

New tools for the encoding of lexical data extracted from corpus

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Abstract

This paper describes the methodology and tools that are the basis of our platform AAILE.⁴ AAILE has been built for supplying those working in the construction of lexicons for syntactic parsing with more efficient ways of visualizing and analyzing data extracted from corpus. The platform offers support using techniques such as similarity measures, clustering and pattern classification.

1. Introduction

The encoding of lexical units for a computational grammar is a complex task. It is difficult for humans because it demands to be both exhaustive and consistent. With large corpora available for lexicographers to look into real data, one could think that the exhaustiveness problem, at least, was solved. Different tools and platforms, mainly based on concordances, have been offered to lexicon developers to inspect, sum up and select data. But, no human can easily cope with the direct examination of, for instance, the 2,988 occurrences that an adjective like *clinical* has in the 3.7 million word corpus on medicine.

We present here a set of new tools, the AAILE platform, devised specifically for lexicographers working on the encoding of computational lexica. These tools allow, on the one hand, the easy inspection and visualization of the syntactic information contained in concordances, and, on the other hand, the computation of specific comparison and prediction functions. These functions are a further attempt to contribute to the solution of the problem of lexical coverage of deep analysis computational grammars (Marimon & Bel 2004).

The basis for AAILE tools is the mapping of the textual contexts into vector spaces such that syntactic information can be handled quantitatively. This projection is the necessary step for computing similarity measures, applying clustering techniques, and predicting the assignment of syntactic features by pattern classification techniques.

Furthermore, a vector representation also becomes a complete and compact representation for human inspection of linguistic data. To have the means to visualize actual syntactic contexts in a more compact way than the commonly used made of word and tag strings facilitates a quick verification of the lexicographer expectations.

The paper is organized as follows. Section 2 presents the process for mapping textual concordances into ‘bag of features’ vectors. Section 3 presents how AAILE displays

data. First, we supply a short overview of the compact representation, where the feature vectors are just listed offering a summary of the data. Later, the graphical view is introduced, together with an explanation of how a similarity measure based on the *cosine distance* between two vectors is used for plotting vectors in a 2-D space. Section 4 presents how the mapping of textual information into such a mathematical object allows for further manipulation and inference of new linguistic information. This information, clustering and confidence measures, is supplied to lexicographers to assist them in the process of encoding lexical entries. The following section briefly accounts for the intended use of AAILE platform. And, finally Section 6 supplies with the most technical details of the platform.

2. Vectors representing word occurrences

Vector spaces for representing textual data were first used in Information Retrieval. Vector representation is very convenient as it allows the use of mathematical techniques, in our case measuring similarity between different instances, clustering of occurrences and Bayes based pattern classification, as we will see below.

In order to represent word occurrences as vectors, we use Regular Expressions (RE’s) that search for local syntactic information –sequences of tags– in a part of speech tagged corpus. In designing the particular RE’s, we follow linguistic criteria to identify those linguistic cues that are considered to play a role on the characterization of the syntactic properties of the grammatical category –part of speech– under consideration.

Different RE’s are used to check whether a number n of particular cues are found in each occurrence of a word in a corpus. The positive or negative results of each checking are stored as binary values of n dimension vectors. Thus, we create a ‘bag of features’ representation (Rosenfeld, 1997) for each occurrence.

Nevertheless, in order to have a complete picture of a word’s behavior, one has to see the characteristics of all its occurrences in a representative corpus (Bel, 2004) to judge whether certain context is more or less frequent,

¹ Ramón y Cajal Program of the Spanish Ministerio de Educación y Ciencia.

² Supported by the Spanish Ministerio de Educación y Ciencia and *Fondo Social Europeo*, PTA-CTE/1370/2003

³ Juan de la Cierva Program of the Spanish Ministerio de Educación y Ciencia.

⁴ AAILE stands for *Automatic Acquisition of Lexical Information*, the project funded by the Spanish Ministerio de Educación y Ciencia (HUM2004-05111-C02-01/FILO) that has partially supported the development of the work presented here.

whether there are particular cues that are constant in more or less occurrences, etc.

