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Forecasting Covid-19 New Cases in Belize

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***Abstract* - Expectedly, the global pandemic of COVID-19 has resulted in a surge in COVID-19 forecasting and control models. In this research article, the ANN methodology was applied to investigate the trends of confirmed daily COVID-19 cases in Belize. This study is based on daily new cases of COVID-19 in Belize 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 employed model reveal that the model is stable in forecasting COVID-19 cases in Belize. It is projected that daily COVID-19 cases in Belize are likely to vanish over the out-of-sample period. Nonetheless, the government of Belize ought to ensure the continued compliance to control and preventive COVID-19 measures such as vaccination, social distancing, quarantine, isolation, face-mask wearing and so on.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Coronavirus Disease 2019 (COVID-19), technically known as SARS-CoV-2, is an infectious disease that was first identified on 31 December 2019 in Wuhan, the capital city of China's Hubei province. The World Health Organization (WHO) declared the coronavirus outbreak a Public Health Emergency of International Concern on 30 January 2020 and a pandemic on 11 March 2020 (Alamo *et al*., 2020). The first case of COVID-19 in Belize was officially reported on the 23rd of March 2020 in San Pedro Town.The clinical presentation of COVID-19 ranges between asymptomatic infection, mild symptoms and critical disease, defined by respiratory and or multi-organ failure and death (Wang *et al*., 2020). Disease severity and mortality are associated with older age and underlying comorbidities such as diabetes, hypertension and cardiovascular disease (Sun *et al*., 2020). The virus is mainly spread during close contact and by small droplets produced when those infected cough, sneeze or talk. These small droplets may also be produced during breathing. The virus is most contagious during the first 4 – 6 days after on-set of symptoms, although spread is possible in asymptomatic conditions and in later stages of the disease (Ferretti *et al*., 2020). The time from exposure to onset of symptoms (incubation period) is typically around 5 days but may range from 2 to 14 days (Lauer *et al*., 2020). The basic reproduction number of COVID-19 has been estimated to be 2.2 (Li *et al*., 2020) but generally ranges between 1.4 and 7.23 (Wu *et al*., 2020), and human-to-human transmission has since occurred to other parts of China and beyond (Li *et al*., 2020). Recommended measures to control the pandemic include social distancing, mobility constraints, pro-active testing and isolation of detected cases (Hellewell *et al*., 2020). COVID-19 forecasting studies are very scanty in Belize. There is need for a forecasting model that would guide policy makers in the country. The government of Belize, just like other governments around the world; is in great need of reliable forecasts of confirmed COVID-19 case volumes for purposes of planning ahead and strengthening, especially the Intensive Care Unit (ICU) capacities within the country's healthcare system. The main objective of this paper is to model and forecast COVID-19 cases in Belize using Artificial Neural Networks.

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 Belize.

Data Issues

This study is based on new daily cases of COVID-19 in Belize for the period 1 January 2020 – 25 March 2021.The out-of-sample forecast covers the period 26 March 2021 – 31 July 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	B
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	0.090172
MSE	4793.080214
MAE	16.802679

