

# Question Answering System beyond Factoid Type Questions

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**Abstract:** In this paper, we describe answer extraction method for non-factoid questions. We classified non-factoid type questions into three types: why type, definition type and how type. We analyzed each type of questions and developed answer extraction patterns for these types of questions. For each question type, we have expanded question analysis modules to determine non-factoid question types and developed answer extraction modules based on the analysis of answer expression patterns in large document set. For evaluation, we used 104 questions which are mainly developed at Question Answering evaluation workshop (NTCIR6-QAC4).

**keywords:** question answering, named entity extraction, answer extraction, non-factoid question, RST

## 1. Introduction

Question Answering is a technology to find information from a huge text base using a given question. There have been some evaluation workshops of question answering such as NTCIR QAC<sup>1</sup>[2] [3] [4] [7] [6] [8], TREC QA<sup>2</sup>[13] track and CLEF<sup>3</sup>. In these evaluation workshops, target of given questions is mainly factoid question which requires person name, organization name, numeric expression, artifact name and so on. In TREC QA, there have applied definition type questions which require description or definition of some word or terms and other type questions which require related information of given questions.

We have already developed factoid type question answering system for QACs [1] [5] and also proposed question answering mechanism for why-type questions as one of non-factoid type questions [[10]]. In order to extract answers for why-type questions, we have extracted causal relations and some other relations from target documents. If one element of these relations matches question sentence, the other element will be answer for the question. We analyzed inter-sentential relations proposed in Rhetorical Structure Theory (RST)[9] and have chosen causal relation, manner relation for purpose of why-type question answering. For how-type question, Nishimura et. al. proposed a method to focus on answer expressions for how-type question from Linux FAQ mailing list data[12].

For QAC4, we improved why-type question answering method and expand our QA system to handle definition-type

question and how-type question [[11]]. In order to improve why-type question answering, we have added several rules and modified rules based on evaluation results using QAC testset. For definition-type question, we have analyzed question answer data and newspaper articles, and extracted patterns for this questions. These patterns are descriptive patterns which consist of some terms and their definition or descriptions. For how-type question, we also applied some kinds of approach as the definition-type questions. Extraction patterns for how-type questions are description of procedure.

## 2. An overview of RitsQ QA system

We have already developed QA system for the previous QAC evaluations and we have improved our system for non-factoid question answering. For QAC4, we expanded our QA system to manage non-factoid questions, that is, expansion of question type analysis patterns for non-factoid type questions and expansion of answer extraction modules. For question type analysis, RitsQ system will analyze question type of a given question and determine its question type as why-type, definition-type or how-type according to surface expression patterns of the question if the question is non-factoid one. The surface patterns of each question type are as follows:

- Why-type:  
“なぜ (naze)”, “何故 (naze)”, “どうして (doushite)”
- Definition type:  
“とは何。(toha nani.)”, “どのような+名詞 (donoyouna + NOUN)”, “どんな+名詞 (donna + NOUN)”, “名詞+って何 (NOUN \* tte nani.)”
- How type:  
“どういう (doui)”, “どうしたら (doushitara)”, “どうする (dousuru)”, “どうすれば (dousureba)”, “どうやったら (douyattara)”, “どうやって (douyatte)”, “どうなりますか (dounarimasuka)”, “どのように (donoyouni)”, “どのような (donoyouna)”

If a given question is non-factoid and does not match to the above surface patterns, our system understand this question is definition type question as the default. For answer extraction, we prepared answer extraction module of each type of question. The details will be presented in the next section.

Another major improvement of our QA system is information retrieval module. Our previous system used Namazu system<sup>4</sup> for document retrieval using extracted clue words but its performance was not at the level of our satisfaction.

