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SEMANTIC RELATIONS AMONG ADJECTIVES
IN POLISH WORDNET 2.0:
A NEW RELATION SET, DISCUSSION AND EVALUATION

Abstract

Adjectives in wordnets are often neglected: there are many fewer of them than nouns, and relations among them are sometimes not as varied as those among nouns or verbs. Polish WordNet 1.0 was no exception. Version 2.0 aims to correct that. We present an overview of a much larger set of lexical-semantic relations which connect adjectives to the other parts of the network. Our choice of relations has been motivated by linguistic considerations, especially the concerns of the Polish lexical semantics, and by pragmatic reasons. The discussion includes detailed substitution tests, meant to ensure consistency among wordnet editors.

Keywords: wordnet, lexico-semantic relations, derivational relations, Polish WordNet, Słowskić, adjective.

1. Introduction

A wordnet is an electronic thesaurus in the form of a graph. Its nodes are lemmas — word/sense pairs — called *lexical units* (LUs); its edges are lexico-semantic relations. A set of *constitutive* relations determines the shape of the wordnet. The choice of such relations is a fundamental design decision; they are very likely to include some forms of synonymy, antonymy, hypernymy, hyponymy, holonymy and meronymy, but beyond that the lexico-semantic makeup of the language is a central consideration. Relations are central in wordnet construction: they help distinguish the senses of a lemma by linking its word with its “semantic neighbours”. Groups of LUs which share all constitutive relations with the rest of the graph (they are essentially near-synonyms) are called *synset*. We say that a relation is a *synset relation* if it can be shared among groups of lexical units; *lexical unit relations* have more individual patterns.

The “mother of all wordnets” is Princeton WordNet (PWN), designed at Princeton University in the late 1980s on the psycholinguistic and computational prin-

ciples. After its emergence, research groups around the world have set to work on wordnets for their own languages. Early, and influential, systems include EuroWordNet (EWN) and GermaNet (GN). All three have been an inspiration for Polish WordNet (*plWordNet*)¹; the first phase of the project, 2005–2009, resulted in version 1.0 with 26990 lexical units — 18611 nouns, 4498 verbs and 3881 adjectives.

The choice of semantic relations for *plWordNet* 1.0 was guided by wordnet-building tradition, theory of lexical semantics and lexicographic practice (Derwojedowa *et al.* 2008). Most relations were taken over from PWN and EWN, not the least for compatibility.² The set included antonymy, hypernymy, meronymy, conversion, two derivational relations — more regular *relatedness* (transpositional, syntactic derivation) and less regular *pertainymy* — and *fuzzynymy* which captures irregular, infrequent semantic phenomena (Piasecki *et al.* 2009).

Adjectives in *plWordNet* 1.0 have been not so much neglected as left for future work. This is in keeping with how creators of new wordnets apportion attention to parts of speech (invariably, nouns are by far the most numerous). Among the 3881 LUs in 1160 synsets there were only 155 instances of hyponymy, 1618 of antonymy, 1226 of relatedness, 295 of pertainymy and 423 of fuzzynymy. Table 1 shows the “relation density” of *plWordNet* 1.0: the average number of synset relations per synset and LU relations per LU.

Table 1. Relation density in plWordNet 1.0

measure	nouns	verbs	adjectives
average number of synset relations per synset	1.11	0.37	0.07
average number of LU relations per LU	0.23	0.70	0.92

The scarcity of synset relations clearly suggests that we need many more adjectival relations than the minimal set in *plWordNet* 1.0. This has been the latest concern in the ongoing *plWordNet* 2.0 project, and it is the focus of this paper. We will present a much-improved set of lexico-semantic relations among adjectives, accompanied by substitution tests and examples.

There have been several rather divergent takes on adjectives in PWN, EWN and GN. It is clearly not easy to describe adjectives in general, and it is distinctly hard to come up with a language-independent relation set. Table 2 sums up the matching relations. Clearly, analogies are imperfect and each of the wordnets has relations not found elsewhere.

Our decision on the set of lexico-semantic relations among adjectives in *plWordNet* 2.0 was again based on three central criteria (Derwojedowa *et al.* 2008): solutions in influential wordnets (mainly PWN and EWN, sometimes GN), lexico-semantic reality of the Polish language, and established lexicographic custom.

¹*Słowniec* in Polish.

²We are now more concerned with linguistic veracity than with compatibility; see (Maziarz *et al.* 2011, 2011b) for details of our current view of relations for nouns and verbs.

Table 2. Relations among adjectives in PWN 3.1, EWN, GN and plWordNet 2.0

PWN 3.1	GN	EWN	plWN 2.0
antonymy (LU: Adj ↔ Adj)	antonymy (LU: Adj ↔ Adj)	antonymy (LU: AdjAdv ↔ AdjAdv) ³	gradable antonymy & complementary antonymy (LU: Adj ↔ Adj)
indirect antonym (LU: Adj ↔ Adj)			
		XPOS_NEAR_ANTONYM (S: N ↔ AdjAdv, V ↔ AdjAdv)	
similar to (S: Adj ↔ Adj)			
domain (S: Adj → N)			~ inter-register synonymy (S: Adj ↔ Adj)
	hyponymy (S: Adj → Adj)		hyponymy (S: Adj ↔ Adj)
attribute (S: Adj → N)		~ HAS_XPOS_HYPERONYM (S: AdjAdv → N, AdjAdv → V)	value of the attribute (S: Adj → N)
pertainym 'related to' (LU-D: Adj → V)	pertainymy (LU-D: Adj → N V)	PERTAINS_TO (LU-D: Adj → N V)	cross-categorial synonymy (LU-D: Adj → N)
participial adjective (LU-D: Adj → V)	participle (LU-D: Adj → V)		cross-categorial synonymy (LU-D: Adj → V)
		BE_IN_STATE (S: N → AdjAdv, V → AdjAdv)	state (S: V → Adj)
	causation relation (S: V → Adj V)	CAUSE (S: V → AdjAdv, N → AdjAd)	cause (S: V → Adj V)
			process (S: V → Adj V)

		XPOS_NEAR_SYNONYM (S: N ↔ AdjAdv, V ↔ AdjAdv)	
derivationally related form (LU-D: Adj → N V Adj)	pertainymy derived from (LU-D: Adj → N V)	DERIVATION (LU: N, V, AdjAdv — across all)	derivativity (LU-D: Adj → N V Adj), some more specific derivational relations (LU-D: Adj → Adj N V)
		MANNER_OF (S: AdjAdv → N V)	
		ROLE (S: AdjAdv → N, AdjAdv → V)	derivational role relations (LU-D: Adj → V)
see also (S: Adj → Adj V N)	association (S: Adj → Adj V N)	XPOS_FUZZYNYM (S: V ↔ AdjAdv, N ↔ AdjAdv)	fuzzynymy (S: Adj → N V Adj)

For every relation we seek motivation in the literature. Sections 2–7 present the main groups of relations, along with a relevant discussion. The lexicographic criterion was implemented via the sampling of the *Universal Dictionary of Polish Language* (UDP) (Dubisz 2004). We chose 100 adjectives by randomly drawing a volume number and page number, and taking the first adjective on the page (if there was none, we took the first adjective from the next page).⁴

The selected adjectives were described with the appropriate substitution tests and equipped with relations to other lexical units. Table 3 shows the whole set. The statistics of the relations in the UDP sample appear at the end of the paper.

Table 3. Relations among adjectives in plWordNet 2.0

synset relations	lexical unit relations
hyponymy/hypernymy (Adj → Adj, §2)	gradable antonymy (Adj ↔ Adj, §3)
value of the attribute (Adj → N, §2)	comparative antonymy (Adj ↔ Adj, §3)
gradation (Adj → Adj, §4)	converseness (Adj ↔ Adj, §3)
distributional properties (Adj → Adj, §5)	derivational relations (Adj → Adj/N/V, §7)
inter-register synonymy (Adj → Adj, §6)	fuzzynymy (Adj → Adj)

→: directional relation, ↔: reflexive relation, §n: section where the relation is described.

⁴The average polysemy was 1.75 per lemma: for 100 adjectives we found 175 senses. If definitions in UDP were inaccurate, the senses were distinguished using *Other Dictionary of Polish* (Bańko, 2000), referred to in this paper as ODP.

In *plWordNet* 2.0, pointers to adjectives go from verbs (state, cause and process relations, see Maziarz *et al.* 2011b) and from nouns (cross-categorial synonymy, formations ending with *-ość*, see Maziarz *et al.* 2011). In this paper, we are only interested in pointers *from* adjectives. Table 3, unlike Table 2, shows a few relations not described in this paper. Derivational relations in Table 2 are divided into groups which match the similar phenomena in other wordnets. Table 3 groups them under the label *derivational relations*.

2. Hyponymy among adjectives

“In natural language, hyponymy is loosely defined as the ‘kind of’ relation”: a horse is a type of animal and a martagon is a kind of lily (Murphy 2003: 217–218). The notion of *hyponymy* among adjectives, however, is not so clear. According to lexicologists and semanticists (Cruse 1997: 141–3) hyponymic taxonomies for adjectives are shallow. There exist proper hyponym pairs, such as *red* – *maroon* «of a dark reddish purple colour» (Croft, Cruse 2004: 142) or *large* – *huge* «extremely large» (Atkins, Rundell 2008), but for many adjectives a superordinate is quite hard to find.

