Plant Doctor

(Knowledge Based Expert System)

Designed with CLIPS

Group No. 09

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Problem Statement – To design an expert System that will be helpful to modern farmers in diagnosing the diseases that are affecting their crops. Also to help general public in schools, houses, hospitals etc. to maintain the health of plants.

Justification – Growing plants in farm sometimes can be troublesome as they might get affected with any disease. Most of the times the symptoms conflict each other and it is hard to determine what the actual disease is. There comes into the picture the expert who can easily say what the disease is. But getting expert for diagnosing plant disease is not easy and cheap task, so this expert system will be an alternative to human expert which surprisingly might be more effective.

Tools Used – CLIPS

Platforms Supported – Multiplatform

Architecture of Expert System – Knowledge Based Expert System

Method of Conflict Resolution – Confidence level associated with each symptom for it to say that particular disease the plant has. This prevents rules from clashing and make matters more realistic.

The files that are used –

1) Project.clp – Actual source code file defining rules for symptoms and functions for running the expert system
2) diagnoses.txt – File for getting the diagnosis strings for every pest-or-disease of each plant
3) advice.txt – File for getting the advice for each disease-or-pest for each plant

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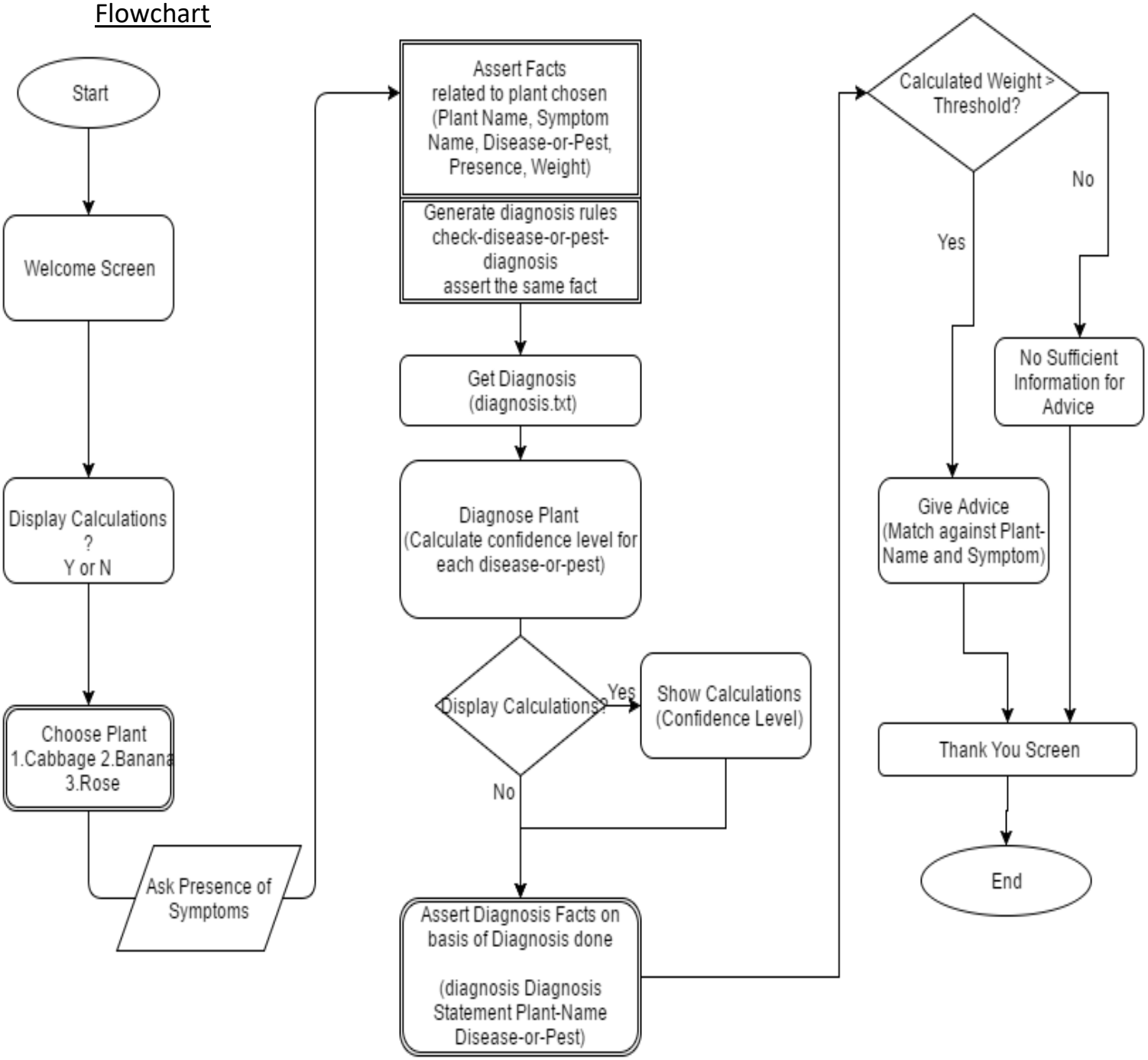
Flowchart


