Sentiment Analysis of Korean Using Effective Linguistic Features and Adjustment of Word Senses

*Hayeon Jang† and Hyopil Shin‡
Seoul National University

Hayeon Jang and Hyopil Shin. 2010. Sentiment Analysis of Korean Using Effective Linguistic Features and Adjustment of Word Senses. *Language and Information 14.2*, 33–46. This paper introduces a new linguistic-focused approach for sentiment analysis (SA) of Korean. In order to overcome shortcomings of previous works that focused mainly on statistical methods, we made effective use of various linguistic features reflecting the nature of Korean. These features include contextual shifters, modal affixes, and the morphological dependency of chunk structures. Moreover, in order to eschew possible confusion caused by ambiguous words and to improve the results of SA, we also proposed simple adjustment methods of word senses using KOLON ontology mapping information. Through experiments we contend that effective use of linguistic features and ontological information can improve the results of sentiment analysis of Korean. (**Seoul National University**)

Key words: sentiment analysis, linguistic features, adjustment of word senses, KOLON ontology

1. Introduction

The Internet is now an important forum where people can express their opinions without formalities or constraints. Online services such as blogs or Twitter now serve as substitutes for private diaries. Political debates are frequently found in the reply pages of news articles. For these reasons, sentiment analysis, automatically extracting subjectivities and classifying sentiments (or polarities, opinions) about some topics in written texts, has been receiving attention in the field of Natural Language Processing (NLP).

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† The first author: Dept. of Linguistics, College of Humanities, Seoul National University, 599 Gwanak-ro Gwanak-gu, Seoul 151-742. Email: hyan05@snu.ac.kr
‡ The corresponding author: Dept. of Linguistics, College of Humanities, Seoul National University, 599 Gwanak-ro Gwanak-gu, Seoul 151-742. Email: hpshin@snu.ac.kr

Sentiment analysis of English employs various statistical and linguistic methods. However, most previous sentiment analysis works in Korea, including Hwang and Ko (2009), have focused only on statistical methods which utilize either the frequency of words or the relevance of co-occurring words in their analysis. This is due to a lack of linguistic resources properly reflecting the nature of Korean. The major drawback of a statistic-focused approach is the fact that the 'actual' meaning of expressions, i.e. the emotion invoked by the articles, cannot be reflected in the analysis. In order to overcome this shortcoming, we propose a linguistic-focused approach for Korean that makes effective use of linguistic information such as the semantic classes of words, semantic scope of negation terms like *not* or *no*, and the functional meaning of modal affixes. This approach limits the semantic scope of the influence of opinionated terms by making chunk structures using dependency relations of morpheme sequences.

Furthermore, in order to improve the results of sentiment analysis, we try to solve the problem of word sense ambiguities by adjusting word senses through information from ontological mappings found in KOLON[1], a Korean ontology. The classifiers in our linguistic-focused approach detect the meanings of words via tags in a polarity dictionary, which includes lexical items having no distinction of senses of ambiguous words. In this polarity dictionary, every ambiguous word has only opinionated meanings. Thus if an ambiguous word has both an opinionated meaning and a non-opinionated meaning then it causes confusion when performing sentiment analysis. Therefore, we intend to properly reduce the influence of such ambiguous words in sentiment analysis.

This paper is composed mainly of five parts: in Chapter 2 we review previous works related to our approaches. In Chapter 3 we follow up by explaining various linguistic features used in sentiment analysis and show how our linguistic-focused approach is feasible for sentiment analysis of Korean by comparing our results with experimental results obtained using a statistical method that employs word frequency, tf-idf[2]. In Chapter 4 we further introduce the Korean ontology called KOLON and, in turn, present the adjustment methods of ambiguous word senses using KOLON mapping information. In the final chapter we describe the second experiments and show how our adjustment methods improve sentiment analysis of Korean.

