data_explore

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1 Assignment 2: Data collection, preprocession and Exploratory Data Analysis

1.1 Topic: Identifying Vacant and Uninhabitable Properties using Publicly Available Data in Philadelphia

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After researching different papers on lots, we decided to work on predicting vacants in Philadelphia. We acculated different types of data after reading papers connected to vacant lots and made a list of data sources that might be useful while we are trying to predict and access vacant lots. Some of the data we collected might not be used in the final model.

Important packages that we used were geopandas and censusdata. geopandas package was used plot maps and it assisted us while working with location data. Censusdata package was used to pull American Community Survey data easily.

The data laid out on this notebook are from the following sources:

1. **Philadelphia Shape Files:** Shape file is a data storage format for storing location, shape and attributes of geo. Shape files assistes use to create maps and we also used it to join with other types of datasets.For this project we focused specifically on Philadelphia.

    - Neighbourhoods: Heighbourhoods act like social communities where people are expected to have more face-to-face interested. There is no official list of neighbourhoods.
        - Source: https://github.com/azavea/geo-data/tree/master/Neighborhoods_Philadelphia

    - Census Block Groups: Census block group is a geographic unit used by United States Census Bureau. It is between Census Tract and Census Block. It is the smallest geographical unit for which the bureau publishes sample data. Typically Block Groups have a population of 600 to 3000 people. Data collected from American Community Survey had data at census block group level, so this shape file was important to analyze this dataset.
        - Source: https://www.opendataphilly.org/dataset/census-block-groups

    - Zip Code: Zip Code is a postal code used by United States Postal Service(USPS). The basic format normally consis of 5 digits. Some of the datasets collected from the city government has zip code level data, we used it to plot them.
        - Source: https://www.opendataphilly.org/dataset/zip-codes

2. **American Community Servey(5 year):** ACE is conducted by Census Bureau. But unlike the Decennial Census which is conducted every 10 years, the American Community Survey is conducted more frequently. The census tries to count every person, where as the ACS is sent to sample addresses. For our purposes, we used the 5-year ACS data where the data has been collected over 5 years between 2015- 2019. Data in ACS is at the block group level. Censusdata package was used to pull the data

    - Occupany Status(Table Code:B25002): Data on whether the property was vacant or occupied.

    - Vacancy Status(Table Code:B25004): Vacant properties could be further broken down accoring to their housing market classification. For our purposes, we will be focusing on "other" vacancy status. Vacant status us classified as other when it does not fall in any of the year round category

3. **Phildelphia City:** The Open Data Program of City of Philadelphia helps departments share data from the city government with the Public on OpenDataPhilly

    - Crime: Data is collected from the the Philadelphia POlice Department. It has data from 2006-Present and is being ipdated everyday. We decided to use city crime data as a lot of papers mentioned that areas with vacant lots tend to have high crime rate.
        - Source: https://metadata.phila.gov/#home/datasetdetails/5543868920583086178c4f8e/representat

    - Property Assessment:Data is collected by the Philadelphia Properties and Assessment History. It includes property characteristics and assessment inormation from the Office of Property Assessment. This dataset includes data of properties that are already known as vacant lands by the city government.
        - Source: https://metadata.phila.gov/#home/datasetdetails/5543865f20583086178c4ee5/

    - 311 Data: Contains data about 311 Service Requests. This represents all service and information requests since December 8th, 2014 submitted to Philly311 via the 311 mobile application, calls, walk-ins, emails, the 311 website or social media. We incorporated this data set as vacant lots tends to get more 311 calls to reports about things like illegal dumping, maintence services, grafitti removal, etc
        - Source: https://metadata.phila.gov/#home/datasetdetails/5543864d20583086178c4e98/representa

    - Property Tax Delinquency: This is a dataset that shows the Philadelphia properties with tax delinquencies, including those that are in payment agreements. An account is delinquent when Real Estate Tax is still unpaid on January 1 the following year the tax was due. Data is from 1972 - 2018. Vacant lots tend to have unpaid taxes and this is good indicator that properties might be vacant soon.
        - Source: https://metadata.phila.gov/#home/datasetdetails/57d9643afab162fe2708224e/representat

    - Property Code Violations: Data contains violations issued by the Department of License and Inspection. We downloaded datasets for 2013-2015, 2016-2018, 2019-now. Data contains where the violation was occured and reason for violation. Some of the violations are vacant lot related.
        - Source: https://www.opendataphilly.org/dataset/licenses-and-inspections-

violations

4. **Predicted Vacant Lots:** The office of Innovation and Technology of City of Philadelphia aggregated multiple city administrative and geographic data source to to come up with a model that can identiy building or land vacancy in each tax parcem boundary in the city. We will be using this dataset to measure our model's performance and accuracy rate
    - Source: https://metadata.phila.gov/#home/datasetdetails/58078697d414285d25b14e3c/representation

The notebook also contains datasets that seemed important but we are still accessing if we should use them. These datasets are not yet explored properly. These are

1. **Open Street Map:** The Open Street Map is a collaboarative project that created free editable geographic database of the world. The dataset contains different types of data such as public places, hospitals, retaurants, main roads, museums etc
    - Source: https://download.geofabrik.de/north-america/us/pennsylvania.html
    - Details: http://download.geofabrik.de/osm-data-in-gis-formats-free.pdf
2. **American Community Servey:**
    - Race (Table Code:B03002)
    - Age and Sex (Table Code:B01001)
    - Poverty Status (Table Code:B17001)
    - Household Income (Table Code:B19001)
    - Educatiion (Table Code:B15001)
    - ZCTAs: ZIP Code Tabulation Areas (ZCTAs) are generalized areal representations of United States Postal Service (USPS) ZIP Code service areas. The ZCTAs were created by first examining all of the addresses within each census block and then the most frequently occuring zip code within each block was assigned to the entire census block. This dataset might be used to connect ACS data with other types of data.
        - Source: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/zctas.html

[ ]:
```
#Libraries used

import pandas as pd
import numpy as np
import geopandas as gpd # for mapping
import matplotlib.pyplot as plt
import descartes # for mapping
from shapely.geometry import Point, Polygon #for mapping
import seaborn as sns
import censusdata # to pull data from census
from datetime import datetime
import folium
from folium.plugins import HeatMap


%matplotlib inline
```

1.1.1 Philly Shape File: ZCTAs

https://www.census.gov/programs-surveys/geography/guidance/geo-areas/zctas.html

Dataset contains ZACTs of all the US. We are still deciding if we need to use it to connect city data with ACS data.

[ ]:
```
census_zip = gpd.read_file("data/census_shape/cb_2018_us_zcta510_500k/
↪cb_2018_us_zcta510_500k.shp") # loading dataset
census_zip.head()
#ZCTA5CE10 -- zip code tabulation area
```

[ ]:
```
  ZCTA5CE10      AFFGEOID10 GEOID10    ALAND10  AWATER10  \
0     36083  8600000US36083   36083  659750662   5522919
1     35441  8600000US35441   35441  172850429   8749105
2     35051  8600000US35051   35051  280236456   5427285
3     35121  8600000US35121   35121  372736030   5349303
4     35058  8600000US35058   35058  178039922   3109259

                                            geometry
0  MULTIPOLYGON (((-85.63225 32.28098, -85.62439 …
1  MULTIPOLYGON (((-87.83287 32.84437, -87.83184 …
2  POLYGON ((-86.74384 33.25002, -86.73802 33.251…
3  POLYGON ((-86.58527 33.94743, -86.58033 33.948…
4  MULTIPOLYGON (((-86.87884 34.21196, -86.87649 …
```

[ ]:
```
census_zip.shape #size of data
```

[ ]:
```
(33144, 6)
```

[ ]:
```
census_zip.nunique()#unique values in dataset
```

[ ]:
```
ZCTA5CE10     33144
AFFGEOID10    33144
GEOID10       33144
ALAND10       33138
AWATER10      28425
geometry      33144
dtype: int64
```

1.1.2 Philly Shape File: Census Block Group

https://www.opendataphilly.org/dataset/census-block-groups https://metadata.phila.gov/#home/datasetdetails/

Dataset was used later while plotting ACS dataset

[ ]:
```
census_blockgroups = gpd.read_file("data/census_shape/
↪Census_Block_Groups_2010-shp/Census_Block_Groups_2010.shp")#loading dataset
census_blockgroups.head()
```

[ ]:
```
   OBJECTID STATEFP10 COUNTYFP10 TRACTCE10 BLKGRPCE10       GEOID10  \
0         1        42        101    010800          1  421010108001
1         2        42        101    010800          2  421010108002
2         3        42        101    010900          2  421010109002
3         4        42        101    011000          2  421010110002
4         5        42        101    011000          1  421010110001

      NAMELSAD10 MTFCC10 FUNCSTAT10  ALAND10  AWATER10   INTPTLAT10  \
0  Block Group 1   G5030          S   161887         0  +39.9687580
1  Block Group 2   G5030          S   103778         0  +39.9665475
2  Block Group 2   G5030          S    43724         0  +39.9642929
3  Block Group 2   G5030          S   108966         0  +39.9753585
4  Block Group 1   G5030          S   142244         0  +39.9724202

     INTPTLON10    Shape__Are    Shape__Len  \
0  -075.1997251  1.742508e+06   8200.327170
1  -075.2004455  1.117026e+06   4364.980144
2  -075.1896435  4.706347e+05   3048.109084
3  -075.2113476  1.172871e+06   5169.004282
4  -075.2051689  1.531076e+06  10476.574129

                                            geometry
0  POLYGON ((-75.19851 39.96945, -75.19744 39.969…
1  POLYGON ((-75.19783 39.96571, -75.20006 39.965…
2  POLYGON ((-75.18766 39.96450, -75.18755 39.963…
3  POLYGON ((-75.20984 39.97351, -75.21221 39.973…
4  POLYGON ((-75.19855 39.97330, -75.19854 39.973…
```

[ ]:
```
census_blockgroups.nunique() #number of unique values in each column.
#important columns to consider is the TRACTCE10 and BLKGRPCE10. The TRACTCE10␣
 ↪is tracts and BLKGRPCE10 stands for block group.
# The number of tract and blockgroup is equal to what was pulled from ACS
```

[ ]:
```
OBJECTID      1336
STATEFP10        1
COUNTYFP10       1
TRACTCE10      384
BLKGRPCE10       8
GEOID10       1336
NAMELSAD10       8
MTFCC10          1
FUNCSTAT10       1
ALAND10       1332
AWATER10       121
INTPTLAT10    1336
INTPTLON10    1336
Shape__Are    1336
```

```
Shape__Len    1336
geometry      1336
dtype: int64
```

[ ]:
```
census_blockgroups['BLKGRPCE10'].value_counts()
```

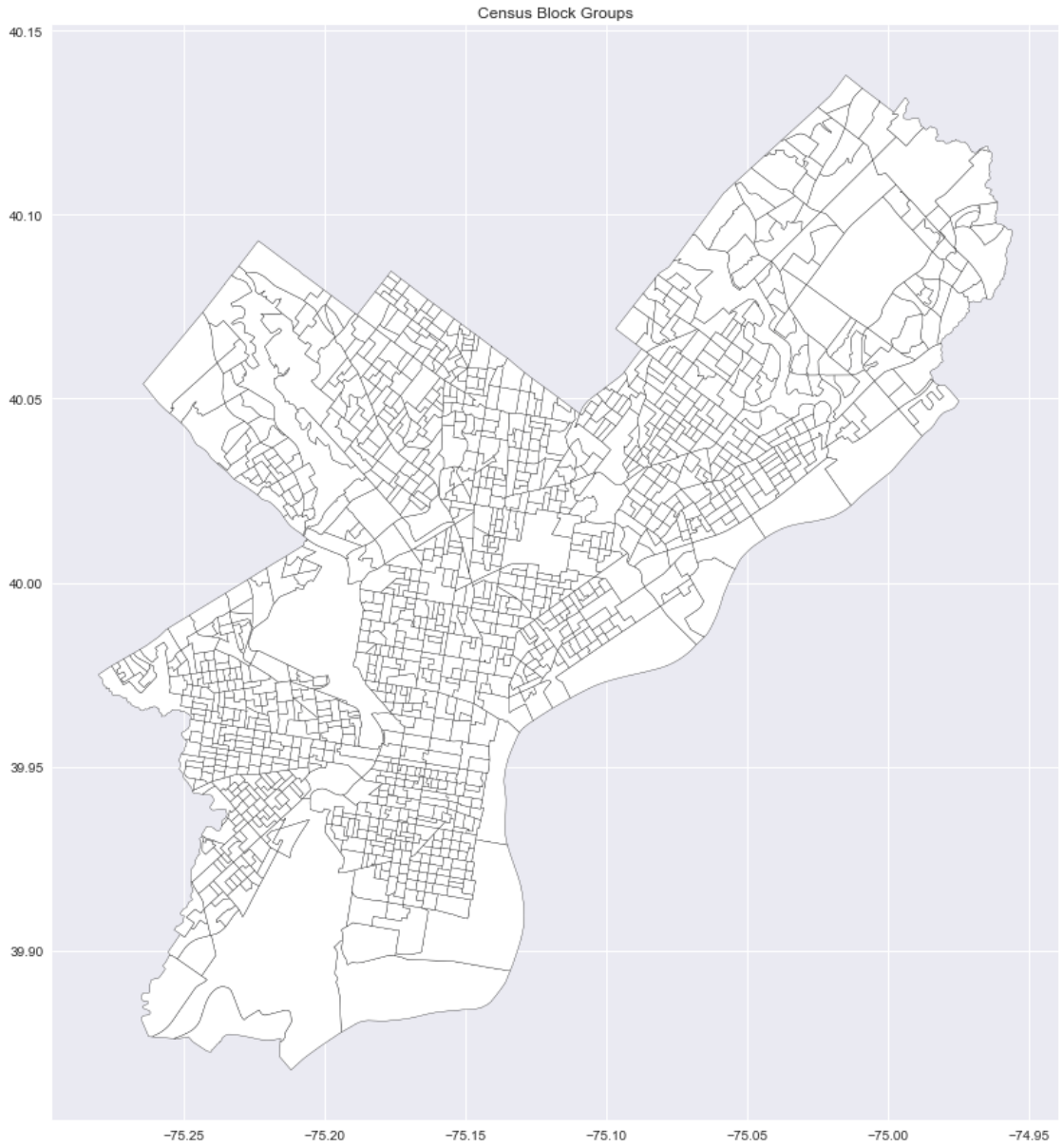
[ ]:
```
1    384
2    349
3    271
4    176
5     88
6     45
7     21
8      2
Name: BLKGRPCE10, dtype: int64
```

[ ]:
```
census_blockgroups['TRACTCE10'].value_counts()
```

[ ]:
```
026600    8
039000    8
018800    7
008200    7
031600    7
         ..
980500    1
980400    1
023500    1
000200    1
005600    1
Name: TRACTCE10, Length: 384, dtype: int64
```

[ ]:
```
#plotting map using the census blockgroup
fig, ax = plt.subplots(figsize=(15,15))
plt.style.use('seaborn')
plt.title("Census Block Groups")
census_blockgroups.to_crs("EPSG:4269").plot(ax=ax, color='white',␣
↪edgecolor='black')# epsg is the coordinate reference system(crs).
#CRS tells python how these coordinates related to places on the Earth
#"EPSG:4269" is for latitude, longitude projection
```

[ ]:
```
<AxesSubplot:title={'center':'Census Block Groups'}>
```



1.1.3 Philly Shape file: Neighbourhoods

https://github.com/azavea/geo-data

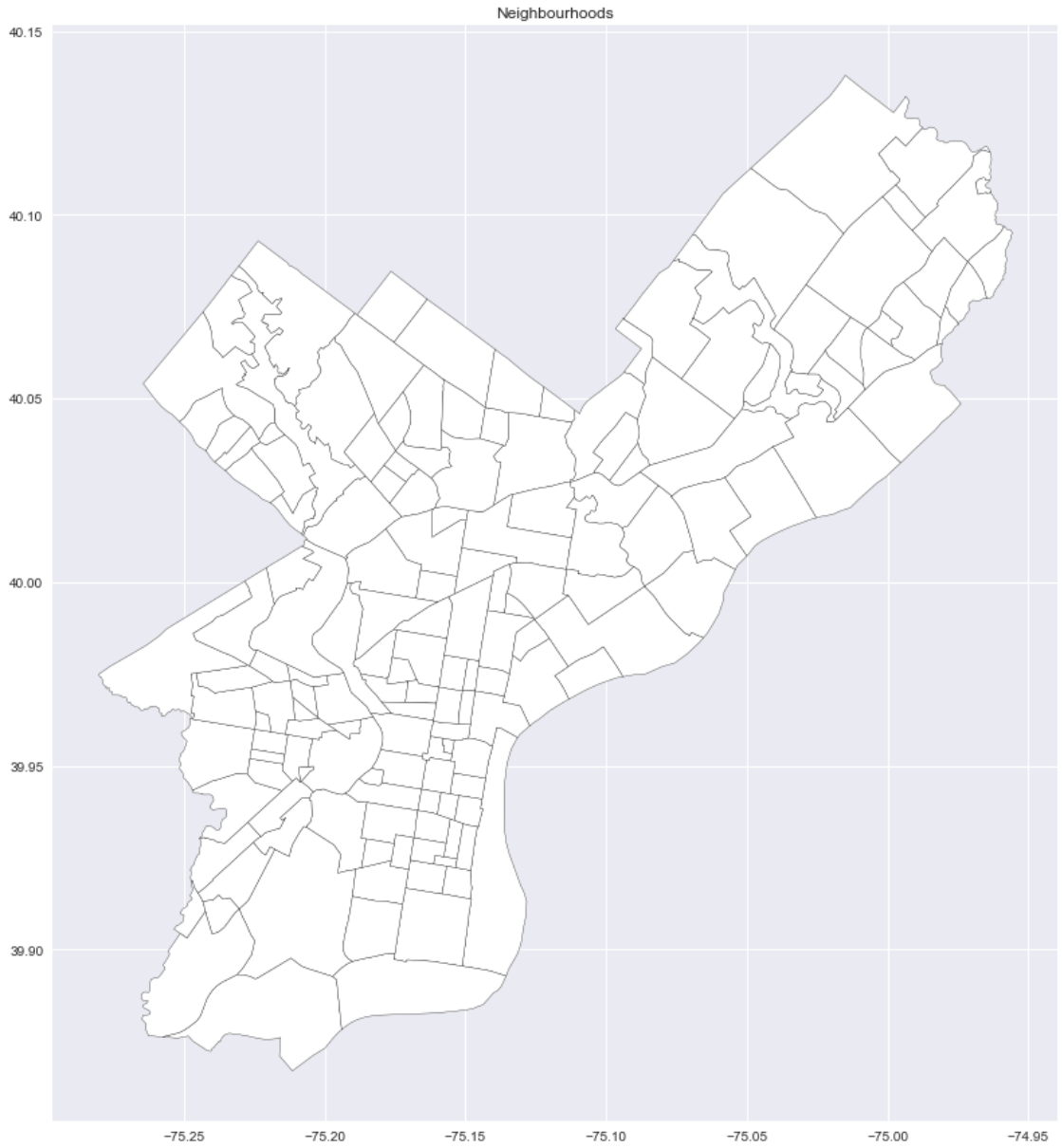
[ ]:
```
street_map = gpd.read_file("data/geo_shape/Neighborhoods_Philadelphia.
↪shp")#loading dataset
#Download shape file from here. Download all files under folder␣
↪"Neighborhoods_philadelphia" and keep in the same folder https://github.com/
↪azavea/geo-data
```

[ ]:
```
street_map.head()
```

[ ]:
```
            NAME       LISTNAME        MAPNAME    Shape_Leng    Shape_Area  \
0     BRIDESBURG     Bridesburg     Bridesburg  27814.546521  4.458626e+07
1      BUSTLETON      Bustleton      Bustleton  48868.458365  1.140504e+08
2     CEDARBROOK     Cedarbrook     Cedarbrook  20021.415802  2.487174e+07
3  CHESTNUT_HILL  Chestnut Hill  Chestnut Hill  56394.297195  7.966498e+07
4     EAST_FALLS     East Falls     East Falls  27400.776417  4.057689e+07

                                            geometry
0  POLYGON ((2719789.837 256235.538, 2719814.855 …
1  POLYGON ((2733378.171 289259.945, 2732818.985 …
2  POLYGON ((2685267.950 279747.336, 2685272.265 …
3  POLYGON ((2678490.151 284400.400, 2678518.732 …
4  POLYGON ((2686769.727 263625.367, 2686921.108 …
```

[ ]:
```
#Plotting with neighbourhoods
fig,ax = plt.subplots(figsize =(15,15))
plt.title("Neighbourhoods")
street_map.to_crs(epsg = 4326).plot(ax = ax, color = "white",␣
 ↪edgecolor='black')# converting axis to coordiate with longitude and latitude
#street_map.to_crs(epsg = 4326).boundary.plot(ax = ax)# plotting only boundary
```

[ ]:
```
<AxesSubplot:title={'center':'Neighbourhoods'}>
```



[ ]:
```
street_map.total_bounds# exact city boundary
```

[ ]:
```
array([2660586.2010556 ,  204650.55486186, 2750109.00494927,
        304965.32339202])
```

[ ]:
```
street_map.centroid# center coordinate of the sape
```

[ ]:
```
0      POINT (2719422.233 253264.287)
1      POINT (2725947.795 288491.804)
2      POINT (2688745.576 280652.166)
```

```
3      POINT (2679098.697 279137.188)
4      POINT (2685458.776 259484.374)
                     …
153    POINT (2688489.596 218958.968)
154    POINT (2697705.388 227294.296)
155    POINT (2691305.087 226663.440)
156    POINT (2688805.843 226518.573)
157    POINT (2693761.573 226871.685)
Length: 158, dtype: geometry
```

1.1.4 Philly Shape Files: Zip Codes

Source: https://www.opendataphilly.org/dataset/zip-codes

[ ]:
```
poly_zip = gpd.read_file("data/zip_shape/Zipcodes_Poly-shp/Zipcodes_Poly.shp")#␣
 ↪uploading dataset
poly_zip.head()
```

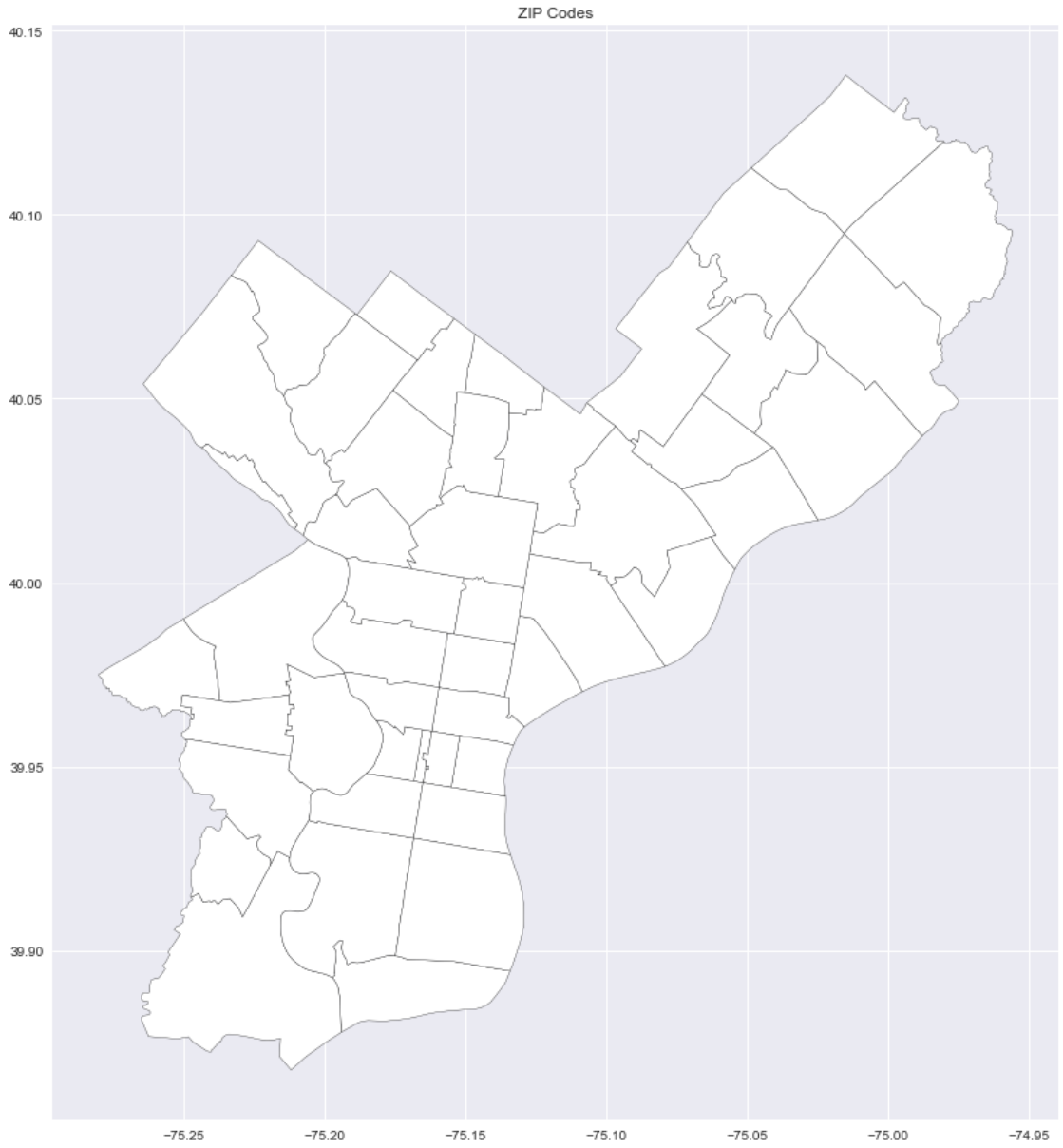
[ ]:
```
   OBJECTID   CODE  COD    Shape__Are    Shape__Len  \
0         1  19120   20  9.177970e+07  49921.544063
1         2  19121   21  6.959879e+07  39534.887217
2         3  19122   22  3.591632e+07  24124.645221
3         4  19123   23  3.585175e+07  26421.728982
4         5  19124   24  1.448080e+08  63658.770420

                                              geometry
0  POLYGON ((-75.11107 40.04682, -75.10943 40.045…
1  POLYGON ((-75.19227 39.99463, -75.19205 39.994…
2  POLYGON ((-75.15406 39.98601, -75.15328 39.985…
3  POLYGON ((-75.15190 39.97056, -75.15150 39.970…
4  POLYGON ((-75.09660 40.04249, -75.09281 40.039…
```

[ ]:
```
poly_zip.dtypes
```

[ ]:
```
OBJECTID         int64
CODE            object
COD              int64
Shape__Are     float64
Shape__Len     float64
geometry      geometry
dtype: object
```

[ ]:
```
#plotting with zip codes
fig,ax = plt.subplots(figsize =(15,15))
plt.title("ZIP Codes")
poly_zip.to_crs(epsg = 4326).plot(ax = ax, color = "white", edgecolor='black')
```

[ ]: <AxesSubplot:title={'center':'ZIP Codes'}>



1.1.5 Open Street Map Files

https://download.geofabrik.de/north-america/us/pennsylvania.htm

http://download.geofabrik.de/osm-data-in-gis-formats-free.pdf

We are still deciding how and where to use this dataset

[ ]:
```
#download pennsylvania open street map data
roads_path = "data/osm/gis_osm_roads_free_1.shp" #loading the roads file from␣
 ↪open map
roads = gpd.read_file(roads_path, encoding='utf-8')
```

[ ]:
```
roads_new = roads.to_crs(epsg = 4326)
street_map_new = street_map.to_crs(epsg = 4326) # neighbourhood shape file
```

[ ]:
```
street_map_new.head()
```

```
           NAME       LISTNAME        MAPNAME    Shape_Leng    Shape_Area  \
0     BRIDESBURG     Bridesburg     Bridesburg  27814.546521  4.458626e+07
1      BUSTLETON      Bustleton      Bustleton  48868.458365  1.140504e+08
2     CEDARBROOK     Cedarbrook     Cedarbrook  20021.415802  2.487174e+07
3  CHESTNUT_HILL  Chestnut Hill  Chestnut Hill  56394.297195  7.966498e+07
4     EAST_FALLS     East Falls     East Falls  27400.776417  4.057689e+07

                                            geometry
0  POLYGON ((-75.06773 40.00540, -75.06765 40.005…
1  POLYGON ((-75.01560 40.09487, -75.01768 40.092…
2  POLYGON ((-75.18848 40.07273, -75.18846 40.072…
3  POLYGON ((-75.21221 40.08604, -75.21210 40.086…
4  POLYGON ((-75.18478 40.02837, -75.18426 40.027…
```

[ ]:
```
roads_new.head()
```

```
   osm_id  code    fclass                name             ref oneway  \
0  368034  5115  tertiary       Seaport Drive            None      F
1  368041  5113   primary  Industrial Highway    US 13;PA 291      B
2  368043  5115  tertiary        Bullens Lane            None      F
3  368044  5113   primary        Chester Road          PA 320      B
4  418185  5113   primary     East 9th Street  US 13 Business      B

   maxspeed  layer bridge tunnel  \
0         0      0      F      F
1         0      0      F      F
2        56      0      F      F
3        64      1      T      F
4        56      0      F      F

                                            geometry
0  LINESTRING (-75.38773 39.82798, -75.38600 39.8…
1  LINESTRING (-75.35786 39.84750, -75.35676 39.8…
2  LINESTRING (-75.35060 39.86874, -75.35050 39.8…
3  LINESTRING (-75.36147 39.87190, -75.36118 39.8…
4  LINESTRING (-75.35941 39.85319, -75.35874 39.8…
```

[ ]:
```
#filtering only for philadelphia shape using neighbourhood shape file
roads = gpd.sjoin(roads_new, street_map_new, predicate ='intersects') # joining␣
 ↪both datasets based on their locations
```

[ ]:
```
roads.head()
```

```
          osm_id  code       fclass            name   ref oneway  maxspeed  \
235570  12108955  5122  residential  Brunner Street  None      F         0
235571  12108958  5122  residential  Brunner Street  None      F         0
238204  12119360  5122  residential    Gratz Street  None      F         0
239953  12133630  5122  residential    Staub Street  None      B         0
239955  12133635  5122  residential    Staub Street  None      F         0

        layer bridge tunnel  \
235570      0      F      F
235571      0      F      F
238204      0      F      F
239953      0      F      F
239955      0      F      F

                                                 geometry  index_right  \
235570  LINESTRING (-75.15542 40.01863, -75.15717 40.0…           61
235571  LINESTRING (-75.15710 40.01773, -75.15856 40.0…           61
238204  LINESTRING (-75.15635 40.02050, -75.15634 40.0…           61
239953  LINESTRING (-75.15447 40.01708, -75.15510 40.0…           61
239955  LINESTRING (-75.15458 40.01727, -75.15440 40.0…           61

            NAME  LISTNAME   MAPNAME    Shape_Leng    Shape_Area
235570  NICETOWN  Nicetown  Nicetown  11237.318154  6.587596e+06
235571  NICETOWN  Nicetown  Nicetown  11237.318154  6.587596e+06
238204  NICETOWN  Nicetown  Nicetown  11237.318154  6.587596e+06
239953  NICETOWN  Nicetown  Nicetown  11237.318154  6.587596e+06
239955  NICETOWN  Nicetown  Nicetown  11237.318154  6.587596e+06
```

[ ]:
```
roads.shape
```

```
(72827, 17)
```

[ ]:
```
roads.fclass.value_counts()# this shows the type of roads. Most of the roads␣
 ↪are  ones that are used for service, foorway and residential
```

```
service          26354
footway          19962
residential      13744
primary           3392
tertiary          2338
secondary         2009
path              1132
```

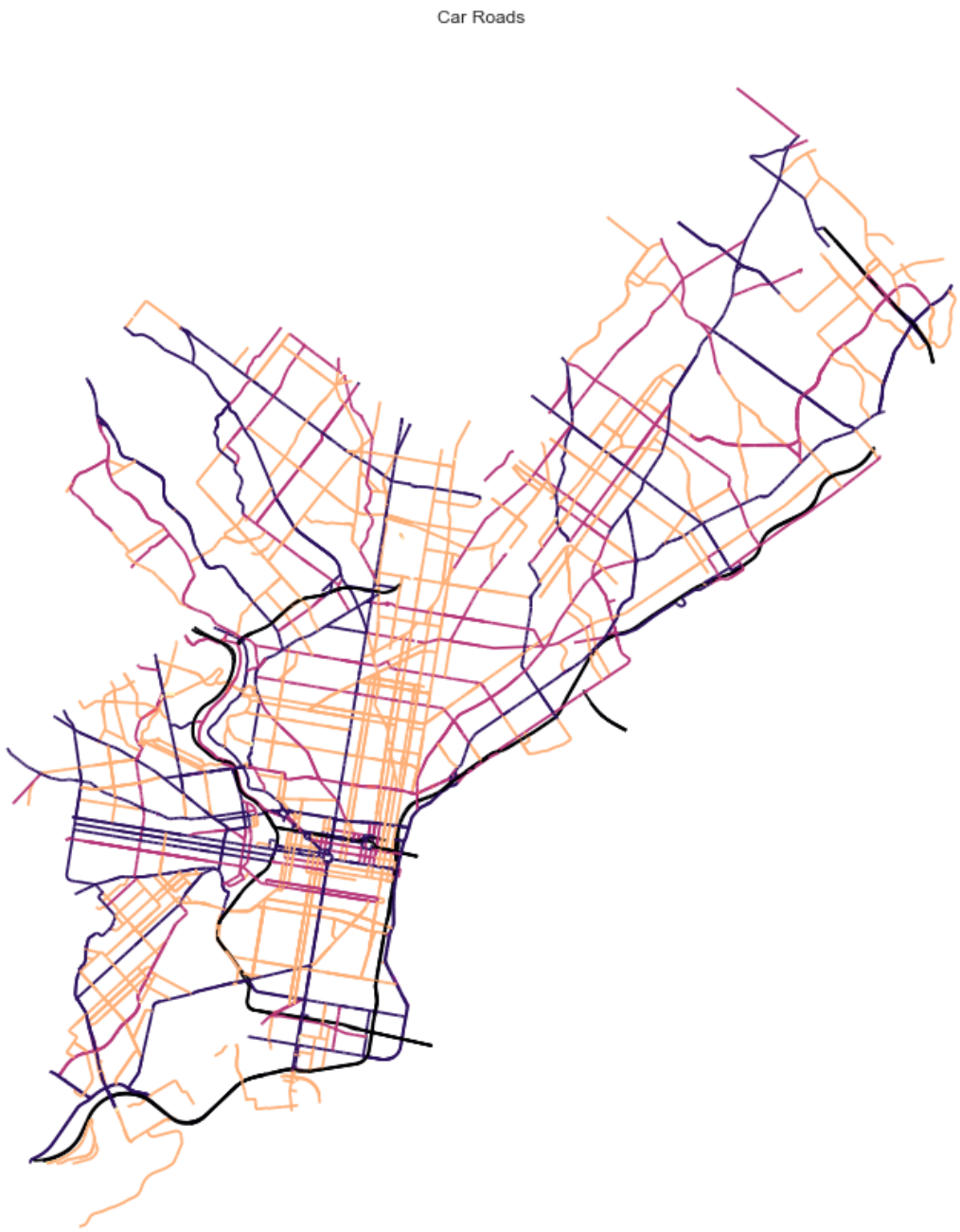
```
trunk               688
motorway_link       649
motorway            625
steps               569
cycleway            351
trunk_link          190
pedestrian          190
unclassified        153
primary_link        150
track               123
secondary_link       87
tertiary_link        62
bridleway            41
track_grade2          5
living_street         5
unknown               4
track_grade5          2
track_grade1          2
Name: fclass, dtype: int64
```

[ ]:
```
#selecting roads where card travel
car_roads = roads[(roads.fclass == 'tertiary') |
                  (roads.fclass == 'tertiary_link') |
                  (roads.fclass == 'secondary') |
                  (roads.fclass == 'secondary_link') |
                  (roads.fclass == 'primary') |
                  (roads.fclass == 'primary_link') |
                  (roads.fclass == 'motorway') |
                  (roads.fclass == 'motorway_linkt')]

car_roads.shape
```

```
(8663, 17)
```

[ ]:
```
#plotting with different type of roads
fig, ax = plt.subplots(figsize =(15,15))
car_roads.plot(ax = ax, markersize=0.01, column='fclass',figsize=(5, 5), cmap =␣
 ↪'magma')
plt.axis('off');
plt.title("Car Roads")
```

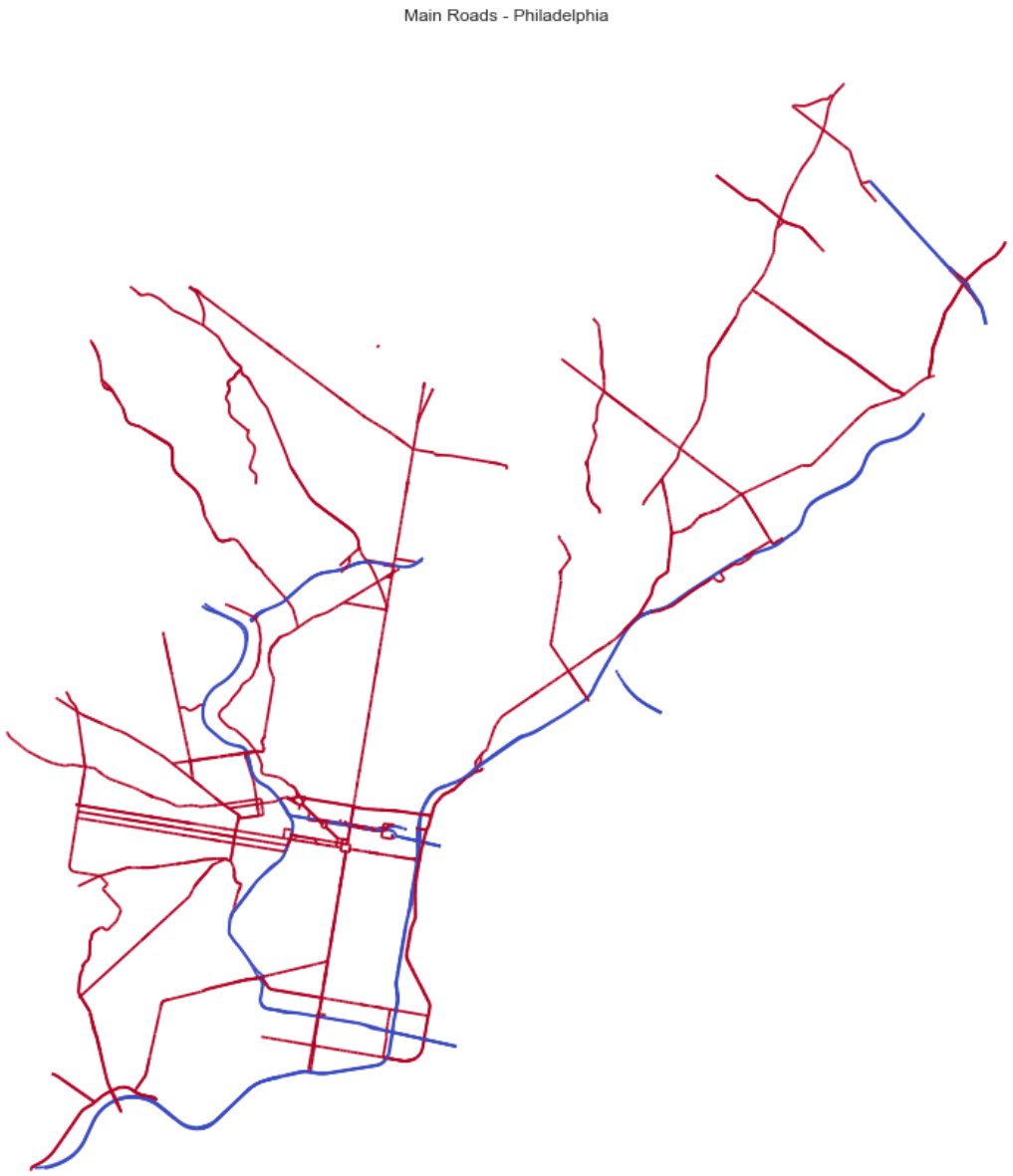
```
Text(0.5, 1.0, 'Car Roads')
```



[ ]:
```
#plotting with main roads only
main_roads = car_roads[(car_roads.fclass == 'primary') |
                       (car_roads.fclass == 'motorway')
                      ]#selectng only primary and motorways

fig, ax = plt.subplots(figsize =(15,15))
```

```
main_roads.plot(ax = ax, column='fclass', cmap = 'coolwarm')
plt.axis('off')
plt.title("Main Roads - Philadelphia")
```

```
Text(0.5, 1.0, 'Main Roads - Philadelphia')
```



