Evaluation Criteria for Computational Quran Search

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ABSTRACT

This paper reviews search tools constructed for Information Retrieval from the Holy Quran. This paper evaluates these different search tools against 13 criteria depending on: search features, output features, precision of the retrieved verses, recall database size and types of database contents. Based on this survey, we conclude that most of the existing Quran search tools still cannot solve the problem of ambiguity in the retrieved results because these tools use traditional query analysis and make limited usage of Quran ontologies.

Keywords: **Holy Quran, Information Retrieval (IR), Natural Language Processing (NLP), Ontology, Semantic Search.**

1. INTRODUCTION

Information Retrieval (IR) can be described as methods for finding required information from large collections of text usually stored on computers (Manning et al., 2008). As early as 1945, Vannevar Bush suggested using computers to search for something specific (Singhal, 2001), and the first automated IR systems were announced in the 1950s. Most people are currently involved in IR daily when they use World Wide Web search engines, such as Google or Yahoo. IR's main practical goals are: to enable users to search huge collections of data quickly, to provide for more flexible matching algorithms, such as stemming query words, and to rank retrieved results.

IR systems use many techniques to increase the search results quality, precision and recall. Examples of these methods are inverted indexes, pre-processing before document indexing, sorting results, term weighting, the vector space model and evaluation of an information retrieval system based on the relevance of the documents it retrieves. However, ambiguity in the search result is still a major issue in IR.

The new version of IR is called semantic search. This search works by reasoning about an input query over a knowledge base and returning the most relevant answers. The input query can have different forms such as a natural language question, a triple knowledge representation of a question, a graphical representation, or keywords. The knowledge base can be one or more ontologies, corpora or plain text documents. Similarly, the retrieved answers from semantic search can take a multitude of forms from pure triples to a natural language representation.

Both techniques IR and Semantic Search have been applied on the Holy Quran. The Holy Quran is the most important resource for the Islamic sciences and Arabic language. Muslims

believe that the Quran is a revelation that came from Allah over 1300 years ago, from 609 to 632 CE, and it contains about 80,000 words forming 114 chapters (Atwell et al., 2011). A chapter consists of a varying number of verses.

Many Quran search applications have been built to facilitate the retrieval of knowledge from the Quran. Depending on this study, techniques were used to retrieve information from the Quran can be classified into two types: semantic-based and keyword-based techniques as can be seen in Figure 1. The semantic-based technique is a concept-based search tool that retrieves results based on word meaning, or concept match, whereas the keyword-based technique returns results based on letters matching word(s) queries (Sudeepthi et al., 2012). The majority of Quran search tools employ the keyword search.

The existing Quran semantic search techniques are an ontology-based (Yauri et al., 2013), a synonyms-set (Shoaib et al., 2009) and a cross-language information retrieval (CLIR) technique (Yunus et al., 2010). The ontology-based technique searches for the concept(s) matching a user query and then returns the verses related to this concept(s). The synonyms-set method produces all synonyms of the query word using WordNet and then finds all Quran verses matching these terms' synonyms. CLIR technique translates words of an input query to another language and then retrieves verses that contain words matching the translated words.

On the other hand, text-based techniques are a keyword-matching, a morphological-based (Al Gharaibeh et al., 2011) and a chatbot technique (Abu Shawar and Atwell, 2004). The keyword-matching method returns verses that contain any query words. The morphological-based method provides a root word search. It generates all other forms of the query word and then finds all Quran verses matching these word forms. The chatbot method selects the most significant or important words from a user query and then returns the Quranic verses containing any words matching the selected words.
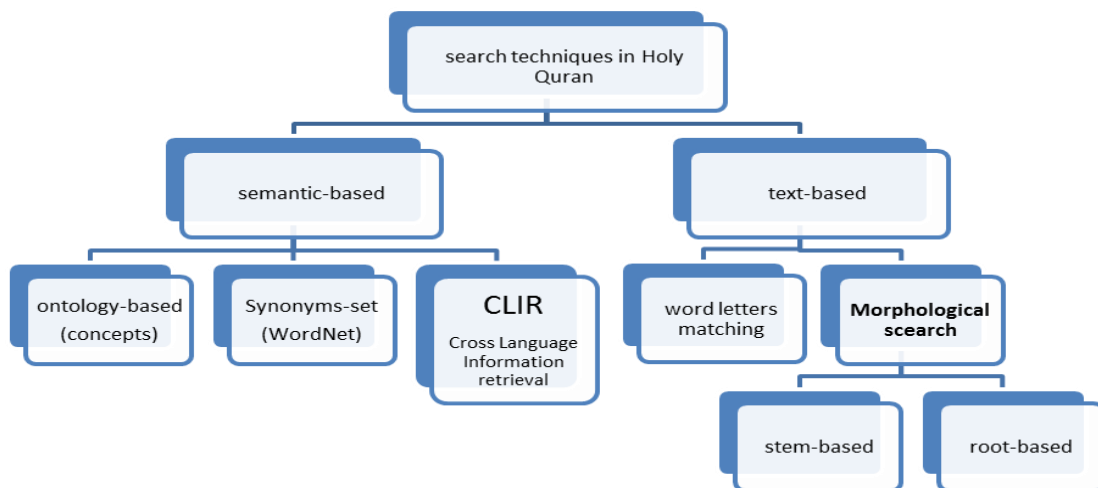