<sup>1</sup><http://www.nlp.is.ritsumeai.ac.jp/qac/>

<sup>2</sup><http://trec.nist.gov/>

<sup>3</sup><http://clef.isti.cnr.it/>

<sup>4</sup><http://www.namazu.org/>

In order to improve its performance, we used information of *Google*<sup>5</sup> snippets to re-order retrieval results of Namazu system. Firstly, we choose top 10 snippets of *Google* using extracted clue words. Then we calculate document similarity between retrieved top 100 documents and top 10 *Google* snippets to re-order the retrieved documents. We could improve IR module of our QA system because documents which include correct answers will be ranked in higher position.

Moreover, we have added another information retrieval module using *Google* web search engine. Our system uses some words extracted from an input question sentence for query words of web search engine. The number of retrieved pages are determined by question types. For example, our system uses top 10 pages for factoid questions and top 30 for how-type questions. For answer extraction, our system removes html tags and some image files are ignored.

### 3. Answer extraction module

Answer extraction module for non-factoid questions extracts answer strings from a paragraph of retrieved documents according to answer extraction patterns of each question type. This module searches linguistic clues of each question type for each document which is retrieved by IR module and extracts one appropriate paragraph which includes linguistic clues and some clue words of question sentence. This extracted paragraph will be a target for extraction of answer string.

#### 3.1 Why-type question

As for why-type question, we will use the following extraction patterns and non-extraction patterns. If one sentence matches extraction patterns, this sentence will be extracted as answer candidate. But this candidate will be removed from candidate list if it matches non-extraction patterns.

- extraction patterns
  - Verb + “ため (tame)”
  - Noun + “ため (tame)”
  - “ため (tame)” + Postposition “に (ni)”
  - “ため (tame)” + “、” — “。”
  - “ため (tame)” + Aux. Verb “だ (da)”
- non-extraction patterns
  - Pronoun + Postposition “の (no)” + “ため (tame)”
  - Verb + “ため (tame)” + Postposition “の (no)”
  - Noun + “ため (tame)” + Postposition “の (no)”

The semantic clue words are the words which mean reason, cause and background. This kind of words is extracted using Japanese thesaurus as follows:

We choose reason part from an extracted sentence as answer candidate. If there is conjunctive expression on the top of an extracted sentence and conjunction has a function of coordination, the previous sentence will be added in this answer candidate. If there is contradictive conjunction in a sentence, the previous part of this sentence will be removed from this answer candidate. Answer candidates are ranked using similarity of cosine measure with a given question sentence. Top 5 answers will be obtained as the system results.

“理由”	“一因”	“根因”	“訴因”
“要素”	“遠因”	“罪因”	“動因”
“背景”	“外因”	“死因”	“導因”
“動機”	“禍因”	“主因”	“道因”
“事由”	“画因”	“徒因”	“内因”
“根拠”	“起因”	“勝因”	“敗因”
“引き金”	“基因”	“心因”	“病因”
“ゆえん”	“近因”	“真因”	“副因”
“ゆえ”	“偶因”	“成因”	“福因”
“きっかけ”	“原因”	“善因”	“誘因”
“悪因”	“業因”	“素因”	“要因”

#### 3.2 Definition-type question

Definition type questions require word meaning, term definition, description of term and so on. For example, in the question “What is World Heritage Convention?”, it requires definition of “World Heritage Convention” which is the most important element in this question. We call the important element Main Keyword. In order to choose Main Keyword, we firstly check blanketed word or named entity, then modifier of topic word, and finally, topic word. In the question “What agreement is World Heritage Convention?”, the word “agreement” is also important as well as Main Keyword. We call this kind of word Attributive Word. Attributive Word is the word which composes noun phrase with an interrogative such as “どういった (douitta)”, “どのような (donoyouna)”, “どんな (donna)” and so on. Extraction patterns are shown as follows:

- Main Keyword + “は (ha)” — “が (ga)” — “も (mo)”
- ... “が (ga)” + Main Keyword + “を (wo)”
- ... “する (suru)” + Main Keyword
- ... “の (no)” + Main Keyword
- Main Keyword + “とは (toha)”
- ... “の (no)” + Attributive Word
- ... “する (suru)” + Attributive Word

If a matched sentence includes Main Keyword, the whole sentence will be an answer candidate. If a matched sentence includes Attributive Word, its modifying element will be an answer candidate. In definition type question, answer candidates are ranked using similarity of term vector measure with a given question sentence. All the possible answers will be obtained as the system results.

