Inclusion of verbal syntagmatic patterns in specialized dictionaries: the case of EcoLexicon[1]

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Abstract

One of the main drawbacks of specialized lexicographical resources is the lack of combinatorial patterns in word descriptions. Various authors have highlighted the need to include verbs in specialized lexicographic resources (William 2010; L'Homme & Leroyer 2009; López-Ferrero & Torner Castells 2008; Alonso Campos & Torner Castells 2008). In this sense, apart from some initiatives (Williams 2008; Williams & Millon 2010 inter alia), verbs have not yet deserved enough attention in terminographic resources. In this research we aim to evaluate how verbs should be ideally described in dictionaries for specific purposes. To this end, we first analyze how the existing specialized resources deal with phraseology and word combination. Based on their main advantages and shortcomings, we present here a new proposal for verb description in EcoLexicon, a specialized knowledge base of environmental sciences. Accordingly, a fine-grained description of the macrostructure and microstructure of a verb entry is provided, based on the main tenets of Frame-Based Terminology (Fillmore 1985, 2006; Faber 2009, 2011, 2012), Role and Reference Grammar (Van Valin 2005) and the Lexical Grammar Model (Faber & Mairal 1999, Ruiz de Mendoza & Mairal 2008). The terminological entry proposed accounts for the combinatorial patterns of terms and verbs and, therefore, is thought to be very useful for translators who are due to produce texts in the target language in the same way natives would do.

1. Introduction

The Internet has brought with it a new way of organizing and obtaining information. Because of the vast amount of language data that it offers, it has been referred to as "a fabulous linguists' playground" (Kilgarriff & Grefenstette 2003: 333). As a consequence, online resources have become the principal source of documentation for translators. However, very frequently, the information that they provide is limited to a series of entries whose design is not systematic.

Furthermore, despite the fact that most terminographers and translators agree that collocations and phraseological information in terminographic products are of paramount importance, few specialized resources actually contain word combinations (L'Homme & Leroyer 2009: 260). In fact, most of them seem to play down the description of verbal lexical units despite the fact that verbs are regarded as the most important lexical and syntactic category of language (Fellbaum 1990; Hanks 2008) and should be taken into account in specialized resources (William 2008).

In this paper we focus on the description of verbal phraseological information in EcoLexicon (http://ecolexicon.ugr.es), currently being implemented. EcoLexicon is an environmental knowledge base that takes the form of a visual online thesaurus. It currently contains more than 3,000 concepts and 14,000 terms in English, Spanish, German, Modern Greek, Russian and French. It offers conceptual, linguistic and visual information that is not found in more conventional repositories. We provide the design of an *ideal* entry for verbs, emphasizing its usefulness for translation. To that end, a fine-grained description of the macrostructure and microstructure of a verb entry is provided: 'release', for English, and '*éjecter*', for French, activated by the concept VOLCANO. The theoretical premises that underline the description of verbs are based on aspects of Frame-Based Terminology (Fillmore 1985, 2006; Faber 2009, 2011, 2012), Role and Reference Grammar (Van Valin

2005) and the Lexical Grammar Model (Faber & Mairal 1999, Ruiz de Mendoza and Mairal 2008).

2. Phraseological information in terminographic products

Specialized dictionaries and databases that include word combinations present them in different ways. Table 1 provides a short description of important terminographic resources regarding: (i) how collocational information can be accessed in each of them; (ii) how they classify and describe collocations. For each dictionary, we underline the negative and positive aspects of the representation technique used. The dictionaries analyzed are: (1) *Lexique de cooccurrents—Bourse et conjuncture économique* (Cohen 1986) in the field of stock exchange; (2) *Internet. Répertoire bilingue de combinaisons lexicales spécialisées français anglais* (Meynard 2000), English-French dictionary for Internet terms; (3) *Vocabulaire et cooccurrents de la comptabilité* (Caignon 2001), French monolingual dictionary on accounting with English equivalences; (4) *Dictionnaire fondamental de l'informatique et de l'Internet* (DiCoInfo) (http://olst.ling.umontreal.ca), online specialized dictionary in French, English, and Spanish on the domains of computing and the Internet; (5) *Dictionnaire fondamental de l'environnement* (DiCoEnviro) (http://olst.ling.umontreal.ca), incipient online dictionary in French, English and Spanish on the environment, and more precisely to the field of the climate change; (6) Termium Plus® (http://www.termiumplus.gc.ca), a large terminological and linguistic data bank that covers "almost every field of human endeavour […] from a simple tool or a complex machine, to a disease or plant, association or committee", in English, French, Spanish and Portuguese; (7) *Dictionnaire d'apprentissage du français des affaires* (DAFA) (Binon *et al* 2001), monolingual French business language available both in paper and electronic form, with equivalences in English, Spanish, German, Dutch and Italian; (8) *Dictionnaire contextuel du français économique* (DICOFE)[2] (Verlinde *et al* 1993-2003), whose online version allows searches for Dutch-French collocational information in the field of business language; and (9) the Accounting Dictionaries (AD), a group of five electronic dictionaries in accounting.[3]

