

# PREDICTION OF NEW COVID-19 DAILY CASES IN ROMANIA USING ARTIFICIAL NEURAL NETWORKS

\*Dr. Smartson. P. NYONI<sup>1</sup>, Thabani NYONI<sup>2</sup>, Tatenda. A. CHIHOHO<sup>3</sup>

<sup>1</sup>ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

<sup>2</sup>Department of Economics, University of Zimbabwe, Harare, Zimbabwe

<sup>3</sup>Department of Economics, University of Zimbabwe, Harare, Zimbabwe

\*Corresponding Author

## ABSTRACT

The need for forecasting the future trend of COVID-19 is at its highest levels now, especially considering the fact there is no effective vaccine yet developed. Forecasting the disease progression will lessen the burden of health workers in terms of managing the pandemic. Romania, just like any other resource-limited country, is in need of accurate forecasts of the COVID-19 cases, in order to be “on top” of the virus. In this research paper, the ANN approach was applied to analyze COVID-19 cases in Romania. The employed data covers the period 26 February 2020 to 31 October 2020 and the out-of-sample period ranges over the period November 2020 to April 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of our model indicate that the model is stable and acceptable for predicting daily new COVID-19 cases. The results of the study indicate that COVID-19 cases are likely to reach a stable equilibrium level of approximately 6595 new cases per day, somewhere around 18 December 2020. Clearly, the pandemic is far from ending in Romania. There is serious need for continued implementation of control and prevention strategies in the country. The public is also urged to strictly exercise caution all the time and strictly adhere to sanitary rules established by WHO, in order to win the war against this deadly scourge.

**Keywords:** - ANN, COVID-19, Forecasting

## INTRODUCTION & BRIEF BACKGROUND

Romania, like all other European countries, was unable to escape COVID-19 (Cretan & Light, 2020). The COVID-19 crisis in Romania was felt in the first half of March 2020, while information about this epidemic with the virus originating from China was circulating already by mid-December 2019 (Antonescu, 2020). Romania’s first case of COVID-19 was officially confirmed on the 26<sup>th</sup> of February, 2020, in a 25 year old man who had been in contact with an Italian visitor on a hunting trip (Cretan & Light, 2020). The government responded by implementing early measures which were able to keep the infection and mortality rates relatively low (Cretan & Light, 2020). Modelling and forecasting COVID-19 dynamics is fundamental to being able to act timeously and take the best safety measures for the population. However, the Romanian authorities have not yet presented any official analysis or predictions for the evolution of the pandemic (Stochitoiu *et al.*, 2020; Petrica *et al.*, 2020) and yet forecasting the pandemic will inform policy on the way forward in terms of control and prevention strategy formulation.

Only Stochitoiu *et al.* (2020) and Petrica *et al.* (2020) have tried to make predictions of the future trends of the COVID-19 pandemic in the country. Stochitoiu *et al.* (2020) used a supervised neural network approach to forecast case fatalities as well as new COVID-19 cases and they came to a conclusion that their proposed model was accurate and reliable in COVID-19 analysis. In a similar study, Petrica *et al.* (2020) applied SIR and SIRD models to predict COVID-19 cases in Romania. The authors basically found out that COVID-19 cases would continue to rise in the country. These study produced forecasts over very short timeframes, for example, Petrica *et al.* (2020)'s forecasts range over a month. While their papers are really important, there is need to come up a new model with forecasts that range over a much longer period. It is this informational gap that we try to close in this regard. Hence, we attempt to model and forecast daily confirmed COVID-19 cases in the country over the period February 26, 2020 to October 31, 2020; with an out-of-sample period of November 2020 to April 2021.

## METHODOLOGY

This research, in line with previous studies such as Stochitoiu *et al.* (2020); applies a neural-analytic method, the multi-layer perceptron neural network type of the ANN approach in order to predict COVID-19 case volumes in Romania. The paper particularly applies the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function. This study is based on new daily COVID-19 cases (referred to as series, RX, in this study) for all age groups in Romania. The data covers the period February 26, 2020 to October 31, 2020 while the out-of-sample forecast covers the period November 2020 to April 2021. All the data employed in this research paper was gathered from the online database of the Johns Hopkins University, United States of America.

