FORECASTING COVID-19 CASES IN ALGERIA USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

Since December 2019, the whole world has been incrementally invaded and tormented by COVID-19. However, the African continent has been the last and least affected part of the world. Algeria is among the first African countries to be affected by the pandemic since February 2020. In this research article, the ANN technique was applied to analyze COVID-19 daily cases in Algeria. The employed data covers the period 25 February 2020 to 31 October 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 apparently tell us that the model is stable in forecasting COVID-19 cases in the country. The results of the study indicate that COVID-19 daily cases are likely to remain very high over the period November 2020 to April 2021 and even beyond. The predicted is reversible through vaccination or tightening-up COVID-19 prevention and control measures [suggested by the World Health Organization (WHO)] in the country. At the moment, there is no known effective vaccine against COVID-19, therefore, the Algeria health authorities, just like the rest of the world; are only left with the option of resorting to prevention and control measures such as social distancing, wearing of masks, travel restrictions, quarantine, isolation, testing and tracing and so on.

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

INTRODUCTION

The novel coronavirus disease 2019 (COVID-19) is an emerging betacoronavirus caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Sohrabi *et al*., 2020). The first infected case was discovered in Hubei, a province in the city of Wuhan in China, on December 31 2019 (Guan *et al*., 2020). While critical cases of COVID-19 may die, infected people usually experience mild to severe respiratory illness (Sohrabi *et al*., 2020). Compared to other coronavirus families, COVID-19 is quite dangerous because of its asymptomatic and high human-to-human transmission (Shereen *et al*., 2020). Algeria's first case of COVID-19 was reported on February 25 2020, after an Italian national tested positive in the Southern part of the country (Ouargla). The main COVID-19 outbreak began on March 1 2020, in the Northen part of Algeria (Blida) when 2 cases tested positive after a contact with 2 Algerian nationals residing in France (Hamidouche & Belmessabih, 2020). Since then the spread of the virus in Algeria has gone through different epidemic phases (Lounis, 2020). Artificial Neural Network (ANN)

modeling and forecasting may play a key role in understanding epidemic features of an outbreak. The main objective of this paper is to analyze the pattern of COVID-19 new daily cases for all age groups in Algeria. This piece of work is envisioned to go a long way in helping policy makers understand the possible spreading pattern of COVID-19 in Algeria. Once this is done, policy makers are expected to act decisively in order to reduce and or avoid the anticipated epidemic damage.

LITERATURE REVIEW

Table 1 below is a summary of the selected relevant previous studied carried out in Algeria:

Table 1: Studies Reviewed

Author/s (Year)	Study Period	Method	Key Results
Hamidouche (2020)	February – April	SI model	Exponential phase will begin on April 7, 2020
Bentout *et al*. (2020)	February – April	SEIR model	Epidemic in Algeria could occur in a strong way
Lounis & Bagal (2020)	February – July	SIR model	Peak of epidemic will be reached on September 8, 2021, and the total infected persons will exceed 800000 cases at the end of the epidemic
Rouabah *et al*. (2020)	February – May	SEIR model	The basic reproduction number is 3.78. The outbreak will end not sooner than October 2020
Belkacem (2020)	February – May	Prophet model	Total number of cases expected to increase in the coming weeks
Boudrioua & Boudrioua (2020)	February – April	SIR model	The epidemic peak of COVID-19 is predicted to attain 24 July 2020 in a worst-case scenario, and the COVID-19 disease is expected to disappear in the period between September 2020 and November 2020 at the latest
Balah & Djeddou (2020)	March – April	ARFIMA models	The ARFIMA (0, 0.431779, 0) build for Algeria, has a long memory and an upward trend over the next 15 days, which coincides with the holy month of Ramadhan
Rezki (2020)	February – April	Logistic growth regression model	Peak of the pandemic is 10 April 2020
Lounis & Azevedo	April –	SEIR model	COVID-19 cases will rise to about 300 cases per

(2020)	August		day by November 2020
Djeddou *et al*. (2020)	February – August	ELM	The proposed ELM model is effective
Rahmani *et al*. (2020)	February – April	Hybrid Kriging technique	In the last week of April 2020, the velocity of transmission of the disease will be rapid

Source: Literature Review (2020)

METHOD

This paper, in line with previous studies such as Djeddou *et al*. (2020); applies machine learning in the context of the multi-layer perceptron neural network type of the ANN approach in order to predict daily COVID-19 cases in Algeria. We particulary apply 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 newly confirmed daily COVID-19 cases (reffered to as the AC series in this study) for all age groups in Algeria. The data covers the period 25 February 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 paper was gathered from the COVID-19 data repository prepared by the CSSE at JH University.

