Creation of Arabic Ontology for Hadith Science

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ABSTRACT

In the context of knowledge representation and sharing, the term ontology is used to mean a specification of conceptualization. An ontology of domain is a description of the concepts and relationships that can exist between them. This work is interested in the knowledge representation. It aims to create an Arabic ontology using a method which consists of two steps: the creation of the ontology's core and then its expansion using real questions and answers about Hadith science. The main objective of this paper is to build and implement an ontology for all concepts and main knowledge of Hadith Science. The collection of all necessary information is based on discussion with experts in the domain and from the famous books. The kernel of the ontology is created with Protégé. The result is an OWL/XML document. To develop the application of information extracting, we used java programming language and SqwrlAPI to ensure the scalability, interoperability and the reusability of resources and developed contents. All extracted information will be later used in several applications like Hadith graduation, judgment on the validity of Hadith, classification, etc.

Key words : Extraction, Hadith Science, Isnad, Knowledge, Narrators, Ontology, OWL.

1. INTRODUCTION

The term "Ontology" was introduced in its Latin form in the seventeenth century by Goclenius (Rudolph Gockel, in philosophical Lexicon, 1613-1615) to refer to the science of being in general. it therefore corresponds to this research on being as a being (we inherited in ancient Greek) that Aristotle had assigned, among other proper objects, to the "first philosophy", subsequently called "metaphysics" [1].

The diffusion of the term is due to the Ontology of Christian Wolff [1], which, in the school concept of metaphysics, considers ontology as "general metaphysics", since it dealt with being in general, and distinguished it from the three special metaphysical sciences (metaphysical specialist) that are rational psychology (the being of the intellective soul), rational cosmology (the being of the world) and rational theology (the being of God), each dealing with a specific region of being.

The supreme principles of ontology are the principle of non-contradiction and the Leibnizian principle of sufficient reason. The internal determinations of being are its essential attributes. For the rest, ontology studies a series of conceptual couples, such as quantity and quality, necessity and contingency, simplicity and composition, finitude and infinity, identity and diversity, cause and effect, and so on. In analytic philosophy, ontology has been closely related to the logic and philosophy of language.

Ontology is therefore determined by the semantics of its language and coincides, in fact, with the general aspects of this semantics. A significant current of analytic philosophy continues the construction of a formal ontology, that is to say a theory formal modes of being. The construction of such a theory coincides with the definition of a semantics for a logical language, in which can find place the types of entities that the theory admits.

In artificial intelligence field, it seems that ontology was approached for the first time by John McCarthy who recognized the overlap between the work done in philosophical ontology and the activity of building logical theories of artificial intelligence systems. McCarthy already asserted in 1980 that intelligent systems designers based on logic must first "list everything that exists by building an ontology of our world". The meaning of the term has evolved,

and while the fields of knowledge engineering, conceptual modeling, and modeling of the domain began to converge, the meaning of the term has done the same.

Artificial Intelligence research on ontology have started indirectly in the 1970s, when researchers interested in expert systems turned their attention to the possibilities of standardizing the representation of knowledge. At that time, the idea that the power of information processing was based as much on an explicit representation of knowledge as on a sophisticated mechanism of inference was beginning to make its way.

The 1980s saw the development of expert systems, then knowledge-based systems performing a variety of tasks (eg planning, diagnosis, design, maintenance), in diverse fields (eg medicine, robotics , mechanical engineering, finance). Experience quickly shows that building a knowledge base is a complex process that takes a considerable amount of time. The wish of the researchers is therefore to be able to reuse and share knowledge or at least parts of its knowledge base. Ontology is therefore an emerging paradigm of knowledge representation.

knowledge representation refers to the general subject of "How can information be appropriately encoded and used in computational models of cognition? ". It is a broad field related to logic, computer science, cognitive psychology, linguistics, and other areas of cognitive science.

