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Predicting Tuition Fee Payment Problem using Backpropagation Neural Network Model

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Abstract

This study aims to predict factors causing tuition fees payment problems with artificial neural networks using Backpropagation algorithm. The data is collected by interview and questionnaire from students having problem in tuition fee payment of a private higher learning institution in Indonesia where in total 20 sample data are obtained. There are six categories and in predicting these factors, the Backpropagation algorithm of artificial neural network has been employed involving training and testing. The training stage is used to get the best architectural model from a series of experiments. Meanwhile, the testing stage is used to see the accuracy of the model used. Four architectural models i.e. 6-5-1, 6-10-1, 6-5-10-1 and 6-10-5-1 have been used. The results show that, the best architectural model is achieved for 6-5-10-1 model with Mean Square Error 0.0010002075 and its respective accuracy up to 80%.

Keywords*: Architecture model; Artificial intelligence; Backpropagation, Tuition fee*

1. Introduction

There are more than 4000 higher learning institutions in Indonesia, where mostly they are private institutions. *Akademi Manajemen Informatika Komputer* (AMIK) Tunas Bangsa which is located in Pematangsiantar, Northern Sumatera is one of private universities in north sumatera which is engaged in computer. In carrying out daily activities, AMIK Tunas Bangsa Pematangsiantar management is led by a director and assisted by the three different deputy directors. Each deputy director cooperates in carrying out their respective responsibilities. In running the educational activities, one of the obligations of a student is to pay tuition fee. In the process of payment of tuition fees, the university provides relief in the form of installment of tuition fee up to several stages to all students.

Over past decades, students in many universities in Indonesia often faced a common problem in the process of tuition fees payment i.e. delay in payment. The delayed payment of tuition fees may cause the operational of a university. To overcome this problem, the financial section of the university then provides analysis results about the factors causing late pay tuition. Activities can happen to private colleges anywhere. Artificial Neural Network (ANN) as one of the most popular methods of Artificial Intelligence [1] has been widely used in prediction and forecasting problems. It able to

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make predictions of past-based activities or learning from experience [2,3]. Generally, past obtained data is learned by artificial neural networks and hence it has the ability to recommend decisions on data which has not been studied [4].

There are many techniques that can be used for the implementation of Artificial Neural Network and one of the most popular is Backpropagation (BP) [5-10]. Backpropagation is often used to solve complex problems related to input identification, prediction, and pattern recognition [11-13]. Repeated training will result in a network that responds correctly to all of its input. That is the main advantage of backpropagation, hence it can realize a system that is resistant to damage and consistently works well. This BP method is done in two different ways, namely training and testing. Consequently, data is divided into two parts i.e. data for the training process and data for testing. The training process aims to identify or find the best architectural pattern, meanwhile the testing process is performed to produce the best accuracy based on the best pattern being treated.

Neural networks has been used in educational data mining including the works of [1,4,14,15]. However, there lacks on the work of employing ANN in specific application for predicting tuition fee payment problems faced by students. Therefore, this study aims to predict factors causing tuition fees payment problem with artificial neural networks using Backpropagation algorithm. The case study in students in a private University i.e. *Akademi Manajemen Informatika Komputer* (AMIK) Tunas Bangsa which is located in Pematangsiantar, Northern Sumatera, Indonesia.

The rest of this paper is organized as follow. Section 2 presents theoretical background on artificial intelligence. Section 3 present the proposed experimental design. Section 4 presents obtainde results and following by discussion. Finally, Section 5 concludes this work.

2. Rudimentary

2.1. Artificial Intelligence

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 [16]. The main aim of Artificial Intelligence (AI) is to study how to build artificial systems that perform tasks normally performed by human beings [17,18,19]. This concept was born in 1956 in the Darthmounth conference [20]. 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 such as Expert Systems, Fuzzy Logic, Genetic Algorithms, Language Processing, Logic Programming, Planning and Scheduling, Neural Networks and Robotics.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).

Classic 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 [13].

2.2. Artificial Neural Networks

Neural network are simplified models of the biological nervous system and therefore have drawn their motivation from the kind of computing performed by a human brain. An NN in general is a highly interconnected of a large number of processing elements called neurons in an architecture inspired by the brain. An NN can be massively parallel and therefore is said to exhibit parallel distributed processing. Neural Network exhibits characteristics such as mapping capabilities or pattern association, generalization, robustness, fault tolerance, and parallel and high speed information processing. Neural network learn by example. They can therefore be trained with known examples of a problem to acquire knowledge about it. Once appropriate trained the network can be put to effective use in solving ‘unknown’ or ‘untrained’ instances of the problem. Neural network adopt various learning mechanism of which supervised learning and unsupervised learning methods have turned out to be very popular. In supervised learning, a teacher is assumed to be present during the learning process, i.e. the network aims to minimize he error between target (desired) output presented by the teacher and the computed output to achieve better performance. However, in unsupervised learning, there is no teacher present to hand over the desired output and the network therefore tries to learn by itself, organizing the input instances of the problem. NN Architecture has been broadly classified as single layer feed forward networks, multilayer feed forward networks and recurrent networks, over the year several other NN. Architecture have evolved .some of the well-known NN system include Backpropagation network, perceptron, ADALINE, Boltzmann machine, adaptive resonance theory, Self-organized feature map, and Hopfield network. Neural Network has been successfully applied to problem in the field of pattern recognition, image processing, data compression, forecasting and optimization to quote a few [7].

2.3. Architecture Backpropagation

The Backpropagation learning algorithm (BPLA) was proposed by Rumelhart, *et al*. [21]. They have since 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 Backpropagation ANN is shown in Figure 1.

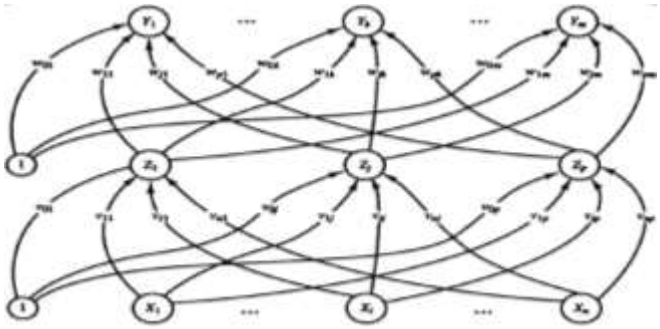

Figure 2.1. Backpropagation ANN

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 [21]. 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 propagation point for sending data from the previous layer to the next layer [16].

2.4. Steps of Backpropagation Neural Network

Phases in Backpropagation technique algorithm can be divided into two phases i.e. 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 propagation through the neural
   network using the training pattern's targeting 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; itis 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 [17].

2.5. Evaluating Performance of the Models

The main measures used for evaluating the performance of machine learning techniques for predicting the software effort are as follows [18]:

a. Sum Squared Error (SSE)

The sum squared error is defined as.

$$\sum_{i=1}^{n}(Pi - Ai)^2 \quad (1)$$

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.

$$\frac{1}{n}\sum_{i=1}^{n}(Pi - Ai)^2 \quad (2)$$

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.

$$\sqrt{\frac{1}{n}\sum_{i=1}^{n}(Pi - Ai)^2} \quad (3)$$

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 of 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.

$$\frac{1}{n}\sum_{i=1}^{n}|\,Pi - Ai| \quad (4)$$

where
Pi = Estimated value for data point *i*;
Ai =Actual value for the data point *i*;
n = Total number of data points.

3. Experimental Design

This section presents experimental design of this work.

3.1. Defining Input and Target

Data factor of tuition fees payment delay will be further processed by Neural Network with Backpropagation method. In order for data to be recognized by Artificial Neural Networks, the data must be represented in numerical form between 0-1, both the variable and the data content which is the input for pattern and output recognition which is the best architectural model in predicting the delay of tuition fees payment. The data conversion process uses the converted fuzzy numbers based on predefined parameters. This is because the network uses a binary sigmoid activation function (log-sig) that ranging from 0-1.

3.2. Input Definition

There are 6 variables used to obtain the factors that cause problem of tuition fees are the criteria that will be used as reference in decision making on the assessment by using Artificial Neural Network as described in Table 1.

Table 1. List of Criteria for Delinquency Factor of Tuition

No	Criteria	Name Variable
1	C1	Parent Income
2	C2	Number of Siblings
3	C3	Parent Occupation
4	C4	Residence Status
5	C5	Misuse of Money
6	C6	External Factors

From Table 1, variables determined by determining at the dependence of student data. Data obtained by interview and questionnaire to student AMIK Tunas Bangsa where in total 20 samples collected.

Table 2. Weight Criteria Factor Tuition Fee Delay Payment

No	Variable Name	Interval	Weight
1	Parent Income	> IDR 5,000,000 (Very High)	0.2
		> IDR 2,000,000 - IDR 5,000,000 (High)	0.4
		IDR 1,000,000 - IDR 2,000,000 (Medium)	0.6
		< IDR 1,000,000 (Low)	0.8
2	Number of Sibling	>= 5	0.9
		4	0.7
		3	0.5
		2	0.4
		1	0.2
3	Parent Occupation	Government Employee	0.2
		Private Employee	0.4
		Entrepreneur	0.5
		Army / Police	0.7
		Farmers, Fishermen, Laborer	0.9
4	Status of Residence	With parents	0.1
		Without parents	0.9
5	Misuse of Money	Yes	0.9
		No	0.1
6	External Factors	Delay Sending	0.8
		Family needs	0.6
		Business Constraints	0.4

3.3. Data Processing

Data processing is done with the help of Matlab 6.1 software application. Sample Data is 20 student AMIK Tunas Bangsa which has problem of delay tuition fee payment. This data will be used in training data and test data. Sample data that has been processed and transformed are gives respectively in Tables 3 and 4 as follows.

Table 3. Sample of Research Data

No	Name	Parent Income (C1)	Number of Siblings (C2)	Parent Occupation (C3)	Residence Status (C4)	Misuse of Money (C5)	External Factors (C6)	Target
1	Student 1	IDR 2,500,000	4	Private Employee	Without Parents	Yes	Late Sending	Problematic
2	Student 2	IDR 1,500,000	3	Laborer	With Parents	No	Family Needs	Problematic
3	Student 3	IDR 3,500,000	3	Army	Without Parents	No	Late Sending	Problematic
4	Student 4	IDR 2,000,000	2	Entrepreneur	Without Parents	Yes	Family Needs	Problematic
5	Student 5	IDR 3,000,000	3	Farmer	With Parents	No	Business Constraints	Problematic
6	Student 6	IDR 5,000,000	4	Private Employee	Without Parents	No	Late Sending	Problematic
7	Student 7	IDR 3,500,000	4	Private Employee	With Parents	No	Family Needs	Problematic
8	Student 8	IDR 4,000,000	2	Private Employee	Without Parents	Yes	Late Sending	Problematic
9	Student 9	IDR 1,800,000	3	Entrepreneur	With Parents	No	Family Needs	Problematic
10	Student 10	IDR 2,000,000	3	Entrepreneur	Without Parents	Yes	Business Constraints	Problematic
11	Student 11	IDR 3,000,000	2	Police	Without Parents	Yes	Late Sending	Problematic
12	Student 12	IDR 3,200,000	4	Entrepreneur	Without Parents	No	Business Constraints	Problematic
13	Student 13	IDR 5,500,000	5	Private Employee	Without Parents	Yes	Late Sending	Problematic
14	Student 14	IDR 1,000,000	2	Laborer	With Parents	No	Family Needs	Problematic
15	Student 15	IDR 2,800,000	3	Farmer	Without Parents	Yes	Late Sending	Problematic
16	Student 16	IDR 3,300,000	4	Entrepreneur	Without Parents	No	Family Needs	Problematic
17	Student 17	IDR 1,800,000	4	Laborer	Without Parents	Yes	Family Needs	Problematic
18	Student 18	IDR 4,500,000	4	Private Employee	Without Parents	No	Late Sending	Problematic
19	Student 19	IDR 3,300,000	4	Army	Without Parents	Yes	Family Needs	Problematic
20	Student 20	IDR 2,000,000	2	Entrepreneur	With Parents	No	Business Constraints	Problematic

Table 4. Samples from the Transformed Data

No	Name Student	C1	C2	C3	C4	C5	C6	Target
1	Student 1	0.4	0.7	0.2	0.9	0.9	0.8	1
2	Student 2	0.6	0.5	0.9	0.1	0.1	0.6	1
3	Student 3	0.4	0.5	0.7	0.9	0.1	0.8	1
4	Student 4	0.6	0.4	0.5	0.9	0.9	0.6	1
5	Student 5	0.4	0.5	0.9	0.1	0.1	0.4	1
6	Student 6	0.2	0.7	0.4	0.9	0.1	0.8	1
7	Student 7	0.4	0.7	0.2	0.1	0.1	0.6	1
8	Student 8	0.4	0.2	0.2	0.9	0.9	0.8	1
9	Student 9	0.6	0.5	0.5	0.1	0.1	0.6	1
10	Student 10	0.6	0.5	0.5	0.9	0.9	0.4	1
11	Student 11	0.4	0.4	0.7	0.9	0.9	0.8	1

12	Student 12	0.4	0.7	0.5	0.9	0.1	0.4	1
13	Student 13	0.2	0.9	0.2	0.9	0.9	0.8	1
14	Student 14	0.6	0.4	0.9	0.1	0.1	0.6	1
15	Student 15	0.4	0.5	0.9	0.9	0.9	0.8	1
16	Student 16	0.4	0.7	0.5	0.9	0.1	0.6	1
17	Student 17	0.6	0.7	0.9	0.9	0.9	0.6	1
18	Student 18	0.4	0.7	0.4	0.9	0.1	0.8	1
19	Student 19	0.4	0.7	0.7	0.9	0.9	0.6	1
20	Student 20	0.6	0.4	0.5	0.1	0.1	0.4	1

3.4. Artificial Neural Network Architecture Design

Neural networks used in predicting factors of tuition fee delay payment using backpropagation with feedforward learning steps. This network has three layers i.e. the input layer (input), output layer (output) and some hidden layer (hidden). The hidden layer helps the network to be able to recognize more input patterns compared to networks that do not have a hidden layer. The parameters in backpropagation network formation use 6 input variables, 1 or more hidden layers and 1 output layer. The architectural models used to get the best architecture are 6-5-1, 6-10-1, 6-5-10-1 and 6-10-5-1. Neural Network which will be built is backpropagation algorithm (backpropagation) with sigmoid activation function. The activation function in the Artificial Neural Network is used to process the calculation of the actual value of the output on the hidden layer and calculate the actual value of the output on the output layer.

3.5. Defining Output

Expected results at this stage are the detection pattern determines the best value to predict the factor of tuition fee delay payment. The test results are as follows:

a. To predict the factors of tuition fees delay payment based on the results of sample data student AMIK Tunas Bangsa. The output of this prediction is the best architectural pattern by looking at the minimum error.
b. Categorization Output training (train) and testing (test)
   The category for output is determined by the minimum error rate of the target. Restrictions on these categories are listed in the following Table 5:

Table 5. Categorization Data

No	Information	Error Minimum
1	Correct (Problematic)	0.01- 0.001
2	Wrong (No Problematic)	> 0.01

4. Results and Discussion

4.1. Artificial neural network architecture design

Artificial Neural Network architecture design for training and testing data then uses 6 input variables Namely:

C_1 = Parent Income
C_2 = Number of Siblings
C_3 = Parents Occupation
C_4 = Status of Residence
C_5 = Misuse of Money
C_6 = External Factors

The following steps will be performed in the user backpropagation algorithm with the sigmoid activation function. Stages That must be done is as follows:

a. Initialization (initialization), is the stage where the variable values will be set or defined first, such as the value of input data, weight, expected output value, learning rate and other data values.
b. Activation (activation) is a process of calculating the actual value of the output on the hidden layer and calculating the actual output value of the output layer.
c. Weight Training is the process of calculating the value of the gradient error in the output layer and calculating the value of gradient error in the hidden layer
d. Iteration is the final stage of the test, where if there is still the expected minimum error has not been found then back at the activation stage (activation).

4.2. Training and Testing for 6-5-1 model

Here are the test results of 20 test data with the 6-5-1 test pattern. Test results and Training data can be seen in the Table 6 as follows:

Table 6. Training Results and Testing by Model 6-5-1

Training						Testing				
No	Name	Target	Output	Error	SSE	Target	Output	Error	SSE	Prediction
1	Student 1	1	0.9499	0.0501	0.0025100100	1	0.9499	0.0501	0.0025100100	Incorrect
2	Student 2	1	0.9820	0.0180	0.0003240000	1	0.9820	0.0180	0.0003240000	Correct
3	Student 3	1	0.9938	0.0062	0.0000384400	1	0.9938	0.0062	0.0000384400	Correct
4	Student 4	1	0.9597	0.0403	0.0016240900	1	0.9597	0.0403	0.0016240900	Incorrect
5	Student 5	1	0.9930	0.0070	0.0000490000	1	0.9930	0.0070	0.0000490000	Correct
6	Student 6	1	0.9939	0.0061	0.0000372100	1	0.9939	0.0061	0.0000372100	Correct
7	Student 7	1	0.9846	0.0154	0.0002371600	1	0.9846	0.0154	0.0002371600	Correct
8	Student 8	1	0.9498	0.0502	0.0025200400	1	0.9498	0.0502	0.0025200400	Incorrect
9	Student 9	1	0.9618	0.0382	0.0014592400	1	0.9618	0.0382	0.0014592400	Incorrect
10	Student 10	1	0.9642	0.0358	0.0012816400	1	0.9642	0.0358	0.0012816400	Incorrect
11	Student 11	1	0.9571	0.0429	0.0018404100	1	0.9571	0.0429	0.0018404100	Incorrect
12	Student 12	1	0.9959	0.0041	0.0000168100	1	0.9959	0.0041	0.0000168100	Correct
13	Student 13	1	0.9590	0.0410	0.0016810000	1	0.9590	0.0410	0.0016810000	Incorrect
14	Student 14	1	0.9862	0.0138	0.0001904400	1	0.9862	0.0138	0.0001904400	Correct
15	Student 15	1	0.9548	0.0452	0.0020430400	1	0.9548	0.0452	0.0020430400	Incorrect
16	Student 16	1	0.9968	0.0032	0.0000102400	1	0.9968	0.0032	0.0000102400	Correct
17	Student 17	1	0.9742	0.0258	0.0006656400	1	0.9742	0.0258	0.0006656400	Incorrect
18	Student 18	1	0.9935	0.0065	0.0000422500	1	0.9935	0.0065	0.0000422500	Correct
19	Student 19	1	0.9682	0.0318	0.0010112400	1	0.9682	0.0318	0.0010112400	Incorrect
20	Student 20	1	0.9508	0.0492	0.0024206400	1	0.9508	0.0492	0.0024206400	Incorrect
				Total	0.0200025400			Total	0.0200025400	45%
				MSE	0.0010001270			MSE	0.0010001270	

4.3. Training and Testing for 6-10-1 Model

Here are the results of Testing with 20 data Testing with Testing patterns 6-10-1. Testing and Training result data can be seen in Table 7 as follows:

Table 7. Training and Testing Results with Model 6-10-1

Training						Testing				
No	Name	Target	Output	Error	SSE	Target	Output	Error	SSE	Prediction
1	Student 1	1	0.9889	0.0111	0.0001232100	1	0.9889	0.0111	0.0001232100	Correct
2	Student 2	1	0.9783	0.0217	0.0004708900	1	0.9783	0.0217	0.0004708900	Incorrect
3	Student 3	1	0.9781	0.0219	0.0004796100	1	0.9781	0.0219	0.0004796100	Incorrect
4	Student 4	1	0.9861	0.0139	0.0001932100	1	0.9861	0.0139	0.0001932100	Correct
5	Student 5	1	0.9369	0.0631	0.0039816100	1	0.9369	0.0631	0.0039816100	Incorrect
6	Student 6	1	0.9151	0.0849	0.0072080100	1	0.9151	0.0849	0.0072080100	Incorrect
7	Student 7	1	0.9928	0.0072	0.0000518400	1	0.9928	0.0072	0.0000518400	Correct
8	Student 8	1	0.9951	0.0049	0.0000240100	1	0.9951	0.0049	0.0000240100	Correct
9	Student 9	1	0.9901	0.0099	0.0000980100	1	0.9901	0.0099	0.0000980100	Correct
10	Student 10	1	0.9810	0.0190	0.0003610000	1	0.9810	0.0190	0.0003610000	Correct
11	Student 11	1	0.9924	0.0076	0.0000577600	1	0.9924	0.0076	0.0000577600	Correct
12	Student 12	1	0.9882	0.0118	0.0001392400	1	0.9882	0.0118	0.0001392400	Correct
13	Student 13	1	0.9358	0.0642	0.0041216400	1	0.9358	0.0642	0.0041216400	Incorrect
14	Student 14	1	0.9701	0.0299	0.0008940100	1	0.9701	0.0299	0.0008940100	Incorrect
15	Student 15	1	0.9860	0.0140	0.0001960000	1	0.9860	0.0140	0.0001960000	Correct
16	Student 16	1	0.9823	0.0177	0.0003132900	1	0.9823	0.0177	0.0003132900	Correct
17	Student 17	1	0.9943	0.0057	0.0000324900	1	0.9943	0.0057	0.0000324900	Correct
18	Student 18	1	0.9711	0.0289	0.0008352100	1	0.9711	0.0289	0.0008352100	Incorrect
19	Student 19	1	0.9948	0.0052	0.0000270400	1	0.9948	0.0052	0.0000270400	Correct
20	Student 20	1	0.9800	0.0200	0.0004000000	1	0.9800	0.0200	0.0004000000	Incorrect
				Total	0.0200080800			Total	0.0200080800	60%
				MSE	0.0010004040			MSE	0.0010004040	

4.4. Training and Testing for 6-5-10-1 Model

Here are the Testing results with 20 Testing data with Testing pattern 6-5-10-1. Testing and Training result data can be seen in Table 8 as follows:

Table 8. Training and Testing Results with Model 6-5-10-1

Training						Testing				
No	Name	Target	Output	Error	SSE	Target	Output	Error	SSE	Prediction
1	Student 1	1	0.9864	0.0136	0.0001849600	1	0.9864	0.0136	0.0001849600	Correct
2	Student 2	1	0.9838	0.0162	0.0002624400	1	0.9838	0.0162	0.0002624400	Correct
3	Student 3	1	0.9822	0.0178	0.0003168400	1	0.9822	0.0178	0.0003168400	Correct
4	Student 4	1	0.9851	0.0149	0.0002220100	1	0.9851	0.0149	0.0002220100	Correct
5	Student 5	1	0.9695	0.0305	0.0009302500	1	0.9895	0.0105	0.0001102500	Correct
6	Student 6	1	0.9303	0.0697	0.0048580900	1	0.9903	0.0097	0.0000940900	Correct
7	Student 7	1	0.9712	0.0288	0.0008294400	1	0.9712	0.0288	0.0008294400	Incorrect
8	Student 8	1	0.9866	0.0134	0.0001795600	1	0.9866	0.0134	0.0001795600	Correct
9	Student 9	1	0.9837	0.0163	0.0002656900	1	0.9837	0.0163	0.0002656900	Correct
10	Student 10	1	0.9812	0.0188	0.0003534400	1	0.9812	0.0188	0.0003534400	Correct
11	Student 11	1	0.9819	0.0181	0.0003276100	1	0.9819	0.0181	0.0003276100	Correct
12	Student 12	1	0.9528	0.0472	0.0022278400	1	0.9528	0.0472	0.0022278400	Incorrect
13	Student 13	1	0.9588	0.0412	0.0016974400	1	0.9588	0.0412	0.0016974400	Incorrect
14	Student 14	1	0.9831	0.0169	0.0002856100	1	0.9831	0.0169	0.0002856100	Correct
15	Student 15	1	0.9755	0.0245	0.0006002500	1	0.9955	0.0045	0.0000202500	Correct
16	Student 16	1	0.9434	0.0566	0.0032035600	1	0.9434	0.0566	0.0032035600	Incorrect
17	Student 17	1	0.9822	0.0178	0.0003168400	1	0.9822	0.0178	0.0003168400	Correct
18	Student 18	1	0.9570	0.0430	0.0018490000	1	0.9870	0.0130	0.0001690000	Correct
19	Student 19	1	0.9812	0.0188	0.0003534400	1	0.9812	0.0188	0.0003534400	Correct
20	Student 20	1	0.9728	0.0272	0.0007398400	1	0.9728	0.0272	0.0007398400	Correct
				Total	0.0200041500			Total	0.0121601500	80%
				MSE	0.0010002075			MSE	0.0006080075	

4.5. Training and Testing for 6-10-5-1 Model

Here are the results of Testing with 20 data Testing with Testing pattern 6-10-5-1. Testing and Training result data can be seen in Table as follows:

Table 9. Training and Testing Results with Model 6-10-5-1

Training						Testing				
No	Name	Target	Output	Error	SSE	Target	Output	Error	SSE	Prediction
1	Student 1	1	0.9845	0.0155	0.0002402500	1	0.9845	0.0155	0.0002402500	Correct
2	Student 2	1	0.9585	0.0415	0.0017222500	1	0.9585	0.0415	0.0017222500	Incorrect
3	Student 3	1	0.9614	0.0386	0.0014899600	1	0.9614	0.0386	0.0014899600	Incorrect
4	Student 4	1	0.9761	0.0239	0.0005712100	1	0.9761	0.0239	0.0005712100	Incorrect
5	Student 5	1	0.9557	0.0443	0.0019624900	1	0.9557	0.0443	0.0019624900	Incorrect
6	Student 6	1	0.9839	0.0161	0.0002592100	1	0.9839	0.0161	0.0002592100	Correct
7	Student 7	1	0.9680	0.0320	0.0010240000	1	0.9680	0.0320	0.0010240000	Incorrect
8	Student 8	1	0.9625	0.0375	0.0014062500	1	0.9625	0.0375	0.0014062500	Incorrect
9	Student 9	1	0.9556	0.0444	0.0019713600	1	0.9556	0.0444	0.0019713600	Incorrect
10	Student 10	1	0.9881	0.0119	0.0001416100	1	0.9881	0.0119	0.0001416100	Correct
11	Student 11	1	0.9658	0.0342	0.0011696400	1	0.9658	0.0342	0.0011696400	Incorrect
12	Student 12	1	0.9963	0.0037	0.0000136900	1	0.9963	0.0037	0.0000136900	Correct
13	Student 13	1	0.9869	0.0131	0.0001716100	1	0.9869	0.0131	0.0001716100	Correct
14	Student 14	1	0.9573	0.0427	0.0018232900	1	0.9573	0.0427	0.0018232900	Incorrect
15	Student 15	1	0.9675	0.0325	0.0010562500	1	0.9675	0.0325	0.0010562500	Incorrect
16	Student 16	1	0.9951	0.0049	0.0000240100	1	0.9951	0.0049	0.0000240100	Correct
17	Student 17	1	0.9899	0.0101	0.0001020100	1	0.9899	0.0101	0.0001020100	Correct
18	Student 18	1	0.9894	0.0106	0.0001123600	1	0.9894	0.0106	0.0001123600	Correct
19	Student 19	1	0.9922	0.0078	0.0000608400	1	0.9922	0.0078	0.0000608400	Correct
20	Student 20	1	0.9316	0.0684	0.0046785600	1	0.9316	0.0684	0.0046785600	Incorrect
				Total	0.0200008500			Total	0.0200008500	45%
				MSE	0.0010000425			MSE	0.0010000425	

4.6. Selection of Best Architecture of Artificial Neural Networks

The results of running Matlab software version 6.1 used for all architectural models i.e. 6-5-1, 6-10-1, 6-5-10-1 and 6-10-5-1 are obtained the best architectural pattern. From this pattern will be used to predict the factor of tuition fee delay payment problem. Assessment of the best architectural model is seen from several aspects such as epoch, minimum error, and Accuracy of truth. For more details, the results summary can be seen in the following Table 10.

Table 10. Summary of Results for all Architectural Model

	6-5-1	6-10-1	6-5-10-1	6-10-5-1
Epochs	6470	5194	3457	5943
MSE	0.0010001270	0.0010004040	0.0010002075	0.0010000425
Accuracy	45%	60%	80%	45%

From Table 10, it can be seen that the best architectural model that will be used to perform Prediction of a series of model trials is 6-5-10-1 with respected epoch 3457, MSE 0.0010002075 and 80% accuracy rate.

5. Conclusion

This study has presented artificial neural networks using Backpropagation model in predicting factors causing tuition fees payment problems. It can be concluded that ANN method has adaptive nature that is network trying to achieve stability again to achieve expected result. This is due to the learning process by adjusting the weight of the connection. Four different architectural models i.e. 6-5-1, 6-10-1, 6-5-10-1 and 6-10-5-1 has been employed for training and testing. From 4 architecture models, it is concluded

that the best architectural model is achieved for 6-5-10-1 with Mean Square Error (MSE) 0.0010002075 and accuracy of 80%. It is expected that this architectural model can be used to predict the factors of tuition delay payment problem in other higher learning institutions.

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