The date predicted 200.000 cases of COVID-19 in Spain

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Abstract

The aim of this study is predicted 200.000 cases of COVID-19 in Spain. COVID-19 Spanish confirmed data obtained from Worldometer from 01 March 2020 – 17 April 2020. The data from 01 March 2020 – 10 April 2020 using to fitting with data from 11 April – 17 April 2020. For the evaluation of the forecasting accuracy measures, we use mean absolute percentage error (MAPE). Based on the results of SutteARIMA fitting data, the accuracy of SutteARIMA for the period 11 April 2020 - 17 April 2020 is 0.61% and we forecast 20.000 confirmed cases of Spain by the WHO situation report day 90/91 which is 19 April 2020 / 20 April 2020.

Keywords: COVID-19, forecast, SutteARIMA.

1. Introduction

COVID-19 was first reported in Wuhan, Hubei Province, China in December 2019. COVID-19 is an infectious disease caused by a new coronavirus (SARS-CoV-2) discovered in China [1]. In Spain, COVID-19 cases began to be detected on February 12, 2020. The highest addition of COVID-19 cases occurred on March 26, 2020, as many as 8271 cases and the highest daily death occurred on April 02, 2020, as many as 961 cases [2]. Based on data presented by Worldometer on April 17, 2020, the number of confirmed cases of COVID-19 in Spain was 190,839 cases or added 5891 cases from yesterday (April 16, 2020) with 20,002 total deaths and was the second highest country with confirmed cases of COVID-19 in the world [2].

To see the case rate further in the future, it is necessary to forecast the data. Forecasting or predictions related to COVID-19 have been studied by various researchers: Koczkodaj, et. al predicts COVID-19 outside of China by using a simple heuristic (exponential curve) [3] and Roosa, et. Al studying about COVID-19 real-time forecast in China with generalized logistic growth model (GLM) [4]. This study forecasts 20.000 confirmed cases of Spain.

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2. SutteARIMA

SutteARIMA is a forecasting method that combines ARIMA and α-Sutte Indicator method.

The (Y_t) process are an autoregressive-moving average or ARMA (p, q) model if it fulfilled [5]:

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

with $\phi_p(B) = (1-\phi_1 B-\phi_2 B^2-\ldots-\phi_p B^p)$ (for AR(p))

and $\theta_q(B) = (1-\theta_1 B-\theta_2 B^2-\ldots-\theta_q B^q)$ (for MA(q))

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

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

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

The equation of the α-Sutte Indicator method are as follows [6,7]:

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

where:

$\delta = Y_{t-4}$

$\gamma = Y_{t-3}$

$\beta = Y_{t-2}$

$\alpha = Y_{t-1}$

$\Delta x = \gamma - \delta = Y_{t-3} - Y_{t-4}$

$\Delta y = \beta - \gamma = Y_{t-2} - Y_{t-3}$

$\Delta z = \alpha - \beta = Y_{t-1} - Y_{t-2}$

Y_t = data at t time

Y_{t-k} = data at $(t-k)$ time

SutteARIMA is a forecasting method that combines the α-Sutte Indicator and ARIMA [8].

The equation (1), we can describe:

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

If equation (3) we reduce using backward shift operator $\left(B^p Y_t = Y_{t-p}\right)$:

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

If we define:

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

The equation (4):

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

and the equation (2) we can simplify:

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

$$Y_t = \frac{\frac{\gamma\Delta x}{\frac{\gamma+\delta}{2}} + \frac{\beta\Delta y}{\frac{\beta+\gamma}{2}} + \frac{\alpha\Delta z}{\frac{\alpha+\beta}{2}}}{3}$$

$$Y_t = \frac{\frac{\gamma\Delta x}{\frac{3\gamma+3\delta}{2}} + \frac{\beta\Delta y}{\frac{3\beta+3\gamma}{2}} + \frac{\alpha\Delta z}{\frac{3\alpha+3\beta}{2}}}{3}$$

$$Y_t = \frac{\frac{2\gamma\Delta x}{3\gamma+3\delta} + \frac{2\beta\Delta y}{3\beta+3\gamma} + \frac{2\alpha\Delta z}{3\alpha+3\beta}}{3}$$

$$Y_t = \gamma\frac{2\Delta x}{3\gamma+3\delta} + \beta\frac{2\Delta y}{3\beta+3\gamma} + \alpha\frac{2\Delta z}{3\alpha+3\beta}$$

Let, Equation (2) added with Equation (5), we finding:

$$2Y_t = \phi_1\alpha + \phi_2\beta + \phi_3\gamma + \phi_4\delta + \ldots + \phi_p Y_{t-p} + a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \ldots - \theta_q a_{t-q} + \gamma\frac{2\Delta x}{3\gamma+3\delta} + \beta\frac{2\Delta y}{3\beta+3\gamma} + \alpha\frac{2\Delta z}{3\alpha+3\beta}$$

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

The equation (6) is the formula of SutteARIMA.

3. Forecasting

COVID-19 Spanish confirmed data obtained from Worldometer. Data starts from 01 March 2020 – 17 April 2020. The total confirmed cases and daily new cases in Spain can be seen in fig. 1 and fig. 2.

Fig. 1 Confirmed Cases of COVID-19 in Spain (01 March 2020 – 17 April 2020)

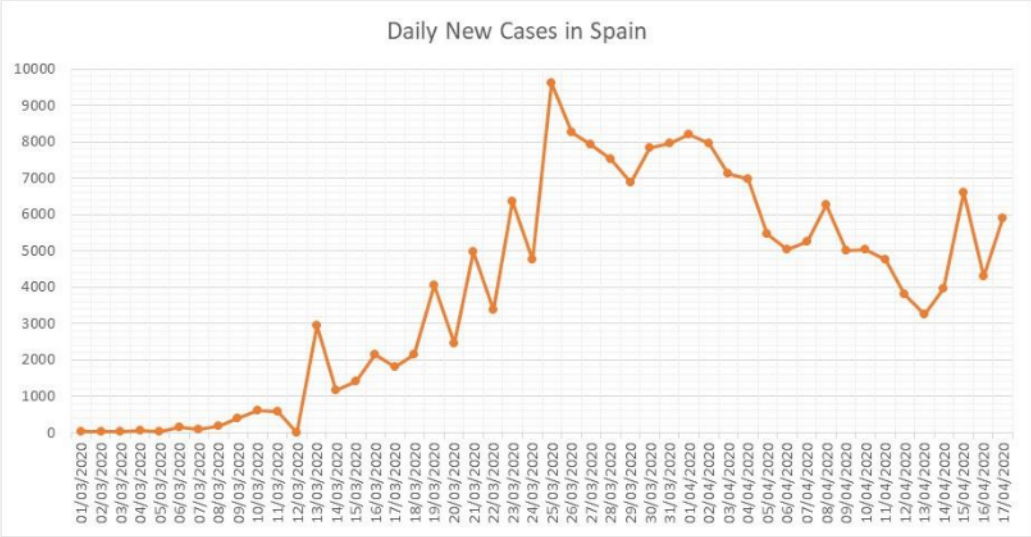

Fig. 2 Daily New Cases of COVID-19 in Spain (01 March 2020 – 17 April 2020)

To obtain the results of forecasting, this study used the forecast and sutteForecastR of R package. To see the reliability of forecasting, first forecasting is done in the 7 previous data periods (11 April 2020 - 17 April 2020). The level of forecasting accuracy can be seen from the mean absolute percentage error (MAPE). The results of this forecast are presented in table 1.

Table 1 Results of Fitting Confirmed Cases of COVID-19 in Spain

Date	Actual	Forecast	APE
11/04/2020	163027	163817	0,48
12/04/2020	166831	168041	0,73
13/04/2020	170099	171433	0,78
14/04/2020	174060	174090	0,02
15/04/2020	180659	177778	1,59
16/04/2020	184948	185335	0,21
17/04/2020	190839	189971	0,45
		MAPE	0,61

The table 1 shown the accuracy of SutteARIMA for the period 11 April 2020 - 17 April 2020 is 0.61%. The next step is to forecast for 20,000 cases (table 2).

Table 2. Forecast 20.000 Confirmed Case of COVID-19 in Spain

Date	Forecast
18/04/2020	196183
19/04/2020	201611
20/04/2020	207087

According to table 2, we predict 20.000 COVID-19 cases of Spain by the WHO situation report day 90/91 which is 19 April 2020 / 20 April 2020.

4. Conclusion

In particular, the SutteARIMA model is a short-term prediction model, which seems very simple and we believe that the forecast results are quite accurate with an accuracy rate of 0.5-1% for short-term predictions. We predict 20.000 COVID-19 cases of Spain by the WHO situation report day 90/91 which is 19 April 2020 / 20 April 2020.

The SutteARIMA approach that we present is based on the assumption that today's events are influenced by the previous day using the moving average approach and the assumption that current trends can continue for the next 10 days based on the number of daily cases. The SutteARIMA results are the results of abstract mathematical forecasts and may be different in the future and the confirmed cases of COVID-19 can change in just a few days depending on whether there is an intervention occurring during the pandemic.

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