Exploratory Data Analysis

April 10, 2020

[129]:

```
import os
import datetime as dt

import pandas as pd
import matplotlib.pyplot as plt
import numpy as np

from sklearn.preprocessing import MinMaxScaler
from sklearn.preprocessing import StandardScaler
```

[130]:

```
DATA_SET = "dataset.csv"
```

[254]:

```
def load_dataset(date, filename=DATA_SET):
    """
    Load training data from the one of the data/date folders.

    :parameter date (string): The date folder name.  Ex: "2020-02-05"
    :parameter filename (string): The csv filename.
    :returns a pandas dataframe.
    """

    basepath = os.path.abspath('')
    filepath = os.path.abspath(os.path.join(basepath, "..", "..")) + "/data/" +␣
 ↪date + "/" + filename
    return pd.read_csv(filepath)
```

0.1 Load Dataset

[199]:

```
data = load_dataset("2020-04-05")
data.head()
```

[199]:

```
      dateRep  day  month  year  cases  deaths countriesAndTerritories geoId  \
0  05/04/2020    5      4  2020     35       1             Afghanistan    AF
1  04/04/2020    4      4  2020      0       0             Afghanistan    AF
2  03/04/2020    3      4  2020     43       0             Afghanistan    AF
3  02/04/2020    2      4  2020     26       0             Afghanistan    AF
4  01/04/2020    1      4  2020     25       0             Afghanistan    AF
```

```
  countryterritoryCode  popData2018
0                  AFG   37172386.0
1                  AFG   37172386.0
2                  AFG   37172386.0
3                  AFG   37172386.0
4                  AFG   37172386.0
```

0.2 Data Preparation

[200]:

```
# Drop unnecessary fields
data.drop(['day', 'month', 'year'], axis=1, inplace=True)
```

[201]:

```
# Format the data as a datetime object
data['dateRep'] = data['dateRep'].apply(lambda x: dt.datetime.strptime(x, '%d/
 ↪%m/%Y'))
```

[202]:

```
# Rename date column
data = data.rename(columns={'dateRep': 'date'})
```

0.3 Get Familiar with the Data

[203]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 8905 entries, 0 to 8904
Data columns (total 7 columns):
 #   Column                   Non-Null Count  Dtype
---  ------                   --------------  -----
 0   date                     8905 non-null   datetime64[ns]
 1   cases                    8905 non-null   int64
 2   deaths                   8905 non-null   int64
 3   countriesAndTerritories  8905 non-null   object
 4   geoId                    8883 non-null   object
 5   countryterritoryCode     8824 non-null   object
 6   popData2018              8873 non-null   float64
dtypes: datetime64[ns](1), float64(1), int64(2), object(3)
memory usage: 487.1+ KB
```

[204]:

```
data['countriesAndTerritories'].value_counts()
```

[204]:

```
Spain                                 97
Denmark                               97
United_Kingdom                        97
Iceland                               97
Singapore                             97
                                      ..
```

```
Sierra_Leone                          5
Bonaire, Saint Eustatius and Saba     4
Malawi                                3
Falkland_Islands_(Malvinas)           2
Saint_Barthelemy                      1
Name: countriesAndTerritories, Length: 204, dtype: int64
```

[258]:

```
# Nubmer of unique countries
len(pd.unique(data['countriesAndTerritories']))
```

[258]:

```
204
```

[264]:

```
# First day of data
uniqueDates = pd.unique(data['date'])
uniqueDates.sort()
uniqueDates[0]
```

[264]:

```
numpy.datetime64('2019-12-31T00:00:00.000000000')
```

[205]:

```
data['geoId'].value_counts()
```

[205]:

```
AT     97
ES     97
CH     97
IT     97
US     97
       ..
BW      5
BQ      4
MW      3
FK      2
BLM     1
Name: geoId, Length: 203, dtype: int64
```

[206]:

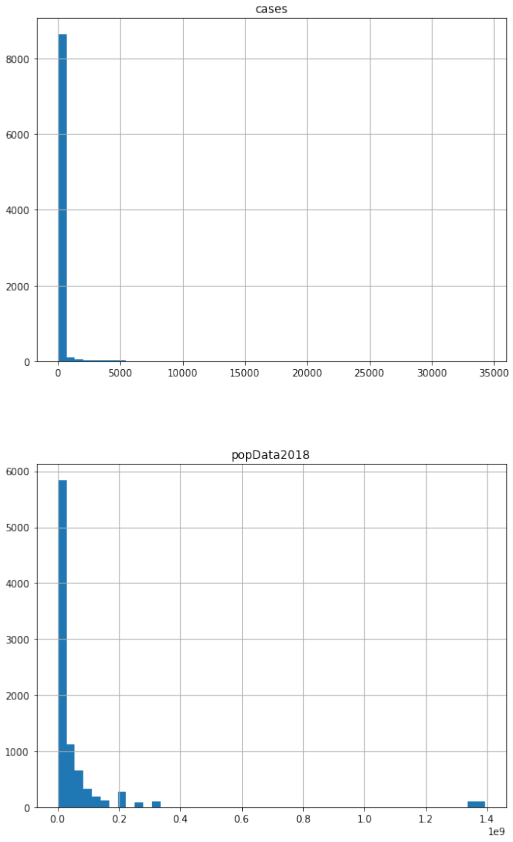
```
data.describe()
```

[206]:

```
              cases       deaths   popData2018
count   8905.000000  8905.000000  8.873000e+03
mean     131.909264     7.231892  6.549505e+07
std     1041.737090    62.844102  2.037894e+08
min       -9.000000     0.000000  1.000000e+03
25%        0.000000     0.000000  3.731000e+06
50%        0.000000     0.000000  1.062570e+07
75%       10.000000     0.000000  4.449450e+07
max    34272.000000  2004.000000  1.392730e+09
```

[243]:

```
data.hist(bins=50, figsize=(20,15))
plt.savefig('temp__Histogram', format='svg')
```



0.4 Looking for Correlations

[141]:

```
corr_matrix = data.corr()
corr_matrix['deaths'].sort_values(ascending=False)
```

[141]:

```
deaths         1.000000
cases          0.745339
popData2018    0.055614
Name: deaths, dtype: float64
```

0.5 Calculate Case Growth Rate and Death Growth Rate

[143]:

