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2020SP_MSDS_422-DL_SEC55

10 April 2020

Assignment 1: Exploring and Visualizing Covid-19 Data

DATA PREPARATION

To prepare the data, I loaded it into a pandas dataframe. From there I dropped the 'day,' 'month,' and 'year' fields because I felt those were redundant. Next I formatted the 'dateRep' field as a Python datetime object. Lastly, I renamed 'dateRep' to 'date'.

DATA EXPLORATION

This dataset includes case, death, and population data for 204 countries. The data set starts on 12/31/2019. For many countries, data is not available for all of the days in the dataset. This indicates that some countries are doing better at collecting data than others. Additionally, it is a challenge to collect data from 200+ countries when there is no central international authority responsible for data collection.

As of April 1st, almost all countries have less than 10 deaths per day and 100 new cases per day. But among large countries like the United States, Spain, France, and Germany, the amounts are much higher. Graphing this data in bar chart format indicates that it the number of new cases and new deaths is likely exponentially distributed.

Graphing the daily case growth rate and daily death growth rate in the United States indicates that it is highly variable from day to day. Additional work could be done to smooth the growth rate and remove a few outliers.

When comparing new cases to new deaths in a scatterplot, there appears to be a weak positive relationship. The relationship appears heteroscedastic. As the number of cases increases, the numbers of deaths becomes more widely dispersed between countries. This could indicate that countries are in different parts of the growth curve. It could also indicate that some countries health care systems are being overrun, while others are able to handle the increased load.

When scaling cases and deaths using standard scaling and min max scaling, the relationship between cases and deaths becomes remarkably linear.

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()
```

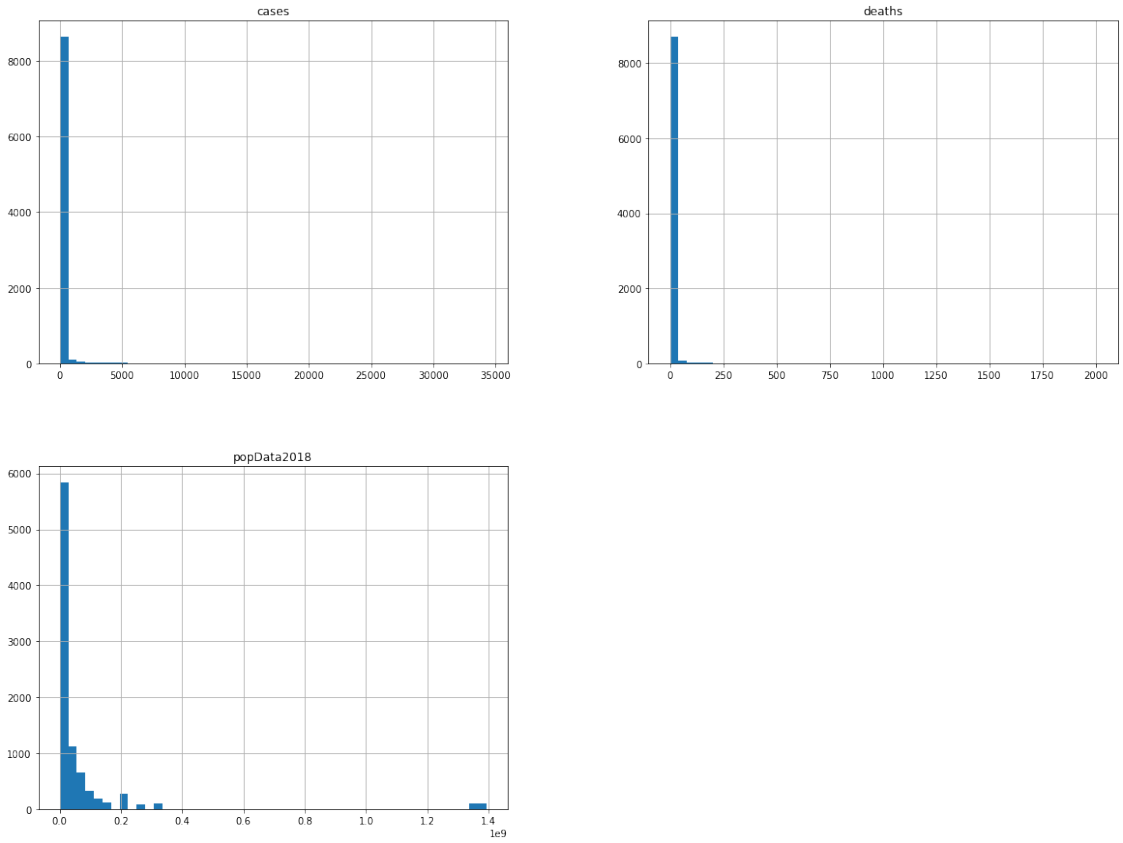
[205]:
```
AT     97
ES     97
CH     97
IT     97
US     97
       ..
BW      5
BQ      4
MW      3
FK      2
BLM     1
Name: geoId, Length: 203, dtype: int64
```

[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	countryterritoryCode	popData2018	deathGrowthRate	caseGrowthRate
0	2020-04-05	35	1	Afghanistan	AF	AFG	37172386.0	0.0	0.000000
1	2020-04-04	0	0	Afghanistan	AF	AFG	37172386.0	0.0	0.000000
2	2020-04-03	43	0	Afghanistan	AF	AFG	37172386.0	0.0	0.653846
3	2020-04-02	26	0	Afghanistan	AF	AFG	37172386.0	0.0	0.040000
4	2020-04-01	25	0	Afghanistan	AF	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
```