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
231.77	185.00	0.0000	675.00
Std. Dev.	C.V.	Skewness	Ex. kurtosis
173.72	0.74953	0.74996	-0.44839

ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN ALGERIA

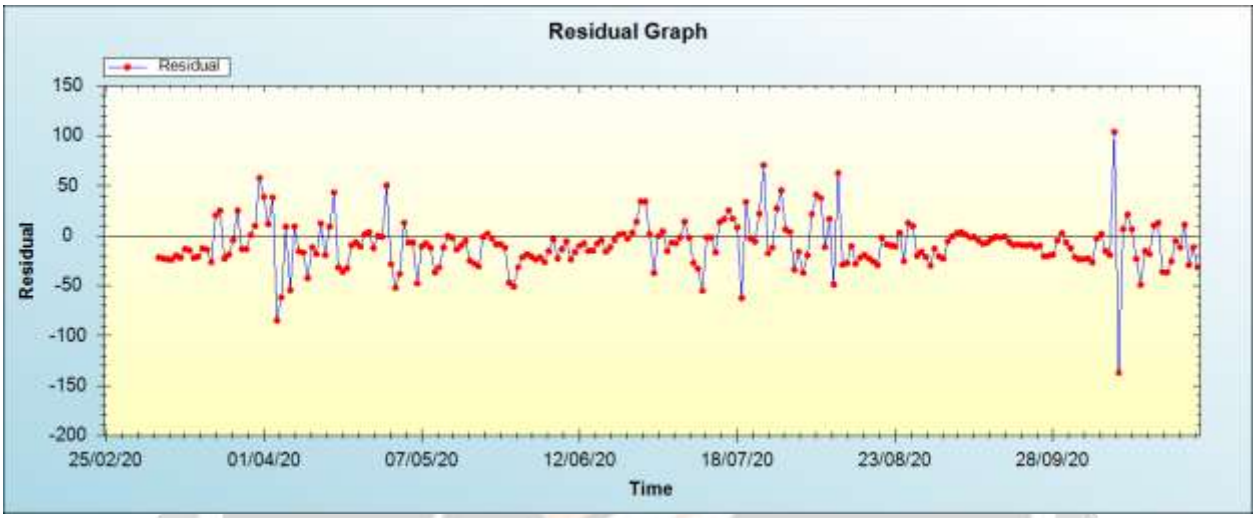
Table 2: ANN model summary

Variable	AC
Observations	238 (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	0.068937
MSE	668.288080
MAE	19.051425

