

Forecasting Covid-19 Deaths in Colombia

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Abstract - In this study, the ANN approach was applied to analyze COVID-19 deaths in Colombia. The employed data covers the period 1 January 2020 to 20 April 2021 and the out-of-sample period ranges over the period 21 April to 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 cases in Colombia are likely to remain significantly high over the out-of-sample period. Therefore there is need for the government of Colombia to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic and scale up COVID-19 vaccination.

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Colombia is a developing country found in South America with an estimated population of approximately 50 million people (Nyoni et al, 2020). The country reported its first case of COVID-19 on the 6th of March 2020 (Rodriguez & Urdinola, 2020) and the first COVID-19 death was reported on the 16th of March 2020. By the 13th of September 2020 the country had reported 716 319 confirmed cases and 22 924 deaths (INS Colombia, 2020). In order to reduce the impact COVID-19 outbreak, the Colombian authorities implemented mitigation measures such as lockdown, hygiene practices, social distancing, contact tracing, isolation and treatment of COVID-19 cases (Ghosh & Martcheva, 2020). Prediction of COVID-19 mortality is very critical in order to assess the impact of COVID-19 mitigation measures including vaccination programme. The COVID-19 pandemic is mostly characterized by many fatalities in affected regions therefore there is need to come up with reliable covid-19 mortality forecasts so that the government can prepare adequate resources to minimize the impact of the pandemic. In this study we applied the artificial neural network approach to predict daily COVID-19 deaths in Colombia using the multilayer perceptron neural network which is one of the accurate and reliable machine learning techniques (Zhang, 2003).

II. LITERATURE REVIEW

Diaz et al (2021) characterized the dynamics of the coronavirus disease 2019 (COVID-19) epidemic, for modeling purposes. Data from Colombian official case information were collated for a period of 5 months. Dynamical parameters of the disease spread were then estimated from the data. Probability distribution models were identified, representing the time from symptom onset to hospitalization, to intensive care unit (ICU) admission, and to death. Kaplan–Meier estimates were also computed for the probability of eventually requiring hospitalization, needing ICU attention, and dying from the disease (the case fatality ratio). The study concluded that the times from one stage of the disease to another were almost independent of the major patient variables (sex, age). The only factor that affected this length was the eventual outcome of the disease (survival or death); the time was significantly longer for surviving patients. Artificial neural networks were applied by Nyoni et al (2020) to predict daily confirmed COVID-19 cases in Colombia using daily data collected from John Hopkins university data base. The study revealed that the projected number of daily new corona virus cases would generally be at an equilibrium point (flattening of the curve) at around 11400 cases per day over the period November 2020 to April 2021. The SEIR model was applied by Rodriguez and Urdinola (2020) to predict the total number of ICU and regular beds that would be needed in Bogotá, Colombia, during the COVID-19 pandemic. The model had three different categories of infection: those who can stay at home, those who need regular hospital beds, and those who need ICU treatment. The model allowed for a time varying transmission rate which was used to incorporate the measures introduced by the government over the period of one semester. The model predicted that by mid November 2020, the city would need 1362 ICU beds and more than 9000 regular hospital beds. The number of active cases would be 67,866 by then and the death toll will reach 13,268 people by the end of December 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 COVID-19 mortality cases Colombia.

Data Issues

This study is based on daily COVID-19 mortality cases in Colombia 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	C
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	0.143249
MSE	1165.604742
MAE	27.138039

