ML_Assignment

June 4, 2020

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

0.0.1 Pred 1: Total Cases till 31st July

[2]:
```
df=pd.read_csv('/Users/shivam_goyal/Downloads/ML Assignment/cases.csv')
```

[3]:
```
df['Date_numbers']=np.arange(len(df))
df.head()
```

[3]:

	cases_time_series/dailyconfirmed	cases_time_series/dailydeceased	cases_time_series/dailyrecovered	cases_time_series/date	cases_time_series/totalconfirmed	cases_time_series/totaldeceased	cases_time_series/totalrecovered	statewise/active	statewise/confirmed
0	1	0	0	30 January	1	0	0	93517.0	190791.0
1	0	0	0	31 January	1	0	0	36040.0	67655.0
2	0	0	0	01 February	1	0	0	9400.0	22333.0
3	1	0	0	02 February	2	0	0	10893.0	19844.0
4	1	0	0	03 February	3	0	0		

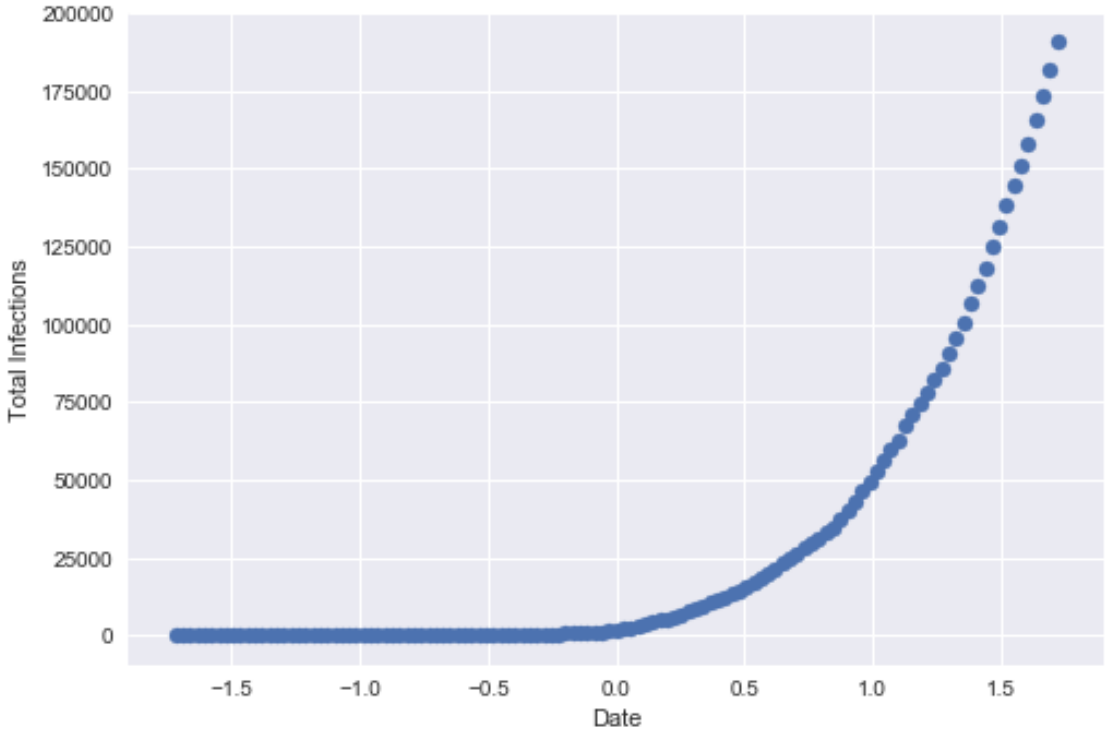
```
4                                0            5837.0              16794.0

   statewise/deaths  …                                tested/source  \
0            5408.0  …          Press_Release_ICMR_13March2020.pdf
1            2286.0  …     ICMR_website_update_18March_6PM_IST.pdf
2             176.0  …  ICMR_website_update_19March_10AM_IST_V2.pdf
3             473.0  …     ICMR_website_update_19March_6PM_IST.pdf
4            1038.0  …    ICMR_website_update_20March_10AM_IST.pdf

   tested/testpositivityrate  tested/testsconductedbyprivatelabs  \
0                      1.20%                                 NaN
1                      1.14%                                 NaN
2                      1.26%                                 NaN
3                      1.28%                                 NaN
4                      1.43%                                 NaN

  tested/testsperconfirmedcase  tested/testspermillion  \
0                        83.33                    5.0
1                        87.50                   10.0
2                        79.26                   10.0
3                        77.88                   11.0
4                        69.79                   11.0

   tested/totalindividualstested tested/totalpositivecases  \
0                         5900.0                        78
1                        12235.0                       150
2                        12426.0                       168
3                        13285.0                       182
4                        13486.0                       206

  tested/totalsamplestested tested/updatetimestamp  Date_numbers
0                    6500.0    13/03/2020 00:00:00             0
1                   13125.0    18/03/2020 18:00:00             1
2                   13316.0    19/03/2020 10:00:00             2
3                   14175.0    19/03/2020 18:00:00             3
4                   14376.0    20/03/2020 10:00:00             4

[5 rows x 32 columns]
```

