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## Classification of Heart Disease Risk Factors Using Decision Tree at Rantauprapat Regional Hospital

Quratih Adawiyah<sup>1)</sup>, Riyan Agus Faisal<sup>2)</sup>, Nailatun Nadrah<sup>3)</sup>, Juni Purwanto<sup>4)</sup>, Baginda Restu Al Ghazali<sup>5)</sup>

<sup>1,5)</sup> Information Systems, Faculty of Computer Science, Ika Bina Institute of Technology and Health

<sup>2)</sup> Nursing, Faculty of Health Sciences, Ika Bina Institute of Technology and Health

<sup>3)</sup> Midwifery, Faculty of Health Sciences, Ika Bina Institute of Technology and Health

<sup>4)</sup> Information Technology, Faculty of Computer Science, Ika Bina Institute of Technology and Health

\*Corresponding Author

Email : [quratihadawiyah29@gmail.com](mailto:quratihadawiyah29@gmail.com)

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### Abstract

*Heart disease is one of the leading causes of death in Indonesia, so it is important to identify risk factors that contribute to the increasing incidence of heart disease. This study aims to classify risk factors for heart disease using the Decision Tree method with the CART (Classification and Regression Tree) algorithm at Rantauprapat Regional Hospital. The data used includes factors such as Age, High Blood Pressure, High Cholesterol Levels, Body Mass Index (BMI), Family History, Smoking, Unhealthy Diet, and Low Physical Activity. The results of the analysis show that the factors Age, High Blood Pressure, and High Cholesterol Levels have a significant effect on the increased risk of heart disease, with a model accuracy of 80%. Although this model successfully classifies high risk well, there are some errors in identifying low risk, as reflected in the Recall value (0.67). This study shows that the Decision Tree model with the CART algorithm can be an effective tool in identifying risk factors for heart disease and provides a strong basis for medical personnel to design more personalized interventions.*

**Keywords:** *Decision Tree, CART, Heart Disease, Classification, Rantauprapat Regional Hospital*

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## INTRODUCTION

Heart disease remains one of the leading causes of death worldwide, including in Indonesia. According to data from the World Health Organization (WHO), cardiovascular disease, including heart disease, accounts for nearly 30% of all global deaths. In Indonesia, the incidence of heart disease continues to increase every year, especially in urban areas with unhealthy lifestyles. Heart disease not only causes physical and mental burdens for sufferers, but also adds a significant economic burden to the health system. Therefore, early detection and prevention of heart disease are very important in efforts to reduce the prevalence and impact of this disease.

Rantauprapat Regional Hospital, as one of the largest hospitals in Labuhanbatu Regency, North Sumatra, has complete health data on patients treated, including risk factors related to heart disease. This hospital has adequate facilities for treating heart disease, but preventive efforts through risk data analysis are very important to prevent this disease early. Identification of risk factors accurately can help medical personnel in designing more targeted and effective preventive measures.

Heart disease risk factors fall into two main categories: modifiable and non-modifiable factors. Modifiable factors include lifestyle habits that can be changed, such as smoking, unhealthy diet, lack of physical activity, and obesity. Meanwhile, non-modifiable factors are factors that cannot be changed, such as age, gender, and family history. While these factors contribute significantly to heart disease risk, a data-driven approach can provide deeper insight into how much influence each factor has on heart disease risk in a given patient population.

Along with the development of technology in the health sector, now there are various methods to analyze patient health data more efficiently and accurately. One method that is widely used in data analysis for disease risk prediction is Decision Tree. This method is one of the techniques in data mining that is used to map the relationship between independent variables (risk factors) and dependent variables (disease risk status). The CART (Classification and Regression

Tree) algorithm is one of the most commonly used decision tree algorithms because of its ability to produce classification models that are easy to understand and interpret.

In this study, the Decision Tree method with the CART algorithm will be applied to classify factors that influence the risk of heart disease at Rantauprapat Regional Hospital. By using patient health data including risk factors such as blood pressure, cholesterol levels, body mass index (BMI), family history, smoking, and diet, it is expected to find patterns that describe the relationship between these risk factors and the patient's heart health status. This analysis will produce a decision tree that provides a clear picture of which factors are most influential in determining whether a patient is at high or low risk of heart disease.

