Forecasting Daily Covid-19 Cases in Libya Using Artificial Neural Networks

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Abstract - **In this piece of work, the ANN approach was applied to analyze daily new COVID-19 cases in Libya. The employed data covers the period 1 January 2020 to 31 December 2020 and the out-of-sample period ranges over the period 1 January 2021 to 31 May 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting daily COVID-19 cases. The results of the study indicate that daily COVID-19 cases will generally range between 0-1700 cases over the out of sample period. Therefore we implore the government to continuously enforce WHO guidelines on prevention and control of COVID-19 to minimize loss of lives.**

Keywords: ANN, Forecasting, COVID-19.

I. INTRODUCTION

Libya is the second largest country in Africa, however the country has not been spared by the COVID-19 pandemic (Daw et al, 2020). The situation in Libya is being aggravated by the ongoing armed conflict which has made it difficult to effectively control the COVID-19 epidemic. The armed war began in 2011 and has led to death, injury and displacement of scores of people (Daw et al, 2015; Daw et al, 2019). In addition, war torn zones are usually characterized by destruction of infrastructure including health infrastructure which then makes it almost impossible to manage infectious diseases like COVID-19. Continuous fighting between rival groups will make certain areas inaccessible (Daw et al, 2020; Elhadi et al, 2020). The armed conflict has affected the geographical spread of COVD-19 in 2 ways. Firstly, it hindered access to certain populations and secondly it facilitated the spread of the epidemic to other cities (Daw et al, 2020). The armed conflicts tend to create conditions favorable for the emergence of infectious agents and fuel their spread. In such situations it is usually hard to use surveillance and response systems or mechanisms (Daw et al, 2020); Hay, 2013). The Libyan government implemented measures to control the epidemic by lock down of cities, isolation and quarantining of cases and social distancing, however the measures were inadequate because they were limited to Tripoli and Benghazi (Daw et al, 2020). In this paper we aim to model and predict daily COVID-19 cases in Libya using the artificial neural network (ANN) approach. The ANN (12, 12, 1) model is the Multilayer perceptron (MLP) where 12, 12, 1 represent the input, hidden and output nodes respectively. The 3 layers of neurons are connected by acyclic links called connection weights (Nyoni et al, 2020; Zhao et al, 2020; Arora et al, 2020; Yan et al, 2018; Kolter & Koltun, 2018; Kaushik & Sahi, 2018; Ruder, 2017; Fojnica et al, 2016; Quazi et al, 2015; Raghupathi & Raghupathi, 2015; Schmidhuber, 2014; Yan et al, 2006; Zhang, 2003; Kishan, 1997; Patterson, 1995). The results of this study are expected to reveal the future trends of daily COVID-19 cases and help in the assessment of COVID-19 mitigatory measures being implemented by the government.

II. LITERATURE REVIEW

Table 1: Literature Review

Author(s)	Study period	Method	Findings
Alemneh & Tilahun (2020)	March – June, 2020	SEIR Model	An integrated strategy effective in controlling the epidemic must apply all control strategies within a short period of time
Khan et al. (2020)	February – May, 2020	VAR model	The maximum number of new daily cases for Pakistan will be 5363 per day on July 3, 2020
Maru et al (2020)	March – September, 2020	Logistic Regression Model	Having diabetes mellitus, fever and shortness of breath are significant

			predictors of death in severe COVID-19 patients
Nyoni et al (2020)	13 March 2020 to 31 October 2020	ANN model	Daily new COVID-19 cases in Ethiopia are likely to continue declining over the period November 2020 to April 2021.

III. METHODOLOGY

The Artificial Neural Network (ANN) will be applied in this study. It has the capability of learning from any data-set to describe the nonlinear and interaction effects with great accuracy. Arguably, explicit guidelines exist for the determination of the ANN structure hence the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function.

