Design for Scientific RENAISSANCE

IIASAT

Ontology Extraction Approach for Prophetic Narration (Hadith) using Association Rules

Fouzi Harrag[1, a], Abdulwahab Alothaim[1,b], Abdulaziz Abanmy[1,c], Faisal Alomaigan[1,d]and Salah Alsalehi[1,e]

[1]College of Computer and Information Sciences, King Saud University, Saudi Arabia

[a]fawzih@ksu.edu.sa, [b]othaim991@gmail.com, [c]ebn-abanmy@hotmail.com, [d]al3migan@gmail.com, [e]sml656@hotmail.com

ABSTRACT

Ontologies have been investigated in many artificial intelligence studies including Knowledge Engineering, Natural Language Processing (NLP) and Knowledge Representation. Moreover, ontological models play an important role in Semantic Web application development. Ontologies are used to represent knowledge in a way that makes it understandable by machines as well as humans. This is achieved by encapsulating semantic aspects of the concepts of a certain domain within the ontology. This research paper is concerned with the use of association rules to extract the ontology of prophetic narrations (Hadith). Our approach involves investigating the use of association rules to identify frequent itemsets over concepts that are related to Islamic jurisprudence (Fiqh) from the Sahîh Al-Bukhârî documents by computing correspondence relations using the Apriori algorithm. In particular, the semantic structure of the Sahîh Al-Bukhârî as a knowledge source is exploited to extract a specific domain ontology, while the conceptual relations embedded in this knowledge source are modeled based on the notion of association rules. The domain ontology will offer a powerful representation of prophetic traditional knowledge, and the association rules will express any relation between two classes of connected concepts in the Sahîh Al-Bukhârî collection.

Keywords: Ontology, Concepts Extraction, Prophetic Narration (Hadith), Association Rules.

1. Introduction

In recent years, ontologies have become common on the World-Wide Web. The ontologies on the Web range from large taxonomies categorizing Web sites (such as on Yahoo!) to categorizations of products for sale and their features (such as on Amazon.com). Ontology provides a mechanism to capture information about the ideas, concepts, and the relationships between them in some domain (Yun Hong-yan et al., 2009). The aim of ontology is to develop knowledge representations that can be shared and reused. Guber (Guber, 1993) defined ontology as "A formal explicit specification of a shared conceptualization." The notion of ontology can also be used to describe a logical domain theory with very expressive, complex, and meaningful information. Ontology is often specified in a declarative form by using semantic markup languages such as RDF and OWL.

Ontology provides a number of potential benefits in representing and processing knowledge, including the separation of domain knowledge from application knowledge, sharing of common knowledge of subjects among human and computers, and the reuse of domain knowledge for a variety of applications.

This paper aims to create an ontology extraction tool for prophetic traditions (Hadith) using an association rule algorithm. This involves investigating the most proper methods for dealing with the Sahîh Al-Bukhârî collection to extract concepts and semantic relations between them specifically with Hadiths pertaining to Fiqh (Islamic jurisprudence). Using this Hadith ontology, various text mining tasks including information extraction, text categorization, concept linkage, and discovery of associations and patterns are tested and evaluated. The paper considers investigating the Sahîh Al-Bukhârî book as a pilot benchmark before focusing later on the entire Hadith collection to build a fully functional ontology. The ontology will provide a powerful representation of Hadith knowledge, with the rule schemas giving a more expressive representation of Hadith relations in term of rules.

2. Literature review

Ontologies provide a framework for handling structured information and extracting conclusions from the structured information (Echarte et al., 2007). The term ontology is used in information and knowledge representation systems to denote a knowledge model, which represents a particular domain of interest (Sharif, 2009). A body of formally represented knowledge is based on a conceptualization: the objects, concepts, and other entities that are assumed to exist in some area of interest and the relationships that exist among them (Lacasta et al., 2007). The goal of a domain ontology is to reduce the conceptual and terminological confusion among the members of a virtual community of users that need to share electronic documents and various kinds of information. Many ontologies learnt from text applications have been published and presented in various domains. (Trappey et al. 2009) presented a novel ontology schema based on a hierarchical clustering approach for knowledge document self-organization, particularly for patent analysis. Sharif (2009) tried to present a simple ontology of folksonomy to show how different elements act in such a dynamic space, and how implicit relations emerge from implicit complex networks within the folksonomies. (Marinica and Guillet, 2009) set out to improve post-processing of association rules by a better integration of user (decision maker) goals and knowledge. (Tatsiopoulos and Boutsinas, 2009) presented a new ontology mapping technique, given two input ontologies, is able to map concepts in one ontology onto those in the other without any user intervention. (Lau et al., 2009) proposed a novel concept map generation mechanism, which is underpinned by a fuzzy domain ontology extraction algorithm.