Formal ontology are specifications of the conceptualization of a field of knowledge using formal semantics, and are exploitable by computer programs to assist the sharing of this knowledge through different applications. In the domain of hadith science and Hadith mustalah, several applications can use the same knowledge. The objective of this work is to apply ontology of domains to ensure a formal representation of the knowledge satisfying the interoperability, reusability and scalability. The rest of this paper will be organized as follows: In the first section, we conduct a literature survey for Arabic ontology. The second section introduces the main concepts of the ontology and the process of its construction. In the third section, we conduct a depth study about mustalah alhadith : we determine all concepts of mustalah alhadith and the relationships between them. After that, we discuss the construction of the Arabic ontology for Hadith science and the implementation of an open source and free prototype that allows whom it may concern to search any information about Hadith and narrators.

2. RELATED WORKS

An ontology is a shared and consensual representation between collaborators that aims to agree on a particular topic with a common objective. The goal is to define a set of knowledge in a given field. It explains a vocabulary by defining the terms necessary to share knowledge related to this field.

There are several types of ontologies and its applications are diverse in the world of development. In computer science, an ontology is a structured set of concepts that make sense for information. Its primary objective is to model a set of knowledge in a given field; in addition, computer ontologies are tools that make possible to represent a corpus of knowledge in a form that can be used by a computer. Ontologies are used in Artificial Intelligence, Semantic Web, Software Engineering, Biomedical Informatics and Information Architecture as a form of representation of knowledge about a world or a certain part of this world.

Comparing it with several natural languages like English, Frensh,…the ontologies in Arabic language especially for Islamic studies are almost non-existent, we can quote some works still in grass in the laboratories that are counted on the fingers of the hand. Yet Arabic is a language spoken by more than 300 million people in more than 22 countries.

The development of Arabic ontologies followed 4 phases.
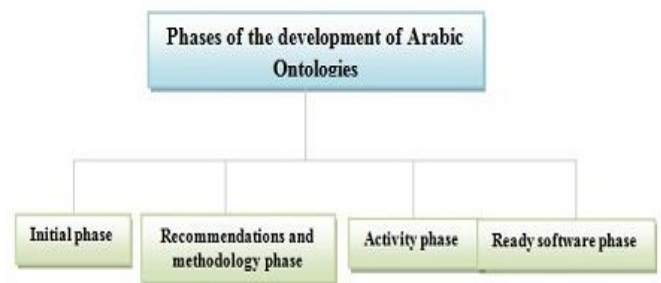
Figure 1: Phases of the development of Arabic Ontologies.

- Initial phase: Appeared in the seventies starting with the comprehensive ontology of terms in the field of economic and social development.

- Recommendations and methodology phase: In the first half of the 1980s, the methodological foundations for the preparation of ontology appeared. This phase is characterized by the creation of some ontologies like the ontology of library and information science.

- Activity phase: The second half of the eighties and the first half of the nineties began producing mass ontologies after the stability of the concept of the use of ontologies in the process of objective and deep analysis and information retrieval.

- Ready software phase for the preparation of Arabic ontologies: This phase was characterized by taking advantage of the potential of the computer in the completion of most of the construction and development of ontology to save time and reduces human effort and ensures accuracy and efficiency in the creation of ontologies.

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Among the most known ontologies, we can cite WordNet [5]. It is a lexical resource for natural language that groups terms (nouns, verbs, adjectives, and adverbs) into sets of synonyms called synsets. A synset includes all terms denoting a given concept. Synsets are interconnected by semantic relations: generalization/specialization relation, component/compound relation. There are many ontologies that have been built on the basis of WordNet.

Amine AWN [6] is a lexical resource of the Arabic language available for free. It is based on the design and content of Princeton WordNet and can be linked to other WN for others languages, which allows translation from and to dozens of languages.
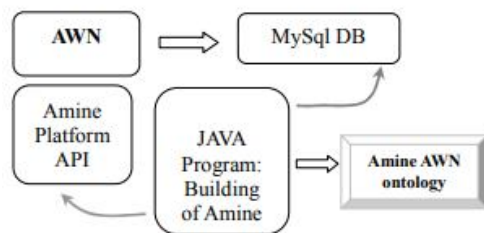
Figure 2: Amine AWN ontology construction.

