Implementation of Neural Network to determine the New College Students

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Implementation of Neural Network to determine the New College Students

R E Putra*, A I Nurhidayat and A Y Wicaksono

Department of Informatics Engineering, Universitas Negeri Surabaya, Ketintang, Surabaya, Indonesia.

*rickyeka25@yahoo.com

Abstract. One of new student admission pathways at Universitas Negeri Surabaya (Unesa) is through the Indonesian National Public University Admission. This path is quite favourable for academic or vocational high school students who want to study at Unesa so that the number of participants for this selection program can reach up to ten thousand people every year. The large number of applicants makes the selection process more complex. Meanwhile, Unesa still uses the concept of weighting criteria in determining the result. One of the constraints in weighting process is the absence of optimal pattern or weight. This paper discusses a supervised learning approach to make determining process pattern which replaces manual weighting criteria. The supervised learning method used in this research was the Neural Network with multilayer perceptron. This research showed sufficient result which can be seen from the high accuracy rate (89.56%). The accuracy rate is enough to decide which participants who pass or fail the national admission. This system can be used as a prediction for the following years.

1. Introduction

Indonesian National Public University Admission System is one of admissions pathways that is conducted annually by most Indonesian public universities. The admission requirements depend on students’ achievement in high school. Universitas Negeri Surabaya (Unesa) is one of the universities which applies this form of admission process. The number of applicants usually reaches tens of thousands of people and the number continues to grow every year because this admission pathway is favoured by academic and vocational high school students who want to continue their study at Unesa. From the data taken in 2016, the number of applicants reached 30665. Since there are more applicants, there are more data that should be processed. Currently, Unesa still selects applicants by weighting mechanism. The selection criteria are evaluated through applicants’ school grades and individual achievements. One of the constraints of weighting process is the absence of an optimal pattern or weight in determining applicants’ final result. More data is evaluated since there are more people applied and more selection criteria determined. It is too difficult to be processed manually. Processing data is the biggest challenge in educational institution. Because it is a big challenge, a good mechanism to manage and process the data is required so that the result is in accordance with the principle of admissions system.

Managing and processing a large amount of data has been one of the focus in some research. The suitable method to overcome this challenge has been studied. Before using machine learning, there were some methods used such as rule and weighting. [1] and [2] conducted rule mining, and weighting
was studied by [3]. The results of the studies were below standard because the researchers found many factors affecting the result. Studies about factors affecting admission selection criteria had been conducted in many countries such as Malaysia [4], Russia [5], Pakistan [6], Columbia [7], and Nigeria [8]. Since there are many factors affecting the result, manual rule mining or weighting is not sufficient. It will contribute more problems to the researchers as the data is multiplied in number every year. Therefore, a better method for data mining is required. One of the example is the research [9] using Naive Bayes Method for Graduation Predictions (Case Study: New Undergraduate Student Data). Another example is research [10] that uses Decision Tree to determine the possibility of new student entry at a private collage. Other research [11] also uses decision tree with simple cart algorithm and there is a research [12] that used C4.5 algorithms for predicting university admission. Another research [13] uses the SVM method for admission in a Chinese college. With the increasing popularity of Neural Network, many researchers such as [14], [15], [16], and [17] implemented this method and the result were sufficient. However, the factor being evaluated in this research was only students’ grade.

To solve data dimension challenge, an automated admission system which has minimum human intervention and short running period is required. This paper proposes an approach in making the pattern of determining process. The approach used is through a supervised learning namely Neural network with multilayer perceptron.

2. Neural network

Multi-Layer Perceptron (MLP) is one of the Neural Network architectures that has one or more layers located between the input layer and the output layer. In other words, this architecture has one or more hidden layers. In general, there is a layer of weights which lies between two adjacent layers. This multi-layered network can solve more difficult problems than a single layer. However, the learning is more complicated. In many cases, multiple layers’ network learning is better in solving problems. The diagram of Neural Network with multiple layers can be seen in Figure 1.

![Diagram of Neural Network](image)

**Figure 1.** Multi layered neural network.

MLP is a feedforward neural network which has a supervised learning system. Examples of responses are needed to be included into the network and they need to be recognized. As like any other Artificial Neural Network technique (supervised learning), MLP learns to transform data input in such a way to produce the desired output or response. MLP is notoriously reliable because the learning process can be directed. The algorithm learning is conducted by updating the backpropagation. Optimal weighting will lead to a proper classification results. MLP Neural Networks is widely used for the classification of application in the areas of parameter estimation, document analysis and recognition, finance, manufacturing, and data mining.
3. Methods
This research used data from national admission at Unesa between the year 2016 and 2017. For implementation, WEKA [18] is used as the classification software library using Multilayer Perceptron class.

3.1. Dataset detail
Both datasets consist of two classes, which are passed and fail with 9 features from the applicant’s data which includes school grades and individual achievement values. The 2016 data has 30665 applicants and the 2017 data has 21731 applicants that the applicants set Unesa as their first choice or second choice in national admission system.