2.1. Arabic Ontologies

(Elkateb et al., 2006) introduced the Arabic WordNet project that was generated using the same methodology used to build EuroWordNet. The Suggested Upper Merged Ontology

(SUMO)1 is used to map between different languages. (Belkredim and Meziane, 2008) proposed DEAR-ONTO, a derivational Arabic ontology that represents the Arabic language. They classified verbs as sound verbs and weak ones, and using measures and derivation they built an ontology for the Arabic language. [Saad et al., 2011] presented a general methodology to extract information from the Islamic Knowledge sources to build an ontology for a given domain. Their approach based on combination of natural language processing techniques, Information Extraction and Text Mining techniques. In the Quranic Ontology [4], a knowledge representation is used to define the key concepts in the Quran, and to show the relationships between these concepts using predicate logic. Named entities in verses, such as the names of historic people and places mentioned in the Quran, are linked to concepts in the ontology as part of named entity tagging. In a recent work (Harrag et al., 2011), named-entity extraction techniques have been applied to identify useful entities from prophetic narration texts (*Sahîh Al-Bukhârî*) in order to annotate the prophetic narration texts and create a usable ontology.

3. Association Rules

Association rule mining is one of the most important and well researched techniques of data mining. It was first introduced by Agrawal, Imielinski, and Swami (Agrawal, et al.,1997). The discovery of "association rules" in databases may provide useful background knowledge to decision support systems, selective marketing, financial forecast, medical diagnosis, and many other applications. Mining association rules is an important data mining problem. Association rules are usually mined repeatedly in different parts of a database. Current algorithms for mining association rules work in two steps:

1. Discover the large itemsets, i.e. the sets of itemsets that have support above a predetermined minimum support σ.

2. Use the large itemsets to generate the association rules for the database.

It is noticed that the overall performance of mining association rules is determined by the first step, which usually requires repeated passes over the analyzed database and determines the overall performance. After the large itemsets are identified, the corresponding association rules can be derived in a straightforward manner. (Saad et al., 2010).

4. Approach

In this section, we will provide a depth look on our approach for constructing the *Hadith Ontology*, so we will describe the corpus of Sahih Al-Bukhari and we will define the steps to build an ontolgy for this corpus.

[1] SUMO: Suggested Upper Merged Ontology, http://www.ontologyportal.org/

4.1. Corpus of "Sahîh of Bukhari"[2]

Prophetic narrations texts or Hadith are considered as very important source of Islamic legislation. Despite the importance of these collections, no reference corpus has been developed for research purposes. "Sahîh of Bukhari, (**صحيح البخاري**)" is compiled by Bukhari scholar; it represents his most famous work. This book covers almost all aspects of life in providing proper guidance of Islam such as the method of performing prayers and other actions of worship directly from the Islamic prophet Muhammad. Bukhari organized his book as taxonomy of prophetic narration concepts, which consist of three hierarchical levels.

4.2. Ontology Building

Our work is based on building ontology for Sahih Al-Bukhari book. Our ontology is divided into two principal's parts. The first part is related to the structure of Sahih Al-Bukhari. This part represents the metadata of our hadith ontology. We need this ontology to browse the book using the usual structure (ketab, bab, hadith,...,etc). The second part is related to the global ontology that represents the main concepts of *Al-hadith* as semantic relationships. By using this ontology, we can search for any word/phrase and find the related *Hadiths* based on some relationships that will be discussed in the next sections.

