PREDICTION OF COVID-19 CASES IN QATAR USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

COVID-19 is a serious global public health emergency. In this research paper, the ANN approach was applied to analyze COVID-19 cases in Qatar. The employed data covers the period February 29, 2020 to October 31, 2020 while 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 indicate that the model is stable in forecasting COVID-19 cases in the country. The results of the study indicate that daily COVID-19 cases will, basically, continue to rise in Qatar. This suggests that the virus is far from disappearing in the country. The government of Qatar, through the ministry of health, should continue to implement COVID-19 control and prevention measures such as isolation, quarantine, testing and tracing, face-mask wearing, sanitization of hands., amongst other measures in line with WHO safety and sanitary rules.

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

INTRODUCTION & OVERVIEW

COVID-19 initially came to attention in a series of patients with pneumonia of unknown etiology in Wuhan city in China (Huang et al., 2020). Coronaviruses are single-stranded, positive-sense RNA viruses belonging to the Coronaviridae family (Chen et al., 2020). COVID-19 is transferable from human to human and it's spreading, and infection factors are very high (Rothan & Byrareddy, 2020; Jin et al., 2020). It is characterized by respiratory symptoms, which deteriorate into respiratory failure in substantial proportion of cases, requiring intensive care up to a third of patients admitted to hospital (Carsana et al., 2020). The first case of COVID-19 was reported in Qatar on the 29th of February 2020. Since then, then virus has continued to spread in the country. Virus spread prediction is very important to actively plan actions (Wieczorek et al., 2020). The main purpose of this study is to use Artificial Neural Networks (ANNs) to explore the transmission dynamics, forecasting and control of COVID-19 in Qatar in the absence of appropriate treatment or effective vaccine. Very few studies, for example, Ghanam et al. (2020) have attempted to analyze the transmission dynamics of COVID-19 in the country. Using a SEIRD model, Ghanam et al. (2020) found out that the pandemic was spreading at a faster rate and that both new cases and deaths would rise in the country.

METHODOLOGY

The study applies the multi-layer perceptron neural network type of the ANN approach in order to predict COVID-19 case volumes in Qatar. The paper particulary makes use of the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function. The study is actually hinged on newly confirmed daily COVID-19 cases (reffered to as the QX series in this study) for all age groups in Qatar. The data covers the period February 29, 2020 to October 31, 2020 while the out-of-sample forecast covers the period November 2020 to April 2021. All the data employed in this work was gathered from the Johns Hopkins University (USA)'s online database.

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
538.85	268.50	0.0000	2355.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
536.34	0.99536	1.2863	0.53532
5% Perc.	95% Perc.	IQ range	Missing obs.
6.3500	1732.7	577.75	0

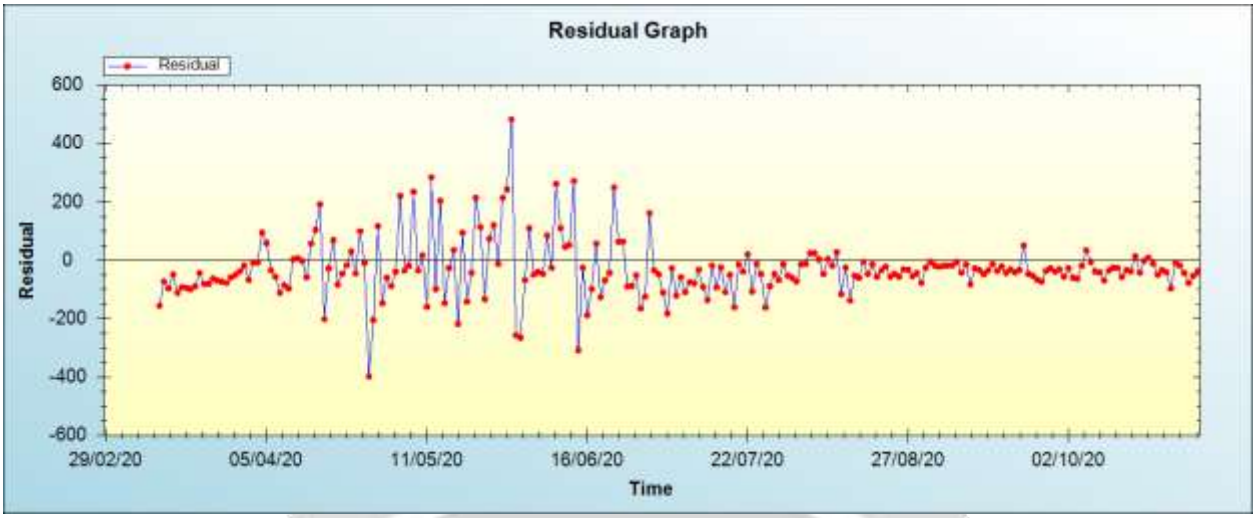
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN QATAR

