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A Similar Legal Case Retrieval System by Multiple Speech Question and Answer

(Full paper)

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ABSTRACT

In real life, on the one hand people often lack legal knowledge and legal awareness; on the other hand lawyers are busy, time-consuming, and expensive. As a result, a series of legal consultation problems cannot be properly handled. Although some legal robots can answer some problems about basic legal knowledge that are matched by keywords, they cannot do similar case retrieval and sentencing prediction according to the criminal facts described in natural language. To overcome the difficulty, we propose a similar case retrieval system based on natural language understanding. The system uses online speech synthesis of IFLYTEK and speech reading and writing technology, integrates natural language semantic processing technology and multiple rounds of question-and-answer dialogue mechanism to realise the legal knowledge question and answer with the memory-based context processing ability, and finally retrieves a case that is most similar to the criminal facts that the user consulted. After trial use, the system has a good level of human-computer interaction and high accuracy of information retrieval, which can largely satisfy people's consulting needs for legal issues.

Keywords: Natural language understanding, artificial intelligence and law, information retrieval system, legal question and answer, semantic similarity, speech recognition and synthesis.

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INTRODUCTION

In daily life, it is not difficult to find that a large number of ordinary people (even well-educated ones) lack legal awareness and knowledge. Once they encounter a criminal case, they go to the hospital in a desperate way, and even some criminals take advantage of their families' eagerness to rescue their loved ones to cheat them out of their hard-won large amounts of money. Even if a lawyer can be found, they are usually busy and unwilling to take up too much valuable time and energy to answer repeatedly simple commonsense questions for free. In addition, the paralegals are not experienced enough to give professional advice and analysis in effective time. Therefore, it is very difficult for the family members of the parties to obtain fast, effective, and accurate legal services. In response to this phenomenon, in line with the current development trend of big data and artificial intelligence related technologies (Chen, Liu, Yin & Tang, 2017), the web-based legal question-and-answer retrieval system emerged at the right moment, bringing “artificial intelligence + law” into people's daily life and alleviating the burden of lawyers' consulting services to a large extent. At the same time, it also makes it easy for people to obtain efficient and high-quality legal services.

On the other hand, in the field of information retrieval, the exploration of the retrieval method of natural language understanding has been going on (Dong, 2013). The initial information retrieval system can, only through the keyword to the mechanical matching of information, search out answers, but with the development of natural language understanding technology, the combination of a new generation of information retrieval search engine (Wang & Ye, 2010) are improved greatly, and already have a very wide application in various fields. For example, mobile learning resource push system (Zhang & Wang, 2012), multimedia information retrieval system (He, 2018), efficient virtual counselor intelligent voice dialogue system (Gao, Wang & Dai, 2017), real-time message push system between teachers and students (Wang, Su & An, 2007), question-and-answer system on tourism information (Li, Wang & Liang, 2008), and so on. However, its application in legal retrieval has not been studied deeply.

To this end, This paper proposes theft similarity retrieval system based on natural language understanding (Zhang, Cao & Wang, 2017), speech synthesis and recognition, the system can allow users reading and writing online, and have basic memory context dialogue technology perfect fusion, so it alleviate the lawyers work, improve people's legal knowledge as the ultimate goal, quickly find cases similar to other cases.

The main contributions of this paper can be summarised as follows. 1) We employ cutting-edge speech reading, writing and synthesis technology, making users more convenient and efficient in conversation. 2) We solve the difficult problem of contextual semantic understanding in the previous dialogue system, and realise the multiple dialogue mechanism, making the dialogue system more colloquial. 3) Our system can retrieve the most similar answers to the legal questions consulted by users through the criminal

facts described in natural language, and state the reasons according to the doubts of users. 4) We integrate the semantic similarity technology in natural language processing, carry out semantic annotation, information extraction and word meaning disambiguation of the unstructured text in the dialogue system, realise the recognition of the diversity of questions, enhance the ability of understanding sentences, and facilitate the intelligent retrieval of subsequent answers.

The rest of this paper is structured as follows. Section 2 briefly introduces the system principle. Sections 3 and 4 explain in detail the design and implementation of the problem handling module and information retrieval module mentioned in the system principle. Section 5 illustrates the results of our system. Section 6 uses the case test results to test the close degree between the retrieval results of the experiment and the judgment results of the actual case, and the evaluation is conducted through the comparison of the experiment. Section 7 discusses related work, especially the differences between our work and theirs. Finally, Section 8 summarizes the work of this paper and gives a brief outlook on its prospects.

