Forecasting Covid-19 Mortality in Bangladesh

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Abstract - **In this study, the ANN approach was applied to analyze COVID-19 mortality in Bangladesh. The employed data covers the period1January 2020-20 April 2021 and the out-of-sample period ranges over the period 21 April-31 August 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 deaths in Bangladesh are likely to decline significantly over the out-of-sample period. However, there is still need for the government of Bangladesh to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic and to speed up COVID-19 vaccination.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The COVID-19 pandemic continues to be a public health problem in many parts of the world (WHO, 2020). The disease is caused by a novel coronavirus, SARS-COV-2 which is the 7th of the coronaviruses that have become a public health threat for WHO (Cascella et al, 2020). The virus was first identified in Wuhan city, China in December 2019 where a cluster of pneumonia cases of unknown aetiogy were reported (Dewit et al, 2020; Paules et al, 2020). Bangladesh reported its first case of COVID-19 on the 8th of March 2020 (Paul, 2020).The country is at high risk of COVID-19 due to its high population density (Lakshimi et al, 2020). The government of Bangladesh like other countries adopted WHO recommendations which are meant to prevent and control COVID-19 such as social distancing, regular hand washing, quarantine, isolation, treatment of COVID-19 positive patients and health education (Haque, 2020; Ferdous et al, 2020).Artificial intelligence techniques such as machine learning can be utilized to analyze huge data sets and construct intelligent prediction models for public health (Aktar et al, 2021; Ceci et al, 2020; Kalajdjieski et al 2020; Liu et al, 2019). Several machine learning methods have been used to predict COVID-19 cases and deaths such as artificial neural networks (ANNs), support vector machine (SVM), K-nearest neighbors (KNNs), tree based models and graphical models (Yadew et al 2020). In this study we applied the ANN approach to predict daily COVID-19 mortality in Bangladesh. The findings of this study are expected to provide an insight of the likely future trends of COVID-19 mortality in Bangladesh and assist in the evaluation of the COVID-19 mitigation measures or intervention activities.

II. LITERATURE REVIEW

Modeling and forecasting is an important tool in public health surveillance especially during the COVID-19 pandemic. There are many studies in Bangladesh which have attempted to predict COVID-19 spread, cases, deaths and recoveries. Haque et al (2021) evaluated and predicted the doubling time for the daily COVID-19 cases and deaths in Bangladesh. Publicly available daily data on COVID-19 new cases from 8 March, 2020 to 14 February, 2021 and the daily deaths data from 18 March, 2020 to 14 February, 2021 were used to predict doubling time based on records from seven days prior. Then, short-term predictions for the next 14 days (1 to 14 February, 2021) were performed to validate the accuracy of our prediction. Finally, using the doubling time data up to 14 February, 2021, a two months (15 February- 15 April, 2021) prediction was made for both daily new COVID-19 cases and deaths. The model prediction suggests that the doubling time for daily confirmed new COVID-19 case would be 1310.33 days [95% CI: 854.33 - 1766.32] and deaths would be 683.04 days [556.05 - 810.03] on 15 April, 2021 in Bangladesh. A cloud-based machine learning short-term forecasting model was developed by Satu et al (2020) for Bangladesh, in which several regression-based machine learning models were applied to infected case data to estimate the number of COVID-19-infected people over the following seven days. The results showed that the model can accurately forecast the number of infected cases daily by training the prior 25 days sample data recorded on our web application. Kundu et al (2020) forecasted the expected number of daily total confirmed cases, total confirmed new cases, total deaths and total new deaths of COVID-19 in Bangladesh for next 30 days. The study utilized the number of daily total confirmed cases, total confirmed new cases, total deaths and total new deaths of COVID-19 from 8 March 2020 to 16 October, 2020. The Autoregressive Integrated Moving Average (ARIMA) model was applied to forecast the spread of COVID19 in Bangladesh from 17th October 2020 to 15th November 2020. All

statistical analyses were conducted using R-3.6.3 software with a significant level of p< 0.05. The study showed an upward trend for the total confirmed cases and total deaths, while total confirmed new cases and total new death, would become stable in the next 30 days if prevention measures are strictly followed to limit the spread of COVID-19. Leon et al (2020) explored different machine learning algorithms that can provide more accurate estimations for predicting future cases which includes infections and deaths due to COVID-19 for Bangladesh. The study showed that in predicting the pandemic situations, amidst many predicting models the Facebook Prophet Model provided the best accuracy.

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 COVID-19 mortality cases Bangladesh.