Table 2: ANN model summary

Variable	QX
Observations	234 (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	0.077741
MSE	10345.220536
MAE	73.857363

Residual Analysis for the ANN model

Figure 1: Residual analysis



In-sample Forecast for QX

Figure 2: In-sample forecast for the QX series

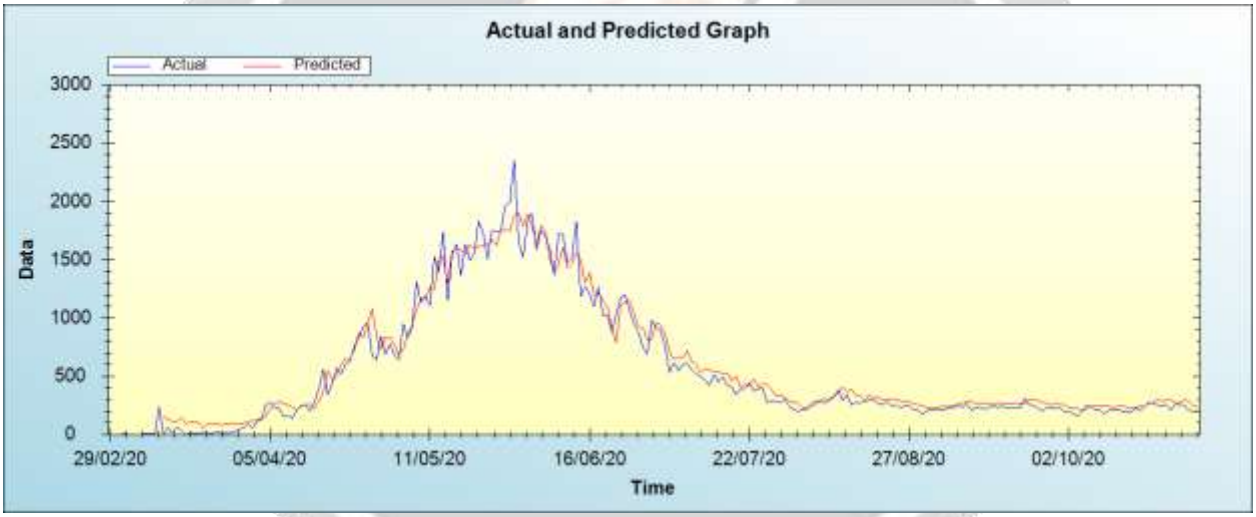
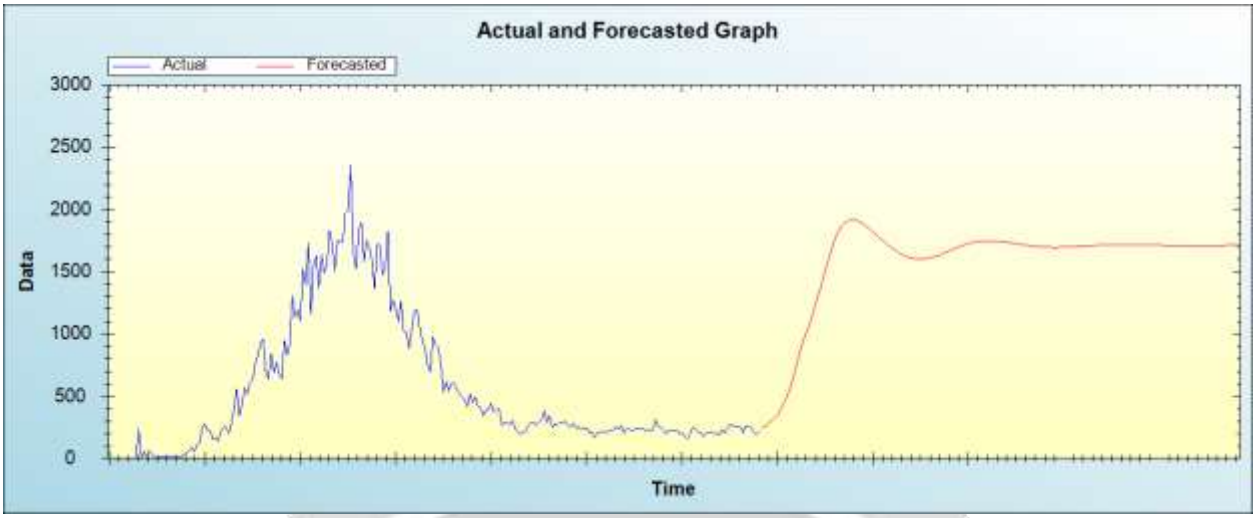


