A framework for the automatic processing of Basque

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Abstract

In this paper we present the tools (lemmatizer-tagger, morphological analyzer, linguistic environment), applications (spelling checker) and resources (lexical data-base, corpora and grammars) developed for the treatment of Basque by the IXA Group. Besides, the main research lines and the strategy followed by the group are presented.

1 Introduction

IXA Group is composed by 18 members from the Computer Science Faculty of the University of the Basque Country and by 2 members of UZEI (Basque Centre for Terminology and Lexicography created in 1977 with the aim of promoting Basque lexicon's modernization within the normalization process of this language).

Basque is a minority language. There are 700,000 Basque speakers, and they are around a 25% of the total population of the Basque Country, but they are not regularly distributed. Most of them are bilingual nowadays. The four main literary dialects are: Guipuzcoan, Biscayan, Labourdin and Souletin. The Academy of the Basque Language (Euskaltzaindia) gave the first rules towards the standard Basque in 1968.

As Basque is a language with a very rich morphology[1], when we started working on the processing of Basque ten years ago we decided to begin trying not with advanced applications such as machine translation or natural language interfaces, but to develop broad basis dealing extensively with lexicon and morphology. Now those foundations have become the basis for present and future developments. We distinguish four main sets among the current works in IXA group. In the first set, **applications**, we include those commercial systems oriented to non- specialized users; in the second set, **tools,** we consider those systems which are oriented to NLP developers; the third group includes the **foundations**; and finally, the four set groups the systems and studies placed at a research level**: research.** Figure 1 shows this four groups and our developments in each one of it are described in the next sections.

Sections 2, 3 and 4 describe respectively the foundations, tools and applications created by IXA group. Section 5 shows other research lines currently in development. Finally the paper ends with some concluding remarks.

2 Foundations

2.1 The lexical data-base EDBL

EDBL is a lexical database for Basque (Agirre et al. 95). It was created because of the peremptory need for sound lexical support for the construction of a general morphological analyzer and its most important by-product so far, the spelling checker/corrector Xuxen. The maintenance of the large amount of lexical information needed in such a project would not have been possible without a database management system. At present it contains over 70,000 entries, each with its associated linguistic features (category, subcategory, case, number, etc.). Other projects our group is currently involved in, like the construction of a lemmatizer/tagger —also derived from the morphological analyzer— or the development of a general syntactic parser require different types of lexical information. In this context, EDBL has been redesigned as a general basis for the multiple lexical needs that current and further work on the automatic treatment of Basque will have (we are involved so far in automatic processing tasks of written Basque).

The morphological usage of EDBL is not longer its central element, but one more of its several purposes. The main key of every item in the database is now composed by the headword and an homograph identifier, as in any conventional dictionary. The information is distributed in different parts, according to the different purposes it is intended to be used for.

This database has been developed under a commercial RDBMS (Oracle V7 manager) and UNIX operating system.

[1] Being Basque an agglutinative language, for the formation of words the dictionary entry independently takes each of the elements necessary for the different functions (syntactic case included). More specifically, the affixes corresponding to the determinant, number and case are taken in this order and independently of each other. below