The first known Arabic ontologies are :

- Endowment science ontology (aqfuna.com).
- Childhood ontology (arabccd.org/meknaz)
- Women's ontology (vocabularyserver.com).

Also, there are ontologies serving the Arabic natural language processing translation systems, information systems, intelligent integration of information, knowledge management and information retrieval. The integration of ontologies in the Arabic information retrieval system is mainly related to the manipulation of knowledge shared by ontologies in order to endow these systems with a little semantics and thus reduce the divergence between the need of the user and the system responses. Once the ontology is chosen, the knowledge that represents can be used at different levels in the information retrieval process. It can help indexing documents also called indexing system. Ontologies can also help to formulate the need of the user and to access to documents. Finally ontology can be used in the model itself to achieve the matching between the need and the documentary granules [7]-[11].

In islamic studies domains, Baqai et al. in [12] and Ul Ain and Basharat in [13]implement a Quranic ontology used English Hadith. In this context, Atwell et al. in [14] mentioned the importance of hadith to understand Quran.

Also they showed the crucial Quran-hadith linkage to construct a Quranic ontology. Javed et al. [14] conceived a based system ontology of annotation of islamic dynamic contents using an ontology.

In this field, some researchers adopted automatic approaches to extract knowledge from religion texts especially Quran and hadith , but the most researchers proposed to manually build ontologies and use them for hadith semantic annotation, information retrieval and classification. For example, Ghanem et al. in [15] created an ontology for Hadith. The concepts of this ontology was extracted from traditional Hadith books. The kernel of this ontology was created manually with Protege 2000. Then the authors used this ontology to manually annotate Hadith with the GATE platform [14]. In reference [16]-[19], the authors use methods for specific tasks like the visualization of Isnad tree using an ontology of Hadith narrators, creation of ontology for Quran,

In all these works we did not find a complete ontology gathering all the concepts of science of Hadith to use it in our future works concerning the search for information in religious documents (Quran and Hadith) or the automatic verification of the conditions of Hadith validation. For that, we decided to create a new ontology for all the science of Hadith. In the next section, we will describe the main concepts of the ontology, the approach followed for its development and the criteria allow to highlight important aspects of an ontology.

3. MAIN HADITH SCIENCE KNOWLEDGE

Hadith Science is defined as the learning of basic rules and principles that make possible to reach the knowledge of the reporter (ar-râwî) and what is reported (al-marwî). It is a science based on rules that permit to know everything about the chain of transmission (Sanad or isnad) and the content that is conveyed by this chain (matn).

In the vocabulary of Hadith scholars, the term "Hadith" refers to the words, deeds, habits, behavior and approvals that are reported from the Prophet Muhammad (pbuh). Each Hadith is composed of two distinct elements: "Sanad" (or "Isnâd") and "Matn".

The "Sanad" or "Isnâd": These two terms, often used as synonyms, designate the Hadith transmission chain. This is the list of all those who reported the Prophetic Tradition statement from Prophet Muhammad (pbuh) to the author who recorded it in his book (Hadith scholar). Figure 3 shows the structure of Isnad.
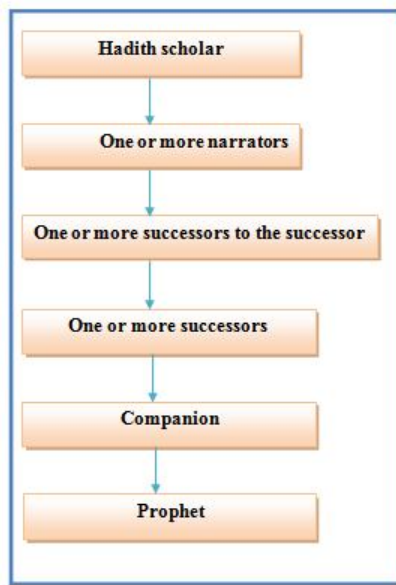
Figure 3: Components of Hadith Isnad

Matn: This term refers to the content of the Hadith proper, ie the statement of the terms that are related to the Prophet Muhammad (peace be upon him) or related to his person.