Figure 1: Classification of Existing Quran Search Techniques

Several deficiencies exist with the retrieved Quran verses (Aya'at) for a query using the existing keyword search technologies. These problems are: some irrelevant verses are

retrieved, some relevant verses are not retrieved or the sequence of retrieved verses is not in the right order (Shoaib et al., 2009). Additionally, the keyword-based techniques have limitations include misunderstanding the exact meaning of input words forming a query and neglecting some theories of information retrieval (Raza et al., 2014).

Moreover, current Quran semantic search techniques have some limitations concerning finding the requested information. These constraints result in ambiguity in the results because these semantic search tools use one or two incomplete Holy Quran ontologies and ignore the others. Additionally, these ontologies have different scopes and formats that need an alignment and normalization (Alrehaili and Atwell, 2014).

This paper aims to review and evaluate search tools constructed for the Holy Quran. This objective is achieved by assessing these different search tools against 13 criteria depending on search features, output features, precision and recall of the retrieved verses, database size, and types of database contents.

This paper is organized as follows. Section 2 is literature review containing an analysis of the characteristics of the Holy Quran, Quran search applications, and previous research on Quran search tools. Section 3 describe the methodology in terms of evaluation criteria and comparison of different Quran search tools. Finally, Section 4 concludes the critical points in this paper.

2. LITERATURE REVIEW

This section discusses the challenging points regarding the natural features of the Holy Quran when applying NLP technologies. Additionally, Quran search applications are reviewed. Finally, research on Quran search tools is reviewed.

2.1 Text Characteristics of The Holy Quran

Challenging points regarding the text of the Holy Quran exist when applying NLP technologies. First, a concept might be mentioned in different verses. For example, the concept of Hell (النار) is discussed in various chapters and verses, and Allah appears throughout the entire Holy Quran.

An additional Quran feature is that one verse may contain or allude to many themes. For example, verse 40 in Chapter 78 contains only seven words, but describing five different concepts. These concepts are: 'Allah' has warned 'Humans', 'Allah' has warned of 'chastisement', 'Man' will see on 'the Judgment day' what his two 'hands' did, and 'Unbelievers' will say on 'the Judgment day' that 'we wish we were dust' (Raza et al., 2014). Note also from the above example that this verse does not have the words 'Allah' and 'the Judgment', but the context reveals what is being said.

Another aspect of the style of the Quran is that one concept is mentioned using many different words, depending on the context. For example, Muhammad is the same as Ahmad, Mudhathir, Muzammil, and messenger of Allah. Another example is that Heaven has different names, such as The Garden and Paradise.

A term may also refer to completely different things, depending on the context: for example, 'الْجَنَّة' refers to the paradise, and the garden. Additionally, two unlike words may

have the same letters but have different diacritics. For example, 'الجنة' represents three different words: (l-jannat) الْجَنَّة means paradise, (junnat) الجُنَّة means cover, and (jinnat) 'الجِنَّة' means ghosts.

Furthermore, a term might have different names which are not in the synonyms group of this term such as other names of the Paradise as in Figure 2.

