

Forecasting Covid-19 New Cases in El Salvador

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Abstract - In this study, the ANN approach was applied to analyze COVID-19 new cases in El Salvador. The employed data covers the period 1 January 2020 – 25 March 2021 and the out-of-sample period ranges over the period 26 March – 31 July 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 cases are likely to vanish around late April 2021. Amongst other suggested policy directions, there is need for the government of El Salvador to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The study of the evolution of infectious diseases is critical in epidemiology because it equips decision makers with requisite knowledge in order to implement appropriate mitigatory measures in time (Wieczorek et al, 2020). Artificial neural networks (ANNs) have been applied in various situations such as prediction of road traffic accidents, suicide deaths and prediction of new cases or progression of disease (Al-Waeli et al, 2020; Pathak et al, 2020; Singh et al, 2020; Sayeed et al, 2020; Sanderson et al, 2020; Hannun et al, 2019; Bogard et al, 2019; Daoud & Mayo, 2019; Ren et al, 2019; Maragatham & Devi, 2019; Das et al, 2019; Reddy et al, 2019; Vasquez – Morales et al, 2019). Various studies have revealed that artificial intelligence can be applied in modeling and forecasting COVID-19 and thus can support the fight against COVID-19 pandemic (Nyoni et al, 2021; Nyoni et al, 2020; Bullock et al, 2020; Luengo-Oroz, 2020). The artificial neural network approach is applied in this study to model and predict daily COVID-19 cases in El Salvador. The technique has been proven to be good in modeling epidemiologic phenomena, forecast epidemic peaks and estimate the dimension of risk and scope of diseases (Castro et al, 2020; Pal et al, 2020; Torrealba-Rodriguez et al, 2020; Manliura et al, 2019). The main feature of ANNs is self-learning without prior knowledge of the complex nonlinear relationships that exist between input and output variables (Schmitt et al, 2018). The ANN approach has been shown to provide forecasting accuracy in emerging epidemiological outbreaks such as COVID-19, Zika and Ebola (Nyoni et al, 2021; Nyoni et al, 2020; Wu et al, 2018; Wahyunggyoro et al, 2013). In this study we apply the ANN (12, 12, 1) model to predict daily COVID-19 cases in El Salvador. The findings of the study are expected to provide an insight of the likely future trends of daily COVID-19 cases in El Salvador and facilitate planning and decision making in order to allocate resources for health so as to curb the spread of SARS-CoV2 virus.

II. LITERATURE REVIEW

The multivariate multilevel regression was applied by Ettensperger (2020) to investigate the link between poverty and COVID-19 case and mortality rates in Germany. As proxies for poverty the unemployment rate, the per capita presence of general practitioners (physicians), per capita GDP, and the rate of employees with no professional job training is evaluated in relation to the accumulated case and mortality numbers on district level taken from RKI data of June and July 2020. The study found no evidence for a poverty-related effect on mortality for German districts. In addition, only employment in low qualification jobs approximated by the job training variable consistently affected case numbers in urban districts in the expected direction. Nyoni et al (2020) modelled and predicted daily COVID-19 case volume for the United Kingdom using the artificial neural network approach using data collected from Johns Hopkins University. The study concluded that COVID-19 cases would continue to surge in the country over the out of sample period. Getz et al (2020) did characterization of Israeli COVID-19 outbreak drivers and forecasting using a versatile web application (NMB-DASA). The study revealed that projections beyond the relaxation phase indicate 85% drop in social relaxation rates needed just to stabilize the current incidence rate and that at least 95% drop is needed to quell the outbreak.

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 new COVID-19 cases El Salvador.

Data Issues

This study is based on daily new cases of COVID-19 in El Salvador for the period 1 January 2020 – 25 March 2021. The out-of-sample forecast covers the period 26 March 2021 – 31 July 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	ES
Observations	438 (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	0.233262
MSE	16029.982438
MAE	90.355736

