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FORECASTING OF COVID-19 PANDEMIC IN NIGERIA USING REAL STATISTICAL DATA

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Abstract: In this paper, we used data released by Nigeria Center for Disease Control (NCDC) every 24 hours for the past consecutive two months to forecast the Coronavirus disease 2019 (COVID-19) cases for the months (September – October 2020). The linear regression forecasting model and R software package are used for the forecast and simulations respectively. The COVID-19 cases in Nigeria is on a decreasing trend and the forecast result show that in the next two months, there is going to be a decrease in new COVID-19 cases in Nigeria. COVID-19 in Nigeria can be drastically reduced if the organizations, management, government or policymakers are constantly proactive

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concerning these research findings.

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1. INTRODUCTION

The coronavirus disease 2019 (COVID-19) is a highly contagious respiratory disease triggered by a strain of coronavirus that causes illness in human. The disease spreads from person to person via infected air droplets that are projected during sneezing or coughing. It may also be transmitted when humans have contact with hands or objects containing the virus, and when infected hands touch their eyes, nose or mouth. In December 2019, COVID-19 was first identified in China, but has now spread around the world.

COVID-19 was first announced in Nigeria on February 27, 2020 [1- 3], and since then, it has been a major concern to public health organizations. Presidential Task Force (PTF) was constituted as a matter of urgency to liaise with Federal Ministry of Health (FMOH) and Nigeria Center for Disease Control (NCDC) to give situation reports every 24 hours of COVID-19 new cases in Nigeria. Therefore, we consider the data given daily from the situation reports by NCDC on COVID-19 new cases in Nigeria from June 1, 2020 to August 31, 2020. These data of COVID-19 cases in Nigeria can be used by researchers to determine how the disease can be control. The data can also be used to know how fast the spread of COVID-19 in Nigeria and the strategies measure that need to be taken so as curb the spread of the disease.

2. EXPERIMENTAL DESIGN, MATERIALS AND METHODS

The data used for this research were obtained from the Nigeria Centre for Diseases Control (NCDC) the data covers a period of three (3) months, starting from June 1, 2020 to the August 31, 2020. The data were collected daily from the NCDC website for a period of 92 days. The first day of COVID-19 occurrence in Nigeria was on 27th of February 2020, and up to the date of this report, the NCDC have provided an up to date data on the COVID-19 pandemic. The first death case

linked to COVID-19 occurred on the 23rd of March. The forecast made in this research is based on the Autoregressive Integrated Moving Average method (ARIMA) model and also the Prophet package which is based on an additive regression time series forecasting algorithm developed by facebook. The Prophet package has strengths of dealing with strong seasonal effects, missing data, outliers and shift in trends [4-9].

2.1 Arima model

An autoregressive model of order p can be written as

$$(1) \quad y_t = c + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + \varepsilon_t$$

where ε_t is white noise. This is like a multiple regression but with *lagged values* of y_t as predictors. We refer to this as an AR(p) model, an autoregressive model of order p [4]. Rather than using past values of the forecast variable in a regression, a moving average model uses past forecast errors in a regression-like model.

$$(2) \quad y_t = c + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_q \varepsilon_{t-q}$$

where c is white noise. We refer to this as an MA(q) model, a moving average model of order q . Of course, we do not observe the values of ε_t , so it is not really a regression in the usual sense.

Table 1. Description of COVID-19 in Nigeria dataset [4]

S/N	Property	Value
1	Description	Time series data
2	[Min, Max]	[0, 790]
3	Characteristics	Strong trend
4	Behaviour	Non-stationary
5	Start date	June 1, 2020
6	End date	August 31, 2020
7	Outliers, Missing	None

2.2 *The prophet package*

The Prophet package uses a decomposable time series model with three main model components: trend, seasonality and holidays. They are combined in the following equation

$$(3) \quad Y(t) = g(t) + s(t) + h(t) + \varepsilon_t$$

where $g(t)$ is a linear or logistic growth curve, $s(t)$ represents periodic changes, $h(t)$ takes care of holiday effects and ε_t is an error term which accounts for any unusual changes not accommodated by the model. Therefore, using the above models, the following graphs and tables are obtained. [4]

