TREND OF THE SPREAD OF COVID-19 IN INDONESIA USING THE MACHINE LEARNING PROPHET ALGORITHM

by Nur Hayati

TREND OF THE SPREAD OF COVID-19 IN INDONESIA USING THE MACHINE LEARNING PROPHET ALGORITHM

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ABSTRACT

Based on information on the website www.bnpb.go.id on September 2, 2020, the positive rate for covid-19 in Indonesia reached 25.25% on August 30, 2020. This is a big challenge for the Indonesian government to reduce the positivity rate to meet the standards safe accepted by WHO is 5%. To ensure the accuracy of government policies, accurate data predictions are needed. Therefore, the Prophet's machine learning algorithm can be used to see trends in the spread of covid-19 in the next one year. This algorithm has a fairly high level of accuracy because the data contains time variables which are adjusted to the dataset. In several previous research, the dataset was vast uncertain and small. Meanwhile, in this research, data was taken from March 2, 2020 to February 12, 2021 on the kawalcovid19.id. This data is used to predict from February 13, 2021 to February 12, 2022. There are 3 data used, namely data confirmed, recovered and died. Based on the analysis, the confirmed patient was 22.60%-42.11%, died amounted to 21.67%-39.00%, and recovered by 22.53%-41.82%. The prediction percentage that the average cases died was 2.43% every day. The accuarcy of data confirmed was 43.97%, died was 72.50% and recovered was 84.24%.

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1. INTRODUCTION

Covid-19 is an outbreak that is currently in an uproar throughout the world, including Indonesia. Based on information on the website www.bnpb.go.id on September 2, 2020, the positive rate for covid-19 in Indonesia reached 25.25% on August 30, 2020 [1]. This is a big challenge for the Indonesian government to reduce the positivity rate to meet the standards safe accepted by WHO is 5% [1]. There are 4 categories of regional colors [2], namely the green zone, an area where there are no cases of coronavi 4 infections. The public is allowed to carry out activities as usual while still following health protocols. Second, the yellow zone means there have been several cases of covid-19 with 1 ne local transmission. This is where the Large-Scale Social Restrictions (PSBB) are carried out partially. Third, the 3 zone means that there are still cases of covid-19 in one or more clusters with a high increase in cases. In this zone, serious health protocols are needed, such as closing schools and places of workship. Fourth, the black zone where cases of covid-19 in an area have been so severe that they have reached over 2000s. The spread of covid-19 is usually through droplets from coughs or sneezes produced from an infected person. Many of the infections that come are caused by direct contact with someone infected. The incubation period for infection ranges from one to fourteen days. However, sometimes the disease caused by covid-19 can spread without severe symptoms. Several studies have been conducted in the analysis of covid-19 [3] - [8]. There has b 2 n an increase in patients identified as covid-19 [9] - [11].

In research using deep learning methods in the form of classification and LSTM has given a prominent value of MSE and RMSE as 1.034 and 1.002 respectively [12]. Whereas the results of lockdown analysis in Italy, China, and

France using the ARIMA model resulted in a decrease in confirmed patients and an increase in patients who recovered from Covid-19 [5], [14] and for Indonesia, it resulted in an R-squared error of 0.9793 with the Neural Network method [15] and to enlarge the efficiency of the algorithm, it is important to estimate the number of hidden layers and their chronological order. [16]. Other results suggest statistical analysis, modeling, and artificial intelligence contain the spread of covid-19 and highlight the impact in the coming days [17] - [19].

To get the spread of covid-19 for the next period, can use the Prophet machine learning algorithm, where the Prophet algorithm works with time-series data that is claimed to have a fairly high level of prediction accuracy [20]. This Prophet algorithm only requires two values in one data frame table, namely a column containing the time/date/day and a column containing a value that we will predict [20]. This algorithm is considered accurate because the data contains time variables adjusted to the dataset [21]-[23]. In the previous analysis with Prophet algorithm, the dataset was from several online portals that announced public information about covid-19 in Indonesia that was taken in 1 day on October 7, 2020 [24]. Meanwhile, in this study, data was taken for 1 years. The use of the original data are more numerous and diverse than previous research which included data on weekdays and holidays is expected to improve the accuracy of the model prophet. This study will predict a positive number of confirmed, recovered, and died for the next year.