## FINDINGS OF THE STUDY

### DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
969.23	420.00	0.0000	6546.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
1219.7	1.2584	2.2910	5.5270
5% Perc.	95% Perc.	IQ range	Missing obs.
3.5000	3982.5	1089.0	0

### ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN ROMANIA

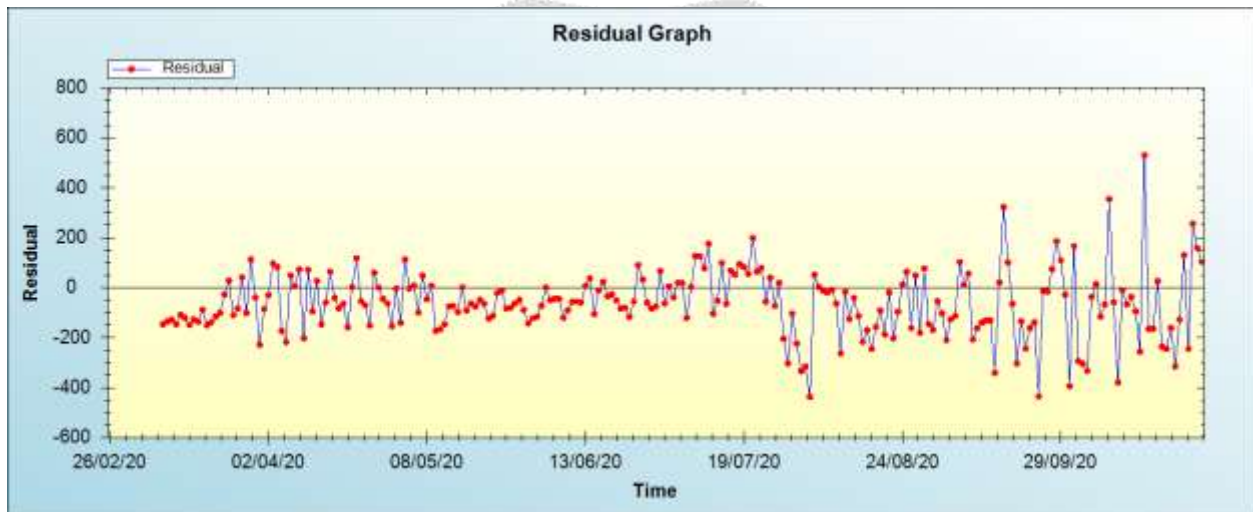
Table 2: ANN model summary

Variable	RX
Observations	237 (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	0.039371
MSE	20500.781664
MAE	110.767876

