

Introduction to questionnaire data patterns using Perceptron Algorithm for lecturer improvement and development in higher education

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Abstract

This artificial neural network research article aimed to overview the current teaching process focusing on lecturer performance using the perceptron algorithm, improving the teaching process, developing the lecturer based on the perceptron algorithm's results, evaluating the speed and accuracy of the perceptron algorithm in evaluating performance lecturer and learning the rules of the perceptron algorithm in processing assessment criteria for lecturers in tertiary institutions. In this case, the perceptron algorithm was used to recognize the questionnaire data input patterns. The perceptron algorithm was trained and tested to recognize input data patterns so that this neural network could identify input data patterns from questionnaire data.

Keywords: Artificial Neural Networks, Perceptron Algorithms, Input Patterns

1. Introduction

The lecturers' quality in carrying out lecture activities at higher education institutions can be measured by evaluating each semester's lecturers' performance. This activity is measured by distributing questionnaires to all students who are taking classes to fill in the questionnaires for all lecturers that are filled in the student's study plan cards. This questionnaire was filled out manually without using a computer application, but using a questionnaire sheet, and it will be collected to determine the lecturer's performance. Furthermore, the questionnaire's collected data was also used to decide the most favorite and discipline lecturers. There are several problems that arise in this study; firstly, it takes a long time to input the data, secondly the complexity of the combination of student number and the course taken, and then there are still errors found in the evaluation results of lecturers in calculating their weight values where the lecturers who do not teach in all classes will get a low probability of weighting scores. Therefore, applying artificial intelligence in processing data from lecturers' questionnaires in tertiary institutions will be the solution for this matter.

Artificial intelligence or artificial neural network technology is currently developing since Warren Culloch, and Walter Pits introduced this system in 1943. This artificial intelligence can solve problems based on the information through the neural network to provide a solution to solve problems. This artificial intelligence has the same characteristic as a network of nerve cells in the human brain, which has the specific ability to learn, think and make decisions. Perceptron is an artificial intelligence algorithm that is systematic and structured with a supervised learning method [1][2].

In previous research, artificial intelligence or artificial neural networks was applied using the perceptron algorithm to analyze character shapes. Perceptron that has been trained can well-recognize the characters' profile [2]. Artificial intelligence was also used to recognize agricultural irrigation systems' flow patterns [4]. Besides, perceptron algorithm research was also applied to identify a specific pattern in some cases. For instance, it was used to recognize the corroded materials to determine the materials used in the construction of nuclear installations, recognition of alphabetic patterns, recognition of facial shapes, and many more recognizable patterns [2][3][4]. Nowadays, Artificial Neural Network applications have spread to many fields, for instance, in aircraft control systems, fault detection, flight path simulation, automotive, and others. Pattern recognition has been developed into more complex systems such as fingerprint, face recognition, and many more [5][6]. Based on the described problems, it is necessary to employ the perceptron method to determine the right and fast decision to evaluate the lecturers' performance.

2. Method

2.1. Research Framework

The methodology describes research activities in the form of a sequential framework starting from data collection, goal setting, literature used, data analysis, data processing, and discussion of results. The sequence of these research activities can be seen in Figure 1.

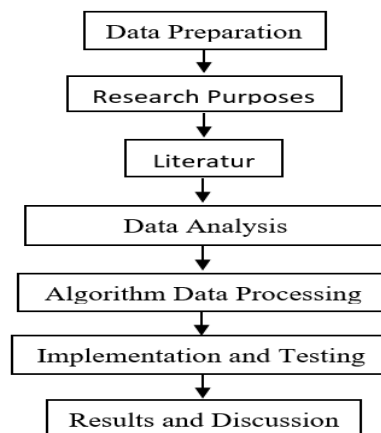


Figure 1. Research Framework

2.2 Artificial Neural Network (ANN)

Artificial neural networks have the same structural model as human neural networks, particularly the human brain neural networks. The nerves of the human brain have interconnected network parts and have the ability to solve problems based on the information they process. An artificial neural network is a processing unit in which the architecture and operations are inspired based on the human nervous system[4]. The structure of the artificial neural network can be seen in Figure 2.