```
data['caseGrowthRate'] = 0
data['deathGrowthRate'] = 0
for row in data.iterrows():
    dateToday = row[1][0]
    cases = row[1][1]
    deaths = row[1][2]
    geoId = row[1][4]
    dateTomorrow = dateToday + dt.timedelta(days=1)
    if len(data.loc[(data.date == dateTomorrow) & (data.geoId == geoId),].
↪index) > 0: # is there data for tomorrow?
        # If so, retrieve tomorrow's death and case counts
        tomDeaths = int(data.loc[(data.date == dateTomorrow) & (data.geoId ==␣
↪geoId),'deaths'])
        tomCases = int(data.loc[(data.date == dateTomorrow) & (data.geoId ==␣
↪geoId),'cases'])
        # If applicable, calculate the case and death growth rates
        if deaths != 0 and tomDeaths != 0:
            data.loc[(data.date == dateTomorrow) & (data.geoId == geoId),␣
↪'deathGrowthRate'] = (tomDeaths / deaths) - 1
        if cases != 0 and tomCases != 0:
            data.loc[(data.date == dateTomorrow) & (data.geoId == geoId),␣
↪'caseGrowthRate'] = (tomCases / cases) - 1

data.head()
```

[143]:

```
         date  cases  deaths countriesAndTerritories geoId  \
0  2020-04-05     35       1             Afghanistan    AF
1  2020-04-04      0       0             Afghanistan    AF
2  2020-04-03     43       0             Afghanistan    AF
3  2020-04-02     26       0             Afghanistan    AF
4  2020-04-01     25       0             Afghanistan    AF

  countryterritoryCode  popData2018  deathGrowthRate  caseGrowthRate
0                  AFG   37172386.0              0.0        0.000000
1                  AFG   37172386.0              0.0        0.000000
2                  AFG   37172386.0              0.0        0.653846
3                  AFG   37172386.0              0.0        0.040000
4                  AFG   37172386.0              0.0       -0.074074
```

0.6 Experimenting with Attribute Combinations

[144]:

```
data['deathsPerMillionPop'] = data['deaths'] / data['popData2018'] / 1000000
data['casesPerMillionPop'] = data['cases'] / data['popData2018'] / 1000000
```

[145]:

```
data.head()
```

[145]:

```
         date  cases  deaths countriesAndTerritories geoId  \
0  2020-04-05     35       1             Afghanistan    AF
1  2020-04-04      0       0             Afghanistan    AF
2  2020-04-03     43       0             Afghanistan    AF
3  2020-04-02     26       0             Afghanistan    AF
```

```
4 2020-04-01     25       0             Afghanistan    AF

  countryterritoryCode  popData2018  deathGrowthRate  caseGrowthRate  \
0                  AFG   37172386.0              0.0        0.000000
1                  AFG   37172386.0              0.0        0.000000
2                  AFG   37172386.0              0.0        0.653846
3                  AFG   37172386.0              0.0        0.040000
4                  AFG   37172386.0              0.0       -0.074074

   deathsPerMillionPop  casesPerMillionPop
0         2.690169e-14        9.415591e-13
1         0.000000e+00        0.000000e+00
2         0.000000e+00        1.156773e-12
3         0.000000e+00        6.994439e-13
4         0.000000e+00        6.725422e-13
```

0.7 Time Series Analysis

[146]:

```
filterCriteria = data['countryterritoryCode'] == 'USA'
usaData = data[filterCriteria]
usaData.head()
```

[146]:

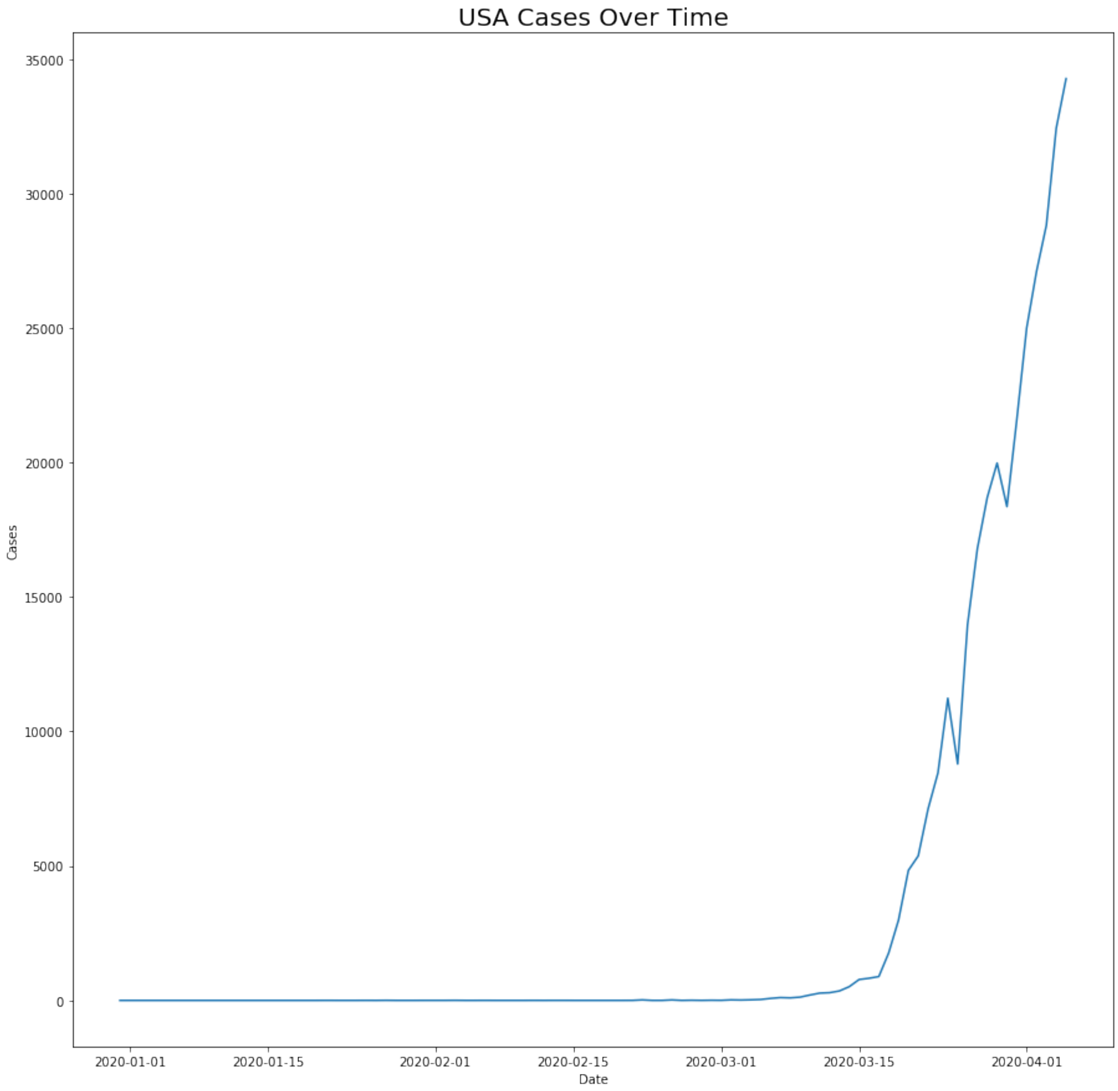
```
           date  cases  deaths  countriesAndTerritories geoId  \
8604 2020-04-05  34272    1344  United_States_of_America    US
8605 2020-04-04  32425    1104  United_States_of_America    US
8606 2020-04-03  28819     915  United_States_of_America    US
8607 2020-04-02  27103    1059  United_States_of_America    US
8608 2020-04-01  24998     909  United_States_of_America    US

