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

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ABSTRACT

Circulating worldwide, the ongoing COVID-19 outbreak continues to cause devastating mortality and is indeed a great threat to global public health. In this research paper, the ANN model was applied to analyze daily COVID-19 cases in Guatemala. The employed data covers the period March 14, 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 model reveal that the model is generally stable. The results of the study reveal a projected sharp downwards trajectory of confirmed daily COVID-19 cases in Guatemala throughout the out-of-sample period. However, the country should not be complacent but rather ensure the continued compliance to control and preventive COVID-19 measures such as social distancing, quarantine, isolation, face-mask wearing and so on.

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

INTRODUCTION

COVID-19 started in Wuhan, China, and has extensively spread all over the world since January 2020. An epidemiological link to the Huanan Seafood Wholesale Market was found as the source of the initial cluster of cases (WHO, 2020). The specific symptoms of COVID-19 are fever (98%) and cough (76%) in addition to other non-specific symptoms such as fatigue (44%), headache (8%) and dyspnea (3%) (Zhang, 2020; Xie, 2020; Wang *et al*., 2020). Humans can acquire COVID-19 when they come into contact contaminated surfaces or form droplets released by infectious symptomatic and asymptomatic individuals (Bai *et al*., 2020). The faster spread of COVID-19 in Guatemala is inevitable, socially and economically. The high cost of COVID-19 socially and economically is enormous, with severe damage in different social groups, especially ways, such as inflation, unemployment, income inequality, discrimination and corruption (Estrada, 2020). Understanding current patterns of COVID-19 and forecasting its trajectory is essential in guiding policies aimed at curtailing the pandemic (Taboe *et al*., 2020). In order to help the government of Guatemala in controlling the pandemic, this research seeks to model and forecast daily confirmed COVID-19 cases in the country.

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 Guatemala. 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 hinged on daily new Covid19 cases (referred to as EG series in this study) for all age groups in Guatemala. The data covers the period 14 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
465.25	363.00	0.00000	4233.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
454.76	0.97744	2.6540	18.413
5% Perc.	95% Perc.	IQ range	Missing obs.
1.0000	1147.5	687.50	0

ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN GUATEMALA

Table 2: ANN model summary

| Variable	EG
Observations	220 (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	0.109899
MSE	66794.473620
MAE	144.567756

Residual Analysis for the ANN model
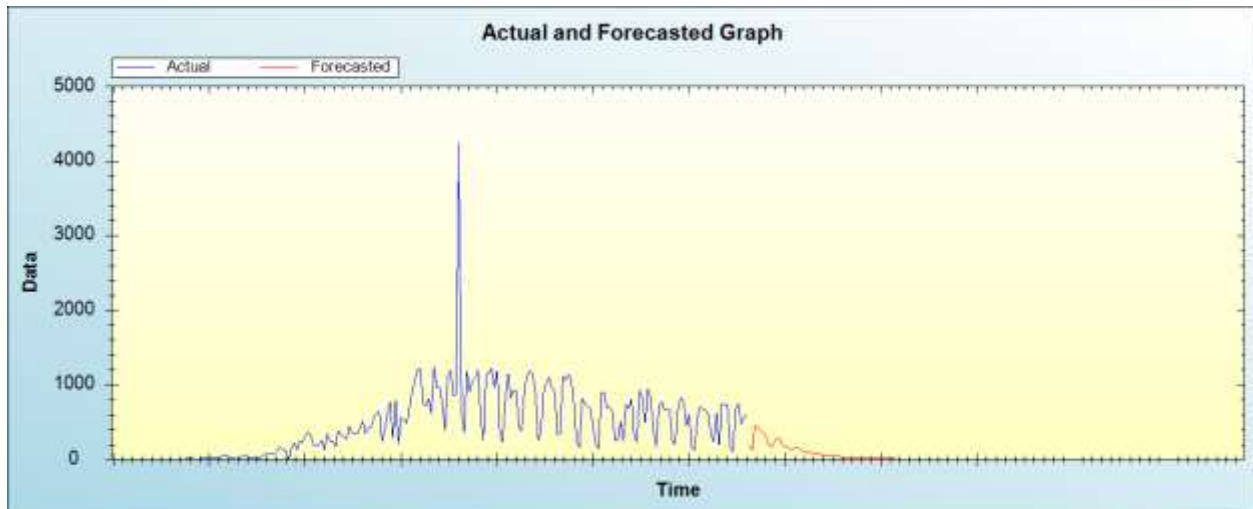
Figure 1: Residual analysis
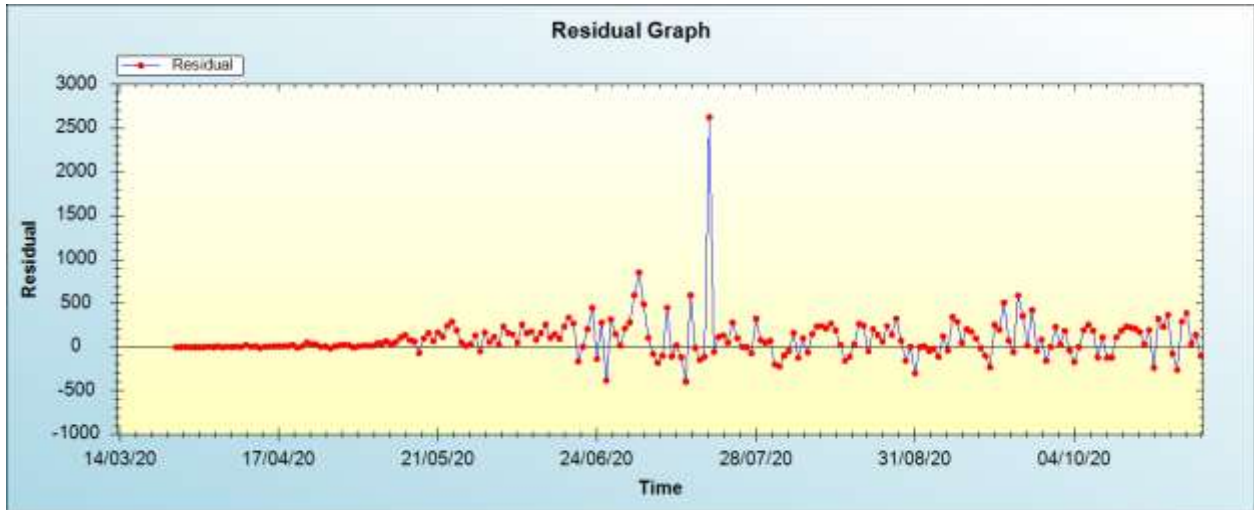
In-sample Forecast for EG

