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Implementation of Case Based Reasoning and Forward Chaining Algorithm to Diagnose Brocoly Plant Disease

M. Syahdan Aulia[1], Hasdiana[2], Yulia Agustina Dalimunthe[3]
Department of Information System, Universitas Harapan, Indonesia

ABSTRACT

Doing a broccoli crop farming business is very promising, but there is little knowledge that farmers and the community have about the types of broccoli plant diseases that often attack these plants. By utilizing an expert system, which is able to make a rapid, precise, and accurate diagnosis of the symptoms caused, it is hoped that it will be able to help farmers in anticipating losses caused by disease attacks. Using the *Forward Chaining* method to determine conclusions starting from a set of facts by looking for rules that match the allegations, and using the *Case Based Reasoning* method that can solve new case problems by looking for similarity values on a case basis. From the sample cases taken are three symptoms of black rot disease, three symptoms of clubroot, and three symptoms of powdery mildew. Produces a value of 81.81% for black rot, then the system will provide a solution for the disease.
Keyword: Broccoli Plant Diseases , *Case Based Reasonin*, *Forward Chaining*, Expert System.

Corresponding Author:
M. Syahdan Aulia,
Department of Information System,
Universitas Harapan Medan,
Jalan Hm. Joni No. 70 c Meda, Indonesia.
Email: msyahdanaulia@gmail.com

1. INTRODUCTION

Broccoli *(Brassica oleracea var. italic)* is a type of cabbage-type plant which is a collection of flowers forming a bunch in the form of a bud. Vegetables are one component of a healthy diet, so it is not surprising that the need for these vegetables is increasing in line with public awareness about health. The broccoli plant is a vegetable commodity that has high commercial value and prospects, among various types of vegetables that can be cultivated (Zaenul Gafari, Eniek Kriswiyanti, 2015).

There are several previous studies that discuss the application of the *case-based reasoning* (CBR) algorithm, namely, The research entitled Application of *case-based reasoning* to identify pest attacks on citrus plants (Silmina & Wardoyo, 2018). In this study, a web-based expert system was used to diagnose pests in citrus plants using the *case-based reasoning* method. There is also a research entitled Expert System for Diagnosing Pests and Diseases in Tea Plants Using an Android-Based Case-based Reasoning Method (Suryadi, 2019). In this study, an Android-based expert system was used to diagnose tea plant diseases using the *case-based reasoning* method. There is also a research entitled Development of an Expert System for Disease Detection in Cats with a *Case-based reasoning* Method and an Android-based *Certainty Factor* (Gupita et al., 2017). In this study, an Android-based expert system is used to diagnose diseases in cats using the *case-based reasoning* method and *Certainty Factor*.

In this study, the authors used *case-based reasoning* (CBR) and *forward chaining*. By using case-based reasoning, the writer can solve problems with the database to store cases where solutions have been found.

There is still a lack of knowledge or insight possessed by farmers and people who want to cultivate broccoli plants regarding the types of diseases that often attack broccoli plants. Based on the background of the problem above, the following problems can be formulated:

1. how to apply the casebased reasoning (CBR) algorithm and forward chaining to diagnose broccoli plant diseases.
2. How to develop an expert system application for web-based broccoli plant disease diagnosis.

The objectives that can be obtained from this research are to use artificial intelligence to create a web-based expert system. And developing and implementing an expert system using a *case based reasoning* (CBR) algorithm and *forward chaining* to diagnose broccoli plant diseases.

2. RESEARCH METHOD

A. System Development Model

System or software development in this study aims to describe the main stages in the system development process. For this system development process. The system development method used is *WaterFall.*

waterfall is often called sequential linear model or classic life cycle. The waterfall model provides a sequential approach to the software life flow starting from analysis, design, coding, testing, and support. (Irnawati, 2018).

1. Requirement / needs analysis in this step the authors conducted a needs analysis with data collection methods by interviewing an expert named Devi Andriani Luta, S.P., M.Agr and a literature study by reading a book entitled Broccoli..
2. Design System / design system in this step the writer designed the web with 2 views, namely user and admin views. The user interface contains our home menu, consultation, help, and contacts. While the admin view contains home, disease, solutions and logout.
3. Coding / Writing program code in this step the author uses the Editplus software and uses PHP as a programming language to create a web and uses MySQL as a database.
4. Testing / Testing the program in this step the authors test the program which ensures that every menu on the user display, namely home, consultation, help, and our contacts, as well as in the admin view, namely home, disease, solutions, and logout run smoothly without any bugs.
5. Operation & Maintenance / Maintenance in this step the writer performs maintenance if there is a display or menu on the web that you want to change or replace which aims to suit user needs.

