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Analytic Predictive of Hepatitis using The Regression Logic Algorithm

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***Abstract*— Hepatitis is an inflammation of the liver which is one of the diseases that affects the health of millions of people in the world of all ages. Predicting the outcome of this disease can be said to be quite challenging, where the main challenge for public health care services itself is due to a limited clinical diagnosis at an early stage. So by utilizing machine learning techniques on existing data, namely by concluding diagnostic rules to see trends in hepatitis patient data and see what factors are affecting patients with hepatitis, can make the diagnosis process more reliable to improve their health care. The approach that can be used to carry out this prediction process is a regression technique. The regression itself provides a relationship between the independent variable and the dependent variable. By using the hepatitis disease dataset from UCI Machine Learning, this study applies a logistic regression model that provides analysis results with an accuracy rate of 83.33%.**

Keywords—Hepatitis, Prediction Analysis, Regression Techniques, Public Health, Big Data

INTRODUCTION

Hepatitis is a chronic disease where when the person has been infected, the condition is still healthy and has not shown the typical symptoms and signs, but the transmission continues. This is what causes viral hepatitis referred to as an iceberg phenomenon, where registered patients or those who come to health services are fewer than the actual number of sufferers. Hepatitis can occur due to viruses, bacteria, drugs, alcohol consumption, excess fat, and autoimmune diseases[1], which has caused around 1.5 million deaths every year worldwide[2]. Hepatitis itself is divided into five types, namely hepatitis A, B, C, D, and E [1] [3][4]where the hepatitis is not related to one another.

Predicting hepatitis which is a global public health problem is challenging to do. In addition to being able to help in answering the need for a diagnosis at an early stage for decision making about health care as to what needs to be given, predictions can also provide a picture of an unknown future condition. The many techniques used in predictive analytic processes[5], with the help of variables used for measurement, the probabilities that emerge are expected to give reliable results.

In this study, a regression technique in machine learning used is logistic regression for the prediction of hepatitis by using a dataset obtained from the UCI Machine Learning Repository. This method looks at the relationship between independent variables or so-called predictors with the dependent variable (target) of existing data[6]. Therefore, logistic regression can be used for datasets that have categorical variables and are used to solve classification problems, so this study aims to see how this logistic regression method can be used in predicting hepatitis using existing datasets and see what factors affect patients to be able to survive, and how the level of accuracy and predictive analysis provided. It is expected that later in this study can provide reliable predictive results and prove the use of appropriate methods.

RELATED WORKS

Machine learning is one of the effective ways that can be used in the biomedical world. This is seen from how machine learning approaches an approach to making good and automatic algorithms that can be used in the process of diagnosis or disease prediction for the decision making process [7] looking at the amount of data generated in the health field, and also the difficult data management process, various approaches are offered using existing machine learning methods[8].

Some research was carried out by looking at some parameters such as Age, Sex, Steroids, Antivirals, Fatigue, Malaise, Anorexia, Liver Big, Liver Firm, Spleen Palpable, Ascites Spiders, Arices, Bilirubin, Alk 'Phosphate', Sgot, Albumin, and Protime and Histology, to see the advantages of ensemble learning. Where the proposed method is the Neuro-Fuzzy Inference system with a better accuracy rate of 93.06%[2]. Another method that is also used is the Autoregressive integrated moving average (ARIMA) model and the generalized neural network (GRNN)[9], by analyzing data and initiating predictions of cirrhosis of the liver (chronic hepatitis C) namely Esophageal varices using various machine learning approaches available [10].

Looking at the performance analysis of several methods in machine learning for the process of diagnosis and predictive analysis [5] one of them with the highest accuracy of 84.52% given by the Naive Bayes method [6]. A hybrid artificial intelligence classifier is also proposed by applying the geometric margin maximization criteria of the LSVM (Lagrangian Support Vector Machine)[11] where this is to predict whether the patient will survive or die. By comparing the performance of logistic regression with some commonly used machine learning techniques[12], the study was conducted in addition to using existing datasets, also considering discussions with specialists in their fields[1], so that diagnosis and prediction are also made in patients with Necroinflammation with chronic hepatitis B (CHB) who do not experience clear clinical symptoms[3].