Many adjectives simply have nouns as superordinates. *Round*, *square*, *oval* are kinds of shape, *sweet*, *bitter*, *sour* or *salty* are kinds of taste, *happy*, *sad*, *angry* are kinds of emotions (Lyons 1977; Murphy 2003: 218; Murphy 2009), while *hot*, *warm*, *cool*, *cold* relate to temperature (Maienborn, von Heusinger 2011: 460). Not all colour adjectives have an adjectival hypernym in English (Lyons 1977: 298).⁵ The same is true for Polish. There is, for example, no hypernym for *czerwony* «będący koloru krwi lub dojrzałego pomidora» ‘red «the colour of blood or ripe tomato»’ UDP, ODP. No such word exists; the adjective *kolorowy* ‘± colourful’ has a specific meaning, so it rather is the noun *kolor* ‘colour’ which serves as a hypernym of *czerwony* (Lyons 1977: 298). For the adjective *głodny* ‘hungry’, the UDP gives the definition «odczuwający głód, pragnący pożywienia» ‘«feeling hunger, craving food»’, while ODP defines it using a verb phrase: «Komuś, kto jest głodny, bardzo chce się jeść» ‘«Someone who is hungry very much wants to eat»’. No obvious adjective candidate for hypernym comes to mind,⁶ but a noun can be easily proposed, for example *potrzeba* ‘(physical) need’. Adjectives, then, may be naturally defined by nouns. Lyons calls such a relation *quasi-hyponymy* (1977).

Polish WordNet 2.0 will include both adjectival hyponymy and quasi-hyponymy; the latter relation is named *value of the attribute*, a borrowing from Princeton WordNet’s *attribute* relation (“WordNet contains pointers between descriptive adjectives and the nouns by which appropriate attributes are lexicalized”, see Miller 1998: 48).

⁵[T]here is no superordinate term in English of which all the colour-words are co-hyponyms. (Logicians frequently cite as an example of analytic implication *If it is red, then it is coloured*. But this implication does not in fact generally hold for all colour-terms in normal English usage. The adjective *coloured* is in contrast with *white* in certain contexts — in sorting out the laundry, in the classification of people according to their race, etc. — and with *transparent* in others: e.g. *There was some colored liquid in the bottle* — one might also wonder whether *coloured* is in contrast with *white*, as well as with *transparent*, in contexts of this kind.) (Lyons 1995: 456).

⁶UDP and SD [*Synonym Dictionary*] (Wiśniakowska 2010) infelicitously give *głodny* ‘hungry’ the hypernym *złakniony* ‘± hungry’. Any Polish native speaker observes a mistake — this rather is a synonym, as in the *Great Synonym Dictionary* (Bańko 2011).

Hyponymy between adjectives is absent in PWN (Miller 1998) and in EWN, but it was introduced into the GN structure (Hamp, Feldwag 1997). Adjectival hyponymy also appears in RussNet (Azarova, Yavorskaya 2010: 217–8).

Murphy (2003: 222) proposes the following test for adjectival hyponymy:

- *To be excellent is to be good to a certain degree.*

Note that such a test is strongly connected with gradable adjectives: the two adjectives occupy a predicative position (*be + Adj*). Croft and Cruse (2004: 142) propose another test suitable for both gradable and relative adjectives (occurring in the attributive position):

- *The class of scarlet things is a subset of the class of red things.*

We merge both tests for use in Polish WordNet 2.0:

Test I. *Hyponymy, Adj → Adj*

- *X, Y to przymiotniki, N to (stosowny) rzeczownik ‘X, Y are adjectives, N is a (suitable) noun’.*
- *Jeżeli ktoś/coś jest X, to jest Y ‘If someone/something is X_{Adj} , then he/she/it is Y_{Adj} ’.*
- *Jeżeli ktoś/coś jest Y, to niekoniecznie jest X ‘If someone/something is Y_{Adj} , then he/she/it need not be X_{Adj} ’.*
- *Jeżeli mówimy o N, że jest to X N, to możemy również powiedzieć, że jest to Y N ‘If we say about N that it is $X_{Adj} N$, then we can also say that it is $Y_{Adj} N$ ’.*
- *Jeżeli mówimy o N, że jest to Y N, to niekoniecznie możemy powiedzieć, że jest to X N ‘If we say about N that it is $Y_{Adj} N$, then we may be unable to say that it is $Y_{Adj} N$ ’.*

Example — *purpurowy ‘crimson’, czerwony ‘red’*

Purpurowy ‘crimson’, czerwony ‘red’ are adjectives, kapelusz ‘hat’ is a suitable noun.

Jeżeli coś jest purpurowe, to jest czerwone ‘If something is crimson, then it is red’.

Jeżeli coś jest czerwone, to niekoniecznie jest purpurowe ‘If something is red, then it need not be crimson’.

Jeżeli mówimy o kapeluszu, że jest to purpurowy kapelusz, to możemy również powiedzieć, że jest to czerwony kapelusz ‘If we say about a hat that it is a crimson hat, then we can also say that it is a red hat’.

Jeżeli mówimy o kapeluszu, że jest to czerwony kapelusz, to niekoniecznie możemy powiedzieć, że jest purpurowy kapelusz ‘If we say about hat that it is a red hat, then we may be unable to say that it is a crimson hat’.

Quasi-hyponymy (Lyons 1977) sometimes appears in wordnets. In PWN, adjectives are linked to nouns via the *attribute* relation if they express the values of an attribute, e.g., *quality* — *superb*, *great*, *good*, *mediocre*, *bad*, *awful*, *atrocious* (Miller 1998: 50–53). In EWN, the *XPOS_HYPONYM* relation is used “to relate nouns that head a class of adjectival values”, e.g., *colour* — *black*, *white*, *blue*, *green*, *yellow*, *red* (Vossen 2002: 24), but tests are not easily found in the EWN documentation. The relation also appears in RussNet (Azarova, Yavorskaya 2010: 217–218), for example, the adjective *кислый* ‘acidic’ is a noun-like hyponym of the noun *вкус* ‘taste’. RussNet constructs the following tests for the two words:

- The *fruit is acidic* implies that the *fruit has (certain) taste*.
- The *fruit has certain taste* does not imply that the *fruit is acidic*.

Note that this test only works for gradable adjectives. We create a similar test for our *value of the attribute* relation.

Test II. *Value (of the attribute)*, Adj → N

- *X* to przymiotnik, *N*, *P* to (stosowne) rzeczowniki ‘*X* is an adjective, *N*, *P* are the (suitable) nouns’.
- Jeżeli ktoś/coś jest *X*, to ma określony *N* ‘If someone/something is X_{Adj} , then he/she/it has a specific *N*’.
- Jeżeli ktoś/coś ma określony *N*, to niekoniecznie jest *X* ‘If someone/something has a specific *N*, then he/she/it need not be X_{Adj} ’.
- Jeżeli ktoś/coś jest *X P*, to ma określony *N* ‘If someone/something is $X_{Adj} P$, then he/she/it has a specific *N*’.
- Jeżeli *P* ma określony *N*, to niekoniecznie jest *X P* ‘If *P* has a specific *N*, then it need not be $X_{Adj} P$ ’.

Example — *czerwony* ‘red’, *kolor* ‘colour’

Czerwony ‘red’ is an adjective, *kolor* ‘colour’, *kapelusz* ‘hat’ are suitable nouns.

Jeżeli coś jest czerwone, to ma określony kolor ‘If something is red, then it has a specific colour’.

Jeżeli coś ma określony kolor, to niekoniecznie jest czerwone ‘If something has a specific colour, then it need not be red’.

Jeżeli coś jest czerwonym kapeluszem, to ma określony kolor ‘If someone/something is a red hat, then it has a specific colour’.

Jeżeli kapelusz ma określony kolor, to niekoniecznie jest czerwonym kapeluszem ‘If a hat has a specific colour, then it need not be a red hat’.

3. Antonymy and Converseness

“Antonymy, or ‘oppositeness of meaning’, has long been recognized as one of the most important semantic relations” (Lyons 1995: 460). Atkins and Rundell state that “as hyponymy holds more often between nouns, so antonymy ‘belongs’ more to adjectives” (2008: 141). According to Clark’s psycholinguistic experiments (1970; after: Nagórko 1987: 63), adjectives are stored in memory in pairs of opposites (antonyms).

Semanticists distinguish two main types of antonymy, among others:⁷ *gradable antonymy* (*polar oppositions*, *classical antonymy*, or simply *antonymy*) and complementarity (*binary*, *ungradable* or *complementary antonymy*, or *contradiction*) (Lyons 1977: 274, 291; Lyons 1995: 461–463; Murphy 2003: 201; Malmkjaer 2002: 341; Atkins, Rundell 2008: 141).

Complementary antonyms are usually defined by entailment: $\sim X \rightarrow Y$ and $Y \rightarrow \sim X$, where X and Y are lexical units (Lyons 1995b: 401, Kreidler 1998: 104–105; Lyons 1995: 128–129; Lyons 1977: 271–272, 279–280). Examples of complementaries are *married* / *single* and *dead* / *alive*: someone cannot be married and single at the same time; it is impossible for someone to be neither dead nor alive.

For gradable antonyms only the latter implication holds: $Y \rightarrow \sim X$ (Lyons 1995b: 466–467). Examples of gradable antonyms are *good* / *bad* and *red* / *blue* (as well as *green* and so on): something cannot be both good and bad; it is quite possible for things or beings to be neither red nor blue (green and so on) (Lyons 1995: 461). Antonymy is recognized also within the Sense \leftrightarrow Text paradigm with the stipulation that Anti₁ type, i.e., direct opposites, corresponds to complementary antonymy, and Anti₂ and Anti₃ of contradictory meaning types refer to gradable antonymy (Mel’čuk 1996: 47–9; Apresjan 2000: 269, 273–277; Wanner 1996: 8).