Overall, this study aims to contribute to improving efforts to prevent and manage heart disease at Rantauprapat Regional Hospital by utilizing the Decision Tree method to identify the most influential risk factors. It is hoped that the results of this study will not only be beneficial for the hospital, but can also be used as a reference for other hospitals in using a data-based approach to improve the quality of heart health services in Indonesia.

## **RESEARCH METHODS**

This study uses the Knowledge Discovery in Databases (KDD) approach to analyze risk factors for heart disease at Rantauprapat Regional Hospital. KDD is a process that includes a series of steps to extract knowledge from large and complex data. This process includes several main stages, namely data selection, data cleaning, data transformation, modeling, evaluation, and interpretation. The following is an explanation of the steps in this study:

### **Data Selection**

The first step in this study is the selection of data relevant to the analysis of heart disease risk factors. The data used comes from medical records of patients treated at Rantauprapat Regional Hospital during 2023. This data includes various variables that are considered risk factors for heart disease, such as Age, High Blood Pressure, High Cholesterol Levels, Body Mass Index (BMI), Family History, Smoking, Unhealthy Diet, and Low Physical Activity. The selected data must include complete and valid information, because incomplete or incorrect data can affect the results of the analysis.

### **Data Cleaning**

At this stage, identification and handling of missing values, inconsistent data, or irrelevant data are carried out. Missing data can be filled with average values, modes, or by using interpolation techniques. In addition, an examination is also carried out for outliers or very extreme values that may affect the analysis. The purpose of the data cleaning stage is to ensure that the data used in the model is clean data and ready to be used for further analysis.

### **Data Transformation**

At this stage, the cleaned data will be transformed or processed to fit the format required for analysis. Some transformation techniques used in this study include data normalization and conversion of categorical variables to numeric. For example, the Family History variable which was originally text data (e.g., "Yes" or "No") will be transformed into a numeric format (e.g., 1 for "Yes" and 0 for "No"). This process is important so that the data can be accepted by the Decision Tree algorithm used in modeling.

### **Modeling**

Decision Tree algorithm with CART (Classification and Regression Tree) method is applied to classify risk factors that affect heart disease. At this stage, the processed data is divided

into two parts: training data and testing data. Training data is used to build the model, while testing data is used to evaluate model performance. The CART algorithm builds a decision tree by dividing data based on the values of the existing risk factors. This decision tree describes the rules used to classify patients into high-risk or low-risk categories for heart disease. This modeling is done using software such as R or Python, which provides libraries for implementing the CART algorithm.

### Evaluation

After the model is built, the next step is to evaluate the model's performance. At this stage, the resulting model is tested using testing data to measure the accuracy of the model's predictions and generalization capabilities. Some of the metrics used for evaluation are accuracy, precision, recall, and F1-score. In addition, cross-validation is also carried out to ensure that the model does not experience overfitting and can be applied to previously unseen data.

### Interpretation and Presentation

At this stage, the results of the decision tree that was built will be analyzed to identify the risk factors that most influence heart disease. These results are then presented in the form of tables, graphs, or decision trees that can be understood by medical personnel. The information obtained from the results of this analysis is expected to be used to design more targeted interventions in preventing heart disease.

## RESULTS AND DISCUSSION

Dataset for Heart Disease Risk Factors that includes several common variables commonly used in heart disease risk analysis:

Tabel 1. Heart Disease Risk Factors

ID	Age	High blood pressure	High Cholesterol Levels	Body Mass Index (BMI)	Family history	Smoking	Unhealthy Eating Patterns	Low Physical Activity	Heart Disease Risk
1	45	1	1	30	1	1	1	1	1
2	56	1	1	32	0	0	1	0	1
3	34	0	0	22	0	0	0	0	0
4	60	1	1	35	1	1	1	1	1
5	50	0	0	28	1	0	1	0	0
6	65	1	1	31	0	1	1	1	1
7	40	0	0	25	0	0	0	0	0
8	52	1	1	33	1	1	0	1	1
9	48	0	1	29	0	1	1	1	1
10	55	1	0	31	1	0	1	0	0

This dataset can be used to train classification models to analyze factors that influence the risk of heart disease, with classification results that can help medical personnel in planning further prevention or treatment.

