Forecasting Covid-19 Deaths in the State of Kuwait

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Abstract - **In this study, the ANN approach was applied to analyze COVID-19 deaths in Kuwait. The employed data covers the period 1 January 2020 to 20 April 2021 and the out-of-sample period ranges over the period 21 April 2021 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 deaths in Kuwait are likely to decline significantly over the out-of-sample period. Around mid-May 2021 onwards no COVID-19 related mortality may be recorded in the country. Therefore there is need for the State of Kuwait to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic and to scale up COVID-19 vaccination.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The ravaging effects of the COVID-19 crisis continues to be felt in every corner of the earth. The negative consequences are on health, society and economy. The state of Kuwait like other countries in the region, is also experiencing the problems brought by the deadly pandemic. As of 18 June 2021 the country had recorded 334 216 confirmed cases, 1842 deaths and 315 645 recoveries (Worldometer, 2021). By the 13th of June 2021, a total of 2 875 000 people had received at least one dose of the COVID-19 vaccine (68.3 % of the population) and 38 000 people had been fully vaccinated representing 0.9 % of the population (our world in data, 2021). Kuwait has a population size of about 4.2 million and the country reported its first 5 cases of COVID-19 on the 24th of February 2020 (Macro trends, 2020). The state responded to the COVID-19 health crisis by implementing travel restrictions, temporary closure of schools, universities and non-essential businesses to prevent the spread of COVID-19 (Almeshal et al, 2020). In this paper we applied an artificial intelligence method to predict daily COVID-19 deaths in the State of Kuwait. The results of this paper are expected to highlight the likely future trends of COVID-19 mortality in the country and trigger an evidence based approach to tackling the COVID-19 epidemic.

II. 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 deaths in Kuwait.

Data Issues

This study is based on daily COVID-19 deaths in Kuwait 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).

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	K
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	0.186229
MSE	2.097991
MAE	0.999310

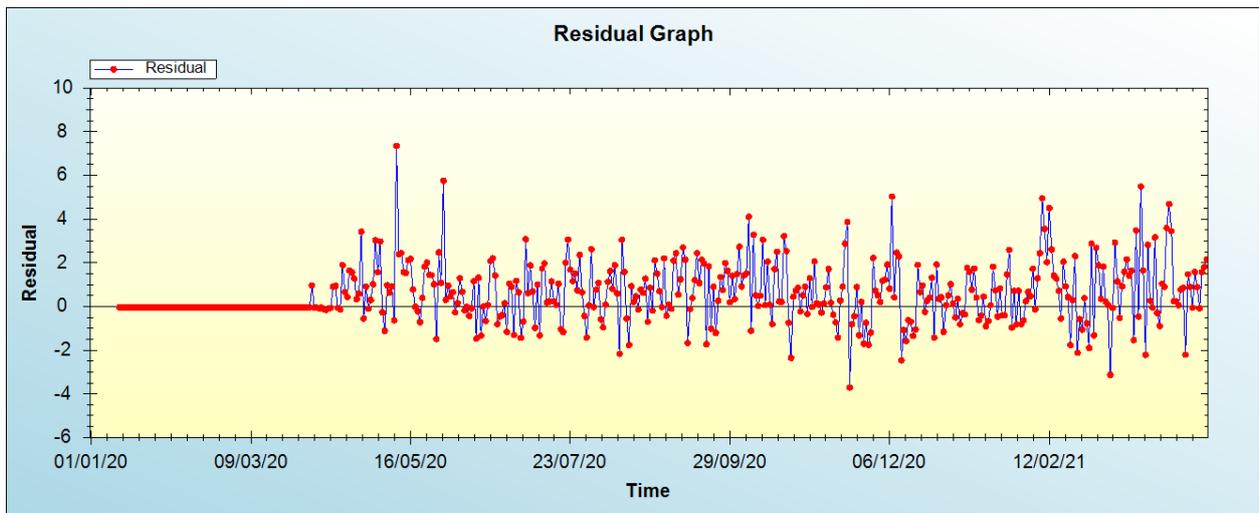*Residual Analysis for the Applied Model*