Before data training, the data is divided into two categories: training data and testing data. Training data will be used for networking training and testing data will be used once the network training has been done. The data used for training data is the admission data at Unesa in the year 2016. The 2017 admission data is used as testing data. The aim is to evaluate whether the data from previous year can recognize certain patterns which were not previously learned. Another aim is to for the system to be able to predict next year’s admission result. Both datasets consist of two classes. There are 9 features in the criteria including school grades and students’ achievement. The 2016 data consists of 30665 applicants and 2017 data consists of 21731 applicants. All applicants choose Unesa as their first or second choice when filling in the national admission system.

3.2. Neural network architecture
The important stage before starting data training is designing neural network architecture. The principals of neural network architecture are: the number of neuron in the layer, the number of layers and the pattern of each layer.

Based on neural network architecture which uses backpropagation, this study only uses one neural network multilayer perceptron with a single hidden layer. It has 11 neurons in the hidden layer which produces $9 - 11 - 2$ neurons pattern each layer. This means 9 neurons are for input data and 2 neurons are as the target or the output. The architecture can be seen in Figure 2. Several learning rate and momentum are tested to choose which configuration produces the best result to the proposed method.

Figure 2. Proposed neural network architecture.
3.3. *Training process*

The purpose of the training process in neural network is to adjust the weighting factor. This should be done in order to get the desired weight. This study adopted backpropagation approach to update the weight. Moreover, there are several steps in backpropagation training, they are:

1. The initial weight initialization.
2. Forwarding propagation steps in order to find errors. This step uses activation function such as Sigmoid function:
   \[ f(x) = \frac{1}{1 + e^{-x}} \]
3. Backward propagation is a training process of weighting value of an artificial neural network. This is carried out by decreasing total error system in the entire data through weighting correction using gradient descent method.

3.4. *Testing process*

The purpose of process testing in neural network is to detect whether trained network is capable of recognizing certain patterns. There are several approaches used to evaluate the trained network in this study:

1. Classification Accuracy. Accuracy is defined as the percentage of correct prediction.
2. Cohen’s kappa coefficient. Kappa is a statistic that measure interrater agreement for qualitative/categorical items. It is generally considered to be more robust than the simple percent agreement calculation, because \( \kappa \) takes into account the possibility that the agreement would occur by chance.

4. *Results and discussion*

The results (Table 1) below present the steps that show how to get the best learning and momentum in order to get the best result in evaluation process. The 2016 dataset is used as the training data and tests the trained model of 2017 dataset.

It can be seen from Table 1 that the 3 biggest value in accuracy were chosen to be the model of the proposed method. Then the 3 values were checked in Cohen’s kappa statistic coefficient. 2 out of 3 values were below standard. Kappa statistic for leaning rate 0.5 and momentum 0.9 is 0.0293. Learning rate 0.9 and momentum 0.9 is 0, a model which tends to fail applicants. The best kappa statistic between those 3 is obtained using learning rate 0.7 and momentum 0.9. The value of kappa statistic is 0.1161. This model has 93% classification accuracy for training data and 89.56% for testing data. These percentage shows the advantages of this model. This model is also suitable for predicting applicants’ outcomes.
Table 1. Training and testing result.

| LR  | Momentum | Accuracy (%) | LR  | Momentum | Accuracy (%) |
|-----|----------|--------------|-----|----------|--------------|
| 0.1 | 0.1      | 78.23        | 0.5 | 0.7      | 78.00        |
| 0.1 | 0.3      | 80.56        | 0.5 | 0.9      | **91.06**    |
| 0.1 | 0.5      | 79.27        | 0.7 | 0.1      | 80.09        |
| 0.1 | 0.7      | 80.22        | 0.7 | 0.3      | 82.60        |
| 0.1 | 0.9      | 79.56        | 0.7 | 0.5      | 82.89        |
| 0.3 | 0.1      | 80.01        | 0.7 | 0.7      | 79.40        |
| 0.3 | 0.3      | 80.51        | 0.7 | 0.9      | **89.56**    |
| 0.3 | 0.5      | 78.75        | 0.9 | 0.1      | 82.55        |
| 0.3 | 0.7      | 77.97        | 0.9 | 0.3      | 81.49        |
| 0.3 | 0.9      | 77.69        | 0.9 | 0.5      | 79.30        |
| 0.5 | 0.1      | 78.02        | 0.9 | 0.7      | 78.71        |
| 0.5 | 0.3      | 81.13        | 0.9 | 0.9      | **91.02**    |

5. Conclusion

Neural Network (NN) is a good machine-learning model. MLP is one of the most popular methods. This study proposes MLP NN to predict new students. First, data features were determined. The 2016 data is for data training, and 2017 data is for data testing.

From this study, we selected the MLP architecture using 11 neurons in the hidden layer, learning rate 0.7, and momentum 0.9. Finally, the accuracy obtained from this research is 89.59% with kappa statistic 0.1161. Our future research will focus on the use of convolutional neural network. This future study should be a study of comparison between classification methods which are shown in this research.

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