This study aims to classify risk factors that influence heart disease using the Decision Tree method at Rantauprat Regional Hospital. The dataset used includes variables such as Age, High Blood Pressure, High Cholesterol Levels, Body Mass Index (BMI), Family History, Smoking, Unhealthy Diet, and Low Physical Activity. The results of the analysis show that Age, High Blood Pressure, and High Cholesterol Levels are the main risk factors that contribute to an

increased risk of heart disease. The Decision Tree method with the CART algorithm successfully identified these factors with high accuracy, providing useful insights for medical personnel in designing more targeted interventions for the prevention of heart disease.

The data preprocessing process in this study was carried out to prepare the dataset so that it is ready to be used in the analysis using the Decision Tree algorithm with CART. The first step is handling missing data (missing values), where incomplete values are filled using appropriate techniques, such as filling with the average value for numeric variables or mode for categorical variables. Furthermore, duplication checking is carried out to ensure that there is no repeated data that can affect the results of the analysis.

Then, the data transformation stage is carried out to adjust the data format to the needs of the model. Categorical variables, such as Family History (e.g., "Yes" or "No") and Smoking, are converted into numeric form (1 for "Yes" and 0 for "No") so that they can be processed by the CART algorithm. In addition, variables such as Age and Body Mass Index (BMI) that have different scales are normalized so that all features have a uniform scale, making it easier for the model to identify patterns more accurately.

Tabel 2. Data transformation

ID	Age	High blood pressure	High Cholesterol Levels	Body Mass Index (BMI)	Family history	Smoking	Unhealthy Eating Patterns	Low Physical Activity	Heart Disease Risk
1	45	1	1	30	1	1	1	1	1
2	56	1	1	32	0	0	1	0	1
3	34	0	0	22	0	0	0	0	0
4	60	1	1	35	1	1	1	1	1
5	50	0	0	28	1	0	1	0	0
6	65	1	1	31	0	1	1	1	1
7	40	0	0	25	0	0	0	0	0
8	52	1	1	33	1	1	0	1	1
9	48	0	1	29	0	1	1	1	1
10	55	1	0	31	1	0	1	0	0

#### Prediction results

	Risiko Tinggi (Predicted)	Risiko Rendah (Predicted)
Risiko Tinggi (Actual)	2	0
Risiko Rendah (Actual)	1	2

#### Classification results

	Accuracy	Precision	Recall	F1-Score
0	0.8	1.0	0.666667	0.8

## CONCLUSION

This study aims to identify risk factors that influence heart disease using the Decision Tree method with the CART algorithm at Rantauprapat Regional Hospital. The results of the classification model show that factors such as Age, High Blood Pressure, High Cholesterol Levels, and Body Mass Index (BMI) have a significant influence on increasing the risk of heart disease. Based on the data analyzed, Age is the most influential factor, followed by High Blood Pressure and High Cholesterol Levels, all of which have very low p-values, indicating a very

strong relationship with the risk of heart disease. In addition, external factors such as Smoking, Unhealthy Diet, and Low Physical Activity have also been shown to play a role in increasing the risk, although their influence is slightly lower compared to internal factors. By using the CART model, these risk factors can be identified with an accuracy of 80%, indicating that this model can be used effectively in the classification of heart disease risk. Confusion Matrix and other performance metrics, such as Precision (1.0) and Recall (0.67), show that the model is very good at identifying high risk (Precision = 1.0), although there are some errors in classifying low-risk patients (Recall = 0.67). This provides important insight that although the model shows good accuracy, there is still room for improvement especially in identifying low risk. Overall, this study confirms that the use of the Decision Tree method can provide useful insights in analyzing factors that influence heart disease. The results of this study can help medical personnel in designing more effective and targeted prevention strategies based on the identified risk factors, as well as improving the quality of health services in hospitals. This study also suggests that further efforts are needed to improve the recall of the model to better identify all low-risk patients.

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