International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 6, pp 605-610, June-2021

https://doi.org/10.47001/IRJIET/2021.506106

Forecasting Covid-19 New Cases in Yemen

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***Abstract* - Yemen, just like any other affected country in the globe, was not able to escape the deadly COVID-19 pandemic. The disease has caused untold 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 Yemen. This study is based on daily new cases of COVID-19 in the country 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. It is projected that daily COVID-19 cases in Yemen are likely to remain high over the out-of-sample period. The study suggests the continued compliance to control and preventive COVID-19 measures such as social distancing, quarantine, isolation, face-mask wearing and so on, as well as country-wide vaccinations.**

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 Yemen 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 in Yemen.

Data Issues

This study is based on daily new cases of COVID-19 in Yemen for the period 1 January 2020 – 25 March 2021.The out-of-sample forecast covers the period 26 March 2021 – 31 2021.All the data employed in this research paper was gathered from the Johns Hopkins University (USA).

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III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	Y
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	0.086701
MSE	46.125443
MAE	4.883501

Residual Analysis for the Applied Model

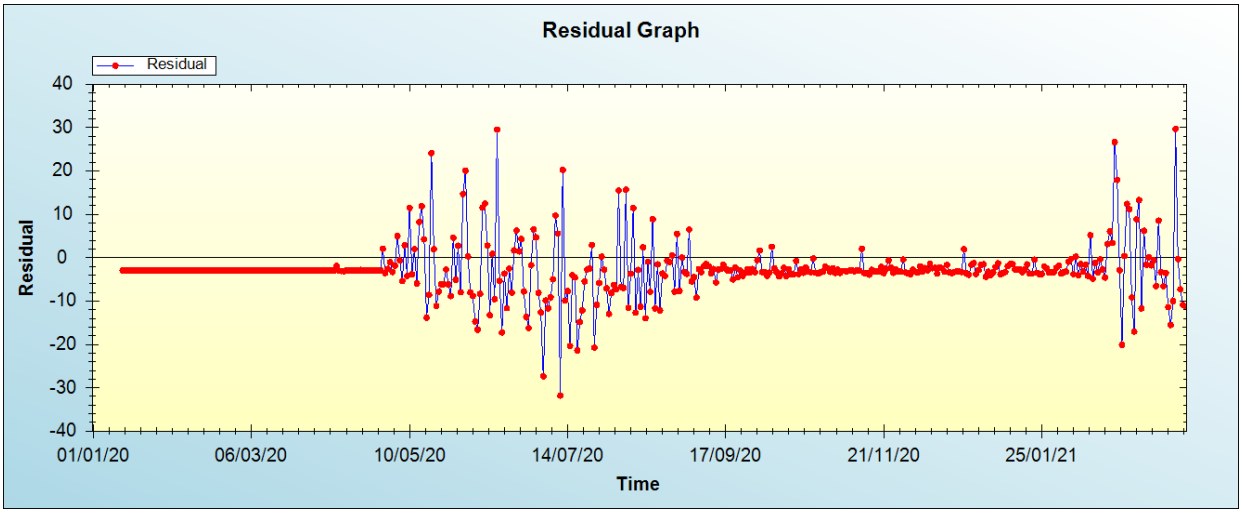

Figure 1: Residual analysis

In-sample Forecast for Y

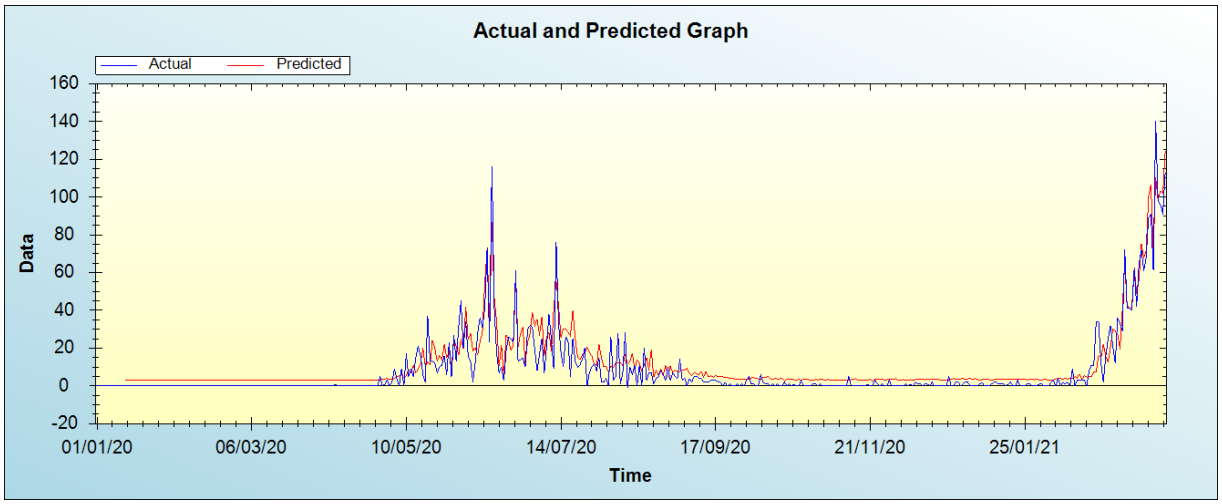

Figure 2: In-sample forecast for the Y series

