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Frame-Based Ontology Alignment

Luigi Asprino
DISI, University of Bologna, Italy
luigi.asprino@unibo.it

Valentina Presutti
ISTC-CNR,Italy
valentina.presutti@cnr.it

Aldo Gangemi
ISTC-CNR, Italy
aldo.gangemi@cnr.it

Paolo Ciancarini
DISI, University of Bologna, Italy
paolo.ciancarini@unibo.it

Abstract

The need of handling semantic heterogeneity of resources is a key problem of the Semantic Web. State of the art techniques for ontology matching are the key technology for addressing this issue. However, they only partially exploit the natural language descriptions of ontology entities and they are mostly unable to find correspondences between entities having different logical types (e.g. mapping properties to classes). We introduce a novel approach aimed at finding correspondences between ontology entities according to the intensional meaning of their models, hence abstracting from their logical types. Lexical linked open data and frame semantics play a crucial role in this proposal. We argue that this approach may lead to a step ahead in the state of the art of ontology matching, and positively affect related applications such as question answering and knowledge reconciliation.

Introduction

Ontologies are artifacts enconding a description of a domain of interest for some purpose. They provide a shared and common understanding of a domain that can be communicated across people and applications, and support information exchange and discovery. Due to the Web's open nature, ontologies can be defined by different people and can vary in quality, expressiveness, richness, and coverage, hence increasing semantic heterogeneity of the resources made available through the Web of Data. Semantic heterogeneity leads to the problems of *redundancy* and *ambiguity*. These problems hinder the semantic interoperability between information systems and represent an obstacle for the development of intelligent agents able to exploit, as a source of knowledge, the semantic information available in multiple web sources.

Among the various semantic technology proposed to handle heterogeneity Ontology Matching (Shvaiko and Euzenat 2013) has proved to be an effective solution to automate integration of distributed information sources. Ontology Matching (OM) finds correspondences between semantically related entities of ontologies. However, most of the current ontology matching solutions present two main limits: (i) they only partially exploit the natural language descriptions of ontology entities and lexical resources as background knowledge (e.g., some examples in this direction are provided by (Giunchiglia, Shvaiko, and Yatskevich ; Gracia and Asooja)); (ii) they are mostly unable to find correspondences between entities specified through different logical types (e.g. mapping properties to classes), hence, they are unable of handling *explication* mismatches (to the best of our knowledge (Ritze et al. ; Li et al. 2009) are the only attempts trying to address this issue).

Frame Semantics can be used as cognitive model for representing the formal meaning of ontology entities thus overcoming the current limits of the current ontology matching techniques. Frame Semantics (Fillmore 1982) is a formal theory of meaning based on the idea that human can better understand the meaning of a single word by knowing the relational knowledge associated to that word. For example, the meaning of the verb *buy* can be clarified by knowing that it is used in a situation of a commercial transfer which involves individuals playing specific roles, e.g. a buyer, a seller, goods, money and so on. In other words, the verb buy *evokes* a scene where there are some individuals are playing specific roles. Our hypothesis is that the frames evoked by words [1] associated with an ontological entity can be used to derive the intended meaning of that entity thus facilitating the ontology matching task.

In this paper we introduce a novel approach aimed at finding correspondences between ontology entities according to the intensional meaning of their models, hence abstracting from their logical types. We claim that the comparison between ontologies entities should be firstly made on the basis of natural language associated with them, and then, their axiomatization can be used to check possible inconsistencies. This strategy allows us to match ontological entities with respect to their intensional meaning (that we suppose it is evoked by the natural language associated with them) instead of their axiomatization, hence to abstract from their ontological type. In fact, the axiomatization could have been forced by the choice of certain language for specifying the ontology, by the personal modeling style of the designer, or, other requirements (e.g. the compatibility with an existing ontology) unrelated to the modeled domain. We argue that this approach may lead to a step ahead in the state of the art of ontology matching, and positively affect related applica-

[1] For instance the words contained in labels and comments.

tions such as question answering and knowledge reconciliation, ontology population and language generation.

Proposed approach

Following (Gangemi and Presutti 2010), we devise an approach for ontology matching that considers frames as "*unit of meaning*" for ontologies and exploits them as a means for representing the intensional meaning of the entities. Our strategy consists of two steps, summarized as follows.

Selecting frames evoked by annotations. In order to associate ontological entities with frames we analyze the textual annotation associated with them. Annotations provides humans with insights of the intensional meaning the designer wants to represent with a certain entity. The main idea of this approach is that words used in the annotations *evoke* frames that are representative of the intensional meaning of the entity. Our hypothesis is that frames evoked by words contained in these annotations provide a model for the intensional meaning of the entity.

In associating entity with frames, the ambiguity of words has to be taken into account. For instance, depending on its sense the verb *bind* evokes either the frame *Imposing obligation* (when it is intended as "*bind by an obligation*") or the frame *Becoming attached* (when it is intended as "*wrap around with something so as to cover or enclose*"). In light of this consideration, to associate entities with the most appropriate frames, we have (i) to disambiguate the sense of the word in the text characterizing entities; (ii) and then, to select evoked frames by exploiting the mapping between WordNet's synsets and FrameNet's frames.

Mapping frames and ontologies. At this point ontology entities are associated with frames that are somehow related (i.e., evoked) to their intensional meaning, now an effective mapping between them has to be created. An example of mapping is provided by FrameBase's integration rules (Rouces, de Melo, and Hose). However, they focused on the transformation of class to frame and properties to frame elements, or properties in binary projection of frames, and classes in their valences. The choice of certain ontological type for representing a concept depends on requirements that are external from the domain that is being represented. Therefore, we claim that the mapping ontologies-frames has to be done without assuming any fixed correspondence between the ontological types of the two models (e.g. without assuming that object properties always correspond to binary projections of frames).

In order to identify the effective mapping between ontologies and frames, we go through ontology entities and for each entity we compute any possible mapping between the entity and the frames selected in the previous step (i.e. those evoked by its annotations). In frame semantics, a frame is characterized by its roles (also called frame elements) and each element possibly define the semantic type of the individual that can play that role in the frame. Frames, frame elements and semantic types have a name and a description. For each ontology entity we compute its similarity with the evoked frames, its elements, and its semantic types. Therefore an ontology entity may correspond to one of these components defined in the evoked frames. The confidence of this correspondence is provided by the Semantic Text Similarity (STS) (computed through ADW (Pilehvar, Jurgens, and Navigli)) of the description of the two elements.

Frame-based ontology matching Once input ontologies and frames are aligned, each ontology entity is associated with a formal specification of its intensional meaning (that we call *frame-based specification*). It is worth noting that frame-based specifications rely on the same "*language*" (i.e. elements of the specification are frames coming from an unique source). In other words, input ontologies at this point are normalized with respect to the frame semantics. The only purpose of this step is to compare frame-based specifications of ontology entities.

Conclusion and Future work

In this paper we introduced a novel approach for ontology matching. This method exploits the frame semantics as cognitive model for representing the intensional meaning of ontology entities. The frame-based representation enabled at finding correspondences between ontology entities abstracting from their logical type thus leading a step ahead the state of the art of ontology matching.

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