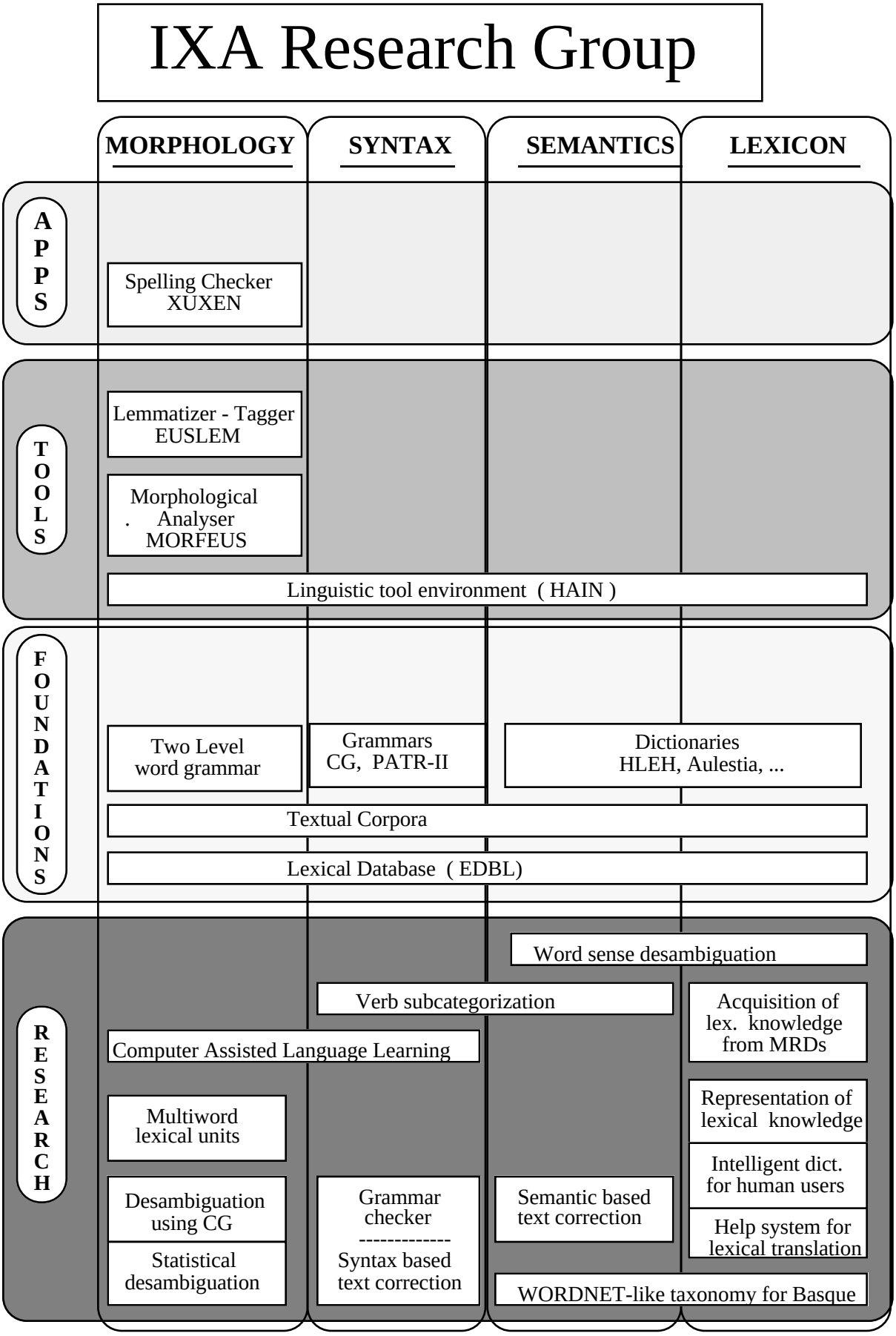

Figure 1: Products and systems sorted by application level and kind of knowledge.

EDBL's main features are the following:

a) Multi-purpose. As said before, it has been designed as a general support and source for different kinds of applications. In the short term, an explanatory dictionary containing definitions and examples (Sarasola I., 95) will be integrated into EDBL, thus enhancing it and converting it into an electronic dictionary suitable for human consultation.
b) Neutral. The linguistic descriptions held in it should not constrain any future application.
c) Open and flexible. It will allow the addition of new information..
d) User friendly. The interface for human users has to be designed as an easy-to-use tool. This interface is currently being developed.

