More Semantic Links in the SIMPLE-CLIPS Database

Nilda Ruimy, Antonio Toral
Istituto di Linguistica Computazionale
Consiglio Nazionale delle Ricerche
Via Moruzzi, 1 – 56124 Pisa - Italy
{nilda.ruimy, antonio.toral}@ilc.cnr.it

Abstract

Notwithstanding its acknowledged richness, the SIMPLE semantic model does not offer the representational vocabulary for encoding some conceptual links holding between events and their participants and among co-participants in events. Although critical for boosting performance in many NLP application tasks, such deep lexical information is therefore only partially encoded in the SIMPLE-CLIPS Italian semantic database. This paper reports on the enrichment of the SIMPLE relation set by some expressive means, namely semantic relations, borrowed from the EuroWordNet model and their implementation in the SIMPLE-CLIPS lexicon. The original situation existing in the database, as to the expression of this type of information is described and the loan descriptive vocabulary presented. Strategies based on the exploitation of the source lexicon data were adopted to induce new information: a wide range of semantic ─ but also syntactic ─ information was investigated for singling out word senses candidate to be linked by the new relations. The lexicon enrichment by 5,000 new relations instantiated so far has therefore been carried out as a largely automated, low-effort and cost-free process, with no heavy human intervention. The redundancy set off by such an extension of information is being addressed by the implementation of inheritance in the SIMPLE-CLIPS database (Del Gratta *et al.*, 2008).

1. Introduction

In the SIMPLE semantic model (Lenci *et al.*, 2000) whose theoretical framework is the Generative Lexicon Theory (Pustejovsky, 1995, 1998, 2001), semantic relations linking word senses play a prominent role and have considerable expressive power. And yet, in our opinion, some conceptual links are still missing in the SIMPLE-CLIPS Italian semantic database which implements this model[1].

A further enrichment of the relation network designed in the framework of the SIMPLE project is therefore being performed with a view to gaining a sharper understanding of the semantic links holding among word senses in a sentence. Such deep lexical information is critical for boosting performance in many NLP application tasks such as sense disambiguation, text understanding, information retrieval, summarization and question answering.

The expressive means to capture the missing links are borrowed from the EuroWordNet (EWN) model (Alonge, 1996; Vossen, 2002) which is implemented in the Italian Wordnet, namely ItalWordNet (IWN) (Roventini et al., 2003).

2. The SIMPLE-CLIPS Database

By 'SIMPLE-CLIPS database', we refer to the semantic level of the four-layered computational lexicon for Italian language PAROLE-SIMPLE-CLIPS (Ruimy et al., 2002). The SIMPLE-CLIPS database consists of 57,000 semantic entries structured in terms of a semantic type system: the SIMPLE-CLIPS ontology[2]. Out of the total number of entries, 28,500 are fully encoded with the whole wealth of mandatory and optional semantic features and relations foreseen by the SIMPLE-CLIPS model; other 28,500 entries bear the main semantic information, namely ontological classification, type defining features and predicative representation[3]. The addition of semantic relations presented in this paper further enriches the set of fully encoded entries.

To express conceptual links, the level of semantic description avails of the SIMPLE relation set whose core is the *Extended Qualia Structure* (EQS). In the EQS, each of the four roles of the original Pustejovsky's *Qualia Structure* (i.e. *Formal, Constitutive, Agentive* and *Telic*) subsumes a set of semantic relations (60 in total) which allow to express fine-grained distinctions both for structuring the information regarding the componential aspect of word meanings and for accurately capturing the nature of the relationships holding among word senses, on both the paradigmatic and syntagmatic axes.

With its four independent hierarchies of relations, the EQS was designed as a flexible structure enabling a revision/extension process without corruption of the whole structure. Both the introduction of new relations in each of the hierarchies and the addition of further subtypes to existing relations were provided for in the design phase of the original model. The ongoing extension of the set of SIMPLE relations in order to account for further links is therefore an unproblematic issue and a licensed task.

[1] The SIMPLE model was slightly enriched in the framework of a follow-up project, the Italian government-funded project '*Corpora e Lessici dell'Italiano Parlato e Scritto*' (CLIPS). From now on, it will therefore be referred to as 'the SIMPLE-CLIPS model'.