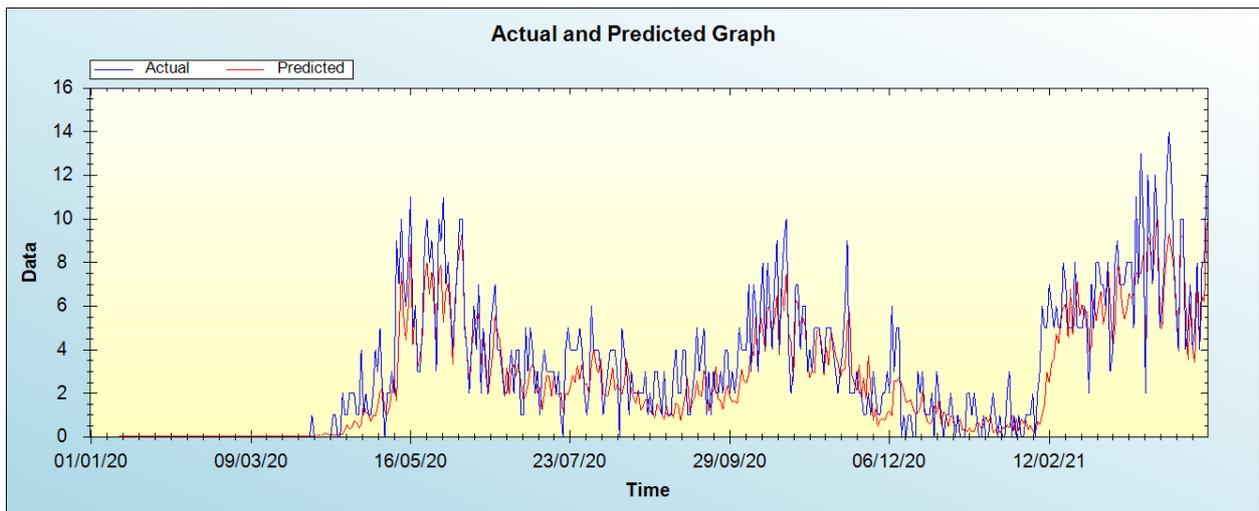**Figure 1: Residual analysis**

In-sample Forecast for K

Figure 2: In-sample forecast for the K series

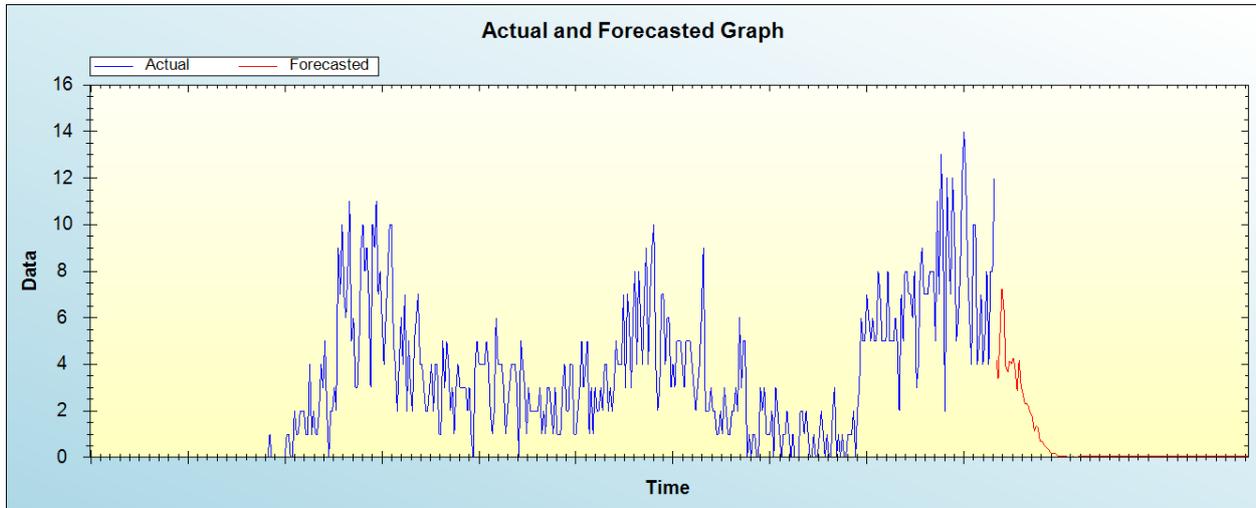*Out-of-Sample Forecast for K: Actual and Forecasted Graph*

