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Multilayer Perceptron Performance Analysis in Liver Disease Classification

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Abstract: Liver disease is a liver disease caused by viruses, alcohol, lifestyle and others. Someone often does not realize or is late to know liver disease so that when examined liver disease is severe, it would be better if treatment is done early by knowing the symptoms suffered. Data mining can help diagnose liver disease more easily, especially to help doctors determine whether patients suffer from liver disease or not, with symptoms almost close to liver disease. The process of diagnosing liver disease is carried out by a classification process and the result is that the patient suffers from liver or not. This research uses a data mining classification method using an artificial neural network method, namely Multilayer Perceptron. The Indian Liver Patient Dataset (ILPD) used in this study was obtained from the UCI Machine Learning Repository. The division of the data set over the training data and test data is done by Cross Validation. Performance measurement of the method uses confusion matrix. Based on the research conducted, it was found that the application of Multilayer Perceptron resulted in varying accuracy based on testing with different Fold values with the highest accuracy of 83.70% when the Fold was 7, and the lowest accuracy of 80.57% when the Fold was 3. Then the average accuracy of all Fold tests is 82.13%

Keywords: Liver Disease; Multilayer Perceptron; Classification; Confusion Matrix.

INTRODUCTION

In our body there are several important organs each of which functions very useful, one of which is the liver. The liver is an organ in our body that has the largest size and has a very important function (Rosida, 2016). The function of the liver is as a place for glycogen storage, helps the process of bile formation and secretion, urea synthesis, acts as cholesterol and fat metabolism and the main function of the liver as a detoxification of toxins or neutralizers of toxins (Hikmah & Yasa, 2021). With the presence of the liver, our bodies will avoid various toxins that can interfere with health (Rizki, 2020). The liver can also be attacked by diseases that cause the liver to be unable to function as usual and even cause death, liver disease is a liver disease that has long existed and is quite common in the community (Patimah et al., 2021).

According to WHO (World Health Organization) data shows almost 1.2 million people per year, especially in Southeast Asia and Africa, die from liver disease (Baiq Nurul Azmi et al., 2023). Factors causing liver disease include liver disorders that have been present since birth, viral or bacterial infections, alcohol addiction, active smoking and poor lifestyle and many others (Abrar et al., 2023). If liver disease attacks and damages the liver, the body's ability will slowly decrease, especially the ability to neutralize toxins that enter our bodies, it will harm the body if not treated immediately (Jaddoa et al.,

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2023). So far, many people do not realize whether they have liver disease or not even though they have liver symptoms, even among them do not try to come to the doctor and check their complaints (Rafsanjani et al., 2018). Almost everyone experiences delays in treatment because they only check when liver disease is severe (Amrin & Pahlevi, 2021). To overcome these problems, a system is needed that is able to determine whether a person is classified as a liver patient or not so that early and routine examinations can be carried out so that liver disease treatment can be done quickly for sufferers. The system is able to generate classifications with the help of data mining algorithms.

Classification is one method of data mining supervised learning, which requires training data that has been labeled as learning to estimate the class of an object whose class is not yet known (Siregar et al., 2021). Data mining consists of many algorithms that can be used for the classification process, one of which is Multilayer Perceptron which is an algorithm within the scope of Artificial Neural Networks. The characteristics possessed by Multilayer Perceptron are advantages in determining weight values better than other methods Multilayer Perceptron can be used without prior knowledge and algorithms can be implemented easily and are able to solve linear and nonlinear problems (Prasetya Wibawa et al., 2020). Based on the characteristics possessed by Multilayer Perceptron, it makes the prediction value better (Putra et al., 2021).

In this case, the classification process with the Multilayer Perceptron algorithm aims to determine whether the patient is affected by liver disease or not with the ILPD (Indian Liver Patient Dataset). So in this study the author will apply the Multilayer Perceptron method to classify liver diseases using a dataset derived from the UCI Machine Learning Repository, namely ILPD (Indian Liver Patient Dataset). And also to see the results of the performance of the Multilayer Perceptron method in the classification of liver diseases.

