CLAREMONT GEOSPATIAL LEARNING LAB

Category: GIS Tutorial
Module Title: Two-step Floating Catchment Method
Level of Expertise: Intermediate-Advanced
Approximate Time to Complete: 1 hour- 1 hour 30 minutes
Module Description: This module is designed to help you to perform the Two-step Floating Catchment Method. Please note that the symbol Ø depicts action steps.
Module Objectives: 1. Understand the Two-step Floating Catchment Method 2. Learn how to perform the Two-step Floating Catchment Method
Module Outline: 1. Brief introduction about the Two-step Floating Catchment Method 2. Perform the first step 3. Perform the second step 4. Display result

Two-step Floating Catchment Method

Introduction

Two-step Floating Catchment Method (2SFCA) is a popular method in measuring accessibility. In this tutorial, we will learn about the method and learn how to perform it. Please note that several pre-processing steps in the tutorial have been covered by other tutorials. You will be given the links for those tutorials should not you know how to perform them. There are several caveats, which all will be described in the later section.

Brief introduction to the 2SFCA

2SFCA is a method that was created by Luo and Wang in 2003 to measure health care accessibility (see http://doi.org/10.1068/b29120). The method has been going through several enhancements. Together, they are forming a Floating Catchment Area Methodology Family. You can read about them in this article by Vo, Plachkinova, Bhaskar (2015). (Article: Assessing Healthcare Accessibility Algorithms: A Comprehensive Investigation of Two-Step Floating Catchment Methodologies Family. Publication: Proceedings of Americas Conference on Information Systems).

Essentially, the 2SFCA has 2 steps: each step creates an area of coverage called catchment. The two catchments lay on top of one another, or 'floating'. The 2SFCA produces a spatial accessibility. The way to calculate is as follows:

"Step 1: Given a default 30-minute drive time (catchment) from a particular health care provider, sum up the total population that the supplier can reach within that drive time, then compute a provider-to-population ratio. In the case of an individual physician, the provider ratio is 1 to the total population reached.

Step 2: Given a 30-minute drive time (catchment) from a particular population center, obtain the previously computed provider-to-population ratio of

each health care that resides within that drive time. Compute the accessibility index by summing up all provider-to-population ratios. “ (Vo et al 2015)

Preparation/ Caveats

This tutorial will help you perform the 2SFCA. There are several caveats. Let’s go over them before we begin.

Please note that our data is different than the one mentioned in the paper. In the tutorial, we will use hospitals instead of physicians. As you can see, the provider-to-population ratio mentioned above has a number of one for each physician. This number is the provider’s capacity. However, the hospital data that used for this tutorial does NOT contain the provider capacity. Thus, we will assume that the hospital’s provider capacity is 100. This oversimplification is helpful to learn should the data you obtain will have the provider capacity.

CAVEAT 1: Hospital’s provider capacity is 100 for each hospital

In almost all Floating Catchment Area methods research, Network Analyst is used. Network Analyst is an ESRI ArcGIS extension that computes driving distance. This driving distance creates the catchment area as described in the research papers. Obtaining this Network Analyst extension might be easy, but obtaining the road network is difficult. Furthermore, performing Network Analyst might be tricky. So, to demonstrate how these steps can be done, we simply use Buffer instead of Network Analyst polygon.

CAVEAT 2: Buffer will replace Network Analyst’s polygons

In the Vo et al 2015 paper, there is a mention about population-weighted centroid. Population-weighted centroid is used as a way to compensate for population density in larger area, for there might be vast regions that inhabitable in Census

tracts. In this tutorial, we ignore population-weighted centroid. We will use the Census Tract centroid instead.

CAVEAT 3: Population-weighted centroid is replaced by the Census Tract centroid.

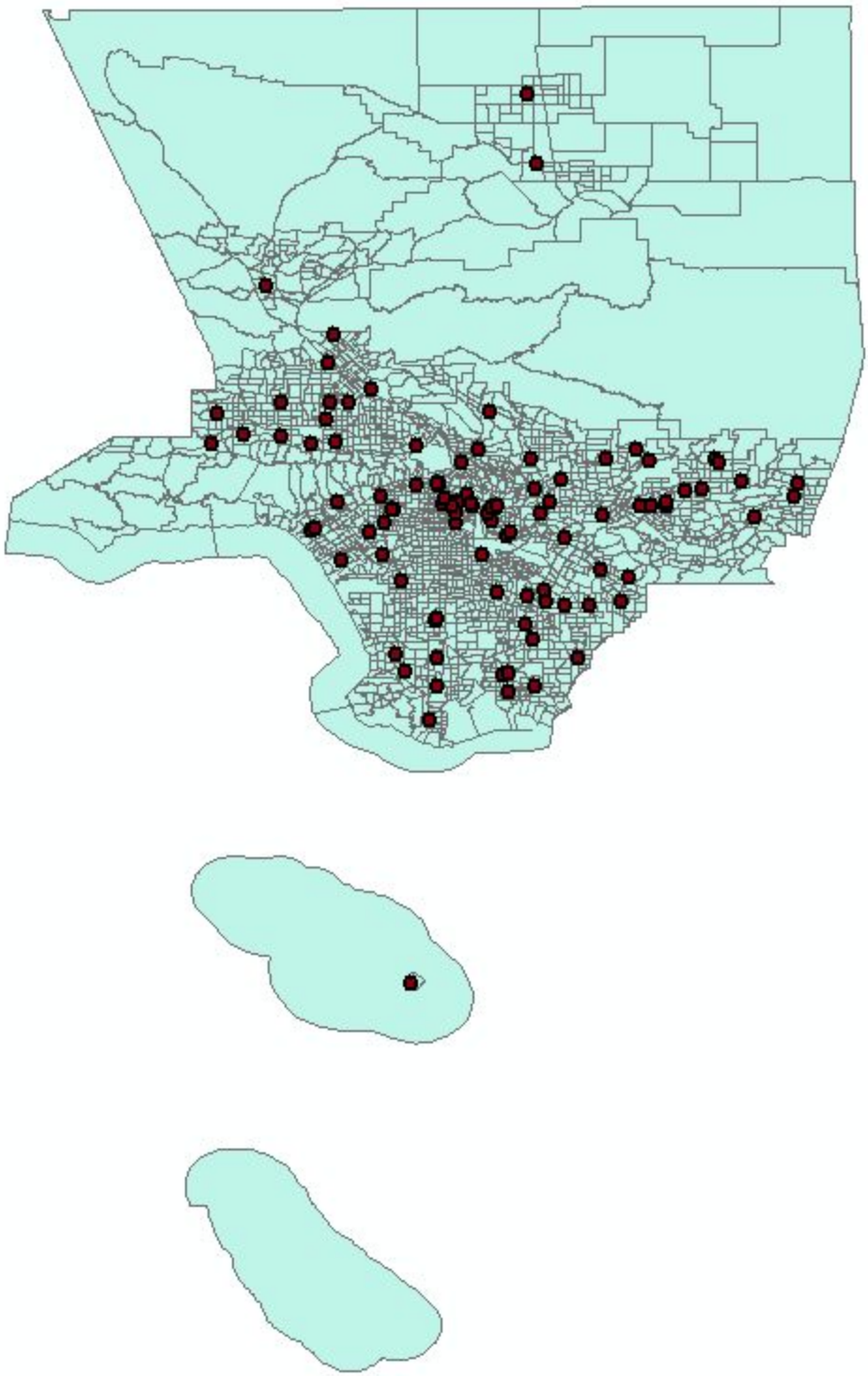
Lastly, we won't go over the data preparation in this tutorial. Here are the list of the previous tutorials if you need. We only use the shapefiles resulted from these tutorials.