Residual Analysis for the ANN model

Figure 1: Residual analysis



In-sample Forecast for AC

Figure 2: In-sample forecast for the AC series

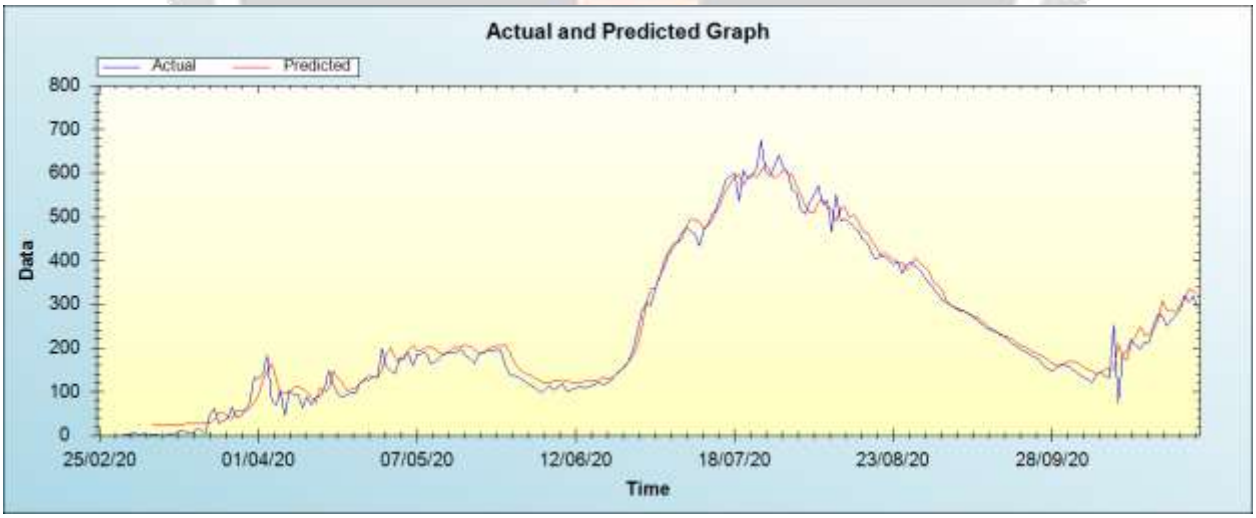
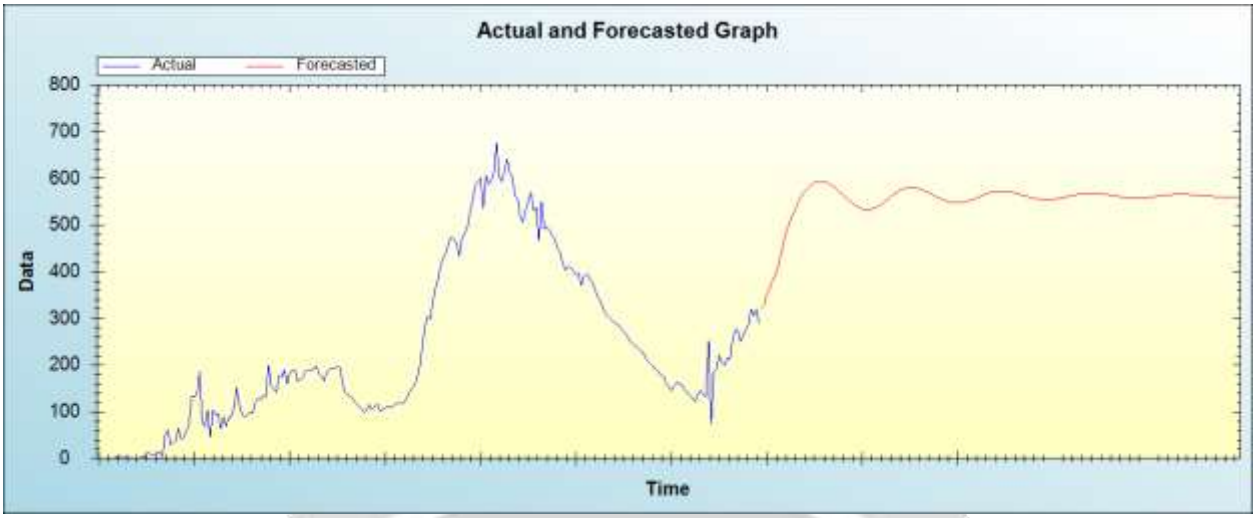


Figure 3 shows the in-sample forecast for AC series.

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

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



Out-of-Sample Forecast for AC: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Predictions
01/11/20	322.0809
02/11/20	327.5454
03/11/20	353.7490
04/11/20	363.0689
05/11/20	379.7720
06/11/20	390.4898
07/11/20	404.4401
08/11/20	431.2306
09/11/20	455.6157
10/11/20	480.4780
11/11/20	496.5950
12/11/20	511.2240
13/11/20	524.0961
14/11/20	536.8006
15/11/20	551.0263

16/11/20	561.8666
17/11/20	570.8059
18/11/20	576.9815
19/11/20	582.8669
20/11/20	587.9864
21/11/20	591.7485
22/11/20	594.1005
23/11/20	594.8544
24/11/20	594.4491
25/11/20	592.7398
26/11/20	590.0751
27/11/20	586.4576
28/11/20	582.3432
29/11/20	577.7448
30/11/20	572.8416
01/12/20	567.6245
02/12/20	562.2630
03/12/20	556.9690
04/12/20	551.8906
05/12/20	547.2239
06/12/20	543.0490
07/12/20	539.5179
08/12/20	536.6723
09/12/20	534.6025
10/12/20	533.3296
11/12/20	532.9204

