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Modelling semantics of E-agriculture system

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Abstract: *There exists various web based agriculture information systems. These systems are providing required information to farmers about different crops, soil, different farming techniques etc. These web based agriculture information systems deal with numerous kinds of data but they don't maintain consistency and semantics in data. Hence ontology is used in web and provides meaningful annotations and vocabulary of terms about a certain domain. Here in this paper we are building ontology in agriculture system in web ontology language (OWL). This paper shows various classes and subclasses using OWL DL in protégé5.0 for an e- agriculture information system. This paper also provides various classes and subclasses and relationship among the classes in UML class diagram for a web based agriculture information system or e-agriculture.*
Keywords: *e-agriculture; ontology; owl dl; owl asserted model*

I. INTRODUCTION

E-agriculture is an web based information system that provides information to farmers/any user at any time through web.This web based agriculture information system delivers information to users about crops, farming resources, plant nutrition, climatic conditions for a particular crop, various technologies and market information etc. These information systems are providing resources about agricultural domain or any domain in a syntactic way. But these information systems are not specified vocabulary and do not have formal meaningfulness of the terms. Hence this web based information system is not handling data consistency and meaningful data. To overcome such things, OWL ontologies are used in web based applications which build semantic data for any domain.

The rest of the paper is organized as follows. Section 2 gives the overall work about e-agriculture system and ontology. Section 3 describes various phases of agriculture system, requirements of a farmer through specifying UML class diagram and designing OWL ontology for e-agriculture system. Section 4 gives implementation through specifying OWL asserted model. Section 5 discusses conclusion.

II. RELATED WORK

A. E-agriculture information systems

The rapid advances in the technologies of wireless communications have brought opportunities for various web applications running on handheld devices. Government has started the e-choupal project which deals with establishing internet centers in rural areas where farmers access real time information easily. The e-Choupal portal [1] also provides the rural agricultural communities with information in their respective local languages on weather forecasting, education on improved farm practices, risk management, knowledge and purchases of better quality farm inputs. m-Krishi[2] is a high-end technical service started by Tata consultancy services (TCS) in 2007 in India to deliver customized advisory services to farmers on crop production, market information and weather forecasting. m-Krishi also involves installation of different kinds of sensors in farmers' field to collect information on soil humidity and weather conditions.

Mobile operator bharti airtel partnered with IFFCO (Indian Farmer Fertilizer Cooperative Ltd) to form the joint venture IKSL[3] in 2007. This company provides information on market prices, farming techniques, weather forecasts, rural health initiatives and fertilizer availability, etc. IKSL sends 5 free daily voice updates except sunday in local language so that also illiterate farmers can benefited.e-sagu[4] is a teleagriculture project started in 2004 by the International Institute of Information Technology IIT, Hyderabad, and Media Lab Asia. e-sagu delivers farm-specific, query-less advice once a week from sowing to harvesting. This service reduces the cost of cultivation and increases farm productivity as well as the quality of agricultural products. The TNAU agritech portal[5], a farm technology portal has been launched in 2009 by integrating allied sectors including agriculture,horiculture,sericulture,seedsector,marketing,fishries,forestry and animal husbandry. The portal have feature of dynamic and multimedia based content covera for the benifit of field extension officials and farmers in bilingual mode. It holds the information about various production technologies of agriculture crops, plant nutrition,resource management and water shed management. This portal also holds information about agricultural engineering,agricultural marketing and seed production.

B. Ontology in web

Ontology represents semantics, concepts and relationships among the data in web. Ontology-driven applications[6], exhibit features such as expressiveness, extensibility, ease of sharing and reuse and logic reasoning support. To achieve interoperability and knowledge in a shared schema, ontologies are used in web any based application domain [7]. The ontology is the combination of classes, subclasses, axioms, relations, functions and instances which designs data in a meaningful way. Hence ontology provides a well founded mechanism for the representation and reasoning of information from the web [8]. Also ontology-based approaches have been used for enquiry-based learning activities in recent projects like the Concept map Learning System (CLS) and the Science Created by You (SCY) project [9].

