Forecasting Covid-19 New Cases in Croatia

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Abstract - **In this study, the ANN approach was applied to analyze COVID-19 new cases in Croatia. 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 COVID-19 cases are likely to remain very high over the out-of-sample period. Amongst other suggested policy directions, there is need for the government of Croatia to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Croatia is southern European country that shares a sea border with Italy (Korajlija & Jokic-Begic, 2020). The country reported its first case of COVID-19 on the 25th February 2020 (CEDC, 2020). By the 9th of April 2020, the country had reported 1343 positive cases and 19 fatalities (Puljak et al, 2020). On the 13th March 2020 the authorities decided to implement a national lockdown, closure of schools and temporary ban on public gatherings and restricting movement of people in addition to the other COVID-19 preventative measures (Ministry of Science and Education, 2020). In this paper we aim to predict daily COVID-19 cases in Croatia using the artificial neural network approach. The artificial intelligence technique has been successfully applied in similar or related studies (Maradze et al, 2021; Nyoni & Nyoni, 2021; Nyoni et al, 2021; Zhao et al, 2020; Nyoni et al, 2020). The results of the study are envisioned to reveal likely future trends of COVID-19 cases and stimulate a scientific evidence based approach to the prevention and control of the epidemic.

II. LITERATURE REVIEW

Guo & He (2021) predicted the global confirmed COVID-19 cases and deaths using an artificial intelligence technique. They developed an artificial neural network (ANN) for modeling of the confirmed cases and deaths of COVID-19. The confirmed cases and deaths data are collected from January 20 to November 11, 2020 by the World Health Organization (WHO).The study showed that the ANN model is suitable for predicting the confirmed cases and deaths of COVID-19 in the future. Ćosićet al (2020) applied artificial intelligence to predict COVID-19 induced mental disorders among healthcare workers in Croatia. The proposed methodology, included objective assessment of intensity of HCWs' stressor exposure during the COVID-19 pandemic, subjective assessment of stress experienced by HCWs during the COVID-19 pandemic based on the specific psychological questionnaire, distinctive stimulation paradigms designed and developed, computed neuro-physiological features based on stimulation responses, as well as statistical and ML data analysis. The study concluded that early identification of mental health disorders based on the proposed methodology as well as early warning indicators and risk factors are prerequisites for on-time prediction and prevention of mental health disorders of the global population, helping clinicians make diagnoses more quickly and accurately, and rapidly providing optimal treatment for patients. Korajlija & Jokic-Begic (2020) examined changes in levels of COVID-19 concern and safety behaviors among persons living in Croatia during the period in which the first COVID-19 case was identified and when the country recorded its first fatality. These changes were examined with respect to gender and family circumstances. Participants completed online questionnaire regarding various COVID-19 concerns and safety behaviors aimed at disease prevention. The findings highlighted the importance of developing clear guidelines for alleviating the negative effects on mental health through effective communication strategies that minimize fear and emphasize positive behavioral change. Yue et al (2020)analyzed the national and global infection status of the Coronavirus Disease that emerged in 2019 (COVID-19), then used the trend comparison method to predict the inflection point and Key Point of the COVID-19 virus by comparison with the severe acute respiratory syndrome (SARS) graphs, followed by using the Autoregressive Integrated Moving Average model, Autoregressive Moving Average model, Seasonal Autoregressive Integrated Moving-Average with Exogenous Regressors, and

Holt Winter's Exponential Smoothing to predict infections, deaths, and GDP in China. The study results showed that even if the risks and impacts of the epidemic are significant, China's economy will continue to maintain steady development.

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 Croatia.

Data Issues

This study is based on daily new cases of COVID-19 in Croatia 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	CR
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	0.062376
MSE	25631.883527
MAE	119.756402

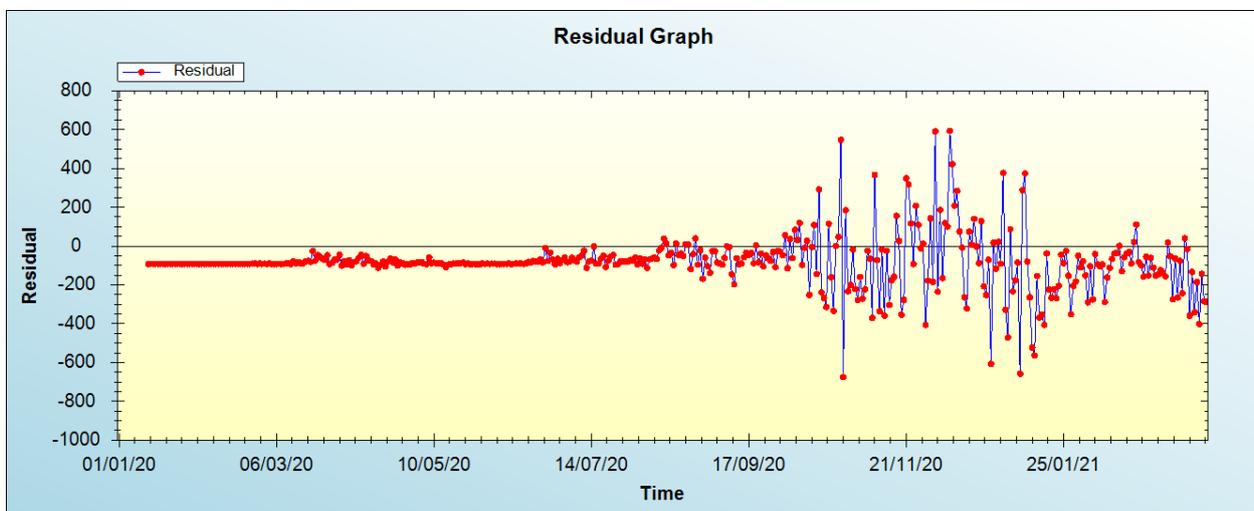*Residual Analysis for the Applied Model*

