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SEMANTIC RELATIONS AMONG NOUNS IN POLISH WORDNET GROUNDED IN LEXICOGRAPHIC AND SEMANTIC TRADITION

Abstract

The paper describes a system of lexico-semantic relations proposed for the nominal part of plWordNet 2.0 — the largest Polish wordnet. We briefly introduce a wordnet as a large electronic thesaurus. We discuss sixteen nominal relations together with many sub-types proposed for plWordNet 2.0. Each relation is based on linguistic intuition and supported by a set of tests which facilitate its identification. There are two main groups: pure lexico-semantic relations and semantic-derivational relations.

Keywords: wordnet, lexico-semantic relations, nouns, plWordNet, Polish WordNet, derivational relations.

1. Introduction

There was no publicly available *wordnet*[1] for Polish before the development of plWordNet began in October 2005. Soon thereafter an early version became accessible via Internet. Work on plWordNet has continued unabated. At present, plWordNet with about 65 000 *lexical units*[2] (LU) described has become one of the

[1]A wordnet is a large electronic thesaurus whose construction follows the main design principles of Princeton WordNet (Fellbaum, 1998). Wordnets have been constructed for more than 50 languages, including all most widely used ones. A large wordnet is a very useful language resource for Natural Language Processing and is often included among so-called basic language resources.

[2]A lexical unit is a pair: *lemma* and one of the *senses* represented across different occurrences of this lemma in language utterances. In a wordnet, we do not make any assumptions on the nature of the senses. A lemma here is understood, a little technically, as a morphological word-form selected as a representative of the whole set of word forms of the same grammatical class.

largest wordnets in the world. Such large scale of a wordnet is its very required property, because wordnets are used as a basic lexical semantic resource in Natural Language Processing. The vast majority of LUs are nouns; this conforms to the needs of the intended applications of plWordNet. The verbal and adjectival parts also grow gradually.

Lexico-semantic relations are a key design consideration for the structure of a wordnet — a network of LUs. LUs are the basic building blocks, and the network of relations is the only means of defining the meanings of LUs in plWordNet.[3] From the lexicographic point of view, linking is recognized as one of the most important characteristics of an electronic dictionary (Svensén 2009: 443). In the perspective of structuralism, the vocabulary of a given language constitutes a system (McCarthy 2003: 76). Although de Saussure's ideas are hard to implement, the very need is to describe words in the light of paradigmatic and syntagmatic relations. In this paper we present nominal lexico-semantic relations of the Polish Wordnet in the perspective of general linguistics and traditional lexicography. We will show that new types of relations introduced in the nominal part of plWordNet 2.0 are well grounded in both disciplines.

2. Overview of the plWordNet Nominal Relations

Due to limited funding, plWordNet 1.0 was planned as a wordnet of a very moderate size, delivering the basic description of the most frequent Polish lemmas[4]. Thus the set of lexico-semantic relations of plWordNet 1.0 was restricted to the most common wordnet relations. In the case of plWordNet 2.0 our goals are much more ambitious. We do not only want to achieve a wordnet very large when measured in the number of LUs. We also aim to construct a rich description of the Polish system of lexical meanings, still based on the relational paradigm, which is in some way useful for language processing. As a result, several new relations have been introduced, and the existing system of relations has been revised.

The system of lexico-semantic relations of plWordNet 2.0 has been built as a direct extension of the plWordNet 1.0 system. A brief comparison of both systems of lexico-semantic relations is presented below. Definitions of all relations have been revised but the additions have been concentrated mainly in the area of those relations which are formally expressed via derivational relations. The relation system must be perceived as a whole, so in the following sections we will discus the present state of all relation definitions.

Nominal relations of plWordNet 1.0:
(in brackets — number of relations in December 2010)

– synonymy[5]: 3 186 (8 783),
– hyponymy/ hypernymy*: 12 150 (38 518),

[3]For practical purposes we distinguish lexical unit relations and synset relations. The latter occur between lexical units grouped into synsets, the former link directly two lexical units.

[4]LUs cannot be automatically counted in a corpus because of lexical meaning ambiguity and lack of robust word sense disambiguation tools for Polish.

[5]The number of synsets with more than two LUs.

– meronymy + holonymy*: 3 017 (12 582),
– antonymy$^{\Diamond}$: 1 212 (2 491),
– converseness$^{\Diamond}$: 35 (133),
– fuzzynymy$^{\Diamond}$: 1 107 (1 496),
– relatedness$^{\Diamond}$: 981 (871),
– pertainymy$^{\Diamond}$: 1 469 (1 025).

New nominal relations in plWordNet (December 2010):
– inter-register synonymy*: 2 289,
– taxonomic meronymy + taxonomic holonymy*: 246,
– type / instance of*: 33,
– cross-categorial synonymy$^{\Diamond}$: 1 643,
– complementary antonymy (i.e. complementary opposition) $^{\Diamond}$: 69,
– real antonymy, gradable antonymy (gradable opposition) $^{\Diamond}$: 137,
– „role" relation$^{\Diamond}$: 1 253,
– „state", „feature" bearer / „state", „feature" $^{\Diamond}$: 109,
– femininity$^{\Diamond}$: 1 038,
– markedness$^{\Diamond}$: 1 364,
– inhabitant$^{\Diamond}$: 124,
– derivationality$^{\Diamond}$: 544.

* – synset relations
$^{\Diamond}$ – lexical unit relations

For the sake of presentation clarity, the relations can be divided into two main groups:

1. *pure lexico-semantic relations* which are not primarily and obligatorily expressed via *derivational relations*,
2. *semantic-derivational relations* for which the primary vehicle is an obligatory formal derivational association between word forms representing LUs from the relation instance (a pair).

The above distinction is mainly based on the presence or absence of a formal derivational link in the background, but we do not exclude the situation in which the relations of the second group are also applied to LU pairs which are derivationally linked. In the following sections we will discuss both groups of relations.

