Journal of Artificial Intelligence and Engineering Applications

Website: https://ioinformatic.org/

15th October 2023. Vol. 3. No. 1; ISSN : 2808-4519

Artificial Neural Network for Classification of Dengue Fever Using Backpropagation Algorithm

Ririn Eka Andrianti Tarigan[1], Fuzy Yustika Manik[2], I Gusti Prahmana[3]

[1,2,3]STMIK Kapuama Binjai
ririnekaadr@gmail.com[1], fuzy.yustika@gmail.com[2], igustiprahmana4@gmail.com[3]*

Abstract

Fever is an increase in body temperature to higher than usual. Normal human body temperature is at 37ºC, if the body temperature is more than this figure, it indicates a fever caused by infectious or non-infectious factors. The main symptom of Dengue hemorrhagic fever is high fever with a temperature between 30ºC - 40ºC which appears suddenly, the fever lasts for 7 days and occurs continuously, body temperature can be normal or low, then will rise slowly every day and can reach 40ºC . These two diseases are still a public health problem in urban areas, including in the cities of Binjai and Medan. The problem that has occurred so far is that people in general cannot differentiate the symptoms of Dengue Fever from Malaria, so the treatment given only provides ordinary fever medicine, so that within three days there is no change and the high body temperature makes the patient know that someone has dengue fever. Therefore, the solution provided in this research is to find out the physical characteristics experienced by the sufferer before further diagnosis is carried out. If someone has a fever above 38ºC, the body has red spots, irregular breathing, immediately go to the doctor because these symptoms indicate symptoms of dengue hemorrhagic fever or malaria fever. Artificial neural networks are an information processing system designed to imitate the workings of the human brain by carrying out a learning process through changing the weights of synapses. The human brain consists of millions of interconnected neurons known as biological neurons. Each neuron consists of a cell that has a number of dendrites (input) and an axon (output). Axons connect to other neurons through connecting pathways that produce chemical reactions when responding to incoming input. The input required includes the number of input variables, input variable values, weights, learning rate, threshold, maximum epoh and target (output) with the error value classification used is Mean Absolute Error (MAE), there are 2 types of disease with fever symptoms used. The types of disease are dengue hemorrhagic fever and malaria and the system will be designed using the Visual Basic 2010 programming language. From the results of the research that has been carried out, classification results are obtained with a value of 0.893619481 or rounded to equal 1 and classified as dengue hemorrhagic fever.

***Keywords**: Artificial Neural Networks, Classification, Dengue Fever, Backpropagation, Visual Basic.*

1. Introduction

Fever is an increase in body temperature to higher than usual. The normal human body temperature is at 37oC, if the body temperature is more than this number it indicates a fever caused by infectious or non-infectious factors. Fever is something that often occurs in humans and is an indicator that the body is fighting against dangerous substances. There are 8 types of fever that need to be watched out for, including Dengue Hemorrhagic Fever, Typhoid, Malaria, Chicken Guinea, Viral, Meningitis, Urinary Tract Infection and HIV. Of the 8 types of fever, two of them are caused by mosquitoes, namely Dengue Hemorrhagic Fever and Malaria.

The main symptoms of Dengue Hemorrhagic Fever are high fever with temperatures between 30oC - 40oC which appear suddenly, fever lasts for 7 days and occurs continuously, body temperature can be normal or low, then it will rise slowly every day and can reach 40oC . These two diseases are still a public health problem in urban areas, including in the cities of Binjai and Medan. Dengue hemorrhagic fever has a large number of sufferers and has a fairly high risk of death.

Artificial neural networks are an information processing system designed to imitate the workings of the human brain by carrying out a learning process through changing the weights of synapses. The human brain consists of millions of interconnected neurons known as biological neurons. Each neuron consists of a cell that has a number of dendrites (input) and an axon (output). Axons connect to other neurons through connecting pathways that produce chemical reactions when responding to incoming input. Dendrites and axons in the human brain act as input layers and output layers in the Artificial Neural Network as well as connecting pathways that act as synapses (Agnesia et al., 2023).

The problem that has occurred so far is that people in general cannot differentiate the symptoms of Dengue Fever from Malaria, so the treatment given only provides ordinary fever medicine, so that within three days there is no change and the high body temperature makes the patient know that someone has dengue fever. . Therefore, the solution provided in this research is to find out the physical characteristics experienced by the sufferer before further diagnosis is carried out. If someone has a fever above 38 OC, body spots,

irregular breathing, immediately go to the doctor because these symptoms indicate symptoms of dengue hemorrhagic fever or malaria fever (Fajarwati et al., 2023).
The purpose of writing this research is to identify DHF (dengue hemorrhagic fever) in patients using the Backpropagation method for initial identification results in DHF (dengue hemorrhagic fever) and to describe the level of accuracy of the Artificial Neural Network method by applying the Backpropagation algorithm in the classification of Fever. From this research it is hoped that it can provide benefits to others, namely helping to overcome the level of spread of DHF (Dengue Hemorrhagic Fever) in the City of Binjai and Medan, to find out DHF (Dengue Hemorrhagic Fever) based on rashes and symptoms suffered by patients and become reference material for researchers others who are interested in developing other research using the Backpropagation method in determining weights in artificial neural networks in the future.

