Expert System For Detection Glaucoma Disease Using Certainty Factor Method

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Abstract. Glaucoma is an eye disease that attacks nerves of human eye and it's often not realized by sufferer until further damage to the eye nerve occurs. Glaucoma is second most common cause of permanent blindness according to Indonesian Ministry of Health. Permanent blindness caused by glaucoma can be avoided by early detection of disease and appropriate regular treatment. Early detection needed in an effort to prevent glaucoma can be done using an expert system. Expert system is an artificial intelligence program that can make reasoning and thinking like an expert in a particular field. Expert systems with certainty factor methods can describe level of certainty of expert expressions such as possible, most likely, and almost certain. Thus everyone can use an expert system to do glaucoma examination. In this research, diagnosis results will be obtained in the form of a percentage of a person’s CF value for glaucoma which is calculated using the certainty factor method based on the CF value of the symptoms entered by the user. Based on results of tests conducted, there are 8 out of 9 case data that are in accordance with the results of expert system diagnosis using certainty factor method that has been built. In other words, expert system has 90% accuracy in diagnosing glaucoma.

1. Introduction
Glaucoma is a disease that attacks nerves of human eye and can cause permanent blindness. Glaucoma is second most common cause of blindness because glaucoma sufferers are often unaware of visual impairment until advanced vision damage occurs [4]. Progression of glaucoma and permanent blindness caused can be inhibited or can be avoided by early identification and detection of glaucoma and regular monitoring and treatment [5][6]. Technological advances can be implemented in various fields including in healty sistem diagnosis. Identification dan detection glaucoma can be done using an expert system

Expert systems are computer-based artificial intelligence programs that act like experts in certain fields of knowledge [1]. Expert systems are useful for emulate the way of thinking and reasoning of an expert in making decisions based on the situation. So people can do consultations to the computer, as if person is consulting with an expert. Thus even ordinary people can use expert system to solve various problems encountered [2]. So many varian method and algorithm can be implemented in expert system such as certainty factor method.

Certainty factor is a method used to overcome uncertainty about a decision. Certainty Factor is one method of artificial intelligence that can be used to solve problems in rule-based systems. Certainty factor (CF) is value of clinical parameters given to show amount of certainty in a decision. An expert often analyzes existing information with expressions such as perhaps, most
likely, almost certainly. To accommodate this, certainty factor method is used to describe level of expert certainty in the problem being faced [3].

In this research, an expert system will be formulated that can assist in diagnosing and detecting glaucoma in a person based on accuracy of calculations using the Certainty Factor method. Calculation results of certainty factor method will be compared with results of the doctor’s medical records.

2. Method

In this section, will be explained how expert systems with certainty factor methods work. First process user have to entering their identity. After entering identity, user will be able to see symptom form. User can choose symptoms according they are felt and choose level of certainty in symptoms that are felt. Symptoms that have been entered by user will be processed using Certainty Factor method. After going through calculation process, hypothesis will be obtained from diagnosis that is in accordance with certainty factor obtained from calculation. It can be concluded that there are 3 processes to obtain final diagnosis results, they are selection of certainty levels, calculation value of certainty level with certainty factor method, calculation of percentage from value of certainty level for diagnosis results.

2.1. Certainty Factor Value

Certainty factor has a CF value in the form of a change in the expression or term of an expert. By interviewing an expert, we can get expressions needed in accordance with the expert’s level of certainty.

| Expression      | CF Value |
|-----------------|----------|
| Definitely not  | -1       |
| Almost certainly| -0.8     |
| Most likely not | -0.6     |
| Maybe not       | -0.4     |
| No              | -0.2 to 0.2 |
| Maybe           | 0.4      |
| Most likely     | 0.6      |
| Almost certainly| 0.8      |
| Definitely      | 1        |

2.2. Calculation of the Certainty Factor Value

In this process, CF value obtained will be calculated using formula commonly used in certainty factor method. Based on the CF value, CF value can be calculated by the equation:

1. If \( CF_1 > 0 \) and \( CF_2 > 0 \), Then \( CF = CF_1 + CF_2 \cdot (1 - CF_1) \).
2. If \( CF_1 < 0 \) and \( CF_2 < 0 \), Then \( CF = CF_1 + CF_2 \cdot (1 + CF_1) \).
3. If \( CF_1 > 0 \) and \( CF_2 < 0 \), Then \( CF = \frac{CF_1 + CF_2}{1 - (\min\{CF_1, |CF_2|\})} \).

