Learning Objective

To become familiar with the relational data model, and its implementation in a GIS software package, including table join, data export, sorting, summarizing, creating new fields, and calculating values for fields based on table and geometric calculations. As a demonstration, you will analyze spatial relationships among data on census tracts, neighborhoods, crime, and businesses in San Francisco, California and Chicago, Illinois.

TUTORIAL

Acquiring the Data

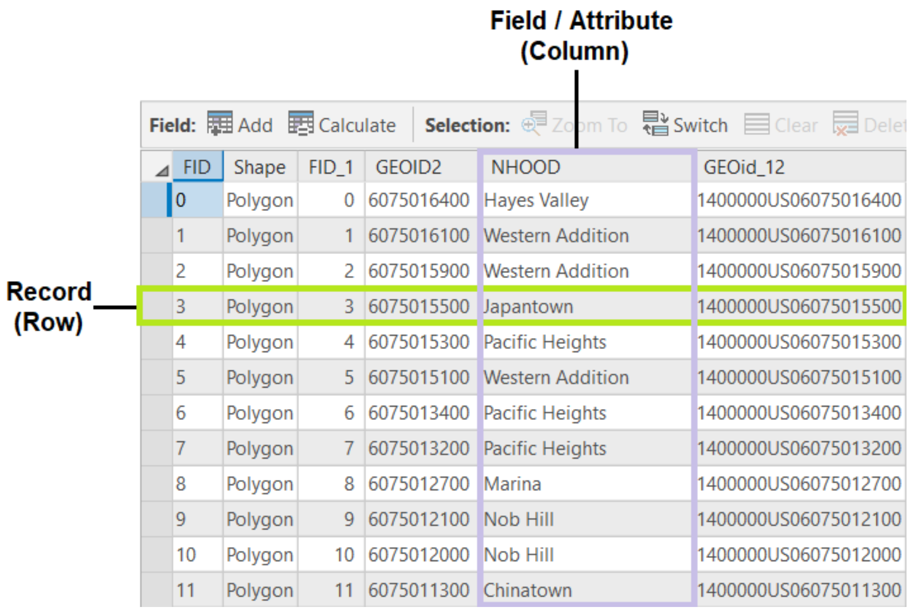
You are provided the data for this lab in the Lab_4_tutorial.zip file, which includes the following files:

- SF_Tracts is a polygon shapefile representing the US Census Bureau tracts in San Francisco. A tract is statistical reporting unit used by the US Census Bureau to publish population data (i.e. it does not necessarily correspond to political or administrative units like cities or wards). The neighborhood assignments in San Francisco originally comes from DataSF, San Francisco's open data portal. The data has been manipulated for the purpose of this lab.
- Total_Population is a table in dBase format that contains the total population of each tract.
- SF_Dissolved is a polygon shapefile representing the neighborhoods in San Francisco. Neighborhoods are defined as one or more adjacent tracts that together compose a named neighborhood.

Move all files to your workspace folder, and unzip any zip files.

GIS and the Relational Data Model

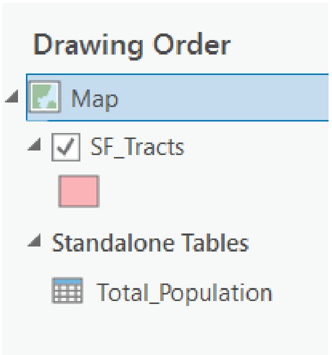
An attribute table in ArcGIS is composed of **records** (rows) and **fields** (columns):



FID	Shape	FID_1	GEOID2	NHOOD	GEOid_12
0	Polygon	0	6075016400	Hayes Valley	1400000US06075016400
1	Polygon	1	6075016100	Western Addition	1400000US06075016100
2	Polygon	2	6075015900	Western Addition	1400000US06075015900
3	Polygon	3	6075015500	Japantown	1400000US06075015500
4	Polygon	4	6075015300	Pacific Heights	1400000US06075015300
5	Polygon	5	6075015100	Western Addition	1400000US06075015100
6	Polygon	6	6075013400	Pacific Heights	1400000US06075013400
7	Polygon	7	6075013200	Pacific Heights	1400000US06075013200
8	Polygon	8	6075012700	Marina	1400000US06075012700
9	Polygon	9	6075012100	Nob Hill	1400000US06075012100
10	Polygon	10	6075012000	Nob Hill	1400000US06075012000
11	Polygon	11	6075011300	Chinatown	1400000US06075011300

Explore the SF_tracts and the TOTAL_POPULATION data sets in the catalog view.

Insert a new map and add both the SF_Tracts layer and the Total_Population table. In the **Contents** pane, notice that Total_Population has a grid icon indicating it is tabular data (with no spatial information) and the SF_Tracts layer has an icon indicating it is a polygon spatial data layer.

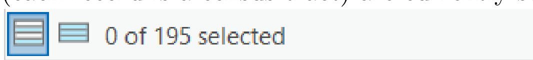


Right-click on each file in the **Contents** pane. You will see that you have different menu options for tables versus spatial data layers.

