

BEST CENSUS TRACT FOR OPENING A NEW SHOP IN PHILADELPHIA

CPLN 503 Modeling Geographic Objects

Term Project: Data Interpretation | Zizhao He

Date: 11/21/2018



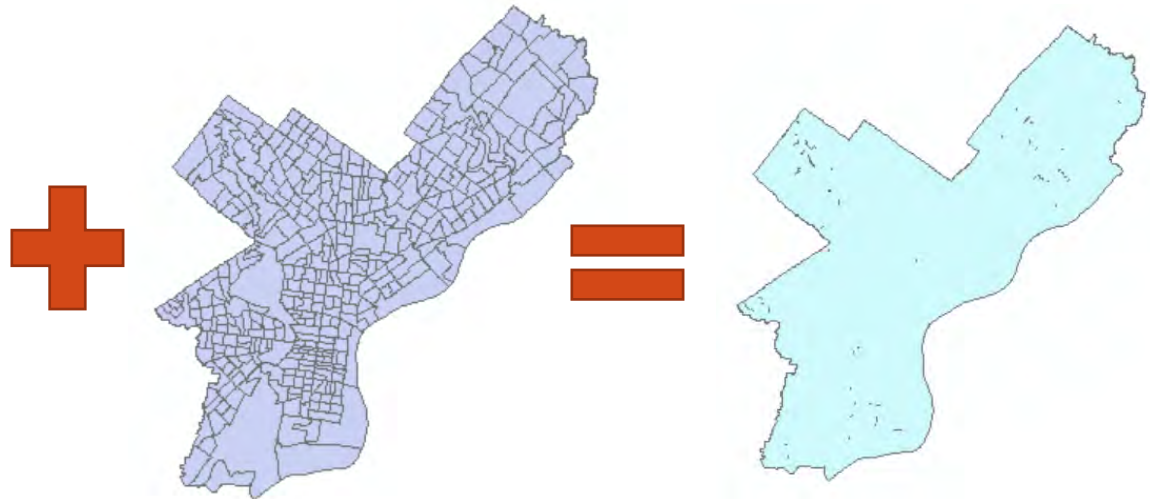
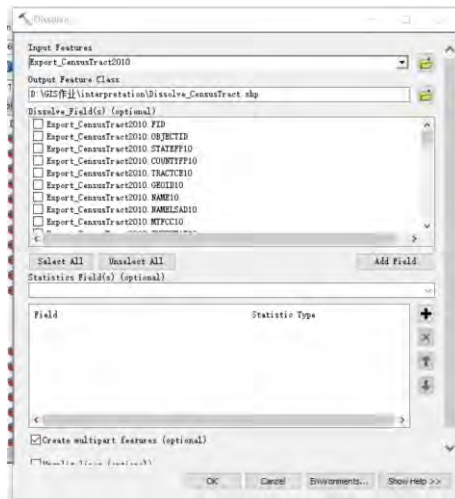
INTRODUCTION

For the term project, I'm interested in evaluating the contexts of all census tracts in Philadelphia to find the best census tract for opening a new shop. In the first part of the term project (Data Preparation), I applied data acquisition skills to get the data of 6 topics, applied data creation skills to transform the raw data into the form which could be used directly, and used data conversion skills to visualize the data and get an intuitive feeling about the outcome of the project (the geographic location of the best census tract). In this part of the term project (Data Interpretation), I will appropriately apply data interpretation skills like Measurement, Superimposition, Aggregation, Selection, Buffering, Joining and Regression to analyze and interpret the data I collected and transformed before and assign scores to each census tract based on their performance on each of the topics. Finally, I will find the best census tract in Philadelphia to open a new shop based on the final score (sum of the scores of each topic).

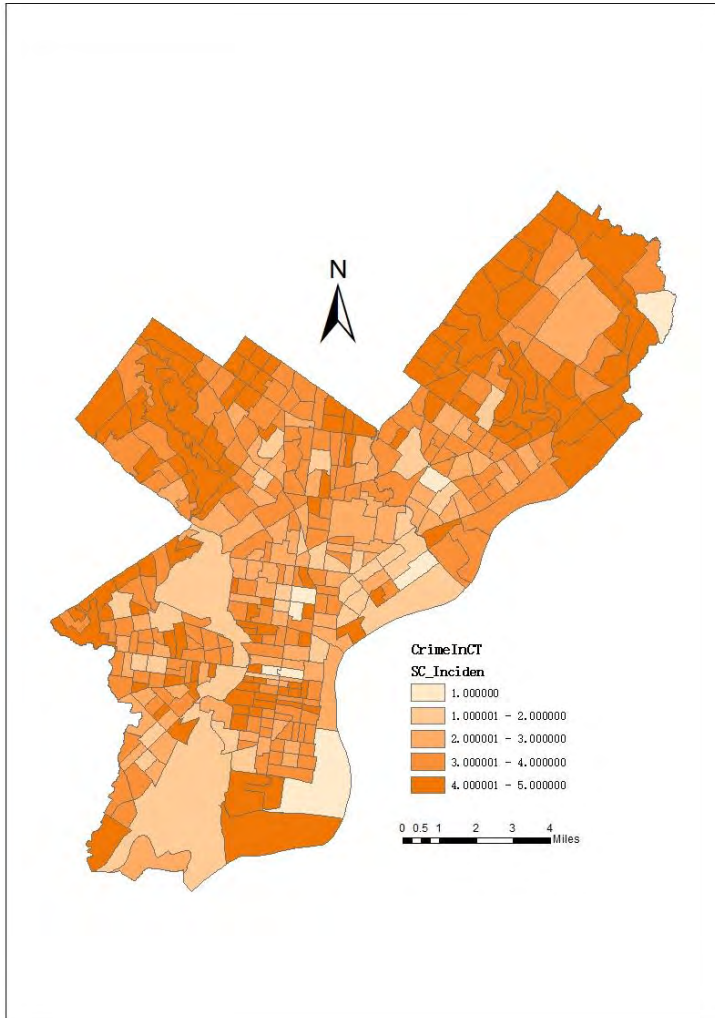


DISSOLVE

Step 1. Because I may want to show some of my outcomes on the map of Philadelphia, I used ArcToolbox → Data Management Tools → Generalization → Dissolve to create a layer of Philadelphia map with only the boundary lines of the county.



LAYER 1: CRIME



In this section, I will evaluate the crime data by scoring the census tracts based on the number of crime incidents happened in them in the recent one month. The fewer the crimes are, the better to open a new shop.

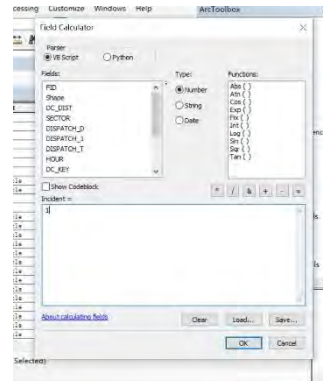


1.1 CRIME

Step 1. Use table option → **select by attributes** to get the crime incidents data in most recent month of the crime dataset.



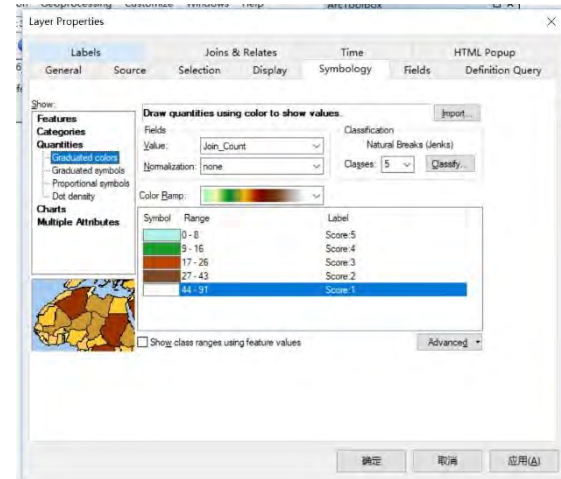
Step 2. Add a new field in the attribute table of the new crime shapefile. Then, right click on the new field → **Field Calculator** to give the same number to all locations of reported crimes which is "1".



Step 3. Use ArcToolbox → Analysis Tools → Overlay → **Spatial Join (Intersect)** and use "sum" as the merge rule with the census tract layer as Target Features and the crime layer as the Join Features. After the spatial join, I get total number of crimes in each census tracts.

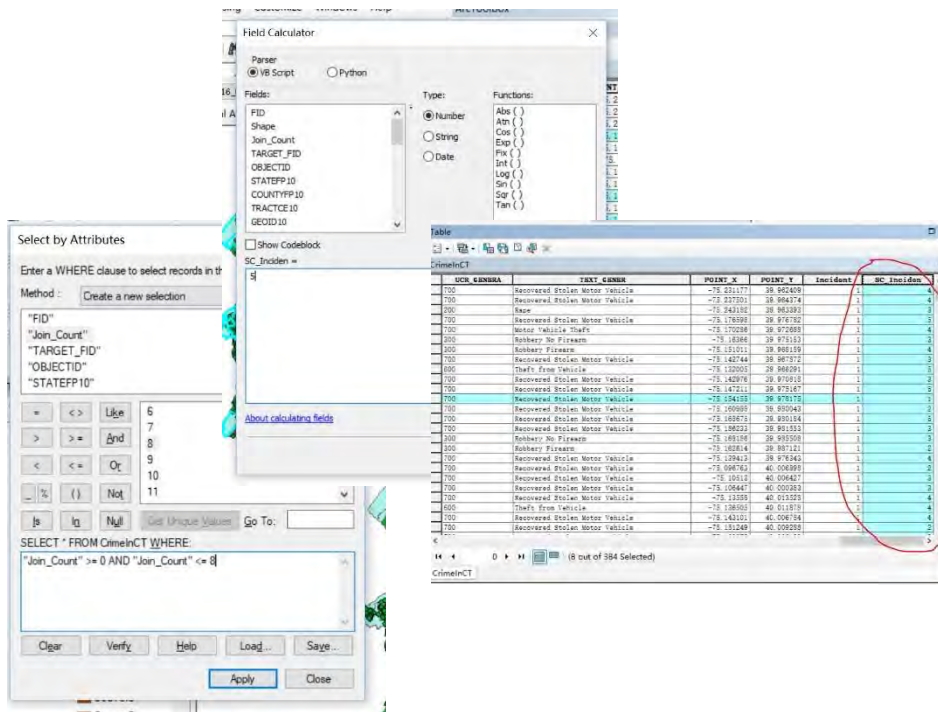
FID	Shape	Join_Count	TARGET_FID	OBJECTID	STATBP_FID	COUNTY_FID	TRACTID
0	Polygon	10	0	1	142	101	009400
1	Polygon	14	1	2	142	101	009500
2	Polygon	24	2	3	142	101	009600
3	Polygon	6	3	4	142	101	012300
4	Polygon	13	4	5	142	101	012400
5	Polygon	24	5	6	142	101	014000
6	Polygon	13	6	7	142	101	014100
7	Polygon	21	7	8	142	101	014200
8	Polygon	6	8	9	142	101	014300
9	Polygon	24	9	10	142	101	014400
10	Polygon	3	10	11	142	101	014500
11	Polygon	50	11	12	142	101	014600
12	Polygon	28	12	13	142	101	014700
13	Polygon	4	13	14	142	101	014800
14	Polygon	24	14	15	142	101	014900
15	Polygon	19	15	16	142	101	015000
16	Polygon	24	16	17	142	101	015100
17	Polygon	12	17	18	142	101	015200
18	Polygon	29	18	19	142	101	015300
19	Polygon	23	19	20	142	101	015400
20	Polygon	22	20	21	142	101	015500
21	Polygon	12	21	22	142	101	015600
22	Polygon	12	22	23	142	101	015700
23	Polygon	16	23	24	142	101	015800
24	Polygon	28	24	25	142	101	015900

Step 4. Properties → Quantities → Color → **Joint_Count** for Value with 5 classes. Set the standard and range (1-5) of the scores according to the amount of incidents in the census tracts.

