

Emotion Judgment Based on Relationship between Speaker and Sentential Actor

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Abstract. Authors are conducting research aiming to develop new interfaces that follow the mechanism of human communication, particularly focusing on human common sense. In this paper, a method is proposed which processes any "subject" using knowledge base and an Association Mechanism. In proposed method, 27 attributes of "subject" were judged by knowledge base. Moreover, an unknown word processing is proposed which deals with actor words which were not registered in the knowledge base. The result of the proposed method gave the correct answer in 75% of cases. If the "not out-of-common-sense" answers were counted as part of the "correct answers", the correct-answer ratio rose to 96%. Therefore, if the proposed method and the existing method were combined, the correct-answer ratio was approximately 85%.

Keywords: Emotion, Common Sense, Concept Base, Degree of Association.

1 Introduction

Authors are conducting research aiming to develop new interfaces that follow the mechanism of human communication, focusing on human common sense. Humans, in such communication, are able to appropriately interpret ambiguous information that they receive and carry on a smooth conversation. Common sense is knowledge (ability) that only man has. The person can express, and act feeling neither sense of incompatibility nor unnatural by using common sense. Moreover, when the sense of incompatibility and unnatural are felt, the person can appropriately interpret them.

Especially, authors focus on the emotion of such common sense and attempt to establish a method to judge the user's feelings based on what the user says. It is expected that use of this system can, for instance, select an appropriate expression if the content that the system tries to provide the user contains expressions that are unpleasant or remind the user of unhappy events.

Such systems and methods have already been developed. The developed method[1] judges a user's emotion, categorized into 10 types, from a sentence the

user utters, based on the four components of the sentence: "subject", "modifier", "object word", and "action word". However, "subject" used in the method has been limited to "I".

However, for example, people judge that speaker is joyful from utterance "My father obtains a lot of money". On the other hand, people judge that speaker is angry from utterance "Thief obtains a lot of money". Thus, proper processing of sentential actor is absolutely imperative for a smooth conversation. Therefore, a method is proposed which processes any "subject" using knowledge base and an Association Mechanism in this paper.

2 The Existing Emotion Judgment System

The components of uttered sentences to be used to judge speaker emotion were limited to four ("subjects", "modifiers", "objects" and "action words")[1]. Figure 1 shows outline of the existing Emotion Judgment method.

A "subject" was a noun that refers to the agent of the uttered sentence. This was limited to "I" which denotes the speaker him/herself.

A "modifier" was an adjective or "adjectival verb" that modifier the "object" which follows the modifier. "Modifiers" may be omitted, as they were not always necessary in textual expression. The direct modification and dependent modification types were further divided into different groups having similar meaning according to the adjectives describing the modifiers, and they were registered in the knowledge base for emotion judgment.

An "object" was a noun that denotes the object of the subject's action, behavior, or state. Objects were also classified according to their meanings using the 203 sense words that the Sense Judgment System[2, 3] can judge. These 203 sense words share the common meaning categories with the modifiers discussed earlier. In addition, "modifiers" and "objects" collectively were referred to as "object words". In short, the 203 sense words were used to categorize the meanings of the object words.

An "action word" was a verb, adjective, or "adjectival verb" that describes the subject's action, behavior, or state. An action word converted the feature

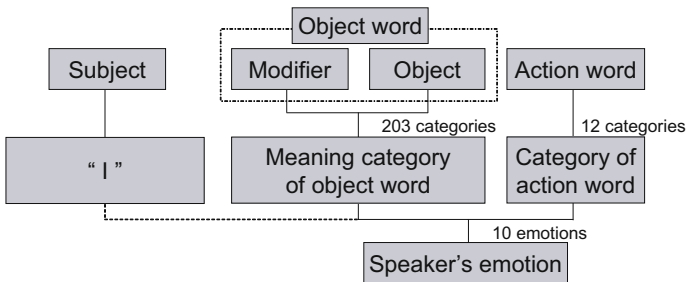


Fig. 1. Outline of the existing Emotion Judgment System

related to the sense and perception that associated with an object word. Features expressed in terms of senses and perceptions could be roughly divided into positive and negative expressions. Likewise, emotions could also be categorized into two groups, positive and negative. Therefore, four types of effect could be found in the action words.