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

Out-of-Sample Forecast for K: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Date	Forecasts
21/04/21	4.1872
22/04/21	3.3844
23/04/21	5.3459
24/04/21	7.2525
25/04/21	6.3321
26/04/21	3.8695
27/04/21	3.6800
28/04/21	4.1569
29/04/21	4.0166
30/04/21	4.2660
01/05/21	3.7439
02/05/21	2.8682
03/05/21	4.1913
04/05/21	3.0814
05/05/21	2.7581
06/05/21	2.3176
07/05/21	2.3184
08/05/21	2.1756
09/05/21	1.8835
10/05/21	1.7404
11/05/21	1.1472
12/05/21	1.3538
13/05/21	1.2801
14/05/21	0.6889
15/05/21	0.7164
16/05/21	0.5757
17/05/21	0.4466
18/05/21	0.3751
19/05/21	0.2829
20/05/21	0.1774
21/05/21	0.1586
22/05/21	0.1663
23/05/21	0.0814
24/05/21	0.0571
25/05/21	0.0707
26/05/21	0.0416
27/05/21	0.0400

28/05/21	0.0375
29/05/21	0.0290
30/05/21	0.0324
31/05/21	0.0371
01/06/21	0.0338
02/06/21	0.0332
03/06/21	0.0380
04/06/21	0.0393
05/06/21	0.0395
06/06/21	0.0414
07/06/21	0.0419
08/06/21	0.0427
09/06/21	0.0439
10/06/21	0.0439
11/06/21	0.0439
12/06/21	0.0445
13/06/21	0.0448
14/06/21	0.0446
15/06/21	0.0447
16/06/21	0.0447
17/06/21	0.0447
18/06/21	0.0447
19/06/21	0.0446
20/06/21	0.0445
21/06/21	0.0445
22/06/21	0.0445
23/06/21	0.0445
24/06/21	0.0445
25/06/21	0.0444
26/06/21	0.0444
27/06/21	0.0444
28/06/21	0.0444
29/06/21	0.0444
30/06/21	0.0444
01/07/21	0.0444
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11/07/21	0.0444
12/07/21	0.0444
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31/07/21	0.0444
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27/08/21	0.0444
28/08/21	0.0444
29/08/21	0.0444
30/08/21	0.0444
31/08/21	0.0444

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 deaths in Kuwait are likely todecline significantly over the out-of-sample period. Around mid-May 2021 onwards no COVID-19 related mortality may be recorded in the country.

IV. CONCLUSION AND POLICY RECOMMENDATIONS

Covid-19 mortality is on top of the global agenda with many governments seriously concerned as their populations are mainly composed of the ageing population and millions of people having chronic medical conditions like diabetes and hypertension which are the leading causes of mortality in their own countries. As the pandemic continues to ravage the world it is clear that these countries will be the most affected therefore urgent action needs to be taken to minimize the effect of the health crisis. With predictive modeling governments are able to detect outbreaks early, facilitate planning and decision making and allocate adequate resources for the COVID-19 response to minimize loss of lives. In this paper we apply the artificial neural network approach to forecast daily COVID-19 deaths in Kuwait and the results revealed that daily COVID-19 deaths in Kuwait are likely to decline significantly over the out-of-sample period. Around mid-May 2021 onwards no COVID-19 related mortality may be recorded in the country. Hence we implore the authorities in Kuwait to focus on scaling up COVID-19 vaccination amongst other WHO recommended mitigation measures.

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