FORECASTING COVID-19 CASES IN CAMEROON USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

Caused by a novel coronavirus, COVID-19 has played havoc on many countries across the globe and Cameroon has never been an exception. Today, the people of Cameroon; just like the rest of the world, continue to live a restricted environment in order to prevent exposure to this highly infectious disease. In this research article, the ANN approach was used to model and forecast daily COVID-19 cases in Cameroon. The employed data covers the period March 6, 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 show us that the model is stable in forecasting COVID-19 daily new infections in Cameroon. The results of the study indicate that the country is likely to record about 26 new cases per day over the period November 2020 to April 2021. We encourage the country to continue enforcing control and preventive measures such as mass-media sensitization, social distancing, face-mask wearing, contact tracing, disinfection and decontamination of infected areas, washing and sanitization of hands and so on as advised by the WHO. These measures will help a lot in avoiding further infections or a second wave of infections in Cameroon.

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

INTRODUCTION

COVID-19 is a deadly viral disease quickly spreading its roots in literally all parts of the world. Its common symptoms include fever, sore throat, coughing and difficulty in breathing. The first few cases appeared in Wuhan, China, and then gradually, cases started coming up in many other countries as well. Today, we see that this virus has infected millions of people around the world (Singhal *et al*., 2020). The first case of COVID-19 in Cameroon was an imported case from France and was officially reported on the 6th of March 2020 (Ministry of Public Health, 2020). Unfortunately, to date, there is no effective treatment for COVID-19 (Rosenberg *et al*., 2020). Therefore, every country has two options at its disposal: to develop immunity against the disease or to prevent and control its spread. The first thing done by the government of Cameroon was to close land, air and sea borders, public and private schools from nursery to university institutions including vocational training centres and professional schools (Ministry of Public Health, 2020). Furthermore, under the supervision of administrative authorities, bar, restaurants and entertainment places were systematically closed from 6pm till dawn (Kouakep *et al*., 2020). Just

like other countries affected, Cameroon later on decided to resume economic and social activities before the end of the pandemic, while implementing preventive and control measures such as wearing of face masks, washing of hands, use of hand sanitizers and so., as recommended by the World Health Organization (WHO). As of April 25, 2020, the number of COVID-19 cases had jumped to 1569, with 53 deaths. These numbers sound shocking but the truth of the matter is that they are an underestimation of reality because the diagnostic system for COVID-19 in Cameroon is not robust (Mbopi-Keou *et al*., 2020). The increased demand for healthcare triggered by large flows of patients leads to hospital bed shortages and straining situations in hospitals. Accurately modelling and forecasting the spread of confirmed COVID-19 cases is vital to understand and help decision makers to slow down or arrest its spreading (Velasquez & Lara, 2020; Yousaf *et al*., 2020; Ribeiro *et al*., 2020). In this research, we attempt to model and forecast daily confirmed COVID-19 cases in the country over the period March 6, 2020 to October 31, 2020; with an out-of-sample period of November 2020 to April 2021.

LITERATURE REVIEW

Table 1 below is a summary of relevant previous studied done in Cameroon:

Table 1: Studies Reviewed

Author/s (Year)	Study Period	Method	Main Results
Nkwayep *et al*. (2020)	March – April	EnKf approach	The number of new COVID-19 cases will still increase
Djaoue *et al*. (2020)	March – June	SEIR model	Isolation has real impact on COVID-19 transmission
Ngondiep (2020)	March – May	SEIR model	The proposed model is accurate
Chelo *et al*. (2020)	March – July	Descriptive and Reproductive Approach	Lockdown caused a drastic drop in hospitalizations in Cameroon
Nguemdjo *et al*. (2020)	March – April	SIR model	The reproduction number of COVID-19 in Cameroon is about 1.5, and the peak of infection should have occurred at the end of May 2020 with about 7.7% of the population infected
Tchoumi *et al*. (2020)	March – May	SEIR model	We will have several peaks before the end of the outbreak

Source: Literature Review (2020)

METHODOLOGY

In this research article, we apply the multi-layer perceptron neural network type of the ANN approach in order to predict COVID-19 cases in Cameroon. This study is actually based on

newly confirmed daily cases of COVID-19 infections in Cameroon (reffered to as the CW series in this study) for all age groups in the country. The data covers the period 6 March 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 2: Descriptive statistics

Mean	Median	Minimum	Maximum
90.804	0.0000	0.0000	2324.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
221.71	2.4416	5.7013	45.800
5% Perc.	95% Perc.	IQ range	Missing obs.
0.0000	461.05	101.25	0