The Hadith can be called "khabar" (news) but "khabar" is naturally divided into two categories: Hadith and "athar": what is reported concerning the Companions of the Prophet (pbuh) and successors.

Nuances in the definition of khabar and athar exist according to the authors but the words of the Prophet (pbuh) are unanimously called hadith. The Prophet (peace be upon him) is certainly the one who is at the origin of the Hadiths. But the set of Hadith is not - as is the Quran - grouped into one book. It happened in the time preceding the systematic recording and criticism of the Hadîths that a Muslim voluntarily, for lack of piety and morality or otherwise, invented a purpose and attributed it to the Prophet. Other times it has happened that a Muslim with a weak memory has mistakenly repeated a Hadith he had heard correctly. On the other hand, it is necessary to be very careful in attributing to the Prophet a saying: are the conditions required to be attributed to him? Did not someone invent it? Would not someone have misunderstood what had been said to him? That is why it is necessary to verify that we can attribute to the Prophet. The Hadith scholars who collected the Hadith have a habit to ask the one who quoted them a Hadith to also cite the chain of transmitters to the Prophet. Their objective is to check who is in this chain: someone trustworthy, or someone with a faulty memory? Or someone who is known to be lying in his life? When we say "this Hadih is weak", that does not mean that we reject a word of the Prophet. It does not mean that Hadith is systematically false and fabricated. That only means the chain of transmitters (sanad) of this Hadith does not satisfy the required conditions.

This verification is truly scientific: the Hadith specialists have done a great job: they have written in books (history of narrators) the names of all those who reported Hadiths, the date of their birth, the date of death, etc., to verify if they have indeed been able to meet the one of whom they say to have heard of him Hadith. They also noted in books ("jar'h wa ta'dîl") which of these transmitters are reliable (according to the criteria we will discuss below) and which ones are not. A Hadith is authentic (sahih) when it satisfies the following five conditions:

- His chain of transmission must be continuous between the various links, from the Prophet to the one who writes it in his collection,

- Each link must be reliable in terms of morality ('adâla),

- Each link must be perfect at the level of retention/ comprehension (dhabt),

- The Hadîth must not be contradicted in an irreconcilable way by a Hadith more authentic than himself (shudhûdh),

- The chain of transmission of this Hadith must not contain a hidden defect ('illa).

An important failure existing in one link of the transmission chain causes that the Hadith which it relates is "weak" (dha'îf).

The science of jarh wa ta'dīl is a part of Hadith science. It is a respectable science that owns its men. it points out a methodical process to evaluate the narrators of Hadith in detailed and analytical way. It concerns with the evaluation of the narrators and also it studies all the details of their life [20]. Science of mustalah (term) Hadith is another part of Hadith science. It concern the classification of Hadith:

- According to the reference of his particular authority.

- According to the transmission chain [Isnad].

- According to the number of narrators involved in each stage of the transmission chain.

- According to the nature of the text and the transmission chain

- According to the reliability and the memory of the narrators (Fig. 4).