AAILE's aim is to help the lexicographer to generalize and abstract from the characteristics of particular occurrences into the characteristics of the whole set of occurrences. A word's *signature* σ is the set of vectors resulting of the transformation from all its occurrences in a corpus and it represents the complete syntactic behavior of that particular word, more technically of that lemma-category pair.

Table 1 shows the *signature* of the adjective *adjacent*, the vectors resulting of applying 14 RE's to every occurrence of this adjective in a corpus of 5 million words (*Corpus Tècnic de l'IULA*, Cabré et al. 2000). Each RE checks whether a particular context is displayed in the occurrence. All occurrences are inspected by the whole collection of RE's.

#occ.	lc ₁	lc ₂	lc ₃	lc ₄	lc ₅	lc ₆	lc ₇	lc ₈	lc ₉	lc ₁₀	lc ₁₁	lc ₁₂	lc ₁₃	lc ₁₄
124	1	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	1	0
23	0	1	0	0	0	0	0	0	0	0	0	0	1	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	1	0	0	0	0	0	0	0	0	0	1	0
1	0	0	1	0	0	0	0	0	1	0	0	0	0	0
1	1	0	1	0	0	0	0	0	0	0	0	0	0	0

Table 1. Signature for the English adjective *adjacent*. The

RE's have check for the following linguistic cues: lc₁, whether the item is located before a noun; lc₂, whether the item is located after a noun; lc₃, if the item is located after a copulative verb; lc₄ after a gradual adverb, and from lc₅ to lc₁₄, whether the item is before a particular preposition.

For the example shown in Table 1, the RE's have check for the following linguistic cues: lc₁ whether the item is located before a noun; lc₂ whether the item is located after a noun; lc₃ if the item is located after a copulative verb; lc₄ after a gradual adverb and lc₅- lc₁₄ whether the item is located before a particular preposition.

Additionally, the first column in Table 1 refers to the number of times that the resulting vectors turn to be the same. We will call *profile* to a particular vector configuration when it is the very same results of the fourteen RE's checking for different occurrences. Hence, the first column refers to the absolute frequency of a *profile* in a *signature*.

In the example of Table 1, the most frequent *profile* (124) corresponds to the occurrences where the only observed cue is its being in pre-nominal position, marked in column lc₁. The positive values in columns lc₂ and lc₃ show that in other *profiles* there were occurrences displaying post-nominal and predicative positions, respectively. And lc₁₃ shows the number of times that this adjective was found immediately before the preposition *to*. The invariance of one of the linguistic cues across different profiles will be crucially used when computing the assignment of syntactic features to *signatures*. In short, we take for granted that it is very likely that the preposition *to*, which appears in three of the seven profiles, has to be considered a bound preposition of that adjective.

Table 2 and Table 3 show, for the same linguistic cues than in Table 1, the signatures of two other adjectives, *countless* and *adhesive*, that display different results. For

instance, *adhesive* has been found in a predicative position, but not *countless*.

#occ.	lc ₁	lc ₂	lc ₃	lc ₄	lc ₅	lc ₆	lc ₇	lc ₈	lc ₉	lc ₁₀	lc ₁₁	lc ₁₂	lc ₁₃	lc ₁₄
16	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2. Signature for English adjective *countless*. Columns refer to the same information than in Table 1.

#occ.	lc ₁	lc ₂	lc ₃	lc ₄	lc ₅	lc ₆	lc ₇	lc ₈	lc ₉	lc ₁₀	lc ₁₁	lc ₁₂	lc ₁₃	lc ₁₄
16	1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	0	0	0	0	0	0	0

Table 3. Signature for English adjective *adhesive*. Columns refer to the same information than in Table 1.

A *signature*, that is, the set of vectors that represents all occurrences of a particular word in a corpus, is the input for the AAILE platform.

AAILE data acquisition module permits the introduction of signatures either by using web services that directly consult the corpus, or by uploading plain files. When uploaded into the platform, a *signature* also contains other information: the lemma and part of speech the language and the identification of the corpus where concordances were extracted.

3. Vector visualization in AAILE

Once the textual data are translated into a vector space, the information can be displayed, analyzed and interpreted in the most suitable ways for supporting lexicographer's work. Figure 1 shows AAILE's main view where most of the information is displayed.

