CAT DISEASE DIAGNOSIS WITH EXPERT SYSTEM USING CERTAINTY FACTOR METHOD

Nadya Andhika Putri
Universitas Pembangunan Panca Budi

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***Correspondence Address:**
nadyaandhika@dosen.pancabudi.ac.id

Abstract: The diagnosis of cat diseases through expert systems using the Certainty Factor method involves the application of advanced computational techniques in veterinary medicine. This research focuses on developing a system that employs the Certainty Factor method for diagnosing cat diseases efficiently. The Certainty Factor method is utilized to handle uncertainty in the diagnostic process, providing a more accurate and reliable outcome. The system is designed to analyze various symptoms exhibited by cats and assess the likelihood of different diseases based on the available information. By incorporating a Certainty Factor, the system can account for the degree of certainty in the diagnosis, enhancing the overall reliability of the results. The outcomes of this study indicate that the Certainty Factor method significantly improves the accuracy of cat disease diagnosis within the expert system framework. This research contributes to the advancement of veterinary diagnostic tools and provides a foundation for the development of intelligent systems to support feline healthcare professionals.

INTRODUCTION

The diagnosis of cat diseases plays a crucial role in ensuring the well-being of feline companions. As advancements in technology continue to reshape various domains, the integration of expert systems in veterinary medicine has emerged as a promising avenue for enhancing diagnostic accuracy(Sihotang, 2018). This research focuses on the development and implementation of an expert system for diagnosing cat diseases, employing the Certainty Factor method to address uncertainties inherent in the diagnostic process(Setyaputri et al., n.d.).

With the aim of improving the efficiency and reliability of cat disease diagnosis, the Certainty Factor method becomes a key component of the proposed system. This method allows the expert system to quantify and manage uncertainty associated with the available information, thereby providing a more nuanced and precise diagnosis.

The significance of this research lies in its potential to contribute to the field of feline healthcare by introducing an intelligent and sophisticated diagnostic tool(Ongko, 2013). By harnessing computational techniques and artificial intelligence, this expert system aims to provide veterinarians and pet owners with a robust platform for accurate and timely cat disease diagnosis(Rizal et al., 2022).

The subsequent sections of this study will delve into the methodology employed(Aini & Rahmania Hatta, 2017), data collection processes, and the training of the expert system. Additionally, the research outcomes and their implications for the veterinary field will be thoroughly discussed(Batubara et al., 2018). Ultimately, the integration of the Certainty Factor method in the expert system is anticipated to bring about advancements in cat disease diagnosis, fostering improved feline health management practices.

RESEARCH METHODS

1. Expert System

An expert system is a sophisticated computer-based technology designed to emulate the decision-making capabilities of a human expert within a specific domain. This artificial intelligence system is crafted to analyze data, interpret complex information, and provide insights or recommendations comparable to those of a human expert in a particular field. At the core of an expert system lies a knowledge base, which encapsulates the wealth of information, rules, and heuristics distilled from human experts. The inference engine processes this knowledge, employing logical reasoning and rule-based mechanisms to draw conclusions or make decisions(Nurkholis et al., n.d.).

These systems often come equipped with a user interface, enabling seamless interaction between users and the system. Users can input queries or problems, and the expert system responds with solutions, recommendations, or diagnoses. An essential aspect of expert systems is their ability to not only provide results but also to explain the rationale behind their decisions(Sulistyohati & Hidayat, 2008). The explanation facility enhances user understanding and trust in the system's capabilities.

Moreover, the knowledge acquisition system is a critical component that facilitates the continuous process of acquiring, updating, and refining the system's knowledge base. This iterative process ensures that the expert system remains dynamic and relevant,

adapting to new information and changes in the domain it serves. Expert systems have found application across diverse fields, including medicine, finance, engineering, and troubleshooting. Their capacity to streamline complex decision-making processes, assist professionals in intricate tasks, and offer valuable insights based on accumulated expertise makes them invaluable tools in various industries. As technology continues to advance, expert systems contribute significantly to augmenting human capabilities and improving efficiency in decision support.

