Forecasting Covid-19 Mortality in Iraq

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Abstract - **In this study, the ANN approach was applied to analyze COVID-19 mortality in Iraq. The employed data covers the period1 January 2020 to 20 April 2021 and the out-of-sample period ranges over the period21 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 daily COVID-19 mortality cases in Iraq are likely to decline over the out-of-sample period and reach zero around early May 2021. Therefore there is need for the government of Iraq to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic and scaling up COVID-19 vaccination.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The prediction of the evolution of viral infections is a complex task where many real data sets consist of different variables to be employed (Yahya et al, 2021).The COVID-19 pandemic began in Wuhan city of China in December 2019 and spread very fast to many parts of the world (Lai et al, 2020). The pandemic has severely impacted the lives of many people both in developing and developed countries. Therefore prediction of COVID-19 cases and deaths is very crucial as the results will provide an insight of the future trends of cases and mortality, and facilitate planning and allocation of adequate resources for COVID-19 response (Nyoni et al, 2020). Artificial intelligence (AI) has been proven in previous studies that it has high forecasting accuracy and capable to model complex nonlinear data (Yahya et al, 2021). AI is a branch of computer science that uses computer programs (Algorithms) to recognize patterns and analyze data (He et al, 2019; Wang et al, 2019). AI techniques play a big role in decision making in public health and other fields because they can be used in classification, regression, pattern recognition and prediction problems (Steimer et al, 2020). The application of AI will enable strategic decisions to be made in real time in order to minimize the effect of the COVID-19 epidemic (Yahya et al, 2021).Artificial neural networks (ANNs) are widely used AI techniques in the field of medicine. In this study we applied the multilayer perceptron neural network, ANN (12, 12, 1) to predict daily COVID-19 deaths in the state of Iraq. The findings of this paper will reveal the likely future trends of COVID-19 mortality and facilitate adequate resource mobilization for the COVID-19 response.

II. LITERATURE REVIEW

Oliveira & Moral (2021) proposed a new modelling framework to describe the pandemic's course with great accuracy and provide short-term daily forecasts for every country in the world. The authors presented forecasts and made all results freely available to any country in the world through an online Shiny dashboard. Their work showed that the model generates highly accurate forecasts up to seven days ahead and use estimated model components to cluster countries based on recent events. Ibrahim & Najafi (2020)investigated the spread of the coronavirus disease 2019 (COVID-19) in Iraq and Egypt by using compartmental, logistic regression, and Gaussian models. They developed a generalized SEIR model for the spread of COVID-19, taking into account mildly and symptomatically infected individuals. The logistic and Gaussian models were utilized to forecast and predict the numbers of confirmed cases in both countries. They estimated the parameters that best fit the incidence data. The results provided discouraging forecasts for Iraq from 22 February to 8 October 2020 and for Egypt from 15 February to 8 October 2020. The study concluded thatthe most effective way to prevent COVID-19 cases is by decreasing the transmission rate. A review and brief analysis of the most important machine learning forecasting models against COVID-19was performed by Rahimi et al (2020). A detailed scientometric analysis was performed on COVID-19 data from the Scopus and Web of Science databases. The study revealed that among the epidemic models, deep learning, SIR, and SEIR are the top models that were used by researchers and Hybrid algorithms are used to enhance the power of forecasting approaches. A model consisting of three artificial neural networks' (ANN) functions was developed by Yahya et al (2021) to predict COVID19 separation in Iraq based on real infection data supplied by the public health department at the Iraqi Ministry of Health. The performance efficiency of this model

was evaluated, where its performance efficiency reached 81.6% when employed four statistical error criteria as mean absolute percentage error (MAPE), root mean square error (RMSE), coefficient of determination (R2), and Nash-Sutcliffe coefficient (NC). The severity of the virus's spread across Iraq was assessed in a short term (in the next 6 months), where the results showed that the spread severity will intensify in this short term by 17.1%, and the average death cases will increase by 8.3%.

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 COVID-19 mortality cases Iraq.

Data Issues

This study is based on daily COVID-19 mortality cases in Iraq 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).