2. Related Work

Sentiment analysis research has been performed to distinguish the authors' polarity (sentiment orientation) on certain topics at the document-level (Turney, 2002; Pang

[1] KOLON is an acronym of "The KOrean Lexicon ONtology", or more specifically "The KOrean Lexicon mapped onto the Mikrokosmos ONtology". You can look up the concepts and words included in KOLON at http://word.snu.ac.kr/kolon/.

[2] tf-idf (term frequency-inverse document frequency): For a term i in document j

$$w_{i,j} = tf_{i,j} \times \log\left(\frac{N}{df_i}\right)$$

$tf_{i,j}$ = number of occurrences of i in j
df_i = number of documents containing i
N = total number of documents

et al., 2002) to sentence-level (Hu and Liu, 2004; Kim and Hovy, 2004). This paper focuses on sentence-level sentiment classification in the assumption that the polarity of sentences in a single document can be diversified according to various subtopics.

Various linguistic features are taken advantage of in previous works of sentiment analysis of English. One typical example is a contextual intensifier. Polanyi and Zaenen (2004) define contextual intensifiers as lexical items that weaken or strengthen the base valence of the modified term. They calculate the effects of intensifiers by adding or subtracting one point to/from the base value of a term. Banamara et al. (2007) categorize intensifying adverbs according to the degree of strength of meaning and assign scores differently. In our approach, every contextual intensifier strengthens the original polarity of opinionated terms by multiplying by two.

Contextual shifters are well known for their effectiveness on sentiment analysis. Kennedy and Inkpen (2006) performs sentiment analysis on movie and product reviews by utilizing the contextual shifter information. Miyoshi and Nakagami (2007) also uses this method to see advancements in the results of sentimental analysis on electric product reviews in Japanese. In the present work, we make use of the functions of each shifter to properly modify the value of the terms in the sentences and to limit the number of the features.

In addition, there are some works using structural information of the target sentiment in order to improve the results of sentiment analysis (Mao and Lebanon, 2006; McDonald et al., 2007; Liu and Seneff, 2009). However, given the nature of Korean, it is hard to find the proper resources to utilize these methods. Korean has characteristics such as rich functional morphemes, a relatively free word-order, and frequent omission of primary elements, i.e. the subject and object. Although many researchers have applied dependency grammars for reducing the complexity of sentences to meet the characteristics of Korean (Kim and Lee, 2005; Nam et al., 2008), these still have problems causing it to be hard to be widely used. Therefore we suggest a new morphological chunking method that binds semantically related concatenations of morphemes. This helps to define boundaries for semantic scopes of opinionated terms. Additionally, it is faster, simpler, and more efficient for use in sentiment analysis than a general full parser.

Although Word Sense Disambiguation (WSD)[3] plays an important part in identifying influential opinionated words in context in sentiment analysis, it is still one of the most challenging tasks in the field of NLP. (Turney. 2001; Katz et al. 1999; Ide and Veronis. 1998). This is because one word often has various senses in the same discourse. Tamara et al. (2010) takes into account the correct senses of the words in the opinions and demonstrates that a WSD method, which makes clusters of semantically related words by utilizing a repository of concepts for WordNet is useful to determine the polarity of opinions. However, Akkaya et al. (2009) verifies that subjectivity word sense disambiguation (SWSD) is more feasible than full WSD by empirical evidence using a targeted supervised SWSD system. Similarly, our approach does not adhere to the general full WSD method; we simply adjust

[3] This refers to the method by which the proper sense of an ambiguous word can be identified from context.

senses of ambiguous words. Our adjustment methods use the information on the ontological mapping in order to check opinionated words having ambiguous meaning and properly reduce the influence of such words in the polarity classification of sentences. In this process, we identify the number of meanings of ambiguous words and especially grasp polarity-related meanings mapped to the target words in KOLON, a Korean ontology.