Figure 1: Residual analysis
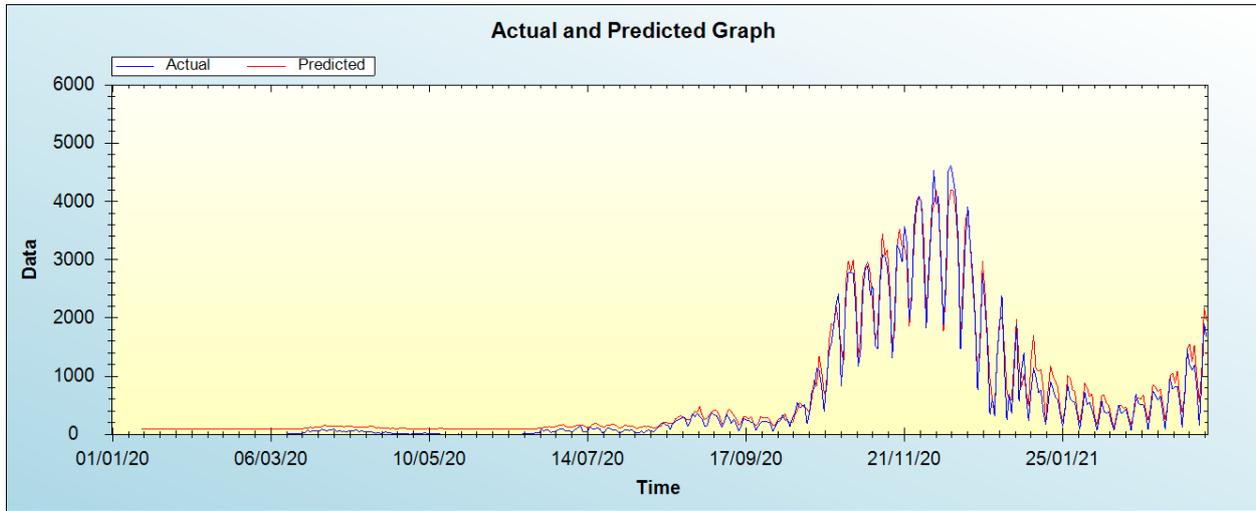
In-sample Forecast for CR

Figure 2: In-sample forecast for the CR series

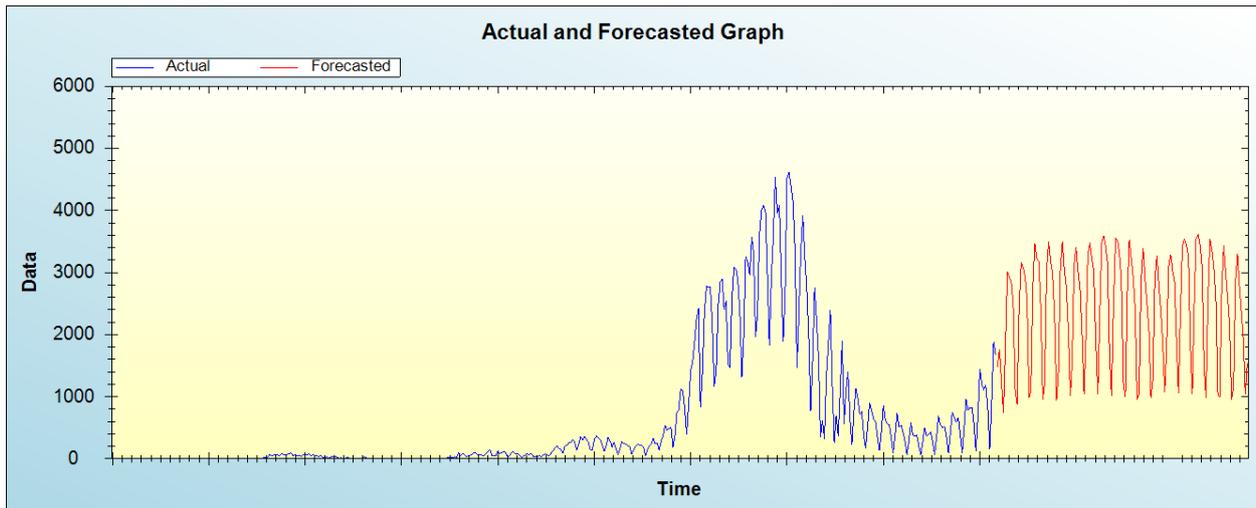*Out-of-Sample Forecast for CR: Actual and Forecasted Graph*

