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The Application of ANN Predicts Students' Understanding of Subjects During Online Learning Using the Backpropagation Algorithm at SMAN 1 Perbaungan

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Abstract

This study is a study to predict the level of students' understanding of the subjects given by educators at SMAN 1 Perbaungan. This study aims to determine how far the level of understanding of students in understanding lessons, especially during the current covid-19 pandemic, which is a process of teaching and learning activities carried out from their respective homes or using online learning media. The method used is an artificial neural network with Backpropagation algorithm with variables used are knowledge values, skill scores, mid-semester exam results, end-semester exam results, and attitude scores. The five variables are used to support predicting the level of student understanding of the subject using the single layer Backpropagation Algorithm. The architectural model used is 5-2-1 with a success accuracy of 85%. The smaller the error value that is close to 0, the smaller the deviation of the results of the Artificial Neural Network with the desired target.

Keywords: *Artificial Neural Network, Backpropagation, Predict students' understanding level, study from home*

1. Introduction

At this time the use of science and technology is developing very quickly and producing new innovations that must be balanced with the ability to adapt to these technologies. An artificial neural network (ANN) is an information processing system that has characteristics resembling a biological neural network. The basic idea is to adopt the workings of the human brain which has the characteristics of parallel processing, large number of processing elements and fault tolerance. Setiabudi D. (2015). One of the methods used in Artificial Neural Networks is Backpropagation, this method is a supervised learning algorithm and is usually used by perceptrons with many layers of screen to change the weights in the hidden layer. The Backpropagation algorithm is an easy and simple iterative algorithm that usually performs well, even with complex data Purba et al., (2019).

The use of the Bacpropagaton method of Artificial Neural Networks is not only limited to the field of technology, the field of education can also take advantage of the system, such as in the teaching and learning process. The teaching and learning process is one of the activities in a school in the intellectual life of the nation. This role cannot be separated from professional teaching staff and good student understanding. In the teaching and learning process, it is necessary to have a two-way relationship between students and teaching staff. This is intended so that there is good cooperation during the teaching and learning process takes place Solikhun at. al. (2017). Because the world is currently experiencing a difficult time, namely the spread of Corona Virus Disease (Covid-19) in the form of an infectious disease caused by a newly discovered type of coronavirus, so that governments around the world, including in Indonesia, impose restrictions on every human interaction. As a result of the enactment of these restrictions, many activities must be done from home or online. The education sector is also not free from these restrictions, thus requiring the teaching and learning process to be carried out from their respective homes. The impact of implementing learning from home is that not a few high school students, especially at SMAN 1 Perbaungan, are negligent in the online teaching and learning process. As a result, SMAN 1 Perbaungan has difficulty predicting how far the students' level of understanding of the subject is.

2. Research Methodology

2.1. Artificial Neural Network

According to Muis, S. (2017:3) Mathematically, the workings of the artificial neural network proposed by McCulloch and Pitts (1943) is described as consisting of inputs x0, x1, ……. xn and its accompanying weights w0, w1, ….. wn, as well as the sigmoid activation function f and the learning rate .

The artificial neural network is developed based on a mathematical model by assuming:

1. Information is processed by simple elements called neurons
2. Signals are passed between interconnected neurons
3. Each connection between two neurons has its own weight which will divert the transmitted signal
4. Each neuron has an activation function that will determine the amount of output.

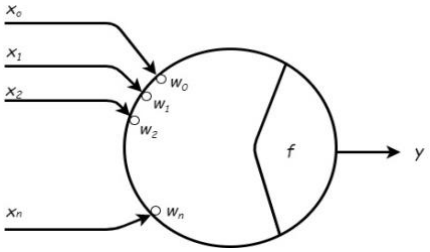

Fig. 1: Artificial Neural Mathematical Model

The output function of the artificial neural network is defined as follows:

$$y = o = f(net) = \frac{1}{1 + e^{-\sigma.net}}$$

$$y = o = f(net) = \frac{1 - e^{-\sigma.net}}{1 + e^{-\sigma.net}}$$

Net is :

$$net = \sum_{i=0}^{n} x_i w_i$$

The activation function above is called a binary sigmoid function and a bipolar sigmoid function, the form of the activation function can be in other forms, such as a step form or a linear/incline function. In the application of artificial neural networks that use learning algorithms that are continuous / continuous, many use sigmoid functions because of the nature of exponential functions that do not enter the saturated area (convergent), with tangent limits between 0 - 1 or -1 + 1, while neural networks imitation that uses a learning algorithm that is non-malar/discrete generally uses a step or linear function.