2. Metodologi Penelitian

The results of the conceptualization will be poured into a complete research method with a pattern of literature studies, data collection needed to analyze the classification system that will be created, namely for the classification of dengue fever using the backpropagation method. On the basis of the research methodology used in this study, a work method activity can be created as shown in the figure below:

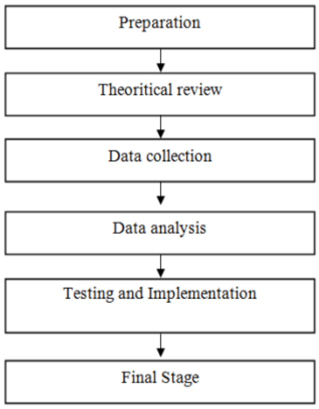

Fig. 2: The structure of the research methodology

Based on the picture above it can be explained that there are several stages used in making this application program, namely as follows:

1. Identify the Problem
   This stage is the initial stage in research, namely determining the background of the problem, objectives and benefits so that it does not leave the focus of the discussion or preparation of the thesis. At this stage the author identifies what problems exist in the object that the author has determined as the research object, namely RSU Delia, Langkat Regency, where when identifying problems in this agency, there are several problems that can be resolved using classification techniques, This problem is in the form of making decisions in classifying dengue fever, so the author conducted research on this agency to be included in the process of implementing the current final assignment. So the author can determine what work plan the author will carry out, as well as determine what data will be needed for this analysis and research process.
2. Theory Study
   At this stage the author searches for the theoretical basis obtained from various sources such as books, scientific journals, and also other references related to the research title in order to complete the research both conceptually and theoretically so that it has a good and relevant reference. Theories collected include classification, dengue fever, backpropagation methods, Matlab, flowcharts, UML (Unified Modeling Language).
3. Data collection
   At this stage the author collects data and information needed in the research. This data collection was carried out using two methods, namely as follows:
   a. Library Studies
      This study was carried out by collecting data by reading and studying books or literature and other writings that are related to the problem being studied, including seeking discussions on the classification of dengue fever, and how to calculate backpropagation results from books and journals that can be accounted for.
   b. Field Study
      Field studies conducted are using the following techniques:
   c. Observation
      Observations made are by way of direct observation of the process of activities related to the classification of dengue fever.
   d. d. Interview
      This method is used to obtain assessment data. The primary data itself is in the form of information obtained from the results of direct interviews with the relevant departments at Delia General Hospital, Langkat Regency.

4. Data analysis
   This stage is the stage of managing and analyzing the data that has been obtained so that the data can be grouped according to predetermined variables. At this stage the author performs data processing, data processing is carried out based on predetermined stages such as patient data, data transformation, backpropagation calculations, evaluation and analysis of results.
5. Testing and implementation
   This stage is the stage that carries out validation testing and implementation of previously analyzed data as well as program preparation. This stage consists of analysis, coding, and tests:

6. Analysis
   Is the stage of analyzing the things needed in building a dengue fever classification system using the backpropagation method. The results obtained can be used as information, which information can be used as a reference for agencies in carrying out the assessment process.
7. Design
   This process translates the data that has been analyzed into a software design. This stage includes the design of flowcharts, use case diagrams, and interface design.
8. Final Stage
   This stage is the stage of drawing conclusions and suggestions that can be done in preparing the thesis. With the conclusion, the overall results will be known and it is hoped that with suggestions there will be improvements and benefits for others.

2.1. Artificial neural networks

Artificial neural networks are networks of a group of small processing units that are modeled on human neural networks. Artificial neural network is an adaptive system that can change its structure to solve problems based on external and internal information flowing through the network. In simple terms, ANN is a non-linear statistical data modeling tool. ANN can be used to model complex relationships between input and output to find patterns in data (Rohayani et al., 2022; Siregar & Octariadi, 2021).
Artificial Neural Networks have developed rapidly in recent years. Artificial Neural Networks were developed before the existence of sophisticated conventional computers and continue to develop even though they have experienced a period of hiatus for several years (Damanik et al., 2021).

2.2. Demam berdarah

Dengue fever is an infectious disease caused by a virus that is transmitted through mosquito bites. This disease causes symptoms of high fever, headache, and bone and muscle pain. If not treated properly, dengue fever is life threatening (Fajarwati et al., 2023).
Dengue fever or DHF can affect children and adults. This disease is transmitted when a mosquito carrying the dengue virus bites a person with dengue fever, then bites a healthy person. This disease is commonly found in tropical climates, including Indonesia, and the incidence of this disease usually increases during the rainy season (Dewi et al., 2023).

2.3. Algoritma Backpropagation

The Backpropagation Algorithm is a systematic method on artificial neural networks using supervised learning algorithms and is usually used by perceptrons with multiple screen layers to change the weights in the hidden layer (Ramli et al., 2021). Algoritma Backpropagation is a controlled type of training which uses a weight adjustment pattern to achieve a minimum error value between the predicted output and the real output (Yuniati, 2021). In detail the Backpropagation network training algorithm, namely:

1. Initialize weights (take initial weights with fairly small random values).
2. Set the maximum Epoch, Target error, and learning rate.
3. Initialization *Epoch = 0.*
4. Do the following steps as long as the condition is false, namely with the following steps:
   a. Forward propagation stages
      1) Each input unit ($x_{i,}$ i=1,2,3,......n) menerima signal xi and forwards the signal to the layer above it (hidden layer).
      2) Each unit in a hidden layer (zj, j=1,2,3,…,p) sums up the weighted signals:
         $$z\_in_j = v0_j + \sum_{i=1}^{n} xi\ v_{ij} \quad (1)$$
         Use the activation function to calculate the output signal:
         $$z_j = f(Z\_in_j) \quad (2)$$
         And send the signal to all units in the upper layers (output units).
      3) Each output unit (($y_{k,}$ $\mathrm{k} = 1,2,3,\ldots\ldots$ m) sums the weighted input signals.
         $$y\_in_k = w0_k + \sum_{j=1}^{p} zi\ v_{jk} \quad (3)$$
         Use the activation function to calculate the output signal:
         $$y_k = f(y\_in_k) \quad (4)$$
         And send the signal to all units on the top layer (output units).
   b. Stages of Backpropagation
      1. Each unit of output ($y_{k,}$ k=1,2,3,.....,m) receive a target pattern that is related to the learning input pattern. Calculate the error information.
         $$\sigma_k = (t_k - y_k)\, f'(y\_in_k\,) \quad (5)$$
         Then calculate the weight correction (which will later be used to correct w_{jk}).
         $$\Delta w_{jk} = \alpha\ \sigma_k z_{ij} \quad (6)$$
         Also calculate the bias correction (which will later be used to correct the value w_{0k}).
         $$\Delta w_{jk} = \alpha\ \sigma_k \quad (7)$$
         Send this σ_k to the units with the bottom layer.
      2. Each unit is hidden ($z_{j,}$ j=1,2,3,.....,p) summing the input delta (of the units in the upper layer).
         $$\sigma\_in_j = \sum_{k=1}^{m} \sigma k\ w_{jk\text{-}} \quad (8)$$
         Multiply this value by the derivative of the activation function to calculate the error information.
         $$\sigma_j = \sigma\_in_j\ f'(z\_in_j) \quad (9)$$
         Then calculate the weight correction (which will later be used to correct the value v_{ij}) .
         $$\Delta v_{jk} = \alpha\ \sigma_j\ xi \quad (10)$$
         Also calculate the bias correction (which will later be used to correct the value v_{0j}).
         $$\Delta v_{jk} = \alpha\ \sigma_{j.} \quad (11)$$