2. *Certainty Factor*

The Certainty Factor is a numerical measure used in artificial intelligence, particularly in expert systems, to quantify the degree of belief or certainty associated with a particular piece of information or a rule. It helps in handling uncertainty in decision-making processes(Aji et al., 2018). The Certainty Factor typically ranges from -1 to 1, representing different degrees of certainty or belief in the truth of a statement or the validity of a rule.

Here's a brief explanation of the Certainty Factor:

Positive Certainty Factor (CF): A positive CF between 0 and 1 indicates a degree of belief or certainty that the statement is true or that the rule is valid. The closer the CF is to 1, the higher the confidence.

Zero Certainty Factor (CF): A CF of 0 indicates complete uncertainty or a lack of belief in the truth of the statement or the validity of the rule.

Negative Certainty Factor (CF): A negative CF between 0 and -1 indicates a degree of belief or certainty that the statement is false or that the rule is invalid. The closer the CF is to -1, the higher the confidence in the falsehood.

In the context of expert systems, the Certainty Factor is often used in rule-based systems where rules are applied to infer conclusions or make decisions. When multiple rules are involved in reaching a conclusion, their individual Certainty Factors may be combined to obtain an overall measure of certainty for the final decision.

The formula for combining Certainty Factors in a rule-based system is often based on mathematical operations like multiplication or addition, taking into account the strength or weakness of each piece of evidence. The goal is to arrive at a more comprehensive assessment of certainty or belief.

In summary, the Certainty Factor is a valuable tool for managing uncertainty in expert systems, providing a way to express and manipulate the level of confidence in the information used for decision-making.

RESULTS AND DISCUSSION

The following data has been obtained from interviews with experts regarding types of diseases along with their characteristics. The data on the types of diseases can be seen in Table 1 as follows:

Table 1. The type of disease

No.	Kode Penyakit	Nama Penyakit
1	P01	*Diabetes*
2	P02	*Feline Leukimia Virus*
3	P03	Infeksi Jamur
4	P04	Penyakit saluran kemih
5	P05	*Feline Panleukopenia*
6	P06	*Rabies*
7	P07	*Stud Tail*
8	P08	*Ispa* atau flu kucing
9	P09	*Ring Worm*
10	P10	Cacingan

The characteristics of diseases in domestic cats can be seen in Table 2 as follows:

Table 2. Table of Characteristics of Cat Diseases

No.	Kode Gejala	Gejala
1	G01	Nafsu makan yang berlebihan
2	G02	Sering buang air kecil
3	G03	Dehidrasi
4	G04	Berat badan berkurang drastis
5	G06	Bersin
6	G10	Masalah pada pernapasan
7	G11	Demam
8	G12	Hilang nafsu makan
9	G14	Lemah lesu
10	G15	Diare
11	G16	Muntah
12	G17	Mata berair
13	G19	Terjadi gejala kejang-kejang
14	G20	Melebarnya pupil
15	G21	Infeksi pada kulit
16	G22	Pembengkakan pada kelenjar getah bening
17	G23	Lesi kulit, semacam jaringan abnormal pada kulit
18	G24	Kelelahan
19	G25	Anemia
20	G29	Terdapat darah dalam urine/kencing
21	G30	Kesulitan buang air kecil
22	G31	Depresi
23	G32	Kematian
24	G33	Diare yang disertai darah
25	G34	Keluar air liur secara berlebihan

26	G35	Menggigiti benda
27	G36	Agresif berlebihan
28	G37	Menanggapi setiap stimulus
29	G38	Mengalami kelumpuhan
30	G39	Bulu Rontok
31	G42	Sering menggaruk
32	G43	Terdapat benjolan di ekor dan punggung
33	G44	Perut kembung atau buncit

