Project Milestone 5

May 25, 2020

[2]:

```
# Project Milestone 5
# Lenin Kamma 05/25/2020
```

[3]:

```
# Import libraries
import numpy as np
import pandas as pd
import sqlite3
import matplotlib.pyplot as plt
import squarify
```

[4]:

```
# Import finalized saved csv files into a dataframe
```

[5]:

```
county_population = pd.read_csv("C:/Lenin Data Science/DSC540/Project/
 ↪FinalCountyPopulationData.csv")
case_count = pd.read_csv("C:/Lenin Data Science/DSC540/Project/
 ↪FinalCaseCountData.csv")
surface_area = pd.read_csv("C:/Lenin Data Science/DSC540/Project/
 ↪FinalSurfaceArea.csv")
hospital_data = pd.read_csv("C:/Lenin Data Science/DSC540/Project/
 ↪FinalHospitalData.csv")
```

[6]:

```
# View each dataframe
county_population.head(10)
```

[6]:

```
   Unnamed: 0    state  STATE  COUNTY  estimate_2019    county  Countycode
0           1  Alabama      1       1          55869   Autauga        1001
1           2  Alabama      1       3         223234   Baldwin        1003
2           3  Alabama      1       5          24686   Barbour        1005
3           4  Alabama      1       7          22394      Bibb        1007
4           5  Alabama      1       9          57826    Blount        1009
5           6  Alabama      1      11          10101   Bullock        1011
6           7  Alabama      1      13          19448    Butler        1013
7           8  Alabama      1      15         113605   Calhoun        1015
8           9  Alabama      1      17          33254  Chambers        1017
9          10  Alabama      1      19          26196  Cherokee        1019
```

[7]:
```
# Update the county column  to County and DROP unwanted columns
county_population['County'] = county_population['county'].rename()
county_population.drop(columns=['STATE','COUNTY', 'county','Unnamed: 0' ],␣
 ↪inplace=True)
county_population
```

[7]:
```
        state  estimate_2019  Countycode      County
0     Alabama          55869        1001     Autauga
1     Alabama         223234        1003     Baldwin
2     Alabama          24686        1005     Barbour
3     Alabama          22394        1007        Bibb
4     Alabama          57826        1009      Blount
…         …              …         …          …
3137  Wyoming          42343       56037  Sweetwater
3138  Wyoming          23464       56039       Teton
3139  Wyoming          20226       56041       Uinta
3140  Wyoming           7805       56043    Washakie
3141  Wyoming           6927       56045      Weston

[3142 rows x 4 columns]
```

[8]:
```
# View case count dataset
case_count.head(10)
```

[8]:
```
   FIPS_code        Date   US_county  US_state  No_of_cases  No_of_deaths
0      10001  2020-05-21        Kent  Delaware         1281            55
1      10003  2020-05-21  New Castle  Delaware         3053           144
2      10005  2020-05-21      Sussex  Delaware         4006           117
3       1001  2020-05-21     Autauga   Alabama          147             3
4       1003  2020-05-21     Baldwin   Alabama          270             8
5       1005  2020-05-21     Barbour   Alabama          100             1
6       1007  2020-05-21        Bibb   Alabama           52             1
7       1009  2020-05-21      Blount   Alabama           48             1
8       1011  2020-05-21     Bullock   Alabama           71             1
9       1013  2020-05-21      Butler   Alabama          321            11
```

[130]:
```
surface_area.head(10)
```

[130]:
```
   Unnamed: 0  STCOU  LND110210D Statecode
0           2   1001      594.44        AL
1           3   1003     1589.78        AL
2           4   1005      884.88        AL
3           5   1007      622.58        AL
4           6   1009      644.78        AL
5           7   1011      622.81        AL
6           8   1013      776.83        AL
7           9   1015      605.87        AL
```

```
8           10   1017      596.53        AL
9           11   1019      553.70        AL
```

[131]:

```
hospital_data.head(10)
```

[131]:

```
   COUNTYFIPS  BEDS
0        1001    85
1        1003   398
2        1005    74
3        1007    35
4        1009    40
5        1011    61
6        1013    94
7        1015   590
8        1017   115
9        1019    60
```

[132]:

```
pd.to_numeric(hospital_data["COUNTYFIPS"])
```

[132]:

```
0        1001
1        1003
2        1005
3        1007
4        1009
        …
2502    72113
2503    72125
2504    72127
2505    72145
2506    72153
Name: COUNTYFIPS, Length: 2507, dtype: int64
```

[133]:

```
# Create a dataframe with State, County, County Code (FIPS code), Surface Area␣
↪and Population
# Drop unwanted columns from the join
df_pop_density = pd.merge(county_population,surface_area, how='left', left_on =␣
↪'Countycode', right_on = 'STCOU').drop(columns=
                                ['STCOU','Unnamed: 0'])
```

