PREDICTION OF CONFIRMED COVID-19 CASES IN THE DOMINICAN REPUBLIC USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

The Dominican Republic, 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 the Dominican Republic. The employed data covers the period March 1, 2020 to October 31, 2020 and the out-of-sample period ranges over the period November 2020 to April 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, in general, daily COVID-19 cases will most likely continue to rise, sharply, in the Dominican Republic. Control and preventive measures should be strictly observed in the country until the situation normalizes.

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

INTRODUCTION

Since December 2019, the outbreak of COVID-19 (Zu *et al*., 2020; Jeong *et al*., 2020) has infected at least 20 million people worldwide, and has already caused more than 800 thousand deaths (Sohrabi *et al*., 2020; 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). In dealing with COVID-19 and future pandemics, it is important to design reliable intervention strategies and to implement effective mitigation efforts. To do so, a reliable method of forecasting the spread of the virus is needed and that could possibly improve the predictive surveillance capability and help in designing policies for disease containment (Ramchandani *et al*., 2020). Above all, the fast spread of COVID-19 has put a lot of burden on the healthcare systems of countries. Therefore, 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 the Dominican Republic using the Artificial Neural Network (ANN) approach.

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 the Dominican Republic. The study particularly employs the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function and is apparently based on daily new Covid-19 cases (referred to as DR series in this study) for all age groups in the Dominican Republic. The data covers the period 1 March 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
518.44	419.00	0.00000	2147.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
421.38	0.81278	1.2231	1.4535
5% Perc.	95% Perc.	IQ range	Missing obs.
0.00000	1368.8	471.50	0

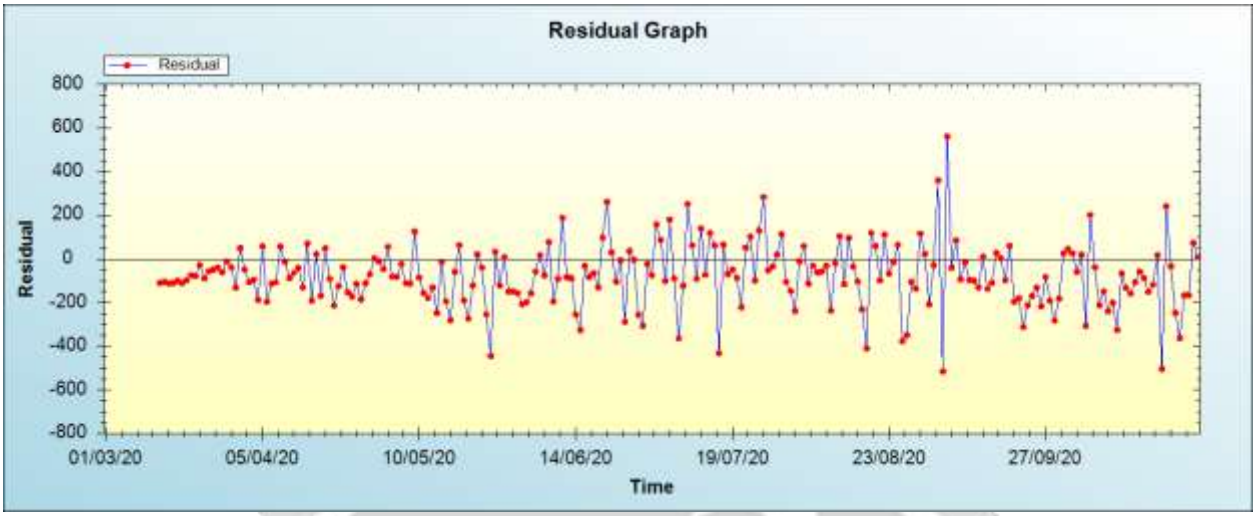
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN THE DOMINICAN REPUBLIC

Table 2: ANN model summary

Variable	DR
Observations	233 (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	0.134969
MSE	25917.061346
MAE	125.659043

