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Forecasting Covid-19 Mortality in Russia

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

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]SAGIT Innovation Center, Harare, Zimbabwe
[3]Independent Health Economist, Harare, Zimbabwe

***Abstract* - In this study, the ANN approach was applied to analyze COVID-19 mortality in Russia. This study is based on daily COVID-19 deaths in Russia for the period 1 January 2020 – 20 April 2021. The out-of-sample forecast covers the period 21 April – 31 August 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is indeed stable. The results of the study indicate that daily COVID-19 mortality cases in Russia are likely to remain very high over the out-of-sample period. Therefore there is need for the Russian government 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 COVID-19 outbreak started in Wuhan City of China in December 2019 (Liu et al, 2020). The rapid spread of the infectious disease was shocking as there was an exponential rise in new cases and hospital admissions. A sudden shortage of medical supplies was inevitable as the first and second waves of COVID-19 hit several countries. Many people had never seen a pandemic of such magnitude before. It was a nightmare for millions of people to find themselves locked down in their homes with no social life and losing their sources of income due to closure of non-essential businesses. WHO named this disease coronavirus disease 19 (COVID-19) after genetic sequencing which showed the same origin of the causative agent with coronaviruses (Ryu et al, 2020; Lai et al, 2020; Rothan & Byrareddy , 2020). One of the most challenging tasks is to construct a model which can accurately predict COVID-19 cases and deaths because of the nature of the virus. Only few studies on forecasting COVID-19 related deaths have been done in Russia, for example; Marina & Natalia (2020); who, based on World Bank and RSSS data, used econometric modeling to analyze COVID-19 mortality in the country. The authors found out that the deaths numbers largely depend on the level of testing. The emergence of mutant strains which are more transmissible has made forecasting more complex. However recent studies by Nyoni et al, 2020 and Maradze et al, 2021 have shown that artificial intelligence techniques have better predictive accuracy when compared to traditional statistical and mathematical models. In this study we apply the artificial neural network approach to predict daily COVID-19 deaths in Russia. The results of the study are expected to reveal future trends of COVID-19 mortality in Russia and facilitate resource mobilization needed in the COVID-19 response.

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 Russia.

Data Issues

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

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III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	R
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	0.098608
MSE	1168.561665
MAE	26.380899

