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USING ECL (EXPLANATORY COMBINATORIAL LEXICOLOGY) TO DISCOVER THE LEXICAL STRUCTURE OF A SPECIALIZED SUBJECT FIELD

A b s t r a c t. This contribution shows how the lexical structure of a specialized subject field can be discovered using the principles and tools provided by Explanatory Combinatorial Lexicology (ECL). I focus more specifically on lexical relations. Based on a specific project that consists in compiling a multilingual lexical database in the field of the environment, I argue that the large set of lexical functions help achieve the following objectives: 1. ensure that the coverage of the database is complete by locating possible gaps; 2. link entries to other entries in a systematic way; 3. ensure that descriptions of semantically-related lexical units are consistent. First, I comment briefly on the kinds of relations that specialized dictionaries usually take into account. Next, I give a short description of the database on the environment and of its data categories, focusing on that of lexical relations. I then show concretely how lexical relations are dealt with in our methodology and how the system of lexical functions is used by lexicographers to meet the objectives listed above.

K e y w o r d s: specialized lexical databases, lexical functions, lexical relations, Explanatory Combinatorial Lexicology, ECL

1. Introduction

The lexicon in specialized subject fields is likely to display a structure similar to that observed in the general lexicon. Furthermore, since specialized lexicographers work with a finite set of lexical meanings and lexical units (those that are relevant in specific fields being described), relations can be observed more readily and represented systematically in databases or dictionaries. Paradoxically, few specialized dictionaries describe relations between terms in a systematic and formal way. Even in those that do, it is sometimes difficult to understand the rationale behind the method used to describe them (cf. Section 2).

This contribution reports on a method developed at the Observatoire de linguistique Sens-Texte (OLST) (Université de Montréal) that aims to capture and represent lexical relations in specialized lexical databases. The method is imple-

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mented in a database called *DiCoEnviro* that contains terms related to the field of the environment, focusing on climate change [1].

The method is designed to help lexicographers discover lexical (syntagmatic as well as paradigmatic) relations that are relevant for specific terms. A simple example is that of the verb *pollute* (vt). The description of the verb should lead to:

— The semantic distinction between two separate meanings of the same word form: POLLUTE$_{1a}$ (a *gas pollutes the atmosphere*) and POLLUTE$_{1b}$ (*someone or an activity pollutes the atmosphere with gas*);
— An antonym related to POLLUTE$_{1b}$, i.e. DEPOLLUTE;
— Two nominalizations with different meanings: POLLUTION$_{1b.1}$ (n.) (the activity: *chemical pollution of waterways*) and POLLUTION$_{1b.2}$ (the result: *actions to reduce pollution*);
— A noun instantiating an agent of POLLUTE$_{1b}$, i.e. POLLUTER$_{1}$;
— A noun instantiating a means of POLLUTE$_{1a}$ and POLLUTE$_{1b}$, i.e. POLLUTANT$_{1}$;
— An adjective that applies to the means of POLLUTE$_{1a}$ and POLLUTE$_{1b}$, i.e. POLLUTING$_{1}$ (*emissions of other polluting gases and particles into the atmosphere can also have large effects*).

In the previous examples, only terms that are morphologically related to *pollute* are listed. Of course, relations can appear between terms that are not formally related: POLLUTING$_{1}$ is opposed to CLEAN and GREEN; POLLUTE$_{1b}$ has a near synonym, i.e. CONTAMINATE; there are types of POLLUTANTS, such as GREENHOUSE GAS, METHANE, CARBON DIOXIDE, etc.

I argue that Explanatory Combinatorial Lexicology (ECL) (Mel'čuk et al. 1995), and more specifically the system it proposes for describing lexical relations, i.e. lexical functions LFs, can be used as the framework to support a method for compiling lexical databases in special subject fields. LFs are also extremely useful for ensuring that:

1. The coverage of the database is complete by locating possible gaps;
2. Entries are linked to other entries in a systematic way;
3. Descriptions of semantically-related lexical units are consistent.

The contribution is structured as follows. Section 2 comments briefly on the kinds of relations that specialized dictionaries usually take into account. In Section 3, I give a short description of the database on the environment and its data categories, focusing on that of lexical relations. In Section 4, I show concretely how lexical relations are dealt with in our methodology and how the system of lexical functions is used by lexicographers to locate and represent lexical relations and meet the objectives listed above.

