

Forecasting Covid-19 New Cases in Serbia

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Abstract - In this research article, the ANN approach was applied to analyze daily new cases of COVID-19 in Serbia. This study is based on daily new cases of COVID-19 in Serbia 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 indicate that the model is stable in forecasting daily new cases of COVID-19 in the country. It is projected that daily COVID-19 cases in Serbia are likely to remain high over the out-of-sample period. We recommend that the Serbian government should ensure adherence to lock-down measures and also embrace the vaccination programme, while creating massive awareness about the COVID-19 pandemic.

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Since the first emergence of the Coronavirus Disease 2019 (COVID-19) in Wuhan, Hubei Province, China, in December 2019 (Wu *et al.*, 2020), the scourge has proliferated globally and has affected literally all nations till date (Worldometers, 2020). The global outbreak and severity of this contagious disease (Li *et al.*, 2020) prompted the World Health Organization (WHO) to declare it as a Public Health Emergency of International Concern (PHEIC) on January 30, 2020, and then subsequently, to classify it as a pandemic on March 11, 2020 (WHO, 2020). As of August 2020, COVID-19 has infected approximately 20 million people across the globe with 90 countries in community transmission stage (WHO, 2020), leading to significant efforts towards control (Rawaf *et al.*, 2020) and search for a cure (Le *et al.*, 2020) for COVID-19 across the world. Definitely, the spread of this virus outbreak has seriously disrupted life, economy and health of citizens and this has become a great concern for everyone, as to how long will this scenario last and when the disease could be controlled (Sardar *et al.*, 2020). Modeling and forecasting of the COVID-19 pandemic in Serbia, just like in any other affected country; remains important.

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 in Serbia.

Data Issues

This study is based on daily new cases of COVID-19 in Serbia 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	S
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	0.055662
MSE	61184.701180
MAE	160.138844

