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The Artificial Neural Network Predicts The Number Of Smart Indonesian Card Recipients Using The Backpropagation Algorithm

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Abstract

The Smart Indonesia Card is a form of implementing the Smart Indonesia Program which is the flagship program of President Joko Widodo. The Smart Indonesia Card program supports the realization of the 9-year compulsory education program for basic education and universal secondary education or 12-year compulsory education. However, in essence, in processing the Smart Indonesia Card, errors still occur in predicting the needs of students who really need the assistance. Unpredictable gifts include students per department. In dealing with the provision of Indonesia Smart Card assistance, predictions are needed in the distribution of funds so that the distribution can be carried out evenly according to students who need the Indonesia Smart Card funds..

Keywords: Backpropagation, Artificial Neural Networks, Smart Indonesia Card.

INTRODUCTION

The Smart Indonesia Card is a form of implementing the Smart Indonesia Program which is President Joko Widodo's flagship program. This card was inaugurated at the same time as the Healthy Indonesia Card and the Prosperous Family Card on November 3, 2014. This program aims to help poor children who have almost dropped out of school to stay in school by getting cash assistance as funds to ease the burden of payment and school needs.

The Smart Indonesia Card program supports the realization of the 9-year compulsory education program for basic education and universal secondary education/12-year compulsory education. But in essence, in processing the KIP card, errors still occur in predicting the needs of students who really need the assistance. One of the schools that provides KIP assistance to its students. Unpredictable gifts include students per department. In dealing with the provision of KIP card assistance, predictions are needed in the distribution of funds so that the distribution can be carried out evenly according to the students who need the KIP funds.

This research was conducted to obtain a time benchmark at the time of the delivery process so that it can be used as a reference in shipping management control. The Backpropagation method is a learning algorithm to reduce the error rate by adjusting its weight based on the difference in output and the desired target. In this study, unemployment data for the previous 3 years were used as training test data and training target data. After discussing, it produces an error value of 0.020043915 in iteration I. The algorithm used in this study is an Artificial Neural Network with the Backpropogation method. with a training and testing architecture model of 4 architectures, namely 7-4-1, 7-8-1, 7-16-1 and 7-32-1. The target data is taken from 2017 data

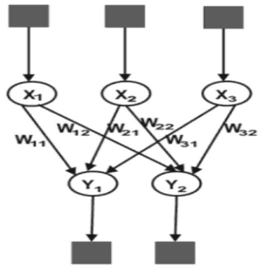
RESEARCH METHODS

Artificial Neural Network (ANN) is one of the artificial representations of the human brain which always tries to simulate the learning process in the human brain. The term artificial is used because the neural network is implemented using a computer program that is able to complete a number of calculation processes during the learning process.

*Backpropagation*is a learning algorithm to reduce the error rate by adjusting its weight based on the difference in output and the desired target. Backpropagation is also a systematic method for multilayer ANN training. Backpopagation is said to be a multilayer training algorithm because Backpropagation has three layers in the training process, namely the input layer, hidden layer and output layer, where this backpropagation is the development of a single layer network (Single Screen Network) which has two layers, namely the input layer and the output layer. .

1. Backpropagation Architecture

Backpropagation architecture with inputs (plus a bias), a hidden layer consisting of units (plus a bias), and m output units. is the line weight from the input unit to the hidden layer unit (is the line weight connecting the bias in the masked unit to the hidden layer unit). is the weight of the hidden layer unit to the output unit (is the bias weight in the hidden layer to the output unit).np$v_{ij} x_i z_j v_{jo} z_i w_{kj} z_j y_k w_{ko} z_k$



2. Activation Function

In an artificial neural network, the activation function is used to determine the output of the neuron unit. In backpropagation, the activation function used must meet several conditions, namely: continuous, easily differentiable and a non-degrading function. one of the functions that meet these three conditions so that it is often used is the binary sigmoid function which has a range of .(0,1)

$f\ (x)\ =\ \frac{1}{1+e^{-x}}$with descendants ………………$f\ '\ = f\ (x)(1 - f\ (x))(1)$

Another function that is often used is the bipolar sigmoid function whose form is similar to the binary sigmoid function, but with a range of .$(-1, 1)$

$f\ (x)\ =\ \frac{1}{1+e^{-x}}$with derivative$f\ '(x) = \frac{(1+f(x))(1-f(x))}{2}$ … … … … . (2)

The activation functions used in this study are as follows:

a. Binary Sigmoid Function

*Binary sigmoid function*has a value in the range up to . This function is often used for neural networks that require output values that lie in the interval up to . The definition of a binary sigmoid function is as follows:0101

$y\ = f_1(x)\ = \frac{1}{(1+e^{-\alpha x})}$ … … … … … … … … … (1)for0 $\leq f(x)1$

- $\alpha$is the form parameter of the sigmoid function. By changing the price, the shape of the sigmoid function will be different.α

The following is an illustration of a binary sigmoid function:

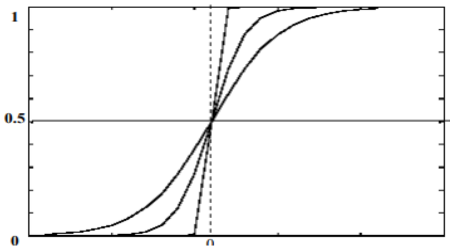


Figure 1. Binary Sigmoid Function Illustration

b. Bipolar Sigmoid Function

The bipolar sigmoid function is almost the same as the binary sigmoid function, except that the output of this function has a range between to . The definition of bipolar sigmoid function is as follows:$1 - 1$

$$y = f(x) = \frac{e^{\alpha x} - e^{-\alpha x}}{e^{\alpha x} + e^{-\alpha x}} \text{for} -1 \leq f(x) \leq 1$$

- $\alpha$is the form parameter of the tanh function. By changing the price, the shape of the land function will be differentα

The following is an illustration of the bipolar sigmoid function:

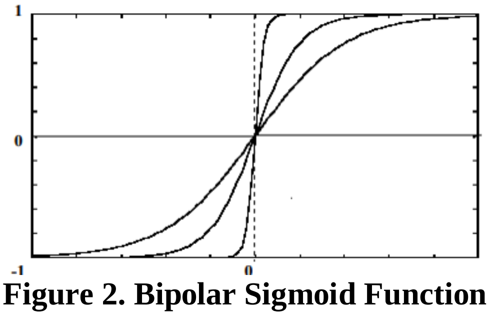


Figure 2. Bipolar Sigmoid Function Illustration

c. *Algorithm* Backpropagation Training

*Algorithm*Backpropagation training is a guided training that has many layers. Backpropagation uses error output to change the values of the weights in the backward direction. To get this error, the forward propagation step must be done first(Putri et al., 2019).

*Algorithm*The training for a network with one hidden layer (with a binary sigmoid activation function) is as follows:

1. *Backpropagation Algorithm*:
   a. Initialization of weights (take the initial weight with a fairly small random value).
   b. Perform the following steps as long as the stop condition is not met.
2. Advanced Propagation Stage

   For each pair of elements to be studied, do:*Feedforward*:
   a. Each input unit receives a signal and forwards the signal to the layer above it (the hidden layer).$(x_i, i = 1,2,3, \ldots \ldots n) x_i$
   b. Each hidden unit sums the weighted input signals:$(z_{j,}\ \ j = 1,2,3, \ldots \ldots, p)$

$$z\_in_j = v0_j + \sum_{i=1}^{n} xi\, v_{ij} \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (1)$$

   - use the activation function to calculate the output signal:

$$z_j = f\left(z\_in_j\right) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots . (2)$$

   - and send the signal to all the units in the layer above it (output units).

   c. Each output unit adds up the weighted input signals$(y_{k,}\ k = 1,2,3, \ldots \ldots, m)$

$$y_{in_k} = w0_k + \sum_{j=1}^{p} z_j w_{jk} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (3)$$

- use the activation function to calculate its output signal.

$$y_k = f\ (y\_in_k) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (4)$$

- and send the signal to all units in the layer above it (output units).

3. *Backpropagation*(Back Propagation):

a. Each output unit receives a target pattern associated with the learning input pattern. Calculate the error information.$(y_{k,} \ \ k = 1,2,3 \ldots\ldots, m)$

$$\delta_k = (t_k - y_k)\ f\ (y\_in_k) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (5)$$

- then calculate the weight correction (which will later be used to correctw_{jk}

$$\Delta W_{jk} = \alpha\ \delta_k z_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(6)$$

- Also calculate the bias correction (which will later be used to correct the value):w_{0k}

$$\Delta w_{jk} = \alpha\ \delta_k \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (7)$$

- Send this to the units in the lower layers.σ_k

b. Each hidden unit sums its input delta (from the units in the layer above it):$(z_{j,} \ \ j = 1,2,3 \ldots\ldots, p)$

$$\delta_{in_j} = \sum_{k=1}^{m} \delta k\ w_{jk} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (8)$$

- multiply this value by the derivative of the activation function to calculate the error information:

$$\delta_j = \delta_{in_j} f'^{\left(z_{in_j}\right)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (9)$$

- then calculate the weight correction (which will later be used to correct the value of vij):

$$\Delta v_{jk} = \alpha\ \ \delta_j\ x_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (10)$$

- Also calculate the bias correction (which will later be used to correct the value of v0j):

$$\Delta v_{oj} = \alpha\ \delta_j \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (1)$$

- Each unit of output corrects its bias and weight.$(y_{k,} \ \ k = 1,2,3 \ldots\ldots, m)(j = 0,1,2,3, \ldots\ldots, p)$

$$w_{jk}(baru) = w_{jk}(lama) + \Delta w_{jk} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (12)$$

- Each hidden unit fixes its bias and weight$(z_{j,} \ \ j = 1,2,3, \ldots\ldots, p)(i = 0,1,2,3, \ldots\ldots, n)$

$$v_{ij}(baru) = v_{ij}(lama) + \Delta v_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (13)$$

Prediction is an action or activity carried out to find out events that will occur in the future. Prediction is widely used by various activities, for example by entrepreneurs in predicting the price of shares that can be bought or sold. Prediction does not have to provide a definite answer to events that will occur, but seeks to find answers as close as possible to what will happen.

RESULTS AND DISCUSSION

Application of the Method

For the 48th iteration using the backpropagation method the result is 0.6530982 with the number of squares of error = 0.01005235, then the results achieved have converged and the square of error < target error (0.01) has been achieved with the results of 0.0743222. From the example calculation above, the prediction results of the numberSmart Indonesia Card acceptanceas follows :

Table 1. Sample Calculations Using the Backpropagation Method

Pattern	Score		Training Target Data	Score		Training Target Data
	X1	X2		X1	X2	
Pattern	**2019**	**2020**	**2021**	0.01	0.05	0.02

The following is the process of building an artificial neural network, with the following conditions:

1. The input layer consists of 14 neurons, namely X1-X14,
2. The hidden layer consists of 4 neurons, namely Z1-Z4,
3. The output layer consists of 1 neuron, namely Y1,
4. Each input layer and hidden layer has 1 bias constant.

The following is a picture of the artificial neural network architecture:

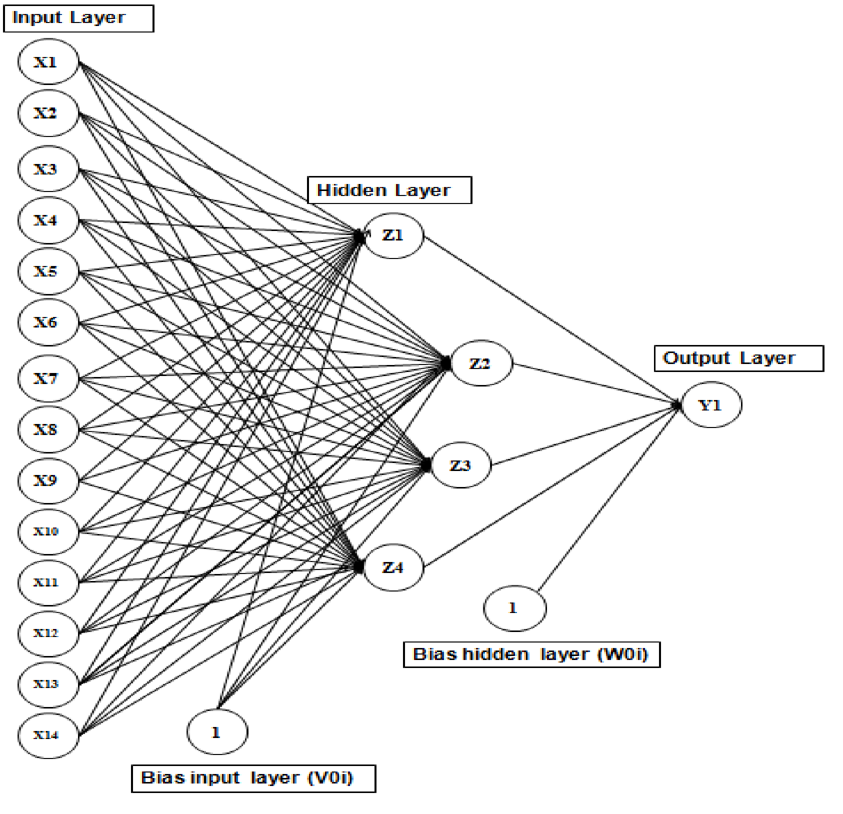


Figure 3. Artificial Neural Network Architecture With Backpropagation Method

Result Overview

For the 48th iteration using the backpropagation method the result is 0.6530982 with the number of squares of error = 0.01005235, then the results achieved have converged and the square of error < target error (0.01) has been achieved with the results of 0.0743222.

From the example calculation above, the prediction results of the numberSmart Indonesia Card acceptanceas follows :

Table 2. Sample After Calculation With Backpropagation Method

Pattern	Score		Prediction Results	Training Target Data
	X1	X2		
Pattern	0.01	0.05	0.01005235	0.0743222

Prediction results from data processed in 2019 and 2020. In the training values made in 2021, there is 1 recipient of Indonesia Smart Card funds in 2019 and there are 5 recipients of Indonesia Smart Card funds in 2020. While recipients in 2021 as training target data are 2 candidates. So, the prediction results in predictions for 2022, namely 7 prospective recipients who will be proposed.

CONCLUSION

From the description above, it can be concluded that the Smart Indonesia Card can help reduce the cost of education for underprivileged high school and vocational high school students. With this research, it is hoped that it will make it easier for schools to predict the number of students who receive the Indonesia Smart Card assistance and it is also hoped that the acceptance of this Smart Indonesia Card assistance is in accordance with the criteria that need it. This study also hopes that there will be no more students who drop out of school because they do not have education funds and are expected to motivate students to be more active in learning.

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