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Comparative Analysis of Certainty Factor Method and Bayes Probability Method on ENT Disease Expert System

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Abstract

Expert system is computer programs that mimic the thought process and expert knowledge in solving a particular problem. Basically, an expert system has various methods to diagnose various kinds of diseases experienced by humans, animals, and plants. This research analyzes the comparison of Certainty Factor method and Bayes Probability method in the expert system of Ear, Nose, and Throat (ENT) diseases. Both methods have the same basic theory of overcoming uncertainties with existing variables. The Certainty Factor method has many variables that are used as systematic knowledge, namely the weight value of the expert which is the basis of knowledge of the system and the user input weight value, while the Bayes Probability method uses only expert knowledge in the calculation. Based on a comparative analysis of the methods obtained with 10 patients data on the ENT disease expert system, the Certainty Factor method has accuracy in diagnosing the disease by 100%, while the Bayes Probability method of system accuracy is 80%. So it can be concluded that the Certainty Factor method is more accurate in diagnosing ENT than the Bayes Probability method.

Keywords: Bayes Probability, Certainty Factor Method, Expert System, ENT Disease

1. INTRODUCTION

This expert system technology includes expert system languages, programs, and hardware designed to assist the development and manufacture of expert systems [1]. The aim of the expert system is not to replace human roles, but to display human knowledge in the form of a system, so that it can be used by many people [2]. Systems that try to adopt human knowledge of computers so that computers can solve problems as is usually done by experts [3]. An expert is a person who has expertise in a particular field, namely an expert who has special knowledge or abilities that other people do not know or are capable of in their fields [4]. The more knowledge that is included in the expert system, the better the system will act [5].

Expert systems have various methods that can be used to diagnose various types of diseases experienced by humans and animals. One of them is an expert system for diagnosing diseases of the respiratory and pulmonary can identify the disease by documenting information or knowledge from experts with the Certainty Factor (CF) method [6]. The CF method is also used in an expert system for diagnosing

pests and diseases of onion plants [7], the results obtained are still a lack of experts who can provide information about the best solutions to existing problems. Bayes Probability (BP) method can be used for all types of data, including health-related data [8]. Expert systems can also be used to diagnose diseases in rabbits using the Bayes theorem method of calculating the probability of each disease in rabbits [9]. There is also an expert system for diagnosing diseases in corn plants using the Bayes method in determining treatment options [10]. This research uses the CF method and BP method where the two methods will be compared. The CF method is a method used to express trust in an event (the fact or hypothesis) based on evidence or expert judgment [11]. Bayes's theorem is used in decision-making processes that cannot be separated from opportunity theory as a basic concept [12]. Comparison of 2 methods with the same method, the CF method and the BP method has also been analyzed in the case of detecting autism spectrum disorders in children under 5 years, and the results obtained are CF methods more accurate than BP [13].

Based on the explanation above, the purpose of this research is to get the right method in making decisions on Ear, Nose, and Throat (ENT) disease suffered by patients based on the input symptoms.

2. METHODS

Each research uses a method. The method needed to facilitate the researcher in carrying out research stages. The methods that can be used in a study can be compared or combined. This study uses two methods to compare, namely the CF method and the BP method.

2.1. Certainty Factor (CF)

The CF method has a range of values from -1 to 1 which represent several rules, where the value -1 means it is wrong and the value 1 means true [14]. The initial calculation step by determining the existing rules or facts, with the equation[15]:

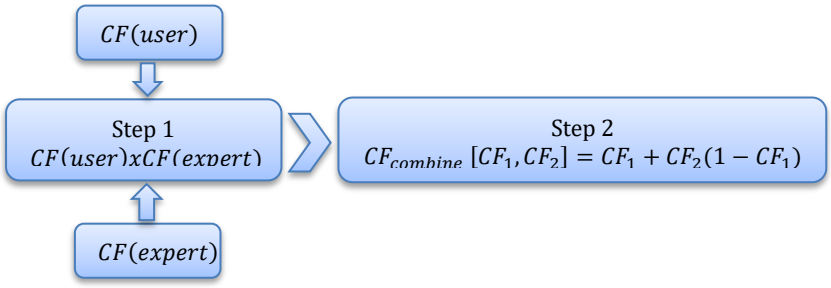

Figure 1. Step of the CF method

Where $CF(expert)$ is the CF of the expert CF value (between 0 and 1) and $CF(user)$ is influenced by symptoms or CF value of user input. In step 1, the calculation is done by multiplying both inputs, CF user and CF expert with the

result that the CF_1 value is obtained, and to get the CF_2 value to repeat step 1. The next step in step 2 combines the multiplication results that have been done in step 1.

