Emotion Estimation from Sentence Using Relation
between Japanese Slangs and Emotion Expressions

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Abstract

Most of Japanese slang words such as Waka-mono Kotoba are analyzed as "unknown word" or segmented wrongly by the morphological analysis system. These problems are causing negative effect on sentiment analysis in text. These words generally have many varieties of notations and conjugations, and they lack versatility. As a result, many of them are not registered in the dictionaries, making morphological analysis more difficult. In this paper, we aimed to decrease such negative effects of Wakamono Kotoba for the accuracy of emotion estimation from sentence and proposed a method to increase the accuracy by using a classification method based on machine learning. In this method we used emotional expressions which had high relevance with Wakamono Kotoba as feature. As a result, the proposed method obtained 20% higher accuracy than the method only using morpheme N-gram as feature.

Emotion Corpus, Japanese Slang, Out of Vocabulary

1 Introduction

The words that are not registered in the dictionaries are called unknown words. In the field of Natural Language Processing unknown words have been traditionally studied. However, many of these studies focused on proper noun, onomatopoeia or emoticon, while a few research targeted slang such as Waka-mono Kotoba. One of the reasons might be that Wakamono Kotoba has been usually treated as "improper expression" or "bad word"(Noguchi , 2004).

However, considering that these words are getting more and more frequently used on WWW, it is inevitable to treat Wakamono Kotoba even though they are improper expressions.

In Japan, many of the Internet users are people from teens to people in their fourties[1]. One of the characteristics of Wakamono Kotoba is that they are specialized in expressing how people especially in their younger age feel. By dealing with such Waka-mono Kotoba, we will be able to use effectively the huge amount of documents on WWW as precious resources for language processing.

This paper aims to estimate emotion from utterances including Wakamono Kotoba. Most of the existing emotion estimation studies from text did not treat the problem of slang such as Wakamono Kotoba. One of the reasons was that there were few text corpora including Wakamono Kotoba. Currently Weblog became very popular and many documents on WWW are written in spoken language. These texts are available as huge corpus. As the result, recently there are active research on new words or unknown words (Murawaki , 2010),(Jiean *et al.*, 2011) and there are also research on emotion estimation based on their findings (Matsumoto *et al.*, 2011),(Matsumoto and Ren, 2011). For example, in (Matsumoto *et al.*, 2011), they used the conventional statistic method to estimate emotion of the sentence including Wakamono Kotoba, then compared the estimation accuracy when Wakamono Kotoba was included in the sentence and it was not included in the sentence. In (Matsumoto and Ren, 2011), they tried to estimate emotion of Wakamono Kotoba by using

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[1]http://www2.ttcn.ne.jp/honkawa/6210.html

features of character.

In this paper, we focused on Wakamono Kotoba, which was traditionally not intended for research on Natural Language Processing, and proposed an emotion estimation method which was robust for utterance including Wakamono Kotoba. Because the notation of Wakamono Kotoba is various, many Wakamono Kotoba are generally low-frequency words in the corpus. Therefore, we attempted to improve the estimation accuracy by using the emotion expressions with strong relation with Wakamono Kotoba as feature instead of using Wakamono Kotoba as feature.

2   Wakamono Kotoba Emotion Corpus

In this section, we collected example sentences including Wakamono Kotoba. Firstly, we chose the Wakamono Kotoba to be the target of analysis, and then collected the example sentences including these target words automatically. Finally, the example sentences were manually annotated emotion tags to construct a corpus.

2.1   Definition of Wakamono Kotoba

The definition of Wakamono Kotoba we treated in this paper was presented. It is difficult to clearly judge whether the word is Wakamono Kotoba or not. In this paper, we regarded the Japanese slangs fulfilling the following two conditions as Wakamono Kotoba.

- The meanings of the words are defined in the glossaries on WWW.

- The words are introduced in the literature on new words or slangs such as "Afureru shingo"(Kitahara, 2009), (Yonekawa , 1998), (Yamaguchi , 2007) and "Japanese Slang Dictionary[2]."