[134]:

```
df_pop_density
```

[134]:

```
        state  estimate_2019  Countycode     County  LND110210D Statecode
0     Alabama          55869        1001    Autauga      594.44        AL
1     Alabama         223234        1003    Baldwin     1589.78        AL
2     Alabama          24686        1005    Barbour      884.88        AL
3     Alabama          22394        1007       Bibb      622.58        AL
4     Alabama          57826        1009     Blount      644.78        AL
```

```
…       …              …          …          …           …         …
3137  Wyoming        42343      56037  Sweetwater   10426.65          WY
3138  Wyoming        23464      56039       Teton    3995.38          WY
3139  Wyoming        20226      56041       Uinta    2081.26          WY
3140  Wyoming         7805      56043    Washakie    2238.55          WY
3141  Wyoming         6927      56045      Weston    2398.09          WY

[3142 rows x 6 columns]
```

[135]:

```
# Calculate population density (population per square mile))
df_pop_density['Popdensity'] = df_pop_density['estimate_2019'] /
 ↪df_pop_density['LND110210D']
```

[136]:

```
# Remove unwanted columns from pop density dataframe
df_pop_density.drop(columns=['state', 'estimate_2019','County','LND110210D'],␣
 ↪inplace=True)
```

[137]:

```
# View data
df_pop_density.head(10)
```

[137]:

```
   Countycode Statecode  Popdensity
0        1001        AL   93.985936
1        1003        AL  140.418171
2        1005        AL   27.897568
3        1007        AL   35.969675
4        1009        AL   89.683303
5        1011        AL   16.218429
6        1013        AL   25.035078
7        1015        AL  187.507221
8        1017        AL   55.745729
9        1019        AL   47.310818
```

[138]:

```
df_pop_density['Countycode']
```

[138]:

```
0        1001
1        1003
2        1005
3        1007
4        1009
        …
3137    56037
3138    56039
3139    56041
3140    56043
3141    56045
Name: Countycode, Length: 3142, dtype: int64
```

[139]:

```
# Merge df_pop_density, hospital_data on county code
df_work = pd.
 ↪merge(df_pop_density,hospital_data,left_on='Countycode',right_on='COUNTYFIPS')
```

[140]:

```
# Merge df_work with case count dataset on FIPS code(county code)
# drop duplicate columns
df_final_work = pd.
 ↪merge(df_work,case_count,left_on='Countycode',right_on='FIPS_code').
 ↪drop(columns=
                                ['COUNTYFIPS','Countycode'])
```

[141]:

```
# This is the final Dataset for Visualizations
df_final_work
```

[141]:

```
      Statecode  Popdensity  BEDS  FIPS_code        Date    US_county US_state  \
0            AL   93.985936    85       1001  2020-05-21      Autauga  Alabama
1            AL  140.418171   398       1003  2020-05-21      Baldwin  Alabama
2            AL   27.897568    74       1005  2020-05-21      Barbour  Alabama
3            AL   35.969675    35       1007  2020-05-21         Bibb  Alabama
4            AL   89.683303    40       1009  2020-05-21       Blount  Alabama
…           …          …   …       …          …           …        …
2364         WY   12.078099    88      56033  2020-05-21     Sheridan  Wyoming
2365         WY    4.061036   115      56037  2020-05-21   Sweetwater  Wyoming
2366         WY    5.872783    48      56039  2020-05-21        Teton  Wyoming
2367         WY    9.718152   225      56041  2020-05-21        Uinta  Wyoming
2368         WY    3.486632    18      56043  2020-05-21     Washakie  Wyoming

      No_of_cases  No_of_deaths
0             147             3
1             270             8
2             100             1
3              52             1
4              48             1
…            …            …
2364           16             0
2365           25             0
2366          100             1
2367           13             0
2368           19             1

[2369 rows x 9 columns]
```

[142]:

```
df_final_work.describe()
```

[142]:

```
        Popdensity         BEDS     FIPS_code  No_of_cases  No_of_deaths
count  2368.000000  2369.000000   2369.000000  2369.000000   2369.000000
mean    260.998342   389.847193  30144.165049   567.322077     30.664415
```

```
std      866.936598   1107.779474  15090.079728   2676.871008    156.209071
min        0.214238      4.000000   1001.000000      1.000000      0.000000
25%       24.013802     25.000000  19003.000000     13.000000      0.000000
50%       58.887062     85.000000  29077.000000     51.000000      1.000000
75%      164.338456    270.000000  42121.000000    221.000000      9.000000
max    18808.384894  25613.000000  56043.000000  67551.000000   3114.000000
```

