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A Research: Knowledge Representation using Fuzzy Logic in Ontology Modelling

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Abstract: Ontology has proved to be very useful in sharing concepts across applications in an unambiguous way. Nowadays, in ontology-based applications information is often vague and imprecise. This paper introduces a system that exploits the semantics of ontology, to improve the accuracy of machine-learning methods. In computer-aided reasoning, the predominant paradigm to manage vague knowledge is fuzzy set theory. This paper presents the proposed work. In proposed work, automate the Ontology Creation Process used along with the Databases. Our motive is to develop the efficient technique for ontology based on Fuzzy Logics along with the ontology mapping.

Keywords: Ontology, Methodology, Knowledge Analysis, Domain Analysis, Fuzzy Logic, Machine Learning Algorithm.

1. INTRODUCTION

Ontology

The term ontology can be defined as an explicit specification of conceptualization. Ontologies capture the structure of the domain that is conceptualization. This includes the model of the domain with possible restrictions. The conceptualization describes knowledge about the domain, not about the particular state of affairs in the domain. In other words, the conceptualization is not changing, or is changing very rarely. Ontology is then specification of this conceptualization; the conceptualization is specified by using particular modeling language and particular terms.

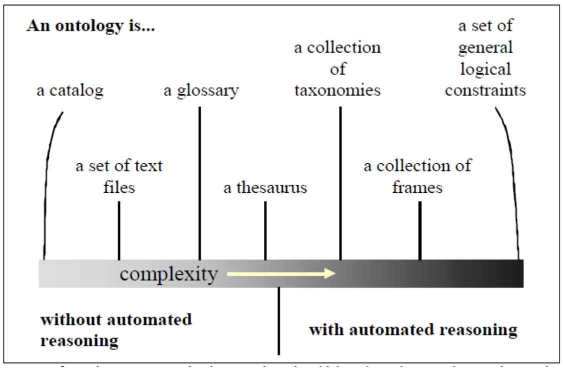

Fig1. Ontology

The visual representation of the generic concepts of a domain best facilitates both syntactic and semantic knowledge. Ontology is the only solution as a common place to interpret the common meanings of the key terms of a domain where conceptual information is spread across two knowledgebase in web.

Ontology Specification

Ontology specification in knowledge systems has two dimensions:

- Domain factual knowledge provides knowledge about the objective realities in the domain of interest (objects, relations, events, states, causal relations, and so forth).
- Problem-solving knowledge provides knowledge about how to achieve various goals. A piece of this knowledge might be in the form of a problem-solving method specifying—in a domain-independent manner—how to accomplish a class of goals.
- Most early research in KB Ontology development is one of the key and significant concerns.
- There are many reasons behind ontology development to make it a difficult task.

Classification of Ontologies

The Ontologies can be classifies according to their accuracy in characterizing the conceptualization they commit to. There are two possible ways ontology can get closer to a conceptualization:

- By developing a richer axiomatization
- By adopting a richer domain and/or a richer set of relevant conceptual relations.

In the first the distance between the set of ontology models and the set of intended models is reduced.

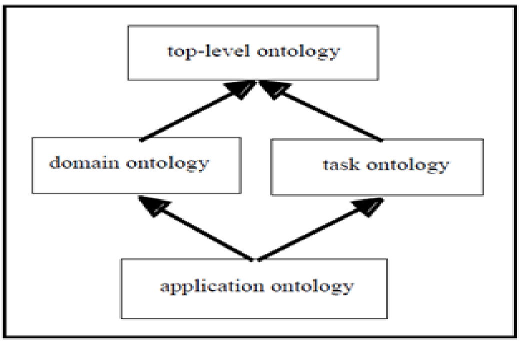

Fig2. Classification of Ontologies

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In the second case, it is possible – at least in principle – to include in the set of relevant conceptual relations (some of) those relations that characterize a world state, extending at the same time the domain in order to include the entities involved by such relations. Another possibility to increase the accuracy of ontology consists of either adopting a modal logic, which allows one to express constraints across worlds, or just reifying worlds as ordinary objects of the domain. Of course, there is a trade off between a coarse and a fine-grained ontology committing to the same conceptualization: the latter gets closer to specifying the intended meaning of a vocabulary but it may be hard to develop and to reason on, both because the number of axioms and the expressiveness of the language adopted. A coarse ontology, on the other hand, may consist of a minimal set of axioms written in a language of minimal expressivity, to support only a limited set of specific services, intended to be shared among users which already agree on the underlying conceptualization.

