PREDICTION OF DAILY NEW CASES OF COVID-19 IN IRAQ USING ARTIFICIAL NEURAL NETWORKS

*Dr. Smartson. P. NYONI[1], Thabani NYONI[2], Tatenda. A. CHIHOHO[3]

[1]*ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe*
[2]*Department of Economics, University of Zimbabwe, Harare, Zimbabwe*
[3]*Department of Economics, University of Zimbabwe, Harare, Zimbabwe*
Corresponding Author

ABSTRACT

In this research article, the ANN approach was applied to analyze daily newCOVID-19 cases in Iraq. The employed data covers the period 24February 2020 to 31 October2020 and the out-of-sample period ranges over the period November 2020 to April 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting daily new COVID-19 cases in Iraq. The results of the study indicate that the projected number of daily new COVID-19 cases will generally be around 4500 cases per day throughout the out of sample period. If an effective vaccine is availed during the out of sample period it will act as a positive shock thus bringing down the daily new cases significantly. Therefore, the government of Iraq should continue enforcing WHO guidelines on prevention and control of COVID-19 to avoid spiking of cases beyond 4500 cases per day.

Keywords: - *ANN, COVID-19, Forecasting*

INTRODUCTION

Iraq is one of the countries in the World that has been affected by coronavirus disease (COVID-19). The virus which is previously known to infect birds and mammals slipped into humans .The first cases of the virus were reported in Wuhan ,China in December 2019 before rapidly spreading to the whole world (Kahn et al, 2020; Guo et al, 2020; Chan et al, 2020; Chowell et al, 2020; Unhale et al, 2020; Emmanuel et al, 2020). The first case of COVID-19 was reported on 24 February 2020 in Najaf before spreading to the other parts of Iraq (WHO, 2020). The number of COVID-19 deaths in Iraq is low as the proportion of elderly people who are at a greater risk of developing severe clinical disease is regarded as small in the demographics of Iraq (Jebril, 2020). By July 21,2020 Iraq had reported 97003 infections ,62836 recoveries and 3969deaths from COVID-19 (Hussen, 2020). Iraq's health system has faced many challenges including the world's biggest displacement in 2014-16 and internal conflict few years ago, all these having a negative impact on the health delivery system(Al-Jumaili & Hamed, 2020).The Republic of Iraq responded to the epidemic by boycotting gathering places,lockdown,closure of schools, social distancing and mass quarantine to reduce morbidity rate of COVID-19.The epidemic had many undesirable effects on Iraq including fall in GDP to 9.7% and least 22.5% are below the poverty line (Wang & Xing, 2020). Not so many empirical studies have been done in Iraq to model and

forecast COVID-19 cases. One of the few studies was done by Hussen etal (2020).The research focused on forecasting COVID-19 cases in Kurdistan Region using some statistical models that is the ARIMA and the exponential smoothing models. The study findings indicated that both ARIMA and exponential smoothing models were close to each other for predicting the COVID-19 infected cases in the Kurdistan Region provinces and the models show that the pandemic might not be under control unless people apply government instructions for health care and keep social distances. In this paper the researchers applied the ANN model (MLP) with a single hidden layer and the activation function being the hyperbolic tangent function. The results of this piece of work will inform the Republic of Iraq about the dynamics of COVID-19 epidemic and to assess the impact of the COVID-19 mitigatory measures implemented by the government.

METHOD

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID-19 infections in Iraq. This study specifically applies the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function. This research is based on daily new COVID-19 cases (referred to as W series in this study) for all age groups in Iraq. The data covers the period 24 February 2020 to 31October 2020 while the out-of-sample forecast covers the period November 2020 to April 2021. All the data employed in this paper was gathered from the COVID-19 data repository prepared by the CSSE at JH University.