The text of the Holy Quran is classical Arabic language, which is different from the modern Arabic language. This difference may cause an incompatibility problem or gap between the query and retrieved verses.
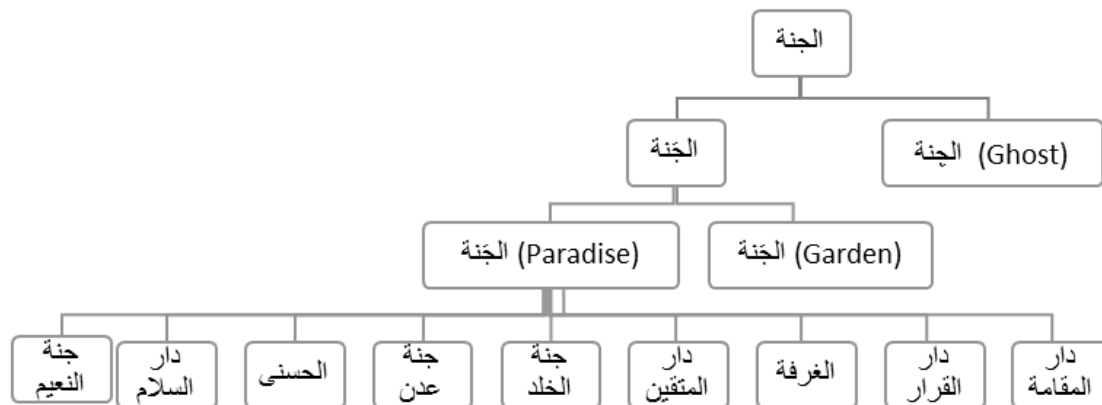

Figure 2: Ambiguity of Arabic Word in the Quran

2.2 Quran Search Applications

Several desktop and Web applications have been developed to retrieve knowledge from the Quran. Many these applications use keyword search techniques with a few information retrieval methods as outlined in the following.

Khazain-ul-Hidayat[1] and Zakr[2] are free desktop applications that enable the user to read, listen to and search the Quran in many different languages. These applications are mainly designed to be tools for teaching the Quran. A user can search the Quran by querying a word or by entering a verse number. When the user searches for a word, the results will include all verses containing same query word.

Almonagib Alqurany[3] (المنقب القراني), Islam web[4] , Tanzil[5] , Quranic Arabic Corpus[6] (QAC) and the Noble Quran[7] are online Web applications that enable users to read, listen to and search the Quran in different languages. Users can search by a chapter number, verse number or word. For instance, a user can search for Chapter 13 and verse 3. Additionally, In the case of searching for a word, these applications will return all verses that have words belonging to the same root of the query word. For example, if the query word is 'ذكر', then

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[1] http://www.khazainulhidayat.com/
[2] http://zekr.org/
[3] http://www.holyquran.net/search/sindex.php.
[4] http://quran.al-islam.com/
[5] http://tanzil.net/
[6] http://corpus.quran.com/
[7] http://quran.com/

the retrieved verses will contain any term of a stem 'ذكر', such as 'اذكر', 'تذكرة', 'الذاكرون' and 'ذكرى'.

KSU Quran[8] is a Web application for the study of the Quran and was developed at King Saud University. This Web application represents the Quran in different data forms, such as text and audio in many languages.

The Quran[9] is a project that has been at the forefront of Quran media for several years, with a vision of broadcasting the voice of the Quran. This project was developed by two former computer science students at the University of Copenhagen in 2007. Many years later, this project has improved by adding more features, such as a search tool, the ability to compare parallel translations of the Quran, and the ability to listen to Quran recitation. Both the websites KSU Quran and Al-Quran.info provide users with search tools using a word, root or phrase search. The main technique here uses the keyword search, and the retrieved verses are ordered depending on the Quran index.

Semantic Quran[10] is an online search tool application that allows a user to search verses based on concepts. In this application, each verse has a set of tags that are concepts. Additionally, not all verses are completely tagged. Therefore, the user can participate in tagging any verse. The idea behind this application is that many verses in the Holy Quran relate to certain concepts even though these verses do not have the words commonly associated with the concepts. For instance, Allah says in verse 94:6: 'Indeed, with hardship will be ease'. This verse points to hope and patience for believers who are in difficulty, but the words 'hope' or 'patience' do not appear in the verse's words, so these concepts will not be found using a basic keyword search.

2.3 Research on Quran Search Tools

Considerable computational research has been carried out on the Quran, including both keyword-based IR and semantic search research.

(Abdelnasser et al., 2014) proposed a new Arabic question-answering system in the domain of the Quran. The system prompts users to enter an Arabic question about the Quran. Then, this system retrieves relevant Quran verses with their Arabic descriptions from Ibn Kathir's Tafsir, a standard commentary textbook on the Quran. This system uses 1,217 Quranic concepts integrated from the Quranic Arabic Corpus Ontology (Dukes, 2012, 2013) and Qurany Ontology (Abbas, 2009, 2013). It is claimed that retrieved results' accuracy can reach 65% using the top result. This system has three phases for answering a question: question analysis, IR and answer extraction. In question analysis, the 'Morphological Analysis and Disambiguation of Arabic' tool (MADA) (Habash et al., 2009) is applied to a user's question to add a part of speech (POS) tag and a stem to each word in this question, and then, all stop words are removed based on their POS tags. Additionally, the remaining words are tagged with Named Entity Recognition (NER) types using the LingPipe tool. For example, the word 'mountain' has an NER type of 'location'. Moreover, this phase uses a

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[8] http://quran.ksu.edu.sa/
[9] http://al-quran.info/
[10] http://semquran.com/

support vector machine (SVM) to identify the question type, such as whether it is about a place or person. In the IR stage, the question is processed via an 'explicit analysis approach' (Gabrilovich and Markovitch, 2007) that enhances a keyword-based text representation with concept-based features in which these features are automatically extracted from the Quran Ontology. After this step, the IR module retrieves related verses from the Quran and their interpretation from Tafsir books. Finally, answer extraction ranks the retrieved answers based on the number of matching words in the answer, the NE type of both the question and answer and the shortest distance between the matched expressions in the retrieved results. This proposed system does not recommend a solution if the question terms do not match any concepts from the Quran Ontology. Moreover, this tool still does not solve the problem of ambiguity in the results. For example, if a user searches for 'النار' (fire) the result should tell the user there are two types of 'النار': The Hell-fire and normal fire.

(Khan et al., 2013) demonstrated a Quran semantic search method by developing a simple ontology for the animals mentioned in the Quran. The ontology was built using the editor Protégé, and SPARQL is used to answer a query about animals. This paper concludes that the existing Arabic WordNet is not sufficient for finding synonyms for query words in an effort to increase one's chances of retrieving information from a document. Based on this, they suggested developing Arabic WordNet for Quran words.

(Yauri, 2014) proposed a semantic search system for retrieving Quran verses based on the enhanced Quranic Arabic Corpus ontology developed by (Dukes, 2012, 2013). The system analyses a user question by removing all words except for nouns and verbs. Then, it checks if these words or their synonyms match concepts in the ontology domain. After that, it uses the matched concepts to generate triples in the form of a subject-predicate-object. Finally, it uses SPARQL to answer the user's query based on generated triples. However, Yauri did not suggest a solution for the ambiguity in the query and the result. Moreover, the proposed search tool is designed for English and Malay translations of the Quran, but not the original Arabic source text.

(Yahya et al., 2013) recommended a semantic search for the Quran based on CLIR. They created a bilingual ontology: English and Malay languages. This ontology is also based on the Quranic Arabic Corpus ontology developed by (Dukes, 2012, 2013). They did this to experiment on this ontology for two translations of the Quran. In the Malay translation, 5,999 verses are assigned to the concepts, and 237 verses do not relate to any concepts. In the English translation, they found 5,695 verses related to concepts in this ontology. On the other hand, 541 documents are not allocated to any concepts.

(Abbas, 2009, 2013) developed a tool called "Qurany" for searching the Quran text in both Arabic and English. In this project, 6,236 HTML pages were created in which each HTML page contains one verse in source Arabic, eight different English translations and the topic(s) of this verse in both Arabic and English. This project's main idea involves searching the Quran's eight translations using the keyword search. This method will enhance the precision of results. Abbas noted that most of the available search tools on the Web use one English translation during the search process, and return results with average recall and precision values of 54% and 48%, respectively. She showed that the Qurany tool provided an 87% recall value and a 58% precision value. However, this tool uses a basic keyword search

when searching for Arabic words. For example, if we search for 'صدق', the tool will return any word contains letters of 'صدق' such as 'صدقات'.