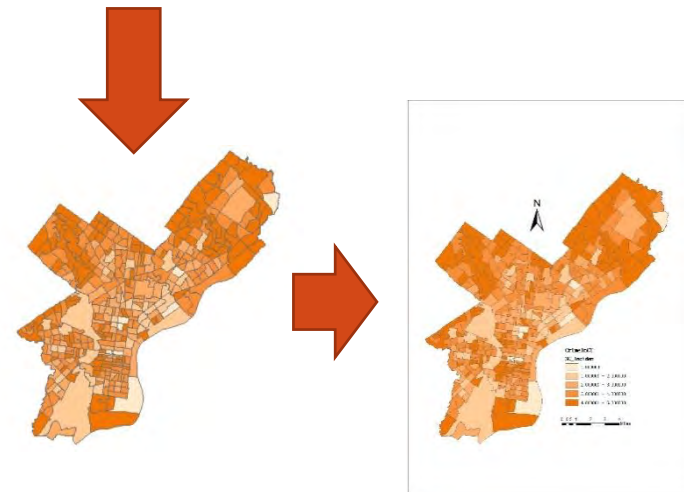
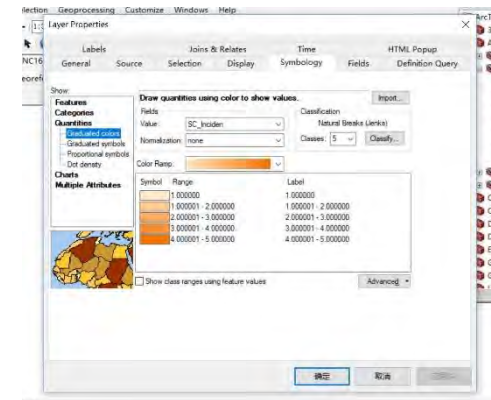


1.2 CRIME

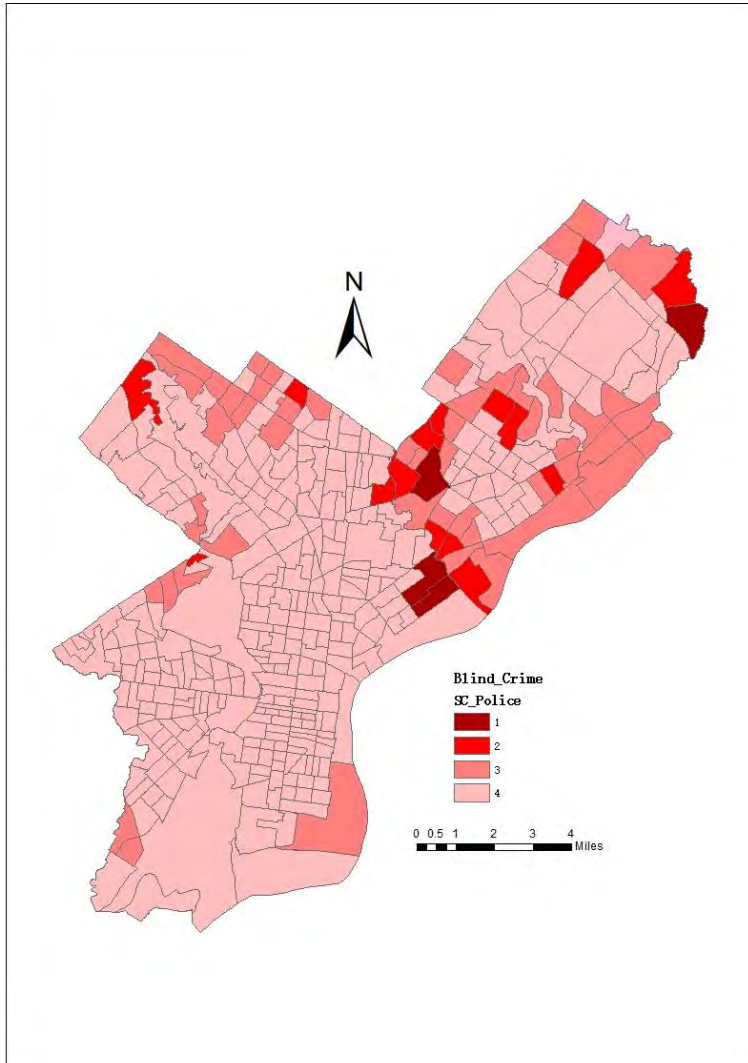
Step 5. Add a **new field** Sc_Incident for the score of the crime incidents. Then, using **select by attributes** to distinguish the 5 classes of scoring. For the selecting features, use field calculator to give them scores (Fewer crime, higher score).



Step 6. Change **Symbology**: Right click on the layer → properties → Quantities (Graduated colors), select Sc_Incident in Value Field. Finally, choose an appropriate Color Ramp and then add map elements.



LAYER 2: POLICE STATION

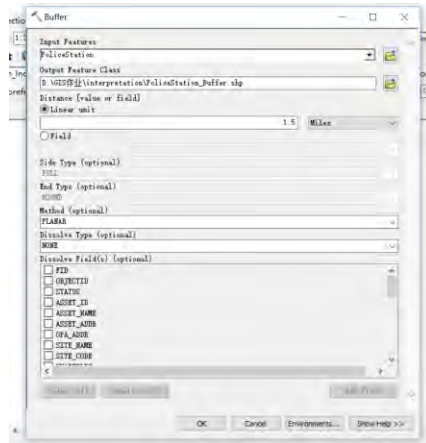


In this section, I will evaluate the police power and the safety level in and out the region controlled by police stations. According to my criteria, the regions controlled by police station are safest. In the area out of the control of police station, the fewer the crimes, the safer the census tract is.

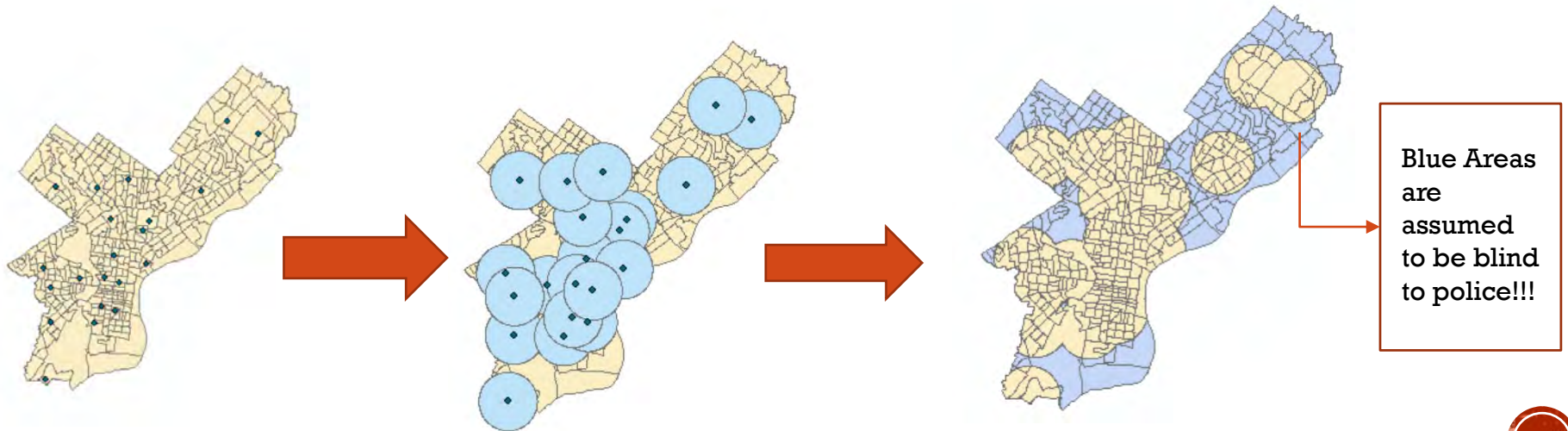
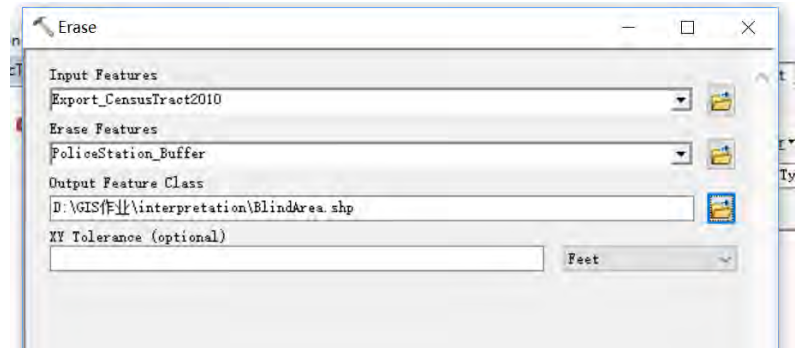


2.1 POLICE STATION

Step 1. Make a buffer around the police stations for 1.5 miles (Police Region → Safer!) by using ArcToolbox → Analysis Tools → Proximity → **Buffer**.

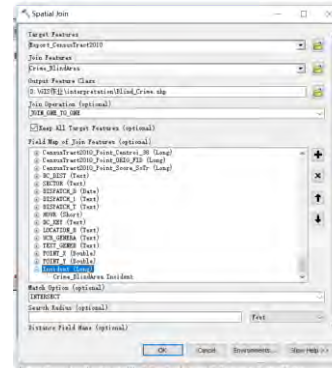
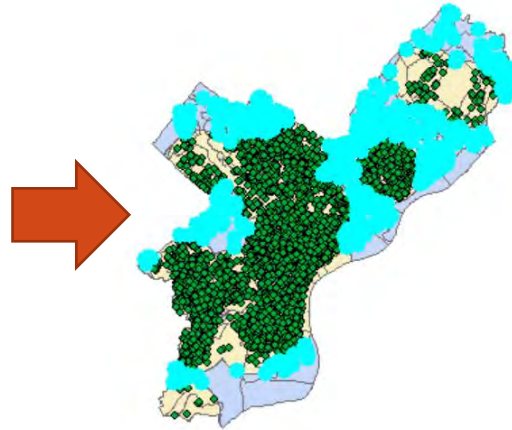
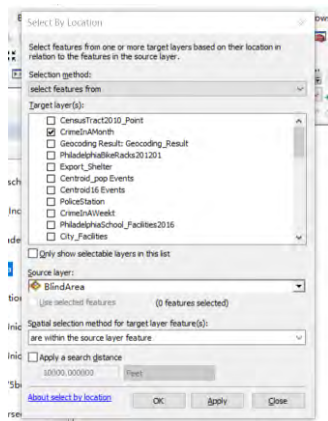


Step 2. Erase the buffer layer from the census tract layer to get the area out of the region of police stations. Using ArcToolbox → Analysis Tools → Overlay → **Erase**.



