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Will Covid-19 cases in the World reach 4 million? a forecasting approach using SutteARIMA

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***Abstract*— This study aimed to determine whether COVID-19 cases in the world would have reached 4 million cases with the SutteARIMA method forecasting approach. Data from this study were obtained from the Worldometer data from 01 March 2020 to 05 May 2020. Data were used to perform data fitting from 01 March 2020 to 28 April 2020 (29 April 2020 - 05 May 2020). The data fitting is used to examine the extent of the accuracy of the SutteARIMA method in predicting the data. To examine the level of the data accuracy, the MAPE method was used in this study. Results of forecasting data for the period of 29 April 2020 to 05 May 2020: 72,731; 84,666; 92,297; 100,797; 84,312; 81,517; 74845. The accuracy of SutteARIMA for the period of 30 April 2020 - 06 May 2020 was 0.069%. The forecasting results that had been obtained were 4 million cases, namely from 08 May 2020 to 10 May 2020: 3,966,786; 4,047,328 and 4,127,747. The SutteARIMA method predicted that 4 million cases of COVID-19 in the world will be reported on the WHO situation report on day 110/111 or 09 May 2020/10 May 2020.**

***Keywords*— COVID-19; short-term forecast; SutteARIMA.**

I. INTRODUCTION

The first confirmed cases of COVID-19 in the world had been reported in Wuhan, China, and COVID-19 is an infectious disease caused by a new coronavirus (SARS-CoV-2) discovered in China [1]. Based on the data submitted by Worldometer on 05 May 2020, the number of confirmed cases of COVID-19 in the world was 3,724,518 or 81,247 cases from yesterday (04 May 2020) [2].

Forecasting is a method to determine the progress of case every day. Forecasting is used as the process of making predictions of the future. The results of this forecast can be used as a reference in the decision-making process. In the case of COVID-19, forecasting can be used as a means of looking at trends in the future and can provide input or advice to decision-makers to prevent the transmission of the COVID-19 case. Forecasting about the number of COVID-19 cases had been discussed by Koczkodaj, et. al. using the Simple Heuristics (exponential curve) method [3]. Koczkodaj, et. al. predicted that 1 million COVID-19 cases outside China would be obtained on 30 March 2020 and this is different from the data displayed by the Worldometer on 03 April 2020. Based on this results, the authors forecasted the SutteARIMA method based on the forecasting results which have a high level of accuracy by referring to the forecasting results in the COVID-19 case in Spain [4][5].

II. SUTTEARIMA

SutteARIMA is a method of forecasting that combines the method of ARIMA [6] with the method of α-Sutte Indicator [7].

The general form of the ARIMA(p,d,q) [6]:

$$\phi_p(B)Z_t = \theta_q(B)a_t, a_t \sim WN\left(0,\sigma^2\right), \phi_p, \theta_q \in Z, t \in Z. \quad (1)$$

with $\phi_p(B) = (1-\phi_1 B - \phi_2 B^2 - ... - \phi_p B^p)$ (for AR(p))
and $\theta_q(B) = (1-\theta_1 B - \theta_2 B^2 - ... - \theta_q B^q)$ (for MA(q))

If there is a differencing then the ARIMA model becomes as follows:

$$\phi_p(B)(1-B)^d Z_t = \theta_q(B)a_t, a_t \sim WN\left(0,\sigma^2\right), \phi_p, \theta_q \in Z, t \in Z.$$

with $\phi_p(B) = (1-\phi_1 B - \phi_2 B^2 - ... - \phi_p B^p)$ (for AR(p)), $(1-B)^d$ (for differencing non seasonal) and $\theta_q(B) = (1-\theta_1 B - \theta_2 B^2 - ... - \theta_q B^q$ (for MA(q)).

And the formula of the α-Sutte Indicator method are as follows [8]:

$$Z_t = \frac{\gamma\left(\frac{\Delta x}{\frac{\gamma+\delta}{2}}\right)+\beta\left(\frac{\Delta y}{\frac{\beta+\gamma}{2}}\right)+\alpha\left(\frac{\Delta z}{\frac{\alpha+\beta}{2}}\right)}{3} \quad (2)$$

where:

$\delta = Z_{t-4}$
$\gamma = Z_{t-3}$
$\beta = Z_{t-2}$
$\alpha = Z_{t-1}$
$\Delta x = \gamma - \delta = Z_{t-3} - Z_{t-4}$
$\Delta y = \beta - \gamma = Z_{t-2} - Z_{t-3}$
$\Delta z = \alpha - \beta = Z_{t-1} - Z_{t-2}$
Z_t = data at t time
Z_{t-k} = data at $(t-k)$ time

