Adapting the Core Language Engine to French and Spanish

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Abstract

We describe how substantial domain-independent language-processing systems for French and Spanish were quickly developed by manually adapting an existing English-language system, the SRI Core Language Engine. We explain the adaptation process in detail, and argue that it provides a fairly general recipe for converting a grammar-based system for English into a corresponding one for a Romance language.

1 Introduction

In this paper, we will describe how substantial domain-independent language-processing systems for French and Spanish were quickly developed by manually adapting an existing English system, the SRI Core Language Engine. The resulting systems have been integrated as components in the Spoken Language Translator (SLT; Rayner et al., 1993a; Agnäs et al., 1994). The English to French version of SLT (Rayner and Bouillon, 1995) is of a standard comparable to the original English to Swedish version.

The syntactic rule-set for French covers nearly all the basic constructions of the language, including the following: declarative, interrogative and imperative clauses; formation of YN and WH-questions using inversion, complex inversion and “est-ce que”; clitic pronouns; adverbial modification; negation; nominal and verbal PPs; complements to “être” and “il y a”; relative clauses, including those with “dont”; partitives, including use of “en”; passives; pre- and post-nominal adjectival modification, including comparative and superlative; code expressions; sentential complements and embedded questions; complex determiners; numerical expressions; date and time expressions; conjunction of most major constituents; and a wide variety of verb types, including modals and reflexives. There is a good treatment of inflectional morphology which includes all major paradigms. The coverage of the Spanish grammar is comparable in scope, though slightly less extensive. The French and Spanish versions of the CLE are both “reversible”, and can be used for either analysis or generation.

We will describe the adaptation process in detail, and argue that it provides a fairly general recipe for converting a grammar-based system for English into a corresponding one for a Romance language. Due to space limitations, and since it is rather the better of the two, we will concentrate on the French version. Examples will be taken from the Air Travel Planning (ATIS) domain used in the current SLT prototype.

The rest of the paper is organized as follows. Section 2 gives an overview of the CLE, focussing on the aspects relevant to this paper. Section 3 describes the French morphology rules. Sections 4 and 5 describe the French and Spanish grammars. Section 6 concludes.

2 Overview of the Core Language Engine

The CLE is a general language-processing system, which has been developed by SRI International in a series of projects starting in 1986. The original system was for English only. A Swedish version (Alshawi (ed), 1992, §14.2) was developed in a collaboration with the Swedish Institute of Computer Science; the French and Spanish versions described here were developed in collaborations with ISSCO and the University of Seville respectively. The CLE is extensively described elsewhere (Alshawi (ed), 1992; Alshawi et al., 1992; Agnäs et al., 1994), so this section will only give the minimum background necessary to understand the remainder of the paper.

The basic functionality offered by the CLE is two-way translation between surface form and a representation in terms of a logic-based formalism called
QLF (Alshawi and Crouch 1992). The modules comprising a version of the CLE for a given language can be divided into three groups, which we refer to as “code”, “rules” and “preferences”. The “code” modules constitute the language-independent compilers and interpreters that make up the basic processing engine; the other two types of module between them constitute a declarative description of the language.

The “rules” contain domain-independent lexicogrammatical information for the language in question; they encode a relationship between surface strings and QLF representations. Thus for any given surface string, the rules define a set of possible QLF representations of that string. Conversely, given a well-formed QLF representation, the rules can be used to produce a set of possible surface-form realizations of the QLF. The code modules support compilation of the rules into forms that allow fast processing in both directions: surface-form → QLF (analysis) and QLF → surface-form (generation).

The relationship between surface form and QLF is in general many-to-many. “Preference” modules contain data in the form of statistically learned distributional facts, based on analysis of domain corpora (Alshawi and Carter, 1994; Rayner and Bouillon, 1993). Using this extra information, the system can distinguish between plausible and implausible applications of the rules with a fairly high degree of accuracy. In particular, the preference information makes it possible in a given application domain to select the intended readings of ambiguous utterances. We will not consider the preference modules further here, as the statistical training procedures are completely language-independent and invisible to the developer.

The non-trivial problems involved in adapting the CLE to a new language arise in connection with the “rule” modules, which we will now consider in more detail. These fall into the following main categories:

Lexicon: The largest single set of rules is that which comprises the lexicon. This is in fact divided up into three subsets: a function-word lexicon; a set of macros specifying generic lexical entries for common types of content word (e.g. “count noun”, “intransitive verb”, etc.); and a content word lexicon which defines lexical entries for other words in terms of the generic macros.

