

Question Answering System for Dialogues: A New Taxonomy of Opinion Questions

Amine Bayoudhi¹, Hatem Ghorbel², and Lamia Hadrich Belguith¹

¹ ANLP Group, MIRACL Laboratory, University of Sfax, B.P. 1088, 3018, Sfax Tunisia
bayoudhi.amine@gmail.com, l.belguith@fsegs.rnu.tn

² ISIC Lab, HE-Arc Ingénierie, University of Applied Sciences, CH-2610 St-Imier Switzerland
hatem.ghorbel@he-arc.ch

Abstract. Question analysis is an important task in Question Answering Systems (QAS). To perform this task, the system must procure fine-grained information about the question types. This information is defined by the question taxonomy. In the literature, factual question taxonomies were the object of many research works. However, opinion question taxonomies did not get the same attention because they are more complicated. Besides, most QAS were focusing on monological texts, while dialogues have rarely been explored by information retrieval tools. In this paper, we investigate the use of dialogue data as an information source for opinion QAS. Hence, we propose a new opinion question taxonomy in the context of an Arabic QAS for political debates and we propose then an approach to classify these questions. Obtained results were relevant with a precision of around 91.13% for the opinion classes' classification.

Keywords: question taxonomy, opinion question classification, sentiment analysis, Question Answering Systems.

1 Introduction

Nowadays, information sources are becoming much larger. As a result, finding the appropriate piece of information using the least effort is becoming more difficult. Question Answering Systems (QAS) are information retrieval tools designed to make this task easier; they offer the user the possibility to formulate his queries in natural language and to get concise and precise answers.

Question analysis is considered as an important task in QAS. To perform this task, the system must procure fine-grained information about the question types. This information is defined by the question taxonomy. In the literature, factual question taxonomies were the object of many research works. However, opinion question taxonomies did not get the same attention.

Dialogues, as the main modality of communication in human interaction, make an essential part of information sources. They occur either directly (i.e. professional meetings, TV programmes and political debates) or virtually (i.e. social networks or blogs). During dialogues, interlocutors perform different interactive actions: they

exchange information, express opinions, make decisions, etc. Nevertheless, dialogues have rarely been explored by information retrieval tools such as QAS. This is due to the lack of linguistic resources, in particular annotated oral corpora, as well as the complexity of processing related to the specific aspects of oral conversations.

The current research is part of a framework aiming to implement an Arabic QAS for political debates. In this paper, we investigate the use of dialogue data as an information source for a QAS and we propose a new opinion question taxonomy in this context. We propose also an approach to classify these questions, based on opinion extraction and machine learning techniques. The rest of this paper is organized as follows. In section 2, we review a selection of previous works related to the opinion question classification. In section 3, we propose our opinion question taxonomy in QAS for dialogues. In section 4, we illustrate our classification approach, report and discuss the obtained results. Finally, we conclude and provide some perspectives in section 5.

2 Related Works

In this section, we present a brief overview of the question type taxonomies, opinion extraction techniques and automatic question classification in the QAS.

2.1 Question Type Taxonomies

Question type taxonomy refers to the set of categories into which questions have to be classified [1]. In the literature, most of the proposed taxonomies concern factual questions. Their architecture can be flat [2] or hierarchical [3]. The taxonomy of Hovy et al. [4] and that of Li and Roth [5] are the most used ones for factual questions. On the other hand, we find few works proposing taxonomies for opinion questions. We cite in this context the works of Ku et al. [6] which deal with the analysis of questions and the retrieval of answer passages for opinion QAS. The training corpus is gathered from conferences question data and Internet Polls, and includes the authors' own corpus called OPQ corpus (created using the NTCIR-2 and NTCIR-3¹ topic data collected from news article). The proposed taxonomy classifies the questions into factual and opinion questions, and then subdivides the opinion questions into six fine-grained types: Holder, Target, Attitude, Reason, Majority and Yes/No. Besides, we cite the works of Moghaddam and Easter [7] addressing the problem of answering opinion questions about products by using reviewers' opinions. The adopted taxonomy, inspired from the works of Ku et al. [6], has dropped out the type Holder since it is irrelevant in mining product reviews domain. Moreover, the type Majority has been replaced by the question form attribute.

