International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 6, pp 732-737, June-2021

https://doi.org/10.47001/IRJIET/2021.506128

Forecasting Covid-19 New Cases in Azerbaijan

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***Abstract* - During the current global urgency, scientists, clinicians and healthcare experts around the globe keep on searching for accurate and reliable COVID-19 forecasting models to support in tackling the deadly and highly infectious disease. In this research paper, the ANN approach was applied to analyze COVID-19 daily cases in Azerbaijan. This study is based on daily new cases of COVID-19 in Azerbaijan for the period 1 January 2020 – 25 March 2021. The out-of-sample forecast covers the period 26 March 2021 – 31 July 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied ANN (12, 12, 1) model indicate that the model is stable in forecasting daily COVID-19 cases in the country. The results of the study indicate that that daily COVID-19 cases in Azerbaijan are likely to remain significantly high over the out-of-sample period. The government of Azerbaijan, through its ministry of health, should continue to implement COVID-19 control and prevention measures such as isolation, quarantine, testing and tracing, face-mask wearing, sanitization of hands and so on, in line with WHO standards.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Escalating at an alarming pace, COVID-19 has emerged as a global pandemic. The virus, thought to be migrated from bats, started transmission in Wuhan, the capital of Hubei, China (Huang *et al*., 2020). COVID-19 affects various people in different ways. Over 80% of COVID-19 patients develop mild to moderate illness and recover without hospitalization (WHO, 2020). Fever, dry cough and tiredness are the most common symptoms of COVID-19. Very few patients will present with symptoms such as chest pain, loss of speech or movement, as well as shortness of breath (Wang *et al*., 2020). There are no specific treatments or vaccines for COVID-19: however, there are many ongoing clinical trials evaluating potential treatments. People can prevent the infection by washing hands, staying home, face-mask wearing, social distancing and so on, as recommended by the World Health Organization (WHO) (Alakus & Turkoglu, 2020). The first case of COVID-19 in Azerbaijan was reported on February 28, 2020. Despite the fact that the COVID-19 pandemic is now widely analyzed using predictive modelling techniques, it is ironical to note that forecasting studies focusing on Azerbaijan are limited, with just a few papers such as Penafiel & Ramirez-Avila (2020) being noticeable. In this paper, we apply the Artificial Neural Network (ANN) model to forecast daily new COVID-19 cases in Azerbaijan. The results of the study are envisioned to ease the strain on the fragile Azerbaijan healthcare system by forecasting the future trends of the infections in the country.

II. 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 look 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 Azerbaijan.

Data Issues

This study is based on daily new cases of COVID-19 in Azerbaijan 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).

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III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	AZB
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	0.048618
MSE	14453.466556
MAE	82.990459