CAVEAT 4: We will use these shapefiles.If you are not familiar with the tutorials tutorial associated with these shapefiles, we recommend you do do so.

Shapefiles used:
1- Los Angeles Census Tract file with population data.
http://agis.maps.arcgis.com/home/item.html?id=b64453dde05d425b8f8970eebd018644
2-Los Angeles Census Centroid (Los_Angeles_Centroid_Inside)
http://agis.maps.arcgis.com/home/item.html?id=0d8e64266e444799b0be86dfdc4199fa
3-Los Angeles Hospitals
(http://agis.maps.arcgis.com/home/item.html?id=0a21867f07bd40da8b207813a5f898e6)

Ø You should download all map packages, put them on ArcMap, and export them all to the Desktop. If you don't know how to do so, the previous three tutorials associated with the 3 shapefiles above will help you to do so.

You now should have 3 layers: LA_Hospitals, Los_Angeles_Centroid_Inside, and Los_Angeles_Census_Tract on ArcMap. Let's start!



Perform the first step

Since our first caveat is that the hospital capacity is 100, we should have this information in our Hospital shapefile. Let's put this information there.

Ø Open the LA_Hospital Shapefile Attribute Table (Ctrl-T when selecting the shapefile)

Ø Add a New Field and name this field Capacity. Use Double as the Data Type

Ø Use the Field Calculator to assign 100 for each hospital

FAC_ADDRES	FAC_CITY	FAC_ZIPCOD	FACILITY_L	LONGITUDE	LATITUDE	TYPE_LIC	Capacity
400 NORTH MC DOWELL BOULEVARD	PETALUMA	94954	Parent Facility	-118.1449	34.08988	General Acute Care	100
13652 CANTARA STREET	PANORAMA CITY	91402	Parent Facility	-118.15767	34.68928	General Acute Care	100
4867 SUNSET BOULEVARD	LOS ANGELES	90027	Parent Facility	-118.33369	33.33887	General Acute Care	100
9333 IMPERIAL HIGHWAY	DOWNEY	90242	Parent Facility	-117.96801	34.06398	General Acute Care	100
9961 SIERRA AVENUE	FONTANA	92335	Parent Facility	-118.24744	34.08058	General Acute Care	100
23625 W. R. HOLMAN HIGHWAY	MONTEREY	93940	Parent Facility	-118.186641	33.780238	General Acute Care	100
1500 EAST DUARTE ROAD	DUARTE	91010	Parent Facility	-118.10132	34.01614	General Acute Care	100
1401 SOUTH GRAND AVENUE	LOS ANGELES	90015	Consolidated Facility	-118.39724	34.02328	General Acute Care	100
155 GLASSON WAY	GRASS VALLEY	95945	Parent Facility	-118.26551	34.03721	General Acute Care	100
900 HYDE STREET	SAN FRANCISCO	94109	Parent Facility	-117.74561	34.09633	General Acute Care	100
2105 FOREST AVENUE	SAN JOSE	95128	Parent Facility	-118.34788	33.94917	General Acute Care	100
16237 VENTURA BOULEVARD	ENCINO	91436	Parent Facility	-118.08169	33.83352	General Acute Care	100
3291 LOMA VISTA ROAD	VENTURA	93003	Parent Facility	-118.29069	34.09805	General Acute Care	100
500 WEST HOSPITAL ROAD	FRENCH CAMP	95231	Parent Facility	-117.97152	34.13216	General Acute Care	100
101 EAST VALENCIA MESA DRIVE	FULLERTON	92835	Parent Facility	-118.29701	33.89042	General Acute Care	100
12401 EAST WASHINGTON BLVD.	WHITTIER	90602	Parent Facility	-118.22466	33.98929	General Acute Care	100
1165 MONTGOMERY DRIVE	SANTA ROSA	95405	Parent Facility	-118.1875	34.01897	General Acute Care	100
825 DELBON AVENUE	TURLOCK	95380	Parent Facility	-118.10503	34.1024	General Acute Care	100
1601 YGNACIO VALLEY ROAD	WALNUT CREEK	94598	Parent Facility	-118.14837	33.86016	General Acute Care	100
300 CANAL STREET	KING CITY	93930	Parent Facility	-118.13196	33.93515	General Acute Care	100
1050 LINDEN AVENUE	LONG BEACH	90813	Parent Facility	-118.18377	34.02383	General Acute Care	100
372 WEST CYPRESS AVENUE	REEDLEY	93654	Parent Facility	-118.48662	34.15686	General Acute Care	100

