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Modelling and Forecasting Covid-19 Deaths in Egypt Using Artificial Neural Networks (ANN)

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Abstract **- In this research paper, the ANN approach was applied to analyze COVID-19 deaths in Egypt. The employed data covers the period January – December 2020 and the out-of-sample period ranges over the period January – May 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 related deaths in the country are likely to be around 80 deaths per day in the out-of-sample period. Amongst other policy recommendations, we strongly recommend that the government of Egypt should ensure strict adherence to lock-down measures while continuing to create awareness about the COVID-19 pandemic.**

Keywords: Modelling, Artificial Neural Networks, ANN.

I. INTRODUCTION

The coronavirus (COVID-19) was declared as an outbreak by the Chinese government in December 2019 (Chen et al, 2020). COVID-19 was declared a global pandemic by the World Health Organization (WHO) on the 11th of March 2020, this is so as it had spread across countries and at the time about 4000 deaths caused, (WHO, 2020). WHO further reports that within the first month of this declaration these deaths increased to about 100000 worldwide. Fast track to 2021, due to its contagiousness the, COVID-19 is still a global threat and has resulted 119 960 700 confirmed cases and 2 656 822 mortalities to date, (WHO Dashboard, 2021). The case of Egypt is similar to that of the rest of the world; the first COVID-19 case was announced on the 14th of February 2020, (Saba & Elsheikh, 2020). Despite being threatened by Gross Domestic Product (GDP) decline and income losses, efforts to contain the spread of the virus were implemented and the government of Egypt imposed lockdown restrictions in Mid-March 2020. However, after three months of implementation, the government of Egypt started lifting some of these restrictions in a bid to bring balance between income generation and preservation of life, (WHO, 2020). To date responsive restrictions have been implemented according to world estimates and forecast of the impact of the virus at a period of time. In this case there is great need to have reliable data and predictions which help the government forecast future responses and be able to know when to intensify COVID-9 restrictions or relax them.

In related studies, Saba & Elsheikh (2020) used the autoregressive integrated moving average (ARIMA) and nonlinear autoregressive artificial neural networks (NARANN) to model and forecast the prevalence of this epidemic in Egypt. Forecasts were in good agreement with officially reported cases. Shereen & Beram, (2020) used time series Auto Regressive Integrated Moving Average (ARIMA) and econometric Autoregressive-Distributed Lag (ARDL) as their forecasting models. The results showed that mobility of population is affected the incidence of new cases of Covid-19 significantly over the period of the study and that deaths were expected to reach 5 938 over the period. In this study we use the Artificial Neural Networks (ANN) to help foresee future COVID-19 deaths in Egypt. The results of this study may be used to develop precautionary plans to overcome this crisis and to offer better care to a patient who does no lead to death.

II. METHODOLOGY

The study applies the Artificial Neural Network (ANN) approach which is usually celebrated for its capability to learn from any data-set and consequently 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.

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Data Issues

This study is based on daily deaths of COVID-19 in Egypt 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.

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	D
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	0.092128
MSE	24.647739
MAE	3.654992

