

Forecasting Covid-19 Mortality in Costa Rica

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Abstract - In this study, the ANN approach was applied to analyze COVID-19 deaths in Costa Rica. 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 the daily COVID-19 deaths in Costa Rica are likely to increase rapidly from 21 April 2021 to reach a plateau point of approximately 60 deaths per day around 14 May 2021 which will persist for the rest of the out-of-sample period. Therefore there is need for the government of Costa Rica to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic and accelerate COVID-19 vaccination in order to achieve herd immunity.

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The entire world is currently adapting to the new 'normal' situation brought by the COVID-19 pandemic. It is not yet clear when the pandemic will end. Various sectors of the economy have put in place measures to adapt to the current situation of COVID-19. International travelers are requested to have valid negative COVID-19 PCR results before they cross borders. The World Health Organization is on the forefront of encouraging people to get vaccinated against COVID-19 in order to achieve herd immunity. However these efforts are being derailed by vaccine hesitancy and delay in the supply of the vaccines by drug manufacturing companies in certain regions of the world (Edwards et al, 2021). The education sector has moved to distant learning (Mukute et al, 2020) and business people have shifted to virtual meetings and conferences and some of the workers are working from home to minimize the spread of the SARS-COV2 virus. The banking industry is encouraging customers to utilize online banking platforms when making payments. The transport sector was not left behind in the COVID-19 response. Strict adherence to COVID-19 protocols such as social distancing, wearing masks, and hygiene practice is being implemented when using the public transport system. Other sectors are following the same guidelines in order to stop the spread of COVID-19.

There are limited empirical COVID-19 studies in Costa Rica. In this paper we will briefly highlight some of them. Nayak et al (2021) conducted a study to investigate the applicability of intelligent systems such as ML, DL and others in solving COVID-19 related outbreak issues. The study revealed that ML algorithms such as SVM, LR, RF, and KNN have been used for solving problems of COVID-19. Gnanv (2020) conducted a global systematic literature review to summarize trends in the modelling techniques used for Covid-19 from January 1st 2020 to June 30th 2020. Authors further examined the reliability and correctness of predictions by comparing predicted and observed values for cumulative cases and deaths. The study found that most studies on the modelling of Covid-19 were from Asia (52.70%) and Europe (25%). Most of them used compartmental models (SIR and SEIR) (57%) and statistical models (growth models and time series) (28%) while few used artificial intelligence (5%) and Bayesian approach (3%). The research findings suggested that while predictions made by the different models are useful to understand the pandemic course and guide policy-making, there should be cautious in their usage. The artificial neural network approach was applied by Nyoni et al (2020) to forecast daily COVID-19 cases in Costa Rica. The employed data covered the period March 6, 2020 to October 31, 2020 while the out-of-sample period ranged over the period November 2020 to April 2021. The results of the study indicated that daily COVID-19 cases in Costa Rica would reach an equilibrium level of approximately 1901 cases per day around January 12, 2021 and this would persist throughout the rest of the out-of-sample period.

The purpose of the study is to predict daily COVID-19 deaths in Costa Rica using a machine learning algorithm because of its popularity and high predictive accuracy (Maradze et al, 2021; Nyoni et al, 2021; Zhao et al, 2020; Nyoni et al, 2020; Kaushik&Sahi, 2018; Fojnica et al, 2016; Zhang, 2003). The results of the study are expected to provide an insight of the likely future trends of COVID-19 mortality in the country and facilitate planning and resource allocation for the COVID-19 response.

II. 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 Costa Rica.

Data Issues

This study is based on daily COVID-19 in Costa Rica 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).

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	CR
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	1.072794
MSE	19.245859
MAE	3.159108

