

## DISEASE DIAGNOSIS SYSTEM IN APPEL PLANT USING BACKWARD CHAINING METHOD

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### ABSTRACT

*Apples are one type of food that contains nutrients, vitamins and minerals that are very good for consumption because it has antioxidants that are good for the body. However, in cultivating these apple plants there are many obstacles, especially when the plant is attacked by disease. Diseases that attack apple plants greatly affect fruit production, because it can produce bad fruit and can result in the death of apple trees. The disease attack can be resolved quickly if it is able to identify the type of disease that attacks it quickly and precisely based on the symptoms that appear. So that the impact can be minimized as early as possible. The purpose of this research is to build an expert system of diagnosing diseases in apple plants by using the backward chaining method that can facilitate in providing information about the causes of the emergence of diseases and how to deal with apple plants quickly and accurately. From the application trial results with the Expert Diagnosis System in Apple Plant Diseases Using the Backward Chaining Method, users can find out the symptoms of diseases experienced by apple plants and test results by making comparisons using the forward chaining method the results are the same as backward chaining accuracy level of 100 % input from backward chaining is the same as output from forward chaining.*

**Keywords:** *Apple, Apple Disease, Backward Chaining*

### 1. INTRODUCTION

Apples for Indonesia are not indigenus plants, but rather are introduced plants from abroad which are imported into Indonesia in Batu Malang [1]. Apples are one type of food that contains nutrients, vitamins and minerals which are generally very good for consumption every day. Not only does it taste fresh and delicious, many studies state that this ripe-looking fruit is good for body health because it has antioxidants that are good for the body. Unexpectedly, there are a lot of ingredients in apples that are good for maintaining the health and function of organs.

But in cultivating this apple plant faces many obstacles, especially when the plant is attacked by disease. Diseases that attack the apple plant greatly affect the fruit production, because it can produce bad fruit and even rot before it is ripe, and can even result in the death of an apple tree. The disease attack can be resolved quickly if farmers are able to identify the type of disease that attacks it quickly and precisely based on the symptoms that arise.

Backward chaining is a tracking process in the opposite direction of the continuous sequence. The reverse trace reasoning process begins with the goal (goal) and then traces back to the path that will lead to the goal, looking for evidence that it was applied when the chosen goal or hypothesis was the starting point for solving the problem. Also called goaldriven search [2]. In the computer world, fast and appropriate actions in identifying the disease can be realized through the creation of an expert system. The main purpose of an expert system is not to replace the position of an expert, but to popularize the knowledge and experience of an expert. With the Expert System to Diagnose Diseases in Apple Plants Using the Backward Chaining Method is expected to help produce apples that are fresh and healthy and certainly worthy of consumption.

## 2. SYSTEM ANALYSIS AND DESIGN

In this study, an Expert System for Diagnosis of Diseases in Apples by the Backward Chaining Method will be built. Before determining the existing problems, it is necessary to conduct an analysis or observation with priority problems that exist and to determine how the right solution to solve the problem. By utilizing the backward chaining method, it is expected to help the diagnosis process in apple plant diseases.

In this study, the data used are data obtained during the data collection process consisting of apple data, disease data, and symptom data. The data was obtained from the results of a survey in the Department of Agriculture in East Java and books related to apple plant diseases.

Based on the description above, then in this study applying "Expert System to Diagnose Diseases in Apple Plants Using the Backward Chaining Method".