[2] http://www.ilc.cnr.it/clips/Ontology.htm

[3] The set of fully encoded entries was developed at ILC while the second one was elaborated by Thamus (http://www.thamus.it/indexeng.html)

3. Rationale of the Initiative

Notwithstanding the acknowledged richness of the SIMPLE-CLIPS model, some semantic relations are still too vaguely expressed or poorly encoded; some can only be represented indirectly while others are inexpressible through lack of appropriate descriptive vocabulary. This is in particular the case of some relevant conceptual links holding between events and their participants and among co-participants in events.

In the current context of the ongoing process towards standardization of lexical description, interoperability of electronic language resources and content interchange, the loan of the missing descriptive vocabulary from the EWN model was deemed a sensible approach. All the more since, though differing in some important respects (Ruimy, 2006)[4], EWN and SIMPLE models present many compatible aspects[5].

The implementation of these new expressive means in the SIMPLE-CLIPS database contributes, in our view, to a further refinement of the SIMPLE-CLIPS model. It results in fact in enhancing the expressiveness of the semantic network and in backing up the informative power of the predicative representation.

The borrowed EWN semantic relations were implemented for Italian in the IWN lexical database ─ though neither extensively nor systematically. The examples provided in section 5, table 1. are taken from this resource.

4. The Descriptive Vocabulary

This section has a twofold aim. It illustrates the EWN relations candidate to be acquired and accounts for the previous situation existing in the SIMPLE-CLIPS model with respect to the expression of similar information.

4.1 Involvement relations

The 'involved' relations, namely 'involved_agent / patient / instrument / location / direction/ result' were designed in the EWN model in order to link 2ndOrderEntities (i.e. static or dynamic situations ─ denoted by nouns and verbs ─ adjectives and adverbs) to arguments realized as 1rst or 3rdOrderEntities (respectively, concrete and abstract entities) and lexicalized within the meaning of the events (Alonge, 1996).

In the SIMPLE-CLIPS database, the only one of these links already existing is the equivalent of the EWN relation 'involved_instrument', namely the constitutive relation 'instrument' which is used to encode typical means (taken in a broad sense).

By contrast, no relation exists to capture the link between an event and its agent (*operare, chirurgo*) [to operate, surgeon] except for those morphologically derived from a verb, e.g. 'agentverb' (*venditore, vendere*) [seller, to sell]. The same holds for events and patients: no link exists between *curare* and *malato* [to treat, patient] since the 'patientverb' relation only links morphologically derived units denoting patients to their base verb, as e.g. (*impiegato, impiegare*) [employee, to employ].

The 'involved_result' relation (*ghiacciare, ghiaccio*) [to freeze, ice] linking resultative verbs and concrete or abstract entities has no equivalent in the SIMPLE-CLIPS database either.

Likewise, the 'involved_location' (*nuotare, acqua*) [to swim, water], 'involved_direction' and subrelations [6] (*sbarcare, nave*) [to disembark, ship] are not foreseen.

4.2 Role relations

The 'role' relations, namely 'role_agent / patient / instrument / location / direction', link 1rst or 3rdOrderEntities to 2ndOrderEntities. Similarly to their counterpart reversed relations 'involved', they are only partially provided for in the SIMPLE model.

The link holding between an agent entity and an event is indeed expressed in the SIMPLE-CLIPS database ─ and, in a sense, in a more fine-grained way ─ by different relations depending on the semantic type they contribute to characterize. For the sub-hierachy of the type 'HUMAN', the relations are the telic ones 'is_the_activity_of' (*venditore, vendere*) [seller, to sell] for the type PROFESSION; 'is_the_ability_of' (*scultore, scolpire*) [sculptor, to sculpt] and 'is_the_habit_of' (*bevitore, bere*) [drinker, to drink] for AGENT_OF_PERSISTENT_ACTIVITY; the agentive ones 'agentive' (*assassino, uccidere*) [murderer, to murder] and 'agentive_ prog' (*studente, studiare*) [student, to study] for AGENT_OF_TEMPORARY_ACTIVITY. For the ANIMAL type hierarchy, the link between an agent and the event it is involved in is expressed by the constitutive relation 'constitutive_ activity' (*cane, abbaiare*) [dog, to bark].