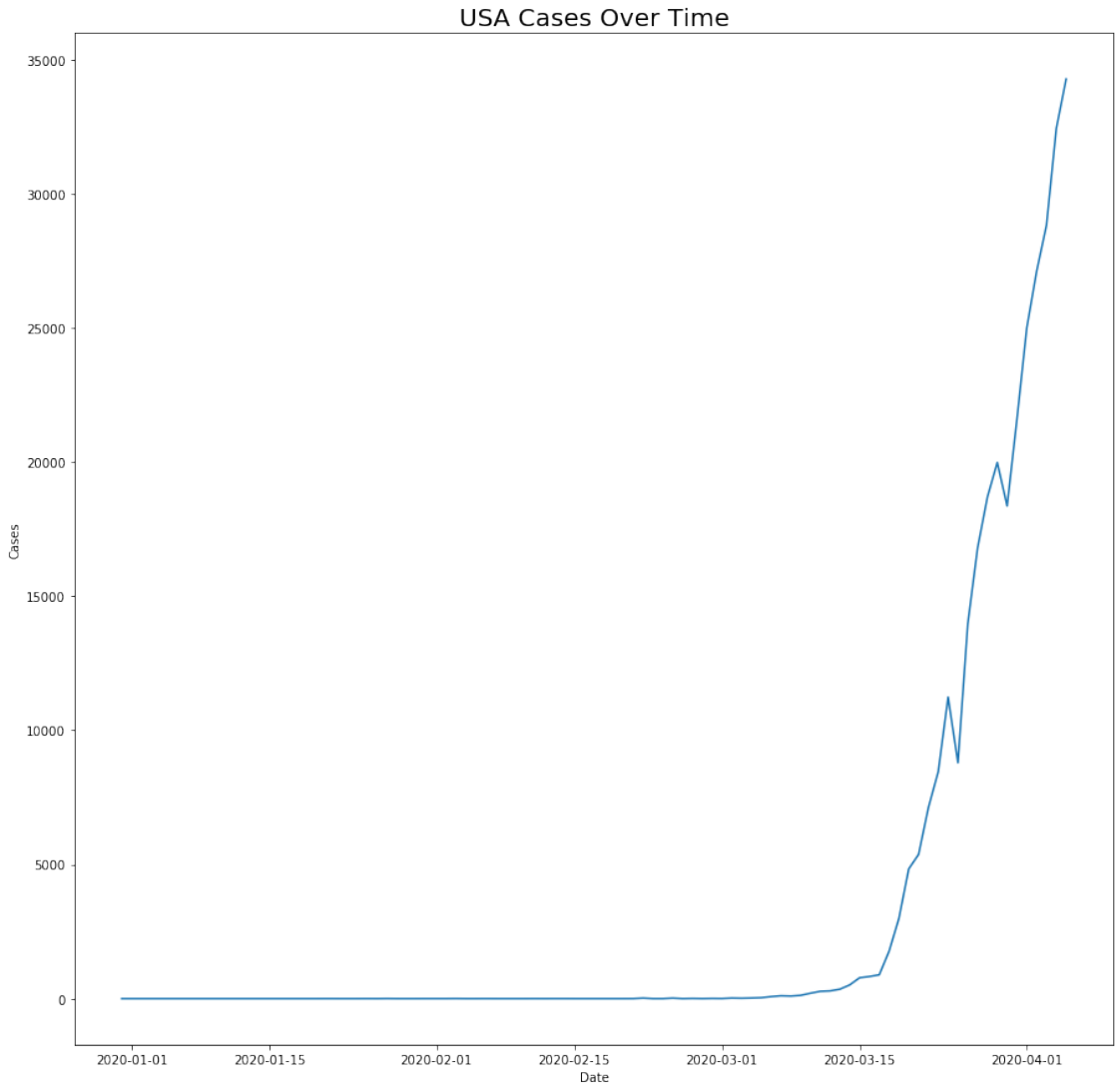
0.7 Time Series Analysis

[146]:
```
filterCriteria = data['countryterritoryCode'] == 'USA'
usaData = data[filterCriteria]
usaData.head()
```

