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Towards a multi-level upper ontology/ foundation ontology framework as background knowledge for ontology matching problem

Alok Chauhan[a]*, V Vijayakumar[b], Ramesh Ragala[c]

[a] SCSE, VIT University, Chennai-600127, Tamil Nadu, India
[b] SCSE, VIT University, Chennai-600127, Tamil Nadu, India
[c] SCSE, VIT University, Chennai-600127, Tamil Nadu,India

Abstract

This paper emphasizes on application of background knowledge in ontology matching problems. The main idea is to have a multi-level structure of ontologies (higher the level, more universal/general the ontology is) to be used as background knowledge for ontology matching. This requires next generation of new upper level ontologies, which are at higher level than current set of upper level ontologies. To create such higher level ontologies, usage of new/ alternative philosophical models is suggested.

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Keywords: Upper ontology; ontology matching; multi-level structure

1. Introduction

An ontology typically provides a vocabulary that describes a domain of interest and a specification of the meaning of terms used in the vocabulary [1]. Semantic heterogeneity is biggest challenge in semantic web. Ontology matching is a solution to the semantic heterogeneity problem. It finds correspondences between semantically related entities of ontologies. These correspondences can be used for various tasks, such as ontology merging, query

* Corresponding author. Tel.: +91 44 3993 1099; fax: +91 44 3993 2555.
E-mail address: alok.chauhan@vit.ac.in

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answering, or data translation [1]. It has been stated that the lack of background, most often domain specific knowledge, is one of the key problems of matching systems these days [2].

2. Related Work

Viviana Mascardi, et al, have proposed set of algorithms that use upper ontologies as background knowledge. They used upper ontologies such as DOLCE, SUMO-OWL and OpenCyc. It was found that these methods provide better precision and F-measure as compared to direct methods (which don't match via background knowledge)[3]. Domain-aware ontology matching also shows promising results when compared with standard approaches. It has been found that boot-strapping the matching process with domain knowledge is advantageous [4].

Ontology matching via harvesting semantic web gives encouraging results and is particularly important from the viewpoint of scaling up the matching process [5]. Automatic selection of background knowledge is another approach which enriches ontology matching process with information retrieval techniques [6]. Upper ontologies in conjunction with word sense disambiguation techniques are found to be useful in repairing incorrect correspondences found in ontology matching process [7].

A more generic framework known as context-based matching has been proposed recently and it shows that limitations of content-based matching can be taken care of by it [8]. Automating the process of discovering missing background knowledge in ontology matching could be helpful in this regard and emphasizes the importance of focus area being discussed about [9].

Solutions provided for contextual ontology alignment of Linked Open Data with an upper ontology addresses important issues related with schema-level mappings [10]. Background ontology is shown to be very helpful in matching unstructured vocabularies and this paper extends this idea further [11].

3. Proposed System

A multi-level structure in the form of a tree of upper ontologies is proposed as a background knowledge framework for the purpose of matching ontologies. As shown in Fig. 1, the whole matching process can be thought of as consisting of following three phases:

Phase I: Semantic entities from source and target ontologies are anchored to leaf upper ontologies of background knowledge framework in first scan. Any string based anchoring mechanism can be used for this purpose.

Phase II: In the second scan of the tree of upper ontologies, lowest common subsumer upper ontology is found on the basis of Tarjan's lowest common ancestor/subsumer algorithm (Fig. 2).

Phase III: Semantic relationship is established between entities of Phase I by again applying algorithm mentioned in Phase II to lowest common subsume ontology found in Phase II.

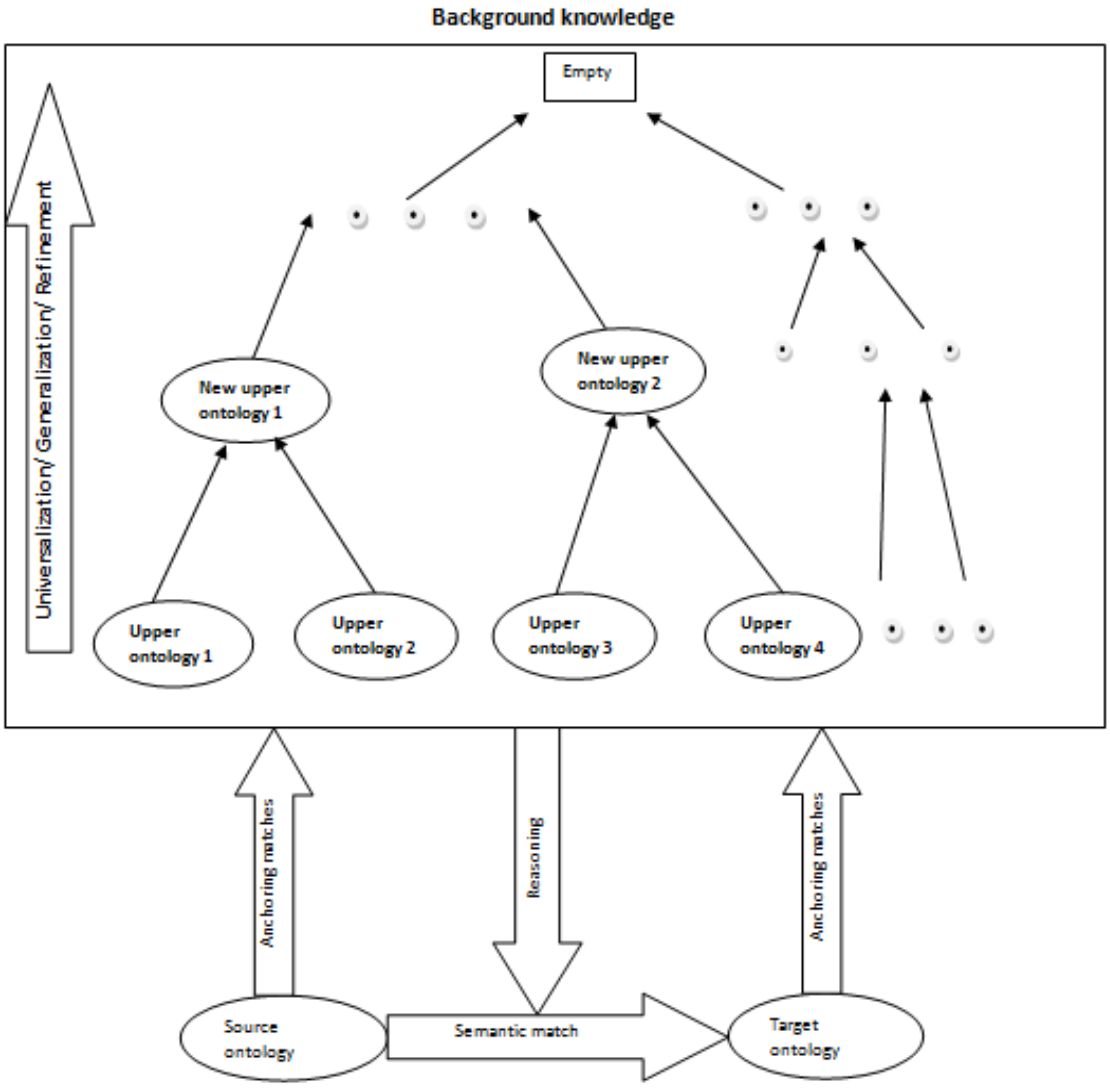

Fig. 1 A multi-level background knowledge framework

Algorithm Lowest Common Subsumer

```
1.  ALGORITHM  LCS (UO_i, UO_j, T)
2.  // INPUT:  UO_i and UO_j are the two Upper Ontologies  in Tree T where
    i ≠j and
    {a_1, a_2, a_3, … a_k} ϵ OU_i ,where 1 <i ≤n.
3.  // OUTPUT: Lowest Common Subsumer Ontology
4.  BEGIN
5.          u ← UO_i, v ← UO_j;
6.          while(T.depth(u) >  T.depth(v)) do
7.                  u ← parent(u);
8.          while(T.depth(v) > T.depth(u)) do
9.                  v ← parent(v);
10.         while(u ≠ v) do
11.                 u  ← parent(u);
12.                 v  ← parent(v);
13.         return(LCS(a_i, a_j, u)); // a_i, a_j ϵ u
14.   END
```

Fig. 2

4. Conclusion & future work

Proposed framework is a comprehensive solution to ontology matching problem based on matching via background knowledge paradigm. It does assume the existence of higher level upper ontologies, for which usage of new alternative philosophical model such as *Madhyastha-darshan* [12] would be explored in future work. Experimental verification of the proposed model will also be carried out and results of proposed matching system will be compared with existing state-of-the-art models.

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