2.2. Bayes Probability (BP)

BP is one method that can overcome data uncertainty by using the Bayes formula as follows [16]:

$$P(H_k|E) = \frac{P(E|H_k)P(H_k)}{\sum_{k=1,n} P(E|H_k)P(H_k)} \quad (1)$$

Where $P(H_k|E)$ is the probability of the type of disease in a symptom, $P(E|H_k)$ is the probability of symptoms in each disease, $P(H_k)$ is the probability of the type of disease, and $\sum_{k=1,n} P(E|H_k)P(H_k)$ is the number of times the probability of symptoms in each disease with the probability of disease.

3. RESULTS AND DISCUSSION

This research requires knowledge from experts to analyze the correct method for diagnosing ENT. Experts in this research were ENT specialists. The results of expert interviews are a knowledge base consisting of symptoms of an ENT disease, five types of ENT diseases, and symptom weight scores for each ENT disease.

3.1. Knowledge-Based

The Knowledge-Based obtained from expert interviews for 25 symptoms and five diseases are listed in Table 1.

Table 1. Symptoms and diseases data.

Symptom ID	Symptom	Disease				
		P1	P2	P3	P4	P5
G01	Cough	*		*	*	
G02	Sneezing					*
G03	Postnasal drip					
G04	Fever	*		*		
G05	Stuffy nose					*
G06	Stuffy nose one side or alternate					*
G07	Excessive cleaning of the ear canal history		*			
G08	Pain on swallowing	*				
G09	Hearing decrease		*	*	*	
G10	Decrease of sense of smell					*
G11	Runny nose	*		*	*	*
G12	A clear fluid runny nose of both nostril					*
G13	Headache			*	*	*
G14	Sore throat	*		*		
G15	Ear discharge or otorrhea				*	
G16	Ear discharge less than 2 months			*		
G17	Ear discharge more than 2 months				*	
G18	Smelly ear discharge more than 2 months				*	

G19	Low pitch tinnitus								*	*
G20	Ear itching						*			
G21	Ear blockage						*			
G22	Earache									
G23	Snoring					*				

Description:
P1: Chronic Tonsillitis (CT)
P2: Ear Wax (EW)
P3: Acute Otitis Media (AOM)
P4: Chronic Suppurative Otitis Media (CSOM)
P5: Chronic Rhinitis (CR)

The weight value obtained from the expert for each symptom in ENT disease is needed to increase the knowledge of the system so that the system can act and produce conclusions like experts. The weight value used in CF calculation and weight value along with disease probabilities used in BP calculation can be seen in Table 2.

Table 2. CF weight value and BP weight value.

Symptom ID	CF Weight Value					BP Weight Value				
	Disease ID					Disease ID				
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5
G01	0.6		0.6	0.6		0.15		0.11	0.12	
G02					0.8					0.15
G03										
G04	0.6		0.8			0.15		0.14		
G05					0.8					0.15
G06					0.8					0.15
G07		0.4					0.17			
G08	0.8					0.20				
G09		0.8	0.6	1.0			0.33	0.11	0.20	
G10					0.6					0.11
G11	0.4		0.8	0.6	1.0	0.10		0.14	0.12	0.18
G12					1.0					0.18
G13			0.4	0.4	0.4			0.07	0.08	0.08
G14	0.8		1.0			0.20		0.18		
G15				0.4					0.08	
G16			0.8					0.14		
G17				0.8					0.16	
G18				0.4					0.08	
G19			0.6	0.8				0.11	0.16	
G20		0.2					0.08			
G21		1.0					0.42			
G22										
G23	0.8					0.20				
Disease Probabilities						0.66	0.60	0.70	0.62	0.74

3.2. Calculation-Based

For example, the user inputs 3 symptoms with a weight value as in Table 3.

Tabel 3. Symptoms of user input.

No	Symptom Name	Value of User Possibilities
1	Cough	0.8
2	Ear discharge less than 2 months	0.6
3	Runny nose	0.8

Certainty Factor Method

The CF method utilizes the weight given by the user then combined with the expert weight values in Table 2. The first step in calculating CF is to multiply the two weight values, the user weight value and the expert weight value which can be seen in Table 4, then the second step combining the CF values obtained from multiplying in the first step can be seen in Table 5, the following calculation steps for Acute Otitis Media (AOM) using the user weight value or user input in Table 3.

Table 4. Multiplication of expert weight value with user weight value.

Symptom Name (1)	Expert Weight Value (2)	Value of User Possibilities (3)	Multiplication (2)*(3)
Cough	0.6	0.8	0.48
Ear discharge less than 2 months	0.8	0.6	0.48
Runny nose	0.8	0.8	0.64

Tabel 5. Combination results.

