TERM PROJECT - FINAL

October 2, 2024

1   Term Project

```python
[261]: from sqlalchemy import create_engine
       import pandas as pd
       import sqlite3
       import matplotlib.pyplot as plt
       import matplotlib.ticker as ticker
```

1.0.1   SQL

```python
[262]: # create database
```

```python
[263]: conn = sqlite3.connect('covid19.db')
```

```python
[264]: conn.close()
```

```python
[265]: # load datasets to database
```

```python
[266]: connection = 'sqlite:////Users/yuhang/Desktop/DSC540/term_project/covid19.db'
```

```python
[267]: engine = create_engine(connection)
```

```python
[268]: df_first1 = pd.read_csv('df_first1.csv')
```

```python
[269]: df_first1.to_sql('df_first1', con=engine, if_exists='replace', index=False)
```

```python
[270]: popu_data1 = pd.read_csv('popu_data1.csv')
```

```python
[271]: popu_data1.to_sql('popu_data1', con=engine, if_exists='replace', index=False)
```

```python
[272]: cases_df_selected_CA = pd.read_csv('cases_df_selected_CA.csv')
```

```python
[273]: cases_df_selected_CA.to_sql('cases_df_selected_CA', con=engine,
       ↪if_exists='replace', index=False)
```

```python
[274]: cases_df_selected_AZ = pd.read_csv('cases_df_selected_AZ.csv')
```

```python
[275]: cases_df_selected_AZ.to_sql('cases_df_selected_AZ', con=engine,
       ↪if_exists='replace', index=False)
```

```python
[276]: cases_df_selected_ID = pd.read_csv('cases_df_selected_ID.csv')
```

```python
[277]: cases_df_selected_ID.to_sql('cases_df_selected_ID', con=engine,
       ↪if_exists='replace', index=False)
```

```python
[278]: cases_df_selected_MN = pd.read_csv('cases_df_selected_MN.csv')
```

```python
[279]: cases_df_selected_MN.to_sql('cases_df_selected_MN', con=engine,
       ↪if_exists='replace', index=False)
```

```python
[280]: cases_df_selected_SD = pd.read_csv('cases_df_selected_SD.csv')
```

```python
[281]: cases_df_selected_SD.to_sql('cases_df_selected_SD', con=engine,
       ↪if_exists='replace', index=False)
```

```python
[282]: cases_df_selected_MA = pd.read_csv('cases_df_selected_MA.csv')
```

```python
[283]: cases_df_selected_MA.to_sql('cases_df_selected_MA', con=engine,
       ↪if_exists='replace', index=False)
```

```python
[284]: stacked_df = pd.read_csv('stacked_df.csv')
```

```python
[285]: stacked_df.to_sql('stacked_df', con=engine, if_exists='replace', index=False)
```

```python
[286]: with sqlite3.connect("covid19.db") as conn:
           cursor = conn.cursor()
           rows = cursor.execute('SELECT * FROM stacked_df')
           for row in rows:
               print(row)
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[287]:
```python
# join datasets in sql
```

[288]:
```python
with sqlite3.connect("covid19.db") as conn:
    cursor = conn.cursor()
    cursor.execute("PRAGMA foreign_keys = 1")
    sql = """
    SELECT df_first1.*, popu_data1.* \
    FROM df_first1 \
    LEFT JOIN popu_data1 ON df_first1.Location = popu_data1.States \
    """
    df_joined = pd.read_sql_query(sql, conn)
    print(df_joined.head())
```

```
        Date Location  Distributed  Administered  Administered_0-18  \
0  05/10/2023       NE      5481710       3822190          7441272.0
1  05/10/2023       LA     10282120       6961453         13742096.0
2  05/10/2023       GA     28727475      17124791         33591078.0
3  05/10/2023       WY      1281755        854132          1683191.0
4  05/10/2023       CO     17769135      13033446         25295803.0
```

```
     Administered_18-65  Administered_65Plus  Administered_Moderna  \
0               3412154              1117112               1240872
1               6443990              2090638               2685630
2              15542310              4409764               6170654
3                790769               284622                347522
4              11614071              3172390               4490965

     Additional_Doses  Additional_Doses_0-18  Additional_Doses_18-65  \
0             718168.0              1416182.0                664415.0
1            1110217.0              2213857.0               1076600.0
2            2705136.0              5369811.0               2567417.0
3             145600.0               289567.0                139599.0
4            2460212.0              4847736.0               2265625.0

     Additional_Doses_65Plus Second_Booster States        Zone Population2020
0                   240367.0           None     NE  US/Central      1,961,504
1                   450792.0           None     LA  US/Central      4,657,757
2                   892658.0           None     GA  US/Eastern     10,711,908
3                    62044.0           None     WY  US/Mountain       576,851
4                   662890.0           None     CO  US/Mountain     5,773,714
```

[289]:
```python
df_joined.to_sql('df_joined', conn, if_exists='replace', index=False)
```

[290]:
```python
with sqlite3.connect("covid19.db") as conn:
    cursor = conn.cursor()
    cursor.execute("PRAGMA foreign_keys = 1")
    df_joined = pd.read_sql_query("SELECT * FROM df_joined", conn)
    stacked_df = pd.read_sql_query("SELECT * FROM stacked_df", conn)
```

[291]:
```python
df_joined['Date'] = pd.to_datetime(df_joined['Date']).dt.strftime('%Y-%m-%d')
stacked_df['Date'] = pd.to_datetime(stacked_df['Date']).dt.strftime('%Y-%m-%d')
```

[292]:
```python
with sqlite3.connect("covid19.db") as conn:
    df_joined.to_sql('df_joined', conn, if_exists='replace', index=False)
    stacked_df.to_sql('stacked_df', conn, if_exists='replace', index=False)
```

[293]:
```python
with sqlite3.connect("covid19.db") as conn:
    cursor = conn.cursor()
    cursor.execute("PRAGMA foreign_keys = 1")
    sql1 = """
    SELECT df_joined.*, stacked_df.*
    FROM stacked_df
    INNER JOIN df_joined
    ON stacked_df.State = df_joined.States
    AND stacked_df.Date = df_joined.Date
    """
    df_joined1 = pd.read_sql_query(sql1, conn)
    print(df_joined1.tail())
```