3. Pure semantic relations

Relations of this group are identified exclusively by semantic criteria. LU word forms do not deliver, in general, any clues to support recognition of their relation. Most relations identified in plWordNet are well grounded in the linguistic and lexicographic tradition, but also often present in wordnets and traceable back to

Princeton WordNet (Fellbaum 1998) — the first wordnet ever constructed. WordNet is focused more on psychological premises, but its structure refers to the relations identified in linguistics as language markers of conceptual relations between concepts lexicalised via particular LUs.

3.1. Similarity relations

Several forms of meaning similarity of nominal LU pairs have been named in the linguistic tradition, e.g.: synonymy, near synonymy and hyponymy. What they share in common is some ability to be used exchangeably across different contexts of use. What differentiates them are conditions imposed on their exchangeability among contexts of use.

3.1.1. Synonymy

From the lexicographic point of view, synonyms occupy a significant position in definitions of word meanings (Svensén 2009: 240–1). They are traditionally attached to intentional[6] definitions; in cumulative synonym definitions they are even the main means of a word's semantic characterization (Svensén 2009: 250).

Synonymy is crucial for the idea of WordNet as a network of *synsets* linked by semantic relations. Typically, a synset is only vaguely defined as a set of near synonyms assumed to "lexicalise" some shared concept — see the discussion in (Piasecki *et. al.* 2009). It is worth emphasizing at the very beginning that WordNet has never been a network of relations defined only over synsets, because relations defined directly on the set of LUs were always present. Moreover, relations introduced in WordNet for synsets have been clearly motivated by lexico-semantic relations (of the same name) used in linguistics.

In plWordNet we decided to adopt a unified model. All relations are defined at the level of LUs, see (Derwojedowa *et. al.* 2008, Piasecki *et. al.* 2009).

WordNet, interpreted as a thesaurus, is often used also as source of sets of synonyms, so the proper identification of synonymy is very important for its construction. Here we face a well known problem: there are many types of synonyms and the term „synonymy" is defined in many ways (Lyons 1995b: 60–1). The most important division is that of absolute synonyms and partial synonyms (or near synonyms) (Gouws 1996: 118–120; cf. more specific Lyons' typology — Lyons 1995b: 60–3). In lexicography three major aspects of the word meaning are commonly distinguished, namely: (1) *descriptive meaning*, (2) *connotative meaning*, (3) *pragmatic characteristics* (Svensén 2009: 214–5). The difference between absolute and partial synonyms lies in the connotative meaning and pragmatic characteristics:

> «Absolute synonyms do not only have the same denotation but also the same connotation and similar stylistic values. They are items that can be used in the same register without loss of communicative success» (...) (Gouws 1996: 119; cf. Sterkenburg 2003: 389).

[6]The intentional analysis consists in describing *genus proximum* and *differentia specifica* of a particular word (Svensén 2009: 218–9).

Although absolute synonymy is very rare, the lexicon contains numerous synonyms of limited substitutability. These items are better called partial (near) synonyms. The defining characteristic of partial synonymy is the contextually constrained substitutability (Gouws 1996: 119–20). Synonymy does not link *lexemes* (with an exception of absolute synonymy (Lyons 1995b: 60–61) but particular senses of polysemous lexemes (Gouws 1996: 120), i.e. LUs in the terminology used here.

Table 1. Absolute and near synonyms (Svensén 2009: 214–5)

	dimensions of meaning	absolute, complete synonyms	near, partial synonyms
(1)	descriptive meaning (denotation)	+	+
(2)	connotative meaning (connotation)	+	− / +
(3)	pragmatic characteristics (stylistic markedness)	+	− / +

Synonymy is a fundamental relation for most wordnets: it is used as a basis for identifying synsets. Princeton WordNet calls synonymy «the basic semantic relation»; one of the criteria is interchangeability of words in some contexts (Miller 1998: 23–4; Cruse 2002: 489).

We avoid defining synonymy directly in plWordNet. Instead, synonymy is defined by synsets and synsets are determined by the structure of selected wordnet relations. Two nominal LUs are synonymous, i.e. they belong to the same synset, if they share the same hyponyms/hypernyms and meronyms/holonyms, thus they are located in the same area of the hypernymy graph (Piasecki *et. al.* 2009). Only LUs sharing links of these relations can be grouped into one synset. This is the basic rule of constructing a synset in plWordNet. In addition to structural clues, linguists are supported in synset construction by substitution tests defined for plWordNet synonymy and based on the idea of interpreting synonymy as mutual hyponymy (Piasecki *et al.* 2009: 23–4; cf. test I on p. 185):

- *Jeśli jest X-em, to jest też Y-em*

  If he/she/it is X, then he/she/it is also Y,

- *Jeśli jest Y-em, to jest też X-em*

  If he/she/it is Y, then he/she/it is also X

This *test set*, however, is only a secondary criterion for identifying synonymous LUs, i.e. for putting two LUs into the same synset. The primary criterion stays unchanged since plWordNet 1.0: LUs from the same synset must share hyponyms/hypernyms and meronyms/holonyms. Thus synonymy, which is encoded by synsets, is to some extent a secondary relation in plWordNet. It is entailed by the

remaining lexico-semantic relations. As a result we obtain a relation that captures both absolute synonyms and part of near synonyms.

In plWordNet 2.0 one more substitution test — a necessary condition — was added to the test set for synonymy. The additional test is intended to emphasize the association of synonymy with the hypernymy hierarchy and other synset relations:

- *X i Y mają wspólny hiperonim i wchodzą w identyczne relacje semantyczne*
  X and Y have a shared hypernym and participate in the identical synset relations.

3.1.2. Inter-register synonymy

Inter-register synonymy, introduced in plWordNet 2.0, can be characterised briefly as synonymy that occurs between lexical units which have different stylistic register. It is a kind of near synonymy.