¹ <http://research.nii.ac.jp/ntcir/permission/perm-en.html#ntcir-3-qa>

2.2 Opinion Extraction Techniques

Opinion extraction is an emerging research area in the opinion mining domain. It aims at extracting the main components of a subjective expression such as the opinion holder, the target towards whom or which the opinion is expressed, and the opinion polarity. The used techniques are based on supervised learning [8] and unsupervised learning [9]. In this context, we cite the model of Paroubek et al. [10] proposed for the evaluation of the opinion mining annotations performed in the industrial context of the DOXA project². This model represents opinion expression within eight attributes:

- *Opinion marker*: the linguistic elements which express an opinion.
- *Opinion polarity*: the more or less positive impression felt while reading an opinion expression.
- *Source*: the opinion holder.
- *Target*: the object, issue or person towards which the opinion is expressed.
- *Intensity*: the strength of the expression.
- *Theme/Topic*: reference of the addressed topic in the document containing the opinion expression.
- *Information*: the more or less factual aspect of the opinion expression.
- *Engagement*: the relative implication that the opinion holder is supposed to have to support his opinion expression.

2.3 Question Classification Approaches

In the literature, we distinguish three different approaches for the question classification: rule based approach, machine learning approach and hybrid approach.

- *Rule based approach*: it consists in associating to the question a number of manually defined rules, called hand-crafted rules [11]. This approach is generally based on interrogative words used in questions. The disadvantages of this approach are linked to the overabundance of the rules to define.
- *Machine learning approach*: it consists of extracting a set of features from the questions themselves and using them to build a classifier that allows predicting the adequate type of the question. In effect, works adopting this approach differ according to: *i*) the type of the classifier in use such as Naive Bayes [12], SVM classifiers [13], and decision trees [14], *ii*) the selected classification features that can be symbolic [15], morpho-syntactic using Part-of-speech tags [16], semantic using hypernyms relations of WordNet [17] or statistical [6].
- *Hybrid approach*: it consists in combining the two previous approaches using as learning features manually defined rules [1], [18].

² DOXA is a project supported by the numeric competitiveness center CAP DIGITAL of Ile-de-France region which aims at defining and implementing an OSA semantic model for opinion mining in an industrial context.

3 Proposed Taxonomy for Opinion Question Classification

In order to identify the different question types in a QAS for dialogues, we have built a study corpus of questions. In this section, we start by explaining the construction steps of the study corpus and presenting its specification details. Then, we argue some question specificities in QAS designed for dialogue data. Finally, we describe our proposed taxonomy for the question classification and we provide some discussion notes.

3.1 Building the Study Corpus

We have built the study corpus COPARQ (Corpus of OPinion ARabic Questions) in order to determine the question types that can be asked in the QAS for political debates. The corpus (Table 1) was built after collecting 14 episodes of political debates broadcast on Aljazeera satellite channel. Starting from these manually transcribed episodes, we have prepared 14 questionnaires containing for every episode: the title, the subtitles, the date, the interlocutors and their affiliations. The questionnaires are distributed to 14 volunteers of different profiles (students, teachers, workers, etc.) so that they contribute with questions relative to the discussed topics. The total number of gathered questions is 620.

Table 1. Specifications of the study corpus COPARQ

<i>Corpus specification</i>	<i>Value</i>
Number of episodes	14
Total number of words in episodes	80,151
Number of participants	14
Total number of questions	620
Average number of questions per episode	44.28
Total number of words in gathered questions	7,549
Average number of words per question	12.176

3.2 Question Specificities of QAS for Dialogues

In a QAS for dialogues, question types differ from those in a QAS for texts in many issues.