Residual Analysis for the Applied Model

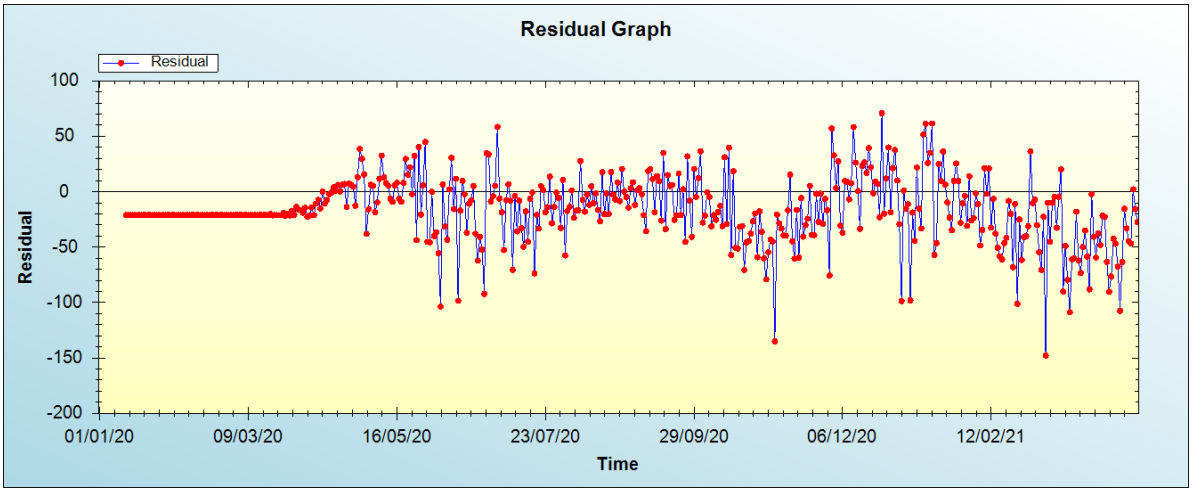

Figure 1: Residual analysis

In-sample Forecast for R

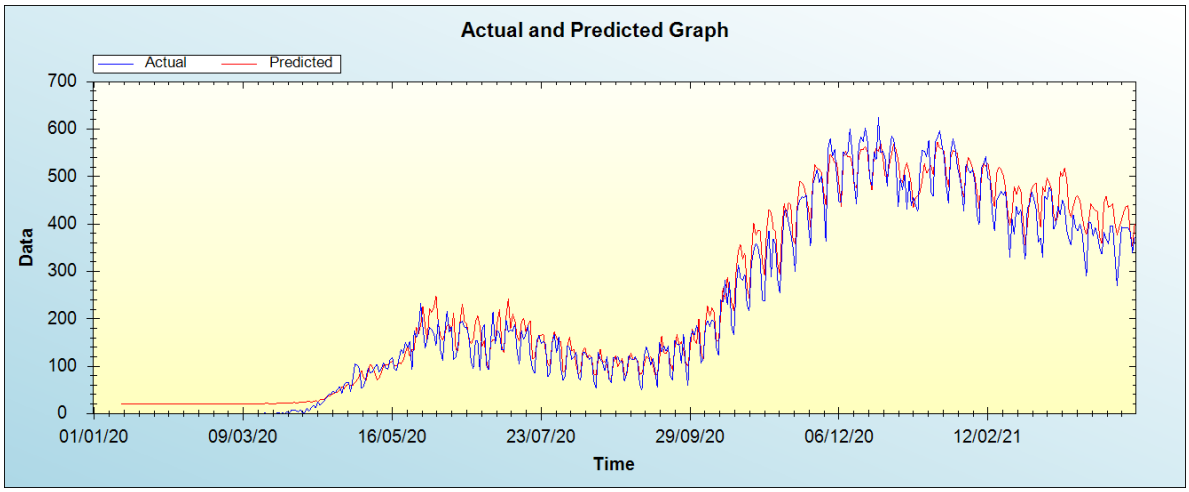

Figure 2: In-sample forecast for the R series

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

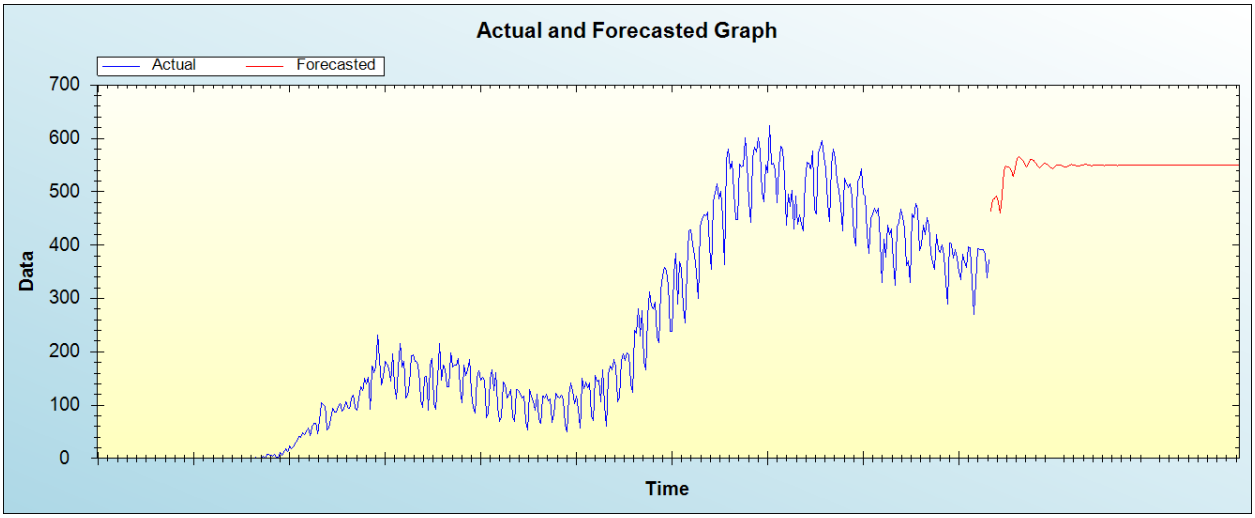

Figure 3: Out-of-sample forecast for R: actual and forecasted graph

Out-of-Sample Forecast for R: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Date	Forecasts
21/04/21	462.9791
22/04/21	484.5138
23/04/21	486.9968
24/04/21	491.9128
25/04/21	482.2707
26/04/21	459.3705
27/04/21	490.7496
28/04/21	538.1024
29/04/21	548.6355
30/04/21	545.6398
01/05/21	545.5077
02/05/21	539.1319
03/05/21	528.0693
04/05/21	543.4807
05/05/21	562.8488
06/05/21	565.9474
07/05/21	562.5356
08/05/21	559.3579
09/05/21	552.4456
10/05/21	545.5580
11/05/21	551.8672
12/05/21	560.1850
13/05/21	560.9090
14/05/21	558.0787
15/05/21	554.4027
16/05/21	548.3895
17/05/21	544.1749
18/05/21	547.4596
19/05/21	552.1609
20/05/21	552.9954
21/05/21	551.5386
22/05/21	548.9806
23/05/21	545.1500
24/05/21	543.2023
25/05/21	545.6974
26/05/21	549.1111