[143]:

```
# Maximum number of deaths in a county is 3114
# Maximum population density is 18808 persons per square mile
# Mean no of cases is 567
```

[144]:

```
# Create a new database covid
conn = sqlite3.connect('covid.db')
c = conn.cursor()
```

[145]:

```
# Create sql using the dataframe
df_final_work.to_sql("covid_data", conn, if_exists="replace")
```

[146]:

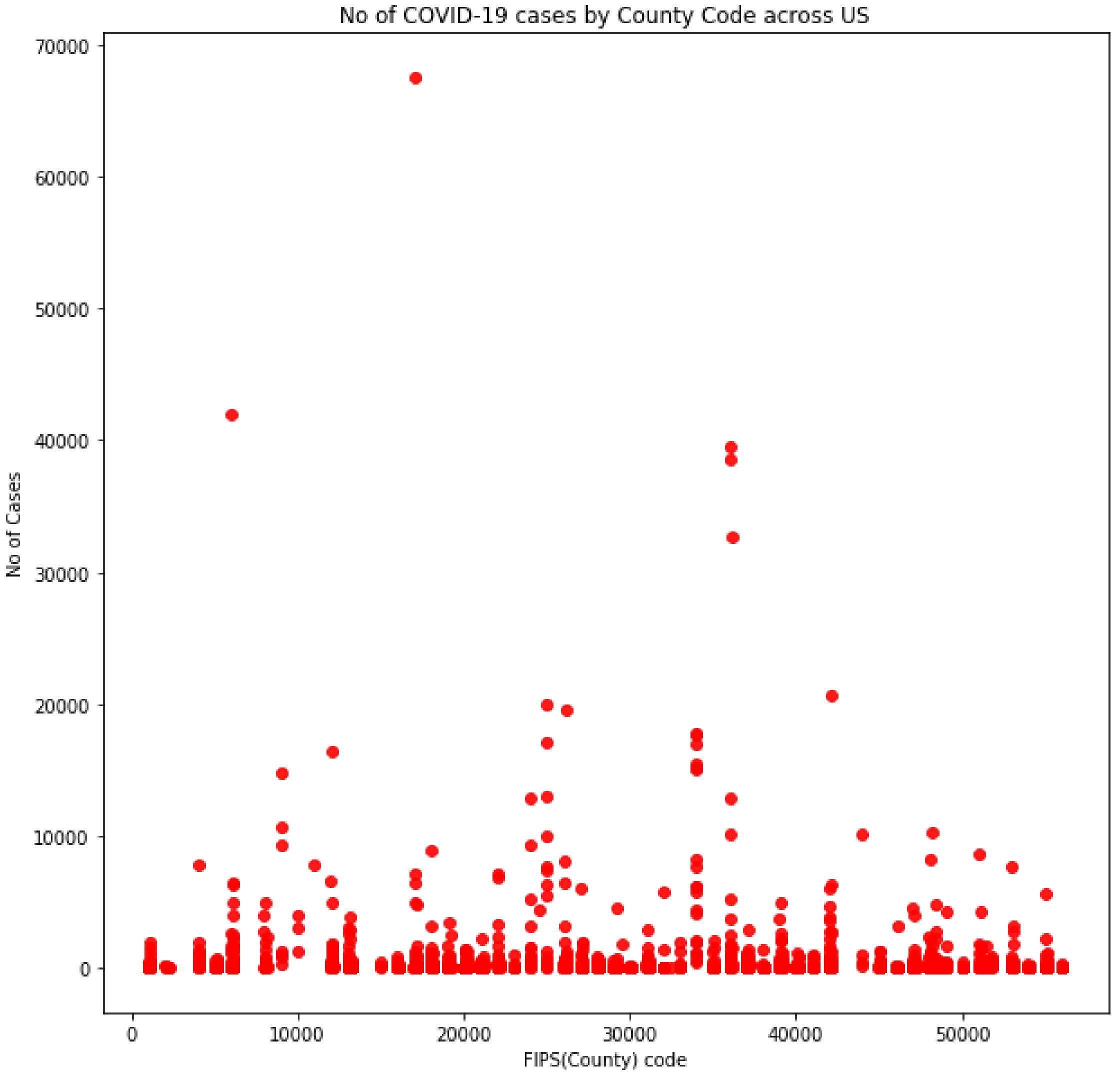
```
# Create a new table in the database
# First drop the table if already exists
conn.execute(
    """
    drop table covid_table
    """)
conn.execute(
    """
    create table covid_table as
    select * from covid_data
    """)
conn.commit()
```

[147]:

```
# Retrive data from database
with sqlite3.connect("covid.db") as conn:
    cursor = conn.cursor()
    rows = cursor.execute("Select * from covid_table")
```

