plWordNet as a Basis for Large Emotive Lexicons of Polish

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Abstract

We present a large emotive lexicon of Polish which has been constructed by manual expansion of the emotive annotation defined for plWordNet 3.0 emo (a very large wordnet of Polish). The annotation encompasses: sentiment polarity, basic emotions and fundamental human values. Annotation scheme and revised guidelines for the annotation process are discussed. We present also statistics for the contemporary state of the development. Finally, the idea of the second plWordNet-based emotive lexicon created in controlled experiments is introduced. A method of selection of word senses for experiments is proposed and evaluated.

1. Introduction

Sentiment analysis of a natural language utterances became one of the most expected techniques. The best results are obtained with classifiers trained on annotated texts from a selected domain, e.g. movie reviews. Cross-domain applications show a significant drop in performance. This can be attributed to high correlation of a classifier with words and phrases that are specific for the positive and negative utterances of the given domain. However, language expresses some lexical means of conveying sentiment polarity in a way that is shared across different domains. The compromise between performance and domain adaptability can be achieved using hybrid methods. A hybrid system usually consist of (Appel et al., 2017): a *sentiment lexicon*, disambiguation, negation handling, and semantic rules to interpret sentiment of complex phrases. A lexicon of sentiment polarity for a given natural language, e.g. Polish, could be a very useful basis for constructing such a domain independent, hybrid system, if such a lexicon is large, comprehensive and reliable enough. plWordNet 3.0[1] (Maziarz et al., 2016), the wordnet of Polish, is a very large lexical semantic network for Polish in which more than 260,000 Polish lexical meanings are described by lexico-semantic relations. plWordNet became one of the largest Polish dictionaries ever built and also the largest available wordnet. A substantial part of plWordNet was manually enriched with emotive annotations (Zaśko-Zielińska et al., 2015). This pilot project showed feasibility of the applied annotation method. Our goal is to expand this emotive annotation to a very large scale and make plWordNet a basis for a large hybrid emotive lexicon of Polish, as well as a hybrid system for sentiment and emotion analysis in Polish texts. Manual emotive annotation will be combined with the annotations acquired experimentally from human subjects in controlled experiments. In this paper we present a method for selection of plWordNet elements for the experiments in way supporting merging both emotive lexicons.

2. Related Works

Sentiment lexicons can be built *manually* or *automatically*. The former requires immense annotation time, but can produce higher reliability, while the latter can result in high coverage, but lower accuracy. However, a lexicon built in an automated way can be biased by the corpus used. A wordnet can be a basis for a *hybrid* approach: some wordnet elements is annotated manually as *seeds*, and next, the initial annotation is automatically propagated across the network. WordNet-Affect is a subset of 2874 synsets (4787 lemmas) that are very likely representing "affective concepts" (Strapparava and Valitutti, 2004). The set was initiated by a core of 1903 lemmas selected and described manually with "affective labels". Next, a rule-based propagation algorithm was applied to expand the description. SentiWordNet (Esuli and Sebastiani, 2006) annotates synsets with values describing synsets as objective, positive, and negative. About 10% of the adjectives were manually annotated, each by 3-5 annotators (Baccianella et al., 2010). In SentiWordNet 3.0 the automated annotation process starts with all the synsets which include 7 "paradigmatically positive" and 7 "paradigmatically negative" lemmas, and next expanded automatically to all synsets of WordNet 3.0. The construction of SentiSense (Carrillo de Albornoz et al., 2012) began with a manual annotation of 1200 synsets with 14 emotions. Annotation was transferred onto other synsets using wordnet relations.

For languages different than English many sentiment lexicons were translated from WordNet. There were several attempts to construct a large sentiment lexicon for Polish, mostly in automated way and none of them is publicly available, e.g. (Haniewicz et al., 2013) acquired automatically 70,000 terms ("concepts") from Web documents and used plWordNet to identify semantic relations between acquired terms. (Haniewicz et al., 2014) expanded this lexicon to 140,000 terms a simple rule-based propagation with an adaptation of Random Walk algorithm on plWordNet.