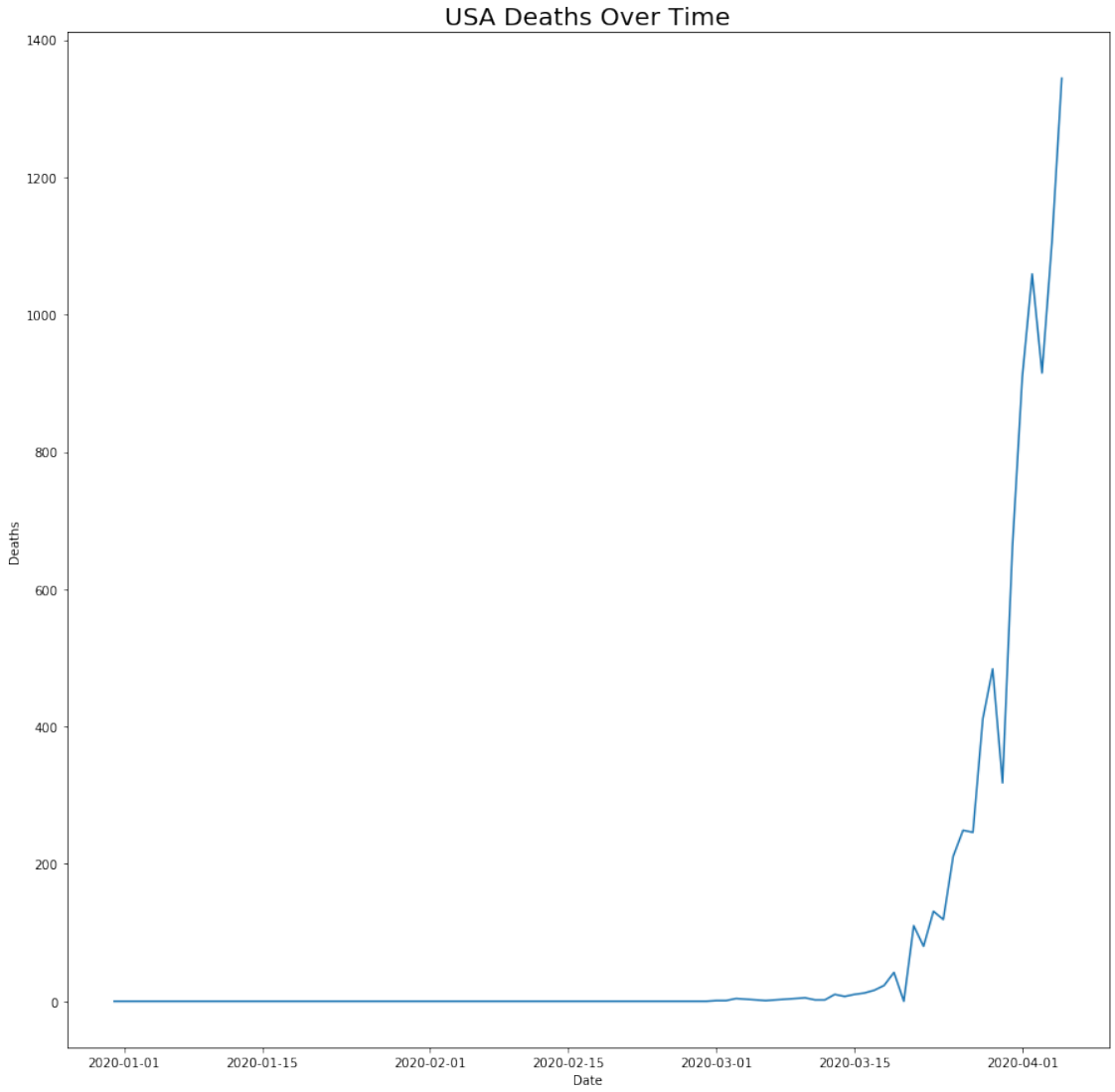
[146]:
```
           date  cases  deaths   countriesAndTerritories geoId  \
8604 2020-04-05  34272    1344  United_States_of_America    US
8605 2020-04-04  32425    1104  United_States_of_America    US
8606 2020-04-03  28819     915  United_States_of_America    US
8607 2020-04-02  27103    1059  United_States_of_America    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')
```

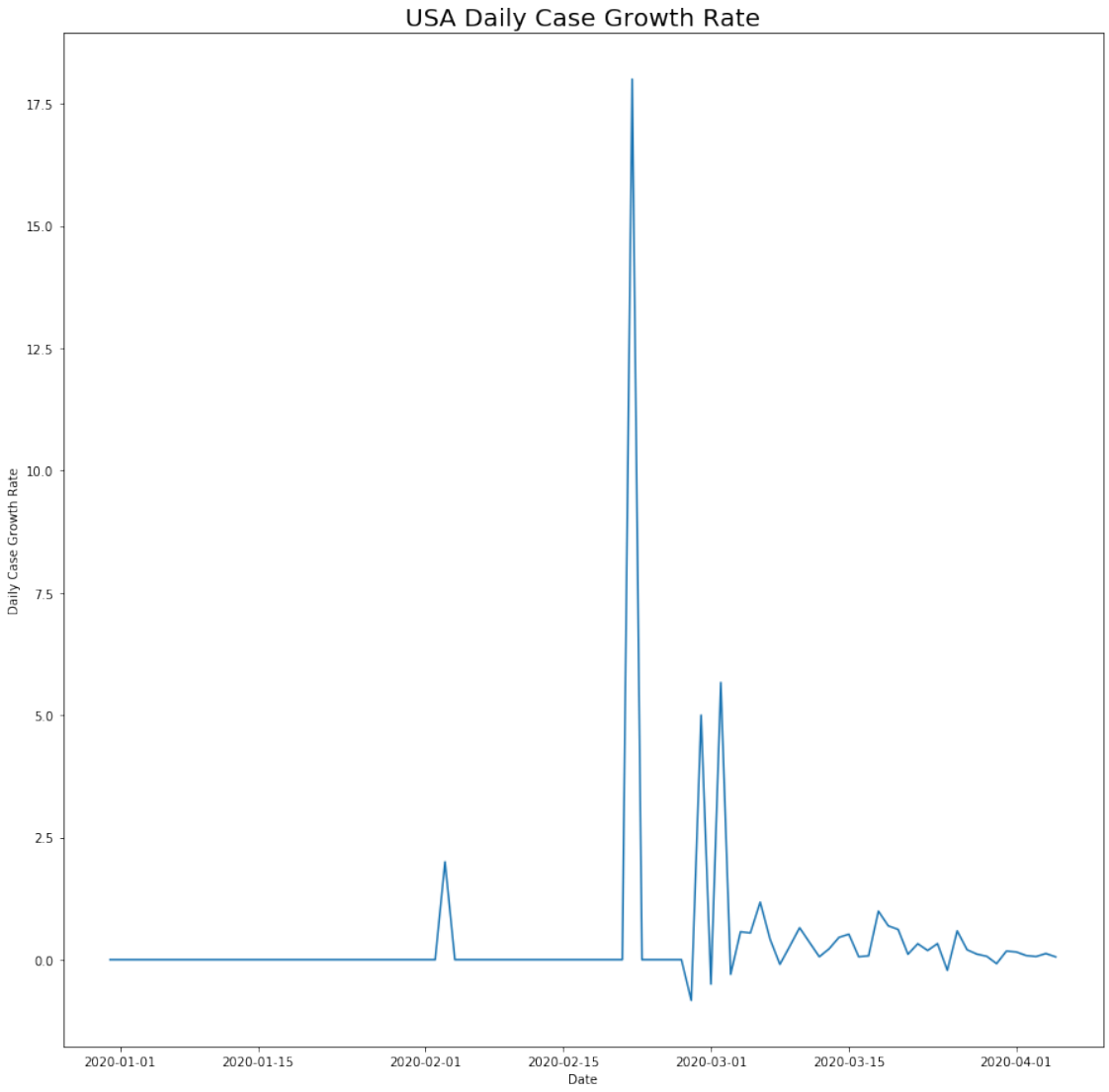
```
plt.xlabel('Date')
plt.title('USA Cases Over Time', fontdict = {'fontsize' : 20})
plt.show()
```