2.2   Construction of Corpus

Wakamono Kotoba has various forms of expressions. It sometimes takes a form of phrase and sometimes takes a form of sentence final expressions. Although our final aim is to propose an emotion estimation method that can be applied to all expressive

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[2]http://zokugo-dict.com/

forms, this paper focused on Wakamono Kotoba taking a form of single word following the definition described in the previous section.

The example sentences were collected in the following steps. The basic Wakamono Kotoba (a set of seed words) were selected from the dictionaries or books that were open to the public(Yonekawa , 1998),(Kitahara, 2009). Using these words as search query we automatically collected the sentences on Web. We used Yahoo! blog search[3] as WWW search engines.

We thought that many Wakamono Kotoba used in the Web texts were likely to be unknown Wakamono Kotoba which were not seed word. First, the small corpus was constructed based on the seed words list. Then we looked for unknown words which were not seed word from the corpus manually. Using the obtained unknown words as new target for collection, the corpus was extended. We regarded these target unknown words as Wakamono Kotoba following the definition described in section2.1.

The features were manually annotated to the collected sentences.

- Wakamono Kotoba in the sentence and its representative notation

- Emoticons included in the sentence

- Emotion tags (emotion of writer or speaker): Joy, Anger, Sorrow, Surprise and Neutral

Plural emotion tags were allowed to be annotated per a sentence. The kind of emotion tags was selected based on Fischer's emotion systematic tree(Fischer, 1989) which was made according to the word classification. The highest classification categories in this systematic tree are "Love and Joy," "Surprise," "Anger" and "Sorrow and Fear." We defined four kinds of emotion tags: "Surprise," "Anger," "Joy" and "Sorrow." [4]

Although we considered and selected emotions from the lowest categories in the Fischer's emotion systematic tree at the time of annotation, we referred to and actually annotated emotions in the four highest categories. When the speaker of the sentence

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[3]http://blog.search.yahoo.co.jp/

[4]We regarded the category of "Love and Joy" as "Joy" and the category of "Sorrow and Fear" as "Sorrow."

did not express any emotion, we annotated the tag of "Neutral." We named this corpus as "Wakamono Kotoba Emotion Corpus"(WKEC).

The outline of the corpus is shown in Table1. MeCab ver.0.98 was used as morphological analysis tool and UniDic 1.3.12[5] was used as morphological analysis dictionary. The number of the annotated emotion tags is shown in Table2. A part of the example sentences included in the corpus is shown in Table3.

Total number of morphemes	401,678
Unique number of morphemes	16,998
Total number of sentences	20,500
Total number of emoticons	2,846
Unique number of emoticons	908
Total number of Wakamono Kotoba	23,644
Unique number of Wakamono Kotoba	2,231
Total number of emotion tags	21,514

Table 1: Outline of the Wakamono Kotoba Emotion Corpus(WKEC).

Joy	Anger	Neutral	Sorrow	Surprise
7,242	5,475	4,620	3,385	792

Table 2: Number of the annotated emotion tags.

3 Relation Analysis between Wakamono Kotoba and Emotion

3.1 Relation between Emotion Expression and Emotion of the Sentence

Matsumoto et al.(Matsumoto *et al.*, 2011) studied about the relation between Wakamono Kotoba and emotion. Their research took the probabilistic classification approach for emotion estimation from sentences and improved the estimation accuracy by using Wakamono Kotoba as feature. This result suggested that special expressions such as Wakamono Kotoba should have some potential to contribute to express emotion.

However, if we use Wakamono Kotoba as feature for probabilistic classification approach, Waka-

5 categories(WKEC)	10 categories (EED)
Joy	Joy, Like
Anger	Anger, Hate
Sorrow	Sorrow, Fear, Shame
Surprise	Surprise, Excitement
Neutral	Relief

Table 4: Correspondence of the 10 kinds of emotions and the 5 kinds of emotions.

mono Kotoba might result in decreasing the estimation accuracy because the frequency of Wakamono Kotoba is low. We thought that we should also consider emotional expressions such as "delightful" and "dislike" as features besides Wakamono Kotoba. The "Emotional Expression Dictionary"(Nakamura , 1993) is a dictionary listing up the keywords to express emotion. In the Wakamono Kotoba Emotion Corpus, the total number of the emotional expressions included in this dictionary was 3,171.

