RESEARCHERID
THOMSON REUTERS

[Titiya* *et al.*,6(12): December, 2017]
ICTM Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

ONTOLOGY BUILDING AND REASONING PROCESS FOR RESOURCE DESCRIPTION FRAMEWORK DATA

Mahesh D. Titiya*, Vipul A. Shah
*Department of Computer Engineering, Government Engineering College, Gujarat, India
Department of Instrumentation & Control, Dharmsinh Desai University, Gujarat, India

DOI: Team 10.5281/zenodo.1085111

ABSTRACT
Since last decade, ontology has been widely used in the field of information retrieval, geographical information system, language processing, and web. Each of the fields uses ontology for its own specific purpose. To represent the information in terms of knowledge in semantic web, we use ontology model. In Agriculture, farmers have so many queries regarding crop, soil, cultivation process, disease and pest. To handle these types of queries we need to design well organized data system. Ontology provides data in-terms of knowledge. Using ontology we can get the solution of such queries. We also need query language which can query on ontology. SPARQL query language use for that. The report describes the ontology structure and reasoning process in it. Using reasoning we are able to find the implicit fact from ontology given explicitly stated fact.

I. OBJECTIVE
The intent of developing Ontology Based Agro Advisory System for Cotton Crop emerged from the idea of designing a recommended system for farmers to pose their queries to the system and getting the best solutions to their problems. The proposed system having concept-based search for knowledge navigation, inferencing and reasoning capability. The key elements for our system are.

• Knowledge Model (KM):- It is designed mainly to browse agricultural knowledge and structure the agricultural content. KMs are the structural representation of knowledge that uses different symbols to depict different pieces of knowledge and relationships between them. We have designed Cotton crop pest ontology as a knowledge base of our system. The ontology contains concepts for soil and climatic conditions for cotton crop, varieties of cotton, disease/pest affecting the cotton crop, reasons for their occurrence, the symptoms of disease/pest, and cure for those diseases/pest. The knowledge base is stored as ontology. The onology is constructed using protégé tool.

• Information Retrieval Mechanism (IRM):- It describes answering a user query by performing a keyword search over the ontology. Result of this search is the optimal path which explains what the user has queried for. Our system generates automatic recommendations for farmer queries regarding cotton crop farming practices. Examples of few queries which can be answered by our system are: What are symptoms of cotton leaf curl disease. What are Cures for Bacterial Blight disease in Cotton? The system stores and maintains farming activities of farmer from time to time. It also sends an alerts to farmers if any sudden change in climate condition to farmer's mobile.

II. INTRODUCTION
Agriculture plays an important role in Indian economy due to the large rural population. In India, cotton is an important commercial crop whose output is used to clothe people especially. As such cotton plays a major role in India's economy. Farmers have many questions related crop and practices for farming. They express their queries in a natural language which are usually answered by human experts. In such situation there might be possible a gap between the farmers and knowledge of agriculture experts and it is confusing for farmers to choose the right knowledge among many choices. It is desirable to capture knowledge in a system that understand the query and give the best solution of farmers' problem. So the idea arises to develop a system which can fill the gap between the experts and set up a unique system to satisfy the farmers' problems.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

We have developed cotton ontology. It is a part of the crop recommendation system that contains the knowledge of cotton cultivation practices [2], [3], [4] at every stage in details. The crop recommendation system helps farmers to choose right decision in their queries related cotton crop. Farmers can ask their queries related cotton crop and get the best recommendation for their problems. Our system is also capable to give the result of reasoning based queries. To deduce the inference from RDF data we require to fire reasoning based queries on cotton ontology.

III. LITERATURE SURVEY

The research topic focused on cotton crop ontology development and reasoning process. The initial idea came from the work on the proposal of Crop Cultivation Information System [1] which is ontology based system. In previous reports we have discussed on the cotton ontology development and simple SPARQL queries (without reasoning). In this report we have discussed reasoning based queries and their results. Many SPARQL tools like protégé SPARQLQuery tab, ARQ (A SPARQL Processor for Jena) [5], and Twinkle [6] are used to query ontology. We are using an ARQ query engine to query ontology and to deduce inference from it. SPARQL queries could be executed from inside a java application using Jena library methods in ARQ or directly from the SPARQL query panel inside in protégé [7]. The Jena model provides OWL reasoning while from the SPARQL query panel we could not get the inference querying by SPARQL. Thus, queries executed using Jena library methods can return results taking into account also the transitive and inferred relations [7].

The Semantic Web

The Semantic Web is emerging as the standard infrastructure of information on the web, a skein of concepts embedded in web pages, databases, and documents across the world.

The Semantic Web is being created ad-hoc everywhere as content publishers tag their content with metadata as RDFs, which is linkable to any other data tagged using common URI vocabularies, in web pages, RSS feeds, and documents, social media, and relational databases. This vast interlinked web of data is revolutionizing the planetary info sphere, enabling new applications that pull together and assemble information as it develops, and opening the gate for enterprises to publish in formats that can be automatically discovered and understood.

As described at SemanticWeb.org: “The Semantic Web is the extension of the World Wide Web that enables people to share content beyond the boundaries of applications and websites. It has been described in rather different ways:, as a web of data, or merely as a natural paradigm shift in our daily use of the Web. Most of all, the Semantic Web has inspired and engaged many people to create innovative semantic technologies and applications.”

Semantic Web Structure

The main aim of semantic web is to convert the unstructured and semi structured data into the web of data. Figure 1.1 shows the "layer cake" of the Semantic Web, which is due to Tim Berners-Lee Semantic Web design and vision.

