# Cognitive Ontology Enrichment for Semantic Information Retrieval

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**ABSTRACT**

Information is Knowledge: Knowledge is Wealth. The combinations of concept with its associative relation, in a quantitative sense is said to be valid information. Relevant information retrieval through cognitive process is our main objective of this paper. The specification of Concept with its relation in an organized way is said to be ontology. Here we use Cognition based ontology for information retrieval which can be implemented in a semantic based information retrieval system.

The main contribution of this paper has been organized in three phase. One is the creation of domain ontology where, here we are using event based sports ontology. The second phase is the conversion of HTML pages through a designed Web Crawler to an entity based XML page and the third phase is the mapping of the entity XML to sports domain ontology. This domain ontology can be used for the refined Semantic information retrieval system.

***Keywords: Ontology, NLP, Syntactic Analysis, Semantic Analysis, OWL, Machine Learning***

## I. INTRODUCTION

Information retrieval is one of the active research areas as the number of users, searching for knowledgeable information and also the amount of information available on internet is increasing exponentially in day-to-day basis. So, we are in need of intelligent information retrieval system.

A retrieval system will be more effective if the machine understands the user query .Thus we required a semantic based information retrieval system. The sole part of semantic based information retrieval system is based on Ontology. Ontology is an organized way of representing the entities and their relationship in a domain. An ontology formally defines different concepts of a domain and relationships between these concepts.

The recent Web Ontology Language (OWL) [14], has become a popular standard for data representation and exchange. The OWL supports the representation of domain knowledge using classes, properties and instances for the use in a distributed environment as the World Wide Web.

The main part of any semantic information retrieval is the recognition of what the user wants to search for. A human response to a query through his cognitive process. Cognition is the process of endless decision making without any perception but through semantic knowledge experience and sense.

In this paper we have designed a framework for semantic information retrieval system using cognitive ontology concept. This paper is organized in such a way that first the overall framework has been explained, next the specific domain ontology is briefed, then the modules of the framework has been explained.

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## II. Related work

In this section, several strategies for deriving Ontologies [20] from heterogeneous XML data sources have been disused. Some approaches targeted either more on a general mapping between XML and RDF others aim at mapping XML Schema to OWL.OWL and RDF are much of the same thing, but OWL is a stronger language with greater machine interpretability than RDF. OWL comes with a larger vocabulary and stronger syntax than RDF.

In [4] the author discussed some XML rule pattern, if the pattern matches it will be converted to the mapped OWL attribute and in [8] discuss the way of converting the HTML to OWL using table. They consider the TABLE tag of HTML page and tried to convert to OWL both of this paper result won't produce any semantic to the ontology. In [9] they tried to convert the HTML to OWL using the FRAME set tags they also tried to incorporate UML to identify the class and subclasses. In [10] the conversion is done by first annotating the web page. The annotation they consider is the semantic annotation thus they tried to provide semantic of the page. They use the tool called GATE to analyze the semantic through natural language processing. In [13] the conversion is take place using the tag and they used GRDDL tool for conversion. In [5] they extend the XML to the existing OWL using a tool JXML to OWL. In [11] the reusability of created OWL from HTML from forms has been discussed. The overall categories of Ontology based search engine as explained is discussed in [12].

## III. Cognitive Ontology Based Information Retrieval Framework

To design an information retrieval system as similar to that of human mind is a challenging research area which comes under computer vision. In [15] [16] the concept of semantic information retrieval using the idea of ontology has been used.

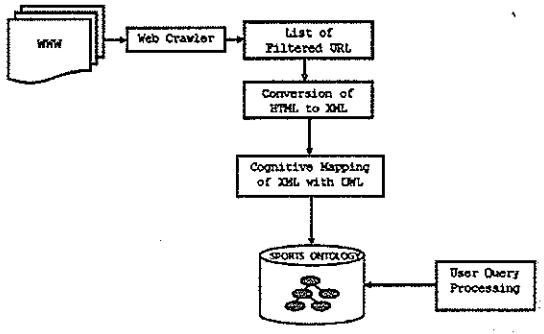



**Figure 1 Proposal Framework**

Figure 1 shows the overall view of the proposed Cognitive Ontology based information retrieval system.

The Sports Ontology is a repository of the domain ontology created for our work. Here we have created ontology by considering 10 events. The information from World Wide Web is been collected through a programmed web spider which is also called as a web crawler. It is programmed in such a way that it would filter out only most of the listed 10 sports related event web pages. Those pages are given to a conversion process of html to xml converter from which the entity related XML is created. Then the intelligent process of mapping the generated XML with our Sports domain ontology is processed. So, for a user query the required result are navigated through the mapped ontology.