3. MAIN RESULTS

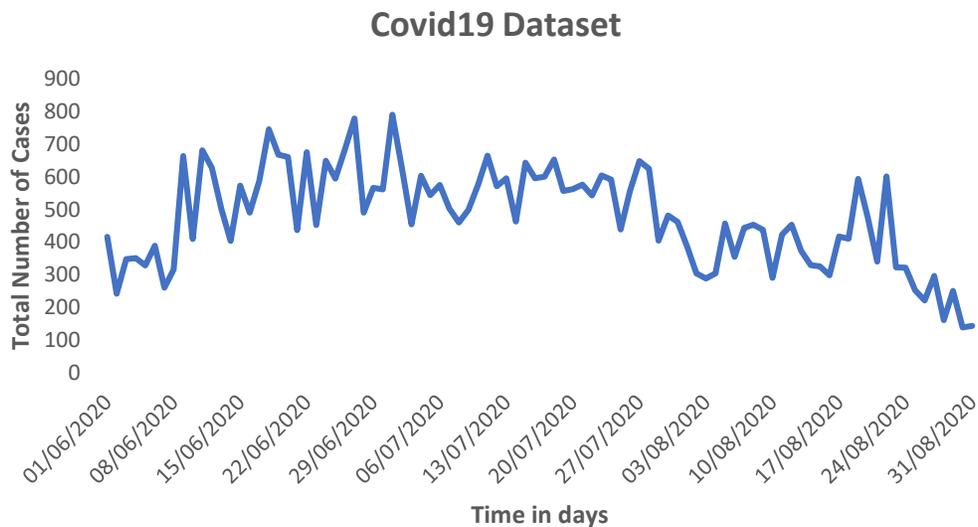


FIGURE1. Covid19 time series graph

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Table 2. COVID-19 in Nigeria Forecasted cases (Upper and lower bounds) with official NCDC report [1, 5]

S/N	Forecasted day	Forecasted cases	Official cases	Within range?
1	2020-06-01	[359 – 638]	416	Yes
2	2020-06-05	[391 – 671]	328	No
3	2020-06-09	[362 – 638]	663	No
4	2020-06-13	[427 – 705]	501	Yes
5	2020-06-17	[414 – 704]	587	Yes
6	2020-06-21	[325 – 604]	436	Yes
7	2020-06-25	[430 – 714]	594	Yes
8	2020-06-29	[388 – 655]	566	Yes
9	2020-07-03	[405 – 676]	454	Yes
10	2020-07-07	[387 – 660]	503	Yes
11	2020-07-11	[444 – 729]	664	Yes
12	2020-07-15	[413 – 692]	643	Yes
13	2020-07-19	[314 – 594]	556	Yes
14	2020-07-23	[388 – 673]	604	Yes
15	2020-07-27	[317 – 602]	648	No
16	2020-07-31	[322 – 611]	462	Yes
17	2020-08-04	[285 – 567]	304	Yes
18	2020-08-08	[315 – 606]	453	Yes
19	2020-08-12	[284 – 572]	453	Yes
20	2020-08-16	[186 – 461]	298	Yes
21	2020-08-20	[259 – 536]	476	Yes
22	2020-08-24	[190 – 476]	321	Yes
23	2020-08-28	[191 – 476]	160	No
24	2020-08-31	[158 – 446]	143	No