Figure 2: In-sample forecast for the EG series
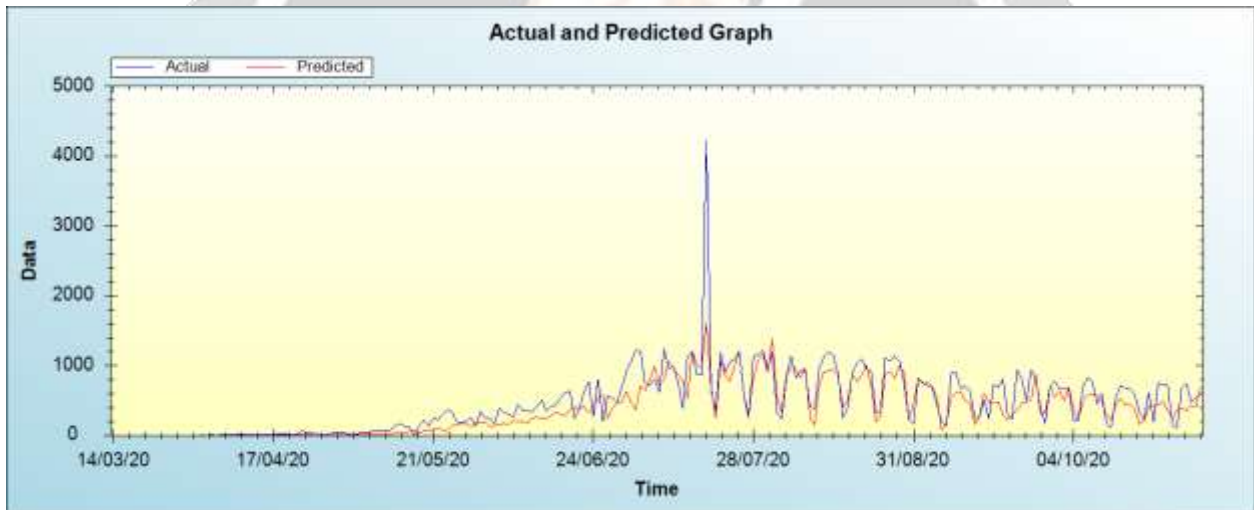
Out-of-Sample Forecast for EG: Actual and Forecasted Graph