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[1] The DiCoEnviro can be accessed at the following address: http://olst.ling.umontreal.ca/cgi-bin/dicoenviro/search_enviro.cgi.

2. Relations in specialized lexical databases

A quick look at specialized dictionaries on the subject field of the environment that are available on the Internet reveals that many do establish relations between terms (or concepts). However, there does not seem to be a finite list of relations and these are not always labelled or explained. The example below is a typical entry reproduced from the UCMP Glossary. In the entry for *kelp forest*, *kelps* and *Miocene* are highlighted showing that some form of relation exists between the headword and the other two terms. In addition, kelp and Miocene are hyperlinked allowing users to access the respective entries. However, nothing is said about the nature of the relations.

> **kelp forest** — Marine ecosystem dominated by large kelps. These forests are restricted to cold and temperate waters, and are most common along the western coasts of continents. Kelp forests first appeared in the Miocene (UCMP Glossary: Ecology).

One notable exception is EcoLexicon (Faber 2011), a knowledge database that its designers describe as being *multimodal*. It has several components, but I focus here on how relations are represented.

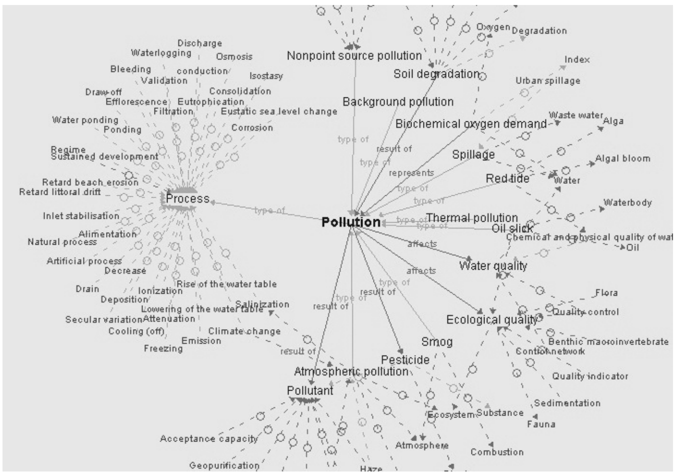

Fig. 1. Relations between «pollution» and other concepts in EcoLexicon

In EcoLexicon, concepts (most of which are designated by terms) belong to a large network of hierarchical (e.g. hypernymy) and non-hierarchical (cause-effect) relations. The network is based on a generic representation of the Environmental

Event (EE). This generic representation is assumed to provide a frame for the organization of all concepts in the knowledge base [2].

Figure 1 shows how the concept of «pollution» is connected to other concepts in the field (EcoLexicon 2012). Concepts are represented with nodes and relations are labelled. For instance, the concepts «background pollution» and «thermal pollution» are said to be type(s) of «pollution». Other relations include: represents, results, etc.

EcoLexicon is certainly innovative and extremely useful as far as conceptual relations are concerned. To my knowledge, it is also the terminological database that covers the largest number of relations and one of the few that labels them explicitly. However, it provides very little information about lexical relations such as those cited in Section 1. In addition, concept relations are said to be extracted from corpora but it is far from clear how this is done concretely, at least for someone who is not working within the framework. Two questions remain: Are relations defined formally? What kind of information in corpora is considered as relevant from the point of view of this form of modelling?

Section 4 will show how lexical relations can be captured in specialized databases. Before, however, I will briefly describe the resource in which our method is implemented (Section 3).

3. DiCoEnviro

DiCoEnviro contains terms that are related to the field of the environment, more specifically climate change and renewable energy (L'Homme, Laneville 2009). Terms are defined as lexical units (Cruse 1986) and belong to the parts of speech of noun, verb, adjective and adverb (e.g. *biodiversity; to warm; human-induced; seasonally*). The database is compiled according to the theoretical and methodological principles set forth by Explanatory Combinatorial Lexicology, ECL (Mel'čuk et al. 1984—1999). These principles had already been applied successfully in a database on computing and the Internet (DiCoInfo: L'Homme 2008). In DiCoEnviro, between 150 and 200 entries are currently online in each language. Entries are written in an XML editor and transformed into HTML when posted on the Web [3].

