**ANALYSIS OF APPLICATION OF BACKPROPAGATION METHODS IN DECISION MAKING OF LECTURER PERFORMANCE DETERMINATION ON THE UTILIZATION OF ONLINE LEARNING IN CREATIVE MEDIA POLYTECHNIC**

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Abstract

The use of online learning at the Creative Media State Polytechnic during the Covid-19 pandemic has had a social impact on the campus community, especially students and lecturers. Learning that is not face-to-face does it have the same effectiveness or increases with face-to-face learning or does it actually decrease. So that in this study has analyzed the performance assessment of lecturers in the use of online learning using the Backpropagation method. The data source comes from the results of a questionnaire which has 20 questions and refers to 4 criteria, namely performance, opportunity, kabsensik and integrity. A total of 142 respondent data have been collected that can be processed. The processing results show a high level of accuracy using the Backpropagation method based on the correlation coefficient value of r = 0.9135. This result is close to 1 which indicates a good match between the network output and the target. So, it can be concluded that this method can be used to determine the performance of lecturers in online learning.

1. **Introduction**

The Covid-19 events that emerged in early 2019 until 2021 have directly or indirectly changed the system in almost all aspects of life. In this condition, the acceleration of the use of technology almost occurs in all fields. This is no exception with teaching and learning activities at the Creative Media Polytechnic campus which organizes online learning during the pandemic. Of course, the use of online learning has a social impact on the campus community, especially students and lecturers. As in direct face-to-face learning, does it have the same effectiveness or increase with face-to-face learning or does it decrease.

In the world of education, the impact of the industrial revolution is forcing educational institutions to apply technological advances (Dalimunte, 2014). With the presence of the industrial revolution, learning can be done not only in the classroom but can be carried out online. Halkinik also forces teachers to be creative in delivering their teaching materials (Utami, 2011).

The success of the learning objectives that have been set or that will be achieved previously depends on the skills of human resources (lecturers) in carrying out the tasks that have been given and targeted. To be able to recognize the ability and potential of a lecturer for his work, a university must have an assessment system to support decisions in determining lecturer performance so that if there is a lack of professionalism of a lecturer, then it is the obligation of the university to facilitate lecturers can take part in training to improve professionalism or what we usually know as lecturer performance (Khasanah et al., 2019).

Information technology innovation is a development for information processing, including preparing, obtaining, combining, storing, and controlling information to produce high quality information and obtain important dynamic information. Or on the other hand, it is often referred to as a Decision Support System (DSS). DSS (Decision Support System) is a system that utilizes computer support in the process of deciding. One of the goals of a Decision Support System is to provide managerial assistance to solve a problem. In Decision Support Systems, various methods can be used, such as the Simple Additive Material (SAW), Artificial Neural Network (ANN), Technique for Order By Similarity (TOPSIS) and the Analytical Hierarchy Process (AHP) method. Artificial Neural Network (ANN) is a method developed for prediction or estimation. This method is used to predict based on events that have occurred. The Backpropagation method is one of the methods of the Artificial Neural Network (ANN) that can be used to solve the problem (Haryanto et al., 2019).

Based on the background of the problem above, so the author is interested in analyzing the accuracy level of one of the artificial neural network methods, namely backpropagation on the problem of evaluating the performance of case study lecturers in the animation study program with the title "Analysis of the Application of Backpropagation Methods in Decision Making in Determining Lecturer Performance on the Utilization of Online Learning in Creative Media Polytechnic”.

1. **Literature Review**

## Decision Support System (DSS)

Definition of Decision Support System (DSS) according to Kusrini in Gunawan (2015) is an interactive information system which provides information, modeling, and manipulating information. And according to Alter in Gunawan (2015) the definition of a Decision Support System (DSS) is a system which is used to help make a decision in semi-structured and unstructured circumstances, where no one knows for sure how the decision was made. A decision support system (DSS) created to support answers to problems or to evaluate opportunities is called a decision support system application. Decision support system applications are used in a decision making. The computer-based decision support system application CBIS (Computer Based Information System) is more flexible, interactive, and adaptable which can be developed to support the solution of a specific unstructured management problem.