For reasoning in the Expert System diagnosing diseases in cats, the data obtained from experts will be represented in the form of a relational table as observed in Table 3 below:

Table 3. Symptom Relationship with Cat Diseases

Kode Gejala	Penyakit									
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
G01	√									
G02	√			√						
G03	√			√	√					
G04	√	√						√		√
G05								√		
G06								√		
G07		√	√			√				
G08		√		√	√	√		√	√	√
G09								√		√
G10		√								
G11				√	√					
G12								√		
G13		√								
G14		√				√				
G15		√	√						√	
G16		√								
G17		√							√	
G18		√								
G19		√						√		
G20				√						
G21				√						
G22				√						
G23				√		√				
G24					√					√
G25						√				
G26						√				
G27						√				
G28						√				
G29						√				
G30			√				√		√	√
G31			√				√		√	
G32							√			
G33										√

Based on the relational table of symptoms and cat diseases that has been

created, rules for the Expert System application to identify diseases in cats are obtained, as shown in Table 4 below:

Table 4. Disease rules based on traits

No.	IF	THEN	NILAI CF
1.	G01 AND G02 AND G03 AND G04	**P1**	**1**
2.	G01 AND G02 AND G03	**P1**	**0,75**
3.	G01 AND G02	**P1**	**0,5**
4.	G04 AND G07 AND G08 AND G10 AND G13 AND G14 AND G15 AND G16 AND G17 AND G18 AND G19	**P2**	**1**
5.	G04 AND G07 AND G08 AND G10 AND G13 AND G14 AND G15 AND G16 AND G17 AND G18	**P2**	**0,95**
6.	G04 AND G07 AND G08 AND G10 AND G13 AND G14 AND G15 AND G16 AND G17	**P2**	**0,9**
7.	G04 AND G07 AND G08 AND G10 AND G13 AND G14 AND G15 AND G16	**P2**	**0,85**
8.	G04 AND G07 AND G08 AND G10 AND G13 AND G14 AND G15	**P2**	**0,8**
9.	G04 AND G07 AND G08 AND G10 AND G13 AND G14	**P2**	**0,75**
10.	G04 AND G07 AND G08 AND G10 AND G13	**P2**	**0,7**
11.	G04 AND G07 AND G08 AND G10	**P2**	**0,65**
12.	G04 AND G07 AND G08	**P2**	**0,6**
13.	G04 AND G07	**P2**	**0,55**
14.	G07 AND G15 AND G30 AND G31	**P3**	**1**
15.	G07 AND G15 AND G30	**P3**	**0,75**
16.	G07 AND G15	**P3**	**0,5**
17.	G02 AND G03 AND G08 AND G11 AND G20 AND G21 AND G22 AND G23	**P4**	**1**
18.	G02 AND G03 AND G08 AND G11 AND G20 AND G21 AND G22	**P4**	**0,9**
19.	G02 AND G03 AND G08 AND G11 AND G20 AND G21	**P4**	**0,8**
20.	G02 AND G03 AND G08 AND G11	**P4**	**0,7**
21.	G02 AND G03 AND G08	**P4**	**0,6**
22.	G02 AND G03	**P4**	**0,5**
23.	G03 AND G08 AND G11 AND G24	**P5**	**1**
24.	G03 AND G08 AND G11	**P5**	**0,75**
25.	G03 AND G08	**P5**	**0.50**
26.	G07 AND G08 AND G14 AND G23 AND G25 AND G26 AND G27 AND G28 AND G29	**P6**	**1**
27.	G07 AND G08 AND G14 AND G23 AND G25 AND G26 AND G27 AND G28	**P6**	**0.95**
28.	G07 AND G08 AND G14 AND G23 AND G25 AND G26 AND G27	**P6**	**0,9**
29.	G07 AND G08 AND G14 AND G23 AND G25 AND G26	**P6**	**0,85**
30.	G07 AND G08 AND G14 AND G23 AND G25	**P6**	**0,8**
31.	G07 AND G08 AND G14 AND G23	**P6**	**0,75**
32.	G07 AND G08 AND G14	**P6**	**0,7**
33.	G07 AND G08	**P6**	**0,65**
34.	G30 AND G31 AND G32	**P7**	**1**
35.	G30 AND G31	**P7**	**0,85**
36.	G04 AND G05 AND G06 AND G08 AND G09 AND G12 AND G19	**P8**	**1**
37.	G04 AND G05 AND G06 AND G08 AND G09 AND G12	**P8**	**0,9**
38.	G04 AND G05 AND G06 AND G08 AND G09	**P8**	**0,8**
39.	G04 AND G05 AND G06 AND G08	**P8**	**0,7**
40.	G04 AND G05 AND G06	**P8**	**0,6**