3.1. Structure of entries

Since the structure of entries is largely based on the principles of ECL, I focus below on the differences between what can be found in our database with respect to

[2] The frame representation found in EcoLexicon is partly based on Fillmore's Frame Semantics (1982).

[3] I do not provide details on the methodology used to compile the entries herein. Readers interested can refer to L'Homme (2008).

the structure of entries in Explanatory Combinatorial Dictionaries, ECDs (Mel'čuk et al. 1984—1999). An example — the entry POLLUTE$_{1b}$ — is reproduced in Figure 2.

— Each entry is devoted to a specific meaning. In our database, only meanings relevant in the field of the environment are taken into account.
— True synonyms and variants (i.e. different spellings used for the same unit) are encoded in a separate field and not in the list of lexical relations. The idea is to be able to access entries online even if users enter a synonym or a variant.

pollute$_{1b}$, vt

Status: 2

Actantial structure: pollute: Agent{human} or Cause{activity} ~ Patient{area} with Means{gas}
Linguistic realizations of actants
Context(s)

Mining or harvesting these resources can also pollute the soil, water and atmosphere. (Source:1EUROPAENV)

And, through the Inuit Circumpolar Conference (ICC), they have even formed a pressure group to sue the United States, which they accuse of destroying their way of life by polluting, while being unwilling to reduce greenhouse gas emissions through the Kyoto Protocol. (Source:NEWCOURIER2005)

The principle of the permit market is in no way immoral: far from consecrating a "right to pollute", the creation of a market for emission permits, on the contrary, limits the rights of economic agents to emit CO" which was hitherto unlimited.' (Source:JACLET)

Lexical relations

español: contaminar$_1$
français: polluer$_{1b}$

Written by: MCLH
Last update: 06/04/2012

Fig. 2. Entry POLLUTE$_{1b}$ in DiCoEnviro

— In DicoEnviro, some entries are accompanied with a subject field label. Most terms are related to the topic of climate change, but recently terms linked to renewable energy were added (e.g. COLLECTOR, GEOTHERMAL, THERMAL) and it appeared necessary to distinguish them from the others.
— The actantial structure is described in a specific data category using a system that differs from what can be found in ECDs (L'Homme, forthcoming). A first label states the semantic role (Agent, Patient, Destination, Instrument, etc.). The second label (between curly brackets) indicates the typical term(s) likely to appear in that position.
— Linguistic realizations of actants: here, forms in which actants can appear in running text are listed.
— Equivalents in other languages (hyperlinked when the entries are available online).

— Contexts: a sample of sentences extracted from corpora is displayed (these are selected among those — between 15 and 20 — that are placed by the lexicographer in the entry).
— Our database does not contain fields devoted to the description of the syntactic government pattern of terms. However, an annotation module allows users to see how terms and their actants as well as other participants combine in sentences extracted from the corpus (L'Homme, Pimentel 2012). The annotation is based on a methodology developed within the FrameNet project (Ruppenhofer et al. 2010).

3.2. Lexical relations

The richest data category of DiCoEnviro is that of lexical relations. It provides a list of terms that are semantically related to the headword along with a short explanation of the relation. The database provides lists of paradigmatic relations (near synonymy, antonymy, relations that are expressed by derivatives and other parts of speech, etc.) and syntagmatic relations (i.e. collocations). Figure 3 shows how lexical relations are displayed in the Web version of the database for the term POLLUTE$_{1b}$.

pollute $_{1b}$, vt

Status: 2

Actantial structure: pollute: Agent{human} or Cause{activity} ~ Patient{area} with Means{gas}
Linguistic realizations of actants
Contexts
Lexical relations
Actantial roles

Explanation - Typical term	Related term
Related Meanings	
≈	contaminate
Opposites	
Antonym	depollute
Other Parts of Speech and Derivatives	
Noun	pollution $_{1b.1}$
Result	pollution $_{1b.2}$
A gas that p.	polluting $_{1}$
The gas p. the area	pollute $_{1a}$

