Forecasting Covid-19 New Cases in Bosnia And Herzegovina

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Abstract - **Bosnia and Herzegovina, just like any other affected country in the globe, was not able to escape the deadly COVID-19 pandemic. The disease has caused a lot of suffering in the country, especially in terms of loss of life and economic damage. In this piece of work, the ANN technique was applied to analyze confirmed COVID-19 cases in Bosnia and Herzegovina. This study is based on daily new cases of COVID-19 in Bosnia and Herzegovina 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 tell us that the model is stable and indeed suitable for forecasting purposes. The results of the study indicate that daily COVID-19 cases in Bosnia and Herzegovina are likely to drop to zero around late May 2021 onwards. Control and preventive measures should be observed in the country despite the projections.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Since December 2019, the outbreak of COVID-19 (Zu *et al*., 2020) has infected at least 20 million people worldwide, and has already caused more than 800 thousand deaths (Sun *et al*., 2020) and has had an unprecedented social and economic impact worldwide (Ramchandani *et al*., 2020). The disease was first reported in Wuhan, China, in late December 2019 (WHO, 2020). Unfortunately, the pandemic is still accelerating globally without showing any signs of nearing an end (Ramchandani *et al*., 2020). COVID-19 is caused by the novel corona virusSARS-CoV-2 (WHO, 2020). Currently, there is no clinically proven medicine to treat this ailment (Sanders *et al*., 2020). Optimistic researchers suggest that a clinically proved and tested vaccine is at least 1 – 2 years away (Ferguson *et al*., 2020). Knowing the number of confirmed cases in future has become an important task for the public health policy makers so that they can increase medical facilities accordingly (Ahmad *et al*., 2020) and also plan ahead in terms of public health messaging, raising awareness of citizens and increasing capacity of the health system (Papastefanopoulos *et al*., 2020). The main aim of this study is to model and forecast confirmed COVID-19 cases in Bosnia and Herzegovina using the Artificial Neural Network (ANN) approach.

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 Bosnia and Herzegovina.

Data Issues

This study is based on daily new cases of COVID-19 in Bosnia and Herzegovina 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	BH
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	0.109190
MSE	39830.42711
MAE	128.057599

Residual Analysis for the Applied Model
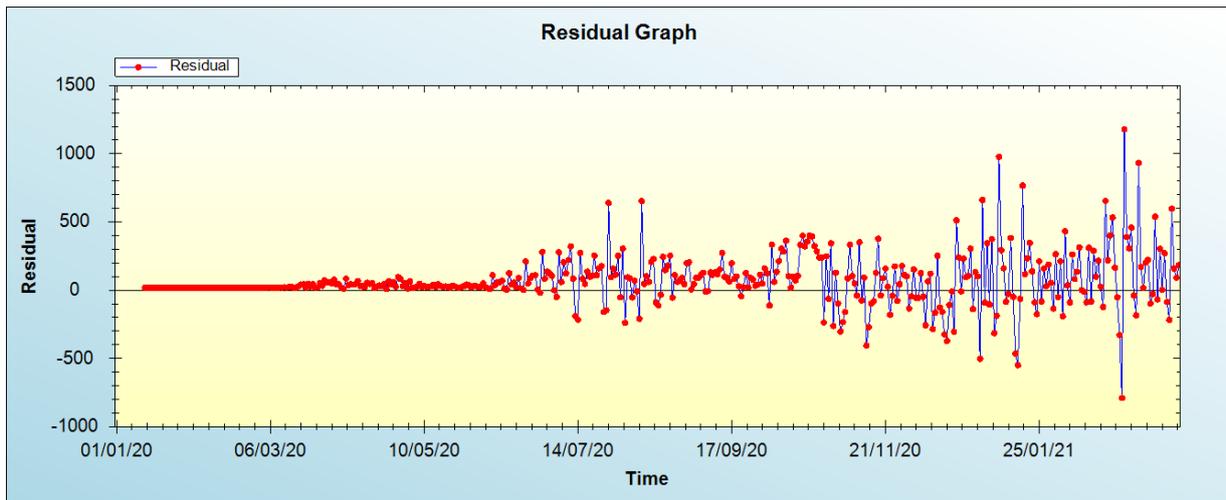
Figure 1: Residual analysis
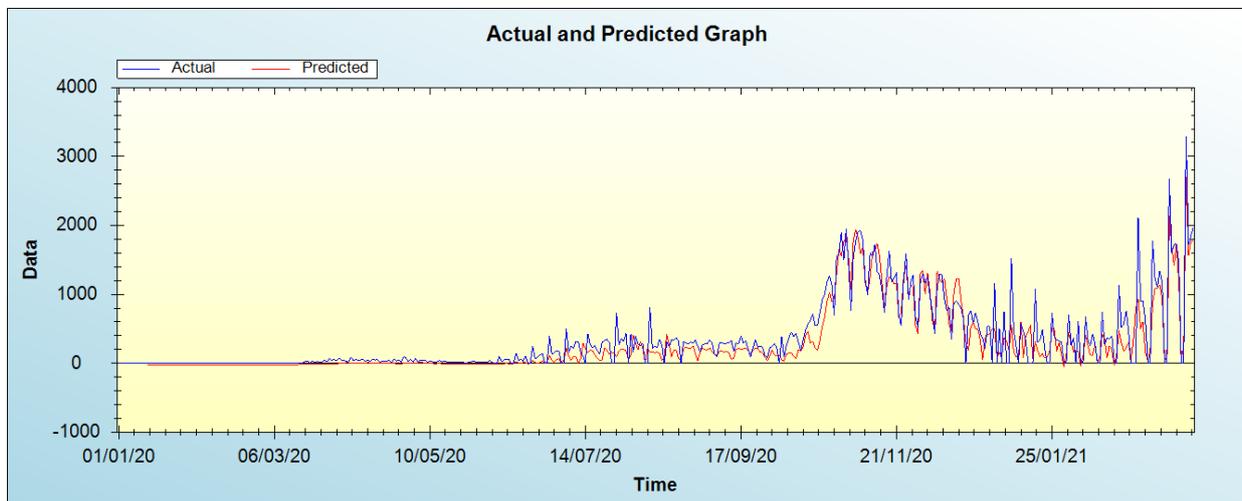
In-sample Forecast for BH

