Designing Decision Support System for Scholarship Prediction Using Adaptive Neuro Fuzzy Inference System Algorithm

To cite this article: A Pujianto et al 2018 J. Phys.: Conf. Ser. 1140 012049

View the article online for updates and enhancements.
Designing Decision Support System for Scholarship Prediction Using Adaptive Neuro Fuzzy Inference System Algorithm

A Pujianto¹, Kusrini² and A Sunyoto³

¹,²,³ Magister of Informatics Engineering Universitas Amikom Yogyakarta, Jl. Ring Road Utara, Condong Catur, Depok Sleman, Yogyakarta 55281, Indonesia.

E-mail: adepujianto@gmail.com

Abstract. The increasing enthusiasm of students applying for scholarships caused the selection committee to experience difficulties in the decision-making process, the large and complex amount of data caused the committee to need a system that could assist in the decision making process. One method in the system that can help in decision making is artificial neural networks. This method is capable of reasoning like the human brain's brain network to solve a problem into a form of neurons or equations as a basis for determining a solution or prediction. Researchers have done the method of artificial neural network using the Backpropagation method with an accuracy of 0.9090 and MAE 0.0001017 on the epoch to 329. Based on these results the researchers want to make improvements using a new method, namely adaptive neuro fuzzy inference system (ANFIS) and yields an accuracy value of 92.04% and Mean Absolute Error (MAE) of 0.0001001 on the epoch to 318. The test results were obtained using 3000 data through the K-3 Fold Validation test and 0.2 learning rate configuration and 0.2 momentum.

1. Introduction

AMIKOM University Yogyakarta is one private university that provides several scholarship programs such as the Bidikmisi scholarship, academic achievement enhancement, Academic Achievement Improvement Education Assistance, Extra Curricular Achievement Scholarship Scholarships, Muamalat Scholarships, and Hafiz Quran Muamalat, Department of Education and Sports Event Scholarships. These scholarship programs are held once a year with the aim of alleviating student studies [1].

Academic achievement enhancement is one of the scholarships that most attracts students to apply for the scholarship. In addition to easy registration requirements such as the Grade Point Average (GPA), credit of number, scholarship status, and parent income, the quota provided for this scholarship is in the range of 210 students and increases for each year [2].

The PPA scholarship registration mechanism itself starts from the stage of filling out the registration form which can be downloaded through the Amikom website, then the applicant candidates fill in the registration form and other requirements into a proposal form to the Badan Eksekutif Mahasiswa (BEM) to check the completeness and format of the proposal, after the checking process is finished next the file will be forwarded to student affairs and then forwarded to Kopertis region V for admission selection.

The selection process of determining the scholarship recipient candidates still delves into the obstacles in the decision making process, an assessment process that is not always decided based on a definite
calculation such as subjective selection of the selection committee causing inaccuracy of the decisions that have been made [3]. Another factor such as a large number of registrant data causes decision makers to need a system to help carry out the selection process and reduce subjectivity in decision making [4].

The system to be created must be able to assist in predicting scholarship candidates with data that is complex, analytical, logical and structured [5]. One such analytical tool is a predictive model (predictive model) which allows making quick predictions for complex problems [6].

To solve complex problems, you can use an artificial neural network model where this model adopts the ability of the human brain that is able to stimulate input, process, and provide output. Output comes from stimulation of input and processes that occur in the human brain. The ability of humans to process information is the result of the complexity of the process in the brain [7]. The ability of the calculation model of human brain reasoning is an advantage in the world of science, especially in predicting certain things [8].

The study uses artificial neural networks that have been conducted by researchers using artificial neural network methods with backpropagation. This study aims to predict student scholarship acceptance using artificial neural network methods. This research resulted in accuracy testing values of 90.00% and Mean Absolute Error (MAE) at a value of 0.000101 obtained at the 329th epoch using the learning rate configuration of 0.2 and momentum of 0.2 [9].

Furthermore, this study will apply artificial neural networks using the adaptive neuro fuzzy inference system (ANFIS) method to be able to optimize the results of previous research. The test model that will be used is to compare the results of previous studies using the same data and configuration to find the results of comparative analysis between the two algorithm models that have been applied.

2. Methodology

2.1. Methodology
The research method used in this study adapts from the previous research namely the experimental method, where this method will describe the process or flow of research on the system from data processing to produce conclusions. The difference in the process with the previous method is the application of the Adaptive neuro fuzzy inference system (ANFIS) algorithm and the addition of the comparison process at the end of the process becomes as follows: Data, the process by which data is collected; Cleaning & Integration, the process by which data will be cleaned and integrated into the system; Selection & Transformation, data selection process and data configuration that has been integrated in the system; Adaptive neuro fuzzy inference system (ANFIS) Training, a process where initialization of determinant variables such as Learning Rate, Momentum, and hidden layers is determined and the calculation and classification process will be carried out; Cross Validation & Test, the process by which the results of the ANFIS process will be validated and tested; Result & Comparison, the final research process in the form of test results and comparison with the results of previous studies [9].