(Dukes, 2012, 2013) developed the Quranic Arabic Corpus, which includes a Web application offering Arabic keyword search and morphological search. These two features enable users to search the Quran by any form of an Arabic word or its POS tag type, such as noun, proper noun, and pronoun. This system does not solve the problem of ambiguity in the keyword or the search results. For example, if a user searches for 'النار' (fire) the result should tell the user there are two types of 'النار': the Hell-fire and the normal fire.

3. METHODOLOGY

This section describes the procedure used to assess Quran search tools. This is achieved by selecting common criteria for evaluating different search tools. Then, evaluating the existing Quran search tools that were discussed in section 2 against these criteria. The main aim of this evaluation is to find the key causes of drawbacks and limitations in existing search tools.

3.1 Criteria for Comparing Quran Search Methods

In this section, the methodology to evaluate the Quran search tools is mainly based on search algorithms, the accuracy of the result, and Database size. (Spiteri & Richard, 2013) summarized the most common criteria in 31 articles related to methodologies for evaluation of search engines. The common measures are search features such as Boolean operators, relevance rankings, recall and precision of results, database size, response time, query type, and database contents. The detailed evaluation criteria for Quran search tools are described in table 1:

Table 1: Comparison Criteria for Quran Search Methods

Comparison Criteria	Possible values for criteria
1. Search techniques	**A.** Semantic search techniques: seek to improve search accuracy by analysing a search query in terms of user intent, the contextual meaning of query terms, and search domain. Semantic search aims to overcome the ambiguity of query words and unranked search results. This technique covers the followings: **B.** Synonym (WordNet): produces all synonyms of the query word using WordNet and then finds all Quranic verses matching these terms' synonyms. **C.** CLIR: translates words of an input query to another language and then retrieves verses that contain words matching the translation. **D.** Ontology: searches for the concept(s) matching a user query and then returns the verses related to this concept(s). **E.** Keywords Search: **F.** Letters are matching: returns verses that contain any query words. **G.** Morphological search: provides a root word search.
2. Query analyser	this is prepossessing stage of a search technique that can use to analyse user's query: A. Part of Speech (POS) B. Spelling check C. Named Entities Recognition. D. Stem, and Lemma of query words. E. The root of query words. F. Synonyms of query words.

	G. None of the above methods.
3. Quran Ontologies	these are the existing ontology of Al-Qur'an. The Quran ontology is defined as the abstract concepts in the Quran, and the relationships between these concepts. This ontology depends on the knowledge enclosed in traditional sources of Quran analysis, including the Hadith of the prophet Muhammad (peace be upon him), and the Tafsir (Quranic exegesis). A. Arabic Qur'an Corpus Ontology: (Dukes, 2012, 2013) extracted 300 concepts and 350 relations from Al Qur'an using predicate logic. The relationship types connecting concepts are Part-of and IS-A. This ontology is created based on a famous discerption book of Al Quran called 'Tafsir Ibn Kathir'. B. Qurany Ontology (Qur'an topics): (Abbas, 2009, 2013) has developed three of nearly 1,100 Quranic concrete and abstract concepts linked to all verses of Al Qur'an. She used existing Quranic topics from the Islamic scholarly book called Mushaf Al Tajweed. C. QurAna Ontology: (Sharaf and Atwell, 2012) developed an ontology for Al Quran in the scope of pronoun antecedents. This ontology consists of 1,050 concepts and more than 2,700 relations. D. QurSim Ontology: is relations between verses of Al-Quran (Sharaf and Atwell, 2012). E. Semantic Quran: (Sherif and Ngonga Ngomo, 2009) developed a Semantic Quran dataset in an RDF format representing 42 different Quran translations. F. Historical concepts: (Aliyu et al., 2014) G. Animal Ontology in Quran domain: (Khan et al., 2013) developed an ontology for the Quran in the scope of the animals found in the Quran. H. None.
4. Total number of Quranic Ontologies: used in a search tool based on list of Quranic ontology in point 3.	

5. Database size (Quran Datasets)	**A.** Quran Arabic text
	 I. Part of Quran
	 II. All chapters.
	 B. Translations
	 I. One English language translation of the original text of the Quran.
	 II. More than one English translation resources.
	 B. Arabic Language Descriptions of the Quran (Tafsirs): books written by Islamic scholars to explain and describe the meaning of each verse:
	     I. Tafsir Ibn Kathir.
	     II. Al-Jalaleen.
	     III. Al Qurtubi.
	     IV. Al Muyaser.
	     V. Al-Jaza'iri.
	     VI. More than 5
	 C. Arabic Quranic Corpus.
	 D. Quranic word meanings.
	 E. Chapters and verses revelation reasons.