1.1.6 City of Philadelphia: Predicted Vacant Lot

[ ]:
```
philly_points = pd.read_csv('data/city/Vacant_Indicators_Points.csv') #loading␣
↪the dataset
philly_points.head()
#https://metadata.phila.gov/#home/datasetdetails/58078697d414285d25b14e3c/
↪representationdetails/59c154f1c8357d22ed035e66/
```

```
           X          Y  OBJECTID            ADDRESS  \
0 -75.178904  39.934505         1       2041 REED ST
1 -75.164548  39.988160         2     2233 N UBER ST
2 -75.180480  39.978561         3  1460 N MARSTON ST
3 -75.186579  40.006852         4   3241 SUGDENS ROW
4 -75.238794  39.954902         5       5816 PINE ST

                     OWNER1            OWNER2              BLDG_DESC  \
0  GREATER DELIVERANCE TEMPL               NaN  VAC LAND COMM. < ACRE
1              CITY OF PHILA               NaN    VAC LAND RES < ACRE
2  PHILADELPHIA HOUSING AUTH               NaN    VAC LAND RES < ACRE
3               JORDAN MARIA               NaN    VAC LAND RES < ACRE
4                WALSH JAMES  LUBLIN WILLIAM H      ROW 2 STY MASONRY

        OPA_ID LNIADDRESSKEY  COUNCILDISTRICT ZONINGBASEDISTRICT  ZIPCODE  \
0  885396760.0        498086                2              CMX-2  19146.0
1  162113701.0        581713                5              RSA-5  19132.0
2  292083110.0        415511                5              RSA-5  19121.0
3  382209500.0        557317                4              RSA-5  19129.0
4  604178400.0        485528                3               RM-1  19143.0

   LAND_RANK  BUILD_RANK VACANT_FLAG  VACANT_RANK
0       0.67         0.0        Land         0.67
1       0.50         0.0        Land         0.50
2       0.50         0.0        Land         0.50
3       1.00         0.0        Land         1.00
4       0.00         1.0    Building         1.00
```

[ ]:
```
philly_points.shape
```

[ ]:
```
(36917, 16)
```

[ ]:
```
philly_points.dtypes #Type of data
```

```
X                    float64
Y                    float64
OBJECTID               int64
ADDRESS               object
OWNER1                object
OWNER2                object
```

```
BLDG_DESC              object
OPA_ID                float64
LNIADDRESSKEY          object
COUNCILDISTRICT         int64
ZONINGBASEDISTRICT     object
ZIPCODE               float64
LAND_RANK             float64
BUILD_RANK            float64
VACANT_FLAG            object
VACANT_RANK           float64
dtype: object
```

[ ]:
```
philly_points.isna().sum() # sum of null values in each column
```

```
X                        0
Y                        0
OBJECTID                 0
ADDRESS                  1
OWNER1                   1
OWNER2               28556
BLDG_DESC               70
OPA_ID                  21
LNIADDRESSKEY          336
COUNCILDISTRICT          0
ZONINGBASEDISTRICT      40
ZIPCODE                322
LAND_RANK                2
BUILD_RANK               0
VACANT_FLAG              2
VACANT_RANK              2
dtype: int64
```

[ ]:
```
philly_points.describe(include = 'all') # Vacant flag column indicates if the␣
↪property is likely to be a vacant building or vacant land
```

[ ]:
```
                   X             Y     OBJECTID             ADDRESS  \
count   36917.000000  36917.000000  36917.00000               36916
unique           NaN           NaN          NaN               36855
top              NaN           NaN          NaN  4923R-47 N 16TH ST
freq             NaN           NaN          NaN                  27
mean      -75.167337     39.985244  18459.00000                 NaN
std         0.041322      0.031944  10657.16428                 NaN
min       -75.269183     39.883301      1.00000                 NaN
25%       -75.189216     39.968623   9230.00000                 NaN
50%       -75.165435     39.986638  18459.00000                 NaN
75%       -75.144508     39.999227  27688.00000                 NaN
max       -74.964149     40.135042  36917.00000                 NaN
```

	OWNER1	OWNER2	BLDG_DESC	OPA_ID	\
count	36916	8361	36847	3.689600e+04	
unique	20842	4550	311	NaN	
top	CITY OF PHILA	OF PHILADELPHIA	VAC LAND RES < ACRE	NaN	
freq	2412	642	23752	NaN	
mean	NaN	NaN	NaN	3.431197e+08	
std	NaN	NaN	NaN	2.276140e+08	
min	NaN	NaN	NaN	1.100490e+07	
25%	NaN	NaN	NaN	1.831285e+08	
50%	NaN	NaN	NaN	3.110167e+08	
75%	NaN	NaN	NaN	4.320889e+08	
max	NaN	NaN	NaN	8.886000e+08	

	LNIADDRESSKEY	COUNCILDISTRICT	ZONINGBASEDISTRICT	ZIPCODE	\
count	36581	36917.000000	36877	36595.000000	
unique	36523	NaN	34	NaN	
top	749746	NaN	RSA-5	NaN	
freq	27	NaN	20941	NaN	
mean	NaN	4.913211	NaN	19131.573330	
std	NaN	2.175462	NaN	11.154188	
min	NaN	1.000000	NaN	19102.000000	
25%	NaN	3.000000	NaN	19122.000000	
50%	NaN	5.000000	NaN	19133.000000	
75%	NaN	7.000000	NaN	19140.000000	
max	NaN	10.000000	NaN	19154.000000	

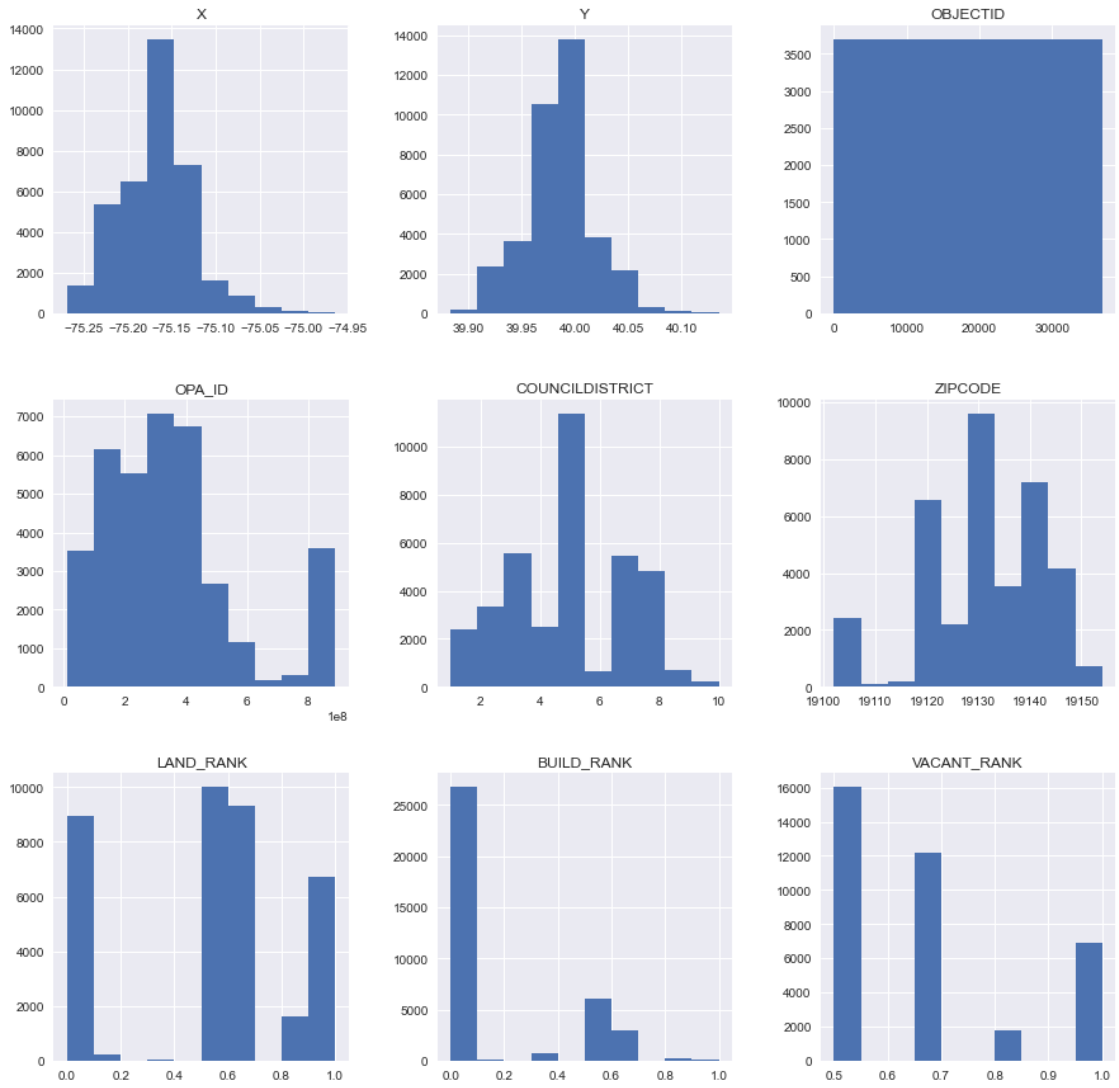
	LAND_RANK	BUILD_RANK	VACANT_FLAG	VACANT_RANK
count	36915.000000	36917.000000	36915	36915.000000
unique	NaN	NaN	2	NaN
top	NaN	NaN	Land	NaN
freq	NaN	NaN	27613	NaN
mean	0.525169	0.150244	NaN	0.665391
std	0.343984	0.252557	NaN	0.184587
min	0.000000	0.000000	NaN	0.500000
25%	0.415000	0.000000	NaN	0.500000
50%	0.500000	0.000000	NaN	0.670000
75%	0.670000	0.500000	NaN	0.670000
max	1.000000	1.000000	NaN	1.000000

[ ]:
```
fig,ax = plt.subplots(figsize =(15,15))
philly_points.hist(ax = ax)#plotting histogram of the dataset to make sure all␣
 ↪data is fine
```

```
/var/folders/6p/wpw9qml57530xkxqkkhprrf40000gn/T/ipykernel_74088/469468503.py:2:
UserWarning: To output multiple subplots, the figure containing the passed axes
is being cleared
```

```
philly_points.hist(ax = ax)
```

[ ]:
```
array([[<AxesSubplot:title={'center':'X'}>,
        <AxesSubplot:title={'center':'Y'}>,
        <AxesSubplot:title={'center':'OBJECTID'}>],
       [<AxesSubplot:title={'center':'OPA_ID'}>,
        <AxesSubplot:title={'center':'COUNCILDISTRICT'}>,
        <AxesSubplot:title={'center':'ZIPCODE'}>],
       [<AxesSubplot:title={'center':'LAND_RANK'}>,
        <AxesSubplot:title={'center':'BUILD_RANK'}>,
        <AxesSubplot:title={'center':'VACANT_RANK'}>]], dtype=object)
```



[ ]:
```
#X and Y columns are latitude and longitude columns. Both columns need to be␣
↪combined for into a geometry column for geo pandas to read and plot the data
```

```
crs = {'init': 'epsg:4326'}
geometry = [Point(xy) for xy in zip(philly_points["X"], philly_points["Y"])]
geometry[:3]
```

[ ]:
```
[<shapely.geometry.point.Point at 0x2e24cba30>,
 <shapely.geometry.point.Point at 0x2e99f90f0>,
 <shapely.geometry.point.Point at 0x2e24e1d50>]
```

[ ]:
```
philly_points = gpd.GeoDataFrame(philly_points,
                                 crs = crs,
                                 geometry = geometry)

philly_points.head()
```

```
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/pyproj/crs/crs.py:131: FutureWarning: '+init=<authority>:<code>' syntax
is deprecated. '<authority>:<code>' is the preferred initialization method. When
making the change, be mindful of axis order changes:
https://pyproj4.github.io/pyproj/stable/gotchas.html#axis-order-changes-in-
proj-6
  in_crs_string = _prepare_from_proj_string(in_crs_string)
```

[ ]:

	X	Y	OBJECTID	ADDRESS	\
0	-75.178904	39.934505	1	2041 REED ST	
1	-75.164548	39.988160	2	2233 N UBER ST	
2	-75.180480	39.978561	3	1460 N MARSTON ST	
3	-75.186579	40.006852	4	3241 SUGDENS ROW	
4	-75.238794	39.954902	5	5816 PINE ST	

	OWNER1	OWNER2	BLDG_DESC	\
0	GREATER DELIVERANCE TEMPL	NaN	VAC LAND COMM. < ACRE	
1	CITY OF PHILA	NaN	VAC LAND RES < ACRE	
2	PHILADELPHIA HOUSING AUTH	NaN	VAC LAND RES < ACRE	
3	JORDAN MARIA	NaN	VAC LAND RES < ACRE	
4	WALSH JAMES	LUBLIN WILLIAM H	ROW 2 STY MASONRY	

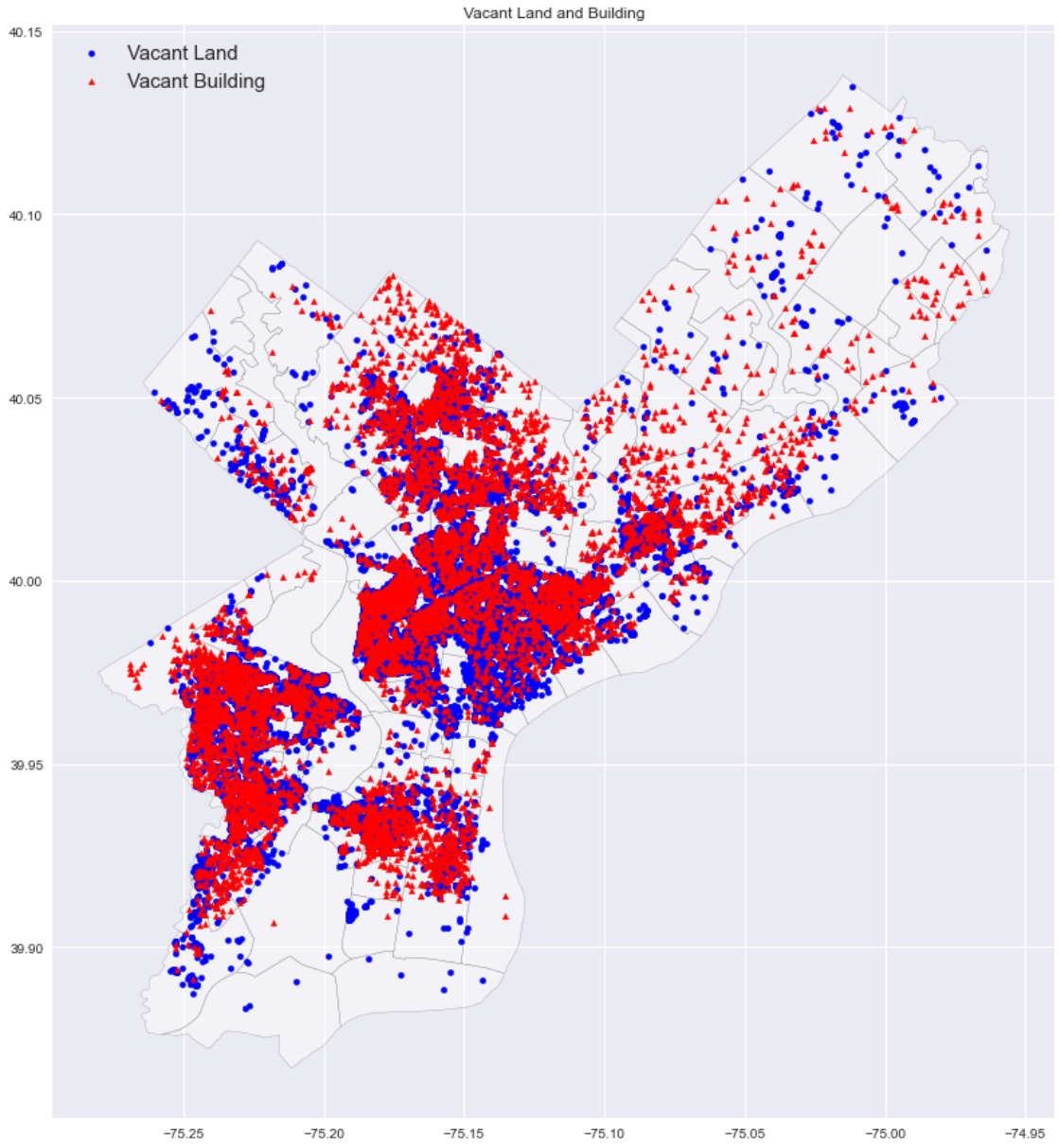
	OPA_ID	LNIADDRESSKEY	COUNCILDISTRICT	ZONINGBASEDISTRICT	ZIPCODE	\
0	885396760.0	498086	2	CMX-2	19146.0	
1	162113701.0	581713	5	RSA-5	19132.0	
2	292083110.0	415511	5	RSA-5	19121.0	
3	382209500.0	557317	4	RSA-5	19129.0	
4	604178400.0	485528	3	RM-1	19143.0	

	LAND_RANK	BUILD_RANK	VACANT_FLAG	VACANT_RANK	geometry
0	0.67	0.0	Land	0.67	POINT (-75.17890 39.93451)
1	0.50	0.0	Land	0.50	POINT (-75.16455 39.98816)
2	0.50	0.0	Land	0.50	POINT (-75.18048 39.97856)

```
3       1.00          0.0         Land          1.00  POINT (-75.18658 40.00685)
4       0.00          1.0     Building          1.00  POINT (-75.23879 39.95490)
```

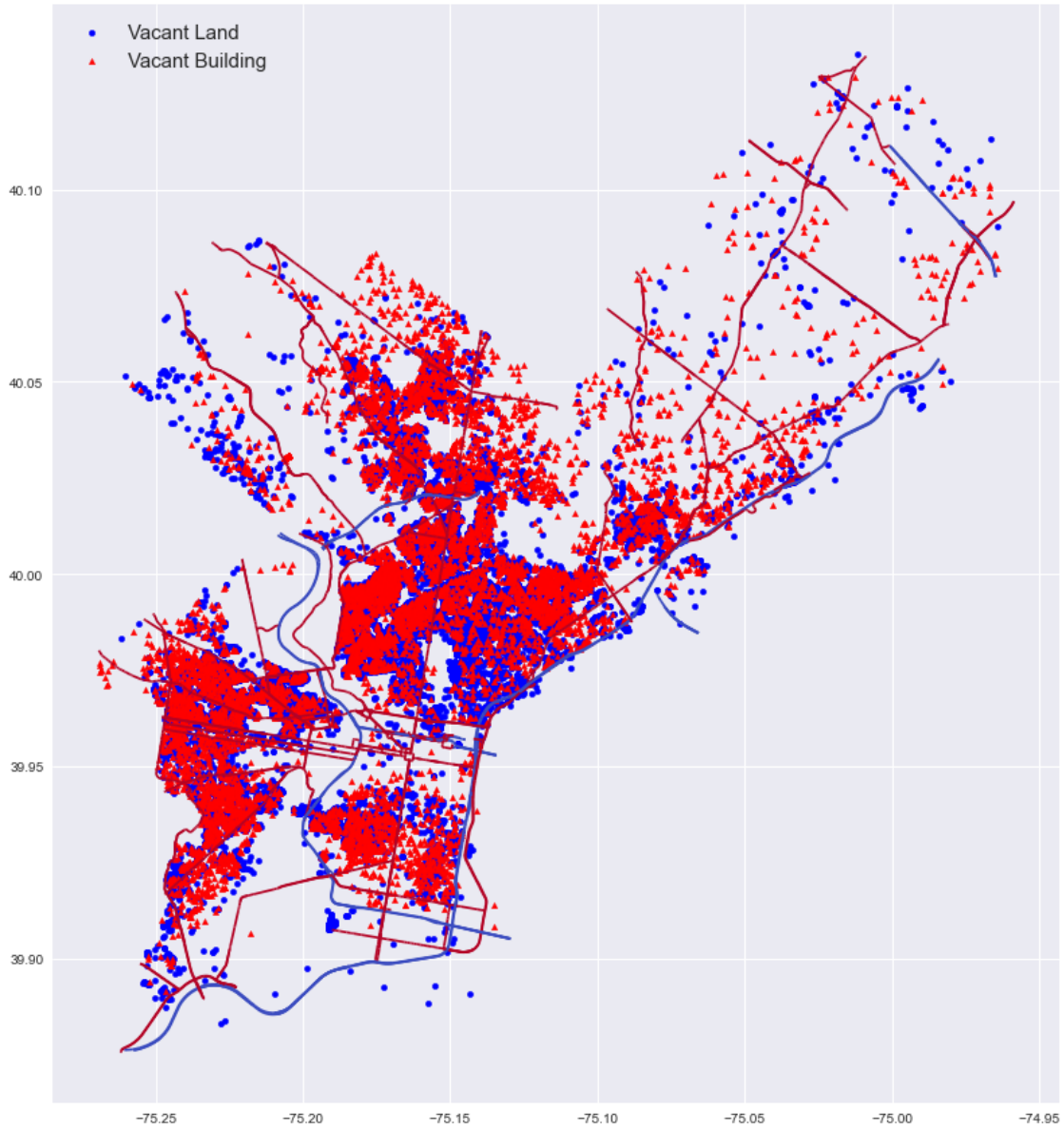
[ ]:
```
#Plotting Vacant land and Vacant buildings
fig, ax = plt.subplots(figsize =(15,15))
street_map.to_crs(epsg = 4326).plot(ax = ax, alpha = 0.4,  color = "white",␣
↪edgecolor='black')
plt.title('Vacant Land and Building')
philly_points[philly_points['VACANT_FLAG'] == 'Land'].plot(ax = ax, markersize␣
↪= 20, color = "blue", marker = "o", label = "Vacant Land")
philly_points[philly_points['VACANT_FLAG'] == 'Building'].plot(ax = ax,␣
↪markersize = 20, color = "red", marker = "^", label = "Vacant Building")
plt.legend(prop = {'size' : 15})
```

[ ]:
```
<matplotlib.legend.Legend at 0x2df0e3f10>
```



[ ]:
```
#vacant land and vant building layer on top of main roads in philadelphia
fig, ax = plt.subplots(figsize =(15,15))
plt.title("Predicted Vacant Land & Building with Main Roads")
main_roads.plot(ax = ax, column='fclass', cmap = 'coolwarm')
philly_points[philly_points['VACANT_FLAG'] == 'Land'].plot(ax = ax, markersize␣
↪= 20, color = "blue", marker = "o", label = "Vacant Land")
philly_points[philly_points['VACANT_FLAG'] == 'Building'].plot(ax = ax,␣
↪markersize = 20, color = "red", marker = "^", label = "Vacant Building")
plt.legend(prop = {'size' : 15})
```

[ ]: <matplotlib.legend.Legend at 0x1d9b1b280>



1.1.7 American Community Survey(ACS)

Census Bureau has data that is in the following levels: states > counties > tracts > blockgroups > blocks

Tracts are fairly homogenous, when tract is beyond 800 people the tract is split up Blockgroup contains blocks. Block groups have between 250 and 550 housing units. Census block is the smalest geographic census unit. Blocks can be bounded by visible features—such as streets—or by invisible boundaries, such as city limits.Census blocks are often the same as ordinary city blocks. Census blocks change every decade.

[ ]:
```
censusdata.search('acs5', 2019,'label', 'vacant')# finding 5 year ACS estimates␣
↪from 2015 with vacant in the concept
```

[ ]:
```
[('B25002_003E', 'OCCUPANCY STATUS', 'Estimate!!Total:!!Vacant'),
 ('B25004_008E', 'VACANCY STATUS', 'Estimate!!Total:!!Other vacant'),
 ('B25005_002E',
  'VACANT - CURRENT RESIDENCE ELSEWHERE',
  'Estimate!!Total:!!Vacant - current residence elsewhere'),
 ('B25005_003E',
  'VACANT - CURRENT RESIDENCE ELSEWHERE',
  'Estimate!!Total:!!All other vacant units')]
```

[ ]:
```
states = censusdata.geographies(censusdata.censusgeo([('state', '*')]), 'acs5',␣
↪2015)#printing name of state and code in the dataset
print(states['Pennsylvania']) # pennsylvania is code 42
```

```
Summary level: 040, state:42
```

[ ]:
```
counties = censusdata.geographies(censusdata.censusgeo([('state', '42'),␣
↪('county', '*')]), 'acs5', 2015)#all counties in Pennsylvania.
#We will be using Philadelphia county with the county code 101
```

[ ]:
```
censusdata.geographies(censusdata.censusgeo([('state', '42'),('county',␣
↪'101')]), 'acs5', 2015)# selecting philadelphia county only
# we will be using these location lode to pull data from teh census package
```

```
{'Philadelphia County, Pennsylvania': censusgeo((('state', '42'), ('county',␣
↪'101')))}
```

[ ]:
```
list_blockgroup = censusdata.geographies(censusdata.censusgeo([('state',␣
↪'42'),('county', '101'), ('block group', '*')]), 'acs5', 2019)
# all block group in philadelphia county
```

1.1.8 ACS: Occupancy Status

Data shows places that are occupied or vacant

[ ]:
```
censusdata.printtable(censusdata.censustable('acs5', 2019, 'B25002'))␣
↪#selecting the occupancy table and it shows the columns available
```

```
Variable     | Table                          | Label
| Type
-------------------------------------------------------------------------------
----------------------------------
B25002_001E  | OCCUPANCY STATUS               | !! Estimate Total
| int
B25002_002E  | OCCUPANCY STATUS               | !! !! Estimate Total Occupied
| int
```

```
B25002_003E  | OCCUPANCY STATUS                | !! !! Estimate Total Vacant
| int
-------------------------------------------------------------------------------
-----------------------------------
```

[ ]:
```
acs_occupancy = censusdata.download('acs5', 2019,
           censusdata.censusgeo([('state', '42'),# PS State
                                 ('county', '101'), # philadelphia county
                                 ('block group', '*')]),#all blockgroups
                                 ['B25002_001E', 'B25002_002E','B25002_003E'])#␣
 ↪selecting which columns I would like to use

acs_occupancy.rename(columns = {'B25002_001E': 'total',
                                'B25002_002E': 'occupied',
                                'B25002_003E' : 'vacant'}, inplace = True)#␣
 ↪renaming all columns

acs_occupancy.to_csv('data/acs/occupancy.csv') # download the data in my␣
 ↪computer
acs_occupancy.head()
```

[ ]:

	total	occupied	vacant
Block Group 1, Census Tract 9807, Philadelphia …	0	0	0
Block Group 3, Census Tract 27.01, Philadelphia…	707	616	91
Block Group 2, Census Tract 337.01, Philadelphi…	400	400	0
Block Group 3, Census Tract 337.01, Philadelphi…	1451	1340	111
Block Group 2, Census Tract 205, Philadelphia C…	774	668	106

[ ]:
```
#convering the first column into different columns for county, census tract and␣
 ↪census blockgroup
acs_occupancy = acs_occupancy.reset_index() #reseting the index
acs_occupancy['index'] = acs_occupancy['index'].astype(str)# turning all values␣
 ↪into string
acs_occupancy[['census_info','county', 'census_tract', 'census_blockgroup']] =␣
 ↪acs_occupancy['index'].str.split('>', expand = True) #splitting the column␣
 ↪based on '>'
acs_occupancy.head()
```

[ ]:

	index	total	occupied	vacant	\
0	Block Group 1, Census Tract 9807, Philadelphia…	0	0	0	
1	Block Group 3, Census Tract 27.01, Philadelphi…	707	616	91	
2	Block Group 2, Census Tract 337.01, Philadelph…	400	400	0	
3	Block Group 3, Census Tract 337.01, Philadelph…	1451	1340	111	
4	Block Group 2, Census Tract 205, Philadelphia …	774	668	106	

	census_info	county	\
0	Block Group 1, Census Tract 9807, Philadelphia…	county:101	

```
1  Block Group 3, Census Tract 27.01, Philadelphi…   county:101
2  Block Group 2, Census Tract 337.01, Philadelph…   county:101
3  Block Group 3, Census Tract 337.01, Philadelph…   county:101
4  Block Group 2, Census Tract 205, Philadelphia …   county:101

    census_tract census_blockgroup
0   tract:980700     block group:1
1   tract:002701     block group:3
2   tract:033701     block group:2
3   tract:033701     block group:3
4   tract:020500     block group:2
```

[ ]:
```
#removing unnecessary words from the new columns eg county, tract, blockgroup
acs_occupancy['county'] = acs_occupancy['county'].str.replace('county:', '',␣
 ↪regex = False)
acs_occupancy['census_tract'] = acs_occupancy['census_tract'].str.
 ↪replace('tract:', '', regex = False)
acs_occupancy['census_blockgroup'] = acs_occupancy['census_blockgroup'].str.
 ↪replace('block group:', '', regex = False)
```

[ ]:
```
acs_occupancy.head()
```

[ ]:
```
                                              index  total  occupied  vacant  \
0  Block Group 1, Census Tract 9807, Philadelphia…      0         0       0
1  Block Group 3, Census Tract 27.01, Philadelphi…    707       616      91
2  Block Group 2, Census Tract 337.01, Philadelph…    400       400       0
3  Block Group 3, Census Tract 337.01, Philadelph…   1451      1340     111
4  Block Group 2, Census Tract 205, Philadelphia …    774       668     106

                                        census_info county census_tract  \
0  Block Group 1, Census Tract 9807, Philadelphia…    101       980700
1  Block Group 3, Census Tract 27.01, Philadelphi…    101       002701
2  Block Group 2, Census Tract 337.01, Philadelph…    101       033701
3  Block Group 3, Census Tract 337.01, Philadelph…    101       033701
4  Block Group 2, Census Tract 205, Philadelphia …    101       020500

  census_blockgroup
0                 1
1                 3
2                 2
3                 3
4                 2
```

[ ]:
```
acs_occupancy.dtypes # datatype of columns
```

[ ]:
```
index               object
total                int64
```

```
occupied              int64
vacant                int64
census_info          object
county               object
census_tract         object
census_blockgroup    object
dtype: object
```

[ ]:
```
acs_occupancy['perc_vacant'] = acs_occupancy['vacant']/
↪acs_occupancy['total']#creating new column which has percentage of vacant lot
```

[ ]:
```
acs_occupancy.describe(include = 'all')# some block groups have 54% vacant␣
↪places
```

[ ]:
```
                                                      index        total  \
count                                                  1336  1336.000000
unique                                                 1336          NaN
top     Block Group 1, Census Tract 9807, Philadelphia…           NaN
freq                                                      1          NaN
mean                                                    NaN   513.440120
std                                                     NaN   254.862223
min                                                     NaN     0.000000
25%                                                     NaN   348.000000
50%                                                     NaN   460.500000
75%                                                     NaN   619.500000
max                                                     NaN  2043.000000

           occupied       vacant  \
count   1336.000000  1336.000000
unique          NaN          NaN
top             NaN          NaN
freq            NaN          NaN
mean     450.102545    63.337575
std      232.346504    58.294697
min        0.000000     0.000000
25%      303.000000    22.750000
50%      397.000000    51.000000
75%      554.250000    92.000000
max     1850.000000   460.000000

                                                census_info county  \
count                                                  1336   1336
unique                                                 1336      1
top     Block Group 1, Census Tract 9807, Philadelphia…    101
freq                                                      1   1336
mean                                                    NaN    NaN
std                                                     NaN    NaN
```

```
min                                                    NaN    NaN
25%                                                    NaN    NaN
50%                                                    NaN    NaN
75%                                                    NaN    NaN
max                                                    NaN    NaN

         census_tract  census_blockgroup  perc_vacant
count     1336.000000        1336.000000  1326.000000
unique            NaN                NaN          NaN
top               NaN                NaN          NaN
freq              NaN                NaN          NaN
mean     27668.919910           2.598802     0.125781
std      87647.462929           1.496302     0.103121
min        100.000000           1.000000     0.000000
25%       9500.000000           1.000000     0.049860
50%      19800.000000           2.000000     0.106026
75%      30200.000000           3.000000     0.185122
max     989100.000000           8.000000     0.542645
```

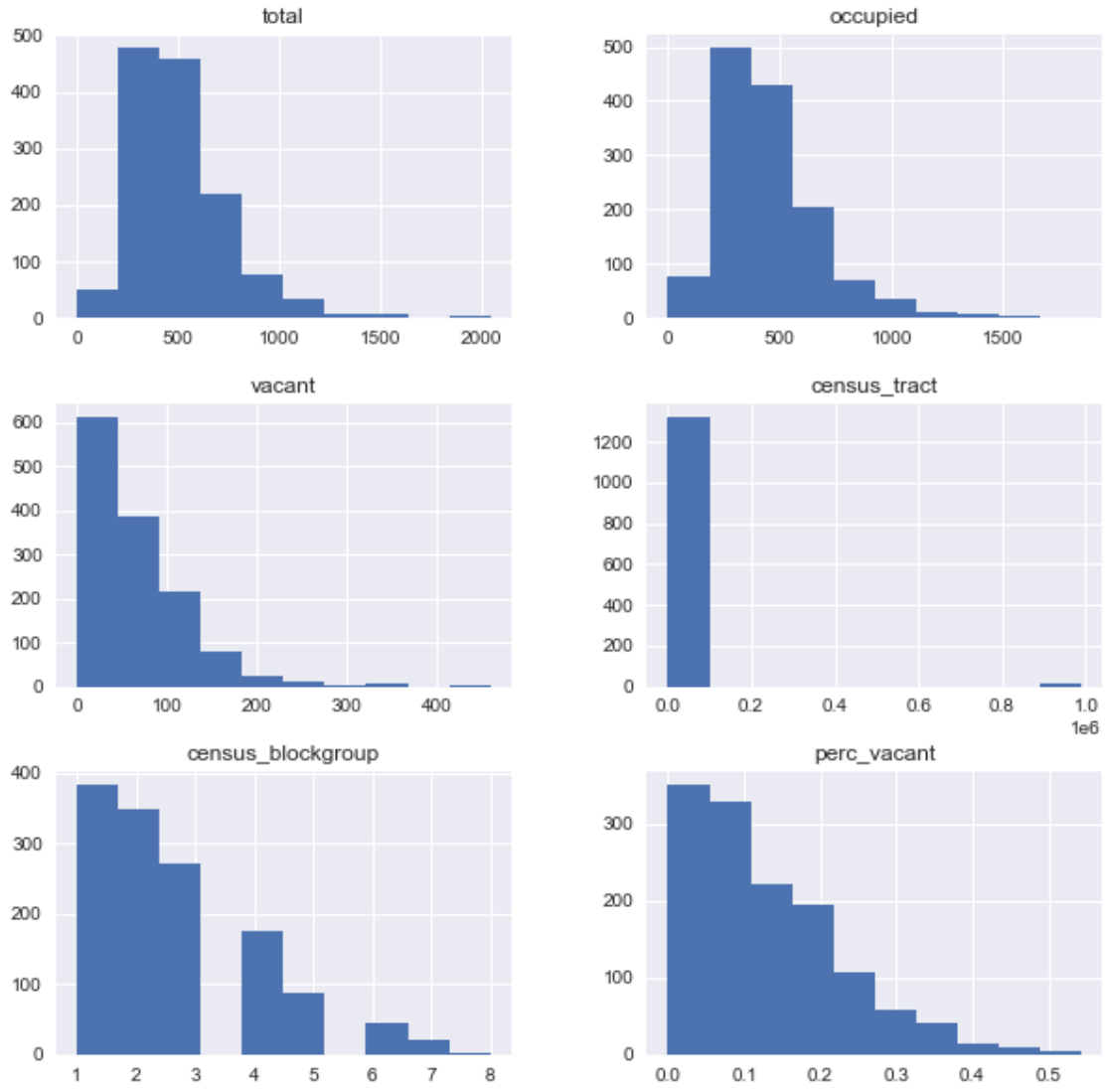
[ ]:
```
acs_occupancy.sum() #there are less vacant lots than occupies lots
```

[ ]:
```
index                Block Group 1, Census Tract 9807, Philadelphia…
total                                                         685956
occupied                                                      601337
vacant                                                         84619
census_info          Block Group 1, Census Tract 9807, Philadelphia…
county                101 101 101 101 101 101 101 101 101 101 101 1…
census_tract                                                36965677
census_blockgroup                                               3472
perc_vacant                                               166.785284
dtype: object
```

[ ]:
```
fig, ax = plt.subplots(figsize =(10,10))
acs_occupancy.hist(ax = ax) # vacant places are skwed
```

```
/var/folders/6p/wpw9qml57530xkxqkkhprrf40000gn/T/ipykernel_74088/2571989370.py:2
: UserWarning: To output multiple subplots, the figure containing the passed
axes is being cleared
  acs_occupancy.hist(ax = ax) # vacant places are skwed
```

[ ]:
```
array([[<AxesSubplot:title={'center':'total'}>,
        <AxesSubplot:title={'center':'occupied'}>],
       [<AxesSubplot:title={'center':'vacant'}>,
        <AxesSubplot:title={'center':'census_tract'}>],
       [<AxesSubplot:title={'center':'census_blockgroup'}>,
        <AxesSubplot:title={'center':'perc_vacant'}>]], dtype=object)
```



[ ]:
```
#converting tract and blockgroups into integer so that we can join dataset␣
 ↪easily
acs_occupancy['census_tract'] = acs_occupancy['census_tract'].astype(int)
acs_occupancy['census_blockgroup'] = acs_occupancy['census_blockgroup'].
 ↪astype(int)

census_blockgroups['TRACTCE10'] = census_blockgroups['TRACTCE10'].astype(int)
census_blockgroups['BLKGRPCE10'] = census_blockgroups['BLKGRPCE10'].astype(int)
```

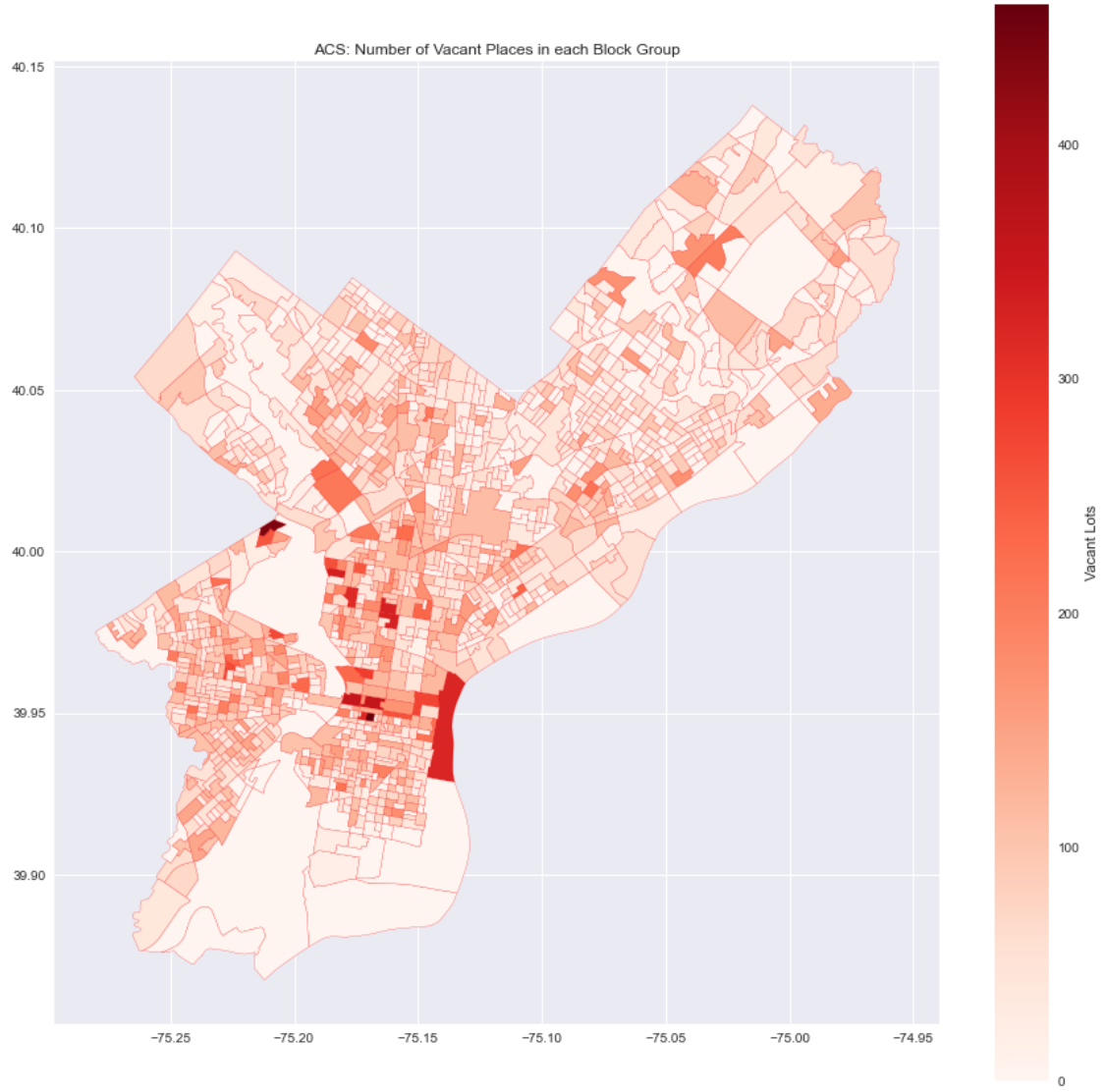
[ ]:
```
#merging occupancy acs dataset with blockgroup shape file
occupancy = census_blockgroups.merge(acs_occupancy, how='left',␣
 ↪left_on=["TRACTCE10", "BLKGRPCE10"],␣
 ↪right_on=["census_tract","census_blockgroup"])
```

```
[ ]: occupancy.head()
```

```
[ ]:    OBJECTID STATEFP10 COUNTYFP10  TRACTCE10  BLKGRPCE10       GEOID10  \
0         1        42        101      10800           1  421010108001
1         2        42        101      10800           2  421010108002
2         3        42        101      10900           2  421010109002
3         4        42        101      11000           2  421010110002
4         5        42        101      11000           1  421010110001

      NAMELSAD10 MTFCC10 FUNCSTAT10  ALAND10  …  \
0  Block Group 1   G5030          S   161887  …
1  Block Group 2   G5030          S   103778  …
2  Block Group 2   G5030          S    43724  …
3  Block Group 2   G5030          S   108966  …
4  Block Group 1   G5030          S   142244  …

                                            geometry  \
0  POLYGON ((-75.19851 39.96945, -75.19744 39.969…
1  POLYGON ((-75.19783 39.96571, -75.20006 39.965…
2  POLYGON ((-75.18766 39.96450, -75.18755 39.963…
3  POLYGON ((-75.20984 39.97351, -75.21221 39.973…
4  POLYGON ((-75.19855 39.97330, -75.19854 39.973…

                                          index total  occupied  vacant  \
0  Block Group 1, Census Tract 108, Philadelphia …   243       202      41
1  Block Group 2, Census Tract 108, Philadelphia …   360       239     121
2  Block Group 2, Census Tract 109, Philadelphia …   236       221      15
3  Block Group 2, Census Tract 110, Philadelphia …   478       348     130
4  Block Group 1, Census Tract 110, Philadelphia …   240       187      53

                                       census_info county  census_tract  \
0  Block Group 1, Census Tract 108, Philadelphia …    101         10800
1  Block Group 2, Census Tract 108, Philadelphia …    101         10800
2  Block Group 2, Census Tract 109, Philadelphia …    101         10900
3  Block Group 2, Census Tract 110, Philadelphia …    101         11000
4  Block Group 1, Census Tract 110, Philadelphia …    101         11000

   census_blockgroup  perc_vacant
0                  1     0.168724
1                  2     0.336111
2                  2     0.063559
3                  2     0.271967
4                  1     0.220833

[5 rows x 25 columns]
```