c. Stages of Change in Weights and Bias
   1) Each output unit ($y_{k,}$ k=1,2,3,.....,m) correct the bias and weights (j=0,1,2,3,.....,p).
      $w_{jk}(\text{new}) = w_{jk}(\text{old}) + \Delta w_{jk}$ (12)
   2) Each unit is hidden ($z_{j,}$ j=1,2,3,.....,p) correct the bias and weights (i=0,1,2,3,.......,n).
      $v_{ij}(\text{new}) = v_{ij}(\text{old}) + \Delta w_{ij}$ (13)

3. Analysis and Design

3.1. Analysis of the Backpropagation method process

Research data is really needed in solving a problem, this research data will later be used as material to analyze the application of methods in research. In this study, patient data was obtained from RSU Delia Langkat which was issued by the relevant department regarding the classification of dengue fever from the results of medical examinations. The following is the data obtained, namely from Delia General Hospital, Langkat Regency regarding the classification of dengue fever:

1. Disease Classification Data

Table 1: Disease Classification Data

No	Code	Disease Name
1	1	Dengue fever
2	3	Malaria

2. Symptom Data

Table 2: Symptom Data

No	Coce	Symptom Name
1	G01	Headache
2	G02	Vomit
3	G03	Persistent Fever
4	G04	Bloodstains
5	G05	Fever Continues to Rise
6	G06	Shivering Body

3. Patient data

Table 3: Patient data

No	Name	Address	Gender	Age	Symptom Code						Diagnosa
					G01	G02	G03	G04	G05	G06	
1	AN	Selesai	Male	26	Yes	No	Yes	No	Yes	No	Dengue fever
2	KN	Kutamnew	Female	54	Yes	Yes	No	Yes	Yes	Yes	Dengue fever
3	NS	Salapian	Female	24	Yes	No	Yes	No	Yes	No	Dengue fever
4	HR	Selesai	Male	30	Yes	Yes	No	No	Yes	Yes	Malaria
5	MD	Kuala	Male	28	Yes	No	Yes	Yes	Yes	No	Dengue fever
6	DY	Kuala	Male	31	Yes	Yes	No	No	Yes	Yes	Malaria
7	SC	Selesai	Female	24	Yes	Yes	No	No	Yes	Yes	Malaria
8	AR	Kuala	Male	3	Yes	Yes	No	No	Yes	Yes	Malaria
9	JK	Salapian	Female	2	Yes	Yes	Yes	Yes	Yes	No	Dengue fever
10	SF	Selesai	Male	47	Yes	No	Yes	No	Yes	No	Dengue fever
11	EL	Selesai	Female	38	Yes	Yes	No	No	Yes	Yes	Malaria
12	AT	Kuala	Male	19	Yes	Yes	No	No	Yes	Yes	Malaria
13	DF	Kuala	Male	18	Yes	Yes	No	No	Yes	Yes	Malaria
14	FH	Selesai	Female	14	Yes	Yes	No	No	Yes	Yes	Malaria
15	WY	Kuala	Female	38	Yes	No	Yes	No	Yes	No	Dengue fever
16	AW	Bahorok	Male	40	Yes	No	Yes	No	Yes	No	Dengue fever
17	IY	Kutamnew	Female	61	Yes	No	Yes	No	Yes	No	Dengue fever
18	NR	Kuala	Male	67	Yes	Yes	No	Yes	Yes	Yes	Dengue fever
19	RK	Selesai	Male	46	Yes	No	Yes	No	Yes	No	Dengue fever
20	ML	Salapian	Female	42	Yes	Yes	Yes	Yes	Yes	No	Dengue fever

Each training data uses 6 patterns and testing data uses 6 data patterns, the target data is the feasibility result data. The table below is the training data values, in the form of patient data that has been transformed:

Table 4: Transformasi data pasien

No	Name	Address	Gender	Age	Trainning Data						Training Targets
					G01	G02	G03	G04	G05	G06	
1	AN	Selesai	Male	26	1	0	1	0	1	0	Dengue fever
2	KN	Kutamnew	Female	54	1	1	0	1	1	1	Dengue fever

No	Name	Address	Gender	Age	Trainning Data						Training Targets
					G01	G02	G03	G04	G05	G06	
3	NS	Salapian	Female	24	1	0	1	0	1	0	Dengue fever
4	HR	Selesai	Male	30	1	1	0	0	1	1	Malaria
5	MD	Kuala	Male	28	1	0	1	1	1	0	Dengue fever
6	DY	Kuala	Male	31	1	1	0	0	1	1	Malaria
7	SC	Selesai	Female	24	1	1	0	0	1	1	Malaria
8	AR	Kuala	Male	3	1	1	0	0	1	1	Malaria
9	JK	Salapian	Female	2	1	1	1	1	1	0	Dengue fever
10	SF	Selesai	Male	47	1	0	1	0	1	0	Dengue fever
11	EL	Selesai	Female	38	1	1	0	0	1	1	Malaria
12	AT	Kuala	Male	19	1	1	0	0	1	1	Malaria
13	DF	Kuala	Male	18	1	1	0	0	1	1	Malaria
14	FH	Selesai	Female	14	1	1	0	0	1	1	Malaria
15	WY	Kuala	Female	38	1	0	1	0	1	0	Dengue fever
16	AW	Bahorok	Male	40	1	0	1	0	1	0	Dengue fever
17	IY	Kutamnew	Female	61	1	0	1	0	1	0	Dengue fever
18	NR	Kuala	Male	67	1	1	0	1	1	1	Dengue fever
19	RK	Selesai	Male	46	1	0	1	0	1	0	Dengue fever
20	ML	Salapian	Female	42	1	1	1	1	1	0	Dengue fever