     countryterritoryCode  popData2018  deathGrowthRate  caseGrowthRate  \
8604                  USA  327167434.0         0.217391        0.056962
8605                  USA  327167434.0         0.206557        0.125126
8606                  USA  327167434.0        -0.135977        0.063314
8607                  USA  327167434.0         0.165017        0.084207
8608                  USA  327167434.0         0.375189        0.157583

      deathsPerMillionPop  casesPerMillionPop
8604         4.107988e-12        1.047537e-10
8605         3.374419e-12        9.910827e-11
8606         2.796733e-12        8.808640e-11
8607         3.236875e-12        8.284137e-11
8608         2.778394e-12        7.640736e-11
```

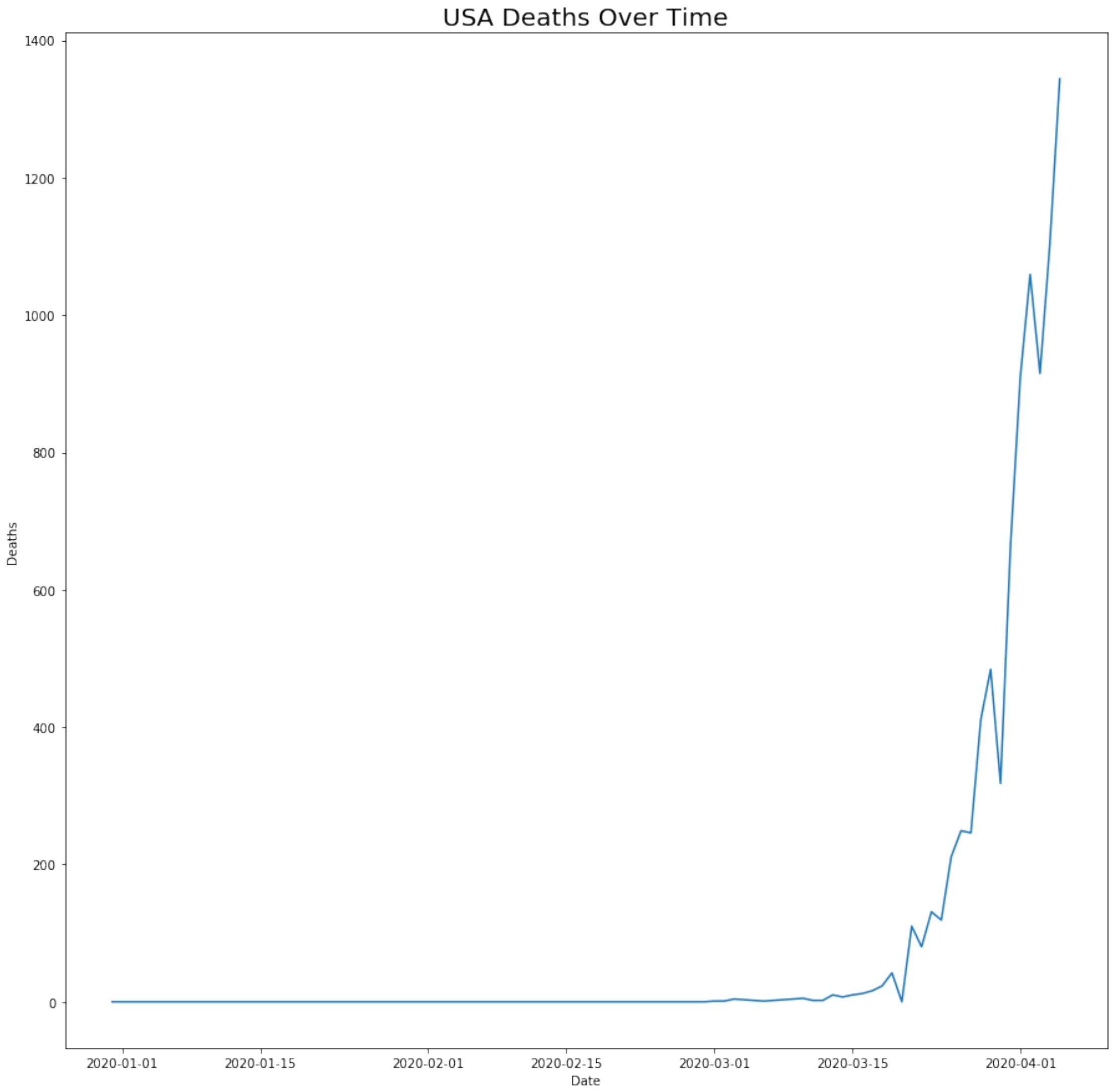
[247]:

```
# Graph USA cases across time
plt.figure(figsize=(15,15))
plt.plot(usaData['date'], usaData['cases'])
plt.ylabel('Cases')
plt.xlabel('Date')
plt.title('USA Cases Over Time', fontdict = {'fontsize' : 20})
plt.show()
```



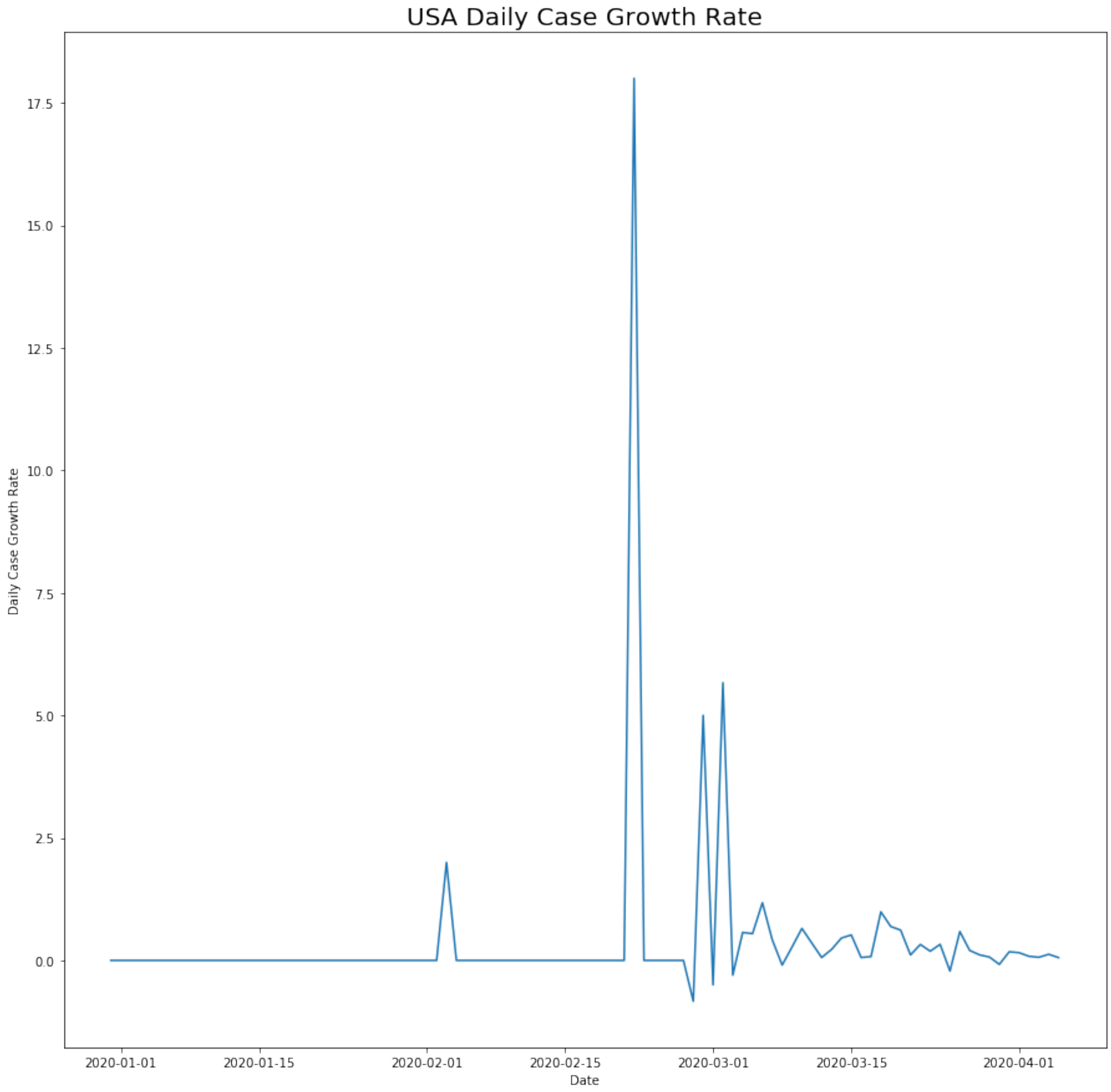
[249]:

```
# Graph USA deaths across time
plt.figure(figsize=(15,15))
plt.plot(usaData['date'], usaData['deaths'])
plt.ylabel('Deaths')
plt.xlabel('Date')
plt.title('USA Deaths Over Time', fontdict = {'fontsize' : 20})
plt.show()
```

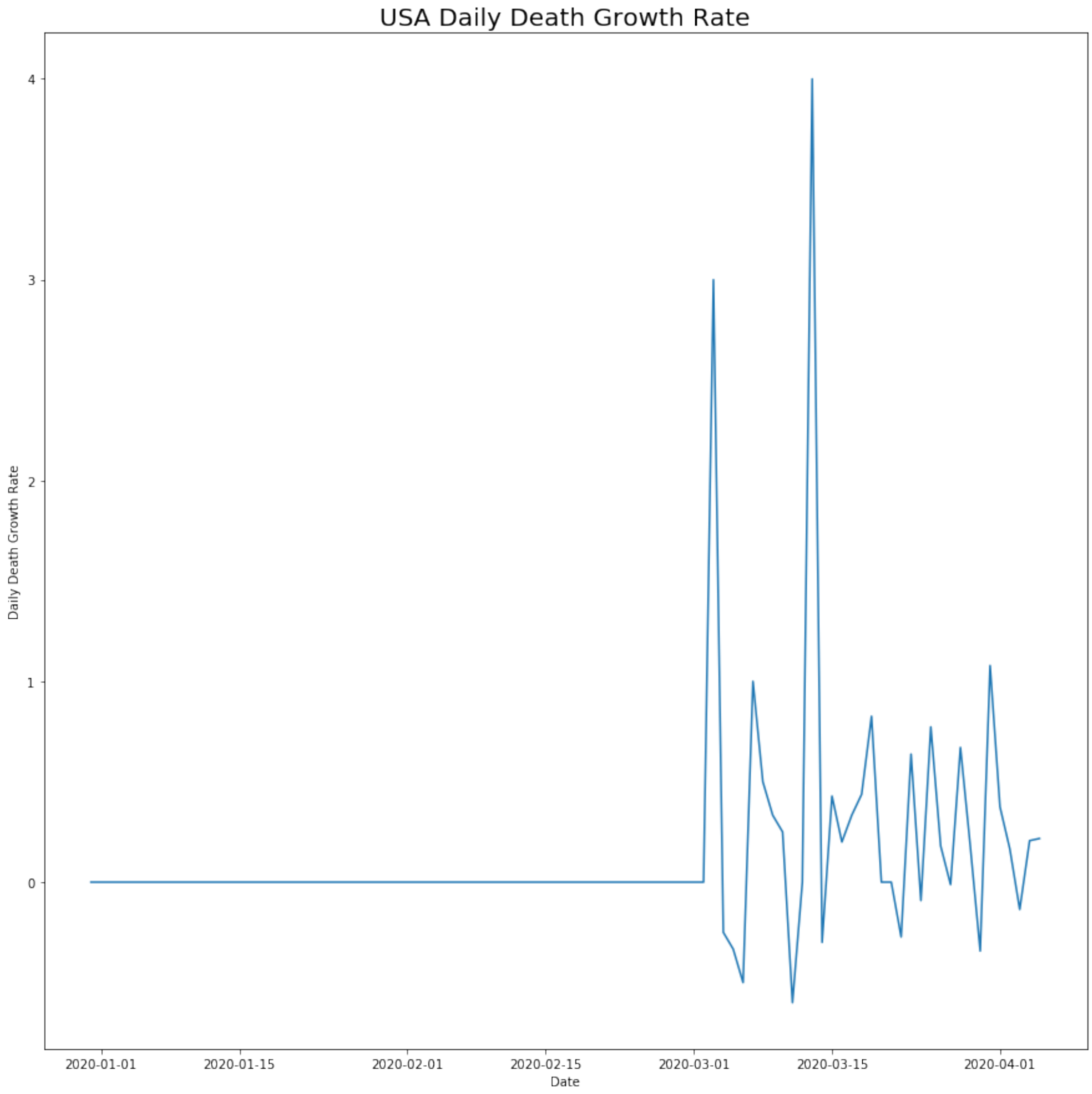


[251]:

```
# Graph USA Case Growth Rate Across Time
plt.figure(figsize=(15,15))
plt.plot(usaData['date'], usaData['caseGrowthRate'])
plt.ylabel('Daily Case Growth Rate')
plt.xlabel('Date')
plt.title('USA Daily Case Growth Rate', fontdict = {'fontsize' : 20})
plt.show()
```



[253]:
```
# Graph USA Case Growth Rate Across Time
plt.figure(figsize=(15,15))
plt.plot(usaData['date'], usaData['deathGrowthRate'])
plt.ylabel('Daily Death Growth Rate')
plt.xlabel('Date')
plt.title('USA Daily Death Growth Rate', fontdict = {'fontsize' : 20})
plt.show()
```



0.8 Univariate Distributions

```
[151]: # Only look at data for 2020-04-01
       filterCriteria = data['date'] == "2020-04-01"
       aprilFirstData = data[filterCriteria]
       aprilFirstData.head()
```

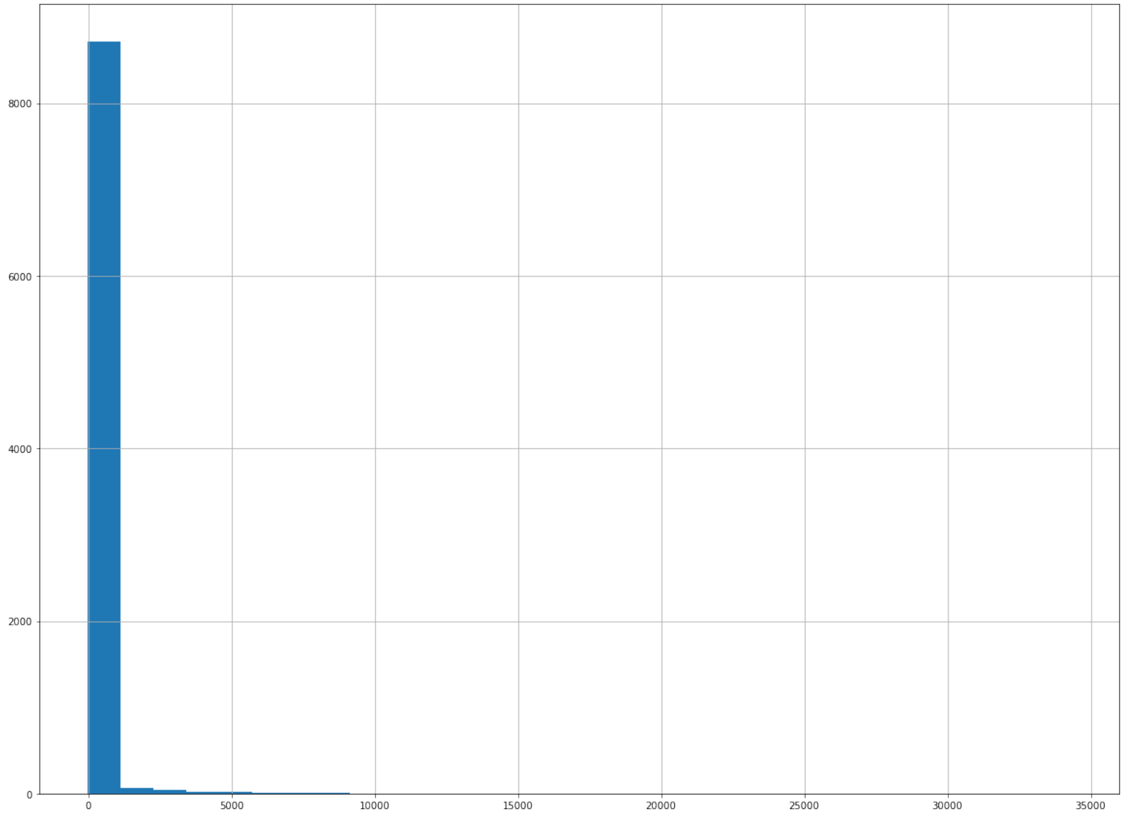
```
[151]:           date  cases  deaths countriesAndTerritories geoId  \
       4   2020-04-01     25       0             Afghanistan    AF
       91  2020-04-01     20       3                 Albania    AL
       119 2020-04-01      6       4                 Andorra    AD
       135 2020-04-01     73       4                 Algeria    DZ
       234 2020-04-01      0       0                  Angola    AO
```

```
    countryterritoryCode  popData2018  deathGrowthRate  caseGrowthRate  \
4                    AFG   37172386.0              0.0       -0.074074
91                   ALB    2866376.0              0.5        0.818182
119                  AND      77006.0              1.0       -0.833333
135                  DZA   42228429.0              1.0        0.280702
234                  AGO   30809762.0              0.0        0.000000

     deathsPerMillionPop  casesPerMillionPop
4           0.000000e+00        6.725422e-13
91          1.046618e-12        6.977452e-12
119         5.194400e-11        7.791601e-11
135         9.472292e-14        1.728693e-12
234         0.000000e+00        0.000000e+00
```

[152]:
```
# Graph distribution of cases across countries
data['cases'].hist(bins=30, figsize=(20,15))
```

[152]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1295f1fa0>
```



```
[153]: # Let's filter out countries with less than 100 cases
       over100Cases = data.loc[(data.cases > 100) & (data.date == "2020-04-01")]
       over100Cases = over100Cases.copy()
       over100Cases.sort_values(by=['cases'], inplace=True, ascending=False)
       over100Cases.head()
```