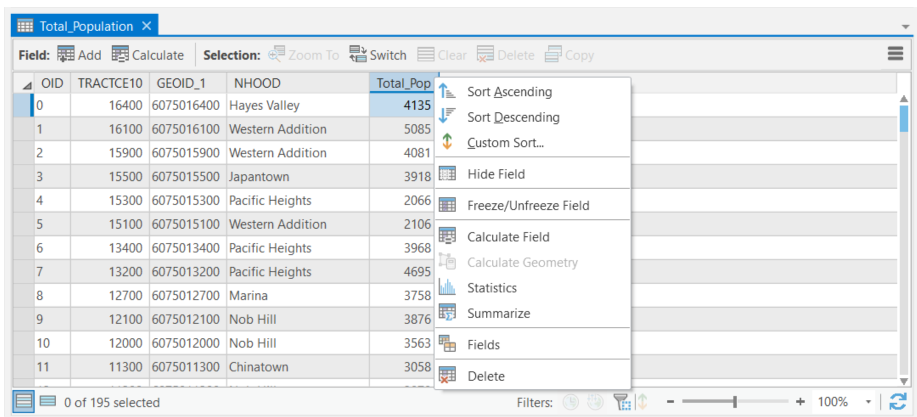
Understanding How Tables Are Organized

1. In the **Contents** pane, right-click on Total_Population

2. Select **Open**.
   a. Draw your attention to the `Total_Pop` field. This field stores the total population of each tract according to the 2010 Census.
   b. Notice also the `NHOOD` field. This field stores the name of the neighborhood within which each tract falls, i.e. each neighborhood wholly contains one or more census tracts.
3. At the bottom of the table it should indicate that 0 out of 195 records (each record is a census tract) are currently selected.



Right-click on the Total_Pop field name. You should see something like this:



The options you see are tools you can use to manipulate the data contained in the field you've selected in various ways. For now, explore the two sorting tools on your own; they're self-explanatory. Below, you'll learn how the **Calculate Field**, **Calculate Geometry** and **Summarize** tools work.

Close the table.

Joining a Table to a Spatial Data Layer

Conceptually, a join operation can be understood as adding attributes (columns) from one table to another based on a common field, such that the output of a join displays a single table with fields from both tables. For example, if you have a table with the unemployment rate by state, and another table with the poverty rate by state, you would join them to get one table that includes both unemployment rate and poverty rate by state.

In ArcGIS, we must specify the target **Layer Name or Table View** that you want new attributes to be added to, and the the **join table** that is 'lending' new attribute fields. In the GIS world, the target layer or table is almost always a spatial data layer, and the join table is often a nonspatial table.

To perform a join, a field in each of the tables must be identified that contains matching values. These **key** fields allow the software to properly link the records from one table with the analogous records from the other table. In the target table, the key field must be a **primary key** or **candidate key** (field that *could* be used as a primary key). This is a unique field which *identifies* the rows (features) in the table. For example, a table of US states might have the state name, two-letter state postal codes, and population. No US state has exactly the same population, so all of the fields are unique. But you wouldn't use the population to *identify* the state. (That is, you wouldn't say 'I'm going to 37,253,956 this week', you would say 'I'm going to California.') You could use either the state name or the postal code, both of which are unique, as the primary key field.

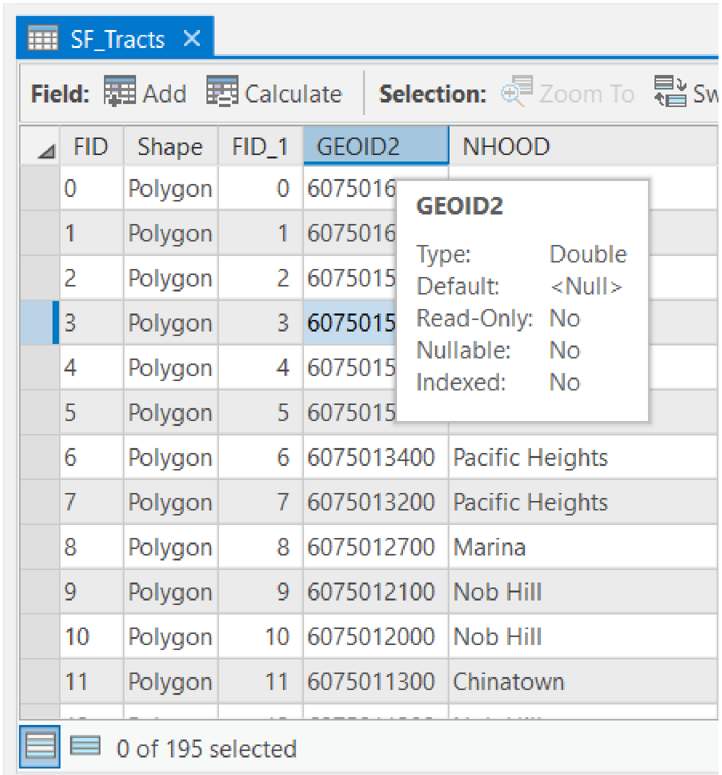
In the join table, the field must be a **foreign key**, which means a field with values matching a candidate key in the target table.

Here, we will join the Total_Population table to the SF_Tracts spatial data layer attribute table. Since the Total_Population is a nonspatial table, this will allow us to (a) map the total population of each tract, and (b) generate a population density variable by dividing the total population by the area of each tract, which we can calculate from the SF_Tracts layer.

First, let's explore our data. Open the SF_Tracts attribute table. Find the `GEOID2` field. This field is a unique identifier used by the U.S. Census Bureau for each tract. No two tracts have the same `GEOID2` value.

Each field has a specific data type, which indicates the types of values it can hold. Common data types include **Text**, which holds letters and/or numbers as text, and numeric data types. Numeric data types include **Integers** (whole numbers) as well as so-called 'floating point' types such as **Double** and **Float**.

Hover over the name of the `GEOID2` field to get some information about the field. Note the data type, which is double (a numeric type).