SYSTEM PRINCIPLE

In recent years, with the advent of the information age and the explosive growth of network information, it becomes more and more difficult for users to correctly and efficiently retrieve the information they need, thus making the retrieval system facing great challenges. The question and answer retrieval system is an important research direction in the field of information retrieval, which is a new generation of search engine combining natural language and information retrieval technology (Wu, Zhao & Duan, 2005). The detailed process of the principle of our question and answer retrieval system based on natural language understanding is shown in Figure 1.

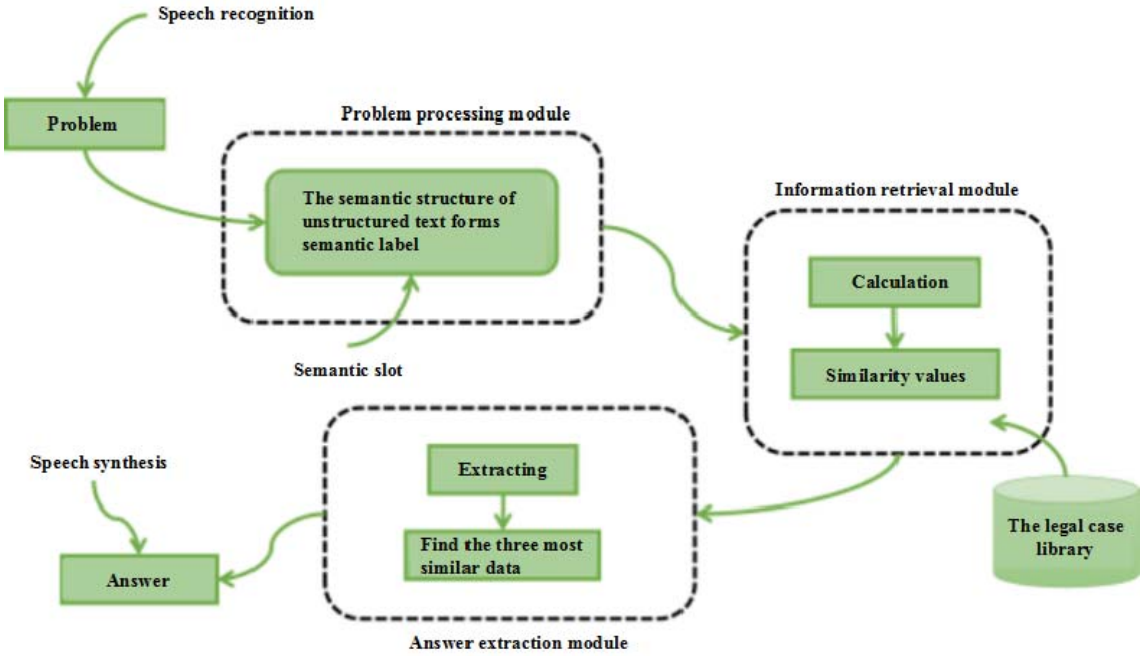

Figure 1: Natural language understanding based Q&A retrieval system schematic.

The system is mainly divided into three parts: 1) Problem processing module, which is mainly responsible for dealing with legal issues consulted by users, identifying relevant semantic slots, and understanding the semantics and intention of problems. 2) Information retrieval module, which mainly carries out weighted retrieval and query according to the semantic fields generated by the problem processing module, and retrieves relevant information most similar to the semantic of question (a set of data fields). 3) Answer extraction module which is mainly to extract relevant information that is consistent with the user's intention to consult legal questions.

In addition, our system problem in processing module and answer extraction module uses the IFLYTEK technology of speech synthesis and recognition, and allows the user to the web client using speech by legal advice in the form of natural language system to retrieve the answer at the same time also can use speech way to read it to the user, enabling users to easy operation.

PROBLEM PROCESSING MODULE

The problem processing module (Zhang, Shao & Zeng, 2012) aims to enable the computer to automatically understand and analyse the questions raised by people in Chinese spoken language, overcome the challenges brought by the diversified expressions

of Chinese spoken questions, and determine the semantic slots, semantic organization methods, and response methods of the questions. The overall framework for problem handling is shown in Figure 2.