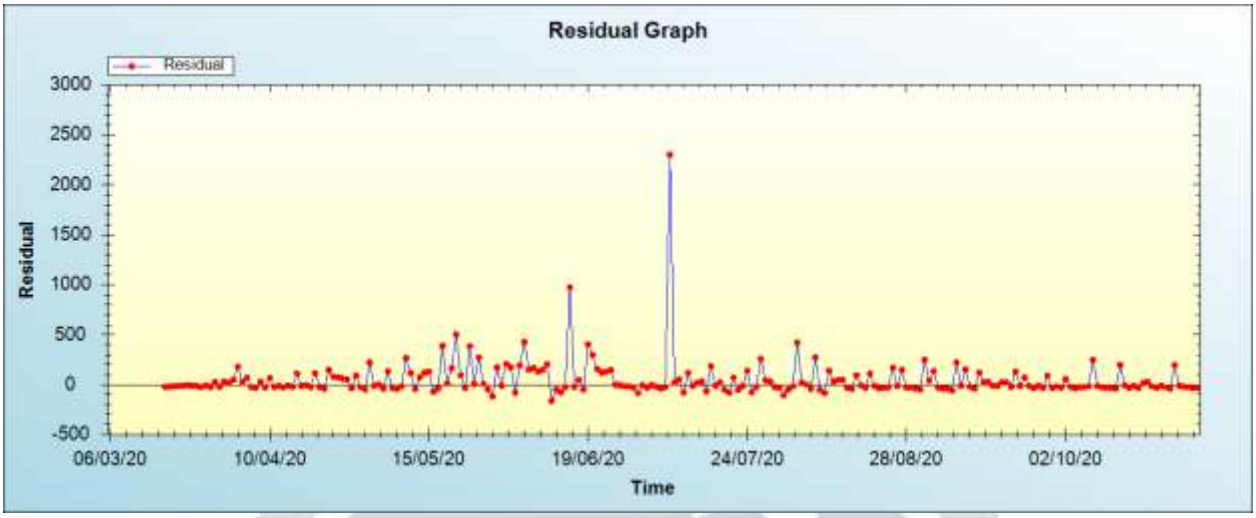
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN CAMEROON

Table 3: ANN model summary

Variable	CW
Observations	228 (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	0.154084
MSE	39577.189826
MAE	85.142121

