A Sarcasm Extraction Method Based on Patterns of Evaluation Expressions

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Abstract—**Sarcasm presents a negative meaning with positive expressions and is a non-literalistic expression. Sarcasm detection is an important task because it contributes directly to the improvement of the accuracy of sentiment analysis tasks. In this study, we propose a extraction method of sarcastic sentences in product reviews. First, we analyze sarcastic sentences in product reviews and classify the sentences into 8 classes by focusing on evaluation expressions. Next, we generate classification rules for each class and use them to extract sarcastic sentences. Our method consists of three stage; judgment processes based on rules for 8 classes, boosting rules and rejection rules. In the experiment, we compare our method with a baseline based on a simple rule. The experimental result shows the effectiveness of our method.**

keywords—**Sarcasm detection, Classification, Sentiment analysis, Rule-based method**

I. INTRODUCTION

In recent years, documents with opinions, such as product reviews, are increasing on the web. The opinions in the documents often influence buying behavior of consumers. Therefore sentiment analysis, which is to analyze opinions, is beneficial to consumers and a important task in natural language processing [1]. A basic task in sentiment analysis is to classify the opinions into positive or negative. The keys for the classification in conventional studies are based on evaluation expressions such as positive words and negative words in the documents [2]. The positive words "excellent" and the negative words "poor" are keys to classify a target into positive and negative opinions, respectively. However, opinions are not always expressed literally. Sarcasm, which expresses a negative meaning with positive words, is a typical problem. Therefore, sarcastic sentences often lead to mistakes in sentiment analysis and sarcasm detection is an important task in sentiment analysis. Many researchers have studied this important task [3][4][5].

In this paper, we propose a method of detection of sarcastic sentences in reviews for the improvement of the accuracy of sentiment analysis tasks. For the purpose, first, we analyze the mechanism of how the negative meaning is indicated in sarcasm. We observe the usage of evaluation expressions in sarcastic sentences. In this process, sarcastic sentences in target reviews are manually classified into 8 classes of sarcasm. On the basis of the analysis, we generate classification rules for each class. Next, we propose a three-stage method based on these rules to detect sarcastic sentences. The first stage is based on the rules for 8 classes. The second stage is based on boosting rules about sarcastic sentences. The third stage is rejection rules to remove sentences containing the expressions for the rejection. The contributions of this paper are as follows:

- Classifying sarcasm into 8 classes on the basis of real sarcastic sentences in review data.

- Verifying the effectiveness of out sarcasm extraction method based on rules about the 8 classes.

II. RELATED WORK

Sarcasm is a nonliteral expression indicating a negative meaning. However, because of diversity of sarcasm, defining linguistic phenomena of sarcasm is difficult. Definition of sarcasm has been studied in [6].

In sarcasm detection, words or phrases in sarcastic sentences are commonly used to detect sarcasm. Tsur et al. [4] have proposed a semi-supervised method to detect sarcasm in reviews. They used pattern-based features extracted from a sarcasm-labeled corpus and features based on punctuations such as "!" and "?". The useful patterns extracted by their method often contained positive words such as "yay!" or "great!". Reyes et al. [3] have verified elements to represent sarcasm. They reported that features such as a sequence of words, called n-grams, and evaluation expressions, especially positive words, were important to detect sarcastic reviews.

As above, positive expressions which are used to indicate a negative meaning are important for sarcasm detection. However, sentence structures containing evaluation expressions are important as well as just appearing positive expressions. A positive word often changes its meaning because of a structure in which a negative phrase appears near the positive word. For example,[1]

ex1)　I have been using this product for years.
　　　The durability is <u>excellent</u>!

ex2)　This product was immediately <u><u>broken</u></u> when I received it.
　　　The durability is <u>excellent</u>!

The second sentences of ex1) and ex2) are the same expressions. The second sentence of ex1) is not sarcastic, namely a positive meaning. In contrast, that of ex2) is sarcastic, namely a negative meaning. This discrepancy in interpretation is caused

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[1]Hereinafter, a double underline denotes a negative expression and a underline denotes a positive expression.

by presence of double underlined negative words. Riloff et al. [5] has proposed a method using a sentence structure. They extracted phrases by using a sentence structure that a positive verb appears to the left of a negative situation phrase as following:

ex3)   I <u>love</u> <u>waiting</u> forever for the doctor.