Residual Analysis for the Applied Model

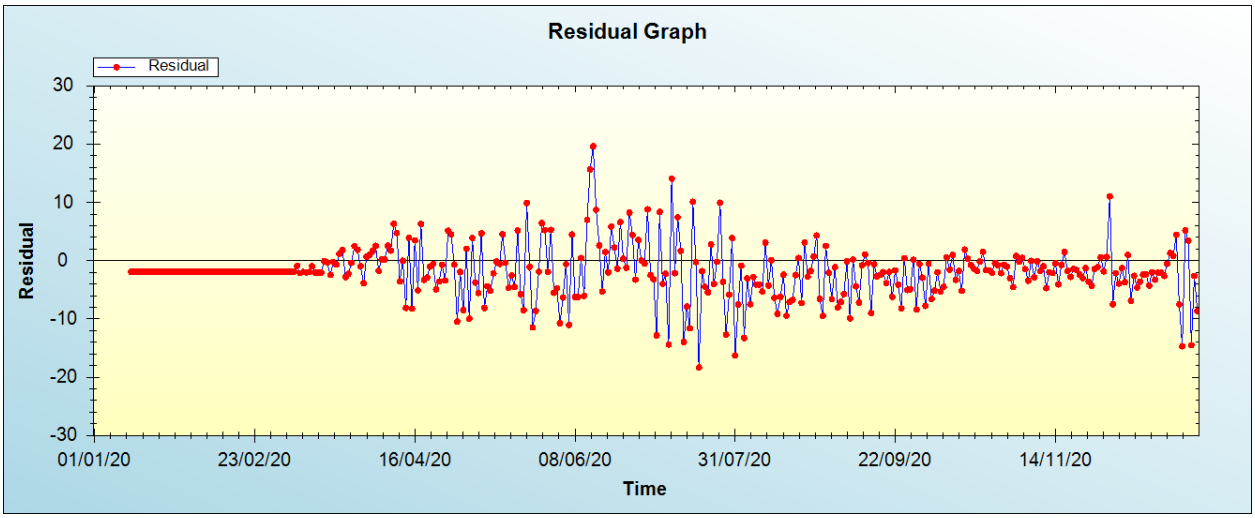

Figure 1: Residual analysis

In-sample Forecast for D

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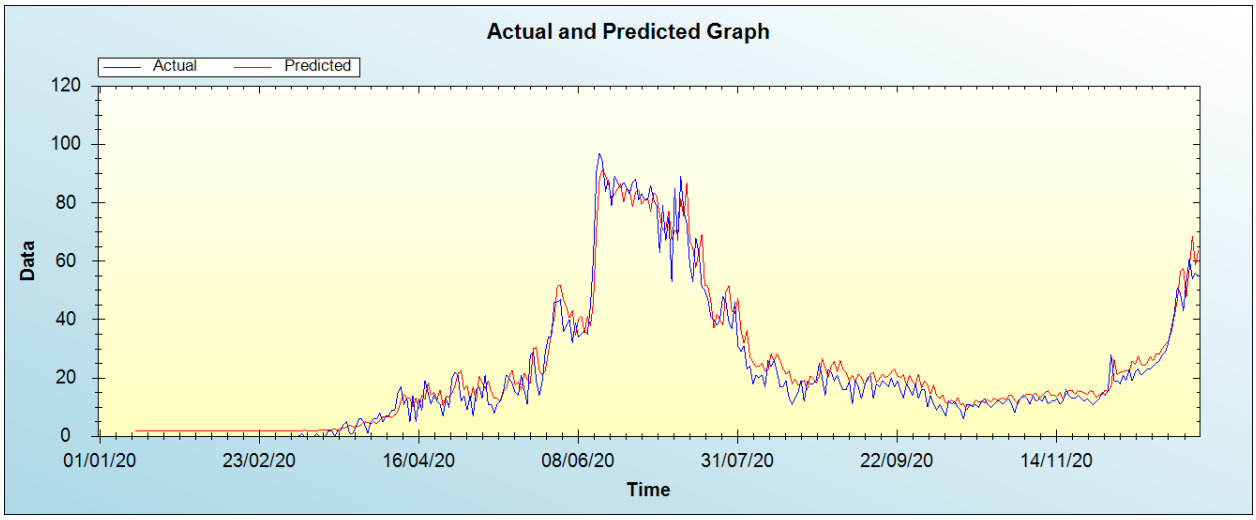