Morphology: This set of rules defines the inflectional morphology of the language, allowing analysis of words in terms of stems and inflections. The morphology rules are described further in Section 3.

Syntax: Syntax rules are written in a unification-based feature-grammar formalism. The style of the CLE grammar is loosely based on GPSG; detailed descriptions of the CLE grammar for English are available in (Pulman, 1992) and (Rayner, 1994).

Semantics: The CLE grammar is “sign-based” (van Eijck and Moore, 1993); each syntax rule is coupled with one or more semantic counterpart, which defines the piece of QLF form produced by that rule. QLF representations are built up compositionally using unification only.

Reference resolution and scoping: Further sets of rules can be used to convert QLF representations into representations in full first-order logic. This phase of processing is required, for example, when using the CLE for database query applications (Alshawi and Crouch 1992; Rayner, 1993).

As noted in (Alshawi (ed), 1992, §14.2.2) the effort involved in adapting a set of rule modules to a new language depends on how directly they refer to surface form; unsurprisingly, modules defining surface phenomena are the ones which require most work. When adapting the system to French and Spanish, the problems arose almost exclusively in connection with morphology and syntax rules. Other parts of the English system were adapted with little effort. In particular, the semantic rule-sets for English could be used for the new languages with only minimal changes.

The following two sections describe in detail the issues pertaining to the morphology and syntax rule-sets respectively.

3 Morphology and spelling

In order to handle the more complex inflectional morphology of Romance and other European languages, a morphological processor based on feature-augmented two-level morphology was developed (Carter, 1993). This allows the complex spelling changes occurring in these languages to be handled quickly in both analysis and generation. Compilation of the full sets of two-level rules describing spelling changes and of production rules describing legal affix combinations takes of the order of a minute, allowing changes to the rules to be debugged relatively easily. Further flexibility is gained by not requiring the lexicon to be present at compile time (contrast (Kaplan and Kay, 1994)); thus the lexicon
can be incremented and tested without any recompilation being required. Two-level spelling rules were also used to describe the inter-word effects that are particularly common in French.

The total number of rules required to describe inflectional morphology was around 75 for French and 50 for Spanish (inter-word rules being responsible for much of the difference). We concentrate here on the French phenomena, which are more complex.

3.1 Intra-word spelling changes

Intra-word spelling changes for French present several problems not encountered in English inflectional morphology. Some of these are technical in nature, and easily dealt with. In particular, French exhibits many multiple letter changes, e.g. “chameau+e” → chamelle, “peign+rai” → peindrai. For reasons explained in (Carter, 1995), these must be handled by a separate rule for each letter that changes, rather than one for the whole changed substring. Also, some changes can be optional. For example, the “y” in verbs such as “payer” can remain the same or change to “i” before silent “e”: “pay+e” → either paye or piae. This phenomenon is rare or absent in English, but is handled easily by making the relevant spelling rule optional.

Less trivial problems, however, arise from the fact that spelling changes in French generally cannot be predicted from the surface form of the word alone. This means the application of the rules must be controlled; we do this by specifying feature constraints, which must match between the rule and all morphemes it applies to. The following extended example describes our treatment of one of the most challenging cases.

Nouns, adjectives and verbs ending in “-et” or “-el” can either double the “t” or “l” before a silent “e” or change the prefinal “e” to “è”: “cadet+e” → cadette, but “complet+e” → complète. The application of the spelling rules is therefore controlled by means of a feature spelling_type, with value double in the first case and change_e,è in the second.

This situation is further complicated by two facts. Firstly, the surface “él” or “èl” of the verbs is ambiguous between a deep “el” or “et”, and “él” or “ét”. For example, we have achète ← “achet+e”, but affrètē ← “affrét+e”. For this reason, we introduce a third value for spelling_type: change_e,è. “Affrét” has thus the feature spelling_type=change_e,è, “achet” spelling_type=change_e,è and “appel” spelling_type=double.

