Chinese QA and CLQA: NTCIR-5 QA Experiments at UNT

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Abstract

This paper describes our participation in the NTCIR-5 CLQA task. Three runs were officially submitted for three subtasks: Chinese Question Answering, English-Chinese Question Answering, and Chinese-English Question Answering. We expanded our TREC experimental QA system EagleQA this year to include Chinese QA and Cross-Language QA capabilities. Various information retrieval and natural language processing tools were incorporated with our home-built programs such as Answer Type Identification, Sentence Extraction, and Answer Finding to find answers to the test questions. Future development will focus on investigating effective question translation and answer finding solutions.
Keywords: *Chinese Question Answering, Cross Language Question Answering, natural language processing, system development.*

1 Introduction

Question Answering (QA) systems identify answers from a large document collection or online information resources to users' natural language questions. Such systems can release the users from digesting huge amounts of text in order to locate particular facts or numbers. Current research on QA is mainly conducted in English. However, today's information sources are becoming more and more multi-linguistic, especially on the Internet. A survey of distribution of languages on the Internet (http://www.netz-tipp.de/sprachen.html) shows that in 2002, only 56.4% of Web pages were in English. Statistics on a Web site listing "Internet Users by Language" (http://www.internetworldstats.com/stats7.htm) updated on March 24, 2005, indicate that English language usage is further reduced to only 32.8% of Internet users. As a result, research is needed to explore solutions for QA in languages other than English and for Cross-Language Question Answering (CLQA). CLQA research explores effective and efficient solutions to find answers for users' questions from documents written in languages different from the questions. It is a more challenging task then monolingual question answering because it involves translation among different languages. Among non-English languages, Chinese, Japanese, and Spanish are the top three languages used on the Web. Therefore, Chinese QA and CLQA research is needed in order to allow users to find answers from a collection of resources in multiple languages.

This year, NTCIR-5 initiated the evaluation of Chinese Question Answering, English-Chinese Question Answering, and Chinese-English Question Answering, along with other QA tasks. Chinese Question Answering (C-C) aims to find answers to Chinese questions in Chinese documents; English-Chinese Question Answering (E-C) finds answers to questions written in English among documents written in Chinese; the purpose of Chinese-English Question Answering (C-E) is to find answers to Chinese questions in English documents. The Chinese document set used this year is a collection of 901,446 news articles spanning from 2000 to 2001 taken from UDN.COM, and the question files are in BIG 5 encoding. The English document set contains news articles from the Daily Yomiuri in 2000 and 2001, and the question files are encoded with ASCII. For formal runs, there were 200 testing questions for each subtask. Answers to all questions were restricted to named entities to create a simpler question target for this pilot task, and all answers were judged with three scores – correct (S), unsupported (A), and incorrect (C). Performance of a run is measured by *accuracy* – the percentage of questions which are correctly answered.

We expanded our TREC experimental QA system EagleQA this year and participated in the CLQA task. Our purposes for participation include: 1) investigate and evaluate a Chinese QA and CLQA solution; 2) evaluate several software tools for certain tasks such as document retrieval and text annotation; and 3) understand the challenges of the CLQA tasks for future improvement. This paper describes our efforts on three subtasks: Chinese Question Answering, English-Chinese Question Answering, and Chinese-English Question Answering. It is arranged as follows: Section 2 briefly describes current Chinese monolingual QA approaches and CLQA approaches. A general overview of our EagleQA system is provided in Section 3. Section 4 lists all linguistic resources and tools we have used for NTCIR-5 experiments. Section 5 describes our strategies specific to the three subtasks that we carried out for the NTCIR-5 Workshop. Section 6 reports our submissions and results. Section 7 reports our analysis of some processes including Question Translation and Answer Type Identification. The paper concludes with future directions for research.

2 Current research on monolingual Chinese QA and CLQA

Research on Monolingual Chinese Question Answering systems is still at its developing stage. Li and Croft [8] built a Chinese QA system utilizing similar approaches to those of English systems. Huang and Yao [6] used the Web as their search engine and knowledge base for Chinese QA combining with natural language parsing and an Entity-Relation-Entity relational model to boost performance. Peng, Weischedel, Licuanan, and Xu [12] explored QA strategies for Chinese definitional questions by combining deep linguistic analysis with surface pattern learning. Meanwhile, Zhang and Zhang [15] employed a rule-based logic form representation algorithm and lexical knowledge extracted from HowNet for logic proving.

