

An ontology driven question answering system for fatawa retrieval

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ABSTRACT

This work aims to propose a system for the Algerian *Fatawa* House in order to facilitate the task of the Expert Mufti who is responsible of giving *fatawa* for Algerian people inquiries. In fact, as this house is recent and does not have sufficient human resources, it is difficult to satisfy all inquiries coming daily; this leads the askers to wait for a long time before getting answers. The proposed system allows the askers to express concerns they may have. By using a case-based reasoning mechanism combined with ontology domain, the system tries to retrieve similar cases from the knowledge base. In the case where the response already exists, the system immediately provides the answer to the askers. Otherwise, an inquiry is automatically formulated and sent to the expert Mufti-which is a certified scholar-in order either to validate the generated response by the system or give a new answer. Such a question-answering system may be very helpful for askers to get their answers faster since it allows both the storage of previous *fatawas* and their retrieval for processing coming inquiries. To validate our proposal, we rely on *fatawas* concerning the Islamic finance and banking transactions domain. Overall, the results are encouraging and satisfactory.

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1. INTRODUCTION

In 2017, the Algerian government restore "the *Fatawa* house" after a long time of inactivity since the independence in 1962. This house is an official organization that provides *Fatawa* (answers) for requests of the Algerian people. In Islamic legislation, a *Fatwa* (singular of *fatawa* or *fatawas*) consists in a declaration of a legal opinion that complies with Islamic precepts. A *Fatwa* is a legal statement in Islam, generated by a Mufti or a religious lawyer, on a specific issue. *Fatawas* are asked by judges or individuals in cases where an issue of *Fiqh* is undecided or uncertain. Lawsuits can be settled on the basis of a *fatwa* [1].

According to "Algerian *Fatwa* house", there is still a lack of an automated system for storing and retrieving answered *fatawa*. Indeed, every day, the house receives a large number of questions through different methods (e.g., phone, fax and web site), some of which have already been asked before. In fact, as the house does not include sufficient human resources, it is very difficult to satisfy all these *fatawa* requests in particular since its activity only started three years ago. Thus, the task of the Expert Mufti becomes very

difficult given that he is the only responsible of giving answers (*fatawa*) to all the questions received, especially that he manages other tasks (e.g., teaching at the university, and religious duties).

Starting from that context, we propose an efficient automatic question-answering system to process *Fatawa* requests through answers and arguments from Quran, Sunnah and Ijtihad. The idea consists in building an intelligent case-based system that can store previous *fatawa* and retrieve them as needed. The need for submitting requests can be optimized since similar requests are already processed by recording their answers in the knowledge base. In this way, the Expert Scholars will only focus on the new issues. This makes the organization handle more and more users without human intervention while increasing the ability to answer inquiries. Certainly, this helps both asker and the Expert Mufti in saving effort and time while processing inquiries.

For this purpose, the case-based reasoning (CBR) paradigm is involved. It is considered as one of the most popular approaches for developing knowledge-based systems due to its ability to retrieve and reuse solutions that have worked for similar situations in the past. This principle is similar to the way the human solves problems [2]. CBR often uses similarity measurements to identify the cases that are more relevant to the considered problem[3]. In fact, although there were some attempts to involve the CBR paradigm to deal with *Fatawa* issues [4], [5], these approaches are, however, based on syntax-based measurements. Indeed, syntax-based measurements have proven – in many cases – unsuccessful due to semantic issues that may occur. To overcome this limitation, we propose to build a domain ontology of a given domain to support the semantic similarity measurement. Measuring a distance between concepts is an essential process. Most methods used for measuring, they usually do not [6] take semantic for consideration [6].

In order to validate our proposal, we have implemented and tested a prototype to deal with *fatawa* in Islamic finance and banking transactions domain. Globally, the obtained results are promising and encouraging and thus show the effectiveness of the proposal.

The rest of this paper is structured as follows, section 2 provides some basic concepts around question-answering systems, CBR paradigm and ontologies. Section 3 gives details about the proposed architecture of the system. Section 4 summarizes and discusses some illustrative examples and scenarios. Finally, section 5 provides some conclusions and final remarks.