Information :
Yes = 1
No = 0

Process manually using data that has been transformed with the results of Dengue Fever. The calculations use the backpropagation method, namely as follows:

Table 5: Process data

Variabel Input		Targets
A1	1	1 (Dengue fever)
A2	0	
A3	1	
A4	0	
A5	1	
A6	0	

Artificial neural network architecture using the backpropagation method consists of:

1. The input layer (Xi) consists of 6 neurons.
2. The hidden layer (Zi) consists of 5 neorons.
3. The output layer (Yi) consists of 1 neuron.
4. Learning rate (α) = 0.2
5. Target error = 0.01
6. Bias constant.

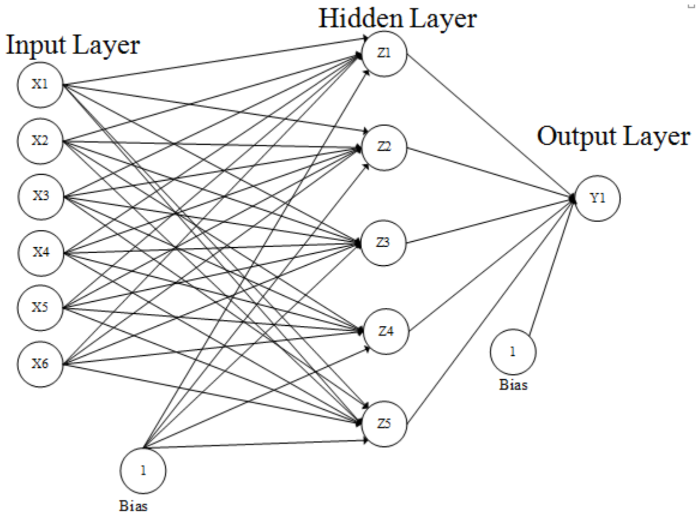

Fig. 2: Drawing of Artificial Neural Network Architecture for the classification of dengue fever using the Backpropagation method

Information :
Xi : Input layer 6 neurons
Zj : hidden layer 5 neurons.

Yk : Layer output 1 neuron.
Vij : The weight on the hidden layer.
Wij : The weight on the output layer.
V0j : Bias on the hidden layer.
W0j : Bias in the output layer.
I,j,k : 1,2,3....n.
n : The number of neurons in one layer.
1 : Bias constant.

The initial weights connecting the neurons in the input layer and the hidden layer (V11, V1-n, V21, V2-n) and the bias weights V01, and V0n are chosen randomly. Likewise, the initial weights connecting the neurons in the hidden layer and the output layer (W11, W12, ..., W1n) and the bias weight W01 are also chosen randomly.
The following is a training calculation using the backpropagation method.
Initialization is set as follows:

1. *Learning rate* (α) = 0,2
2. *Error Targets* = 0,01
3. *Maximum Epoch* = 10000
4. Targets (T) = 1

Random initialization of weights is as follows:

1. The initial weight of the input to the hidden layer (V_{ij}):

V11 = 0,1	V12 = 0,2	V13 = 0,3	V14 = 0,4	V15 = -0,2
V21 = 0,3	V22 = 0,1	V23 = 0,4	V24 = 0,2	V25 = -0,5
V31 = -0,2	V32 = -0,3	V33 = 0,2	V34 = -0,5	V35 = 0,1
V41 = 0,4	V42 = 0,4	V43 = 0,1	V44 = 0,1	V45 = 0,3
V51 = 0,2	V52 = -0,1	V53 = 0,5	V54 = 0,2	V55 = -0,3
V61 = 0,1	V62 = 0,2	V63 = 0,1	V64 = -0,3	V65 = 0,5

2. The initial weight is biased towards the hidden layer (V_{0j}) :
V01 = 0,2 V02 = 0,1 V03 = 0,3 V04 = 0,5 V05 = 0,4
3. Initial weight of the hidden layer to the output layer (W_{jk})
W11 = 0,2 W21 = 0,3 W31 = 0,2 W41 = 0,4 W51 = 0,2
4. The initial weight is biased towards the output layer (W_{0j}) :
W01 = 0,1

- -Advanced propagation stage

Operations on the hidden layer with the equation:

$Z\_in_1 = V_{01} + \sum_{i=1}^{12} x_1 V_{i1})$
$Z\_in_1 = 0{,}2 + (1 * 0{,}1) + (0 * 0{,}3) + (1 * -0{,}2) + (0 * 0{,}4) + (1 * 0{,}2) + (0 * 0{,}1)$
$= 0{,}30$
$Z\_in_2 = V_{02} + \sum_{i=1}^{12} x_1 V_{i2})$
$Z\_in_2 = 0{,}1 + (1 * 0{,}2) + (0 * 0{,}1) + (1 * -0{,}3) + (0 * 0{,}4) + (1 * -0{,}1) + (0 * 0{,}2)$
$= -0{,}10$
$Z\_in_3 = V_{03} + \sum_{i=1}^{12} x_1 V_{i3})$
$Z\_in_3 = 0{,}3 + (1 * 0{,}3) + (0 * 0{,}4) + (1 * 0{,}2) + (0 * 0{,}1) + (1 * 0{,}5) + (0 * 0{,}1)$
$= 1{,}30$
$Z\_in_4 = V_{04} + \sum_{i=1}^{12} x_1 V_{i4})$
$Z\_in_4 = 0{,}5 + (1 * 0{,}4) + (0 * 0{,}2) + (1 * -0{,}5) + (0 * 0{,}1) + (1 * 0{,}2) + (0 * 0{,}2)$
$= 0{,}60$
$Z\_in_5 = V_{05} + \sum_{i=1}^{5} x_1 V_{i5})$
$Z\_in_5 = 0{,}4 + (1 * -0{,}2) + (0 * 0{,}5) + (1 * 0{,}1) + (0 * 0{,}3) + (1 * -0{,}3) + (0 * 0{,}5)$
$= 0{,}00$