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27/05/21	550.3540
28/05/21	549.9337
29/05/21	548.4563
30/05/21	546.3150
31/05/21	545.5890
01/06/21	547.4284
02/06/21	549.7832
03/06/21	550.8398
04/06/21	550.6840
05/06/21	549.6767
06/06/21	548.3330
07/06/21	547.9499
08/06/21	549.0498
09/06/21	550.4530
10/06/21	551.0873
11/06/21	550.8860
12/06/21	550.0794
13/06/21	549.1254
14/06/21	548.8241
15/06/21	549.4183
16/06/21	550.2200
17/06/21	550.5763
18/06/21	550.3790
19/06/21	549.7797
20/06/21	549.1331
21/06/21	548.9321
22/06/21	549.2900
23/06/21	549.7946
24/06/21	550.0361
25/06/21	549.9115
26/06/21	549.5228
27/06/21	549.1267
28/06/21	549.0271
29/06/21	549.2765
30/06/21	549.6226
01/07/21	549.8046
02/07/21	549.7407
03/07/21	549.5009
04/07/21	549.2645
05/07/21	549.2198
06/07/21	549.3914
07/07/21	549.6235
08/07/21	549.7492
09/07/21	549.7097
10/07/21	549.5535
11/07/21	549.4029
12/07/21	549.3758
13/07/21	549.4841
14/07/21	549.6305
15/07/21	549.7081
16/07/21	549.6765
17/07/21	549.5692
18/07/21	549.4684
19/07/21	549.4481
20/07/21	549.5141
21/07/21	549.6050
22/07/21	549.6521
23/07/21	549.6280
24/07/21	549.5557
25/07/21	549.4895
26/07/21	549.4762
27/07/21	549.5185
28/07/21	549.5771
29/07/21	549.6075

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30/07/21	549.5917
31/07/21	549.5451
01/08/21	549.5035
02/08/21	549.4964
03/08/21	549.5248
04/08/21	549.5637
05/08/21	549.5842
06/08/21	549.5744
07/08/21	549.5448
08/08/21	549.5188
09/08/21	549.5151
10/08/21	549.5342
11/08/21	549.5597
12/08/21	549.5730
13/08/21	549.5667
14/08/21	549.5475
15/08/21	549.5307
16/08/21	549.5285
17/08/21	549.5408
18/08/21	549.5571
19/08/21	549.5655
20/08/21	549.5610
21/08/21	549.5483
22/08/21	549.5374
23/08/21	549.5358
24/08/21	549.5437
25/08/21	549.5541
26/08/21	549.5593
27/08/21	549.5562
28/08/21	549.5478
29/08/21	549.5408
30/08/21	549.5398
31/08/21	549.5449

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 Russia are likely toremain very high over the out-of-sample period.

IV. CONCLUSION AND POLICY RECOMMENDATIONS

Russia is one of the top 10 countries in the world which have been seriously affected by the COVID-19 pandemic. Several researchers around the globe have applied deep learning approaches to predict COVID-19 cases and deaths. Examples of such approaches include artificial neural networks (ANNs), ensembles, Bayesian networks and support vector machines. The Multilayer perceptron (MLP) is a popular neural network, which utilizes several nonlinear transformations to make a prediction. In this study, the applied ANN (12, 12, 1) model has three layers of nodes, the input features are called the input layer, and the intermediate transformations are called the hidden layer (Zhang, 2003). The outputs of the first layer (input) are used as the inputs of the next layer (hidden). The output of the hidden layer is used as the input of the output layer. All nodes in hidden layers use a nonlinear activation function. The ANN model in this paper was used to predict daily COVID-19 mortality in Russia. The model predictions suggest that daily COVID-19 mortality cases in Russia are likely to remain very high over the out-of-sample period. Therefore we encourage the Russia government to accelerate COVID-19 vaccination amongst other measures recommended by WHO.

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