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Enhanced Expressivity using Deontic Logic and Reuse Measure of Ontologies

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Abstract

Measuring and aligning ontologies is the only remedy of ontology sharing and reuse. The management of the less expressive target ontology is a complicated problem and such reduced expressivity often occurs due to poor implicit semantic knowledge representation and the use of polymorphic objects. Efficient sharing and reuse of knowledge is achieved by providing enhanced expressivity by uncovering the implicit knowledge of the target domain and the detection of erasure of polymorphic objects. This paper uses deontic logic based Graph Derivation Representation approach in order to provide enhanced expressivity of the target ontologies. Distance based similarity metric is used in the proposed framework for the purpose of ontology reuse. The proposed framework is implemented on several web datasets which shows the efficiency of the underlying algorithm. The effectiveness of the experimental results is promising when compared to other Graph Derivation Representation methods that are evident from the illustrated graphical results.

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Keywords: Expressivity; Graph derivation representation; Ontology; Ontology reuse; Polymorphic objects.

1. Introduction

Ontology is a term which means “theory of existence”. The main advantage of ontology that they provide a knowledge – sharing framework that supports the representation and sharing of domain knowledge by formalizing the content and information so ontology is said to be the body of knowledge. Ontologies have been widely applied in many fields such as knowledge management[1–3], Semantic Web[4], information integration[5–7], and semantic search[8–10].

The underlying semantic knowledge of the target datasets can be well expressed using several knowledge representation languages like logic. Out of several logic languages available for knowledge representation, ontology can be expressed in different logics such as predication, fuzzy, temporal, situational, description logic and modal logic. However, for certain data sets, the use of DL might not be feasible due to the presence of non-dominant words in the target datasets. In such cases, the expressivity of the target data will be reduced, causing several issues like instability and occurrence of polymorphic objects. Therefore, it is necessary to enhance the expressivity by uncovering

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the implicit semantic knowledge, providing expressivity is by using modal logic. Deontic logic is a kind of modal logic and has a great impact of non-dominant words occurring in the documents. It is the formal study dealing with the statements of compulsory, forbidden and permissible clauses. It can handle sentences containing negated words like SHOULD_NOT, MUST_NOT, SHALL_NOT, COULD_NOT, WILL_NOT, etc. instead of the conventional negation symbols as used in the other logic languages. In addition to this, it includes the other symbols that are available in description logic.

Ontology alignment is an important concept in the ontology reuse. The semantic knowledge of an existing ontology can be utilized for a newly constructed ontology even in a heterogeneous environment. Reusability is an important estimation parameter in order to resolve the degree of intersection. Resolving such intersection measure poses to be a very challenging issue since such measure depends on the underlying explicit and implicit semantic knowledge. Distance based methods are the widely used technique for measuring the similarity measure.

In this paper, an enhanced framework is proposed which provides separate working modules for ontology construction and ontology reuse which is otherwise known as ontology alignment. In case of ontology construction module deontic logic based GDR technique is used for the construction of expressive ontology. There are three different phases in the proposed framework. In the first phase, a GDR for each concept and the different relationships in a given ontology by recursively applying a series of derivation is generated. In the second phase, an integration technique is applied to merge multiple GDRs in order to produce an initial integrated GDR for the given ontology. In the third phase, a complete GDR representation of the given ontology is generated by deleting the unstable relations for semantic measurements are done. The major objectives of the proposed framework are given below:

- To provide a stable structural ontology of the underlying knowledge using GDR
- To visualize a highly expressive ontology using the implicit knowledge
- To compute the distance deviation of two different ontologies to estimate the degree of reusability

The remainder of this paper is structured as follows. Section 2 presents a quick survey of the related works. Section 3 gives a detailed description of the proposed framework. Section 4 discusses performance analysis of the proposed framework. The final section gives the conclusion of the paper and few directions of future work.

2. Literature Review

Many graphical models have been introduced recently for ontology construction and alignment[8–10]. One among them is the Unified Modelling Language (UML) associated with Object Constrained Language (OCL). OCL can also be used as graphical model for representing ontologies.UML is suitable for representing explicit taxonomical information instead of implicit non-taxonomic relationship. Semantic Link Network (SLN) provides description of semantic relations among existing objects. SLN helps to obtain semantic richness instead of semantic correctness. This model also fails to explain the explicitly express implicit semantic constraint. Ordered Binary Decision Diagram (OBDD) provides generalization of binary decision trees in which every concept is converted into its NNF (negation normal form). The existing techniques does not make use of existing measures.

Ontology measurement refers to the process of measuring ontologies based on ontology measures. Existing ontology measures uses only the explicit semantics of ontologies to compare similarity of ontological entities and structures explicitly expressed in ontologies. A cluster – based measure was proposed in[11], which combines the minimum path length and the taxonomical depth and defines clusters for each of the branches in the hierarchy with respect to the root node. An ontology – based measure utilizing taxonomical features was proposed in[12] without using tuning parameters to weight the contribution of potentially scarce semantic features.

[13]uses a similarity function to determine a similar entity class by a matching process based on semantics and calculates the similarity of two concepts using the relevant super-concepts and sub-concepts of the two concepts. It provides methods to calculate the similarity of two gene products with graph-based ontology terms. Quality measures[14–18] were introduced to measure and evaluate certain ontology quality properties such as cohesion, complexity, richness, and so forth. However, most of the existing systems for handling polymorphism of ontology representation are limited and inefficient. In this paper, we define a solution of stable semantic measurement to handle polymorphism of ontology representation for ontology measurement and comparison.