4.3. Steps for building the ontology

The first part of our ontology is easy to build. The process consists of creating a relation between a concept and a sub-concept from the structral taxonomy of Sahih Al-Bukhari. Every chapter (**كتاب**) is considred as concept and all the sections (**أبواب**) related to this chapter are considred as sub-concepts associated to this super-concept by a relation of type: "sub class of". The figure 1 represent an example of this relation:

باب فضل العلم **is a sub class of** كتاب العلم

Figure. 1 Example of relation from the metadata ontology.

The second part of our ontology consists of building ontology from the set of concepts extracted out of the texts of hadiths and the set of the relations between these concepts. We follow the same steps of the methodology described in (Noy et al., 2001). Table 1 shows the comparison between the concepts and the relations of the two parts of our ontology.

Table.1 Concepts and relations from metadata and semantic ontologies.

Part	Concept	Relation	Example
Metadata Hadith ontology	Kitab(X) , Bab(X) , Hadith(X)	Only one : is sub class of	باب فضل العلم **is a sub class of** كتاب العلم
Semantic Hadith ontology	Words or (concepts) that exist in the Matn of the hadith: Islam, Solah, ….etc .	Many relations like: Part of, Synonym, kind of,...,etc .	الصلاة **is a part of** الاسلام . النخلة **is a kind of** الشجر

[2] Wikipedia, Sahih Bukhari: http://fr.wikipedia.org/wiki/Sahih_al-Bukhari, Last Visited: May 14, 2013.

The steps of building the second ontology are the following:

4.3.1. Determining the domain and the scope of our ontology

From the whole Islamic knowledge domain, we focus our attention on the *Hadith* science due to its importance in the Muslims life. In our work, we opted for the use of a collection of prophetic narration texts from "Sahîh of Bukhari" as a domain for our ontology.

4.3.2. Extracting the important terms in the ontology

Before starting the process of building of our ontology, we have to list all the important terms in the texts to facilitate the next operation of concepts extraction. Arabic Natural language processing (NLP) tools are used for this goal. The *KP-Miner*[3] System is considered for this preprocessing step. This system applies an oparation of tagging to all the words of the texts and after that, it starts the operation of key phrases extraction. These operations will allow us to reduce the domain of our ontology by focusing only on verbs, nouns and multi-words. Figure 2 shows an overview of this step.

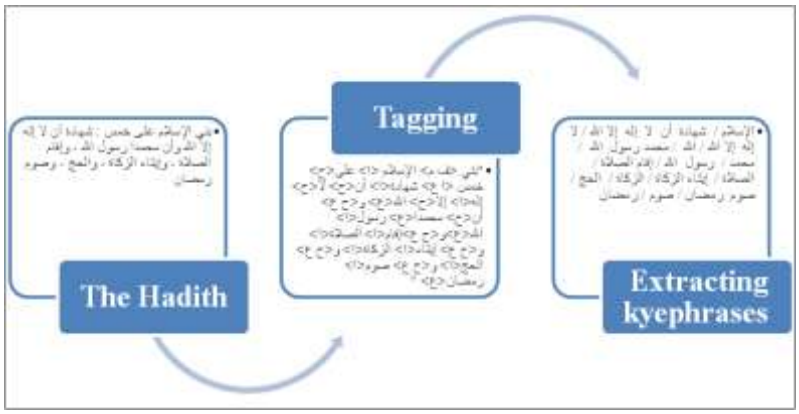

Figure. 2 Extracting the important terms in the ontology.

4.3.3. Defining the concepts

This step is consacred to the operation of concepts extraction. The inputs of this step are the outputs of the previous one i.e the importants extracted terms. In this step, we apply the stemming operation. Stemming is concerned with the transformation of all word derivatives to their single common stem or canonical form. This process is very useful in terms of reducing and compressing the indexing structure, and it takes advantage of the semantic/conceptual relationships between the different forms of the same root (Fig. 3). A modified version of *Shereen Khoja*[4] stemmer, has been used to complete this step.

[3] The *KP-Miner* System: http://www.claes.sci.eg/coe_wm/kpminer/. Last Visited: May 14, 2013.
[4] *Shereen Khoja* stemmer: http://zeus.cs.pacificu.edu/shereen/research.htm. Last Visited: May 14, 2013.