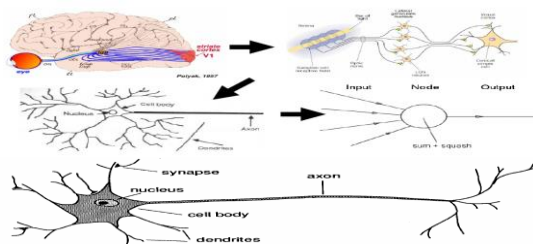


Figure 2. Structure of an artificial neural network

ANN is a mathematical model inspired by how human biological neural information processing is used to solve problems. ANN is implemented in many fields, such as pattern classification, functional approach, forecasting, control, data analysis, data compression, categorization, and forecasting [3]. Unlike the Artificial Intelligence approach in general, which attempts to model how humans think, the ANN approach seeks to model how humans physically process information by modeling human nerve cells' workings. The ANN approach argues that intelligence can arise from several interconnected process elements concerning human neurons and brains, each performing a simple computation process. The ANN's Knowledge is contained in the weights of the relationship between elements and each element's activation value [5,6].

2.3 Knots

An ANN node is the smallest computational element. The node receives an input signal that has a weight effect according to the signal traverses' relationship through the connection connected to it. The node's signal value depends on the ratio between the number of signal values and the activation limit that the node has. The activation limit of a node can be discrete (0 and 1) or continuous in a range (e.g., along [0,1], depending on the node's activation function.

2. 4 Activation functions

Some of the activation functions used by the artificial neural network are

2.4.1. Linear activation function

$$f(x) = x \text{ for all } x \tag{Eq. 1}$$

The graph of the linear activation function can be seen in Figure 3.

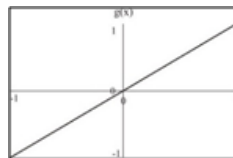


Figure 3. Graph of Linear Activation Functions

2.4.2. Binary step / binary step function

$$f(x) = \begin{cases} 1 & \text{jika } x \geq \theta \\ 0 & \text{jika } x < \theta \end{cases} \tag{Eq. 2}$$

where θ is the threshold value

2.4.3. Sigmoid function

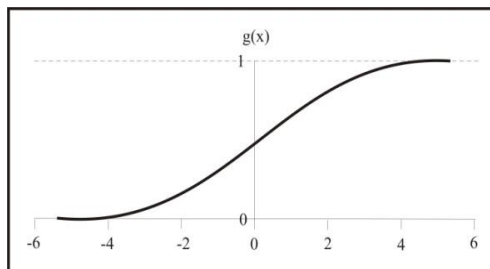


Figure 4 Graph of the sigmoid activation function

Binary sigmoid function (logistic), output value between 0 and 1

$$f(x) = \frac{1}{1 + \exp(-\sigma x)}$$
Eq. 3

where σ is a constant

Sigmoid bipolar function, output value -1 to 1

$$f(x) = \frac{1 - \exp(-\sigma x)}{1 + \exp(-\sigma x)}$$
Eq. 4

where σ is a constant

Hyperbolic tangent function, family value between -1 and 1

$$f(x) = \frac{1 - \exp(2\sigma x)}{1 + \exp(2\sigma x)}$$
Eq. 5

2.5. Data normalization or preprocessing

Before the data is trained into the network using the perceptron method, the lecturer assessment questionnaire's data are normalized first. The purpose of normalization is to convert data values over a range of values that the network can process. Normalizing the input values will accelerate the training phase. Because the activation function used is the Binary Sigmoid function, where the value ranges are 0 and 1, then the lecturer assessment questionnaire's data will be normalized to 0 and 1 [7]. The method used to normalize the data from the lecturer assessment questionnaire is the Min-Max method, which transforms the value of the data linearly. Data normalization using the Min-Max formula is as follows:

$$f(x) = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}}$$
Eq. 6.

