

Forecasting Covid-19 New Cases in Moldova

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Abstract - In this study, the ANN approach was applied to analyze COVID-19 new cases in Moldova. The employed data covers the period 1 January 2020 – 25 March 2021 and the out-of-sample period ranges over the period 26 March – 31 July 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 cases in Moldova are likely to remain high over the out-of-sample period. Amongst other suggested policy directions, there is need for the government of Moldova to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Moldova was hit by a twin shock of the COVID-19 pandemic and a severe drought in the past 2 decades (World Bank, 2020). The country reported over 135,000 confirmed cases of COVID-19 and more than 2,700 deaths in 2020 (country coronavirus update, 2020). The COVID-19 outbreak hit an already decelerating economy. Economic activities decline significantly in the second quarter of 2020 by 14% year on year (Moldova country assessment, 2020). By the 6th of April, 2021, Moldova had reported a total of 236,563 confirmed cases and 5,224 total deaths (Moldova situation report, 2021). The government responded to the pandemic by implementing measures such as travel restrictions, social distancing, wearing masks, hygiene practice, contact tracing, isolation and treatment of cases. Time series modeling and forecasting is a key component of public health surveillance hence prediction of daily COVID-19 cases in Moldova will be done in this study in order to understand the evolution of the SARS-CoV2 virus. Several models have been applied by various researchers in public health and these include exponential, logistic regression, compartmental (SEIR), machine learning and hybrid models. In this piece of work we applied the artificial neural network approach because of its popularity and its ability to model nonlinear complex data as demonstrated by various authors in recent studies (Maradze et al, 2021; Nyoni & Nyoni, 2021; Zhao et al, 2020).

II. LITERATURE REVIEW

Sim et al (2020) described the clinical characteristics of COVID-19 cases nationwide and determined the risk factors associated with disease severity in Malaysia. Clinical records of all RT-PCR confirmed COVID-19 cases aged ≥ 12 years admitted to 18 designated hospitals in Malaysia between 1st February and 30th May 2020 with complete outcomes were retrieved. Epidemiological history, co-morbidities, clinical features, investigations, management and complications were captured using Redcap database. Variables were compared between mild and severe diseases. Univariate and multivariate regression were used to identify determinants for disease severity. The study concluded that Lower case fatality rate was possibly contributed by young cases with mild diseases and early hospitalization. Abnormal chest radiographic findings in elderly with tachypnea require close monitoring in the first five days to detect early deterioration. A mathematical model was proposed by Motasem et al (2020) in Jordanto estimate the R0 of COVID-19 in an outbreak occurring in both local and international clusters in light of published data. Different types of clusters (religious, wedding, and industrial activity) were selected based on reported events in different countries between February and April 2020. The highest R0 values were found in wedding party events (5), followed by religious gathering events (2.5), while the lowest value was found in the industrial cluster (2). In another study, Rahimi et al (2020) reviewed COVID-19 forecasting models. The authors provided a detailed sciento-metric analysis which was performed on COVID-19 data from the Scopus and Web of Science databases. For the above-mentioned analysis, keywords and subject areas are addressed, while the classification of machine learning forecasting models, criteria evaluation, and comparison of solution approaches were discussed.

III. 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 new COVID-19 cases Moldova.

Data Issues

This study is based on daily new cases of COVID-19 in Moldova for the period 1 January 2020 – 25 March 2021. The out-of-sample forecast covers the period 26 March 2021 – 31 July 2021. All the data employed in this research paper was gathered from the Johns Hopkins University (USA).

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	M
Observations	438 (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	0.098945
MSE	15611.356236
MAE	88.751800

