PREDICTION OF COVID-19 CASES IN BELGIUM USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

In Belgium, just like in any other affected country, COVID-19 has potentially disastrous implications. The global research community has responded with a surge in forecasting models. In this research paper, the ANN approach was applied to examine COVID-19 cases in Belgium. The employed data covers the period February 4, 2020 to October 31, 2020 whereas the out-of-sample period ranges over the period November 2020 to April 2021. The residuals and forecast evaluation statistics (Error, MSE and MAE) of the applied model suggest that the model is quite stable and basically acceptable for forecasting daily COVID-19 cases in Belgium. The results of the study indicate that the COVID-19 pandemic in Belgium will not end anytime soon as cases will remain, generally; significantly high throughout the out-of-sample period. The government of Belgium in line with the findings of the study; should ensure the continued compliance to control and preventive COVID-19 measures.

Keywords: - *ANN, COVID-19, Forecasting*

INTRODUCTION

Coronavirus Disease 2019 (COVID-19) is a respiratory disease caused by a highly infectious single-stranded RNA corona virus, SARS-CoV-2 (Chen *et al*., 2020; Wu *et al*., 2020). Its first case was reported in Wuhan, the capital city of the Hubei province of China, in late December 2019 (Zhu *et al*., 2020). Belgium's first case was an imported one, and was officially reported on February 4, 2020, in Brussels. Since then, cases of COVID-19 infections have surged. The Belgian government continues to undertake measures to slow down community transmissions (Neyens *et al*., 2020; Ruzhansky *et al*., 2020). Models focusing on analyzing the COVID-19 pandemic in Belgium have already been done, for example; Neyens *et al*. (2020), Ruzhansky *et al*. (2020) and Decock *et al*. (2020). However, studies inclined towards forecasting daily COVID-19 case volumes in the country are scanty. Therefore, it is this information gap that this study seeks to fill. Forecasting daily COVID-19 cases is pivotal for management and future directions as well as allocating necessary resources to restrict the virus spreading (Wang *et al*., 2020; Mavroudis *et al*., 2020; Awan & Aslam, 2020).

METHODOLOGY

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID -19 infections in Belgium. The study particularly applies the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function. This study is actually based on daily new Covid-19 cases (referred to as BG series in this study) for all age groups in Belgium. The data covers the period 4 February 2020 to 31 October 2020 while the out-of-sample forecast covers the period November 2020 to April 2021. All the data employed in this paper was gathered from the COVID-19 data repository prepared by the CSSE at JH University.

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
1583.9	389.00	0.00000	23921.
Std. Dev.	C.V.	Skewness	Ex. kurtosis
3720.6	2.3490	3.7115	14.034
5% Perc.	95% Perc.	IQ range	Missing obs.
0.00000	10294.	954.00	0

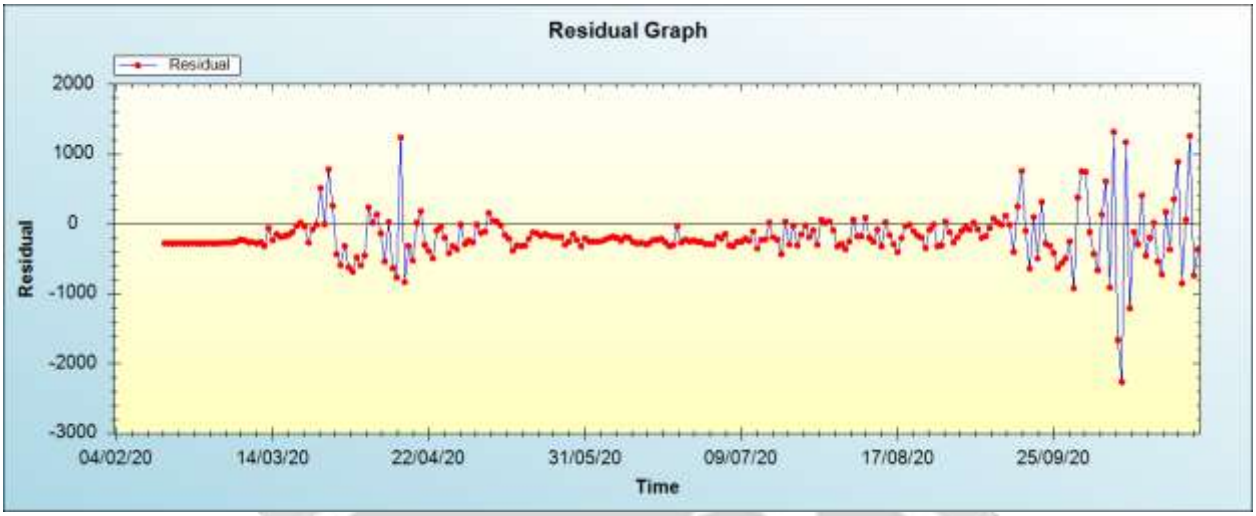
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN BELGIUM