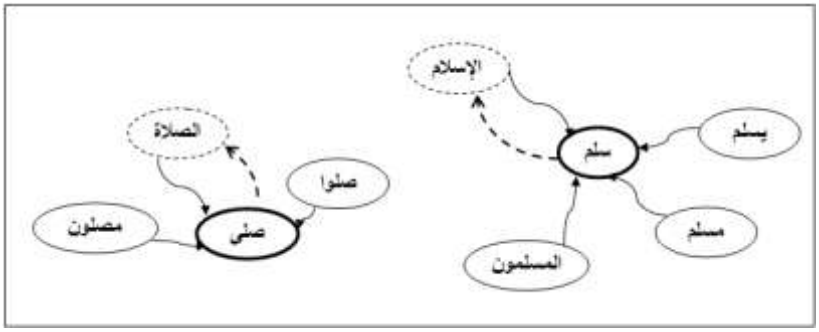

Figure. 3 Overview of the defining concepts step.

Table 2 gives an example for the result of this operation. The two words "Islam, **الإسلام**" and "Solat, **الصلاة**" are the extracted as concepts for the lists of the words in the table.

Table.2 example of results from the Defining Concepts step

Words	Repetition	Root	The common (the most Repetition)
مسلم	12	سلم	الإسلام
المسلمون	4		
الإسلام	20		
سلم	3		
يسلم	1		
صلوا	2	صلى	الصلاة
الصلاة	5		
صلى	4		
مصلون	1		

4.3.4. Defining the relationships between concepts

Once we have defined the concepts, we must define the relationship between them. This step is the most important one in the process of building our ontology. This importance is due to the idea that ontology is based on the representation of the extracted concepts with their relationships. Actually, there are many algorithms and techniques to extract relations between concepts, but the problem is that some of them don't fit to the Arabic language. For this purpose, we opte for the use of association rules method to extract relations. This choice is justified by the idea that associations rules don't depend on any linguistic consideration. Two important points must be mentioned before starting the discussion of our relations extraction method. In the association rules method, the rule (A → B) represents the relationship between the two concepts A and B. The concept B will be considered to be in a higher conceptual level than the concept A. Let's take for example the rule: الفجر → الصلوات . The concept **الصلوات** is located in a higher conceptual level than the concept **الفجر**. The sub-concept **الفجر** is a kind of the super-concept **الصلوات**. To apply the association rules method, we represent all the hadiths of our corpus as instance of transaction as it is mentioned in Table 3.

Table.3 Representation of hadiths as instance of transaction.

ID	Hadith
1	الإيمان بضع وستون شعبة ، والحياء شعبة من الإيمان
2	إن من أشراط الساعة : أن يرفع العلم ويثبت الجهل، ويشرب الخمر، ويظهر الزنا
……	**……**

The hadith ontology represents the semantic relations between the different concepts extracted from the corpus of *Sahih Al-Bukhari*. Multiple instances of these relations are of type "part of", "kind of" and "synonym of". Our approach is based on assigning a set of tags to each type of relation; these tags will be used to detect the type of the relations and the concepts concerned by this relation.

If we consider the different type of relations as: $\mathbf{R_i} = \{\mathbf{R_1}, \mathbf{R_2}, \mathbf{R_3}, \mathbf{R_4}, \ldots, \mathbf{R_n}\} / \mathbf{i=1..n}$, then for each relation $\mathbf{R_k}$, we define a set of **tags** $\mathbf{Tj=\{T_1, T_2, T_3, \ldots, T_m\} / j=1..m}$. if any tag T_j from $\boldsymbol{T}$ is found in the text of the hadith, this means the existence of a relation of type $\mathbf{R_i}$:

$$T_k \in M;\ M = T_k AB \rightarrow \exists\, R_k \,/\, A \overset{R_k}{\Rightarrow} B \qquad (1)$$

Table 4 gives some examples of relations of type "is a part of" extracted from Sahih Al-Bukhari:

Table.4 Some examples of relations of type "is a part of".

Hadith	Result
الإيمان بضع وستون شعبة ، والحياء **شعبة** من الإيمان.	The word **شعبة** is a tag of the relationship "is a part of"
إن من أشراط الساعة : أن يرفع العلم ويثبت الجهل، ويشرب الخمر، ويظهر الزنا	The word **إن من** is a tag of the relationship "is a part of"
أي العمل أفضل ؟ فقال: إيمان بالله ورسوله . قيل :ثم ماذا ؟ قال :الجهاد في سبيل الله . قيل :ثم ماذا ؟ قال :حج مبرور.	The word **أي** is a tag of the relationship "is a part of"

The method of relation's extraction can be summerized as follows:

- **Step-1**: for each relation, find all tags that co-occurs with the higher concept (B) of the relation R.
- **Step-2**: apply the Apriori algorithm by finding all the itemsets of concepts with (*K=2*) and *min_support=1*, then find all possible association rules between concepts in each *Hadith*.
- **Step-3**: Determine the position of the tag word in the relation and then delete all the rules that don't satisfy the condition defined in step 1.

- **Step-4**: Find the confidence for each rule and accept only the rule that satisfy (confidence >= min_ confidence). The confidence of the rule $A \xrightarrow{x} B$ is found by counting the number of occurrence of the itemsets {A, B} in all *Hadiths*.

5. An illustartive Example

Let's us take four hadiths from *Sahih Al-Bukhari* as examples for this process (see Table 5). We are only interested in the relations of type "***is a part of***".

Table.5 Examples of hadiths used in the illustrative example.

Tag	Higher concept position	Example
شعبة من	The concept "**الإيمان**" is immediately After the tag-word "**شعبة**".	**الإيمان** بضع وستون **شعبة ، والحياء شعبة** من الإيمان**.**
أي	The concept "**العمل**" is immediately After the tag-word "**أي**".	**أي** العمل أفضل ؟ فقال: **إيمان بالله ورسوله .** قيل **:** ثم ماذا ؟ قال **:الجهاد في سبيل الله .** قيل **:**ثم ماذا ؟ قال **:حج مبرور.**
بني	The concept "**الإسلام**" is immediately After the tag-word "**بني**".	**بني** الإسلام على خمس : شهادة أن لا إله إلا الله وأن محمدا رسول الله ، وإقام الصلاة ، وإيتاء الزكاة ، والحج ، وصوم رمضان
إن من	The concept "**أشراط الساعة**" is immediately After the tag-word "**إن من**".	**إن من** أشراط الساعة : أن يرفع العلم ويثبت الجهل، ويشرب الخمر، ويظهر الزنا
…	…	**…**

Table 6 shows an example for the concepts extracted in the first step for the hadith #2.

Table.6 Concepts extracted from hadith #2.

Hadith	Concepts from the Previous step
أي العمل أفضل ؟ فقال: إيمان بالله ورسوله . قيل **:**ثم ماذا ؟ قال **:**الجهاد في سبيل الله . قيل **:**ثم ماذا ؟ قال **:**حج مبرور**.**	افضل العمل ، الايمان ، الجهاد ، السبيل ، الحج ، البر .

Once the concepts are extracted, we starts step 2 which consists of applying the *appriori Algorithm* to find the different itemsets for this hadith and to find the accepted rules. The results of this step are given in Table 7:

Table 7 Results of application of Appriori Algorithm on hadith #2.

{ افضل العمل , البر }	{ افضل العمل , السبيل }	{ افضل العمل , الجهاد }	{ افضل العمل , الايمان }
{ الايمان , البر}	{ الايمان , السبيل}	{ الايمان , الجهاد}	
{ الجهاد , البر}	{ الجهاد , السبيل}		
{ السبيل , البر}			
{ الحج , البر}			

Table 8 shows us the set of rules generated from the itemsets found in the previous step:

Table 8 The set of rules generated from the itemsets of hadith #2.