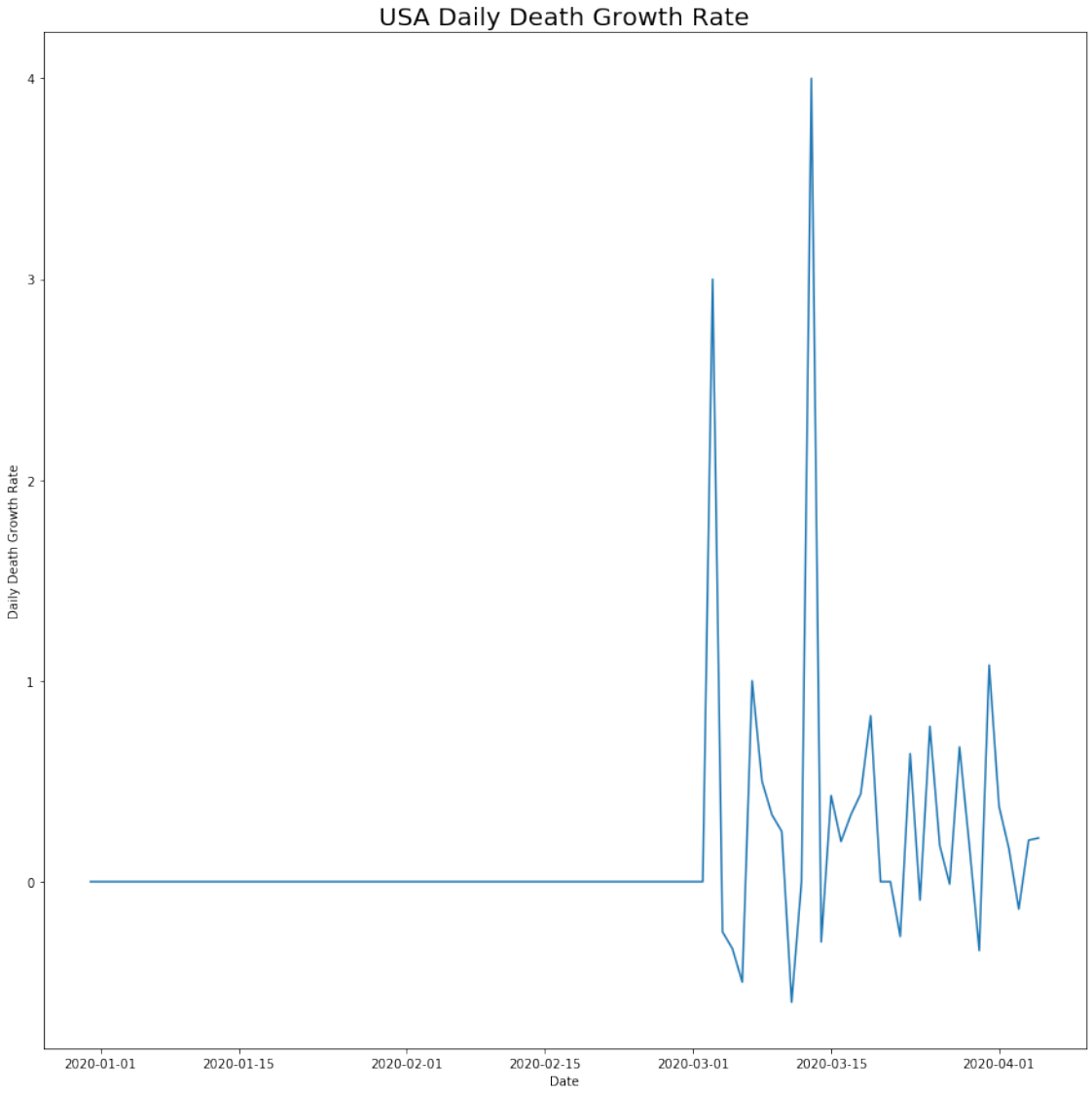
[249]:
```
# Graph USA deaths across time
plt.figure(figsize=(15,15))
plt.plot(usaData['date'], usaData['deaths'])
plt.ylabel('Deaths')
plt.xlabel('Date')
plt.title('USA Deaths Over Time', fontdict = {'fontsize' : 20})
plt.show()
```