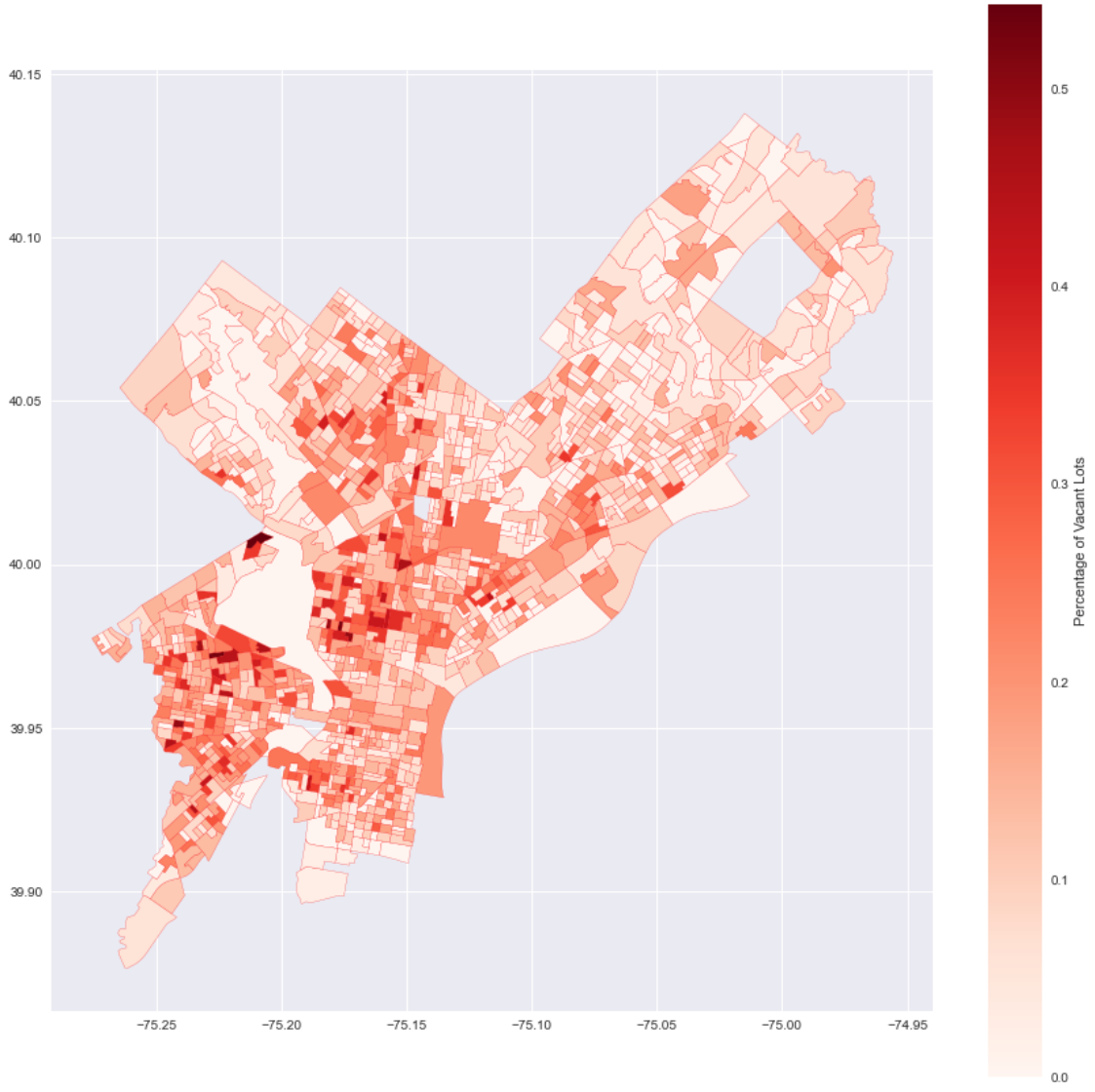
[ ]:
```
#plotting vacant lots on each block group
fig, ax = plt.subplots(figsize=(15,15))
plt.style.use('seaborn')
plt.title('ACS: Number of Vacant Places in each Block Group')
#census_blockgroups.to_crs("EPSG:4269").plot(ax=ax, color='white',␣
↪edgecolor='black')
occupancy.plot(ax=ax, column='vacant',
               edgecolor='red', linewidth=.2,
               cmap='Reds', legend=True,
               legend_kwds={'label': 'Vacant Lots'})
```

[ ]:
```
<AxesSubplot:title={'center':'ACS: Number of Vacant Places in each Block
Group'}>
```



[ ]:
```
#plotting percentage of vacant lots on each block group
#this shows that when when you do percentage, the plot changes completely. Think would be a better variable to consider than just looking at vacant lots
fig, ax = plt.subplots(figsize=(15,15))
plt.style.use('seaborn')
plt.title('ACS: Percentage of Vacant Places in each Block Group')
#census_blockgroups.to_crs("EPSG:4269").plot(ax=ax, color='white', edgecolor='black')
occupancy.plot(ax=ax, column='perc_vacant',
               edgecolor='red', linewidth=.2,
               cmap='Reds', legend=True,
               legend_kwds={'label': 'Percentage of Vacant Lots'})
```

[ ]: <AxesSubplot:>



1.1.9 ACS: Vacancy Type

[ ]:
```
censusdata.printtable(censusdata.censustable('acs5', 2019, 'B25004'))#␣
↪selecting type of vacancy table and the columns included
```

```
Variable     | Table                          | Label
| Type
-----------------------------------------------------------------------------
-----------------------------------
B25004_001E  | VACANCY STATUS                 | !! Estimate Total:
| int
B25004_002E  | VACANCY STATUS                 | !! !! Estimate Total: For rent
| int
B25004_003E  | VACANCY STATUS                 | !! !! Estimate Total: Rented,
not occupied               | int
B25004_004E  | VACANCY STATUS                 | !! !! Estimate Total: For sale
only                       | int
B25004_005E  | VACANCY STATUS                 | !! !! Estimate Total: Sold, not
occupied                 | int
B25004_006E  | VACANCY STATUS                 | !! !! Estimate Total: For
seasonal, recreational, or occ | int
B25004_007E  | VACANCY STATUS                 | !! !! Estimate Total: For
migrant workers                | int
B25004_008E  | VACANCY STATUS                 | !! !! Estimate Total: Other
vacant                       | int
-----------------------------------------------------------------------------
-----------------------------------
```

[ ]:
```
acs_vacant_type = censusdata.download('acs5', 2019,
           censusdata.censusgeo([('state', '42'),
                                 ('county', '101'), # philadelphia county
                                 ('block group', '*')]),# all blockgroups
                                 ['B25004_001E', 'B25004_002E', 'B25004_003E',␣
↪'B25004_004E', 'B25004_005E', 'B25004_006E',
                                 'B25004_007E', 'B25004_008E'])#selecting all␣
↪columns

acs_vacant_type.rename(columns = {'B25004_001E': 'total',
                                 'B25004_002E':  'for_rent',
                                 'B25004_003E' : 'rented_not_occupied',
                                 'B25004_004E' : 'for_sale_only',
                                 'B25004_005E' : 'sold_not_occupied',
                                 'B25004_006E' : 'seasonal_recreational',
                                 'B25004_007E' : 'migrant_workers',
```

```
                                'B25004_008E' : 'other'}, inplace =␣
↪True)#renaming columns

acs_vacant_type.to_csv('data/acs/vacant_type.csv')#downloading dataset
acs_vacant_type.head()
```

[ ]:

	total	for_rent	\
Block Group 1, Census Tract 9807, Philadelphia …	0	0	
Block Group 3, Census Tract 27.01, Philadelphia…	91	0	
Block Group 2, Census Tract 337.01, Philadelphi…	0	0	
Block Group 3, Census Tract 337.01, Philadelphi…	111	73	
Block Group 2, Census Tract 205, Philadelphia C…	106	0	

	rented_not_occupied	\
Block Group 1, Census Tract 9807, Philadelphia …	0	
Block Group 3, Census Tract 27.01, Philadelphia…	0	
Block Group 2, Census Tract 337.01, Philadelphi…	0	
Block Group 3, Census Tract 337.01, Philadelphi…	0	
Block Group 2, Census Tract 205, Philadelphia C…	0	

	for_sale_only	\
Block Group 1, Census Tract 9807, Philadelphia …	0	
Block Group 3, Census Tract 27.01, Philadelphia…	48	
Block Group 2, Census Tract 337.01, Philadelphi…	0	
Block Group 3, Census Tract 337.01, Philadelphi…	0	
Block Group 2, Census Tract 205, Philadelphia C…	0	

	sold_not_occupied	\
Block Group 1, Census Tract 9807, Philadelphia …	0	
Block Group 3, Census Tract 27.01, Philadelphia…	0	
Block Group 2, Census Tract 337.01, Philadelphi…	0	
Block Group 3, Census Tract 337.01, Philadelphi…	38	
Block Group 2, Census Tract 205, Philadelphia C…	0	

	seasonal_recreational	\
Block Group 1, Census Tract 9807, Philadelphia …	0	
Block Group 3, Census Tract 27.01, Philadelphia…	0	
Block Group 2, Census Tract 337.01, Philadelphi…	0	
Block Group 3, Census Tract 337.01, Philadelphi…	0	
Block Group 2, Census Tract 205, Philadelphia C…	0	

	migrant_workers	other
Block Group 1, Census Tract 9807, Philadelphia …	0	0
Block Group 3, Census Tract 27.01, Philadelphia…	0	43
Block Group 2, Census Tract 337.01, Philadelphi…	0	0
Block Group 3, Census Tract 337.01, Philadelphi…	0	0
Block Group 2, Census Tract 205, Philadelphia C…	0	106

[ ]:
```
acs_vacant_type.describe(include = 'all')#describing dataste
```

[ ]:
```
              total     for_rent  rented_not_occupied  for_sale_only  \
count  1336.000000  1336.000000          1336.000000    1336.000000
mean     63.337575    14.039671             3.464072       4.755240
std      58.294697    25.349141            11.301529      13.120158
min       0.000000     0.000000             0.000000       0.000000
25%      22.750000     0.000000             0.000000       0.000000
50%      51.000000     0.000000             0.000000       0.000000
75%      92.000000    22.000000             0.000000       0.000000
max     460.000000   231.000000           105.000000     135.000000

       sold_not_occupied  seasonal_recreational  migrant_workers        other
count        1336.000000            1336.000000      1336.000000  1336.000000
mean            3.907186               2.559880         0.142964    34.468563
std            11.882524              11.040043         3.346382    40.548789
min             0.000000               0.000000         0.000000     0.000000
25%             0.000000               0.000000         0.000000     0.000000
50%             0.000000               0.000000         0.000000    25.000000
75%             0.000000               0.000000         0.000000    52.000000
max           147.000000             144.000000       114.000000   334.000000
```

[ ]:
```
acs_vacant_type.sum() #most of the vacant places are "other"
```

[ ]:
```
total                   84619
for_rent                18757
rented_not_occupied      4628
for_sale_only            6353
sold_not_occupied        5220
seasonal_recreational    3420
migrant_workers           191
other                   46050
dtype: int64
```

[ ]:
```
(acs_vacant_type.sum()/acs_vacant_type['total'].sum()).sort_values()# other is␣
↪the highest percentage type of vacant lots, we will be focusing on this type␣
↪of vacant lot
```

[ ]:
```
migrant_workers         0.002257
seasonal_recreational   0.040416
rented_not_occupied     0.054692
sold_not_occupied       0.061688
for_sale_only           0.075078
for_rent                0.221664
other                   0.544204
total                   1.000000
dtype: float64
```

[ ]:
```
#splitting column to have seperate columns for blockgroup and tract.
acs_vacant_type = acs_vacant_type.reset_index() # reset index
acs_vacant_type['index'] = acs_vacant_type['index'].astype(str)# turning to␣
 ↪string
acs_vacant_type[['census_info','county', 'census_tract', 'census_blockgroup']]␣
 ↪= acs_vacant_type['index'].str.split('>', expand = True)
acs_vacant_type.head()
```

[ ]:

	index	total	for_rent	\
0	Block Group 1, Census Tract 9807, Philadelphia…	0	0	
1	Block Group 3, Census Tract 27.01, Philadelphi…	91	0	
2	Block Group 2, Census Tract 337.01, Philadelph…	0	0	
3	Block Group 3, Census Tract 337.01, Philadelph…	111	73	
4	Block Group 2, Census Tract 205, Philadelphia …	106	0	

	rented_not_occupied	for_sale_only	sold_not_occupied	\
0	0	0	0	
1	0	48	0	
2	0	0	0	
3	0	0	38	
4	0	0	0	

	seasonal_recreational	migrant_workers	other	\
0	0	0	0	
1	0	0	43	
2	0	0	0	
3	0	0	0	
4	0	0	106	

	census_info	county	\
0	Block Group 1, Census Tract 9807, Philadelphia…	county:101	
1	Block Group 3, Census Tract 27.01, Philadelphi…	county:101	
2	Block Group 2, Census Tract 337.01, Philadelph…	county:101	
3	Block Group 3, Census Tract 337.01, Philadelph…	county:101	
4	Block Group 2, Census Tract 205, Philadelphia …	county:101	

	census_tract	census_blockgroup
0	tract:980700	block group:1
1	tract:002701	block group:3
2	tract:033701	block group:2
3	tract:033701	block group:3
4	tract:020500	block group:2

[ ]:
```
#removing unnecessary words from the columns
acs_vacant_type['county'] = acs_vacant_type['county'].str.replace('county:',␣
 ↪'', regex = False)
```

```
acs_vacant_type['census_tract'] = acs_vacant_type['census_tract'].str.
 ↪replace('tract:', '', regex = False)
acs_vacant_type['census_blockgroup'] = acs_vacant_type['census_blockgroup'].str.
 ↪replace('block group:', '', regex = False)

#converting to integer
acs_vacant_type['census_tract'] = acs_vacant_type['census_tract'].astype(int)
acs_vacant_type['census_blockgroup'] = acs_vacant_type['census_blockgroup'].
 ↪astype(int)

#converting to integer
census_blockgroups['TRACTCE10'] = census_blockgroups['TRACTCE10'].astype(int)
census_blockgroups['BLKGRPCE10'] = census_blockgroups['BLKGRPCE10'].astype(int)

acs_vacant_type.head()
```

[ ]:

	index	total	for_rent	\
0	Block Group 1, Census Tract 9807, Philadelphia…	0	0	
1	Block Group 3, Census Tract 27.01, Philadelphi…	91	0	
2	Block Group 2, Census Tract 337.01, Philadelph…	0	0	
3	Block Group 3, Census Tract 337.01, Philadelph…	111	73	
4	Block Group 2, Census Tract 205, Philadelphia …	106	0	

	rented_not_occupied	for_sale_only	sold_not_occupied	\
0	0	0	0	
1	0	48	0	
2	0	0	0	
3	0	0	38	
4	0	0	0	

	seasonal_recreational	migrant_workers	other	\
0	0	0	0	
1	0	0	43	
2	0	0	0	
3	0	0	0	
4	0	0	106	

	census_info	county	census_tract	\
0	Block Group 1, Census Tract 9807, Philadelphia…	101	980700	
1	Block Group 3, Census Tract 27.01, Philadelphi…	101	002701	
2	Block Group 2, Census Tract 337.01, Philadelph…	101	033701	
3	Block Group 3, Census Tract 337.01, Philadelph…	101	033701	
4	Block Group 2, Census Tract 205, Philadelphia …	101	020500	

	census_blockgroup
0	1
1	3

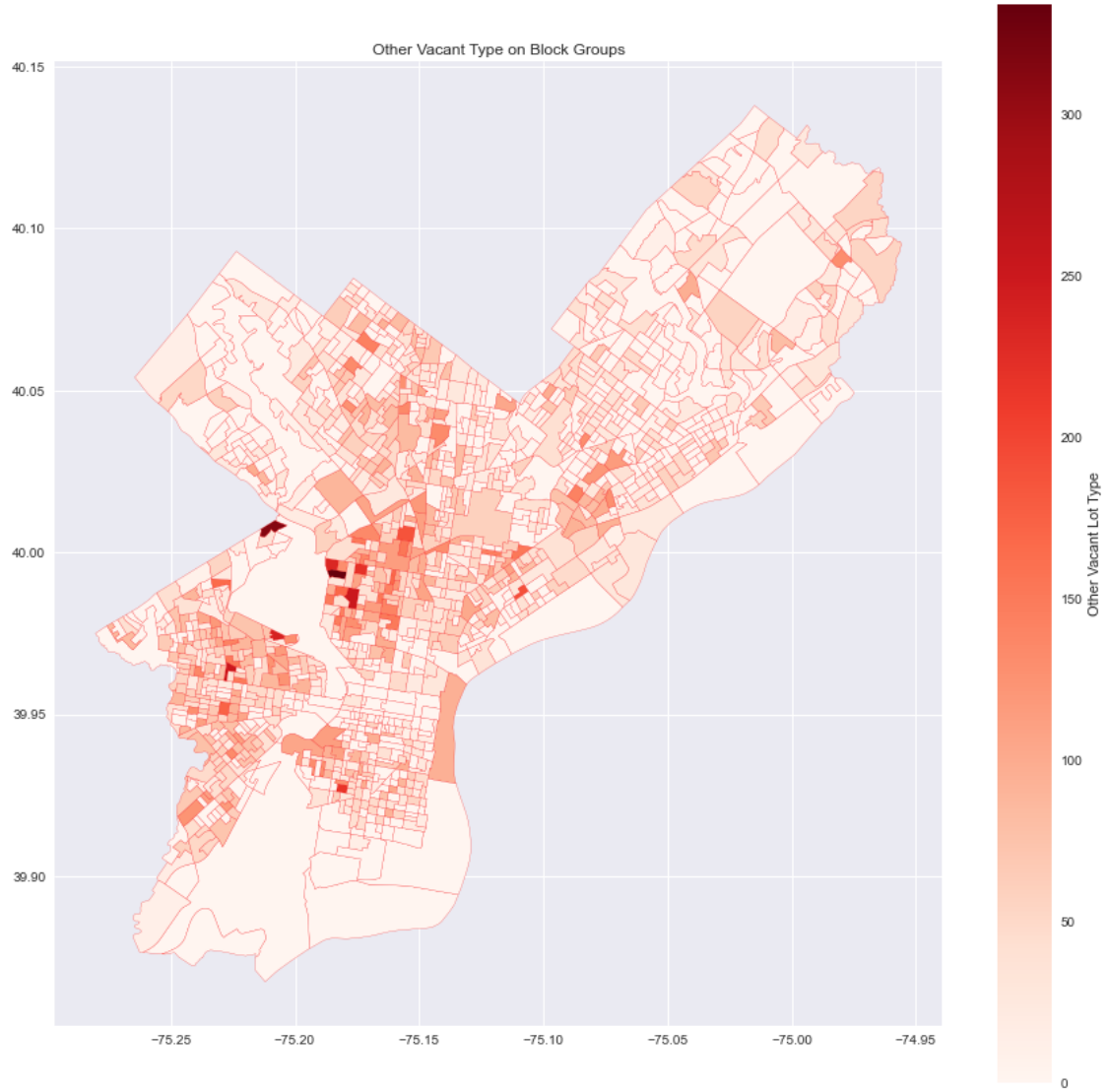
```
2                2
3                3
4                2
```

[ ]:
```
#merging vacant tyep file with shape file of blockgroup based on tract and␣
↪blockgroup
vacant_type = census_blockgroups.merge(acs_vacant_type, how='left',␣
↪left_on=["TRACTCE10", "BLKGRPCE10"],␣
↪right_on=["census_tract","census_blockgroup"])
vacant_type.head()
```

[ ]:
```
   OBJECTID STATEFP10 COUNTYFP10  TRACTCE10  BLKGRPCE10       GEOID10  \
0         1        42        101      10800           1  421010108001
1         2        42        101      10800           2  421010108002
2         3        42        101      10900           2  421010109002
3         4        42        101      11000           2  421010110002
4         5        42        101      11000           1  421010110001

      NAMELSAD10 MTFCC10 FUNCSTAT10  ALAND10  …  rented_not_occupied  \
0  Block Group 1   G5030          S   161887  …                    0
1  Block Group 2   G5030          S   103778  …                    0
2  Block Group 2   G5030          S    43724  …                    8
3  Block Group 2   G5030          S   108966  …                   32
4  Block Group 1   G5030          S   142244  …                   33

  for_sale_only sold_not_occupied  seasonal_recreational  migrant_workers  \
0             0                 0                      0                0
1             0                21                      0                0
2             0                 0                      0                0
3            25                 0                      0                0
4             0                 0                      0                0

  other                                        census_info  county  \
0    41  Block Group 1, Census Tract 108, Philadelphia …      101
1    82  Block Group 2, Census Tract 108, Philadelphia …      101
2     7  Block Group 2, Census Tract 109, Philadelphia …      101
3    73  Block Group 2, Census Tract 110, Philadelphia …      101
4    20  Block Group 1, Census Tract 110, Philadelphia …      101

   census_tract  census_blockgroup
0         10800                  1
1         10800                  2
2         10900                  2
3         11000                  2
4         11000                  1

[5 rows x 29 columns]
```

[ ]:
```
fig, ax = plt.subplots(figsize=(15,15))
plt.style.use('seaborn')
plt.title("Other Vacant Type on Block Groups")
#census_blockgroups.to_crs("EPSG:4269").plot(ax=ax, color='white',␣
↪edgecolor='black')
vacant_type.plot(ax=ax, column='other',
            edgecolor='red', linewidth=.2,
            cmap='Reds', legend=True,
            legend_kwds={'label': 'Other Vacant Lot Type'})
```

[ ]:
```
<AxesSubplot:title={'center':'Other Vacant Type on Block Groups'}>
```



1.1.10 Other Important ACS datasets

Datasets in this section are uploaded but not explored a lot at the moment. We are still deciding whether to use them.

ACS: Race

[ ]:
```
censusdata.printtable(censusdata.censustable('acs5', 2019, 'B03002'))#race
#censusdata.censustable('acs5', 2019, 'B03002')
```

```
Variable     | Table                            | Label
| Type
-------------------------------------------------------------------------------
-----------------------------------
B03002_001E  | HISPANIC OR LATINO ORIGIN BY R | !! Estimate Total:
| int
B03002_002E  | HISPANIC OR LATINO ORIGIN BY R | !! !! Estimate Total: Not
Hispanic or Latino:            | int
B03002_003E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total: Not
Hispanic or Latino: White a | int
B03002_004E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total: Not
Hispanic or Latino: Black o | int
B03002_005E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total: Not
Hispanic or Latino: America | int
B03002_006E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total: Not
Hispanic or Latino: Asian a | int
B03002_007E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total: Not
Hispanic or Latino: Native  | int
B03002_008E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total: Not
Hispanic or Latino: Some ot | int
B03002_009E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total: Not
Hispanic or Latino: Two or  | int
B03002_010E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! !! Estimate Total: Not
Hispanic or Latino: Two  | int
B03002_011E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! !! Estimate Total: Not
Hispanic or Latino: Two  | int
B03002_012E  | HISPANIC OR LATINO ORIGIN BY R | !! !! Estimate Total: Hispanic
or Latino:                | int
B03002_013E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total:
Hispanic or Latino: White alone | int
B03002_014E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total:
Hispanic or Latino: Black or Af | int
B03002_015E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total:
Hispanic or Latino: American In | int
B03002_016E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total:
Hispanic or Latino: Asian alone | int
B03002_017E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total:
Hispanic or Latino: Native Hawa | int
B03002_018E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total:
```

```
Hispanic or Latino: Some other  | int
B03002_019E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! Estimate Total:
Hispanic or Latino: Two or more | int
B03002_020E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! !! Estimate Total:
Hispanic or Latino: Two or m | int
B03002_021E  | HISPANIC OR LATINO ORIGIN BY R | !! !! !! !! Estimate Total:
Hispanic or Latino: Two or m | int
--------------------------------------------------------------------------------
----------------------------------
```

[ ]:
```
acs_race = censusdata.download('acs5', 2019,
           censusdata.censusgeo([('state', '42'),
                                 ('county', '101'), # philadelphia county
                                 ('block group', '*')]),
                                 ['B03002_001E', 'B03002_003E', 'B03002_004E',␣
 ↪'B03002_006E', 'B03002_012E'])

acs_race.rename(columns = {'B03002_001E': 'race_total',
                           'B03002_003E': 'race_white',
                           'B03002_004E': 'race_black',
                           'B03002_006E': 'race_asian',
                           'B03002_012E': 'race_hispanic'}, inplace = True)

acs_race.to_csv('data/acs/race.csv')
acs_race.head()
```

[ ]:

	race_total	race_white	\
Block Group 1, Census Tract 9807, Philadelphia …	0	0	
Block Group 3, Census Tract 27.01, Philadelphia…	1955	904	
Block Group 2, Census Tract 337.01, Philadelphi…	976	654	
Block Group 3, Census Tract 337.01, Philadelphi…	3859	1594	
Block Group 2, Census Tract 205, Philadelphia C…	1017	36	

	race_black	race_asian	\
Block Group 1, Census Tract 9807, Philadelphia …	0	0	
Block Group 3, Census Tract 27.01, Philadelphia…	262	502	
Block Group 2, Census Tract 337.01, Philadelphi…	0	99	
Block Group 3, Census Tract 337.01, Philadelphi…	477	305	
Block Group 2, Census Tract 205, Philadelphia C…	796	124	

	race_hispanic
Block Group 1, Census Tract 9807, Philadelphia …	0
Block Group 3, Census Tract 27.01, Philadelphia…	251
Block Group 2, Census Tract 337.01, Philadelphi…	79
Block Group 3, Census Tract 337.01, Philadelphi…	1301
Block Group 2, Census Tract 205, Philadelphia C…	61

ACS: Education

```
[ ]: censusdata.printtable(censusdata.censustable('acs5', 2015, 'B15002'))#education
```

```
Variable     | Table                              | Label
| Type
-------------------------------------------------------------------------------
-----------------------------------
B15002_001E  | SEX BY EDUCATIONAL ATTAINMENT  | !! Estimate Total
| int
B15002_002E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! Estimate Total Male
| int
B15002_003E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male No
schooling completed      | int
B15002_004E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
Nursery to 4th grade        | int
B15002_005E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male 5th
and 6th grade           | int
B15002_006E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male 7th
and 8th grade           | int
B15002_007E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male 9th
grade                   | int
B15002_008E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
10th grade                  | int
B15002_009E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
11th grade                  | int
B15002_010E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
12th grade, no diploma      | int
B15002_011E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
High school graduate (inclu | int
B15002_012E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
Some college, less than 1 y | int
B15002_013E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
Some college, 1 or more yea | int
B15002_014E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
Associate's degree          | int
B15002_015E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
Bachelor's degree           | int
B15002_016E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
Master's degree             | int
B15002_017E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
Professional school degree  | int
B15002_018E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Male
Doctorate degree            | int
B15002_019E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! Estimate Total Female
| int
B15002_020E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
No schooling completed    | int
```

```
B15002_021E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
Nursery to 4th grade      | int
B15002_022E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
5th and 6th grade         | int
B15002_023E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
7th and 8th grade         | int
B15002_024E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
9th grade                 | int
B15002_025E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
10th grade                | int
B15002_026E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
11th grade                | int
B15002_027E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
12th grade, no diploma    | int
B15002_028E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
High school graduate (inc | int
B15002_029E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
Some college, less than 1 | int
B15002_030E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
Some college, 1 or more y | int
B15002_031E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
Associate's degree        | int
B15002_032E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
Bachelor's degree         | int
B15002_033E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
Master's degree           | int
B15002_034E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
Professional school degre | int
B15002_035E  | SEX BY EDUCATIONAL ATTAINMENT  | !! !! !! Estimate Total Female
Doctorate degree          | int
--------------------------------------------------------------------------------
----------------------------------
```

ACS: Household Income

[ ]:
```
censusdata.printtable(censusdata.censustable('acs5', 2015, 'B19001'))#household␣
↪income
```

```
Variable     | Table                          | Label
| Type
--------------------------------------------------------------------------------
----------------------------------
B19001_001E  | HOUSEHOLD INCOME IN THE PAST 1 | !! Estimate Total
| int
B19001_002E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total Less than
$10,000                   | int
B19001_003E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $10,000 to
$14,999                   | int
```

```
B19001_004E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $15,000 to
$19,999                  | int
B19001_005E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $20,000 to
$24,999                  | int
B19001_006E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $25,000 to
$29,999                  | int
B19001_007E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $30,000 to
$34,999                  | int
B19001_008E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $35,000 to
$39,999                  | int
B19001_009E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $40,000 to
$44,999                  | int
B19001_010E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $45,000 to
$49,999                  | int
B19001_011E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $50,000 to
$59,999                  | int
B19001_012E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $60,000 to
$74,999                  | int
B19001_013E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $75,000 to
$99,999                  | int
B19001_014E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $100,000 to
$124,999                | int
B19001_015E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $125,000 to
$149,999                | int
B19001_016E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $150,000 to
$199,999                | int
B19001_017E  | HOUSEHOLD INCOME IN THE PAST 1 | !! !! Estimate Total $200,000 or
more                     | int
--------------------------------------------------------------------------------
----------------------------------
```

ACS: Age and Sex

[ ]:
```
censusdata.printtable(censusdata.censustable('acs5', 2019, 'B01001'))#age and sex
```

```
Variable     | Table                          | Label
| Type
--------------------------------------------------------------------------------
----------------------------------
B01001_001E  | SEX BY AGE                     | !! Estimate Total:
| int
B01001_002E  | SEX BY AGE                     | !! !! Estimate Total: Male:
| int
B01001_003E  | SEX BY AGE                     | !! !! !! Estimate Total: Male:
Under 5 years             | int
B01001_004E  | SEX BY AGE                     | !! !! !! Estimate Total: Male: 5
to 9 years                | int
```

```
B01001_005E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
10 to 14 years            | int
B01001_006E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
15 to 17 years            | int
B01001_007E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
18 and 19 years           | int
B01001_008E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
20 years                  | int
B01001_009E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
21 years                  | int
B01001_010E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
22 to 24 years            | int
B01001_011E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
25 to 29 years            | int
B01001_012E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
30 to 34 years            | int
B01001_013E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
35 to 39 years            | int
B01001_014E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
40 to 44 years            | int
B01001_015E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
45 to 49 years            | int
B01001_016E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
50 to 54 years            | int
B01001_017E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
55 to 59 years            | int
B01001_018E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
60 and 61 years           | int
B01001_019E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
62 to 64 years            | int
B01001_020E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
65 and 66 years           | int
B01001_021E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
67 to 69 years            | int
B01001_022E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
70 to 74 years            | int
B01001_023E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
75 to 79 years            | int
B01001_024E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
80 to 84 years            | int
B01001_025E  | SEX BY AGE                    | !! !! !! Estimate Total: Male:
85 years and over         | int
B01001_026E  | SEX BY AGE                    | !! !! Estimate Total: Female:
| int
B01001_027E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
Under 5 years           | int
B01001_028E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
5 to 9 years            | int
```

```
B01001_029E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
10 to 14 years          | int
B01001_030E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
15 to 17 years          | int
B01001_031E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
18 and 19 years         | int
B01001_032E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
20 years                | int
B01001_033E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
21 years                | int
B01001_034E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
22 to 24 years          | int
B01001_035E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
25 to 29 years          | int
B01001_036E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
30 to 34 years          | int
B01001_037E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
35 to 39 years          | int
B01001_038E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
40 to 44 years          | int
B01001_039E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
45 to 49 years          | int
B01001_040E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
50 to 54 years          | int
B01001_041E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
55 to 59 years          | int
B01001_042E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
60 and 61 years         | int
B01001_043E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
62 to 64 years          | int
B01001_044E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
65 and 66 years         | int
B01001_045E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
67 to 69 years          | int
B01001_046E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
70 to 74 years          | int
B01001_047E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
75 to 79 years          | int
B01001_048E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
80 to 84 years          | int
B01001_049E  | SEX BY AGE                    | !! !! !! Estimate Total: Female:
85 years and over       | int
--------------------------------------------------------------------------------
----------------------------------
```

[ ]:
```
acs_gender = censusdata.download('acs5', 2019,
           censusdata.censusgeo([('state', '42'),
```

```
                                ('county', '101'), # philadelphia county
                                ('block group', '*')]),
                                ['B01001_001E', 'B01001_002E', 'B01001_026E'])

acs_gender.rename(columns = {'B01001_001E': 'total',
                             'B01001_002E': 'Male',
                             'B01001_026E': 'Female',}, inplace = True)␣
 ↪#include age here, group by under 18, 18-64, 65 and over

acs_gender.to_csv('data/acs/gender.csv')
acs_gender.head()
```

	total	Male	Female
Block Group 1, Census Tract 9807, Philadelphia …	0	0	0
Block Group 3, Census Tract 27.01, Philadelphia…	1955	1023	932
Block Group 2, Census Tract 337.01, Philadelphi…	976	541	435
Block Group 3, Census Tract 337.01, Philadelphi…	3859	1969	1890
Block Group 2, Census Tract 205, Philadelphia C…	1017	553	464

ACS: Poverty Status

[ ]:
```
censusdata.printtable(censusdata.censustable('acs5', 2015, 'B17001'))#poverty␣
 ↪stattus
```

```
Variable     | Table                          | Label
| Type
-------------------------------------------------------------------------------
-----------------------------------
B17001_001E  | POVERTY STATUS IN THE PAST 12  | !! Estimate Total
| int
B17001_002E  | POVERTY STATUS IN THE PAST 12  | !! !! Estimate Total Income in
the past 12 months below  | int
B17001_003E  | POVERTY STATUS IN THE PAST 12  | !! !! !! Estimate Total Income
in the past 12 months bel | int
B17001_004E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_005E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_006E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_007E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_008E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_009E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_010E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
```

```
B17001_011E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_012E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_013E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_014E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_015E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_016E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_017E  | POVERTY STATUS IN THE PAST 12  | !! !! !! Estimate Total Income
in the past 12 months bel | int
B17001_018E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_019E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_020E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_021E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_022E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_023E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_024E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_025E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_026E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_027E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_028E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_029E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_030E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_031E  | POVERTY STATUS IN THE PAST 12  | !! !! Estimate Total Income in
the past 12 months at or  | int
B17001_032E  | POVERTY STATUS IN THE PAST 12  | !! !! !! Estimate Total Income
in the past 12 months at  | int
B17001_033E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
B17001_034E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
```

B17001_035E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_036E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_037E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_038E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_039E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_040E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_041E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_042E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_043E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_044E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_045E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_046E | POVERTY STATUS IN THE PAST 12 | !! !! !! Estimate Total Income in the past 12 months at | int
B17001_047E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_048E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_049E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_050E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_051E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_052E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_053E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_054E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_055E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_056E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_057E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int
B17001_058E | POVERTY STATUS IN THE PAST 12 | !! !! !! !! Estimate Total Income in the past 12 months | int

```
B17001_059E  | POVERTY STATUS IN THE PAST 12  | !! !! !! !! Estimate Total
Income in the past 12 months  | int
--------------------------------------------------------------------------------
---------------------------------
```

1.1.11 City of Philadelphia: Property Tax Delinquency

https://metadata.phila.gov/#home/datasetdetails/57d9643afab162fe2708224e/representationdetails/57d9643cfab

An account is delinquent when Real Estate Tax is still unpaid on January 1 the following year the tax was due

Date Range 1972 - 2018, Updated Monthly

[ ]:
```
tax = pd.read_csv('data/city/real_estate_tax_delinquencies.csv')#uploading␣
↪dataset
```

[ ]:
```
tax.head()
```

[ ]:
```
   objectid   opa_number    street_address  zip_code   zip_4 unit_type  \
0   2556493  493169300.0   6045 N CAMAC ST   19141.0  3227.0       NaN
1   2556494  493179100.0   5620 N CAMAC ST   19141.0  4106.0       NaN
2   2556495  493180700.0   5714 N CAMAC ST   19141.0  4108.0       NaN
3   2556496  493183600.0   5812 N CAMAC ST   19141.0  4123.0       NaN
4   2556497  223166200.0  420 GLEN ECHO RD   19119.0  2914.0       NaN

  unit_num                owner             co_owner  principal_due  …  \
0      NaN  WILLIAMS JACQUELINE  WILLIAMS JACQUELINE       12200.18  …
1      NaN          RAY MATTIE E          RAY MATTIE E          -0.05  …
2      NaN          TOMLIN PAULA          TOMLIN PAULA         895.87  …
3      NaN    BATTS PRINCETON B    BATTS PRINCETON B        4536.94  …
4      NaN        WHITE CLARENCE       WHITE CLARENCE        4224.60  …

   oldest_bankrupt_year  principal_sum_bankrupt_years  \
0                   NaN                           NaN
1                   NaN                           NaN
2                   NaN                           NaN
3                   NaN                           NaN
4                   NaN                           NaN

   total_amount_bankrupt_years  sheriff_sale  liens_sold_1990s  \
0                          NaN             N             False
1                          NaN             N             False
2                          NaN             N             False
3                          NaN             N             False
4                          NaN             N             False

   liens_sold_2015  assessment_under_appeal  year_month        lat        lng
0                N                    False      202111 -75.140099  40.045081
```

```
1                N                    False      202111 -75.141930  40.039007
2                N                    False      202111 -75.141727  40.039940
3                N                    False      202111 -75.141395  40.041404
4                N                    False      202111 -75.195309  40.051563

[5 rows x 55 columns]
```

[ ]:
```
tax.columns #columns in dataset
```

[ ]:
```
Index(['objectid', 'opa_number', 'street_address', 'zip_code', 'zip_4',
       'unit_type', 'unit_num', 'owner', 'co_owner', 'principal_due',
       'penalty_due', 'interest_due', 'other_charges_due', 'total_due',
       'is_actionable', 'payment_agreement', 'num_years_owed',
       'most_recent_year_owed', 'oldest_year_owed', 'most_recent_payment_date',
       'year_of_last_assessment', 'total_assessment', 'taxable_assessment',
       'mailing_address', 'mailing_city', 'mailing_state', 'mailing_zip',
       'return_mail', 'building_code', 'detail_building_description',
       'general_building_description', 'building_category',
       'coll_agency_num_years', 'coll_agency_most_recent_year',
       'coll_agency_oldest_year', 'coll_agency_principal_owed',
       'coll_agency_total_owed', 'exempt_abatement_assessment',
       'homestead_value', 'net_tax_value_after_homestead', 'agreement_agency',
       'sequestration_enforcement', 'bankruptcy', 'years_in_bankruptcy',
       'most_recent_bankrupt_year', 'oldest_bankrupt_year',
       'principal_sum_bankrupt_years', 'total_amount_bankrupt_years',
       'sheriff_sale', 'liens_sold_1990s', 'liens_sold_2015',
       'assessment_under_appeal', 'year_month', 'lat', 'lng'],
      dtype='object')
```

