Application of Case Base Reasoning Algorithm in Detecting Disease in Pineapple Fruit

Nurhaeka Tou[1], Putri Mentari Endraswari[2], Nur Annisa[3]

[1,2]Information Technology, Bangka Belitung University, Balunijuk, Bangka, 33172, Indonesia
[3] Informatics, Cokroaminoto Palopo University, Jl. Latamacelling, Palopo, 91911, Indonesia

ARTICLE INFO

ABSTRACT

Pineapple fruit is a type of horticultural plant that has the potential to be developed. In the process of pineapple cultivation, it is very susceptible to pests and diseases. Diseases that often attack pineapples such as; wilt disease, stem base rot, fusariosis, bacterial rot, and urethral disease. The process of identifying pineapple diseases is often done manually so it takes a long time. In addition, in the process of controlling pests and diseases, farmers only spray pesticides or other handling techniques that are not suitable for the pests and diseases that attack them. Thus, the treatment is not optimal and has an impact on the emergence of new pests and diseases in pineapple. Currently, computer technology can be used in various branches of science, one of which is artificial intelligence. The expert system is a scientific branch of artificial intelligence that can solve problems. The purpose of this research is to assist farmers in identifying pests and diseases in pineapples so that the control process can be carried out optimally, quickly and on target. The implementation of an expert system uses the Case Base Reasoning (CBR) method which will produce a diagnostic similarity value and provide recommendations for diseases that attack. This research processes data in the form of symptoms seen in pineapple plants. The test results obtained a percentage of 100%. Thus, the application of the CBR method is very relevant in identifying pests and diseases of pineapple plants.

Corresponding Author:

Nurhaeka Tou
Information Technology, Bangka Belitung University, Balunijuk, Bangka, 33172, Indonesia
Email: nurhaeka@ubb.ac.id

1. INTRODUCTION

Pineapple is a type of horticultural plant that has the potential to be developed because it can dominate the world tropical fruit trade [1]. Pineapple is a very important commodity owned by Indonesia. Indonesian people like to consume pineapple because it contains many vitamins such as; B1, B2, B3, B5, B6 and vitamin C. Pineapple can be consumed directly, or in processed forms such as: juice, pineapple jam, and cocktails [2]. In addition to the fruit which contains a lot of vitamins, the pineapple plant also has other uses, such as: (1) The leaves of the pineapple can be used as fiber (yarn) for clothing, (2) the pineapple contains the enzyme bromelain which can break down proteins, so that used for meat tenderizer, and (3) pineapple peel can be used for animal feed and as organic fertilizer [1].

Pineapple belongs to the bromoliaceace family category which has the property of growing in the soil using roots. Pineapple plants usually grow on home yard soil, soil that contains a lot of organic elements that can hold a lot of water, so that it can survive on dry soil for a long time [3].

In an effort to increase the productivity of pineapple fruit, various problems were found, such as the presence of plant-disturbing organisms (OPT) that cause disease. One type of disease that is dangerous in pineapple is rotting fruit disease caused by bacteria [4]. During the growth process, pineapple plants are susceptible to pests and diseases. Pest and disease disturbances in pineapples can be in the form of fruit rot, wilt disease, stem rot disease, urethritis, interknoas, and fusariosis [5]. This pest and disease attack is a concern for farmers, because it can reduce the quality of the pineapple. In addition, these pests and diseases not only attack the fruit, but also attack the pineapple crown which can affect the availability of pineapple seeds [6].

In general, if plants are attacked by pests and diseases, conventional farmers will spray pesticides or a treatment method that is not suitable for pests and diseases that attack plants. However, this method is not effective and maximal, which results in the emergence of new pests and diseases.

Based on these problems, a system is needed that is able to identify pests and diseases that attack pineapple plants, so that the control process can be carried out optimally, quickly, and on target. An expert system is a computer system that adopts human knowledge. This system can be used to solve a problem based on facts, knowledge, and reasoning like an expert or expert [7]. Until now, expert systems have been widely applied in various fields such as health, fisheries, animal husbandry, plantations, education and many more. In the problem-solving process, a suitable algorithm is needed to solve the problem, namely the Case Base Reasoning (CBR) algorithm. CBR is an algorithm that uses experience to solve a problem. The problem solving process of the CBR algorithm is to find a case that is similar to the past case and reuse it to become a new problem [8]. The CBR algorithm is applied to define the level of logical confidence in evaluating a possibility.