[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()
```

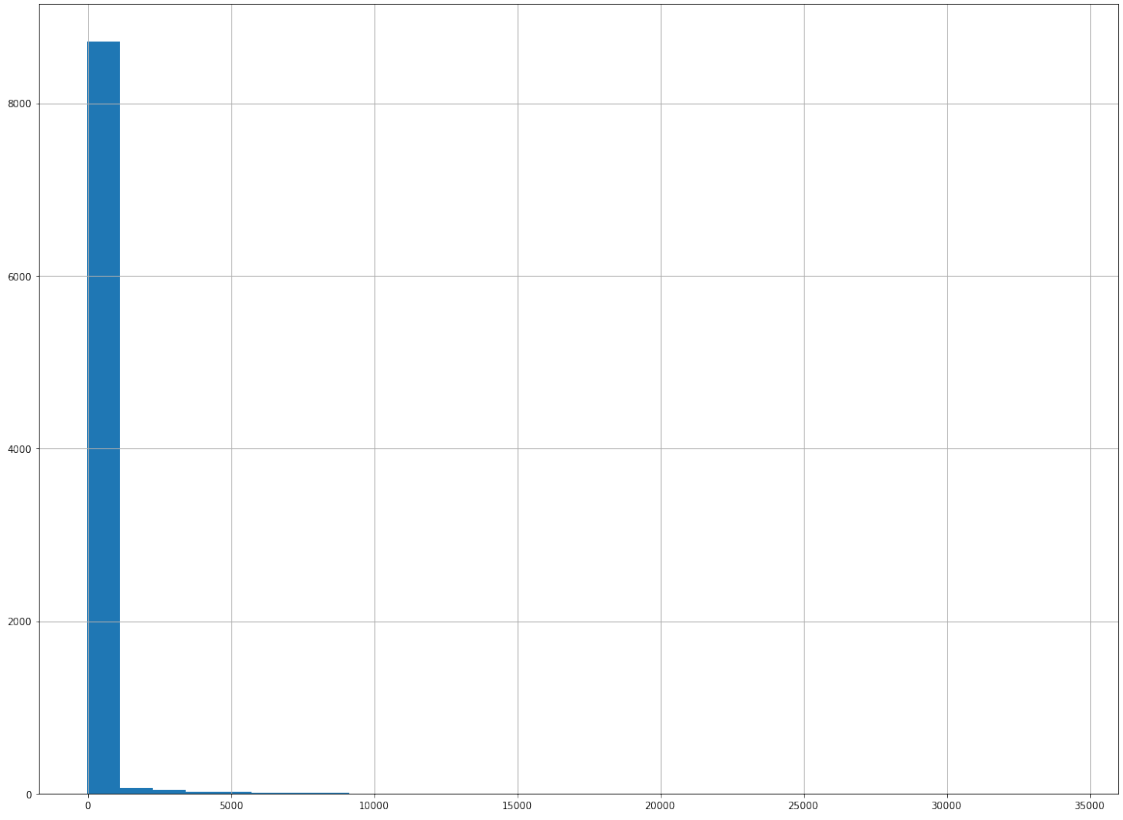
[151]:

	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>



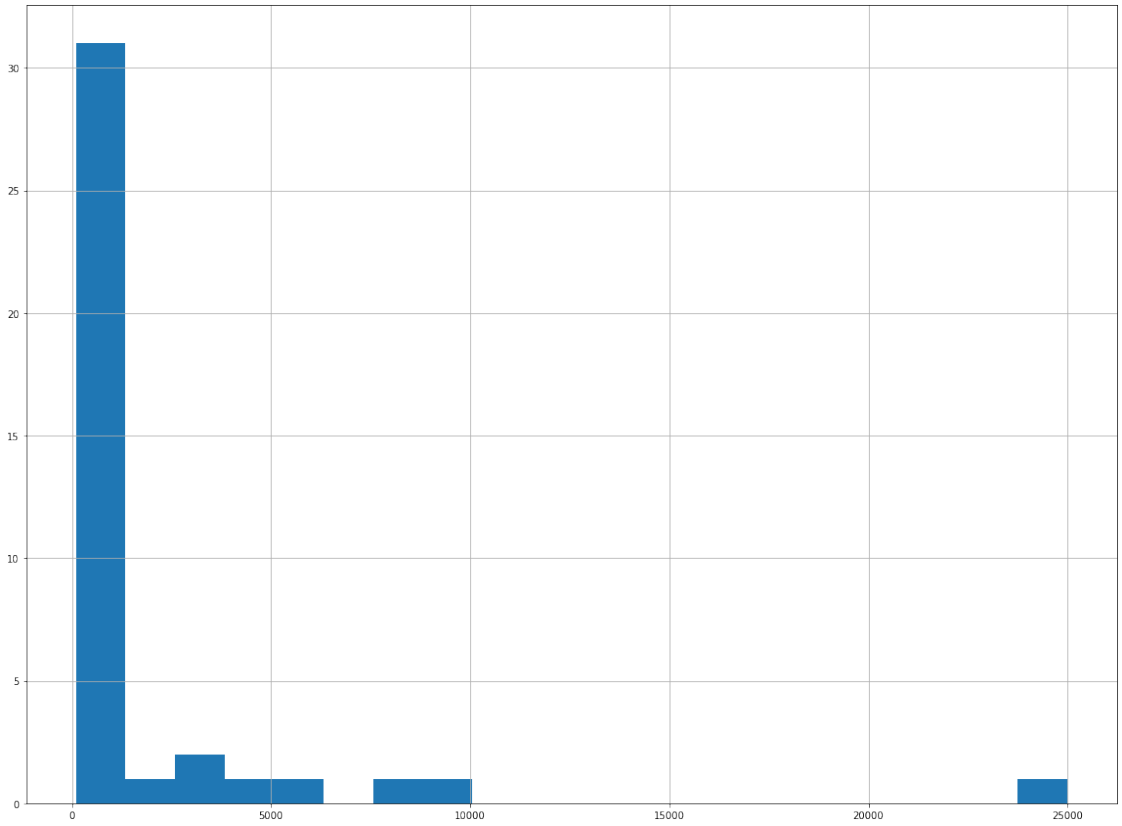
[153]:
```
# Let's filter out countries with less than 100 cases
over100Cases = data.loc[(data.cases > 100) & (data.date == "2020-04-01")]
over100Cases = over100Cases.copy()
over100Cases.sort_values(by=['cases'], inplace=True, ascending=False)
over100Cases.head()
