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Particle Swarm optimization-based Neural Network method for predicting satisfaction of recipients of internet data quota assistance from the ministry of education and culture

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Abstract
The free quota assistance program for students and lecturers is an assistance program provided by The Ministry of Education and Culture. This program has been implemented since the spread of the covid-19 pandemic in all regions of Indonesia. This assistance is expected to help students and lecturers carry out online learning caused by the pandemic covid-19. This study aims to predict the satisfaction level of the users so that it can help the government in advancing education. The data processing is carried out using the rapid miner application and the neural network method with particle swarm optimization. From the results of data processing, the accuracy value for the neural network algorithm model is 42.44%, and the accuracy value for the PSO-based neural network algorithm model is 91.86%.

Keywords: *Neural Network*; PSO; Covid-19; Quota Assistance; Pohuwato.

Introduction

Corona Virus Disease 2019 (COVID-19) is not only a problem in the health sector but in several sectors. One of them is in the field of education. The great spread of the virus, marked by the increasing number of cases and deaths, has led to calls for stay at home, work from home, and distance learning during the pandemic [1]. Therefore, to continue to support distance learning, the government is deemed necessary to ensure the availability of internet data packages for educators and students for the smooth teaching and learning process. Internet data quota assistance is distributed to students, educators, and lecturers [2]. The purpose of this study is to measure the level of user satisfaction through predictions of satisfaction to assist the government in advancing education. At Pohuwato University, the number of valid and eligible recipients of internet assistance reached 578 people, and the number of lecturers was 45. The problem is that many recipients of internet data quota assistance cannot directly convey the impression they feel when using and enjoying the internet quota provided by the government. Meanwhile, the government needs to know the level of user satisfaction to continue striving to improve and advance education. Therefore, a method is needed to help predict the satisfaction of recipients of internet data quota assistance to overcome these problems. Several studies on predicting satisfaction have been widely studied [3-6]. Still, it was found that the objects, methods, data, and parameters used by several researchers were different, resulting in different predictive values and accuracy. One method often used in prediction is Neural Network with Backpropagation algorithm[7/10. This study applies the BP algorithm and PSO feature selection. The results concluded that it successfully predicts visitor satisfaction with an accuracy value of 85.00% [7].

Method

This study discusses the prediction of satisfaction of recipients of free quota assistance from the Ministry of Education and Culture using the Neural Network with the selection of the Particle Swarm Optimization (PSO) feature.

A. Neural Network

Neural Network is a parallel distributed processor made of simple units that can store experimentally acquired knowledge and are ready to use for various purposes (S.Haykin, 1999) in [7]. This neural network mimics the human brain from the following angles:

• The network acquires knowledge from the environment through a learning process.

• The strength of the connection between units called synaptic weights serves to store the network's knowledge.

In 1943, Mc. Culloch and Pitts introduced a mathematical model which simplifies the actual structure of a nerve cell.

$$y = f(\sum_{i=1}^{n} x_i w_i) \quad (1)$$

The correlation between the three components in the equation above is: Signal x in the form of a vector with dimensions n (x_1 , x_2 ,…,x_n)T will be amplified by synapse w (w_1, w_2 ,…,w_n)T. Furthermore, the accumulation of the reinforcement will be transformed by the activation function f. This f function will monitor, if the accumulation of signal gain has exceeded a certain limit, then the neuron cell which was originally in a condition "0", will issue a signal "1". **Figure 1** shows the output value (y), a neuron can be in two states: “0” or “1”. A neuron is said to be firing if it produces an output of "1" [8].

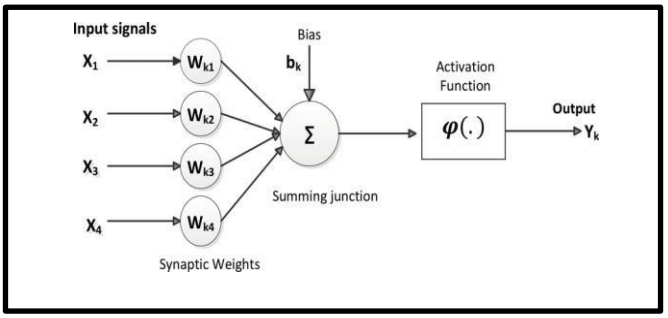


Figure 1. Mc. Culloch and Pitts Neuron Model [8]

B. Backpropagation Method

One of the supervised training methods on neural networks is the Backpropagation method, where the characteristic of this method is to minimize errors in the output generated by the network. In the **Figure 2**, the input unit is denoted by X, the hidden unit is denoted by Z, and the output unit is denoted by Y. The weight between X and Z is denoted by v while the weight between Z and Y is denoted by w.

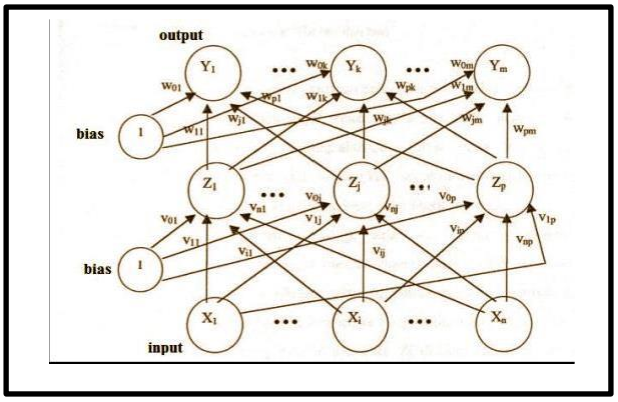


Figure 2. Backpropagation Network Architecture [9]

The application of the backpropagation network consists of 2 stages:

1. The training stage, where at this stage a number of training data and targets are given
2. The testing or evaluation phase, carried out after the training phase is complete

As an overview, training with the backpropagation method consists of three steps:

1. Data is entered into the network input (feedforward)
2. Calculation and back propagation of the related errors
3. Weight and bias adjustments

To make predictions in the Backpropagation method of Artificial Neural Networks, data is needed as input in the processing to produce output or output [9]. Several studies have applied neural network models and feature-selection methods to improve predictive performance [10]. Particle Swarm Optimization has also been combined with neural networks for various prediction problems [11], [12]. Furthermore, backpropagation, deep neural networks, and artificial neural network algorithms have been widely discussed and implemented in data-mining and prediction applications [13][14][15].

