The chapter concerned with the structuring of knowledge from the raw knowledge base of rice plant diseases and their symptoms. In this chapter, it is described how to represent the knowledge from raw knowledge base in the form of rules using the Java Expert System Shell (JESS).
Structuring Knowledge from Raw Knowledge Base

4.1. Introduction

An expert system uses a repository of human knowledge captured and stored in a computer to solve problems that ordinarily require human expertise. It design focuses and then converges on a narrow area of expertise called domain. Expert System is the endpoint of knowledge engineering. The format which is used to capture knowledge by the knowledge engineers is known as knowledge representation.

A knowledge base system usually provides consistent solutions, aids knowledge transfer to remote locations and training of non-experts. Knowledge base system can also handles the uncertainty of making the human knowledge used explicitly. Since it produces fewer errors than non-experts in which the knowledge base system ultimately performs better. Knowledge demands more than the conventional representation structures used for databases and information. This is because information is derived from processing, referring and analysing raw data. Additionally, it is the extra refinement analysis and addition of heuristics to information that converts it to knowledge.
Different knowledge representation formatting have emerged and derive towards efficient knowledge representation has also led to the development of knowledge representation languages like PROLOG, JESS etc. The choice of a knowledge representation technique is usually dependent on a range of factors. By defining the characteristics of a given representation technique and determining the ability to handle the functional equivalence of a specific knowledge area, we can determine whether it is a suitable matter.

Therefore, in this chapter, we build up the current issues in structuring knowledge bases by firstly determining the features of an efficient knowledge representation system and factors that influence their expressiveness and power.

4.2. Representation of Raw Knowledge Base in to Structured Knowledge Base

The knowledge base is represented in the form of rules using the Java Expert System Shell. Here the user of the system is first presented with a list of questions which the user has to answer in yes or no. With the help of the questions the symptoms and predisposing factors of the disease are acquired. Then by using the RETE algorithm, which is a pattern matching algorithm, the knowledge base is searched for matching the symptoms of the rice plant with those
already present in the knowledge base. For this, our proposed system uses backward chaining method. Once the system finds the appropriate match, the diagnosis is shown to the user along with the tests that the farmer has to perform and the options for treatment of the plant. In this expert system, to structure the knowledge from raw knowledge base Java Expert System Shell (JESS) is used to perform its functions, facts, rules and procedures. An example of how knowledge is structured in JESS is shown in the following as below.

(defrule symptom-35
    ?s <- (Symptom {symptomID == 35})
    (answer (symptom abnormal_elongation_of_plants_in_seedbed) (text yes))
    (answer (symptom reduced_tillering_and_drying_of_leaves) (text yes))
    (answer (symptom partially_filled_grains) (text yes))
    (answer (predisposing presence_of_infected_seeds) (text yes))
    (answer (predisposing soil_born_pathogens) (text yes))
    (answer (predisposing high_nitrogen_application) (text yes))
    (answer (predisposing temperature_ranging_from_30_to_35°C) (text yes))
)
The developed expert system has the rules which covered the rice plant diseases caused by the fungi, bacteria and viruses during their life span. A brief identification of diseases caused by each of these three causing agents is described in the following.

4.2.1. **Fungal Diseases**

Fungal is responsible for a large number of diseases in rice plants. The important fungal diseases occurred in rice plant, their control measures and how to structure them in the knowledge base of the expert system is presented here in this chapter.

4.2.1.1. **Rice Blast**

Blast of rice plant disease known to occur in every region of the world wherever rice is grown. The blast disease of rice is caused by a fungal named *Pyricularia oryzae*. It infects at different growth stages
such as: leaf, collar, node, internode, base, or neck, panicle, and also sometimes the leaf sheath. There are four different types of blast diseases in rice plant. They are: *Leaf blast*, *Collar blast*, *Node blast*, *Neck blast*. The diseases are structured in the knowledge base in the following way.