A speaker's emotion was judged based on the "subject", "object words", and "action words". With respect to the emotions that were generated, those associated with a total of 406 pairs of the meaning categories of object words (203 categories) and action words (2 categories of "succession" and "opposite") were manually defined and registered in the system's Emotion Judgment Knowledge Base.

Many psychologists, philosophers, etc., have studied human emotions[4, 5, 6]. However, these researchers have had different interpretations of emotions and devised different models for emotions, as emotions have no substance and are quite ambiguous. Therefore, emotions have been defined as "something one feels instantaneously when an action takes place" and has defined the following ten emotions to judge: "joy", "sadness", "anger", "ease", "fear", "disappointment", "shame", "regret", "sense of guilt", and "no emotion".

Some knowledge related to the "generation of emotions", the "action words", and the "modifiers" of the "object words" were registered in the Emotion Judgment Knowledge Base. Based on this, the system associated words and expanded its knowledge within the range of common sense, making it possible to handle many expressions. The word association was realized by using the huge Concept Base[7, 8] that was automatically built from multiple digital dictionaries, and a method to calculate the Degree of Association[9] that evaluates the relationship between words. Hereafter, this Concept Base and the calculation method are called the "Association Mechanism".

3 Elemental Technique

3.1 Concept Base

The Concept Base is a large-scale database that is constructed both manually and automatically using words from multiple electronic dictionaries as concepts and independent words in the explanations under the entry words as concept attributes. In the present research, a Concept Base containing approximately 90,000 concepts was used, in which auto-refining processing was carried out after the base had been manually constructed. In this processing, attributes considered inappropriate from the standpoint of human sensibility were deleted and necessary attributes were added.

In the Concept Base, Concept A is expressed by Attributes a_i indicating the features and meaning of the concept in relation to a Weight w_i denoting how important an Attribute a_i is in expressing the meaning of Concept A . Assuming that the number of attributes of Concept A is N , Concept A is expressed as indicated below. Here, the Attributes a_i are called Primary Attributes.

$$A = \{(a_1, w_1), (a_2, w_2), \dots, (a_N, w_N)\}$$

↑ Concept	train, 0.36	locomotive, 0.21	railroad, 0.10	...	a_1, w_1	Primary Attributes
	train, 0.36	locomotive, 0.21	railroad, 0.10	...	a_{i1}, w_{i1}	
	locomotive, 0.21	streetcar, 0.23	subway, 0.25	...	a_{i2}, w_{i2}	Secondary Attributes
	⋮	⋮	⋮	⋮	⋮	
	a_{1j}, w_{1j}	a_{2j}, w_{2j}	a_{3j}, w_{3j}	...	a_{ij}, w_{ij}	

Fig. 2. Example of the Concept “train” expanded as far as Secondary Attributes

Because Primary Attributes a_i of Concept A are taken as the concepts defined in the Concept Base, attributes can be similarly elucidated from a_i . The Attributes a_{ij} of a_i are called Secondary Attributes of Concept A . Figure 1 shows the elements of the Concept ”train” expanded as far as Secondary Attributes.

3.2 Degree of Association Algorithm

For Concepts A and B with Primary Attributes a_i and b_i and Weights u_i and v_j , if the numbers of attributes are L and M , respectively ($L \leq M$), the concepts can be expressed as follows:

$$A = ((a_1, u_1), (a_2, u_2), \dots, (a_L, u_L))$$

$$B = ((b_1, v_1), (b_2, v_2), \dots, (b_M, v_M))$$

The Degree of Identity $I(A, B)$ between Concepts A and B is defined as follows (the sum of the weights of the various concepts is normalized to 1):

$$I(A, B) = \sum_{a_i=b_j} \min(u_i, v_j)$$

The Degree of Association is calculated by calculating the Degree of Identity for all of the targeted Primary Attribute combinations and then determining the correspondence between Primary Attributes. Specifically, priority is given to determining the correspondence between matching Primary Attributes. For Primary Attributes that do not match, the correspondence between Primary Attributes is determined so as to maximize the total degree of matching. Using the degree of matching, it is possible to give consideration to the Degree of Association even for Primary Attributes that do not match perfectly.