2. BASIC CONCEPTS

2.1. Question answering system

Question-answering (QA) systems in information retrieval are tasks that automatically answer the questions asked by humans in natural language using either a pre-structured database or a collection of natural language documents [7], [8]. In order to better understand what QA systems are, the associated terminology is firstly provided, namely *Question Phrase*, *Question Type*, *Answer Type* and *Question Focus*. The term *Question Phrase* is the part of the question that specifies what exactly is sought. The term *Question Type* refers to a categorization of the question regarding its purpose. The term *Answer Type* refers to a class of objects that the question is looking for. Finally, the term *Question Focus* is the property or entity being searched by the question [9].

2.2. Islamic finance and banking

In last few decades, Islamic finance and banking (IFB) has grown exponentially and it is now regarded as one of the most important trends in the global financial industry. Indeed, that kind of financial transactions attracts not only Islamic communities, but also many people over all the world for many reasons, among others: i) making sound economic investment, ii) exchanging products, iii) satisfying people living in non-Muslim Countries. In IFB, financial and banking institutions do not make usury and interest-based transactions with their customers but rather to transactions that lead to benefits by taking into account the risk to result in some financial losses [10]. In fact, the compliance of IFB regulations may vary from one bank to another. This usually leads customers to ask some specific councils (e.g., Algerian *Fatawa* House) about the conformity of their products and services with IFB principles.

2.3. Case based reasoning

Case based reasoning (CBR) is an artificial intelligence paradigm that solves new problems by retrieving stored records of prior problem-solving episodes (cases) and adapting their solutions to fit new circumstances. Processing each episode provides a new case that is stored for future reuse, making learning a natural side-effect of the reasoning process [11]. The CBR can be very advantageous for a decision maker which knows a large number of cases and is able to index them so that the most relevant ones come to mind when needed [4].

2.4. Ontology

Ontologies play an important role for many knowledge-intensive applications [12]. They provide a number of useful features for intelligent systems, as well as for knowledge representation in general and for knowledge engineering processes [13]. Currently, ontologies are used to make information explicit and sharable. In addition, to further improve data and information management, one would create an ontology-based application that processes all knowledge related to a given topic. Such a process would involve knowledge modeling through an ontology [14].

3. RELATED WORKS

The literature review on studies involving assistance to *Fatawa* generation systems showed us that there is only a very small number of research-works. The authors [5] have proposed an intelligent *Fatawa* Question Answering system using SOPHIA-textual case-based reasoning (TCBR) which was firstly used in Patterson's work [15]. This is a subfield of case-based reasoning (CBR) in which knowledge sources (expertise) are available in textual format. It is based on the conditional probability distributions of terms within documents. The limitation of this system lies in the fact that SOPHIA-TCBR is not endowed with a mechanism to identify words' order, negation and synonyms and thus it lacks of objectiveness since these elements play a key role in interpretation of questions.

The authors [4] have designed an intelligent tool-called El Bayane-to give *Fatawa* for new situations, by using the *Fatawa* of past situations. The system deals with *fatawa* related to the field of drinking and smoking in Islamic legislation. It is also built around the CBR paradigm where the knowledge is organized into cases stored in a case-base. Then, an inference process is performed in order to find and reuse the appropriate *Fatwa* and its argumentation. Even so, this system retrieves only similar cases based on syntactic analysis and thus it does not consider the semantic aspect.

The aim targeted by this paper is twofold:

- processing *Fatawa* in IFB field to assist the Expert Mufti in his task and
- using a new semantic similarity assessment mechanism based on a domain ontology for IFB.

Thus, we develop an automatic QA system to deal with *Fatawa* requests by means of an intelligent case-based system that can store previous *fatawa* and retrieve them as needed. For this purpose, the case-based reasoning (CBR) paradigm is involved by using similarity measurements to identify the cases that are more relevant. And as syntax-based measurements have proven – in many cases – unsuccessful because of semantic issues, we build an ontology to support the semantic similarity measurement. It should be noted that our proposal is different from *fatawa* web sites for which users can either ask questions and wait for getting answers or search manually for *fatwa* from booklet through keywords.