Fig. 3. Lexical relations currently encoded in the entry POLLUTE$_{1b}$

As can be seen in the table in Figure 3, terms that are semantically related to POLLUTE$_{1b}$ are listed in the left column. Terms that are available online (POLLUTION$_{1b.1}$, POLLUTION$_{1b.2}$, POLLUTING$_{1}$ and POLLUTE$_{1a}$) are hyperlinked allowing users to access their entries directly. In contrast, DEPOLLUTE is not yet accessible but will probably be in the future. An explanation of the relations appears in the first column. In addition, each relation is classified in a "family" of relations (e.g. related meanings, opposites, other parts of speech and derivatives, lexical combinations). The next section explains how lexical functions (LFs) are used in order to identify, represent, explain and organize these relations.

4. Discovering the lexical structure of specialized subject fields

To my knowledge, the system of lexical functions (LFs) is the only system that allows a systematic encoding of the syntactic, actantial and semantic properties of syntagmatic relations (i.e. collocations) and of the relevant linguistic properties of a large set of paradigmatic relations. For example, assuming that POLLUTE_{1b} has the following actantial structure:

POLLUTE_{1b}: Agent{human} or Cause{activity} ~ Patient{area} with Means{gas}
or: X ~ Y with Z

and that POLLUTANT_1, POLLUTER_1 and POLLUTING_1 are related semantically, each relation will be defined as follows:

$\mathbf{S_1}$(POLLUTE_{1b}) = POLLUTER_1 (the typical noun that expresses the first actant of POLLUTE_{1b})

$\mathbf{S_3}$(POLLUTE_{1b}) = POLLUTANT_1 (the typical noun that expresses the third actant of POLLUTE_{1b})

$\mathbf{A_3}$(POLLUTE_{1b}) = POLLUTING_1 (the adjective that applies to the third actant of POLLUTE_{1b})

Although they were originally developed for the lexicon in general, LFs prove extremely useful for capturing relations between terms that are viewed as lexical units with a meaning that is associated with a special subject field [4]. Table 1 shows how the relations mentioned in Section 1 are represented by means of LFs in French and in English.

When adding entries to the database, lexicographers use an XML editor (oXygen) and insert the information shown in Figure 4 [5]. The related term encoded here is POLLUTING_1 and it appears in the entry POLLUTE_{1b}. For each relation, three levels of explanation are provided: the first two are based on a proposal made by Polguère (2003)

[4] To our knowledge, the first proposal to use LFs to represent lexical relations in specialized knowledge fields was made by Frawley (1988). Since then, LFs have been used in other specialized resources but not as systematically as in the DiCoEnviro and DiCoInfo.

[5] XML tags are labelled in French in all our entries (this is also the case in the Spanish version of the DiCoInfo). However, names for data categories are localized in the Web version of the database.

Keyword	**Related LU (En)**	**LF**	**Explanation (En)**	**Keyword (Fr)**	**Related LU (Fr)**
POLLUTE$_{1b}$	POLLUTE$_{1a}$	ResultConv$_{32}$	The means ~ the patient	POLLUER$_{1b}$	POLLUER$_{1a}$
POLLUTE$_{1b}$	DEPOLLUTE	Anti-2 [6]	Antonym	POLLUER$_{1b}$	DÉPOLLUER
POLLUTE$_{1a}$	POLLUTION$_{1b.1}$	S_0	Noun	POLLUER$_{1a}$	POLLUTION$_{1b.1}$
POLLUTE$_{1a}$	POLLUTION$_{1b.2}$	S_{res}	Result	POLLUER$_{1a}$	POLLUTION$_{1b.2}$
POLLUTE$_{1b}$	POLLUTER$_1$	S_1 [7]	Name for agent	POLLUER$_{1b}$	POLLUEUR$_1$
POLLUTE$_{1a}$	POLLUTANT$_1$	S_1	Name for means	POLLUER$_{1a}$	POLLUANT$_2$
POLLUTE$_{1b}$	POLLUTANT$_1$	S_3	Name for means	POLLUER$_{1b}$	POLLUANT$_1$
POLLUTE$_{1a}$	POLLUTING$_1$	A_1	A means that ~	POLLUER$_{1a}$	POLLUANT$_1$
POLLUTE$_{1b}$	POLLUTING$_1$	A_3	A means that ~	POLLUER$_{1b}$	POLLUANT$_1$
POLLUTE$_{1b}$	CONTAMINATE	QSyn	Near synonym	POLLUER$_{1b}$	CONTAMINER
POLLUT-ING$_1$	GREEN	QAnti	Opposite	POLLUANT$_1$	VERT
POLLUT-ING$_1$	CLEAN$_1$	Anti	Antonym	POLLUANT$_1$	PROPRE$_1$