The words included in the Emotion Expression Dictionary(EED) were classified into ten kinds of emotions. We further classified these ten kinds of emotions into the five kinds of emotions which we used in the Wakamono Kotoba Emotion Corpus. This correspondence table is shown in Table 4. We excluded the emotion expressions classified into "Relief" in the following analysis because we did not target the emotion of "Neutral" for analysis in this paper.

The match rate between the emotion of the emotional expression appeared in WKEC and the emotion of the sentence was calculated by equation 1. $|S|$ indicates the number of the sentences including emotional expressions in WKEC[6]. Table 5 shows the match rate of each emotion category.

$$\text{Match Rate} = \frac{\sum_{i=1}^{|S|} M_{ij}}{N_E} \quad (1)$$

Emotion	Joy	Anger	Sorrow	Surprise
Match Rate	0.77	0.86	0.04	0.0

Table 5: Match rate of each emotion category.

Sentence	Wakamono Kotoba	Emotion
Shikashi, yappari mukatsukuze–!!! (But I am pissed off after all!!!)	*Mukatsuku*	Anger
Riaju-ppoi kanjino charao ya uzakimo kappuru toka hotondo inakattanode, sonnani kutsuu deha nakatakann w (Because there were only few play boys having fulfilling lives or annoying and disgusting couples, it was not such torture for me.)	*Riaju, Charao, Uzakimo*	Joy
Asu no asa yarou... Shibou Flag kanaa (I will do it tomorrow morning... Postponing might end in failure though.)	*Shibou Flag*	Sorrow

Table 3: Example of corpus.

M_{ij} indicates the number of the emotions matched between s_i and $e_j \in s_i$. N_E indicates the total number of emotion expressions in the corpus.

From this result, it was found that the emotion of the emotional expression and the sentence emotion highly matched when the emotions were "Joy" and "Anger." They rarely matched when the emotions were "Sorrow" and "Surprise."

This reason might be that most of the emotional expressions classified into "Sorrow" and "Surprise" are not commonly used in case of spoken language. Actually, we do not often use the expressions such as "*Hiai*" meaning "woe" to express "Sorrow" in spoken language. If only emotion expressions are used as features, the accuracy of emotion estimation in the categories of "Sorrow" or "Surprise" is expected to become low.

3.2 Relevance between Wakamono Kotoba and Emotional Expressions

In the preceding section, the relevance between emotional expressions and emotion of the sentence was investigated and the high relevance was found in the specific emotions of "Joy" and "Anger." If highly related emotional expressions are used as features instead of Wakamono Kotoba when the Wakamono Kotoba is unknown word in training data, we thought that we would realize robust emotion estimation from the sentences including unknown expressions.

This section analyzed the relation of co-occurrence between emotional expressions and Wakamono Kotoba to acquire "emotional expressions highly related to Wakamono Kotoba."

To calculate co-occurrence relation it is necessary to have a huge corpus including both of Wakamono Kotoba and emotional expressions. We used a corpus randomly collected from weblog articles which is called "Wakamono Kotoba Raw Corpus"(WKRC). The sentences included in the corpus are not annotated emotion tags but Wakamono Kotoba are annotated automatically.

The details of the WKRC is shown in Table 6. Because annotation was automatically made in

# of Sentences	128,394
# of Morphemes	2,129,931
# of Uniq. Morphemes	32,144

Table 6: Details of raw corpus including Wakamono Kotoba.

WKRC, there were some example sentences whose substrings matched Wakamono Kotoba. However, instead of manual correction, we automatically removed HTML tags and too short or too long sentences[7].

As a criterion to indicate how strong the co-occurrence is between each word, pointwise mutual information (MI-score) and t-score are often used. LogLog score(Kilgarriff *et al.*, 2001) is a criterion which lays weight on co-occurrence frequency. The co-occurrence scores between Wakamono Kotoba yw_i and emotional expression ew_j were calculated by equation 2 (MI), equation 3 (t-score) and equation 4 (LogLog score).

