Analyzing user interactions with Cotton Crop Ontologies: A visual perspective.

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ABSTRACT

In the agricultural domain, the main challenge is to present the new information and research to the farmers so that they can leverage the power of technologies to improve their agricultural practices and thereby the production. Huge amounts of agriculture-related data like weather data, soil health records, disease and pest are collected from different sources like web services, remote satellites, and a network of sensors. Our ontology-based agro advisory system will help to bridge the gap between farmers and the agriculture domain experts. It has three main components: Cotton Ontology, Web services and Mobile Application Development. Protégé tool is used to develop ontology. The RESTful web services are programmed in Java using the JAX-RS/Jersey API and Eclipse IDE. RESTful web services are all developed and deployed on a cloud-based application server provided by Heroku.The farmers can access an application by android mobile.The Android user interface is created using Java, Android SDK-v1.4 and Eclipse IDE.

KEYWORDS

RESTful services, Ontology, Semantic Web, Agro-advisory system, Service Oriented Architecture, Mobile application

1. INTRODUCTION

In the year 1994, the internet was opened to the general user and the era of information and communication technology has played a vital role which allows the user to access information from World Wide Web. The current search engines such as Google, AltaVista are searching information based on keywords. The keyword-based search engine does not allow a user to access relevant information very easily.

The ontology is shared dictionary which depicts the individual, domain concepts, properties of individual, and relationship between concepts. The agricultural knowledge base can be created with the help of ontology.

Unfortunately, the knowledge base for the plant and crop production is not updated regularly as well as it is not correctly utilized by farmers. Currently, the research efforts are made for developing ontology with two methods which are automatic and semi-automatic.

The cotton crop pest ontology which developed by us is going to be used by farmers to submit their query related to cotton farming. The ontology able to answer any difficult query generated by farmers and it provides a relevant solution to farmers.

2. RESEARCH MOTIVATION

Agricultural has an important role in Indian Economy. About 70% population who lives in rural is doing agricultural activities. Nowadays, there is a huge quantity of data about agricultural domain such weather data, soil health card information, cropping pattern for different crop, disease and pests affecting to crop, prevention and cure techniques for disease and pests are retrieved from various types of resources such as web services, network sensors, satellite which are located remotely .The collected data are not utilized efficiently and optimally by the farmers due to an absence of medium which can flow the data between experts and farmers.

3. RELATED WORK

During literature survey, we found existing Agro Advisory systems like eSagu [11], Agrisnet [1].

eSagu is a web-based recommended system for an agricultural domain. It uses web technology to resolve the problems of agriculture. The eSagu project initiated in Telangana city of Andhra Pradesh state. The meaning of eSagu is cultivation in the Telugu language. It exploits the inventions made in computing era to construct an agricultural information broadcasting system to spread the expert's knowledge or expertise to the farmers which lead to increase in crop production. It is developed by Media Labs Asia. Its advice to the farmers for improving farm productivity. The farmer can send the status of their crop by sending text or photographs. Based on the status of crop agricultural experts give advice farmers.

The AGRISNET project was conceptualized with the vision of creating an interconnected technology-enabled network. The project aimed to integrate cross-functional processes of agriculture, so as to effectively and efficiently communicate informational services to the farming community through one-stop. It is web-based portal gives information for soil health card, weather, crop varieties, plant protection, and fertilizer to farmers. Through AGRISNET, the benefits of personalized/individual farm level advice are analyzed to be the most viable alternative to reduce yield gap, increase production and income of the farmer.

4. RESEARCH CHALLENGE

To develop an advisory system for an agricultural domain is challenging task. We found several research challenges to develop our system.

User Interface: To build the user interface for farmers to express their query is challenging issue. The system should be more easy to use to farmers. The users will not prefer to use the system especially farmers if it is complex for submitting their crop related query.

Ontology development for the cotton crop: - At present we don't have the knowledge base in the form of ontology which has information for cotton crop cultivation practices. A complete ontology for cotton crop should be constructed which allows farmers to submit any question related to cotton crop farming.

Deployment of the system: System should be easy to access. The system should be deployed on a cloud which can be effortlessly available to users. Knowledge base, services to retrieve agricultural information and records of agricultural should be placed on cloud such that the user can able to use from anywhere, independent of location.

