Forecasting the Drought in Bali using the Multilayer Perceptron Method

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ABSTRACT

Disasters have a huge impact on a country and a region. Bali is one of the provinces in Indonesia which has some disaster, one of the disasters that occurred in Bali was drought. Forecasting of droughtinn Bali is necessary so that the government can prevent and manage this kind disastersand can make wise decisions based on information regarding the number of drought. This study aims to predict the number of drought in the next five years. The method used is the Multilayer Perceptron because it is able to predict time series events. The data used are drought disaster events from 2011 to 2019. The results of the analysis in this study indicate that the best Learning Rate and Hidden Layer for forecasting the number of disaster events are Learning Rate 0.7 and Hidden Layer 3.2 respectively with MAPE accuracy is 19.91%. Forecasting results in the coming years show that there is an increase and decrease in the number of drought in 2020 to 2024.

KEYWORDS: Drought, Forecasting, Multilayer Perceptron

INTRODUCTION

Disaster is one of the events that got special attention from the government. One of the disaster-prone areas in Indonesia is Bali Province. Disasters that possible occurred in Bali included natural disasters, non-natural disasters and catastrophic events. The definition of disaster according to Law Number 24 of 2007 is an event or series of events that threatens and disrupts the life and livelihoods of the community caused by natural or non-natural factors, and social factors, resulting in casualties, environmental damage, loss of property and psychological impact. One of the disasters that occurred in Bali was drought.

Handling and recording of disasters that occur in regions and provinces are managed by a non-departmental government agency, namely the Bali Province BPBD (Regional Disaster Management Agency). Disaster data recorded in the BPBD of Bali Province is very diverse, but the most important data is one of which is disaster data. Disaster events are events that occur and are recorded based on the date of the incident, location, type of disaster, casualties or damage. If a disaster occurs on the same date and hits more than one area, it is counted as one event [1]. Disaster data is then processed using data mining. Data mining is a process that uses statistical techniques, mathematics, artificial intelligence, and machine learning to extract and identify useful information and related knowledge from large databases[2]. Data mining serves to assist in the decision-making process of large volumes of data stored in databases, data warehouses, or information stored in repositories [3]. One of the uses of data mining is forecasting. Forecasting is an event that predicts future conditions through testing past conditions [4]. There are many methods for forecasting, one of which is the Multilayer Perceptron method. The Multilayer Perceptron method has characteristics in its calculations, including hidden layer, learning rate, and epoch which are used to determine good MAPE accuracy results.

This study only focuses on making comparisons on the Multilayer Perceptron method by comparing the accuracy values from the results of comparisons made on the hidden layer, learning rate, and epoch on WEKA tools. The best results are generated based on the best MAPE accuracy values for each of the characteristics of the Multilayer Perceptron method. The best results will be used to make the forecast.

A. Research Method
Forecasting the number of droughtin Bali is done using the Multilayer Perceptron method. There are several stages of research for forecasting can be seen in Figure 1.
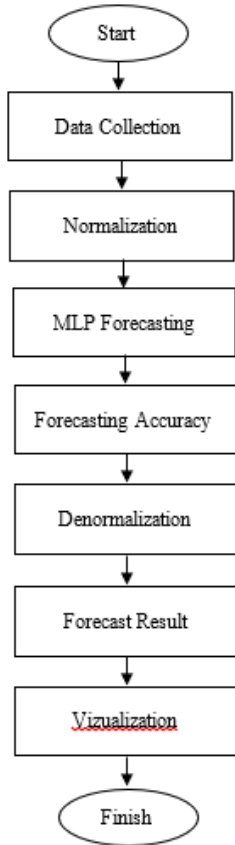
Figure 1Research Stage

1. Data Collection
Data collection on the number of droughtin Bali from 2011 to 2019 was obtained from the Regional Disaster Relief Agency of Bali. The data provided is in the form of an excel file. The drought data is used as the basis for forecasting.

2. Data Normalization
Data normalization aims to facilitate data processing so that it is able to produce training outputs that are in accordance with the activation function used.

$$\frac{x - minA}{maxA - minA}(1 - 0) + 0 \qquad (1)$$

The normalization stage was carried out on 9 data on the number of drought. The results of data normalization on the number of drought can be shown in Table 1.

Table 1 Results of Data Normalization on the Number of Drought

Year	Drought	X'
2011	1	0.016667
2012	2	0.033333
2013	15	0.25
2014	1	0.016667
2015	38	0.633333
2016	3	0.05
2017	0	0
2018	11	0.183333
2019	6	0.1

Table 1 shows the data normalization on the number of drought. The maximum value in the data is 38, namely in 2015. The minimum value in the data is 0, namely in 2017. The data on the number of droughtis processed using Equation 1. The value of normalization results can be shown in Table 1 with information X '.

3. Multilayer Perceptron Forecast
Forecasting by building an MLP model using the WEKA application by adding the method package.

4. Forecasting Accuracy
Forecasting accuracy uses MAD, MSE and MAPE to determine the error value from the results of the formation of the MLP model which is processed by excel.

5. Denormalization
Denormalization which aims to change the predicted data back to the beginning in order to maintain stability and prevent data confusion.

$$X_i = (\$NormalizedValue * (\$max - \$min) + \$min \qquad (2)$$

6. Forecast Result
Forecast results are carried out for the next five years, that is from 2020 to 2024

7. Data Visualization
Data visualization is display forecasting results via excel to facilitate data analysis.

B. Literature Study
Multilayer Perceptron method is part of the Neural Network Method. This method has been used to predict the level of results of public high school exams in Palestine. The data used are data from groups of scientific and literary students. The data are from 2006 to 2017. The results in the scientific and literary groups show that the lowest MSE value comes from the Multilayer Perceptron architecture with 50 neurons [5].

Multilayer Perceptron method was used to study the relationship between crude palm oil, vegetable oil, crude oil prices and monthly exchange rates. This research was conducted using Multilayer Perceptron, Support Vector Regression and Holt-Winter Exponential. The prediction results show that SVM has a higher accuracy compared to Multilayer Perceptron and Holt Winter Exponential Smoothing Method [6].
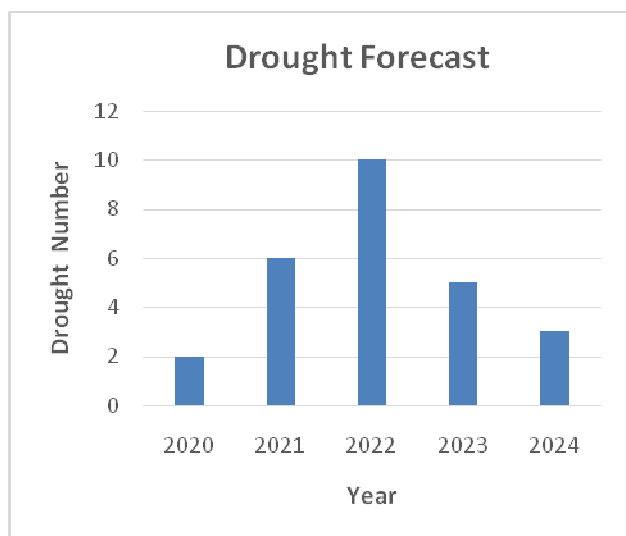
C. Result
Forecasting is carried out on the number of drought disaster in Bali Province using the Multilayer Perceptron method with different Learning Rate, Hidden Layer and Epoch. The function is applied to the number of drought data as well to get the best forecasting results. The results of forecasting can be seen in Table 2.

Table 2Comparison Forecasting Accuracy Results

Learning rate	Hidden layer	Epoch	MAPE
0.1	2.2	1000	32.75%
0.1	3.2	1000	32.25%
0.2	2.2	1000	33.10%
0.2	3.2	1000	31.61%
0.3	2.2	1000	32.85%
0.3	3.2	1000	31.94%
0.4	2.2	1000	31.44%
0.4	3.2	1000	33.55%
0.5	2.2	1000	33.34%
0.5	3.2	1000	29.88%
0.6	2.2	1000	35.30%
0.6	3.2	1000	29.28%
0.7	2.2	1000	31.39%
0.7	3.2	1000	19.91%
0.8	2.2	1000	32.35%
0.8	3.2	1000	30.07%
0.9	2.2	1000	36.72%
0.9	3.2	1000	27.88%
1	2.2	1000	45.09%
1	3.2	1000	71.28%

Table 2 shows the results of the comparison accuracy of forecasting the number of droughtin Bali. The comparison used are Learning Rate, Hidden Layer and Epoch. The accuracy show that the best result is Learning Rate by 0.7, Hidden Layer by 3.2 and Epoch by 1000. The comparison result shows that the Learning Rate by 0.7, Hidden Layer by 3.2 and Epoch by 1000 has the lowest error value than other. The MAPE values obtained were was 19.91%.

Figure 2Drought Disaster Forecasting Results

Figure 2 shows the long-term results of forecasting the number of drought in Bali. Forecasting results show the number of droughtoccurence in 2020 will increase to 2incidents. In 2021 the number of drought disaster will increase to 6incidents. The number of drought is predicted to increase again in 2022 to 10incidents. The years 2023 and 2024 are predicted to increase to 5 and 3incidents, respectively.

D. Conclusion

Forecasting the number of drought in Bali uses comparison of Learning Rate, Hidden Layer and Epoch with different results. Forecasting accuracy is done using MAPE. The best MLP function is Learning Rate by 0.7, Hidden Layer by 3.2

and Epoch by 1000because it has the lowest error value, namely MAPE 19.91%. Forecasting results show the number of drought will increase in 2020 by 2incident. The number of Disaster occurrence in 2021 to 2024 has increased with the highest number in 2022 of 10incident. Further research can be carried out by developing forecasts using a larger dataset size, to obtain better accuracy. Other disaster factors can be added to make a complete and accurate research. The use of other forecasting methods can be done to get results with better accuracy values.

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