First, users in QAS for dialogues tend to ask questions especially about the subjective aspect of the utterances. These questions, generally identified through opinion markers (i.e. opinion verbs, adjectives and adverbs), are hard to classify if the subjective aspect of the question is implicit. That's why, using the existing taxonomies (originally designed for QAS for texts) may not provide efficient results in the classification of questions in QAS for dialogues. For example, the question "من المسؤول عن جرائم القناصة إبان الثورة" ("Who is responsible for the snipers' crimes during the revolution?") will be most likely classified as a factual question since it does not contain any explicit subjective information. However, the user asked this question to know the

feedbacks of all the dialogue participants in the question issue. He wanted to say "حسب الضيوف من المسؤول عن جرائم القناصة إبان الثورة؟" (According to the guests, who is responsible for the snipers' crimes during the revolution?), and this is an opinion question. Therefore, a question taxonomy in QAS for dialogues must have flexible type definitions and must be provided with adaptation techniques to support implicit subjective questions.

Second, Yes/No questions are classified according to the existing taxonomies as objective or subjective questions. But in our case, Yes/No questions, which have the form of "Q X according to P?" where Q is a Yes/No question form (i.e. is, do, have), X is a statement and P is a person, can be written into the form of "Does P believes that X?". For example, the question "هل نجحت الحكومة الحالية في قيادة البلاد في المرحلة الانتقالية؟" (Did the current government succeed in leading the country during the transitional period?) can be written into the form of "هل يعتبر الضيوف أن الحكومة الحالية نجحت في قيادة البلاد في المرحلة الانتقالية؟" (Do the guests consider that the current government succeeded in leading the country during the transitional period?). Therefore, we consider that all Yes/No questions, in our QAS for dialogues, are opinion questions.

Third, asked questions in a QAS for dialogues concern the interlocutors' feelings and attitudes as well as their beliefs and arguments (i.e. How does a specific action happen according to a given interlocutor). They may directly query information about what an interlocutor feels or thinks such as the question "ما هو رأي قيس سعيد في تسليم البغدادي المحمودي إلى ليبيا؟" (What does Qais Saiyed think about the extradition of Baghdadi Mahmoudi to Libya?). Also, they may query information about the discussed topic according to the opinion of a given interlocutor such as the question "كيف تم تسليم البغدادي المحمودي إلى ليبيا حسب رأي قيس سعيد؟" (How was Baghdadi Mahmoudi extradited to Libya according to Qais Saiyed?). However, the existing taxonomies do not make distinction between these two types of opinion questions despite the fact that they do not share the same answering strategies.

3.3 Proposed Taxonomy for Opinion Questions

Since the existing taxonomies are not completely convenient for questions in QAS for dialogues, we propose, after a deep study of the corpus, a new question taxonomy within the framework of an Arabic QAS for political debates. This taxonomy, unlike the Ku et al. taxonomy for instance (addressed to news articles which are more structured than dialogues), allows us to solve the issues raised from the specificities of dialogue data by making some reformulations to the questions and setting more precise question type definitions. To define this taxonomy, we are essentially inspired from the model proposed by Paroubek et al. [10], since this model gives a synthetic view of the main opinion mining models (20 models) listed in the literature. It was also successfully used to automatically detect and annotate topics, feelings and opinions in English and French texts.

In order to differentiate between objectivity/subjectivity levels and fine-grained opinion information, we propose a two level hierarchical taxonomy. The first level namely question categories describes high level classes depending on the degree of

the subjective aspect; the second level namely opinion question classes describes opinion question types according to the requested information and the expected answer.

First Level: Question Categories. With reference to the Paroubek et al. model for annotating opinion expressions [10], we propose, at a first stage, three main categories to classify questions within the framework of an Arabic QAS for political debates. The categories are: Thematic, Informational and Opinionated (Table 2).

- *Thematic*: it is the category of questions asking for the discussed topics and the involved interlocutors. These questions can be answered using classic techniques of information extraction (e.g. bag of words, TF-IDF) and they do not require deep semantic analysis. This category contains questions asking whether a given interlocutor has participated in the discussion of a given topic, or asking to report the communication of a given interlocutor in a given topic.
- *Informational*: it is the category of questions in which the factual aspect dominates the subjective aspect. It contains questions asking information about an event, a person, an object or an issue according to a given interlocutor. This information can be named entities or any other type of non factual questions such as reason, manner or definition.
- *Opinionated*: it is the category of questions asking for an opinion expression attribute such as attitude, opinion holder or target. The extraction of these attributes is one of the issues dealt with in the opinion extraction domain [8].