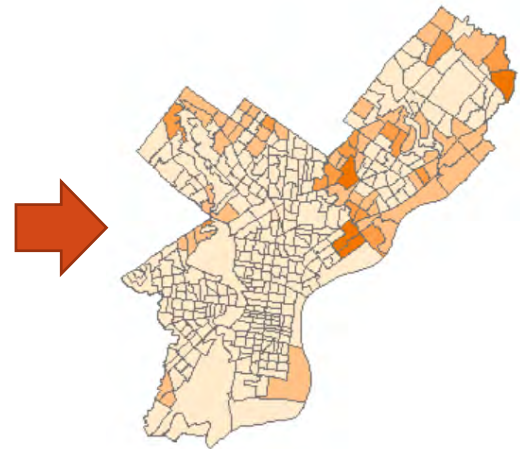
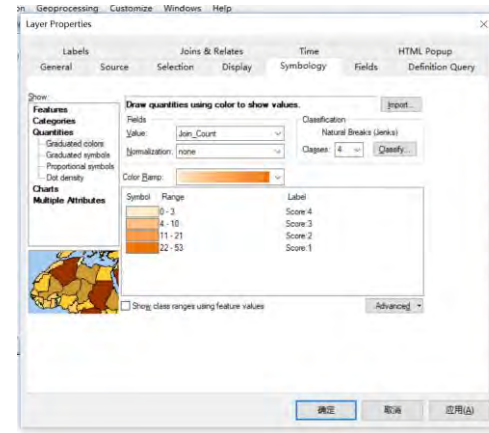
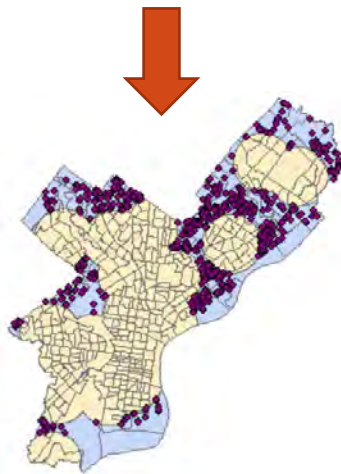
2.2 POLICE STATION

Step 3. Select the crimes happened in the area out of police control by using selection → select by location. Method is “are within the source layer feature”. Then, export the selected data.



Blind_Crime				
FID	Shape	Join_Count	TARGET_FID	Q
0	Polygon	0	0	
1	Polygon	0	1	
2	Polygon	0	2	
3	Polygon	0	3	
4	Polygon	0	4	
5	Polygon	0	5	
6	Polygon	0	6	
7	Polygon	0	7	
8	Polygon	0	8	
9	Polygon	0	9	
10	Polygon	0	10	
11	Polygon	0	11	
12	Polygon	0	12	
13	Polygon	0	13	
14	Polygon	0	14	
15	Polygon	0	15	

Step 5. Properties → Quantities → Color → Joint_Count for Value with 4 classes



2.3 POLICE STATION

Step 6. Add a field in the attribute table for scoring. Then, using select by attributes to distinguish the 4 classes of scoring. For the selecting features, use field calculator to give them scores (More incidents, lower score!)

The image is a collage of screenshots from the QGIS interface, showing various dialog boxes and a data table.

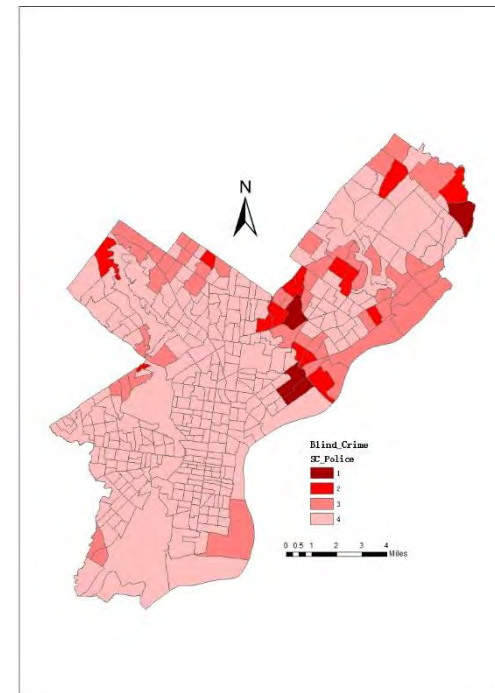
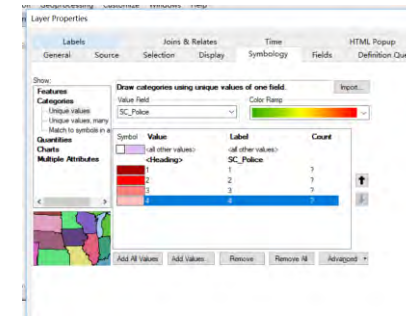
Add Field Dialog: Shows the process of adding a new field named "SC_Police" of type "Long Integer" with a precision of 10.

Select by Attributes Dialog: Shows the process of selecting records based on the condition "Join_Count" >= 22 AND "Join_Count" <= 53.

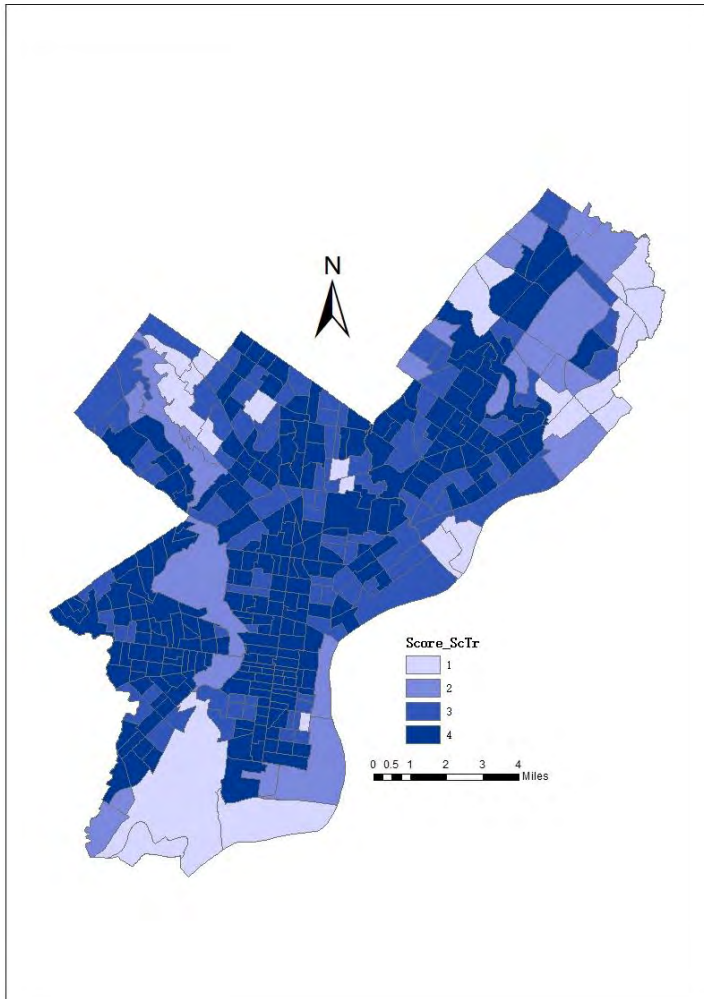
Field Calculator Dialog: Shows the process of calculating the value for the "SC_Police" field, with the expression "1" entered.

Data Table: A table with two columns: "Incident" and "SC_Police". The "Incident" column contains values from 0 to 21, and the "SC_Police" column contains values from 0 to 4.

Step 7. Change Symbology: Right click on the layer → properties → Categories (Unique Values), select SC_Police in Value Field. Finally, choose an appropriate Color Ramp and add basic map elements.



LAYER 3: ACCESSIBILITY TO BUS SHELTER AND SCHOOL



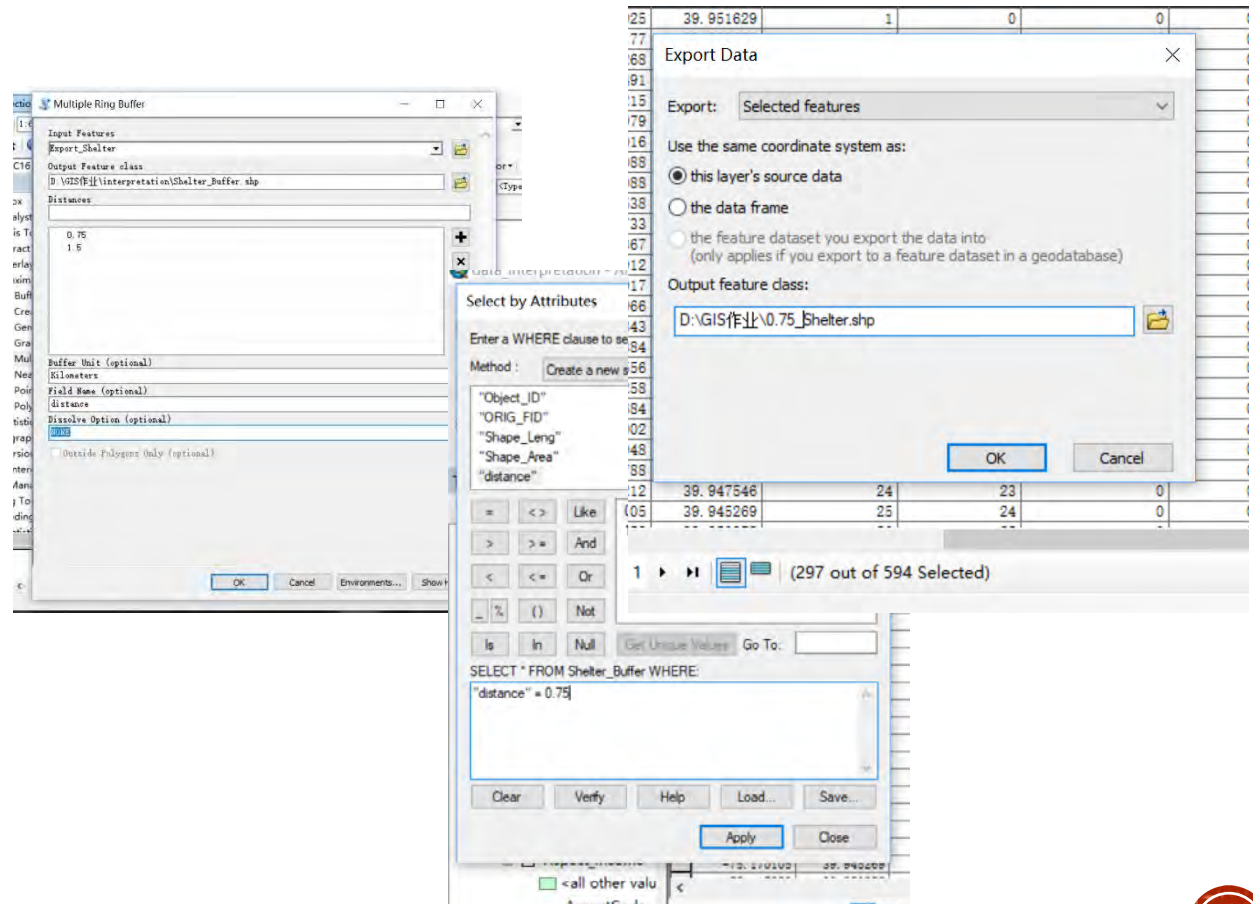
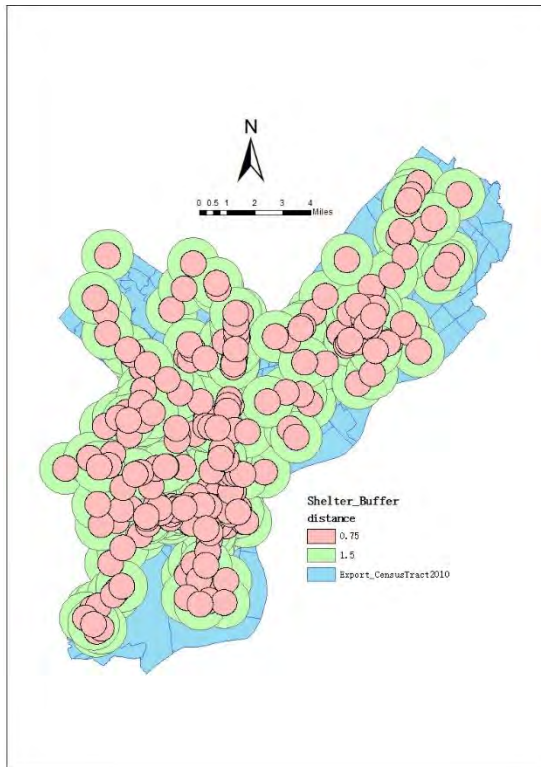
The higher accessibility to bus shelters could encourage people to get to the shop due to the convenience of using public transit. What's more, the higher accessibility to schools means a large pool of potential consumers. So, in this section, I tried to evaluate the accessibility to both bus shelters and schools comprehensively.