4. SYSTEM COMPONENTS

4.1. *Fatawa* question answering system architecture

Islamic *Fatwa* is what the Islamic rules judge about an issue. When generating a *fatwa*, Muftis must have the document of prior *fatawa* and all updates given by expert scholars. This document keeps hundreds of millions of such Islamic *Fatwa*, searching the right *fatwa* may takes days. On the other hand, when, Imam (Mufti Novice) haven't the document of *fatwa*. Then, they could wrongly try to give *fatwa*. In principle, the *fatwa* must be given by Jurisprecedent (expert scholars). These reasons motivate us to create a knowledge-based system for assisting Mufti.

The architecture of the system shown in Figure 1 includes three components (case memory, Islamic finance domain ontology, system interfaces) and five modules (indexing module, extracting module, adaptation module, validation module and storage module). The system takes the description of the situation as input and provides an answer with arguments as output.

The proposed system is intended for both expert and novice (learner) Muftis. It saves *fatawa* in a case-base memory (i.e., all prior *Fatawa*) for further reuse. The expert Mufti can add, update or delete *fatawa* via a specific interface. In addition, both expert and learner Mufti can retrieve *fatawa* by interrogating the system via another interface that allows running queries on the specific fields. The system analyzes queries syntactically and semantically. The first version of this approach was proposed on [16].

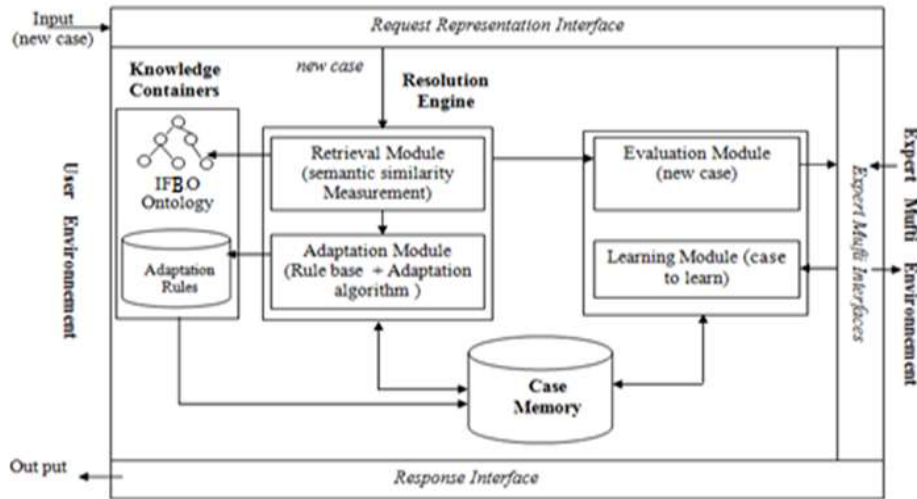


Figure 1. Fatawa system architecture

4.2. Domain ontology

The ontology reuse is highly recommended as it helps researchers and developers to save time, efforts and costs [17]. In the context of IFB field, very few ontologies already exist; the most relevant are: Semantic-based Multilingual Islamic Finance Thesaurus [18] and I-FIKR Ontology. The former was used earlier (i.e., in past time) in the MIMOS web site: <http://www.mimos.my/IFT#> and it is currently not available for reuse. The latter is not available as an open data since it is still under construction and therefore not ready for reuse. Accordingly, we built the Islamic Finance and Banking Ontology (IFBO) (see Figure 2), a domain reference ontology for IFB, by following the design process specified by Neon methodology [19]. This ontology provides a consensual sense for each word which helps in retrieving and learning from existing cases in order to endow the base with new cases. It is created for free reuse by making it available to users under the following link:

https://www.researchgate.net/publication/323454895_IFBO_Islamic_Finance_and_Banking_Ontology For more details about IFBO ontology as well as the development process, the reader should refer to [20].