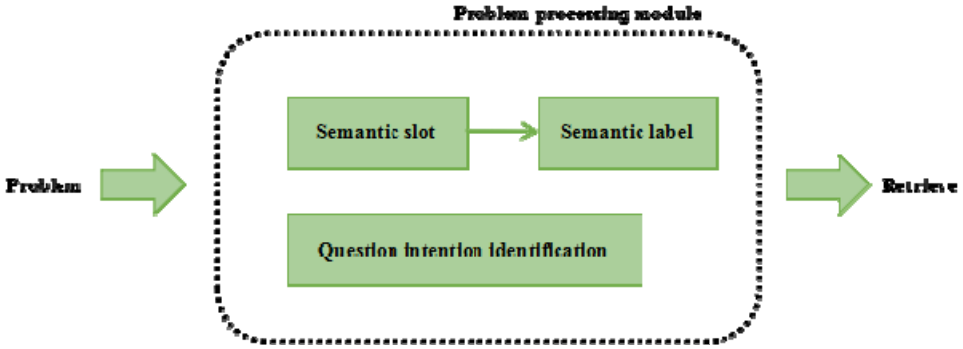

Figure 2: The overall framework of the problem processing module.

3.1 Problem handling process

We manually compile the question semantic slot and the legal related word library, and then carry out the semantic slot recognition to the question. Each semantic slot can uniquely determines the answer mode of the question, so as to realise the problem processing mechanism. The specific implementation of problem processing is mainly divided into three parts: 1) The user's input information is automatically matched to the corresponding semantic slot, and the similarity degree and synonym sentences are processed. 2) Classify user input information into intent category (Sun & Wang, 2007). 3) extract knowledge from statements entered by the user and label the field information with semantic label.

3.2 Semantic slots

Due to the diversity of oral Chinese expressions, there are many synonyms, but the sentence structure is limited. Diversified sentence expressions can cover the corresponding semantic slots through good sentence pattern. For example, the following questions have the same pattern.

- What is the likely punishment?
- What kind of punishment will there be?
- What are the consequences?

Pattern matching can be unified into a pattern *[excuse me] thief (should/need/will)... (indemnity/liability/penalty)* , or further signed as *<name><ad>...<thing>*. The semantic slot library and the synonym variable library are required. The semantic slot library and the synonym variable library are required.

Through the determination of semantic slots, we can also determine the user's intention of input questions, such as whether to inquire the punishment or compensation amount of the criminal in the theft. The thesaurus mainly solves the problems caused by the diversity of spoken Chinese expressions. In the semantic slot library, such as the words “need”, “should”, “will” and so on in the example above, if all these words are integrated into the semantic slot library, the data in the semantic slot will be very redundant, so we can effectively solve this problem by calling the synonym library in the semantic slot library.

3.3 Knowledge extraction and semantic annotation

The process of knowledge extraction and semantic annotation is listed in Algorithm 1.

Algorithm 1: Text semantic annotation

Input: user question text
Output: text semantic tags
Process:
1. Get the user question text from the web page.
2. Pass the text to the Java background via Ajax requests.
3. Conduct semantic annotation.
4. Get the semantic tag line by line.

The question text entered by the user is unstructured data. In order to understand its semantics and extract its useful information, it needs to be transformed into structured data, that is, it needs to be semantically annotated to obtain semantic labels.

INFORMATION RETRIEVAL MODULE

The retrieval module (Zhao, Wang & Wang, 2016) adopts the edge weight model algorithm based on concept density to realise the weighted strategy to calculate the maximum similarity algorithm to retrieve the best answer, and abandons the search method based on the completely accurate or very weak fuzzy matching template to search the answer, so that the system can truly "understand" the user's question (Wang, Wang & Wang, 2008). The overall framework of the system information retrieval module is to a question shown in Figure 3.

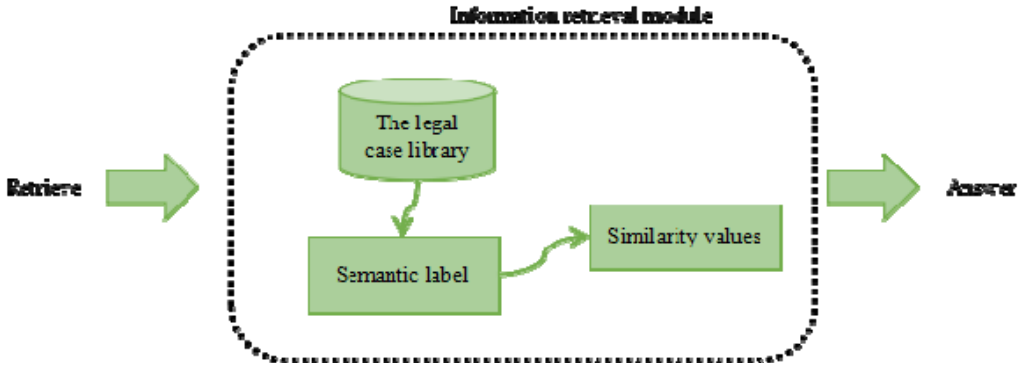

Figure 3: The overall framework of the information retrieval module.