5. KISANMITRA: ONTOLOGY BASED AGRO ADVISORY SYSTEM

After reviewing existing systems and looking at the specific open research issues, we have developed an Ontology-Based Agro Advisory System for Cotton Crop Farmers named KisanMitra. KisanMitra proposes a system where various data resources like ontological knowledge base and spatial data are brought together using the integration of RESTful services.

In KisanMitra the important task was to build the ontology which should be rich enough to answer queries of users. We have developed cotton crop ontology from scratch using protégé tool. Our system has ontology as a knowledge base which supports semantic searches and allows the user to query the ontology and provide better responses to a user based on reasoning and inference.

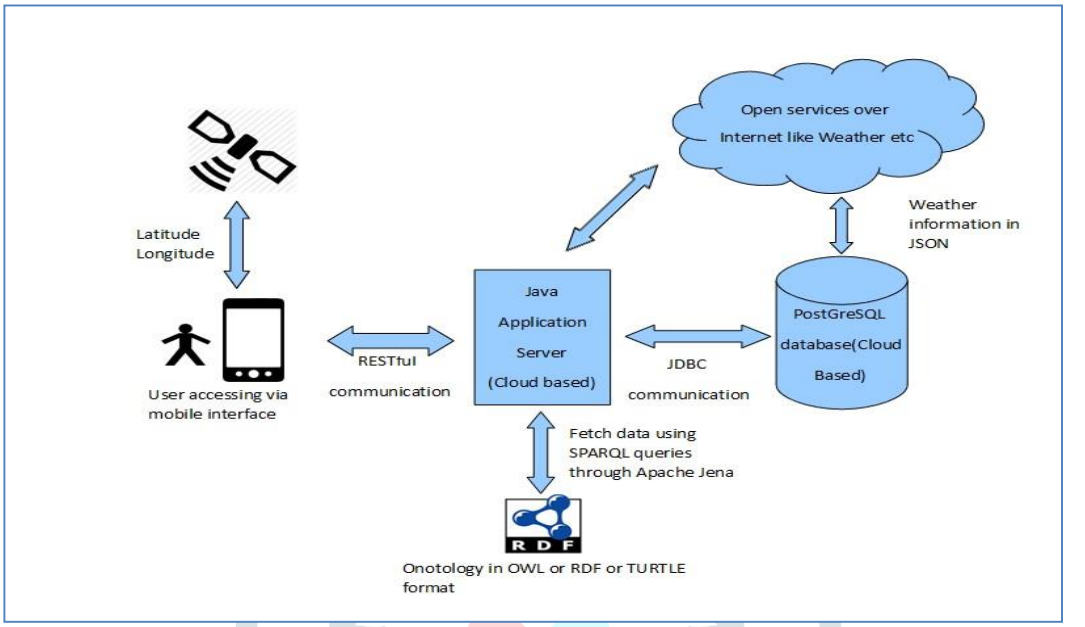
6. DESIGN AND IMPLEMENTATION

Our system will help the farmers by improving the production of cotton. The architecture of our system is shown in Figure1. The online system is accessible using a web browser or mobile device. The farmers can query the system for pest and disease affecting cotton crop, prevention and cure for disease or pest etc.The farmers will be able to get weather data and also get warning and notification if there are any sudden or adverse changes in the weather condition.

The system provides information to farmers regarding disease and pest in surrounding farms, soil health card information, climatic condition, pest, and disease etc. The system recommends to

farmers for prevention and cure techniques to be used for avoidance of pest and disease to the cotton crop. The system can be accessed using user-friendly interface which requires minimal training to use the system.

Figure 1. KisanMitra System Architecture



The major components of the system are explained below.

The Resource Description Framework (RDF) knowledge base: The knowledge base for the cotton crop is represented in RDF format. It contains information in the form of different concepts such as Pest, Disease, Climate, Irrigation, Insecticide etc., SPARQL is RDF query language and reasoning are used in an ontology to respond query of farmers. We have used protégé tool to construct ontology. To query the ontology Apache Jena Framework is used and response of queries is given to farmers using web services.

