

Forecasting Daily New Covid-19 Cases in the Gambia Using the Artificial Neural Networks

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Abstract - In this research paper, the ANN approach was applied to analyze daily new COVID-19 cases in Gambia. The employed data covers the period 1 January 2020 to 31 December 2020 and the out-of-sample period ranges over the period 1 January 2021 to 31 May 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting daily COVID-19 in the Gambia. The results of the study indicate that Gambia is likely to witness another wave of infections over the period 1 January 2021 and 31 May 2021 as indicated by the out of sample forecasts. Therefore the government is encouraged to continue practicing WHO guidelines on prevention and control of COVID-19.

Keywords: ANN, Forecasting, COVID-19.

I. INTRODUCTION

The COVID-19 virus was first detected and reported in Wuhan city of China in December 2019 (Toit, 2020). The SARS CoV 2 virus was discovered as the causative agent .The virus is highly contagious and rapidly spread across the globe and was declared a global pandemic by WHO on the 11th of March 2020 (WHO, 2020). By 18 April 2020, WHO had reported more than 2.1 million confirmed cases of COVID-19 including 142 229 fatalities in 213 countries (WHO, 2020).The African continent reported its first case of COVID-19 in Egypt on the 14th February 2020 and from the Sub Saharan Africa the first case was reported in Nigeria on the 27th of February 2020 (WHO, 2020; NCDC, 2020). The origin of the COVID-19 virus is not fully understood but it is believed that it originated from bats which are usually known as natural reservoirs of corona viruses including SARS CoV like and MERS –Cov like Viruses (Giovan et al, 2020; Paraskavis et al, 2020; Banerjee et al, 2019; Hampton , 2005; Li et al, 2005).According to phylogenetic analysis studies it has been revealed that COVID-19 belongs to the Beta corona viruses that infects humans ,bats, and other wild animals (Zhou et al, 2020; Wu et al, 2020; Lu et al, 2020; Zhu et al, 2020; Liu et al, 2020; Foster et al, 2020). Gambia responded to the pandemic by implementing WHO guidelines such as wearing face masks, social distancing, regular hand washing, isolation and treatment of cases and contact tracing. In this paper we aim to model and forecast daily COVID-19 cases in the Gambia using the artificial neural network approach. The results of the study are expected to reveal the future trends of daily COVID-19 cases in the Gambia and facilitate planning and resource allocation to limit the spread of the COVID-19 epidemic.

II. LITERATURE REVIEW

Table 1: Literature Review

Author (s)	Study period	Method	Findings
Patrikar et al (2020)	January – March, 2020	Modified SEIR model	Social distancing seems to be working for India
Ibrahim & Oladipo (2020)	February – April, 2020	ARIMA models	The ARIMA (1, 1, 0) model was the best fit model. The 10 day forecast from this model showed a steep upward trend of the spread of the COVID-19 pandemic in Nigeria

Nurudeen et al (2020)	February – May, 2020	ARIMA	The best model is the ARIMA (1, 2, 1) model
Nyoni et al (2020)	28 February 2020 to 31 October 2020	ANN model	daily new COVID-19 cases are likely to fall to zero cases per day somewhere between 25 and 27 November 2020 and onwards, suggesting that Nigeria is now “on top” of the COVID-19 pandemic
Roosa et al (2020)	22 June 2020-9 February 2021	Generalized logistic growth model, Richards growth model	The epidemic growth in China has slowed in recent days and the containment measures have successfully reduced transmission

III. METHODOLOGY

The Artificial Neural Network (ANN) will be applied in this study. It has the capability of learning from any data-set to describe the nonlinear and interaction effects with great accuracy. Arguably, explicit guidelines exist for the determination of the ANN structure hence the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function.

Data Issues

This study is based on daily new cases of COVID-19 in Gambia for the period 1 January – 31 December 2020. The out-of-sample forecast covers the period January 2021 – May 2021. All the data employed in this paper was gathered from the World Bank.

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 2: ANN model summary

Variable	V
Observations	354 (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	0.066031
MSE	47.260976
MAE	3.929283

Residual Analysis for the Applied Model

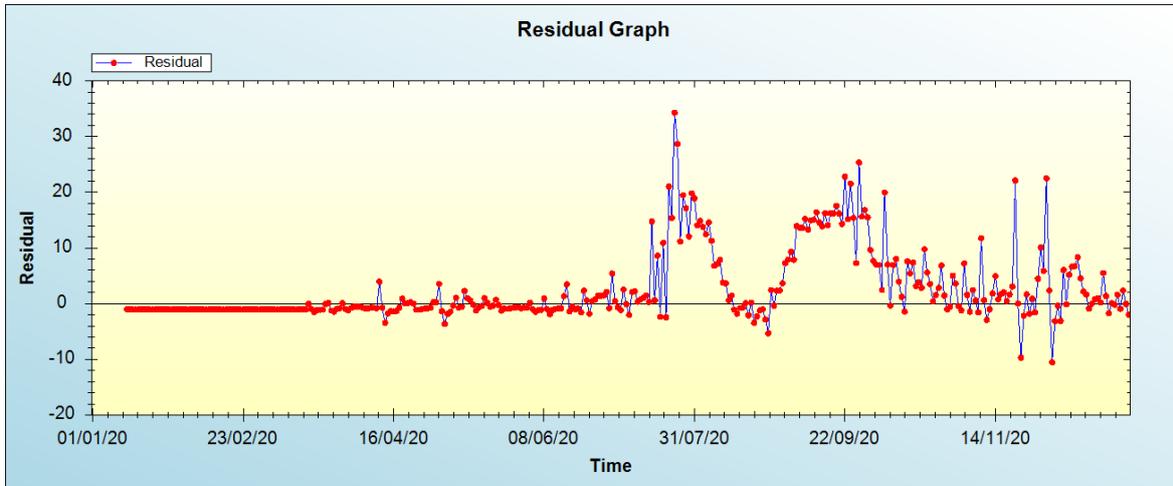


Figure 1: Residual analysis

In-sample Forecast for V

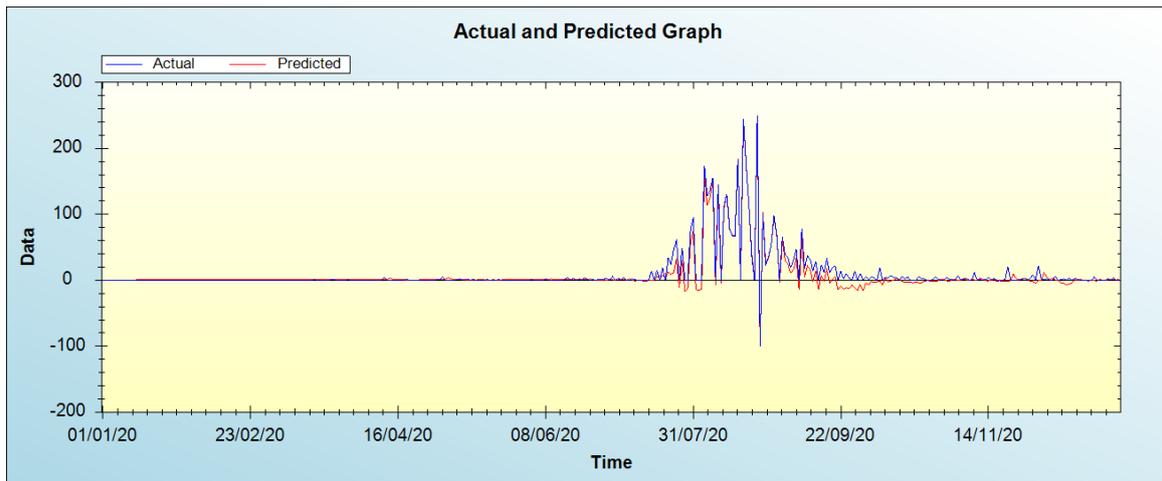


Figure 2: In-sample forecast for the V series

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

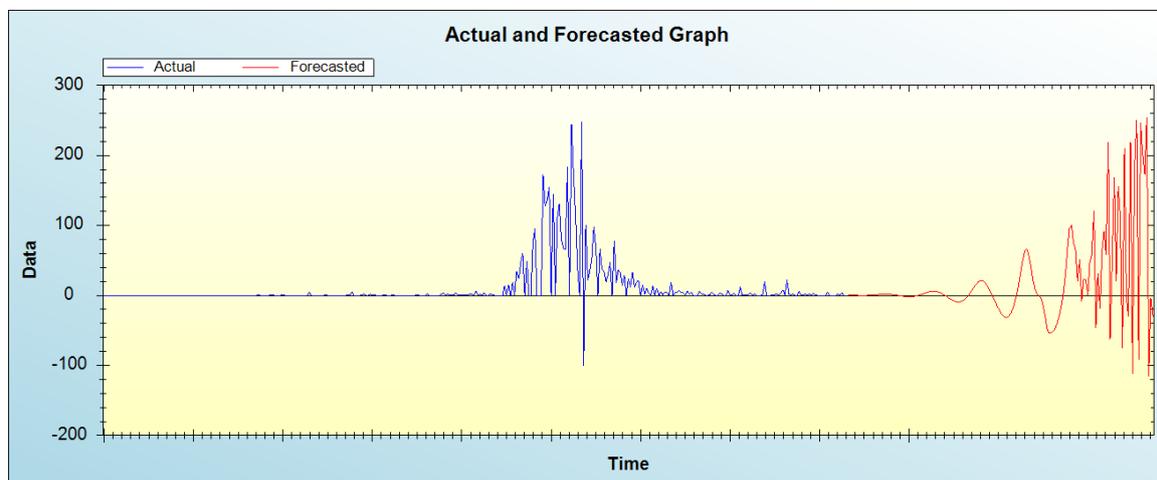


Figure 3: Out-of-sample forecast for V: actual and forecasted graph

Out-of-Sample Forecast for V: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasted daily COVID-19 cases
01/01/21	0.2078
02/01/21	-0.0001
03/01/21	0.0849
04/01/21	0.9135
05/01/21	0.3737
06/01/21	0.0607
07/01/21	-0.0728
08/01/21	-0.5093
09/01/21	-0.0830
10/01/21	-0.0896
11/01/21	0.7899
12/01/21	0.6137
13/01/21	0.9865
14/01/21	0.9242
15/01/21	1.2106
16/01/21	1.3827
17/01/21	1.8278
18/01/21	2.0025
19/01/21	2.1166
20/01/21	2.0594
21/01/21	1.7738
22/01/21	1.5313
23/01/21	1.1263
24/01/21	0.8309
25/01/21	0.3316
26/01/21	-0.1189
27/01/21	-0.7082
28/01/21	-1.2041

29/01/21	-1.6632
30/01/21	-1.9236
31/01/21	-2.0427
01/02/21	-1.9523
02/02/21	-1.6841
03/02/21	-1.2370
04/02/21	-0.5852
05/02/21	0.2276
06/02/21	1.2228
07/02/21	2.2850
08/02/21	3.3904
09/02/21	4.3830
10/02/21	5.2204
11/02/21	5.7682
12/02/21	5.9959
13/02/21	5.8216
14/02/21	5.2396
15/02/21	4.2402
16/02/21	2.8656
17/02/21	1.1862
18/02/21	-0.7005
19/02/21	-2.6758
20/02/21	-4.6152
21/02/21	-6.3875
22/02/21	-7.8621
23/02/21	-8.9070
24/02/21	-9.3997
25/02/21	-9.2298
26/02/21	-8.3162
27/02/21	-6.6089
28/02/21	-4.1063

01/03/21	-0.8587
02/03/21	3.0145
03/03/21	7.3126
04/03/21	11.7351
05/03/21	15.8728
06/03/21	19.2235
07/03/21	21.2520
08/03/21	21.5137
09/03/21	19.8007
10/03/21	16.2481
11/03/21	11.3040
12/03/21	5.5705
13/03/21	-0.4386
14/03/21	-6.4677
15/03/21	-12.4773
16/03/21	-18.3922
17/03/21	-23.8581
18/03/21	-28.2617
19/03/21	-31.0110
20/03/21	-31.7302
21/03/21	-30.2024
22/03/21	-26.2704
23/03/21	-19.8228
24/03/21	-10.7401
25/03/21	1.1225
26/03/21	15.7618
27/03/21	32.6314
28/03/21	49.8990
29/03/21	63.2724
30/03/21	66.1877
31/03/21	57.0275

01/04/21	41.6545
02/04/21	21.7534
03/04/21	9.7229
04/04/21	2.1088
05/04/21	-0.8123
06/04/21	-4.2536
07/04/21	-13.9834
08/04/21	-28.7056
09/04/21	-47.0176
10/04/21	-54.1594
11/04/21	-52.9707
12/04/21	-50.8010
13/04/21	-47.1521
14/04/21	-39.0306
15/04/21	-28.4537
16/04/21	-15.7349
17/04/21	3.4802
18/04/21	29.4534
19/04/21	64.8520
20/04/21	95.2069
21/04/21	100.3268
22/04/21	74.1062
23/04/21	65.8749
24/04/21	20.9430
25/04/21	51.1480
26/04/21	-8.5186
27/04/21	23.1450
28/04/21	22.1229
29/04/21	-0.0929
30/04/21	46.6271
01/05/21	57.7460

02/05/21	120.6309
03/05/21	-45.9777
04/05/21	31.0909
05/05/21	-18.1658
06/05/21	63.9948
07/05/21	91.6732
08/05/21	58.7804
09/05/21	219.2057
10/05/21	-62.8800
11/05/21	46.1535
12/05/21	168.7075
13/05/21	20.0986
14/05/21	156.3867
15/05/21	112.0730
16/05/21	-75.5845
17/05/21	210.1506
18/05/21	-3.7828
19/05/21	-29.5785
20/05/21	219.4603
21/05/21	-111.9977
22/05/21	178.6847
23/05/21	250.8869
24/05/21	-91.4513
25/05/21	245.9863
26/05/21	202.0593
27/05/21	173.0625
28/05/21	253.7541
29/05/21	-114.9186
30/05/21	-3.5317
31/05/21	-30.3504

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 Gambia is likely to witness another wave of infections over the period 1 January 2021 and 31 May 2021 as indicated by the out of sample forecasts.

V. CONCLUSION & RECOMMENDATIONS

Artificial neural networks (ANNs) are widely used in time series forecasting problems and have proven to be superior to traditional statistical methods like the ARIMA and exponential smoothing models (Zhao et al, 2020; Nyoni et al, 2020; Kaushik & Sahi, 2018; Fojnica et al, 2016). They are self-adaptive and inherently nonlinear (Zhang, 2003). They are appropriate models for nonlinear complex data sets such the daily COVID-19 cases. The findings of this study revealed that Gambia is likely to witness another wave of infections over the period 1 January 2021 and 31 May 2021 as indicated by the out of sample forecasts. Therefore the government is encouraged to enforce adherence to the WHO guidelines and protocols of prevention and control of COVID-19.

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