3. Linguistic Features for Sentiment Analysis

In our linguistic approach, every term gets its own value by using a polarity dictionary and contextual shifters. Our polarity dictionary contains 5,291 Korean lexical items that mark POS tags of morphological analysis[4], and labels of functional categories like polarity ('Positive', 'Negative') or modal role ('Conjectural', 'Obligative'). Furthermore, we make chunk structures by using dependency relations of morpheme sequences to limit the semantic scope of opinionated terms. This chunking method is simpler and more efficient than total syntactic parsing, especially in Korean which has rich functional morphemes, a relatively free word-order and frequent omission of primary elements of sentences like subjects and objects.

3.1 Contextual Shifters

In this paper, the term 'contextual shifter' covers both the negation shifter and the flow shifter: the former refers to the term which can change semantic orientation of other terms from positive to negative and vice versa, and the latter refers to the term which can control sentiment flow in sentences; e.g. English *not, nobody* (negation shifters), *however, but* (flow shifters). Contextual shifters in Korean consist of 13 negation shifters (adverbs such as 안 *an* 'not', 못 *mos* 'cannot' and auxiliary verbs such as 않 *anh* 'not', 말 *mal* 'stop', 없 *eps* 'no') and 23 flow shifters (sentence-conjunctive adverbs such as 그러나 *kulena*, 하지만 *haciman* 그래도 *kulayto* 'but, nevertheless, though', subordinative conjunctive suffixes -ㅂ니다만 *pnitaman*, -는데 *nuntey* and conjunctive suffixes such as -어도 *eto*)[5].

3.2 Modal Affixes

Korean as the agglutinative language has various functional affixes. Among them modal (aspectual) affixes comprise a crucial meaning of contexts such as possibility, or evidentiality. For this reason, we utilize various modal affixes of Korean to distinguish realis events from irrealis events[6] and to weaken the weight of irrealis events in computing an evaluation of the author's attitude by dividing by two.

Conjectural mood is used in Korean to express some suppositions about the future, present or past. It can be translated into English words such as 'probably', 'perhaps' etc. Since we cannot assure that opinionated words in the scope

[4] We use the KTS which is open-source probability based Korean morphological analyzer. (http://kldp.net/projects/kts/)

[5] In this paper, all Korean examples are transliterated via the Yale Romanization system.

[6] Realis events represent events or situations which are asserted to have happened or are happening, and irrealis events represent those which might, could, should, ought to, or possibly occur or are going to occur. (Polanyi and Zaenen. 2004)

of conjectural mood are the actual sentiments of the author, the conjectural lexical items decrease the value of opinioned terms in their scopes in the process of our term weighting. A total of 18 Korean lexical items (13 final suffixes such as -ㄹ텐데 *-ltheyneey* 'would' and -ㄹ걸 *-lkel* 'probably', four pre-final suffixes such as -겠 *-keyss* 'wish', one adnominal suffix -ㄹ- *-l-* 'might') play a role as conjectural. Imperative mood denotes the speaker's degree of requirement of conformity to the proposition expressed by an utterance, especially in commands. In a view from sentiment analysis, Imperative also expresses the author's wish similar to the aforementioned conjectural. In our approach a total of 13 final suffixes play a role as Imperative: -라 *-la* and -어다오 *-etao* to name a few. An interrogative mood connotes how much certainty or evidence a speaker has on the proposition expressed by an utterance and presents questions to elicit information concerning the topic of an utterance from the addressee. A total of 16 final suffixes such as -ㄹ까 *-lkka* and -ㄴ가요 *-nkayo* are used in this work to control the weight of terms in the scope of interrogative mood. Quotative means that opinionated terms which are in the same phrase express another person's opinions. In our approach, a total of five final suffixes such as -라고 *-lako*, -다고 *-tako*, -ㄴ다는군 *-ntanunkwun* are used as quotative to weaken the value of terms which are the attitude of other people, not the author. Such suffixes can be translated as 'he/she said that~' in English.

