# Deep Learning Ontology: Dimensions in the Field of Agriculture, A Survey

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***Abstract:*** **Agriculture is well known as the backbone of India and it is one of the main occupation of human habitat. The field is gaining more importance in the current years by attracting most of the youths towards it. It is important to give the technical touch to this field to get the best outcome. Ontology being the current trend of technology in the semantic word it's important to gain more interoperability in agriculture system, which helps in the clear understanding of the heterogeneous data and gain an outstanding result out of it. High attention and importance must be provided to an agricultural field as the researchers say agricultural production must increase 60% by 2050 to meet the world population. Hence adopting current trends in the agriculture will help in improving the production of yield, maintaining a healthy soil, brilliant use of water resources, efficient use of fertilizers and its effects, prediction of diseases according to the crop and region all these factors prediction will positively affect the agricultural field.**

***Keyword:*** **Ontology, Deep learning, Web ontology, Agriculture IOT.**

## I. INTRODUCTION

The challenges in agriculture can be addressed by collecting several types of data related to the agricultural domain and making them available in sophistication to make the better decision out of it. Farmers, scientists and researchers are made accessible to three types of data-intensive technologies 1) Farm Management Information System(FMIS) which is a planned system for collecting, processing, storing and broadcasting data in the required format 2) To increase the economic return and reduce the environment impact precision agriculture a scientific domain is made available 3) Automation of agriculture, the process of applying artificial intelligence and robotics at each level. These data-sets were analyzed as big data and agricultural improvement like soil nutrition management, crop detection and protection, weed control was achieved [15].

Neches and Fikes define ontology as the "explicit formal specifications of the terms in the domain and relations among them".The most widely quoted definition of "ontology" was given by Tom Gruber in 1993, who defines ontology as "An explicit specification of a conceptualization" [2]. In general ontology is a way of representing heterogeneousdata using a key word like buzz. These keywords create a directory kind of data on the heterogeneous and multidimensional data by integrating it in to one space by building a relationship between the data and by naming them uniquely which reduces the unambiguity. Ontology plays a very important role by providing a common understanding of knowledge between the people who communicate and the application that use the ontology knowledge. It also helps to analyze the integrated knowledge and gain better understanding.

There are many ontology constructs method, commonly used are skeleton method, TVOE, Seven step method, OntoEdit, WebOnto.

Ontology is an iterative process and involves these steps:

1. Design: Deciding on the domain, scope, design of the ontology and the relationship between them.
2. Develop: To start constructing the ontology from scratch or reuse the already present.
3. Integrate: to integrate the developed classes with the other or integrate with already present.
4. Validate and feedback: the constructed ontology is tested for the correctness, if errors present feedback is sent for the correctness.
5. Repeat: as said before the ontology construction is iterative so, the above steps are repeated.

In the agriculture domain, various aspects must be integrated to build a fully functioning system with all the information related to agriculture such as weather conditions, soil characteristics, new research results and findings, government policies, market information and inventory, fertilizers and its hazards, organic farming etc. All of such different data are produced by different bodies of the government and also by the farmers, all of these departments are working rather independently or with limited integration between them [1]. It's important to integrate the things which in turn helps in knowledge acquisition and decision making to improve the yield production. As the agricultural data is very vast and large it's difficult to integrate them and provide well versed knowledge and to search for a particular data in the database. The agriculture language changes from one locality to another, it's difficult and even important to create awareness of technology usage to farmers in their own common language rather than in English [3].

There are many ontology methods present which includes the domains: crop and its yield, fishing, animal husbandry, fertilizers, soil nutrition but all these have limitations as these are not effective in adopting themselves to the real world. Few ontology constructs are: Crop ontology,ontocrop ontology, Integrated Agriculture Information Framework [ IAIF], ONTAgriScalable Service Oriented Agriculture Ontology for Precision Farming, AGROVOC, Agricultural Ontology Service (AOS), World Agriculture Information Center (WAICENT) [3].

Deep learning in combination with ontology provides the best result in applying machine learning process to agriculture field. Deep Learning has become one of the most sought-after skills in the technology world. As the scarcity of the land for cultivation exists, scientists are utilizing deep learning methods to get the best out come from the remaining left-over land. Combining the field of machine learning, knowledge representation and reasoning we step towards an advance field called human level artificial intelligence. Deep learning is a sub set of machine learning where it has layers of information arranged in hierarchy to process.