[ ]:
```
tax.dtypes #type of data included
```

[ ]:
```
objectid                        int64
opa_number                    float64
street_address                 object
zip_code                      float64
zip_4                         float64
unit_type                      object
unit_num                       object
owner                          object
co_owner                       object
principal_due                 float64
penalty_due                   float64
interest_due                  float64
other_charges_due             float64
total_due                     float64
is_actionable                    bool
payment_agreement                bool
```

```
num_years_owed                    int64
most_recent_year_owed             int64
oldest_year_owed                  int64
most_recent_payment_date         object
year_of_last_assessment         float64
total_assessment                float64
taxable_assessment              float64
mailing_address                  object
mailing_city                     object
mailing_state                    object
mailing_zip                     float64
return_mail                      object
building_code                    object
detail_building_description      object
general_building_description     object
building_category                object
coll_agency_num_years             int64
coll_agency_most_recent_year    float64
coll_agency_oldest_year         float64
coll_agency_principal_owed      float64
coll_agency_total_owed          float64
exempt_abatement_assessment     float64
homestead_value                 float64
net_tax_value_after_homestead   float64
agreement_agency                 object
sequestration_enforcement          bool
bankruptcy                         bool
years_in_bankruptcy             float64
most_recent_bankrupt_year       float64
oldest_bankrupt_year            float64
principal_sum_bankrupt_years    float64
total_amount_bankrupt_years     float64
sheriff_sale                     object
liens_sold_1990s                   bool
liens_sold_2015                  object
assessment_under_appeal            bool
year_month                        int64
lat                             float64
lng                             float64
dtype: object
```

[ ]:
```
tax.T# transposing the dataset
```

[ ]:
```
                                        0                    1      \
objectid                          2556493              2556494
opa_number                    493169300.0          493179100.0
street_address            6045 N CAMAC ST      5620 N CAMAC ST
```

zip_code	19141.0	19141.0
zip_4	3227.0	4106.0
unit_type	NaN	NaN
unit_num	NaN	NaN
owner	WILLIAMS JACQUELINE	RAY MATTIE E
co_owner	WILLIAMS JACQUELINE	RAY MATTIE E
principal_due	12200.18	-0.05
penalty_due	1110.17	0.0
interest_due	14261.97	41.05
other_charges_due	3098.66	0.0
total_due	30670.98	41.0
is_actionable	False	False
payment_agreement	True	True
num_years_owed	23	1
most_recent_year_owed	2021	2021
oldest_year_owed	1994	2021
most_recent_payment_date	2021-09-16 00:00:00	2021-09-17 00:00:00
year_of_last_assessment	2021.0	2021.0
total_assessment	111400.0	111200.0
taxable_assessment	111400.0	111200.0
mailing_address	NaN	NaN
mailing_city	NaN	NaN
mailing_state	NaN	NaN
mailing_zip	NaN	NaN
return_mail	True	NaN
building_code	R30	R30
detail_building_description	ROW B/GAR 2STY MASON	ROW B/GAR 2STY MASON
general_building_description	house	house
building_category	residential	residential
coll_agency_num_years	0	0
coll_agency_most_recent_year	NaN	NaN
coll_agency_oldest_year	NaN	NaN
coll_agency_principal_owed	0.0	0.0
coll_agency_total_owed	0.0	0.0
exempt_abatement_assessment	0.0	0.0
homestead_value	629.91	629.91
net_tax_value_after_homestead	929.47	926.67
agreement_agency	TIPS	TIPS
sequestration_enforcement	False	False
bankruptcy	False	False
years_in_bankruptcy	NaN	NaN
most_recent_bankrupt_year	NaN	NaN
oldest_bankrupt_year	NaN	NaN
principal_sum_bankrupt_years	NaN	NaN
total_amount_bankrupt_years	NaN	NaN
sheriff_sale	N	N
liens_sold_1990s	False	False

liens_sold_2015	N	N	
assessment_under_appeal	False	False	
year_month	202111	202111	
lat	-75.140099	-75.14193	
lng	40.045081	40.039007	

	2	3	\
objectid	2556495	2556496	
opa_number	493180700.0	493183600.0	
street_address	5714 N CAMAC ST	5812 N CAMAC ST	
zip_code	19141.0	19141.0	
zip_4	4108.0	4123.0	
unit_type	NaN	NaN	
unit_num	NaN	NaN	
owner	TOMLIN PAULA	BATTS PRINCETON B	
co_owner	TOMLIN PAULA	BATTS PRINCETON B	
principal_due	895.87	4536.94	
penalty_due	0.0	283.14	
interest_due	120.94	1161.05	
other_charges_due	0.0	710.57	
total_due	1016.81	6691.7	
is_actionable	False	False	
payment_agreement	False	True	
num_years_owed	1	5	
most_recent_year_owed	2021	2021	
oldest_year_owed	2021	2017	
most_recent_payment_date	2020-02-22 00:00:00	2021-08-26 00:00:00	
year_of_last_assessment	2021.0	2021.0	
total_assessment	109000.0	110600.0	
taxable_assessment	109000.0	110600.0	
mailing_address	NaN	NaN	
mailing_city	NaN	NaN	
mailing_state	NaN	NaN	
mailing_zip	NaN	NaN	
return_mail	NaN	True	
building_code	R30	R30	
detail_building_description	ROW B/GAR 2STY MASON	ROW B/GAR 2STY MASON	
general_building_description	house	house	
building_category	residential	residential	
coll_agency_num_years	1	0	
coll_agency_most_recent_year	2021.0	NaN	
coll_agency_oldest_year	2021.0	NaN	
coll_agency_principal_owed	895.87	0.0	
coll_agency_total_owed	1016.81	0.0	
exempt_abatement_assessment	0.0	0.0	
homestead_value	629.91	629.91	
net_tax_value_after_homestead	895.87	918.27	

agreement_agency	NaN	TIPS
sequestration_enforcement	False	False
bankruptcy	False	False
years_in_bankruptcy	NaN	NaN
most_recent_bankrupt_year	NaN	NaN
oldest_bankrupt_year	NaN	NaN
principal_sum_bankrupt_years	NaN	NaN
total_amount_bankrupt_years	NaN	NaN
sheriff_sale	N	N
liens_sold_1990s	False	False
liens_sold_2015	N	N
assessment_under_appeal	False	False
year_month	202111	202111
lat	-75.141727	-75.141395
lng	40.03994	40.041404

	4 \
objectid	2556497
opa_number	223166200.0
street_address	420 GLEN ECHO RD
zip_code	19119.0
zip_4	2914.0
unit_type	NaN
unit_num	NaN
owner	WHITE CLARENCE
co_owner	WHITE CLARENCE
principal_due	4224.6
penalty_due	0.0
interest_due	570.32
other_charges_due	0.0
total_due	4794.92
is_actionable	False
payment_agreement	False
num_years_owed	1
most_recent_year_owed	2021
oldest_year_owed	2021
most_recent_payment_date	2020-12-22 00:00:00
year_of_last_assessment	2021.0
total_assessment	346800.0
taxable_assessment	346800.0
mailing_address	NaN
mailing_city	NaN
mailing_state	NaN
mailing_zip	NaN
return_mail	NaN
building_code	D30
detail_building_description	DET W/B GAR 2 STY MA

general_building_description	house
building_category	residential
coll_agency_num_years	1
coll_agency_most_recent_year	2021.0
coll_agency_oldest_year	2021.0
coll_agency_principal_owed	4224.6
coll_agency_total_owed	4794.92
exempt_abatement_assessment	0.0
homestead_value	629.91
net_tax_value_after_homestead	4224.6
agreement_agency	NaN
sequestration_enforcement	False
bankruptcy	False
years_in_bankruptcy	NaN
most_recent_bankrupt_year	NaN
oldest_bankrupt_year	NaN
principal_sum_bankrupt_years	NaN
total_amount_bankrupt_years	NaN
sheriff_sale	N
liens_sold_1990s	False
liens_sold_2015	N
assessment_under_appeal	False
year_month	202111
lat	-75.195309
lng	40.051563

	5 \
objectid	2556498
opa_number	882929915.0
street_address	2312 DUNCAN ST
zip_code	19124.0
zip_4	4110.0
unit_type	NaN
unit_num	NaN
owner	WHITE DIAMOND ATHLETIC ASSN
co_owner	WHITE DIAMOND ATHLETIC ASSN
principal_due	1068.0
penalty_due	131.99
interest_due	286.92
other_charges_due	445.91
total_due	1932.82
is_actionable	True
payment_agreement	False
num_years_owed	3
most_recent_year_owed	2021
oldest_year_owed	2018
most_recent_payment_date	2021-09-30 00:00:00

year_of_last_assessment	2021.0
total_assessment	62900.0
taxable_assessment	62900.0
mailing_address	NaN
mailing_city	NaN
mailing_state	NaN
mailing_zip	NaN
return_mail	NaN
building_code	JE0
detail_building_description	AMUSE CLUB PRIV MASO
general_building_description	theater_stadium_other amuse
building_category	commercial
coll_agency_num_years	3
coll_agency_most_recent_year	2019.0
coll_agency_oldest_year	2018.0
coll_agency_principal_owed	1068.0
coll_agency_total_owed	1893.2
exempt_abatement_assessment	0.0
homestead_value	0.0
net_tax_value_after_homestead	880.47
agreement_agency	NaN
sequestration_enforcement	False
bankruptcy	False
years_in_bankruptcy	NaN
most_recent_bankrupt_year	NaN
oldest_bankrupt_year	NaN
principal_sum_bankrupt_years	NaN
total_amount_bankrupt_years	NaN
sheriff_sale	N
liens_sold_1990s	False
liens_sold_2015	N
assessment_under_appeal	False
year_month	202111
lat	-75.080997
lng	40.006557

	6	7	\
objectid	2556499	2556500	
opa_number	231024100.0	231042300.0	
street_address	4321 MELROSE ST	4540 MILNOR ST	
zip_code	19124.0	19124.0	
zip_4	4100.0	4120.0	
unit_type	NaN	NaN	
unit_num	NaN	NaN	
owner	HOPWOOD WILLIAM D	KARAS HELEN	
co_owner	HOPWOOD WILLIAM D	KARAS HELEN	
principal_due	1493.6	21.92	

penalty_due	102.78	1.53
interest_due	503.95	1.97
other_charges_due	741.76	4.58
total_due	2842.09	30.0
is_actionable	True	True
payment_agreement	False	False
num_years_owed	5	1
most_recent_year_owed	2021	2020
oldest_year_owed	2016	2020
most_recent_payment_date	2021-09-21 00:00:00	2021-01-05 00:00:00
year_of_last_assessment	2021.0	2021.0
total_assessment	21800.0	104400.0
taxable_assessment	21800.0	104400.0
mailing_address	NaN	NaN
mailing_city	NaN	NaN
mailing_state	NaN	NaN
mailing_zip	NaN	NaN
return_mail	NaN	NaN
building_code	SR	H31
detail_building_description	VAC LAND RES < ACRE	SEMI/DET 2 STY MAS.+
general_building_description	vacantLand	house
building_category	residential	residential
coll_agency_num_years	4	1
coll_agency_most_recent_year	2019.0	2020.0
coll_agency_oldest_year	2016.0	2020.0
coll_agency_principal_owed	1188.44	21.92
coll_agency_total_owed	2495.73	30.0
exempt_abatement_assessment	0.0	0.0
homestead_value	0.0	0.0
net_tax_value_after_homestead	305.16	1461.39
agreement_agency	NaN	NaN
sequestration_enforcement	False	False
bankruptcy	False	False
years_in_bankruptcy	NaN	NaN
most_recent_bankrupt_year	NaN	NaN
oldest_bankrupt_year	NaN	NaN
principal_sum_bankrupt_years	NaN	NaN
total_amount_bankrupt_years	NaN	NaN
sheriff_sale	N	N
liens_sold_1990s	False	False
liens_sold_2015	N	N
assessment_under_appeal	False	False
year_month	202111	202111
lat	-75.08183	-75.079183
lng	40.006032	40.005409

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objectid	2556501
opa_number	871569460.0
street_address	4920 LANCASTER AVE
zip_code	19131.0
zip_4	4519.0
unit_type	NaN
unit_num	NaN
owner	MICHAEL EARL DAVIS JR IRREVOCA
co_owner	MICHAEL EARL DAVIS JR IRREVOCABLE TRUST
principal_due	1054.91
penalty_due	45.88
interest_due	202.88
other_charges_due	181.5
total_due	1485.17
is_actionable	False
payment_agreement	True
num_years_owed	2
most_recent_year_owed	2021
oldest_year_owed	2019
most_recent_payment_date	2021-09-13 00:00:00
year_of_last_assessment	2021.0
total_assessment	82100.0
taxable_assessment	82100.0
mailing_address	3708 SPRING GARDEN ST
mailing_city	PHILADELPHIA
mailing_state	PA
mailing_zip	19104.0
return_mail	NaN
building_code	S30
detail_building_description	ROW W-OFF/STR 2STY M
general_building_description	mixedUsage
building_category	commercial
coll_agency_num_years	0
coll_agency_most_recent_year	NaN
coll_agency_oldest_year	NaN
coll_agency_principal_owed	0.0
coll_agency_total_owed	0.0
exempt_abatement_assessment	0.0
homestead_value	0.0
net_tax_value_after_homestead	1149.24
agreement_agency	TIPS
sequestration_enforcement	False
bankruptcy	False
years_in_bankruptcy	NaN
most_recent_bankrupt_year	NaN
oldest_bankrupt_year	NaN
principal_sum_bankrupt_years	NaN

total_amount_bankrupt_years			NaN	
sheriff_sale			N	
liens_sold_1990s			False	
liens_sold_2015			N	
assessment_under_appeal			False	
year_month			202111	
lat			-75.220452	
lng			39.973931	

		…		\
	9	…	72708	
objectid	2556502	…	2628136	
opa_number	442203100.0	…	462127900.0	
street_address	923 N FALLON ST	…	5217 BALTIMORE AVE	
zip_code	19131.0	…	19143.0	
zip_4	5120.0	…	2622.0	
unit_type	NaN	…	NaN	
unit_num	NaN	…	NaN	
owner	SMITH FRANK	…	WHITING WARNER H	
co_owner	SMITH FRANK	…	WHITING WARNER H	
principal_due	2009.47	…	1758.15	
penalty_due	297.5	…	0.0	
interest_due	2647.13	…	237.35	
other_charges_due	767.26	…	0.0	
total_due	5721.36	…	1995.5	
is_actionable	False	…	False	
payment_agreement	True	…	False	
num_years_owed	12	…	1	
most_recent_year_owed	2021	…	2021	
oldest_year_owed	2007	…	2021	
most_recent_payment_date	2021-09-14 00:00:00	…	2021-08-11 00:00:00	
year_of_last_assessment	2021.0	…	2021.0	
total_assessment	50700.0	…	125600.0	
taxable_assessment	50700.0	…	125600.0	
mailing_address	NaN	…	NaN	
mailing_city	NaN	…	NaN	
mailing_state	NaN	…	NaN	
mailing_zip	NaN	…	NaN	
return_mail	NaN	…	NaN	
building_code	O30	…	U30	
detail_building_description	ROW 2 STY MASONRY	…	ROW CONV/APT 2STY MA	
general_building_description	house	…	apartmentSmall	
building_category	residential	…	residential	
coll_agency_num_years	0	…	0	
coll_agency_most_recent_year	NaN	…	NaN	
coll_agency_oldest_year	NaN	…	NaN	
coll_agency_principal_owed	0.0	…	0.0	
coll_agency_total_owed	0.0	…	0.0	

exempt_abatement_assessment	0.0	…	0.0
homestead_value	629.91	…	0.0
net_tax_value_after_homestead	79.79	…	1758.15
agreement_agency	TIPS	…	NaN
sequestration_enforcement	False	…	False
bankruptcy	False	…	False
years_in_bankruptcy	NaN	…	NaN
most_recent_bankrupt_year	NaN	…	NaN
oldest_bankrupt_year	NaN	…	NaN
principal_sum_bankrupt_years	NaN	…	NaN
total_amount_bankrupt_years	NaN	…	NaN
sheriff_sale	N	…	N
liens_sold_1990s	False	…	False
liens_sold_2015	N	…	N
assessment_under_appeal	False	…	False
year_month	202111	…	202111
lat	-75.217579	…	-75.228101
lng	39.969481	…	39.947988

	72709	72710 \
objectid	2628137	2628138
opa_number	463006800.0	463008600.0
street_address	5638 LARCHWOOD AVE	5720 LARCHWOOD AVE
zip_code	19143.0	19143.0
zip_4	1909.0	1912.0
unit_type	NaN	NaN
unit_num	NaN	NaN
owner	SHEFFIELD ANITA	WILLIAMS DORIS
co_owner	SHEFFIELD ANITA	WILLIAMS DORIS
principal_due	1377.13	99.69
penalty_due	111.59	0.0
interest_due	308.31	55.35
other_charges_due	397.64	0.0
total_due	2194.67	155.04
is_actionable	True	False
payment_agreement	False	True
num_years_owed	4	1
most_recent_year_owed	2021	2021
oldest_year_owed	2018	2021
most_recent_payment_date	2021-09-23 00:00:00	2021-09-10 00:00:00
year_of_last_assessment	2021.0	2021.0
total_assessment	82800.0	85500.0
taxable_assessment	82800.0	85500.0
mailing_address	NaN	NaN
mailing_city	NaN	NaN
mailing_state	NaN	NaN
mailing_zip	NaN	NaN

return_mail	NaN	NaN
building_code	030	030
detail_building_description	ROW 2 STY MASONRY	ROW 2 STY MASONRY
general_building_description	house	house
building_category	residential	residential
coll_agency_num_years	3	0
coll_agency_most_recent_year	2020.0	NaN
coll_agency_oldest_year	2018.0	NaN
coll_agency_principal_owed	848.01	0.0
coll_agency_total_owed	1594.12	0.0
exempt_abatement_assessment	0.0	0.0
homestead_value	629.91	0.0
net_tax_value_after_homestead	529.12	1196.83
agreement_agency	NaN	TIPS
sequestration_enforcement	False	False
bankruptcy	False	False
years_in_bankruptcy	NaN	NaN
most_recent_bankrupt_year	NaN	NaN
oldest_bankrupt_year	NaN	NaN
principal_sum_bankrupt_years	NaN	NaN
total_amount_bankrupt_years	NaN	NaN
sheriff_sale	N	N
liens_sold_1990s	False	False
liens_sold_2015	N	N
assessment_under_appeal	False	False
year_month	202111	202111
lat	-75.23575	-75.237316
lng	39.95296	39.95315

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	72711	72712	
objectid	2628139	2628140	
opa_number	463012500.0	406265800.0	
street_address	5541 HAZEL AVE	6434 GARMAN ST	
zip_code	19143.0	19142.0	
zip_4	1905.0	3023.0	
unit_type	NaN	NaN	
unit_num	NaN	NaN	
owner	PHILSON JANICE	SMITH DAVID A	
co_owner	PHILSON JANICE	SMITH DAVID A	
principal_due	5869.57	4740.34	
penalty_due	753.48	677.16	
interest_due	10820.57	4218.91	
other_charges_due	1408.16	1886.04	
total_due	18851.78	11522.45	
is_actionable	False	True	
payment_agreement	True	False	
num_years_owed	13	12	

most_recent_year_owed	2021	2021
oldest_year_owed	2002	2009
most_recent_payment_date	2021-09-10 00:00:00	2020-02-18 00:00:00
year_of_last_assessment	2021.0	2021.0
total_assessment	48100.0	78200.0
taxable_assessment	48100.0	78200.0
mailing_address	NaN	649 HEMLOCK CT
mailing_city	NaN	BENSALEM
mailing_state	NaN	PA
mailing_zip	NaN	19020.0
return_mail	NaN	NaN
building_code	O30	R30
detail_building_description	ROW 2 STY MASONRY	ROW B/GAR 2STY MASON
general_building_description	house	house
building_category	residential	residential
coll_agency_num_years	0	11
coll_agency_most_recent_year	NaN	2020.0
coll_agency_oldest_year	NaN	2009.0
coll_agency_principal_owed	0.0	3645.7
coll_agency_total_owed	0.0	10280.03
exempt_abatement_assessment	0.0	0.0
homestead_value	629.91	0.0
net_tax_value_after_homestead	43.39	1094.64
agreement_agency	TIPS	NaN
sequestration_enforcement	False	False
bankruptcy	False	False
years_in_bankruptcy	NaN	NaN
most_recent_bankrupt_year	NaN	NaN
oldest_bankrupt_year	NaN	NaN
principal_sum_bankrupt_years	NaN	NaN
total_amount_bankrupt_years	NaN	NaN
sheriff_sale	N	N
liens_sold_1990s	False	False
liens_sold_2015	N	N
assessment_under_appeal	False	False
year_month	202111	202111
lat	-75.233814	-75.227927
lng	39.952345	39.920792

	72713	72714	\
objectid	2628141	2628142	
opa_number	406297800.0	406299300.0	
street_address	6918 DICKS AVE	7009 W PASSYUNK AVE	
zip_code	19142.0	19142.0	
zip_4	2517.0	1713.0	
unit_type	NaN	NaN	
unit_num	NaN	NaN	

owner	CAO SON THANH	MCMICHAEL RICHARD
co_owner	CAO SON THANH	MCMICHAEL RICHARD
principal_due	71.34	1542.58
penalty_due	0.0	0.0
interest_due	22.48	208.25
other_charges_due	0.0	0.0
total_due	93.82	1750.83
is_actionable	False	False
payment_agreement	True	False
num_years_owed	1	1
most_recent_year_owed	2021	2021
oldest_year_owed	2021	2021
most_recent_payment_date	2021-09-28 00:00:00	2020-06-16 00:00:00
year_of_last_assessment	2021.0	2021.0
total_assessment	75600.0	110200.0
taxable_assessment	75600.0	110200.0
mailing_address	NaN	NaN
mailing_city	NaN	NaN
mailing_state	NaN	NaN
mailing_zip	NaN	NaN
return_mail	NaN	NaN
building_code	R30	O30
detail_building_description	ROW B/GAR 2STY MASON	ROW 2 STY MASONRY
general_building_description	house	house
building_category	residential	residential
coll_agency_num_years	0	1
coll_agency_most_recent_year	NaN	2021.0
coll_agency_oldest_year	NaN	2021.0
coll_agency_principal_owed	0.0	1542.58
coll_agency_total_owed	0.0	1750.83
exempt_abatement_assessment	0.0	0.0
homestead_value	629.91	0.0
net_tax_value_after_homestead	428.34	1542.58
agreement_agency	TIPS	NaN
sequestration_enforcement	False	False
bankruptcy	False	False
years_in_bankruptcy	NaN	NaN
most_recent_bankrupt_year	NaN	NaN
oldest_bankrupt_year	NaN	NaN
principal_sum_bankrupt_years	NaN	NaN
total_amount_bankrupt_years	NaN	NaN
sheriff_sale	N	N
liens_sold_1990s	False	False
liens_sold_2015	N	N
assessment_under_appeal	False	False
year_month	202111	202111
lat	-75.233571	-75.23451

lng	39.915321	39.914297	
	72715	72716	\
objectid	2628143	2628144	
opa_number	406313100.0	406317000.0	
street_address	6737 GUYER AVE	6853 GUYER AVE	
zip_code	19142.0	19142.0	
zip_4	2610.0	2518.0	
unit_type	NaN	NaN	
unit_num	NaN	NaN	
owner	COPPOLA JOHN	JEAN-LOUIS PATRICIA	
co_owner	COPPOLA JOHN	JEAN-LOUIS PATRICIA	
principal_due	2504.38	4079.25	
penalty_due	115.86	219.7	
interest_due	311.99	697.49	
other_charges_due	392.2	1030.92	
total_due	3324.43	6027.36	
is_actionable	False	True	
payment_agreement	True	False	
num_years_owed	4	4	
most_recent_year_owed	2021	2021	
oldest_year_owed	2018	2018	
most_recent_payment_date	2021-09-13 00:00:00	2018-03-09 00:00:00	
year_of_last_assessment	2021.0	2021.0	
total_assessment	78200.0	67200.0	
taxable_assessment	78200.0	67200.0	
mailing_address	1742 DELSEA DR	6853 GUYER AVE	
mailing_city	DEPTFORD	PHILA	
mailing_state	NJ	PA	
mailing_zip	8096.0	19142.0	
return_mail	NaN	NaN	
building_code	R30	R30	
detail_building_description	ROW B/GAR 2STY MASON	ROW B/GAR 2STY MASON	
general_building_description	house	house	
building_category	residential	residential	
coll_agency_num_years	0	3	
coll_agency_most_recent_year	NaN	2020.0	
coll_agency_oldest_year	NaN	2018.0	
coll_agency_principal_owed	0.0	3138.58	
coll_agency_total_owed	0.0	4959.7	
exempt_abatement_assessment	0.0	0.0	
homestead_value	0.0	0.0	
net_tax_value_after_homestead	1094.64	940.67	
agreement_agency	TIPS	NaN	
sequestration_enforcement	False	False	
bankruptcy	False	False	
years_in_bankruptcy	NaN	NaN	

most_recent_bankrupt_year	NaN	NaN
oldest_bankrupt_year	NaN	NaN
principal_sum_bankrupt_years	NaN	NaN
total_amount_bankrupt_years	NaN	NaN
sheriff_sale	N	N
liens_sold_1990s	False	False
liens_sold_2015	N	N
assessment_under_appeal	False	False
year_month	202111	202111
lat	-75.230644	-75.232507
lng	39.917135	39.915844

	72717
objectid	2628145
opa_number	406349800.0
street_address	6716 DOREL ST
zip_code	19142.0
zip_4	2607.0
unit_type	NaN
unit_num	NaN
owner	HABIL HOUSSEINI
co_owner	HABIL HOUSSEINI
principal_due	2301.27
penalty_due	84.56
interest_due	256.31
other_charges_due	360.15
total_due	3002.29
is_actionable	True
payment_agreement	False
num_years_owed	2
most_recent_year_owed	2021
oldest_year_owed	2020
most_recent_payment_date	2019-11-18 00:00:00
year_of_last_assessment	2021.0
total_assessment	78100.0
taxable_assessment	78100.0
mailing_address	2527 S CARROLL ST
mailing_city	PHILADELPHIA
mailing_state	PA
mailing_zip	19142.0
return_mail	NaN
building_code	R30
detail_building_description	ROW B/GAR 2STY MASON
general_building_description	house
building_category	residential
coll_agency_num_years	1
coll_agency_most_recent_year	2020.0

```
coll_agency_oldest_year                2020.0
coll_agency_principal_owed             1208.03
coll_agency_total_owed                 1761.46
exempt_abatement_assessment               0.0
homestead_value                           0.0
net_tax_value_after_homestead          1093.24
agreement_agency                          NaN
sequestration_enforcement               False
bankruptcy                              False
years_in_bankruptcy                       NaN
most_recent_bankrupt_year                 NaN
oldest_bankrupt_year                      NaN
principal_sum_bankrupt_years              NaN
total_amount_bankrupt_years               NaN
sheriff_sale                                N
liens_sold_1990s                        False
liens_sold_2015                             N
assessment_under_appeal                 False
year_month                             202111
lat                                -75.229525
lng                                 39.916847

[55 rows x 72718 columns]
```

[ ]:
```
tax.isna().sum()#null values included in the dataset
```

[ ]:
```
objectid                       0
opa_number                     3
street_address                10
zip_code                      59
zip_4                       3102
unit_type                  71339
unit_num                   71339
owner                          2
co_owner                      98
principal_due                  0
penalty_due                    0
interest_due                   0
other_charges_due              0
total_due                      0
is_actionable                  0
payment_agreement              0
num_years_owed                 0
most_recent_year_owed          0
oldest_year_owed               0
most_recent_payment_date    4920
year_of_last_assessment     1482
```

```
total_assessment                  1482
taxable_assessment                1482
mailing_address                  46023
mailing_city                     46022
mailing_state                    46025
mailing_zip                      46024
return_mail                      61696
building_code                     1484
detail_building_description       1487
general_building_description      1487
building_category                 1487
coll_agency_num_years                0
coll_agency_most_recent_year     34121
coll_agency_oldest_year          34121
coll_agency_principal_owed           0
coll_agency_total_owed               0
exempt_abatement_assessment       1482
homestead_value                   1482
net_tax_value_after_homestead     1482
agreement_agency                 48917
sequestration_enforcement            0
bankruptcy                           0
years_in_bankruptcy              72171
most_recent_bankrupt_year        72171
oldest_bankrupt_year             72171
principal_sum_bankrupt_years     72171
total_amount_bankrupt_years      72171
sheriff_sale                         0
liens_sold_1990s                     0
liens_sold_2015                      0
assessment_under_appeal              0
year_month                           0
lat                                193
lng                                193
dtype: int64
```

[ ]:
```
tax.shape #size of dataset
```

[ ]:
```
(72718, 55)
```

[ ]:
```
tax.isna().sum()/tax.shape[0] # remove mailing_address, mailing_city,␣
 ↪unit_type, unit_num, mailing_state, mailing_zip,
# remove return_mail, coll_agency_most_recent_year, coll_agency_oldest_year,␣
 ↪agreement_agency, years_in_bankruptcy ,
# remove most_recent_bankrupt_year, oldest_bankrupt_year,␣
 ↪principal_sum_bankrupt_years, total_amount_bankrupt_years
```

[ ]:
```
objectid                          0.000000
opa_number                        0.000041
street_address                    0.000138
zip_code                          0.000811
zip_4                             0.042658
unit_type                         0.981036
unit_num                          0.981036
owner                             0.000028
co_owner                          0.001348
principal_due                     0.000000
penalty_due                       0.000000
interest_due                      0.000000
other_charges_due                 0.000000
total_due                         0.000000
is_actionable                     0.000000
payment_agreement                 0.000000
num_years_owed                    0.000000
most_recent_year_owed             0.000000
oldest_year_owed                  0.000000
most_recent_payment_date          0.067659
year_of_last_assessment           0.020380
total_assessment                  0.020380
taxable_assessment                0.020380
mailing_address                   0.632897
mailing_city                      0.632883
mailing_state                     0.632924
mailing_zip                       0.632911
return_mail                       0.848428
building_code                     0.020408
detail_building_description       0.020449
general_building_description      0.020449
building_category                 0.020449
coll_agency_num_years             0.000000
coll_agency_most_recent_year      0.469224
coll_agency_oldest_year           0.469224
coll_agency_principal_owed        0.000000
coll_agency_total_owed            0.000000
exempt_abatement_assessment       0.020380
homestead_value                   0.020380
net_tax_value_after_homestead     0.020380
agreement_agency                  0.672695
sequestration_enforcement         0.000000
bankruptcy                        0.000000
years_in_bankruptcy               0.992478
most_recent_bankrupt_year         0.992478
oldest_bankrupt_year              0.992478
principal_sum_bankrupt_years      0.992478
```

```
total_amount_bankrupt_years      0.992478
sheriff_sale                     0.000000
liens_sold_1990s                 0.000000
liens_sold_2015                  0.000000
assessment_under_appeal          0.000000
year_month                       0.000000
lat                              0.002654
lng                              0.002654
dtype: float64
```

[ ]:
```
tax.drop(['mailing_address', 'mailing_city', 'unit_type', 'unit_num',␣
↪'mailing_state', 'mailing_zip',
       'return_mail', 'coll_agency_most_recent_year',␣
↪'coll_agency_oldest_year', 'agreement_agency', 'years_in_bankruptcy' ,
       'most_recent_bankrupt_year', 'oldest_bankrupt_year',␣
↪'principal_sum_bankrupt_years', 'total_amount_bankrupt_years'],
       axis=1, inplace=True) # removing columns thta have high null values
```

[ ]:
```
tax.columns
```

[ ]:
```
Index(['objectid', 'opa_number', 'street_address', 'zip_code', 'zip_4',
       'owner', 'co_owner', 'principal_due', 'penalty_due', 'interest_due',
       'other_charges_due', 'total_due', 'is_actionable', 'payment_agreement',
       'num_years_owed', 'most_recent_year_owed', 'oldest_year_owed',
       'most_recent_payment_date', 'year_of_last_assessment',
       'total_assessment', 'taxable_assessment', 'building_code',
       'detail_building_description', 'general_building_description',
       'building_category', 'coll_agency_num_years',
       'coll_agency_principal_owed', 'coll_agency_total_owed',
       'exempt_abatement_assessment', 'homestead_value',
       'net_tax_value_after_homestead', 'sequestration_enforcement',
       'bankruptcy', 'sheriff_sale', 'liens_sold_1990s', 'liens_sold_2015',
       'assessment_under_appeal', 'year_month', 'lat', 'lng'],
      dtype='object')
```

[ ]:
```
(tax.isna().sum()/tax.shape[0]).sort_values(ascending=False)
```

[ ]:
```
most_recent_payment_date         0.067659
zip_4                            0.042658
building_category                0.020449
general_building_description     0.020449
detail_building_description      0.020449
building_code                    0.020408
taxable_assessment               0.020380
net_tax_value_after_homestead    0.020380
homestead_value                  0.020380
exempt_abatement_assessment      0.020380
```

```
total_assessment                0.020380
year_of_last_assessment         0.020380
lat                             0.002654
lng                             0.002654
co_owner                        0.001348
zip_code                        0.000811
street_address                  0.000138
opa_number                      0.000041
owner                           0.000028
num_years_owed                  0.000000
year_month                      0.000000
assessment_under_appeal         0.000000
liens_sold_2015                 0.000000
liens_sold_1990s                0.000000
sheriff_sale                    0.000000
bankruptcy                      0.000000
sequestration_enforcement       0.000000
coll_agency_total_owed          0.000000
most_recent_year_owed           0.000000
coll_agency_principal_owed      0.000000
coll_agency_num_years           0.000000
principal_due                   0.000000
penalty_due                     0.000000
interest_due                    0.000000
other_charges_due               0.000000
total_due                       0.000000
is_actionable                   0.000000
payment_agreement               0.000000
oldest_year_owed                0.000000
objectid                        0.000000
dtype: float64
```

[ ]:
```
#minimum and maximum latitude
print(tax['lat'].min())
print(tax['lat'].max())
```

```
-75.27396176893846
-74.9593407520959
```

[ ]:
```
#minimum and maximum longitude
print(tax['lng'].min())
print(tax['lng'].max())
```

```
39.88640598393346
40.13621377256551
```

[ ]:
```
#dropping null values within  longitude and latitude
tax.dropna(subset=['lat'], inplace=True)
tax.dropna(subset=['lng'], inplace=True)
```

[ ]:
```
#combining latitude and longitude data into one column called geometry for␣
 ↪gropandas to read
crs = {'init': 'epsg:4326'}
geometry = [Point(xy) for xy in zip(tax["lat"], tax["lng"])]
tax = gpd.GeoDataFrame(tax,
                       crs = crs,
                       geometry = geometry)

tax.head()
```

```
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/pyproj/crs/crs.py:131: FutureWarning: '+init=<authority>:<code>' syntax
is deprecated. '<authority>:<code>' is the preferred initialization method. When
making the change, be mindful of axis order changes:
https://pyproj4.github.io/pyproj/stable/gotchas.html#axis-order-changes-in-
proj-6
  in_crs_string = _prepare_from_proj_string(in_crs_string)
```

[ ]:

	objectid	opa_number	street_address	zip_code	zip_4	\
0	2556493	493169300.0	6045 N CAMAC ST	19141.0	3227.0	
1	2556494	493179100.0	5620 N CAMAC ST	19141.0	4106.0	
2	2556495	493180700.0	5714 N CAMAC ST	19141.0	4108.0	
3	2556496	493183600.0	5812 N CAMAC ST	19141.0	4123.0	
4	2556497	223166200.0	420 GLEN ECHO RD	19119.0	2914.0	

	owner	co_owner	principal_due	penalty_due	\
0	WILLIAMS JACQUELINE	WILLIAMS JACQUELINE	12200.18	1110.17	
1	RAY MATTIE E	RAY MATTIE E	-0.05	0.00	
2	TOMLIN PAULA	TOMLIN PAULA	895.87	0.00	
3	BATTS PRINCETON B	BATTS PRINCETON B	4536.94	283.14	
4	WHITE CLARENCE	WHITE CLARENCE	4224.60	0.00	

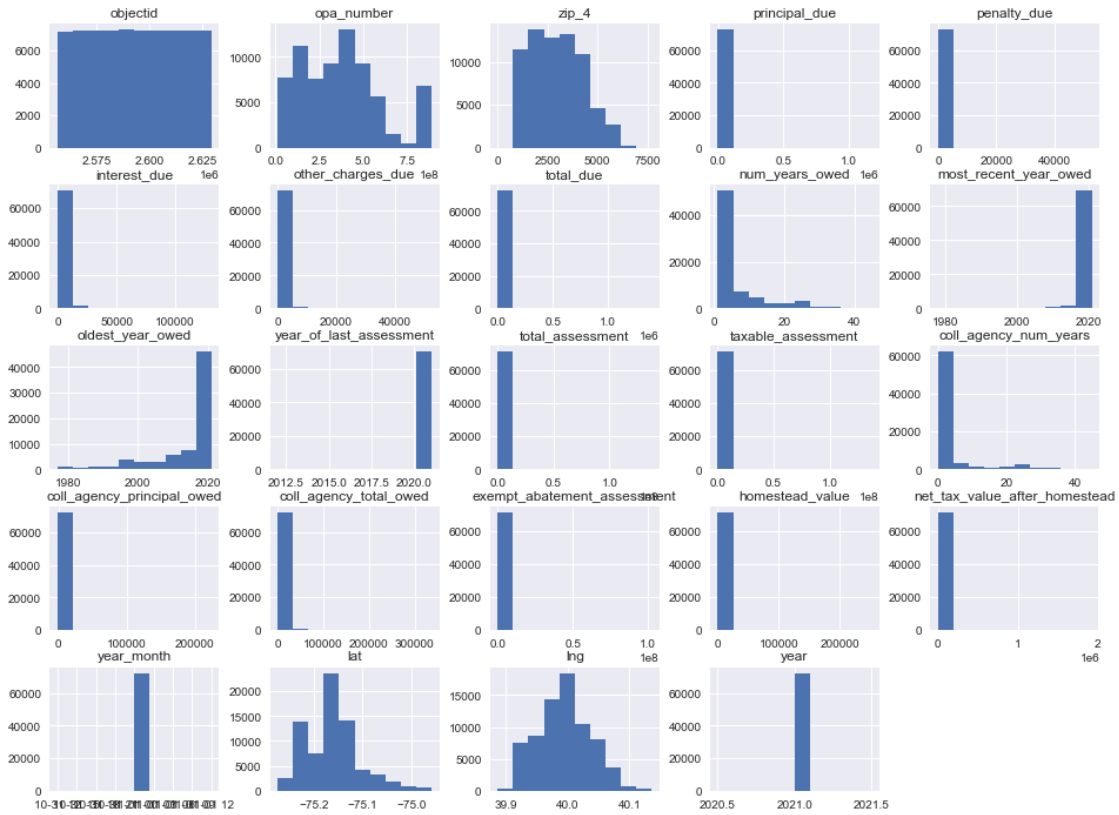
	interest_due	…	sequestration_enforcement	bankruptcy	sheriff_sale	\
0	14261.97	…	False	False	N	
1	41.05	…	False	False	N	
2	120.94	…	False	False	N	
3	1161.05	…	False	False	N	
4	570.32	…	False	False	N	

	liens_sold_1990s	liens_sold_2015	assessment_under_appeal	year_month	\
0	False	N	False	202111	
1	False	N	False	202111	
2	False	N	False	202111	

```
3             False                N                    False      202111
4             False                N                    False      202111

          lat        lng                     geometry
0 -75.140099  40.045081  POINT (-75.14010 40.04508)
1 -75.141930  40.039007  POINT (-75.14193 40.03901)
2 -75.141727  40.039940  POINT (-75.14173 40.03994)
3 -75.141395  40.041404  POINT (-75.14140 40.04140)
4 -75.195309  40.051563  POINT (-75.19531 40.05156)

[5 rows x 41 columns]
```