Table 2. Examples for the question categories

Question category	Example
Thematic	هل قال نور الدين البحيري شيئا عن قانون الأحزاب الجديد؟ Did Noureddine Beheiri say anything about the new political parties Act?
Informational	كيف استطاع الرئيس المخلوع مغادرة البلاد حسب رأي محمد الغنوشي؟ According to Mohamed Ghannouchi, How did the ousted president manage to leave the country?
Opinionated	ما هو موقف راشد الغنوشي من السعودية بعد استقبالها الرئيس المخلوع؟ What does Rached Ghannouchi think of Saudi Arabia after it received the ousted president?

Second Level: Opinion Question Classes. Since our QAS is designed for opinion questions, we are interested in the current work in the Opinionated category. In fact, giving the opinion QAS more fine-grained information about the question types will improve its performance more than simply distinguishing between subjective and factual information [19]. That’s why, we have proceeded, at a second stage, with a supplementary level of classification that concerns the category Opinionated. Inspired by the model of Paroubek et al. [10] and the classification of Ku et al. [6], we define seven opinion classes for this category (Table 3).

- Attitude: asks about the attitude of the given holder towards the given target.
- Yes/No: asks whether the given holder has adopted the specified attitude towards the given target.
- Holder: asks about who expressed the specified attitude towards the given target.
- Target: asks about toward whom or what the given holder has the given attitude.
- Reason: asks about the reasons for which the given holder has expressed the specified attitude towards the given target.
- Majority: asks about which of the opinions (listed or not) is the one of the given holder toward the given target.
- Intensity: Asks about how far the given holder has the specified attitude toward the given target.

Table 3. Examples of the opinion classes

<i>Opinion class</i>	<i>Example</i>
Attitude	ماهو موقف سهام بن سدرين من وضعيية حقوق الإنسان في تونس قبل الثورة ؟ What's the attitude of Sihem Bensedrine about human rights situation in Tunisia before the revolution?
Yes/No	هل يظن عصام الشابي أنه بالفعل هناك أيد خفية تعبث بالثورة ؟ Does Issam Chebbi think that there are actually unknown forces trying to sabotage the revolution?
Holder	من من الحاضرين يعتقد أن الثورة التونسية هي بداية ثورة عربية عامة ستمتد لبقية الدول العربية؟ Among those present people, who thinks that the Tunisian revolution is the beginning of a general Arab revolution that will be widespread in the remaining Arab countries?
Target	فيمن تشك سهام بن سدرين أن يكون المسؤول عن جرائم القناصة إبان الثورة ؟ Who does Sihem Ben Sedrine suspect for being responsible of the snipers' crimes during the revolution?
Reason	لماذا يرى منصف المرزوقي أن التمويل الخارجي يهدد مستقبل الديمقراطية في تونس ؟ Why does Moncef Marzougui think that foreign funding can threaten the future of democracy in Tunisia?
Majority	هل يعتبر محمد الأحمرى أن التجربة الديمقراطية الغربية تجربة مثالية نموذجية أم أنها تشكو العديد من النقص رغم ما حققته من إنجازات ؟ Does Muhammad Alahmari consider that the occidental democratic experience is a perfect and typical one, or that it is suffering from a number of flaws in spite of its accomplishments?
Intensity	إلى أي حد يعتبر أمان الله المنصوري أن شباب الثورة في تونس قادر على المشاركة في إدارة البلاد في المرحلة القادمة ؟ How far does Amen-Allah Almansouri believe that the revolution youth in Tunisia are able to take part in running the country during the coming period?

3.4 Discussions about the Proposed Taxonomy

In the context of QAS for text data, most researches on opinion question classification, similarly to sentence classification, addressed the problem of subjectivity classification.

