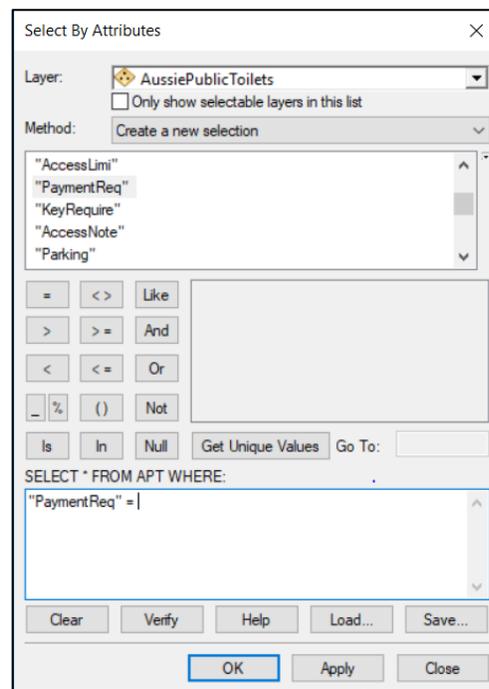
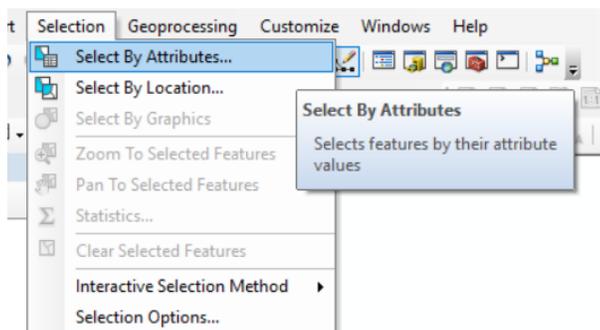


[4] Remember that this layer of points is temporary. To make it permanent, **right-click** on *AussiePublicToilets Events*. Choose **Data > Export**. Name the new file *AussiePublicToilets.shp* and save it somewhere you will be able to find it again. Add that saved file to the map and remove both the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



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

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

Click **OK**.

[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: the census.data.gov website, *Middlesex_Tracts.shp*, and *Travel_90min.csv*

[1] Open a browser and navigate to <https://data.census.gov/cedsci/advanced>.

[2] At the top, type **travel time to work**. For Geography, choose **Census Tracts**. Choose **Massachusetts** and **Middlesex County**. Then choose **All Census Tracts within Massachusetts**. Finish this step by clicking [**SEARCH**] and selecting the first table in the results, table B08135.

Advanced Search

The screenshot shows the 'Advanced Search' interface on the census data website. At the top, the search term 'travel time to work' is entered. Below the search bar, the text 'Narrow search with filters' is displayed. A search filter is applied: 'e.g. 336111 - Automobile Manufacturing'. The interface is divided into several filter panels:

- BROWSE FILTERS:** Includes Topics, Geography (selected), Years, Surveys, and Codes.
- GEOGRAPHY:** Includes a 'Show Summary Levels' toggle and a list of levels: Division, State, County, Tract (selected), Block Group, and Block.
- WITHIN STATE:** A list of states including Louisiana, Maine, Maryland, Massachusetts (selected), Michigan, Minnesota, and Mississippi.
- MASSACHUSETTS:** A list of geographies within Massachusetts, including 'All Census Tracts within Massachusetts' (checked), Barnstable County, Berkshire County, and Bristol County.

[3] In the left-hand pane, choose **Download**, click the box next to table B08135, and choose **Download Selected**. If prompted, choose file format **CSV**.

Unzip your downloaded folder, navigate to it, and open the file *2018.B08135_data_with_overlay* with Excel or Notepad to inspect it.

