International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 6, pp 726-731, June-2021

https://doi.org/10.47001/IRJIET/2021.506127

Forecasting Covid-19 Mortality in Argentina

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***Abstract* - In this study, the ANN approach was applied to analyze COVID-19 deaths in Argentina. The employed data covers the period 1 January 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 Argentina are likely to be around 168 deaths per day over the out-of-sample period. Therefore there is need for the government of Argentina to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic and speed up COVID-19 vaccination.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

As the COVID-19 pandemic was declared in March 2020, many countries around the world had started reporting cases of the novel coronavirus, SARS-COV2 (Zhou et al, 2020, WHO, 2020). The nature of the virus is frightening and no one would ever imagine the entire world could be brought to a halt by several lockdowns around the globe, closure of schools and universities, ban on public gatherings and shut down of businesses (Burki, 2020). The spread of the virus is shocking and the world bodies decided to unite in the fight against the deadly pandemic. International organizations such as the Global fund,WHO, UNICEF and other UN bodies pledged support for the COVID-19 response. Although the world has made significant progress in containing the SARS-COV2 virus a lot needs to be done in terms of research to have a deeper understanding of the virus. The new strains of the virus which are being reported in UK, Brazil and India are now an issue of concern as these variants are more transmissible (Mahase, 2021; Sahoo et al, 2021; ECDC, 2020). The high mortality being reported in Brazil and India cannot be celebrated as there is a high probability of the spread of these new variants to every corner of the world with a great potential of global disaster in this century. Predictive modeling is an essential tool for surveillance and enables people to have a better understanding of the future evolution of the virus. In this study we propose to apply an artificial intelligence technique to predict daily COVID-19 deaths in Argentina. The results of the study are going to trigger an appropriate timely action in order to halt the spread the SARS-COV2 virus.

II. LITERATURE REVIEW

Salazar et al (2021) investigated the risk factors for 28-days mortality in patients who received convalescent plasma for COVID-19 compared to those who did not, who were admitted to hospitals in Buenos Aires Province, Argentina, throughout the pandemic. This was a multicenter, retrospective cohort study of 2-month duration beginning on June 1, 2020, including unselected, consecutive adult patients with diagnosed COVID-19, admitted to 215 hospitals with pneumonia. Epidemiological and clinical variables were registered in the Provincial Hospital Bed Management System. Convalescent plasma was supplied as part of a centralized, expanded access program. The study concluded that the administration of convalescent plasma in COVID-19 pneumonia admitted to the hospital might be associated with improved outcomes. Another study was carried out by Scho¨nfeld et al (2021) who investigated the clinical characteristics of SARS-CoV-2 infection in Latin America. Data were extracted from the COVID-19 database of the Integrated Argentina Health Information System, encompassing the period of March 3rd to October 2nd, 2020, using a standardized case report form that included information on contact history, clinical signs and symptoms, and clinical diagnosis. The study results indicated that most cases of COVID-19 diagnosed in Argentina were mild and had a favorable outcome, but fatality rates were relatively elevated. Risk factors for adverse outcome included older age, male sex, coma and seizures, and the concurrent presence of several morbidities. Martinez-Valle (2021) examined how Argentina, Brazil, Chile, Colombia, Mexico, and Peru addressed the COVID-19 pandemic and the effectiveness of these policy responses from the date each country declared a sanitary emergency, between middle and late March 2020 until 23 September 2020. The results showed that both timelier and more stringent implementation of the public policies analyzed to address the COVID-19 pandemic seemed

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to be associated with higher mobility reductions and lower mortality rates. Yacobitti et al (2021) investigated the clinical characteristics of vulnerable populations hospitalized and diagnosed with COVID-19 in Buenos Aires, Argentina. The study was a prospective cohort investigation of patients with lab-confirmed COVID-19, who required to any of the Health Centers response from April 8, 2020, to August 18, 2020. In Buenos Aires Metropolitan Area (AMBA), April 8, 2020 the virus was identified in patients hospitalized in the "Southeast Network" (SN), AMBA. The study results demonstrated older persons, and those with comorbidities have the highest risk of mortality related to COVID-19.

