

Forecasting Covid-19 Mortality in Ecuador

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Abstract - In this study, the ANN approach was applied to analyze COVID-19 deaths in Ecuador. 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 deaths in Ecuador are likely to be close to 40 deaths per day over the out-of-sample period. Therefore there is need for the government of Ecuador 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

The Chinese city Wuhan is now popular at international level because it is now known as the origin of the deadly coronavirus, SARS-COV2 in December 2019 (CDC, 2020; Tang et al, 2020). At the start of the global pandemic numerous pneumonia cases were reported and they were noted to be associated with high morbidity and mortality (Wang et al, 2020; Read et al, 2020). The highly infectious COVID-19 virus swept across the globe quickly facilitated by the travel of people from one region to another. The pandemic came with its negative and positive impacts but to a larger extent the world continues to suffer from the negative impacts (Karunathilake, 2020). The positive impact of the global health crisis include the booming of the pharmaceutical industry due to increased demand of medical supplies like oxygen, oxygen concentrators, face masks, ICU drugs and vaccines. The negative consequences include morbidity and mortality due to COVID-19, high cost of COVID-19 hospital admission in certain countries, massive drug shortages, shortage of health care workers and economic meltdown characterized by loss of sources of income due to closure of businesses and restricted movement of commodities (ILO, 2020). Massive shortage of oxygen for ICU patients in countries like India and Brazil has significantly contributed to the COVID-19 mortality (Toner, 2021).

It is necessary to predict some of the negative impacts of COVID-19 such as morbidity, mortality, and ICU bed occupancy and unemployment rate during the pandemic. In this study we propose an artificial intelligence technique to predict daily COVID-19 deaths in Ecuador. The findings of this study are envisioned to facilitate resource mobilization for the COVID-19 response in the country.

II. LITERATURE REVIEW

Dwomoh et al (2021) proposed the SEIQHRS model (susceptible-exposed-infectious-quarantine-hospitalized-recovered-susceptible) that predicts the evolution of the COVID-19 epidemic in Ghana. A short-term forecast of the early phase of the epidemic evolution in Ghana using the generalized growth model. The results indicated that enhanced government and individual-level interventions and the intensity of media coverage could have a substantial effect on curbing the transmission of new COVID-19 cases and reduced death rates in Ghana. El-Solh et al (2020) compared the predictive accuracy of four outcome models of patients hospitalized with coronavirus disease 2019 (COVID-19) published between January 1st and May 1st 2020. Data obtained from the Veterans Affairs Corporate Data Warehouse (CDW) between January 1st, 2020, and May 1st 2020 as an external validation cohort. The outcome measure was hospital mortality. Areas under the ROC (AUC) curves were used to evaluate discrimination of the four predictive models. The Hosmer-Lemeshow (HL) goodness-of-fit test and calibration curves assessed applicability of the models to individual cases. The study revealed that all four prognostic models examined in the study portend high-risk bias. A machine learning technique was applied by Nyoni et al (2020) to predict daily COVID-19 new cases in Ecuador. The employed data covered the period March 1, 2020 to October 31, 2020 and the out-of-sample period ranged over the period November 2020 April 2021. The artificial neural network predictions indicated that COVID-19 daily cases in Ecuador

would briefly continue on a downward trend from the estimated 956 cases on November 1, 2020 until an equilibrium case volume of approximately 619 cases per day is reached around January 8, 2021.

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 deaths in Ecuador.

