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

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ABSTRACT

When it comes to public health these days, COVID-19 is of critical concern and considered as the supreme crisis of the present era. A surge in the number patients testing positive for COVID-19 has created a lot of stress and confusion on governing bodies across the globe and they are finding it difficult to tackle the situation. Panama is one of the Central American countries greatly affected by the COVID-19 pandemic. In this research article, the ANN approach was applied to analyze COVID-19 case volumes in Panama. The employed data covers the period March 10, 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 model reveal that the model is stable in forecasting COVID-19 cases in Panama. The results of the study imply that daily COVID-19 cases in Panama will continue to, generally, decline; and then reach an equilibrium level of approximately 575 cases per day around February 20, 2021 and this may persist throughout the rest of the out-of-sample period. The responsible authorities of Panama, in partnership with the ministry of health; should continue to ensure that there is 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

The Corona Virus Disease (COVID-19) is a global pandemic that was discovered by a Chinese physician in Wuhan, the capital city of Hubei province in mainland China, in December 2019 (WHO, 2020). It then propagated worldwide, and was declared a pandemic by the World Health Organization (WHO) at the tail end of January 2020 (Butt *et al*., 2020). Symptoms of the disease include dry cough, sore throat and fever. Although, the majority of the cases are mild, some cases may lead to Acute Respiratory Distress Syndrome (ARDS), severe pneumonia, pulmonary oedema and organ failure (Chen *et al*., 2020). COVID-19 propagation is faster when people are in close proximity. Thus, travel restrictions control the spread of the disease, and frequent hand washing is always recommended to prevent potential viral infections (Alazab *et al*., 2020). Forecasting COVID-19 case volumes is very important (Medina-Mendieta *et al*., 2020; Li *et al*., 2020; Zhao *et al*., 2020; Liu *et al*., 2020; Lai *et al*., 2020; Khakharia *et al*., 2020). In the first place, to inform government and healthcare professionals on what to expect and which measures

to impose, and secondly, to motivate the wider public to adhere to the measures that were imposed to decelerate the spreading before a regrettable scenario unfolds (Ippolito *et al*., 2020; McCloskey *et al*., 2020). Thirdly, forecasting models are used as a reference to make new policies and to evaluate the conditions of COVID-19 curfews (Remuzzi & Remuzzi, 2020). The motive behind this paper is to model and forecast daily confirmed cases of COVID-19 in Panama.

METHODOLOGY

Advancing accurate prediction models is of utmost importance to take proper actions (Pinter *et al*., 2020). This paper uses the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID-19 infections in Panama. This study particularly makes use of the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function. The paper is based on daily new Covid-19 cases (referred to as PC series in this study) for all age groups in Panama. The data covers the period 10 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 research paper was gathered from John Hopkins University (USA).

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
566.09	622.50	0.00000	1540.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
367.82	0.64975	0.16963	-0.88480
5% Perc.	95% Perc.	IQ range	Missing obs.
13.700	1167.5	631.00	0

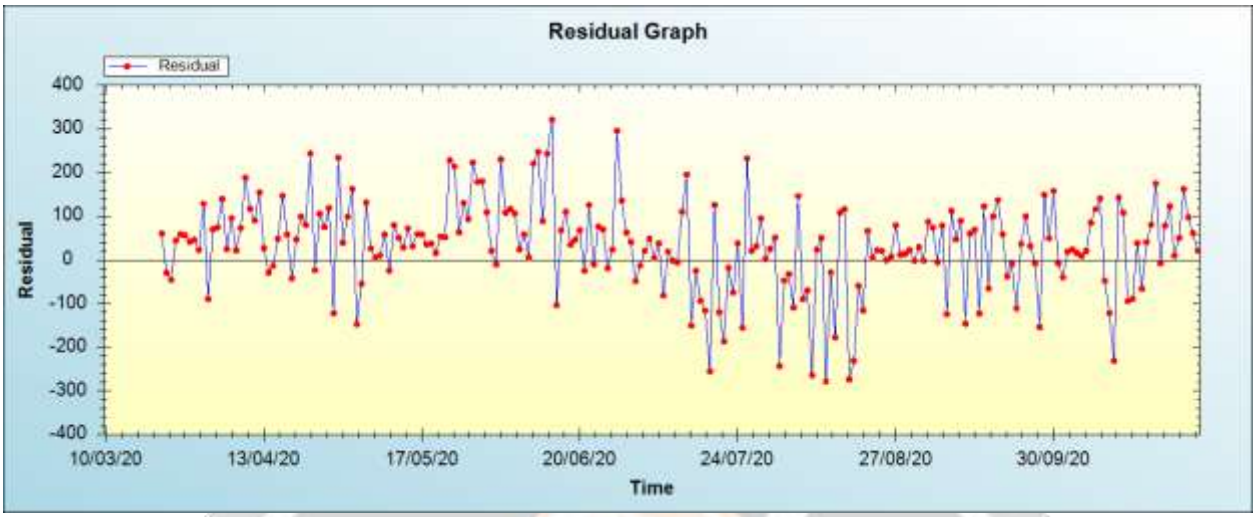
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN PANAMA