This research refers to several previous research studies that have implemented an expert system such as, Research conducted by [3] who created a Mobile-Based Expert System to Diagnose Pests and Diseases of Pineapple Plants Using Forward Chaining Methods. Furthermore, it was carried out by [7] to produce a system for diagnosing diseases in shallots to help farmers identify diseases in onion plants, an expert system for diagnosing diseases in gourami [9], an expert system for diagnosing infertility in men [10], and expert systems in determining healthy menus for pregnant women [11].

2. RESEARCH METHOD

2.1. Expert System

Expert System (Expert System) is a branch of artificial intelligence. An expert system is a system that adopts human knowledge to a computer or a system created to solve problems as done by an expert [12]. A good expert system is made with the aim of being able to solve certain problems by imitating the way experts work. An expert is a person who has special knowledge or expertise in solving problems that others do not have.

The purpose of the expert system is to perform problem solving in various ways such as: Interpretation, Diagnosis, Design, Planning, Monitoring, Debugging, Instryksi, and Control. Furthermore, expert systems are useful for storing knowledge from experts [13].

2.2. Case Base Reasoning

Case Base Reasoning (CBR) is a reasoning model that combines the process of problem solving, understanding. And learning. This process is carried out in various situations that have been stored in the system [14]. The process cycle of the CBR algorithm is as follows:

1. Retrieve is a process to find new cases that are similar to the old cases stored in the base case. Furthermore, it is used again to find a solution for the new case. In CBR, retrieval consists of two algorithms, namely the decision tree algorithm and the nearest neighbor algorithm.
2. Reuse is a process that reuses existing cases. This process is carried out because it is almost rare for new cases to be the same as old cases, so that solutions are made in the previous case to match the new case.
3. Revise is a process that changes and adopts the proposed solution. Revise has two main tasks, namely: Evaluation of solutions is carried out based on responses from experts, and perform error

correction (adaptation). The adaptation method can be done by, Substitution, Transformation, Re-instantiation (copying process), and using the solution from the previous case to become a solution to the new case.
4. Retain is a process of storing and validating solutions from new cases into case-based [15].

The stages of the case base reasoning process can be seen in
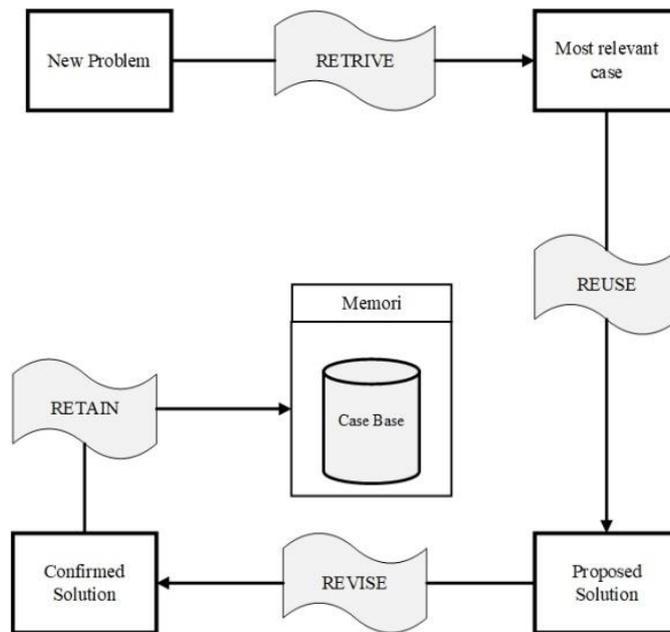Figure *1*.