Research on Cross-Language Question Answering systems was initiated at the Cross Language Evaluation Forum (CLEF) in 2003. CLEF focuses mainly on evaluating and encouraging CLQA systems for European languages. In its first campaign year, five languages (Italian, Spanish, Dutch, French, and German) were tested and searched against an English corpus [13]. How-questions and definition questions were introduced as testing queries in 2004. At CLEF 2005, nine target languages and ten source languages were explored for 73 cross-language tasks [14]. Various approaches were utilized to bridge the language barriers including shallow linguistic analysis, statistical analysis, and question translation using bilingual dictionaries or machine translation systems [1, 5, 9, 10, 11].

3 EagleQA architecture

In general, our current QA system EagleQA contains six modules as illustrated in Figure 1. They are Question Processing, Document Retrieval, Text Annotation, Sentence Extraction, Answer Finding, and Submission, as described below. These modules have integrated several freely available NLP software tools for the purposes of Chinese QA and/or Cross-Language QA. Those NLP tools will be introduced in the next section.

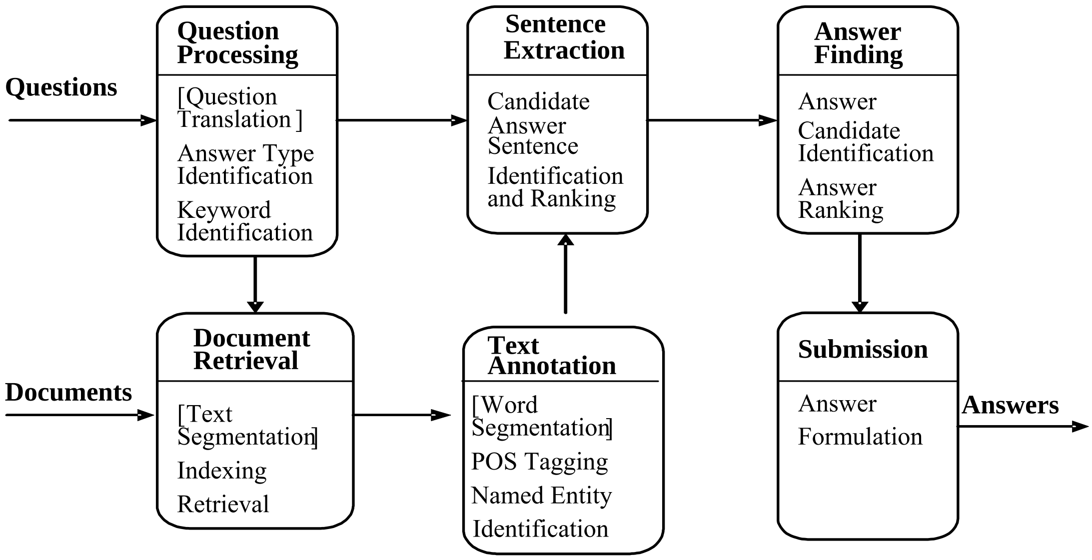

Figure 1. EagleQA architecture

3.1 Question Processing

The Question Processing module performs three processes: Question Translation, Answer Type Identification, and Keyword Identification.

Question Translation is applicable only to Cross-Language subtasks such as Chinese-English and English-Chinese QA. Current implementation includes submitting Chinese or English queries to Babel Fish, an online machine translation system, for translation. The ongoing development in Question Translation includes constructing a lexical knowledge base from the document collection in combination with Babel Fish or other MT system for query translation. However, the development could not be completed when NTCIR-5 CLQA experiments were conducted.

Answer Type Identification is the second process performed by this module. *Answer type* refers to the category in which the answer to a question should belong. For example, "PERSON" is the answer type for question "Who is the first astronaut in the world?" EagleQA automatically assigns an answer type to an incoming question by comparing the question with a manually developed answer type pattern file. The pattern file is extracted from 2393 TREC sample questions (for English), and 200 Chinese sample questions distributed by NTCIR-5 CLQA organizer (for Chinese). The most common answer types are: PERSON, LOCATION, ORGANIZATION, NUMBER, TIME, MONEY, and NAME (ARTIFACT).

