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Recommendation System for Plant Disease Using Semantic Agent Model for Treatment Proposal

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Abstract. Agriculture is a basic economical source that is important for the survival of the population. Plants also like people suffer from diseases and their diagnostic and treatment is very important aspect of plant productivity. Generally, the most diseases may be detected and classified from the symptoms that appeared. Therefore in this article when using the artificial intelligence is proposed a new recommendation system that is based on plant profile and give comparatively high precision of the returned results.The system depend on the requested criteria from the user that make diagnostic using the system and consecutively lead to the on time treatment of the plants. The system when implemented artificial intelligence is characterized with high quality returned results.

Keywords. agriculture, plant disease, recommendation system, data mining, ontology, semantics, multi-agent systems, information systems, decision support systems, personalization

1. Introduction

Plants can have pathogen diseases from fungi, bacteria and viruses that lead to plant damage and the food from plant production reduction. Nowadays, people more and more use internet as a source of information for different diseases. Not only non-expert use internet for searching of specific information in a plant diseases but also expert search information for plant diseases. But the information in internet is not always from reliable sources and can lead to disinformation and misunderstanding that could be crucial for the producers of plant production. Furthermore, the possibility of early diagnostic of the plant diseases during plant growth will determine it's future growth of the plant that will allow the development of the species. That lead to the need for creation of easy accessible and reliable system for treatment recommendation. Artificial intelligence is able to provide its new methods and instruments for the creation of the recommendation system. Semantic technologies can help to find the right disease concerning the symptoms that was described from the user. The quality of the information system is provided

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when using semantics, that gives the connection and the meaning of the words. The recommendation system is searching information from internet about the different diseases that are caused by fungi, bacteria and viruses. Because plant diseases reduce the plant production, the early diagnostic of the disease of the plant is critical for the food productivity [1][2]. That can make the system very valuable as a plant disease recommendation system.

2. A model of multi-agent based recommendation system for early diagnostic

The model of the system is presented in Figure 1. The architecture of the system is based on agents so that to perform the searching of the information from different sources [3]. The system can be separated into five modules.

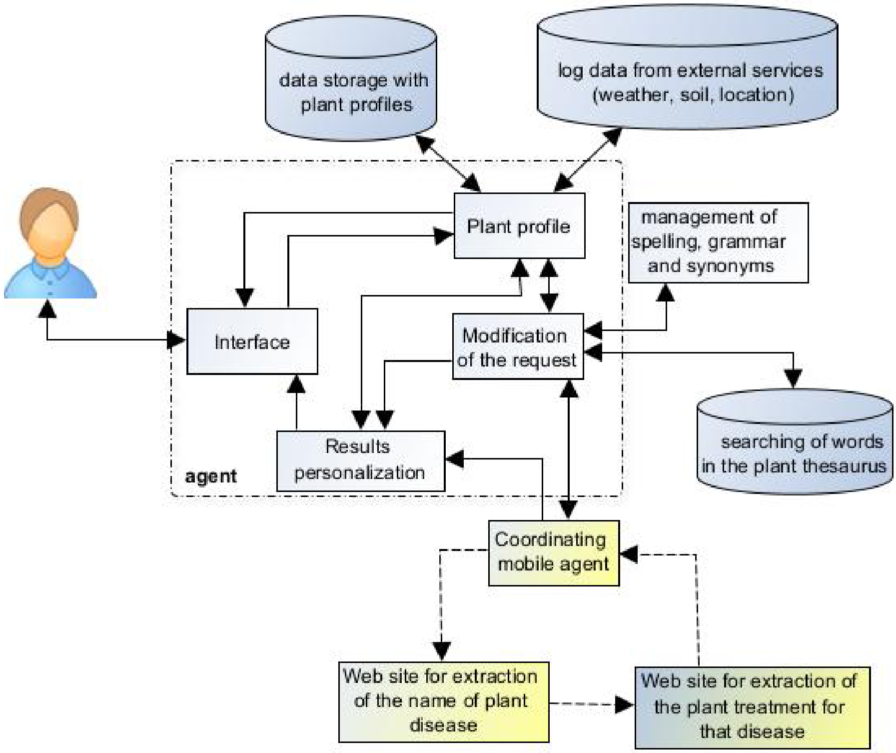

Figure 1. A model of the plant disease recommendation system

2.1. Interface module.

The first module include the interface with security authentication system. This module provide secure access into the system to each user. That can improve and protect the performance of the system. Furthermore, this module will give the possibility to the system to return personalized results to each user as a need of authentication is required. The security system authentication is directly related with the interface that interact with the user.