```
         Date Location  Distributed  Administered  Administered_0-18  \
3523  2023-02-08       MA     23037230      17991517           34897736.0
3524  2023-02-15       MA     23096880      18010421           34930205.0
3525  2023-02-22       MA     23152420      18024986           34955069.0
3526  2023-03-01       MA     23201200      18039745           34980283.0
3527  2023-03-08       MA     23268890      18052941           35002281.0


      Administered_18-65  Administered_65Plus  Administered_Moderna  \
3523            15979588              4518951               7127045
3524            15993570              4522507               7133858
3525            16004374              4525512               7139405
3526            16015071              4527957               7144761
3527            16024486              4530360               7149461


      Additional_Doses  Additional_Doses_0-18  Additional_Doses_18-65  \
3523         3279811.0             6461762.0               3010402.0
3524         3283473.0             6467740.0               3012530.0
3525         3286280.0             6472255.0               3014239.0
3526         3289271.0             6477076.0               3015976.0
3527         3291942.0             6481288.0               3017489.0


      Additional_Doses_65Plus Second_Booster States      Zone  \
3523                 920320.0           None     MA  US/Eastern
3524                 920762.0           None     MA  US/Eastern
3525                 921148.0           None     MA  US/Eastern
3526                 921464.0           None     MA  US/Eastern
3527                 921782.0           None     MA  US/Eastern


      Population2020        Date  new_case_sums State
3523       7,029,917  2023-02-08             51    MA
3524       7,029,917  2023-02-15             34    MA
3525       7,029,917  2023-02-22              0    MA
3526       7,029,917  2023-03-01              0    MA
3527       7,029,917  2023-03-08              0    MA
```

[294]: `df_joined1.to_sql('df_joined1', con=engine, if_exists='replace', index=False)`

[295]: `df_joined1`

[295]:
```
              Date Location  Distributed  Administered  Administered_0-18  \
0       2020-12-14       CA        33150             0                0.0
1       2020-12-15       CA       148200             0                0.0
2       2020-12-16       CA       195000             4                0.0
3       2020-12-17       CA       326625           273                0.0
4       2020-12-18       CA       326625           273                0.0
...            ...      ...          ...           ...               ...
3523    2023-02-08       MA     23037230      17991517           34897736.0
```

```
3524   2023-02-15   MA      23096880        18010421            34930205.0
3525   2023-02-22   MA      23152420        18024986            34955069.0
3526   2023-03-01   MA      23201200        18039745            34980283.0
3527   2023-03-08   MA      23268890        18052941            35002281.0


       Administered_18-65  Administered_65Plus  Administered_Moderna  \
0                       0                    0                     0
1                       0                    0                     0
2                       0                    0                     0
3                       0                    0                     1
4                       0                    0                     1
...                   ...                  ...                   ...
3523             15979588              4518951               7127045
3524             15993570              4522507               7133858
3525             16004374              4525512               7139405
3526             16015071              4527957               7144761
3527             16024486              4530360               7149461


       Additional_Doses  Additional_Doses_0-18  Additional_Doses_18-65  \
0                   NaN                    NaN                     0.0
1                   NaN                    NaN                     0.0
2                   NaN                    NaN                     0.0
3                   NaN                    NaN                     0.0
4                   NaN                    NaN                     0.0
...                 ...                    ...                     ...
3523         3279811.0              6461762.0               3010402.0
3524         3283473.0              6467740.0               3012530.0
3525         3286280.0              6472255.0               3014239.0
3526         3289271.0              6477076.0               3015976.0
3527         3291942.0              6481288.0               3017489.0


       Additional_Doses_65Plus Second_Booster States        Zone  \
0                          0.0           None     CA  US/Pacific
1                          0.0           None     CA  US/Pacific
2                          0.0           None     CA  US/Pacific
3                          0.0           None     CA  US/Pacific
4                          0.0           None     CA  US/Pacific
...                        ...            ...    ...         ...
3523                  920320.0           None     MA  US/Eastern
3524                  920762.0           None     MA  US/Eastern
3525                  921148.0           None     MA  US/Eastern
3526                  921464.0           None     MA  US/Eastern
3527                  921782.0           None     MA  US/Eastern


     Population2020        Date  new_case_sums State
0        39,538,223  2020-12-14          33360    CA
1        39,538,223  2020-12-15          55236    CA
```

```
2        39,538,223  2020-12-16              56122    CA
3        39,538,223  2020-12-17              44433    CA
4        39,538,223  2020-12-18              45570    CA
...             ...         ...                 ...    ..
3523      7,029,917  2023-02-08                 51    MA
3524      7,029,917  2023-02-15                 34    MA
3525      7,029,917  2023-02-22                  0    MA
3526      7,029,917  2023-03-01                  0    MA
3527      7,029,917  2023-03-08                  0    MA

[3528 rows x 19 columns]
```

[ ]:

1.0.2 Data Visualization

[297]: ```python
1. bar chart - population in 6 states
```