3.3 Morphological Dependency Chunk

Korean is a head-final language: in terms of dependency grammar, governors are always located after their dependents. We reflect this characteristic to form a relation if a certain morpheme acts as the governor of the previous morpheme. Chunks are formed until an unrelated morpheme appears. The terms in a single chunk exert their own semantic influence to each other and control the values. After determining the values of every morpheme in each chunk, this process is replicated at a higher level and finally the ultimate values of every term in the sentence are determined. Our morphological dependency chunking method helps effective sentiment analysis by providing the structural information which properly limits the semantic influential scope of functional terms such as negation shifters.

(1) 천/nn 년/nbu 의/jcm 세월/nc 이/jc 흐르/pv 어도/ecx
chen *nyen* *uy* *seywel* *i* *hulu* *eto*
1000 year Genitive time Nominative flow Conjectural

끝나/pv 지/ecx 않/px 는/exm 미완/nc 의/jcm 사랑/nc[7]
kkuthna *ci* *anh* *nun* *miwan* *uy* *salang*
finish Conjectural not Adnominal incomplete Genitive love

'an incomplete love that has not finished even after 1000 years'

(1)' [[chen+nyen]+uy] [seywel+i] [hulu+eto] [kkuthna+ci+anh+nun] [miwan+uy] [sarang]

[7] POS tags of morphological analysis: a(adverb), ecx(auxiliary conjunctive ending), ef(final ending), efp(prefinal ending), exm(adnominal ending), jc(case particle), jcm(adnominal case particle), nbu(unit bound noun), nc(common noun), nca(active common noun), nn(numeral), pv(verb), px(auxiliary verb), xpv(verb-derived suffix)

For example, the result of the chunking process of sentence (1) is the structure of (1)'. The flow shifter '어도 *-eto* (even if)' limits the number of object morphemes to seven by counting only words after the shifter appears. In the remaining chunks, the only thing the negation shifter '않 *anh* (not)' can change is the polarity of '끝나 *kkuthna* (finish)' in the same chunk. If the chunking method is not used, however, in a window [-2, +2] '미완 *miwan* (incomplete)' is also influenced. That makes the program misclassify the sentiment of negative expression '미완의 사랑 *miwan-uy salang* (incomplete love)' as positive.

4. Experiment 1

4.1 Corpora

We collected 79,390 news articles from the web site of a daily newspaper, The Hankyoreh[8], during the period of January 1, 2009 to April 7, 2010 (total 146.6MB). We categorized the news corpus into three groups by the characteristics related to subjectivity: 71,612 general news articles, 3,743 opinionated news articles having subjective subtopics such as victory, terrorism, etc. and 3,432 editorial articles including columns and contributions. The collection of sample sentences consists of 1,225 general news sentences, 1,185 subtopic news sentences and 2,592 sentences of editorial articles by randomly extracting 100 articles from each data group.

In contrast to the grading systems found in movie review texts, news articles have no indices representing subjectivity or polarity of sentences. Therefore, in our work, two native Korean annotators manually attached polarity labels to each sentence. Sentences were classified as subjective when they contained opinions pertaining to a certain object. Polarity tags were only attached if sentences are classified as subjective. The agreement rate of the two annotators in the manual annotation of polarity was 71%.

4.2 Results

Table 1 shows the results of a 10-fold cross variation experiment on the sentiment analysis of each of the three groups of news articles using SVMlight[9], a powerful tool for binary classification. In Table 1, numbers in bold face are the highest result scores in each dataset.

First of all, all of our proposed linguistic methods obtained higher results than tf-idf except in the case of F-measure score of the subtopic news article corpus, which did not use a chunking method. Accuracy values were increased by about 2% to 28% and F-measure values were improved by about 1% to 21%. The most subjective dataset, editorial article corpus, showed the greatest improvements in both accuracy and F-measure values. This means various linguistic features used in this work properly reflected the sentimental meanings included in subjective texts. On the other hand, the subtopic news article corpus showed the smallest improvements.

