Why-type Question classification in Question Answering System

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ABSTRACT

The fundamental requisite to acquire information on any topic has become increasingly important. The need for Question Answering Systems (QAS) prevalent nowadays, replacing the traditional search engines stems from the user requirement for the most accurate answer to any question or query. Thus, interpreting the information need of the users is quite crucial for designing and developing a question answering system. Question classification is an important component in question answering systems that helps to determine the type of question and its corresponding type of answer. In this paper, we present a new way of classifying Why-type questions, aimed at understanding a questioner's intent. Our taxonomy classifies Why-type questions into four separate categories. In addition, to automatically detect the categories of these questions by a parser, we differentiate them at lexical level.

CCS CONCEPTS

• **Information systems → Question answering**;

KEYWORDS

Question answering system, why-questions, question classification, answer types

1 INTRODUCTION

The rapid advancement of Web has allowed the researchers to store information on a wide variety of topics. Search engines [5] return a relevant list of web pages, according to the user's need. But finding the most appropriate and precise answer for a given question, has motivated the development of Question Answering Systems. These days, QA becomes a researched topic in the field of NLP and IR. Question answering System [8] is an information retrieval system that automatically generates an accurate answer of a natural language question. Questions elicit information in the form of answers. The answer to the questions depends on the types of questions. In English language, there are several types of questions starting with word what, when, who, where, why, how, etc. Questions beginning with what, when, who and where are factoid type questions [13] and can be answered in a single phrase or sentence. Whereas, questions starting with why and how belong to non-factoid questions. Such type of questions are complex and involve variations in their answers. Why-type questions require reasoning and explanations in their answers and how-type questions involve procedures/manners which vary among individuals. Their answers range from a sentence to a paragraph or even a whole document. Though past studies addressed the issue of question classification for various questions starting with what, when, where, etc., few of them have addressed the classification of Why-type questions. As an attempt to understand the questioner's intent in the why-question asked on QASs, we propose a classification of why-type questions which plays an important role in the development of QASs. We begin the analysis of 1000 why-questions, randomly sampled from the QA sites and from the datasets available on the Web. With the analysis, we propose a classification with four categories (1) Informational Why-questions, (2) Historical Why- questions, (3) Contextual/Situational Why-questions, and (4) Opinionated Why-questions. To enable the automatic detection of these four types of questions by a parser [2], we discussed the features that differentiate them and helps them to be recognized.

Our proposed taxonomy can serve as a crucial step in the development of Why-type QAS: first, by automatically differentiating questions, it can help us decide the knowledge source to be referred to find an answer, secondly it can help determine the expected answer type of a question.

The rest of this paper is organized as follows: In section 2, we give a brief overview on QA systems. In section 3, we discuss the motivation for carrying out research in why-QA. Section 4 discusses the related work on question classification. Section 5 describes the research issues faced in why-QA. Section 6 introduces the research objectives. Section 7 describes the methodology used in research. Section 8 describes the procedure of data collection to carry out research, Section 9 discusses the proposed classification of why-questions and their distinguished features analysis. Finally, Section 10 concludes our work with future plans.

2 QUESTION ANSWERING SYSTEM

Question answering systems answer the questions asked in natural language. They use information retrieval and natural language processing techniques to find an appropriate answer. The architecture of QAS includes four modules namely, question processing, document retrieval, answer extractor, and answer re-ranker as illustrated in Figure 1.

Question processing module performs activities (1) question classification, and (2) question reformulation. The question classification is an important module of QAS as it affects the subsequent answer extraction module, and hence determines the accuracy and performance of QAS. Question classification accurately assign a label to a question and categorize it into one of the predefined classes. This further helps in predicting the answer type for the given question [33]. The question reformulation module reformulates a question (Q) into a new question (Q') by adding appropriate terms, deleting punctuation marks, and thus, highlighting the information needs of a user. After question processing, document retrieval module of a QAS returns a ranked list of relevant documents in response to a reformulated question. A document is considered to be relevant if its contents are relevant to the answer

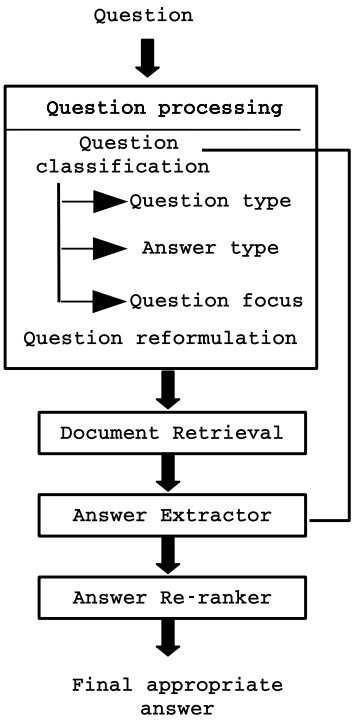

Figure 1: Architecture of Question Answering System

and fulfills the needs of the user. The retrieval of appropriate documents is important in QASs as it searches for correct answers from those documents. The answer extractor module extracts a candidate set of answers from the documents, that matches with answer types given by the question classification module. The answer re-ranker module ranks the obtained answer candidates using various techniques and returns the highest scored answer to the user.