So by looking at various existing studies, then in this study used a logistic regression method that can provide accurate results and predictive analysis that can be relied upon to determine the factors that influence the survival of patients with hepatitis.

A. Logistics Regression

Logistic regression is a method for finding the best matching model by providing a relationship between the independent variable and the dependent variable. In the process, data analysis usually has many independent variables that help determine results. Also, it is only measured by variables that have two possible outcomes[6]. This method explains the results through a mathematical transformation that allows all values to be weighted with a value between 0 and 1 [13].

$$p = 1/1 + e^{-y} \quad (1)$$

Where y = β0 + β1X1 + β2X2 + β3X3 + β4X4 and e being Euler's number. β0 is the constant, β1 is the coefficient for variable X1, β2 is the coefficient for variable X2, and so on[14].

B. Classification of Performance Measures

In the process of evaluating the performance and classification results obtained, a performance metrics model is used which is explained as follows:

1) *Confusion Matrix*: one technique that can be used in measuring performance to find the truth and accuracy of a model. By providing information comparing the results of classifications conducted by the system with actual classification results. Most performance metrics are based on the confusion matrix and the numbers in it[13]. Following are the terms related to the confusion matrix, which can be seen in the following table:

TABLE I. CONFUSION MATRIX

Prediction Result	Real Situation	
	Positive Class	Negative Class
Positive Class	TP	FP
Negative Class	FN	TN

- True Positive (TP): is a condition in which the case is worked on, the data is true (positive data) and correctly predicted.
- False Negative (FN): is a condition where the actual class of data is true (positive) and predicted to be false or in other words, the model is predicted as negative data while the data is positive.
- False Positive (FP): is a condition in which the actual class of data points is false (is negative data) and predicted as positive data (true).
- True Negative (TN): is the condition of the actual data is wrong (negative data) and correctly predicted as negative data (false).

The following explains the two metrics that are also generated from the table above, namely precision (P) and recall (R):

$$P = \frac{TP}{TP+FP} \quad (2)$$

$$R = \frac{TP}{TP+FN} \quad (3)$$

The precision value is the ratio of positive true predictions compared to the overall positive predicted results, while the recall value aims to determine what the ratio of true positive predictions is compared to all true positive data.

2) Accuracy

Accuracy is the ratio of true (positive and negative) predictions to the overall data based on the confusion matrix table obtained. Accuracy calculations are obtained using the following formula:

$$Accuracy = \frac{TP+TN}{TP+FN+FP+TN} \quad (4)$$

3) F1- Score

Is a weighted average of the precision and recall values, which can be seen in the formula below:

$$F1\ Score = \frac{2*P*R}{P+R} \quad (5)$$

RESEARCH METHODOLOGY

There are several stages used in this study, which are explained in the figure below:

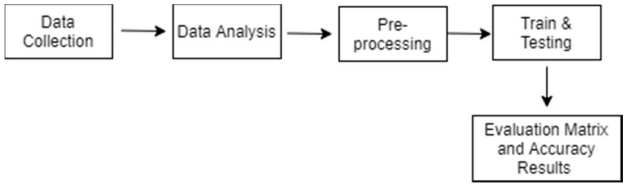

Fig. 1. Stages of the method implementation

In this study, the implementation phase starts with the process of collecting data, analyzing the process of checking the accuracy of the results obtained. More details are explained as follows :

1) Data collection

The process of data collection/collection of datasets needed in research. In this case, to predict hepatitis, the dataset used will be obtained from the UCI Machine Learning Repository[15].