Secondly, our morphological dependency chunking method (see the parts la-

[8] http://www.hani.co.kr/

[9] http://svmlight.joachims.org/

[10] F-measure=2*Precision*Recall/(Precision+Recall)

[Table 1] The Results of Sentiment Analysis of Korean News Corpus.

Data	Method			accuracy (%)	f-measure[10] (%)
EDItorial articles	Statistical	tf-idf		45.555	36.499
	Our linguistic approach	NO chunking	NO shifter	71.874	56.011
			YES shifter	70.193	55.462
		YES chunking	NO shifter	**72.743**	**57.774**
			YES shifter	71.684	57.189
SUBtopic News articles	Statistical	tf-idf		49.753	65.911
	Our linguistic approach	NO chunking	NO shifter	52.915	65.881
			YES shifter	51.574	64.948
		YES chunking	NO shifter	55.346	67.147
			YES shifter	**55.818**	**67.347**
NEWS articles	Statistical	tf-idf		42.416	57.074
	Our linguistic approach	NO chunking	NO shifter	47.589	59.455
			YES shifter	49.149	60.115
		YES chunking	NO shifter	50.484	59.898
			YES shifter	**50.598**	**60.656**

beled 'Yes chunking' in Table 1 and Figure 2), in comparison with the experimental results which do not use the chunking method, improved accuracy values by about 1% to 4% and F-measure values by about 0.4% to 2%.

Finally, we obtained the more improved results in the less subjective data when we used the function of contextual shifters. The effects of using contextual shifters in the process of sentiment analysis are summarized as follows; 1) in the editorial article corpus which was the most subjective dataset, utilizations of contextual shifters lowered the efficiency of sentiment analysis, 2) in the subtopic news article corpus which was less subjective than the editorial articles, the results were improved only when the chunking method was also used, and 3) using contextual shifters advanced the results of sentiment analysis regardless of the utilization of the chunking method in the news article corpus which is the least subjective.

4.3 Discussion

In this experiment, by using a Korean news article corpus, we observed improved results in comparison with the results obtained by using the popular statistical method tf-idf, especially when both chunk relations and contextual shifters were used. These results show that by utilizing language-specific features reflecting Korean linguistic characteristics well, even without making use of complex mathematical measuring techniques, we could obtain better results than pure statistical methods in sentiment analysis. When utilizing both chunking structures and contextual shifters, we consistently obtained higher values of sentiment classification in all of our data. This implies that the methods reducing target features by flow shifters and modifying values of polarity terms by negation shifters have merits in sentiment analysis and the restriction on the semantic scope of functional terms re-

lated to sentiment polarity using structural information of Korean helps to classify sentiments of sentences correctly. The proposed chunking method especially could aid the sentiment analysis of other agglutinative languages such as Japanese and Turkish.

However, this approach takes no account of the distinction between different meanings of ambiguous words and different influencing powers of each meaning in sentiment analysis. In this experiment, the polarities of words were determined by matching word forms and POS in a polarity dictionary. Such an approach has the shortcoming that ambiguous words with multiple meanings according to the context can be misinterpreted. This can bring about the wrong classification in sentiment analysis. For this reason, we propose new adjustment methods for ambiguous word senses utilizing the information from ontological mappings. Unlike general Word Sense Disambiguation, our adjustment methods focus only on identification of ambiguous words which possibly caused confusion in the sentiment analysis.

5. Adjustment of Word Senses

5.1 The KOLON Ontology

The KOLON Ontology is a project currently under development by Computational Linguistics Laboratory at Seoul National University. It was born from the need for a Korean ontology in order to improve Korean Natural Language Processing projects (KNLP). KOLON was built on the top of two important projects: the Mikrokosmos Ontology built in the Computing Research Laboratory at New Mexico State University, and the 21st Century Sejong Electronic Dictionary[11]. The Mikrokosmos Ontology is written in English as a meta-language but relations are built between universal concepts, after which the lexical units of specific languages (English, Chinese, and Spanish) are mapped to the resulting ontological structure (Mahesh, K., 1996). Sejong Dictionary is a large-scale digital linguistic body of dictionaries and corpora presenting information which is related not only to the meanings of the words in terms of translations into English, variant forms, the original word form in the case of loanwords but also morphological and syntactico-semantic information, such as arguments and special lexical units taken by verbs and adjectives with their respective semantic restrictions and case roles.