2.2 Two-level word grammar

The two-level model of morphology (Koskenniemi, 83) has become the most popular formalism for highly inflected and agglutinative languages. The two-level system is based on two main components:

- a lexicon where the morphemes (lemmas and affixes) and the possible links among them (morphotactics) are defined.
- a set of rules which controls the mapping between the lexical level and the surface level due to the morphophonological transformations

The rules are compiled into transducers, so it is possible to apply the system for both analysis and generation. We did our own implementation of the two-level model with slight variations, and applied it to Basque (Alegria et al. 96a, b). Our two-level system has the following components:

1) 21 rules describing changes due to phonological, morphological, morphophonological and ortho-graphical reasons.
2) 44,384 items in the lexicon: 35,421 lemmas, 8,825 verb forms and 138 affixes
3) The items are grouped into 135 sublexicons and 99 continuation classes have been defined.

2.3 Grammars

In the way of the computational treatment of a language, parsing is the task that necessarily follows morphology. Therefore, our group has already undertaken the syntactic challenge. After an study of different parsing formalisms, we chose to follow two of them in parallel. We are currently experimenting with both formalisms and we think they may be seen as complementary methods.

2.3.1 PATR-II like unification grammar. Unification based formalisms provide a linguistically and mathematically well-founded apparatus, tied with direct computational implementations. As there have not been many studies on unification grammars for Basque, we adopted the PATR-II formalism due to its flexibility for our proposes, giving the possibility of solving in a declarative way many linguistic problems that will have to be dealt with in other, more restrictive formalisms like LFG or HPSG. A first prototype grammar was implemented allowing wide coverage parsing of noun phrases. We plan to use this grammar in the detection of noun phrases, teaching syntax to Basque students, and in the implementation of a grammar checker. In order to treat efficiently grammar errors the system uses the gradual relaxation of syntactic constraints (Gojenola K. and Sarasola K., 94)

2.3.2 Constraint Grammar. The aim of Constraint Grammar (CG) is not, as it often happens with other formalisms, to create a toy grammar to play with laboratory sentences, but to analyze real texts (Karlsson et al., 95). That philosophy agrees thoroughly with our aims, since the parser we are developing for Basque (Aduriz et al., 97b) must be the basis for other applications.

On the other hand, CG parsing is based on morphology. It goes without saying that this fits perfectly to a language like Basque where morphology and syntax are so related. A very important part of the CG analysis is morphological disambiguation, namely the treatment of ambiguous output from morphological analysis using constraints based on linguistic knowledge. Our system reduces the number of morphological interpretations to about a half (the average number of interpretations per word drops from 2.65 to 1.45) maintaining 97,51% of the correct interpretations. When only the 19 main categories are considered the average number of interpretations is reduced from 1.55 to 1.10 and the number of remaining correct interpretations reaches to 99.12%.

We considered that CG formalism was appropriate to be used in general syntactic treatment. Far from the stiffness of other formalisms and, in spite of the problems, we think it is fit for languages with quite a free word order.

2.4 Corpus resources.

There are two main electronic corpora in Basque. Both of them are managed by UZEI to prepare dossiers about the origin and present use of the lexicon. Those dossiers are used by the Academy of the Basque Language (Euskaltzaindia) to take decisions on the unified lexicon. Both corpora are in a relational data-base (Oracle), but they are going to work in Basis in a few months when they will be publicly accessible via Internet.

1. The Corpus of the General Dictionary (OEH-Orotariko Euskal Hiztegia).

It is the historical corpus, the base for the general dictionary of the Academy. There are 310 books -complete works- with a total of 5.800.000 words. These books represent the Basque language from the 16th to the middle of the 20th century and are exhaustively copied out. Apart from the author and the title, the information about the period, dialect and text type is marked. It is not completely lemmatized. Currently it is used only when the Unified Lexicon Commission of the Academy asks for the dossiers about the history and variants of a word. But it can be consulted and it is possible to export data from it.

