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

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ABSTRACT

The COVID-19 pandemic has caused a lot of suffering and deaths across the whole world. Many people have lost their jobs, suffered from the disease or even died. Several forecasting models have been applied in order to understand the nature of the pandemic to bring immediate solutions in order to save lives. In this piece of work the researchers applied the artificial neural network, ANN (12, 12, 1) model with activation function being the hyperbolic tangent function. The model evaluation statistics show that the applied ANN is adequate and stable and suitable for forecasting daily new COVID-19 cases in Russia. The results of the study indicate that generally the daily new corona virus infections will be constant at around 16116 until 30 April, 2021. The Russian government should continuously enforce WHO guidelines on prevention and control of COVID-19 as the country is projected to continue battling the novel Corona virus over the out of sample period.

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

INTRODUCTION

The first pneumonia cases of unknown cause were first reported in Wuhan in the Hubei province of China in December 2019 (Guan et al, 2020). This outbreak initiated an intense cautionary notice not only in China but across the whole world (Lasisi &Eluwole, 2020). It is still unclear when this pandemic is going to end although some countries especially in Africa have managed to control the disease. In most first world countries the pandemic is growing and spreading rapidly and far from under control (Fang et al, 2020). This viral infection causes a severe acute respiratory condition (Pramanik et al, 2020). The first corona virus case and death in Russia was reported in Moscow on March 2 and 19, 2020 and as of 12 June 2020 the confirmed cases had increased to 511,423(The Moscow times, 2020). The Russian Federation has been facing a myriad of challenges in the control of the epidemic, chief among them is the nature of the virus which is rapidly spreading among communities and is very fatal especially in high risk groups such as the elderly and COVID-19 infected patients with co-morbidities like Diabetes Mellitus and Heart failure. Several predictive models have been applied for forecasting COVID-19 infections and deaths. These include ARIMA and Machine learning algorithms whose results of have been seen to be very accurate and reliable (Gregory et al, 2020; Miller et al, 2020; Pham, 2020). In this study the researchers chose to apply the artificial neural network, the Multilayer perceptron with a single hidden layer because it has been widely used and has good accuracy as

well as reliable results. The findings of this piece of work will help the Russian government to have more understanding of the trends of the daily new cases of corona virus from November 1, 2020 to 30 April, 2021.This will enable the state to plan, make decisions and to respond appropriately to the epidemic.

LITERATURE REVIEW

Table 1: Selected Papers for Review

Author(s)/year	Study Period	Method	Major Findings
Lakman et al (2020)	23March ,2020 to 10May,2020	ARIMA, SIRD, Holt's exponential smoothing	Prediction of short-term morbidity and mortality and survival of patients with an accuracy of 90%in Russia Federation in general. Moscow and Moscow region have maximum spread of the corona virus and other regions lagging behind in the dynamics of the incidence by 1-3 weeks.
Pramanik et al (2020)	2March to 26 May 2020	Random Forest algorithm.	Temperature seasonality has the highest contribution for COVID-19 transmission in the humid continental region. September and October have favorable climatic conditions for the COVID-19 spread in the arctic and humid continental regions. From June to August the high favorable zone for COVID-19 spread will shift towards the subarctic region from the continental region.

Fang et al (2020)	3January 2020 to 20May 2020	ARIMA (2,2,1), ARIMA (3,2,0), ARIMA (0,2,1). -prediction of cumulative confirmed, dead and recovered cases	Russian's health system can effectively respond to the COVD-19 pandemic.
Lasisi &Eluwole (2020)	21March 2020 to 28May 2020	Spearman-Rank Order Correlation of the number of confirmed COVID-19 cases in Russia with temperature (minimum, maximum, average)	There is a stronger correlation between average temperature and number of confirmed cases and also significant correlations for the other variants of temperature.

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 Russia. The study particularly applies the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function.