3.1 ACCESSIBILITY TO BUS SHELTER AND SCHOOL

Step 1. Buffer (Multiple Ring)

ArcToolbox → Analysis Tools → Proximity → Multiple Buffer Ring. Make 0.75 and 1.5 kilometers buffers of the SEPTA bus shelters of the whole Philadelphia. Then, Table Option → Select by Attributes → Data → Export Data to export data separately.



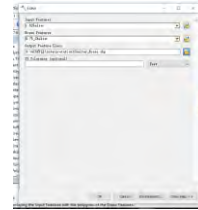
3.2 ACCESSIBILITY TO BUS SHELTER AND SCHOOL

Step 2. Erase the buffers by ArcToolbox → Analysis Tools → Overlay → Erase
Then, the outcome is the buffer between 0.75km and 1.5km.

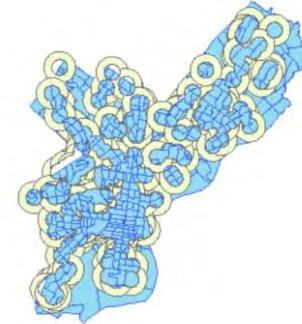
- 1.5km Buffer



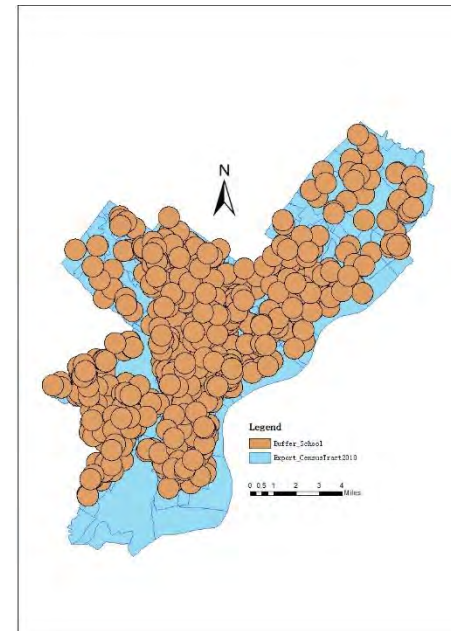
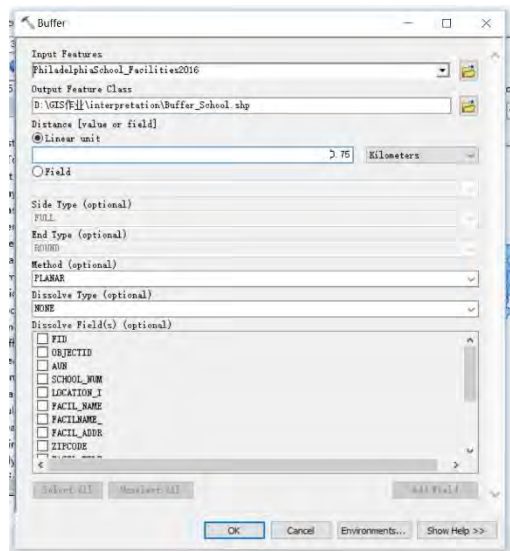
- 0.75km Buffer



- 0.75-1.5km Buffer

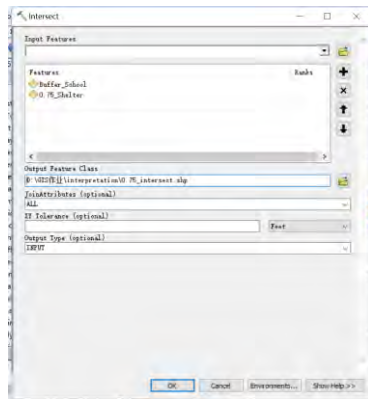


Step 3. ArcToolbox → Analysis Tools → Proximity → Buffer. Buffer the school facilities for 0.75km.

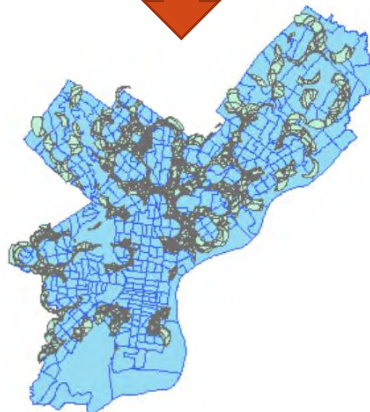
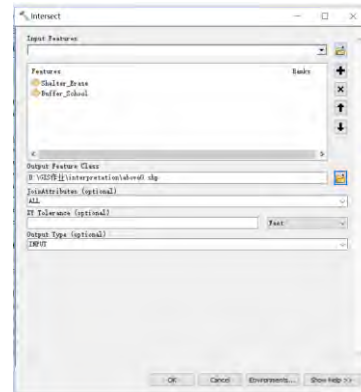


3.3 ACCESSIBILITY TO BUS SHELTER AND SCHOOL

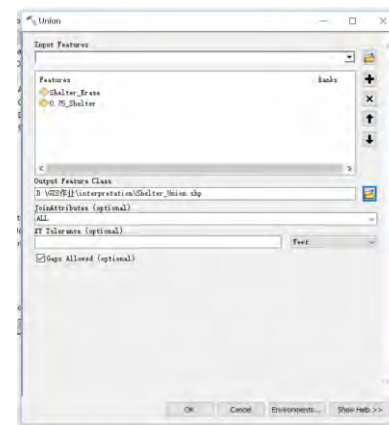
Step 4. Intersect buffers of bus shelter and school facilities: ArcToolbox → Analysis Tools → Overlay → Intersect. Then, export the intersected parts separately.



Score4: 0.75km intersect

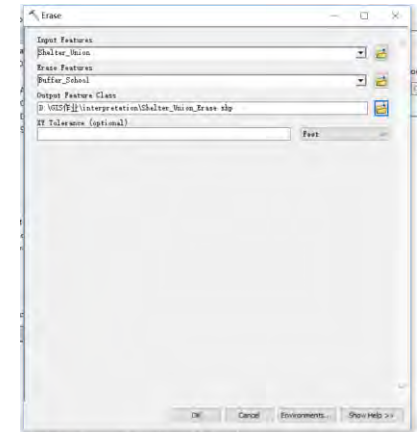


Score 3: 0.75-1.5km intersect



Score 2: 0.75-1.5km (out of school buffer)

Step 5. Union 0.75 and 0.75-1.5km buffers: ArcToolbox → Analysis Tools → Overlay → Union. Then, erase the school_buffer from the unioned feature.



3.4 ACCESSIBILITY TO BUS SHELTER AND SCHOOL

Step 6. Feature to Point. By use ArcToolbox → Data Management Tools → Features → Feature to Points



Step 7. Select by location & Field Calculation

Use selection → select by location with the target layer as census tract point shapefile, and source layer as the intersect layers did before. Then add a new field of the score of the accessibility. Give the census tract of these 3 layers 4, 3 and 2. The rest census tracts will get 1.

Select By Location

Select features from one or more target layers based on their location in relation to the features in the source layer.

Select method: Select features from

Target layer(s):

- ☒ CensusTract2010_Point
- ☐ CensusTract2010
- ☐ Geocoding Result
- ☐ PhiladelphiaBikeR
- ☐ Export_Shelter
- ☐ Centroid_pop_Eve
- ☐ Centroid_16_Events
- ☐ PoliceStation
- ☐ CensusWeek
- ☐ PhiladelphiaSch
- ☐ City_Facilities

Source layer: 0.75_Intersection

Spatial selection method for target layer feature(s): are within the source layer feature

Apply a search distance: 20000.000000 Feet

Add Field

Name: Score_ScTr

Type: Long Integer

Field Properties: Precision: 10

Field Calculator

Parser: VB Script Python

Fields:

- FID
- Shape
- Export_Cen
- Export_C_1
- Export_C_2
- Export_C_3
- Export_C_4
- Export_C_5
- Export_C_6

Type: Number String Date

Functions:

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

Score_ScTr = 4

Select By Attributes

Enter a WHERE clause to select records in the table window.

Method: Create a new selection

Expression: Score_ScTr = 4

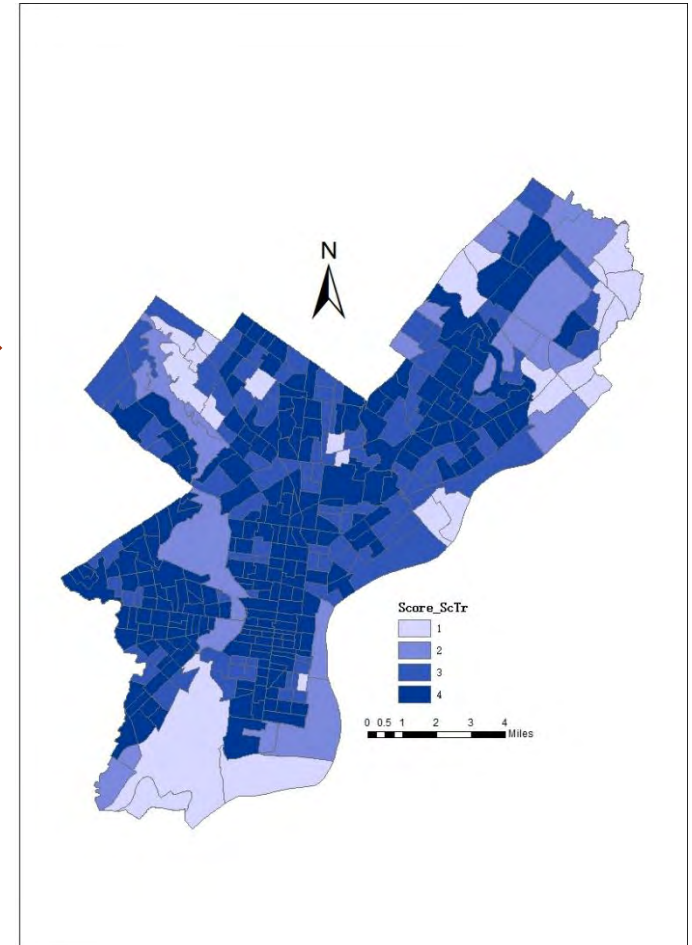
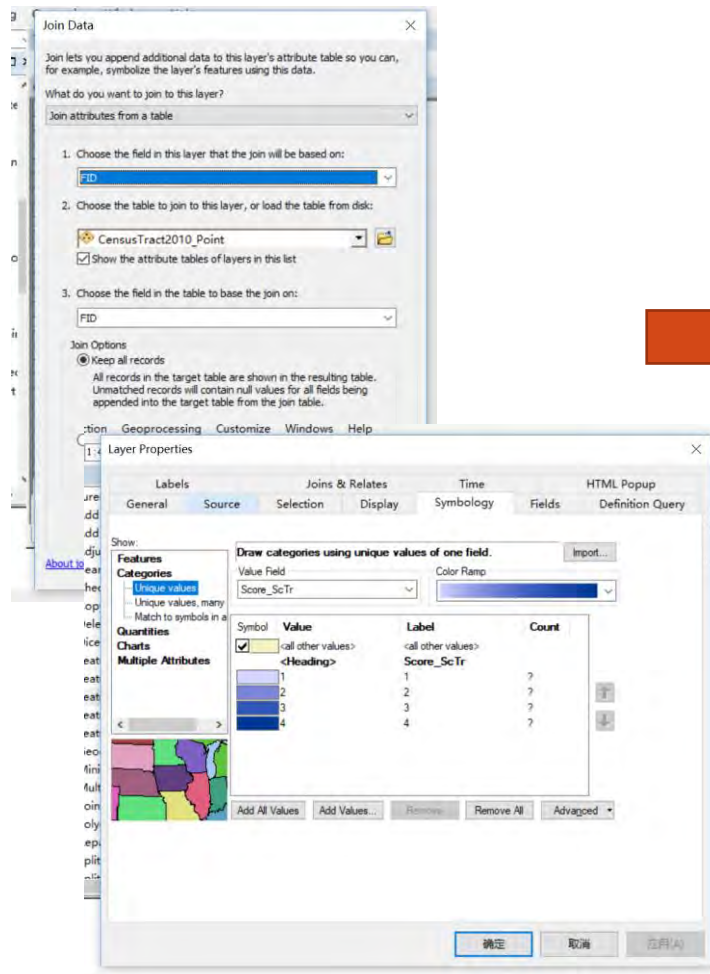
Table