Secondly, the “e” that begins future and conditional endings sometimes affects preceding letters as if it were silent, and sometimes as if it were not. For example, “appel+erai” → appellerai, doubling the “l” just as in “appel+c” → appelle, where the final “e” actually is silent. However, “céd+erai” → cédérerai, not *cédérerai as would be expected from the silent-e behaviour “céd+e” → cède. To make this distinction, we use a feature muet (“silent”) for specifying if the “e” in the suffix is silent, as “e” (mu=1), not silent, as “ez” (mu=0) or the “e” of the future or conditional tenses, for example “erai/erais” (mu=fut, cond). Then, we restrict the rule for doubling the consonant with the features spelling_type=double, mu=1/fut, cond, and the one for “è” “è” with the features spelling_type=change_e,è, mu=0.

3.2 Inter-word spelling changes

In English, inter-word spelling changes occur only in the alternation between “a” and “an” before consonant and vowel sounds respectively. In French, such changes are far more widespread and can be complex. However, they can be handled by judiciously specifying contexts in two-level rules and, in a few cases, by postulating non-obvious underlying lexical items. Some important cases are:

- The “e” in the function words “de”, “je”, “le”, “me”, “ne”, “que”, “se” and “te” is elided before (most) words starting in a vowel sound, except when the function word follows a hyphen: “le homme” → l’homme, “je ai” → j’ai, but “pUIS-je avoir” does not elide, so the elision rule specifies that the hyphen be absent from the context. “Ce” also elides when used as a pronoun (“ce est” → c’est, but when used as a determiner it takes the form “cet” before a vowel: cet homme. We therefore take the underlying form of the determiner to be “cet”, which loses its “t” when followed by a consonant-initial word (“cet soir” → ce soir). Numerals do not allow elision either: “le onze” does not become *l’onze. We therefore treat the lexical form as being “#onze”, where “#” acts as an underlying consonant but is realised as a null. (Syntax plays a role here too: “le un” → l’un when is a determiner, but not when it is a numeral. Thus lexically we have “un” as determiner and “#un” as numeral).

- The very common preposition/article combinations “de”/“à” and “le”/“les”: “de le” → du, “à les” → aux, etc. These contractions span constituent boundaries (we view du vol as being syntactically [PP de [NP le vol]]) so need
to be treated as spelling effects. Also, vowel elision takes precedence: “de le homme” → de l’homme, not *du homme.

- Hyphens between verbs and clitic pronouns are treated as lexical items in our grammar. They are realised as “t” when preceded by “a” or “e” and followed by “e”, “i” or “o”: “va - il” → va-t-il, but “vont - ils” → vont-ils. Hyphens joining nouns or names are treated as different lexical items not subject to this change: “les vols Atlanta - Indianapolis” does not involve introduction of “t”.

4 French syntax

When comparing the French and English grammars, there are two types of objects of immediate interest: syntax rules and features. Looking first at the rules themselves, about 80% of the French syntax rules are either identical with or very similar to the English counterparts from which they have been adapted. Of the remainder, some rules (e.g those for date, time and number expressions) are different, but essentially too trivial to be worth describing in detail. Similar considerations apply to features.

We will concentrate our exposition on the rules and features which are both significantly different, and possess non-trivial internal structure. Examining the grammar, we find that there are three large interesting groups of rules and features, describing three separate complexes of linguistic phenomena: question-formation, clitic pronouns and agreement. As we have argued previously [Rayner and Bouillon 1993], all of these are rigid and well-defined types of construction which occur in all genres of written and spoken French. It is thus both desirable and reasonable to attempt to encode them in terms of feature-based rules, rather than (for instance) expecting to derive them as statistical regularities in large corpora. In Sections 4.1 and 4.3, we describe how we handle these key problems.

4.1 Question-formation

We start this section by briefly reviewing the way in which question-formation is handled in the English CLE grammar. There are two main dimensions of classification: questions can be either WH- or Y-N; and they can use either the inverted or the uninverted word-order. Y-N questions must use the inverted word-order, but both word-orders are permissible for WH-questions. The phrase-structure rules analyse an inverted WH-question as constituting a fronted WH+ element followed by an inverted clause containing a gap element. The feature `inv` distinguishes inverted from uninverted clauses. The following examples illustrate the top-level structure of Y-N, unmoved WH- and moved WH-questions respectively.

[Does he love Mary]$_S$:[$inv=y$]

[Who loves Mary]$_S$:[$inv=n$]

[[Whom]$_NP$ [does he love]$_S$:[$inv=y$]]

The French rules for question formation are structurally fairly similar to the English ones. However, there are several crucial differences which mean that the constructions in the two languages often differ widely at the level of surface form. Two phenomena in particular stand out. Firstly, English only permits subject-verb inversion when the verb is an auxiliary, or a form of “have” or “be”; in contrast, French potentially allows subject-verb inversion with any verb. For this reason, English question-formation using auxiliary “do” lacks a corresponding construction in French.

Secondly, French permits two other common question-formation constructions in addition to subject-verb inversion: prefaceing the declarative version of the clause with the question particle “est-ce que”, and “complex inversion”, i.e. fronting the subject and inserting a dummy pronoun after the inverted verb. In certain circumstances, primarily if the subject is the pronoun “ca”, it is also possible to form a non-subject WH-question out of a fronted WH+ phrase followed by an uninverted clause containing an appropriate gap. We refer to this last possibility as “pseudo-inversion”.

If the subject is a pronoun, only inversion and the “est-ce que” construction are allowed; if it is not a pronoun, only the “est-ce que” construction and complex inversion are valid. In addition, a subject pronoun following an inverted verb needs to be linked to it by a hyphen, which can be realised as a “-t-” (cf. Section 3). Figure 1 presents examples illustrating the main French question constructions.

Modification of the English syntax rules to capture the basic requirements so far is quite simple. In our grammar, we added three extra rules to cover the “est-ce que”, complex-inversion and pseudo-inversion constructions: the second of these rules combines the complex-inverted verb with the following dummy pronoun to form a verb, in essence treating the dummy pronoun as a kind of verbal affix. A further rule deals with the hyphen linking an inverted verb with a following subject.

With regard to the feature-set, the critical change involves the `inv` feature. In English, as we saw,
Y-N, inversion:
Aime-t-il Marie?

Y-N, “est-ce que”:
Est-ce que Jean aime Marie?

Y-N, complex inversion:
Jean aime-t-il Marie?

WH, subject question, no inversion:
Quel homme aime Marie?

WH, inversion:
Quelle femme aime-t-il?

WH, “est-ce que”:
Quelle femme est-ce que Jean aime?

WH, complex inversion:
Quelle femme Jean aime-t-il?

WH, pseudo-inversion:
Combien ça coûte?

Figure 1: Main French question constructions

this feature had two possible values, y and n. In French, the corresponding feature has five values: inverted, uninverted, est-ce que, complex and pseudo, distinguishing clauses formed using the different question-formation constructions. (It is important to note, though, that the semantic representation of the clause is the same irrespective of its inversion-type). To enforce the restrictions concerning combinations of inversion-type and subject form, we also added a new clausal feature which distinguished clauses in which the subject is a pronoun.

The attractive aspect of this treatment is that the remaining English rules used for question-formation can be retained more or less unchanged. In particular, the English semantic rules can still be used, and produce QLF representations with similar form.

It would almost be true to claim that the above constituted our entire treatment of French question-formation. In practice, we have found it desirable to add a few more features to the grammar in order to block infelicitous combinations of the inversion rules with certain commonly occurring lexical items. It is possible that the effect of these features could be achieved equally well by statistical modelling or other means, but we describe them here for completeness:

Restrictions on use of “est-ce que”: Question-formation with “est-ce que” is strongly dispreferred when the main verb is a clause-final occurrence of “être”, or existential “avoir” (as in “il y a”). For example:

?Quand est-ce que le prochain vol est?
?Combien de vols est-ce qu’il y a?

We enforce this by adding a suitable feature to the verb category.

Fronting of “heavy” NPs: Most languages prefer not to front “heavy” NPs, and this dispreference is particularly strong in French. We have consequently added an NP feature called heavy, which has the value y on NPs containing PP and VP post-modifiers. Thus for example generation of

Quels vols en partance de Dallas y a-t-il?

is blocked, but the preferable

Quels vols y a-t-il en partance de Dallas?

is permitted.

Inverted subject NPs: Occurrence of some pronouns (in particular “cela”, and “ça”) is strongly dispreferred in inverted subject position. A binary feature enforces this as a rule, for example blocking

Combien coûte ça pour aller à Boston?

but instead permitting

Combien ça coûte pour aller à Boston?