[298]: ```python
popu_data1 = pd.read_csv('popu_data1.csv')
```

[299]: ```python
popu_data1
```

[299]:
```
    States   Zone Population2020
0   CA   US/Pacific   39,538,223
1   TX   US/Central   29,145,505
2   FL   US/Eastern   21,538,187
3   NY   US/Eastern   20,201,249
4   PA   US/Eastern   13,002,700
5   IL   US/Central   12,812,508
6   OH   US/Eastern   11,799,448
7   GA   US/Eastern   10,711,908
8   NC   US/Eastern   10,439,388
9   MI   US/Eastern   10,077,331
10   NJ   US/Eastern   9,288,994
11   VA   US/Eastern   8,631,393
12   WA   US/Pacific   7,705,281
13   AZ   US/Mountain   7,151,502
14   TN   US/Central   6,910,840
15   MA   US/Eastern   7,029,917
16   IN   US/Eastern   6,785,528
17   MO   US/Central   6,154,913
18   MD   US/Eastern   6,177,224
19   WI   US/Central   5,893,718
20   CO   US/Mountain   5,773,714
21   MN   US/Central   5,706,494
22   SC   US/Eastern   5,118,425
23   AL   US/Central   5,024,279
```

```
24      LA          US/Central      4,657,757
25      KY          US/Eastern      4,505,836
26      OR          US/Pacific      4,237,256
27      OK          US/Central      3,959,353
28      CT          US/Eastern      3,605,944
29      UT          US/Mountain     3,271,616
30      IA          US/Central      3,190,369
31      PR  America/Puerto_Rico     3,285,874
32      NV          US/Pacific      3,104,614
33      AR          US/Central      3,011,524
34      KS          US/Central      2,937,880
35      MS          US/Central      2,961,279
36      NM          US/Mountain     2,117,522
37      NE          US/Central      1,961,504
38      ID          US/Mountain     1,839,106
39      WV          US/Eastern      1,793,716
40      HI          US/Hawaii       1,455,271
41      NH          US/Eastern      1,377,529
42      ME          US/Eastern      1,362,359
43      MT          US/Mountain     1,084,225
44      RI          US/Eastern      1,097,379
45      DE          US/Eastern        989,948
46      SD          US/Central        886,667
47      ND          US/Central        779,094
48      AK          US/Alaska         733,391
49      DC          US/Eastern        689,545
50      VT          US/Eastern        643,077
51      WY          US/Mountain       576,851
52      GU          Pacific/Guam      153,836
53      VI          America/Virgin     87,146
54      AS          US/Samoa           49,710
55      MP          Pacific/Guam       47,329
```

[300]:
```python
states_to_select = ['CA', 'AZ', 'ID', 'MN', 'SD', 'MA']
```

[301]:
```python
popu_filtered = popu_data1[popu_data1['States'].isin(states_to_select)]
```