3 MOTIVATION

Many researchers have carried work on different modules of question answering system. According to Moldovan [9, 27], the accuracy of QAS is dependent on the question classification module. If the questions are properly classified, it will result in the extraction of the accurate answer. The questions beginning with why and how are very complex, and it is very difficult to extract one accurate answer to such questions. Whereas, the questions beginning with what, where, who, which etc. are simple and can be answered by named entity tagging. Very less question answering systems deal with why-type questions because their answers are complex and differ from one user to another, depending on the context in which it is asked. Therefore, extracting one answer to a why-question is one of the research area in the field of IR. However many researches have been carried out on classification of What-type questions [10, 11, 18, 24, 41] questions posted on social networking sites [7, 14, 19–22], questions asked in Community QAS [4, 17, 40], etc., but less work has been done to classify why-type questions [12, 22, 31, 34, 35, 37, 38] and How-type questions [3, 23]. Extracting one unique answer to a Why-type question is an open research challenge in Question Answering community. Thus, we aim to work on Why-type questions, so that it can contribute the development of QAS dealing with all types of questions. Question classification is a crucial component of modern QAS. It classifies questions into several semantic categories which further determines the expected semantic type of their answers. The semantic category helps to filter out irrelevant answer candidates, and determine the one accurate answer.

4 RELATED WORK

In literature, many researchers have addressed the issue of classifying questions asked in different domains. Zhang et. al. [41] followed the taxonomy for TREC-style questions, which contains 6 coarse grained categories (ABBR, DESC, ENTY, HUM, LOC, NUM) and 50 fine grained categories. They considered only syntactic structure of the question in the system whose performance can be improved by incorporating semantic knowledge. Lili Aunimo [1] developed a typology of general domain question answering systems. Questions are evaluated on 7 set of features, consisting of lemmatized words, part-of-speech (POS) tags, punctuation marks, semantic tags, and target tags. Metzler and Croft [24] used question words and types and found correlations between them to train word-specific question classifiers. They identified question words firstly, and trained separate classifier for each question word. Nguyen et. al. [15] proposed a subtree mining method for question classification. Fangtao Li et. al. [18] classified the what-type questions using head noun's tag. The system can't produce correct results, in case the head noun is not present in the question. Zhiheng Huang et. al. [11] presented five binary feature sets, namely question wh-word, head word, WordNet semantic features (hypernym) for head word, word grams, and word shape feature for question classification. Ambiguity arises in classifying questions. Inconsistent labeling in training and test data produces incorrect parse tree which results in wrong head word extraction. Eduard Hovy et.al. [10] created a QA typology, consisting of 5 types of Qtargets as, Abstract, Semantic, Syntactic, Role, and Slot. Baoli Li et. al. [26] introduced Universal Question Answering in which answer types are detected according to following criteria that (1) correct answer shares the same topic with its question, (2) it has the same answer type as that expected by its question. Harper et. al. [7] automatically classified questions into conversational and informational. [14] classified questions from Yahoo! Answers into four categories, as informational, suggestion, opinion, and other. Zhao and Mei [42] classified question tweets into two categories, tweets conveying information needs and tweets not conveying information needs. Morris et. al. [28] manually labeled a set of questions posted on social networking platforms and identified eight question types, including recommendation, opinion, factual knowledge rhetorical, invitation, favor, social connection, and offer. Zhe Liu and Bernard J. Jansen [19, 20] proposed a taxonomy of questions posted on social networking sites, called ASK. In accuracy questions, people ask for facts or common sense; social questions in which people ask for the coordination or companion; and knowledge questions in which people seek personal opinions or advices. The performance of the system can be improved by

employing semi-supervised learning algorithm such as co-EM support vector learning. Authors continued their research in 2016 [21], and modeled the intent detection as a binary classification problem, which classified the questions into subjective and objective. A classifier is built on lexical, syntactical and contextual features. Long Chen et. al. [4] classified the questions asked on Community Question Answering systems into 3 categories according to their user intent as, subjective, objective, and social. [17] investigated, how to automatically determine the subjectivity orientation of questions, posted in community QA portals, which helped to evaluate the correct answer. They explored a supervised machine learning algorithms with features like char 3-grams, word, word+char 3grams, word-n-gram, and word POS n-gram to predict the question subjectivity.