On the contrary, the relationship holding between an entity and the event it is the patient of, e.g.: (*malato, curare*) [patient, to treat] is not accounted for.

The link holding between an instrument and the action it is used for, as well as the relation between a location and its typical function are too vaguely captured in the SIMPLE-CLIPS database via the same relation 'used_for' (*ago, cucire*) [needle, to sew]; 'used_for' (*mattatoio, macellare*) [abattoir, to slaughter]. Such relationships could be more precisely rendered by the EWN relations 'role_instrument' and 'role_location' respectively.

As to 'role_direction' and its subrelations, they have no equivalent in the SIMPLE-CLIPS database[7]. However, for the time being, neither 'involved_direction' nor 'role_direction' will be imported to the SIMPLE-CLIPS model.

[4] The two resources show, for example, a different ontological framework and a different organization of lexical units.

[5] It is worth reminding that EWN was one of the inspiration sources for the SIMPLE model.

[6] 'involved_source_direction' and 'involved_target_direction'.

[7] The information expressed in EWN by both 'involved_direction' and 'role_direction' relations is conveyed in the SIMPLE-CLIPS database ─ though less accurately and systematically ─ by the selectional restrictions of the event's participants, e.g.: Pred_sbarcare_1: arg1{semantic type: VEHICLE; domain: Sea Transport}; Pred_condurre_2: arg2{semantic type: LOCATION}.

4.3 Co-role relations

Co-role relations link together co-participants in an event. Both relation members belong to 1rst or 3rdOrderEntities (Vossen, 2002). The EWN model foresees six different co-role relations 'co_agent_patient', 'co_agent_ instrument', 'co_patient_instrument', 'co_agent_result' 'co_patient_result', 'co_instrument_result' as well as the reverse ones. The 'co_agent_instrument' and 'co_instrument_agent' relations are the only one having an equivalent in the SIMPLE-CLIPS model, namely 'uses' (*violinista, violino*) [violinist, violin] and 'used_by' (*violino, violinista*).

Other types of link, such as 'co_patient_instrument' (*legna, ascia*) [wood, axe]; 'co_agent_patient'; (*insegnante, alunno*) [teacher, pupil]; 'co_agent_result' (*pittore, dipinto*) [painter, painting]; 'co_patient_result' (*cute, tatuaggio*) [skin, tattoo]; 'co_instrument_result' (*fotocamera, fotografia)* [camera, photo] and their reverse relations are not expressed.

5. Imported relations

The table below summarizes the expressive means offered by the two models. As regards the SIMPLE-CLIPS model, it emphasizes on the one hand the widespread existence of relations linking animate or inanimate entities to their inherent activity, function or purpose but, on the other, the almost total lack of links relating events to their participants. The table also highlights the imported relations, which will be illustrated in the next section. Light grey marked EWN relations were imported to the SIMPLE-CLIPS model; dark grey ones totally or partially substituted for overused or underspecified existing expressive means. Uncolored SIMPLE-CLIPS relations were maintained.

EWN/IWN	SIMPLE-CLIPS
role_agent: *doctor, to treat* **role_agent:** *painter, to paint* **role_agent:** *smoker, to smoke* **role_agent:** *killer, to kill* **role_agent:** *pedestrian, to walk* **role_agent:** *bird, to fly*	**is_the_activity_of**: **is_the_ability_of** **is_the_habit_of** **agentive** **agentive_prog** **constitutive_activity**
role_patient: *patient, to treat*	
role_instrument: *gun, to shoot*	**used_for**
role_location: *school, to teach*	**used_for**
role_result: *steam, evaporation*	**resulting_from**
involved_agent: *to teach, teacher*	
involved_patient: *to teach, pupil*	
involved_location: *to swim, water*	
involved_instrument: *to hammer, hammer*	**instrument**
involved_result: *to freeze, ice*	
co_agent_patient: *teacher, pupil*	
co_patient_agent: *pupil, teacher*	
co_agent_instrument: *guitar player, guitar*	**uses**
co_instrument_agent: *guitar, guitar player*	**used_by**
co_patient_instrument: *wood, axe*	
co_instrument_patient: *axe, wood*	
co_agent_result: *painter, painting*	
co_result_agent: *painting, painter*	
co_patient_result: *skin, tattoo*	
co_result_patient: *tattoo, skin*	
co_instrument_result: *camera, photo*	
co_result_instrument: *photo, camera*	