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	IQ
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	0.114632
MSE	60.364650
MAE	5.491715

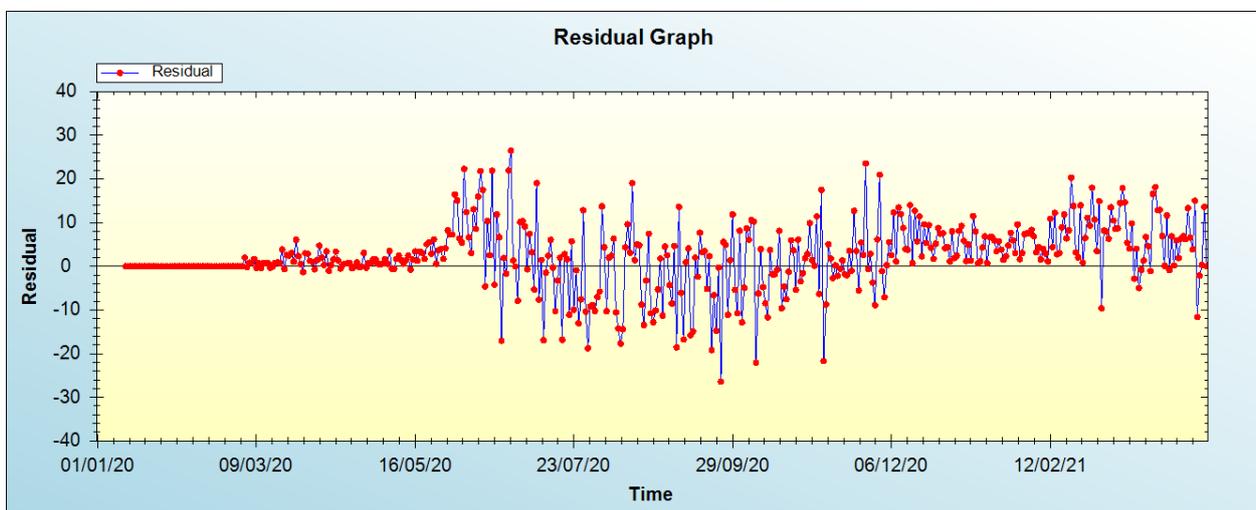*Residual Analysis for the Applied Model*

Figure 1: Residual analysis
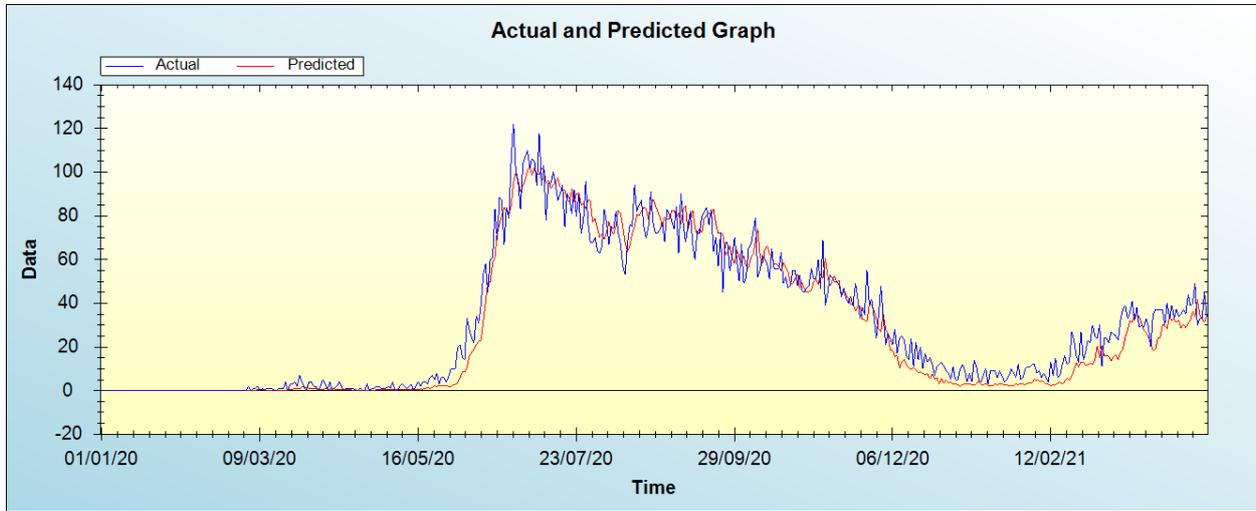
In-sample Forecast for IQ