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[7]We registered the sentences consisting of 10 to 75 characters in double-byte.

$$MI_{ij} = log_2 \frac{f_{ij} \times f_{all}}{f_i \times f_j} \qquad (2)$$

$$t\text{-score}_{ij} = \left(f_{ij} - \frac{f_i \times f_j}{f_{all}}\right) \times \frac{1}{\sqrt{f_{ij}}} \qquad (3)$$

$$LogLog_{ij} = MI_{ij} * log_2 f_{ij} \qquad (4)$$

f_i, f_j indicates frequency of Wakamono Kotoba yw_i and emotional expression ew_j, f_{ij} indicates co-occurrence frequency of yw_i and ew_j. f_{all} shows the total number of Wakamono Kotoba and emotional expressions in the corpus. These scores were not calculated in the combinations which did not appear together in the corpus. These scores can become high when Wakamono Kotoba co-occur a few times with the frequently appeared emotional expressions even if the Wakamono Kotoba do not express any emotion. In this paper, we proposed a score to keep down the value by multiplying the log value of the appearance frequency of the emotional expression by the co-occurrence frequency. This co-occurrence score was defined as e-score and calculated with equation 5. df_i is a weight to decrease the value more when the co-occurrence frequency with other emotional expression becomes higher [8]. f_{y_u} indicates the unique number of Wakamono Kotoba in the corpus.

$$e\text{-score} = f_{ij} \times log_2 \left(\frac{f_{y_u}}{df_i}\right) \times log_2 \left(\frac{1}{f_j + 1}\right) \quad (5)$$

We judged which co-occurrence score was effective to calculate the relevance between Wakamono Kotoba and emotional expressions. We investigated how often the emotion of the emotional expression co-occurred with each Wakamono Kotoba and the positive / negative evaluation of Wakamono Kotoba matched[9].

We calculated the average of the match rates for the top 1 to 10 co-occurred emotional expressions. Fig. 1 shows the result. The vertical scale indicates the average of the match rate (%), and the horizontal scale indicates the threshold of the rank.

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[8] df_i indicates the number of the kinds of emotional expressions that co-occurred with yw_i

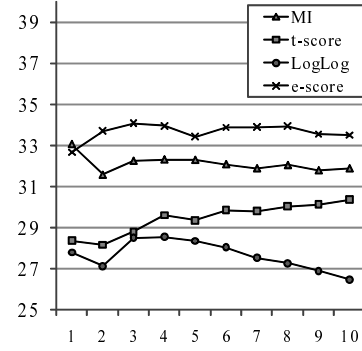[9] The positive / negative evaluation of Wakamono Kotoba was annotated manually

Figure 1: Comparison of the match rates for the co-occurrence score in higher rank.

The e-score showed a little higher match rate than other co-occurrence scores. The LogLog score is likely to become 0 value when the appearance frequency of the emotional expression is low. Therefore, when the threshold of the score's rank increases, the emotional expressions whose emotions do not match the emotions of Wakamono Kotoba are more included. As the result, the match rate tended to become lower. From this result, we thought that it would be able to extract emotional expressions with strong relevance with Wakamono Kotoba by using e-score.

However, because this emotional match rate did not exceed 33% to 34%, if this method is used to add feature, many emotional expressions whose emotions do not match the emotions of Wakamono Kotoba would be included and consequently the accuracy of emotion estimation would decrease. To solve this problem, it would be necessary to filter the additional emotional expressions as for the Wakamono Kotoba included in the training data.

4 Emotion Estimation Method Using Emotional Expression Related to Wakamono Kotoba

Fig. 2 shows the distribution of the appearance frequency of Wakamono Kotoba in WKEC. The vertical scale indicates the log value of the number of kinds of Wakamono Kotoba which appeared k times, and the horizontal scale indicates the appearance frequency k in the corpus. This distribution of the appearance frequency was limited because the

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corpus size was small. It would be possible to acquire the web appearance frequency by using search engines such as Google. However, because the purpose of this paper was to estimate emotion using small corpus, we did not investigate that possibility.

