

Knowledge Base Tool for Enhancing Expert Systems Dialogue

Abdelrahman Elsayed

Climate Change Information Center & Renewable Energy & Expert Systems,
Agricultural Research Center, Giza, Egypt

abdotool@gmail.com

Abstract

Available diagnosis expert systems ask users many questions in order to identify the diseases. These questions are sometimes vague and need more interpretations. Further, using a lot of questions does not satisfy the end-user and turn the expert system to be boring and unfriendly. In this paper, I introduce a tool for building knowledge base. Also, I propose an approach for enhancing expert system dialogue with end-user. The proposed approach was applied in plant diseases. Instead of just asking the end user only text questions, images for different symptoms on different part of the plants are displayed to him. Then the end-user selects the images which are approximate to his plant symptoms. Finally, the system adapts the dialogue. This process is repeated till reaching the final diagnosis. The proposed tool is a web-based, and it adopts XML to store ontology, schema of knowledge base and knowledge base. The proposed tool was applied in building a prototype for barley knowledge base and diagnosis expert system.

Keywords: *Knowledge management, Expert systems, Software tools.*

1. Introduction

Knowledge base is a method for representing and storing knowledge in organized way. It uses ontology to describe the main concepts of specific domain of interest. An expert system or knowledge based system adopt knowledge base for solving complex problems [1].

Many expert systems have been developed in different fields. In medical application, diverse numbers of expert systems were developed. For example, MYCIN [2] is an expert system developed to help practitioners in diagnosis and treatment process of bacterial infections. Also, another expert system specialized in heart diseases were developed to serve as doctor diagnostic assistant [3]. In agriculture domain there is a lot of efforts in utilizing information technology in agriculture process in order to effectively manage crop life cycle starting from land preparation to harvesting and manufacturing. In Egypt researchers at Central Laboratory for Agricultural Expert Systems (CLAES) developed many expert systems for different crops [4]. Cucumber seedling production in plastic tunnels was considered as the first expert system for cucumber [5]. Furthermore, CLAES developed expert systems for other crops such as citrus [6], wheat [7], barley, mango, grape and tomato [8]. In the veterinary domain CLAES developed expert systems for diagnosis of buffalo, cows, sheep and goats in addition to poultry expert system for diagnosis and poultry care.

The main problems facing expert system development are knowledge acquisition and updating. Knowledge engineer needs to meet the domain expert to get knowledge. But it is preferable to enable domain experts to build a knowledge base by themselves. On the other hand, the most effective problems which face expert system users are vague questions and inconsistent dialogues. A lot of efforts have been done for enhancing expert system dialogue. In [9], the author introduced an approach for enhancing the user interface of diagnostic expert

system through enabling the end-user to navigate graphically on all parts of the animal. After that, the end-user can select properties which are related to specific animal part. This approach optimized number of asked questions to the-end-user.

Also, many tools have been developed to rapid creation and development of expert system generally such as CLIPS [10] and Java DON [11]. Also, other tools specialized in plant protection expert systems have been developed [12, 13]. But all these tools have some shortage in associating textual and image together during getting the inputs from the end-user.

In order to mitigate the problems which are related to knowledge acquisition and usage of expert system, I introduced a tool for building knowledge base in simple way. Further, a new data type was proposed for the properties of the concepts. It will facilitate the representation of property values in textual and image forms. The suggested name of the new data type is Symptom-Image.

I developed a prototype for diagnosis expert system of barley diseases. Barley is an important cereal crop. It can be cultivated in soil that has low fertility compared to wheat, and it is tolerant to severe weather conditions [14]. Its main use is animal feeding. Also, it can be blended with wheat flour to produce biscuit [15]. Furthermore, it can decrease the problem of wheat shortage in country like Egypt [16].

The rest of this paper organized as the following: section 2 introduces the knowledge acquisition tool, section 3 introduces case study for using knowledge acquisition tool in developing prototype for barley knowledge base system, and finally section 4 is a conclusion and future work.