[302]:
```python
popu_filtered
```

[302]:
```
    States        Zone Population2020
0       CA   US/Pacific     39,538,223
13      AZ  US/Mountain      7,151,502
15      MA   US/Eastern      7,029,917
21      MN   US/Central      5,706,494
38      ID  US/Mountain      1,839,106
46      SD   US/Central        886,667
```

```
[364]: plt.figure(figsize=(15, 8))
       #popu_filtered['Population2020'] = popu_filtered['Population2020'].str.
        ↪replace(',', '').astype(int)
       plt.bar(popu_filtered['States'], popu_filtered['Population2020'])
       plt.xlabel('States')
       plt.ylabel('Population2020')
       plt.title('Population of Selected States in 2020')
       plt.xticks(rotation=45)
       plt.ylim(0, 42000000)
       plt.gca().yaxis.set_major_formatter(ticker.FuncFormatter(lambda x, pos: '{:,.
        ↪0f}'.format(x)))
       plt.grid(axis='y', linestyle='--', alpha=0.7)
       #plt.yticks(range(500000, 45000001, 1000000))
       plt.show()
```
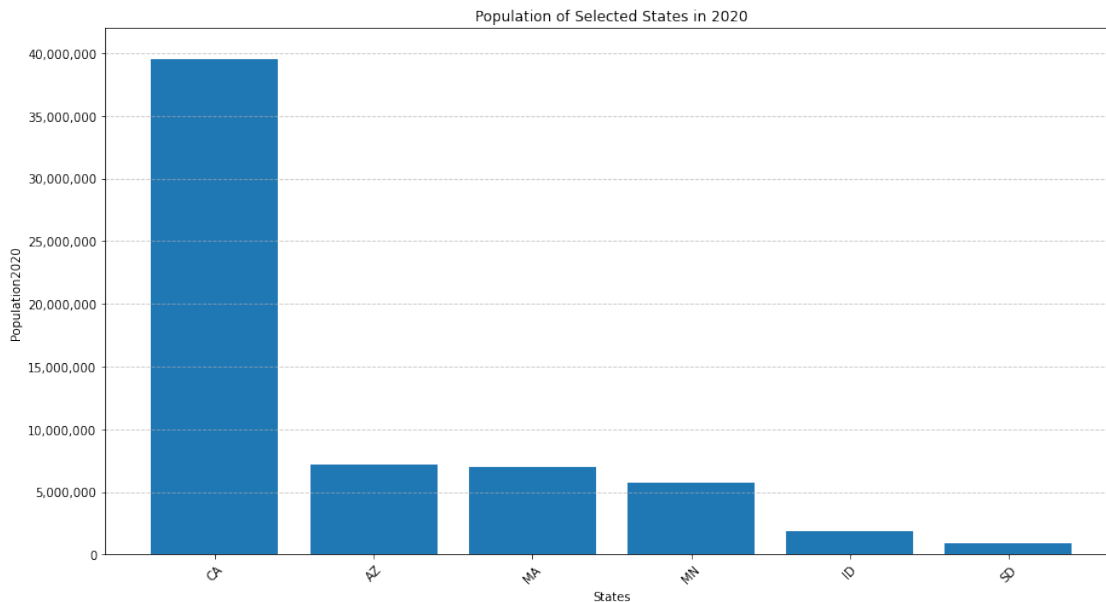


```
[335]: # 2. line chart - AZ new cases
```

```
[319]: df_T = df_joined1.T
```

```
[320]: df_T = df_T[~df_T.index.duplicated(keep='first')]
```

```
[321]: df_joined1 = df_T.T
```

```
[347]: df_joined1.to_csv(r'/Users/yuhang/Desktop/DSC540/term_project/joined1.csv')
```

```
[322]: print(df_joined1)
```

```
            Date Location Distributed Administered Administered_0-18  \
0     2020-12-14       CA       33150            0               0.0
1     2020-12-15       CA      148200            0               0.0
2     2020-12-16       CA      195000            4               0.0
3     2020-12-17       CA      326625          273               0.0
4     2020-12-18       CA      326625          273               0.0
...          ...      ...         ...          ...               ...
3523  2023-02-08       MA    23037230     17991517        34897736.0
3524  2023-02-15       MA    23096880     18010421        34930205.0
3525  2023-02-22       MA    23152420     18024986        34955069.0
3526  2023-03-01       MA    23201200     18039745        34980283.0
3527  2023-03-08       MA    23268890     18052941        35002281.0

      Administered_18-65 Administered_65Plus Administered_Moderna  \
0                      0                   0                    0
1                      0                   0                    0
2                      0                   0                    0
3                      0                   0                    1
4                      0                   0                    1
...                  ...                 ...                  ...
3523            15979588             4518951              7127045
3524            15993570             4522507              7133858
3525            16004374             4525512              7139405
3526            16015071             4527957              7144761
3527            16024486             4530360              7149461

      Additional_Doses Additional_Doses_0-18 Additional_Doses_18-65  \
0                  NaN                   NaN                    0.0
1                  NaN                   NaN                    0.0
2                  NaN                   NaN                    0.0
3                  NaN                   NaN                    0.0
4                  NaN                   NaN                    0.0
...                ...                   ...                    ...
3523         3279811.0             6461762.0              3010402.0
3524         3283473.0             6467740.0              3012530.0
3525         3286280.0             6472255.0              3014239.0
3526         3289271.0             6477076.0              3015976.0
3527         3291942.0             6481288.0              3017489.0

      Additional_Doses_65Plus Second_Booster States       Zone Population2020  \
0                         0.0           None     CA  US/Pacific    39,538,223
1                         0.0           None     CA  US/Pacific    39,538,223
2                         0.0           None     CA  US/Pacific    39,538,223
3                         0.0           None     CA  US/Pacific    39,538,223
4                         0.0           None     CA  US/Pacific    39,538,223
...                       ...            ...    ...         ...           ...
3523                 920320.0           None     MA  US/Eastern     7,029,917
3524                 920762.0           None     MA  US/Eastern     7,029,917
```

```
3525               921148.0          None    MA  US/Eastern       7,029,917
3526               921464.0          None    MA  US/Eastern       7,029,917
3527               921782.0          None    MA  US/Eastern       7,029,917

      new_case_sums State
0             33360    CA
1             55236    CA
2             56122    CA
3             44433    CA
4             45570    CA
...             ...   ...
3523             51    MA
3524             34    MA
3525              0    MA
3526              0    MA
3527              0    MA

[3528 rows x 18 columns]
```

[348]:
```python
AZ_df = df_joined1[(df_joined1['States'] == 'AZ')]
print(AZ_df)
AZ_df.to_csv(r'/Users/yuhang/Desktop/DSC540/term_project/AZ_joined1.csv')
```

```
            Date Location  Distributed  Administered  Administered_0-18  \
588   2020-12-14       AZ        21450             0                0.0
589   2020-12-15       AZ        58500             0                0.0
590   2020-12-16       AZ        58500             0                0.0
591   2020-12-17       AZ        58500             3                0.0
592   2020-12-18       AZ        58500             3                0.0
...          ...      ...          ...           ...                ...
1171  2023-02-08       AZ     19400730      14449773         28224081.0
1172  2023-02-15       AZ     19452760      14465675         28253428.0
1173  2023-02-22       AZ     19497420      14514535         28347206.0
1174  2023-03-01       AZ     19541930      14526275         28368480.0
1175  2023-03-08       AZ     19577130      14538315         28390518.0

      Administered_18-65  Administered_65Plus  Administered_Moderna  \
588                    0                    0                     0
589                    0                    0                     0
590                    0                    0                     0
591                    0                    0                     0
592                    0                    0                     0
...                  ...                  ...                   ...
1171            12907985              4399726               5568694
1172            12920946              4403753               5573103
1173            12962905              4419485               5589819
1174            12971967              4422533               5593345
1175            12981747              4425839               5596928
```

