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Implementation of Bayes Theorem in Expert System to Diagnose Coronary Heart Disease

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ABSTRACT

Coronary heart disease is a heart disease that involves disorders of the blood vessels (coronary arteries). Recognizing and treating them requires attention and recognition of existing risk factors. In this study, an expert system has been built to diagnose coronary heart disease which is useful for knowing the type of coronary heart disease someone is experiencing and knowing the percentage level of disease that is experienced. The problem of this research is how to build an expert system to diagnose coronary heart disease to make it easier for the public to find out what disease is being suffered by implementing the Bayes theorem in an expert system. The Bayes theorem method is machine learning using probability calculations using the Bayesin approach concept. How to use this application, the admin first enters questions in the form of symptoms experienced by the patient, then the system will process all patient answers using the Bayes method and the system will issue an output in the form of a diagnosis of the disease. This system can assist sufferers in knowing the type of disease that is being experienced and in accordance with the analysis of coronary heart disease.

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1. INTRODUCTION

In line with technological developments the higher public awareness of health, the need for information on prevention of diagnosis is increasingly becoming. For this reason, every expert / expert working in the health sector who works in the health sector is required to answer these needs by providing accurate and easy to understand information. Coronary heart disease is a heart disease that involves disorders of the coronary arteries in recognizing and handling them requires attention and recognition of the existing risk factors.

The problem that often occurs is that to seek treatment for a patient, it is expensive to diagnose a specialist. Besides that, a doctor / expert sometimes experiences problems in helping diagnose a patient's disease because of the large number of patients that must be treated. With this system, it can make it easier for people to know the symptoms and types of diseases without having to pay expensive fees for consultations.

There are still many people who do not maintain a healthy lifestyle which can lead to coronary heart disease. The need for rapid treatment of patients suffering from Corner's heart disease. The need for help from experts in coronary heart disease through an expert system that does not require time and money to identify the symptoms of coronary heart disease.

2. RESEARCH METHOD

2.1. Research Framework

The research framework is a stage or flow of research that is systematically structured to achieve the objectives of the research. The research framework is as follows:

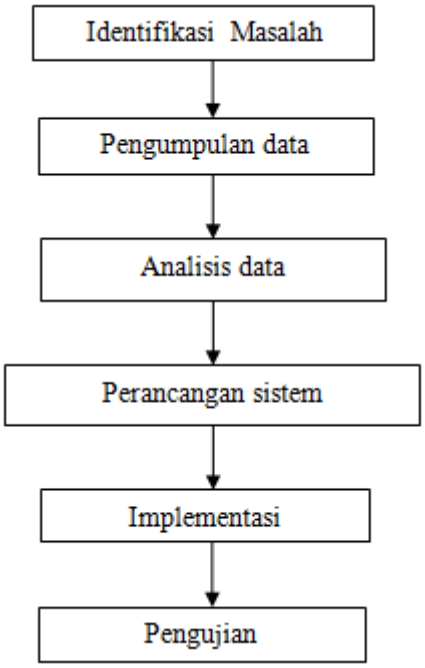

Figure 1. Research Framework

2.2. Description of the Framework

a. Problem Identification
Based on the literature study conducted, a problem was found which was then carried out by modeling and limiting the problem to provide a solution to the problem.

b. Data Collection
The data collection techniques that the authors use in this study are:
1. Observation
In the observation stage, the writer collected data in the field by making observations by visiting a hospital.
2. Interview
Doing questions and answers between the author and experts or experts to obtain information about the disease and symptoms of the disease so that accurate data can be obtained.
3. Literature review
Library studies are carried out with the aim of collecting data from books, journals, and other sources related to the problem so that it has a strong theoretical basis and foundation.

c. Needs Analysis
Based on the identification of the problem that has been carried out, then analyze the data that will be needed in the process of developing an expert system.

d. System Design
The next stage is software development with the waterfall method. This method consists of 4 steps, namely analysis, design, coding, and testing.
1. Analysis
In this step, an analysis of software requirements is carried out, including the needs for input, process and system output.
2. Design
In this step, data structure design, software architecture, display and calculation are carried out.
3. Coding
In this step, the application coding process is carried out based on the planned design.

4. Testing
   In this step, the application is tested whether it is running well or not. This application will be tested 3 times, namely the theory validation test to find out the truth of the knowledge base in the application, the blackbox test to test the functionality of the system, and the usage test to test whether the system is suitable for use. If there are still errors in the application, the researcher will do the correcting coding. If the application is running well, the application is complete and ready to use.
5. Testing
   This stage aims to ensure that the system created can run properly in accordance with the established steps and find errors and fix errors that occur in the system.

2.3. Artificial Intelligence

Artificial intelligence comes from the English word "Artificial Intelligence" or AI abbreviated, namely Intelligence is an adjective which means intelligent, while Artificial means artificial[1], [2]. Artificial intelligence is referred to here as referring to machines that are able to think, weigh actions to be taken and are able to make decisions like those made by humans[3], [4].

