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A Review on Evolution and Versioning of Ontology Based Information Systems

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Abstract: *This paper presents the survey of evolution and versioning of ontology based information systems (ISs). With change being the inherent property of each system, it becomes indispensable to keep the information base of the ontology state-of-the-art. Ontology versioning and evolution is an important area of research as ontology progress is a collaborative and ubiquitous process. Therefore, question of maintaining ontologies gained more magnitude. As a result , multiple scenarios for ontology maintenance and evolution are emerging. This paper presents the work previously taken on ontology evolution and versioning. This study reveals the current approaches for handling ontology in an unfailing manner and tools developed for its evolution and versioning. The main incentive behind this work is to summarize the previous approaches in this field of research, challenges faced and to motivate this research further.*
Keywords: *change management, evolution, ontology, semantics, tools, versioning*

I. Introduction

Information semantics and semantic interoperability among applications, systems and services are mostly based on ontology [13]. Its increase usage in information systems and knowledge sharing systems raises the importance of ontology maintenance [13]. Information systems developed are time variant and evolve over a period of time just as the database schema changes with time. Therefore, Ontologies requires Change Management, which is a complex task, as ontologies incorporate semantics and managing the changes without the loss of data in a timely manner requires great deal of effort . Ontologies are the means for the agreement on the meaning of 'things' between interaction partners, either humans or computers[15].

Ontologies gained importance with their usage in semantic web which is the next generation of conventional web with semantics attached to data. Studies reveal that ontologies can serve efficiently as the backbone of semantic web. Ontology provides formal structure with semantics about how an expert perceives the domain of interest with its real meaning [13].

In computer science, ontology is seen as a semantic support to explicit and to enrich data models as well as to ensure interoperability [8]. The term ontology is sometimes used to refer to a body of knowledge describing some domain, typically a commonsense knowledge domain, using a representation vocabulary [17] .Due to the dynamic nature of information systems, it becomes necessary to evolve the ontology to reflect changes in new domain knowledge. For example, an obsolete classification of knowledge items in an ontology based management system decreases the precision of knowledge retrieval process [14]. Currently in use and most appreciate approach for information modeling, mediation and technology, service[13].

In the field of ontology engineering, supporting ontology evolution and versioning becomes essential and extremely important [8]. By storing successive versions in an incremental fashion, we will be able to achieve, preservation of critical information and the ability to support historical queries on the evolution of ontology and its contents [9]. Sometimes, old and new versions of ontologies are archived, but no mechanisms are provided to highlight the differences between versions. Different tools have been developed for highlighting the differences between different versions of Ontology. Moreover, the new changes could affect the dependent data, applications, systems and services [13]. Therefore, special attention must be paid to minimize the after effects of ontology evolution. Ontology evolves from one consistent state to another and to accomplish the evolution process several different sub-tasks are performed in a sequence, i.e., Capturechange, Change representation, Semantics of change, Change implementing and verification, and Change propagation[13].

Research is still active in this area. The different tasks involved during the evolution process must be automated as the human intervention is error prone and time consuming. The approaches developed so far has their own strengths and weaknesses. Each time a new change is identified its relevance must be known as a relevant change can effectively improve the information base. Undo/redo facility must be provided to recover the ontology manually or automatically. Inconsistency resolution is also amongst the most critical problems that needs attentionbefore, during and after evolution. The consistency is checked for; consistentmodeling of new resources in presence of existing resources, consistency with theother side matching ontology, and consistency with the business rules of organization[13].

This work is organized as follows, section 2 shows some previous works taken in the field of ontology evolution and versioning, Section 3 is the followed research method that has been followed to achieve the desired answers to posed research questions and motivation behind them. Section 4 gave the detailed review of the literature that supported in finding satisfying answers that gave the insight into this research area. Section 5 concludes this research work on ontology versioning and evolution.

II. Related Work

In literature, the problems faced by ontological information systems is addressed and problems of its evolution and versioning are studied in brief. Different approaches have been studied to automate the process of evolution and versioning to make it less error prone due to less human intervention. In [13], authors discussed about different challenges faced when ontologies are upgraded. Changes are made to the body of the knowledge as experts widen a better understanding of the domain. This paper proposes some unfold challenges that must be trounce as new changes are introduced and affects dependent artifacts , data, applications, services and systems. Brief description about various ontology editing tools is given along with their contributions and limitations. Kondylakis and Plexousakis [21] provided a solution that allows query answering in evolving ontology systems exclusive of mapping redefinition. In engineering applications, multiple copies of object descriptions have to coexist in a single database [16]. Initially, new versions of objects were created and very little explicit semantics were used and database schema was centralized in nature. The database technology developed several years ago provides facilities that are extremely constructive for managing a centralized repository, although deficiencies have been known when the technology was used for managing engineering rather than business data[16]. Klaus R. and Raymond provided generic references and user specific environment to solve the problem of inter object references on the conception of new objects.

With the rising importance of knowledge interchange, many business and academic applications have adopted ontologies as their conceptual backbone [14]. Ontologies themselves incorporate semantics and therefore, provides a more user interactive approach. Till then existing mechanisms do not provide for[6] change propagation based on the change semantics. Handling different versions of artifacts has always been important.DiomidisSpinellis [1] says if you or your project is not using a VCS, then adopting one might be a single most important tooling improvement. Versioning a stand-alone monolithic application is usually straightforward, the only problem we might worry about is backward compatibility[2] with data read or written by previous versions. Distributed version control systems are difficult to handle because of local and remote transparency problems. Similarly, just like all other artifacts, components also evolute with time. Alexander Stuckenholz analyzed the problem of component evolution and the incompatibilities which result during component upgrades [4]. The most commonly used versioning mechanism is the so called Major. Minor. Build scheme [4]. The core mechanisms provided by the OSGi specifications are the version and version range[1] [3]. Here, the versioning scheme is of four tuples- major, minor, micro and qualifier.

Ontology gained more importance lately as many researchers think that it can serve as the backbone of Semantic Web[15].The semantic web is an extended form of the current data with semantics attached to data, which can makes it easier for humans and machines to find information[15]. Just like database schema, ontologies also evolve over time. Many researchers have developed strategies to confront the challenges posed with the use of ontologies in information systems and its evolution and versioning.. Ontologies are like schema versioning in temporal databases can be useful in order to propose an approach for ontology versioning[8], having three temporal schema versioning mechanism-Transaction time schema versioning, Valid Time and Bi-temporal time schema versioning. However, some researchers believe that evolution in database schema and ontology are different. Noy and Klein [11] says the differences stem from different usage paradigms, the presence of explicit semantics and different knowledge models. These differences have important implications for the development of ontology evolution frameworks[11] and have two kinds of evolution- traced and untraced evolution.Ontologies are the knowledge bearing artifacts and can be used in any application area where the domain of interest has to be conceptualized [15].

A typical example is the MEDLINE system[2][14], the largest medical knowledge base available over the Internet, which is based on the MESH medical ontology. In order to stay in line with the state-of-the art in medical research, MESH is frequently restructured [14].

AsadMasood et al.in [13] emphasized, that preserving consistency, while accommodating new changes, is a crucial task that needs special attention during Ontology evolution, Ontology versioning, Ontology merging and Ontology integration. λXSchema schema is a framework for the creation and validation of time varying XML documents[5]. Barbara Oliboni et al. proposed a set of schema change primitives for the maintenance of logical and physical annotations and define their operational semantics in [5]. Some researchers also criticize the use of ontology and doubt that they would bring significant changes as promised. However, according to Guarino [1998] their use can be beneficial during the development time and run time of an IS. The usage during development time[15] enables the developer to practice a higher level of reuse. For the usage at run time he distinguishes between two types: ontology aware IS and ontology driven IS. Ontology aware ISs are systems where the system was built by keeping the ontology in 'mind' and where the [15]ontology is at hand for usage. Ontology driven ISs, at the other hand, include the ontology as yet another component of the system which contributes to the overall IS goal [15].Till now many automatic and semi automatic tools have been developed for the change management. Managing different versions of the ontology and pointing out differences between the versions involves great deal of complex task. SHOE enables ontology developers to state whether a version is backward-compatible with an old version or not[15]. Many other tools have been generated. This area is still active as the challenges posed and tools generated does not fully automate the process of change management in ontologies. The need of fully automating the process of ontology management is required as human intervention is time consuming and error prone.

III. Research Method

The identification of research questions is imperative and foremost step towards systematic literature review(SLR). Research questions play a vital role in making the foundation of the research more strong. Ontologies require maintenance for increasing the precision of the information base. Many ontologies of our interest could be conceptualized, be it education field or transportation, geographic or e-governance, pattern research or product catalogues, and requires proper change management for efficient knowledge retrieval. During this research, many research papers have been read. Research started from the understanding of version control systems, versioning in distributed systems, component based systems and how versioning and evolution is implemented in different ontology domains.

Some basis questions related to ontology versioning and evolution have been taken. Research questions relevant to this study are as follows:

RQ1 What are the proposed definitions for ontology and its evolution and versioning and why we need them?

Motivation: The first step is to comprehend the meaning of ontology, evolution and versioning and its magnitude.

RQ2 What are existing solutions for ontology evolution and its version management and languages used for the conception of ontology?

Motivation: The review of existing solutions is important so that newer solutions could be constructed. The overview of existing solutions helps in outlining its pros and cons.

RQ3 What are the challenges faced during ontology versioning and evolution?

Motivation: There is a need for automating the process of ontology evolution and versioning to make it less error prone due to less human intervention. Maintaining consistent ontology is an easier said than done task. Change propagation needs to be performed to all dependent artifacts as ACID(Atomicity, Consistency, Isolation and Durability) properties are need to be fulfilled and therefore, change must be propagated to all dependent artifacts and in doing so semantics must be preserved, otherwise the meaning may differ leading to inconsistency in the information base.

RQ4 What led to increased usage of ontologies for domain conceptualization of our interest and what all domains are conceptualized?

Motivation: This question helps in understanding why conventional approaches are being/have been replaced by ontology. The advantages of ontology based information systems and extensive use in different domains.

RQ5 What are the tools available for ontology change management?
Motivation: As change management is the most important part of ontology management , This research question helps in finding answers to maintaining ontology in a consistent manner. different tools have been developed for achieving the same and have their own pros and cons. Tools developed provides evolution and versioning support. Some provides manual and some semi-automatic support.

IV. Observation

In this section, promising answers to the aforesaid research questions have been discussed.
RQ1 What are the proposed definitions for ontology and its evolution and versioning and why we need them?

Khattak, Batool, Pervez, Khan and Lee proposed two definitions of ontology based on two perspective in [13], philosophical and in computer science. In the review, Ontology is something that exists. In philosophy, authors defined it as " the science of what is, of the kinds and structures of objects, properties, events, processes and relations in every area of reality". In computer science " as the formal specification of the shared conceptualization of a domain of discourse". One of the near the beginning definition of ontology is given by Gruber[1993] who said " Ontologies, are the explicit specifications of conceptualizations. Guarino[1998] defined ontology as " engineering artifact, constituted by specific vocabulary used to describe certain reality plus a set of explicit assumptions regarding intended meaning of vocabulary words". One of the first definitions was given by Neches and colleagues [39], who defined an ontology as follows: ''an ontology defines the basic terms and relations comprising the vocabulary of a topic area as well as the rules for combining terms and relations to define extensions to the vocabulary''In [17], Josephson, Chandrasekaran, Benjamins, says ontology is a representation ontology, often specialized to some domain or subject matter. Ontology sometimes also refer to a body of knowledge describing specific domain. In [13], authors defined ontology evolution as " modifying or upgrading the ontology when there is a need for change or there comes a change in domain knowledge". Klein [2002] defines Ontology Versioning as "the ability to manage ontology changes and their effects by creating and maintaining different variants of the ontology". Klein and Noy, use the term versioning to describe their approach of ontology change. Versioning supports reusability as each version is archived in version log, thereby, supporting historical queries. Yildz in [15] says Ontologies can be used to share a specific conceptualisation among communication partners, its usage is theoretically beneficial wherever an agreement on the meaning of things is important, provides interoperability and reusability. In [17], authors say that ontological analysis clarifies the structure of knowledge. Noy and Klein in[11] emphasized ontologies are decentralized by nature, have richer data models, provides reusability, handles large information bases and incorporate semantics.

RQ2 What are existing solutions for ontology evolution and its version management and languages used for the conception of ontology?

M. Toledo in [7] has proposed an organizational memory architecture in which knowledge retrieval and storage strategies are based on domain ontologies which take in account complex words to retrieve information through natural language queries. Using standard measures results are also evaluated .Ellouze, Bouaziz and Jmal [9] maintained a document in which detail of each version is kept and an algorithm is proposed for the generation and insertion of elements in document. An application developed is called TOM-RMS. M. Toledo in [12] proposed an agent based strategy for the evolution of the existing ontology and semantics of the corpus . Document semantic annotation algorithm is implemented, tested and experimental results using proposed strategy are evaluated. Jaziri [8] proposed an approach for ontology evolution which consists of three phases- evolution changes, ontology coherence and versioning management. Each phase is explained and OntoChanges tool is used as a plug-in to protégé. S. Srinath et al. have proposed a generic model for semantic based versioning in projects. A generic model for semantic based version management in projects was built over existing tools [6]. As each system is time variant, evolution is always inevitable. The model proposed is applied to CAD framework and SDP. The more efficient retrieval of knowledge items in a knowledge management systems requires the establishment of hierarchical relationships between their conceptual descriptions[14]. Ontologies are written using different languages. In [27], Pittet, Cruz and Nicolle, on hand a new semantic architecture which combines versioning tools with the evolution process called version graph. Nowakowski and Stuckenschmidt [24] has encoded the ontology in OWL (Web Ontology Language) for the implementation of product catalogues and argued of using eCl@ss with formal language OWL for enhanced results. DARPA (Defence Advanced Research Projects Agency) [30] with W3C, has developed DARPA Agent Markup Language(DAML) by extending RDF (Resource Description Framework) with more expressive constructs aimed at facilitating agent interaction on the web. RDF is a [30] language developed for encoding knowledge on web pages. XML is also used for encoding the information in [9] the structure specification and semantics of the clinical information is supported well using XML temporal schema and solution to the problem of modeling, managing and implementing temporal medical data is handled. There are different species of OWL [18] –OWL Lite , OWL DL, OWL Full; lite is meant for lower formal complexity, DL supports with maximum expressiveness, Full supports maximum expressiveness and syntactic freedom of RDF.

The following table shows different languages that are used ontology domain conceptualization.

Table 1: languages used for ontology domain conceptualization

Language	Features	Review Available In
XOL	Proposed for the domain of bioinformatics, formalization of knowledge models, restricted to language where only concept, concepts taxonomies are only specified	[41][43]

SHOE	Extension of html, rules and frames, representing concepts, instances and deduction rules, inference engine	[43]
DAML+OIL	Extending RDF with more expressive constructs, agent interaction on the web, formal semantics based on DL, FaCT classifier, concepts, concepts taxonomies, functions, instances ,binary relations	[30][43]
RDF(S)	Semantic network based language to describe web resources, not very expressive, allowing representation of concepts, concept taxonomies are only specified, inference engine for constraint checking, encodes knowledge on the web	[43]
OWL	Domain formalization, individual and assert properties of those classes, reason about these classes and individual to the degree permitted by formal semantics	[18]
OWL Lite	Overcome the limitation of rdfs, based on strict segmentation of vocabulary, lower formal complexity	[18][41]
OWL DL	Additional language constructs, supports Boolean arbitrary expressions, strict segmentation of vocabulary	[18][41]
OWL Full	No strict segmentation of vocabulary, supports practical ontology integration, treat construction of the language as semantic objects	[18][41]

RQ3 What are the challenges faced during ontology versioning and evolution?

The change management requires proper representation of changes while editing or upgrading ontologies. The most easiest way is to keep a change log for all the changes made to the original ontology as said in [15]. The lack of critical mass of reusable ontologies became a bottleneck to achieving the vision of widespread use and reuse of ontologies[11].Managing different versions of the ontology and pointing out differences between the versions involves great deal of complex task.Khattak, Batool, Khan, Lee and Pervez in [13] emphasis, that current ontology evolution techniques have several drawbacks. Specification of new changes is the major weakness, changes affects dependent artifacts, suitable change detection and its effective propagation, resolving inconsistencies is a tedious task.In [8], Jaziri emphasized that establishing links between different version is a complex task and requires an investment. The linking process must respect the order of versions and the changes that have beenoccurred. These links can be used to re-interpret data and knowledge under different versions of ontologies. Klein et al. discusses that their arises discrepancy between change in specification and conceptualization in [38]. So,changes that affectconceptualization from that that don't must be distinguished. Anamendment in one part of the ontology may engender subtle inconsistencies in other parts of the same ontology, in the ontology-based instances as well as in depending ontologies and applications. In literature , many approaches have been proposed in order to minimize the challenges that are facedduring evolution and versioning process. Sari and Kartika in [39] proposed a solution for change propagation in SNOMED CT systems meant for healthcare. As the health care systems is susceptible to lot of changes every year, the proposed approach helps in achieving a consistent ontology. In [33], Abghaz, Javed, Pahl proposed an approach for analyzing the impact o changes. They proposed a bottom up approach for change impact analysis in two phases,1) impacts of atomic operations and 2) impacts of composite operations. In [33], Plessers and Troyer, proposed an approach using Version log. The request for changes is complemented wih automatic change detection approach. In [46], Pittet, Cruz and Nicolle has proposed a solution called Version graph, so as to integrate ontology evolution with versioning. Using ontology evolution and versioning tools, they have presented a way for managing ontology lifecycle.

RQ4 What led to increased usage of ontologies for domain conceptualization of our interest and what all domains are conceptualized?

In the present literature, many research papers have been read that outlines the importance of ontology. Chandrasekaran, Josephson and Benjamins in [17], highlight the importance and its need for domain conceptualization. They state that ontology clarifies the structure of information base of domain ontology and enables knowledge sharing among heterogeneous components that increases the potential for knowledge reuse as well. Klein and Noy in [11] points out the differences between database schema and ontology on account of which advantages of ontology over database schema could be known.The differences in both arises from the fact that ontologies incorporate semantics and different knowledge models which are richer than database schema models. Ontologies are decentralized in nature and its several dimensions are taken into consideration during change management for preserving data, consequence, consistency and ontology itself and therefore, provides more user interactive approach. Ontology forms the heart of many different domains. In [18], Eleni, Tomai, Maria, Spanaki provided a web tool for developing geographic ontologies. The authors have specified ontology building and its implementation in a two step process-1) building generic geographic ontology and 2) predefined generic ontology which users can use as an interface to develop their own geographic ontology. The values to the properties are saved in OWL FULL format. In the present literature, there are efforts to model semantic ontology in government service domain. But the present literature still shows an unclear scenario how existing ontology methodology can be applied to model government service domain. In [19], Dombeu and Huisman, used Uschold and King methodologyto build government ontology, its semantic consistency is evaluated and domain ontology is written in OWL format to enable its automatic processing by computers. In [23], Salhofer, Stadlhofer and Tretterhas also presented an approach for ontology driven e-government.

Dicheva, Sosnovsky, Gavrilova and Bruislovsky in [20] presents a methodology for educational ontologies. Authors propose of an ontology-driven web portal providing a single network place, where researchers, students, and practitioners can hit upon information about available research projects and successful practices in this field. In [22], Cheng and Du proposes to establish a knowledge base for transportation ontology in OWL format and SWRL rules to express rich semantic knowledge for transportation ontology and provides rule based reasoning to enhance inquiry efficiency.

Nowakowski and Stuckenschmidt [24], gave an example of ontology implementation using Product catalogues in which semantic match making of user requests is supported against product descriptions in the catalogue using OWL. Different convergence technologies: services of semantic web, Software Agents, Semantic Grid, Context-Aware search engines use ontologies for their adapted needs. In [52], Sassi, Jaziri and Gargouri has developed a semantic tool called CONSISTOLOGY to maintain the consistency of the ontology whenever a change has occurred and has been experimented in education ontology to generate coherent ontology versions. In [53], Cakula and Salem, have applied ontological engineering methodology in e- learning domain.

Table 2: different domain conceptualizations based on ontology

Different Ontology Conceptualizations	Content Available In
Geographic Ontology	[18]
E-Government	[19][23]
Educational Ontology	[20][25][26][52][53]
Transportation Ontology	[22]
Product Catalogues	[24]
Information Science Research	[31]

RQ5 What are the tools available for ontology change management?

Ontolingua server was the first ontology editing tool that was created.Klein and Noy in [11], gives an account for the tools available for the ontology change management.Jaziri [8] proposed an approach for ontology evolution which consists of three phases- evolution changes, ontology coherence and versioning management. Each phase is explained and OntoChanges tool is used as a plug-in to protégé. B. Yildz, [15], In this report, the work done so far in the field of ontology versioning and evolution is given . Different tools are also summarized for change management along with their contributions and weaknesses. Tools like Protégé[3], OilEd, KAON and Ontoview is discussed. KAON[5] [29]provides the facility for undo /redo change operations.OilEd[7] is another tool for ontology management but does not support versioning, integration or migration of ontologies.

[3] http://protege.stanford.edu/
[5] http://kaon.semanticweb.org/
[7] http://oiled.man.ac.uk/

Protege provides manual evolution support and there is no facility for ontology recovery. OntoView is a web based tool that wires online ontologies. Some other works are also worth mentioning in the area of semantic annotations. With the rise of information systems and for their management, many frameworks and tools have arisen. KIM and sesame RDF[7] for ontology and knowledge base storage. Another frameworks for semantic annotations are PANKOW(Pattern based Annotation through Knowledge On the Web), Cerno, SemTag.Tudor Groza et al. introduced a new RDF-centric versioning approach and an implementation called SemVersion integrated as the semantic manager plug- in in protégé[10]. ISOCO KPOntology[4] is another example similar to this system which focuses on ontology management. . A brief description of ontology editing tools is given: KAON , Protege, OntoEdit, OilEd in [13]. Noy and Musen in 2000, proposed an algorithm called PROMPTDIFF[6] that points out the difference between two ontologies based on their structures[15].

SHOE enables ontology developers to affirm whether a version is backward-compatible with an old version or not[15].TM4L (Topic Maps 4 E-Learning)Editor [26][25] facilitates the creation of ontology-aware courseware and is based on an emerging technology of topic maps that attempts to solve information recovery challenges on the web. The Swoop ontology editor [6] supports an extensive set of annotations, distinction between annotations that indicate whether an annotation is a comment, advice, example.

In [48], Noy and Musen gave an account for ontology editing tools like protégé, OntoView, ONION, Chimaera for managing different ontology editing environments. The authors have discussed Prompt ontology management framework consisting of IPROMPT, ANCHORPROMPT and PROMPTDIFF.

[4]http://kpontology.isoco.com/
[6] This algorithm is available as a plugin for the Prot´eg´e 2000 ontology-editing environment

Table 3: list of ontology editing environments

TOOL	Features	Limitations	Encoding of Knowledge	Content Available in
Protégé	Allows users to make changes to ontology, support undo/redo facility, archiving , reverting to previous versions, versioning enhanced by integrating it with PROMPTDIFF	Weak ontology support, no support for ontology recovery, no built in consistency checking, manual evolution	Stores knowledge in special purpose flat file format, allows to read form and write to pdf files, relational database format, SparQL queries support, RDF(S), XML	[13][14] [15][32][47][50]
KAON	Creation, storage, retrieval, maintenance, automatic undo, redo, evolution log, consistency checker	Complex system, slow in response, ontology engineer for conflict resolution	RDF(S), XML, OWL	[13][15][29][35]
OilEd	Creation of ontology, fact reasoner, no undo redo, versioning , integration , semi automated ontology evolution	No change logging facility, no ontology recovery, strict in its operations	XML,DAMI+ OIL, OWL	[13][15][36][37]
OntoView	Supports wiring of online ontologies, change propagation, transformations and mapping, identification of ontologies	Conflict resolution by ontology engineer	RDF(S), DAML+OIL	[14][15][42]
TM4L	Based on topic maps, development of reusable, searchable, interchangeable learning objects on web	Specific to e-learning domain	Context based, XML based repositories	[25][26]
[8]SWOOP	Collaborative annotation, ontology refactoring, data mark up, debugging, multiple ontology environment	No methodology for ontology construction	Developed for OWL ontologies	[43][47][50]
[9]Evolva (NeOn Toolkit)	Step by step evolution process, used as plug-in with NeOn ontology editor, information discovery, data validation, inferencing relationships	No support for ontology construction.	OWL, RDF(S), XML	[44][45][49]
[10]OntoComp	Used as a protégé plug in, completes ontology information of a domain	Assist only in completing the information base	Supports owl ontologies, supports protégé features as well	[51]

V. Conclusion

Ontology evolution is a collaborative process and incorporates works from related fields like ontology matching, merging, integration, versioning and reasoning [13]. In this work, our entire focus is on its versioning and evolution.

This work deals with the predicament of ontology evolution and versioning. Ontology can serve as a backbone to the next generation of web with semantics attached to data leading to a more user interactive approach. A petite survey on the ontology changing tools shows that only few tools are available for the change management in ontology. Some tools support undo/redo facility by keeping log files while some does not and therefore, does not cover each aspect of ontology management. Automation of ontology management is required for change detection and propagation.

Research in the field of ontology can add its wider significance in the information systems which would result in better change management for ontology and automate the process because [15] their application fields are in general dynamic by nature and it is not realistic to assume that an ontology will not undergo changes over time.

Using ontology as the backbone of any domain results in many benefits and supports interoperability and reusability. The literature shows extensive work is being done in this field in order to minimize the after effects of changes on the domain ontology. Change detection and propagation must be done in a proper manner so as to conserve the semantics and consistency of the ontology.

[8] http://www.mindswap.org/2004/SWOOP

[9] http://www.neon-toolkit.org

[10] http://ontocomp.googlecode.com

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