This knowledge as well as others concerning several other aspects of Hadith science that will be represented by the ontology are described in [20]-[27].
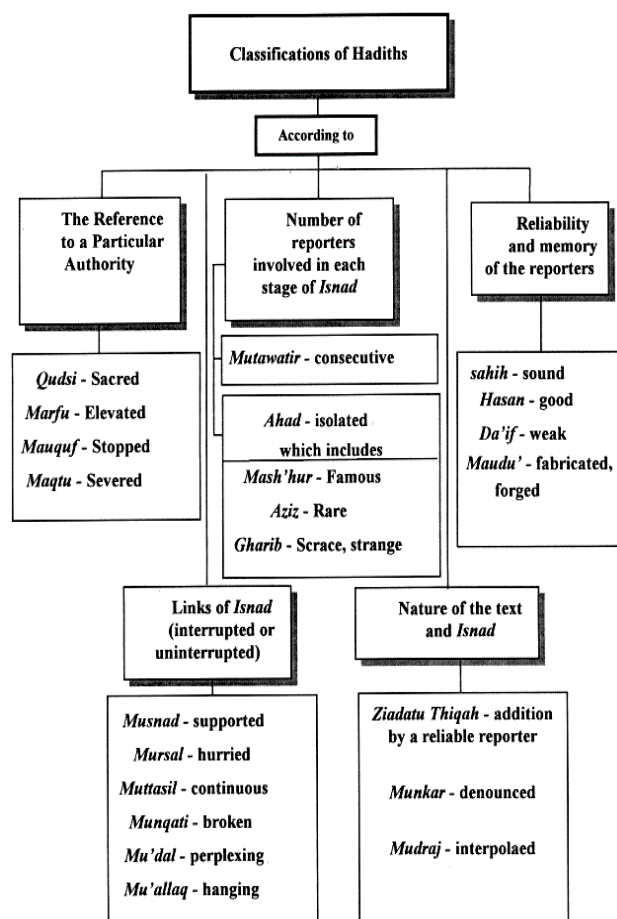
Figure 4: Classification of Hadith

4. STEPS AND CRITERIA TO CREATE A DOMAIN-DEPENDENT ONTOLOGY

As discussed above, ontologies provide a common vocabulary of a domain and define the meaning of terms and relationships between them. The knowledge in the ontologies is mainly formalized by using the five types of components [28]: concepts (or classes), relations (or properties), functions, axioms (or rules) and instances (or individuals).

Concept: A concept is a constituent of thought (a principle, an idea, an abstract notion) semantically evaluable and communicable. A concept has one or more properties, the set of properties of a concept constitutes its comprehension or intension and all the beings that it encompasses, its extension.

Examples : Hadith, Isnad, narrator, Hadith scholar, etc

Relationships: Represent interactions between concepts that make it possible to construct complex representations of domain knowledge. They establish binary semantic links that can be organized hierarchically.

Functions: They represent particular cases of relations in which the nth element of the relation is unique for the n-1 preceding elements [28]. The functions are defined as:

F: $c_1 * c_2 * ... * c_{n-1} -----> c_n$. Where C_i represents the concept i in ontology.

Axioms (or rules): Are expressions that are always true. Their purpose is to define in a logical language the description of the concepts and relationships that make it possible to represent their semantics. Their inclusions in an ontology can have several objectives:

- Define the meaning of the components.

- Set restrictions on the value of attributes.

- Define the arguments of a relationship.

- Check the validity of the specified information or deduce new ones.

Instances (or individuals): They constitute the extensional definition of ontology. They are used to represent elements in a domain.

We define five criteria to highlight important aspects of the ontology:

1. *Clarity*: The definition of a concept must convey the intended meaning of the term, as objectively as possible (independent of the context). A definition must be complete and documented in natural language.

2. *Consistency*: Nothing that cannot be inferred from the ontology must be inconsistent with the definitions of the concepts (including those expressed in natural language).

3. *Extensibility*: Extensions that can be added to the ontology must be anticipated. It must be possible to add new concepts without having to touch the foundations of ontology.

4. *Minimal Encoding Deformation*: An encoding deformation occurs when the specification influences the conceptualization (a given concept may be simpler to define in some way for a given ontology language, although this definition does not correspond exactly to the original meaning). These deformations should be avoided as much as possible.