Fungsi aktivasi *sigmoid biner* pada *hidden layer* dengan persamaan :

$Z_1 = \frac{1}{1+e^{-z\_in_1}} = \frac{1}{1+e^{-0{,}30}} = 0{,}57444$
$Z_2 = \frac{1}{1+e^{-z\_in_2}} = \frac{1}{1+e^{-(-0{,}10)}} = 0{,}47502$
$Z_3 = \frac{1}{1+e^{-z\_in_3}} = \frac{1}{1+e^{-1{,}30}} = 0{,}78583$
$Z_4 = \frac{1}{1+e^{-z\_in_4}} = \frac{1}{1+e^{-0{,}60}} = 0{,}5000$
$Z_5 = \frac{1}{1+e^{-z\_in_4}} = \frac{1}{1+e^{-0}} = 0{,}5000$

Operations on the output layer with the equation $Y\_in_1 = W_{k1} + \sum_{i=1}^{3} Z_j W_{kj})$:
$Y\_in_1 = 0{,}1 + (0{,}57444 * 0{,}1) + (0{,}47502 * 0{,}3) + (0{,}78583 * 0{,}2) + (0{,}50 * 0{,}4) + (0{,}50 * 0{,}2) = 0{,}81538$

Binary sigmoid activation function in the output layer with equation:
$Y_1 = \frac{1}{1+e^{-y\_in_1}} = \frac{1}{1+e^{-0{,}81538}} = 0{,}693255$
Check for errors (iteration stops if there is an error < 0,01)
Layer error $Y_1 = 1 - 0{,}693255 = 0{,}3067452$
Sum of squared errors = $(0{,}3067452)^2 = 0{,}094092638$

- Backpropagation stage

$\delta_1 = (T_1 - y) * (\frac{1}{1+e^{-y\_in_1}})*[1-(\frac{1}{1+e^{-y\_in_1}})]$

$\delta_1 = (1 - 0{,}693255)* (\frac{1}{1+e^{-0{,}81538}})*[1-(\frac{1}{1+e^{-0{,}81538}})] = 0{,}065230$

W_{kj} weight change term (with α = 0.2):

Calculate the weight correction with the equation:

ΔW11 = αδ1Z1 = 0,2 * 0,06523 * 0,574443 = 0,00749
ΔW21 = αδ1Z2 = 0,2 * 0,06523 * 0,475021 = 0,00620
ΔW31 = αδ1Z3 = 0,2 * 0,06523 * 0,785835 = 0,01025
ΔW41 = αδ1Z4 = 0,2 * 0,06523 * 0,645656 = 0,00842
ΔW51 = αδ1Z5 = 0,2 * 0,06523 * 0,500000 = 0,00652

Calculate the bias correction with the following equation:

$\Delta W_{01} = \alpha\delta_1 = 0{,}2 * 0{,}06523 = 0{,}01305$

The hidden unit sums the input deltas:

δ_in_1	=	$\sum_{k=1}^{m} \delta_1 W_{1k})$	=	0,06523	*	0,1	=	0,00652
δ_in_1	=	$\sum_{k=1}^{m} \delta_1 W_{2k})$	=	0,06523	*	0,3	=	0,01957
δ_in_1	=	$\sum_{k=1}^{m} \delta_1 W_{3k})$	=	0,06523	*	0,2	=	0,01305
δ_in_1	=	$\sum_{k=1}^{m} \delta_1 W_{4k})$	=	0,06523	*	0,4	=	0,02609
δ_in_1	=	$\sum_{k=1}^{m} \delta_1 W_{5k})$	=	0,06523	*	0,2	=	0,01305

Calculate the output information with the equation:

$\delta_1 = \delta\_in_1 * (\frac{1}{1+e^{-z\_in_1}})*[1-(\frac{1}{1+e^{-z\_in_1}})]$

$\delta_1 = 0{,}00652 * (\frac{1}{1+e^{-0{,}30}})*[1-(\frac{1}{1+e^{-0{,}30}})] = 0{,}00159$

$\delta_2 = \delta\_in_2 * (\frac{1}{1+e^{-z\_in_2}})*[1-(\frac{1}{1+e^{-z\_in_2}})]$

$\delta_2 = 0{,}01957 * (\frac{1}{1+e^{-(-0{,}10)}})*[1-(\frac{1}{1+e^{-(-0{,}10)}})] = 0{,}00488$

$\delta_3 = \delta\_in_3 * (\frac{1}{1+e^{-z\_in_3}})*[1-(\frac{1}{1+e^{-z\_in_3}})]$

$\delta_3 = 0{,}01305 * (\frac{1}{1+e^{-1{,}30}})*[1-(\frac{1}{1+e^{-1{,}30}})] = 0{,}00220$

$\delta_4 = \delta\_in_4 * (\frac{1}{1+e^{-z\_in_4}})*[1-(\frac{1}{1+e^{-z\_in_4}})]$

$\delta_4 = 0{,}02609 * (\frac{1}{1+e^{-0{,}60}})*[1-(\frac{1}{1+e^{-0{,}60}})] = 0{,}00597$

$\delta_5 = \delta\_in_5 * (\frac{1}{1+e^{-z\_in_5}})*[1-(\frac{1}{1+e^{-z\_in_5}})]$

