covidus

April 11, 2022

```
[ ]: import numpy as np
     import pandas as pd
     import seaborn as sb
     import matplotlib.pyplot as plt
     from matplotlib.ticker import FuncFormatter
```

```
[ ]: data = pd.read_csv('us_covid19_daily.csv')
     data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 320 entries, 0 to 319
Data columns (total 25 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   date                      320 non-null    int64
 1   states                    320 non-null    int64
 2   positive                  320 non-null    int64
 3   negative                  320 non-null    int64
 4   pending                   278 non-null    float64
 5   hospitalizedCurrently     265 non-null    float64
 6   hospitalizedCumulative    278 non-null    float64
 7   inIcuCurrently            256 non-null    float64
 8   inIcuCumulative           257 non-null    float64
 9   onVentilatorCurrently     257 non-null    float64
 10  onVentilatorCumulative    250 non-null    float64
 11  recovered                 257 non-null    float64
 12  dateChecked               320 non-null    object
 13  death                     301 non-null    float64
 14  hospitalized              278 non-null    float64
 15  totalTestResults          320 non-null    int64
 16  lastModified              320 non-null    object
 17  total                     320 non-null    int64
 18  posNeg                    320 non-null    int64
 19  deathIncrease             320 non-null    int64
 20  hospitalizedIncrease      320 non-null    int64
 21  negativeIncrease          320 non-null    int64
 22  positiveIncrease          320 non-null    int64
 23  totalTestResultsIncrease  320 non-null    int64
 24  hash                      320 non-null    object
dtypes: float64(10), int64(12), object(3)
memory usage: 62.6+ KB
```

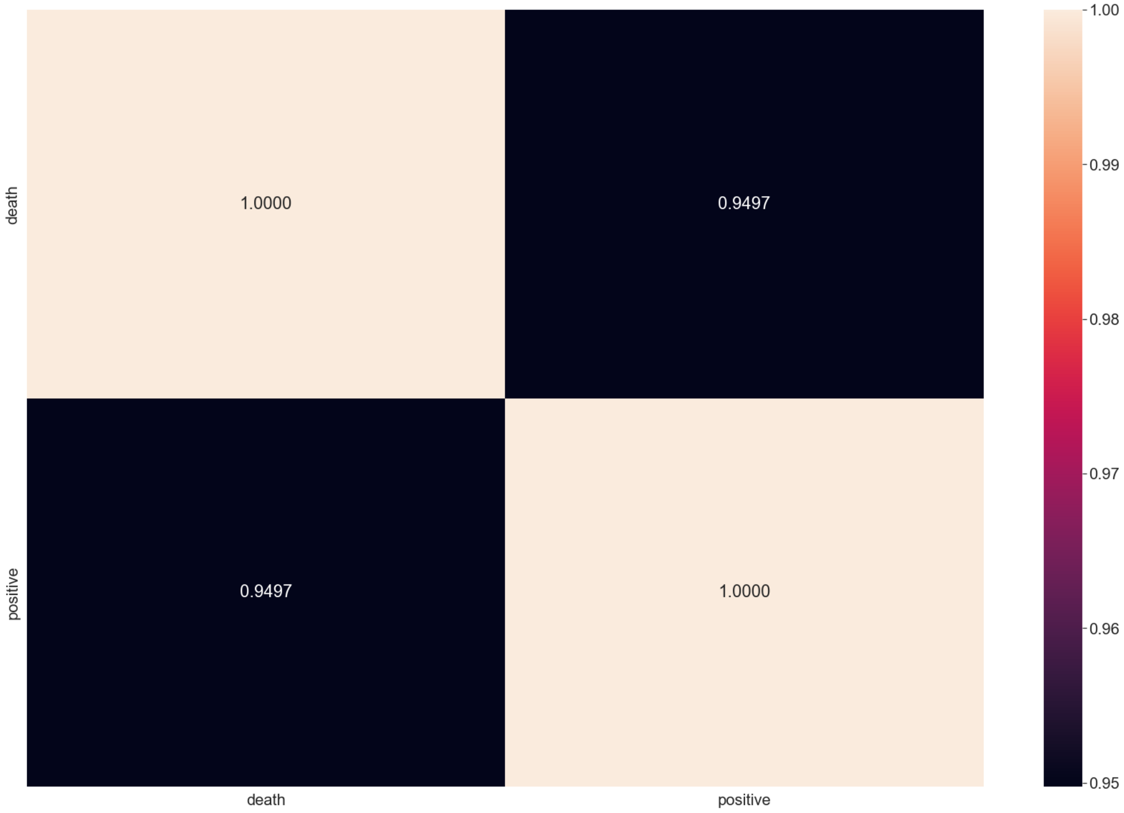
[ ]:
```
from sklearn.linear_model import LinearRegression
linreg = LinearRegression()
```

1 Whole US data

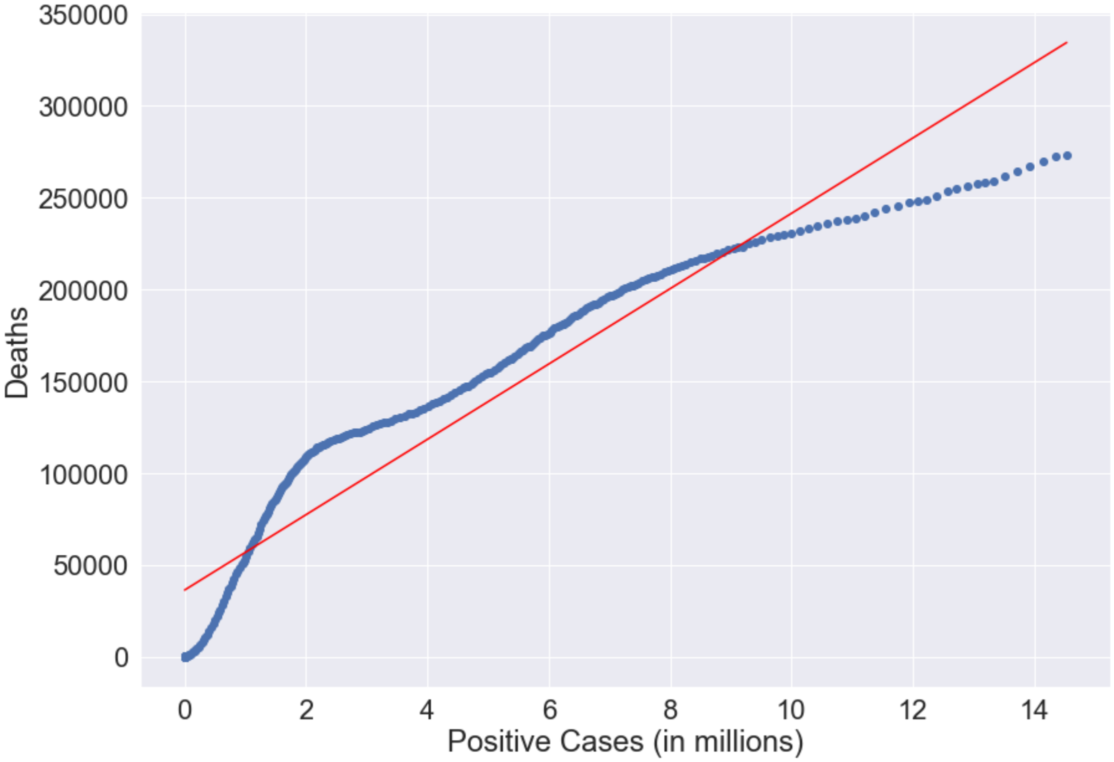
[ ]:
```
wholeposdeath=data[(data['death']>=0) & (data['positive']>=0)]
wholeposdeath=pd.DataFrame(data[['death','positive']])
print(wholeposdeath.head())
sb.heatmap(wholeposdeath.corr(),annot=True,fmt='0.4f')
wholeposdeath = wholeposdeath.dropna()
wholepos = wholeposdeath[['positive']]
wholedeath=wholeposdeath[['death']]
linreg.fit(wholepos,wholedeath)
regline_x = wholepos
regline_y = linreg.intercept_ + linreg.coef_ * wholepos
print(linreg.coef_)
print(linreg.intercept_)
f,ax=plt.subplots()
ax.scatter(wholepos,wholedeath)
ax.xaxis.set_major_formatter(FuncFormatter(lambda x, pos: '{0:g}'.format(x/
 ↪1e6)))
f.set_size_inches(14,10)
ax.plot(regline_x,regline_y,color='red')
plt.ylabel('Deaths')
plt.xlabel('Positive Cases (in millions)')
```

```
      death  positive
0  273374.0  14534035
1  272236.0  14357264
2  269791.0  14146191
3  267228.0  13921360
4  264522.0  13711156
[[0.02052035]]
[36282.71647573]
```

[ ]:
```
Text(0.5, 0, 'Positive Cases (in millions)')
```



death
positive
1.0000
0.9497
0.9497
1.0000
death
positive
1.00
0.99
0.98
0.97
0.96
0.95

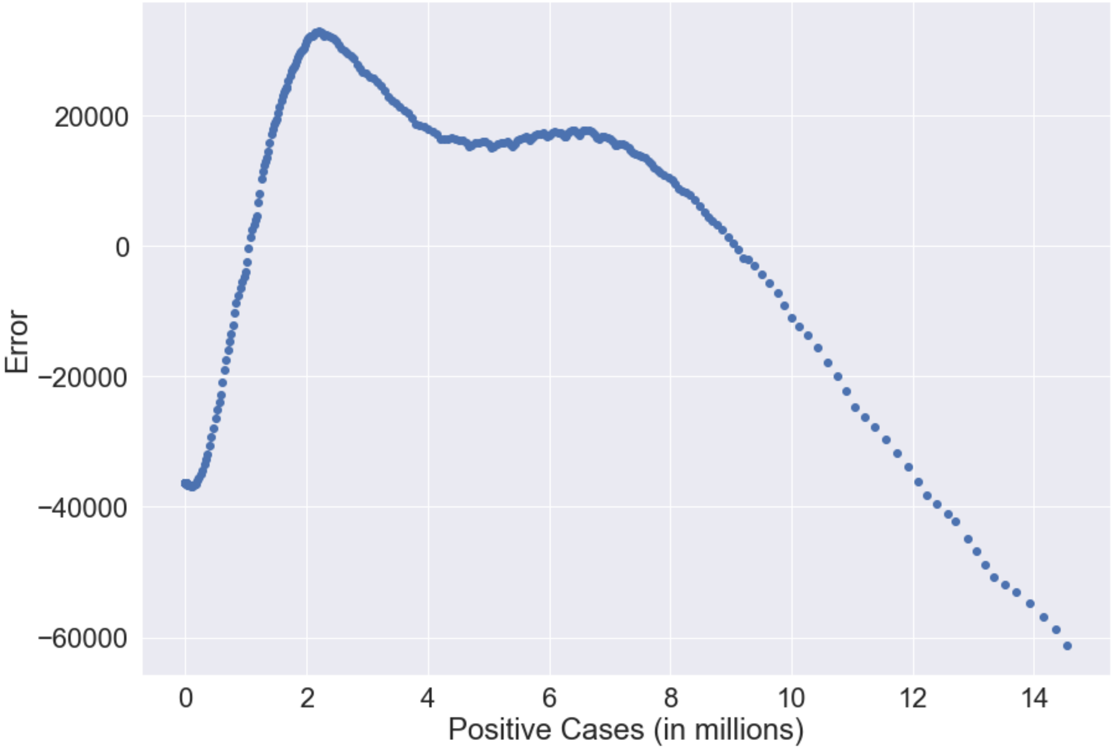


350000
300000
250000
200000
150000
100000
50000
0
Deaths
0
2
4
6
8
10
12
14
Positive Cases (in millions)

[ ]:

```
error=wholedeath-linreg.predict(wholepos)
f,ax=plt.subplots()
ax.scatter(wholepos,error)
ax.xaxis.set_major_formatter(FuncFormatter(lambda x, pos: '{0:g}'.format(x/
 ↪1e6)))
f.set_size_inches(14,10)
plt.ylabel('Error')
plt.xlabel('Positive Cases (in millions)')
erroradj=error.abs()
print(erroradj.describe())
```

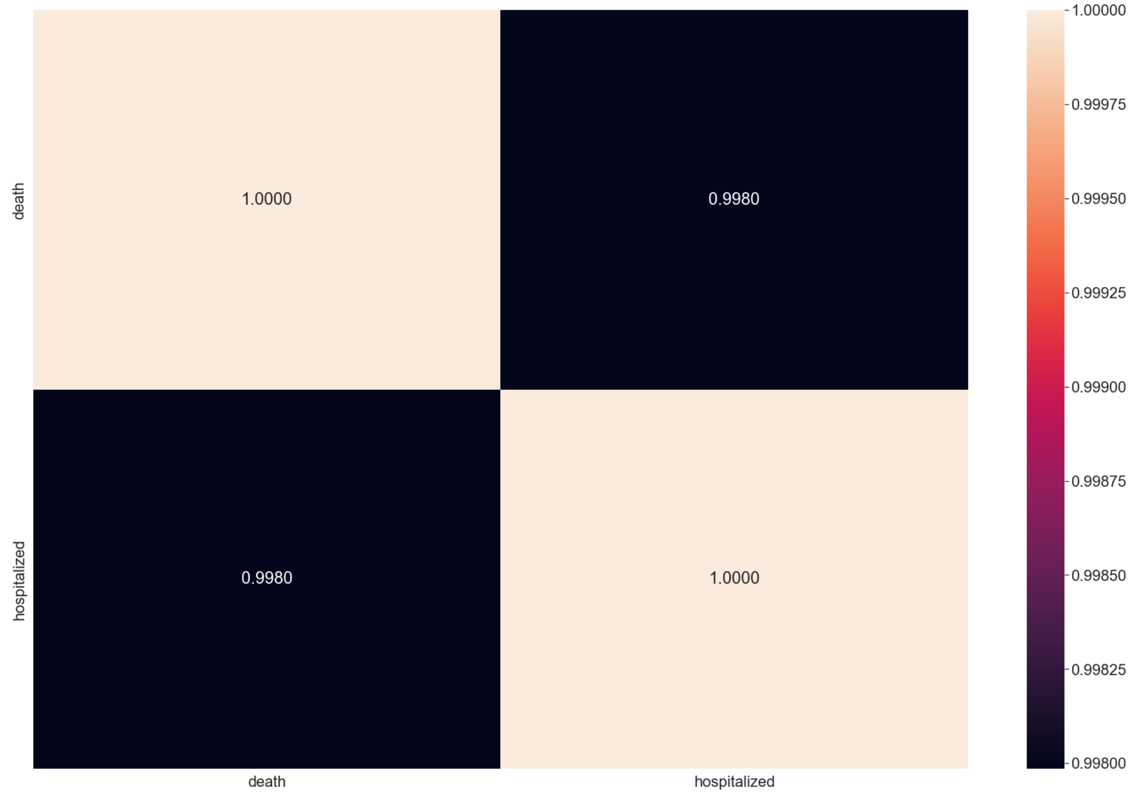
```
              death
count    301.000000
mean   22936.168152
std    11832.466148
min      255.323857
25%    15652.525913
50%    19535.389625
75%    32691.176960
max    61152.195743
```

