Emotion Recognition from Text Using Knowledge-based ANN

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Abstract: This paper proposes an emotion recognition system. Human emotion can be expressed through many kinds of medium such as speech, image, facial expression, and so forth. This paper focuses on the textual data of them. Proposed system is a hybrid system that uses alternatively two methods, keyword-based and machine learning method.

Keyword-based methods are traditional approaches using emotional keywords to make a decision of emotional state. They are very correct if emotional keywords exist within text segment. However, there is nothing to do if keywords to be able to catch emotional state do not exist. Therefore, in the case of no emotional keywords, our proposed method uses KBANN to able to infer emotional state through implicit knowledge constructed with the third-party information.

Finally, through experiments, we show that the proposed system is more accurate than some previous approaches.

1. Introduction

Recently, many researchers are much interested in the recognition of emotion. The ability which recognizes emotions is very useful to human-machine communication. Many kinds of the communication system, such as dialogue system, automatic answering system and human-like robot, can apply the emotion recognition techniques so that a user feel as if the system is like human. In addition, the systems can react properly for the human's emotional actions.

The recognition of emotion has been implemented in many kinds of media. Some examples are speech, image, signal, facial expressions, textual data, and so on. Among this, the textual data is very popular medium, consisting of books, newspapers, and letters. And due to its small storage requirements textual data is the most appropriate medium for network transmissions. In addition to the variety and complexity of textual data makes it possible for people to exchange ideas, opinions, and emotions using text only. For these reasons the research for recognizing from textual data is valuable.

Traditional researches attempted to recognize emotion using emotional keywords. However, keyword-based researches have many problems. To overcome the problems we propose the system using hybrid method. If input sentence have emotional keywords, we apply the keyword-based approach to the system since the keyword-based approach still shows high recognizing accuracy just for sentences with emotional keywords. In other cases, we try to recognize emotions from sentence with no emotional keywords using machine learning method, Knowledge-Based Artificial Neural Network (KBANN).

2. Previous works

Traditionally, research on the recognition of emotion from text was focused on the discovery and utilization of emotional keywords. Using emotional keywords is most intuitional way to recognize a user's emotions from text input, and several methods were proposed that used selected emotional keywords.

Yanaru [6] took footage of real speakers while they were talking using emotional keywords and defined the emotional states corresponding to the keywords. Subasic and Huettner [7] classified a group of emotional words by manually scoring the emotion level for each word. Boucouvalas and Zhe [8] applied a parser to identify the objects associated with the emotional keywords. Devillers et al. [9;10] found the most appropriate emotional state by calculating the conditional probability between the emotional keywords and the emotional states. Tao and Tan [11] used emotional function words instead of emotional keywords to evaluate emotional states.

However, keyword-based researches have the following problems. Ambiguity in defining all emotional keywords; Recognizing emotion from sentences with no emotional keywords; Lack of semantic and syntactic information for emotion recognition. In order to solve above problems, we propose the hybrid system which combine keyword-based approach and machine learning based approach, and use domain knowledge for emotions.

3. Emotion

To recognize someone's emotional state, according to Lazarus' psychological theory [2], we have to know both the situation that emotional subject is placed in and how to be interpreted the situation by emotional subject. Like other domain researches, it might be tried to imitate the human's thinking patterns. Until now, however, because of its difficulty there is no research using such approach. By using KBANN (It will explain in chapter 5), we can use domain knowledge for emotion generation [2].

4. Overview of the system

4. 1 A recognition unit

We try to recognize emotion from a sentense. There are some reasons to select sentense as a recognition unit. It is difficult to know where emotion is expressed from text sequences except the case that include emotional keywords. Regardless of emotional keyword to handle almost all usage of human language, we may try to recognize from

predefined range such as document, paragraph, sentence, phrase, word, and so forth. If the recognition unit is small, it is hard to find information about emotion. In contrast, if the recognition unit is large, there are plentiful information. However, because too many emotions exist within the large unit we may miss some of emotions.

We choose the sentence as a compromise unit. A sentence has more information than smaller units have. In simple sentence, generally, a sentence has one intention. It is same to emotion. In addition, recognizing emotion from a sentence unit can apply many area such as dialogue system, chatting system, android robot and so forth easily.