Table 1: Importing EWN relations in SIMPLE-CLIPS DB

6. The Enrichment Process

The extraordinary richness of information of the SIMPLE-CLIPS model and the possibility offered by the lexicon management tool to investigate every single feature of the lexical data in the input lexicon have facilitated to a large extent the enrichment process. The pairs of word senses candidate to a new relation have in fact been automatically identified and extracted, through a weaving of queries and constraints which exploited not only the semantic information of the SIMPLE-CLIPS database but also the one contained in the syntactic layer of the whole PAROLE-SIMPLE-CLIPS lexicon.

Routines were then designed for automating both the insertion of additional links and the modification of existing ones.

In the following, examples concerning some of the imported relations are provided which give a flavour of how candidate entries were spotted and automatically handled.

6.1 Role relations

As observed in section 4.2., the SIMPLE-CLIPS 'used_for' relation, which was originally meant to encode the typical function of an instrument or device, has also been used, during the encoding phase, to express the typical function of a location, in absence of a specific relation. The import of the two new relations, 'role_instrument' and 'role_location', enabled us to differentiate and refine the existing encoding.

For the 'role_instrument' relation, all candidate entries were retrieved i) by constraining the target word sense of the SIMPLE-CLIPS 'instrument' relation to the semantic type INSTRUMENT and inverting the terms of the relation and ii) by constraining the word pairs linked by the 'used_for' relation to a semantic type belonging to the Artifact hierarchy for the first term and to PoS=V for the second one.

On the other hand, candidate entries for 'role_location' were retrieved by constraining the word pairs linked by the 'used_for' relation. The first term was constrained to the semantic types Location, Building or Artifactual_area and the second term to a verbal PoS.

By investigating and constraining existing data in this way, a total number of 1585 'role' relations have been introduced so far.

6.2 Involved relations

Verbs and related deverbal nouns filling the agent role were identified, in the SIMPLE-CLIPS database, through the links holding between a lexicalized predicate and the set of entries sharing such predicate, e.g.:

Pred_diffendere_2:
'Master' link: *difendere* (V)
'AgentNominalization' link: *difensore* (N)
Through the 'AgentNominalization' link, 489 verb-agent role filler pairs were retrieved, which were automatically assigned the 'involved_agent' relation.
Such a relation was also assigned to non deverbal agent nouns (hence, not retrievable through the predicate links) by reversing the terms of the existing SIMPLE-CLIPS relations which are used in the definition of HUMAN and ANIMAL-typed entities and correspond to the EWN 'role_agent', viz. 'is_the_activity_of', 'is_the_ability_of', 'is_the_habit_of', 'agentive', 'agentive_prog' and 'constitutive_ activity' (see section 4.2.), e.g.: 'agentive' (*killer, uccidere*) [killer, to kill] → 'involved_agent' (*uccidere, killer*). In this way, a set of 1239 additional word pairs were handled straightforwardly.
As mentioned in section 4.1., in the SIMPLE-CLIPS database, the typical means (taken in a broad sense) used i) to perform an action; ii) for an event to take place; iii) in a particular domain of application were all encoded using the constitutive relation 'instrument'. The acquisition of the EWN 'involved_instrument' relation has permitted to differentiate the types of means by encoding actions performed through more concrete means (proper instruments and vehicles) with the new relation, e.g.: 'involved_instrument' (*martellare, martello*) [to hammer, hammer], *volare, aeromobile* [to fly, aircraft]; thus dedicating the existing relation to 151 more generic means such as body part, substances etc., e.g.: 'instrument' (*vedere, occhio*) [to see, eye], (*incollare, colla*) [to glue, glue], (*comprare, denaro*) [to buy, money].

