Construction of the Recognition Model for Trigger Words of Chinese Acupuncture and Moxibustion Events

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ABSTRACT. *The recognization of trigger words for Chinese acupuncture and moxibustion events is a key step in the extraction of Chinese acupuncture and moxibustion events. It plays an important role in knowledge mining in the field of Chinese acupuncture and moxibustion. This paper extracts the manually annotated trigger words from the training corpus, constructs the table of trigger words for Chinese acupuncture and moxibustion events, then expands this table with the Tongyici Cilin (Chinese thesaurus), and identifies the candidate trigger words for Chinese acupuncture and moxibustion events based on the extended trigger word table; and then according to characteristics of the expressions in the field of Chinese acupuncture and moxibustion, this paper prepares the filtering rules for candidate trigger words for Chinese acupuncture and moxibustion events. This paper uses the above techniques to construct the recognition model of trigger words for Chinese acupuncture and moxibustion events that integrates dictionary matching and rule-based filtering. The results of the experiment show that this model has a good trigger word recognition function, and F-measure of trigger words recognition for the cure and health events reaches 88.28% and 34.15% respectively.*
Keywords: Chinese acupuncture and moxibustion event; Trigger word recognition; Extended trigger word table; Rule-based filtering.

1. **Introduction.** Event extraction[1-6] is to automatically identify event information people are interested in from the massive data texts, and convert such information into structured data and present it. Event extraction technology, as an important research direction in the field of information extraction, involves the technologies and methods of several disciplines such as natural language processing, data mining, and machine learning, which has a wide range of applications in automatic abstract, information retrieval and other fields. Event extraction mainly consists of two steps: one is to detect the candidate statements containing the specific event in the text and determine the category of the event, and the other is to extract the event arguments from the event statements and fill it into the predefined event template. In recent years, domestic and foreign scholars have studied and experimented with the extraction of English biomedical events and Chinese general field events, and have obtained some valuable research results. For example, M. V. Tran [7] studied biomedical event extraction in the CG (Cancer Genetics) corpus and Z. Chen [8] studied Chinese general field event extraction in the ACE.

With the re-emergence of traditional Chinese medicine and pharmacy, the number of Chinese acupuncture and moxibustion literature is growing rapidly. Studying the technology of automatically extracting Chinese acupuncture and moxibustion events from a huge number of Chinese acupuncture and moxibustion literature plays an important role in knowledge mining in the field of Chinese acupuncture and moxibustion. However, due to the linguistic features of Chinese and the one-character words and idioms that appear frequently in the text of Chinese acupuncture and moxibustion, such as "JIU" (moxibustion), "Ci" (insert), "Kang" (anti), "Shu Gan Li Qi" (relief liver for smooth Qi), and "Tong Jing Huo Luo" (clearing and activating the channels and collaterals), the application of research achievements of event extraction technology obtained from the English biomedical field and Chinese general field in the extraction of Chinese acupuncture and moxibustion events has been hindered. So far, no event information extraction system in the field of Chinese acupuncture and moxibustion is available, and fewer research papers related to event extraction technology in the field of Chinese acupuncture and moxibustion are reported.

Event trigger words are words that can clearly characterize events. Trigger word recognition is the recognition of event categories, which plays a key role in event extraction tasks. This paper studies the construction technology of event trigger word recognition model in the field of Chinese acupuncture and moxibustion. Firstly, this paper collects manually annotated trigger words from the training corpus to construct the table of trigger words for Chinese acupuncture and moxibustion events, then expands this table with the Tongyici Cilin, and recognizes the candidate trigger words for Chinese acupuncture and moxibustion events based on the extended trigger word table; Second, the paper analyzes the linguistic features and domain characteristics of Chinese acupuncture and moxibustion texts and constructs the filtering rules for candidate event trigger words. Finally, integrating dictionary matching and rule-based filtering technology, this paper constructs a mixed recognition model of trigger words for Chinese acupuncture and moxibustion events, and detects and classifies the Chinese acupuncture and moxibustion statements in the Chinese acupuncture and moxibustion literature.