4. 2 Hybrid system

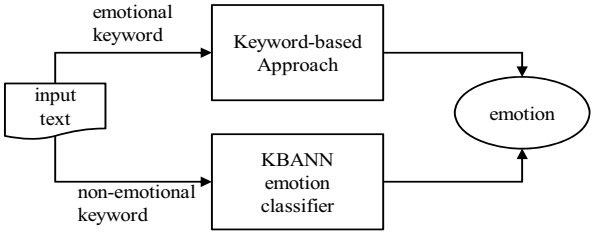

Figure 1. The proposed hybrid approach

The proposed system is hybrid system which combined two approaches. At first the system confirm whether input text has emotional keywords or not. If the input text has one or more emotional keyword then we use traditional keyword-based approach. In order to determine which emotion is expressed in the input text, we use the EKD (emotional keyword dictionary). The EKD consist of words that has emotional meaning. If there is at least a word which exists in the EKD, the system determines output the emotion in accordance with the EKD. If the input text has no emotional keyword then KBANN emotion classifier is used to recognize emotion. This process is described in Figure 2.

5. KBANN

The emotion recognition problem is considered as the classification problem. We use a classifier in second approach of the proposed hybrid emotion recognition system. Among many classification methods, we employ the Knowledge Based Artificial Neural Network (KBANN).

Most of the past researches using classification technique, employ empirical machine learning method. However, it is almost impossible to solve the recognition problem only using empirical learning method without linguistic information. We studied methods using rational information related to emotion as well as emprirical data, One of them is KBANN.

The KBANN is a kind of Artificial Neural Network, and use domain knowledge as well as example data. The best advantage of the KBANN is to use approximate domain knowledge. Because the emotion has no correct domain knowledge, it is very useful property in emotion recognition area.

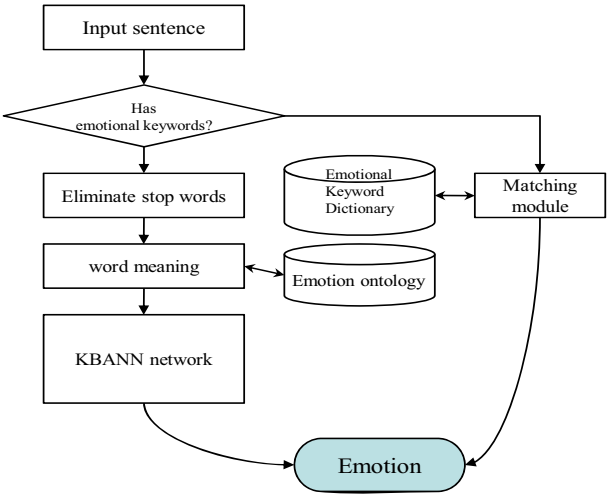

Figure 2. Flow chart of emotion recognition process in proposed system

In contrast with other learning methods, the KBANN can use hierarchical feature. The domain knowledge for KBANN is expressed in rules which are Horn clause form. A set of rules can have hierarchical structure and it is the feature that describe an input data. For this reason, the KBANN can use more complicate and abstract information for emotions.

As mentioned above, since the KBANN is a kind of ANN, the network outputs numerical values. The proposed system consists of a set of module to recognize one emotion, and each module outputs numerical value individually. The system can express multi-emotion through this. In addition, the pre-output value can be reflected to current decision process.

5. 1 Feature

Training examples must be described by features for learning. Because the performance of learned system is affected by definition of feature, definition of feature is very important. Most of previous researches use low level features such as words. However, low level features are cause of losing semantic information from input text and cause of data sparseness problem. For example, the word feature does not have semantic information, but only symbolic information although we need semantic information for emotion recognition. In addition, if we use low level feature, it is easy to make data sparseness problem by means of its large feature space.

The KBANN can use hierarchical features which are defined by a set of rules. In order to use semantic information, we use meaning of word in ontology as terminal literals of the rules.

5. 2 Emotion generation rules

There is no appropriate theory for process of emotion generation. The existing hypotheses are too abstract to make the rule. Fortunately, because the KBANN can use approximate domain knowledge to initialize neural network, we make the emotion generation rules which refer to the

theory for emotion generation[2]. One of them illustrated in Figure 3.

$$\text{anger} \rightarrow \text{me} \wedge \text{displeasing attack}$$
$$\text{me} \rightarrow \text{meaning(me)} \vee \text{meaning(my thing)}$$
$$\text{displeasing attack} \rightarrow \text{bad speech} \vee \text{bad action}$$
$$\text{bad speech} \rightarrow \text{meaning(bad speech)}$$
$$\text{bad action} \rightarrow \text{meaning(bad action)}$$

Figure 3. Rule set for anger emotion

5. 3 Initializing the neural network

The KBANN initializes the neural network using a set of rules. In other words, a set of rules are translated into KBANN network. There are seven steps for translation[3] and after the process we can get the initialized neural network. The proposed system handles eight emotions, and each emotion is tried to recognize by independent KBANN network except neutral emotion. Therefore whole system consists of seven KBANN networks. Among them, initialized KBANN network for anger emotion is shown by Figure 4.