Table 2. plWordNet synonymy and inter-register synonymy

	dimensions of meaning	plWordNet synonyms	inter-register synonyms
(1)	descriptive meaning (denotation)	+	+
(2)	connotative meaning (connotation)	− / +	− / +
(3)	pragmatic characteristics (stylistic markedness)	+	−

The difference between inter-register synonyms (in a sense defined here) and synonyms depends on the difference of stylistic registers to which two LUs belong: inter-register synonyms belong to significantly different registers, while synonyms (LUs of one synset) must be in the same register. Thus the difference results from the pragmatics characteristics of LUs, while their denotational meaning is identical or very close (Table 2). The difference in registers directly influences the structure of the relation graph. It is caused by our understanding of synonymy as topological identity (i.e. network location identity) with respect to the network of relations. Inter-register synonyms do not share locations in the network, because they do not belong to identical lexico-semantic relations. It is not possible to link by hyponymy an unmarked LU (general language LU) with a marked LU (e.g. a vulgar LU), for instance:

{*dziecko* ‘child’}
↑ HYPONYMY
*{*chłopiec* ‘boy’, *gówniarz* ‘∼squirt’}
↑ *HYPONYMY
{*orlę* «odważny chłopiec, zwłaszcza elew lub podchorąży szkoły lotniczej» (USJP) ‘a brave boy, especially graduate or cadet of an aviation school’}

Henceforth, we use the sign "*" to mark incorrect synset or relation instance.

Orlę is a hyponym of *chłopiec*, but not of *gówniarz*. Inter-register synonymy makes it possible to avoid this contradiction, i.e.:

Marked near-synonym inherits the hyponymy relation of its unmarked near-synonym. Such view is familiar for lexicography:

> «General-language expressions must not be explained by means of technical-language synonyms (...). Similarly, words and phrases belonging to normal prose should not be defined by means of synonyms that belong to statistically marked language varieties (**boy* lad). The opposite procedure, on the other hand, is normal, with stylistically marked expressions being explained by unmarked near synonyms; however, it is then necessary to specify that the expression is marked, and in what way» (Svensén 2009: 216–7; cf. 249).

Substitution tests for inter-register synonymy are presented below:

- X i Y mają ten sam hiperonim, zbiory ich hiponimów nie pokrywają się 'X and Y share a hypernym, their sets of hyponyms do not overlap'
- X i Y nie są synonimami 'X and Y are not synonyms'
- Jeżeli jest X, to także jest Y [pomijając różnicę rejestrów stylistycznych] 'If he/she/it is X, then he/she/it is also Y [to the extent of the stylistic register difference]',
- Jeżeli jest Y, to także jest X [pomijając różnicę rejestrów stylistycznych] 'If he/she/it is X, then he/she/it is also Y [to the extent of the stylistic register difference].

3.1.3. Hyponymy/hypernymy

Linking words by the hyponymy/hypernymy relation is the main way to define lexemes in dictionaries: a head of an intentional definition is usually a hypernym, whereas an extensional definition lists a number of hyponyms. Sometimes both hyponyms and hypernyms are built into the definition structure (Svensén 2009: 218–9, 249).

Hyponymy/hypernymy symmetric relations constitute the skeleton of the wordnet structure (Piasecki *et al.* 2009: 28). Hypernymy, for example, can be characterised by a pair of implications:
$p \Rightarrow q$, $\sim q \Rightarrow p$, where q is a hypernym, and p — a hyponym (Lyons 1995b: 127).

Hyponymy *kobieta* 'woman' — *człowiek* 'man' is sometimes identified with the implication $p \Rightarrow q$, and the mutual implication $p \Leftrightarrow q$, used here to characterise synonymy, is called mutual hyponymy. Thus hypernymy perceived in this way becomes a primary relation in comparison to synonymy (Lyons 1995b: 127–8).

Substitution tests for hyponymy/hypernymy have been changed slightly in comparison to plWordNet 1.0 (Piasecki *et al.* 2009: 187, test X). In order to express better an aspect of the implication „⇒" in the tests, we introduced modal verbs *musieć* 'have to' i *móc* 'be able':

- *Jeżeli ktoś/coś jest X-em, to musi być Y-em* (X ⇒ □Y)
  'If he/she/it is X, then he/she/it must be Y',
- *Jeżeli ktoś/coś jest Y-em, to niekoniecznie jest X-em*
  'If he/she/it is Y, then he/she/it not necessarily is X'
  (Y ⇒ ∼□X),
- If he/she/it is not Y, then he/she/it cannot be X.

As a result, unacceptable implications similar to those listed below are systematically blocked:

*Jeżeli jest *orlęciem*, to musi być *gówniarzem*. 'If he is *brave boy*, then he must be a *squirt*' (vulgarism)',

*Jeżeli jest *istotą żywą*, to musi być *bytem*. 'If it is *a living being*, then it must be *an entity*' (phil. «everything what exists in some way; main subject of ontological investigations»),

*Jeżeli jest *taksówką*, to musi być *furą*. 'If it is a taxi, it must be a *a good, expensive car* (*joke*, informally)'.

*Jeżeli jest *dowcipasem*, to musi być *konceptem*. 'If it is a ∼*jest* (informally, an unfunny jest), then it must be a *joke* (old fashioned)'.

Blocking of inter-register hypernymic links together with a new relation of inter-register synonymy resulted in a kind of hierarchy of stylistic registers. Linking a marked LU and an unmarked LU with hypernymy is excluded because of a general rule. This rule fits the linguistic intuition. In that way LUs of the Polish wordnet are divided into two main separate classes: general LUs and other. LUs of the general register encompass literary language and colloquial words. The set of other registers includes: scientific, technical, informal, vulgar, in jest, outdated (old use), archaic and historical, regional (dialects).