**Diagnosis process of the disease and Representation of Knowledge:**

In the diagnosis process of the diseases of rice plant in our system, the specific symptom details and the major predisposing factors which are favouring in the occurrence of the disease are represented in the knowledge representation and the affected disease is diagnosed. After the diagnosis of the disease occurred, we have represented a separate rule for the control measure of the disease. For the diagnosis of blast disease of rice plant, the symptom details are classified for four different types of the blast disease. These symptoms are represented separately for different type of blast disease with the same predisposing factors of the blast disease.

**Rule for disease diagnosis:**

(defrule symptom-5
   ?s <- (Symptom {symptomID == 5})
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(answer (symptom spindle_with_pointed_area_spots) (text yes))

(answer (symptom spot_is_grey_white_with_brown_margin) (text yes))

(answer (symptom spots_have-tendency_to_join_together) (text yes))

(answer (symptom occurs_at_seedling_stage) (text yes))

(answer (predisposing long_dew_period) (text yes))

(answer (predisposing relative_humidity_above_90%) (text yes))

(answer (predisposing lower_night_temperature) (text yes))

=>

(printout t "The disease found in the plant is Leaf Blast" crlf)

(assert (Details disease_details))

)

Rule for disease Control:

(defrule Control_Leaf_Blast

  (answer (disease leaf_blast) (text yes))

  =>

  )
(recommend-action "The control measures for the diagnosed disease is seed treatment with tricyclazole @4gm/kg seed, increase the level of the potassium over the recommended level")

In this way, we have represented the knowledge for other types of blast diseases of rice plant which are caused by the fungal in the expert system from the raw knowledge base.

4.2.1.2. Brown Spot

Brown Spot is one of the rice plant diseases caused by the fungus Cochilobolus miyabeanus Helminthosporium oryzae and Bipolaris oryzae. The disease causes yield losses of 40-90% of rice production.

Diagnosis process of the disease and Representation of Knowledge:

To diagnose the brown spot disease, the mostly seen symptom of the disease with nature and details of the symptom is represented with the predisposing factor of the disease in the knowledge base.

Rule for disease diagnosis:

(defrule symptom-20

?s <- (Symptom {symptomID == 20})

(answer (symptom coleoptic_infected_from_diseased_seeds) (text yes))

(answer (symptom spots_are_much_larger_on_susceptible_varities) (text yes))

(answer (symptom size_of_the_spot_increase_slowly) (text yes))

(answer (symptom concentric_lines_on_the_spot) (text yes))

(answer (predisposing free_water_on_leaf_surface) (text yes))

(answer (predisposing partial_shading_during_inoculation) (text yes))

(answer (predisposing potash_efficiency) (text yes))

=>

(printout t "The disease found in the plant is Brown Spot" crlf)

(assert (Details disease_details))

)

**Rule for disease Control:**

(defrule Control_Brown_Spot

 (answer (disease brown_spot) (text yes))

 =>

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In this way, we have represented the knowledge for other diseases of rice plant which are caused by the fungal in the expert system from the raw knowledge base.

4.2.2. Bacterial Diseases

Bacteria are a serious agricultural problem for growth of rice plants seedlings. Depending upon the species, host-parasite, relationship and environment the bacterial disease produces different types of symptoms on the rice plant.

3.2.2.1. Bacterial Blight

Bacterial Blight disease of rice plant is caused by the bacteria *Xanthomonas oryzae pv. Oryzae*, one of the oldest known diseases. It reduces the grain yield at varying levels, depending on the stage, degree of cultivar susceptibility and to a great extent, the conduciveness of the environment in which it occurs.
Diagnosis process of the disease and Representation of Knowledge:

For the diagnosis of the bacterial blight disease of rice plant, the details of the symptom like yellowish stripes on leaf blades and then later increase in length and width with a wavy margin is structured in the knowledge base with the related predisposing factors.