Figure 2: In-sample forecast for the BH series

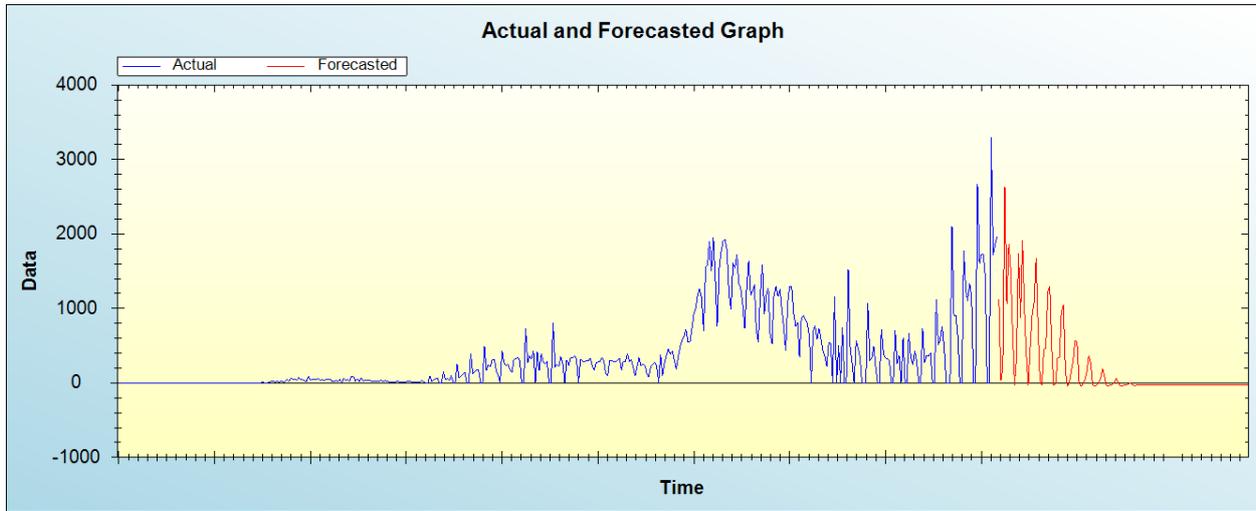*Out-of-Sample Forecast for BH: Actual and Forecasted Graph*