B. *Forward Chaining*

A forward sequence is a tracing process that begins with presenting a compelling collection of data or facts leading to a conclusion. A foreward sequence may also be referred to as forward chaining or data driven search. So starting from the premises or input information (if) first then leading to a conclusion or derived information (then) or it can be modeled as follows:

IF (input information)
THEN (conclusion)

Input information can be in the form of data, evidence, findings, or observations. Meanwhile, conclusions can be in the form of goals, hypotheses, explanations, or diagnoses. So that the progressive path of continuous transmission can be started from the data towards the goal, from evidence to hypothesis, from findings to explanation, or from observation to diagnosis (Noor Mutsaqof et al., 2016).

C. *Case Based Reasoning* (CBR)

Case-Based Reasoning (CBR) is a method for solving problems by adapting solutions that have been used in the past considering similar events that have occurred in the past and then using this knowledge / information to solve problems that have occurred in the past new (Putri et al., 2016).

Application of the K-NN (K-Nearest Neighbor) Algorithm in Case Based Reasoning According to (Putri et al., 2016), including the instance-based learning group. KNN is done by looking for groups of k objects in the training data that are closest (similar) to objects in new data or testing data. The steps to calculate the *k-nearest neighbor* method are:

1. Determine the similarity between the old case and the new case.
2. Carry out the weighting that has been given by the expert.
3. Calculate the similarity value (similarity) with the weight that has been given

The formula for calculating the similarity weight (similarity) to the *k-nearest neighbor* is:

$$Similarity(p,q) = \frac{s1 \times w1 + s2 \times w2 + ... + sn \times wn}{w1 + w2 + ... + wn} \quad (1)$$

Information:

S = similarity (similarity value), namely 1 (same) and 0 (different)
W = weight (given weight)

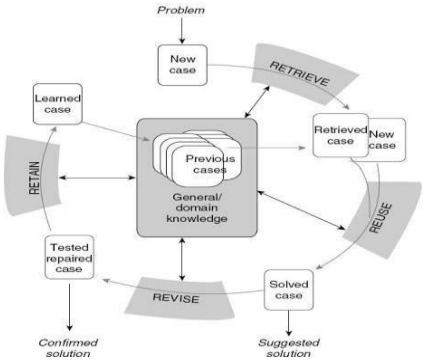

Fig 1. The stages of the *case-based reasoning* metode (Putri et al., 2016)

Cased based reasoning method is a method that applies 4 stages of the process, namely retrieving, reuse, revise, and retain. The way the system works in general is guided by the knowledge base possessed by the system which is derived from facts in the form of previous cases that have ever existed and a series of flows to examine, calculate, and conclude a solution to the problem given (Putri et al., 2016).

1. *Retrieve*

Get / retrieve the most similar case with the new case. This retrieval stage begins by describing / describing some of the problems, and ends if a match is found against the previous problem with the highest level of compatibility. This section refers to the aspects of identification, initial match, search and selection and execution.

2. *Reuse*

Modeling / reusing old case knowledge and information based on the similarity weight of the most relevant into the new case, to produce proposed solutions where an adaptation to the new problem may be needed. The similarity value for each case is obtained from the number of selected similar symptom values multiplied by the weight and divided by the total weight value.

3. *Revise*

Review the proposed solution then test it in a real case (simulation) and if necessary refine the solution to match the new case.

4. *Retain*

After the revise process is complete and the correct solution has been found, then the expert starts adding rules by entering the new case data where the solution has been found into the knowledge base which can later be used for subsequent cases that have the same problem. This process is called the retain process.

3. RESULTS AND DISCUSSION

The following is data that has been obtained from the results of interviews by expert Devi Andriani Luta, S.P., M.Agr. The system used is 5 for important symptoms, 3 for moderate symptoms and 1 for ordinary symptoms.

Tabel 1. Weight and Symptoms of Broccoli Plant Diseases.

Disease blackrot		
No.	**Symptoms**	**Value**
1	Yellow spots shaped like a letter V on broccoli leaves	3
2	The yellow patches are brown and fall off	1
3	All leaves have spots	1
4	The mass of broccoli flowers looks black or brownish in color	5
5	Blackish patches appear on the leaves, stems and flower branches	1
Disease club root		
No.	**Symptoms**	**Value**

1	The leaves are pale green to yellowish	1
2	The drooping leaves wilt during the day	1
3	Plants become stunted	1
4	Plants suffer growth inhibition or do not produce on flowers	3
5	The roots of the plant experience spindle-shaped swelling (long skinny)	3
6	The root swelling becomes large until it comes together to form a fist	5

Disease powdery mildew

No.	Symptoms	Value
1	Pale black spots on the tips of leaves	1
2	Pale black patches turn lavender-wight or purple in color	3
3	Leaves curled and stunted	1
4	The leaves turn yellow, dry up, and die	3
5	The dead leaves are white and covered with black hair	5

Tabel 2. New Case Examples

No.	Broccoli Plant Disease Symptoms
1.	Yellow spots shaped like a letter V on broccoli leaves
2.	The yellow patches are brown and fall off
3.	The mass of broccoli flowers looks black or brownish in color
4.	The leaves are pale green to yellowish
5.	The drooping leaves wilt during the day
6.	Plants become stunted
7.	Pale black spots on the tips of leaves
8.	Leaves curled and stunted
9.	The leaves turn yellow, dry up, and die