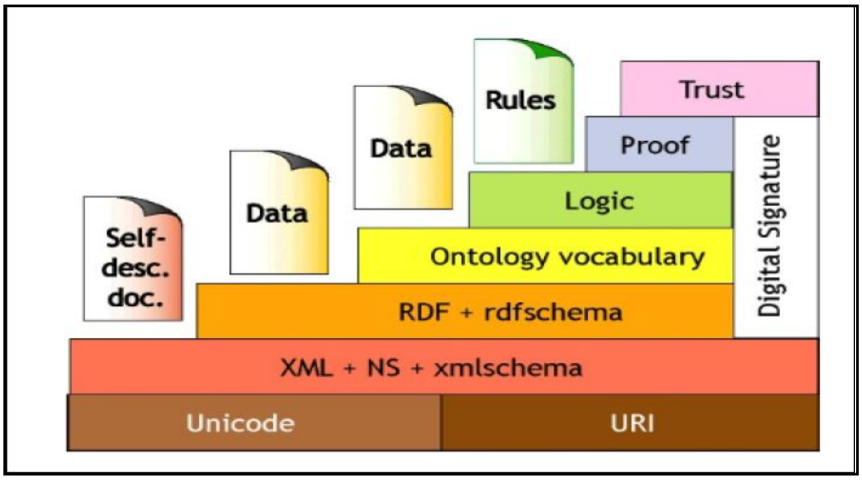

Figure 1: A Layered Approach to the Semantic Web

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

The Resource Description Framework (RDF)
"RDF is a family of World Wide Web Consortium (W3C) specifications originally designed as a metadata data model. It has come to be used as a general method for conceptual description or modeling of information that is implemented in web resources, using a variety of syntax formats."

RDF is expressed in Subject, Predicate and Object. "The subject denotes the resource, and the predicate denotes traits or aspects of the resource and expresses a relationship between the subject and the object." Resources - subject, object, and predicate are expressed as URIs; an object may also be a Unicode string literal. Subjects and objects may be empty. Predicates are also expressed as URIs.

This use of URIs is a foundational mechanism that asserts agreement on terms, a kind of semantic handshake that guarantees that if we use the same URI, we agree on the term of the reference. Agreement on meaning-in-context requires deeper semantic modeling. That's as much as we can claim as a standard for the use of URIs – they are not required to be reference-able and when they are, there's no standard yet for the meaning of the result; agreements on URI use are developing. The result could be an ontology reference.

The W3C RDF model is an abstraction that is expressed in XML modeled graphically as labeled, directed multi-graphs and query-able using the W3C standard query language SPARQL.

RDF is the foundational language of the Semantic Web, the framework for expressing Rdfs, RDF Schema, SKOS, Linked Data, Turtle, and OWL (Web Ontology Language).Rdfs is an extension of RDF "that adds a set of attribute level extensions to XHTML for embedding rich metadata with in Web documents." This provides explicit linking of machine-readable metadata to web pages that can be captured as RDF, and linked into semantic structures. RDFs is emerging as the fabric of the Semantic Web. "A little semantics and a lot of data" is putting cross-platform integration, across the web, into the hands of anyone who is willing to use it.

RDF Schema is a modeling language extension of RDF that introduces class types, value constraints, and properties as predicate classes, with domain and range. It's a core subset of OWL. Linked Data – From Tim-Berners-Lee, universally credited with inventing the World Wide Web: "The Semantic Web isn't just about putting data on the web. It is about making links, so that a person or machine can explore the web of data. With linked data, when you have some of it, you can find other, related, data."

Turtle-Terse is a RDF Triple Language which is textual syntax for RDF for composing graphs in a compact and natural text form with abbreviations for common usage patterns and data types. Turtle is popular among Semantic Web developers as a human-friendly alternative to RDF/XML.

The Web Ontology Language (OWL)
Ontologies on the web and as computational objects in general, have been the subject of a great deal of research. Several language models have been developed with varying degrees of expressive power. OWL is generally recognized as the standard ontology language for the Semantic Web.

OWL is "a family of knowledge representation languages for authoring ontologies, characterized by formal semantics and RDF/XML-based serialization for the Semantic Web" The OWL family includes three sub-languages, in increasing expressivity: OWL Lite, OWL DL, and OWL Full. Greater expressivity requires more complex and difficult reasoning algorithms: the general graph search problem is NP-Complete. Expressivity and decidability must be balanced for applications of this technology to be practical. A summary of OWL sub- language properties and capabilities can be found at the species link on the Wikipedia OWL page.

Ontologies can be linked to, and will provide semantic depth to, information coded in RDF. Ontologies themselves are usually exchanged as RDF documents. The implications of this are very broad, and include the entire domain of published information in almost any format that is in any way semantically discoverable. Using graph manipulation algorithms, distributed information repositories tagged using RDF can be joined graphically and bound as instances to ontologies, enabling reasoning and semantic search across all of them.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Quads, n-ary Relationships, and Reification

RDF is typically, and by design, persisted as triples of (entity, relationship, entity). Sometimes, and increasingly, we need to associate information such as source, trust, or date with an RDF triple - capturing and attaching provenance to data is becoming very important. This kind of annotation, also called reification, is modeled as a quad (entity, relationship, entity, and provenance). The fourth member could be anything; however the semantic intent is an annotation of the triple. Reification in OWL entails another order of complexity involving the creation of a new class to capture the complexity of n-ary (greater than three) relationships that are not amenable to reasoning algorithms.

Query

Ontologies are normally persisted as RDF triples or quads. These are typically modeled in a directed, labeled graph data format. Searches over semantic repositories, ontologies and the instance data they describe are implemented as graph searches.

SPARQL, the SPARQL Protocol and RDF Query Language ('sparkle'), is a W3C semantic query language specification. It uses a SQL –like syntax, but allows the use of variables as objects of the search.

For example: SELECT? title WHERE
{
<http://example.org/book/book1><http://purl.org/dc/elements/1.1/title> ?title
}

SPARQL was designed to express queries across diverse data sources, whether the data is stored natively as RDF or viewed as RDF via middleware. It is capable of querying graph patterns along with their conjunctions and disjunctions. SPARQL also supports extensible value testing and constraining queries by source RDF graphs. The results of SPARQL queries can be results sets or RDF graphs.

Most forms of SPARQL query contain a set of triple patterns called a basic graph pattern. Triple patterns are like RDF triples except that each of the subject, predicate and object may be a variable. A basic graph pattern matches a subgraph of the RDF data when RDF terms from that subgraph may be substituted for the variables and the result is an RDF graph equivalent to the subgraph.

Rules

Rules are expressed in different ways at different levels of the semantic stack: query and search, ontology-embedded pattern-based rules, inference, and policy. Rules are used elsewhere to drive workflow, interoperability and integration, determine authorization and entitlement, service policies, evaluate risk and compliance, and to make decisions involving complex conditions among thousands of variables.