2.2. User personalization module.

Each user have his profile that correspond to the previously searched results. It is related with interaction of the interface agent to return the final results that is a plant disease that correspond to a particular symptoms entered from the user. The agent for results personalization interact with the agent for the plant disease and also with the coordinating mobile agent so that to return to the user appropriate results.

2.3. Semantic module.

Implication of ontology plant profile for the user system that interact with the external data as weather, soil and other to improve the information about the plant profile. Then the semantic relation between the profile information and the user query is established so that to produce a meaningful results.

2.4. Request responsible module.

In the request responsible module the entered request is checked for spelling and grammar mistakes and also about words in specialized plant thesaurus for synonyms. This module in general include the agent for modification of the request, management of the spelling and grammar and enriching the words with synonyms from the plant thesaurus as TOP thesaurus (Thesaurus of Plant Characteristics)[2] . That help to be removed some stop words and the relation between the words. Then the information is checked with the plant profile and the results are send to the personalization agent. The query module is with direct interaction with the semantic module and also with the module for searching of information.

2.5. Module related with information searching

Searching of the information from internet sources is performed with two mobile agents that visit specialized web sites and improve the searched results. Firstly the mobile agent search the disease in the web site for diseases. Then the mobile agent visit that website with information for treatment of the disease to take the corresponding treatment of the disease. Web agents have the role of retrieving information from a specific web page. This process is performed using the getResults () method of the class on the web page. This method uses the HtmlUnit class libraries to fill in the search form from the web page, then click the submit button, and finally parse the resulting HTML page to collect

[2] http://agroportal.lirmm.fr/ontologies/TOP

the data. Fig.2 shows the introduction of the algorithm, which demonstrates the search in the site [3] for description of the plant diseases. In the same way, information about the medicines for the corresponding disease is collected from the site [4].

```
public void getResults(){
    WebClient webClient = new WebClient();
    webClient.setJavaScriptEnabled(false);
    HtmlPage page = null;
    try{
        page = webClient.getPage(webSite);
    } catch (Exception e){
        e.printStackTrace();
    }
    HtmlForm form = (HtmlForm) page.getElementById("search_form");
    HTMLElement destTB = form.getElementById("diseaseSearch");
    destTB.setAttribute("value", disease);
    HtmlElement checkbox = form.getElementById("showAvail");
    HtmlElement submitButton = form.getElementById("submitBtn");
    HtmlPage resultPage= null;
    try {
        resultPage = submitButton.click();
    }catch (IOException e) {e.printStackTrace();}
    }
```

Figure 2. Collect data from a web page using HtmlUnit

The results are returned to the coordinating mobile agent that also interact with a repository that store the returned results. Then the information is send to the agent into results personalization module. The interface module, the user personalization module, semantic module and the request responsible module are included into an agent, so that to perform multi-agent system with the coordinating mobile agent that is used to search information from internet.

For the creation of the system is used the Recolibri software that is available in internet[5][4]. This software provide easy prototyping functionality and contain different searching algorithms for testing. But to create the system as multi-agent and benefit from their advantages, it is used also other extension. Mobile agents have the advantage to enhance the management task when searching information from internet.

3. Functional diagram about plant- user profile

When implementing in the recommendation system plant- user profile, the system is becoming personalized. The ontology model described in Figure 3 is a part of the recommendation system showed in Figure 1. The information related with the plant can be classified into five categories. First category include plant basic information such as the name of the plant, genus of the plant, the species that belong that plant and other. The second category include information about the person that is in charge of particular type of plants. Third part include plants condition that include root, leaf and other. The fourth

[3]https://cropwatch.unl.edu/soybean-management/plant-disease
[4]https://www.planetnatural.com/pest-problem-solver/plant-disease/anthracnose/
[5]https://gaia.fdi.ucm.es/research/colibri/recolibry/index.php

part include nutrients provided to the plants. And in the fifth part are included the environment parameters. Environmental parameters contain information about the weather, the geographical coordinates of the plant, the soil.