2. Knowledge Acquisition Tool (KAT)

The main purposes of the proposed tool are facilitating knowledge acquisition, building, and enabling non computer programmer to build their knowledge base for plant protection. Further, it enables expert to associate textual data with images. The tool consists of four modules which are:

- **Varietal Identification:** This module aims to list crop varieties, including its main characteristics such as suitable region, yield, resistant to disease and salinity, in addition to other properties.
- **Cultural Practices:** It is concerned with pre-cultivation practices which enable crops to resist disease and increase yields.
- **Pest Identification:** It enables the expert and end-user to specify and know all pests which affect specific crop and its symptoms.
- **Pest Control:** It introduces the procedures that control the pests.

The domain expert has to complete a set of stages in order to finalize knowledge base as shown in figure (1). These stages are registration, ontology editing, schema editing, and knowledge entry. Moreover, the expert can modify and search the knowledge base.

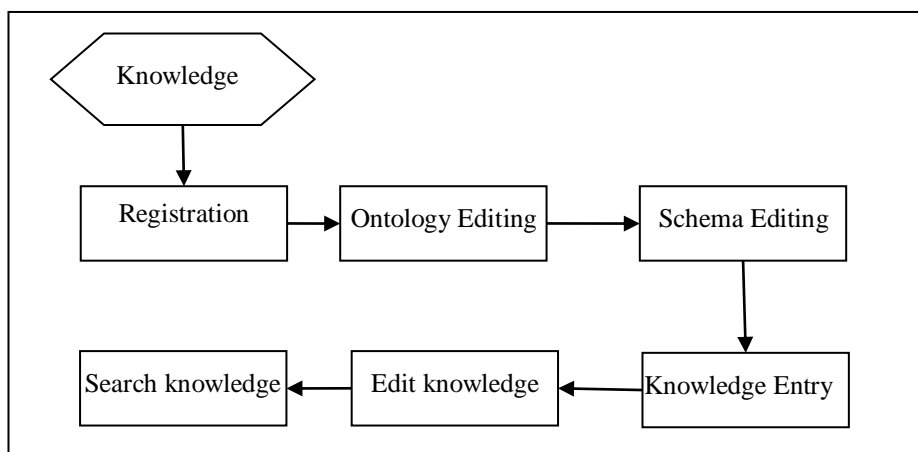


Figure: 1 Stages involved in knowledge acquisition tool

a. Registrati

The domain expert or knowledge engineer can register for creating knowledge base for any field crop. He or she should specify the name of the crop and the personal data such as: the expert name, affiliation, e-mail, user name and password.

b. Ontology editing

The next stage is ontology editing, it is an iterative process. The user can create concept hierarchies. He or she can add properties to concepts; actually I modified the developed property editor to include new type (Symptom_ Image) as shown in figure (2). Hence, I enable the user to add the symptoms of the pests visually in images in addition to text. Other properties data types are (string, string multiline, nominal, etc.).