Table 1. Description of phraseological information in a set of terminographic resources.

	Access	Classification and description	Advantages	Disadvantages
Cohen (1986)	-Base term	-Part of speech -Meaning	Theoretically based	Not really classified according to meaning, in the section everything can fit.
Meynard (2000)	-Base term	-Part of speech -Syntactic behavior + translation	Translation of the collocations into the other language	Non-exhaustive list.
Caignon (2001)	-Base term	-Part of speech	-Extensive phraseological information	Not really bilingual, just equivalences between base terms.
DiCoInfo DiCo-Enviro	-Base term -Collocation (lexical relation)	-Syntactic behavior (actantial structure) - Meaning	-Extensive phraseological information -Fine-grained description -Theoretically based -Multilingual	-Lack of user friendliness for general users because of the assumption of too much linguistic knowledge. -No correspondence in collocations among languages.
Termium Plus	-Base term	-Part of speech	-Huge database: great quantity of information	-Difficult accessibility. -Excessive quantity of information -Too much knowledge assumed. -Collocations only listed in a limited number of articles.
DAFA	-Base term	-Part of speech -Syntactic behavior	-Extensive phraseological information	-Difficult access due to linguistically determined data presentation.

		(verbs) -Meaning (description + synonym/antonym collocations+ex. of use)	-Fine-grained description -Theoretically based	-Although translated, it is monolingual and information is just given for French terms.
DICOFE	-Base term	Collocation in Dutch + translation into French	-Extensive phraseological information	-Limited access, just from Dutch into French.
DA	-Base term	Collocation + translation	-Extensive phraseological information -Translation offered	-No classification for collocations.

As shown in table 1, except for the DiCoInfo and the DiCoEnviro, collocations can only be accessed from the headword or main term. In other words, if the user is looking for the phrase 'develop a market', it will only be displayed once the entries for 'develop' or 'market' have been extracted from the dictionary. DiCoInfo and DiCoEnviro, apart from allowing access through the headword, permit searches directly by means of the collocation or word combination in question through the option *lexical relation*. In consonance with DiCoInfo and DiCoEnviron, an 'ideal' terminographic dictionary should favor accessibility by providing different ways of accessing the information depending on users' needs (Bergenholtz &Tarp 2004, 2010). In regards to the classification and description of collocations within an entry, the DA or the DICOFE do not offer any type of classification, but rather present the different word combinations concerning an entry term together with their equivalent in the other language. The rest of the terminographic products classify the entries according to their morphological categories. Meynard (2001), the DiCoInfo and the DiCoEnviro also specify the syntactic relationship between the base and the collocate. Meynard offers a syntactic description differentiating among (i) collocate noun + base noun; (ii) collocate verb + base noun; (iii) base noun + collocate verb; and (iv) collocate adj. + base noun, always offering the translation into either French or English, whereas DiCoInfo and DiCoEnviro offer a syntactic description involving the description of the actantial structure (i.e. semantic roles) of the base. Finally, meaning is of paramount importance for DiCoInfo, DiCoEnviro, DAFA and Cohen (1986), which classify collocations according to their sense, based on the lexical functions of the Explanatory and Combinatorial Lexicology (ECD) (Mel'čuk *et al.*, 1995; Mel'čuk 1984-1999). Cohen (1986) adapts the ECD representation, and uses paraphrases of a certain number of lexical functions such as *début* (start), *croissance* (growth) and *fin* (end). Based on the information in table 1, the following guidelines can be specified for an ideal terminological entry in a specialized dictionary: (1) the resource should be available online and offer different ways of accessing collocations, adapted to different user needs and situation profiles (Bergenholtz & Tarp 2004, 2010); (ii) it should be bilingual or multilingual, and include correspondences between the phraseological units in different languages; (iii) it should offer phraseological information and a description of the semantic and syntactic patterns associated with the meaning of each verb (Hanks 2008: 89).