6.3 Co-role relations

As to **'co_role' relations**, a very small number of links have been actually encoded so far, just as example types. However, a relevant number of candidate word pairs is being straightforwardly and automatically inferred from the 'involved' relations already instantiated. For example, considering the lexical entry for the event *curare,* the two relations 'involved_agent' (*curare, medico*) [to treat, doctor] and 'involved_patient' (*curare, malato*) [to treat, patient] enabled to infer the 'co_role' relations: co_agent_patient' (*medico, malato*) and 'co_patient_agent' (*malato, medico*).
Likewise, provided the result noun is a deverbal one, 'co_agent_result' and the reverse 'co_result_agent' relations can be automatically encoded by exploiting the 'involved_result' relation and substituting the first term of the relation for the semantic unit linked to the predicate by means of the 'Agent Nominalization' link, e.g.:
'involved_result' (*acquistare, acquisto*) [to buy, purchase]
Pred_acquistare_1:'AgentNominalization': *acquirente*
⇔
'co_agent_result' (*acquirente, acquisto*) [buyer, purchase]

Before the new relations are instantiated, the candidate word pairs obviously undergo manual inspection to discard possible errors imputable to the original encoding. It is worth observing here that exploiting existing data yields the additional benefit of a *de facto* checking of the original lexical resource consistency.
Table 2. provides figures about the new relations instantiated so far.

Relation name	Instantiated links
role_patient	**10**
role_instrument	**1061**
role_location	**514**
involved_agent	**1728**
involved_patient	**16**
involved_location	**507**
involved_instrument	**1132**
involved_result	**66**
co_agent_patient	**7**
co_patient_agent	
co_agent_result	**2**
co_result_agent	
co_instrument_result	**3**
co_result_instrument	

Table 2: New relations instantiated in SIMPLE-CLIPS DB

As illustrated in this section, the enrichment process has been essentially based so far on the exploitation of existing data, in particular on encoded SIMPLE-CLIPS relations, either by restricting their scope or by constraining and inverting their terms.
The instantiation of 5,046 new relations has therefore been carried out as a largely automated, low-effort and cost-free process, with no heavy human intervention.

7. Avoiding redundancy

Clearly, such an extension of information has greatly increased the degree of information redundancy already existing in the SIMPLE-CLIPS database. As a matter of fact, for lack of inheritance computation in this database, every single property of each semantic unit ─ expressed either as features or semantic relations ─ had to be explicitly specified in the corresponding entry, although many of them, shared by a high number of word senses, could have been inherited from their ancestors' entries. The fully encoded set of 28,500 entries originally required, for example, the instantiation of 63,700 semantic relations.
The expression of more than 5,000 new links has clearly determined a further exponential growth of information redundancy. For some word senses ─ such as, for example, high frequency activity verbs encoding the link to their typical agents ─ the size of the enriched entries is such that they are hardly manageable unless the information inheritance enters the picture.
The implementation of inheritance, which was scheduled for the original SIMPLE-CLIPS database and is currently being performed with a view to reducing redundancy and optimizing the lexicon format (Del Gratta et al., 2008) is clearly all the more crucial for the enriched lexicon.

Exploiting inheritance, only those properties that are peculiar of a particular word sense and crucial to capture its very meaning are overtly represented in its lexical entry, while the more generic ones are inherited from its ancestors' entries.

Needless to say, the inheritance of properties is critically dependent on a high-quality encoding and in particular on a consistent instantiation of hyperonymic links. Its implementation required therefore a preliminary phase of 'cleaning' and harmonization of the lexical resource, particularly as regards the 'isa' relation.

In the input lexicon, the inheritance of semantic relations has allowed to prune more than 18% of relations from the descendant entries since they were inherited from their superordinate term entry.

In the enriched version of the lexicon, the positive impact of inheritance computation on the relations number is even more significant.