Figure 2 shows the in-sample forecast for QX series.

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

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



Out-of-Sample Forecast for QX: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	244.0551
02/11/20	255.3876
03/11/20	264.1945
04/11/20	292.5924
05/11/20	304.2687
06/11/20	324.6528
07/11/20	347.0316
08/11/20	384.0316
09/11/20	433.4389
10/11/20	473.8680
11/11/20	520.7799
12/11/20	581.1608
13/11/20	654.2910
14/11/20	736.7352
15/11/20	822.4283

16/11/20	902.1104
17/11/20	967.0827
18/11/20	1017.0185
19/11/20	1071.6761
20/11/20	1142.5473
21/11/20	1216.2532
22/11/20	1285.4096
23/11/20	1355.6386
24/11/20	1431.6842
25/11/20	1509.0080
26/11/20	1581.6329
27/11/20	1652.2482
28/11/20	1721.7040
29/11/20	1779.9766
30/11/20	1824.9571
01/12/20	1860.9211
02/12/20	1887.8120
03/12/20	1904.4530
04/12/20	1912.5100
05/12/20	1915.7091
06/12/20	1915.3724
07/12/20	1909.7277
08/12/20	1900.0614
09/12/20	1888.3421
10/12/20	1873.5249
11/12/20	1856.1684

12/12/20	1838.1258
13/12/20	1819.7047
14/12/20	1800.5906
15/12/20	1781.1981
16/12/20	1762.2000
17/12/20	1743.4326
18/12/20	1724.8331
19/12/20	1707.3505
20/12/20	1691.2242
21/12/20	1676.0301
22/12/20	1662.0540
23/12/20	1649.5667
24/12/20	1638.3602
25/12/20	1628.4563
26/12/20	1620.1925
27/12/20	1613.6514
28/12/20	1608.6020
29/12/20	1605.0278
30/12/20	1603.0472
31/12/20	1602.5084
01/01/21	1603.3031
02/01/21	1605.5305
03/01/21	1609.1332
04/01/21	1613.9020
05/01/21	1619.7167
06/01/21	1626.5058

07/01/21	1634.1129
08/01/21	1642.3537
09/01/21	1651.1194
10/01/21	1660.2803
11/01/21	1669.6164
12/01/21	1678.9426
13/01/21	1688.1320
14/01/21	1697.0297
15/01/21	1705.4809
16/01/21	1713.3792
17/01/21	1720.6368
18/01/21	1727.1570
19/01/21	1732.8648
20/01/21	1737.7319
21/01/21	1741.7447
22/01/21	1744.8919
23/01/21	1747.1926
24/01/21	1748.6861
25/01/21	1749.4093
26/01/21	1749.4094
27/01/21	1748.7518
28/01/21	1747.5067
29/01/21	1745.7422
30/01/21	1743.5312
31/01/21	1740.9516
01/02/21	1738.0757