Residual Analysis for the Applied Model

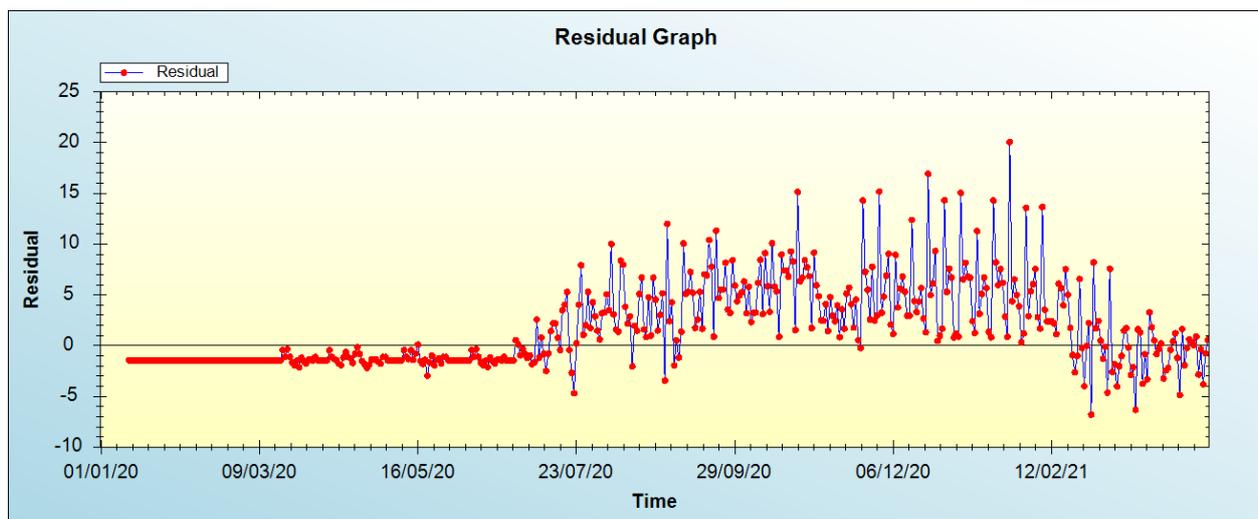


Figure 1: Residual analysis

In-sample Forecast for CR

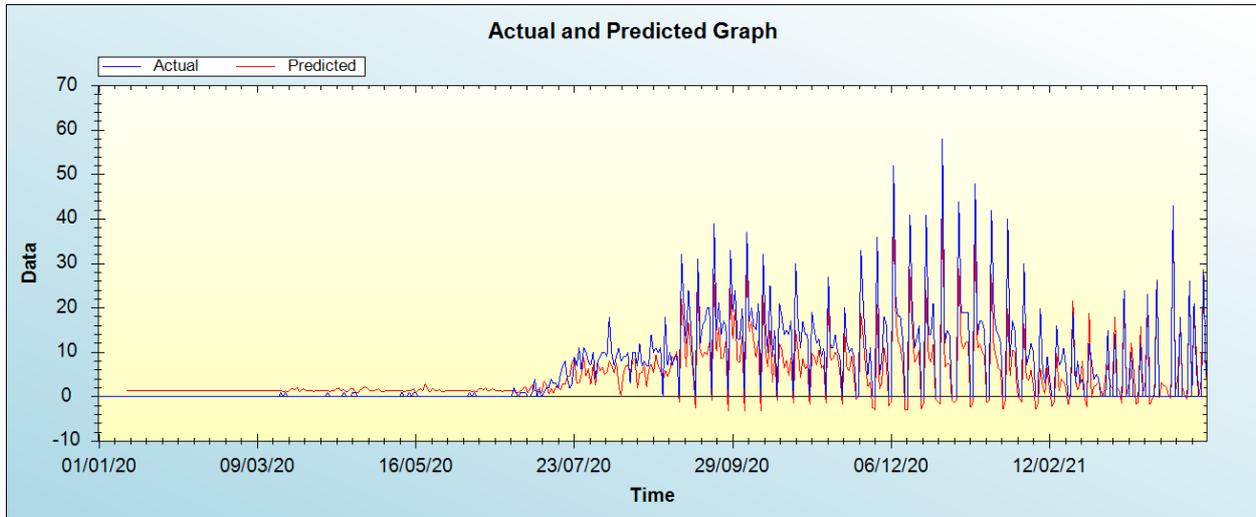


Figure 2: In-sample forecast for the A series

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

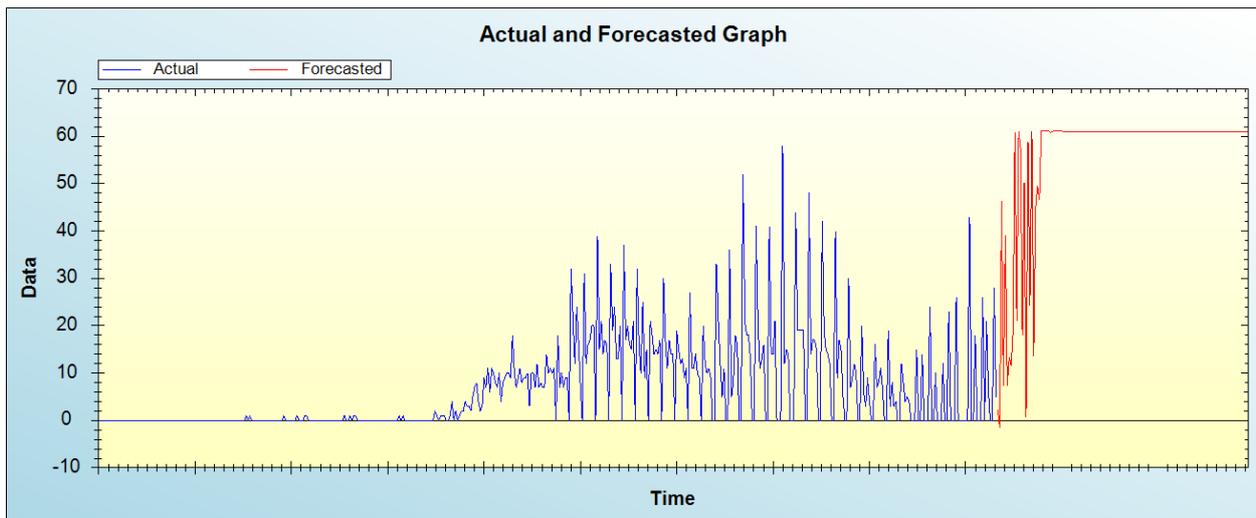


Figure 3: Out-of-sample forecast for CR: actual and forecasted graph

Out-of-Sample Forecast for CR: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Projected COVID-19 deaths
21/04/21	2.2626
22/04/21	-1.5303
23/04/21	46.2691
24/04/21	7.4300
25/04/21	38.9699
26/04/21	7.4447
27/04/21	13.3177
28/04/21	11.6212
29/04/21	18.8697
30/04/21	60.7546
01/05/21	21.0287
02/05/21	61.1566
03/05/21	57.4622
04/05/21	18.0142

05/05/21	50.2259
06/05/21	0.7019
07/05/21	58.8402
08/05/21	24.2649
09/05/21	61.1473
10/05/21	13.5425
11/05/21	44.9655
12/05/21	49.5395
13/05/21	46.6598
14/05/21	61.1636
15/05/21	61.2075
16/05/21	61.2190
17/05/21	61.0706
18/05/21	61.2129
19/05/21	60.8133
20/05/21	60.9683
21/05/21	61.2113
22/05/21	61.2195
23/05/21	61.2150
24/05/21	61.2154
25/05/21	61.1076
26/05/21	60.8909
27/05/21	60.8818
28/05/21	60.8901
29/05/21	60.8931
30/05/21	60.9197
31/05/21	60.9228
01/06/21	60.9073
02/06/21	60.8946
03/06/21	60.8906
04/06/21	60.8878
05/06/21	60.8939
06/06/21	60.9088
07/06/21	60.9145
08/06/21	60.9147
09/06/21	60.9139
10/06/21	60.9117
11/06/21	60.9104
12/06/21	60.9110
13/06/21	60.9123
14/06/21	60.9132
15/06/21	60.9137
16/06/21	60.9135
17/06/21	60.9125
18/06/21	60.9118
19/06/21	60.9116
20/06/21	60.9117
21/06/21	60.9119
22/06/21	60.9120
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24/06/21	60.9120
