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

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ABSTRACT

In this research article, the ANN approach was applied to analyze daily new COVID-19 cases in Ukraine. The employed data covers the period March 3, 2020 to October 31, 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 the applied model indicate that the model is stable in forecasting daily new COVID-19 cases in Ukraine. The results of the study indicate that the projected number of daily new COVID-19 cases will generally be around 8700 cases per day from November 1, 2020 to 30 April, 2021.Therefore the Ukrainian government needs to continue enforcing adherence to WHO guidelines on prevention and control of COVID-19 epidemic.

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

INTRODUCTION & BACKGROUND

The COVID-19 pandemic has significantly affected the world economy with the projected global fall in GDP to 2.4% overall in 2020 (Vojtiuk & Shkoda, 2020).The deadly SARS-COV-2 virus was first reported in Wuhan a city in China in December 2019 and it then spread rapidly across borders to many regions of the world (Kahn et al, 2020; Guo et al, 2020; Chan et al, 2020; Wu et al, 2020; Unhale et al, 2020). In Ukraine the Hotel and business industry has been hard hit by the pandemic. The introduction of quarantine over a large territory and for long periods carries serious negative effects on the economy. Closed restaurants in cities could lead to bankruptcy (Vojtiuk & Shkoda, 2020). A survey of the SUP participants suggests that the quarterly revenue for Ukraine would drop by an average of 30-50% due to disruption of supply chains and suspension of production. Ukraine responded to the COVID-19 epidemic by implementing severe restrictions which included quarantine for all people above 60years of age, postponement of all non-urgent medical admissions and elective surgeries amongst other strategies (Mankovsky, 2020). The SARS-CoV-2 virus is mainly transmitted via the respiratory route and its clinical symptoms are dry cough, high fever, shortness of breath and loss of smell and/taste (Yuliya et al, 2020). Some patients are asymptomatic which accounts for about 50-75% of the COVID-19 infected patients (Mizumoto et al, 2020; Day et al, 2020). Elderly patients and those with chronic medical illnesses tend to develop severe disease. The most severe cases will require ICU care and ventilatory support (Richardson et al, 2020; Berlin et al, 2020). The incubation period of SARS-CoV-2 varies with individuals. On average it takes 5.5days but can go up to

14days. The viral loads of asymptomatic and symptomatic patients are similar; hence they have the same ability to infect (Wang et al, 2020; Zou et al, 2020). There are few empirical studies in Ukraine which focus on the dynamics of COVID-19 epidemic. One such study was carried out by Yuliya et al (2020). The researchers did mathematical modeling and containment of COVID-19 in Ukraine. The SEIR model was applied and the findings of the study indicated that the model is able to provide accurate short term forecasts for the numbers and age distribution of the cases and deaths. The results also suggest that reducing work contacts is more efficient at reducing the disease burden than reducing school contacts or implementing shielding for people over 60. In this paper we applied the ANN (multilayer perceptron) to model and forecast daily new COVID-19 cases from November 2020 to April 2021. The research findings will help Ukraine to plan, make decisions and allocate resources for health which in turn will trigger an evidence-based National health response to curb the spread of the epidemic in the communities.

METHOD

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID-19 infections in Ukraine. This 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 CU series in this study) for all age groups in Ukraine. The data covers the period 3March 2020 to 31October 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 Johns Hopkins University (USA).

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
1643.3	828.00	0.00000	9058.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
1955.2	1.1897	1.6941	2.2218
5% Perc.	95% Perc.	IQ range	Missing obs.
0.00000	6156.2	1987.0	0

ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN UKRAINE

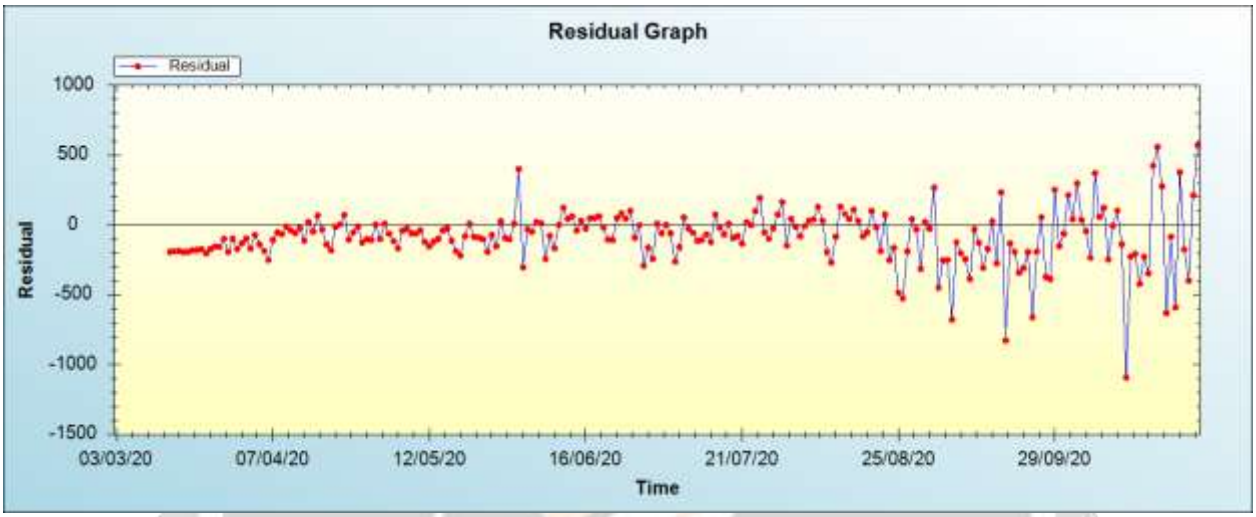
Table 2: ANN model summary

Variable	CU
Observations	231 (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	0.042120
MSE	44925.195622
MAE	148.812929