Residual Analysis for the Applied Model

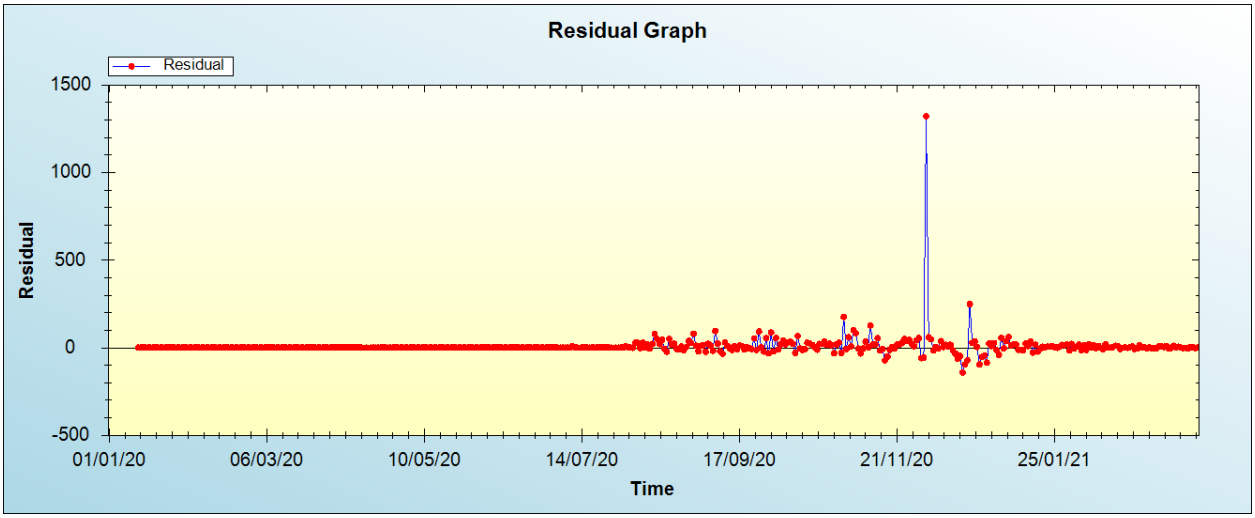

Figure 1: Residual analysis

In-sample Forecast for A

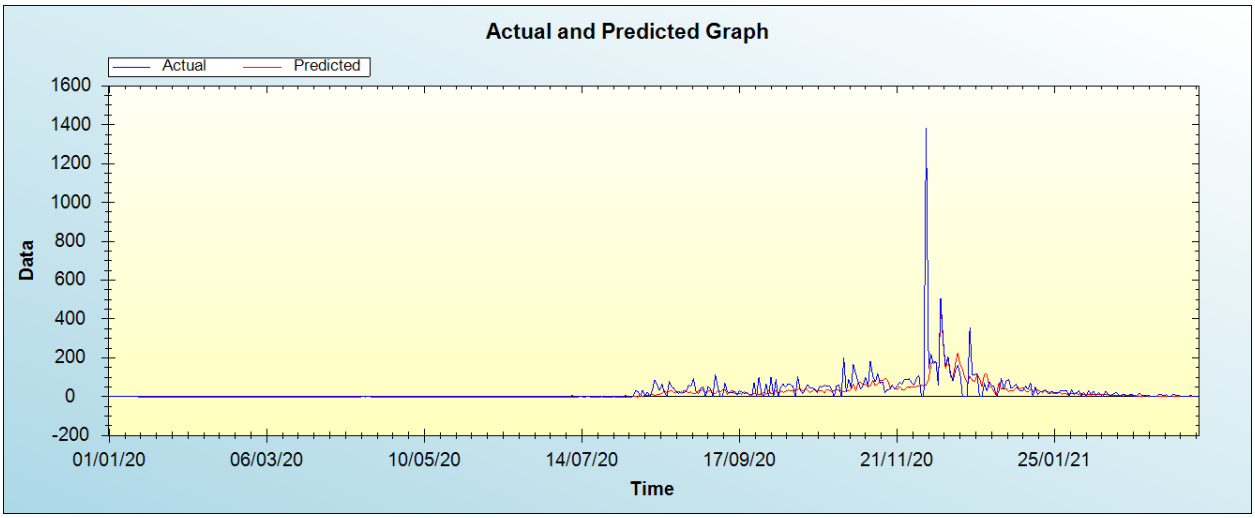

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Figure 2: In-sample forecast for the A series