RESTful services: The RESTful services are created to make communication between the different components of the system. The services establish a connection of user with a knowledge base which is in the form of SQL database, the RDF format [11]. The user submits their query with the help of services. The response of the query generated and convey to a user using services. The services have REST architecture style. We have used Eclipse Integrated Development Environment for developing services using JAX-RS supported in java programming language. We have followed the below sequence for tasks during development.

- Designing of databases.
- Construction of cotton crop ontology.
- Development of web services.
- Development of Android mobile application and web based interface.
- Deployment of the database and web services on cloud based provider making it accessible from the internet.
- Notification and alert generation to farmers.

7. IMPLEMENTATION DETAIL

We have used the following Domain specific knowledge materials and tools for development, testing and deployment:

7.1 Hardware and Software Requirements

We have used the below tools and softwares for development, testing and deployment:

- Java Development kit 1.6 or higher.
- Eclipse J2EE Juno version for developing REST based web services.
- Apache Tomcat (preferred) or other Java Application web server.
- PostgreSQL 9.2, pgAdmin, PostGIS 2.0.
- Android SDK v4.0 or higher.
- Apache Jena for RDF queries.

7.2. Domain specific knowledge material

To collect information regarding cotton farming practices we have referred various resources such as handbook of cotton [6], agropedia [2], and web resources for Central Institute for Cotton Research (CICR)[9,21], Indian Agricultural Statistics Research Institute (IASRI)[13],etc.

7.3. Agropedia

Agropedia [2] is an agriculture portal. It is an online knowledge repository system that contains the information of agriculture in India. It is useful for communities like farmers, universities, institutions, and crop sectors. Agropedia is formally titled as Agropedia Indica. It is a team project which is started by various institutions of India and led by Indian Institute of Technology, Kanpur. It has own crop library where we can search any information related to crops and their practices. We can refer books or publications related to agriculture of India and also get the useful information like any recent workshops and training programme on agropedia. Agropedia also provides a video tutorial to assist in accessing the portal.

It contains information which is common to every crop type. The information includes the following things [12]:

- Environmental information – include information like soil and climate
- Crop varieties and cropping system.
- Origin – geographical area.
- Crop Production practices.
- Post production practice – include information related to harvesting, threshing, post-harvest technologies, and marketing.

7.4. RESTful services developed

We have developed RESTful web services to establish communication between different components of a system. Some of the web services are explained below.

CottonCropInfo: This service gives information regarding various stages of the cotton crop.

CottonTypeInfoService: This service gives information about the variety name of cotton crop which needs to cultivate on farm based on soil information provided by the farmer.

CottonVarietyInfoService: The different cotton crop varieties are retrieved from our ontology by passing the arguments of a query as CottonVarietyId. It will retrieve name of a variety of cotton crop such as BT Cotton etc.

8. RESULTS

We have placed our system on cloud-based server Heroku which allows KisanMitra system to access from anywhere by using a mobile device which has internet access. We have deployed SQL database, as a PostGreSQL server on Heroku server. The ontology .owl file in the form of RDF data along with the web services file is stored on the Heroku server.

The recommendation to the farmers can be generated using RDF concepts and ontology promptly. The system is able to answer the queries related to disease and pest affecting the cotton crop. It also generates the recommendation for the pesticides and insecticides which needs to be

used to prevent the relevant disease. The prevention recommendation is generated with considering symptoms, obtaining types of soils and cotton crop variety which is used.