153

```
      Additional_Doses Additional_Doses_0-18 Additional_Doses_18-65  \
588                NaN                   NaN                    0.0
589                NaN                   NaN                    0.0
590                NaN                   NaN                    0.0
591                NaN                   NaN                    0.0
592                NaN                   NaN                    0.0
...                ...                   ...                    ...
1171        2394240.0             4742506.0              2235541.0
1172        2397276.0             4748094.0              2237813.0
1173        2400513.0             4754160.0              2240251.0
1174        2402447.0             4757687.0              2241533.0
1175        2404211.0             4760959.0              2242843.0

      Additional_Doses_65Plus Second_Booster States        Zone  \
588                       0.0           None     AZ  US/Mountain
589                       0.0           None     AZ  US/Mountain
590                       0.0           None     AZ  US/Mountain
591                       0.0           None     AZ  US/Mountain
592                       0.0           None     AZ  US/Mountain
...                       ...            ...    ...          ...
1171                 853089.0           None     AZ  US/Mountain
1172                 853469.0           None     AZ  US/Mountain
1173                 854119.0           None     AZ  US/Mountain
1174                 854438.0           None     AZ  US/Mountain
1175                 854799.0           None     AZ  US/Mountain

      Population2020 new_case_sums State
588        7,151,502          1700    AZ
589        7,151,502           680    AZ
590        7,151,502          1530    AZ
591        7,151,502           952    AZ
592        7,151,502          1071    AZ
...              ...           ...   ...
1171       7,151,502            51    AZ
1172       7,151,502            34    AZ
1173       7,151,502             0    AZ
1174       7,151,502             0    AZ
1175       7,151,502             0    AZ

[588 rows x 18 columns]
```

```python
[349]:  AZ_df['Date'] = pd.to_datetime(AZ_df['Date'])

        # Create a line trend plot
        plt.figure(figsize=(12, 8))
```

```python
plt.plot(AZ_df['Date'], AZ_df['new_case_sums'], marker='o', linestyle='-',␣
 ↪color='b')
plt.xlabel('Date')
plt.ylabel('New Case Sums')
plt.title('AZ New Case Sums Trend')
plt.grid(True)
plt.tight_layout()
```

/var/folders/6q/k8jdwbv174s78xj3x3kzvn0w0000gn/T/ipykernel_33428/456174564.py:1:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-
docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  AZ_df['Date'] = pd.to_datetime(AZ_df['Date'])
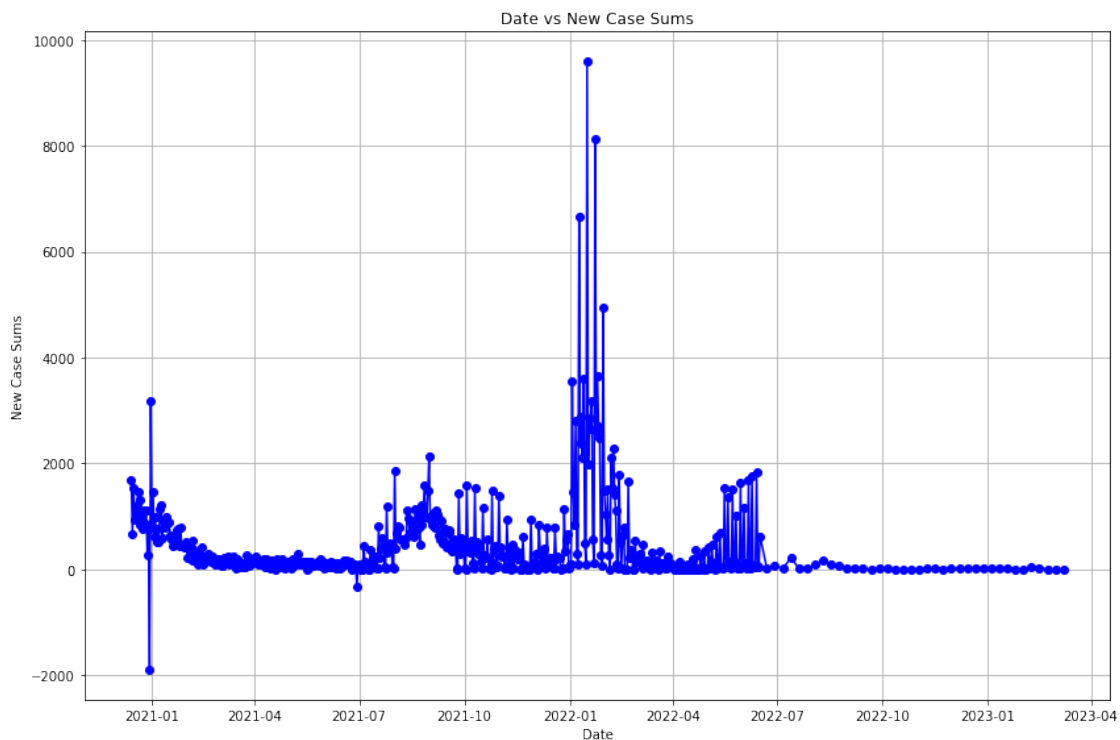

```python
[334]: # 3. scatter plot – ID
```

```python
[350]: ID_df = df_joined1[(df_joined1['States'] == 'ID')]
print(ID_df)
ID_df.to_csv(r'/Users/yuhang/Desktop/DSC540/term_project/ID_joined1.csv')
```

