GIS II: Data Management
Leveraging the *Where* of Geographic Data Exercise

*** Files needed for exercise: *LA_tract2017ACS features, and MD_USA_CANADA.shp*

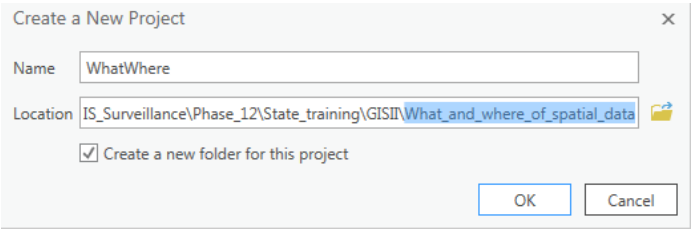
Goals: The goals for this exercise are to gain experience performing table operations: attribute selections and calculating new fields; and spatial operations: spatial joins.

Skills: After completing this exercise, you will be able to:

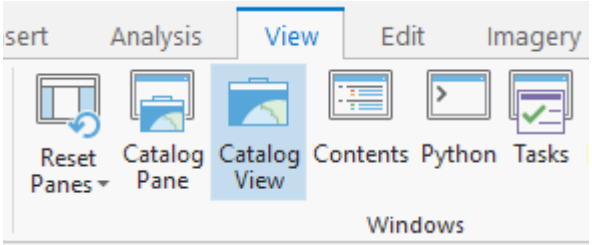
1. Confidently perform attribute selections, add new fields to tables and calculate values for fields; and
2. Spatially join a point dataset (businesses of interest) to a polygon dataset (census tracts). This is a useful method for the enumeration of points within polygons: i.e. what is the count for points of interest within geography of interest?

Adding Data and Checking Coordinate Systems

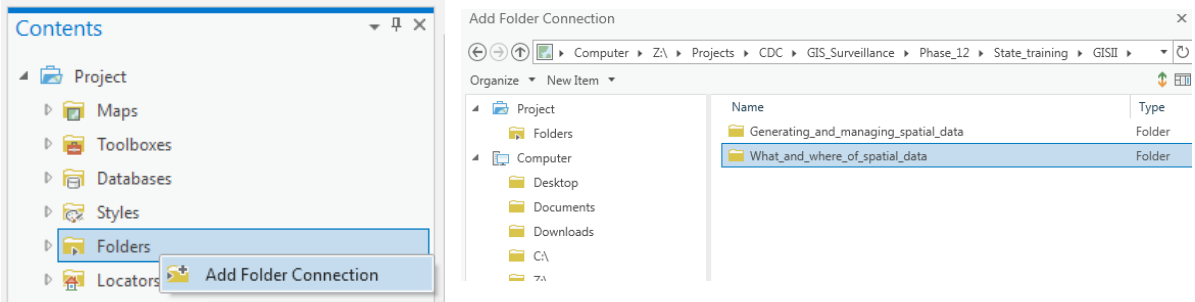
1. Open ArcGIS Pro. Start a New project using the Map template. Name the new project: "WhatWhere" and save it in the *What_and_where_of_spatial_data* folder.



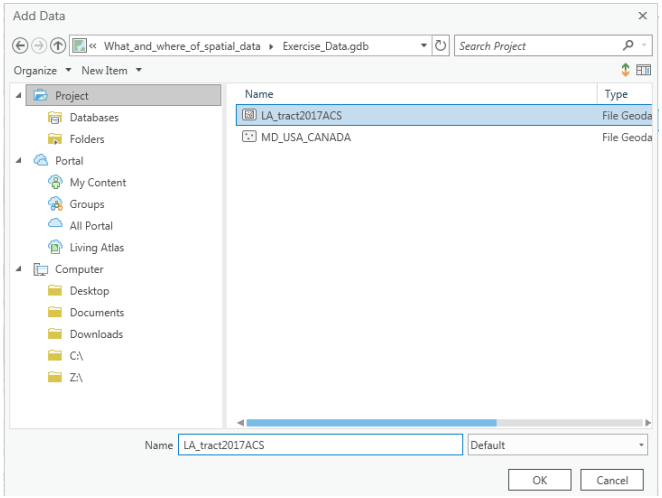
2. Select the View Tab and Activate Catalog View.



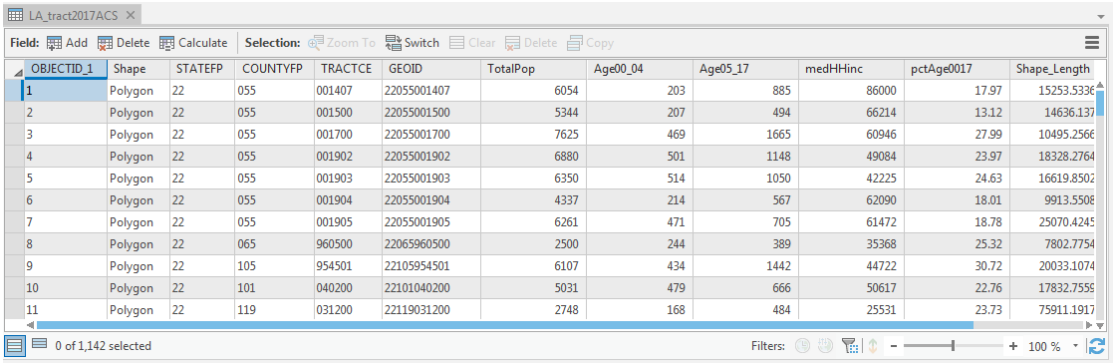
3. Then, right click on Folders and Add Folder Connection. Navigate to the location where you have saved the Exercise Data for this module.



4. Switch back to the Map View tab. Under the Map ribbon tab, click the **Add Data** button .
5. Navigate from Folders to the Exercise Data folder. Double click on *Exercise_Data.gdb and add the LA_tract2017ACS feature* to your project.

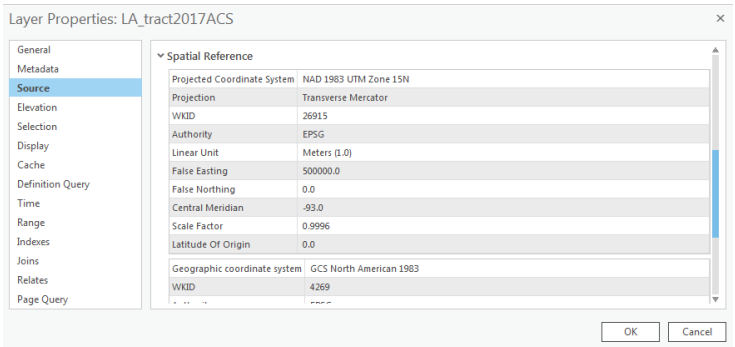


6. This feature has select American Community Survey 2013-2017 socio-economic and demographic data appended to it. Open the table and take a look at the attribute fields.

