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Forecasting Covid-19 New Cases in Lebanon

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***Abstract* - In this study, the ANN approach was applied to analyze COVID-19 new cases in Lebanon. 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 decline to zero by early May 2021. Amongst other suggested policy directions, there is need for the government of Lebanon to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The SARS-COV 2 virus was first reported in Wuhan City of China in December 2019 and since that time the virus rapidly spread to all the parts of the world (Wang et al, 2020; Tang et al, 2020; CDC, 2020). Lebanon did not escape from the COVID-19 pandemic as it reported its case of COVID-19 on the 21st of February 2020 (DRU, 2020; World meter, 2020). By the 7th of February 2021 the country had reported 319,917 confirmed cases and 3616 fatalities (El Deb & Jauoul, 2021). The country has witnessed a rise in the infections which have been associated with high numbers of ICU admissions (MOH Lebanon, 2020). The government responded well to the pandemic by imposing lockdowns and enforcing adherence to WHO guidelines. The aim of this paper is to predict daily COVID-19 cases in Lebanon using the artificial neural network approach. The model is capable of modeling nonlinear big data sets as demonstrated in various studies (Maradze et al, 2021; Nyoni et al, 2021; Nyoni & Nyoni, 2021; Nyoni et al, 2020; Zhao et al, 2020). The results of the study are expected to reveal future trends of COVID-19 in Lebanon and stimulate an appropriate and evidence based response to the epidemic.

II. LITERATURE REVIEW

Motasem et al (2020) estimated the probable outbreak size of COVID-19 clusters in Jordan mathematically using a mathematical model to estimate the R0 of COVID-19 in an outbreak occurring in both local and international clusters in light of published data. Different types of clusters (religious, wedding, and industrial activity) were selected based on reported events in different countries between February and April 2020. The study concluded that this model offers a contact-tracing task with the predicted number of cases, this would help in epidemiological investigations by knowing when to stop. El Deeb & Jalloul (2021) implemented an iterative method in order to predict the number of active COVID-19 cases and consequently forecast the number of inpatients to hospitals and ICU in Lebanon according to different scenarios after end of the complete closure and curfew implemented between January 13 and February 7, 2021. The forecast predicted a decrease in the number of infections and people in need for hospitalization and ICU during the 2 weeks after the curfew (until February 21st), with varying extents depending on the subsequent commitment to mitigation measures, except for the case of a 2% absolute increase from the current rate of infection, which would bring back the numbers of cases back to an increasing trend. Pais & Taveira (2020) developed a mathematical model to estimate the strength of Government-Imposed Measures (GIM) in Portugal and predicted the impact of the degree of compliance on the number of infected cases and peak of infection. The estimated peak was around 650 thousand infected cases with 53 thousand requiring hospital care by the beginning of May if no measures were taken.

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

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activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting new COVID-19 cases Lebanon.

Data Issues

This study is based on daily new cases of COVID-19 in Lebanon 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	L
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	0.083514
MSE	81524.824865
MAE	181.719454