Table 2: ANN model summary

Variable	BC
Observations	259 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.030028
MSE	159249.346445
MAE	290.809545

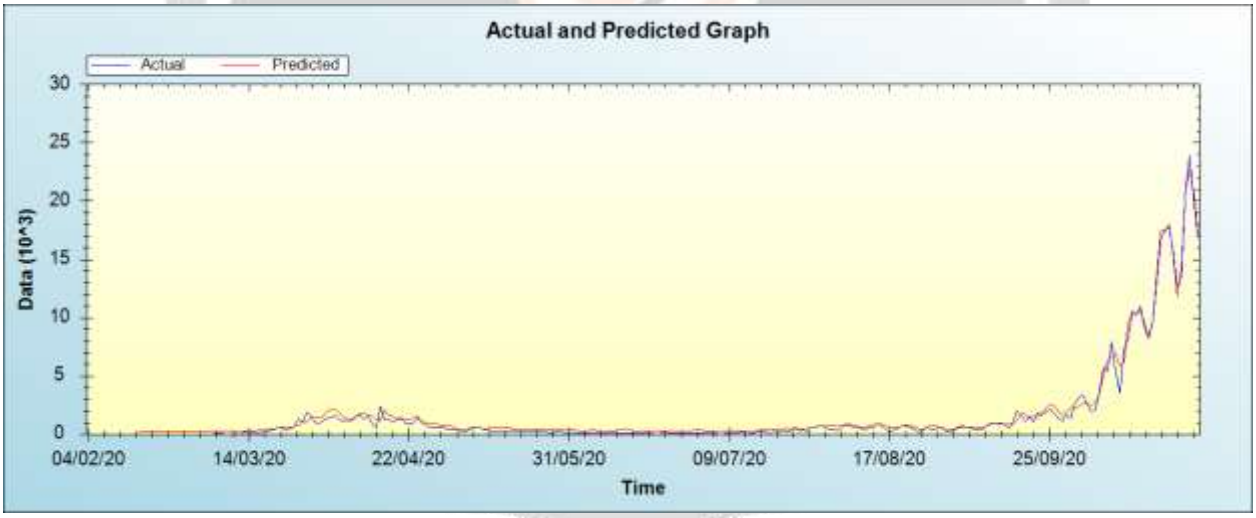
Residual Analysis for the ANN model

Figure 1: Residual analysis



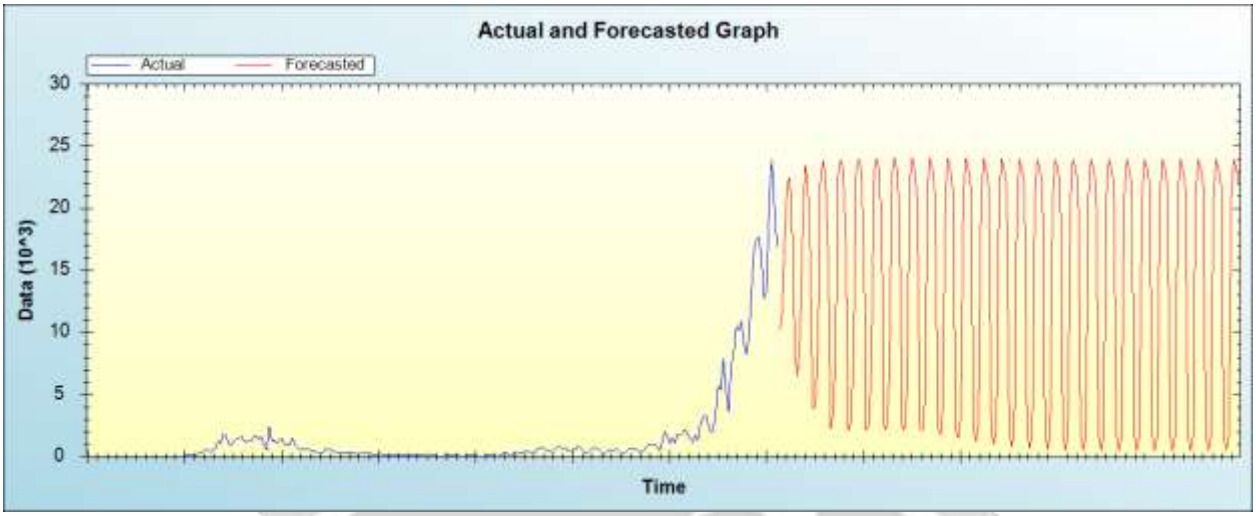
In-sample Forecast for BC

Figure 2: In-sample forecast for the BC series



Out-of-Sample Forecast for BC: Actual and Forecasted Graph

Figure 3: Out-of-sample forecast for BC: actual and forecasted graph



Out-of-Sample Forecast for BC: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	10203.2546
02/11/20	11543.4629
03/11/20	17624.3005
04/11/20	21966.2921
05/11/20	22470.8369
06/11/20	17631.7378
07/11/20	8065.2720
08/11/20	6425.8588
09/11/20	9482.1868
10/11/20	17728.0011
11/11/20	23500.0502
12/11/20	22140.9862
13/11/20	16532.8476
14/11/20	3831.2355

15/11/20	3935.6550
16/11/20	8578.8475
17/11/20	22155.6668
18/11/20	23857.1392
19/11/20	22680.8556
20/11/20	16460.8452
21/11/20	2247.3044
22/11/20	3409.2596
23/11/20	8750.5566
24/11/20	23088.3701
25/11/20	23952.9434
26/11/20	23015.8532
27/11/20	16919.5429
28/11/20	2106.3535
29/11/20	2844.1120
30/11/20	8322.3217
01/12/20	23086.5623
