A neural network based on particle swarm optimization for detection forest fire

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Abstract. An Opening of forest for agriculture land which usually occurs in large areas and tend to be difficult to control. Economically for actors, make clearing land with that way is effective because it requires little cost and energy. However, the impact of clearing agricultural land by burning forests are disturbing ecological life and disturbing human life, especially in the health sector. There were a several research about forest fire has done but there are still many weaknesses and laxity of each method that is applies. Therefore, this study will create model to optimize detection and reduce the level of error in forest fire with the BPNN method and evaluated using RMSE. The dataset in this study are fine fuel moisture index (FFMC), the average rating of water content from organic matter on the surface (DMC), the average rating of water content from organic matter under the surface (DC), the figure ranking of expected/expected fire speed (ISI), Relative Humidity (RH), Wind speed (wind), Rainfall (rain) and Area, where the data consist of 517 data records. And the result, prediction value of RMSE (Root Mean Squared Error) is 37.364. Based on the analysis of testing between neural network models with neural network optimization with PSO is 34.199.

1. Introduction
Nearly the majority of cases of forest fire are caused by human factor, either intentionally or unintentionally. International forest fires are usually carried out to open agricultural land which usually occurs in large areas and tend to be difficult to control. Economically for actors, make land for agriculture by burning forests is effective way because it requires little cost and energy. However, from another perspective, it is very detrimental to wider community both in terms of economy, health and ecology. Suyatno, A. has done research about the Risk Assessment System for measure the level of risk of forest fire based on artificial neural network [1]. One of method that can be used to measure the level of risk of forest fire Hazard is the Keetch-Byram Drought Index measurement develop in 1968 by Keetch and Bryan from Florida (United States). Keetch-Byram defines a drought index as expression of lack of soil moisture according to the maximum possible moisture content of the soil (land capacity) [2].

Detection is done by comparing photos of the initial state of forest fire with photos whose taken periodically. If there is find differences at the point, so the color differences tht occur at that point will
be examined. There are also several studies such as Agwil, et al. Conducted research with the title Prediction of Forest Fire Area Based on meteorological data using multivariate adaptive Regression Splines (MARS) approach [3]. Data used by Cortez and Morais about 2000 forest fires in Portugal [4]. This research using this method will be tested the accuracy of the prediction of the MARS model that is formed from the data, the test is carried out simultaneously and individually on each functions that exist. Research conducted in the MARS model can explain the diversity of response variables in this study, namely the area of forest fire is 95.8%. Of the 12 predictor variables examined in this study, only 9 predictor variables contributed to the MARS model, namely FFMC, day, temperature, DMC, relative humidity, moon, y-axis coordinates spatial location in the map, DC, and spatial x-axis coordinates a location on the map. H.R Kim also carried out research with the title Prediction of forest fires using data mining methods [5] using the Neural Network method with Support Vector Machine by evaluating using the Root Mean Square Error (RMSE) and obtained the result that the error rate was still high.

In addition, Cortez, P and Morais, A conducted research a data mining approach to predict forest fires using meteorological data [4] based on data mining models With Neural Network techniques and Decesion Tree, then evaluated using NAD and RMSE. The problem in this study is the high error rate problematic. There are several DM techniques that have been applied to the domain of forest fire detection such as Veg-Garcia et.al adopting Neural Network (NN) to predict the occurence of human-caused forest fire using Infrared scanner and NN has been combined to reduce false alarm of forest fires and the result are 90% successfull. Stojanova et.al it has also implemented Logistic Regression, Random Fores (RF) and Decision Tress (DT) to detect fires in Slovenian forests, using satellite-based and meteorological data. The best model is obtained by DT, with an overall 80% accuracy [6].

Based on the above research, there are still many weaknesses and laxity of each method that is applied, [7][8], therefore the research will create a model to optimize detection and reduce the level of error in forest fires with the Neural Network method and evaluated using RMSE [9].