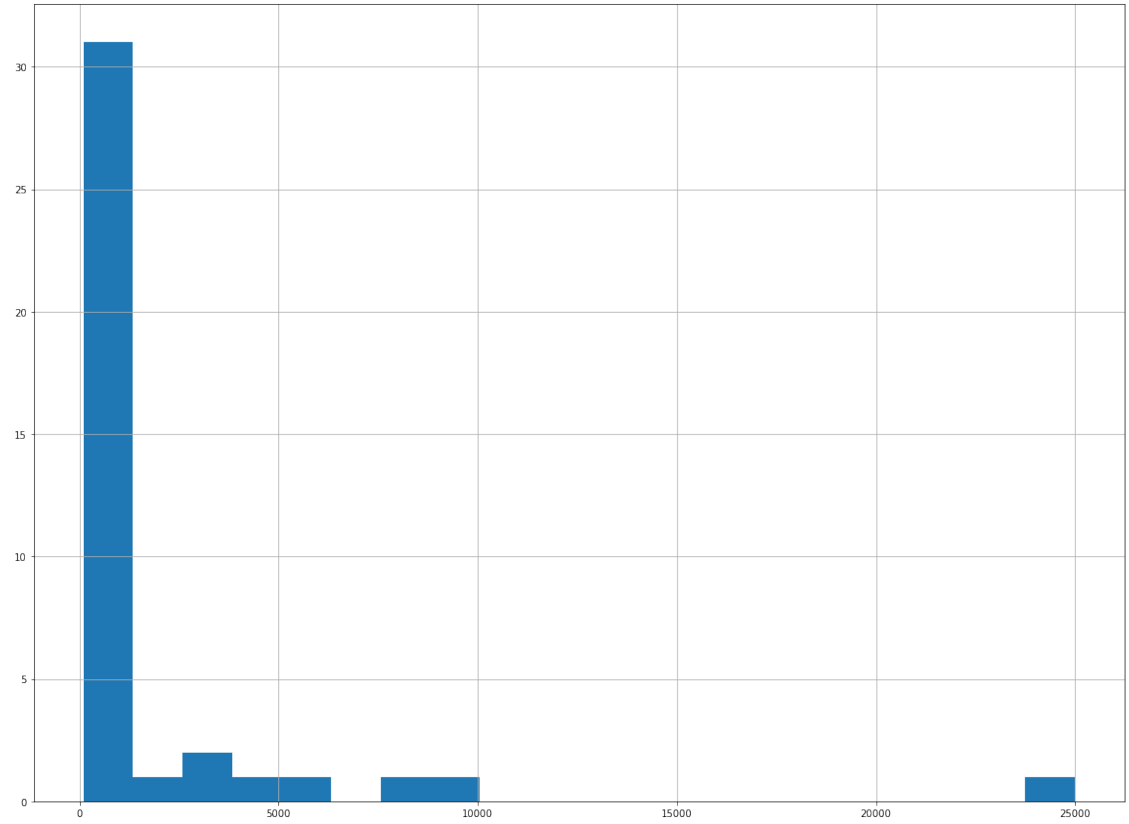
```
[153]:            date  cases  deaths   countriesAndTerritories geoId  \
       8608 2020-04-01  24998     909  United_States_of_America    US
       7619 2020-04-01   9222     849                     Spain    ES
       2919 2020-04-01   7578     499                    France    FR
       3170 2020-04-01   5453     149                   Germany    DE
       4317 2020-04-01   4053     839                     Italy    IT

            countryterritoryCode  popData2018  deathGrowthRate  caseGrowthRate  \
       8608                  USA  327167434.0         0.375189        0.157583
       7619                  ESP   46723749.0         0.045567        0.441388
       2919                  FRA   66987244.0         0.193780        0.731718
       3170                  DEU   82927922.0         0.164062        0.181582
       4317                  ITA   60431283.0         0.035802        0.000741

             deathsPerMillionPop  casesPerMillionPop
       8608         2.778394e-12        7.640736e-11
       7619         1.817063e-11        1.973729e-10
       2919         7.449179e-12        1.131260e-10
       3170         1.796741e-12        6.575590e-11
       4317         1.388354e-11        6.706791e-11
```

```
[210]: over100Cases['cases'].hist(bins = 20, figsize=(20,15))
```

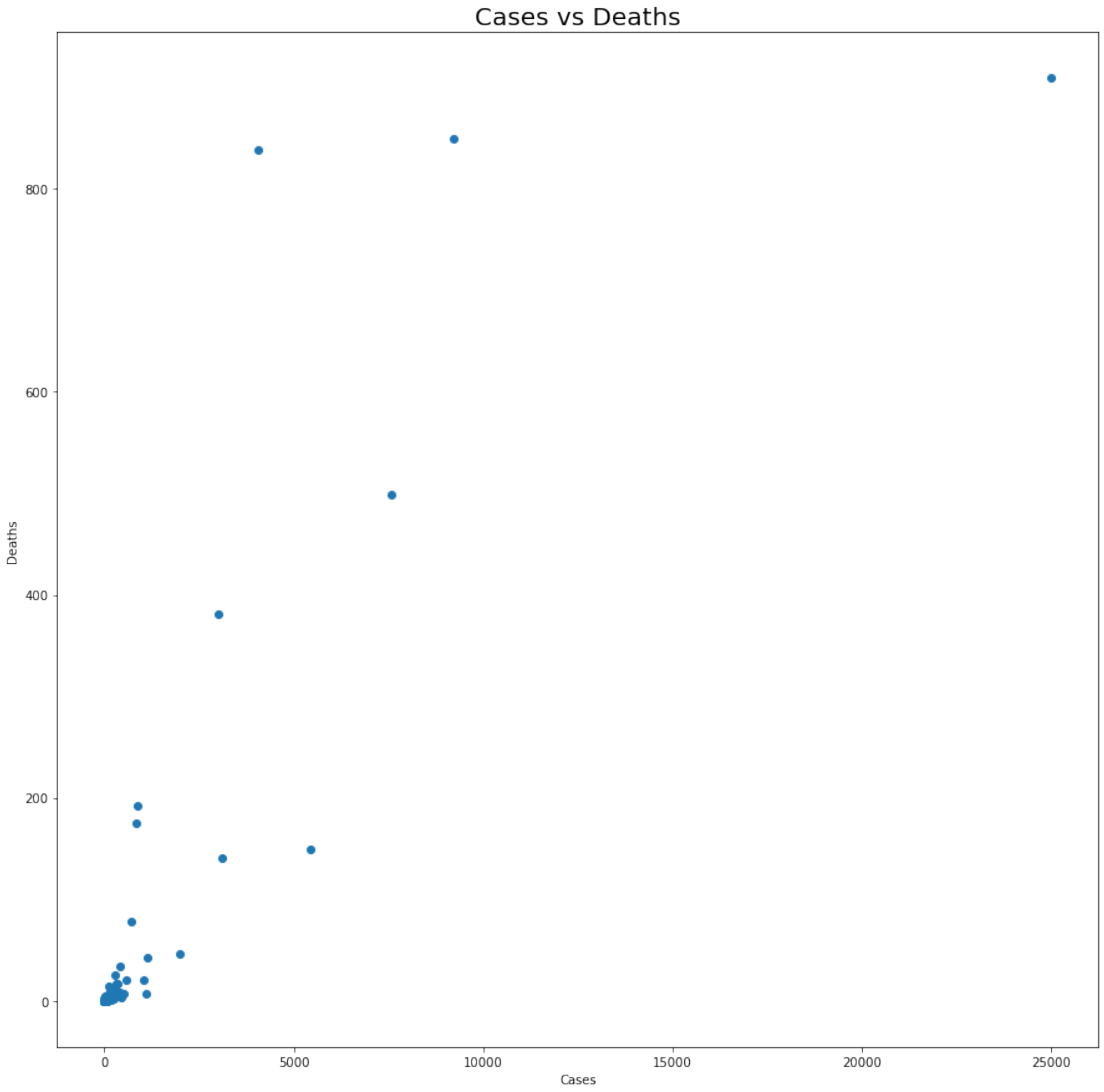
```
[210]: <matplotlib.axes._subplots.AxesSubplot at 0x12d9397c0>
```