```

[153]:

	date	cases	deaths	countriesAndTerritories	geoId	countryterritoryCode	popData2018	deathGrowthRate	caseGrowthRate	deathsPerMillionPop	casesPerMillionPop
8608	2020-04-01	24998	909	United_States_of_America	US	USA	327167434.0	0.375189	0.157583	2.778394e-12	7.640736e-11
7619	2020-04-01	9222	849	Spain	ES	ESP	46723749.0	0.045567	0.441388	1.817063e-11	1.973729e-10
2919	2020-04-01	7578	499	France	FR	FRA	66987244.0	0.193780	0.731718	7.449179e-12	1.131260e-10
3170	2020-04-01	5453	149	Germany	DE	DEU	82927922.0	0.164062	0.181582	1.796741e-12	6.575590e-11
4317	2020-04-01	4053	839	Italy	IT	ITA	60431283.0	0.035802	0.000741	1.388354e-11	6.706791e-11

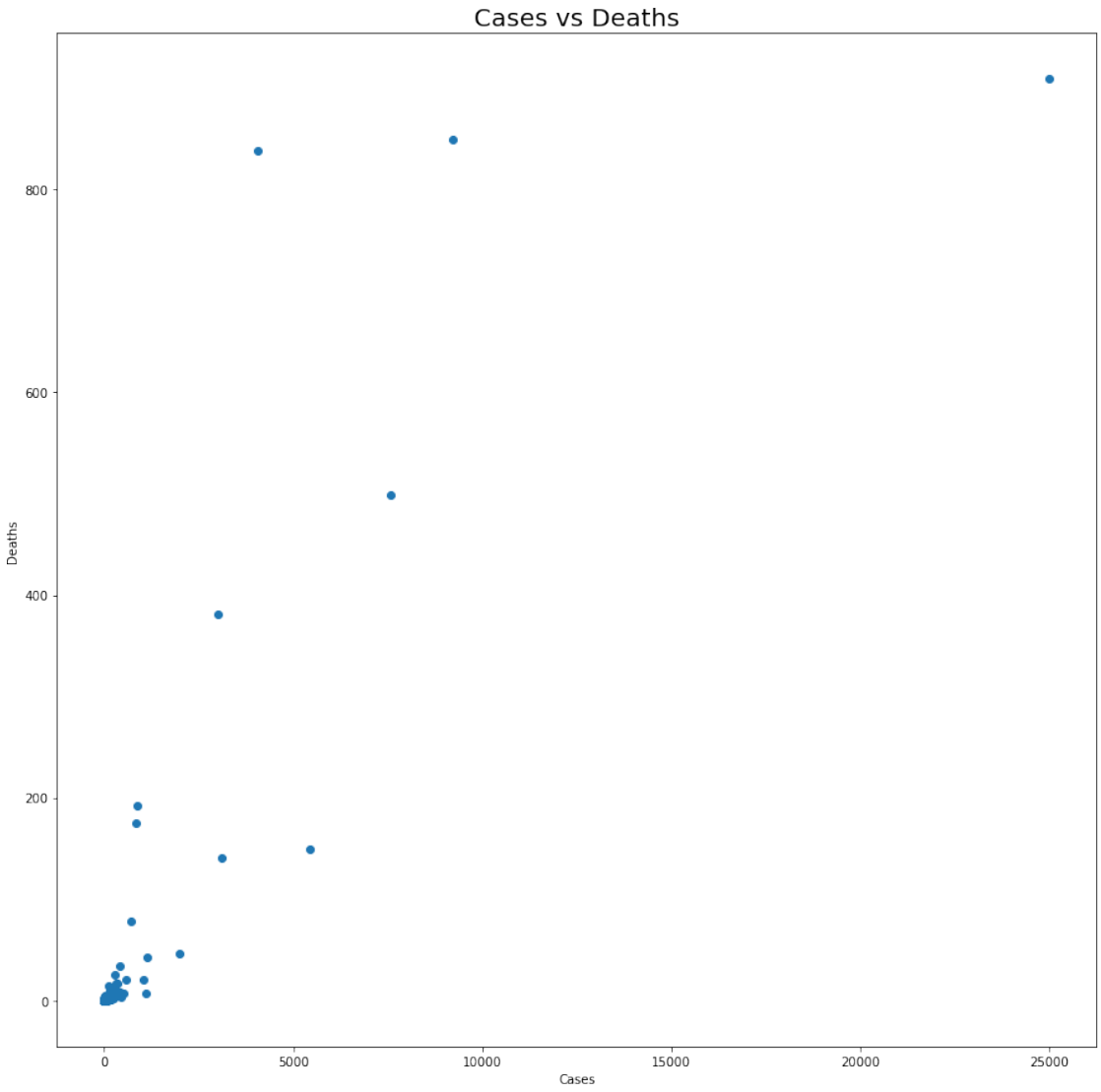
[210]:
```
over100Cases['cases'].hist(bins = 20, figsize=(20,15))
```

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

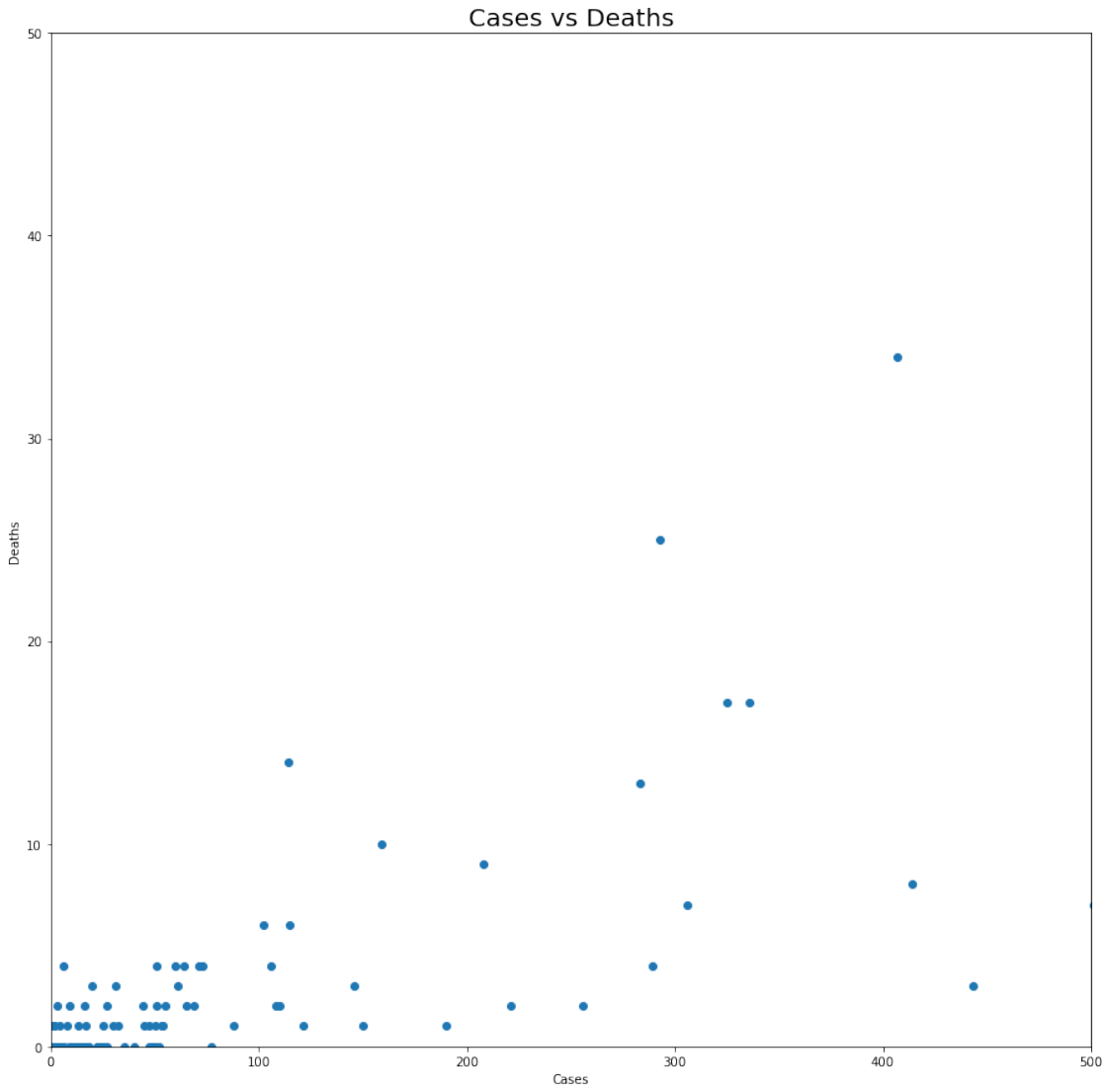


0.9 Bivariate Distribution

[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()
```