2.4. Bayes' Theorem

The Bayes theorem allows a person to influence his belief about a parameter after the data is obtained[5]. So in this case it requires prior belief before starting inference. Basically, the prior distribution is obtained based on the subjective belief of the research itself regarding the possible values for the estimated parameters, so it is necessary to pay attention to how to determine the priors[6]–[8].

The Bayesian method is a statistical approach to calculating the trade off between different decisions, using the probability and value that accompany a decision making[8]–[10]. The Bayesian method is used to calculate the uncertainty of data into definite data by including the percentage[11], [12]. The Bayesian theorem is mostly applied to matters relating to statistical diagnoses related to the probability and likelihood of the disease and associated symptoms. The Bayesian Formula can be stated as follows.

$$P\ (H \mid E) = \frac{P(E|H)\ .\ P(E)}{P(E)}$$

3. RESULTS AND DISCUSSION

This system analysis is done so that we can understand the system that will be designed later. And produce an output that contains information in the form of an expert system to diagnose coronary heart disease. Through this stage we can find out the comparison between the current system and the system that we created. The types of coronary heart disease that occur can be seen in the following table:

Table 1. Types of coronary heart disease

No	Kode Penyakit	Nama penyakit	Solusi
1.	P01	Penyakit Jantung Koroner Stabil Tanpa Gejala	Membutuhkan penanganan medis segera.
2.	P02	Angina Pektoris Stabil	Latihan fisik, penerunan berat badan dan penghentian merokok.
3.	P03	Sindrom Koroner Akut	Melakukan olahraga dan aktivitas fisik lainnya secara teratur, mengurangi makanan dan minuman yang kaya akan lemak dan gula.

Table 2. Value of the probability of symptoms of coronary heart disease

Kode Gejala	Gejala	Probabilitas
G001	Penumpukan timbunan lemak di dinding arteri koroner	0,9
G002	Nyeri rasa tidak nayman di dada atau angina	0,9
G003	Punggung seperti tertekan diremas terbakar atau tertusuk	0,8
G004	Keringat dingin, mual, muntah, lemas	0,5
G005	Timbuk tiba-tiba dengan integritas tinggi	0,3
G006	Sesak nafas	0,7
G007	Serangan jantung	0,6
G008	Kelelahan	0,4
G009	Disfungsi ereksi	0,5
G010	Sakit di punggung bagian bawah	0,6
G011	Rasa sakit, kebas atau dingin pada kaki dan tangan	0,2
G012	Jantung berdebar-debar	0,8
G013	Rasa panas di dada (*heart burn*)	0,4
G014	Gangguan pencernaan	0,4
G015	Kram	0,3
G016	Nyeri ulu hati	0,8
G017	Perut terasa sakit	0,9
G018	Kepala terasa pusing	0,7
G019	Detak jantung tak wajar	0,3
G020	Gagal jantung	0,7
G021	Perasaan cemas yang berlebihan	0,3
G022	Keringat berlebih	0,6

Table 3. Disease Relationship with Symptoms

KodeGejala	Kode Penyakit		
	P01	P02	P03
G001	✓		
G002		✓	
G003		✓	✓
G004	✓		✓
G005	✓		
G006			✓
G007		✓	
G008	✓		✓
G009	✓		
G010			✓
G011	✓		
G012			✓
G013		✓	
G014	✓		
G015	✓		
G016			✓
G017		✓	
G018			✓
G019			✓
G020	✓		
G021		✓	
G022		✓	
G023	✓		
G024			✓
G025	✓	✓	
G026	✓		
G027			✓
G028	✓	✓	

A patient wants to make a diagnosis of coronary heart disease by answering questions according to the following symptoms:

Kode Gejala	Gejala	Jawaban
G001	Penumpukan timbunan lemak di dinding arteri koroner	Tidak
G002	Nyeri rasa tidak nayman di dada atau angina	Ya
G003	Punggung seperti tertekan diremas terbakar atau tertusuk	Ya
G004	Keringat dingin, mual, muntah, lemas	Tidak
G005	Timbuk tiba-tiba dengan integritas tinggi	Tidak
G006	Sesak nafas	Tidak
G007	Serangan jantung	Ya
G008	Kelelahan	Ya
G009	Disfungsi ereksi	Ya
G010	Sakit di punggung bagian bawah	Tidak
G011	Rasa sakit, kebas atau dingin pada kaki dan tangan	Tidak
G012	Jantung berdebar-debar	Tidak
G013	Rasa panas di dada (*heart burn*)	Ya
G014	Gangguan pencernaan	Tidak
G015	Kram	Tidak
G016	Nyeri ulu hati	Tidak
G017	Perut terasa sakit	Ya
G018	Kepala terasa pusing	Tidak
G019	Detak jantung tak wajar	Tidak
G020	Gagal jantung	Tidak
G021	Perasaan cemas yang berlebihan	Ya
G022	Keringat berlebih	Ya
G023	Pembengkakan kaki	Tidak
G024	Batuk tak sembuh-sembuh	Tidak
G025	Sakit lengan terasa	Ya
G026	Mendengkur	Tidak
G027	Pusing	Tidak
G028	Pingsan (*syncope*)	Ya