They detected new sarcasms which were not detected by previous methods. However, they focused on only the limited contrast structure of a positive verb and a negative situation phrase. Not all sarcasm is expressed in the structure. Sarcasm is expressed diversely as follows:

ex4)   I just <u>love</u> THE PACKAGE !

ex5)   If you use this product, you will realize that other products are <u>excellent</u>.

ex6)   This product is <u>conspicuous</u> in a bad way.

The Riloff's method could not deal with these situation because there are no positive-negative structures in the sentences. We solve the problem on the basis of deep analysis of the usage of evaluation expressions in sarcastic sentences.

III. ANALYSIS

In this section, we analyze sarcastic sentences and classify them into 8 classes.

A. Data

The target in this paper is Japanese product reviews from Rakuten Ichiba in Rakuten Data[2]. Each review contains a product name, evaluation points, a review title and review sentences. We analyze 10,000 reviews consisting of 34,917 sentences.

B. Result of Analysis

We manually analyzed each sentence in the data. As the result, we obtained 70 sentences as sarcastic sentences from 34,917 sentences. The 70 sentences in analysis data were manually labeled as sarcastic. We manually classified the sarcastic sentences in terms of the usage of positive expressions. As a result, we obtained 8 classes about the sarcastic sentences. We describe these classes in detail.

Class 1: The sarcastic sentences in Class 1 are as below:

ex7)   *Zenzen <u>amaku nai</u> desu.*
        (It's <u>not sweet</u> at all.)
        Iwayuru johin na <u>amasa</u> tte yatsu deshi ta.
        (This is what is called "<u>delicate</u> sweetness.")

In this example, there is the positive expression "johin na amasa (delicate sweetness)" in the second sentence while there is the negative expression "amaku nai (not sweet)" in the first sentence. In other words, sarcasm in this class is expressed by coexistence of positive expressions and negative expressions about the same evaluation point.

Class 2: The sarcastic sentences in Class 2 are as below:

ex8)   title : *Amaku te oishii (ˆ q ˆ)*
        (Sweet and delicious :-)～)
        sentences : <u>*Amaku te oishii* mikan !</u>
        (<u>Sweet and delicious</u> oranges !)
        Hako no naka de <u>kusatte</u> imashita .
        (They are <u>rotten</u> in a delivery box.)

In this example, the phrase "Amaku te oishii (Sweet and delicious)" appears in the title and the first sentence. It is a kind of emphasis of a positive meaning. On the other hand, there is a negative word in the second sentence. From these sentences, we regard the emphasis as a boosting word for a negative meaning. This is the usage of positive expressions in this class; emphasis.

Class 3: The sarcastic sentences in Class 3 are as below:

ex9)   *Kekkou <u>ii</u> o nedan nanode nayami mashita .*
        (I was thinking about whether I should buy the product because the price was (<u>good/expensive</u>).)

Here the Japanese expression "ii" is good in English. However, combination of words often complicates the meaning. The combination of "ii (good)" and "nedan (price)" changes the meaning of "ii" to "too expensive". This kind of positive expressions belongs to this class.

Class 4: The sarcastic sentences in Class 4 are as below:

ex10)   *Haisou ha <u>yoka tta</u> kedo ...*
        (Delivering was <u>good</u>, but ...)

In this example, the target of the evaluation "yoka tta (good)" is the delivering, but not the product. It implies a negative meaning to the product; the delivering is good but the product is not good. In other words, sarcasm in this class is indirect evaluation to the product with positive expressions.

Class 5: The sarcastic sentences in Class 5 are as below:

ex11)   *Kono syouhin wo katte koukai shiteimasu .*
        (I regret that I bought this product.)
        Shikashi, <u>mata son wo suru</u> yori <u>ii</u> desyou .
        (But it's <u>better</u> than <u>losing money</u> again.)