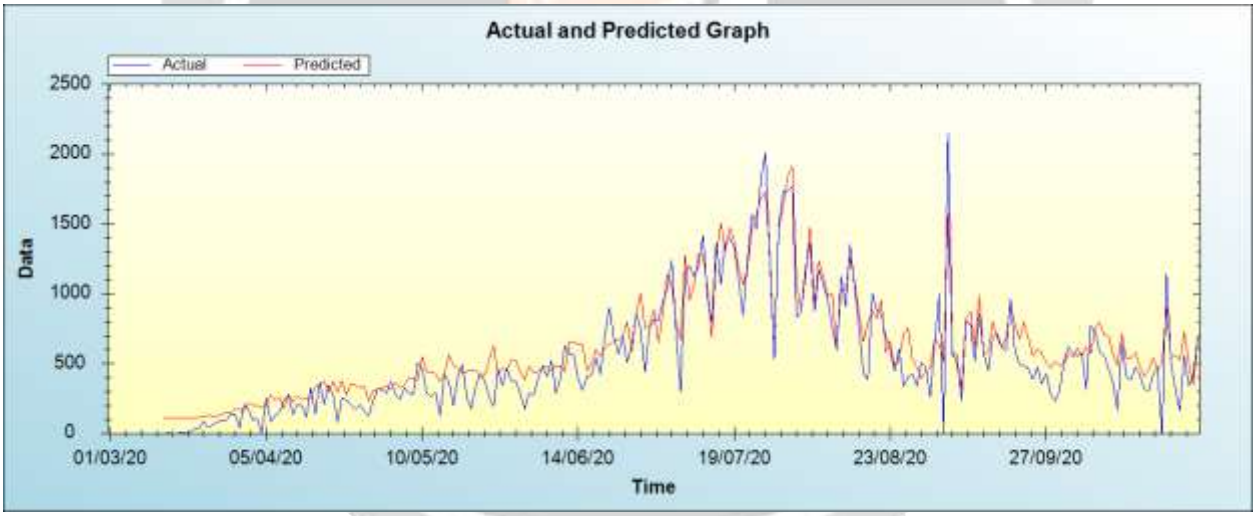
Residual Analysis for the ANN model

Figure 1: Residual analysis



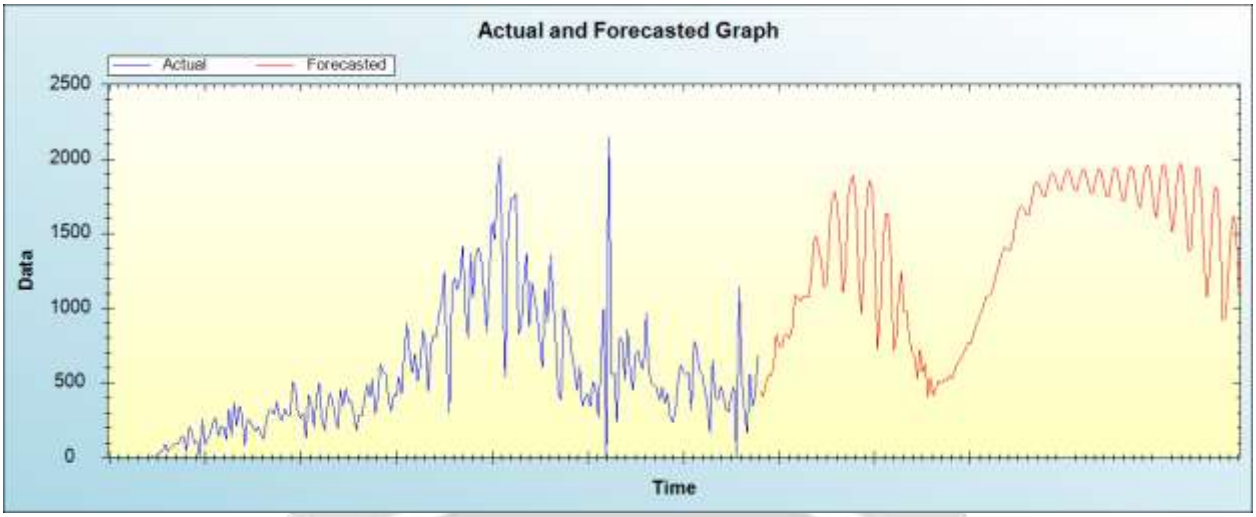
In-sample Forecast for DR

Figure 2: In-sample forecast for the DR series



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

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



Out-of-Sample Forecast for DR: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	445.4500
02/11/20	411.4568
03/11/20	492.1039
04/11/20	554.3160
05/11/20	550.4851
06/11/20	620.5409
07/11/20	826.6506
08/11/20	745.7026
09/11/20	739.7944
10/11/20	813.8062
11/11/20	829.8789
12/11/20	801.0049
13/11/20	872.3763
14/11/20	1086.3221
15/11/20	1076.5053