### 2.1 Optimization System

Data on the types of apples that will be processed in the expert system for diagnosing diseases in apple plants amount to 3. The data of these types of apples can be seen in table 1.:

Table 1. Apple Type Data

ID Type	Apple Type
A01	Manalagi
A02	Rome Beauty
A03	Anna

### 2.2 Disease Data

Disease data to be processed in an expert system of diagnosing diseases in apple plants amounted to 15 kinds of diseases. Data on apple plant diseases can be seen in table 2.:

Table 2. Disease Data

ID Disease	Disease Name
P01	Dew Flour ( <i>Powdery Mildew</i> )
P02	Fruit Cancer ( <i>Botryosphaeria Sp.</i> )
P03	Root Rot ( <i>Armillaria Melea</i> )
P04	Scabies ( <i>Scab</i> )
P05	Rotten Fruit ( <i>Gloeosporium</i> )
P06	Leaf Spot ( <i>Marssonina Coronaria</i> )
P07	CVPD ( <i>Citrus Vein Phloem Degeneration</i> )
P08	Premature Deciduous Fruit
P09	Mushroom Upas ( <i>Upasia Salmonicolor</i> )
P10	Leaf Extractor ( <i>Helopheltis Sp.</i> )
P11	Fruit Flies ( <i>Rhagoletis Pomonella</i> )
P12	Trips
P13	Green Fleas ( <i>Aphis pomi Geer</i> )
P14	Leaf Caterpillar ( <i>Spodoptera Litura</i> )
P15	Mite ( <i>Panonychus Ulmi</i> )

### 2.3 Symptoms Data

The data used in the expert system of diagnosing diseases in apple plants amounted to 48 symptoms. Symptom data can be seen in table 3:

Table 3. Symptoms Data

ID Symptoms	Symptoms Name
G01	The surface of the leaves looks white
G02	Bud growth is not normal
G03	Brownish fruit
G04	Leaves arise brown
G05	Chocolate warty fruit
G06	Pale fruit color
G07	Stems or branches release fluid
G08	Rot stems or branches
G09	Fruit rot
G10	Fruit bulging or bulging
G11	Falling leaves
G12	Root bark rot
G13	Withered leaves
G14	Being in a cold and wet area
G15	The orange spotted fruit is uneven
G16	Leaf surface has brownish green spots
G17	The surface of the leaves grows black spots
G18	Fruit has black spots
G19	Irregular holes with holes
G20	Gray brown patches
G21	Very sour fruit taste
G22	Fruit has a small size
G23	Dry bark
G24	The color of the stem becomes grayish
G25	Fruit easily fall
G26	Bitter fruit taste
G27	The fruit withers and wrinkles
G28	There are white spots on the surface of the plant skin
G29	The fungus forms small dark red spots on the sides that have been rotten and dry
G30	The fungus forms an orange crust like salmon
G31	Pests suck leaf cell fluid
G32	The buds become brown and dry
G33	Symmetrical leaf development
G34	Silvery patches on fruit
G35	Poor fruit quality
G36	Fruit becomes lumps
G37	Fruit arise holes
G38	Shrinkle leaf shape
G39	The leaves at the tips of the shoots dry out and fall
G40	White speckled leaves
G41	The side of the leaf curls upward
G42	Abnormal leaf growth
G43	The leaves have grayish brown scars
G44	Flowering too late
G45	There are larvae on the underside of the leaf

G46	The leaves are only the bones
G47	The leaves turn yellow
G48	The leaves turn dry

## 2.4 Rule Set Backward Chaining

In this study, the types of apples that will be diagnosed are Manalagi, Rome beauty, and Anna. Each type of apple has a different disease. Therefore, a rule for each type of apple is made using the backward chaining method.

Table 4. Manalagi Apple Rule

Rule	The Rules
R1	IF P01 THEN G01 AND G02 AND G03 AND G04 AND G05
R2	IF P03 THEN G11 AND G12 AND G13 AND G14
R3	IF P04 THEN G05 AND G15 AND G16
R4	IF P05 THEN G03 AND G09 AND G17 AND G18
R5	IF P06 THEN G11 AND G17 AND G19 AND G20
R6	IF P07 THEN G21 AND G22 AND G23 AND G24
R7	IF P08 THEN G25 AND G26
R8	IF P09 THEN G27 AND G28 AND G29 AND G30
R9	IF P10 THEN G04 AND G31 AND G32 AND G33 AND G34 AND G35
R10	IF P11 THEN G09 AND G17 AND G25 AND G35 AND G36 AND G37 AND G38
R11	IF P12 THEN G39 AND G40 AND G41 AND G42 AND G43
R12	IF P13 THEN G17 AND G25 AND G35 AND G38 AND G44
R13	IF P14 THEN G19 AND G42 AND G45 AND G46
R14	IF P15 THEN G34 AND G47 AND G48