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

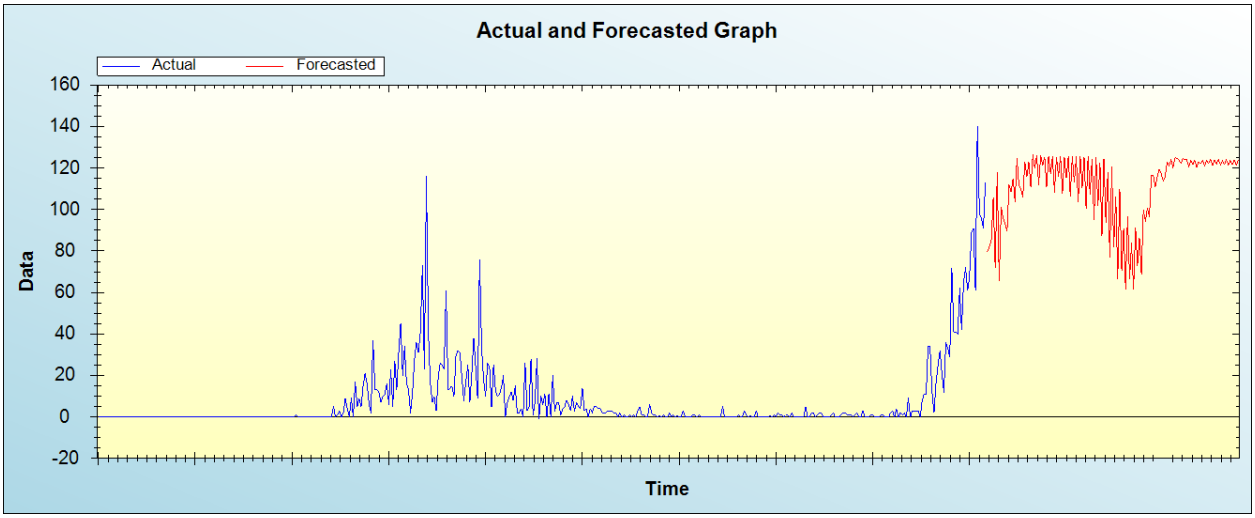

Figure 3: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Date	Forecasts
26/03/21	79.7368
27/03/21	82.1100
28/03/21	84.7705
29/03/21	105.6994
30/03/21	71.7628
31/03/21	117.7862
01/04/21	65.5539
02/04/21	101.1969
03/04/21	95.5636
04/04/21	93.4771
05/04/21	89.3374
06/04/21	112.0865
07/04/21	108.4679
08/04/21	114.9956
09/04/21	103.7669
10/04/21	124.8315
11/04/21	111.5523
12/04/21	109.6168
13/04/21	106.0555
14/04/21	122.9712
15/04/21	115.9283
16/04/21	122.9715
17/04/21	110.9317
18/04/21	126.3438
19/04/21	119.9587
20/04/21	126.1285
21/04/21	112.0426
22/04/21	126.0133
23/04/21	121.0827
24/04/21	125.4341
25/04/21	111.0204
26/04/21	125.7724
27/04/21	117.1947
28/04/21	125.4265
29/04/21	108.4392
30/04/21	125.1434
01/05/21	115.7866

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02/05/21	125.5428
03/05/21	107.6624
04/05/21	125.2783
05/05/21	115.1888
06/05/21	125.6250
07/05/21	106.4579
08/05/21	125.7883
09/05/21	113.0690
10/05/21	125.3970
11/05/21	103.8134
12/05/21	125.7464
13/05/21	110.4740
14/05/21	125.0781
15/05/21	100.2698
16/05/21	125.6465
17/05/21	107.0841
18/05/21	124.4036
19/05/21	95.0362
20/05/21	125.3408
21/05/21	101.8083
22/05/21	122.6294
23/05/21	87.3172
24/05/21	124.1939
25/05/21	93.5684
26/05/21	117.9671
27/05/21	76.9956
28/05/21	120.4578
29/05/21	81.9957
30/05/21	106.3756
31/05/21	66.7080
01/06/21	110.0809
02/06/21	70.5539
03/06/21	91.0423
04/06/21	61.5148
05/06/21	96.6065
06/06/21	66.5359
07/06/21	83.7065
08/06/21	61.5507
09/06/21	91.4386
10/06/21	72.9986
11/06/21	86.2815
12/06/21	68.8052
13/06/21	100.0437
14/06/21	94.3636
15/06/21	100.4756
16/06/21	96.5208
17/06/21	116.4109
18/06/21	116.5847