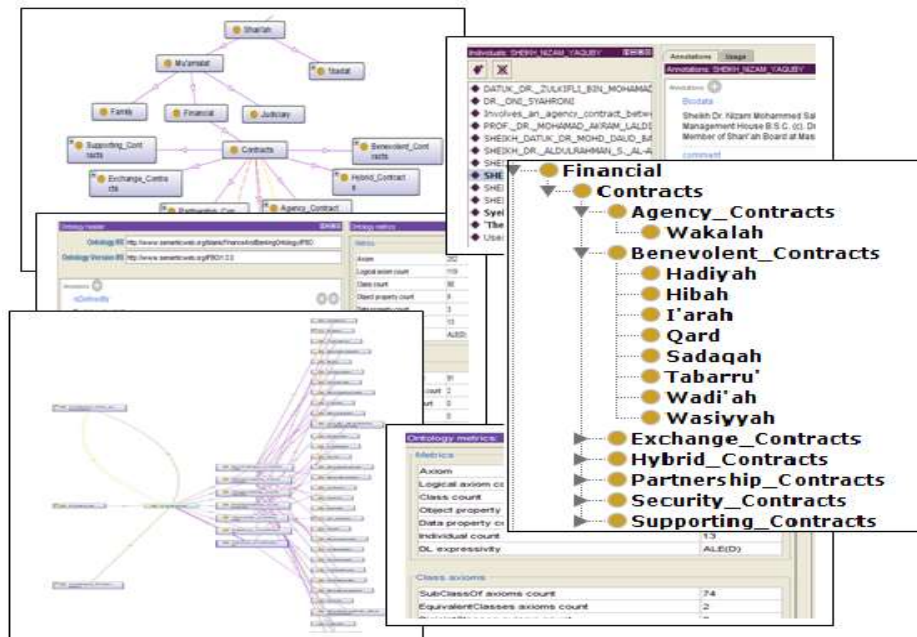


Figure 2. IFBO ontology

4.3. Case description

A case is a contextualized piece of knowledge representing an experience. It contains the past lesson outlining the context of the case and the context in which the lesson can be used. A case can be an account of an event, a story, or a record typically comprising [21]. Regarding our QA system, the case contains two parts as shown in Figure 3.

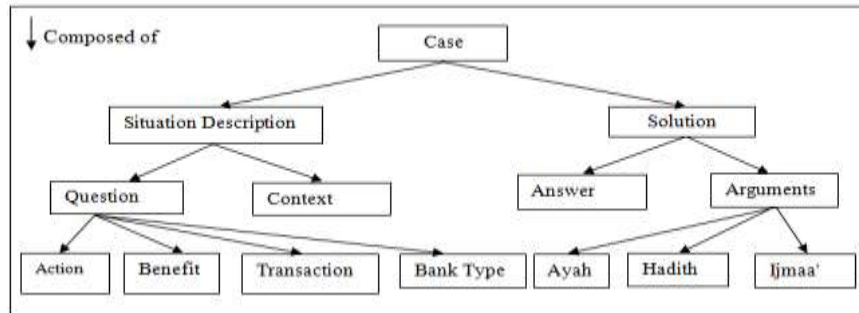


Figure 3. Case description

The problem description part (the query) that contains:

- Action: <Buy, Sale, Offer, Rent, Loan,>.
- Benefit Name: <Car, Apartment, Home, ...>.
- Contract: <Murabahah, Mudarabah, Leasing, Istisna'...>.
- Bank Type: < Conventional, Islamic, Window in conventional,>.

The solution description part (the answer).

4.4. Case base

Case-base is used to store previous and new learned cases. As reported in [22], there are several methods for memory organization:

- The flat organization (a flat memory): cases are sequentially stored one after the other in a simple list, an array, or a file.
- Shared feature Network: this regroups cases presenting similarities in one cluster. Hierarchies are formed when clusters are subdivided into under-clusters. The methods used in regrouping clustering are the ones used in machine learning.
- Discrimination Networks: the regrouping clustering made in shared feature networks leads to a discrimination. In this organization networks, every internal node is a question that discriminates according to the answer cases contained in the base. The most important questions are put in first.

In our QA system, cases are stored in a flat case memory given that the current number of cases leads to better performances.

4.5. Inference cycle

Reasoning modules are the operational part of the system: retrieval module, adaptation module, evaluation and learning module.

