Implementation of Neural Networks in Predicting the Understanding Level of Students Subject

Sumijan¹, AgusPerdana Windarto², Abulwafa Muhammad¹ and Budiharjo³

¹Universitas Putra Indonesia YPTK Padang, Sumatera Barat, Indonesia
²STIKOM Tunas Bangsa, Pematangsiantar, Sumatera Utara, Indonesia
³Universitas Prof DrMoestopo (Beragama), Jakarta, Indonesia
sumijan@upiyptk.ac.id, agus@stikomtunasbangsa.ac.id, abulwafa@upiyptk.ac.id, budiharjo@dsn.moestopo.ac.id

Abstract

This paper implements artificial neural network in predicting the understanding level of students' course. By implementing artificial neural network based on backpropagation algorithm, an institution can give a fair decision in prediction level of students' understanding of particular course / subject. This method was chosen because it is able to determine the level of students' understanding of the subject based on input from questionnaires given. The study was conducted into two ways, namely training and testing. Data will be divided into two parts, the first data for the training process and the second reading data of the testing process. The training process aims to identify or search for goals that are expected to use a lot of patterns. Thus, it will be able to produce the best pattern to train the data. After reaching the goal of training which is based on the best pattern, then it will be tested with new data to see the accuracy of the target data using Matlab 6.1 software. The results show that it can accelerate the process of prediction of students' understanding. By using architectural models 6-50-1 as the best model, some architectural models are tested and the result of prediction is reach to 87.75%. In other word, this model is good enough to make predictions on the level of students' understanding of the subject.

Keywords: Artificial neural network; Backpropogation; Level Comprehension; Student; Subject

1. Introduction

Private college like AMIK Tunas Bangsa Pematangsiantar, North Sumatera, Indonesia has not introduced a system of determining the level of students' understanding of the subject based on professional teaching activities. The process of learning is one of the activities in a college / institution in academic life [1]. The role is inseparable from professional teaching activities. In the learning process there needs to be a two-way relationship between students and professional teachers [2]. This meant that there was good cooperation during the learning process takes place. Evaluations are conducted by the university / institution of the learning process is necessary to end the semester. It is intended that no assessment of students and faculty professional. For these students aimed at assessing the level of understanding and absorption of the subjects that are taught and for faculty professional aims to assess the extent to which professional teaching activities can be channeled towards the subjects that diampunyapengetahuanya for 1 (one) semester. Therefore, the university or higher institution can provide equitable policies.

Prediction of students' understanding of the subject by professional teaching staff can help the university or higher institution in making policies on the future of professional teaching activities [3,4]. To determine the level of students' understanding of the subject is
done by assessing (scoring) through questionnaires. Questionnaires were administered to represent the entire process of assessing the level of understanding of students on the course. Having obtained the target or goal of the assessment is desired then made the determination (determination) for the level of students' understanding of the subject by professional teachers. Artificial Neural Networks (ANN) is one of the information processing systems that are designed to mimic the way the human brain works in resolving a problem with the learning process through changes in weight [7-11]. There are many techniques that can be used for the implementation of Artificial Neural Networks one of them is Backpropagation [12-15]. Artificial Neural Networks by using the backpropagation algorithm has been widely used to solve some problems, one prediction problem.

This paper implements artificial neuralnetworkin predictingthe understanding level ofstudent’s subject. This method was chosen because it is able to determine the level of students' understanding of the subject based on input from questionnaires given. The study was conducted into two ways, namely training and testing. Data will be divided into two parts, the first data for the training process and the second reading of the testing process. The training process aims to identify or search for goals that are expected to use a lot of patterns, then it will be able to produce the best pattern to train the data. After reaching the goal of training which is based on the best pattern, then it will be tested with new data to see at the accuracy of the target using Matlab 6.1 software.

The rest of this paper is organized as follow. Section 2 presents rudimentary of artificial intelligence, artificial neural networks and backpropagation algorithm. Section 3 presents experimental design. Section 4 presents results and following by discussion. Finally, the conclusion of this work is presented in Section 5.

2. Rudimentary

2.1. Artificial Intelligence

AI is a field of study based on the premise that intelligent thought can be regarded as a form of computation - one that can be formalized and ultimately mechanized. To achieve this, however, two major issues need to be addressed. The first issue is knowledge representation, and the second is knowledge manipulation [1]. The main aim of Artificial Intelligence (AI) is to study how to build artificial systems that perform tasks normally performed by human beings. This concept was introduced in 1956 in the Dartmouth conference. From that moment on a lot of effort has been made and many goals have been achieved but unfortunately many failures as well. Today, the AI is a very important discipline and it includes a number of well-recognized and mature areas including Expert Systems [16-18], Fuzzy Logic [19-22], Genetic Algorithms [23-25], Language Processing, Logic Programming, Planning and Scheduling, Neural Networks and Robotics [26]. The general problem of simulating intelligence has been simplified to specific sub-problems which have certain characteristics or capabilities that an intelligent system should exhibit. The following characteristics have received the most attention:

a. Deduction, reasoning, problem solving (embodied agents, neural networks, statistical approaches to AI);

b. Knowledge representation (ontologies);

c. Planning (multi-agent planning and cooperation);

d. Learning (machine learning);
e. Natural Language Processing (information retrieval – text mining, machine translation);

f. Motion and Manipulation (navigation, localization, mapping, motion planning);

g. Perception (speech recognition, facial recognition, object recognition);

h. Social Intelligence (empathy simulation);

i. Creativity (artificial intuition, artificial imagination); and

j. General Intelligence (Strong AI).

Classical AI approaches focus on individual human behavior, knowledge representation and inference methods. Distributed Artificial Intelligence (DAI), on the other hand, focuses on social behavior, i.e., cooperation, interaction and knowledge-sharing among different units (agents). The process of finding a solution in distributed resolution problems relies on sharing knowledge about the problem and cooperation among agents. It was from these concepts that the idea of intelligent multi-agent technology emerged. An agent is an autonomous cognitive entity which understands its environment, i.e., it can work by itself and it has an internal decision-making system that acts globally around other agents. In multi-agent systems, a group of mobile autonomous agents cooperate in a coordinated and intelligent manner in order to solve a specific problem or classes of problems [27].

2.2. Artificial Neural Networks (NN)

Artificial Neural Network (ANN) is a computational model, which is based on Biological Neural Network. Artificial Neural Network is often called as Neural Network (NN) (See Figure 1). From Figure 1, to build artificial neural network, artificial neurons, also called as nodes, are interconnected [7,8]. The architecture of NN is very important for performing a particular computation. Some neurons are arranged to take inputs from outside environment. These neurons are not connected with each other, so the arrangement of these neurons is in a layer, called as Input layer. All the neurons of input layer are producing some output, which is the input to next layer. The architecture of NN can be of single layer or multilayer. In a single layer Neural Network, only one input layer and one output layer is there, while in multilayer neural network, there can be one or more hidden layers. An artificial neuron is an abstraction of biological neurons and the basic unit in an ANN [9,10]. The Artificial Neuron receives one or more inputs and sums them to produce an output. Usually the sums of each node are weighted, and the sum is passed through a function known as an activation or transfer function. The objective here is to develop a data classification algorithm that will be used as a general-purpose classifier. To classify any database first, it is required to train the model. The proposed training algorithm used here is a Hybrid BP-GA [11,12]. After successful training, user can give unlabeled data to be classified.
The synapses or connecting links: that provide weights, \( w_j \), to the input values, \( x_j \) for \( j = 1 \ldots m \). An additional function that sums the weighted input values to compute the input to the activation function as follow:

\[
V = W0 + \sum_{j=1}^{m} W_j x_j
\]

(1)

where, \( w_0 \) is called the bias, is a numerical value associated with the neuron. It is convenient to think of the bias as the weight for an input \( x_0 \) whose value is always equal to one, so that;

\[
V = \sum_{j=1}^{m} W_j x_j
\]

(2)

An activation function \( g \): that maps \( v \) to \( g(v) \) the output value of the neuron. This function is a monotone function. The logistic (also called the sigmoid) function \( g(v) = \frac{e^v}{1+e^v} \) as the activation function works best. The practical value of the logistic function arises from the fact that it is almost linear in the range where \( g \) is between 0.1 and 0.9 but has a squashing effect on very small or very large values [28].

2.3. Architecture of Backpropogation

The back-propagation learning algorithm (BPLA) has become famous learning algorithms among ANNs. In the learning process, to reduce the inaccuracy of ANNs, BPLAs use the gradient-decent search method to adjust the connection weights. The structure of a back-propagation ANN is shown in Figure 2. The output of each neuron is the aggregation of the numbers of neurons of the previous level multiplied by its corresponding weights. The input values are converted into output signals with the calculations of activation functions. Backpropagation ANNs have been widely and successfully applied in diverse applications, such as pattern recognition, location selection and performance evaluations [29].
There are several algorithms that can be used to create an artificial neural network, but the Back propagation was chosen because it is probably the easiest to implement, while preserving efficiency of the network. Backward Propagation Artificial Neural Network (ANN) use more than one input layers (usually 3). Each of these layers must be either of the following:

a. Input Layer – This layer holds the input for the network
b. Output Layer – This layer holds the output data, usually an identifier for the input.

c. Hidden Layer – This layer comes between the input layer and the output layer. They serve as a propagation point for sending data from the previous layer to the next layer [30].

2.4. Backpropagation Neural Network

Phases in Backpropagation Technique algorithm can be divided into two phases: propagation and weight update.

| Phase 1: Propagation |
|-----------------------|
| Each propagation involves the following steps: |
| 1. Forward propagation of a training pattern's input is given through the neural network in order to generate the propagation's output activations. |
| 2. Back propagation of the output activations through the neural network using the training pattern's targets in order to generate the deltas of all output and hidden neurons. |

| Phase 2: Weight Update |
|------------------------|
| For each weight-synapse: |
| 1. Multiply its input activation and output delta to get the gradient of the weight. |
| 2. Bring the weight in the direction of the gradient by adding a ratio of it from the weight. |

This ratio impacts on the speed and quality of learning; it is called the learning rate. The sign of the gradient of a weight designates where the error is increasing; this is
why the weight must be updated in the opposite direction. The phases 1 and 2 are repeated until the performance of the network is satisfactory [31].

2.5. Evaluating the Performance of the Models

The main measures used for evaluating the performance of machine learning techniques for predicting the software effort are as follows [32]:

a. **Sum Squared Error (SSE)**
   The sum squared error is defined as.
   \[
   \sum_{i=1}^{n}(Pi - Ai)^2
   \]
   where
   \[Pi\] = Estimated value for data point i;
   \[Ai\] = Actual value for the data point i;
   \[n\] = Total number of data points.

b. **Mean Squared Error (MSE)**
   The mean squared error is defined as.
   \[
   \frac{1}{n}\sum_{i=1}^{n}(Pi - Ai)^2
   \]
   where
   \[Pi\] = Estimated value for data point i;
   \[Ai\] = Actual value for the data point i;
   \[n\] = Total number of data points.

c. **Root Mean Squared Error (RMSE)**
   The root mean squared error is defined as.
   \[
   \sqrt{\frac{1}{n}\sum_{i=1}^{n}(Pi - Ai)^2}
   \]
   where
   \[Pi\] = Estimated value for data point i;
   \[Ai\] = Actual value for the data point i;
   \[n\] = Total number of data points.

d. **Mean Absolute Error (MAE)**
   The mean absolute error measures how far the estimates are from actual values. It could be applied to any two pairs of numbers, where one set is “actual” and the other is an estimate prediction.
   \[
   \frac{1}{n}\sum_{i=1}^{n}|Pi - Ai|
   \]
   where
   \[Pi\] = Estimated value for data point i;
   \[Ai\] = Actual value for the data point i;
   \[n\] = Total number of data points.
3. Experiment Design

3.1. Data Collection

In this study, the pattern recognition system and prediction of students’ understanding of the subject is presented. Data were obtained from questionnaires distributed to students grouped by subjects that taught by faculty as a lecturer. As for the format of a questionnaire given to students in the form of questions by 30 questions in which each question represents the study variables (See Figure 3). The research variables are learning, skills, assessment and workload, guidance and counseling, learning resources and standards and targets. Students need to give a score of 1=Strongly Disagree, 2=Disagree, 3=moderate, 4=Agree, 5=Strongly Agree, such as the following format:

| No. | Commentary                                                                 | Score |
|-----|-----------------------------------------------------------------------------|-------|
| A   |                                                                            |       |
| 1   | At the beginning of the lecture the lecturer expressed about the ability of  |       |
|     |   the students obtained after following this course                          |       |
| 2   | At the beginning of the lecture the lecturer explained well about the main   |       |
|     |   points of the lecture and learning methods                                |       |
| 3   | At the beginning of the lecture the lecturer explained well about the system |       |
|     |   of assessment of students                                                  |       |
| 4   | Textbooks, workbooks and / or handouts are provided with good               |       |
| 5   | Bibliography required to process a given learning courses                   |       |
|     |   delivered very clearly by lecturers                                        |       |
| 6   | Lecturers prepare teaching materials with good lectures                     |       |
| 7   | Lecturers to inspire and motivate                                           |       |
| 8   | Lecturers explain and facilitate learning activities well                    |       |
| 9   | Textbooks, workbooks and / or handouts to help me understand lectures       |       |
| 10  | I get a lot of knowledge of the way of learning this course                 |       |
| 11  | I think working in a group is an effective way to learn                     |       |
| 12  | Through this course I get a good understanding                             |       |
| 13  | Lecturer always assigns the end of each subject                             |       |
| 14  | Results correction tasks immediately returned by the lecturers              |       |
| B   |                                                                            |       |
| 15  | I have learned to think critically as a result of the activity of this      |       |
|     |   course                                                                    |       |
|   |                                                                 |   |   |   |   |
|---|-----------------------------------------------------------------|---|---|---|---|
| 16 | I have learned to present ideas in a way that is clearly as a     |   |   |   |   |
|    | result of the activity of this course                            |   |   |   |   |
| 17 | I have developed communication skills as a result of the        |   |   |   |   |
|    | activity of this course                                         |   |   |   |   |
| 18 | I have developed my ability to work in groups or teams as a     |   |   |   |   |
|    | result of the work I do in these lectures                       |   |   |   |   |
| C  | AssessmentAndWorkload                                          | 1 | 2 | 3 | 4 |
| 19 | How to vote in this study clearly                               |   |   |   |   |
| 20 | How to vote in this study clearly                              |   |   |   |   |
|    | Assessment of this study into account the work of individuals   |   |   |   |   |
|    | and work groups                                                |   |   |   |   |
| D  | GuidanceAndCounseling                                          | 1 | 2 | 3 | 4 |
| 21 | I get enough of tutoring from the lecturer's                    |   |   |   |   |
| 22 | There is a good academic guidance on the choice of subjects     |   |   |   |   |
|    | which correspond to the needs and interests of my               |   |   |   |   |
| E  | Learning Resources                                              | 1 | 2 | 3 | 4 |
| 23 | I easily get reading materials to complete this course           |   |   |   |   |
| 24 | The use of LCD projectors in learning easier for me to          |   |   |   |   |
|    | understand what is being taught                                 |   |   |   |   |
| 25 | Libraries University / Faculty / Department have enough books,  |   |   |   |   |
|    | journals and other reading materials for the completion of this |   |   |   |   |
|    | course                                                         |   |   |   |   |
| F  | Standards AndTargets                                           | 1 | 2 | 3 | 4 |
| 26 | I understand very well the terms desired of us in the process   |   |   |   |   |
|    | of learning this course                                        |   |   |   |   |
| 27 | I see clearly how the parts of this lecture strung together to  |   |   |   |   |
|    | accomplish the desired target                                   |   |   |   |   |
| 28 | I understand how the activity of our lectures rated             |   |   |   |   |
| G  | Public Impact and Quality                                       | 1 | 2 | 3 | 4 |
| 29 | Overall I am satisfied with the quality of learning from this   |   |   |   |   |
|    | course                                                         |   |   |   |   |
| 30 | This subject has an impact on how I make decisions              |   |   |   |   |

**Figure 3. Student Questionnaire Data**

The charging process is done by taking a sample of some of the classes are categorized by subjects that taught by professional teacher. The list of criteria to determine the prediction of students' understanding of the subject is given in Table 1 as follows:
### Table 1. The List of Criteria

| No | Criteria                  | Variable | Description         | Weight |
|----|---------------------------|----------|---------------------|--------|
| 1  | Learning                  | A        | Strongly Agree      | 1      |
|    |                            |          | Agree               | 0.8    |
|    |                            |          | Moderate            | 0.6    |
|    |                            |          | Disagree            | 0.4    |
|    |                            |          | Strongly Disagree   | 0.2    |
| 2  | Skills                    | B        | Strongly Agree      | 1      |
|    |                            |          | Agree               | 0.8    |
|    |                            |          | Moderate            | 0.6    |
|    |                            |          | Disagree            | 0.4    |
|    |                            |          | Strongly Disagree   | 0.2    |
| 3  | Assessment And Workload   | C        | Strongly Agree      | 1      |
|    |                            |          | Agree               | 0.8    |
|    |                            |          | Moderate            | 0.6    |
|    |                            |          | Disagree            | 0.4    |
|    |                            |          | Strongly Disagree   | 0.2    |
| 4  | Guidance And Counseling   | D        | Strongly Agree      | 1      |
|    |                            |          | Agree               | 0.8    |
|    |                            |          | Moderate            | 0.6    |
|    |                            |          | Disagree            | 0.4    |
|    |                            |          | Strongly Disagree   | 0.2    |
| 5  | Learning Resources        | E        | Strongly Agree      | 1      |
|    |                            |          | Agree               | 0.8    |
|    |                            |          | Moderate            | 0.6    |
|    |                            |          | Disagree            | 0.4    |
|    |                            |          | Strongly Disagree   | 0.2    |
| 6  | Standards And Targets     | F        | Strongly Agree      | 1      |
|    |                            |          | Agree               | 0.8    |
|    |                            |          | Moderate            | 0.6    |
|    |                            |          | Disagree            | 0.4    |
|    |                            |          | Strongly Disagree   | 0.2    |

#### 3.2. Data Processing

Data processing is done with the help of matlab 6.1 software application. The raw data from a sample of 80 students will be divided into two parts, namely the test data and data testing. The raw data will be transformed into a table predetermined criteria in Table 2. As for the sample of data that has been processed and ditransformasi are as follows.
Once the raw data is transformed into a table predetermined criteria, the next step is to determine the best architecture with patterns by performing a series of tests. The second stage is to predict the best architectural patterns obtained in the first stage. Testing process is carried out by entering the data and comparing the minimum error value is obtained from the best architectural pattern carried on the first stage.

### 3.3. Manual Design of Architectural Patterns

The desired outcome at this stage is the detection of a pattern determining best value for the level of students’ understanding of the subject. The results are as follows:

**a.** To determine the level of students' understanding of the course is based on professional teaching activities. Output from pemahan level there are 2 possibilities, namely “Understand” with weight 1 and “Not familiar” with weights0.

**b.** Categorization “understand” or “do not understand”

Category for “understand” is determined by the minimum error rate of the target “understand” that is 1. Those categorizations can be seen in Table 3 as follow:

#### Table 3. Data Categorization “understand”

| No | Description       | Error Minimum   |
|----|-------------------|-----------------|
| 1  | VeryUnderstand   | 0.0000 - 0.0010 |
| 2  | Understand       | 0.0011 - 0.0100 |
| 3  | UnderstandEnough | 0.0101 - 0.1000 |

Categorization “not understand” is determined by the minimum error level of 0. The targets “do not understand” that “do not understand” the categorization can be seen in Table 4 as follow:

#### Table 2. Samples of Data that has been Transformed

| No | NIM | Name                      | X1 | X2 | X3 | X4 | X5 | X6 | X7 |
|----|-----|---------------------------|----|----|----|----|----|----|----|
| 1  | 26128019036 | Mari Htzagad   | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.8 | 0.8 | 1  |
| 2  | 26128019033 | Ravi Faenalvapi | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.6 | 1  |
| 3  | 26128019042 | Agatnra       | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.8 | 0.6 | 1  |
| 4  | 26128019031 | Hali Htlepap   | 0.2 | 1  | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 1  |
| 5  | 26128019061 | Ahamdul Tgaran | 0.8 | 0.8 | 1  | 0.6 | 0.6 | 0.8 | 0.6 | 0  |
| 6  | 26128019066 | Eko Sattawan   | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.8 | 1  |
| 7  | 26128019083 | Nahi Lkuta Tang | 1  | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1  |
| 8  | 26128019098 | Tumur Tannapo Htalbarrat | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 9  | 26128019002 | Domancen Simaraste | 0.8 | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 10 | 26128019007 | Indra Pratama  | 0.8 | 1  | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 11 | 26128019016 | Muhammad Abdul Aqil Dikmurah | 1  | 0.6 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 1  |
| 12 | 26128019011 | Fiza          | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1  |
| 13 | 26128019013 | Mertoona      | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 14 | 26128019008 | Ika Yani      | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 15 | 26128019052 | Ila Sylagtri  | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 16 | 26128019055 | Anya Hnda Syhnpura | 1  | 0.8 | 0.8 | 0.5 | 0.5 | 0.8 | 0.8 | 0  |
| 17 | 26128019050 | Sit bahaktwi   | 0.8 | 1  | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 18 | 26128019094 | Effendi       | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 19 | 26128019074 | Muhammad Sofyan | 1  | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 20 | 26128019077 | Radh Aspldi   | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 21 | 26128019083 | Egi Vulanti  Damirak  | 0.8 | 0.8 | 0.8 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 22 | 26128019093 | Nela Puspa  San | 0.8 | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 23 | 261280190102 | Ahmad Latek    | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 24 | 26128019014 | Eko Sudlo      | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0  |
| 25 | 26128019016 | Inator        | 0.8 | 1  | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 1  |
Table 4. Data Categorization “not understand”

| No | Description          | Error Minimum   |
|----|----------------------|-----------------|
| 1  | Very Not Understand  | 0.0000 - 0.0010 |
| 2  | Do Not Understand    | 0.0011 - 0.0100 |
| 3  | Enough Not Understand| 0.0101 - 0.1000 |

4. Results and Discussion

4.1. The Best Pattern Determination

Training and testing is done several times with different parameters to get the best results with the software application Matlab 6.1 Neural Network method in determining the best pattern for the level of students' understanding of subjects by professional teaching staff has three part process, namely:

a. The process of data input and the target includes inputting learning, skills assessment and workload, guidance and counseling, learning resources and standards and targets. As the target is the level of students' understanding of the course

b. The process of determining the results of processed data that includes data conversion process into a pre-determined weight, calculate the weight value into the back propagation stage.

c. The results of the process of determining the data that is processed with Matlab 6.1 software application will be used to predict the level of student understanding terhadapat subjects by comparing the value of the minimum error.

From the series of experiments performed using Matlab 6.1 software application with 6-50-1, 6-75-1, 6-100-1, 6-50-75-1 and architectural patterns obtained 6-75-100-1. The best at 6-50-1 models with attribute parameters as follows:

- ActivationfunctiontoHiddenLayer: Tansig
- ActivationfunctiontoOutputLayer: Logsig
- TypeTrainning: Traingd
- HiddenNeuronLayernumber: 50
- Learningrate: 0.1
- ErrorlimitsMaximum: 0.001
- Showlimit: 1000
- EpochlimitMaximum: 5000000
- Momentum: 0.8

Of the parameters used to model architectural epochs 6-50-1 with 166828 and MSE0.0009991940 shown in Figure 4.
Of the five models tested architecture, architectural models 6-50-1 obtained with the smallest MSE. 6-50-1MSE results are given in Table 5 below:

### Table 5. Results MSE6-50-1 Architecture Model using Matlab 6.1 Application

| No | Target | Output | Error  | SSE           |
|----|--------|--------|--------|---------------|
| 1  | 1      | 0.9792 | 0.0208 | 0.0004326400  |
| 2  | 1      | 0.9443 | 0.0557 | 0.0031024900  |
| 3  | 1      | 0.9565 | 0.0435 | 0.0018922500  |
| 4  | 1      | 0.9944 | 0.0056 | 0.0000313600  |
| 5  | 0      | 0.0409 | -0.0409| 0.00016728100 |
| 6  | 1      | 0.9891 | 0.0109 | 0.0001188100  |
| 7  | 1      | 0.9858 | 0.0142 | 0.0002016400  |
| 8  | 0      | 0.0376 | -0.0376| 0.0001437600  |
| 9  | 0      | 0.0181 | -0.0181| 0.0003276100  |
| 10 | 1      | 0.9861 | 0.0139 | 0.0001932100  |
| 11 | 1      | 0.9701 | 0.0299 | 0.0008940100  |
| 12 | 1      | 0.9985 | 0.0015 | 0.0000022500  |
| 13 | 0      | 0.0206 | -0.0206| 0.0004243600  |
| 14 | 0      | 0.0509 | -0.0509| 0.00025908100 |
| 15 | 1      | 0.9755 | 0.0245 | 0.0006002500  |
| 16 | 0      | 0.0576 | -0.0576| 0.00033177600 |
| 17 | 1      | 0.9540 | 0.0460 | 0.0002116000  |
| 18 | 1      | 0.9792 | 0.0208 | 0.0004326400  |
| 19 | 0      | 0.0131 | -0.0131| 0.0001716100  |
| 20 | 1      | 0.9931 | 0.0069 | 0.0000476100  |
|    | Total  |        |        | 0.0199838800  |
|    | MSE    |        |        | 0.0009991940  |
To see the results of the comparison data MSE all architectural models are tested using matlab 6.1. All application is complete, it can be seen from Table 6 as follow:

**Table 6. Comparison of each Model Epoch and every MSE Architecture Model**

|            | 6-50-1 | 6-75-1 | 6-100-1 | 6-50-75-1 | 6-75-100-1 |
|------------|--------|--------|---------|-----------|------------|
| Epochs     | 166828 | >200000 | 38820   | 25145     | 19255      |
| MSE        | 0.0009991940 | Not Defined | 0.0009995025 | 0.0009997820 | 0.0009993985 |

4.2. Students Understanding Level Predictions of the Course

The last stage is the prediction of student understanding of the subjects that diabawakan by professional teachers. This stage is done by comparing the minimum error value of the results obtained. With 6-50-1 architecture model, the data will be predicted to see how accurate the model is able to recognize data. The desired results of this final stage are to get the minimum error value for the prediction of architectural patterns. The results are as follows:

a. Categorization “understand and do not understand”
   Categorization “understand” is determined by the minimum error rate, where “familiar” with a weight of 1 and “not familiar” with weights 0

b. Categorization minimum error for prediction data to understand and do not understand can be seen in Table 7 as follow:

**Table 7. Data Categorization Prediction**

| No | Description     | Error Minimum   |
|----|-----------------|-----------------|
| 1  | Understand      | 0.0000 – 0.0010 |
| 2  | Do Not Understand | 0.0011 – 0.0100 |

Data to be predicted to see correctness level can be seen in Table 8 as follow:

**Table 8. Results Prediction Model 6-50-1**

| No | NIM           | Prediction   | Information |
|----|---------------|--------------|-------------|
|    |               | Real Data    | JST         | Result     |
| 1  | 201201030083  | 1            | 0.00092     | True       |
| 2  | 201201030091  | 0            | 0.00033     | True       |
| 3  | 201201030102  | 0            | 0.00036     | True       |
| 4  | 201201030104  | 1            | 0.00078     | True       |
| 5  | 201201030106  | 1            | 0.00082     | True       |
| 6  | 201201030111  | 1            | 0.00038     | True       |
| 7  | 201201030127  | 1            | 0.00038     | True       |
| 8  | 201201030142  | 0            | 0.0036      | True       |
| 9  | 201201030148  | 1            | 0.00032     | True       |
| 10 | 201201030156  | 0            | 0.0057      | True       |
| 11 | 201201030157  | 0            | 0.0094      | True       |
| 12 | 201201030159  | 1            | 0.0374      | True       |
| 13 | 201201030160  | 0            | 0.008       | True       |
| 14 | 201201030162  | 0            | 0.008       | True       |
| 15 | 201201030173  | 0            | 0.0038      | True       |
| 16 | 201201030175  | 0            | 0.0038      | True       |
By using architectural models 6-50-1 prediction results obtained 87.75%. In other words, this model is good enough to predict the level of students' understanding of the subject.

### 5. Conclusion

In this paper, implementation of artificial neural network in predicting the understanding level of student’s subject has been presented. Based on the results and analysis of the previous chapter, the author can draw conclusions as follows:

a. Adding lots of hidden layer during the training and testing, not a maximum results. To 5 models designed architecture, 6-50-75-1 is a model that has the largest MSE is 0.028540763

b. Having carried out experiments in the training process and system testing is done using Matlab 6.1 software application. Neural Network Model used was 6-50-1, 6-75-1 models, the model 6-100-1, 6-50-75-1 models and models 6-75-100-1, can be obtained good results with a view MSE the smallest and fastest epochsis 6-50-1.

c. With 6-50-1 architectural models, can make predictions on the students' understanding of the subject by showing the performance above 92%.
Acknowledgment
This work is supported by Universitas Putra Indonesia YPTK Padang, West Sumatera, Indonesia.

References
[1] M. Khalid, “Teaching and Learning Using Computers: How Should We Tread on Its’ Changing Technology?”, International Journal of Emerging Technologies in Learning, vol. 9, no. 5, (2014).
[2] Z. Abdullah, “Mining significant association rules from educational data using critical relative support approach”, Procedia-Social and Behavioral Sciences, vol. 28, (2011), pp. 97-101.
[3] I. Tri Riyadi Yanto, “Applying variable precision rough set model for clustering student suffering study’s anxiety”, Expert Systems with Applications, vol. 39, no. 1, (2012), pp. 452-459.
[4] T. Herawan, “A Soft Set Approach for Clustering Student Assessment Datasets”, Journal of Computational and Theoretical Nanoscience, vol. 12, no. 12, (2015), pp. 5928-5939.
[5] H. Chiroma, S. Abdul Kareem and T. Herawan, “Evolutionary Neural Network model for West Texas Intermediate crude oil price prediction”, Applied Energy, vol. 142, (2015), pp. 266.
[6] N. M. Nawi, A. Khan, M. Z. Rehman, H. Chiroma and T. Herawan, “Weight optimization in recurrent neural networks with hybrid metaheuristic Cuckoo search techniques for data classification”, Mathematical Problems in Engineering. (2015).
[7] A. I. Abubakar, A. Khan, N. M. Nawi, M. Z. Rehman, T. Y. Wah, H. Chiroma and T. Herawan, “Studying the Effect of Training Levenberg Marquardt Neural Network by Using Hybrid Meta-Heuristic Algorithms”, Journal of Computational and Theoretical Nanoscience, vol. 13, no. 1, (2016), pp. 450-460.
[8] H. Chiroma, S. Abdul-kareem, U. Ibrahim, I. G. Ahmad, A. Garba, A. Abubakar, M. F. Hamza and T. Herawan, “Malaria severity classification through Jordan-Elman neural network based on features extracted from thick blood smear”, Neural Network World, vol. 25, no. 5, (2015), pp. 565.
[9] N. A. Husaini, R. Ghazali, N. M. Nawi, L. H. Ismail, M. M. Deris and T. Herawan, “Pi-Sigma Neural Network For A One-Step-Ahead Temperature Forecasting”, International Journal of Computational Intelligence and Applications, vol. 13, no. 04, (2014), pp. 1450023.
[10] N. M. Nawi, M. Z. Rehman, M. A. Aziz, T. Herawan and J. H. Abawajy, “Neural network training by hybrid accelerated cuckoo particle swarm optimization algorithm”, In International Conference on Neural Information Processing, Springer International Publishing, (2014) November, pp. 237-244.
[11] N. M. Nawi, M. Z. Rehman, M. A. Aziz, T. Herawan and J. H. Abawajy, “An Accelerated Particle Swarm Optimization Based Levenberg Marquardt Back Propagation Algorithm”, In International Conference on Neural Information Processing, Springer International Publishing, (2014) November, pp. 245-253.
[12] H. Chiroma, S. Abdul-Kareem, S. A. Muaz, A. Khan, E. N. Sari and T. Herawan, “Neural Network Intelligent Learning Algorithm for Inter-related Energy Products Applications”, In International Conference in Swarm Intelligence, Springer International Publishing, (2014) October, pp. 284-293.
[13] R. Ghazali, N. A. Husaini, L. H. Ismail, T. Herawan and Y. M. M. Hassim, “The performance of a Recurrent HONN for temperature time series prediction”, In 2014 International Joint Conference on Neural Networks (IJCNN), IEEE, (2014) July, pp. 518-524.
[14] N. A. Husaini, R. Ghazali, L. H. Ismail and T. Herawan, “A Jordan Pi-Sigma Neural Network for Temperature Forecasting in BatuPahat Region”; In Recent Advances on Soft Computing and Data Mining, Springer International Publishing, (2014), pp. 11-24.
[15] N. M. Nawi, A. Khan, M. Z. Rehman, T. Herawan and M. M. Deris, “CSSLVEN: A New Cuckoo Search Levenberg Marquardt Elman Network for Data Classification”, In Recent Advances on Soft Computing and Data Mining, Springer International Publishing, (2014), pp. 173-182.
[16] H. Chiroma, S. Abdul-Kareem, A. I. Abubakar and T. Herawan, “Kernel functions for the support vector machine: comparing performances on crude oil price data”, In Recent Advances on Soft Computing and Data Mining, Springer International Publishing, (2014), pp. 273-281.
[17] R. F. Hakim, E. N. Sari and T. Herawan, “Soft Solution of Soft Set Theory for Recommendation in Decision Making”, In Recent Advances on Soft Computing and Data Mining, Springer International Publishing, (2014), pp. 313-324.
[18] A. Lasiri, R. Ghazali and T. Herawan, “Comparative performance analysis of negative selection algorithm with immune and classification algorithms”, In Recent Advances on Soft Computing and Data Mining, Springer International Publishing, pp. 441-452.
[19] B. Handaga, T. Herawan and M. M. Deris, “FSSC: An Algorithm for Classifying Numerical Data Using Fuzzy Soft Set Theory”, International Journal of Fuzzy System Applications (IJFSA), vol. 2, no. 4, (2012), pp. 29-46.
[20] T. Herawan, Z. Abdullah, H. Chiroma, E. N. Sari, R. Ghazali and N. M. Nawi, “Cauchy criterion for the Henstock-Kurzweil integrability of fuzzy number-valued functions”, In Advances in Computing, Communications and Informatics (ICACCI, 2014 International Conference, IEEE, pp. 1329-1333.
[21] Ma, X., Qin, H., Sulaiman, N., Herawan, T. and Abawajy, J.H., 2014. The parameter reduction of the interval-valued fuzzy soft sets and its related algorithms. IEEE Transactions on Fuzzy Systems, 22(1), pp.57-71.

[22] Yanto, I.T.R., Ismail, M.A. and Herawan, T., 2016. A modified Fuzzy k-Partition based on indiscernibility relation for categorical data clustering. Engineering Applications of Artificial Intelligence, 53, pp.41-52.

[23] Abubakar, A.I., Zeki, A., Chiroma, H. and Herawan, T., 2014. Investigating Rendering Speed and Download Rate of Three-Dimension (3D) Mobile Map Intended for Navigation Aid Using Genetic Algorithm. In Recent Advances on Soft Computing and Data Mining (pp. 261-271). Springer International Publishing.

[24] Qin, H., Ma, X., Herawan, T. and Zain, J.M., 2012, May. An improved genetic clustering algorithm for categorical data. In Pacific-Asia Conference on Knowledge Discovery and Data Mining (pp. 100-111). Springer Berlin Heidelberg.

[25] Shah, H., Ghazali, R., Nawi, N.M., Deris, M.M. and Herawan, T., 2013. Global artificial bee colony-Levenberg-Marquardt (GABC-LM) algorithm for classification. International Journal of Applied Evolutionary Computation (IJAECC), 4(3), pp.58-74.

[26] Castaño, B., Moreno, Á., Carbajo, M. and de Pedro, J., 2008. Artificial Intelligence and Bluetooth Techniques in a Multi-user M-learning Domain. IJCSA, 5(1), pp.1-13.

[27] Dilek, S., Çakır, H. and Aydın, M., 2015. Applications of Artificial Intelligence Techniques to Combating Cyber Crimes: A Review. arXiv preprint arXiv:1502.03552.

[28] Ganatra, A., Kosta, Y.P., Panchal, G. and Gajjar, C., 2011. Initial classification through back propagation in a neural network following optimization through GA to evaluate the fitness of an algorithm. International Journal of Computer Science and Information Technology, 3(1), pp.98-116.

[29] Che, Z.G., Chiang, T.A. and Che, Z.H., 2011. Feed-forward neural networks training: A comparison between genetic algorithm and back-propagation learning algorithm. International Journal of Innovative Computing, Information and Control, 7(10), pp.5839-5850.

[30] Choudhary, N.Y., Patil, M.R., Bhadade, U. and Chaudhari, B.M., 2013. Signature Recognition & Verification System Using Back Propagation Neural Network. International Journal of IT, Engineering and Applied Sciences Research (IJIEASR), 2(1), pp.1-8.

[31] Baboo, S.S. and Shereef, I.K., 2010. An efficient weather forecasting system using artificial neural network. International Journal of Environmental Science and Development, 1(4), p.321.

[32] Venkatachalam, A.R., 1993, October. Software cost estimation using artificial neural networks. In Neural Networks, 1993. IJCNN'93-Nagoya. Proceedings of 1993 International Joint Conference on (Vol. 1, pp. 987-990). IEEE.