2.3. Calculation of Percentage of Certainty Factor Values

In this process, CF value that has been obtained from the previous process will be used to calculate final value in the form of a percentage. Percentage calculations can use this equation \( \%CF = CF \cdot 100\% \).
3. Results And Discussion
Consider a case for testing where input data from the process of selecting symptoms and CF value of each symptom according to experts. Diagnostic process in an expert system is calculated by certainty factor method. Input values for calculating diagnoses are obtained from the CF value of symptoms selected by the user. CF values for each symptom were obtained from interviews with experts.

3.1. Certainty Factor Value (User)
As an example of case for testing, input data from process of selecting symptoms and CF value of each symptom based on experts can be seen in table 2 below.

| Symptoms | User’s CF       | CF Value |
|----------|----------------|----------|
| G1       | Definitely not  | -1       |
| G2       | Definitely not  | -1       |
| G3       | Definitely not  | -1       |
| G4       | Definitely not  | -1       |
| G5       | Definitely not  | -1       |
| G6       | Definitely not  | -1       |
| G7       | Definitely not  | -1       |
| G8       | Definitely not  | -1       |
| G9       | Definitely not  | -1       |
| G10      | Most Likely    | -1       |
| G15      | Definitely     | 1        |

3.2. Calculation of Certainty Factor Value (User)
Input values for calculating diagnoses are obtained from CF value of symptoms selected by user. Here, steps to calculate value of CF:

1. Process of calculating value of CF will begin with symptom G1. Because CF value of G1 and G2 are smaller than 0, calculation from value of CF will use equation $CF = CF1 + CF2 \times (1 + CF1)$.

   $CF = CFG1 + (CFG2 \times (1 + CFG1))$
   $CF = -1 + (-1 \times (1 - 1))$
   $CF = -1$

2. Calculation process is continued with G3, where CF value from previous calculation acts as $CF_{first}$. Next calculation will use equation $CF = CF1 + CF2 \times (1 + CF1)$. Because CF values of G3 and $CF_{first}$ are smaller than 0.

   $CF = CF_{first} + (CF_{G3} \times (1 + CF_{first}))$
   $CF = -1 + (-1 \times (1 - 1))$
   $CF = -1$

3. Calculation process is continued with G4, where CF value from previous calculation acts as $CF_{first}$, next calculation will use equation $CF = CF1 + CF2 \times (1 + CF1)$. Because CF values of G4 and $CF_{first}$ are smaller than 0.

   $CF = CF_{first} + (CF_{G4} \times (1 + CF_{first}))$
   $CF = -1 + (-1 \times (1 - 1))$
   $CF = -1$
4. Calculation process is continued with G5, where CF value from previous calculation acts as $CF_{first}$. Next calculation will use equation $CF = CF_1 + CF_2 \times (1 + CF_1)$. Because CF values of G5 and $CF_{first}$ are smaller than 0. $CF = CF_{first} + (CF_{G5} \times (1 + CF_{first}))$

$CF = -1 + (-1 \times (1-1))$

$CF = -1$

5. Calculation process is continued with G6, where CF value from previous calculation acts as $CF_{first}$. Next calculation will use equation $CF = CF_1 + CF_2 \times (1 + CF_1)$. Because CF values of G6 and $CF_{first}$ are smaller than 0. $CF = CF_{first} + (CF_{G6} \times (1 + CF_{first}))$

$CF = -1 + (-1 \times (1-1))$

$CF = -1$

6. Calculation process is continued with G7, where CF value from previous calculation acts as $CF_{first}$. Next calculation will use equation $CF = CF_1 + CF_2 \times (1 + CF_1)$. Because CF values of G7 and $CF_{first}$ are smaller than 0. $CF = CF_{first} + (CF_{G7} \times (1 + CF_{first}))$

$CF = -1 + (-1 \times (1-1))$

$CF = -1$

7. Calculation process is continued with G8, where CF value from previous calculation acts as $CF_{first}$. Next calculation will use equation $CF = CF_1 + CF_2 \times (1 + CF_1)$. Because CF values of G8 and $CF_{first}$ are smaller than 0. $CF = CF_{first} + (CF_{G8} \times (1 + CF_{first}))$

$CF = -1 + (-1 \times (1-1))$

$CF = -1$

8. Calculation process is continued with G9, where CF value from previous calculation acts as $CF_{first}$. Next calculation will use equation $CF = CF_1 + CF_2 \times (1 + CF_1)$. Because CF values of G9 and $CF_{first}$ are smaller than 0. $CF = CF_{first} + (CF_{G9} \times (1 + CF_{first}))$

$CF = -1 + (-1 \times (1-1))$

$CF = -1$

9. Calculation process is continued with G10, where the CF value from previous calculation acts as $CF_{first}$. Next process calculation will use equation $CF = \frac{CF_1 + CF_2}{1 - \text{min}(|CF_1|, |CF_2|)}$. Because CF values of G10 and $CF_{first}$ are smaller than 0.