Start
Welcome Screen
Display Calculations ? Y or N
Choose Plant 1.Cabbage 2.Banana 3.Rose
Ask Presence of Symptoms
Assert Facts related to plant chosen (Plant Name, Symptom Name, Disease-or-Pest, Presence, Weight)
Generate diagnosis rules check-disease-or-pest-diagnosis assert the same fact
Get Diagnosis (diagnosis.txt)
Diagnose Plant (Calculate confidence level for each disease-or-pest)
Display Calculations?
Yes
Show Calculations (Confidence Level)
No
Assert Diagnosis Facts on basis of Diagnosis done (diagnosis Diagnosis Statement Plant-Name Disease-or-Pest)
Calculated Weight > Threshold?
Yes
No
Give Advice (Match against Plant-Name and Symptom)
No Sufficient Information for Advice
Thank You Screen
End

Functions that are defined using deffunction in project.clp –

1) quest (?question $?allowed-values) --

   This function asks for the question and check from the allowed values if the answer to question is valid or not. This function returns the answer.

2) YorN (?question) –

   This function asks a question and returns yes or no.

3) display-cal (?response) –

   This function decides if analysis variable is set true or false. If analysis value is true then how the decision is made is shown .This denotes self-explanation characteristics of expert system

4) which-plant (?question) –

   This assigns the value to variable plant-name after taking input from user.

5) diagnose-plant (?plant-name ?disease-or-pest ?threshold) –

   This function calculates the confidence level for the given plant and the given disease name and returns true if the disease weight is greater than the threshold value which is set to 0.7 for optimal results.

6) get-diagnosis (?plant-name ?disease-or-pest) –

   This function creates the rules for diagnosis named as “check <disease-or-pest> -diagnosis”. Then if diagnosis is not done yet then that string above is added in facts

7) give-advice (?plant-name ?disease-or-pest $?filename) –

   This function searches the file advice.txt for identified disease-or-pest for a particular plant and then prints it and ends the program.

8) create-diagnosis-rules (?plant-name ?disease-or-pest ?diagnosis-st) --

   This function does two things. First it creates a rule named “confirm <disease-or-pest>”.In that rule if “check <disease-or-pest> -diagnosis” is present in facts then it is removed and it is diagnosed using diagnose plant function. If diagnose-plant returns true then the fact is added into fact database that plant has disease. The format of fact is “diagnosis <diagnosis-st> <plant-name> <disease-or-pest> "

9) read-from-diagnoses-file (?file) –

   This function calls the create-diagnosis-rules function by reading from the diagnoses.txt file.

Rules that are defined in overall expert system –

- system-banner “”
  <This rule is just for printing the logo>
- determine-analysis "Rules for when no analysis mode has been set"
  If (~analysis) implies (get value of analysis and assert analysis)
- begin “”
  <This rule just calls the function “read-from-diagnoses-file”>

Now the rules for confirming if a particular disease-or-pest exists. The format of rule is given below.

