Forecasting Covid-19 Deaths in Romania

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Abstract - **In this research article, the ANN approach was applied to analyze daily COVID-19 related deaths in Romania. This study is based on daily COVID-19 deaths in Romania 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 stable in forecasting daily COVID-19 related deaths in the country. The results of the study indicate that daily COVID-19 deaths in Romania are likely to decline significantly over the out-of-sample period. We, however; still recommend that the Romanian government should ensure adherence to lock-down measures while creating massive awareness about the COVID-19 pandemic as well as scaling up vaccinations.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Since the first emergence of the Coronavirus Disease 2019 (COVID-19) in Wuhan, Hubei Province, China, in December 2019 (Wu *et al*., 2020), the scourge has proliferated globally and has affected literally all nations till date (Worldometers, 2020). The global outbreak and severity of this contagious disease (Li *et al*., 2020) prompted the World Health Organization (WHO) to declare it as a Public Health Emergency of International Concern (PHEIC) on January 30, 2020, and then subsequently, to classify it as a pandemic on March 11, 2020 (WHO, 2020). As of August 2020, COVID-19 has infected approximately 20 million people across the globe with 90 countries in community transmission stage (WHO, 2020), leading to significant efforts towards control (Rawaf *et al*., 2020) and search for a cure (Le *et al*., 2020) for COVID-19 across the world. Definitely, the spread of this virus outbreak has seriously disrupted life, economy and health of citizens and this has become a great concern for everyone, as to how long will this scenario last and when the disease could be controlled (Sardar *et al*., 2020). The first case of COVID-19 was confirmed on the 26th of February 2020 in Romania and since then cases have continued to cumulatively surge. Modeling and forecasting of the COVID-19 pandemic in Romania, just like in any other affected country; remains important. Although studies such as Stonia *et al*. (2020) have analyzed COVID-19 deaths in Romania, not even a single attempt has been made towards forecasting daily COVID-19 related deaths. Stonia *et al*. (2020) revealed that males, hypertension, diabetes, obesity and chronic kidney disease were most frequent in the COVID-19 fatalities, and that the burden of disease was low and that prognosis for one-year survival probability was high in the sample.

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 Romania.

Data Issues

This study is based on daily COVID-19 deaths in Romania 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	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	0.127337
MSE	281.098648
MAE	12.113879

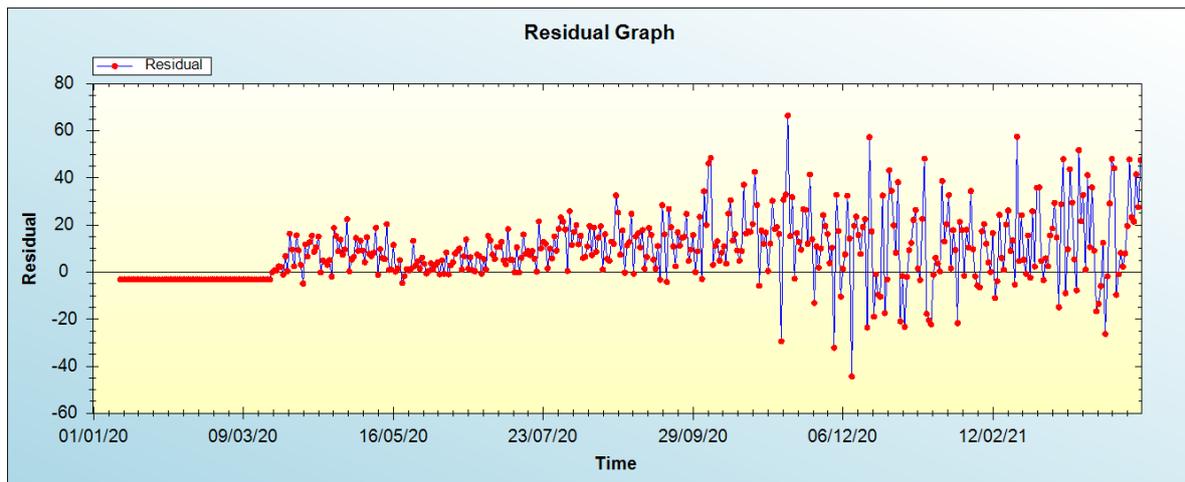*Residual Analysis for the Applied Model*