12/12/20	533.4060
13/12/20	534.8050
14/12/20	537.0881
15/12/20	540.1720
16/12/20	543.9409
17/12/20	548.2249
18/12/20	552.8370
19/12/20	557.5604
20/12/20	562.1892
21/12/20	566.5280
22/12/20	570.4180
23/12/20	573.7383
24/12/20	576.4112
25/12/20	578.3970
26/12/20	579.6845
27/12/20	580.2854
28/12/20	580.2261
29/12/20	579.5478
30/12/20	578.3038
31/12/20	576.5608
01/01/21	574.3964
02/01/21	571.8977
03/01/21	569.1575
04/01/21	566.2708
05/01/21	563.3316
06/01/21	560.4306

07/01/21	557.6540
08/01/21	555.0818
09/01/21	552.7879
10/01/21	550.8376
11/01/21	549.2869
12/01/21	548.1801
13/01/21	547.5485
14/01/21	547.4088
15/01/21	547.7618
16/01/21	548.5912
17/01/21	549.8635
18/01/21	551.5274
19/01/21	553.5151
20/01/21	555.7450
21/01/21	558.1251
22/01/21	560.5585
23/01/21	562.9492
24/01/21	565.2074
25/01/21	567.2545
26/01/21	569.0263
27/01/21	570.4740
28/01/21	571.5651
29/01/21	572.2818
30/01/21	572.6203
31/01/21	572.5889
01/02/21	572.2072

02/02/21	571.5042
03/02/21	570.5174
04/02/21	569.2908
05/02/21	567.8740
06/02/21	566.3197
07/02/21	564.6828
08/02/21	563.0182
09/02/21	561.3798
10/02/21	559.8191
11/02/21	558.3837
12/02/21	557.1166
13/02/21	556.0547
14/02/21	555.2284
15/02/21	554.6600
16/02/21	554.3634
17/02/21	554.3435
18/02/21	554.5957
19/02/21	555.1059
20/02/21	555.8508
21/02/21	556.7987
22/02/21	557.9105
23/02/21	559.1416
24/02/21	560.4435
25/02/21	561.7665
26/02/21	563.0618
27/02/21	564.2835

28/02/21	565.3908
01/03/21	566.3493
02/03/21	567.1316
03/03/21	567.7186
04/03/21	568.0987
05/03/21	568.2682
06/03/21	568.2307
07/03/21	567.9963
08/03/21	567.5812
09/03/21	567.0064
10/03/21	566.2972
11/03/21	565.4821
12/03/21	564.5918
13/03/21	563.6581
14/03/21	562.7130
15/03/21	561.7878
16/03/21	560.9124
17/03/21	560.1141
18/03/21	559.4170
19/03/21	558.8415
20/03/21	558.4037
21/03/21	558.1147
22/03/21	557.9805
23/03/21	558.0017
24/03/21	558.1738
25/03/21	558.4868

26/03/21	558.9260
27/03/21	559.4727
28/03/21	560.1044
29/03/21	560.7963
30/03/21	561.5220
31/03/21	562.2548
01/04/21	562.9686
02/04/21	563.6389
03/04/21	564.2438
04/04/21	564.7647
05/04/21	565.1869
06/04/21	565.4996
07/04/21	565.6964
08/04/21	565.7753
09/04/21	565.7382
10/04/21	565.5908
11/04/21	565.3423
12/04/21	565.0050
13/04/21	564.5932
14/04/21	564.1236
15/04/21	563.6138
16/04/21	563.0822
17/04/21	562.5471
18/04/21	562.0266
19/04/21	561.5376
20/04/21	561.0955

21/04/21	560.7136
22/04/21	560.4030
23/04/21	560.1721
24/04/21	560.0265
25/04/21	559.9686
26/04/21	559.9979
27/04/21	560.1109
28/04/21	560.3011
29/04/21	560.5598
30/04/21	560.8758

Descriptive statistics of the series under consideration are shown in table. The most important characteristic of these statistics is that the average daily cases are 232 new cases over the period under study. The maximum is number of daily cases over the study is 765 cases. Table summarizes the applied model. Figure 1 shows the residual analysis of the model: the applied model is indeed stable and acceptable. In-sample forecasts are shown in figure 2 while figure 3 and table 3 show out-of-sample forecasts. As shown in the results, the pandemic in Algeria is there to stay; it will not end anytime soon unless there is a vaccine. In fact, the results of this study basically indicate that the pandemic will remain highly prevalent in the country. These results are not surprising at all, but rather consistent with a number of previous studies such as Lounis & Bagal (2020), Bentout (2020), Hamidouche (2020), Rouabah *et al*. (2020) as well as Lounis & Azevedo (2020).