Residual Analysis for the Applied Model

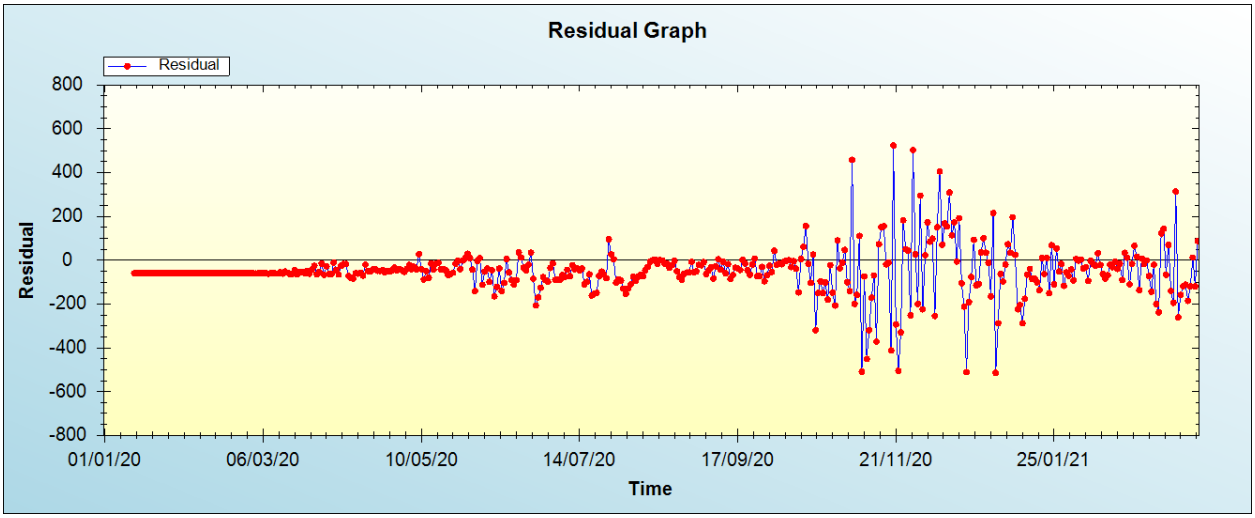

Figure 1: Residual analysis

In-sample Forecast for AZB

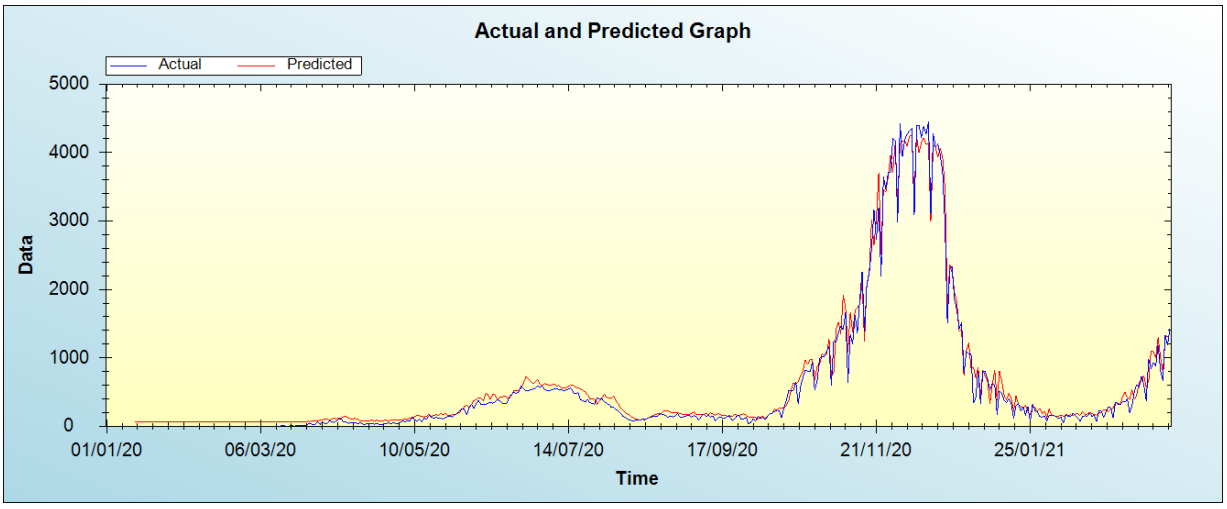

Figure 2: In-sample forecast for the AZB series

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

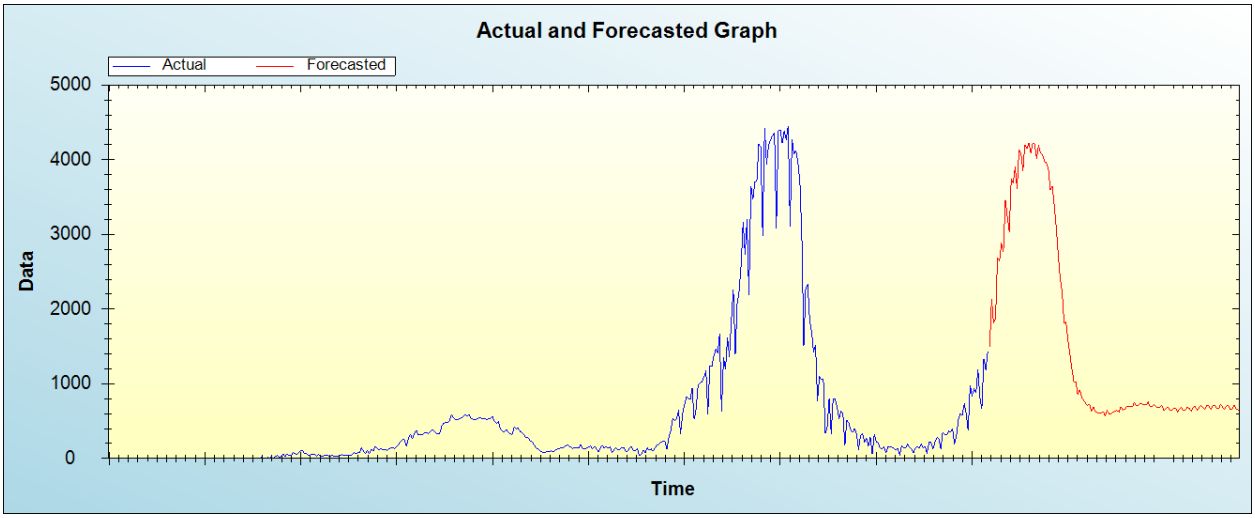

Figure 3: Out-of-sample forecast for AZB: actual and forecasted graph

Out-of-Sample Forecast for AZB: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	1492.7909
27/03/21	2138.1509
28/03/21	1819.2431
29/03/21	1867.6821
30/03/21	2684.0650
31/03/21	2646.7100
01/04/21	2884.2982
02/04/21	2761.9174
03/04/21	3459.7717
04/04/21	3243.3255
05/04/21	3034.3478
06/04/21	3737.5946
07/04/21	3687.5132
08/04/21	3908.5857
09/04/21	3618.9725
10/04/21	4132.2818
11/04/21	4080.5869
12/04/21	3848.6712
13/04/21	4203.4216
14/04/21	4142.9608
15/04/21	4226.0372
16/04/21	4088.0726
17/04/21	4215.7800
18/04/21	4207.1990
19/04/21	4013.2672
20/04/21	4189.1563
21/04/21	4091.4128
22/04/21	4063.2117
23/04/21	3977.9876
24/04/21	3957.3074
25/04/21	3881.7242
26/04/21	3591.3738
27/04/21	3649.3245
28/04/21	3379.5100
29/04/21	3101.2366
30/04/21	2736.6715
01/05/21	2414.3331

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02/05/21	2230.6535
03/05/21	1807.8534
04/05/21	1829.1981
05/05/21	1576.9330
06/05/21	1398.8138
07/05/21	1199.6250
08/05/21	1028.4703
09/05/21	1029.8419
10/05/21	853.5064
11/05/21	919.6701
12/05/21	825.1131
13/05/21	776.5817
14/05/21	740.9111
15/05/21	704.5351
16/05/21	729.5472
17/05/21	627.6929
18/05/21	693.4909
19/05/21	628.6391
20/05/21	610.7036
21/05/21	613.9064
22/05/21	606.5956
23/05/21	628.2311
24/05/21	571.7561
25/05/21	644.5712
26/05/21	596.6695
27/05/21	598.1590
28/05/21	623.6800
29/05/21	629.1123
30/05/21	645.2883
31/05/21	621.5723
01/06/21	692.8787
02/06/21	649.0726
03/06/21	659.3713
04/06/21	695.0583
05/06/21	697.3680
06/06/21	702.6765
07/06/21	696.1482
08/06/21	754.2872
09/06/21	701.2920
10/06/21	710.5439
11/06/21	743.3005
12/06/21	729.4483
13/06/21	719.9086
14/06/21	720.0566
15/06/21	756.5953
16/06/21	691.0225
17/06/21	700.2596
18/06/21	726.2018
19/06/21	695.3807
20/06/21	681.2282
21/06/21	691.7202
22/06/21	709.1110
