Factors and Features Determining the Inheritance of Semantic Primes between Verbs and Nouns within WordNet

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Abstract

The paper outlines the mechanisms of inheriting semantic content between verbs and nouns as a result of derivational relations. The main factors determining the inheritance are: (1) the semantic class of the verb as represented by the noun; (2) the subcategorisation frame and argument structure of the verb predicate; (3) the derivational relation between the verb and the noun, as well as the resulting semantic relation made explicit through the derivation; (4) hierarchical relations within WordNet.

The paper explores three types of verb-noun prime inheritance relations: (a) universal – not depending on the argument structure, which are eventive or circumstantial; (b) general – specific to classes of verbs, for example agentive or non-agentive; (c) verb-specific – depending on the specific subcategorisation frame of the verb as presented in VerbNet and/or FrameNet. The paper presents a possibility for extended coverage of semantic relations based on information about the argument structure of verbs.

Further, the work focuses on the regularities in the way in which derivationally related nouns inherit semantic characteristics of the predicate. These regularities can be applied for the purposed of predicting derivationally and semantically related synsets within WordNet, as well as for the creation of language specific synsets, for consistency checks and verification.

1. Introduction

The study explores the ways in which the derivationally based semantic relations between a verb and a set of nouns are predetermined by the features of the verb, its semantics, subcategorisation frame and set of arguments. Both nous and verbs within WordNet are classified into semantic classes (defined by their corresponding semantic primes). The nouns inherit certain semantic characteristics from the verb with which they have a derivational relation and we call this process inheritance of semantic primes between verbs and nouns within WordNet. The study does not take into account the direction of derivation (verb derived from a noun or vice versa) but considers the process of inheritance of semantic primes as directed from the predicate to the corresponding nouns.

The observations presented here include examples from Princeton WordNet[1] and the Bulgarian WordNet (BulNet)[2]. The methodology and conclusions are based on generalised semantic features and are thus largely language independent. In addition to the semantic description of verbs and nouns in WordNet based on the semantic primes and the hierarchical organisation of the lexical-semantic network, we also use information about the FrameNet frames and verb arguments lists from VerbNet to the end of studying the inheritance of semantic features and lexical conceptual structures.

[1] https://wordnet.princeton.edu/
[2] http://dcl.bas.bg/bulnet/

Keywords: WordNet, semantic primes, semantic relations, derivation

Section 2 outlines some previous work in the field. Section 3 describes resources and results that have been applied in the study. Factors that determine the inheritance of semantic primes are discussed in section 4, followed by the main results in terms of deduced regularities in the process of inheritance in section 5. The paper concludes with some notes on the application of the research and possible future developments in section 6.

2. Related work

Most attention semantic primes attract with respect to semantic decomposition and interpretation (Goddard and Wierzbicka, 1994; Gomez, 1998; Fähndrich et al., 2014). Extensive classifications of verbs have also been proposed (Wilks, 1987; Levin, 1993; Korhonen, 2002; Van Valin, 2006), which are based on the notion of semantic primes (also called primitives or universals) as generalised concepts.

The purpose of the classification of verbs introduced in WordNet (Fellbaum, 1999a) is to reflects their regular syntactic behavior, including in terms of possible alternations. Additionally, semantic primes contribute to the network of semantic relations by assigning the verb to a semantic class with stable features which are inherited by the hyponym from its hypernym. Some semantic primitives in WordNet are also introduced as relations, e.g. CAUSE.

Recent studies focus on shared semantic features between derivationally related literals within synsets in the context of morphosemantic relations (Fellbaum et al., 2009; Koeva, 2008; Mititelu, 2012). Pala and Hlaváčková (2007) use a limited number of derivational relations between verbs and nouns (agent, patient, instrument, action, property) and consider derivational nests of words around a certain root. Dziob et al. (2017) describe two main types of derivational relations between nouns and verbs – role inclusion (fine-grained into subject, instrument, result, location, object, time) and circumstance.

Research on derivational and morphosemantic relations for Bulgarian has recently been presented by Stoyanova et al. (2013), Leseva et al. (2014), Tarpomanova et al. (2014), Dimitrova et al. (2014), and Leseva et al. (2015). They analyse the semantic information carried by various derivational models. The set of morphosemantic relations used in Princeton WordNet is used and semantic primes of nouns are considered in order to identify inconsistencies with the semantic roles (Leseva et al., 2015).