There are emerging standards for rules on the Semantic Web. Rules-ML has been around a while. SWRL has evolved from RuleML. Commercial rules engines are taking advantage of this. Semantic Web applications are looking at rules that govern web services such as policies, access, trust management, privacy, pre and post condition evaluations and much more. Contracts are in-effect, rule sets. RIF, the Rules Interchange Format has recently been released by W3C. It formalizes the patterns and formats required to communicate rules among different systems.

There are a number of ways that rules implicit within an ontology and rules expressed externally can work together. As functionality spreads to intranets, internets, and clouds, the reuse and interoperability of rules become critical; these are primary goals of Semantic Web rules initiatives.

Ontology and Semantic Web

The term "ontology" has a long history in philosophy, in which it refers to the subject of existence. In the context of knowledge management, ontology is referred as the shared understanding of some domains, which is often conceived as a set of entities, relations, functions, axioms and instances. There are several reasons for developing context models based on ontology:

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Knowledge Sharing. The use of context ontology enables computational entities such as agents and services in pervasive computing environments to have a common set of concepts about context while interacting with one another.

Logic Inference. Based on ontology, context aware computing can exploit various existing logic reasoning mechanisms to deduce high-level, conceptual context from low-level, raw context,and to check and solve inconsistent context knowledge due to imperfect sensing.

Knowledge Reuse. By reusing well-defined Web ontologies of different domains (e.g., temporal and spatial ontology), we can compose large-scale context ontology without starting from scratch.

Semantic Web [5] is an effort that has been going on in the W3C to provide richer and explicit descriptions of Web resources. The essence of Semantic web is a set of standards for exchanging machine understandable information. Among these standards, Resource Description Framework (RDF) provides data model specifications and XML-based serialization syntax, Web Ontology Language (OWL) [6] enables the definition of domain ontologies and sharing of domain vocabularies. OWL is modeled through an object-oriented approach, and the structure of a domain is described in terms of classes and properties. From a formal point of view, OWL can be seen to be equivalent to description logic (DL), which allows OWL to exploit the considerable existing body of DL reasoning including class consistency and consumption, and other ontological reasoning. We believe that Web ontology and other Semantic Web technologies can also be employed in modeling and reasoning about context information in pervasive computing environments.

IV. SYSTEM ARCHITECTURE

The system is developed to help the cotton crop farmers for improving their cotton production practices and its architecture is shown in Figure 1. The KisanMitra system is a deployed on liver server which can be accessible using a mobile device and web browsers. The user can request information which can be location based such as check disease in surrounding farms, report diseases, request for recommendations regarding cure and prevention of diseases and pest infections etc. The user will be able to get data regarding weather conditions and also get notifications and warning about adverse changes in weather conditions. The system can be accessed using user-friendly mobile interface which requires minimal training to use the system.

The information for KisanMitra system is stored in different data sources such as Geographical Information system (GIS) data, Structured Query Language (SQL) data, and Resource description framework (RDF) knowledge base. The RESTful services are developed to make communication between the system components.

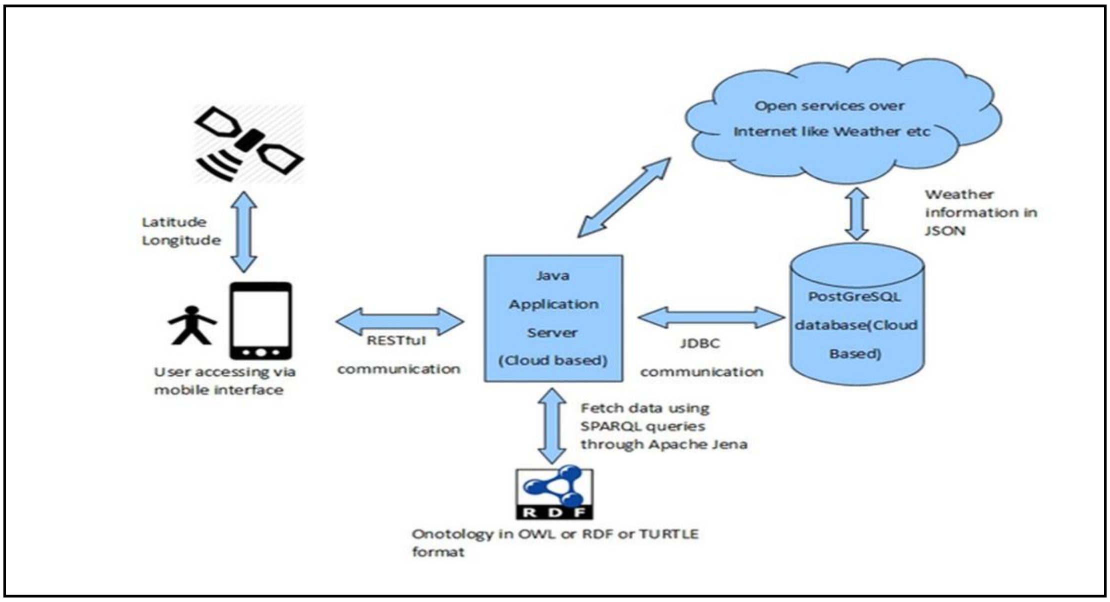

Figure 1: System Architecture

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Implementation of System

We have explained major components of the system following.

Web Services

Web services form the backbone of any online system. They interact with the data sources and the get/put the data from and to the interface. We are using RESTful web services programmed in Java using the JAX-RS/Jersey API and the Eclipse EE IDE. The services are all developed and deployed on a cloud based application server provided by Heroku (http://www.heroku.com).

The web services are invoked from the mobile device and in turn they connect to various data sources like Open Weather API, SQL database and the Ontologies developed to fetch/put the data and give it back to the users.

The initial set of services is ready and already deployed along with its integration with the mobile interface.

SQL Database

As a part of the system some data like farmer information, farm information, AEZ/District/Taluka/Village information, Soil Health card data etc which is more or less static and less prone to change is stored in a cloud based database which can be accessed online by any application wishing to use that data. The database is PostGreSQL and it is hosted on a server provided by Heroku (http://www.heroku.com).

The web services interact with the database using the standard JDBC connections. The basic database with schemas is deployed and is in use by the web services over the internet.