Rule for disease diagnosis:

(defrule symptom-63

  ?s <- (Symptom {symptomID == 63})

  (answer (symptom water_soaked_to_yellwish_strips_on_leaf_blades) (text yes))

  (answer (symptom appearance_of_bacteriaLoozeJooksJike_milky) (text yes))

  (answer (symptom lesions_turn_yellow_to_white) (text yes))

  (answer (symptom severelyInfectedJeaves_tend_to_dry) (text yes))

  (answer (symptom lesions_become_grayish) (text yes))

  (answer (predisposing presence_of_weeds) (text yes))

  (answer (predisposing presence_of_rice_stubbles) (text yes)))
(answer (predisposing presence_of_bacteria) (text yes))

(answer (predisposing warm_temperature) (text yes))

(answer (predisposing high_humidity) (text yes))

(answer (predisposing rain_and_deep_water) (text yes))

(answer (predisposing over_fertilization_and_handlings_of_seedlings) (text yes))

=>

(printout t "The disease found in the plant is Bacterial Blight"
crlf)

(assert (Details disease_details))

)

Rule for disease Control:

(defrule Control_Bacterial_Blight

  (answer (disease bacterial_blight) (text yes))

  =>

  (recommend-action "The control measures for the diagnosed
disease is practicing field sanitation such as removing weed
hosts, rice straws, ratoons and volunteer seedlings is important
to avoid infection caused by this disease.")

)
In this similar process, the knowledge about the other diseases of rice plant caused by bacteria is structured in the knowledge base by the knowledge from raw knowledge base.

4.2.3. **Virus Diseases**

Virus diseases constitute a serious threat to increased rice production. Since then, virus diseases have been increasingly recognized in most rice growing districts and they could develop into epidemic proportions, particularly under conditions of high fertilization, cultivation of susceptible varieties, multiple cropping and haphazard cultural practice.

4.2.3.1. **Tungro**

Tungro is the rice diseases caused by a viral complex, *Rice tungro bacilliform virus* (RTBV) *and rice tungro spherical virus* (RTSV), with outbreaks affecting thousands of hectares. It is considered as one of the most economically important viral disease of rice.

**Diagnosis process of the disease and Representation of Knowledge:**

The specific symptom details of the tungro disease of rice plant which is caused by a virus is represented in the knowledge base with
the predisposing factors of the disease to diagnose the disease by the expert system in such a way that is in the format of JESS language.

**Rule for disease diagnosis:**

(defrule symptom-72
  ?s <- (Symptom {symptomID == 72})
  (answer (symptom discoloration_begins_from_leaf_tip) (text yes))
  (answer (symptom infected_leafs_show_mottled_or_stunning) (text yes))
  (answer (symptom reduced_tillering) (text yes))
  (answer (symptom delayed_flowering) (text yes))
  (answer (symptom panicles_sterile_or_partially_filled_grains) (text yes))
  (answer (predisposing presence_of_virus_sources) (text yes))
  (answer (predisposing presence_of_vectors) (text yes))
  (answer (predisposing age_and_susceptibility_of_host_plants) (text yes))

  =>

  (printout t "The disease found in the plant is Tungro" crlf)

  (assert (Details disease_details))
Rule for Disease Control:

(defrule Control_Tungro

  (answer (disease tungro) (text yes))

  =>

  (recommend-action "The control measures for the diagnosed disease is planting of resistant varieties against tungro virus diseases is the most economical means of managing the disease."
)

Similarly, the knowledge about the other diseases of rice plant caused by virus is also structured in the knowledge base by the knowledge from raw knowledge base.

Structuring the knowledge base is one of the major importance’s in the expert system development. Available representation schemes vary in the level of expressiveness and power. Each knowledge base structuring scheme has merits. For a greater efficiency and better knowledge structure, an efficient knowledge representation scheme may be needed for structuring a particular knowledge base. There are many representation schemes
for the structure of a knowledge base. We have used here the production rules for the structure of the knowledge base in this system and such a representation scheme enhance the modelling and development of the system that provides for visual conception and communication of abstract information.