Ø Close the Attribute Table

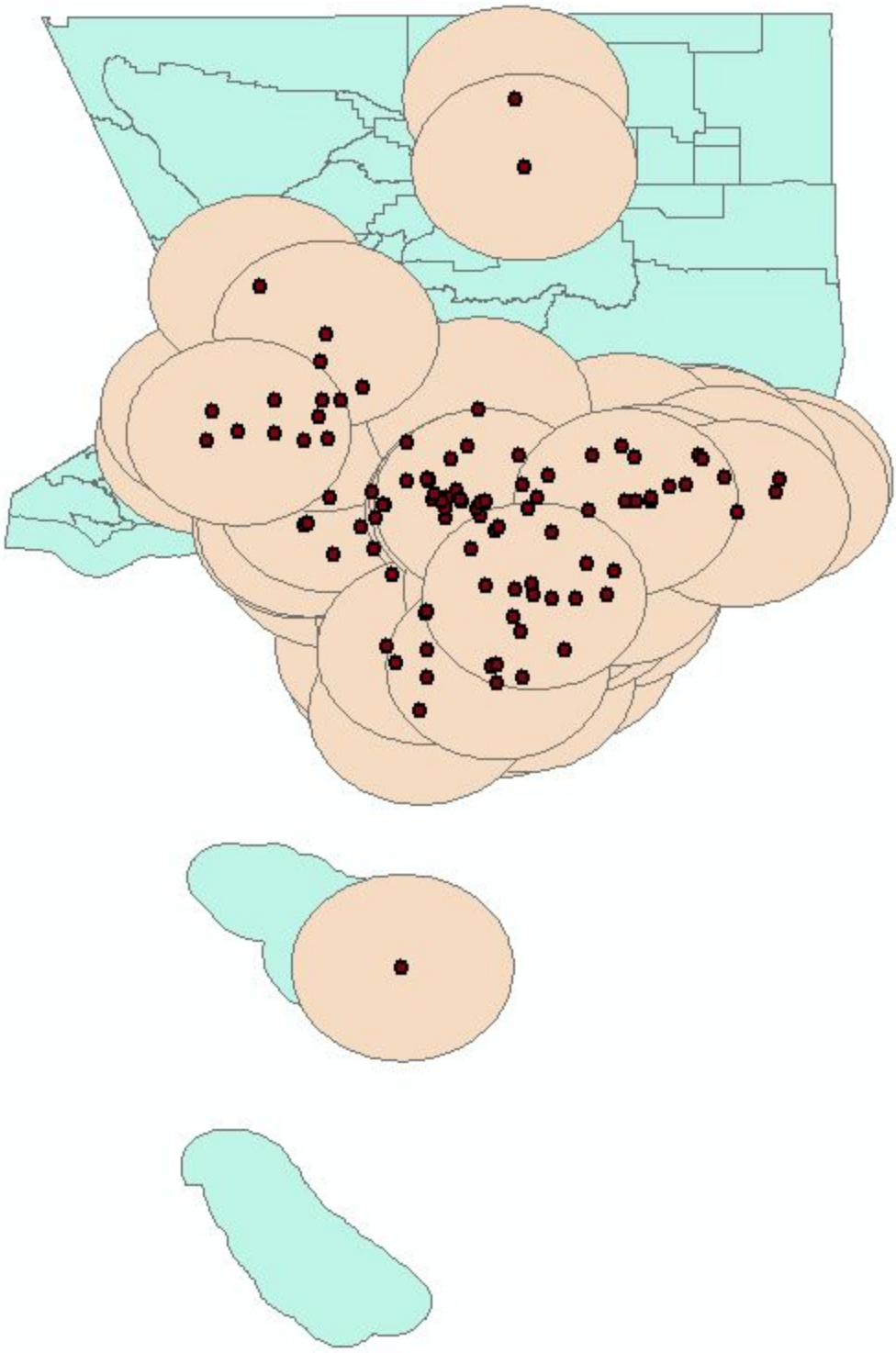
Now we will create the buffer for this hospital shapefile. This will be our first catchment. Remember, in the research, the catchment is the product of a 30-minute drive time analysis. In our tutorial, we will use 10-mile radius instead.

Ø Go to Geoprocessing on the Menu Bar and select Buffer

Ø Change the Output Feature Class to LA_Hospitals_Buffer and place it on the Desktop. While keeping the Linear Unit checked, type 10 into the field. Change the right drop down to Miles. Everything else should remain unchanged.

Ø Hit OK when done.

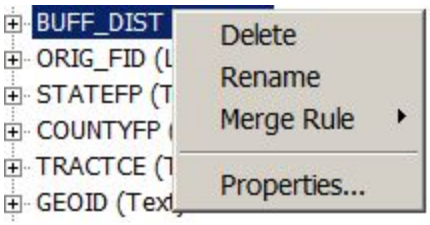
You should see there are overlapping buffers in our map. When the buffer is done, we need to calculate the provider-population ratio.



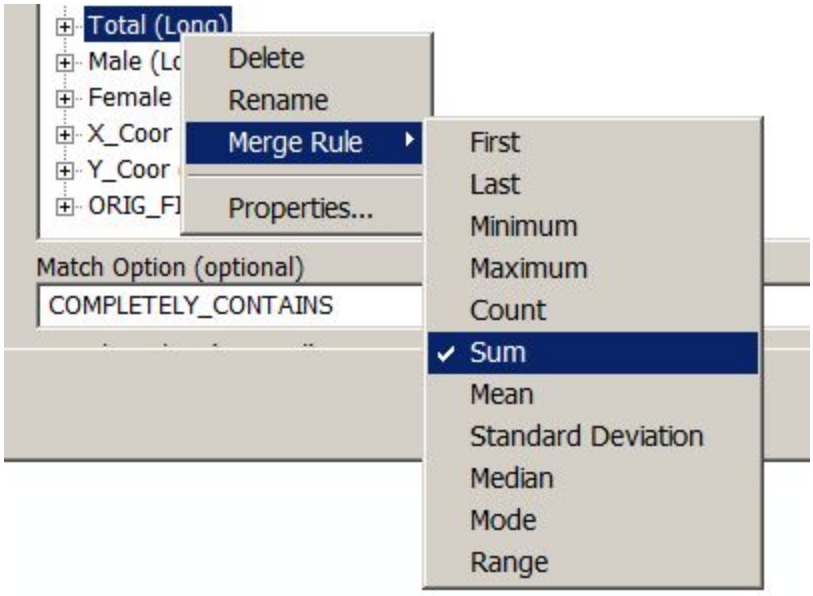
To calculate the provider-to-population ratio, we need to perform a spatial join between the LA Hospital Buffers (not the points) with the LA Census Tract Centroid.

Ø Go to the search bar (Ctrl-F) and type in Spatial Join. Choose the first link (Spatial Join Analysis)
Ø In the Target Features, choose LA_Hospitals_Buffer. In the Join Features, choose Los_Angeles_Centroid_Inside. The Output Feature Class should be LA_first_catchment. Please this output on the desktop. Change the Match Option to COMPLETELY_CONTAINS