افضل العمل $\xrightarrow{\text{part of}}$ الايمان	افضل العمل $\xrightarrow{\text{part of}}$ الجهاد	افضل العمل $\xrightarrow{\text{part of}}$ السبيل	افضل العمل $\xrightarrow{\text{part of}}$ الحج	افضل العمل $\xrightarrow{\text{part of}}$ البر
الايمان $\xrightarrow{\text{part of}}$ افضل العمل	الايمان $\xrightarrow{\text{part of}}$ الجهاد	الايمان $\xrightarrow{\text{part of}}$ السبيل	الايمان $\xrightarrow{\text{part of}}$ الحج	الايمان $\xrightarrow{\text{part of}}$ البر
الجهاد $\xrightarrow{\text{part of}}$ افضل العمل	الجهاد $\xrightarrow{\text{part of}}$ الايمان	الجهاد $\xrightarrow{\text{part of}}$ السبيل	الجهاد $\xrightarrow{\text{part of}}$ الحج	الجهاد $\xrightarrow{\text{part of}}$ البر
السبيل $\xrightarrow{\text{part of}}$ افضل العمل	السبيل $\xrightarrow{\text{part of}}$ الايمان	السبيل $\xrightarrow{\text{part of}}$ الجهاد	السبيل $\xrightarrow{\text{part of}}$ الحج	السبيل $\xrightarrow{\text{part of}}$ البر
الحج $\xrightarrow{\text{part of}}$ افضل العمل	الحج $\xrightarrow{\text{part of}}$ الايمان	الحج $\xrightarrow{\text{part of}}$ الجهاد	الحج $\xrightarrow{\text{part of}}$ السبيل	الحج $\xrightarrow{\text{part of}}$ البر
البر $\xrightarrow{\text{part of}}$ افضل العمل	البر $\xrightarrow{\text{part of}}$ الايمان	البر $\xrightarrow{\text{part of}}$ الجهاد	البر $\xrightarrow{\text{part of}}$ السبيل	البر $\xrightarrow{\text{part of}}$ الحج

In this example, when we look at the *Hadith* we find that the tag-word "**أي**" come immediately before the concept "**أفضل الاعمال**" which means that the concept **أفضل الاعمال** will represent the second part (B) in any accepted rule: A $\xrightarrow{\text{part of}}$ B. So, all the rules that don't satisfy the condition {B="**أفضل الاعمال**"} will be automatically deleted. The result of this step is given in Table 9:

Table 9 The set of rules accepted as valid rules for the hadith #2.

افضل العمل $\xrightarrow{\text{part of}}$ الايمان	افضل العمل $\xrightarrow{\text{part of}}$ الجهاد	افضل العمل $\xrightarrow{\text{part of}}$ السبيل	افضل العمل $\xrightarrow{\text{part of}}$ الحج	افضل العمل $\xrightarrow{\text{part of}}$ البر

After scanning all the hadiths, we found that the confidence of the itemsets { **السبيل ، افضل الجهاد ،** } and { **البر ، افضل العمل** } is *Low* compared to the itemsets { **الايمان ، افضل العمل** }, { **الحج ، افضل العمل** } and { **افضل العمل** } which co-occure many times and have a *High* confidence. Then, the results after deleting the non-strong rules is given in Table 10:

Table 10 The set of strong rules after deleting the non-strong rules for the hadith #2.

افضل العمل $\xrightarrow{\text{part of}}$ الايمان	افضل العمل $\xrightarrow{\text{part of}}$ الجهاد	افضل العمل $\xrightarrow{\text{part of}}$ الحج

6. Representation Model

Ontological knowledge representation enables domain experts to define knowledge in a consistent way using a standard format (such as XML, RDF, or OWL). OWL can be used to explicitly represent the meaning of terms in vocabularies and the relationships between those terms. This representation of terms and their interrelationships is called ontology. OWL has more facilities for expressing meaning and semantics than XML, RDF, and RDF-S (schema), and thus OWL goes beyond these languages in its ability to represent machine interpretable content on the Web. This point justifies our choice in using OWL to represent our ontology.

7. Conclusion

This paper use of association rules method in the process of concepts extraction in order to build an ontology for the corpus *Sahih Al-bukhari*. The approach was based on using association rules to identify strong rules over the concepts etracted from *Sahih Al-bukhari* texts by generating a set of accepted rules using the Apriori algorithm. Our ontology was portioned into two principal parts or sub-ontology: Hadith Metadata-ontology and Hadith Semantic ontology. The taxonomic structure of *Sahih Al-bukhari*` was used in the process of building for the first part of our ontology, while the set of concepts extracted from the texts of

the whole hadiths of Sahih Al-Bukhari and their conceptual relations was modeled based on the notion of association rules to construct the second part. The generated ontology will be used as new representation tool for Sahih Al-Bukhari and the other prophetic traditional knowledge.