16/11/20	1048.6709
17/11/20	1076.5313
18/11/20	1079.9398
19/11/20	1070.1693
20/11/20	1174.9470
21/11/20	1447.4981
22/11/20	1485.1005
23/11/20	1398.6808
24/11/20	1294.5765
25/11/20	1137.7303
26/11/20	1165.3286
27/11/20	1555.9157
28/11/20	1726.4538
29/11/20	1782.5696
30/11/20	1680.5827
01/12/20	1428.4388
02/12/20	1110.4216
03/12/20	1229.6687
04/12/20	1758.1857
05/12/20	1856.7610
06/12/20	1888.1142
07/12/20	1675.5633
08/12/20	1186.3791
09/12/20	959.7371
10/12/20	1274.2825
11/12/20	1754.8634

12/12/20	1859.8451
13/12/20	1795.9903
14/12/20	1402.9442
15/12/20	726.8829
16/12/20	942.9661
17/12/20	1386.5071
18/12/20	1629.3472
19/12/20	1633.6699
20/12/20	1359.6187
21/12/20	723.2643
22/12/20	759.9397
23/12/20	1084.5591
24/12/20	1251.8387
25/12/20	967.4352
26/12/20	987.5060
27/12/20	797.7546
28/12/20	710.1847
29/12/20	682.9731
30/12/20	523.0360
31/12/20	724.4692
01/01/21	571.4585
02/01/21	631.2881
03/01/21	405.9254
04/01/21	540.2340
05/01/21	413.3357
06/01/21	464.3400

07/01/21	516.2272
08/01/21	493.0915
09/01/21	520.7476
10/01/21	509.8193
11/01/21	554.2590
12/01/21	524.9586
13/01/21	574.4882
14/01/21	634.8323
15/01/21	645.6951
16/01/21	686.3926
17/01/21	717.2196
18/01/21	766.1055
19/01/21	762.3721
20/01/21	811.9374
21/01/21	880.3033
22/01/21	919.7227
23/01/21	971.6627
24/01/21	1017.6013
25/01/21	1076.8985
26/01/21	1078.3040
27/01/21	1101.9281
28/01/21	1173.2908
29/01/21	1247.7474
30/01/21	1316.5802
31/01/21	1367.3032
01/02/21	1411.6969

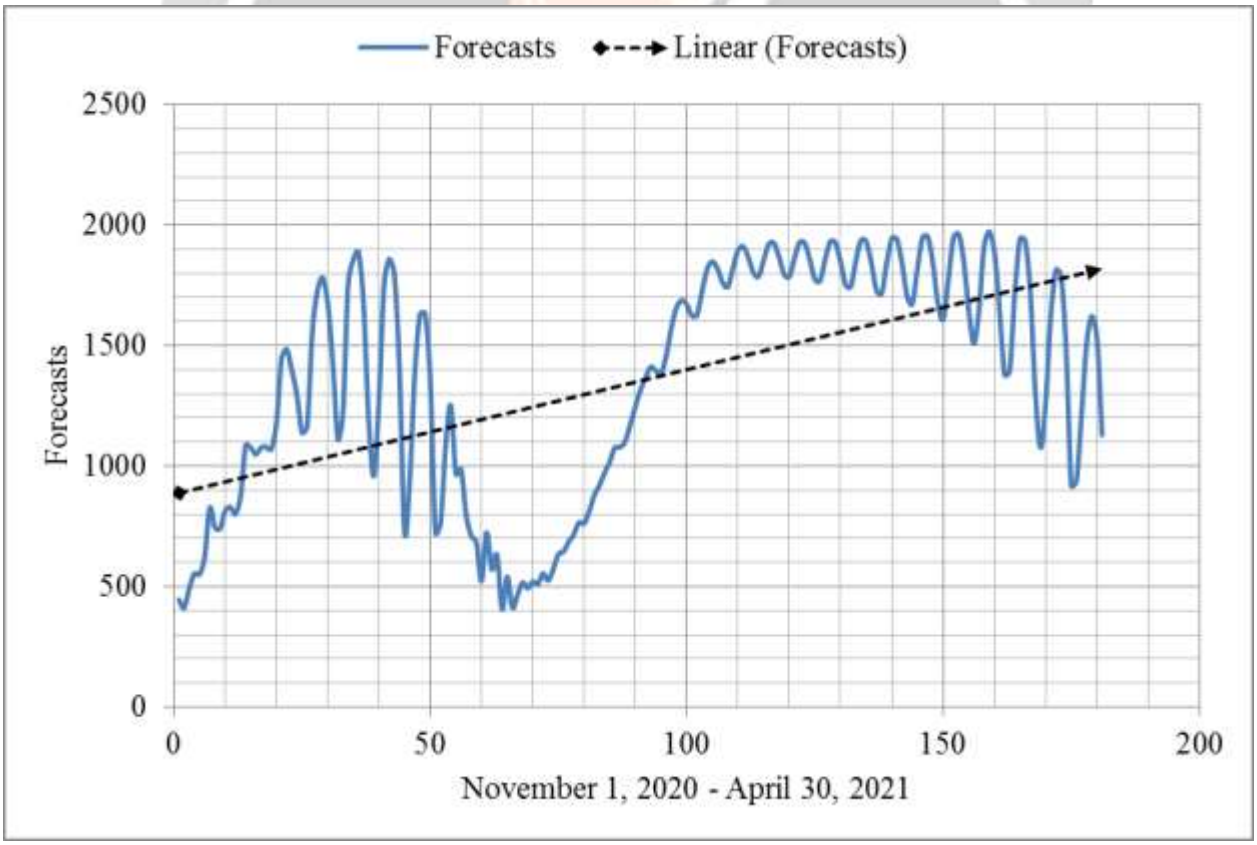
02/02/21	1396.2290
03/02/21	1385.5032
04/02/21	1456.0880
05/02/21	1571.6240
06/02/21	1656.7909
07/02/21	1687.9122
08/02/21	1671.7695
09/02/21	1624.6926
10/02/21	1626.6982
11/02/21	1726.0660
12/02/21	1818.6675
13/02/21	1848.8812
14/02/21	1820.9920
15/02/21	1762.3551
16/02/21	1744.4557
17/02/21	1817.0784
18/02/21	1895.1838
19/02/21	1911.9850
20/02/21	1867.8325
21/02/21	1803.6959
22/02/21	1786.6766
23/02/21	1853.8175
24/02/21	1921.4499
25/02/21	1926.3935
26/02/21	1868.7399
27/02/21	1796.7475