III. ONTOLOGY IN E-AGRICULTURE

Now–a-days OWL ontologies are used in any web based information system which improves the information retrieval by designing the data consistently and semantically on web. It is because OWL ontologies allow building several classes, subclasses, relation/property and defining class axioms and property restrictions in any domain. The OWL ontologies can be used in e-agriculture information system to deliver semantic information to users.Before designing the data using ontology, it is necessary to analyze the various phases in an agriculture system and what information the farmer need in those phases. Here in this paper we have analyzed the various phases in an agriculture system and the information need of a farmer. After that we have specified the requirements of a farmer by building UML class diagram which is shown in section A and B.

C. Phases in an agriculture system

In an agriculture system, there are several phases which consist of crop identification, soil preparation and sowing, crop production and protection, harvesting and storage distribution [10]. These phases describe the requirements/information needed of a farmer to produce crop.

- Crop identification – In this phase a particular crop is selected on the basis of zone type which is again determined by the soil type and weather condition [11].
- Soil preparation and sowing- In this phase the soil bed is prepared and the sowing of the seed is done depending on seed variety by using farming equipment.
- Crop production and protection- In this phase the actual crop care and growth is monitored and is supported by activities like irrigation, applying fertilizers and biocides [12].
- Harvesting- In this phase the crop is harvested from the farm and is processed for storage and distribution.
- Storage and distribution- In this phase the harvested and processed crop is stored by packing and distributed by commercial and public distribution system [13]. The pricing is determined in the commercial distribution in terms of minimum support price (MSP), wholesale price and retail price [14].

D. UML class diagram

The farmer/user needs information about the various components associated with agriculture system such as crop, farmer, soil, zone, irrigation, fertilizers, biocides and prices etc. Here we have identified these components as classes and established relations among the classes using class diagram.

- In the class diagram, the agriculture system is the root class under which the other classes are associated. For example the class farmer is a part of the class agriculture system, which shows aggregation relation among them.
- In the class diagram, the class season is associated with the class crop by the relation “determine” and further the class season is generalized into subclasses Kharif and Rabi.

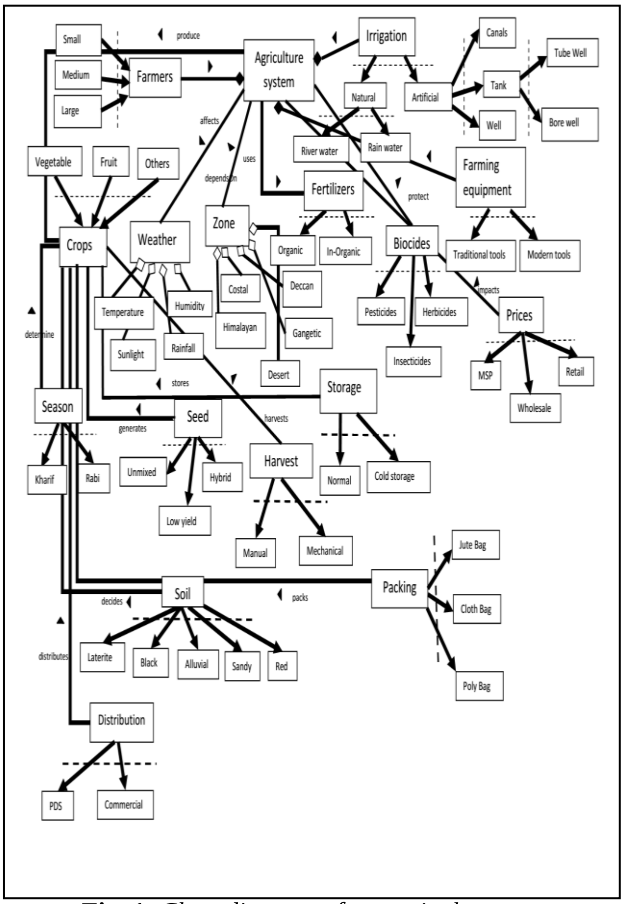

Fig. 1. *Class diagram of an agriculture system*

E. Building ontology in E-agriculture

Ontologies are used to capture knowledge about any domain.The OWL ontology is used to design classes and relationship among classes. In the class diagram, we have taken various classes, subclasses and relationships among classes. Based on this class diagram, the ontology will be built about agriculture domain by taking those classes, subclasses and relationships. Here we have design the data for an agriculture system with OWL descriptive logic language (OWL DL) in protégé 5.0. At first we have taken the class Thing and built a class hierarchy by taking other classes such as agriculture system, farmer, crops, fertilizers, irrigation etc. These classes are the subclasses of the class Thing in agriculture ontology which is shown in fig.2. The OWL DL ontology uses pellet, a reasoner that checks consistency about the classes.