6. Number of dataset types: are involved in search tools	
7. Query types	input user query type: A. One word. B. Two words. C. Sentences. D. Questions.
8. Results types	based on the kind of retrieved answer: A. Texts (word, two words, phrase, not a verse, part of description of verse). B. Verse. C. Combined verses. D. Description of verse. E. Concept(s).
9. Availability	is this tool available as an application to be used by others: A. Available. B. Not available
10. Result Ranking	how are the retrieved results ordered: A. Ranked results: ranking the retrieved verses depending on relevance to the

	conceptual meaning of the query.
	B. Not ranked: ranking the retrieved verses based on order of their chapters (chapter 1, 2, ……….114))
11. User categories	the target users for this application: A. Public (General use). B. Education C. Islamic Scholar D. Linguistics scholar
12. Search Domain Coverage	A. All Quran chapters B. Part of Quran, e.g. one or more specific chapters
13. Language of input query	A. Arabic language B. Non-Arabic language

3.2 Comparison of the different existing Quran search tools

The above 13 features described in table 1 are used to compare the different existing Quran search tools that were discussed in section 2. Table 2 summarizes the comparison results of Quran computational search tools which are discussed in section 2.

Table 2: List of evaluated Quran search tools

Quranic Search tool	1. Search techniques	2. Query analyser	3. Quranic Ontologies	4. No. of Ontology	5. Quran Datasets	6. Number of dataset types	7. Query types	8. Results types	9. Availability	10. Result Ranking	11. Systems Users	12. Search Domain Coverage	13. Language of query
Al- Bayan. (Abdelnasser et al., 2014)	A.III	A, D	A, B	2	C.I, C.V	3	D	A	B	A	A, C	B	A
(Yauri, 2014)	A.III	A, D	F	1	A.I	1	D	B, E	B	B	A	B	B
(Yahya et al. 2013)	A.II, A.III	F	A	1	B.II	2	A, B, C	D	B	B	A	A	B
(Abbas 2009, 2013)	B.I	G	B	1	A.II, B.II	2	A, B	B, D, E	A	B	A	A	A, B
(Dukes 2012, 2013)	B.I, B.II		A	1	A.II, D	2	A	A, B	A	B	A, B, C, D	A	A, B
(Shoaib et al., 2009)	A.I	F	H	0	A.I, B.I	2	A	B	B	B	A, C	B	B
(Al Gharaibeh et al., 2011)	A.I, B	D, F	H	0	A.II	1	B	B	B	B	A	A	A
(Yunus et al., 2010).	A.II	F	H	0	A.II, B.II	3	A, B	B	B	B	A	A	A, B
(Abu Shawar and	B.I	G	H	0	A.II	1	A,	B	B	B	A	A	A

Atwell, 2004)						B, C							
Quran.com	B.I, B.II	E	H	0	A.II, B.II, C.II	3	A, B, C	B, D	A	B	A, C	B	A, B
Tanzil.net	B.I, B.II	F	H	0	A.II, B.II, C.II, C.IV		A, B	B	A	B	A, C	B	A

4. CONCLUSION AND FUTURE WORK

This paper summarizes the search techniques used in existing search tools for the Quran such as desktop applications and online applications. Additionally, this paper reviews the previous research on Quran search tools. These Quran search tools are evaluated against 13 criteria. Depending on this study, several deficiencies have been found. Firstly, limitations of existing Quran search tools for retrieving all requested information. These search tools do not prompt users to search by concepts, phrases, sentences, questions or topics. Another limitation is that, most search tools used only a unique source or part of existing Quran ontologies and that affected the accuracies of the retrieved results. Moreover, no search tool aligned Quran ontologies to solve the ambiguity in the retrieved result as described in Figure. 2. Additionally, these tools do not use advanced methods to analyze the query texts by applying NLP techniques, such as parsing and spell check. A final restriction in these tools is that there is no well-formatted Arabic Named Entities lists specialized for Quran text, such as prophets' names, Allah's names, animals, times and religion; so the search tools cannot use Named Entity Recognition. Future work will develop semantic search methods which incorporate solutions to these limitations

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