KOLON includes 45,037 Korean words linked to their 65,326 word senses and related concepts (Shin, 2010). In KOLON, there are 5,449 semantic concepts classified according to language-independent taxonomy. As a general rule of KOLON mapping, one word can map to various concepts according to its various senses. Therefore we regard the words having multiple senses and concepts as ambiguous words and control the value of such words by using information on the number and type of senses and their related concepts.

5.2 Ontology-based Adjustment Methods

In this paper, the following four simple adjustment formulas are proposed. In the process of sentiment analysis of this paper every word in a sentence gets a basic

[11] http://sejong.or.kr

value based on the polarity dictionary used in the first experiment, and in turn, the values are modified by utilizing various functional linguistic features like negation expressions, contextual shifters, and the relations of morphologically dependent chunks. In the last step of term weighting, the modified values are controlled according to ontology-based adjustment methods in order to reduce the influence of ambiguous words. Therefore, 'value' in the formulas means 'the modified value reflecting linguistic features'.

$$\text{MULTIconcREDUCE} = \frac{Vw}{Sw} \tag{1}$$

$$\text{POLconcPERADD} = Vw \times \frac{Pw}{Sw} \tag{2}$$

$$\text{NOTPOLconcREDUCE} = \frac{Vw}{\bar{P}w} \tag{3}$$

$$\text{POLnNOTPOLconc} = Vw \times \frac{Pw}{\bar{P}w} \tag{4}$$

where

Vw	The value of a certain word
Sw	The number of senses of the word
Pw	The number of polarity-related senses of the word
$\bar{P}w$	The number of non-polarity-related senses of the word

Formula (1) is the MULTIconcREDUCE method. The basic assumption of MULTIconcREDUCE method is that an ambiguous word which is mapped to many senses in ontology is less important in respect of the sentence than a word which is mapped to only one sense and has integrated meaning.

When we focus only on the total number of senses mapped to certain words, however, important senses which include valuable meanings can be neglected. Especially in the process of sentiment analysis, it is very important to grasp opinionate senses which are related to polarity-related concepts. Therefore we manually choose 372 concepts having polarity-related definitions of total 5,449 concepts in the KOLON ontology and use this polarity-related concept list in the process of adjustment. Firstly, POLconcPERADD method controls the value of certain word according to the relative weight of polarity-related senses in the total senses mapped to the word. This method operates under the assumption that ambiguous word which has fundamental opinionated meaning is mapped to relatively more polarity-related senses and such ambiguous words are given much greater weight than other words.

NOTPOLconcREDUCE method reduces the value of words which are mapped to many polarity-unrelated senses as much as the number of the senses. This method is the opposite of the above POLconcADD method. If this method is used, the more the ambiguous words have polarity-unrelated senses, the more the values of the words are weakened regardless of the number of polarity-related senses of the words.

Finally, the purpose of POLnNOTPOLconc method properly controls the value

of the words by intensifying according to the number of polarity-related senses mapped to the words or weakening according to the number of polarity-unrelated senses mapped to the words. Through consideration of both polarity-related and polarity-unrelated senses, this method can reflect all of senses mapped to one word. This and the above NOTPOLconcREDUCE method can be applied if and only if there is more than one polarity-unrelated sense.

Each ontology-based adjustment method proposed in this paper has distinct type of target ambiguous words according to assumption of the method. For this reason, the effectiveness of the ontology-based adjustment methods for sentiments of the expressions can vary depending on the context.