Keyword Identification extracts important words or phrases from the annotated question. Each question is annotated applying the Text Annotation process described below in Section 3.3. A word or a phrase is regarded as important if it is not included in the stopword list of the system. The stopword list was prepared from training questions (2393 previous TREC questions for English stopword list, and 200 sample Chinese questions for the Chinese stopword list) by taking into account each word's Part-of-Speech (POS) and its frequency. For English questions, word expansion is also performed. Nouns and verbs were expanded by adding their synonyms and derivation forms to the keyword list based on WordNet 2.0 (www.princeton.edu).

3.2 Document Retrieval

We used Lemur to retrieve relevant documents from the provided document collections for both Chinese and English. Our NTCIR-5 Chinese Information Retrieval paper [4] describes in detail the evaluation we conducted on Chinese Information Retrieval experiments using Lemur. Based on our previous experimental results, we consider that Lemur's performance is acceptable. Prior to document retrieval, Chinese texts were segmented into bi-grams. Then we used Lemur to index the document collections. For both Chinese and English text retrieval, we chose to use Lemur's Okapi BM25 retrieval module with relevance feedback. The document number for relevance feedback is 5. The maximum number of new terms that were added to the original questions was 20.

3.3 Text Annotation

The retrieved documents obtained from the Document Retrieval module were annotated before the system performed sentence extraction.

3.3.1 English Text Annotation. We used LingPipe and Minipar together to perform Part-of-Speech tagging, named entity categorization, and noun phrase detection for English text annotation. The method is described in our TREC paper [3]. In general, LingPipe is used first to detect sentence boundaries, then the identified sentences are sent to Minipar for Part-of-Speech tagging and named entity categorization. We also keep the named entity categorization from LingPipe and combine the annotation results from the two systems.

3.3.2 Chinese Text Annotation. Chinese Text Annotation is our new development this year. Due to time constraints we performed preliminary annotation including following steps: a) Chinese segmentation dictionary construction, which combined multiple lexical resources [4]; b) Chinese word segmentation using forward maximum matching approach [4]; c) Part-of-Speech (POS) tagging. Since the segmentation dictionary also contains the POS for each word, it was also used to assign Parts-of-Speech to the collection. If a word had more than one POS, the most frequent used POS was selected. Also, simple rules were applied to identify number, time, and English words. The segmentation and POS tagging approaches were originally employed to automatically develop a draft annotation for human annotators to create training data, which will be used to develop statistical solutions to Chinese word segmentation and POS tagging. However, we could not complete the whole development process in time for the NTCIR-5 evaluation.

3.4 Sentence Extraction

The Sentence Extraction module identifies a certain number of non-duplicate sentences (500 sentences maximum for this year) from the annotated documents as sentence candidates which may contain an answer to each test question from the retrieved documents. The keyword lists and answer type information obtained in Question Processing are utilized to weigh extracted sentences for each question. The top 500 sentences were returned to the Answer Finding module to find the answers.

3.5 Answer Finding

The Answer Finding module applies multiple evidences to find answers for test questions. First, answer candidates were identified based on their annotation, and/or Part-of-Speech tagging. Then, each candidate was weighed based on certain factors including: 1) answer type: whether the candidate was annotated a category which is the same as the answer type of the question; 2) weight of the sentence, which is inherited from the sentence extraction module; 3) distance to keywords in the same sentence; and 4) whether it is a candidate returned by a submodule which searched the Web for answers [3]. A linear function was applied to combine the above factors and to calculate the weight for each candidate. The top N (N=1 for formal runs or N=5 for informal runs) candidates were returned as the answers for each question.

3.6 Submission

Finally, the Submission Module evaluated the answers and formulated the answer file as required by the workshop. One special procedure was to change the answer to "NIL" if the weight of one answer was lower than a threshold.

4 Incorporated software tools

As mentioned in the previous section, EagleQA made use of several freely available software tools for the purpose of Chinese QA and CLQA. Table 1 lists the software tools or online systems that we have incorporated in various modules of our EagleQA system to carry out different processes.

The Chinese segmentation dictionary used in the Chinese Text Annotation made use of several lexical resources, which are described in [4].