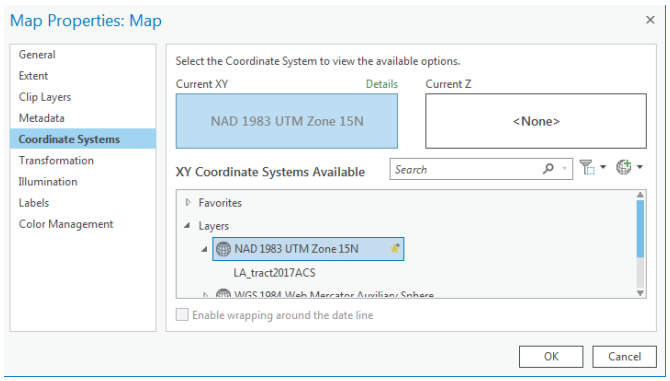


OBJECTID_1	Shape	STATEFP	COUNTYFP	TRACTCE	GEOID	TotalPop	Age00_04	Age05_17	medHHinc	pctAge0017	Shape_Length
1	Polygon	22	055	001407	22055001407	6054	203	885	86000	17.97	15253.5336
2	Polygon	22	055	001500	22055001500	5344	207	494	66214	13.12	14636.137
3	Polygon	22	055	001700	22055001700	7625	469	1665	60946	27.99	10495.2566
4	Polygon	22	055	001902	22055001902	6880	501	1148	49084	23.97	18328.2764
5	Polygon	22	055	001903	22055001903	6350	514	1050	42225	24.63	16619.8502
6	Polygon	22	055	001904	22055001904	4337	214	567	62090	18.01	9913.5508
7	Polygon	22	055	001905	22055001905	6261	471	705	61472	18.78	25070.4245
8	Polygon	22	065	960500	22065960500	2500	244	389	35368	25.32	7802.7754
9	Polygon	22	105	954501	22105954501	6107	434	1442	44722	30.72	20033.1074
10	Polygon	22	101	040200	22101040200	5031	479	666	50617	22.76	17832.7559
11	Polygon	22	119	031200	22119031200	2748	168	484	25531	23.73	75911.1917

7. This feature class is projected properly to conform to the standard projected coordinate system for Louisiana. Confirm this by right clicking on the layer in your **Contents**, clicking **Properties**, selecting the **Source** option, and finally expanding **Spatial Reference**. Once you have verified the projected coordinate system, close the **Properties** view.

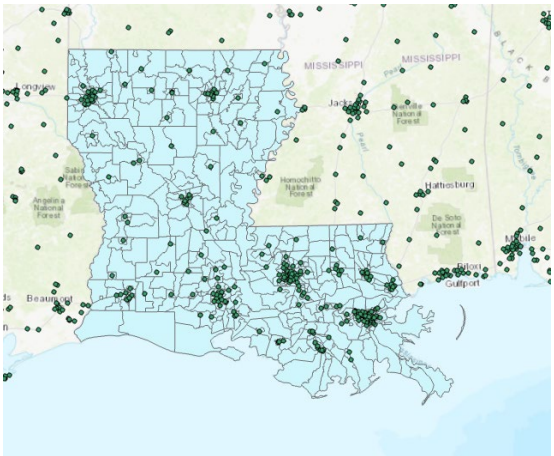


8. Since this is the first projected data ***that you have added*** to your map (that is not a Base Map), the map projection now matches *LA_tract2017ACS features.* Check this by right clicking **Map** in the Contents pane and going to **Properties**. Take a look at the **Coordinate Systems** page. Once you have verified that the map and data are in the same coordinate system, close the Map Properties.



Projecting On the Fly

1. Add ***MD_USA_CANADA.shp*** to your map from the *Exercise_Data.gdb*.
2. You should now see *MD_USA_CANADA.shp* in the Contents on the left hand side. *MD_USA_CANADA.shp* is a continental dataset of McDonald's restaurants, so it probably uses a coordinate system that differs from *LA_tract2017ACS features*. Let's confirm this.
3. What coordinate system is defined for the McDonald's? **GCS_WGS_1984** is the de facto projected coordinate system for Global Position System (GPS) gathered data. These came from ***Points of Interest Factory*** – check it out: http://www.poi-factory.com/node/11154. Note these data are current as of 01/30/2020.
4. Since the projected and geographic coordinate systems are both defined, ArcGIS Pro can project on the fly and make the McDonald's data display in the same map as the Louisiana tract data.
5. The McDonald's eating establishments should be displayed on top of your tracts.

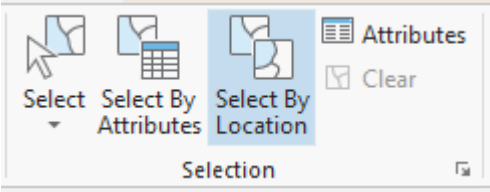


6. As an experiment, right click on *MD_USA_CANADA.shp* in your Contents pane and select the **Zoom To Layer** option. You should see the many McDonald's restaurants across the USA & Canada that have been projected on the fly to Louisiana's projected coordinate system: NAD 1983 UTM Zone 15 North.

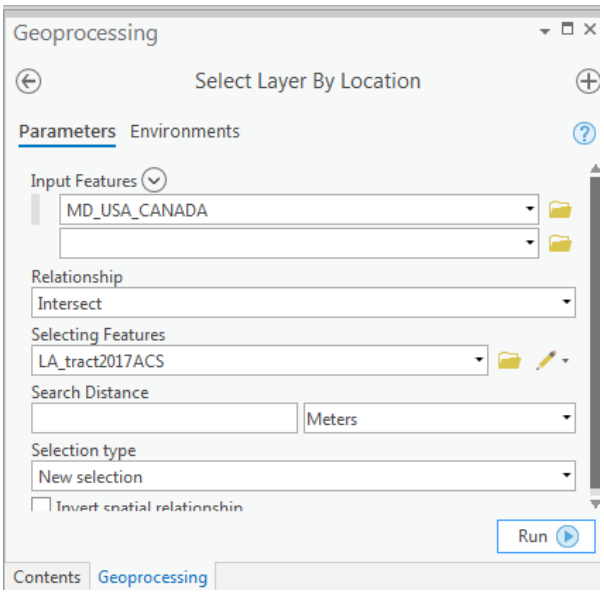
7. Open the attribute table to find out how many McDonald's are in the table. You should see 15,488 records - each represents one McDonald's restaurant.
8. Once you have done this, zoom back to the Louisiana tracts by right clicking on the *LA_tract2017ACS features* and selecting **Zoom to Layer**.