With regard to the classification of why-type questions, Moldovan et al. [27] considered answers of all why-questions as only one type, i.e., reason type. Ferret et al. [6] proposed a syntactic categorization of factoid questions to determine the expected answer type. They also have viewpoint that the answers of why and how verb type questions are difficult to reduce to a syntactic pattern. Suzan Verberne [34, 35, 37–39] used Ferret's approach for syntactically categorizing the why-questions and determining their expected answer type. The author formed a set of hand written rules based on words and classes of verb used in the why-questions. A parser [32] generates a parse tree and uses the set of hand written rules to choose the syntactic category of a why-question. The author defines six syntactic categories of why-questions (1) action questions, e.g. Why did Ratan Tata write a letter to Narendra Modi?, (2) process questions, e.g. Why has Dixville grown famous since 1964?, (3) intensive complementation questions, e.g. Why is Microsoft Windows a success?, (4) monotransitive have questions, e.g. Why do cats have slits in their ears?, (5) existential there questions, e.g. Why is there a need of resource planning?, and (6) declarative layer questions, e.g. Why did they say that migration occurs?. The author subdivides the answer types of why-questions into cause, motivation, circumstance, and purpose, on the basis of the classification of adverbial clauses given by Quirk [16].The system could not categorize these groups of questions, (1) in which subject was incorrectly not marked as agentive in action questions (2) questions with an action verb as main verb but a non-agentive subject (3) passive questions and (4) no general rule for monotransitive have questions.

5 RESEARCH ISSUES FACED IN WHY-QA

There are few research issues that are faced in Why-QAS, which are described as follows:-

(1) **Problems in appropriate question classification:** Correctly classifying why-questions and determining their expected answer type is one of the research problem [27, 36]. Almost all why-questions have 'Reason' answer type . Suzan Verberne in 2007, subdivided the 'Reason' answer type into purpose, motivation, circumstance and cause.
(2) **Problems in determining one unique answer:** Why-questions require reason, elaboration, explanation etc. in their answers. Answers to why questions are subjective generally. Different people answer the questions differently, depending on the context of the questioner and the context in which the question has been asked [25, 39]. Thus, retrieving one accurate answer is a challenging task.
(3) **Problems in paraphrasing Why-type questions:** Paraphrasing is the process of restating the giving statement/ question with other words, without changing their actual meaning. Hence determining the semantic class of the questions is necessary to answer why type questions [35].
(4) **Question focus and semantics of why-QA:** Why-QAS will be able to handle the questions of type "Why do our ears ring?" because the correct answer passage to this question does not contain the words ears and ring rather it is a phenomenon called tinnitus and the answer passage returns the reason for the Tinnitus [39].
(5) **Problems related to answers extraction in Why-QAS:** Many of the conventional QASs are based on bag of words model which face problems in retrieving appropriate answers due to semantic relations between words like polysemy, homonymy and synonymy [25]. Thus, discourse relationships between the sentences and Bag-of-concepts model are needed to retrieve an appropriate answer to Why-questions.
(6) **Problems related to answer re-ranking in Why-QAS:** Candidate answers are re-ranked by the classifiers. Usually classifiers are trained on the basis of the features, according to which they return a score to each answer. Different features like causal relations, semantic word classes, sentiment polarities, morpho-syntactic information, bag-of-words etc. have already been utilized [29, 30]. Thus, deciding the importance of the features on which classifiers are trained, is itself an another challenging task.

6 RESEARCH OBJECTIVES

To address the gaps, mentioned in the related work section, we aim to work on the below research objectives:

(1) Propose a taxonomy of why-questions with the consideration of identifying the questioner's need, extracting a correct answer, and thus maximizing the response probability.
(2) Understanding the different features of why-type questions on lexical level.

7 RESEARCH METHODOLOGY

We will be following qualitative research which is collecting, analyzing and interpreting data by observing what people do and say. Qualitative research is subjective in nature that uses very different methods of collecting information, mainly individual, in-depth interviews and focus groups. The nature of this type of research is exploratory and open ended. Thus, we try to collect the dataset of why-questions and answers, and analyze them to propose a taxonomy for why-type questions.

8 DATA COLLECTION

To fulfill the above mentioned research objectives, we collected why-type questions from the various question answering sites such as Yahoo! Answers (https://in.answers.yahoo.com/, Quora (https://www.quora.com/, Twitter (https://twitter.com/search etc. We also consulted a dataset of why-questions and their answers, used by

Suzan Verberne available at (http://liacs.leidenuniv.nl/~verbernes/ in her research. This process resulted in our dataset, consisting of 1000 why-questions.