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

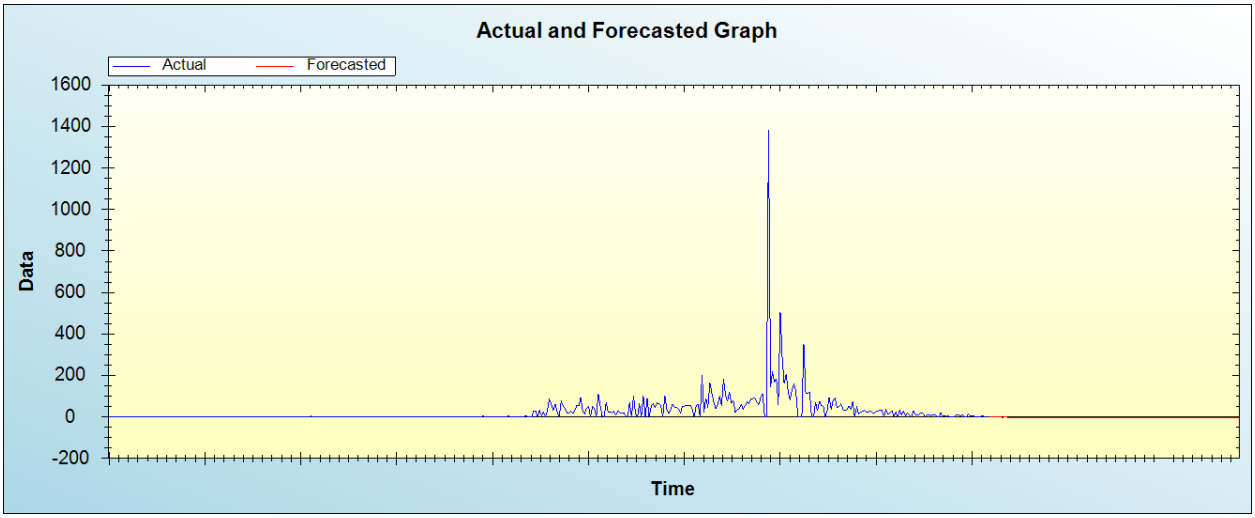

Figure 3: Out-of-sample forecast for B: actual and forecasted graph

Out-of-Sample Forecast for B: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	-0.0397
27/03/21	0.4679
28/03/21	0.0007
29/03/21	0.4598
30/03/21	-0.7880
31/03/21	-0.9587
01/04/21	-1.4552
02/04/21	-1.5511
03/04/21	-0.8450
04/04/21	-1.4206
05/04/21	-1.8741
06/04/21	-1.8980
07/04/21	-2.0275
08/04/21	-2.1917
09/04/21	-2.2344
10/04/21	-2.2052
11/04/21	-2.4709
12/04/21	-2.5403
13/04/21	-2.6610
14/04/21	-2.7225
15/04/21	-2.6993
16/04/21	-2.7909
17/04/21	-2.8908
18/04/21	-2.9334
19/04/21	-2.9735
20/04/21	-3.0408
21/04/21	-3.0650
22/04/21	-3.0826
23/04/21	-3.1423
24/04/21	-3.1742
25/04/21	-3.2065
26/04/21	-3.2336
27/04/21	-3.2509
28/04/21	-3.2738
29/04/21	-3.3014

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30/04/21	-3.3204
01/05/21	-3.3366
02/05/21	-3.3575
03/05/21	-3.3703
04/05/21	-3.3812
05/05/21	-3.3974
06/05/21	-3.4099
07/05/21	-3.4206
08/05/21	-3.4310
09/05/21	-3.4398
10/05/21	-3.4478
11/05/21	-3.4565
12/05/21	-3.4638
13/05/21	-3.4702
14/05/21	-3.4770
15/05/21	-3.4823
16/05/21	-3.4871
17/05/21	-3.4922
18/05/21	-3.4968
19/05/21	-3.5007
20/05/21	-3.5045
21/05/21	-3.5080
22/05/21	-3.5110
23/05/21	-3.5140
24/05/21	-3.5167
25/05/21	-3.5191
26/05/21	-3.5214
27/05/21	-3.5235
28/05/21	-3.5253
29/05/21	-3.5271
30/05/21	-3.5288
31/05/21	-3.5302
01/06/21	-3.5316
02/06/21	-3.5329
03/06/21	-3.5340
04/06/21	-3.5351
05/06/21	-3.5361
06/06/21	-3.5370
07/06/21	-3.5378
08/06/21	-3.5386
09/06/21	-3.5393
10/06/21	-3.5399
11/06/21	-3.5405
12/06/21	-3.5411
13/06/21	-3.5416
14/06/21	-3.5421
15/06/21	-3.5425
16/06/21	-3.5429
17/06/21	-3.5432
18/06/21	-3.5436
19/06/21	-3.5439
20/06/21	-3.5442
21/06/21	-3.5444
22/06/21	-3.5446
23/06/21	-3.5449
24/06/21	-3.5451
25/06/21	-3.5453
26/06/21	-3.5454
27/06/21	-3.5456
28/06/21	-3.5457
29/06/21	-3.5459
30/06/21	-3.5460
01/07/21	-3.5461
02/07/21	-3.5462

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03/07/21	-3.5463
04/07/21	-3.5464
05/07/21	-3.5465
06/07/21	-3.5465
07/07/21	-3.5466
08/07/21	-3.5467
09/07/21	-3.5467
10/07/21	-3.5468
11/07/21	-3.5468
12/07/21	-3.5469
13/07/21	-3.5469
14/07/21	-3.5469
15/07/21	-3.5470
16/07/21	-3.5470
17/07/21	-3.5470
18/07/21	-3.5471
19/07/21	-3.5471
20/07/21	-3.5471
21/07/21	-3.5471
22/07/21	-3.5472
23/07/21	-3.5472
24/07/21	-3.5472
25/07/21	-3.5472
26/07/21	-3.5472
27/07/21	-3.5472
28/07/21	-3.5472
29/07/21	-3.5473
30/07/21	-3.5473
31/07/21	-3.5473

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 Belize are likely to vanish over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

COVID-19 has led to unprecedented healthcare crisis with millions of infected people across the globe often pushing infrastructures, healthcare workers and entire economies beyond their limits (Tsiknakis *et al*., 2020). Belize has not been spared by this pandemic and hence the need for modeling and forecasting. This study used the ANN (12, 12, 1) model to come up with forecasts. It has been projected that daily COVID-19 cases in Belize are likely to vanish over the out-of-sample period. Nevertheless, the government should ensure the continued compliance to control and preventive COVID-19 measures such as vaccination, social distancing, quarantine, isolation, face-mask wearing and so on.

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