Table 2: ANN model summary

Variable	PC
Observations	224 (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	O.126881
MSE	11783.993403
MAE	84.318202

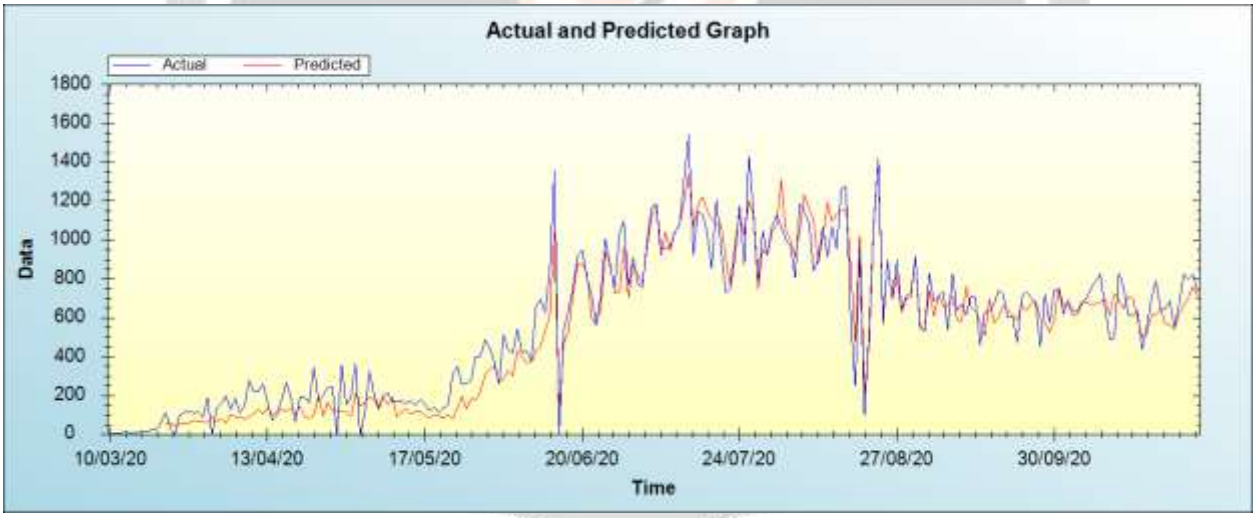
Residual Analysis for the ANN model

Figure 1: Residual analysis



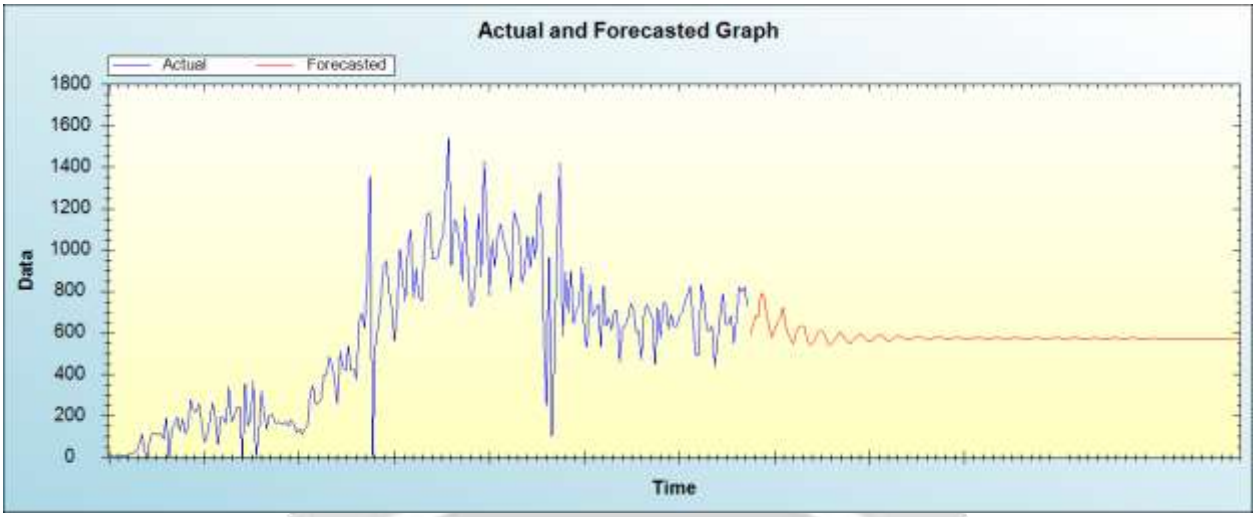
In-sample Forecast for PC

Figure 2: In-sample forecast for the PC series



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

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



Out-of-Sample Forecast for PC: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	592.0611
02/11/20	635.5727
03/11/20	682.3120
04/11/20	677.5829
05/11/20	794.0158
06/11/20	786.4592
07/11/20	694.6068
08/11/20	627.2615
09/11/20	582.5931
10/11/20	614.5122
11/11/20	652.7307
12/11/20	671.8992
13/11/20	724.1030
14/11/20	642.6652
15/11/20	595.9565

16/11/20	569.0278
17/11/20	548.9654
18/11/20	609.7853
19/11/20	631.5931
20/11/20	636.3345
21/11/20	630.9700
22/11/20	566.2299
23/11/20	542.1938
24/11/20	548.9384
25/11/20	572.7837
26/11/20	605.5556
27/11/20	614.7284
28/11/20	603.2183
29/11/20	574.7980
30/11/20	541.8951
01/12/20	547.4009