4.2 Clitics

The most difficult technical problems in adapting an English grammar to a Romance language are undoubtedly caused by clitic pronouns. In contrast to English, certain proform complements of verbs do not appear in their normal positions; instead, they occur adjacent to the main verb, and possibly joined to it by a hyphen. The position of the clitics in relation to the verb (pre- or post-verbal) is determined by the mood of the verb, and whether or not the verb is negated. If two or more clitics are affixed to the verb, their internal order is determined by their surface forms. Several attempts to account for the above and other data have previously been described in the literature e.g. (Grimshaw 1982; Bébc and Gardent 1989; Festiva, 1991; Miller and Sag 1995); we have in particular been influenced by the last of these,
Although the underlying framework is very different from the HPSG formalism used by Miller and Sag, our basic idea is the same: to treat “clitic movement” by a mechanism similar to the one used to handle WH movement. More specifically, we introduce two sets of new rules. The first set handles the “surface” clitics. They define the structure of the verb/clitic complex, which we, like Estival, regard as a constituent of category V composed of a main verb and a “clitic-list”. A second set of “gap” rules defines empty constituents of category NP or PP, occurring at the notional “deep” positions occupied by the clitics. Thus, for example, on our account the constituent structure of “Est-ce que vous le voulez?” will be

\[ \text{[Est-ce que [vous}_{NP} [le voulez]_{V} [[[NP]_{S}]_{S} \] \]

where the “gap” NP category represents the notional direct object of “voulez”, realised at surface level by the pre-verbal clitic “le”.

To make this work, we add an extra feature, clitics, to all categories which can participate in clitic movement: in our grammar, these are V, VP, S, NP and PP. The clitics feature is used to link the cliticised V constituent and its associated clitic gap or gaps. We have found it convenient to define the value of the clitics feature to be a bundle of five separate sub-features, one for each of the five possible clitic-positions in French. Thus for instance the second-position clitics “le”, “la” and “les” are related to object-position clitic gaps through the second sub-feature of clitics: the fourth-position “y” clitic is related to its matching PP gap through the fourth sub-feature; and so on. The linking relation between a clitic-gap and its associated clitic is formally exactly the same as that obtaining between a WH-gap and its associated antecedent, and can if desired be conceptualized as a type of coindexing.

The clitics feature-bundle is threaded through the grammar rule which defines the structure of the list of clitics associated with a cliticised verb, and enforces the constraints on ordering of surface clitics. These constraints are encoded in the lexical entry for each clitic.

This basic framework is fairly straight-forward, though a number of additional features need to be added in order to capture the syntactic facts. We summarize the main points:

**Position of surface clitics**: Clitics occur post-verbally in positive imperative clauses, otherwise pre-verbally. The clitic-list constituent consequently needs to share suitable features with the verb it combines with.

**Surface form of clitics**: The first- and second-person singular clitics are realised differently, depending on whether they occur pre- or post-verbally: for example “Vous me réservez un vol” versus “Réservez-moi un vol”. Moreover, “me” and “te” are first-position clitics (e.g. “Vous me les donnez”), while “moi” and “toi” are third-position (“Donnez-les-moi”). This alternation is achieved simply by having separate lexical entries for each form. The entries have different syntactic features, but a common semantic representation.

**Special problems with the “en” clitic**: The most abstruse problems occur in connection with the “en” clitic, and are motivated by sentences like

Combin en avez-vous?

Here, our framework seems to dictate a constituent structure including three gaps, viz:

\[ \text{[Combin [en avez]_{V} [vous}_{NP} [[[NP]_{PP}][NP]_{S}]_{S} \] } \]

in which the V gap links to “avez”, the NP gap to “combin”, and the PP gap to “en”. The specific difficulty here is that the “en” PP gap ends up as an NP modifier (it modifies the NP gap). Normally, however, PP modifiers of NPs cannot be gaps, and the above type of construction is the only exception we have found.

Rather than relax the very common NP → NP rule to permit a gap PP daughter, we introduce a second rule of this type which specifically combines certain NPs, including suitable gaps resulting from WH-movement, and an “en” clitic gap. A feature, takes partative, picks out the NPs which can participate as left daughters in this rule.

### 4.3 Agreement

Although grammatical agreement is a linguistic phenomenon that plays a considerably larger role in French than in English, the adjustments needed to the lexicon and syntax rules are usually obvious. For instance, a feature has to be added to the both daughters of the rule for pre-nominal adjectival modification, to enforce agreement in number and gender. In nearly all cases, this same procedure is used. A feature called agr is added to the relevant categories, whose value is a bundle representing the category’s person, number and gender, and the agr feature is shared between the categories which are required to agree.
There are however some instances where agreement is less trivial. For example, the subject and nominal predicate complement of “Être” may occasionally fail to agree in gender, e.g.