## Backpropagation Method.

The Backpropagation method is an advancement in the development of a single layer single neural architecture structure. This design consists of an input layer, a hidden layer, and an output layer. In each layer there is at least 1 neuron (Fausett, 1994). So the name of this technique is Globally Multilayer Neural Network.

Diagram

Description automatically generated

Figure 1. Backpropagation network architecture

By utilizing this multilayer architecture, the training strategy used is using the Backpropagation method which is commonly referred to as a feedforward network.

## Performance

Performance is an inspiration and capacity to complete a task or work (Ritongga, 2013). An individual must have a certain level of readiness and capacity. A person's abilities and abilities are not strong enough to achieve something without a reasonable understanding of what to do and how to do it. A real behavior shown by everyone in the implementation of work carried out representing their duties in the organization is also called performance. To achieve the goals of an organization employee performance is very important.

Performance evaluation is a method of estimating an individual's commitment to the organization. The important value of evaluating a performance is to determine the level of responsibility or personal commitment that is communicated when carrying out the tasks that are the responsibility of the individual.

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## 3. Research methods

## Research stages.

Globally, the main stages of this research method are divided into four stages, namely, the preparation stage, the data collection stage, the data processing stage, and the data testing stage. The following is the flow of the research stages:

Figure 2. Research phase flow

From the picture of the flow of the research stages above, it can be described at each stage as follows:

1. **Preparation Stage**

This stage starts from the problem assessment, as well as conducting a literature study on similar research that has been done.

1. **Data Collection Stage**

In this research, data collection was carried out by interviewing the Head of the Animation Center and observing the online learning process in the Animation study program as well as filling out questionnaires.

1. **Data Processing Stage**

The data processing stage is divided into three stages, among others: determining the value of the input (input), determining the result or output (output), and data processing methods.

1. Determine the Input Value (input)

Before processing or processing data, at this stage it begins by preparing input values ​​by determining criteria. In this study, there are four criteria that become indicators of lecturer performance assessment. The four criteria are absenteeism, performance, opportunity, and integrity.

2. Determine the Result/Output (Output)

After determining the input value, the next step is to determine the desired result or output from the lecturer's performance assessment. In this study determine three results of performance decisions achieved by lecturers, namely very satisfactory, quite satisfactory, and not yet satisfactory. The results will be a reference in providing solutions to the performance of lecturers. The following are the rules or conditions for the results of the decisions and the solutions obtained:

* 1. If the criteria for performance, opportunity, kabsensik and integrity are in the category of very good (A) , will you get a preference for the subject.
  2. If the value of the criteria for performance, 0 opportunity, absence and integrity is in the good category (B) then will p get a preference for the subject
  3. If the value of the criteria for performance, popportunity, discipline and integrity is in the adequate category of (C) then will you get training for discussing material & communication, training in teaching techniques, training for taught subjects and training for motivation.
  4. If the value of the criteria for performance, popularity, discipline and integrity is in the poor category (D), then you will get a review from the head of the study program.
  5. If you assess the performance criteria are sufficient (C), then you will receive technical training and teaching & training in colleges that you can afford
  6. If you assess the criteria for poor performance (D) then you will get a review from the head of the study program.
  7. If the value of the opportunity criteria is sufficient (C) then you will receive training in teaching techniques.
  8. If you assess the criteria for opportunity as poor (D) then you will get a review from the head of the study program
  9. If you score enough absenteeism criteria (C), you will receive motivation and discipline training
  10. If the assessment criteria for absenteeism are poor (D), they will receive a review from the head of the study program.
  11. If the score of the integrity criteria is sufficient (C) the grave will receive technical training in discussing lectures and communication.
  12. If you assess the integrity criteria as poor (D) then you will get a review from the head of the study program.
  13. If the lecturer gets a (D) or bad score in one of the criteria, he will get a review from the head of the study program (review is only for bad grades).