Fig. 2 shows that many of Wakamono Kotoba appeared 1 to 40 times, and 1,265 kinds of Wakamono Kotoba appeared once in the corpus, which was approximately 57%. For example, even commonly used Wakamono Kotoba such as "*Dekikon*" meaning shotgun marriage and "*Doyagao*" meaning smug look appeared only once in the corpus in the exact notations.
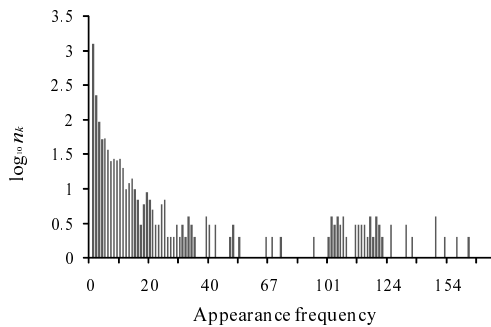

Figure 2: Distribution of the appearance frequency of Wakamono Kotoba.

One of the possible solution for such problem of the difference of notations would be to replace Wakamono Kotoba to other existing words having the same or similar meanings. However, we thought that for the purpose of emotion estimation, semantic equality was not necessarily required if only the emotions matched each other.

In our proposed method the Wakamono Kotoba with low appearance frequency were converted into the co-occurring emotional expressions extracted from huge corpus. This method enables to use effectively Wakamono Kotoba with low appearance frequency.

4.1 Experiment of Emotion Estimation Using Co-occurring Emotional Expressions

The co-occurrence score between Wakamono Kotoba and emotional expressions was calculated with the equations described in the section 3.2. Then the emotional expressions whose co-occurrence score

with Wakamono Kotoba was high were added. We also weighted the features based on the following conditions:

1. Add high weight when the emotion of the emotional expression matches the negative / positive evaluation of Wakamono Kotoba

2. Add high weight when the emotion of the emotional expression and the emotion of the sentence match in the training data.

Of course, the WKRC includes the sentences that do not express any emotion. Therefore, the emotional expressions whose emotions are different from the emotions of the Wakamono Kotoba are sometimes extracted.

Feature should not be always added only because it has the same emotions with Wakamono Kotoba. We focused on the emotional expressions with high co-occurrence rate and having the same emotions with Wakamono Kotoba, and treated them as features. The training data was created combining multiple features and the evaluation experiment was conducted with 10-fold cross validation. The target emotions were "Joy," "Anger," "Sorrow" and "Surprise." The 792 sentences were randomly selected from WKEC for each emotional category. We used Naive Bayes classifier (multinomial model) for emotion estimation which was probabilistic classifier. The multinomial model is a model to consider the appearance frequency of the feature in the sentences.

The equation 6 is to classify sentence s into $\hat{e}$. $\hat{e}$ is the emotion that maximizes the probability $P(e)(s|e)$ when a set of the features included in s is defined as $w \in V$. E is a set of the emotional categories. $|E|$ indicates the number of the categories. $n_{w,s}$ indicates the appearance frequency of w in s. $q_{w,e}$ indicates the probability of the feature w being selected when the emotion is e.

We also had to solve the zero frequency problem in which the probability became zero if the inputted sentence included unknown features. For this problem, we used MAP estimation for parameters.

The equation 7 calculates appearance probability of word w and emotion e based on MAP estimation. $n_{w,e}$ indicates the appearance frequency of

the word w included in the sentences whose emotions are e. n_e indicates the number of the sentences whose emotion are e. In this paper we set $\alpha = 2$. In this case the calculation results become the same with those when 1 is added to the appearance frequency in the training data, and it is generally called Laplace smoothing.

$$
\begin{aligned}
\hat{e} &= \arg\max_{e \in E} P(e)P(s|e) \\
&= \arg\max_{e \in E} \; p_e \prod_{w \in V} q_{w,e}^{n_{w,s}}
\end{aligned} \tag{6}
$$

$$
\begin{aligned}
q_{w,e} &= \frac{n_{w,e} + (\alpha - 1)}{\sum_w n_{w,e} + |W|(\alpha - 1)} \\
p_e &= \frac{n_e + (\alpha - 1)}{\sum_e n_e + |E|(\alpha - 1)}
\end{aligned} \tag{7}
$$

The training data added feature and the estimation accuracy for each training data are shown in Table 7. FY indicates using Wakamono Kotoba as feature, FE indicates using emotional expression as feature, FF indicates using emoticon as feature, and N_1 indicates using morpheme 1-gram as feature.

