Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 5, May -2017

A Query Relevant Context Driven Ontology Recommendation System incorporating Semantics Preservation and Semantic Ontology Matching

[1]Leena Giri G, [2]Gerard Deepak, [3]Manjula S H, [4]Venugopal K R

[1,2,3,4] *Department of Computer Science and Engineering*
University Visvesvaraya College of Engineering
Bangalore University, Bangalore.

Abstract— *The World Wide Web is evolving into a standard Semantic Web that requires efficient modeling of knowledge bases. Knowledge Bases are the constructed mainly based on the domain level segregation of Ontologies. Most interestingly, dynamic construction of knowledge bases is a vital and an important task wherein query relevant domain level ontology bases are constructed. Ontology Recommendation is a methodology to construct knowledge bases and is vital in the context of Semantic Web. It is quite important to retain the initial associations and axioms between the ontologies as they are recommended to preserve ontology semantics. A semantic strategy that preserves associations among the ontology entities during recommendation of ontologies has been proposed. In this approach, domain level OWL ontologies are converted into RDF by the derivation of intermediate XML parse trees. A HashMap-HashTable methodology is used to preserve the axioms between the ontological concepts and individuals. The SemantoSim measure for computing the semantic similarity has been proposed. The semantic relatedness is computed between the query and the concepts at first and then between the query and the description logics which makes this a context driven ontology recommendation system. The context based ontology recommendation system with ontology relationship preservation yields an overall accuracy of 86.87 %.*

Keywords— *Ontologies, Ontology Recommendation, Recommender Systems, Semantic Similarity, Web 3.0.*

I. INTRODUCTION

The World Wide Web is one single repository with a high level of dynamism as its constantly changing and transforming. With the paradigm shift towards social networking and internet technologies, the data and information in the web is continually increasing without any upper limit. Organizing the contents on the web is really a tedious task but it is highly essential to make the retrieval process easy, efficient and less complex. The large amounts of heterogeneous web data needs organization to render information relevant to the query as well as the user. Web information heterogeneity is due to the presence of structured, unstructured and semi-structured data. Data enormity on the web makes it highly difficult to organize and retrieve the required information from the Web. The task of enhancing the relevance of Web Search can be simplified by the incorporation of ontologies. Ontologies can be dynamically constructed for a input query and the Web Data can be recommended to make the retrieval process easier and simpler.

Ontologies are explicit specification of conceptualizations [1]. They are the most basic entities of Semantic Web. The problem of Web based recommendation can be quite easily solved by organization of the ontological entities. Henceforth, searching relevant ontologies from the World Wide Web is the first step for recommending information from the Web. Ontologies are recommended by several types of evaluations. A few systems use one-one mapping of concepts alone with the search term. Some of them map concepts and individuals. A few ontology recommendation systems use purely statistical techniques for filtering Domain Relevant Ontologies. Although a few systems use semantics for recommending ontologies, the original structures of the ontological relations are never preserved.

The preservation of ontological structures is highly important. If a specific ontology has more than one context, then such ontology is said to be ontologically committed. Most ontologies are associated with ontological commitments Once ontology that is committed is "*bat*" which has two explicit meanings which is *"a bird" and "sports bat"* that can further be categorized as a *"cricket bat"*, *"tennis bat"* or even a *"baseball bat"*. *"Bat"* is as well associated with a *"British Pub Game"* named *"Bat-and-Trap"*. Likewise "*bat*" can be used in various contexts like *"to bat"* or even *"batting"*. These are only a few contexts for the ontology *"bat"*. However, there are many more contexts for the term *"bat"* and the list goes on. Similarly, every ontology has more than a context which needs to be analyzed.

Most ontology matching and recommendation systems only have a basic context check for the ontologies where inference is drawn by comparing the concepts and individuals. The axioms and structures are broken and made as per the context of the query using axiomating agents which contain previously defined axioms. However, the context is just assumed by these agents based on the previous There is a need for preserving the original structure between the ontological entities but it's a challenge to preserve them during clustering of ontologies which is solved in the proposed system. An algorithm for recommending ontologies by preserving the original axiomitization between the concepts and individuals of Domain Ontologies is proposed.

Motivation: The traditional web based recommendation and retrieval systems were made suitable to the evolving trends of Semantic Web by inclusion of ontologies. Although the ontologies when fitted into web page recommendation systems yielded better results, the entire context of ontologies were not explicitly visible in the recommendation results. The main reason was because the description logics and the associations of the ontological entities were not taken into consideration by traditional ontology based systems. It is a mandatory requirement for the ontological entities to preserve the axioms and relationships among their concepts and individuals. This ultimately increases the recommendation relevance of web based items.

Contribution: A novel algorithm for Interdomain clustering of ontologies for multi scenario ontologies with many ontological commitments is proposed. The algorithm focuses on the preservation of the semantics between the ontologies. The algorithm focuses on recommending ontologies based on the input query in a way such that the context of the ontologies are checked by a scenario based ontology matching using the proposed SemantoSim measure. The proposed strategy focuses on the OWL to XML conversion of the ontological entities and then derives its equivalent RDF structures. The context level evaluation of ontologies is achieved by the computation of Semantic Similarity between the description logics of initially matching concepts and individuals. This also evaluates the correctness of ontologies. The algorithm further concentrates on the aggregation of the final concepts and individuals based on their original relationships. Finally, the precision, recall, accuracy and F-measure of the query based context driven ontology recommendation system is evaluated.

Organization*:* The remaining of this paper is organized as follows. The Section II provides a brief overview of Related Work. Section III describes the Problem Statement. Section IV depicts the Proposed Architecture. Section V discusses the Implementation in detail. The Performance Analysis & Results is discussed in Section VI. Section VII finally and ultimately concludes the paper.

II. RELATED WORK

Ivan et al., [2] have improved the CORE [3] framework for recommending ontologies and its reuse. The proposed system uses informal description for domain specific ontologies and uses WordNet for refining them. The evaluations are manual and needs human collaborative assessment for determining if the ontologies were domain specific. Marcos et al., [4, 5] have proposed a methodology for Ontology Recommendation using Collaborative Knowledge. The ontologies are recommended with the motive of information organization for a set of initial terms by considering the semantic richness, coverage and the popularity of ontology in the existing Web. Marcos at al., [6] have proposed another Ontology Recommender which evaluates biomedical ontology based on coverage, acceptance of the ontology, details of ontological classes and specialization of the ontology with respect to the input domain data and have conducted evaluations.

Małgorzata et al., [7] have proposed a semantic methodology for validating the classes in UML models. Based on the compliance of the UML models with the OWL domain ontologies, the classes are validated and matched. The UML diagrams are validated based on their semantic correctness without the involvement of Domain Experts. Doan et al., [8] have proposed a system named GLUE for ontology matching based on one-on-one mapping of the ontological entities. The proposed system GLUE is based on machine learning that semi-automatically creates semantic mappings. Todd et l., [9] have discussed the fundamental problems that are involved in Ontology Alignment along with detailed discussions of the various complexities and anomalies faced by systems for aligning ontologies.

Sergio et al, [10] have proposed a technique for ontology matching by visualizing the problem of ontology matching as a binary classification problem. A pattern classification model by aligning the instances of from heterogeneous ontologies is proposed. The OWL ontologies are considered as a Learning Objects Metadata model in this approach. However, the ontology structure preservation and context based ontological matching or recommendation is never targeted. Ujwala et al., [11] have proposed an ontology matching technique by deriving the degree interoperability between informational sources. The experimentation is done for the geospatial domain thus constituting Geo-ontologies. An ontology matching framework by incorporating interoperability measurement is proposed.

Anam et al., [12] have proposed a Knowledge Based Schema Matching technique for mapping ontologies. A machine learning approach is incorporated into the system which is further for classification and further incremental knowledge is instilled into a graph schema. This approach is an integrated approach that combines machine learning and knowledge acquisition as a Hybrid Ripple Down Rules approach. Ranjini et al., [13] have proposed an approach for identifying the semantically rich concepts by incorporating concept and relationship level classification. The approach is a weight based iterative approach where weights are assigned to clusters of ontologies and ranking is done based on these weights.

Xiang et al., [14] have proposed a random walk approach which is based on affinity preservation and mapping-oriented random walks. It is a graph based strategy which is a one-to-one matching strategy. The algorithmic complexity is very high as graph based approach is used. Xue et al., [15] have proposed an ontology matching technique based on matching ontological segments. Initially the ontologies are partitioned into a number of segments. Using individual segments, the target ontologies are further segmented by using concept based relevance .Ultimately the segments that are matched are induced into ontology alignment. Although this is a very good technique for ontology alignment, the ontological structures are not preserved.

Jean-Mary et al., [16] has proposed a unique strategy of semantic matching of ontologies with the inclusion of verification. The proposed strategy is iterative in nature and uses the combination of lexical and structural characteristics of ontologies. The verification is incorporated to check for semantic inconsistencies. Ferdous et al., [17] have proposed a semantic content based news recommendation system. The news Ontologies are initially created by considering the title and the body of the news separately. Further Ontologies are matched between translated ontology and English Ontology. Semantic Similarity which is the matching factor is considered for matching and recommendation is done based on it.

Cantador et al., [18] have proposed a semantic hybrid recommendation model in which the item features and user preferences are considered as ontological entities. The clustering is done between the concept features and the user spaces in a highly co-ordinated manner. Multiple Semantic Layers are formulated in this approach to find similar items using the clustered items. The recommendations of community interests are achieved by layer formulation. Jiménez-Ruiz et al., [19] have proposed LogMap which is an ontology matching and mapping framework which is scalable and operable for very large classes of ontologies. LogMap yields consistent ontology classes and the output is defined as a clean approach and does not yield unsatisfactory classes in the final output. Bella et al., [20] have proposed an innovative strategy of ontology matching of light weight ontologies. The semantic matching here is referred as a cross-linguistic matching where multilingual NLP techniques are used to match labels using domain aware language independent knowledge. Further a fusion matcher is also proposed which is a hybridized technique.

Seig et al., [21] have proposed an approach for context sensitive collaborative recommendation. The approach proposed is also driven semantically and the knowledge used is semantically aligned and corresponds to ontological knowledge. An ontological user profile is modeled and are learned methodologically which are updated in an incremental fashion and is used in a collaborative fashion. Butt et al., [22] have proposed an innovative methodology for recommending ontologies for queries without any structure. The approach proposed formulated a list of relevant ontologies and their ranks correspondingly on it. The ontologies are matched for a multi keyword query. The strategy proposed recommends ontologies and formalizes the same to yield information and popular ontologies with reduced matching costs. Hertlinge et. al., [23] have used a large scale external internet resources for matching ontologies namely the Wikipedia and have depicted the feasibility of the usage of Wikipedia in solving ontology matching problem.

III. PROBLEM DEFINITION

Recommending Ontologies and dynamic construction of query relevant knowledge bases is a huge challenge owing to the linked structure of Ontologies. The traditional Ontology Modeling and Retrieval systems operate by focusing on the ontological entities namely the concepts and individuals and are least concerned about the preservation of the ontological relationships or axioms. The greatest challenge is to track the origin of the ontologies in the Ontology Repository and keep the axioms and the description logics between the concepts and the individuals of the ontologies intact. Above all the relevance of the ontologies with that of the query must be high. Although the ontologies may canonically match with the input query, their description logics need to be validated where their contexts need to be estimated. Moreover the much complicated OWL ontologies need to be evaluated along with their associations and ontological commitments such that they could be easily matched or classified depending on the query that is input.

IV. PROPOSED ARCHITECURE

The architecture of the proposed system is depicted in Figure1 where a specific query for which ontologies should be recommended is entered. The query can be specified by a user or by ontology experts like the Knowledge Engineers or Domain Experts. The query can also be entered by bots or third party systems seeking domain ontologies. As the system is queried, the query undergoes pre-processing. The query pre-processing is done by tokenization and stemming. A customized blank space Tokenizer tokenizes the query into individual query words. The query generally is to search and retrieve a class or a group of ontologies from an OWL ontology domain without breaking the axioms and the relationships between the ontological entities. The principal reason for stemming is to eliminate the unwanted and redundant stop words from the query. The query pre-processing yields a set of unique query terms for which the ontologies that are context relevant must be yielded.

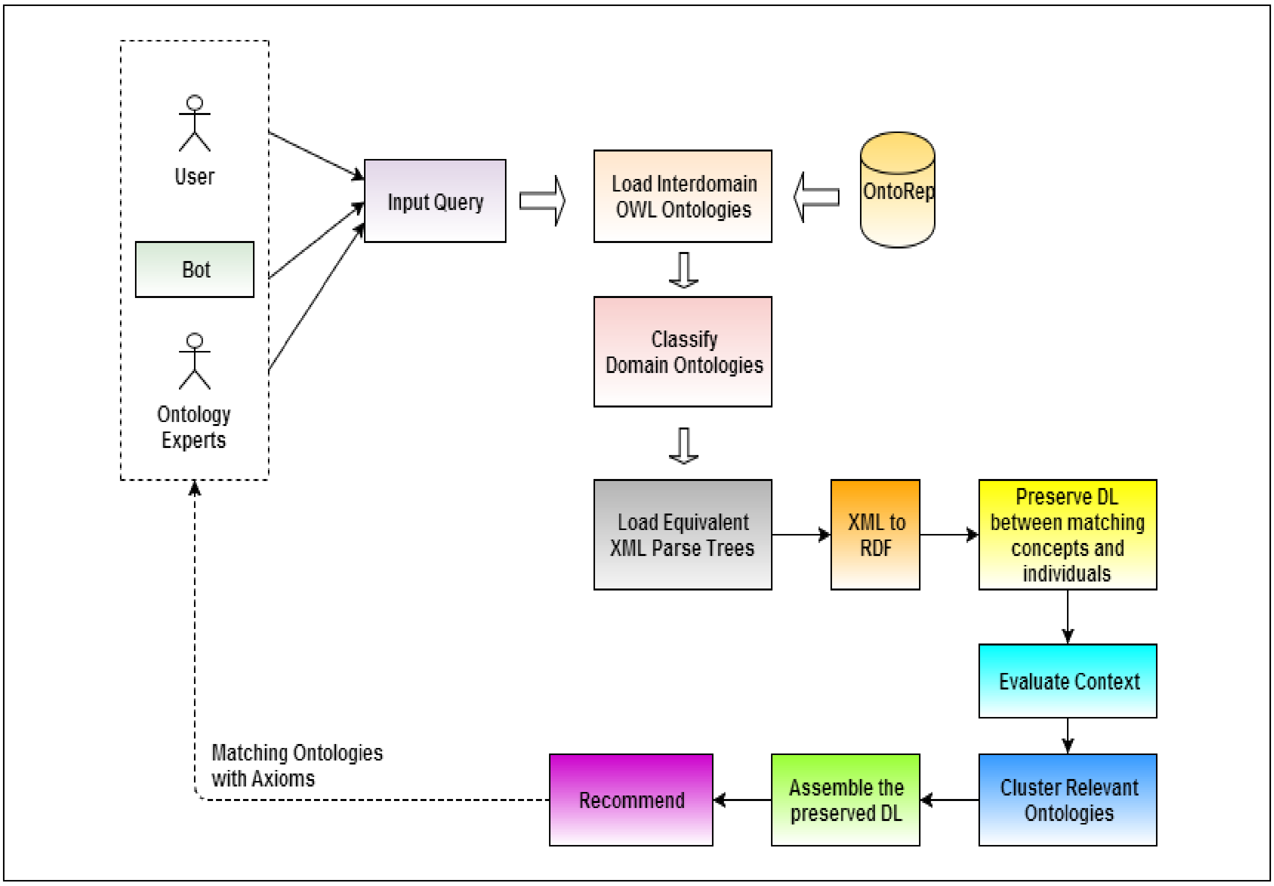

Figure 1: Architecture of the Proposed Context Driven Ontology Recommendation System

OWL ontologies have a characteristic property of description logics. The concepts and individuals of owl ontologies are described using semantic description logics. The analysis of these description logics of the ontological entities will definitely yield the context of ontology and its ontological commitment if any. It's definitely impossible to directly interpret the contents of an .owl file as they are unreadable and irrational to any naïve user. Only Ontological Experts and Knowledge Engineers are capable of interpreting a .owl file. To over this anomaly, the proposed ontology recommendation system is capable of loading and classifying the .owl ontologies. The system allows the users' to add Domain Level Ontologies as .owl files. The system is able to convert the .owl file structure into its equivalent XML parse tree structure. The reason why OWL files can be converted into their equivalent XML structures is that the basic semantics of OWL and XML are correlative and assume a hierarchical nested tree structure.

The ontological elements are both concepts and individuals that need to be organized. Once the equivalent XML schema for the OWL Ontological Domains is obtained, they are expressed into their triadic RDF format. The RDF or the Resource Description Framework is a metadata model that is used to describe the ontologies and directly relate them with each other based on their description logics. The description logic analysis of the concepts and individuals of ontologies will give a discernment of the context of the ontologies. The OWL ontologies are stored in the repository called as OntoRep. OntoRep is the storehouse of .owl formats of several Domain Level ontologies. The Semantic Similarity is computed initially between the query words and the conceptual nodes of the XML parse tree formulated from the Domain Level OWL Ontologies. The RDF equivalence of the matching nodes is retrieved and the semantic similarity is computed between the description logic of the matching concepts and individuals

The semantically relevant concepts and individuals with relevant description logics are clustered together. The description logics of the ontologies which describe their hierarchy are also extracted when the clustering on ontologies takes place and are used for axiomitization by the Semantic Agents. The ontologies are arranged in the increasing order of their semantic similarity. There is a high degree of Semantic Alignment as the Semantic Similarity Computation yields closely related ontologies to be recommended to the user. The traditional graph based approach for processing the hierarchical ontologies is overcome by incorporating a HashMap-Hash Table Approach.

The usage of Graphs for processing the ontologies is implemented as the relationships between the ontological entities can be expressed quite distinctively. The usage of graphs can be tedious and they tend to increase the overall complexity of the system. Moreover, the axioms retention between the concepts and individuals or between two concepts of the same domain is highly cumbersome. This anomaly can be solved using a HashMap and a Hash Table coherently to store and map the concepts and individuals along with their axioms. The hierarchy of the concepts is maintained as it is in the same order and form the Key of the HashMap. The individuals for specific concepts are concatenated with a unique HashValue generated. The axioms that are description logics to the individuals are stored in the Hash Table as values where the HashValue form the Key. This is done in with the main objective of preserving the relationships, hierarchies and axioms between the concepts, individuals and axioms of a specific domain. There is a need for the generation of a unique HashValue to ensure that the description logics for the concepts and individuals are kept in order without losing its track.

The Semantic Similarity is computed between the query words and the concepts at first. Further the description logics in the HashTable of matching concepts are loaded to compute its semantic similarity with the query words in order to derive the matching scenario and context. Only the concepts and description logics whose semantic similarities are matching are clustered together and further arranged in their increasing order of their semantic similarity. Ultimately, the axioms in the form of description logics are induced between the concepts and the individuals based on the unique hash value. This definitely solves the problem of preserving the axioms between the concepts and individuals without any further problem. The Semantic Similarity is computed using the SemantoSim Measure which is a semantic measure inspired from the Pointwise Mutual Information [24] measure proposed by Church & Hanks.

$$\text{SemantoSim}(x, y) = \frac{\text{pmi}(x,y) + p(x,y)\log[p(x,y)]}{[p(x).p(y)] + \log[p(y,x)]} \quad (1)$$

The SemantoSim measure is a semantic similarity measure that is derived from the Pointwise Mutual Information measure and is a normalized semantic measure. The query terms are paired as (x, y) if there are two terms in the query. If there are three query terms then permutations of the three pairs are considered. If it's a single term query, then semantic similarity for the term x and its most closely related semantically relevant term is considered. The query terms are the query words that are tokenized and stemmed. The SemantoSim yields the semantic relatedness between two terms (x, y). The pmi(x, y) is computed using equation (1). The expression p(x, y) is the probability of the term x in its co-occurrence with y. p(x, y) is the probability of occurrence of the term y with x. p(x) and p(y) are the probabilities of the presence of the terms x and y respectively.

V. IMPLEMENTATION

The implementation of the proposed system is done in JAVA using Netbeans as the suitable IDE. The preferred backend was MYSQL lite. JAVA Collections framework as well as JAVA SWINGS framework was also made use of. The HashMap and HashTable were implemented from the JAVA collections framework. HTML was also used in the front-end design apart from JAVA SWINGS. The Ontologies were of OWL format in the ontology repository. Multi-Scenario Interdomain ontologies were considered for experimentation. The Ontologies has explicit axioms as well as relationships expressed in the form of Description Logics and were stored in the centralized Ontology Repository. To suit the domains, the available ontologies were enhanced by modeling many individuals to them. Also, custom authored ontologies were modeled using Protégé and OntoCollab [25]. The existing ontologies were made more complex by associating many scenarios to it and adding relative concepts and their individuals. Also, the associations between the concepts and the individuals were made complex with axiom induction and description logics formulation. The mappings between concepts and individuals were maintained to be *m:n* to facilitate the derivation of a complex multi context dataset. The concepts and individuals are relative to each other as the association is in a way such that certain concepts are individuals to others and vice-versa. The data sets are made complex to achieve the best outcome in terms of relevance of ontologies recommended.

The Domain Ontologies that considered for experimentation were stored in the centralized Ontology Knowledge Base OntoRep. The ontologies that had many contexts were chosen. For instance, one of the ontologies chosen was the "Book" Ontologies that had several contexts. Each context for the "Book" ontology was incorporated in separate .owl files. Though the term "Book" can be expressed as a specific descriptive ontology, it can have several contexts with respective to authors, subjects, type of books, target people of the book, etc. Similarly, another prospective ontology can be a simple "Product" ontology which can have its context in "Supermarket" ontology, "E-Commerce", etc. If the specific product is an electronic item, it can have its context in "Student Project" ontology or even in the "ElectronicItems" ontology. The details of ontologies, their different contexts and the number of concepts/individuals associated with the Ontology Datasets is depicted in Table 1.

Table 1: Ontologies and Their Contexts Used

OWL Ontologies	Contexts	No. of Concepts	No. of Individuals
Products Ontology	Electronics, Cosmetics, Baking Products, Food,Crockery.	27	118
Books Ontology	Fiction, Work books, School Text Books, Author Based, and Computer ScienceBooks.	85	292
Cake Ontology	Flavor, Brand, Price.	18	54
Furniture Ontology	Wooden, Metal, Modern, Contemporary, Type of Wood	27	86
Cars Ontology	Brand, Price, Model, Based on Sedan or Hatch Back, Engine.	22	56

The proposed algorithm for Context Driven Ontology Recommendation is depicted in Table 2. The query input by the system is subject to pre-processing which further yields the individual query words. The Ontology Repository is Looked Up for the keyword matches based on which the Domain Level OWL Ontologies are loaded. Further the equivalent XML parse tree for the Domain Ontologies is loaded. The algorithm involves the computation of semantic similarity twice. At first, the semantic similarity is computed between the query words and the distinct concepts of the Domain Ontologies. Further, the semantic relatedness is computed between the Description Logics Preserved between the matching concepts and their individuals. The Description Logics Evaluation checks for the context of the ontological entities, thereby the ontological commitments for the specific ontologies is also checked. The Description Logics needs to be preserved between the matching concepts and their individuals, to evaluate the context as well as keep the relationships intact among the ontologies without re-axiomitization. The Algorithm yields an artifact of the relevant ontologies with its associated relationships that are recommended to the user.

Table 2: Context Based Axioms Preservation Semantic Algorithm for Recommending Ontologies

Input : The query q for recommending ontologies is the primary input, Domain Level Ontologies from heterogeneous sources with inter domain associations as axioms and Description Logics
Output: Query Relevant Ontologies with their relationships and axioms exactly as in the source ontologies in the Knowledge Base
Begin
Step 1: The query q input is preprocessed in which tokenization and stemming is performed to obtain a set of query words Q.
Step 2: while(Q.next() is!=0)
    Match the Ontological Entites in Ontology Repository
    Load the matching concepts and individuals

Step 3: The matching OWL Multi Domain ontologies are transformed into XML trees using concept hierarchy.
Step 4: Compute the Semantic Similarity ss between elements in Q and the concepts c in XML tree using SemantoSim measure
    if(ss<0.25)
    HashMap H_c←c, ss
Step 5: for every concept c in H_c
    Individuals I→C
    Generate unique Hash Value and concatenate it with I
    Extract Description logics DL_i of I→C
    HashMap H_t← c, C_i
    HashTable H_m←I,DL_i
Step 6: for each DL in H_m
    ss1=SemantoSim(q', DL_i)
    if(ss1<0.25)
    L=Tokenize and Remove Numeric Content from C_i
Step 7: Using L Lookup H_m, Retrieve current DL
    Axiomitize L and current concepts with DL.
Step 8: Formulate an artifact comprising of current concepts with their respective relevant individuals.
Ensure that the concepts and their respective individuals are arranged in the increasing order of their semantic similarity.
The Axioms are kept intact between the concepts and individuals
end

VI. PERFORMANCE ANALYSIS AND RESULTS

The system was queried with distinct queries mentioned in Table 3 and the performance was evaluated for the proposed system for Ontology Recommendation. The ontologies that were specific to the query were clustered and recommended based on their SemantoSim values preserving the axioms between the concepts and individuals. Precision, Recall and Accuracy are the metrics that were chosen for evaluating the Performance as they are the most preferred measures for any class of recommendation or information retrieval systems. Since the proposed system recommends ontologies by preserving the ontological structures, the chosen metrics are comprehendible. Precision is defined as the ratio of the retrieved and relevant ontologies to the total number of retrieved ontologies. Recall is the ratio of the ontologies retrieved and relevant to the total number of relevant ontologies. Accuracy is defined as the average of the Precision and Recall Measures. Equations (2). (3) and (4) depicts the Precision, Recall and Accuracy of the system. The F-Measure is depicted by equation (5) which is defined as the Harmonic Mean of the Precision and Recall.

$$\text{Precision} = \frac{No.of\ \ retrieved\ \ and\ relevant\ \ Ontologies}{Total\ No.of\ Ontologies\ \ retrieved} \quad (2)$$

$$\text{Recall} = \frac{No.of\ \ retrieved\ and\ relevant\ Ontologies}{Total\ No.of\ \ Ontologies\ that\ are\ relevant} \quad (3)$$

$$\text{Accuracy} = \frac{Precision + Recall}{2} \quad (4)$$

$$\text{F-Measure} = \frac{2 * Precision * Recall}{Precision + Recall} \quad (5)$$

Table 3: Performance Evaluation for the Proposed Context Driven Ontology Recommendation System

Query	Precision %	Recall %	Accuracy %	F-Measure %
Computer Science Books	85.19	88.46	86.83	86.79
Books	86.55	89.96	88.26	88.22
Petrol Cars below 25 Lakhs	84.21	88.89	86.55	86.49
Modern Wooden Furniture	84.72	88.41	86.57	86.53
Cakes with Mixed Flavors	83.33	88.99	86.16	86.07
Average	**84.8**	**88.94**	**86.87**	**86.82**

The proposed system furnishes an average Precision of 84.8 % and an average recall of 88.4 %. An overall accuracy percentage of 86.87 is achieved by the proposed context driven Ontology Recommendation System. The reason for higher performance when the ontological structures are preserved is that, there is a query based evaluation as well as a context based evaluation. This increases the overall relevance of the recommended ontologies and makes the recommendations highly specific to the query as well as the domain. Moreover, the SemantoSim measure proposed is an adaptation of the Pointwise Mutual Information algorithm with a semantic flavor added to it. With the intelligent integration of a semantic methodology for semantic similarity computation, retaining the original axiomitization between ontological entities along with estimating the semantic heterogeneity between the query words and the description logics increases the relevance of results.

Since the proposed system is one of its kind and is the first system to recommend ontologies by preserving the ontological relationships and semantics between its concepts and individuals, its comparison is done by eliminating the Ontology Structure Preservation. The Ontologies are processed without preserving their structures by only recommending the ontologies by computing SemantoSim between the query words and the concepts/individuals. The overall precision, recall and accuracy measures dropped. The reason for a low relevance rate is mainly due to the ignorance of context of the ontologies. An overall Precision of 81.78 %, Recall of 84.99 & and 83.39 % was achieved when the structure preservation of ontologies were ignored. This clearly justifies the fact that the proposed system preserves the original Description Logics between ontological entities performs way better.

Table 4: Performance Evaluation without Ontology Structure Preservation

Query	Precision %	Recall %	Accuracy %	F-Measure%
Computer Science Books	81.63	85.11	83.37	86.79
Books	82.5	84.92	83.71	88.22
Petrol Cars below 25 Lakhs	81.81	84.37	83.09	86.49
Modern Wooden Furniture	81.15	84.84	82.99	86.53
Cakes with Mixed Flavors	81.81	85.71	83.76	86.07
Average	**81.78**	**84.99**	**83.38**	**86.82**

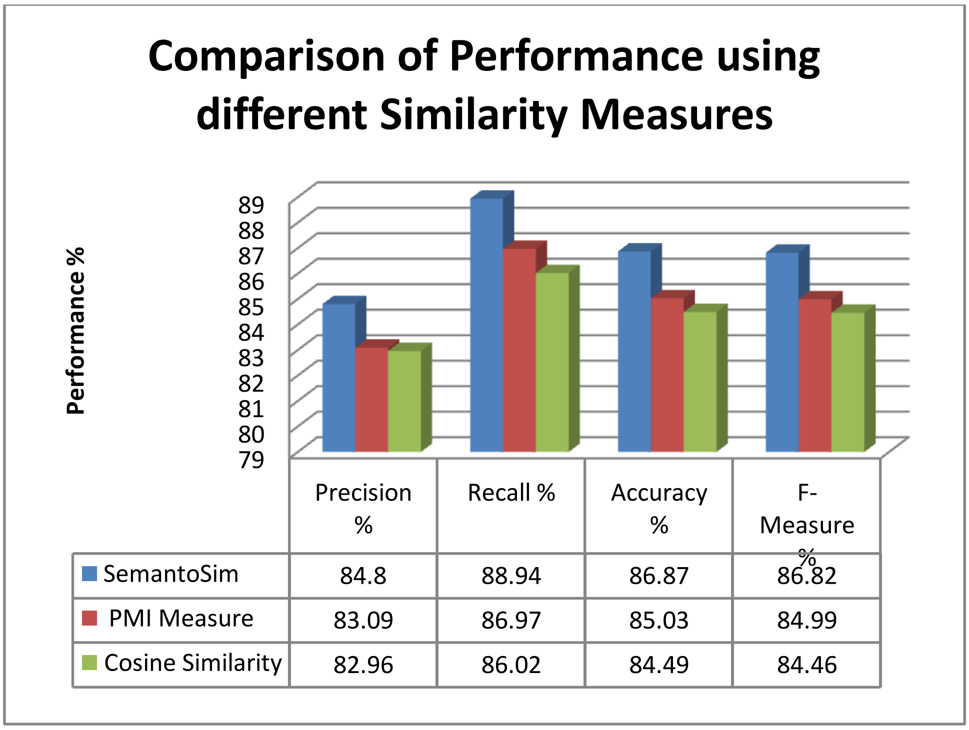

Figure 2: Performance Comparison in the proposed system with various Similarity Measures

The performance of the proposed system was further evaluated by replacing the SemantoSim measure by the traditional measures such as the PMI [24] and Cosine Similarity measures. This is done with the ultimate motive to compare the proposed similarity measure with that of the existing measures. The comparison is well evident and is clearly depicted in Figure 2 and it is inferable that the SemantoSim measure yields higher precision, recall, accuracy and f-measures than the existing traditional approaches. SemantoSim measure yields and overall precision of 84.8 %, an average recall of 88.94 %, an average accuracy of 86.87 % and a f-measure of 86.82%. When PMI measure was incorporated into the proposed system it only yielded an overall precision of 83.09%, an average recall of 86.97%, an overall accuracy of 85.03% with an F-measure of 84.99. The cosine similarity measure when fitted in the proposed system yields an overall precision of 82.96%, an average recall of 86.02 % , an accuracy of 84.49 % with an F-measure of 84.46 %.

VII. CONCLUSIONS

An innovative algorithm for dynamic recommendation of ontologies with axiom preservation is proposed. The proposed ontology recommendation system constructs efficient ontology knowledge bases depending on the input query and also evaluates the context as well as the scenario of the ontologies before recommendation. The ontological commitment is check evaluated before the final recommendation of ontologies. The SemantoSim measure proposed for computing the semantic similarity in recommendation of ontologies performs much better than the existing approaches and yields a higher precision, recall, accuracy and f-measure. The strategy proposed operates by converting OWL to its equivalent XML trees which are then transformed into RDFs for processing. The HashMap-HashTable strategy that is adopted for ontology structure preservation performs well and the original ontological associations are well preserved. An overall precision of 84.8%, recall of 88.94% and an accuracy of 86.87% is achieved by the proposed system.

ACKNOWLEDGEMENT

I thank God the Almighty and Eternal Father for having given me the strength and wisdom to carry out this research work.

REFERENCES

.

[1] Gruber, Thomas R. "Toward principles for the design of ontologies used for knowledge sharing?." International journal of human-computer studies 43, no. 5 (1995): 907-928. Cantador, Iván, Miriam Fernández, and Pablo Castells. "Improving ontology recommendation and reuse in WebCORE by collaborative assessments." (2007).

[2] Cantador, Iván, Miriam Fernández, and Pablo Castells. "Improving ontology recommendation and reuse in WebCORE by collaborative assessments." (2007).

[3] Fernández, Miriam, Iván Cantador, and Pablo Castells. "CORE: A tool for collaborative ontology reuse and evaluation." (2006).

[4] Romero, Marcos Martínez, José M. Vázquez-Naya, Cristian R. Munteanu, Javier Pereira, and Alejandro Pazos. "An approach for the automatic recommendation of ontologies using collaborative knowledge." In International Conference on Knowledge-Based and Intelligent Information and Engineering Systems, pp. 74-81. Springer Berlin Heidelberg, 2010.

[5] Martínez-Romero, Marcos, José M. Vázquez-Naya, Javier Pereira, and Alejandro Pazos. "A multi-criteria approach for automatic ontology recommendation using collective knowledge." In Recommender Systems for the Social Web, pp. 89-103. Springer Berlin Heidelberg, 2012.

[6] Martinez-Romero, Marcos, Clement Jonquet, Martin J. O'Connor, John Graybeal, Alejandro Pazos, and Mark A. Musen. "NCBO Ontology Recommender 2.0: An Enhanced Approach for Biomedical Ontology Recommendation." arXiv preprint arXiv:1611.05973 (2016).

[7] Sadowska, Małgorzata, and Zbigniew Huzar. "Semantic Validation of UML Class Diagrams with the Use of Domain Ontologies Expressed in OWL 2." In Software Engineering: Challenges and Solutions, pp. 47-59. Springer International Publishing, 2017.

[8] Doan, AnHai, Jayant Madhavan, Pedro Domingos, and Alon Halevy. "Ontology matching: A machine learning approach." In Handbook on ontologies, pp. 385-403. Springer Berlin Heidelberg, 2004.

[9] Hughes, Todd C., and Benjamin C. Ashpole. The semantics of ontology alignment. LOCKHEED MARTIN ADVANCED TECHNOLOGY LABS CHERRY HILL NJ, 2004.

[10] Cerón-Figueroa, Sergio, Itzamá López-Yáñez, Wadee Alhalabi, Oscar Camacho-Nieto, Yenny Villuendas-Rey, Mario Aldape-Pérez, and Cornelio Yáñez-Márquez. "Instance-based ontology matching for e-learning material using an associative pattern classifier." Computers in Human Behavior 69 (2017): 218-225.

[11] Bharambe, Ujwala, S. S. Durbha, Roger L. King, Nicolas H. Younan, and Kuldeep Kurte. "Use of geo-ontology matching to measure the degree of interoperability." In Geoscience and Remote Sensing Symposium (IGARSS), 2016 IEEE International, pp. 7601-7604. IEEE, 2016.

[12] Anam, Sarawat, Yang Sok Kim, Byeong Ho Kang, and Qing Liu. "Adapting a knowledge-based schema matching system for ontology mapping." In Proceedings of the Australasian Computer Science Week Multiconference, p. 27. ACM, 2016.

[13] Ranjini, S., and K. Saruladha. "Concept type and relationship type classification based approach for identifying and prioritizing potentially interesting concepts in ontology matching." In Emerging Trends in Engineering, Technology and Science (ICETETS), International Conference on, pp. 1-5. IEEE, 2016.

[14] Xiang, Chuncheng, Baobao Chang, and Zhifang Sui. "An ontology matching approach based on affinity-preserving random walks." In *Proceedings of the 24th International Conference on Artificial Intelligence*, pp. 1471-1477. AAAI Press, 2015.

[15] Xue, Xingsi, and Jeng-Shyang Pan. "A segment-based approach for large-scale ontology matching." *Knowledge and Information Systems* (2017): 1-18.

[16] Jean-Mary, Yves R., E. Patrick Shironoshita, and Mansur R. Kabuka. "Ontology matching with semantic verification." *Web Semantics: Science, Services and Agents on the World Wide Web* 7, no. 3 (2009): 235-251.

[17] Ferdous, Syeda Nyma, and Muhammad Masroor Ali. "A semantic content based recommendation system for cross-lingual news." In *Imaging, Vision & Pattern Recognition (icIVPR), 2017 IEEE International Conference on*, pp. 1-6. IEEE, 2017.

[18] Cantador, I., Bellogín, A., & Castells, P. (2008). A multilayer ontology-based hybrid recommendation model. *Ai Communications*, *21*(2-3), 203-210.

[19] Jiménez-Ruiz, E., & Grau, B. C. (2011, October). Logmap: Logic-based and scalable ontology matching. In *International Semantic Web Conference* (pp. 273-288). Springer Berlin Heidelberg.

[20] Bella, G., Giunchiglia, F., & McNeill, F. (2017). Language and domain aware lightweight ontology matching. *Web Semantics: Science, Services and Agents on the World Wide Web*.

[21] Sieg, A., Mobasher, B., & Burke, R. (2010). Ontology-based collaborative recommendation. *Computing*.

[22] Butt, Anila Sahar, Armin Haller, and Lexing Xie. "RecOn: Ontology recommendation for structureless queries." *Applied Ontology* 11, no. 4 (2016): 301-324.

[23] Hertling, Sven, and Heiko Paulheim. "WikiMatch: using wikipedia for ontology matching." In *Proceedings of the 7th International Conference on Ontology Matching-Volume 946*, pp. 37-48. CEUR-WS. org, 2012.

[24] Church, Kenneth Ward, and Patrick Hanks. "Word association norms, mutual information, and lexicography." Computational linguistics 16, no.(1990):22-29.

[25] C. N. Pushpa, G. Deepak, J. Thriveni and K. R. Venugopal, "Onto Collab: Strategic review oriented collaborative knowledge modeling using ontologies," *2015 Seventh International Conference on Advanced Computing (ICoAC)*, Chennai, 2015, pp. 1-7.

