Geospatial Analysis of Crime Statistics in Detroit, MI Areas

Relating Data on Crime with Neighborhoods, Zip Codes, and Grocery Stores

September 28, 2023

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Introduction and Methods

By request of the City of Detroit, Michigan, this project seeks to generate geospatial data and visualizations of the crime statistics in Detroit, Michigan. The data utilized includes 4 shapefiles. The first is a vector polygon comprising the city's 205 neighborhoods, and the second is also a vector polygon consisting of the 31 zip code areas. The third shapefile is a vector point of 74 Detroit grocery stores, and the fourth is a vector point of the crime incidents that occurred in Detroit, modified to only 2021 crimes.

The data will be employed for geospatial analysis– mainly producing visual maps of Detroit sectioned by neighborhoods and zip codes that contain information about safety levels in Detroit areas by crimes. Using the projected shapefile on crimes in 2021, the 2 maps of the city's neighborhoods and zip codes will flag areas with the highest and lowest levels of crime. The final map will exhibit half mile and mile radii around each of the grocery stores found in the relevant shapefile. Then, filtering the crime data for robberies, analysis will be done to determine the number of robberies occurring within the given radii.

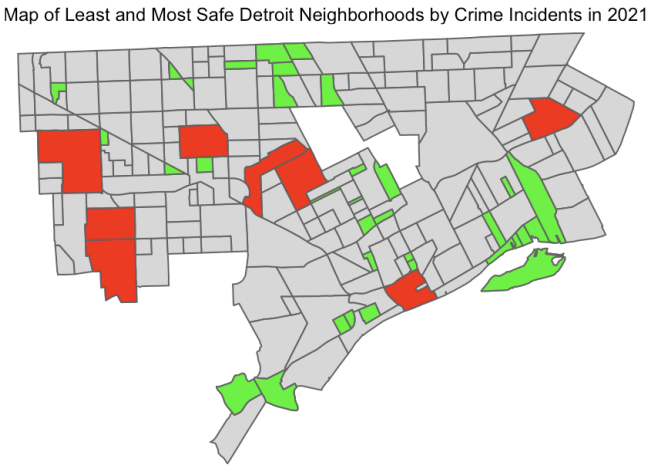
The shapefiles were first all read in and projected via "st_read()" and "st_transfom()". In Task 1, for the creation of the 2 maps (of both neighborhoods and zip codes), the "st_within()" function was used to map the number of crimes in 2021 over the neighborhoods and zip codes data, creating a boolean matrix. Then, the "apply()" function was utilized to tally the number of "TRUE" values, or the number of crimes that occurred in each neighborhood and each zip code. The "cbind()" functions were necessary to join the counted "TRUE" values to neighborhoods and zip codes datasets. Next, the combined data was filtered for neighborhoods with crimes less than 100 or greater than 1200, and zip codes less than 1000 and greater than 5000. Finally, using the t_map library, the "tm_shape()" functions were employed to create 3 maps: one of the boundaries for the neighborhoods/zip codes, one for the neighborhoods/zip codes with the least crimes, and one for the neighborhoods/zip codes with the most crime. These maps were layered on top of each other for Detroit's neighborhood and zip code maps, resulting in the final two maps.

In Task 2, first the appropriate t_map functions were used to generate a map of Detroit and the locations of the 74 grocery stores from the grocery shapefile, and then the "st_buffer()" function was used to create 2 radii of 0.5 miles and 1 mile around each store. These 3 files were then layered into a final map that displayed the radii on a map of Detroit. Next, the same combination of "st_within()," "apply()" was used on the projected robberies and grocery buffer data to obtain the number of robberies within each radii for each grocery store. Next, "cbind()" was employed to bind the grocery store data with the robberies data within the given radii, and this data was cleaned to drop unnecessary columns. Finally, the "summary()" function was run on this dataframe to obtain descriptive statistics for the 2 robbery radii variables.

Findings

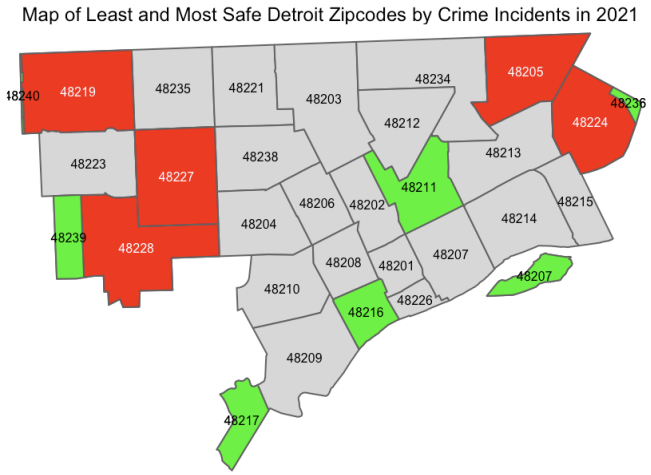
Task 1

Map 1



The first map created demonstrates the safest and most dangerous neighborhoods in Detroit measured by the number of crime incidents that occurred in each neighborhood in 2021. The regions that are colored green represent the safest neighborhoods by crime incidents, which have had less than 100 of these occurrences in 2021. The neighborhoods that are colored red represent the least safe or most dangerous neighborhoods by crime incidents, which have had more than 1200 of such happenings in 2021.