Explanation from Table 4 Manalagi Apple Rule Type:

R1: If the apple plant experiences powdery mildew, then the symptoms experienced are the surface of the leaves appear white, the growth of buds is not normal, the fruit is brownish, the leaves are brown, and the fruit is brown warty.

R2: If an apple has a root rot, the symptoms experienced are falling leaves, root skin rot, wilting leaves, and are in a cold and wet area.

R3: If an apple has scurvy, the symptoms experienced are brown warty fruit, uneven orange speckled fruit, and leaf surface with brownish green spots.

R4: If an apple has a fruit rot, the symptoms experienced are brownish fruit, rotting fruit, the surface of the leaf grows black, and the fruit has black spots.

R5: If the apple plant has leaf spot disease, the symptoms experienced are falling leaves, the leaf surface grows black spots, irregular holes with leaves, and leaves have brown and gray spots.

R6: If the apple plant experiences cvpd disease, the symptoms experienced are a very sour fruit taste, the fruit has a small size, the bark dries out, and the color of the stem becomes grayish.

R7: If the apple plant experiences premature deceased disease, the symptoms experienced are easily deciduous fruit, and bitter fruit taste.

R8: If the apple plant has an upas fungus, the symptoms experienced are the fruit withering and wrinkling, white spots on the surface of the plant's skin, the fungus forming small dark red spots on the rotten and dry side, and the fungus

form an orange crust like salmon.

R9: If the apple plant experiences leaf-sucking disease, the symptoms experienced are brown leaves, pests suck leaf cell liquid, buds turn brown and dry, leaf development is not symmetrical, silvery spots on fruit, and fruit quality is poor. R10: If the apple plant experiences fruit fly disease, the symptoms experienced are fruit rot, leaf surface grows black spots, the fruit is easy to fall, the quality of the fruit is bad, the fruit becomes lumps, the fruit arises holes, and the shape of the leaf shrinks.

R11: If the apple plant experiences a trip disease, the symptoms experienced are the leaves at the tips of the shoots dry up and fall off, the leaves have white spots, the sides of the leaves curl up, the leaf growth is abnormal, and the leaves have grayish brown scars.

R12: If an apple has green lice, the symptoms experienced are leaf surface growing with black spots, perishable fruit, poor fruit quality, shrunken leaf shape, and late flowering.

R13: If an apple has a leaf caterpillar, the symptoms experienced are irregular holes with leaves, abnormal leaf growth, larvae on the underside of the leaf, and leaves only the bones.

R14: If an apple has a mite, the symptoms experienced are silvery patches on the fruit, the leaves turn yellow, and the leaves turn dry.

*Table 5. Rome Beauty Apple Rule*

Rule	The Rules
R1	IF P01 THEN G01 AND G02 AND G03 AND G04 AND G05
R2	IF P02 THEN G04 AND G06 AND G07 AND G08 AND G09 AND G10
R3	IF P03 THEN G11 AND G12 AND G13 AND G14
R4	IF P05 THEN G03 AND G09 AND G17 AND G18
R5	IF P06 THEN G11 AND G17 AND G19 AND G20
R6	IF P09 THEN G27 AND G28 AND G29 AND G30
R7	IF P10 THEN G04 AND G31 AND G32 AND G33 AND G34 AND G35
R8	IF P11 THEN G09 AND G17 AND G25 AND G35 AND G36 AND G37 AND G38
R9	IF P12 THEN G39 AND G40 AND G41 AND G42 AND G43
R10	IF P13 THEN G17 AND G25 AND G35 AND G38 AND G44
R11	IF P14 THEN G19 AND G42 AND G45 AND G46
R12	IF P15 THEN G34 AND G47 AND G48

Explanation of Table 5. Rome Beauty Apple Rule Types:

R1: If the apple plant experiences powdery mildew, then the symptoms experienced are the surface of the leaves appear white, the growth of shoots is not normal, the fruit is brownish, the leaves appear brown, and the fruit is brown warty.