[ ]:
```
#histogram of the dataset
#important column that we will be considering is the principal due column. The␣
 ↪data is skwed
fig, ax = plt.subplots(figsize=(16,12))
tax.hist(ax=ax)
```

```
/var/folders/6p/wpw9qml57530xkxqkkhprrf40000gn/T/ipykernel_74088/1335946433.py:2
: UserWarning: To output multiple subplots, the figure containing the passed
axes is being cleared
  tax.hist(ax=ax)

array([[<AxesSubplot:title={'center':'objectid'}>,
        <AxesSubplot:title={'center':'opa_number'}>,
        <AxesSubplot:title={'center':'zip_4'}>,
        <AxesSubplot:title={'center':'principal_due'}>,
        <AxesSubplot:title={'center':'penalty_due'}>],
       [<AxesSubplot:title={'center':'interest_due'}>,
        <AxesSubplot:title={'center':'other_charges_due'}>,
        <AxesSubplot:title={'center':'total_due'}>,
        <AxesSubplot:title={'center':'num_years_owed'}>,
        <AxesSubplot:title={'center':'most_recent_year_owed'}>],
       [<AxesSubplot:title={'center':'oldest_year_owed'}>,
        <AxesSubplot:title={'center':'year_of_last_assessment'}>,
        <AxesSubplot:title={'center':'total_assessment'}>,
        <AxesSubplot:title={'center':'taxable_assessment'}>,
        <AxesSubplot:title={'center':'coll_agency_num_years'}>],
       [<AxesSubplot:title={'center':'coll_agency_principal_owed'}>,
        <AxesSubplot:title={'center':'coll_agency_total_owed'}>,
        <AxesSubplot:title={'center':'exempt_abatement_assessment'}>,
        <AxesSubplot:title={'center':'homestead_value'}>,
        <AxesSubplot:title={'center':'net_tax_value_after_homestead'}>],
       [<AxesSubplot:title={'center':'year_month'}>,
        <AxesSubplot:title={'center':'lat'}>,
        <AxesSubplot:title={'center':'lng'}>,
        <AxesSubplot:title={'center':'year'}>, <AxesSubplot:>]],
      dtype=object)
```



[ ]:
```
tax.describe().T # median for principal value is around #2000
```

	count	mean	std	\
objectid	72525.0	2.592829e+06	2.098687e+04	
opa_number	72525.0	3.735889e+08	2.357474e+08	
zip_code	72479.0	1.911504e+04	6.070185e+02	
zip_4	69616.0	2.969683e+03	1.271406e+03	
principal_due	72525.0	3.170896e+03	1.031891e+04	
penalty_due	72525.0	2.143030e+02	5.637250e+02	
interest_due	72525.0	1.752588e+03	4.424587e+03	
other_charges_due	72525.0	7.366745e+02	1.324276e+03	
total_due	72525.0	5.875430e+03	1.486095e+04	
num_years_owed	72525.0	6.231134e+00	8.224082e+00	
most_recent_year_owed	72525.0	2.020192e+03	3.371291e+00	
oldest_year_owed	72525.0	2.014309e+03	9.664412e+00	
year_of_last_assessment	71212.0	2.020957e+03	4.939431e-01	
total_assessment	71212.0	1.456987e+05	1.343773e+06	
taxable_assessment	71212.0	1.258007e+05	1.014012e+06	
coll_agency_num_years	72525.0	3.205088e+00	7.344373e+00	
coll_agency_principal_owed	72525.0	1.108963e+03	3.934209e+03	
coll_agency_total_owed	72525.0	2.211462e+03	6.939029e+03	
exempt_abatement_assessment	71212.0	1.989802e+04	8.101003e+05	

homestead_value	71212.0	2.220513e+02	9.916045e+02
net_tax_value_after_homestead	71212.0	1.539039e+03	1.376266e+04
year_month	72525.0	2.021110e+05	0.000000e+00
lat	72525.0	-7.516213e+01	5.420265e-02
lng	72525.0	3.999380e+01	4.274897e-02

	min	25%	50%	\
objectid	2.556371e+06	2.574662e+06	2.592829e+06	
opa_number	1.100080e+07	1.810721e+08	3.640166e+08	
zip_code	1.000000e+00	1.912800e+04	1.913500e+04	
zip_4	3.000000e+00	1.907000e+03	2.908000e+03	
principal_due	-1.741060e+03	2.456400e+02	1.197030e+03	
penalty_due	-1.089500e+02	0.000000e+00	5.749000e+01	
interest_due	-4.703100e+02	7.841000e+01	2.664700e+02	
other_charges_due	-4.526000e+01	0.000000e+00	2.747300e+02	
total_due	1.000000e-02	4.627300e+02	2.021930e+03	
num_years_owed	1.000000e+00	1.000000e+00	3.000000e+00	
most_recent_year_owed	1.978000e+03	2.021000e+03	2.021000e+03	
oldest_year_owed	1.977000e+03	2.012000e+03	2.019000e+03	
year_of_last_assessment	2.012000e+03	2.021000e+03	2.021000e+03	
total_assessment	0.000000e+00	3.430000e+04	7.300000e+04	
taxable_assessment	0.000000e+00	3.310000e+04	7.120000e+04	
coll_agency_num_years	0.000000e+00	0.000000e+00	1.000000e+00	
coll_agency_principal_owed	-1.741060e+03	0.000000e+00	0.000000e+00	
coll_agency_total_owed	0.000000e+00	0.000000e+00	5.719000e+01	
exempt_abatement_assessment	0.000000e+00	0.000000e+00	0.000000e+00	
homestead_value	0.000000e+00	0.000000e+00	0.000000e+00	
net_tax_value_after_homestead	0.000000e+00	2.785600e+02	7.516900e+02	
year_month	2.021110e+05	2.021110e+05	2.021110e+05	
lat	-7.527396e+01	-7.519973e+01	-7.516256e+01	
lng	3.988641e+01	3.996484e+01	3.999254e+01	

	75%	max
objectid	2.611000e+06	2.629184e+06
opa_number	5.021726e+08	8.888007e+08
zip_code	1.914300e+04	1.919200e+04
zip_4	3.920000e+03	7.711000e+03
principal_due	3.363210e+03	1.174312e+06
penalty_due	2.477300e+02	5.273024e+04
interest_due	1.245950e+03	1.307921e+05
other_charges_due	9.641100e+02	5.252586e+04
total_due	6.237140e+03	1.391257e+06
num_years_owed	7.000000e+00	4.500000e+01
most_recent_year_owed	2.021000e+03	2.021000e+03
oldest_year_owed	2.021000e+03	2.021000e+03
year_of_last_assessment	2.021000e+03	2.021000e+03
total_assessment	1.307000e+05	1.375769e+08
taxable_assessment	1.258000e+05	1.375769e+08

```
coll_agency_num_years          2.000000e+00  4.500000e+01
coll_agency_principal_owed     1.033050e+03  2.245500e+05
coll_agency_total_owed         1.726990e+03  3.371071e+05
exempt_abatement_assessment    0.000000e+00  1.023300e+08
homestead_value                6.299100e+02  2.519640e+05
net_tax_value_after_homestead  1.455790e+03  1.925801e+06
year_month                     2.021110e+05  2.021110e+05
lat                           -7.513773e+01 -7.495934e+01
lng                            4.002372e+01  4.013621e+01
```

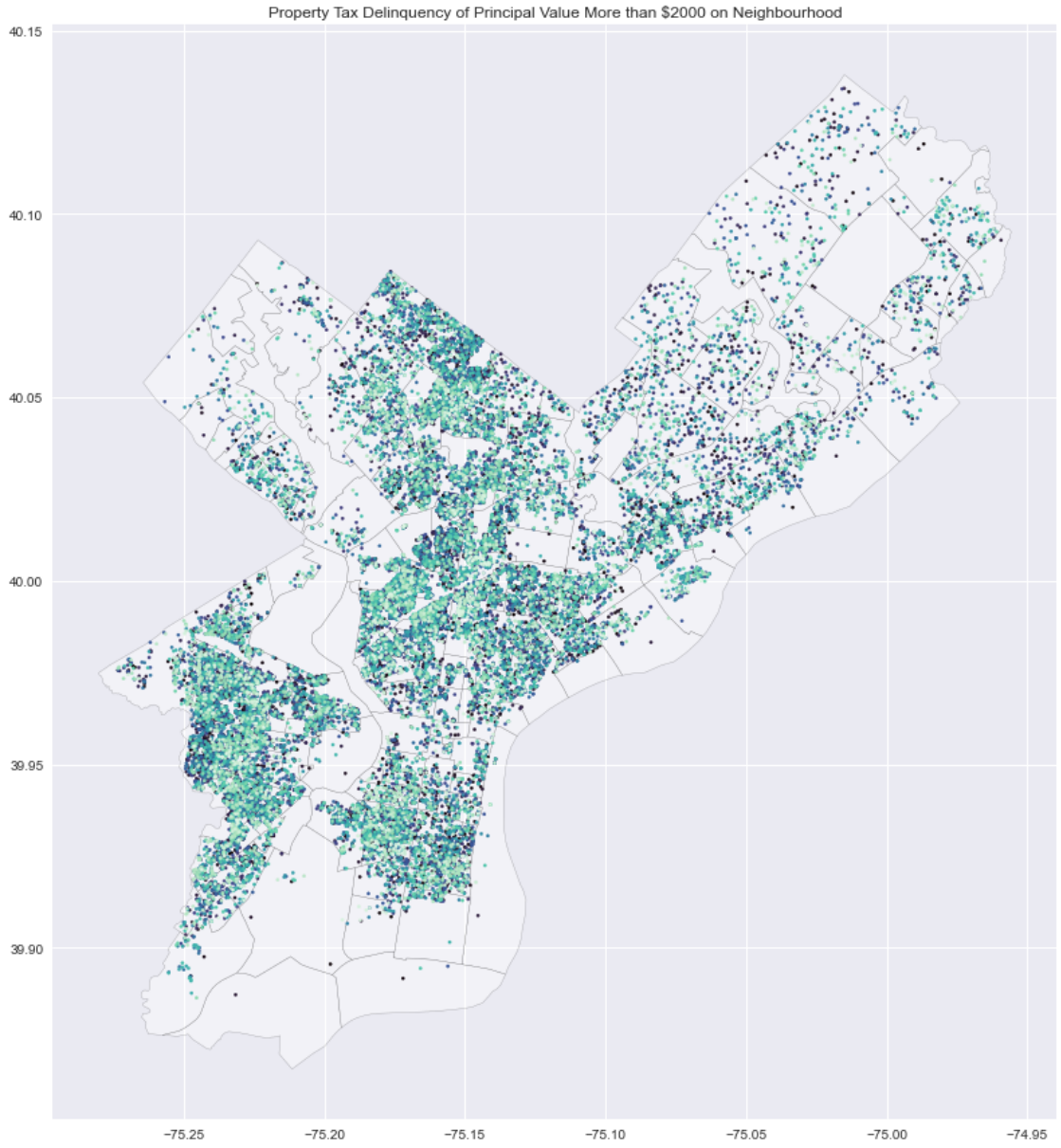
[ ]:
```
tax.isna().sum()
```

[ ]:
```
objectid                          0
opa_number                        0
street_address                    0
zip_code                         46
zip_4                          2909
owner                             1
co_owner                         35
principal_due                     0
penalty_due                       0
interest_due                      0
other_charges_due                 0
total_due                         0
is_actionable                     0
payment_agreement                 0
num_years_owed                    0
most_recent_year_owed             0
oldest_year_owed                  0
most_recent_payment_date       4793
year_of_last_assessment        1313
total_assessment               1313
taxable_assessment             1313
building_code                  1314
detail_building_description    1316
general_building_description   1316
building_category              1316
coll_agency_num_years             0
coll_agency_principal_owed        0
coll_agency_total_owed            0
exempt_abatement_assessment    1313
homestead_value                1313
net_tax_value_after_homestead  1313
sequestration_enforcement         0
bankruptcy                        0
sheriff_sale                      0
liens_sold_1990s                  0
```

```
liens_sold_2015                 0
assessment_under_appeal         0
year_month                      0
lat                             0
lng                             0
geometry                        0
dtype: int64
```

[ ]:
```
fig, ax = plt.subplots(figsize =(15,15))
plt.style.use('seaborn')
plt.title("Property Tax Delinquency of Principal Value More than $2000 on␣
 ↪Neighbourhood")
street_map.to_crs(epsg = 4326).plot(ax = ax, alpha = 0.4,  color = "white",␣
 ↪edgecolor='black') #using shape map of neighbourhood
tax[tax['principal_due'] > 2000].plot(ax = ax, cmap = 'mako',legend=True,␣
 ↪markersize = 5)#principal that is more than 2000
#plt.legend(prop = {'size' : 15})
#plt.show()
```

[ ]:
```
<AxesSubplot:title={'center':'Property Tax Delinquency of Principal Value More
than $2000 on Neighbourhood'}>
```



[ ]:
```
tax.dropna(subset=['zip_code'], inplace=True)# dropping null values zip code
tax['zip_code'] = tax['zip_code'].astype(int).astype(str) #turning number to␣
↪integer then to object
```

[ ]:
```
tax.dtypes
```

[ ]:
```
objectid                          int64
opa_number                      float64
street_address                   object
zip_code                         object
```

```
zip_4                              float64
owner                               object
co_owner                            object
principal_due                      float64
penalty_due                        float64
interest_due                       float64
other_charges_due                  float64
total_due                          float64
is_actionable                         bool
payment_agreement                     bool
num_years_owed                       int64
most_recent_year_owed                int64
oldest_year_owed                     int64
most_recent_payment_date            object
year_of_last_assessment            float64
total_assessment                   float64
taxable_assessment                 float64
building_code                       object
detail_building_description         object
general_building_description        object
building_category                   object
coll_agency_num_years                int64
coll_agency_principal_owed         float64
coll_agency_total_owed             float64
exempt_abatement_assessment        float64
homestead_value                    float64
net_tax_value_after_homestead      float64
sequestration_enforcement             bool
bankruptcy                            bool
sheriff_sale                        object
liens_sold_1990s                      bool
liens_sold_2015                     object
assessment_under_appeal               bool
year_month                           int64
lat                                float64
lng                                float64
geometry                          geometry
dtype: object
```

[ ]:
```
tax_zip_sum = tax.groupby('zip_code')[['principal_due','total_due',␣
↪'is_actionable']].sum().reset_index()#grouping by zip code and sum of values
tax_zip_count = tax.groupby('zip_code')[['opa_number']].count().
↪reset_index()#group by zip codes  and number of delinquent properties
```

[ ]:
```
poly_zip_tax_count = pd.merge(poly_zip, tax_zip_count, left_on = "CODE",␣
↪right_on = "zip_code", how = 'left')#combining the tax file with zip code␣
↪with zip code shape file
```

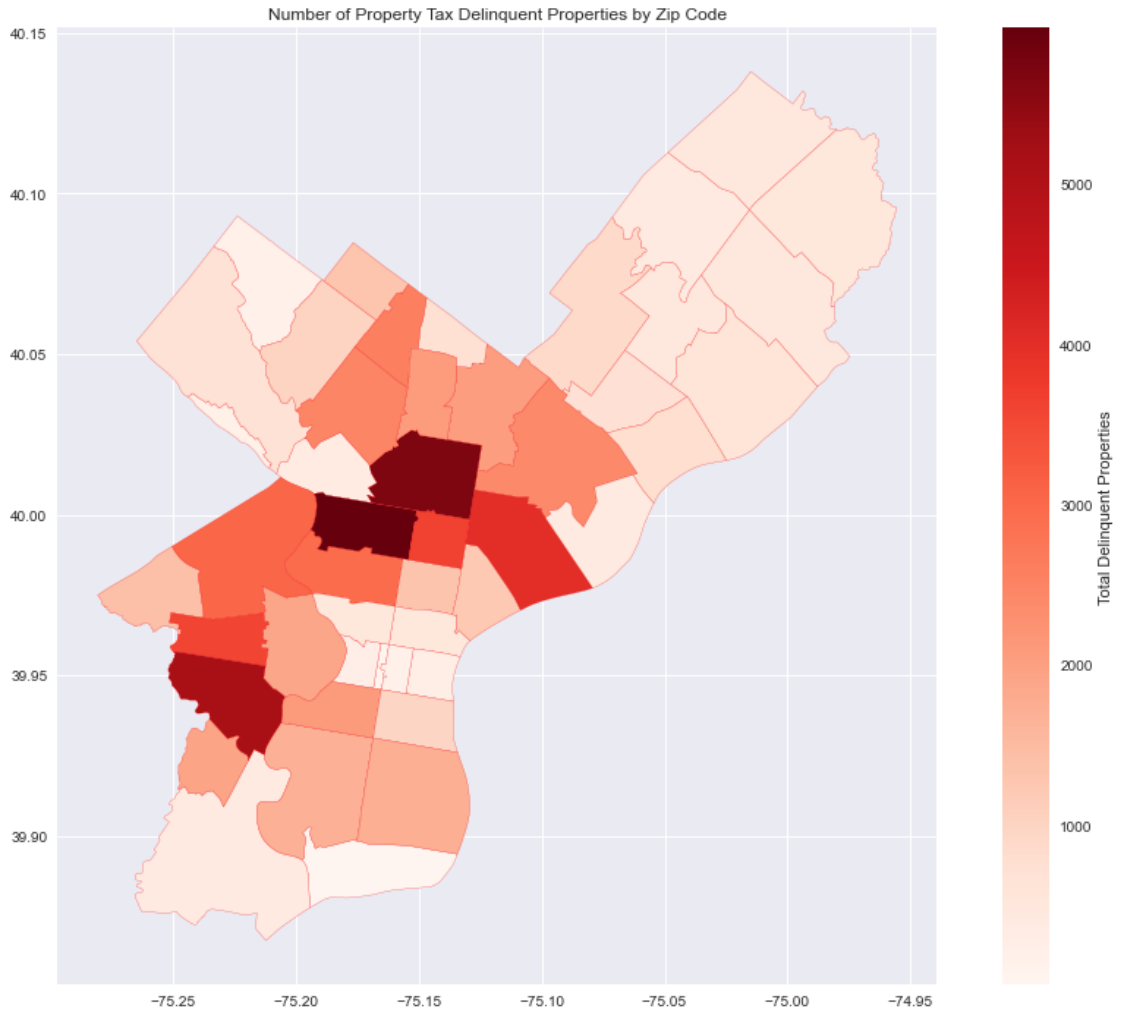
```
poly_zip_tax_count.head()
```

[ ]:

	OBJECTID	CODE	COD	Shape__Are	Shape__Len	geometry	zip_code	opa_number
0	1	19120	20	9.177970e+07	49921.544063	POLYGON ((-75.11107 40.04682, -75.10943 40.045…	19120	2039.0
1	2	19121	21	6.959879e+07	39534.887217	POLYGON ((-75.19227 39.99463, -75.19205 39.994…	19121	2948.0
2	3	19122	22	3.591632e+07	24124.645221	POLYGON ((-75.15406 39.98601, -75.15328 39.985…	19122	1329.0
3	4	19123	23	3.585175e+07	26421.728982	POLYGON ((-75.15190 39.97056, -75.15150 39.970…	19123	523.0
4	5	19124	24	1.448080e+08	63658.770420	POLYGON ((-75.09660 40.04249, -75.09281 40.039…	19124	2393.0

[ ]:
```
fig, ax = plt.subplots(figsize=(16,12))
plt.title("Number of Property Tax Delinquent Properties by Zip Code")
poly_zip_tax_count.plot(ax=ax, column='opa_number',
            edgecolor='red', linewidth=.2,
            cmap='Reds', legend=True,
            legend_kwds={'label': 'Total Delinquent Properties'})

#sum of delinquent properties and the number of delinquent properties seems to␣
 ↪be around in the same zip codes
```

[ ]:
```
<AxesSubplot:title={'center':'Number of Property Tax Delinquent Properties by
Zip Code'}>
```



[ ]:
```
poly_tax_zip_sum = pd.merge(poly_zip, tax_zip_sum, left_on = "CODE", right_on =␣
↪"zip_code", how = 'left')#merging zip code shape file with  sum of values␣
↪dataset
poly_tax_zip_sum.head()
```

[ ]:

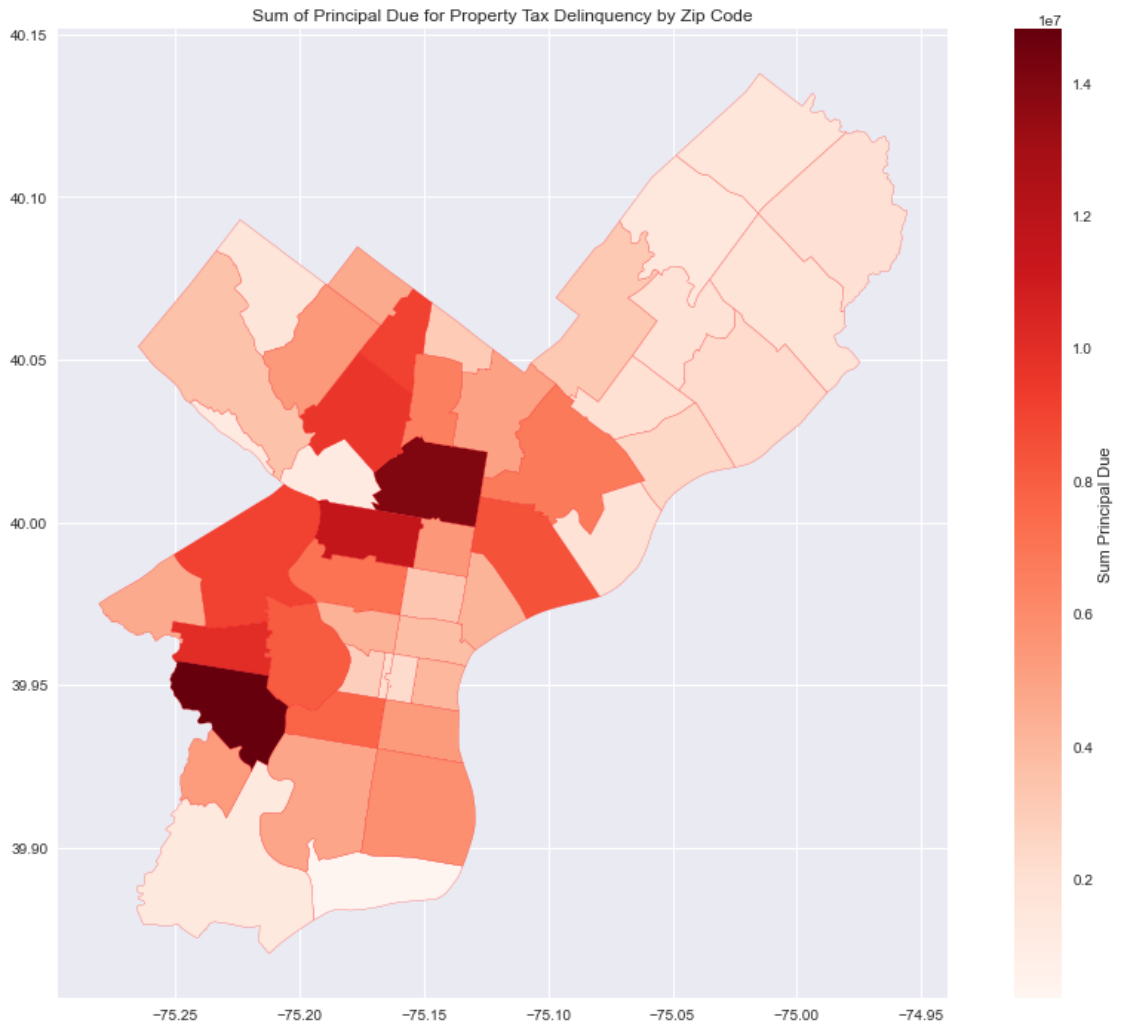
	OBJECTID	CODE	COD	Shape__Are	Shape__Len	\
0	1	19120	20	9.177970e+07	49921.544063	
1	2	19121	21	6.959879e+07	39534.887217	
2	3	19122	22	3.591632e+07	24124.645221	
3	4	19123	23	3.585175e+07	26421.728982	
4	5	19124	24	1.448080e+08	63658.770420	

	geometry	zip_code	principal_due	\
0	POLYGON ((-75.11107 40.04682, -75.10943 40.045…	19120	5017812.12	
1	POLYGON ((-75.19227 39.99463, -75.19205 39.994…	19121	7093001.39	
2	POLYGON ((-75.15406 39.98601, -75.15328 39.985…	19122	3344355.11	

```
3  POLYGON ((-75.15190 39.97056, -75.15150 39.970…    19123     3743411.62
4  POLYGON ((-75.09660 40.04249, -75.09281 40.039…    19124     6791774.93

     total_due  is_actionable
0   9529801.48          880.0
1  12953515.62         1827.0
2   5839664.03          733.0
3   5372027.03          298.0
4  12672901.32         1142.0
```

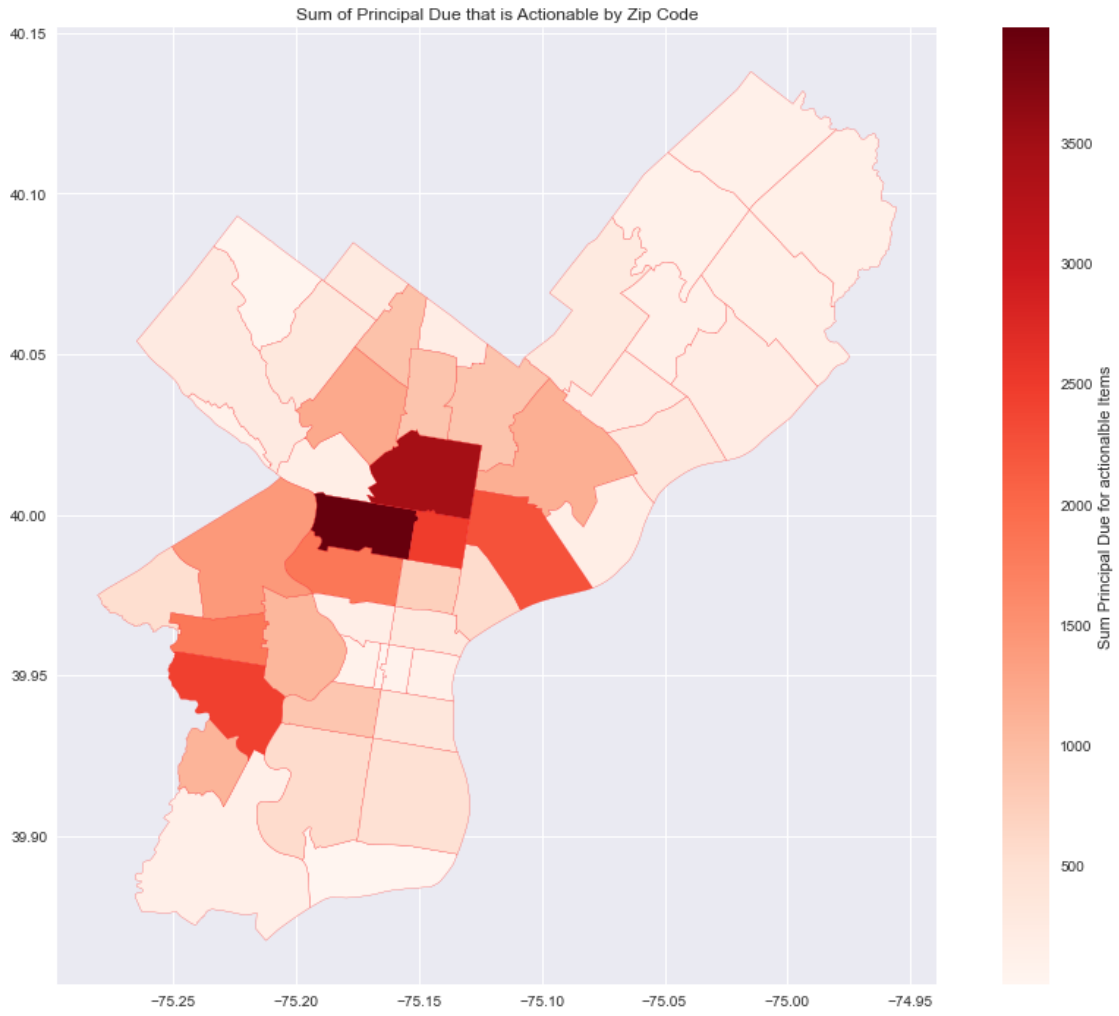
[ ]:
```
fig, ax = plt.subplots(figsize=(16,12))
plt.title("Sum of Principal Due for Property Tax Delinquency by Zip Code")
poly_tax_zip_sum.plot(ax=ax, column='principal_due',
            edgecolor='red', linewidth=.2,
            cmap='Reds', legend=True,
            legend_kwds={'label': 'Sum Principal Due'})
```

[ ]:
```
<AxesSubplot:title={'center':'Sum of Principal Due for Property Tax Delinquency
by Zip Code'}>
```



[ ]:
```
fig, ax = plt.subplots(figsize=(16,12))
plt.title("Sum of Principal Due that is Actionable by Zip Code")
poly_tax_zip_sum.plot(ax=ax, column='is_actionable',
            edgecolor='red', linewidth=.2,
            cmap='Reds', legend=True,
            legend_kwds={'label': 'Sum Principal Due for actionalble Items'})
```

[ ]:
```
<AxesSubplot:title={'center':'Sum of Principal Due that is Actionable by Zip
Code'}>
```



[ ]:
```
tax['principal_due'].sum()#sum of principal due
```

[ ]:
```
229224414.01999998
```

[ ]:
```
tax['is_actionable'].unique()#this is boolean value
```

[ ]:
```
array([False,  True])
```

[ ]:
```
tax.loc[tax['is_actionable']== True]['principal_due'].sum()#sum of principal␣
 ↪due that is actionable
#Actionable means that the city is actively working to collect these accounts,␣
 ↪non-actional means that the city can't do anything further or thery are␣
 ↪barrred from collection
```

[ ]:
```
121126557.50999999
```

[ ]:
```
tax.groupby(tax['is_actionable'])['principal_due'].sum().reset_index() # is␣
↪actionable and not actionable is not that different
#Accounts that are in payment agreement, bankruptcy, or overdue but not yet␣
↪delinquent are considered "not actionable".
```

[ ]:

	is_actionable	principal_due
0	False	1.080979e+08
1	True	1.211266e+08

[ ]:
```
tax.groupby(tax['is_actionable'])['principal_due'].sum()/tax['principal_due'].
↪sum()#percentage of actional and non-actionable principal due  is almost the␣
↪same
#more percentage of principal due for actionaable
```

[ ]:
```
is_actionable
False    0.471581
True     0.528419
Name: principal_due, dtype: float64
```

[ ]:
```
tax.groupby(tax['num_years_owed'])['principal_due'].sum().reset_index().
↪sort_values(by = ['principal_due'], ascending= False)
#Most of the principal due is owned for 1-4 years, then there is 25 years which␣
↪has the highest principal due
```

[ ]:

	num_years_owed	principal_due
1	2	26959928.69
0	1	25667386.23
2	3	22582465.41
3	4	16764381.46
24	25	13166360.38
4	5	12543099.89
5	6	11032846.29
6	7	8113435.71
7	8	7243378.20
11	12	6592288.78
8	9	6354391.31
9	10	6061230.49
10	11	5512859.40
13	14	5014584.95
12	13	4920943.23
14	15	4249660.21
20	21	3845421.86
15	16	3773332.27
23	24	3620005.06
17	18	3510552.36
16	17	3374508.34
18	19	3123978.55

```
22                23      3083700.57
21                22      3063217.30
19                20      2910133.65
27                28      1472989.17
25                26      1450242.28
26                27      1429127.75
28                29      1229403.04
32                33      1114820.15
31                32      1077972.33
43                44      1044263.97
30                31       973101.27
29                30       868240.63
33                34       826829.43
35                36       778074.76
34                35       765812.31
36                37       718980.99
37                38       574930.25
38                39       516875.32
42                43       381043.12
39                40       368221.62
41                42       292565.37
40                41       253507.86
44                45         3321.81
```

[ ]:
```
tax.groupby(tax['num_years_owed'])['principal_due'].median().reset_index().
↪sort_values(by = ['principal_due'], ascending= False)
#when you do median principal dues, it is 18, 23, 22 and 27 years.
#principal value is skewed so meadian is a better measure
```

[ ]:
```
    num_years_owed  principal_due
17              18       5783.580
22              23       5735.850
21              22       5725.700
26              27       5666.460
18              19       5291.020
27              28       5131.220
25              26       4909.580
19              20       4787.910
15              16       4720.230
16              17       4666.210
39              40       4592.710
23              24       4543.620
13              14       4525.560
41              42       4448.170
30              31       4270.680
42              43       4204.530
14              15       4095.185
```

40	41	4017.970
29	30	3820.270
24	25	3718.880
38	39	3698.420
11	12	3592.830
12	13	3572.330
43	44	3497.240
36	37	3478.085
32	33	3436.920
37	38	3414.990
9	10	3324.215
44	45	3321.810
35	36	3275.390
8	9	3238.390
10	11	3225.175
34	35	3158.905
7	8	3075.225
6	7	2879.590
33	34	2860.270
31	32	2805.345
5	6	2594.335
28	29	2411.840
4	5	2274.055
3	4	2006.705
2	3	1704.090
20	21	1406.630
1	2	1082.570
0	1	208.580

[ ]:
```
tax.groupby(tax['num_years_owed'])['opa_number'].count().reset_index().
↪sort_values(by = ['opa_number'], ascending= False)
#most of the delinquent properties are between owened for 1-6 year , then there␣
↪is 25 years owned of delinquent properties
```

[ ]:

	num_years_owed	opa_number
0	1	26311
1	2	9556
2	3	6669
3	4	4562
4	5	3310
5	6	2626
24	25	2277
6	7	1827
7	8	1592
8	9	1246
9	10	1164
10	11	1080

```
11              12          1017
12              13           863
20              21           800
13              14           759
14              15           666
15              16           528
16              17           487
23              24           455
17              18           445
18              19           421
19              20           402
21              22           400
22              23           378
28              29           222
43              44           219
31              32           194
25              26           191
27              28           190
29              30           166
30              31           165
32              33           164
26              27           159
35              36           150
33              34           147
34              35           142
36              37           116
37              38           106
38              39            95
42              43            57
39              40            56
40              41            52
41              42            46
44              45             1
```

[ ]:
```
tax.groupby(tax['building_category'])['opa_number'].count()# most of the␣
↪dentinquent properties are  residential
```

[ ]:
```
building_category
commercial      6021
residential    65186
Name: opa_number, dtype: int64
```

[ ]:
```
tax.groupby(tax['building_category'])['opa_number'].count()/tax['opa_number'].
↪count()#89% is residential properties
```

[ ]:
```
building_category
commercial     0.083072
```

```
residential    0.899378
Name: opa_number, dtype: float64
```

[ ]:
```
#converting year_month column to year only
tax['year_month'] = pd.to_datetime(tax['year_month'], format="%Y%m")
tax['year'] = pd.DatetimeIndex(tax['year_month']).year
```

[ ]:
```
tax[['is_actionable', 'bankruptcy', 'sheriff_sale',␣
 ↪'sequestration_enforcement', 'payment_agreement',␣
 ↪'principal_due']]#selecting only columns that are important
```

[ ]:
```
       is_actionable  bankruptcy sheriff_sale  sequestration_enforcement  \
0              False       False            N                      False
1              False       False            N                      False
2              False       False            N                      False
3              False       False            N                      False
4              False       False            N                      False
…                  …           …            …                          …
72713          False       False            N                      False
72714          False       False            N                      False
72715          False       False            N                      False
72716           True       False            N                      False
72717           True       False            N                      False

       payment_agreement  principal_due
0                   True       12200.18
1                   True          -0.05
2                  False         895.87
3                   True        4536.94
4                  False        4224.60
…                      …              …
72713               True          71.34
72714              False        1542.58
72715               True        2504.38
72716              False        4079.25
72717              False        2301.27

[72479 rows x 6 columns]
```

[ ]:
```
#bankrupcy is non-actionable
print(tax.groupby(tax['bankruptcy'])['principal_due'].sum())
print(tax['bankruptcy'].value_counts())
```

```
bankruptcy
False    2.292244e+08
Name: principal_due, dtype: float64
False    72479
```

```
Name: bankruptcy, dtype: int64
```

[ ]:
```
#payment agreement non-actionable. Payment agreement is one of the way the city␣
 ↪collect debts
print(tax.groupby(tax['payment_agreement'])['principal_due'].sum())
print(tax['payment_agreement'].value_counts())
```

```
payment_agreement
False    1.482439e+08
True     8.098053e+07
Name: principal_due, dtype: float64
False    48678
True     23801
Name: payment_agreement, dtype: int64
```

[ ]:
```
#sheriff sale is actionable. A sheriff's sale is a public auction where␣
 ↪mortgage lenders, banks, tax collectors, and other litigants can collect␣
 ↪money lost on property
print(tax.groupby(tax['sheriff_sale'])['principal_due'].sum())
print(tax['sheriff_sale'].value_counts())
```

```
sheriff_sale
N    2.138628e+08
Y    1.536159e+07
Name: principal_due, dtype: float64
N    70314
Y     2165
Name: sheriff_sale, dtype: int64
```

[ ]:
```
# sequestration is actionable
#The taking of someones property, voluntarily (by deposit) or involuntarily (by␣
 ↪seizure),
# by court officers or into the possession of a third party, awaiting the␣
 ↪outcome of a trial in which ownership of that property is at issue
#If the delinquent property is a rental property, the City can take over the␣
 ↪rent collection and apply those rental payments to the delinquent Real␣
 ↪Estate Tax bill.
print(tax.groupby(tax['sequestration_enforcement'])['principal_due'].sum())
print(tax['sequestration_enforcement'].value_counts())
```

```
sequestration_enforcement
False    2.287520e+08
True     4.724364e+05
Name: principal_due, dtype: float64
False    72381
True        98
Name: sequestration_enforcement, dtype: int64
```

[ ]:
```
#The assessment appeal process allows property owners the opportunity to␣
 ↪dispute the value determined by the Department.
print(tax.groupby(tax['assessment_under_appeal'])['principal_due'].sum())
print(tax['assessment_under_appeal'].value_counts())
#most of the assessment are not under appeal
```

```
assessment_under_appeal
False    2.230154e+08
True     6.208983e+06
Name: principal_due, dtype: float64
False    71971
True       508
Name: assessment_under_appeal, dtype: int64
```

[ ]:
```
tax['general_building_description'].unique()#different type of descriptions␣
 ↪included
```

[ ]:
```
array(['house', 'theater_stadium_other amuse', 'vacantLand', 'mixedUsage',
       'apartmentSmall', 'retail', 'industrial', nan, 'apartmentLarge',
       'miscCommercial', 'nonProfit', 'parking_garage', 'condo', 'garage',
       'hotel', 'Restaurant_Bar', 'officeBuilding', 'miscResidential',
       'parkingLot', 'bank', 'utility'], dtype=object)
```

[ ]:
```
tax.groupby(tax['general_building_description'])['principal_due'].sum().
 ↪sort_values(ascending=False)
#principal due is also the most for house and vacant land
```

[ ]:
```
general_building_description
house                           1.331961e+08
vacantLand                      3.026161e+07
apartmentSmall                  1.320392e+07
mixedUsage                      1.133693e+07
apartmentLarge                  9.104813e+06
nonProfit                       5.194570e+06
industrial                      4.105313e+06
retail                          3.802362e+06
condo                           3.304997e+06
miscCommercial                  2.440253e+06
officeBuilding                  1.892045e+06
parkingLot                      1.778640e+06
theater_stadium_other amuse     1.595614e+06
Restaurant_Bar                  7.796232e+05
parking_garage                  6.016357e+05
garage                          5.697422e+05
hotel                           4.450313e+05
miscResidential                 2.573390e+05
utility                         5.262612e+04
```

```
bank                            9.603020e+03
Name: principal_due, dtype: float64
```

[ ]:
```
print(tax['general_building_description'].value_counts()) # most of them are houses and vacant lots
```

```
house                          49796
vacantLand                     11623
apartmentSmall                  3528
mixedUsage                      2374
condo                            910
industrial                       560
retail                           415
nonProfit                        365
apartmentLarge                   331
miscCommercial                   324
garage                           275
parkingLot                       235
miscResidential                  191
theater_stadium_other amuse       90
officeBuilding                    76
Restaurant_Bar                    71
hotel                             22
parking_garage                    16
bank                               3
utility                            2
Name: general_building_description, dtype: int64
```

[ ]:
```
tax.groupby(tax['general_building_description'])['principal_due'].median().sort_values(ascending=False)
#howver, the median and mean principal due is not high for house and vacant lots
```

[ ]:
```
general_building_description
utility                        26313.060
officeBuilding                  8626.265
apartmentLarge                  8141.580
hotel                           7714.150
Restaurant_Bar                  6149.910
theater_stadium_other amuse     5572.080
nonProfit                       4324.050
parking_garage                  4072.705
retail                          3360.110
miscCommercial                  3225.140
bank                            2920.940
industrial                      2705.660
mixedUsage                      2397.415
apartmentSmall                  2069.885
```

```
condo                          1121.630
vacantLand                     1101.110
house                          1086.830
parkingLot                      979.070
garage                          911.270
miscResidential                 494.970
Name: principal_due, dtype: float64
```