3. Emotive Annotation in plWordNet

plWordNet follows the main ideas of WordNet (Fellbaum, 1998) and consists of *lexical units* grouped into *synsets* which are linked by *lexico-semantic relations*. A lexical unit (LU) represents a lexical meaning and is a triple: lemma, Part of Speech and sense identifier. LU is described by the network of relation links in which

[1] http://plwordnet.pwr.edu.pl

it participates. Simplifying, see (Maziarz et al., 2013) for details, LUs that share relation links are treated as synonyms and are grouped into a synset ('a set of synonyms'). plWordNet provides also for LUs: *glosses* and *usage examples*. *Emotive annotation* was manually added for the selected subset of more than 31,000 LUs of plWordNet 2.3 emo (Zaśko-Zielińska et al., 2015). LUs were described by *sentiment polarity*, *basic emotions*, and *fundamental human values*. A unique linguistically motivated annotation method was applied. In our work we follow this work, but expand and improve in several aspects.

3.1. Annotation scheme

The main annotation scheme was preserved from plWordNet 2.3 emo for the sake of compatibility. The annotation is called emotive as it goes beyond a typical sentiment polarity. Sentiment polarity is expressed on the 5 grades scale: strong & weak vs negative & positive, plus neutral. LUs that express both positive and negative sentiment polarity are described as *ambiguous* (amb). The set of 8 basic emotions is used, following (Plutchik, 1980) and his Wheel of Emotions: joy, trust, fear, surprise, sadness, disgust, anger, anticipation. Complex emotions can be expressed by assigning more than one emotion to LU. As in (Zaśko-Zielińska et al., 2015) we do not encode intensity of emotions, because the number of annotators is too small, see Sec. 3.2.. LU is also described by *fundamental values*: *użyteczność* 'utility', *dobro drugiego człowieka* 'another's good', *prawda* 'truth', *wiedza* 'knowledge', *piękno* 'beauty', *szczęście* 'happiness' (all of them positive), *nieużyteczność* ''futility', *krzywda* 'harm', *niewiedza* 'ignorance', *błąd* 'error', *brzydota* 'ugliness', *nieszczęście* 'misfortune' (all negative) (Puzynina, 1992). Annotations are completed by usage examples illustrating contexts characteristic for the given LU and its annotation. For ambiguous LUs two examples must be given: for positive and negative interpretations.

Emotive interpretation of an utterance is influenced by context, but following (Zaśko-Zielińska et al., 2015), we concentrate on these aspects of the LU meaning that seem to be shared across different linguistic contexts. LU's polarization determined on the basis of many contexts does not give information about emotional attitudes of the speaker, but rather tells us about possible interpretations. Thus, the annotation is performed from the perspective of the hearer, but still we want to limit the context of interpretation during annotation as far as possible, i.e. only to linguistic factors that are shared among different usage examples observed in large corpora, see Sec. 3.2.. We try to avoid referring to any extra-linguistic factors. For instance ***szalbierski*** 2 'deceitful' received the following annotation (where A1 and A2 means respectively the first and the second annotation added, BE – basic emotions, FHV – fundamental human values, SP – sentiment polarity, and Exam – usage example): ⟨ Annot.:A1, BE: {*smutek* 'sadness', *złość* 'anger'}, FHV: {*krzywda* 'harm', *błąd* 'error' }, SP:−*s*,Exam: "Nie chciałam brać udziału w tym szalbierskim planie, którego pomyślność zależała od stopnia naiwności nieświadomych klientów." 'I did not want to take part in this deceitful plan, whose success depended on level of naiveness of the unaware clients.'⟩⟨A2, BE: {*smutek* 'sadness', *złość* 'anger'}, FHV: {*krzywda* 'harm', *błąd* 'error'}, SP:−*s*,Exam: "Mam szalbierski pomysł, który pomoże nam naciągnąć paru idiotów." 'I have a deceitful idea which might help us to con a couple of idiots. '⟩

Basic emotions are often associated with the fundamental human values (Zaśko-Zielińska et al., 2015). With assigned emotions and fundamental values we can examine how intense should be the polarity of a given LU. The basic emotions with fundamental values were treated as supporting to the primary annotation of sentiment polarity. However, we observed that only rarely the annotators did refrain from their decision. The reason was that the annotators were combining basic emotions to express complex emotions for which association with fundamental human values was not straightforward. Thus, LUs marked by sentiment polarity and given some fundamental value had at least two or three basic emotions assigned.