LITERATURE REVIEW

Here are some previous studies in the scope of data mining or machine learning that have been applied to complete disease predictions such as research by Erdiansyah in 2022 examining the application of Multilayer Perceptron which is an artificial neural network method in the classification of diabetic retinopathy. From the test results in the study, the accuracy of testing the Multilayer Perceptron method was obtained with test evaluation using the Confusion Matrix with prediction accuracy results of 71.80% (Erdiansyah, Lubis, et al., 2022).

Research in 2015, Rahmati conducted a study using Naïve bayes and C4.5 on data on Liver Patients. To measure the performance of the two algorithms, Cross Validation, and Split Percentace testing methods are used, and the measure is using a confusion matrix. The result obtained is that C4.5 has a higher accuracy with a value of 69.828% than Naïve Bayes with a value of 63.362%. Thus C4.5 provides better problems for identifying liver disease.

Research from Sari & Mar'atullatifah in 2023 examines the application of the multilayer perceptron method for breast cancer identification. From the test results in the study, the accuracy of testing the Multilayer Perceptron method with 3-layers was obtained by producing predictions with an accuracy value of 93.59% (Sari & Mar’atullatifah, 2023).

METHOD

Stages of Research

This research is carried out through the stages of research as shown in figure 1 below:

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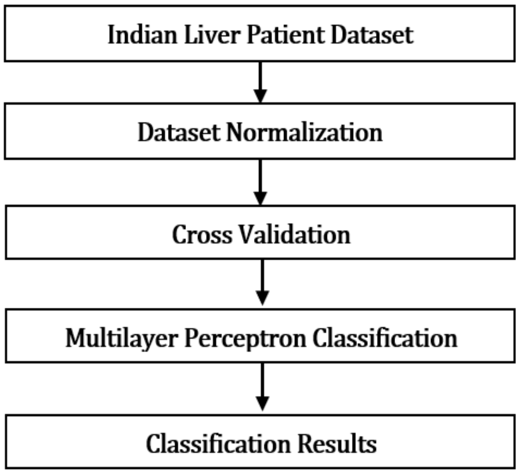

Figure 1. Research Flow

The explanation of the stages of research in Figure 1 shown above is as follows:

1. The Indian Liver Patient Dataset (ILPD) is preparing a data set to be tested in this study which is a data set derived from the UCI Machine Learning Repository.
2. Dataset normalization is a process for data cleaning before classification is carried out in this study.
3. Cross Validation is dividing training data and test data.
4. Multilayer Perceptron is to carry out the classification process on the data tested.
5. Classification results are to discuss the results of testing methods used on the data tested.

Dataset

This study used a dataset obtained from the UCI Machine Learning Repository website, the Indian Liver Patient Dataset (ILPD). This dataset contains data collected from patients in northeastern Andhra Pradesh, India. The dataset contained 416 patients with liver while 167 patients were not liver, data on male patients were 441 and 142 female patients. This dataset has 11 attributes of which 10 attributes are regular attributes while 1 attribute as a class or label is shown in table 1, and has 583 instances or data bodies. Instances in this dataset do not have missing values so all attributes contain values in good condition and ready to be processed (Lubis et al., 2022).

Cross Validation

Cross Validation is a random process that divides a data set into K continuous discount points of approximately equal size and each fold is used alternately to test the model induced by the classification algorithm x by other K-1 folds (Lubis et al., 2022). In Figure 2 here is an example of the *Cross Validation process schema*.

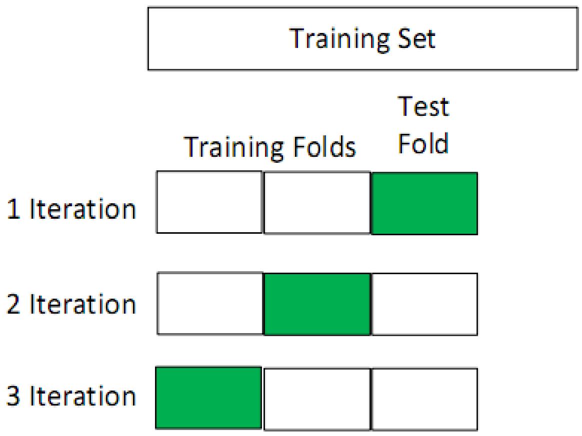

Figure 2. Cross Validation Process Flow

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Multilayer Perceptron

Multilayer Perceptron is one type of Artificial Neural Network that is widely used in various classification and regression applications in various fields of speech recognition, pattern and other classification problems (Erdiansyah, Lubis, et al., 2022). In MLP, perceptrons are connected to form several layers. An MLP has an input layer, at least one hidden layer, and an output layer. Multilayer Perceptron (MLP) is usually referred to as the multilayer backpropagation method (Putra et al., 2021). This algorithm uses error output in changing the weight value called backward. To get the error value, the first step that is done is the forward propagation stage (Resha & Syamsu, 2021). An example of a multilayer perceptron architecture is presented in figure 3 below:

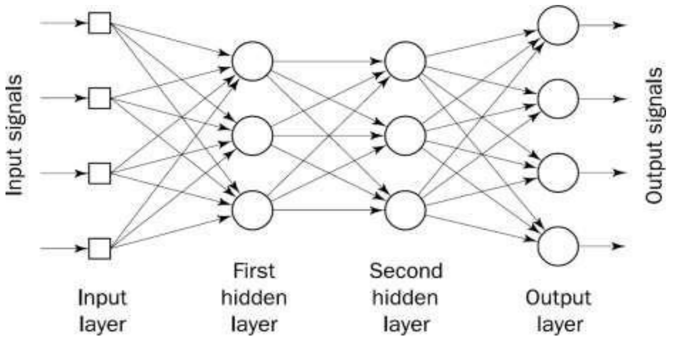

Figure 3. Multilayer Perceptron Architecture

Backpropagation is an algorithm used in *multilayer perceptron* training. The stages carried out in this algorithm, namely (Prasetya Wibawa et al., 2020):

1. Initialization

   Each weight connecting all existing neurons is assigned a random value with an even distribution and a small range.
2. Activation (*Feed-forward*)

   The activation or feed-forward process will input all existing inputs into the artificial neural network to produce output. Activation of the artificial neural network is performed using the expected input output .
3. Training of Weights

   Update or update the value of each weight in the artificial neural network will be done by propagating back to errors in the output layer.
4. Iteration

   Adding one loop value and returning to step 2 will be done if the *error* criteria are not as expected. The reverse propagation training algorithm is completed when *the error* criteria are as expected.

Confusion Matrix

Confusion Matrix serves to measure classification performance in the form of *Accuracy*, Precision, *and Recall, and serves for* classifier quality (Lubis & Chandra, 2023). Table 1 is the following table of the *Confusion Matrix*:

Table 1. Table of Confusion Matrix

ACTUAL CLASS	ASSIGNED CLASS	
	POSITIVE	NEGATIVE
POSITIVE	TRUE POSITIVE	FALSE NEGATIVE
NEGATIVE	FALSE POSITIVE	TRUE NEGATIVE

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True Positive and *True Negative* are the conditions of the prediction results in accordance with actual conditions. While *False Positive* and *False Negative* are conditions of prediction results with conditions that are not true. Accuracy, precision, and *recall measurements* can be calculated using the formula:

$$Acuracy = \frac{TP+TN}{TP+TN+FP+FN} \quad (1)$$

$$Recall = \frac{TP}{TP+FN} \quad (2)$$

$$Precision = \frac{TP+TN}{TP+FP} \quad (3)$$

RESULT

Dataset Information

The following displays attribute data information and detailed data on the Indian Liver Patient Dataset (ILPD) used in this study obtained from the *UCI Machine Learning Repository* can be seen in Table 2 and Table 3 below:

Table 2. Information Data Records Indian Liver Patient Dataset (ILPD)

No	**X1**	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**	**X10**	Class
1	65	Female	0.7	0.1	187	16	18	6.8	3.3	0.9	1
2	62	Male	10.9	5.5	699	64	100	7.5	3.2	0.74	1
3	62	Male	7.3	4.1	490	60	68	7	3.3	0.89	1
4	58	Male	1	0.4	182	14	20	6.8	3.4	1	1
5	72	Male	3.9	2	195	27	59	7.3	2.4	0.4	1
6	46	Male	1.8	0.7	208	19	14	7.6	4.4	1.3	1
7	26	Female	0.9	0.2	154	16	12	7	3.5	1	1
8	29	Female	0.9	0.3	202	14	11	6.7	3.6	1.1	1
9	17	Male	0.9	0.3	202	22	19	7.4	4.1	1.2	2
10	55	Male	0.7	0.2	290	53	58	6.8	3.4	1	1
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
583	**38**	**Male**	**1**	**0.3**	**216**	**21**	**24**	**7.3**	**4.4**	**1.5**	2