[172]:

```
# Draw scatter plot with number of cases on y-axis and county code on x-axi
rng = np.random.RandomState(0)
colors = rng.rand(2369)
sizes = 10000 * rng.rand(2369)
plt.figure(figsize=(10,10))
plt.plot(df_final_work["FIPS_code"], df_final_work["No_of_cases"],'o',color=␣
 ↪'red',alpha=0.9)
plt.xlabel('FIPS(County) code')
plt.ylabel('No of Cases');
plt.title("No of COVID-19 cases by County Code across US")
plt.savefig('C:/Lenin Data Science/DSC540/scatter1.pdf', dpi=1200)
plt.show()
```

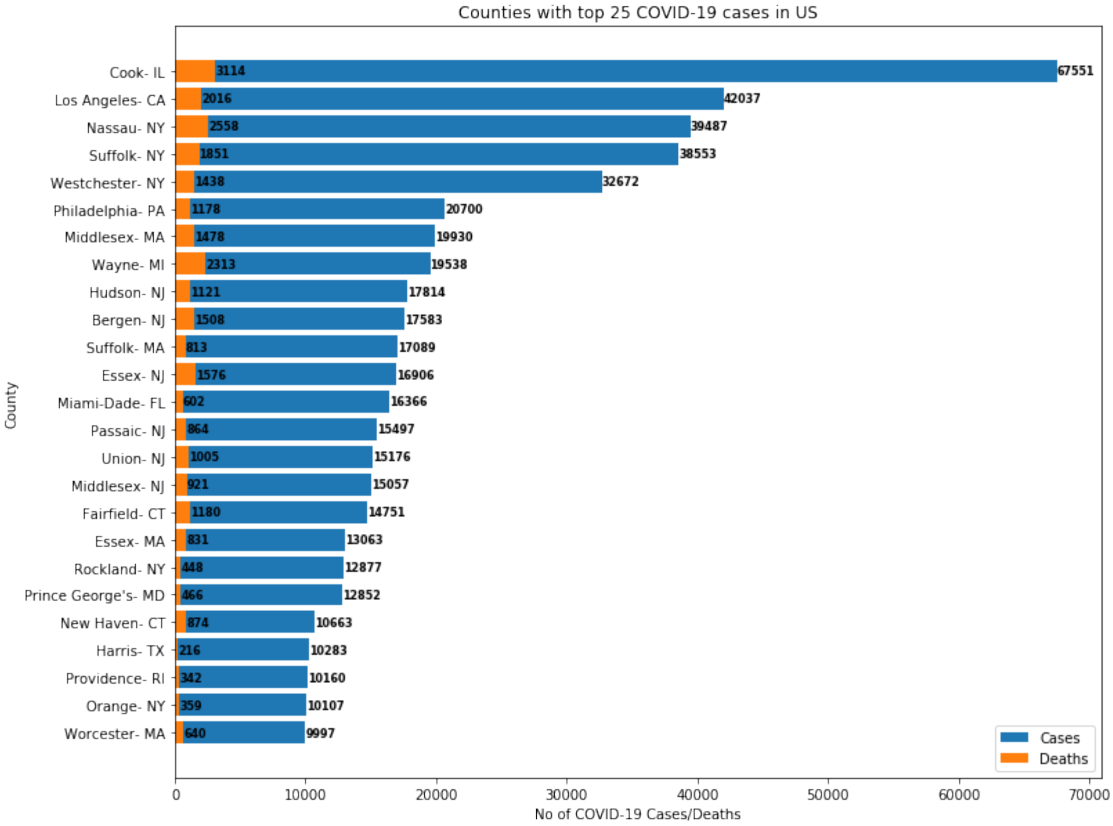


[149]:
```
# There is one outlier with number of cases close to 70000
# Most of the counties have covid cases less than 5000
```

[150]:
```
# Let's take top 25 counties from DB
list1 = []
columns = ['County', 'Count', 'Deaths']
with sqlite3.connect("covid.db") as conn:
    cursor = conn.cursor()
    rows = cursor.execute("SELECT US_county||'-'||Statecode,␣
 ↪No_of_cases,No_of_deaths from covid_table ORDER BY No_of_cases desc LIMIT␣
 ↪25")
    for row in rows:
        list1.append(row)
top25_df = pd.DataFrame(list1, columns=columns)
top25_df = top25_df.sort_values(by='Count')
```

