Forecasting Daily Covid-19 Cases in Burundi Using a Machine Learning Algorithm

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Abstract - **In this study, the ANN approach was applied to analyze daily new COVID-19 cases. The employed daily data covers the period 1 January 2020 to December 2020 and the out-of-sample period ranges over the period January 2021 to 31May 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting daily new COVID-19 cases in Burundi. The results of the study indicate that daily COVID-19 cases are likely to be between 0-10 cases per day over the out of sample period. Therefore the government of Burundi must continue enforcing the implementation of WHO recommendations on the prevention and control of COVID-19.**

Keywords: ANN, Forecasting, COVID-19.

I. INTRODUCTION

Africa's first confirmed case of COVID-19 was reported on the 27th February 2020 (WHO, 2020). By mid-July 2020 most affected countries had reported a total of 337 594 confirmed cases and fatalities had reached 4804 but in countries such as Burundi the pandemic appeared to be progressing slowly (WHO, 2020 a; WHO,2020b). Burundi reported its first two cases of COVID-19 on the 31st of March 2020 (Habonimana et al, 2020). Its first COVID-19 death was reported on the 13th April 2020 (WHO, 2020; Bagcchi, 2020). Burundi's initial national response to the pandemic was condemned by international bodies such as WHO (Allison, 2020). WHO was particularly concerned about Burundi because the authorities refused to place cities under lockdown and its passive approach was seen when the government authorized the holding of elections against WHO advice (Brima, 2020). Since the beginning of the epidemic in the country there has been a slow but steady increase in the number of new coronavirus infections (WHO, 2020).

The objective of this paper is to model and forecast daily new COVID-19 cases in Burundi using the artificial neural network approach. The multilayer perceptron (MLP) is utilized in this study because of its popularity, accurate and reliable results. The model is made up of 3 layers of neurons namely the input, hidden and output layer connected by connection weights (Arora etal, 2020; Nyoni et al, 2020; Zhao et al, 2020; Kaushik & Sahi, 2018; Yan et al, 2018; Fojnica et al, 2016; Quazi et al, 2015; Zhang, 2003; Kishan, 1997; Patterson, 1995). The results of this study are envisioned to provide and insight of the future trends of daily COVID-19 cases in Burundi and facilitate planning and allocation of resources in order control the epidemic.

II. LITERATURE REVIEW

Table 1: Review of Literature

Author (s)	Study period	Method	Findings
Amar et al (2020)	15February ,2020 to 15June 2020	Logit regression, exponential polynomial regression, quadratic,3rd,4th ,5th & 6th degree polynomial regression models	The epidemic peak is 22 June, 2020 and could reach the final time on 8September 2020.the result indicate that the COVID-19 epidemic would not end so quickly in Egypt.
Anwar & Mokhtar (2020)	14February 2020 to	SEIR compartmental	The highest calculated case fatality rate is 7.7%,

	11May 2020	model	the number of hospitalized individuals is expected to peak mid-June 2020 with the peak of hospitalized cases of 20,126 and total expected deaths
Bentout et al (2020)	February – April 2020	SEIR model	Epidemic in Algeria could occur in a strong way
Nyoni et al (2020)	March 20, 2020 to December 10, 2020	ANN model	Zimbabwe is likely to record between 0-330 new cases per day over the period 11 December 2020 to 29 April 2021
Nyoni et al (2020)	14 February 2020 to 31 October 2020	ANN model	The projected daily new corona virus (covid-19) cases will sharply rise from November 1, 2020(208 cases) to around 3December 2020(1536 cases) and then descend to equilibrium level of 1400 daily new infections until 30April 2021.

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 Burundi 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	M
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	2.082174
MSE	28.858754
MAE	3.932745

Residual Analysis for the Applied Model
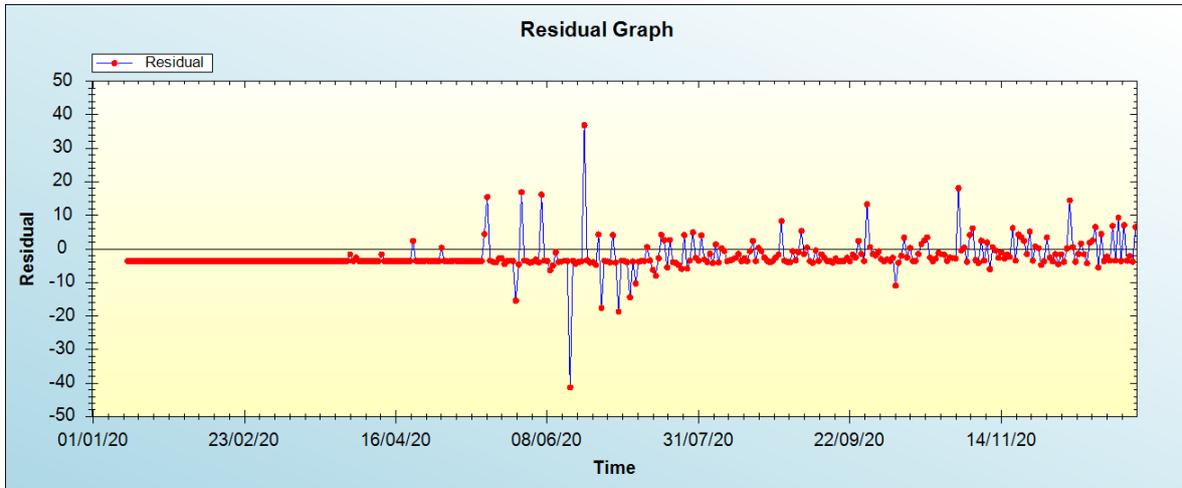

Figure 1: Residual analysis
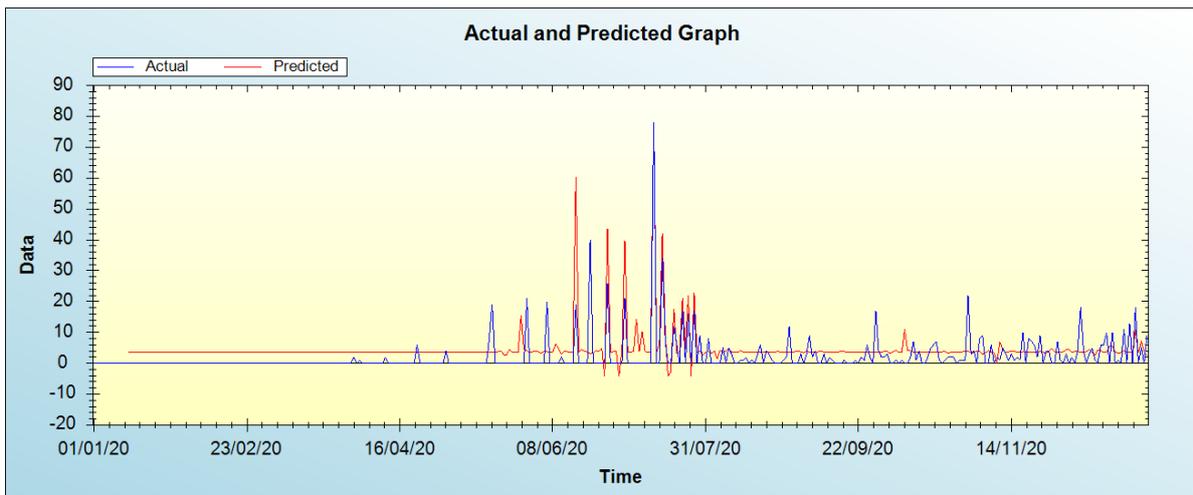
In-sample Forecast for A

Figure 2: In-sample forecast for the M series

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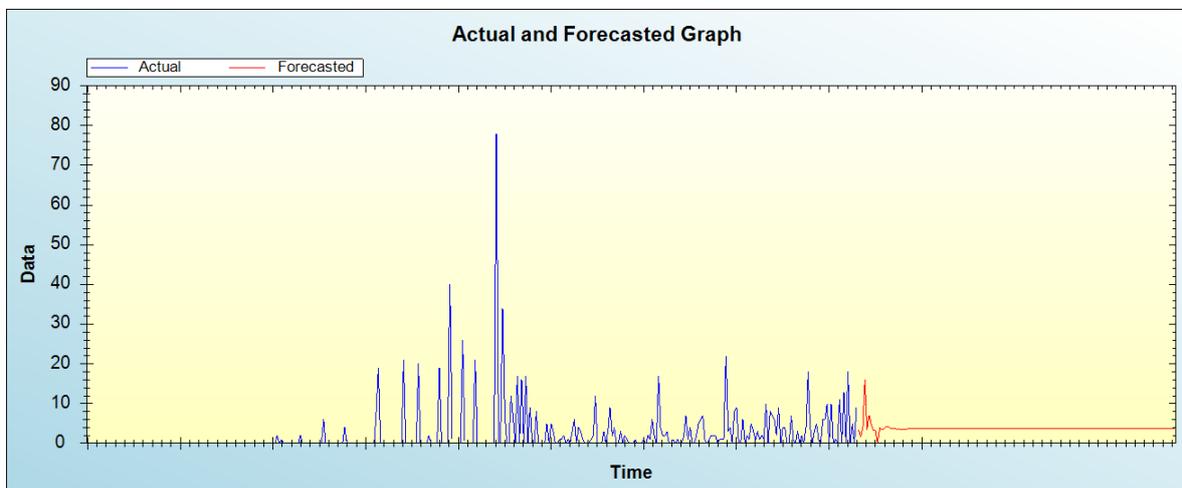

Figure 3: Out-of-sample forecast for M: actual and forecasted graph

Out-of-Sample Forecast for M: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/ Month/Year	Forecasted daily COVID-19 cases
01/01/21	3.4160
02/01/21	1.7234
03/01/21	4.0706
04/01/21	16.1049
05/01/21	3.4691
06/01/21	7.0585
07/01/21	4.8276
08/01/21	3.2723
09/01/21	3.3792
10/01/21	0.1200
11/01/21	4.0109
12/01/21	3.4970
13/01/21	3.6150
14/01/21	4.3133
15/01/21	4.1694
16/01/21	3.7968
17/01/21	3.6939
18/01/21	3.8722
19/01/21	3.5867
20/01/21	3.6348
21/01/21	3.5115
22/01/21	3.5853
23/01/21	3.6180
24/01/21	3.6186
25/01/21	3.6478
26/01/21	3.6550
27/01/21	3.6430
28/01/21	3.6282

Out-of-Sample Forecast for M: Forecasts only

29/01/21	3.6394
30/01/21	3.6300
31/01/21	3.6277
01/02/21	3.6251
02/02/21	3.6249
03/02/21	3.6264
04/02/21	3.6270
05/02/21	3.6283
06/02/21	3.6289
07/02/21	3.6289
08/02/21	3.6280
09/02/21	3.6283
10/02/21	3.6281
11/02/21	3.6279
12/02/21	3.6278
13/02/21	3.6278
14/02/21	3.6278
15/02/21	3.6278
16/02/21	3.6279
17/02/21	3.6279
18/02/21	3.6279
19/02/21	3.6279
20/02/21	3.6279
21/02/21	3.6279
22/02/21	3.6279
23/02/21	3.6279
24/02/21	3.6279
25/02/21	3.6279
26/02/21	3.6279
27/02/21	3.6279
28/02/21	3.6279

01/03/21	3.6279
02/03/21	3.6279
03/03/21	3.6279
04/03/21	3.6279
05/03/21	3.6279
06/03/21	3.6279
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24/04/21	3.6279
25/04/21	3.6279
26/04/21	3.6279
27/04/21	3.6279
28/04/21	3.6279
29/04/21	3.6279
30/04/21	3.6279
01/05/21	3.6279

Date	Value
02/05/21	3.6279
03/05/21	3.6279
04/05/21	3.6279
05/05/21	3.6279
06/05/21	3.6279
07/05/21	3.6279
08/05/21	3.6279
09/05/21	3.6279
10/05/21	3.6279
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25/05/21	3.6279
26/05/21	3.6279
27/05/21	3.6279
28/05/21	3.6279
29/05/21	3.6279
30/05/21	3.6279
31/05/21	3.6279

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 are likely to be between 0-10 cases per day over the out of sample period.

V. CONCLUSION & RECOMMENDATIONS

The COVID-19 pandemic is a litmus test for all the health systems around the world. Even the developed nations are finding it hard to prevent and control the deadly virus as most hospitals are being overwhelmed by COVID-19 patients who require admission. African countries usually rely on external funding to sustain their health systems and during this era of the COVID-19 pandemic funding has been reduced which has left these nations in need of critical resources for the control of the COVID-19 virus (OECD, 2020; MIF, 2020; BCG, 2020). The limited testing capacity, shortage of trained staff required for diagnostics and intensive care units (ICU), inadequate ventilators and ICU facilities (needed in severe cases of COVID-19), lack of personal protective equipment (PPE) for healthcare workers and scarcity of funds for the health sector, are some of the continent's core healthcare related issues, which make it more susceptible to the COVID-19 pandemic (McKenzie, 2020). The results of this study revealed that daily COVID-19 cases are likely to be between 0-10 cases per day over the out of sample period. Therefore the government should continue to enforce WHO guidelines on prevention and control of COVID-19.

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