            Date Location Distributed Administered Administered_0-18 \

```
1176  2020-12-14       ID        1950            0              0.0
1177  2020-12-15       ID        2925            0              0.0
1178  2020-12-16       ID        2925            0              0.0
1179  2020-12-17       ID       13650            0              0.0
1180  2020-12-18       ID       13650            0              0.0
...      ...          ...         ...          ...              ...
1759  2023-02-08       ID     4637950      2863847        5625855.0
1760  2023-02-15       ID     4645980      2866310        5630460.0
1761  2023-02-22       ID     4655910      2868576        5634682.0
1762  2023-03-01       ID     4663090      2871087        5639400.0
1763  2023-03-08       ID     4671440      2873124        5643441.0

      Administered_18-65 Administered_65Plus Administered_Moderna  \
1176                   0                   0                    0
1177                   0                   0                    0
1178                   0                   0                    0
1179                   0                   0                    0
1180                   0                   0                    0
...                  ...                 ...                  ...
1759             2618844              909701              1079074
1760             2620975              910376              1079992
1761             2622908              910989              1080762
1762             2625055              911746              1081521
1763             2627046              912386              1082195

      Additional_Doses Additional_Doses_0-18 Additional_Doses_18-65  \
1176               NaN                   NaN                    0.0
1177               NaN                   NaN                    0.0
1178               NaN                   NaN                    0.0
1179               NaN                   NaN                    0.0
1180               NaN                   NaN                    0.0
...                ...                   ...                    ...
1759          489699.0              971766.0               463297.0
1760          490150.0              972611.0               463654.0
1761          490585.0              973435.0               463997.0
1762          490944.0              974109.0               464261.0
1763          491240.0              974698.0               464548.0

      Additional_Doses_65Plus Second_Booster States        Zone  \
1176                      0.0           None     ID  US/Mountain
1177                      0.0           None     ID  US/Mountain
1178                      0.0           None     ID  US/Mountain
1179                      0.0           None     ID  US/Mountain
1180                      0.0           None     ID  US/Mountain
...                       ...            ...    ...          ...
1759                 191446.0           None     ID  US/Mountain
1760                 191529.0           None     ID  US/Mountain
1761                 191604.0           None     ID  US/Mountain
```

```
1762                       191674.0                   None        ID   US/Mountain
1763                       191731.0                   None        ID   US/Mountain

      Population2020 new_case_sums State
1176      1,839,106              4600      ID
1177      1,839,106              1840      ID
1178      1,839,106              4140      ID
1179      1,839,106              2576      ID
1180      1,839,106              2898      ID
...             ...               ...      ...
1759      1,839,106               138      ID
1760      1,839,106                92      ID
1761      1,839,106                 0      ID
1762      1,839,106                 0      ID
1763      1,839,106                 0      ID

[588 rows x 18 columns]
```

```python
[352]:  plt.figure(figsize=(12, 8))
        plt.scatter(ID_df['Administered'], ID_df['new_case_sums'], color='purple',␣
          ↪alpha=0.6)
        plt.xlabel('Administered')
        plt.ylabel('New Case Sums')
        plt.title('ID Administered vs New Case Sums (Scatter Plot)')
        plt.grid(True)
        plt.tight_layout()
        plt.show()
```

ID Administered vs New Case Sums (Scatter Plot)
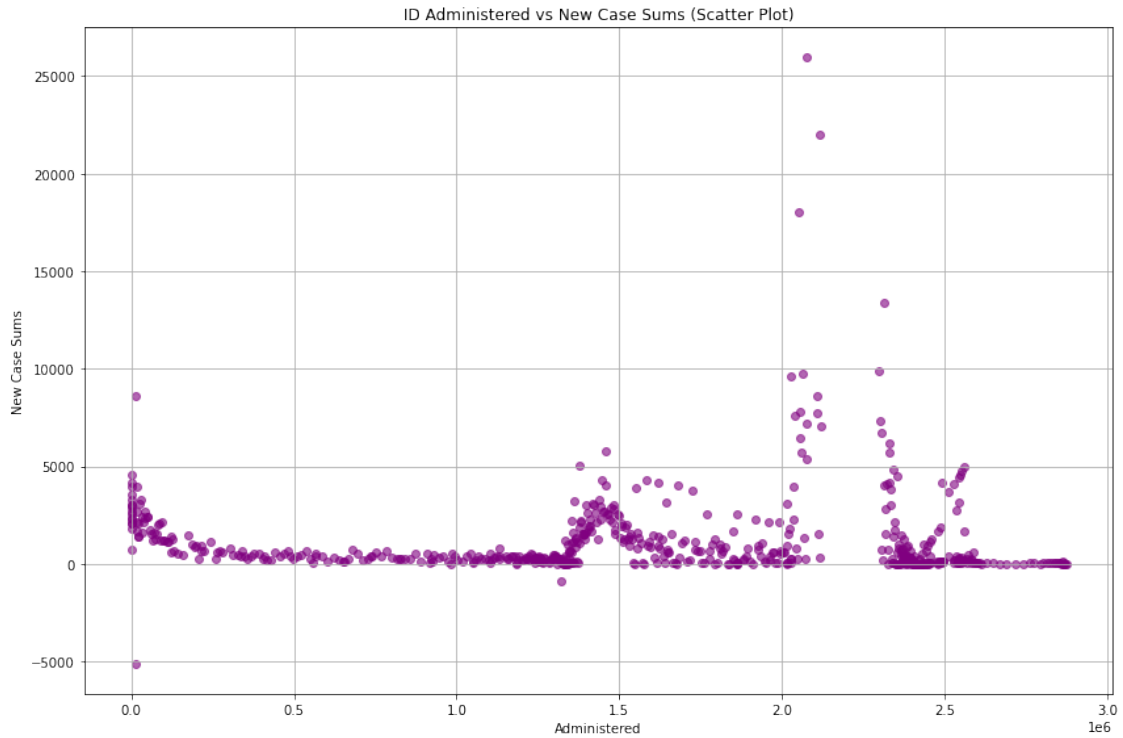
[353]: `# 4. box plot - MA Administered 0-18 year old`

