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Ontology Reusing: A Review

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Abstract. Building ontologies from scratch is a process that requires many resources as time, knowledge about the domain, among others. Sometimes ontologies are developed in the same domain with similar designs and the same propose causing a repetitive work. Ontology reusing allows us to build models with lower resources. There are several techniques for ontology reusing as: mapping, alignment, fusion, ontology integration, ontology networks, among others. In this paper, we analyze three techniques oriented to ontology reusing from the use of entire ontologies (no modularization).

Keywords. Ontology reusing, ontology mapping, ontology alignment, ontology networks.

1 Introduction

Many ontologies have been developed in order to build models that can facilitate the semantic interoperability. The term ontology is defined by Gruber [5]: *an explicit, formal specification of a shared conceptualization*, that has a defined and legible vocabulary to express main concepts and relationships about a specific domain [19, 13]. The ontologies allow the computers and humans understand the relationships about a domain using formal language [12].

Ontology reusing is based on builds models faster and at with a lower cost than build a model from scratch using traditional ontology design methodologies [17]; this task increases the interoperability of involved ontologies [22]. In general, ontology reusing belongs to the Ontology Learning area, and is based on building a new ontology by assembling, extending, specializing and adapting other ontologies [10].

There are techniques for ontology reusing as: mapping, alignment, fusion, ontology integration, ontology networks, among others. In order to select an optimal technique for building a model from ontological resources, we must consider the answer of the next questions:

- Does model include different domains?
- Is there an ontology for each model component?
- Is it necessary design ontologies from scratch for complementing the model or only some components (relationships, axioms, etc.)?

Further, there are mismatches for considering in order to a correct ontology reusing, some of them are classified in according to differences from design and construction stages (see Fig. 1)[1].

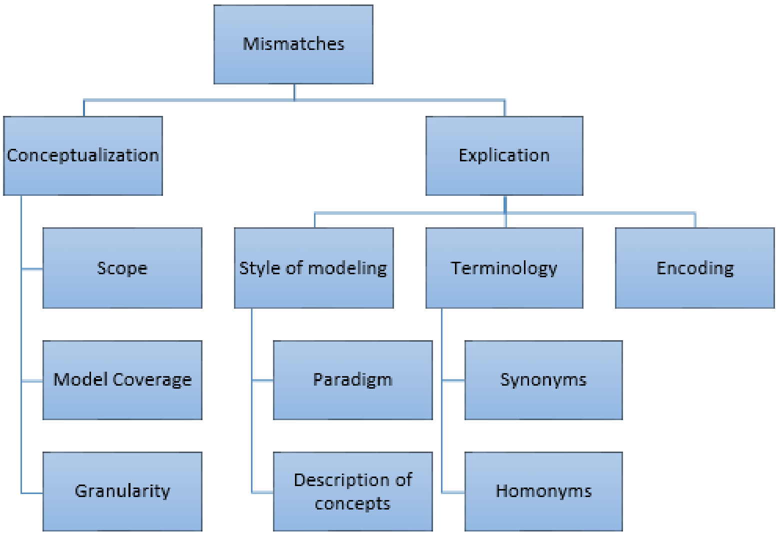

Fig. 1. Mismatches in ontology reusing.

For evaluating the resulted ontology, there are many criteria as modularity, which indicates if exist sets of reusable components [4]; connectivity, it measures the most important concepts based on the amount of relationships [20]; and coupling, this is about the number of external concepts that are referenced or imported [7].

In this work, the alignment, mapping and ontology networks techniques for ontology reusing are analyzed in order to offer a global vision about this approaches. This document has divided into five sections; the section 2 shows the ontology mapping task, in the section 3 the ontology alignment task is described; the section 4 contains information about the ontology network; and finally, the conclusion and future work are explained in the section 6.

2 Ontology Mapping

Ontology Mapping or Ontology Matching is the proccess to find correspondences between two ontologies, this correspondences are not belonging part of any ontology [1, 9]. The resulted correspondences are affected by the granularity level into the information of the ontologies [3]. The ontology mapping is defined as a 4-tuple $\langle e, e', r, c \rangle$ where e and e' are entities of two ontologies (O_1 and O_2

respectively); r is a semantic relation $\in \{\sqsubseteq$ more general, $\sqsupseteq$ more specific, and $\equiv$ equivalence$\}$; and the confidence value c $(0, 1]$, i.e. 0=not reliable and 1= reliable [6]. There are three phases for mapping: mapping discovery, mapping representation, and mapping execution [1].

In the Fig. 2 it shows two ontologies, after a mapping process the result is an equivalence correspondence between the car and vehicle classes.

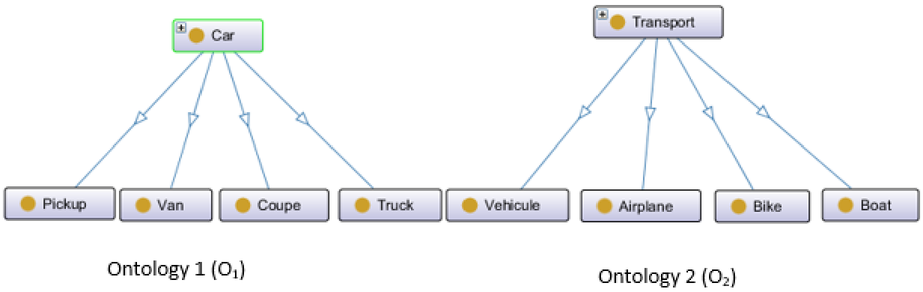

Fig. 2. Example of two ontologies.

3 Ontology Alignment

In ontology learning, the ontology alignment is the task that puts different models in correspondences by discovering similarities between discrete entities from two ontologies by a semi-automatic process in order to give semantic interoperability [1, 18]. Ontology alignment allows to visualise correspondences, resource transformation, and querying in two ontologies at the same time [21]. The ontology alignment is defined as $O^M = O_1 \bigcup O_2 \bigcup M$ [6]; where M is the set of correspondences as a result of application of Match operator. Fig. 3 illustrates the result of ontology alignment using the ontologies shown in the Fig. 2.

The Match operator has schema-based or instance-based matching; in schema-based, it considers the concepts and relations in order to determine correspondences using a similarity measure; in instance-based, the instances that belong to different concepts are consider for discovering a similarity [1].

For alignment evaluation using user validation approach, is necessary that users are acquainted with the formal representations of involved ontologies [2]. In [6] recommend if the evaluation is based on precision, recall and F-measure, using Gold standard and Silver standard approaches to guaranty the correct results.

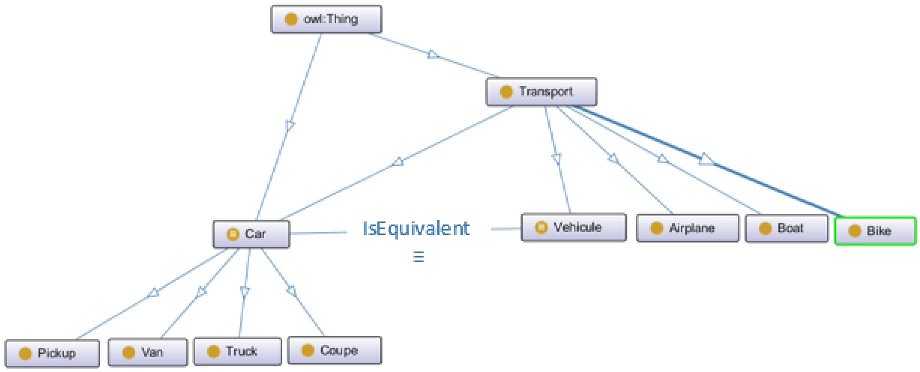

Fig. 3. Result of ontology alignment.

4 Ontology Networks

Unlike mapping and alignment ontology, an ontology network is a collection of ontologies related through meta-data that indicate the dependence between them [18], and sometimes these ontologies do not share the same domain. Specifically, the ontology network design refers to create meta-relationships between ontological entities and represents the opposite process of ontology modularization, where the main task is finding parts into ontology that can work as modules. The meta-relationships in the ontology network (versioning, inclusion, inconsistency, similarity, among others) are relationships whit a meaning that depends of the meanings of the others ontologies used in the network [16], i.e. the relations in an ontology depend of the domain, while, the meta-relations are explicit and independent of the domain [15].

An example of ontology network is presented in [11], in this paper we can see the representation of modules is through triangles and contains the name of the reused ontologies; the relations do not belong to a particular domain, but indicate the way of the modules are related by general terms (see Fig. 4).

5 Related Works

Zulkarnain et al. [22] propose a methodology for ontology reusing in medical area, this methodology is focused to use one or more ontological modules by term extraction, ontology recommendation and mapping; the evaluation of resulted ontology is based on the resources from domain. Pinto et al. [10] developed a methodology for reusing ontology by integration focus; where the ontologies for integration must be compatible with the requirements of the domain according the knowledge pieces for changing or removing. Finally, in the last step, the ontology structure using full or partial ontology integration is built.

In [3], it is presented a proposal of the union of three medical domain ontologies through the mapping of ontologies, which represent information about

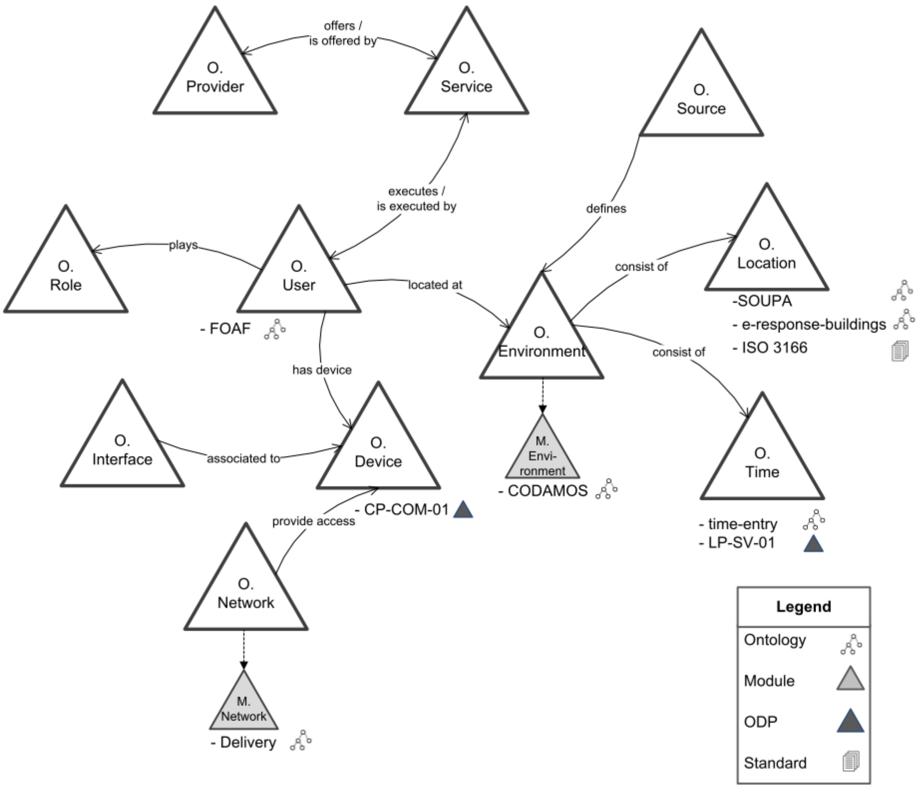

Fig. 4. Example of ontology network [11].

the Diseases (*Disease Ontology* , DO), Human Phenotypes (*Human Phenotype Ontology*, HPO) and X-Ray (*Radiology Gamuts Ontology*, RGO).

They looked for elements that were synonyms and the longer text strings between the main RGO classes with respect to DO and HPO. In the case of relationship mapping, three types were identified: sameAs, subsumption and mayCause, in order to integrate a relationship scheme based on elements coming in the following order DO-RGO-HPO.

Also, it has been proposed to use an ontology to integrate information in a heterogeneous way in order to create a repository using a detection similarity algorithm; for the creation of the main ontology, it was necessary to map features from ontologies already known to extend the domain [14].

Dragisic et al. [2] proposed to evaluate the ontology alignment results by a user validation. In this, using three main aspects: user profile (familiarity into the domain and the elements of knowledge representation); system services; and user interface (explanation of results).

In [15], an ontology network was developed in order to describe the pedagogy evaluation domain and the semi-automatic generation of evaluation, using ontologies focused on evaluation process. Poveda-Villalón et al. [11] built an ontology network for mobile environments (mIO) using the scenarios 2,3,7,8, and 9 of NeOn Methodology [8]; they reused many ontologies in order to create modules as time, location, user, among others; the modules were connected by relations extracted from textual natural language that describes use cases.

6 Conclusions and Future Work

For knowledge representation is very important reusing ontological resources, because many of them are evaluated and maintained by domain experts; it allows building model at a low cost. Mapping ontology finds correspondences between two ontologies that represent the same domain or only a part of it; meanwhile, the ontology alignment uses these correspondences for merging the ontologies. On the other hand, the ontology networks use some not related ontologies and design new relations for the interoperability independently of the ontology domain.

In future work, we will develop a methodology for ontology network design that includes mapping and alignment task in order to include ontologies with correspondences.

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