[4]:
```
df=df.values
```

[5]:
```
y_train=df[:,4]
x_train=df[:,-1]
u=x_train.mean()
std=x_train.std()
print(u,std)
x_train=(x_train-u)/std
```

```
61.0 35.505868059613285
```

[6]:
```
plt.style.use('seaborn')
plt.xlabel('Date')
plt.ylabel('Total Infections')
plt.scatter(x_train,y_train)
plt.show()
```



[7]:
```
x_orig=x_train
y_orig=y_train
print(x_train.shape,y_train.shape)
```

```
(123,) (123,)
```

[8]:
```
# LOCALLY WEIGHTED REGRESSION
def getW(query_point,X,tau):
    M=X.shape[0]
    W=np.mat(np.eye(M))
    for i in range(M):
        xi=X[i].astype(float)
        x=query_point
        W[i,i]=np.exp(np.dot((xi-x),(xi-x).T)/(-2*tau*tau))
    return W
```

[9]:
```
x_=(183-u)/std
print(x_)
```

```
3.436051747704511
```

[10]:
```
x_train=x_train.reshape((123,-1))
y_train=y_train.reshape((123,-1))
x_train=np.mat(x_train,dtype=float)
y_train=np.mat(y_train,dtype=float)
print(x_train.shape)
```

```
(123, 1)
```

[11]:
```
M=x_train.shape[0]
print(M)
```

```
123
```

[12]:
```
W=getW(x_,x_train,0.5)
print(W.shape)
print(W)
```

```
(123, 123)
[[8.44023350e-24 0.00000000e+00 0.00000000e+00 … 0.00000000e+00
  0.00000000e+00 0.00000000e+00]
 [0.00000000e+00 1.50603984e-23 0.00000000e+00 … 0.00000000e+00
  0.00000000e+00 0.00000000e+00]
 [0.00000000e+00 0.00000000e+00 2.67880113e-23 … 0.00000000e+00
  0.00000000e+00 0.00000000e+00]
 …
 [0.00000000e+00 0.00000000e+00 0.00000000e+00 … 1.84243276e-03
  0.00000000e+00 0.00000000e+00]
 [0.00000000e+00 0.00000000e+00 0.00000000e+00 … 0.00000000e+00
  2.24654757e-03 0.00000000e+00]
 [0.00000000e+00 0.00000000e+00 0.00000000e+00 … 0.00000000e+00
  0.00000000e+00 2.73062214e-03]]
```

[13]:
```
def predict(X,Y,query_x,tau):
    ones=np.ones((M,1))
    X_=np.hstack((X,ones))
    print('X',X_.shape)
    qx=np.mat([query_x,1])
    print('qx',qx.shape)
    print('Y',Y.shape)
    W=getW(qx,X_,tau)
    print('W',W.shape)
    theta=np.linalg.pinv(X_.T*(W*X_))*(X_.T*(W*Y))
    print(theta.shape)
```

```
    pred=np.dot(qx,theta)
    return theta,pred
```