3.2. Annotation Process

The annotation is performed manually by six annotators: four linguists and two psychologists. Each LUs is annotated by one psychologist and one linguist. Annotators are rotated in pairs for different LUs in order to minimise a potential bias. Contrary to the process in plWordNet 2.3, our annotators work completely independently from each other. The work of annotators is coordinated and verified by a supervisor, who can access all annotations and solve disagreements. The annotators are obliged to follow precisely the defined procedure which is based on (Zaśko-Zielińska et al., 2015) and combines decision lists, substitution tests and corpus analysis. It consists of the basic core, next further specified for different PoS:

Step 1 identification of LUs with *neutral* and *non-neutral* sentiment polarity;

Step 2 assignment of the basic emotions and fundamental human values;

Step 3 recognition of the LU polarity direction: negative or positive, but also *ambiguous*, if the collected use examples show both behaviours;

Step 4 assignment of the sentiment polarity intensity;

Step 5 illustration of the assigned annotation by sentences representing use examples: at least one sentence in the case of positive and negative LUs, and at least two example sentences for ambiguous LUs.

Each step is associated with linguistic tests, e.g. substitution tests, and requires consulting corpus. The detailed specification of the steps depends on a particular PoS. In the case of nouns we used guidelines from (Zaśko-Zielińska et al., 2015). Only minor details were fine-tuned, e.g. we added a test for distinguishing diminutive formant function (Siudzińska, 2016) (not always connected with sentiment polarity). Guidelines for adjectives have been significantly revised. As adjective LUs in plWordNet have mostly more fine grained meanings than those in dictionaries, the annotator has to check whether he is working on the appropriate LU, not, e.g., deviating accidentally to another sense of the LU lemma. For this purpose annotators should

check and use collocations as a tool from prompting a particular meaning.

Step 1 Neutrality test for adjectives is related to wordnet structure of derivational relations for adjectives, non-derived adjectives are analysed according to the noun procedure. Adjectives derived from adjectives are skipped in **Step 1**. Those derived from verb and nouns are tested for the derivation type and emotive aspects of their bases.

Step 2 Assignment of emotions and values: adjectives derived from verbs by the suffix *-alny* (meaning 'to be able/possible to') form a characteristic group of LUs. They are not connected with emotions, but they are related to the fundamental values: utility, futility, e.g. *zmywalny* 'such that, can be removed by washing' in *tatuaż zmywalny*.

Step 3 Marking LUs as negative, positive or ambiguous: four tests are applied: a *congruence test*, a *discord test*, a *test of collocation* and a *test of dictionary definitions* – formulated in a similar way to noun guidelines.

Step 4 Assignment of the sentiment polarity intensity: grade forms of adjectives do not indicate the intensity of sentiment polarity of the derivational basis, but they show comparison, e.g., the suffix derivative *-utki* which expresses that the described feature is not at its maximum, in the lower part of a scale, and there may be something that is even smaller than *malutki* '≈very small'.

3.3. Statistics

The pilot described $> 31,000$ LUs (19,625 noun LUs and 11,573 adjective LUs) in plWordNet 3.0 emo by emotive annotation (Zaśko-Zielińska et al., 2015). From that point we started the annotation process aiming at its expansion by complete emotive annotations (2+1) for around 100k more LUs. Some annotations done in the pilot project included decisions of only one annotator and had to be completed. We started adding emotive annotation to noun LUs with focus first on these hypernymic branches that are likely to include LUs with polarised sentiment. We try also to distribute manual annotation across the network of synsets in such a way that it will facilitate future automated spreading of annotations. Recent statistics are presented in Tab. 1. Only LUs annotated by two annotators are counted as completed. This number includes also completed annotations during the pilot project. As annotators are mixed in pairs and subsets of LUs are assigned to them in diversified ways, a large number of LUs have received so far only one annotation. As it was also the case in the pilot project, more than half of the noun LUs are annotated as neutral. However, only ≈30% of adjective LUs are neutral contrary to almost 60% in plWordNet 3.0 emo. This difference can be caused by a much broader coverage of noun LUs, while adjective LUs were selected by (Zaśko-Zielińska et al., 2015) in a slightly accidental way.

As our annotators work completely independently, we could measure the inter-annotator agreement (IAA) with respect to the sentiment polarity using the Cohen's Kappa measure (Cohen, 1960), see Tab. 2. Due to the large number of annotators, and simplifying a little bit, we present the agreement between the first and the second decision registered in the system for LUs. LUs with at least one annotation from the pilot project were excluded from this analysis. The observed IAA values, both, 0.78 for all decisions and around 0.75 for different sentiment polarity values, are very high. The value for the neutral polarity is a value for the decision: polarised vs non-polarised in fact. It can show that the annotators are quite confident about the neutrality of the LUs, but also it can be biased by the fact that describing a LU as a neutral can be easier than by other values. This issue needs further investigation. As the neutral annotations dominate, we have calculated an estimated IAA value for the marked LUs only, all LUs with neutral tags were excluded. The obtained values are much higher than for all decisions, so we can conclude that neutral values do not increase artificially the general IAA.