Let's take, by way of example, the verb *vendere* (to sell), which is linked to 67 word senses such as *fioraio* (florist) , *libraio* (bookseller) or *panettiere* (baker) by means of the 'involved_agent' relation. Among those lexical items are 5 more generic terms, viz. *venditore* (seller), *commesso* (shop assistant), *commerciante* (dealer), *artigiano* (craftsman) and *fabbricante* (producer) to which the other 62 are related as hyponyms. Thanks to the implementation of inheritance, the verb is only related to these 5 generic terms and 62 links are inherited.

Likewise, out of 66 shop-denoting nouns, 60 inherit from their hyperonym *negozio, bottega* or *mercato* the 'role_location' relation whose target is *vendere*.

So, although *vendere* is involved (as source or target term) in 274 semantic relations, only 31 links will be overtly represented while other 243 will be derived by inheritance.

8. Conclusion

The expressive means imported from the EWN/IWN framework in order to model the relationships holding between events and their participants and among co-participants in events are intended to be extensively used in the SIMPLE-CLIPS database. A large number of new links between word senses are in fact being instantiated in the semantic lexicon. These very semantic relations were, by contrast, only scarcely and sporadically instantiated in the ItalWordNet lexical database whereas other semantic links ─ such as the synonymic and taxonomic ones ─ are very largely and consistently encoded.

The work undertaken and illustrated in this paper is therefore in no way a duplication of data that could have been simply imported from another lexical resource; it rather aims to enrich the Italian semantic lexicon with crucial additional information. Besides, the lexicon enrichment is being implemented at virtually no cost.

It has in fact been demonstrated that, to a very large extent, the lexical items candidate to be linked by the new relations were easily identified in the source lexicon by investigating a wide range of data of semantic ─ and also syntactic ─ nature and were then inexpensively captured. In a nutshell, we have reused and manipulated existing, high quality data to induce new information.

The PAROLE-SIMPLE-CLIPS source lexicon, which offers very rich information about single lexical units across various levels of linguistic description was, in our opinion, the ideal frame whereby these newly inserted relations could be profitably exploited, especially in combination with the wealth of already existing information. The last two descriptive layers of the lexicon, in particular, encode in fact outstanding data that characterize the syntactic and semantic behaviours of words, including semantic frames, their syntactic realizations and the link between both levels.

The imported relations obviously further enhance the semantic description of lexical units, by providing additional information and by allowing to restrict the scope of existing, overused relations. They also allow a more in depth view of their syntactic and semantic context. The information provided in the syntactic layer[8], which maps ─ through a network of correlations ─ onto the corresponding information supplied at the semantic level by the argument structure description (i.e. semantic role, ontological restriction and argument type of semantic arguments) is strengthened and backed up by the introduction of these new relations. Actually, the newly acquired information enables to move from the expression of combinatorial possibilities at the ontological level to their specification at the lexical level, e.g.: besides having the following information: (Pred_insegnare_1 (to teach): arg0: [HUMAN], arg1: [DOMAIN], arg2: [HUMAN]), the new one: 'involved_agent' (*insegnare*, *insegnante*) (teacher); 'involved_patient' (*insegnare*, *studente*) (student) further specifies the lexical combinations.

The whole information represents a step forward towards a representation of knowledge *à la* FrameNet. Direct links are in fact established among lemmas belonging to the same semantic frame. Such links supplement the information provided in the SIMPLE argument structure also by extending it to those adjuncts which are part of a semantic scenario and are crucial to the semantics of predicates.

Tables 3 and 4 below illustrate the semantic relations in which the word sense *curare* (to cure, to treat) participates, both as source or target term, in the enriched SIMPLE-CLIPS database, the new relations being marked in bold. In the last column are the corresponding Frame Elements (semantic arguments) of the frame 'Cure' in FrameNet. The relation between 'to treat' and Body_part or Affliction, two FrameNet FEs which are not represented in SIMPLE-CLIPS by semantic relations, are supplied by the selectional restrictions of the second argument of the predicate Pred_curare_1.

[8] i.e. syntactic function, syntagmatic realization, syntactically relevant restrictions and possible optionality of frame elements.

