Forecasting Covid-19 New Cases in Bulgaria

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Abstract - **When it comes to public health nowadays, COVID-19 is of serious concern and considered as the supreme crisis of the present era. A surge in the number of patients testing positive for COVID-19 has created a lot of stress and frustration on governing bodies worldwide and they are finding it difficult to tackle the situation. In this research article, the ANN approach was applied to analyze COVID-19 case volumes in Bulgaria. This study is based on daily new cases of COVID-19 in Bulgaria for the period 1 January 2020 – 25 March 2021. The out-of-sample forecast covers the period 26 March 2021 – 31 July 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model reveal that the model is stable in forecasting COVID-19 cases in Bulgaria. It is projected that daily COVID-19 cases in Bulgaria are likely to decline to zero cases per day around mid-June 2021. The government of Bulgaria should continue to ensure that there is compliance to control and preventive COVID-19 measures such as social distancing, quarantine, isolation, face-mask wearing and so on. There is also need to embrace the vaccination programme in the country.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The Corona Virus Disease (COVID-19) is a global pandemic that was discovered by a Chinese physician in Wuhan, the capital city of Hubei province in mainland China, in December 2019 (WHO, 2020). It then propagated worldwide, and was declared a pandemic by the World Health Organization (WHO) at the tail end of January 2020 (Butt *et al.*, 2020). Symptoms of the disease include dry cough, sore throat and fever. Although, the majority of the cases are mild, some cases may lead to Acute Respiratory Distress Syndrome (ARDS), severe pneumonia, pulmonary oedema and organ failure (Chen *et al.*, 2020). COVID-19 propagation is faster when people are in close proximity. Thus, travel restrictions control the spread of the disease, and frequent hand washing is always recommended to prevent potential viral infections (Alazab *et al.*, 2020). Forecasting COVID-19 case volumes is very important (Medina-Mendieta *et al.*, 2020). In the first place, to inform government and healthcare professionals on what to expect and which measures to impose, and secondly, to motivate the wider public to adhere to the measures that were imposed to decelerate the spreading before a regrettable scenario unfolds (McCloskey *et al.*, 2020). Thirdly, forecasting models are used as a reference to make new policies and to evaluate the conditions of COVID-19 curfews (Remuzzi & Remuzzi, 2020). The motive behind this paper is to model and forecast daily confirmed cases of COVID-19 in Bulgaria.

II. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modeling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting new COVID-19 cases Bulgaria.

Data Issues

This study is based on daily new cases of COVID-19 in Bulgaria for the period 1 January 2020 – 25 March 2021.The out-of-sample forecast covers the period 26 March 2021 – 31 July 2021.All the data employed in this research paper was gathered from the Johns Hopkins University (USA).

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	B
Observations	438 (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	0.073185
MSE	38900.99194
MAE	122.51961

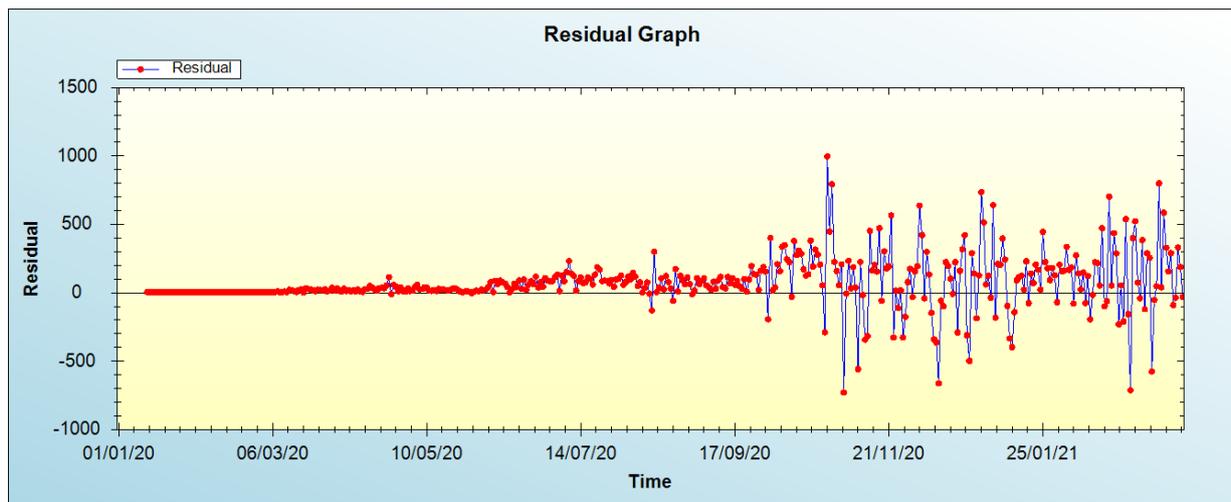*Residual Analysis for the Applied Model*