The screenshot shows the 'Download Selected' interface for table B08135. At the top, there are tabs for 'ALL', 'TABLES' (selected), 'MAPS', and 'PAGES'. Below the tabs, it shows '581 Results' and a 'Close Download' button. A 'Download Selected (1)' button is also visible. The selected table is:

- AGGREGATE TRAVEL TIME TO WORK (IN MINUTES) OF WORKERS BY TRAVEL TIME TO WORK**
- Survey/Program: American Community Survey
- Years: 2018,2017,2016,2015,2014,2013,2012,2011,2010
- Table: B08135

[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 ArcGIS Pro. Pro is not prepared to handle data with two header rows. Furthermore, there are many more columns than we may want to use.

GEO_ID	NAME	B08135_001E	B08135_001M
id	Geographic Area Name	Estimate!!Aggregate travel time to work (in minutes)	Margin of Error!!Aggregate travel time to work (in
1400000US25001011300	Census Tract 113, Barnstable County, Massachusetts	31340	8121
1400000US25001012002	Census Tract 120.02, Barnstable County, Massachusetts	22155	5601
1400000US25001014300	Census Tract 143, Barnstable County, Massachusetts	39485	9463
1400000US25001014800	Census Tract 148, Barnstable County, Massachusetts	35020	8816
1400000US25001990000	Census Tract 9900, Barnstable County, Massachusetts	-	**
1400000US25005640901	Census Tract 6409.01, Bristol County, Massachusetts	48645	12194
1400000US25005650800	Census Tract 6508, Bristol County, Massachusetts	35835	7571
1400000US25005650900	Census Tract 6509, Bristol County, Massachusetts	22670	5484
1400000US25005990000	Census Tract 9900, Bristol County, Massachusetts	-	**
1400000US25007200200	Census Tract 2002, Dukes County, Massachusetts	21595	4163
1400000US25007990000	Census Tract 9900, Dukes County, Massachusetts	-	**
1400000US25009218100	Census Tract 2181, Essex County, Massachusetts	84075	12108
1400000US25009250100	Census Tract 2501, Essex County, Massachusetts	26625	8850
1400000US25009990100	Census Tract 9901, Essex County, Massachusetts	-	**
1400000US25011041300	Census Tract 413, Franklin County, Massachusetts	36915	7020
1400000US25013801502	Census Tract 8015.02, Hampden County, Massachusetts	20250	4247
1400000US25013801503	Census Tract 8015.03, Hampden County, Massachusetts	27495	6266

Suppose we are 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, Mid	1585	116
3	1400000US25017301101	25017301101	Census Tract 3011.01, f	1894	33
4	1400000US25017301102	25017301102	Census Tract 3011.02, f	2774	111
5	1400000US25017310100	25017310100	Census Tract 3101, Mid	2594	128
6	1400000US25017310200	25017310200	Census Tract 3102, Mid	3332	10
7	1400000US25017310300	25017310300	Census Tract 3103, Mid	2461	22

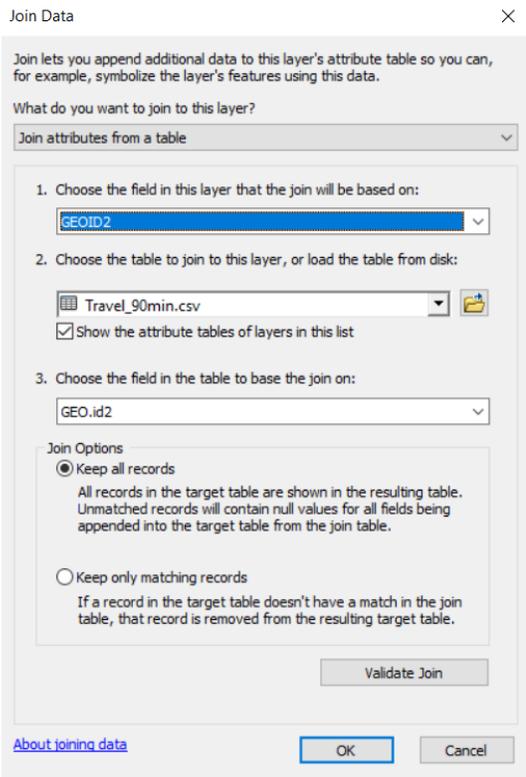
★ This has already been done for you and is saved in your lab materials as **Travel_90min.csv**.