Figure 1. Process Case Base Reasoning

The equation used in the case base reasoning (CBR) algorithm is as follows:

$$Similarity(P,C) = \frac{S1+W1...,(Sn+Wn)}{W1+\cdots,+Wm} \tag{1}$$

2.3. Research Stages
3.3.   The stages of research carried out in this study started from the Problem Description, Literature Study, Data Collection, Data Analysis, Result Testing, and Drawing Conclusions which can be seen in
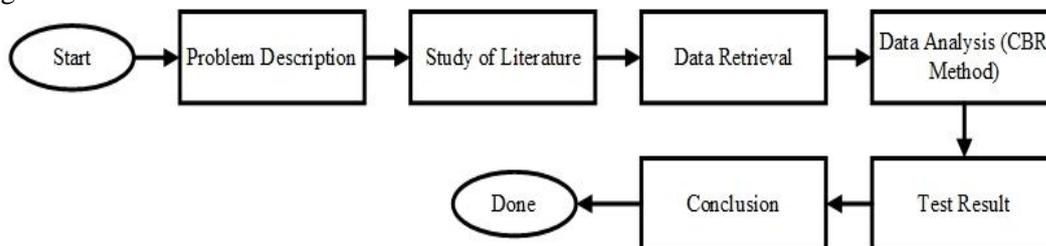Figure *2*.

Figure 2. Research Flowchart

1. Problem Description
    Based on
    Figure *2*, this research stage begins with the problem description stage. This stage is very important to do, to know the scope of the problem under study to find the best solution.
2. Study of Literature

The second stage in this research is literature study, to seek and study scientifically and theoretically previous studies that are relevant to the research conducted.

3. Data Retrieval

   The data collection technique used in this research is the observation data calculation technique.

4. Data Analysis (CBR Method)

   The fourth stage in this research is to analyze the data using Case Base Reasoning (CBR) method. The problem-solving process using the CBR method is carried out with the hope of finding the right similarity value based on the symptoms of the user. The following are the steps of the CBR method that will be carried out in this study:

   a. Determine the disease and symptoms
   b. Detrmine the relationship between disease and symptoms
   c. Determine the weight of each symptom
   d. Determine the similarity by the user with the disease on pineapple plants
   e. Comparing the similarity values for each disease
   f. Conclude the diseases found in pineapple fruit plants.

5. Test Result

   The next stage is to carry out the testing process using the CBR method based on criteria data, to determine the level of system accuracy with manual calculations.

6. Conclusion

   The last stage of this research is to draw conclusions based on the problems and results of research data analysis. The conclusion that is expected is to determine the type of disease from pineapple fruit plants.

In this study the determination of the type of disease in pineapple fruit using the Case Base Reasoning (CBR) algorithm. The CBR algorithm process combines the stages of problem-solving, understanding, and learning into memory processing. The flowchart of the CBR algorithm can be seen in Figure 3.
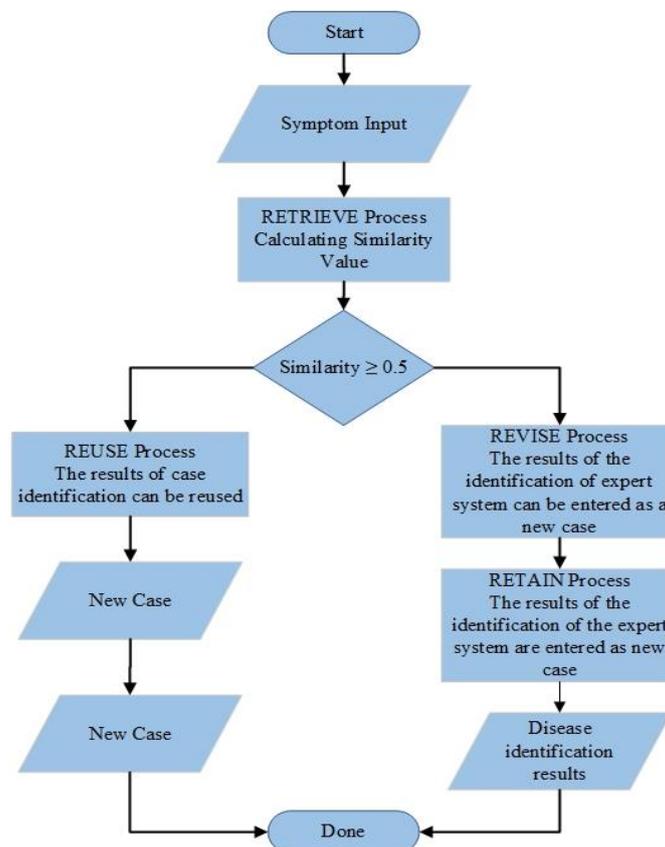

