Knowledge Representation of Quran Text: A Literature Review

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Abstract

The Holy Quran is the main source of knowledge for billions of Muslims around the world. Many computing studies focus on investigating methods in order to facilitate the extraction and understanding of this knowledge. The current study utilizes a research methodology consisting of seven stages to identify and classify studies related to the representation of the Holy Quran concepts. Studies are identified and classified into three categories: ontology development, concepts representation, concept-mapping/mind-mapping. Results of the content analysis of the collected papers revealed that the most common type of research is the development of Quranic ontologies to represent Quranic concepts as well as the relationship between these concepts. The study contributes to the literature as a comprehensive reference to what has been done in this research area so far.

Keywords: *Literature review; Quran ontology; knowledge representation*

1. Introduction

The Holy Quran is the religious text of Islam that was revealed to the prophet Muhammad (PBUH) by the angel Gabriel. It consists of 114 chapters divided into 30 parts (juz'). As shown in Figure 1, each chapter (Surah) contains a varying number of verses (Ayah) ranging from three verses to 286 verses. The total number of verses is 6236 verses. A wide range of concepts is enclosed in its verses. Some of these concepts are of similar (synonymous) meaning, or opposite (antonyms), or part of, or of include relationship between them. While others may be of the same letters (Homonymous) but each indicates a different meaning, this is based on the context in which this concept is written in. This is closely related to the semantic science. The semantic science is an old science that is much related to the Arabic language [1]. In this study, the objective is to understand how knowledge representation topics were utilized in the Holy Quran domain and what the current major trends in the research area are, and how the different knowledge representation-related topics have been addressed.
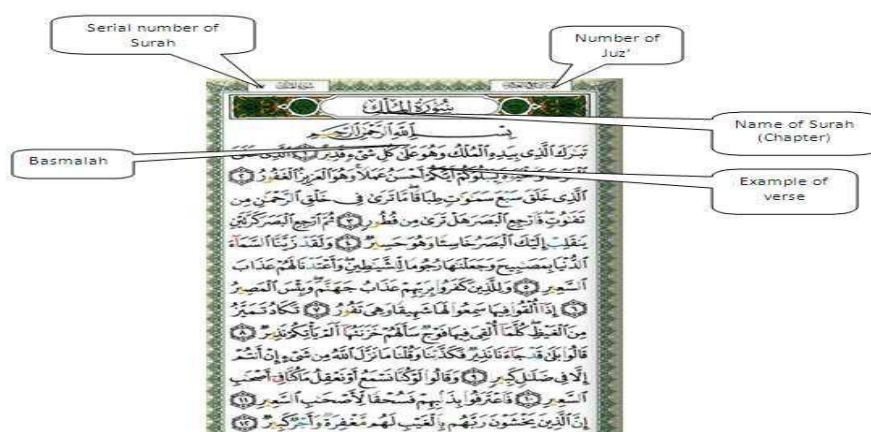
Figure 1: A graphical structure to Holy Quran components and information, Structure of Surat Al-Mulk[2]

Nowadays, Both Muslims and Non-Muslims, Arabic–speakers and Non-Arabic speakers are showing an arising interest in the Holy Quran and its sciences. For Muslims, they need to get a better and deeper understanding of its concepts. For Non-Muslims, they need an easy and clear way to get close and to understand the main concepts and relationships between these concepts in the right contexts. In this paper, the objective is to assess the knowledge representation domain and its applications in the Holy Quran domain by the means of an organizing framework and literature review, conducted with major research databases. The study identified 68 items collected from Scopus, Web of Science and Google Scholar. In addition, Google and other search websites have been used as well to collect relevant articles. The collected papers were classified and categorized to understand the focus and the current themes of the knowledge representation in Quranic research. The research questions of this paper are ''what are the current trends of knowledge representation in the Quranic research?'' and ''what is the focus in this research?''.

The rest of the paper is organized as follows: section 2 provides a survey of the related literature, section 3 highlights the research problem and describes the research method, section 4 presents the results, discussion and a detailed description of each category and subcategories, and section 5 offers conclusions, limitations, and future research directions.

2. Related Research

The objective of this paper is to examine and classify the published work in knowledge representation of the Holy Quran to identify the current status of research. This results in identifying the current status of such research and opens the door for new trends. Few researchers have reviewed literature for knowledge representation in the Holy Quran domain. However, none of these researches were comprehensive enough to cover the topic. Some investigated the application of some specific computing field branches, while others poorly reviewed a very limited set of literature. In summary, none of these researchers, to the best of our knowledge, had provided an elaborated comprehensive review of the literature. For example, Alqahtani and Atwell [3] reviewed the literature on the search techniques used in existing Quranic search tools, Quranic search applications and research on the ontology of the Holy Quran and highlighted on the main limitations exist in such tools and ontologies. The review in this study was limited because it reviewed only 10 Quranic applications

covered only five Quranic studies on existing Quranic search tools and 7 studies on developing a Quranic ontology. Existing ontology-basedQuranic research was reviewed by Ahmed et al. [4] for reviewing the literature, the authors proposed an authentic framework for ontology applications. The framework consists of six components namely the purpose, role, actors, representation of meaning, supporting technologies and maturity level of the ontology. The framework components were utilized for comparing existing research on Quranic ontology. The review was limited because the framework was utilized for comparing a small number of studies (11 studies). Similarly, Arabic ontology-basedresearchwas reviewed by Al-Zoghby et al. [5]. The study surveyed the research that addressed the construction or the usage of the Arabic ontologies. The study also reviewed research that used the Arabic WordNet (AWN) or intended to improve it as an alternative to the ontology. The review included a few Holy Quran and Islamic Knowledge semantic representation studies as the main focus was on the Arabic language. The development of Quranicontology-based semantic Quranic research in the literature was reviewed by Farooqui and Noordin[6]. The review highlighted the main challenges face researchers in designing ontologies and in selecting tools and evaluation techniques. The review was very limited as only 9 studies were reviewed.