1. Data Processing Method

The first step in processing data using the Backpropagation method is to conduct data training (data training). This serves to introduce patterns according to the target output. There are 3 stages to train Backpropagation. The first stage is to determine the activation function as an indicator of the output target limit. Next calculate the input layer which will produce the output layer using the activation function. This stage is also known as forward propagation. Next, in the second stage, looking for error conditions or errors by calculating the result of the difference between the output target and the output layer of the results of the first step. This stage is also known as backward propagation. In the third stage, namely correcting the error rate contained in the second step above by making modifications to the weights.

The three stages are carried out repeatedly if the condition still exceeds the fault tolerance limit. The concept of the three stages of Backpropagation training above can be implemented in the Backpropagation algorithm below:

1. Step 0 :

Determine all the input weights for the hidden layer randomly with small numbers.

1. Step 1 :

Determine the training data pair if the termination condition has not been met.

1. Step 2 :

Perform steps 3 — 8 for each pair of training data.

Phase I : Forward Propagation

1. Step 3 :

Each input unit () will receive a signal which will then be sent to the hidden layer unit.

1. Step 4 :

Perform a count of all outputs on each hidden unit

(*, j = 1,2,…, p)*.





1. Langkah 5 :

Perform calculations of all network output units (*, k = 1,…, m)* by adding up the weights of the input signals





Phase II : Back Propagation

1. Step 6 :

Perform a factor calculation on the output unit by referring to the error contained in the output unit (*yk , k = 1,…, m*)

δk = (tk-yk)f’(y\_netk)=(tk-yk)yk (1-yk)

then calculate weight change rate (used to update later),

Δwjk= α δk zj

Δwok= α δk

Calculate the bias correction (used to update wok ), and send δk to each unit in the layer below it

1. Step 7 :

Perform a factor calculation on the hidden layer referring to the errors contained in each hidden layer (*, j = 1… p*) by adding up the results of the input changes (from each unit layer above it),



The result is then multiplied by the derivative of the activation function,



Calculate the term on the change in the weight of Vji (used to update the weight of Vji later),

ΔVji= α δj xj

Phase II : Weight Modification

1. Step 8 :

Modify the weights by calculating all changes to the weights. The following is the change in the weight of the line that will go to each unit of output:

Wjk(baru)=Wjk(lama) + ΔWjk)

Whereas, for each hidden unit starting from the 1st unit to the p-th unit, weight and bias modifications are also carried out:

Vji(baru)=Vji(lama) + ΔVij).

1. **Data Testing Phase**

In this step, the data is tested, namely the data from the assessment results by the lecturer's supervisor and student questionnaires represented by the four criteria above. Before testing the data (data testing), data training (data training) is carried out which has already been determined directly by the input and output values. Then the data is trained by introducing the two data processing methods, namely Backpropagation.

Then, the data is tested by taking data samples that have never been a training data sample. The results of the testing data will be adjusted to the conditions of the criteria that have been set. In the method that has a high level of accuracy, recommendations will be made on the method that will be used to determine the performance of the lecturer.

1. **Research Results**

## Data

Data collection has been carried out using a google form with the link address: https://bit.ly/KuisionerPenelitianKompetif2021. With the number of respondents as many as 142 people in the Animation Study Program students of all D4 and D3 classes as shown in Figure 3.

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Figure 3. Percentage of Respondents Per Class

## Data Processing

In determining the Decision Support System (DSS) or making decisions on determining the performance of lecturers with the Backpropagation method, that is in accordance with the algorithm contained in that method. However, before entering the Backpropagation algorithm, first perform a preprocessing step by determining the input value obtained from the questionnaire data. The steps and their provisions are as follows:

1. Four criteria have been determined, each of which has a different number of questionnaires with a total of 20 questionnaires as an assessment of lecturer performance indicators, namely:
   1. Attendance (4 questionnaires)
2. Timeliness of the lecturer to start the course?
3. How long does it take on average for online lectures to take place?
4. How is the time provided by the lecturer for students to ask questions and discuss during the teaching and learning process?
5. The number of meetings held by the lecturer concerned?
   1. Performance (5 questionnaires)
      * 1. Study materials / lecture materials according to the method in the online lecture process?
        2. Regularity and order in the implementation of online lectures?
        3. Lecturers are able to liven up the atmosphere of online lectures?
        4. Mid-Semester Examination and Final Semester Examination according to the material / material in the online lecture process?
        5. Lecturers are able to deliver material and answers to questions online?
   2. Opportunity (6 questionnaires)
      * 1. Giving feedback on student assignments submitted online?
        2. Do you understand the explanation of the study material / topic of lecture material online?
        3. Do you understand examples of concepts in the online lecture process?
        4. Do you understand the relevance of the field / topic / material being taught with the context of everyday life through online lectures?
        5. Do you understand the latest issues presented by lecturers in the fields taught through online lectures?
        6. Using examples of previous research results in improving the quality of online lectures?
   3. Integrity (5 questionnaires)
      * 1. Wisdom / Wisdom of the lecturer in making decisions in the online lecture process?
        2. Lecturers are fair in treating students?
        3. Lecturer of courses Receive criticism or suggestions from students?
        4. Communicative in the online lecture process?
        5. Interact with students in the online lecture process?
6. Of the 20 questionnaires, a graded scale rating of 1 to 5.
7. Three results of lecturer performance assessment have been determined, namely:
8. The performance results are very satisfactory;
   * + 1. If the quantity value 5 has a percentage 10% and a value 4 has a percentage 90% and a value 3 has a percentage 10%
       2. If the quantity value 5 has a percentage 20% and a value 4 has a percentage 70% and a value 3 has a percentage 10%
       3. If the quantity value 5 has a percentage 30% and a value 4 has a percentage 50% and a value 3 has a percentage 10%
       4. If the quantity value 5 has a percentage 40% and a value 4 has a percentage 40% and a value 3 has a percentage 10%
       5. If the quantity value 5 has a percentage 50% and a value 4 has a percentage 30% and a value 3 has a percentage 10%
       6. If the quantity value 5 has a percentage 60% and a value 4 has a percentage 20% and the value 3 has a percentage 10%
9. The performance results are quite satisfactory;

If it does not meet criteria A (very satisfactory) and criteria B (not satisfactory)

1. The performance results are not satisfactory;
   * + 1. If the quantity value 3 has a percentage 10% and a value 2 has a percentage 30% and the value 1 has a percentage 50%
       2. If the quantity value 3 has a percentage 20% and value 2 has a percentage 50% and value 1 has a percentage 30%
       3. If the quantity value 3 has a percentage 30% and value 2 has a percentage 60% and value 1 has a percentage 20%
2. There are a total of 142 respondents who sent answers to the questionnaire and it was collected successfully.
3. The input value for the Backpropagation method is 20 questionnaires based on 4 lecturer performance criteria.
4. It has been determined for training data that 50% of the total respondents are taken on odd rows with a total of 71 data.
5. It has been determined that the test data (testing) is 50% of the total respondents who are taken on even rows with a total of 71 data.
   1. **Working manually**

From the above conditions, the Backpropagation method can be developed to determine the assessment of lecturer performance results. There are 20 initial and target data inputs taken from the first data (first row) of the training data and a hidden layer which has 5 units of neurons. Then determine the initial weight at random, determine the activation function, namely sigmoid and the rate of understanding (Learning Rate) = 0.2. Here are the steps for the construction of the Backpropagation method.

|  |  |
| --- | --- |
| Tabel 1. Network pattern input | |
|  | 4 |
|  | 2 |
|  | 2 |
|  | 5 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 3 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 4 |
|  | 4 |
| Target | 3 |

1. The first step is to determine the weights randomly.

There are two weights, namely the initial weight of the input and bias randomly from the input layer to the hidden layer and the weight from the hidden layer and bias to the output layer. Here are the weight values ​​at random.

* + 1. Weight from input layer to hidden layer.

At this stage the number of weights of course adjusts to the needs of the number of inputs and biases to the number of hidden layers. So if the input in the pattern above is 20 which has 5 neuron units in the hidden layer, the total number of weights is 105 weights obtained from 20 (input) + 1 (bias) \* 5 (neuron units in the hidden layer). The following is a table of initial input weights and random bias from the input layer to the hidden layer. Then the value is as shown in the table below.