R2: If an apple develops fruit cancer, the symptoms experienced are brown leaves, pale color, stems or branches emit liquid, rot stems or branches, fruit rot, and fruit swell or swell.

R3: If an apple has a root rot, the symptoms experienced are falling leaves, root skin rot, wilting leaves, and are in a cold and wet area.

R4: If an apple has a fruit rot, the symptoms experienced are brownish fruit, rotting fruit, the surface of the leaves grows black, and the fruit has black spots.

R5: If the apple plant has leaf spot disease, the symptoms experienced are falling leaves, the leaf surface grows black

spots, irregular holes with leaves, and leaves have brown and gray spots.

R6: If the apple plant has an upas fungus, the symptoms experienced are the fruit wilting and wrinkling, there are white spots on the surface of the plant's skin, the fungus forms small dark red spots on the rotten and dry sides, and the fungus form an orange crust like salmon.

R7: If an apple experiences a leaf-sucking disease, the symptoms experienced are brown leaves, pests suck leaf cell liquid, buds turn brown and dry, leaf development is not symmetrical, silvery spots on fruit, and fruit quality is poor.

R8: If the apple plant experiences fruit fly disease, the symptoms experienced are fruit rot, the leaf surface grows black spots, the fruit is easy to fall, the quality of the fruit is bad, the fruit becomes lumps, the fruit emerges holes, and the shape of the leaf shrinks.

R9: If the apple plant experiences a trip disease, the symptoms experienced are the leaves on the tips of the buds dry up and fall off, the leaves have white spots, the sides of the leaves curl up, the leaf growth is abnormal, and the leaves have grayish brown scars.

R10: If the apple plant has green lice, the symptoms experienced are the surface of the leaves grow black spots, the fruit is easy to fall, the quality of the fruit is bad, the shape of the leaves shrink, and late in flowering.

R11: If an apple plant has leaf caterpillar disease, the symptoms experienced are irregular holes with leaves, abnormal leaf growth, larvae on the underside of the leaf, and leaves only the bones.

R12: If an apple has a mite, the symptoms experienced are silvery patches on the fruit, the leaves turn yellow, and the leaves turn dry.

Table 6. Apple Type Rule

Rule	The Rules
R1	IF P02 THEN G04 AND G06 AND G07 AND G08 AND G09 AND G10
R2	IF P03 THEN G11 AND G12 AND G13 AND G14
R3	IF P04 THEN G05 AND G15 AND G16
R4	IF P05 THEN G03 AND G09 AND G17 AND G18
R5	IF P06 THEN G11 AND G17 AND G19 AND G20
R6	IF P08 THEN G25 AND G26
R7	IF P09 THEN G27 AND G28 AND G29 AND G30
R8	IF P10 THEN G04 AND G31 AND G32 AND G33 AND G34 AND G35
R9	IF P11 THEN G09 AND G17 AND G25 AND G35 AND G36 AND G37 AND G38
R10	IF P12 THEN G39 AND G40 AND G41 AND G42 AND G43
R11	IF P13 THEN G17 AND G25 AND G35 AND G38 AND G44
R12	IF P14 THEN G19 AND G42 AND G45 AND G46
R13	IF P15 THEN G34 AND G47 AND G48

Explanation of Table 6. Apple Apple Type Rule:

R1: If an apple has a fruit cancer, the symptoms experienced are brown leaves, pale fruit color, stems or branches discharge, stems or branches rot, fruit rot, and fruit swells or bulges.

R2: If an apple has a root rot, the symptoms experienced are falling leaves, root skin rot, wilting leaves, and are in a cold and wet area.

