The application of particle swarm optimization using neural network to optimize classification of employee performance assessment

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Abstract. The measurement of employee value performance in an institution is very important for the future evaluation and planning. The employee performance assessment absolutely must be done to determine the accomplishments to be achieved by every employee. Policy makers are difficult to determine the optimal classification toward assessment of the performance appraisal. Selection of the best attributes weights in optimizing Neural Network for the performance appraisal that has been not optimal yet and the effect on level of accuracy that is generated. Practitioners of Particle Swarm Optimization (PSO) on Neural Network (NN) are expected to optimize the selection of the best attribute weights to the performance appraisal classification resulting in increased accuracy.

1. The first section in your paper

Measurement of employee value performance in an institution is very important for future evaluation and planning. Assessment of employee performance must be done to find out the achievement of each employee whether the achievement of each employee good, medium or less. Achievement assessment is very important for the institution to establish further policy [1]. The method that is often used by institution in assessing employee performance is using performance appraisal. It aims to evaluate employee performance in a predetermined period of time based on predetermined standard. Using performance appraisal can help to identify employee weaknesses, it’s useful for planning his/her career and influencing salary and promotion improvement decisions. According to Dessler (2018) performance appraisal has several weaknesses, such as: (1) Halo Effect, the evaluator likes or dislikes the nature of the employees he assesses; (2) Central tendency, the value given tends to be in the middle, so it is not too high and not too low; (3) Leniency, the evaluator tends to assume that he must be kind to his employees, so the value given is good for all aspects of the assessment; (4) Prejudice,
assessor is often influenced by these factors such as age, race and gender so that it can influence employee achievement [2].

From some weaknesses above, it can be concluded that the performance appraisal method has not been effective because the assessment is subjective so that it cannot provide comprehensive analysis and information. Besides that there is also a problem when the institution wants to evaluate employee performance using several parameters, which these parameters are in the assessment factor in the performance appraisal. These parameters such as: employee attendance data, warning data, reward data and training results data. Because there are several weaknesses in the performance appraisal assessment, the results are less effective. Research related to employee performance appraisal has been carried out by researchers, including Labate, F and Medsker, L (1993) analyzing the ability of employees using hybrid neural network models and intelligent systems, in this study neural networks are used to identify patterns of information in employee databases and expert system components to get rule-based analysis to recommend staff for projects [3]. W. Denton, James, et al. (1995) conducted research using neural networks to classify employees for tax purposes [4]. Similar to the previous research, Yang, S & Zhu, Q conducted research using Backpropagation Neural Network which was improved to evaluate employee performance [5]. Neural network is a branch of Artificial Intelligent. The advantage of Neural Network is its ability to be able to do learning based on data used for training, be able to do self organization or make representation of the information it receives and have a real time operation in the sense that Artificial Neural Networks can perform calculations in parallel and have high tolerant fault [6] Besides that Artificial Neural Network has several other advantages including its ability to do modeling for pattern recognition. One of the popular technique in the neural network method is the backpropagation algorithm that is widely used to solve many problems that exist by building a trained model that shows good performance in some non-linear problems.

In addition, neural network also has disadvantages, such as : (1) backpropagation algorithm can be trapped in a minimum local problem, this can cause failure to find the optimal solution in the selection of features on the weight of the attributes used; (2) backpropagation algorithm has a convergent speed that is too slow which in the end the backpropagation algorithm is very dependent on the initial parameters such as number of inputs, hidden nodes, output, learning rate and connection weights in the network [7]. To implement the Neural Network in finding the optimal solution in the selection of features on the weight of the attributes used, it is necessary to use methods that can solve these problems. Particle Swarm Optimization (PSO) is a population-based optimization technique that is inspired by the social behavior of flocks of birds or fish [8]. Particle swarm optimization can be assumed as a group of birds that are looking for food in an area. The bird does not know where the food is, but they know how far the food is, so the best strategy for finding the food is to follow the bird closest to the food [9].

Based on the problem, the difference between this study and the previous research is that in this research the model of Particle swarm optimization (PSO) is applied to Neural Networks which are expected to accelerate the search process in obtaining the best attribute weight values to be more optimal in the Neural Network so that optimizing employee performance appraisal classification and increasing accuracy

2. Literature
2.1. Related Reserach
The study was conducted by [10] conducted a research that is applying data mining for prediction in increasing performance using classification method. In this study the model used is Bayes classification, the model is used to predict student performance so that it can be classified between high-performing and low-performing students. Ahmed, I., et al (2013) conducted research related to employee performance using the Fuzzy Logic approach. In this fuzzy research is used as a measuring tool to assess employee performance so that it can be used as a decision support [11]. Other research conducted by Ochoti, et al. (2012) examined the factors that influence multifaceted employee performance appraisal systems in the State Ministry of Nyamira Provincial Administration of Kenya.
Multiple regression analysis techniques are used to explain the nature of the relationship between performance appraisal and the factors that influence it [12].

From several studies that have been mentioned, the application of data mining to analyze the performance of employees and students by using the proposed model can be applied, but in this case the level of accuracy produced is still low so it is necessary to have an appropriate model to increase the classification accuracy. In this study different from the research that has been done, the neural network and PSO are proposed as models.