2. The Systematic Compilation of the Modern Basque (EEBS - Egungo Euskararen Bilketa-lan Sistematikoa).

EEBS contains 4.000.000 lemmatized words showing the Basque lexicon of the 20th century (1900-1992). It is an statistical corpus: there are not full books, but randomly selected pages from nearly 5.000 works, with the aim of compiling as much as possible different words from multiple books and, inside them, from different chapters. All the documents (small parts of a work) contain information about the author, title, (in the case of signed

articles, the magazine -including the name, year, number and pages- where it was published), period, dialect, text type and size.
The origin of this sample is the classified inventory of all the publications in Basque language made by UZEI, from where a cross-section sample was extracted, compiling works –proportionally- from all the periods, dialects and text types. Apart from that, there is another non-classified section with voluminous and fast publications, as newspapers, magazines, etc. These are not, often, written in a very "elaborated" language. This is an open corpus, it means, it is updated every year; its aim is to represent today's lexicon.
The full corpus is lemmatized (with the standard lemma and the lemma of the variant), including complex words as compounds, idioms, etc. From 1900 to 1990 the corpus is marked in a homemade format, which is going to be converted (semi)automatically to SGML format. The last four years are coded in SGML format and lemmatized automatically using Euslem (The automatic lemmatizer for Basque described below).

3. Tools

The tools described in this section are not designed for common users, but for researchers or developers of linguistic applications.

3.1 Morphological Analyzer (Morfeus)

MORFEUS performs a basic task in the automatic processing of Basque (Alegria et al. 96b). It assigns to each text token its lemma as well as all its possible morphological analyses. The rest of the modules will make use of its output so as to accomplish disambiguation and identify lexical units. This analyzer is based on the two-level formalism.
First MORFEUS tries to analyze the word as **standard**. If the standard analyzer fails then a second module is activated and the analyzer tries to understand it as a **variant** or **typical error**. If that module fails too, the third one analyzes the word **without lexicon,** so that in the end all the words have at least one interpretation.
This analyzer is a basic tool for current and future work on automatic processing of Basque and its first two applications are a commercial spelling corrector and a general purpose lemmatizer/tagger.
Lexical transducers are generated as a result of compiling the lexicon and a cascade of two-level rules (Karttunen et al. 94). Their main advantages are speed and expressive power. Using lexical transducers for our analyzer we have improved both the speed and the description of the different components of the morphological system. Some slight limitations have been found too.
The number of interpretations given by both variant and lexicon-free modules is usually bigger than the one given in standard analyses. Therefore, and in order to avoid complicating further processes, a new module (the local disambiguation) discards some interpretations without taking the context into account.
Finally, the morphosyntactic treatment is applied, so that the features actually necessary in syntax are raised from the morphemes that compose the word-form. The output is given in text-format but we are currently working so as to give it in SGML format.

3.2 Lemmatizer (Euslem)

A lemmatizer-tagger is a computational tool used for assigning the correct lemma and grammatical category to each token of a corpus. It is a basic device for corpus analysis, automatic indexation, syntactic and semantic analyses etc. For example, the lemmatizer-tagger for Basque (EUSLEM) (Aduriz *et al.*, 94; Aduriz *et al.*, 96a, b) is essential for the Systematic Compilation of Modern Basque[2] project (Urkia, 97).
The tagset system developed may be considered as an outcome of this work. The one we have chosen for Basque is a three level system. In the first level seventeen general categories are included (noun, adjective, verb, etc). In the second one each category tag is further refined by subcategory tags. The last level includes other interesting morphological information (case, number, etc.). Users can parameterize the lemmatizer, when examining the results.
In order to create our lemmatiser/tagger for Basque, we have used the following components:

- A pre-processor to detect and tag figures, punctuation marks, etc. Pre-processing those elements is very useful because they don't produce ambiguous tags and, therefore, they reduce the strings of ambiguous elements.
- The general-purpose morphological analyzer for Basque,).
- Lexicon-free lemmatization so that the system is robust.
- Treatment of compound lexical units.
- Disambiguation based on linguistic knowledge, completed by disambiguation based on statistics.