3.1.4. Instance-of and type relations

In plWordNet we tried to avoid introducing proper names and linking them to common nouns. In the relation structure of plWordNet 2.0 we made one exception to this rule. A proper name is included in the wordnet only if there is a common noun derived from it. The noun must be also relatively frequent in the corpus. Such *nomina propria* are included in the wordnet structure by means of the *type* relation (from an instance to superior category — a type LU) and the *instance of* relation (from the superior category to an instance), e.g. *Wrocław* is an instance of *miasto* 'a city' and *miasto* 'a city' is a type of *Wrocław*. The substitution test for the *instance of* relation received the following form:

- X jest Y-em 'X is Y'.

3.2. Contrast and meaning opposition relations

A wordnet is built not only on lexico-semantic relations expressing different kinds of similarity, but also on opposition. Antonymy is commonly used in dictionaries; it occurs in definitions and entries of many dictionaries (Svensén 2009: 248, 251).

The relation is of high importance in semantics: «Antonymy, or 'oppositeness of meaning', has long been recognized as one of the most important semantic relations» (Lyons 1995b: 460). Its status is not disputed: «Unlike synonymy, everyone agrees that antonymy exists, and it is robustly evident in natural language» (Murphy 2003: 169). Lyons distinguishes three types of opposition:

- complementarity — *single* : *married*, *man* : *woman*,
- gradable opposition,
- converseness.

Following Lyons we divide antonymy into the three categories.

3.2.1. Complementarity

Complementary terms (e.g. *mężczyzna* 'man' — *kobieta* 'woman') are of Apresjan's $Anti_1$ *type*, i.e., they directly express opposite meaning (Apresjan 2000: 269, 273–4). «It is characteristic of such pairs of lexical items that the denial of the one implies the assertion of the other and the assertion of the one implies the denial of the other: ∼x ⊃ y and y ⊃ ∼x» cf (Lyons 1995b: 401; cf. Kreidler 1998: 104–5; Lyons 1995: 128–9; Lyons 1977: 271–2, 279–80).

The complementarity is caused by the fact that *X* and *Y* belong to a two-term set (Lyons 1995b: 461) (*people* are either *men* or *women* with regard to sex):

adult (human being)

man «an adult male human being» CALD*	*woman* «an adult female human being» CALD*

*The definitions come from *The Cambridge Advanced Learner's Dictionary* online (CALD 2010)

In our tests for antonymy, we follow Lyons's entailment scheme:
[Complementary Antonymy]

- Jeżeli ktoś/coś jest X, to **nie może być** Y
  'If someone/something is X, then he/she/it **cannot be** Y'.
- Jeżeli ktoś/coś nie jest X, to **musi być** Y
  If someone/something is not X, then he/she/it **must be** Y'.

The answer to the latter question is not obvious for complementary terms:
Q: If someone/something is not a man, then he/she/it is a woman.
A: It depends (think of a child, neither a man, nor a woman).

> «The theoretical problem arising at this point is to make it [sc. formal definition of antonymy] narrow enough, that is, rule out words that are not true opposites but simply instances of incompatibility of sense (Lyons 1981: 154–5)» (Stępień 2008: 228).

To answer „yes" we must know that we are talking about *adults* and we put only the matter of *gender* in focus. In addition we must ensure that words in question are strongly semantically associated, i.e. they share a substantial part of their meanings. Antonyms — a little paradoxically — have a lot in common. An antonym negates only part of the definition of its counterpart, what is left remains unnegated (Apresjan 2000: 269, 270 and 273). That is why we add to the test set an additional necessary condition:

- X and Y must be co-hyponyms or co-meronyms of the same lexical unit(s).

This condition guarantees that the words tested for antonymy are compatible in meaning.

3.2.2. Gradable opposition

Some words do not belong to bipolar LU pairs, though they show opposite-ness of senses, e.g. *góra* 'mountain' — *dolina* 'valley'. They are of Apresjan's $Anti_2$ and $Anti_3$ *type* of contradictory meaning ('P' — 'not P', 'big/a lot of P' — 'small/little P') (Apresjan 2000: 275–277). Such pairs do not fulfill the condition of complementary antonymy (Lyons 1995b: 466–7):

- *Jeśli ktoś/coś nie jest X-em, to jest Y-em*
  'If someone/something is not X, then he/she/it is Y'.

To test them for gradable antonymy, we use Lyons's second question and the necessary condition:

[Gradable Antonymy]

- *X i Y muszą być kohiponimami lub komeronimami tej samej jednostki leksykalnej.*
  'X and Y must be co-hyponyms or co-meronyms of the same lexical unit(s)'.
- Jeżeli ktoś/coś jest X, to **nie może być** Y.
  'If someone/something is X, then he/she/it **cannot be** Y.'

But it is not enough. All co-hyponyms of X pass that test, although they are merely its antonyms. To focus the linguist's attention on the contradiction of the senses, we broaden the test with this sentence:

- Is he/she/it X? — No, on the contrary: he/she/it is Y.

The motivation for this question is similar to Cruse's proposal: «Ask someone for the opposite of table, or gold, or triangle (...)» (Cruse 1997: 257).

To distinguish between complementary terms and gradable antonyms we must also ask the question:

- *Jeżeli ktoś/coś nie jest X, to musi być Y*
  If someone/something is not X, then he/she/it must be Y'.

The answer for gradable antonyms is: NO.

3.2.3. Converseness

Converseness is the third relation expressing the oppositeness of two words (Lyons 1995b: 467). It is characteristic especially of verbs (Apresjan 2000: 248), but some nouns also are in the converseness relation (Apresjan 2000: 249; Derwojedowa, Zawisławska 2007). If one changes the order of converses' arguments, one will receive synonymous expressions:

$$P_1(a, b, \dots) = P_2(b, a, \dots)$$

(Kreidler 1998: 97; Apresjan 2000: 241; Lyons 1995b: 467–9).