The topic of cross-POS inheritance of semantic primes and semantic features, in particular between verbs and nouns connected by a derivational relation within WordNet, has rarely been discussed in the literature. Pustejovsky (1991), Pustejovsky (1995), Copestake (1992), among others, discuss lexical inheritance structure which defines how one lexical structure is related to other lexical structures in the lexicon. Inheritance of semantic features from verbs to nouns as presented in this paper is similar to the projective inheritance (Pustejovsky, 1995) since it also relies on linking the conceptual information from syntactic-based realisation of lexical items.

3. Prerequisites

WordNet (Miller, 1995; Fellbaum, 1999b) is a large lexical-semantic resource that groups word senses rather than lexical units into a large network. The individual senses correspond to synonym sets (synsets). WordNet provides multilingual support through a unique identification index. The relational structure of WordNet relies on: (a) conceptual relations such as hypernymy/hyponymy, holonymy/ meronymy, etc.; (b) lexical relations between members of synsets (literals) such as antonymy; (c) derivational relations between literals; (d) morphosemantic relations between verbs and nouns where the derivational relation (at the literal level) reflects a semantic relation (at the synset level). The hierarchical structure of WordNet is based on the relations of hypernymy/hyponymy. The root (top node in the tree) represents the most generalised meaning and its hyponyms down the tree inherit this meaning and make it more specific.

All the verb and noun synsets in Princeton WordNet are classified into a number of language-independent semantic primes. The nouns are categorised into 25 groups, such as noun.act (acts or actions), noun.artifact (man-made objects), noun.person, etc. The verbs fall into 15 groups, such as verb.body (verbs of grooming, dressing and bodily care), verb.change (verbs of size, temperature change, intensifying, etc.), verb.cognition (verbs of mental operations), as defined in the PWN lexicographer

files[3]. Semantic primes within WordNet are aimed to represent universal semantic-conceptual categories of verbs and nouns which provide a generalised description of their semantic features and syntactic behavior.

Morphosemantic relations link verb–noun pairs of synsets that contain derivationally related literals. For the purposes of this study, we do not consider the direction of the derivation (source and derivative) and assume that derivational relations are symmetric. As semantic and morphosemantic relations refer to concepts, they are universal, and such a relation must hold between the relevant concepts in any language, regardless of whether it is morphologically expressed or not. This has enabled the automatic transfer of the relations to other languages, e.g. from Princeton WordNet to Bulnet (Koeva, 2008; Stoyanova et al., 2013; Leseva et al., 2014; Leseva et al., 2015).

We use the inventory of morphosemantic relations from the Princeton WordNet 3.0. morphosemantic database[4]: Agent, By-means-of (inanimate Agents or Causes but also Means and possibly other relations), Instrument, Material, Body-part, Uses (intended purpose or function), Vehicle (means of transportation), Location, Result, State, Undergoer, Destination, Property, and Event (linking a verb to its eventive nominalisation).

On the other hand, VerbNet verb classes and FrameNet frames provide more detailed features for the classification of verbs with respect to their semantic and syntactic properties and function. Both resources can be used to group verbs into semantic classes of different granularity and different level of generalisation as part of a hierarchical organisation.

FrameNet (Baker et al., 1998) represents conceptual structures called frames which describe particular types of objects, situations, etc. along with their participants, or frame elements (Ruppenhofer et al., 2016). FrameNet is internally hierarchically structured using a set of frame-to-frame relations, in particular *Inheritance* – the child frame is a subtype of the parent frame, e.g. *Change_position_on_a_scale* inherits from *Event* and is inherited by *Change_of_temperature*.

The VerbNet (Kipper-Schuler, 2005; Kipper et al., 2008) classes represent formations of verbs with shared semantic and syntactic properties and behaviour. They are organised in a shallow hierarchy grouping classes into generalised types such as *Verbs of Creation and Transformation*, *Verbs of Communication*, *Verbs of Social Interactions*, etc.

