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Application of The Certainty Factor Method for Diagnosing Osteoarthritis using The Python Programming Language

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ABSTRACT

Osteoarthritis is a disease that causes the joints in the bones to become weaker and less able to function properly. Osteoarthritis can cause Pain, stiffness, and even deformity in the joints. The solution to the problem of diagnosing Osteoarthritis is to use a tool, namely a system (expert system) that uses computer technology to make decisions more easily, effectively and efficiently. This study uses the Certainty Factor method in diagnosing Osteoarthritis and uses eight symptoms, namely, Pain in the joints, joints feeling stiff, clicks or cracks appearing when the joints are bent or moved, joints losing their flexibility properties, joints feeling softer when pressure is applied, spurs appear bones around the joints, namely hard and sharp bony protrusions, swelling around the joints, and muscles around the joints. The conclusions from the calculations and program implementation, the application of the certainty factor in diagnosing Osteoarthritis with existing test data, results in 95.38% that the patient has severe symptoms of Osteoarthritis, so he must be taken to an orthopaedic specialist.

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1. INTRODUCTION

Osteoarthritis is a disease that causes joints and bones to become weaker and less able to function properly. Osteoarthritis can cause Pain, stiffness, and even deformity in the joints. Osteoarthritis is a type of disease that many people experience. The cause of Osteoarthritis cannot be traced with certainty. Several things can increase your risk of developing Osteoarthritis. Some of these are things you can do to increase your odds. Factors that influence a person to get Osteoarthritis are age, smoking, body weight, whether there is a family history of the disease, how active they are, and how much physical activity they do. Most Indonesian people often do not pay attention to how much Pain is felt in a part of the body when it is moved. This could be a sign that they have Osteoarthritis [1].

The solution to the problem of diagnosing Osteoarthritis is to use a tool, namely a system (expert system) that uses computer technology to make decisions more easily, effectively and efficiently. An expert system is a computer system that can do things as the best experts do. They can understand complex problems and produce good solutions [2]. An expert has a lot of knowledge and experience in a particular field, making him more capable of solving certain problems than most people [3]. So, an expert system is a computer program that can make decisions based on a collection of expert knowledge in a particular field [4],[5]. In expert

systems, two methods can be used: the forward chaining method and the certainty factor method [6]. The Certainty Factor method is the method used in this study.

The Certainty Factor (CF) method is a way to help machines make decisions with more confidence. The Certainty Factor can help produce accurate results when calculating the weighted value of the symptoms that the patient has answered. The CF method helps solve the problem of uncertainty in disease diagnosis and also provides a measure of the level of expert certainty in the problem [7],[8].

The differences between previous and current research are the symptoms and system implementation. This research is in diagnosing Osteoarthritis, including mild or severe symptoms to severe symptoms and uses eight symptoms to diagnose and uses the python programming language.

This study uses the Certainty Factor method in diagnosing Osteoarthritis. It uses eight symptoms, namely, Pain in the joints, joints feeling stiff, and clicking or cracking sounds when the joints are bent or moved. Joints lose their flexibility, and joints feel softer when pressure is applied. Spurs appear in bones around the joints, namely hard and sharp bony protrusions, swelling around the joints, and muscles around the joints. The result of this research is to build an expert system for the early detection of Osteoarthritis using the Python programming language.

2. LITERATURE REVIEW

2.1. Related Research

Similar previous research was conducted by Erika et al. titled "Expert System for Diagnosing Osteoarthritis Using the K-Nearst Neighbor Method" using the K-Nearst Neighbor method and 17 symptoms in diagnosing Osteoarthritis with test results of 91.67% accuracy and implemented on the website [1]. Next, Risvan et al. Title "Expert System for Diagnosing Joint Diseases Using the Certainty Factor Method", used the Certainty Factor method and 13 symptoms in diagnosing joint diseases and implemented them on the website [4].

2.2. Expert System

An expert system is a type of machine that uses a lot of special knowledge to solve problems that are difficult for humans [9],[10]. With an expert system, you can easily solve problems or find quality information that can only be provided by experts in that field [11],[12].

2.3. Python

Python is a programming language that many people use to create various kinds of applications. Guido Van Rossum created Python in 1990. He is a computer programmer who created it to make programming easier. Van Rossum created Python as a hobby, and people find it a useful programming language because it is easy to understand, has a large library of functions and is concise [13].