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

Out-of-Sample Forecast for BH: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	1126.4670
27/03/21	27.0503
28/03/21	223.9082
29/03/21	2632.0671
30/03/21	1057.6570
31/03/21	1864.6857
01/04/21	1517.7324
02/04/21	679.6712
03/04/21	-24.4012
04/04/21	331.4253
05/04/21	1738.5187
06/04/21	874.7529
07/04/21	1917.0540
08/04/21	1012.5990
09/04/21	381.9041
10/04/21	-28.2942
11/04/21	483.5057
12/04/21	915.4030
13/04/21	1078.1855
14/04/21	1677.1564
15/04/21	755.7522
16/04/21	32.4061
17/04/21	-25.0710
18/04/21	452.7352
19/04/21	467.5014
20/04/21	1227.6278
21/04/21	1299.2792
22/04/21	465.1507
23/04/21	-29.2570
24/04/21	-4.8813
25/04/21	334.3658
26/04/21	340.0621
27/04/21	943.6119
28/04/21	1048.8088
29/04/21	151.5670
30/04/21	-42.9919
01/05/21	-4.2207

02/05/21	166.5468
03/05/21	282.2472
04/05/21	573.9125
05/05/21	544.3776
06/05/21	23.3551
07/05/21	-46.3082
08/05/21	-13.5372
09/05/21	46.3866
10/05/21	154.7204
11/05/21	364.9868
12/05/21	263.8204
13/05/21	-27.3870
14/05/21	-43.2547
15/05/21	-22.1493
16/05/21	0.3923
17/05/21	64.4702
18/05/21	193.2493
19/05/21	97.4078
20/05/21	-36.5188
21/05/21	-37.9068
22/05/21	-27.3452
23/05/21	-21.2145
24/05/21	10.3332
25/05/21	64.8649
26/05/21	11.2748
27/05/21	-36.7199
28/05/21	-36.1134
29/05/21	-30.8404
30/05/21	-29.8125
31/05/21	-15.5371
01/06/21	0.5009
02/06/21	-18.8618
03/06/21	-34.4196
04/06/21	-33.4800
05/06/21	-31.0875
06/06/21	-30.8536
07/06/21	-24.9449
08/06/21	-20.8117
09/06/21	-26.8311
10/06/21	-31.6631
11/06/21	-31.0434
12/06/21	-30.1043
13/06/21	-29.8896
14/06/21	-27.7427
15/06/21	-26.6531
16/06/21	-28.5378
17/06/21	-30.0048
18/06/21	-29.7132
19/06/21	-29.3906
20/06/21	-29.2488
21/06/21	-28.5370
22/06/21	-28.2473
23/06/21	-28.8578
24/06/21	-29.3018
25/06/21	-29.1887
26/06/21	-29.0840
27/06/21	-29.0185
28/06/21	-28.7922
29/06/21	-28.7195
30/06/21	-28.9210
01/07/21	-29.0555
02/07/21	-29.0160
03/07/21	-28.9822
04/07/21	-28.9565

05/07/21	-28.8857
06/07/21	-28.8693
07/07/21	-28.9360
08/07/21	-28.9766
09/07/21	-28.9633
10/07/21	-28.9522
11/07/21	-28.9427
12/07/21	-28.9208
13/07/21	-28.9177
14/07/21	-28.9396
15/07/21	-28.9518
16/07/21	-28.9473
17/07/21	-28.9436
18/07/21	-28.9402
19/07/21	-28.9334
20/07/21	-28.9331
21/07/21	-28.9402
22/07/21	-28.9438
23/07/21	-28.9423
24/07/21	-28.9410
25/07/21	-28.9398
26/07/21	-28.9377
27/07/21	-28.9378
28/07/21	-28.9401
29/07/21	-28.9412
30/07/21	-28.9407
31/07/21	-28.9403

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 Bosnia and Herzegovina are likely to drop to zero around late May 2021 onwards.

IV. CONCLUSION AND POLICY RECOMMENDATIONS

COVID-19 is one of the biggest health challenges that the world has ever faced. Public health policy makers need the reliable prediction of confirmed cases in future to plan medical facilities (Ahmad *et al*., 2020). Based on 450 daily observations of COVID-19 cases in Bosnia and Herzegovina, this study used the ANN (12, 12, 1) model to come up with forecasts ranging over the period March 26, 2021 to July 31, 2021. Clearly, the country is no longer in serious trouble with the pandemic. The disease is projected to disappear soon around late May 2021. The study, however, suggests the continued compliance to control and preventive COVID-19 measures such as social distancing, quarantine, isolation, face-mask wearing and so on.

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