Data Issues

This study is based on daily new cases of COVID-19 in Libya for the period 1 January – 31 December 2020. The out-of-sample forecast covers the period January 2021 – May 2021. All the data employed in this paper was gathered from the World Bank.

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 2: ANN model summary

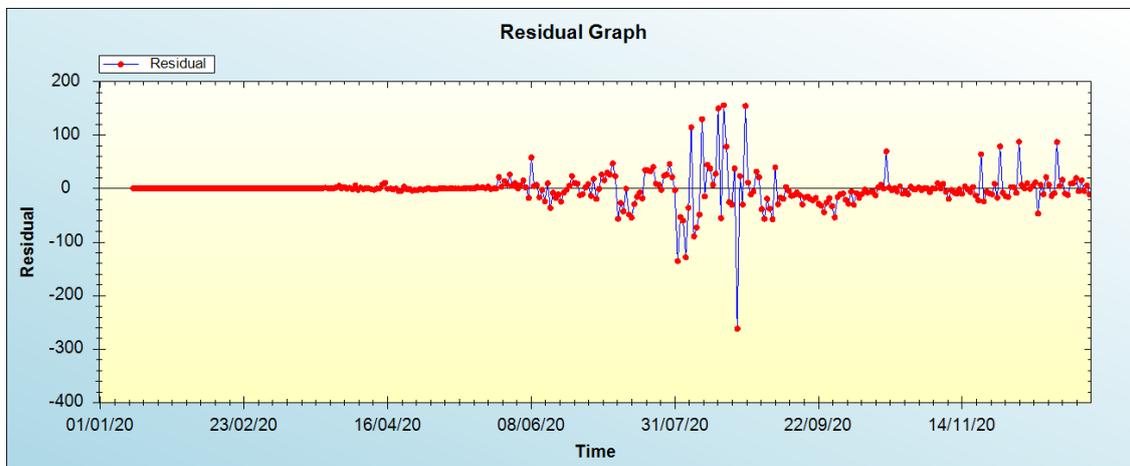| Variable	N
Observations	354 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.226800
MSE	995.602021
MAE	15.118602

Residual Analysis for the Applied Model

Figure 1: Residual analysis
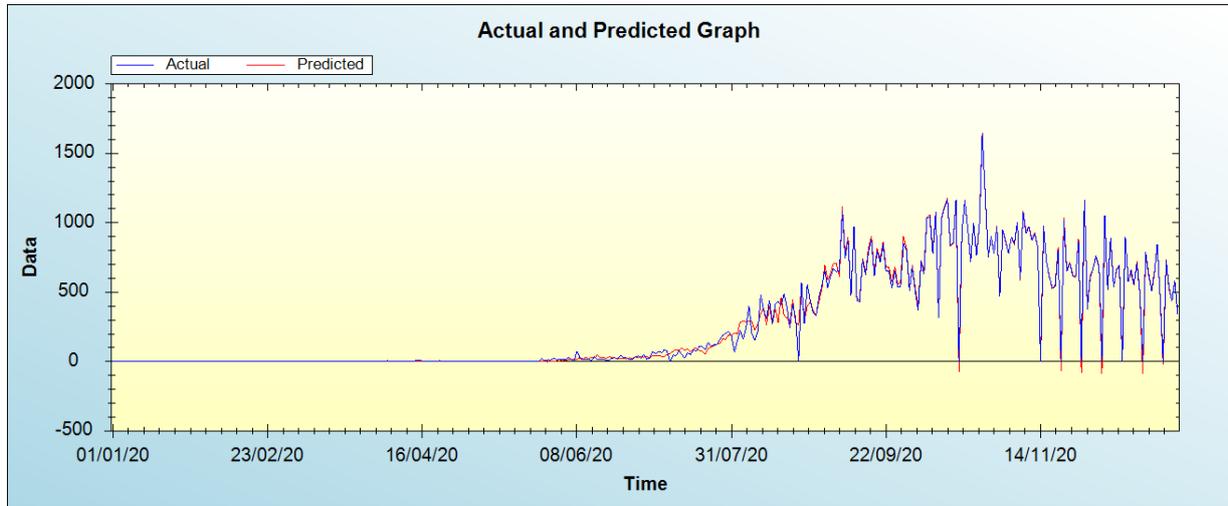
In-sample Forecast for N