2. **Related works.** Trigger word recognition is the first step in the step-by-step event extraction process, whose performance will directly affect the performance of the subsequent event arguments recognition steps and plays a vital role in improving the overall performance of the event extraction. From the literature related to research on the existing event trigger word extraction technology, there are mainly three ways to recognize the event trigger words: the rule-based method [9-11], the method based on dictionary matching [12-14], and the method based on machine learning [15-21].

Rule-based method defines a set of generalized rules according to the linguistic features and domain features of the corpus being processed, and uses the rule matching to extract the trigger words. For example, Literature [9] uses the rules after the stem processing to extract the biomedical event trigger words in the text. Rule-based trigger word recognition model relies heavily on the coverage of rules programmed by man, and the trigger words that are not covered by rules cannot be recognized. The model is high in accuracy, but lower in recall rate and poor in portability.

The method based on dictionary matching is to use the manually annotated trigger words in the training corpus to establish the trigger word dictionary, through which other words will be determined for trigger words. For example, in Literature [12], all the trigger words are extracted from the training corpus to establish initial trigger word dictionary. And the dictionary is extended by using the Tongyici Cilin to construct a relatively complete trigger word dictionary. Then this dictionary is used to determine whether the

words containing the concentrated candidate trigger words are event trigger words. The method is a typical empirical method, with a higher recall rate, but lower accuracy rate. It requires the training corpus to be large enough and classic enough.

The method based on machine learning regards the trigger word recognition task as the classification problem or the sequence annotation problem. It uses a large number of features and annotation data to establish the statistical machine learning model and realize the determination of sample instance. For example, in Literature [15], binary classifier is used to determine whether a word in the sentence is a trigger word. If so, a multiple classifier is used to classify it and obtain the event type. In Literature [16], vocabulary and its context, phrase marking features, word clustering features, and statistical dictionary features are used to construct different word-level CRF models for the annotation of biological event trigger words. The method based on machine learning is objective and does not require too much human intervention and domain knowledge, but requires training corpus and test corpus to meet a certain scale in order to ensure the accuracy of the recognition results.

The above three kinds of trigger word recognition technology have their own advantages and disadvantages. As the scale of event annotation corpus in the field of Chinese acupuncture and moxibustion used for the research is too small, and the positive and negative examples in the training set and test set are seriously imbalanced, this paper intends to integrate dictionary matching and rule extraction technology in one to construct a mixed recognition model for Chinese acupuncture and moxibustion event trigger words, which is used to automatically detect and classify the statements in the field of Chinese acupuncture and moxibustion and lays the foundation for the further study of extraction of Chinese acupuncture and moxibustion event arguments.

TABLE 1. Chinese acupuncture and moxibustion events and their annotation examples

Event type name	Event type definition	Event annotation example
Health event	Health events mean that there are words related to the Chinese acupuncture and moxibustion health fact in the sentence. The health event trigger words are the indicative word in these event statements. Seven event arguments that can appear in the health event include: Drug-Arg, Method-Arg, Acupoint-Arg, Instrument-Arg, Time-Arg, Health-Arg, and Disease-Arg.	<Method-Arg>Massage</Method-Arg>can<Health-trigger>relieve</Health-trigger><Disease-Arg>piriformis spasm</Disease-Arg>, and <Health-trigger>improve</Health-trigger>local<Health-Arg>blood circulation</Health-Arg>.
Cure event	Cure events mean that there are words related to the Chinese acupuncture and moxibustion cure fact in the sentence. The cure event trigger words are the indicative word in these event statements. Six event arguments that can appear in the cure event include: Drug-Arg, Acupoint-Arg, Method-Arg, Instrument-Arg, Time-Arg, and Disease-Arg.	This paper introduces the research progress that <Method-Arg>Chinese acupuncture and moxibustion</Method-Arg><Cure-trigger>cure</Cure-trigger><Disease-Arg>scapulohumeral periarthritis</Disease-Arg>in the past decade.