Where :

- X_i = i^{th} data
- X_{\min} = data with the minimum value
- X_{\max} = data with a maximum value

Before working on data normalization, the initial process is to determine the initial assessment data from X1-X8, as in Table 1.

Table 1. Initial Data

No.	Assessment					Average
	X1	X2	X3	...	X8	
1	3.00	3.50	4.00	...	3.50	3.50
2	3.58	3.45	3.55	...	3.35	3.49
3	4.00	3.67	3.33	...	3.00	3.42
4	3.60	3.20	3.60	...	3.40	3.40
5	3.50	3.33	3.42	...	3.50	3.40
6	3.41	3.46	3.44	...	3.28	3.39
7	3.50	3.40	3.60	...	3.10	3.38
8	3.58	3.54	3.60	...	3.09	3.38
9	4.00	4.00	3.00	...	3.00	3.38
10	3.67	3.33	3.33	...	3.00	3.29

...
...
...
...
...
99	3.00	3.20	2.80	...	2.80	3.03
100	2.77	2.37	2.59	...	2.72	2.69

In Table 1, we determine the smallest value and the most significant value from the X1 column data, the most considerable value = 4.00 and the smallest value = 2.00. The data normalization process uses equation 6. Table 2 is the normalized X1 assessment data.

Table 2. Evaluation Data of X1 Normalization

No.	Min-Max (f)	Score
1	$f(1) = \frac{4.00 - 2.00}{4.00 - 2.00} = 1.00$	1.00
2	$f(2) = \frac{2.85 - 2.00}{4.00 - 2.00} = 0.43$	0.43
3	$f(3) = \frac{3.00 - 2.00}{4.00 - 2.00} = 0.50$	0.50
4	$f(4) = \frac{2.46 - 2.00}{4.00 - 2.00} = 0.23$	0.23
5	$f(5) = \frac{2.64 - 2.00}{4.00 - 2.00} = 0.32$	0.32
6	$f(6) = \frac{2.90 - 2.00}{4.00 - 2.00} = 0.45$	0.45
7	$f(7) = \frac{2.95 - 2.00}{4.00 - 2.00} = 0.48$	0.48
Etc.

2.6. Perceptron algorithm

Algorithm perceptron is a simple artificial neural network with a supervised learning method in classifying incoming data through an artificial neural network. Generally, the perceptron is applied in identifying a particular form or appearance. The perceptron algorithm will regulate the independent indicators' measures through the guided learning process in its application. The threshold value contained in the activation function is non-negative. The activation function is created in order to separate the data into two parts between the positive and negative regions using the following formula:

$$w_1x_1 + w_2x_2 + b > \theta \tag{Eq. 7}$$

$$w_1x_1 + w_2x_2 + b < \theta \tag{Eq. 8}$$

In the learning process, a series of input data and target output data will be trained as pairs of data series so that we will have an algorithm like the following: 1. Give initial values for all weights and biases. The calculation process will be made more accessible by giving the value of importance and preference equal to zero. Give the value of Set learning rate (α) with $0 < \alpha \leq 1$. (To make it easier, set $\alpha = 1$), 2. When the condition stops, it will be wrong, do the following steps for each pair of the st learning series:

- a) Give the input value the same value as the input $X_i = S_i$,
- b) Calculate the response for the unit of output with the following equation:

$$\text{net} = b + \sum_{i=1}^n x_i w_i$$

$$y = \begin{cases} -1, & \text{net} < -\theta \\ 0, & -\theta \leq \text{net} \leq \theta \\ 1, & \text{net} > \theta \end{cases} \quad \text{Eq. 9}$$

c) Make changes to the weight and bias values if an error occurs:

If $y \neq t$ then:

$$w_i \text{ (new)} = w_i \text{ (old)} + \alpha * t^* \quad \text{Eq. 10}$$

$$X_{ib} \text{ (new)} = b \text{ (old)} + \alpha * t \quad \text{Eq. 11}$$

$$\Delta w = P \text{ if } (ta) > 0$$

$$-P \text{ if } (t - a) < 0 \quad \text{Eq. 12}$$

$$0 \text{ if } (t - a) = 0$$

Test the condition when it is false; if there is no change in the weight value, then the stop condition will have the correct value. The stop condition will be inaccurate if there is still a change in the weight value.

