

# Semantic Hand-Tagging of the SenSem Corpus Using Spanish WordNet Senses

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## Abstract

This paper presents the semantic annotation of the SenSem Spanish corpus, a research focused on the semantic annotation of the nominal heads of the verbal arguments, with the final goal of acquiring semantic preferences for verb senses. We used Spanish WordNet 1.6 senses in the annotation process. This process involves the analysis of the adequacy of WordNet for semantic annotation and, in cases of inadequacy, the proposal of solutions. The results are the tagged corpus, a guide with semantic annotation criteria, and a critical assessment of WordNet as a resource for semantic corpus tagging.

## 1 Introduction

The semantic annotation of corpora provides a basis for characterizing lexical-semantic information. In this paper we present a relevant part of the long-term project of annotation of the SenSem Spanish corpus (Alonso et al., 2007), i.e. the semantic annotation of the nominal heads of the verbal arguments using the Spanish WordNet 1.6 (hereinafter ESPWN1.6) (Atserias et al., 2004a). The final goal of this research is the acquisition of semantic preferences for verb senses.

This process involved two lead-up tasks:

- 1) Assessing the adequacy of ESPWN1.6 (and thus WordNets in general) for corpus annotation.
- 2) Finding solutions for such inadequacy problems — thus setting an annotator’s guide providing stable criteria, specially for sense disambiguation.

SenSem is a databank of Spanish which maps a corpus and a verbal database. The corpus consists of 25,000 sentences, 100 for each of the 250 most frequent verbs of Spanish (Davies, 2002).

Sentences are tagged at both syntactic and semantic levels: verb sense, phrase and construction types, aspect, argument functions and semantic roles.

Currently, the project finished the semantic tagging of the heads of the verbal arguments. This phase of the project consists of tagging noun heads with ESPWN1.6, — a resource integrated into the Multilingual Central Repository<sup>1</sup> (MCR) (Atserias et al., 2004b) which follows the EuroWordNet architecture (Vossen, 1998) and currently maps multiple wordnets and ontologies, e.g. Top Ontology (Álvez et al., 2008) and SUMO (Niles and Pease, 2003).

The next section comments on the state of the art in semantic annotation of corpus and §3 introduces our methodology. Then §4 presents the assessment of ESPWN1.6 as a resource for semantic tagging; and §5 shows the set of solutions and annotation criteria stated to solve problems arisen. The results of the project are presented in section 6 and, finally, conclusions and proposed future work conclude the paper.

## 2 Semantic Annotation of Corpora

There are several semantically-tagged corpora for English such as PropBank (Palmer et al., 2003) or FrameNet (Baker et al., 1997). However, the projects that are more closely related to ours are Ontonotes (Yu et al., 2007), SemCor (Miller et al., 1994) and Multi-SemCor (Bentivogli and Pianta, 2005) as they use WordNets for sense tagging.

For Spanish, two main semantically-annotated corpora have been developed: ADESSE (García Miguel and Albertuz, 2005) and AnCora (Taulé et al., 2008). Both consist of a corpus annotated with references to a verbal database.

<sup>1</sup><http://adimen.si.ehu.es/web/MCR>

SenSem is structured in the same way, being its main difference that (i) it is not *a posteriori* mapping since from the beginning it was designed and built in order to annotate corpus data with verb sense information from the database; (ii) it is a balanced representation as each verb lemma holds 100 sentence examples; and (iii) it applies to the most frequent verbs of the language.

### 3 SenSem Methodology

Our methodology draws upon that of Eusemcor (Agirre et al., 2006) which carried out a concurrent processes of corpus annotation, correction and extension of WordNet for the Basque language. However, for several practical reasons, we did not modified the Spanish WordNet. We just keep record of the potential changes to be incorporated when necessary.

The process presented here was performed by six linguists, three annotators and three annotators and judges. The task spent 6 months and its cost was 8 person/month. The process was divided into the following steps:

- 1) Automatic POS tagging of the corpus using FreeLing (Padró et al., 2010). This process led to identifying the heads of the nominal arguments.
- 2) Adapting Eusemcor interface to the specific needs of the project.
- 3) A preliminar test in order to set an agreement between annotators for developing the initial criteria.
- 4) Full corpus annotation.
- 5) In parallel with 4, coordination sessions with judges and annotators for establishing, extending or modifying the initial criteria.

The annotation was performed using an interface implemented as a web service which facilitates the annotation of all occurrences of a single lemma in the corpus<sup>2</sup>. This ensures annotation consistency as the same linguist deals with all instances of the same word and, in turn, it allows him/her to get a holistic view of the distribution of the lemma in different ESPWN1.6 meanings.

The annotation of the test phase was performed by a team of four linguists (Carrera et al., 2008). They all annotated the same subset of the corpus with a total of 50 sentences. Instructions

to annotators for such preliminary test were quite general — they are listed in §5.1 as *general instructions*.

The initial agreement between annotators was only 40%. Then, we discussed the annotation decisions for producing a first set of disambiguation criteria. A subsequent annotation of a subset of the corpus based on this consensus reached an agreement between annotators of 84.32%. The establishment of specific criteria for disambiguation and semantic annotation continued until they became stable.

This process led to a general assessment of the drawbacks of the nominal part of ESPWN1.6 as a resource for semantic annotation which can be quite straightforwardly ported to other wordnets in similar projects for other languages. This assessment is presented in the following section.

### 4 Assessment of ESPWN1.6 as a Resource for Semantic Tagging

We have classified the drawbacks found when using ESPWN1.6 for semantic annotation into five general types: technical (§4.1), structural (§4.2), derived from ambiguity or uncertainty of meaning (§4.3), related to incompleteness (§4.4), and interlinguistic (§4.5).

#### 4.1 Technical problems

Firstly, let us consider some problems derived from decisions taken on the original design of WordNet and ESPWN1.6.

**Lexicographical description.** WordNet glosses and/or examples might conflict with the meaning one can infer from the ontological relations of the concept.

**Morphology.** ESPWN1.6 was derived by mapping and translating the English WordNet version 1.6. Thus, it encodes as lemmas English feminine forms which in Spanish are inflectional (e.g. *sister*-‘hermano/a’). Similar problems are found with diminutives. This causes mismatching between FreeLing and ESPWN1.6 lemmatization criteria thus leading to several problems in annotation.

#### 4.2 WordNet 1.6 structural drawbacks

Since ESPWN1.6 follows the expand approach (Vossen 1998) it also inherits the English WordNet structural problems.

**Autohyponymy.** Quite often two senses of the same word exhibit a direct hyponymy relation-

<sup>2</sup><http://ixa2.si.ehu.es/spsemcor/>

ship. In these cases, WordNet encodes different levels of generalization of the same concept.

For instance, the lemma ‘trabajo’ (*work*) in ESPWN1.6 spans in seven senses, including ‘trabajo\_4’ (“productive work”) and ‘trabajo\_1’ (“activity directed toward making or doing something”); this two synsets are related by hyponymy — ‘trabajo\_4’ ISA ‘trabajo\_1’.

**False hyponymy.** The taxonomic structure of WordNet encodes ontological inaccuracies. Guarino (1998) classifies such false hyponymy into the following categories:

- Confusion of meaning in situations of multiple inheritance. Incompatible meanings collapse into one synset, e.g. ‘Statue of Liberty’ having both hypernyms ‘statue’ (an object) and ‘plastic\_art’ (an abstract concept).
- Reduction of meaning e.g. ‘organization’ as hyponym of ‘group’ — while the meaning of *organization* is wider than that of *group*, not an specialization of it.
- Overgeneralization. It happens in case of excessive heterogeneity of cohyponyms so that indirectly WordNet forces an inappropriate more general interpretation of the hyperonym — e.g. *an amount of matter* as hyponym of a *physical object*.
- Confusion between type and role. This is a common mistake in the WordNet taxonomy. A taxonomic relation by definition must be established between entity types but in WordNet there are relations from type to role, e.g. ‘persona\_1’ (*person*) as a hyponym of ‘agente\_causal\_1’ (*causal agent*).
- Relationship confusion. One of the most common structural problems is the confusion between taxonomy and meronymy; e.g. ‘hueso\_1’ (*bone*) shows up as hyponym of ‘connective\_tissue\_1’ when in fact *bone* is an entity “made of” *tissue*, so the relationship should be meronymy.

### 4.3 Ambiguity and vagueness of meaning

Excessive granularity of WordNet senses is the most mentioned problem in the literature, especially that concerning Word Sense Disambiguation (Agirre and Edmonds 2007). As a direct consequence of this problem semantic distinctions are difficult to be drawn by human annotators: for the same lemma very similar senses can be possible. Moreover, regular distinctions, such

as various types of regular polysemy (Apresjan, 1973) are not applied consistently in WordNet.

We can classify the general problem of excessive granularity of meaning in WordNet on the following basic types:

**Regular Polysemy.** Some entities or situation types are systematically polysemous, as in the case of events and its resulting state. For example, in one occurrence of “the education of youth”, it is difficult to discern whether someone is talking about either the event or the final state of the person as “educated” — both possibilities are synsets in ESPWN1.6.

**Sense proliferation because of the point of view.** Frequently, many different WordNet synsets actually denote the same type of entity but being observed from different points of view. For instance, ‘familia’ (*family*) has three senses in ESPWN1.6 corresponding respectively to “a social unit living together”, a “primary social group” and “people descended from a common ancestor”.

**Senses modulated by context.** Only a very rich context could allow annotators to disambiguate between the possible meanings of a word. For instance, ‘interno’ has three meanings in ESPWN1.6: (i) a child in a boarding school, (ii) a person confined in an institution (like a prison or hospital) or (iii) a resident doctor in a hospital. Annotation is performed on a sentence basis so usually there is no context enough to draw such subtle differences.

**Sense intersection.** In some cases two meanings of a word do not stand for completely disjoint aspects of the denotation — instead, they intersect.

Clearly these types of ambiguity are facts of language, not drawbacks of WordNet. The point here is that WordNet’s developers rather than address these problems in some simple and structured way, they choose to add new word meanings, not always consistently.

A different but related problem arises not from WordNet design but from the information it provides:

**Insufficient or misleading information.** When neither the gloss nor the examples or the structure of ESPWN1.6 help to make the semantic distinctions clear.

### 4.4 Problems of ESPWN1.6 incompleteness

WordNet, despite being the largest lexical-semantic knowledge base, does not include all the existing vocabulary of a language. The main dimensions of its incompleteness are the following:

**Lack of synset.** There are lemmas not appearing in ESPWN1.6. Moreover also the resource does not contain the corresponding interlingual concept, e.g. ‘seguridad social’, whose English translation would be something like *social health system*.

**Lack of variant.** Some synsets are incomplete as they do not bear some Spanish synonyms. For instance, ‘testamento vital’ is not encoded in ESPWN1.6 but it is in the English WordNet.

**Metaphorical senses.** WordNet does not include in a systematic way those meanings created by metaphorical extension. For example, ESPWN1.6 ‘puente’ (*bridge*) does incorporate the original architectural sense plus those senses denoting a dental prosthesis and the gymnastics exercise, but it does not have the sense of a special bank holiday in Spain.

Moreover, in some cases ESPWN1.6 includes the metaphorical sense but not the original one, as in ‘pie’ (*foot*), which bears the meaning corresponding to the base of a mountain but surprisingly not that of the limb of a person.

These are both examples of incompleteness of the building process of ESPWN1.6 from the English WordNet. In the first case because the meaning of ‘bridge’ as “holiday” is not lexicalized in English and in the second because of a simple oversight.

**Lack of multiword units.** Similarly, ESPWN1.6 implements multiword units without following consistent criteria, e.g. it includes ‘agente secreto’ (*secret agent*), which has a non-compositional reading, and also ‘police officer’, which has a compositional reading.

**Lack of named entities.** Proper names in WordNet are mostly culturally related to the United States. ESPWN1.6 incorporates a number of named entities but of course not all of the existing ones.

#### 4.5 Interlinguistic problems: language versions of WN1.6

Several reported problems are caused by the way ESPWN1.6 was built, i.e. as an expansion of the English WordNet so that the level of adaptation

of WordNet into Spanish is very limited. In this section we list the drawbacks straightforwardly caused by this.

**Lack of Spanish equivalent.** There are cases where the concept does exist in the English WordNet but the ESPWN1.6 has not the equivalent translation. For instance, ‘juez’ (*judge*) is monosemous in ESPWN1.6 as it appears only with the usual sense related to the legal system. However the sense of “evaluator”, which is present in the English WordNet (‘judge\_2’, ‘evaluator\_1’) is not present in ESPWN1.6.

**Synsets split because of morphological mismatches.** Since English has no grammatical gender there are cases in which two lemmas of English correspond to only one in Spanish. This causes the inappropriate splitting of the Spanish word in two different synsets, as in ‘tia\_1’ and ‘tio\_2’ as a result of the projection of English ‘aunt\_1’ and ‘uncle\_1’.

**Cultural bias.** Some concepts in ENGWN1.6 are culturally marked. This is improperly projected to Spanish thus causing several imbalances in ESPWN1.6. For example, the lemma ‘presidente’ (*president*) does not include the case of the head of the government in a kingdom or similar type of state; WordNet only has the President as the head of a (republican) state.

## 5 Solutions and Annotator's Guide

This section details the solutions adopted for the problems outlined above, which have been collected in a guideline for the annotators. Most are pragmatic solutions, often conditioned to the initial requirement of performing the annotation without changing the original ESPWN1.6. This decision relied on the fact that their improvement was out of the scope of the project and we had not the rights to do it. However, the assessment described in §4 is a good base to face the task in future projects.

### 5.1 Technical problems

**General instructions.** The following instructions have been defined in order to carry out the annotation process:

- The relations of a synset should be always inspected, at least the hypernym(s) and the first level of hyponyms.

- The semantic features and ontologies integrated into the MCR, especially TO and SUMO, must always be considered.
- Glosses are usually less informative than relations and semantic features. Anyway, the annotator should pay more attention to the English glosses than to the Spanish ones since the latter might be non accurate translations of the former.

**Morphology.** The tagging is not performed when lemmatization mismatches appear between FreeLing and ESPWN1.6 but the case is recorded in a special separate list.

**Operators.** Some special notation operators had to be defined in order to allow for more flexibility in the selection of the appropriate synset. For instance we stated markers for indicating the metaphorical or metonymical use of a synset (MTF, MET), for identifying a multiword (MLTW) or for marking a partitive noun, e.g. ‘slice’ in ‘a slice of bread’ (PRT).

## 5.2 Structural problems

**Autohyponymy.** Whenever two synsets standing for the same concept are found in this relationship, the more general is chosen to tag the word—except when the context is rich enough to draw the distinction.

**False hyponymy.** These errors are treated case by case as separate problems of ambiguity of meaning as explained below.

## 5.3 Problems of ambiguity and vagueness

In cases of serious difficulty for distinguishing senses in specially complex lemmas, the judges developed a particular guide for every one. See in Figure 1 an abridged guide for ‘consejo’.

Other criteria involve specific classes of nouns, such as the following: in the case of polysemy between an objective description of an entity and the corresponding social use (e.g. between the physical and the social meaning of ‘año’-*year*), unless strong evidence against, the social use will be chosen.

In several cases of excessive granularity of meaning synsets have been clustered. 58 clusters affecting 129 synsets have been created.

### Synsets of the lemmata ‘consejo’ :

consejo\_1: it is a committee.  
 consejo\_2: it is a recommendation.  
 consejo\_3: it is about guidelines.  
 consejo\_4: it is also a committee.  
 consejo\_5: it is about a ‘tip-off’.  
 consejo\_6: it is a not stable committee, an improvised one.

### Annotation guidelines:

- When choosing between 2, 3 and 5, sense 2 should be always used unless there are contexts where senses 2 and 5 are clearly differentiated (highly unlikely).
- 1 and 4 are virtually identical and both are hyponyms of "administrative unit". 1 is always annotated.
- 6 is only used when it is very clear that the context deals with not stable committees. Otherwise, 1

Figure 1: Guide for disambiguating “consejo”

## 5.4 Problems related to incompleteness

**Metaphorical and metonymic senses.** When the metaphorical or the metonymic senses of a word are not declared in ESPWN1.6 we annotate the occurrence using the synset for the literal interpretation and we mark it with the MTF or MET operator.

**Named Entities.** Named entities (proper names, dates and amounts of money) are tagged using the MUC categories<sup>3</sup> since they have become a standard in NLP. Moreover, we see them as well suited for establishing selective preferences— which is the final goal of SenSem.

**Lack of sense.** When a lemma in the corpus is not recorded in ESPWN1.6 as synset or the appropriate sense is not recorded as a variant, the fact is documented and described for a future revision of the resource.

**Multiwords.** When the interpretation of a multiword is compositional (e.g. ‘colegio electoral’, *electoral college*) the annotator tags analytically every part of the compound. If it is not compositional but the concept is recorded in ESPWN1.6 (e.g. ‘célula madre’, *stem cell*), it is tagged as MTW (multiword). If it is neither compositional nor is recorded in ESPWN1.6 (e.g. ‘puesta en marcha’, *the action or effect of putting on or switching on something*) the compound is tagged

<sup>3</sup> *Message Understanding Conference*. [http://www-nlpir.nist.gov/related\\_projects/muc/proceedings/muc\\_7\\_toc.html](http://www-nlpir.nist.gov/related_projects/muc/proceedings/muc_7_toc.html)

using two operators: MTW (multiword) and FLT (lack of sense).

### 5.5 Interlinguistic problems

Interlinguistic drawbacks such as lacking Spanish equivalents or synsets split because of morphological mismatches can not be solved without changing ESPWN1.6 as it is now. Therefore the annotator is instructed to record the case for the future.

## 6 Results

As a result of the research here presented, 23,307 forms for 3,693 noun lemmas of the SenSem corpus have been semantically annotated with ESPWN1.6; this corresponds to the 82.6% of the total amount of verbal arguments in the corpus. In this phase of the project, in order to achieve the optimal cost-effectiveness only lemmas which occur more than 5 times have been annotated. Therefore, 17.4% of the corpus remains untagged. 91 lemmas were not tagged because they are not recorded in ESPWN1.6, being most of them culturally-specific concepts; as explained, they have been recorded for their inclusion in future versions of the Spanish WordNet.

### Conclusions and future work

This paper has presented the methodology and development of a project for the semantic disambiguation and annotation of the arguments of the nominal heads of the SenSem corpus. SenSem is a balanced corpus containing 100 sentences for each of the 250 most frequent verbs in Spanish.

The result, added to previous developments in SenSem, is a richly tagged corpus both syntactically and semantically as the annotation includes verb sense, head sense of the arguments, type of phrase, argument functions, thematic roles, construction type and aspectual information. The SenSem corpus is mapped to a database bearing relevant information for each verb sense, therefore the result is a well suited resource for empirical studies focused on verbs and for the acquisition and representation of selectional preferences.

As a collateral result of the process, a critical assessment of ESPWN1.6 has been presented. Possibly, such an assessment is applicable to other WordNets as resources for annotating semantically corpus of other languages. As a result of the assessment, an annotation guide has been devel-

oped which may also be useful for similar projects.

Besides, the casuistry detected and recorded during the annotation is now being applied by our research group for developing the Spanish WordNet 3.0 (Fernandez et al., 2008; Oliver and Climent, 2011).

The SenSem corpus is freely available under a GPL license<sup>4</sup>.

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<sup>4</sup><http://grial.uab.es/SenSem/download/main>

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