9 PROPOSED CLASSIFICATION OF WHY-QUESTIONS

In this paper, we try to resolve the research issue of appropriate classification that helps to categorize the why-questions. With a viewpoint to identify the main focus of the question, and determining the context of answering a question, why-questions are categorized into four categories as illustrated in Figure 2.

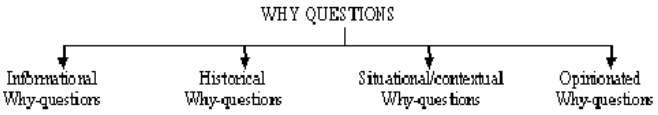

Figure 2: Categorization of why-questions

(1) informational (factual) why-question that asks for reasoning about some fact (either scientific or non-scientific), (2) historical why-question that asks for the reasoning about some event/action happened in the past, (3) situational why-question asks for the reason about the event occurred at a particular context of time, and (4) opinionated why-question that asks for the personal opinions on some other person/product.

9.1 Informational Why-Questions

The intent of an informational why-question is to receive answers, describing the reason for some facts, asked in the question. These questions look for the factual or prescriptive knowledge. The data source which is used to answer such questions are WWW, domain knowledge, expert knowledge, books etc. because their answers are fixed and easily available from the Web. There is only one possible answer to such questions and no ambiguous/conflicting answers are possible for such questions. Etymology questions starting with Why also belongs to this category. For example, a. Why are rabbits eyes red? b. Why is Indiglo called Indiglo? c. Why do scuba divers go into the water backwards? These questions contain either one fact or more than one fact, which might involve comparative reasoning in their answers.

9.2 Historical Why-questions

The intent of historical why-question is to receive the reasoning of an event/action occurred in the past. These questions generally relate to domains like War, inventions, Law, Rights, etc. occurred in the past. These questions generally have one correct answer. Justification and evidence is required in the answering of such questions. Examples of historical why-questions are: a. Why were people recruited for the Vietnam War ? b. Why did the Globe Theatre burn down ? c. Why were medieval castles built?

9.3 Situational Why-Questions

The intent of situational why-question is to receive the reasoning for the action occurred at a particular context of time or in different situations. These questions generally involve the condition, circumstance, under which a particular event happened. These questions are related to the domains like day-to-day circumstances, personal life, travelling, education, science, etc. There can be one, multiple or ambiguous answers to such type of questions depending on the context of the user and question in which it is asked. Thus, the main focus of these questions is on the condition/context of time at which event has happened. The examples of such questions are: a. Why do the clouds darken when it rains? b. Why do you say "God bless you" when people sneeze ? c. Why does the moon turn orange?

9.4 Opinionated Why-Questions

The intent of an opinionated why-question is to receive reasoning about some person or product. They seek responses reflecting the answerer's personal opinions, advices, preferences, desires, or experiences. They encourage respondents to prove their personal answers. Due to which, there can be multiple answers possible for a question, which can be ambiguous or controversial in some cases. These questions usually ask for the reviews of some products, or ask for the personal life, travelling, education, etc. The examples of these opinionated why-questions are: a. Why was my payment in a message cancelled? b. Why are some people 'doublejointed'? c. Why do we laugh?

Continuing our research work, we will analyze the lexical features in detail to distinguish the above categories of why-questions. Since different terms in question are used to depict the different information needs, we will use the parts of speech tagging to identify different categories. For POS tagging, we will make use of Stanford Tagger [38]. For example, opinionated why-questions contain personal pronouns except 'it', common noun pointing to a person like boy, girl, man, woman, lady, etc., and concrete noun referring to a person, followed by any action verb. Historical why-questions use the auxiliary verbs and main action verbs in the past tense like did, was, were, had, could, would, should etc. Informational why-questions use 'there' which is tagged as EX (representing Existential there) by Stanford Tagger. Etymology questions which use terms like 'called', 'named', 'represented as', 'referred', 'considered to be' etc. also belong to informational why-questions. Situational why-questions use 'when', 'if', 'while', 'thought', 'after', 'before', 'during' etc. as conjunction.

Some why-questions might have features belonging to more than one category. To remove ambiguity, we will identify the rules that helps to assign one category to a why- question. This classification of question will further help to identify the intent and main focus of the question.

10 CONCLUSION AND FUTURE WORK

This paper has given a new classification of why-questions for question answering system. We have classified why-questions in four categories, and continue to identify different features of these why-questions. We will implement a parser which will categorize why-questions according to their features. We will also do analysis of the answers for why-questions and determine their expected answer types.

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