3.3 Linguistic tool environment (HAIN)

A prototype of a linguistic environment has been developed. The philosophy of the system is to make accessible simultaneously all the linguistic tools described. This environment provides a graphical user interface that allows the user, among other operations, to look up in a dictionary, to analyze morphologically a word-form, to check if it is correct and to look for proposals.
HAIN's main features are the following:

a) Multi-purpose. It has been designed as a general environment to integrate different applications and as a workbench for different users (linguists, Basque students, journalists, and so on).
b) Open and flexible, so that it will allow, at anytime, the integration of new tools.
c) User friendly and adaptive. Conceived for both programs and human users (specialized or not), the different interfaces corresponding to the tools have been designed as an easy-to-use environment.

This environment has been developed in a SUN workstation and the version allowing World Wide Web access will be complete for the next summer.

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[2] During the 1987-1992 period UZEI manually compiled and lemmatized a three million word corpus of twentieth century's Basque texts, which is annually renewed.

4. Applications

4.1 Spelling Checker/Corrector (Xuxen)

Xuxen is a spelling checker/corrector for Basque (Agirre *et al.*, 92; Aduriz *et al.*, 93; Aduriz et al., 1997) based on two-level morphology). As mentioned before, being Basque an agglutinating and highly inflected language, a system based on a word-form list is not suitable.

The checker recognizes a word-form if a correct morphological breakdown is allowed.

- The treatment of orthographic errors is based on the parallel use of a two-level subsystem designed to detect previously typified misspellings, which is added to the two-level system used by the morphological checker.
- The treatment of typographical errors is quite conventional; the proposals are fed into the spelling checker to check whether they are valid or not.
- Two-level morphology has been the base for the design of the checker/corrector. Only a slight adaptation was needed for the treatment of orthographic error and to improve the checking of proposals.
- The program has been developed in C and runs on a SUN SPARC machine, Macintosh and PC. It was commercialized in 1994.
- A filter program, buffers for the most frequent words (to improve the performance) and the maintenance of the user's own dictionary are the essential elements added to the morphological system.
- In order to manage with precision the inclusion of new lemmas in the user's own dictionary, an interface for lexical knowledge acquisition has been designed.

The main existing correction method (to define a measurement for the distance between words and to calculate which words of the dictionary have a lesser distance) is not suitable for a lexicon system not based on a word-form list.

The treatment of typographical errors is quite conventional and performs the following steps:

- Generation of proposals to typographical errors using Damerau's classification (single deletion, insertion, substitution or transposition).
- Trigram analysis: proposals with trigrams below a certain probability threshold are discarded, while the rest are classified in order of trigrammic probability.
- Spelling checking of the remaining proposals.

5. Research and future work

Finally, we present other research lines currently developed in our group.

5.1 IDAZKIDE: A help system for the study of Basque

IDAZKIDE is an intelligent system that helps learners of Basque to write their texts. This help is not only given at word level but also (in some features) at sentence level. The system is based on a student model that gathers some futures of the students' learning process such as language level, student's favorite learning strategy, mother tongue, etc. All this information is extracted from a database completed by the teacher.

An intelligent system for analyzing a second language learning process is also being developed. That system is composed of two subsystems: the Knowledge Acquisition Subsystem and the Learning Process Subsystem. The database fits into the first subsystem and IDAZKIDE, the tool assisting in writing texts, fits into the second one.

In the student model of IDAZKIDE we are also gathering information on the students' knowledge about a second language. We call that knowledge interlanguage (Díaz de Ilarraza et al., 97). To complete the interlanguage, we work with a corpus collected in some language schools of Basque (Maritxalar et al., 96). For the study of the corpus, we are adapting some linguistic tools developed by the IXA Group such as the morphologic analyzer, and the lemmatizer (Maritxalar et al., 97).

