In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
```

In [2]:
```
df = pd.read_csv('data.csv')
```

In [3]:
```
df = df[(df['iso_code']=='FRA') | (df['iso_code']=='GBR') | (df['is
        (df['iso_code']=='CHE') | (df['iso_code']=='DEU') | (df['is
```

In [4]:
```
df = df[(df['date'] >= '2020-03-15') & (df['date'] <= '2020-11-09')
```

In [5]:
```
df.head()
```

Out[5]:

	iso_code	continent	location	date	total_cases	new_cases	new_cases_sm
4997	BEL	Europe	Belgium	2020-03-15	1541.0	179.0	
4998	BEL	Europe	Belgium	2020-03-16	1755.0	214.0	
4999	BEL	Europe	Belgium	2020-03-17	2142.0	387.0	2
5000	BEL	Europe	Belgium	2020-03-18	2564.0	422.0	
5001	BEL	Europe	Belgium	2020-03-19	3098.0	534.0	3

5 rows × 49 columns

In [6]:
```
df5ub = df[['location', 'date','new_cases','population', 'populatio
```

In [7]:
```
A = df5ub[df5ub['location']!='France']
```

In [8]:
```
A = A[['location','new_cases','population']]
```

In [9]:
```
germ = A[A['location']=='Germany'].reset_index().drop('index',axis=
ita = A[A['location']=='Italy'].reset_index().drop('index',axis=1)
port = A[A['location']=='Portugal'].reset_index().drop('index',axis
swi = A[A['location']=='Switzerland'].reset_index().drop('index',ax
unk = A[A['location']=='United Kingdom'].reset_index().drop('index'
bel  = A[A['location']=='Belgium'].reset_index().drop('index',axis=
```

In [10]:
```
N = pd.DataFrame(columns=['Italy'],index = range(0,240))
N['United Kingdom'] = unk['new_cases']
N['Italy']= ita['new_cases']
#N['Portogal'] = port['new_cases']
#N['Switzerland'] = swi['new_cases']
#N['Germany'] = germ['new_cases']
N['Belgium']= bel['new_cases']
N
```

Out[10]:

	Italy	United Kingdom	Belgium
0	3497.0	478.0	179.0
1	2823.0	361.0	214.0
2	4000.0	442.0	387.0
3	3526.0	611.0	422.0
4	4207.0	769.0	534.0
...	...	...	...
235	30548.0	25177.0	9057.0
236	34502.0	24138.0	7411.0
237	37802.0	23287.0	6047.0
238	39809.0	24957.0	NaN
239	32614.0	20572.0	NaN

240 rows × 3 columns

In [11]:
```
#correcting NaN values:
N['Belgium'].iloc[238] = N['Belgium'].iloc[237]
N['Belgium'].iloc[239] = N['Belgium'].iloc[237]
N
```

Out[11]:

	Italy	United Kingdom	Belgium
0	3497.0	478.0	179.0
1	2823.0	361.0	214.0
2	4000.0	442.0	387.0
3	3526.0	611.0	422.0
4	4207.0	769.0	534.0
...	...	...	...
235	30548.0	25177.0	9057.0
236	34502.0	24138.0	7411.0
237	37802.0	23287.0	6047.0
238	39809.0	24957.0	6047.0
239	32614.0	20572.0	6047.0

240 rows × 3 columns

In [12]:
```
A = N.to_numpy()
```

In [13]:
```
b = df5ub[df5ub['location']=='France']
```

In [14]:
```
b = b[['new_cases']]
```

In [15]:
```
b=b.to_numpy()
for i in range(0,240): ## correct corrupted data.
    if b[i] == 0:
        b[i]= b[i-1]
    elif b[i]<0:
        b[i]= -b[i]
```

In [16]:
```
A_train = A[:220]
b_train = b[:220]
A_test = A[220:]
b_test = b[220:]
```

In [17]:
```
 x = (np.linalg.inv((A_train.transpose()@A_train)))@A_train.transpo
    #@minimization (by def), using train only
```

In [18]:
```
x
```

Out[18]:
```
array([[0.41421485],
       [0.86787094],
       [0.3041958 ]])
```

In [19]:
```
predictions = A_test@x
```

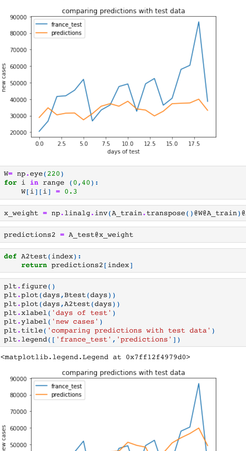
In [20]:
```
 r=predictions - b_test

np.linalg.norm(r)
```

Out[20]:
```
73500.42783145294
```

In [21]:
```
sns.histplot(r).set(xlabel='new cases', title = 'error distribution
```

Out[21]:
```
[Text(0.5, 0, 'new cases'), Text(0.5, 1.0, 'error distribution')]
```

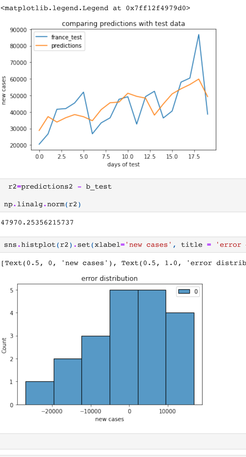


In [22]:
```
def Atest(index):
    return predictions[index]
def Btest(index):
    return b_test[index]

days = range(0,20)
```

In [23]:
```
plt.figure()
plt.plot(days,Btest(days))
plt.plot(days,Atest(days))
plt.xlabel('days of test')
plt.ylabel('new cases')
plt.title('comparing predictions with test data')
plt.legend(['france_test','predictions'])
```

Out[23]:
```
<matplotlib.legend.Legend at 0x7ff12f463580>
```



In [24]:
```
W= np.eye(220)
for i in range (0,40):
    W[i][i] = 0.3
```

In [25]:
```
x_weight = np.linalg.inv(A_train.transpose()@W@A_train)@A_train.tra
```

In [26]:
```
predictions2 = A_test@x_weight
```

In [27]:
```
def A2test(index):
    return predictions2[index]
```

In [28]:
```
plt.figure()
plt.plot(days,Btest(days))
plt.plot(days,A2test(days))
plt.xlabel('days of test')
plt.ylabel('new cases')
plt.title('comparing predictions with test data')
plt.legend(['france_test','predictions'])
```

Out[28]:
```
<matplotlib.legend.Legend at 0x7ff12f4979d0>
```

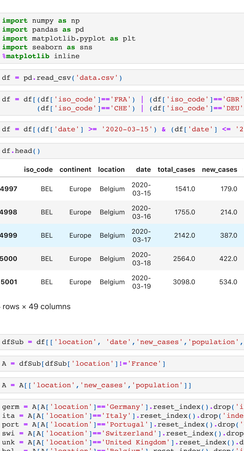

In [29]:
```
 r2=predictions2 - b_test

np.linalg.norm(r2)
```

Out[29]:
```
47970.25356215737
```

In [30]:
```
sns.histplot(r2).set(xlabel='new cases', title = 'error distributio
```

Out[30]:
```
[Text(0.5, 0, 'new cases'), Text(0.5, 1.0, 'error distribution')]
```



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