Table 1. Examples of lexical relations in English and in French along with their explanation

```
<lien-lexical>
    <explication-ra>A <role-ref nom=«Means»/> that <lexie-
  ref/></explication-ra>
    <explication-tt>A <role-ref nom=«Means» lemme=«gas»/> that <lexie-
  ref/></explication-tt>
    <fonction-lexicale>A3</fonction-lexicale>
     <lien identificateur=«polluting» numero-acception= «1» …
        xlink:href=«polluting.xml#_polluting1»>polluting 1</lien>
  </lien-lexical>
```

Fig. 4. Encoding of the related term POLLUTING$_1$ in the entry POLLUTE$_{1b}$

[6] Reversive antonyms are distinguished from other types of antonyms with –2 (added to the Anti LF).

[7] In our database, values for typical instantiations of actants are listed in the data category «Linguistic realizations of actants» and not in «Lexical relations», but the nature of the relation is the same.

to «translate» lexical functions into natural language explanations. In DiCoEnviro, these explanations are divided into two systems: the first one (explication-ra) explains the relation in terms of semantic roles (A **Means** that «key word»); the second one (explication-tt) refers to the typical term (A **gas** that p.). Then the lexical function (**A_3**) is indicated. Finally, a pointer to the related term is given (POLLUTING$_1$).

In addition to the explanatory power of LFs, the system has a number of other advantages (for our own purposes):

— LFs provide a reliable framework for listing and organizing lexical relations between terms. As was briefly mentioned above, lexical relations are classified in "families" that correspond to groups of LFs: related meanings, opposites, types of, collocations, etc. [8]

— LFs remain the same regardless of the language to which terms belong as shown in Table 1. Hence, the same lexical relation observed between English, French and Spanish is encoded with the same LF.

LFs have offen been criticized due to their lack of transparency for users that are not familiar with them. But, as shown in Polguère (2003), they can be paraphrased with natural language formulas (column «Explanation» in Table 1). In the Web version of our database, only explanations are displayed. However, lexicographers formally encode LFs in the entry: this allows us to implement different access methods based on LFs, namely a module for accessing translations of collocations and a module for accessing collocates based on their meaning (L'Homme et al. 2012).

In the process of encoding lexical relations within entries, LFs are also used as a mechanism to locate possible gaps and inconsistencies. This is illustrated in the next three subsections.

4.1. Completeness of the coverage of lexical databases

When completed each entry in the database should contain the entire set of relations a headword shares with other terms or lexical units as well as explanations for these. For example, when writing the entry POLLUTE$_{1b}$, the lexicographer should discover and encode the list of lexical units that are related to this specific meaning of the verb. However, when lexicographers start writing an entry they are likely to miss some relevant relations: many are discovered as the database is enriched.

The system of LFs can guide lexicographers during the encoding process and help them identify possible gaps in their description of lexical relations of a spe-

[8] Collocations themselves are grouped and ordered: collocates that convey a meaning of «change» (e.g. *increase*, *reduce*) appear first, followed by collocates that refer to typical uses.

cific term. For instance, when writing the entry for a verb, lexicographers should ask themselves the following questions:

— Is there a noun that conveys the same meaning, i.e. is there a value for S_0?
— Is there a noun that conveys a meaning of result, i.e. is there a value for S_{res}?
— Is there a noun that refers to the typical $Actant_1$, $Actant_2$, $Actant_n$ of the — verb, i.e. is there a value for S_1, S_2, S_n?
— Is there an adjective that applies to $Actant_1$, $Actant_2$, $Actant_n$ of the verb, i.e. is there a value for A_1, A_2, A_n?
— Is there a near synonym, i.e. a value for QSyn?
— Is there an antonym, i.e. a value for Anti?