Residual Analysis for the ANN model

Figure 1: Residual analysis



In-sample Forecast for CW

Figure 2: In-sample forecast for the CW series

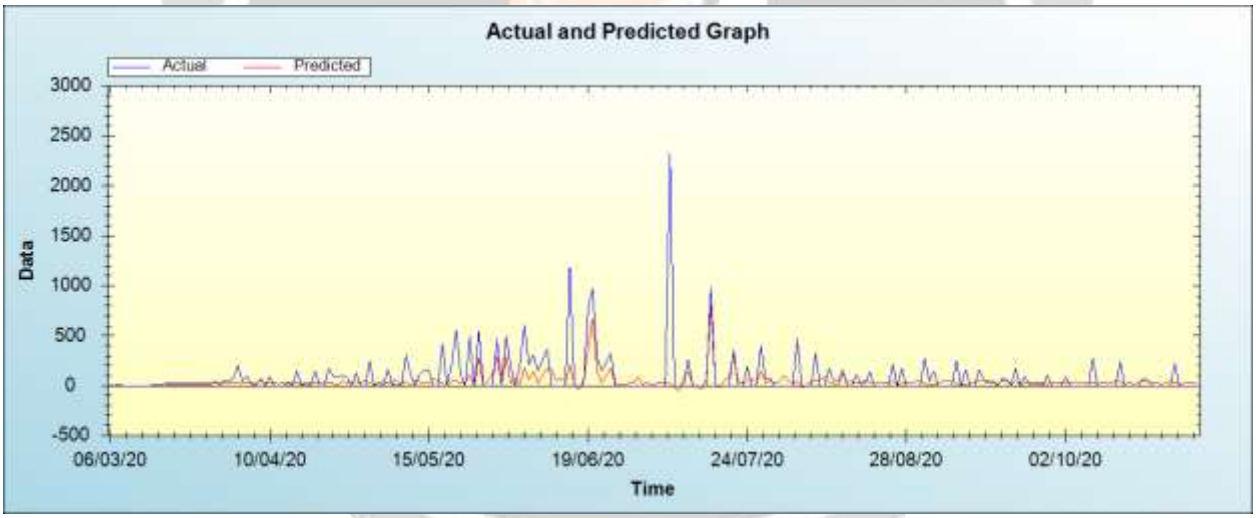
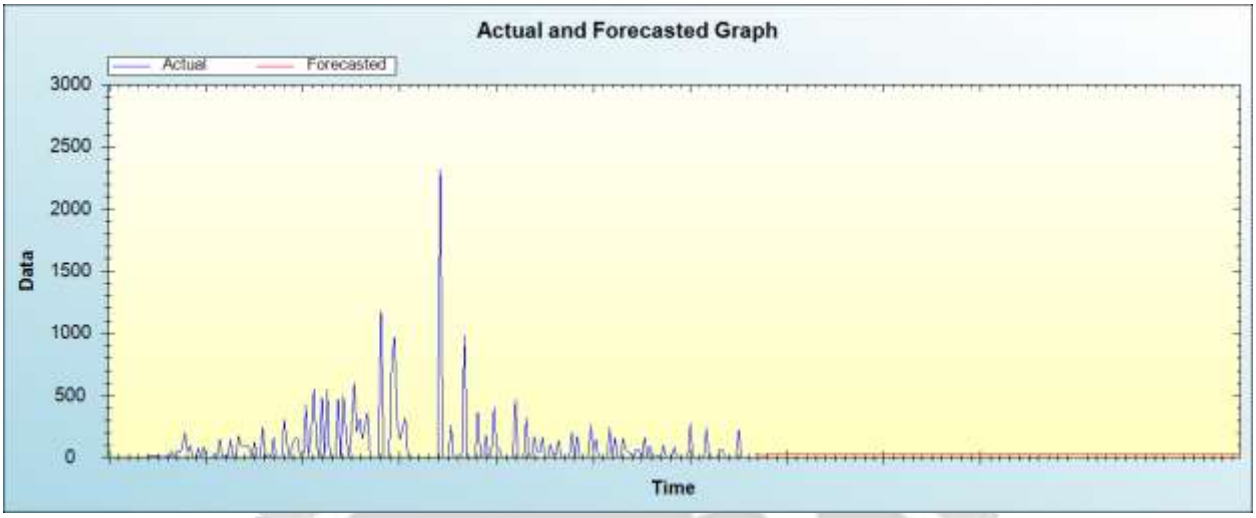


Figure 3 shows the in-sample forecast for CW series.

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

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



Out-of-Sample Forecast for CW: Forecasts only

Table 4: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
01/11/20	38.0566
02/11/20	18.2979
03/11/20	25.1736
04/11/20	9.0530
05/11/20	24.5598
06/11/20	34.9837
07/11/20	28.2605
08/11/20	24.8412
09/11/20	26.7234
10/11/20	22.4528
11/11/20	25.9096
12/11/20	26.7875
13/11/20	26.8207
14/11/20	25.7506

15/11/20	24.6380
16/11/20	25.5554
17/11/20	26.6892
18/11/20	26.0901
19/11/20	26.2864
20/11/20	26.0159
21/11/20	25.7667
22/11/20	25.9902
23/11/20	26.1623
24/11/20	26.1713
25/11/20	26.0856
26/11/20	25.9255
27/11/20	26.0209
28/11/20	26.0729
29/11/20	26.0707
30/11/20	26.0912
01/12/20	26.0583
02/12/20	26.0275
03/12/20	26.0486
04/12/20	26.0625
05/12/20	26.0738
06/12/20	26.0626
07/12/20	26.0496
08/12/20	26.0537
09/12/20	26.0568
10/12/20	26.0592

11/12/20	26.0627
12/12/20	26.0584
13/12/20	26.0558
14/12/20	26.0565
15/12/20	26.0581
16/12/20	26.0596
17/12/20	26.0588
18/12/20	26.0577
19/12/20	26.0577
20/12/20	26.0577
21/12/20	26.0582
22/12/20	26.0586
23/12/20	26.0583
24/12/20	26.0580
25/12/20	26.0579
26/12/20	26.0581
27/12/20	26.0583
28/12/20	26.0582
29/12/20	26.0581
30/12/20	26.0581
31/12/20	26.0581
01/01/21	26.0581
02/01/21	26.0582
03/01/21	26.0582
04/01/21	26.0581
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06/01/21	26.0581
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30/04/21	26.0581

As shown in table 2 above, the average number of daily COVID-19 cases is 91 cases while the maximum is 2340 for the period under study. The summary of the ANN (12, 12, 1) model applied is shown in table 3. Figure 1 are residuals of the applied model and they are shown to be stable, which implies that the model is acceptable for forecasting purposes. In-sample predictions are shown in figure 2 while figure 3 and table 4 display out-of-sample predictions. Our model basically suggests that the evolution of the pandemic in Cameroon will reach its equilibrium level of approximately 26 cases per day on 16 November 2020 and this shall be recorded throughout the out-of-sample period. This implies that with the level and amount of preventive and control measures, the country will still record about 26 new cases of COVID-19 per day.

CONCLUSION & RECOMMENDATIONS

COVID-19 has spread all over the world, catching many people unaware and this comes up with new challenges to the research community. Forecasting the future trend of the pandemic is one such challenge. This paper applied the neural network approach to analyze daily new COVID-19 cases in Cameroon. The proposed model is stable and acceptable for predicting COVID-19 cases in the country. The model shows that the country is likely to record about 26 new cases per day over the period November 2020 to April 2021. We encourage the country to continue enforcing control and preventive measures such as mass-media sensitization, social distancing, face-mask wearing, contact tracing, disinfection and decontamination of infected areas, washing and sanitization of hands and so on as advised by the WHO. These measures will go a long way arresting a further increase or second wave of infections in Cameroon.

REFERENCES

[1] Chelo, D., *et al*. (2020). Decrease in Hospitalizations and Increase in Deaths During the COVID-19 Epidemic in a Pediatric Hospital, Yaounde-Cameroon and Prediction for the Coming Months, *Fetal and Pediatric Pathology*, pp: 1 – 15.

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

[3] Djaoue, S., *et al*. (2020). Mathematical Modeling, Analysis and Numerical Simulation of the COVID-19 Transmission With Mitigation of Control Strategies Used in Cameroon, *Chaos, Solitons and Fractals*, 139 (2020): 1 – 15.

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

[5] Kouakep, Y. T., *et al*. (2020). Modelling the Anti-COVID-19 Individual or Collective Containment Strategies in Cameroon, *University of Ngaoundere*, Ngaoundere.

[6] Mbopi-Keou, F., Pondi, J., & Sosso, M. A. (2020). COVID-19 in Cameroon: A Crucial Equation to Resolve, *Lancet Infectious Diseases*, pp: 1.

[7] Ministry of Public Health (2020). First COVID-19 Case Imported From France, *Ministry of Public Health*, Cameroon.

[8] Ngondiep, E. (2020). An Efficient Explicit Approach for Predicting the COVID-19 Spreading With Undetected Infectious: The Case of Cameroon, *medRxiv*, pp: 1 – 27.

[9] Nguemdjo, U., *et al*. (2020). Simulating the Progression of the COVID-19 Disease in Cameroon Using SIR Models, *PLoS ONE*, 15 (8): 1 – 10.

[10] Nkwayep, C. H., et al. (2020). Short-term Forecasts of the COVID-19 Pandemic: A Study Case of Cameroon, *Chaos, Solitons and Fractals*, 140 (2020): 1 – 17.

[11] Ribeiro, M. H. D. M., *et al*. (2020). Short-term Forecasting of COVID-19 Cumulative Confirmed Cases: Perspectives for Brazil, *Chaos, Solitons and Fractals*, 138 (2020): 1 – 13.

[12] Rosenberg, E. S., *et al*. (2020). Association of Treatment With Hydroxychloroquine or Azithromycin With In-hospital Mortality in Patients With COVID-19 in New York State, *JAMA*, pp: 1 – 17.

[13] Singhal, A., *et al*. (2020). Modeling and Prediction of COVID-19 Pandemic Using Gaussian Mixture Model, *Chaos, Solitons and Fractals*, 138 (2020): 1 – 8.

[14] Tchoumi, S. Y., *et al*. (2020). COVID-19 Modeling and Caution in Relaxing Control Measures and Possibilities of Several Peaks in Cameroon, *University of Ngaoundere*, Ngaoundere.

[15] Velasquez, R. M. A., & Lara, J. V. M. (2020). Forecast and Evaluation of COVID-19 Spreading in USA With Reduced-space Gaussian Process Regression, *Chaos, Solitons and Fractals*, 138 (2020): 1 – 9.

[16] Yousaf, M., *et al*. (2020). Statistical Analysis of Forecasting COVID-19 for Upcoming Month in Pakistan, *Chaos, Solitons and Fractals*, 138 (2020): 1 – 15.