Analysis of backpropagation neural neural network algorithm on student ability based cognitive aspects

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Abstract. Back propagation is one of the supervised learning and multi-layered training program and uses errors during the process of changing the weight value in the backward process as well as the forward propagation. In the method for predicting cognitive abilities backpropagation the first step is to set the input neuron number, the number of neurons that are hidden, and the number of output neurons. The number of neurons used in the program is 6 neurons consisting of cognitive criteria, 6 hidden neuron layers, and 2 neuron outputs. The highest level of accuracy is in the binary sigmoid and bipolar sigmoid activation functions at the 64th epoch with the accuracy of each function of 82.93% +/- 37.63% and 85.37% +/- 35.34%. The smallest root mean squared error value was found in binary sigmoid of 0.266 with a tolerance of +/- 0.258 on the 100th epoch with an accuracy of 80.49% while for the sigmoid bipolar activation function the smallest root mean squared error value was obtained at the epoch 500 of 0.282 with tolerance +/- 0.353.

1.Introduction

Information technology has developed so rapidly. Therefore it gives positive and negative things to human daily life. Information technology has provided useful benefits by accident and not by chance. In the process of implementing IT, it is necessary to have an information system process in carrying out a job. In the process of information that is formed by imitating the workings of the human brain in solving a problem by making stages and concepts of learning by changing the weight of the synapses namely Artificial Neural Networks (ANN) which can also be used to create a model between input and output in the data pattern.

The back propagation algorithm is a popular learning approach to the feed forward multilayer perceptron network. But experiencing serious problems related to Back propagation, namely local minimum and slow speed of convergence. (Hamid, 2011) proposed a modified back propagation learning algorithm by introducing adaptive benefits along with adaptive momentum and the level of adaptive learning to be an update process. Back propagation has quality in conducting good training to facilitate the convergence rate.

According to (Maharani, 2009) Data mining is a process of deflecting certain information to data that has a size that is quite wide and large. Data mining in classification is most often used, which is useful for finding a collection of modeling so that it can distinguish grouping data in conducting predictive testing. ANN is a classifying process that can be relied upon because of its expertise by forecasting. In addition, high tolerance is also possessed on ANN on noise data that is adaptive, therefore ANN is able to learn from data trained on it beforehand.

2. Problems Identification

Neural networks are trained to distinguish criteria easily in finding predictive results in the form of new information, making patterns with certain processes from some large data. So from that, the formulation of this problem is how to predict the level of children's ability based on cognitive aspects in the search for the highest accuracy both in binary sigmoid function and bipolar sigmoid on Back propagation Neural Networks.

3. Research Methods

In the research conducted, it requires a stage in getting the results of the research objectives. Each step of the research is described using a flowchart. This research was conducted for the first time, namely collecting raw data. Then determine the architecture design by determining the input and output patterns for training needs and testing the method used. Furthermore, in the data training step that is normalized and determined by the model, initial training uses the back propagation algorithm. The goal is to pay attention to the output values and patterns produced in this training. After conducting the training phase, the next step is testing the data, which aims to improve the validation of the results.

The Artificial neural network architecture used in this study consists of 3 layers, namely 6 input nodes, 6 hidden nodes, and 2 output nodes. With the activation function used is binary sigmoid and sigmoid bipolar functions with a range of values for binary sigmoid 0 to 1 while sigmoid bipolar -1 reaches 1. Test target (target output) which is the output of the output neurons of the layer. The structure of ANN can be seen in the following figure.

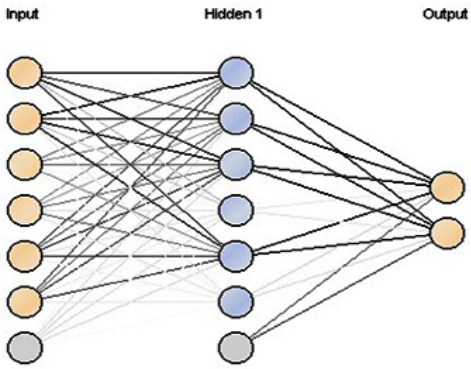

Figure 2.Network architecture used

4. Results and Discussion

A. Result

Tests conducted by researchers are using data sets from the results of tests conducted to students relating to students' abilities in terms of cognitive assessment based on assessment including: knowledge, understanding of the material provided by educators, application of application of learning material to everyday life, analysis of problems given by educators, synthesis of a solution that must be given in the future.

In the Back propagation method in predicting cognitive abilities, the researcher carried out the training and testing process by searching the highest accuracy level both in binary sigmoid and sigmoid bipolar functions on the Back propagation Artificial Neural Network. ANN input

neurons Back propagation in predicting students abilities in terms of cognitive assessment can be seen in the following table:

Table 1. Initialization of ANN Input Neurons

No.	Cognitive Assessment	Neuron Input Initialization in ANN
1	Knowledge	X_1
2	Understanding	X_2
3	Knowledge Application	X_3
4	Analysis of Problem Solving	X_4
5	Synthesis of Solution	X_5
6	Student Evaluation	X_6

In testing the data made predictions that use software that is Rapid Miner in order to find out the resulting pattern and the level of predictions from the data set, namely binary input and binary targets, bipolar input and bipolar targets, and binary input testing. Back propagation trains the network so that it can produce a balanced ability to recognize patterns in the training process on Back propagation networks that can produce appropriate responses to similar or not patterns to the patterns used during the analysis process of this test. The data tested aims to be able to study the various patterns contained in the program as well as the differences generated from each of the data tested. The training data used in the Back propagation ANN method for testing this study are as follows:

Testing patterns that use data as training data, namely the formation of the pattern of the first test data are binary input and binary target. In this pattern data, it consists of six input data and one target data by testing using Epoch 20, 50, 64, 100 and 500 and Learning Rate 0.1. The dataset tested in this study will be normalized so that the tested data aims to be more optimal in carrying out the testing.