R3: If an apple experiences scurvy, the symptoms experienced are brown warty fruit, orange spotted fruit is uneven, and leaf surface has brownish green spots.

R4: If an apple has a fruit rot, the symptoms experienced are brownish fruit, rotting fruit, the surface of the leaf grows

black, and the fruit has black spots.

R5: If the apple plant has leaf spot disease, the symptoms experienced are falling leaves, the leaf surface grows black spots, irregular holes with leaves, and leaves have brown and gray spots.

R6: If the apple plant experiences premature deceased disease, the symptoms experienced are easily deciduous fruit, and bitter fruit taste.

R7: If the apple plant has an upas fungus, the symptoms experienced are the fruit wilting and wrinkling, there are white spots on the surface of the plant's skin, the fungus forms small dark red spots on the sides that have been decayed and dry, and the fungus form an orange crust like salmon.

R8: If the apple plant experiences leaf-sucking disease, the symptoms experienced are brown leaves, pests suck leaf cell liquid, buds turn brown and dry, leaf development is not symmetrical, silvery spots on fruit, and fruit quality is poor.

R9: If the apple plant experiences fruit fly disease, the symptoms experienced are fruit rot, the leaf surface grows black spots, the fruit is easy to fall, the quality of the fruit is bad, the fruit becomes lumps, the fruit arises holes, and the shape of the leaf shrinks.

R10: If the apple plant experiences a trip disease, the symptoms experienced are the leaves at the tips of the shoots dry up and fall off, the leaves have white spots, the sides of the leaves curl up, the leaf growth is abnormal, and the leaves have grayish brown scars.

R11: If an apple has green lice, the symptoms experienced are leaf surface growing with black spots, perishable fruit, bad fruit quality, shrunken leaf shape, and late flowering.

R12: If an apple has a leaf caterpillar, the symptoms experienced are irregular holes with leaves, abnormal leaf growth, larvae on the underside of the leaf, and leaves only the bones.

R13: If an apple has a mite, the symptoms experienced are silvery patches on the fruit, the leaves turn yellow, and the leaves turn dry.

## 2.5 Flowchart

To create this application requires some process data analysis which is explained with a flowchart. This flowchart describes the steps of the program flow process. To start diagnosing diseases in apple plants using the backward chaining method, the first step taken by the user is to choose the type of apple first. After the type of apple is chosen, the next step is to choose the disease suffered in apple plants. After that, the system will make the diagnosis process based on the rules in the system database. After the system makes a diagnosis, data appears on the symptoms of the previously selected disease.



Figure 1 Flowchart system design to be made

**2.6 Entity Relationship Diagram (ERD)**

The following is an Entity Relationship Diagram of an Expert System to Diagnose Diseases in Apple Plants Using the Backward Chaining Method.

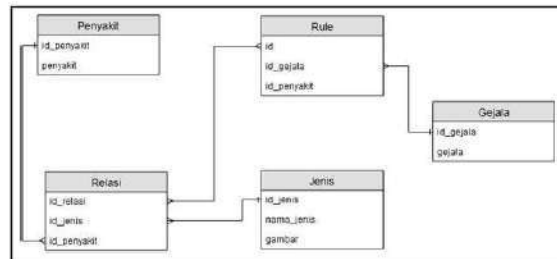


Figure 2. ERD Program Design System

**2.7 Data Flow Diagram (DFD)**

The first user is the admin who accesses the system by logging in, maintaining Apple data types, disease data, and symptom data. The second user is the user who can only choose the types of apples and diseases, which can then be found symptoms. The following is DFD Level 0 of the Expert System for Diagnosing Diseases in Apple Plants Using the Backward Chaining Method.