However, linking VerbNet and FrameNet to WordNet is not straightforward. There are two main types of mappings that have already been applied on the lexical resources discussed herein: (a) lexical mapping – lexical units (from one resource) have been assigned categories from another resource; and (b) structural mapping – classification categories from one resources have been aligned to categories from another. Previous efforts at linking these resources include Shi and Mihalcea (2005), Baker and Fellbaum (2009), Laparra and Rigau (2010), as well as the SemLink project[5] and WordFrameNet[6]. These result in limited coverage of WordNet synsets and further efforts are required in order to improve the mappings. More details on linking WordNet, VerbNet and FrameNet are presented by Leseva et al. (2018).

4. Factors determining the inheritance of semantic primes between verbs and nouns

This section outlines the process of analysis of derivation and the resulting semantic relations between the verb and a set of derivationally related nouns. We briefly discuss the types of inheritance (as reflected by the morphosemantic relations adopted in Princeton WordNet). These, coupled with the semantic and syntactic features of a given verb, play a significant role in determining the semantic primes of the associated nouns.

4.1. Features of the verbs

The following features of the description of the verbs are essential for the analysis of inheritance:

[3] https://wordnet.princeton.edu/man/lexnames.5WN.html
[4] http://wordnetcode.princeton.edu/standoff-files/morphosemantic-links.xls
[5] https://verbs.colorado.edu/semlink/
[6] http://adimen.si.ehu.es/web/WordFrameNet

(a) Semantic prime of the verb in WordNet. The semantic prime describes the abstract semantic category of the verb. We use the following list of verb semantic primes: verb.body, verb.change, verb.cognition, verb.com-munication, verb.competition, verb.consumption, verb.contact, verb.creation, verb.emotion, verb. motion, verb.perception, verb.possession, verb.social, verb.stative, verb.weather.

(b) Semantic frame from FrameNet. Each frame is described by the following components: a general definition of the frame; a list of frame elements (core, peripheral and extra-thematic elements of the frame) corresponding to arguments or adjuncts, which may also contain relevant semantic restrictions; a set of relations to other frames in FrameNet (in their entirety these frame-to-frame relations establish the internal structure of FrameNet).

(c) The VerbNet class and the set of arguments associated with it. The description provided by the class and the superclass in VerbNet partially overlaps with the information encoded in the semantic frame from FrameNet. We enrich the descriptions from the two sources by combining them. A VerbNet class is typically associated with more than one syntactic frame which shows possible syntactic variations of the usage of the verb.

(d) Known morphosemantic relations in WordNet. When we analyse the set of possible derivational and semantic relations, we consider the ones that have already been encoded. These are also useful in making observations about the frequency of pairs of semantic primes and corresponding morphosemantic relations.

(e) Hierarchical relations within WordNet. The structure of WordNet can be helpful since the hyponyms inherit the semantic properties of the hypernym (a more concrete concept inherits the properties of a more general one and adds on a more specific meaning).

The semantic primes of verbs impose restrictions on the possible semantic roles and the semantic frame of the verb. For example, verb.weather or verb.phenomenon are not compatible with the frame element or the semantic role Agent since the meaning of the verb implies the action of natural forces.

4.2. Semantic primes of the nouns

We work with the following set of noun semantic primes: noun.act, noun.animal, noun.artifact, noun.attribute, noun.body, noun.cognition, noun.communication, noun.event, noun.feeling, noun.food, noun. group, noun.location, noun.person, noun.phenomenon, noun.possession, noun.process, noun.relation, noun.shape, noun.state, noun.time, noun.vehicle. Also, the generalised label noun.Tops is used to signify top-level (root) abstract nouns (e.g. *entity*) which are not relevant for the present analysis.

There are various restrictions imposed on the possible relations and verb arguments which stem from the noun semantic class as expressed by the semantic prime. For example, Agent is associated with persons (noun.person), social entities, e.g., organisations (noun.group) and animals (noun.animal) that are capable of acting. Instruments are concrete man-made objects (noun.artifact), but nouns with the prime noun.communication may also function as instruments, e.g. дебъгър:1 – *debugger:1 (n)*.