If the key word is a noun, questions will be different. If the noun denotes an activity of an event, lexicographers will ask themselves if there is a verb that conveys the same meaning (V_0), if there is a collocate in the form of a support verb ($Oper_i$), etc.

Of course, even this method does not ensure that all possibilities are covered. DiCoEnviro is still under construction and our methodology must be designed in a way that allows us to display entries with relevant however incomplete information.

4.2. Links to other entries

A systematic description of lexical relations within entries is also extremely useful to discover terms that should appear in the word list of a lexical resource. Adding a relation to an entry will often trigger the creation of a new entry. For example, in a previous version of DiCoEnviro, only *pollute* and *pollution* were listed. While describing them, the lexicographer added *pollutant*, *polluting*, *polluter* to the list of lexical relations. The latter three terms were then added to the word list of the resource and their entry was written at a later stage.

When adding a relation to an entry that points to a term that appears in the word list, lexicographers must ensure that references are bidirectional. For example, if DEPOLLUTE appears in the entry of $POLLUTE_{1b}$, then $POLLUTE_{1b}$ must be listed as a relation in the entry for DEPOLLUTE. In addition, the lexicographer must ensure that the description is consistent. Below are some examples of how this is done in our database:

— If B in entry A is the value of **Anti-2** (**Anti-2**($POLLUTE_{1b}$) = DEPOLLUTE), then A in entry B must be the value of **Anti-2** (**Anti-2**(DEPOLLUTE) = $POLLUTE_{1b}$);
— If B in entry A is the value of $\mathbf{S_0}$ ($\mathbf{S_0}$ ($POLLUTE_{1b}$) = $POLLUTION_{1b.1}$), then A in entry B must the value of $\mathbf{V_0}$ ($\mathbf{V_0}$($POLLUTION_{1b.1}$) = $POLLUTE_{1b}$);

— If B in entry A is the value of **S_1** (**S_1**(POLLUTE$_{1b}$) = POLLUTER$_1$), then A in entry B is the value of a syntagmatic LF (**$Fact_2$**(POLLUTER$_1$) = the ~ POLLUTES$_{1b}$);

4.3. Consistency of descriptions of semantically related units

A third aspect of the description of terms that lexicographers check is the consistency of the actantial structures of semantically related units. As was said above, the representation system we use for actantial structures differs from that used in ECL since we state semantic roles and typical terms. When creating entries for semantically related terms, we ensure that semantic roles and typical terms are assigned consistently as shown in the examples below.

POLLUTE$_{1b}$, vt: Agent{human} or Cause{activity} ~ Patient{area} with Means{gas} (*Mining or harvesting these resources can also pollute the soil, water and atmosphere*);

POLLUTING$_1$, adj: ~ Means{gas} (*Emissions of other polluting gases and particles into the atmosphere can also have large effects*);

POLLUTER$_1$, n: Agent{human} is a ~ of Patient{area} (*China and India, the ringleaders in this dispute, are the second and the sixth greatest polluters respectively in terms of CO2*);

POLLUTANT$_1$, n: Means(gas) is a ~ Patient{air} (*Effects of climate change on other air pollutants are less well established*);

POLLUTION$_{1b.1}$, n: ~ of Patient{area} by Agent{human} or Cause{activity} by Means{gas} (*Key human influences include changes in greenhouse gas concentrations, stratospheric ozone depletion, local air pollution and alterations in land use*).

5. Concluding remarks

In this contribution, I argued that lexical functions (LFs) are useful devices to capture and represent lexical structures that can be observed in specialized subject fields. I used examples from the field of the environment, but the same method was applied in a resource that contains terms in the fields of computing and the Internet. I also tried to show how LFs can guide lexicographers' intuitions when identifying new lexical relations. I focused mainly on paradigmatic relations but the observations made in this contribution can easily be extended to syntagmatic relations. For instance, the preparation of the entry for the term ECOSYSTEM$_1$, will inevitably lead to the discovery of relevant collocates such as *degrade* and *protect*. Then new entries will be created for these verbs.

