PREDICTION OF CONFIRMED COVID-19 CASES IN OMAN USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

COVID-19 continues to have a devastating effect on the health and well-being of the global population. One of the vital steps in the fight against COVID-19 is to come up with accurate forecasting models. In this research endeavor, the ANN approach was applied to analyze confirmed COVID-19 cases in Oman. The employed data covers the period February 24, 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 technique indicate that the model is stable and acceptable. The results of the study show that, in general, COVID-19 cases will most likely continue to rise, gradually, in Oman. Control and preventive measures should be observed in the country until the situation stabilizes.

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

INTRODUCTION

The outbreak of COVID-19 started in China in December 2019 and has spread worldwide (Bayyurt & Bayyurt, 2020), largely because of a lack of prior immunity combined with relatively high infectiousness (Li *et al*., 2020; Wolfel *et al*., 2020; Zhou *et al*., 2020). The common symptoms of the disease are fever, fatigue and dry cough (Drosten *et al*., 2020; Zhou *et al*., 2020). COVID-19 may cause fatality, especially among elderly, and people with chronic health problems (Direkoglu & Sah, 2020). The disease is highly contagious. A single infected person will transmit the virus (usually via human-to-human transmission) with a reproduction number of approximately 1.4 to 2.5 (WHO, 2020). People infected with COVID-19 are placed quarantine, so that the virus does not spread (Uddin *et al*., 2020) and their own immune system is expected to fight off the virus (Chan *et al*., 2020). Modeling and future forecast of daily number of confirmed cases and deaths can help the treatment system (Dehesh *et al*., 2020), especially given the fact that there is no effective vaccine against the COVID-19 pandemic. Indeed, the only way to combat the pandemic so far is to take prevention and control measures as well as forecast its spread. This research seeks to model and forecast COVID-19 daily confirmed cases in Oman.

METHODOLOGY

Researchers continue to face unprecedented challenges during this global pandemic to forecast future real-time cases with traditional mathematical, statistical and machine learning based forecasting tools (Fanelli & Piazza, 2020; Zhuang *et al*., 2020; Kucharski *et al*., 2020; Feng *et al*., 2020; Wu *et al*., 2020). Because forecasting COVID-19 is relatively harder (Ioannidis *et al*., 2020), this study opts for applying a more robust and reliable predictive model, the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID-19 infections in Oman. This study particularly applies the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function. The study is based on daily new Covid-19 cases (referred to as OC series in this study) in all age groups in Oman. The data covers the period 24 February 2020 to 31October 2020 while the out-of-sample forecast covers the period November 2020 to April 2021. All the data employed in this research paper was gathered from John Hopkins University (USA).

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
455.91	207.00	0.00000	2685.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
528.97	1.1602	1.2100	0.91892
5% Perc.	95% Perc.	IQ range	Missing obs.
0.00000	1548.6	758.00	0

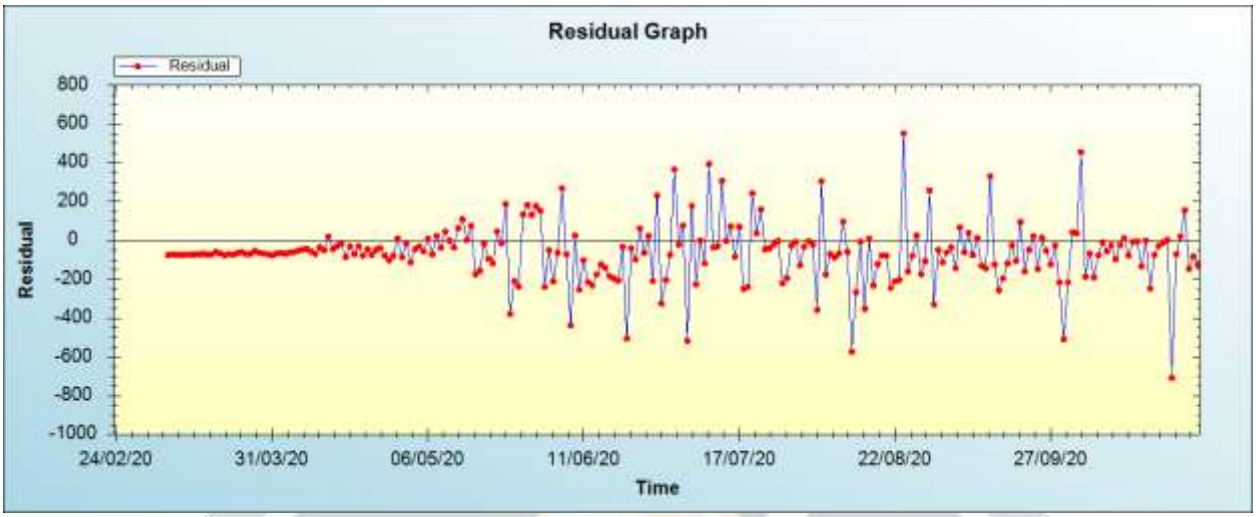
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN OMAN