[169]:

```
# Draw bar plot with number of cases/Number of deaths on y-axis and county code␣
 ↪on x-axis
fig, ax = plt.subplots(figsize=(12,10))
ax.barh(top25_df['County'], top25_df['Count'], align='center')
ax.barh(top25_df['County'], top25_df['Deaths'], align='center')
legend_val = ['Cases', 'Deaths']
plt.xlabel('No of COVID-19 Cases/Deaths')
plt.ylabel('County')
plt.title("Counties with top 25 COVID-19 cases in US")
for i, v in enumerate(top25_df['Count']):
    ax.text(v + 10, i, str(v), color='black', fontweight='bold', fontsize=8,␣
 ↪ha='left', va='center')
for i, v in enumerate(top25_df['Deaths']):
    ax.text(v + 10, i, str(v), color='black', fontweight='bold', fontsize=8,␣
 ↪ha='left', va='center')
ax.legend(legend_val,loc='best')
plt.savefig('C:/Lenin Data Science/DSC540/bar1.pdf', dpi=1200)
plt.show()
```



[152]:

```
# No. of cases are highest in Cook (IL) county
# There are 24 counties with more than 10000 cases (as of 05/23/2020)
```

[153]:

```
# Let's take top 25 counties from DB
list1 = []
columns = ['County', 'Popdensity', 'Casecount']
with sqlite3.connect("covid.db") as conn:
    cursor = conn.cursor()
    rows = cursor.execute("SELECT US_county||'-'||Statecode, Popdensity,␣
 ↪No_of_cases from covid_table ORDER BY No_of_cases desc LIMIT 25")
    for row in rows:
        list1.append(row)
top25_den_df = pd.DataFrame(list1, columns=columns)
top25_den_df
```

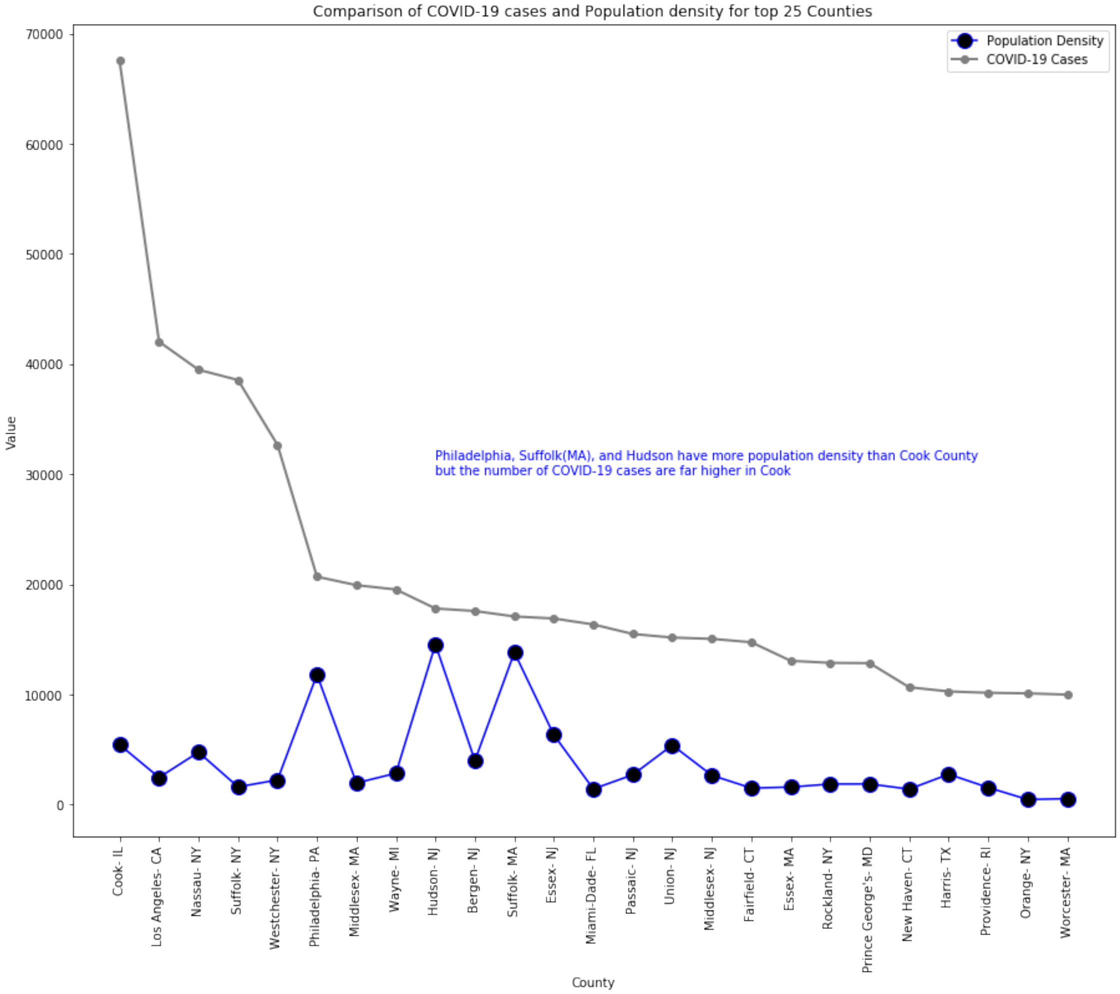
[153]:

```
                County    Popdensity  Casecount
0             Cook- IL   5448.079507      67551
1      Los Angeles- CA   2473.978284      42037
2           Nassau- NY   4765.819050      39487
3          Suffolk- NY   1618.991283      38553
4      Westchester- NY   2247.400697      32672
5     Philadelphia- PA  11812.557793      20700
6        Middlesex- MA   1970.725832      19930
7            Wayne- MI   2858.029996      19538
8           Hudson- NJ  14557.068630      17814
9           Bergen- NJ   4000.695249      17583
10         Suffolk- MA  13824.711952      17089
11           Essex- NJ   6330.520561      16906
12      Miami-Dade- FL   1431.686445      16366
13         Passaic- NJ   2718.597974      15497
14           Union- NJ   5408.720591      15176
15       Middlesex- NJ   2670.881487      15057
16       Fairfield- CT   1509.596889      14751
17           Essex- MA   1601.904337      13063
18        Rockland- NY   1877.205416      12877
19  Prince George's- MD   1883.873708      12852
20       New Haven- CT   1413.966684      10663
21          Harris- TX   2766.880151      10283
22      Providence- RI   1560.271062      10160
23          Orange- NY    474.245094      10107
24       Worcester- MA    549.800433       9997
```