4.5.1. Retrieval module

When, a new problem (query) is posed and is described as the problem part of a new case. The semantic similarity measurement is computed between new case problem descriptors and old cases problem descriptors to identify the most similar cases to the new problem from the case memory (case base). The semantic similarity measurement assumed by the Application Ontology built before. It was integrated to the CBR cycle for improving their results of cases retrieval because the syntactic measurement often give fail. For example:

Problem description = <Action', benefit', transaction', Bank Type'>.

In this case, syntactic measurement give fail. Thus, the system should be able to select the case or set of cases with greater similarity to reuse the solution after possible adaptation. That is why, the application ontology is

needed to asses similarity between the case problem descriptors. The proposed approach is detailed in [16] and summarized as follow:

- Syntactic measurement:

```
if ∃problem description=<action, benefit, transaction, Bank Type>
    then < Solution>
else <Fail>;
```

- Semantic measurement:

```
if ∃problem description=<Action', benefit', transaction', Bank Type> And
    {
        Sim(Action, Action')=1;
        Sim(benefit, benefit')=1;
        Sim(transaction, transaction')=1;
        Sim (Bank Type, Bank Type')=1
    }
    then< Solu
else <fail>;
```

- Similarity attributes:

$$Sim(D,D') = \begin{cases} 1 & \text{if } (D \text{ same as } D') \text{ or } (D \text{ equivalent to } D'); \\ & // D \text{ value of the new problem case} \\ & // D' \text{ value of retrieved problem case.} \\ 0 & \text{otherwise;} \end{cases}$$

4.5.2. Average semantic measurement:

The Average Similarity measurement (A-Sim) between new case problem descriptors (NDP) and old cases problem descriptors (ODP), in the proposed system, is given by:

$$A-Sim (NPD, OPD) = \sum_{j=1}^n \frac{Sim(D,D')}{n};$$

where

- j refers to a problem descriptors attribute.
- n refers to a number of descriptors attribute.

4.5.3. Adaptation module

The result of retrieving module is a set of cases with greater similarity. Then, the adaptation module reuses the solution of old cases retrieved after possible adaptation. This adaptation uses a set of base rules, the application ontology, and is performed by the adaptation Algorithm.

- Rule Base

The rule base contains 4 principals’ rules as shown in table as shown in (Table 1).

Table 1. Rule base (excerpt)

Rul	Descriptions	Conditions	Examples
Rul D inverse of D'		D,D' instances of Acti	(Sale, Bay)
Rul D sub class direct		D' = Halal Benefit / D'= Haram Benefit/ D'= Contracts	(Reality, Halal Benefit)/ (Alcohol, Haram Benefit)/ (Musharakah,Contracts)
Rul D sub class indirect of		D' = Halal Benefit / D'= Haram Benefit/ D'= Contracts	(Commercial Reality, Halal Benef (Gelatine, Haram Benefit)/ (Bay' Bi Thaman 'Ajil, Contracts)
Rul D instance of D'		-	(Terrain, Halal Benefit)
Rul Sim (D,D')=1		-	(Car, Automobile)

- Adaptation algorithm

The adaptation Algorithm is the core of adaptation module, it consists of set of cases to be executed in dependent with the problem descriptors and based on the application ontology.

```

begin
  if [case retrieved] then
    < Extracted Answer>
  else
    case 1: D inverse of D' do D=D';
    case 2: D sub class direct of D' do D=D';
    case 3: D sub class indirect of D' do D=D';
    case 4: D instance of D' do D=D';
    case 5: Sim(D,D')=1 do D=D';
    .....
    .....
    otherwise: <send the query to expert Mufti>;
  end;

```

For example:

- User asked the question: what is the ruling on buying a truck by Murabaha through an Islamic bank?
- New problem description = <Buy, Truck, Murabaha, Islamic Bank>;
- Three Hypotheses may suggest, as follow:

Hypothesis one: suppose that exists,

Old problem description = < Buy, Truck, Murabahah, Islamic Bank>;

Then by semantic measurement: Murabaha is equivalent to Murabahah,

```

Sim(Buy,Buy)=1;
Sim(Truck,Truck)=1;
Sim(Murabaha, Murabahah)=1;
Sim(Islamic Bank,Islamic Bank)=1;
A-Sim= (1+1+1+1)/4=1
New problem description=<Buy, Truck, Murabahah, Islamic Bank>;
then <Extract the exact Answer>;

```

Hypothesis two: suppose that, after computing semantic similarity measurement between the both descriptors, the average similarity is between 0 and 1, ($0 < A-Sim < 1$). In this situation, the adaptation module search in the rule base for the appropriate rule.