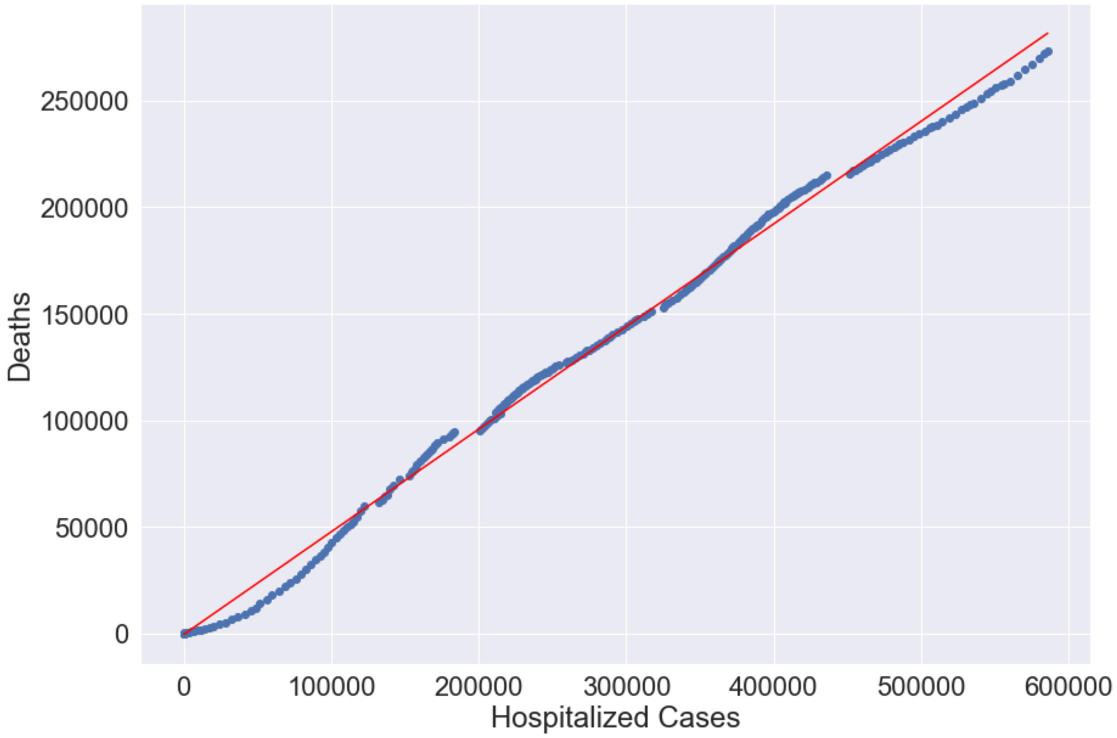


[ ]:

```
wholedeathhospitalized=data[(data['death']>=0) & (data['hospitalized']>=0)]
wholedeathhospitalized=pd.DataFrame(data[['death','hospitalized']])
wholedeathhospitalized = wholedeathhospitalized.dropna()
sb.heatmap(wholedeathhospitalized.corr(),annot=True,fmt='0.4f')
wholedeath = wholedeathhospitalized[['death']]
wholehospitalized=wholedeathhospitalized[['hospitalized']]
linreg.fit(wholehospitalized,wholedeath)
regline_x = wholehospitalized
regline_y = linreg.intercept_ + linreg.coef_ * wholehospitalized
print(linreg.coef_)
print(linreg.intercept_)
f,ax=plt.subplots()
ax.scatter(wholehospitalized,wholedeath)
f.set_size_inches(14,10)
ax.plot(regline_x,regline_y,color='red')
plt.ylabel('Deaths')
plt.xlabel('Hospitalized Cases')
print(wholedeathhospitalized.head())
```

```
[[0.4816166]]
[-414.14772099]
      death  hospitalized
0  273374.0      585676.0
1  272236.0      583420.0
2  269791.0      580104.0
3  267228.0      575452.0
4  264522.0      570121.0
```

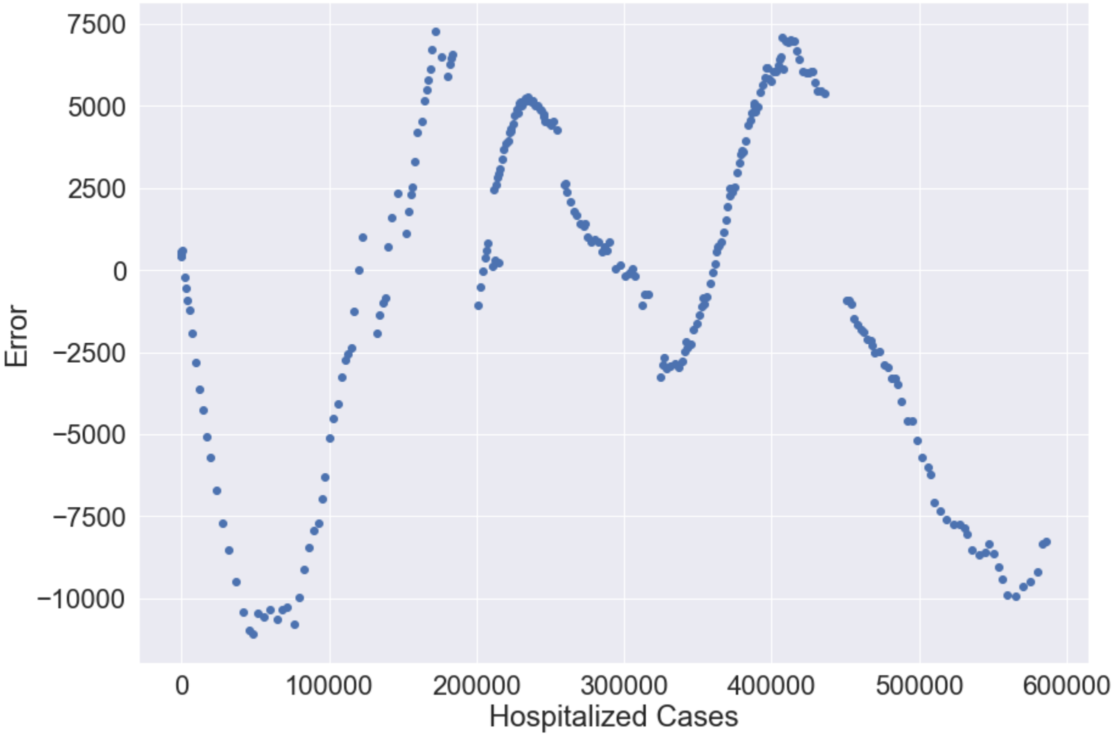

death
hospitalized
1.0000
0.9980
0.9980
1.0000
death
hospitalized
1.00000
0.99975
0.99950
0.99925
0.99900
0.99875
0.99850
0.99825
0.99800


Deaths
250000
200000
150000
100000
50000
0
0
100000
200000
300000
400000
500000
600000
Hospitalized Cases

[ ]:

```
error=wholedeath-linreg.predict(wholehospitalized)
f,ax=plt.subplots()
ax.scatter(wholehospitalized,error)
f.set_size_inches(14,10)
plt.ylabel('Error')
plt.xlabel('Hospitalized Cases')
erroradj=error.abs()
print(erroradj.describe())
```

```
                death
count    278.000000
mean    3967.585926
std     2909.289552
min        4.027230
25%     1273.183970
50%     3624.108551
75%     6022.411361
max    11071.496200
```

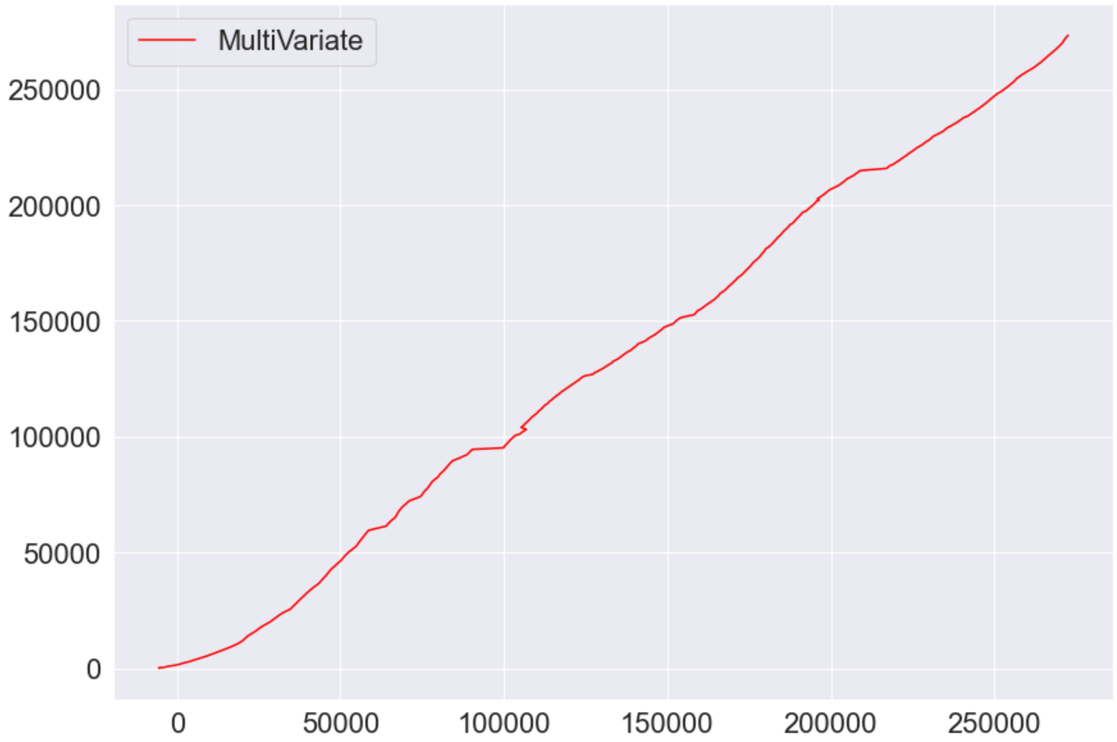


[ ]:

```
f,ax=plt.subplots()
f.set_size_inches(14,10)
```

```
multi=data[(data['death']>=0) & (data['positive']>=0) &␣
 ↪(data['hospitalized']>=0)]
multi=pd.DataFrame(data[['death','positive','hospitalized']])
multi = multi.dropna()
#sb.heatmap(multi.corr(),annot=True,fmt='0.4f')
predictors=multi[['positive','hospitalized']]
target=multi[['death']]
linreg.fit(predictors,target)
regline_x = linreg.intercept_ + (linreg.coef_[0][0]* predictors['positive']) +␣
 ↪(linreg.coef_[0][1]* predictors['hospitalized'])
regline_y = target
ax.plot(regline_x,regline_y,color='red')
ax.legend(['MultiVariate'])
```

```
[ ]: <matplotlib.legend.Legend at 0x16f03222100>
```

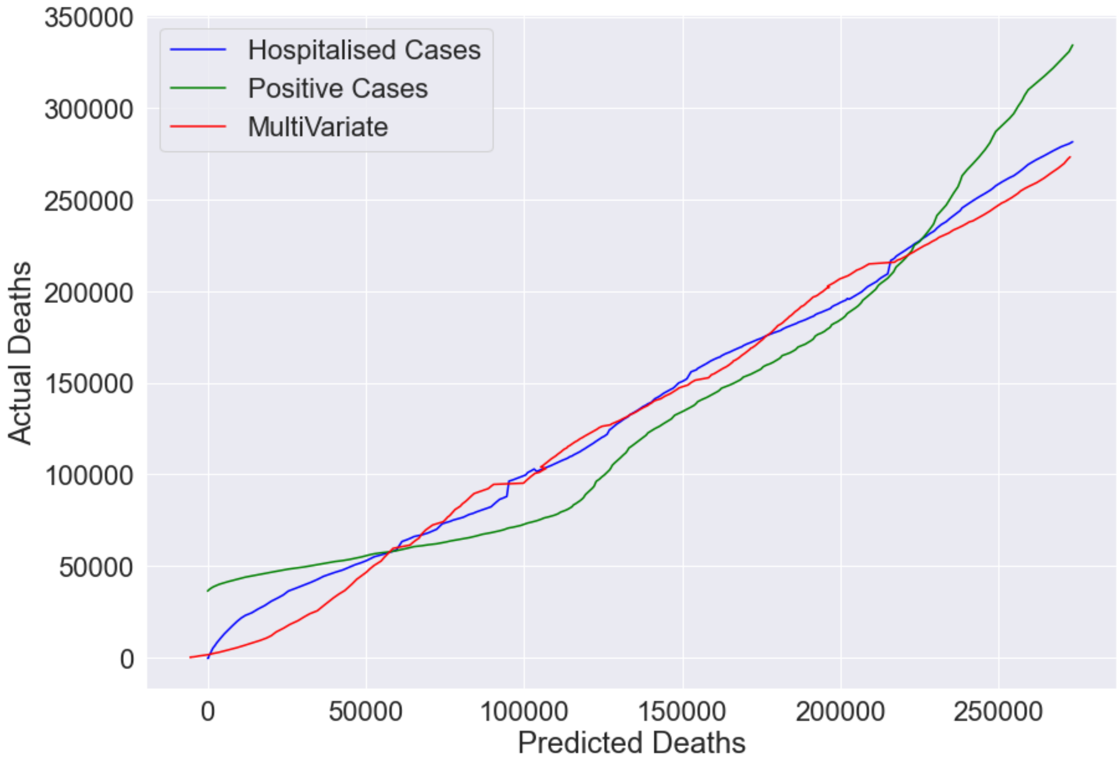


```
[ ]: f,ax=plt.subplots()
     f.set_size_inches(14,10)

     wholedeathhospitalized=data[(data['death']>=0) & (data['hospitalized']>=0)]
     wholedeathhospitalized=pd.DataFrame(data[['death','hospitalized']])
     wholedeathhospitalized = wholedeathhospitalized.dropna()
     wholedeath = wholedeathhospitalized[['death']]
```

```
wholehospitalized=wholedeathhospitalized[['hospitalized']]
linreg.fit(wholehospitalized,wholedeath)
regline_x = wholedeath
regline_y = linreg.intercept_ + linreg.coef_ * wholehospitalized
ax.plot(regline_x,regline_y,color='blue')

wholeposdeath=data[(data['death']>=0) & (data['positive']>=0)]
wholeposdeath=pd.DataFrame(data[['death','positive']])
wholeposdeath = wholeposdeath.dropna()
wholepos = wholeposdeath[['positive']]
wholedeath=wholeposdeath[['death']]
linreg.fit(wholepos,wholedeath)
regline_x = wholedeath
regline_y = linreg.intercept_ + linreg.coef_ * wholepos
ax.plot(regline_x,regline_y,color='green')

multi=data[(data['death']>=0) & (data['positive']>=0) &␣
 ↪(data['hospitalized']>=0)]
multi=pd.DataFrame(data[['death','positive','hospitalized']])
multi = multi.dropna()
#sb.heatmap(multi.corr(),annot=True,fmt='0.4f')
predictors=multi[['positive','hospitalized']]
target=multi[['death']]
linreg.fit(predictors,target)
regline_x = linreg.intercept_ + (linreg.coef_[0][0]* predictors['positive']) +␣
 ↪(linreg.coef_[0][1]* predictors['hospitalized'])
regline_y = target

print(linreg.coef_[0][0])
print(linreg.coef_[0][1])
print(linreg.intercept_)

ax.plot(regline_x,regline_y,color='red')
plt.ylabel('Actual Deaths')
plt.xlabel('Predicted Deaths')
# ax.legend(['MultiVariate'])
ax.legend(['Hospitalised Cases','Positive Cases','MultiVariate'])
```