It should be noted that the entailment $Y \rightarrow \sim X$ holds not only for antonyms but also for other words which share the incompatibility of meaning, for instance, co-hyponyms, such as *blue* and *green*, or unrelated words, like *overture* and *bottle*, *justice* and *cat* (Lyons 1981: 154–155; Murphy 2009: 25; Murphy 2003: 249–250; cf. Griffiths 2006: 52–54). Antonyms have a lot in common; an antonym negates only part of the meaning of its counterpart (Apresjan 2000: 269, 270, 273). The compatibility of senses between antonyms comes from the fact that they have a common hypernym (Lewandowska-Tomaszczyk 1998: 124).

Antonymy is one of the most prominent adjective relations in PWN. Relations in PWN are psycholinguistically motivated: “The importance of antonymy first become obvious from results obtained with word association test: when the probe [i.e., an adjective given to a respondent] is a familiar adjective, the response commonly given by adult speaker is its antonym. For example, to the probe *good*, the common response is *bad*; to *bad*, the most frequent response is *good*” (Miller 1998: 48). Descriptive adjectives which express the value of the same attribute are divided into antonymic clusters.

⁷We consider *antonymy* more broadly in order to capture classical antonymy and complementarity of senses (Allan 2009: 26). Other types of antonymy, such as directional antonymy (Atkins, Rundell 2008: 141), will not be discussed here. It should be noted, however, that directional antonyms (*North* – *South*, *top* – *bottom*) will pass *plWordNet* tests for gradable antonymy.

X and Y are antonyms if they are co-hyponyms or co-meronyms. This condition guarantees that they have a common semantic element. Our tests include yet another condition, after Cruse's proposal: "[N]ot all lexical items are felt to have opposites. Ask someone for the opposite of *table*, or *gold*, or *triangle*, and he will be unable to oblige. Some lexical items, it seems, are inherently non-opposable" (Cruse 1997: 257–8). We have decided to check for every pair whether it is an example of opposition:

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

This helps distinguish antonyms from co-hyponyms. Here is the whole test.

TEST III. *Complementary antonyms*

- X, Y to przymiotniki 'X, Y are adjectives'
- X i Y muszą być kohiponimami lub kowartościami tej samej cechy 'X, Y must be co-hyponyms or co-values of the same attribute'
- 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'

Example — *żywy* 'alive', *martwy* 'dead'

Żywy 'alive', *martwy* 'dead' are adjectives which are co-values of the same attribute STAN 'state'.

Jeżeli ktoś jest martwy, to nie może być żywy 'If someone is dead, then he/she cannot be alive'.

Jeżeli ktoś nie jest martwy, to musi być żywy 'If someone is not dead, then he/she must be alive'.

TEST IV. *Gradable antonyms*

- X, Y to przymiotniki 'X, Y are adjectives'
- X i Y muszą być kohiponimami lub kowartościami tej samej cechy 'X, Y must be co-hyponyms or co-values of the same attribute'
- Czy ktoś/coś jest X? Nie, wręcz przeciwnie: jest Y! 'Is he/she/it X? No, on the contrary: he/she/it is Y!'
- 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 niekoniecznie musi być Y 'If someone/something is not X, then he/she/it need not be Y'

Example — *dobry* ‘good’, *zły* ‘bad’

dobry ‘good’, *zły* ‘bad’ are adjectives which are co-values of the same attribute WŁAŚCIWOŚĆ ‘quality’

Czy on jest dobry? Nie, wręcz przeciwnie: jest zły! ‘Is he good? No, on the contrary: he is bad!’

Jeżeli ktoś jest dobry, to nie może być zły ‘If someone is good, then he/she cannot be bad’

Jeżeli ktoś nie jest dobry, to niekoniecznie jest zły ‘If someone is not good, then he/she need not be bad’

Converseness is another kind of semantic opposition within which the inter-related words have reversible characteristics: they become synonymous when one changes their actants. For example, A is a husband of B implies that B is a wife of A. Similarly, A sells B to C means that B buys C from A (Lyons 1977: 274; Lyons 1995: 467–469; Malmkjaer 341; Apresjan 2000: 241–265; Kreidler 1998: 97; Kempson 1996: 85; Wanner 1996: 8–9).

Converseness is regular among comparative forms of antonymous gradable adjectives, like *older* / *younger*, *bigger* / *smaller* (Lyons 1977; Lyons 1995: 464; Lyons 1995b: 128–129; Murphy 2003: 196). The relation between comparatives is so clear that Lyons used it to define antonymy (Lyons 1995: 464).

We construct our tests for the relation out of Lyons’s tests for adjective converseness (Lyons 1996(1977): 280, Lyons 1995b: 128–129):

TEST V. *Converseness*

- X, Y to przymiotniki w stopniu wyższym ‘X, Y are the comparative forms of adjectives’.
- Jeżeli A jest X_{COMP} niż B, to B jest Y_{COMP} niż A ‘If A is X-er than B, then B is Y-er than A’.
- Jeżeli B jest Y_{COMP} niż A, to A jest X_{COMP} niż B ‘If B is Y-er than A, then A is X-er than B’.

Example — *lepsz*y ‘better’, *gorsz*y ‘worse’

Lepszy, gorszy are the comparative forms of adjectives *dobry, zły*.

Jeżeli A jest lepszy niż B, to B jest gorszy niż A ‘If A is better than B, then B is worse than A’.

Jeżeli B jest gorszy niż A, to A jest lepszy niż B ‘If B is worse than A, then A is better than B’.

4. Gradation

We have seen that lack of complementarity (defined by the implication $X \rightarrow \sim Y$) is the property not only of antonyms but also co-hyponyms (*blue — green*) or even unrelated words (*dog — tree*). To Lyons, it seems that the paradox could be resolved with the notion of gradability rather than truth values of implication (Lyons 1977; Miller 1998: 52–53). Gradable antonyms express different values of the same attribute — they belong to the same scale (cf. Verbuk 2007; Croft and Cruse 2004: 169–192). Of course, there are other adjectives connected with the same attribute (scale, van Rooij 2011: 131). The order of different values could be seen as a semantic ordering relation for adjectives pointing to the same scale. Bierwisch (1989) calls it *gradation*. Miller (1998: 53) gives a few examples of the relation: SIZE: *astronomical — huge — large — small — tiny — infinitesimal*; QUALITY: *superb — great — good — mediocre — bad — awful — atrocious*. Such sequences could be easily proposed for Polish.

TEMPERATURA: *gorący — ciepły — ciepławy — letni — chłodnawy — chłodny — zimnawy — zimny — lodowaty* ‘TEMPERATURE: hot — warm — warmish — lukewarm — cool — coldish — cold — ice-cold’

NATEŻENIE DŹWIĘKU: *niestyszalny — cichy — głośny — potężny* ‘SOUND INTENSITY: inaudible — soft — loud — powerful’

POŁOŻENIE (with regard to the water level): *nadwodny — nawodny — podwodny* ‘LOCATION: above-water — on-water — under-water’

Nagórko (1987: 68–70) introduces the semantic component [+INTENS] (intensity) to model Polish adjectives gradation semantically. She refers to relations similar to gradation as ordering relations (*ibid.*).

Following K. Miller (1998: 52–53), we establish a new *plWordNet* relation, named *gradation*.

TEST VI. *Gradation*

- X, Y to przymiotniki będące wartościami cechy N ‘X, Y are adjectives which express values of attribute N’.
- Przymiotniki X i Y nie wyrażają podobnego natężenia cechy N ‘adjectives X and Y do not express similar degrees (intensity) of attribute N’.⁸
- Przymiotnik X wyraża większe natężenie cechy N niż przymiotnik Y ‘adjective X exhibits a intensity of attribute N than Y’.
- Żaden inny przymiotnik nie może zastąpić ani X, ani Y w poprzednim zdaniu ‘No other adjective can replace X or Y in the preceding statement’.

⁸This means that the two adjectives cannot be synonymous.

Example: gorący ‘hot’ – ciepły ‘warm’

Adjectives *gorący* ‘hot’, *ciepły* ‘warm’ express the values of attribute TEMPERATURA.

Adjectives *gorący* i *ciepły* do not express similar degrees of attribute TEMPERATURA.

Adjective *gorący* exhibits higher intensity of the property TEMPERATURA than *ciepły*.

No other adjective can replace *gorący* or *ciepły* in the preceding statement.

The example is supported by lexicographic data. The UDP defines *gorący* as «mający wysoką temperaturę, bardzo ciepły, silnie nagrzaný, rozpalony» ‘having high temperature, very warm, strongly heated, glowing’. ODP gives a definition relativised to the scale: «Coś, co jest gorące, ma temperaturę wysoką, bardzo wysoką lub wyższą od normalnej» ‘Something that is hot has high temperature, very high or higher than average’. For *ciepły* the dictionary has following definition: «Coś, co jest ciepłe, ma temperaturę wysoką, ale niezbyt wysoką, albo taką, jaką zwykle mają rzeczy tego rodzaju» ‘Something that is warm has a high temperature, but not very high, or such temperature as is common for things of that sort’. Both dictionaries agree that *gorący* has a higher intensity of TEMPERATURE than *ciepły*.