In following sub-section the creation of sports event ontology, HTML to XML conversion and the Cognitive mapping of XML to OWL mapping is discussed in detail.

### *A. SportEvent Ontology*

Ontology is an organized way of representing the entities and their relationship in a domain. This ontology can be represented using OWL the Web Ontology Language. At first few decades after introducing the concept of Semantic web technologies Resource Description Framework, RDF [1] is used to define the ontology of an domain, where the hyperlink in a html page is replaced by the <subject,object,predicate> triplets.

Then in second decade of ontology the concept of RDFS that is RDF Schema is used which introduce the concept of creating associate relationship between two entities. Then by 2004[2] W3C recommend OWL which is the combination of RDF,RDFS and some of cardinal expression which is missing out in RDFS which also help us to build more complex domain ontology. Fig.2 shows the structure of OWL

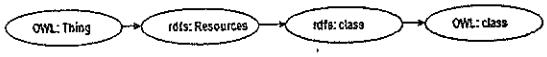



**Figure 2: OWL language structure**

The sports event consider to create the sports ontology are cricket, croquet, marathon, polo, rowing, Mountain climbing, sailing, ski, tennis and volley ball.

The sports event ontology is designed by classifying into two different classes at the top level which is shown in Fig.3

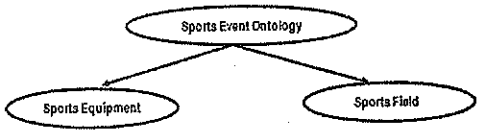



**Figure 3: Sports Event Ontology- level 1**

The Sub-classes of sports field class are:

- ⇒ Grass field
- ⇒ Water field
- ⇒ Road field
- ⇒ Indoor stadium
- ⇒ Rocky field
- ⇒ Snow field

The Sub-classes of sports equipment class are:

- ⇒ Ball
- ⇒ Bat
- ⇒ Boat
- ⇒ Hoop
- ⇒ Mallet
- ⇒ Mast
- ⇒ Net
- ⇒ Oar
- ⇒ Pole
- ⇒ Racquet
- ⇒ Rope
- ⇒ Stump
- ⇒ Skis

All the above entities is defined as classes and its sub classes. The 10 events are specified as individuals as they have to be related to all the two major classes. In Table 1 shown the Individual (instants) created for the sub class of the class Sports Field is specified. In Table 2 the individual created for the sub class Sports Equipment is shown

**TABLE I**

SPORTS FIELD CLASS – INDIVIDUAL RELATION

| Classes | Individual |
|---|---|
| Grass field | Cricket |
| | Croquet |
| | Polo |
| Water field | Sailing |
| | Rowing |
| Road field | Marathon |
| Rocky field | Mountain Climbing |
| Indoor Stadium | Tennis |
| | Volley ball |
| Snow field | Ski |

**TABLE II**

SPORTS EQUIPMENT CLASS – INDIVIDUAL RELATION

| Classes | Individual |
|---|---|
| Ball | Cricket |
| | Croquet |
| | Polo |
| | Tennis |
| | Volley ball |
| Bat | Cricket |
| Boat | Sailing |
| | Rowing |
| Hoop | Croquet |
| Mallet | Croquet |
| | Polo |
| Mast | Sailing |
| Net | Tennis |
| | Volley ball |
| Oar | Rowing |
| Polo | Ski |
| Racquet | Tennis |
| Rope | Mountain Climbing |
| Stump | Cricket |
| | Croquet |
| Skis | Ski |



With this class, sub-class and individual hierarchy organization we have to specify the object property of

each individuals. The identified object properties are listed in Table 3

TABLE III
SPORTS EVENT ONTOLOGY INDIVIDUAL'S OBJECT PROPERTIES

| Classes | Individual |
|---|---|
| Cricket | has_criketball |
| | has_criketbat |
| | has_criketstump |
| Croquet | has_croquetball |
| | has_croquetmallet |
| | has_croquethoop |
| Polo | has_poloball |
| | has_polomallet |
| Rowing | has_rowingoar |
| | has_rowingboat |
| Sailing | has_sailingboat |
| | has_sailingmast |
| Mountain Climbing | has_rope |
| Ski | has_skipolo |
| | has_skiskies |
| Tennis | has_tennisball |
| | has_tennisnet |
| | has_tennisracquet |
| Volley ball | has_volleyball |
| | has_volleyballnet |