Map 2

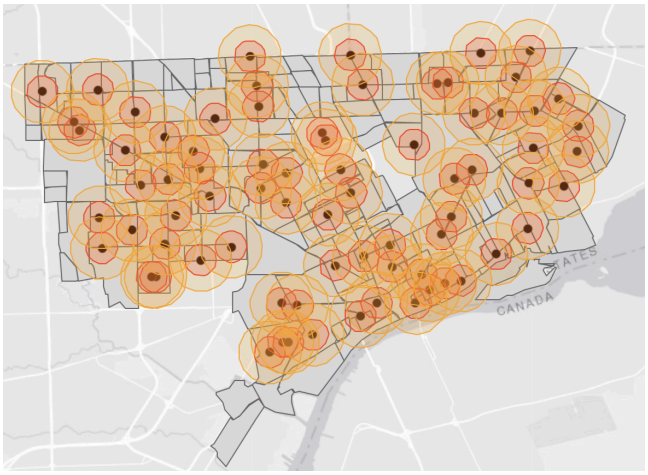


The second map generated exhibits Detroit's safest and most dangerous zip code areas, also measured by the number of crime incidents that occurred in each neighborhood in 2021. The zip code areas that are colored green belong to the safest regions by crime incidents, which sport less than 1000 of these events

in 2021. Conversely, the zip code areas that are colored red represent the most dangerous regions by crime incidents, identified by having over 5000 of such occurrences in 2021.

Task 2

Map 3



The third map is a visualization of the grocery stores in Detroit, which are the black symbols on the image. The map includes a representation of the half-mile and mile radii around each grocery store, with the half-mile radius colored red, while the mile radius is colored orange.This visualization was paired with data and statistics about the number of robberies in 2021 that fell within these 2 radii. The descriptive statistics are as followed:

	Robberies Within ½ Mile of Grocery Store	**Robberies Within 1 Mile of Grocery Store**
Minimum	0.00	6.00
First Quartile	5.25	21.25
Median	9.00	30.00
Mean	10.11	31.73
Third Quartile	14.00	39.75
Maximum	44.00	75.00

Observing some important values from the statistics, the minimum value for robberies within a 0.5 mile radius of the grocery stores is 0, while the maximum robbery count is 44. The mean is 10.11 robberies,

close to the median of 9. The minimum value for robberies within a 1 mile radius is 6, the maximum is 75, and the mean is 31.73 robberies, close to the median of 30.

Conclusions

The shapefiles consisting of zip code, neighborhood, and crime data were used to create maps of Detroit based on both neighborhood and zip code boundaries, and determine which areas had the highest and lowest numbers of crime incidents in 2021. Important functions included “st_transform()” to project the data, the “st_within()”, “apply()”, and “cbind()” functions to find the number of crime incidents in each region, and the t_map library functions to create the maps. Then, the shapefile on grocery store location data was used to pin-point the location of the 74 grocery stores in Detroit, and the “st_buffer()” function was used to create half-mile and mile radii around each grocery store, which were then layered along with the store locations onto a map visualize the radii around each grocery store in a geospatial context using the needed t_map functions. Finally, the crime incidents in 2021 data was filtered to only include robberies and “st_within()” and “apply()” were used to determine the number of robberies that fell into each of the radii. From there, the data on the number of robberies in each grocery store radii was binded to the original grocery store dataset using “cbind(),” and descriptive statistics via the “summary()” function and a cleaned dataset were obtained for the 2 radii variables.

Comparing the zip code and neighborhood maps of Detroit, it is evident that the northwest region of the city seems to have a larger number of crime incidents on both maps, with the 48227 and 48228 zip codes almost mirroring the red colored neighborhoods in the corresponding map. The northeast area also seems to have more crime incidents, as the 48224 and 48225 zip code areas are red, and there is a neighborhood in that region that is also red on the other map. The safer regions appear to be in the 48207 zip code and neighborhood region and the southern tip of the city when cross-referencing both maps. The 48211 zip code and the corresponding neighborhoods in the region also appear to have less crime incidents

Analyzing the grocery store and robbery statistics, it appears that there are a considerable (average of 31.73) robberies within a mile radius of each grocery store, with some as high as between 60 and 75 robberies. Of course, it is expected that the number of robberies would decrease as we reduce the radius around the grocery store, since if there is less area, the chances of covering an area with a robbery incident goes down. This is reflected in the “Robberies Within ½ Mile of Grocery Store” column of the table, where the average is 10.11 robberies, and the minimum-maximum counts are (0, 44) as opposed to (6, 75) for the 1 mile radius column. The high number of robberies near these stores may indicate that these robberies take place at the grocery stores themselves, and are target areas to focus on in prevention.