SECTION I: Explains ontology, construction and its importance in agriculture.

SECTION II: Literature survey on different ontology model and technologies used in agriculture.

## II. LITERATURE SURVEY

AGROVAC is a controlled and structured vocabulary which is able to cover all the areas like Food and Agricultural organization of the United Nations. It used for indexing and retrieving data in agricultural information system. It can be used to look for a crop name, plant name, disease name which is not been mastered by a person. It is even used as hub to access other vocabulary which is available online. AGROVAC is named for its richer set of relationships it exhibits between the words, strings, terms, concepts. AGROVAC ontology was used as description of learning on organic agriculture [7]. Utilizing AGROVAC richer set of data and knowledge to the simple and general applications of organic farming was implemented on the thesaurus. The fertilizers are categorized on the basis of the content and the nutrition value it holds. In AGROVAC fertilizer is considered as a physiological concept which defines the terms that helps in relating the application to soil or plant that uses it. The later term related to (RT) is used to specify the relation that a fertilizers fetch. The nitrogen, phosphate and its derivatives are harmful component they do not come under organic. These kinds of fertilizers are related by a term NT, a term called fertilizer combination is used, which represents the fertilizer mixture with agents, plant growth or pesticides. Another called soil pollution is used a general RT component for soil degradation. The current relation of AGROVAC suggests that:

- All kinds of Fertilizers can be involved in Soil degradation, a concept RT related to Soil Pollution which is in turn related to Fertilizers.

- Any instance of Fertilizers can be part of Fertilizers combinations, which is probably false for some kinds of Biological fertilizers.

The detail explanation for the above is pictorially represented in the figure1.

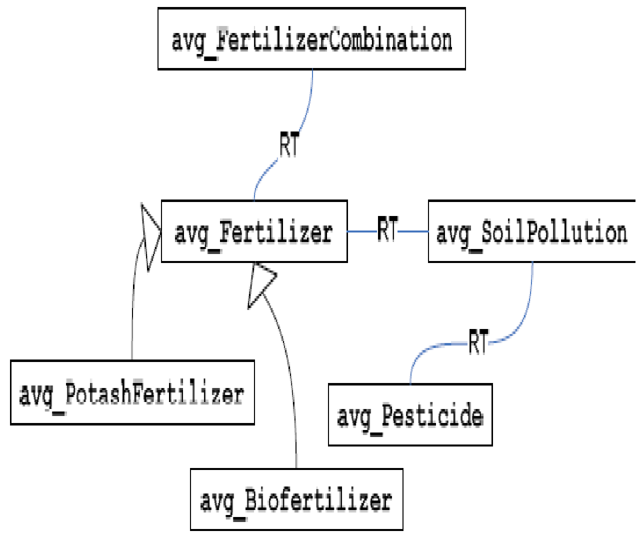


Fig 1. AGROVAC vocabulary usage

Agricultural Activity Ontology AAO [6] acts as a basic core vocabulary of agriculture and it contains description logics. Vocabulary of agriculture is defined as subset of the ontology in AAO. AAO agricultural activities are structured using a top-down approach, this approach helps classifying concept more specifically by starting more generally and then reaching very specifically. By considering top-down approach we are able to explain top activities of agriculture and then breaking the general concept to concreate values. By developing AAO and implementing it to IT system it was made possible to understand the agriculture beyond the linguistic nature. AAO was adopted to explain core vocabulary of agricultural activity. The strategy here is structuring the activity in top-down i.e generalizing the activity from top and then heading towards deep and specific activity involved in agriculture. The activities are described using description language(DL) in ontology. The ontology is built by considering the farmer purpose(generalizing) and then deciding on the other attributes like crop, season, place, target, means, equipment and the act.

Recently there was a tremendous change in the agriculture over internet where it was answering the various questions of farmers using informatic data source over World Wide Web such as NASS, FAOSTAT and ACO.It's important to fetch the data effectively from them, it was achieved by IAIF ontology. semantic IAIF model framework was implemented on agriculture. IAIFhas the capability to extract the knowledge from different domains. IAIF employs the metadata and domain ontology to combine, aggregate, merge the knowledge which is stored in the repository. The IAIF has three sub-ontology domains, resource and linking ontology. WWW agricultural application provide a framework for decision support system, expert system for the questions of farmer. As we known sematic web has a magnificent work in solving major problems, it achieves in inter-technology practice, provide ability for machine readable, standard format of application and domain knowledge. IAIF implements a computer bases discussion support system to humans and farmers. The figure2 represents the complete architecture of IAIF sematic web architecture. The model intended to show the frame work of stand-alone multitopic repository using semantic web base [8].