Nevertheless, seeing that the subjective aspect is quite dominant over the factual aspect in the questions of QAS for dialogues, we consider that this problem should be differently addressed in our context. Indeed, factual aspect exists only as minor information parts of the question. Therefore, we have proposed, instead of the factual class, the Informational category to include opinionated question which have a more or less factual aspect. Besides, the category Informational allows discriminating opinion questions asking about beliefs or arguments among those asking about attitudes or feelings. Previous researches [6] [7] omitted this distinction despite the fact that answering strategies to these questions are completely divergent. This was stated especially by Somasundaran et al. [19] who developed an automatic classifier for recognizing sentiment and arguing attitudes.

In the matter of the opinion classes, we note that the class Intensity was not taken into account in the classification of Ku et al. [6]. But, we have noticed after observing our study corpus that users' questions in political debates focus sometimes on the opinion intensity of an interlocutor (5% of opinionated questions in the study corpus). Thus, we have added the class Intensity to our taxonomy.

In addition, Moghaddam et al. [7] considered that questions belonging to the class Majority defined in [6] can be expressed as Target, Reason, Attitude and Yes/No, and therefore it is not an independent class of question. In this way, they did not consider the class Majority and add instead an attribute called question form. This attribute is an additional description defined for every class and it allows distinguishing between the simple form and the comparative form of questions. In accordance with this hypothesis, we enrich our taxonomy with the attribute question form (Table 4). Despite the fact that values of this attribute do not still cover all question forms, we believe that they are sufficient to resolve most of cases we are dealing with.

Table 4. Examples of the two question forms for the class Attitude

<i>Question form</i>	<i>Example</i>
Simple	<p>ما هو رأي الحزب الديمقراطي التقدمي في قانون الأحزاب الجديد ؟</p> <p>What does the Democratic Progressive Party think of the new Political Parties Act?</p>
Comparative	<p>ما هو رأي سهام بن سدرين في أن انتهاكات حقوق الإنسان في حكم بن علي أكثر بكثير منها في حكم بورقيبة ؟</p> <p>What does Sihem Bensedrine think of the assertion that the violation of human rights was far greater during the rule of Ben-Ali than during the rule of Bourguiba?</p>

Nevertheless, we maintain the class Majority because we believe that this class has an independent answer type, conversely to Moghaddam et al. [7]. In fact, Moghaddam et al. consider that, for example, in the question "Why is Canon X better than Samsung Y?", there is confusion between the class Majority and the class Reason. However, we consider that the question belongs only to the class Reason, since it asks about reason and does not list options as recommended by the class majority such as the question "What do you prefer better, Canon X or Samsung Y?". In addition, we

confirm that the illustrated question is of a comparative form, in accordance with the proposition of Moghaddam et al. [7] of using the question form attribute. This attribute would be very useful in the information extraction task.

4 Proposed Approach for the Opinion Question Classification

Our approach of question classification is inspired from the techniques of opinion extraction and it is based on supervised machine learning methods. It consists of two main phases: the extraction of learning features and the automatic question classification. This approach requires different resources and linguistic tools such as a morpho-syntactic tagger, lexical resources and an annotated training corpus.

4.1 Extraction of Classification Features

With reference to the works presented in section 2.2, we have chosen to adopt lexical, morpho-syntactic and statistic features. Extraction of these features is performed in four steps:

1. Extraction of POS tags and verbs tense: extracts POS tags by using an Arabic POS tagger. This step enables also to detect the tense of the verb if the question contains a verbal phrase.
2. Extraction of interrogative words: extracts interrogative words (lexical features) by using exhaustive lists of interrogative words such as "من" (who), interrogative words attached to prepositions such as "لأي" (for what), and imperative verbs used in an interrogation context of as "الذكر" (list).
3. Extraction of opinion markers: extracts question opinion markers (lexical features) by using lists of opinion verbs, nouns, adjectives or adverbs such as "اعتقد" (think), "رأي" (opinion), "إيجابي" (positive) and "أفضل" (better).
4. Extraction of statistic features: extracts statistic features by calculating the number of words in the question. This extraction is performed after removing punctuation and stop words such as "و" (and), "في" (in) and "من" (from). In addition, this step allows calculating the probabilities of unigrams and bigrams such as "أكد" (confirm) "علق" (comment), "حول موضوع" (about the subject of). Unigrams and bigrams are used mainly to identify the Thematic category.