3. Lexical entries of verbs in EcoLexicon

We describe below the conception of the macro and microstructure of verbs description in EcoLexicon.

3.1. *A conceptually motivated macrostructure*

According to the Lexical Grammar Model (Faber & Mairal 1999, 2012; Ruiz de Mendoza & Mairal 2008), the verbal lexicon of any language is organized in ten lexical domains.[4] Each of

these domains is subdivided in lexical sub-domains or subsets that are hierarchically organized. At the uppermost level of each hierarchy is the genus or superordinate term, which approaches the status of a semantic primitive (Wierzbicka's 1995; Apresjan 1993) obtained through stepwise lexical decomposition (Dik 1978). At the other levels, hyper/hyponymy relationships are determined by means of the troponomy tests proposed by Fellbaum (1990) and Miller (1992). Since verbs at the lower levels of the hierarchy inherit the semantic and syntactic properties of the superordinate, the representation of the sub-domains is meaningful concerning the semantic and syntactic restrictions of verb arguments (Gross 1992). Table 2 illustrates the macrostructure of the verbal sub-domain CAUSE MOTION, within the MOVEMENT domain, in the specialized subject field of volcanology.

Table 2. Macrostructure of the sub-domain CAUSE MOTION in the field of volcanology.

1. dégager: libérer une substance
Les volcans dégagent du souffre.
    1.1. émettre: dégager quelque chose.
    Le volcan de l'île de Vulcano émet des fumerolles.
      1.1.1. **laisser échapper**: émettre ce qui était retenu.
    Le volcan laisse échapper des gaz.
      1.1.2. exhaler: émettre des substances gazeuses.
    Le volcan a exhalé 20 millions de tonnes de CO2.
      1.1.3. **rejeter**: émettre hors de soi avec force.
      Le volcan de l'Eyjafjallajokull rejette des cendres.
      1.1.2.1 cracher: rejeter hors de la bouche.
        Le volcan a craché un panache de cendres.
      1.1.2.2 éjecter: rejeter avec force.
        Le volcan a éjecté d´énormes masses
        de laves et de cendres.
	1. release: to allow something to flow freely.
	Volcanoes release massive amounts of co2.
	2. emit: to throw out.
	The majority of volcanoes emit sulphur in the form of gaseous SO 2.
	  2.2. expel: to emit liquid, gaseous or solid material.
	  A *volcano* expels more than molten material or lava when it erupts.
	  2.1.1. eject: to expel out with force.
	  The volcano ejects thousands of tons of boiling, poisonous mud.
	    2.1.1.1. spit: to eject from the mouth.
	    For more than nine hours the volcano spit vigorous ash in a large plume.
	    2.1.1.2. erupt: to eject (gas and solid material) out of the volcano.
	    In 1902, the La Soufriere volcano erupted, killing 2,000 people.
	    2.1.1.2.1. spew: to erupt with force
	     A volcano expels more than molten material or lava when it erupts.

This representation is in consonance with the way concepts are stored in the human mind (Tranel *et al*. 2001; Damasio *et al.* 2004). The organization of the macrostructure of a dictionary in bilingual lexical domains is useful for user groups, such as translators, who must generate texts in another language because it allows users to have instant access to the whole conceptual system of both source and target language (Faber & Pérez 1997). Moreover, this type of representation highlights the differences in the conceptualization of a domain in each language. In this case, it can be observed that English has four verbs codifying explosive volcanic emissions whereas there are only two in French.

EcoLexicon is designed as a repository that describes the prototypical activities and states associated with the specialized environmental entities. Thus, when users look up a term such as 'volcano', they can have access to the verbs most frequently associated in the corpus with this term in both the source and target language simultaneously. It has been proved that bilingual lexical domains facilitate the choice of the correct verb in the target text and increase lexical variation in texts generated by users of such resources (Sánchez Cárdenas 2009).

