

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

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ABSTRACT

Machine learning is now popular in the field of Human Medicine. Many algorithms have been applied by many researchers and these are 1) classification algorithms 2) clustering or density estimation algorithms and 3) regression algorithms. Algorithms can also fall into either of the two broad categories: supervised and unsupervised learning algorithms. In supervised learning input and output values are available for training and the model learns a predictor function which will be used to generate forecasts. Input values only are available in unsupervised learning, the algorithm learns a hypothesis function by finding the hidden or inherent structure of the data. Artificial neural networks, Support vector machine, tree-based models and ensembles have been widely used in modeling and forecasting in public health. In this paper we apply the Artificial neural network (multilayer perceptron), ANN (12,12,1) model. Study findings indicate that the COVID-19 virus will be under control (around zero daily new covid-19 cases are projected) from November 2020 to April 2021 and the study recommends the government of Ghana to continue applying WHO recommended preventive measures to prevent another wave of the deadly corona virus.

Keywords: - ANN, COVID-19, Forecasting

INTRODUCTION

The novel corona virus (Covid-19) is a communicable disease which is highly contagious and known to cause an upper respiratory tract infection and viral pneumonia. The first case of the corona virus in Ghana was reported on the 12th of March 2020 and on the 11th of June 2020 the country had recorded over 11000 cases with 48 deaths (Bukari et al, 2020). The global pandemic has affected many countries in the world and Ghana is not an exception. Projections from the World Bank suggest that COVID-19 will push 49million people into extreme poverty in 2020 out of which 23 million are expected to be in Sub-Saharan Africa (Bukari et al, 2020). The most recent estimates from Ghana Living Standards Survey (GSS7) suggests that the battle to end poverty in all its forms everywhere in Ghana is far from being over and in some regions, getting harder to achieve as the proportion of Ghana's poor remains unacceptably high (Ghana Statistical Service, 2018). This means that it will be difficult for Ghana to achieve its Sustainable Development Goals (SDGs). Ghana ministry of Health has made tremendous efforts to curb the spread of covid-19. Trace teams have been put in place to trace contacts of infected persons and by the 20th of March 2020 300 contacts had been identified (Bukari et al, 2020). Closure of all

schools and Universities was inevitable in order to control the outbreak (UNESCO, 2020). The government issued a lockdown in 2 regions of Ghana in the early stages of the outbreak. This lockdown was issued in selected cities and specific instructions were given. (Ofori, 2020; Ndour, 2020, Lin et al, 2020). Ghana's response to the outbreak has been highly commended by several international bodies. It was scientific, competent and realistic. Its key response was health education, regular hand washing with soap, wearing face masks and social distancing (Dickson, 2020; Bondah & Agyemang, 2020). In this paper we aim to forecast the number of daily new covid-19 cases from November 2020 to April 2021. This piece of work will generate forecasts which will help the government of Ghana to formulate policy, plan and implement a National health response to the deadly outbreak.

LITERATURE REVIEW

Table 1: Literature Review

Author(s)/yr.	Study period	Method	Major findings
Wiah et al (2020)	23May 2020 to 24April 2020	SEIRQT Model	Early quarantine and high quarantine rate are crucial to control of COVID-19
Lin et al (2020)	1960-2019	ARIMA, Monte-Carlo simulation	The economic prosperity of Ghana will be disrupted and major revenue margins shrunk this year ((2020).
Asamoah et al (2020)	12March 2020 to 26April 2020.	SEAQIHRDS model	Continuous increase in the rate of diagnosis, the rate of quarantine through doubling enhanced contact tracing and stringent safety measures in hospitals/isolation centres with a constant supply of PPEs will help reduce control reproduction number to less than a unity.
Gyilbag et al (2020)	29Feb 2020 to 23June 2020	Holt's Exponential smoothing model (HES).	The cumulative case count in Ghana is projected to be 14086 by 23December 2020. Many activities embody the electoral cycle could exacerbate the cumulative cases in Ghana and neighboring countries.