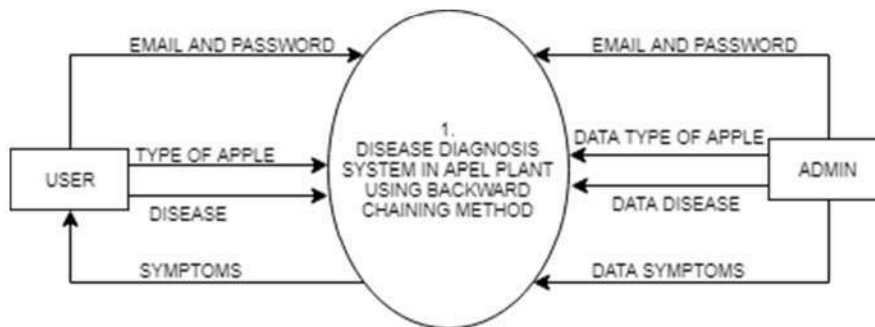


Figure 3. Data Flow Diagram Level 0

The following is the DFD Level 1 User of the Expert System for Diagnosing Diseases in Apple Plants Using the Backward Chaining Method:



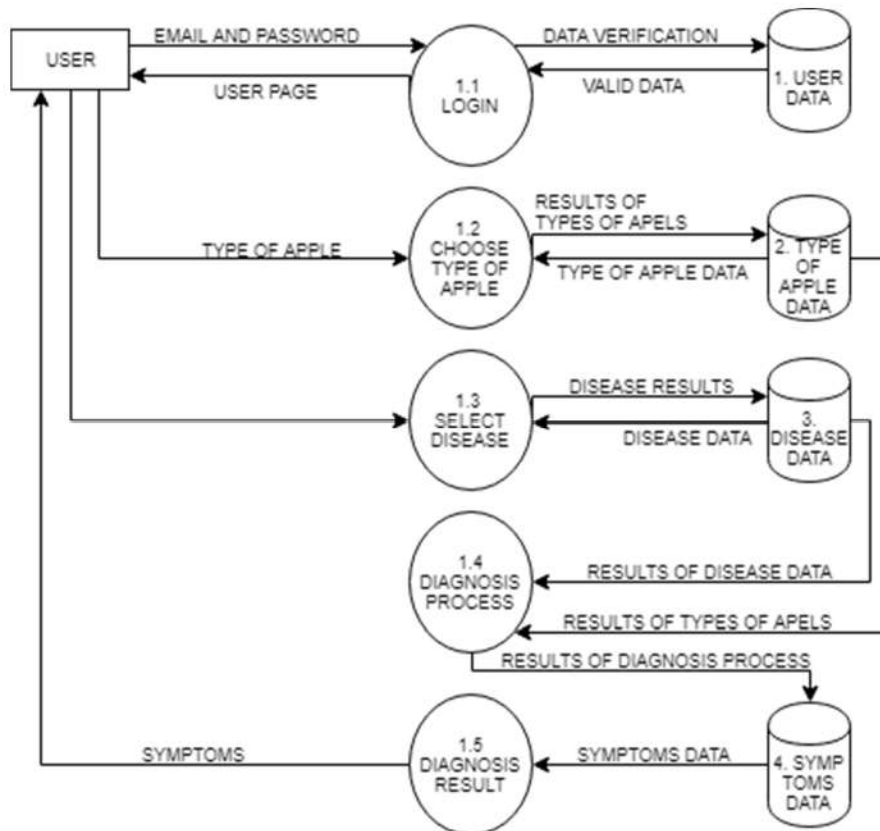


Figure 4. DFD Level 1 User

From the level 1 DFD image the user above explains about the flow process of the user where the user processes the input type of apple and selects the disease to produce the requested symbol. Furthermore, in processing applications such as updating and deleting data will be explained in DFD level 1 admin below:

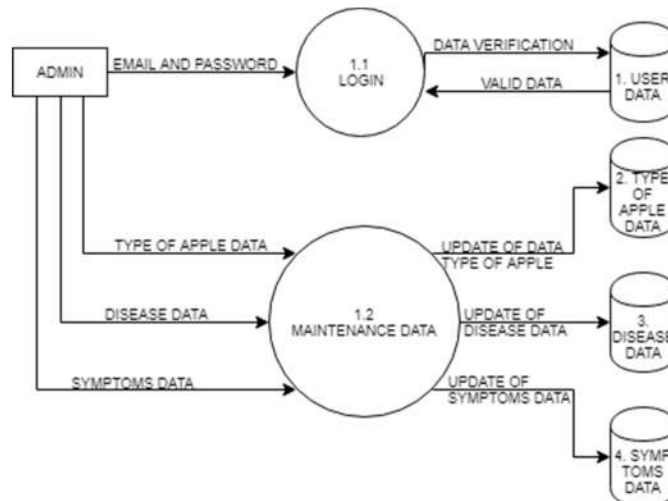


Figure 5. DFD Level 1 Admin

From the DFD level 1 Admin data above, it can be broken down into DFD Level 2 as shown below:

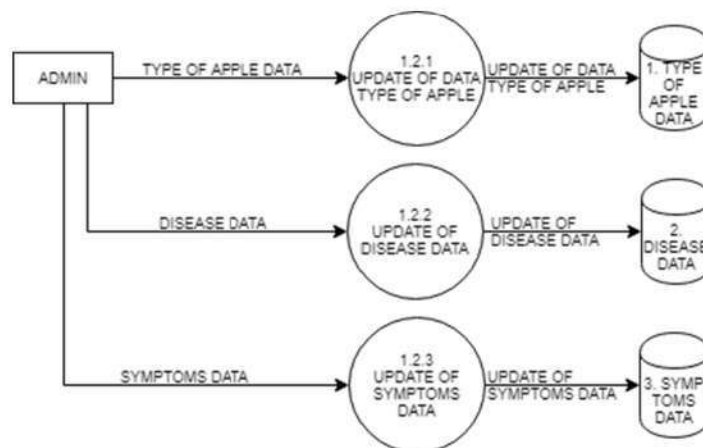


Figure 6. DFD Level 2 Admin

## 2.8 Interface Implementation

Implementation of the interface is done with every display program that is built. The following is the interface implementation of the Expert System for Disease Diagnosis in Apple Plants Using the Backward Chaining Method.

### 2.8.1 Menu Dashboard User

The dashboard menu is the first form that is run by the user after logging in.



Figure 7. Menu Dashboard User

### 2.8.2 Menu Dashboard Admin

The dashboard menu is the first form that is run by the admin after logging in.



Figure 8. Menu Dashboard Admin

## 3. RESULT AND DISCUSSION

Expert System Testing for Disease Diagnosis in Apple Plants Using the Backward Chaining Method. The purpose of testing this system is to find out the diagnosis of apple plant disease in determining accurate results. The test method used is validity testing which aims to test the suitability of the relationship between symptoms and the actual diagnosis compared to the program output and accuracy testing which aims to measure the accuracy of the diagnosis of the program outputs.

### 3.1 Validity Testing

In this test carried out by inputting all diseases in apple plants. Validity Testing can be seen in the following table:

Table 7. Validity Testing

No	Real Data	Real Diagnosis	Program Input	Output Program	Conclusion	
					S	TS
1	Dew Flour	G01, G02, G03, G04, G05	Dew Flour	G01, G02, G03, G04, G05	√	
2	Fruit Cancer	G04, G06, G07, G08, G09, G10	Fruit Cancer	G04, G06, G07, G08, G09, G10	√	
3	Root Rot	G11, G12, G13, G14	Root Rot	G11, G12, G13, G14	√	
4	Scabies	G05, G15, G16	Scabies	G05, G15, G16	√	
5	Rotten Fruit	G03, G09, G17, G18	Rotten Fruit	G03, G09, G17, G18	√	
6	Leaf Spot	G11, G17, G19, G20	Bercak Daun	G11, G17, G19, G20	√	
7	Cvpd	G21, G22, G23, G24	Cvpd	G21, G22, G23, G24	√	
8	Premature Deciduous Fruit	G25, G26	Premature Deciduous Fruit	G25, G26	√	
9	Mushroom Upas	G27, G28, G29, G30	Mushroom Upas	G27, G28, G29, G30	√	
10	Leaf sucker	G04, G31, G32, G33, G34, G35	Leaf Sucker	G04, G31, G32, G33, G34, G35	√	
11	Fruit Flies	G09, G17, G25, G35, G36, G37, G38	Fruit Flies	G09, G17, G25, G35, G36, G37, G38	√	
12	Trips	G39, G40, G41, G42, G43	Trips	G39, G40, G41, G42, G43	√	
13	Green Fleas	G17, G25, G35, G38, G44	Green Fleas	G17, G25, G35, G38, G44	√	
14	Leaf Caterpillar	G19, G42, G45, G46	Leaf Caterpillar	G19, G42, G45, G46	√	
15	Mite	G34, G47, G48	Mite	G34, G47, G48	√	
<b>Amount</b>					15	0

Knowledge of symptom data with codes G01 through G48 is explained in the Symptoms Data table. In testing table 7. above, the validity testing shows that the validity level of the relationship between real diagnosis and program output is 100%.

### 3.2 Accuracy Testing

Testing is done by the user to select one of the diseases until the system will display the output in the form of a list of symptoms. Furthermore, the list of symptoms will be processed using the forward chaining method. Accuracy testing is intended to test the extent of the accuracy of disease input from the backward chaining method to the disease outcome of the forward chaining method.

Table 8. Diagnosis of Apple Plant Diseases Using Backward Chaining

Disease	Symptoms
P01	G01, G02, G03, G04, G05
P02	G06, G07, G08, G09, G04, G10
P03	G11, G12, G13, G14
P04	G15, G16, G05
P05	G17, G03, G18, G09
P06	G17, G11, G19, G20
P07	G21, G22, G23, G24
P08	G25, G26
P09	G27, G28, G29, G30
P10	G31, G04, G32, G33, G34, G35
P11	G36, G37, G09, G17, G25, G38, G35
P12	G39, G40, G41, G42, G43
P13	G17, G25, G44, G38, G35
P14	G19, G42, G45, G46
P15	G47, G34, G48

Table 9. Diagnosis of Apple Plant Diseases Using Forward Chaining

Symptoms	Disease
G01, G02, G03, G04, G05	P01
G06, G07, G08, G09, G04, G10	P02
G11, G12, G13, G14	P03
G15, G16, G05	P04
G17, G03, G18, G09	P05
G17, G11, G19, G20	P06
G21, G22, G23, G24	P07
G25, G26	P08
G27, G28, G29, G30	P09
G31, G04, G32, G33, G34, G35	P10
G36, G37, G09, G17, G25, G38, G35	P11
G39, G40, G41, G42, G43	P12
G17, G25, G44, G38, G35	P13
G19, G42, G45, G46	P14
G47, G34, G48	P15

When the user selects a disease from the backward chaining method, the system will display the results in the form of a list of symptoms. Furthermore, when the user selects the symptoms of forward chaining, the system will display the results in the form of disease.

From table 8. and table 9. above, it shows that the results of input from backward chaining are the same as the output from forward chaining. the accuracy testing shows that the level of accuracy between the diagnosis by the backward chaining method and the diagnosis by the forward chaining method is 100%.

#### **4. CONCLUSION**

Based on the problems developed in the Expert System of Diagnosis in Apple Plant Diseases Using the Backward Chaining Method, then some conclusions can be drawn as follows:

1. With the Expert Diagnosis System in Apple Plant Disease Using this Backward Chaining Method users can find out the symptoms of diseases experienced by apple plants.
2. Based on the results of testing by comparing using the forward chaining method, it can be concluded that the results of disease input from backward chaining are the same as the disease output from forward chaining with 100% accuracy rate.

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