> «These have been called 'converse' pairs (cf. Lyons 1968L 467–9) for they exhibit a converseness relation between the objects related» (Kempson 1996: 85).

It would be difficult to encompass in one test all possibilities opened by converses due to the permutations of actants. Thus, we will focus only on 2-actant converses, leaving aside converses of more active valency slots. The latter, by the way, are far less frequent (Apresjan 2000: 250–1).

[Converseness]

- Jeśli a jest X-em (Praep) b, to b jest Y-em (Praep) a

  'If a is X (Praep) b, then b is Y (Praep) a',

where „Praep" means 'preposition', i.e. *dla* 'for', *na* „on" etc., brackets mean that the appearance of a preposition depends on a noun's valency.[7]

3.2.4. Oppositeness of senses

Putting things together, the final set of substitution tests for the semantic contrast is presented in the table below:

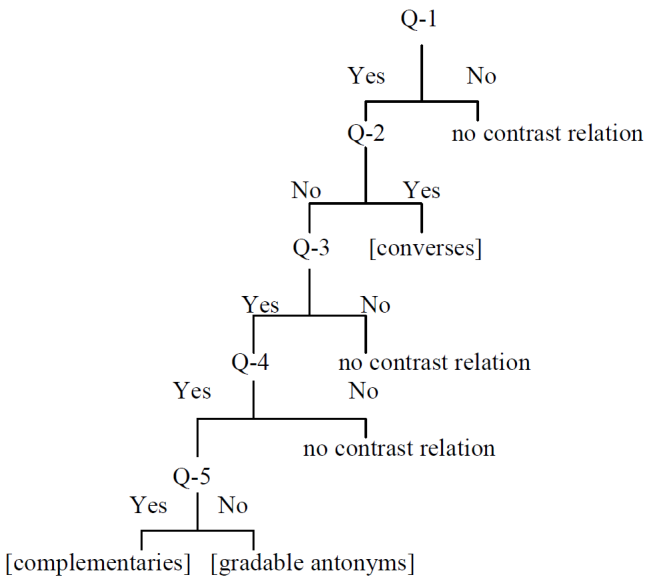
[7] It may be sometimes omitted, especially when the object word is used in Genitive.

	TESTS
Complementary Antonymy	X and Y must be co-hyponyms or co-meronyms of the same lexical unit(s) If someone/something is X, then he/she/it **cannot be** Y If someone/something is not X, then he/she/it **must be** Y It is not true, that if a is X (Praep) b, then b is Y (Praep) a
Gradable Antonymy	X and Y must be co-hyponyms or co-meronyms of the same lexical unit(s) Is he/she/it X? — No, **on the contrary**: he/she/it is Y If someone/something is X, then he/she/it **is not** Y If someone/something is not X, then he/she/it **must be** Y [NO] It is not true, that if a is X (Praep) b, then b is Y (Praep) a
Converseness	X and Y must be co-hyponyms or co-meronyms of the same lexical unit(s) If a is X (Praep) b, then b is Y (Praep) a

The last test in the Gradable Antonymy and Complementary Antonymy group was added in order to exclude the possibility of classifying proper gradable antonyms as converses.

We can notice that test groups for all three opposition relations can be merged into one sequence of tests — presented in the table below — defining a kind of algorithm — shown below.

line	TEST
1	X and Y must be co-hyponyms or co-meronyms of the same lexical unit(s)
2	If a is X (Praep) b, then b is Y (Praep) a
3	Is he/she/it is X? — No, on the contrary: he/she/it is Y
4	If someone/something is X, then he/she/it cannot be Y
5	If someone/something is not X, then he/she/it must be Y



This cascade-like system of testing sentences enables linguists to distinguish between words of contrast (antonyms and converses) and words which are related in some other way.

3.3. Meronymy / holonymy — part / whole relation

Meronymy and holonymy are part/whole relations (Cruse 1997: 157). Together with hyponymy/hypernymy they group words into semantic fields (Jackson 2002: 17–8). Meronymy/holonymy are present in extensional lexicographic definitions (Svensén 2009: 220–2), but they are not as frequent in dictionaries as synonymy and hyponymy/hypernymy relations (Murphy 2003: 123), probably because they are less well recognised (Jackson 2002: 98). Meronymy is commonly used in wordnets (Miller 1998: 37–39; Vossen *et al.* 1998: 105–6).

We distinguished five subtypes of meronymy/holonymy in plWordNet 1.0, namely: *part*, *place*, *portion*, *element of a collection* and *substance* (Piasecki *et al.* 2009: 31–2, test XIII). In plWordNet 2.0 this set has been extended with an additional subtype of *taxonomic unit*. It is motivated by the needs of expressing lexico-semantic relations inside scientific taxonomies, especially biological taxonomy, e.g. *kotowate* 'felidae' — *kotokształtne* 'feliformia'. The test set for meronymy/holonymy of the *taxonomic unit* type is presented below:

- *X jest elementem taksonomicznym Y*,
  'X is a taxonomic unit within Y'

- *Y reprezentuje poziom taksonomiczny, którego elementem jest X*,
  'Y represents a taxonomic level, whose unit is X'

- *Y nie jest elementem taksonomicznym X*
  'Y is not a taxonomic unit of X'

3.4. Fuzzynymy

The space of different kinds of lexical semantic association seems to be a continuum. Some of its more prominently delimited subspaces have been named by wordnet relations. However, we can still expect many distinguishable but less frequent types of associations, e.g. *informatyk* 'computer scientist' — *komputer* 'computer'. In order to collect instances of those associations, we introduced the fuzzynymy relation in plWordNet 1.0. Fuzzynymy links LUs both inside a part of speech, e.g. Noun — Noun, as well as in a cross-categorial way, e.g. Noun — Verb or Adjective. We follow here the practice of EuroWordNet. Fuzzynymy is underspecified and expresses a kind of lexical semantic association visible for native speakers. Concerning dictionary definitions, fuzzynymy corresponds to the expressions like "about someone, about something", "connected with" used to refer to a semantic field, to focus the reader's attention on them or to characterise use of a word in particular subject field (Svensén 2009: 210; Piotrowski 2001: 151), e.g.