Result and Discussion

This research uses the descriptive research method because it is considered to suit the problem being investigated. The solution is by taking samples from students and lecturers within the University of Pohuwato as respondents. The algorithm used is Neural Network Backpropagation Algorithm and Particle Swarm Optimization (PSO). The main steps of the Backpropagation Algorithm are taking input, tracing errors, and then adjusting the weights. The following are the stages of the research that will be carried out:

1. The first stage is data collection by taking an initial sample of 100 respondents from students and lecturers at the University of Pohuwato to be used as a dataset.
2. The second stage is preprocessing stage by normalizing and continuing with experiments until testing.
3. The third stage is the evaluation and validation of the research, followed by writing progress reports and results reports.

The procedure in this study starts with data collection. The data collection process is carried out within the University of Pohuwato through questionnaires that have been distributed online to students through social media called Whatsapp. The questionnaire was created using Google Forms and distributed to students via the link https://forms.gle/nLDtFc3MiSmLXNk28. The data obtained from the questionnaire results through Google Form was123 records, which then downloaded and stored in Microsoft Excel with the extension .xlsx. Proceed to the initial processing or Preprocessing, this stage separates between Data Training and Data Testing. In Experiments and Tests stage, data processing is carried out using the rapid miner application. The stages are carried out in 2 stages: processing with the neural network method and processing data using the neural network method with PSO with the best parameter values. The method is based on the smallest Root Mean Square Error (RMSE) obtained from the test results. Then apply the best method selected from the test results. The last is the stage of evaluation and validation of results.

A. Experimental Design

In this study, the value of the training cycle, momentum, and learning rate was determined by testing by entering a value with a range of 500 for training cycles, and a value of 0.3 for the learning rate and 0.2 for momentum. The following are the results of the experiments that have been carried out:

Parameters NN:

Training cycles : 500	Optimize Weights (Pso)
Learning rate : 0.3	Population size 5
Momentum : 0.2	Maximum number of generations : 30
X –Validation	Inertia weight : 1.0
Number of validations : 10	Local best weight : 1.0
Sampling type : shuffled sampling.	Global best weight : 1.0
	Min weight : 0.0

B. Neural Network test results

The results of model testing that have been carried out are to measure the level of accuracy and AUC (Area Under Curve). Confusion Matrix Based on the processed training data, the following results were obtained in **Table 1**

Table 1. Neural Network Accuracy Value

Accuracy:42.44% +/-40,40%(micro 42.28%)			
	True maybe	***True yes***	***Class prediction***
Pred. Maybe	7	67	9.48%
Pred. Yes	4	45	91.84%

Class recall	63.64%	40.18%	

C. Backpropagation test result based on Particle Swarm Optimization (PSO)

The results of model testing that have been carried out are to measure the level of accuracy and AUC (Area Under Curve). Confusion Matrix Based on the processed data obtained the following results in **Table 2**

Table 2. Neural Network Accuracy Value with PSO

Accuracy:91.86% +/-0.29% (micro 91.87%)			
	True Maybe	***True Yes***	***Class prediction***
Pred. Maybe	1	0	100%
Pred. Yes	10	112	91.80%
Class recall	9.09%	100%	

D. Evaluation analysis and mode analysis

Based on the experiments, both evaluations used a confusion matrix and ROC curve. It is stated that the results of applying a neural network algorithm based on Particle Swarm Optimization (PSO) produce a higher accuracy value to improve the accuracy of the resulting weakness in the neural network. **Table 3** indicates that the accuracy value for the neural network algorithm model is 42.44%, and the accuracy value for the PSO-based neural network algorithm model is 91.86%, as listed in the following table:

Table 3. Accuracy Value

	Accuracy	**AUC**
Neural Network	42.44%	0.500
Neural Network with PSO	91.86%	0.525

E. Discussion of the Analysis of Experimental Results

Based on the experiments, it can be concluded that PSO can solve the optimization problem of the Neural Network algorithm in predicting the satisfaction of recipients of Internet quota assistance from the Ministry of Education and Culture. This can be seen from the increase in accuracy when the Neural Network algorithm produces an accuracy of 42.44% and an AUC of 0.500. Then an increase occurred when the PSO optimization method was added, so the accuracy and AUC increased to 91.86% and 0.525, respectively. This increase occurs because the PSO optimization method searches for the optimal solution until all particles have the same solution scheme or when the maximum iteration has been reached to increase the accuracy value.

Conclusion

Based on the experiments, it is concluded that the prediction of satisfaction of recipients of internet quota assistance from the Ministry of Education and Culture using the Neural Network Algorithm and the PSO Selection Feature has increased the accuracy compared to using only the Neural Network. The accuracy value for Neural Network is 42.44%, and the accuracy value for the Neural Network algorithm model with PSO Selection Feature is 91.86%. Based on these results, it means that the recipients of the Ministry of Education and Culture's internet quota assistance gave a good impression that they were satisfied with the free internet support.

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