Data Issues

This study is based on daily new covid-19 cases (referred to as D series in this study) for all age groups in Russia. The data covers the period 31 January 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
5841.0	5779.0	0.00000	17987.
Std. Dev.	C.V.	Skewness	Ex. kurtosis
4432.3	0.75883	0.47990	-0.052914
5% Perc.	95% Perc.	IQ range	Missing obs.
0.00000	15038.	7412.0	0

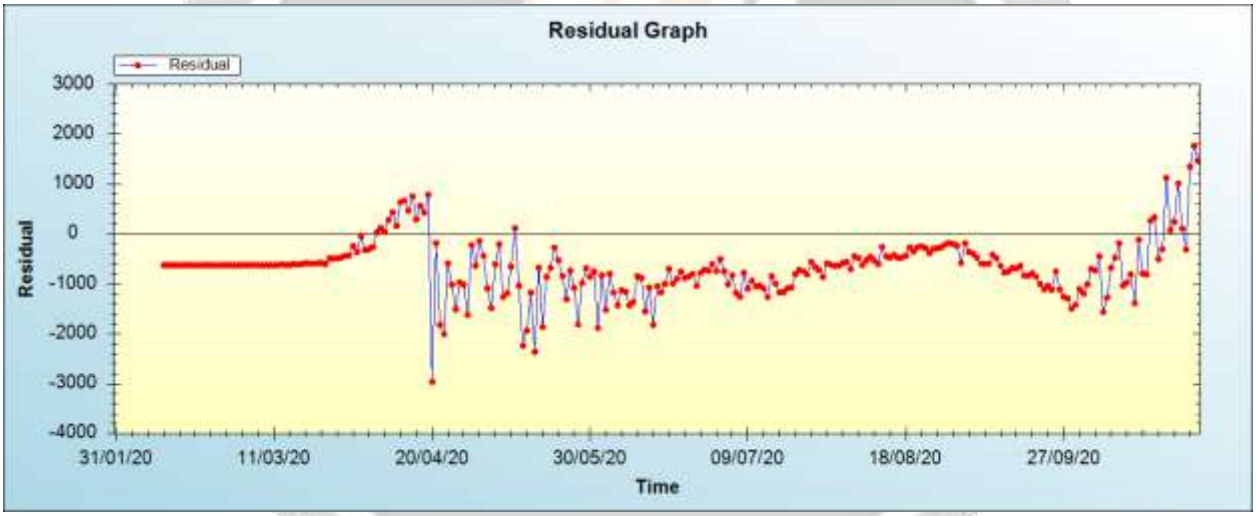
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN RUSSIA

Table 2: ANN model summary

Variable	D
Observations	263 (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	0.087677
MSE	767608.316037
MAE	761.375090