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 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 G series in this study) for all age groups in Ghana. The data covers the period 14March 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 1: Descriptive statistics

Mean	Median	Minimum	Maximum
207.13	95.000	0.00000	1513.0
Std. Dev.	C.V.	Skewness	Ex. kurtosis
277.58	1.3401	2.0088	4.5282
5% Perc.	95% Perc.	IQ range	Missing obs.
0.00000	795.40	309.00	0

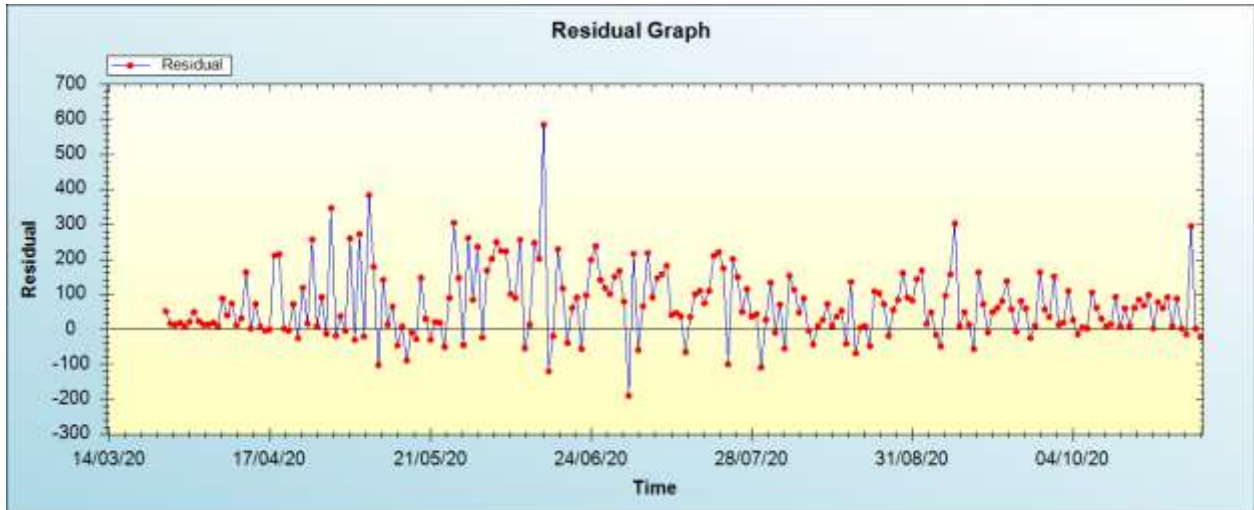
ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN GHANA

Table 2: ANN model summary

Variable	G
Observations	220 (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	0.145213
MSE	14898.480437
MAE	87.732010