Fuzzy logic

Our attempt is to forecast rainfall with the help of fuzzy logic based approximate reasoning. This process uses the concept of a pure fuzzy logic system where the fuzzy rule base consists of a collection of fuzzy (IF–THEN) rules. The FIS (fuzzy inference engine) uses these fuzzy IF–THEN rules to determine a mapping from fuzzy sets in the input universe of discourse to fuzzy sets in the output universe of discourse based on fuzzy logic values. In order to form our models we defines the fuzzy sets consist of five parameters: total cloud cover, wind direction, temperature ,relative humidity and surface pressure are the input variables for our model; each has three membership functions with single output which is rain event percentage. Fuzzy inference is the process of mapping functions from a given input to an output using fuzzy logic

The fuzzy theory operated through three main steps.

- Fuzzification: This step is to determine the definition domain of each variable based on the ranges of input and output variables in actual conditions.
- Determination: Fuzzy rules determination and fuzzy inference: Based on the experience and knowledge of experts, the language rules of determination were transferred into the executable fuzzy syntax for inference.
- Defuzzification: The FIS (fuzzy inference system) outputs are finally transformed back into crisp values.
- A fuzzy ontology is a quintuple F =< I, C,T,N,X > where
- I is the set of individuals (objects), also called instances of the concepts.
- C is a set of fuzzy concepts (or classes - cf. in OWL - of individuals, or categories, or types). Each concept is a fuzzy set on the domain of instances.
- The set of entities of the fuzzy ontology is defined by E = C ∪ I.
- T denotes the fuzzy taxonomy relations among the set of concepts C. It organizes concepts into sub-(super-) concept tree structures. The taxonomic relationship T (i, j) indicates that the child j is a conceptual specification of the parent i with a certain degree.
- N denotes the set of non-taxonomy fuzzy associative relationships that relate entities across tree structures, for example:
  - Naming relationships, describing the names of concepts
  - Locating relationships, describing the relative location of concepts
  - Functional relationships, describing the functions (or properties) of concepts
- X is the set of axioms expressed in a proper logical language, i.e., predicates that constrain the meaning of concepts, individuals, relationships and functions.

Machine Learning Technique

Machine learning is a subfield of computer science that evolved from the study of pattern recognition and computational learning theory in artificial intelligence. Machine learning explores the construction and study of algorithms that can learn from and make predictions on data. There are different ways an algorithm can model a problem based on its interaction with the experience or environment want to call the input data. There are only a few main learning styles or learning models. This taxonomy or way of organizing machine learning algorithms is useful because it forces you to think about the roles of the input data and the model preparation process and select one that is the most appropriate for your problem in order to get the best result.

Supervised Learning

Input data is called training data and has a known label or result such as spam/not-spam or a stock price at a time. A model is prepared through a training process where it is required to make predictions and is corrected when those predictions are wrong. The training process continues until the model achieves a desired level of accuracy on the training data. Example problems are classification and regression. Example algorithms are Logistic Regression and the Back Propagation Neural Network.

Unsupervised Learning

Input data is not labelled and does not have a known result. A model is prepared by deducing structures present in the input data. Example problems are association rule learning and clustering. Example algorithms are the Apriori algorithm and k-means.

Semi-Supervised Learning

Input data is a mixture of labelled and unlabelled examples. There is a desired prediction problem but the model must learn the structures to organize the data as well as make predictions. Example problems are classification and regression. Example algorithms are extensions to other flexible methods that make assumptions about how to model the unlabelled data.

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Reinforcement Learning

Input data is provided as stimulus to a model from an environment to which the model must respond and react. Feedback is provided not from of a teaching process as in supervised learning, but as punishments and rewards in the environment. Example problems are systems and robot control. Example algorithms are Q-learning and Temporal difference learning.

Types of Machine Learning Problems

Reading through the list of example machine learning problems above, I'm sure you can start to see similarities. This is a valuable skill, because being good at extracting the essence of a problem will allow you to think effectively about what data you need and what types of algorithms you should try.

There are common classes of problem in Machine Learning. The problem classes below are archetypes for most of the problems we refer to when we are doing Machine Learning.

