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Expert System for Diagnosing Skin Diseases in Dogs using the Bayes' Theorem Method

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A B S T R A C T

Skin disease in dogs is the most common disease found by veterinarians. The impact of skin diseases on dogs can be aesthetically disturbing, resulting in infection and even death if left untreated a limited number of veterinarians in Indonesia compared to the number of cases of skin diseases in dogs, as well as human ignorance in identifying skin diseases in dogs, are the reasons why a system is needed that can assist in the process of diagnosing skin diseases in dogs. In the expert system, there are many methods used, one of which is the Bayes theorem method. Bayes theorem is used to calculate a decision and the right information based on observations that have been made. An expert system can replace the role of an expert whose working principle can provide definite results, as is done by an expert. This research resulted in a system application that can assist doctors in handling problems in dog skin diseases. The concept of an expert system is a program that can analyze problems and produce conclusions with the process of transferring expert knowledge into the system.

1. Introduction

Dogs are very loyal types of animals, dogs can be said to be good and fun friends. Nowadays there are more and more dog lovers, some are even willing to spend up to tens of millions of rupiah to buy a dog [1]. Their cuteness and intelligence are one of the reasons to keep these animals as pets as well as great housekeepers. Dogs are one of the animals that can be invited to play, live with humans, and be invited to socialize with humans. Not a few people are interested in choosing dogs as pets.

In addition to the many reasons for being attracted to dogs, there is also a disease problem in these dogs. One of the most common diseases is skin disease. Skin disease is a condition where the skin is disturbed (abnormal) which can be caused by viruses, bacteria, and infections. Skin disease in dogs is one of the most common diseases, environmental and climatic conditions that are different from their natural habitat are one of the reasons why dogs are very susceptible to skin diseases. All skin diseases are harmless and easily cured if they get the right treatment.

Skin diseases are different from rabies and other dangerous diseases found in dogs, but skin diseases are also very important and require serious treatment [2]. An expert system is a computer system that resembles (emulation) the decision-making ability of an expert. The term emulation can be interpreted that the Expert System being expected to work in various ways like an expert. This expert knowledge is used as a basis by the Expert System to answer various questions. Expert systems have many methods, one of the methods used in making such a system is the Bayes theorem method. Bayes theorem is used to calculate the probability of an event occurring based on the effect obtained from observations. Bayes' theorem allows one to influence beliefs about a parameter after the data has been obtained belief prior before starting inference. The prior obtained is based on the subjective belief of the researcher himself regarding the possible values for the estimated parameters, so it is necessary to pay attention to how to determine the priors [3].

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2. Method

Bayes' theorem was proposed by a Presbyterian priest (England) in 1763 named Thomas Bayes, then refined by Laplace. Bayes theorem is used to calculate the probability of an event occurring based on the effect obtained from the observations. In addition to this, the Bayes theorem method also utilizes sample data obtained from the population and also takes into account an initial distribution called the prior distribution [4].

Bayes theorem was then developed with various sciences including for solving Expert System problems by determining the probability value of the expert hypothesis and the value of the evidence obtained from the facts obtained from the diagnosed object.

Bayesian probability is one way to overcome data uncertainty by using the Bayesian formula stated [5]:

$$P(H \mid E)\ (P(E \mid H).P(H))/P(E) \quad \text{.....(1)}$$

Where :

P(H|E) : the probability of hypothesis H, if given evidence E
P(E | H) : the probability of emergence of evidence E, if known hypothesis H
P(H) : the probability of hypothesis H, regardless of any evidence
P (E) : probability evidence E

Algorithm The system algorithm is an important stage to find out the steps made in the Expert System to be designed

Following is a flowchart method Bayes Theorem as follows:

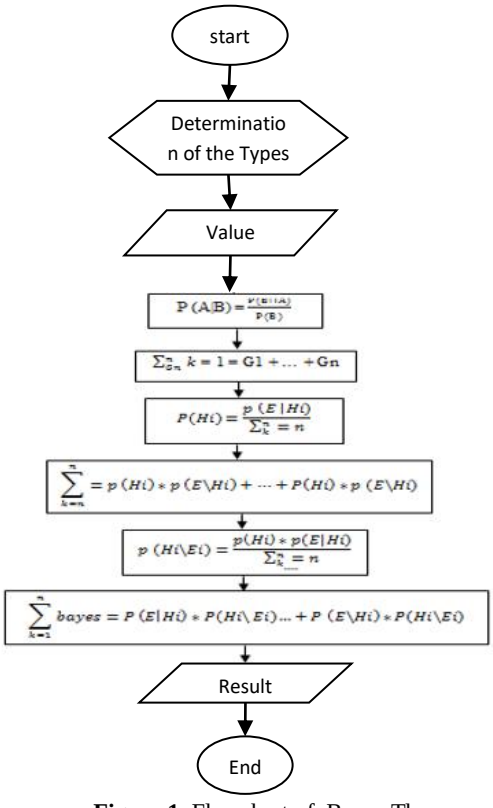

Figure 1. Flowchart of Bayes Theorem

3. Result and Discussion

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3.1 Determining Skin Diseases in Dogs

From the symptom data above, it can be classified as a type of skin disease in dogs. The following is a table of skin diseases in dogs as follows:

TABLE 1
DATA ON SKIN DISEASES IN DOGS

No	Disease Code	Name Of Disease
1	P01	Scabies
2	P02	Access (lump)
3	P03	Ulcer (Wound)
4	P04	Tumor (cancer)

3.2 Determining Data on Skin Disease Symptoms in Dogs

This step was made to identify symptom data obtained from research results at UPT. Medan Animal Health Clinic. Below is a table of symptom data that will be used in diagnosing skin diseases in dogs as follows:

TABLE 2
DATA SYMPTOMS OF SKIN DISEASES IN DOGS

No	Code Symptoms	Symptoms of Disease
1	G1	Hair loss
2	G2	Scabs/crusts occur
3	G3	Itching (usually rubbing against a rough surface)
4	G4	Swelling/bump on the skin surface
5	G5	Pain on the skin
6	G6	The appearance of sores on the skin (reddish skin rash)
7	G7	The appearance of lumps on the skin
8	G8	Trauma
9	G9	numbness of the skin
10	G10	On the part of the skin affected by cancer usually the lump will burst

3.3 Determining the Knowledge Base

Knowledge of the system is represented by a set of rules in the form of IF-THEN. Here knowledge is presented in rules in the form of acondition-action" IF (IF) the condition is fulfilled or occurs THEN (THEN)" an action will occur.

TABLE 3
KNOWLEDGE BASE OF SKIN DISEASES IN DOG

No	Code Symptoms	Symptoms Disease	Disease Code			
			P01	P01	P01	P01
1	G1	Hair loss	✓		✓	✓
2	G2	Scabs	✓			
3	G3	Itching	✓			
4	G4	Swollen skin		✓		
5	G5	Pain in the skin		✓		
6	G6	Rash on the skin			✓	
7	G7	Traumatic			✓	
8	G8	Lump on the skin				✓
9	G9	The skin numb				✓
10	G10	The skin flared in of cancer disease				✓

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Knowledge of the system is represented by a set of rules in the form of IF-THEN. Here knowledge is presented in rules in the form of a condition-action" IF (IF) the condition is fulfilled or occurs THEN (THEN)" an action will occur. The following is rule based on the rules of the Expert System using the Bayes Theorem, as follows:

Rule 1: IF Hair loss
AND Scabs/crusts occur
AND Itchiness
THEN Scabies

Rule 2: IF There is swelling/bump on the skin surface
AND pain on the skin
THEN Access (lumps)

Rule 3: IF Appearsto the skin
AND hair loss
AND trauma
THEN Ulcer (Wound)

Rule 4: IF A lump appears on the skin
AND Numb
AND on the part of the skin where the lump will break
AND Hair loss
THEN Cancer (Tumor)

3.4 Determining the Probability Value

Below is a table of values for the symptoms of skin diseases in dogs obtained from historical data on dogs with skin diseases that have been consulted, where the data will be used to find probability values or symptom values as the basis for obtaining Bayesian conclusions.

