Forecasting Covid-19 New Cases in Mongolia

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Abstract - **In this study, the ANN approach was applied to analyze COVID-19 new cases in Mongolia. 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 Mongolia are likely to remain very high over the out-of-sample period. Amongst other suggested policy directions, there is need for the government of Mongolia to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The novel coronavirus (SARS-COV2) was discovered in Wuhan, China in December 2019 (Wang et al, 2020). The new pathogen known is now known to cause the popular viral disease called COVID-19 (Corona Viridae study group, 2020; Cui et al, 2019). WHO declared the viral pneumonia a global health threat on the 11th of March 2020 (WHO, 2020). Mongolia is a lower middle income country with an estimated population size of about 3.3 million people (Erkhembayar et al, 2020). The country has a high literacy rate, 96.4 % in females and 93 % for males which is very important for public health education (NSOM, 2019). In 2018 the country reported a high poverty rate of 28.4 % of the population and 9.5 % unemployment rate among those 15 years and above (NSOM, 2020).The government responded well to the first wave of COVID-19 by adequately putting in place precautionary measures like tightening Mongolia's southern border to China by imposing air, road and rail travel restrictions (National Emergency Management Agency of Mongolia, 2020; Mongolia government, 2020). The government also enforced the adherence of WHO guidelines on COVID-19 prevention and control such as social distancing, wearing face masks, regular hand washing, contact tracing, isolation and treatment of cases. The aim of this paper is to predict daily COVID-19 cases in Mongolia using the artificial neural network approach. The artificial intelligence method is now popular in modeling and forecasting studies because it is able to capture nonlinear patterns in the given data as demonstrated in some of the recent studies (Maradze et al, 2021; Nyoni &Nyoni, 2021; Zhao et al, 2020).The findings of this study are expected to trigger an appropriate health response to the epidemic so as to mitigate the spread of the deadly virus.

II. LITERATURE REVIEW

Erkhembayar et al (2020)discussed the early policy actions and emergency response to the COVID-19 pandemic in Mongolia. The Mongolian case shows that with robust preventive systems, an effective response to a pandemic can be mounted in a low-income or middle-income country. A mathematical model was proposed by Motasem et al (2020) to estimate the R0 of COVID-19 in an outbreak occurring in both local and international clusters in light of published data in Jordan. Different types of clusters (religious, wedding, and industrial activity) were selected based on reported events in different countries between February and April 2020.The highest R0 values were found in wedding party events (5), followed by religious gathering events (2.5), while the lowest value was found in the industrial cluster (2).Gecilli et al (2020) forecasted confirmed cases, deaths and recoveries in USA and Italy using time series forecasting models in R. Four models were applied to publicly available data of the COVID-19 pandemic for both the USA and Italy. It was observed that all models reasonably predicted the future numbers of confirmed cases, deaths, and recoveries of COVID-19.Singh et al (2020) forecasted confirmed COVID-19 cases in Malaysia using ARIMA models. This study was conducted using daily confirmed cases of COVID-19 collected from the official Ministry of Health, Malaysia (MOH) and John Hopkins University websites. An Autoregressive Integrated Moving Average (ARIMA) model was fitted to the training data of observed cases from 22 January to 31 March 2020, and subsequently validated using data on cases from 1 April to 17 April 2020. The ARIMA model satisfactorily forecasted the daily confirmed COVID-19 cases from 18 April 2020 to 1 May 2020 (the testing phase). The Random walk model was the best model and the forecasts showed a downward trend of COVID-19 cases until 1 May 2020.

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 Mongolia.

Data Issues

This study is based on daily new cases of COVID-19 in Mongolia 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	0.057736
MSE	196.478444
MAE	7.632150

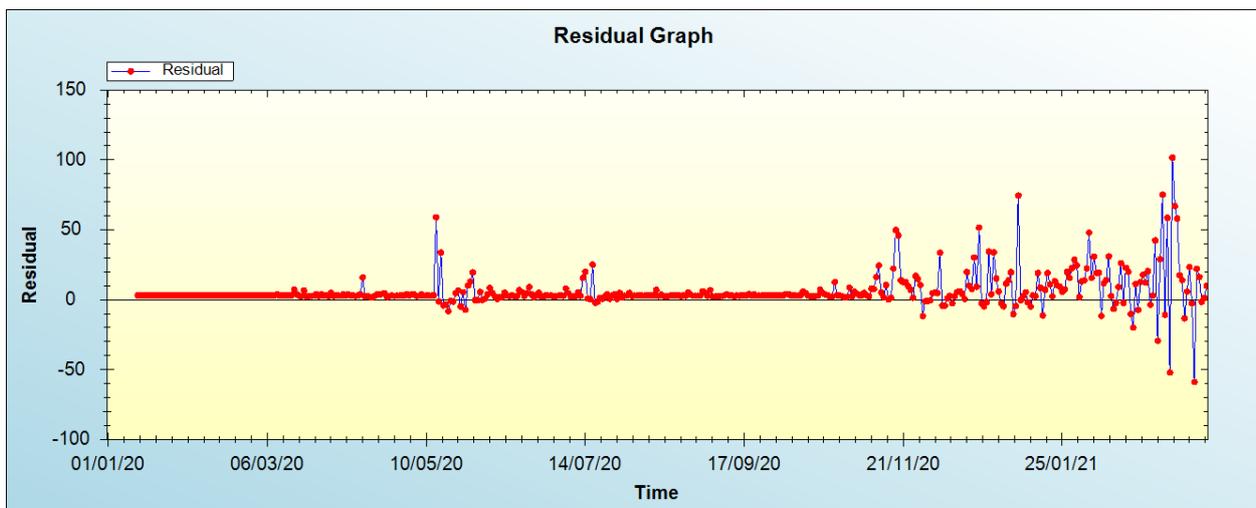*Residual Analysis for the Applied Model*

Figure 1: Residual analysis
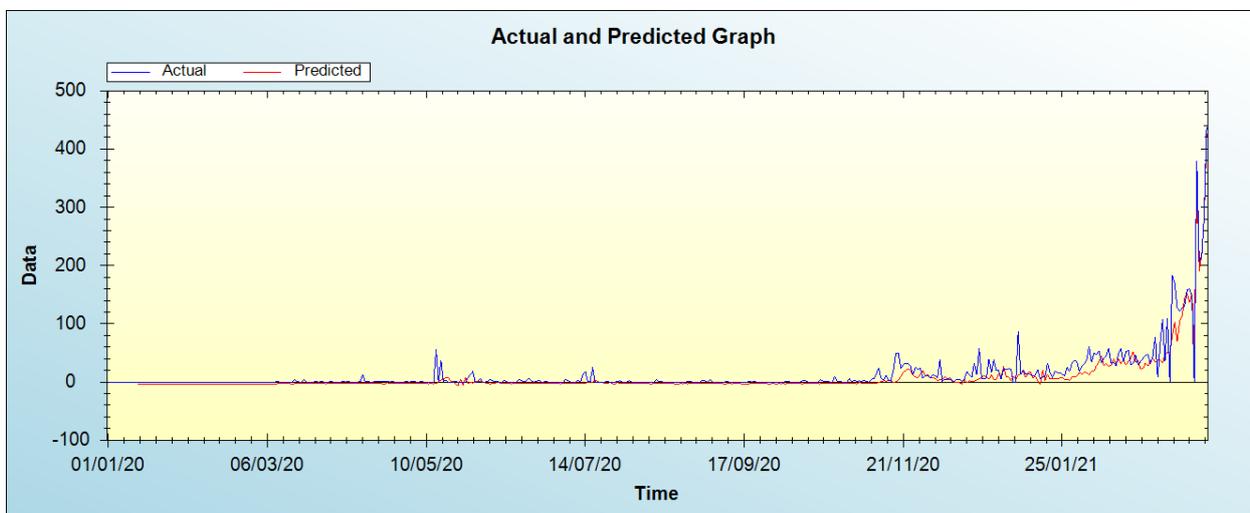
In-sample Forecast for M

Figure 2: In-sample forecast for the M series

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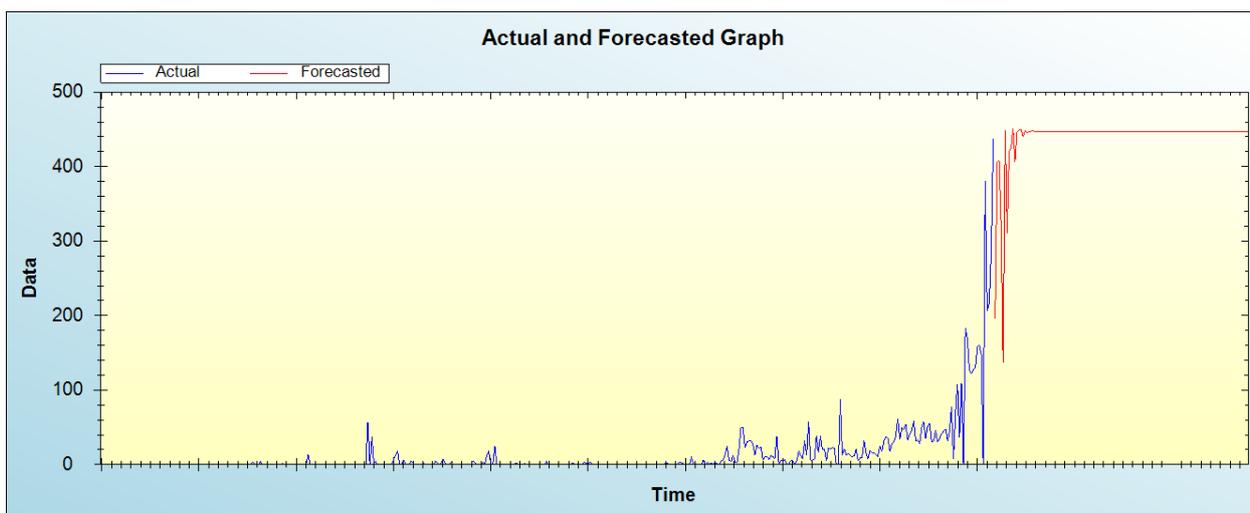

Figure 3: Out-of-sample forecast for M: actual and forecasted graph

Out-of-Sample Forecast for M: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	196.6380
27/03/21	405.2519
28/03/21	408.7207
29/03/21	324.2749
30/03/21	136.7005
31/03/21	448.1854
01/04/21	310.5741
02/04/21	420.7738
03/04/21	424.2334
04/04/21	451.6299
05/04/21	406.6228
06/04/21	446.6972
07/04/21	448.8471

08/04/21	449.4765
09/04/21	440.4758
10/04/21	448.0851
11/04/21	445.0121
12/04/21	446.6209
13/04/21	447.3269
14/04/21	447.7751
15/04/21	446.9948
16/04/21	446.9829
17/04/21	447.3069
18/04/21	447.2371
19/04/21	447.1155
20/04/21	447.1649
21/04/21	447.1894
22/04/21	447.1434
23/04/21	447.1628
24/04/21	447.1730
25/04/21	447.1666
26/04/21	447.1576
27/04/21	447.1640
28/04/21	447.1657
29/04/21	447.1629
30/04/21	447.1630
01/05/21	447.1643
02/05/21	447.1636
03/05/21	447.1633
04/05/21	447.1637
05/05/21	447.1638
06/05/21	447.1636
07/05/21	447.1636
08/05/21	447.1637
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27/07/21	447.1636
28/07/21	447.1636
29/07/21	447.1636
30/07/21	447.1636
31/07/21	447.1636

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

IV. CONCLUSION AND POLICY RECOMMENDATIONS

From 15 November, 2020, the State Emergency Commission (SEC) identified a total of eight clusters of COVID-19 transmission: two in Ulaanbaatar City and one in Selenge, Darkhan-Uul, Gobisumber, Orkhon, Dornogobi and Arkhangai provinces respectively (UNFPA, 2020). The clusters are linked with close and secondary contacts of an index case of COVID-19. The government has taken rapid action including contact tracing, immediate testing of contacts, quarantine, and treatment of positive cases. The Mongolian government concluded that it was dealing with a cluster transmission. In this study we proposed an

artificial neural network technique to model and predict daily COVID-19 cases in Mongolia. The results of the study revealed that daily COVID-19 cases in Mongolia are likely to remain very high over the out-of-sample period. Therefore the government is encouraged to relentless enforce adherence to public health mitigation measures.

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