3.2. *Lexical entries: corpus based argument structure*

The representation for verbs in Ecolexicon is currently being accomplished. With the aim of describing the syntagmatic behavior (Hanks 2008) of the environmental sciences language units, verb argument structures are characterized from a semantic and role-based perspective. The linguistic information has been extracted from a subcorpus –obtained from the corpus compiled by the Lexicon research group– in the subdomain of Geology with roughly 1,000,000 tokens for English and 1,000,000 for French. It is mainly composed of specialized research articles, monographies dealing with geological phenomena, scientific reports, and texts extracted from websites with a valuable authority (Buendía-Castro & Ureña 2009).

Verbal entries are divided into the following sections: lexical domain, semantic frame, semantic roles, noun typology, syntactic function, argument examples, and contexts.

1. Lexical domain. As previously mentioned, verbs are classified into ten lexical domains. Since they have a wide semantic spectrum, it is useful to classify verbs into more specific semantic classes, which is done using frame semantics. This is especially relevant in terminology, where term meaning depends on their membership in specialized knowledge subdomains (Faber *et al* 2010).

2. Semantic frame. Frames can be defined as prototypical situations of events, relations, or entities that are characterized by the configuration of their semantic roles (Fillmore *et al* 1976, 2003). Since frames refer to general situations, the linguistic units associated to each frame share the same actantial configuration.

3. Noun typology. The selective restrictions imposed on verbs arguments are characterized from a linguistic perspective according to Barrios (2010) noun typology. This classification relies on (a) a set of grammatical traits and (b) on "semantic tags" (Polguère 2003), inspired on Gross (1994) object classes and established upon Mel'čuk's (1996) lexical functions.[5] Grammatical traits are constituted by five couples: continue / discontinue, singular / collective (Bosque 1983), animate / inanimate, natural / artificial, intensive / extensive (Flaux & Van de Velde 2000). Semantic tags are used to gather nouns sharing the same semantic properties. For example, the name *mountain* is characterized by the traits "continue, singular, inanimate, natural and extensive" from a grammatical point of view and it is described using the semantic tag of "geographical accident". This typology[6] is useful to help predict verb meaning and can thus be applied to translation. For example, when the AGENT of the verb *éjecter* is constrained t a "geographical accident" and its THEME to a "natural resource" it means to "spew lava".

4. Thematic roles and macroroles. Thematic relations (AGENT, THEME, GOAL, etc.) describe the semantic behavior of verb arguments. They are generalizations across semantic roles (AGENT, THEME, GOAL, etc.) and allow the user to understand and predict relations between verbs and nominal forms. According to Van Valin (2005) and others (Pustejovsky 1995; Vetters 1996) the lexical representation of a verb can be derived from its logical structure. To this end, verbs are classified into *Aktionsart* categories (state, activity, achievement, semelfactive, accomplishment and active accomplishment) based on inclusion tests (Sánchez Cárdenas 2010). Verb argument structure can be derived from the aspectual nature of the verb. Finally, argument structure is represented in terms of the macroroles ACTOR and UNDERGOER, which are generalizations of thematic relations. Macroroles are then linked to syntactic functions. Thus, they are part of the semantic and syntactic interface.

5. Syntax. The advantage of using RRG thematic relations and macroroles is that syntactic structures can be separated from semantic ones (Van Valin & LaPolla 1997). This facilitates the description of thematic relations that appear in more than one syntactic position. For example in the sentences "The volcano ejects ashes" and "Ashes are ejected from the volcano", the NP *ashes* appears in the syntactic positions of Direct Object and Subject but in both sentences, it has the thematic relation of THEME and the macrorole of UNDERGOER.

6. Argument example. The examples are directly extracted from the corpus. They illustrate prototypical noun phrases selected by each verbs language. Even if in specialized texts the verbs express very similar ideas across different languages, the syntactic configuration and types of noun phrases of the verbal argument structure of each language tend to vary.

7. **Context**. Frequency-related information extracted from concordances help users to produce text in the same way as a native speaker with expert knowledge.

The templates in Tables 2 and 3, soon to be available in EcoLexicon, illustrate the syntax-semantic interface and combinatorial constraints (Hanks & Ježek 2008) of specialized language through the terminological unit *volcan* (French) and *volcano* (English).