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								1	2	3	4	5	6	7	8	9	10	
FID	Shape *	STATEFP	COUNTYFP	NAMESAD	ALAND	AWATER	GEOID2	GEO.id	GEO.id2	CensusTra	TotalPop	90min						
0	Polygon	25	017	Census Tract 3212	4596280	962007	25017321200	1400000US25017300100	25017300100	Census Tra	1585	116						
1	Polygon	25	017	Census Tract 3837	4293522	369224	25017383700	1400000US25017301101	25017301101	Census Tra	1894	33						
2	Polygon	25	017	Census Tract 3838	5269623	304363	25017383800	1400000US25017301102	25017301102	Census Tra	2774	111						
3	Polygon	25	017	Census Tract 3851	17363842	579477	25017385100	1400000US25017310100	25017310100	Census Tra	2594	128						
4	Polygon	25	017	Census Tract 3221	14081676	557716	25017322100	1400000US25017310200	25017310200	Census Tra	3332	10						
5	Polygon	25	017	Census Tract 3394	629016	25734	25017339400	1400000US25017310300	25017310300	Census Tra	2461	22						
6	Polygon	25	017	Census Tract 3531.02	901795	698900	25017353102	1400000US25017310400	25017310400	Census Tra	1467	8						
7	Polygon	25	017	Census Tract 3689.01	4020837	25552	25017368901	1400000US25017310500	25017310500	Census Tra	1731	62						
8	Polygon	25	017	Census Tract 3531.01	411670	0	25017353101	1400000US25017310601	25017310601	Census Tra	3048	195						
9	Polygon	25	017	Census Tract 3173.01	4023677	125860	25017317301	1400000US25017310602	25017310602	Census Tra	3028	22						
10	Polygon	25	017	Census Tract 3201.03	17071414	409723	25017320103	1400000US25017310603	25017310603	Census Tra	3028	22						

[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:



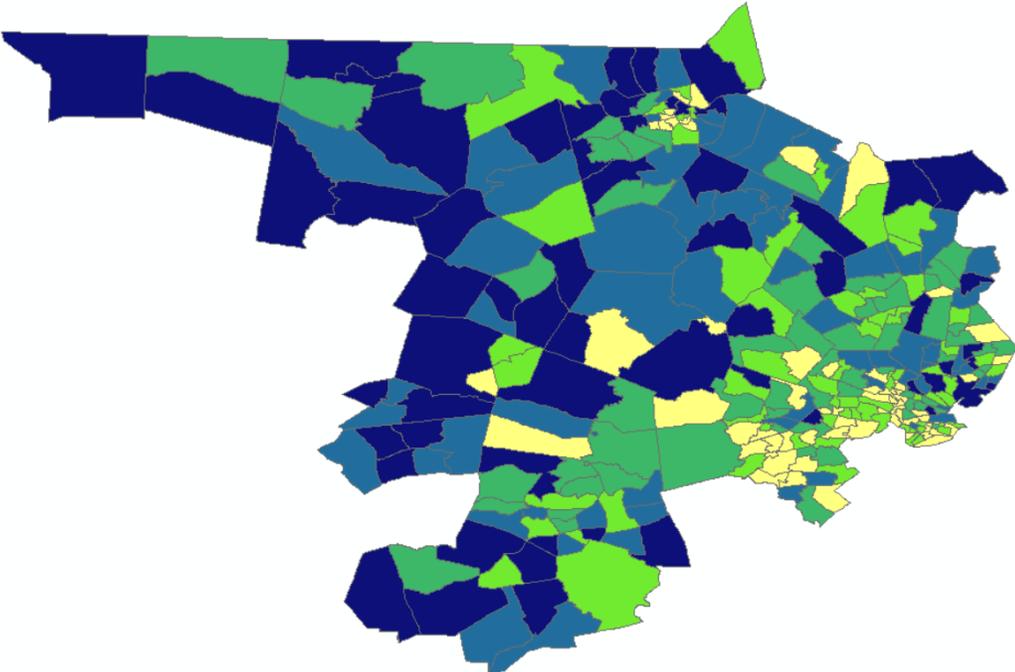
This is where you tell ArcMap what the right-hand table will be (*Travel_90min*) and what the matching fields will be – GEOID2 and GEO.id2.