In this example, the positive expression "ii (better)" in the bad situation "losing money again" indicates a negative meaning for the target of the review in a general situation. As above, it expresses that this situation is not bad as compared with worse situations although the situation is not good.

Class 6: The sarcastic sentences in Class 6 are as below:

ex12)   *Motto <u>oishii</u> mikan ga kinzyo ni urareteimasu.*
        (I know more <u>delicious</u> oranges that are sold nearby.)

In this example, the positive expression "*oishii* (delicious)" is

used for oranges which are sold nearby. It indicates a negative meaning for the target in the review. The sarcasm in this class contains a positive evaluation to another product. It eventually indicates that the target product is not good.

Class 7: The sarcastic sentences in Class 7 are as below:

ex13) *Tsukaisute to omoeba dai <u>manzoku desu</u>.*
(If this were a disposable product, I could <u>get satisfaction</u> about it.)

In this example, the positive expression "*manzoku* (get satisfaction)" is not used for its original purpose ; in this case, "*Tsukaisute* (disposable)". In other words, it implies a negative meaning to the target product in the review. The sarcasm in this class contains positive expressions to other purpose or usage.

Class 8: The sarcastic sentences in Class 8 are as below:

ex14) *Maa hutsu ni <u>shiyou dekimasu</u>.*
(I <u>can use</u> it so so.)

In this example, the positive expression "*shiyou deki masu* (can use)" is qualified by "*hutsu ni* (so so)". It implies that there is no specific positive point about the product. In other words, the product have no particularly outstanding points although the sentence contains positive expressions.

IV. PROPOSED METHOD

We propose our method based on the result of analysis in Section III to extract sarcastic sentences from review documents. Our method consists of three stages. First, we explain the overall process of our method. Then, we explain the details of each step in our method.

A. Outline

Our three-stage method is shown in Figure 1. The input of our system is review documents consisting of several sentences. Our method judges whether each sentence in the reviews contains a sarcastic meaning or not.

There are several approaches for sarcasm extraction; machine learning and rule-based methods. Machine learning methods, such as SVMs, are well-known as good approaches for classification tasks. However, most of sentences in reviews do not related to sarcasm. As a result, the ratio of sarcastic sentences and non-sarcastic sentences is biased. The biased data tend to generate a unsuitable classifier. In addition, the coverage of sarcasm in the biased data is probably insufficient. Therefore, we focus on a rule-based approach in this paper. We manually create generic rules for the sarcasm extraction.

Our method uses three types of rules; (1) rules for 8 classes and (2) boosting rules and (3) rejection rules. We generate rules for 8 classes manually in advance. In the first stage, we apply the rules to each sentence in the input. Sentences matching with the rules, namely candidates as sarcastic sentences, are the input of the second stage. In the second stage, we use boosting rules focusing on sarcasm-like expressions. If a sentence after the first stage contains words or phrases in the boosting rules, we judge the sentence as a sarcastic sentence. Besides, by rejection rules, if a sentence after the second stage contains

the expressions for the rejection, we remove the sentence from the final list.

B. First Stage

The purpose of the first stage is to extract candidates as sarcastic sentences on the basis of the analysis in Section III, namely 8 classes. For this purpose, we generate classification rules for each class. By using the rules, our method classifies each sentence into 9 classes; 8 classes in Section III and non-sarcastic sentences. The non-sarcastic sentences are rejected in this process. The rules are based on (1) the polarity of the review, (2) syntactic patterns, (3) high-frequency positive phrase, (4) relations between two Sentences. The rules for 8 classes are shown in Table I. The hyphen mark in the table denotes that the class does not require the rule in the process.