Performing a Spatial Selection of Points to limit the McDonald's dataset to the state of Louisiana:

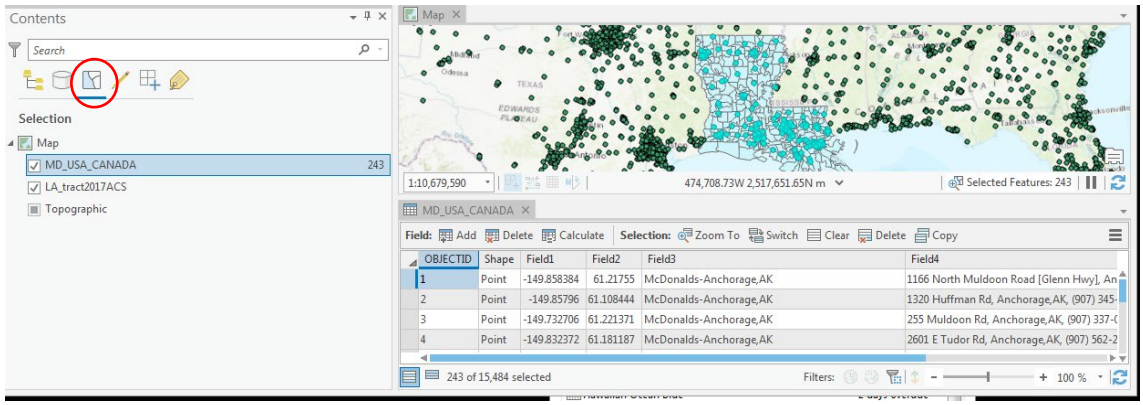
1. Under the Map ribbon tab, click **Select by Location** to bring up the Select Layer by Location geoprocessing pane on the right.



2. You want to use the location information of both the McDonald's points and Louisiana tracts to select features from **input features, McDonald's points that intersect** the **selecting features, Louisiana tracts.** *Plainly put: which McDonald's restaurant points are located inside of Louisiana's US Census Tracts?*



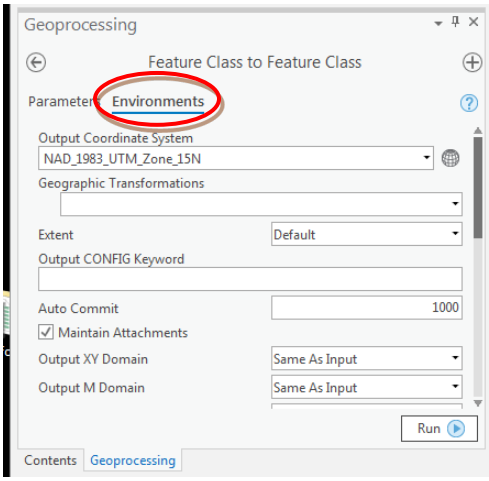
3. Run your spatial selection.
4. Click on List by Selection tab in your contents: this will list the number of selections for each feature in the map. How many records have been selected based on your spatial query? You can also see how many records are selected in the table.



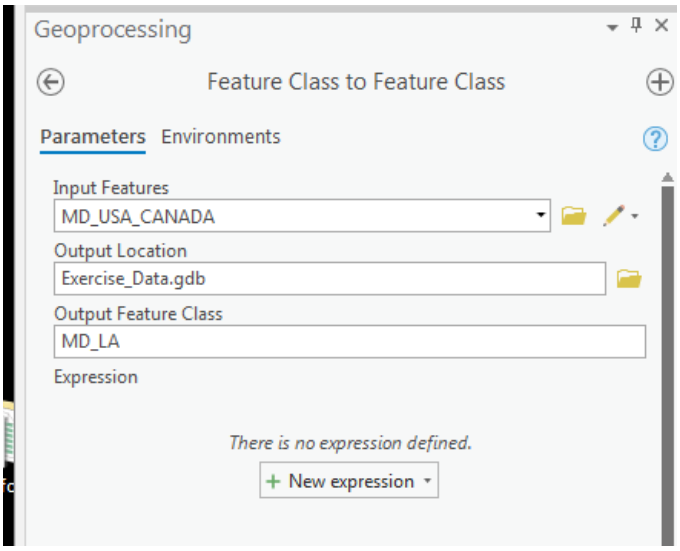
5. Once you have confirmed that **243 records** have been selected, close the table.
6. How could you have created this selection with a tabular selection?
7. Now you will export your selected McDonald's to a new feature class in your *Exercise_Data.gdb*.
8. In the process, you will set a new coordinate system, making sure it matches your Louisiana tracts.

a. Right click on *MD_USA_CANADA.shp* in the Contents pane. Select **Data** > **Export Features**. This will bring up the **Feature Class to Feature Class** dialogue. First, select the **Environments** tab:**Environments**: For Output Coordinate System, you will choose use the state of Louisiana's coordinate system: NAD_1983_UTM_Zone_15N.

b. Recall that you added a projected dataset at the start of the exercise *LA_tract2017ACS features* as the first layer. With this information, ArcGIS Pro can project the data to Louisiana's projected coordinate system.