Figure 1: Residual analysis
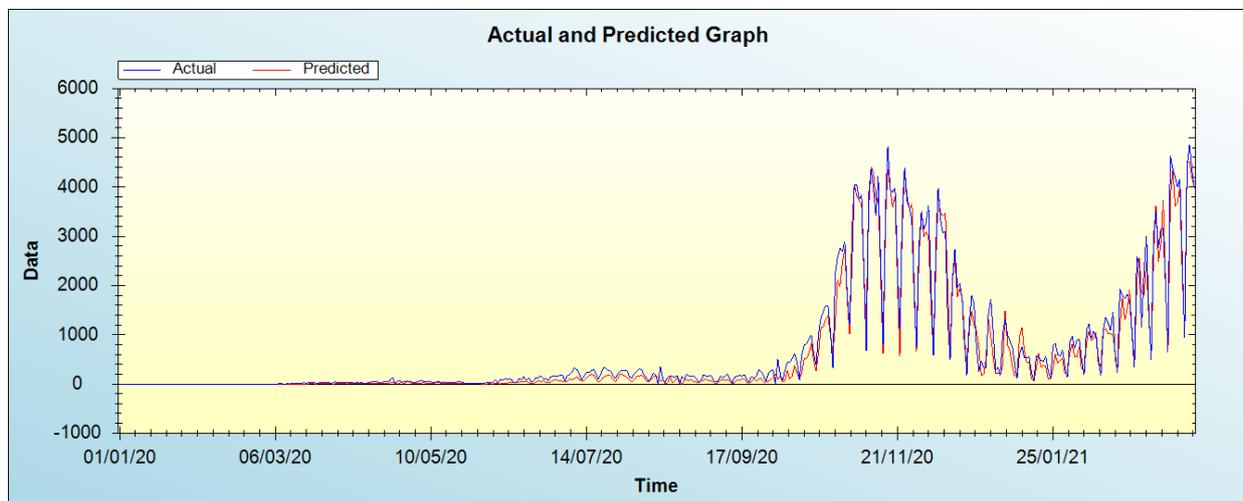
In-sample Forecast for B

Figure 2: In-sample forecast for the B series

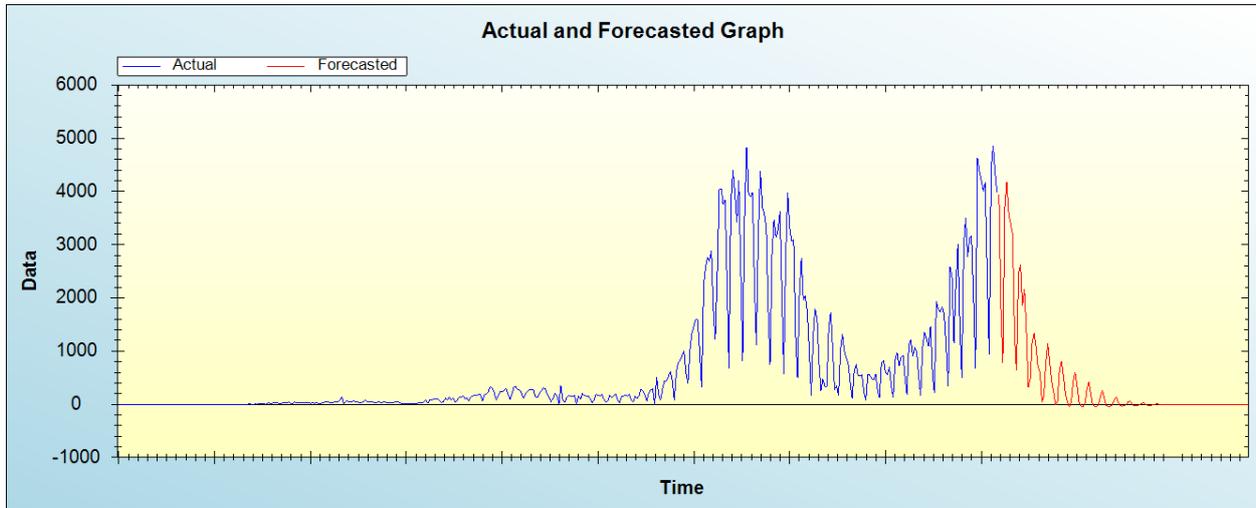*Out-of-Sample Forecast for B: Actual and Forecasted Graph*