2) Data analysis

In this process, the dataset that has been obtained is analyzed according to the needs of the study. Look at all the factors that exist in hepatitis and the relationship between one variable with another variable so that later it can be used optimally.

3) Data allowance / pre-processing

Doing data removal or cleaning by eliminating data that is not valuable or data that is not needed in the existing dataset for the prediction process.

4) Train & Test

After eliminating the data that is not needed, then the training and testing process is done using existing datasets. For this process, the data needs to be divided into two for training needs and the testing process.

5) Evaluation Matrix and Accuracy Results

From the existing training and testing stages, the results obtained are then checked for accuracy as to what, to then be made a conclusion on the desired prediction results and also as an analysis material needed in research.

RESULT AND DISCUSSION

In obtaining the results in this study, researchers used Python as a tool that helps in the analysis process to achieve accuracy. The process undertaken to achieve this begins with a preliminary analysis of the data that has been obtained from UCI Machine Learning to find out the interrelationships of information contained in the data. For hepatitis, based on small interviews conducted with relevant medical personnel and according to the data obtained are divided into two categories, namely clinical symptoms and laboratory examination results. Clinical symptoms consist of steroids, antivirals, fatigue, malaise, anorexia, liver big, liver firm, spleen palpable, spiders, ascites, varices, and histology while for the category of laboratory examination results consist of bilirubin, alk phosphate, SGOT, albumin, and protime.

After knowing the information contained in the data used by conducting the data analysis process, the next process is pre-processing the data. In this stage, the removal or removal of data that is not used or worthless is carried out. From 155 available data, it is obtained that there is valuable information on the attributes of steroids, fatigue, malaise, anorexia, liver big, liver firm, spleen palpable, spiders, ascites, varices, bilirubin, alk phosphate, SGOT, albumin, and protime. However, not all data that is valuable in these attributes is a large percentage. For more details, you can see the following picture:

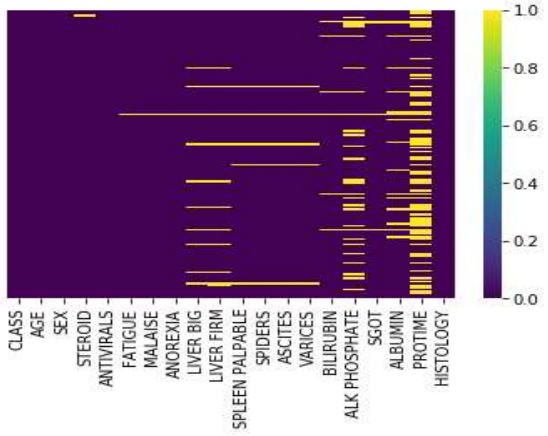

Fig. 2. Information that has no value in the dataset

In Figure 2, it can be seen that the attribute that has the most valuable information is protime so that in the process of eliminating this data, the researcher removes all information that is not valuable in the dataset so that it can be used optimally in the next process. The remaining dataset after the pre-processing of data is 80 data. This data is then used to train and test data stages and obtain accuracy.

A. Train and Test data

In this process, the attributes contained in the data are divided into two, namely training data and testing data. The goal is to build a model using training data and predict output with its test data, by determining the dependent and independent variables as the initial step. In the training process, the value of x is expressed as an influence (independent variable) and the value of y is expressed as being influenced or dependent on the value of other variables (the dependent variable). The following tables 2 and 3 represent the two variables in question:

TABLE II. INPUT VARIABLE (INDEPENDENT VARIABLE)

No.	Attributes	Values
1	Age	7 - 78 years
2	Sex	Male, Female
3	Steroid	No, Yes
4	Antivirals	No, Yes
5	Fatigue	No, Yes
6	Malaise	No, Yes
7	Anorexia	No, Yes
8	Liver Big	No, Yes
9	Liver Firm	No, Yes
10	Spleen Palpable	No, Yes
11	Spiders	No, Yes
12	Ascites	No, Yes
13	Varices	No, Yes
14	Bilirubin	0.3 - 4.8
15	Alk Phosphate	26 - 295
16	Sgot	14 - 420
17	Albumin	2.1 - 5.3
18	Protime	21 - 100
19	Histology	No, Yes