02/12/20	23964.1255
03/12/20	23104.5969
04/12/20	17460.5855
05/12/20	2115.4320
06/12/20	2548.0354
07/12/20	7446.4232
08/12/20	22928.1667
09/12/20	24016.8967
10/12/20	23123.7981

11/12/20	18570.1813
12/12/20	2146.1024
13/12/20	2349.1835
14/12/20	6584.8152
15/12/20	22675.5523
16/12/20	24063.7052
17/12/20	23140.9954
18/12/20	19644.7749
19/12/20	2216.2435
20/12/20	2210.9024
21/12/20	5612.3118
22/12/20	22281.8003
23/12/20	24070.3029
24/12/20	23153.2295
25/12/20	20475.8871
26/12/20	2248.3656
27/12/20	2027.0810
28/12/20	4667.8504
29/12/20	21829.3954
30/12/20	24052.1027
31/12/20	23159.8124
01/01/21	21038.4474
02/01/21	2237.2882
03/01/21	1776.7429
04/01/21	3851.7211
05/01/21	21431.9221

06/01/21	24028.0768
07/01/21	23162.8867
08/01/21	21399.5033
09/01/21	2197.1093
10/01/21	1492.8836
11/01/21	3198.6987
12/01/21	21149.5932
13/01/21	24008.7593
14/01/21	23164.4794
15/01/21	21628.5056
16/01/21	2138.6818
17/01/21	1222.3623
18/01/21	2702.7130
19/01/21	20979.1607
20/01/21	23995.7657
21/01/21	23166.0596
22/01/21	21773.2555
23/01/21	2069.5712
24/01/21	996.5971
25/01/21	2341.2107
26/01/21	20889.4569
27/01/21	23987.6254
28/01/21	23167.9142
29/01/21	21863.1965
30/01/21	1998.0179
31/01/21	824.8303