1.1.12 City of Philadelphia: Property Code Violations

https://www.opendataphilly.org/dataset/licenses-and-inspections-violations

Column description: https://metadata.phila.gov/#home/datasetdetails/5543ca7a5c4ae4cd66d3ff86/representatio

This dataset was quite big so we had to download three different datasets for different years and combine them togather

[ ]:
```
#upload all datasets
violation1 = pd.read_csv('data/city/violations_2019.csv')
violation2 = pd.read_csv('data/city/violations2016-2018.csv')
violation3 = pd.read_csv('data/city/violations2013-2015.csv')


violation = [violation1, violation2, violation3]
violation = pd.concat(violation)#combining all datasets
```

```
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/IPython/core/interactiveshell.py:3457: DtypeWarning: Columns
(2,3,6,10,15,16,20,21) have mixed types.Specify dtype option on import or set
low_memory=False.
  exec(code_obj, self.user_global_ns, self.user_ns)
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/IPython/core/interactiveshell.py:3457: DtypeWarning: Columns
(2,3,6,15,16,20) have mixed types.Specify dtype option on import or set
low_memory=False.
  exec(code_obj, self.user_global_ns, self.user_ns)
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/IPython/core/interactiveshell.py:3457: DtypeWarning: Columns
(3,6,15,16,20) have mixed types.Specify dtype option on import or set
low_memory=False.
  exec(code_obj, self.user_global_ns, self.user_ns)
```

[ ]:
```
violation.head()
```

[ ]:

	objectid	addressobjectid	parcel_id_num	casenumber	casecreateddate
0	22000	156857764.0	NaN	678967	2019-04-05 14:04:19
1	199	15897333.0	475137	568999	2017-01-09 13:23:18
2	20439	131980134.0	NaN	678131	2019-03-29 12:09:52

```
3       385       15514326.0        326877     569328  2017-01-13 08:41:18
4       386       15514326.0        326877     569328  2017-01-13 08:41:18

     casecompleteddate             casetype    casestatus  \
0                  NaN  NOTICE OF VIOLATION  IN VIOLATION
1                  NaN  NOTICE OF VIOLATION  IN VIOLATION
2  2020-09-21 12:32:03  NOTICE OF VIOLATION        CLOSED
3                  NaN  NOTICE OF VIOLATION  IN VIOLATION
4                  NaN  NOTICE OF VIOLATION  IN VIOLATION

              caseresponsibility caseprioritydesc  …         zip  \
0  CODE ENFORCEMENT INVESTIGATOR        HAZARDOUS  …         NaN
1               CSU INVESTIGATOR           UNSAFE  …  19104-1123
2          BUILDING INVESTIGATOR         STANDARD  …         NaN
3          BUILDING INVESTIGATOR         STANDARD  …  19138-3051
4          BUILDING INVESTIGATOR         STANDARD  …  19138-3051

  censustract        opa_owner systemofrecord     geocode_x      geocode_y  \
0         NaN              NaN        ECLIPSE           NaN            NaN
1       110.0  COLEMAN GREGORY        ECLIPSE  2.683078e+06  243246.473027
2         NaN              NaN        ECLIPSE           NaN            NaN
3       267.0   JAQUEZ RAMON M        ECLIPSE  2.695877e+06  272847.558740
4       267.0   JAQUEZ RAMON M        ECLIPSE  2.695877e+06  272847.558740

  council_district  posse_jobid        lat        lng
0              NaN  195203950.0        NaN        NaN
1              3.0  195194705.0  39.972746 -75.200065
2              NaN  195203407.0        NaN        NaN
3              9.0  195194755.0  40.052946 -75.151310
4              9.0  195194755.0  40.052946 -75.151310

[5 rows x 32 columns]
```

[ ]:
```
violation.head().T
```

[ ]:
```
                                                    0  \
objectid                                        22000
addressobjectid                             156857764.0
parcel_id_num                                       NaN
casenumber                                       678967
casecreateddate                     2019-04-05 14:04:19
casecompleteddate                                   NaN
casetype                            NOTICE OF VIOLATION
casestatus                                  IN VIOLATION
caseresponsibility       CODE ENFORCEMENT INVESTIGATOR
caseprioritydesc                               HAZARDOUS
violationnumber                                211959680
```

```
violationdate                     2019-04-05 00:00:00
violationcode                                PM15-301
violationcodetitle          VACANT STRUCTURE AND LAND
violationstatus                                 OPEN
violationresolutiondate                          NaN
violationresolutioncode                          NaN
mostrecentinvestigation          2020-06-24 12:01:43
opa_account_num                                  NaN
address                                          NaN
unit_type                                        NaN
unit_num                                         NaN
zip                                              NaN
censustract                                      NaN
opa_owner                                        NaN
systemofrecord                             ECLIPSE
geocode_x                                        NaN
geocode_y                                        NaN
council_district                                 NaN
posse_jobid                              195203950.0
lat                                              NaN
lng                                              NaN

                                                   1  \
objectid                                         199
addressobjectid                          15897333.0
parcel_id_num                                475137
casenumber                                   568999
casecreateddate                  2017-01-09 13:23:18
casecompleteddate                                NaN
casetype                         NOTICE OF VIOLATION
casestatus                               IN VIOLATION
caseresponsibility                  CSU INVESTIGATOR
caseprioritydesc                             UNSAFE
violationnumber                           211935476
violationdate                    2019-01-23 00:00:00
violationcode                            PM15-304.1G
violationcodetitle       EXTERIOR STRUCT UNSAFE COND 7
violationstatus                                 OPEN
violationresolutiondate                          NaN
violationresolutioncode                          NaN
mostrecentinvestigation          2021-09-28 12:01:31
opa_account_num                          243186900.0
address                           3831 WYALUSING AVE
unit_type                                        NaN
unit_num                                         NaN
zip                                      19104-1123
censustract                                  110.0
```

opa_owner	COLEMAN GREGORY			
systemofrecord	ECLIPSE			
geocode_x	2683077.781269			
geocode_y	243246.473027			
council_district	3.0			
posse_jobid	195194705.0			
lat	39.972746			
lng	-75.200065			

	2	\
objectid	20439	
addressobjectid	131980134.0	
parcel_id_num	NaN	
casenumber	678131	
casecreateddate	2019-03-29 12:09:52	
casecompleteddate	2020-09-21 12:32:03	
casetype	NOTICE OF VIOLATION	
casestatus	CLOSED	
caseresponsibility	BUILDING INVESTIGATOR	
caseprioritydesc	STANDARD	
violationnumber	211959511	
violationdate	2019-03-27 00:00:00	
violationcode	A-303.2/2	
violationcodetitle	DEMOL- NOTICE REMOVED TOO SOON	
violationstatus	CLOSED	
violationresolutiondate	2020-09-18 00:00:00	
violationresolutioncode	CLOSED - ADMINISTRATIVELY	
mostrecentinvestigation	2020-09-21 12:32:02	
opa_account_num	NaN	
address	NaN	
unit_type	NaN	
unit_num	NaN	
zip	NaN	
censustract	NaN	
opa_owner	NaN	
systemofrecord	ECLIPSE	
geocode_x	NaN	
geocode_y	NaN	
council_district	NaN	
posse_jobid	195203407.0	
lat	NaN	
lng	NaN	

	3	4
objectid	385	386
addressobjectid	15514326.0	15514326.0
parcel_id_num	326877	326877

casenumber	569328	569328
casecreateddate	2017-01-13 08:41:18	2017-01-13 08:41:18
casecompleteddate	NaN	NaN
casetype	NOTICE OF VIOLATION	NOTICE OF VIOLATION
casestatus	IN VIOLATION	IN VIOLATION
caseresponsibility	BUILDING INVESTIGATOR	BUILDING INVESTIGATOR
caseprioritydesc	STANDARD	STANDARD
violationnumber	211935656	211935657
violationdate	2020-03-14 00:21:37	2020-03-14 00:21:37
violationcode	E-1201.1/217	PM-407.2/4
violationcodetitle	SERVICE HEAD-RAINTIGHT REQ'D	ELEC-CORD DEFECTIVE-RES
violationstatus	OPEN	OPEN
violationresolutiondate	NaN	NaN
violationresolutioncode	NaN	NaN
mostrecentinvestigation	NaN	NaN
opa_account_num	871515040.0	871515040.0
address	6441 N 20TH ST	6441 N 20TH ST
unit_type	NaN	NaN
unit_num	NaN	NaN
zip	19138-3051	19138-3051
censustract	267.0	267.0
opa_owner	JAQUEZ RAMON M	JAQUEZ RAMON M
systemofrecord	ECLIPSE	ECLIPSE
geocode_x	2695877.169947	2695877.169947
geocode_y	272847.55874	272847.55874
council_district	9.0	9.0
posse_jobid	195194755.0	195194755.0
lat	40.052946	40.052946
lng	-75.15131	-75.15131

[ ]:
```
violation.shape# side of dataset
```

[ ]:
```
(903633, 32)
```

[ ]:
```
violation.columns# different columns included
```

[ ]:
```
Index(['objectid', 'addressobjectid', 'parcel_id_num', 'casenumber',
       'casecreateddate', 'casecompleteddate', 'casetype', 'casestatus',
       'caseresponsibility', 'caseprioritydesc', 'violationnumber',
       'violationdate', 'violationcode', 'violationcodetitle',
       'violationstatus', 'violationresolutiondate', 'violationresolutioncode',
       'mostrecentinvestigation', 'opa_account_num', 'address', 'unit_type',
       'unit_num', 'zip', 'censustract', 'opa_owner', 'systemofrecord',
       'geocode_x', 'geocode_y', 'council_district', 'posse_jobid', 'lat',
       'lng'],
      dtype='object')
```

[ ]:
```
violation.dtypes #type of dataset
```

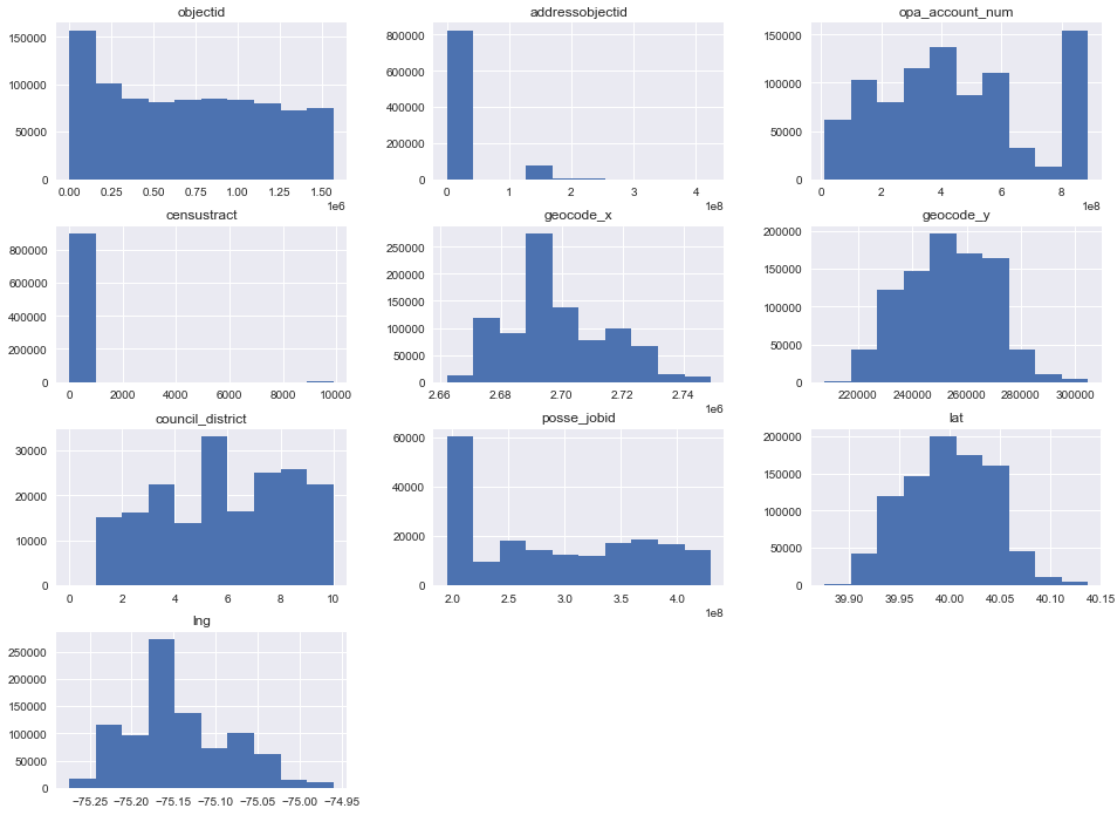
[ ]:
```
objectid                    int64
addressobjectid           float64
parcel_id_num              object
casenumber                 object
casecreateddate            object
casecompleteddate          object
casetype                   object
casestatus                 object
caseresponsibility         object
caseprioritydesc           object
violationnumber            object
violationdate              object
violationcode              object
violationcodetitle         object
violationstatus            object
violationresolutiondate    object
violationresolutioncode    object
mostrecentinvestigation    object
opa_account_num           float64
address                    object
unit_type                  object
unit_num                   object
zip                        object
censustract               float64
opa_owner                  object
systemofrecord             object
geocode_x                 float64
geocode_y                 float64
council_district          float64
posse_jobid               float64
lat                       float64
lng                       float64
dtype: object
```

[ ]:
```
#plotting histogram
fig, ax = plt.subplots(figsize=(16,12))
violation.hist(ax=ax)
```

```
/var/folders/6p/wpw9qml57530xkxqkkhprrf40000gn/T/ipykernel_74088/1763168730.py:2
: UserWarning: To output multiple subplots, the figure containing the passed
axes is being cleared
  violation.hist(ax=ax)
```

[ ]:
```
array([[<AxesSubplot:title={'center':'objectid'}>,
        <AxesSubplot:title={'center':'addressobjectid'}>,
```

```
 <AxesSubplot:title={'center':'opa_account_num'}>],
[<AxesSubplot:title={'center':'censustract'}>,
 <AxesSubplot:title={'center':'geocode_x'}>,
 <AxesSubplot:title={'center':'geocode_y'}>],
[<AxesSubplot:title={'center':'council_district'}>,
 <AxesSubplot:title={'center':'posse_jobid'}>,
 <AxesSubplot:title={'center':'lat'}>],
[<AxesSubplot:title={'center':'lng'}>, <AxesSubplot:>,
 <AxesSubplot:>]], dtype=object)
```



[ ]:
```
violation.describe(include = 'all').T# describing dataset
```

[ ]:
```
                          count  unique  \
objectid                903633.0     NaN
addressobjectid         902429.0     NaN
parcel_id_num             191017   65323
casenumber                903633  400338
casecreateddate           888022  387418
casecompleteddate         718252  319955
casetype                  192360       5
casestatus                903633       7
```

caseresponsibility	887458	39
caseprioritydesc	887986	10
violationnumber	903633	903633
violationdate	903633	4556
violationcode	903377	2260
violationcodetitle	903159	2286
violationstatus	895070	13
violationresolutiondate	108619	1376
violationresolutioncode	108620	14
mostrecentinvestigation	879738	335052
opa_account_num	894028.0	NaN
address	902082	163352
unit_type	5827	13
unit_num	11379	613
zip	902075	37162
censustract	901417.0	NaN
opa_owner	896510	132306
systemofrecord	903633	2
geocode_x	901396.0	NaN
geocode_y	901396.0	NaN
council_district	190477.0	NaN
posse_jobid	192575.0	NaN
lat	901396.0	NaN
lng	901396.0	NaN

	top \
objectid	NaN
addressobjectid	NaN
parcel_id_num	DATA CONVERSION ONLY
casenumber	569328
casecreateddate	2018-07-02 07:43:19
casecompleteddate	2016-07-20 08:37:14
casetype	NOTICE OF VIOLATION
casestatus	CLOSED
caseresponsibility	CLIP
caseprioritydesc	STANDARD
violationnumber	211959680
violationdate	2018-06-21 00:00:00
violationcode	CP-01
violationcodetitle	CLIP VIOLATION NOTICE
violationstatus	COMPLIED
violationresolutiondate	2021-06-02 00:00:00
violationresolutioncode	COMPLIED - OWNER REPAIR
mostrecentinvestigation	2018-07-23 00:00:00
opa_account_num	NaN
address	DATA CONVERSION ONLY 1DATA CONVERSION ONLY MAR…
unit_type	#

unit_num	1
zip	19121-0000
censustract	NaN
opa_owner	PHILADELPHIA HOUSING AUTH
systemofrecord	HANSEN
geocode_x	NaN
geocode_y	NaN
council_district	NaN
posse_jobid	NaN
lat	NaN
lng	NaN

	freq	mean	std	\
objectid	NaN	700253.822956	469527.1076	
addressobjectid	NaN	14387905.594245	39731469.555869	
parcel_id_num	498	NaN	NaN	
casenumber	41	NaN	NaN	
casecreateddate	48	NaN	NaN	
casecompleteddate	8096	NaN	NaN	
casetype	192025	NaN	NaN	
casestatus	803203	NaN	NaN	
caseresponsibility	314813	NaN	NaN	
caseprioritydesc	745654	NaN	NaN	
violationnumber	1	NaN	NaN	
violationdate	823	NaN	NaN	
violationcode	133117	NaN	NaN	
violationcodetitle	133117	NaN	NaN	
violationstatus	699572	NaN	NaN	
violationresolutiondate	459	NaN	NaN	
violationresolutioncode	55298	NaN	NaN	
mostrecentinvestigation	147	NaN	NaN	
opa_account_num	NaN	449880985.849242	258958681.014763	
address	498	NaN	NaN	
unit_type	3885	NaN	NaN	
unit_num	1751	NaN	NaN	
zip	3282	NaN	NaN	
censustract	NaN	225.867819	540.346234	
opa_owner	13011	NaN	NaN	
systemofrecord	711058	NaN	NaN	
geocode_x	NaN	2698469.028863	16675.065162	
geocode_y	NaN	253109.841246	15919.340083	
council_district	NaN	5.381343	2.542162	
posse_jobid	NaN	287458400.794828	79257460.572387	
lat	NaN	39.998561	0.042816	
lng	NaN	-75.144111	0.060601	

	min	25%	50%	\

objectid	1.0	255821.0	680843.0
addressobjectid	1038.0	322714.0	514315.0
parcel_id_num	NaN	NaN	NaN
casenumber	NaN	NaN	NaN
casecreateddate	NaN	NaN	NaN
casecompleteddate	NaN	NaN	NaN
casetype	NaN	NaN	NaN
casestatus	NaN	NaN	NaN
caseresponsibility	NaN	NaN	NaN
caseprioritydesc	NaN	NaN	NaN
violationnumber	NaN	NaN	NaN
violationdate	NaN	NaN	NaN
violationcode	NaN	NaN	NaN
violationcodetitle	NaN	NaN	NaN
violationstatus	NaN	NaN	NaN
violationresolutiondate	NaN	NaN	NaN
violationresolutioncode	NaN	NaN	NaN
mostrecentinvestigation	NaN	NaN	NaN
opa_account_num	11004900.0	243207800.0	412025650.0
address	NaN	NaN	NaN
unit_type	NaN	NaN	NaN
unit_num	NaN	NaN	NaN
zip	NaN	NaN	NaN
censustract	1.0	108.0	179.0
opa_owner	NaN	NaN	NaN
systemofrecord	NaN	NaN	NaN
geocode_x	2662255.079664	2688400.696487	2695435.196684
geocode_y	207591.375288	241379.31152	252487.560163
council_district	0.0	3.0	5.0
posse_jobid	195194617.0	195213867.0	279522734.0
lat	39.875131	39.967756	39.996909
lng	-75.274275	-75.180733	-75.155205

	75%	max
objectid	1100259.0	1567618.0
addressobjectid	693697.0	423909631.0
parcel_id_num	NaN	NaN
casenumber	NaN	NaN
casecreateddate	NaN	NaN
casecompleteddate	NaN	NaN
casetype	NaN	NaN
casestatus	NaN	NaN
caseresponsibility	NaN	NaN
caseprioritydesc	NaN	NaN
violationnumber	NaN	NaN
violationdate	NaN	NaN
violationcode	NaN	NaN

```
violationcodetitle                  NaN            NaN
violationstatus                     NaN            NaN
violationresolutiondate             NaN            NaN
violationresolutioncode             NaN            NaN
mostrecentinvestigation             NaN            NaN
opa_account_num           621072400.0    888800162.0
address                             NaN            NaN
unit_type                           NaN            NaN
unit_num                            NaN            NaN
zip                                 NaN            NaN
censustract                       298.0         9891.0
opa_owner                           NaN            NaN
systemofrecord                      NaN            NaN
geocode_x                2709493.522028  2748942.42556
geocode_y                 265671.390854  304755.168331
council_district                    8.0           10.0
posse_jobid                 361314020.0    429848513.0
lat                           40.031826      40.137402
lng                          -75.104109     -74.959958
```

[ ]:
```
violation.isna().sum()# null values
```

[ ]:
```
objectid                       0
addressobjectid             1204
parcel_id_num             712616
casenumber                     0
casecreateddate            15611
casecompleteddate         185381
casetype                  711273
casestatus                     0
caseresponsibility         16175
caseprioritydesc           15647
violationnumber                0
violationdate                  0
violationcode                256
violationcodetitle           474
violationstatus             8563
violationresolutiondate   795014
violationresolutioncode   795013
mostrecentinvestigation    23895
opa_account_num             9605
address                     1551
unit_type                 897806
unit_num                  892254
zip                         1558
censustract                 2216
opa_owner                   7123
```

```
systemofrecord                 0
geocode_x                   2237
geocode_y                   2237
council_district          713156
posse_jobid               711058
lat                         2237
lng                         2237
dtype: int64
```

[ ]:
```
(violation.isna().sum()/violation.shape[0]).sort_values(ascending=False)#unit␣
↪type, unit num, has a lot of null values
```

[ ]:
```
unit_type                 0.993552
unit_num                  0.987407
violationresolutiondate   0.879797
violationresolutioncode   0.879796
council_district          0.789210
parcel_id_num             0.788612
casetype                  0.787126
posse_jobid               0.786888
casecompleteddate         0.205151
mostrecentinvestigation   0.026443
caseresponsibility        0.017900
caseprioritydesc          0.017316
casecreateddate           0.017276
opa_account_num           0.010629
violationstatus           0.009476
opa_owner                 0.007883
geocode_x                 0.002476
geocode_y                 0.002476
lat                       0.002476
lng                       0.002476
censustract               0.002452
zip                       0.001724
address                   0.001716
addressobjectid           0.001332
violationcodetitle        0.000525
violationcode             0.000283
systemofrecord            0.000000
violationdate             0.000000
violationnumber           0.000000
casestatus                0.000000
casenumber                0.000000
objectid                  0.000000
dtype: float64
```

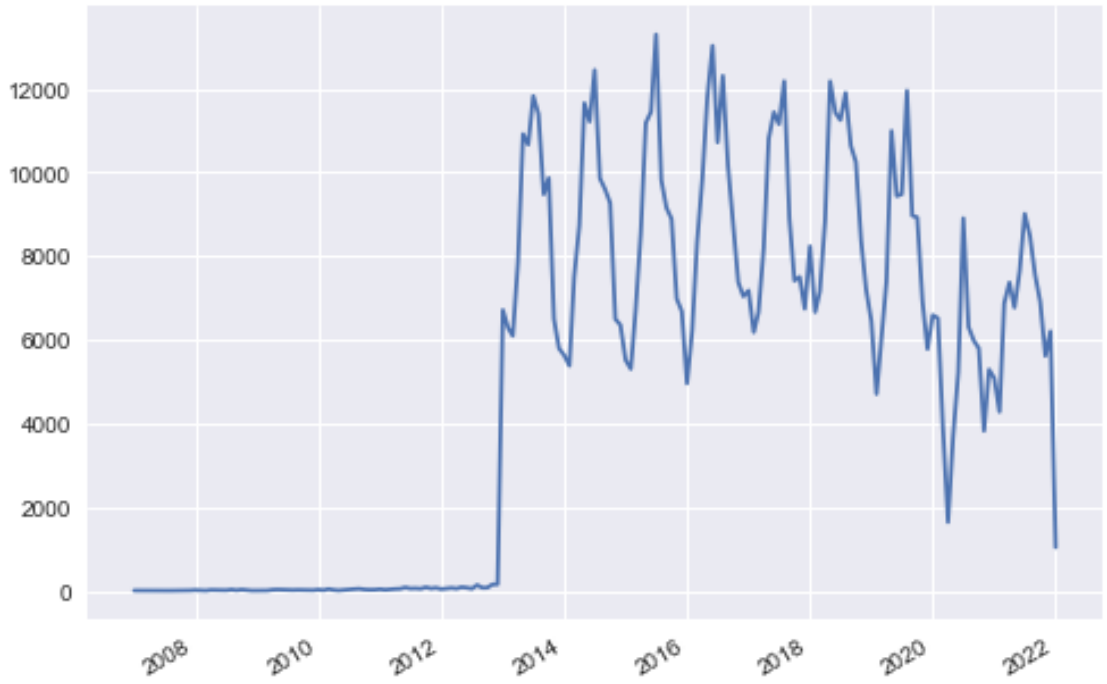
[ ]:
```
violation.dropna(subset=['lat', 'lng', 'zip'], inplace = True)#dropping nuull␣
↪values within latitude, longitude and zip code data
```

[ ]:
```
#converting  date columns to datetime
violation['casecreateddate'] = pd.to_datetime(violation['casecreateddate'])
violation['casecompleteddate'] = pd.to_datetime(violation['casecompleteddate'])
violation['violationdate'] = pd.to_datetime(violation['violationdate'])
violation['violationresolutiondate'] = pd.
↪to_datetime(violation['violationresolutiondate'])
```

[ ]:
```
violation['casecreateddate_year'] = pd.to_datetime(violation['casecreateddate'].
↪dt.strftime('%Y-%m'))
```

[ ]:
```
violation['casecreateddate_year'].value_counts().plot()#theere seems to some␣
↪seasonality in case violations
```

[ ]: <AxesSubplot:>



[ ]:
```
violation['caseprioritydesc'].value_counts()# most of the cases are standard
```

[ ]:
```
STANDARD                    743549
CONSTRUCTION SERVICES        49410
UNSAFE                       45166
HAZARDOUS                    30076
```

```
IMMINENTLY DANGEROUS                17454
ACCELERATED REVIEW                     31
UNLAWFUL                               24
AIU LICENSING VIOLATION NOTICE         17
UNFIT                                   7
5 DAY REVIEW GROUP                      3
Name: caseprioritydesc, dtype: int64
```

[ ]:
```
violation['opa_owner'].value_counts().head(20)# opa_owner is Office of Property␣
↪Assessment's ownership  from the current deed for the property.
#Most of these were from tPhiladelphia housing Auth and second highest was␣
↪philadelphia land bank
```

[ ]:
```
PHILADELPHIA HOUSING AUTH                   13011
PHILADELPHIA LAND BANK                       6810
SCHOOL DISTRICT OF PHILA                     4412
REDEVELOPMENT AUTHORITY  OF PHILADELPHIA     3922
CITY OF PHILADELPHIA                         2296
REDEVELOPMENT AUTHORITY  OF PHILA            1506
CITY OF PHILA                                1457
GEENA LLC                                    1260
REDEVELOPMENT AUTHORITY O                    1056
REDEVELOPMENT AUTHORITY, OF PHILADELPHIA      859
EMARCO DREW                                   715
STABLE GENIUS LLC                             685
GULLE JEAN PAUL                               633
PHILADELPHIA REDEVELOPMEN                     630
CITY OF PHILA, DEPT OF PUBLIC PROP            565
BID PROPERTIES LLC                            548
BCM INVESTMENTS LLC                           545
ULATOWSKI WALTER                              544
CORESTATES GROUP LLC                          540
TTP HOLDINGS LLC                              513
Name: opa_owner, dtype: int64
```

[ ]:
```
violation['opa_owner'].nunique()# number of unique opa_owner
```

[ ]:
```
132279
```

[ ]:
```
(violation.groupby('violationcodetitle')['objectid'].count()).
↪sort_values(ascending=False).reset_index().head(20)
#included description of the violations.  A lot of them are related to vacant␣
↪lots
```

[ ]:
```
                violationcodetitle  objectid
0            CLIP VIOLATION NOTICE    133117
1   EXT A-VACANT LOT CLEAN/MAINTAI     57499
```

```
2                  HIGH WEEDS-CUT     50055
3              EXTERIOR AREA WEEDS     35311
4   RUBBISH/GARBAGE EXTERIOR-OWNER     30000
5         VACANT STRUCTURE LICENSE     23305
6         EXTERIOR AREA SANITATION     15877
7                 UNSAFE STRUCTURE     13107
8               RUBBISH & GARBAGE      11461
9        LICENSE - RENTAL PROPERTY     11417
10            LICENSE-VAC RES BLDG     10600
11               INTERIOR SURFACES      9034
12       VACANT STRUCTURE AND LAND      9026
13                 VACANT AND OPEN      9020
14         VACANT STRUCTURE & LAND      8349
15            VACANT PROP STANDARD      8284
16   EXTERIOR STRUCT UNSAFE COND 7      8139
17                 PERM Z- NEW USE      7390
18         ONE AND TWO FAMILY (R3)      6870
19     ARCHITECT/ENGINEER SERVICES      6737
```

[ ]:
```
violation['violationcodetitle'].nunique()# around 2 thoughsad violation types
```

[ ]:
```
2286
```

[ ]:
```
violation['violationstatus'].value_counts() # most of the status of violation␣
↪are complied
```

[ ]:
```
COMPLIED          699572
OPEN               83955
CLOSEDCASE         76789
CLOSED             11377
DEMOLISH           10165
ERROR               6709
RESOLVE             4916
CVN ISSUED          1386
STOP WORK            108
WARNING ISSUED        67
SVN ISSUED            22
COMPEXCP               3
CMPLY                  1
Name: violationstatus, dtype: int64
```

[ ]:
```
violation.columns # column names in the dataset
```

[ ]:
```
Index(['objectid', 'addressobjectid', 'parcel_id_num', 'casenumber',
       'casecreateddate', 'casecompleteddate', 'casetype', 'casestatus',
       'caseresponsibility', 'caseprioritydesc', 'violationnumber',
       'violationdate', 'violationcode', 'violationcodetitle',
```

```
       'violationstatus', 'violationresolutiondate', 'violationresolutioncode',
       'mostrecentinvestigation', 'opa_account_num', 'address', 'unit_type',
       'unit_num', 'zip', 'censustract', 'opa_owner', 'systemofrecord',
       'geocode_x', 'geocode_y', 'council_district', 'posse_jobid', 'lat',
       'lng', 'casecreateddate_year'],
      dtype='object')
```

[ ]:
```
#combining latitude and longitue columns into geometru column for geo pandas to␣
↪read and make maps
crs = {'init': 'epsg:4326'}
geometry = [Point(xy) for xy in zip(violation["lng"], violation["lat"])]
violation = gpd.GeoDataFrame(violation,
                         crs = crs,
                         geometry = geometry)

violation.head()
```

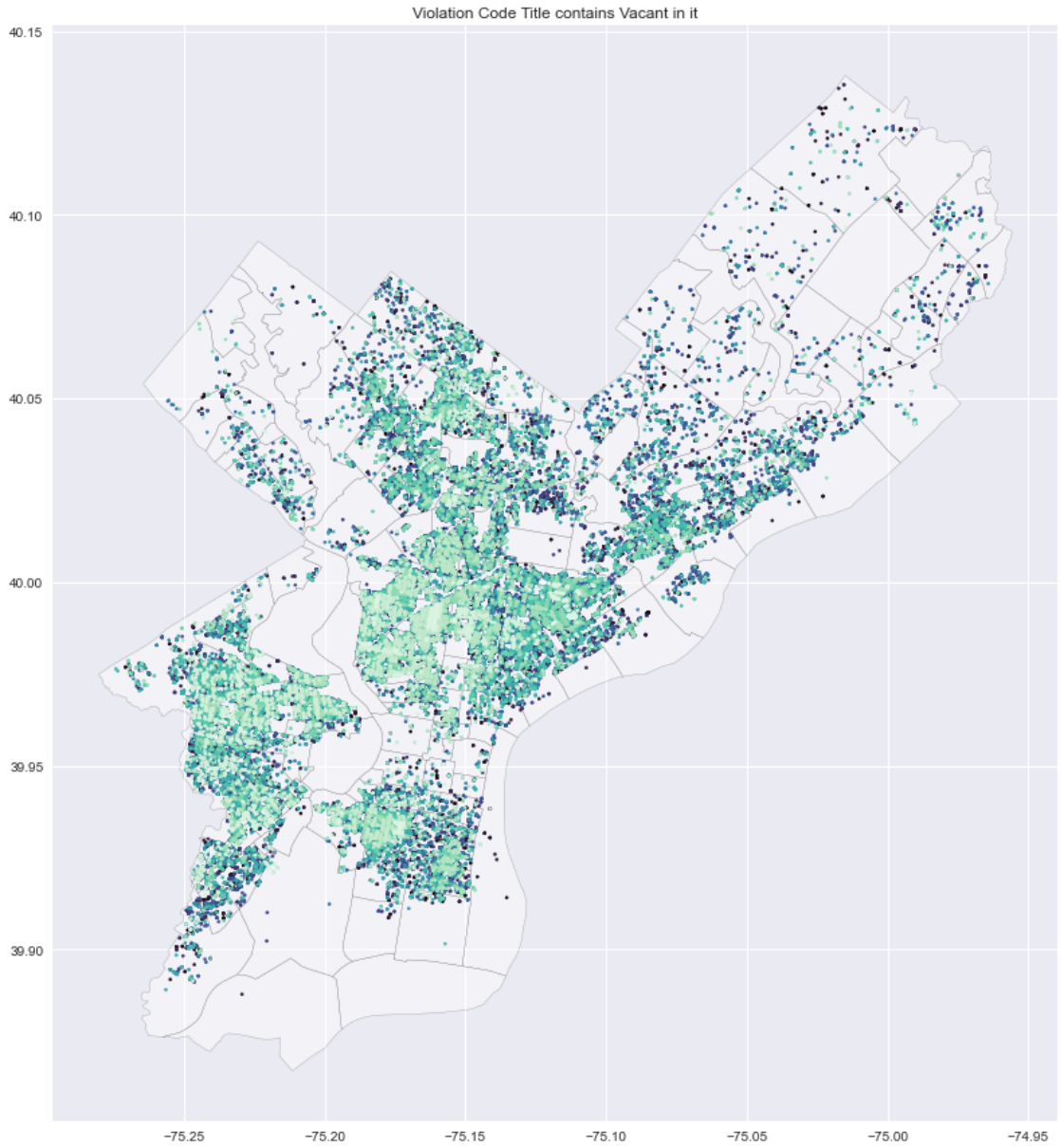
```
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/pyproj/crs/crs.py:131: FutureWarning: '+init=<authority>:<code>' syntax
is deprecated. '<authority>:<code>' is the preferred initialization method. When
making the change, be mindful of axis order changes:
https://pyproj4.github.io/pyproj/stable/gotchas.html#axis-order-changes-in-
proj-6
  in_crs_string = _prepare_from_proj_string(in_crs_string)
```

[ ]:
```
   objectid  addressobjectid parcel_id_num casenumber     casecreateddate  \
1       199       15897333.0        475137     568999 2017-01-09 13:23:18
3       385       15514326.0        326877     569328 2017-01-13 08:41:18
4       386       15514326.0        326877     569328 2017-01-13 08:41:18
5       387       15514326.0        326877     569328 2017-01-13 08:41:18
6       388       15514326.0        326877     569328 2017-01-13 08:41:18

  casecompleteddate             casetype    casestatus     caseresponsibility  \
1               NaT  NOTICE OF VIOLATION  IN VIOLATION       CSU INVESTIGATOR
3               NaT  NOTICE OF VIOLATION  IN VIOLATION  BUILDING INVESTIGATOR
4               NaT  NOTICE OF VIOLATION  IN VIOLATION  BUILDING INVESTIGATOR
5               NaT  NOTICE OF VIOLATION  IN VIOLATION  BUILDING INVESTIGATOR
6               NaT  NOTICE OF VIOLATION  IN VIOLATION  BUILDING INVESTIGATOR

  caseprioritydesc  …        opa_owner systemofrecord     geocode_x  \
1           UNSAFE  …  COLEMAN GREGORY        ECLIPSE  2.683078e+06
3         STANDARD  …   JAQUEZ RAMON M        ECLIPSE  2.695877e+06
4         STANDARD  …   JAQUEZ RAMON M        ECLIPSE  2.695877e+06
5         STANDARD  …   JAQUEZ RAMON M        ECLIPSE  2.695877e+06
6         STANDARD  …   JAQUEZ RAMON M        ECLIPSE  2.695877e+06

       geocode_y council_district  posse_jobid        lat        lng  \
```

```
1  243246.473027              3.0  195194705.0  39.972746 -75.200065
3  272847.558740              9.0  195194755.0  40.052946 -75.151310
4  272847.558740              9.0  195194755.0  40.052946 -75.151310
5  272847.558740              9.0  195194755.0  40.052946 -75.151310
6  272847.558740              9.0  195194755.0  40.052946 -75.151310

   casecreateddate_year                    geometry
1            2017-01-01  POINT (-75.20007 39.97275)
3            2017-01-01  POINT (-75.15131 40.05295)
4            2017-01-01  POINT (-75.15131 40.05295)
5            2017-01-01  POINT (-75.15131 40.05295)
6            2017-01-01  POINT (-75.15131 40.05295)

[5 rows x 34 columns]
```

[ ]:
```
#creating map with vacant in the code violation title
fig, ax = plt.subplots(figsize =(15,15))
plt.style.use('seaborn')
plt.title("Violation Code Title contains Vacant in it")
street_map.to_crs(epsg = 4326).plot(ax = ax, alpha = 0.4,  color = "white",␣
↪edgecolor='black')# shape file of neighbourhood
violation[violation['violationcodetitle'].str.contains('VACANT',na=False)].
↪plot(ax = ax, cmap = 'mako',legend=True, markersize = 5, label = "Vacant lot␣
↪violations")
```

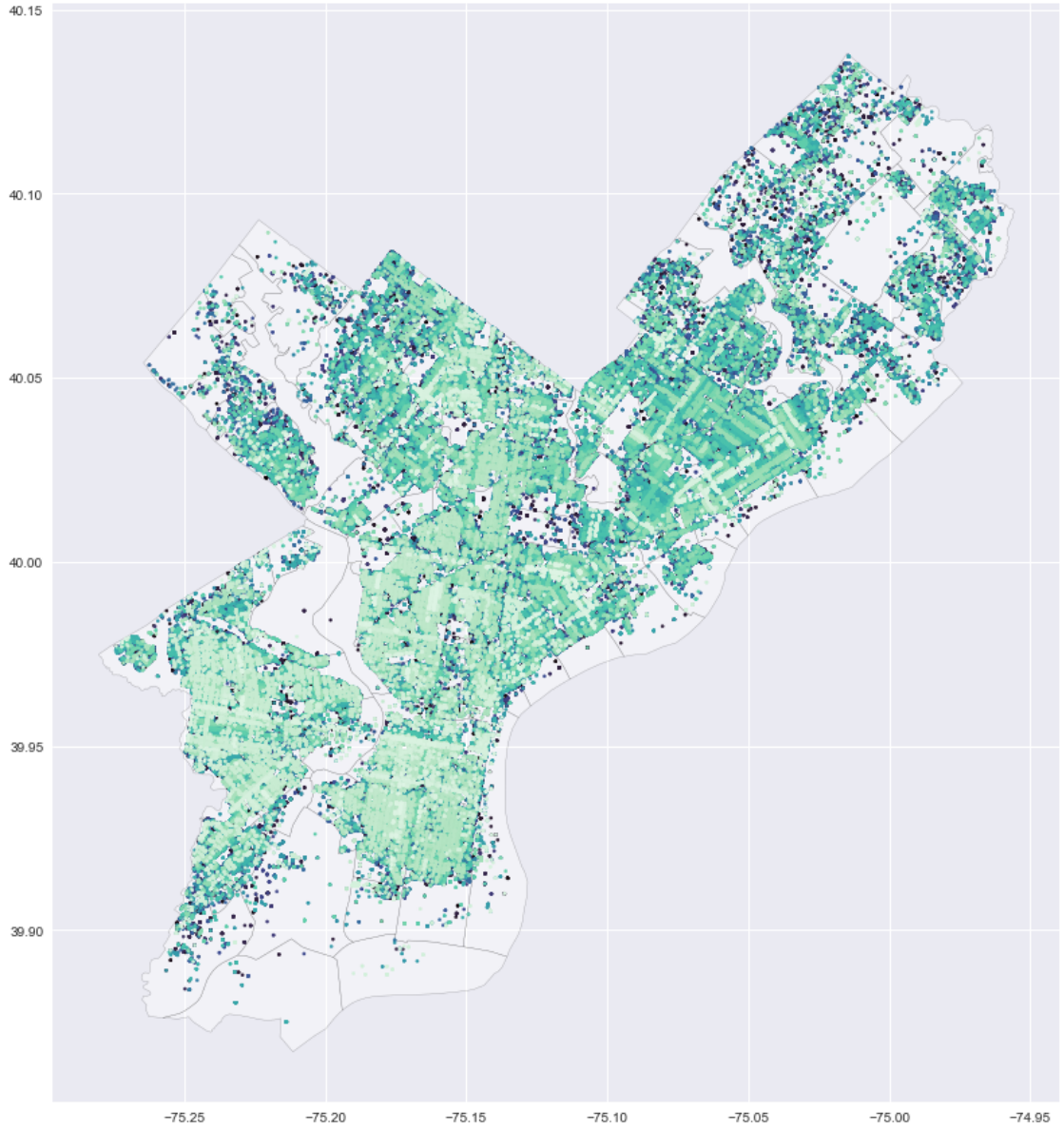
[ ]:
```
<AxesSubplot:title={'center':'Violation Code Title contains Vacant in it'}>
```