Table 1. Incorporated software tools

Applications	URLs if Obtained Online	Modules that Use the Application	Usage Description
Babel Fish	http://babelfish.altavista.com/	Query Processing – Question Translation	Translating Chinese into English for C-E QA, and translating English into Chinese for E-C QA
Lemur IR Toolkit	http://www.lemurproject.org/	Document Retrieval	Chinese document indexing and retrieval, English document indexing and retrieval
Chinese Encoding Converter	http://www.mandarintools.com/zhcode.html	Question Processing	Convert Big5-encoding Chinese documents into GB-encoding for question translation
LingPipe	http://www.alias-i.com/lingpipe/	English Text Annotation	English sentence boundary detection, named entity annotation
Minipar	http://www.cs.ualberta.ca/~lindek/minipar.htm	English Text Annotation	English Part-of-Speech tagging, information extraction, noun phrase annotation

5 Cross-Language Question Answering strategies for NTCIR-5

We have managed to submit runs for three subtasks: Chinese Question Answering, English-Chinese Question Answering and Chinese-English Question Answering. We developed our prototype Chinese Question Answering (QA) system within two months. Many of the programs could not be completed as we expected, and the prototype Chinese QA was not tested at all before the experiments. In this section, we will describe what has been actually implemented and employed for the NTCIR-5 CLQA subtasks.

5.1 Chinese Question Answering

The original 200 Chinese test questions were encoded in Big5. These questions were first sent to the Chinese Text Annotation module for annotation. Then they were processed by the Question Processing module to specify answer types and keyword lists. Figure 2 shows a sample output of the Question Processing module. The first line after the original question specifies the answer type; the line following the answer type line lists extracted keywords for this question; and the last line is a list of Chinese characters for the same question.

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CLQA1-ZH-T1156-00: 請問 2002 年冬季奧運會在美國猶他州何地舉行？
LOCATION
請問 2002 年 冬季 奧運會 美國 猶他州 舉行
請 問 2 0 0 2 年 冬 季 奧 運 會 美 國 猶 他 州 舉 行
```

Figure 2. Question processing results

The original questions were also converted to the format acceptable by Lemur for document retrieval. The top 1000 retrieved documents for each question were extracted from the collection and sent to the Text Annotation module for word segmentation and POS tagging. Figure 3 displays segments of an annotated Chinese document. The string after each "/" specifies the POS of the word.

The Chinese Sentence Extraction examines each Chinese document for candidate sentences. The module detected the Chinese sentence boundaries by looking for Chinese punctuation marks such as "？", "。", and "！". Then the extracted sentences were ranked according to their weights determined by the number of keywords and key characters in the sentences, and whether the sentence contains a word that was tagged the same as the answer type. The extracted sample sentence candidates are presented in Figure 4.

```
<DOC>
<DOCNO>edn_xxx_20000104_0262595</DOCN
O>
<TEXT>
<P> 【/w 新竹/ldc 訊/Ng 】/w 經濟部/n 爲/p
積極/ad 推動/v 節約能源/ldc 及/c 抑/ldc 低/a
二氧化碳/n 排放/v ，/w 繼/Vg 去/v (/w
88/num )/w 年/q 舉辦/v「/w 節約能源/ldc 表
揚/v 大會/n 」/w ，/w 促使/v 產業界/n 建立
/v 能源/n 查/v 核/n 管理制/n 度/q 後/f ，/w
爲/p 加強/v 節約能源/ldc 工作/vn 的/u 推動
/v ，/w 舉辦/v 系列/q 觀摩/v 會/v 。/w 這項
/r 節約能源/ldc 績/ldc 優/Ag 廠商/n 觀摩/v
會/v 由/p 經濟部/n 能源/n 委員會/n 主辦
/v 、/w …….
</TEXT>
</DOC>
```

Figure 3. Chinese text annotation examples