Residual Analysis for the Applied Model

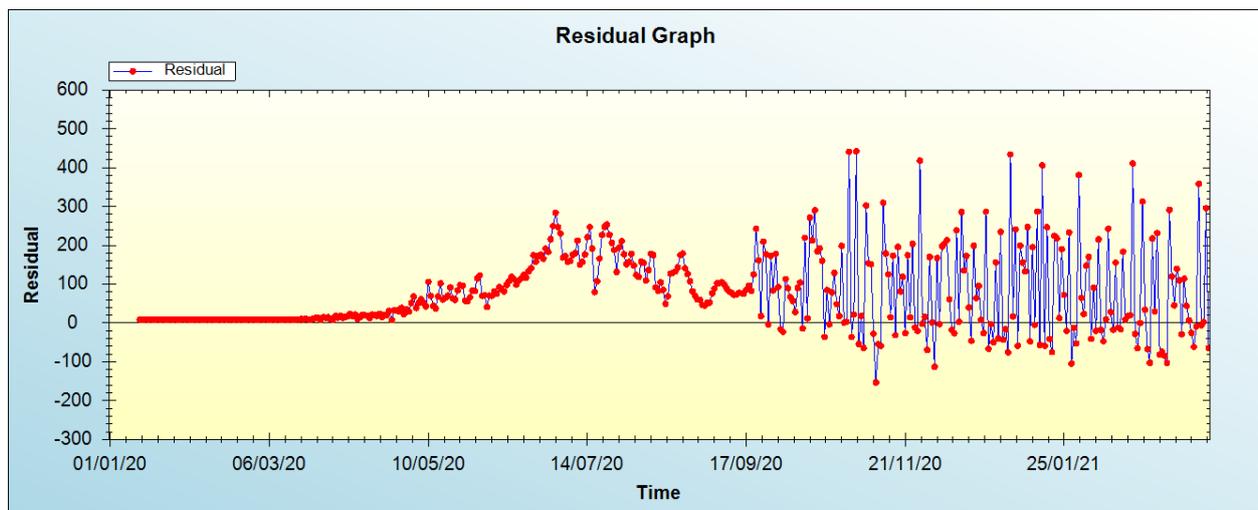


Figure 1: Residual analysis

In-sample Forecast for ES

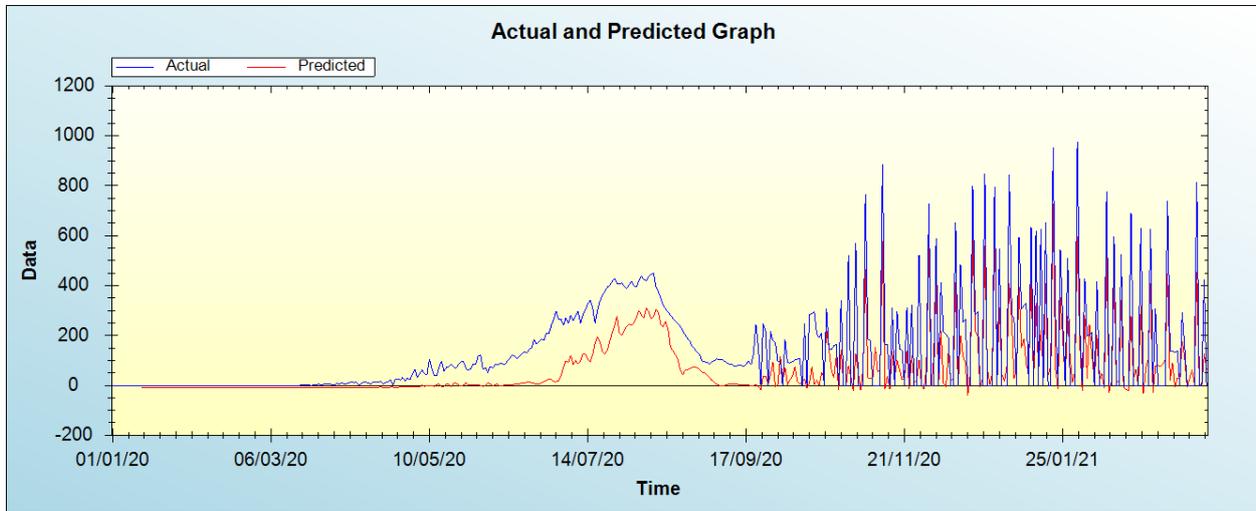


Figure 2: In-sample forecast for the ES series

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

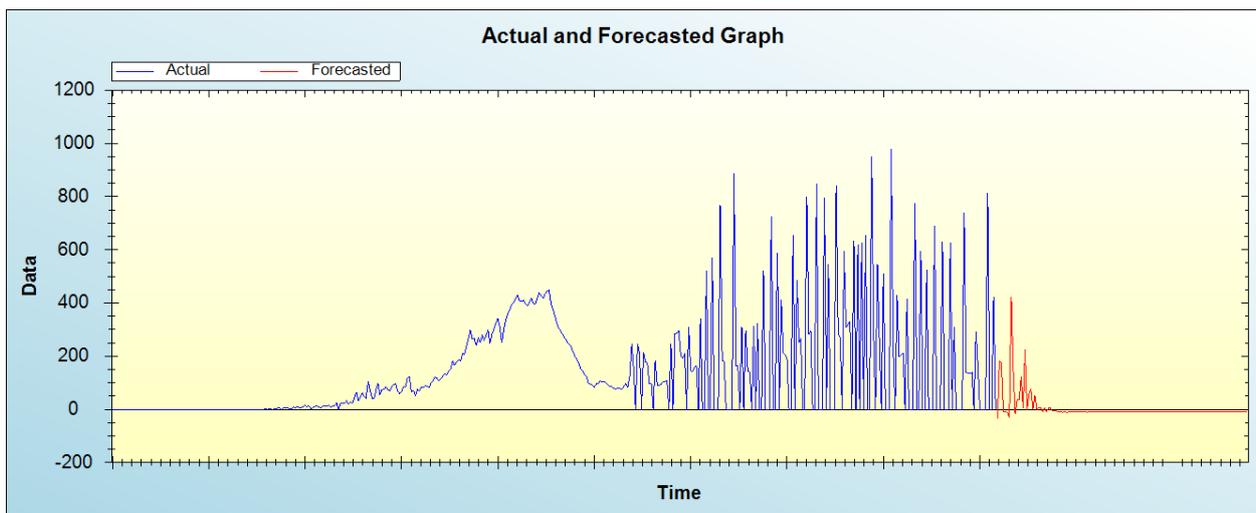


Figure 3: Out-of-sample forecast for ES: actual and forecasted graph

Out-of-Sample Forecast for ES: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	-33.0961
27/03/21	183.9673
28/03/21	173.3338
29/03/21	-7.4204
30/03/21	-8.3768
31/03/21	-10.8999
01/04/21	-31.5820
02/04/21	423.5167
03/04/21	145.4656
04/04/21	-17.6120
05/04/21	35.5603
06/04/21	37.0186
07/04/21	124.2177

08/04/21	5.2271
09/04/21	222.7736
10/04/21	-0.2858
11/04/21	57.8649
12/04/21	76.6338
13/04/21	-0.3000
14/04/21	52.2780
15/04/21	-1.8218
16/04/21	6.9996
17/04/21	6.2319
18/04/21	-7.5905
19/04/21	5.8980
20/04/21	-8.1983
21/04/21	4.2753
22/04/21	4.0223
23/04/21	-6.8127
24/04/21	-5.6375
25/04/21	-6.1860
26/04/21	-10.2650
27/04/21	-7.8943
28/04/21	-10.7635
29/04/21	-9.6700
30/04/21	-10.6390
01/05/21	-10.1690
02/05/21	-8.0368
03/05/21	-9.4397
04/05/21	-9.9766
05/05/21	-9.2771
06/05/21	-10.0289
07/05/21	-9.8869
08/05/21	-9.9578
09/05/21	-10.1350
10/05/21	-10.1778
11/05/21	-10.3424
12/05/21	-9.9347
13/05/21	-9.8937
14/05/21	-10.1415
15/05/21	-9.9864
16/05/21	-10.0072
17/05/21	-10.0697
18/05/21	-10.0197
19/05/21	-10.0486
20/05/21	-10.0725
21/05/21	-10.1184
22/05/21	-10.0853
23/05/21	-10.0314
24/05/21	-10.0773
25/05/21	-10.0739
26/05/21	-10.0508
27/05/21	-10.0687
28/05/21	-10.0630
29/05/21	-10.0563
30/05/21	-10.0619
31/05/21	-10.0718
01/06/21	-10.0739
02/06/21	-10.0617
03/06/21	-10.0647
04/06/21	-10.0704
05/06/21	-10.0645
06/06/21	-10.0656