Figure 2: In-sample forecast for the N series

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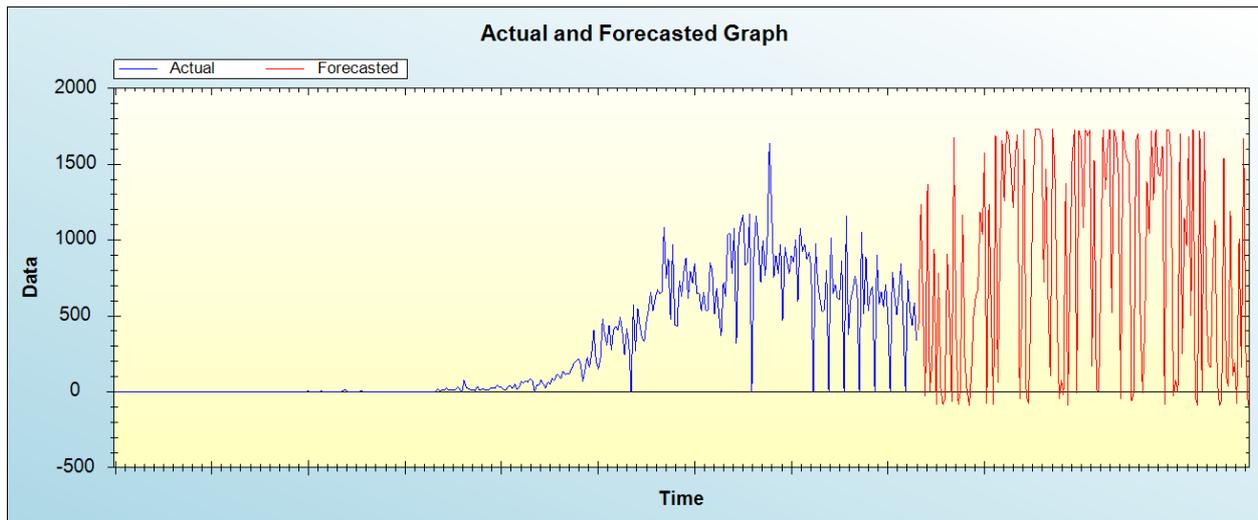

Figure 3: Out-of-sample forecast for N: actual and forecasted graph

Out-of-Sample Forecast for N: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasted Daily COVID-19 cases
01/01/21	404.6468
02/01/21	1233.7343
03/01/21	568.8265
04/01/21	-28.5343
05/01/21	1365.5917
06/01/21	3.3528
07/01/21	179.8078

08/01/21	937.8037
09/01/21	-85.2860
10/01/21	780.8554
11/01/21	35.9729
12/01/21	-83.3657
13/01/21	-45.1819
14/01/21	907.4525
15/01/21	507.8117
16/01/21	-63.1130
17/01/21	1673.3551
18/01/21	385.2336
19/01/21	-85.9418
20/01/21	5.7030
21/01/21	1165.4789
22/01/21	232.4160
23/01/21	6.7495
24/01/21	-87.1743
25/01/21	128.3441
26/01/21	512.9535
27/01/21	635.5650
28/01/21	677.2894
29/01/21	1184.4440
30/01/21	1037.3076
31/01/21	1572.0261
01/02/21	-77.1776
02/02/21	1234.9332
03/02/21	500.0332
04/02/21	-82.3788
05/02/21	1689.8481
06/02/21	61.5930
07/02/21	921.6750
08/02/21	1658.4483
09/02/21	1253.8306