[ ]:
```
#creating map that does not include vacant in the code violation title
fig, ax = plt.subplots(figsize =(15,15))
plt.style.use('seaborn')
plt.title("Violation Code Title contains that does not contain Vacant in it")
street_map.to_crs(epsg = 4326).plot(ax = ax, alpha = 0.4,  color = "white",␣
 ↪edgecolor='black')
violation[~violation['violationcodetitle'].str.contains('VACANT',na=False)].
 ↪plot(ax = ax, cmap = 'mako',legend=True, markersize = 5, label = "Violation␣
 ↪does not cotain Vacant")
```

```
#the map shows that the violations are very different from what we see where␣
↪vacant lots tend to be
```

[ ]: <AxesSubplot:>



1.1.13 City of Philadelphia: Crime

[ ]:
```
#Source: https://metadata.phila.gov/#home/datasetdetails/
↪5543868920583086178c4f8e/representationdetails/570e7621c03327dc14f4b68d/
crime = pd.read_csv('data/city/crime.csv')
```

[ ]:
```
crime.columns
```

[ ]:
```
Index(['the_geom', 'the_geom_webmercator', 'objectid', 'dc_dist', 'psa',
       'dispatch_date_time', 'dispatch_date', 'dispatch_time', 'hour_',
       'dc_key', 'location_block', 'ucr_general', 'text_general_code',
       'point_x', 'point_y', 'lat', 'lng'],
      dtype='object')
```

[ ]:
```
crime.head()
```

[ ]:

	the_geom	the_geom_webmercator	objectid	dc_dist	psa
0	0101000020E6100000EA77405D0DC952C016F8ED98F8FA…	0101000020110F000080BB90BAA8E85FC1EC88B8A8528A…	107	6	1
1	0101000020E6100000EA77405D0DC952C016F8ED98F8FA…	0101000020110F000080BB90BAA8E85FC1EC88B8A8528A…	108	6	1
2	0101000020E6100000EA77405D0DC952C016F8ED98F8FA…	0101000020110F000080BB90BAA8E85FC1EC88B8A8528A…	109	6	1
3	0101000020E6100000EA77405D0DC952C016F8ED98F8FA…	0101000020110F000080BB90BAA8E85FC1EC88B8A8528A…	110	6	1
4	0101000020E6100000FB79CF5866C552C0942E81847604…	0101000020110F0000A78BF98174E25FC145F74595D894…	111	2	1

	dispatch_date_time	dispatch_date	dispatch_time	hour_	dc_key
0	2013-05-28 09:43:00	2013-05-28	09:43:00	9.0	201306025636
1	2013-11-26 10:24:00	2013-11-26	10:24:00	10.0	201306061456
2	2013-12-16 13:10:00	2013-12-16	13:10:00	13.0	201306064336
3	2014-01-27 13:12:00	2014-01-27	13:12:00	13.0	201406003790
4	2011-09-08 11:27:00	2011-09-08	11:27:00	11.0	201102059237

	location_block	ucr_general	text_general_code	point_x
0	N 02ND ST / SPRING GARDEN ST	600	Thefts	-75.141441
1	N 02ND ST / SPRING GARDEN ST	300	Robbery No Firearm	-75.141441
2	N 02ND ST / SPRING GARDEN ST	600	Thefts	-75.141441
3	N 02ND ST / SPRING GARDEN ST	600	Thefts	-75.141441
4	5900 BLOCK LORETTO AVE	500	Burglary Residential	-75.084372

	point_y	lat	lng
0	39.960712	39.960712	-75.141441
1	39.960712	39.960712	-75.141441
2	39.960712	39.960712	-75.141441
3	39.960712	39.960712	-75.141441
4	40.034867	40.034867	-75.084372

[ ]:
```
crime.isna().sum()# sum of null values
```

[ ]:
```
the_geom                 282
the_geom_webmercator     282
objectid                   0
dc_dist                    0
psa                      644
dispatch_date_time         0
dispatch_date              0
dispatch_time              0
hour_                     28
dc_key                     0
location_block            55
ucr_general                0
text_general_code          0
point_x                 1423
point_y                 1423
lat                      282
lng                      282
dtype: int64
```

[ ]:
```
crime.dtypes#type of data
```

[ ]:
```
the_geom                 object
the_geom_webmercator     object
objectid                  int64
dc_dist                   int64
psa                      object
dispatch_date_time       object
dispatch_date            object
dispatch_time            object
hour_                   float64
dc_key                    int64
location_block           object
ucr_general               int64
text_general_code        object
point_x                 float64
point_y                 float64
lat                     float64
lng                     float64
dtype: object
```

[ ]:
```
#dropping null values of lat  and lng values
crime.dropna(subset=['lat'], inplace=True)
crime.dropna(subset=['lng'], inplace=True)
```

[ ]:
```
crime['dispatch_date'] = pd.to_datetime(crime['dispatch_date'])# converting␣
 ↪dispatch date ti time value
```

[ ]:
```
crime.shape#size of dataset
```

[ ]:
```
(2828248, 17)
```

[ ]:
```
crime = crime.loc[crime["dispatch_date"] >= "2013-01-01"].
↪reset_index(drop=True)#filtering for dataset for 2013 and onwards
crime.shape
```

[ ]:
```
(1436678, 17)
```

[ ]:
```
crime.info()#dataset description
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1436678 entries, 0 to 1436677
Data columns (total 17 columns):
 #   Column                Non-Null Count    Dtype
---  ------                --------------    -----
 0   the_geom              1436678 non-null  object
 1   the_geom_webmercator  1436678 non-null  object
 2   objectid              1436678 non-null  int64
 3   dc_dist               1436678 non-null  int64
 4   psa                   1436508 non-null  object
 5   dispatch_date_time    1436678 non-null  object
 6   dispatch_date         1436678 non-null  datetime64[ns]
 7   dispatch_time         1436678 non-null  object
 8   hour_                 1436673 non-null  float64
 9   dc_key                1436678 non-null  int64
 10  location_block        1436671 non-null  object
 11  ucr_general           1436678 non-null  int64
 12  text_general_code     1436678 non-null  object
 13  point_x               1435537 non-null  float64
 14  point_y               1435537 non-null  float64
 15  lat                   1436678 non-null  float64
 16  lng                   1436678 non-null  float64
dtypes: datetime64[ns](1), float64(5), int64(4), object(7)
memory usage: 186.3+ MB
```

[ ]:
```
#minimum of pointx and lngitude
print(crime['point_x'].min())
print(crime['lng'].min())
```

```
-81.58137853
-81.58137853
```

[ ]:
```
#maximum of point x and longitude
print(crime['point_x'].max())
print(crime['lng'].max())
```

```
2725830.9416288
-74.95753244
```

[ ]:
```
print(crime['point_y'].max())
print(crime['lat'].max())
```

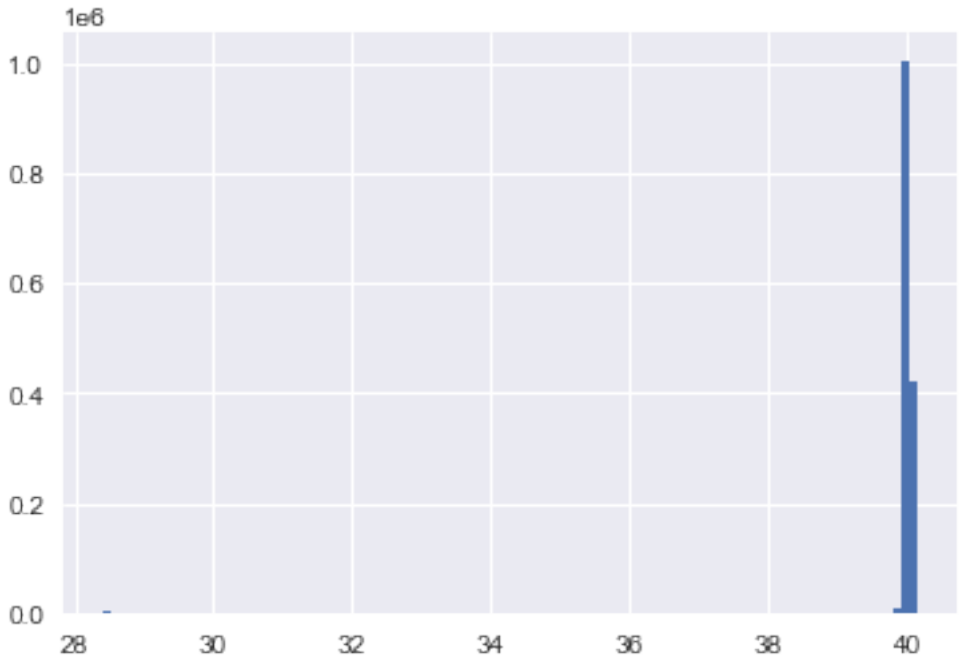
```
278069.04403542
40.13771285
```

[ ]:
```
print(crime['point_y'].min())
print(crime['lat'].min())
#After analyzing longitude and latude and point_x and point_y, we came to the␣
 ↪conclusion that we should not use point_x and point_y as they have more␣
 ↪orregular values.
#lat and lng also have values that are beyond the range
```

```
-3975202.88585439
28.41954829
```

[ ]:
```
crime['lat'].hist(bins = 100) # histogram shows the irregularies in lat data
```

[ ]: <AxesSubplot:>



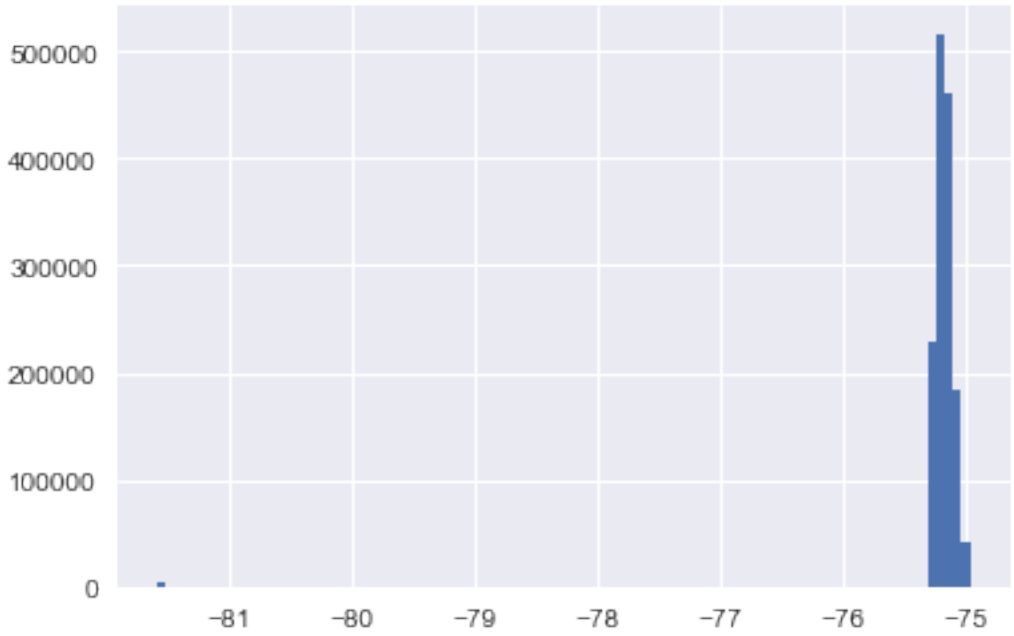
[ ]:
```
print(crime.loc[crime['lat']>30].shape)#size of dataset after with just more␣
 ↪than 30 lat
```

```
print(crime.loc[crime['lat']<30].shape)#size of dataset after with less than␣
 ↪than 30 lat.
#There are just around 5000 rows that are irregular. Thus if we remove them we␣
 ↪dont be losing a lot fo data
```

```
(1431665, 17)
(5013, 17)
```

[ ]:
```
crime['lng'].hist(bins= 100)# historgram shows the irregularities in lng data
```

[ ]:
```
<AxesSubplot:>
```



[ ]:
```
print(crime.loc[crime['lng']<-81].shape)#size of dataset after with less than␣
 ↪-81 as longitude. This isthe irredular data.
print(crime.loc[crime['lng']>-81].shape)#size of dataset after with more than␣
 ↪-81 as longitude.
```

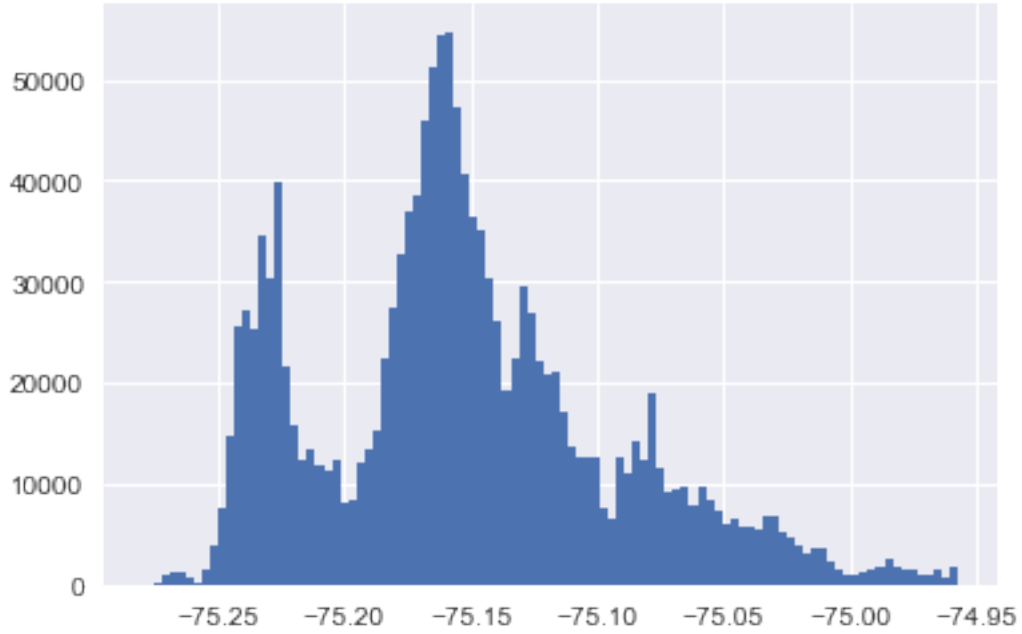
```
(5013, 17)
(1431665, 17)
```

[ ]:
```
crime = crime.loc[crime['lng']>-81].reset_index(drop=True)#dropping all␣
 ↪irregular longitude and latitude
crime.shape
```

[ ]:
```
(1431665, 17)
```

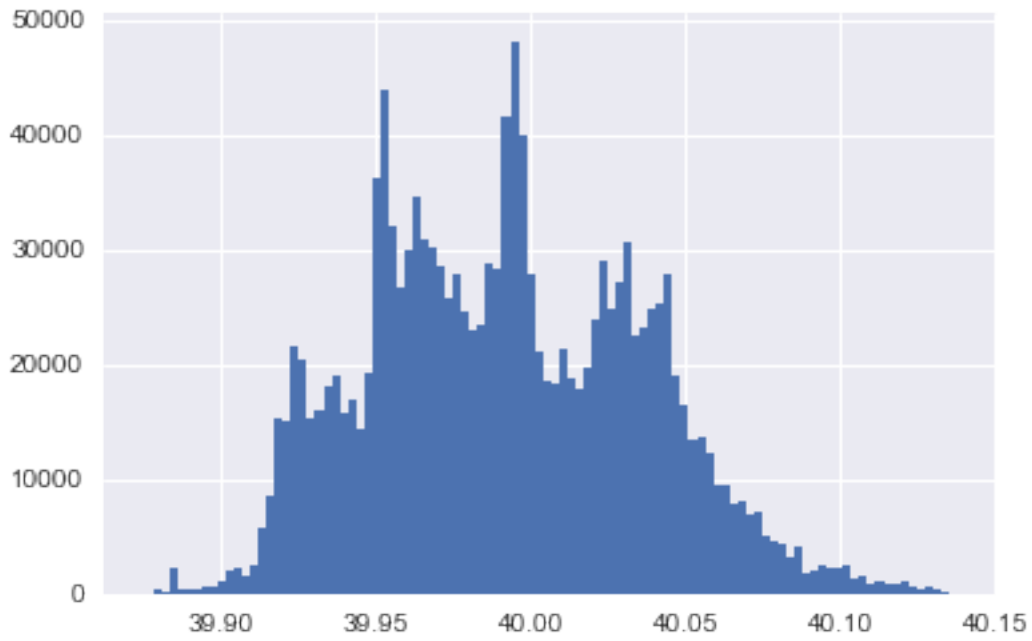
[ ]:
```
crime['lng'].hist(bins= 100)#histogram shows that values are within the range␣
↪it is supposed to be
```

[ ]: <AxesSubplot:>



[ ]:
```
crime['lat'].hist(bins= 100)#histogram shows that values are within the range␣
↪it is supposed to be
```

[ ]: <AxesSubplot:>



[ ]:
```
#combining latitude and longitude data into geometrey column so that we can use␣
 ↪it on map
crs = {'init': 'epsg:4326'}
geometry = [Point(xy) for xy in zip(crime["lng"], crime["lat"])]
geometry[:3]
```

[ ]:
```
[<shapely.geometry.point.Point at 0x32bb18bb0>,
 <shapely.geometry.point.Point at 0x32ba08ac0>,
 <shapely.geometry.point.Point at 0x32b79ebc0>]
```

[ ]:
```
crime = gpd.GeoDataFrame(crime,
                         crs = crs,
                         geometry = geometry)

crime.head()
```

```
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/pyproj/crs/crs.py:131: FutureWarning: '+init=<authority>:<code>' syntax
is deprecated. '<authority>:<code>' is the preferred initialization method. When
making the change, be mindful of axis order changes:
https://pyproj4.github.io/pyproj/stable/gotchas.html#axis-order-changes-in-
proj-6
  in_crs_string = _prepare_from_proj_string(in_crs_string)
```

[ ]:
```
                                              the_geom  \
 0  0101000020E6100000EA77405D0DC952C016F8ED98F8FA…
```

```
1  0101000020E6100000EA77405D0DC952C016F8ED98F8FA…
2  0101000020E6100000EA77405D0DC952C016F8ED98F8FA…
3  0101000020E6100000EA77405D0DC952C016F8ED98F8FA…
4  0101000020E61000002FD31F2F1ECE52C07129BE0C0CF5…

                              the_geom_webmercator  objectid  dc_dist psa  \
0  0101000020110F000080BB90BAA8E85FC1EC88B8A8528A…       107        6   1
1  0101000020110F000080BB90BAA8E85FC1EC88B8A8528A…       108        6   1
2  0101000020110F000080BB90BAA8E85FC1EC88B8A8528A…       109        6   1
3  0101000020110F000080BB90BAA8E85FC1EC88B8A8528A…       110        6   1
4  0101000020110F0000401FFA8143F15FC1160AD2D2C283…       117       12   1

    dispatch_date_time dispatch_date dispatch_time  hour_        dc_key  \
0  2013-05-28 09:43:00    2013-05-28      09:43:00    9.0  201306025636
1  2013-11-26 10:24:00    2013-11-26      10:24:00   10.0  201306061456
2  2013-12-16 13:10:00    2013-12-16      13:10:00   13.0  201306064336
3  2014-01-27 13:12:00    2014-01-27      13:12:00   13.0  201406003790
4  2018-01-06 10:56:00    2018-01-06      10:56:00   10.0  201812001185

                location_block  ucr_general   text_general_code    point_x  \
0  N 02ND ST / SPRING GARDEN ST          600              Thefts -75.141441
1  N 02ND ST / SPRING GARDEN ST          300  Robbery No Firearm -75.141441
2  N 02ND ST / SPRING GARDEN ST          600              Thefts -75.141441
3  N 02ND ST / SPRING GARDEN ST          600              Thefts -75.141441
4     6600 BLOCK ESSINGTON AVE           600              Thefts -75.220592

     point_y        lat        lng                    geometry
0  39.960712  39.960712 -75.141441  POINT (-75.14144 39.96071)
1  39.960712  39.960712 -75.141441  POINT (-75.14144 39.96071)
2  39.960712  39.960712 -75.141441  POINT (-75.14144 39.96071)
3  39.960712  39.960712 -75.141441  POINT (-75.14144 39.96071)
4  39.914430  39.914430 -75.220592  POINT (-75.22059 39.91443)
```

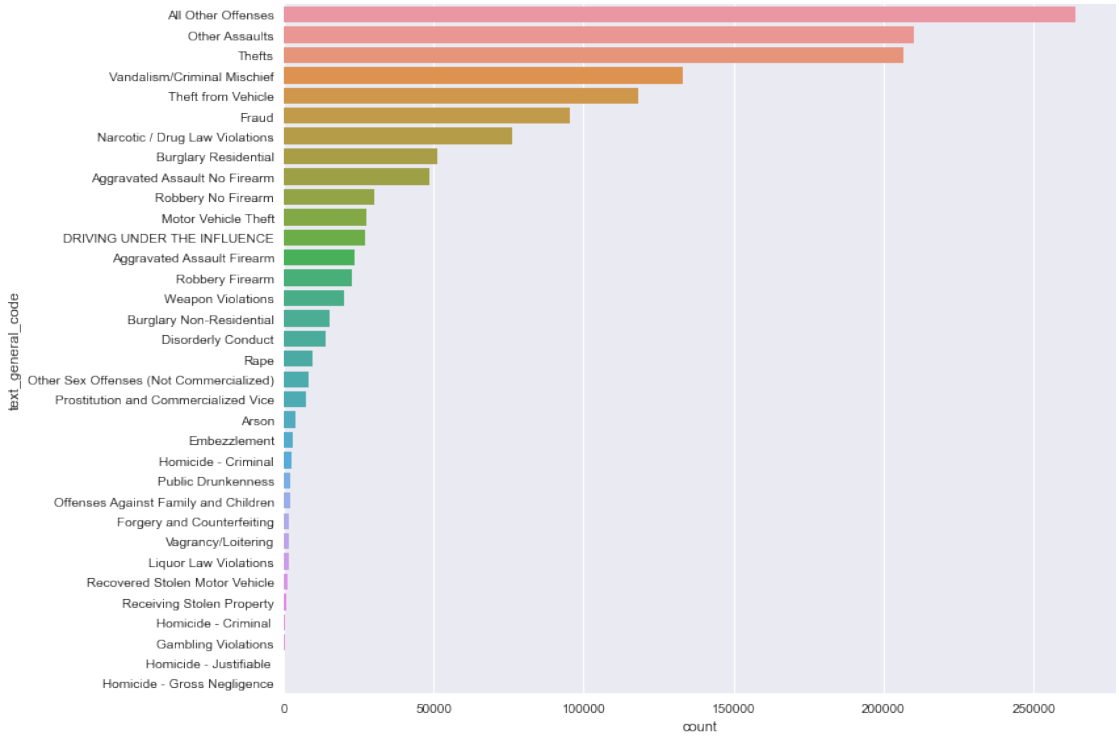
[ ]:
```
crime['text_general_code'].value_counts()
```

[ ]:
```
All Other Offenses                  264088
Other Assaults                      210109
Thefts                              206410
Vandalism/Criminal Mischief         133131
Theft from Vehicle                  118242
Fraud                                95562
Narcotic / Drug Law Violations       76201
Burglary Residential                 51046
Aggravated Assault No Firearm        48424
Robbery No Firearm                   30353
Motor Vehicle Theft                  27425
DRIVING UNDER THE INFLUENCE          27275
```

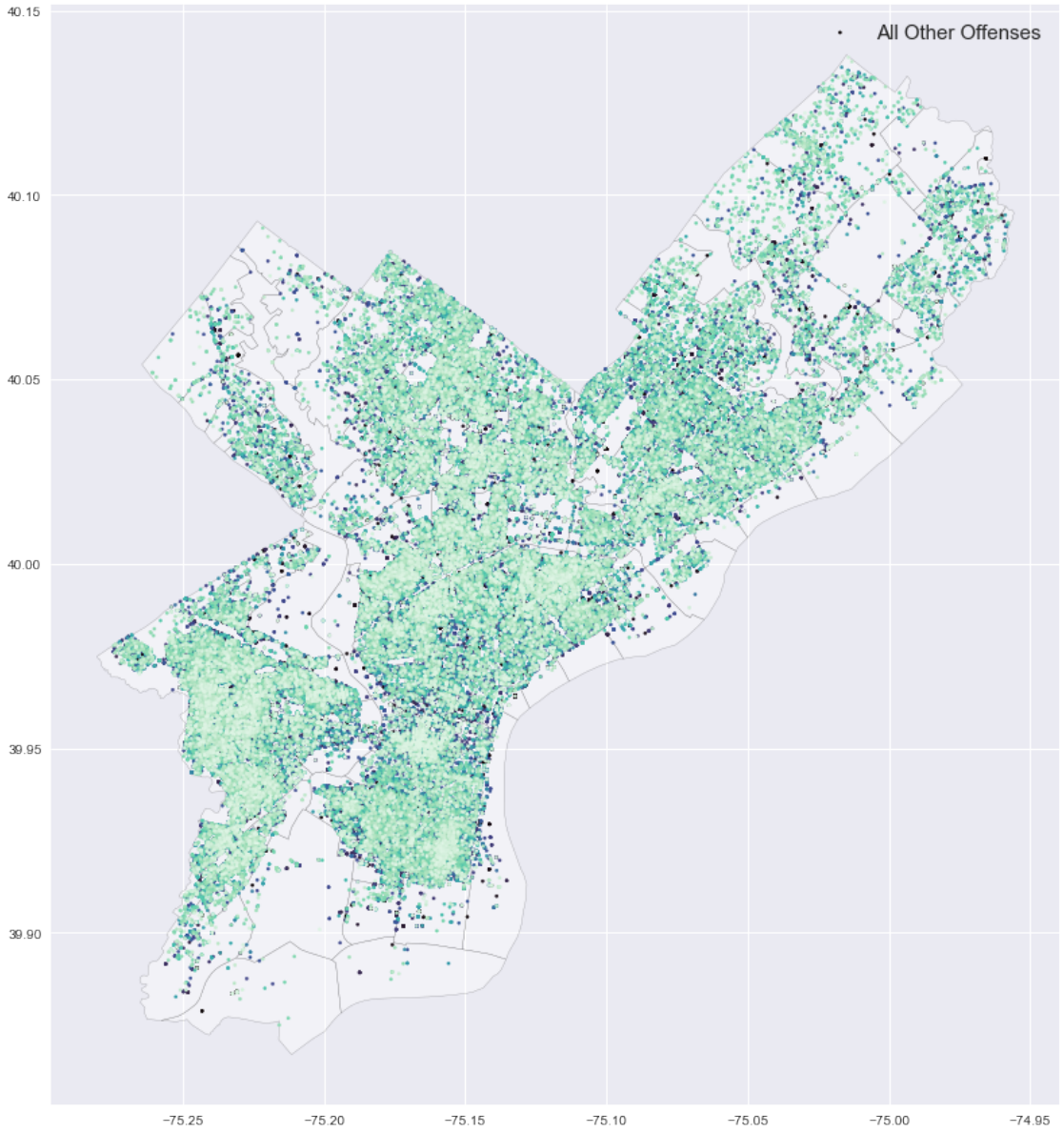
```
Aggravated Assault Firearm                    23573
Robbery Firearm                               22727
Weapon Violations                             20170
Burglary Non-Residential                      15327
Disorderly Conduct                            14032
Rape                                           9803
Other Sex Offenses (Not Commercialized)        8506
Prostitution and Commercialized Vice           7229
Arson                                          4040
Embezzlement                                   3070
Homicide - Criminal                            2451
Public Drunkenness                             2199
Offenses Against Family and Children           2022
Forgery and Counterfeiting                     1901
Vagrancy/Loitering                             1768
Liquor Law Violations                          1618
Recovered Stolen Motor Vehicle                 1137
Receiving Stolen Property                      1016
Homicide - Criminal                             453
Gambling Violations                             347
Homicide - Justifiable                            9
Homicide - Gross Negligence                       1
Name: text_general_code, dtype: int64
```

[ ]:
```
# Countplot of crime tyope
# most fo the crime are all other offenses,assults is the second highest
sns.catplot(y = 'text_general_code',
            kind = 'count',
            height = 8,
            aspect = 1.5,
            order = crime.text_general_code.value_counts().index,
            data = crime)
```

[ ]:
```
<seaborn.axisgrid.FacetGrid at 0x2e6b20730>
```



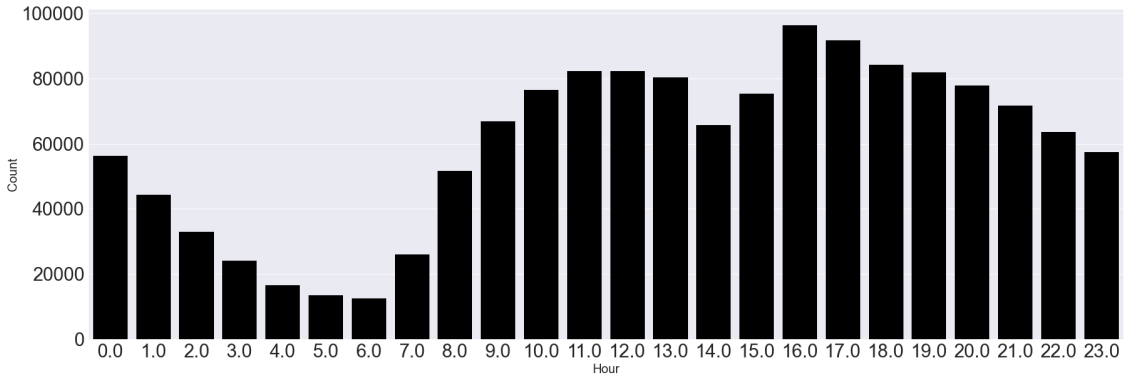
[ ]:
```
#plotting where all other offenses are occuring
fig, ax = plt.subplots(figsize =(15,15))
plt.style.use('seaborn')
street_map.to_crs(epsg = 4326).plot(ax = ax, alpha = 0.4,  color = "white",␣
 ↪edgecolor='black')
#crime[crime['text_general_code'] == 'All Other Offenses'].plot(ax = ax,␣
 ↪markersize = 20, color = "blue", marker = "o", label = "All Other Offenses")
crime[crime['text_general_code'] == 'All Other Offenses'].plot(ax = ax, cmap =␣
 ↪'mako', legend=True, markersize = 5, label = "All Other Offenses")
#crime[crime_df['text_general_code'] == 'Thefts'].plot(ax = ax, markersize =␣
 ↪20, color = "red", marker = "^", label = "Thefts")
plt.legend(prop = {'size' : 15})
plt.show()
```



[ ]:
```
# Crimes by the hour

sns.catplot( x = 'hour_',
             kind = 'count',
             height = 8,
             aspect = 3,
             color = 'black',
             data = crime)

plt.xticks(size=30)
plt.yticks(size=30)
```

```
plt.xlabel('Hour', fontsize = 20)
plt.ylabel('Count', fontsize = 20)
```

[ ]: Text(-12.949999999999974, 0.5, 'Count')



1.1.14 City of Philadelphia: Property Assessment

https://metadata.phila.gov/#home/datasetdetails/5543865f20583086178c4ee5/

[ ]:
```
assess = pd.read_csv('data/city/opa_properties_public.csv')#uploading dataset
```

```
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/IPython/core/interactiveshell.py:3457: DtypeWarning: Columns
(1,2,4,11,12,21,25,30,34,42,47,53,54,55,60,67,69,71) have mixed types.Specify
dtype option on import or set low_memory=False.
  exec(code_obj, self.user_global_ns, self.user_ns)
```

[ ]:
```
assess.head()
```

[ ]:
```
   objectid      assessment_date basements beginning_point book_and_page  \
0  55242915  1949-01-01 00:00:00       NaN             NaN       0872170
1  55242916  1949-01-01 00:00:00       NaN             NaN       2620507
2  55242917  1949-01-01 00:00:00       NaN             NaN       2677268
3  55242918  1949-01-01 00:00:00       NaN             NaN       2886779
4  55242919  1949-01-01 00:00:00       NaN             NaN       2886779

  building_code  building_code_description  category_code  \
0            SR     VACANT LAND RESIDE < ACRE              6
1            SR     VACANT LAND RESIDE < ACRE              6
2            SR     VACANT LAND RESIDE < ACRE              6
3            SR     VACANT LAND RESIDE < ACRE              6
4            SR     VACANT LAND RESIDE < ACRE              6

  category_code_description  census_tract  … unit utility view_type  \
```

```
0              Vacant Land         142.0  …   CA     NaN       NaN
1              Vacant Land         379.0  …  NaN     NaN       NaN
2              Vacant Land         142.0  …  NaN     NaN       NaN
3              Vacant Land         367.0  …  NaN     NaN       NaN
4              Vacant Land         367.0  …  NaN     NaN       NaN

   year_built  year_built_estimate  zip_code  zoning        pin        lat  \
0         0.0                  NaN   19123.0    RSA5  1001317719 -75.144757
1         0.0                  NaN   19134.0    RSA5  1001124565 -75.092534
2         0.0                  NaN   19123.0    RSA5  1001430746 -75.146154
3         0.0                  NaN   19123.0    ICMX  1001206446 -75.145586
4         0.0                  NaN   19123.0    ICMX  1001206456 -75.146035

         lng
0  39.967847
1  39.991459
2  39.967067
3  39.962679
4  39.962772

[5 rows x 78 columns]
```

[ ]:
```
assess.dtypes#type of data
```

[ ]:
```
objectid             int64
assessment_date     object
basements           object
beginning_point     object
book_and_page       object
                    …
zip_code           float64
zoning              object
pin                  int64
lat                float64
lng                float64
Length: 78, dtype: object
```

[ ]:
```
assess.columns
```

[ ]:
```
Index(['objectid', 'assessment_date', 'basements', 'beginning_point',
       'book_and_page', 'building_code', 'building_code_description',
       'category_code', 'category_code_description', 'census_tract',
       'central_air', 'cross_reference', 'date_exterior_condition', 'depth',
       'exempt_building', 'exempt_land', 'exterior_condition', 'fireplaces',
       'frontage', 'fuel', 'garage_spaces', 'garage_type',
       'general_construction', 'geographic_ward', 'homestead_exemption',
       'house_extension', 'house_number', 'interior_condition', 'location',
```

```
       'mailing_address_1', 'mailing_address_2', 'mailing_care_of',
       'mailing_city_state', 'mailing_street', 'mailing_zip', 'market_value',
       'market_value_date', 'number_of_bathrooms', 'number_of_bedrooms',
       'number_of_rooms', 'number_stories', 'off_street_open',
       'other_building', 'owner_1', 'owner_2', 'parcel_number', 'parcel_shape',
       'quality_grade', 'recording_date', 'registry_number', 'sale_date',
       'sale_price', 'separate_utilities', 'sewer', 'site_type', 'state_code',
       'street_code', 'street_designation', 'street_direction', 'street_name',
       'suffix', 'taxable_building', 'taxable_land', 'topography',
       'total_area', 'total_livable_area', 'type_heater', 'unfinished', 'unit',
       'utility', 'view_type', 'year_built', 'year_built_estimate', 'zip_code',
       'zoning', 'pin', 'lat', 'lng', 'geometry'],
      dtype='object')
```

[ ]:
```
assess.isna().sum()#sum of null values
```

[ ]:
```
objectid               0
assessment_date    547392
basements          255101
beginning_point     11174
book_and_page        2769
                     …
zip_code               53
zoning                734
pin                     0
lat                    52
lng                    52
Length: 78, dtype: int64
```

[ ]:
```
assess['assessment_date'] = pd.to_datetime(assess['assessment_date'])#turning␣
↪into datetime value
```

[ ]:
```
assess.describe(include = 'all')
```

```
/var/folders/6p/wpw9qml57530xkxqkkhprrf40000gn/T/ipykernel_74088/2767216599.py:1
: FutureWarning: Treating datetime data as categorical rather than numeric in
`.describe` is deprecated and will be removed in a future version of pandas.
Specify `datetime_is_numeric=True` to silence this warning and adopt the future
behavior now.
  assess.describe(include = 'all')
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/pandas/core/dtypes/cast.py:118: ShapelyDeprecationWarning: The array
interface is deprecated and will no longer work in Shapely 2.0. Convert the
'.coords' to a numpy array instead.
  arr = construct_1d_object_array_from_listlike(values)
```

[ ]:

	objectid	assessment_date	basements	\
count	5.813520e+05	34005	326298	
unique	NaN	1662	16	
top	NaN	2021-10-06 17:51:57	D	
freq	NaN	133	119848	
first	NaN	1949-01-01 00:00:00	NaN	
last	NaN	2022-01-05 13:57:16	NaN	
mean	5.553357e+07	NaN	NaN	
std	1.678322e+05	NaN	NaN	
min	5.524285e+07	NaN	NaN	
25%	5.538822e+07	NaN	NaN	
50%	5.553358e+07	NaN	NaN	
75%	5.567892e+07	NaN	NaN	
max	5.582427e+07	NaN	NaN	

	beginning_point	book_and_page	building_code	\
count	570185	578589	581348	
unique	435461	499505	806	
top	57' S BAINBRIDGE ST	0000000	030	
freq	862	28711	176691	
first	NaN	NaN	NaN	
last	NaN	NaN	NaN	
mean	NaN	NaN	NaN	
std	NaN	NaN	NaN	
min	NaN	NaN	NaN	
25%	NaN	NaN	NaN	
50%	NaN	NaN	NaN	
75%	NaN	NaN	NaN	
max	NaN	NaN	NaN	

	building_code_description	category_code	category_code_description	\
count	581335	581352.000000	581275	
unique	798	NaN	6	
top	ROW 2 STY MASONRY	NaN	Single Family	
freq	176691	NaN	461869	
first	NaN	NaN	NaN	
last	NaN	NaN	NaN	
mean	NaN	1.606206	NaN	
std	NaN	1.435171	NaN	
min	NaN	1.000000	NaN	
25%	NaN	1.000000	NaN	
50%	NaN	1.000000	NaN	
75%	NaN	1.000000	NaN	
max	NaN	15.000000	NaN	

	census_tract	…	utility	view_type	year_built	year_built_estimate	\
count	581349.000000	…	9096	560322	578828.0	438571	

```
unique            NaN  …       5          8      402.0                   3
top               NaN  …       A          I     1925.0                   Y
freq              NaN  …    8477     521858   113704.0                438277
first             NaN  …     NaN        NaN        NaN                   NaN
last              NaN  …     NaN        NaN        NaN                   NaN
mean       195.130075  …     NaN        NaN        NaN                   NaN
std        118.747152  …     NaN        NaN        NaN                   NaN
min          1.000000  …     NaN        NaN        NaN                   NaN
25%         93.000000  …     NaN        NaN        NaN                   NaN
50%        188.000000  …     NaN        NaN        NaN                   NaN
75%        302.000000  …     NaN        NaN        NaN                   NaN
max        891.000000  …     NaN        NaN        NaN                   NaN

             zip_code  zoning           pin            lat            lng  \
count   581351.000000  580670  5.813520e+05  581352.000000  581352.000000
unique            NaN      36           NaN            NaN            NaN
top               NaN    RSA5           NaN            NaN            NaN
freq              NaN  311976           NaN            NaN            NaN
first             NaN     NaN           NaN            NaN            NaN
last              NaN     NaN           NaN            NaN            NaN
mean     19133.376399     NaN  1.001361e+09     -75.143498      39.999843
std        183.463516     NaN  1.805607e+05       0.065909       0.050866
min      19102.000000     NaN  1.001049e+09     -75.274389      39.875128
25%      19123.000000     NaN  1.001204e+09     -75.182677      39.957730
50%      19134.000000     NaN  1.001361e+09     -75.155155      39.996529
75%      19144.000000     NaN  1.001516e+09     -75.104724      40.039888
max      88888.000000     NaN  1.001682e+09     -74.958190      40.137705

                                          geometry
count                                       581352
unique                                      546092
top     POINT (-75.18428130135817 39.94405422821897)
freq                                           958
first                                          NaN
last                                           NaN
mean                                           NaN
std                                            NaN
min                                            NaN
25%                                            NaN
50%                                            NaN
75%                                            NaN
max                                            NaN

[13 rows x 79 columns]
```