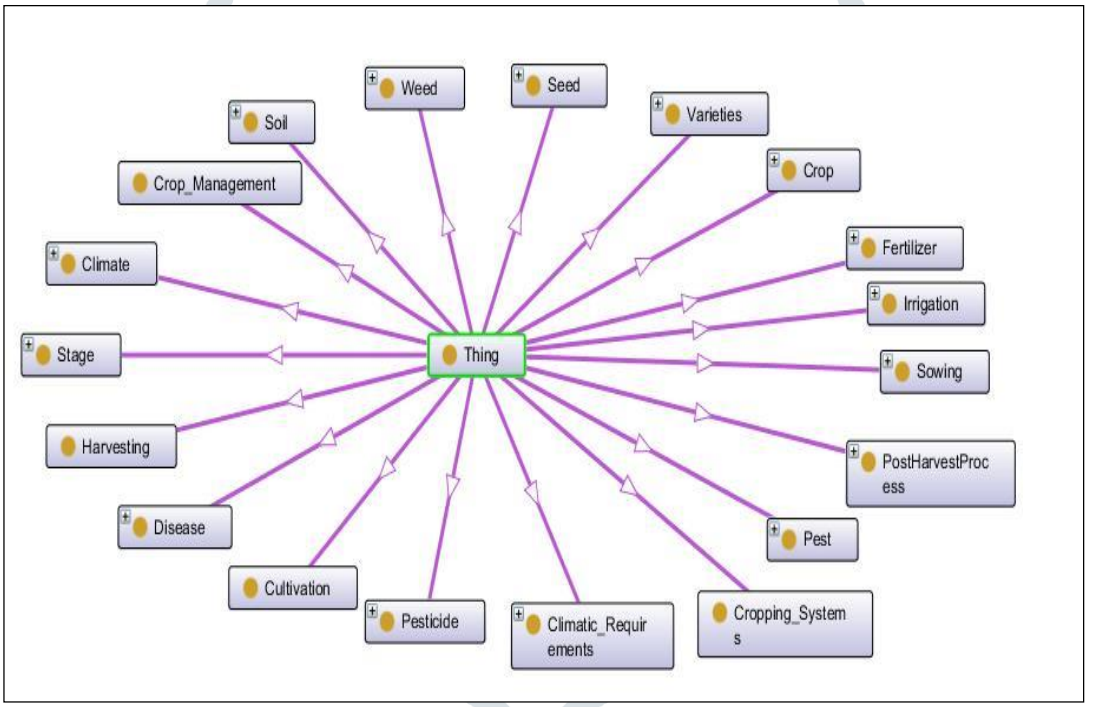
We have utilized the OpenWeatherMap web services to get climate information. The farmers can get current climate data for their present areas through our system. Aside from that, we have accumulated past climate information to deduce pattern and recognize spikes in climate conditions. We are additionally producing an alarm to farmers by a message in mobile phones if there are any sudden unfavorable changes in climate condition.

The farmers also get knowledge about the pest /disease affecting nearby cotton crop farms which helps them to take precautionary measure in advance.

9. SYSTEM SCREENSHOTS

The system is using crop pest ontology as a knowledge base. The constructed crop ontology is shown in Figure2. the concepts with its name are represented by a rectangle. We have used different types of concepts such as Pest, Insecticide, Pesticide, Disease, Cultivation, sowing, Irrigation, Fertilizer, Cropping system, Postharvest Process, Climate etc.

Figure 2. Snapshot of Cotton Crop Ontology Concepts



There are different kinds of pest affecting cotton crop in India. The dangers of cotton pests in the cotton production process have been a more prominent issue, seriously affecting the cotton production. In order to effectively diagnose and control pests, we have carried out many different aspects of studies and explorations.

The pest ontology for cotton crop shown in Figure 3.The pest ontology is constructed which contains knowledge base of different types of pests is affecting cotton crop at different stages which are from sowing of seed to maturity of the cotton crop. The concepts are created for pest such as insect pest, sucking pest, stem_ feeder, strainers, semi loopers which are affecting the cotton crop. The regional name and scientific name of all pests were stored in the ontology.

Figure 3. Snapshot of Pest Ontology Concepts

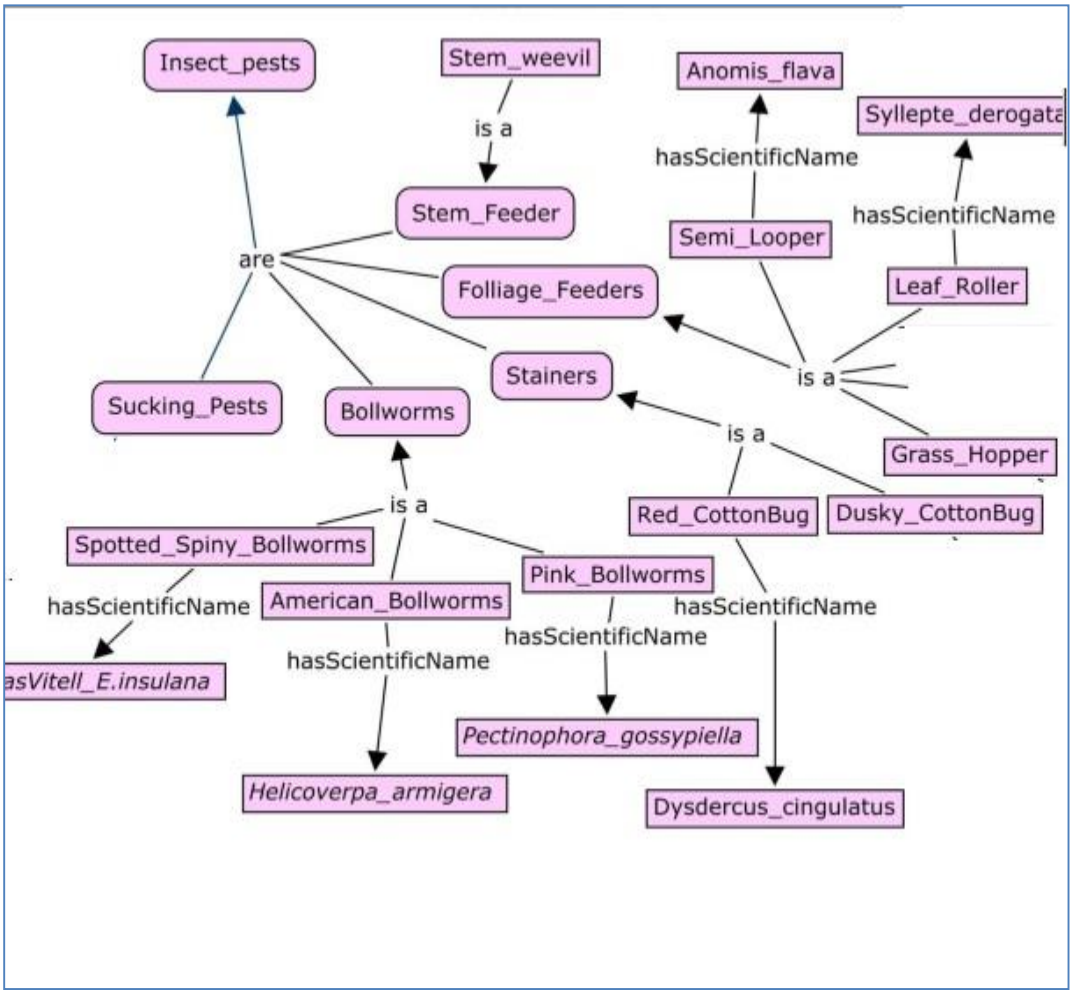


Figure 4 shows the relationships between the individuals of two different concepts. Here in figure rectangle with diamond states the individuals of concepts. Individual Vegetation_Growth have a relation “occurs_At” with White_fly individual which one belongs to pest concept.