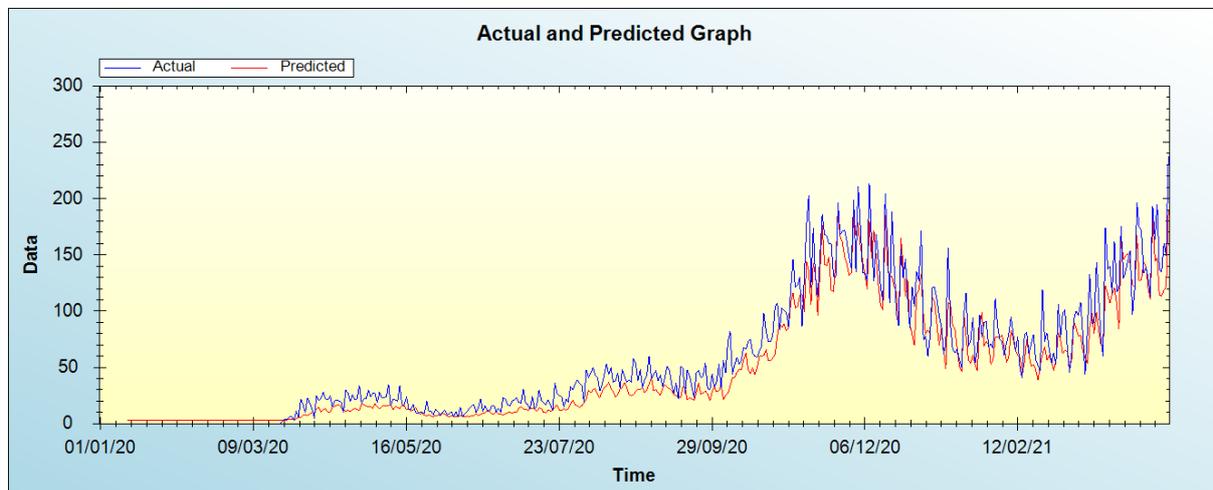**Figure 1: Residual analysis**

In-sample Forecast for R

Figure 2: In-sample forecast for the R series

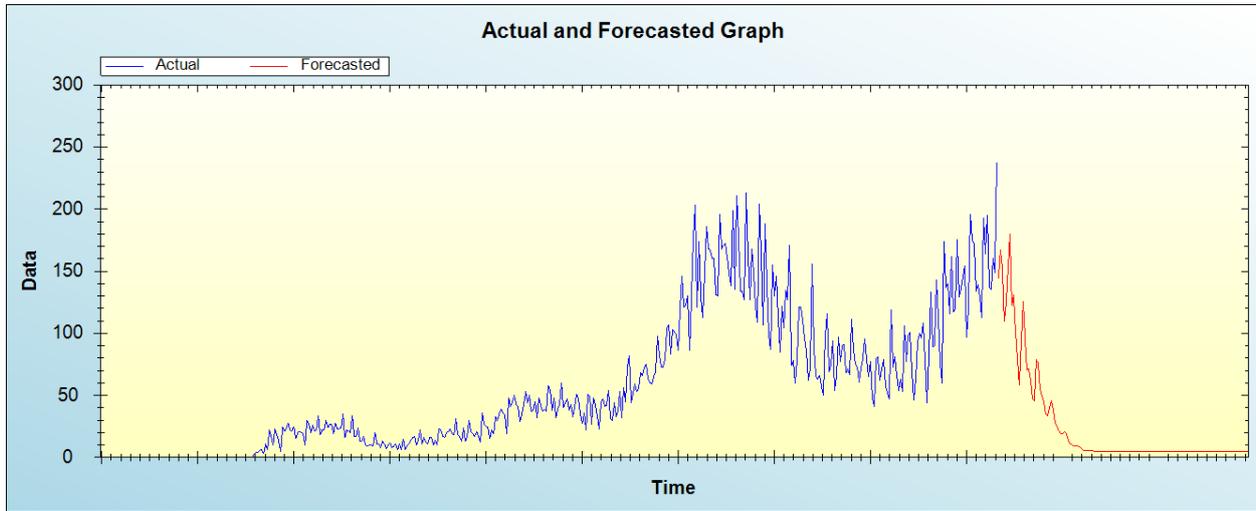*Out-of-Sample Forecast for R: Actual and Forecasted Graph*