$\delta_5 = 0{,}01305 * (\frac{1}{1+e^{-(-0)}})*[1-(\frac{1}{1+e^{-0)}})] = 0{,}00326$

Calculate the weight correction with the equation:

ΔV11 = α δ1X1 = 0,2 * 0,00159 * 1 = 3,1904
ΔV12 = α δ2X1 = 0,2 * 0,00488 * 1 = 9,7604
ΔV13 = α δ3X1 = 0,2 * 0,00220 * 1 = 4,3904
ΔV14 = α δ4X1 = 0,2 * 0,00597 * 1 = 1,1903
ΔV15 = α δ5X1 = 0,2 * 0,00326 * 1 = 6,5204

ΔV21 = α δ1X2 = 0,2 * 0,00159 * 0,00 = 0,00
ΔV22 = α δ2X2 = 0,2 * 0,00488 * 0,00 = 0,00
ΔV23 = α δ3X2 = 0,2 * 0,00220 * 0,00 = 0,00
ΔV24 = α δ1X2 = 0,2 * 0,00597 * 0,00 = 0,00
ΔV25 = α δ2X2 = 0,2 * 0,00326 * 0,00 = 0,00

ΔV31 = α δ1X3 = 0,2 * 0,00159 * 1 = 3,1904
ΔV32 = α δ2X3 = 0,2 * 0,00488 * 1 = 9,7604
ΔV33 = α δ3X3 = 0,2 * 0,00220 * 1 = 4,3904
ΔV34 = α δ4X3 = 0,2 * 0,00597 * 1 = 1,1903
ΔV35 = α δ5X3 = 0,2 * 0,00326 * 1 = 6,5204

ΔV41 = α δ1X4 = 0,2 * 0,00159 * 0,00 = 0,00
ΔV42 = α δ2X4 = 0,2 * 0,00488 * 0,00 = 0,00
ΔV43 = α δ3X4 = 0,2 * 0,00220 * 0,00 = 0,00
ΔV44 = α δ1X4 = 0,2 * 0,00597 * 0,00 = 0,00
ΔV45 = α δ2X4 = 0,2 * 0,00326 * 0,00 = 0,00

ΔV51 = α δ1X5 = 0,2 * 0,00159 * 1 = 3,1904
ΔV52 = α δ1X5 = 0,2 * 0,00488 * 1 = 9,7604
ΔV53 = α δ1X5 = 0,2 * 0,00220 * 1 = 4,3904
ΔV54 = α δ1X5 = 0,2 * 0,00597 * 1 = 1,1903
ΔV55 = α δ1X5 = 0,2 * 0,00326 * 1 = 6,5204

ΔV61 = α δ1X6 = 0,2 * 0,00159 * 0,00 = 0,00
ΔV62 = α δ2X6 = 0,2 * 0,00488 * 0,00 = 0,00
ΔV63 = α δ3X6 = 0,2 * 0,00220 * 0,00 = 0,00
ΔV64 = α δ4X6 = 0,2 * 0,00597 * 0,00 = 0,00
ΔV65 = α δ5X6 = 0,2 * 0,00326 * 0,00 = 0,00

Calculate the bias correction with the equation:
ΔV01 = α δ1 = 0,2 * 0,00159 = 0,000319
ΔV02 = α δ2 = 0,2 * 0,00488 = 0,000976
ΔV03 = α δ3 = 0,2 * 0,00220 = 0,000439
ΔV04 = α δ4 = 0,2 * 0,00597 = 0,001194
ΔV05 = α δ5 = 0,2 * 0,00326 = 0,000652

Calculate changes in weight and bias with the equation:
V11(New) = V11(Old) + ΔV11 = 0,1 + 3,18904 = 0,10
V12(New) = V12(Old) + ΔV12 = 0,2 + 9,76004 = 0,20
V13(New) = V13(Old) + ΔV13 = 0,3 + 4,39104 = 0,30
V14(New) = V14(Old) + ΔV14 = 0,4 + 1,19403 = 0,40
V15(New) = V15(Old) + ΔV15 = 0,2 + 6,52304 = -0,20

V21(New) = V21(Old) + ΔV21 = 0,3 + 0,00 = 0,30
V22(New) = V22(Old) + ΔV22 = 0,1 + 0,00 = 0,10
V23(New) = V23(Old) + ΔV23 = 0,4 + 0,00 = 0,40
V24(New) = V24(Old) + ΔV24 = 0,2 + 0,00 = 0,20
V25(New) = V25(Old) + ΔV25 = 0,5 + 0,00 = -0,50

V31(New) = V31(Old) + ΔV31 = 0,2 + 3,1904 = -0,199681
V32(New) = V32(Old) + ΔV32 = 0,3 + 9,7604 = -0,299024
V33(New) = V33(Old) + ΔV33 = 0,2 + 4,3904 = 0,200439
V34(New) = V34(Old) + ΔV34 = 0,5 + 1,1903 = -0,498806
V35(New) = V35(Old) + ΔV35 = 0,1 + 6,5204 = 0,100652

V41(New) = V41(Old) + ΔV41 = 0,4 + 0,00 = 0,40
V42(New) = V42(Old) + ΔV42 = 0,4 + 0,00 = 0,40
V43(New) = V43(Old) + ΔV43 = 0,1 + 0,00 = 0,10
V44(New) = V44(Old) + ΔV44 = 0,1 + 0,00 = 0,10
V45(New) = V45(Old) + ΔV45 = 0,3 + 0,00 = 0,30

V51(New) = V51(Old) + ΔV51 = 0,2 + 3,1904 = 0,200319
V52(New) = V52(Old) + ΔV52 = 0,1 + 9,7604 = -0,099024
V53(New) = V53(Old) + ΔV53 = 0,5 + 4,3904 = 0,500439
V54(New) = V54(Old) + ΔV54 = 0,2 + 1,1903 = 0,201194
V55(New) = V55(Old) + ΔV55 = 0,3 + 6,5204 = -0,299348