02/02/21	1734.9714
03/02/21	1731.7096
04/02/21	1728.3577
05/02/21	1724.9753
06/02/21	1721.6189
07/02/21	1718.3417
08/02/21	1715.1896
09/02/21	1712.2019
10/02/21	1709.4141
11/02/21	1706.8570
12/02/21	1704.5538
13/02/21	1702.5227
14/02/21	1700.7773
15/02/21	1699.3255
16/02/21	1698.1695
17/02/21	1697.3076
18/02/21	1696.7342
19/02/21	1696.4390
20/02/21	1696.4080
21/02/21	1696.6244
22/02/21	1697.0684
23/02/21	1697.7175
24/02/21	1698.5478
25/02/21	1699.5340
26/02/21	1700.6497
27/02/21	1701.8680

28/02/21	1703.1623
01/03/21	1704.5063
02/03/21	1705.8746
03/03/21	1707.2430
04/03/21	1708.5891
05/03/21	1709.8923
06/03/21	1711.1341
07/03/21	1712.2983
08/03/21	1713.3713
09/03/21	1714.3418
10/03/21	1715.2011
11/03/21	1715.9430
12/03/21	1716.5639
13/03/21	1717.0622
14/03/21	1717.4387
15/03/21	1717.6962
16/03/21	1717.8391
17/03/21	1717.8735
18/03/21	1717.8068
19/03/21	1717.6476
20/03/21	1717.4053
21/03/21	1717.0900
22/03/21	1716.7123
23/03/21	1716.2829
24/03/21	1715.8126
25/03/21	1715.3121

26/03/21	1714.7918
27/03/21	1714.2615
28/03/21	1713.7308
29/03/21	1713.2081
30/03/21	1712.7015
31/03/21	1712.2180
01/04/21	1711.7639
02/04/21	1711.3443
03/04/21	1710.9636
04/04/21	1710.6252
05/04/21	1710.3316
06/04/21	1710.0844
07/04/21	1709.8842
08/04/21	1709.7310
09/04/21	1709.6240
10/04/21	1709.5616
11/04/21	1709.5417
12/04/21	1709.5615
13/04/21	1709.6180
14/04/21	1709.7076
15/04/21	1709.8266
16/04/21	1709.9708
17/04/21	1710.1363
18/04/21	1710.3187
19/04/21	1710.5139
20/04/21	1710.7178

21/04/21	1710.9265
22/04/21	1711.1362
23/04/21	1711.3434
24/04/21	1711.5449
25/04/21	1711.7378
26/04/21	1711.9196
27/04/21	1712.0881
28/04/21	1712.2415
29/04/21	1712.3783
30/04/21	1712.4976