[168]:

```
# Compare number of cases with population density
fig, ax = plt.subplots(figsize=(15,12))
```

```
plt.plot(top25_den_df['County'], top25_den_df['Popdensity'], marker='o', markerfacecolor='black', markersize=12, color='blue', label="Population Density")
plt.plot(top25_death_df['County'], top25_death_df['Casecount'], marker='o', color='gray', linewidth=2, label="COVID-19 Cases")
plt.xlabel('County')
plt.xticks(rotation=90)
plt.ylabel('Value');
plt.title("Comparison of COVID-19 cases and Population density for top 25 Counties")
plt.text(8,30000,'Philadelphia, Suffolk(MA), and Hudson have more population density than Cook County\nbut the number of COVID-19 cases are far higher in Cook'
        ,color='blue')
plt.legend()
plt.savefig('C:/Lenin Data Science/DSC540/line1.pdf', dpi=1200)
plt.show()
```



[155]:

```
# Top 25 counties with highest cases
list3 = []
columns = ['County','Casecount', 'Beds']
with sqlite3.connect("covid.db") as conn:
    cursor = conn.cursor()
    rows = cursor.execute("SELECT US_county||'-'||Statecode, No_of_cases, BEDS␣
 ↪from covid_table ORDER BY No_of_cases desc LIMIT 25")
    for row in rows:
        list3.append(row)
top25_beds_df = pd.DataFrame(list3, columns=columns)
top25_beds_df = top25_beds_df.dropna()
top25_beds_df
```