Table 3. Attribute Information Indian Liver Patient Dataset (ILPD)

Attribute	Information	Marker
Age	Age of the patient	X1
Gender	Gender of the patient (Female: 0, Male:1)	X2
TB	Total bilirubin patient	X3
DB	Direct bilirubin patients	X4
Alkphos	Alkaline phospotase	X5
Sgpt	Alamine aminotransferase	X6
Sgot	Aspartate aminotransferase	X7
TP	Total protiens	X8
ALB	Albumin	X9
A/G	Albumin dan Globulin ratio	X10
Ratio Dataset	Selector/Class/Label to determine whether the patient has liver or not	Output

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Among some of the attributes above, there are several important attributes that can determine whether the patient is suffering from liver disease. The important attributes that determine patients affected by liver disease are an increase in total bilirubin (TB), an increase in SGPT (Alamine Aminotransferase), an increase in SGOT (Asparte Aminotransferase), a decrease in albumin (ALB) (Gobel, 2018).

Table 4. Target of Attribute Indian Liver Patient Dataset (ILPD)

No.	Output	Number of Data Records
1	Liver	416
2	Non-Liver	167
Total		583

Data Preprocessing Stages

Data preprocessing is carried out before the classification process on the data set to be tested. In this study, preprocessing was carried out by applying a min-max normalization technique with a minimum data value equal to 0 and a maximum value equal to 1. The calculation of the *normalization of min-max* uses the following equation (4) (Erdiansyah, Irmansyah Lubis, et al., 2022):

$$N^* = \frac{N - min(n)}{max(n) - min(n)} \quad (4)$$

The normalization results obtained are in Table 5 below:

Table 5. Results of Normalization Indian Liver Patient Dataset (ILPD)

No.	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
1.	0.709	1	0.004	0	0.060	0.003	0.001	0.594	0.521	0.24
2.	0.674	0	0.140	0.275	0.310	0.027	0.018	0.695	0.5	0.176
3.	0.674	0	0.092	0.204	0.208	0.025	0.011	0.623	0.521	0.236
4.	0.627	0	0.008	0.015	0.058	0.002	0.002	0.594	0.543	0.28
5.	0.790	0	0.046	0.096	0.064	0.008	0.009	0.666	0.326	0.04
6.	0.488	0	0.018	0.030	0.070	0.004	0.001	0.710	0.760	0.4
7.	0.255	1	0.006	0.005	0.044	0.003	0.004	0.623	0.565	0.28
8.	0.290	1	0.006	0.010	0.067	0.002	0.002	0.579	0.586	0.32
9.	0.151	0	0.006	0.010	0.067	0.006	0.001	0.681	0.695	0.36
10.	0.593	0	0.004	0.005	0.110	0.021	0.009	0.594	0.543	0.28
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
583.	0.395	0	0.008	0.010	0.074	0.005	0.002	0.666	0.760	0.48

Classification Testing with Multi-Layer Perceptron

Furthermore, the classification testing process was carried out with *Multilayer Perceptron*. Then for testing with *Multilayer Perceptron using* Cross Validation *evaluation techniques* with *fold* testing from values 1 to 10 and each is tested to obtain the correct amount of data (*Correct*) and incorrect data (*Incorrect*) from the classification results to calculate the accuracy value. Then determine the parameters of the Artificial Neural Network in data classification testing with Multilayer Perceptron against the tested data set. The parameters used are:

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Table 6. Test Parameter Multilayer Perceptron

No.	Parameter	Value
1.	Learning Rate	0.1
2.	Momentum	0.9
3.	Hidden Layer	1
4.	Number of Neurons	5
5.	Error Tolerance Limit	0.001

In shortening the time of testing the proposed classification method, in this study the author used the help of Waikato Environment for Knowledge Analysis (WEKA). The example of the display of test results with Multilayer Perceptron using WEKA in Figure 4 and the classification results obtained with Multilayer Perceptron are in Table 5 below.