Figure 2: In-sample forecast for the D series

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

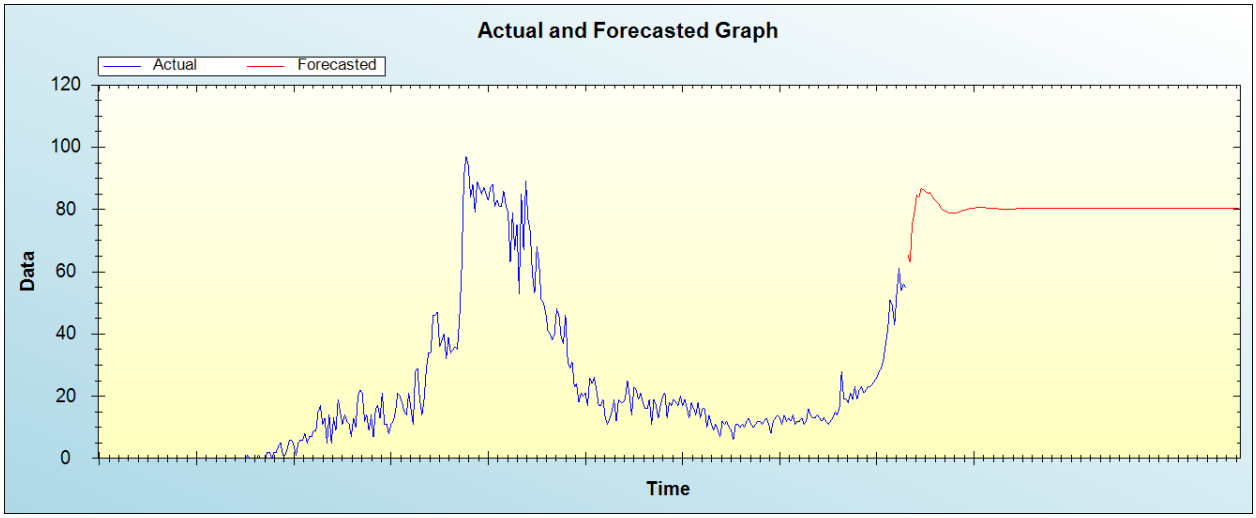

Figure 3: Out-of-sample forecast for D: actual and forecasted graph

Out-of-Sample Forecast for D: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Date	Forecasts
01/01/21	65.5052
02/01/21	62.9865
03/01/21	75.2808
04/01/21	79.2076
05/01/21	84.7359
06/01/21	83.8111
07/01/21	86.6828
08/01/21	86.4274
09/01/21	85.6852
10/01/21	85.2671
11/01/21	85.3831
12/01/21	84.3220
13/01/21	83.1525
14/01/21	82.5836

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15/01/21	81.7530
16/01/21	80.5469
17/01/21	79.8145
18/01/21	79.5595
19/01/21	79.1223
20/01/21	78.7859
21/01/21	78.8411
22/01/21	78.9785
23/01/21	78.9722
24/01/21	79.1351
25/01/21	79.4537
26/01/21	79.6819
27/01/21	79.8517
28/01/21	80.1086
29/01/21	80.3322
30/01/21	80.4353
31/01/21	80.5206
01/02/21	80.6160
02/02/21	80.6382
03/02/21	80.6058
04/02/21	80.5874
05/02/21	80.5589
06/02/21	80.4903
07/02/21	80.4231
08/02/21	80.3773
09/02/21	80.3246
10/02/21	80.2679
11/02/21	80.2331
12/02/21	80.2129
13/02/21	80.1913
14/02/21	80.1794
15/02/21	80.1833
16/02/21	80.1903
17/02/21	80.1967
18/02/21	80.2102
19/02/21	80.2275
20/02/21	80.2409
21/02/21	80.2530
22/02/21	80.2664
23/02/21	80.2769
24/02/21	80.2829
25/02/21	80.2876
26/02/21	80.2913
27/02/21	80.2915
28/02/21	80.2898
01/03/21	80.2879
02/03/21	80.2852
03/03/21	80.2812
04/03/21	80.2775
05/03/21	80.2744
06/03/21	80.2713
07/03/21	80.2685
08/03/21	80.2667
09/03/21	80.2655
10/03/21	80.2646
11/03/21	80.2642
12/03/21	80.2646
13/03/21	80.2650

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14/03/21	80.2657
15/03/21	80.2666
16/03/21	80.2675
17/03/21	80.2683
18/03/21	80.2691
19/03/21	80.2698
20/03/21	80.2703
21/03/21	80.2706
22/03/21	80.2709
23/03/21	80.2710
24/03/21	80.2710
25/03/21	80.2708
26/03/21	80.2707
27/03/21	80.2705
28/03/21	80.2702
29/03/21	80.2700
30/03/21	80.2698
31/03/21	80.2697
01/04/21	80.2695
02/04/21	80.2694
03/04/21	80.2694
04/04/21	80.2693
05/04/21	80.2693
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11/05/21	80.2697
12/05/21	80.2697
13/05/21	80.2697
14/05/21	80.2697
15/05/21	80.2697
16/05/21	80.2697
17/05/21	80.2697
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26/05/21	80.2697
27/05/21	80.2697
28/05/21	80.2697
29/05/21	80.2697
30/05/21	80.2697
31/05/21	80.2697

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 COVID-19 related deaths in the country are likely to be around 80 deaths per day in the out-of-sample period.

IV. CONCLUSION AND POLICY RECOMMENDATIONS

COVID-19, declared as a pandemic by WHO, has not completely been curbed and the risks of more variants developing and getting people sicker are even higher. For Egypt COVID-19 has become a major threat hence it has become inevitable to forecast the corona virus death rates in the country. This information is important for policy makers to be in a position to control the pandemic and forecast responsive mechanisms in line with the death trends. The paper made use of a simple ANN model. We strongly recommend that the government of Egypt should ensure strict adherence to lock-down measures while creating awareness about the COVID-19 pandemic. Advice is on the quick adoption of WHO recommended vaccines and create a herd immunity of at least 20% of the total Egyptian population. In these times when people have become complacent, emphasis is on the Egyptian community to responsibly carry out their economic activities while we also urge physically distancing, washing hands and wearing masks at all times.

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