After training the data, it will be known the bias of the hidden layer and threshold of the output layer of the test with epoch 20, 50, 64, and 500 and the Learning Rate 0.1 in the search for the highest accuracy both in binary sigmoid and sigmoid bipolar functions on the Neural Network Artificial Back propagation. The influence of the weight values contained in the node in the input layer is from the level of speed and accuracy in training data, when using large enough data, the time for training will be longer and finding patterns in achieving the target will also belong. Then if it is used very little then it is possible to occur in a system that cannot recognize the pattern properly. In training this data, the use of learning rates and epochs is very influential on increasing or decreasing the activation function. This study explains the comparison between bias, number of epochs, and activation of binary and bipolar sigmoid functions in a system of testing student predictions on cognitive aspects, from testing the data carried out using binary target data along with bipolar targets with Learning Rate 0.1 in the search for the highest level of accuracy that is good then it can produce predictions that can be seen in the following Table:

Table 2. Comparison of Accuracy in Epoch 20

	biner		bipolar	
	0	1	-1	1
class precision	0.00%	56.10%	0.00%	56.10%
class recall	0.00%	100.00%	0.00%	100.00%
Accuracy	56.10% +/- 49.63%		56.10% +/- 49.63%	
root mean squared error	0.494 +/- 0.073		0.495 +/- 0.076	

Table 3. Comparison of Accuracy in Epoch 50

	biner		bipolar	
	0	1	-1	1
class precision	86.67%	80.77%	86.67%	80.77%
class recall	72.22%	91.30%	72.22%	91.30%
Accuracy	82.93% +/- 37.63%		82.93% +/- 37.63%	
root mean squared error	0.344 +/- 0.162		0.342 +/- 0.164	

Table 4. Comparison of Accuracy in Epoch 64

	biner		Bipolar	
	0	1	-1	1
class precision	82.35%	83.33%	87.50%	84.00%
class recall	77.78%	86.96%	77.78%	91.30%
accuracy	82.93% +/- 37.63%		85.37% +/- 35.34%	
root mean squared error	0.300 +/- 0.205		0.299 +/- 0.207	

Table 5. Comparison of Accuracy in Epoch 100

	biner		bipolar	
	0	1	-1	1
class precision	77.78%	82.61%	0.00%	56.10%%
class recall	77.78%	82.61%	0.00%	100%
accuracy	80.49% +/- 39.63%		56.10% +/- 49.63%	
root mean squared error	0.266 +/- 0.258		0.504+/-0.066	

Table 6. Comparison of Accuracy in Epoch 500

	biner		bipolar	
	0	1	-1	1
class precision	73.68%	81.82%	72.22%	78.26%
class recall	77.78%	78.26%	72.22%	78.26%
accuracy	78.05% +/- 41.39%		75.61% +/- 42.94%	
root mean squared error	0.269 +/- 0.362		0.282 +/- 0.353	

B. Discussion

In this test, the highest accuracy is obtained in both the binary sigmoid and bipolar sigmoid activation functions at the 64th epoch with the accuracy of each function of 82.93% +/- 37.63% and 85.37% +/- 35.34%. The binary sigmoid function recognizes patterns only at the 20th epoch while the bipolar sigmoid activation function in the epoch to 100 prediction targets recognizes patterns very well. The smallest root mean squared error value was found in binary sigmoid of 0.266 with tolerance of +/- 0.258 on the 100th epoch with an accuracy of 80.49% while for the smallest sigmoid bipolar activation function the root mean squared error value was obtained at the epoch to 500 of 0.282 with tolerance + / - 0.353.

By analyzing the activation functions of both binary and bipolar sigmoid on the ability of students based on cognitive aspects, both of them are able to recognize the desired target pattern to obtain values and accuracy based on the back propagation algorithm. So that a good cognitive assessment is obtained for students and knowing the level of the weakness of students based on the root mean squared error resulting from binary sigmoid and bipolar activation functions. This test provides performance effectiveness using the back propagation algorithm. The binary activation function provides training for artificial neural networks better than the bipolar activation function. Due to the range produced by the binary activation function, 0 and 1, it can provide an error value that continues to decrease rather than the sigmoid bipolar activation function which can change sharply due to the resulting range at -1 and 1.

5. Conclusion

In the research conducted on dataset, the ability of children on cognitive aspects is done by generating predictions from artificial neural networks using the back propagation method by searching for the highest accuracy both in binary sigmoid and bipolar sigmoid on Back propagation Neural Networks. The success in predicting uses the Back propagation ANN method to predict students' abilities on cognitive assessment.

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