Inanimate causes (Fellbaum et al., 2009) – non-living (and non-volitional) entities that bring about a certain effect or result – are expressed by the morphosemantic relations Body-part, Material, Vehicle, and By-means-of. The relation Body-part may be an inanimate cause that is an inalienable part of an Actor and is expressed by nouns with the prime noun.body (rarely noun.animal or noun.plant). The relation Material denotes a subclass of inanimate causes – substances that may bring about a certain effect, e.g. *inhibitor:1* (a substance that retards or stops an activity). Beside noun.substance, noun.artifacts (synthetic substances or products) also qualify for the relation, e.g. *depilatory:2* (hair removal cosmetics). The relation Vehicle represents a subclass of artifacts (means of transportation); consequently the respective synsets have the prime noun.artifact and are generally hyponyms of the synset *conveyance:3; transport:8*. Inanimate causes whose semantics differ from that of the other three relations, are assigned the generic relation By-means-of, e.g. *geyser:2* ('a spring that discharges hot water and steam') (noun.object), etc.

The relation Event denotes processual nominalisation and involves nouns such as noun.act, noun.event, noun.phenomenon, and rules out concrete entities such as animate beings, natural (noun.object) and man-made (noun.artifact) objects, etc. The relation State denotes abstract entities such as feelings, cognitive states, etc. Undergoer is assigned to entities which are affected by the event or state. The relation Result involves entities that are produced or have come to existence as a result of the event or state. Property signifies various attributes and qualities. These relations involve nouns with various primes.

The relation Location denotes a concrete (natural or man-made) or an abstract location where an event takes place and therefore relates verbs with nouns with various primes – noun.location, but also noun.object, noun.plant, noun.artifact, noun.cognition, etc. The relation Destination is associated with the primes noun.person, noun.location and noun.artifact, which corresponds to two distinct interpretations of the relation – Recipient (noun.person) and Goal (noun.artifact, noun.location). The relation Uses denotes a function or purpose, e.g. *lipstick:1 – lipstick:3*. The relation allows nouns with various primes, both concrete and abstract.

4.3. Types of inheritance

Derivational relations between verbs and nouns (regardless of the direction of derivation) result in semantic relations which depend on the semantic characteristics of the verb. We analyse the typology of derivationally-based inheritance of semantic properties as a factor for the realisation of the semantic relations.

We recognise three types of verb-to-noun inheritance of semantic characteristics:

(1) **Universal inheritance** potentially can apply to all verbs regardless of their semantic prime and argument structure. However, not all verbs exhibit these relations: firstly, it is a matter of linguistic choice whether to lexicalise certain concepts, and secondly, there may be no derivational relation even if a semantic relation is present.

Universal inheritance is carried out by two types of relations: (1) Eventive relations such as EVENT, STATE or PROCESS – nominalisations of the action, state or process signified by the verb, e.g. EVENT готвя:2 */ cook:1 (v)* – готвене:1 */ cooking:1 (n)*, STATE завиждам:1 */ envy:2 (v)* – завист:1 */ envy:1 (n)*, etc.; and (2) circumstantial relations such as LOCATION, e.g. печатам:1 */ print:1 (v)* – печатница:1 */ printing press:1 (n)*; TIME, e.g. вечерям:1 */ dine:2 (v)* – вечер:3 */ evening:1 (n)*; ATTRIBUTE/ABSTRACT, e.g. издържам:1 */ endure:1 (v)* – издръжливост:4 */ endurance:1 (n)*; etc.

Cases where LOCATION or TIME are part of the subcategorisation frame of the verb, e.g. LOCATION лагерувам:1 */ camp:4 (v)* – лагер:6 */ camp:6 (n)* (noun.location), are not regarded as universal but as verb-specific (see below).

(2) **General inheritance** is determined from the verb's membership to the general semantic class defined by its semantic prime. The properties of the semantic class often influence the set of possible arguments of the verb and thus, the set of semantic relations that can be manifested through a derivational relation.

General inheritance mostly refers to the division between agentive and non-agentive verbs. Some classes, such as verb.cognition, verb.possession, verb.consumption, associate with an AGENT, e.g. продавам:5 */ sell:4 (v)* – продавач:1 */ seller:1 (n)*, while other classes, such as verb.weather, associate with an inanimate ACTOR, e.g. гърмя:6 */ thunder:4 (v)* – гръмотевица:1 */ thunderbolt:2 (n)*. There are also verb classes whose members can take either an animate or an inanimate subject. However, for a better classification of verbs with a view to their syntactic behavior, these classes need to be subdivided into relevant subcategories that reflect these differences.