4.1 Similarity retrieval algorithm

Based on the weight value model based on the concept density weight (Zhou, Lu & Wang, 2017), the relevant data in the database is weighted to find a piece of data with the maximum similarity, and then the field that needs to be returned is found according to the intention recognition semantics obtained from the question processing. The specific algorithm is shown in Algorithm 2.

Algorithm 2: Similarity retrieval algorithm

Input: semantic field and intent
Output: the most similar answer field
Process:
1. Determine whether the data is successfully found from the database.
2. Through the data, if the fields in database equal to the fields in question semantic, weighted to store a piece of data.
3. Find the case with the maximum similarity
4. Identify the semantic output answer field based on intent.

In the similarity searching algorithm, the input information is the semantic field of question text and the semantic meaning of intention recognition, and the output is the answer with the highest similarity of question. The process is as follows. First, the weight value of each text semantic field is calculated based on the concept density weight model, and then the data is weighted one by one in the database, and the semantic similarity of each data and question text is obtained, and the data with the largest similarity is obtained. Finally, according to the intention to identify the semantics in the maximum similarity of the data, we find the answer field and output.

PROTOTYPE SYSTEM AND EXAMPLE

Legal consultation is a complicated situation in information retrieval, because the factors influencing the result of legal judgment are intricate and complex, and even the judgment standards of different regions and nationalities are different. For the legal retrieval system of this article, in terms of user experience, the dialogue text in the retrieval system will be saved by the page. At the same time, users can use voice to input text, the system can speak out the output text. From a technical perspective, the unstructured question text entered by the user is transformed, by using natural language processing technology to structured text, and its semantic annotation and intention recognition are obtained. See Figure 4 for details. In addition, two main functions are

implemented on the web page, one is user legal consultation and the other is user's query answer to the system. Will carry on detailed explanation with larceny case next.

Figure 4: User interface of our system.

5.1 User legal advice

Before user consultation, we need to perform automatic extraction of some court's judgment, and store its useful information in the database for the convenience of information retrieval later, this will be discussed in our paper. After the preparations are completed, the user can start legal consultation on the website.

When the user enters the question, the system runs the module of question processing, and the system will determine the semantic slot according to the question you asked, as well as the knowledge extraction and semantic annotation of the question content information. After semantic annotation, the default information will be sent: whether the thief has grown up or not, and whether he has a previous record. The system automatically raises the question and then adds the answer to the semantic field in the previous knowledge extraction. Then the system enters the retrieval module from the module of question processing. Since we have converted the judgment to structured SQL data in advance, and calculated the weight of each field through the weight calculation model (Zhang, Lu & Wang, 2017). According to the weight, the similarity of each group of data is obtained. Finally, in the answer extraction module, the system identifies the fields according to the intention obtained in the problem processing module and retrieve the field information required by the user for the data output in the module. After the legal consultation is completed, the user can also ask the questions about "whether the thief has criminal record" or "thief underage". The system will cover the original field with the user's modified field information.

5.2 Question the system answer

After the system output the judgment result of the legal case most similar to that of the legal case consulted by the user, the user questions the retrieval answer, and the system can give the judgment of the corresponding legal provisions that it violates. Table 1 is an example of a Q&A test.

Table 1. Q&A example

	Conversation
System：	The thief will be sentenced to one year in prison.
User：	Why?
System：	For the violation of the following criminal laws: article 264, article 52, article 67, paragraph 3 of the criminal law of the People's Republic of China and article 5 of the supreme people's court's provisions on the application of certain property penalties.
User：	What are the contents of article 52?
System：	Article 52 of the criminal law of the People's Republic of China is .....

After the system retrieves the answers to the most similar case, users may ask the reason why it is. In this time our system will return to violate the criminal law sub system. The user can also directly ask questions law, without having to input their documents to the query.

EXPERIMENTAL RESULTS AND EVALUATION

6.1 Multiple rounds of Q&A test results

Considering the lack of legal knowledge of most users, the system realises a function of colloquial legal questioning and answering matured language. The useful information field is extracted according to the user's statement. Meanwhile, for the important field information that needs to be supplemented, the system will fill in the default information through multiple rounds of Q&A. One example of a multiple rounds Q&A comparison is shown in Figure 5.