19/06/21	110.7183
20/06/21	115.4885
21/06/21	119.2673
22/06/21	117.3478
23/06/21	113.7945
24/06/21	115.6836
25/06/21	122.9368
26/06/21	120.9151
27/06/21	124.2379
28/06/21	120.0977
29/06/21	124.9661
30/06/21	124.6432
01/07/21	123.8493
02/07/21	122.3055
03/07/21	124.7662
04/07/21	123.8947

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05/07/21	124.0214
06/07/21	120.4872
07/07/21	123.7780
08/07/21	121.6808
09/07/21	123.7639
10/07/21	120.3487
11/07/21	123.1091
12/07/21	122.1130
13/07/21	123.6593
14/07/21	120.9363
15/07/21	123.5385
16/07/21	122.0631
17/07/21	124.2399
18/07/21	121.2789
19/07/21	123.9162
20/07/21	121.8927
21/07/21	124.2431
22/07/21	121.4472
23/07/21	123.7471
24/07/21	121.7803
25/07/21	124.1121
26/07/21	121.3510
27/07/21	123.7874
28/07/21	121.4810
29/07/21	124.0830
30/07/21	121.3060
31/07/21	123.8692

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

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 daily observations of COVID-19 cases in Yemen, 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. It is projected that daily COVID-19 cases in Yemen are likely to remain high over the out-of-sample period. The study suggests the continued compliance to control and preventive COVID-19 measures such as social distancing, quarantine, isolation, face-mask wearing and so on, as well as country-wide vaccinations.

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Citation of this Article:

Dr. Smartson. P. NYONI, Mr. Thabani NYONI, Mr. Tatenda. A. CHIHOHO, "Forecasting Covid-19 New Cases in Yemen" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 6, pp 605-610, June 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.506106

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