1.1. Dataset
This stage is carried out as the initial step of research. To obtain truly accurate data, determining the type and source of data is very important. For that type and source of data in this research is the UCI Dataset Repository [10]. The forest fire dataset in this study is fine fuel moisture index (FFMC), the average rating of water content from organic matter on the surface (DMC), the average rating of water content from organic matter under the surface (DC), the figure ranking of expected / expected fire speed (ISI), Relative Humidity (RH), Wind speed (Wind), Rainfall (Rain) and Area, where the data consist of 517 data records.

1.2. Preprocessing data
To simplify, there are some data can be used to be variables related to the research that is prediction of forest fires, then in the dataset selected variables that are suitable for use as input. Because there are 13 real dataset, only are FFMC, DMC, DC, ISI, RH, wind, rain, and the area with the amount of data still 517 data records. To facilitate the calculation in the data training process, the record value of dataset is normalized with the value rage 0-1. After determining the input data and output data, then the training data and testing data are determined. Training and testing data in this study were taken from the existing dataset of 517 records.
The proposed method is the use of Neural Network (NN) backpropagation [11] for forest fire, while to increase the level of accuracy, Particle Swarm Optimization (PSO) is applied [12]. The application of PSO in this study is used for determination in finding the best weight of attributes so as to obtain a more optimal weight value so that it can increase the level of classification accuracy the model to be applied.

2. Result and Discussion
For experiments and testing of the proposed method, use Rapid Miner5 tools. With the model architecture that has been used in the experiment above, a prediction value of RMSE (Root Mean Squared Error) is 37,364. The value of momentum is determined by conducting a test to enter a value with a range of 0 to 0.9. 1100 cycles training values and 0.1 rate learning rate are selected based on previous experiments. The following are the results of experiments that have been carried out to determine the value of momentum as in table 1.

![Figure 1. Proposed method](image)

| Table 1. Experiments result with NN |
|------------------------------------|
| learning rate | momentum | RMSE  |
|----------------|----------|-------|
| 0.3            | 0.1      | 39.130|
| 0.3            | 0.2      | 37.364|
| 0.3            | 0.3      | 39.216|
| 0.3            | 0.4      | 45.381|
| 0.3            | 0.5      | 55.376|
| 0.3            | 0.6      | 67.516|
| 0.3            | 0.7      | 69.558|
| 0.3            | 0.8      | 98.419|
| 0.3            | 0.9      | 79.236|
Figure 2. Result

From the experiments that have been done as in the table above, the best RMSE (Root Mean Squared Error) value is 37.364. Based on the analysis of testing between neural network models with neural network optimization with PSO, the results can be summarized in table 2 and Figure 3.

Table 2. Evaluation Result value

| Model      | RMSE  |
|------------|-------|
| NN         | 37.364|
| NN + PSO   | 34.199|

Figure 3. Evaluation method NN and NN+PSO
Based on the results of the analysis in the experiments that have been carried out, it can be seen that the optimization of Neural Network (NN) using the Particle Swarm Optimization (PSO) algorithm makes the RMSE prediction value better, namely a decrease in the RMSE (Root Mean Squared Error) value. Thus, with the optimization of the PSO algorithm on neural networks an increase in prediction occurs, namely by decreasing the value of RMSE (Root Mean Squared Error).

3. Conclusion
From the research conducted, the determination of the attribute weight values that have been optimized using the PSO Algorithm has been proven to be able to improve the accuracy of predictions of forest fires. The model formed by neural networks with Particle Swarm Optimization (PSO) algorithm optimization produces better accuracy compared to neural networks without being optimized. The increase can be seen from the increase in the accuracy value for the Neural Network model with the RMSE (Root Mean Squared Error) value obtained, after the accuracy of Particle Swarm Optimization (PSO) based Neural Network algorithm has been optimized, the RMSE values obtained are smaller than before optimization, with Thus it can be concluded that the application of optimization techniques with the Particle Swarm Optimization (PSO) algorithm can increase the accuracy of the Neural Network algorithm so that it can determine the prediction of a forest fire.

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