After the results of the answers to the questions posed, then the calculation is carried out using the Bayes Tteorema for each symptom:
First define the probability value of each evidence for each hypothesis based on existing sample data using the Bayes probability formula.
Probability of Symptoms

G002 = 0,9
G003 = 1,6
G007 = 0,6
G013 = 0,4
G017 = 0,9
G021 = 0,3
G022 = 0,9
G025 = 0,4
G028 = 0,4

a. For stable coronary heart disease without symptoms.
G0025 = 0.2 = P (E | H_1)
G0028 = 0.2 = P (E | H_9)
Then calculate the probability value of hypothesis H without looking at any evidence, which is as follows:

$$P(H_1) = \frac{P(E|H_1)}{\sum_{k=1}^{12} P(E|H_1)} = \frac{0,2}{0,4} = 0,5$$

$$P(H_2) = \frac{P(E|H_2)}{\sum_{k=1}^{12} P(E|H_2)} = \frac{0,2}{0,4} = 0,5$$

To find the universe can be added from the above hypothesis:

$$\sum_{k=1}^{12} = G0025 + G0028$$
$$= 0,5 + 0,5$$
$$= 1$$

b. For Angina Pectoris
G002 = 0,9 = P (E |H_1) G003 = 0,8 = P (E |H_2)
G007 = 0,6 = P (E |H_3) G013 = 0,4 =P (E |H_4)
G017= 0,9 = P(E|H_5) G021 = 0,3 =P(E |H_5)
G022 = 0,6=P (E|H_5) G025 = 0,2 =P(E|H_5) G028 = 0,2 =P (E|H_5)

After obtaining the above summations, then calculating the probability value of the hypothesis H without looking at any evidence, namely as follows:

$P(H_1) = \frac{P(E|H_1)}{\sum_{k=1}^{9} P(E|H_1)} = \frac{0,9}{0,9} = 1$

$P(H_2) = \frac{P(E|H_2)}{\sum_{k=1}^{9} P(E|H_2)} = \frac{0,8}{1,6} = 0,5$

$P(H_3) = \frac{P(E|H_3)}{\sum_{k=1}^{9} P(E|H_3)} = \frac{0,6}{0,6} = 1$

$P(H_4) = \frac{P(E|H_4)}{\sum_{k=1}^{9} P(E|H_4)} = \frac{0,4}{0,4} = 1$

$P(H_5) = \frac{P(E|H_5)}{\sum_{k=1}^{9} P(E|H_5)} = \frac{0,9}{0,9} = 1$

$P(H_6) = \frac{P(E|H_6)}{\sum_{k=1}^{9} P(E|H_6)} = \frac{0,3}{0,3} = 1$

$P(H_7) = \frac{P(E|H_7)}{\sum_{k=1}^{9} P(E|H_7)} = \frac{0,6}{0,6} = 1$

$P(H_8) = \frac{P(E|H_8)}{\sum_{k=1}^{9} P(E|H_8)} = \frac{0,2}{0,4} = 0,5$

$P(H_9) = \frac{P(E|H_9)}{\sum_{k=1}^{9} P(E|H_9)} = \frac{0,2}{0,4} = 0,5$

To find the universe can be added from the above hypothesis:

$\sum_{k=1}^{9} = G002 + G003 + G007 + G013 + G017 + G021 + G022 + G025 + G028$

$= 1 + 0,5 + 1 + 1 + 1 + 1 + 1 + 0,5 + 0,5$

$= 7,5$

c. For Acute Coronary Syndrome

G003 = 0, 8 = $P(E|H_1)$

After obtaining the above summations, then calculating the probability value of the hypothesis H without looking at any evidence, namely as follows:

$P(H_1) = \frac{P(E|H_1)}{\sum_{k=1}^{11} P(E|H_1)} = \frac{0,8}{1,6} = 0,5$

To find the universe can be added from the above hypothesis:

$\sum_{k=1}^{11} = G003$

$= 0,5$

The final step is to calculate the percentage of the total value of the bayes

Kode	Nama Penyakit	Bayes	Persen
P01	Penyakit Jantung Koroner Stabil Tanpa Gejala	1	10%
P02	Angina Pektoris Stabil	7.5	75%
P03	Sindrom Koroner Akut	0.5	5%

Based on the calculation of the disease suffered by this patient is Stable Angina Pectoris with a percentage of 75%.

4. CONCLUSION

From the results of the expert system diagnosing coronary heart disease using the Bayes theorem method, several conclusions can be drawn, namely this expert system is made to help users to find out about coronary heart disease that is experienced based on the symptoms and rules determined by the expert, the expert system diagnoses the disease. Coronary heart disease was successfully applied using the Bayes theorem method in the inference process based on the rules made by experts and this research has resulted in an expert system to diagnose web-based coronary heart disease using the Bayes theorem method using 3 types of disease where there are 28 symptoms of disease.

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