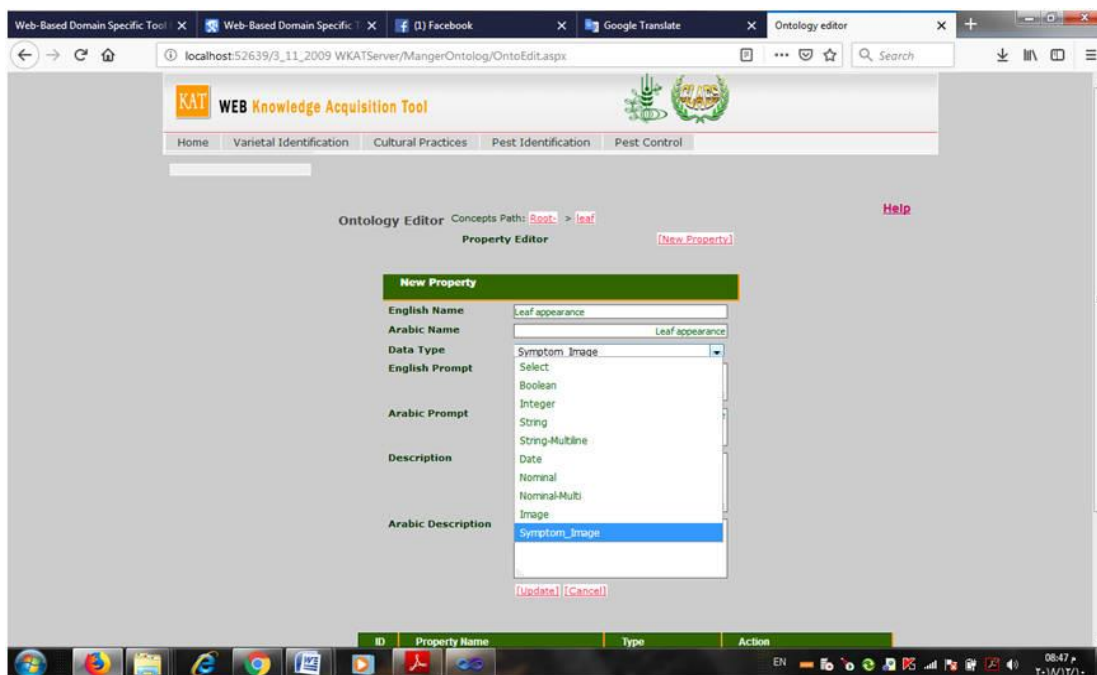


Figure: 1 Property editor screen.

The KAT tool stores ontology data in XML format and it assigns automatic identification (id) for concepts, properties and legal value of properties in order to enhance knowledge management. Also, the tool supports representing knowledge in Arabic and English. Figure (3) shows part of the XML file for storing crop ontology. Each concept in crop ontology is represented as XML node with three XML attributes, the first attribute is the concept identifier (Concept_ID), and the other attributes are concept names in Arabic (NameA) and English Language (NameL). The concept-node has a set of child nodes for representing its properties. The property-node contains the following XML attributes:

- 1- Property identifier (Property_ID).
- 2- Property name in Arabic (NameA).
- 3- Property name in English (NameL).
- 4- Property type.
- 5- Property prompt in Arabic (PromptA), which will be displayed to the end-user.
- 6- Property prompt in Arabic (PromptL).

Also, the property node has child nodes for storing metadata in Arabic and English (DefinitionA, Definition). The legal values of properties are represented as child nodes. Each legal value node has XML attributes for value identifier, Arabic name, English name, and path of image for properties of type Symptom_Image.

```

- <CONCEPT Concept_ID="44" NameA="المسق" NameL="Stem">
- <PROPERTY Property_ID="1" NameL="Color" NameA="اللون" Type="Nominal-Multi" Prompt="What is the color of the stem" PromptA="ما هو لون المسق">
  <Definition>The color of the stem</Definition>
  <DefinitionA>لون المسق</DefinitionA>
  <LegalValue Value_ID="1" NameL="Red" NameA="أحمر" />
  <LegalValue Value_ID="2" NameL="Green" NameA="أخضر" />
  <LegalValue Value_ID="3" NameL="Blue" NameA="أزرق" />
</PROPERTY>
- <PROPERTY Property_ID="2" NameL="Image" NameA="صور المسق" Type="Nominal-Multi" Prompt="What is the color of the stem" PromptA="ما هو لون المسق">
  <Definition>Image to describe the stem</Definition>
  <DefinitionA>صور لوصف المسق</DefinitionA>
</PROPERTY>
- <PROPERTY Property_ID="3" NameL="stem appearance" NameA="stem appearance" Type="Symptom_Image" Prompt="stem appearance"
  PromptA="stem appearance">
  <Definition>To associates images with symptoms</Definition>
  <DefinitionA>لدمج صور مع أعراض الإصابة في المسق</DefinitionA>
  <LegalValue Value_ID="1" NameL="Dark red-brown spores masses on the stem" NameA="Dark red-brown spores masses on the stem"
    ImageFileName="721470.jpg" />
</PROPERTY>
<SubConceptOf />
<Definition>To describe the stem of the plant</Definition>
<DefinitionA>يستخدم لوصف ساق النبات</DefinitionA>
</CONCEPT>