2.1. Backpropagation

The Backpropagation method uses an error output to change the value of the weight in the backward direction. To get the output error value, the forward propagation step must be done first by activating the neuron with the sigmoid activation function.

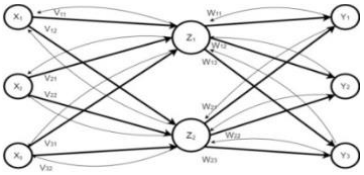

Fig. 2: Backpropagation Network Architecture

The following are the stages of working on the backpropagation method of ANN according to Muis, S (2017: 250).

$$f(x) = \frac{1}{1 + e^{-x}}$$

Algorithm :

1. Initialize the initial weight with a fairly small random value
2. If the stop condition is FALSE, then:

FeedForward :

a. Each input receives signal xi and forwards it to the layer above it (hidden layer).
b. Each hidden unit zi sums the weighted input signals:

$$z\_in_j = v_{oj} + \sum_{i=l}^{n} x_i v_{ij}$$

Use the activation function to calculate the output signal:

$$z_j = f(z\_in_j)$$

Then channel the signal to the layer above it (output).

Backpropagation :

a. Each output unit (yk) receives a target pattern related to the learning input pattern, calculate the error value (mistake):

$$\delta_k = (t_k - y_k) f'(y\_in_k)$$

use weight correction to correct the w_{jk} value:

$$\Delta w_{jk} = \alpha\ \delta_k\ z_j$$

use bias correction to correct the w_{0k} value:

$$\Delta w_{0k} = \alpha\ \delta_k$$

send δk to the layer below it.

b. Each hidden unit (z_i) adds up its input delta from the units above it.

$$\delta\_in_j = \sum_{k=1}^{m} \delta_k w_{jk}$$

this value is multiplied by the derivative of the activation function to get the error value:

$$\delta_j = \delta_{in_j} f'(z\_in_j)$$

Use the error correction value to correct the value of v_{ij}:

$$\Delta v_{ij} = \alpha \delta_j x_i$$

Also use the bias correction value to correct the value of v_{0j} :

$$\Delta v_{oj} = \alpha \delta_j$$

c. Each unit of output (y_k) fixes the bias and its weight:
3. Perform a stop condition test.

3. Research Framework

To assist in the preparation of this research, it is necessary to have a clear framework of the stages, this framework is the steps that will be taken in solving the problems to be discussed, as for the research framework used as shown in the figure 3.

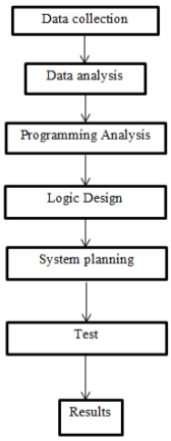

Fig. 3: Research Framework

4. Research result

4.1. Data analysis

Data analysis can be interpreted as data modeling which will later provide information from research results based on data from class XI students for the 2020/2021 academic year which will later predict the process of predicting the level of student understanding in learning. The selection of class XI is considered very suitable as a data reference because from research conducted by means of direct interviews and field surveys, class XI has experienced 2 phases of the learning process, in the form of face-to-face learning before the Covid-19 pandemic and online learning during the Covid-19 pandemic. -19, while for class X students have carried out online learning since entering school and for class XII they have graduated, so that further prospects cannot be determined from the prediction results of the level of understanding in learning in the following year at SMAN 1 Perbaungan. In addition, to collect other supporting data by means of a literature study which is carried out in stages to obtain the required data, then the data will be processed to obtain conclusions in accordance with the research conducted. The following is the data for class XI IPA 1 as a test sample to predict the level of understanding of subjects during online learning in table 1.