The system will make different response mechanism according to the user's default information, so that the user can use the system more conveniently. As to the experimental effect shown in Figure5, when the user describes the criminal process, the left user answers the criminal amount, while the right user does not answer the criminal amount, so the system will automatically ask an additional question in the experimental effect on the right side. For example, "how much is the car?" In the same way, for a stolen mobile phone or others, the system will also intelligently consult with the corresponding amount. In addition, the user's default field is variable. Here, only the comparison of examples illustrates the effect of default amount. Some other important field information can also be default.

Figure5: Multiple rounds Q&A comparison diagram.

Compared with the current method of realising this function of legal robot, namely, single or multiple choice topics are supplemented with default field information. Multiple rounds of Q&A can make legal questions and answers closer to the real scene of consultation between consultants and lawyers, and more flexible and closer to the way of human communication.

6.2 Retrieval of experimental results

This system uses the field weighting method to search similar cases of theft, which greatly improves the closeness rate of sentencing compared with the field matching method. Therefore, it is reasonable to consider that different fields have different degrees of influence in the crime of theft. Figure 6 is a retrieval result test with a case of car theft. From this figure we can see that the searched results of similar cases are closer to the actual sentencing results by using field weighting, and the influence of individual special cases on the sentencing results can be effectively excluded. In contrast, the way a field is matched is vulnerable to individual special cases.

In the figure, the abscissa is the case and the ordinate is the judgment result of the corresponding case. The large scale is the month in the judgment result, a large scale is the month, a small scale is the fine in the judgment result, and a small scale is the thousand yuan. According to the six test examples, the retrieval results of the field weighting method are closer to its actual judgment results,

while the field matching method has great fluctuations, mainly because it cannot deal with special cases. After the field weighting, the judgment results of different decisions of the same case can be effectively avoided to some extent.

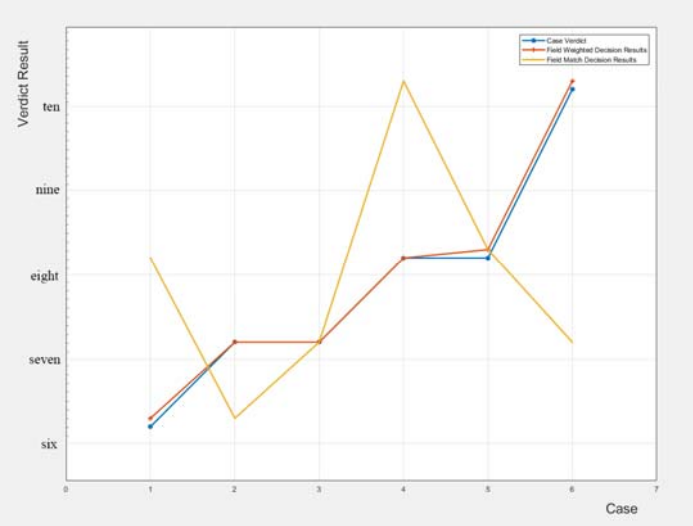

Figure6: Retrieval results comparison diagram.

RELATED WORK

7.1 Speech synthesis and recognition of IFLYTEK

The application of speech synthesis and speech reading and writing technology has been mature in China. The following are two examples of systems embedded with the open platform of artificial intelligence: efficient virtual counselor dialogue system (Zeng, Zheng & Zhou, 2017) and efficient 3d virtual experimenter guidance system (Qu, Gao & Wang, 2018). These systems, however, have nothing to do with legal advice. On the other hand, although the application of voice technology in legal robots is very common (such as the intelligent legal robot "small law" in Anhui province and the legal aid robot "Longhua small law" in Shenzhen, Guangdong.), it has not been applied in the legal question-answering system on the web page yet.

This system makes use of the speech synthesis and speech recognition functions of IFLYTEK and applies speech to the legal Q&A system of web page, realising the speech dialogue function of human and machine, realising the conversion between text and speech, and promoting the efficiency of user text input. In the dialog system, after users' voice input, the input box of the web page terminal will display the recognised voice text information intelligently, and then users can process the text information after the recognition and send it again, which can greatly alleviate the user's consuming typing text. At the same time, voice synthesis technology is applied into the system to answer in voice and display the corresponding Chinese text information in the dialogue system, which can make users have a good user experience and facilitate users to view and use the conversation later.