3. **Definition of event type in the field of Chinese acupuncture and moxibustion.** Chinese acupuncture and moxibustion is a clinical medicine that uses acupuncture, moxibustion, massage, traction, cupping, scraping and other methods to prevent and cure diseases. It is an important part of traditional Chinese medicine. As UNESCO included Chinese acupuncture and moxibustion into Representative List of the Intangible Cultural Heritage of Humanity on November 16, 2010 and the international intellectual circles gradually recognize Chinese acupuncture and moxibustion, the Chinese acupuncture and moxibustion discipline enters into a fast development period. Chinese acupuncture and

moxibustion literature, as the demonstration of results in the field of Chinese acupuncture and moxibustion and the main carrier for academic exchange, increases rapidly in number. It is imperative to extract the information from the massive Chinese acupuncture and moxibustion literature and construct the knowledge base of Chinese acupuncture and moxibustion. This is of great significance for carrying forward Chinese acupuncture and moxibustion culture, protecting, inheriting, developing and disseminating Chinese acupuncture and moxibustion.

Through the analysis of Chinese acupuncture and moxibustion texts and learning from definition of Chinese general field events and the annotation method of Chinese events [22], this paper defines two types of Chinese acupuncture and moxibustion events, namely, cure event and health event. Chinese acupuncture and moxibustion events and their annotation examples are shown in Table 1.
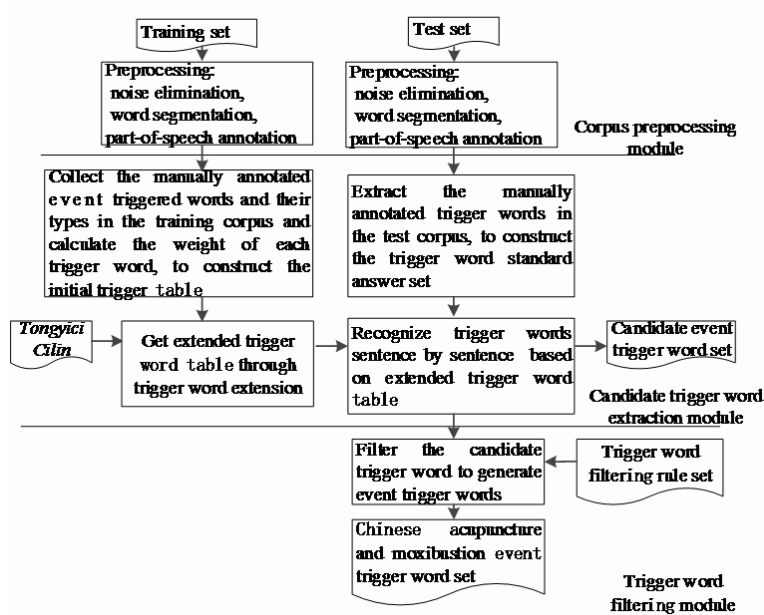

FIGURE 1. Extraction system frame of Chinese acupuncture and moxibustion event trigger words

4. **Extraction of Chinese acupuncture and moxibustion event trigger words.** The language features and domain characteristics of the text in the field of Chinese acupuncture and moxibustion make the recognition task of Chinese acupuncture and moxibustion event trigger words much more difficult than that in the English biomedical field and the Chinese general field. This paper constructs a recognition model for Chinese acupuncture and moxibustion event trigger words based on the extended trigger word table and trigger word filtering rules. This model avoids the problem of imbalance of positive and negative examples and data sparseness of the event trigger words in corpus. The extraction system of Chinese acupuncture and moxibustion event trigger word consists of corpus preprocessing module, candidate trigger word extraction module, and trigger word filter module. The system frame is shown in Figure 1.

4.1. **Corpus preprocessing.** There are many punctuation, character and word misuses in the corpus gathered from the websites, and there is also inconsistent manual annotation information on Chinese acupuncture and moxibustion events. Therefore, before the construction of recognition model for Chinese acupuncture and moxibustion event trigger

words, the corpus needs to be preprocessed. The corpus preprocessing in this paper consists of the following four tasks: (1) extract the abstract information of each document in the corpus and store it as the abstract text set of Chinese acupuncture and moxibustion; (2) remove the repeated text in the abstract text set and eliminate the noise and wrong manually annotated information; (3) process abstract text set, remove the manually annotated event trigger words and event argument tag information, and store them as unannotated abstract text set; (4) use the Language Technology Platform (LTP) developed by the Research Center for Social Computing and Information Retrieval of Harbin Institute of Technology (HIT-SCIR) to carry out word segmentation and part-of-speech annotation for the unannotated abstract text set, to obtain the word segmentation and part-of-speech information of the abstract text and store them as the word segmentation abstract text set.