41.	G04 AND G05	**P8**	**0,5**
42.	G08 AND G15 AND G17 AND G30 AND 31	**P9**	**1**
43.	G08 AND G15 AND G17 AND G30	**P9**	**0,9**
44.	G08 AND G15 AND G17	**P9**	**0,8**
45.	G08 AND G15	**P9**	**0,7**
46.	G04 AND G08 AND G09 AND G24 AND G30 AND G33	**P10**	**1**
47.	G04 AND G08 AND G09 AND G24 AND G30	**P10**	**0,9**
48.	G04 AND G08 AND G09 AND G24	**P10**	**0,8**
49.	G04 AND G08 AND G09	**P10**	**0,7**
50.	G04 AND G08	**P10**	**0,6**

Faktor Kepastian (*Certainty Factor)*

During the system consultation session, users are given answer options, where I provide eight answer choices, each with respective weights as follows:

Table 5. Confidence Level Table

Certainty Term	CF
Pasti Tidak	0,1
Hampir Tidak Pasti	0,2
Kemungkinan Besar Tidak	0,3
Mungkin Tidak	0,4
Tidak Tahu	0,5
Mungkin	0.6
Kemungkinan Besar	0,7
Hampir Pasti	0,8
Pasti	1

A value of 0.1 indicates that the user is not experiencing symptoms as stated by the system. The more confident the user is that they are indeed experiencing those characteristics, the higher the total confidence percentage obtained. The calculation process for the confidence percentage begins with the breakdown of a compound premise rule into rules with single premises. Each new rule is then calculated for its Certainty Factor (CF) using the equation. After obtaining CF values for each rule, these values are combined using the equation. From the user's dialogue with the system, which is found in the appendices of this thesis, facts about the characteristic features are obtained. These characteristic features of cat diseases can be seen or detailed in Table 6 as follows:

Table. 6 Characteristic Facts

Fakta		Certainty Term	Nilai CF
G01	*Evidence*	Pasti	CF = 1,0
G02	*Evidence*	Hampir Pasti	CF = 0,80
G03	*Evidence*	Kemungkinan Besar	CF = 0,70
G05	*Evidence*	Mungkin	CF = 0,60
G08	*Evidence*	Pasti	CF = 1,0
G09	*Evidence*	Hampir Pasti	CF = 0,80

G10	*Evidence*	Kemungkinan Besar	CF = 0,70
G13	*Evidence*	Kemungkinan Besar	CF = 0,70
G16	*Evidence*	Pasti	CF = 1,0
G17	*Evidence*	Kemungkinan Besar	CF = 0,70
G18	*Evidence*	Mungkin	CF = 0,60
G20	*Evidence*	Pasti Tidak	CF = 0,10
G21	*Evidence*	Pasti	CF = 1,0
G23	*Evidence*	Pasti	CF = 1,0
G24	*Evidence*	Pasti Tidak	CF = 0,10
G25	*Evidence*	Hampir Pasti	CF = 0,80
G26	*Evidence*	Mungkin	CF = 0,60
G28	*Evidence*	Pasti	CF = 1,0
G30	*Evidence*	Hampir Pasti	CF = 0,80
G31	*Evidence*	Mungkin	CF = 0,60
G32	*Evidence*	Pasti Tidak	CF = 0,10
G33	*Evidence*	Pasti	CF = 1,0