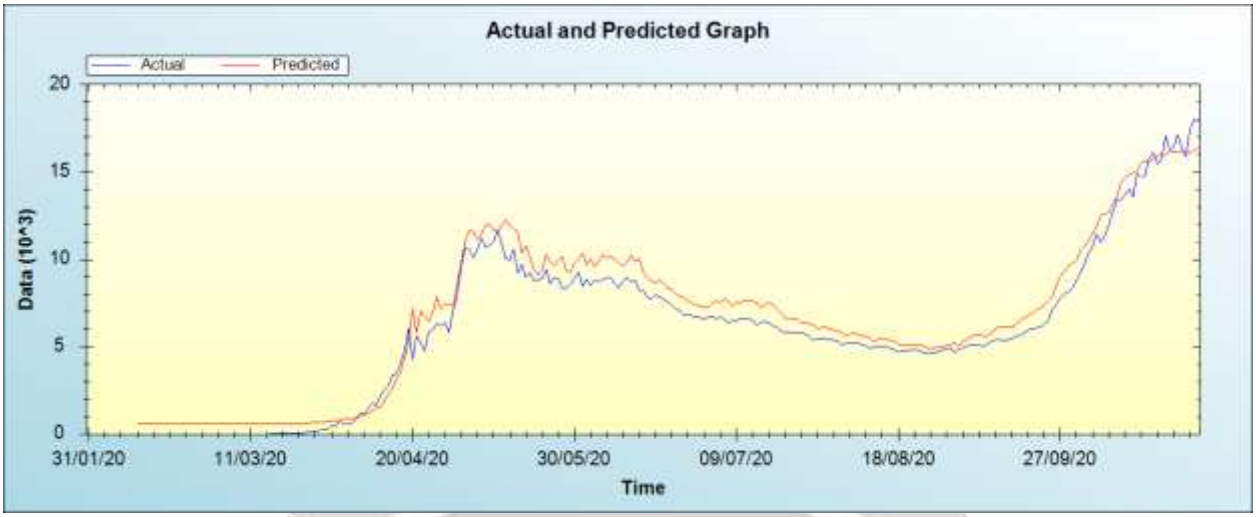
Residual Analysis for the ANN model

Figure 1: Residual analysis



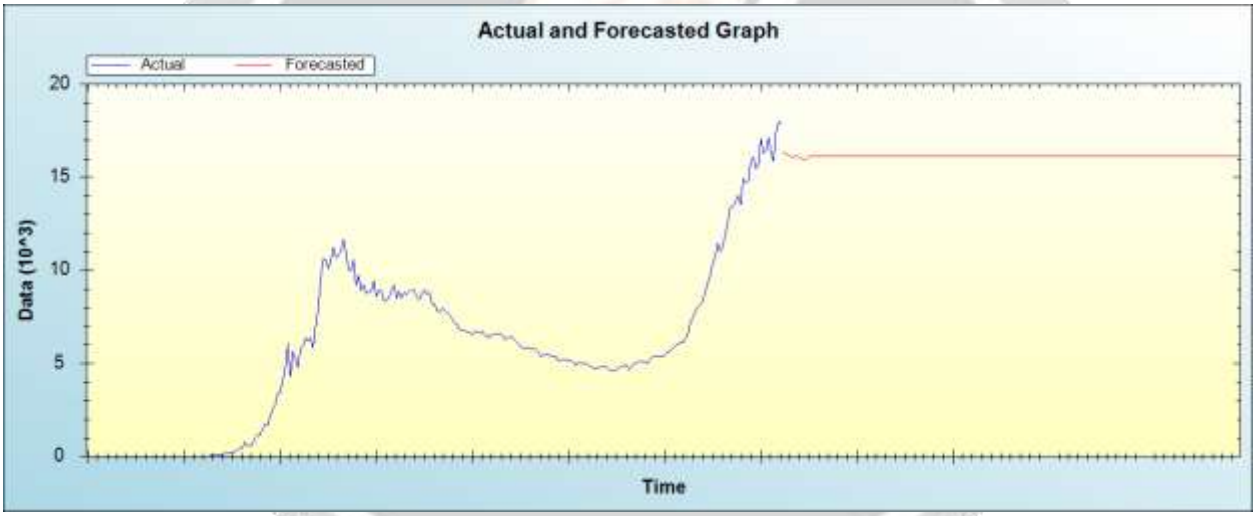
In-sample Forecast for D

Figure 2: In-sample forecast for the D series



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

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



Out-of-Sample Forecast for D: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/month/year	Focasted daily new COVID-19 cases
01/11/20	16337.8268
02/11/20	16233.3926
03/11/20	16210.5317
04/11/20	16132.3030
05/11/20	16043.3265

06/11/20	16150.1368
07/11/20	16111.5844
08/11/20	16037.5962
09/11/20	15924.0405
10/11/20	16027.6475
11/11/20	16113.5924
12/11/20	16120.8613
13/11/20	16108.1151
14/11/20	16122.3038
15/11/20	16119.5062
16/11/20	16115.6498
17/11/20	16112.8709
18/11/20	16125.5764
19/11/20	16126.4110
20/11/20	16116.9559
21/11/20	16111.1656
22/11/20	16114.5428
23/11/20	16115.7266
24/11/20	16115.4244
25/11/20	16115.2943
26/11/20	16116.4005
27/11/20	16116.0246
28/11/20	16115.2002
29/11/20	16115.3687
30/11/20	16116.3573
01/12/20	16116.4138