5. *Minimal ontological commitment*: The purpose of an ontology is to define a vocabulary to describe a domain, if possible in a complete way; no more no less. Unlike knowledge bases, for example, we do not expect an ontology to be able to systematically provide a response to an arbitrary question about the domain. it only defines the terms necessary to share knowledge related to this area [29].

the method followed to develop domain-dependent ontology for Hadith science in Arabic language has seven steps:

1) *Determine the domain and scope of the ontology,*

2) *Reuse existing ontologies,*

3) *List the important terms of the ontology,*

4) *Define class and class hierarchy,*

5) *Define the properties of classes (attributes),*

6) *Define the facets of the attributes,*

7) *Create instances of classes in the hierarchy*

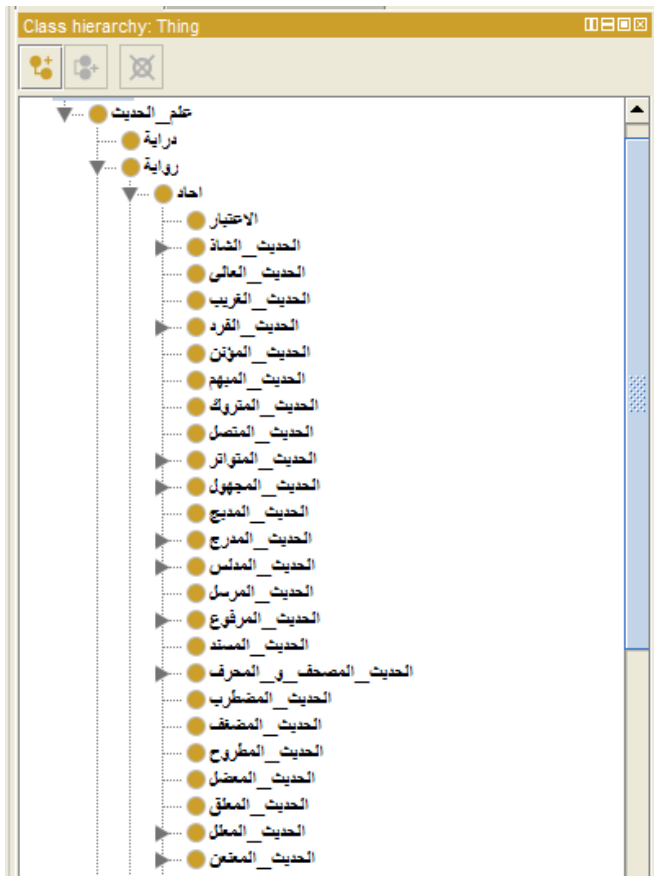Fig. 5 shows the class hierarchy of the new ontology.
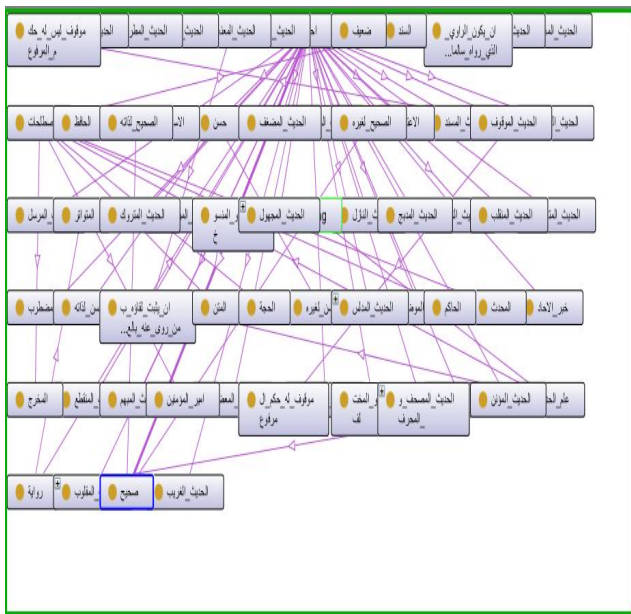

Figure 5: Class hierarchy

Figure 6: Vertical structure of the concept "Mustalah Alhadith"

Fig. 6, presents some of the main classes and subclasses of the ontology. The main relationships between the concepts will be described in Table 1.

