OntoTag's Linguistic Ontologies: Improving Semantic Web Annotations for a Better Language Understanding in Machines

Guadalupe Aguado de Cea
DLACT, UPM
lupe@fi.upm.es

Inmaculada Álvarez de Mon
DLACT, UPM
ialvarez@euitt.upm.es

Asunción Gómez-Pérez
DIA, UPM
asun@fi.upm.es

Antonio Pareja-Lora
SIP, UCM / LIA, UPM
apareja@sip.ucm.es

Abstract

Following the road in-between purely linguistic annotation and solely ontology-based annotations for the Semantic Web, a hybrid (ontological and linguistic) model and platform, called OntoTag, has been created, aiming at better machine communication, interoperability and language understanding; these capabilities are derived from the incorporation into the platform of a set of linguistic ontologies, the main topic of this paper, suitable for the multi-leveled and standardized annotation of Semantic Web documents.

1. Introduction

Many schemas have been developed so far for the different kinds of annotation required in the field of **Corpus Annotation**. Besides, with the appearance of the **Semantic Web** [1] many other schemas, most of them based on *ontologies* [2, 3], have been devised for *web page annotation*. In this context, the *semantic annotation of texts*, in so far as it makes meaning explicit, has become a relevant topic; both a design of advanced models and formalisms and their application to the semantic annotation of web pages are needed.

Thus far, on the one hand, *Corpus Linguistics researchers* are trying to cover as many levels and aspects of annotation as possible—from a linguistic point of view—to describe language phenomena [4, 5, 6, 7]; on the other hand, *researchers in the Semantic Web area* are focusing on:

1. Achieving a sound model of semantic annotation for web pages, that is able to capture as much knowledge from these pages as possible, so that computers can process them in a much smarter way [8, 9, 10, 11] and even be closer to understanding their meaning [12].

2. Finding the best way to describe web resources and vocabulary and the underlying meaning of web pages, mainly by means of languages like XML, RDF(S) or OWL [13, 14].

However, there is an emerging road in-between, nowadays, that seeks to merge and sum up both kinds of annotations, combining them in order to bear a new, unified, multilingual, flexible, extensible and fully semantic model of annotation, useful for both communities [15, 16]. Moreover, as shown by [17] “there is an increasing need for new standardization as well as urgent recognition of existing *de facto* standards and their transformation into International Standards”. In fact, one of the main aims of the ISO - TC37SC4 committee is “to develop standards and related documents to maximize the applicability of language resources”.

The *OntoTag hybrid* (linguistic and ontological) model for **Semantic Web Annotation** [16], whose linguistic ontologies we present here, is being developed following this in-between road aforementioned, as well as a number of guidelines hitherto published [18, 19, 20, 21, 22], in order to achieve the goal of standardization sought within the ISO - TC37SC4 committee, which will enable interoperability between systems, as a direct side effect, by means of sharing a common vocabulary and resource description based on ontologies.

This paper is organized as follows: firstly, some brief notes on the use of ontologies in semantic annotation will be sketched (section 2). Then, in section 3, an introduction to the state of the art in Corpus Linguistics for text annotation will be presented. In section 4, the platform *OntoTag* for hybrid (ontological and linguistic) annotation is shown, together with the other modules of our project, to proceed next to the discussion of *OntoTag's* linguistic ontologies in section 5 (some of them separately analyzed in subsections 5.1 and 5.2). Finally, some conclusions and future work will be stated—section 6—together with the

acknowledgements section (7) and the references (section 8).

2. Ontology-based annotations for the Semantic Web.

As stated in [13], “ontologies have proven to be an essential element in many applications and [...] are useful not only for applications in which knowledge plays a key role, but also they can trigger a major change in current Web contents [...] leading to the third generation of the Web—known as the Semantic Web”. As the same authors comment, there is much in common between the definitions of ontology and of Semantic Web given, respectively, in [23] and in [1].

From this point of view, ontologies, implemented with the newly created and standardised knowledge representation languages for the Web [13, 14], are called to be the ideal way to:

1. Make explicit the underlying meaning of web page terms.
2. Describe in a more machine-readable way Web resources and vocabulary.

Moreover, ontology-based annotations for the Web are expected to allow a smarter access to the resources within the WWW, to enable the inference of information from Web data and to ease the searching and browsing of web pages.

A survey on ontology based annotation tools and schemas can be found in [24].

3. Linguistically-based annotations.

Even though much research has been carried out by ontologists in the Semantic Web field on the semantic annotation of web pages [24], it is in the field of Corpus Linguistics where most standards, criteria and recommendations on annotation can be found. In [18], a list of the main different levels of linguistic annotation can be found, namely: lemma, morpho-syntactic, syntactic, semantic and discourse annotation. They are shown in *Figure 1* (Annotation Level Pyramid), together with their corresponding tools (Linguistic Tool Stack) and applicable criteria, recommendations and guidelines (Linguistic Annotation Criteria Heap). A deep analysis of these concepts and their potential value for the Semantic Web can be found in [15, 24].

4. OntoTag’s hybrid annotations

OntoTag was intended to be the platform for a standard-annotated and shared intermediate representation for the documents processed within two funded projects in

Figure 1. Linguistically based kinds of annotation.

our laboratory, *ContentWeb* and *PLAN-H-SemWeb*. As explained in [15], ontological annotations can be considered as a type of semantic annotation in the Corpus Linguistics field and, thus, *OntoTag* was designed as a hybrid annotation platform, that is, taking into account both ontological and linguistic annotation criteria and elements. Having in mind that, as stated by the same authors, meaning is not only within the semantic level but, instead, can be implicit and distributed among the rest of the levels, *OntoTag* was conceived as a multi-levelled annotation platform, in order to capture as much semantics as possible from documents.

When devising *Ontotag*, interoperability issues had also to be taken into consideration since it can be regarded as the base for the intercommunication and metadata storage of these other modules of *ContentWeb*:

1. Semi-automatic ontology learning in the domains of e-commerce and entertainment, reusing existent ontologies and international e-commerce standards and joint initiatives.
2. Development of a natural language interface based on ontologies.
3. Creation of an ontology-based system for querying and retrieving information from annotated web documents in the entertainment domain.

5. OntoTag’s linguistic ontologies

One of the main components of the *OntoTag* model is its set of linguistic ontologies, devised to represent the structure and relationships between the elements of language at different linguistic levels. The kind of elements and relationships considered in these ontologies are the ones usually included in existing annotation schemas and also those already discussed in the literature

but not implemented yet [4, 5] as well as some others, decided by our research team. First of all, a Linguistic Level Ontology (LLO) was developed both to capture the stratification of natural language analysis and generation and to simplify the study of the other elements. Then, following the EAGLES guidelines for morpho-syntactic annotation of corpora [18], but obviously broadening its scope, three different ontologies were built to represent the category-attribute-value formalism at all levels of annotation (morpho-syntactic, syntactic, semantic, discourse and pragmatic): a Linguistic Unit Ontology (LUO), a Linguistic Attribute Ontology (LAO), and a Linguistic Value Ontology (LVO).

Complementing these four ontologies, a fifth one (the Linguistic Pattern Ontology, LPO) has been designed for representing the patterns that these units follow when combined in an utterance. Finally, the *OntoTag* Integration Ontology (OIO) establishes the main relationships between documents (annotated and non-annotated), units, attributes, and values both in the linguistic and in the ontological areas of annotation.

The application of these six ontologies in the *OntoTag* annotation model is twofold: first, as discussed above, they identify the different elements (mostly linguistic, but also ontological) that are annotable in the Semantic Web field; second, once the ontology has been populated (instantiated) by the annotations obtained with *OntoTag*, they will also act as a repository or database of these annotations.

Let us now take a closer look to the four core *OntoTag* linguistic ontologies, namely: the LLO, the LUO, the LAO and the LVO.

5.1. The Linguistic Level Ontology (LLO)

As mentioned before, the Linguistic Level Ontology (LLO) was developed both to capture the stratification into different levels of natural language analysis and generation and to simplify the study of the other elements. A screen capture of this ontology is shown in *Figure 2*. The main sources of information for building it were the EAGLES recommendations for the morpho-syntactic and syntactic annotation of corpora [18, 19] and, thus the linguistic levels considered in the LUO are the morpho-syntactic, the syntactic (sub-stratified in all its layers), the semantic, the discourse, and the pragmatic levels. As commented in [19], the syntactic level was sub-divided in eight layers, namely, bracket, category, dependency relation, functional, sub-classification, logical relation, rank, and non-fluency phenomena layers.

The addition of the last and upper level of *Pragmatics*, which was not considered in EAGLES (perhaps subsumed within the discourse level), is of a considerable interest for human communication and language understanding (and also, consequently, in human-computer interaction and communication); according to [25], **Pragmatics** is the study of four areas: *speaker meaning* (that is, what is the

Figure 2: OntoTag's Linguistic Level Ontology (WebODE capture)

speaker intention, independently of what he/she finally utters), *contextual meaning* (what people mean in a particular context and how the context influences what is said), *invisible meaning* (how more gets communicated than is said) and *relative distance expression* (how much needs to be said, according to the physical, social or conceptual subjective distance between the speaker and the listener). A description of the kind of information that the annotations at this level can give us to improve language understanding by computers can be found in the following subsection.

5.2. The Linguistic Unit, Attribute and Value Ontologies (LUO, LAO, LVO)

Whilst the Linguistic Unit Ontology (LUO) includes all the units (categories) identified at the different levels of annotation considered in the LLO, the Linguistic Attribute Ontology (LAO) includes the various attributes associated to the units in the LUO; the Linguistic Value Ontology (LVO) accounts for the possible values of the attributes in the LAO.

These three ontologies are presented together because of the close connection and parallelisms between them. For instance, the lemma level can be considered so simple that it has no unit associated, and, consequently, no further study for attributes or values is needed; in the morpho-syntactic and in the syntactic level, the LUO incorporates all the categories included in their respective EAGLES recommendations [18,19], re-structured in order to better differentiate between what can be considered an ontology class and what a class or an instance value. Therefore, a huge number of the values contained in [18] were included in the LUO as units and their associated attributes transformed in IsA (SubClassOf) relations in the LAO, since this recommendation did not differentiate two distinct layers of categorization and inflection; values such as “Common” or “Proper” (from the “Type” attribute for nouns) are included as subclasses of “Noun”, the class that has associated all attributes corresponding to the morpho-syntactic category of nouns.

At the semantic level, a subset of the SIMPLE ontologies [26] has been reused, after some adaptation, and attributes and values coming from Halliday’s Functional Grammar [27] have been attached to these semantic units; with regard to the discourse and pragmatic levels, some units have already been identified: a reference assignment unit, that is, exophora and endophora with their subclasses, a deictic unit and its subclasses, etc. Morpho-syntactic attributes revealing a semantic, discourse or pragmatic projection have been replicated or directly assigned to the corresponding level: this is the case of “Politeness” (pragmatic) or “Person” and “Possessive number” (discourse). *Named entities*, included as a class of

exophora at the moment, *deixis* and *co-reference*, and the aforementioned *politeness* or speaker-listener physical or psychological *distance* are the kind of elements that have been included in the model at these levels to capture as much knowledge and meaning as possible from web pages, but these and other details will require further study still.

6. Conclusions and further work

In this paper we have presented the set of linguistic ontologies developed for *OntoTag*, a Semantic Web hybrid annotation model, in order to:

- identify the different elements (mostly linguistic, but also ontological) that are annotable in the Semantic Web field and that can make its pages more machine-readable.
- act as a repository or database of annotations obtained with *OntoTag*, stored as instances in the ontologies.

The advantages of using the different linguistic ontologies presented in this paper are, on the one hand, derived from the very nature of ontologies, that is, extensibility, flexibility and, to some extent, multilinguality; the consensual nature of ontologies and the sources used in their construction [18, 19, 20, 21, 22, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34] also enable them (and the annotations obtained with them) to be considered standardized.

On the other hand, the meaning of a page with explicit semantic annotation obtained by means of these ontologies is reinforced by the meaning contribution provided by all of the linguistic levels; semantic analysis also benefits from the invaluable work done so far on the development of ontologies as conceptual and consensual models, which eases language understanding and communication.

However, the main disadvantage lies still in the limitations imposed by current technologies: the process of obtaining automatically annotated compact, readable, and verifiable pages is quite a hard task to be fully specified and delimited; besides, as mentioned before, further efforts must be devoted to the refinement of the discourse and the pragmatic sub-models of *OntoTag* and linguistic ontologies. Nevertheless, the work being done in our laboratory tries to bring some light upon these issues.

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