### B. HTML to XML Conversion

The first phase of this Framework is the conversation of all the web page collected from the designed web crawler to a standard XML files with name entity concept. Name Entity Recognition is a concept of Natural Language Processing. In short it is called as NER. The main technology [13] used here are patterns and Lexicons. For the given Corpus text NER classifies the entity as Person Name, Organization Name, Location and Miscellaneous (Date, Time, Number, Percentage, Monetary expression, Number expression and Measurement expression)

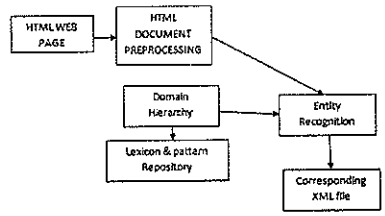



**Figure 4 : Entity based XML Conversion**

Fig. 4 shows the general framework for converting HTML document to XML using Name Entity concept this technique is derived from [3].

In this process a domain hierarchy is created manually as per the domain knowledge, where the possible knowledge on the entities listed is hierarchy organized. When an HTML page is given as input to this process the unwanted advertisement and post are all removed with the help of DOM of the HTML page. With the preprocessed page the entities are all matched through the lexical pattern with the help of Domain Hierarchy. Thus identified pattern are list under their corresponding tag such as <organization> with the instant tag.

### C. XML to OWL Mapping

In general an well formed XML can be converted or mapped to an ontology through an syntactic way. In [4] & [6] the general rule of converting an XML Schema to ontology is explained. An overview of those mapping is tabulated in table 4

TABLE IV
XML TO OWL MAPPING

| XSD | OWL |
|---|---|
| Xsd:elements,containing other elements or having at least one attribute | Owl:class,coupled with owl:ObjectProperties |
| Xsd:elements,with neither sub-elements nor attributes | Owl:DatatypeProperties |
| Named xsd:complexType | Owl:class |
| Named xsd:SimpleType | Owl:DatatypeProperties |
| Xsd:minOccurs,xsd:maxOccurs | Owl:minCardinality,owl:maxCardinality |
| Xsd:sequence,xsd:all | Owl:intersectionOf |
| Xsd:choice | Combination of owl:intersectionOf, owl:unionOf and owl:complementOF |

In [17] the mapping of XML to OWL has been discussed for a B2B domain where the heterogeneous classes and attributes are employed.

The concept of this mapping is been explain in my paper [7]. The lack in this kind of conversion is that here the XML is not converted in a semantic way[18]. Thus here we designed a framework were we tried to convert the XML in a meaningful way.

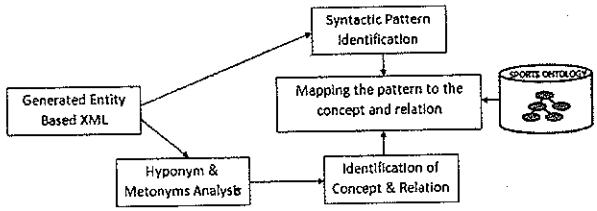



**Figure 5 : Semantic based XML- OWL Mapping**

As per Fig.5, from the generated XML, the OWL classes, sub-classes, Object property and data property are identified as per the pattern explained in Table 4.

In parallel to that hyponyms and meronyms are analyzed. Where hyponyms are, semantically related words. Thus it provide a semantic relationship "is-a" between two related concepts or terms. For example has_cricket_batting_ball and has_cricket_bowling_ball are semantically related. Meronyms provides the "part-of" relationship between the concepts or terms for example has_croqent_hoop is a part of has_croquent_mallent. Likewise the "part-of" and "is-a" relationship between all the classes and object properties is been analyzed over here thus to provide an semantic knowledge to the semantic search system.

Thus the Semantically identified concepts and it relation is mapped with the syntactically generated pattern. Thus generated XML is mapped with the created sports domain ontology.

Searching the ontology is done by SPRQL [19] or OWL-QL language. Logical descriptive language is one of the strong foundations of ontology. These query language is basically used to search ontology for relevant result of each classes in the ontology is represented by a specific URI.

For the given textual keywords or a sentence the probability reasoning concept is used to analyse the query to extract the main concepts, relation words form the query with that, we can search the Sports ontology for the related URI.

## IV. Conclusion

The main objective of this paper is the mapping of existing HTML page to the domain Ontology for this an entity based XML conversion and semantic based OWL mapping is used. Such created ontology can be used for semantic search system.

The future part of our work [22] is to employ an multimodal base ontology search [21], where an user can give both text and image as query.

## References

[1] Linyang Yu *"Introduction to the Semantic Web and Semantic Web Services"* Chapman & Hall/CRC Taylor & Francis Group 2007

[2] Dean, M. and Schreiber, G., 2004, OWL Web Ontology Language Reference, W3C Recommendation, http://www.w3.org/TR/2004/REC-owl-ref-20040210/.S.

[3] Jianhan Zhu,Victoria Uren, Enrico Motta *"Espotter:Adaptive named Recognition for web browsing"* (2004)

[4] Ivan Bedini,Christopher Matheus and Benjamin Nguyen *"Transforming XML Schema to OWL using Patterns"* 2010

[5] Toni Rodrigues,Pedor Rosa and Jorge Cardoso *"Mapping XML to Existing Owl Ontologies"* 2006 Hannes Bohring and Soren Auer *"Mapping XML to OWL Ontologies"* 2005.

[6] G.Nagarajan,Dr.K.K.Thyagaharajan *"Linguistic Conversion of Syntactic to Semantic Web Page"* The Second International conference on Advances in Computing and Information Technology 2012,Publish on Springer

[7] Alessandro Lenci et al *"NLP based ontology learning from legal texts. A case study"* (2006)

[8] Yuri A Tijerino et al *"Towards ontology generation from tables"* Kluwer academic publishers (2004)

[9] Sidi Benslimane et al *"Towards ontology extration from data intensive web sites: An html forms based reverse engineering approach"* International arab journal of information tecnology (2006)

[10] Debajyoti Mukhopadhyay et al *" A New semantic web services to translate HTML pages to RDF"* Int, Conference of IT (2007)

[11] HOOn Hwangbo et al *"Reusing of information constructed in HTML document : a conversion of HTML to OWL"* Int. conference on control,automation and systems (2008)

[12] Kyumars Sheykh Esmaili, Hassan Abolhassani *" A Categorization scheme for semantic web search engines"* (2005)

[13] Jianhan Zhu,Victoria Uren, Enrico Motta *"Espotter:Adaptive named Recognition for web browsing"* (2004)

[14] P. Hitzler,.M. Krötzsch., B. Parsia, P.F Patel-Schneider, and S. Rudolph, *"OWL 2 Web Ontology Language Primer"*, W3C Recommendation 27 October (2009).

[15] Mirian Fenandez et al *"Semantically enhanced information retrieval:An ontology based approach"* Elsevier's Web semantics:Science,Services and Agent on the World wide web vol 9 issue 4, dec (2011), Pp:434 - 452

[16] Soner kara et al *" An ontology based retrieval system using semantic indexing"* Elsevier's Information systems Vol 37, issue 4, june (2012) pp 294 – 305

[17] Jorge cardoso and christoph Bussler *"Mapping between heterogeneous XML and OWL transaction representations in B2B integration"* Elsevier Data & Knowledge Engineering Vol 70, Issue 12 Dec(2011) Pg:1046 - 1069

[18] Damine Lacoste et al *"An efficient XML to OWL converter"* ACM ISEC'11 Proceedings of the 4th indian software engineering conference (2011) Pg: 145 – 154

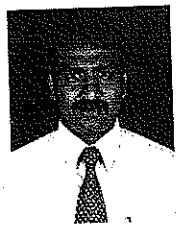
[19] Rashmi Chauhan et al *"Ontology based automatic query expansion for semantic information retrieval in sports domain"* Communications in computer and information science volume 305,(2012), pp 422-433

[20] G.Nagarajan,Dr.K.K.Thyagharajan (2010) *"A Survey On the ethical implications of Semantic Web Technology"* Journal of Advance Research in Computer Engineering: An International Journal ISSN:0947-4320 Vol 4,Number 1, Pg:123-133

[21] Yanti idaya Aspura Mohd Khalid et al *"Towards a multimodality ontology image retrieval"* LNCS Visula informatic: sustaining research and innovations (2011) vol 7067 pp 382 – 393

[22] G.Nagarajan & K.K.Thyagharajan *"Cognitive ontology enrichment using natural language text captions to enhance semantic information retrieval"* paper submitted to Indian Journal of Computer science for (2012) December issue

## Author's Biography



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