CensusTract2010_Point

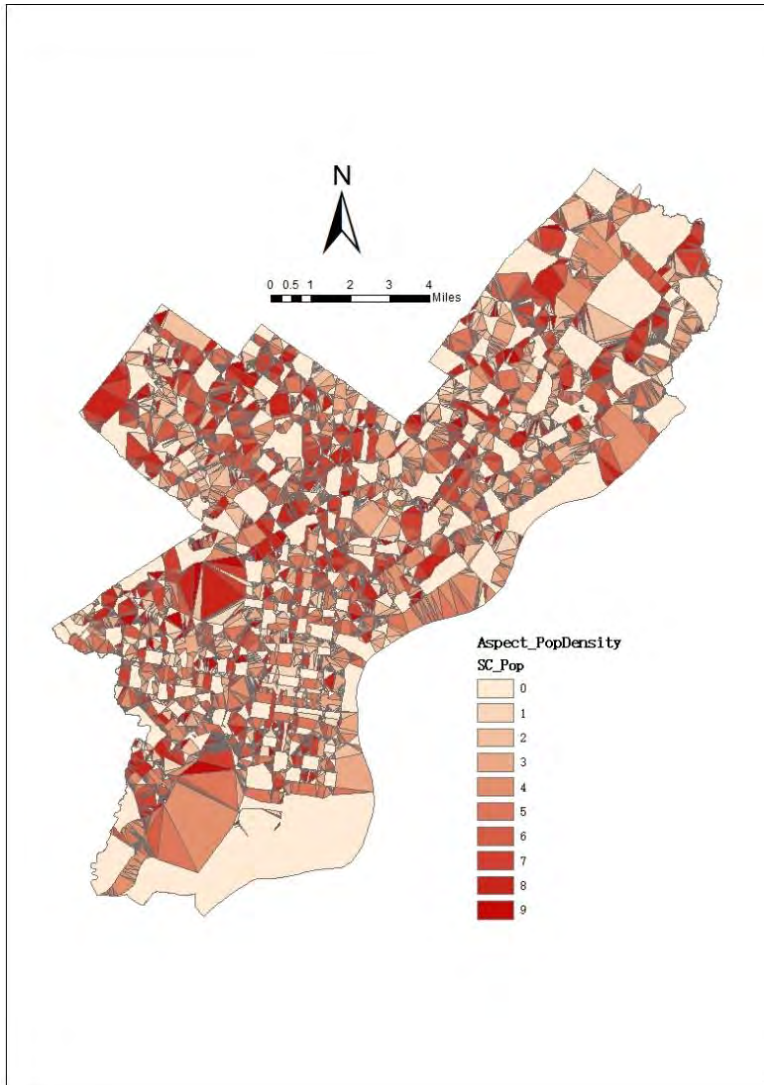
CensusTract2010_Point	ORIG_FID	Score_ScTr
7051	34	4
2008	53	4
2662	56	4
4039	57	4
4472	58	4
1597	59	4
3728	60	4
3846	61	4
2599	62	3
2926	63	4
2083	64	4
4966	65	4
2744	66	4
7219	67	4
2688	68	3
6183	69	4
6721	70	3
9964	71	3
2441	72	3
3710	73	4
4338	74	4
2687	75	4
1627	76	4
2603	77	4
6234	78	4

3.5 ACCESSIBILITY TO BUS SHELTER AND SCHOOL

Step 8. Use Join and relate → Join to join the census tract point table to the census tract attribute table. Then, symbologize the map based on the score of the accessibility (Score_ScTr).



LAYER 4: POPULATION (DENSITY)



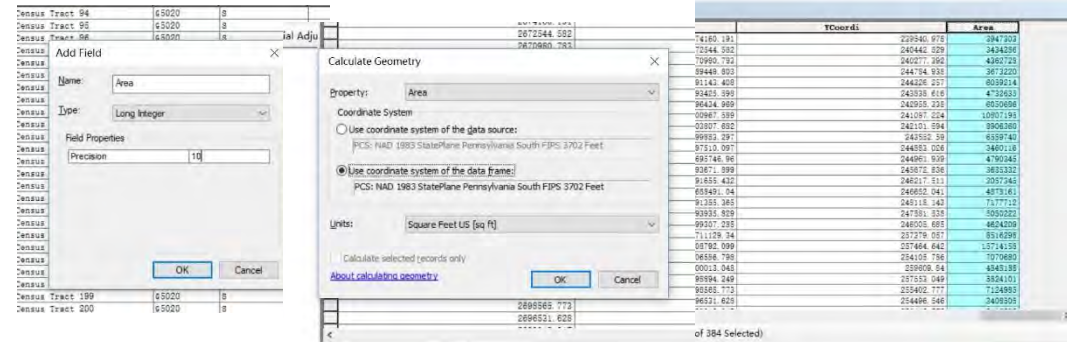
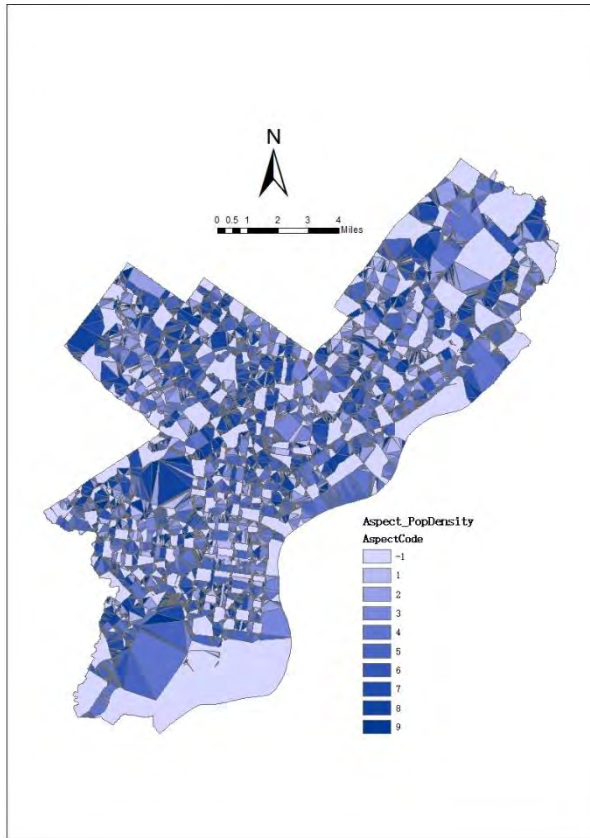
In this section, I will evaluate not only the population density itself, but also the direction of change of the population density. In fact, if a census tract has high population density and have a largely positive tendency to keep growing, the pool of the potential consumers would be very large and it's good for opening a new shop there.



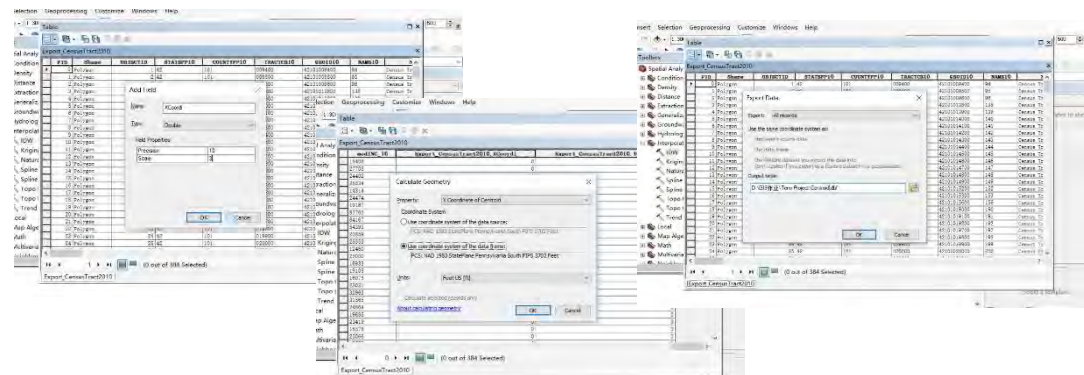
4.1 POPULATION (DENSITY)

From the surface aspect measure, I can know what direction the population density will change.

Step 1. Area & Field Calculation. Firstly, add a new field in the attribute table of census tract layer for Area of each census tract. Then, right click on the field → Calculate Geometry to get the area numbers (in square feet).



Step 2. Create Centroid. Firstly, add two new fields (XY coordinates) to generate the centroids. Then, right click on both fields → Calculate Geometry to get the result, and export it as a new dbf file. Finally, right click the table → Display XY data to get a map of centroids.

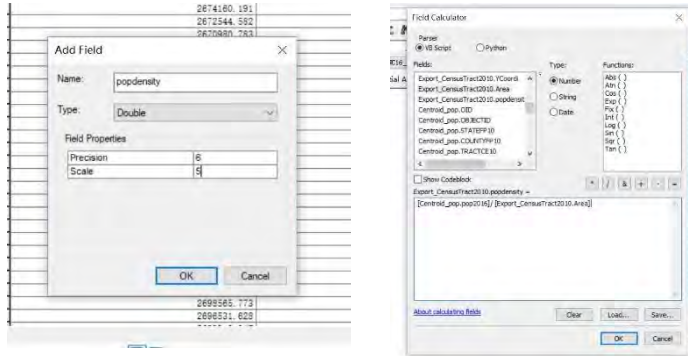


- Surface Aspect of Population Density

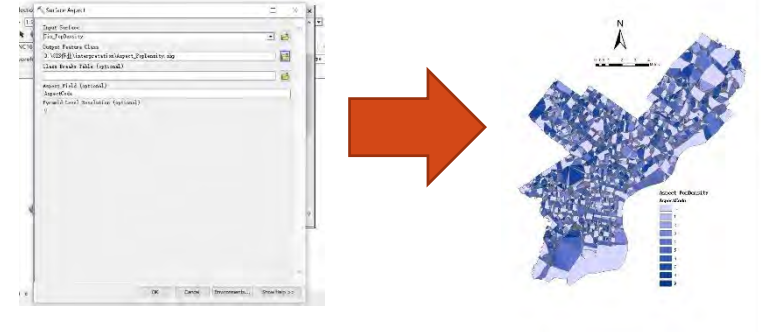


4.2 POPULATION (DENSITY)

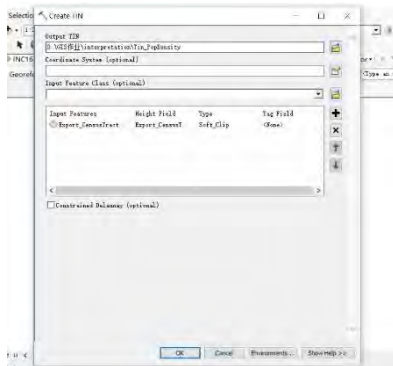
Step 3. Add a new field in the attribute table called popdensity. By using Field Calculator, I divided population by area to get the density of population in each census tract.