5. Distributional properties

It is quite a common situation when an adjective serves as a modifier of a limited group of nouns. A case in point are Polish adjectives which describe equine coat colours — see examples in Table 4. The adjective *kary* ‘black (with regard to a horse)’ has its synonym *czarny* ‘black’. They differ in their distributional properties. The usage of *kary* is limited to nouns denoting horses, the applicability of *czarny* is much wider.

Table 4. Examples of equine coat colours

kary ‘black’ «o maści konia: czarny; wrony» UDP ‘of horse coat: black; like crow’s’
dereszowaty ‘roan’ «o koniu lub jego maści: właściwy dereszowi, charakterystyczny dla deresza» UDP ‘of horse or its coat: characteristic of roan’

gniady ‘bay’ «o maści konia: jasnobrązowy z odcieniem czerwonobrunatnym, z czarną grzywą, czarnym ogonem i czarnymi dolnymi częściami kończyn» UDP ‘of horse coat: light brown with a red-brown tint, with a black mane, black tail and black lower parts of limbs’

kasztanowaty ‘maroon’ «o koniu lub jego maści: brązowożółty» UDP ‘of horse or its coat: brown-yellow’

The same property is exhibited by adjectives *piwny* ‘~hazel’, *pierworodny* ‘first-born’ or *podkasana* ‘± frivolous’. They point only to the specific types of objects, animals and people. 5 illustrates.

Table 5. Examples of restrictions on adjective connectivity

Example — limitations in modifying properties

piwny ‘~hazel’ «o oczach, ich kolorze: brązowy z żółtym odcieniem, taki jak piwo» UDP ‘of eyes, of eye colour: brown tinted yellow, like beer’

pierworodny ‘first-born’ «o dziecku: urodzony najwcześniej, jako pierwszy, najstarszy z rodzeństwa» UDP ‘of a child: born at first, as first one, eldest of the siblings’

podkasana ‘lit. short-skirted; fig. frivolous’ «o kobiecie: nosząca bardzo krótkie sukienki, spódnice itp.» ‘of a woman: wearing short dresses, skirts etc.’

The following test will be used to check whether an adjective modifies a given noun or a noun class. If a pointer of the relation links the adjective with a certain noun, it also means that all its hyponyms may be modified with the adjective. Note that only gradable adjectives pass the test.

TEST VII. Modifier

- X to przymiotnik, N, P to rzeczowniki ‘X is an adjective, N and P are nouns’.
- X wchodzi w relację wartości cechy z P ‘X is a value of attribute P’.
- P zazwyczaj charakteryzuje N ‘P usually characterises N’.
- Mówi się o N, że jest X w odniesieniu do jego/jej P ‘It is said about N that it is X with regard to its/his/her P’.
- Jeżeli N jest X, to ma określone P ‘If N is X, then it has a specific P’.
- Jeżeli N ma określone P, to niekoniecznie jest X ‘If N has a specific P, then it/he/she need not be X’.

Example – piwny ‘~hazel’

Piwny is an adjective, *oko*, *kolor oczu* are a noun and a noun phrase.

Piwny wchodzi w relację wartości cechy z KOLOR OCZU ‘*Hazel* is a value of attribute EYE COLOUR’.

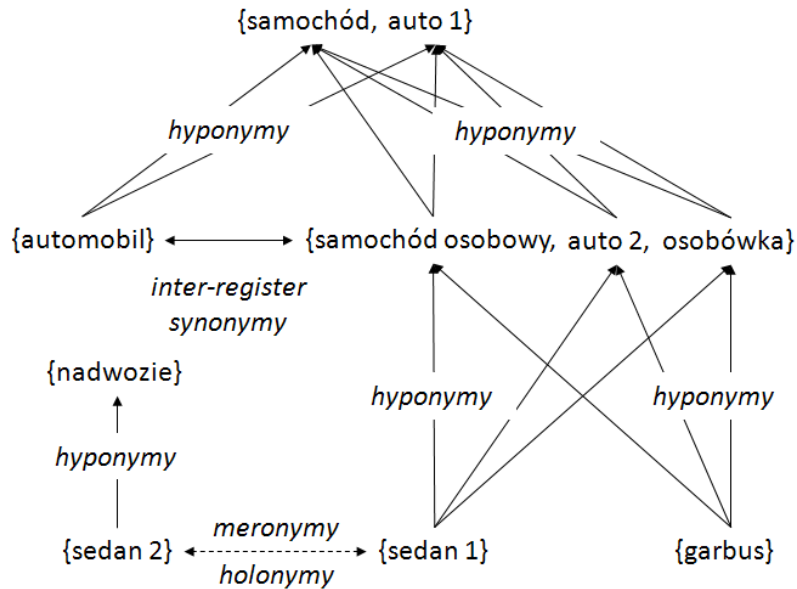
KOLOR OCZU zazwyczaj charakteryzuje oko ‘eye colour usually characterises an eye’.

Mówi się o oku, że jest piwne w odniesieniu do jego KOLORU ‘It is said about an eye that it is hazel with regard to its COLOUR’.

Jeżeli oko jest piwne, to ma określony KOLOR ‘If an eye is hazel, then it has specific COLOUR’.

Jeżeli oko ma określony KOLOR, to niekoniecznie jest piwne ‘If an eye has specific COLOUR, then it need not be hazel’.

Figure 1. An example of incompatibility of relation sets of inter-register synonyms for nouns.



6. Inter-register synonymy

Lexical units with a very similar denotation (or even true synonyms) often cannot be used in the same contexts — for stylistic reasons or because of differences in connotation. Yet if the LUs are very close in meaning, we want them to be somehow interchangeable, just as proper near-synonyms are. The construction of *plWordNet* relies on grouping into synsets LUs with the same “topology” in the network: with the same links via instances of constitutive relations.

Thus for example *automobil* ‘automobile’ (a marked LU, labelled in the UDP as «przestarzały» ‘obsolete’) and *samochód osobowy* ‘passenger car’ have different relations, but almost identical meaning. *Samochód osobowy* has a large set of hyponyms (placed in 32 synsets), whereas *automobil* has none. In Figure 1 we present relations of two synsets: $\{\text{samochód osobowy, auto 2, osobówka}\}$ and $\{\text{automobile}\}$. The hyponyms of the former are *sedan 1* ‘sedan’ and *garbus* ‘Volkswagen Bug’. It is improbable for hyponymy to link *sedan 1* and *automobile* or *garbus* and *automobile*. It is, however, quite natural to connect *sedan* and *garbus* with two synonyms of *samochód osobowy* — *auto 2* and *osobówka*. The four inter-register synonyms, $\{\text{automobil}\}$ and $\{\text{samochód osobowy, auto 2, osobówka}\}$, share connection to their hypernyms, $\{\text{samochód, auto 1}\}$ ‘wheeled vehicle’. Note that *sedan 1* and *garbus* are not near-synonyms because meronymy differentiates the relation between *sedan 1* ‘car’ and *sedan 2* ‘sedan’ — a hyponym of *nadwozie* ‘car body type’. This is where inter-register synonymy, a relation which we have already defined for nouns and verbs, comes in.

Inter-register synonymy relaxes one condition on synonymy: stylistic registers of the two LUs differ significantly. The relation links LUs which can have the same direct hypernym and share instances of other constitutive relations except hyponyms, so they do not meet the criteria for belonging to the same synset. LUs linked by inter-register synonymy can also have different connotations, collocations and sentiment (emotional polarity).

By analogy we perceive inter-register synonymy in such adjective pairs as *modny* ‘fashionable’ — *wyczesany* ‘(a fully idiomatic new usage of ±) combed out_{perf}’, *kobięcy* ‘of women’ — *samiczy* (vulgar) ‘of mammal females’ or *kobięcy* — *niewieści* (obsolete) ‘of women’.

The following is a test for inter-register synonymy adapted to adjectives:

TEST VIII. Inter-register synonymy

- X, Y to przymiotniki ‘X, Y are adjectives’.
- Jeżeli ktoś/coś jest X, to jest także Y [pomijając różnicę rejestrów stylistycznych i konotacji] ‘If someone/something is X, then he/she/it is also Y [disregarding the stylistic register difference and connotation]’.
- Jeżeli ktoś/coś jest Y, to jest także X [pomijając różnicę rejestrów stylistycznych i konotacji] ‘If someone/something is X, then someone/something is also Y [disregarding the stylistic register difference and connotation]’.
- X i Y w istotny sposób różnią się rejestrami stylistycznymi ‘X and Y do significantly differ in stylistic registers’.

Example — inter-register synonymy

marny «zły, mający niską wartość lub złą jakość; lichey, nędzny» ‘bad, having a low value or an inferior quality’ — *badziewny* (*slang*) «beznadziejny, słaby» ‘shoddy, hopeless, weak’.

Jeżeli coś jest marne, to jest także badziewne ‘if something is poor, then it is also shoddy [disregarding the stylistic register difference and connotation]’.

Jeżeli coś jest badziewne, to jest także marne ‘if something is poor, then it is also shoddy [disregarding the stylistic register difference and connotation]’.

Marny is not a hyponym of *badziewny*, *badziewny* is not a hyponym of *marny*.

Marny and *badziewny* do significantly differ in stylistic registers.

7. Derivational relations

We based our derivational relation tests on the works of Nagórko (1987), Grzegorzyczkowa (1979, 1982), Kallas (1998), Urban (2006), and Szymanek (2010). We devote a subsection each to deverbal adjectives, denominal and deadjectival adjectives.