Negative polarity values dominate in annotation: 33.84% vs 15.38% in Tab. 2. This correlates with the observed dominance of the negative basic emotions, i.e. 76.48% emotions of noun LUs and 70.13% of adjective LUs are negative. A similar dominance of words marked negatively could be also observed in the dictionary of the colloquial Polish language (Anusiewicz and Skawiński, 1996). For instance, if we compare two thematic fields of this dictionary, namely: acting towards somebody's harm – enforcing some particular behaviours (id:2.3.2) and acting towards somebody's profit (id.: 2.3.3), we can notice that the former includes 324 entries while the latter only 20.

4. Sense Selection for Annotation

The proposed and implemented linguistic method of the emotive annotation for plWordNet seem to work well, both in terms of the good IAA, as well as of promising results of preliminary applications. Nevertheless, plWordNet emo is based on the work of a limited set of annotators and it would be very informative to confront these results with more experiments involving hundreds participants. Project *Sentimenti* (see Ack.) aims at the development of a system for emotive analysis of Polish. A hybrid combination of methods based on an emotive lexicon and domain classifiers is planned. In order to decrease the problem of word polysemy, the lexicon will be organised around plWordNet LUs, not lemmas. 60,000 LUs of different PoSs will be selected for the controlled experiments during which people will be asked to assign basic emotions in the model similar to the Plutchik Weel of Emotions and sentiment polarity. Each LU will be rated in a large-scale survey by at least 50 different people to test whether the perception of polarity is uniform or rather heterogeneous.

As 60,000 LUs is only a small subset of plWordNet it is important to make proper selection. Firstly, several methods for sentiment propagation in the wordnet network were proposed, e.g. (Esuli and Sebastiani, 2006), and we want to follow this kind of an approach. Thus, the selected LUs must be later a good basis (a set of seeds) to propagate the annotation to the rest of plWordNet. Secondly, the selected 60k LUs must be also a good emotive lexicon by itself, i.e. focused on LUs that are emotively marked (i.e. not neutral), relatively frequent and evenly distributed in the lexicon (plWordNet). Thirdly, we could have the largest possible emotive lexicon, if plWordNet emo and the experiment-based lexicon are complementary. In this section we are going to present a method for the selection

PoS	# Comp	# Sing	-s	-w	n	+w	+s	amb
N	25,919	18,574	16.62	14.64	51.59	6.05	4.23	6.87
Adj	14,817	5,392	14,87	22.59	31.39	15.03	7.50	8.62
All	40,773	24,002	15.89	17.95	43.18	9.79	5.59	7.60

Table 1: Sentiment polarity annotation of plWordNet 4.0 in progress (Comp – completed, Sing – one annotator only so far); -s, -w, n, +w, +s, amb (negative strong/weak, neutral, positive weak/strong, ambiguous) are shown in percentage points.

PoS	All	-s	-w	n	+w	+s	amb
All	0.78	0.77	0.78	0.82	0.74	0.73	0.65
Mrk.	0.84	0.80	0.84	–	0.89	0.80	0.86

Table 2: Inter-annotator agreement (IAA), measured in Cohen's' κ, for different sentiment polarities: -s, -w, n, +w, +s, amb (negative/positive vs strong/weak, neutral, ambiguous). *All* describes agreement for all decisions, *Mrk* – estimated IAA for marked LUs only.

of LUs which tries to fulfil these contradictory objectives.

4.1. Constraints and Final Selection Criteria

Constraints imposed on the seeds will lead to the selection of LUs with excellent properties for the annotation process. On the other hand, the negative side is the loss in the final number of collected units, thus obtaining the target number of LUs requires relaxing the imposed restrictions. The mental effort of a human annotator to determine the polarity of words / senses is not uniform, and may depend on the individual linguistic skills of the annotator and his initial knowledge in particular domains. The use of selection constraints should guarantee a reduction in time and effort spent on making decisions.

Our first limitation, $freq_{sort}$, is simply based on the lemma frequencies, to select LUs that are more common. LUs with a higher frequency are selected first. We may also reject the units, if they have significantly low frequency, below the acceptable threshold.

Propagated polarity values are strongly influenced by selected seeds, thus our constraints should be also closely related to the propagation process. Polarity propagation uses label propagation algorithm. Labels are spread iteratively among instance graph, to acquire the final labelling of all nodes. Iterative labelling is sensitive to the update order of nodes, and the propagation error is a composition of intermediate errors accumulated in each iteration. We believe, that limiting the number of required iterations has a positive impact on reducing the final error. To obtain a high coverage of the lexicon in a limited number of iterations, a $degree_{sort}$ constraint was introduced. This restriction prefers LUs with relatively higher degree in the graph, so we could easily propagate in few iterations.