Table 2: ANN model summary

Variable	OC
Observations	239 (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	0.109986
MSE	26916.304218
MAE	116.686026

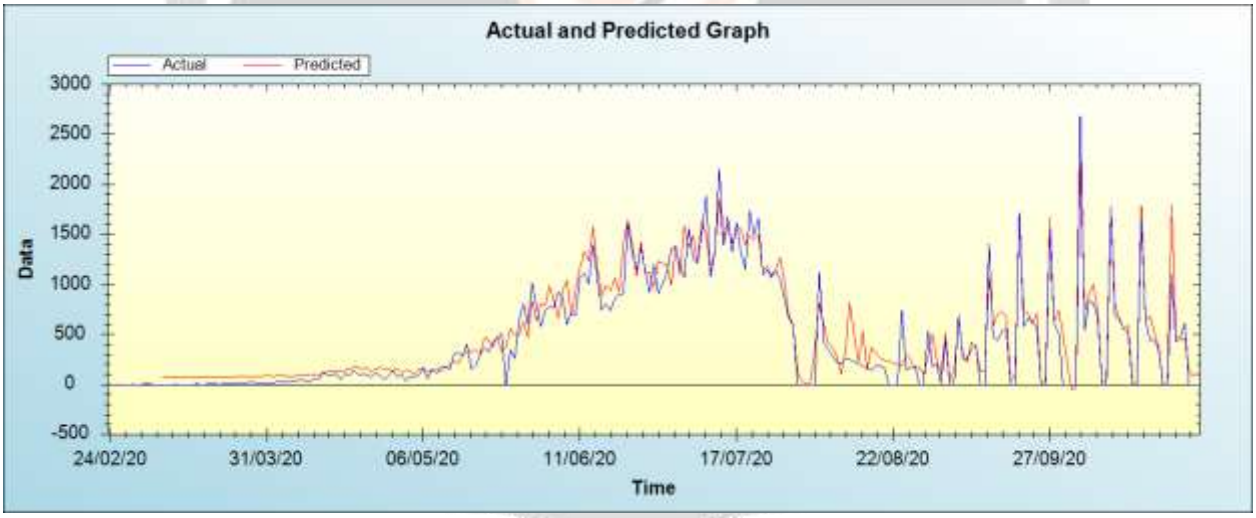
Residual Analysis for the ANN model

Figure 1: Residual analysis



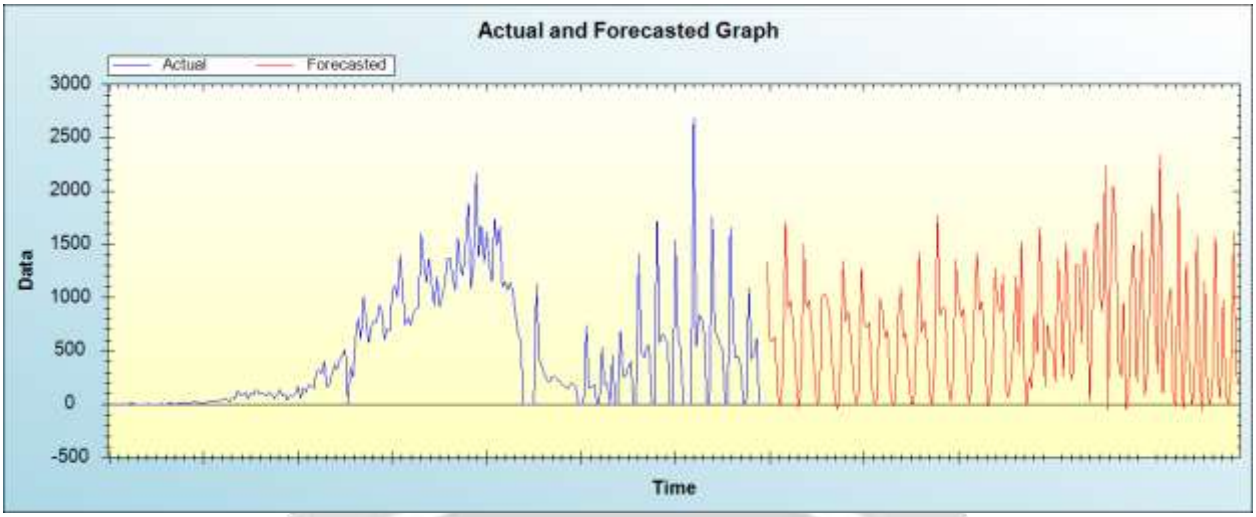
In-sample Forecast for OC

Figure 2: In-sample forecast for the OC series



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

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



Out-of-Sample Forecast for OC: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	1331.2207
02/11/20	594.8258
03/11/20	593.2724
04/11/20	633.2025
05/11/20	92.3812
06/11/20	-13.0889
07/11/20	255.1781
08/11/20	1714.4345
09/11/20	899.7863
10/11/20	972.2629
11/11/20	720.6332
12/11/20	270.3162
13/11/20	-29.3948
14/11/20	194.5082
15/11/20	1501.6220