Residual Analysis for the Applied Model

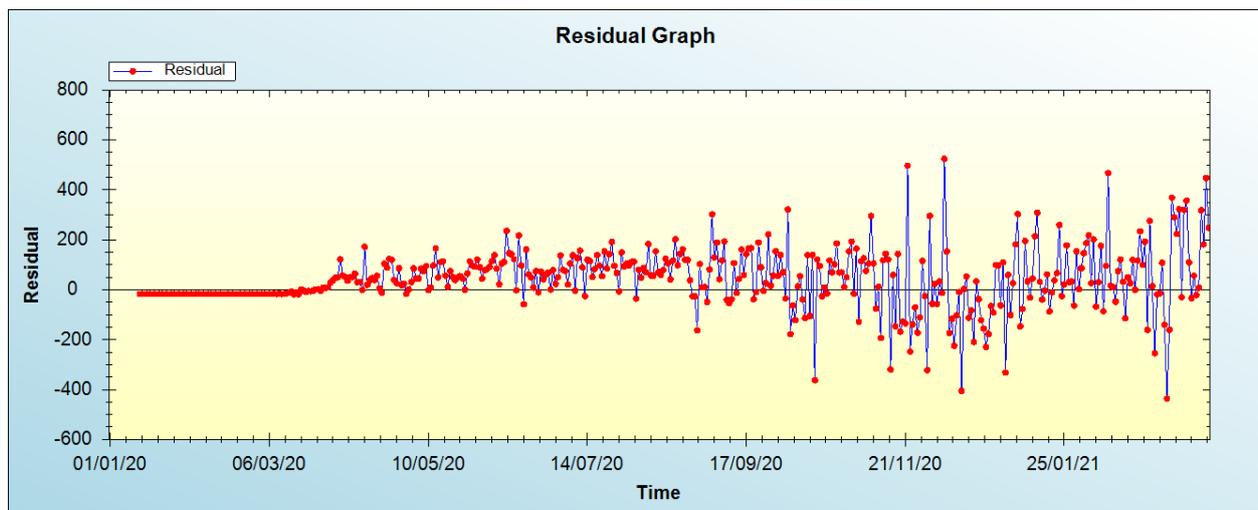


Figure 1: Residual analysis

In-sample Forecast for M

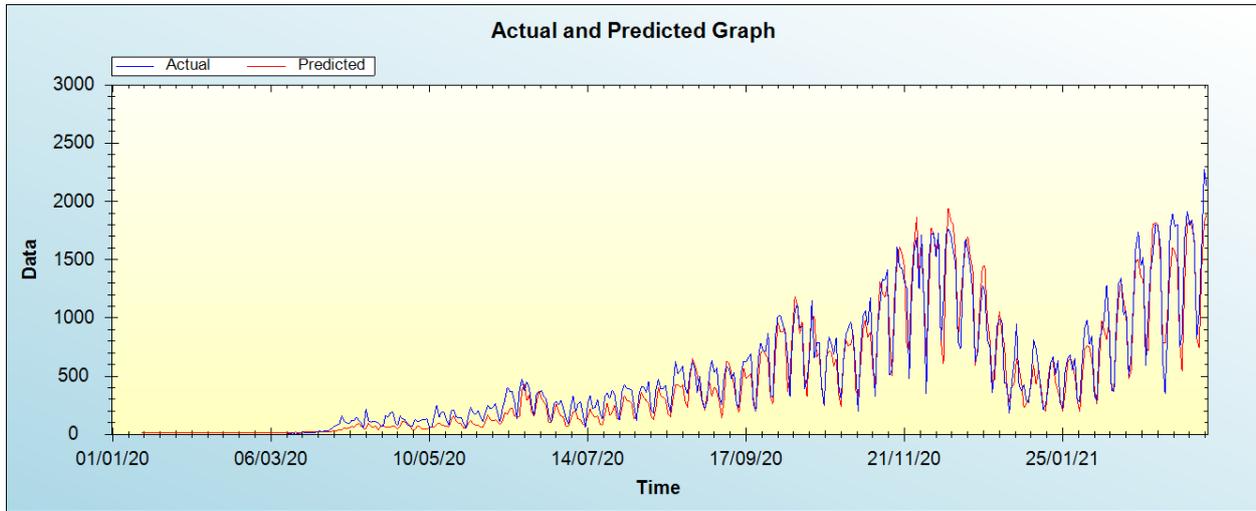


Figure 2: In-sample forecast for the M series

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

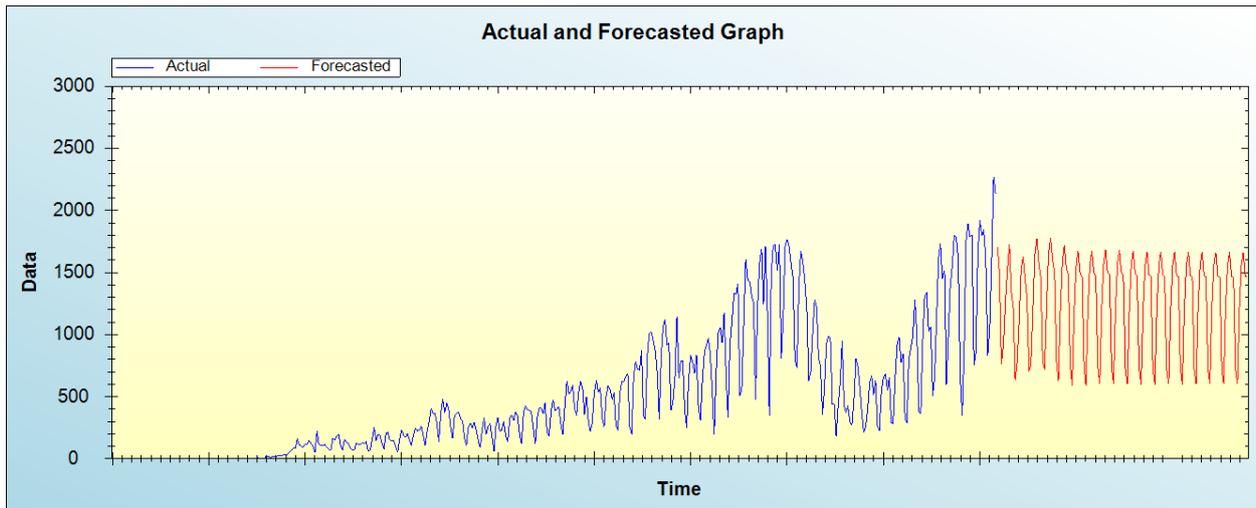


Figure 3: Out-of-sample forecast for M: actual and forecasted graph

Out-of-Sample Forecast for M: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	1700.1939
27/03/21	1502.0478
28/03/21	762.5391
29/03/21	920.2527
30/03/21	1269.1480
31/03/21	1527.8927
01/04/21	1727.7295
02/04/21	1340.0008
03/04/21	1218.1915
04/04/21	633.5777
05/04/21	778.3622
06/04/21	1115.5818
07/04/21	1528.0478
08/04/21	1623.9055
09/04/21	1453.9528

10/04/21	1287.1955
11/04/21	706.3877
12/04/21	755.5649
13/04/21	1197.4412
14/04/21	1648.6862
15/04/21	1775.5953
16/04/21	1573.7949
17/04/21	1458.8666
18/04/21	785.7679
19/04/21	716.8959
20/04/21	1219.5511
21/04/21	1655.9698
22/04/21	1777.6069
23/04/21	1594.6028
24/04/21	1508.4634
25/04/21	786.7570
26/04/21	628.9871
27/04/21	1191.4713
28/04/21	1577.0312
29/04/21	1717.2113
30/04/21	1538.1386
01/05/21	1479.4190
02/05/21	755.7208
03/05/21	591.9717
04/05/21	1180.4491
05/05/21	1540.2977
06/05/21	1673.6477
07/05/21	1499.8069
08/05/21	1459.9702
09/05/21	741.4152
10/05/21	592.4169
11/05/21	1195.7440
12/05/21	1551.3239
13/05/21	1671.3882
14/05/21	1496.1495
15/05/21	1470.1852
16/05/21	742.3757
17/05/21	601.9572
18/05/21	1213.5774
19/05/21	1569.0590
20/05/21	1680.1081
21/05/21	1503.2110
22/05/21	1481.7056
23/05/21	741.4424
24/05/21	605.2387
25/05/21	1220.4025
26/05/21	1571.2148
27/05/21	1680.1737
28/05/21	1500.2704
29/05/21	1480.8565
30/05/21	734.7486
31/05/21	603.1732
01/06/21	1217.8353
02/06/21	1564.6132
03/06/21	1673.0178
04/06/21	1490.0064
05/06/21	1473.3388
06/06/21	727.7756
07/06/21	600.9088
08/06/21	1215.2078
09/06/21	1560.3102
10/06/21	1667.1967
11/06/21	1481.2712
12/06/21	1467.7855

13/06/21	724.0814
14/06/21	600.8647
15/06/21	1215.7056
16/06/21	1560.7534