I also showed how LFs can be used by lexicographers when encoding data concretely to help them prevent certain gaps in the list of lexical relations as well as in the word list of a lexical resource. The discovery of potential gaps could be partly automated, for example, ensuring that bidirectional relations are described systematically. Some work in that direction has started in the DiCoInfo and DiCoEnviro projects. Robichaud (2011) developed a tool that displays sets of potential paradigmatic relations between terms graphically and gaps can be more readily identified.

Of course, learning to manipulate LFs and encoding them in resources is extremely time-consuming, but the benefits compensate what could appear at first sight as a disadvantage.

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Bibliography

Cruse 1986 — *Cruse D. A*. Lexical Semantics. Cambridge: Cambridge University Press, 1986.

EcoLexicon 2012 — EcoLexicon. Terminological Knowledge Base (http://ecolexicon.ugr.es/visual/index_en.html). Accessed 7 May 2012.

Faber 2011 — *Faber P.* The dynamics of specialized knowledge representation: Simulational construction or the perception — action interface // Terminology. 2011. 17 (1). P. 9—29.

Fillmore 1982 — *Fillmore C. J.* Frame Semantics // The Linguistic Society of Korea (ed.). Linguistics in the Morning Calm. Seoul: Hanshin, 1982. P. 111—137.

Frawley 1988 — *Frawley W.* 1988. New forms of specialized dictionaries // International Journal of Lexicography. 1988. 1 (3). P. 189—213.

L'Homme 2008 — *L'Homme M. C.* Le DiCoInfo. Méthodologie pour une nouvelle génération de dictionnaires spécialisés // *Traduire. 2008.* 217. P. 78—103.

L'Homme, forthcoming — *L'Homme M. C.* Adding syntactico-semantic information to specialized dictionaries: an application of the FrameNet methodology // *Heid U.* (ed.). *Lexiocographica*. Forthcoming.

L'Homme et al. 2009 — *L'Homme M. C., Laveville M. E.* Le dictionnaire fondamental de l'environnement Dictionnaire élaboré par l'équipe ÉCLECTIK. Montréal: Observatoire de Linguistique Sens-Texte (OLST), 2009. http://olst.ling.umontreal.ca/dicoenviro/manuel-DiCoEnviro.pdf. (Accessed 26 April 2012.)

L'Homme, Pimentel 2012 — *L'Homme M. C., Pimentel J.* Capturing syntactico-semantic regularities among terms: An application of the FrameNet methodology to terminology // Language Resources and Evaluation, LREC 2012. Istanbul, 2012.

L'Homme et al. 2012 — *L'Homme M. C., Robichaud B., Leroyer P.* Encoding collocations in DiCoInfo: From formal to user-friendly representations // *Granger S., Paquot M.* (eds.). Electronic Lexicography. Oxford: Oxford University Press, 2012.

Mel'čuk et al. 1995 — *Mel'čuk I., Clas A., Polguère A*. Introduction à la lexicologie explicative et combinatoire. Louvain-la-Neuve: Duculot / Aupelf — UREF, 1995.

Mel'čuk et al. 1984—1999 — *Mel'čuk I. et al.* Dictionnaire explicatif et combinatoire du français contemporain. Montréal: Presses de l'Université de Montréal, 1984—1999.

Polguère 2003 — *Polguère A*. Collocations et fonctions lexicales: pour un modèle d'apprentissage // *Grossmann F., Tutin A*. (eds.). Les Collocations. Analyse et traitement. Amsterdam: De Werelt, 2003. P. 117—133.

Robichaud 2011 — *Robichaud B*. A Graph Visualization Tool for Terminology Discovery and Assessment // *Boguslavsky I., Wanner L*. (eds.). Proceedings of the Fifth International on Meaning-Text Theory (MTT'11). Barcelona, 2011.

Ruppenhofer et al. 2010 — *Ruppenhofer J., Ellsworth M., Petruck M., Johnson C., Scheffczyk J.* FrameNet II: Extended Theory and Practice. 2010. http://framenet.icsi.berkeley.edu/. (Accessed 8 March 2012.)

UMCP Glossary: Ecology — *UMCP Glossary: Ecology*. http://www.ucmp.berkeley.edu/glossary/gloss5ecol.html. Accessed 7 May 2012.