Table 1: Some Hadith science knowledge

Object	Relation	Description
Hadith Science	HasDefinition	Basic rules and principles that make possible to reach the knowledge of the reporter (ar-râwî) and what is reported (al-marwî).
Hadith Science	HasType	Riwayah and Dirayah
Hadith Science	DefinedBy	Hadith Scholars
Hadith	HasDefinition	Words, deeds, habits, behavior and approvals that are reported from the Prophet Muhammad (pbuh).
Hadith	HasComponents	Transmission chain, Part and text.
Hadith	CanBeCalled	Khabar or Athar
Hadith	CanBe	Mutawatir (Rrequent) or Ahad (Isolated).
Hadith Ahad	CanBe	Machhour (Famous) or Aziz (Rare) or Gharib (Scrace).
Hadith Ahad	HasConditions	A Hadith is authentic (Sahih) when it satisfies the five conditions.
Hadith Ahad	HasMustalah	Sahih (Sound), Hassen (Good) or Dhaif (Weak)
Hadith Sahih(correct)	CanBe	True to itself, True to others
Hadith Dhaif (Weak)	HasMustalah	Mursal (Hurried), Munqati (Broken), Mu'dal (perplexing), Mu'allaq (Hanging), Munkar (Denounced)…
Sanad (Transmission chain)	HasDefinition	the list of all those who reported the Prophetic Tradition statement from Prophet Muhammad (pbuh) to the author who recorded it in his book
Narrator	HasInformation	Name, Konia, Birthdate, Death date, City, rank, layer,…
Narrator	CanBe	Companion, Successor, Succsessor of Successor, hadith Scholar, …
…		

The kernel of the ontology is created with the Protégé Editor and OWL. It includes 183 concepts, 145 relations, 87 semantic relationships and 450 instances. Knowledge for this ontology is gathered from several resources such as Hadith Science books, the Internet and Hadith experts.

OWL (Web Ontology Language) [1] is a language of description of ontologies designed for the publication and sharing of ontologies on the Semantic Web. The OWL language depends on structures defined by RDF, RDFS, and XML schema data types. OWL allows people and machines:

- A rich representation of knowledge: properties, classes with identity, equivalence, opposite, cardinality, symmetry, transitivity, ...

- To reason on this knowledge by relying on a Formal Axiomatic (Logic of description).

- To facilitate the reasoning of software agents who access Web resources

- The use of multiple ontologies that can be linked [30]

The extraction of information from this ontology is performed in a first step with SPARQL Query [1]. Ii is a protocol for

searching, adding, modifying, or deleting RDF data available across the Internet.

Examples:

- The question: What is the definition of HAdith? will be in SPAROL Query : *SELECT ?o WHERE {:Hadith:hasDefinition ?o.}*

- The question: What are the components of Hadith? *SELECT ?o2 WHERE {?s:hasComponnts?o1. ?o1 :Components ?o2.}*

The second step is to develop with Java and SqwrlAPI a question answering system with a graphical user interface to interrogate the ontology (Fig. 7). The questions that can be asked belong to 3 categories :

- Affirmative(Yes/No)

- Definition (Information)

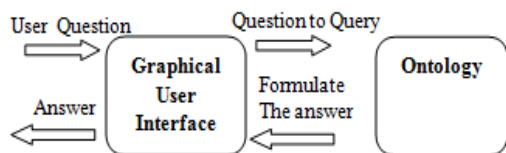- Explanatory (steps, methods, condition, person, information, etc).

Figure 7: Question Answering system based on ontology

5. CONCLUSION

In this article, we presented our work on the creation of a domain-dependent ontology for Hadith science in Arabic language. It structures Hadith concepts into a set of equivalent classes, properties and relationships. Knowledge for this ontology is gathered from several resources such as Hadith Science books, the Internet and Hadith experts. This ontology will improve the process of knowledge extraction or information retrieval by reducing the search space, guiding the choice of support for the extraction of the rules of association. The ontology can be used in the different phases of an information retrieval process. It can be used in the document indexing system as well as queries in the information filtering process and finally in the research process itself in the mechanism of comparison between the representation of query and documents of the collection. And it will be enriched and exploited in the Matn and Sanad Criticisms in classification and Evaluation of Hadith.

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