16/11/20	902.5291
17/11/20	977.4775
18/11/20	709.3858
19/11/20	324.7947
20/11/20	7.8110
21/11/20	34.0417
22/11/20	1010.8758
23/11/20	1039.6130
24/11/20	974.0570
25/11/20	798.5436
26/11/20	340.8916
27/11/20	13.1911
28/11/20	-48.4796
29/11/20	371.5474
30/11/20	1347.6955
01/12/20	774.4555
02/12/20	874.7318
03/12/20	595.7309
04/12/20	141.8202
05/12/20	4.1166
06/12/20	105.4610
07/12/20	1280.3455
08/12/20	762.1648
09/12/20	718.8132
10/12/20	766.3905
11/12/20	167.8387

12/12/20	9.2967
13/12/20	43.7108
14/12/20	995.1566
15/12/20	878.2672
16/12/20	625.5249
17/12/20	684.8196
18/12/20	133.0885
19/12/20	-12.2096
20/12/20	32.4960
21/12/20	834.2209
22/12/20	1098.2902
23/12/20	621.4381
24/12/20	670.6209
25/12/20	232.5085
26/12/20	5.8905
27/12/20	1.4739
28/12/20	673.9497
29/12/20	1427.1097
30/12/20	676.1331
31/12/20	788.4761
01/01/21	562.1060
02/01/21	91.3341
03/01/21	-15.3610
04/01/21	417.7431
05/01/21	1768.3483
06/01/21	831.4137

07/01/21	911.0419
08/01/21	891.8598
09/01/21	197.9341
10/01/21	21.3960
11/01/21	262.7582
12/01/21	1351.8486
13/01/21	1007.7561
14/01/21	819.3045
15/01/21	900.3103
16/01/21	350.2290
17/01/21	-1.7243
18/01/21	153.0258
19/01/21	862.2375
20/01/21	1420.4409
21/01/21	879.0042
22/01/21	960.9074
23/01/21	616.4545
24/01/21	-22.0205
25/01/21	48.0657
26/01/21	335.6021
27/01/21	1277.5139
28/01/21	944.9163
29/01/21	854.4645
30/01/21	1212.4436
31/01/21	174.0644
01/02/21	63.0209