2.2. Data Analisys
The data that will be used in this study is the data of students who register for scholarships, the data obtained in previous research through the results of observation, interviews, and documentation tracking with Amikom student affairs to find parameters (attributes) that have been determined Kopertis region V, namely: GPA (Grade Point Average), number of credits, status, income of parents. The value of each
parameter can be seen in Table 1. The data that will be used for the dataset is the scholarship recipient data obtained from previous research from 2012-2017 with 3000 data. Both data will be ANFIS input to perform calculations to find the results of accuracy and error values to then compare the results with previous studies.

**Table 1. Data Attribute Value**

| No | Atribut       | Value                                      |
|----|---------------|--------------------------------------------|
| 1  | GPA           | (3 - 3,25); (3,26 - 3,5); (3,6 - 3,75); (3,76 - 4) |
| 2  | Number of Credit | (<24); (24-72); (73-120); (>120)          |
| 3  | Status        | ‘Extend; ‘New’                              |
| 4  | Income Parents | (<2,5M); (>2,5M-3,5M); (>3,5M-5M); (>5M)   |

The value of each parameter in Table 1 will be configured or converted to a weight with values ranging from 0 to 1 as shown in Table 2. The method of determining a weight for each parameter is done manually by the student side by assigning values to the parameters according to the values in the old system, by determining the configuration value as in Table 2.

**Table 2. Data Attribute Conversion Values**

| No | Atribut       | Value                  | Weight |
|----|---------------|------------------------|--------|
| 1  | GPA           | (3 - 3.25)             | 0,3    |
|    |               | (3.26 - 3.5)           | 0,5    |
|    |               | (3.6 - 3.75)           | 0,7    |
|    |               | (3.76 - 4)             | 0,9    |
|    |               | (<24)                  | 0,8    |
| 2  | Number of Credit | (24 - 72)            | 0,7    |
|    |               | (73 - 120)             | 0,6    |
|    |               | (>120)                 | 0,5    |
| 3  | Status        | Extend                 | 0,6    |
|    |               | New                    | 0,8    |
|    |               | (<2,5jt)               | 0,8    |
|    |               | (>2,5jt -3,5jt)        | 0,6    |
|    | Income Parents | (>3,5jt -5jt)         | 0,4    |
|    |               | (>5jt)                 | 0,2    |
After the value conversion process in each attribute, the next result of the conversion value in Table 2 will be implemented into a dataset from scholarship applicants that have been entered into the system and obtained results as in Table 3.

**Table 3. Example of Dataset Conversion**

| No | Name | x1  | x2  | x3  | x4  |
|----|------|-----|-----|-----|-----|
| 1  | M1   | 0,9 | 0,8 | 0,6 | 0,8 |
| 2  | M2   | 0,7 | 0,8 | 0,8 | 0,8 |
| 3  | M3   | 0,7 | 0,8 | 0,8 | 0,4 |
| 4  | M4   | 0,3 | 0,5 | 0,8 | 0,2 |
| 5  | M5   | 0,9 | 0,8 | 0,8 | 0,8 |

Description: x1 = GPA, x2 = Number of Credit, x3 = Status, x4 = Income of Parents

### 2.3 Algorithm Model Analysis

At this stage, an analysis of the model will be conducted to find the best accuracy and MAE values. Model analysis is done by making ANFIS with the configuration as shown in Figure 1:

![Figure 1. Anfis Architecture](image)

In Figure 4 there are two types of vertices, namely the adaptive node (denoted by the box) and non-adaptive (looped loop). Has 5 layers, each has a function that represents the fuzzy Takagi-Sugeno-Kang method. Case examples with the application of the ANFIS method can be seen in Table 4. The case will be calculated through layers 1 through layer 5 to get results as in Table 5.

**Table 4. ANFIS Case Examples**

| Name | x1  | x2  | x3  | x4  | d  |
|------|-----|-----|-----|-----|----|
| M1   | 0,9 | 0,8 | 0,6 | 0,8 | 1  |
| M2   | 0,3 | 0,5 | 0,8 | 0,3 | 0  |
| M3   | 0,7 | 0,8 | 0,8 | 0,4 | 1  |
Description: \( x_1 = \text{GPA}, x_2 = \text{SKS}, x_3 = \text{Status}, x_4 = \text{Income of Parents}, d = \text{destination} \)

Layer 1: Is an adaptive layer, with a membership function of data on the set or group that is formed. The degree of membership is a value of the membership function of a data for each set, the value of the degree of membership has a scale of 0 to 1. This study will use the generalized bell equation to calculate the degree of membership. The formula used in layer 1 as in equation (1).

\[
Gbell(x, a, b, c) = \frac{1}{1 + 3 / (x - c)/a/3^2b} \tag{1}
\]

Gbell has 3 parameters, namely parameters \( a, b \) and \( c \) where each set has different parameters. For initialization of the three parameters will be determined based on the data.

Layer 2: This layer is a nonadaptive layer, is an activation function of the existing rules. The number of nodes in this section will correspond to the total rules that are formed where the total rules will be as many as the number of classes available. In this section, all degrees of membership will be combined using the T-Norm equation according to each set. The formula used in layer 2 as in equation (2).

\[
W_i = A_i(X), B_i(Y) i = i - \text{set} \tag{2}
\]

Layer 3: This layer is a layer that normalizes the value of the activation level before it. The formula used in layer 3 as in equation (3).

\[
\bar{W}_i = \frac{W_i}{\sum_{i=0}^{n} W_i} \tag{3}
\]

Layer 4: Layer 4 is a nonadaptive layer, which is the consequent part of a fuzzy rule. At this layer there are weights, the number of parameters weights will be as much (number of inputs + 1), for initial initialization, the parameter values are taken from the data randomly. The formula used in layer 4 as in equation (4).

\[
\bar{W}(i) f_i = W_i'(P_iX + Q_iY + r_i) i - \text{set} \tag{4}
\]

Layer 5: This layer is a layer that functions to sum up all outputs obtained from layer 4 with output values between 0 and 1. This process is also called the defuzzification process. The formula used in layer 5 as in equation (5).

\[
i = \sum_{i=0}^{c} \bar{W}(i) f_i \tag{5}
\]

After passing through the 5 layers that have been made, the results of the case examples are shown in Table 5.
| Name | z-target | z-output | Error     |
|------|----------|----------|-----------|
| M1   | 1        | 1        | 0.0001009 |
| M2   | 0        | 0        | 0.0001011 |

Table 5. Hasil Kasus ANFIS

2.4. Information Analysis

At this stage, information analysis will be carried out based on the results of data analysis in the previous stage. The output generated from this system is in the form of a "Received" and "Rejected" decision to apply for a scholarship based on the parameters that have been determined, where the results are obtained through the testing mechanism using ANFIS. In addition to the "Accepted" and "Rejected" decisions, this ANFIS output is the result of accuracy, MAE, and Epoch to be used as performance benchmarks with previous research through the application of Backpropagation. The output of information in this study can be seen in Figure 2 and Table 6.

![Anfis Prediction Results](image)

Figure 2. Anfis Prediction Results

3. Result and Discussion

The test results in the study adopted a test scenario in the previous research, using K-Fold Cross-Validation with K-3 configuration, the test was done by dividing the existing 3000 data into 2 parts, namely 2000 data for training and 1000 data for testing conducted as 3 or 3 folds.

To accelerate and optimize the test results, the researcher also added the learning rate configuration and momentum at the end of the implementation of the algorithm model with a configuration value of 0.2 and 0.8 for the learning rate and a combination of 0.2 and 0.8 for momentum, rate and momentum in previous research.

The comparison results of the two algorithms can be seen as in Table 6 and the graph of the results can be seen in Figure 3.
Table 6. Comparative Research Results

| No | Algorithm | K-Fold | Learning Rate | Momentum | Accuracy | MAE       | Epoch |
|----|-----------|--------|---------------|----------|----------|-----------|-------|
| 1  | Backpropagation | K1     | 0.2           | 0.2      | 0.9032   | 0.0001060 | 276   |
|    |           |        | 0.8           | 0.2      | 0.9049   | 0.0001082 | 271   |
|    |           |        | 0.8           | 0.8      | 0.9065   | 0.0001101 | 268   |
|    |           |        | 0.2           | 0.2      | 0.9056   | 0.0001032 | 296   |
|    |           | K2     | 0.2           | 0.8      | 0.9041   | 0.0001048 | 292   |
|    |           |        | 0.8           | 0.2      | 0.9040   | 0.0001049 | 293   |
|    |           |        | 0.8           | 0.8      | 0.9031   | 0.0001062 | 288   |
|    |           |        | 0.2           | 0.2      | 0.9090   | 0.0001017 | 329   |
|    |           | K3     | 0.2           | 0.8      | 0.9069   | 0.0001033 | 327   |
|    |           |        | 0.8           | 0.2      | 0.9066   | 0.0001035 | 327   |
|    |           |        | 0.8           | 0.8      | 0.9058   | 0.0001049 | 324   |
|    |           |        | 0.2           | 0.2      | 0.9154   | 0.0001041 | 267   |
| 2  | ANFIS     | K1     | 0.2           | 0.8      | 0.9138   | 0.0001058 | 264   |
|    |           |        | 0.8           | 0.2      | 0.9139   | 0.0001057 | 264   |
|    |           |        | 0.8           | 0.8      | 0.9119   | 0.0001065 | 261   |
|    |           |        | 0.2           | 0.2      | 0.9182   | 0.0001020 | 285   |
|    |           | K2     | 0.2           | 0.8      | 0.9171   | 0.0001034 | 280   |
|    |           |        | 0.8           | 0.2      | 0.9172   | 0.0001035 | 282   |
|    |           |        | 0.8           | 0.8      | 0.9153   | 0.0001042 | 269   |
|    |           |        | 0.2           | 0.2      | 0.9204   | 0.0001009 | 318   |
|    |           | K3     | 0.2           | 0.8      | 0.9198   | 0.0001012 | 310   |
|    |           |        | 0.8           | 0.2      | 0.9197   | 0.0001013 | 312   |
|    |           |        | 0.8           | 0.8      | 0.9178   | 0.0001021 | 308   |

The test results in Table 4 explain that the testing using the Backpropagation algorithm model gets the highest performance value in the K-3 experiment through a learning rate configuration of 0.2 and a momentum of 0.2 with an accuracy value of 0.9090 and MAE 0.0001017 at the 329th epoch While the ANFIS algorithm model gets the highest performance value in the K-3 experiment through a learning rate configuration of 0.2 and 0.2 momentum with an accuracy value of 0.9204 and MAE 0.0001009 on the 318 epoch. Graphs of the comparison results can be seen in Figure 2.

![Figure 3. Graph of Comparison](image-url)
4. Conclusion

Based on the results of the study, it was successfully carried out the design of a decision support system for the prediction of scholarship recipients using the Adaptive Neuro Fuzzy Inference System (ANFIS) algorithm model. In this system produces the highest accuracy value of 92.00%, MAE error value of 0.0001009 and is obtained at the 318th epoch is higher if compared with the previous research namely Backpropagation with the highest accuracy value of 90.90%, MAE error value of 0.0001017 and obtained at the 329th epoch.

5. References

[1] N R Alfie, E Pujastuti & Henderi 2013 “Perancangan Model Sistem Pendukung Keputusan Penentuan Mahasiswa Penerima Beasiswa” (Seminar National Information and Multimedia Technology) pp 09-19
[2] Norhikmah Rumini & Henderi 2013 “Metode Fuzzy Ahp Dan Ahp Dalam Penerapan Sistem Pendukung Keputusan” (Seminar Nasional Teknologi Informasi dan Multimedia) pp 09-32
[3] M Munir 2012 “Pengaruh Kemampuan Interlektual, Pembelajaran Individual dan Internal Locus of Control Terhadap Kompetensi dan Kinerja Dosen” (Journal Of Economics And Business Airlangga) pp 91-105
[4] U Pramudi 2011 “Analisis Kontribusi Pemberian Beasiswa Terhadap Peningkatan Prestasi Akademik Mahasiswa Fakultas Teknik Universitas Negeri Yogyakarta” (Jurnal Pendidikan dan Teknologi) vol 20 No 1 ISSN 0854-4735 & E-ISSN 2477-2410
[5] Kunartinah 2010 “Pengaruh pendidikan dan pe latihan, pembelajaran organisasi terhadap kinerja dengan kompetensi sebagai mediasi” (Jurnal Bisnis dan Ekonomi (JBE)) vol 17(1) pp 74-84
[6] N Asep & R Dewi R 2017 “Prediction Student Graduation on Time Using Artificial Neural Network on Data Mining Students STMIK Widya Cipta Dharma Samarinda” (Proceedings of the 2017 International Conference on E-commerce, E-Business and E-Government) pp. 86-89
[7] I Rizianiza and A S Aisjah 2015 ”Prediction of Significant Wave Height in The Java Sea Using Artificial Neural Network” (International Seminar on Intelligent Technology and Its Applications (ISITIA)) pp 41-49
[8] M M Munir, M A Fauzi and R S Perdana 2018”Implementasi Metode Backpropagation Neural Network berbasis Lexicon Based Features dan Bag of Words Untuk Identifikasi Ujaran Kebencian Pada Twitter” (Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer) vol 2(10) pp 3182-3191
[9] A Pujianto, Kusrini & A Sunyoto 2018 “Perancangan Sistem Pendukung Keputusan Untuk Prediksi Penerima Beasiswa Menggunakan Metode Neural Network Backpropagation” (Jurnal Teknologi Informasi dan Ilmu Komputer (JTIIK)) vol 5(2) pp 157-168