

PREDICTION OF DAILY NEW COVID-19 CASES IN IRAN 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 Iran. The employed data covers the period 19February 2020 to 31 October2020 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 coronavirus cases in the Republic of Iran. The results of the study indicate that the projected number of daily new COVID-19 cases will generally be around 7800 cases from November 1, 2020 to 30 April 2021. If an effective COVID-19 vaccine is introduced new cases are expected to drop drastically in the out-of sample period. The Iranian government should continue to enforce the WHO guidelines on prevention and control of COVID-19 which includes social distancing, wearing masks, regular washing of hands with soap and water, testing and treatment of cases, early isolation and health education at all community or political levels.

Keywords: - ANN, COVID-19, Forecasting

INTRODUCTION

The Republic of Iran is located in South Western Asia in the Middle East. It has a mean population density of 52 inhabitants per square kilometer (Dadar et al, 2020). The first COVID-19 case in Iran was reported on 19February 2020 in the city of Qom (Takian et al, 2020; Malik et al, 2020). Unfortunately the Iranian government did not respond early to the epidemic as a result the virus spread rapidly among the communities (Abdi, 2020; Arab et al, 2020). On the 11th of March 2020 WHO reported 118,329 confirmed cases and 4627 deaths worldwide, with 8042confirmed cases and 291deaths reported in Iran (WHO, 2020).COVID-19 is a member of beta corona viruses like the Severe Acute Respiratory syndrome human virus(SARS-CoV) and the Middle East Respiratory syndrome human virus (MERS) (Elfiky etal,2020).Early findings from Chinese scientists revealed that the virus is highly contagious and its spread increases rapidly (exponentially and logarithmic) (Huang et al, 2020; Wang et al, 2020; Li et al, 2020). Despite the delays to respond to the epidemic earlier on ,Iran had to follow WHO guidelines on prevention and Control of COVID-19. The government closed schools, universities, cinemas ,concerts, theatres ,national competitions, and sports leagues (Gharakhanlou & Hooshangi, 2020). Many studies have been carried out in order to investigate the dynamics of COVID-19 epidemic and these include SEIR models, neural networks, logistic regression and Gompertz

model. In this paper, the researchers applied the Artificial neural network to model and forecast the number of daily new COVID-19 cases. The findings of this piece of work will help in the assessment of the impact of COVID-19 mitigatory measures as well as future planning so that an appropriate National health response is implemented to save precious lives.

LITERATURE REVIEW

Table 1: Literature Review

Authors(s)/year	Study period	Method	Major findings
Ghanbari. B (2020)	22January 2020 -20 June 2020.	SIR model	The second wave of COVID-19 is likely to be more severe than the first one
Pourghasemi et al (2020)	19February 2020-14 June 2020	-Spatial modeling -Random Forest Algorithm -Polynomial regression	The trends of new COVID-19 and deaths are increasing in Iran.
Gharakhanlou &Hooshangi (2020).	25February 2020- 10 May 2020.	Agent based spatiotemporal model, SEIRD model	Heeding social distancing significantly reduces the number of new COVID-19 cases.
Zareie etal (2020).	2January 2020 - 8March 2020.	GAM models	The average daily new COVID-19 cases in Iran is 925 and the epidemic peak is likely to be between 15March 2020 and 21March 2020.
Zahiri et al (2020).	19February 2020- 24March 2020.	SIR model	The epidemic peak in Iran is likely to be around 21March 2020 and the epidemic will be terminated at the end of April 2020.
Moftakhar et al (2020).	19February 2020- 30March 2020.	ANN, ARIMA	Both models predicted an exponential increase in the number of new

			COVID-19 cases over the 1month period 31March 2020 to 29 April 2020. The ARIMA model was more accurate than the ANN.
Ahmadi etal (2020).	19February 2020-29March 2020.	Gompertz, least squares, VonBertalanffy.	The epidemic peak will flatten from 13May until July 2020.

METHOD

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID-19 infections. This research article 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 Q series in this study) for all age groups in Iran. The data covers the period 19 February 2020 to 31October 2020 while the out-of-sample forecast covers the period November 2020 to April 2021. All the data employed in this paper was gathered from the COVID-19 data repository prepared by the CSSE at JH University.

