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Assignment 8

COVID-19 Data Modelling

Basic Model of COVID-19 Growth Case in Indonesia

Part1.

The data is based on the following URL:

```
https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide
```

The country which is chosen to do the modelling is Indonesia. Such data contains about 101 rows. However, as the existing cases starts from 3/2/2020, the number of rows which is used to do the modelling is only 37 rows.

Data Exploration

while exploring the data, I found there is the non-sequence data. Therefore, I sort the data based on the sequence date in order to obtain the better growth. The following code is the data exploration code for Indonesia case.

```
#read directory
os.chdir('D:/George Mason University/Semester 2/Analytics Big Data to Information/Assignment 8')
os.getcwd()

#Import the data1
data1 = pd.read_csv('COVID-19-geographic-disbtribution-worldwide-2020-04-16.csv', sep = ',')
data1
data1.head(10)
data1.info()
data1['countriesAndTerritories']

#setdata1 Indonesia
data1_indonesia = data1.query('countriesAndTerritories == "Indonesia"')
len(data1_indonesia.index)
data1_indonesia2 = data1_indonesia.sort_values(by='dateRep')
data1_indonesia2.info()
data1_indonesia3 = data1_indonesia2[['dateRep', 'day', 'month', 'year', 'cases', 'deaths', 'popData2018',
'countriesAndTerritories']]
data1_indonesia3.head(50)

#test_data1_indonesia3 = data1_indonesia3.query('cases > 0')
#test_data1_indonesia3 = test_data1_indonesia3[['dateRep', 'day', 'month', 'year', 'cases', 'deaths', 'popData2018']]

#convert to array for sorting
dateRep1 = np.array(data1_indonesia3['dateRep'])
day1 = np.array(data1_indonesia3['day'])
month1 = np.array(data1_indonesia3['month'])
year1 = np.array(data1_indonesia3['year'])
cases1 = np.array(data1_indonesia3['cases'])
deaths1 = np.array(data1_indonesia3['deaths'])
popData1 = np.array(data1_indonesia3['popData2018'])
countriesAndTerritories1 = np.array(data1_indonesia3['countriesAndTerritories'])
```

```
################################################################################
#sort based on year
################################################################################
i = 0
while (i < (len(data1_indonesia3) - 1)):
    j = 0
    while (j < (len(data1_indonesia3)-i-1)):

        if (year1[j] > year1[j + 1]):
            temp1 = year1[j]
            year1[j] = year1[j + 1]
            year1[j + 1] = temp1

            temp2 = day1[j]
            day1[j] = day1[j + 1]
            day1[j + 1] = temp2

            temp3 = month1[j]
            month1[j] = month1[j + 1]
            month1[j + 1] = temp3

            temp4 = cases1[j]
            cases1[j] = cases1[j + 1]
            cases1[j + 1] = temp4

            temp5 = deaths1[j]
            deaths1[j] = deaths1[j + 1]
            deaths1[j + 1] = temp5

            temp6 = dateRep1[j]
            dateRep1[j] = dateRep1[j + 1]
            dateRep1[j + 1] = temp6

            temp7 = popData1[j]
            popData1[j] = popData1[j + 1]
            popData1[j + 1] = temp7

        j = j + 1
    i = i + 1
################################################################################
#sort based on month
################################################################################
i = 0
while (i < (len(data1_indonesia3) - 1)):
    if (year1[i] == year1[i + 1]):
        print("same year")

        j = i;
        while (j < (len(data1_indonesia3) - 1)):
            k = j
            while (k < (len(data1_indonesia3)-i-1)):
                print('sorting process')
                if (month1[k] > month1[k + 1]):
                    temp1 = year1[k]
                    year1[k] = year1[k + 1]
                    year1[k + 1] = temp1

                    temp2 = day1[k]
                    day1[k] = day1[k + 1]
                    day1[k + 1] = temp2

                    temp3 = month1[k]
                    month1[k] = month1[k + 1]
                    month1[k + 1] = temp3

                    temp4 = cases1[k]
                    cases1[k] = cases1[k + 1]
                    cases1[k + 1] = temp4

                    temp5 = deaths1[k]
                    deaths1[k] = deaths1[k + 1]
                    deaths1[k + 1] = temp5

                    temp6 = dateRep1[k]
                    dateRep1[k] = dateRep1[k + 1]
                    dateRep1[k + 1] = temp6

                    temp7 = popData1[k]
                    popData1[k] = popData1[k + 1]
                    popData1[k + 1] = temp7
                k = k + 1
            j = j + 1
    else:
        print("different year")
    i = i + 1
################################################################################
#sort based on day
################################################################################
i = 0
while (i < (len(data1_indonesia3) - 1)):
    if (year1[i] == year1[i + 1]):
        print("same year")

        j = i;
        while (j < (len(data1_indonesia3) - 1)):
```

```
            k = j
            while (k < (len(data1_indonesia3)-i-1)):
                if (month1[k] == month1[k + 1]):
                    print("same month")

                    l = k
                    while ((l < (len(data1_indonesia3)-i)) and (month1[l] == month1[l + 1])):
                        if (day1[l] > day1[l + 1]):
                            temp1 = year1[l]
                            year1[l] = year1[l + 1]
                            year1[l + 1] = temp1

                            temp2 = day1[l]
                            day1[l] = day1[l + 1]
                            day1[l + 1] = temp2

                            temp3 = month1[l]
                            month1[l] = month1[l + 1]
                            month1[l + 1] = temp3

                            temp4 = cases1[l]
                            cases1[l] = cases1[l + 1]
                            cases1[l + 1] = temp4

                            temp5 = deaths1[l]
                            deaths1[l] = deaths1[l + 1]
                            deaths1[l + 1] = temp5

                            temp6 = dateRep1[l]
                            dateRep1[l] = dateRep1[l + 1]
                            dateRep1[l + 1] = temp6

                            temp7 = popData1[l]
                            popData1[l] = popData1[l + 1]
                            popData1[l + 1] = temp7
                        l = l + 1
                else:
                    print("different month")
                k = k + 1
            j = j + 1
    else:
        print("different year")
    i = i + 1
################################################################################
#New Data Frame for setdata1 Indonesia
################################################################################
data1_indonesia4 = pd.DataFrame({'dateRep' : dateRep1,
                                 'day' : day1,
                                 'month' : month1,
                                 'year' : year1,
                                 'cases' : cases1,
                                 'deaths' : deaths1,
                                 'popData2018' : popData1,
                                 'countriesAndTerritories' : countriesAndTerritories1})

data1_indonesia4 = data1_indonesia4.query('cases > 0').reset_index(drop=False).reset_index(drop=False)

#data1_indonesia4 = data1_indonesia4[['level_0', 'dateRep', 'day', 'month', 'year', 'cases', 'deaths', 'popData2018']]
data1_indonesia4 = data1_indonesia4[['level_0', 'dateRep', 'day', 'month', 'year', 'cases']]

#data1_indonesia4.columns = ['Timestep', 'dateRep', 'day', 'month', 'year', 'cases', 'deaths', 'popData2018']
data1_indonesia4.columns = ['Timestep', 'dateRep', 'day', 'month', 'year', 'cases']

data1_indonesia4.head(16)
```

create a basic model of the growth of the virus in that country

prior to decide the best basic model, the summary of the model should be performed at first in order to check the R-Square value. In this case, since the R-Square value has the best value which almost approach to 1, and already been proved by analyzing the diagnostic plot, so the model seems to be the best basic model. The model summary is shown by the following summary:

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                   cases   R-squared:                       0.857
Model:                             OLS   Adj. R-squared:                  0.853
Method:                  Least Squares   F-statistic:                     215.0
Date:                 Sun, 19 Apr 2020   Prob (F-statistic):           9.38e-17
Time:                         00:21:18   Log-Likelihood:                -194.53
No. Observations:                   38   AIC:                             393.1
Df Residuals:                       36   BIC:                             396.3
Df Model:                            1
Covariance Type:            nonrobust
```

```
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        -31.6437     13.224     -2.393      0.022     -58.464      -4.823
Timestep       9.0163      0.615     14.662      0.000       7.769      10.263
==============================================================================
Omnibus:                        7.199   Durbin-Watson:                   1.538
Prob(Omnibus):                  0.027   Jarque-Bera (JB):                6.598
Skew:                           0.645   Prob(JB):                       0.0369
Kurtosis:                       4.582   Cond. No.                         42.2
==============================================================================
```

The following code is used to perform the summary above:

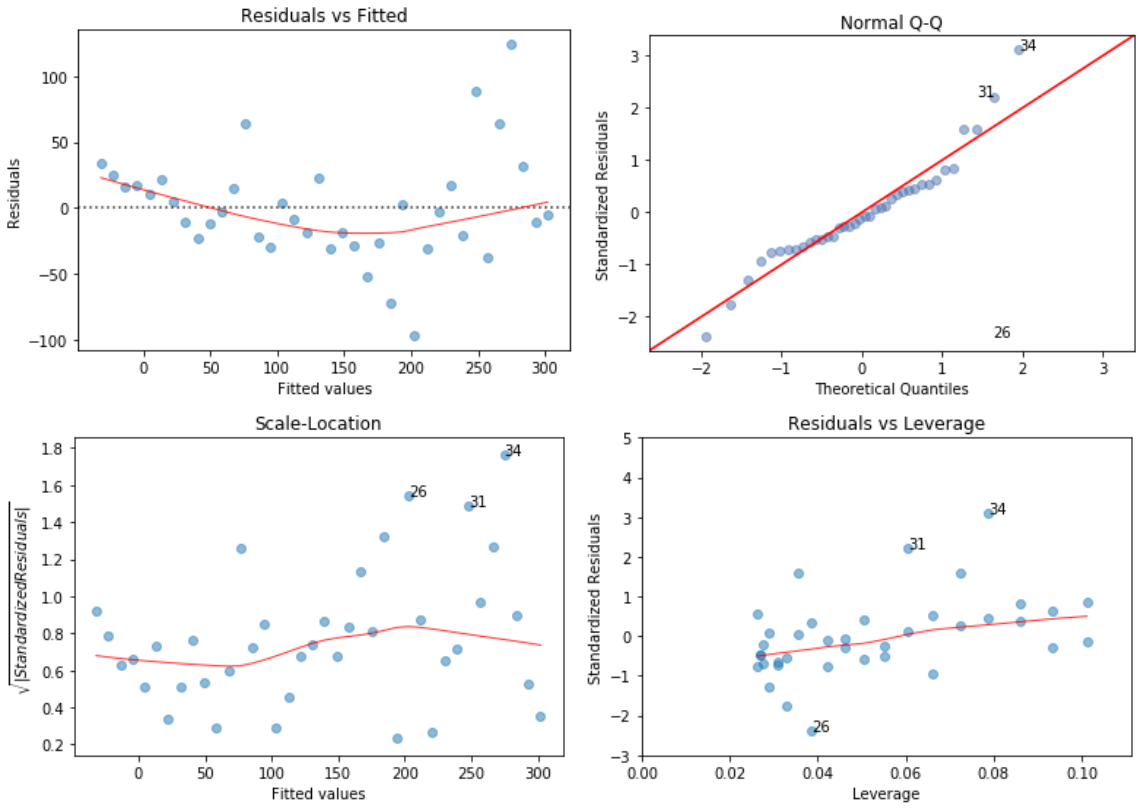
```
X = data1_indonesia4.Timestep
X = sm.add_constant(X)

y1 = data1_indonesia4.cases


model1 = sm.OLS(y1, X)
model_fit1 = model1.fit()

print(model_fit1.summary())
```

The diagnostic plot is performed while analyzing the model. The diagnostic plot is shown through the following picture.



According to the four diagnotic plot above, it can be concluded that the basic model is the best fit for the data. The first plot, which is the Residuals vs Fitted, shows that the model does not violate

the linear assumtions since the red line still adjacent to the dash line. Also, the spread residuals still surrounds the red line without many distinct patterns of the red line.

The second plot shows a little violations to the normality assumptions since there are some residuals with the extreme values than would be expected. However, even though the extreme data are omited, that would not make a lot of change since all the data are beyond the cook's distance as shown through plot number 4, the residuals vs leverage.

The third plot shows that the red line does not perfectly appear to be horizontal. However, as long as the red line is not the same as y = 0, it does not violate the equal variance.

The basic model of the residuals is **y = (-31.6437) + 9.0163X**. The declaration code of such model is shown through the following:

```
#basic model function =
#y = (-31.6437) + 9.0163X
def linear_predictions(t):
    return (-31.6437) + (9.0163 * t)
```

The actual data and the predicted data shown by the following:

	Timestep	dateRep	day	month	year	cases	PredictedCases
0	0	3/2/2020	2	3	2020	2	-31.6437
1	1	3/7/2020	7	3	2020	2	-22.6274
2	2	3/9/2020	9	3	2020	2	-13.6111
3	3	3/11/2020	11	3	2020	13	-4.5948
4	4	3/12/2020	12	3	2020	15	4.4215
5	5	3/14/2020	14	3	2020	35	13.4378
6	6	3/15/2020	15	3	2020	27	22.4541
7	7	3/16/2020	16	3	2020	21	31.4704
8	8	3/17/2020	17	3	2020	17	40.4867
9	9	3/18/2020	18	3	2020	38	49.5030
10	10	3/20/2020	20	3	2020	55	58.5193
11	11	3/21/2020	21	3	2020	82	67.5356
12	12	3/22/2020	22	3	2020	141	76.5519
13	13	3/23/2020	23	3	2020	64	85.5682
14	14	3/24/2020	24	3	2020	65	94.5845
15	15	3/25/2020	25	3	2020	107	103.6008
16	16	3/26/2020	26	3	2020	104	112.6171
17	17	3/27/2020	27	3	2020	103	121.6334
18	18	3/28/2020	28	3	2020	153	130.6497
19	19	3/29/2020	29	3	2020	109	139.6660
20	20	3/30/2020	30	3	2020	130	148.6823
21	21	3/31/2020	31	3	2020	129	157.6986
22	22	4/1/2020	1	4	2020	114	166.7149
23	23	4/2/2020	2	4	2020	149	175.7312
24	24	4/3/2020	3	4	2020	113	184.7475
25	25	4/4/2020	4	4	2020	196	193.7638
26	26	4/5/2020	5	4	2020	106	202.7801
27	27	4/6/2020	6	4	2020	181	211.7964
28	28	4/7/2020	7	4	2020	218	220.8127
29	29	4/8/2020	8	4	2020	247	229.8290
30	30	4/9/2020	9	4	2020	218	238.8453
31	31	4/10/2020	10	4	2020	337	247.8616
32	32	4/11/2020	11	4	2020	219	256.8779
33	33	4/12/2020	12	4	2020	330	265.8942
34	34	4/13/2020	13	4	2020	399	274.9105
35	35	4/14/2020	14	4	2020	316	283.9268
36	36	4/15/2020	15	4	2020	282	292.9431
37	37	4/16/2020	16	4	2020	297	301.9594

The potential limitations of the model are the extreme spike of the data can't be predicted. Other than that, as shown in the second plot of the diagnostic plot, the data model does not perfectly match the residuals since the head and the tail does not perfectly match the diagonal line.

Part 2 (10 pts):

In order to make the changes and do the improvement, the search term trends I would look for is "fever" and" tiredness". It is obvious since those are considered as one of the symptoms of covid-19 [1]. Also, those are the most common first sign of covid-19 infection [2]. Moreover, such key words ever reach the highest key search in March 19th, 2020 [3].

References

[1] World Health Organization, "Q&A on coronaviruses (COVID-19)," WHO, 8 April 2020 . [Online]. Available: https://www.who.int/news-room/q-a-detail/q-a-coronaviruses#:~:text=symptoms. [Accessed 19 April 2020].

[2] Science Daily, "Loss of smell and taste validated as COVID-19 symptoms in patients with high recovery rate," Science News, 13 April 2020. [Online]. Available: https://www.sciencedaily.com/releases/2020/04/200413132809.htm. [Accessed 19 April 2020].

[3] Google, "Coronavirus Search Trends," Google, 4 April 2020. [Online]. Available: https://trends.google.com/trends/story/US_cu_4Rjdh3ABAABMHM_en. [Accessed 19 April 2020].