Now open the Total_Population table. Find the `GEOID_1` field. This field is also a unique identifier for each tract. Even though the name of the field differs from the `GEOID2` field in the SF_Tracts table, it contains the same information—a specific tract will have the same value in each table. These two fields will facilitate the join operation.

Close both tables.

Keep in mind the following information about joins:

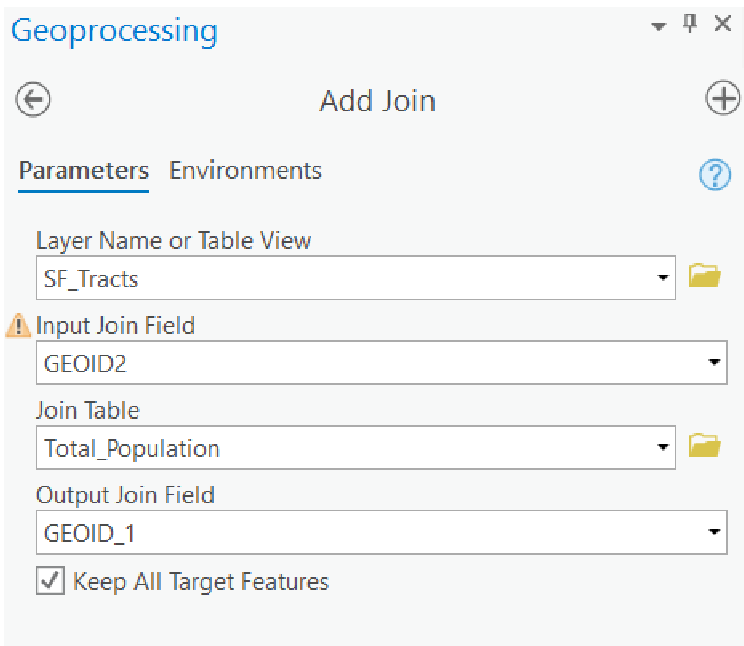
1. Always begin a join operation with the target table (by right-clicking on the target table in the **Contents** pane).
2. The key fields in both the target and join table must contain similar information.
   a. They should both refer to the same entity.
   b. They should both identify each entity using a common value.
   c. They should be the same data type. Usually this means text or integer.
   d. They do not have to have the same field name (though they can). Also, just because they have the same field name doesn't mean they have matching values. In one table a `state` field might have state *names*, while in another table a `state` field might have state *postal*

codes. You *must* become familiar with the data you are working with.

e. The `OID` or `FID` fields should not generally be used as a join field (even though internally they are used as the primary key by ArcGIS).

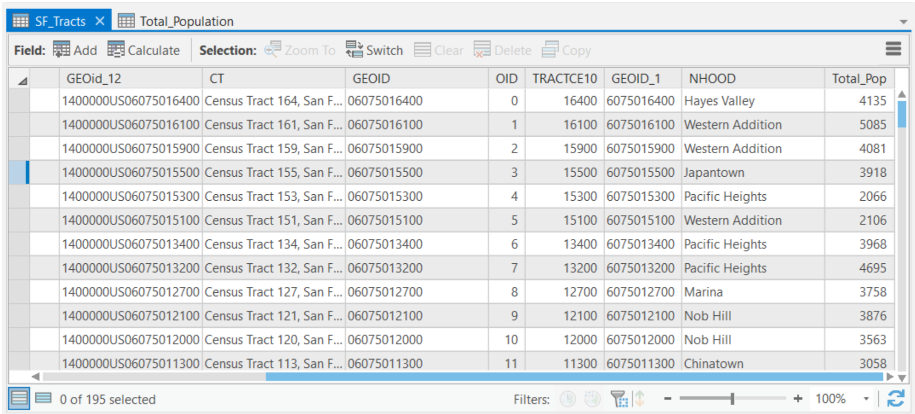
To execute the join operation, in the **Contents** pane, right-click on SF_Tracts (the target or destination), and select **Joins and Relates** → **Add Join**. The **Add Join** Geoprocessing pane should appear.

1. For **Layer Name or Table View**, make sure the SF_Tracts table is selected.
2. For **Input Join Field**, choose the field `GEOID2` (the key identifying each tract in the SF_Tracts table)
3. For **Join Table**, choose the Total_Population table
4. For **Output Join Field**, choose `GEOID_1` (the foreign key identifying each tract in the Total_Population table).



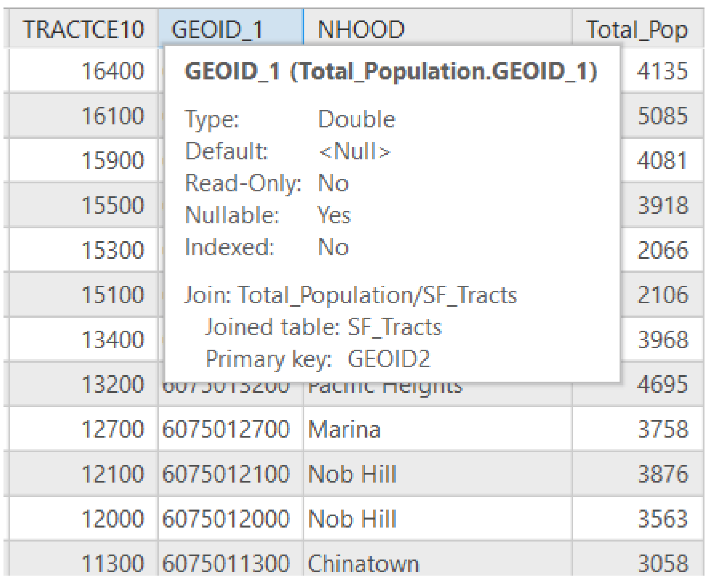
5. Press Run.