2.4. Certainty Factor

The certainty Factor is a way to help make decisions when feeling uncertain. CF can occur for many reasons. CF is also often known as trust and mistrust [14]. The calculation steps use the Certainty Factor method, namely first looking for the CF value as shown in equation (1) and getting CF symptoms by multiplying CF_{expert} and CF_{user} as shown in equation (2), then calculating the $CF_{combine}$ as shown in equation (3) and the final stage is to calculate the $CF_{percentage}$ obtained from $CF_{combine}$ multiplied by 100% as shown in equation (4). Calculating the CF value uses the following basic formula [7].

$$CF[A,B] = NX[A,B] - NY[A,B] \quad (1)$$

Where

$CF[A,B]$: The Certainty Factor in hypothesis A is influenced by facts (symptoms) B.

$NX[A,B]$: The Measure of belief, which is the increase in the value of trust in hypothesis A influenced by fact.

$NY[A,B]$: The Measure of Disbelief, which is the increase in the value of disbelief in hypothesis A influenced by fact B

A : A hypothesis (temporary guess).
B : Evidence

$$CF_{\text{symptom}}[A,B] = CF_{\text{expert}}[A,B] - CF_{user}[A,B] \quad (2)$$

Where

$CF_{\text{symptom}}[A,B]$: The CF value of disease hypothesis A with evidence factor B
$CF_{\text{expert}}[A,B]$: The value of CF evidence factor A, which is influenced by evidence B
$CF_{user}[A,B]$: The CF value of the disease hypothesis A, which affects the evidence factor B if all evidence on the antecedents is known with certainty.

I calculated the combination CF value ( ) with the formula.

$$CF_{combine} = CF[A,B]_{old} + CF[A,B]_{\text{symptom}} * (1 - CF[A,B]_{old}) \quad (3)$$

After getting the following, the last step of the calculation is calculating the $CF_{\text{percentage}}$

$$CF_{percentage} = CF_{combine} * 100\% \quad (4)$$

3. RESEARCH METHODS

3.1. The Calculation Process Uses the Certainty Factor Method

In the calculation design process using the Certainty Factor method, the calculation steps are entering symptom weights, establishing a rule base, calculating CF Symptoms, calculating CF Combinations, calculating CF Percentages and finally, the percentage value. The calculation process uses the Certainty Factor method, as shown in Figure 1.

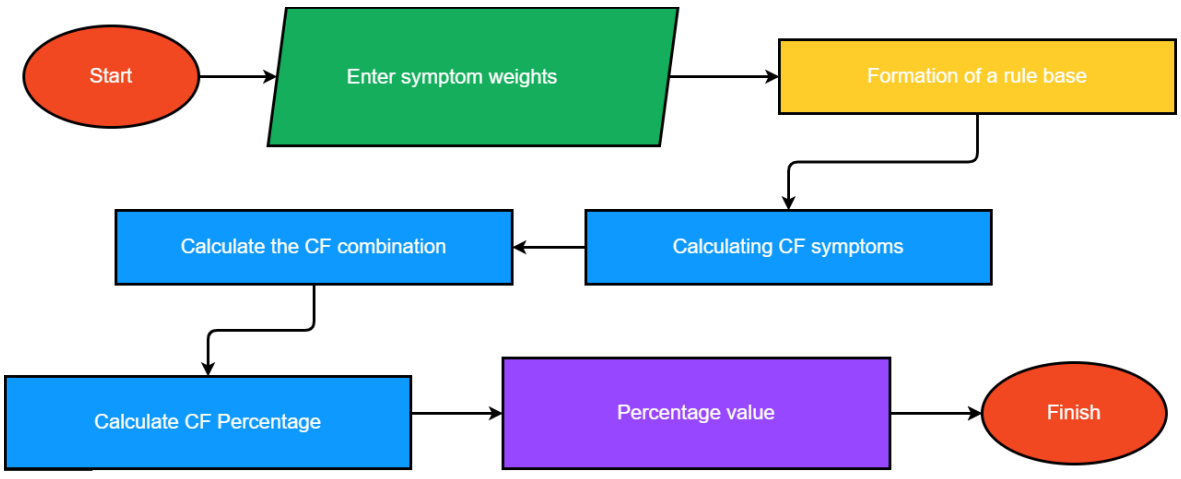

Fig. 1. Certainty Factor Method Calculation Process

3.1. Data Collection

The data collection process was carried out by observing and interviewing experts in their fields. The experts have determined that many things are important by analysing the interview information. The CF (rule) value is based on expert interpretation, converted into a certain CF value, as shown in Table I.