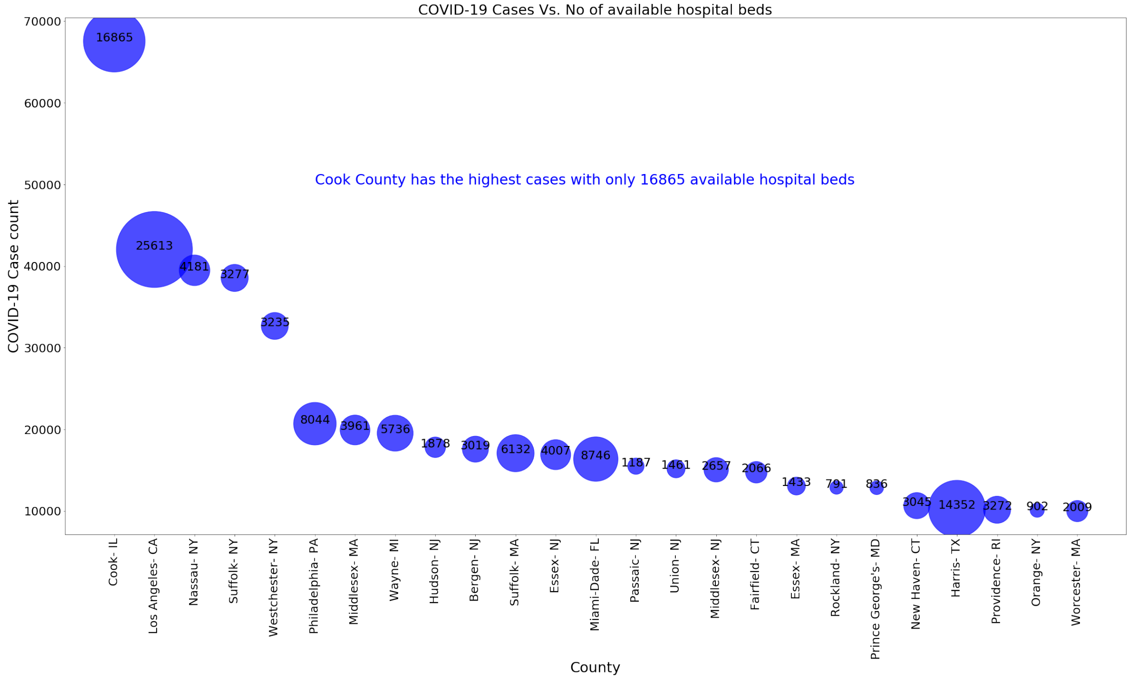
[155]:

```
                  County  Casecount   Beds
0              Cook- IL       67551  16865
1       Los Angeles- CA       42037  25613
2           Nassau- NY        39487   4181
3          Suffolk- NY        38553   3277
4       Westchester- NY       32672   3235
5      Philadelphia- PA       20700   8044
6         Middlesex- MA       19930   3961
7             Wayne- MI       19538   5736
8            Hudson- NJ       17814   1878
9            Bergen- NJ       17583   3019
10          Suffolk- MA       17089   6132
11            Essex- NJ       16906   4007
12       Miami-Dade- FL       16366   8746
13          Passaic- NJ       15497   1187
14            Union- NJ       15176   1461
15        Middlesex- NJ       15057   2657
16        Fairfield- CT       14751   2066
17            Essex- MA       13063   1433
18         Rockland- NY       12877    791
19  Prince George's- MD       12852    836
20        New Haven- CT       10663   3045
21           Harris- TX       10283  14352
22       Providence- RI       10160   3272
23           Orange- NY       10107    902
24        Worcester- MA        9997   2009
```

[171]:

```
# Create a bubble plot with number of Cases and Beds
fig = plt.figure(figsize=(40,20))
area1 = (top25_beds_df['Beds'])

# Choose random colors
colors1=np.random.rand(15)
```

```
# Scatter plot and labels
plt.scatter(top25_beds_df['County'],␣
 ↪top25_beds_df['Casecount'],s=area1,color='blue', alpha=0.7)
plt.title('COVID-19 Cases Vs. No of available hospital beds', fontsize=30 )
plt.xlabel('County', fontsize=30)
plt.ylabel('COVID-19 Case count', fontsize=30)

x , y = top25_beds_df['County'], top25_beds_df['Casecount']
for i, txt in enumerate(top25_beds_df['Beds']):
    plt.annotate(txt, (x[i], y[i]), fontsize=25, horizontalalignment='center')


# Rotate xticks to show vertical
plt.xticks(rotation=90, fontsize=25)
plt.yticks(fontsize=25)

plt.text(5,50000,'Cook County has the highest cases with only 16865 available␣
 ↪hospital beds', color='blue', fontsize=30)
plt.savefig('C:/Lenin Data Science/DSC540/bubble1.pdf', dpi=2400)
plt.show()
```



[160]:
```
# Top 25 counties with highest cases
list4 = []
columns = ['County','Casecount', 'Popdensity']
```

```
with sqlite3.connect("covid.db") as conn:
    cursor = conn.cursor()
    rows = cursor.execute("SELECT US_county||'-'||Statecode, No_of_cases,␣
 ↪popdensity from covid_table ORDER BY No_of_cases DESC LIMIT 50")
    for row in rows:
        list4.append(row)
top50_pop_df = pd.DataFrame(list4, columns=columns)
top50_pop_df = top50_pop_df.dropna()
top50_pop_df
```