Figure 4. Relation between Individuals of Different Concepts

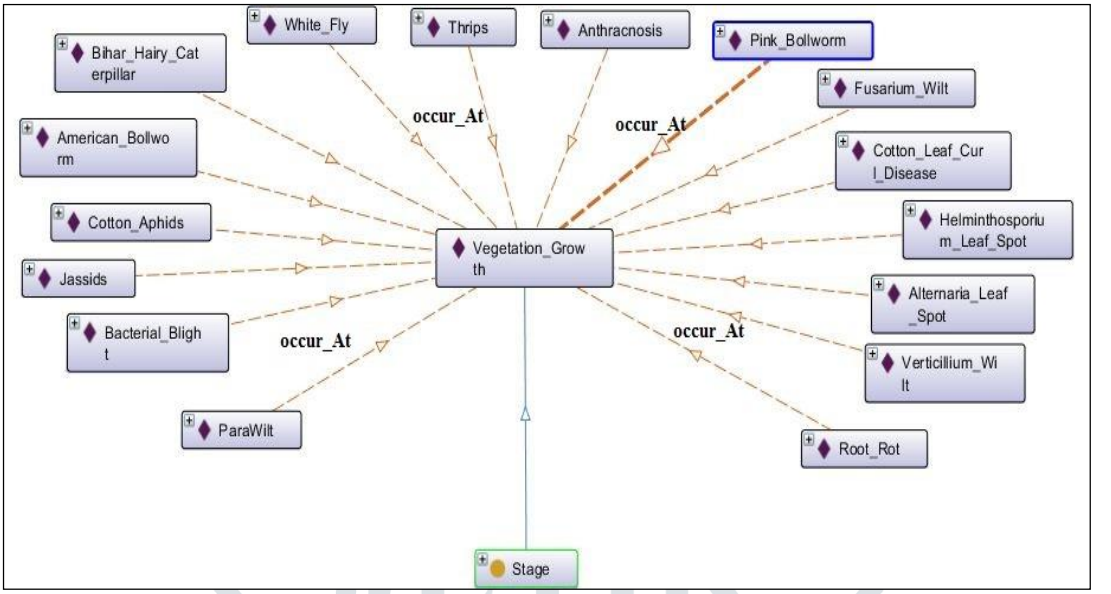


Figure 5 shows the system home screen with a menu available like my information, farmer information, weather information, query information, report disease, queries, and map. Farmers can get the recommendations of their queries by clicking on "queries" icon.

Figure 6 shows the query list of farmers. This screen will be available after clicking on a select box of queries. It includes all the queries that generally asked by the farmers. A farmer can select the query from this list.

Figure 5. Home Screen with user detail

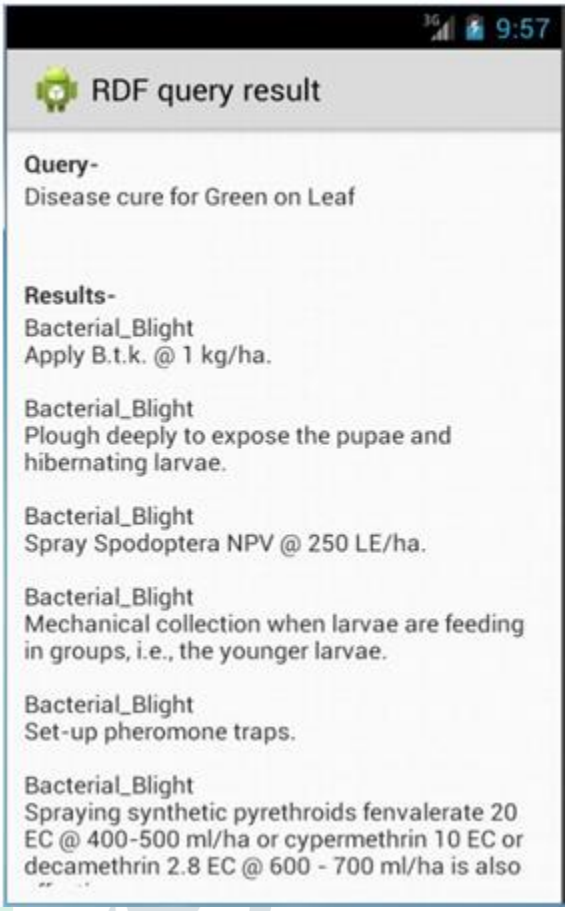
Figure 6. Query- List

Figure 7 shows the screen available to farmers after clicking disease and cure by observation submenu. Observation and part of the cotton plant are given as an input. Inputs are supplied for the query.

Figure 8 shows the result of query asked by farmers. This screen will be available after user give input for observation and part and click on fetch data to retrieve the result of query

Figure 7. Recommendation Center

Figure 8. Recommendation for Query asked by farmer



10. CONCLUSION AND FUTURE SCOPE

We have presented a paper which introduces recommended system for cotton crop farmers to improve cotton farming practices. It uses advanced semantic web technologies such as ontology, Resource Description Framework, SPARQL query language. Due to the use of SPARQL query and reasoning capability our system to generate the recommendation to farmers regarding cotton crop farming practices. The system generates advice such as what is the best time for sowing of the seed of cotton crop, names of spraying insecticide and pesticide for cure and prevention of disease which lead to increase in production of a cotton crop. The system also considers external factors such as a location of the farm, the presence of any disease in surrounding farm while generating a recommendation to farmers.

Mostly the farmers know only regional language. The user interface in regional language can be developed which allows the farmers to present their query to expert. Many advisory systems were developed to perform search on documents but with the involvement of Ontology into picture very refined way of searching can be achieved.

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