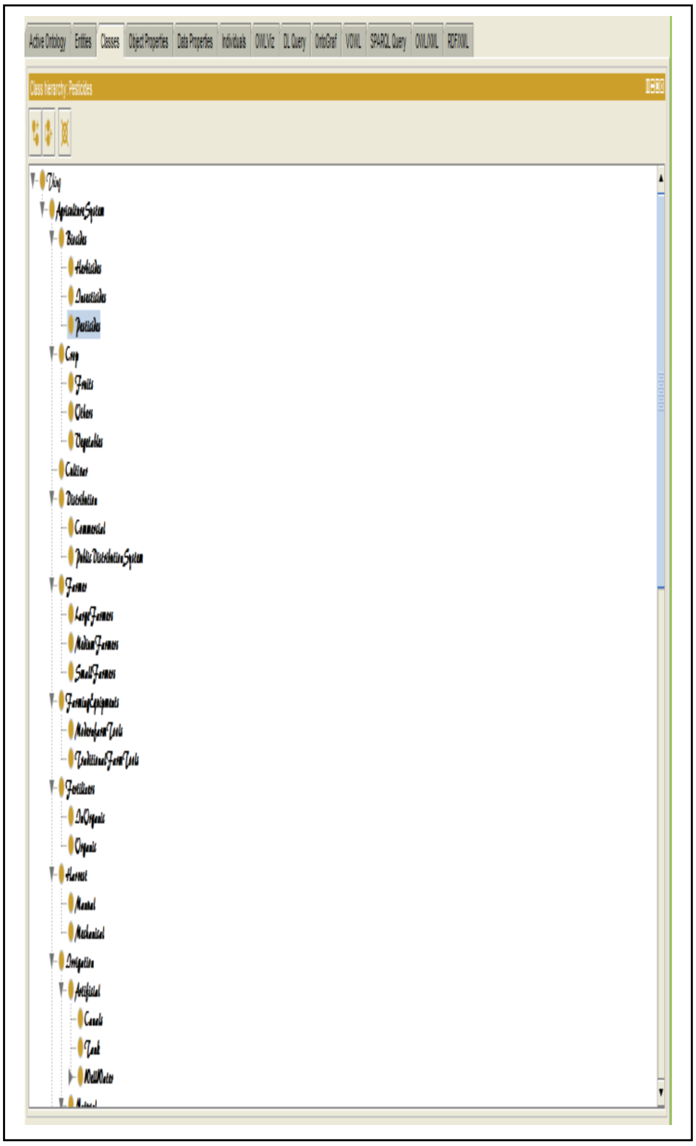

Fig.2. *Class hierarchy in an agriculture ontology*

IV. IMPLEMENTATION IN OWL DL

OWL DL stands for web ontology language description logic which is a sublanguage of OWL and provides logics for formal description of concepts and roles. Here concepts in ontology describe a set of individuals and role defines the relationship/property holds among them. Semantically these logics are found in predicate logics and have efficient decidability to build knowledge base information system or ontology.

F. Building disjoint class

Here we have built ontology based on agriculture domain and define various classes and design them in the class hierarchy as shown in the fig.2. In this agriculture ontology we have taken the classes such as agriculture system, crop, farmer, fertilizers, pesticides, farming equipments, seed etc. All these classes are made disjoint class so that simultaneously the instance of one class can't be the instance of another class. It is don't with the "&owl;AllDisjointClasses". For example the subclasses of class zone are made disjoint such that an individual of coastal zone can't be an individual of himalayan zone.This can be represented in OWL DL by the following syntax as follows

1) Syntax:

DisjointClasses(Himaliyan,Coastal,Deccan,Desert,Gangetic): Himaliyan∩Coastal∩Deccan∩Desert∩Gangetic = { }

2) OWL description logic in Protégé 5.0:

<rdf:Description>

<rdf:type rdf:resource="&owl;AllDisjointClasses"/>
<owl:members rdf:parseType="Collection">
<rdf:Description
rdf:about="http://www.semanticweb.org/ontologies/2015/2/untitled-ontology-98#Coastal"/
<rdf:Description rdf:about="http://www.semanticweb.org/ontologies/2015/2/untitled-ontology-98#Deccan"/>
<rdf:Description rdf:about="http://www.semanticweb.org/ontologies/2015/2/untitled-ontology-98#Desert"/>
<rdf:Description rdf:about="http://www.semanticweb.org/ontologies/2015/2/untitled-ontology-98#Gangetic"/>
<rdf:Description rdf:about="http://www.semanticweb.org/ontologies/2015/2/untitled-ontology-98#Himalayan"/>
</owl:members>
</rdf:Description>

G. Building asserted model of agriculture ontology

Asserted model provides the actual relationship between the classes which are described by the ontology built. In the agriculture ontology we have taken the agriculture system having depth/level 1 which is the subclass of root class Thing having depth/level 0. Similarly the subclass farmer, crop, fertilizers, irrigation etc. are having depth/level 2. Similarly the subclasses of irrigation artificial and natural are having a depth/level 3 and so on. The leaf classes of agriculture ontology are having a maximum depth/level 5. This is shown by the asserted model of the agriculture ontology.

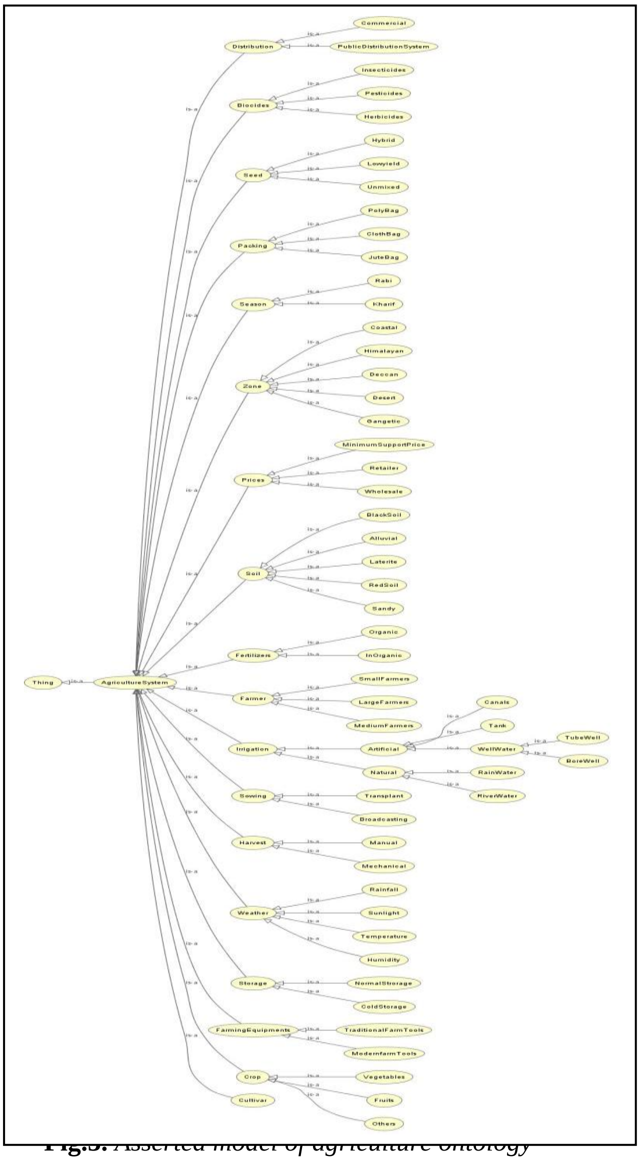

Fig.5: *Asserted model of agriculture ontology*

V. CONCLUSION

In this paper we have collected data from the various agriculture departments and analyzed the various phases of agricultural system in India. We have analyzed the information requirements of a farmer through specifying them in UML class diagram. After finding the various classes, their subclass and relationships, we have built ontology for an agricultural system. The agriculture ontology builds the various classes, their subclasses and relationships consistently and semantically by using OWL DL. It also specifies various class axioms to design the information about classes, subclasses through which information retrieval can be done from the web in a semantic way.

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