Figure 2: In-sample forecast for the IQ series

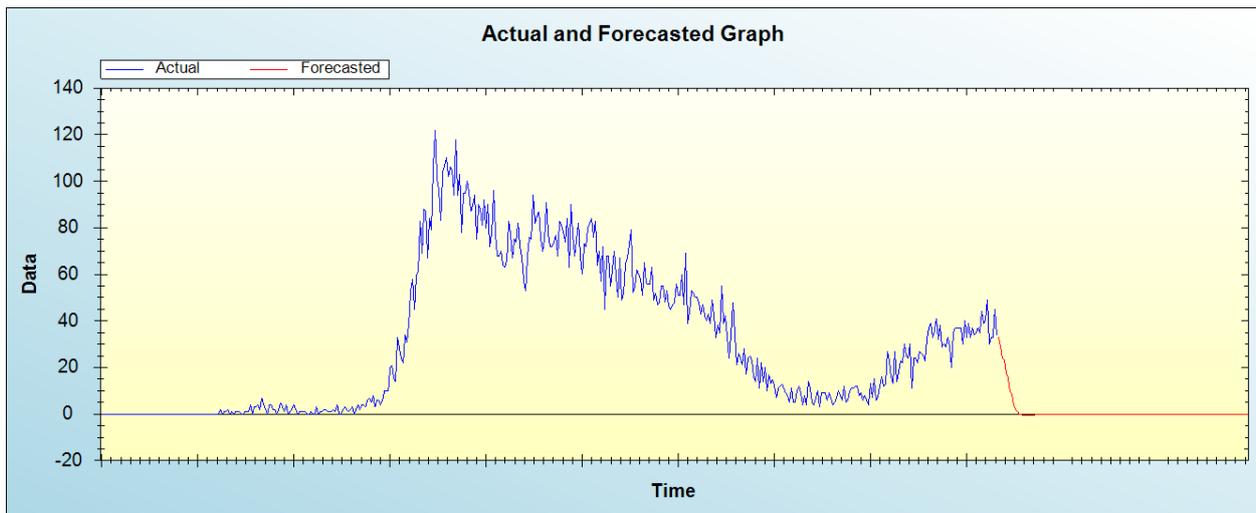*Out-of-Sample Forecast for IQ: Actual and Forecasted Graph*

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

Out-of-Sample Forecast for IQ: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Date	Forecasts
21/04/21	32.8426
22/04/21	29.2562
23/04/21	23.9130
24/04/21	23.2941
25/04/21	17.6797
26/04/21	15.6753
27/04/21	9.7464
28/04/21	8.6654
29/04/21	3.9281
30/04/21	2.2535
01/05/21	1.0530
02/05/21	0.0490
03/05/21	-0.1747

04/05/21	-0.6290
05/05/21	-0.5550
06/05/21	-0.7502
07/05/21	-0.5841
08/05/21	-0.5592
09/05/21	-0.4276
10/05/21	-0.3709
11/05/21	-0.2510
12/05/21	-0.1625
13/05/21	-0.1127
14/05/21	-0.0461
15/05/21	-0.0229
16/05/21	0.0157
17/05/21	0.0218
18/05/21	0.0417
19/05/21	0.0420
20/05/21	0.0453
21/05/21	0.0435
22/05/21	0.0420
23/05/21	0.0392
24/05/21	0.0348
25/05/21	0.0331
26/05/21	0.0294
27/05/21	0.0280
28/05/21	0.0256
29/05/21	0.0248
30/05/21	0.0235
31/05/21	0.0230
01/06/21	0.0226
02/06/21	0.0223
03/06/21	0.0223
04/06/21	0.0222
05/06/21	0.0224
06/06/21	0.0224
07/06/21	0.0225
08/06/21	0.0226
09/06/21	0.0227
10/06/21	0.0228
11/06/21	0.0228
12/06/21	0.0229
13/06/21	0.0229
14/06/21	0.0229
15/06/21	0.0229
16/06/21	0.0230
17/06/21	0.0230
18/06/21	0.0230
19/06/21	0.0230
20/06/21	0.0230
21/06/21	0.0230
22/06/21	0.0230
23/06/21	0.0230
24/06/21	0.0229
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30/06/21	0.0229
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31/07/21	0.0229
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29/08/21	0.0229
30/08/21	0.0229
31/08/21	0.0229

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 mortality cases in Iraq are likely to decline over the out-of-sample period and reach zero around early May 2021. The findings also imply that, from May onwards, the country will rarely experience any COVID-19 related deaths.

V. CONCLUSION AND POLICY RECOMMENDATIONS

Iraq is one of the Middle East countries bordered by Iran, Kuwait, Saudi Arabia, Jordan, Syria, Turkey and the Arab Gulf. It has a population size of about 40,278,833 people based on the latest update of the United Nations database (Yahya et al, 2021). According to Iraq Ministry of Health, a total of 38,000 confirmed cases were reported in Iraq from February 25, 2020, to July 15, 2020. The study predicts COVID-19 mortality in Iraq using an artificial intelligence technique. The results of the study indicate that daily COVID-19 mortality cases in Iraq are likely to decline over the out-of-sample period and reach zero around early May 2021. Therefore we encourage authorities in Iraq to scale up covid-19 vaccination amongst are measures recommended by WHO.

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