The equation (1), can be described as:

$$(1-\phi_1 B-\phi_2 B^2-\ldots-\phi_p B^p)Z_t = (1-\theta_1 B-\theta_2 B^2-\ldots-\theta_q B^q)a_t$$
$$Z_t-\phi_1 BZ_t-\phi_2 B^2 Z_t-\ldots-\phi_p B^p Z_t = a_t-\theta_1 Ba_t-\theta_2 B^2 a_t-\ldots-\theta_q B^q a_t \quad (3)$$

While equation (3), can be reduced by using backward shift operator $\left(B^p Z_t = Z_{t-p}\right)$:

$$Z_t-\phi_1 Z_{t-1}-\phi_2 Z_{t-2}-\ldots-\phi_p Z_{t-p} = a_t-\theta_1 a_{t-1}-\theta_2 a_{t-2}-\ldots-\theta_q a_{t-q}$$
$$Z_t = \phi_1 Z_{t-1}+\phi_2 Z_{t-2}+\ldots+\phi_p Z_{t-p}+a_t-\theta_1 a_{t-1}-\theta_2 a_{t-2}-\ldots-\theta_q a_{t-q} \quad (4)$$

If we define:

$\delta = Z_{t-4}$
$\gamma = Z_{t-3}$
$\beta = Z_{t-2}$
$\alpha = Z_{t-1}$

The equation (4):

$$Z_t = \phi_1\alpha+\phi_2\beta+\phi_3\gamma+\phi_4\delta+\ldots+\phi_p Z_{t-p}+ a_t-\theta_1 a_{t-1}-\theta_2 a_{t-2}-\ldots-\theta_q a_{t-q} \quad (5)$$

and the equation (2) can be simplified as:

$$Z_t = \frac{\gamma\left(\frac{\Delta x}{\frac{\gamma+\delta}{2}}\right)+\beta\left(\frac{\Delta y}{\frac{\beta+\gamma}{2}}\right)+\alpha\left(\frac{\Delta z}{\frac{\alpha+\beta}{2}}\right)}{3}$$
$$Z_t = \frac{\frac{\gamma\Delta x}{\frac{\gamma+\delta}{2}}+\frac{\beta\Delta y}{\frac{\beta+\gamma}{2}}+\frac{\alpha\Delta z}{\frac{\alpha+\beta}{2}}}{3}$$
$$Z_t = \frac{\frac{\gamma\Delta x}{\frac{3\gamma+3\delta}{2}}+\frac{\beta\Delta y}{\frac{3\beta+3\gamma}{2}}+\frac{\alpha\Delta z}{\frac{3\alpha+3\beta}{2}}}{2}$$
$$Z_t = \frac{2\gamma\Delta x}{3\gamma+3\delta}+\frac{2\beta\Delta y}{3\beta+3\gamma}+\frac{2\alpha\Delta z}{3\alpha+3\beta}$$

Let, Equation (4) added with Equation (5), we will find the formula of SutteARIMA:

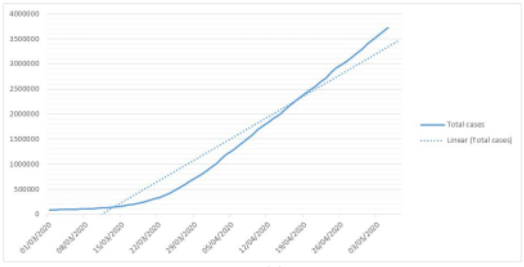
$$2Z_t = \phi_1\alpha+\phi_2\beta+\phi_3\gamma+\phi_4\delta+\ldots+\phi_p Z_{t-p}+a_t-\theta_1 a_{t-1}-\theta_2 a_{t-2}-\ldots-\theta_q a_{t-q}+\gamma\frac{2\Delta x}{3\gamma+3\delta}+\beta\frac{2\Delta y}{3\beta+3\gamma}+\alpha\frac{2\Delta z}{3\alpha+3\beta}$$
$$Z_t = \alpha\left(\frac{\phi_1}{2}+\frac{\Delta z}{3\alpha+3\beta}\right)+\beta\left(\frac{\phi_1}{2}+\frac{2\Delta y}{3\beta+3\gamma}\right)+\gamma\left(\frac{\phi_1}{2}+\frac{2\Delta x}{3\gamma+3\delta}\right)+\frac{\phi_1\delta}{2}+\ldots+\frac{\phi_p Z_{t-p}}{2}+\frac{a_t}{2}-\frac{\theta_1 a_{t-1}}{2}-\frac{\theta_2 a_{t-2}}{2}-\ldots-\frac{\theta_q a_{t-q}}{2} \quad (6)$$

where:

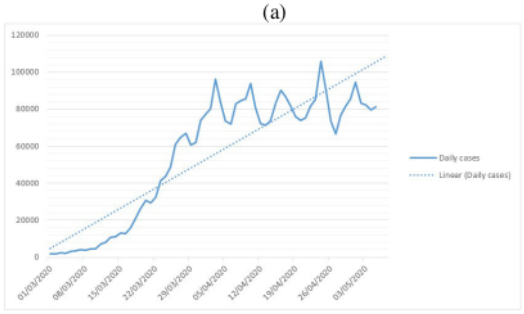
$\delta = Z_{t-4}$
$\gamma = Z_{t-3}$
$\beta = Z_{t-2}$
$\alpha = Z_{t-1}$
$\Delta x = \gamma - \delta = Z_{t-3} - Z_{t-4}$
$\Delta y = \beta - \gamma = Z_{t-2} - Z_{t-3}$
$\Delta z = \alpha - \beta = Z_{t-1} - Z_{t-2}$
Z_t = data at t time
Z_{t-p} = data at $(t-p)$ time

III. SUTTEARIMA FORECAST

The data for the COVID-19 cases were obtained from the Worldometer data. Data starts from 01 March 2020 - 05 May 2020. The total cases in the world are shown in Figure 1.



(a)



(b)

Fig. 1 (a) Total cases and linear trends (Total cases) of COVID-19 in the world (01 March 2020 – 05 May 2020); (b) Daily cases of COVID-19 in the world (01 March 2020 – 05 May 2020)

On the base of figure 1, it can be seen that the COVID-19 case has an upward trend from time to time. This trend indicates that 4 million cases will be completed in a short time. This is also reinforced by Figure 2, which shows that the average number of confirmed cases per day from 22 April 2020 to 05 May 2020 is around 80,000 cases.

To further examine the likelihood of achieving the 4 million confirmed cases in the world, it is necessary to forecast the data. The forecasting method used in this study was the SutteARIMA method. The first stage carried out in this study was to determine the level of forecasting accuracy. Testing the accuracy of the SutteARIMA forecasting was done by fitting the data on the period of 29 April 2020 - 05 April 2020 by using the data from the period of 01 March 2020 - 28 April 2020. The level of forecasting accuracy can be seen from the mean absolute percentage error (MAPE). The results of this forecast are shown in Table 1.

TABLE 1
RESULTS OF FITTING CONFIRMED CASES OF COVID-19 IN WORLD

Date	Actual	Forecast	APE
29/04/2020	81648	72731	0,109
30/04/2020	85643	84666	0,011
01/05/2020	94550	92297	0,024
02/05/2020	83335	100797	0,210
03/05/2020	82260	84312	0,025
04/05/2020	79582	81517	0,024
05/05/2020	81247	74845	0,079
		MAPE	0,069

Table 1 shows that the accuracy of the SutteARIMA method is 0.069% for the period of 29 April 2020 - 05 April 2020. By looking at the value of the low level of accuracy of the SutteARIMA method, the SutteARIMA method is used to predict when World cases reach 4 million cases and the results of this forecast can be seen in Table 2.

TABLE 2
FORECAST 4 MILLION CASES OF COVID-19 IN WORLD

Date	Forecast
08/05/2020	3966786
09/05/2020	4047328
10/05/2020	4127747

According to Table 2, the SutteARIMA method predicts that 4 million cases of COVID-19 in the world will be reported by the WHO situation report on 110/111 day or by 09 May 2020/10 May 2020.

IV. CONCLUSIONS

The SutteARIMA method is a combination of the ARIMA method and the α-Sutte indicator. In this study, the SutteARIMA method had an accuracy rate on data fitting of 0.069% or may be extended to 1%. Based on the results of this study, the SutteARIMA method predicted that 4 million cases will be obtained from the WHO situation report on day 110/111 or 09 May 2020 or 10 May 2020. It is expected that the results of this study will provide input to the World Government to be able to adopt policies aimed at preventing the COVID-19 cases, because based on the results of the ongoing analysis of the SutteARIMA method, if the addition of these cases is stagnant, it is expected that there will be around 4.5 million cases between 14 May 2020 and 15 May 2020.

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