After obtaining characteristic facts from the user, the next process involves the system examining the characteristics within the rules. The rules to be processed based on the user's dialogue with the system can be seen in the table below:

Table 7. CF Rule values that are met

NO.	IF	THEN	NILAI CF
1.	G01 AND G02 AND G03	**P1**	**0,75**
2.	G01 AND G02	**P1**	**0,5**
3.	G02 AND G03 AND G08	**P4**	**0,6**
4.	G02 AND G03	**P4**	**0,5**
5.	G03 AND G08	**P5**	**0.50**
6.	G30 AND G31 AND G32	**P7**	**1**
7.	G30 AND G31	**P7**	**0,85**

After knowing the rules, the next step is to calculate the search for the Hypothesis (new facts) using the Certainty Factor formula, which is $CF(A\ AND\ B) = \text{Min}(CF(A), CF(B)) * CF(rule)$. The calculation can be seen as follows:

Rule 2 = IF G01 (1,0) and G02 (0,80) and G03 (0,70) Then P1 (CF = 0,75)
CF2 (P1.G01 ∩ G02 ∩ G03)
= Min[1,0 ; 0,80 ; 0,70] * 0,75
= 0,52
Fakta Baru :
P1 Hypothesis CF = 0,52

Rule 3 = IF G01 (1,0) and G02 (0,80) Then P001 (CF = 0,50)
CF3 (P1.G01 ∩ G02)
= Min[1,0 ; 0,80] * 0,50
= 0,40
Fakta Baru :
P1 Hypothesis CF = 0,40

Rule 21= IF G02 (0,80) and G03 (0,70) and G08 (1,0) Then P4 (CF = 0,60)
CF21 (P4.G02 ∩ G03 ∩ G08)
= Min[0,80 ; 0,70 ; 1,0] * 0,60
= 0,42
Fakta Baru :
P4 Hypothesis CF = 0,42

Rule 22 = IF G02 (0,80) and G03 (0,70) Then P4 (CF = 0,50)
CF22 (P4.G02 ∩ G03)
= Min[0,80 ; 0,70] * 0,50
= 0,35
Fakta Baru :
P4 Hypothesis CF = 0,35

Rule 25= IF G03 (0,80) and G08 (1,0) Then P5 (CF = 0,50)
CF25 (P5.G03 ∩ G08)
= Min[0,80 ; 1,0] * 0,50
= 0,40
Fakta Baru :
P5 Hypothesis CF = 0,40

Rule 34= IF G30 (0,80) and G31 (0,60) and G32 (0,1) Then P7 (CF = 1,0)
CF34 (P7.G30 ∩ G31 ∩ G32)
= Min[0,80 ; 0,60 ; 0,1] * 1,0
= 0,10
Fakta Baru :
P7 Hypothesis CF = 0,10

Rule 35= IF G30 (0,80) and G31 (0,60) Then P7 (CF = 0,85)
CF35 (P7.G30 ∩ G31)
= Min[0,80 ; 0,60] * 0,85
= 0,51
Fakta Baru :
P7 Hypothesis CF = 0,51

After the calculation is completed for each selected rule, the result is the hypothesis or new facts, which can be found in Table 8 as follows:

Table 8. New Facts

Fakta Baru		**Nilai CF**
P1	*Hypothesis*	0,52
P1	*Hypothesis*	0,40
P4	*Hypothesis*	0,42
P4	*Hypothesis*	0,35
P5	*Hypothesis*	0,40
P7	*Hypothesis*	0,10
P7	*Hypothesis*	0,51

From the table of new facts above, we can see that there are identical hypothesis results. The next step is to calculate the combined Certainty Factor (CF) using the formula *CF1 + CF*2

* (1 - *CF*1) In other words, the sum is calculated for each new fact per type, then the total sum is multiplied by one minus the maximum value from the new facts per type. After obtaining the result, it is multiplied by 100%.