- Polarity of Reviews
  Sarcastic sentences generally appear in negative reviews. Therefore, the polarity of each review, namely positive or negative comments, is one of the most important points for sarcastic sentence extraction. In Table I, the classes with "Neg" in the second column require the polarity feature for the judgment.
  The polarity of a review is determined by a PN score of sentences; the ratio of positive sentences to negative sentences. In other words, the feature sets "Neg" if the number of negative sentences in the review is same and more than that of positive sentences.
  For the judgment, we need to classify each sentence into positive or negative. We use ACP Corpus [7][8] for the sentence PN classification. The ACP Corpus is a Japanese corpus containing one million sentences with a polarity. We generate a machine learning based classifier with the bag-of-words features from the ACP corpus, and then classify target sentences in the PN classification.

- Syntactic Patterns
  We prepare syntactic patterns for each class. The patterns in Table II correspond to P1 to P8 in Table I, respectively. Each syntactic pattern includes evaluation expressions. "Pos" and "Neg" denote a positive expression and a negative expression, respectively. We judge whether a sentence contains one of the syntactic patterns or not. We need evaluation expressions for the matching process. We use two resources for the process: a Japanese Sentiment Polarity Dictionary [9][10] and a Polar Phrase Dictionary [11].

- High-Frequency Positive Phrase
  If a positive phrase appears high-frequently in a class, we use the phrase as an important point for sarcasm detection. This is used for Class 4 as the phrase "*benkyou ni nari mashi ta*(I learned a lot from that.)".

- Relations between Two Sentences
  The presence of a positive expression after a negative expression in a sentence is an important point for sarcasm detection.
  ex15) *Yasuppo sugi te <u>waraeru</u>.*
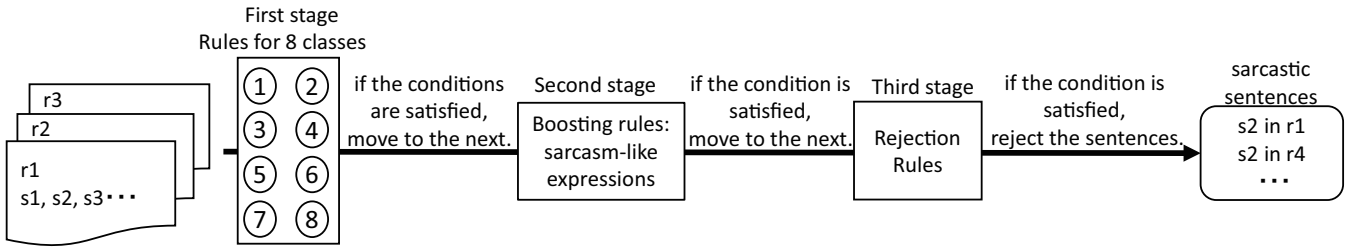 (That's funny because it looks too <u>cheap</u>.)

Fig. 1. The outline of our method.

TABLE I. EXTRACTION RULES.

Classes	Rules			
	Polarity of Reviews	Syntactic Patterns	High-Frequency Positive Phrase	Relation
1	Neg	P1	-	Correspondence and high similarity
2	Neg	P2	-	-
3	Neg	P3	-	-
4	Neg	P4	"*benkyou ni nari mashi ta*"	Syntactic Patterns P2-1
5	Neg	P5	-	Syntactic Patterns P2-2 and low similarity
6	-	P6	-	-
7	Neg	P7	-	-
8	Neg	P8	-	-

We can handle this situation by using the syntactic patterns. However this phenomenon does not always occur within one sentence.

ex16) *Katte koukai shimashita.*
(I regretted to buy.)
Aruimi ii keiken ni narimashita.
(It was a good lesson for me.)

Therefore, we need to handle relations between two sentences. The "Relation" in Table I denotes this rule. The sentence pair consists of the target sentence, such as the second sentence in ex16), and the previous sentence, such as the first sentence ex16). We have three patterns for the rule: (a) the correspondence between evaluation items in two sentences, (b) a similarity between two sentences and (c) syntactic patterns in the target sentence. (a) and (b) are used for Class 1 and Class 5. (c) is used for Class 4 and Class 5.

  a) The correspondence between evaluation items. Here we regard a word that has a dependency with an evaluation expression as an evaluation item. For example, "expensive" and "price" are the evaluation expression and the evaluation item in the phrase "the price is expensive", respectively. If the evaluation item in the target sentence corresponds to that in the previous sentence, it is true.