7.1. Deverbal adjectives

Deverbal adjectives are usually divided into two main groups — predisposition (or potential) and activity adjectives (Puzynina 1976, Grzegorzczkova 1979, Kallas 1998, Nagórko 1987: 152). The former express the tendency of the agent or patient to act somehow or to get into a particular state (so, it is likely that the agent does something or something is done to him/her/it). The latter have the semantic property of action or process perpetuity — without any modal modifiers (so the agent simply does something or something is done to him/her/it) (Kallas 1998: 471). Predisposition adjectives are paraphrased using such terms as *habitually* or *potentially*, while activity adjectives lack this kind of modality: they can be explained by terms such as *usually* or *often* (Grzegorzczkova 1982: 51–2).

We should carefully distinguish between deverbal adjectives and participles (either active, *-ący*, or passive, *-ny*, *-ty*). Participles denote actual situations; deverbal adjectives cannot do it (Kallas 1998: 473). Grzegorzczkova (1979: 62–3) states that participles, but not deverbal adjectives, appear with time determiners like *wczoraj* ‘yesterday’, *dzisiaj* ‘today’, *na długo* ‘for long’.

- **Roles (Adj → V)**

Activity adjectives are divided according to the semantic roles of the nouns they modify: agent, patient, instrument and so on. Among the role relations which we consider in *plWordNet* there are the following *semantic roles of adjectives*.

In all tests, A is an adjective and V is a verb.

- **Agent.** The noun modified is the agent of an activity described by the adjective. Following Kallas (1998: 474–5) and Nagórko (1987: 126–8, 134),⁹ and Grzegorzczkova (1979: 64–5) we use the morphological paraphrases:

A = taki, który $V_{3.sg.praes.+impf./3.sg.praet.+pf}$. ‘that who/which V’ (for imperfective and perfective verbs).

Examples:

wważny (*uczeń*) ‘attentive (pupil)’ = taki, który *uwaga*_{3sg.praes.impf.} ‘that who pays attention’, *ożywczy* (*napój*) ‘invigorating (drink)’ = taki, który *ożywia*_{3sg.praes.impf.} ‘that which invigorates’; *zbiegły* (*jeniec*) ‘escaped (prisoner-of-war)’ = taki, który *zbiegł*_{3sg.praet.pf.} ‘that who has escaped’.

- **Patient.** The noun modified is the patient of the activity expressed by the adjective. Substitution tests are based on Kallas’ (1998: 475) and Nagórko’s paraphrases:

A = taki, który *ktoś/coś/się* $V_{3.sg.praes.+impf./3.sg.praet.+pf}$. ‘that whom / which someone V’ (for imperfective and perfective verbs).

Examples:

(*pole*) *uprawne* ‘(field) cultivated or earmarked for cultivation’ = takie, które *ktoś uprawia*_{3.sg.praes.+impf.} ‘that which is cultivated or earmarked

⁹Please, note that *agent* and *object* roles in Nagórko’s model equal Kallas’ (and ours) *agent*.

for cultivation', *najęty (pracownik)* = taki, którego ktoś najął_{3.sg.praes.+pf.}
 'that whom someone hired'.

- **Instrument.** The noun modified denotes a tool or instrument. It is paraphrased thus:

A = taki, za pomocą którego ktoś/coś/się V_{3sg.praes.} 'that which someone / something V using it' (for imperfective verbs):

ogrzewcze (urządzenie) 'heating (device)' = takie, za pomocą którego ktoś/coś ogrzewa_{3.sg.praes.impf.} 'that by means of which someone / something heats'.

- **Location.** The noun modified denotes the place of the activity (Kallas 1998: 475–6):

A = taki, gdzie ktoś/coś/się V_{3sg.praes.} 'that where someone/something V' (for imperfective verbs):

grząski (grunt) 'marshy (ground)' = taki, gdzie się grzęźnie 'that where one mires'.

- **Time.** The noun modified denotes the time of the activity (Kallas 1998: 476–7):

A = taki, w czasie którego ktoś/coś/się/NULL V_{3sg.praes.} 'that when someone/something V' (for imperfective verbs):

mżysty (dzień) 'drizzly (day)' = taki, w czasie którego mży_{3sg.praes.impf.} 'that when it is drizzling'.

- **Result.** The superordinate noun denotes the result of the activity (Kallas 1998: 476–7):

A = taki, który jest efektem tego, że ktoś/coś/się V_{/[3.sg.praes.impf./pf.]} 'that which is caused by the fact that someone/something V' [for imperfective verbs]:

(cecha) dziedziczna 'inherited (trait)' = taka, która jest efektem tego, że ktoś dziedziczy 'that which is the result of the fact that someone inherits'.

- **Cause.** The noun modified denotes the cause of the activity (Kallas 1998: 477):

A = taki, który powoduje, że ktoś/coś V_{3.sg.praes.impf.} 'that which causes that someone/something inherits':

(lek) wykrztuśny 'expectorant' = taki, który powoduje, że ktoś wykrztusza 'that which makes someone expectorate'.

- **Predisposition (Adj → V)**

Predisposition adjectives are involved in three subtypes of *predisposition* relations: potential, habituality and quantification (Kallas 1998: 478–480).

In all tests, A is an adjective and V is a verb.

- **Potential.** The relation links an adjective which could be explained by the phrase 'it is possible that'. There are a few suffixes with that function, including *-ny* (*materiał palny* 'flammable material'), *-liwy* (*łamliwie*

kości ‘breakable bones’) and a very productive *-alny* roughly equivalent to English *-able* (*poznawalny* ‘recognizable, that which can be recognized’, *mieszkalny* ‘livable, that in which someone can live’). Potential adjectives appear in the objective case (Kallas 1998: 478–9).

A = taki, (prep) który można $V_{\text{infinitive}}$ ‘that which it is possible to V’ (both perfective and imperfective):

akceptowalny ‘acceptable’ = taki, który można zaakceptować ‘that which is possible to accept’, *pitna (woda)* ‘drinking (water)’ = taka, którą można pić ‘that which is drinkable’.

- **Habituality.** This is described with the adverbs such as *always*, *often*, *easily* (Kallas 1998: 479). The noun modified is the subject. Habituality is signalled by a specialised suffix *-liwy*.

A = taki, który zawsze/często/łatwo $V_{3.\text{sg.praes.}}$ ‘that which always, often, easily V’:

płochliwy (ptak) ‘skittish (bird)’ = taki, który zawsze/często/łatwo płoszy się ‘that which is always/often/easily scared’.

- **Quantification.** The modifying adjective signals a large amount of something (*dużo* ‘a lot’) or an evaluation (*dobrze* ‘well’) of what the noun denotes (Kallas 1998: 479–80):

A = ‘taki, (prep) który dużo bądź dobrze $V_{3.\text{sg.praes.}}$ ’ = ‘that which does a lot or in a good manner’ (for imperfective verbs only):

wytrzymały ‘resistant’ = taki, który może dużo wytrzymać ‘that who can resist a lot’, *widny (pokój)* ‘light (= well lighted)’ = taki, w którym dużo/dobrze widać ‘± that where one can see well’.

7.2. Deadjectival adjectives — markedness

Polish deadjectival derivatives are created not only by suffixation but also by prefixation: *krótk-awy* ‘shortish’, *przy-krótki* ‘rather short’ from *krótki* ‘short’ (Kallas 1998: 501). Linguists distinguish three main types of deadjectival derivatives: negative adjectives (for absence or lack of something), gradation adjectives (for intensification or diminution of the attribute value) and expressive markedness (Kallas 1998: 501–9). Only the latter type will be encoded with a special relation *markedness*. Negative and gradation adjectives can only be coded with vague derivational relation (derivativity, cf. Section 7.4). That is because we can encode the relations without resorting to primary (more specific) derivational relations.

• Negative adjectives

Negative adjectives, such as *bez-dyskusyjny* ‘undisputed’ from *dyskusyjny* ‘debatable’ or *nie-pewny* ‘unsure’ from *pewny* ‘sure’, can be explained with gradable/complementary antonymy or converseness and hyponymy (see Figure 2). They are created by prefixation (the list of prefixes includes: *nie-* ‘non-’, *bez-* ‘without’, *a-*, *ir-* ‘non-, ir-, a-’ and *anty-* ‘anti-’, *inter alia*).