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

Actual and Forecasted Graph

Out-of-Sample Forecast for EG: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	203.6943
02/11/20	127.1784
03/11/20	451.8414
04/11/20	444.9103
05/11/20	393.2388
06/11/20	350.2093
07/11/20	314.6254
08/11/20	194.2750
09/11/20	170.7531
10/11/20	232.2547
11/11/20	284.4516
12/11/20	283.1981
13/11/20	197.5377
14/11/20	174.8501
15/11/20	157.8432

16/11/20	136.5946
17/11/20	142.5784
18/11/20	164.9544
19/11/20	149.6288
20/11/20	117.8600
21/11/20	104.4356
22/11/20	93.2542
23/11/20	91.0297
24/11/20	90.1782
25/11/20	84.4327
26/11/20	77.6029
27/11/20	69.2910
28/11/20	58.9870
29/11/20	54.4175
30/11/20	54.4289
01/12/20	50.2539
02/12/20	45.8765
03/12/20	42.6964
04/12/20	38.3276
05/12/20	34.7628
06/12/20	32.9145
07/12/20	30.9704
08/12/20	28.9600
09/12/20	27.1458
10/12/20	24.8513
11/12/20	23.0875

12/12/20	21.9148
13/12/20	20.5773
14/12/20	19.4439
15/12/20	18.5578
16/12/20	17.4817
17/12/20	16.4894
18/12/20	15.7847
19/12/20	15.0841
20/12/20	14.4589
21/12/20	13.9492
22/12/20	13.4084
23/12/20	12.9200
24/12/20	12.5252
25/12/20	12.1398
26/12/20	11.8031
27/12/20	11.5300
28/12/20	11.2511
29/12/20	10.9953
30/12/20	10.7855
31/12/20	10.5843
01/01/21	10.4040
02/01/21	10.2538
03/01/21	10.1099
04/01/21	9.9781
05/01/21	9.8659
06/01/21	9.7602

07/01/21	9.6655
08/01/21	9.5851
09/01/21	9.5094
10/01/21	9.4406
11/01/21	9.3814
12/01/21	9.3262
13/01/21	9.2764
14/01/21	9.2335
15/01/21	9.1939
16/01/21	9.1579
17/01/21	9.1266
18/01/21	9.0977
19/01/21	9.0717
20/01/21	9.0489
21/01/21	9.0281
22/01/21	9.0093
23/01/21	8.9927
24/01/21	8.9776
25/01/21	8.9640
26/01/21	8.9519
27/01/21	8.9410
28/01/21	8.9312
29/01/21	8.9224
30/01/21	8.9145
31/01/21	8.9074
01/02/21	8.9010

02/02/21	8.8953
03/02/21	8.8901
04/02/21	8.8855
05/02/21	8.8814
06/02/21	8.8776
07/02/21	8.8743
08/02/21	8.8713
09/02/21	8.8686
10/02/21	8.8662
11/02/21	8.8640
12/02/21	8.8620
13/02/21	8.8603
14/02/21	8.8587
15/02/21	8.8573
16/02/21	8.8560
17/02/21	8.8548
18/02/21	8.8538
19/02/21	8.8529
20/02/21	8.8521
21/02/21	8.8513
22/02/21	8.8506
23/02/21	8.8500
24/02/21	8.8495
25/02/21	8.8490
26/02/21	8.8486
27/02/21	8.8482

28/02/21	8.8478
01/03/21	8.8475
02/03/21	8.8472
03/03/21	8.8470
04/03/21	8.8468
05/03/21	8.8465
06/03/21	8.8464
07/03/21	8.8462
08/03/21	8.8460
09/03/21	8.8459
10/03/21	8.8458
11/03/21	8.8457
12/03/21	8.8456
13/03/21	8.8455
14/03/21	8.8454
15/03/21	8.8454
16/03/21	8.8453
17/03/21	8.8452
18/03/21	8.8452
19/03/21	8.8451
20/03/21	8.8451
21/03/21	8.8451
22/03/21	8.8450
23/03/21	8.8450
24/03/21	8.8450
25/03/21	8.8449

26/03/21	8.8449
27/03/21	8.8449
28/03/21	8.8449
29/03/21	8.8449
30/03/21	8.8449
31/03/21	8.8448
01/04/21	8.8448
02/04/21	8.8448
03/04/21	8.8448
04/04/21	8.8448
05/04/21	8.8448
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12/04/21	8.8448
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18/04/21	8.8447
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25/04/21	8.8447
26/04/21	8.8447
27/04/21	8.8447
28/04/21	8.8447
29/04/21	8.8447
30/04/21	8.8447