* + 1. Weight from hidden layer to output layer.

In the weighting from the hidden layer to the output layer, it takes 6 weight values ​​based on 5 neuron units in the hidden layer and a bias that leads to one output unit so that a total of 6 weights are determined randomly. Here are the six weights that have been determined.

1. In the second stage, which is to calculate the hidden unit output based on the input unit using the function below:

* +2(-0,09)+2(-0,93)+5(0,16)+4(-0,89)+4(-0,86)+4(0,52)+4(-0,43)+4(0,91)+4(-0,29)+4(0,28)+4(0,31)+4(0,48)+4(-0,36)+3(-0,98)+4(-0,63)+4(0,89)+4(-0,75)+4(-0,89)+4(0,59) =
* (0,59)+2(0,03)+2(-0,30)+5(0,89)+4(-0,96)+4(-0,97)+4(-0,34)+4(-0,46)+4(0,09)+4(0,42)+4(-0,96)+4(-0,65)+4(-0,98)+4(0,23)+3(-0,34)+4(-0,07)+4(0,32)+4(-0,86)+4(0,26)+4(0,24)
* 4(-0,33)+2(-0,74)+2(-0,34)+5(0,18)+4(-0,09)+4(-0,88)+4(-0,24)+4(-0,47)+4(0,01)+4(-0,91)+4(-0,06)+4(0,88)+4(-0,54)+4(-0,02)+3(0,04)+4(-0,89)+4(0,92)+4(0,33)+4(-0,15)+4(0,23) =
* (-0,56)+2(-0,33)+2(0,94)+5(0,48)+4(0,79)+4(0,52)+4(0,04)+4(-0,73)+4(0,16)+4(0,54)+4(-0,12)+4(-0,73)+4(0,69)+4(0,48)+3(0,07)+4(-0,04)+4(-0,24)+4(0,44)+4(0,28)+4(0,51) =
* 4(-0,52)+2(0,60)+2(0,55)+5(-0,74)+4(0,10)+4(0,65)+4(-0,02)+4(0,68)+4(-0,02)+4(0,41)+4(-0,27)+4(-0,32)+4(0,14)+4(0,21)+3(-0,61)+4(-0,65)+4(-0,29)+4(0,27)+4(-0,28)+4(-0,33) =

Then calculate the results above using the sigmoid activation function.

* **3,2E-06**
* **4,0E-07**
* **0,002**
* **0,99**

1. After knowing the output of the unit in the hidden layer, the next step is to calculate the value of the output unit , using the function below.

Then the value of the output unit is as follows

= -0,19+(3,2E-06)( 0,15) +(4,0E-07)( 0,71) +(0,002)( 0,71) +(0,99)( 0,22) +(0,13)( 0,86)

= **1,5E-01**

Then the above results are entered into the sigmoid activation function

1. The next step is to calculate the factor in the output unit

In this network only has one output unit so,

Weight change rate (with ) :

1,2E-01

4,0E-07

4,9E-08

2,8E-07

1,2E-01

1,7E-02

1. Next is to calculate the sum of the errors of the hidden units (=)

In this network also has an output unit then,

Error factor in hidden units:

**3,0E-07**

**1,7E-07**

**9,8E-07**

**1,6E-07**

**6,2E-02**

Weight change rate to hidden units:

1. After knowing the error of the hidden unit, the next step is to determine the weight change in both the output unit and the hidden unit.
   1. Output units weight change :
   2. Hidden units weight change :
2. The next step is to repeat the process as above with the new input contained in the next line.
   1. **Working using MATLAB**

In determining the performance of lecturers with the Backpropagation method using the Matlab application, it can be seen the level of the percentage of the accuracy of the results. The higher the percentage, the higher the level of accuracy. The Backpropagation neural network method includes 1 input layer, 2 hidden layers, and 1 output layer. The input layer has 20 neurons that represent the input of the lecturer's performance indicator questionnaire. Meanwhile, the first hidden layer has 10 neurons with a tangig activation function, the second layer has 5 neurons with a logsig activation function. In the output layer which has 1 neuron using the purelin activation function. Here are the steps to do it:

* + 1. **Conversion data**, in the first step, data conversion is carried out, namely preparing initial data in the form of an assessment of the results of the lecturer's performance questionnaire in the form of a spreadsheet obtained from Google Form. Of the 142 data divided for training data and test data, it is found that each has 71 data. In addition, it also transposes data so that it can be built on the Backpropagation neural network. Here is the programming:

1. Import excels data as main data

data=xlsread("Published/Matrix Kuisioner Kinerja Dosen Oleh Mahasiswa PerDosen.xlsx")

1. Divide the training data (P) and the target (T) by determining odd rows in the main data and transpose the data:

P=data(:,1:20)’

T=data(:,21)’

1. Divide the test (Q) and target (QT) data by determining even rows in the main data and transpose the data:

Q=data(:,1:20)’

QT=data(:,21)’

* + 1. **Preprocessing**, the next step is to do preprocessing by normalizing using the mean and standard deviation normalization before the network is built.

[pn,mean,stdp,tn,meant,stdt] = prestd(P,T)

From the above preprocessing will produce the initial weight of the network.

* + 1. Build a feedforward neural network with the gradient descent momentum learning method (traingdm).

netBP=newff(minmax(pn),[10 5 1],{‘tansig’ ‘logsig’ ‘purelin’},’traingdm’)

From the construction of a feedforward neural network, it will produce the final weight of the network.

* + 1. Next do the training.

netBP=train(netBP,pn,tn)

From conducting network training on the training data above, it can be seen that network processing in the form of Epoch, Time, Performance, and Gradient. In the picture below, it is known that it requires 1000 epochs or repetitions to get the maximum weight so that the Mean Squared Error (mse) level is 1.12. Because in this step we do not limit the epoch or mse it is automatically determined. But we can also set limits on epoch and mse.

Graphical user interface, application

Description automatically generated

Figure 4. Result of data training

* + 1. Then test the data that was trained

ujiDatalatih=sim(netBP,pn)

udl=poststd(ujiDatalatih,meant,stdt)

In this step will generate network output. This result will be the determination of the lecturer's performance assessment on the training data.

* + 1. This step is to find out the error value by looking at the difference between the target and the network output. So that it can be seen the smallest and largest errors from the test results on the training data.

errorDatalatih=T-udl

By ignoring the minus results, the error value or the maximum distance difference in the training data above was found to be 0.9053, while the minimum error was 0.0043 in the training data.

* + 1. See the correlation coefficient of the network output with the target which is analyzed by linear regression using postreg.

[m1,a1,r1]=postreg(udl,T)

In determining the feasibility of this method, it is possible to use the value of the correlation coefficient which is the level of correlation of the overall compatibility of the inputted data between the network output and the target in this step the compatibility of the network training with the training data, the value of r1 = 0.9135 as shown below. These results are close to 1 which indicates a good match between the network output and the target.

Graphical user interface, chart, line chart

Description automatically generated

Figure 5. Result of comparison of output and target data training

* + 1. The next step is to test the test data, that is, the data is not trained. At this stage, denormalization is also carried out first with trastd. While the simulation results are denormalized with poststd.

Qx=trastd(Q,mean,stdp)

ujiDatauji=sim(netBP,Qx)

udu=poststd(ujiDatauji,meant,stdt)

This process will produce network output data which is the result in determining the lecturer's performance assessment on the test data.

* + 1. See the smallest and largest errors from the test results on the test data.

errorDatauji=QT-udu

By ignoring the minus results, the error value or the maximum distance difference in the training data above was found to be 0.9053, while the minimum error was 0.0021 in the training data.

* + 1. Look at the correlation coefficient of the network output with the target which is analyzed by linear regression using postreg.

[m1,a1,r1]=postreg(udu,QT)

Graphical user interface, chart, line chart

Description automatically generated

Figure 6. Result of comparison of output and target data testing

In network training with test data the value of r1 = 0.9135 as shown above. These results are close to 1 which indicates a good match between the network output and the target. So it can be concluded that the method on the Backpropagation neural network for decision making in determining the performance of lecturers gets results with a high level of accuracy.

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