Plant diseases are an important component of the widely accepted disease triangle concept where they cause diseases in susceptible hosts under favorable environmental conditions. Under such favorable environmental conditions, pathogens often spread rapidly to new hosts. Therefore, early and accurate detection of a disease and diagnosis of its causal agent is highly important for disease control and sustainable agricultural production [5][6].

The diagnosis of the disease of the plant is performed with the plant specific characteristics and their current symptoms. This is visualized in Figure 3.

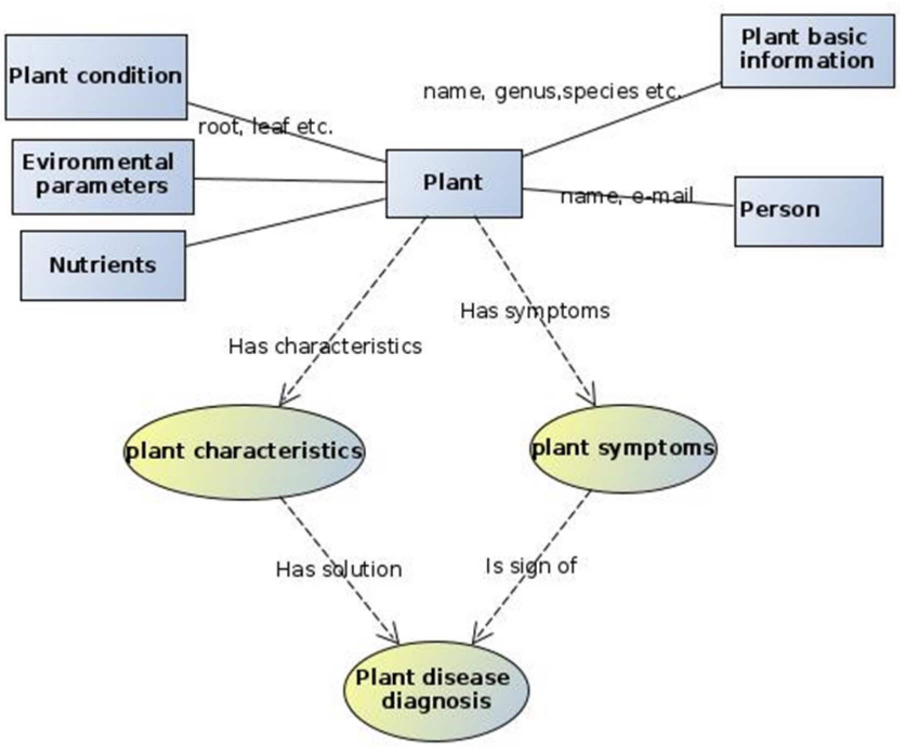

Figure 3. Functional diagram of the proposed personalized recommendation system

There are included a group of fields about the nutrients of the corresponding plant. Then a semantic connection is established between the plant characteristics, so that to create plant disease diagnosis. Based on the diagram in Figure 3 are presented the classes of the ontology in the Figure 4. In Figure 4 the classes are from the ontology as a graph.

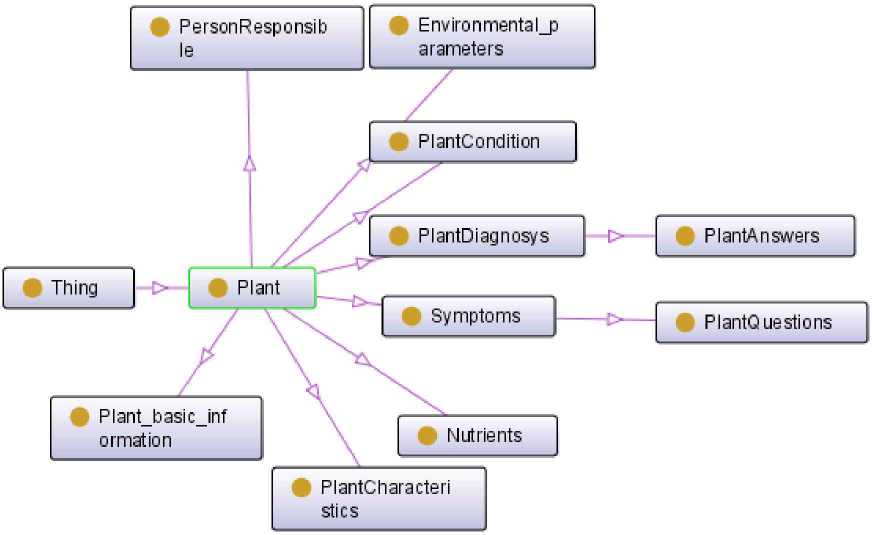

Figure 4. Visualization of the classes of the disease ontology

4. Results from the proposed recommendation system

The results returned from the systems are evaluated in Table 1 base on the most popular vegetable in the world tomatoes, onions, cucumbers, cabbages, eggplants, carrots, peppers, lettuce, spinach, garlic. Table 1 propose evaluation of the system based on the results returned from the recommendation system and the answers proposed from an expert in the agricultural domain. The total number of the questions evaluated concerning ten vegetables categories are 231. In column named Case 1 the system and the expert return the same answer for the disease and the column is filled in with number of the questions that have the same answer. In column named Case 2 are placed the number of the answers for each vegetable where the system and the expert have answered differently, because the expert gave not correct answer of the disease. In the column named Case 3 are noted the answers of the questions for each category of vegetable when the expert decide correctly, but the system decide wrong. Then a Precision, Recall and F-measure are presented for each category of the ten most popular vegetables, concerning the questions and the answers of the system and the expert. The quality of the system is defined based on the results calculated for precision of the system 97% , the recall 94% and f-measure with 96%.
After deep analysis and review of the results provided from the other digital instruments for plant diagnostic [8], [9], [10], [11], [12], [13], can be defined that the proposed systems is having comparatively high returned results. But the information provided from the system is very general than some other systems that have more precise information but also can make analysis to only one plant type [12].

Table 1. Results evaluation table.

Vegetables	Total questions	System response	Expert response	Instance1	Instance2	Instance3	Precision	Recall	F-measure
tomatoes	35	34	36	31	1	3	0,968	0,911	0,93
onions	22	22	22	20	0	2	1	0,909	0,952
cucumbers	19	19	19	18	0	1	1	0,947	0,972
eggplants	20	19	18	19	1	0	0,95	1	0,974
carrots	23	18	23	23	2	0	0,92	1	0,958
peppers	27	26	27	25	0	2	1	0,925	0,961
lettuce	30	32	30	28	1	1	0,965	0,965	0,965
spinach	21	20	20	18	1	2	0,947	0,9	0,923
garlic	34	32	33	33	0	1	1	0,97	0,985
Total	231	222	228						
Average							0,97	0,947	0,96

[1] System response- Response returned appropriately from the system
Expert response- Response returned appropriately from the expert
Instance 1- The proposed system and also the domain expert decide the same disease
Instance 2- The system and the expert differ about disease diagnostic
Instance 3- Expert define correctly the disease, but the system gave incorrect answer

5. CONCLUSION

Diseases can impact the plant production that will reduce the food availability[14]. The proposed model for recommendation system for plant diseases provide information about the disease and the treatment about certain disease to the farmers. The system is multi-agent based using also information from internet that assure the constant update of the information that is used from the system. Also to increase the quality of the researched results the system use semantic technologies (domain ontology and thesaurus) [7] [11]. Furthermore, not all the web sites for information are reliable sources that can impact the quality of the returned results. Because of this, the proposed system perform searching of information in a specific web sites confirmed by experts. That provide to the user quickly accessible system that help for early diagnostic and prevention to spread the disease into the other plants. The system have relative results with the other systems for plant diagnostic 97% Precision, 94% Recall and 96% F-measure. Further investigation about the diseases in a particular type of vegetable plant need to be performed. More detailed comparison between different type of vegetables and the results from the system could be further evaluated. As a conclusion can be added that the results from the system are relatively high 97% Precision that show the quality of the system about the returned results.

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