Figure 2. Negative adjectives encoded with opposition relations, hyponymy and derivativity

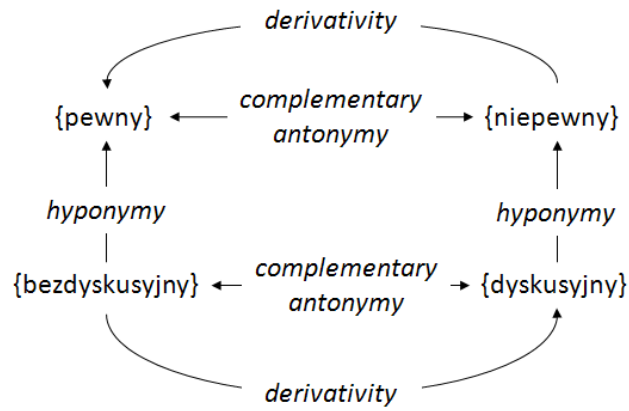
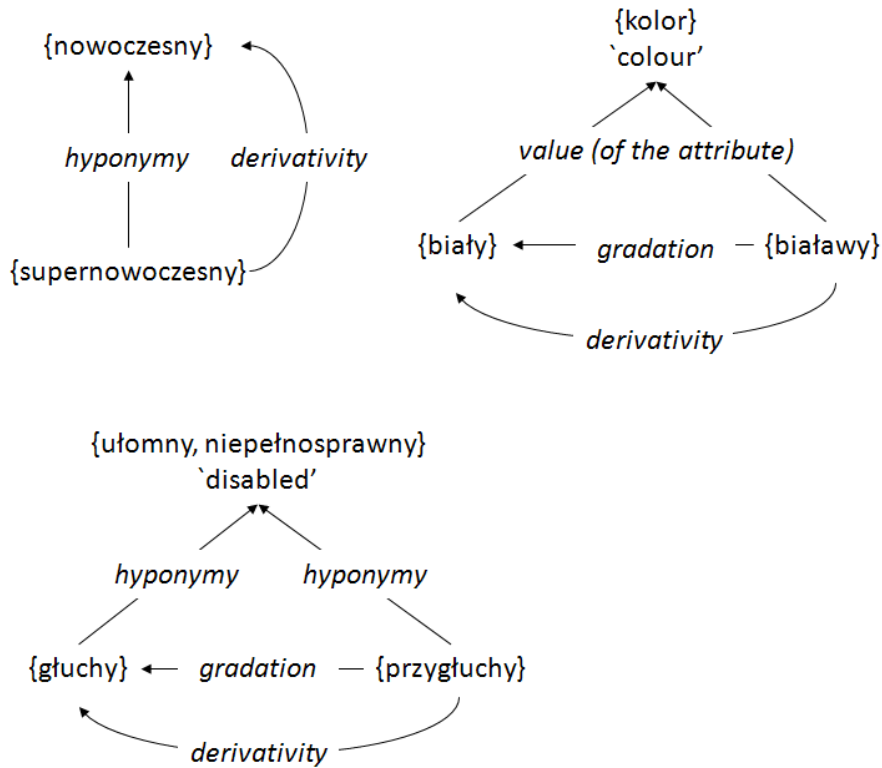


Figure 3. Gradation adjectives will be explained by hyponymy, value of the attribute and gradation.



• Gradation adjectives

A gradation adjective denotes intensification or diminution of a value expressed by the base adjective. There are either comparative or superlative adjective forms, described in Section 7.2. or less categorial derivatives, produced by *absolute derivation by degree* (pol. *derywaty stopniowania bezwzględnego*, Kallas 1998: 502–506): *biał-awy* ‘whitish’ from *biały* ‘white’, *przy-głuchy* ‘partly deaf’ from *głuchy* ‘deaf’, *super-nowoczesny* ‘supermodern’ from *nowoczesny* ‘modern’ etc. We decided to define such adjectives by other relations (for example, hyponymy and derivativity). The semantic feature ‘very’ (intensification) can be treated as a *differentia specifica*, and the meaning of the base as a *genus proximum*. This is the case of *super-nowoczesny*, which can be linked to *nowoczesny* by hyponymy (if something is very modern, then it is also modern). On the other hand, *przygłuchy* and *białawy* cannot be so analysed. The implication does not hold: someone partly deaf need not be deaf; something whitish need not be white. It seems that the gradation relation serves such cases better (see Figure 3).

• Markedness

Markedness is a derivational relation which encodes emotional markedness (usually positive) and non-obligatory intensification or diminution. There are several suffixes which serve as determiners of markedness: *-utki*, *-uśki*, *-uchny*, *-eńki*, *-aśny*, *-usi* or *-uni* (Kallas 1998: 506–7). Here is a substitution test for marked deadjectival adjectives (X and Y are adjectives):

X = przyjemnie Y (i bardzo Y) ‘pleasantly Y (and very Y)’:

Example: *mal-utki* ‘very small and pleasantly small’ from *mały* ‘small’, *mokr-uśki* ‘very wet and pleasantly wet’ from *mokry* ‘wet’, *śłodzi-uchny* ‘very sweet and pleasantly sweet’ from *śłodki* ‘sweet’. There can be sequences of such derivations where suffixes sometimes merge (Kallas 1998: 507): *mal-usienieczki* from *mal-usieńki* from *mal-usi* ‘very and pleasantly small’ from *mały* ‘small’. Each adjacent pair will be linked by the markedness relation.

• Comparatives and superlatives

Comparative and superlative relations link pairs of adjectives. Synthetic comparative and superlative degrees in Polish have a slightly uncertain status. Some researchers place them among inflectional phenomena (Tokarski 1973, Nagórko 1987), while others hold that they belong to the world of derivation and thus constitute autonomous lexemes (Laskowski 1998). We opted for the derivational view for pragmatic reasons: many words are derived from adjectives in the synthetic comparative or superlative degree, and the degrees should appear in their definitions:

powiększyć ‘enlarge’ «spowodować, że coś stanie się większe pod względem rozmiarów, ilości, intensywności ‘cause something to become larger by size, quantity or intensity’» (*większy* ‘larger’ from *duży* ‘large’);

zmniejszyć ‘diminish’ «uczynić coś mniejszym pod względem rozmiarów, intensywności, ilości itp. ‘make something smaller by size, intensity, quantity, among others’» (*mniejszy* ‘smaller’ from *mały* ‘small’);

mniejszość ‘minority’ «mniejsza część jakiejś całości ‘a smaller part of a whole’» (*mniejszy* ‘smaller’).

We introduce the two derivational relations (comparative and superlative) in cases when we define a given word using adjectives in those degrees.

7.3. Denominal adjectives — relational and gradable adjectives

Denominal adjectives make up 87% of all adjectival derivatives in Polish (Kallas 1998: 482; cf. Urban 2006: 19–20). Semanticists find them difficult to describe. There usually is a strong context-dependence. Consider the adjective *wiejski* ‘rural’ from the noun *wieś* ‘village’. Here is a selection of its senses:

wiejski kościół ‘church (located) in a village’;

wiejskie dożynki ‘harvest festival (celebrated) in a village’;

wiejska kiełbasa ‘country sausage, made in a village or in village style’, ‘sausage from village’;

wiejska wspólnota ‘rural community, community that consists of villagers and inhabits a village’, ‘community from a village’.

The senses oscillate around location, origin or collectiveness. Their variety is constrained by the semantic properties of *wieś*: it is a place where people live in a community. While the sense set is determined by the meaning of the base, sense distribution depends on the semantics of the noun modified. Thus, *kościół* ‘church’ is a building, *dożynki* ‘harvest festival’ — a feast, *kiełbasa* ‘sausage’ — food, *wspólnota* ‘community’ — a group of people.

• Relational adjectives and cross-categorical synonymy

Such varied behaviour is typical of relational adjectives. Their meaning is so diverse that it can only be explained by a pure relation to its derivational base, the noun (Trask 1996: 236, Post 1986: 1003–13, Grzegorzczkowska 1979: 67). In Polish dictionaries, relational adjectives tend to have a vague definition: ‘related to...’, ‘connected with...’, ‘concerning...’, and so on. Here are two examples:

wojskowy [from *wojsko* ‘army’] «związany z wojskiem, ...należący do wojska» ‘associated with the army, ...belonging to the army’;

eurolpejski ‘European’ [from *Europa* ‘Europe’] «dotyczący Europy, Europejczyków, pochodzący z Europy, taki jak w Europie» ‘concerning Europe, Europeans, originated in Europe, as in Europe’.

Relational adjectives are assumed to be transposition (syntactic) derivatives.¹⁰ (Kallas 1998: 482). Nagórko (1987), Grzegorzczkowska (1979) and many others state that

¹⁰Transpositional (syntactic) derivatives are those lexical units which inherit the meaning of the derivational base almost unchanged; the only difference is a part-of-speech shift.

a paraphrase is possible using a noun (in a suitable case) or a simple prepositional phrase. The following examples illustrate: *pałac_N królewski_{Adj}* ‘royal palace’ = *pałac_N króla_{N-gen}* ‘king’s palace’ (*genetivus possessivus*), *rybi_{Adj} ogon_N* ‘fish tail’ = *ogon_N ryby_{N-gen}* ‘tail of fish’ (*genetivus partitivus*), *oddział_N strzelecki_{Adj}* ‘rifleman detachment’ = *oddział_N strzelców_{N-gen}* ‘detachment of riflemen’ (genitive of collection), *wetniana_{Adj} sukienka_N* ‘woollen dress’ = *sukienka_N [zrobiona] z_{+gen} wełny_{N-gen}* ‘dress [made] of wool’ (genitive of material), *brodaty_{Adj} starzec_N* ‘bearded old man’ = *starzec_N z_{+instr} brodq_{N-instr}* ‘old man with a beard’, *samolot_N pasażerski_{Adj}* ‘passenger aircraft’ = *samolot_N dla_{+gen} pasażerów_{N-gen}* ‘aircraft for passengers’ (genitive of purpose) — see Nagórko (1987: 145–8). Kallas (1998: 483–94) lists many such contextual roles (cases): of subject, object, material, instrument, location, time, result, possession, origin and so on.

Because of the contextual nature of the senses of denominal adjective, we must not include them in Polish WordNet. It consists of lexical units — word+sense pairs — not of contextual meanings. Relational adjectives belong rather to the world of syntax than to the lexis. Instead of giving them a specific semantic relation (e.g., “role”), we may link them by *cross-categorial synonymy*. In *plWordNet* 2.0 this relation has already been used to link transpositional deadjectival nouns with the suffix *-ość* (± English *-ness*) and their adjectival bases, as in *czerwoność* ‘redness’ from *czerwony* ‘red’. It also connects gerunds (categorical deverbal nouns with suffixes *-anie*, *-enie*, *-cie*) and their base verbs (Maziarz et al. 2011b: 190).