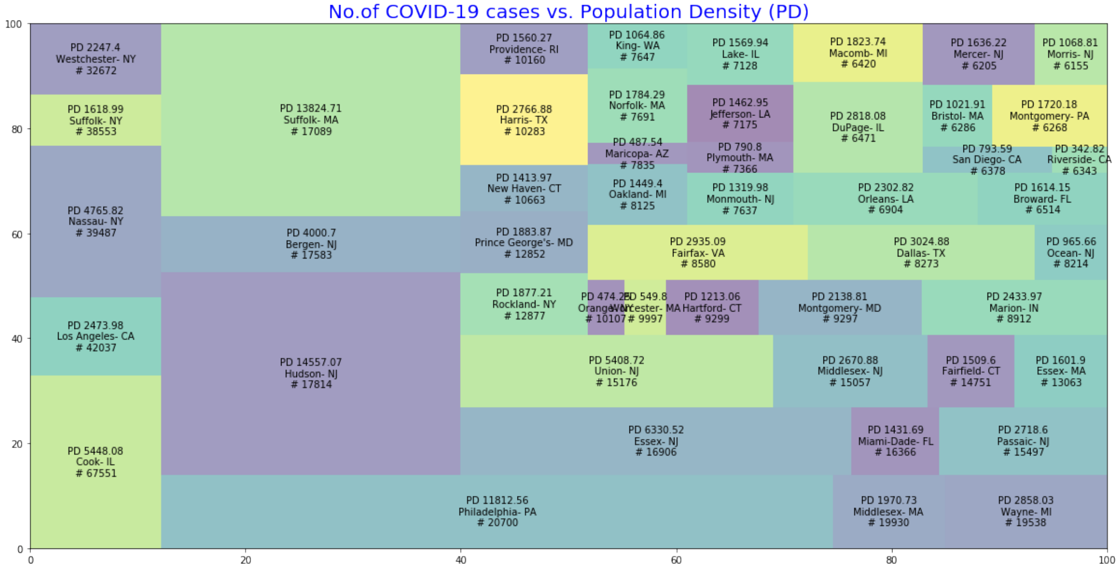
[160]:

```
                County  Casecount    Popdensity
0                Cook- IL      67551   5448.079507
1         Los Angeles- CA      42037   2473.978284
2              Nassau- NY      39487   4765.819050
3             Suffolk- NY      38553   1618.991283
4         Westchester- NY      32672   2247.400697
5        Philadelphia- PA      20700  11812.557793
6           Middlesex- MA      19930   1970.725832
7               Wayne- MI      19538   2858.029996
8              Hudson- NJ      17814  14557.068630
9              Bergen- NJ      17583   4000.695249
10            Suffolk- MA      17089  13824.711952
11              Essex- NJ      16906   6330.520561
12         Miami-Dade- FL      16366   1431.686445
13            Passaic- NJ      15497   2718.597974
14              Union- NJ      15176   5408.720591
15          Middlesex- NJ      15057   2670.881487
16          Fairfield- CT      14751   1509.596889
17              Essex- MA      13063   1601.904337
18           Rockland- NY      12877   1877.205416
19    Prince George's- MD      12852   1883.873708
20          New Haven- CT      10663   1413.966684
21             Harris- TX      10283   2766.880151
22         Providence- RI      10160   1560.271062
23             Orange- NY      10107    474.245094
24          Worcester- MA       9997    549.800433
25           Hartford- CT       9299   1213.059448
26         Montgomery- MD       9297   2138.805089
27             Marion- IN       8912   2433.969215
28            Fairfax- VA       8580   2935.089649
29             Dallas- TX       8273   3024.878340
30              Ocean- NJ       8214    965.657305
31            Oakland- MI       8125   1449.397229
32           Maricopa- AZ       7835    487.537581
34            Norfolk- MA       7691   1784.289718
35               King- WA       7647   1064.858171
36           Monmouth- NJ       7637   1319.983361
```

```
37          Plymouth- MA       7366    790.802331
38         Jefferson- LA       7175   1462.953692
39              Lake- IL       7128   1569.939369
40           Orleans- LA       6904   2302.821391
41           Broward- FL       6514   1614.146257
42            DuPage- IL       6471   2818.079389
43            Macomb- MI       6420   1823.738575
44         San Diego- CA       6378    793.587741
45         Riverside- CA       6343    342.822848
46           Bristol- MA       6286   1021.907431
47        Montgomery- PA       6268   1720.178453
48            Mercer- NJ       6205   1636.221945
49            Morris- NJ       6155   1068.810031
```

[167]:

```
# Create a label to show on tree map
top50_pop_df['label1'] = "PD " + round(top50_pop_df["Popdensity"],2).
 ↪astype(str) +'\n'+ top50_pop_df["County"].astype(str) +'\n' + "# " +␣
 ↪top50_pop_df["Casecount"].astype(str)

# Create tree map
plt.figure(figsize=(20,10))
squarify.plot(sizes=top50_pop_df['Popdensity'],label=top50_pop_df["label1"],␣
 ↪alpha=0.5 )
plt.title("No.of COVID-19 cases vs. Population Density (PD)", fontsize=20,␣
 ↪color="blue")
plt.savefig('C:/Lenin Data Science/DSC540/tree1.pdf', dpi=1200)
plt.show()
```



[162]:

```
# Save final data file to the local drive
#Save final dataset to a csv file
df_final_work.to_csv(r'C:/Lenin Data Science/DSC540/Project/FinalDataFile.csv')
```