[14]:
```
theta,pred_july=predict(x_train,y_train,x_,0.5)
```

```
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
```

[15]:
```
print(pred_july)
```

```
[[586109.75123282]]
```

The total number of cases till 31st july should be approx 586110

[16]:
```
# 137-> jan to june
# 183-> jan to july
time_period=[]
pred_values_infections=[]
for i in range(137,183):
    e=(i-u)/std
    time_period.append(e)
    theta,pred=predict(x_train,y_train,time_period[i-137],0.5)
    pred_values_infections.append(pred)
```

```
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
```

```
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
```

```
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
```

```
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
```

```
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
```

```
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
```

[17]:
```
b=np.array(pred_values_infections)
b=b.flatten()
b
```

[17]:
```
array([254317.12899852, 260553.90705421, 266851.13354357, 273207.50056603,
       279621.7033718 , 286092.44223478, 292618.42421826, 299198.36483443,
       305830.98959867, 312515.03548041, 319249.25225258, 326032.40374194,
       332863.26898264, 339740.64327611, 346663.33915993, 353630.18728874,
       360640.03723059, 367691.75818149, 374784.23960188, 381916.39177787,
       389087.14631089, 396295.45653873, 403540.29789131, 410820.66818435,
       418135.58785417, 425484.10013655, 432865.27119269, 440278.19018552,
       447721.96930868, 455195.74377158, 462698.67174279, 470229.93425487,
       477788.73507251, 485374.30052747, 492985.87932166, 500622.74230155,
       508284.1822056 , 515969.51338688, 523678.0715137 , 531409.2132491 ,
       539162.31591183, 546936.77712082, 554732.01442415, 562547.46491487,
       570382.58483524, 578236.84917024])
```

[18]:
```
print(type(b))
print(b.shape[0])
```

```
<class 'numpy.ndarray'>
46
```

0.0.2 Pred 2: Number of deaths till 31st july

[19]:
```
df2=pd.read_csv('/Users/shivam_goyal/Downloads/ML Assignment/cases.csv')
```

[20]:
```
df2['Date_numbers']=np.arange(len(df))
df2.head()
```

[20]:

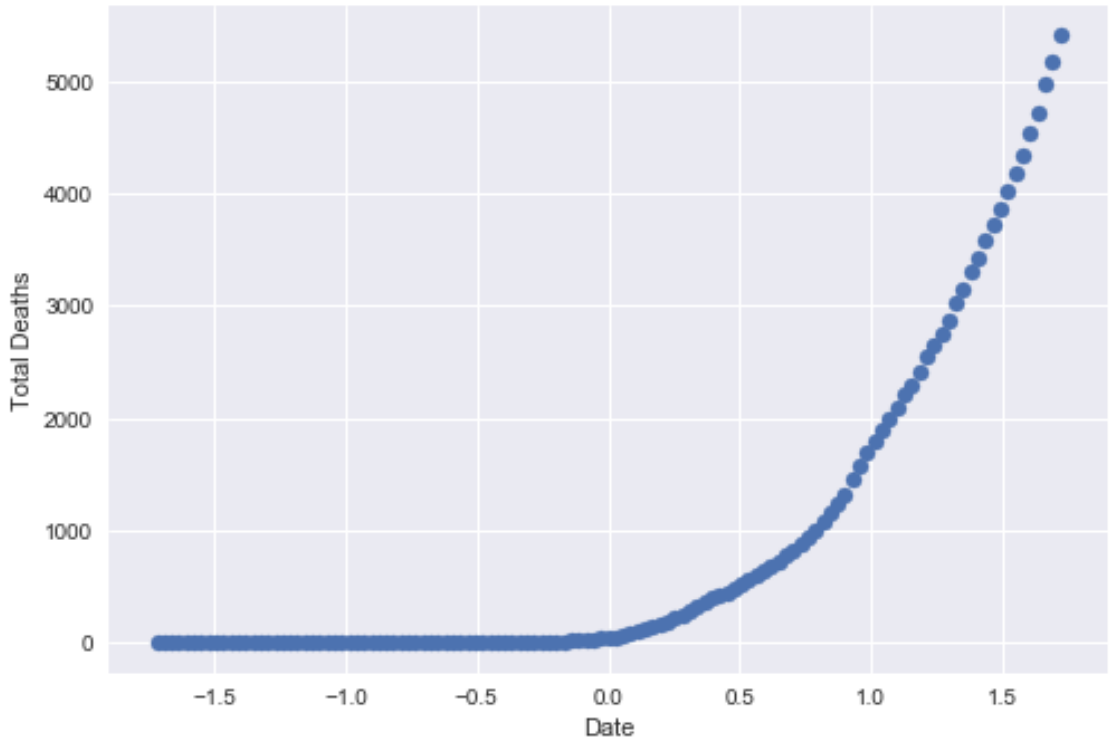
	cases_time_series/dailyconfirmed	cases_time_series/dailydeceased	cases_time_series/dailyrecovered	cases_time_series/date	cases_time_series/totalconfirmed	cases_time_series/totaldeceased	cases_time_series/totalrecovered	statewise/active	statewise/confirmed	statewise/deaths	…	tested/source	tested/testpositivityrate	tested/testsconductedbyprivatelabs	tested/testsperconfirmedcase	tested/testspermillion
0	1	0	0	30 January	1	0	0	93517.0	190791.0	5408.0	…	Press_Release_ICMR_13March2020.pdf	1.20%	NaN	83.33	5.0
1	0	0	0	31 January	1	0	0	36040.0	67655.0	2286.0	…	ICMR_website_update_18March_6PM_IST.pdf	1.14%	NaN	87.50	10.0
2	0	0	0	01 February	1	0	0	9400.0	22333.0	176.0	…	ICMR_website_update_19March_10AM_IST_V2.pdf	1.26%	NaN	79.26	10.0
3	1	0	0	02 February	2	0	0	10893.0	19844.0	473.0	…	ICMR_website_update_19March_6PM_IST.pdf	1.28%	NaN	77.88	11.0
4	1	0	0	03 February	3	0	0	5837.0	16794.0	1038.0	…	ICMR_website_update_20March_10AM_IST.pdf	1.43%	NaN		

```
4                         69.79                     11.0

   tested/totalindividualstested tested/totalpositivecases  \
0                         5900.0                         78
1                        12235.0                        150
2                        12426.0                        168
3                        13285.0                        182
4                        13486.0                        206

  tested/totalsamplestested tested/updatetimestamp  Date_numbers
0                    6500.0    13/03/2020 00:00:00             0
1                   13125.0    18/03/2020 18:00:00             1
2                   13316.0    19/03/2020 10:00:00             2
3                   14175.0    19/03/2020 18:00:00             3
4                   14376.0    20/03/2020 10:00:00             4

[5 rows x 32 columns]
```

[21]:
```
df=df2.values
y_train=df[:,5]
x_train=df[:,-1]
u=x_train.mean()
std=x_train.std()
print(u,std)
x_train=(x_train-u)/std
```

```
61.0 35.505868059613285
```

[22]:
```
plt.style.use('seaborn')
plt.xlabel('Date')
plt.ylabel('Total Deaths')
plt.scatter(x_train,y_train)
plt.show()
```



[23]:
```
x_train=x_train.reshape((123,-1))
y_train=y_train.reshape((123,-1))
x_train=np.mat(x_train,dtype=float)
y_train=np.mat(y_train,dtype=float)
print(x_train.shape)
```

```
(123, 1)
```

[24]:
```
W=getW(x_,x_train,0.5)
print(W.shape)
print(W)
```

```
(123, 123)
[[8.44023350e-24 0.00000000e+00 0.00000000e+00 … 0.00000000e+00
  0.00000000e+00 0.00000000e+00]
 [0.00000000e+00 1.50603984e-23 0.00000000e+00 … 0.00000000e+00
  0.00000000e+00 0.00000000e+00]
 [0.00000000e+00 0.00000000e+00 2.67880113e-23 … 0.00000000e+00
  0.00000000e+00 0.00000000e+00]
 …
 [0.00000000e+00 0.00000000e+00 0.00000000e+00 … 1.84243276e-03
  0.00000000e+00 0.00000000e+00]
 [0.00000000e+00 0.00000000e+00 0.00000000e+00 … 0.00000000e+00
```

```
 2.24654757e-03 0.00000000e+00]
[0.00000000e+00 0.00000000e+00 0.00000000e+00 … 0.00000000e+00
 0.00000000e+00 2.73062214e-03]]
```

[25]:
```
theta,pred=predict(x_train,y_train,x_,0.5)
```

```
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
```

[26]:
```
print(pred)
```

```
[[15522.38508576]]
```

The total number of deaths till 31st july should be approx 15522

0.0.3 Pred 3: Recovery and Death Rate from 15th June - 31st July

[27]:
```
df3=pd.read_csv('/Users/shivam_goyal/Downloads/ML Assignment/cases.csv')
df3['Date_numbers']=np.arange(len(df))
df3.head()
```

[27]:

	cases_time_series/dailyconfirmed	cases_time_series/dailydeceased	\
0	1	0	
1	0	0	
2	0	0	
3	1	0	
4	1	0	

	cases_time_series/dailyrecovered	cases_time_series/date	\
0	0	30 January	
1	0	31 January	
2	0	01 February	
3	0	02 February	
4	0	03 February	

	cases_time_series/totalconfirmed	cases_time_series/totaldeceased	\
0	1	0	
1	1	0	
2	1	0	
3	2	0	
4	3	0	

	cases_time_series/totalrecovered	statewise/active	statewise/confirmed	\
0	0	93517.0	190791.0	
1	0	36040.0	67655.0	

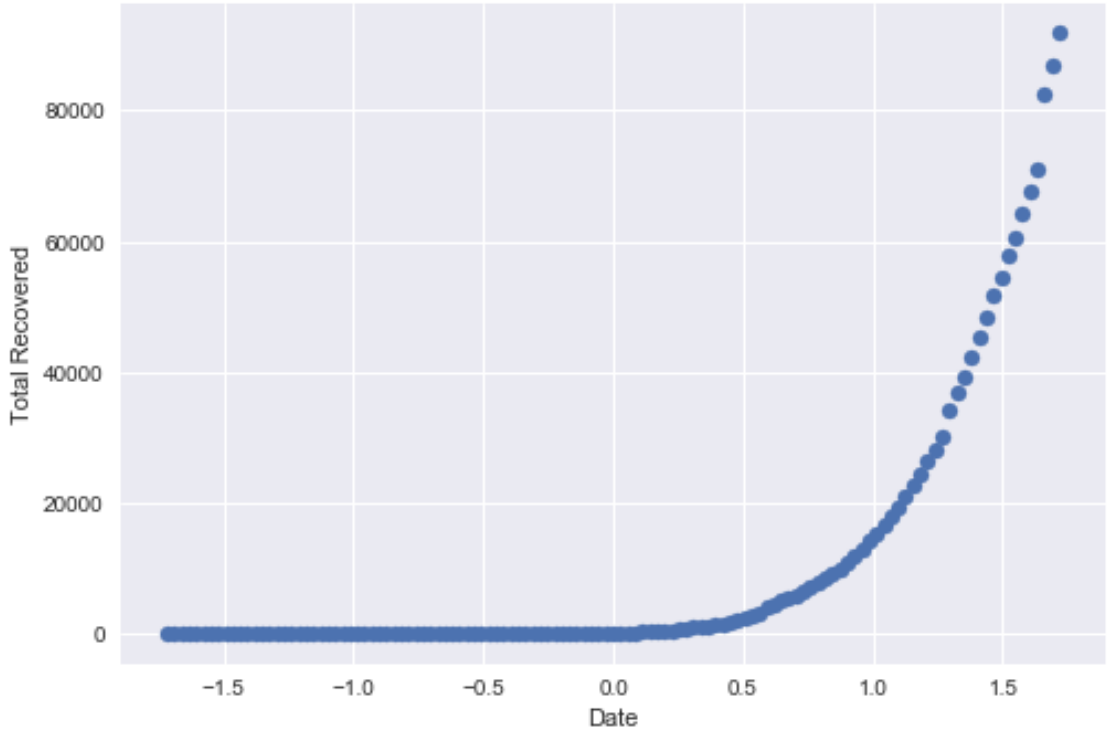
```
2                                0            9400.0              22333.0
3                                0           10893.0              19844.0
4                                0            5837.0              16794.0

   statewise/deaths  …                                tested/source  \
0            5408.0  …           Press_Release_ICMR_13March2020.pdf
1            2286.0  …      ICMR_website_update_18March_6PM_IST.pdf
2             176.0  …  ICMR_website_update_19March_10AM_IST_V2.pdf
3             473.0  …      ICMR_website_update_19March_6PM_IST.pdf
4            1038.0  …     ICMR_website_update_20March_10AM_IST.pdf

   tested/testpositivityrate  tested/testsconductedbyprivatelabs  \
0                      1.20%                                 NaN
1                      1.14%                                 NaN
2                      1.26%                                 NaN
3                      1.28%                                 NaN
4                      1.43%                                 NaN

  tested/testsperconfirmedcase  tested/testspermillion  \
0                        83.33                    5.0
1                        87.50                   10.0
2                        79.26                   10.0
3                        77.88                   11.0
4                        69.79                   11.0

   tested/totalindividualstested tested/totalpositivecases  \
0                         5900.0                        78
1                        12235.0                       150
2                        12426.0                       168
3                        13285.0                       182
4                        13486.0                       206

  tested/totalsamplestested tested/updatetimestamp  Date_numbers
0                    6500.0    13/03/2020 00:00:00             0
1                   13125.0    18/03/2020 18:00:00             1
2                   13316.0    19/03/2020 10:00:00             2
3                   14175.0    19/03/2020 18:00:00             3
4                   14376.0    20/03/2020 10:00:00             4

[5 rows x 32 columns]
```

[28]:
```
df=df3.values
y_train_recover=df[:,6]
y_train_death=df[:,5]
x_train=df[:,-1]
u=x_train.mean()
std=x_train.std()
```

```
print(u,std)
x_train=(x_train-u)/std
```

```
61.0 35.505868059613285
```

[29]:
```
plt.style.use('seaborn')
plt.xlabel('Date')
plt.ylabel('Total Recovered')
plt.scatter(x_train,y_train_recover)
plt.show()
```



[30]:
```
x_train=x_train.reshape((123,-1))
y_train_recover=y_train_recover.reshape((123,-1))
y_train_death=y_train_death.reshape((123,-1))
x_train=np.mat(x_train,dtype=float)
y_train_recover=np.mat(y_train_recover,dtype=float)
print(x_train.shape)
```

```
(123, 1)
```

[31]:
```
# 137-> jan to june
# 183-> jan to july
time_period=[]
```

```
pred_values_recover=[]
pred_values_death=[]
for i in range(137,183):
    e=(i-u)/std
    time_period.append(e)
    theta,pred_recover=predict(x_train,y_train_recover,time_period[i-137],0.5)
    pred_values_recover.append(pred_recover)
    theta,pred_death=predict(x_train,y_train_death,time_period[i-137],0.5)
    pred_values_death.append(pred_death)
```

```
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
```

```
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
```

```
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
```

```
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
```

```
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
```

```
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
```

```
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
```

```
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
```

```
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
```

```
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
X (123, 2)
qx (1, 2)
Y (123, 1)
W (123, 123)
(2, 1)
```

[32]:
```
r=np.array(pred_values_recover)
r=r.flatten()
r
```

[32]:
```
array([121431.42085998, 124953.74320456, 128523.65706024, 132140.57242255,
       135803.89997682, 139513.05241399, 143267.44564026, 147066.49988131,
```

```
       150909.64068168, 154796.29980131, 158725.91601152, 162697.93579332,
       166711.81394139, 170767.01407741, 174863.00907697, 178999.28141419,
       183175.32342871, 187390.63751962, 191644.73627117, 195937.14251502,
       200267.38933388, 204635.0200112 , 209039.58793174, 213480.65643763,
       217957.79864425, 222470.59722043, 227018.64413712, 231601.54038844,
       236218.89568899, 240870.32815111, 245555.46394529, 250273.93694726,
       255025.38837433, 259809.46641435, 264625.82584918, 269474.12767586,
       274354.03872684, 279265.23129186, 284207.38274331, 289180.17516614,
       294183.29499439, 299216.43265539, 304279.28222278, 309371.54107932,
       314492.90959058, 319643.09078983])
```

[33]:
```
d=np.array(pred_values_death)
d=d.flatten()
d
```

[33]:
```
array([7116.750246443891, 7275.192917006905, 7434.923876036697,
       7595.92583763583, 7758.181944310223, 7921.675747744195,
       8086.3911890059135, 8252.312578449417, 8419.42457554683,
       8587.712168855267, 8757.160656306329, 8927.755625971411,
       9099.482937433855, 9272.328703883179, 9446.27927501166,
       9621.321220788175, 9797.44131615677, 9974.626526688184,
       10152.863995213931, 10332.141029434912, 10512.445090509473,
       10693.763782596892, 10876.084843335924, 11059.396135224362,
       11243.685637863542, 11428.941441025274, 11615.151738494367,
       11802.30482264301, 11990.389079683075, 12179.392985547987,
       12369.305102355676, 12560.114075404308, 12751.808630641088,
       12944.37757258086, 13137.809782597324, 13332.094217576294,
       13527.219908867723, 13723.175961499972, 13919.951553641647,
       14117.535936246604, 14315.918432872688, 14515.088439645551,
       14715.03542532698, 14915.748931479578, 15117.218572709167,
       15319.434036941628], dtype=object)
```

recovery rate from 15th June to 31st July

[34]:
```
for i in range(b.shape[0]):
    rr=(r*100/b)
print(rr)
print(rr.shape)
print(type(rr))
```