General inheritance also has to do with the division between causative and inchoative verbs. Analysis of material from WordNet shows that large verb groupings determined by a common semantic prime contain both causative and inchoative members, e.g. the prime verb.change is assigned to both превръщам:3 */ convert:5 (v)* and превръщам се:2 */ convert:1 (v)*, and even that causative

and inchoative verbs may be found in a single synset, e.g. *blacken:1 (v) 'make or become black'*. Clearly, a more finely grained classification of verbs with respect to their syntactic behavior will enforce a clear-cut distinction between these two types of verbs since they exhibit diametrically different semantic relations and inheritance capabilities.

It can also be possible to introduce further granularity of verb classes with respect to the semantic relations of RESULT (resultative verbs as part of semantic classes such as verb.change or verb.perception). Another relation is INSTRUMENT / BY_MEANS_OF / USES where a distinction can be made between concrete verbs of actions such as verb.body or verb.contact, which can involve instruments, unlike abstract verbs such as verb.cognition or verb.communication, which will more likely be associated with BY_MEANS_OF. However, these categories need further analysis and consideration in order to provide a clear-cut classification.

(3) **Verb-specific inheritance** depends on the semantic frame and the set of arguments of the particular verb. This type of inheritance can be influenced by the hierarchical relations within WordNet, e.g. the frame of the direct hypernym of the verb synset.

For example, the verb кърмя:1 */ breastfeed:1 (v)* realises universal inheritance through the semantic relation of EVENT кърмене:2 */ breast feeding:1 (n)* and general inheritance by being an agentive verb of the class verb.consumption through the semantic relation of AGENT кърмачка *(not in WordNet) 'breastfeeding mum' (n)*. In addition, the verb has arguments that are inherited through the specific meaning which determines its membership to the VerbNet class feeding-39.7 (Verbs of Ingesting): Recipient (+animate), which is realised through the semantic relation of BENEFICIENT кърмаче:1 */ nursling:1 (n)*, and Theme (+comestible) which is realised through BY_MEANS_OF кърма:2 */ milk:4 (n)*.

4.4. Potential extended coverage of semantic relations of verb synsets

The process of gradually extending the number of possible semantic relations of verbs is also illustrated in Figures 1–3. Figure 1 shows the verb завиждам:1 */ envy:2 (v)* with its single derivationally related counterpart in WordNet, the noun завист:1 */ envy:1 (n)*, which exhibits the morphosemantic relation of STATE. Further, we extend the number of potential relations by considering the different sources of relations (Figure 2) – the universal eventive relation has been saturated, but it is potentially possible to have some circumstantial relations such as ATTRIBUTE. The verb belongs to the class verb.feeling which entails an animate Experiencer. The verb belongs to the VerbNet class admire-31.2 (Psych Verbs) which can have arguments such as Stimulus, Experiencer (+animate) and Attribute. Figure 3 shows that some of these potential relations have been realised.

Relations can either be: (a) lexicalised, presented by a synset in WordNet and encoded with explicit morphosemantic relation to the verb (e.g. STATE завист:1 */ envy:1 (n)*); (b) lexicalised, presented by a synset in WordNet, but not encoded with a morphosemantic relation to the verb (e.g.); (c) lexicalised but not present in WordNet (e.g. EXPERIENCER завистник, завистливец *'envious person' (n)*); or (d) not be lexicalised in a given language (e.g. in Bulgarian, STIMULUS обект на завист *'object of envy' (n)*).

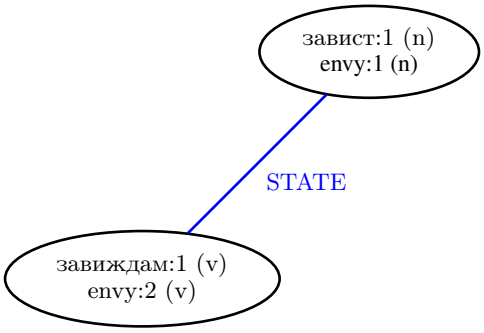

Figure 1: Verb synset connected to a set of noun synsets via morphosemantic relations in WordNet.