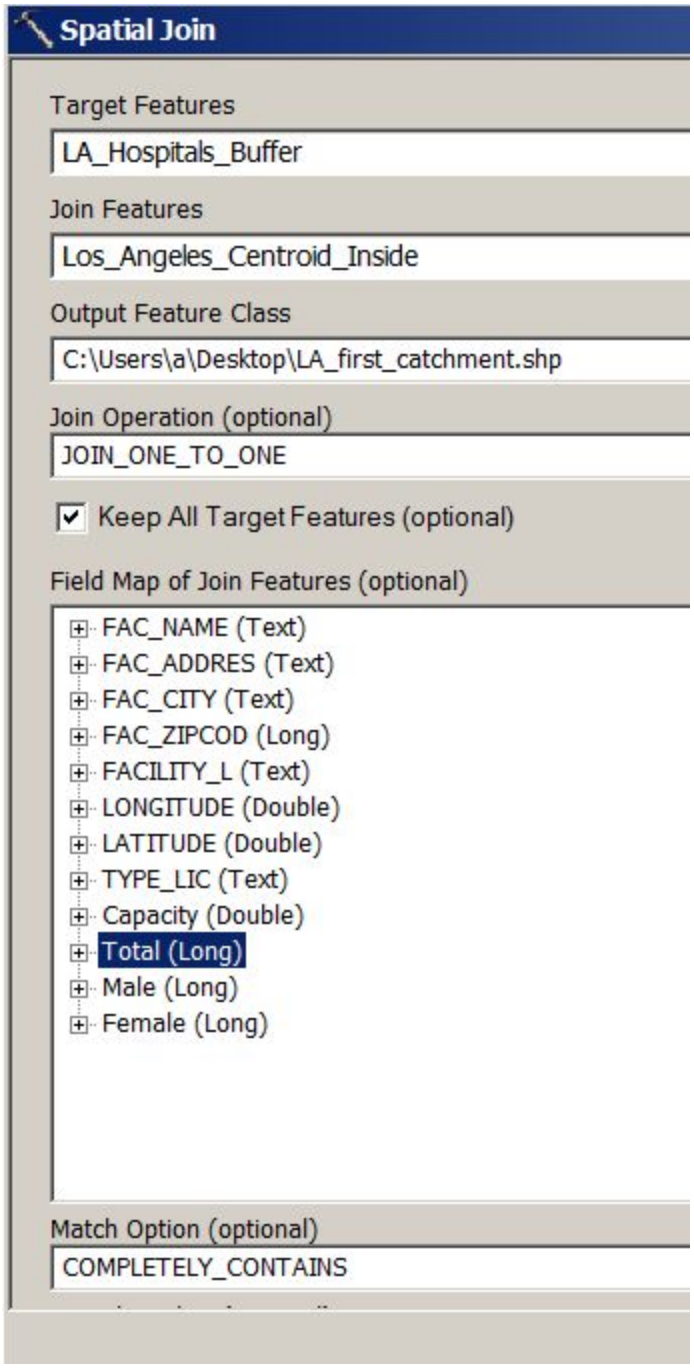
Ø In the Field Map, right click on the BUFF_DIST and select Delete to remove this field. This helps us to unclutter our table. Do the same for ORIG_ID, STATEFP, COUNTYFP, TRACTCE, GEOID, NAME, NAMELSAD, MTFCC, FUNCSTAT, ALAND, AWATER, INTPTLAT, INTPTLON, TractGEOID, Id, Id2, Geography, X_Coor, Y_Coor, and ORIG_FID_1.



Ø Right click on Total, use Merge Rule, and choose Sum. When the spatial join happens, the Total field (total population) from the LA Centroid will be added into a particular buffer if the centroid is within the buffer. Repeat this step for Male and Female.



Ø Your Spatial Join should look like this. Hit OK when done



You should see the the shapefile is unchanged, but the population data has been added into the new shapefile.

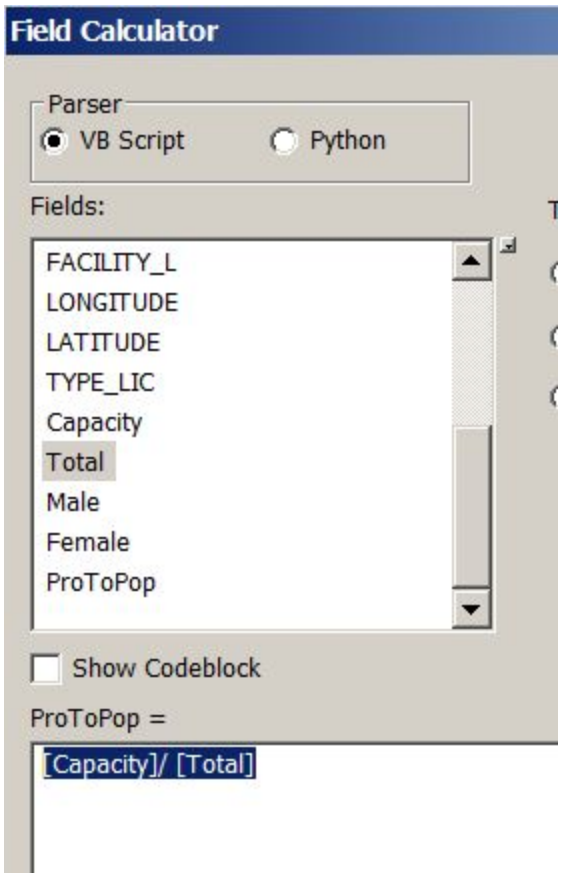
Ø Open the attribute table for LA_first_catchment to verify and perform the provider-to-population ratio calculation

Capacity	Total	Male	Female
100	2687945	1342298	1345647
100	275973	137436	138537
100	4051	2005	2046
100	1557817	759268	798549
100	3255792	1613750	1642042
100	1406713	689866	716847
100	2741734	1359687	1382047
100	2606658	1291304	1315354
100	3553191	1756351	1796840

Ø As you can see, Total, Male, and Female have been added. Let's perform the provider-to-population ratio.

Ø Add a New Field called ProToPop. Set the datatype as Double.

Ø Use the Field Calculator and input this formula: [Capacity]/[Total]

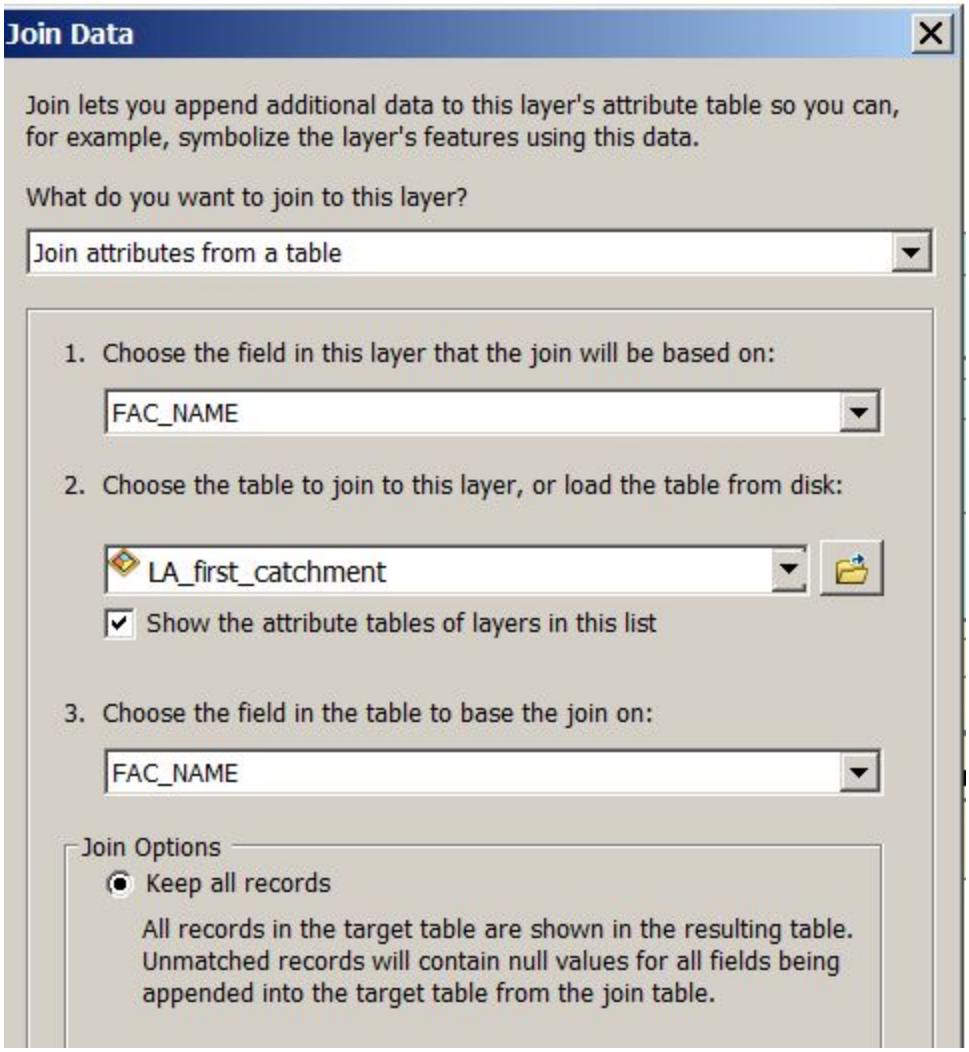


Ø When you click OK, you should see that the provider-to-population field has been added.

Capacity	Total	Male	Female	ProToPop
100	2687945	1342298	1345647	0.000037
100	275973	137436	138537	0.000362
100	4051	2005	2046	0.024685
100	1557817	759268	798549	0.000064
100	3255792	1613750	1642042	0.000031
100	1406713	689866	716847	0.000071
100	2741734	1359687	1382047	0.000036
100	2606658	1291304	1315354	0.000038
100	3553191	1756351	1796840	0.000028
100	543375	264141	279234	0.000184
100	3084139	1512034	1572105	0.000032
100	1425237	702127	723110	0.00007
100	3119937	1547673	1572264	0.000032
100	1230391	599916	630475	0.000081
100	2716771	1320414	1396357	0.000037
100	3668308	1810454	1857854	0.000027

The number is too small? Don't worry. This is normal, and rightfully so. We don't have enough health care for each of us. Just imagine that we use physician data, which is 1 in capacity. The ratios then will approach 0 fast!

To complete the first step, we has to join this data back to the LA_Hospital.
Ø Close the Attribute Table if you still have it open.
Ø Right click the LA_Hospitals and choose Joins and Relates-Joins
Ø Since all the fields are similar, let's chose FAC_NAME in the first option. Change the second option to LA_first_catchment. the second option will change to FAC_NAME automatically for you.
Ø Hit OK when done.



Ø You should Open the Attribute Table and confirm. As you can see many of the fields are duplicated. Let's export this join table into the desktop and call this LA_Hospitals_ProToPop. Display this shapefile on our map.

Ø Now let's open the attribute table for LA_Hospitals_ProToPop and remove unwanted fields to unclutter our data. right click on the FID_1 field and choose Delete Field. Confirm the deletion. Do the same for TARGET_ID, FAC_NAME_1, FAC_ADDR_1, FAC_CITY_1, FACZIPC_1, FACILITY_1, LONGITUD_1, LATITUDE_1, TYPE_LIC_1, CAPACITY_1, Total, Male, and Female.

Our last four columns should look like this:

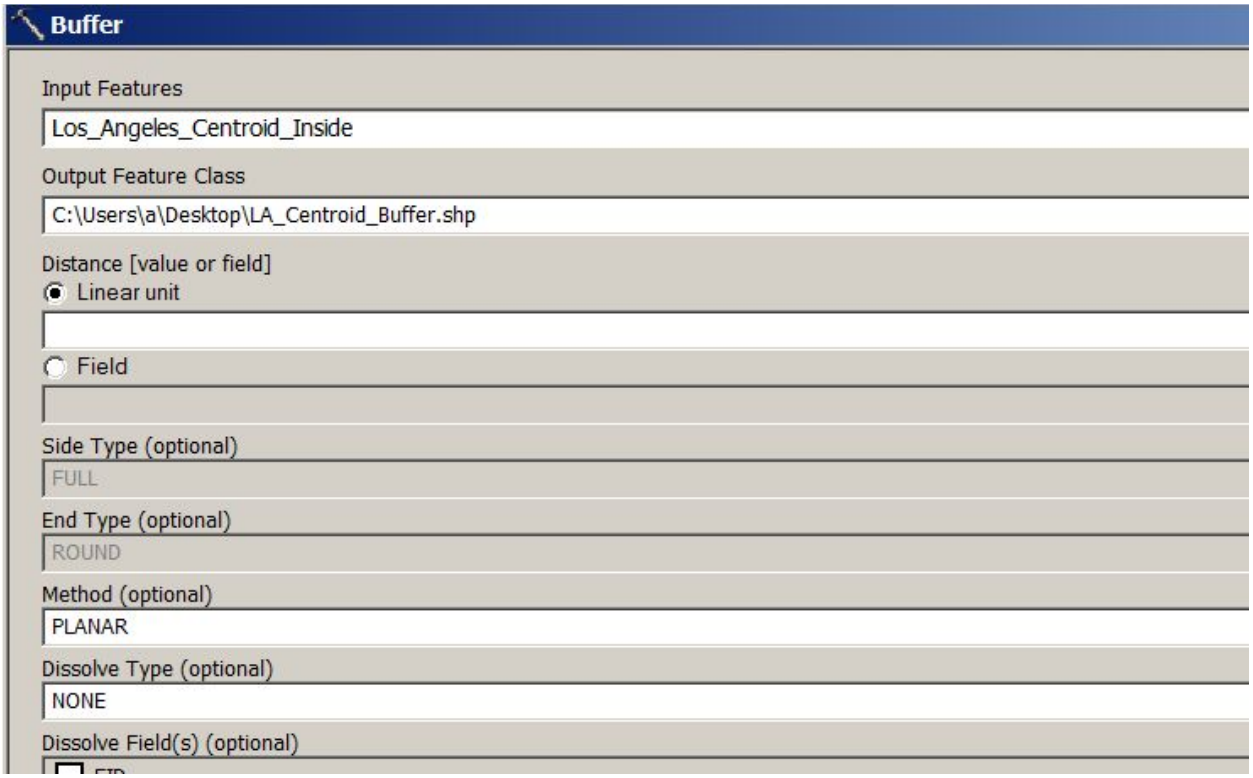
TYPE_LIC	Capacity	Join_Count	ProToPop
General Acute Care	100	657	0.000037
General Acute Care	100	55	0.000362
General Acute Care	100	2	0.024685
General Acute Care	100	350	0.000064
General Acute Care	100	820	0.000031
General Acute Care	100	323	0.000071
General Acute Care	100	632	0.000036
General Acute Care	100	668	0.000038
General Acute Care	100	884	0.000028
General Acute Care	100	119	0.000184
General Acute Care	100	751	0.000032
General Acute Care	100	314	0.00007
General Acute Care	100	805	0.000032
General Acute Care	100	274	0.000081
General Acute Care	100	623	0.000037

Now, let's move on to step 2.

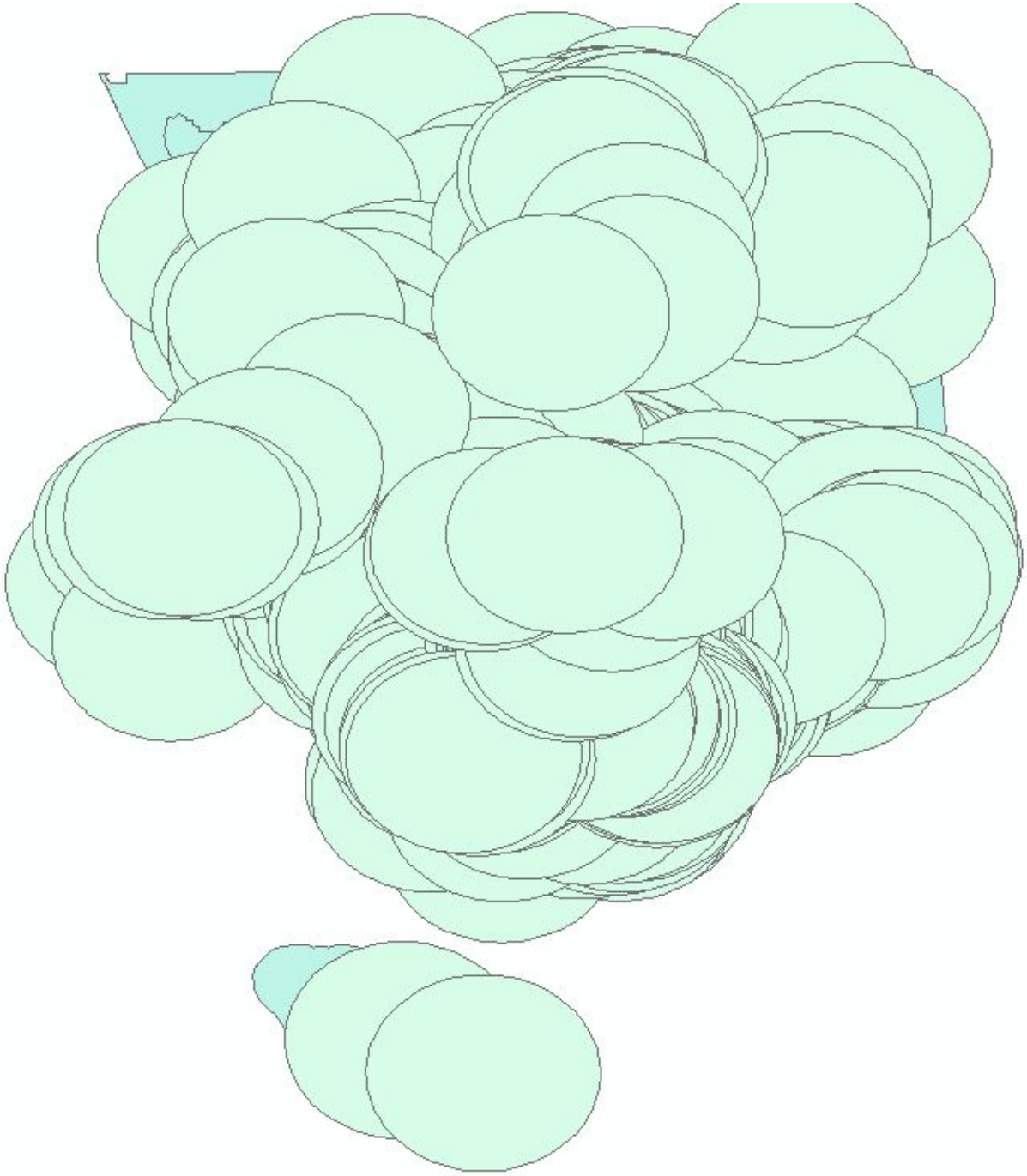
Perform the second step

It turns out that the second step is similar to the first step. Let's start by create the Buffer for each Census Tract Centroid.