TABLE 4
TABLE OF PROBABILITY VALUES

No	Disease	Symptoms	Probability
1.	Scabies	Hair Loss	0.6
		Crusts occur	0.7
		Itchiness	0.8
2	Access (lumps)	Swelling/bump on the skin surface	0.9
		Pain on the skin	0.6
3	Ulcer (Wound)	Reddish skin rash	0.5
		Hair Loss	0.8
		Trauma	0.9
4	Cancer	The appearance of a lump on the skin	0.66
		Numbness of skin	0.6
		On the skin affected by cancer usually, the lump will burst	0.8
		Hair loss	0.53

3.5 Bayes Theorem Calculation Process

The following is a case that shows a symptom of skin disease in dogs. To perform a calculation in ascertaining the disease on the dog's skin, a calculation is needed as follows:

a. With the probability value that has been determined, the probability value will then be added up. Based on the new sample data sourced from the consultation table.

$$= \sum_{Gn}^{n} k = 1 = Gn + \cdots + Gn \quad \text{.....(1)}$$

P01 = *Scabies*

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G1 = P (E|H1) = 0.6
G2 = p (E|H2) = 0.7
G3 = P (E|H3) = 0.8

$$= \sum_{G3}^{3} k = 3 = 0.6 + 0.7 + 0.8 = 2.1$$

P02 = Access (lumps)
G4 = P (E|H4) = 0.9
G5 = P (E|H5) = 0.6

$$= \sum_{G2}^{2} k = 3 = 0.9 + 0.6 = \ 1.5$$

P3 = Ulcer (Wound)
G1 = P (E|H1) = 0.5
G6 = P (E|H6) = 0.8
G7 = P (E|H) = 0.9

$$= \sum_{k=3}^{3} K = 4 = 0.5 + 0.8 \ + 0.9 \ = 2.2$$

P04 = *Cancer*
G1 = P (E|H1) = 0.53
G8 = P (E|H8) = 0.66
G9 = P (E|H9) = 0.6
G10 = P (E|H10) = 0.8

$$= \sum_{k=4}^{4} K = 4 = 0.53 + 0.66 \ + 0.6 \ + 0.8 = 2.59$$

b. Next, look for a probability hypothesis H regardless of evidence by dividing the probability value of the evidence by the sum of the probabilities based on a new sample of data.

$$P(Hi) = \frac{\text{p (E|Hi)}}{\sum_{k}^{n} \quad = n}$$

P01 = *Scabies*
G1 = P (H1) $= \frac{0.6}{2.1}$ = 0.285
G2 = p (H2) $= \frac{0.7}{2.1}$ = 0.333
G3 = P (H3) $= \frac{0.8}{2.1}$ = 0.539
P02 = Access (lumps)
G2 = P (H2) $= \frac{0.9}{1.5}$ = 0.6
G4 = P (H4) $= \frac{0.6}{1.5}$ = 0.4
P03 = Ulcer (Wound)
G1 = P (H1) $= \frac{0.5}{2.2}$ = 0.227
G6 = P (H6) $= \frac{0.8}{2.2}$ = 0.363
G7 = P (H7) $= \frac{0.9}{2.2}$ = 0.409
P04 = Cancer
G1 = P (H1) $= \frac{0.53}{2.59}$ = 0.204
G8 = P (H8) $= \frac{0.66}{2.59}$ = 0.254
G9 = P (H9) $= \frac{0.6}{2.59}$ = 0.231
G10 = P (H10) $= \frac{0.8}{2.59}$ = 0.308

c. Next, look for a probability hypothesis H regardless of evidence by dividing the probability value of the evidence by the sum of the probabilities based on a new sample of data.

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$= \sum_{k=n}^{n} = p\ (H_{\mathrm{i}}) * p(E|H_{\mathrm{i}}) + \cdots + P(H_{\mathrm{i}}) * P(E|H_{\mathrm{i}})$

P01 = *Scabies*

$\sum_{k=3}^{3} = \ (0.6 * 0.285) + (0.7 * 0.333) + (0.8 * 0.539)$

= 0.154 + 0.233 + 0.431

= 0.818

P02 = Access (lumps)

$\sum_{k=2}^{2} = \ (0.9 * 0.6) + (06 * 0.4)$

= 0.54 + 0.24

= 0.78

P03 = Ulcer (Wound)

$\sum_{k=3}^{3} = (0.5 * 0.227) + (0.8 * 0.363) + (0.9 * 0.409\ )$

= 0.113 + 0.290 + 0.368

= 0.771

P04 = Cancer

$\sum_{k=4}^{4} = (0.53 * 0.204) + (0.66 * 0.254) + (0.6 * 0.231)\ + (0.8 * 0.308)$

= 0.166 + 0.167 + 0.138 + 0.246

= 0.717

d. Next, look for the probability of the hypothesis H, in a way that produces the value of the probability of the hypothesis regardless of an evidence with an initial probability value and then divides the results the probability of the hypothesis by looking at the evidence.

$p\ (H_{\mathrm{i}} \backslash E_{\mathrm{i}}) = \frac{P(H_{\mathrm{i}}) * P(E \backslash H_{\mathrm{i}})}{\sum_{k}^{n} \quad = N}$

P01 = Scabies

P (H1\E) = $\frac{0.6 * 0.285}{0.818}$ = 0.209

P (H2\E) = $\frac{0.7 * 0.333}{0.818}$ = 0.284

P (H\E) = $\frac{0.8 * 0.539}{0.818}$ = 0.527

P02 = Access (lumps)

P (H4\E) = $\frac{0.9 * 0.6}{0.78}$ = 0.692

P (H5\E) = $\frac{0.6 * 0.4}{0.78}$ = 0.307

P03 = Ulcer (Wound)

P (H1\E) = = 0.147

P (H6\E) = = 0.376

P (H10\E) = = 0.447

P04 = Cancer

P (H1\E) = = 0.150

P (H8\E) = = 0.233

P (H9\E) = = 0.236

P (H10\E) = = 0.343

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e. The next step is to find the Bayes value from the Bayes Theorem by multiplying the probability value of the evidence or P ($E|H_i$) with the hypothesis value H_i is true if given evidence of E or P ($H_i|E$) and adding up the multiplication.

$$\sum_{k=0}^{n} \text{bayes} = P\ (E|H_i) * P\ (H_i|E_i) \ldots + P\ (E|H_i) * P\ (H_i|E_i)$$

P01 = Scabies

$$\sum_{k=3}^{3} = \ (0.6 * 0.209) + (0.7 * 0.284) + (0.8 * 0.527)$$

= 0.125 + 0.198 + 0.421

= 0.744

P02 = Access (lumps)

$$\sum_{k=2}^{2} = \ (0.9 * 0.692) + (0.6 * 0.307)$$

= 0.622 + 0.184

= 0.806

P03 = Ulcer (Wound)

$$\sum_{k=3}^{3} = (0.5 * 0.147) + (0.8 * 0.376) + (0.9 * 0.447)$$

= 0.073 + 0.300 + 0.402

= 0.775

P04 = Cancer

$$\sum_{k=4}^{4} = (0.53 * 0.150) + (0.66 * 0.233) + (0.6 * 0.236) \ + (0.8 * 0.343)$$

= 0. 079+ 0. 153+ 0.141 + 0.274

= 0.647

4. Conclusion

From the results of calculations using the Bayes Theorem above, it can be seen that the diagnosis of dog skin disease is access (lumps) with a certainty value of 0.806 or 80.6%, and the solution is to clean the wound and and keep consulting with a veterinarian for appropriate treatment.

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