Figure 3. Expert System CBR Flowchart

Figure *3* Shows the Flowchart of the CBR process on the expert system. In the flowchart, the first thing to do is to input the symptoms of the pineapple plant. Next, the system will perform the Retrieve process by calculating the similarity value. If the similarity value obtained is more than 0.5, then the system will reuse the old case for reuse, so that the diagnosis of pineapple disease is immediately obtained. However, if the similarity value obtained is less than 0.5, the system will process Revise and Retain as a new case.

3.   RESULTS AND DISCUSSION

3.1. Description of Research Data

The data used in this study were pineapple plant diseases which were used as research objects, types of diseases in pineapples and symptoms of each pineapple fruit disease.

Data on diseases and symptoms of pineapple plants were obtained from interviews with experts. Thus, information on knowledge and rules that will be used in the decision-making system based on the pineapple fruit disease category can be obtained which can be seen in Table 1.

Table 1. Pineapple Pests and Disease

Code	Disease
P1	Wither Disease
P2	Stem Rot
P3	Fusariosis
P4	Bacterial Rot
P5	Urethral Disease

Furthermore, Table 2 shows the symptoms of pests and diseases on pineapple plants:

Table 2. Symptoms of Pineapple Pests and Diseases

Code	Symptom	Weight
G01	Curved Leaves	5
G02	There are mealybugs on the roots	3
G03	Withered leaves are brown, trun yellow, and dry	5
G04	Root growth stops	5
G05	Root rot	5
G06	Rot at the base of the stem	5
G07	The base of the stem is brown	3
G08	Yellowish white leaves	3
G09	The fruit turns yellow and then black	5
G10	Leaves and fruit are easy to remove	3
G11	The rotting part smells bad	3
G12	Stunted plant grwoth (Dwarf)	5
G13	Wound at the base of the stem	3
G14	Roots and stems have urethra	3

Each disease in pineapple has symptoms that can be seen in Table 3.

Table 3. Symptoms Pineapple and Relationships

Code	P1	P2	P3	P4	P5
G01	*		*		
G02	*				
G03	*		*		*
G04	*			*	*
G05	*			*	*
G06		*	*		
G07		*			
G08	*	*			
G09		*			
G10				*	*
G11		*		*	
G12			*	*	
G13		*			*

G14					*

In the expert system there is an inference engine which becomes the rules for matching facts. The inference engine will start tracking by matching the facts contained in the knowledge base with the rules that have been set based on the knowledge base.

3.2 Symptom Input

The symptoms of pineapple that are inputted will be given a weight based on the answers given by the user. If the user answers YES then it will be given a weight according to the weight of each symptom, but if the user answers NO then it will be given a weight = 0. The symptom input from the user can be seen in Table 4.

Table 4. User's Answer

Code	Symptom	Answer	Weight
G01	Curved Leaves	No	0
G02	There are mealybugs on the roots	No	0
G03	Withered leaves are brown, trun yellow, and dry	No	0
G04	Root growth stops	Yes	5
G05	Root rot	Yes	5
G06	Rot at the base of the stem	No	0
G07	The base of the stem is brown	No	0
G08	Yellowish white leaves	No	0
G09	The fruit turns yellow and then black	No	0
G10	Leaves and fruit are easy to remove	Yes	5
G11	The rotting part smells bad	Yes	3
G12	Stunted plant grwoth (Dwarf)	Yes	5
G13	Wound at the base of the stem	No	0
G14	Roots and stems have urethra	No	0

Next, make the formation of rules obtained from experts, and apply them to the expert system. The experts in question are experts in the field of pests and diseases on pineapples. The following rules will be set in the expert system:

RULE   1= IF G01 AND G02 AND G03 AND G04 AND G05 THEN P01
RULE   2= IF G06 AND G07 AND G08 AND G09 AND G11 AND G13 THEN P02
RULE   3= IF G01 AND G03 AND G06 AND G12 THEN P03
RULE   4= IF G04 AND G05 AND G10 AND G11 AND G12 THEN P04
RULE   5= IF G03 AND G04 AND G05 AND G10 AND 13 AND G 14 THEN P05

After forming the rule from the expert, then execute the rule based on the answers to the symptoms selected by the user. The execution process is carried out by inputting the value of the symptom selected by the user into the predefined rule. Furthermore, from each of these symptoms, the minimum value is calculated for all symptoms that are in accordance with the rule and multiplied by the value of each rule.

3.3 Retrieve Process

The retrieval process is a process of finding similarities between new cases and cases in the knowledge base. The search process is carried out by matching the symptoms entered by the user with the symptoms contained in the knowledge base. In this retrieval process, a weighting process will be carried out using the Nearest Neighbor Retrieval (KNN) method.

In the initial stages of diagnosis, the user will input the symptoms experienced by the pineapple in the expert system. Next, the user will press the process button to find out the results of the pineapple disease diagnosis. In the next stage, the system will do the weighting by matching one by one the inputted symptoms with the symptoms contained in the knowledge base. The following equation is used to calculate the similarity of weights in the system:

$$Similarity(P,C) = \frac{s1*w1+ s2*w2+..sn+wn}{w1 +w2...,+Wn} \qquad (2)$$

The process of calculating the case of wilting disease can be seen in Table 5.

Table 5. Wilt Disease Scheme

Disease Symptoms	Weight	User's Symptoms	Weight

Curved Leaves	5	Root growth stops	5
There are mealybugs the roots	3	Root rot	5
Withered leaves are brown, yellowes, and dry	5	Leaves and fruit are easy to remove	5
Root growth stops	5	The rotting part has an unpleasant odor	3
Root rot	5	Stunted plant growth (dwarf)	5
Yellowish-white rickshaw leaves	3		

$$S\,(P,C) = \frac{0*5 + 0*3 + 0*5 + 1*5 + 1*5}{5 + 3 + 5 + 5 + 5 + 3}$$

$$= \frac{10}{26} = 0.36 = 36\%$$

From the case calculation above, the user inputs 2 symptoms that have similarities with the old case. After the similarity calculation process was carried out, it was found that 43% of the diseases experienced by pineapples were wilt diseases. Furthermore, the calculation process for stem rot disease can be seen in Table 6.

Table 6. Stem Base Disease Scheme

Disease Symptoms	Weight	User's Symptoms	Weigth
Rot at the base of the stem	5	Root growth stops	5
The base of the stem is brown	3	Root rot	5
Yellowish white leaves	3	Leaves and fruit are easy to remove	5
The fruit turns yellow and then black	5	The rotting part has an unpleasant odor	3
The rotting part smells bad	3	Stunted plant growth (dwarf)	5
Wound at the base of the stem	3		

$$S\,(P,C) = \frac{0*5 + 0*3 + 0*3 + 0*5 + 1*3}{5 + 3 + 3 + 5 + 3 + 3}$$

$$= \frac{3}{22} = 0.13 = 13\%$$

From the case calculation above, the user inputs 1 symptom that has similarities with the old case. After the similarity calculation process was carried out, it was found that 13% of the diseases experienced by pineapples were root rot diseases. Furthermore, the process of calculating Fusariosis can be seen in Table 7.

Table 7. Fusariosis Disease Scheme

Disease Symptoms	Weight	User's Symptoms	Weight
Curved leaves	5	Root growth stops	5
Withered leaves are brown, yellowed, and dry	5	Root rot	5
Rot at the base of the stem	5	Leaves and fruit are easy to remove	5
Stunted plant growth (dwarf)	5	The rotting part has an unpleasant odor	3
		Stunted plant growth (dwarf)	5

$$S\,(P,C) = \frac{0*5 + 0*5 + 0*5 + 1*5}{5 + 5 + 5 + 5}$$

$$= \frac{5}{20} = 0.25 = 25\%$$

From the case calculation above, the user inputs 2 symptoms that have similarities with the old case. After the similarity calculation process was carried out, it was found that 50% of the diseases experienced by pineapples were Fusariosis. Furthermore, the calculation process for Bacterial Rot Disease can be seen in Table 8.