02/12/20	16116.0383
03/12/20	16115.8988
04/12/20	16116.0289
05/12/20	16115.9888
06/12/20	16115.9246
07/12/20	16115.9706
08/12/20	16116.0495
09/12/20	16115.9916
10/12/20	16115.9278
11/12/20	16115.9445
12/12/20	16115.9887
13/12/20	16115.9859
14/12/20	16115.9733
15/12/20	16115.9768
16/12/20	16115.9832
17/12/20	16115.9751
18/12/20	16115.9714
19/12/20	16115.9777
20/12/20	16115.9821
21/12/20	16115.9781
22/12/20	16115.9750
23/12/20	16115.9763
24/12/20	16115.9777
25/12/20	16115.9769
26/12/20	16115.9766
27/12/20	16115.9773

28/12/20	16115.9775
29/12/20	16115.9768
30/12/20	16115.9766
31/12/20	16115.9771
01/01/21	16115.9773
02/01/21	16115.9770
03/01/21	16115.9770
04/01/21	16115.9771
05/01/21	16115.9771
06/01/21	16115.9770
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30/04/21	16115.9770

Figure 1 shows that the daily minimum and maximum number of new COVID-19 cases over the study period is 0 and 17987 cases respectively. The average daily new cases are 5841infections.Table 2 and Figure 5 is the out of sample forecasts and the results indicate that the daily new corona virus infections over the out of sample period is expected to decrease from around 16338 on Nov, 1 2020 to about 16116 on 20 November, 2020. Daily new infections are then projected to be constant at around 1616 new cases until 30 April, 2021.

CONCLUSION & RECOMMENDATIONS

Russia will still be battling the COVID-19 epidemic in 2021. The study findings indicate that generally the daily new COVID-19 cases will be constant over the out of sample period with daily cases of around 16116.The Russian government should continue to enforce WHO

guidelines on COVID-19 prevention and control particularly, regular hand washing or hand sanitization, physical distancing, wearing face masks, testing and treatment of cases, isolation and continuous health education at all levels in the country.

REFERENCES

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

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

[3] Fang et al (2020). Analysis and Estimation of COVID-19 spreading in Russia Based on ARIMA model. Springer Nature. pp 1-7.

[4] Gregory et al (2020). Fusing a Bayesian case velocity model with Random Forest for predicting COVID-19 in the US. Manuscript. pp 1-51

[5] Guan et al (2020). China Medical Expert Group for COVID-19, others. Clinical characteristics of corona virus disease 2019 in China.

[6] Lasisi &Eluwole (2020). Is the weather induced COVID-19 spread hypothesis a myth or reality. Evidence from the Russian Federation. Environmental Science and Pollution Research. Springer Nature pp 1-5.

[7] Mollalo et al (2020). Artificial Neural Networks Modeling of novel corona virus (COVID-19) incidence rates across the continental United States. International Journal of Environmental Research and Public health.17,204,1-13.

[8] Moscow Times (2020). Russian's corona virus cases continue steady rise

past 500k as country emerges from lockdown. https://www.themoscowtimes.com/2020/06/12/russia-coronavirus-cases-continue-steady-rise-as-country -emerges -from -lockdwn-a69710.

[9] Pham.H(2020). Predictive modeling on the number of COVID-19 death toll in the United States considering the effects of corona virus related changes and COVID-19 Recovered cases. medRxiv pp1-19.

[10] The New York times (2020). A corona virus mystery explained. Moscow has 1,700 extra death. https://www.nytimes.com/2020/05/11/world/Europe/corona virus-deaths-moscow.html