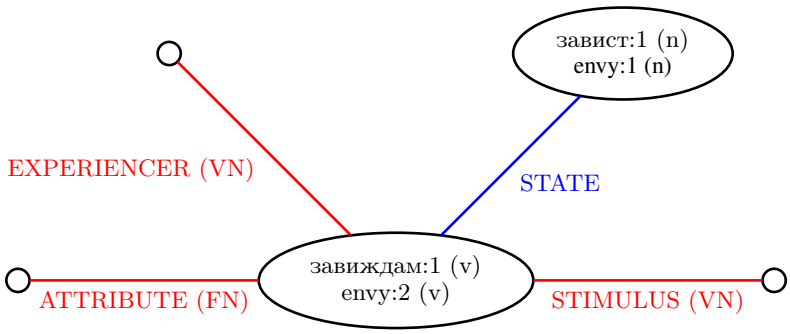

Figure 2: Extending the set of potential semantic relations using universal, general and verb-specific inheritance (non-exhaustive). Source: VN – VerbNet; FN – FrameNet.

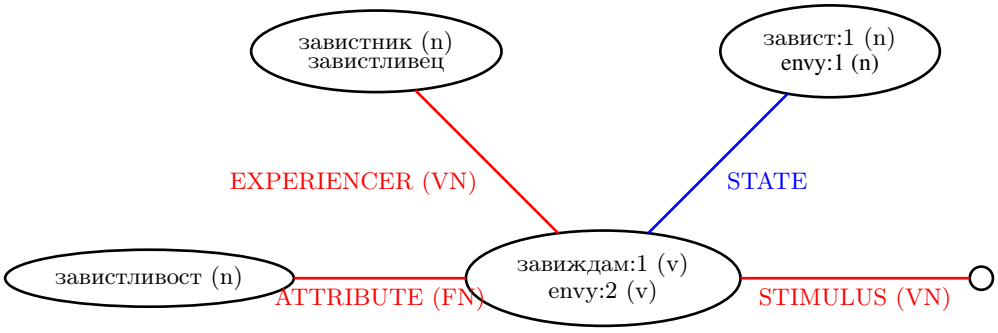

Figure 3: Filling (some of) the potential semantic relations slots (non-exhaustive).

5. Regularities in the inheritance of semantic primes

The main result of the study presented in the paper consists of discovering regularities in the process of inheriting semantic features from verbs to nouns as exhibited through derivational (and consequently) semantic relations.

Initial observations are performed on the morphosemantic relations already present in BulNet. The data are presented in the following format: for each pair <Verb_sem_prime,Morphosem_relation> we find all corresponding Noun_sem_prime (NSP) values with their respective frequencies within WordNet. The data show that within each verb semantic class, depending on the relation, there are a limited number of dominating noun semantic primes, while others are underrepresented either because they show rare cases or because they are due to errors or inconsistencies in the semantic prime assignments.

Table 1 shows the distribution of relations across verbs in BulNet, and the verb primes the highest percentage of which enter this relation. For certain relations reliable conclusions cannot be drawn due to the limited amount of data and these are not presented in the table. Moreover, the last column of Table 1 shows the potential extended coverage obtained by the method in section 4.4. Further, the coverage can be extended by introducing a more fine-grained classification of semantic relations aligning them to the thematic roles as presented in VerbNet and FrameNet, e.g. introducing the subrelation *Product* within *Result*, or *Material* within *By_Means_of*, etc. This will complement the semantic description of verbs within WordNet and will facilitate further investigation of semantic inheritance.

Table 2 shows the results from the observations on the most common (universal) relation, EVENT, which is realised for 42% of the verbs in WordNet. The distribution of some semantic primes follow a similar pattern being dominated by a small number of primes: AGENT (where all verb categories are dominated by noun.person), INSTRUMENT (dominated largely by noun. artifact), LOCATION (dominated by noun.location and noun.artifact), STATE (dominated largely by noun.state with the exception of verb.emotion dominated by noun.feeling and verb.cognition dominated by noun.cognition). More varied is the distribution of relations such as RESULT (Table 3), BY_MEANS_OF, USES, UNDERGOER, which result in more diverse set of noun semantic primes.