Table 1. CF Value Data (Rule)

No	Information	CF Value (*Rule*)
1	Pasti	1
2	Hampir pasti	0.8
3	Kemungkinan besar	0.6
4	Mungkin	0.4
5	Mungkin tidak	0.2
6	Tidak	0

3.2. Representation of Knowledge with Production Rule

IF THEN is used as a basic rule [15]. With production rules for diagnosing Osteoarthritis (joints) with knowledge representation of expert system applications with the following description.

A. Rules (Rule 1)

IF Mild Symptoms
AND Pain in the joints
AND Joints feel stiff
AND A clicking or cracking sound occurs when the joint is bent or moved
AND Joints lose their flexibility
THEN Experiencing mild symptoms of Osteoarthritis, you need lots of exercises and a healthy diet

B. Rules (Rule 2)

IF Severe Symptoms
AND Joints feel softer when pressure is applied
AND The appearance of bone spurs around the joints, which are hard and sharp bony protrusions
AND Swelling around the joints
AND Weakened muscles around the joints
THEN Experiencing severe symptoms of Osteoarthritis, you should be taken to an orthopaedic specialist

4. RESULT AND DISCUSSION

4.1. Manual Calculation of the Certainty Factor Method

In manual calculations using the certainty factor method, 3 (three) data are used, namely symptom data, expert certainty data, and user certainty data. This study used 8 (eight) symptoms, namely Pain in the joints, joints feeling stiff, clicking or cracking sounds when the joints are bent or moved, joints losing their flexibility, joints feeling softer when pressure is applied, bone spurs appearing around the joints, i.e. hard and sharp bony protrusions, swelling around the joints, and muscles around the joints. Each symptom has a symbol shown in Table II.

Table 2. Symptoms Data

No	Symptom Name	Symbol Name
1	Nyeri pada persendian	GB1
2	Sendi Terasa kaku	GB2
3	Timbul bunyi klik atau retakan ketika sendi ditekuk atau digerakkan.	GB3
4	Sendi kehilangan sifat fleksibilitasnya	GB4
5	Sendi terasa lebih lunak saat diberikan tekanan.	GB5
6	Munculnya taji tulang di sekitar sendi, yakni tonjolan tulang yang keras dan tajam.	GB6
7	Pembengkakan di sekitar sendi.	GB7
8	Otot di sekitar sendi yang melemah.	GB8

Based on calculations using the CF method using the data in Table I and Table II, it is possible to obtain expert certainty data, as shown in Table III and user certainty data, as shown in Table IV.

Table 3. Expert Certainty Data

No	Symptom Symbol	CF (*Rule*) Value
1	GB1	0.8
2	GB2	0.8
3	GB3	0.6
4	GB4	0.4
5	GB5	0.6
6	GB6	0.4
7	GB7	0.2
8	GB8	0.6

Table 4. User Certainty Data

No	Symptom Symbol	CF (*Rule*) Value
1	GB1	0.8
2	GB2	0.6
3	GB3	0.6
4	GB4	0.6
5	GB5	0.4
6	GB6	0.4
7	GB7	0.2
8	GB8	0.4

Based on Table III and Table IV using the equation formula (2), which is to find the CF value of symptoms with the following calculations:

$CF_{\text{symptom}}[A,B] = CF_{\text{expert}}[A,B] * CF_{user}[A,B]$

$CF_{\text{symptom}}1 = 0.8 * 0.8 = 0.64$
$CF_{\text{symptom}}2 = 0.8 * 0.6 = 0.48$
$CF_{\text{symptom}}3 = 0.6 * 0.6 = 0.36$
$CF_{\text{symptom}}4 = 0.4 * 0.6 = 0.16$
$CF_{\text{symptom}}5 = 0.6 * 0.4 = 0.24$
$CF_{\text{symptom}}6 = 0.4 * 0.4 = 0.16$
$CF_{\text{symptom}}7 = 0.2 * 0.3 = 0.06$
$CF_{\text{symptom}}8 = 0.6 * 0.4 = 0.2$

CF_{symptom} Of each symptom has been obtained, then look for CF Combinations using equation (3) with the following calculations:

$CF_{combine} = CF\ [A,B]_{old} + CF\ [A,B]_{\text{symptom}} * (1 - CF\ [A,B]_{old})$
Calculation $CF_{combine}$ (CF symptoms 1 value and CF symptoms 2 value)
$CF[A,B]_{1,2} = CF\ [A,B]_1 + CF\ [A,B]_2 * (1 - CF\ [A,B]_1)$
$CF[A,B]_{1,2} = 0.64 + 0.48 * (1 - 0.64)$
$CF[A,B]_{1,2} = 0.64 + 0.48 * 0.36$
$CF[A,B]_{1,2} = 0.64 + 0.1728$
$CF[A,B]_{1,2} = 0.8128$ old