- *wiekowy* «***o człowieku**: taki, który przeżył wiele lat, bardzo stary; leciwy*»
  'aged «**about a man**: such who lived for many years, very old, elderly»' (USJP), so fuzzynymy: *człowiek* 'man' — *wiekowy* 'aged'

- *niedomyty* «***o rzeczy**: umyty niedokładnie*» '∼*non-completely-washed*
  «**about thing**: non-precisely washed»' (USJP), so fuzzynymy *rzecz* 'thing' — *niedomyty* '∼*non-completely-washed*'

- *rustykalny* «mający związek z wsią i jej mieszkańcami, mający cechy wiejskie; wiejski, chłopski, wieśniaczy, ludowy» (USJP)[8] 'rustic «connected with a village and its dwellers, having features associated with a village, rural, related to villagers, folk (Adj.)»'

4. Semantic-derivative relation

The word formation process is semanticaly fertile, but ways of creating new meanings are vague and sometimes erratic (Malmkjaer 2004: 359). Suffixation and composition remain the basic ways of contemporary Polish noun formation (Bajerowa 2003: 62–67; Grzegorczykowa, Puzynina 1998: 389), but the meaning of a particular suffix varies: for example, in some deverbal derivatives the *-ca* suffix means 'person who does something': *wystawca* 'a person who shows to the public industrial goods, works of art' < wystawiać 'to show to the public industrial goods, works of art', *zbawca* 'a person who saves someone from danger' < *zbawiać* 'to save someone from danger', whereas in compounds the *-ca* suffix has different sense 'animal': *roślinożerca* 'phytofag, animal that eats only plants' < roślina 'plant',

[8] According to Piotrowski, phrases *mający związek z* and *związany z* are quite frequent in SWJP's definitions (480x and 718x respectively), this proves that fuzzynymy is present in Polish dictionaries (Piotrowski 2001: 151).

żreć 'to eat', *mięsożerca* 'carnivore, animal that eats meat' < *mięso* 'meat' (Grzegorczykowa, Puzynina 1998: 373–4). Some suffixes are more productive than others, some loose their power and popularity, while another gain it, which is a complex historical process (Malmkjaer 2004: 359; Bajerowa 2004: 67–69).

Because the meaning of the derivational base usually becomes part of a derivative, it seams natural to define semantics of the latter by the former. Giving a meaning paraphrase with derivational characteristics is an ordinary way to define morphologically related words via morpho-semantic definition (Svensén 2009: 227; Sterkenburg 2003: 88–91, 93; Szymczak 1982: XVIII–XIX).

In plWordNet 1.0 derivational relations were divided simply into two large groups providing a coarse-grained level classification of relations, named *relatedness* and *pertainymy* (Piasecki *et al.* 2009: 32–34; tests XV, XVIII). This division was intentionally provisional and motivated to a very large extent not by semantic but by formal criteria (e.g. regularity).

In plWordNet 2.0 we replaced this classification with a set of more detailed lexico-semantic relations which are expressed by means of derivational transformations but have a clear semantic motivation.

We selected several lexico-semantic relations from many possible ones which are expressed by the derivational associations. The only criterion was productivity. All more frequent relations — representing from several hundred to several thousand occurrences in the lexicon were selected:

- Cross-categorial synonymy (e.g. *pisać* 'to write' — *pisanie* 'writting', *czerwoność* 'red (*noun*)' — *czerwony* 'red (*adj.*)',
- thematic role, e.g. *więzień* 'prisoner' < *więzić* ' to imprison'[9],
- markedness, e.g. *synuś* '∼son (*diminutive*)' < *syn* 'son',
- state|feature bearer, e.g. *głupek* 'fool' < *głupi* 'fooly',
- femininity *pisarka* 'writer (*fem.*)' < *pisarz* 'writer' (*masc.*),
- inhabitant, e.g. *mieszczanin* 'burgher' < *miasto* 'city'.

4.1. Semantic roles

Thematic role relations semantically characterise associations between a noun and derivationally linked verb from the perspective of a situation denoted by the verb. According to Fillmore's Frame Semantics every predicate has its own semantic frame, which consists of different semantic roles (Fillmore 1968). The approach is used also outside the area of frame-based verb description (Vossen *et al.* 1998: 101–2). In EuroWordNet the only limitation is the strength of semantic connection of two words:

[9]Signs „>" and „<" show a direction of the derivation process: from a basis to a derivative and to a derivative from a basis (respectively).

> «This relation is only being used to encode data on arguments/adjuncts that are strongly implied in the meaning of a verb/noun. This is not the same as encoding arguments or adjuncts co-occurring with a verb/noun in a sentence. In the relational approach we follow, we only encode the semantic features incorporated in the meaning of a word. These certainly also determine the kind of syntactic contexts in which that word may occur, but do not necessarily coincide with them» (Vossen *et al.* 1998: 101–2).

The semantic roles strongly affects the word formation process (Grzegorczykowa, Puzynina 1998: 378–383; Laskowski 1973). Following solutions proposed in EuroWordNet and the scheme proposed for Polish by Grzegorczykowa and Puzynina (Grzegorczykowa, Puzynina 1998: 398–415), we distinguished nine roles — relation subtypes: *agent*, *patient*, *instrument*, *location*, *product*, *time*, *agent of hidden predicate*, *object* (*of hidden predicate*) and *product* (*of hidden predicate*). Morphological connections between deverbal nouns and their derivational bases guarantee that the meaning of a predicate is involved in the meaning of an argument.