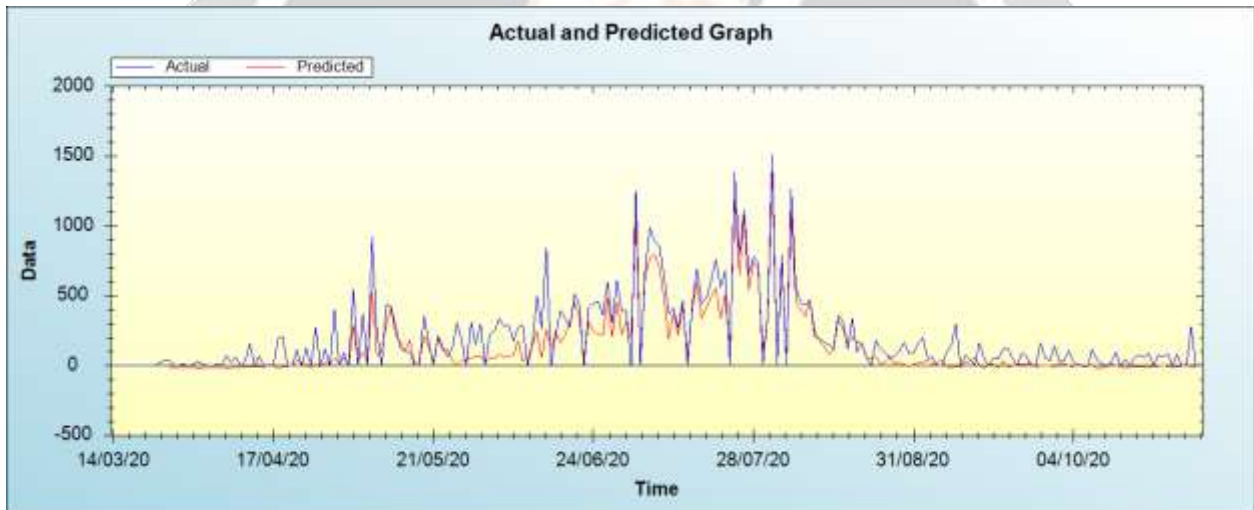
Residual Analysis for the ANN model

Figure 1: Residual analysis



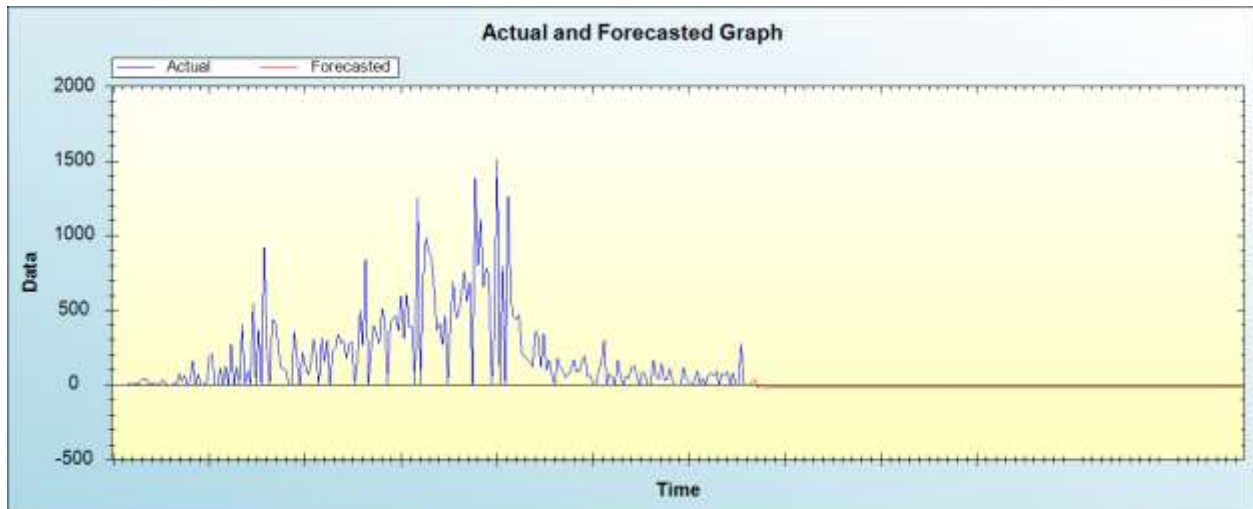
In-sample Forecast for G

Figure 2: In-sample forecast for the G series



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

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



Out-of-Sample Forecast for: Forecasts only

Table 4: Predictions

Day/Month/Year	Forecasted daily new cases
01/11/20	3.4948
02/11/20	19.3196
03/11/20	36.1825
04/11/20	-22.2352
05/11/20	-13.2949
06/11/20	0.1380
07/11/20	-23.6286
08/11/20	-18.0600
09/11/20	-18.6800
10/11/20	-11.3928
11/11/20	-17.5996
12/11/20	-21.2974
13/11/20	-17.1590
14/11/20	-16.8436
15/11/20	-18.5587

The image contains a large, semi-transparent watermark of the IJARIE logo in the center. The logo is circular with a stylized globe and the acronym 'IJARIE' written across it.

16/11/20	-17.6859
17/11/20	-18.0075
18/11/20	-17.5850
19/11/20	-17.9691
20/11/20	-17.8742
21/11/20	-17.4388
22/11/20	-17.8066
23/11/20	-17.8267
24/11/20	-17.6669
25/11/20	-17.7116
26/11/20	-17.6999
27/11/20	-17.7497
28/11/20	-17.7246
29/11/20	-17.6987
30/11/20	-17.7430
01/12/20	-17.7221
02/12/20	-17.7173
03/12/20	-17.7295
04/12/20	-17.7246
05/12/20	-17.7271
06/12/20	-17.7231
07/12/20	-17.7241
08/12/20	-17.7279
09/12/20	-17.7239
10/12/20	-17.7248
11/12/20	-17.7257

12/12/20	-17.7248
13/12/20	-17.7253
14/12/20	-17.7249
15/12/20	-17.7252
16/12/20	-17.7253
17/12/20	-17.7249
18/12/20	-17.7252
19/12/20	-17.7252
20/12/20	-17.7250
21/12/20	-17.7251
22/12/20	-17.7251
23/12/20	-17.7251
24/12/20	-17.7251
25/12/20	-17.7251
26/12/20	-17.7251
27/12/20	-17.7251
28/12/20	-17.7251
29/12/20	-17.7251
30/12/20	-17.7251
31/12/20	-17.7251
01/01/21	-17.7251
02/01/21	-17.7251
03/01/21	-17.7251
04/01/21	-17.7251
05/01/21	-17.7251
06/01/21	-17.7251

A large, semi-transparent watermark of the IJARIE logo is centered over the table. The logo features a stylized globe with a swoosh and the acronym 'IJARIE' below it.

07/01/21	-17.7251
08/01/21	-17.7251
09/01/21	-17.7251
10/01/21	-17.7251
11/01/21	-17.7251
12/01/21	-17.7251
13/01/21	-17.7251
14/01/21	-17.7251
15/01/21	-17.7251
16/01/21	-17.7251
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25/01/21	-17.7251
26/01/21	-17.7251
27/01/21	-17.7251
28/01/21	-17.7251
29/01/21	-17.7251
30/01/21	-17.7251
31/01/21	-17.7251
01/02/21	-17.7251

A large, semi-transparent watermark of the IJARIE logo is centered over the table. The logo features a stylized globe with a swoosh and the text 'IJARIE' below it.

02/02/21	-17.7251
03/02/21	-17.7251
04/02/21	-17.7251
05/02/21	-17.7251
06/02/21	-17.7251
07/02/21	-17.7251
08/02/21	-17.7251
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22/02/21	-17.7251
23/02/21	-17.7251
24/02/21	-17.7251
25/02/21	-17.7251
26/02/21	-17.7251
27/02/21	-17.7251

A large, semi-transparent watermark of the IJARIE logo is centered over the table. The logo features a stylized globe with a white swoosh and the acronym 'IJARIE' in bold, white, sans-serif font below it.

28/02/21	-17.7251
01/03/21	-17.7251
02/03/21	-17.7251
03/03/21	-17.7251
04/03/21	-17.7251
05/03/21	-17.7251
06/03/21	-17.7251
07/03/21	-17.7251
08/03/21	-17.7251
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18/03/21	-17.7251
19/03/21	-17.7251
20/03/21	-17.7251
21/03/21	-17.7251
22/03/21	-17.7251
23/03/21	-17.7251
24/03/21	-17.7251
25/03/21	-17.7251

The logo for IJARIE is a circular emblem with a stylized globe in the center, surrounded by a decorative border. The text 'IJARIE' is prominently displayed across the middle of the emblem.

26/03/21	-17.7251
27/03/21	-17.7251
28/03/21	-17.7251
29/03/21	-17.7251
30/03/21	-17.7251
31/03/21	-17.7251
01/04/21	-17.7251
02/04/21	-17.7251
03/04/21	-17.7251
04/04/21	-17.7251
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14/04/21	-17.7251
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18/04/21	-17.7251
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20/04/21	-17.7251

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24/04/21	-17.7251
25/04/21	-17.7251
26/04/21	-17.7251
27/04/21	-17.7251
28/04/21	-17.7251
29/04/21	-17.7251
30/04/21	-17.7251

Figure 1 shows that over the study period the minimum and maximum number of daily new corona virus cases are 0 and 1513 and the average daily new corona virus infections are 207. The data is positively skewed with a kurtosis of 4.0 meaning that the data is not normally distributed. The residual graph and model evaluation criteria indicate that the applied ANN (12,12,1) model is adequate and stable for forecasting daily covid-19 cases. The results of the study indicate that the COVID-19 pandemic may disappear in Ghana around November 4, 2020. This may not necessarily indicate completely zero cases per but rather imply that the pandemic is under control in Ghana.

CONCLUSION & RECOMMENDATIONS

Ghana's response to COVID-19 has widely been praised by international organizations. The key response was health education among communities, social distancing, regular hand washing with soap, use of hand sanitizers, and face masks. Lockdown was instituted to control the out break and the citizens were cooperative in the process which has helped to control the disease. The results of the study indicate a success story in the control of covid-19(projected around zero daily new cases), therefore the government of Ghana should continue the good work so as to prevent another wave of the deadly corona virus.

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