0.9 Bivariate Distribution

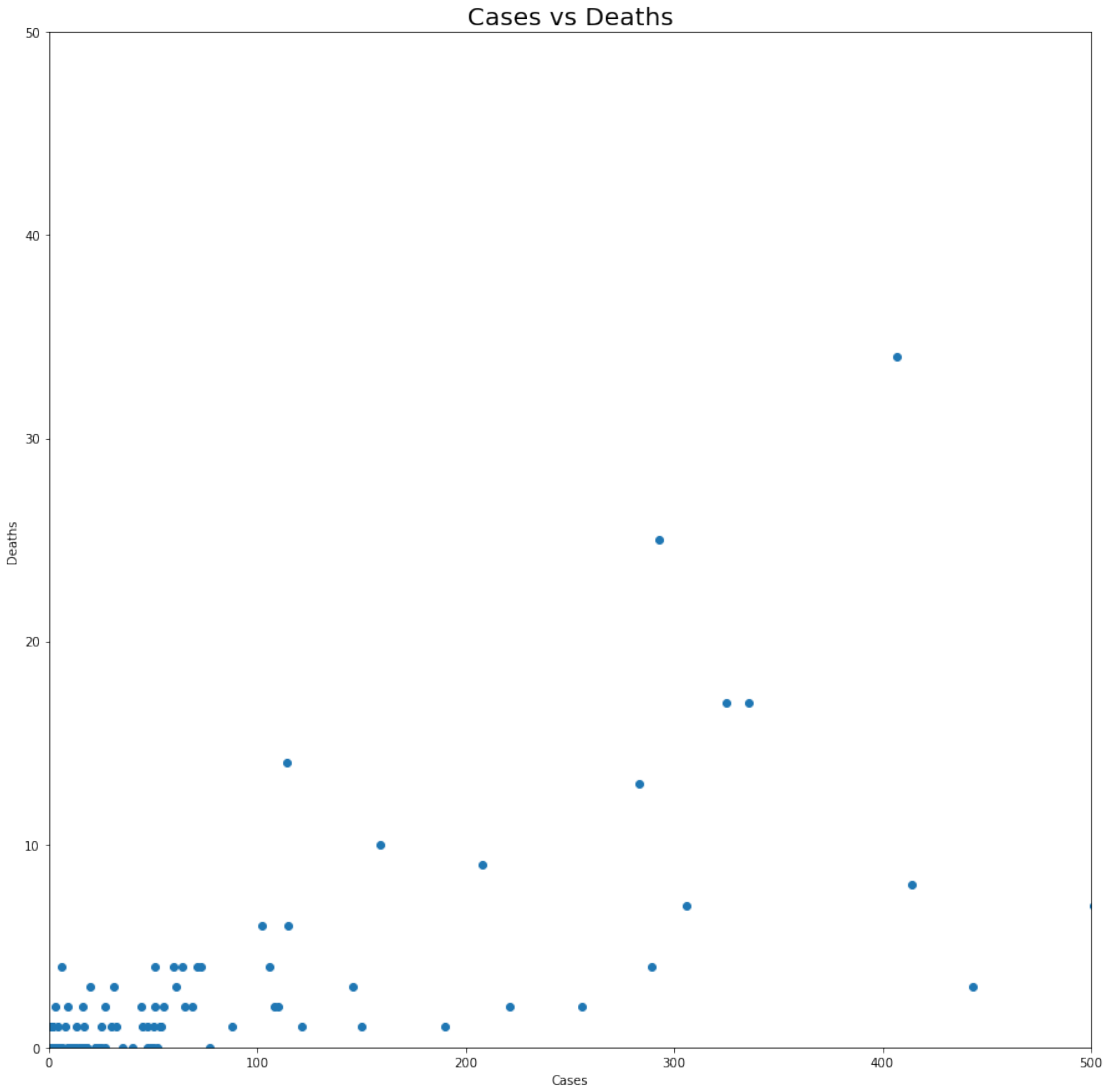
[242]:

```
plt.figure(figsize=(15,15))
plt.scatter(aprilFirstData['cases'], aprilFirstData['deaths'])
plt.ylabel('Deaths')
plt.xlabel('Cases')
plt.title('Cases vs Deaths', fontdict = {'fontsize' : 20})
plt.show()
```



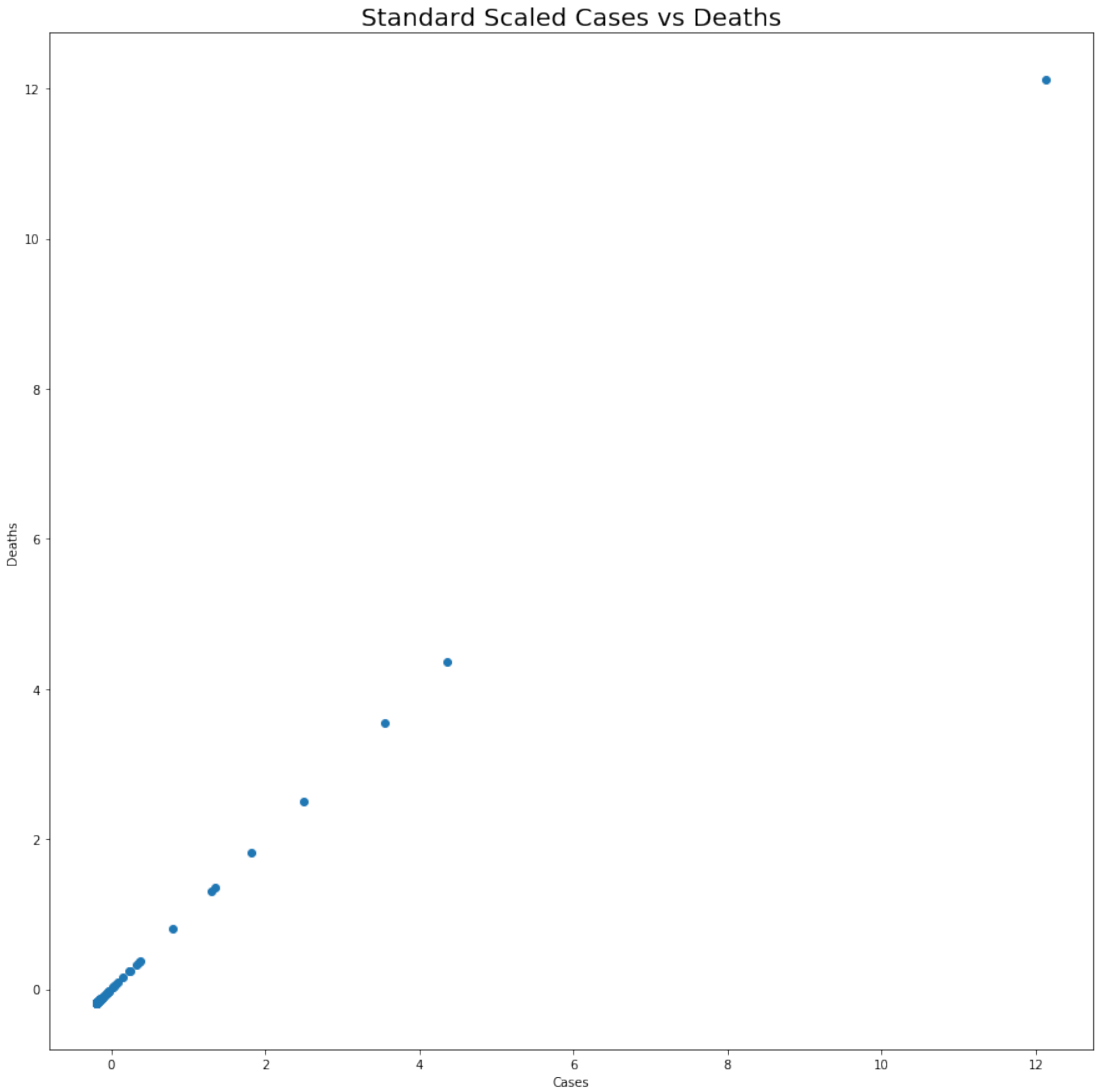
[240]:

```
# Let's zoom in
plt.figure(figsize=(15,15))
plt.scatter(aprilFirstData['cases'], aprilFirstData['deaths'])
plt.xlim(0, 500)
plt.ylim(0, 50)
plt.ylabel('Deaths')
plt.xlabel('Cases')
plt.title('Cases vs Deaths', fontdict = {'fontsize' : 20})
plt.show()
```