Open up the attribute table in SF_Tracts and scroll to the right. You should see that the fields from the Total_Population table are now joined to the SF_Tracts attribute table.



GEOid_12	CT	GEOID	OID	TRACTCE10	GEOID_1	NHOOD	Total_Pop
1400000US06075016400	Census Tract 164, San F...	06075016400	0	16400	6075016400	Hayes Valley	4135
1400000US06075016100	Census Tract 161, San F...	06075016100	1	16100	6075016100	Western Addition	5085
1400000US06075015900	Census Tract 159, San F...	06075015900	2	15900	6075015900	Western Addition	4081
1400000US06075015500	Census Tract 155, San F...	06075015500	3	15500	6075015500	Japantown	3918
1400000US06075015300	Census Tract 153, San F...	06075015300	4	15300	6075015300	Pacific Heights	2066
1400000US06075015100	Census Tract 151, San F...	06075015100	5	15100	6075015100	Western Addition	2106
1400000US06075013400	Census Tract 134, San F...	06075013400	6	13400	6075013400	Pacific Heights	3968
1400000US06075013200	Census Tract 132, San F...	06075013200	7	13200	6075013200	Pacific Heights	4695
1400000US06075012700	Census Tract 127, San F...	06075012700	8	12700	6075012700	Marina	3758
1400000US06075012100	Census Tract 121, San F...	06075012100	9	12100	6075012100	Nob Hill	3876
1400000US06075012000	Census Tract 120, San F...	06075012000	10	12000	6075012000	Nob Hill	3563
1400000US06075011300	Census Tract 113, San F...	06075011300	11	11300	6075011300	Chinatown	3058

Note that while the join is displayed as though the two tables have become one, the join is not permanent, i.e. the storage of the SF_Tracts attribute table has not changed. You can see this illustrated by hovering over an attribute from the target table, then doing the same for an attribute from the join table. The field properties will show the 'owner' of the field.



TRACTCE10	GEOID_1	NHOOD	Total_Pop
16400			4135
16100			5085
15900			4081
15500			3918
15300			2066
15100			2106
13400			3968
13200			4695
12700	6075012700	Marina	3758
12100	6075012100	Nob Hill	3876
12000	6075012000	Nob Hill	3563
11300	6075011300	Chinatown	3058

To permanently store the SF_Tracts layer with the joined attributes, export the layer to a new shapefile. Right-click on SF_Tracts in the **Contents** pane and choose **Data** → **Export Features**. Save as a new shapefile and call it 'Tract_Pop'. Add the new shapefile to ArcGIS, open the attribute table, and scroll to the right. You will see that this shapefile includes the joined attributes – not as a join, but encoded as a part of the shapefile attribute table. Hovering over the field names will not display the table names we saw before.

You can remove a join you no longer need by right-clicking SF_Tracts in the **Contents** pane, going to **Joins and Relates** and choosing **Remove Join**. Sometimes you will perform a join incorrectly—for example, by joining the tables in the wrong direction, or by selecting fields that don't quite match. Since joins don't modify the data on disk, there is no harm in creating an incorrect join. Just remove the undesired join and try again.

Summarizing and Joining

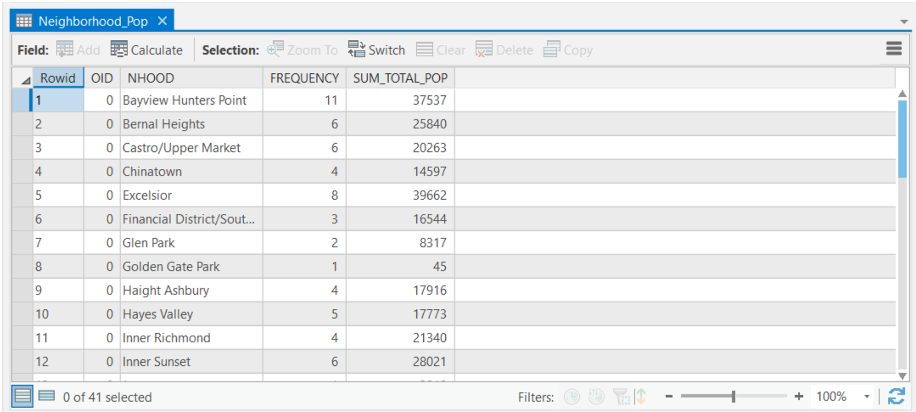
It is possible to summarize one field by another. This means calculating summary statistics (such as the sum or average) of a quantitative field grouped by the unique values in a nominal (categorical) field.[1] The Total_Population table has population by tract. The field with unique values that we want to summarize by is the neighborhoods. We will sum the total population for the set of tracts in each neighborhood, to yield the total population of each neighborhood.

The output table from the summarize operation will also show the number of records, displayed as a field named `FREQUENCY`, summarized for each category, which in this case is the number of tracts in each neighborhood.

To calculate the total population of each neighborhood:

1. Open the 'Total_Population' table.
2. Right-click on the `NHOOD` field and choose **Summarize** to open the **Summary Statistics** pane. Recall that this field is a unique identifier of each neighborhood. This is the field we are summarizing on.
3. The **Input Table** box should have `Total_Population` selected.
4. Click the folder icon next to **Output Table** and navigate to your Lab4 folder. Type 'Neighborhood_Pop' in the name box and save the output file in this location.
5. In the first box under **Field**, choose the `Total_Pop` field, and `Sum` for the **Statistic Type**.
6. In the first box under **Case field**, choose the `NHOOD` field. This indicates that we want the sum of the total population for all tracts that are in the same neighborhood.

The new table should be added to the **Contents** pane. Open it to view the attributes.



Rowid	OID	NHOOD	FREQUENCY	SUM_TOTAL_POP
1	0	Bayview Hunters Point	11	37537
2	0	Bernal Heights	6	25840
3	0	Castro/Upper Market	6	20263
4	0	Chinatown	4	14597
5	0	Excelsior	8	39662
6	0	Financial District/Sout...	3	16544
7	0	Glen Park	2	8317
8	0	Golden Gate Park	1	45
9	0	Haight Ashbury	4	17916
10	0	Hayes Valley	5	17773
11	0	Inner Richmond	4	21340
12	0	Inner Sunset	6	28021

Notice there are 41 records—one record for each neighborhood.

The `SUM_TOTAL_POP` field contains the total population of each neighborhood.

Notice there is a `FREQUENCY` field that indicates the number of records in the Total_Population table that were summed for each record in the Neighborhood_Pop table, i.e. the number of tracts in each neighborhood. For example, there are 11 Census tracts in the Bayview Hunters Point neighborhood in the Total_Population table. The `SUM_TOTAL_POP` field contains the sum of the populations of those 11 Census tracts. This frequency field is created automatically by the **Summarize** operation, and will be useful in the lab assignment.

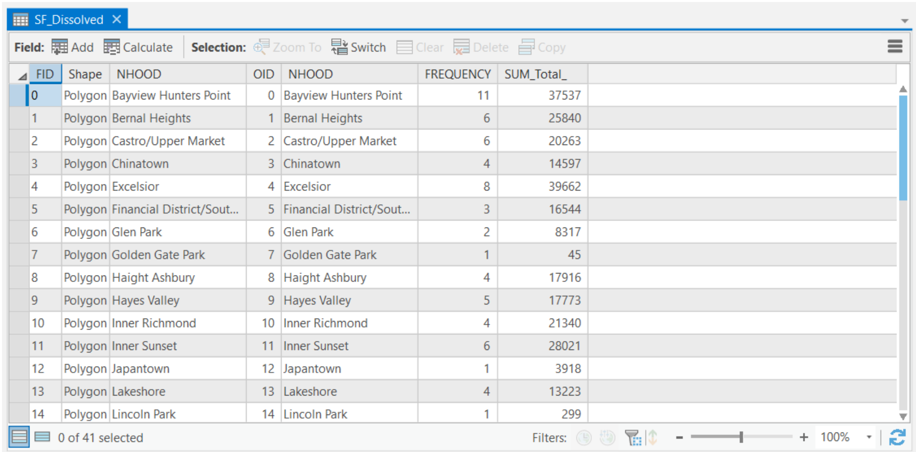
We will use this new table to map the population density of each neighborhood. For this, we need a neighborhood spatial data layer.

Add the 'SF_Dissolved' data layer to the map. Each polygon in this layer is a **neighborhood**—an aggregation of one or more adjacent tracts that compose a neighborhood.

We can join the Neighborhood_Pop table to the SF_Dissolved layer's attribute table using `NHOOD` as the join field in both tables, because they both contain common values that identify each neighborhood.

1. Right-click on SF_Dissolved. Select **Joins and Relates** → **Add Join**.
    a. For **Layer Name or Table View**, make sure SF_Dissolved is selected.
    b. For **Input Join Field** choose `NHOOD`.
    c. For **Join Table** choose `Neighborhood_Pop`.
    d. For **Output Join Field** choose `NHOOD`.
2. Click Run.

Check to see if your join was successful by opening the SF_Dissolved attribute table and seeing if the `SUM_TOTAL_POP` field (it may be shortened by ArcGIS to something like `SUM_Total`) is there and the population data are displayed.



FID	Shape	NHOOD	OID	NHOOD	FREQUENCY	SUM_Total_
0	Polygon	Bayview Hunters Point	0	Bayview Hunters Point	11	37537
1	Polygon	Bernal Heights	1	Bernal Heights	6	25840
2	Polygon	Castro/Upper Market	2	Castro/Upper Market	6	20263
3	Polygon	Chinatown	3	Chinatown	4	14597
4	Polygon	Excelsior	4	Excelsior	8	39662
5	Polygon	Financial District/Sout...	5	Financial District/Sout...	3	16544
6	Polygon	Glen Park	6	Glen Park	2	8317
7	Polygon	Golden Gate Park	7	Golden Gate Park	1	45
8	Polygon	Haight Ashbury	8	Haight Ashbury	4	17916
9	Polygon	Hayes Valley	9	Hayes Valley	5	17773
10	Polygon	Inner Richmond	10	Inner Richmond	4	21340
11	Polygon	Inner Sunset	11	Inner Sunset	6	28021
12	Polygon	Japantown	12	Japantown	1	3918
13	Polygon	Lakeshore	13	Lakeshore	4	13223
14	Polygon	Lincoln Park	14	Lincoln Park	1	299

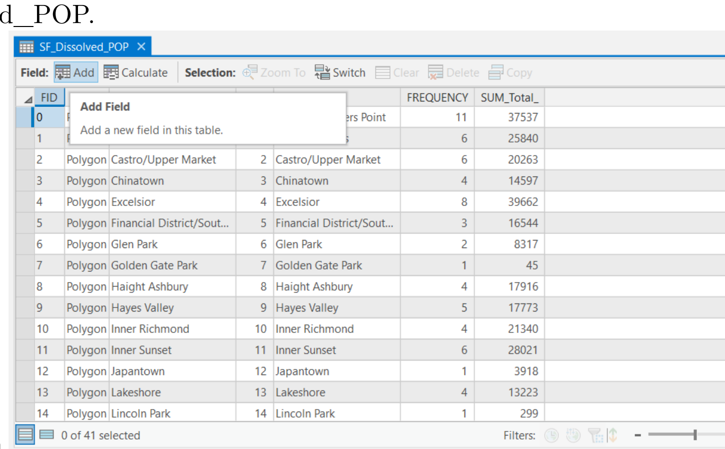
To preserve the join permanently, export the SF_Dissolved layer to its own layer and call the new layer SF_Dissolved_POP. Add it to the map and open the attribute table to ensure the join and export worked properly.

Calculating Population Density

To calculate population density, we need to find the area of each neighborhood. We will calculate the area in square kilometers, so that we can ultimately calculate the population density as people per square kilometer.

First, we need to create a new field to hold the area value:

1. Open the attribute table for SF_Dissolved_POP.



FID					FREQUENCY	SUM_Total_
0				...rs Point	11	37537
1					6	25840
2	Polygon	Castro/Upper Market	2	Castro/Upper Market	6	20263
3	Polygon	Chinatown	3	Chinatown	4	14597
4	Polygon	Excelsior	4	Excelsior	8	39662
5	Polygon	Financial District/Sout...	5	Financial District/Sout...	3	16544
6	Polygon	Glen Park	6	Glen Park	2	8317
7	Polygon	Golden Gate Park	7	Golden Gate Park	1	45
8	Polygon	Haight Ashbury	8	Haight Ashbury	4	17916
9	Polygon	Hayes Valley	9	Hayes Valley	5	17773
10	Polygon	Inner Richmond	10	Inner Richmond	4	21340
11	Polygon	Inner Sunset	11	Inner Sunset	6	28021
12	Polygon	Japantown	12	Japantown	1	3918
13	Polygon	Lakeshore	13	Lakeshore	4	13223
14	Polygon	Lincoln Park	14	Lincoln Park	1	299

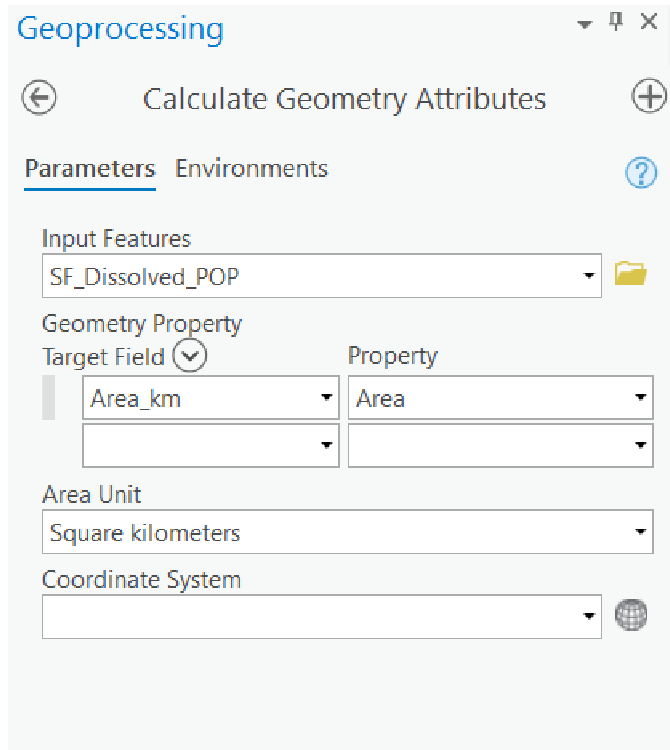
2. In the table, click on the **Add Field** button in the upper left hand corner of the table. This will open up the list of fields for the table.
3. In the highlighted row, replace `Field` with `Area_km` and set the data type to **Double**.

4. Close the fields box, and save the changes.

Your attribute table should show your new field as the last entry on the right side.

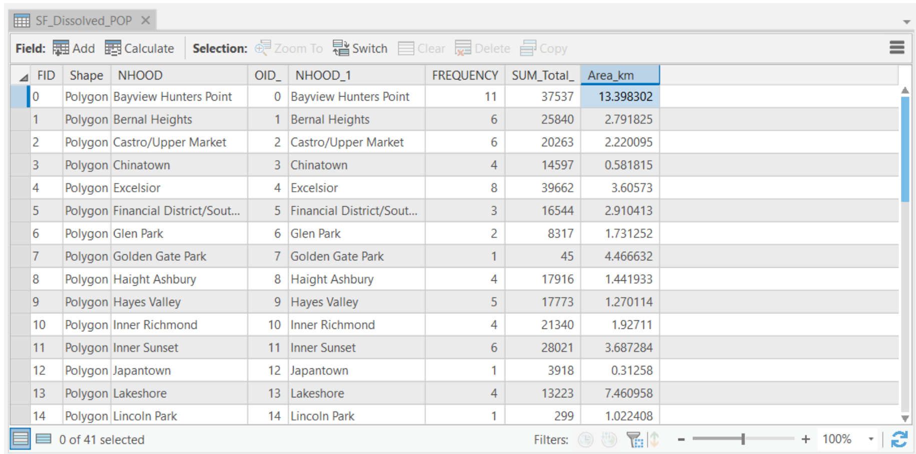
To calculate the area of each neighborhood:

1. Right-click on your new `Area_km` field at the top of the column and select **Calculate Geometry**.
2. In the **Calculate Geometry Attributes** pane, choose `Area_km` as the target field with the `Area` property.



3. For **Area Unit** choose 'Square kilometers'.
4. Click Run.

You should see that the `Area_km` column has been updated with the calculated values:



SF_Dissolved_POP

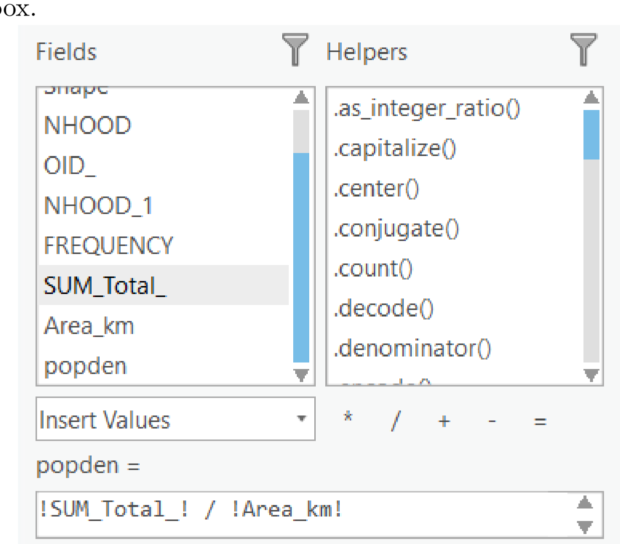
Field: Add Calculate Selection: Zoom To Switch Clear Delete Copy

FID	Shape	NHOOD	OID_	NHOOD_1	FREQUENCY	SUM_Total_	Area_km
0	Polygon	Bayview Hunters Point	0	Bayview Hunters Point	11	37537	13.398302
1	Polygon	Bernal Heights	1	Bernal Heights	6	25840	2.791825
2	Polygon	Castro/Upper Market	2	Castro/Upper Market	6	20263	2.220095
3	Polygon	Chinatown	3	Chinatown	4	14597	0.581815
4	Polygon	Excelsior	4	Excelsior	8	39662	3.60573
5	Polygon	Financial District/Sout...	5	Financial District/Sout...	3	16544	2.910413
6	Polygon	Glen Park	6	Glen Park	2	8317	1.731252
7	Polygon	Golden Gate Park	7	Golden Gate Park	1	45	4.466632
8	Polygon	Haight Ashbury	8	Haight Ashbury	4	17916	1.441933
9	Polygon	Hayes Valley	9	Hayes Valley	5	17773	1.270114
10	Polygon	Inner Richmond	10	Inner Richmond	4	21340	1.92711
11	Polygon	Inner Sunset	11	Inner Sunset	6	28021	3.687284
12	Polygon	Japantown	12	Japantown	1	3918	0.31258
13	Polygon	Lakeshore	13	Lakeshore	4	13223	7.460958
14	Polygon	Lincoln Park	14	Lincoln Park	1	299	1.022408

0 of 41 selected Filters: 100%

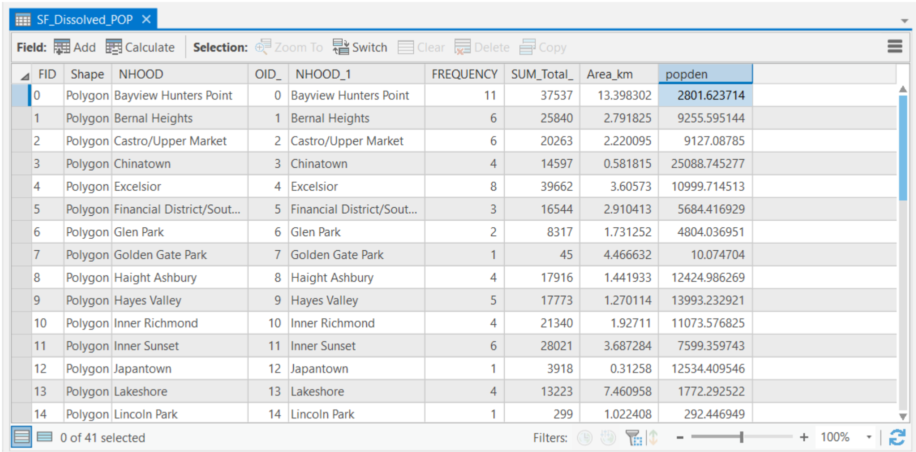
Now that we have the area of each neighborhood encoded, we can calculate the population density of each neighborhood:

1. Add a new field to the SF_Dissolved_Pop table, using the **Double** data type, and call it `popden` .
2. Right-click on the new field `popden` at the top of the column and choose **Calculate Field** .
3. Create an equation in the text box below 'popden=' where the neighborhood population is divided by the neighborhood area:
   a. Double click on `SUM_Total_` in the list of **Fields** to add it to the equation text box.
   b. Click on the '/' operator to add it to the box.



   c. Double-click on `Area_km` to add it to the box.