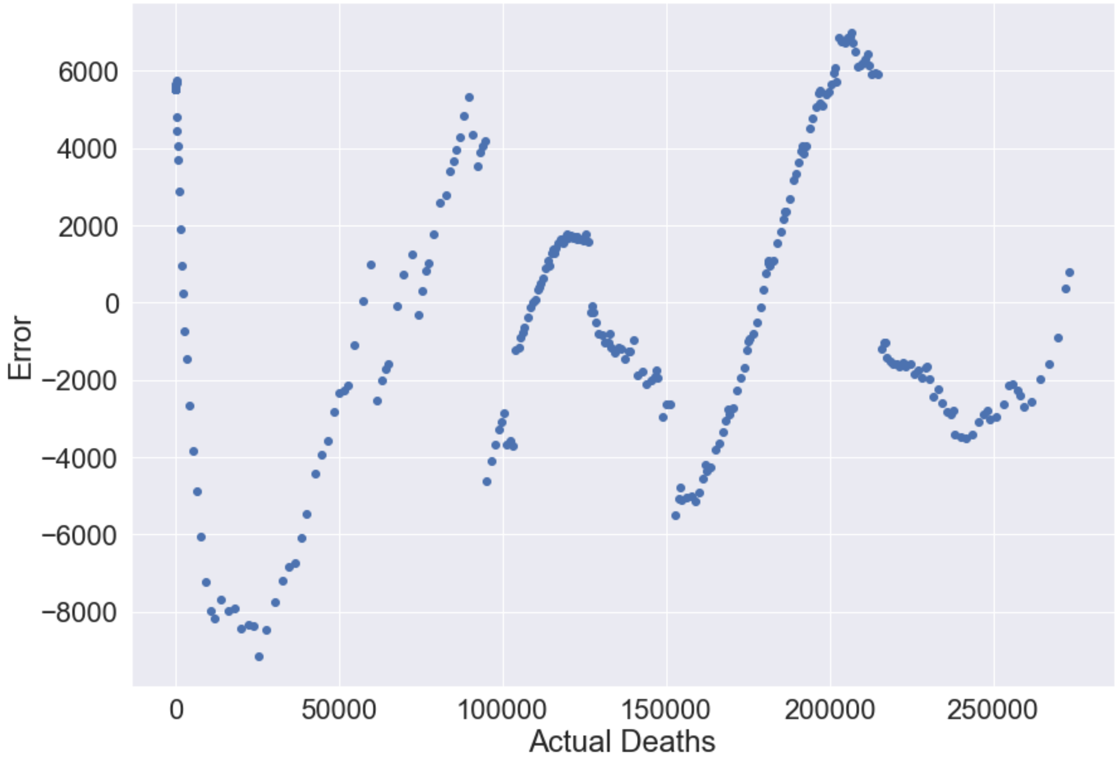
```
-0.0030233799419104035
0.549814584060474
[-5498.79912884]
```

```
[ ]: <matplotlib.legend.Legend at 0x16f03501310>
```



```
[ ]: error=target-linreg.predict(predictors)
     f,ax=plt.subplots()
     ax.scatter(target,error)
     f.set_size_inches(14,10)
     plt.ylabel('Error')
     plt.xlabel('Actual Deaths')
     erroradj=error.abs()
     print(erroradj.describe())
```

```
             death
count   278.000000
mean   3159.119711
std    2159.313012
min      16.487495
25%    1471.029974
50%    2643.260863
75%    4975.228876
max    9135.128663
```



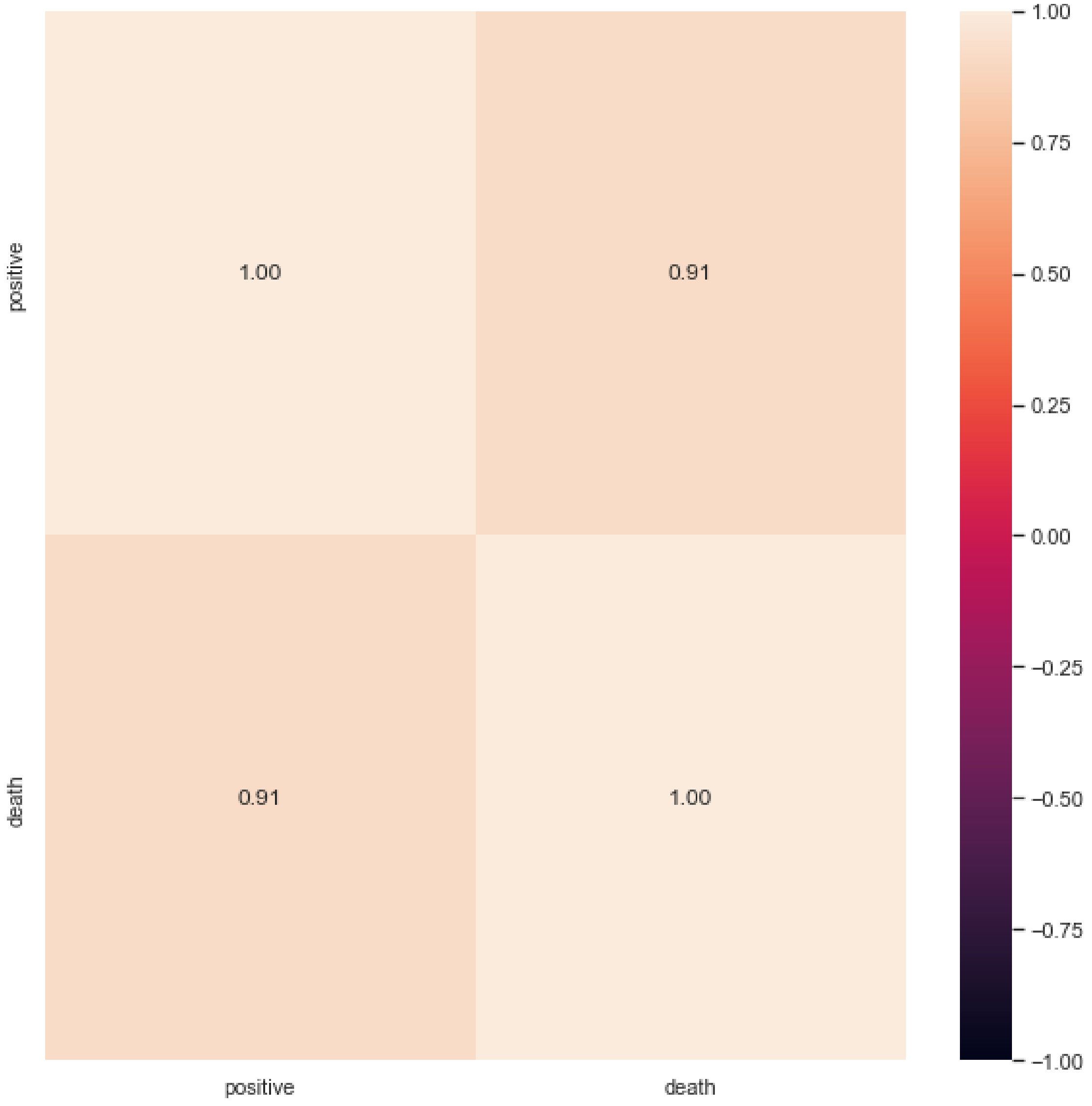
[ ]:
```
bystates = pd.read_csv('us_states_covid19_daily.csv')
bystates['date'] = pd.to_datetime(bystates['date'], format='%Y%m%d')
bystates.head()
```

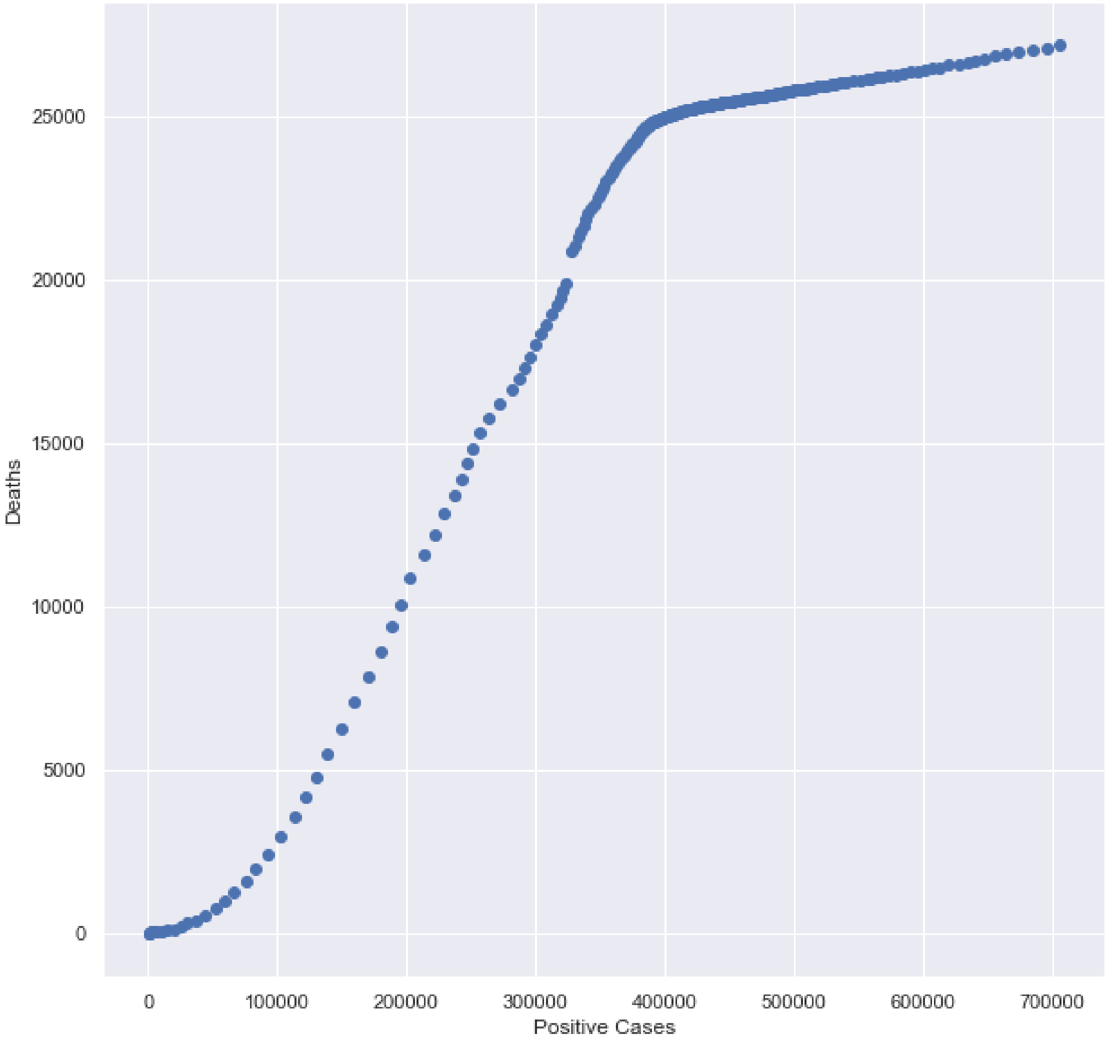
[ ]:
```
        date state  positive  probableCases   negative  pending  \
0 2020-12-06    AK   35720.0            NaN  1042056.0      NaN
1 2020-12-06    AL  269877.0        45962.0  1421126.0      NaN
2 2020-12-06    AR  170924.0        22753.0  1614979.0      NaN
3 2020-12-06    AS       0.0            NaN     2140.0      NaN
4 2020-12-06    AZ  364276.0        12590.0  2018813.0      NaN

  totalTestResultsSource  totalTestResults  hospitalizedCurrently  \
0        totalTestsViral         1077776.0                  164.0
1  totalTestsPeopleViral         1645041.0                 1927.0
2        totalTestsViral         1763150.0                 1076.0
3        totalTestsViral            2140.0                    NaN
4  totalTestsPeopleViral         2370499.0                 2977.0

   hospitalizedCumulative  …   posNeg  deathIncrease  hospitalizedIncrease  \
0                   799.0  …  1077776              0                     0
1                 26331.0  …  1691003             12                     0
2                  9401.0  …  1785903             40                    21
```

```
3                     NaN  …     2140              0                     0
4                 28248.0  …  2383089             25                   242

                                       hash  commercialScore  \
0  7b1d31e2756687bb9259b29195f1db6cdb321ea6                0
1  19454ed8fe28fc0a7948fc0771b2f3c846c1c92e                0
2  25fc83bffff5b32ba1a737be8e087fad9f4fde33                0
3  8c39eec317586b0c34fc2903e6a3891ecb00469e                0
4  7cf59da9e4bc31d905e179211313d08879880a85                0

  negativeRegularScore negativeScore positiveScore score  grade
0                    0             0             0     0    NaN
1                    0             0             0     0    NaN
2                    0             0             0     0    NaN
3                    0             0             0     0    NaN
4                    0             0             0     0    NaN

[5 rows x 55 columns]
```

[ ]:

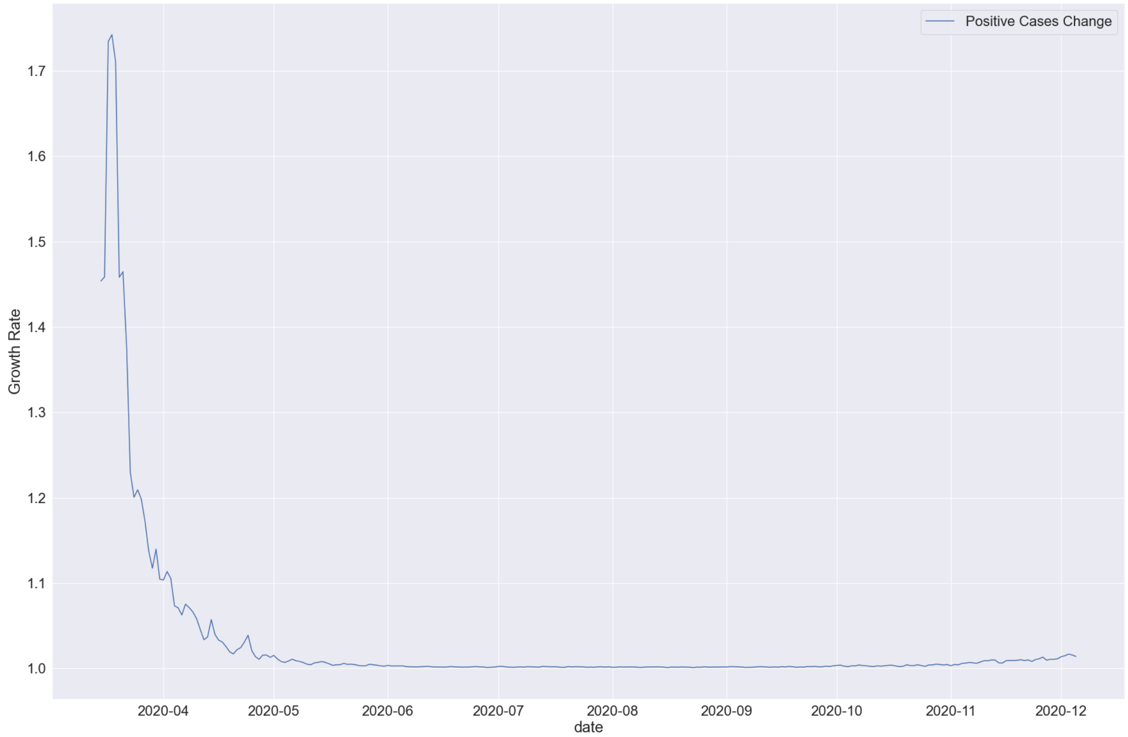
```
ny = bystates[bystates.state == 'NY']
cleaned = ny[ny.death >= 0]
ny = cleaned[cleaned.positive >= 0]
nydeath = pd.DataFrame(ny['death'])
nypos = pd.DataFrame(ny['positive'])
combined = pd.concat([nypos, nydeath], axis=1)
sb.set(rc={'figure.figsize':(10,10)})
sb.heatmap(combined.corr(), vmin=-1, vmax=1, annot=True,fmt='.2f')
linreg.fit(nypos, nydeath)
regline_x = nypos
regline_y = linreg.intercept_ + linreg.coef_ * nypos

f=plt.figure(figsize=(10,10))
plt.scatter(nypos, nydeath)
#plt.plot(regline_x, regline_y, color='red')
plt.xlabel('Positive Cases')
plt.ylabel('Deaths')
plt.show()

nyposanddate = pd.DataFrame(ny[['positive', 'date']])
nydeathanddate = pd.DataFrame(ny[['death', 'date']])
nyposanddate['Growth Rate'] = nyposanddate['positive'].shift(1)/
 ↪nyposanddate['positive']
nydeathanddate['Growth Rate'] = nydeathanddate['death'].shift(1)/
 ↪nydeathanddate['death']
```


positive
death
1.00
0.91
0.91
1.00
positive
death
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00



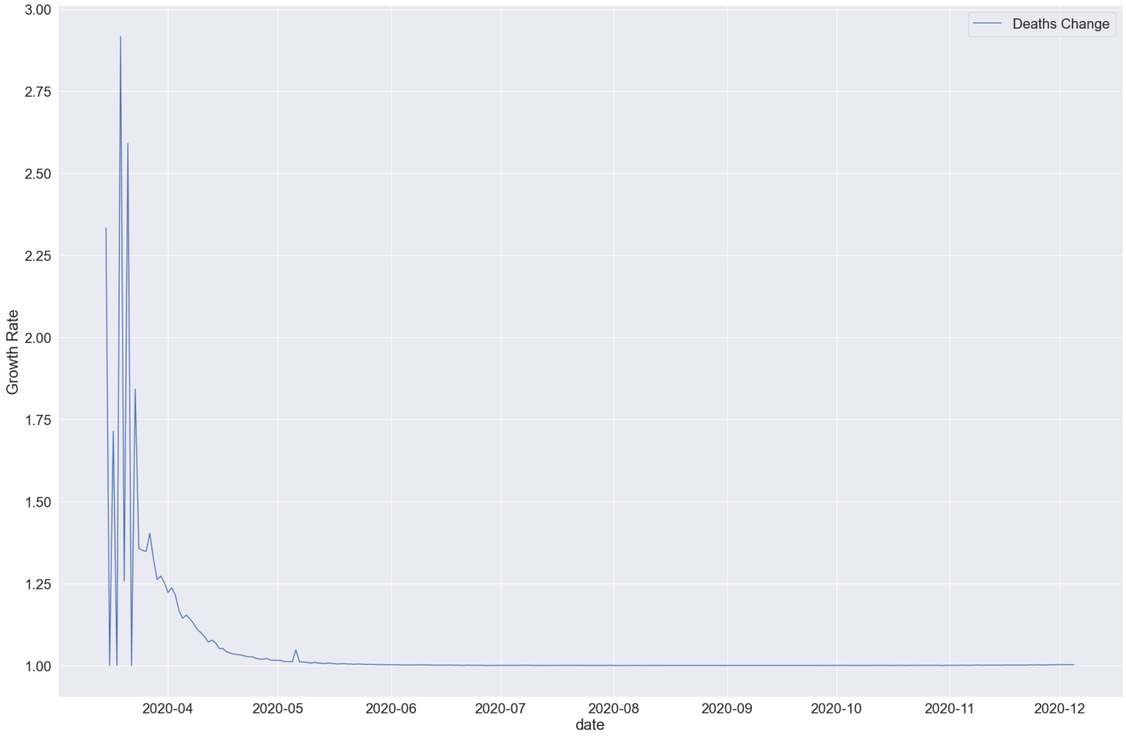
```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(x='date', y='Growth Rate', data=nyposanddate, label='Positive Cases␣
      ↪Change')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='Growth Rate'>
```



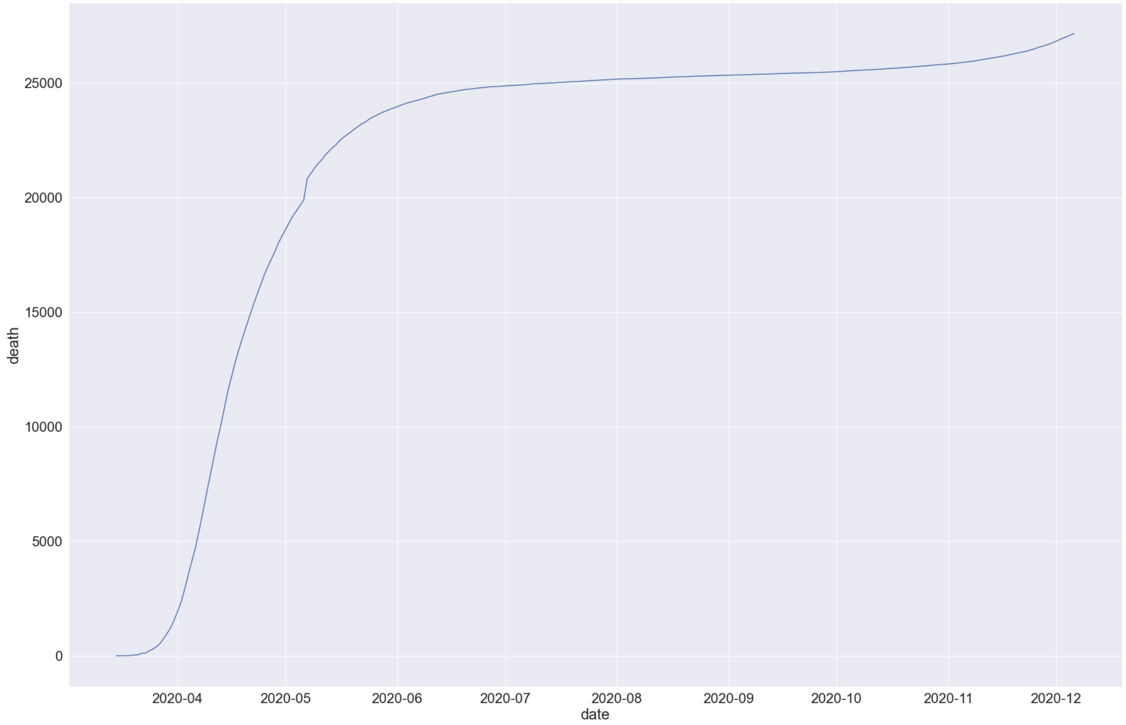
[ ]:
```
sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
sb.lineplot(x='date', y='Growth Rate', data=nydeathanddate, label='Deaths␣
↪Change')
```

[ ]:
```
<AxesSubplot:xlabel='date', ylabel='Growth Rate'>
```



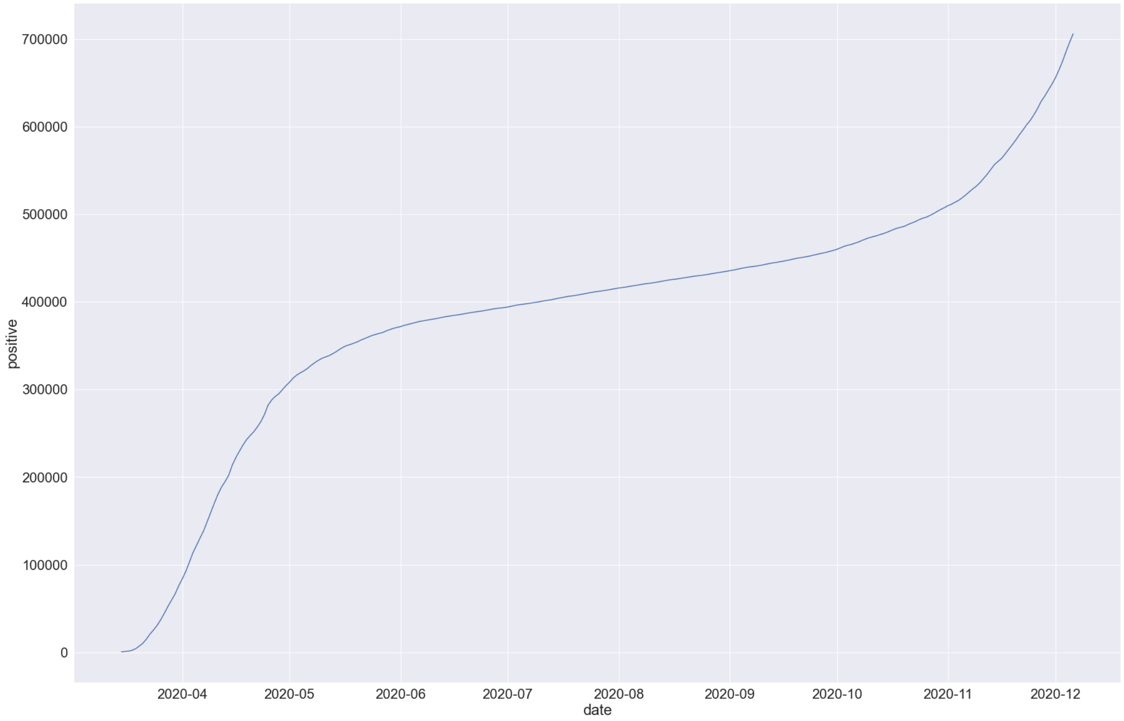
```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(data=ny,x='date', y='death')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='death'>
```



```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(data=ny,x='date', y='positive')
```

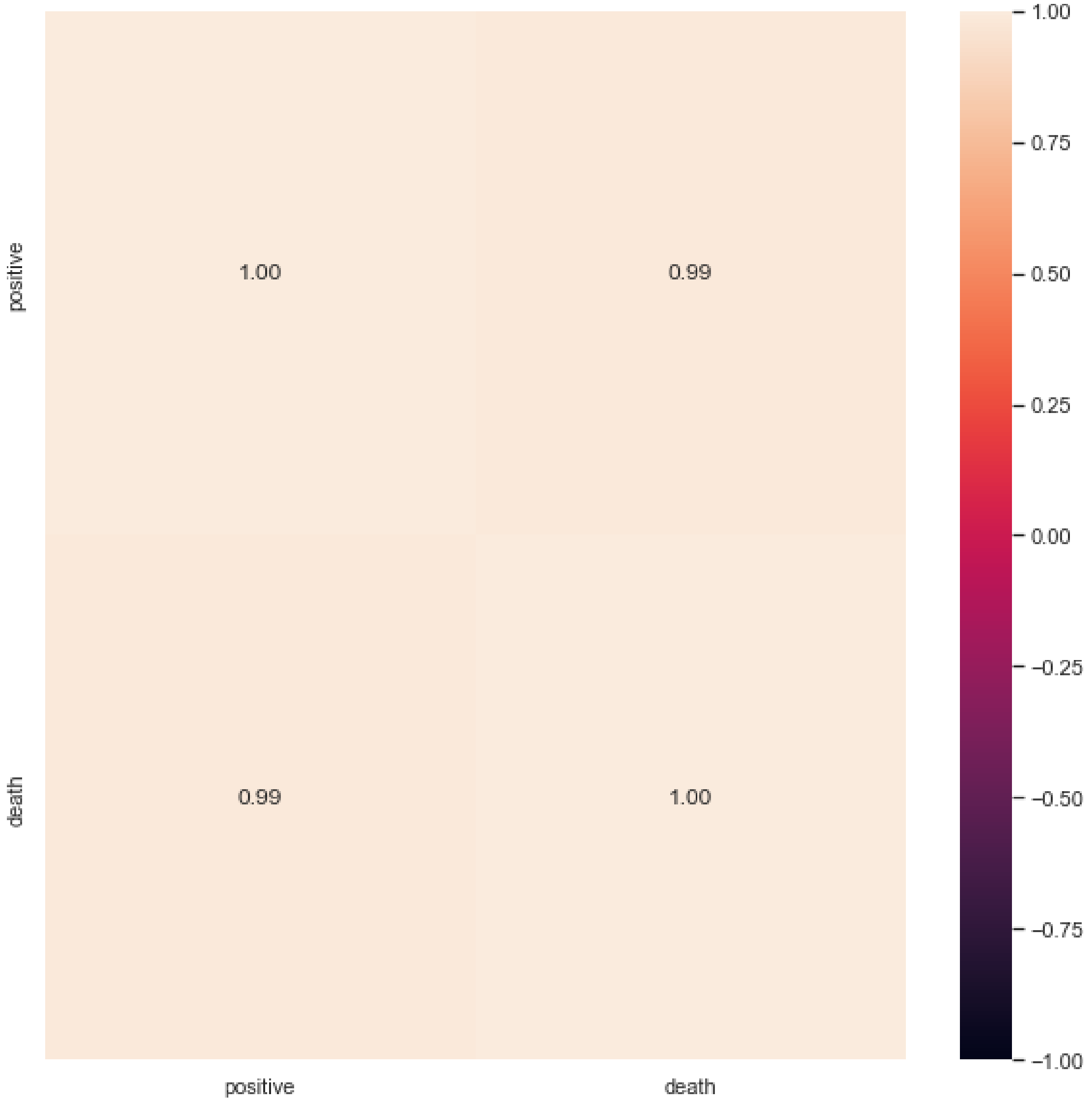
```
[ ]: <AxesSubplot:xlabel='date', ylabel='positive'>
```