Agent — this thematic role relation associates names of agents of activities, processes and states with their verbal derivational bases. Agent names are formed with suffixes of the following types: -*acz* (*spawacz* 'welder' < *spawać* 'to weld'), -*ca* (*zbawca* 'saviour' < *zbawiać* 'to save'), -*iciel* (*oswobodziciel* 'someone who make someone free' < *oswobodzić* 'to set someone free'), -*ator* (*kreator* 'creator' < *kreować* 'to create'), -*arz* (*malarz* 'painter' < *malować* 'to paint') etc.. «Agent names follow in different ways meaning and syntactic features of their verb bases. First of all, many of them refer only to selected meanings of the verb base, e.g. *odkrywca* 'inventor' only derived from *odkryć* 'to discover/to invent' (*odkrywać* 'to discover/to invent') in the sense of *wynaleźć* 'to invent' (but not in the sense of e.g. *odsłonić* 'to unveil'), *wydawca* 'publisher' from *wydać* 'to publish/to sell somebody down the river' — in the sense of *drukować* 'to print' — (but not in the sense of e.g. *zdradzić* 'to betray'), *wyznawca* 'believer' from *wyznawać* 'to profess/to confide' e.g. *poglądy* 'beliefs', *idée* 'ideas' (but not e.g. *grzechy* 'sins'). In the case of almost all agent names the verb basis loses an aspect of actuality, it refers to potential or habitual activities (*sprzedawca* 'seller', *roznosiciel* '∼carrier (person)', *hodowca* 'breeder' etc.), however, actual or occasional uses are exceptionally possible, especially in the case of derivatives with the suffix -*acz*, e.g. *zapowiadacz* 'announcer', *oprowadzacz* '∼guide', *zagajacz* '∼bringer-up'.» (Grzegorczykowa, Puzynina 1998: 398–405).

The patient subtype associates patients denoting concrete objects with their derivative bases. Patient names are created e.g using the suffixes -*a* (*zguba* '∼a lost thing/person' < *zgubić* 'to lose'), -ø (masc.) (*zbiór* 'crop' < *zbierać* 'to collect'), -*anie* (*ubranie* 'clothes' — *to, co się ubiera* 'this what is clothed'), -*enie* (*jedzenie* 'food' — *to, co się je* 'this what is eaten'), -*cie* (*szycie* 'sewing' — *rzecz szyta, uszyta* 'a a thing — an effect of sewing'), -*ka* (*nakrętka* 'nut' < *nakręcać* 'to wind up') etc. (Grzegorczykowa, Puzynina 1998: 405–8).

Instrument — links nouns representing instruments whose names are derived from the verbal bases using the suffixes: -*arka* (*koparka* 'digger' < *kopać* 'to dig'), -*acz* (*spychacz* 'bulldozer' < *spychać* 'to bulldoze'), -ak (*straszak* '∼something that scares' < *straszyć* 'to scare'), -nik (*nadajnik* 'transmitter' < *nadawać* 'to beam/to

broadcast') etc. (Grzegorczykowa, Puzynina 1998: 410–3).

Location — associates derivatives representing locations of situations denoted by the verbal bases; derivatives are created using the suffixes: *-nia* (*pijalnia* 'pump room' < *pić* 'to drink'), *-isko* (*rozlewisko* 'backwater' < *rozlewać się* 'to spill'), *-nica* (*strzelnica* 'range' < *strzelać* 'to shoot') etc. (Grzegorczykowa, Puzynina 1998: 413–4).

Product — relation of this subtype is intended to link names of objects created as an effect of the action or being the result of the process denoted by the derivative basis. Names of the results of actions or processes are created by such suffixes as: *-ø* (masc.) (*naciek* 'infiltration (*medical*)' < *naciec* 'infiltrate'), *-ina* (plural *-iny*; *wydalina* 'excretion' < *wydalić* 'excrete', *strużyny* 'shavings' < *strugać* '∼to whittle'), *-anie* (*uczesanie* 'coiffure' < *uczesać* 'to make coiffure') etc. (Grzegorczykowa, Puzynina 1998: 410–3).

Time — in this one case we stray from the criterion of derivational productivity. We introduce this subtype in order to achieve a complete description, to some extent. Temporal names are not numerous, we can include in them. e.g., names of different periods of the day (*świt* 'dawn' < *świtać* 'to dawn', *zmierzch* 'twilight' < *zmierzchać* '∼to grow dark', *zachód* 'sunset' < *zachodzić* 'to set (about sun)'), seasons (*roztopy* 'thaw' < *roztopić* 'to melt', *odwilż* 'thaw' < *odwilganie* '∼to remove wet'), periods in the agricultural calendar (*wykopki* 'harvest potatos' < *wykopać* 'to dig out'), etc.

Besides names (nouns) derived from verbs representing verb predicate arguments (i.e. roles), there are also nouns derived from other nouns, whose meaning we want to classify in plWordNet along three basic sub-types:

Agent of hidden predicate — corresponds to the agent relation defined above: *-arz* (*blacharz* '∼person working with sheet metal' < *blacha* 'sheet metal'), -owiec (*PiS-owiec* < *PiS*), *-ista* (*SOK-ista* < *SOK*), *-nik* (*ogrodnik* 'gardener' < *ogród* 'garden') etc. (Grzegorczykowa, Puzynina 1998: 445).

Object (of hidden predicate) — corresponds to the patient relation introduced above: *-ec* (*żaglowiec* 'sailing ship' < *żagiel* 'sail'), *-ec* (*śmigłowiec* 'helicopter' < *śmigło* 'propeller'), *-ak* (*ropniak* '∼diesel (*informally*)' < *ropa* 'diesel oil') (Grzegorczykowa, Puzynina 1998: 445–6).

Product (of hidden predicate) — corresponds to the product relation: *-yna* (*pajęczyna* 'web' < *pająk* 'spider'), *-ec* (*krowiniec* 'fertilizer produced by cows' < *krowa* 'cow'), *-isko* (*kretowisko* 'molehill' < *kret* 'mole') (Grzegorczykowa, Puzynina 1998: 445–6).