9. Next, return to the **Parameters** tab:

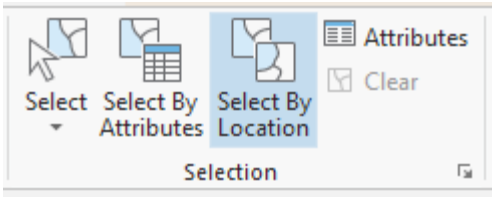


Click the folder icon to browse to your *Exercise_Data.gdb*. Name your output feature class: *MD_LA*

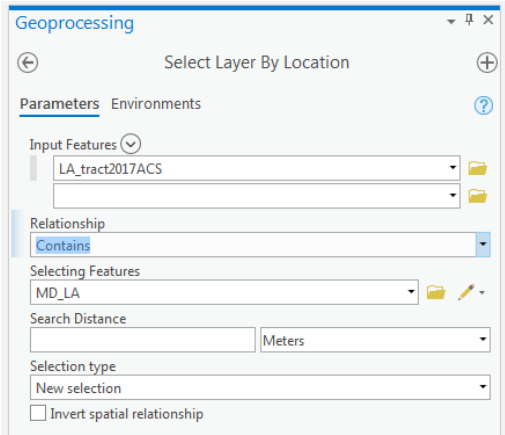
10. **Run** the tool and it should automatically add the result to your map. You can now remove the *MD_USA_CANADA feature class* from your Contents.

Performing a Spatial Selection of Polygons

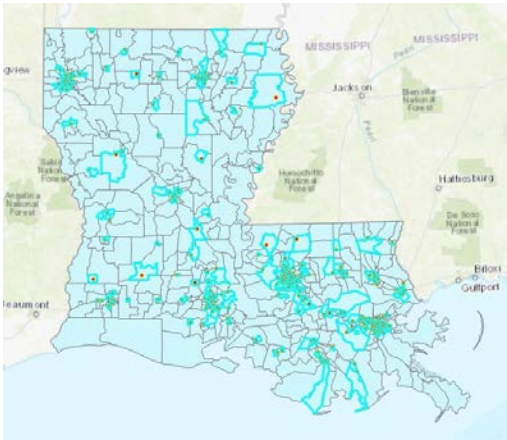
1. You now have a feature class that contains only McDonald's within any Census Tract for Louisiana, *MD_LA*. Let's say you are interested in a list of census tracts containing at least one McDonald's restaurant. You could not do this using a tabular selection, so you must use a spatial selection.
2. In the Map tab, click the **Select by Location** tool again to answer the question: which census tracts contain a McDonald's restaurant?



3. You will select features from *LA_tract2017ACS features* (input features) that **contain** features from the *MD_LA* layer (selecting features). **Run** the tool.

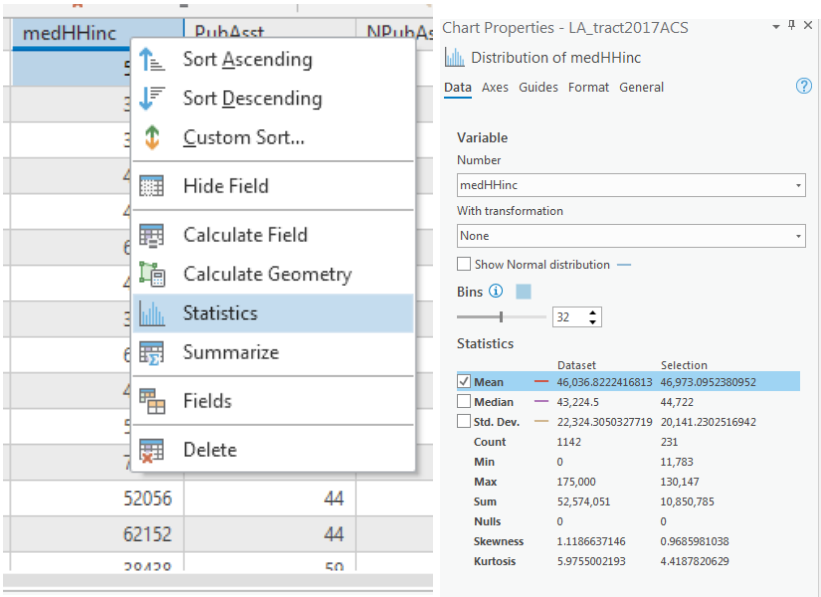


4. Take a look at your map. The tracts highlighted are the census tracts that contain McDonald's.

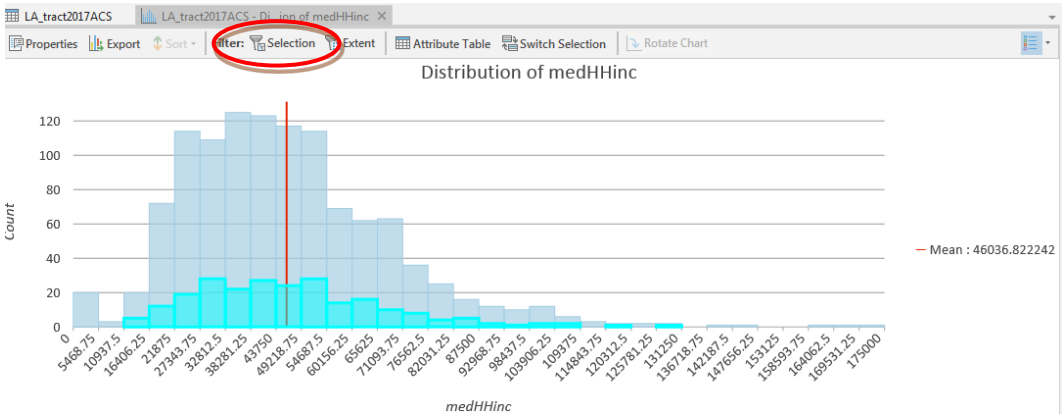


5. How many tracts contain McDonald's? You should note that there are **231 tracts** that contain a McDonald's for the state of Louisiana.

6. Take a look at median household income (MedHHinc) for the tracts that contain McDonald's as opposed to those that do not. To do this, open the *LA_tract2017ACS features* table and right click on the MedHHinc field. Select **Statistics**. A chart will appear and statistics displayed on the right.



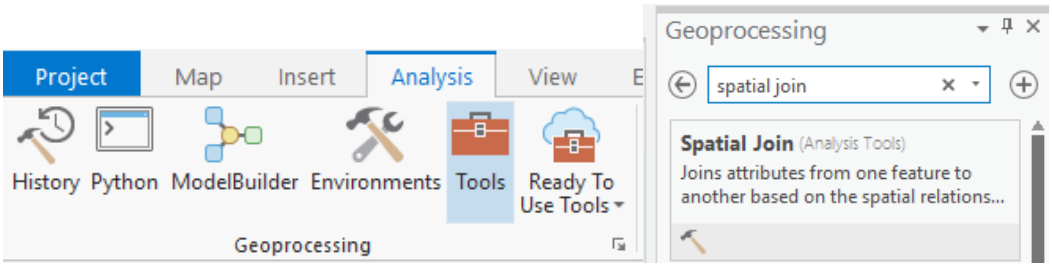
7. Choose to filter the data by the current selection (tracts that contain McDonald's).