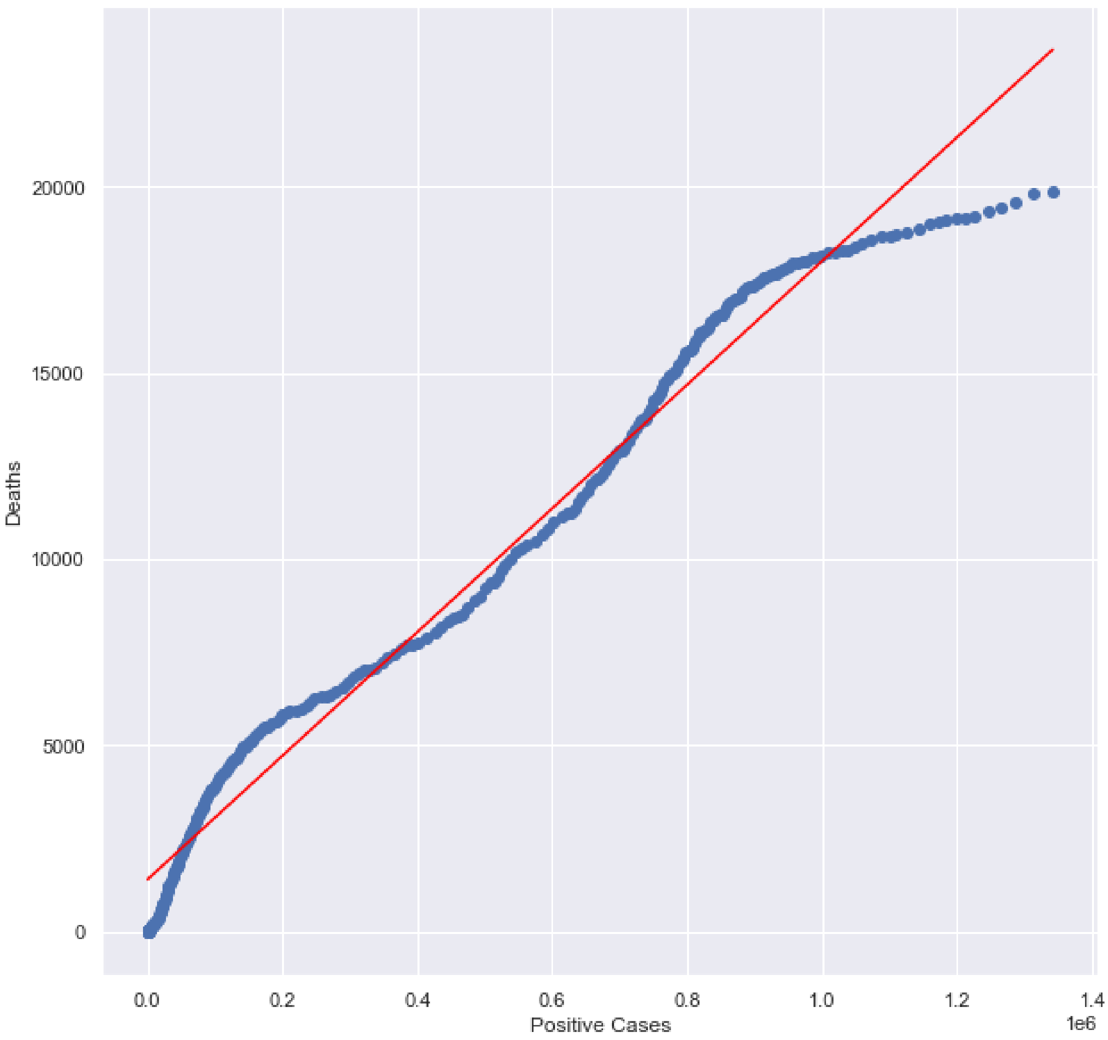


[ ]:

```
CA = bystates[bystates.state == 'CA']
cleaned = CA[CA.death >= 0]
CA = cleaned[cleaned.positive >= 0]
CAdeath = pd.DataFrame(CA['death'])
CApos = pd.DataFrame(CA['positive'])
combined = pd.concat([CApos, CAdeath], axis=1)
sb.set(rc={'figure.figsize':(10,10)},font_scale=1)
sb.heatmap(combined.corr(), vmin=-1, vmax=1, annot=True,fmt='.2f')
linreg.fit(CApos, CAdeath)
regline_x = CApos
regline_y = linreg.intercept_ + linreg.coef_ * CApos

f=plt.figure(figsize=(10,10))
plt.scatter(CApos, CAdeath)
plt.plot(regline_x, regline_y, color='red')
plt.xlabel('Positive Cases')
plt.ylabel('Deaths')
plt.show()

CAposanddate = pd.DataFrame(CA[['positive', 'date']])
CAdeathanddate = pd.DataFrame(CA[['death', 'date']])
CAposanddate['Growth Rate'] = CAposanddate['positive'].shift(1)/
 ↪CAposanddate['positive']
```

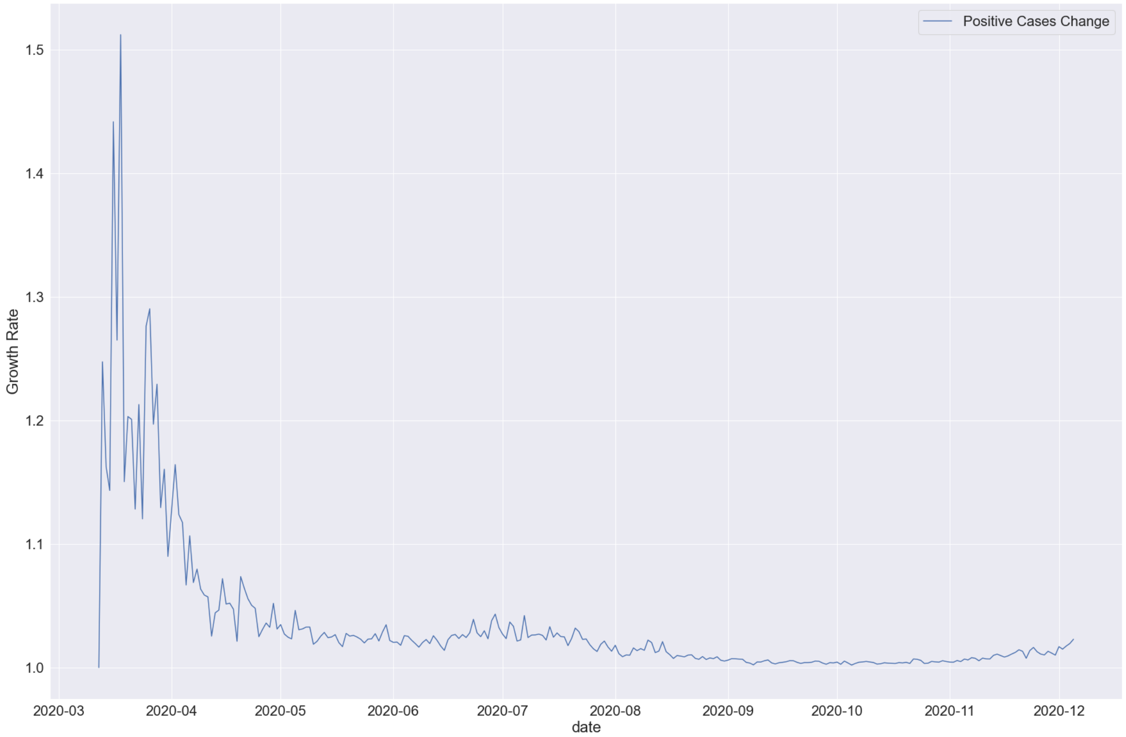
```python
CAdeathanddate['Growth Rate'] = CAdeathanddate['death'].shift(1)/CAdeathanddate['death']
```





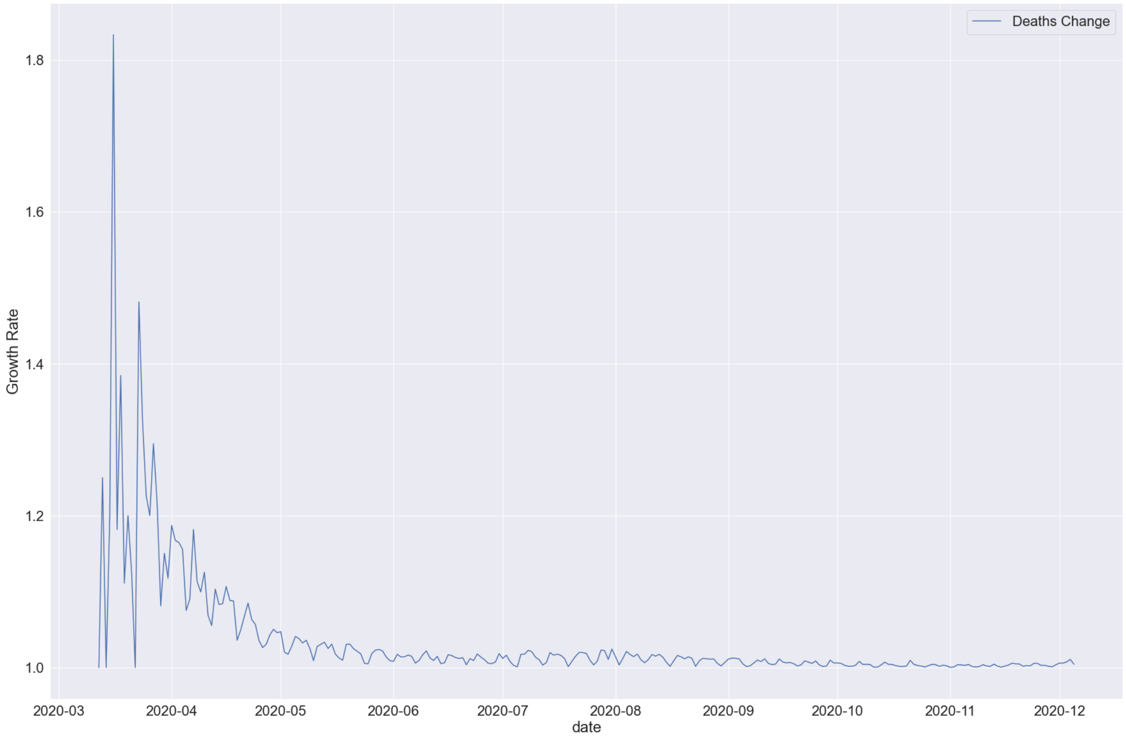
```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(x='date', y='Growth Rate', data=CAposanddate, label='Positive Cases␣
      ↪Change')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='Growth Rate'>
```



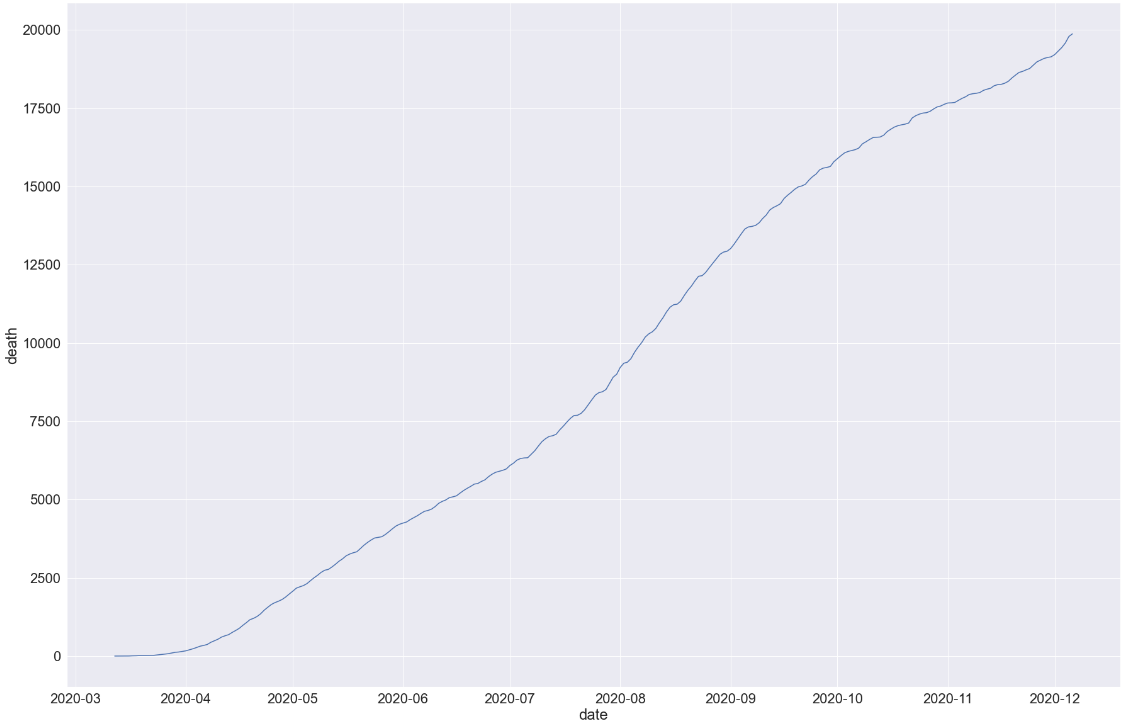
```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(x='date', y='Growth Rate', data=CAdeathanddate, label='Deaths␣
      ↪Change')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='Growth Rate'>
```