- confirm-<disease-or-pest>

  (remove check-<disease-or-pest> fact and for every removed fact
  if(diagnose-plant function returns true) implies (assert the diagnosis))

All confirm-<disease-or-pest> rules are –

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confirm-rose-rust

confirm-black-spot

confirm-metallic-flea-beetles

confirm-two-spotted-mites

confirm-rhizome-rot

confirm-banana-mosaic

confirm-banana-aphids

confirm-banana-weevil

confirm-downy-mildew

confirm-white-rust

confirm-slugs-and-snails

confirm-cabbageworms

confirm-gibberella-ear-rot

confirm-leaf-blight

confirm-termites

confirm-weevils

- determine-plant "Rules for when no plant name or diagnosis is available"
  If (analysis is asserted) && (diagnosis is not assigned) && (plant name is not assigned) implies (assert plant-name with the obtained value of plant)

Now the rules for symptoms which assert the structure of type symptom-details which has following structure

(deftemplate symptom-details

(slot symptom-name)

(slot plant-name)

(slot disease-or-pest)

(slot prescence (default no))

(slot weight (default 0)))

- determine-<symptom-name>

  If (~diagnosis) implies (add fact into facts database with template symptom-details as above. The presence is assigned value using YorN function)

Symptom rules are –

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determine-yellow-patch-leaves

determine-orange-spores-leaves

determine-leaves-fall

determine-plants-defoliated

determine-black-spots-leaves

determine-distance-between-spots

determine-circular-spots-irregular-edge-yellow-halo

determine-yellow-leaves-fall-early

determine-continual-defoliation-cause-death

determine-chewed-irregular-shaped-holes

determine-leaves-holes-enlarge

determine-silvering-of-leaves

determine-fine-webbing-eggs-underside

determine-irregular-yellow-patches-leaves

determine-fluffy-gray-growth-leaves

determine-white-pustules

determine-leaves-roll-thicken

determine-irregularly-shaped-holes-leaves-stem

determine-slime-trails

determine-shredded-leaves

determine-ragged-holes

determine-frass

determine-caterpillar-green-hairy

determine-pseudostem-breaks-from-rhizome

determine-rhizome-fails-to-germinate

determine-chlorotic-mottling-stripes-on-foliage

determine-distorted-fruit-with-chlorotic-streaks-mottling

determine-distorted-leaves

determine-leaf-necrosis

determine-deformed-plants-curled-shrivelled-leaves

determine-galls-form-on-leaves

determine-colonies-of-aphids-present

determine-visible-tunnels-in-corm

determine-plants-wilting-toppling

determine-destruction-root-system

determine-reduced-plant-growth

determine-reduced-fruit-production

determine-black-beetle-between-leaf-sheaths

After every symptom rules for every disease-or-pest for every plant is added the check rules are added along with them. The format of check rule is

- check-<disease-or-pest>-diagnosis
  If (~diagnosis)&&(plant-name is <plant-name>) implies (assert the check-<disease-or-pest>-diagnosis in fact database)

All check rules are –

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check-rose-rust-diagnosis

check-black-spot-diagnosis

check-metallic-flea-beetles-diagnosis

check-downy-mildew-diagnosis

check-white-rust-diagnosis

check-slugs-and-snails-diagnosis

check-cabbageworm-diagnosis

check-rhizome-rot-diagnosis

check-banana-mosaic-diagnosis

check-banana-aphid-diagnosis

check-banana-weevil-diagnosis

Facts that are defined in overall expert system –

Note – The presence is set to no to get the maximum facts for each plant that might get asserted.

In case of Banana –

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f-0 (initial-fact)

f-1 (analysis)

f-2 (plant-name banana)

f-3 (symptom-details (symptom-name pseudostem-breaks-from-rhizome) (plant-name banana) (disease-or-pest rhizome-rot) (prescence no) (weight 0.5))

f-4 (symptom-details (symptom-name rhizome-fails-to-germinate) (plant-name banana) (disease-or-pest rhizome-rot) (prescence no) (weight 0.6))

f-6 (disease-weight (disease-or-pest-name rhizome-rot) (plant-name banana) (weight 0))

f-7 (symptom-details (symptom-name chlorotic-mottling-stripes-on-foliage) (plant-name banana) (disease-or-pest banana-mosaic) (prescence no) (weight 0.6))

f-8 (symptom-details (symptom-name distorted-fruit-with-chlorotic-streaks-mottling) (plant-name banana) (disease-or-pest banana-mosaic) (prescence no) (weight 0.6))

f-9 (symptom-details (symptom-name distorted-leaves) (plant-name banana) (disease-or-pest banana-mosaic) (prescence no) (weight 0.4))

f-10 (symptom-details (symptom-name leaf-necrosis) (plant-name banana) (disease-or-pest banana-mosaic) (prescence no) (weight 0.5))

f-12 (disease-weight (disease-or-pest-name banana-mosaic) (plant-name banana) (weight 0))

f-13 (symptom-details (symptom-name deformed-plants-curled-shrivelled-leaves) (plant-name banana) (disease-or-pest banana-aphid) (prescence no) (weight 0.4))

f-14 (symptom-details (symptom-name galls-form-on-leaves) (plant-name banana) (disease-or-pest banana-aphid) (prescence no) (weight 0.5))

f-15 (symptom-details (symptom-name colonies-of-aphids-present) (plant-name banana) (disease-or-pest banana-aphid) (prescence no) (weight 0.7))

f-16 (check-banana-aphid-diagnosis)

f-17 (symptom-details (symptom-name visible-tunnels-in-corm) (plant-name banana) (disease-or-pest banana-weevil) (prescence no) (weight 0.5))

f-18 (symptom-details (symptom-name plants-wilting-toppling) (plant-name banana) (disease-or-pest banana-weevil) (prescence no) (weight 0.4))

f-19 (symptom-details (symptom-name destruction-root-system) (plant-name banana) (disease-or-pest banana-weevil) (prescence no) (weight 0.4))

f-20 (symptom-details (symptom-name reduced-plant-growth) (plant-name banana) (disease-or-pest banana-weevil) (prescence no) (weight 0.4))

f-21 (symptom-details (symptom-name reduced-fruit-production) (plant-name banana) (disease-or-pest banana-weevil) (prescence no) (weight 0.4))

f-22 (symptom-details (symptom-name black-beetle-between-leaf-sheaths) (plant-name banana) (disease-or-pest banana-weevil) (prescence no) (weight 0.6))

f-24 (disease-weight (disease-or-pest-name banana-weevil) (plant-name banana) (weight 0))

f-25 (check-most-probable)

In case of Cabbage –

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f-0 (initial-fact)

f-1 (analysis)

f-2 (plant-name cabbage)

f-3 (symptom-details (symptom-name irregular-yellow-patches-leaves) (plant-name cabbage) (disease-or-pest downy-mildew) (prescence no) (weight 0.5))

f-4 (symptom-details (symptom-name fluffy-gray-growth-leaves) (plant-name cabbage) (disease-or-pest downy-mildew) (prescence no) (weight 0.6))

f-6 (disease-weight (disease-or-pest-name downy-mildew) (plant-name cabbage) (weight 0))

f-7 (symptom-details (symptom-name white-pustules) (plant-name cabbage) (disease-or-pest white-rust) (prescence no) (weight 0.6))

f-8 (symptom-details (symptom-name leaves-roll-thicken) (plant-name cabbage) (disease-or-pest white-rust) (prescence no) (weight 0.4))

f-10 (disease-weight (disease-or-pest-name white-rust) (plant-name cabbage) (weight 0))