T_4 and T_5 are training data where the Wakamono Kotoba in the sentence were converted into the emotional expressions with high co-occurrence scores[10] FE_{mi}, FE_e are features which were converted Wakanomo Kotoba into the emotional expressions by using MI and e-score respectively.

We added weight on each feature. In the table, 'w' means the value that changes according to the emotion of the feature. As described in section 3.1, due to low matching rate of the emotions in between emotional expression and sentence, we thought that estimation accuracy would decrease. Therefore, the feature weight was changed in T_4, T_5 depending on whether both emotions matched or not. T_4', T_5' are the changed feature weight. Concretely, if the emotions of the emotional expression and the sentence matched, the weight was set as 10, and if they did not match, the weight was set as 1. The weights of other features, i.e. morpheme n-gram or emoticons, were set as 0.5 because their effect on emotion was not clear.

Then, when the positive / negative evaluation of Wakamono Kotoba and the emotion of the emotional

expression matched, the feature weight was set as 1.0, otherwise, set as 0.1. Finally, the emotional expressions whose co-occurrence scores with Wakamono Kotoba were lower than half of the maximum co-occurrence score were excluded from features.

	Feature Combinations (Weight)	Accuracy(%)
T_0	$N_1(1)$	62.2
T_1	$N_1(1) + FY(1)$	66.1
T_2	$N_1(1) + FY(1) + FE(1)$	66.4
T_3	$N_1(1) + FY(1) + FE(1) + FF(1)$	66.5
T_4	$N_1(1) + FE(1) + FF(1) + FE_{mi}(1)$	63.2
T_5	$N_1(1) + FE(1) + FF(1) + FE_e(1)$	62.9
T_4'	$N_1(0.5) + FE(\text{w}) + FF(0.5) + FE_{mi}(\text{w})$	**83.8**
T_5'	$N_1(0.5) + FE(\text{w}) + FF(0.5) + FE_e(\text{w})$	**76.6**

Table 7: Comparison of estimation accuracy feature combinations.

4.2 Discussion

The experimental result showed that only adding emotional expressions that had high relevance with Wakamono Kotoba could not increase the accuracy of emotion estimation. In fact, it might decrease the accuracy. However, by changing the feature weight, the accuracy was improved to 83.8% at T_4'. Because Wakamono Kotoba tend to appear less frequently due to their varieties of notations even though they are expressing emotions. Therefore, they were difficult to be used as a trigger for emotion estimation. However, it was effective to replace these Wakamono Kotoba into the emotional expressions that have strong co-occurrence with the Wakamono Kotoba.

5 Conclusion

This paper proposed the emotion estimation method from the sentence including Wakamono Kotoba. Wakamono Kotoba were not always effective as feature for emotion estimation because they generally tended to have low appearance frequency, therefore,

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[10]We used the emotional expressions having the 10 highest co-occurrence scores.

we proposed to convert the features based on the co-occurrence frequency between the Wakamono Kotoba and the emotional expressions. The conversion did not largely improve the estimation accuracy, however, by adjusting the weight of feature the accuracy was improved approximately 17.7% than when Wakamono Kotoba and word 1-gram were used as feature.

The proposed method only targeted the sentence including known Wakamono Kotoba. However, whether Wakamono Kotoba are included in the corpus or not, by extracting unknown and low-frequency words and by adding the emotional expressions having high relevance to them to the learning feature at the time of expanding the training data, more effective emotion estimation was thought to become possible.

In future, we would like to confirm the efficiency of the proposed method to the sentences including the unknown Wakamono Kotoba which were extracted automatically. Then, without limiting in the unknown words of Wakamono Kotoba, we would like to evaluate our method in the sentences including new words related to emotion.

Acknowledgement

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