```
<sent>
<sentNo>mhn_xxx_20010529_0925402_1</sentN
o>
<sentScore>0.822222222222222</sentScore>
<TEXT>
/w 他/r 說/v ，/w 京都/ns 議定書/n 規定/n 到
/v 二/m ○/w 一/m ○/w 年/q ，/w 各國/r 須/d
將/d 二氧化碳/n 排放量/n 降/v 到/v 一/m 九
九/ldc ○/w 年/q 標/v 準/Unknown ，/w 台灣/ns
地區/n 目前/t 二氧化碳/n 排放量/n 已/d 居/v
全球/n 第二十六/m 名/q ，/w 如果/c 能源/n
結構/n 未/d 改變/v ，/w 四年/ldc 後/f 將/d 躍
/Vg 升/v 爲/p 第十五/m 名/q ，/w 超過/v 二
/m ○/w 一/m ○/w 年/q 的/u 標/v 準/Unknown
很多/m ，/w 更/d 不要/d 提/v 回歸/v 一/m 九
九/ldc ○/w 的/u 標/v 準/Unknown 了/u
</TEXT>
</sent>
```

Figure 4. Chinese sentence candidates

Then the Answer Finding module took the question file in a format as shown in Figure 2 and searched for answer candidates in the sentence candidates. A weighting formula was utilized to generate a score for each candidate by taking into account of factors such as 1) match on the answer type; 2) number of query keywords in the sentences; 3) distances to the query keywords in the sentences. The top result was considered the answer to the question.

It is obvious that our Chinese QA strategy is quite simple due to the limited knowledge resources and development time. Our result shows that the strategy was not able to find answers to many questions. Analysis is underway to identify the weakest link in the system and modify the QA strategy.

5.2 Chinese-English Question Answering

As for the Cross-Language subtasks, we took the question translation strategy which converts test questions into the same language as the documents, and then carried out monolingual question answering. For Chinese-English QA, we used Babel Fish to translate the Chinese questions into English, and then carried out English QA using our TREC-2004 EagleQA system [3].

The original Chinese questions were first converted to GB encoding using the Chinese Encoding Converter, and then submitted to Babel Fish for translation. Table 2 displays some questions that were well translated by Babel Fish. However, the majority of translations from Babel Fish were not satisfactory, as analyzed in section 7.

Table 2. Sample translations using Babel Fish

Translation Type	Original Chinese or English Questions	Translation of the Question
Chinese to English	哪個國家被認爲綁架了日本國民？	Which country was considered has kidnapped the Japanese nationals?
	1999 年日本觀光客最熱門的國外旅遊點是哪裡？	Where in 1999 is the Japanese tourist most popular overseas traveling spot?
English to Chinese	Which team won the NBA championship in the 2000-2001 season?	請問 2000~2001 年賽季 NBA 總冠軍爲何隊？
	What is the height in meters of the Eiffel Tower?	請問法國地標艾菲爾鐵塔高幾公尺？

Then the translated results were converted into two files in different formats. One was sent to the Question Processing module to identify answer types and keywords; the other was sent to Lemur for English document retrieval.

We used Minipar and LingPipe together to annotate each retrieved English document. The annotation was performed applying the same approach and format as the text annotation for the TREC 2004 QA track [3].

Finally, we applied our TREC QA strategies for answering the TREC 2004 Main Task factoid questions to the following two processes: Sentence Extraction and Answer Finding, as described in Section 3.4 and 3.5.

5.3 English-Chinese Question Answering

For English-Chinese QA, we again used Babel Fish to translate English questions into Chinese, and then applied our prototype Chinese QA system as described in Section 5.1 to obtain the answers. Table 2 also shows sample translation results obtained from Babel Fish for the E-C subtask.

Table 3. Chinese QA and CLQA results

RUNID	# of Correct Answers	Accu-racy	Accuracy of the Best System
UNTIR-C-E-01	12	0.06	0.06
UNTIR-C-C-01	20	0.1	0.375
UNTIR-E-C-01	6	0.03	0.125

6 Experimentation and submissions

We submitted three runs: one for Chinese QA, one for Chinese-English QA, and one for English-Chinese QA. Table 3 presents our official evaluation results. It was not surprising that our Chinese QA and English-Chinese QA did poorly due to unfinished system development and limited knowledge resources. Our Chinese-English QA could find correct answers for only 12 questions, even though it achieved the highest accuracy among the participants. A brief analysis is presented in the next section to discover the reasons behind the performance.

7 Analysis

We started to analyze the evaluation results in order to inform future development and further improvement of the current system. Due to space limits, below we report only our analysis on question translation for the C-E subtask and answer type identification for the C-C and C-E subtasks.

7.1 Question translation