Step 5. Based on the TIN of pop density, I used ArcToolbox → 3D Analyst Tools → Triangulated Surface → **Surface Aspect** to get the Aspect layer of pop density.

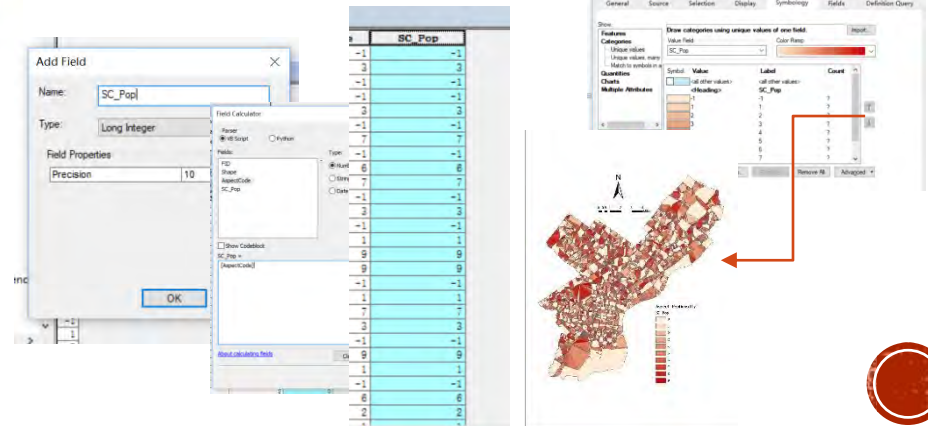


Step 4. Create TIN of pop density: ArcToolbox → 3D Analyst Tools → Data Management → TIN → Create TIN.

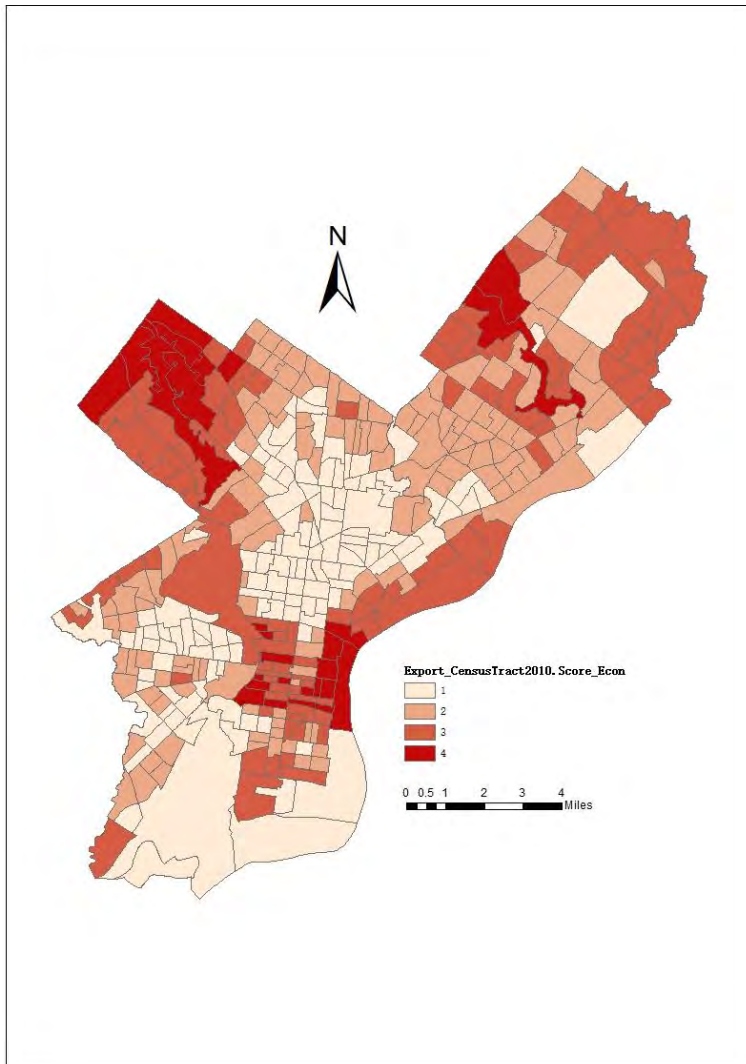


- TIN of pop density

Step 6. Through the aspect, I know what direction the population density will change. So, I score the population density based on the legend of the aspect layer except set -1 to 0. More dense the area is, larger market and more opportunities there is. Add a new field of the score and set the score equal to the aspect number. Change Symbology based on the score.



LAYER 5: ECONOMY (MEDIAN HH INCOME)



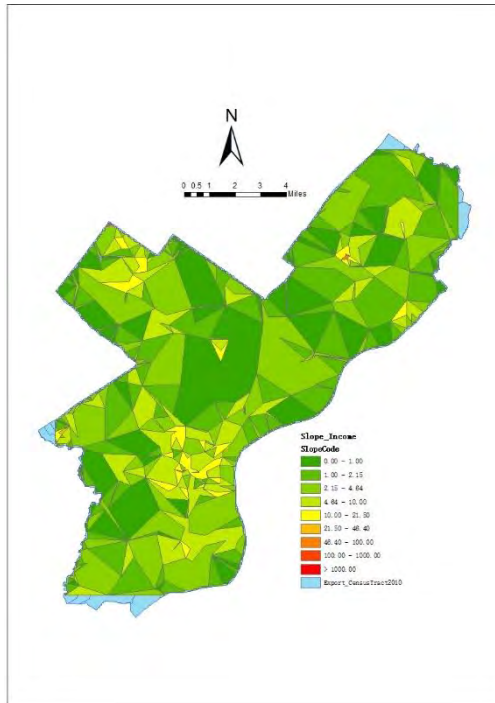
In this section, I will evaluate the economic level of each single census tract in Philadelphia. Although many factors could be used, I would only use median household income to evaluate the specific number for each census tract, and the extent and direction it would change. In fact, if a census tract has high median household income and have a largely positive tendency to keep growing, the purchase power would be very high among the local residents. So, it would be easy to sell the goods.



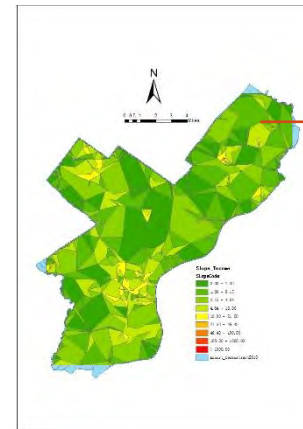
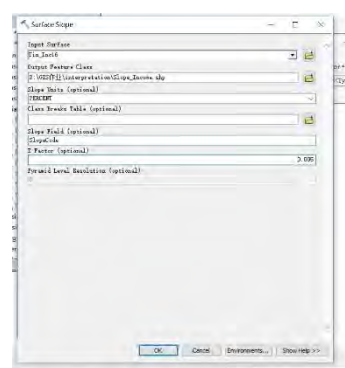
5.1 ECONOMY (INCOME): SLOPE AND ASPECT

From the surface slope measure, I can know what extent the income varies and how the extent changes.

Step 1. Create TIN from IDW of median household income layer. After getting the clipped IDW map of Income from data preparation, use ArcToolbox → 3D Analyst Tools → Conversion → From Raster → Raster to TIN to create the TIN graph for median household income.



Step 2. Based on the TIN layer, I used ArcToolbox → 3D Analyst Tools → Triangulated Surface → **Surface Slope** to get the Slope layer of median household income of all census tracts of Philadelphia.



The larger the slope is, the larger the extent would change!!!

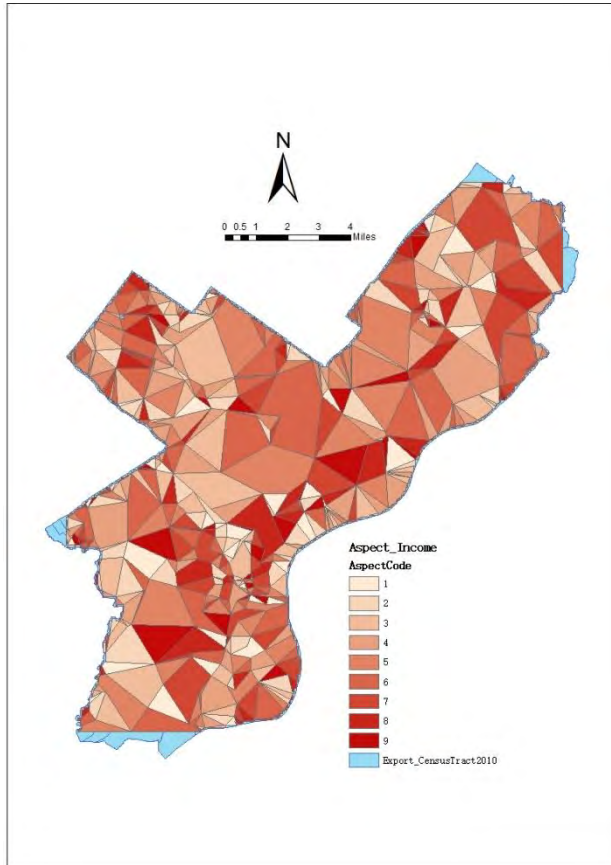
- Surface slope of Income



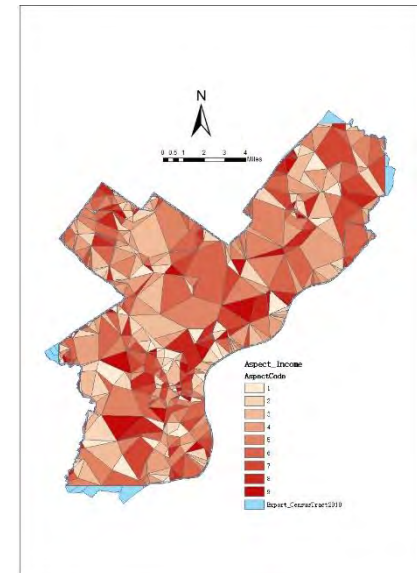
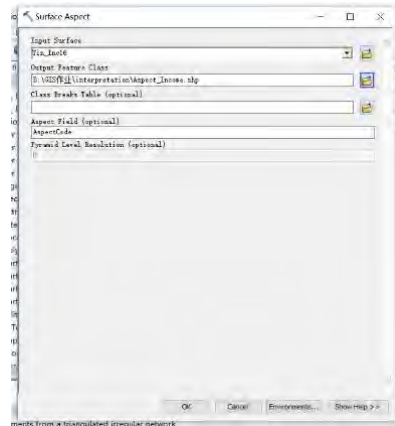
5.2 ECONOMY (INCOME): SLOPE AND ASPECT

From the surface aspect measure, I can know what direction the Income will change.

Step 3. Based on the TIN layer, I used ArcToolbox → 3D Analyst Tools → Triangulated Surface → **Surface Aspect** to get the Aspect layer of median household income of all census tracts of Philadelphia.



- Surface Aspect of Income



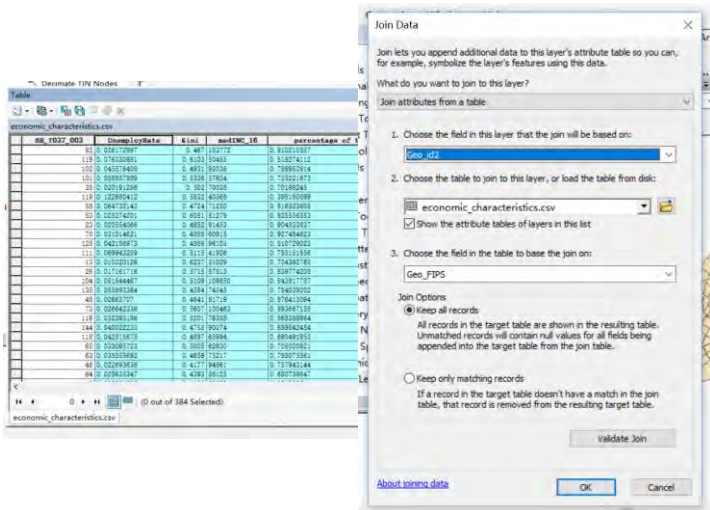
Step 4. **Change to appropriate symbologies** by right click the layers → properties → symbology to both the slope and aspect layers. According to the AspectCode, income will change to the direction that the color becomes darker.