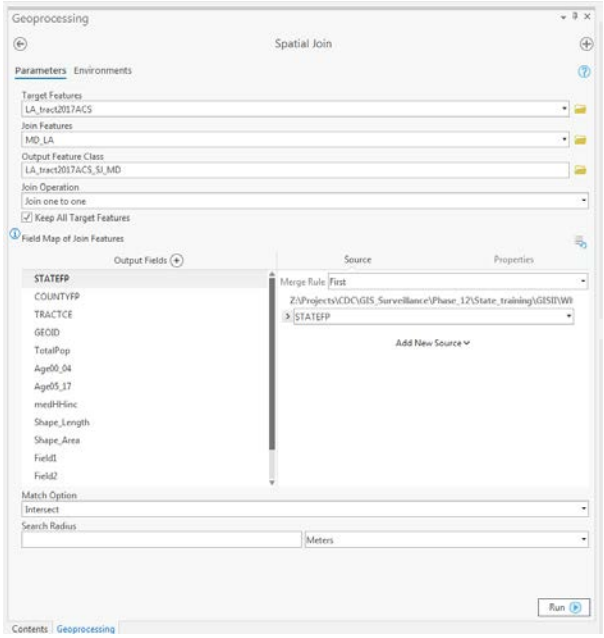
8. Return to the table view. Click to **Switch** the selection (to tracts that don't contain McDonald's). Check the descriptive statistics for median household income again on the new selection.
9. This is great information and a good way to understand your data with a query, but like a tabular selection, it is not permanent. What about making a more formal connection between the data? How about determining the count of the McDonald's restaurants by census tract? You can accomplish this with a spatial join.
10. **Clear** your selected features using the button in the Map ribbon tab.

Performing a Spatial Join: Joining the attributes of the McDonald's dataset to our tract data based on location.

1. You are now ready to perform a spatial join between two related layers of data with the goal of answering a question that was initiated by a spatial selection: How many restaurants of interest are present with each host tract?
2. Under the Analysis ribbon tab, click **Tools**. Use the Geoprocessing search bar to find the **Spatial Join** tool. Click the result to open up the tool.



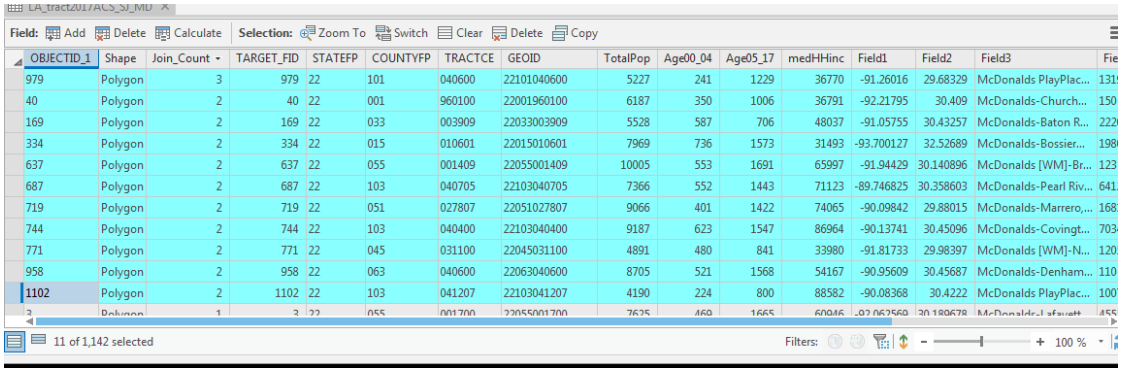
3. Our **Target Features** (the data to which you are appending) will be *LA_tract2017ACS features.* Our **Join Features** (the data you are appending) will be *MD_LA* **Join Operation**: you want to Join one to one. Keep the other defaults: **Keep All Target Features** checked, and **Match Option** as Intersect.



4. Notice that this spatial operation creates a new dataset that you will need to name and find a home for on your computer. Make sure you save it in your *Exercise_Data.gdb* as a **new feature class:** LA_tract2017ACS_SJ_MD
5. Think about this join: McDonald's to tract. It is possible that one tract may contain more than one McDonald's, right? So how will the attribute fields be handled for your join features (McDonald's)

when multiple restaurants are present in a tract? **Other than a count of restaurants by tract, there are no fields from our Louisiana McDonald's table that you are interested in capturing. However, if you had numeric values that you would like to monitor by tract, such as sales volume or number of employees, you would adjust the merge rules for your fields in the Field Map of the Join Features window.** This controls what happens to fields when there is more than one record that fulfills your match option (i.e. tracts that contain more than one McDonald's).

6. Run the spatial join tool. The new dataset will be automatically added to your map. Open the attribute table and take a look the fields. For every record in your tract table (each record represents a closed polygon geometry) where a McDonald's is present, information for the restaurant has been appended to the tract.
7. You can also check this by looking at the *Join_Count* field. It will be the first field in your new table. A count greater than zero means that the tract contains a McDonald's.
8. Are there any tracts with multiple McDonald's? Sort the *Join_Count* field in descending order by right clicking on the field and choosing **Sort descending**.