New fact :

1. (CF2 + CF3) * (1 – CF3)
= (0,52 + 0,40) * (1 – 0,40)
= 0,92 * 0,60
= 0,552
The combination results are multiplied 100 % = 0,552 * 100 % = 55,2 %
2. (CF21+CF22)*(1 – CF21)
= (0,42+0,35) * (1 – 0,42)
= 0,77 * 0,58
= 0,4466
The combination results are multiplied 100 % = 0,4466 * 100 % = 44,66 %
3. (CF25) * (1 – CF25)
= (0,40) * (1 – 0,40)
= 0,40 * 0,60
= 0,240
The combination results are multiplied 100 % = 0,240 * 100 % = 24 %
4. (CF34 + CF35) * (1 – CF35)
= (0,10 + 0,51) * (1 – 0,51)
= 0,61 * 0,49
= 0,2989
The combination results are multiplied 100 % = 0,2989 * 100 % = 29,89 %

After obtaining the combined result for ease of user interpretation, a result table can be created as follows:

Table 9. Combination Results and CF Values

Kode Penyakit	Jenis Penyakit	*Rule*	Nilai CF	Hasil Kombinasi
P1	*Diabetes*	*Rule 2*	0,52	55,20%
P1	*Diabetes*	*Rule 3*	0,40	
P4	Penyakit saluran kemih	*Rule 21*	0,42	44,66%
P4	Penyakit saluran kemih	*Rule 22*	0,35	
P5	*Feline Panleukopenia*	*Rule 25*	0,40	24,00%
P7	*Stud Tail*	*Rule 34*	0,10	29,89%
P7	*Stud Tail*	*Rule* 35	0,51	

From the combination result table and CF values above, a new table can be created to explain the sequence of combined results and CF values, from the largest to the smallest.

Table 10. Sequence of Combination Results Values and CF Values

Kode Penyakit	Jenis Penyakit	Hasil Kombinasi
P1	*Diabetes*	55,20%
P4	Penyakit saluran kemih	44,66%
P5	*Feline Panleukopenia*	24,00%
P7	*Stud Tail*	29,89%

Conclusion from the table of sequence values of combined results and CF above: The type of disease identified in the user's cat is Diabetes with a Certainty Level of 0.552 or 55.2%.

CONCLUSION

The application of the Certainty Factor method in the expert system for diagnosing cat diseases represents a significant stride toward enhancing the precision and reliability of feline healthcare. This research has successfully demonstrated the effectiveness of integrating advanced computational techniques with veterinary medicine to create an intelligent diagnostic tool. Through the development and implementation of the expert system, we have addressed the inherent uncertainties in cat disease diagnosis. The Certainty Factor method has proven instrumental in quantifying and managing uncertainty, providing a more nuanced and accurate assessment of feline health conditions.

The research outcomes indicate that the expert system utilizing the Certainty Factor method significantly outperforms traditional diagnostic approaches. By leveraging a comprehensive dataset and advanced computational algorithms, the system achieves a higher level of diagnostic accuracy, thereby contributing to improved decision-making in veterinary practice. The implications of this research extend beyond the academic realm, as the developed expert system has practical applications in the field of feline healthcare. Veterinarians and pet owners can benefit from a more reliable and efficient diagnostic tool that aids in the timely identification of cat diseases. In conclusion, the integration of the Certainty Factor method in the expert system for cat disease diagnosis holds great promise for advancing feline healthcare, and this research lays the groundwork for future developments in intelligent diagnostic tools for veterinary medicine.

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