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
1883.0	2022.0	0.00000	5055.0
Std. Dev.	C.V.	Skewness	Ex. Kurtosis
1702.0	0.90390	0.20743	-1.4998
5% Perc.	95% Perc.	IQ range	Missing obs.
6.0000	4536.4	3462.0	0

ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN IRAQ

Table 2: ANN model summary

Variable	W
Observations	239 (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

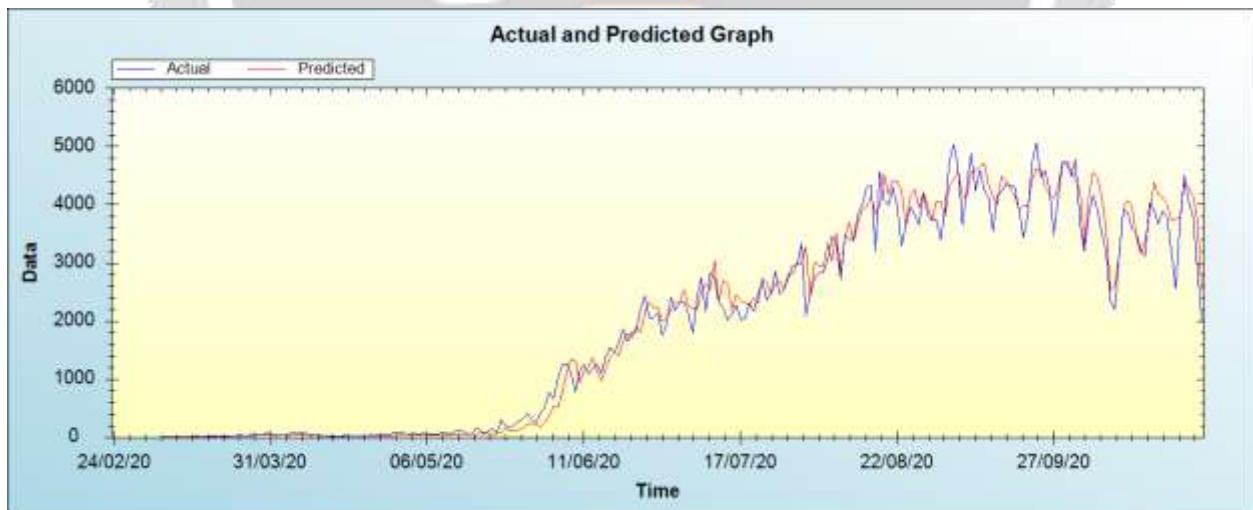| Criteria:	
Error	0.097365
MSE	74765.863547
MAE	180.051076