Until

calculation $CF_{combine}$ ($CF_{combine}$ old 6 value and CF symptoms 8 value)
$CF[A,B]_{old6,8} = CF\ [A,B]_{old6} + CF\ [A,B]_{8} * (1 - CF\ [A,B]_{old6})$
$CF[A,B]_{old6,8} = 0.9393 + 0.24 * (1 - 0.9393)$
$CF[A,B]_{old6,8} = 0.9393 + 0.24 * 0.0607$
$CF[A,B]_{old6,8} = 0.9393 + 0{,}0145$
$CF[A,B]_{old6,8} = 0.9538$ old6

Based on the final result is then calculated using equation (4) as follows:

$CF_{percentage} = CF_{combine} * 100\%$
$CF_{percentage} = 0.9538 * 100\%$
$CF_{percentage} = 95.38\%$

The result of the manual calculation of the percentage CF value resulting from the symptoms experienced by the user is 95.38%. Based on these calculations, it can be concluded that the user is experiencing severe symptoms of Osteoarthritis, so he must be brought to an orthopaedic specialist.

4.2. Implementation in Python

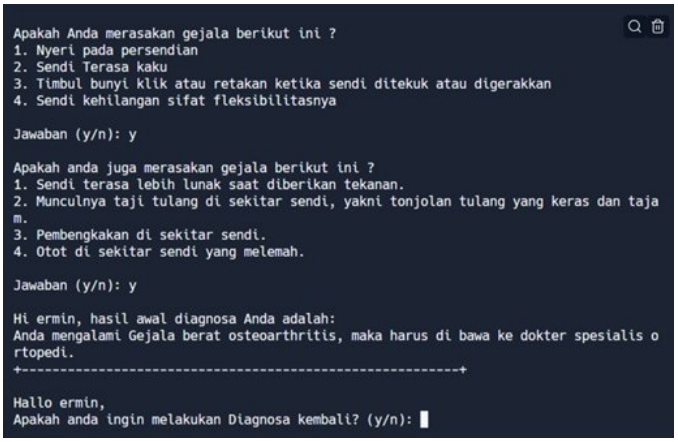

Fig. 2. Appearance of the application with 2 (two) rules yes

Based on the implementation display in Figure 2, it is explained following the knowledge representation with the previously made production rules that rule 1 is filled in "y" and rule 2 is filled in "y", the result will appear, namely experiencing severe symptoms of Osteoarthritis, then it must be treated. Please take it to an orthopaedic specialist. Meanwhile, if rule (rule) 1 is filled in with "y" and rule (rule) 2 is filled in with "n", then it will appear as shown in Figure 3.

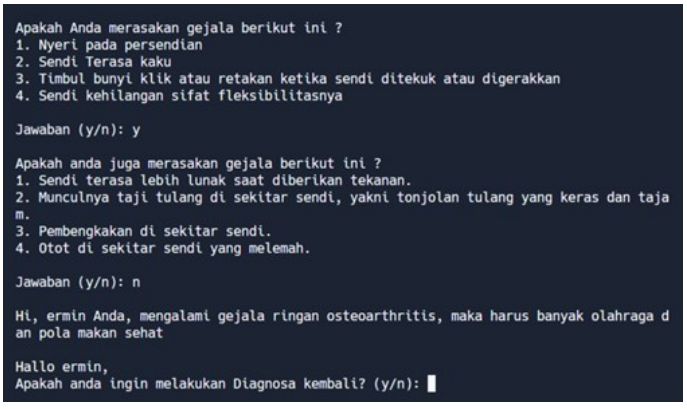

Fig. 3. Appearance of the application with 1 (one) rule yes.

Based on the implementation display in Figure 3, it is explained according to the results obtained that experiencing mild symptoms of Osteoarthritis, you have to do a lot of exercises and eat a healthy diet. The conclusion results from the calculations and implementation of the program, the application of the certainty factor method in diagnosing Osteoarthritis with existing test data, the result is 95.38% that the patient has severe symptoms of Osteoarthritis, so he must be taken to an orthopaedic specialist.

Conclusion

The conclusions obtained in the calculation and implementation results for diagnosing Osteoarthritis using the Certainty Factor method use eight symptoms in the process. The calculation results have obtained the percentage value of 95.38%, with the result that the patient has severe symptoms of Osteoarthritis, so he must be taken to an orthopaedic specialist. So it can be said that this method is good for diagnosing Osteoarthritis and is implemented in the Python programming language. Furthermore, research on this topic can use other methods or different symptoms.

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