8. References

[1] R. Agrawal and R. Srikant. Fast algorithms for mining association rules in large databases. Proceedings of the 20th International Conference on Very Large Data Bases, VLDB, pages 487-499, Santiago, Chile, September 1994.

[2] F.Z. Belkredim and F. Meziane: DEAR-ONTO: A Derivational Arabic Ontology Based on Verbs. *Int. J. Comput. Proc. Oriental Lang*. 21(3): 279-291, 2008.

[3] K. Dukes, E. Atwell and N. Habash. Supervised Collaboration for Syntactic Annotation of Quranic Arabic. Language Resources and Evaluation Journal (LREJ). Special Issue on Collaboratively Constructed Language Resources, 2013.

[4] F. Echarte, J.J. Astrain, A. Córdoba and J. Villadangos, *Ontology of folksonomy: a new Modeling method*, In Proceedings of Semantic Authoring, Annotation and Knowledge Markup, 2008.

[5] S. Elkateb, W. Black, P. Vossen, D. Farwell, A. Pease, and C. Fellbaum, *Arabic WordNet and the Challenges of Arabic*, In Proceedings of Arabic NLP/MT Conference, London, U.K. 2006.

[6] T.R.Guber, "Towards principles for the design of ontologies used for knowledge sharing," in Int..J.Human-Computer Studies. Florida Institute for Human and Machine Cognition,43(5-6), p.p 9.7-928, 1993.

[7] F. Harrag, E. El-Qawasmeh, and A.S. Al-Salman, *Extracting Named Entities from Prophetic Narration Texts (Hadith) Categorization*, Proceedings of The 2nd International Conference on Software Engineering and Computer Systems, ICSECS2011, 2011, Malaysia, June 27-29, 2011.

[8] J. Lacasta, J. Nogueras-Iso, R. Béjar, P.R. Muro-Medrano, F.J. Zarazaga-Soria, Web Ontology Service to facilitate interoperability within a Spatial Data Infrastructure: Applicability to discovery". *Data & Knowledge Engineering*, 63:947-971, 2007.

[9] R. Lau, D. Song, Y. Li, T. Cheung and J.X. Hao, *Towards A Fuzzy Domain Ontology Extraction Method for Adaptive e-Learning*, TKDE'09, 2009.

[10] C. Marinica and F. Guillet, *Improving Post-Mining Of Association Rules With Ontologies*, The XIII International Conference "Applied Stochastic Models and Data Analysis" (ASMDA'09), Vilnius, LITHUANIA, 2009.

[11] Natalya F. Noy and Deborah L. McGuinness. ``Ontology Development 101: A Guide to Creating Your First Ontology". Stanford Knowledge Systems Laboratory Technical Report KSL-01-05 and Stanford Medical Informatics Technical Report SMI-2001-0880, March 2001.

[12] Saad K. Majeed & Hussein K. Abbas. (2010). An Improved Distributed Association Rule Algorithm. Eng.& Tech. Journal, Vol.28, No.18 .

[13] S. Saad, N. Salim and S. Zainuddin (2011). *An Early Stage of Knowledge Acquisition based on Quranic Text*. International Conference on Semantic Technology and Information Retrieval (STAIR). Putrajaya, Malaysia.

[14] Sharif, Atefeh *Combining Ontology and Folksonomy:An Integrated Approach to Knowledge Representation.*, 2009 . In Emerging trends in technology: libraries between Web 2.0, semantic web and search technology, Italy, August 19-20.

[15] Trappey AJ, Trappey CV, Hsu FC, Hsiao DW., A fuzzy ontological knowledge document clustering methodology. IEEE Trans Syst Man Cybern B Cybern. 2009 Jun ;39(3):806-14. doi: 0.1109/TSMCB.2008.2009463. Epub 2009 Mar 24.

[16] C. Tatsiopoulos and B. Boutsinas, *Ontology Mapping Based On Association Rule Mining*, International Conference on Enterprise Information Systems, ICEIS'09, 2009.

[17] W. M.-j. YUN Hong-yan, XU Jian-liang and X. Jing, "Development of domain ontology for e-learning course," in ITIME-09IEEE international symposium, 2009.