Table 8. Bacterial Rot Disease Schematic

Disease Symptoms	Weight	User's Symptoms	Weight
Root growth stops	5	Root growth stops	5
Root rot	5	Root rot	5
Leaves and fruit are easy to remove	5	Leaves and fruit are easy to remove	5
The rotting part has an unpleasant odor	3	The rotting part has an unpleasant odor	3

| Stunted plant growth (dwarf) | 5 | Stunted plant growth (dwarf) | 5 |

$$S\ (P,C) = \frac{1*5 + 1*5 + 1*5 + 1*3 + 1*5}{5 + 5 + 5 + 3 + 5}$$

$$= \frac{23}{23} = 1.00 = 100\%$$

From the case calculation above, the user inputs 5 symptoms that are similar to the old case in the knowledge base. After the similarity calculation process was carried out, it was found that 100% of the diseases experienced by pineapples were bacterial rot diseases. Furthermore, the calculation process for Urethral Disease can be seen in Table 9.

Table 9. Urethral Disease Scheme

Disease Symptoms	Weight	User's Symptoms	Weight
Withered leaves are brown, yellowed, and dry	5	Root growth stops	5
Root growth stops	5	Root rot	5
Root rot	5	Leaves and fruit are easy to remove	5
Leaves and fruit are easy to remove	3	The rotting part has an unpleasant odor	3
Wounds ont the trunk	3	Stunted plant growth (dwarf)	5
Roots and stems have urethra	3		

$$S\ (P,C) = \frac{0*5 + 1*5 + 1*5 + 1*3 + 0*3}{5 + 5 + 5 + 3 + 3 + 3}$$

$$= \frac{13}{24} = 0.54 = 54\%$$

From the case calculation above, the user inputs 3 symptoms that have similarities with the old case. After the similarity calculation process was carried out, it was found that 54% of the diseases experienced by pineapples were Urethritis.

After calculating the similarity to the symptoms entered by the user, the identification results are obtained which can be seen in Table 10.

Table 10. Identification Results

Code	Disease	Identification Value
P01	Penyakit Layu	36%
P02	Penyakit Busuk Pangkal Batang	13%
P03	Fusariosis	25 %
P04	Busuk Bakteri	100 %
P05	Penyakit Uret	54%

Based on Table 10, obtained five types of diseases have similar values, namely wilting disease 36%, root rot 13%, fusariosis 25%, bacterial rot 100%, and urethral disease 54%. However, of the 5 similarities, the one with the greatest similarity value is Bacterial Rot Disease. So, it can be concluded that Pineapple is attacked by Bacterial Rot Disease. Then, testing with an expert system can be seen in Figure 4.

Figure 4. System Test Results

4.   CONCLUSION

Based on the results of the research that has been done, it can be concluded that the Expert System that has been created can track the symptoms of the pineapple fruit plant selected by the user. The results of the identification of pineapple fruit plant diseases with symptoms: Root rot, Leaves, and fruit are easily removed, root growth stops, rotting parts have a bad smell, and stunted plant growth (Dwarf). Then the identification results were obtained in the form of wilting disease 36%, root rot disease 13%, fusariosis at 25%, bacterial rot 100%, and urethral disease 54%. Based on the results of the comparison of the similarity values for each disease, it can be concluded that the pineapple fruit plant was infected with bacterial rot disease with a similarity value of 100%.

REFERENCES

[1]   T. Oviana, T. N. Aeny, and J. Prasetyo, "Isolasi dan Karakterisasi Penyebab Penyakit Busuk Buah pada Tanaman Nanass (Ananas Comosus [L.] Merr.)," *J. Agrotek Trop.*, vol. 3, no. 2, pp. 220–225, 2015.

[2]   F. S. Sihombing, "Sistem Pakar Mendiagnosa Penyakit Pada Tanaman Nanas Dengan Menggunakan Metode Clustering," *Inf. dan Teknol. Ilm.*, vol. 7, no. 2, pp. 198–202, 2020.