2. COVID-19 DATASET

The dataset used comes from www.kawalcovid19.id. The data was taken from March 2, 2020, to February 12, 2021. The data obtained were in the form of daily cases of positive covid patients. Then, the data is made into dataset as follows:

Table 1. Dataset of confirmed, death, and recovered of Covid [25]

Observation	Date	Confirmed	Deaths	Recovered
0	March 02, 2020	2	0	0
1	March 03, 2020	2	0	0
2	March 04, 2020	2	0	0
3	March 05, 2020	2	0	0
4	March 06, 2020	4	0	0
...	...	...	...	...
345	February 11, 2021	1191990	32381	993117
346	February 12, 2021	1201859	32656	1004117

Base on the table 1, the number of data sets used in this study was 347. The data consisted of confirmed, recovered, and death from covid patients. We can see that there is increase data of confirmed, death and recovered in everyday.

3. SPREAD OF COVID-19

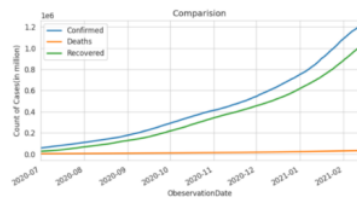Based on the data obtained, the spread of covid-19 in Indonesia has increased every month.

Figure 1. Visualizazion of case from March 1, 2020 until February 12, 2021

In Figure 1 above, we can see that the number of confirmed covid-19 patients increases every month. By the number confirmed affected by covid-19, most of them recovered from covid-19. Although it appears that the number of deaths is less than the number recovered, this virus can still cause fatal things, namely death. Table 2 shows the addition of daily cases for the last month.

Table 2. The average daily case additions over the last month

The average addition of daily cases January 12, 2021 to February 12, 2021	
Confirmed	11.454
Deaths	258
Recovered	9.945

In the table data above, we can see that 86.8% of patients were recovered from covid-19, and as many as 2.25% were died. In the timeframe from March 2020 to February 2021, data on the addition of the highest daily cases during the last month were obtained. In Table 3, we can see that the highest patient data in the last month was on January 30, 2021, amounting to 14,158 patients affected by covid-19

Table 3. The highest increase in daily cases during the last month

The highest increase in daily cases January 12, 2021 to February 12, 2021	
Date	Cases
January, 30 2021	14.158 (Confirmed)
January, 28 2021	476 (Deaths)
February, 8 2021	13.038 (Recovered)

4. PROPHET ALGORITHM MODEL

Prophet is a procedure for predicting time series data based on an additive model in which non-linear trends match data on annual, weekly, daily, seasonal, and holiday effects. The Prophet's algorithm fits many linear and nonlinear functions of time as a component (time as regressor). Forecasting FB Prophet works best with time series that have seasonal effects (strong seasonal effects and some historical season data). FB Prophet is strong at data loss and trend shifts, and usually handles outliers well. The simple functions of the Prophet [26] algorithm are:

$$k(t) = tr(t) + se(t) + ho(t) + id(t)$$

where: $tr(t)$ = trend, $se(t)$ = seasonality, $ho(t)$ = holiday and $id(t)$ = individual
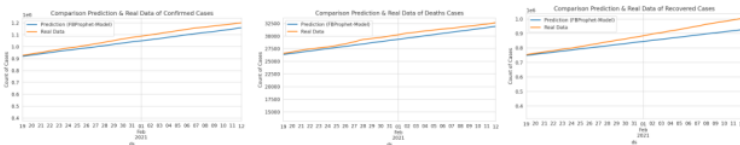Below is a visualization of the training data and test data:

Figure 2. Prediction model vs real data (test data) of confirmed, deaths, recovered cases

Because there were too many ready-made datasets and this step was carried out only to ensure the accuracy of the model, it was decided to take only the last 3 months of data from November 11, 2020 to January 18, 2021 for train data and January 19, 2021 to February 12, 2021 for test data. There is a difference of 25 days between the train data and the test data, from this gap the model will be set to predict for the next 25 days with the train data input. After inputting the train data, the model already has predictions for the next 25 days. If the model of prediction (blue line) is below from the real data (red line), then the model can be used to determine predictions of the next spread of covid-19. In Figures 2 above, it can be seen that the prediction model of confirmed, died, and recovered are below the real data so that it can be used to predictions the spread of covid-19.

4.1 Accuracy

The level of accuracy is needed to see how valid the prediction model we get from the original data. The greater the value of accuracy, the more valid the prediction model that has been obtained. The following is a formula for determining the accuracy value:

$$R - squared = 1 - \frac{first\ sum\ of\ error}{second\ sum\ of\ error}$$
$$= \frac{the\ amount\ of\ predicted\ correct\ training\ data}{the\ total\ amount\ of\ predicted\ data}$$

5. RESULT AND DISCUSSION

This research uses google colab with python programming language. In this research, a forcasting was carried out for the next 1 year of data starting from February 13, 2021 to February 12, 2022. There are 3 data that will be predicted (according to the dataset in the original data), namely confirmed data, recovered and died. The following is the prediction data for 1 year:

Table 4. The prediction data of confirmed, death and recover for 1 year

Observation	Date	Confirmed	Deaths	Recovered
347	13 Februari 2021	1172774	32350	957141
348	14 Februari 2021	1181827	32571	964447
349	15 Februari 2021	1190880	32791	971753
350	16 Februari 2021	1199933	33011	979059
351	17 Februari 2021	1208985	33231	986365
...	...	...	...	...
710	11 Februari 2022	4458961	112316	3609237
711	12 Februari 2022	4468014	112536	3616543

From the table 4, we can see that the prediction for the spread of covid-19 will increased in every day. From dataset prediction we can predicted the percentage of three months as following table 5:

Table 5. The prediction results for the total confirmed cases

Prediction of total comfirmed cases, deaths and recovered at third of the month February 13, 2021 to February 12, 2022			
Date	Confirmed	Deaths	Recovered
May 13, 2021	1.978.724	51.969	1.607.848
August 13, 2021	2.811.990	72.237	2.280.201
November 13, 2021	3.644.385	92.485	2.951.312
February 12, 2022	4.468.195	112.531	3.616.163

Based on table 5, the percentage of three months for confirmed patients was 22.60% - 42.11%, died was 21.67% - 39.00%, and recovered was 22.53% - 41.82%. Furthermore, to predict the average addition of daily cases can be seen in the following table 6:

Table 6. The prediction result of addition average in daily cases

Prediction of addition average in daily cases February 13, 2021 to February 12, 2022	
Confirmed	9.052
Deaths	220
Recovered	7.306

In table 6 above, we can see that the predicted percentage of the average cases dying is 2.43%, and cases recovered by 80.71% for each day. Furthermore, we can see the prediction of the highest increase in daily cases in the table below:

Table 7. The prediction result of the highest addition in daily cases

Confirmed		Deaths		Recovered	
Date	Predicted Value	Date	Predicted Value	Date	Predicted Value
20, 27 February 2021		19, 26 February 2021		19, 26 February 2021	
5, 13, 20, 27 March 2021		5, 12, 19, 26 March 2021		5, 12, 19, 26 March 2021	
3, 10, 17, 24 April 2021		2, 9, 16, 23, 30 April 2021		2, 9, 16, 23, 30 April 2021	
1, 8, 15, 22, 29 May 2021		7, 14, 21, 28 May 2021		7, 14, 21, 28 May 2021	
5, 12, 19, 26 June 2021		4, 11, 18, 25 June 2021		4, 11, 18, 25 June 2021	
3, 10, 17, 24, 31 July 2021		2, 9, 16, 23, 30 July 2021		2, 9, 16, 23, 30 July 2021	
6, 14, 21, 28 August 2021	9,455	6, 13, 20, 27 August 2021	232	6, 13, 20, 27 August 2021	7,552
4, 11, 18, 25 September 2021		3, 10, 17, 24 September 2021		3, 10, 17, 24 September 2021	
2, 9, 16, 23, 30 October 2021		1, 8, 15, 22, 29 October 2021		1, 8, 15, 22, 29 October 2021	
6, 13, 20, 27 November 2021		5, 12, 19, 26 November 2021		5, 12, 19, 26 November 2021	
4, 11, 18, 25 Desember 2021		3, 10, 17, 24, 31 Desember 2021		3, 10, 17, 24, 31 Desember 2021	
1, 8, 15, 22, 29 January 2022		7, 14, 21, 28 January 2022		7, 14, 21, 28 January 2022	
5, 12 February 2022		4, 11 February 2022		4, 11 February 2022	

In table 7 we can see the prediction of the highest addition of confirmed cases of covid occurring on Saturdays except March 5, 2021. That means an increase in the number of confirmed covid, died and recovered during holidays which is one of the parameters of the trend on the Prophet algorithm. The results of the prediction of the highest daily increase of cases from the 1-year simulation are 9,455 people for confirmed cases, 232 people for dead cases and 7,552 people for recovered cases. For a visualization of the 1-year prediction, we display it in the following graph:
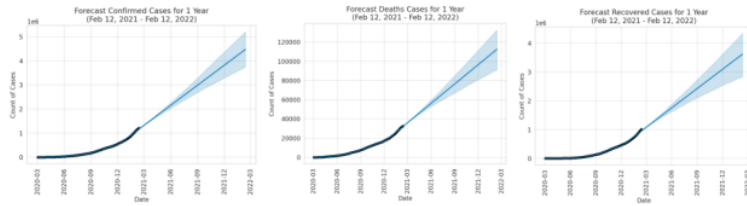

Figure 3. Forcast cornfirmed, deaths and recovered cases for 1 year

Based on Figures 3, the black line shows the dataset used as training data, while the blue line is the prediction model of the Prophet algorithm. Because the training data is already on the line of the prediction model, we can use this prediction model for the prediction process for the next 1 year. For blue shading is the lower limit and upper limit of the prediction data data. The longer the prediction time, the bigger of the lower limit and upper limit. After obtaining a prediction model and predictive data for the spread of covid-19, the authors then compare and calculate the accuracy value of prediction data for the next 1 year with real data that is currently running from February 13, 2021 to May 3, 2021. Based on the table 8, it can be seen that the accuracy rate of patients with confirmed covid-19 is below 50%, namely 43.97%. Meanwhile, the accuracy of data recovered and died is above 50%. The higher the level of accuracy obtained, the more accurate the prediction model will be made with the real data.

Table 8. The accuracy of confirmed, deaths and recover at February 13, 2021 to May 3, 2021

Confirmed	43.97%
Death	72.13
Recovered	84.24%

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Commented [NH2R1]: done

The level of accuracy can be done for the same time span, for example one year starting from the initial prediction data and then comparing it with the original data that is currently running.

6. RESEARCH METHOD

Based on figure 4, the research method is divided into several parts, namely data gathering, data preprocessing, modeling, and evaluation. In the first stage, it begins by taking a dataset from kawalcovid19.id. Data gathering starts with taking the main dataset then filtering the main dataset and then creating a new dataset to retrieve the attributes needed by the prediction / forecasting model, after the new dataset has been created, the dataset is ready and the new dataset will be applied to the model. Next we do data preprocessing with manipulate the filtered dataset before inputting it to the FBProphet model. FBProphet only accepts 2 columns of input, the date column (Observation Date) must be in the ideal form, namely the dataframe and the data dtype must be datetime64 [ns] then have the YYYY-MM-DD format and the column you want to predict must be numeric. After preprocessing, the dataset is ready to be input into the model. But to ensure the accuracy of the model, we must train the model and test the model with the input dataset and then the results will be compared. Next, Comparing the results of the prediction of 25 days with the 25 days original data test. If prediction data is under original data test, it means the model already to prediction for the next one years. After prediction, then calculate the accuracy value from the predicted data. The higher of accuracy value, mean the closer of prediction data to real data. The following is a flowchart of the research methodology:
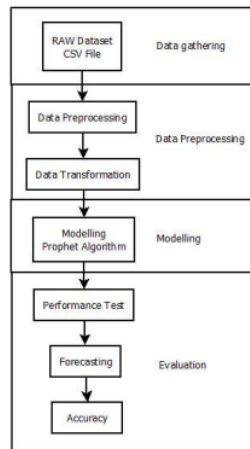
Figure 4. Research Methods

7. CONCLUSION

To reduce the spread of covid-19 and make the right decisions for the government, predictions of future cases are needed. Therefore, the Prophet algorithm is used to predict the spread of covid-19 for the next one year. The authors choose Prophet algorithm because this algorithm has a fairly high level of accuracy. For the authors, this research was to proof the accuracy of prediction model with a time span of one year (March 2, 2020 to February 12, 2021). The percentage for confirmed patients was 22.60%-42.11%, died was 21.67%-39.00%, and recovered was 22.53%-41.82%. The predicted percentage of cases died was 2.43% every day. Then for the level of accuracy, the author uses the prediction and original data from February 13, 2021 to May 03, 2021. In further research, the level of accuracy was carried out at the same time span as the prediction modeling time. The accuracy of data confirmed was 43.97%, died was 72.50% and recovered was 84.24%. Based on the results of the accuracy, it seen that data for patients with confirmed covid-19 get a value below 50%, which is different from data on death and recovery which reaches an accuracy rate of more than 50%. This can be due to the modeling process where the prediction model wasn't so close to the model from the original data. This means that the use of the Prophet algorithm to predict the spread of

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covid-19 in Indonesia is still not valid enough, so validation or comparison is needed using other logistical algorithms.However, the data on covid-19 reconfirmation in Indonesia is still very high, so it needs the right decision by the government.

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