Ontology and Query Execution

In Agriculture, farmers have many queries regarding crop, soil, cultivation process, disease and pest. They express their queries in a natural language which are usually answer by human expert. In such situation there might be possible a gap between the farmers and knowledge of agriculture experts and it is confusing for farmers to choose the right knowledge among many choices. To handle these types of queries we need to design well organized data system. We are designing a system which are able give best solution for farmers' these queries. It is named as Agro Advisory System. Cotton Ontology is an important part of Agro Advisory System. It contains the knowledge based data. It contains the knowledge of cotton crop varieties, diseases, pests, pesticides, irrigation, climate factor and weed control. The initial idea comes to design cotton ontology from the IIT Bombay's cotton ontology which is part of their Agro Advisory System [1].

In our research we inspired to work on ontology which contains the knowledge of cotton crop practices. It is part of Agro Advisory System [2]. We had a many challenges in front of us when we decide to work for this system. First big challenge is to complete partial ontology. We have started to work by building partial ontology. We have first compared our ontology with IIT Bombay's cotton ontology. Then we have started to populate data in ontology. We populated some new concepts like Climatic Requirements, Pesticides, Stage, Cotton Crop Varieties, Seed, and Post Harvest Process. We also added new properties to relate concepts like Min-Max Temperature, Min-Max Rain and Min-Max Dose require for pest.

Techniques like SPARQL queries and reasoning are using on the Ontology in RDF format to generate recommendations for the user. The system is now capable of suggesting cure and prevention for a lot of symptoms and observations. We use the Apache Jena framework combined with the web services to generate the results for the queries and showing them to the user. We prepared list of farmers queries and include in our system. We divided farmer's queries in three parts: Simple Queries, Complex Queries and Reasoning Based Queries. We have also designed queries flow diagrams to understand easily it.

Android Application and other interfaces

Considering the reach and availability of mobile smart phones as a part of the project we have developed an Android OS based mobile application. The application will be the primary interface to access and use the system by the end users(farmers). The application can be used to query data from various sources from one screen. The UI is kept very simple and easy to use. We are working on making it available in more languages to support localization so that more people can use the system.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Apart from this we have developed the mapping interface using CartoDB(http://www.cartodb.com) which is also connected to our system using web services. Any disease reported can be observed on this interface where it shows different farms and activities on them.

The Android prototype is created using Java, Android SDK - v14 and Eclipse IDE and ready. The CartoDB maps are also live and ready to use.

Data Collection
To kick off the project we will need a dataset and so a data collection drive is to be launched. We have chosen formhub.org (http://www.formhub.org) which is a free open source project to collect data. Forms on formhub can be filled offline too which makes it our prime tool. The forms are ready to use on formhub for this project. We have also prepared a detailed plan of how to make the system live with full fledged functionality.

V. RESULTS AND DISCUSSION

Simple Query Flow
Figure 2 shows end to end execution flow of simple queries. User can ask queries through android device. User query is an input to the web service. At the backend, a SPARQL query will be executed using ontology. In case of queries requiring implicit data, reasoner helps in getting that. Query result is displayed on an Android device.

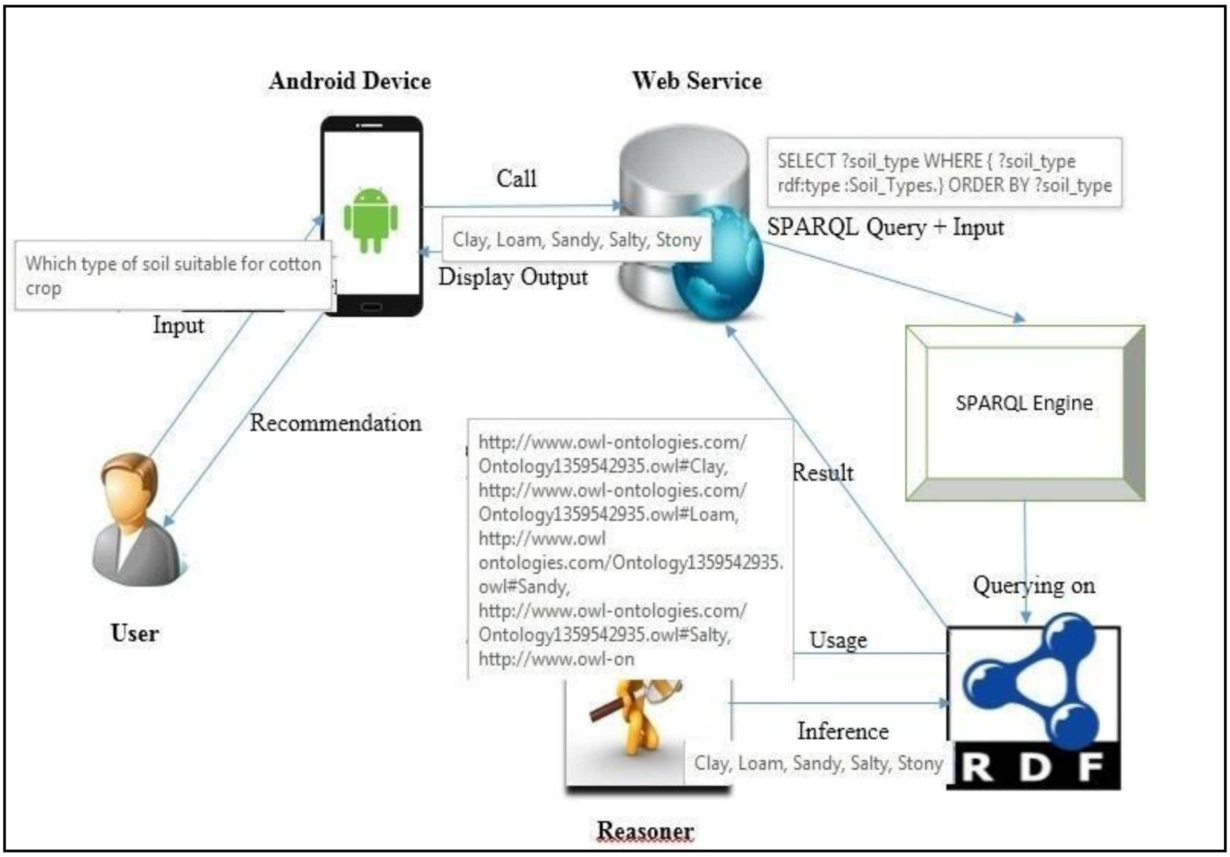

Figure 2: SimpleQueryFlow

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Complex Query Flow

Figure 3 shows end to end execution flow of complex query. User can ask queries through android device. User query is an input to the web service. The query is complex as we need to SQL data like GIS and Weather data required at the backend. At the backend, SPARQL query also will be executed using ontology. In case of queries requiring implicit data, reasoner helps in getting that. Query result is displayed on an Android device.