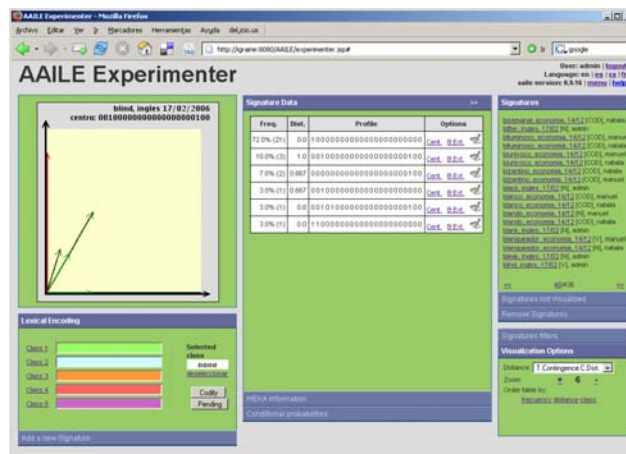


Figure 1: Main window of AAILE's encoding page. At the left-upper corner, the display shows the different vectors with a representation of its similarity (as calculated by *cosine distance*). The centre of the window shows the *signature*, the set of vectors that represents the occurrences of a particular word, in this case the adjective *blind*. The right column contains visualization choices (zoom, ordering criteria, etc.) and other administrative information.

5. Using AAILE platform for lexical encoding

Along the preceding sections, we have provided details on how the system has been designed to assist the lexicographer when taking decisions about what are the relevant characteristics of a word. We should see now how is the intended use of the platform.

The lexicographer using AAILE has been asked to relate lemmas belonging to a particular grammatical category and the lexical classes defined on linguistic grounds, for instance for the use by Natural Processing Tools (Lenci et al. 2000.) The lexicographer should, instead of looking at texts, receive enough analytical information to determine the class of the word under study.

A typical encoding exercise is based on the observation of the *profiles* that conform a *signature*, their frequency and the selection of profiles that correspond to a given class.

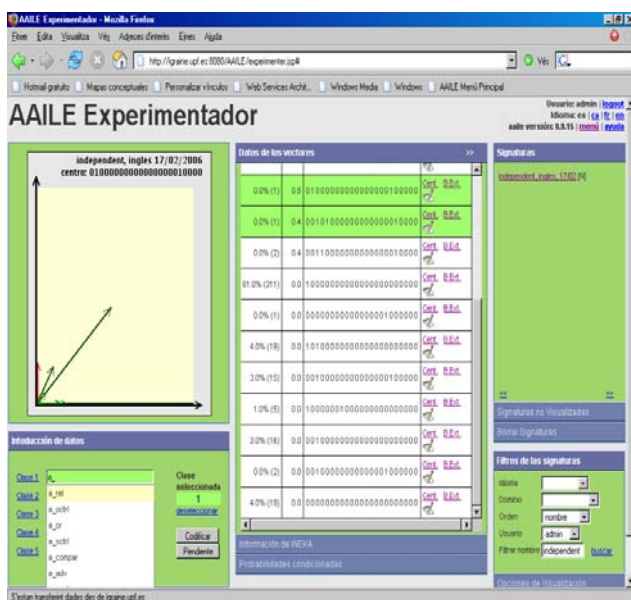


Figure 7: AAILE main window. At the left-bottom corner the lexicographer is assisted with complete writing for consistency encoding

Figure 7 shows, at the bottom left hand corner, the encoding section of the AAILE main view. The lexicographer should use it when entering the class or classes assigned. The system asks the lexicographer to mark (in the Figure, in green color) those profiles that are related to the class selected. The system allows to create two different lexical entries out of a unique signature. This could be the case when encoding different bound prepositions, for instance.

The lexicographer enters the selected lexical class help by AAILE that shows him or her the possible classes with a complete writing facility.

In the most simple case, the encoding exercise should take just few minutes. Analytical information is mostly required when dealing with high frequency words, that present a large number of profiles, with high variation in the *linguistic cues* shown. Then the lexicographer might find useful to check whether there is a particular profile that shows to be a better point of reference because it

creates a big distance between two groups of profiles, for instance. This could be a sign that there is more than one lexical entry in the signature.