Table 1 : Student Data for Class XI IPA 1

NO	NIS	NAME	Score					Average
			Knowledge	Skills	Mid	UAS	Attitude	
1	19289	AHMAD RIDHO PRATAMA	83	83	80,50	83,61	85	83,04
2	19015	AIDIL FARISYES	84	84	84,75	84,83	90	86,53
3	19016	AIDIL QODRI	78	78	77,25	78,07	80	78,44
4	19290	ANANDA REGINA VASHA	85	84	82,00	84,97	90	85,66
5	19042	AWANG ARYO YUANDA	86	86	85,50	86,07	90	87,19
6	19065	DIKY ARDANA	86	86	87,25	86,86	90	88,04
7	19078	DWI SINTIA	86	86	85,00	86,61	90	87,20
8	19090	FACHRUR ROZI	79	79	77,75	79,50	80	79,08
9	19101	FEBRIAN TRI ANANDA	85	86	85,75	85,96	90	87,24
10	19119	HAYYU NISA ABDILLAH	86	86	86,00	86,79	90	87,60
11	19123	INDAH SYESHPUTRI	86	87	86,25	86,86	90	87,70
12	19129	JENNI MARSELLA BR BARUS	86	86	85,75	86,35	90	87,37
13	19132	JOSUA SURYES DARMA SILABAN	86	86	85,75	86,32	90	87,36

14	19137	KHAIRIL AKBAR	86	86	86,25	86,25	90	87,50
15	19146	LAILAN RAMADHANI	87	87	87,50	87,68	90	88,39
16	19148	LIDIA WATI	86	86	85,25	86,72	90	87,32
17	19292	MASTIUR RENITA DAMANIK	84	84	82,75	84,61	90	85,79
18	19293	MAY ARSHITA DEWI	84	85	81,75	84,79	90	85,51
19	19158	MHD DZAKI ZULWAQAR	85	85	85,00	85,50	90	86,83
20	19162	MIFTAHUL HUSNA SYESFITRI	87	87	86,75	87,50	90	88,08
21	19167	MUHAMMAD HIDAYEST	80	79	78,25	80,25	85	81,17
22	19295	MUHAMMAD SALMAN BOBBY	83	82	79,50	82,89	85	82,46
23	19183	NANANG KURNIAWAN NASUTION	83	82	81,75	83,14	85	83,30
24	19213	RAHMA SARI NASUTION	87	87	85,75	87,32	90	87,69
25	19238	SATRIA WIRATAMA	84	83	82,75	84,11	90	85,62
26	19239	SENDIA HAIJI	84	84	84,75	84,75	90	86,50
27	19245	SITI AISYESH	85	85	85,00	85,40	90	86,80
28	19248	SITI SALSABI	85	85	83,50	85,11	90	86,20
29	19259	TANIA OCTAVIA	86	86	86,00	86,15	90	87,38
30	19260	TAQIYYESH NABILA PUTRI	87	87	88,00	87,25	90	88,42
31	19261	TENGKU ZIDANE MAZLIKA RAMADHAN	83	82	81,50	83,07	85	83,19
32	19275	WIDIYES WULANDARI	86	86	85,75	86,75	90	87,50
33	19278	WINDA SIHOMBING	86	86	85,50	86,72	90	87,41
34	19282	YOGA AKBAR ADHA	80	79	77,50	80,07	85	80,86

4.2 Data Normalization

To carry out the processing and calculation, student data that has been obtained from SMAN 1 Perbaungan must be normalized first using the normalization formula.

$$X' = \frac{0{,}8(x-a)}{b-a} + 0{,}1$$

Information :

X' : Normalized data

x : Data to be normalized

a : Minimum data

b : Maximum data

then one value will be taken from respondent 1 as an example to be normalized,

Known :

x : 83 (Respondent knowledge value 1)

a : 77.25 (Smallest value of all respondents' scores)

b : 90 (The biggest value of all respondents' scores)

Asked: X'

$$X' = \frac{0{,}8(83 - 77{,}25)}{90 - 77{,}25} + 0{,}1 = 0{,}4608$$

resulting in normalized value data including X1 (Knowledge), X2 (Skills), X3 (Mid Semester), X4 (UAS), X5 (Attitude Value) and Target (Average) as shown in table 2 as follows:

Table 2 : Normalization of student score data

NO	NIS	VARIABEL					TARGET
		X1	X2	X3	X4	X5	
1	19289	0.4608	0.4608	0.3039	0.4987	0.5863	0.4630
2	19015	0.5235	0.5235	0.5706	0.5753	0.9000	0.6820
3	19016	0.1471	0.1471	0.1000	0.1515	0.2725	0.1747
4	19290	0.5863	0.5235	0.3980	0.5841	0.9000	0.6274
5	19042	0.6490	0.6490	0.6176	0.6534	0.9000	0.7237
6	19065	0.6490	0.6490	0.7275	0.7030	0.9000	0.7768
7	19078	0.6490	0.6490	0.5863	0.6870	0.9000	0.7244
8	19090	0.2098	0.2098	0.1314	0.2412	0.2725	0.2150
9	19101	0.5863	0.6490	0.6333	0.6465	0.9000	0.7266
10	19119	0.6490	0.6490	0.6490	0.6983	0.9000	0.7491
11	19123	0.6490	0.7118	0.6647	0.7027	0.9000	0.7558
12	19129	0.6490	0.6490	0.6333	0.6707	0.9000	0.7347
13	19132	0.6490	0.6490	0.6333	0.6691	0.9000	0.7341
14	19137	0.6490	0.6490	0.6647	0.6647	0.9000	0.7431
15	19146	0.7118	0.7118	0.7431	0.7544	0.9000	0.7992
16	19148	0.6490	0.6490	0.6020	0.6939	0.9000	0.7319
17	19292	0.5235	0.5235	0.4451	0.5618	0.9000	0.6356
18	19293	0.5235	0.5863	0.3824	0.5728	0.9000	0.6184
19	19158	0.5863	0.5863	0.5863	0.6176	0.9000	0.7013
20	19162	0.7118	0.7118	0.6961	0.7431	0.9000	0.7797

21	19167	0.2725	0.2098	0.1627	0.2882	0.5863	0.3458
22	19295	0.4608	0.3980	0.2412	0.4539	0.5863	0.4271
23	19183	0.4608	0.3980	0.3824	0.4696	0.5863	0.4794
24	19213	0.7118	0.7118	0.6333	0.7318	0.9000	0.7551
25	19238	0.5235	0.4608	0.4451	0.5304	0.9000	0.6252
26	19239	0.5235	0.5235	0.5706	0.5706	0.9000	0.6804
27	19245	0.5863	0.5863	0.5863	0.6111	0.9000	0.6991
28	19248	0.5863	0.5863	0.4922	0.5929	0.9000	0.6617
29	19259	0.6490	0.6490	0.6490	0.6581	0.9000	0.7357
30	19260	0.7118	0.7118	0.7745	0.7275	0.9000	0.8007
31	19261	0.4608	0.3980	0.3667	0.4652	0.5863	0.4727
32	19275	0.6490	0.6490	0.6333	0.6961	0.9000	0.7431
33	19278	0.6490	0.6490	0.6176	0.6939	0.9000	0.7372
34	19282	0.2725	0.2098	0.1157	0.2769	0.5863	0.3263

4.3. Artificial Neural Network Design

The backpropagation training algorithm uses 5 input layers, 2 hidden layers, 1 output layer with a binary sigmoid activation function with the following steps:

Step 1

1. Initialization stage

As a first step, 1 respondent will be taken as an example to complete the calculation process with variable values as follows:

X_1 = 0.4608
X_2 = 0.4608
X_3 = 0.3039
X_4 = 0.4987
X_5 = 0.5863
Target = 0.4630
Learning rate (a) = 0.1

Assign a weight value (V) from the input to the hidden layer with a random value to calculate the input value in table 3 as follows:

Table 3 : Weight Value from input to hidden layer

In	V_1	V_2
X_1	0.3758	-0.2870
X_2	0.6743	0.6995
X_3	-0.8778	0,0844
X_4	-0.7844	-0,2453
X_5	0,3421	-0,7931
V_j	-0,6670	0,0640

Assign a weight value (W) from the hidden layer to the output with a random value to calculate the output value in table 4 as follows:

Table 4 : Weight value from hidden layer to output

	Y
W_1	0,8919
W_2	0,8982
W_j	-0,8909

Known:
X_1 = 0.4608 X_2 = 0.4608 X_3 = 0.3039 X_4 = 0.4987 X_5 = 0.5863
V_{11} = 0,3758 V_{12} = -0,2870 V_{21} = 0,6743 V_{22} = 0.6995 V_{31} = -0.8778
V_{32} = 0,0844 V_{41} = -0.7844 V_{42} = -0,2453 V_{51}= 0,3421 V_{52}= -0,7931
W_{11} = 0,8919 W_{12} = 0,8982 V_{j11} = -0,6670 V_{j12} = 0,0640 W_{j1} = -0,8909
t = 0.4630 *a* = 0,1

Phase I : Forward Propagation

Step 2

Each input unit receives a signal and forwards it to the hidden layer

1. Activation Stage

a. Each input receives the Xi signal and forwards the signal to all units in the hidden layer.
b. Each hidden layer unit adds the signal weight with the input using the following equation:

Z_net 1 = $V_{j11} + (X_1 * V_{11}) + (X_2 * V_{21}) + (X_3 * V_{31}) + (X_4 * V_{41}) + (X_5 * V_{51})$
K1 = -0,6670 + (0.4608 * 0.3758) + (0.4608 * 0.6743) + (0.3039 * - 0.8778) + (0,4987* - 0.7844) + (0,5863*0,3421)
= - 0,6405

Z_net 2 = V_{j12} + (X_1 * V_{12}) + (X_2 * V_{22}) + (X_3 * V_{32}) + (X_4 * V_{42}) + (X_5 * V_{52})
K_2 = 0,0640 + (0.4608*-0.2870) + (0.4608*0.6995) + (0.3039*0,0844) + (0.4987*-0,2453) +(0.5863*-0,7931)
= - 0,3076
Then calculated using the following formula.
$Z_j = f'(z\_net_1)$ = $\frac{1}{1+e^{-z\_net_j}}$
$K_1 = \frac{1}{1+e^{-(-0,6405)}}$ = 0,3451
$K_2 = \frac{1}{1+e^{-(-0,3076)}}$ = 0,4237

Step 3
The network has 1 unit of output y, so calculate the unit of output (y_k) with the formula:

$$y\_net_1 = \sum_{j=1}^{1} z_j w_{kj}$$

y_net 1 = W_j + (K_1*W_1) + (K_2*W_2)
= -0,8909 + (0,3451*0,8919) + (0,4237*0,8982)
= -0,2025
Then calculated using the following formula.
$y = f(y_{net}) \frac{1}{1+e^{-y\_net_j}}$
$y = f(y_{net}) \frac{1}{1+e^{-(-0,2025)}}$ = 0,4495

Phase II: Backpropagation
Step 4
Calculate the factor in the unit of output (y_k) with the formula:

$$\delta_k = (t_k - y_k) f'(y\_net_k) = (t_k - y_k) y_k (1 - y_k)$$

because the network only has 1 unit of output, then:
δ_1 = (t – y) y (1 – y) = (0,4630 – 0,4495) 0,4495 (1 – 0,4495) = 0,0033
Conclusion: in step 4, the expected actual output value has been obtained, when viewed with the threshold function, namely f(net) = {1 if net> 0 if net θ }, then the value data from respondent 1 can be recognized. Because 1 produces a value that is [0.0033].
Next do the weight changes using the equation w_jk= w_jk with (a = 0.1) as follows:
ΔK_{j11} = 0,1 (0,0033)(0,3451) = 0,00011
ΔK_{j12} = 0,1 (0,0033)(0,4237) = 0,00013

Step 5
In step 5, calculate the error from the hidden layer (δ) with a network that has 1 output unit, then:
δ_net_1 = (0.0033)(0,8919) = 0,0029
δ_net_2 = (0.0033)(0,8982) = 0,0030
To calculate the error information, multiply the obtained value by the derivative of the activation function with the formula:

$$\delta_j = \delta_{net\ j} f'(z_{net\ j}) = \delta_{net\ j} z_j (1 - z_j)$$

δ_1 = 0,0029 (0,3451)(1-0,3451) = 0,0006
δ_2 = 0,0030 (0,4237)(1-0,4237) = 0,0007
Then calculate the weight correction with the formula

$$\Delta V_{ji} = a\ \delta_j\ x_i$$

ΔV_{11} = $a\ \delta_j\ x_i$ = 0,1 * δ_1 * X_1
= 0,1 * 0,0006 * 0,4608 = 0,00003
ΔV_{12} = $a\ \delta_j\ x_i$ = 0,1 * δ_2 * X_1
= 0,1 * 0,0007 * 0,4608 = 0,00003
ΔV_{21} = $a\ \delta_j\ x_i$ = 0,1 * δ_1 * X_2
= 0,1 * 0,0006 * 0.4608 = 0,00003
ΔV_{22} = $a\ \delta_j\ x_i$ = 0,1 * δ_2 * X_2
= 0,1 * 0,0007 * 0,4608 = 0,00003
ΔV_{31} = $a\ \delta_j\ x_i$ = 0,1 * δ_1 * X_3
= 0,1 * 0,0006 * 0.3039 = 0,00002
ΔV_{32} = $a\ \delta_j\ x_i$ = 0,1 * δ_2 * X_3
= 0,1 * 0,0007 * 0.3039 = 0,00002
ΔV_{41} = $a\ \delta_j\ x_i$ = 0,1 * δ_1 * X_4
= 0,1 * 0,0006 * 0.4987 = 0,00003
ΔV_{42} = $a\ \delta_j\ x_i$ = 0,1 * δ_2 * X_4
= 0,1 * 0,0007 * 0.4987 = 0,00003
ΔV_{51} = $a\ \delta_j\ x_i$ = 0,1 * δ_1 * X_5
= 0,1 * 0,0007 * 0.5863 = 0,00004
ΔV_{52} = $a\ \delta_j\ x_i$ = 0,1 * δ_2 * X_5
= 0,1 * 0,0007 * 0.5863 = 0,00004
After the weight correction is obtained in table 4.8, the results of the weight changes will be added to the weight of the old hidden layer.
Table 5 : Change to hidden layer

Var	Z_1	Z_2
X_1	0,00003	0,00003
X_2	0,00003	0,00003
X_3	0,00002	0,00002
X_4	0,00003	0,00003
X_5	0,00004	0,00004

Phase III: weight update

Step 6

Calculate all the weight changes obtained

To change the weight of the output unit, it is done by the formula:

$$w_{jk} = w_{jk}(new) = w_{jk}(old) + \Delta w_{jk}$$

$w_1 = w_{jk}(new) = w_{jk}(old) + \Delta w_{jk}$
= 0,8919 + (0,0006)
= 0,8925

$w_2 = w_{jk}(new) = w_{jk}(old) + \Delta w_{jk}$
= 0,8982 + (0,0007)
= 0,8999

In table 6, the new weights from the hidden layer to the output layer have been changed.

Table 6 : New weight

W_{11}	0,8925
W_{12}	0,8999

To calculate the new weight change on the hidden layer, use the following formula:

$$v_{ij}(new) = v_{ij}(old) + \Delta v_{ij}$$

$V_{11} = v_{ij}(old) + \Delta v_{ij}$ = 0,3758 + 0,00003 = 0,37583
$V_{12} = v_{ij}(old) + \Delta v_{ij}$ = (-0,2870) + 0,00003 = - 0,28697
$V_{21} = v_{ij}(old) + \Delta v_{ij}$ = 0.6743 + 0,00003 = 0,67433
$V_{22} = v_{ij}(old) + \Delta v_{ij}$ = 0.6995 + 0,00003 = 0,69953
$V_{31} = v_{ij}(old) + \Delta v_{ij}$ = (-0.8778) + 0,00002 = - 0,87778
$V_{32} = v_{ij}(old) + \Delta v_{ij}$ = 0,0844 + 0,00002 = 0,08442
$V_{41} = v_{ij}(old) + \Delta v_{ij}$ = (-0.7844) + 0,00003 = - 0,78441
$V_{42} = v_{ij}(old) + \Delta v_{ij}$ = (-0,2453) + 0,00003 = - 0,24527
$V_{51} = v_{ij}(old) + \Delta v_{ij}$ = 0,3421 + 0,00004 = 0,34214
$V_{52} = v_{ij}(old) + \Delta v_{ij}$ = (-0,7931) + 0,00004 = - 0,79306

The calculation stage that has been carried out is called epoch I on the data of respondent 1, if the Backpropagation algorithm process has not reached the desired error, the network training process must be repeated starting from step 2 to produce an error value in accordance with expectations. The new weight in the hidden layer unit that has been obtained from the changes can be seen in table 7 which will then be used as the input weight to the hidden layer in epoch 2:

Tabel 7 : New weight on hidden layer

	V_1	V_2
X_1	0,37583	-0,28697
X_2	0,67433	0,69953
X_3	-0,87778	0,08442
X_4	-0,78441	-0,24527
X_5	0,34214	-0,79306

Phase IV: Prediction of Students' Level of Understanding of Subjects

The last stage is the result of the students' prediction of the subject. This stage is determining the level of understanding of students receiving the lessons given as follows:

Table 8 : Prediction Results with ANN Model 5-2-1

ANN Model 5-2-1		Prediction		Result Truth
No	NIS	Level	ANN - Backpropagation	
1	19289	Understand	0,0033	Yes
2	19015	Quite Understand	0,0613	Yes
3	19016	Do not Understand	-0,0710	No
4	19290	Quite Understand	0,0465	Yes
5	19042	Quite Understand	0,0709	Yes
6	19065	Quite Understand	0,0852	Yes
7	19078	Quite Understand	0,0712	Yes
8	19090	Do not Understand	-0,0607	No
9	19183	Understand	0,0088	Yes
10	19119	Quite Understand	0,0778	Yes
11	19123	Quite Understand	0,0788	Yes
12	19129	Quite Understand	0,0739	Yes

13	19132	Quite Understand	0,0737	Yes
14	19137	Quite Understand	0,0761	Yes
15	19101	Quite Understand	0,0717	Yes
16	19148	Quite Understand	0,0732	Yes
17	19292	Quite Understand	0,0488	Yes
18	19293	Quite Understand	0,0431	Yes
19	19158	Quite Understand	0,0657	Yes
20	19261	Understand	0,0070	Yes

Based on table 8, the prediction results of the understanding level of 20 respondents using the input layer values in the form of knowledge, skills, mid-semester, end-of-semester exams, and student attitudes. The value of the output unit obtained by respondent 1 as an example of calculation data is [0.0033], based on the Understanding Categorization table, respondent 1 is declared to understand the subject being taught.

5. Implementation

1. Login Form

When the program is run, a login form will appear. This form is a display to be able to access the main form by filling in the user name and password registered in the database.

Fig 3 : Login Form

2. Main Form / Home

After the admin logs in, it will enter the main menu which displays the website's home page. Here is the home page interface display.

Fig 4 : Home Form Display

3. Calculation Form

This calculation display contains the calculation of test data using ANN-Bacpropagation. The display of the calculation form can be seen in the following image.

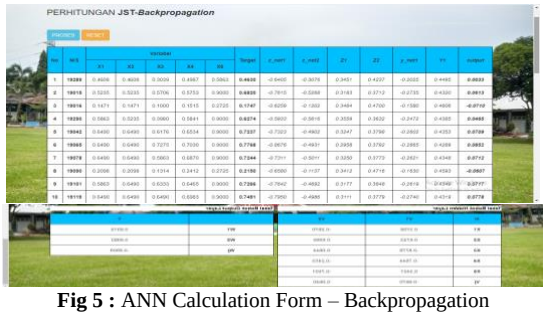

Fig 5 : ANN Calculation Form – Backpropagation

4. Information/Result Form

To be able to access the information menu on the level of student understanding, on the login menu select the student information menu. The next form is an interface that displays predictive results that can be accessed by students of SMAN 1 Perbaungan after the data is processed by the school admin.

Fig 6 : Information Form Display

6. Conclusion

After carrying out various stages, the following conclusions are obtained:

1. Artificial Neural Networks – Single layer backpropagation can be used as a method to predict the level of student understanding of the subject. Of the 20 samples of respondents who have been tested, 18 samples of respondents get predictive results of the level of understanding of the subject as expected.
2. The use of the PHP programming language and MySQL database as a system for implementing ANN – Backpropagation predicting the level of student understanding of the subject can make it easier for users to update the system if data changes are needed in the predicting process.
3. By utilizing the system that has been created, the school does not have to collect students during the current covid-19 pandemic and test students one by one to find out their level of understanding of the subject, it is enough to use the scores obtained by students during 1 semester of the academic year as test data to carry out the process of predicting their level of understanding.

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