5.2 IDHS (Intelligent Dictionary Help System)

IDHS (Intelligent Dictionary Help System) is a monolingual (explanatory) dictionary system (Artola & Evrard, 92). Its design was conceived from the study of questions that human users would like to be answered when consulting a dictionary. The fact that it is intended for people instead of automatic processing distinguishes it from other systems dealing with the acquisition of semantic knowledge from conventional dictionaries. The system provides various access possibilities to the data, allowing to deduce implicit knowledge from the explicit dictionary information. IDHS deals with reasoning mechanisms analogous to those used by humans when they consult a dictionary.

The starting point of IDHS is a Dictionary Database (DDB) built from an ordinary French dictionary. Meaning definitions have been analyzed using linguistic information from the DDB itself and interpreted to be structured as a Dictionary Knowledge Base (DKB). As a result of the parsing, different lexical-semantic relations between word senses are established by means of semantic rules (attached to the patterns); these rules are used for the initial construction of the DKB.

Once the acquisition process has been performed and the DKB built, some enrichment processes have been executed on the DKB in order to enhance its knowledge about the words in the language. Besides, the dynamic exploitation of this knowledge is made possible by means of specially conceived deduction mechanisms. Both the enrichment processes and the dynamic deduction mechanisms are based on the exploitation of the properties of the lexical semantic relations represented in the DKB (Agirre *et al.*, 94).

5.3 ANHITZ: A Multilingual Dictionary-System to Assist in Translation

This doctoral thesis shows the most relevant aspects of an innovator multilingual dictionary-system named ANHITZ (Arregi et al. 94b). The system has been designed to help in the human translation, namely in the word-level translation. ANHITZ can offer both passive and active help, so that far from a single query-system it can be seen as an intelligent help-system.

This work brings together three different areas: machine assisted human translation, computational lexicography and knowledge-based help-systems. From our view, it is necessary to integrate these areas, given that dictionaries should be specialized, active, adaptable and easy-to-use.

We have adapted the KADS methodology to model the use of dictionaries in the lexical translation. Based on KADS, four levels of knowledge —domain, inferences, tasks and strategy— have been distinguished in our model.
A way of representing the multilingual lexical-semantic knowledge has been proposed and, according to this representation, knowledge from dictionaries —two monolingual ones and one bilingual— has been stored in the domain-level. This proposal of representation is highly consistent and it could be used for any language.
In the inference level the basic "behavior" of the dictionary knowledge is treated by means of lexical reasoning mechanisms, such as enrichments, lexical rules for dynamic deductions and operational basic functions.
Task descriptions of dictionary queries and their hierarchical organization have been managed in the strategic level. The conceptual model is the base for the design model and the system's architecture, in which the implementation aspects are defined. This architecture has adopted features of the active help systems in order to configure the external behavior of ANHITZ and its interaction with the human translator.

5.4 ITEM: Recovery and Extraction of Textual Information in a Multilingual Environment with Natural Language.

The main aim of this project is to explore and evaluate to which extent the use of NLP techniques can improve the processes of information recovery and extraction in textual or multimedia systems, enabling a multilingual access to them.
To develop these techniques we need resources and tools that allow to extract from any text the linguistic information necessary for the search, indexation and control processes that take part in information recovery. These resources and tools include a lexical database, a conceptual knowledge base, robust analyzers that permit to carry out efficiently morphological analysis, tagging, syntactic and semantic analysis of texts (total or partial). As to multilingual access (Basque, Catalan, English, Spanish), we will focus on making possible that the search in a language allows to access to the information in another one. Therefore, we will build a conceptual knowledge base that will connect the lexical databases of the different languages.
This project is being carried out in collaboration with the Natural Language Research Group from the Polytechnic University of Catalonia (UPC), the Computational Linguistics Group from Central University of Barcelona (UB) and UNED.

6. Conclusions

In this paper we have presented the different studies and products developed by our group during the last years. We think that these are important steps towards the process of making the language able to suit the modern life needs.
Once some basic tools have been developed and during the production of new ones, our efforts are concentrated now on providing access to the tools to any type of user: linguists, literate users, Basque students, translators and so on.
Until now a number of tools have been developed but important basis have been established for the development of new ones.

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