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 2: Descriptive statistics

Mean	Median	Minimum	Maximum
2393.6	2313.0	2.0000	8293.0
Std. Dev.	C.V.	Skewness	Ex. Kurtosis
1327.3	0.55450	1.4399	4.0606
5% Perc.	95% Perc.	IQ range	Missing obs.
502.30	4861.3	1043.8	0

ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN IRAN

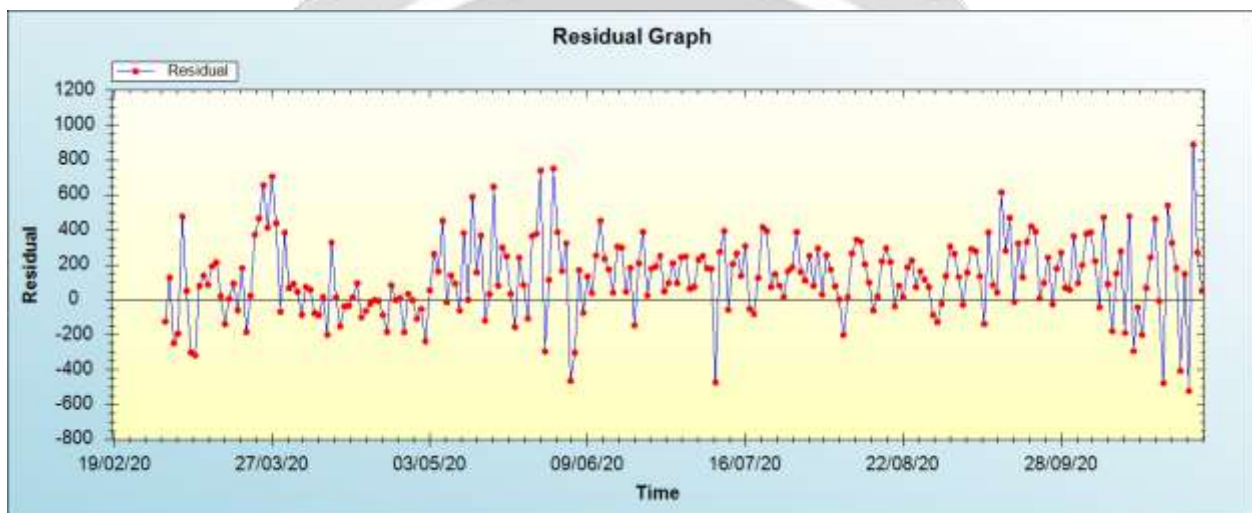
Table 3: ANN model summary

Variable	Q
Observations	244 (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	0.055527
MSE	65414.548955
MAE	198.167434

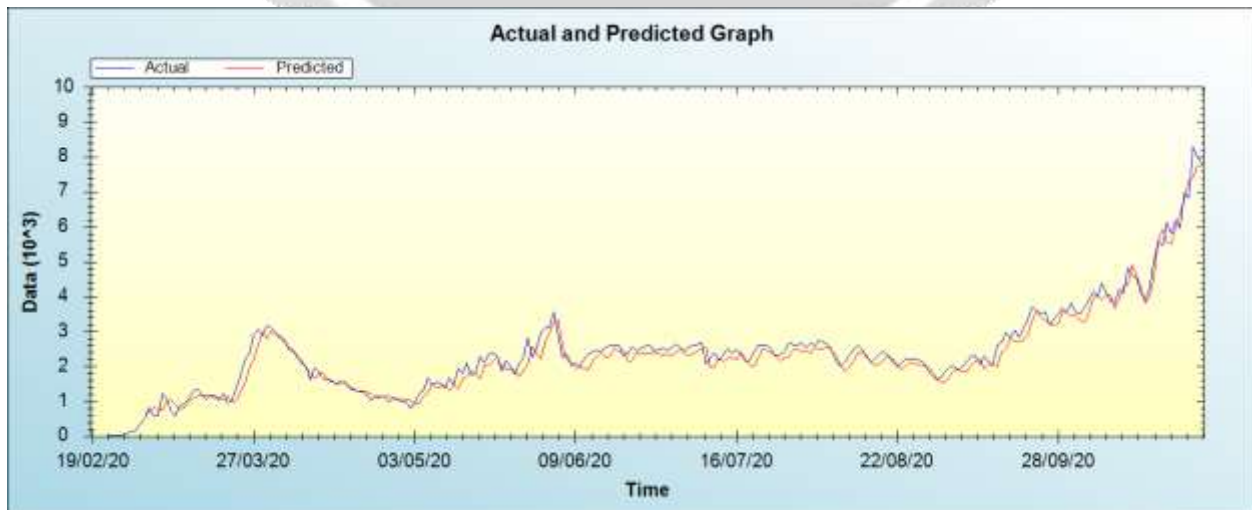
Residual Analysis for the ANN model

Figure 1: Residual analysis



In-sample Forecast for Q

Figure 2: In-sample forecast for the Q series



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

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



Out-of-Sample Forecast for Q: Forecasts only

Table 4: Tabulated out-of-sample forecasts

Day/Month/year	Forecasted daily new COVID-19 cases
01/11/20	7647.4587
02/11/20	7606.7599
03/11/20	7840.8151
04/11/20	7880.6227
05/11/20	7960.5151
06/11/20	7822.1166
07/11/20	7845.1716
08/11/20	7652.8049
09/11/20	7815.4704
10/11/20	7775.8256
11/11/20	7807.0852
12/11/20	7785.0833
13/11/20	7757.7585