Residual Analysis for the Applied Model

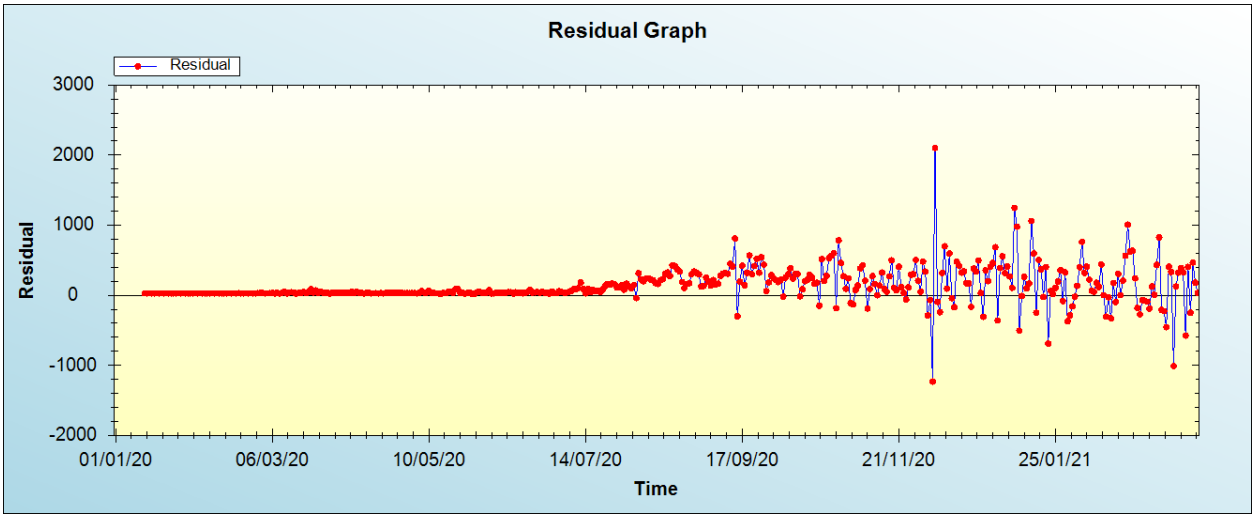

Figure 1: Residual analysis

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In-sample Forecast for L

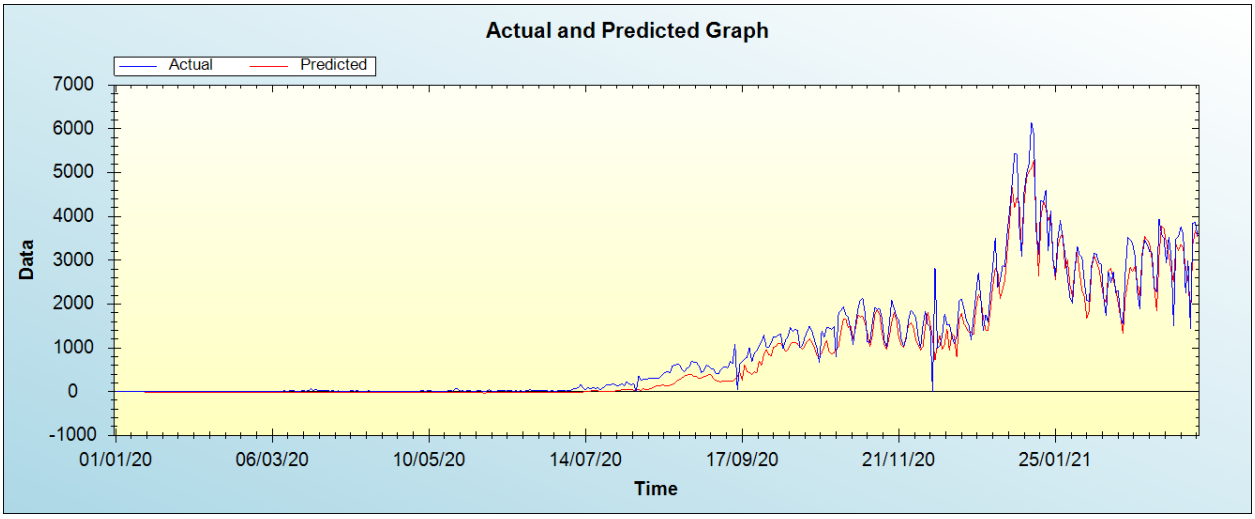

Figure 2: In-sample forecast for the L series

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

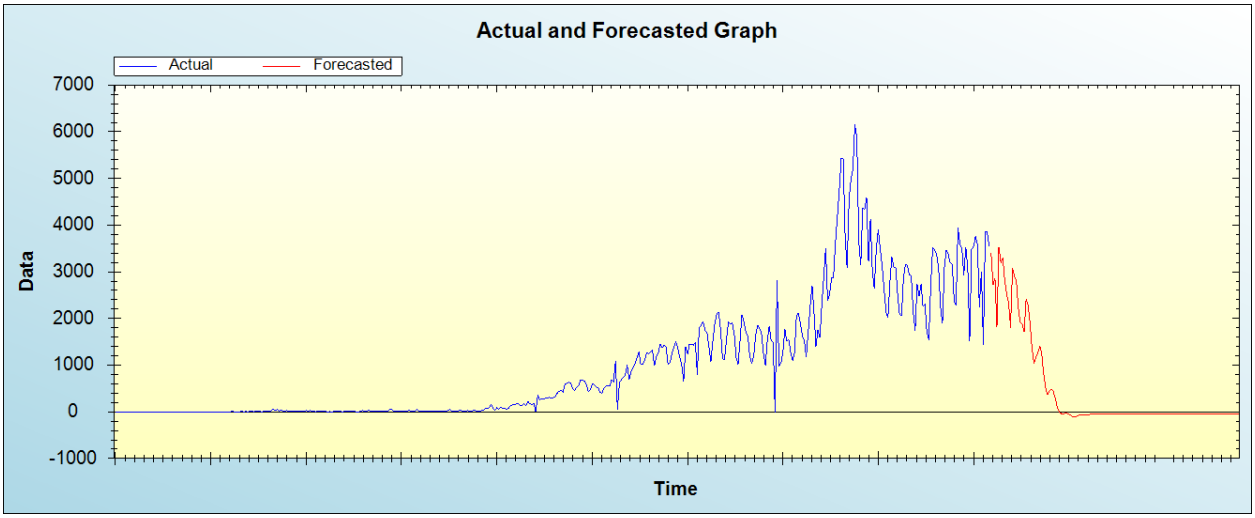

Figure 3: Out-of-sample forecast for L: actual and forecasted graph

Out-of-Sample Forecast for L: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	3398.4484
27/03/21	2717.9171
28/03/21	2854.7804
29/03/21	1821.7875
30/03/21	3532.8205
31/03/21	3195.3688
01/04/21	3293.1201
02/04/21	2812.3077
03/04/21	2518.0346
04/04/21	2352.9380
05/04/21	1811.5539
06/04/21	3078.1683
07/04/21	2899.4353
08/04/21	2805.6183
09/04/21	2221.7518

