PREDICTION OF COVID-19 CASES IN POLAND USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

The COVID-19 pandemic has triggered an unprecedented global public health response. In this research paper, the ANN approach was applied to analyze COVID-19 cases in Poland based on data that covers the period March 4, 2020 to October 31, 2020. The out-of-sample period covers the period November 2020 to April 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the model applied in this research indicate that the model is stable. The results of our research indicate that daily COVID-19 cases will slightly increase, from approximately 21241 cases on November 1, 2020; until around December 7, 2020; where an equilibrium daily case volume of approximately 22084 cases will be reached and this daily equilibrium case volume is likely to be persistant through out the rest of the out-of-sample period. The Polish government, in line with WHO guidelines; should continue to implement serious control and preventive measures in order to save as many lives as possible.

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

INTRODUCTION

In late December 2019, COVID-19 cases were officially reported in Wuhan, China. On March 11, 2020, the WHO declared the COVID-19 outbreak a pandemic, indicating the global spread of a new disease (Holmes *et al*., 2020; Hui *et al*., 2020). First cases of COVID-19 infections in Poland were reported on March 4, 2020 and the first death on March 10, 2020. 2 days later, a state of epidemic was introduced, followed by imposition of quarantine measures (Wanat, 2020). Despite the fact that a number of COVID-19 studies have been carried out in Poland, for example, Piasecki *et al*. (2020), Zimon & Dankiewicz (2020), Napierala *et al*. (2020), Moron & Biolick-Moron (2020), Rizun & Strzelecki (2020), Zawadka *et al*. (2020), Nagaj & Korpysa (2020), Malesza & Kaczmarek (2020), Zavala *et al*. (2020), Pustulka & Buler (2020) and Jarynowski *et al*. (2020); no study has specifically forecasted daily COVID-19 case volumes in the country and yet such information is critical for planning purposes, especially with regards to optimal resource allocations in the fight against the pandemic. It is this research gap that we seek to fill. Therefore, we apply an Artificial Neural Network (ANN) model to forecast daily confirmed COVID-19 cases in Poland.

METHODOLOGY

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID-19 infections. The study particularly applies the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function. The study is based on daily new COVID-19 cases (referred to as E series in this study) for all age groups in Poland. The data covers the period 4 March 2020 to 31 October 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 John Hopkins University (USA).

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
1498.9	399.50	0.00000	21897.
Std. Dev.	C.V.	Skewness	Ex. kurtosis
3522.7	2.3502	3.8844	15.709
5% Perc.	95% Perc.	IQ range	Missing obs.
21.400	9572.3	416.50	0

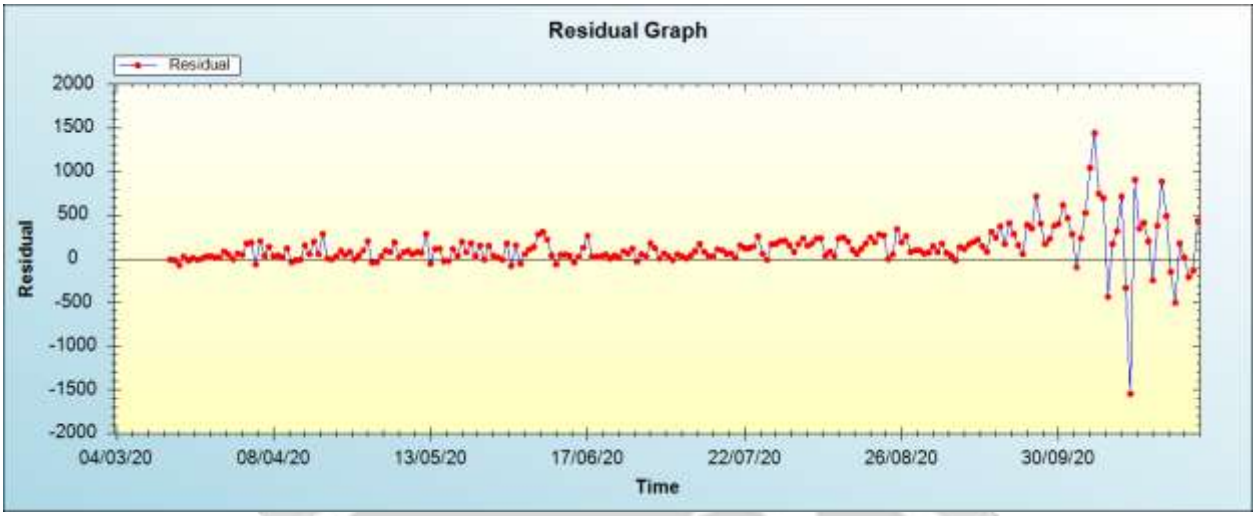
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN POLAND