23/06/21	644.4729
24/06/21	666.9111
25/06/21	689.8338
26/06/21	651.2057
27/06/21	648.5804
28/06/21	672.8802
29/06/21	675.0576
30/06/21	622.9742
01/07/21	663.1527
02/07/21	680.4416
03/07/21	638.8781
04/07/21	653.3875

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05/07/21	685.3928
06/07/21	671.5724
07/07/21	634.9816
08/07/21	688.1213
09/07/21	692.7318
10/07/21	649.4427
11/07/21	679.7583
12/07/21	709.3401
13/07/21	677.8190
14/07/21	656.7315
15/07/21	715.0516
16/07/21	700.2705
17/07/21	657.6093
18/07/21	700.8659
19/07/21	718.5293
20/07/21	671.2360
21/07/21	667.6727
22/07/21	724.0976
23/07/21	687.5629
24/07/21	652.6819
25/07/21	707.1750
26/07/21	706.7456
27/07/21	651.8274
28/07/21	670.1384
29/07/21	718.6622
30/07/21	663.6022
31/07/21	646.4541

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 Azerbaijan are likely to remain significantly high over the out-of-sample period.

IV. CONCLUSION AND POLICY RECOMMENDATIONS

COVID-19 is an epidemic that spreads very fast. For this reason, it has very catastrophic consequences in many areas worldwide. Therefore, it is essential to forecast daily COVID-19 cases as quickly as possible in order to plan ahead on how to restrain the spread of the disease. In this piece of work, we attempt to model and forecast COVID-19 daily cases in Azerbaijan. We applied the basic ANN (12, 12, 1) model and found out that COVID-19 daily cases were, in general, likely to remain very high over the out-of-sample period. The government, through the ministry of health, should continue to implement COVID-19 control and prevention measures such as isolation, quarantine, testing and tracing, face-mask wearing, sanitization of hands and so on., in line with WHO guidelines. This will go a long way in controlling the pandemic in Azerbaijan.

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Citation of this Article:

Dr. Smartson. P. NYONI, Mr. Thabani NYONI, Mr. Tatenda. A. CHIHOHO, "Forecasting Covid-19 New Cases in Azerbaijan" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 6, pp 732-737, June 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.506128

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