#### 3.3 How-type question

How-type question is inquiry of some procedure, method or conditions of action. In our approach of this question type, we firstly extract a list of itemized elements from target documents. Itemize elements are indicated by list tag < li > in html tagged documents, item numbers and so on. However, itemized elements do not always indicate procedural expression. They are sometimes simple list expressions. According to statistical analysis, when 80% of itemized elements include verbal expressions, they are procedural expression. In order to choose answer candidate from extracted list expressions, verbal expressions in a question sentence will be clue to rec-

<sup>5</sup><http://www.google.co.jp/>

ognize answer for this type of questions. For example, in the question “How is World Heritage decided?”, the verb “decide” will be important clue for answer extraction.

Extraction pattern for How-type question, we will use the main verb (Main Verb) of a question sentence and Main Keyword which is clue for Definition type question. Extraction patterns are shown as follows:

- Main Keyword + “は (ha)” — “が (ga)” + Main Verb
- “手順 (procedure)” — “手法 (method)” — “方法 (method)” — “条件 (condition)” + “は (ha)”
- “が (ga)” + “手順 (procedure)” — “手法 (method)” — “方法 (method)” — “条件 (condition)”

In how-type question, answer candidates are ranked using similarity of term vector measure with a given question question sentence. All the possible answers will be obtained as the system results.

#### 4. Experiments

In order to evaluate our QA system, we selected why-type questions and definition type question from 100 questions of QAC4 testset. We have made how-type question because there was no such type question in QAC4 testset, Finally, we used 32 definition type, 42 why-type and 29 how-type questions (the sum of questions is 104). Evaluation was done by one human assessor using QAC4 testset question answering data. When the assessor judged that there was a correct answer in the system answer list of a question, this question could get a correct answer.

As for system setting, we used Google web search engine for document retrieval. Top 30 documents are used for how-type questions and 10 documents for the other type of questions. Question type was determined by question type analysis module of our system.

Evaluation results will be shown in Table 1.

Table 1. Evaluation results of each question type

question type	the num of correct answers / the num of questions
why-type	10/32
definition type	18/43
how-type	14/29

#### 5. Discussions

In the experiment using question data, our system returned 10, 18 and 14 answers for why-type, definition type and how-type questions, respectively. Main failure reason was lack extraction patterns. In why-type questions, most of failed questions are this reason. There was 10 more questions which our system could extract correct answers but their ranking were not ranked in top 5 answers.

In definition type questions, if target sentences are matched with extraction pattern of this type question. However, there were some difficult cases for extraction of answer candidates. For example, a question “what kinds of thinking ...” requires description of *thinking* but there was no such pattern in our

system. A question “What kinds of relationship between ...” requires relationship information but it is very difficult to identify such kind of information type.

In how-type questions, our system succeeded to extract some sort of itemized elements from target documents but selection of procedural expression failed. It is necessary to improve detection mechanism of procedural expressions. Moreover, there are some cases that all the itemized elements are not described in a document and several last elements are omitted. In this case, it is difficult to recognize scope of itemized elements.

#### 6. Conclusion

In this paper, we describe answer extraction method for non-factoid questions. We classified non-factoid type questions into three types: why type, definition type and how type. We analyzed each type of questions and developed answer extraction patterns for these types of questions. In the evaluation of the experiment, we used question data of NTCIR6 QAC4 and how-type question developed by us. In the result of the experiment, our system could get correct answers for 42 questions among 104 questions. However, performance of our QA system is not enough because of short of question patterns and answer extraction patterns for questions. It is necessary to expand extraction rules and scoring method of answer candidates.

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