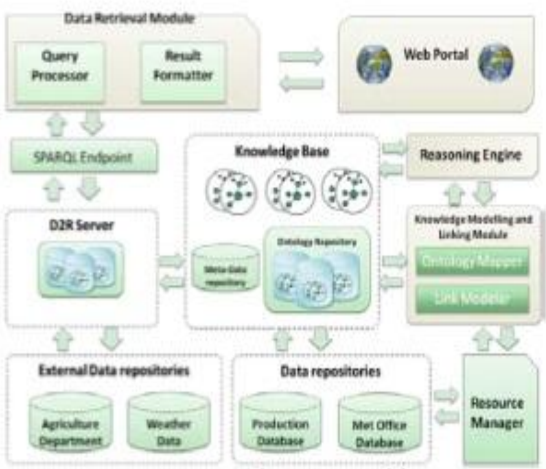


Fig2. Architecture of IAIF semantic web architecture

Many government websites fail to provide the information effectively to the users as the data is distributed on different websites and user has to visit many pages for the information. To overcome this Sematic web concept is used on e-governance data and developing agricultural ontology. With localization of Indian government data spread at different placeshave integrated each other on the internet called as Semantic Web Network. Semantic data model for Indian agriculture e-governance is using RDF/XML/OWL data which is spread across different platform. The data is further analyzed using spine line curve and fitting it into mat lab converting to matrix format to reduce the errors. Once the data is organized the data is logically connected by establishing relationship between the data. Constructing this agricultural model there require many more components that were attached to this model to answer and handle various propaganda [11]. The various components and its interactions are depicted in the figure below.

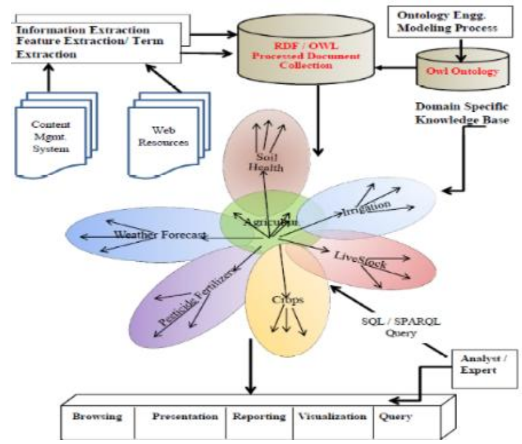


Fig 3. Agriculture Ontology and its various components in sematic web.

Ontology has the capacity to relate, organize, generalize, search, compare and also find the new model and model elements. By considering this advantage they applied ontology to maintain soil, water and nutrient management [9]. Ontology of simulation is knowledge building and doesn't not relate to software engineering. The knowledge is built here on two factors one is defining the data structures on the domain and the other is inference created on these data structures by providing automatic relation on the built data structure. Ontology for simulation address many problems, utilizing this ontology management a model was constructed which provides tools and management platform to manage ontology which was called as Lyra. This method was implemented on citrus water and nutrient management system to monitor the soil components, nutrient and the water management for the citrus plant.

Advancement of network and sensor has made the physical objects to respond to human actions using Internet Of Things(IOT) [10]. IOT is also been highly implemented in agriculture lands, this makes the different agriculture IT systems to get integrating into agriculture IOT. The key challenge is to handle the heterogeneity multiple information resources. Using AgOnto ontology with IOT made possible to reuse the agricultural knowledge and solve interoperation problem. Ontology is constructed light weighted by considering minimal properties like location, timestamp, environment parameters, processing status. These are related using three relations between them, Is-a, Has Property, Source from. AgOnto gives total description of life cycle of agriculture and creates well versed bond with IOT.

As said deep learning's deep neural network was used to identify the plant diseases by classifying the images of different plants [13]. This model is able to recognize 13 different types of plant diseases by distinguishing plant leaves from surrounding. Deep convolution neural network is used to identify the soil nutrition level by analyzing the images and the historical data collected [14]. By aggregating the images from national botany institutes and applying neural networks they were able to identify the plants accurately in a noise large dataset which is available online.