Residual Analysis for the Applied Model

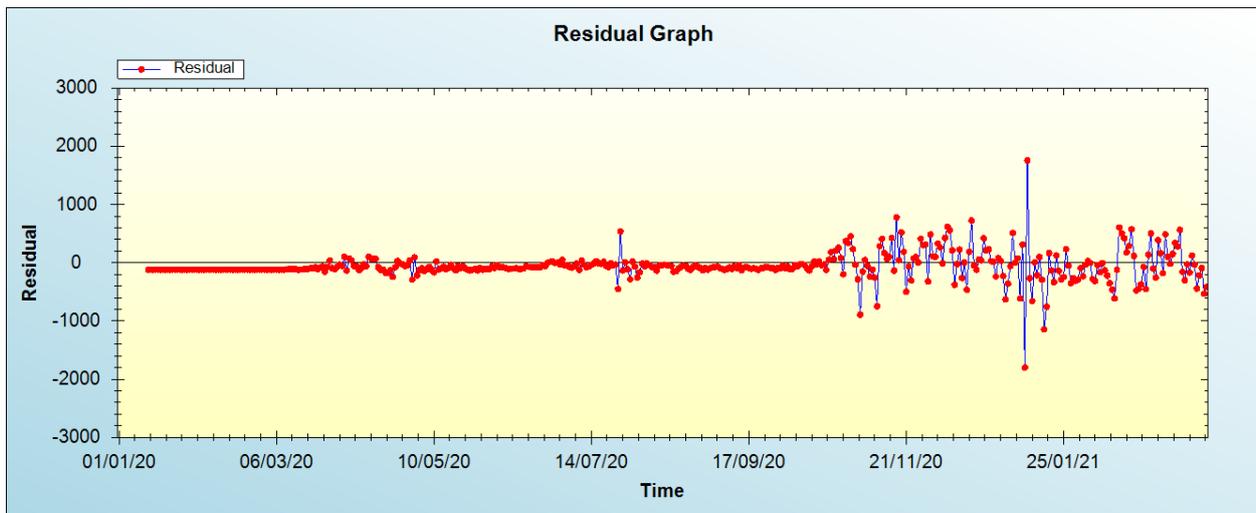


Figure 1: Residual analysis

In-sample Forecast for S

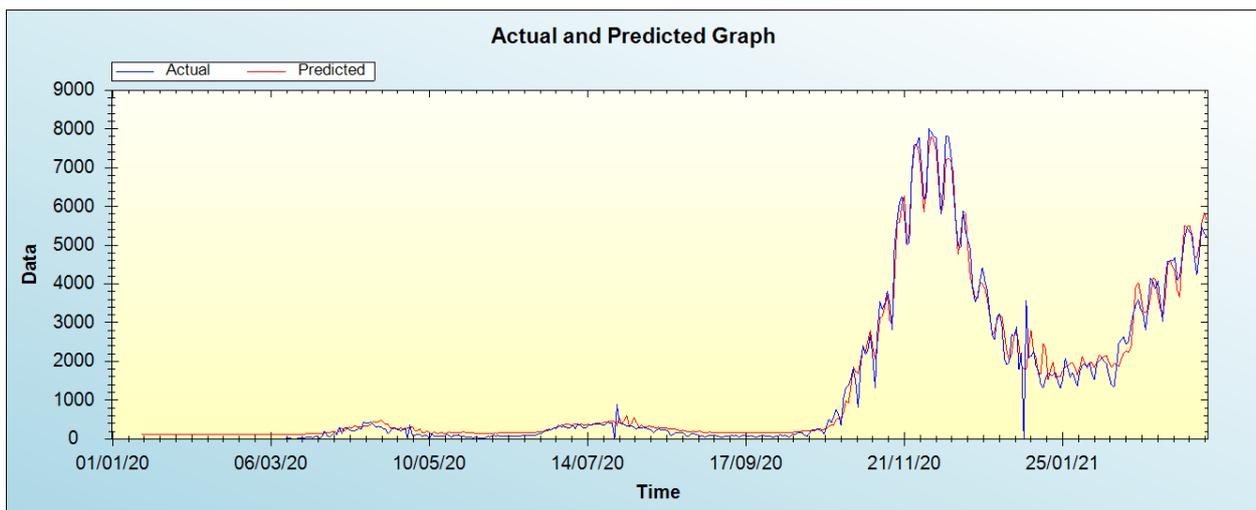


Figure 2: In-sample forecast for the S series

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

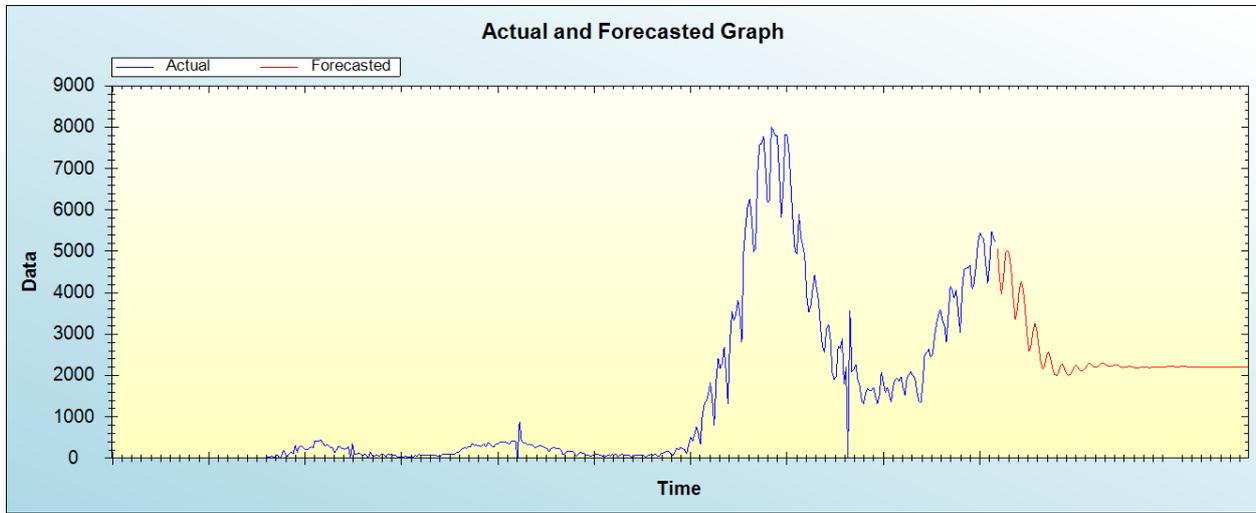


Figure 3: Out-of-sample forecast for S: actual and forecasted graph

Out-of-Sample Forecast for S: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Date	Forecasts
26/03/21	5067.4332
27/03/21	4367.5304
28/03/21	3964.5560
29/03/21	4334.1194
30/03/21	4956.6563
31/03/21	5024.9779
01/04/21	4911.3131
02/04/21	4520.4899
03/04/21	3876.9870
04/04/21	3347.6331
05/04/21	3553.4502
06/04/21	4071.0969
07/04/21	4260.8317
08/04/21	4094.7763
09/04/21	3618.8896
10/04/21	3021.0074
11/04/21	2588.5241
12/04/21	2681.4878
13/04/21	3067.4349
14/04/21	3257.6769
15/04/21	3064.6940
16/04/21	2685.0109
17/04/21	2325.4316
18/04/21	2146.6615
19/04/21	2230.8208
20/04/21	2474.3047
21/04/21	2576.5750
22/04/21	2409.2301
23/04/21	2176.0387
24/04/21	2025.5160
25/04/21	1986.9517
26/04/21	2066.0889
27/04/21	2222.5946
28/04/21	2283.7999
29/04/21	2181.4015

30/04/21	2056.0409
01/05/21	2007.3025
02/05/21	2022.1289
03/05/21	2094.2830
04/05/21	2206.5082
05/05/21	2251.9354
06/05/21	2192.0965
07/05/21	2123.1066
08/05/21	2111.5186
09/05/21	2139.8459
10/05/21	2197.9451
11/05/21	2273.7779
12/05/21	2300.3410
13/05/21	2256.1903
14/05/21	2207.8801
15/05/21	2201.2987
16/05/21	2222.1531
17/05/21	2258.4129
18/05/21	2299.4702
19/05/21	2305.1308
20/05/21	2265.0838
21/05/21	2224.6961
22/05/21	2215.5313
23/05/21	2226.4925
24/05/21	2245.1590
25/05/21	2263.0902
26/05/21	2258.0148
27/05/21	2226.0042
28/05/21	2196.7738
29/05/21	2190.8603
30/05/21	2199.4633
31/05/21	2211.4098
01/06/21	2220.7573
02/06/21	2216.0098
03/06/21	2196.1923
04/06/21	2180.0264
05/06/21	2180.2868