CONCLUSION & RECOMMENDATIONS

The untimely wave of COVID-19 has spread all over the world and Algeria has not been spared. In this piece of work, we applied a basic ANN (12, 12, 1) model. The results of the model indicate that the pandemic will not end anytime soon in Algeria. While the preventive and control strategies that have been in Algeria, especially from March 23 onwards; seem to have been effective and apparently resulted in avoiding a possibility of thousands of infections and deaths; our model tells us a different story altogether. There is need for Algeria health authorities to tighten-up preventive and control measures, especially travel restrictions, wearing of masks, social distancing and so on. Our study also serves as an empirical confirmation that the COVID-19 pandemic is not yet under maximum control in Algeria.

REFERENCES

[1] Balah, B., & Djeddou, M. (2020). Forecasting COVID-19 New Cases in Algeria Using Autoregressive Fractionally Integrated Moving Average Models (ARFIMA), *medRxiv*, pp: 1 – 22.

[2] Belkacem, S. (2020). COVID-19 Data Analysis and Forecasting: Algeria and the World, *medRxiv*, pp: 1 – 11.

[3] Bentout, S., *et al*. (2020). Parameter Estimation and Prediction for Coronavirus Disease Outbreak 2019 (COVID-19) in Algeria, *Public Health*, 7 (2): 306 – 318.

[4] Boudrioua, M. S., & Boudrioua, A. (2020). Predicting the COVID-19 Epidemic in Algeria Using the SIR Model, *medRxiv*, pp: 1 – 11.

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

[6] Djeddou, M., *et al*. (2020). Predictive Modelling of COVID-19 New Cases in Algeria Using An Extreme Learning Machines (ELM), *medRxiv*, pp: 1 – 18.

[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] Guan, W., *et al*. (2020). Clinical Characteristics of Coronavirus Disease 2019 in China, *New England Journal of Medicine*, 382 (18): 1708 – 1720.

[9] Hamidouche, M. (2020). COVID-19 Outbreak in Algeria: A Model to Predict Cumulative Cases, *Journal of Contemporary Studies in Epidemiology and Public Health*, 1 (1): 1 – 6.

[10] Hamidouche, M., & Belmessabih, N. (2020). Time Course of COVID-19 Epidemic in Algeria: Retrospective Estimate of the Actual Burden, *medRxiv*, pp: 1 – 14.

[11] Lounis, M. (2020). COVID-19 in Algeria, *European Journal of Medical and Educational Technologies*, 13 (1): 1 – 9.

[12] Lounis, M., & Azevedo, J. S. (2020). Application of a Generalized SEIR Model for COVID-19 in Algeria, *medRxiv*, pp: 1 – 10.

[13] Lounis, M., & Bagal, D. K. (2020). Estimation of SIR's Model Parameters of COVID-19 in Algeria, *Bulletin of the National Research Centre*, 44 (180): 1 – 6.

[14] Rahmani, S. E. A., *et al*. (2020). Spatial Distribution of COVID-19, A Modelling Approach: Case of Algeria, *Research Square*, pp: 1 – 11.

[15] Rezki, M. (2020). Estimating the Total Size of Coronavirus Epidemic in Algeria via Different Approaches, *medRxiv*, pp: 1 – 5.

[16] Rouabah, M. T., Tounsi, A., & Belaloui, N. E. (2020). A Mathematical Epidemic Model Using Genetic Fitting Algorithm With Cross-validation and Application to Early Dynamics of COVID-19 in Algeria, *medRxiv*, pp: 1 – 12.

[17] Shereen, M. A., *et al*. (2020). COVID-19 Infection: Origin, Transmission, and Characteristics of Human Coronaviruses, *Journal of Advanced Research*, pp: 1 – 12.

[18] Sohrabi, C., *et al*. (2020). WHO Declares Global Emergency: A Review of the 2019 Novel Coronavirus (COVID-19), *International Journal of Surgery*, pp: 1 – 6.