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

Out-of-Sample Forecast for B: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	3940.6823
27/03/21	1852.1446
28/03/21	780.6117
29/03/21	3710.5990
30/03/21	4173.4588
31/03/21	3562.3643
01/04/21	3393.3695
02/04/21	3186.2835
03/04/21	1329.7094
04/04/21	640.1106
05/04/21	2457.2784
06/04/21	2621.3046
07/04/21	1854.8038
08/04/21	2159.0349
09/04/21	1445.7740
10/04/21	322.5819
11/04/21	477.4752
12/04/21	1150.3483
13/04/21	1331.7033
14/04/21	1065.9481
15/04/21	699.3397
16/04/21	611.8062
17/04/21	48.9921
18/04/21	140.7042
19/04/21	793.5421
20/04/21	1137.1069
21/04/21	766.7229
22/04/21	427.9421
23/04/21	222.1913
24/04/21	-12.4024
25/04/21	63.2116
26/04/21	639.4397
27/04/21	813.4695
28/04/21	539.7867
29/04/21	196.6284
30/04/21	38.1145
01/05/21	-50.7343

Date	Value
02/05/21	38.6781
03/05/21	435.0128
04/05/21	604.9319
05/05/21	338.9498
06/05/21	52.4037
07/05/21	-31.2445
08/05/21	-51.3308
09/05/21	15.9444
10/05/21	277.0870
11/05/21	418.3940
12/05/21	192.1325
13/05/21	-11.3887
14/05/21	-45.1544
15/05/21	-43.7782
16/05/21	0.2082
17/05/21	164.3345
18/05/21	257.0298
19/05/21	94.3701
20/05/21	-30.7627
21/05/21	-41.8313
22/05/21	-35.3974
23/05/21	-8.2200
24/05/21	88.9368
25/05/21	135.7909
26/05/21	37.3925
27/05/21	-32.0295
28/05/21	-33.8304
29/05/21	-28.0435
30/05/21	-10.8727
31/05/21	42.3877
01/06/21	61.3825
02/06/21	8.7710
03/06/21	-26.7896
04/06/21	-25.8564
05/06/21	-21.6900
06/06/21	-10.7777
07/06/21	16.4913
08/06/21	22.9193
09/06/21	-3.5096
10/06/21	-20.7372
11/06/21	-19.5965
12/06/21	-16.7761
13/06/21	-10.0773
14/06/21	3.2172
15/06/21	4.9133
16/06/21	-8.0551
17/06/21	-16.1506
18/06/21	-15.3630
19/06/21	-13.5317
20/06/21	-9.6177
21/06/21	-3.3481
22/06/21	-3.1988
23/06/21	-9.5158
24/06/21	-13.2727
25/06/21	-12.8003
26/06/21	-11.6613
27/06/21	-9.4746
28/06/21	-6.5882
29/06/21	-6.8319
30/06/21	-9.9024
01/07/21	-11.6385
02/07/21	-11.3651
03/07/21	-10.6835
04/07/21	-9.5044

05/07/21	-8.2011
06/07/21	-8.4672
07/07/21	-9.9586
08/07/21	-10.7590
09/07/21	-10.6011
10/07/21	-10.2059
11/07/21	-9.5872
12/07/21	-9.0091
13/07/21	-9.2071
14/07/21	-9.9310
15/07/21	-10.2989
16/07/21	-10.2072
17/07/21	-9.9838
18/07/21	-9.6660
19/07/21	-9.4143
20/07/21	-9.5424
21/07/21	-9.8934
22/07/21	-10.0616
23/07/21	-10.0083
24/07/21	-9.8847
25/07/21	-9.7242
26/07/21	-9.6170
27/07/21	-9.6939
28/07/21	-9.8639
29/07/21	-9.9402
30/07/21	-9.9093
31/07/21	-9.8421

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that daily COVID-19 cases in Bulgaria are likely to decline to zero cases per day around mid-June 2021.

IV. CONCLUSION & RECOMMENDATIONS

The rapid spread of COVID-19 across the globe as well as the increasing number of deaths requires drastic actions from all sectors. Future prediction of potential infections will enable authorities to tackle the consequences effectively (Alazab *et al*., 2020). Indeed, forecasting the number of new confirmed cases of COVID-19 is crucial in the prevention and control of the COVID-19 outbreak (Lei *et al*., 2020). This study used the ANN (12, 12, 1) model to come up with reliable predictions of the disease progression in Bulgaria. It is projected that daily COVID-19 cases in Bulgaria are likely to decline to zero cases per day around mid-June 2021. The government of Bulgaria should continue to ensure that there is compliance to control and preventive COVID-19 measures such as social distancing, quarantine, isolation, face-mask wearing and so on. There is also need to embrace the vaccination programme in the country.

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