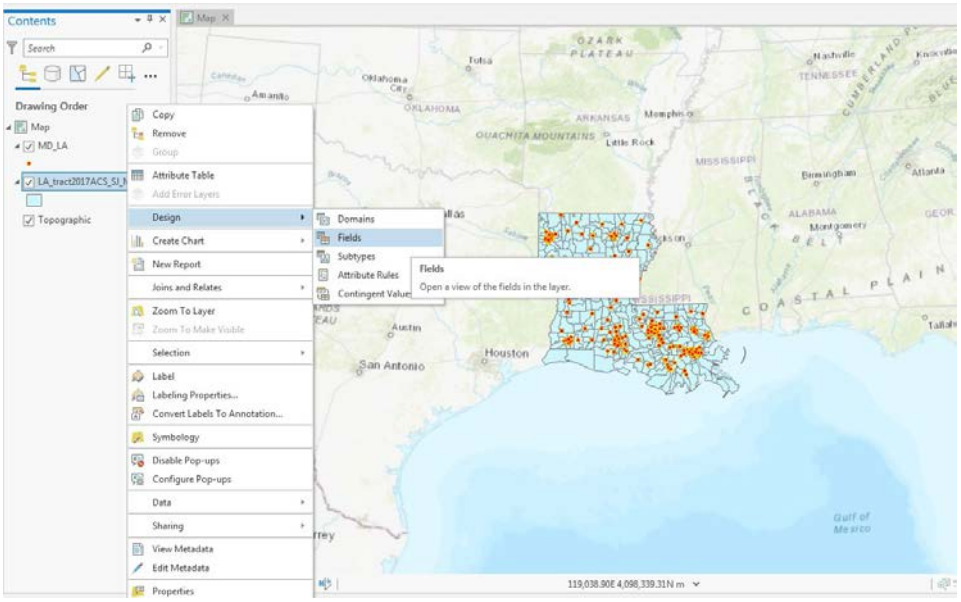


OBJECTID_1	Shape	Join_Count	TARGET_FID	STATEFP	COUNTYFP	TRACTCE	GEOID	TotalPop	Age00_04	Age05_17	medHHinc	Field1	Field2	Field3	Fie
979	Polygon	3	979	22	101	040600	22101040600	5227	241	1229	36770	-91.26016	29.68329	McDonalds PlayPlac...	131
40	Polygon	2	40	22	001	960100	22001960100	6187	350	1006	36791	-92.21795	30.409	McDonalds-Church...	150
169	Polygon	2	169	22	033	003909	22033003909	5528	587	706	48037	-91.05755	30.43257	McDonalds-Baton R...	222
334	Polygon	2	334	22	015	010601	22015010601	7969	736	1573	31493	-93.700127	32.52689	McDonalds-Bossier...	198
637	Polygon	2	637	22	055	001409	22055001409	10005	553	1691	65997	-91.94429	30.140896	McDonalds [WM]-Br...	123
687	Polygon	2	687	22	103	040705	22103040705	7366	552	1443	71123	-89.746825	30.358603	McDonalds-Pearl Riv...	641
719	Polygon	2	719	22	051	027807	22051027807	9066	401	1422	74065	-90.09842	29.88015	McDonalds-Marrero,...	168
744	Polygon	2	744	22	103	040400	22103040400	9187	623	1547	86964	-90.13741	30.45096	McDonalds-Covingt...	703
771	Polygon	2	771	22	045	031100	22045031100	4891	480	841	33980	-91.81733	29.98397	McDonalds [WM]-N...	120
958	Polygon	2	958	22	063	040600	22063040600	8705	521	1568	54167	-90.95609	30.45687	McDonalds-Denham...	110
1102	Polygon	2	1102	22	103	041207	22103041207	4190	224	800	88582	-90.08368	30.4222	McDonalds PlayPlac...	100
3	Polygon	1	3	22	055	001700	22055001700	7625	469	1665	60946	-92.062569	30.189678	McDonalds-Lafayett...	455

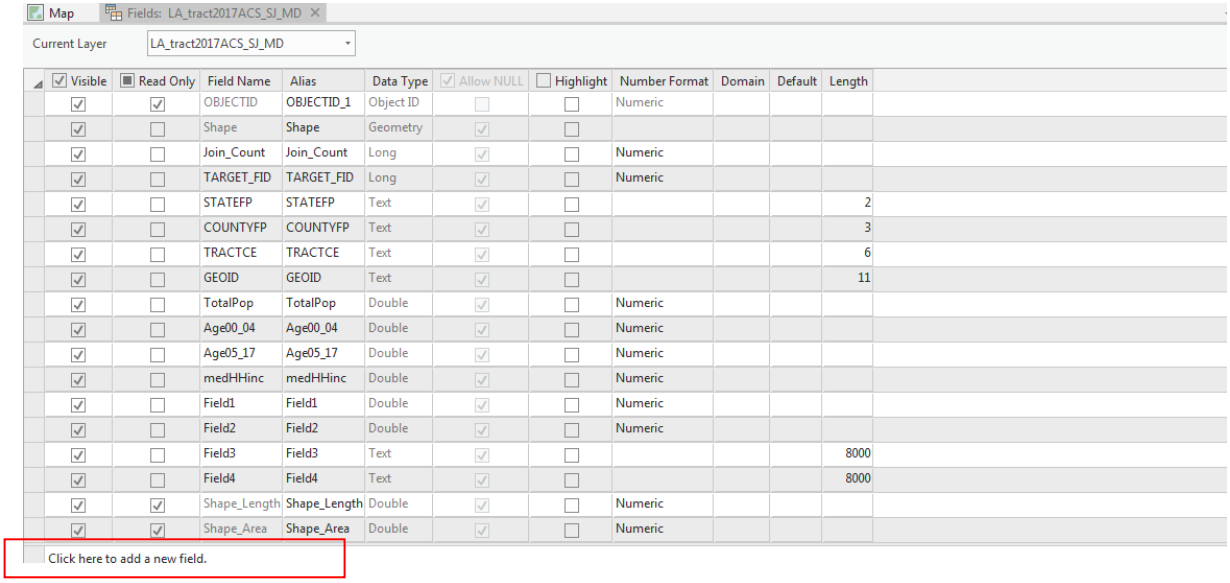
Take a look at the resulting data; can you think of useful applications in your own work?

Adding a Field to a Table: Adding a new attribute field and using the field calculator to populate this field.

1. We want to examine the spatial distribution of the children less than 18 years of age and McDonald's restaurants; to do this, we need the population that is less than 18 years old. Looking at current fields, we don't see any fields that can provide us exactly what we need. But we do have data for total population, population 0-4, and population 5-17 years old.
2. We will use the two age based population estimates to calculate a new field: Age00_17 (total population less than 18 years of age).
3. First, we need to add a new field to store the calculated data (Age00_17). Right click on LA_tract2017ACS_SJ_MD layer click on Fields under Design sub category.