Soil knowledge base ontology was constructed to assist the search of soil knowledge which is stored in various sources [16]. Knowledge base system has 3 process steps for ease of use. First step is to retrieve all the unstructured data and clean it to form a structured one this step is known as feature extraction and knowledge importing. Terms are extracted from the data base and weightage is added to each term extracted by giving them is-a and part of relationship, the related data is then stored in OWL data storage. The knowledge stored is then retrieved by specifying a particular keyword.

## III. OUTCOME OF ONTOLOGY AND DEEP LEARNING ADOPTION IN AGRICULTURE

- Information and communication technologies has become the dominance in all the field. This idea was actively encouraged and adopted in the areas of Nepal for the data access and information processing for the effective farming. They used the existing ontologies like FAO, AGROVAC, EUROVAC etc and stepped towards a data management method called AgriNepalDataProject.

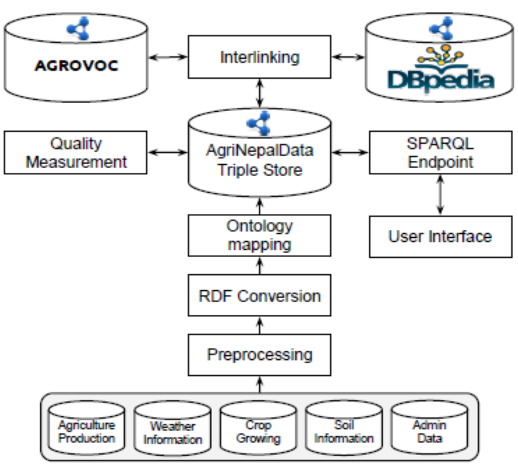


Fig 4. AgriNepalData Data Management Framework

By developing the above structure for Nepal by lining data sources and combining with other data sets made possible to obtain different agricultural information from a single data store. This made the Nepal region farmers a step towards increase production and planned farming [17].

- To increase the productivity in Tamil Nadu they utilized a network prototype method like wireless sensor network which considers temperature, humidity, water supply, moisture and nutrient level in soil. The wireless device is constructed with micro controller, built-in radio receiver, power generation and storage devices. The model measures the various concepts mentioned above and starts refer with the ontology results which were collected and stored to predict and guide the farmers to their smart phone through message alert about the environment, productivity, best climatic and crop suggestion to the farmers. The below figure represents the model prescribed model [18].

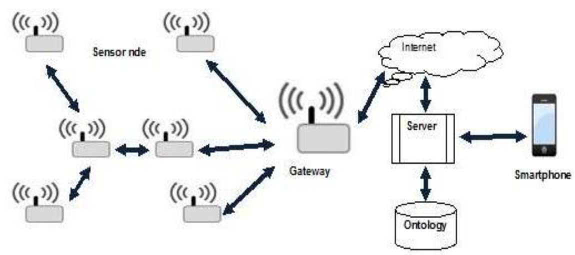


Fig 5: Block diagram for WSN based agriculture

- As the technology takes a world-wide space including agriculture an emerging idea called precision farming came to picture, this is a method of farming management which used information technology to improvise the production. Precision farming is also called as satellite agriculture. Agricultural control centers integrate sensor data and imaging input with other data, providing farmers with the ability to identify fields that require treatment and determine the optimum amount of water, fertilizers and pesticides to apply. The system is based on plant driven ontologymodel and its completely hybrid including software, hardware components, datastores, sensors which is positioned around the plants, simulative sensors etc. The hybrid system work on the plant ontology and decide the queries on soil, climate, production etc [19].
- An ontology was developed by a name called OntoAgroHidro which is based on water driven model that represents knowledge about impacts of agricultural activities and climatic changes on water resources. This ontology supports multi-dimensional data support which share information from various domain and integrate them and provide connection between the various department scientist which helps them to fetch the answer efficiently without a barrier between the department. This model is capable of providing interoperability issues by providing network to share and recover the knowledge [20].

## IV. CONCLUSION

Here, the dimension are discussed on ontology and deep learning in ontology, its importance in the field of agriculture. The survey depicts the different ways how ontology can be utilized and applied to get the maximum production in farming and to deal with the challenges of environment. Further work can be done by applying deep learning ontology techniques to the precision farming technique and then by adopting to the regional language, crop, soil, climatic conditions.