Residual Analysis for the Applied Model

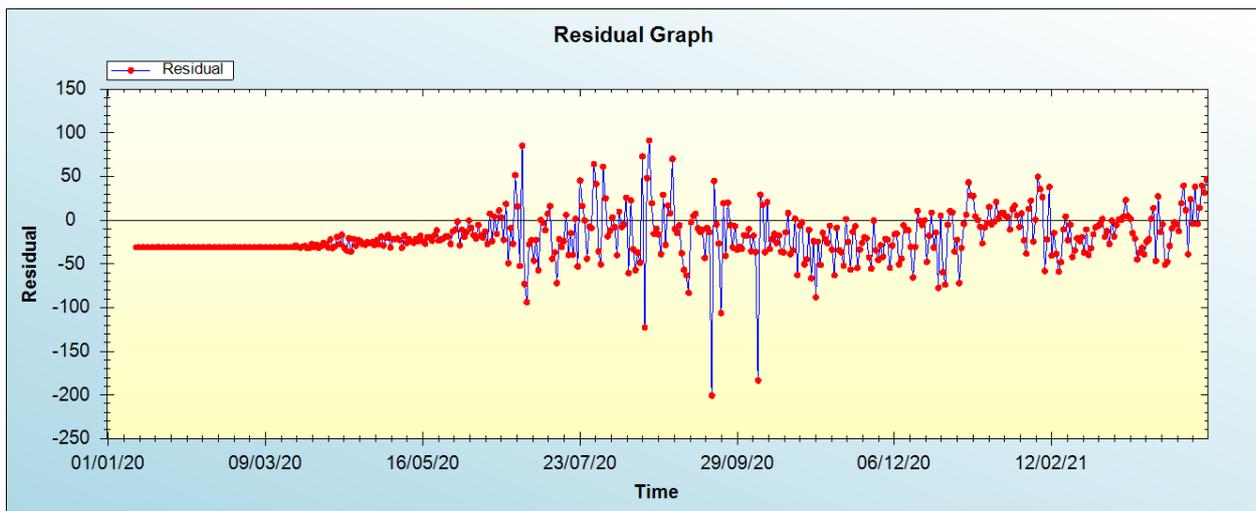


Figure 1: Residual analysis

In-sample Forecast for C

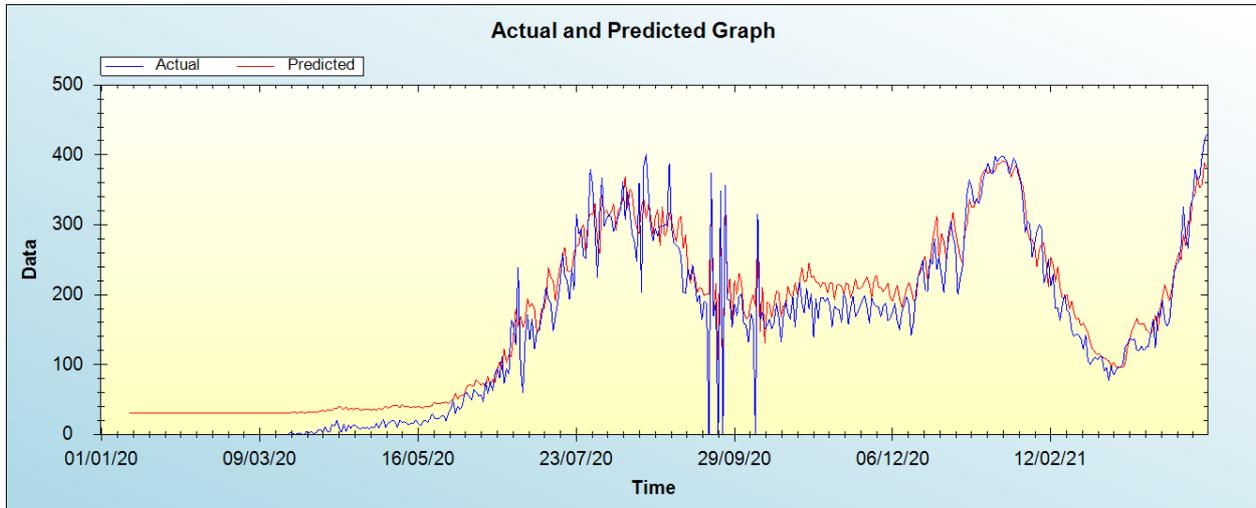


Figure 2: In-sample forecast for the C series

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

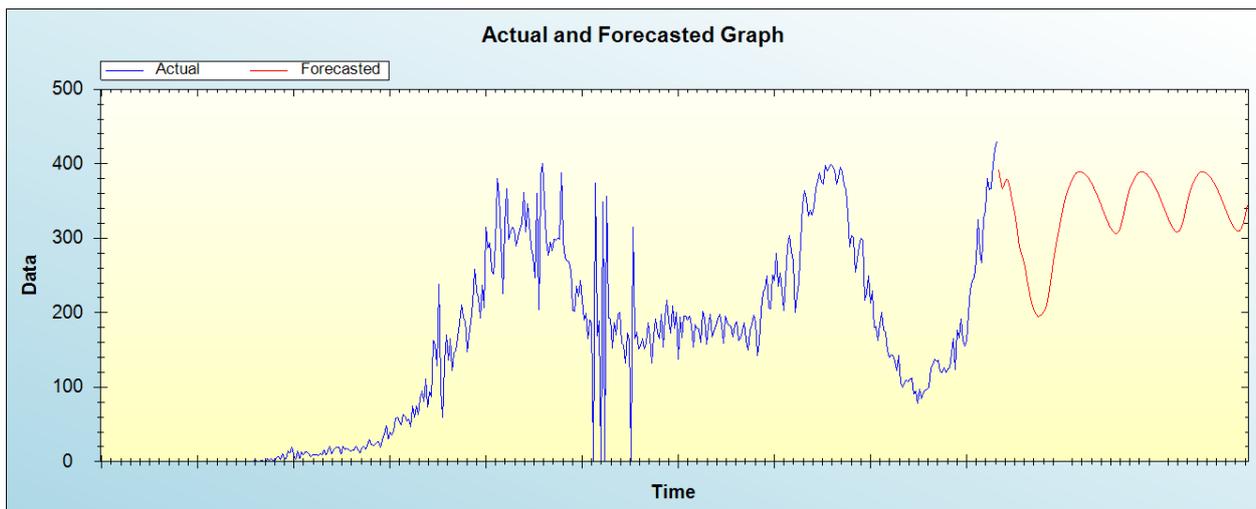


Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Month	Forecasts
21/04/21	392.0964
22/04/21	378.6438
23/04/21	366.0417
24/04/21	372.1149
25/04/21	378.9614
26/04/21	377.9410
27/04/21	367.7600
28/04/21	352.6752
29/04/21	340.8874
30/04/21	327.8761
01/05/21	308.9627
02/05/21	288.4089
03/05/21	280.5637
04/05/21	271.9762
05/05/21	262.2381

06/05/21	245.5536
07/05/21	232.6690
08/05/21	218.6691
09/05/21	209.7952
10/05/21	201.9899
11/05/21	198.1827
12/05/21	194.6074
13/05/21	196.3457
14/05/21	197.7595
15/05/21	201.0556
16/05/21	206.0646
17/05/21	215.8141
18/05/21	230.5628
19/05/21	248.8809
20/05/21	267.3311
21/05/21	283.0013
22/05/21	297.8001
23/05/21	310.7876
24/05/21	324.3132
25/05/21	337.1713
26/05/21	349.0527
27/05/21	358.5396
28/05/21	366.1733
29/05/21	372.6314
30/05/21	378.4250
31/05/21	383.5966
01/06/21	387.0834
02/06/21	389.0027
03/06/21	389.4178
04/06/21	388.9226
05/06/21	387.7328
06/06/21	385.8770
07/06/21	383.1924
08/06/21	379.6597
09/06/21	375.3962
10/06/21	370.5713
11/06/21	365.3039
12/06/21	359.5646
13/06/21	353.4537
14/06/21	347.0778
15/06/21	340.6103
16/06/21	334.1562
17/06/21	327.8101
18/06/21	321.7311
19/06/21	316.1787
20/06/21	311.4839
21/06/21	308.0295
22/06/21	306.2493
23/06/21	306.6935
24/06/21	310.0316
25/06/21	316.8870
26/06/21	327.3439
27/06/21	340.0635
28/06/21	352.2926
29/06/21	361.9858
30/06/21	369.1820
01/07/21	374.8926
02/07/21	379.8736
03/07/21	384.1990
04/07/21	387.4622
05/07/21	389.2441
06/07/21	389.4913
07/07/21	388.5806
08/07/21	386.9956

09/07/21	384.8549
10/07/21	381.9797
11/07/21	378.2924
12/07/21	373.8972
13/07/21	368.9668
14/07/21	363.6079
15/07/21	357.8473
