Forecasting Covid-19 New Cases in Maldives

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Abstract - **In this study, the ANN approach was applied to analyze COVID-19 new cases in Maldives. The employed data covers the period 1 January 2020 – 25 March 2021 and the out-of-sample period ranges over the period 26 March – 31 July 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is quite stable. The results of the study indicate that daily COVID-19 cases in Maldives are likely to remain high over the out-of-sample period. Amongst other suggested policy directions, there is need for the government of Maldives to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The World Health Organization declared COVID-19 virus a global health threat on the 11th March 2020 following the discovery of the novel coronavirus (SARS-COV2) which was first detected in Wuhan, China before spreading fast to all the regions of the World (WHO, 2020). Maldives reported the first cases of COVID-19 on the 7th of March 2020 and they were imported cases that originated from tourist resorts (UNDP, 2020). By the 5th of August 2020 the country had reported a total of 4,446 confirmed cases and 19 fatalities (World meter, 2020). The government responded to the pandemic by implementing strict containment measures such as closure of government offices and schools, temporary ban on public gatherings and restrictions on the movement of people (UNDP, 2020). In addition the government enforced the practice of COVID-19 WHO public health measures such as social distancing, regular hand washing, wearing face masks, contact tracing, isolation and treatment of cases. The purpose of this study is to predict daily COVID-19 cases in Maldives using the artificial neural network approach. The artificial intelligence technique is based on the structure and function of the human brain (Zhang, 2003). The method is now prominent in public health to predict epidemiologic incidences (Maradze et al, 2021; Nyoni et al, 2021; Nyoni & Nyoni, 2021; Nyoni et al, 2020; Zhao et al, 2020). The results of this paper are expected to highlight future trends of COVID-19 in the country and facilitate planning, decision making and allocation of resources towards the prevention and control of the epidemic.

II. LITERATURE REVIEW

Suzana et al (2020) described the early measures for prevention and containment of COVID-19 that contributed to delaying the pandemic entry into the country and helped contain the first wave of the outbreak in the Maldives. This was a descriptive study of publicly available secondary data. Social media channels, websites of stakeholder agencies, developmental and technical agencies both nationally and internationally during 1st December 2019 to 30th March 2020 were analyzed. The study concluded that stringent measures and stricter compliancy are needed to combat community transmission of the disease. A statistical model for COVID-19 cases and deaths in New Zealand was estimated by Ho et al (2020). Functional forms for infections and deaths that incorporate important features of epidemiological models but allow for flexible parameterization to capture different trajectories of the pandemic were chosen. The Bayesian estimation revealed that the simple statistical framework employed in the study fitted the data well and allowed for a transparent characterization of the uncertainty surrounding the trajectories of infections and deaths. In another study, Ettensperger (2020) investigated the link between poverty related indicators and case and mortality rates of the outbreak using multivariate, multilevel regression while also considering the urban-rural divide in Germany. As proxies for poverty the unemployment rate, the per capita presence of general practitioners (physicians), per capita GDP, and the rate of employees with no professional job training is evaluated in relation to the accumulated case and mortality numbers on district level taken from RKI data of June and July 2020. The study found no evidence for a poverty-related effect on mortality for German districts.

III. 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 Maldives.

Data Issues

This study is based on daily new cases of COVID-19 in Maldives 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).

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	M
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	0.192042
MSE	526.166422
MAE	14.885961

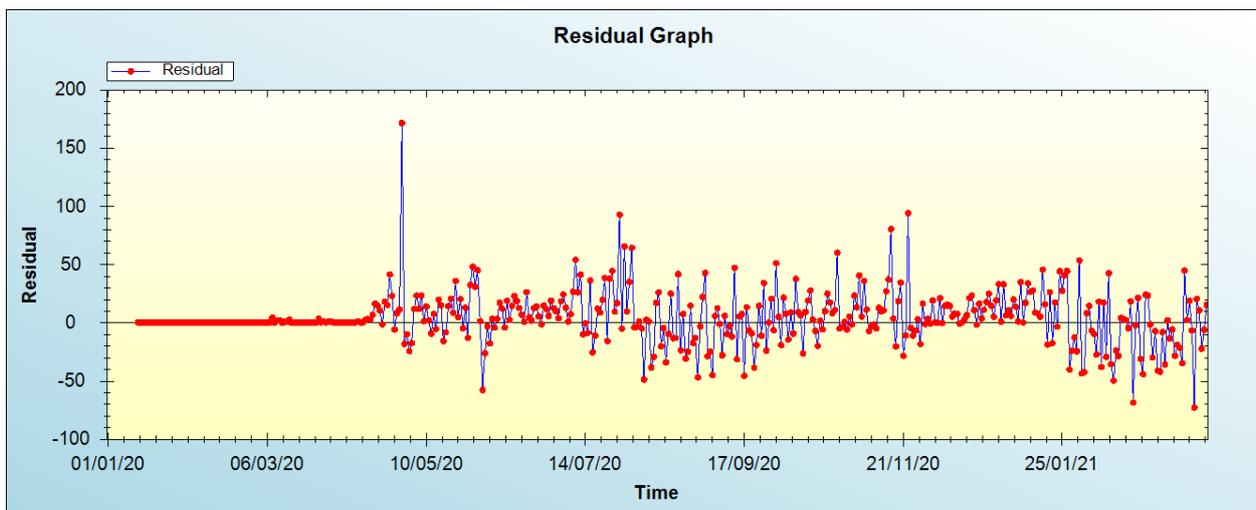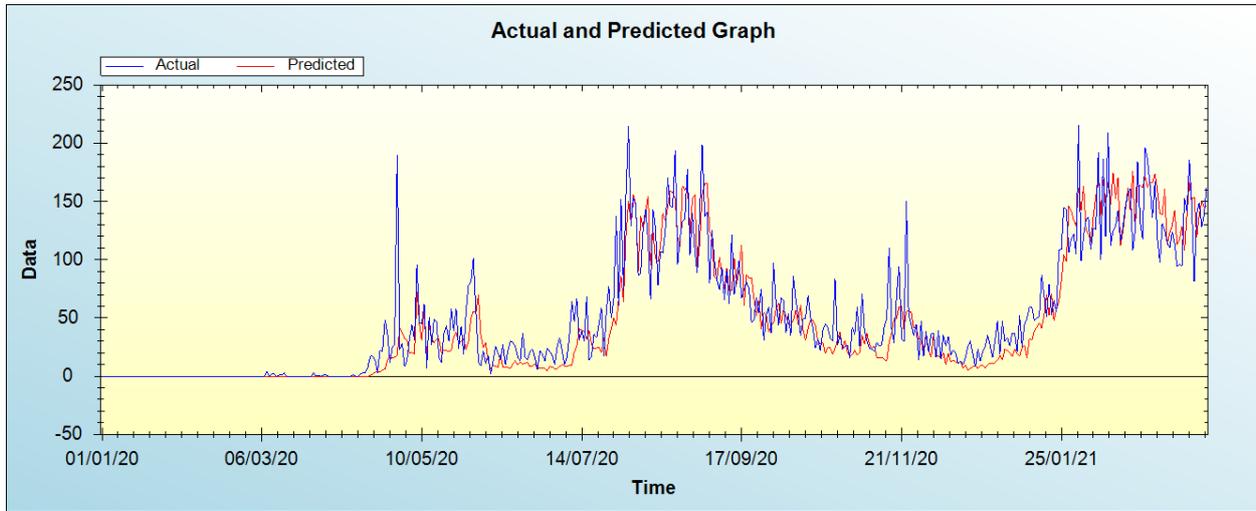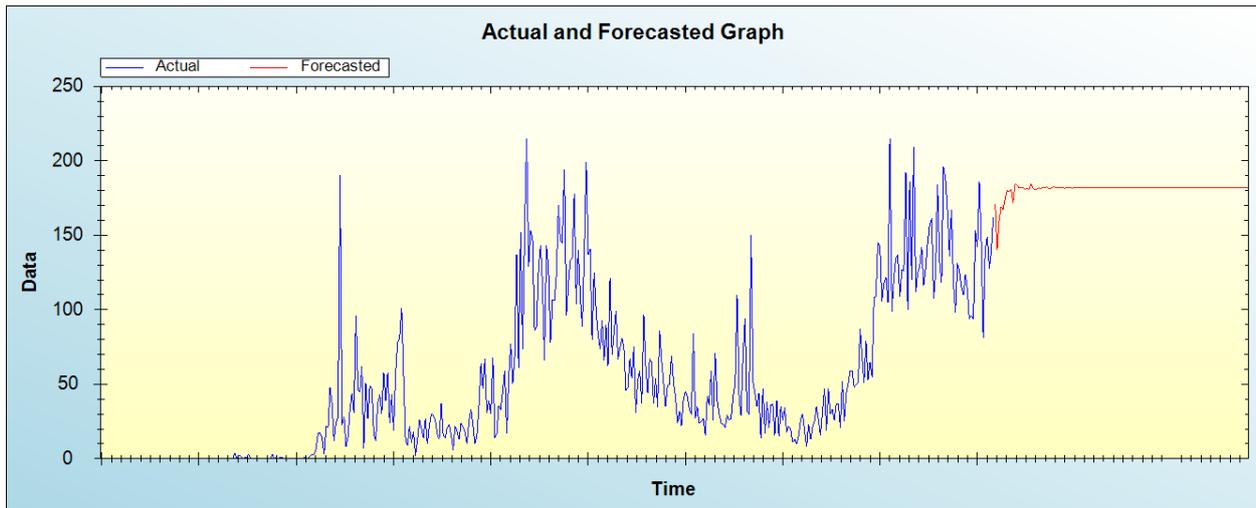*Residual Analysis for the Applied Model*

Figure 1: Residual analysis

In-sample Forecast for M

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 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	170.6066
27/03/21	140.2717
28/03/21	159.7071
29/03/21	169.2004
30/03/21	167.0600
31/03/21	174.7383
01/04/21	179.9402
02/04/21	179.1982
03/04/21	180.6931
04/04/21	171.7263
05/04/21	184.3739
06/04/21	183.8761
07/04/21	181.9335
08/04/21	182.1091
09/04/21	182.3603

10/04/21	180.5926
11/04/21	181.5670
12/04/21	180.4456
13/04/21	184.4240
14/04/21	181.6872
15/04/21	180.1307
16/04/21	181.0923
17/04/21	181.7292
18/04/21	181.3927
19/04/21	182.1551
20/04/21	181.6628
21/04/21	182.4391
22/04/21	181.1697
23/04/21	181.4333
24/04/21	182.3131
25/04/21	182.2589
26/04/21	181.7936
27/04/21	181.9373
28/04/21	181.6521
29/04/21	181.8966
30/04/21	181.5866
01/05/21	181.8714
02/05/21	182.0019
03/05/21	181.7111
04/05/21	181.5688
05/05/21	181.7883
06/05/21	181.7611
07/05/21	181.8737
08/05/21	181.7756
09/05/21	181.8590
10/05/21	181.8323
11/05/21	181.7461
12/05/21	181.7978
13/05/21	181.9022
14/05/21	181.8301
15/05/21	181.8247
16/05/21	181.7789
17/05/21	181.8099
18/05/21	181.7995
19/05/21	181.7886
20/05/21	181.8153
21/05/21	181.8229
22/05/21	181.7759
23/05/21	181.7914
24/05/21	181.7980
25/05/21	181.8169
26/05/21	181.8106
27/05/21	181.8069
28/05/21	181.8128
29/05/21	181.8098
30/05/21	181.7990
31/05/21	181.8146
01/06/21	181.8141
02/06/21	181.8114
03/06/21	181.8039
04/06/21	181.8035
05/06/21	181.8065
06/06/21	181.8058
07/06/21	181.8039
08/06/21	181.8091
09/06/21	181.8054
10/06/21	181.8041
11/06/21	181.8046
12/06/21	181.8073

13/06/21	181.8085
14/06/21	181.8075
15/06/21	181.8067
16/06/21	181.8081
17/06/21	181.8065
18/06/21	181.8069
19/06/21	181.8076
20/06/21	181.8077
21/06/21	181.8068
22/06/21	181.8061
23/06/21	181.8062
24/06/21	181.8069
25/06/21	181.8064
26/06/21	181.8067
27/06/21	181.8068
28/06/21	181.8066
29/06/21	181.8065
30/06/21	181.8067
01/07/21	181.8070
02/07/21	181.8071
03/07/21	181.8068
04/07/21	181.8069
05/07/21	181.8069
06/07/21	181.8068
07/07/21	181.8068
08/07/21	181.8069
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25/07/21	181.8068
26/07/21	181.8068
27/07/21	181.8068
28/07/21	181.8068
29/07/21	181.8068
30/07/21	181.8068
31/07/21	181.8068

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 Maldives are likely to remain high over the out-of-sample period.

V. CONCLUSION AND POLICY RECOMMENDATIONS

Maldives has made significant progress towards achieving Global Goals (SDGs) and Universal Health Coverage (UHC), by ensuring access to safe and quality healthcare, and the government is looking at social determinants of health and identifying those being left behind and putting them at the very forefront (WHO, 2020). The emergence of the COVID-19 outbreak was a litmus test for the country. Forecasting the evolution of the COVID-19 epidemic is crucial to enable the country to prepare for possible future COVID-19 waves in order to save lives. In this study we applied the ANN (12, 12, 1) model to predict daily

COVID-19 cases. The results of the study indicate that daily COVID-19 cases in Maldives are likely to remain high over the out-of-sample period. Therefore the government must enforce adherence to COVID-19 public health mitigation measures.

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