Source semantic unit	Semantic relation	Semantic type of target entry	FrameNet FEs
curare	Isa	ACT	
	Involved_agent	PROFESSION	Healer
	Involved_patient	HUMAN	Patient
	Involved_location	BUILDING	Place (non-core)
	Purpose	PURPOSE_ACT	Motivation (non-core)

Table 3: *curare* as source of semantic relations expressing FrameNet FEs

Target semantic unit	Semantic type of source entry	Semantic relation	FrameNet FEs
curare	PROFESSION	Istheactivityof	Healer
	PURPOSE_ACT	Purpose	Treatment
	SUBSTANCE	Usedfor	Medication
	BUILDING	**RoleLocation**	Place (non-core)
	INSTRUMENT	**RoleInstrument**	Manner (non-core)

Table 4: *curare* as target of semantic relations expressing FrameNet FEs

9. References

Alonge A. ed. (1996). Definition of the links and subsets for verbs, EuroWordNet Project LE2-4003, Deliverable D006, WP4.1, final version, November 1996. http://dienst.isti.cnr.it/Dienst/UI/2.0/Describe/ercim.cnr.ilc/1996-TR-001?tiposearch=cnr&langver=

Del Gratta R., Ruimy N., Toral A., SIMPLE-CLIPS ongoing research: more information with less data by implementing inheritance, LREC 2008, Marrakech, Morocco. *Proceedings.*

Lenci A., Busa F., Ruimy N., Gola E., Monachini M., Calzolari N., Zampolli A. et al. (2000). SIMPLE Linguistic Specifications. LE-SIMPLE (LE4-8346), Deliv. D2.1 & D2.2. ILC and University of Pisa, Pisa, 404 pp. http://www.ub.es/gilcub/SIMPLE/simple.html#Specifications

Pustejovsky J. (1995). *The Generative Lexicon*, The MIT Press, Cambridge, MA.

Pustejovsky J., (1998). Specification of a Top Concept Lattice, ms., Brandeis University.

Pustejovsky J. (2001). Type Construction and the Logic of Concepts, In P. Bouillon and F. Busa (eds.), *The Syntax of Word Meanings*, Cambridge University Press, pp. 91--123.

Roventini A., Alonge, A., Bertagna, F., Calzolari, N., Cancila, J., Girardi, C., Magnini, B., Marinelli, R., Speranza, M., Zampolli, A. (2003). ItalWordNet: building a large semantic database for the automatic treatment of Italian. In A. Zampolli, N. Calzolari, L. Cignoni, (eds.), *Computational Linguistics in Pisa. Linguistica Computazionale*, Special Issue, XVIII-XIX, Pisa-Roma, IEPI. Tomo II, pp. 745--791.

Ruimy N., Monachini M., Distante R., Guazzini E., Molino S., Ulivieri M., Calzolari N., Zampolli A. (2002). CLIPS, A Multil-level Italian Computational Lexicon: a Glimpse to Data. LREC 2002. Las Palmas de Gran Canaria, Spain. *Proceedings*, Volume III, Paris, The European Language Resources Association, pp. 792--79. http://www.ilc.cnr.it/clips/Ruimy_LREC2002.pdf

Ruimy N. (2006). Merging two Ontology-based Lexical Resources. LREC 2006. Genoa, Italy, 24-25-26 May 2006. *Proceedings*, Paris, The European Language Resources Association (ELRA). CD-ROM, pp. 1716--1721. http://www.ilc.cnr.it/clips/Ruimy_LREC2006_1.pdf

Ruimy N. (2007). Enhancing SIMPLE Semantic Relations: A Proposal**.** In Zygmunt Vetulani (ed.), *Proceedings of 3rd Language & Technology Conference*. Fundacja Uniwersytetu im A. Mickiewicza, Poznań, pp. 119--123. http://www.ilc.cnr.it/clips/ltc-84-ruimy.pdf

Vossen P. editor 1998, EuroWordNet: A Multilingual Database with Lexical Semantic Networks, Kluwer Academic Publishers, Dordrecht.

Vossen P. ed. (2002). EuroWordNet General Document, version 3 final, July 2002, Amsterdam: Vrije Universiteit, http://dare.ubvu.vu.nl/bitstream/1871/11116/1/EWNGeneral.pdf