28/02/21	1785.8630
01/03/21	1860.4816
02/03/21	1927.6908
03/03/21	1926.1087
04/03/21	1857.4161
05/03/21	1775.4264
06/03/21	1768.1291
07/03/21	1857.5115
08/03/21	1931.8345
09/03/21	1927.4533
10/03/21	1848.6130
11/03/21	1753.0868
12/03/21	1744.9000
13/03/21	1852.2266
14/03/21	1938.0357
15/03/21	1933.0748
16/03/21	1843.4829
17/03/21	1730.1656
18/03/21	1715.3364
19/03/21	1842.3740
20/03/21	1944.5985
21/03/21	1941.5253
22/03/21	1840.9720
23/03/21	1704.0770
24/03/21	1673.0021
25/03/21	1820.2743

26/03/21	1948.9776
27/03/21	1952.4447
28/03/21	1843.1600
29/03/21	1674.6161
30/03/21	1608.3745
31/03/21	1768.8713
01/04/21	1946.2528
02/04/21	1965.3573
03/04/21	1856.4655
04/04/21	1647.8268
05/04/21	1509.9119
06/04/21	1647.2574
07/04/21	1913.6971
08/04/21	1973.5198
09/04/21	1891.4513
10/04/21	1647.4841
11/04/21	1378.5113
12/04/21	1396.8909
13/04/21	1722.7331
14/04/21	1944.0338
15/04/21	1935.1916
16/04/21	1725.0609
17/04/21	1304.7737
18/04/21	1077.0932
19/04/21	1261.2945
20/04/21	1620.1341

21/04/21	1815.1884
22/04/21	1790.9039
23/04/21	1480.1082
24/04/21	919.2772
25/04/21	936.5546
26/04/21	1215.9852
27/04/21	1509.3293
28/04/21	1622.5007
29/04/21	1535.2660
30/04/21	1128.9576

Figure 4: Graphical presentation of out-of-sample forecasts



The descriptive statistics, summary of the applied model, residual analysis, in-sample forecasts as well as out-of-sample forecasts are shown in table 1, table 2, figure 1, figure 2 and well as figures 3 and 4 and table 4, in such chronological order. The applied model is indeed stable and acceptable as indicated in the residual analysis. The results of the study indicate that, in general,

confirmed COVID-19 cases will most likely continue to rise, sharply, in the Dominican Republic.

CONCLUSION & 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 245 daily observations of COVID-19 cases in the Dominican Republic, this study used the ANN (12, 12, 1) model to come up with forecasts ranging over the period November 2020 to April 2021. Clearly, the country is in serious trouble due to the pandemic. The disease is projected to end not anytime soon but rather persist in the rest of the out-of-sample period. The study recommends 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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