  b) A similarity between two sentences. Here we focus on distributed representations. In this paper, we use Paragraph Vector, an unsupervised framework that learns continuous distributed vector representations proposed by [12]. The similarity between two vectors which represents meanings of the two sentences is measured by cosine similarity. By the similarity, it is judged whether meanings of the two sentences are similar or not. The range of the cosine similarity is ranges from -1 to 1. In our method, if the cosine similarity is greater than

0, we regard that the two sentences are similar (high similarity in Table I). On the other hand, if the similarity is less than 0, we regard that the sentences is not similar (low similarity in Table I).

  c) Syntactic Patterns in The Target Sentence. For this process, we use syntactic patterns shown in Table III.

The polarity in Table I is strict. If the value is not "Neg", our method does not extract any sentences. The syntactic patterns, high-frequency positive phrases and relations are non-strict. If one of them is satisfied, our method extracts the sentence as a sarcastic sentence.

C. Second Stage

In the second stage, we apply boosting rules to the output of the first stage. We focus on sarcasm-like expressions as the boosting rules. If a sentence contains words or phrases in the boosting rules, we judge the sentence as a sarcastic sentence.

Takizawa and Ito [13] have proposed a method for detecting ironic utterances. They reported that ironic utterances tend to contain particular sentence-ending particles and exclamations. We also introduce the characteristics of sarcasm into our method. We collect expressions manually for the boosting rules. Table IV shows the boosting rules. If a sentence contains an expression in the table, we extract the sentence as the input of the third stage.

D. Rejection rules

We remove sentences containing the expressions for the rejection shown in Table V from the output of the second stage. Although each expression for the rejection is a positive expression and often indicates a negative meaning, it is used to express wishes, regret or compromise. In this study, we regard sentences containing such expressions as non-sarcastic sentences.
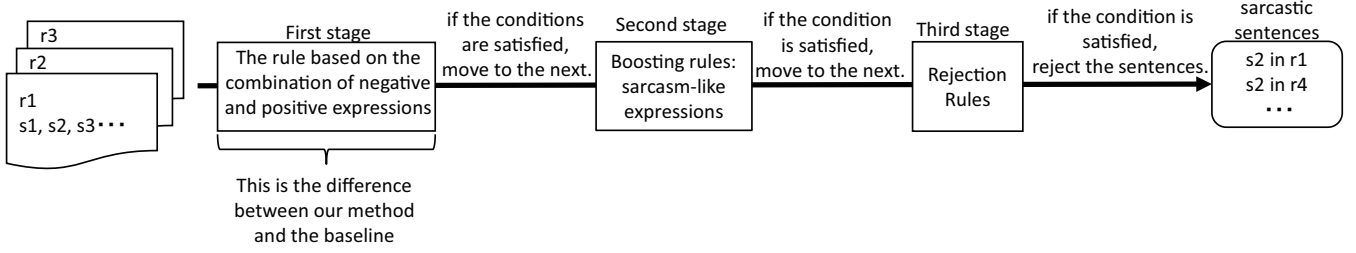
Fig. 2. The outline of the baseline.

TABLE II. SYNTACTIC PATTERNS.