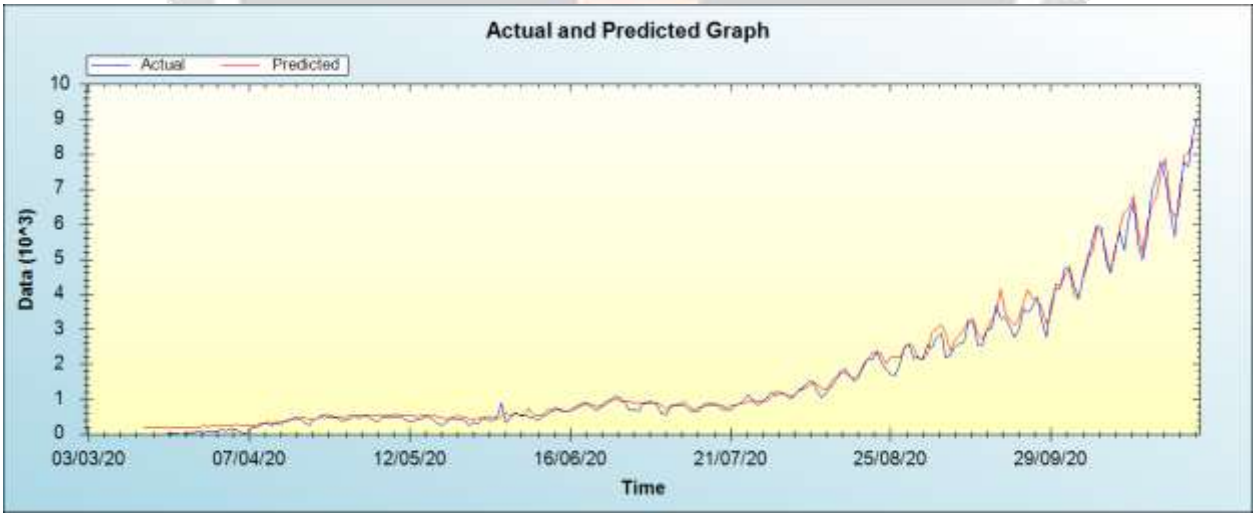
Residual Analysis for the ANN model

Figure 1: Residual analysis



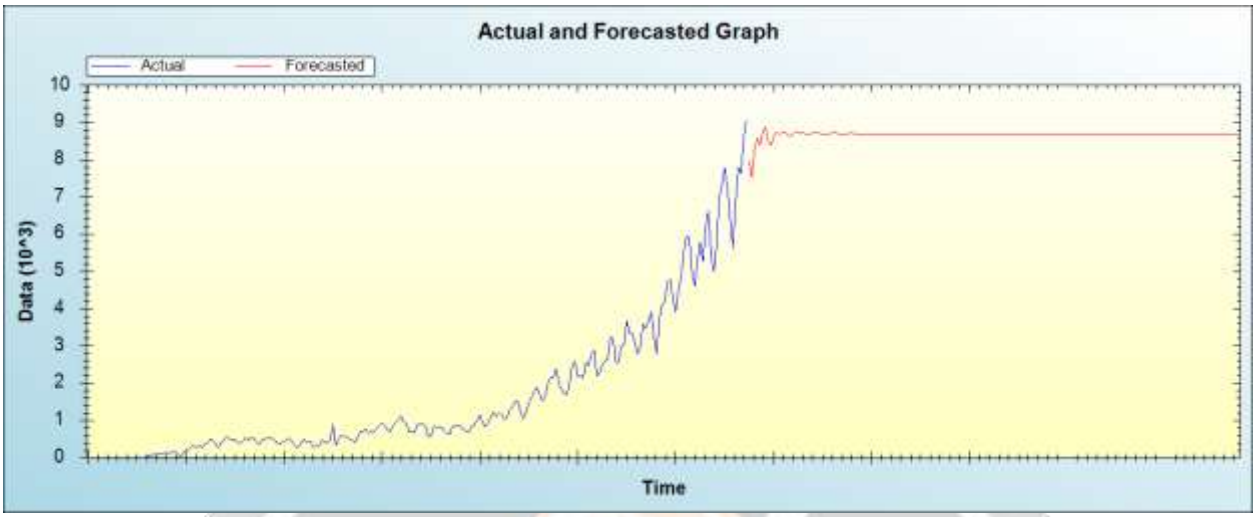
In-sample Forecast for CU

Figure 2: In-sample forecast for the CU series



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

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



Out-of-Sample Forecast for CU: Forecasts only

Table 3: Forecasted daily new COVID-19 cases

Day/Month/Year	Forecasted daily new COVID-19 cases
01/11/20	7967.8075
02/11/20	7532.0350
03/11/20	8297.5897
04/11/20	8574.9084
05/11/20	8398.1128
06/11/20	8762.2757
07/11/20	8874.5205
08/11/20	8499.2534
09/11/20	8378.3331
10/11/20	8620.2564
11/11/20	8740.5462
12/11/20	8678.2304
13/11/20	8725.3846

14/11/20	8752.6783
15/11/20	8662.2121
16/11/20	8629.8109
17/11/20	8692.0866
18/11/20	8730.0653
19/11/20	8709.8196
20/11/20	8707.5630
21/11/20	8714.5261
22/11/20	8698.7574
23/11/20	8691.1558
24/11/20	8705.4203
25/11/20	8715.3789
26/11/20	8709.7646
27/11/20	8706.1215
28/11/20	8707.8316
29/11/20	8706.1776
30/11/20	8704.6294
01/12/20	8707.4684
02/12/20	8709.8112
03/12/20	8708.3998
04/12/20	8706.9902
05/12/20	8707.3961
06/12/20	8707.5234
07/12/20	8707.2567
08/12/20	8707.7184
09/12/20	8708.2109

10/12/20	8707.8924
11/12/20	8707.4873
12/12/20	8707.5816
13/12/20	8707.7201
14/12/20	8707.6847
15/12/20	8707.7325
16/12/20	8707.8224
17/12/20	8707.7597
18/12/20	8707.6612
19/12/20	8707.6823
20/12/20	8707.7343
21/12/20	8707.7322
22/12/20	8707.7283
23/12/20	8707.7415
24/12/20	8707.7315
25/12/20	8707.7106
26/12/20	8707.7150
27/12/20	8707.7299
28/12/20	8707.7306
29/12/20	8707.7264
30/12/20	8707.7275
31/12/20	8707.7266
01/01/21	8707.7228
02/01/21	8707.7236
03/01/21	8707.7272
04/01/21	8707.7276