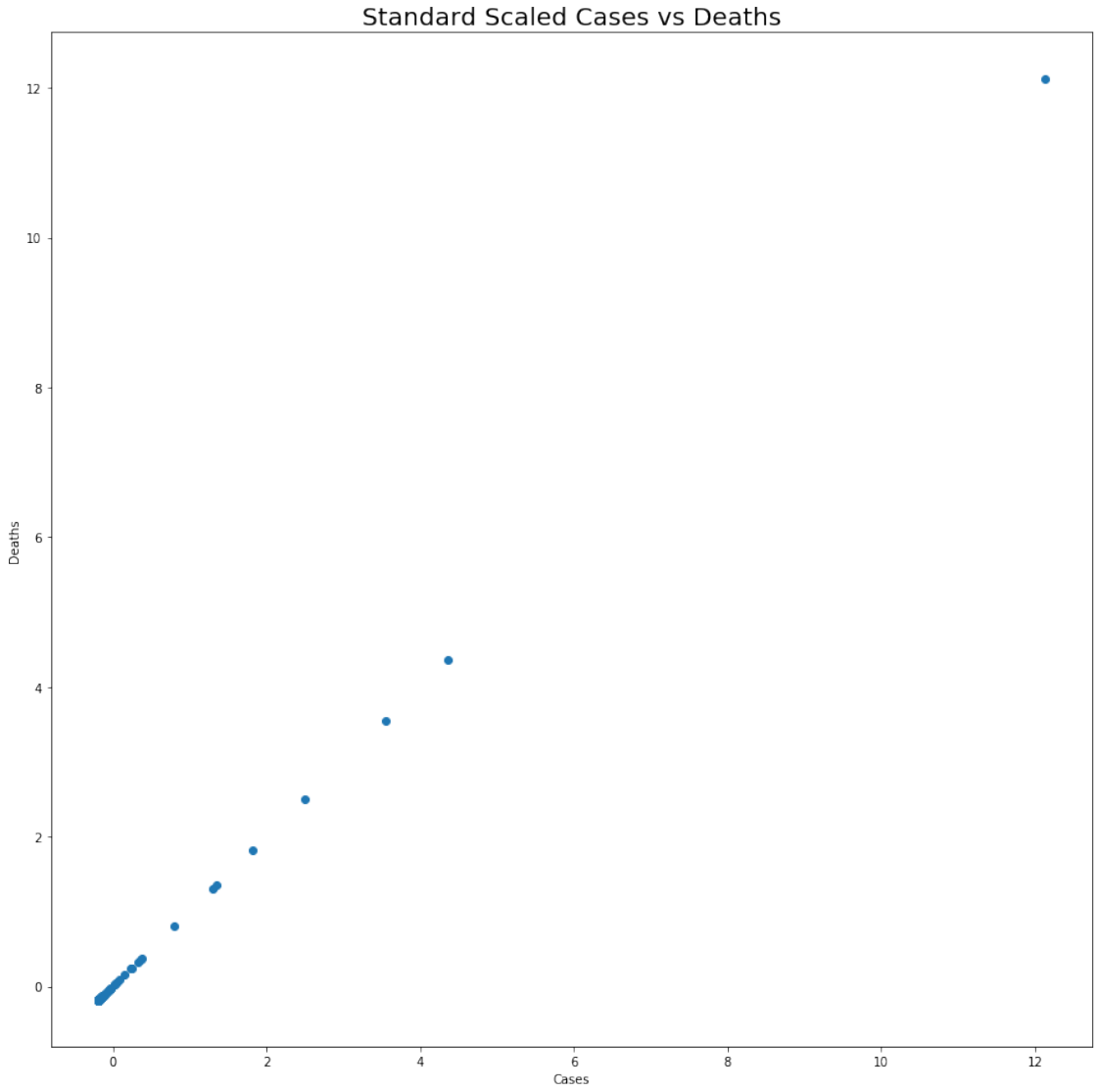


[240]:
```
# Let's zoom in
plt.figure(figsize=(15,15))
plt.scatter(aprilFirstData['cases'], aprilFirstData['deaths'])
plt.xlim(0, 500)
plt.ylim(0, 50)
plt.ylabel('Deaths')
plt.xlabel('Cases')
plt.title('Cases vs Deaths', fontdict = {'fontsize' : 20})
plt.show()
```

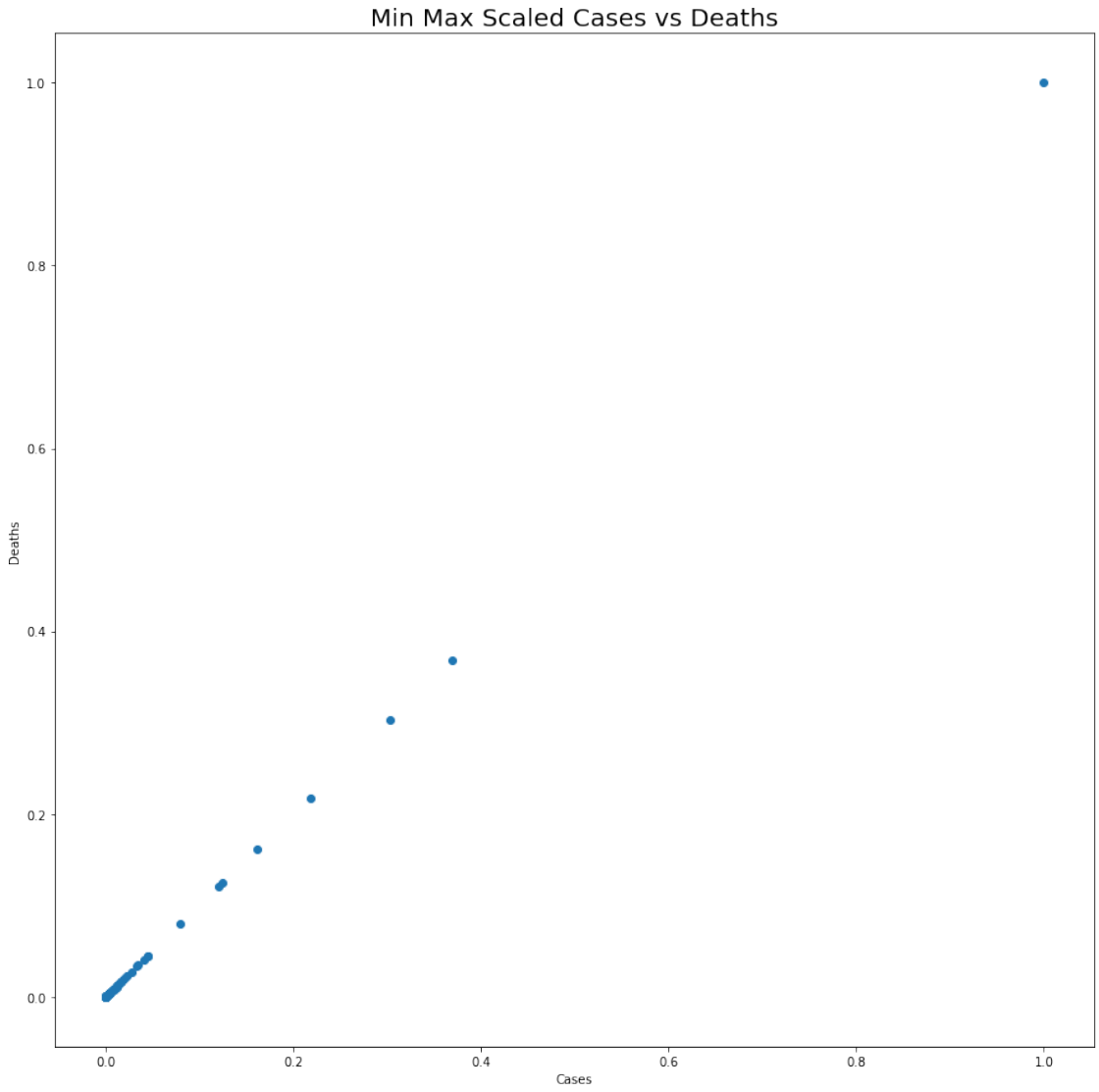


0.10 Scalers

[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()
```



[238]:
```
# 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
```