Semantic relation	Coverage across all verb synsets	Most coverage among the following verb primes	Potential extended coverage
Event	42%	verb.communication (67%) verb.perception (65%) verb.social (63%)	65%
Agent	16%	verb.social (33%) verb.competition (28%) verb.communication (28%)	35%
Result	8%	verb.creation (25%) verb.change (14%) verb.contact (12%)	14%
By_Means_of	6.5%	verb.communication (12%) verb.emotion (11%) verb.cognition (10%)	6.5%
Instrument	4.5%	verb.contact (16%) verb.creation (6%) verb.change (5%)	9%
State	3%	verb.emotion (30%) verb.cognition (6%) verb.stative (5%)	3%
Location	2%	verb.motion (4%) verb.stative (4%) verb.contact (3%)	6%

Table 1: Distribution of semantic relations across WordNet (as percentage of verb synsets) and the verb semantic primes for which the highest coverage of the relation occurs. Last column shows potential extended coverage obtained by the method.

Verb_semantic_prime	Number of different NSPs	Predominant primes	Coverage
verb.change	13	noun.act noun.process noun.event	83.8%
verb.cognition	12	noun.act noun.cognition	77.3%
verb.communication	13	noun.communication noun.act	82.8%
verb.consumption	11	noun.act	70.7%
verb.contact	11	noun.act noun.event	86.1%
verb.emotion	8	noun.feeling noun.act	70.0%
verb.motion	12	noun.motion noun.act noun.event	85.1%
verb.weather	7	noun.phenomenon noun.event noun.process	66.0%

Table 2: Distribution of resulting noun semantic primes from the EVENT relation across verb semantic primes (non-exhaustive). In the 3rd column the most frequent noun primes are listed corresponding to each verb prime which accumulatively account for over $2/3$ of the cases.

Verb_semantic_prime	Number of different NSPs	Predominant primes	Coverage
verb.creation	15	noun.artifact, noun.communication, noun.cognition, noun.attribute, noun.food	77.2%
verb.change	20	noun.attribute, noun.substance, noun.object, noun.state, noun.food, noun.shape, noun.communication	71.7%
verb.contact	16	noun.artifact, noun.shape noun.object, noun.attribute noun.group	70.3%

Table 3: Distribution of noun semantic primes from the RESULT relation across verb semantic primes (non-exhaustive, for demonstration purposes only) demonstrating a variety of noun primes with no clear dominance.

These observations confirm the need for further refining of the semantic relations in order to capture better the variety of arising inheritance between a verb and the set of derivationally related nouns. By introducing subrelations such as BY_MEANS_OF_ACTOR, e.g. облекчавам:3 */ palliate:1 (v)* – успокоително:2 */ palliative:2 (n)*, BY_MEANS_OF_INSTRUMENT, e.g. пека на скара:1 */ grill:1 (v)* – скара */ grill:3 (n)*, this will lead to more consistent results. Moreover, it will allow further refining of inheritance within complex semantic primes such as noun.artifact or noun.communication.

6. Applications and further development

The research presented in this paper can be applied for the description of language-specific synsets in WordNet which at present are not part of the semantic classes. Moreover, as mentioned above, a more detailed classification of verbs and verb primes within WordNet will be beneficial for distinguishing groups of verbs with distinct syntactic features, such as causative and inchoative verbs, personal and impersonal verbs, etc. An improved mapping of VerbNet classes and FrameNet frames to WordNet synsets will be essential in obtaining more data and performing further analyses.

The results of the study can be used for consistency checks and verification of existing semantic relations. Further analysis is needed in order to distinguish rare but regular cases of inheritance from inconsistencies and mistakes, based on the semantic frames and the semantic and syntactactic properties of both the verb and the noun, as well their respective place in the WordNet hierarchy and the relations with other synsets.

One of the most significant applications of the results is in extending WordNet with new semantic relations stemming from the argument structure of verb predicates. Correspondence between verb semantic primes and noun semantic primes in a derivational relation can help limit the scope of the search for possible new relations which will significantly improve the quality of automatic identification of relations. Further, the detailed classifications will be beneficial in identifying and defining new relations that have not been considered before, and may be used to further fine-grain the scope of relations and to enhance WordNet with richer semantic description.

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