P1	"iwayuru"+Pos "aru imi"+Pos Pos+"kurai"+Neg Neg+"kurai"+Pos Pos+"node"+Neg Neg+"node"+Pos Pos+"to"+Neg Neg+"to"+Pos Pos+"noha"+Neg Neg+"noha"+Pos
P2	A Pos appers two times within 3 words. A phrase with Pos in the title appears in the main text of the review.
P3	Pos+"node"+[a phrase containing Neg and a verb] Pos+"kara"+[a phrase containing Neg and a verb] Pos+"sugite"+[a phrase containing Neg and a verb] "yoi" modifies [a phrase containing Neg and a noun]
P4	"ha"（particle）+Pos+[a phrase containing contradictory conjunction]
P5	"ima no tokoro"+Pos Neg+"yoriha"+Pos Neg+"yori"+Pos
P6	"hoka no"+[a phrase starting with a noun and containing Pos] "betsu no"+[a phrase starting with a noun and containing Pos] "ruizi"+[a phrase starting with a noun and containing Pos] [a phrase ending with a noun]+"no hou ha"+Pos [a phrase ending with a noun]+"no hou ga"+Pos [a phrase ending with a noun]+"no ha"+Pos "dattara"+[any phrase]+"motto"+Pos "demo"+[any phrase]+"motto"+Pos
P7	[a phrase ending with a word other than a noun]+"to omoe ba"+Pos [a phrase ending with a word other than a noun]+"niha"+Pos [a phrase ending with a word other than a noun]+"tsumori de"+Pos [a phrase ending with a word other than a noun]+"naraba"+Pos [a phrase ending with a word other than a noun]+"ba"+Pos
P8	"hutuu ni" modifies Pos or "dekiru" "souou ni" modifies Pos or "dekiru" "heibon ni" modifies Pos or "dekiru" "bunan ni" modifies Pos or "dekiru" "atarimae ni" modifies Pos or "dekiru" "kurai no" modifies Pos or "dekiru"

TABLE III. SYNTACTIC PATTERNS IN THE TARGET SENTENCE.

P2-1	"ha" (particle)+Pos
P2-2	[a phrase ending with a word other than a noun]+"de"+Pos [a phrase ending with a word other than a noun]+"node"+Pos [a phrase ending with a word other than a noun]+"kara"+Pos [a phrase ending with a word other than a noun]+"te"+Pos

TABLE IV. SARCASM-LIKE EXPRESSIONS.

Part of Speech	Expression
Polite or Honorifics	"o-"（prefix）, "go-"（prefix）, "goran", "gozonzi", "kenzyou", "sanzyou", "haiken", "haidoku", "zonzi", "tyoudai", "ni naru", "reru", "nasaru", "itadaku", "oru", "ossyaru", "meshi", "mousu", "itasu", "sasiage", "ukagau", "mairu", "kudasaru"
adverbs	"hontou", "tashikani", "kakuzitsuni", "sugoku", "sasuga", "totemo", "kekkou", "kanari", "itsumo", "mou", "yoku", "omowazu", "mekimeki", "yappri", "yahari", "sugu", "yohodo", "aratamete", "tyoudo", "nandaka", "mattaku", "motto"
Prefixes	"dai-", "do-", "tyo-", "zen-", "shin-"
punctuations	!, ?, ··, （笑, w, 「,」, [,], 『,』, ...,。。, ～, ^, ;

TABLE V. EXPRESSIONS FOR REJECTION.

"nara ii noni", "nara yokatta", "ba ii noni", "ba yokatta", "demo ii noni", "demo yokatta", "hou ga ii noni", "hou ga yokatta", "maa ii", "yoshi to suru"

data. The second one is another dataset, namely test data. There is no overlap between the development and test data. The development data contained 34,917 sentences with 70 sarcastic sentences, and the test data contained 33,864 sentences from 10,000 reviews[3].

We also prepared a baseline method. The outline of the baseline is shown in Figure 2. The difference between our method and the baseline is on the first stage. In our method, the first stage is based on rules for 8 classes. On the other hand, the first stage of the baseline is based on a simple rule. The simple rule is based on a combination of negative and positive expressions. In the baseline, if a positive expression exists in a sentence and the positive expression appears immediately after a negative expression, the sentence is extracted as a candidate for the second stage. We used the Japanese Sentiment Polarity Dictionary and the Polar Phrase Dictionary that were used in Section IV-B for the process. This baseline was also used in the Riloff's work [5].

B. Result

Table VI shows the results of our method and the baseline method on the development data. For example, the numbers in parentheses about the precision are the number of extracted sentences correctly and the number of extracted sentences; 29 and 5083 for the baseline on the development data. Table VII shows the results of our method and the baseline method on the test data.