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

Middlesex_Tracts													
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	1400000U	250173212	Census Tract 321	3526	82
1	Polygon	25	017	25017383	Census Tr	4293522	369224	2501738	1400000U	250173837	Census Tract 383	3190	44
2	Polygon	25	017	25017383	Census Tr	5269623	304363	2501738	1400000U	250173838	Census Tract 383	2924	51
3	Polygon	25	017	25017385	Census Tr	17363842	579477	2501738	1400000U	250173851	Census Tract 385	3449	150
4	Polygon	25	017	25017322	Census Tr	14081676	557716	2501732	1400000U	250173221	Census Tract 322	2311	117
5	Polygon	25	017	25017339	Census Tr	629016	25734	2501733	1400000U	250173394	Census Tract 339	2054	32
6	Polygon	25	017	25017353	Census Tr	901795	698900	2501735	1400000U	250173531	Census Tract 353	1992	15
7	Polygon	25	017	25017368	Census Tr	4020837	25552	2501736	1400000U	250173689	Census Tract 368	3320	49
8	Polygon	25	017	25017353	Census Tr	411670	0	2501735	1400000U	250173531	Census Tract 353	1490	6
9	Polygon	25	017	25017317	Census Tr	4023677	125860	2501731	1400000U	250173173	Census Tract 317	1127	59
10	Polygon	25	017	25017320	Census Tr	17071414	409723	2501732	1400000U	250173201	Census Tract 320	1294	42
11	Polygon	25	017	25017339	Census Tr	1937421	268689	2501733	1400000U	250173398	Census Tract 339	2174	101
12	Polygon	25	017	25017350	Census Tr	891197	227873	2501735	1400000U	250173501	Census Tract 350	854	30
13	Polygon	25	017	25017351	Census Tr	448512	0	2501735	1400000U	250173511	Census Tract 351	2161	59

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:

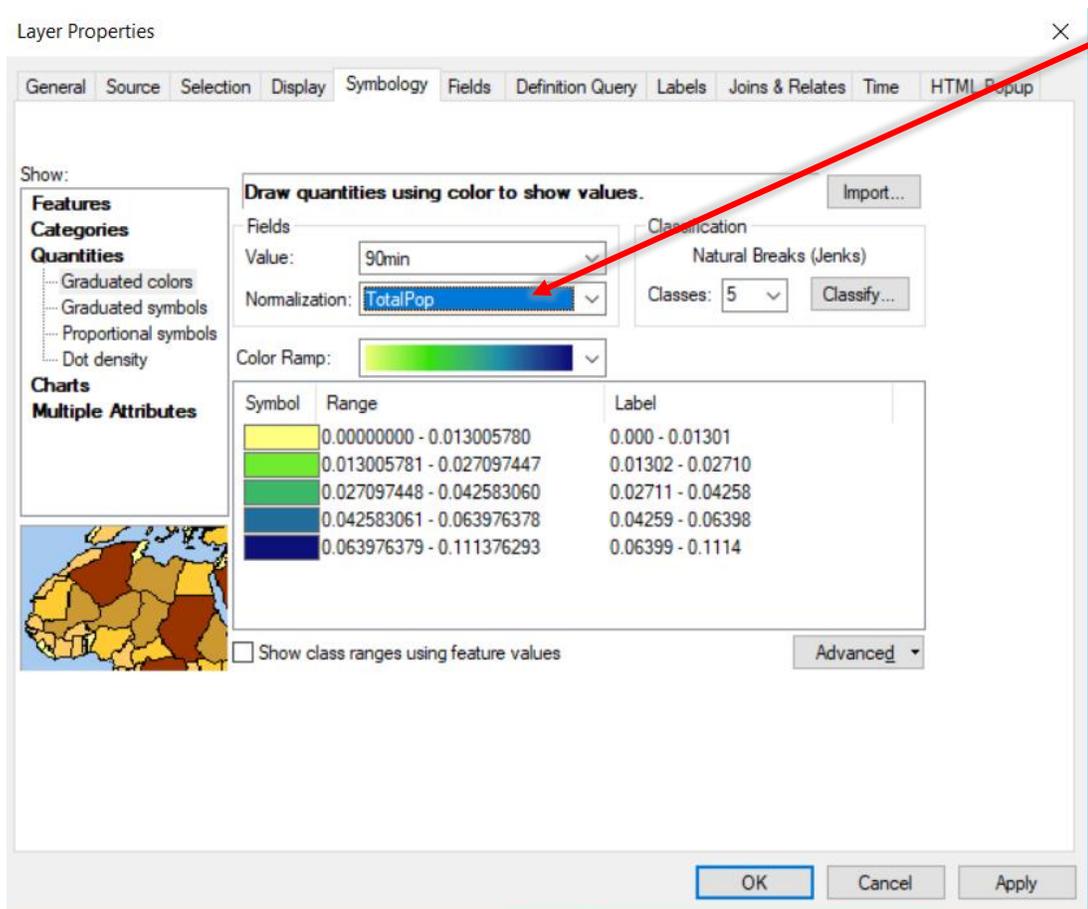


Extra: Field Calculation

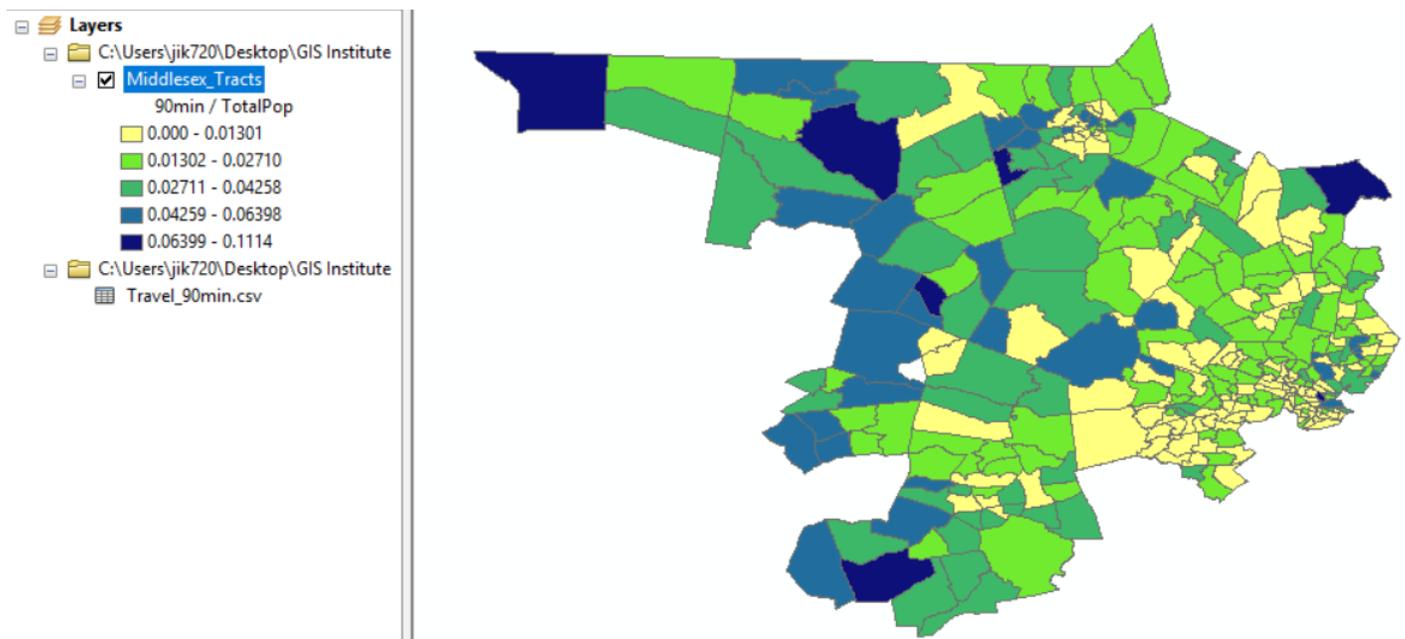
Materials needed: *Middlesex_joined.shp*, your exported shapefile from the previous section

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**.