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

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Date	Forecasts
21/04/21	144.2826
22/04/21	167.0967
23/04/21	153.3658
24/04/21	109.3369
25/04/21	124.4193
26/04/21	152.0081
27/04/21	179.5786
28/04/21	122.1148
29/04/21	130.7468
30/04/21	101.4406
01/05/21	80.1404
02/05/21	58.4910
03/05/21	92.3909
04/05/21	125.5483
05/05/21	97.6108
06/05/21	70.7044
07/05/21	71.2111
08/05/21	62.4922
09/05/21	47.4363
10/05/21	45.6271
11/05/21	78.6898
12/05/21	76.2403
13/05/21	55.6653
14/05/21	49.3748
15/05/21	44.7742
16/05/21	35.4300
17/05/21	33.3258
18/05/21	39.9016
19/05/21	45.4741
20/05/21	38.6120
21/05/21	28.0779
22/05/21	24.7954
23/05/21	21.3849
24/05/21	19.1163
25/05/21	19.4324
26/05/21	20.8535

27/05/21	19.0924
28/05/21	13.7435
29/05/21	11.0913
30/05/21	10.1189
31/05/21	9.2546
01/06/21	9.0394
02/06/21	9.1224
03/06/21	8.4901
04/06/21	6.8728
05/06/21	5.7839
06/06/21	5.4620
07/06/21	5.3922
08/06/21	5.4823
09/06/21	5.5564
10/06/21	5.3900
11/06/21	4.9834
12/06/21	4.6738
13/06/21	4.6158
14/06/21	4.7098
15/06/21	4.8485
16/06/21	4.9334
17/06/21	4.9059
18/06/21	4.7994
19/06/21	4.7170
20/06/21	4.7188
21/06/21	4.7848
22/06/21	4.8631
23/06/21	4.9070
24/06/21	4.8992
25/06/21	4.8608
26/06/21	4.8315
27/06/21	4.8343
28/06/21	4.8630
29/06/21	4.8953
30/06/21	4.9110
01/07/21	4.9048
02/07/21	4.8870
03/07/21	4.8738
04/07/21	4.8740
05/07/21	4.8850
06/07/21	4.8971
07/07/21	4.9021
08/07/21	4.8981
09/07/21	4.8899
10/07/21	4.8840
11/07/21	4.8839
12/07/21	4.8883
13/07/21	4.8930
14/07/21	4.8947
15/07/21	4.8927
16/07/21	4.8892
17/07/21	4.8868
18/07/21	4.8868
19/07/21	4.8887
20/07/21	4.8907
21/07/21	4.8913
22/07/21	4.8904
23/07/21	4.8890
24/07/21	4.8880
25/07/21	4.8881
26/07/21	4.8890
27/07/21	4.8898
28/07/21	4.8900
29/07/21	4.8896

30/07/21	4.8890
31/07/21	4.8887
01/08/21	4.8888
02/08/21	4.8891
03/08/21	4.8895
04/08/21	4.8896
05/08/21	4.8894
06/08/21	4.8891
07/08/21	4.8890
08/08/21	4.8890
09/08/21	4.8892
10/08/21	4.8893
11/08/21	4.8894
12/08/21	4.8893
13/08/21	4.8892
14/08/21	4.8891
15/08/21	4.8892
16/08/21	4.8892
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23/08/21	4.8892
24/08/21	4.8893
25/08/21	4.8893
26/08/21	4.8892
27/08/21	4.8892
28/08/21	4.8892
29/08/21	4.8892
30/08/21	4.8892
31/08/21	4.8892

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 Romania are likely to decline significantly over the out-of-sample period. These results are consistent with previous studies such as Stonia *et al*. (2020) who found out that the burden of COVID-19 was generally low in Romania.

IV. CONCLUSION & RECOMMENDATIONS

COVID-19, declared as a pandemic by WHO, is currently the most aggressive threat in the entire world, affecting everyone in this world, in one way or the other. It has become inevitable to forecast the daily COVID-19 related deaths in Romania as this information is important for policy makers to be in a position to properly handle the pandemic. It is projected that daily COVID-19 deaths in Romania are likely to decline significantly over the out-of-sample period. We, however; still recommend that the government ought to ensure adherence to lock-down measures while creating massive awareness about the COVID-19 pandemic. We also encourage the government to scale up COVID-19 vaccinations throughout the country.

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