We conducted a manual evaluation of the question translation for the C-E subtask. The purpose is to understand how Babel Fish did the question translation job for the C-E subtask. Two of the authors served as independent evaluators to classify the translations into six categories. The categories and results are shown in Table 4.

The result shows that both evaluators considered that more than 50% of the questions were poorly translated. The percent agreement between them was 68% – only 136 questions are classified into the same categories by both of them. However, the percent agreement reached 81.5% when the categories were collapsed into three classes: acceptable translation, poor/missing translation, and not sure. Table 5 is a list of key terms that were incorrectly translated by Babel Fish. Obviously, translation is a big challenge for CLQA. How to achieve high-quality translation for CLQA is an important research topic.

Table 4. Question translation evaluation results for the C-E subtask

Categories	Classification Criteria	# of Questions Identified by Evaluator 1	# of Questions Identified by Evaluator 2	# of Common Questions
Perfect translation	Questions are perfectly translated, the translated sentence is readable and correct	4	5	3
Good translation	All important terms are correctly translated. The order of the terms may not make sense	15	35	11
Fair translation	Most of the important terms are correctly translated. Minor mistakes in the translation should not affect the meaning	44	35	17
Poor translation	Important terms are not correctly translated or missing translation. The translated sentence is hard to understand	124	117	104
No translation	The system returned the original questions without any translation, or only translated certain unimportant terms	1	3	1
Not Sure	Unable to judge the translation	12	5	0
Total		200	200	136 (68%)

Table 5. Incorrect translation examples

Original Term	The Question	Incorrect Translation from Babel Fish	Correct Translation
於何年	CLQA1-ZH-T0033-00: "漢城奧林匹克運動會於何年舉行？"	Seoul Olympics games *Yu Honien* holds?	*Which year* was the Seoul Olympic Games held?
藍芽	CLQA1-ZH-T0124-00: "全世界最早在市場上推出藍芽無線技術的是哪一家公司？"	Which company does the world most as early as promote the *blue bud* wireless technology in the market is?	Which is the first company in the world that introduced the *Bluetooth* wireless technology into the market?
管弦樂團	CLQA1-ZH-T0118-00: "拉莫婁管弦樂團每年從法國政府和巴黎市獲得多少補助？"	How many does the *Low wind and stringed musical instruments philharmonic orchestra* every year obtain from the French government and Paris to subsidize?	How many subsidies does the Lamoureux *Orchestra* receive from the French government and Paris each year?
現代汽車公司	CLQA1-ZH-T0129-00: "現代汽車公司的董事長是誰？"	Who is *modern car company*'s chairman of the board?	Who is the board chairman of *Hyundai Motor Company*?
卡夫吉	CLQA1-ZH-T0184-00: "2001 年哪一個日本公司持有卡夫吉油田的開採權？"	In 2001 which Japanese company does have the *Cuff lucky* oil field the exploitment right?	Which Japanese company has the right of exploitation of the *Khafji* oil field in 2001?

7.2 Answer type identification

For the Chinese QA and Chinese-English QA subtasks, the Answer Type Identification submodule only achieved 58% accuracy. Our system did well in identifying questions that ask for a country name and a location name. It could not identify the correct answer types for many questions asking for a person's name. Also, answer type identification for questions that need an organization name was problematic. Many questions could not be assigned a specific answer type when they asked for the name of an artifact or an event due to the limited number of categories in our classification scheme.

8 Future development

We have learned good lessons from the participation in the CLQA task of NTCIR-5: It was a disaster to do too many things at the same time! However, our experience offered us a clear understanding of the challenges of Chinese QA and CLQA, which allows us to think about solutions to certain challenges such as question translation and answer finding. One strategy for dealing with translation problems might be to integrate the LKB approach proposed in [2] with a MT system. We would like to investigate such integration as one of our future research and development areas.

We will continue to analyze the current system and start to work on exploring more effective answer finding solutions to Chinese QA and CLQA. We are creating training materials and seeking linguistic resources to improve our QA system. Please contact Jiangping Chen (jpchen@unt.edu) if you would like us to evaluate your NLP tools or linguistic resource for Chinese QA or CLQA.

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