- Classification: Data is labelled meaning it is assigned a class, for example spam/non-spam or fraud/non-fraud. The decision being modelled is to assign labels to new unlabelled pieces of data. This can be thought of as a discrimination problem, modelling the differences or similarities between groups.
- Regression: Data is labelled with a real value (think floating point) rather then a label. Examples that are easy to understand are time series data like the price of a stock over time, the decision being modelled is what value to predict for new unpredicted data.
- Clustering: Data is not labelled, but can be divided into groups based on similarity and other measures of natural structure in the data. An example from the above list would be organising pictures by faces without names, where the human user has to assign names to groups, like iPhoto on the Mac.
- Rule Extraction: Data is used as the basis for the extraction of propositional rules (antecedent/consequent aka if-then). Such rules may, but is typically not directed, meaning that the methods discover statistically supportable relationships between attributes in the data, not necessarily involving something that is being predicted. An example is the discovery of the relationship between the purchase of beer and diapers (this is data mining folk-law, true or not, it's illustrative of the desire and opportunity).

2. LITERATURE REVIEW

The different researchers studied multiple aspects and some of the explanation is below:
Semantic integration is an active area of research in several disciplines, such as databases, information-integration, and Ontologies. This paper provides a brief survey of the approaches to semantic integration developed by researchers in the ontology community. They focus on the approaches that differentiate the ontology research from other related areas. The goal of the paper is to provide a reader who may not be very familiar with ontology research with introduction to major themes in this research and with pointers to different research projects. They discuss techniques for finding correspondences between Ontologies, declarative ways of representing these correspondences, and use of these correspondences in various semantic-integration tasks [1].

While there are efforts to establish a single international accounting standard, there are strong current and future needs to handle heterogeneous accounting methods and systems. They advocate a context-based approach to dealing with multiple accounting standards and equational ontological conflicts. In this paper they first define what we mean by equational ontological conflicts and then describe a new approach, using Constraint Logic Programming and abductive reasoning, to reconcile such conflicts among disparate information systems. In particular, they focus on the use of Constraint Handling Rules as a simultaneous symbolic equation solver, which is a powerful way to combine, invert and simplify multiple conversion functions that translate between different contexts. Finally, they demonstrate a sample application using our prototype implementation that demonstrates the viability of our approach [2].

"Semantic Web" refers to W3C's vision of future web. It aims at a web of data, where information is linked up in such a way to be process able by devices and agents. In a wider canvas, semantic web can be seen as a huge engineering solution. Ontologies are playing the vital role in Semantic Web vision for its full-fledged implementation. Though lot of developments happened in this arena of ontology development in line with the implementation of semantic web, the standardization of process models, tools and methodologies are yet to be saturated. Researches in ontology engineering had pointed out that an effective ontology application development methodology with integrated tool support is a mandatory for its success. The researcher in his previous publication, proposed a hybrid methodology for ontology development by leveraging the well proven process models and methods of software engineering. This paper explains the philosophical, engineering aspects of the newly derived methodology and applies the same for the development of a Java Learning Educational

Ontology (JLEO). JLEO organizes the learning hierarchy of Java Programming Language suitable to the related modules spread across the curriculum of Middle East College. An appropriate ontology editing tool has been used for the practical development of ontology [3].

In this paper, they show that representation and reasoning techniques used in traditional knowledge engineering and the emerging Semantic Web can play an important role for heterogeneous database integration. Their Onto Grate architecture combines ontology-based schema representation, first order logic inference, and some SQL wrappers to integrate two sample relational databases. They define inferential data integration as the theoretical

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framework for our approach. The performance evaluation for query answering shows that Onto Grate reformulates conjunctive queries and retrieves over 100,000 answers from a target database in less than 30 seconds. In addition to query answering, the system translates 40,000 database facts from source to target in under 30 seconds [4].
This introduction to the second international conference on Formal Ontology and Information Systems presents a brief history of ontology as a discipline spanning the boundaries of philosophy and information science. They sketch some of the reasons for the growth of ontology in the information science field, and offer a preliminary stocktaking of how the term 'ontology' is currently used. They conclude by suggesting some grounds for optimism as concerns the future collaboration between philosophical ontologists and information scientists [5].

Semantic web Ontologies have several advantages over other knowledge representation formats that make them appropriate for information logistics architectures and applications However, the construction of ontology is still time-consuming and error prone for practitioners. One recent development that aims to remedy this situation is the introduction of ontology design patterns, codifying best practices and promoting reuse. This paper presents a literature survey into the state of research on ontology patterns, and suggests the use of such patterns for modelling information demand and distribution [6].

The paper provides OWL ontology for legal cases with an instantiation of the legal case Popov v. Hayashi. The ontology makes explicit the conceptual knowledge of the legal case domain, supports reasoning about the domain, and can be used to annotate the text of cases, which in turn can be used to populate the ontology. A populated ontology is a case base which can be used for information retrieval, information extraction, and case based reasoning. The ontology contains not only elements of indexing the case (e.g. the parties, jurisdiction, and date), but as well elements used to reason to a decision such as argument schemes and the components input to the schemes. They use the Protégé ontology editor and knowledge acquisition system, current guidelines for ontology development, and tools for visual and linguistic presentation of the ontology [7].

The aim of this chapter is to give a general introduction to some of the ontology languages that play a prominent role on the Semantic Web, and to discuss the formal foundations of these languages. Web ontology languages will be the main carriers of the information that they want to share and integrate [8].

3. OBJECTIVES

The purpose of research is to discover answer to questions through the application of scientific procedures. The main aim of research is to find out the hidden truth and not been discovered yet. Through each research study has its own specific purposes. The present study has been carried out with the following objectives in mind:

The objective of this research is the automation of the ontology creation process from databases, while taking into account, both the model of the database and the records that are stored inside. Machine learning techniques will be used for the creation of the ontology, in order to limit the creation time and the human intervention during the whole process

- To understand the use and purpose of ontology
- To Automate the Ontology Creation Process used along with the Databases.
- To add the machine learning Technique to enhance the Ontology
- To develop the efficient technique for ontology based on Fuzzy Logics along with the ontology mapping.

Problem Statement

Ontology is the latest buzz word within which research and application on ontology mapping are going at fast pace. It is hailed as the next big thing and according to the researchers, will change the world for good. But still there are many problems that need to be further researched and worked on to provide a holistic solution to current and future problems. Present problem faced in this research is that there is no uniform definition of lifecycle and criterion of Ontology and also there is common ontological developing methodology and technology at universal level. Therefore the need of hour is to build systematic and concrete methods in this area, which will provide an integral and universal solution to problems at global level and will help in better resource utilization.

4. PROPOSED METHODOLOGY

Research can be defined as the search for knowledge, or as any systematic investigation, with an open mind, to establish novel facts, solve new or existing problems, prove new ideas, or develop new theories, usually using a scientific method. The purpose of research is to discover answers to questions through the application of scientific procedures. The main aim of research is to find out the truth which is hidden and which has not been discovered as yet. The most important aspect of research is data collection. Primary data can be collected either through experiment or through survey. The different steps will be followed up to generate ontology:

1. Study of Ontology Concepts and Steps.
2. Identify and analyze the benefits of ontology.
3. Research on the ontology real time issues.
4. Choose the reliable ontology technique.
5. Flow Development of new research and its Implementation in any of the language for making it understandable steps.
6. Analyze the results.

Classical ontology languages are not appropriate to deal with imprecision or vagueness in knowledge. Therefore, Description Logics for the semantic web has been enhanced by various approaches to handle probabilistic uncertainty, and vagueness.

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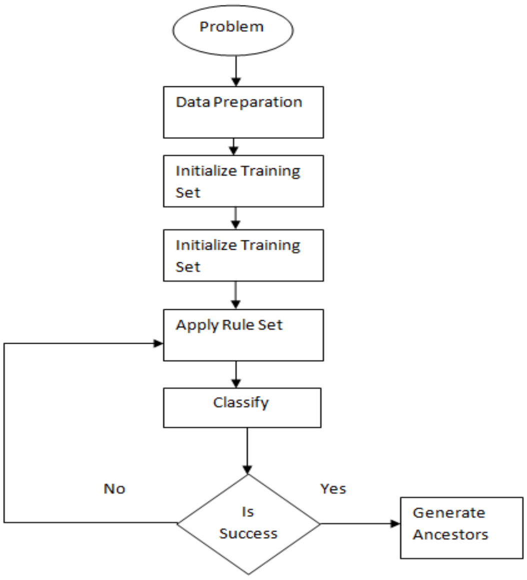

Fig3. Flow Chart

5. RESULTS AND DISCUSSION

Ontology describes a domain, while a knowledge base based on ontology describes particular state of affairs. Each knowledge based system or agent has its own knowledge base, and only those things that can be expressed using ontology can be stored and used in the knowledge base. An agent communicates to another agent by using the constructs from some ontology. In order to understand in communication, ontology's must be shared between agents.

Results

Example:

Input Data:

```
namespace: cellular_component
def: "A macromolecular complex containing both protein and RNA molecules." [GOC:krc]
subset: goslim_pir
subset: gosubset_prok
exact_synonym: "protein-RNA complex" []
exact_synonym: "ribonucleoprotein" []
exact_synonym: "RNA-protein complex" []
exact_synonym: "RNP" []
xref_analog: Wikipedia:Ribonucleoprotein
is_a: GO:0032991
is_a: GO:0044424

[Term]
id: GO:0005844
name: Tomato
namespace: cellular_component
def: "A multiribosomal structure representing a linear array of ribosomes held together by messenger RNA. The
subset: goslim_pir
exact_synonym: "polyribosome" [NIF_Subcellular:sao1038025871]
xref_analog: NIF_Subcellular:sao1038025871
xref_analog: Wikipedia:Polysome
is_a: GO:0030529
```

Fig4. Input Data 1

This section describes the coding Explanation which has been implemented in the MATLAB Simulation tool and different data have been considered from the gene dataset.

```
           default_namespace: ''
              format_version: '1.0'
                     version: ''
                        date: '27:06:2015
                    saved_by: 'jenkins-sl
           auto_generated_by: ''
                   subsetdef: []
                      import: ''
              synonymtypedef: ''
                     idspace: ''
default_relationship_id_prefix: ''
                  id_mapping: ''
                      remark: ''
                     typeref: ''
            unrecognized_tag: {'ontology'
                       Terms: [6x1 geneor

rpt =

    [ 5575]    'Pizza'
    [30529]    'Veg'
    [ 5844]    'Tomato'
    [44424]    'Cheese'
    [32991]    'Pasta'
    [44464]    'Pizza Topping'
```

Fig5. Load Sample Data

```
        id: 5844
      name: 'Tomato'
  ontology: 'cellular component'
definition: [1x301 char]
   comment: ''
   synonym: {'exact_synonym'  '"polyribosome" [NIF_Subcellular:sao1038025871]'}
      is_a: 30529
   part_of: [0x1 double]
  obsolete: 0

Elapsed time is 6.826399 seconds.
```

Fig6. Terms Description

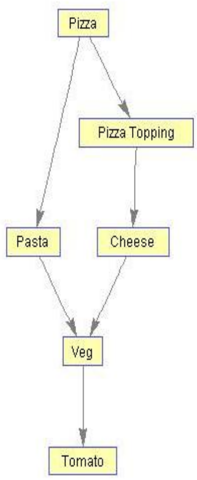

Fig7. Example of Pizza

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```
GO =geneont('File','D:\thesis\2014-2015\Preksha JCD\Final Submission\final IMplementation\gene.obo');
get(GO)
GO(5844).terms % the ribosome Gene Ontology term
ancestors = mgetancestors(GO,5844);
riboanc = GO(ancestors);
cm = getmatrix(riboanc);
BG = biograph(cm,get(riboanc.Terms,'name'));
view(BG);
```

```
% remove any IDs that are invalid
null_terms = GO.hashID(terms+1)==0;
if any(null_terms)
    warning('Bioinfo:geneont:getancestors:InvalidID',...
        'Invalid or obsolete IDs: %s\nCheck that your annotation file is up to date.',...
        num2str(terms(null_terms)));
    terms(null_terms) = [];
end

if isempty(terms)
   GOanc = [];
   if nargout>0
       idx = zeros(size(GO.gonumlist));
   end
   return
end

if nargout>1
    switch relation
        case 0
            cm = double(GO.isarelationmatrix|GO.partofrelationmatrix);
        case 1
            cm = double(GO.isarelationmatrix);
        case 2
            cm = double(GO.partofrelationmatrix);
    end
```

Fig.: Sample Matlab Code

6. CONCLUSION AND FUTURE WORK

In this paper a modified Ontology based Knowledge representation has been auspiciously explained. The proposed approach will produce a remarkable performance as compared to the previously used algorithms.

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