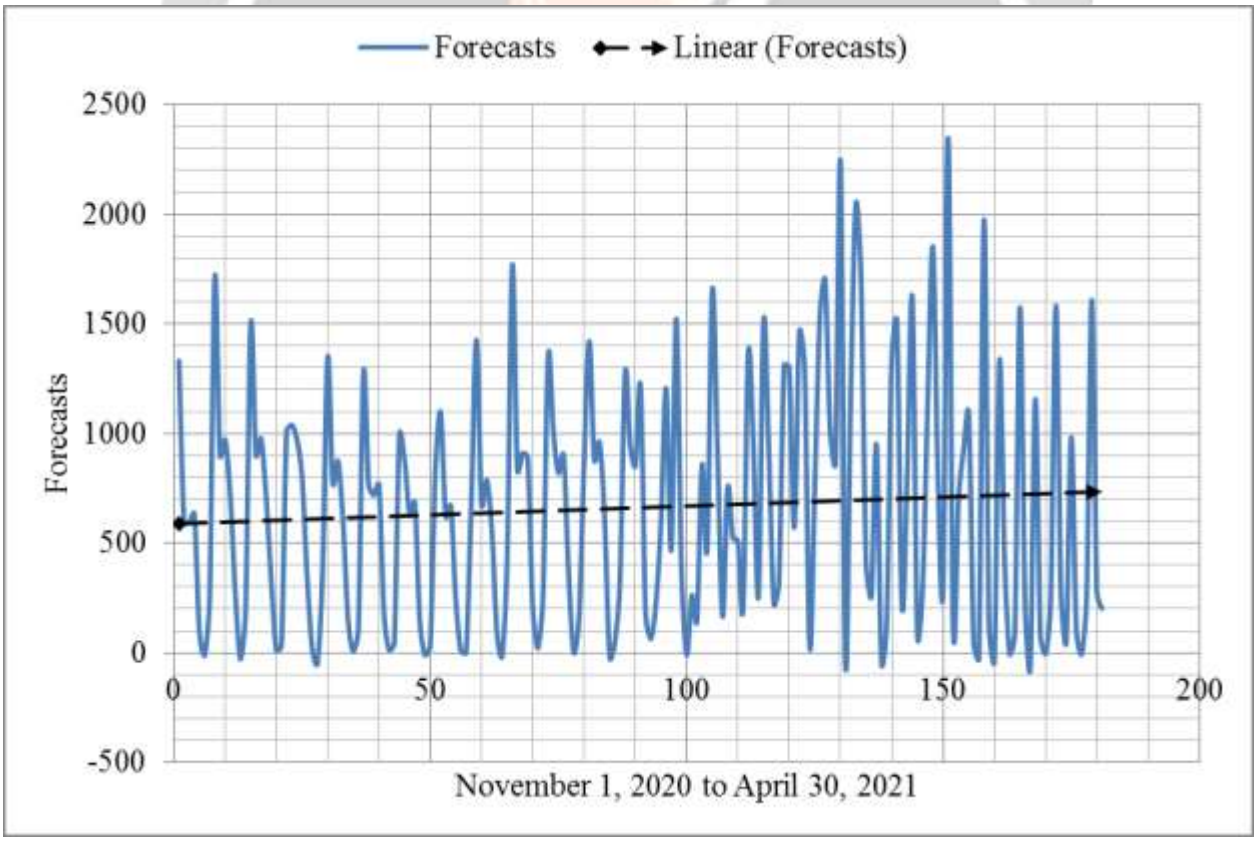
02/02/21	223.0302
03/02/21	601.1452
04/02/21	1206.1537
05/02/21	467.6908
06/02/21	1522.8338
07/02/21	369.3596
08/02/21	-10.5426
09/02/21	262.0113
10/02/21	144.8004
11/02/21	857.5990
12/02/21	472.2805
13/02/21	1656.5759
14/02/21	946.1907
15/02/21	165.5219
16/02/21	753.0436
17/02/21	523.5465
18/02/21	510.3073
19/02/21	205.0151
20/02/21	1364.6403
21/02/21	958.3007
22/02/21	257.0022
23/02/21	1513.6843
24/02/21	938.1704
25/02/21	222.4828
26/02/21	325.4896
27/02/21	1310.8088

28/02/21	1302.0197
01/03/21	570.9603
02/03/21	1466.5787
03/03/21	1300.6499
04/03/21	23.1801
05/03/21	777.0107
06/03/21	1540.4160
07/03/21	1699.5164
08/03/21	1008.5590
09/03/21	867.6176
10/03/21	2237.6197
11/03/21	-59.5314
12/03/21	1173.3914
13/03/21	2049.0251
14/03/21	1715.9907
15/03/21	408.8282
16/03/21	254.2293
17/03/21	949.6065
18/03/21	-51.1081
19/03/21	125.7302
20/03/21	1342.3227
21/03/21	1510.1881
22/03/21	208.5021
23/03/21	799.2115
24/03/21	1619.0630
25/03/21	79.0334

26/03/21	286.7060
27/03/21	1124.5105
28/03/21	1849.7860
29/03/21	803.2305
30/03/21	299.2374
31/03/21	2345.3449
01/04/21	106.6891
02/04/21	693.6541
03/04/21	926.2189
04/04/21	1090.5809
05/04/21	36.9176
06/04/21	-26.3177
07/04/21	1976.6685
08/04/21	109.2940
09/04/21	-40.3067
10/04/21	1334.3274
11/04/21	423.2124
12/04/21	-8.8514
13/04/21	89.5755
14/04/21	1575.0551
15/04/21	212.7261
16/04/21	-70.9783
17/04/21	1156.3820
18/04/21	67.4895
19/04/21	-6.2354
20/04/21	237.6365

21/04/21	1582.6202
22/04/21	261.5387
23/04/21	46.3458
24/04/21	982.3980
25/04/21	96.1838
26/04/21	-9.2954
27/04/21	257.6392
28/04/21	1608.6628
29/04/21	275.6225
30/04/21	200.3532

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 3, respectively. The applied model is stable and acceptable as indicated in the residual analysis. The results of the study indicate that, in general, COVID-19 cases will most likely continue to rise, gradually, in Oman.

CONCLUSION & RECOMMENDATIONS

Forecasting COVID-19 has become a key research interest, especially for medical doctors and health economists. There is no doubt, these forecasts are essential for the effective allocation of healthcare resources, stockpiling and help in strategic planning for clinicians and relevant government authorities. Based on 251 daily observations of COVID-19 cases in Oman, this study used the ANN (12, 12, 1) model to come up with forecasts ranging over the period November 2020 to April 2021. Clearly, Oman is in trouble due to the virus. The disease is projected to end not anytime soon but persist in the rest of the out-of-sample period. However, we recommend 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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