2.2. Neural Network
Neural Network (NN) or artificial neural network (ANN) is an attempt to mimic the function of the human brain. The human brain is believed to consist of millions of small processing units, called neurons, which work in parallel. Neurons are connected to each other through neuron connections. Each individual neuron takes input from a set of neurons. This then processes the input and passes the output to a set of neurons. Output is collected by other neurons for further processing. The human brain is a complex network of neurons in which connections remain breaking and forming. Many models similar to the human brain have been proposed [13]. Backpropagation algorithm is one of the supervised training methods in the neural network is the backpropagation method, where the characteristic of this method is to minimize errors in output generated by the network. The backpropagation method was originally designed for feedforward neural networks, but in its development, this method was adapted for learning in other neural network models [14].

2.3. Particle Swarm Optimization (PSO)
Particle swarm optimization was first introduced by Dr. Eberhart and Dr. Kennedy in 1995 at a nerve network conference in Perth, Australia [15]. The particle swarm optimization algorithm is a stochastic-based optimization technique that is inspired by the social behavior of a flock of birds or a group of fish.

3. Method
3.1. Data collection
The dataset used in this study is in the form of private data regarding the performance of Harapan Bersama Polytechnic Tegal Employees in 2012. The employee performance dataset that is taken consists of 9 data attributes namely "loyalty", "work performance", "responsibility", "obedience", "honesty", "cooperation", "discipline", "initiative", and "leadership" using a total of 250 data records. Before processing the data in accordance with the dataset that will be used, then do some early stages, using data preprocessing by data normalization. The real dataset that has not been processed for data is in the table 1.

3.2. Proposed Method
The proposed method is the use of Neural Network (NN) Backpropagation for Employee performance classification, while to increase the level of accuracy, Particle Swarm Optimization (PSO) is applied. 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 in the model to be applied.

| NIPY    | X1  | X2  | X3  | X4  | X5  | X6  | X7  | X8  | X9  | STATUS  |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------|
| 01.006.023 | 71.33 | 65.50 | 72.50 | 68.40 | 63.00 | 66.83 | 55.00 | 76.67 | 73.40 | No Productive |
| 01.009.052 | 91.33 | 89.00 | 87.50 | 85.60 | 91.00 | 88.17 | 85.00 | 91.00 | 88.50 | Productive |
| 01.009.053 | 71.33 | 65.50 | 72.50 | 68.40 | 63.00 | 66.83 | 56.00 | 76.67 | 73.40 | No Productive |
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4. Results and Discussion
4.1. Neural Network Experiment Result
In determining the number of neurons in the hidden layer several experiments are done to get the best, in this experiment one hidden layer is used. By default this experiment uses a parameter value of 0.3 learning rate and 0.2 for momentum and values for 500 training cycles. From the experiments that have been done as in the table above, the best accuracy value is 76.40% +/- 8.09%, resulting in 1 (one) hidden layer with 6 (six) neurons, 9 (nine) input layer attributes and 2 (two) output layer.

Table 2. Neural Network experiment result
| learning rate | momentum | Accuracy  |
|---------------|----------|-----------|
| 0.6           | 0.1      | 76.40%    |

Figure 1. A proposed method
4.2. PSO-based Neural Networks
PSO is used to obtain and find the weight value of each best variables so that the optimal value of accuracy obtained means the value of the accuracy obtained becomes more. In the table above to optimize the best weight value on the Neural Network parameters used in Particle Swarm Optimization (PSO) is used. The level of accuracy generated in the optimization is 78.00% +/- 8.25%.

4.3. Model Evaluation
After several combinations of parameter value that have been obtained, then after validation on the model that has been used, the results of the optimization of the best parameter values obtained are in table 3.

| Model       | Accuracy |
|-------------|----------|
| NN          | 76.40%   |
| NN + PSO    | 78.00%   |

Table 3. NN parameter value after PSO optimization

From the table 3, it can be seen that after validation using 10 K-Fold Cross Validation of the dataset, then after the optimization is obtained the accuracy value obtained is 78.00%. from the table we know that there is the difference of accuracy level which is resulted between before and after being optimized by PSO. Based on the result of the experiment produced there is a difference in the accuracy level of 1.60%, so there is an increase in accuracy.

5. Conclusion
In this study, the accuracy of the employee performance appraisal results with the classic NN method has an accuracy of 76.40% but using NN-PSO the accuracy is 78.00%. From the research conducted, the determination of the attribute weight values that have been optimized using the PSO Algorithm has been proven to improve the accuracy of Employee performance classifications. The model that is formed by neural networks with algorithm optimization of Particle Swarm Optimization (PSO) produces better accuracy than the structural network without optimization. Although the neural network and PSO algorithm models used have given better results, but there are some things that can be used as notes for further research, it is necessary to have similar research with various model processes, for example by setting the amount of training and testing data so that it can be a comparison of the results of the study this. From the model that is formed can be implemented into an application that can be used by policy makers related to employee performance classification.

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