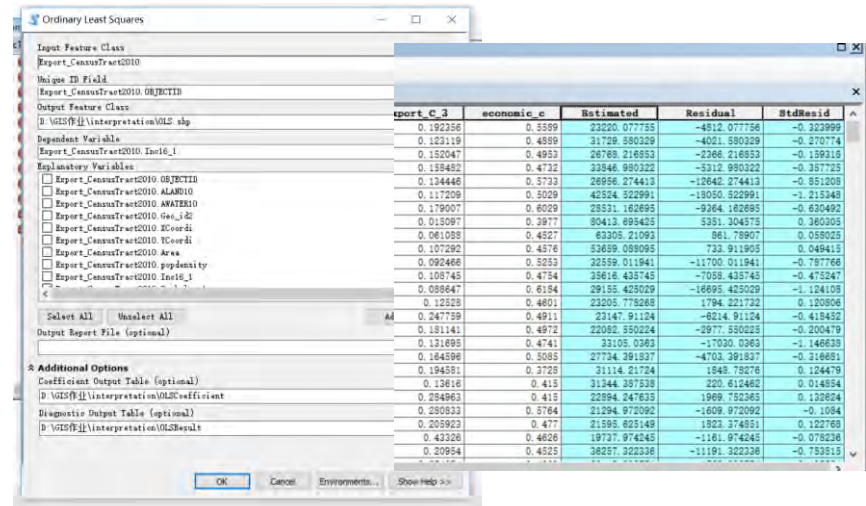
5.3 ECONOMY (INCOME): REGRESSION

In order to assess the economy of the census tracts of Philadelphia, I choose Median Household Income as the standard. However, there are many other characteristics also may affect the economic level of the county. So, I ran an OLS regression model to check if the median household income is highly correlated to them, which are unemployment rate, Gini Index (economic inequality) and percentage of people who attained bachelor or high for education.

Step 1. Getting the csv files of selected economic characteristics from Social Explorer, and combining them together. Then, add the csv file to ArcMap. After that, join the csv file to the attribute table.



Step 2. Run the OLS Regression by ArcToolbox → Spatial Statistics Tools → Modeling Spatial Relationship → Ordinary Least Square. Set median household income as dependent variable and unemployment rate, Gini Index, Percentage of people who get bachelor degree or higher as explanatory variables. Then, I got the estimated value, residuals and standard deviations.



5.4 ECONOMY (INCOME): REGRESSION

- OLS Coefficient Output Table

Variable	Coef	StdError	t-Stat	Prob	Robust SE	Robust t	Robust Pr	StdCoef
Intercept	45409.51064	4043.422844	11.230484	0	9736.479652	4.683553	0.000000	0
EXPORT_CENSUSTRACT2010_BACHELOR_1	72479.200468	4396.089547	16.487198	0	5853.730444	12.173746	0	0.72012
EXPORT_CENSUSTRACT2010_UNEMPLOYMB	-27286.276621	11812.535849	-2.309942	0.021414	14846.993326	-1.937844	0.0665	-0.098213
ECONOMIC_CHARACTERISTICS_CSV_GINI	-42137.977875	9135.232212	-4.612677	0.000007	19093.243706	-2.209109	0.027551	-0.165725

From the OLS Coefficient Output Table, I got the coefficient of the explanatory variables to the dependent variable, which shows that unemployment rate and Gini Coefficient have largely negative relations to median household income, but the education attainment has a largely positive relation to income. What's more, I also got the values of robust standard error, robust T-test and robust probability in the table.

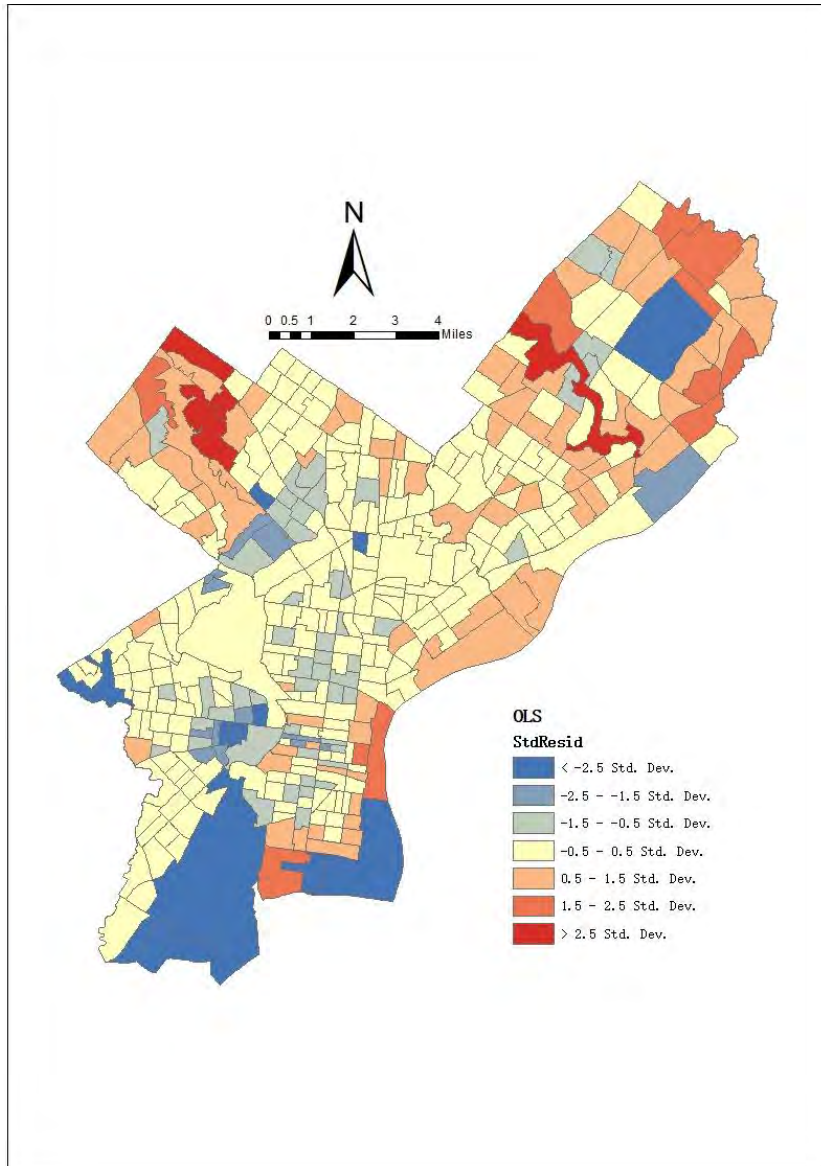
- OLS Diagnostic Output Table

OID	Field1	Diag_Name	Diag_Value
0	AIC	Akaike's Information Criterion: A	8451.005111
1	AICc	Corrected Akaike's Information Cri	8451.104262
2	R2	R-Squared, Coefficient of Determin	0.581067
3	AdjR2	Adjusted R-Squared: R-Squared adju	0.577751
4	F-Stat	Joint F-Statistic Value: Used to s	175.226528
5	F-Prob	Joint F-Statistic Probability (p-v	0
6	Wald	Wald Statistic: Used to assess ove	329.106911
7	Wald-Prob	Wald Statistic Probability (p-valu	0
8	K(BP)	Koenker's studentized Breusch-Page	60.541907
9	K(BP)-Prob	Koenker (BP) Statistic Probability	0
10	JB	Jarque-Bera Statistic: Used to det	377.804201
11	JB-Prob	Jarque-Bera Probability (p-value):	0
12	Sigma2	Sigma-Squared: OLS estimate of the	220586296.505

From the OLS Diagnostic Output Table, I got the values of R-square and Adjust R-square which are both around 0.58, which means that about 58% of dependent variables data could be explained by the explanatory variable data. Thus, to some extent, the independent variables fit the model well, and it's a good model.



5.5 ECONOMY (INCOME): REGRESSION



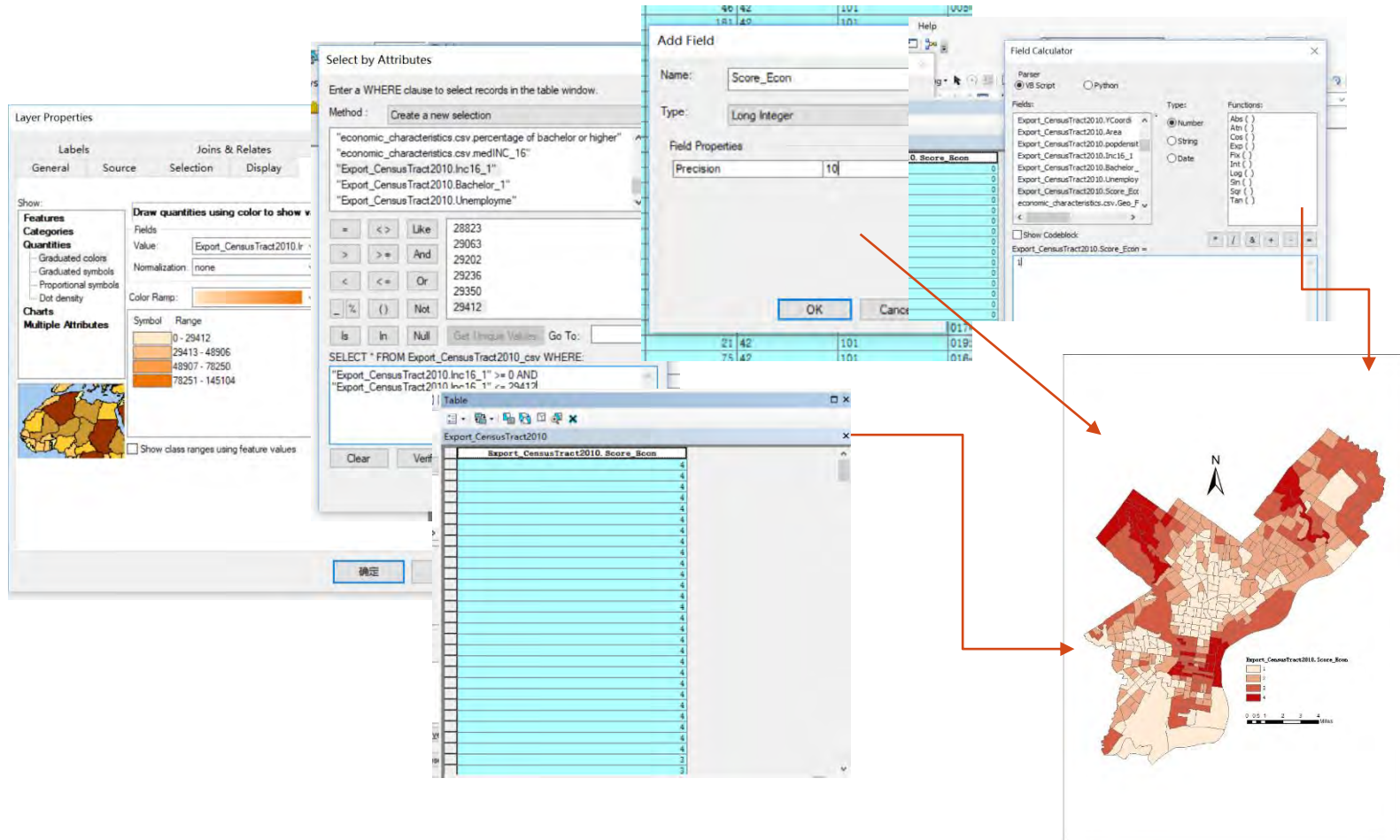
Summary

It's the outcome map for OLS regression! The symbology is based on the distance (how many standard deviations) between the data to the mean value.