06/06/21	2190.2049
07/06/21	2200.7453
08/06/21	2207.9447
09/06/21	2206.2354
10/06/21	2195.9218
11/06/21	2188.6473
12/06/21	2192.2599
13/06/21	2201.7838
14/06/21	2210.3491
15/06/21	2215.3674
16/06/21	2214.4549
17/06/21	2208.4854
18/06/21	2204.7154
19/06/21	2207.9432
20/06/21	2214.6238
21/06/21	2219.7466
22/06/21	2221.6870
23/06/21	2219.7488
24/06/21	2214.9976
25/06/21	2211.9434
26/06/21	2213.4625
27/06/21	2217.0668
28/06/21	2219.2185
29/06/21	2218.9498
30/06/21	2216.3741
01/07/21	2212.4975
02/07/21	2210.0633

03/07/21	2210.7154
04/07/21	2212.7062
05/07/21	2213.5911
06/07/21	2212.8120
07/07/21	2210.7827
08/07/21	2208.3220
09/07/21	2207.0418
10/07/21	2207.8155
11/07/21	2209.4137
12/07/21	2210.1756
13/07/21	2209.7889
14/07/21	2208.7208
15/07/21	2207.5890
16/07/21	2207.3118
17/07/21	2208.3136
18/07/21	2209.7396
19/07/21	2210.4872
20/07/21	2210.3976
21/07/21	2209.8982
22/07/21	2209.4442
23/07/21	2209.5486
24/07/21	2210.3948
25/07/21	2211.4030
26/07/21	2211.8632
27/07/21	2211.7140
28/07/21	2211.3155
29/07/21	2210.9994
30/07/21	2211.0474
31/07/21	2211.5207

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 Serbia are likely to remain high over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

COVID-19, is currently the most aggressive disease in the entire world, affecting everyone in this world, in one way or the other. It has become inevitable to forecast the daily new COVID-19 cases in Serbia as this information is important for policy makers to be in a position to control the pandemic. It is projected that daily COVID-19 cases in Serbia are likely to remain high over the out-of-sample period. We recommend that the Serbian government should ensure adherence to lock-down measures and also embrace the vaccination programme, while creating massive awareness about the COVID-19 pandemic.

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