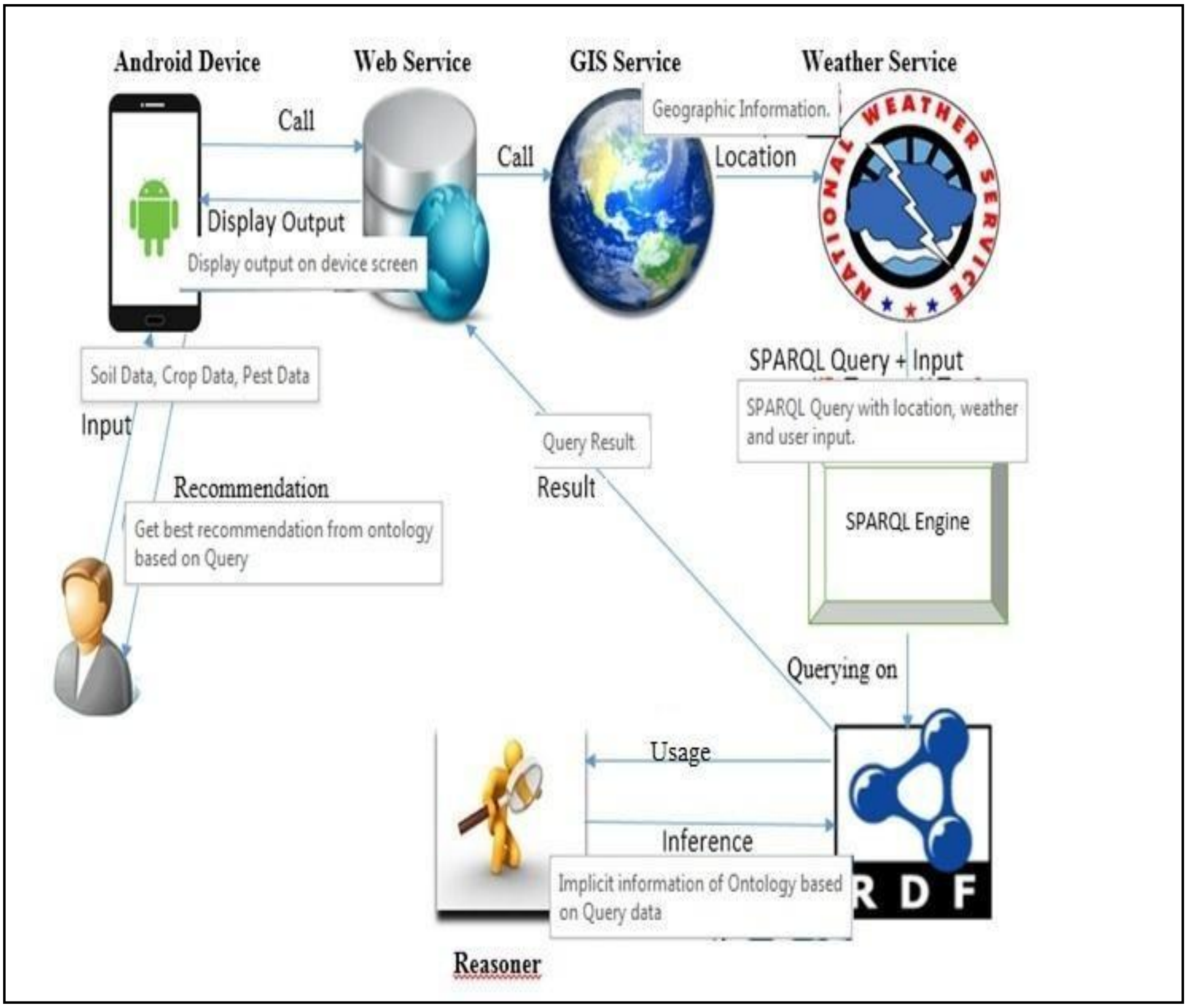

Figure 3: Complex Query Flow

Reasoning Based Query Flow

Figure 4 shows end to end execution flow of reasoning based query. User can ask queries through Android device. User query is an input to the web service. At the backend, SPARQL query will be executed using ontology. Query is reasoning based as we need to reasoner helps to deduce inference from ontology. Query result is displayed on an Android device.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