• Relational versus gradable/qualitative adjectives

It is important to distinguish relational and non-relational (also called *gradable* or *qualitative*) adjectives, because only the former may be linked by cross-categorial synonymy. Several tests have been proposed to capture the difference.

It is said that relational adjectives are not gradable (**bardziej mineralny* ‘*more mineral’), in contrast with qualitative adjectives (*najbardziej esowaty* ‘the most S-shaped’) (Nowakowska 1998: 83–4, Szymanek 2010: 83). Relational adjectives occupy the attributive position (*woda_N mineralna_{Adj}* ‘mineral water’) while the predicative position in natural contexts is prohibited (**ta ciecz jest mineralna* ‘*this liquid is mineral’).¹¹ Qualitative adjectives occur in both positions (*esowaty patyk* ‘S-shaped stick’, *ten patyk jest esowaty* ‘this stick is S-shaped’) (Szymanek 2010: 81; Nagórko 1987: 52–62). The natural order of the noun and its modifier also depends on the class of the adjective: relational adjectives are postposed (*woda_N mineralna_{Adj}*), qualitative adjectives — preposed (*esowaty patyk*) (Szymanek 2010: 81–2). It is possible to derive from qualitative adjectives *nomina essendi* with suffix *-ość* (*esowatość* ‘S-shapedness’), relational adjectives do not have this property (**mineralność* ‘?mineralness’) (Nowakowska 1998; Szymanek 2010: 82).

The two classes are not fully separable, and some researchers posit a third class of relational-qualitative denominal adjectives (Grzegorzczkova 1979, Szymanek 2010). “[T]here are specific semantically defined subclasses of denominal

¹¹ According to Nowakowska (1998), relational adjectives may appear in predicative function in language games, but that would be a marked context.

adjectives which, quite systematically, meet only some of the afore-mentioned criteria which define the contrast between the purely relational and the qualitative function” (Szymanek 2010: 83–4).

Possessive adjectives are a good example. They denote a state of possession. Consider *zamężna (kobieta)* ‘married (woman)’ (lit. ‘with a husband’ = ‘who has a husband’, from *mąż* ‘husband’). This adjective can serve as an attribute, or can be used in a predicative function (*ta kobieta jest zamężna* ‘this woman is married’). It is also possible to create an abstract derivate *?zamężność* ‘?marriedness’ (it does appear on the Internet). We cannot, however, grade it: **bardziej zamężna* ‘more married’ is practically unacceptable in Polish.

We note the same phenomenon for material adjectives which carry the meaning ‘made of...’. Consider *stalowy drut* ‘steel wire, wire made of steel’, *to jest stalowy drut* ‘this is a steel wire’, *?stalowość* ‘?steelness’, and **bardziej stalowy* ‘± *steeler’ (comparative).

Linguists distinguish a few groups of qualitative adjectives according to different definitions of qualitiveness. For instance, Grzegorzycowa (1979), and Gawełko (1976) list three categories of qualitative adjectives. Following Szymanek (2010: 97–100) and Nagórko (1987: 148–150), we adopted two qualitative denominal adjective classes which meet all the conditions we have discussed thus far.¹²

Similitudinal adjectives denote “resemblance or similarity” (Szymanek 2010: 99–100, cf. Grzegorzycowa 1979: 68, Nagórko 1987: 149–150). They are paraphrased by the expression ‘taki jak’ ‘such as, like’, and carry the suffixes *-owaty* (*esowaty* ‘like S, S-shaped’), *-isty*, *-ysty*, *-asty*, *-aty*.

We introduce the *similarity* relation mapping adjectives to nouns. Q is a qualitative adjective, N is a noun, Q’s derivational base, Q is in the *value of the attribute* relation with Z):

Jeżeli ktoś/coś jest Q, to przypomina Z_{instr} N_{acc} ‘If someone/something is Q, then it resembles Z of N’.

Example: *Jeżeli coś jest esowate, to przypomina kształtem S* ‘if something is S-shaped, then it resembles the shape of S’.

The designate of a **characteristic** adjective characterises the noun modified (Grzegorzycowa 1979, called *possessive* in Szymanek 2010, cf. Nagórko 1987: 119, 148–9). The derivates are created mainly by the suffixes *-asty* (*liściasty* ‘± leafy’ from *liść* ‘leaf’), *-aty* (*garbaty* ‘humpbacked’ from *garb* ‘hump’), *-isty* (*kościasty* ‘bony’ from *kość* ‘bone’, *gwiazdzisty* ‘starry’ from *gwiazda* ‘star’), *-ny* (*sławny* ‘famous’).

We introduce the *characteristic* relation mapping adjectives to nouns. Q is a qualitative adjective, N is a noun, a derivative base of Q:

Jeśli ktoś/coś jest Q, to jest pełen/pełne N_{pl} / ma charakterystyczne N / jest charakteryzowany(e, a) przez N ‘If someone/something is Q, then he/she/it is full of N_{pl} / has a characteristic N /is characterised by N’.

¹²It is interesting that the two adjective groups have their own specialised suffixes (*-owaty* and *-isty/-ysty*) which may confirm their qualitative features (Nagórko 1987: 119, 148–9, see also Urban 2006: 18).

For example, the adjective *sławny* ‘famous’ (from *sława* ‘fame’) is defined in the UDP as «mający sławę, rozgłos, słynący z czegoś» ‘having fame, renown, being famous for something’. The substitution test for characteristic adjectives works: *Jeśli ktoś jest sławny, to jest charakteryzowany przez sławę* ‘If someone is famous, then he is characterised by fame’.

7.4. Derivativity

To be consistent with our verb and noun derivation systems (Maziarz *et al.* 2011, 2011b) we also mark *derivativity* relation if none of the relations discussed in Section 7.1–7.3 holds and if the given pair of words is connected by derivational dependency. The relation will be used, for example, to link gradation adjectives with their adjective bases (see Section 7.2). The test for derivativity is this (X is an adjective, Y is an adjective, a noun or a verb):

X jest derywatem Y ‘X is a derivate of Y’

Thus, *arcy-ciekawy* ‘most/extremely interesting’ is a derivate of *ciekawny* ‘interesting’.

Because of the semantics of derivation phenomena, derivativity also carries an unspecified semantic relation together with morphological processes.

7.5. Derivational relations and word-sense differentiation

The system of derivational relations presented in Sections 7.1–7.3 is part-of-speech-dependent. For deverbal and deadjectival adjectives, the relations are explicit and their semantics is quite well established.¹³ The majority of deverbal, deadjectival and simplex (underived) adjectives are qualitative (Post 1986: 109, Szymanek 2010: 83). It is the denominal adjective which is supposed to cause most semantic problems (Heinz 1957, Urban 2006). We built an algorithm for adjectives which can be used to supply the right class of adjectives with the right relations (Figure 4).

It is well known that senses are distinguished in wordnets on the basis of relations, mainly synset relations (Miller 1998: 36–7). The set of derivational relations which we have established will be useful as an auxiliary tool in distinguishing and describing various adjective senses. If a given derived adjective can be matched to a proper derivational relation, then it can be distinguished as a separate lexical unit. Two prominent exceptions are gradation and negative adjectives which have their own derivational relations which are not, however, included in our derivational-semantic model. They also should be given appropriate lexical units in Polish WordNet. Derivational relations will help decide the number and type of meanings of a derived adjective.

¹³But see potential and habituality categories neutralisation in (Kallas 1998: 480). Note that in our model potential adjectives are paraphrased with the predicative *można*, while habitual adjectives occur in active voice. The difference is sufficient to distinguish between all adjectives listed by Kallas. The ambiguity between habitual and quantitative adjectives remains. There is also in some cases uncertainty around the activity-predisposition distinction (Kallas 1998: 471–2), conditioned contextually, like in denominal adjectives. In such situations we will distinguish the contextually motivated meaning as separate senses, in order to maintain coherence.

For example, the denominal adjective *żmijowaty* is a qualitative adjective (it passes all tests described in Section 7.3. for the relation/qualitative opposition). The UDP lists three senses of the word:

- I «podobny do żmii» ‘similar to a viper’,
- II «o człowieku: zły, podstępny, nieprzyjazny» ‘of a man: bad, devious, hostile’,
- III «[of the man’s deeds or behaviour] świadczący o takich cechach» ‘attesting to such features [as hostility, deviousness, badness]’.

The similitudinal relation could be applied to sense (I) by linking this lexical unit to *żmija* ‘viper’ (something is *żmijowate* ‘viper-like’ if it resembles a viper by shape). Sense (II) would be given the same relation to another, metaphorical meaning of *żmija* ‘someone who is bad, devious, hostile’. Since the two denominal adjectives receive their own derivational relation, according to the morphological criteria they may be distinguished as separate lexical units.

Indeed, the two meanings have different superordinates and acquire different synset relations in Polish WordNet 2.0, see Figure 4.

The third sense from the UDP (‘expressing such features’) will not get a separate entry in Polish WordNet, since we do not recognize any proper derivational relation for it. According to many linguists, such senses are a manifestation of adjective contextual properties and regular polysemy (Nagórko 1987: 110, Apresjan 1980: 275).