Figure 4: Out-of-sample forecast for QX: forecasted graph

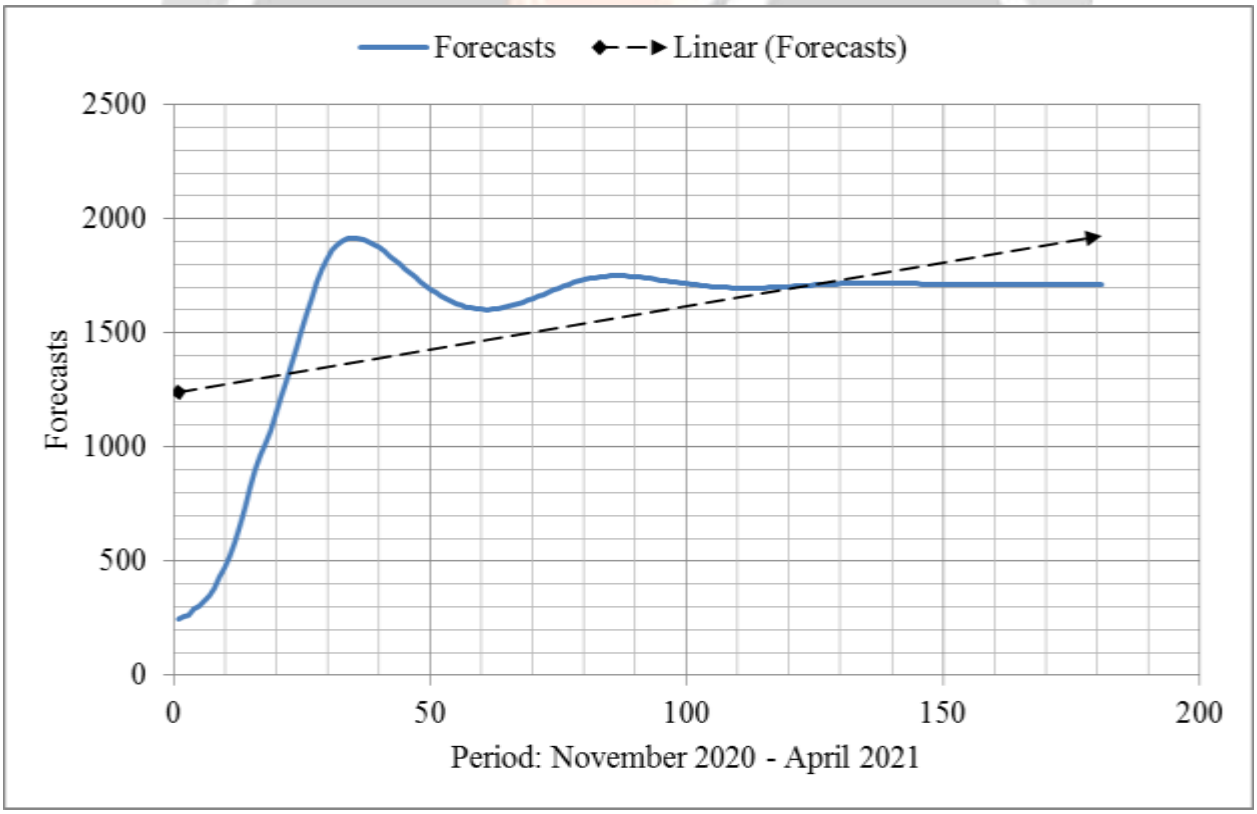


Table 1shows the descriptive statistics of the series, QX, under consideration. Worthy to note is that the average number of infections per day has been as high as 539 cases over the period under study while the maximum was as high as 2355 cases. The summary of the ANN (12, 12, 1) model is shown in table 2 above. The model was checked for stability using figure 1 and we found that the residuals are as close to zero as possible, implying that the model is acceptably

stable for predictive purposes. Figure 2 shows the in-sample forecast graph while figures 3 & 4 and table 3 generally show out-of-sample predictions. The study found out that daily COVID-19 cases in Bolivia will continue to rise from the estimated 244 cases on November 1, 2020 to a maximum level of approximately 1900 on December 8, 2020. After that, new cases may be slightly lower that this maximum but the fact is that new infections will remain significantly high throughout the out-of-sample period. The fitted trend line in figure 4 further confirms that generally COVID-19 cases are on the rise in Qatar. The results of this study are consistent with Ghanam *et al*. (2020) who already warned of a possible rise in COVID-19 infections in the country.

CONCLUSION & RECOMMENDATIONS

Nowadays, a significant number of infectious diseases such as COVID-19 are threatening the world by spreading at an alarming rate. In this research, we attempt to model and forecast COVID-19 daily cases in Qatar. We applied the basic ANN (12, 12, 1) model and found out that COVID-19 daily cases were, basically, likely to increase over the out-of-sample period. The government of Qatar, through the ministry of health, should continue to implement COVID-19 control and prevention measures such as isolation, quarantine, testing and tracing, face-mask wearing, sanitization of hands., amongst other measures in line with WHO guidelines. This will go a long way in controlling the pandemic from extremely devastating the country.

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