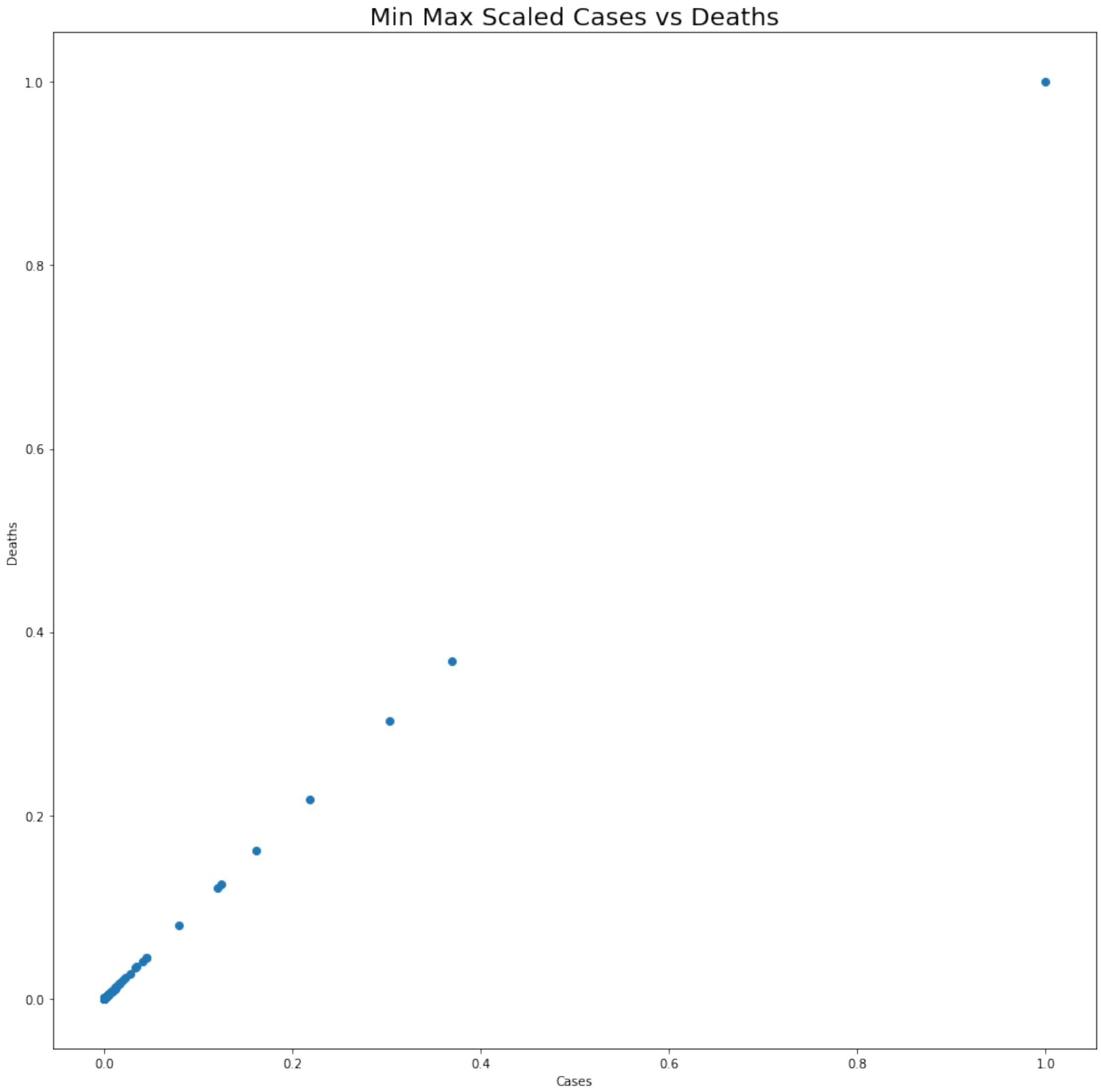
0.10 Scalers

[239]:
```
# Scale cases and deaths with standard scaler
standardScaler = StandardScaler()
standardScaler.fit(aprilFirstData[['cases', 'deaths']])
standardScaledData = standardScaler.transform(aprilFirstData[['cases',␣
 ↪'deaths']])
plt.figure(figsize=(15,15))
plt.scatter(standardScaledData[:,0], standardScaledData[:,0])
plt.ylabel('Deaths')
plt.xlabel('Cases')
plt.title('Standard Scaled Cases vs Deaths', fontdict = {'fontsize' : 20})
plt.show()
```



Standard Scaled Cases vs Deaths

[238]:
```python
# Scale cases and deaths with min max scaler
minMaxScaler = MinMaxScaler()
minMaxScaler.fit(aprilFirstData[['cases', 'deaths']])
minMaxScaledData = minMaxScaler.transform(aprilFirstData[['cases', 'deaths']])
plt.figure(figsize=(15,15))
plt.scatter(minMaxScaledData[:,0], minMaxScaledData[:,0])
plt.ylabel('Deaths')
plt.xlabel('Cases')
plt.title('Min Max Scaled Cases vs Deaths', fontdict = {'fontsize' : 20})
plt.show()
```



```
[265]: !jupyter nbconvert --to html "Exploratory Data Analysis.ipynb"
```

```
[NbConvertApp] Converting notebook Exploratory Data Analysis.ipynb to html
[NbConvertApp] Writing 636250 bytes to Exploratory Data Analysis.html
```