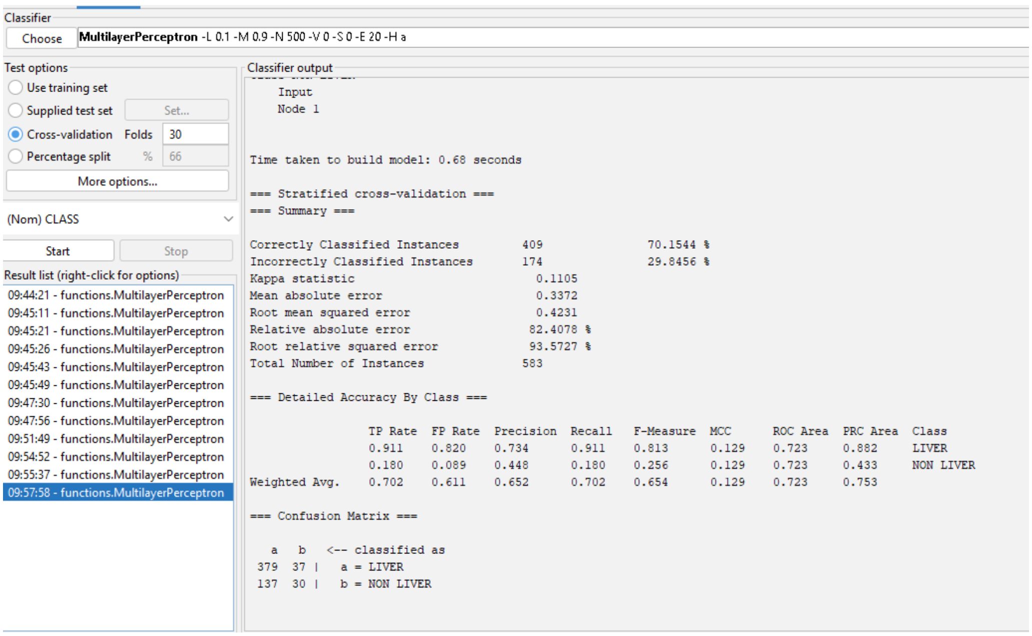

Figure 4. Illustration of Multilayer Perceptron Classification Testing with WEKA

Then for the results of all tests with Multilayer Perceptron using Fold 1 to 10 test parameters, namely in Table 7 below:

Table 7. Indian Liver Patient Dataset Classification Results With Multilayer Perceptron

Fold	Correct Data Amount	Incorrect amount of data	*Accuracy* (%)	*Precision* (%)	*Recall* (%)
1	459	124	82.90	83.20	82.90
2	455	128	81.77	82.20	81.77
3	452	131	80.57	81.50	80.57
4	455	128	81.77	82.20	81.77
5	457	126	82.50	82.77	82.50
6	457	126	82.50	82.77	82.50
7	461	122	83.70	84.00	83.70
8	457	126	82.50	82.77	82.50
9	456	127	82.10	82.50	82.10
10	453	130	81.00	81.70	81.00
Average			**82.13**	**82.56**	**82.13**

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From the research that has been conducted, an overall accuracy value of 82.13% was obtained with a total sample data of 583 data records, where the accuracy value is quite good in classifying liver disease medical record data using the MLP (*Multilayer Perceptron*) method.

DISCUSSIONS

In this study, the performance measurement of the Multilayer Perceptron algorithm uses classification evaluation based on confusion matrix calculations in measuring *Accuracy*, *Precision*, and *Recall* values. Then the process to divide the amount of training data and test data uses the mechanism of Cross Validation with testing using variations in the Fold value in Cross Validation. Based on testing from the research conducted, it was found that the application of Multilayer Perceptron resulted in varying accuracy based on testing with different Fold values with the highest accuracy of 83.70% when the Fold was 7, and the lowest accuracy of 80.57% when the Fold was 3. Then the average accuracy of all Fold tests is 82.13%

CONCLUSION

From the results of the research that has been done, it can be concluded that the classification of Indian Liver Patient Dataset (ILPD) medical record data using the Multilayer Perceptron algorithm is quite good in the Indian Liver Patient Dataset (ILPD) which is a testing instrument in this study. This can be seen from the accuracy value obtained by 82.13%. Where the precision value is 82.56%, and recall is 82.13%. For further development suggestions, it can be tested by selecting attributes before classifying to obtain attributes that have a significant influence on the data set so as to improve the accuracy of data set classification.

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