f-11 (symptom-details (symptom-name irregularly-shaped-holes-leaves-stem) (plant-name cabbage) (disease-or-pest slugs-and-snails) (prescence no) (weight 0.4))

f-12 (symptom-details (symptom-name slime-trails) (plant-name cabbage) (disease-or-pest slugs-and-snails) (prescence no) (weight 0.6))

f-13 (symptom-details (symptom-name shredded-leaves) (plant-name cabbage) (disease-or-pest slugs-and-snails) (prescence no) (weight 0.4))

f-15 (disease-weight (disease-or-pest-name slugs-and-snails) (plant-name cabbage) (weight 0))

f-16 (symptom-details (symptom-name ragged-holes) (plant-name cabbage) (disease-or-pest cabbageworm) (prescence no) (weight 0.4))

f-17 (symptom-details (symptom-name frass) (plant-name cabbage) (disease-or-pest cabbageworm) (prescence no) (weight 0.4))

f-18 (symptom-details (symptom-name caterpillar-green-hairy) (plant-name cabbage) (disease-or-pest cabbageworm) (prescence no) (weight 0.6))

f-19 (check-cabbageworm-diagnosis)

f-20 (check-most-probable)

In case of Rose –

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f-0 (initial-fact)

f-1 (analysis)

f-2 (plant-name rose)

f-3 (symptom-details (symptom-name yellow-patch-leaves) (plant-name rose) (disease-or-pest rose-rust) (prescence no) (weight 0.4))

f-4 (symptom-details (symptom-name orange-spores-leaves) (plant-name rose) (disease-or-pest rose-rust) (prescence no) (weight 0.5))

f-5 (symptom-details (symptom-name leaves-fall) (plant-name rose) (disease-or-pest rose-rust) (prescence no) (weight 0.3))

f-6 (symptom-details (symptom-name plants-defoliated) (plant-name rose) (disease-or-pest rose-rust) (prescence no) (weight 0.6))

f-8 (disease-weight (disease-or-pest-name rose-rust) (plant-name rose) (weight 0))

f-9 (symptom-details (symptom-name black-spots-leaves) (plant-name rose) (disease-or-pest black-spot) (prescence no) (weight 0.6))

f-10 (symptom-details (symptom-name distance-between-spots) (plant-name rose) (disease-or-pest black-spot) (prescence no) (weight 0.5))

f-11 (symptom-details (symptom-name circular-spots-irregular-edge-yellow-halo) (plant-name rose) (disease-or-pest black-spot) (prescence no) (weight 0.5))

f-12 (symptom-details (symptom-name yellow-leaves-fall-early) (plant-name rose) (disease-or-pest black-spot) (prescence no) (weight 0.4))

f-13 (symptom-details (symptom-name continual-defoliation-cause-death) (plant-name rose) (disease-or-pest black-spot) (prescence no) (weight 0.4))

f-15 (disease-weight (disease-or-pest-name black-spot) (plant-name rose) (weight 0))

f-16 (symptom-details (symptom-name chewed-irregular-shaped-holes) (plant-name rose) (disease-or-pest metallic-flea-beetles) (prescence no) (weight 0.6))

f-17 (symptom-details (symptom-name leaves-holes-enlarge) (plant-name rose) (disease-or-pest metallic-flea-beetles) (prescence no) (weight 0.6))

f-19 (disease-weight (disease-or-pest-name metallic-flea-beetles) (plant-name rose) (weight 0))

f-20 (symptom-details (symptom-name silvering-of-leaves) (plant-name rose) (disease-or-pest two-spotted-mites) (prescence no) (weight 0.6))

f-21 (symptom-details (symptom-name fine-webbing-eggs-underside) (plant-name rose) (disease-or-pest two-spotted-mites) (prescence no) (weight 0.5))

References

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[2] "Banana", *Kissankerala.net*, 2017. [Online]. Available: http://www.kissankerala.net:8080/KISSAN-CHDSS/English/Banana/Disease/6.htm. [Accessed: 11- Nov- 2017].