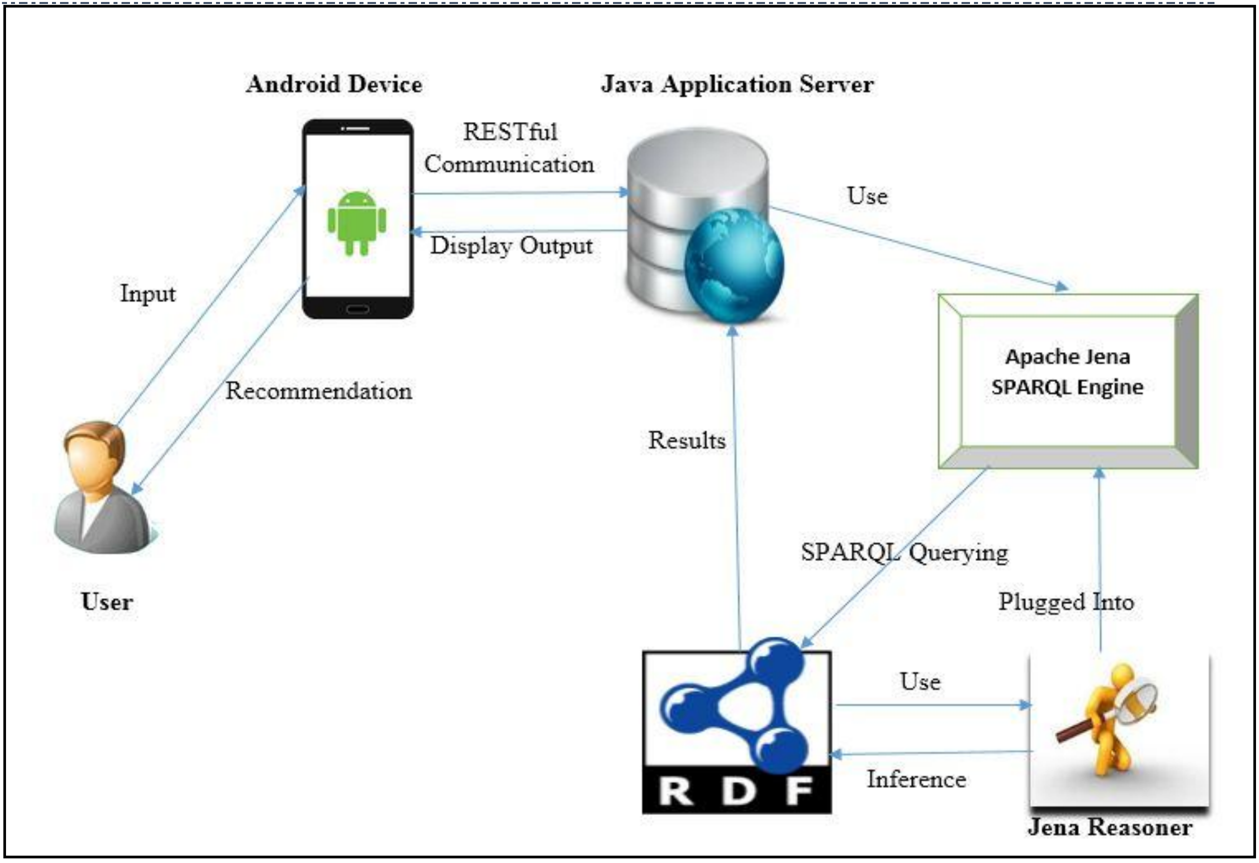

Figure 4: Reasoning Query Flow

Example of Simple Query Execution

Query 1: Find disease observations.

SPARQL Code: SELECT ? Disease_Observation_List
WHERE {
? Disease_Observation_List rdf:type :Disease_Observations.}
ORDER BY? Disease_Observation_List

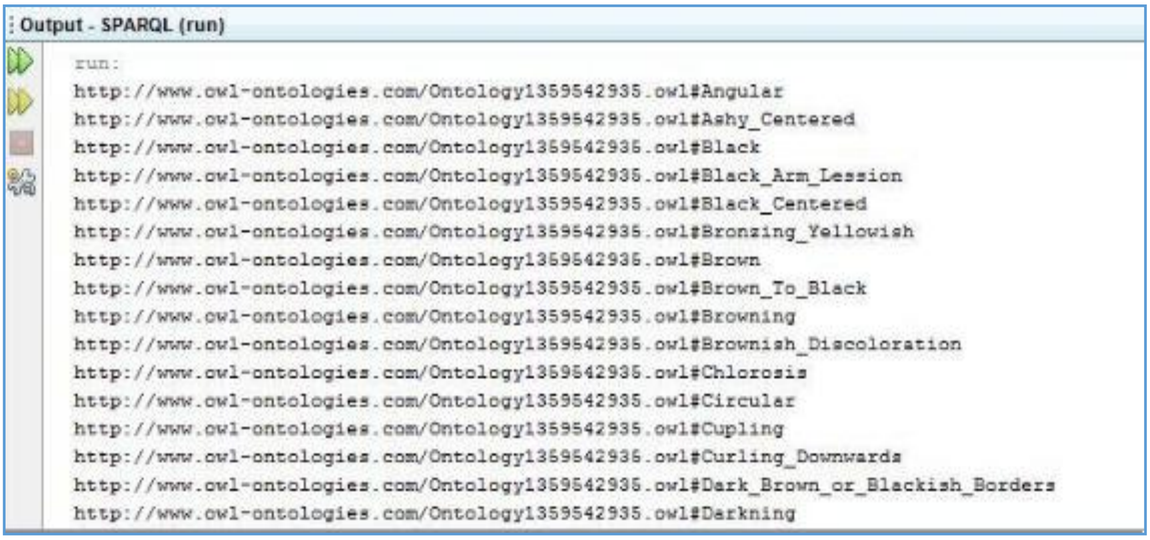

Figure 5 Query 1 Result

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

Figure 6 shows the diagram of Query 1. The diagram gives us an abstract idea of reasoning process. Here individuals are not directly belongs to the Disease Observation concept but they are under sub concept of Disease Observation. So when we start reasoner in protégé then we can get the all individuals under Disease Observation. Query 1 is an example of "retrieval of individuals" reasoning type.

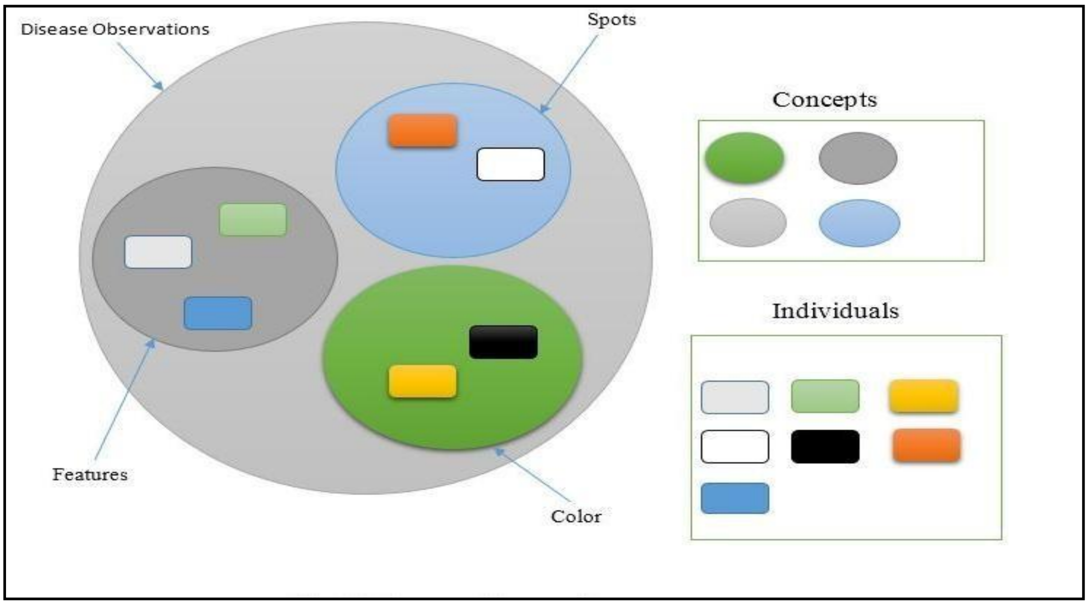

Figure 6 Query 1 Diagram

Example of Complex Query Execution

Query 2 C=Stage And Weed, D=Stage Or Weed ,C {c1, c2}, D {d1, d2}.
Then Find the instance of D.