Symptom Name	CF Value of Symptoms	CF Combination
Cough	0.48	= $CF1 + CF2\ (1 - CF1)$
Ear discharge less than 2 months	0.48	= 0.48 + 0.48 (1 – 0.48) = 0.730 ($CF12$)
Runny nose	0.64	= $CF12 + CF3\ (1 - CF12)$ = 0.730 + 0.64 (1 – 0.730) = **0.813** ($CF123$)

Based on Table 5, it is known that the possibility of users experiencing Acute Otitis Media (AOM) with a value of **0.813**.

Bayes Probability Method

The BP method utilizes the probability value obtained from the expert weight value in each symptom for each disease and the probability value can be seen in Table 2. Steps for calculating the BP method for Acute Otitis Media (AOM) can be seen in Table 6.

Table 6. Bayes probability calculation.

$P(H_i\|E)$	$P(E\|H_i) * P(H_i)$	$\sum_{k=1}^{n} P(E\|H_k) * P(H_k)$	$P(H_i\|E) = \frac{P(E\|H_i) * P(H_i)}{\sum_{k=1}^{n} P(E\|H_k) * P(H_k)}$
P(P3|G01)	P(G01|P3)xP(P3) (0.11 x 0.70)	P(G01|P3)xP(P3) + P(G01|P1)xP(P1) + P(G01|P4)xP(P4) (0.11 x 0.70) + (0.15 x 0.66) + (0.12 x 0.62)	$\frac{0.08}{0.25} = 0.31$
P(P3|G16)	P(G16|P3)xP(P3) (0.14 x 0.70)	P(G16|P3)xP(P3) (0.14 x 0.70)	$\frac{0.10}{0.10} = 1.00$
P(P3|G11)	P(G11|P3)xP(P3) (0.14 x 0.70)	P(G11|P3)xP(P3) + P(G11|P1)xP(P1) + P(G11|P4)xP(P4) + P(G11|P5)xP(P5) (0.14 x 0.70) + (0.10 x 0.66) + (0.12 x 0.62) + (0.18 x 0.74)	$\frac{0.10}{0.37} = 0.26$
Total Bayes P3			1.57

The next step is to add up all the total Bayes for each disease:

$$\begin{aligned} \textit{The Summation of The Total Bayes} &= P1 + P2 + \boldsymbol{P3} + P4 + P5 \\ &= 0.57 + 0.00 + \mathbf{1.57} + 0.50 + 1.00 \\ &= 3.64 \end{aligned}$$

After getting all the total Bayes, the next step is to find out how likely it is for the user to experience Acute Otitis Media (AOM), with the following steps:

$$\textit{Bayes Probability } P3\ (AOM) = \frac{1.57}{3.64} = \mathbf{0.42}$$

Based on the probability calculations that have been done previously, the possibility of users experiencing Acute Otitis Media (AOM) with a probability value of **0.42**.

Based on the manual calculations previously described implemented in the system, a diagnosis is obtained for 10 patients data on the CF method calculation and BP method is found in Table 7.

Tabel 7. The accuracy result of the method of the ENT disease expert system

Patient	Symptom	Expert	CF System	Accuracy	BP System	Accuracy
A	G01, G16, G11	P3	P3	Corresponding	P3	Corresponding
B	G01, G02, G04, G11, G22	P3	P3	Corresponding	P5	Not Corresponding
C	G01, G02, G06, G13	P5	P5	Corresponding	P5	Corresponding
D	G04, G14, G23	P1	P1	Corresponding	P1	Corresponding
E	G01, G11, G16	P3	P3	Corresponding	P3	Corresponding
F	G09, G13, G18, G19	P4	P4	Corresponding	P4	Corresponding
G	G01, G09, G11, G16, G22	P3	P3	Corresponding	P3	Corresponding
H	G01, G04, G11, G22	P3	P3	Corresponding	P1	Not Corresponding
I	G01, G04, G11, G14, G23	P1	P1	Corresponding	P1	Corresponding
J	G09, G18, G22	P4	P4	Corresponding	P4	Corresponding

Based on data from 10 patients, it was found that in CF calculations for the symptoms complained of stated accurately and the BP calculation stated that the two data were not corresponding. Thus, the accuracy of the 10 patients data on the CF system was 100% in accordance with the expert diagnosis, while in the BP system 80% accuracy with the expert diagnosis.

4. CONCLUSION

Comparative analysis of CF methods and BP methods in the expert system of ENT diagnoses to find out better and more accurate methods of diagnosing ENT. The CF method has more variables in the calculation, namely the value of the expert weight and the value of the user weight, which then from the two values will be combined for the result. The BP method only utilizes the value that the expert provides regardless of the user input value in the system for its calculation. Accuracy results based on 10 patients data for CF calculation in the ENT diagnosis system stated 100% accuracy, while in BP calculation stated 80% accuracy. So it can be concluded from the above analysis that the CF method is more accurate in diagnosing 10 data of ENT patients compared to the BP method.

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