From the ontology:

```

Buy is inverse of Sale, then Rule 1, executed ;
Truck is instance of Halal benefit, then Rule 4, executed ;
Murabahah is sub class direct of Contracts, then Rule 2, executed ;
Sim(Islamic Bank, Islamic Bank)=1, then Rule 5, executed;
New problem description= <Sale, Truck, Murabahah, Islamic Bank>;
then <A-Sim Recalculated>;
If A-Sim =1 then
<Extract Answer>;
<New case learned>;
else
<Extract set of similar cases>; // will show as similar cases
<Send the query with a set of similar cases to be evaluated>; // by
the expert Mufti

```

Hypothesis three: suppose that, after computing semantic similarity measurement no likeness between the both descriptors; all dimensions give zero ($A-Sim=0$); In this situation, the adaptation module send this query to expert Mufti. For giving new answers (manual learning). And, show to the user a message: "Sorry there is no answer for your query, your request was sent to the expert Mufti. Please, try again after few days".

4.5.4. Learning and evaluation module

The Expert-Mufti enriches the case base and the application ontology when required. The Expert-Mufti has a specific interface to add, modify and deleting cases. His role is to evaluate the proposed answers for cases having between (0 and 1). He may validate them or generate new ones to make the system learn. The automatic learn is realized only when the Average Similarity ($A-Sim= 1$).

5. RESULTS: ILLUSTRATIVE EXAMPLE

To validate this work, we have implemented a prototype of the proposed QA system. It consists in a multilanguage application developed using the Java language. In what follows, screenshots are illustrated in both English and Arabic languages. Three users' classes are considered: simple user (سائل) (is simple user a novice or learner Imam), expert Mufti (خبير) and administrator (مدير); Figure 4 shows the main panel.



Figure 4. The main menu

It should be noted that the current version of the prototype does not allow users to interact with the system through questions formulated in natural languages. This lies to the fact that the use of natural languages may pose several problems related to natural language processing (NLP). Consequently, we have limited ourselves by imposing some restrictions on the way the questions are formulated since the main objective here is only to check the effectiveness of the approach.

- User space, the user space allows simple users to formulate their questions by specifying (see Figure 5):
 - a) The kind of question which can be: (What is the judgment? What is the punishment?): (ما حكم؟ ما حد؟)
 - b) The action (Buy, Rent, Sell, Mortgage): (شراء, كراء, بيع, رهن).
 - c) The benefit (Commercial location, House, Car): (محل, منزل, سيارة).
 - d) The type of contract (Murabaha, Musharakah, Mudharabah): (مزابحة, مضاربة, مشاركة).
 - e) The type of bank (conventional, Islamic): (تقليدي, إسلامي).



Figure 5. Question form

Once the question is formulated, the user asks for the answer by clicking on the button (Analyze: (حلل)). The result is shown in Figure 6.



Figure 6. Response form

The system allows the simple user to take a look at the similar cases (Similar cases: (الحالات المتشابهة)), as depicted in Figure 7.



Figure 7. Similar cases form

– Administrator space

The administrator is responsible for setting-up and managing the case base before starting to use the QA system. At any time, he can browse the case base (see Figure 8).

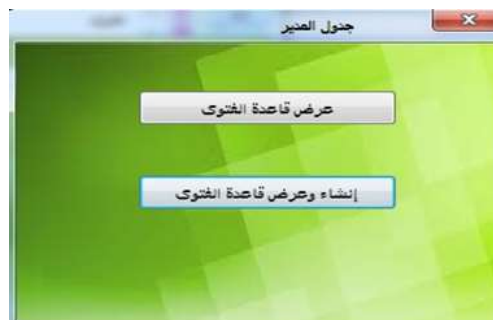


Figure 8. Administrator main menu

– Expert Mufti space

The expert Mufti ensure three roles: add new questions to enrich the list of all questions, introduce answers to previously asked questions and finally modify a response in the case base, as given on Figure 9. Depending on the selected option, the system displays the corresponding screen as shown in Figures 10 and 11.