SPARQL Code: SELECT? D_individuals
WHERE {
?D_individuals rdf:type :D.} ORDER BY? D_individuals

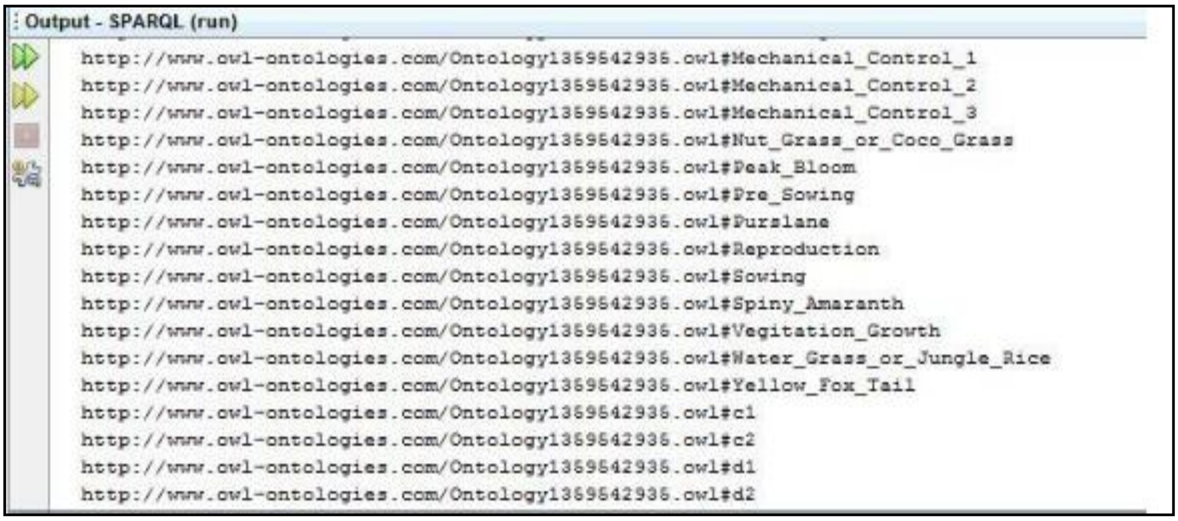
Output - SPARQL (run)
http://www.owl-ontologies.com/Ontology1369542938.owl#Mechanical_Control_1
http://www.owl-ontologies.com/Ontology1369542938.owl#Mechanical_Control_2
http://www.owl-ontologies.com/Ontology1369542938.owl#Mechanical_Control_3
http://www.owl-ontologies.com/Ontology1369542938.owl#Nut_Grass_or_Coco_Grass
http://www.owl-ontologies.com/Ontology1369542938.owl#Peak_Bloom
http://www.owl-ontologies.com/Ontology1369542938.owl#Pre_Sowing
http://www.owl-ontologies.com/Ontology1369542938.owl#Purslane
http://www.owl-ontologies.com/Ontology1369542938.owl#Reproduction
http://www.owl-ontologies.com/Ontology1369542938.owl#Sowing
http://www.owl-ontologies.com/Ontology1369542938.owl#Spiny_Amaranth
http://www.owl-ontologies.com/Ontology1369542938.owl#Vegitation_Growth
http://www.owl-ontologies.com/Ontology1369542938.owl#Water_Grass_or_Jungle_Rice
http://www.owl-ontologies.com/Ontology1369542938.owl#Yellow_Fox_Tail
http://www.owl-ontologies.com/Ontology1369542938.owl#c1
http://www.owl-ontologies.com/Ontology1369542938.owl#c2
http://www.owl-ontologies.com/Ontology1369542938.owl#d1
http://www.owl-ontologies.com/Ontology1369542938.owl#d2

Figure 7 Query 2Result

Figure 8 shows the diagram of Query 2. Query 2 is also reasoning type query. When we start reasoner in protégé then we can get the inference as a C subset of D. Because we can conclude from given data in query 2 that D is bigger concept and it covers the whole C concept. Query 2 is an example of "Subsumption of concepts" and "retrieval of individuals" reasoning type.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