Click Run. You should see that the `popden` field has been updated with the calculated values, representing people per square kilometer:



FID	Shape	NHOOD	OID_	NHOOD_1	FREQUENCY	SUM_Total_	Area_km	popden
0	Polygon	Bayview Hunters Point	0	Bayview Hunters Point	11	37537	13.398302	2801.623714
1	Polygon	Bernal Heights	1	Bernal Heights	6	25840	2.791825	9255.595144
2	Polygon	Castro/Upper Market	2	Castro/Upper Market	6	20263	2.220095	9127.08785
3	Polygon	Chinatown	3	Chinatown	4	14597	0.581815	25088.745277
4	Polygon	Excelsior	4	Excelsior	8	39662	3.60573	10999.714513
5	Polygon	Financial District/Sout...	5	Financial District/Sout...	3	16544	2.910413	5684.416929
6	Polygon	Glen Park	6	Glen Park	2	8317	1.731252	4804.036951
7	Polygon	Golden Gate Park	7	Golden Gate Park	1	45	4.466632	10.074704
8	Polygon	Haight Ashbury	8	Haight Ashbury	4	17916	1.441933	12424.986269
9	Polygon	Hayes Valley	9	Hayes Valley	5	17773	1.270114	13993.232921
10	Polygon	Inner Richmond	10	Inner Richmond	4	21340	1.92711	11073.576825
11	Polygon	Inner Sunset	11	Inner Sunset	6	28021	3.687284	7599.359743
12	Polygon	Japantown	12	Japantown	1	3918	0.31258	12534.409546
13	Polygon	Lakeshore	13	Lakeshore	4	13223	7.460958	1772.292522
14	Polygon	Lincoln Park	14	Lincoln Park	1	299	1.022408	292.446949

You have now encoded the population density for each neighborhood in San Francisco.

Create a choropleth map of population density using the skills you learned previously.

ASSIGNMENT

Objective

You have been hired as a GIS crime analyst for the city of Chicago. Your boss is upset about how presidential candidates judge your whole city based on the murder rate. She is also interested in how homicides might impact tourism in the city.

You have two objectives.

1. To describe the spatial distribution of the density of homicides by police district in Chicago.
2. To compare the spatial patterns of homicides, Airbnb listings, and Airbnb prices in Chicago.

Deliverables

Turn in a report in the format described in the syllabus.

Be sure to include the following information:

1. A choropleth map that shows the spatial distribution of the density of homicides (per square mile) in Chicago by police district, displayed in an

appropriate UTM coordinate system. **Note:** This requires you to change the CRS of the file you are given.
2. A choropleth map that shows the spatial distribution of the density of Airbnb reviews (per square mile) in Chicago by police district, displayed in an appropriate UTM coordinate system.
3. A table that summarizes the average Airbnb price for each police district in Chicago.

The **Introduction** section should state the research objective.

The **Data and Methods** section should state the data sets used in the analysis (only the data used for the assignment), from where those data were acquired, and the GIS operations employed to investigate the research objective.

The **Results** section should state the results (i.e. the spatial distribution of the density of homicides by police district and the spatial patterns of homicides, Airbnb listings, and Airbnb prices). The maps and table should be cited in the text here (e.g. Figure 1, Figure 2, Table 1).

The **Discussion** section should state an interpretation of the results. Consider:

1. Where are the homicides in Chicago concentrated?
2. Where are the Airbnb reviews in Chicago concentrated?
3. Which police districts have the highest average Airbnb prices? Which have the lowest?
4. Is there a relationship, or pattern, between homicides and Airbnb reviews and/or prices?
5. If so, what is the form of this relationship and why might it occur?
6. The limitations of the analysis, and how the analysis could be improved or expanded.

The **Tables and Figures** section should contain the table and maps noted above, each on a separate page with a caption. The table and maps should be cited in the text.

Data

Several data sets are provided to you in the Lab_4_assignment.zip file.

- Police_Districts_Chicago is a polygon shapefile of the police districts in Chicago. The `DISTRICT` field is a unique number used by the police department that identifies each police district. This data is from the City of Chicago Data Portal (https://data.cityofchicago.org/).
- Selected_Crimes_in_Chicago is a point shapefile of the crime incidents in Chicago. The `PRIMARY_DE` field indicates the type of crime (i.e. homicides versus other types of crime). The `DISTRICT` field is a unique number used by the police department that identifies each police district. This data is from the City of Chicago Data Portal (https://data.cityofchicago.org/).

- AirBnB_Data is a point shapefile of the Airbnb listings in Chicago. The `price` field contains the nightly price for the listing. The `number_of_` field contains the number of reviews for that listing. This data is provided by Inside AirBnb (http://insideairbnb.com/).

It is not uncommon for data of unknown location to be geocoded oddly. For example, many of the points in the crimes layer appear at Null Island. Most likely this means that when these crimes were reported, the exact location was unknown, and the database applied a default value of 0° Latitude, 0° Longitude. Three of the Airbnb properties are at the latitude of Chicago, but for some reason their longitude is 0° (the Prime Meridian).

For this assignment you can ignore these misplaced features. Use Zoom to Layer on the police districts layer to zoom the map canvas to our area of interest. Optionally, you could use a Definition Query (ask your instructor how to do this) to exclude features, or you could extract only the features you are interested in by selecting them in the map canvas, then exporting the layers to new shapefiles.

Getting Started

You will need to use several GIS operations you have learned from this lab and previous labs:

1. Use operations in projections and coordinate systems to transform your data to UTM (research which UTM zone Chicago is in).
2. Use operations in selection and data export to create a spatial data layer of only homicides (not including other crime types).
3. Use the **Summarize** operation to calculate the number of homicides and Airbnb reviews, and average price, for each police district. Please note the you want the sum of Airbnb *reviews* which is contained in the `number_of_` field, not want the count of Airbnbs.
4. Use **Calculate Field** to calculate the density of homicides and density of Airbnb reviews for each police district.
5. Use your thematic mapping skills to create the choropleth maps.

1. See Bolstad 5e, pp. 39-40 for a refresher on levels of measurement.