Residual Analysis for the ANN model
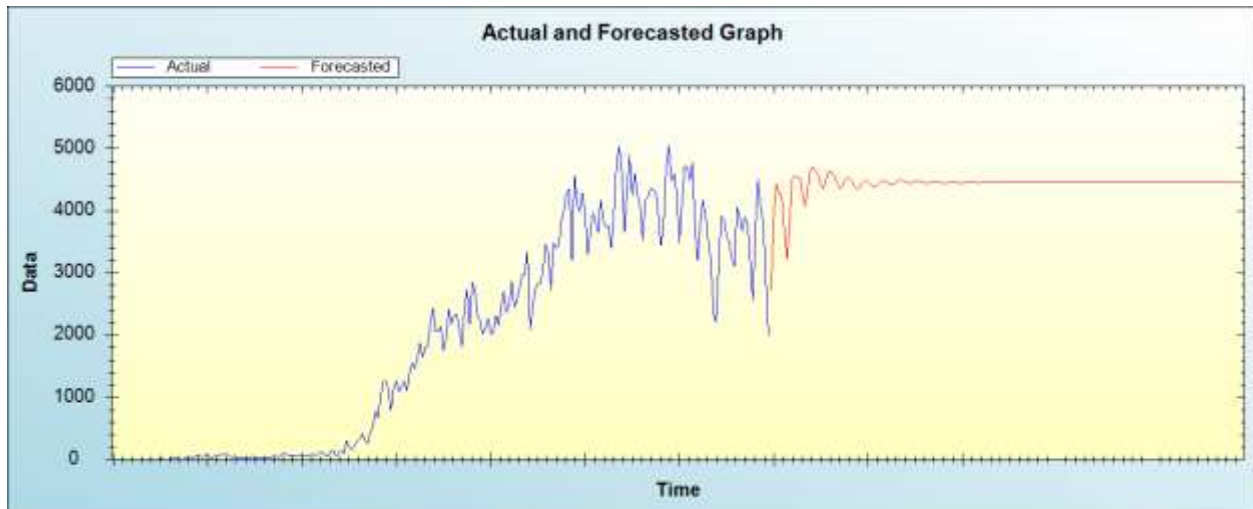
Figure 1: Residual analysis
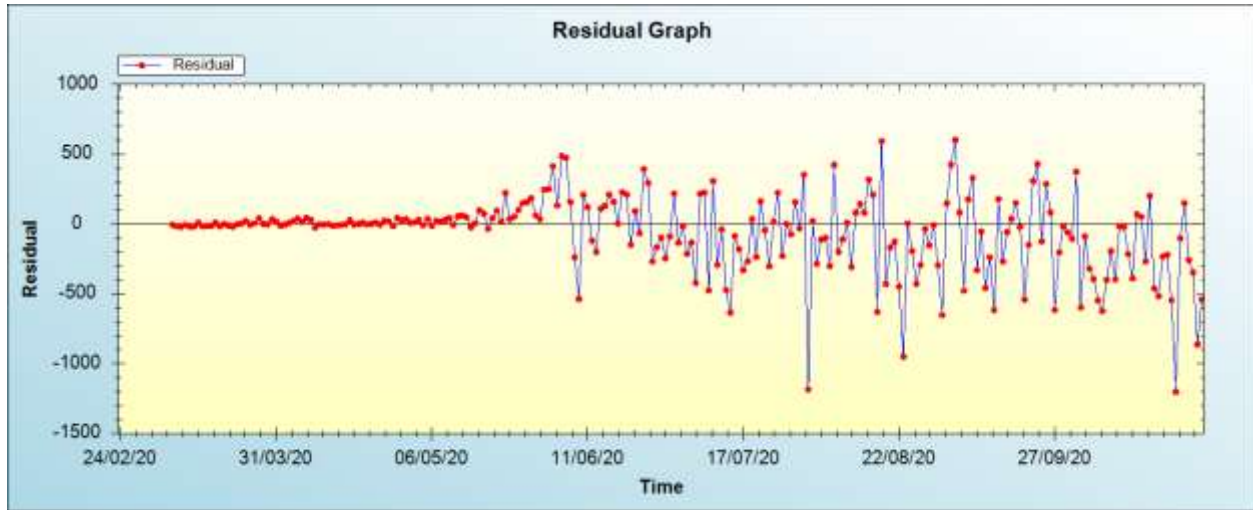
In-sample Forecast for W

Figure 2: In-sample forecast for the W series

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

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

Out-of-Sample Forecast for W: Forecasts only

Table 3: Forecasts

Day/Month/Year	Forecasted daily new COVID-19 cases
01/11/20	2722.6213
02/11/20	3929.9202
03/11/20	4429.6534
04/11/20	4284.7359
05/11/20	4257.0963
06/11/20	3710.5241
07/11/20	3228.2273
08/11/20	3771.2643
09/11/20	4504.2664
10/11/20	4565.6908
11/11/20	4536.2748
12/11/20	4542.1613
13/11/20	4262.4464
14/11/20	4060.9144
15/11/20	4362.1682

16/11/20	4659.2439
17/11/20	4705.7140
18/11/20	4635.2366
19/11/20	4588.7824
20/11/20	4404.3567
21/11/20	4355.2138
22/11/20	4515.3989
23/11/20	4636.0836
24/11/20	4623.2964
25/11/20	4566.3475
26/11/20	4472.5411
27/11/20	4370.2156
28/11/20	4380.5654
29/11/20	4481.5869
30/11/20	4537.6237
01/12/20	4515.9117
02/12/20	4457.3470
03/12/20	4383.6511
04/12/20	4345.5152
05/12/20	4390.3841
06/12/20	4462.2038
07/12/20	4489.9353
08/12/20	4467.6885
09/12/20	4424.0271
10/12/20	4385.8865
11/12/20	4389.3363