La gare est le plus grand bâtiment de la ville.

However, if the predicate complement is a pronoun (“lequel”, “celui-ci”, “quel”...) agreement in both gender and number is obligatory: thus for instance

Quel/*quelle/*quels est le premier vol.

It would be most unpleasant to duplicate the syntax rules, with separate versions for the pronominal and non-pronominal cases. Instead, we add a second agreement feature (compagr) to the NP category, which is constrained to have the same value as agr on pronominal NPs; subject/predicate agreement can then use the compagr feature on the predicate, getting the desired behaviour.

Similar considerations apply to the rule allowing modification of a NP by a “de” PP. In general, there is no requirement on agreement between the head NP and the NP daughter of the PP. However, for certain pronominal NP (“lequel”, “l’un”, “chacun”) gender agreement is obligatory, e.g.

lequel/*laquelle de ces vols
laquelle/*lequel de ces dates

This is dealt with correspondingly, by addition of a new agreement feature specific to the NP → NP PP rule.

5 Spanish syntax

This section briefly describes the interesting features of the Spanish syntactic rule-set. In general, the Spanish rules were distinctly simpler than the French ones. With a few exceptions noted below (in particular, prodrop), the current Spanish syntax rules are essentially a slightly modified subset of the French ones. Despite this, they give very adequate coverage of the ATIS domain, the only in which they have so far been seriously tested. In a little more detail:

Question-formation: The Spanish rules for question-formation are similar to, but less elaborate than the French ones. Subject-verb inversion is allowed with any subject; there is no restriction that it be pronominal. There are no constructions corresponding to “est-ce que” or complex inversion. When the inverted subject is a pronoun, it does not require a preceding hyphen linking it to the verb.

Clitics: The Spanish clitic system is also considerably simpler than the French one. There are fewer clitics; in particular, there are no clitics corresponding to the French “y” and “en”, which as we saw in Section 4.2 above gave rise to many of the difficult problems in French.

Postverbal clitics are affixed directly to the verb, rather than being joined by hyphens. Since CLE morphotax rules have a uniform format (Alshawi (ed), 1992, §3.9), this only involved moving the relevant syntax rules to the morphology rule file.

Phrasal rules: The rules for Spanish numbers, dates and times are substantially different from the French ones, and those for dates in particular needed to be rewritten more or less from scratch. The issues involved are however straightforward.

Also, the form of the Spanish superlative adjective is slightly different: the postnominal superlative adjective has no extra article, e.g. “le vol le [plus cher] versus “la plaza [menos cara]”.

The necessary adjustments are again simple.

Relative clauses: A less trivial difference involves relative clauses. In Spanish, the main verb of the relative clause must be in the subjunctive mood if it modifies an argument of a verb in the imperative mood. Thus for example

Which is the first flight that serves a meal?
→ Cuál es el primer vuelo que sirve una comida?

(“sirve” = present indicative), but

Show me flights that serve a meal!
→ Enséñeme los vuelos que sirva una comida

(“sirva” = present subjunctive). Handling this alternation correctly involves trailing an extra feature through many grammar rules, so as to link the main verb in the relative clause to the main verb in the clause immediately above it.

Prodrop: The second substantial change required when adapting the French grammar to Spanish was necessitated by the prodrop rule: Span-
ish, unlike French, permits and indeed encourages omission of the subject when it is a pronoun. Perhaps surprisingly, prodrop in fact only resulted in a few divergences between the Spanish and French grammars. A new syntax rule of the form $S \rightarrow VP$ was added (it is in fact a slightly modified version of the French imperative-formation rule). The associated semantic rule fills in a representation of the omitted clausal subject from the main verb; to make this possible, the semantic entries for inflected verbs are all modified to contain an extra feature encoding the possible prodrop subject. The details are straight-forward.

6 Conclusions

The preceding sections describe in essence all the changes we needed to make in order to adapt a substantial English language processing system to French and Spanish. Due to space limitations, we have been obliged to present some of the details in a more compressed form than we would ideally have wished, but nothing important has been omitted. Creation of a good initial French version required about five person-months of effort; after this, the Spanish version took only about two person-months. We do not believe that we were greatly aided by any special features of the Core Language Engine, other than the fact that it is a well-engineered piece of software based on sound linguistic ideas. Our overall conclusion is that an English-language system conforming to these basic design principles should in general be fairly easy to port to Romance languages.

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