3. Results and discussion

3.1. Preparation data

Data collection from questionnaires was carried out to achieve this study's ultimate goal. This section aims to classify the data to make it easier to carry out the subsequent analysis. The data used is a lecturer assessment questionnaire data obtained from the Pelita Indonesia College of Computer Science (STIKOM), in the form of a questionnaire filled out by all students in each class.

In the STIKOM Pelita Indonesia lecturer assessment questionnaire, there are several attributes of lecturer assessment that students, namely, will score:

1. Class
The student class concerned
2. Lecturer Name
Name of Lecturer - the lecturer who teaches the student concerned
3. Assessment
Assessment of lecturers consisting of eight assessments.

Table 1. Assessment

Assessment	Information
1	Teaching Time Discipline
2	Teaching Methods and Techniques
3	Presentation and Material Mastery
4	Lecturer and Student Communication
5	Lecturer Appearance in Teaching
6	The suitability of the examination material with the lecture material
7	Lecturer Attention to Student Ability
8	How Lecturers provide Value to Students

Each of the above assessments has assessment criteria

Table 2. assessment criteria

Numbers	Predicate
4	Very good
3	Good
2	Enough
1	Less
0	Very less

Table 1 and Table 2 are attributes that serve as a measure of the assessment distributed to students as respondents. From the categories in table 1 and table 2, a lecturer assessment questionnaire for STIKOM Pelita Indonesia Pekanbaru will be compiled. The data obtained from this student questionnaire will be recapitulated and grouped for each lecturer so that the data can be grouped and sorted based on each lecturer's average value. The perceptron algorithm will then process with a total of 100 respondents. The questionnaire data grouped by lecturers are then grouped and reordered based on the average value obtained to get the STIKOM PI lecturer assessment questionnaire results.

3.2 Data processing with perceptron algorithm

The data needed in this artificial neural network is the result of the STIKOM PI Pekanbaru lecturer assessment questionnaire in the odd semester of the 2019/2020 Academic Year with variables which include:

1. Time discipline
2. Methods and techniques of teaching
3. Presentation and mastery of the material
4. Lecturer communication with students
5. Lecturer appearance in teaching
6. The suitability of the exam material with the course material
7. Lecturer attention to student abilities
8. The way the lecturer gives student scores

The assessment variables above are used as input (input) and the average value as a target (output). The data used is as many as 40 people from the lecturer assessment questionnaire data. The data will be trained on the network as many as 20 data will be taken randomly. The remaining 20 data will be used to test the artificial neural network's accuracy in identifying input patterns from the questionnaire data collected.

3.3 Pattern determination

The data from the assessment questionnaire obtained are grouped into two parts, namely input and output targets. The inputted data can be sorted as follows:

1. Time discipline, stored in variable X1
2. Methods and teaching techniques, stored on variable X2
3. Presentation and mastery of the material, stored on variable X3
4. Communication between lecturers and students is stored on variable X4
5. The appearance of the lecturer in teaching is stored on variable X5
6. The suitability of the exam material with the course material is stored on variable X6
7. The lecturers' attention to student abilities is stored on variable X7
8. The way the lecturer assigns student scores is stored in the X8 variable

These variables will be trained with 20 lecturer data formed into a P matrix, with an 8 x 20 matrix order and 20 lecturer data as examiner data included into a U matrix, with an 8 x 20 matrix order.