4.2. Emotional markedness

Many Polish nouns have emotional markedness encoded in their structure via suffixes: the most frequent in the lexicon are diminutives, augmentatives and names of young beings (Grzegorczykowa, Puzynina 1998: 427–30).

Diminutives are formed mainly with suffixes *-ek*, *-ik* (*domek* 'small, nice, sweet house/home' < *dom* 'house/home', *samochodzik* 'small, nice car' < *samochód* 'car'), *-ka* (*córeczka* 'little, nice daughter' < *córka* 'daughter'), *-ko* (*słonko* < 'small, nice sun' < *słońce* 'sun') and few others (e.g., *syn-uś* 'little, nice son' < *syn* 'son').

Diminutive nouns could be paraphrased by senses ‘small, little’ and ‘nice, sweet’ as well (Grzegorczykowa, Puzynina 1998: 427–9).

An *augmentative* has a meaning ‘big, awful’, it is created with suffixes: *-isko* (*artykulisko* ‘big, awful article/paper’ < *artykuł* ‘article/paper’), *-sztyl* (*babsztyl* ‘big, awful woman’ < *baba* ‘unpleasant woman’), *-al* (*nochal* ‘big, awful nose’ < *nos* ‘nose’) and many others. It should be noted that in some contexts sense ‘awful’ is neutralized and augmentative gains positive connotation (for example *psisko* means ‘big, awful dog’ or ‘nice, loved dog’; Grzegorczykowa, Puzynina 1998: 427–9).

Two suffixes form names of *young beings*: *-ę* (*wronię* ‘youngling of a crow’ < *wrona* ‘crow’) and *-ak* (*kociak* ‘kitty’ < *kot* ‘cat’). The emotional positive markedness sometimes comes with those names (thus *kociak* means also ‘nice cat’; Grzegorczykowa, Puzynina 1998: 429–30).

The emotional markedness is similar to inter-register synonymy, because the relations both carry stylistic register markings. The difference is essential, however: the emotionally marked words are hyponyms or unmarked counterparts rather than their inter-register synonyms (*kociak* ‘small’ + ‘nice’ + ‘cat’ is rather hyponym of *kot* ‘cat’).

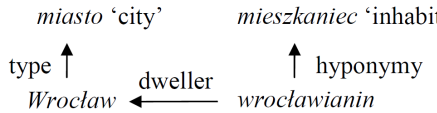
4.3. Others

In plWordNet there are additional four derivational relations linking nouns with nouns, adjectives and verbs: i.e., *state/feature bearer*, *femininity*, *dweller* and *derivation*.

The *state/feature bearer* relation is a cross-categorial relation which characterises a noun by its adjectival derivative basis: *głupek* ‘fool’ < *głupi* ‘foolish’, *ślepiec* ‘blind man’ < *ślepy* ‘blind’). The paraphrase contains the expression «is in state of being + Adj» or simply «is (permanently) + Adj»: a blind man (*ślepiec*) is in state of being blind (*ślepym*) or a blind man (*ślepiec*) is permanently blind (*ślepy*; (Grzegorczykowa, Puzynina 1998: 418–20).

The *femininity* relation links nominal names of women (females) with male (or general) names: *pisarka* ‘female writer’ < *pisarz* ‘writer’, *dozorczyni* ‘female caretaker’ < *dozorca* ‘caretaker-man’, *kocica* ‘female cat’ < *kot* ‘cat’ (Grzegorczykowa, Puzynina 1998: 422–425). If hyponymic hierarchies for male and female names are parallel, we simply build “male” structure and then connect the words by the *femininity* relation.

The *inhabitant* relation is very productive in Polish. There are whole series of derivatives with semantic element ‘inhabitant’: *domownik* < *dom*, *wrocławianin* < *Wrocław*, *Kanadyjczyk* < *Kanada* etc. (Grzegorczykowa, Puzynina 1998: 437–8). The *inhabitant* relation links *nomina propria* and *nomina appellativa*:



The *derivativeness* is a last-chance relation. If none of the previously mentioned derivational relation is suitable for a given pair of related words, then that morphosemantic relation should be used.

5. Conclusions

For linguists, a wordnet often seems to be a simple thesaurus based on simple rules and well known relations. Two aspects make a wordnet an interesting language resource: its scale and consistency in implementing the adopted set of rules. A wordnet should be large and deliver a broad picture of the lexical-semantic system of the given language. The development of plWordNet 2.0 goes exactly in this direction. It now offers a large-scale description of nouns and it will provide mass-scale description of verbs and adjectives soon. A description of the lexical meanings is being consequently built in plWordNet 2.0 as a network of lexical units. What makes plWordNet different from other wordnets is that all relations introduced are clearly linguistically motivated. By constructing plWordNet 2.0 we want to achieve a relatively complete picture of the Polish lexical-semantic system with respect to two aspects: coverage of LUs and richness of description.

The relational paradigm, in which the means of description are reduced to the lexico-semantic relations, introduces definite limitations on the description's richness. The amount of semantic information provided for a LU is correlated with the number of relation links which concern it. With a greater number of relation types a better wordnet-based description can be obtained. However, too infrequent relations will result in too fragmented and too accidental a description, especially from the perspective of wordnet applications in language technology. Thus, we explored a wide range of potential lexico-semantic relations. In the paper we presented a selected sub-set. Relation originating from the formal derivational associations are its important part. Their strong presence is a characteristic feature of wordnets for Slavic languages, see e.g. (Pala & Hlaváčková 2007; Koeva 2008). It is worth emphasizing that derivative associations were only the starting point and our goal was to identify several more productive and more frequent classes of semantic dependencies behind them. It is hard to evaluate the proposed system of relations. It will be possible only when we complete a large wordnet — plWordNet 2.0, which this system of relations will underlie.

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