4.2 Training Corpus

Our training corpus (Table 5) is collected from three sources: i) the COPARQ corpus (see section 4.1); ii) extracts from Polls created by some TV channels (Aljazeera, Al-Alam, Russia Today); iii) Selected questions from international conferences corpus (TREC, TAC and CLEF) after their translation to Arabic. The training corpus was annotated by two linguistic experts according to our proposed taxonomy.

To evaluate disagreement degree between the two annotators, we have calculated the kappa coefficient which allows measuring agreement between the annotators. The

Average kappa value obtained is around **0.97** (**0.96** for the question categories annotations and **0.99** for the opinion classes annotations), which allows to judge that our training corpus is quite homogenous.

Table 5. Specifications of the training corpus

<i>Source</i>	<i>Total number of questions</i>	<i>Total size (number of words)</i>	<i>Average question length (number of words)</i>
COPARQ	620	7,531	12.146
Conferences	723	6,000	8.298
Polls	596	5,915	9.942
Total	1,939	19,446	10.028

4.3 Results and Discussions

We have evaluated our classification approach in terms of precision (2) which measures the ability to classify the question into the appropriate category or class. The precision is calculated after applying the 10-fold cross validation evaluation method.

$$\text{Precision} = \frac{\text{Number of well classified questions}}{\text{Total number of questions}} \quad (1)$$

Table 6 illustrates the results of the classification into question categories and into opinion classes according to four algorithms: the three most common learning algorithms Naïve Bayes, decision trees and SVM, and the Zero-R as a baseline algorithm. In particular, SVM provided the best performance with a rate of **87.9%** for the question categories' classification and **91.13%** for the opinion classes' classification.

Table 6. Results of the question classification

<i>Algorithms</i>	<i>Precision of the question categories' classification (%)</i>	<i>Precision of the opinion classes' classification (%)</i>
Rule based	75.65	63.34
Naïve Bayes	81.05	90.67
Decision tree	86.58	90.03
SVM	87.9	91.13

Concerning the opinion classes' classification, the results are good and show that the selected classification features are relevant. Hence, we consider that shallow features that we have used are sufficient to get a good opinion question classification for Arabic. We note that Ku et al. [6] have also used, to classify Chinese opinion questions, shallow features compound of heuristic rules and scores calculated based on unigrams and bigrams. They obtained a nearly similar average performance around of 92.5%. The little difference might be due to the nature of the selected topics. While they used news articles data, we have used political debates data which have much more fuzzy and irregular structure.

Besides, precision obtained for the classification into question categories reached **87.9%** (**87.8%** by Ku et al. using a sentiment lexicon of over 10,000 words). The main difficulty encountered in our classifier is due to the ambiguity in recognizing factual information in the question to discriminate between Informational and Opinionated categories. Indeed, this task, already considered difficult for texts, is more for a question whose content is shorter and therefore contains less lexical information. In addition, the limits of used Arabic linguistic tools reduced the performance of the classifier. For example, the ambiguity due to non-vowel words causes confusion between the preposition "من" (from) and the interrogative word "من" (who).

5 Conclusion and Perspectives

In this paper, we have proposed a new taxonomy for the question classification in an opinion QAS for political debates, inspired by opinion mining and sentiment analysis models. This taxonomy, composed of two classification levels, provides a wider and more comprehensive description of opinion questions. In addition, we have proposed an approach for the automatic classification of opinion questions based on different shallow features. To evaluate the proposed approach, we have developed a classification tool using four different learning algorithms. The results were encouraging and reached an average accuracy of 91.31% for the opinion classes' classification. These results show that the shallow features are sufficient enough to build a satisfactorily accurate classifier for opinion question.

As perspectives, we intend to evaluate our question classification tool within each training corpus source separately. The aim is to compare the obtained results per corpus source dataset in order to evaluate the affect of the question topic domain on the classification performance. Moreover, we intend to build a sentiment lexicon to collect opinion markers and to assign degrees of subjectivity to them. The lexicon will allow us to solve the problem of detecting the subjective nature of the questions and subsequently to improve the results obtained in the question category classification. In addition, it can be used to define polarity and calculate its intensity in the information extraction of our opinion QAS.

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