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 Argentina.

Data Issues

This study is based on daily COVID-19 deaths in Argentina 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	AG
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	1.824357
MSE	39504.338303
MAE	121.663995

Residual Analysis for the Applied Model

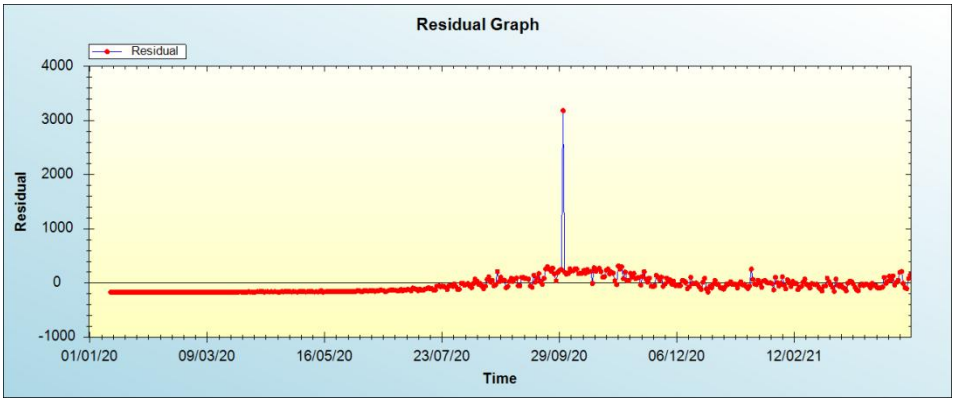

Figure 1: Residual analysis

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In-sample Forecast for AG

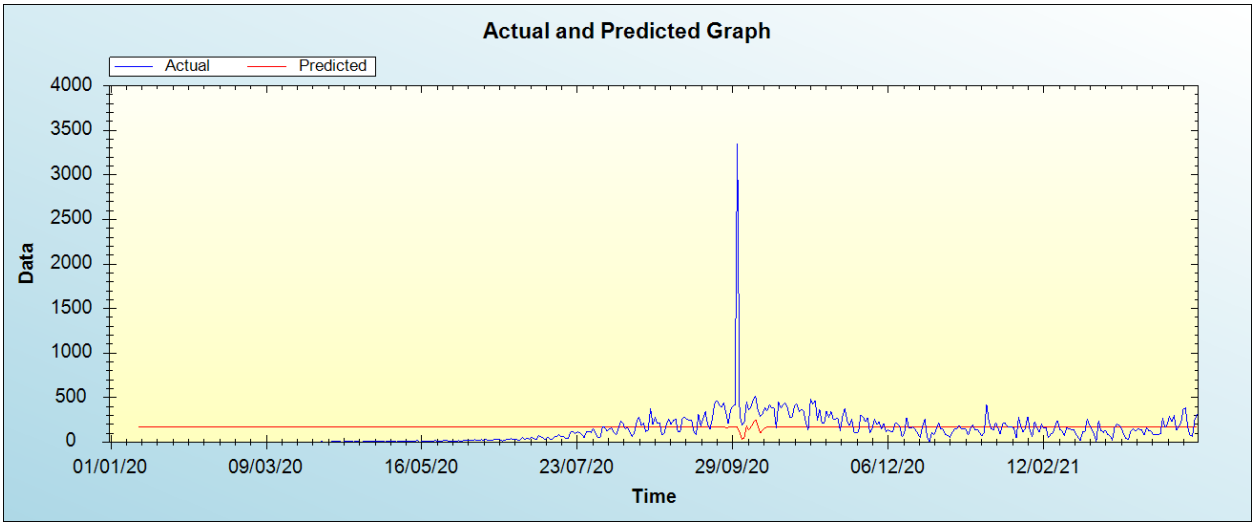

Figure 2: In-sample forecast for the AG series

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

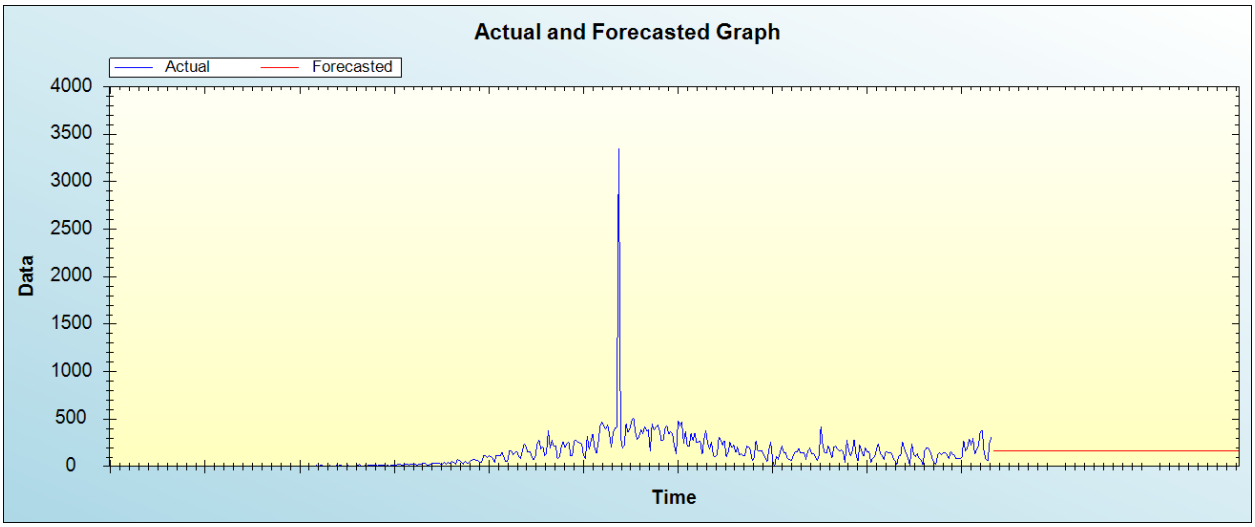

Figure 3: Out-of-sample forecast for AG: actual and forecasted graph

Out-of-Sample Forecast for AG: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/year	Projected COVID-19 deaths
21/04/21	168.5408
22/04/21	168.7711
23/04/21	168.6155
24/04/21	167.2739
25/04/21	166.1965
26/04/21	167.3315
27/04/21	168.3994
28/04/21	168.6935
29/04/21	168.1026
30/04/21	167.5441
01/05/21	167.5576
02/05/21	167.6986
03/05/21	167.8317
04/05/21	167.8389

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05/05/21	167.8476
06/05/21	167.8480
07/05/21	167.8426
08/05/21	167.8373
09/05/21	167.8370
10/05/21	167.8393
11/05/21	167.8411
12/05/21	167.8416
13/05/21	167.8411
14/05/21	167.8408
15/05/21	167.8407
16/05/21	167.8406
17/05/21	167.8406
18/05/21	167.8407
19/05/21	167.8407
20/05/21	167.8407
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27/08/21	167.8407
28/08/21	167.8407
29/08/21	167.8407
30/08/21	167.8407
31/08/21	167.8407

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 Argentina are likely to be around 168 deaths per day over the out-of-sample period.

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V. CONCLUSION AND POLICY RECOMMENDATIONS

The world is currently frustrated by the ongoing COVID-19 pandemic. Many countries have highlighted that their financial resources are not enough to fight the outbreak on their own hence financial assistance from international organization is required to tackle the global health threat of COVID-19. Predictive modeling is essential during this pandemic because it provides the highlights of the evolution of the disease and facilitate planning and resource mobilization for the COVID-19 response. In this study we proposed a machine learning technique to forecast COVID-19 mortality in Argentina. The findings revealed that daily COVID-19 deaths in Argentina are likely to be around 168 deaths per day over the out-of-sample period. Therefore the government needs to scale up vaccination against COVID-19 in order to achieve herd immunity amongst other measures.

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Citation of this Article:

Dr. Smartson. P. NYONI, Mr. Thabani NYONI, Mr. Tatenda. A. CHIHOHO, "Forecasting Covid-19 Mortality in Argentina" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 6, pp 726-731, June 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.506127

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