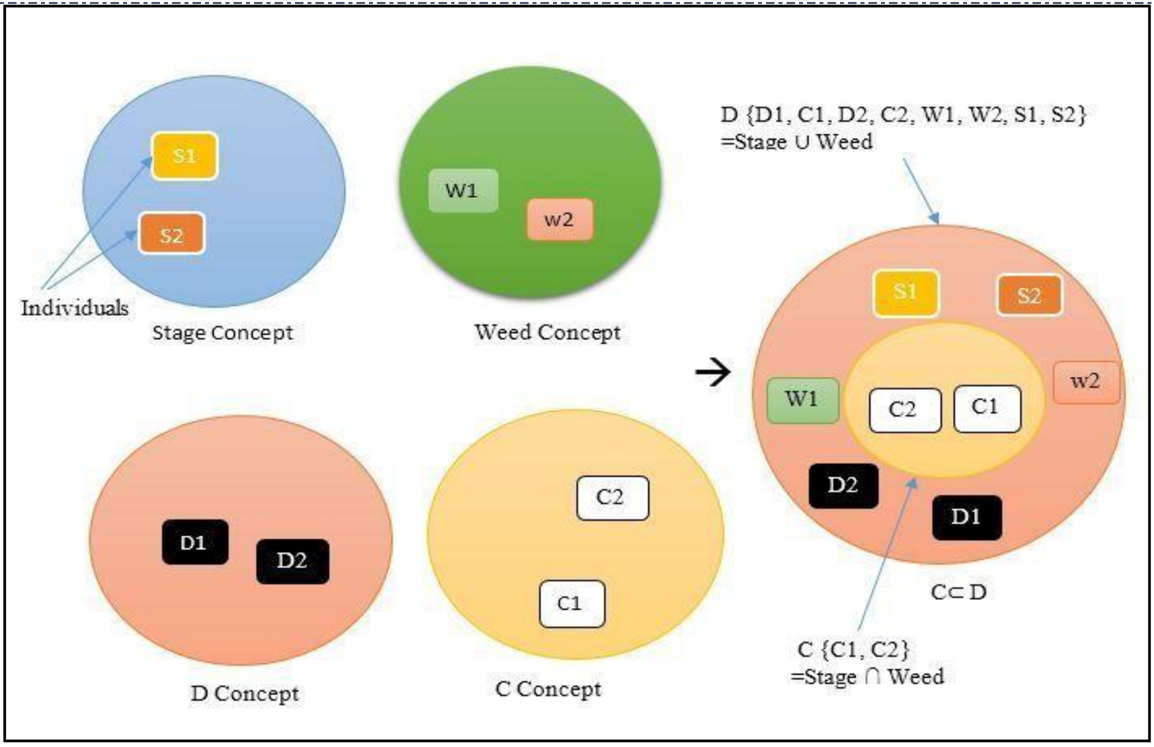

Figure 8:Query2Diagram

VI. 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.

Our system can be more useful to farmers if we could include current climate condition data and prediction techniques for weather. The system can generate and send alert and notification to farmers so that precautionary steps can be taken in advance before heavy damage occurs to a farmer. The system can also be extending to include the soil health condition of a farm. After analyzing soil health data the system will generate recommendation such as which is the best crop to cultivate, what is the best fertilizer to use to increase the productivity? To provide the alert for the weather change and recommendation to improve the soil condition more concepts of soil and weather should be included in the ontology which make the scope of ontology large. The system can generate effective recommendation if it has a larger ontology and efficient inference engine capability.

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.

Cotton crop ontology is a very useful resource for processing Cotton agricultural knowledge base. Our KisanMitra system is pioneer and pilot work to develop agro advisory system using ontology. This system will be also a model for building agro advisory system for other crop which leads to increase in the production of crop.

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

VII. REFERENCES

1. Agrisnet(2014).A Mission mode project to promote agricultural informatics and communications, http://agrisnetodisha.ori.nic.in/ June, 2014.
2. Agropedia(2014) A free and open source Java framework for building Semantic Web and Linked Data applications. http://agropedia.iitk.ac.in/, June,2014.
3. Apache Jena(2014). A free and open source Java framework for building Semantic Web and Linked Data applications. http://jena.apache.org, June, 2014.
4. Aree Thunkijjanukij(2009).Ontology development for agricultural research knowledge management: a case study for thai rice, PhD thesis, Graduate School, Kasetsart University, 2009.
5. Arun Pande, Bhushan G. Jagyasi, Sanjay Kimbahune, Pankaj Doke, Ajay Mittal, Dineshkumar Singh, and Ramesh Jain(2009).Mobile Phone based Agro-Advisory System for Agricultural Challenges in Rural India(mKrishi), in IEEE Conference on Technology for Humanitarian Challenges, Aug 2009.
6. G.K. Koutu,P.P Shastry, D.K. Mishra, and K.C. Mandloi(2014).Handbook of COTTON, Studium Press Pvt. Ltd,India, 2014.
7. KissanKerela(2014) An Integrated multi-modal agricultural information system for kerela," IIITM-K, Thiruvanathapuram, http://www.kissankerala.net.June.2014.
8. M. H. Bohara, M. Mishr, and S. Chaudhary(2013).RESTful Web Service Integration Using Android Platform, in Fourth International Conference on Computing Communication and Networking Technologies , Tiruchengode, Tamilnadu,India, July 4-6, 2013.
9. P. Krishna Reddy, G. V. Ramaraju, and G. S. Reddy(2007)."eSagu™: a data warehouse enabled personalized agricultural advisory system in SIGMOD'07 Proceedings of the 2007ACM SIGMOD international conference on Management of data, pp.910-914,June 2007.
10. OWL: Web Ontology Language(2014). http://www.w3.org/2001/sw/wiki/OWL, June, 2014
11. Ramamritham Krithi, Anil Bahuman, Ruchi Kumar, Aditya Chand, Subhasri Duttagupta, G.V. Raja Kumar, and Chaitra Rao(2004).aAQUA Multilingual, Multimedia Forum for the community, in IEEE International Conference on Multimedia and Expo, vol. 3,2004.
12. RDF: Resource Description Framework(2014). http://www.w3.org/RDF/, June, 2014.
13. S.Chaudhary and M. Bhise(2013).RESTful Services for Agricultural Recommendation System in Proceedings of NSDI-2013, IIT, Mumbai,pp. 46-52, November 29-30,2013).
14. S.Sahni(2012).Ontology Based Agro Advisory System, Department of Computer Science and Engineering, IIT Mumbai, M.Tech. thesis , June 2012.
15. SPARQL:SPARQL Protocol and Query Language for RDF(2014). http://www.w3 .0rgITRlrdf-sparq I-query/, June, 2014.
16. Thomas B. Freeland Jr. (lead), Gordon Andrews, Bill Pettigrew, and Peggy Thaxton.Guide to Agricultural Metrological Practices, Chapter 10.1 AGROMETEOROLOGY AND COTTON PRODUCTION ", World Meteorological Organization publication, Switzerland, ISBN 978-92-63-10134-1.
17. Tim Berners-Lee, James Hendler and OraLassila(2001).The Semantic Web, Scientific American, pp. 02, May 17, 2001.
18. V.Kumar, V. Dave, R. Nagrani, S. Chaudhary, and M. Bhise(2013).Crop Cultivation Information System on Mobile Phones, in IEEE Global Humanitarian Technology Conference (GHTC), pp. 196-202, ISBN: 978-1-4799-1094-6,2013.
19. XML: Extensible Markup Language,(2014). http://www.w3.org/XMLI, June, 2014.

CITE AN ARTICLE

Titiya, M. D., & Shah, V. A. (n.d.). ONTOLOGY BUILDING AND REASONING PROCESS FOR RESOURCE DESCRIPTION FRAMEWORK DATA. INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY, 6(12), 43-56.