When the correspondences are thus determined, the Degree of Association $R(A, B)$ between Concepts A and B is as follows:

$$R(A, B) = \sum_{i=1}^L I(a_i, b_{xi})(u_i + v_{xi}) \times \{\min(u_i, v_{xi}) / \max(u_i, v_{xi})\} / 2$$

In other words, the Degree of Association is proportional to the Degree of Identity of the corresponding Primary Attributes, and the average of the weights of those attributes and the weight ratios.

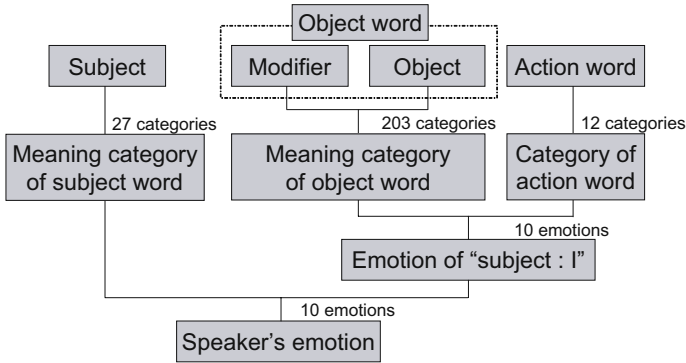


Fig. 3. Outline of proposed Emotion Judgment System

3.3 Sense Judgment System[2, 3]

The knowledge base for the sense and perception judgments has a structure like a thesaurus, and it contains sense and perception words that are associated with typical nouns, which have been entered manually. In cases when an unknown word not registered in the Sense Knowledge Base needs to be processed, the system calculates the Degree of Association with those known words registered in the knowledge base for the sense and perception judgments and chooses the one with the highest Degree of Association for processing. This lets the system obtain the rough corresponding sense and perception. In addition, the system refers to the attributes registered in the Concept Base to find the sense and perception particular to that word. Due to its structure, these attributes in the Concept Base contain some inappropriate words as senses and perceptions to be associated, and thus the system is carefully designed so that the correct sense and perception is selected using the Degree of Association.

4 Processing of Emotion Judgment Based on the Relationship between Speaker and Sentential Actor

The existing Emotion Judgment System has been limited to "I" which denotes the speaker him/herself for "subject". However, for example, people judge that speaker is joyful from utterance "My father obtains a lot of money". On the other hand, people judge that speaker is angry from utterance "Thief obtains a lot of money". Thus, proper processing of sentential actor is absolutely imperative for a smooth conversation. Therefore, an emotion judgment method is proposed which any "subject" is processable in this paper.

Figure 3 shows outline of the proposed Emotion Judgment System.

"Object word" and "action word" are categorized into 203 sense words and 12 categories, respectively. Moreover, emotion of "subject(I)" are judged by these combination. The method is same in section 2.

In the proposed method, to correspond besides "I" which is "subject" in the existing method, the processing of the subject is enhanced. Concretely, "subject" is categorized into 3 attributes: liking (likes and dislikes), familiarity (closeness), sociality (good and evil). These 3 attributes have 3 values. In short, "subject" is categorized into 27 categories. Speaker's emotion is judged by combination of these 27 categories and judged emotion of "I". In addition, 3 attributes of "subject" and speaker's emotion are judged by knowledge base.

4.1 Sentential Actor's Attribute Knowledge

A knowledge base for judgment of sentential actor's emotion was manually defined. The knowledge base was created based on an existing thesaurus[10] using a tree structure to represent its knowledge efficiently. All nouns registered in the thesaurus were related to the above-mentioned 3 attributes values. In addition, the nouns related to the 3 attributes values were 9068 words.

4.2 Unknown Word Processing for Sentential Actor Judgment

Even if the attributes values of the sentential actor are related to 9068 words by using the thesaurus, all sentential actors cannot be covered. Thus, an unknown word processing is proposed which deals with words which were not registered in the knowledge base.