Figure 9. Expert mufti main menu

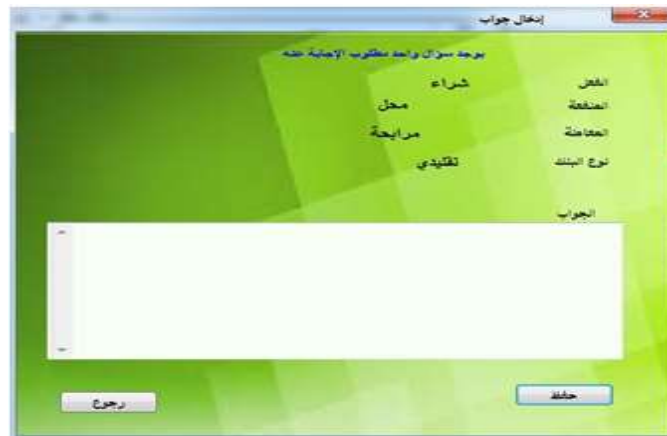


Figure 10. Introducing responses



Figure 11. Adjusting response

6. ASSESSMENT OF THE WORK

Finally, we theoretically assess and compare our contribution with other related works, as given on Table 2.

Table 2. Comparative table of some existing approaches with our method

Authors	Systems Proposed	Aims	Domains	Paradigm Used	Semantic Analyze
Nouaouria et al. [23]	El Bayane	Answering new questions based on pre-answered ones	Limited to Islamic legislation on drinking	CBR	No
Amari et al. [4]	Intelligent tool for Mufti Assistance	Answering new questions based on pre-answered ones	Limited to Islamic legislation on drinking	CBR	No
Elhalwany et al. [5]	Using Textual Case-based Reasoning in Intelligent <i>Fatwa</i> QA System	Answering new questions based on pre-answered ones	Open Domain	TCBR	No
Elhalwany et al. [24]	Enhancements to knowledge discovery framework of SOPHIA Textual Case-based Reasoning	Answering new questions based on pre-answered ones	Open Domain	TCBR	No
Salisu et Hassan [25]	Theoretical study no systems proposed	Review on Shariah Regulatory framework of Islamic financial Institutions	Islamic Finance and Banking	None	No
Our proposal	QA System Fatawa retrieval	Answering new questions based on pre-answered ones With semantic controle	Islamic Finance and Banking	CBR	Yes

6.1. The advantages

- Using of Case based reasoning paradigm wich is similar to human remembrance and reuse of old solutions.
- The key element of this work is the used of a domain ontology, which permits the semantic mesearments.
- Assist Imam in the process of retrieving and generating *fatawa*.

6.2. The limitations

- This system is limited to Islamic finance and banking domain.
- The use of frames form for asking a question, however in generally, questions about fatawa are asked in the form of stories not frames.

7. CONCLUSION AND FUTURE WORK

The main objective of this paper was to propose a question answering system for giving *fatawa* in Islamic Finance and banking for the Algerian *fatawa* house to help expert Mufti in his task of generating *fatwa*. The proposed system is built around a combination of the case-based reasoning paradigm and ontology-based computing. In particular, it uses semantic similarity measurements upon the Islamic Finance and Banking domain Ontology (IFBO). This ontology is in fact a key-element since it provides a domain vocabulary and allows the determination of degree of likeness between two classes or objects. The QA system has a case base memory that stores both prior *fatawa* and the new ones. Each case in the memory is represented by two parts: description and solution of the problem. To validate our proposal, a prototype was implemented and tested. Overall, the results are encouraging and satisfactory.

Our orientation in the future will be in three areas: to extend the application domain, to diversify sources of knowledge concerning questions presentation and jurisprudences conclusions; and to enlarge the scope of the tool *via* the web media.

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