05/01/21	8707.7260
06/01/21	8707.7258
07/01/21	8707.7259
08/01/21	8707.7254
09/01/21	8707.7255
10/01/21	8707.7263
11/01/21	8707.7264
12/01/21	8707.7259
13/01/21	8707.7258
14/01/21	8707.7259
15/01/21	8707.7259
16/01/21	8707.7259
17/01/21	8707.7260
18/01/21	8707.7261
19/01/21	8707.7259
20/01/21	8707.7259
21/01/21	8707.7259
22/01/21	8707.7260
23/01/21	8707.7260
24/01/21	8707.7260
25/01/21	8707.7260
26/01/21	8707.7260
27/01/21	8707.7259
28/01/21	8707.7260
29/01/21	8707.7260
30/01/21	8707.7260

31/01/21	8707.7260
01/02/21	8707.7260
02/02/21	8707.7260
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28/04/21	8707.7260
29/04/21	8707.7260
30/04/21	8707.7260

Figure 1 shows that over the study period the minimum and maximum number of daily new COVID-19 cases are 0 and 9058 respectively. The average daily new cases are 1643 cases. The data is positively skewed with a kurtosis of 2.2218 meaning that the data is not normally distributed. The residual graph and model evaluation criteria indicate that the model is stable and suitable for forecasting daily new COVID-19 cases in Ukraine. The out -sample forecasts in table 3 indicate that the projected number of daily new COVID-19 cases in the out -of sample period will generally be around 8700 cases per day (equilibrium level) until 30 April 2021.

CONCLUSION & RECOMMENDATIONS

The Ukrainian economy and the health system have been severely affected by the COVID-19 epidemic. The government of Ukraine put in place strict measures to contain the epidemic which is suggested by the projected number of daily new cases which are expected to reach equilibrium point from November 1, 2020 to April 30, 2021.The authorities in this country should continue enforcing adherence to the WHO guidelines on prevention and control of the epidemic.

REFERENCES

[1] Berlin etal (2020). Severe Covid-19. N. Engl. J. Med., 10.1056/NEJMcp2009575.

[2] Blyuss & Kyrychko (2020). Effects of latency and age structure on the dynamics and containment of COVID-19. Preprint at https://www.medrxiv.org/content/10.1101/2020.04.25.20079848v1.

[3] Chen etal (2020). Emerging coronaviruses: genome structure, replication, and pathogenesis. Journal of medical virology, 92,4, 418-423.

[4] Chowell etal (2015). Transmission characteristics of MERS and SARS in the healthcare setting: a comparative study. BMC medicine, 13,1, 210.

[5] COVID-19 Repository By the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University.

[6] Day, M (2020). COVID-19: identifying and isolating asymptomatic people helped eliminate virus in Italian village. BMJ 368, m1165; https://doi.org/10.1136/bmj.m1165

[7] Dong, E., *et al*. (2020). An Interactive Web-based Dashboard to Track COVID-19 in Real Time, *Lancet Infectious Diseases*, 20 (5): 533 – 534.

[8] Guo etal (2020). The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak–an update on the status. Military Medical Research, 7,1, 1-10.

[9] Kahn etal (2005). History and recent advances in coronavirus discovery. The Pediatric infectious disease journal, 24,11, S223-S227.

[10] Mankovsky (2020). Diabetes Care at the Times of Transition and COVID-19 Pandemics (Ukrainian Experience) Journal of Diabetes science and Technology 14,4,754-755.

[11] Mizumoto et al (2020). Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020. Euro Surveill.25, 2000180.

[12] Richardson et al (2020). Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with COVID-19 in the New York City area. JAMA 323, 2052-2059.

[13] Wang etal (2020). A novel coronavirus outbreak of global health concern. Lancet395, 470-473.

[14] Yuliya etal (2020). Mathematical modelling of dynamics and containment of COVID-19 in Ukraine medRxiv pp 1-13.

[15] Zou, etal (2020). SARS2viral load in upper respiratory specimens of infected patients. N.Engl.J.Med. 382,1177-1179.