7.2 The context dialogue technique with basic memory

Table 2. Example of legal regulations for contextual dialogue

	Conversation
User:	I was stolen the thing that value should 5000 yuan, thief oneself went to police station surrender. Then how should the thief responsibility assume for excusing me?
System:	How old is the thief ?
User:	About 20 years old
System:	Did the thief have a previous conviction?
User:	No
System:	We predicted results about adult, no previous record and confession.

User：	What if the thief had a previous conviction?
System：	We predicted results about adult, previous record and confession.

In common dialogue system applications, context-related default data will appear, which will lead to the need for data retrieval of default data. This is because there are many relevant practical considerations: the thinking of artificial intelligence jurisprudence (Gao & Zhang, 2018) and the thinking of artificial intelligence on the mechanism of resolving legal disputes (Zhang & Yi, 2017). Yet most existing dialogue systems struggle to do so. However, after the legal voice dialogue system in this paper is integrated with the context dialogue technology with basic memory (Wang, Wang & Wang, 2016), users can conduct default inquiry based on contextual information and conduct multiple default inquiry operations.

In addition, the context processing technology with basic memory not only realises the system's multiple queries to the default field, but also enables the user to change the answer to the previous question and truly realise the conversational colloquialism. In several rounds of conversations, users can continuously correct or improve the legal issues they want to consult. At the same time, the system can help users to find satisfactory results of legal consultation by asking questions and confirming when users' questions are incomplete or unclear. An example of this is shown in Table 2.

7.3 Natural language comprehension techniques

Natural language is a good representation of the semantic structure of unstructured text information. In this dialogue system, due to the diversity of the same semantic expression, it is necessary to integrate the text processing methods of natural language understanding and the related processing methods of term vectors so as to automatically handle the semantic similarity questions in the text (Huang, Huang & Wu, 2014), such as answering the question of "is the thief grown up?", there are many ways for users to reply. See Table 3 for details.

Table 3. Adult or not semantic similarity judgment

Answer the statement	Semantic slot	Semantic
He's about 18 Should be adults About 20 years old Have come of age	Age default answer	Age of suspect: adult
Eleven or twelve About fifteen A minor	Age default answer	Age of suspect: under age

In addition, in the process of dialogue, user input text information is unstructured data. In order to make the system to understand what we want to express the semantic, will translate into structured data, then extract the useful text field, understand its underlying semantics, and make corresponding answer or ask mechanism based on semantic. Take a legal question asked by a user, such as the semantic understanding of unstructured data in Table 4.

Table 4. Semantic understanding of unstructured data

Questions	Semantic slot	Semantic
I am stolen the thing which should 5000 Yuan, the thief was been caught now. How should the thief assume responsible excusing me?	Law to ask	Type of crime: theft Amount of crime: 5,000 Yuan

I was stolen a cellular phone, two computers, should be worth 10 thousand. To excuse me how should the thief be assume responsibility?	Law to ask	Type of crime: theft Amount of crime: 10,000 Yuan
	.....	

CONCLUSION

Although the Q&A retrieval system based on natural language processing has become a hot research topic after years of development, the Q&A similar case recommendation system in the legal domain is studied little (He, 2012). In addition, the ability to understand language in the Q&A system is still insufficient, and various technologies are still immature (Su, 2005). In particular, it is still not enough to handle the retrieval of legal information. For example, in multiple rounds of Q&A, when the answer is ambiguous, what choices should be made so that the system can answer the user question best. To solve these problems, we developed a system that uses technologies of natural language understanding as well as speech recognition and synthesis to satisfy people's needs for similar case retrieval, which can help people to know, understand and obey the law better, thus reducing a little legal things.

However, there are still some aspects that need to be improved further. 1) The accuracy of information extraction needs to be improved, and the professionalism of information classification needs to be improved. The professional document content that our system can wander as well is not comprehensive enough and needs to be improved. 2) The answers to the certain questions need to be improved together with the similarity algorithm. In this paper, the weight is used to calculate the best answer that is asked by the user, but the value of the weight sometimes has some errors. Maybe the machine learning method can remove these errors. 3) Since the system fills in the default information through the questioning and confirmation mechanism when the user's consulting questions are incomplete and unclear, but if the user is unclear when answering the default information, how should the system choose? This paper has not found the appropriate algorithm to cope with the issue which showed definitely be investigated in future. 4) Due to the limitations of voice conversation, one time people cannot talk too long, which is a little insufficient in expression. However, this can be implemented through multiple rounds of questioning.

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