An example of such a case is the adjective *consistent*, where we could identify the *consistent-with* reading and the *be-consistent* one. Figure 8 shows the main view for *consistent*.

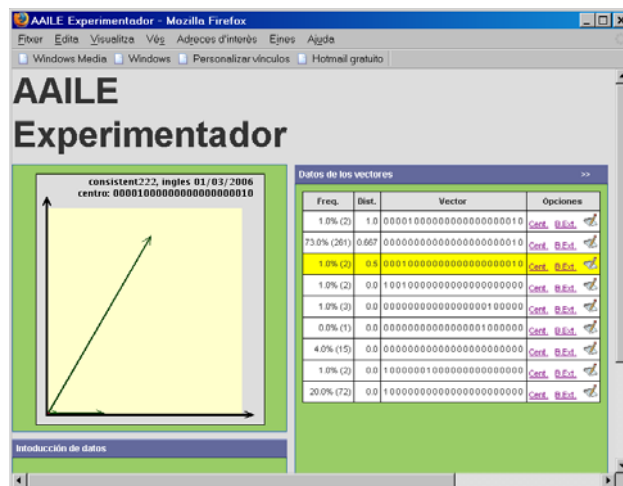


Figure 8: AAILE view for *consistent*

The most significant information comes from the clean cut between the three profiles with 0.5 distance, and the others going directly to 0. This is a sign that it is worth considering two different entries.

As already mentioned, invariant components across different signatures are very informative, specially for bound prepositions. We see in the example of Figure 8 that *with* is present in 3 profiles, while other prepositions like *in* or *from* are present only in 1. AAILE can also supply the lexicographer with a confidence measure on what are the relevant characteristics of the signature to classify the lexical entry. In the case of *consistent*, it shows a clear confidence on the bound character of preposition *_with*:

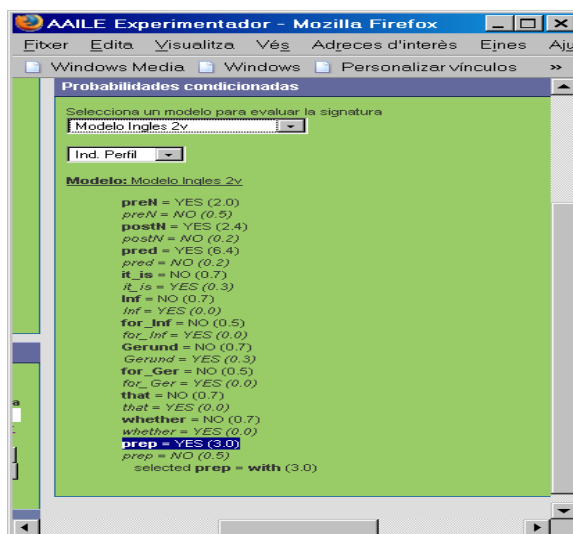


Figure 9: Linguistic cues confidence for *consistent*

6. Technical details

AAILE platform is divided into three tiers, following model view controller (MVC) pattern: user system interface, process management and database management. Database management tier is implemented using MySQL 4.1., MySQL JDBC driver and DAO pattern access to data.

Process management is performed in Java 5, and uses various open source libraries: Jakarta Commons DBUtils, Jakarta Commons FileUpload, Jakarta Log4j and Apache Axis 1.2.

The user interface tier is developed using AJAX, Javascript, CSS in the client side and Java Server Pages in the server side.

Logically, the architecture of the system can be divided as follows: A data acquisition and introduction module, a codification module, a visualization module and a knowledge module. These modules use data from a database and a wiki.

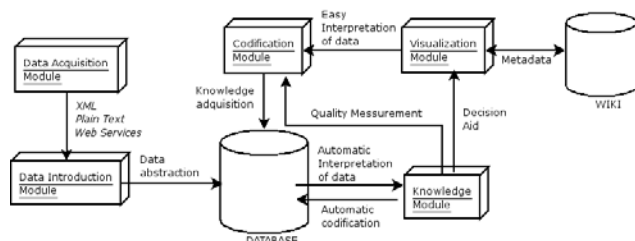


Figure 8: AAILE architecture

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