07/06/21	-10.0674
08/06/21	-10.0645
09/06/21	-10.0641
10/06/21	-10.0661

	11/06/21		-10.0676
	12/06/21		-10.0659
	13/06/21		-10.0651
	14/06/21		-10.0668
	15/06/21		-10.0662
	16/06/21		-10.0657
	17/06/21		-10.0664
	18/06/21		-10.0661
	19/06/21		-10.0656
	20/06/21		-10.0658
	21/06/21		-10.0663
	22/06/21		-10.0662
	23/06/21		-10.0658
	24/06/21		-10.0661
	25/06/21		-10.0662
	26/06/21		-10.0660
	27/06/21		-10.0661
	28/06/21		-10.0661
	29/06/21		-10.0660
	30/06/21		-10.0660
	01/07/21		-10.0661
	02/07/21		-10.0661
	03/07/21		-10.0660
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	10/07/21		-10.0660
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	26/07/21		-10.0660
	27/07/21		-10.0660
	28/07/21		-10.0660
	29/07/21		-10.0660
	30/07/21		-10.0660
	31/07/21		-10.0660

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 El Salvador are likely to vanish around late April.

V. CONCLUSION AND POLICY RECOMMENDATIONS

COVID-19 is an emerging public health problem which has shaken health systems in various countries. Developing countries have become more vulnerable as they have to rely on donor funds to drive their health systems. Interestingly even the developed world has suffered from the deadly virus aggravated by emerging mutant strains which are more transmissible. Vaccine supply hesitancy and supply challenges continue to hamper efforts to effectively control the pandemic. In this study we predicted

daily COVID-19 cases in El Salvador using the artificial neural network approach. The findings indicate that COVID-19 cases are likely to vanish around late April. Therefore the government should relentlessly enforce adherence to the WHO guidelines on prevention and control of COVID-19.

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