10/02/21	1721.1857
11/02/21	1687.5859
12/02/21	1473.7550
13/02/21	1215.1506
14/02/21	1577.9003
15/02/21	1695.8433
16/02/21	-46.5264
17/02/21	541.1912
18/02/21	1728.3739
19/02/21	-29.3823
20/02/21	-73.1598
21/02/21	471.8941
22/02/21	1298.3587
23/02/21	1729.5398
24/02/21	1729.8805
25/02/21	1729.2067
26/02/21	1662.3480
27/02/21	723.1452
28/02/21	1469.7999
01/03/21	626.3302
02/03/21	105.2227
03/03/21	1728.5791
04/03/21	1481.9507
05/03/21	560.6483
06/03/21	-45.2657
07/03/21	77.7092
08/03/21	-18.9500
09/03/21	1375.4542
10/03/21	-88.6766
11/03/21	864.2176
12/03/21	1537.6963
13/03/21	1727.4121
14/03/21	-4.3164

15/03/21	1721.8510
16/03/21	1652.4832
17/03/21	1081.5522
18/03/21	1725.5036
19/03/21	1687.4298
20/03/21	1724.9277
21/03/21	169.7712
22/03/21	1524.3816
23/03/21	9.6041
24/03/21	9.0351
25/03/21	806.9194
26/03/21	1728.5068
27/03/21	1331.9032
28/03/21	1588.9302
29/03/21	1729.0914
30/03/21	520.9535
31/03/21	1727.8155
01/04/21	1651.1157
02/04/21	1429.4103
03/04/21	-46.2666
04/04/21	1728.1405
05/04/21	1589.5207
06/04/21	1527.2623
07/04/21	1500.4945
08/04/21	-60.4696
09/04/21	-3.4559
10/04/21	1653.7069
11/04/21	1703.8035
12/04/21	441.0267
13/04/21	-5.6896
14/04/21	453.1079
15/04/21	1390.5452
16/04/21	1040.5690

17/04/21	1717.2786
18/04/21	1261.8611
19/04/21	1729.6081
20/04/21	1431.6372
21/04/21	1418.4962
22/04/21	1619.1197
23/04/21	-82.3298
24/04/21	1724.7875
25/04/21	1727.0687
26/04/21	1542.3640
27/04/21	-27.6165
28/04/21	77.1301
29/04/21	-2.0914
30/04/21	1702.9221
01/05/21	250.6472
02/05/21	1149.0679
03/05/21	963.3258
04/05/21	1680.3944
05/05/21	503.7605
06/05/21	1729.9693
07/05/21	-32.5937
08/05/21	-88.7066
09/05/21	1719.9142
10/05/21	2.8742
11/05/21	1713.7071
12/05/21	585.8384
13/05/21	178.8324
14/05/21	160.7458
15/05/21	834.0650
16/05/21	1130.2292
17/05/21	85.1305
18/05/21	-90.0742
19/05/21	-49.8517

20/05/21	1537.6213
21/05/21	103.9673
22/05/21	38.9388
23/05/21	1193.1744
24/05/21	103.0209
25/05/21	188.7232
26/05/21	-74.6553
27/05/21	1011.6406
28/05/21	164.4001
29/05/21	1667.7678
30/05/21	258.4105
31/05/21	-88.6290

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 will generally range between 0-1700 cases over the out of sample period.

V. CONCLUSION & RECOMMENDATIONS

Libya is one of the African countries which is deeply politically divided and is witnessing an armed conflict which seems not to have any promises of a ceasefire. Its health system is fast deteriorating aggravated by the destructive war making the situation unbearable for the ordinary citizens. The emergence of the COVID-19 pandemic has increased the vulnerability of its citizens especially the elderly, chronically ill and disabled persons. Emergency relief has been difficult to execute due to inaccessibility of certain regions. The results of this study revealed that daily COVID-19 cases will generally range between 0-1700 cases over the out of sample period. Therefore the government should continuously educate its citizens through mass media communication to adhere to the WHO guidelines on prevention and control of COVID-19.

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