V. EXPERIMENT

A. Experimental settings

We prepared two data sets for the evaluation. The first one is data for the analysis in Section III, namely development

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[3]We did not annotate sentences in the test data. Therefore, the number of sarcastic sentences in the test data is unknown.

TABLE VI. Experimental results on the analysis data

	Precision	Recall	F score
Baseline	0.006 (29/5083)	0.414 (29/70)	0.012
Our method	0.028 (38/1381)	0.543 (38/70)	0.053

TABLE VII. Experimental results on the test data

	Precision
Baseline	0.009 (43/4681)
Our method	0.036 (47/1300)

The precision rates of both of the baseline and our method were extremely low; 0.006 for the baseline and 0.028 for our method. The reason was that this sarcastic sentence extraction was a great challenge; the task extracting 70 sentences from 30,000 sentences. However, our method outperformed the baseline on all criteria; precision, recall and F-score. There was the same tendency for the test data; 0.009 and 0.036. These result shows the effectiveness of our method based on polished rules about 8 classes, as compared with the baseline with a simple rule. On the other hand, the recall rate was insufficient (0.543). The result shows the analysis of sarcastic sentences was not enough. To improve the accuracy, we need more deep analysis for sarcastic sentences.

VI. Error Analysis

After the experiment, we analyzed the errors on the development data. As a result, we obtain some typical errors from the error analysis.

First, some sarcastic sentences didn't fit to syntactic patterns because of omission of particles and expressions. For the problem, we need deeper analysis such as predicate argument structure analysis and semantic analysis.

Secondly, common knowledge was necessary to extract some sarcastic sentences. For instance, the sarcastic sentence "*Yahari zyunsei no deki ga subarashii desu* (After all, genuine products are well-made).", does not contain any contrast between positive and negative expressions. However, the evaluation about genuine products in this instance implies that compatible products generate lower performance as compared with the genuine products. The estimation is a difficult task.

The third errors were caused by the context dependency of evaluation expressions in the dictionary. For instance, the sentence "*Kono shiri-zu ha kotsubu ga uri no you desu .^^ ;* (The selling point of products of this series may its small size. :&)" has the expression "kotsubu (small size)" and the polarity of the expression depends on the context. To solve this problem, it is necessary to recognize the context in the sentence.

The fourth problem was caused by the boosting rule. some sentences were not extracted by a deficiency of expressions in the boosting rules. In essence, it is difficult to collect expressions related to the rules exhaustively. To extract more sarcastic sentences, we need to consider another approach that is not based on the boosting rules.

VII. Discussion and Conclusions

In this paper, we proposed a extraction method of sarcastic sentences in product reviews. Sarcasm, which expresses a negative meaning with positive words, often lead to mistakes in sentiment analysis. Therefore, sarcasm detection is an important task in sentiment analysis. For our method, we collected sarcastic sentences to analyze them in advance. We manually labeled 70 sentences as sarcastic sentences from 10,000 reviews. We generated extraction rules on the basis of the analysis of the sentences. The rate of sarcastic sentences contained in reviews was low (70/10,000). However, 21 sarcastic sentences appeared in 233 reviews with 1-point, which is the worst point in this review dataset. In other words, approximately 10contained sarcastic sentences. This fact denotes that the detection of sarcastic sentences lead to the improvement of sentiment analysis, namely positive-negative identification, because conventional PN identification methods without sarcastic detection can not recognize the polarity of the reviews correctly. This result shows a significance of sarcasm extraction even if the number of sarcastic sentences in reviews is small.

In the experiment, we compared our method with a baseline based on a simple rule. As a result, Our method outperformed the baseline. However, some approaches to extract sarcastic sentences have been proposed, such as Riloff's method. Comparison with state-of-the-art methods is important future work to evaluate our method. In Addition, the accuracy of our method was insufficient, especially the precision rate. The result is due to the lack of analysis. Although we analyzed sarcastic sentences in our data, the data contains only 70 sarcastic sentences. Collecting new sarcastic sentences and analyzing the sentences manually are important future work to improve our method. Moreover, Manual analysis of numerous sentences is costly. Therefore, generating rules automatically becomes necessary.

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