12/12/20	4435.7592
13/12/20	4479.1387
14/12/20	4487.1339
15/12/20	4466.8942
16/12/20	4438.3130
17/12/20	4423.6470
18/12/20	4438.3895
19/12/20	4469.4991
20/12/20	4488.8869
21/12/20	4485.2142
22/12/20	4466.7688
23/12/20	4448.3551
24/12/20	4444.2256
25/12/20	4457.4220
26/12/20	4474.3865
27/12/20	4480.0383
28/12/20	4471.7183
29/12/20	4457.0647
30/12/20	4446.7689
31/12/20	4448.0654
01/01/21	4458.2163
02/01/21	4466.9372
03/01/21	4466.8863
04/01/21	4459.0385
05/01/21	4449.8301
06/01/21	4446.1082

07/01/21	4450.1653
08/01/21	4457.6818
09/01/21	4462.0126
10/01/21	4460.2492
11/01/21	4454.6724
12/01/21	4450.0937
13/01/21	4450.1573
14/01/21	4454.5408
15/01/21	4459.4006
16/01/21	4461.0270
17/01/21	4458.8331
18/01/21	4455.2101
19/01/21	4453.3171
20/01/21	4454.6409
21/01/21	4457.9145
22/01/21	4460.4063
23/01/21	4460.3574
24/01/21	4458.2153
25/01/21	4455.9423
26/01/21	4455.3514
27/01/21	4456.7218
28/01/21	4458.7116
29/01/21	4459.6330
30/01/21	4458.8589
31/01/21	4457.1561
01/02/21	4455.9072

02/02/21	4455.9820
03/02/21	4457.1071
04/02/21	4458.2062
05/02/21	4458.3641
06/02/21	4457.5312
07/02/21	4456.4419
08/02/21	4455.9484
09/02/21	4456.3448
10/02/21	4457.1940
11/02/21	4457.7596
12/02/21	4457.6289
13/02/21	4456.9935
14/02/21	4456.4195
15/02/21	4456.3612
16/02/21	4456.8164
17/02/21	4457.3791
18/02/21	4457.6096
19/02/21	4457.3853
20/02/21	4456.9550
21/02/21	4456.6970
22/02/21	4456.8079
23/02/21	4457.1683
24/02/21	4457.4743
25/02/21	4457.5005
26/02/21	4457.2673
27/02/21	4456.9939

28/02/21	4456.9023
01/03/21	4457.0432
02/03/21	4457.2764
03/03/21	4457.4048
04/03/21	4457.3372
05/03/21	4457.1469
06/03/21	4456.9938
07/03/21	4456.9891
08/03/21	4457.1137
09/03/21	4457.2491
10/03/21	4457.2831
11/03/21	4457.1977
12/03/21	4457.0711
13/03/21	4457.0051
14/03/21	4457.0420
15/03/21	4457.1386
16/03/21	4457.2105
17/03/21	4457.2037
18/03/21	4457.1332
19/03/21	4457.0625
20/03/21	4457.0480
21/03/21	4457.0951
22/03/21	4457.1605
23/03/21	4457.1917
24/03/21	4457.1698
25/03/21	4457.1198

26/03/21	4457.0857
27/03/21	4457.0936
28/03/21	4457.1332
29/03/21	4457.1704
30/03/21	4457.1770
31/03/21	4457.1521
01/04/21	4457.1196
02/04/21	4457.1062
03/04/21	4457.1202
04/04/21	4457.1472
05/04/21	4457.1643
06/04/21	4457.1590
07/04/21	4457.1379
08/04/21	4457.1193
09/04/21	4457.1170
10/04/21	4457.1306
11/04/21	4457.1470
12/04/21	4457.1526
13/04/21	4457.1440
14/04/21	4457.1295
15/04/21	4457.1208
16/04/21	4457.1240
17/04/21	4457.1349
18/04/21	4457.1439
19/04/21	4457.1441
20/04/21	4457.1364

21/04/21	4457.1278
22/04/21	4457.1253
23/04/21	4457.1301
24/04/21	4457.1376
25/04/21	4457.1418
26/04/21	4457.1398
27/04/21	4457.1340
28/04/21	4457.1297
29/04/21	4457.1300
30/04/21	4457.1343

Figure 1 shows that over the study period the minimum and maximum number of daily new COVID-19 cases are 0 and 505 respectively. The average daily new cases are 1883 cases. The data is positively skewed with a kurtosis of -1.4998; meaning that the data is not normally distributed. The model simulates and predicts the observed data very well as clearly illustrated in figures 2 and, and table 3, respectively. The residual graph and model evaluation criteria indicate that the applied model is stable and suitable for forecasting new daily cases of COVID-19 in Iraq. The projected daily new COVID-19 cases are expected to be generally around 4500 cases per day (at equilibrium) in the out-of sample period.

CONCLUSION & RECOMMENDATIONS

Iraq is still battling with COVID-19 epidemic. Our findings indicate that the projected number of daily new COVID-19 cases will be generally around 4500 cases per day in the out of sample period. This means that the social distancing measures have played a significant effect in controlling the epidemic; however the government of Iraq should continuously enforce recommended WHO guidelines on prevention and control of COVID-19 to avoid spikes of new cases beyond 4500. COVID-19 cases are expected to drop significantly if an effective vaccine is availed during the out of sample period.

REFERENCES

[1] Chen et al (2020). Emerging coronaviruses: genome structure, replication, and pathogenesis. Journal of medical virology, 92,4, 418-423.

[2] COVID-19 Repository By the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University.

[3] Dong, E., *et al*. (2020). An Interactive Web-based Dashboard to Track COVID-19 in Real Time, *Lancet Infectious Diseases*, 20 (5): 533 – 534.

[4]   Chowell et al (2015). Transmission characteristics of MERS and SARS in the healthcare setting: a comparative study. BMC medicine, 13,1, 210.

[5]   Emanuel et al (2020). Fair allocation of scarce medical resources in the time of Covid-19.

[6]   Guo etal (2020). The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak–an update on the status. Military Medical Research, 7,1, 1-10.

[7]   Hadi &Hamed (2020). Coronavirus Disease-19: Outbreaks in Iraq pp 1-13.

[8]   Hussen.S.H (2020) Forecasting of COVID-19 Cases in Kurdistan Region Using Some Statistical Models. Academic Journal of Applied Mathematical Sciences Academic Research Publishing Group   6, 8, 172-180.

[9]   Jebril, N, 2020c. Distinguishing Epidemiological Curve of Novel Coronavirus Disease (COVID-19) Cases in Iraq: How It Does Not Follow the Epidemic Curve of China. Available   at   SSRN: https://ssrn.com/abstract=3571889   or http://dx.doi.org/10.2139/ssrn.3571889

[10]   Kahn et al (2005). History and recent advances in coronavirus discovery. The Pediatric infectious disease journal, 24,11, S223-S227.

[11]   Unhale et al (2020). A REVIEW ON CORONA VIRUS (COVID-19). International Journal of Pharmaceutical and Life Sciences.109-115

[12]   Wang, V. X., & Xing, B. B. (2020). Talk about the Coronavirus Pandemic: Initial Evidence from Corporate Disclosures. Available at SSRN 3585951.

[13]   World Health Organization (2020). Coronavirus disease 2019 (COVID-19) Situation Report-36, February 25, 2020. World Health Organization Geneva. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200225-sitrep-36

[14]   Wu et al (2020). Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72314 cases from the Chinese Center for Disease Control and Prevention. JAMA.