[355]:
```
MA_df = df_joined1[(df_joined1['States'] == 'MA')]
print(MA_df)
MA_df.to_csv(r'/Users/yuhang/Desktop/DSC540/term_project/MA_joined1.csv')
```

```
            Date Location Distributed Administered Administered_0-18  \
2940  2020-12-14       MA        5850            0               0.0
2941  2020-12-15       MA       39975            0               0.0
2942  2020-12-16       MA       59475            0               0.0
2943  2020-12-17       MA       59475           69               0.0
2944  2020-12-18       MA       59475         2261               0.0
...          ...      ...         ...          ...               ...
3523  2023-02-08       MA    23037230     17991517        34897736.0
3524  2023-02-15       MA    23096880     18010421        34930205.0
3525  2023-02-22       MA    23152420     18024986        34955069.0
3526  2023-03-01       MA    23201200     18039745        34980283.0
3527  2023-03-08       MA    23268890     18052941        35002281.0


      Administered_18-65 Administered_65Plus Administered_Moderna  \
2940                   0                   0                    0
2941                   0                   0                    0
2942                   0                   0                    0
2943                   0                   0                    0
```

158

```
2944                       0                 0                          0
...                     ...               ...                        ...
3523                15979588           4518951                    7127045
3524                15993570           4522507                    7133858
3525                16004374           4525512                    7139405
3526                16015071           4527957                    7144761
3527                16024486           4530360                    7149461

      Additional_Doses Additional_Doses_0-18 Additional_Doses_18-65  \
2940               NaN                   NaN                    0.0
2941               NaN                   NaN                    0.0
2942               NaN                   NaN                    0.0
2943               NaN                   NaN                    0.0
2944               NaN                   NaN                    0.0
...                ...                   ...                    ...
3523         3279811.0             6461762.0              3010402.0
3524         3283473.0             6467740.0              3012530.0
3525         3286280.0             6472255.0              3014239.0
3526         3289271.0             6477076.0              3015976.0
3527         3291942.0             6481288.0              3017489.0

      Additional_Doses_65Plus Second_Booster States        Zone Population2020  \
2940                      0.0           None     MA  US/Eastern      7,029,917
2941                      0.0           None     MA  US/Eastern      7,029,917
2942                      0.0           None     MA  US/Eastern      7,029,917
2943                      0.0           None     MA  US/Eastern      7,029,917
2944                      0.0           None     MA  US/Eastern      7,029,917
...                       ...            ...    ...         ...            ...
3523                 920320.0           None     MA  US/Eastern      7,029,917
3524                 920762.0           None     MA  US/Eastern      7,029,917
3525                 921148.0           None     MA  US/Eastern      7,029,917
3526                 921464.0           None     MA  US/Eastern      7,029,917
3527                 921782.0           None     MA  US/Eastern      7,029,917

      new_case_sums State
2940           1700    MA
2941            680    MA
2942           1530    MA
2943            952    MA
2944           1071    MA
...             ...    ...
3523             51    MA
3524             34    MA
3525              0    MA
3526              0    MA
3527              0    MA

[588 rows x 18 columns]
```

```
[362]: intervals = range(0, 40000000, 5000000)
```

```
[375]: MA_df['Administered_0-18'].sum()
```

```
[375]: 8856466415.0
```

```
[376]: MA_df['Administered_18-65'].sum()
```

```
[376]: 5191936140
```

```
[377]: MA_df['Administered_65Plus'].sum()
```

```
[377]: 1356053506
```

```
[363]: plt.figure(figsize=(10, 6))
       plt.boxplot([MA_df['Administered_0-18'],␣
        ↪MA_df['Administered_18-65'],MA_df['Administered_65Plus']], \
                   patch_artist=True, boxprops=dict(facecolor='lightblue'), \
                   labels=['Administered_0-18', 'Administered_18-65',␣
        ↪'Administered_65Plus'])
       plt.xlabel('Category')
       plt.ylabel('Administered Counts')
       plt.title('Box Plot of Administered Counts by Age Groups')
       plt.yticks(intervals)
       plt.grid(True)
       plt.show()
```
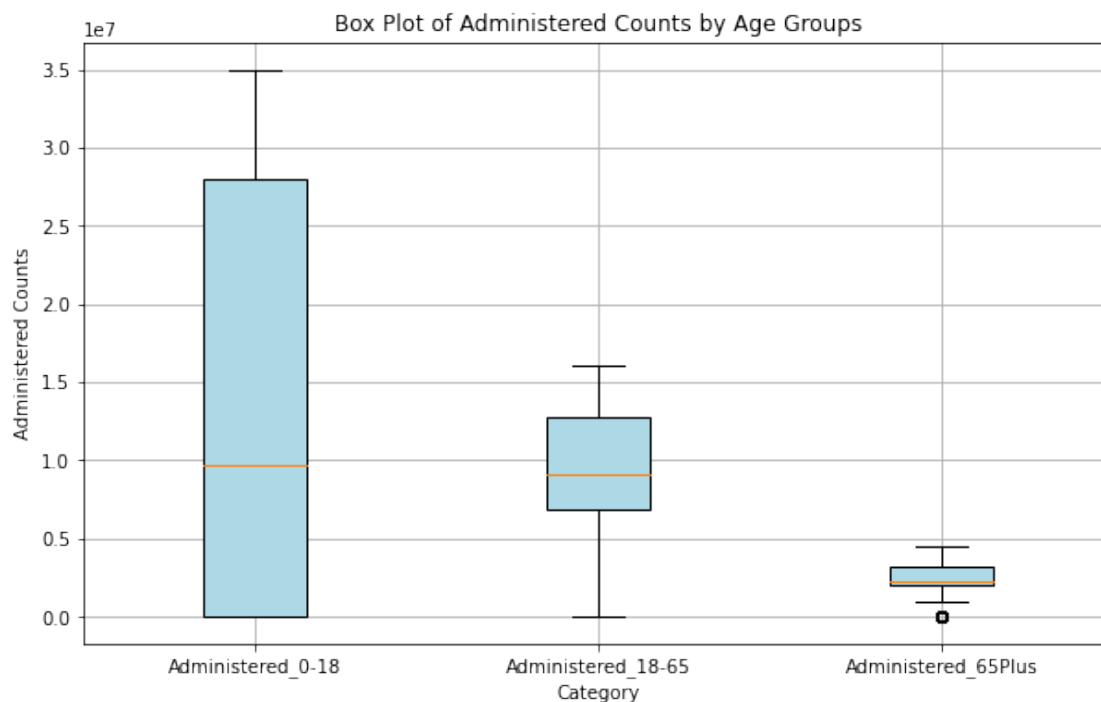
```
[385]:  # 5. histogram - 'Distributed', 'Administered', 'Administered_0-18',␣
        ↪'Administered_18-65', 'Administered_65Plus' counts frequency
```

```
[386]:  columns_to_plot = ['Distributed', 'Administered', 'Administered_0-18',␣
        ↪'Administered_18-65', 'Administered_65Plus']
```

```
[387]:  plt.figure(figsize=(20, 10))
```

```
[387]:  <Figure size 1440x720 with 0 Axes>

        <Figure size 1440x720 with 0 Axes>
```

```
[388]:  for column in columns_to_plot:
            plt.hist(df_joined1[column], bins=10, alpha=0.5, label=column)
        plt.xlabel('Counts')
        plt.ylabel('Frequency')
        plt.title('Histogram of Various Administered Counts')
        plt.legend(loc='upper right')
        plt.grid(True)
```
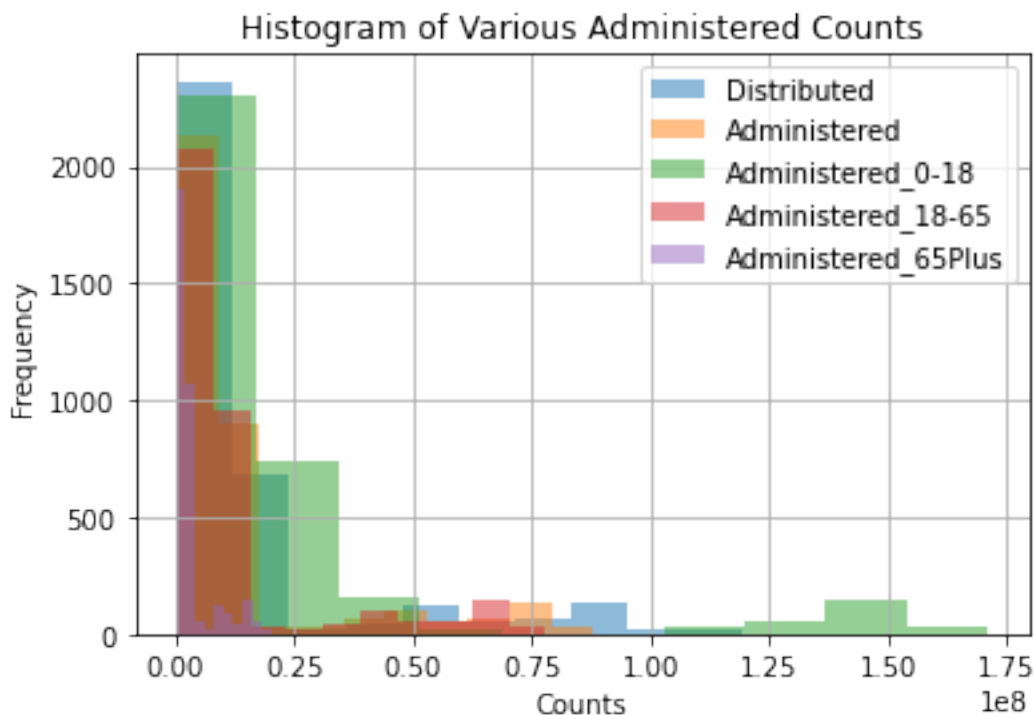

