EDA for Time series forecasting

Infected by COVID-19 (USA)

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In [1]:

```
import sys
#!{sys.executable} -m pip install seaborn==0.9.0
import seaborn
import random
from mpl_toolkits.mplot3d import Axes3D
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
#sns.set(rc={"figure.figsize": (24, 12)})
plt.style.use({'figure.figsize':(24, 12)})
sns.set_style('dark')
sns.set_context("poster")
#np.set_printoptions(suppress=True,   precision=10,  threshold=2000,  linewidth=150)
pd.set_option('display.float_format',lambda x : '%.2f' % x)
plt.rcParams['axes.unicode_minus'] = False
from warnings import filterwarnings
filterwarnings('ignore')
```

总览

In [2]:

```
df = pd.read_csv('./US/datasets_555089_1255330_us_covid19_daily.csv')
df = pd.read_csv('./US-812/datasets_555089_1411155_us_covid19_daily.csv')
df = pd.read_csv('./US-830/us_covid19_daily.csv')
df['date'] = df['date'].astype(str)
df.sort_values('date',ascending=True,inplace=True)
df.shape
```

Out[2]:

```
(221, 25)
```

In [3]:

```
print(df['date'].min(),"---",df['date'].max())
df.tail(5)
```

```
20200122 --- 20200829
```

Out[3]:

	date	states	positive	negative	pending	hospitalizedCurrently	hospitalizedCumulative	inIcuCurrently	inIcuCumulative	onVentilatorCurrently	...	las
4	20200825	56	5750167	67625238	4091.00	38762.00	362452.00	7851.00	16920.00	2163.00	...	25T
3	20200826	56	5793523	68256910	4081.00	38411.00	364325.00	7763.00	17046.00	2142.00	...	26T
2	20200827	56	5837507	68954986	11168.00	37464.00	365993.00	7717.00	17181.00	2125.00	...	27T
1	20200828	56	5884053	69680696	10428.00	37239.00	367588.00	7558.00	17304.00	2086.00	...	28T
0	20200829	56	5928381	70397186	11151.00	36470.00	368866.00	7426.00	17401.00	2060.00	...	29T

5 rows × 25 columns

In [4]:

```
df.isnull().sum()
```

Out[4]:

```
date                        0
states                      0
positive                    0
negative                    0
pending                    42
hospitalizedCurrently      55
hospitalizedCumulative     42
inIcuCurrently             64
inIcuCumulative            63
onVentilatorCurrently      63
onVentilatorCumulative     70
recovered                  63
dateChecked                 0
death                      19
hospitalized               42
lastModified                0
total                       0
totalTestResults            0
posNeg                      0
deathIncrease               0
hospitalizedIncrease        0
negativeIncrease            0
positiveIncrease            0
totalTestResultsIncrease    0
hash                        0
dtype: int64
```

In [5]:

```
df.dtypes
```

Out[5]:

```
date                         object
states                        int64
positive                      int64
negative                      int64
pending                     float64
hospitalizedCurrently       float64
hospitalizedCumulative      float64
inIcuCurrently              float64
inIcuCumulative             float64
onVentilatorCurrently       float64
onVentilatorCumulative      float64
recovered                   float64
dateChecked                  object
death                       float64
hospitalized                float64
lastModified                 object
total                         int64
totalTestResults              int64
posNeg                        int64
deathIncrease                 int64
hospitalizedIncrease          int64
negativeIncrease              int64
positiveIncrease              int64
totalTestResultsIncrease      int64
hash                         object
dtype: object
```

In [6]:

```
df.describe(include='all')
```

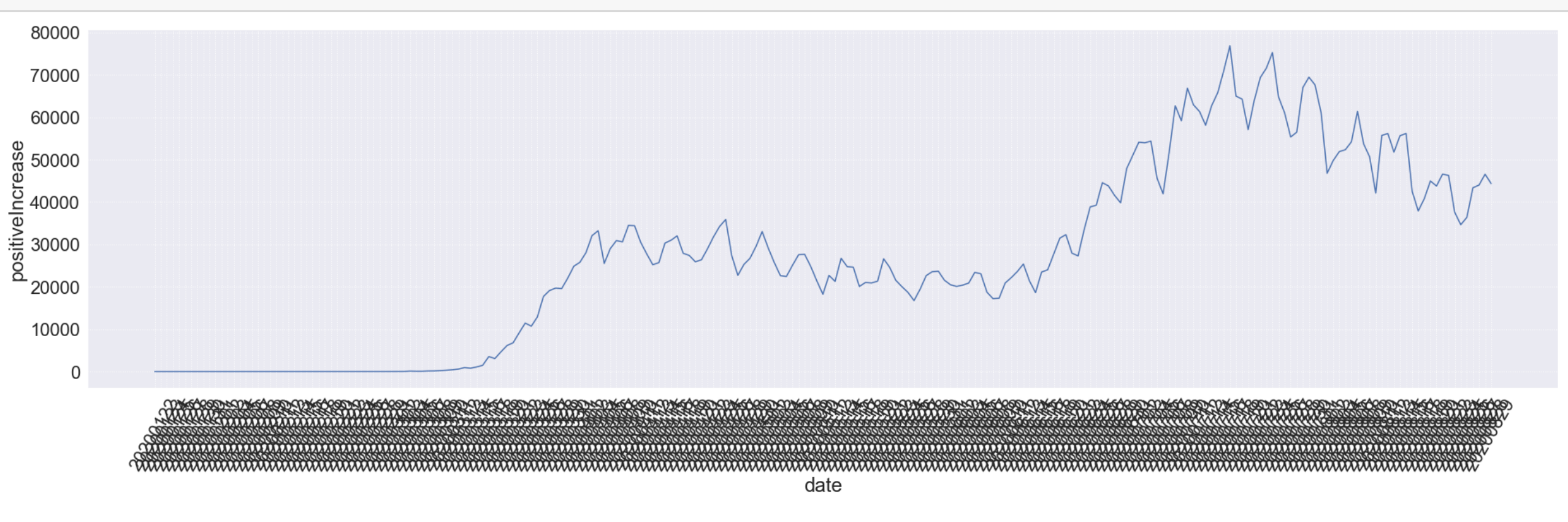
Out[6]:

	date	states	positive	negative	pending	hospitalizedCurrently	hospitalizedCumulative	inIcuCurrently	inIcuCumulative	onVentilatorCurrent
count	221	221.00	221.00	221.00	179.00	166.00	179.00	157.00	158.00	158.
unique	221	nan	nan	nan	nan	nan	nan	nan	nan	n
top	20200217	nan	nan	nan	nan	nan	nan	nan	nan	n
freq	1	nan	nan	nan	nan	nan	nan	nan	nan	n
mean	NaN	45.04	1789319.04	18507044.70	7509.68	41164.01	184439.07	8690.90	8790.17	3319.
std	NaN	21.39	1835068.15	21726886.07	13753.12	15071.24	114424.28	3197.06	5084.23	1626.
min	NaN	1.00	0.00	0.00	103.00	325.00	4.00	1299.00	74.00	167.
25%	NaN	56.00	10342.00	65131.00	2120.50	32457.25	91137.50	5930.00	4521.25	2260.
50%	NaN	56.00	1352463.00	8053622.00	3307.00	42533.00	213260.00	8487.00	9334.00	2707.
75%	NaN	56.00	2890899.00	32872797.00	4195.00	53973.75	270650.50	10472.00	12590.50	4758.
max	NaN	56.00	5928381.00	70397186.00	65709.00	59940.00	368866.00	15130.00	17401.00	7070.

11 rows × 25 columns

In [7]:

```
plt.style.use({'figure.figsize':(32, 8)})
sns.set(font_scale=2)
ax=sns.lineplot(x='date', y="positiveIncrease", data=df)
ax.set_xticklabels(df['date'], rotation=60)
plt.grid(linestyle=':')
plt.show()
```



根据日期变化趋势分析

原始数据中已经有了increase，因此不需要特别计算，如果没有，可通过以下方式计算梯度 df3 = df[df['date']>'20200401'] df3 = df3.groupby(['date','state'])['positive'].sum().reset_index(name="count") df3.sort_values('date',ascending=False,inplace=True) df3.head(3) df3['increase'] = df3['count'].diff(periods=1) df3['increase'].fillna(value=0,inplace=True) df3.head(3)

In [8]:

```
df = pd.read_csv('./US/us_states_covid19_daily.csv')
df = pd.read_csv('./US-830/us_states_covid19_daily.csv')
del df['hash']
del df['commercialScore']
del df['negativeRegularScore']
del df['negativeScore']
del df['positiveScore']
del df['score']
del df['grade']
del df['hospitalizedIncrease']
del df['deathIncrease']
del df['hospitalizedCumulative']
del df['hospitalizedCurrently']
del df['inIcuCurrently']
del df['inIcuCumulative']
del df['onVentilatorCurrently']
del df['onVentilatorCumulative']
del df['recovered']
del df['lastUpdateEt']
del df['dateModified']
del df['checkTimeEt']
del df['dateChecked']
df['date'] = df['date'].astype(str)
df.fillna(value=0,inplace=True)
df.head(5)
```

Out[8]:

	date	state	positive	negative	pending	dataQualityGrade	death	hospitalized	totalTestsViral	positiveTestsViral	...	totalTestsAntigen	positiveTes
0	20200829	AK	6035.00	339660.00	0.00	A	37.00	0.00	345695.00	5558.00	...	0.00	
1	20200829	AL	123889.00	851929.00	0.00	B	2152.00	14267.00	967213.00	0.00	...	0.00	
2	20200829	AR	60378.00	646592.00	0.00	A	772.00	4142.00	706970.00	0.00	...	3610.00	
3	20200829	AS	0.00	1514.00	0.00	C	0.00	0.00	0.00	0.00	...	0.00	
4	20200829	AZ	201287.00	991089.00	0.00	A+	5007.00	21433.00	1190668.00	0.00	...	0.00	

5 rows × 34 columns

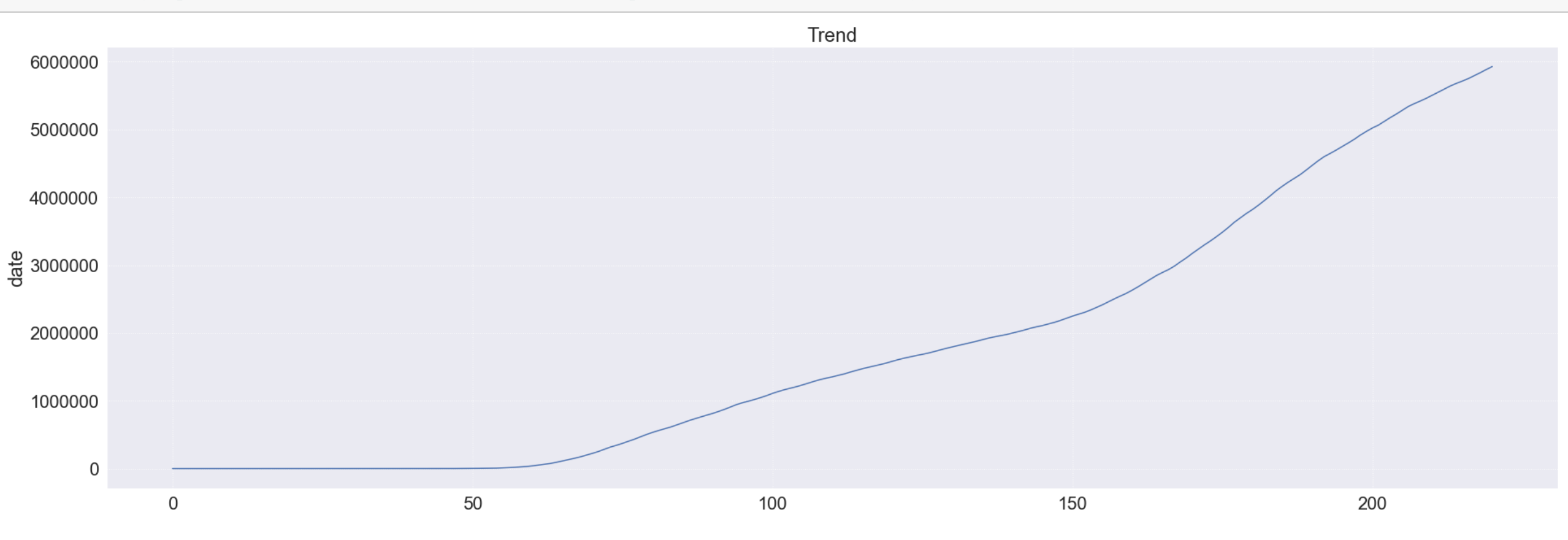
In [9]:

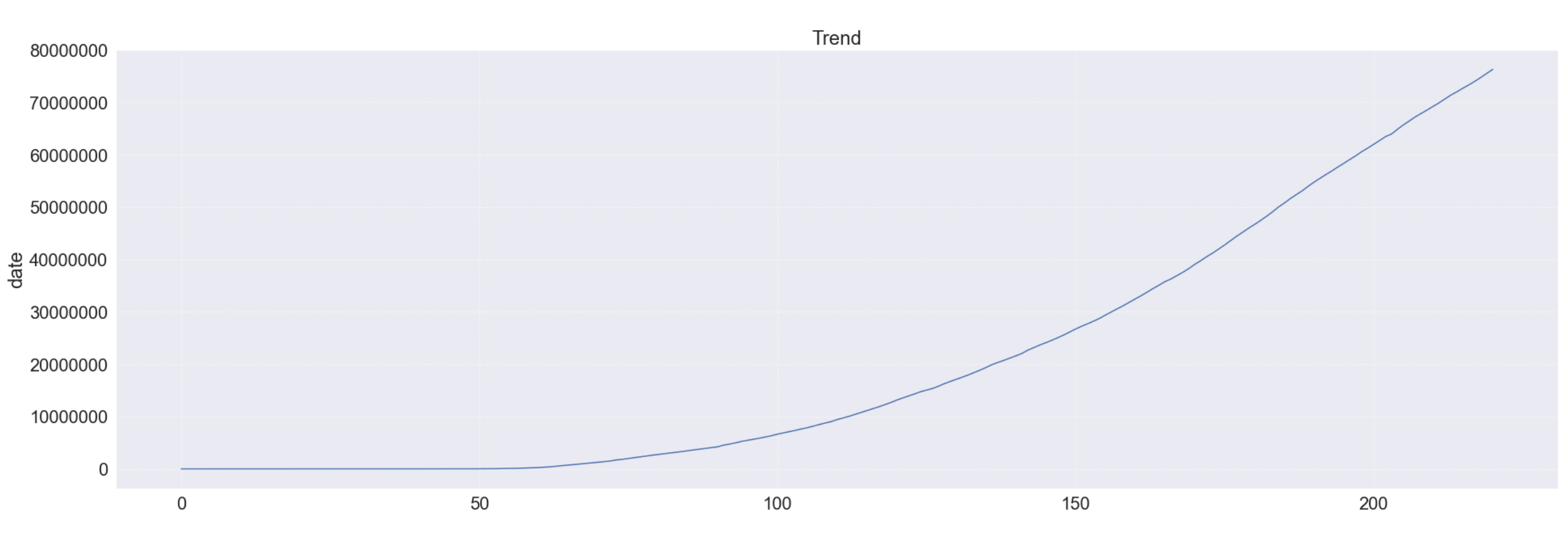
```
def GetSeries(key):
    df1 = df.groupby(['date'])[key].sum()
    df1 = df1.to_frame().reset_index()
    df1.sort_values(key,ascending=True,inplace=True)
    return df1

def ShowTrend(key_list,df):
    plt.style.use({'figure.figsize':(32, 10)})
    sns.set(font_scale=2)
    if type(key_list) == type([]):
        dd = []
        for key in key_list:
            dd.append(df[key])
        ax = sns.lineplot(data=dd)
    else:
        ax = sns.lineplot(x=df.index, y=key_list, markers=True, data=df)
        #ax.set_xticklabels(df[key_list], rotation=60)
    ax.ticklabel_format(style='plain',axis='both')
    ax.set_title('Trend')
    ax.set_ylabel('count')
    ax.set_ylabel('date')
    plt.grid(linestyle=':')
    plt.show()

def GetFeatures():
    df2 = pd.DataFrame()
    df2['date'] = GetSeries('positive')['date']
    df2['positive']=GetSeries('positive')['positive']
    df2['positiveIncrease']=GetSeries('positiveIncrease')['positiveIncrease']
    df2['test'] = GetSeries('total')['total']
    df2['testIncrease'] = GetSeries('totalTestResultsIncrease')['totalTestResultsIncrease']
    return df2
```

检测数量和感染数量同步增加

In [10]:

```
df1 = GetFeatures()
ShowTrend('positive',df1)
ShowTrend('test',df1)
#ShowTrend('positiveIncrease',df1)
#ShowTrend('testIncrease',df1)
#ShowTrend(['positiveIncrease','testIncrease','positive','test'],df1)
```





提取大规模检测后的数据

In [11]:

```
df2 = df1[df1['positiveIncrease']>25000]
df2.head(3)
```

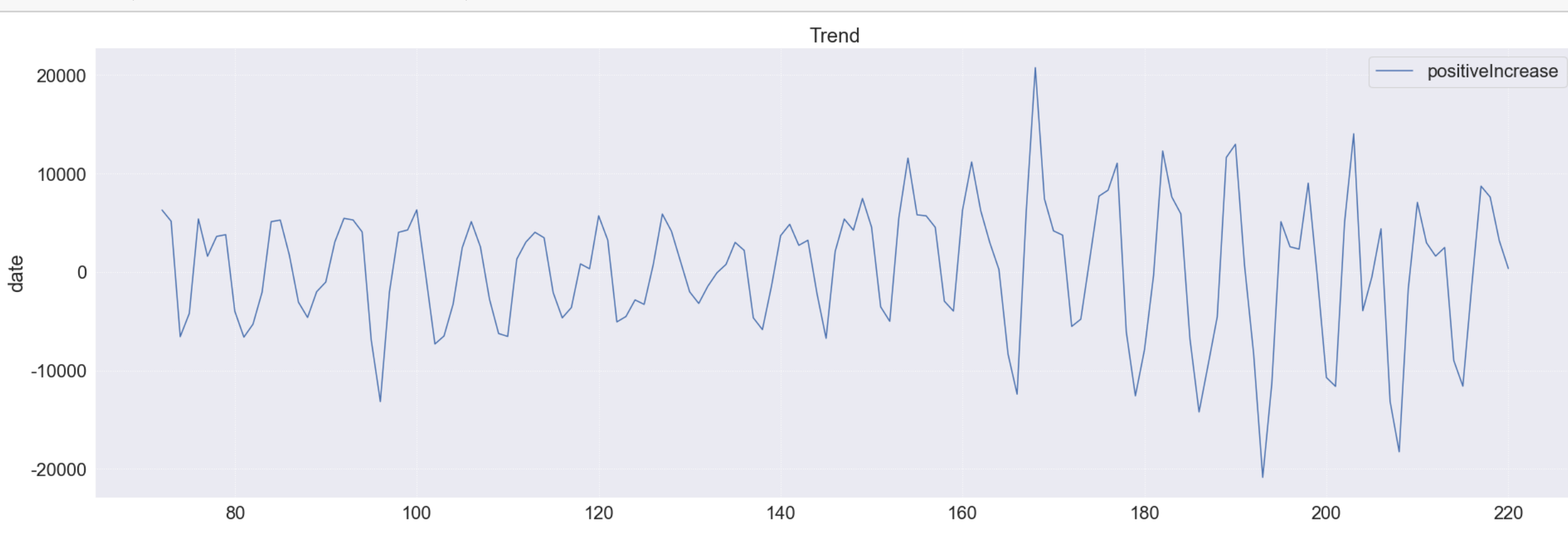
Out[11]:

	date	positive	positiveIncrease	test	testIncrease
70	20200401	224089.00	25785	1268243	108383
71	20200402	252146.00	28057	1389790	119310
72	20200403	284222.00	32076	1522758	132623

感染新增人数震荡下滑趋势

In [12]:

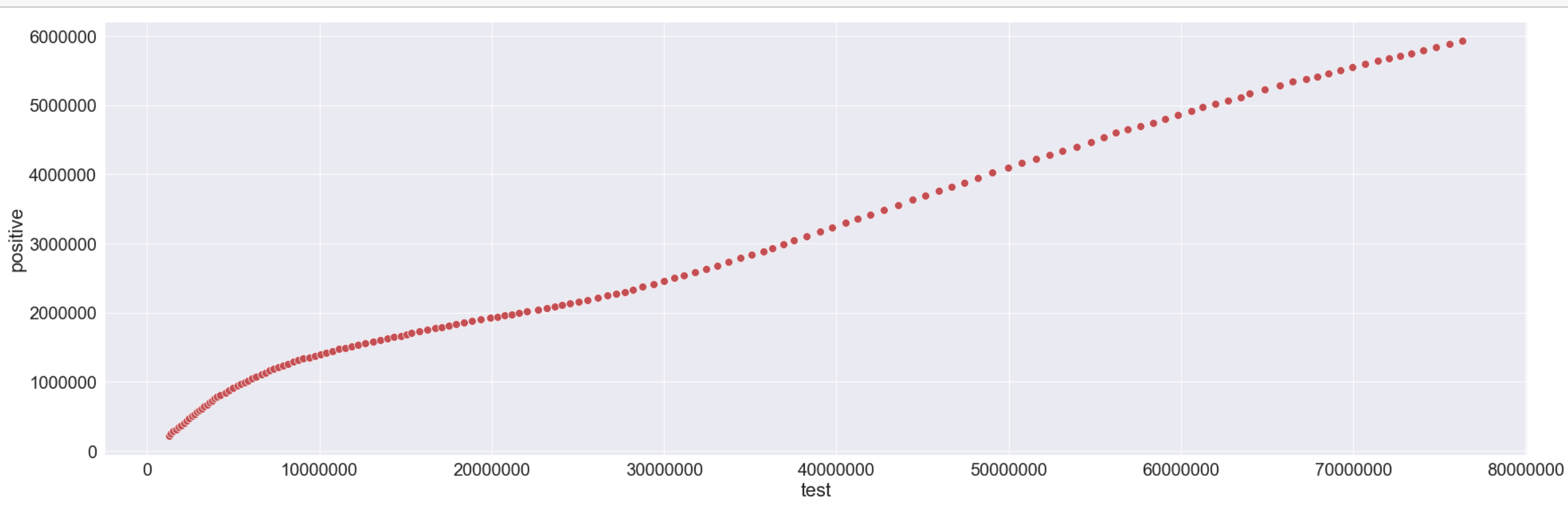
```
df2 = df1[df1['date']>='20200401']
df2['positiveIncrease'] = df2['positiveIncrease'].diff(2)
ShowTrend(['positiveIncrease'],df2)
```



检测数量和感染人数强关联

In [13]:

```
ax = sns.scatterplot(x="test", y="positive",s=100,color='r',data=df2)
#ax = sns.scatterplot(x="testIncrease", y="positiveIncrease",s=100,color='r',data=df2)
ax.ticklabel_format(style='plain',axis='both')
```



In [14]:

```
df2.corr()
```

Out[14]:

	positive	positiveIncrease	test	testIncrease
positive	1.00	-0.05	1.00	0.88
positiveIncrease	-0.05	1.00	-0.03	0.06
test	1.00	-0.03	1.00	0.89
testIncrease	0.88	0.06	0.89	1.00

根据地区（州）感染人数分析

In [15]:

```
df3 = df[df['date']>='20200401']
df3 = df3.groupby(['date','state'])['positive'].sum().reset_index(name="count")
df3.sort_values('date',ascending=False,inplace=True)
df3.head(3)
```

Out[15]:

	date	state	count
8455	20200829	WY	3784.00
8427	20200829	MP	56.00
8425	20200829	MN	74257.00

In [16]:

```
pt = df3.pivot_table(index='date', columns='state',  values=['count'],aggfunc=np.mean)
pt.fillna(value=0,inplace=True)
pt.head(10)
```

Out[16]:

	count																	
state	AK	AL	AR	AS	AZ	CA	CO	CT	DC	DE	...	TN	TX	UT	VA	VI	VT	WA
date																		
20200401	133.00	1077.00	584.00	0.00	1413.00	8155.00	2966.00	3557.00	586.00	368.00	...	2683.00	3997.00	1012.00	1484.00	30.00	359.00	73
20200402	143.00	1233.00	643.00	0.00	1598.00	9191.00	3342.00	3824.00	653.00	393.00	...	2845.00	4669.00	1074.00	1706.00	33.00	390.00	77
20200403	157.00	1432.00	704.00	0.00	1769.00	10701.00	3728.00	4914.00	757.00	450.00	...	3067.00	5330.00	1246.00	2012.00	38.00	460.00	82
20200404	171.00	1580.00	743.00	0.00	2019.00	12026.00	4173.00	5276.00	902.00	593.00	...	3321.00	6110.00	1428.00	2407.00	40.00	512.00	84
20200405	185.00	1796.00	830.00	0.00	2269.00	13438.00	4565.00	5675.00	998.00	673.00	...	3633.00	6812.00	1605.00	2637.00	42.00	543.00	85
20200406	191.00	1968.00	875.00	0.00	2456.00	14336.00	4950.00	6906.00	1097.00	673.00	...	3802.00	7276.00	1675.00	2878.00	43.00	575.00	89
20200407	213.00	2119.00	946.00	0.00	2575.00	15865.00	5172.00	7781.00	1211.00	928.00	...	4138.00	8262.00	1738.00	3333.00	43.00	608.00	93
20200408	226.00	2369.00	1000.00	0.00	2726.00	16957.00	5429.00	7781.00	1440.00	928.00	...	4362.00	9353.00	1846.00	3645.00	45.00	631.00	97
20200409	235.00	2769.00	1119.00	0.00	3018.00	18309.00	5655.00	9784.00	1523.00	1207.00	...	4634.00	10230.00	1976.00	4042.00	46.00	680.00	101
20200410	246.00	2968.00	1171.00	0.00	3112.00	19472.00	6510.00	10538.00	1660.00	1326.00	...	4862.00	11671.00	2102.00	4509.00	50.00	713.00	104

10 rows × 56 columns

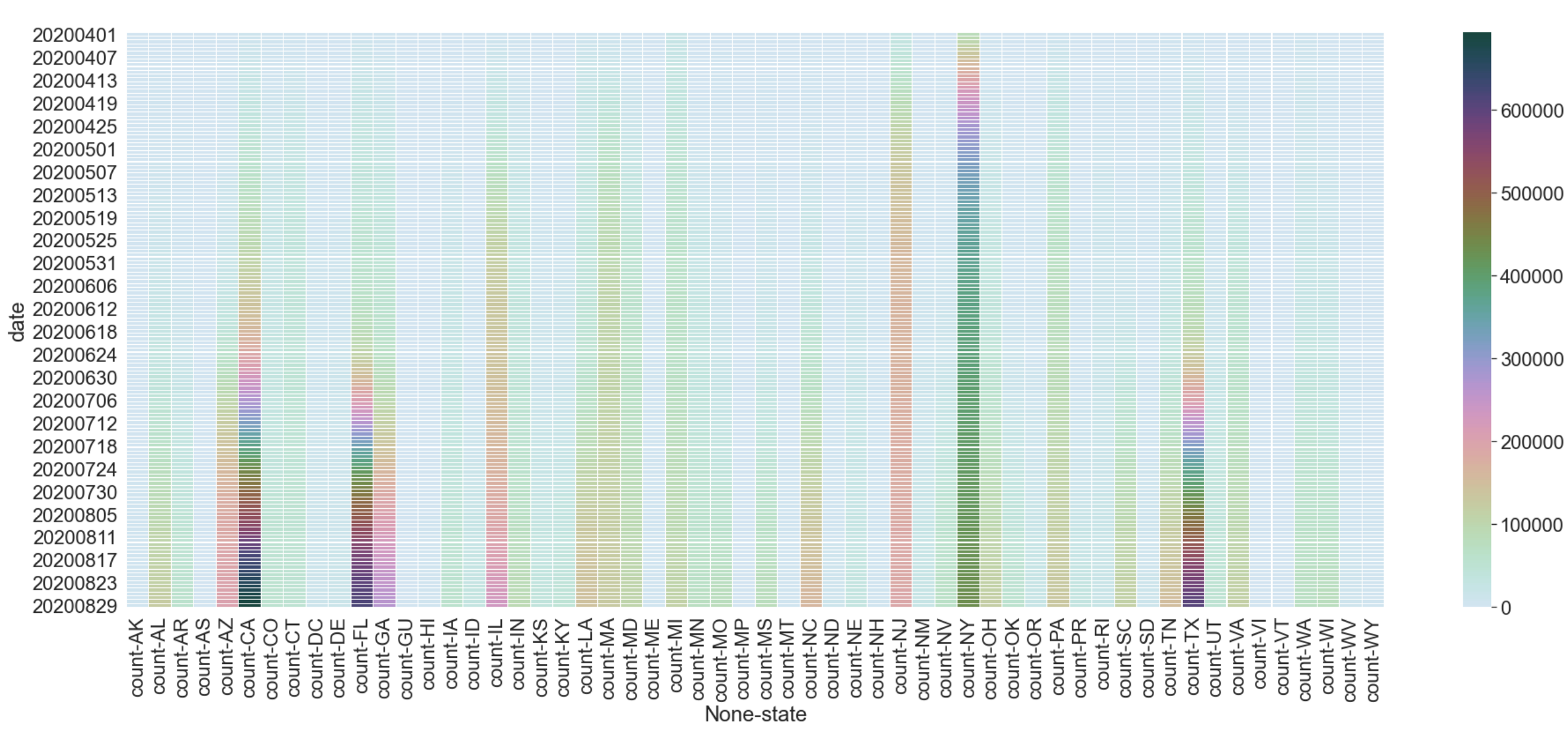
NY,CA,IL,MA,NJ 感染人数较多，CA,TX,FL,AZ 新增较多

In [17]:

```
plt.style.use({'figure.figsize':(32, 12)})
plt.ticklabel_format(style='plain',axis='both')
cmap = sns.cubehelix_palette(start = 1, rot = 3, gamma=0.8, as_cmap = True)
sns.heatmap(pt, cmap = cmap, linewidths = 0.05,annot=False, fmt="g")
```

Out[17]:

```
<AxesSubplot:xlabel='None-state', ylabel='date'>
```



州感染人数总数对比 df3['state'].unique() plt.style.use({'figure.figsize':(32, 24)}) ax = sns.barplot(x="count", y="state", data=df3) plt.grid(linestyle=':') plt.show()

In [18]:

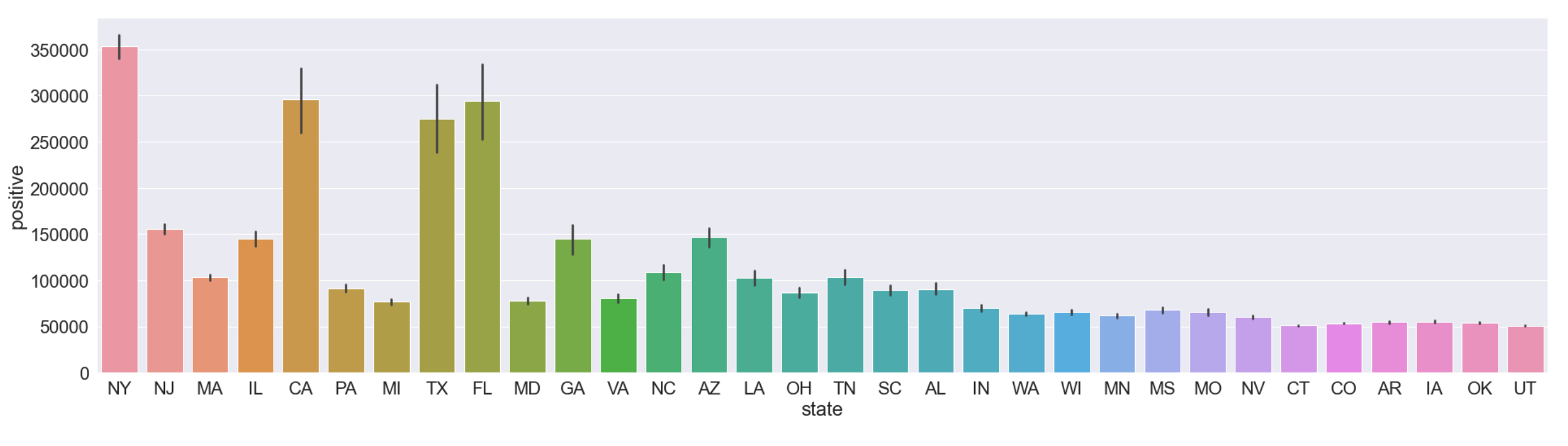
```
df4 = df[(df['date'] >= '20200401') ]
df5 = df4[df4['positive']>50000]
#df5 = df5[df5['state']!='NY']
df5.fillna(value=0,inplace=True)
df5 = df5.reset_index()
df5.sort_values('date',ascending=True,inplace=True)
```

In [19]:

```
plt.style.use({'figure.figsize':(32, 8)})
sns.set(font_scale=2)
sns.barplot(x="state", y="positive", data=df5)
```

Out[19]:

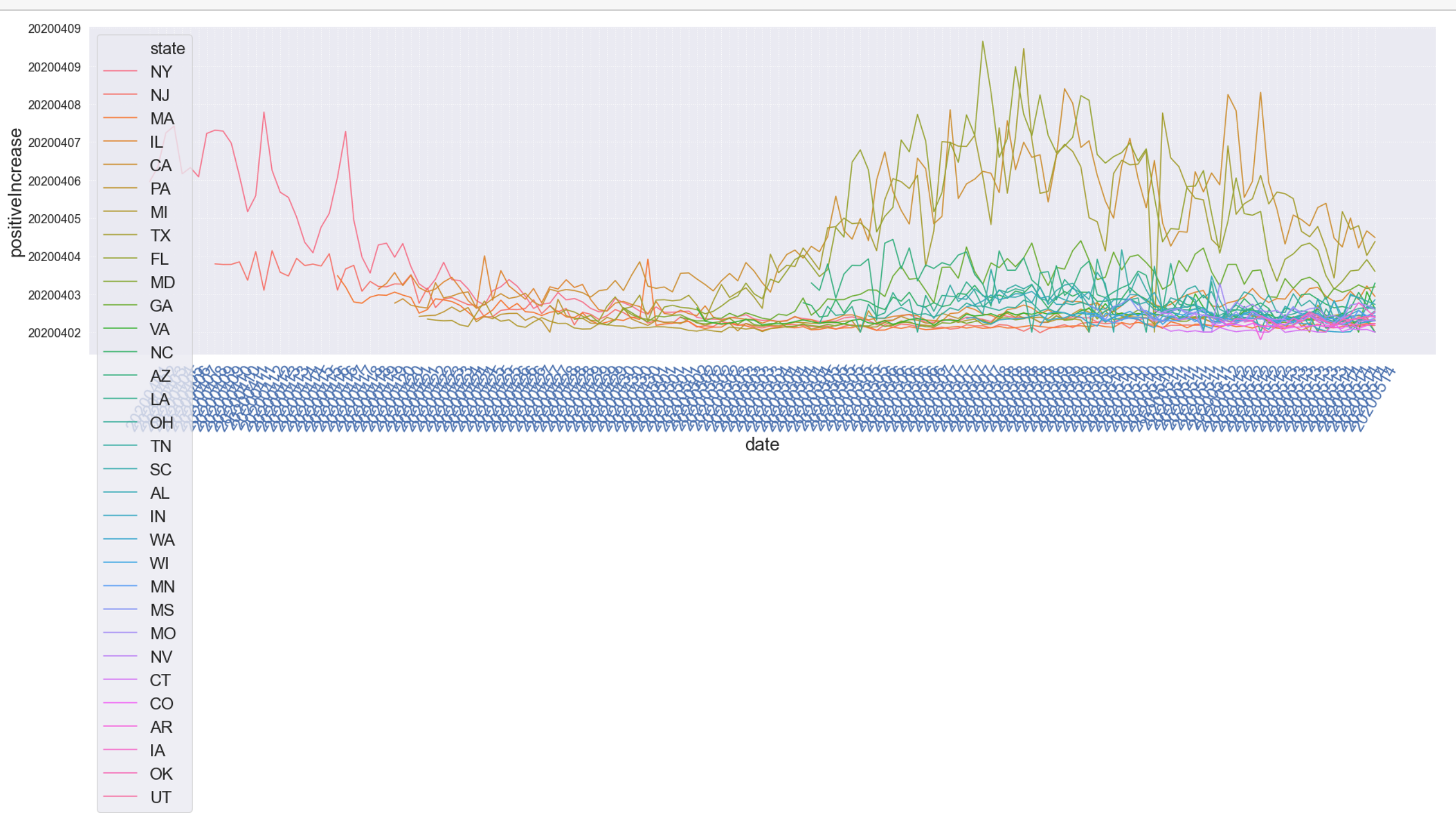
```
<AxesSubplot:xlabel='state', ylabel='positive'>
```



各州疫情爆发日期不同，无明显规律，需要进一步研究

In [20]:

```
ax = sns.lineplot(x='date', y='positiveIncrease', hue="state", markers=True, data=df5)
ax.tick_params(axis='x', colors='b') # x轴
ax.set_xticklabels(df5['date'], rotation=60)
ax.set_yticklabels(ax.get_xticklabels(),fontsize=16)
ax.set_yticklabels(ax.get_yticklabels(),fontsize=16)
plt.grid(linestyle=':')
plt.show()
```



总结： 1. 2020-04-01增幅震荡减少（进一步做平稳性检验） 2. 检测数量和感染人数强关联 3. NY,CA,IL,MA,NJ 感染人数较多 4. 各州疫情爆发日期不同，增幅无明显规律，需做进一步研究

In [ ]: