Spanish FreeLing Dependency Grammar

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Abstract

This paper presents the development of an open-source Spanish Dependency Grammar implemented in FreeLing environment. This grammar was designed as a resource for NLP applications that require a step further in natural language automatic analysis, as is the case of Spanish-to-Basque translation. The development of wide-coverage rule-based grammars using linguistic knowledge contributes to extend the existing Spanish deep parsers collection, which sometimes is limited. Spanish FreeLing Dependency Grammar, named EsTxala, provides deep and robust parse trees, solving attachments for any structure and assigning syntactic functions to dependencies. These steps are dealt with hand-written rules based on linguistic knowledge. As a result, FreeLing Dependency Parser gives a unique analysis as a dependency tree for each sentence analyzed. Since it is a resource open to the scientific community, exhaustive grammar evaluation is being done to determine its accuracy as well as strategies for its maintenance and improvement. In this paper, we show the results of an experimental evaluation carried out over EsTxala in order to test our evaluation methodology.

1. Introduction

Spanish FreeLing Dependency Grammar (EsTxala) was developed as a resource for FreeLing1, an open-source multilingual NLP library (Atserias et al., 2006). It was designed for those NLP applications that require need deeper syntactic representation or certain level of semantic representation.

Because of deep parsing importance in NLP, a wide range of resources has been developed from different approximations and linguistic formalisms. For languages like English, large amount of deep parsers exists such as MaltParser (Nivre, 2006), Minipar (Lin, 1998), Connexor (Järvinen and Tapanainen, 1998) or Link Parser (Sleator and Temperley, 1991).

However, few broad-coverage parsers and grammars are developed for languages like Spanish, such as Constraint-Grammar for HISPAL parser (Bick, 2006), Slot Unification Grammar developed by Ferrández et al. (2000) or Spanish Resource Grammar in the framework of HPSG (Marimón et al., 2007).

Further, although dependency formalism was implemented in NLP (By, 2004), there are few dependency parsers for Spanish, MaltParser (Nivre, 2006), DILUCT (Gelbukh et al., 2005) and Connexor (Järvinen and Tapanainen, 1998). One additional problem is that few resources for Spanish are open-source. While MaltParser and DILUCT are totally open-source, Connexor grants a restrictive licence to researchers and HISPAL provides only parsed texts.

On the other hand, among deep parsers for Spanish, most of them are based on statistical knowledge, while Txala (the FreeLing Dependency Parser) relies on hand-written heuristic rules based on linguistic knowledge (Atserias et al., 2005).

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included in corpora) by combining each two adjacent sub-
trees of a linguistic chain. To attach consecutive subtrees a
priority value is assigned to each rule. The rule with highest
priority is applied and the pair of subtrees are merged into
one.
Apart from priority, rules also express conditions that each
subtree head must meet. These conditions can be related to:

- Morphology: PoS tag.
- Lexicon: word form, lemma.
- Syntax: context boundaries of the pair of subtrees,
  word classes defined as a lemmata lists.
- Semantics: word classes.

Also, the head node is marked on the rules becoming the
parent of all subtrees below.

The example labeling rule in Figure 2 states that a node
depending of the head of a verb group (grup-verb) will
be labeled as subject (subj) if it is the head of a noun
phrase (sn*), located at the right of the verb phrase, and
the class for the verb is intransitive (intr).
As a result of the steps described above, Txala parser gives
a unique analysis as a dependency tree for each sentence
analyzed.
The version of the parser presented in this paper includes
some improvements respect to the version described in At-
serias et al. (2005), which include:

1. About tree attachment rules:
   - Extension of the catalogue of subtree-fusion op-
erations.
   - Possibility of specifying form, lemma, PoS or
     word class conditions on subtree heads.
   - Possibility of specifying context conditions
     (stated as labels corresponding to subtrees).
   - Defining word classes via lists in external files.

2. Labeling rules also accept new conditions regarding:
   - EWN Top Ontology properties.
   - WN semantic file.
   - Synonyms.
   - Hyponyms.

Txala parser also includes dependency grammars for En-
lish, Catalan and Galician, but this paper describes the
development of FreeLing Spanish Dependency Grammar,
EsTxala, which is currently at the most advanced stage of
development.

3. EsTxala Grammar
EsTxala includes a set of 4,408 rules. Of those, 3,808 relate
to full parsing tree construction, and 600 are used to define
dependency relations by labeling each dependency.
The former are used to handle recursion and attachments
between phrases, finite clauses (headed by conjunctions or
relative pronouns), non-finite clauses (headed by infinitive,
participle or gerund), simple coordinations (i.e. between
phrases), and passive, among other structures.
Among the latter, labeling rules carry on intrachunk rela-
tions and external chunk relations.
Intrachunk relations include labeling determiners and mod-
ifiers, which doesn’t require much rules.
External chunk relations are based on argument and adjunct
recognition, as well as argument or adjunct types distinc-
tion, which are cases usually complex to solve. To be able
to perform external chunk labeling, EsTxala distinguishes
among structures like transitive, intransitive, ditransitive,
prepositional (singly or doubled), and impersonal.
To carry out wide-coverage full syntactic analysis of natu-
ral language sentences, complex phenomena (prepositional
phrase attachment, coordination, prepositional arguments
and prepositional adjuncts) have to be solved. Rules them-
selves will not succeed without some sort of additional
knowledge.
Figure 3: Preposition Phrase Attachment to Noun Phrase – *La solución al desempleo está ahí fuera* (‘The solution to unemployment is out there’).

EsTxala includes external modules as linguistic knowledge used by rules:

- Semantic knowledge (WordNet, EuroWordNet Top-ontology features).
- Syntactic knowledge: SenSem Corpus (Alonso et al., 2007) has been used to represent verbal subcategorization classes.
- Lexical information: EsTxala include a lexicon of prototypical discourse markers.

One of the main complex phenomena to be solved at EsTxala was prepositional phrase attachment. In Spanish prepositions can modify either a noun phrase –e.g., *La solución al desempleo está ahí fuera* (‘The solution to unemployment is out there’)– as it is illustrated at Figure 3 or a verb phrase –e.g., *Mi vecina piensa en cambiar de casa* (‘My neighbour is thinking about moving to another flat’). Most problems are related to preposition *de* (‘of/from’, genitive among others) because is commonly used as noun phrase modifier –*El libro de Cervantes es bien conocido* (‘Cervantes’s book is well-known’)– as well as argument –*Mi hijo viene del mercado* (‘My son comes from the market’)– or adjunct –*Empezaron la excursión de madrugada* (‘They began the excursion at daybreak’).

Nevertheless, adding information about both verb and noun behaviour and defining immediate syntactic context of prepositional phrase allow to partly account for these problematic cases (s. Figure 4).

Preposition phrases in Spanish also are problematic when labeling dependencies. Sometimes they act as argument, sometimes as adjunct, and there are also several arguments whose head is a preposition. It seems that some prepositions accept to be used in more contexts than others, as preposition *a* (‘to/for’).

When a preposition phrase headed by *a* is an argument, it can be a prepositional argument –e.g., *Disfruta yendo al cine cada domingo por la noche* (‘He enjoys going to the cinema every Sunday evening’)–, indirect object –e.g., *El presidente presentó la ley a los diputados* (‘The president presented the law to the congressmen.’), or direct object referring human entities –e.g., *El juez convocó al empresario* (‘The judge summoned the company manager’).–

EsTxala labeling rules decide which phrases are verb arguments and which others are adjuncts by resorting to external linguistic knowledge linked to EsTxala. Sometimes it is
necessary to combine informations from different resources depending on phenomena complexity. For example, carrying out direct object referring human entities it is required to consult TCO features and verb diathesis (s. Figure 5).

4. EsTxala Evaluation

Rigorous and exhaustive grammar evaluation requires qualitative and quantitative analysis in order to observe which phenomena fail and which failures are relevant for significatively improving the grammar. In this paper, we present results obtained from experimental evaluation.

Two evaluation corpora are used on this task, AnCora (Martí et al., 2007) and SenSem (Alonso et al., 2007). On this evaluation stage, 25 sentences were randomly selected from AnCora (AnCoraR) and 25 from SenSem (SenSemR) as real corpora samples. On the other hand, EsTxala evaluation statistics were obtained using ‘CoNLL-X Shared Task (2006): Multi-lingual Dependency Parsing’ evaluation script and three metrics are taken into account:

- Labeled Attachment (LA): the amount of trees that are assigned the correct head and dependency relation.
- Unlabeled Attachment (UA): the amount of trees that are assigned the correct head.
- Label Accuracy (LAcc): the amount of trees that are assigned the correct dependency relation.

EsTxala scores satisfactorily in both evaluation corpora (s. Table 1). In AnCoraR, 73.88% of the trees receive correct head and dependency relation jointly (LA), 81.13% are well-headed (UA) and 78.81% are labeled with correct dependency relation (LAcc). Regarding SenSemR, similar scores are obtained: 74.33% of the trees have correct head and dependency relation jointly (LA), 80.93% have correct head (UA) and 77.28% get correct dependency relation. In order to determine whether these rather low scores are caused motivated by sentence complexity (i.e. finite and non-finite clauses), complex sentences were isolated by hand from other linguistic phenomena present at both evaluation corpora. AnCoraR and SenSemR were transformed into two single-clause samples: AnCoraS and SenSemS.

As expected, the simple sentences corpora AnCoraS and SenSemS obtain best scores (s. Table 1), increasing about 10 points at the three metrics taken into account. Therefore, while trees are well-built in single clauses context, complex
feeder line still is problematic to deal with in EsTxala. In terms of unlabeled attachment score (s. Table 2), best results in both corpora and their single clauses variants are found on those nodes placed near to terminal nodes like determiner (DET), noun (NOUN) or adjective (ADJ). Also, phenomena usually difficult to solve in NLP are quite problematic in EsTxala (s. Table 2): Coordination (COOR) and clauses (CONJ and REL) are quite low a part from prepositional phrase attachment. Finite clauses (CONJ) score 58.82% in AnCoraR and 55.00% in SemSemR. Relative clauses (REL) are frequently problematic (62.50% in AnCoraR and 43.48% in SenSemR). Coordination rules succeed in few cases (44.44% in AnCoraR, 23.81% in SemSemR and 42.86% in SenSemS), but are built quite satisfactorily (71.43%) in AnCoraS. However, prepositional phrase attachment (PREP) is well-built (71.07% in AnCoraR, 69.23% in SenSemR, 83.05% in AnCoraS and 80.92% in SenSemS) in more cases than coordination or clauses. Regarding labeled attachment score, best results (s. Table 3) are found in those tags related to internal phrase relations like some noun modifiers (adj-mod, sp-mod, subord-mod), determiners (espec), or auxiliaries (aux). On the other hand, dependency labels for relations between main verb and its children show some problems. Relations like subject (subj), patient as subject (subj-pac) and direct object (dobj) succeed satisfactorily. However, most difficulties are found in preposition-headed arguments or adjuncts. Regarding verb arguments, indirect object (iobj) scores 58.82% in AnCoraR and 44.44% in SenSemR, and prepositional argument (sp-obj) scores 50% in AnCoraR and 45.28% in SenSemR. Accuracy in predicate adjuncts (cc) reaches 59.77% in AnCoraR and 56.64% in SenSemR, and sentence adjuncts (ador) score 52.18% in AnCoraR and 40% in SenSemR. Simple clauses samples are similar to real corpora samples, although they slightly increase accuracy scores.

5. Conclusions & further work

In this paper we presented an open-source dependency grammar for Spanish, implemented in FreeLing environ-
ment. EsTxala was developed as a broad-coverage rule-based grammar relying on linguistic information. We have also described the most recent update of the Txala parser, which features a number of improvements over its predecessor (Atserias et al., 2005).

Finally, we exposed results from a limited experimental evaluation: 73.88% (Label Accuracy), 77.28% (Label Accuracy) in SenSem. Results from first experiments encourage developing an exhaustive evaluation.

Because evaluating precision and coverage of grammars like EsTxala is a complex task, we are still developing experiments to determine EsTxala accuracy in terms of qualitative and quantitative analysis. These experiments also aim to find out whether the use of linguistic knowledge improves grammar accuracy.

One of the most important evaluation topics is to test external syntactic knowledge included in EsTxala (i.e. verb subcategorization classes), since a large amount of labeling rules depend on it. Studying EsTxala resources evaluation we will verify if syntax knowledge is enough or semantic information is required to improve grammar accuracy. However, before carrying out quantitative evaluation, we must solve linguistic criteria differences between evaluation corpora and EsTxala. We are developing a mapping between EsTxala and AnCora labeling tags and structures which allows to evaluate EsTxala on CoNLL shared tasks datasets.

This empirical evaluation methodology will also allow to maintain and improve EsTxala in the future.

| Function | AnCora | SenSem |
|----------|--------|--------|
|          | Real   | Simple | Real   | Simple |
| adj-mod  | 91.36  | 91.89  | 87.81  | 92.10  |
| ador     | 52.18  | 53.33  | 40.00  | 20.00  |
| att      | 53.33  | 78.57  | 50.00  | 76.92  |
| aux      | 100.00 | 100.00 | 100.00 | 94.74  |
| cc       | 59.77  | 64.37  | 56.64  | 64.96  |
| co-n     | 73.69  | 94.12  | 76.19  | 85.71  |
| co-sp    | -      | -      | 44.44  | 40.00  |
| co-v     | 41.38  | -      | 75.68  | -      |
| dep      | 66.67  | 75.00  | 100.00 | 100.00 |
| dobj     | 79.02  | 86.42  | 69.03  | 83.76  |
| dprep    | 100.00 | 100.00 | 100.00 | 100.00 |
| dverb    | 100.00 | 100.00 | 92.31  | 92.31  |
| es       | 82.35  | 75.00  | 91.67  | 91.67  |
| espec    | 95.49  | 96.99  | 98.82  | 99.22  |
| iobj     | 58.82  | 66.67  | 44.44  | 66.67  |
| obj-prep | 94.17  | 96.99  | 94.86  | 99.24  |
| sn-mod   | 76.92  | 84.62  | 51.85  | 51.85  |
| sp-mod   | 88.00  | 90.00  | 77.65  | 80.46  |
| sp-obj   | 50.00  | 43.24  | 45.28  | 43.34  |
| subj     | 82.86  | 96.15  | 70.77  | 85.19  |
| subj-pac | 50.00  | 80.00  | -      | -      |
| subord-mod| 89.66 | 100.00 | 74.28  | -      |
| top      | 69.39  | 97.50  | 65.31  | 97.30  |
| vsubord  | 93.11  | 100.00 | 92.31  | -      |

Table 3: EsTxala LAcc F1

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