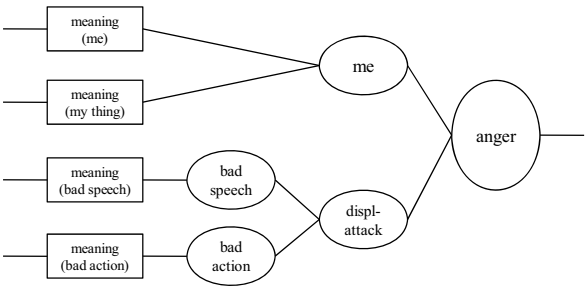

Figure 4. Initialized KBANN network for anger emotion

5. 4 Refining KBANN network

The system refines KBANN network using backpropagation algorithm[12], a standard neural network learning method. We use 3,200 sentences size of emotion tagged corpus as training example for learning. We choose a script of drama, novel and public web diary as the corpus, since those sentences have a lot of emotional expressions. Each sentence in the corpus is manually tagged with eight kinds of emotions. The system used three forth of the whole corpus for training and remaining part for evaluation.

5. 5 Determining emotion

After seven KBANN networks are trained then the system can recognize the emotion of an input sentence. When input sentence is came, seven modules output numerical value then the system choose the emotion of module that outputs maximum value. There is threshold in each module(In our experiment, defined 0.5). If all output values of seven modules do not exceed to threshold, the system considers the emotion as neutral emotion.

6. Evaluatition

As mentioned above chapter, we used thousands of sentences to train and evaluate our system. The system used three forth of the whole corpus for training and one forth for evaluation.

The system handles eight kinds of emotion (anger, fear, hope, sadness, happiness, love, thank, neutral) and each emotion is evaluated by separated module. Therefore we tested each module one by one. Each module is tested with both the corpus for testing and the corpus for training.

There are two categories for sentences. One is the sentences with emotional keyword. These sentences are evaluated by keyword-based module in the proposed system. The other is the sentences without emotional keyword. These sentences are evaluated by trained KBANN networks. The accuracy of recognition for the sentences with emotional keyword is about 90 percent for each emotion. The accuracy of recognition for the sentences without emotional keyword is shown by Table 1.

Table 1. The accuracy of recognition for the sentences without emotional keyword

Emotion	# of sentence in training corpus	# of sentence in test corpus	Accuracy(%)
Anger	300	100	63
Fear	300	100	60
Hope	300	100	47
Sadness	300	100	65
Happiness	300	100	61
Love	300	100	56
Thank	300	100	45
Neutral	300	100	65

In our experiment, the ratio of sentences with emotional keyword and sentences without emotional keyword is approximately 1:9. Since the accuracy of keyword-based recognition is very high, the accuracy of combined system was more improved than result of Table 1.

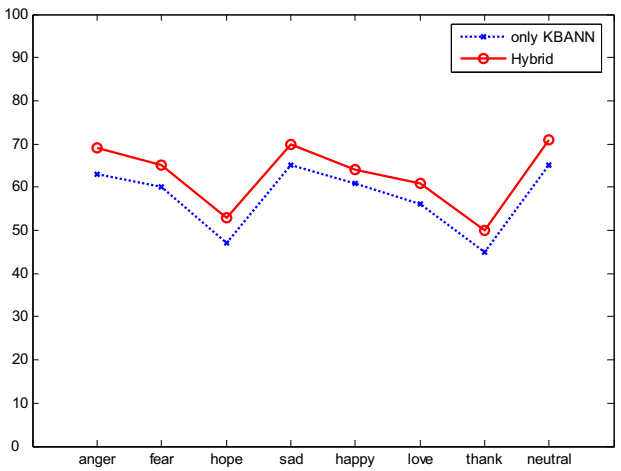

Figure 5. Comparison of the system using only KBANN and the system using Hybrid (keyword-based and KBANN)

There are no systems which handle similar emotions of our system. Also, the system evaluates eight kinds of emotion by separated module. Moreover, the system outputs the result with numerical value form. For these reasons, we could not compare our system with other systems as fair point of view. However, if we only evaluate the accuracy of recognizing each emotion, the proposed system shows more accurate result than previous systems.

7. Conclusion

We propose the emotion recognition system which combines keyword-based approach and KBANN machine learning approach. Previous researches which mainly use empirical learning method have shown low accuracy. Also, since we don't have clear knowledge for emotion, we proposed the system that overcomes the circumstance. The KBANN was suitable to the circumstance. By using KBANN, we can use approximate domain knowledge and high level feature. The system showed improved results for the case that have sparse examples as well as for general case.

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