Table 3. Template for the verb in the terminological entry for *volcan* in EcoLexicon.

ÉJECTER (FRENCH) Lexical domain: **MOVEMENT.** Frame: **Cause Motion**					
semantic tag	macrorole	thematic relation	syntactic function	argument example	context
GEOGRAPHICAL ACCIDENT	ACTOR	Agent	S	- volcan	Le **volcan** Kizimen a éjecté une colonne de cendres à une altitude de 7,4 kilomètres.
NATURAL RESOURCE	UNDER-GOER	Theme	COD	- des gaz et du magma - des débris - de la lave - de la matière volcanique - des cendres volcaniques - des bombes volcaniques - des fragments de roche	- Le volcan éjecte **gaz et magma** à grande vitesse. - Le volcan éjecte **des cendres** dans l'atmosphère ce qui perturbe le trafic aérien mondial.

Table 4. Template for the verb *spew* in the terminological entry for *volcano* in EcoLexicon.

RELEASE (ENGLISH) Lexical domain: **MOVEMENT.** Frame: **Cause Motion**					
semantic tag	macrorole	thematic relation	syntactic function	argument example	context
GEOGRAPHICAL ACCIDENT	ACTOR	Agent	S	- volcano - volcanoes	It may well be that undersea **volcanoes** release far more CO2 from the oceans and the sediments than any human consumption.
			Object of prep.		A secondary atmosphere was slowly released **by volcanoes** as gases were released from the molten rock.
NATURAL RESOURCE	UNDER-GOER	Theme	COD	- sulfate aerosols - sulphur dioxide - carbon dioxide - CO2 - greenhouse gas	Volcanoes release **massive amounts of CO2.**
			S		In Venus **gasses** released by volcanoes have slowly accumulated in the atmosphere.

As shown, the verb *release* is more specific than *éjecter* since it admits a more restricted number of nouns phrases in the THEME position. One advantage of this kind of representation is that the syntactic description is separated from the semantic function of the arguments. In the case of 'release', the subject can be represented by the AGENT (the VOLCANO) or by the THEME (the substance being ejected out of the VOLCANO). The computational application of this entry structure in Ecolexicon is designed to allow the users choose the fields that best fit their needs.

4. Conclusions

We have outlined the design of a prototypical lexical entry in Ecolexicon. The macrostructure organization is useful to rapidly access the way a lexical domain is conceptually organized. The terminological entry proposed describes the combinatorial patterns of terms and verbs. Dictionary users who need to generate texts in a second language inevitably run the risk of directly priming source language structures in the target text. This new resource allows users to predict the "prototypical syntagmatic patterns" (Hanks & Pustejovsky 2005) of a term in a

given target language. Besides the terminological usefulness of this resource, it helps users to produce text in a target language in the same way native expert would do.

Notes

[1] This research has been carried out within the framework of the project RECORD: Representación del Conocimiento en Redes Dinámicas [Knowledge Representation in Dynamic Networks, FFI2011-22397], funded by the Spanish Ministry for Science and Innovation.

[2] It also has a paper version in which users acquire conceptual and lexical knowledge at the same time.

[3] (1) *Den Danske Regnskabsordbog* (The Danish Dictionary of Accounting); (2) *Den Dansk-Engelske Regnskabsordbog* (The Danish-English Dictionary of Accounting); (3) *Den Engelske Regnskabsordbog* (The English Dictionary of Accounting); (4) *Den Engelsk-Danske Regnskabsordbog* (The English-Danish Dictionary of Accounting; and (5) *The English-Spanish Dictionary of Accounting*.

[4] The lexical domains are EXISTENCE, CHANGE, POSSESION, SPEECH, EMOTION, ACTION, COGNITION, MOVEMENT, PHYSICAL PERCEPTION and MANIPULATION

[5] In addition, lexical functions are also used to describe noun-verb combinations. For example, the French verb *éjecter* usually appears in the corpus related to nous *volcan* and *lave* which is expressed as "$Fact^0$ (volcan) = éjecter" and "$Oper^1$ (lave) = éjecter". However, this subject is beyond the scope of this article.

[6] The noun typology proposed by Barrios in currently being adapted to specialized knowledge in order to make it more operative for EcoLexicon.

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