## REFERENCES

[1]. Suresh Pokharel, Mohamed Ahmed Sherif, Jens Lehmann University at Leipzig, Institut fur Informatik,AKSW "Ontology Based Data Access and Integration for Improving the Effectiveness of Farming in Nepal".

[2]. Prof. Shweta B.Barshe, Prof. D.K.Chitre, "Agriculture System based on OntologyAgroSearchInternational Journal of Emerging Technology and Advanced Engineering Website",(2012), ISSN 2250-2459, Volume 2, Issue 8.

[3]. Prachi Dalvi, Varsha Mandave, Madhu Gothkhindi, Ankita Patil, S. Kadam, S. S. Pawar, "Overview of Agriculture Domain Ontologies",ISSN (Online): 2347 - 2812, Volume-4, Issue -7, 2016.

[4]. Dineshkumar P, Manoj G, Punyashree PB, Shruthi Nand Rajendra Akerkar,"A Comprehensive Agriculture Ontology: Modular ApproachInternational Journal of Innovative Science, Engineering & Technology", ISSN 2348 – 7968, Vol. 1 Issue 10, December 2014..

[5]. SungminJoo, Seiji Koide, Hideaki Takeda, Daisuke Horyu, AkaneTakezaki, and Tomokazu Yoshida,"Agriculture Activity Ontology: An ontology for core vocabulary of agriculture activity".

[6]. Salvador Sánchez-Alonso and Miguel-Angel Sicilia, "Using an AGROVOC-based ontology for the description of learning resources on organic agriculture".

[7]. Muhammad Shoaib, AmnaBasharat, "Semantic Web based Integrated Agriculture Information Framework", Second International Conference Computer Research and Development.

[8]. Howard Beck, Kelly Morgan, Yunchul Jung, Jin Wu, Sabine Grunwald and Ho-young Kwon, "Ontology-Based Simulation Applied to Soil, Water, and Nutrient Management".

[9]. Siquan Hu, Haiou Wang, Chundong She, Junfeng Wang, "AgOnt: Ontology for Agriculture Internet of Things".

[10]. Swaran Lata, Bhaskar Sinha, Ela Kumar, Somnath Chandra, Raghu Arora, "Semantic Web Query on e-Governance Data and Designing Ontology for Agriculture Domain", International Journal of Web & Semantic Technology (IJWesT) Vol.4, No.3, July 2013.

[11]. Li Deng. Three Classes of Deep Learning Architectures and Their Applications: A Tutorial Survey.

[12]. SrdjanSladojevic, Marko Arsenovic, Andras Anderla, DubravkoCulibrk and Darko Stefanovic , "Deep Neural Networks Based Recognition of Plant Diseases by Leaf Image Classification", Volume 2016, Article ID 3289801.

[13]. Halimatu S. Abdullahi, Ray E. Sheriff, Fatima Mahieddine,"Using Deep Learning Convolution Neural Network for Soil Nutrient Classification", International Journal of Agricultural and Biosystems Engineering Vol:11, No:7, 2017.

[14]. F K van Evert,S Fountas, D Jakovetic, V Crnojevic, I Travlos, C Kempenaar, "Big Data for weed control and crop protection", International research of weed biology Volume 57, Issue 4 Pages 213–292.

[15]. TongpoolHeeptaisong and AnongnartShivihok, "Soil Knowledge-based Systems Using Ontology", International Multi Conference of engineers and computer scientist, 2012 Vol 1.

[16]. Suresh Pokharel, Mohamed Ahmed Sherif, Jens Lehmann,"Ontology Based Data Access and Integration for Improving the Effectiveness of Farming in Nepal", Universit¨at Leipzig, Institutf¨urInformatik, AKSW.

[17]. M.G. Kavitha S. Sendhil Nathan, "Ontology Based Agriculture Using Wireless Sensor Networks", Journal of Advances in chemistry, ISSN 2321 -807X, Volume 12, Number 26.

[18]. Christos Goumopoulos, Achilles D. Kameas, "An ontology-driven system architecture for precision agriculture applications, International Journal of Metadata Semantics and Ontologies", *Vol. 4, Nos. 1/2, 2009.*

[19]. Rodrigo Bonacin , Olga Fernanda Nabuco, Ivo Pierozzi Junior , "Ontology models of the impacts of agriculture and climate changes on water resources: Scenarios on interoperability and information recovery", Future Generation Computer Systems 54 (2016) 423–434.