[ ]:
```
#dropping null values of lat  and lng values
assess.dropna(subset=['lat'], inplace=True)
```

```
assess.dropna(subset=['lng'], inplace=True)
```

[ ]:
```
assess.shape
```

[ ]:
```
(581352, 78)
```

[ ]:
```
assess.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 581352 entries, 0 to 581403
Data columns (total 78 columns):
 #   Column                      Non-Null Count   Dtype
---  ------                      --------------   -----
 0   objectid                    581352 non-null  int64
 1   assessment_date             34005 non-null   datetime64[ns]
 2   basements                   326298 non-null  object
 3   beginning_point             570185 non-null  object
 4   book_and_page               578589 non-null  object
 5   building_code               581348 non-null  object
 6   building_code_description   581335 non-null  object
 7   category_code               581352 non-null  int64
 8   category_code_description   581275 non-null  object
 9   census_tract                581349 non-null  float64
 10  central_air                 286727 non-null  object
 11  cross_reference             114843 non-null  object
 12  date_exterior_condition     334294 non-null  object
 13  depth                       580743 non-null  float64
 14  exempt_building             581109 non-null  float64
 15  exempt_land                 581109 non-null  float64
 16  exterior_condition          553554 non-null  float64
 17  fireplaces                  576960 non-null  float64
 18  frontage                    580744 non-null  float64
 19  fuel                        13982 non-null   object
 20  garage_spaces               576876 non-null  float64
 21  garage_type                 500809 non-null  object
 22  general_construction        517343 non-null  object
 23  geographic_ward             581349 non-null  float64
 24  homestead_exemption         580922 non-null  float64
 25  house_extension             26738 non-null   object
 26  house_number                581352 non-null  int64
 27  interior_condition          552755 non-null  float64
 28  location                    581352 non-null  object
 29  mailing_address_1           56731 non-null   object
 30  mailing_address_2           6518 non-null    object
 31  mailing_care_of             28372 non-null   object
 32  mailing_city_state          232848 non-null  object
 33  mailing_street              232359 non-null  object
```

```
 34  mailing_zip               231711 non-null  object
 35  market_value              581109 non-null  float64
 36  market_value_date         0 non-null       float64
 37  number_of_bathrooms       577028 non-null  float64
 38  number_of_bedrooms        577270 non-null  float64
 39  number_of_rooms           547825 non-null  float64
 40  number_stories            577270 non-null  float64
 41  off_street_open           580503 non-null  float64
 42  other_building            1312 non-null    object
 43  owner_1                   581352 non-null  object
 44  owner_2                   203765 non-null  object
 45  parcel_number             581352 non-null  int64
 46  parcel_shape              575505 non-null  object
 47  quality_grade             56269 non-null   object
 48  recording_date            581203 non-null  object
 49  registry_number           580649 non-null  object
 50  sale_date                 581344 non-null  object
 51  sale_price                581338 non-null  float64
 52  separate_utilities        25671 non-null   object
 53  sewer                     8855 non-null    object
 54  site_type                 296357 non-null  object
 55  state_code                573060 non-null  object
 56  street_code               581352 non-null  int64
 57  street_designation        581347 non-null  object
 58  street_direction          226495 non-null  object
 59  street_name               581352 non-null  object
 60  suffix                    2918 non-null    object
 61  taxable_building          581109 non-null  float64
 62  taxable_land              581109 non-null  float64
 63  topography                542453 non-null  object
 64  total_area                580908 non-null  float64
 65  total_livable_area        578832 non-null  float64
 66  type_heater               294554 non-null  object
 67  unfinished                2706 non-null    object
 68  unit                      38892 non-null   object
 69  utility                   9096 non-null    object
 70  view_type                 560322 non-null  object
 71  year_built                578828 non-null  object
 72  year_built_estimate       438571 non-null  object
 73  zip_code                  581351 non-null  float64
 74  zoning                    580670 non-null  object
 75  pin                       581352 non-null  int64
 76  lat                       581352 non-null  float64
 77  lng                       581352 non-null  float64
dtypes: datetime64[ns](1), float64(26), int64(6), object(45)
memory usage: 350.4+ MB
```

[ ]:
```
print(assess['lng'].min())
```

```
39.87512753045684
```

[ ]:
```
print(assess['lng'].max())
```

```
40.137704744433634
```

[ ]:
```
print(assess['lat'].max())
```

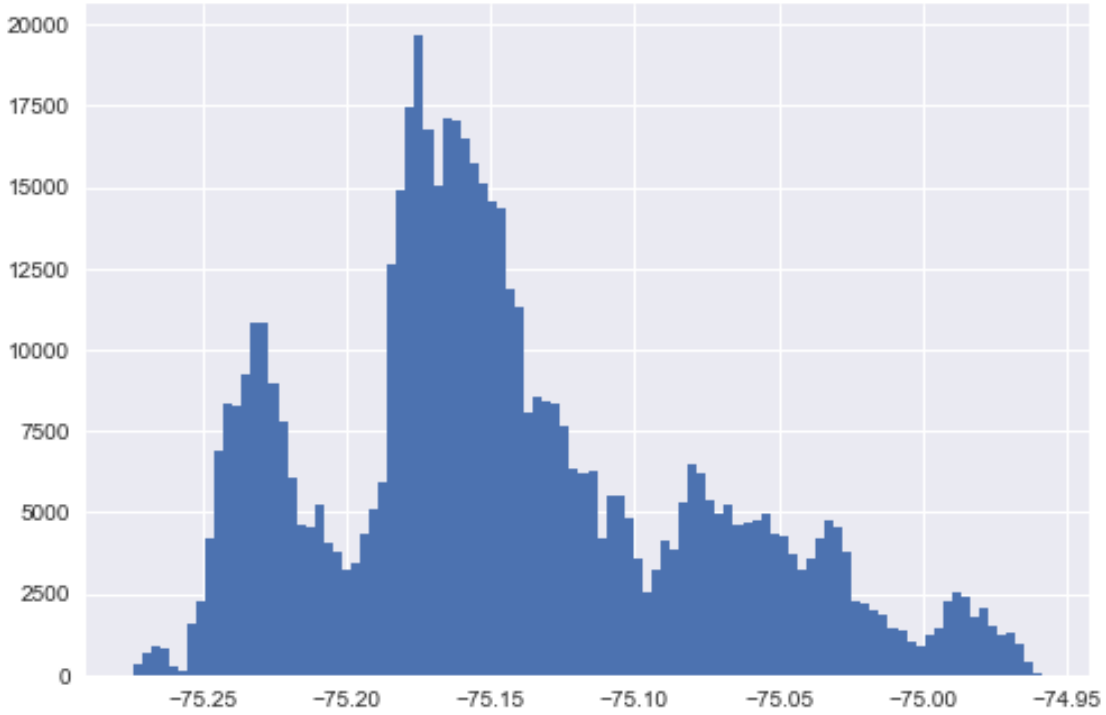
```
-74.9581902396646
```

[ ]:
```
print(assess['lat'].min())
```

```
-75.27438935809397
```

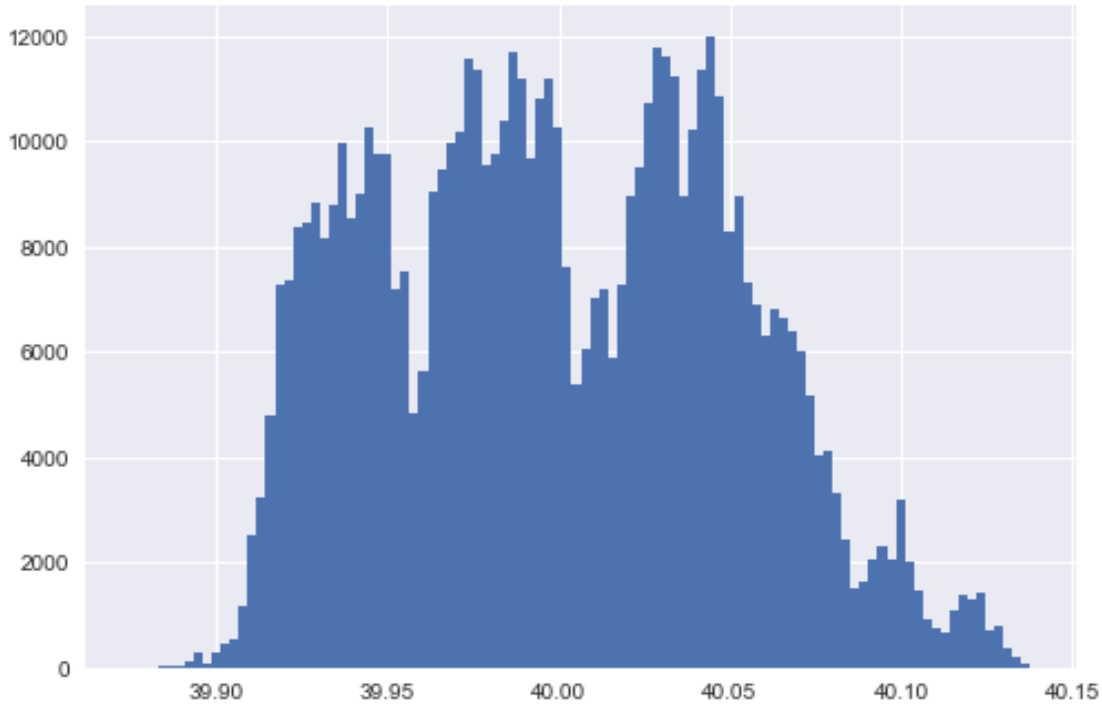
[ ]:
```
assess['lat'].hist(bins = 100)#histogram of latitude
```

[ ]:
```
<AxesSubplot:>
```



[ ]:
```
assess['lng'].hist(bins= 100)#histogram of longitude
```

[ ]:
```
<AxesSubplot:>
```



[ ]:
```
#combining latitude and longitude data to make geometry column
crs = {'init': 'epsg:4326'}
geometry = [Point(xy) for xy in zip(assess["lat"], assess["lng"])]
geometry[:3]
```

[ ]:
```
[<shapely.geometry.point.Point at 0x2e90aa7a0>,
 <shapely.geometry.point.Point at 0x2eadb0fd0>,
 <shapely.geometry.point.Point at 0x2eadb2200>]
```

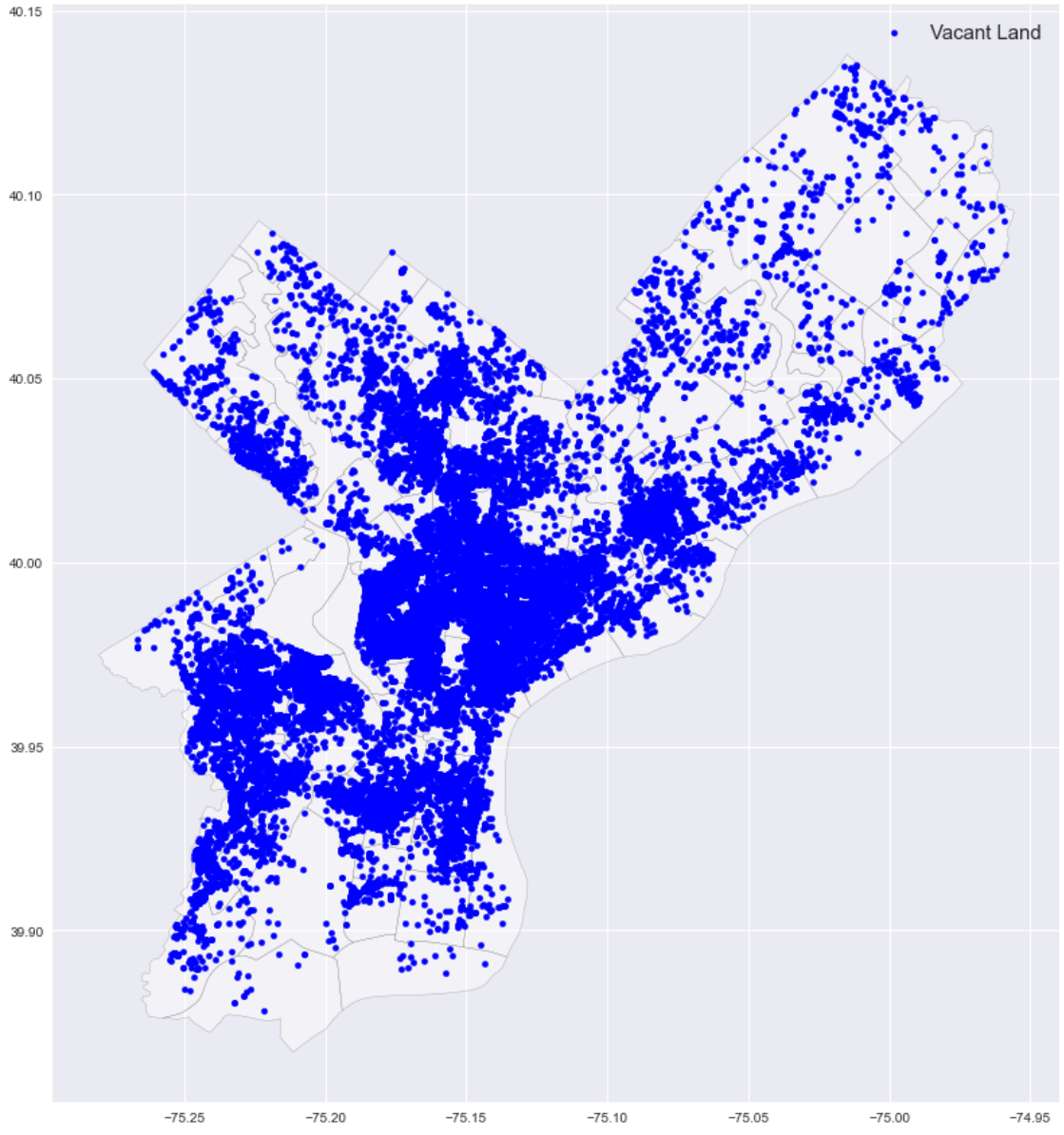
[ ]:
```
assess = gpd.GeoDataFrame(assess,
                          crs = crs,
                          geometry = geometry)

assess.head()
```

```
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/pyproj/crs/crs.py:131: FutureWarning: '+init=<authority>:<code>' syntax
is deprecated. '<authority>:<code>' is the preferred initialization method. When
making the change, be mindful of axis order changes:
https://pyproj4.github.io/pyproj/stable/gotchas.html#axis-order-changes-in-
proj-6
  in_crs_string = _prepare_from_proj_string(in_crs_string)
```

[ ]:
```
   objectid assessment_date basements beginning_point book_and_page  \
0  55242915      1949-01-01       NaN             NaN       0872170
1  55242916      1949-01-01       NaN             NaN       2620507
2  55242917      1949-01-01       NaN             NaN       2677268
3  55242918      1949-01-01       NaN             NaN       2886779
4  55242919      1949-01-01       NaN             NaN       2886779

  building_code  building_code_description  category_code  \
0            SR     VACANT LAND RESIDE < ACRE              6
1            SR     VACANT LAND RESIDE < ACRE              6
2            SR     VACANT LAND RESIDE < ACRE              6
3            SR     VACANT LAND RESIDE < ACRE              6
4            SR     VACANT LAND RESIDE < ACRE              6

  category_code_description  census_tract  … utility view_type year_built  \
0               Vacant Land          142.0  …     NaN       NaN        0.0
1               Vacant Land          379.0  …     NaN       NaN        0.0
2               Vacant Land          142.0  …     NaN       NaN        0.0
3               Vacant Land          367.0  …     NaN       NaN        0.0
4               Vacant Land          367.0  …     NaN       NaN        0.0

   year_built_estimate  zip_code  zoning         pin        lat        lng  \
0                  NaN   19123.0    RSA5  1001317719 -75.144757  39.967847
1                  NaN   19134.0    RSA5  1001124565 -75.092534  39.991459
2                  NaN   19123.0    RSA5  1001430746 -75.146154  39.967067
3                  NaN   19123.0    ICMX  1001206446 -75.145586  39.962679
4                  NaN   19123.0    ICMX  1001206456 -75.146035  39.962772

                     geometry
0  POINT (-75.14476 39.96785)
1  POINT (-75.09253 39.99146)
2  POINT (-75.14615 39.96707)
3  POINT (-75.14559 39.96268)
4  POINT (-75.14604 39.96277)

[5 rows x 79 columns]
```

[ ]:
```
#crime_df = crime_df.to_crs(epsg = 4326)
fig, ax = plt.subplots(figsize =(15,15))
plt.style.use('seaborn')
street_map.to_crs(epsg = 4326).plot(ax = ax, alpha = 0.4,  color = "white",␣
↪edgecolor='black')
assess[assess['category_code_description'] == 'Vacant Land'].plot(ax = ax,␣
↪markersize = 20, color = "blue", marker = "o", label = "Vacant Land")
#crime_df[crime_df['text_general_code'] == 'Thefts'].plot(ax = ax, markersize =␣
↪20, color = "red", marker = "^", label = "Thefts")
```

```
#geo_df.plot(column = 'BUILD_RANK', ax = ax, alpha = 0.5, legend = True,␣
↪markersize = 10)
plt.legend(prop = {'size' : 15})
plt.show()
```



1.1.15 City of Philadelphia: 311 Calls

https://metadata.phila.gov/#home/datasetdetails/5543864d20583086178c4e98/representationdetails/5762e19fa23

[ ]:
```
philly_311 = pd.read_csv("data/city/311Request_2019.csv")
```

```
philly_311.head(10)
```

```
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/IPython/core/interactiveshell.py:3457: DtypeWarning: Columns (12) have
mixed types.Specify dtype option on import or set low_memory=False.
  exec(code_obj, self.user_global_ns, self.user_ns)
```

[ ]:

	objectid	service_request_id	status	status_notes	\
0	5933314	12471689	Closed	NaN	
1	5933315	12471188	Closed	Completed	
2	6287831	12579945	Closed	NaN	
3	6287832	12585987	Closed	NaN	
4	6287833	12584999	Closed	NaN	
5	6427983	12629554	Closed	Question Answered	
6	6427985	12629556	Closed	NaN	
7	5776446	12427253	Open	NaN	
8	6540805	12660537	Closed	Question Answered	
9	5933291	12474020	Closed	Question Answered	

	service_name	service_code	\
0	Street Defect	SR-ST01	
1	Revenue Escalation	NaN	
2	Rubbish/Recyclable Material Collection	SR-ST03	
3	Rubbish/Recyclable Material Collection	SR-ST03	
4	Illegal Dumping	SR-ST02	
5	Information Request	SR-IR01	
6	Information Request	SR-IR01	
7	Revenue Escalation	NaN	
8	Information Request	SR-IR01	
9	Information Request	SR-IR01	

	agency_responsible	service_notice	requested_datetime	\
0	Streets Department	3 Business Days	2019-02-13 19:50:26	
1	Revenue Department	NaN	2019-02-13 15:28:02	
2	Streets Department	2 Business Days	2019-04-17 13:25:09	
3	Streets Department	NaN	2019-04-22 14:47:16	
4	Streets Department	5 Business Days	2019-04-22 10:48:51	
5	First Judicial District/Courts	NaN	2019-05-14 14:54:39	
6	Streets Department	NaN	2019-05-14 14:55:04	
7	Revenue Department	NaN	2019-01-16 15:00:35	
8	Animal Care and Control - ACCT	NaN	2019-05-30 10:30:20	
9	Department of Records	NaN	2019-02-15 09:30:23	

	updated_datetime	expected_datetime	address	zipcode	\
0	2019-02-15 09:31:24	2019-02-18 19:00:00	532 WATKINS ST	NaN	
1	2019-02-15 09:31:25	2019-02-15 10:00:17	NaN	NaN	
2	2019-04-23 08:01:09	2019-04-18 20:00:00	1423 W TIOGA ST	NaN	

```
3  2019-04-23 08:01:11  2019-04-23 20:00:00     12601 CALPINE RD     NaN
4  2019-04-23 08:01:14  2019-04-28 20:00:00  1246 N HOLLYWOOD ST   19121
5  2019-05-14 14:54:58  2019-05-14 15:00:16                  NaN     NaN
6  2019-05-14 14:55:22  2019-05-14 15:00:16                  NaN     NaN
7  2019-01-16 15:00:36  2019-01-16 15:30:16                  NaN     NaN
8  2019-05-30 10:30:27  2019-05-30 11:00:22                  NaN     NaN
9  2019-02-15 09:30:32  2019-02-15 10:00:17                  NaN     NaN

  media_url        lat        lon
0       NaN  39.927043 -75.155113
1       NaN        NaN        NaN
2       NaN  40.006315 -75.152884
3       NaN  40.098897 -74.971720
4       NaN  39.975887 -75.183814
5       NaN        NaN        NaN
6       NaN        NaN        NaN
7       NaN        NaN        NaN
8       NaN        NaN        NaN
9       NaN        NaN        NaN
```

[ ]:
```
philly_311.columns
```

[ ]:
```
Index(['objectid', 'service_request_id', 'status', 'status_notes',
       'service_name', 'service_code', 'agency_responsible', 'service_notice',
       'requested_datetime', 'updated_datetime', 'expected_datetime',
       'address', 'zipcode', 'media_url', 'lat', 'lon'],
      dtype='object')
```

[ ]:
```
philly_311.dtypes
```

[ ]:
```
objectid               int64
service_request_id     int64
status                object
status_notes          object
service_name          object
service_code          object
agency_responsible    object
service_notice        object
requested_datetime    object
updated_datetime      object
expected_datetime     object
address               object
zipcode               object
media_url             object
lat                  float64
lon                  float64
dtype: object
```

[ ]:
```
philly_311.isna().sum()
```

[ ]:
```
objectid                  0
service_request_id        0
status                    0
status_notes         307158
service_name              0
service_code         101992
agency_responsible        3
service_notice       390564
requested_datetime        0
updated_datetime          0
expected_datetime         0
address              329515
zipcode              594034
media_url            578638
lat                  350470
lon                  350470
dtype: int64
```

[ ]:
```
philly_311.describe()
```

[ ]:

	objectid	service_request_id	lat	lon
count	6.230420e+05	6.230420e+05	272572.000000	272572.000000
mean	6.847379e+06	1.272970e+07	39.990820	-75.152511
std	6.574168e+05	1.928838e+05	0.052109	0.103089
min	5.690931e+06	1.239670e+07	31.798323	-106.401761
25%	6.289357e+06	1.256194e+07	39.951036	-75.185402
50%	6.898952e+06	1.272900e+07	39.986678	-75.159537
75%	7.396704e+06	1.289744e+07	40.028212	-75.121924
max	1.147772e+07	1.306357e+07	40.137508	-74.959341

[ ]:
```
philly_311.lat.replace(-1, None, inplace = True)
philly_311.lon.replace(-1, None, inplace = True)
```

[ ]:
```
philly_311.shape
```

[ ]:
```
(623042, 16)
```

[ ]:
```
philly_311.isnull().sum(axis=0)
philly_311.shape
```

[ ]:
```
(623042, 16)
```

[ ]:
```
philly_311.isnull().sum(axis=0)
```

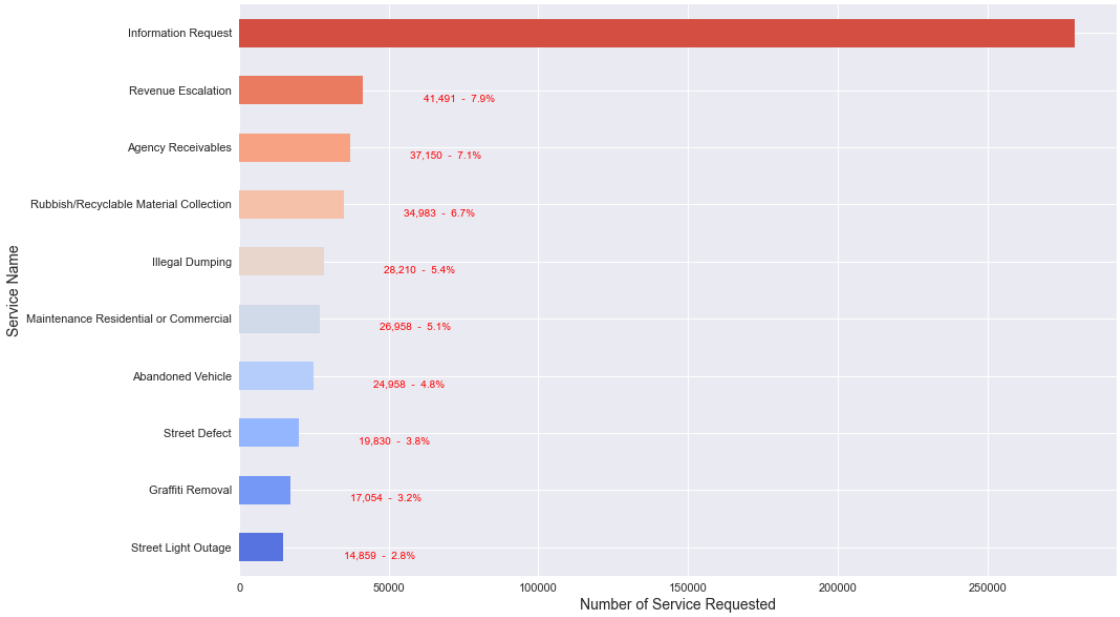
[ ]:
```
objectid                  0
service_request_id        0
status                    0
status_notes         307158
service_name              0
service_code         101992
agency_responsible        3
service_notice       390564
requested_datetime        0
updated_datetime          0
expected_datetime         0
address              329515
zipcode              594034
media_url            578638
lat                  350470
lon                  350470
dtype: int64
```

[ ]:
```
philly_311['service_name'].value_counts()
```

[ ]:
```
Information Request                        279286
Revenue Escalation                          41491
Agency Receivables                          37150
Rubbish/Recyclable Material Collection      34983
Illegal Dumping                             28210
                                            …
Right-of-Way                                    4
Emergency Air Conditioning                      1
Complaint against Fire or EMS                   1
No Heat Residential                             1
Maintenance Complaint                           1
Name: service_name, Length: 61, dtype: int64
```

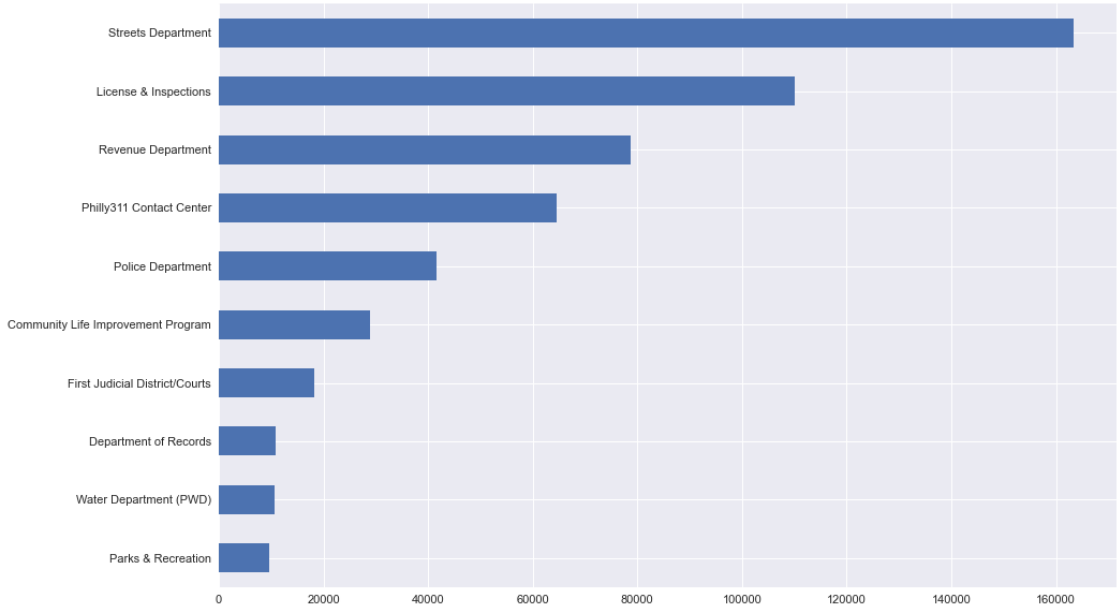
[ ]:
```
#plotting bar chart based on service(name) type requested
philly_service = philly_311['service_name'].value_counts().head(10).
 ↪sort_values()
philly_service.plot(kind='barh',figsize=(15,10),fontsize=11, color=sns.
 ↪color_palette('coolwarm',len(philly_service)))
plt.ylabel('Service Name', fontsize = 14)
plt.xlabel('Number of Service Requested', fontsize = 14)


# Include the number of service name and the corresponding percentage for every␣
 ↪type

for index, value in enumerate(philly_service):
```

```
    label = str(format(int(value), ',')) + '  -  {}%'.format(round( (value/
↪philly_service.sum())*100, 1))
    plt.annotate(label, xy = (value + 20000, index - 0.2 ), color = 'red')
```



[ ]:
```
#Agencies responsible for 311 calls. Most of the calls are for the Street␣
↪Department
philly_agency = philly_311['agency_responsible'].value_counts().head(10).
↪sort_values()
philly_agency.plot(kind='barh',figsize=(15,10),fontsize=11)
```

[ ]: <AxesSubplot:>



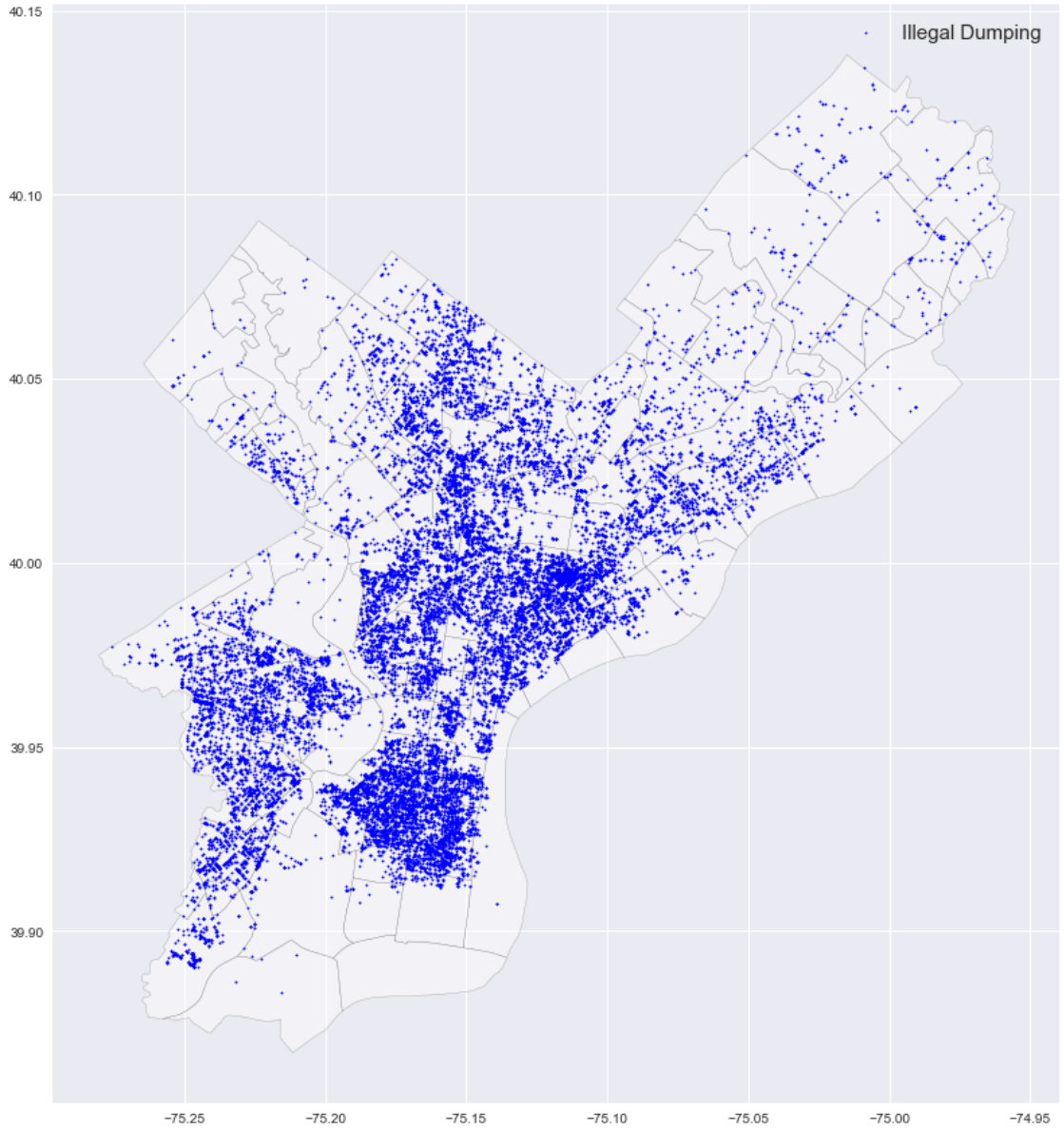
[ ]:
```
#creating geometry column based on longitude and latitude data
crs= {'init': 'epsg:4326'}
geometry = [Point(xy) for xy in zip(philly_311["lon"],philly_311["lat"])]

philly_311 = gpd.GeoDataFrame(philly_311,
                              crs = crs,
                              geometry = geometry)

philly_311.head()
```

```
/Users/priankaball/opt/anaconda3/envs/geo_env/lib/python3.10/site-
packages/pyproj/crs/crs.py:131: FutureWarning: '+init=<authority>:<code>' syntax
is deprecated. '<authority>:<code>' is the preferred initialization method. When
making the change, be mindful of axis order changes:
https://pyproj4.github.io/pyproj/stable/gotchas.html#axis-order-changes-in-
proj-6
  in_crs_string = _prepare_from_proj_string(in_crs_string)
```

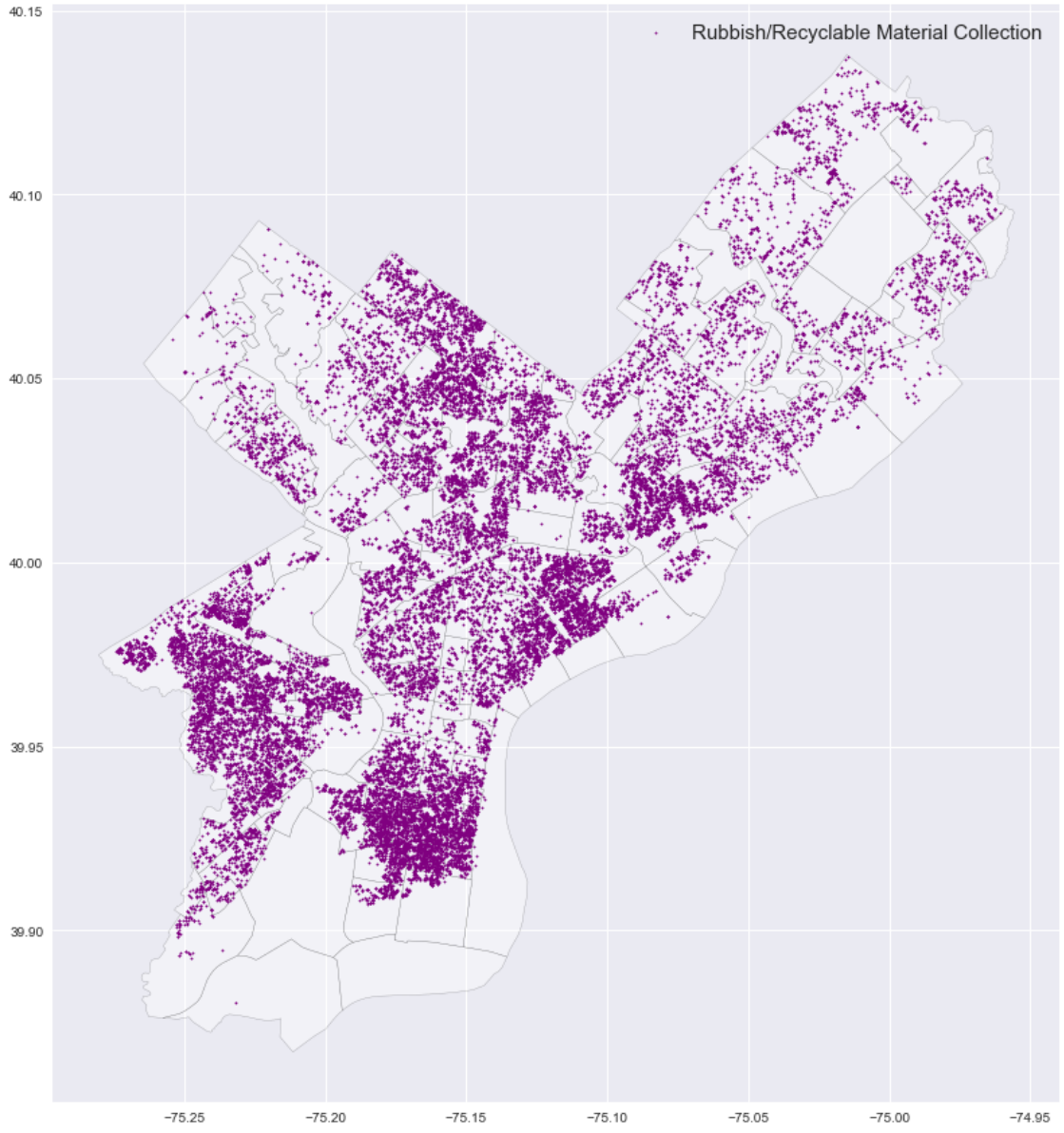
[ ]:
```
   objectid  service_request_id  status status_notes  \
0   5933314            12471689  Closed          NaN
1   5933315            12471188  Closed    Completed
2   6287831            12579945  Closed          NaN
3   6287832            12585987  Closed          NaN
4   6287833            12584999  Closed          NaN

                          service_name service_code  agency_responsible  \
0                        Street Defect      SR-ST01  Streets Department
```

```
1                     Revenue Escalation          NaN  Revenue Department
2  Rubbish/Recyclable Material Collection      SR-ST03  Streets Department
3  Rubbish/Recyclable Material Collection      SR-ST03  Streets Department
4                         Illegal Dumping      SR-ST02  Streets Department

    service_notice   requested_datetime     updated_datetime  \
0  3 Business Days  2019-02-13 19:50:26  2019-02-15 09:31:24
1              NaN  2019-02-13 15:28:02  2019-02-15 09:31:25
2  2 Business Days  2019-04-17 13:25:09  2019-04-23 08:01:09
3              NaN  2019-04-22 14:47:16  2019-04-23 08:01:11
4  5 Business Days  2019-04-22 10:48:51  2019-04-23 08:01:14

     expected_datetime              address zipcode media_url        lat  \
0  2019-02-18 19:00:00       532 WATKINS ST     NaN       NaN  39.927043
1  2019-02-15 10:00:17                  NaN     NaN       NaN        NaN
2  2019-04-18 20:00:00      1423 W TIOGA ST     NaN       NaN  40.006315
3  2019-04-23 20:00:00     12601 CALPINE RD     NaN       NaN  40.098897
4  2019-04-28 20:00:00  1246 N HOLLYWOOD ST   19121       NaN  39.975887

         lon                     geometry
0 -75.155113  POINT (-75.15511 39.92704)
1        NaN                 POINT EMPTY
2 -75.152884  POINT (-75.15288 40.00632)
3 -74.971720  POINT (-74.97172 40.09890)
4 -75.183814  POINT (-75.18381 39.97589)
```

[ ]:
```
#plotting for Illegal Dumping service
fig, ax = plt.subplots(figsize =(15,15))
plt.style.use('seaborn')
street_map.to_crs(epsg = 4326).plot(ax = ax, alpha = 0.4,  color = "white",␣
 ↪edgecolor='black')
philly_311[philly_311['service_name'] == 'Illegal Dumping'].plot(ax = ax,␣
 ↪markersize = 2, color = "blue", marker = "o", label = "Illegal Dumping")

plt.legend(prop = {'size' : 15})
plt.show()
```



[ ]:
```
#plotting for Rubbish/Recyclable Material Collection service
fig, ax = plt.subplots(figsize =(15,15))
plt.style.use('seaborn')
street_map.to_crs(epsg = 4326).plot(ax = ax, alpha = 0.4,  color = "white",␣
 ↪edgecolor='black')
philly_311[philly_311['service_name'] == 'Rubbish/Recyclable Material␣
 ↪Collection'].plot(ax = ax, markersize = 2, color = "purple", marker = "o",␣
 ↪label = "Rubbish/Recyclable Material Collection")
plt.legend(prop = {'size' : 15})
plt.show()
```


Rubbish/Recyclable Material Collection
40.15
40.10
40.05
40.00
39.95
39.90
−75.25
−75.20
−75.15
−75.10
−75.05
−75.00
−74.95

[ ]: