

# Modelling and Forecasting Covid-19 Deaths in India Using Artificial Neural Networks (ANN)

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**Abstract** - In this research paper, the ANN approach was applied to analyze COVID-19 deaths in India. The employed data covers the period January – December 2020 and the out-of-sample period ranges over the period January – May 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 COVID-19 mortality in India is likely to equilibrate around 1313 deaths per day especially towards the end of the out-of-sample period. With the recent influx of new COVID-19 vaccines in India, great emphasis should be put on the quick uptake of these vaccines so as to curb the effects of the virus; and of course alongside ensuring strict adherence to COVID-19 safety measures.

**Keywords:** Modelling, Forecasting, Artificial Neural Networks, ANN.

## I. INTRODUCTION

Having started in Wuhan city, in China the COVID-19 virus has spread across many countries. The number of Covid-19 related deaths has been at an alarming rate with 119 960 700 confirmed cases and 2 656 822 mortalities to date (16/3/2021), (WHO Dashboard, 2021). Fanelli and Piazza, (2020) highlighted that since the virus is spread across all global nations, COVID-19 has varying spread rates and fatalities. In a bid to curb the detrimental affects of the virus, most nations enforced lockdowns and social distancing initiatives which helped keep the mutation levels of the virus on check, and thus controlling the outbreak (Kupferschmidt, 2020). According to the World Health Organization (WHO) (2020), the world-wide fatality rate is at 8-10%, in India it is reported to be 3%. India has had 11.4 million confirmed cases, 11 million recoveries and approximately 160 000 deaths (WHO Dashboard, 2021). These Indian deaths account for 6% of the world-wide deaths which are at 2.67 million to date. The death trend has been seen to be on the decline with average deaths per day now ranging around 131 per day. Olsen et al (2020) used a multidisciplinary Hierarchical model for it to recognize the nested levels of the pandemic in India. Results were based on all 11 states of India and they showed that COVID-a0 deaths were higher in northern and central India as they are residence of the older and overweight populations. Many other others like Anastassopoulou et al (2020) and Abdulwasaa et al (2020) focused on commenting on the COVID-19 death trends and did not apply any models to the mortalities. Forecasting and prediction of future deaths induced by this pandemic heavily rely on accurate data which is also available, hence forecasting while utilizing mathematical models has become crucial. This better equips governments and decision makers to better understand present situations and be able to plan future responses. In India no study has used the Artificial Neural Networks (ANN) to model and predict COVID-19 fatalities hence the initiative of this study to do so and help bring about better inferences especially in this time of the introduction of the COVID-19 vaccine.

## II. METHODOLOGY

The study applies the Artificial Neural Network (ANN) approach which is usually celebrated for its capability to learn from any data-set and consequently 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 deaths of COVID-19 in India 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.

### III. FINDINGS OF THE STUDY

#### ANN Model Summary

Table 1: ANN model summary

Variable	A
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	0.104427
MSE	13516.773619
MAE	0.65673161

#### Residual Analysis for the Applied Model

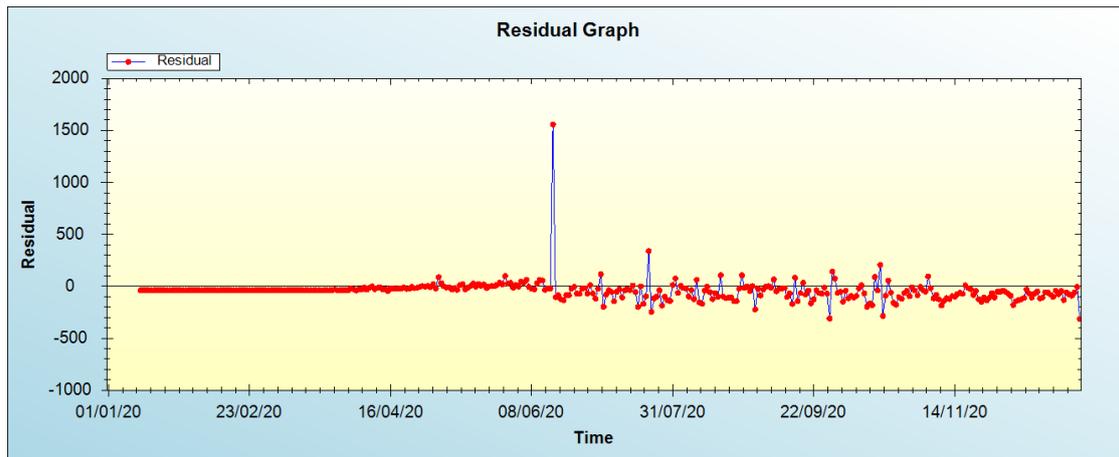


Figure 1: Residual analysis

#### In-sample Forecast for A

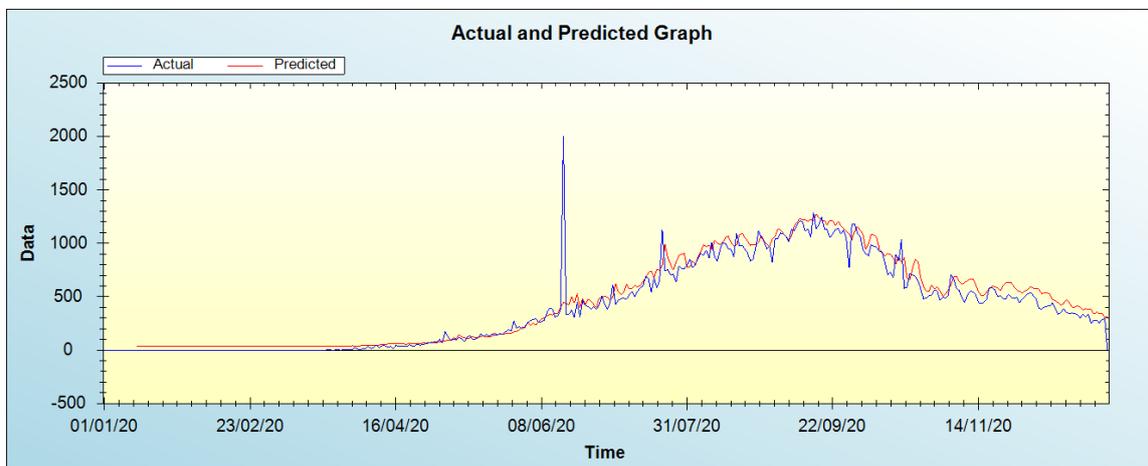


Figure 2: In-sample forecast for the A series

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

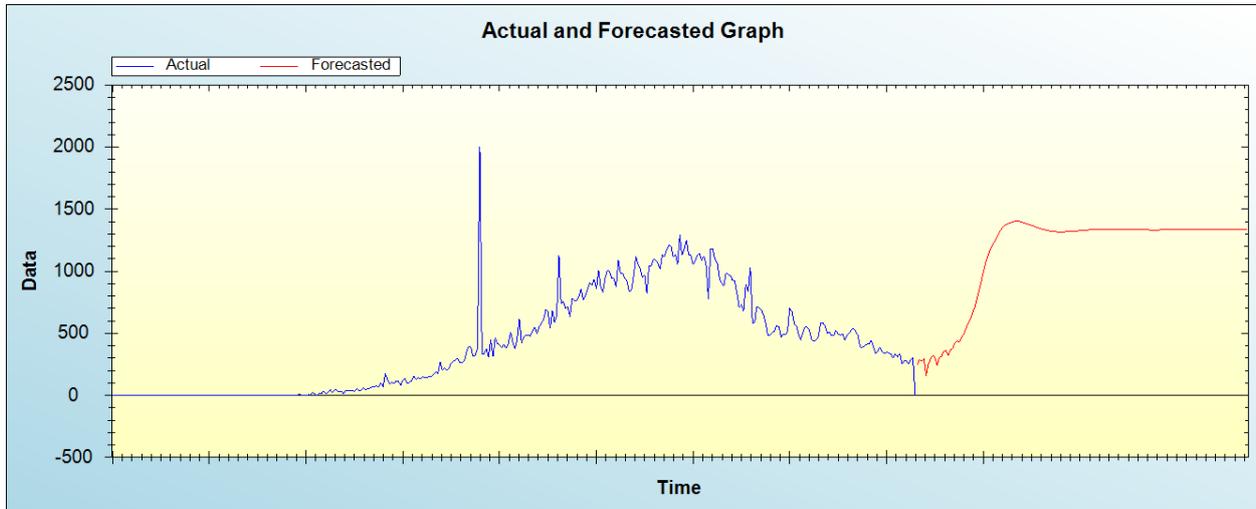


Figure 3: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Dates	Forecasts
01/01/21	251.6854
02/01/21	289.1100
03/01/21	275.6739
04/01/21	296.9536
05/01/21	159.9540
06/01/21	249.3494
07/01/21	296.6867
08/01/21	322.2721
09/01/21	307.6498
10/01/21	240.5961
11/01/21	307.0267
12/01/21	313.3485
13/01/21	355.8726
14/01/21	359.8189
15/01/21	319.8448
16/01/21	365.7175
17/01/21	377.4286
18/01/21	415.3915
19/01/21	436.2967
20/01/21	430.9786
21/01/21	464.9740
22/01/21	489.2439
23/01/21	533.8534
24/01/21	575.3581
25/01/21	607.3017
26/01/21	655.7235
27/01/21	706.9099
28/01/21	770.5822
29/01/21	843.3475
30/01/21	915.1433
31/01/21	989.6888
01/02/21	1061.2035
02/02/21	1119.5041

03/02/21	1167.7247
04/02/21	1203.4318
05/02/21	1235.3964
06/02/21	1269.8318
07/02/21	1303.3897
08/02/21	1333.6769
09/02/21	1356.5819
10/02/21	1371.4459
11/02/21	1381.1254
12/02/21	1388.6983
13/02/21	1395.2088
14/02/21	1400.5743
15/02/21	1403.2495
16/02/21	1402.2138
17/02/21	1398.0404
18/02/21	1392.2120
19/02/21	1386.1950
20/02/21	1380.6144
21/02/21	1375.1532
22/02/21	1369.0757
23/02/21	1362.1287
24/02/21	1354.7234
25/02/21	1347.6699
26/02/21	1341.6219
27/02/21	1336.6894
28/02/21	1332.4999
01/03/21	1328.6165
02/03/21	1324.9107
03/03/21	1321.6175
04/03/21	1319.1118
05/03/21	1317.5851
06/03/21	1316.9092
07/03/21	1316.7550
08/03/21	1316.8400
09/03/21	1317.0916
10/03/21	1317.6245
11/03/21	1318.5752
12/03/21	1319.9460
13/03/21	1321.5798
14/03/21	1323.2605
15/03/21	1324.8450
16/03/21	1326.3206
17/03/21	1327.7584
18/03/21	1329.2153
19/03/21	1330.6682
20/03/21	1332.0252
21/03/21	1333.1910
22/03/21	1334.1286
23/03/21	1334.8700
24/03/21	1335.4772
25/03/21	1335.9900
26/03/21	1336.4034
27/03/21	1336.6840
28/03/21	1336.8077
29/03/21	1336.7852
30/03/21	1336.6579
31/03/21	1336.4718
01/04/21	1336.2533

02/04/21	1336.0030
03/04/21	1335.7105
04/04/21	1335.3741
05/04/21	1335.0096
06/04/21	1334.6444
07/04/21	1334.3017
08/04/21	1333.9907
09/04/21	1333.7071
10/04/21	1333.4431
11/04/21	1333.1973
12/04/21	1332.9771
13/04/21	1332.7930
14/04/21	1332.6510
15/04/21	1332.5487
16/04/21	1332.4779
17/04/21	1332.4306
18/04/21	1332.4036
19/04/21	1332.3977
20/04/21	1332.4149
21/04/21	1332.4539
22/04/21	1332.5095
23/04/21	1332.5748
24/04/21	1332.6442
25/04/21	1332.7156
26/04/21	1332.7890
27/04/21	1332.8644
28/04/21	1332.9403
29/04/21	1333.0135
30/04/21	1333.0806
01/05/21	1333.1398
02/05/21	1333.1912
03/05/21	1333.2358
04/05/21	1333.2742
05/05/21	1333.3065
06/05/21	1333.3316
07/05/21	1333.3491
08/05/21	1333.3593
09/05/21	1333.3633
10/05/21	1333.3626
11/05/21	1333.3582
12/05/21	1333.3505
13/05/21	1333.3397
14/05/21	1333.3261
15/05/21	1333.3104
16/05/21	1333.2936
17/05/21	1333.2766
18/05/21	1333.2601
19/05/21	1333.2441
20/05/21	1333.2288
21/05/21	1333.2143
22/05/21	1333.2010
23/05/21	1333.1891
24/05/21	1333.1790
25/05/21	1333.1708
26/05/21	1333.1642
27/05/21	1333.1590
28/05/21	1333.1552
29/05/21	1333.1528

30/05/21	1333.1516
31/05/21	1333.1517

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 COVID-19 mortality in India is likely to equilibrate around 1313 deaths per day especially towards the end of the out-of-sample period.

#### IV. CONCLUSION AND POLICY RECOMMENDATIONS

It was the aim of this paper to come up with responsive strategies that help reduce the COVID-19 induced mortalities. While using the ANN model we managed to model and predict future death rates in India. With the influx of new COVID-19 vaccines in India emphasis is on the quick uptake of these vaccines so as to curb the effects of the virus. Eased lock down restrictions should also be accompanied by proper sanitization and proper wearing of masks. Policy makers should take note of the trend and ensure they are up to date as these predictions are accurate.

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