- *żmijowaty 1* —value→ *kształt* ‘shape’ (because something that is *żmijowate* has a specific shape),
- *żmijowaty 2* —HYPONIMY→ *nieszczery* ‘dishonest’, *żmijowaty 2* —value→ *charakter* ‘character’ (because someone who is *żmijowaty* has a specific character).

Consider the adjective *październikowy* (from *październik* ‘October’) which the UDP defines as “adjective [derived] from *październik*”. The relation/qualitative tests establish that there are:

- I a true relational meaning (expressed by the definition of the UDP),
- II a marginal (rare) qualitative sense ‘having weather conditions like in October’¹⁴, not-distinguished in the UDP.

This observations tell us that in Polish WordNet there are two lexical units *październikowy*, of which the first would be linked by cross-categorial synonymy to the noun *październik* ‘October’, while the second would be linked to the very same lexical unit with the similitudinal relation.

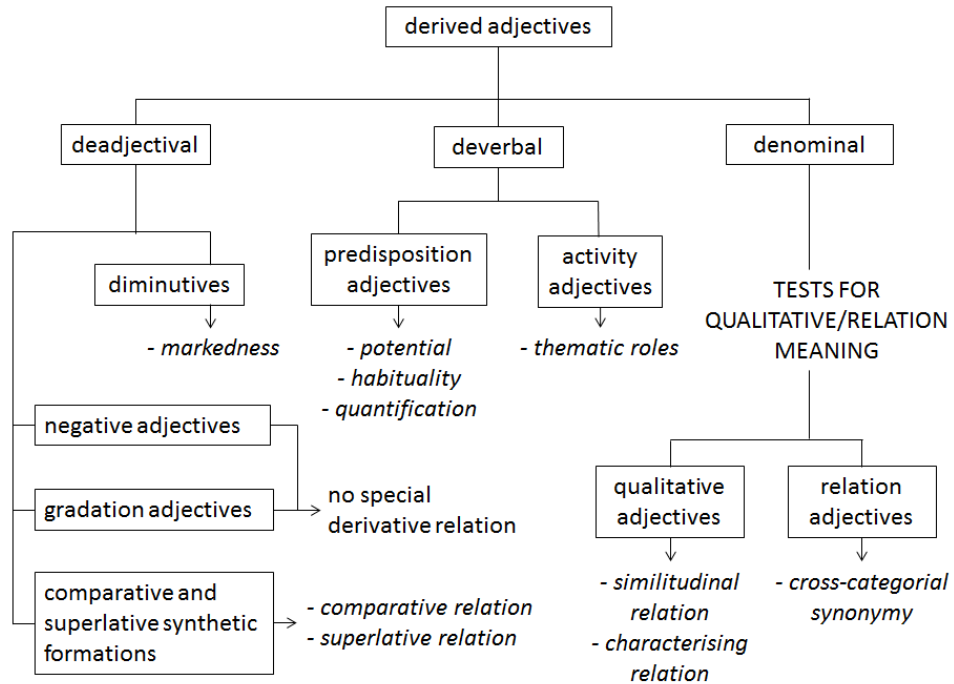
To sense (I) hardly any hyponym could be suited. Neither the adjective *miesięczny* ‘occurring every month, lasting a month’, nor the poetical (or dialectal)

¹⁴The meaning was distinguished through checking on the Internet such phrases as “jest [Eng. is] październikowy”, “bardziej [Eng. more] październikowy”.

miesięcowy ‘of the Moon’ is appropriate to *październikowy*.¹⁵ It seems that the cross-categorical synonymy would be the only lexico-semantic relation devoted to that LU. The more specific meaning (II), apart from the similitudinal relation, will also get two other relations:

- *październikowy 2* —value→ *warunki atmosferyczne* ‘weather conditions’ (if something is *październikowe 2* then it has weather conditions characteristic of October weather),
- *październikowy 2* —MODIFIER→ *czas* ‘time, period’ (in contexts found on the Internet the adjective usually modifies durations).

Figure 4. Derivational relations across different adjective morphological and semantic classes



The final examples are the deverbal adjective *odstrasający* ‘scary, scaring off’ (e.g., *odstrasająca mina* ‘a scary face’) and for a deadjectival adjective *prościutki* ‘very simple’:

Odstrasający is an adjective of the active participle form ending with *-ący*. The UDP gives it the definition «wywołujący strach, zniechęcający do czegoś» ‘causing fear, discouraging from something’ and clearly distinguishes it from the homonymous participle *odstrasający*. As we know, if such adverbial modifiers as

¹⁵That is despite the fact that *październik* ‘October’ is a hyponym of *miesiąc* ‘month’.

teraz ‘now’ cannot be combined with a given word (there is no phrase **odstraszaający teraz* ‘frightening now’ in this non-participial sense), it is not a participle (Section 7.1.). The adjective *odstraszaający* will be connected via the role-agent relation to *odstraszać* ‘to scare someone/something off’, according to the substitution test: *odstraszaający* = taki, który odstrasza ‘that which scares someone/something off’. Since it has its own derivational relation, we would say that it is a distinct LU in Polish WordNet 2.0. We could give it a series of relations:

- *odstraszaający* —HYPONIMY→ *niemiły* ‘(of behaviour or appearance) unpleasant’ (it is the UDP’s hint);
- *odstraszaający* ←GRADABLE–ANTONYMY→ *pociągający* ‘(of behaviour or appearance) appealing’ (UDP);
- *odstraszaający* —GRADATION→ *obojętny* ‘bland, harmless (of behaviour or appearance)’ —GRADATION→ *pociągający* ‘appealing’;
- *odstraszaający* —MODIFIER→ *wygląd* ‘appearance’ / *mina* ‘facial expression’ / *zachowanie* ‘behaviour’.

Prościutki has three meanings in the UDP. All of them are relativized to meanings of *prosty* from which the adjective was derived with a suffix *-utki*:

- I a diminutive form of *prosty* ‘straight, not curving’;
- II (of objects) a diminutive form of *prosty* ‘simple, plain, without decoration’;
- III ‘easy to do or to understand, simple’.

Prościutki has its own relation in —markedness. It will be linked by this relation to the three listed senses of *prosty*, creating three lexical units. *Prościutki 1* ‘pleasantly and very straight’ and *prościutki 2* ‘pleasantly without decoration’ will gain the following relations:

- *prościutki 1* —VALUE→ *kształt* ‘shape’;
- *prościutki 2* —VALUE→ *forma* ‘form’;
- *prościutki 2* —MODIFIER→ *przedmiot* ‘object’.

None of our relations make sense for *prościutki 3* ‘pleasantly and very easy to do or to understand’. The markedness relation to *prosty* ‘easy to do or to understand’ shall suffice.

8. Statistics and discussion

Sections 2–6 describe a system of semantic relations: hyponymy, value of the attribute, modifier, gradation, antonymy and converseness, as well as inter-register synonymy. Sections — present a system of derivational relations. Finally, Section introduces a support criterion of distinguishing senses for derivational relations: if an adjective can be attributed to one of the main adjective classes and if it can be

given a proper relation (with the exception of negative and gradation adjectives), it constitutes a lexical unit, a unit of Polish WordNet 2.0. For underived (simple) adjectives the semantic relations will be decisive: different senses should acquire different instances of relations (Miller 1998: 36–7).

The system of semantic and derivational relations based on semantic, lexicographic and wordnet tradition has been tested on a small but carefully selected 100-word sample taken from the UDP. All adjectives have been passed through our substitution tests, and given the appropriate relations to lexical units. Four of 100 adjectives (*zmijowaty*, *październikowy*, *odpychający* and *prościutki*) were featured in Section 7.5. in order to illustrate our sense recognition, division, and establishing approach. To every adjective we applied methods presented in detail in the preceding sections. The results appear in Table 6.

Table 6. Statistics of relations in the UDP sample (antonymy is gradable and complementary, without converseness).

number of adjectives	100	
number of distinct senses	175	
average polysemy	1.75	
	instances of a relation	percentage of all relations
instances of relations	294	100%
instances of relations per LU	2.94	
Adj → Adj relations	98	33.(3)%
antonymy*	22	7.5%
hyponymy	48	16.3%
gradation	28	9.5%
Adj → N relations	168	57.1%
value of the attribute	39	13.2%
modifier	43	14.6%
cross-categorial synonymy (for relational adjectives)	60	20.4%
Other derivational relations Adj → Adj N V	57	19.3%

Surprisingly, it was the Adj-N relation type that had nearly 60% of all instances of relations. The next one was the Adj-Adj type (1/3 of all instances). This explains why the set in plWordNet 1.0 could not capture all the semantic properties of adjectives — as in PWN 1.5, it was based mainly on Adj-Adj relations.

Pure semantic relations (not necessarily derivational) — antonymy, hyponymy, value of the attribute, modifier and gradation — account for 61.1% of all instances

of relations. Cross-categorial synonymy for relational adjectives with 20.4% is the most frequent relation. The least frequent relation is gradation with frequency of 7.5%: still high.

We feel that the proposed system of adjectival relations in *plWordNet* 2.0 is not only grounded in linguistic premises but also quite well suited to the Polish language. The “relation density” now reaches 2.94 relations per LU (cf. Table 1 in Section 1). The “experiment” is clearly too small to draw far-reaching conclusions: we must repeat it on a larger sample. Constructing Polish WordNet will lead to real statistics which should prove convincingly that the relation set described in this paper is appropriate for Polish adjectives.

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