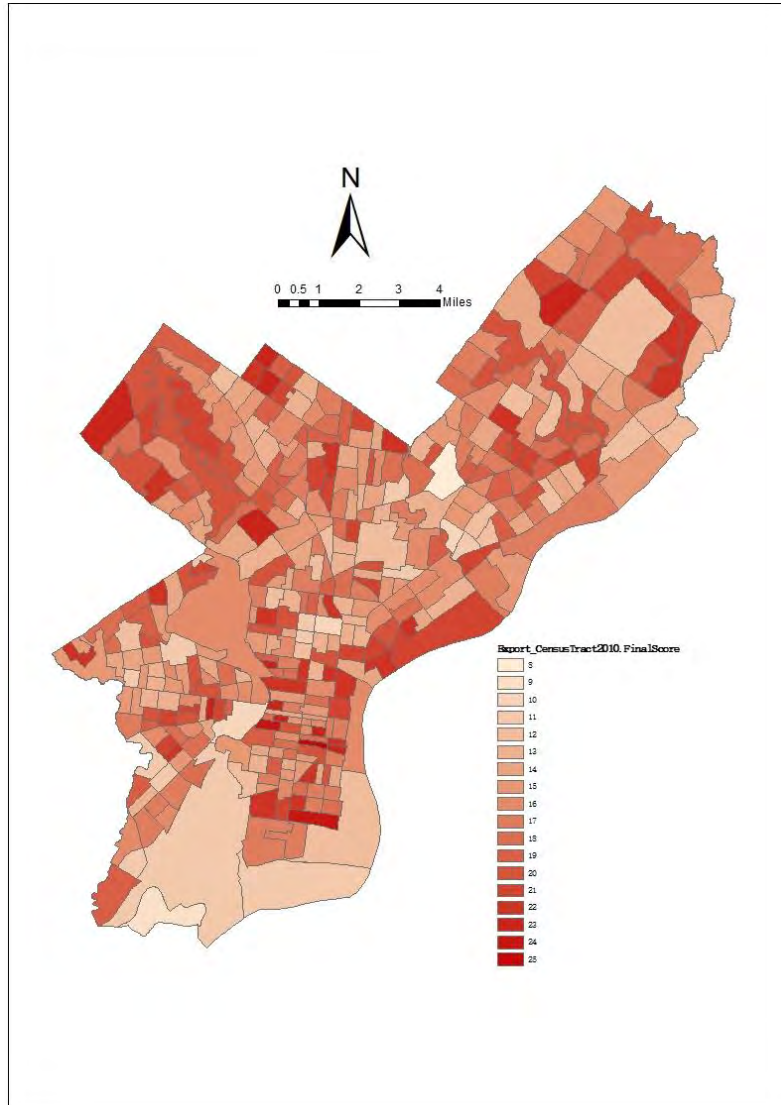


5.6 ECONOMY (INCOME): SCORING

As did before in the section of crime and accessibility to bus shelters and schools, I firstly use layer properties to determine the standard of scores. Then, I add a new field for scoring in the attribute table and then use select by attribute and field calculator to give scores to the field. Finally, based on the scores, I change the symbology for the map.



LAYER 6. RESULT (FINAL SCORE)



In this section, I would combine the scores of the 5 topics I discussed before to generate the final score for opening a new shop within each census tract. The higher the score, the better to open the shop.



6.1 RESULT (FINAL SCORE)

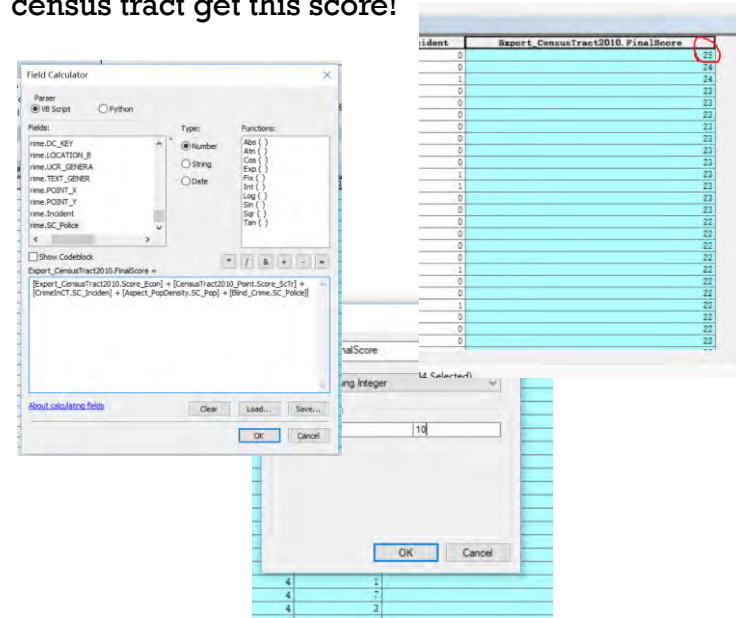
Step 1. Join all tables with related scores to the attribute table census tract shapefile to get scores of Crime Incidents, Population Density, Accessibility to Bus Shelters and Schools, Police Power (Police Stations) and Economy (Median Household Income).

The image shows a sequence of steps in ArcGIS Desktop. On the left, the 'Join Data' dialog box is open, showing the process of joining a table to a layer. The dialog is configured to join the 'Blind_Crime' table to the 'CriminCT' layer, using 'FID' as the join field. The 'Join Options' are set to 'Keep all records'. A large orange arrow points from the dialog box to the right, where a 'Table' window is open. This window displays the joined data, showing columns for 'BC_Inciden', 'BC_Police', 'BC_Pop', 'Export_CensusTract2010_Score_Sum', 'Score_BcTr', and 'FID'. The table contains 384 rows of data, with the first few rows showing values for the joined attributes.

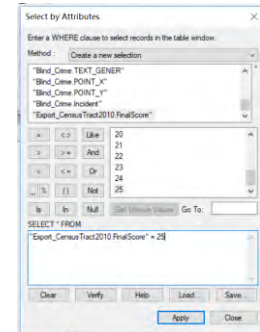
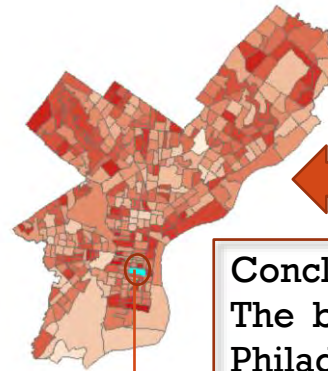
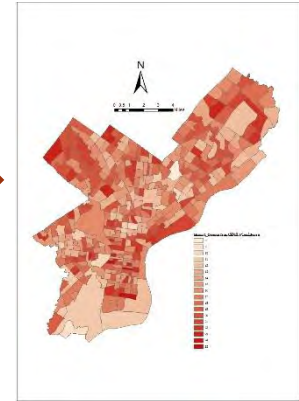
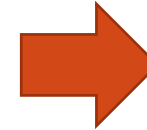
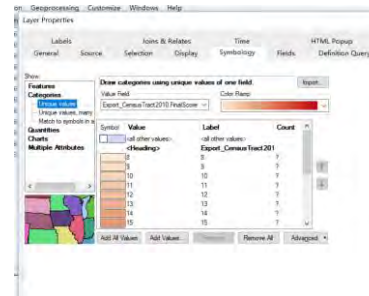
BC_Inciden	BC_Police	BC_Pop	Export_CensusTract2010_Score_Sum	Score_BcTr	FID
4	4	0	1	4	1
3	4	0	1	2	2
3	4	0	1	4	3
3	4	0	1	4	4
3	4	0	1	4	5
3	4	0	1	4	6
3	4	0	1	4	7
3	4	0	1	4	8
3	4	0	1	4	9
3	4	0	1	4	10
3	4	0	1	4	11
3	4	0	1	4	12
3	4	0	1	4	13
3	4	0	1	4	14
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3	4	0	1	4	26
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3	4	0	1	4	287

6.2 RESULT (FINAL SCORE)

Step 2. Add a new field for Final Score. Then, use Field Calculator to get the sum of the scores of these 5 classes, which is the final score of each census tract. According to the range of each score criteria, the range of the final score would be 4-26. The highest score among all census tract is 25 and only one census tract get this score!



Step 3. Based on the final score, properties → symbology to make a good map for the Final Score. After that, use Select by Attribute and set the final score = 25 to find the location of that “best” census tract for opening a new shop.



Conclusion:
The best census tract in Philadelphia for opening a new shop is **Census Tract 18!!!**

COUNTYFP10	TRACTCB10	GBOID10	NAME10	NAME10AD10	MTCPC10	FUNCTST10
101	001800	42101001800	18	Census Tract 18	65020	S
101	001201	42101001201	12.01	Census Tract 12.01	65020	S
101	0037200	421010037200	372	Census Tract 372	65020	S
101	0020600	421010020600	206	Census Tract 206	65020	S
101	001700	42101001700	17	Census Tract 17	65020	S
101	000401	42101000401	4.01	Census Tract 4.01	65020	S



6.3 RESULT (FINAL SCORE): SUMMARIZE

Finally, I want to statistically **summarize** the output of the final score. Right click on the head of the field of final score → summarize to get the mean values and standard deviations of the 5 scores, and also the situation of the final score. What's more, from the field Count_FinalScore, I get the information as before that there's only one census tract which get the highest score: 25.

Summarize

Summarize creates a new table containing one record for each unique value of the selected field, along with statistics summarizing any of the other fields.

1. Select a field to summarize:

Export_CensusTract2010.FinalScore

2. Choose one or more summary statistics to be included in the output table:

- ☐ Export_CensusTract2010.Bachelor_1
- ☐ Export_CensusTract2010.Unemployeme
- ☐ Export_CensusTract2010.Score_Econ
- ☐ Minimum
- ☐ Maximum
- ☒ Average
- ☐ Sum
- ☒ Standard Deviation
- ☐ Variance

3. Specify output table:

D:\GIS\作业\interpretation\Sum_Final.dbf

☐ Summarize on the selected records only

[About summarizing data](#) OK Cancel

FinalScore	Count_FinalScore	Average_Score_Scon	StdDev_Score_Scon	Average_Score_ScTr	StdDev_Score_ScTr	Average_SC_Inciden
8	1	2	0	3	0	
9	1	1	0	1	0	
10	3	1.2333	0.5774	3	1	
11	13	1.1538	0.2755	3	1.0801	2.848
12	17	1.5294	0.7174	2.8824	1.1663	3.178
13	33	1.6384	0.7424	3.2424	1.0317	3.575
14	33	2.0303	0.919	3.3636	0.9293	4.080
15	47	2	0.9089	3.5219	0.778	3.508
16	44	2.0485	0.9614	3.3636	0.9904	3.651
17	35	2.0288	0.9907	3.4288	0.7391	3.628
18	33	2.1818	0.9828	3.697	0.5855	4.212
19	29	1.921	0.9232	3.6552	0.7209	4.103
20	32	2.3438	0.937	3.4375	0.8007	4.2
21	25	2.32	0.8524	3.4	0.9129	4.129
22	24	2.625	0.8242	3.625	0.7109	4.416
23	11	2.9091	0.9439	3.8182	0.4045	4.909
24	2	3.5	0.7071	4	0	4
25	1	4	0	4	0	



Thanks for Reviewing!