02/12/20	567.1814
03/12/20	587.1463
04/12/20	605.6303
05/12/20	597.1685
06/12/20	574.6534
07/12/20	557.1107
08/12/20	549.6089
09/12/20	566.2345
10/12/20	582.4736
11/12/20	593.5375

12/12/20	597.0483
13/12/20	578.9213
14/12/20	562.5488
15/12/20	559.1847
16/12/20	564.4103
17/12/20	579.2975
18/12/20	589.4553
19/12/20	590.5087
20/12/20	583.3685
21/12/20	568.5572
22/12/20	562.4650
23/12/20	567.2368
24/12/20	575.3837
25/12/20	585.2348
26/12/20	588.1101
27/12/20	581.9731
28/12/20	573.4974
29/12/20	566.2792
30/12/20	567.4700
31/12/20	574.6217
01/01/21	580.9159
02/01/21	584.9670
03/01/21	582.1013
04/01/21	574.6035
05/01/21	569.7367
06/01/21	568.7035

07/01/21	572.9786
08/01/21	578.9582
09/01/21	581.7452
10/01/21	581.0515
11/01/21	576.2461
12/01/21	571.1613
13/01/21	570.3037
14/01/21	572.4912
15/01/21	576.7295
16/01/21	580.0545
17/01/21	579.6015
18/01/21	576.7371
19/01/21	572.9714
20/01/21	571.0604
21/01/21	572.6545
22/01/21	575.5203
23/01/21	578.1713
24/01/21	578.8532
25/01/21	576.6927
26/01/21	573.9796
27/01/21	572.2750
28/01/21	572.6194
29/01/21	574.9219
30/01/21	576.9940
31/01/21	577.7781
01/02/21	576.8164

02/02/21	574.5654
03/02/21	573.0863
04/02/21	573.0887
05/02/21	574.3857
06/02/21	576.2317
07/02/21	577.0484
08/02/21	576.5225
09/02/21	575.1225
10/02/21	573.6861
11/02/21	573.4479
12/02/21	574.3124
13/02/21	575.5671
14/02/21	576.4992
15/02/21	576.3059
16/02/21	575.2987
17/02/21	574.2603
18/02/21	573.7787
19/02/21	574.2801
20/02/21	575.2532
21/02/21	575.9799
22/02/21	576.0901
23/02/21	575.4295
24/02/21	574.5728
25/02/21	574.1485
26/02/21	574.3230
27/02/21	575.0177

28/02/21	575.6715
01/03/21	575.8248
02/03/21	575.4765
03/03/21	574.8280
04/03/21	574.3864
05/03/21	574.4534
06/03/21	574.8837
07/03/21	575.4137
08/03/21	575.6478
09/03/21	575.4329
10/03/21	574.9941
11/03/21	574.6042
12/03/21	574.5475
13/03/21	574.8470
14/03/21	575.2338
15/03/21	575.4745
16/03/21	575.3997
17/03/21	575.0732
18/03/21	574.7674
19/03/21	574.6614
20/03/21	574.8231
21/03/21	575.1295
22/03/21	575.3377
23/03/21	575.3357
24/03/21	575.1315
25/03/21	574.8729

26/03/21	574.7597
27/03/21	574.8398
28/03/21	575.0495
29/03/21	575.2423
30/03/21	575.2732
31/03/21	575.1474
01/04/21	574.9580
02/04/21	574.8340
03/04/21	574.8668
04/04/21	575.0104
05/04/21	575.1619
06/04/21	575.2219
07/04/21	575.1471
08/04/21	575.0076
09/04/21	574.9011
10/04/21	574.8939
11/04/21	574.9904
12/04/21	575.1099
13/04/21	575.1712
14/04/21	575.1401
15/04/21	575.0390
16/04/21	574.9478
17/04/21	574.9265
18/04/21	574.9813
19/04/21	575.0737
20/04/21	575.1335

21/04/21	575.1236
22/04/21	575.0584
23/04/21	574.9829
24/04/21	574.9527
25/04/21	574.9841
26/04/21	575.0488
27/04/21	575.1032
28/04/21	575.1085
29/04/21	575.0654
30/04/21	575.0088

The descriptive statistics, summary of the employed model, residual analysis, in-sample forecasts as well as out-of-sample forecasts are presented in table 1, table 2, figure 1, figure 2 and well as figure 3 and table 3, respectively. The applied predictive model is stable and acceptable for analyzing COVID-19 cases in Panama as indicated in the residual analysis. The results of the study basically indicate that daily COVID-19 cases in Panama will continue to, generally, decline; and then reach an equilibrium level of approximately 575 cases per day around February 20, 2021 and this shall persist throughout the rest of the out-of-sample period.

CONCLUSION & RECOMMENDATIONS

The rapid spread of COVID-19 across the world as well as the increasing number of deaths requires drastic actions from all sectors. Future prediction of potential infections will enable authorities to tackle the consequences effectively (Alazab *et al*., 2020). Indeed, predicting the number of new confirmed cases of COVID-19 is crucial in the prevention and control of the COVID-19 outbreak (Lei *et al*., 2020). Hinged on 236 daily observations of COVID-19 cases in Panama, this study used the ANN (12, 12, 1) model to come up with reliable predictions ranging over the period November 2020 to April 2021. Panama is likely to be experience a brief decline in the cases, at from now (November 1, 2020) until around February 19, 2020, after which an equilibrium daily case volume could be reached and may be observed for the rest of the out-of-sample period. The government of Panama should continue to ensure that there is compliance to control and preventive COVID-19 measures such as social distancing, quarantine, isolation, face-mask wearing and so on. This is expected to help a lot, particularly in avoiding regrettable daily COVID-19 case volumes in the country.

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