*Residual Analysis for the ANN model*

Figure 1: Residual analysis



*In-sample Forecast for RX*

Figure 2: In-sample forecast for the RX series

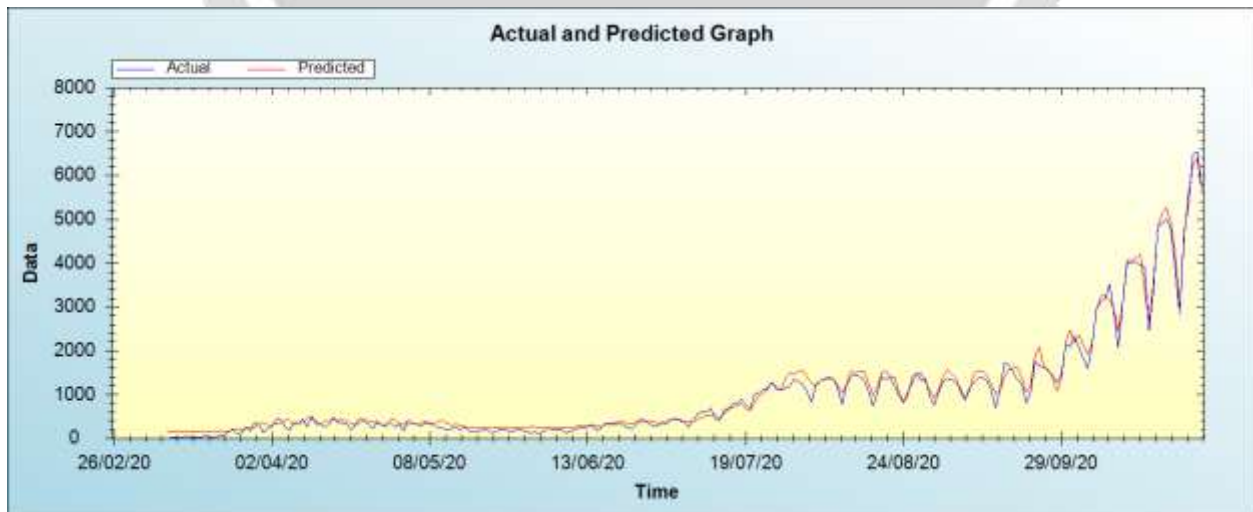
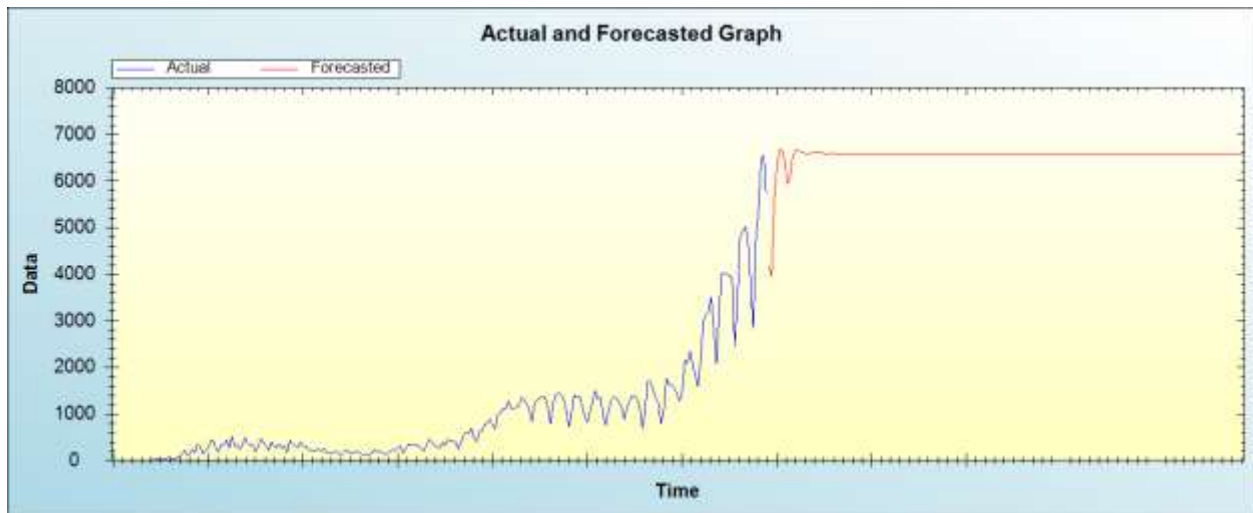


Figure 3 shows the in-sample forecast for RX series.

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

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



*Out-of-Sample Forecast for RX: Forecasts only*

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	4185.7409
02/11/20	3944.5369
03/11/20	5541.9452
04/11/20	6302.2092
05/11/20	6687.5690
06/11/20	6647.8399
07/11/20	6435.5280
08/11/20	5945.1472
09/11/20	6054.1780
10/11/20	6512.1725
11/11/20	6663.5572
12/11/20	6653.3130
13/11/20	6629.7654
14/11/20	6631.5373