As mentioned, words which are lower than some node have similar attributes values, because the knowledge base was created based on the thesaurus. Therefore, when input word are not registered in the knowledge base, the Degree of Association are calculated between the word and 437 nodes (words) in the thesaurus. Moreover, Words which have the Degree of Association among the top ten are selected. Attributes values of unknown word are defined by a majority vote of the attributes values of the selected words. As a result, the attributes values can be related to the unknown word.

4.3 Knowledge for Emotion Judgment

As mentioned, speaker's emotion is judged by combination of attributes values of sentential actor and judged emotion of "I". Therefore, an emotion generation knowledge base was newly made besides the existing emotion generation knowledge base. 270 rules which are combination of 27 categories (attributes values) of sentential actor and 10 emotions are registered in the knowledge base.

5 Performance Evaluation of the Proposed Emotion Judgment Method

In order to evaluate how valid the emotions generated by proposed emotion judgment method were, 530 sentences were collected from 5 test subjects to be used as data for evaluation. In addition, in this evaluation, "object word" ("modifier"

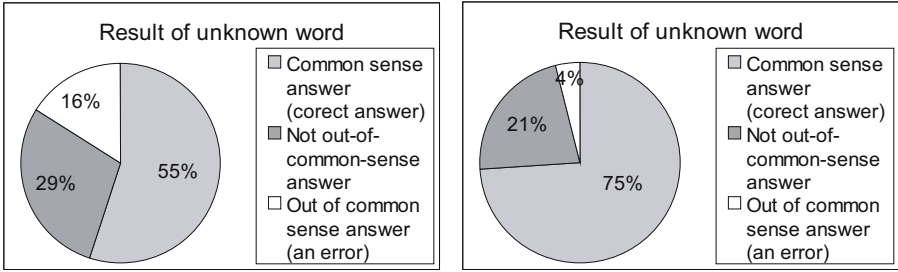


Fig. 4. Result of proposed Emotion Judgment method

and "object") and "action word" which were perfectly processed were selected for evaluation of sentential actor's processing. Five test subjects were then asked to judge whether the emotions generated by the proposed method were common sense. If four or more of judges said emotion generated was a common sense emotion, the emotion was considered as "common sense" (correct answer). In cases when two or three subjects said the emotion was "common sense", the generated emotion was considered as being "not out-of-common-sense". If only one subject or no subjects considered the generated emotion as "common sense", the emotion was thought of as "out of common sense" (an error). For cases when multiple emotions were generated, they were considered as being "common sense" (correct answer) if all of the generated emotions were common sense ones. If any one of the emotions was considered to be "out of common sense", then the particular emotion generated was considered as being "out of common sense" (an error). All others were regarded as being "not out-of-common-sense".

Figure 4 shows the result of the proposed emotion judgment method. Sentences which had unknown word of sentential actor were 80 sentences. The result gave the correct answer in 55% of cases. If the "not out-of-common-sense" answers were counted as part of the "correct answers", the correct-answer ratio rose to 84%. In addition, all result gave the correct answer in 75% of cases. If the "not out-of-common-sense" answers were counted as part of the "correct answers", the correct-answer ratio rose to 96%. Furthermore, the existing Emotion Judgment method had 88% as the correct-answer ratio. If the proposed method and the existing method were combined, the correct-answer ratio was approximately 85%. Because these ratios were high, authors believe that proposed method is effective.

6 Conclusions

In this paper, authors focused on emotions, which are part of the common sense judgments humans make in everyday communication. Such existing method judges a user's emotion, categorized into 10 types, from a sentence the user utters, based on the four components of the sentence: "subject", "modifier",

”object word”, and ”action word”. However, ”subject” used in the method has been limited to ”I”. Therefore, a method was proposed which processed any ”subject” using knowledge base and an Association Mechanism. In proposed method, 27 attributes of ”subject” were judged by knowledge base. Moreover, an unknown word processing is proposed which deals with actor words which were not registered in the knowledge base.

The result of the proposed method gave the correct answer in 75% of cases. If the ”not out-of-common-sense” answers were counted as part of the ”correct answers”, the correct-answer ratio rose to 96%. Therefore, if the proposed method and the existing method were combined, the correct-answer ratio was approximately 85%. Because these ratios were high, authors believe that proposed method is effective.

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