(2)

자신/nc	들/nc	의/jcm	이익/nc	추구/nc
casin	*tul*	*uy*	*iik*	*chwukwu*
oneself	Plural	Genitive	benefit	pursuit

'the pursuit of themselves' benefit'

For example, the polysemous noun '자신 *casin*' has the 'POSITIVE' tag in the polarity dictionary and the positive value 1 based on the presumption that the meaning of '자신' should be 'confidence'. The intended '자신' of example (2), however, means 'oneself'. In the KOLON ontology '자신' has two senses which are mapped to the 'SELF' concept and the 'HAVE-TRUST-IN' concept; among these only 'HAVE-TRUST-IN' is included in the polarity-related concept list. Although the value of '자신' will be maintained via adjustment method POLnNOTPOLconc or POLnNOTPOLconc, if MULTIconcREDUCE or POLconcPERADD method is used, the value of '자신' will be reduced to half. The reduced value is the intended result considering intended meaning of '자신' in the phrase of example (2).

As was observed, the efficiency of each ontology-based adjustment method varies according to the context. In the following section, through experimentation we will look into which method among proposed ontology-based adjustment methods can improve the results of sentiment analysis under unsupervised conditions.

6. Experiment 2[12]

6.1 Results

Table 2 shows the results of a 10-fold cross variation experiment using SVMlight. Numbers in bold are the values which improved upon the results of the first experiment according to the p-value. The p-value is the result of t-test. In this paper we compare the experimental results of the first experiment and each result of proposed adjustment methods of the second experiment by using the paired t-test. According to 95 percent confident interval, if p-value is below 0.05, the result is statistically significant.

In the results of the editorial article corpus ('EDI' in Table 2), the most subjective, though there are some results which are slightly improved from about 0.2% to 2% in accuracy and F-measure values, no results show statistically significant improvements.

[12] In the second experiment, we use the same corpus as the first experiment in order to compare the experimental results under the same conditions.

[Table 2] The Results of the Adjustment of Word Senses

Data	Method		Use of Chunking-Shifter			
			NONO	NOYES	YESNO	YESYES
EDI	MULTIconcREDUCE	accuracy	67.67	70.106	72.992	73.034
		f-measure	53.070	53.060	56.802	58.343
	POLconcPERADD	accuracy	66.656	68.103	70.444	72.43
		f-measure	54.210	55.908	56.959	57.502
	NOTPOLconcREDUCE	accuracy	70.698	72.409	71.845	72.077
		f-measure	52.946	54.956	55.837	56.805
	POLnNOTPOLconc	accuracy	68.518	66.729	68.954	72.312
		f-measure	55.258	54.109	56.543	56.401
SUB	MULTIconcREDUCE	accuracy	56.362	**57.189**	55.241	55.822
		f-measure	68.112	**68.601**	67.391	67.512
	POLconcPERADD	accuracy	**57.316**	**55.471**	56.231	55.926
		f-measure	**68.356**	**67.233**	68.384	67.963
	NOTPOLconcREDUCE	accuracy	**58.377**	54.247	54.23	55.234
		f-measure	**69.536**	**67.501**	66.97	67.606
	POLnNOTPOLconc	accuracy	54.878	54.786	56.497	55.876
		f-measure	67.566	**67.584**	68.701	68.289
NEWS	MULTIconcREDUCE	accuracy	48.057	42.362	47.489	51.814
		f-measure	59.463	56.041	58.492	60.893
	POLconcPERADD	accuracy	47.357	48.754	48.266	51.067
		f-measure	59.071	59.483	58.872	60.014
	NOTPOLconcREDUCE	accuracy	46.199	49.381	49.205	**54.736**
		f-measure	57.857	60.376	60.007	61.93
	POLnNOTPOLconc	accuracy	45.645	46.573	45.557	49.604
		f-measure	58.687	59.042	58.722	60.488

In the general news article corpus (NEWS), the least subjective or, in other words, the most objective, the accuracy value of NOTPOLconcREDUCE adjustment method with chunking and shifter is the only statistically significant improvement (p-value: 0.01078).