17/06/21	1665.3707
18/06/21	1476.9673
19/06/21	1466.1936
20/06/21	722.7995
21/06/21	601.8643
22/06/21	1217.5295
23/06/21	1562.6316
24/06/21	1665.3725
25/06/21	1474.9858
26/06/21	1466.0902
27/06/21	721.9119
28/06/21	602.4477
29/06/21	1218.6972
30/06/21	1563.3886
01/07/21	1664.9420
02/07/21	1472.9701
03/07/21	1465.4348
04/07/21	720.6446
05/07/21	602.3935
06/07/21	1218.9470
07/07/21	1563.0549
08/07/21	1663.7807
09/07/21	1470.4966
10/07/21	1464.1574
11/07/21	719.3129
12/07/21	602.1911
13/07/21	1218.9714
14/07/21	1562.6506
15/07/21	1662.6132
16/07/21	1468.2511
17/07/21	1463.0006
18/07/21	718.3083
19/07/21	602.1777
20/07/21	1219.2107
21/07/21	1562.6490
22/07/21	1661.8866
23/07/21	1466.6754
24/07/21	1462.3183
25/07/21	717.6528
26/07/21	602.3179
27/07/21	1219.5918
28/07/21	1562.8603
29/07/21	1661.5008
30/07/21	1465.6439
31/07/21	1461.9479

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 cases in Moldova are likely to remain high over the out-of-sample period.

V. CONCLUSION AND POLICY RECOMMENDATIONS

COVID-19 cases have reached over 135,000 with more than 2,700 deaths in 2020 (World Bank, 2020). The needed containment measures both at national and international levels have negative consequences on demand, production, trade, firms, employment and household income. In addition, the most severe drought since 2000 has hit the country, with agricultural production falling by more than 30 percent in the third quarter compared to the same period in 2019 (World Bank, 2020). Modeling and COVID-19 forecasting will help the country to plan and prepare resources to manage future COVID-19 cases. In this study we applied the artificial neural network approach to predict daily COVID-19 cases. The results of the study revealed

that daily COVID-19 cases in Moldova are likely to remain high over the out-of-sample period. Therefore we advise the government to continue enforcing implementation of WHO guidelines on prevention and control of COVID-19.

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