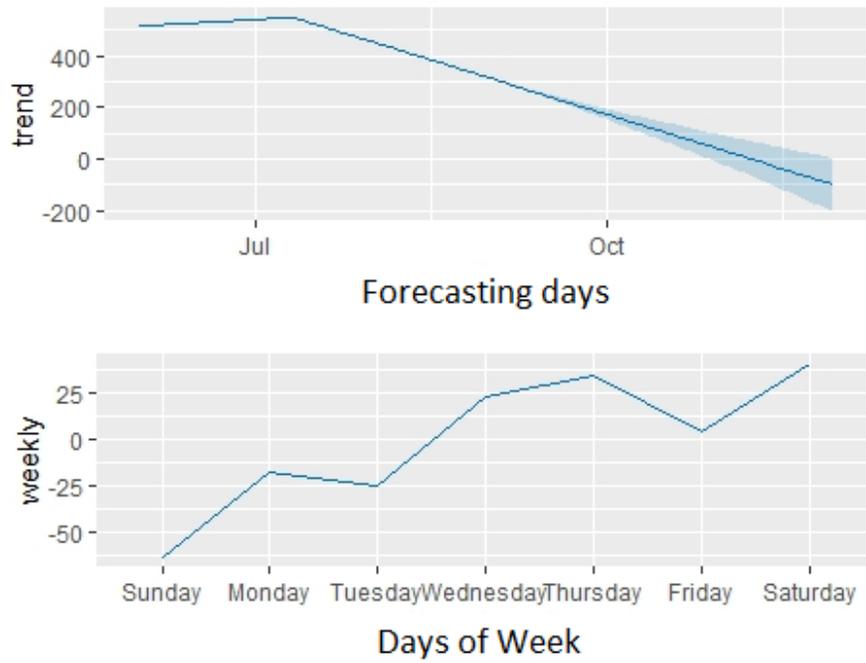


FIGURE 2. COVID-19 trend and weekly graphs

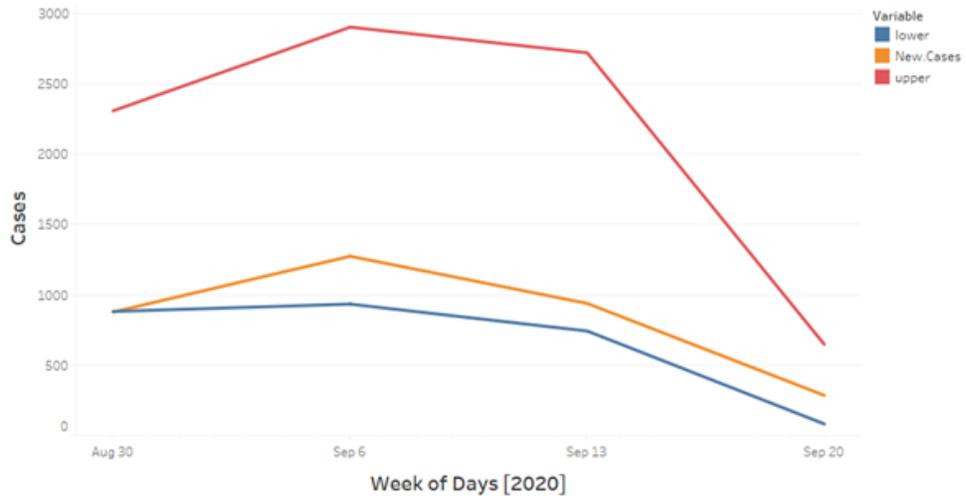


FIGURE 3. COVID-19 forecast values for September

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FIGURE 4. Comparison of COVID-19 new cases with forecast values for September

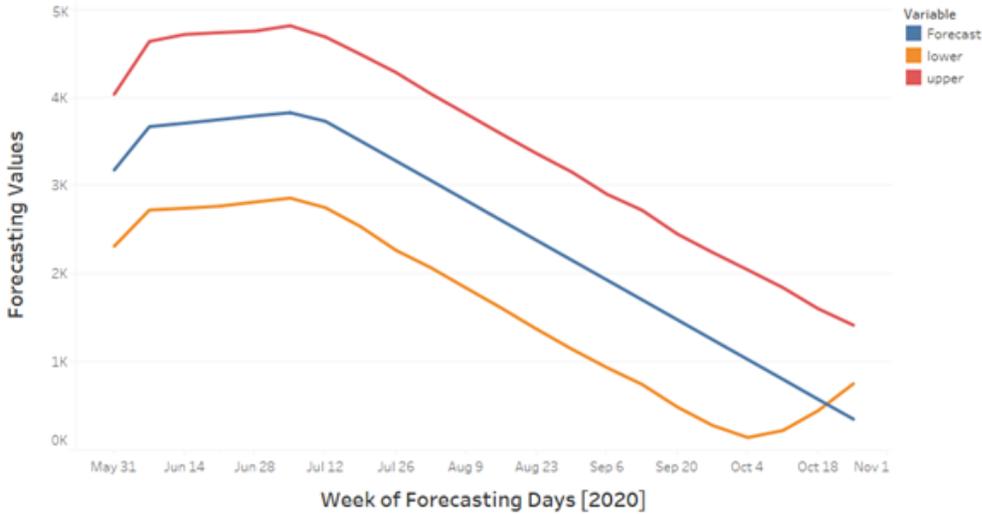


FIGURE 5. COVID-19 Predicted values with upper and lower bounds

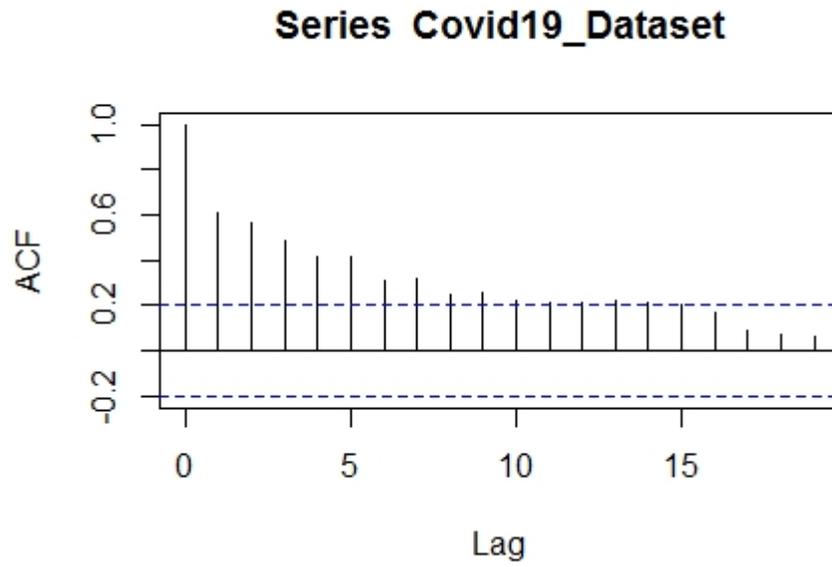


FIGURE 6. Partial Autocorrelation function for the COVID-19 dataset graph

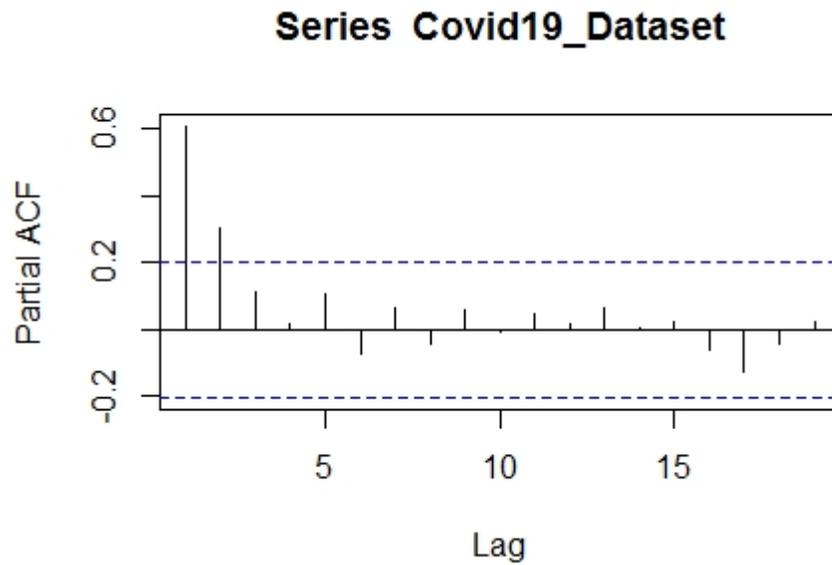


FIGURE 7. Autocorrelation function for the COVID-19 graph

Table 3. COVID-19 in Nigeria Forecasted cases (Upper and lower bounds) with official NCDC cases

S/N	Forecasted day	Forecasted cases	Official cases	Within range?
1	2020-09-01	[142 – 426]	143	Yes
2	2020-09-05	[200 – 478]	156	No
3	2020-09-09	[157 – 434]	296	Yes
4	2020-09-13	[52 – 344]	160	Yes
5	2020-09-17	[138 – 425]	126	No
6	2020-09-21	[63 – 344]	97	Yes
7	2020-09-25	[67 – 351]	-	-
8	2020-09-29	[16 – 304]	-	-
9	2020-10-03	[55 – 345]	-	-
10	2020-10-07	[24 – 326]	-	-
11	2020-10-11	[82 – 212]	-	-
12	2020-10-15	[0 – 288]	-	-
13	2020-10-19	[73 – 212]	-	-
14	2020-10-23	[66 – 231]	-	-
15	2020-10-27	[125 – 190]	-	-
16	2020-10-31	[77 – 227]	-	-

4. DISCUSSIONS OF RESULTS

Table 1 gives a description of the COVID-19 dataset used for this study and it contains 92 time-series data points. COVID-19 in Nigeria forecasted values (Upper and lower bounds) were compared with official NCDC cases to see if they are within the range of the forecast from 1st June 2020 to 31st August 2020. The lower and upper boundaries of these predicted cases are also presented in table 2.

In recent months, the COVID-19 pandemic in Nigeria has been on a decreasing trend and this is shown in figure 1. The COVID-19 dataset is shown graphically in figure 1. For effective forecasting of the COVID-19 data, the data was stored as a *CSV* file which was then loaded into ARIMA model and the Prophet package. Figure 2 shows the general trend and weekly trend of the COVID-19 dataset for the period of study. These cases are then compare with the official cases that were published by NCDC within that period. Figure 6 shows the autocorrelation function graph while figure 7 shows the partial autocorrelation graph of the COVID-19 dataset.

These plots gave insight on the best ARIMA (0, 1, 1) model to use for the forecast. The new cases of COVID-19 published by the NCDC in the month of September 2020 are presented graphically in figure 4 together with the forecast values. Daily forecast from the 1st September 2020 to the 21st September 2020 together with its lower and upper boundaries is shown in Figure 5. This graph is plotted as an extension of the raw data. Figure 3 shows upper and lower forecast values for September 2020 compared with the New cases published by NCDC within the first 21 days of September 2020. Table 3 shows predicted values of COVID-19 for the month of September and October 2020.

5. CONCLUSION

The forecast of Covid 19 cases in Nigeria has been carried out and the following conclusions are presented. The plotted data used shows that the Covid 19 cases in Nigeria is on the decline. This research also shows that the trend in the Covid cases within the study period (1st June 2020 to 31st August 2020) is a decreasing trend. Covid 19 cases increased during weekdays but reduced to the least value on Sundays through out the study period. The forecast values are near the published new cases in September 2020. For the study period, a greater percentage of the published values were in range of the predicted values. This shows that the Prophet package can be used to forecast the Covid 19 cases in Nigeria accurately. The forecast values also show that the COVID-19 cases will continue to be on a decreasing trend.

Data Access Statement

The authors confirm that the data supporting the findings of this study are available within the article and can be obtained at Online at <http://covid19.ncdc.gov.ng/>, <https://ncdc.gov.ng/diseases/sitreps>, <https://ncdc.gov.ng/diseases/sitreps> and <https://ourworldindata.org/coronavirus-testing-source-data>

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

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