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10/04/21	1909.6997
11/04/21	1880.4413
12/04/21	1716.7715
13/04/21	2422.5806
14/04/21	2286.5577
15/04/21	1903.3996
16/04/21	1377.4224
17/04/21	1047.9764
18/04/21	1160.8583
19/04/21	1252.2767
20/04/21	1409.6651
21/04/21	1248.2492
22/04/21	814.3668
23/04/21	529.7776
24/04/21	358.2243
25/04/21	441.6187
26/04/21	489.7718
27/04/21	433.9629
28/04/21	286.9294
29/04/21	96.1901
30/04/21	2.5345
01/05/21	-36.9879
02/05/21	-44.4240
03/05/21	-31.2813
04/05/21	-34.5609
05/05/21	-52.3235
06/05/21	-82.6113
07/05/21	-102.4729
08/05/21	-104.8735
09/05/21	-94.6579
10/05/21	-75.7252
11/05/21	-63.0224
12/05/21	-60.1595
13/05/21	-61.0670
14/05/21	-61.9157
15/05/21	-59.4638
16/05/21	-54.0733
17/05/21	-47.1769
18/05/21	-41.7902
19/05/21	-39.6327
20/05/21	-39.5779
21/05/21	-40.5066
22/05/21	-40.9077
23/05/21	-40.0358
24/05/21	-38.6395
25/05/21	-37.6513
26/05/21	-37.5588
27/05/21	-38.1563
28/05/21	-39.0141
29/05/21	-39.6877
30/05/21	-39.9178
31/05/21	-39.8704
01/06/21	-39.7991
02/06/21	-39.8751
03/06/21	-40.1488
04/06/21	-40.5045
05/06/21	-40.7811
06/06/21	-40.8940
07/06/21	-40.8811
08/06/21	-40.8299
09/06/21	-40.8080
10/06/21	-40.8438
11/06/21	-40.9100
12/06/21	-40.9598

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13/06/21	-40.9684
14/06/21	-40.9387
15/06/21	-40.8931
16/06/21	-40.8572
17/06/21	-40.8437
18/06/21	-40.8469
19/06/21	-40.8519
20/06/21	-40.8487
21/06/21	-40.8354
22/06/21	-40.8178
23/06/21	-40.8039
24/06/21	-40.7980
25/06/21	-40.7986
26/06/21	-40.8017
27/06/21	-40.8032
28/06/21	-40.8018
29/06/21	-40.7986
30/06/21	-40.7959
01/07/21	-40.7954
02/07/21	-40.7969
03/07/21	-40.7993
04/07/21	-40.8012
05/07/21	-40.8019
06/07/21	-40.8018
07/07/21	-40.8015
08/07/21	-40.8016
09/07/21	-40.8022
10/07/21	-40.8031
11/07/21	-40.8038
12/07/21	-40.8041
13/07/21	-40.8041
14/07/21	-40.8039
15/07/21	-40.8038
16/07/21	-40.8038
17/07/21	-40.8040
18/07/21	-40.8041
19/07/21	-40.8042
20/07/21	-40.8041
21/07/21	-40.8040
22/07/21	-40.8039
23/07/21	-40.8038
24/07/21	-40.8038
25/07/21	-40.8039
26/07/21	-40.8039
27/07/21	-40.8038
28/07/21	-40.8038
29/07/21	-40.8037
30/07/21	-40.8037
31/07/21	-40.8037

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 Lebanon are likely to decline to zero by early May 2021.

V. CONCLUSION AND POLICY RECOMMENDATIONS

Predictive modeling and forecasting is an essential tool in public surveillance. It acts as an early warning tool so that people can prepare resources to control epidemic incidences or disease outbreaks. Several methods have been proposed in literature, however artificial intelligence techniques and hybrid models are gaining prominence because of their high level of accuracy. In this study we apply the artificial neural network approach to predict daily COVID-19 cases in Lebanon. The results of the study indicate that COVID-19 casesare likely to decline to zero by early May 2021. Therefore the government must enforce adherence to COVID-19 public health mitigation measures including vaccination against SARS-COV2 virus.

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