The importance of nodes can be also determined in terms of decision uncertainty. Uncertainty about the decision is partially dependent on the structure of the emotive graph. It is difficult to accurately assess the polarisation to nodes, in a places with a complex link structure and varying polarity of neighbours. For this purpose, a measure of emotive entropy was used. To calculate polarity entropy for all synsets, we applied simple preliminary propagation:

1. Initialise polarity labels for seeds in the graph,
2. Apply filters to the seeds and arrange the nodes according to the constraints,
3. For each node iteratively update polarisation using the polarity state of his neighbourhood,
4. For every new node collect his neighbourhood - the union of collected units forms a new seed set,
5. If a new seed set is empty, the propagation ends, otherwise repeat from step (2) on the new seeds.

Neutral units dominate the emotional units in our language, which is also confirmed by our statistics on the existing emotive annotation in plWordNet. This fact is the motivation for imposing further restrictions on unit selection. Therefore, we favour potentially emotive units to obtain polarity balance before actual annotation.

The propagation scheme is based on relational label propagation, with synchronous node updates. This propagation procedure leads us to obtaining approximate polarization for the entire network. Preliminary propagation may indicate potentially difficult places in predicting the polarity, thus the manual annotation of such places will increase the quality of the final propagation.

4.2. Selection Algorithm

Several constraints are based on *a priori* information about polarity distribution in the network. Therefore, our selection process is carried out in three steps:

1. Initialise with seeds of manually annotated LUs,
2. Perform a preliminary propagation procedure, to label entire graph with polarity values,
3. Apply selection criteria to all nodes in the graph, respecting their order of execution.

Once the preliminary propagation is done, we select LUs by applying our constraints in a specific order of execution: (i) filter out units with low lemma frequency (ii) sort by lemma frequency (iii) sort by unit degree - the number of links in plWordNet graph (iv) sort by emotion entropy of neighbours (v) balance positive, negative and neutral units, with respect to order of units after sorting.

4.3. Evaluation

We used a task-based evaluation for our approach. To measure the quality of selection, we applied our polarity propagation method for plWordNet graph, using selected LUs as seeds. To compare the results, we used manually annotated LUs as a Gold Standard, and performed for them a full propagation over plWordNet. The result labelling was used to compare propagation performance between randomly generated seeds and seeds generated with

Sel. Type	P-Neg	P-Neu	P-Pos	R-Neg	R-Neu	R-Pos	F-Neg	F-Neu	F-Pos
Random	**0,696**	0,982	0,459	0,661	0,980	0,567	0,676	0,981	0,499
Criteria	0,683	0,986	**0,540**	**0,733**	0,981	**0,666**	**0,705**	0,984	**0,590**

Table 3: The averaged precision, recall and F-measure for full propagation in plWordNet, with respect to polarity classes - positive (P/R/F-Pos), neutral (P/R/F-Neu) and negative (P/R/F-Neg) polarity.

the criteria-based solution. The following selection criteria were applied: (i) frequency filter - filter out units with corpus frequency lower than 1000, (ii) sort (desc.) by unit degree - degree in range <1-12>, (iii) sort (asc.) by polarity entropy - this was reversed, to reject uncertain units, because they have negative impact on propagation results (iv) and polarity balance - 40% of positive units, 40% of negative and 20% of neutral. The initial seed set consisted of 25000 units, mapped to their synsets. To make a fair comparison between random and criteria-based selections, a test set for evaluation should not contain any node from the initial seeds. Full propagation results are in Tab. 3.

5. Further Works

plWordNet 4.0 emo will be completed and published on open licence by June 2018. The target size is more than 130k LUs with manual emotive annotation from all PoS. We presented an intermediate version of almost 64k LUs manually annotated in way expressing high Inter-annotator Agreement. Next, the annotation will be automatically spread to the rest of plWordNet. In parallel, the experiment-based emotive lexicon in the *Sentimenti* project will be built. The proposed automated selection method of LUs will be used to select LUs for the experiments. plWordNet descriptions of all selected LUs will be supplemented with possibly missing glosses and use examples, but not with emotive annotations, because we expect still to achieve some complementarity. We need also to solve the problem of appropriate prompting of LUs to the experiment participants, i.e. to find a way in which a certain meaning of a lemma is clearly targeted.

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