Ø Perform the buffer as below and call the output LA_Centroid_Buffer



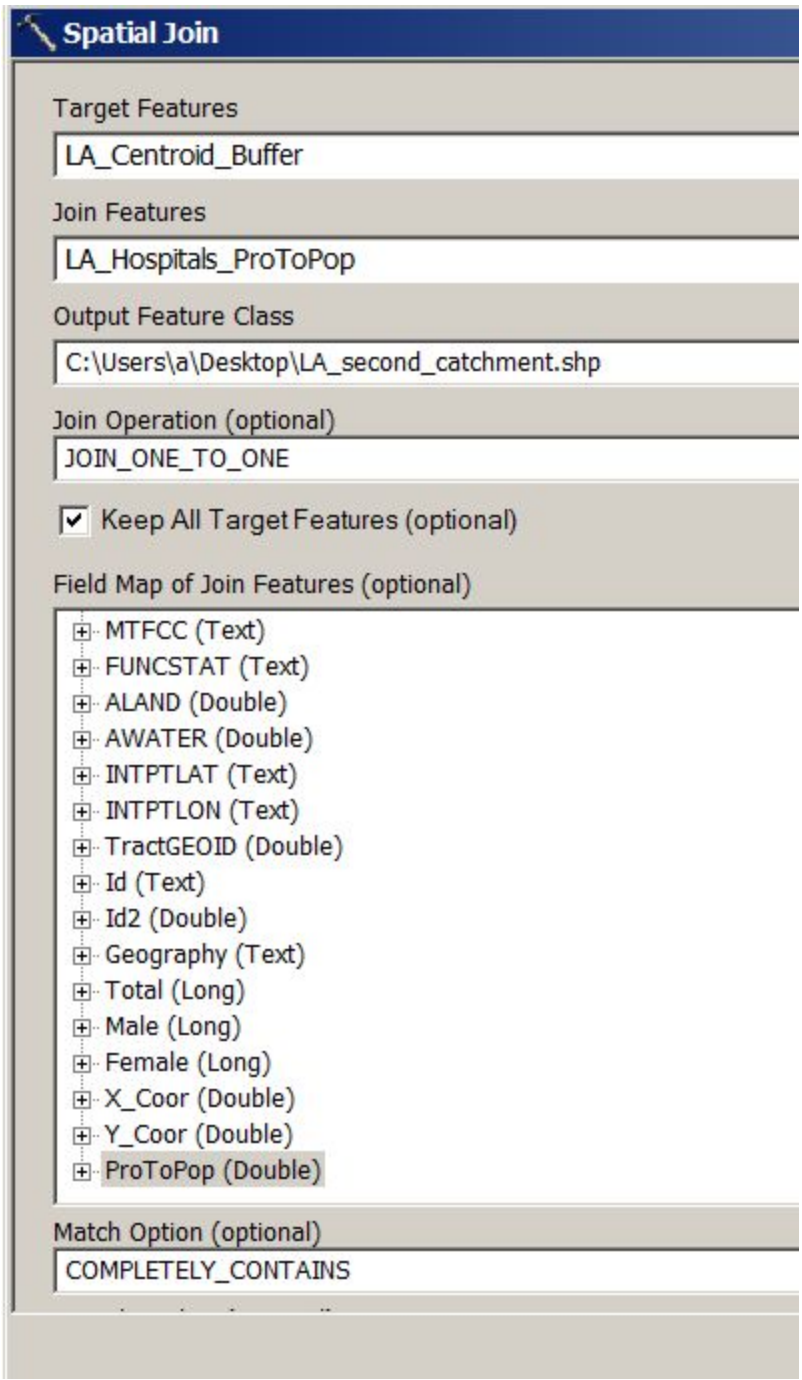
The result is something like this



Using these buffer, let’s perform a spatial join, this time, with the new shapefile call LA_Hospitals_ProToPop

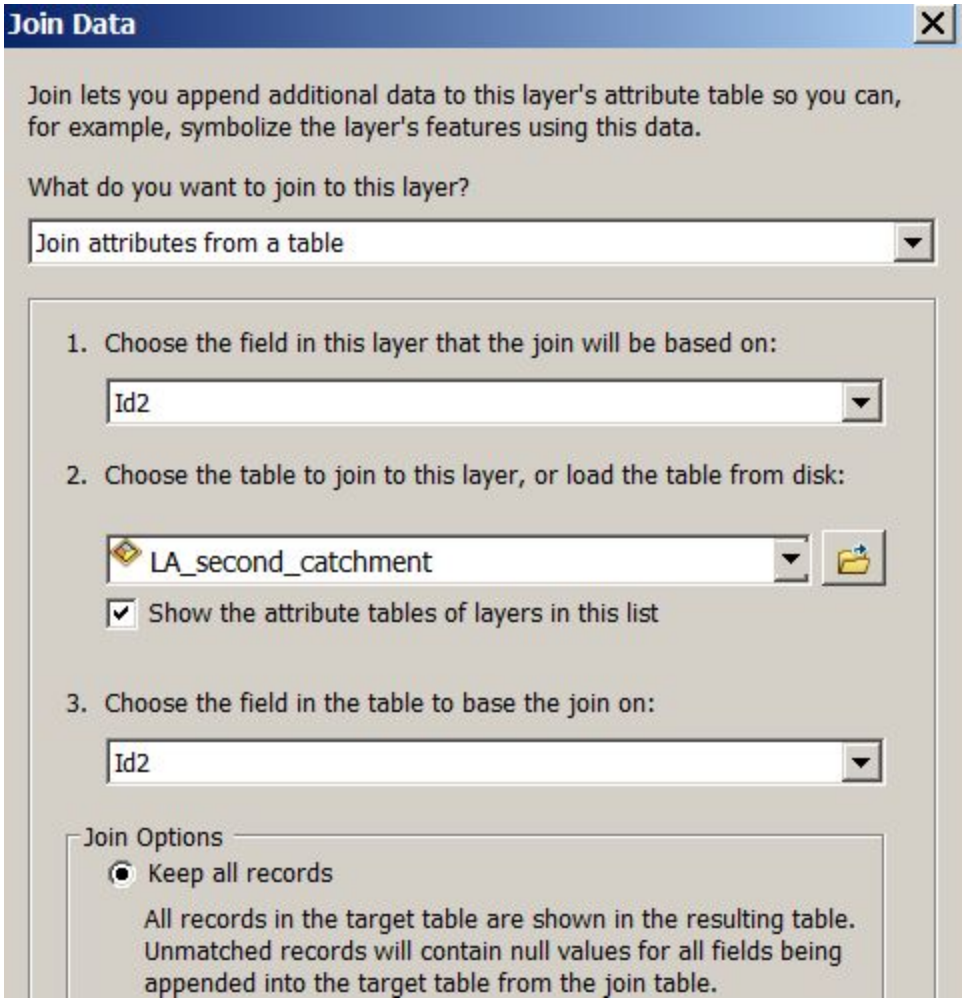
Ø Perform the spatial Join like below. Delete all fields that belongs to the LA_Hospitals_ProToPop but keep ProToPop field. Right click the ProToPop field

and change the Merge Rule to Sum (this is the spatial accessibility index calculation). Rename the output to LA_second_catchment.



Now, instead of joining the LA_second_catchment with the Los_Angeles_Centroid_Inside shapefile, we need to join this with the Los_Angeles_Census_Tract.

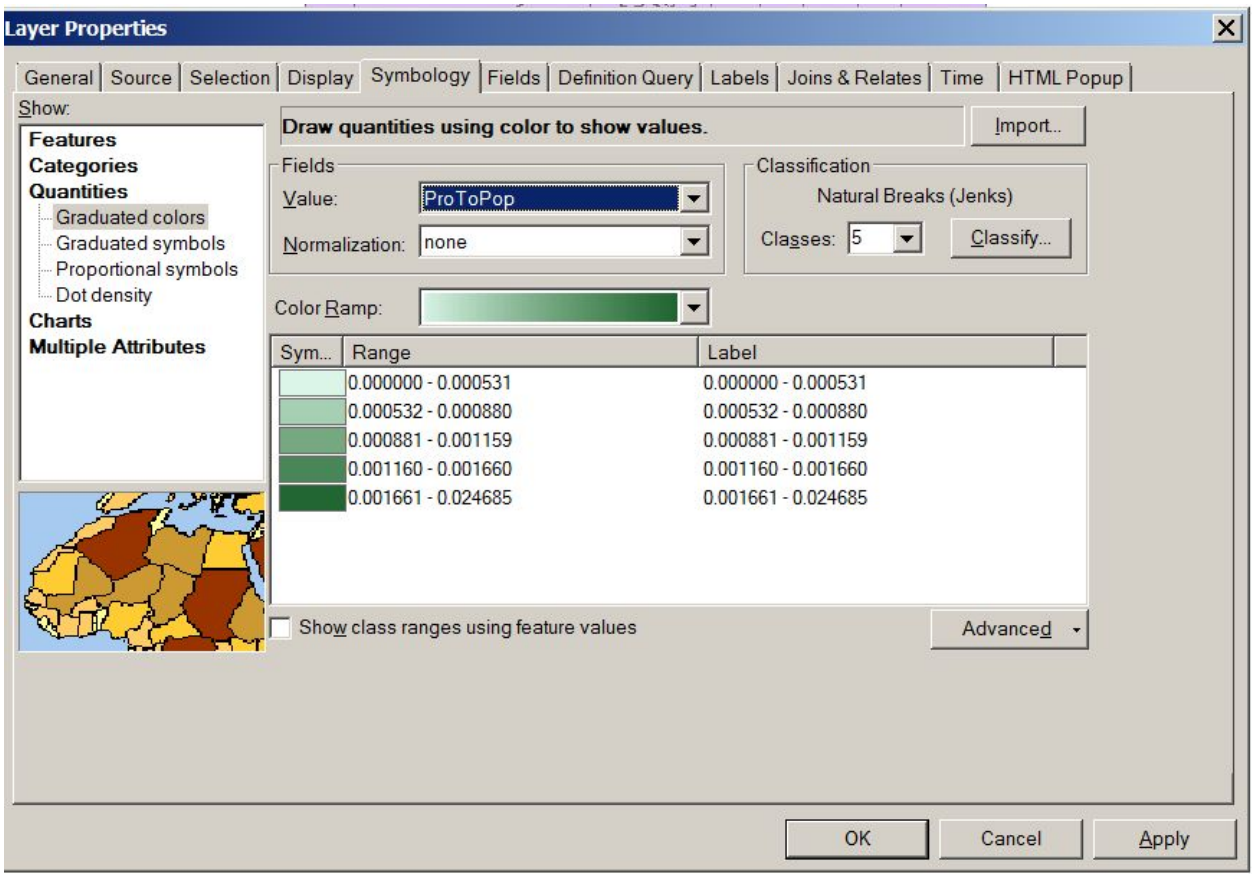
Ø Right click on the Los_Angeles_Census_Tract and choose Joins and Relates-Join. The join operation should be as follows Choose Id2 as the join field, LA_second_catchment as the join layer. The last field should be automatically filled in.



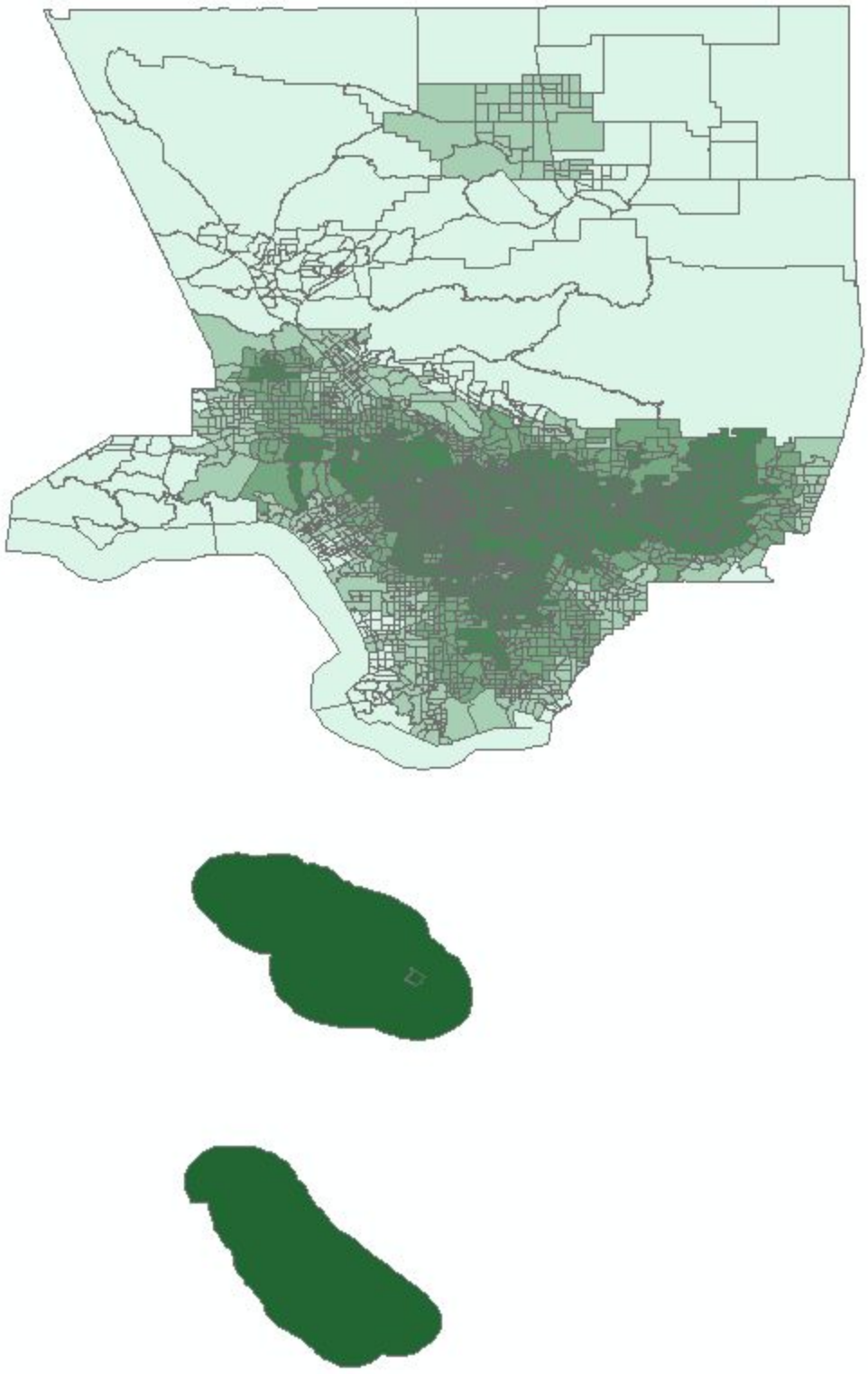
Ø Afterwards, select the Los_Angeles_Census_Tract that has the join data from LA_second_catchment and export it to the Desktop. Change the name to LA_2SFCA

Ø Uncheck all other layers but the LA_2SFCA layer. As you can see, naturally, the LA_2SFCA is the LA Census Tract. This layer, however, contains our spatial accessibility index.

Ø Double click on the LA_2SFCA layer to go to the layer's properties. Go to Symbology and select on the left Quantities- Graduate Colors. Change the Value to ProToPop. Choose your preferred Color Ramp. Everything else should be the same. You can see that the range, and label has been created automatically. Click OK when done.



Now here is the result.



What you see here is the health-spatial-accessibility-esque map. Our tutorial contains caveats, which is why the graph doesn't look the same as the research

might indicate. You can see, however, that the concentration of access is in the middle of LA, while the outskirt doesn't enjoy the same level of access.

This concludes our tutorial. Thank you for reading. We hope that this is a useful tutorial for you.