4.2. Extraction of candidate trigger words based on extended trigger word table. The abstract text set after de-replication and de-noising is randomly divided into seven parts, six of which are used as training corpus and used for constructing the event trigger word table in the field of Chinese acupuncture and moxibustion by the method in Literature [23]. This trigger word table is used to judge whether the words in the test corpus are the trigger words for Chinese acupuncture and moxibustion events and determine their categories. Concrete steps for the extraction of candidate event trigger words in the field of Chinese acupuncture and moxibustion based on extended trigger word table are as follows:

1) Collect the manually annotated trigger words for Chinese acupuncture and moxibustion events and their categories in the training corpus, calculate the weight of each trigger word and construct the initial trigger word table for Chinese acupuncture and moxibustion events;

2) Extend the synonyms for each trigger word in the initial trigger word table for Chinese acupuncture and moxibustion events by Tongyici Cilin to acquire the extended trigger word table for Chinese acupuncture and moxibustion events;

3) Judge sentence by sentence and word by word whether the words in the test corpus are the trigger words for Chinese acupuncture and moxibustion events and determine their categories based on the extended trigger word table, so as to acquire the alternate trigger word set for Chinese acupuncture and moxibustion events.

4.2.1. *Construction of initial trigger word table for Chinese acupuncture and moxibustion events.* Analyze the abstract text set in training corpus, collect article by article and sentence by sentence the manually annotated trigger words for Chinese acupuncture and moxibustion events and their categories. Count the number of events triggered by each trigger word, the number of the trigger words appearing in the sentence, total number of various event types having appeared, total number of sentences and other information within the range of training corpus, and calculate the weight of each trigger word according to the statistical data. The initial trigger word table for Chinese acupuncture and moxibustion events constructed is shown in Table 2.

Calculation of the weight of event trigger word in Table 2 is shown in Formula (1), which employs the method similar to TF*IDF[23].

$$Score_i = TF(w_i) * IDF(w_i). \tag{1}$$

TF means Term Frequency, which reflects the contributions of a trigger word w_i to the event category it belongs to. The calculation is as shown in Formula (2).

TABLE 2. Initial trigger word table for Chinese acupuncture and moxibustion events

Trigger word	Event type	Weight (Score)	Number of events triggered by trigger word	Number of trigger words appearing in the sentence	Total number of event types having appeared	Total number of sentences
Cure	Cure event	0.5165	623	807	648	1381
Heal	Cure event	0.0099	2	55	648	1381
Curative effective	Cure event	0.0355	18	385	648	1381
...	...	...	...	...	...	...
Improve	Health event	0.6573	9	48	46	1381
Relieve	Health event	0.4127	4	12	46	1381
...	...	...	...	...	...	...

$$TF(w_i) = \frac{n_i}{m_i}. \qquad (2)$$

In the formula, n_i is the total number of one category of events triggered by the trigger word w_i in all the training corpus, and m_i is the total number of such category of event in the training corpus.

IDF means Inverse Document Frequency, which reflects the frequency of a trigger word w_i in the training corpus. The calculation is shown in Formula (3).

$$IDF(w_i) = log_2(\frac{N_i}{M_i}). \qquad (3)$$

In the formula, N_i is the total number of sentences in the training corpus, and M_i is the total number of sentences that contains the trigger word w_i in the training corpus.

4.2.2. *Extension of trigger word table for Chinese acupuncture and moxibustion events.* Since the manually annotated training corpus has a limited scale, the seed trigger words collected in the initial trigger word table can' t cover the complete trigger word set for Chinese acupuncture and moxibustion events. Some important trigger words are not collected in the initial trigger word table, which directly causes loss of new events during event recognition in the test corpus. In order to make the trigger word table cover the trigger words of various types of events as much as possible, this paper has extended the initial trigger words according to the Tongyici Cilin (Extended) completed by HIT-SCIR. Extension algorithm of trigger word table for Chinese acupuncture and moxibustion events is described in the following:

1) Cluster the words that the former 4 levels of word coding in Tongyici Cilin (Extended) are the same and the 8th digit is marked with "=", construct word$\rightarrow$ coding mapping and coding $\rightarrow$ synonym set mapping;

2) Process the segmented abstract text set in the training corpus, collect the verbs and nouns in it and construct the verb and noun set (VerbAndNonSet);

3) Successively process each trigger word w_i in the initial trigger word table for Chinese acupuncture and moxibustion events, map w_i to the synonym set with the same code with it and use VerbAndNonSet to filter the non-verb and non-noun words in this synonym set (note: the part-of-speech of the trigger word is generally verb and noun);

4) Add the words in the synonym set after being filtered into the event trigger word table to be expanded and set the event type and weight value of these words to be the same as w_i;

5) Turn to Step 3) until the processing of trigger words in the initial trigger word table is finished;

6) Combine the to-be-extended event trigger word table with the initial event trigger word table to acquire the extended trigger word table for Chinese acupuncture and moxibustion events.

4.2.3. *Extraction of candidate trigger words for Chinese acupuncture and moxibustion events.* Use the extended trigger word table for Chinese acupuncture and moxibustion events to judge whether the words in the test corpus are the trigger words for Chinese acupuncture and moxibustion events and determine their categories. Algorithm for the extraction of candidate trigger words for Chinese acupuncture and moxibustion events based on the extended trigger word table is as follows:

1) Segment the sentences in the test corpus, extract sentence by sentence the manually annotated trigger words and their types, construct the trigger word standard set for Chinese acupuncture and moxibustion events in the test corpus and count the number of various standard trigger words;

2) Check sentence by sentence and word by word whether the word in the unannotated test abstract text set exists in the extended trigger word table for Chinese acupuncture and moxibustion events. If so and its weight is larger than the preset threshold value, we can judge that this word is a candidate trigger word for Chinese acupuncture and moxibustion events, and then check the table to determine its type;

3) Add this word and its type into the candidate trigger word set for Chinese acupuncture and moxibustion event and increase the number of recognition trigger words of corresponding category;

4) Compare the recognized trigger word and its type with the standard trigger word and its type to judge whether the recognition is correct or not. If it is correct, increase the number of correct recognition trigger words of corresponding category;

5) Turn to Step 2) until the processing of the test corpus is finished;

6) Calculate the P, R and F values of trigger word recognition for various types of Chinese acupuncture and moxibustion events.

4.3. **Rules for trigger word filtering.** In order to increase the precision of trigger word recognition for Chinese acupuncture and moxibustion events, we analyzed the misrecognized trigger words in the candidate trigger word set and summarized 2 rules for trigger word filtering as follows:

Rule 1: for a trigger word in the category of <Cure> in the candidate trigger word set, if there is no named entity of the category of set $\{<Disease>, <Method>\}$ at its left or right neighbor, abandon this trigger word;

Rule 2: for a trigger word in the category of <Health> in the candidate trigger word set, if there is no named entity of the category of set$\{<Health>, <Method>, <Disease>\}$ at its left or right neighbor, abandon this trigger word.

5. **Performance analysis.**

5.1. **Source of corpus in the experiment and its evaluation indices.** The literatures used in the corpus in the experiment in this paper are the Chinese abstracts of literatures on Chinese acupuncture and moxibustion gathered from http : //www.cqvip.com/.

The total size of the gathered information was 4.2M and after de-replication and de-noising, 561 pieces of them were selected to manually annotate the event trigger words and event arguments according to the definition of Chinese acupuncture and moxibustion events specified in this paper. We randomly selected 481 pieces of them as the training corpus for the trigger word recognition model and the rest 80 pieces were used as test corpus set. We employed three general evaluation indices of precision rate (P), recall rate (R) and F-value to evaluate the model constructed in this paper. Assuming that the number of correctly recognized trigger words for some kind of Chinese acupuncture and moxibustion events is TR, the total number of model-recognized trigger words for some kind of Chinese acupuncture and moxibustion events is MR and the total number of trigger words for some kind of Chinese acupuncture and moxibustion events in the test corpus is TC, evaluation indices are concretely defined as in the formulas below:

$$P = \frac{TR}{MR} \times 100\%. \tag{4}$$

$$R = \frac{TR}{TC} \times 100\%. \tag{5}$$

$$F - value = \frac{2 \times P \times R}{P + R} \times 100\%. \tag{6}$$

5.2. **Experimental results analysis.** Based on the above-mentioned idea of model construction, we used Java language to realize a prototype system of trigger word recognition of Chinese acupuncture and moxibustion events and in the test corpus set we compared the recognition method of Chinese acupuncture and moxibustion event trigger words constructed in this paper with the method set out in Literature [23] through comparative tests. The weight threshold of the trigger word shall be adjusted and set according to the experimental results and we set the value as 0.1 in this experiment. The results of the comparative experiments are shown in Table 3.

TABLE 3. The Results of Experimental Comparison between Suggested and Baseline Methods

Experimental method	Event type	P	R	F	Remarks
Baseline Method	Cure event	54.33%	96.58%	69.54%	Extended trigger word table
Baseline Method	Health event	14.29%	53.85%	22.58%	Extended trigger word table
Suggested Method	Cure event	81.29%	96.58%	88.28%	Extended trigger word table + Rule 1
Suggested Method	Health event	25.00%	53.85%	34.15%	Extended trigger word table + Rule 2

It can be seen from Table 3 that, the precisions of the trigger word recognition in Baseline Method are much lower than the recall rates of both cure event and health event. This indicates that it is easy to get wrong to judge whether a word is the trigger word for cure or health event merely by checking the table. This is because some statements that contain the trigger words don' t express relevant events and some words may also serve as trigger words in multiple event categories. Therefore, it is not precise enough

to determine the trigger words and their categories simply according to the trigger word table.

In order to filter the misrecognized trigger words and increase the precision of trigger word recognition for Chinese acupuncture and moxibustion events, we discovered by analyzing the misrecognized sample set that, the context of trigger word contains various characteristics which are of great reference value to the determination of event trigger word and its category. For example, some named entities of specific types in the context of the trigger word play an important role in distinguishing trigger words from common words. Therefore, we adopted corresponding rules to filter the candidate trigger words of cure events and health events generated by checking the table. Data in Table 3 indicates that rule-based filtering can substantially increase the precision of trigger word recognition.

Data of Table 3 indicates that the recall rate of trigger word recognition for health events is relatively low. This is mainly because some of such words are one-character words. For example, the trigger words "$anti-$" and "$relieving$" in the sentence "$< Drug - Arg >$ bee venom$< /Drug - Arg >$ does have the function of $< Health - trigger >$anti-$< /Health-trigger >< Health-Arg >$inflammation$< /Health-Arg >$ and $< Health-trigger >$relieving $< /Health-trigger >< Health-Arg >$the pain$< /Health-Arg >$, and is worthy of clinical popularization and *application*" are one-character words. Word tokenizers usually recognize "$anti-inflammation$" and "$relieving\ the\ pain$" as one word, and as a result, the trigger words "$anti-$" and "$relieving$" cannot be recognized, which influences the recall rate of trigger word recognition for health events.

6. **Conclusion.** Two types of Chinese acupuncture and moxibustion events have been defined according to the characteristics of the texts in the field of Chinese acupuncture and moxibustion. The trigger word automatic recognition model for Chinese acupuncture and moxibustion events based on the combination of extended trigger word table and rule-based filtering have been constructed. Experiment on test corpus set indicates that this model shows relatively fine performance in trigger word recognition for cure events. In follow-up researches, we will explore the characteristics contained in the context of trigger words that is of reference value to the determination of trigger words and their categories and construct more effective filtering rules to further increase the precision of trigger word recognition. Meanwhile, as regards the problem that the performance in trigger word recognition for health events is not ideal, we will collect the one-character words that are of specific meanings in the field of Chinese acupuncture and moxibustion, such as "anti-" "relieve" and "reduce" for training segmentation dictionary, so as to adapt the word tokenizers to the characteristics of the literal expressions in the field of Chinese acupuncture and moxibustion, and while segmenting the texts in this field, they can correctly segment one-character word and therefore further enhance the model's recognition capacity of trigger words for health events.

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