V61(New) = V61(Old) + ΔV61 = 0,1 + 0,00 = 0,10
V62(New) = V62(Old) + ΔV62 = 0,2 + 0,00 = 0,20
V63(New) = V63(Old) + ΔV63 = 0,1 + 0,00 = 0,10
V64(New) = V64(Old) + ΔV64 = 0,3 + 0,00 = -0,30
V65(New) = V65(Old) + ΔV65 = 0,5 + 0,00 = 0,50

V01(New) = V01(Old) + ΔV01 = 0,2 + 3,1904 = 0,200319
V02(New) = V02(Old) + ΔV02 = 0,1 + 9,7604 = 0,100976
V03(New) = V03(Old) + ΔV03 = 0,3 + 4,3904 = 0,300439
V04(New) = V04(Old) + ΔV04 = 0,5 + 1,1903 = 0,501194
V05(New) = V05(Old) + ΔV05 = 0,4 + 6,5204 = 0,400652

W11(New) = W11(Old) + ΔW11 = 0,1 + 7,4903 = 0,107494
W12(New) = W12(Old) + ΔW12 = 0,3 + 6,2003 = 0,306197
W13(New) = W13(Old) + ΔW13 = 0,2 + 1,0302 = 0,210252
W14(New) = W14(Old) + ΔW14 = 0,4 + 8,4203 = 0,408423
W15(New) = W15(Old) + ΔW15 = 0,2 + 6,5203 = 0,206523

W01(New) = W01(Old) + ΔW01 = 0,1 + 1,3002 = 0,113046

$Y_1 = \frac{1}{1+e^{-y\_in_1}} = \frac{1}{1+e^{-0,81538}} = 0,693255$
Check for errors (iteration stops if there is an error < 0,01)
Layer error Y_1 = 1 – 0,693255 = 0,3067452
Sum of squared errors = $(0,3067452)^2$ = 0,094092638

For one iteration using the backpropagation method the result is 0.693255 with the sum of squared errors = 0.094092638, so the results achieved are not in accordance with the target. Because it has a difference of 0.3067452, it must be repeated again until it converges or until the maximum epoch or squared error < target error (0.01).
From the example calculation above to reach the target error, it is iterated up to the 37th iteration with the following results:

$Y_1 = \frac{1}{1+e^{-y\_in_1}} = \frac{1}{1+e^{-2,128257583}} = 0,893619481$

Check for errors (iteration stops when error<0.01)
Y1 layer error = 1 – 0.893619481= 0.1334719
Sum of squared errors = (0.1334719)2 = 0.017814758
From the calculation above, a classification result is obtained with a value of 0.893619481 or rounded up to equal 1 (dengue hemorrhagic fever). The results of the above calculations are as follows:

Table 6: Results of the Backpropagation process

Variabel	Input	Targets
A1	1	0,893619481= 1 (Dengue hemorrhagic fever)
A2	0	
A3	1	
A4	0	
A5	1	
A6	0	

3.2. System flow design

In designing an artificial neural network system using the backpropagation algorithm, we want to classify dengue fever. The design of the training and testing process on artificial neural networks can be seen in the flowchart as shown below:

1. Use case diagram
   A use case diagram is a representation or model used in software engineering that shows a set of use cases and actors and the relationship between them as shown in the following figure:

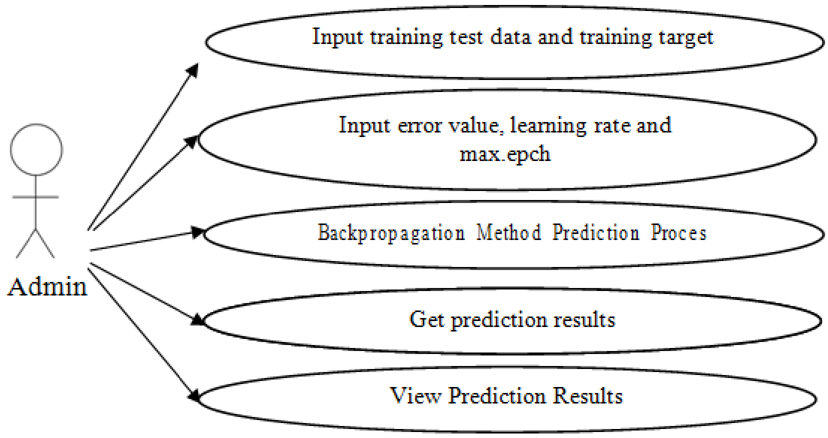

Fig. 3: Designing use case diagrams

   In the use case above, it can be described as follows:
   a. Admin is an actor.
   b. Admin can input training data and test data into the artificial neural network application for classification of dengue fever using the backpropagation method.
   c. Admin can make changes to training data and test data, aadmin inputs epoch, learning rate, and target error using the backpropagation method.
   d. Admin performs the training process and data testing.
   e. Admin can see the results of the training and testing process.
2. Program Flowchart
   The flowchart begins with a terminal symbol which marks the start of system work. Then the steps continue when entering training data in the form of data on symptoms experienced by the patient, hidden layer and output layer. After that, determine the maximum epoch, target error and learning rate. Then train the data by calculating the forward propagation and backward propagation, if it does not converge, then the process is repeated until the training data converges. If the training data has converged, input the test data and then test the data. Classification results are known and the process is complete. But if the training data does not match, then the process is repeated until the target is achieved. The test target is said to be convergent if the results are close to the target error:

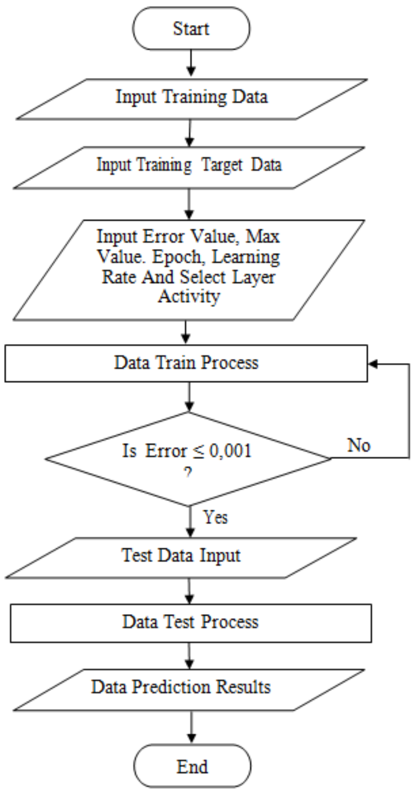

Fig. 4: Flowchart Design Program

The system flowchart description above is as follows:
1. Starting with inputting training data and training target data.
2. Next, input the output layer error value, max. epoch, learning rate and determines layer activity.
3. The process of training data with calculations using the Backpropagation method.
4. Check the error, is it smaller than 0.001; if yes, then input test data, if not then the system will process it until the error is less than or equal to 0.001; Finished.
5. After the data test process is complete, the predicted results of the data data will be displayed, complete.

4. Conclusion

After the author performs analysis analysis, in closing the writing of this research, the authors draw conclusions about the classification system for dengue fever using the Backpropagation algorithm, the conclusions are as follows:
1. Stages of the Artificial Neural Network in the classification prediction process for dengue fever using the Backpropagation algorithm using 3 years of data obtained from Delia Langkat General Hospital. The data prediction process is carried out in 2 stages, namely the data training and data testing stages.
2. Design and development of a classification system for dengue fever using the Backpropagation algorithm utilizing the Visual Basic 2010 programming application. The system was built using the stages of the Artificial Neural Network process by implementing the Backpropagation method in the programming script, and the system built can be easily understood by users when using the system data prediction.
3. The test results on the implementation of the Artificial Neural Network on the data prediction system were successfully carried out, by inputting a maximum epoch value of 10000, a target error value of 0.001 and a learning rate of 0.2, the result was that the final prediction value was 0.893619481 or 1 classified as dengue hemorrhagic fever from the processed patient data.

Acknowledgement

In preparing this research, the author received a lot of help and suggestions for guidance in completing this research, both in the form of guidance and constructive criticism. Through this opportunity, the author would like to express a very big thank you to:
1. Mr. Dr. Relita Buaton, S.Kom., M.Kom., as chairman of STMIK Kaputama.
2. Mrs. Yani Maulita, S.Kom., M.Kom., as head of the Information Systems Study Program.
3. Mrs. Fuzy Yustika Manik, S. Kom., M. Kom., as Supervisor I lecturer who provided input that helped the author in completing this research while providing guidance.
4. Mr. I Gusti Prahmana, S.Kom., M.Kom., as Supervisor II lecturer who has provided input that helped the author in completing this research while providing guidance.
5. All STMIK Kaputama teaching lecturers who have provided a lot of knowledge while the author has attended the lectures.
6. All staff and employees of STMIK Kaputama who have provided enthusiasm and good administrative services, after the author completes his lectures.
7. Special to my father, mother and the entire family who have provided enthusiasm, affection, support and also sincere prayers while the author is attending lectures at STMIK Kaputama.

8. And also all friends of the Information Systems Study Program class of 2019, who have provided support, sincere prayers and enthusiasm for the author during his lectures at STMIK Kaputama.

References

[1] Agnesia, Y., Nopianto, Sari, S. W., & Ramadhani, D. W. (2023). Demam Berdarah Dengue (DBD) : Determinan & Pencegahan. In *NEM*.

[2] Damanik, E. H., Irawan, E., & Rizki, F. (2021). Jaringan Syaraf Tiruan Untuk Memprediksi Nilai Siswa SMA Menggunakan Backpropagation. *Jurnal Sistem Informasi Dan Ilmu Komputer Prima(JUSIKOM PRIMA)*, *4*(2), 1–7. https://doi.org/10.34012/jurnalsisteminformasidanilmukomputer.v4i2.1500

[3] Dewi, D. A. I. P., Lely, A. A. O., & Aryastuti, S. A. (2023). Gambaran Faktor Risiko Penyakit Demam Berdarah Dengue pada Anak di Wilayah Kerja Puskesmas Tabanan I. *Aesculapius Medical Journal*, *3*(1).

[4] Fajarwati, E., Nurvinanda, R., & Mardiana, N. (2023). Pengaruh Pemberian Terapi Tepid Sponge Water untuk Mengatasi Hipertermi pada Pasien Demam Berdarah Dengue. *Jurnal Penelitian Perawat Profesional*, *5*(2). https://doi.org/10.37287/jppp.v5i2.1542

[5] Ramli, Nurhayati, & Saragih, R. (2021). Jaringan Syaraf Tiruan Memprediksi Kebutuhan Alat Suntik Medis Dirumah Sakit Menggunakan Backpropagation, (Studi Kasus : RSU Bathesda). *JIKSTRA*, *3*(1).

[6] Rohayani, H., Josh, J., Choirul Umam Fakultas Sains Dan Teknologi, M., Muhammadiyah Jambi, U., Jl Kapten Pattimura, J., Sipin, S. I., Telanaipura, K., & Jambi, K. (2022). Prediksi Penentuan Program Studi Berdasarkan Nilai Siswa dengan Metode Backpropagation. *Journal of Information System Research*, *3*(4), 122–132.

[7] Siregar, A. C., & Octariadi, B. C. (2021). Perbandingan Metode Jaringan Syaraf Tiruan Pada Klasifikasi Motif Kain Tenun Sambas. *CYBERNETICS*, *4*(02). https://doi.org/10.29406/cbn.v4i02.2489

[8] Yuniati, F. (2021). Aplikasi Jaringan Syaraf Tiruan Untuk Memprediksi Prestasi Siswa SMU Dengan Metode Backpropagation. *Universitas Islam Negeri Sunan Kalijaga*, *6*(1), 1–9.