Figure 4: Graphical presentation of out-of-sample forecasts
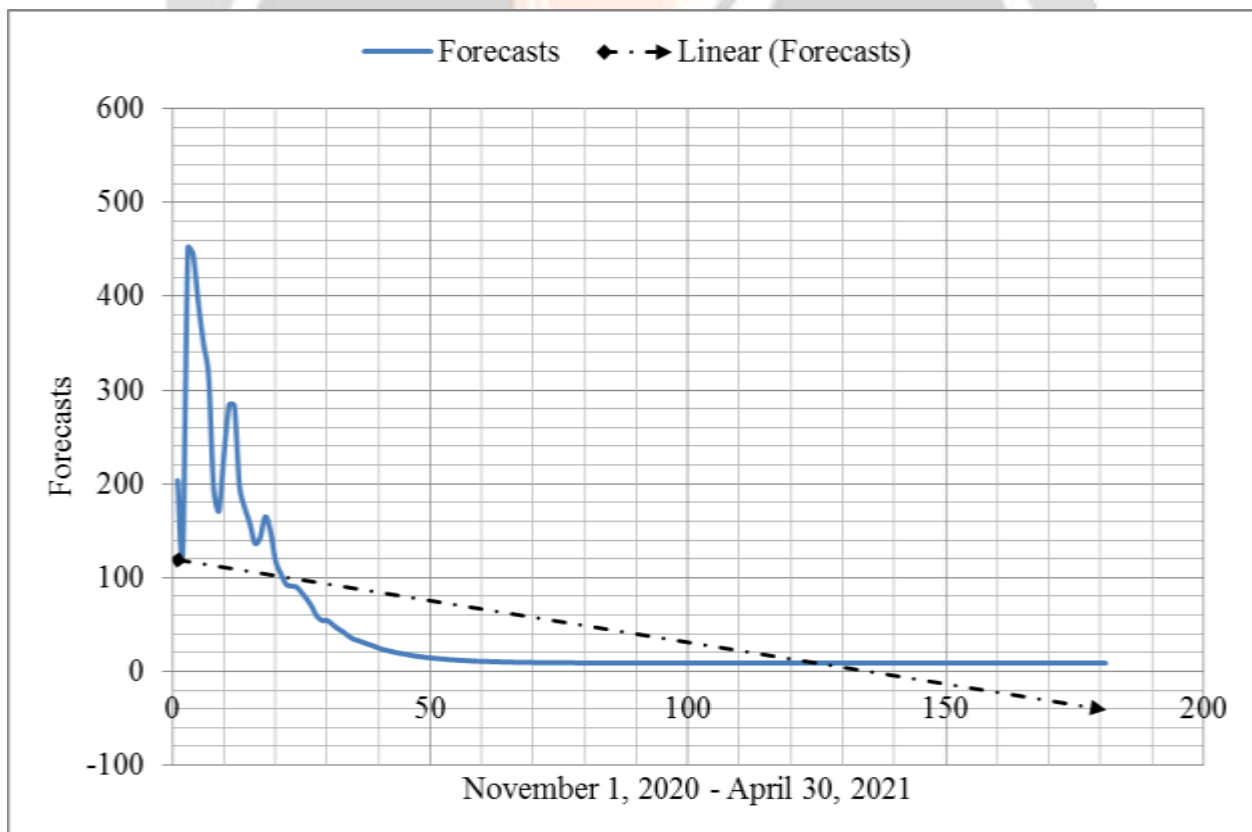
The descriptive statistics, summary of the applied model, residual analysis, in-sample forecasts as well as out-of-sample forecasts are shown in table 1, table 2, figure 1, figure 2 and well as figures 3 and 4 as well as table 3, respectively. The results of the study show that daily COVID-19 cases will continue to decline from approximately 204 cases (01/11/2020) to about 9 cases

around the tail end of April 2021. The predicted trend is only realistic if the government of Guatemala remains serious and dedicated to the fight against the virus.

CONCLUSION & RECOMMENDATIONS

COVID-19 is still spreading rapidly in many countries around the world. Based on 232 daily observations of COVID-19 cases in Guatemala, this study used the ANN (12, 12, 1) model to come up with forecasts ranging over the period November 2020 to April 2021. Given that Central America is currently also an epicenter of the virus, it is indeed surprising to see a projected downwards trajectory in daily cases in Guatemala. However, the country should not be complacent but rather ensure 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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