15/11/20	6566.9044
16/11/20	6568.9119
17/11/20	6615.4158
18/11/20	6635.5221
19/11/20	6612.0140
20/11/20	6608.1590
21/11/20	6607.2565
22/11/20	6593.5651
23/11/20	6589.7827
24/11/20	6595.1850
25/11/20	6598.8932
26/11/20	6594.8821
27/11/20	6594.1082
28/11/20	6594.7413
29/11/20	6593.8440
30/11/20	6592.8702
01/12/20	6594.3556
02/12/20	6595.2516
03/12/20	6594.8016
04/12/20	6594.7462
05/12/20	6594.9937
06/12/20	6594.9930
07/12/20	6594.7924
08/12/20	6594.9917
09/12/20	6595.1427
10/12/20	6595.0673

11/12/20	6594.9915
12/12/20	6595.0411
13/12/20	6595.0280
14/12/20	6594.9796
15/12/20	6594.9942
16/12/20	6595.0161
17/12/20	6595.0036
18/12/20	6594.9845
19/12/20	6594.9930
20/12/20	6594.9940
21/12/20	6594.9867
22/12/20	6594.9873
23/12/20	6594.9937
24/12/20	6594.9924
25/12/20	6594.9897
26/12/20	6594.9914
27/12/20	6594.9925
28/12/20	6594.9916
29/12/20	6594.9914
30/12/20	6594.9927
31/12/20	6594.9926
01/01/21	6594.9921
02/01/21	6594.9922
03/01/21	6594.9925
04/01/21	6594.9923
05/01/21	6594.9922



06/01/21	6594.9923
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30/01/21	6594.9922
31/01/21	6594.9922

The image contains a large, semi-transparent watermark of the IJARIE logo in the center. The logo features a stylized globe with a white swoosh and the acronym 'IJARIE' in bold, capital letters below it.

01/02/21	6594.9922
02/02/21	6594.9922
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26/02/21	6594.9922



The logo for IJARIE is a circular emblem with a gear-like border. Inside the circle, there is a stylized globe with a white swoosh above it. The acronym 'IJARIE' is written in a bold, sans-serif font across the bottom of the circle.

27/02/21	6594.9922
28/02/21	6594.9922
01/03/21	6594.9922
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30/04/21	6594.9922

As indicated in table 1, the average daily new COVID-19 cases, over the period under study; is 969 cases per day while the maximum is 6546 cases. These are alarming numbers for a developing country like Romania and it calls for immediate action. Table is the summary of the model that we applied. Figure 1 shows the residuals of the applied model: these residuals are as minimum as possible and this suggests that our model is quite acceptable for forecasting COVID-19 cases in the country. Figure displays in-sample predictions while figure 3 and table 3 show out-of-sample forecasts. The results of the study indicate that daily COVID-19 cases will continue to rise until they reach their equilibrium level of 6595 cases per day by around December 18, 2020; and this equilibrium trend is projected to continue throughout the out-of-sample period. Authorities now need to understand that these are very high numbers especially given that that they will be occurring on a daily basis. This implies that there is need for more responsible behavior on the part of people in Romania especially with regards to adherence to sanitary rules gazzetted by the World Health Organization (WHO). The government should also continue will its current public health policy response to the pandemic.

## CONCLUSION & RECOMMENDATIONS

COVID-19, which has evolved as a global public health emergency; has killed many people in the entire world and Romania is not an exception. In this study, we attempted to model and forecast daily COVID-19 case volumes for Romania with the purpose of informing policy. The study applied a generalized ANN model. The results of the study indicated that the pandemic is far from ending in Romania. The pandemic is projected to reach its equilibrium level of approximately 6595 cases per day somewhere around December 18, 2020. This level is also projected to stretch throughout the out-of-sample period. Indeed, the pandemic is far from ending in Romania. Relevant authorities, especially the ministry responsible for public health; have a big role to play in terms of controlling the further spread of the virus. There is serious need for continued implementation of control and prevention strategies in the country. The public is also

urged to exercise caution all the time and strictly adhere to sanitary rules established by WHO, in order save lives.

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