Data Issues

This study is based on daily COVID-19 deaths in Ecuador 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	EC
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	1.685696
MSE	33085.733561
MAE	33.773775

Residual Analysis for the Applied Model

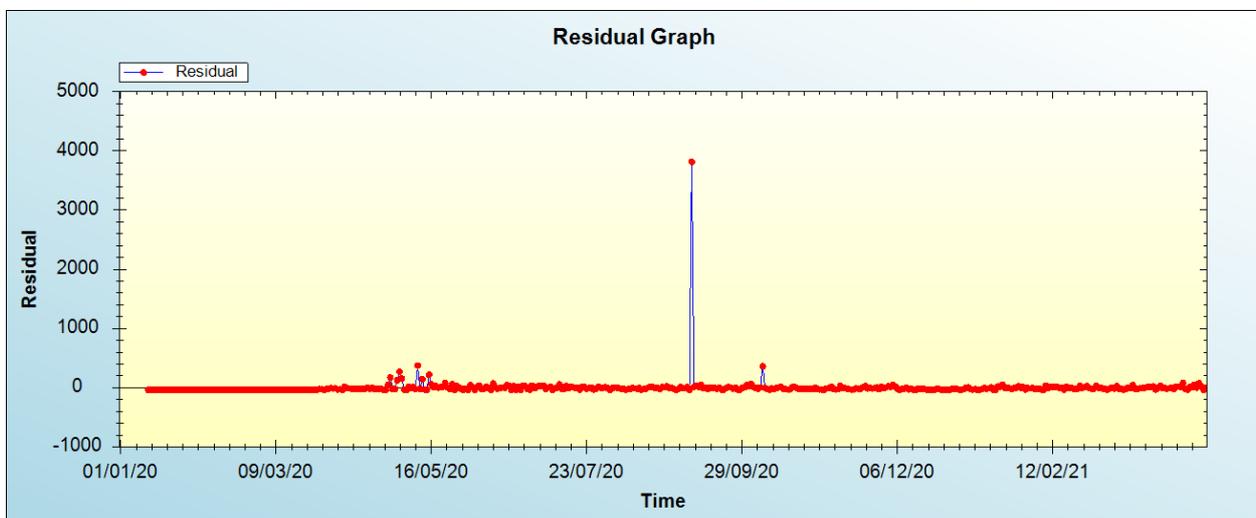


Figure 1: Residual analysis

In-sample Forecast for EC

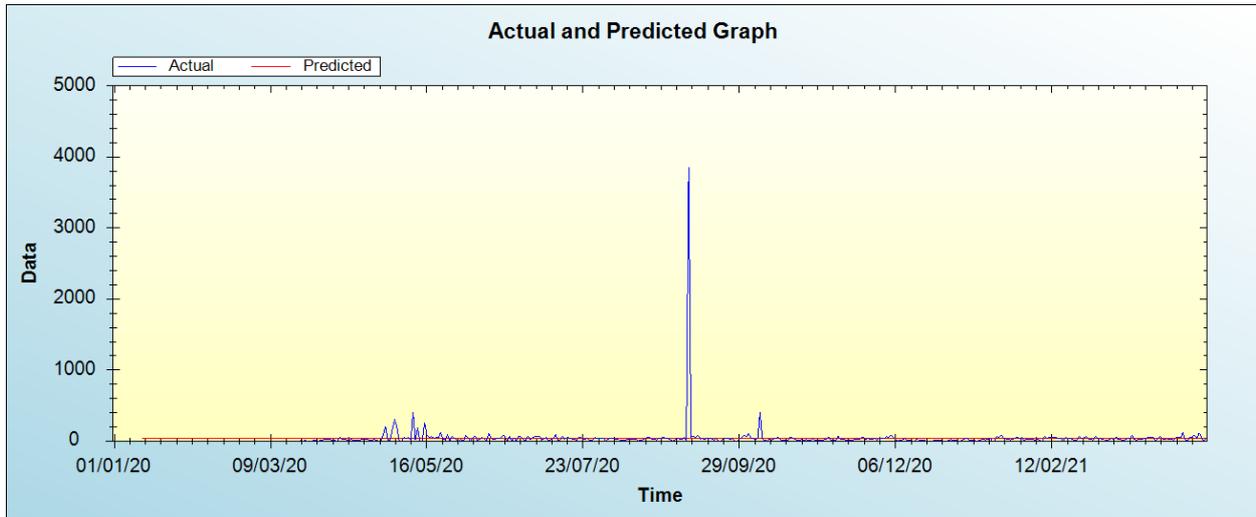


Figure 2: In-sample forecast for the EC series

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

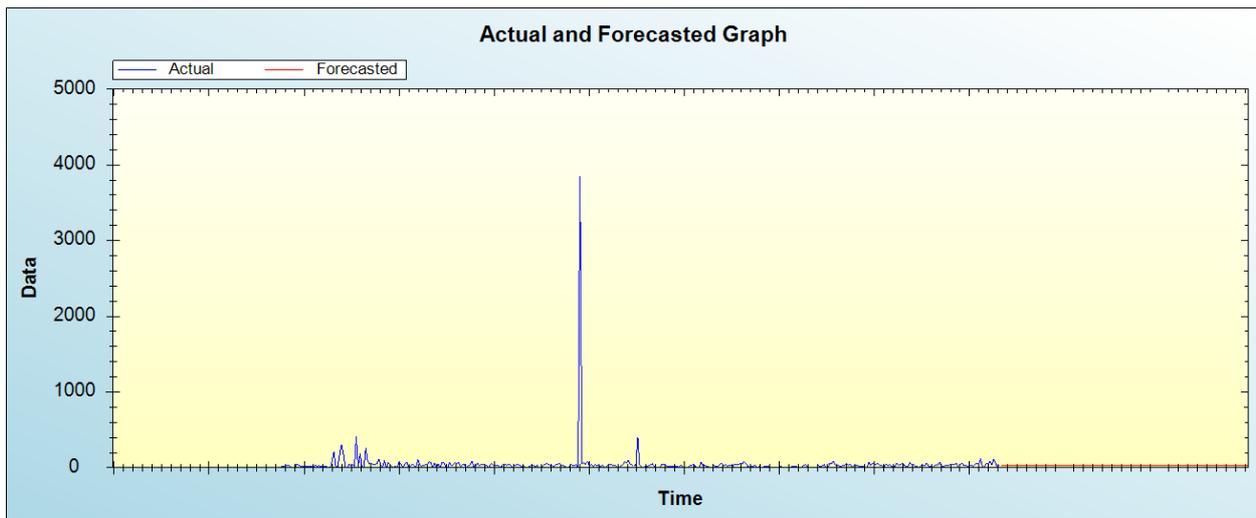


Figure 3: Out-of-sample forecast for EC: actual and forecasted graph

Out-of-Sample Forecast for EC: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Projected COVID-19 deaths
21/04/21	36.4995
22/04/21	36.5018
23/04/21	36.4988
24/04/21	36.5002
25/04/21	36.4999
26/04/21	36.4969
27/04/21	36.4957
28/04/21	36.5010
29/04/21	36.5055
30/04/21	36.5059
01/05/21	36.5042
02/05/21	36.5044
03/05/21	36.5044
04/05/21	36.5044

05/05/21	36.5044
06/05/21	36.5044
07/05/21	36.5044
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09/05/21	36.5044
10/05/21	36.5044
11/05/21	36.5044
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26/08/21	36.5044
27/08/21	36.5044
28/08/21	36.5044
29/08/21	36.5044
30/08/21	36.5044
31/08/21	36.5044

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 Ecuador are likely to be close to 40 deaths per day over the out-of-sample period.

IV. CONCLUSION AND POLICY RECOMMENDATIONS

The respiratory disease, COVID-19 is highly infectious and the condition tends to be more severe in the elderly and patients with pre-existing medical conditions. COVID-19 mortality is an issue of concern especially in countries with high proportions of an aging population and comorbidities. Countries which have been hardest hit include Brazil, Mexico, India, Spain, Italy, Germany and the UK. In this study we propose an artificial intelligent technique to predict daily COVID-19 deaths in Ecuador. The ANN model predictions suggest that daily COVID-19 deaths in Ecuador are likely to be close to 40 deaths per day over the out-of-sample period. Therefore we encourage the government to speed up COVID-19 vaccination amongst other measures.

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