16/07/21	351.7302
17/07/21	345.3751
18/07/21	338.9600
19/07/21	332.6536
20/07/21	326.5719
21/07/21	320.8635
22/07/21	315.7933
23/07/21	311.7269
24/07/21	309.0900
25/07/21	308.3704
26/07/21	310.1597
27/07/21	315.1109
28/07/21	323.6366
29/07/21	335.2018
30/07/21	347.6932
31/07/21	358.4947
01/08/21	366.6452
02/08/21	372.8209
03/08/21	377.9672
04/08/21	382.4896
05/08/21	386.1849
06/08/21	388.6055
07/08/21	389.4978
08/08/21	389.0281
09/08/21	387.6638
10/08/21	385.7306
11/08/21	383.1623
12/08/21	379.8131
13/08/21	375.7084
14/08/21	370.9986
15/08/21	365.8282
16/08/21	360.2544
17/08/21	354.3051
18/08/21	348.0647
19/08/21	341.6894
20/08/21	335.3647
21/08/21	329.2358
22/08/21	323.4294
23/08/21	318.1577
24/08/21	313.7480
25/08/21	310.6083
26/08/21	309.2051
27/08/21	310.0902
28/08/21	313.9030
29/08/21	321.1783
30/08/21	331.7833
31/08/21	344.1430

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

V. CONCLUSION AND POLICY RECOMMENDATIONS

Colombia is a developing country in South America and is not fully equipped to tackle the COVID-19 epidemic. The country has witnessed shortages of health personnel and medical supplies (Rodriguez & Urdinola, 2020). Bearing in mind that the

country has these serious challenges it is therefore crucial to predict COVID-19 mortality in Colombia in order to understand the likely negative health impact of COVID-19 and trigger an appropriate health response from the country's authorities so that adequate resources are put in place for the COVID-19 response. In this study we utilized an artificial intelligence technique to predict COVID-19 mortality in Colombia. The model predictions suggest that daily COVID-19 cases in Colombia are likely to remain significantly high over the out-of-sample period. Therefore we encourage the authorities in Colombia to scale up COVID-19 vaccination and to tirelessly enforce public adherence to WHO guidelines.

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