[3]   Nurmayanti and R. Saputra, "Implementasi Sistem Pakar Berbasis Mobile Untuk Mendiagnosa Hama Dan Penyakit Tanaman Nanas," *Sist. Inf. dan Komputerisasi Akunt.*, vol. 04, no. 02, pp. 12–16, 2018.

[4]   S. Rodliyatun, S. Triyanti, S. H. Suseno, and D. A. Nugroho, "Standar Operasional Prosedur Budi Daya Nanas sebagai Upaya Penanggulangan Serangan Hama dan Penyakit pada Tanaman Nanas," *J. Pus. Inov. Masy.*, vol. 1, no. 1, pp. 13–20, 2019.

[5]   R. Rachman, "Implementasi Case Based Reasoning Mendiagnosa Penyakit Stroke Menggunakan Algoritma Probabilistic Symmetric," *J. Inform.*, vol. 8, no. 1, pp. 10–16, Feb. 2021.

[6]   E. Simatupang, "Jaringan syaraf tiruan menggunakan metode perceptron untuk menentukan penyakit pada tanaman buah nanas," *Maj. Ilm. INTI*, vol. 6, no. 2, pp. 55–60, 2019.

[7]   Y. S. R. Nur, A. Burhanuddin, D. Aldo, and W. Lelisa Army, "Sistem Pakar Deteksi Penyakit Bawang Merah dengan Metode Case Based Reasoning," *J. MEDIA Inform. BUDIDARMA*, vol. 6, no. 3, p. 1356, Jul. 2022.

[8]   Z. Nenova and J. Shang, "Chronic Disease Progression Prediction: Leveraging Case-Based Reasoning and Big Data Analytics," *Prod. Oper. Manag.*, vol. 31, no. 1, pp. 259–280, Jan. 2022.

[9]   A. R. Saraswati, Y. Saintika, A. N. A. Thohari, and A. R. Iskandar, "Sistem Pakar Diagnosis Penyakit Ikan Gurami (Osphronemus Goramy) Menggunakan Case Based Reasoning," *J. Teknol. Inf. dan Ilmu Komput.*, vol. 7, no. 4, p. 779, Aug. 2020.

[10]   A. Alwendi and K. Samosir, "Perancangan Aplikasi Sistem Pakar dalam Mendiagnosa Penyakit Infertilitas pada Pria Menggunakan Metode Certainty Factor Berbasis Web," *J. Inform. dan Rekayasa Perangkat Lunak*, vol. 4, no. 1, p. 24, Mar. 2022.

[11]   E. Krisnanik, K. Kraugusteeliana, and V. Indriasari, "Desain Model Sistem Pakar Menu Sehat Wanita Hamil Berdasarkan Gizi Menggunakan Metode Cooper," *J. Teknol. Inf. dan Ilmu Komput.*, vol. 5, no. 6, p. 643, Nov. 2018.

[12]   P. Wahyuningsih and S. Zuhriyah, "Sistem Pakar Diagnosa Penyakit Campak Rubella pada Anak

Menggunakan Metode Certainty Factor Berbasis Website," *J. Teknol. Inf. dan Ilmu Komput.*, vol. 8, no. 1, p. 85, Feb. 2021.

[13] Asmira and Syamsul Alam, "Aplikasi Sistem Pakar Pengidentifikasi Penyakit Dan Hama Pada Tanaman Padi Berbasis Android," *SIMKOM*, vol. 5, no. 2, pp. 19–27, Jul. 2020.

[14] R. Adawiyah, "Case Based Reasoning Diagnosis Hama dan Penyakit Tanaman Nilam," *INTENSIF*, vol. 2, no. 1, p. 57, Feb. 2018.

[15] R. Adawiyah and F. Handayani, "Rancang Bangin Case Based Reasoning untuk Diagnosis Hama dan Penyakit Tanaman Nilam menggunakan Nearest Neighbor Kombinasi Certainty Factor," *J. Teknol. Inf. dan Ilmu Komput.*, vol. 7, no. 3, p. 477, May 2020.