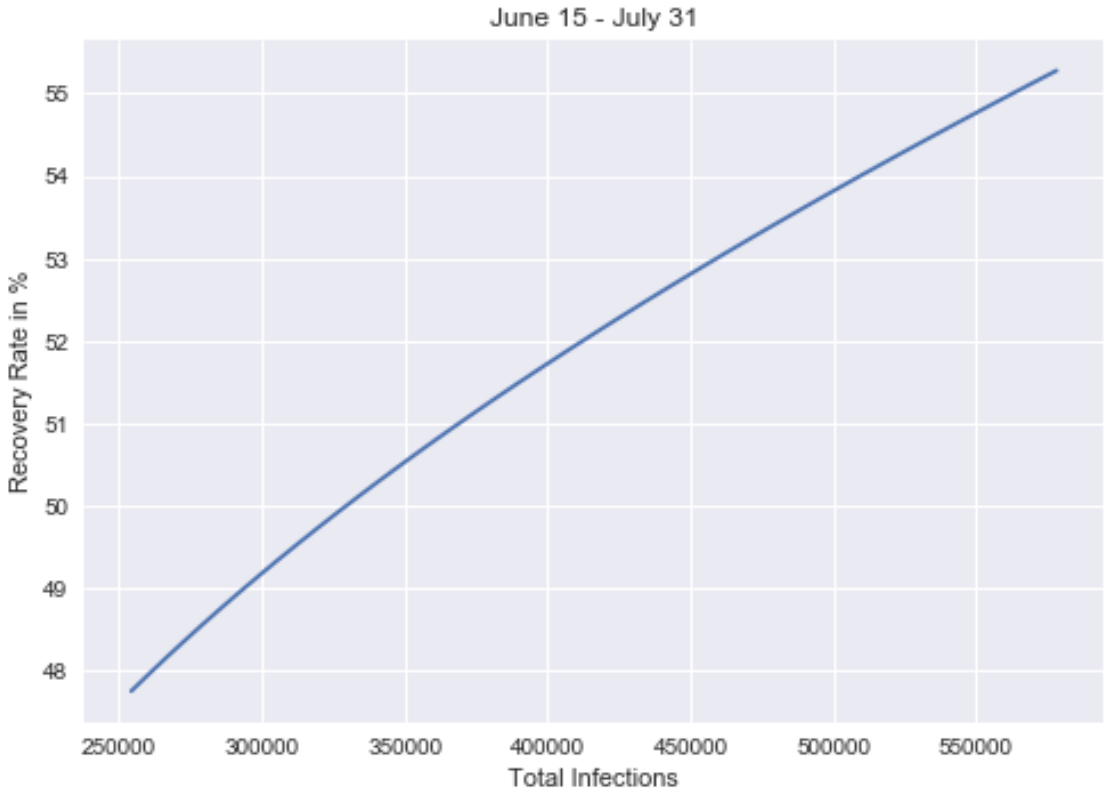
```
[47.74803071 47.95696392 48.16305457 48.36637799 48.56700976 48.7650255
 48.9605007  49.15351057 49.34412987 49.53243276 49.71849265 49.90238207
 50.08417253 50.2639344  50.44173679 50.61764743 50.79173262 50.96405708
 51.13468391 51.3036745  51.47108848 51.63698363 51.80141587 51.96443922
 52.12610574 52.2864655  52.44556661 52.60345517 52.76017526 52.91576897
 53.07027639 53.22373561 53.37618275 53.52765199 53.67817557 53.82778386
 53.97650534 54.12436666 54.27139271 54.41760661 54.56302978 54.70768198
 54.85158136 54.99474451 55.1371865  55.27892096]
```

```
(46,)
<class 'numpy.ndarray'>
```

[35]:
```
print(b.shape)
print(rr.shape)
```

```
(46,)
(46,)
```

[36]:
```
plt.xlabel('Total Infections')
plt.ylabel('Recovery Rate in %')
plt.title('June 15 - July 31')
plt.plot(b,rr)
plt.show()
```



death rate from 15th June to 31st July

[37]:
```
for i in range(b.shape[0]):
    dr=(d*100/b)
print(dr)
print(dr.shape)
print(type(dr))
```

```
[2.7983762928077476 2.792202580747841 2.7861691188292 2.7802771965991036
 2.77452781767606 2.7689217114108313 2.7634593449161153 2.7581409353677255
 2.7529664624881036 2.7479356811277826 2.743048133869345
 2.7383031635830286 2.7336999258720995 2.7292374013512903
 2.7249144077083223 2.7207296115058264 2.7166815396850814
 2.712768590740256 2.7089890455369567 2.705341077751993 2.701822763918723
 2.698432093064329 2.695166975929975 2.692025253768794 2.6890047067184373
 2.686103061749549 2.683318000192246 2.6806471648459076 2.678088166680139
 2.6756385911331395 2.673296004020417 2.6710579570624633
 2.6689219930448864 2.6668856506233913 2.664946468786242
 2.6631019909890137 2.6613497689755135 2.659687366297948
 2.6581123615517814 2.6566223513383123 2.655214952970446
 2.6538878069336898 2.652638579116815 2.6514649628252682
 2.6503646805899352 2.649335485783166]
(46,)
<class 'numpy.ndarray'>
```

[38]:
```
plt.xlabel('Total Infections')
plt.ylabel('Death Rate in %')
plt.title('June 15 - July 31')
plt.plot(b,dr)
plt.show()
```