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

Out-of-Sample Forecast for CR: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	1481.5774
27/03/21	1758.4459
28/03/21	1266.9089
29/03/21	738.8108
30/03/21	1803.6182
31/03/21	3015.7477
01/04/21	2918.9381
02/04/21	2843.6275
03/04/21	2446.5566
04/04/21	1091.1775
05/04/21	876.5890
06/04/21	2470.1285
07/04/21	3160.3321
08/04/21	3080.7042
09/04/21	2935.9064

10/04/21	2564.0249
11/04/21	978.0217
12/04/21	1097.9889
13/04/21	2790.7149
14/04/21	3462.3737
15/04/21	3219.4643
16/04/21	3173.2677
17/04/21	2453.3539
18/04/21	959.5033
19/04/21	1204.9059
20/04/21	3054.0078
21/04/21	3485.9930
22/04/21	3177.7525
23/04/21	2973.7259
24/04/21	2324.2560
25/04/21	941.0560
26/04/21	1355.8275
27/04/21	3036.5791
28/04/21	3497.4543
29/04/21	3046.7748
30/04/21	2767.0561
01/05/21	2079.2864
02/05/21	1010.6645
03/05/21	1590.5325
04/05/21	3122.0680
05/05/21	3406.2337
06/05/21	3017.1694
07/05/21	2738.6691
08/05/21	1961.0146
09/05/21	1035.0508
10/05/21	1996.2675
11/05/21	3271.8168
12/05/21	3474.6325
13/05/21	3212.3609
14/05/21	3033.4781
15/05/21	1885.7639
16/05/21	1041.7106
17/05/21	2341.1373
18/05/21	3485.4097
19/05/21	3588.5073
20/05/21	3428.3251
21/05/21	3167.4456
22/05/21	1682.0277
23/05/21	1012.8810
24/05/21	2532.1478
25/05/21	3552.1376
26/05/21	3524.0861
27/05/21	3303.1668
28/05/21	2907.4460
29/05/21	1240.8156
30/05/21	993.3868
31/05/21	2696.2418
01/06/21	3529.7470
02/06/21	3227.5400
03/06/21	2919.2853
04/06/21	2415.6237
05/06/21	951.3452
06/06/21	1048.3696
07/06/21	2859.8956
08/06/21	3388.0940
09/06/21	2902.4843
10/06/21	2481.9472
11/06/21	2064.0266
12/06/21	982.7696

13/06/21	1279.5248
14/06/21	2893.3502
15/06/21	3272.1387
16/06/21	2765.9399
17/06/21	2399.3440
18/06/21	1867.4131
19/06/21	1075.3080
20/06/21	1771.6109
21/06/21	3094.5307
22/06/21	3294.3431
23/06/21	3015.6755
24/06/21	2849.9475
25/06/21	1870.3597
26/06/21	1056.9462
27/06/21	2291.0970
28/06/21	3419.3056
29/06/21	3543.5128
30/06/21	3444.4124
01/07/21	3250.0251
02/07/21	1809.3113
03/07/21	1039.7576
04/07/21	2483.3135
05/07/21	3543.3468
06/07/21	3610.4789
07/07/21	3443.6025
08/07/21	3097.5287
09/07/21	1463.9713
10/07/21	993.9509
11/07/21	2574.9249
12/07/21	3541.3624
13/07/21	3366.6644
14/07/21	3080.2192
15/07/21	2586.3919
16/07/21	1028.8101
17/07/21	998.8328
18/07/21	2773.6450
19/07/21	3427.3563
20/07/21	3002.6484
21/07/21	2599.2888
22/07/21	2167.1145
23/07/21	952.3474
24/07/21	1147.8271
25/07/21	2861.7224
26/07/21	3302.5500
27/07/21	2786.4333
28/07/21	2373.0028
29/07/21	1928.5901
30/07/21	1047.0609
31/07/21	1538.1827

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 Croatia are likely to remain very high over the out-of-sample period.

V. CONCLUSION AND POLICY RECOMMENDATIONS

Artificial neural networks have been applied by various researchers to forecast emerging infectious diseases such as COVID-19. They have an ability to model nonlinear big data. Their use is not only for prediction purposes but also for solving pattern recognition, classification and regression problems. The multilayer perceptron is the most widely applied neural network and has been noted to have high accuracy. In this study the ANN (12, 12, 1) was applied to predict daily new COVID-19 cases in Croatia. The results of the study indicate that COVID-19 cases are likely to remain very high over the out-of-sample period.

Therefore we encourage the government to continue enforcing adherence to the COVID-19 public health mitigation measures and promotion of COVID-19 vaccination.

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