Table 2: ANN model summary

Variable	E
Observations	230 (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	0.021883
MSE	70863.156617
MAE	164.992287

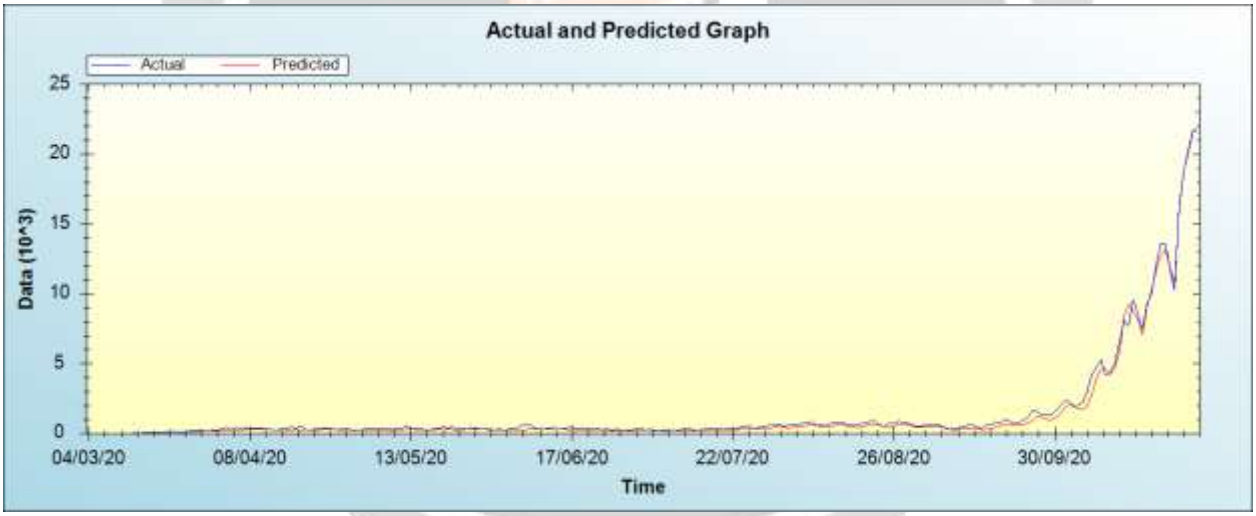
Residual Analysis for the ANN model

Figure 1: Residual analysis



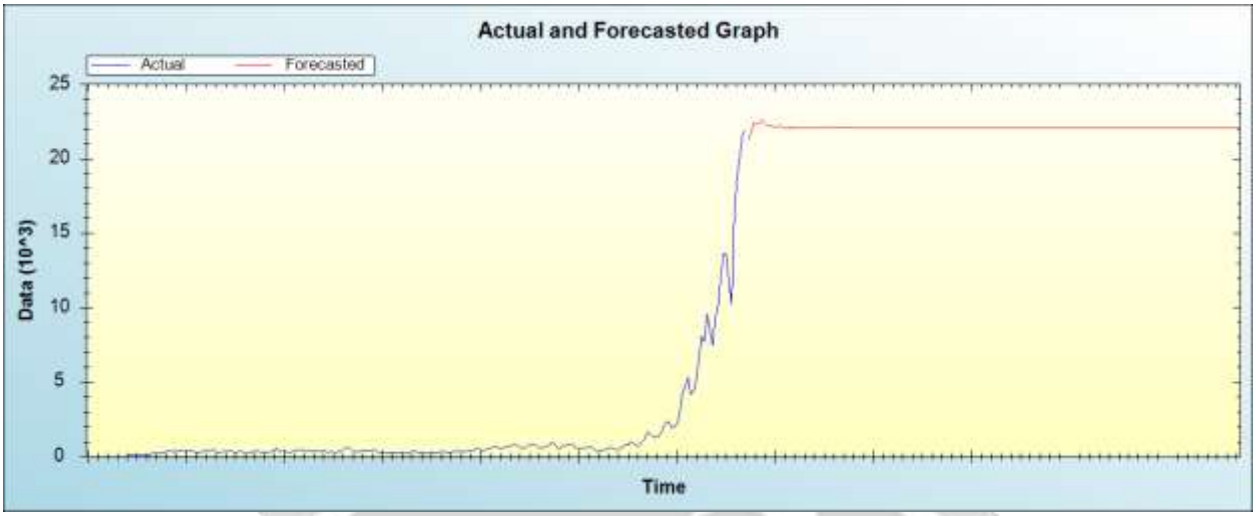
In-sample Forecast for E

Figure 2: In-sample forecast for the E series



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

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



Out-of-Sample Forecast for E: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	21240.9741
02/11/20	21706.7590
03/11/20	22358.3287
04/11/20	22319.7534
05/11/20	22358.0374
06/11/20	22616.5467
07/11/20	22426.4127
08/11/20	22236.4706
09/11/20	22240.5479
10/11/20	22187.5913
11/11/20	22113.9272
12/11/20	22162.2878
13/11/20	22173.3439
14/11/20	22101.0752

15/11/20	22074.5824
16/11/20	22084.9911
17/11/20	22060.2344
18/11/20	22058.9715
19/11/20	22081.3053
20/11/20	22081.0242
21/11/20	22073.7932
22/11/20	22079.8717
23/11/20	22080.1023
24/11/20	22075.1318
25/11/20	22079.7033
26/11/20	22085.2524
27/11/20	22083.7525
28/11/20	22084.2171
29/11/20	22085.9650
30/11/20	22084.4505
01/12/20	22083.5739
02/12/20	22084.8998
03/12/20	22085.0651
04/12/20	22084.5326
05/12/20	22084.9659
06/12/20	22085.0183
07/12/20	22084.3615
08/12/20	22084.3437
09/12/20	22084.5536
10/12/20	22084.3839

11/12/20	22084.3681
12/12/20	22084.5254
13/12/20	22084.4411
14/12/20	22084.3303
15/12/20	22084.3887
16/12/20	22084.3971
17/12/20	22084.3517
18/12/20	22084.3942
19/12/20	22084.4251
20/12/20	22084.3937
21/12/20	22084.3917
22/12/20	22084.4086
23/12/20	22084.3971
24/12/20	22084.3936
25/12/20	22084.4087
26/12/20	22084.4086
27/12/20	22084.4018
28/12/20	22084.4060
29/12/20	22084.4066
30/12/20	22084.4018
31/12/20	22084.4034
01/01/21	22084.4061
02/01/21	22084.4043