```

Figure: 3 Representation of Concept in XML format

c. Schema editor

The role of schema editor is to enable the knowledge base builder to specify which parts of ontology are related to each module. Figure (4) displays schema editor screen for pest identification module. Firstly, the user points to the concepts and select the properties. Then, he specifies the properties that will be used for search and editing. The schema data are stored in XML file "Schema XML file". The XML file consists of a set of XML nodes, each node holds information about selected properties, and it has XML attributes for storing property data such as concept identifier, property identifier, used-for-search, used-for-editing.

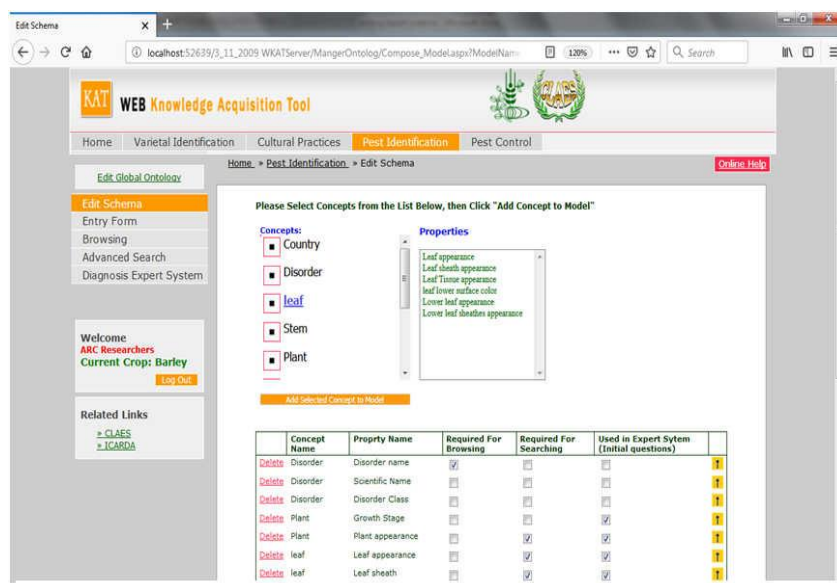


Figure: 4 Schema editor screen

d. Knowledge entry

After building ontology and modifying schema editor, the next step is to enter knowledge which is related to each module. In fact the data entry screen is considered as rule editor of logical conjunction “and” only. But it appears as if it was traditional data entry screen as show in figure (5). After finalizing data entry stage, the end-user such as farmer or agriculture agent can search and use the knowledge.

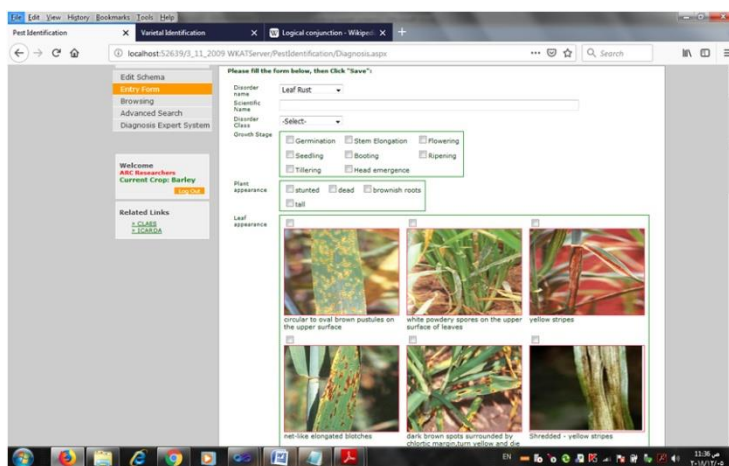


Figure: 5 knowledge entry screen

According to the data types of the properties, the proposed tool will automatically generate data entry controls such as text box or drop down list box, or check box list with image, etc. Algorithm (1) shows steps for drawing dynamic knowledge entry form.