4. A new view will appear in the middle of your screen. This view shows the properties for each field in the table. To add a new field, click on the bottom text **Click here to add a new field.**



Map | Fields: LA_tract2017ACS_SJ_MD

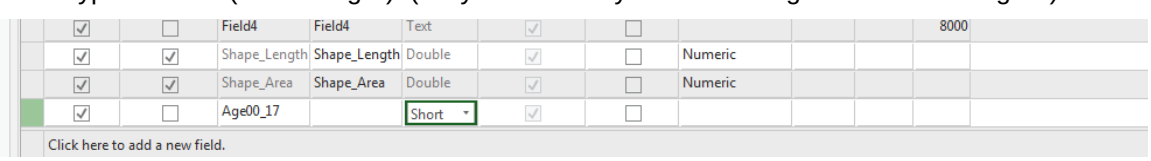
Current Layer: LA_tract2017ACS_SJ_MD

Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format	Domain	Default	Length
✓	✓	OBJECTID	OBJECTID_1	Object ID			Numeric			
✓		Shape	Shape	Geometry	✓					
✓		Join_Count	Join_Count	Long	✓		Numeric			
✓		TARGET_FID	TARGET_FID	Long	✓		Numeric			
✓		STATEFP	STATEFP	Text	✓					2
✓		COUNTYFP	COUNTYFP	Text	✓					3
✓		TRACTCE	TRACTCE	Text	✓					6
✓		GEOID	GEOID	Text	✓					11
✓		TotalPop	TotalPop	Double	✓		Numeric			
✓		Age00_04	Age00_04	Double	✓		Numeric			
✓		Age05_17	Age05_17	Double	✓		Numeric			
✓		medHHinc	medHHinc	Double	✓		Numeric			
✓		Field1	Field1	Double	✓		Numeric			
✓		Field2	Field2	Double	✓		Numeric			
✓		Field3	Field3	Text	✓					8000
✓		Field4	Field4	Text	✓					8000
✓	✓	Shape_Length	Shape_Length	Double	✓		Numeric			
✓	✓	Shape_Area	Shape_Area	Double	✓		Numeric			

Click here to add a new field.

Click here to add a new field two more times to create two more fields and type those new field names under the **Field Name** column. If you created too many new fields, you can always right click on the field row and **Delete** the row.

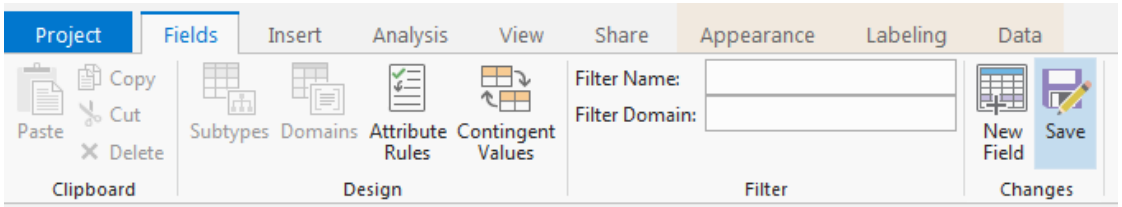
5. Next, you want to make sure the **Data Type** is correct for the new field we just added. Set the Data Type to Short (short integer). (Do you know why are we setting this to short integer?)



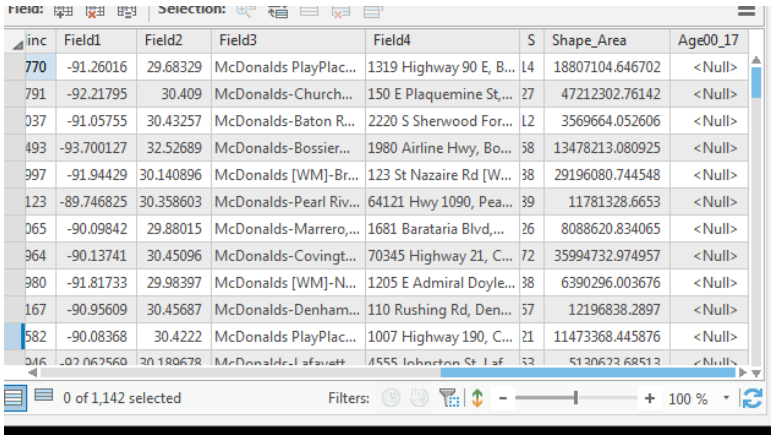
✓		Field4	Field4	Text	✓					8000
✓	✓	Shape_Length	Shape_Length	Double	✓		Numeric			
✓	✓	Shape_Area	Shape_Area	Double	✓		Numeric			
✓		Age00_17		Short	✓					

Click here to add a new field.

6. You may notice that there are some green boxes to our newly added field. The green box is a sign of unsaved progress. To save the change and apply it to the table, go to top ribbon, under **Fields** tab, click on **Save** button to save all your edits. Please make sure your Fields view is active while you try to save the field edits.



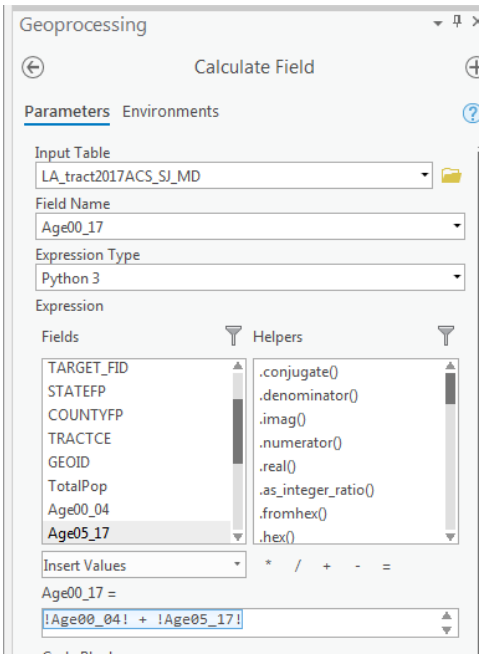
7. Right click on *LA_tract2017ACS_SJ_MD* and open **Attribute Table**. You should see your new field *Age00_17* at the far right of this table:



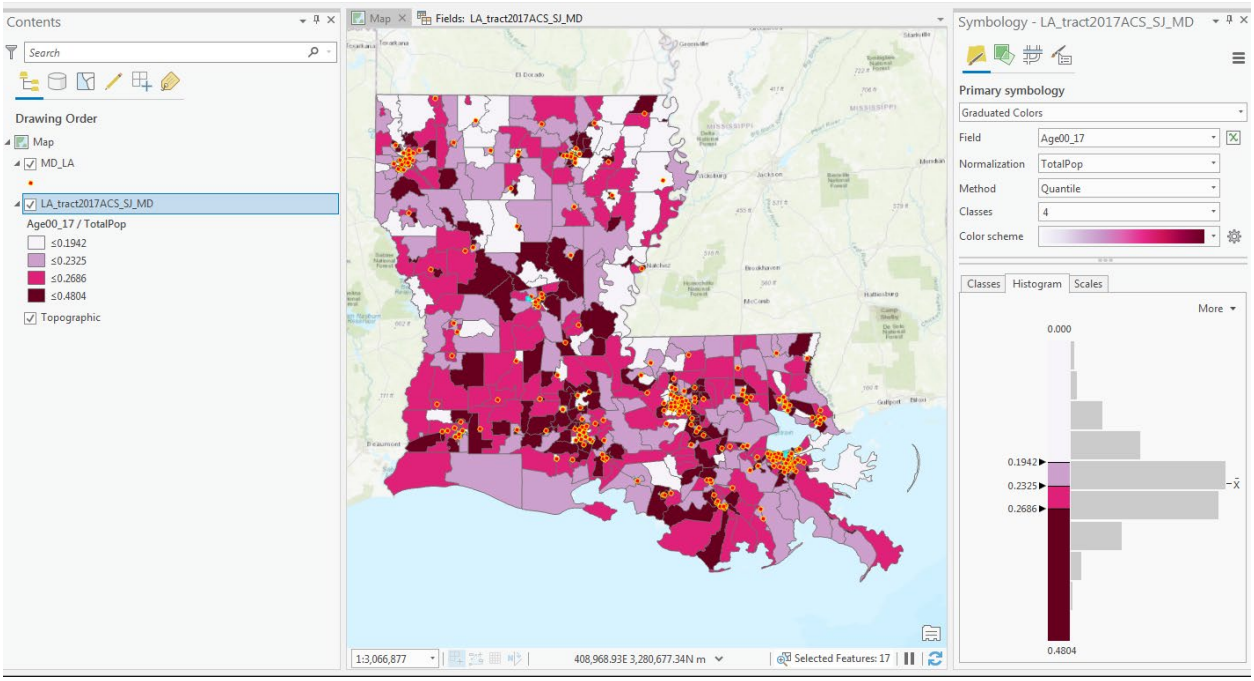
inc	Field1	Field2	Field3	Field4	S	Shape_Area	Age00_17
770	-91.26016	29.68329	McDonalds PlayPlac...	1319 Highway 90 E, B...	14	18807104.646702	<Null>
791	-92.21795	30.409	McDonalds-Church...	150 E Plaquemine St,...	27	47212302.76142	<Null>
037	-91.05755	30.43257	McDonalds-Baton R...	2220 S Sherwood For...	12	3569664.052606	<Null>
493	-93.700127	32.52689	McDonalds-Bossier...	1980 Airline Hwy, Bo...	58	13478213.080925	<Null>
997	-91.94429	30.140896	McDonalds [WM]-Br...	123 St Nazaire Rd [W...	38	29196080.744548	<Null>
123	-89.746825	30.358603	McDonalds-Pearl Riv...	64121 Hwy 1090, Pea...	39	11781328.6653	<Null>
065	-90.09842	29.88015	McDonalds-Marrero,...	1681 Barataria Blvd,...	26	8088620.834065	<Null>
964	-90.13741	30.45096	McDonalds-Covingt...	70345 Highway 21, C...	72	35994732.974957	<Null>
980	-91.81733	29.98397	McDonalds [WM]-N...	1205 E Admiral Doyle...	38	6390296.003676	<Null>
167	-90.95609	30.45687	McDonalds-Denham...	110 Rushing Rd, Den...	57	12196838.2897	<Null>
582	-90.08368	30.4222	McDonalds PlayPlac...	1007 Highway 190, C...	21	11473368.445876	<Null>

Calculate Field

1. Calculate Field is a powerful tool that will let you perform a variety of mathematical or programmatic operations on the existing fields of your table. In this case, you want to add two pre-existing fields to create one field encompassing two age categories. We will use the Python 3 to build our calculation.
2. Right click on *Age00_17* and click on **Calculate Field**. The Calculate Field tool side pane will appear on you right hand side. *Age00_17* is equal to the sum of *Age00_04* plus *Age05_17*, you can go through the **Fields** to find both double click on the field name *Age00_04* in the **Fields** section to add it to the equation, then add a plus operator (**+**) in between, finally double click on the field name. Make sure you equation looks like this: **!Age00_04! + !Age05_17!**



3. Click **Run** to calculate population less than 18 years old.
4. Now that we have a count of the population less than 18 years of age we can create a choropleth map showing the percentage of the total population represented by this age category. We do this by symbolizing based on the *Age00_17* field, and using *TotalPop* to normalize (act as the denominator). The end result is a map showing the % population less than 18 years of age.
5. This is a simple calculation but hopefully illustrates the potential of the field calculator; for example, it may be useful to calculate the change over two periods of time.



This type of examination is particularly useful in assessing the food environment for your state or community. More information on assessing the food environment may be found here:

http://www.cdc.gov/obesity/downloads/HFRassessment.pdf

Modified Retail Food Environment Index Across Census Tracts within State:

- Measures the number of healthy and unhealthy food retailers across census tracts in a state
- Lower scores indicate:
  - Less healthy food retailers
  - More convenience stores and fast food restaurants relative to healthy food retailers

Modified Retail Food Environment Index Across Impoverished Census Tracts within State:

- Measures only census tracts where 20% or more of the residents are below the poverty line

Community Food Environment

Strategies to improve the community food environment include increased access and availability to healthier food retailers. The modified Retail Food Environment Index (mRFEI) measures the number of healthy and less healthy food retailers within a census tract using the formula shown.

$$mRFEI = 100 \times \frac{\text{\# Healthy Food Retailers}}{\text{\# Healthy Food Retailers} + \text{\# Less Healthy Food Retailers}}$$

For this indicator, healthy food retailers include supermarkets, supercenters, and produce stores.† Less healthy food retailers include convenience stores, fast food restaurants, and small grocery stores with 3 or fewer employees.† Higher mRFEI scores indicate more access to healthy food retailers and fewer less healthy food retailers.

Indicator	National Data*
• Modified Retail Food Environment Index across census tracts within state	10
• Modified Retail Food Environment Index across impoverished census tracts within state	7

*The numbers shown for national data are the medians of all state scores.
† Areas without these types of healthy food retailers may still provide adequate access if smaller stores and fast food restaurants provide quality and affordable healthy foods and beverages.

More information on mRFE can be found here:

http://www.cdc.gov/obesity/downloads/NationalActionGuide.pdf