A. Algoritma *Forward Chaining*

The steps taken in system analysis with the Forward chaining algorithm process are as follows:

1. Determine the premises or input information *(if)*
2. Then go to conclusions or drived information *(then)*

RULE 1 :
IF Yellow spots shaped like a letter V on broccoli leaves.
AND The yellow patches are brown and fall off.
AND The mass of broccoli flowers looks black or brownish in color.
THEN Disease blackrot.
RULE 2 :
IF The leaves are pale green to yellowish.
AND The drooping leaves wilt during the day.
AND Plants become stunted.
THEN Disease club root.
RULE 3 :

IF Pale black spots on the tips of leaves.
AND Leaves curled and stunted.
AND The leaves turn yellow, dry up, and die.
THEN Disease powdery mildew.

B. Algoritma *Case Base Reasoning*

The steps taken in the expert system analysis with the *case-based reasoning* (CBR) algorithm process which is an artificial intelligence approach (Artificial Intelligent) and emphasizes problem solving based on knowledge from previous cases.

1. *Retrieve*

To analyze whether the disease is from the broccoli plant, calculations are carried out based on the closeness of the old case which is the knowledge base possessed by the system using the similarity technique (problem, case).

1. Calculates the proximity of new symptoms to blackrot symptoms.

$$Similarity(p,q) = \frac{s1\times w1 + s2\times w2 + \ldots\ldots + sn\times wn}{w1 + w2 + \ldots\ldots + wn}$$

$$= \frac{[(1\times 3)+(1\times 1)+(1\times 5)]}{3+1+1+5+1}$$
$$= \frac{3+1+5}{3+1+1+5+1}$$
$$= \frac{9}{11}$$
$$= 0{,}8181$$
$$= 81{,}81\%$$

2. Calculate the proximity of new symptoms to club root symptoms.

$$Similarity(p,q) = \frac{s1\times w1 + s2\times w2 + \ldots\ldots + sn\times wn}{w1 + w2 + \ldots\ldots + wn}$$

$$= \frac{[(1\times 1)+(1\times 1)+(1\times 1)]}{1+1+1+3+3+5}$$
$$= \frac{1+1+1}{1+1+1+3+3+5}$$
$$= \frac{3}{14}$$
$$= 0{,}2142$$
$$= 21{,}42\%$$

3. Calculate the proximity of new symptoms to powdery mildew symptoms.

$$Similarity(p,q) = \frac{s1\times w1 + s2\times w2 + \ldots\ldots + sn\times wn}{w1 + w2 + \ldots\ldots + wn}$$

$$= \frac{[(1\times 1)+(1\times 1)+(1\times 3)]}{1+3+1+3+5}$$
$$= \frac{1+1+3}{1+3+1+3+5}$$
$$= \frac{5}{13}$$
$$= 0{,}3846$$
$$= 38{,}46\%$$

2. *Reuse*

From the calculation of the closeness between old cases and new cases, the case with the highest similarity weight was blackrot disease, which was 0.8181 or 81.81%. Meanwhile, the case with the lowest similarity weight was powdery mildew disease, which was 0.3846 or 38.46%.

In the *reuse* process, the solution given is the solution with the highest similarity weight to the old case and the new case, in this case, blackrot disease is 81.81%. The results of the calculation with weight show the level of confidence for the similarity of cases of 81.81%, so the solution for blackrot disease cases is recommended to *users*.

3. *Revise*

The *revise* process is the process of reviewing cases and solutions provided if the system retrieves the results of the failure to provide a correct diagnosis. In this example the case of black rot disease has produced a solution showing a similarity value of 81.81% so that the resulting solution can be given immediately.

4. *Retain*

After the revise process is complete and the correct solution has been found, then the admin starts adding rules by entering the new case data whose solution has been found into the knowledge base.

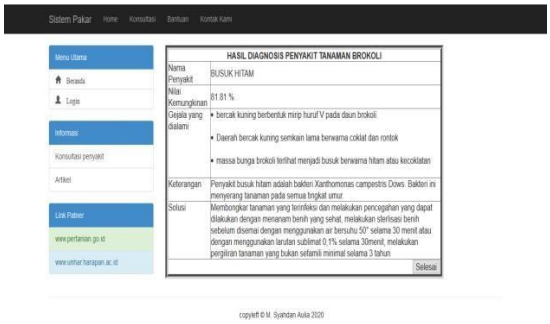

Fig 2. Diagnosis result

4. CONCLUSION

With this application we can diagnose broccoli plant diseases. From the case example above, it can be concluded that broccoli plants have black rot disease with a percentage of 81.81%. This value is based on the calculation of the similarity of the new case to the old case stored on the case basis. Because this application can only accommodate 8 diseases of broccoli plants for further research, it can add additional disease features that can accommodate many types of diseases.

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