Data Issues

This study is based on daily COVID-19 mortality cases in Bangladesh for the period 1 January 2020 – 20 April 2021. The out-of-sample forecast covers the period 21 April – 31 August 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	B
Observations	464 (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	0.116709
MSE	52.734778
MAE	5.488217

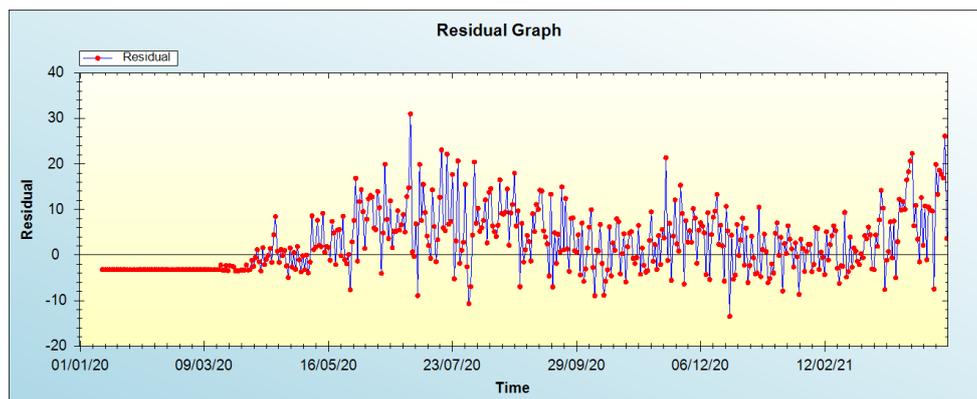*Residual Analysis for the Applied Model*

Figure 1: Residual analysis
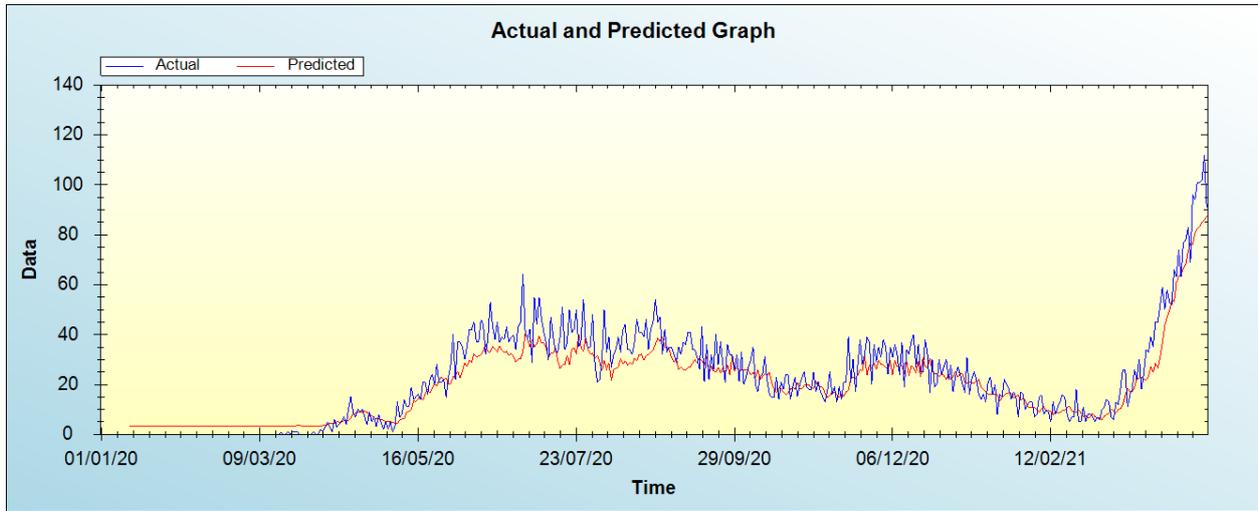
In-sample Forecast for B

Figure 2: In-sample forecast for the B series

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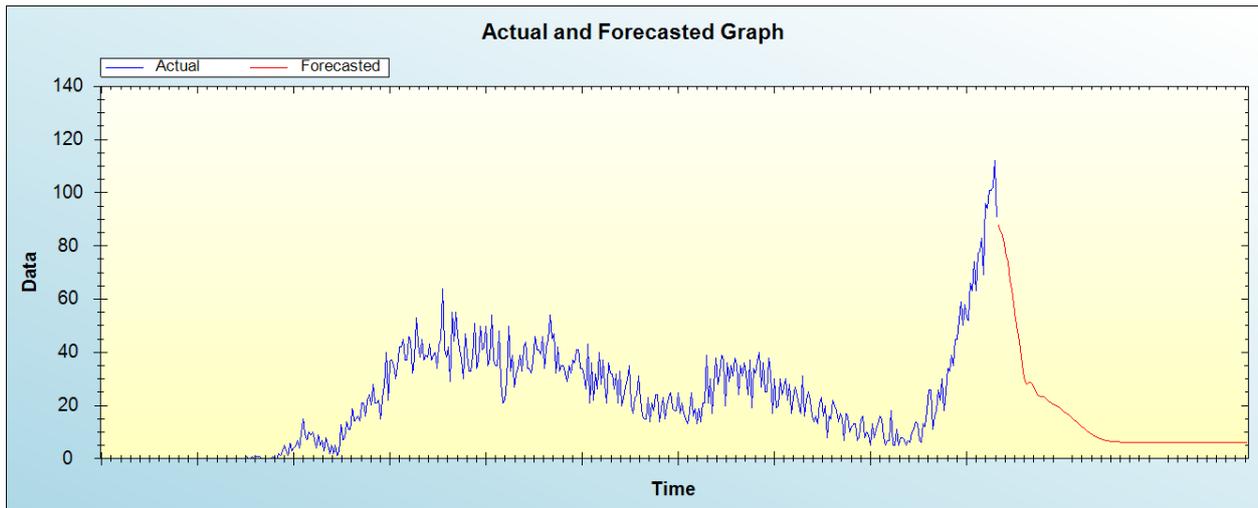

Figure 3: Out-of-sample forecast for B: actual and forecasted graph

Out-of-Sample Forecast for B: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Date	Forecasts
21/04/21	87.6876
22/04/21	85.6482
23/04/21	84.2121
24/04/21	80.7462
25/04/21	76.4151
26/04/21	74.1242
27/04/21	66.9944
28/04/21	63.9265
29/04/21	58.3334
30/04/21	52.4700
01/05/21	48.1177
02/05/21	44.4347
03/05/21	38.7987
04/05/21	32.9016
05/05/21	29.0171

06/05/21	27.9330
07/05/21	28.4675
08/05/21	28.7721
09/05/21	27.9373
10/05/21	26.3500
11/05/21	24.8746
12/05/21	23.8288
13/05/21	23.3339
14/05/21	23.2639
15/05/21	23.2238
16/05/21	22.8768
17/05/21	22.1827
18/05/21	21.4029
19/05/21	20.7818
20/05/21	20.3955
21/05/21	20.1200
22/05/21	19.7949
23/05/21	19.3495
24/05/21	18.7842
25/05/21	18.1640
26/05/21	17.5663
27/05/21	17.0272
28/05/21	16.5179
29/05/21	15.9805
30/05/21	15.3831
31/05/21	14.7338
01/06/21	14.0678
02/06/21	13.4155
03/06/21	12.7880
04/06/21	12.1821
05/06/21	11.5882
06/06/21	11.0032
07/06/21	10.4342
08/06/21	9.8957
09/06/21	9.3994
10/06/21	8.9492
11/06/21	8.5433
12/06/21	8.1777
13/06/21	7.8503
14/06/21	7.5606
15/06/21	7.3088
16/06/21	7.0941
17/06/21	6.9137
18/06/21	6.7637
19/06/21	6.6399
20/06/21	6.5387
21/06/21	6.4572
22/06/21	6.3929
23/06/21	6.3437
24/06/21	6.3070
25/06/21	6.2805
26/06/21	6.2621
27/06/21	6.2500
28/06/21	6.2428
29/06/21	6.2393
30/06/21	6.2388
01/07/21	6.2404
02/07/21	6.2433
03/07/21	6.2472
04/07/21	6.2514
05/07/21	6.2557
06/07/21	6.2600
07/07/21	6.2641
08/07/21	6.2678

09/07/21	6.2713
10/07/21	6.2743
11/07/21	6.2769
12/07/21	6.2791
13/07/21	6.2810
14/07/21	6.2825
15/07/21	6.2838
16/07/21	6.2848
17/07/21	6.2856
18/07/21	6.2862
19/07/21	6.2866
20/07/21	6.2869
21/07/21	6.2872
22/07/21	6.2873
23/07/21	6.2874
24/07/21	6.2874
25/07/21	6.2874
26/07/21	6.2873
27/07/21	6.2873
28/07/21	6.2872
29/07/21	6.2872
30/07/21	6.2871
31/07/21	6.2871
01/08/21	6.2870
02/08/21	6.2869
03/08/21	6.2869
04/08/21	6.2869
05/08/21	6.2868
06/08/21	6.2868
07/08/21	6.2868
08/08/21	6.2868
09/08/21	6.2867
10/08/21	6.2867
11/08/21	6.2867
12/08/21	6.2867
13/08/21	6.2867
14/08/21	6.2867
15/08/21	6.2867
16/08/21	6.2867
17/08/21	6.2867
18/08/21	6.2867
19/08/21	6.2867
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22/08/21	6.2867
23/08/21	6.2867
24/08/21	6.2867
25/08/21	6.2867
26/08/21	6.2867
27/08/21	6.2867
28/08/21	6.2867
29/08/21	6.2867
30/08/21	6.2867
31/08/21	6.2867

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 deaths in Bangladesh are likely to decline significantly over the out-of-sample period.

V. CONCLUSION AND POLICY RECOMMENDATIONS

The emergence of COVID-19 has resulted in alarm and confusion all over the World with many scientists racing to find a lasting solution to the Global pandemic. Therefore, there is an urgent need for investigating and predicting COVID-19 mortality in

order to evaluate the impact of mitigation measures. Bangladesh is one of the most densely populated countries around the world; it has a great risk of exposure due to COVID-19 (Kundu et al, 2021). The government of Bangladesh has put in place a raft of measures in order to prevent and control the epidemic including adopting WHO recommendations. In this study we applied an artificial intelligence technique to predict COVID-19 mortality in Bangladesh. The results of the study revealed that that daily COVID-19 deaths in Bangladesh are likely to decline significantly over the out-of-sample period. The authorities in Bangladesh are encouraged to speed up COVID-19 vaccination and continue implementing other WHO recommendations to curb the spread of the epidemic.

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