TABLE III. OUTPUT VARIABLE (DEPENDENT VARIABLE)

No.	Attributes	Values
1	Class	Die, Live

In the two tables above, the x values consist of age, sex, steroid, fatigue, malaise, anorexia, liver big, liver firm, palpable spleen, spiders, ascites, varices, bilirubin, alk phosphate, SGOT, albumin, and protime. (output) is a class attribute that represents two conditions of hepatitis patients, namely death and/or survival.

After the process of determining input and output variables, the dataset used in the study is then divided by a percentage of 70% of the overall data used for the training process while for the testing process 30% of the entire dataset is used. Next is the use of the logistic regression model algorithm to train and test and predict the data.

B. Evaluation of Classification and Accuracy Results

The prediction stage is done by testing a predetermined dataset and through a training process that has been done before with the existing logistic regression model. The results obtained from the performance of the model are then calculated with evaluation metrics such as accuracy,

precision, and recall [4] to obtain a comparison of the resulting classification results. Obtaining the level of accuracy represents the ability of the existing algorithm in assessing the overall data. The higher the accuracy obtained, the better the classification[1]. Therefore, this study uses a confusion matrix to display the results of the analysis obtained. The following tables 4 and 5 are the results of a classification in the confusion matrix and other classification performance measures:

TABLE IV. CLASSIFICATION RESULTS IN THE CONFUSION MATRIX

Prediction Result	Real Situation	
	Positive Class	Negative Class
Positive Class	3	0
Negative Class	4	17

TABLE V. SHOWS OTHER CLASSIFICATION PERFORMANCE MEASURES

	Precision	Recall	F1 Score
Die	0.43	1.00	0.60
Live	1.00	0.81	0.89
Avg	0.71	0.90	0.75

Table 4 above shows the classification results generated by the system, with real and negative class real situation values consisting of a true positive, false negative, false positive, and true negative which indicate that 30% of the test data from all the datasets used, generated true prediction of true (positive) data has a value of 3, negative data condition (false) which is predicted as positive data (true) has a value of 0, positive data predicted to be false data (negative) has a value of 4 and negative data condition (false) and correctly predicted as negative data is 17.

While table 5 shows the performance measures with the evaluation metrics used. The first row represents the class "Die" with a precision value of 0.43, a recall value of 1.00, and an F-1 score of 0.60 while the second row in the table represents the "Live" class with a precision value of 1.00, recall 0.81, F-1 score 0.89. The avg is the average value of the two classes. With each value, a precision value of 0.71, recall of 0.90, and F-1 score of 0.75. The obtained accuracy level is 0.8333 or 83.33%; then, the results can be accepted.

Besides, from the data and analysis of research that has been done, it is known that patients suffering from hepatitis in addition to being seen through the results of existing laboratory examinations, in clinical symptoms, there are several factors that also most influence on patients who survive or die, including endurance body, diet and body needs for nutrition, and healthy liver function (big heart).

In existing patient data, these three factors are seen from clinical symptoms called antivirals, anorexia, and liver big. Therefore patients with hepatitis need to continue to maintain a healthy and balanced lifestyle and endurance.

CONCLUSION

The conclusions that can be conveyed from the results and discussions in this study are:

1. The use of logistic regression as a prediction method is good enough to answer the research objectives by obtaining an accuracy rate of 83.33%.
2. Factors that affect patients with hepatitis in addition to the results of laboratory tests, clinical symptoms that need to be considered are endurance, diet, and nutritional needs of the body, as well as maintaining healthy liver function through the two previous factors.

Future advice in research is to be able to use a larger and more complex amount of data, more directed by the types of hepatitis, and be able to make comparisons using more than one classification model.

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