01/02/21	2086.5624
02/02/21	20849.0637
03/02/21	23982.6696
04/02/21	23169.7328
05/02/21	21917.2614
06/02/21	1931.7186
07/02/21	701.7611
08/02/21	1912.1300
09/02/21	20835.8556
10/02/21	23979.7210
11/02/21	23171.2347
12/02/21	21948.4395
13/02/21	1875.6230
14/02/21	616.9734
15/02/21	1795.4578
16/02/21	20836.3063
17/02/21	23978.0289
18/02/21	23172.3569
19/02/21	21965.6652
20/02/21	1831.4806
21/02/21	560.2509
22/02/21	1719.1252
23/02/21	20842.5787
24/02/21	23977.1106
25/02/21	23173.1636
26/02/21	21974.7863

27/02/21	1798.7096
28/02/21	523.2854
01/03/21	1670.2560
02/03/21	20850.3459
03/03/21	23976.6494
04/03/21	23173.7395
05/03/21	21979.3974
06/03/21	1775.5153
07/03/21	499.7937
08/03/21	1639.6297
09/03/21	20857.4781
10/03/21	23976.4420
11/03/21	23174.1485
12/03/21	21981.5947
13/03/21	1759.7419
14/03/21	485.2162
15/03/21	1620.8278
16/03/21	20863.1780
17/03/21	23976.3648
18/03/21	23174.4343
19/03/21	21982.5527
20/03/21	1749.3724
21/03/21	476.3671
22/03/21	1609.5102
23/03/21	20867.3658
24/03/21	23976.3483

25/03/21	23174.6290
26/03/21	21982.9078
27/03/21	1742.7508
28/03/21	471.1031
29/03/21	1602.8255
30/03/21	20870.2712
31/03/21	23976.3562
01/04/21	23174.7579
02/04/21	21982.9915
03/04/21	1738.6287
04/04/21	468.0314
05/04/21	1598.9503
06/04/21	20872.2036
07/04/21	23976.3711
08/04/21	23174.8411
09/04/21	21982.9683
10/04/21	1736.1204
11/04/21	466.2729
12/04/21	1596.7458
13/04/21	20873.4469
14/04/21	23976.3857
15/04/21	23174.8934
16/04/21	21982.9138
17/04/21	1734.6257
18/04/21	465.2857
19/04/21	1595.5162

20/04/21	20874.2250
21/04/21	23976.3975
22/04/21	23174.9257
23/04/21	21982.8593
24/04/21	1733.7527
25/04/21	464.7430
26/04/21	1594.8447
27/04/21	20874.7002
28/04/21	23976.4062
29/04/21	23174.9451
30/04/21	21982.8152

The descriptive statistics, summary of the model used, analysis of residuals, in-sample forecasts as well as out-of-sample forecasts are shown in table 1, table 2, figure 1, figure 2 and well as figure 3 and table 3, respectively. The applied forecasting model is stable and acceptable as indicated in the residual analysis. The study established that the COVID-19 pandemic may not end anytime soon in Belgium: daily cases are likely to range from as low as 100 cases per day to as high as almost 25000 cases per day; over the out-of-sample period.

CONCLUSION & RECOMMENDATIONS

Indeed, COVID-19 is a serious concern for governments across the world. By studying its behavior, we can save millions of lives as authorities can use this information to prepare and face the crisis. Everyday, thousands of COVID-19 patients arrive at different hospitals around the globe needing immediate assistance, which; unfortunately, is usually not available. Therefore, it is fundamental to forecast the number of infected people and anticipate the future trends (Jojoa & Garcia-Zapirain, 2020; WHO, 2020; Atkeson, 2020). Based on 271 daily observations of COVID-19 cases in Belgium, this study used the ANN (12, 12, 1) model to come up with forecasts ranging over the period November 2020 to April 2021. The government of Belgium in line with the results of the study, should ensure the continued compliance to control and preventive COVID-19 measures such as social distancing, quarantine, isolation, face-mask wearing and so on. This will help a lot, especially in terms of avoiding extremely catastrophic daily COVID-19 case volumes in the country.

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