Algorithm 1: Drawing knowledge entry controls algorithm

Inputs: Current module file (*Schema_XML_file*), Knowledge Entry Form control *KEF*

Steps:

1. Create XmlDocument control *XMLschema*
2. Load *Schema_XML_file* to *XMLschema* ;
3. Set *Property_List* = all properties in *XMLschema*;
4. Create XmlDocument control *XMLOntology*
5. Load the ontology XML file to *XMLOntology*
6. For each Property *P* in *Property_List*
7. Begin
8. Set Type *T*= get property type of *P* from "*Ontology XML file*"
9. Set Label *L* = get label of *P* from "*Ontology XML file*"
10. Add *L* to *KEF*
11. If *T* = "nominal"
12. Create Dropdown List control *DDL* and fill it with its legal values, then add *DDL* to *KEF*
13. If *T* = "Nominal-Multi"
14. Create Checkbox List control *CBL* and fill it with its legal values, then add *CBL* to *KEF*
15. If *T* = "Symptom_Image"
16. Create Checkbox List control *CBLI* and fill it with its legal values *LV*.
17. for each legal value *V* in *LV*
18. begin
19. Create Image control *IMG* for each legal value, then get its image source
20. add *IMG* to *V*
21. End
22. Add *CBLI* to *KEF*
23. Else If *T* = "string"
24. Create Textbox control *TB* then add it to *KEF*
25. Else If *T*= "String-Multiline"
26. Create Multiline Textbox *MTB* control then add it to *KEF*
27. If *T*= "Image"
28. Create File Upload *FU* control , then add *it* to *KEF*
29. End

The inputs of this algorithm are the knowledge entry form and the selected module such as "pest identifications". The algorithm starts by loading "Schema XML file" which represents the schema of the selected module. Also, it loads the "Ontology XML" file of the current crop ontology. Then, it iterates over each property in "Schema XML file". It uses the "Ontology XML" file to get the type of the property and the label of the property. Finally, it generates a data entry control in addition to label control for each property.

e. Diagnosis expert systems

I added the capabilities of developing diagnosis expert system to the KAT. Diagnosis expert system is composed of two sub tasks. The first task is predict, it takes initial complaints or symptoms from the end user and displays the suspected disorders to the user. The next sub task is confirm, which displays more symptoms related to the suspected disorders. Then it differentiates between disorders based on user inputs.

Using schema editor's components, the domain expert can specify which symptoms will be displayed as initial question in pest identification module. The KAT will automatically generate the diagnosis expert system based on the domain expert specification.

3. Case study

The proposed idea adopted in developing a prototype for barley diagnosis expert system. I started by the most effective diseases of barley which are (Leaf rust, Powdery mildew, Net form Net blotch, Spot form Net blotch, Stem Rust, Barley Stripe, Covered Smut, Loose smut, Dry-land root rot.) For each disease, I identified its symptoms from domain expert in addition to extension document of barley and other resources [17, 18]. Also, I modified barley ontology to include concepts and properties which are related to disorders. Table (1) displays the concepts and properties which are used to describe the implemented barley diseases.

Table: 1 Concepts and properties of the implemented diseases

Concept	Property	Data type
Disorder	Disorder name	Nominal
	Scientific Name	String
	Disorder Class	Nominal
	Disorder Image	Image
Leaf	Leaf appearance	Symptom_Image
	Leaf sheath appearance	Nominal
	Leaf Tissue appearance	Nominal
	leaf lower surface color	Nominal
	Lower leaf appearance	Nominal-Multi
	Lower leaf sheathes appearance	Symptom_Image
	Stem	stem appearance
Plant	Color	Nominal-Multi
	Image	Image
	Growth Stage	Nominal-Multi
Head	Plant appearance	Nominal-Multi
	Head appearance	Nominal
Spike	Head color	Nominal
	Spike appearance	Symptom_Image
Inflorescence	Inflorescence appearance	Symptom_Image
Crown	Sub-crown internode appearance	Nominal
	Crown appearance	Nominal

For properties of type “Symptom_Image” such as leaf appearance, the tool enabled me to represent leaf appearance symptoms in textual and graphical form. Figure (6) displays sample of leaf appearance symptoms. It shows three symptoms related to leaf appearance. The first symptom was represented by the top image and it was described textually as “circular to oval brown pustules on the upper surface”. The second symptom was described textually as “shredded yellow stripe” and it was represented by the middle image. Finally, the third symptom was described by the bottom image and it was represented textually as “dark pustules on the upper surface”.



Figure: 6 Sample of leaf appearance symptoms

a. Front-end interface for the diagnosis expert system

The farmer or the extension agent can use the expert system for diagnosing the diseases by using the developed expert systems. The interface of the expert system was generated automatically based on the schema editors selected options. Figure (7) displays the diagnosis expert system for barley.

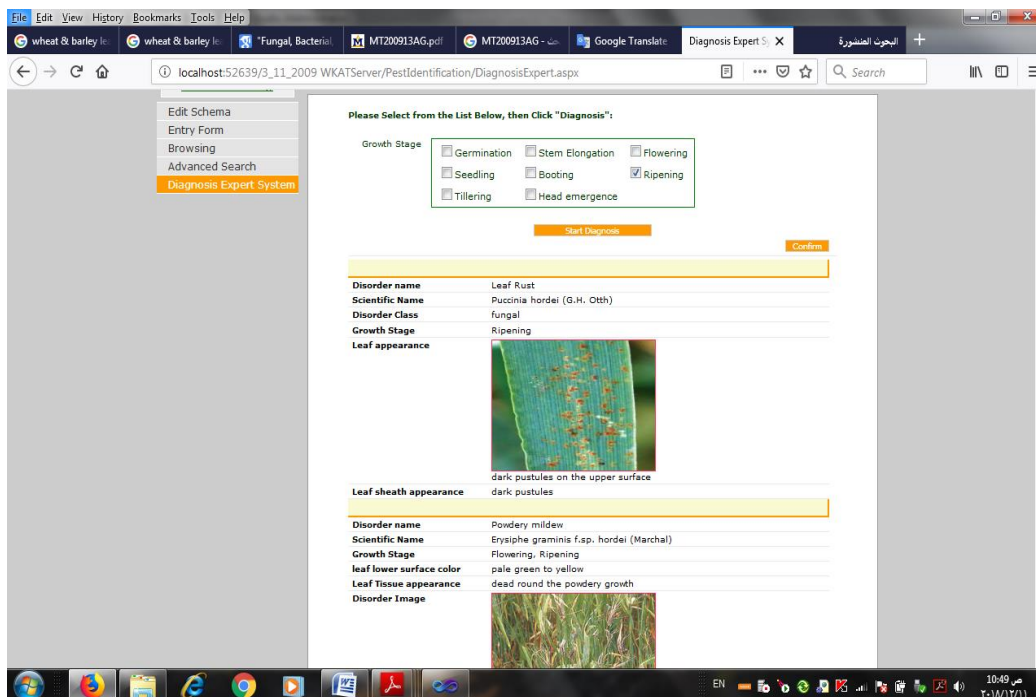


Figure: 7 Diagnosis expert systems

Firstly, the end-user will specify the growth stage, and then he or she will click start-diagnosis button. After that, a list of possible diseases of the selected growth stage will be displayed on the screen. If the end-user wants to confirm the disease, he can click the confirmation button. Figure (8) shows an example of the confirmation stage of barley diagnosis; the end-user can specify plant-appearance, leaf-appearance and leaf-sheath-appearance. The introduced tool will filter the generated questions and suspected diseases based on the end-user inputs.