LISA	ALAND	AWATER	GEOID2	GEO_id	GEO_id2	CensusTract	TotalPop	90min
js Tr 4596280	962007	2501732	1400000U	250173212	Census Tract 321	3526	82	
js Tr 4293522	369224	2501738	1400000U	250173837	Census Tract 383	3190	44	
js Tr 5286923	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	698900	2501735	1400000U	250173531	Census Tract 353	1992	15	
js Tr 1400000U	250173689	Census Tract 368	3320	49				
js Tr 1400000U	250173531	Census Tract 353	1490	6				
js Tr 1400000U	250173173	Census Tract 317	1127	59				
js Tr 1400000U	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	2161	53	
js Tr 411601	157315	2501735	1400000U	250173521	Census Tract 352	1410	0	
js Tr 1070648	0	2501737	1400000U	250173702	Census Tract 370	2519	19	
js Tr 3119550	921967	2501738	1400000U	250173840	Census Tract 384	826	44	
js Tr 617861	0	2501734	1400000U	250173421	Census Tract 342	2137	91	
js Tr 694736	177668	2501738	1400000U	250173883	Census Tract 388	2155	105	
js Tr 1136778	3533	2501735	1400000U	250173567	Census Tract 356	3618	80	
js Tr 24963655	3372406	2501732	1400000U	250173201	Census Tract 320	2549	139	
js Tr 48871325	2361393	2501732	1400000U	250173261	Census Tract 326	3167	220	
js Tr 36016617	229543	2501732	1400000U	250173261	Census Tract 326	2048	63	
js Tr 884682	20294	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 519545	0	2501734	1400000U	250173422	Census Tract 342	2550	42	
js Tr 40980387	201817	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 2965287	17552	2501736	1400000U	250173690	Census Tract 369	613	5	
js Tr 11155822	78978	2501733	1400000U	250173311	Census Tract 331	1794	5	
js Tr 1352938	89273	2501733	1400000U	250173311	Census Tract 331	3640	28	
js Tr 6356809	145974	2501733	1400000U	250173312	Census Tract 331	3064	72	
js Tr 514215	2953	2501735	1400000U	250173532	Census Tract 353	2918	23	
js Tr 474775	50195	2501735	1400000U	250173533	Census Tract 353	2123	31	

The following dialog box appears. Choose the options shown:

Add Field

Name:

Type:

Field Properties

Precision	10
Scale	5

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 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, CensusTract, TotalPop, 90min, 90_fractions

Type: Number String Date

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

Show Codeblock:

90_fractions =

[90min]/[TotalPop]

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 $100*[90min]/[TotalPop]$.

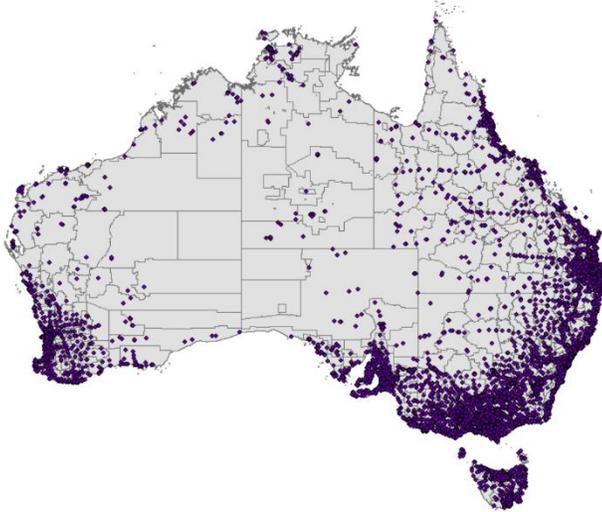
Press **OK** to execute the calculation. The field is filled with new values, and Symbology can now make use of them. Interestingly, the quantile breaks are different for this computed field than they were for the normalized symbology. Why do you think that is?