14/11/20	7758.3278
15/11/20	7739.2230
16/11/20	7769.8879
17/11/20	7756.9548
18/11/20	7780.8842
19/11/20	7747.2757
20/11/20	7768.7502
21/11/20	7754.3541
22/11/20	7763.7556
23/11/20	7764.1740
24/11/20	7765.0442
25/11/20	7767.0618
26/11/20	7761.5521
27/11/20	7766.3412
28/11/20	7761.8791
29/11/20	7767.9754
30/11/20	7762.7734
01/12/20	7767.2999
02/12/20	7763.9526
03/12/20	7765.3057
04/12/20	7764.6494
05/12/20	7764.7967
06/12/20	7765.4306
07/12/20	7764.4455
08/12/20	7765.4750
09/12/20	7764.2420

10/12/20	7765.3734
11/12/20	7764.2874
12/12/20	7765.2292
13/12/20	7764.6129
14/12/20	7764.9522
15/12/20	7764.7763
16/12/20	7764.7765
17/12/20	7764.8974
18/12/20	7764.7053
19/12/20	7764.9561
20/12/20	7764.7040
21/12/20	7764.9478
22/12/20	7764.7196
23/12/20	7764.9050
24/12/20	7764.7782
25/12/20	7764.8577
26/12/20	7764.8235
27/12/20	7764.8246
28/12/20	7764.8483
29/12/20	7764.8051
30/12/20	7764.8576
31/12/20	7764.8037
01/01/21	7764.8562
02/01/21	7764.8091
03/01/21	7764.8467
04/01/21	7764.8194

05/01/21	7764.8359
06/01/21	7764.8284
07/01/21	7764.8288
08/01/21	7764.8340
09/01/21	7764.8249
10/01/21	7764.8359
11/01/21	7764.8243
12/01/21	7764.8354
13/01/21	7764.8256
14/01/21	7764.8335
15/01/21	7764.8279
16/01/21	7764.8313
17/01/21	7764.8297
18/01/21	7764.8298
19/01/21	7764.8309
20/01/21	7764.8290
21/01/21	7764.8314
22/01/21	7764.8289
23/01/21	7764.8312
24/01/21	7764.8292
25/01/21	7764.8308
26/01/21	7764.8297
27/01/21	7764.8304
28/01/21	7764.8301
29/01/21	7764.8301
30/01/21	7764.8303

31/01/21	7764.8299
01/02/21	7764.8304
02/02/21	7764.8299
03/02/21	7764.8304
04/02/21	7764.8299
05/02/21	7764.8303
06/02/21	7764.8300
07/02/21	7764.8302
08/02/21	7764.8301
09/02/21	7764.8301
10/02/21	7764.8302
11/02/21	7764.8301
12/02/21	7764.8302
13/02/21	7764.8301
14/02/21	7764.8302
15/02/21	7764.8301
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17/02/21	7764.8301
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23/03/21	7764.8301

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24/03/21	7764.8301
25/03/21	7764.8301
26/03/21	7764.8301
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28/03/21	7764.8301
29/03/21	7764.8301
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27/04/21	7764.8301
28/04/21	7764.8301
29/04/21	7764.8301
30/04/21	7764.8301

Figure 1 shows that over the study period, the minimum and maximum daily new COVID-19 cases are 2 and 8293 cases respectively. The in-sample forecasts show that the ANN (12,121) model simulates the observed data very well. The residual graph and evaluation criteria indicate that the model is stable and suitable for forecasting daily new COVID-19 cases. Figure 4 and Table 4 shows the out of sample forecasts and the results indicate the projected number of daily new COVID-19 cases will be generally around 7800 cases from November 1, 2020 to 30 April 2021.

CONCLUSION & RECOMMENDATIONS

The Republic of Iran will continue to face the COVID-19 epidemic in 2021 as the research findings indicated that the daily new COVID-19 cases will be around 7800 cases from November 2020 to 30 April 2021. The COVID-19 vaccine, if introduced during the out-of sample period will act as a positive shock leading to a drop in the daily COVID-19 cases. The government of Iran should continuously enforce the WHO guidelines on prevention and control of COVID-19 which include social distancing, wearing face masks, regular washing of hands with soapy water, testing, treatment and early isolation of COVID19 cases and health educations at all community or political levels.

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