In contrast, the subtopic news article corpus (SUB), less subjective than EDI one but more subjective than NEWS, we observe many statistically significant improvements[13] especially when chunking method is not used.

[13] (p-value) NONO-POLconcREDUCE: in Accuracy 0.00748, in F-measure 0.00563
NONO-NOTPOLconcREDUCE: in Accuracy 0.01559, in F-measure 0.00587
NOYES-MULTIconcREDUCE: in Accuracy 0.019, in F-measure 0.02744
NOYES-POLconcPERADD: in Accuracy 0.01532, in F-measure 0.04791
NOYES-NOTPOLconcREDUCE: in F-measure 0.04399
NOYES-POLnNOTPOLconc: in F-measure 0.04967

6.2 Discussion

In the results of the second experiments, only in SUB and especially when chunking method is not used, we can observe improvement of results of sentiment analysis. In contrast, in the first experiment, SUB shows the smallest improvements. We could suggest two reasons for these results. First, this phenomenon might be attributed to the characteristics of news articles aiming to provide facts, not particular opinions. In order to maintain objectivity, news articles dealing with subjective topics tend to express opinions related to the topics in a polite and euphemistic way instead of using direct opinionated terms. In comparison, the editorial articles which have the purpose of expressing author's opinion to social issues use relatively direct opinionated word and the general news articles practically include object words, except for the case of citation. For this reason, our dictionary-based term weighting system has difficulty in finding the implicit meanings and so subtopic news articles strongly need to adjust word senses of ambiguous terms and reduce influence of the terms in the process of sentiment analysis in order to keep out from possible confusion caused by such ambiguous terms related to opinion in the text.

Second, difference between a semantic approach and a structural approach might cause this phenomenon. The results of the first experiment verify that proper utilization of structural information and relations of morphological dependency chunks is helpful in sentiment analysis of Korean. This shows the structural approach is useful. However, in this paper the adjustment of word senses is a completely semantic issue. Due to the distinct characteristics of the two approaches, when one approach is not applied, the other approach works better. Furthermore, most results of the subjective news article corpus surpass the best results of the same corpus of the first experiment (using both chunking and shifter). This implies that a more elaborate adjustment method is needed such as regarding of argument structures and eventually the general WSD.

7. Conclusions

In this paper, we verified that the effective use of linguistic features can improve the results of sentiment analysis just by taking simple measurements. In the process of term weighting, our approach utilizes various Korean lexical items that reflect the nature of Korean well, such as contextual intensifiers, contextual shifters (negation shifters and flow shifters), modal affixes, and morphological dependency chunk structures. In addition, to control the influence of ambiguous words having many senses according to the sentence context, we propose simple ontology-based adjustment methods for sentiment analysis by utilizing KOLON, the Korean ontology. The importance of our approach is that using simple formulas can obtain good results in sentiment analysis without adding an inefficient workload burden. In addition, we can find possibilities for improved performance of the classifier for sentiment analysis by using adjustment methods which apply the KOLON ontology as a valuable Korean lexical resource.

We have plans to confirm the results of this paper by experiments on corpora which are expanded in size and type in future work. In that process, we will find elaborate and efficient formulas for ontology-based adjustment methods in order

to overcome possible problems related to such simple formulas as the ones used in this paper and further improve the results of sentiment analysis on any kind of dataset.

Furthermore, we believe that improvements to our ontology, such as expanding mapped Korean lexical items, modifying wrong mappings, or creating new concepts reflecting meaning of Korean words, will continue to make steady progress even though our adjustment methods are at a low level which simply find ambiguous words and reduce value of those words. Finally, general WSD tasks will be performed to find correct meanings of ambiguous word in certain contexts through valuable linguistic information included in the KOLON ontology,s such as information on semantic roles required by certain words and relation map of concepts. The results of sentiment analysis of Korean will then be greatly improved. Also, we expect that such ample linguistic information for Korean as that in the KOLON ontology could benefit other NLP tasks.

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