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28/06/21	60.9118
29/06/21	60.9119
30/06/21	60.9119
01/07/21	60.9119
02/07/21	60.9119
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30/08/21	60.9119
31/08/21	60.9119

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 Costa Rica are likely to increase rapidly from 21 April 2021 to reach a plateau point of approximately 60 deaths per day around 14 May 2021 which will persist for the rest of the out-of-sample period.

IV. CONCLUSION AND POLICY RECOMMENDATIONS

The whole world has been shaken by the COVID-19 outbreak, all sectors of the economy being affected. However the world is continuously adapting to the emerging daily problems which are associated with the COVID-19 pandemic. Many sectors have suddenly shifted to online platforms in order to survive. What remains unknown is how long the pandemic will take. Different countries therefore have to plan and allocate adequate resources for COVID-19 response. Predictive modeling is a necessary tool to reveal the likely future trends of the disease. In this paper we therefore propose a machine learning algorithm to predict daily COVID-19 deaths in Costa Rica. The results indicate that daily COVID-19 deaths in Costa Rica are likely to increase rapidly from 21 April 2021 to reach a plateau point of approximately 60 deaths per day around 14 May 2021 which will persist for the rest of the out-of-sample period. Hence we implore the government to speed up COVID-19 vaccination amongst other measures.

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