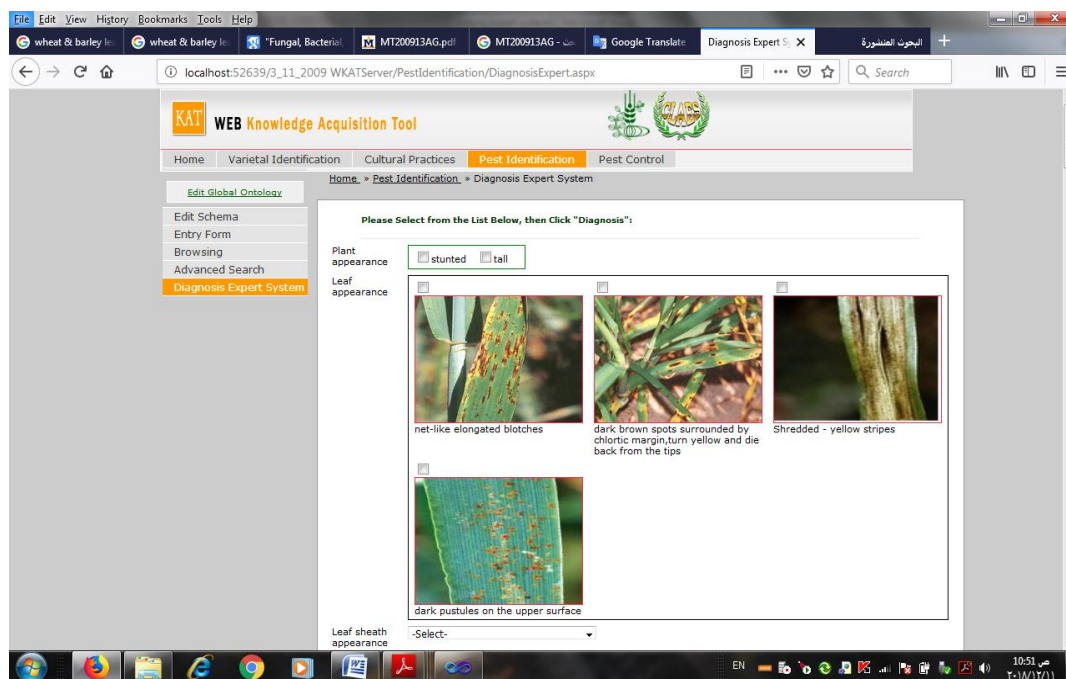


Figure: 8 Conformation stage of diagnosis expert system.

4. Conclusion

The main contribution of this paper is enriching expert systems with visualization. Now the end-user can select images which are nearest to his crop symptoms. Also, this paper presents a tool for facilitating the process of building knowledge base. Furthermore, the proposed tool enables the person with non programming experience to build knowledge base easily. For future work, the proposed idea could be applied to enhance and develop expert systems for other crops. Further, research still needed for optimizing expert system dialogue. As well, the tool will use a recent ontology representation language such as OWL to adopt its power in reasoning and standardization. Furthermore, integrating of image processing and deep learning is an interesting research area in developing diagnosis expert systems because it helps in automatically detecting plant diseases. The farmer can take an image for suspected plants and uploads it to the expert system, and then the expert system will use the integrated machine learning techniques to recognize the pests and enhance expert system dialogue.

Acknowledgement

This work is an extension for barley knowledge base system which is funded by International Center for Agricultural Research in the Dry Areas (ICARDA). Also, I would like to thank domain experts and CLAES team who supported me in this work.

References

- [1]. L V Naykhanova, and I V Naykhanova, "Conceptual model of knowledge base system" *Journal of Physics: Conference Series*. vol. 1015. no. 3. IOP Publishing, 2018, pp. 1-4.
- [2]. W. V. Melle, "MYCIN: a knowledge-based consultation program for infectious disease diagnosis" *International Journal of Man-Machine Studies*, vol. 10 no.3, 1978, pp. 313-322.
- [3]. A. M. Salem, M. Roushdy, and R. A. HodHod, "A Rule-Based Expert System for Diagnosis of Heart Diseases" *Egyptian Computer Science Journal* vol. 23 no. 1, 2001.
- [4]. A. Rafea, "Agricultural expert systems developed in Egypt" In *Proc. of Int. Con. on Expert Systems for Development, ICES-94, Bangkok, Thailand, March, 1994*, pp. 218-285.
- [5]. A. Rafea, M.Warkentin, and S. Ruth, "An Expert System for Cucumber Production in Plastic Tunnel" In *Proc. of the World Congress on Expert Systems, Florida-U.S.A., 1991*, pp. 909-916.
- [6]. A. Salah, A. Rafea, and E. Mohamed, "An Expert System for Citrus Cultivation Feasibility" In *Proc. of the First Int. Conf. on Expert Systems and Development (ICESD-92), MOALR, Cairo- Egypt, 1992*, pp. 33-40.
- [7]. S. Edrees, A. Rafea, I. Fathy, and M. Yahia, "NEPER: a multiple strategy wheat expert system" *Computers and Electronics in Agriculture*, vol. 40, 2003, pp. 27-43.
- [8]. E. El-Azhary, H. Hassan, and A. Rafea, "Pest control expert system for tomato (PCEST)" *Knowledge and Information Systems*, vol. 2 no. 2, 2000, pp. 242-257.
- [9]. Y. Abdelhamid, "Enhanced User Interfaces for Diagnostic Expert Systems" *Egyptian Computer Science Journal*, vol. 27 no.1, 2005.
- [10]. R. M. Wygant "CLIPS — A powerful development and delivery expert system tool" *Computers & Industrial Engineering*, vo.17 no (1-4), 1989, pp. 546-549.
- [11]. B. Tomić, J. Jovanović, and V. Devedžić, "JavaDON: an open-source expert system shell" *Expert Systems with Applications*, vol. 31 no. 3, 2006, pp. 595-606.
- [12]. Z. Abdul-Hadi, et al, "Rapid Generation of Plant Protection Expert Systems" *Computers in Agriculture and Natural Resources – Proc.of the 4th World Congress (Orlando, Florida USA), 2006*, pp. 282-287.
- [13]. A. Rafea, "Web-Based Domain Specific Tool for Building Plant Protection Expert Systems" *Expert Systems, Petrica Vizureanu (Ed.), ISBN: 978-953-307-032-2, InTech, 2010*, pp. 193-202.
- [14]. H.Verstegen, O.Köneke, V.Korzun, and R. von Broock "The World Importance of Barley and Challenges to Further Improvements" In: Kumlehn J., Stein N. (eds) *Biotechnological Approaches to Barley Improvement. Biotechnology in Agriculture and Forestry*, vol. 69. Springer, Berlin, Heidelberg, 2014, pp. 3-20.
- [15]. C. W.NEWMAN, and R. K. NEWMAN, "A brief history of barley foods" *Cereal foods world*, vol. 51 no. 1, 2006, pp. 4-7.
- [16]. A. M. S. HUSSEIN, M. M. Kamilet, and N. A. Hegazy, S.A.H. Abo El-Nor, "Effect of wheat flour supplemented with barely and/or corn flour on balady bread quality" *Polish Journal of Food and Nutrition Sciences*, vol. 63 no. 1, 2013, pp. 11-18.
- [17]. S. NEATE, and M. McMullen, "Barley Disease Handbook" published by North Dakota State University, 2005.
- [18]. M. Burrows, J. Olmstead, and W. E. Grey "Fungal, Bacterial, and Physiological Leaf Diseases", MSU Extension office, 2013.