3.4. Perceptron architecture

The perceptron architecture to be formed has two layers, namely an input layer consisting of eight nerve cell units, one refractive cell unit, and one nerve cell unit as the output target. The perceptron architecture can be seen in Figure 4.

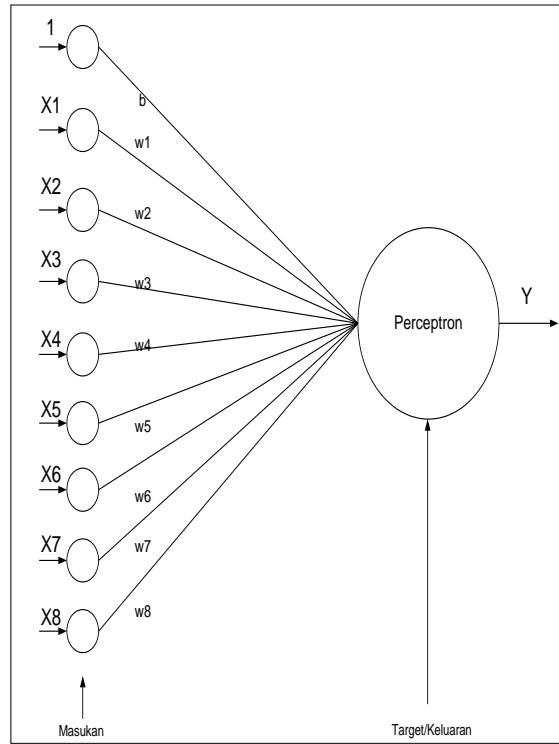


Figure 4. Perceptron Architecture of Lecturer Performance Evaluation

Figure 4 shows the input data in the form of X1, X2, X8 with weights on each w1, w2, ... w8 and a bias of b = 1. All input data, consequences, and bias will be processed into the perceptron, resulting in a target Y[4].

3.5. Perceptron training

Based on the formalized training data and the perceptron architectural form in Figure 3, a learning process is carried out so that the perceptron can recognize the input pattern to match the desired target. The input data is X1, X2, X8 with the output is target Y. To carry out the process learning and iteration, there are four stages that we must follow, which are called the perceptron training algorithm follows:

1. Give initial values of all weights and biases, for this initial stage we use weights and biases as follows: for bobos is $w_1 = -1, w_2 = -1, w_3 = -1, w_4 = -1, w_5 = 1, w_6 = 1, w_7 = 1, w_8 = 1$ and the bias is $b = 1$.
Determine the learning rate ($=\alpha$), give the initial value = 1
2. If there is an input vector element whose output unit response is not the same as the output target, then do:
 - a. Give the input unit activation value with $x_i = s_i (i = 1, \dots, n)$
 - b. Calculate the response to the output unit, using equation 2
 - c. Make corrections for the pattern weight values that contain errors ($y \neq t$) using equation 10 and equation 11.

The network recognizes all input patterns at epoch 6 six, where the error value is the difference between Y (net) and the target, i.e., $\text{Error} = 0$. The iteration will be terminated. With the weight change value $W1 = 1.13$, $W2 = 0.5$, $W3 = -0.05$, $W4 = 1.8$, $W5 = 0.66$, $W6 = 0.6$, $W7 = 2.8$, $W8 = 0.57$ with a bias value = -2 . Determining and assigning appropriate weight values affects the number of iterations to be carried out. Each iteration that is carried out will not recognize the input pattern if the weight value used for each epoch is almost always the same where the weight changes based on the Error formed.

4. Conclusion

In conclusion, perception can be used as a reliable method for evaluating the lecturer assessment questionnaire results. But giving a weight value that is not possible will make the network produce output values that are not optimal with the desired target at the time of perceptron training. The more nodes or neurons tested on the perceptron, the longer the training processing time will be, but the more accurate the results will be. Perceptron is limited to only having two layers of data processing with one weight layer that can adapt so that processing a large number of inputs will take a long time.

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