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.



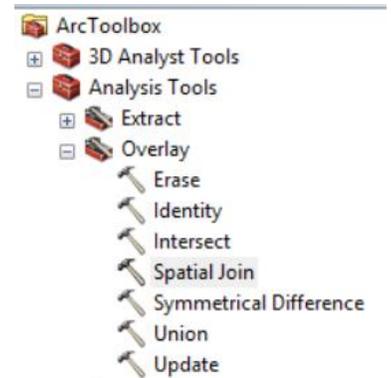
Spatial Join is a technique that associates one layer with the features of another based on their location in space.

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

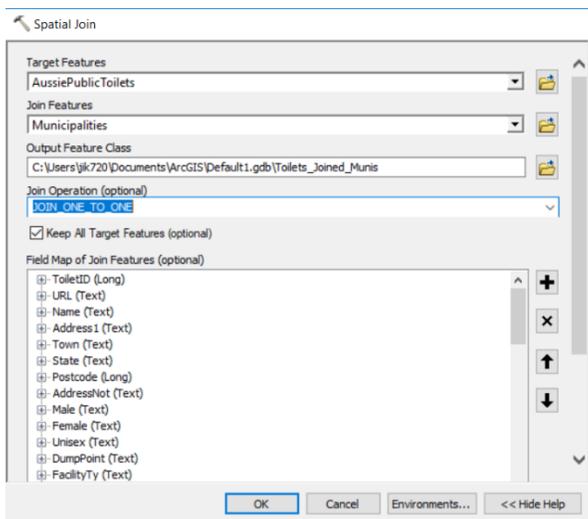
Click the ArcToolbox  icon to open the Toolbox.

Then navigate to Analysis > Overlay > Spatial Join.

Double-click to run the tool.



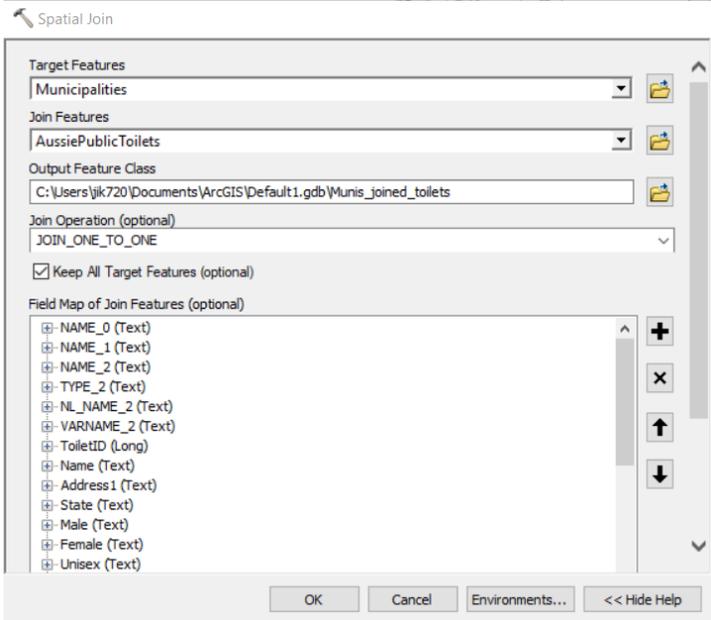
The first time we join, the Target Layer will be the toilets and the Join Layer will be the municipalities. Join one-to-one. At the bottom of the dialog, you will see a choice for Match Option, set to INTERSECT. For now, leave that choice, but inspect the alternatives in the drop-down menu. Run the tool 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
9	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
8	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.