03/01/21	22084.4039
04/01/21	22084.4052
05/01/21	22084.4042

06/01/21	22084.4034
07/01/21	22084.4042
08/01/21	22084.4043
09/01/21	22084.4038
10/01/21	22084.4041
11/01/21	22084.4043
12/01/21	22084.4039
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27/04/21	22084.4041
28/04/21	22084.4041
29/04/21	22084.4041
30/04/21	22084.4041

The descriptive statistics, summary of the applied predictive model, residual analysis, in-sample forecasts as well as out-of-sample forecasts are shown in table 1, table 2, figure 1, figure 2 and well as figure 3 and table 3, respectively. The results of the study indicate that daily COVID-19 cases will slightly increase, from the estimated 21241 cases on November 1, 2020; until around December 7, 2020; where an equilibrium daily case volume of approximately 22084 cases will be reached and this daily equilibrium case volume is likely to be persistant through out the rest of the out-of-sample period.

CONCLUSION & RECOMMENDATIONS

COVID-19 is a global public health emergency with no end date in sight (Pustulka & Buler, 2020). Poland, just any other country in any part of the globe, has not been spared by the COVID-19 pandemic and hence the need for forecasting and control. Based on 242 daily observations of COVID-19 cases in Poland, this study used the ANN model to come up with daily forecasts ranging over the period November 2020 to April 2021. The COVID-19 pandemic, as revealed by our forecasts is still and will remain highly prevalent in Poland, for the next 6 months (that is, November 2020 – April 2021) and even beyond; especially when no effective vaccine against COVID-19 is yet found. The Polish government should continue to implement serious control and preventive measures in order to save as many lives as possible.

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