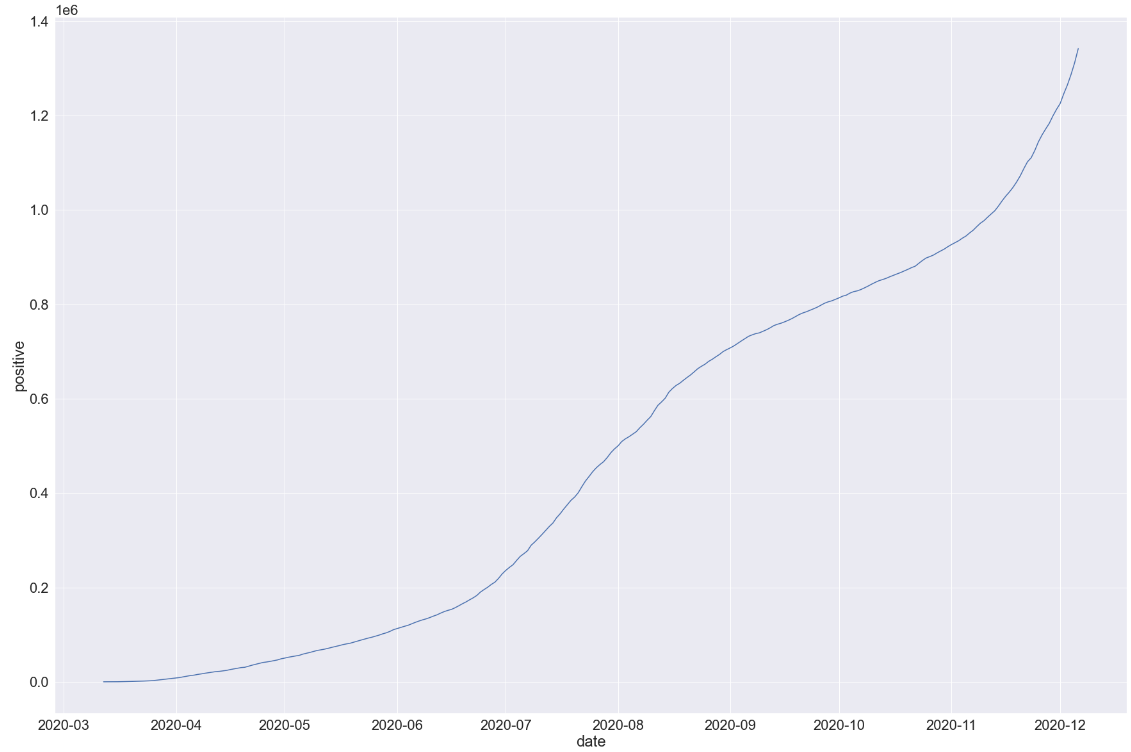
```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(data=CA,x='date', y='death')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='death'>
```



```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(data=CA,x='date', y='positive')
```

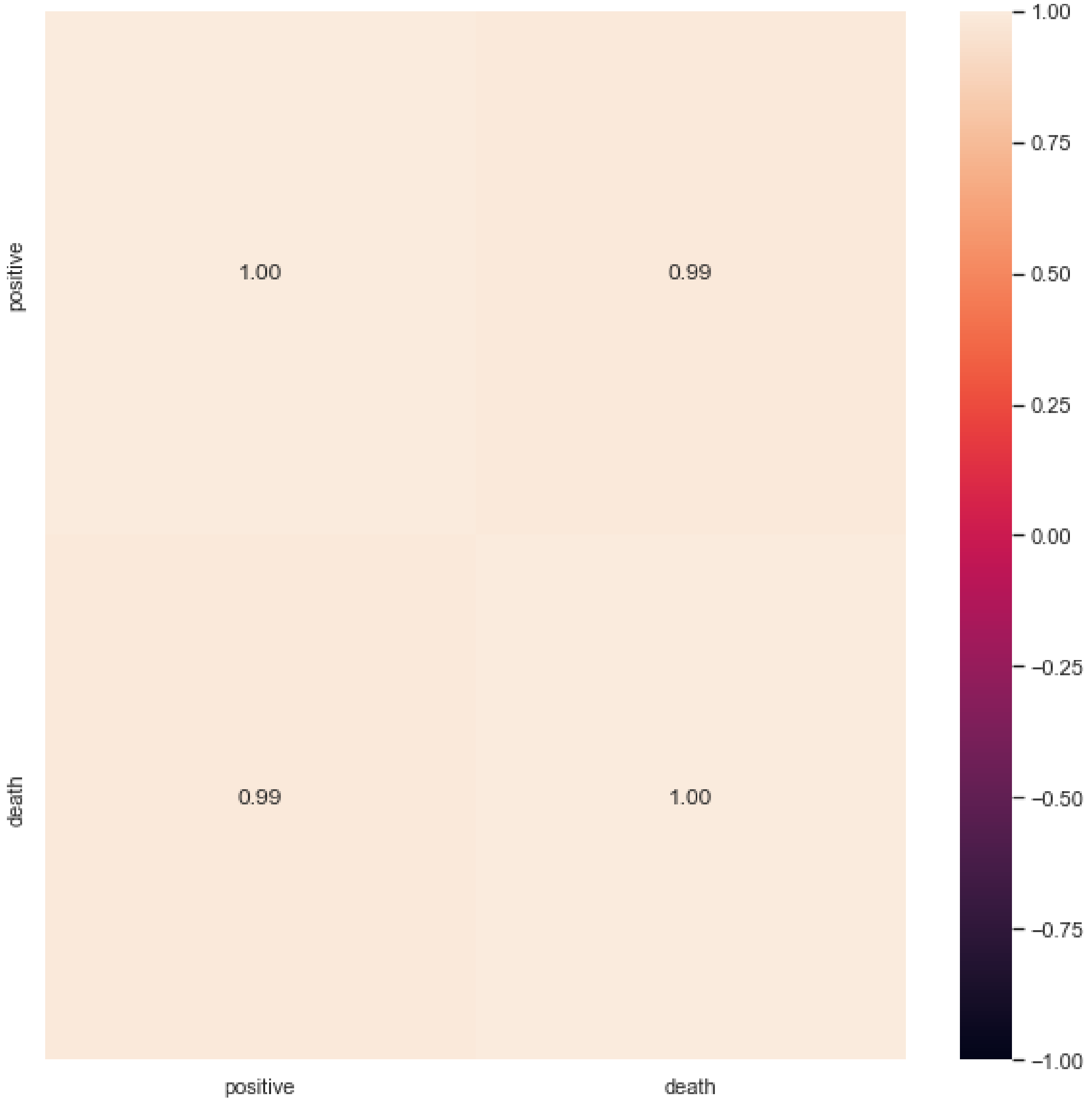
```
[ ]: <AxesSubplot:xlabel='date', ylabel='positive'>
```

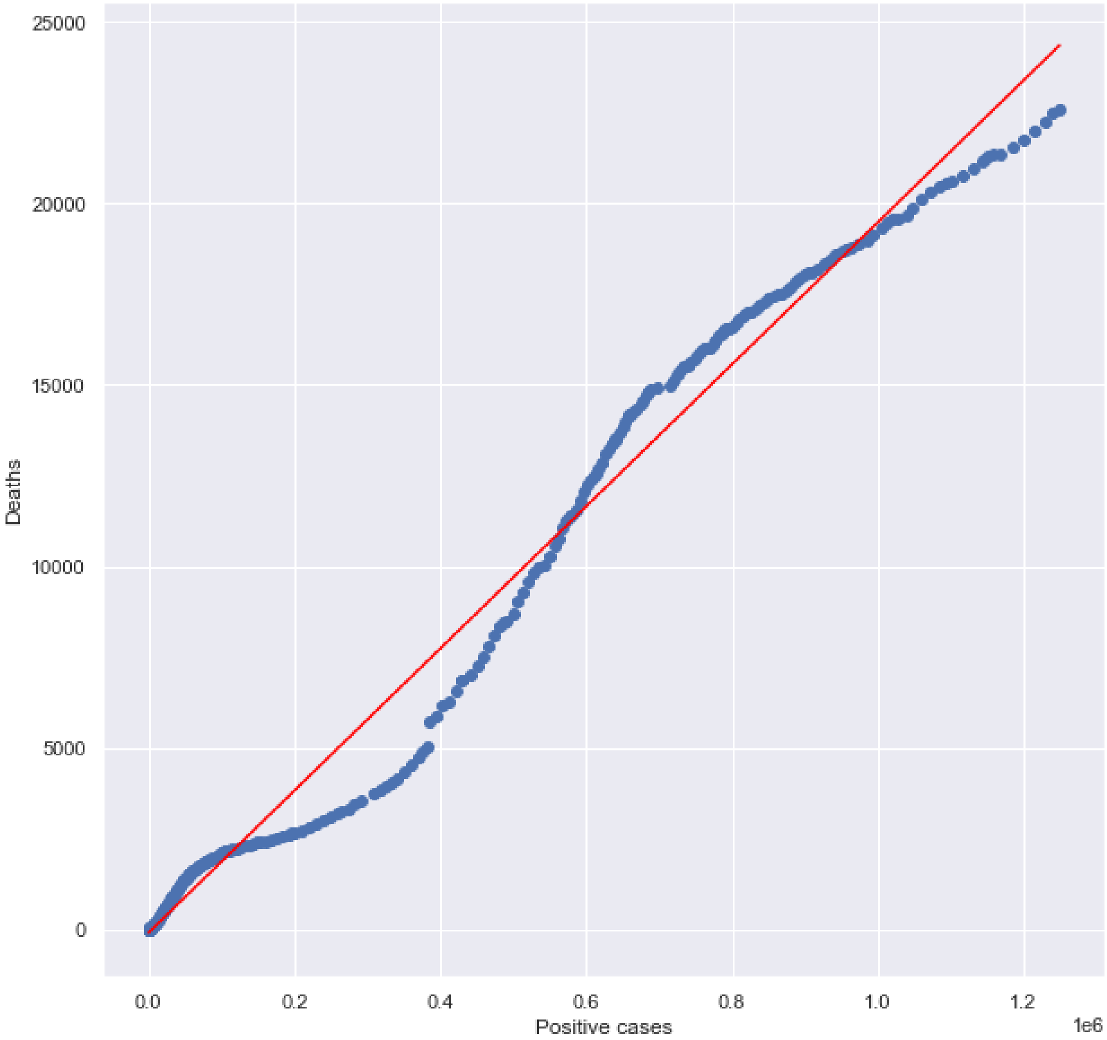


[ ]:

```
TX = bystates[bystates.state == 'TX']
cleaned = TX[TX.death >= 0]
TX = cleaned[cleaned.positive >= 0]
TXdeath = pd.DataFrame(TX['death'])
TXpos = pd.DataFrame(TX['positive'])
combined = pd.concat([TXpos, TXdeath], axis=1)
sb.set(rc={'figure.figsize':(10,10)},font_scale =1)
sb.heatmap(combined.corr(), vmin=-1, vmax=1, annot=True,fmt='.2f')
linreg.fit(TXpos, TXdeath)
regline_x = TXpos
regline_y = linreg.intercept_ + linreg.coef_ * TXpos

f=plt.figure(figsize=(10,10))
plt.scatter(TXpos, TXdeath)
plt.plot(regline_x, regline_y, color='red')
plt.xlabel('Positive cases')
plt.ylabel('Deaths')
plt.show()

TXposanddate = pd.DataFrame(TX[['positive', 'date']])
TXdeathanddate = pd.DataFrame(TX[['death', 'date']])
TXposanddate['Growth Rate'] = TXposanddate['positive'].shift(1)/
 ↪TXposanddate['positive']
```

```
TXdeathanddate['Growth Rate'] = TXdeathanddate['death'].shift(1)/
↪TXdeathanddate['death']
```

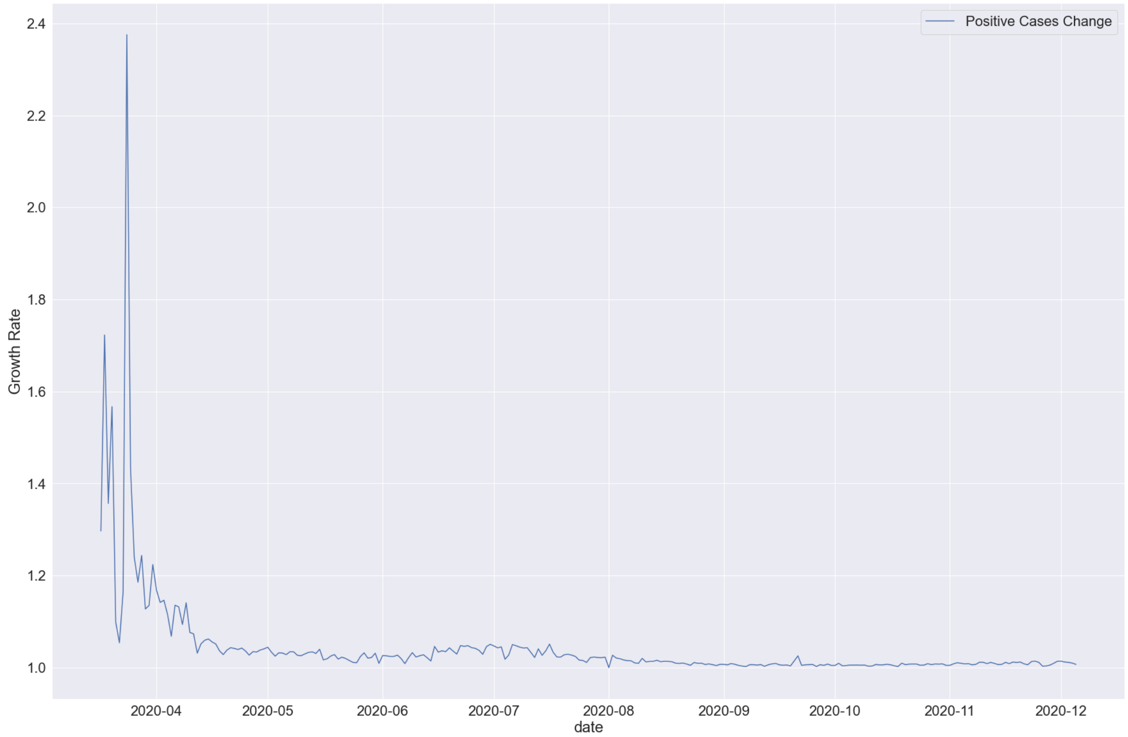




[ ]:

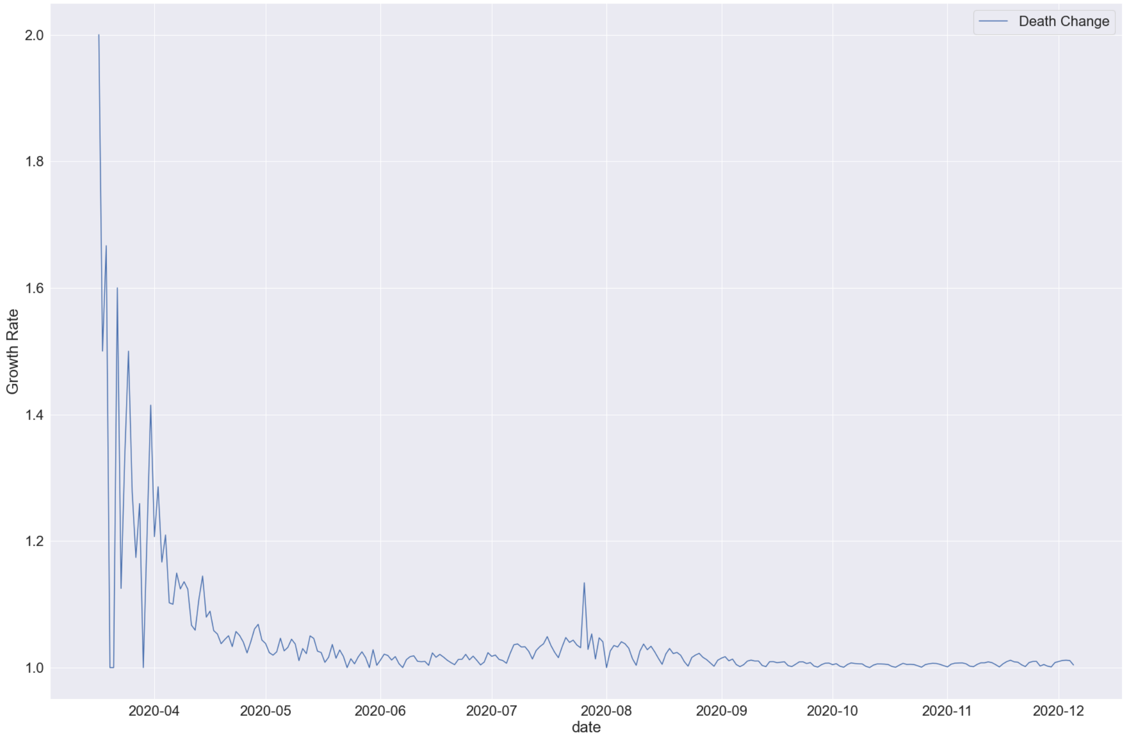
```
sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
#TXposanddate = TXposanddate[TXposanddate.date >= '2020-04-01']
sb.lineplot(x='date', y='Growth Rate', data=TXposanddate, label='Positive Cases Change')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='Growth Rate'>
```



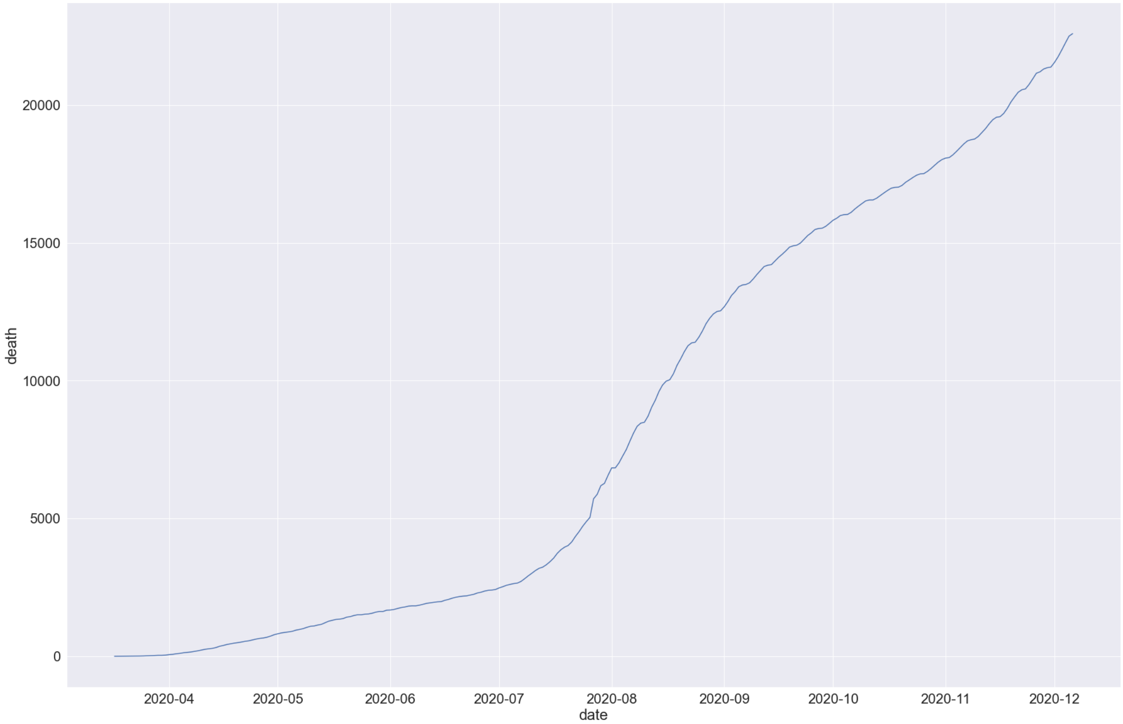
[ ]:
```
sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
#keep april onwards

sb.lineplot(x='date', y='Growth Rate', data=TXdeathanddate, label='Death␣
 ↪Change')
```

[ ]:
```
<AxesSubplot:xlabel='date', ylabel='Growth Rate'>
```



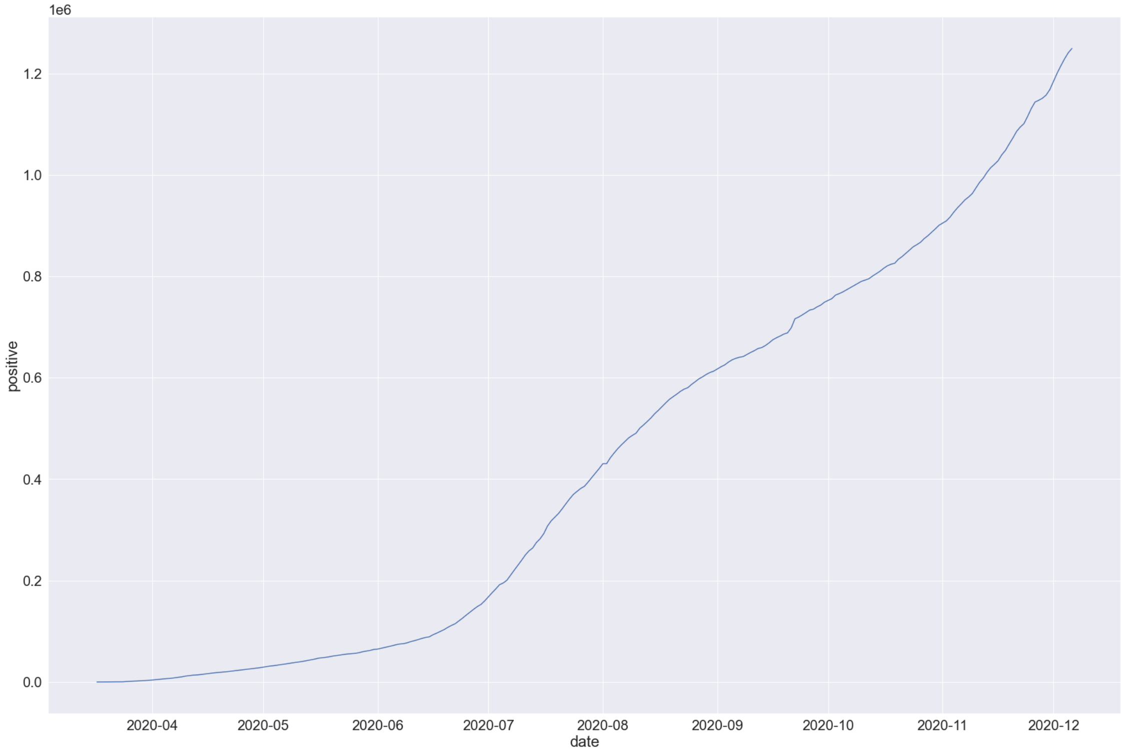
```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(data=TX,x='date', y='death')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='death'>
```



```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(data=TX,x='date', y='positive')
```

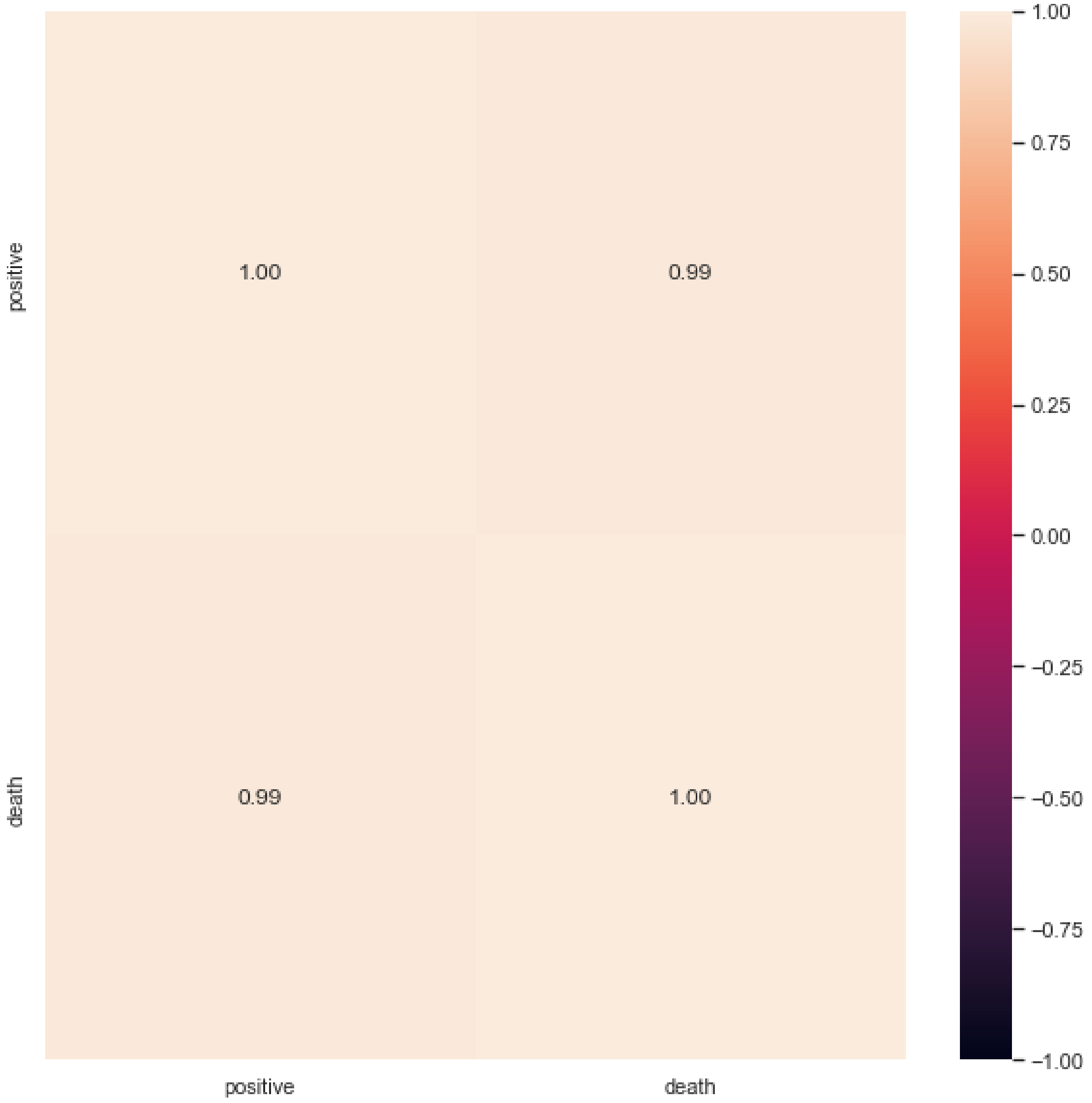
```
[ ]: <AxesSubplot:xlabel='date', ylabel='positive'>
```

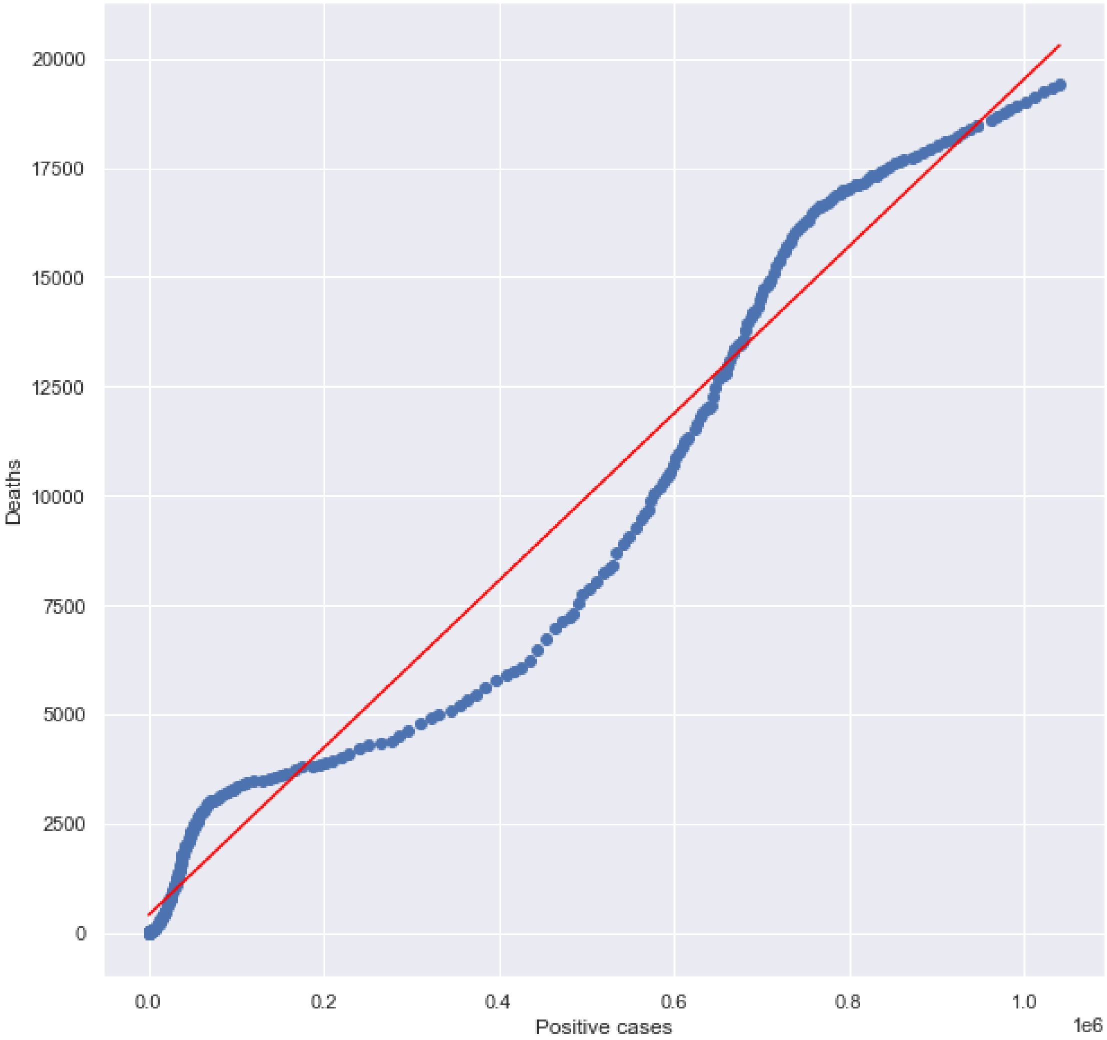


[ ]:

```
FL = bystates[bystates.state == 'FL']
cleaned = FL[FL.death >= 0]
FL = cleaned[cleaned.positive >= 0]
FLdeath = pd.DataFrame(FL['death'])
FLpos = pd.DataFrame(FL['positive'])
combined = pd.concat([FLpos, FLdeath], axis=1)
sb.set(rc={'figure.figsize':(10,10)},font_scale = 1)
sb.heatmap(combined.corr(), vmin=-1, vmax=1, annot=True,fmt='.2f')
linreg.fit(FLpos, FLdeath)
regline_x = FLpos
regline_y = linreg.intercept_ + linreg.coef_ * FLpos

f=plt.figure(figsize=(10,10))
plt.scatter(FLpos, FLdeath)
plt.plot(regline_x, regline_y, color='red')
plt.xlabel('Positive cases')
plt.ylabel('Deaths')
plt.show()

FLposanddate = pd.DataFrame(FL[['positive', 'date']])
FLdeathanddate = pd.DataFrame(FL[['death', 'date']])
FLposanddate['Growth Rate'] = FLposanddate['positive'].shift(1)/
 ↪FLposanddate['positive']
```

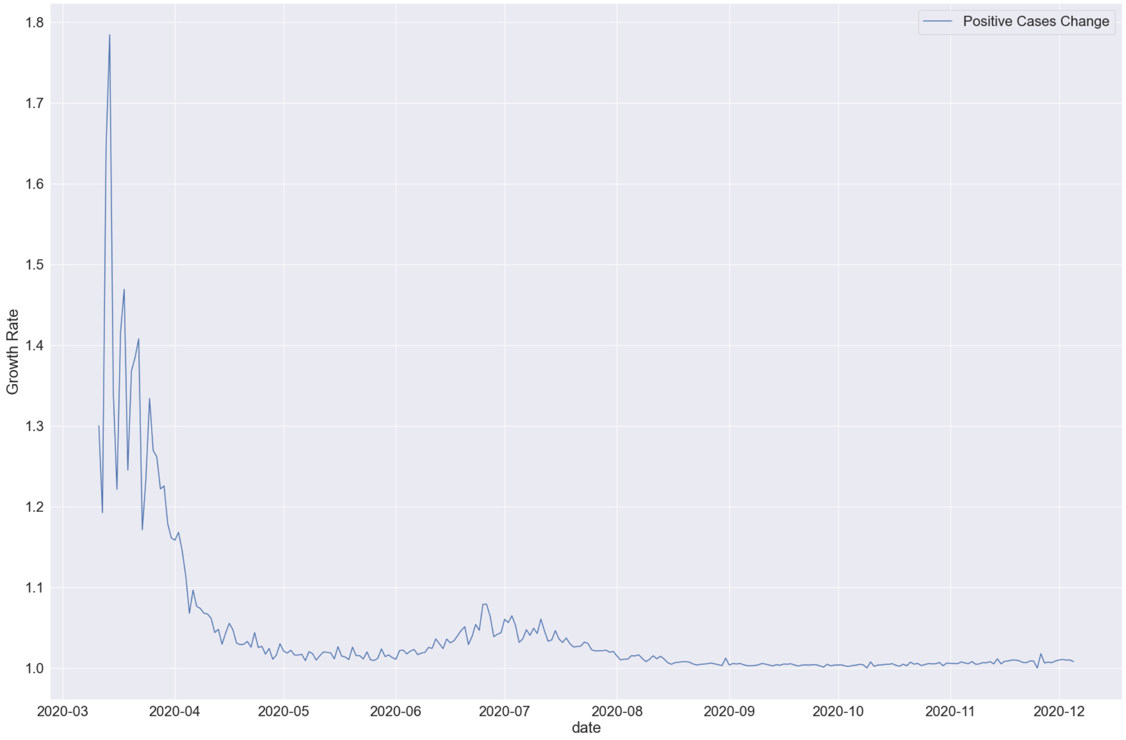
```
FLdeathanddate['Growth Rate'] = FLdeathanddate['death'].shift(1)/
↪FLdeathanddate['death']
```





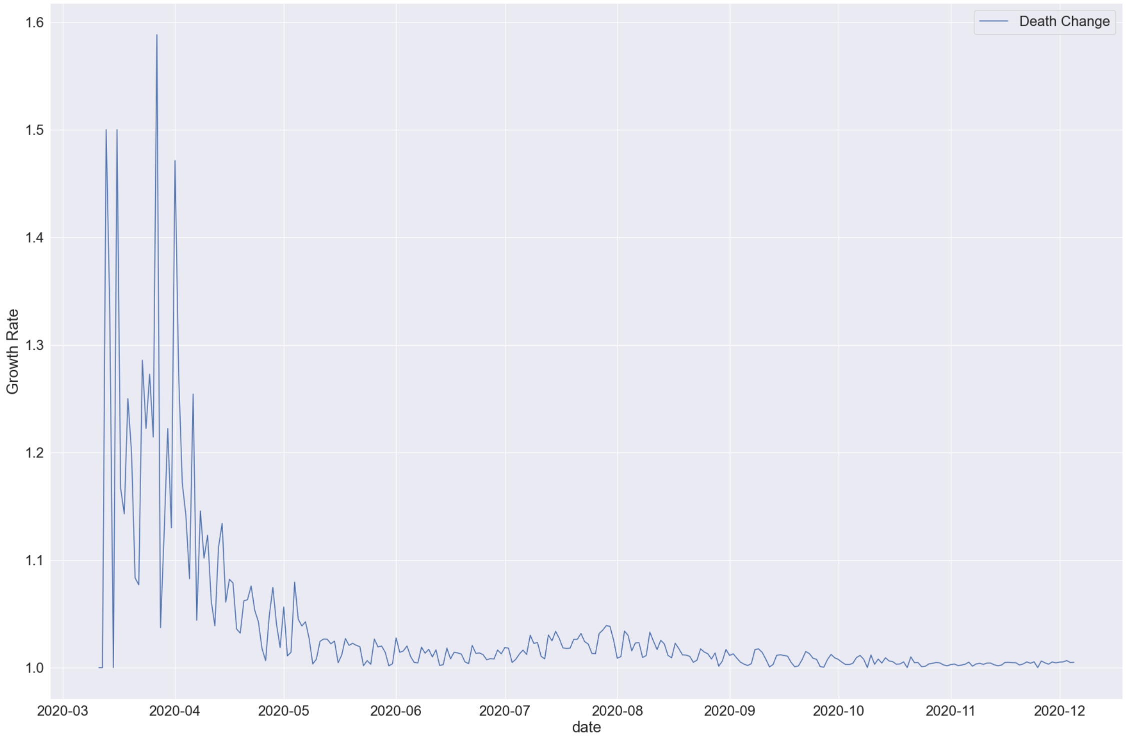
```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(x='date', y='Growth Rate', data=FLposanddate, label='Positive Cases␣
      ↪Change')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='Growth Rate'>
```



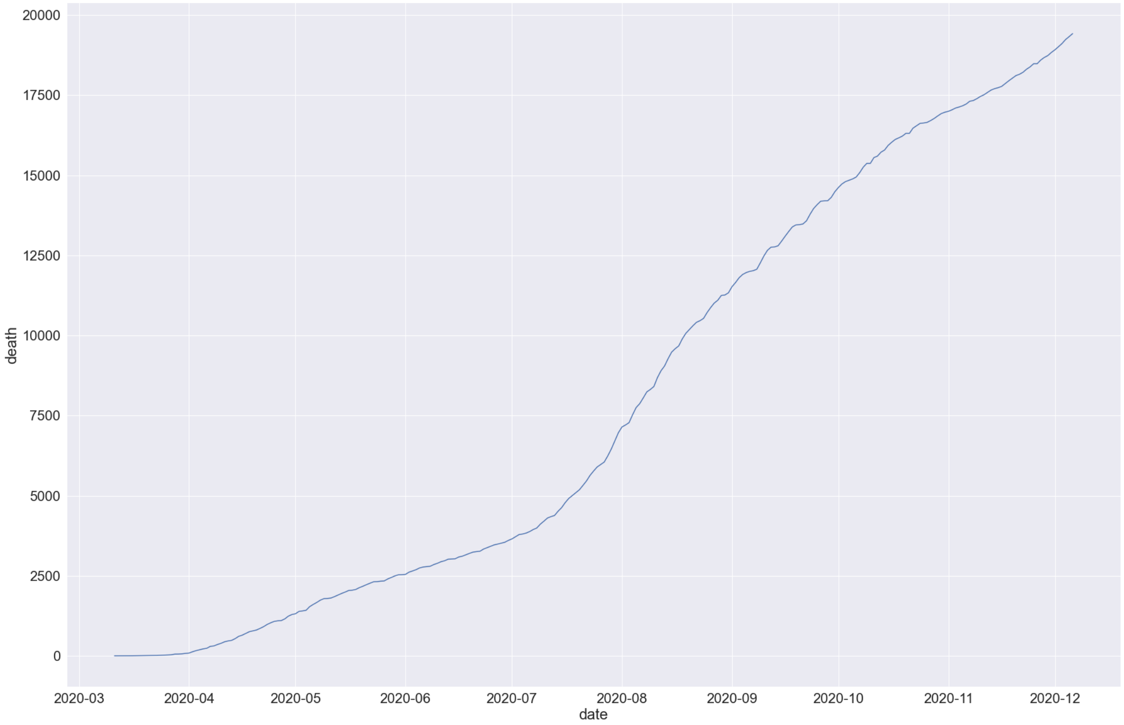
```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(x='date', y='Growth Rate', data=FLdeathanddate, label='Death␣
      ↪Change')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='Growth Rate'>
```



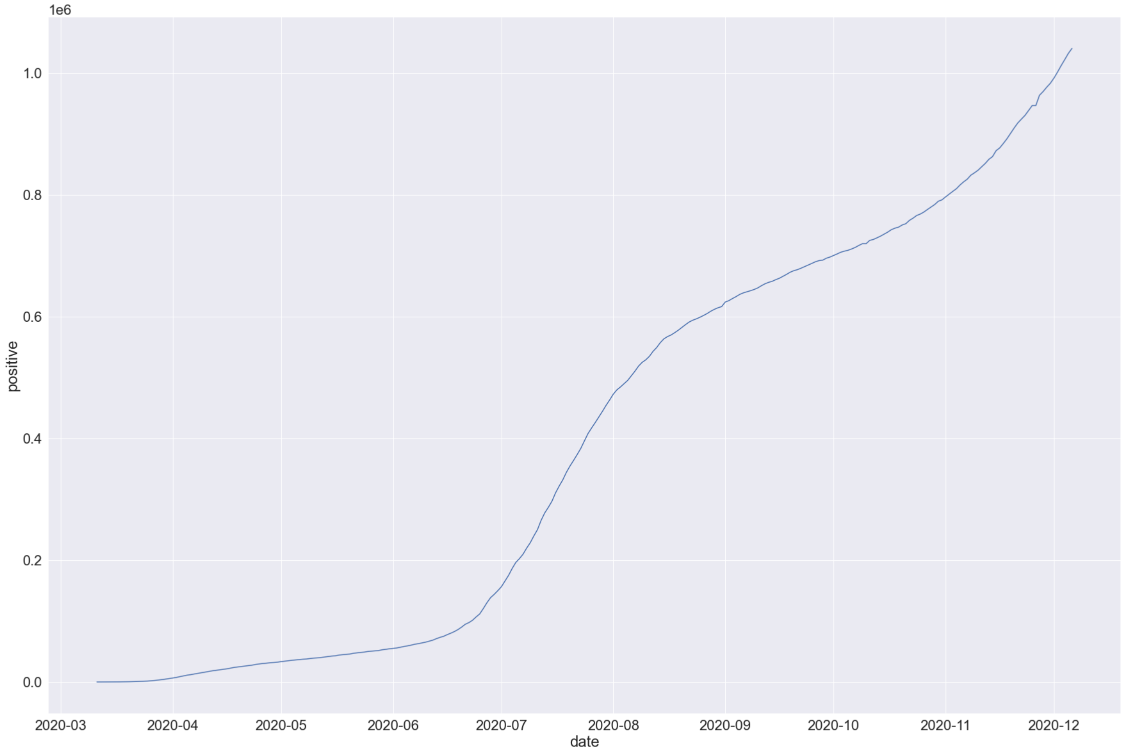
```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(data=FL,x='date', y='death')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='death'>
```



```
[ ]: sb.set(rc={'figure.figsize':(30,20)},font_scale = 2)
     sb.lineplot(data=FL,x='date', y='positive')
```

```
[ ]: <AxesSubplot:xlabel='date', ylabel='positive'>
```


1e6
1.0
0.8
0.6
0.4
0.2
0.0
positive
2020-03
2020-04
2020-05
2020-06
2020-07
2020-08
2020-09
2020-10
2020-11
2020-12
date