$CF = \frac{CF_{first} + CF_{G10}}{1 - \text{min}(|CF_{first}|, |CF_{G10}|)}$

$CF = \frac{-1 + 0.5}{1 - \text{min}(0.5, (-1))}$

$CF = \frac{-1 + 0.5}{1 - (-1)}$

$CF = \frac{(-0.5)}{2}$

$CF = -0.25$

10. Calculation process is continued with G10, where the CF value from previous calculation acts as $CF_{first}$. Next calculation will use equation $CF = \frac{CF_1 + CF_2}{1 - \text{min}(|CF_1|, |CF_2|)}$. Because CF values of G15 and $CF_{first}$ are smaller than 0.

$CF = \frac{CF_{first} + CF_{G15}}{1 - \text{min}(|CF_{first}|, |CF_{G15}|)}$

$CF = \frac{-0.25 + 0.25}{1 - \text{min}(-0.25, (1))}$

$CF = \frac{-0.25 + 0.25}{1 - (-0.25)}$

$CF = \frac{0.75}{1.25}$

$CF = 0.6$

Percentage Value of Certainty Factor Calculation (User)

1. At this process, used CF value that has been obtained from the previous process. Percentage value of CF calculation can use equation % $CF = CF \times 100\%$. Percentage results of this CF value is value to determine diagnosis of glaucoma.
\[% CF = CF \times 100\% \\
\% CF = 0.46 \times 100\% \\
\% CF = 46\% \\

2. Evaluation system is done by comparing data obtained from medical records through doctors with the results of diagnoses made on the system. Evaluation results can be seen in the following table 3.

4. Conclusion

The conclusions that can be drawn on data mining techniques in clustering Percentage of Illiteracy Age 15+ by Province with this k-means algorithm are as follows:

1. The k-means clustering algorithm can help researchers group the Percentage of Illiteracy Age 15+ by Province in Indonesia. From the percentage of illiteracy age 15+ in Indonesia, it can be seen that there are 1 province with high level clusters, namely: Papua, 10 provinces with medium level clusters namely Awa Tenga, DI Yogyakarta, East Java, Bali, NTB, NTT, West Kalimantan, South Sulawesi, Central Sulawesi, West Sulawesi, and 23 other provinces with low clusters.

2. This rapidminer application can help researchers group the Percentage of Illiteracy Age 15+ by Province in Indonesia. The manual calculation of the k-means clustering algorithm in grouping the Illiteracy Percentage Age 15+ and the application in Rapidminer show the same results.

### Table 3. System Evaluation Results.

| Medical Record          | System Diagnose | Evaluation Result |
|-------------------------|-----------------|-------------------|
| Open-angle glaucoma     | Open-angle      | Appropriate        |
| Open-angle glaucoma     | Open-angle      | Appropriate        |
| Angle-closure glaucoma  | Open-angle      | Inappropriate      |
| Open-angle glaucoma     | Open-angle      | Appropriate        |
| Open-angle glaucoma     | Open-angle      | Appropriate        |
| Open-angle glaucoma     | Open-angle      | Appropriate        |
| Angle-closure glaucoma  | Angle-closure glaucoma | Appropriate |
| Open-angle glaucoma     | Open-angle      | Appropriate        |
| Angle-closure glaucoma  | Angle-closure glaucoma | Appropriate |

Based on test table 3, it was found that certainty factor method implemented in expert system for diagnosing glaucoma has an accuracy of 90%, based on test results from 9 medical record data, there are 8 case data that is already in compliance and there is 1 case data that is inappropriate, where in one case there is Special case are symptoms that felt differently from doctor’s general diagnosis

5. Conclusion

Conclusion of this research that the diagnosis results from this expert system of glaucoma detection of users can be a reference to the hospital or an specialist doctor. For getting more accurate result, it can be additional knowledge base related to glaucoma and value of belief for each more specific symptom from more than one expert specialist doctor, so it can be more accurate by comparing knowledge from others expert. And for developing this research,
Glaucoma detection expert systems can be developed using different inference methods or combining other inference methods with certainty factor methods for more optimal diagnostic results.

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