Throughout the data analysis process, several changes and transformations were made to the data
to facilitate meaningful visualizations. Initially, load the dataframes to a database, those data files

containing information about state populations, new COVID-19 cases, and vaccine administration. This was a big challenge for me, but sqlite is a great tool to utilize. The data included various columns such as state names, population counts, dates, and administered vaccine counts segmented by age groups.

The changes I made to the data including remove commas from population figures and converted them to integer data types for accurate plotting. Ensured that date columns were in a consistent datetime format. Focused on relevant columns such as Administered_0-18, Administered_18-65, and Administered_65Plus for specific visualizations.

The data used pertains to public health information, specifically COVID-19 cases and vaccine administration. Handling such data is subject to stringent legal and regulatory guidelines, including health data privacy, data accuracy and public data use.

Transforming data, especially health-related data, carries certain risks, like loss of accuracy, misinterpretation, as well as bias introduction.

Data was assumed to be sourced from credible public health repositories and databases. However, in a real-world scenario, we have to ensure that the data is from reputable sources such as government health departments or established research institutions. Comparing data points with multiple sources to ensure consistency and accuracy is also crucial.

In summary, the process of analyzing and visualizing COVID-19 data requires meticulous attention to detail, adherence to legal standards, and a commitment to ethical practices to ensure the integrity and accuracy of the insights derived.

[ ]: