A Layered Approach to Inferring Similarity Measurement of Ontologies Using Concept Mapping

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Abstract. The similarity measurement of mapping between ontologies has been evaluated through prior terms like instance, properties and association. Concept similarity measurement (CSM) technique is most applicable for mapping among ontologies which calculates similarity matching of data given by user (i.e. data mention in search query, mostly various keywords are typed). The basic purpose of this research is to suggest a SM technique which uses similar super concepts for mapping and increase the matching similarity with some additional datasets. We have analyzed the various limitations in previous techniques and have effort to modify the limitations of these techniques in our proposed architecture. The paper presents a layered approach for similarity matching using super concepts and measures the synonym of concepts by using domain vocabulary. It also uses the (ESR) explicit semantic relation to measure the responsibility of concepts which create conflict in mapping process. A sample case study has employed to test the SM technique of proposed architecture .Two matrices for evaluation which is efficiency and definitiveness parameters has used to improve performance of mapping by adding concept explicit semantic relation. The proposed architecture provides the enhancement of mapping results by classify super concepts which are based on the semantic responsibility of concepts. This improvement plays a vital role in the domain of ontologies for mapping, alignment and merging and will also give a clear, obvious outcome of search.

Keywords: *Ontologies, Ontology Mapping, SM (Similarity Measurement), Concept information, ESR (explicit semantic relation).*

1. Introduction

With the formation of semantic web, the need of ontologies has significantly increased. Ontologies are well known necessary factor of semantic web, which are defined specification of shared conceptualization. Ontology consists of number of concepts, attributes and associations. Attributes represent the concept as well as association represents relation among concepts. So, Ontologies may refer to reuse, share the knowledge. In order to make the better use of ontologies, similarity matching process between various ontologies is used. Another new advancement in SM is ontology mapping. Ontology mapping is a methodology in which similar pairs among various ontologies are matched through semantic associations. The mapping of ontology has become entirely applicable for testing the semantics among ontologies. However, users can give query data from various data sources transparently and applications can serve every data source despites of their varying representations.
It is considered that various ontologies have alike components, so that there can be certainly used concepts, attributes and relations of components among two or more ontologies. The "Fig. 1,"depicts the overall implementation of mapping tools besides their features.

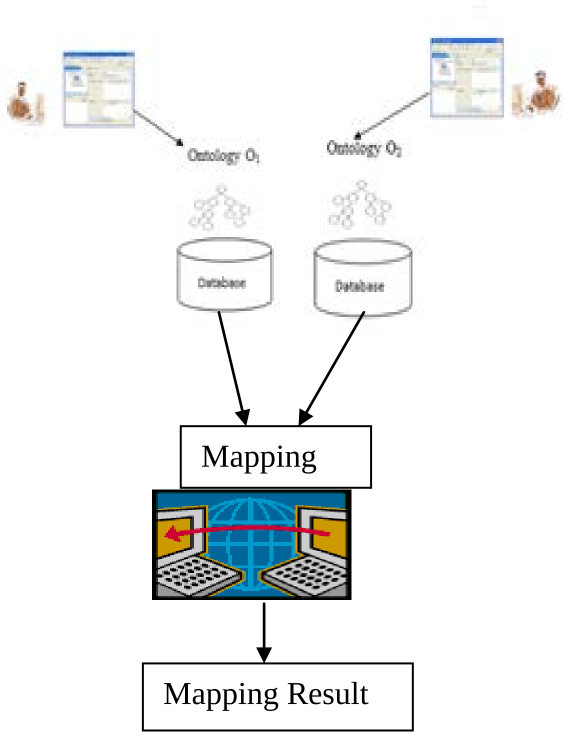

Fig.1. The mapping approach

In the above figure, mapping result shows the result of mapping of two ontologies. Two ontologies O1, O2 are given, some of earlier mapping result, parameters and external resources are also used in process. This mapping process is used as instances, concepts and attributes from source to the target ontology, while it involves the conceptual semantic level from base to end ontology. In this paper, we first and foremost intellectually describe ontologies and mapping, and then infer about the common principles of ontology mapping. Next, we analyze the outcomes of literature review of different research approaches that suggest their own, specific way of working of ontology mapping. These approaches are compared and contrasted.

The research is structured as follows: In Section 2, we confer Literature Review material about ontology mapping; the proposed layered structure is presented in section 3; Section 4 differentiates the methods mentioned in section 3; and finally in Section 5, we present a case study, Section 6 concludes the research report through experiments.

2. Background and Literature Review:

Techniques of the semantic similarity measurements are sufficient to deal with the mapping, alignment and merging (Stephan *te al.*, 2011).A SM has been suggested to get result by providing properties, attributes and association of ontology.SM can be calculated by concept distance, concept semantic correlation and concept schema. It calculates the matching through concept based on concept name, properties and associations that provides the taxonomic and non-taxonomic link. It is only node based approach and cannot describe the appropriate weight, (Stephen *te al.*, 2002) (Neiter, 2000) (Junte *te al.*, 2005) (Alexander *te al.*, 2008), A structural prototype of ontology mapping (Wenjie *te al.*, 2009) (Wu *te al.*, 2009) (Dixit *te al.*,2012)(Tamer *te al.*,2013), Statistical model for ontology matching (Prashant *te al.*, 2008)(Gau *te al.*, 2006), NLP based mapping methodologies (Sean *te al.*, 2011) (Sadaqat *te al.*, 201) (Tao *te al.*, 2005) (Hongke *te al.*, 2005) , Background knowledge patterns for SM (Igor *te al.*,2004) (Renaldo *te al.*,2014) (James *te al.*, 2013), Schematic approach of matching between ontologies (Jaynat *te al.*,2009) (Guihua *te al.*, 2009) (Savithri *te al.*,2008), Ontology mapping tool (Gabriele *te al.*, 2009) (Emil *te al.*, 2011)(Saruladha *te al.*,2011), Automatic SM (Feng *te al.*, 2008)(Su *te al.*, 2010), Hierarchical ontology-based framework that employs parameters CSV and WSD to deal with semantic similarity measurements of concepts (Tianging *te al.*,2009)(Marc *te al.*, 2004)(Lun *te al.*, 2005) , A typical algorithm includes GLUE, S-Match and PROMPT which also employs the machine learning tools and instances to generate mappings among heterogeneous ontologies (Shvaiko *te al.*, 2005), Different mapping languages compares between OWL, C-OWL, SEKT and FLogic ,also semantically map local ontologies (Gómez *te al*., 2008),(Abdul-Kareem *te al*., 2008), For calculation of similarity between two elements (terms) from two ontologies, *Mapping Function (MF): [0 1]* is used as range value(Yi Zhao, *te al*., 2008), usually some of functions such as Jaccard similarity, Jaro-Winkler, Cosine similarity and Levenstein distance based on string similarity are used(Chee een *te al*., 2011).

By examining the currently used SM techniques, it was observed that most of the techniques make use of Word Net and Cyc. And Word Net consists of synonym, antonym and all association words. The basic concept of overlapping the terms is get from biomedical ontologies by using the constraints keyword. In addition, it also depicts the existing strategies used by system such as ArtGen, ASCO, Chimaera, OntoMapper, and IF-Map (Patrick *te al*., 2005) (Shvaiko *te al*., 2013).The researchers are paying attention to improve the interoperability among domain specific ontologies with the help of Micro data vocabulary(Zhenyu *te al*., 2016),As Word Net is useful for SM of concepts but Word Net is not used suitable for graphic terms which is difficult to find as synonyms(Agustina *te al*., 2010). Techniques of semantic similarity measurement are used to improve the performance of matching between two ontologies. The main idea is automatic featuring of concepts for SM to provide the more commonness and the less weight but it cannot cover the large data set (Feng *te al*., 2008), some approaches has the hierarchical self-organizing matching which never provides the better scalability. SM questions are based on the combination of different ontological material and actions. To get overlapped information from numerous research studies shows the importance of knowledge base reasoning, data mining and finding the semantic similarity measurements.

This amendment needs a user to deal with better ontology mapping solutions. The proposed technique suggests the layered architecture and elaborates the functionality of lexical, semantic lingual and contextual similarity. SM will be completed with the help of super concepts name. Semantically, overlapping of concepts name will be evaluated by using domain vocabulary.

3. Proposed Architecture:

Flow of the proposed technique is when user interacts with system to find some specific concept. The given input consists of source and target ontology. The proposed technique Concept Similarity Mapping (**CSM**) is used to discover, structure, and demonstrate correlations among concepts, which incorporate properties and roles. The working of CSM technique will be follow layered method. In the start, user pass a query which analyses the similarity testing among concepts and manipulates the refine similarity metric that root on the lexical, semantic lingual and contextual similarity levels. Fig. 2," is the description of framework of proposed technique.

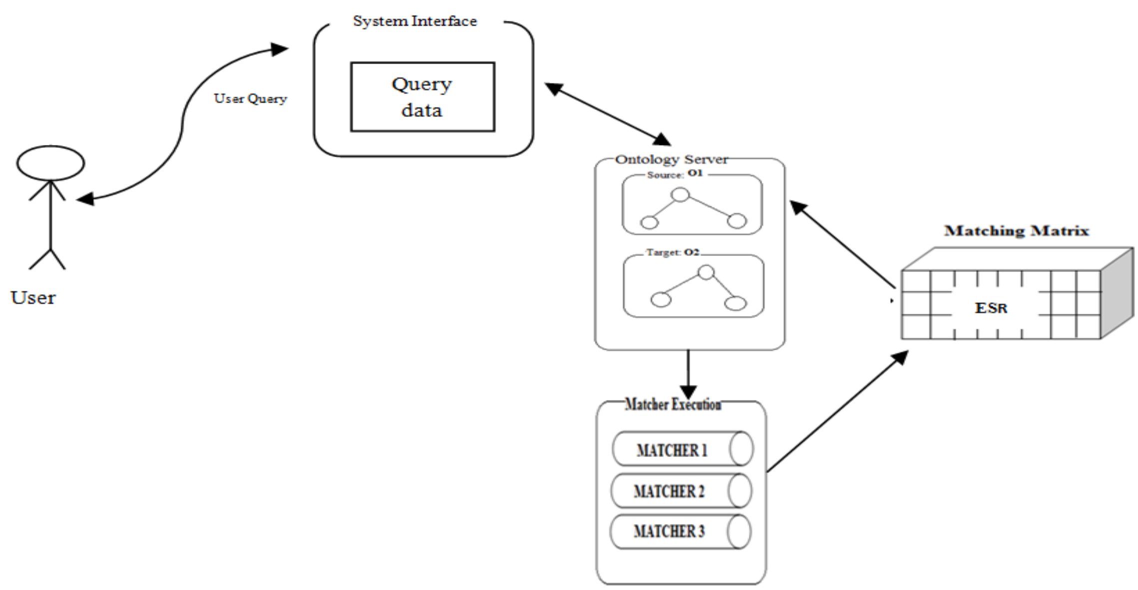

Fig. 2. Proposed Architecture Mapping technique

4. *Components of Architecture:*

I. Concept:

Concept is a scheme that corresponds to some distinct object, group of objects, or to its obligatory attributes and properties. It describes the identical as a biquadrate: analogy of Concept= {ID, L, A, P}, enclosed through concept ID. As L employ concept discourse of the lexicon. A denotes attributes. P signifies rigid of properties.

II. Mapping Execution Strategy:

An exhaustive discourse on individual matching level is specified in the following section.

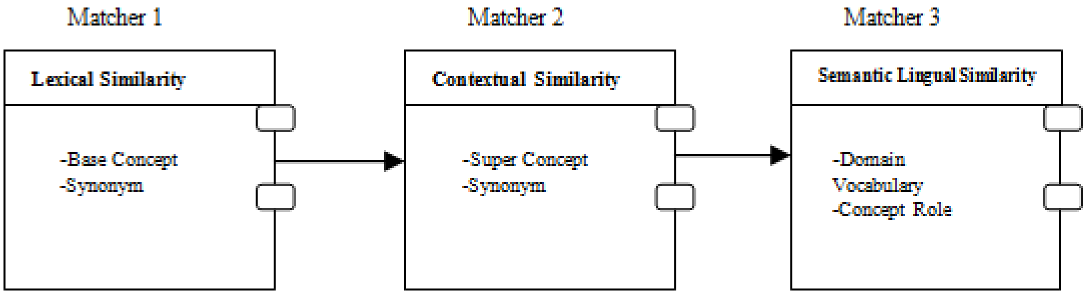

Fig. 3: Matcher Level VS Similarity Measurement

i. Lexical Similarity:

In this lexical similarity, query is analyzed by synonyms of base concepts. English grammar guidelines are used to acquire lexical matching similarity.

ii. Contextual Similarity:

Second level depicts the contextual similarity in which one or more super concepts are declared to be homogeneous contextually only in case they have central similarity and have subsidiary typical concepts in their equivalent catalogues of super-concepts.

iii. Semantic Lingual Similarity:

In the third level, semantic lingual similarity is applied on user query. It measures similarity between concepts through customized domain-specific vocabulary.

III. Explicit Semantic Relation:

Explicit semantic relation is distinct in provisions by responsibilities. The value get from matching execution become a matrix. Thus matching matrix evaluates according to a certain domain. Let x, y be the position of responsibilities of two ontologies respectively A & B. Subsequently the functions for calculating semantic relation between concepts of ontologies are describes as:
ESR = '='; x is same to y;
ESR= '≥'; x is more generic than y;
ESR= '≤ 'x is less generic than y;
ESR= 'X'; if Explicit semantic relation is undefined; (also for manual decision)

IV. Efficiency:

The performance of mapping similarity measurement is computed through evaluation metrics. First, evaluation category describes the efficiency of mapping similarity of a certain technique that is similar to precision operation point out in sequence retrieval [17]. It shows the association among the word perfect mappings divided by all the retrieval mapping data. If all data of mapping depicts the total number of mapping data in which word-perfect mappings are correct, then all-data of mapping >= word-perfect mapping,

$$\textit{Efficiency} = \frac{\textit{Word-perfect mapping}}{\textit{All data of mapping}}$$

V. Definitiveness:

Secondly, evaluation category illustrates the definitiveness of mapping similarity of a certain technique that is similar to recall operation point out in sequence retrieval [17]. The definitiveness is employed to calculate word perfect mapping in differentiation to complete existing mapping. Existing-mapping denotes the complete figure of existing mapping and word-perfect mapping denotes the exact found, like existing mapping >= word-perfect mapping, so definitiveness is described as,

$$\textit{Definitiveness} = \frac{\textit{word -perfect mapping}}{\textit{Existing mapping}}$$

5. Case Study:

Consider an instance of web-based application of reservation. A user who makes a room reservation for three days and affords to spend 500 dollars .An application of web offers services to explore for hotel reservation including dataset. The user acknowledges a query to explore for reservation is less than 500 dollar. Then web application may requisite to explore the sources of data throughout the web (ontologies of different reservation applications like airline, travelling). The web faced some complication that all the ontologies has generated independently, and particular queries will be pass to ontology sever. One perspective output is to direct the schemas of utterly viable data sources and produce distinctive query for one and all, although, data sources may fluctuate in the hundreds, this is not helpful positively. The *Hotel* Ontology *O*1, *O*2 shows in "Fig. 4,"Two web ontologies as evaluated which supply services about *Room Reservation*

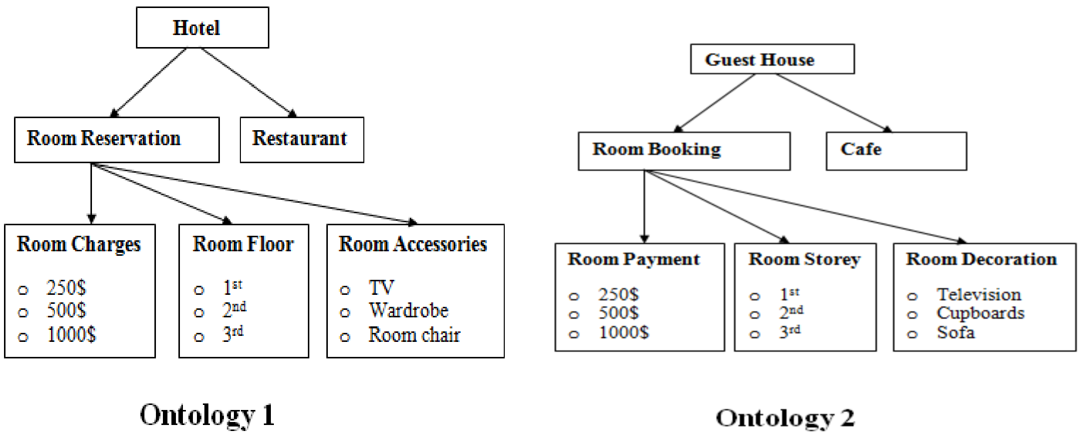

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Fig .4. Hotel ontologies, Ontology *O*1 and Ontology *O*2 employ as information sharing frame work form on the established mappings.

A scenario is examined where a user wishes to reserve a room. However, the required information is not accessible from web service. To fulfill the request absolute mapping of information is essential from both sides. So, to enlarge the mappings and to sustain the sharing of information, actual continuation of ontology and its manifestation is obligatory.

6. Experiments:

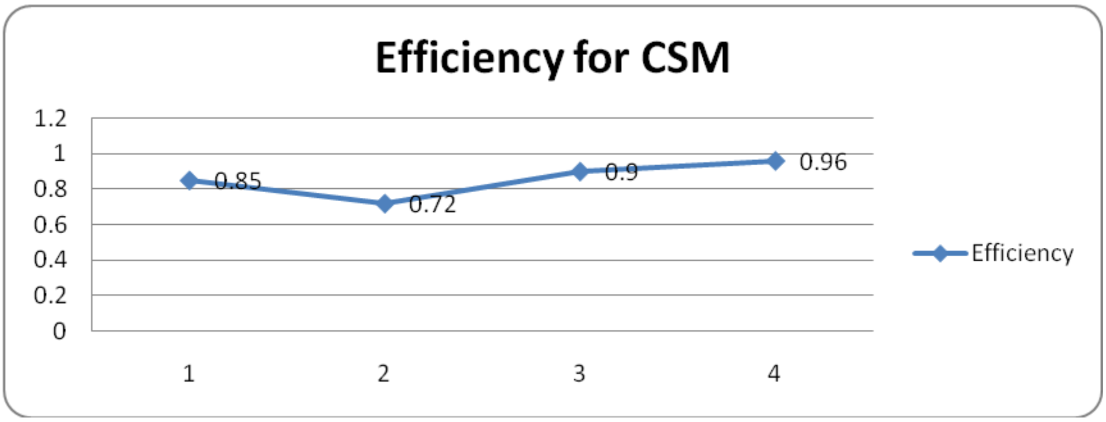
As an example, a case study was use to execute a pair of ontologies to assess performance with respect to efficiency, definitiveness. And the expecting result is comparatively examined among the earlier matching outcome methodologies used in various forms. The example is as under.

Table.1. Evaluate pairs of concept using ESR

Input parameter No	Pair of Concepts	ESR
1	O1:Hotel,O2: Guest House	=
2	O1:Room reservation,O2:RoomBooking	<
3	O1:Resturent,O2:Café	X
4	O1:Roomcharges,O2:Roompayment	=
5	O1:Roomfloor,O2:Roomstorey	=
6	O1:Roomaccessories,O2:Roomdecoration	X

Table.2. Evaluation metrics for CSM

No. of input	Similar super concept	Word Perfect mapping	Efficiency	Definitiveness
1	23	22	0.85	0.68
2	20	18	0.72	0.72
3	18	16	0.9	0.72
4	14	13	0.96	0.88



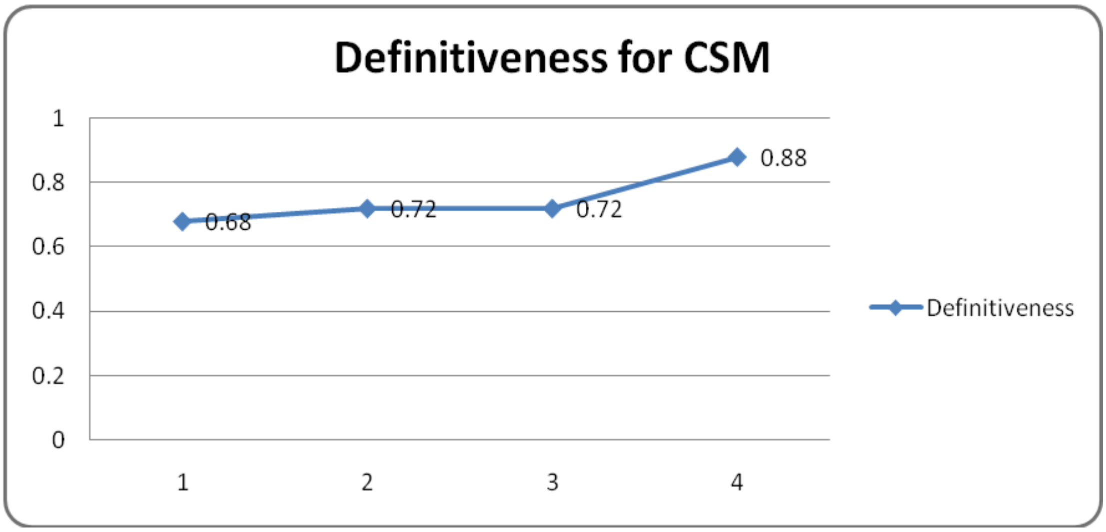


Fig. 5. Efficiency and Definitiveness factor

7. Recommendations for Further Research:

The proposed system classify into a layered approach where each matching level is performed an individual task and produce highly cohesive .Our focal point is to describe the technique of mapping among two ontologies, previous one declared to work with data from ontology to ontology, alike terms of these ontologies is confirm. The suggested method has used to direct the mapping similarity among super concepts along with its role. In which ontology server receives query from user and regain information related to equivalence ontology class. Results show that the matching metrics have exact similarity and increase performance of mapping. Therefore in future this method will enlarge to assemble the requisites of similarity of extraneous concepts. So, there would be necessary to do work on its interpretation while merging two concepts into a rare concept. Furthermore, we will emphasis on how to upgrade the functionality of system, and also realize the many-to-many relations among concepts or properties to improve the solution of heterogeneity.

References:

1. Abdolreza H., S. Abdul-Kareem, 2008. An Approach for Mapping of Domain-based Local Ontology, International Conference on Complex, Intelligent and Software Intensive Systems.
2. Albert, D and C, M Steiner, 2005. Empirical Validation of Concept Maps: Preliminary Methodological Considerations, in Proceedings of the Fifth IEEE International Conference on Advanced Learning Technologies 0-7695-2338-2.
3. Agustina, B C., Alejandra. 2008. The Geographic information integration through enriched ontology matching.
4. A., Farooq. 2010. The Similarity measurement and identification between ontologies, in proceeding of ACM international conference of development in information retrieval.
5. Chee, Y and K, Myung, 2013. Instance-based ontology matching with rough set features selection.
6. Dieter, F., 2000.Ontology: Silver bullet for knowledge management and electronic commerce, in Proceedings of the ECAI-98 Workshop on Applications of Ontology.
7. Diego, D and S Alan., 2015.Applications of ontologies in requirements engineering: a systematic review of the literature, in proceedings of ACM international conference of development in information retrieval.
8. Dietrich, A. and S, Christina, 2005.Empirical validation of concept maps: preliminary methodological considerations. In Proceedings of, Fifth IEEE international conference on advanced learning technologies.
9. E, Şt. Chifu, I. A. Leţia, 2011. A Neural Model for Ontology Matching, Proceedings of the Federated Conference on Computer Science and Information Systems ISBN 978-83-60810-39-2.
10. Enhong, C and W, Gaofeng, 2005.An ontology learning methodology enhanced by frame Semantics IEEE international symposium on multimedia.
11. Fausto, G and S, Pavel, 2004.An algorithm and implementation of semantic matching .in proceedings of European semantic web symposium, LNCS 3053.
12. Gabriele, M and M Tania., 2011.MDSS: A framework for the integration of ontology mapping tools.
13. Godugula S., 2008.Survey of Ontology Mapping Techniques, Proceedings of Software Quality and Assurance.
14. Guo, W. and W, Ya-Dong, 2006.An ontology –based method for similarity calculation of concept in the semantic web, Fifth international conference on machine learning and cybernetics.
15. Hongke, X. Z., Xuefeng, 2009.Multi-strategy ontology mapping based on stacking method, Sixth international conference of fuzzy systems and knowledge discovery, 978-1-4577-0966-1.
16. Jayant, M. B., Philip, 2002. Representing and reasoning about mappings between domain models of AAAI-02.
17. Jerome, E. and S, Pavel. 2010. Ontology matching solutions to problem.
18. Jurisica, I., Y, Eric. 2004. Ontologies for Knowledge Management: An Information Systems Perspective, Proceedings of the Knowledge and Information Systems.
19. K. Saruladha, G.Aghila, A., Bhuvaneswary, 2011. COSS: Cross Ontology Semantic Similarity Measure-Information Content Based Approach, IEEE-International Conference on Recent Trends in Information Technology.

20. K.J. Lee, Taeg Keun Whangbo, 2007. Semantic Mapping between RDBMS and Domain Ontology PROCEEDINGS OF IEEE Institute 1-4244-1521.
21. Li H., G. Hu., X. Yang, 2012. Review of Ontology Mapping, in proceedings of international IEEE Conference 978-1-4577-1415-3.
22. Marc, E. and S, York. 2004. Ontology mapping-An integrated approach.
23. Marta, S and A., Mathieu, 2006.Using the semantic web as background knowledge for ontology mapping.
24. Maedche, A., and S., Stab, 2009.Ontology Learning for the Semantic Web, PROCEEDINGS OF IEEE Institute AIFB, D-76128.
25. Nie G., Meng F., Huan Xia. A Semantic Mapping System based on E-Commerce Logistics Ontology, Proceedings of World Congress on Software Engineering Wuhan.
26. Patrick, L and He, Tan. 2011. The Ontology Alignment and Merging, in proceedings of Sixth Framework Program.
27. P. Dixit, S. Seethe, A. K. Sharma, A., Dixit. 2012. The Design of an Automatic Ontology Construction Mechanism using Semantic Analysis of the Documents, Fourth International Conference on Computational Intelligence and Communication Networks.
28. Pan C.P., L.Soldatova, S. Džeroski, 2014.Ontology of core data mining entities, in proceedings of ACM international conference about development in information retrieval.
29. Pavel, S, E., Jerome, 2004. A survey of schema-based matching approaches, in proceedings of journal on data semantics.
30. R. Lima, H, Oliveira, and Fred Freitas, 2014. Ontology Population from the Web: an Inductive Logic Programming-Based Approach, 11th International Conference on Information Technology.
31. R. Khaled, S., Hooria, 2013. The Mapping Ontology used for Geographic Information Retrieval. IEEE International Conference 978-1-4799-3392-1.
32. Ryutaro, I., 2011. Machine learning approaches for ontology mapping using multiple concept similarity measures.
33. Rashmi, C. and G. Rayan., 2012.Ontology based automatic query expansion for semantic information retrieval in sports domain, In: International Conference on Methods and Models in Computer Science.
34. Stephen, R, L. Douglas, 2002.Mapping ontologies into cyc AAAI Technical Report WS-02-11.
35. EL.T. U., S. Rajaranganathan, S.Karthik, 2013.A Survey of ontology in semantic web. International Journal of Science, Engineering and Technology Research (IJSETR) ISSN: 2278 – 7798.
36. S M Falconer, M A, Storey. 2002. A cognitive support framework for ontology mapping: ISWC/ASWC 2007, LNCS 4825, pp. 114–127.
37. Su H. and K. Mar Saw Hla, 2011.An Efficient Ontology Approach for Organizing and Mapping Deep Web Resources, in IEEE-International Conference 978-1-4244-5586-7.
38. T.A Farrag., A.I Saleh., H.A Ali., 2013. Toward SWSs Discovery: Mapping from WSDL to OWL-S Based on Ontology Search and Standardization Engine, Proceedings of IEEE transactions on knowledge and data engineering.
39. Tao, J. and F, Yuchen, 2010.A method of ontology mapping based on instance CNSF NO.60673092.
40. Thomas, L. and S. Heiner., 2012.Tightly integrated probabilistic description logic programs for representing ontology mapping.
41. Vipul, K and S, Amit. 1995. Semantic and schematic similarities between database objects: A context-based approach in proceedings of VLBB journal.
42. Wenjie, L. and Z, Yan, 2009.The Concept similarity calculation in ontology mapping, sixth international conference on fuzzy system and knowledge discovery.
43. Wu, Y and J, Lang., 2009.A similarity-based approach for ontology mapping, forth international conference on computer science & education.
44. Ying, W and L, Weiru. 2012. A structure-base similarity spreading approach for ontology matching.
45. Y. Chai H., Weiping He., Wang X., Song G., 2013. Semantic similarity calculation method for ontology mapping of CCIS IEEE 2nd international conference no: 13898189.
46. Zhang, J and P, Olango, 2005. The Populating Ontologies in proceedings of ACM international conference.