3. Research Problem and Method

In this study, the research problem is to review the existing computing studies that address the knowledge representation of Quranic text in order to identify the research trends in such area. A content analysis approach was utilized to understand, analyze and classify the existing literature. The current study research methodology consists of seven stages as shown in Figure 2. This approach was also used by Amani and Fadlalla [7].

Stage 1. Identifying the scope of the study: This study focuses on the knowledge representation-based academic research

Stage 2.Identifying the search criteria: keywords that combine both Quranic related research and computing field-related aspects were used as search terms to retrieve the relevant studies. The Holy Quran is translated in different ways such as Quran, Qur'an, Koran and Kur'an. Holy Quran-related keywords: Quran, Qur'an, Koran, Kur'an, were used in combination with any of the following search terms such as Ontology, concept (s), visual, representation, knowledge representation and text.

Stage 3.Identifying the data sources: data sources such as Scopus, ABI-INFORM, Science Direct, Web of Science and Google Scholar were used in the search process. Google and other search websites have been used as well to collect relevant articles.

Stage 4. Article collection: articles were collected from the data sources identified in stage 3 using the search terms identified in stage 2 without any limits on the date of publication.

Stage 5. Article filtering: A manual filtering process was conducted to include only papers that satisfy the following inclusion criteria: (1) papers that describe any aspect related to knowledge representation in the Holy Quran domain such as developing Quranic ontologies, Representation of Quranic concepts, using concept-mapping or mind-mapping in teaching Quranic topics, …etc. (2) papers that provide a review of the literature in any of the given search combinations were included. (3) papers exist as references in the collected review papers those satisfying the current research scope and the search combinations were

also collected as well in order to ensure the comprehensive nature of this study. A total of 68 Papers satisfying any of the three identified inclusion criteria were collected.

Stage 6. Content evaluation: the content of each collected paper was inspected using both manual and automated process. The automation was in the selection of a reference manager software, Endnote software (Endnote X7), to collect the bibliographic details including author(s), publication date, title, journal, volume, issue, and pages. The manual process was undertaken to cluster and classify each paper according to:

Knowledge representation sub-topics (ontology development, concepts representation, concept-mapping/mind-mapping and others).

Stage 7. Summative tabular representation: for each study related to a topic/sub-topic, a set of information fields were extracted from each study such as study objective, methodology, results, and limitations.

Table 1.Knowledge representation topic and sub-topics covered in the Quranic literature

Knowledge Representation	No. of studies
Ontology development	25
Concepts representation	20
concept and mind maps	13
Others	10
Total	**68**

68 distinct papers were retrieved as shown in Table 1. Literature review papers, as well as other related supporting papers at each sub-topic, are counted under "others".

4. Results and Discussion

Knowledge Representation (KR) is an artificial intelligent field that focuses on how knowledge can be represented in a symbolic format. KR is much related to both conceptual and ontological domains [8] where both building an ontology for a specific domain of knowledge is an important task as well as representing it in a graphical readable method. Under this topic, two sub-topics namely Ontology and graphical representation related research were identified.

4.1. Ontology Development

Concepts are considered to be the backbone of any science. Understanding a concept paves the way to understand another concept, which in turn helps to understand another…etc. Our Knowledge acquisition in any field can be measured by the amount of our understanding of a set of concepts as well as our understanding of the relationships between these concepts. Using Information technologies can improve our vision towards knowledge acquisition in terms of the accessibility, easiness, and visualization of knowledge.

Ontologies are ways needed for establishing a customized formal vocabulary of concepts to be used in a specific domain and to be shared among applications [9]. Due to the significant importance of the role of ontology in the retrieval and presentation of the Quranic text and having it as a basis of most knowledge retrieval of the Holy Quran systems, applications, there is an evolving trend to summarize and compare the existing proposed ontologies.

Start

Stage 1: Identifying scope: Knowledge representation of Quranic text

Stage 2: Identifying search criteria:
Holy Quran-related keywords:
Quran, Qur'an, Koran, Kur'an,

Computing -related keywords:
Ontology, concept (s), visual, representation, knowledge representation, text.

Stage 3: Identifying data sources:
Scopus, ABI-INFORM, Science Direct, Web of science, Google Scholar, Google

Stage 4: Article collection
Articles are collected according to stage 2 and 3

Manual filtering

Stage 6: Content evaluation
Articles are classified to knowledge representation sub-topics

Stage 5: Article filtering
Inclusion/Exclusion criteria:
Does the article:
(1) papers satisfying the search combinations
(2) papers that provides a review to the literature in any of the given search combinations
(3) papers exist as references in the collected review papers those satisfying the s current research scope and the search combinations

Yes

Stage 7: Summative tabular representation of articles
Data extraction (e.g. study author(s), objective, methodology and results/limitations/others)
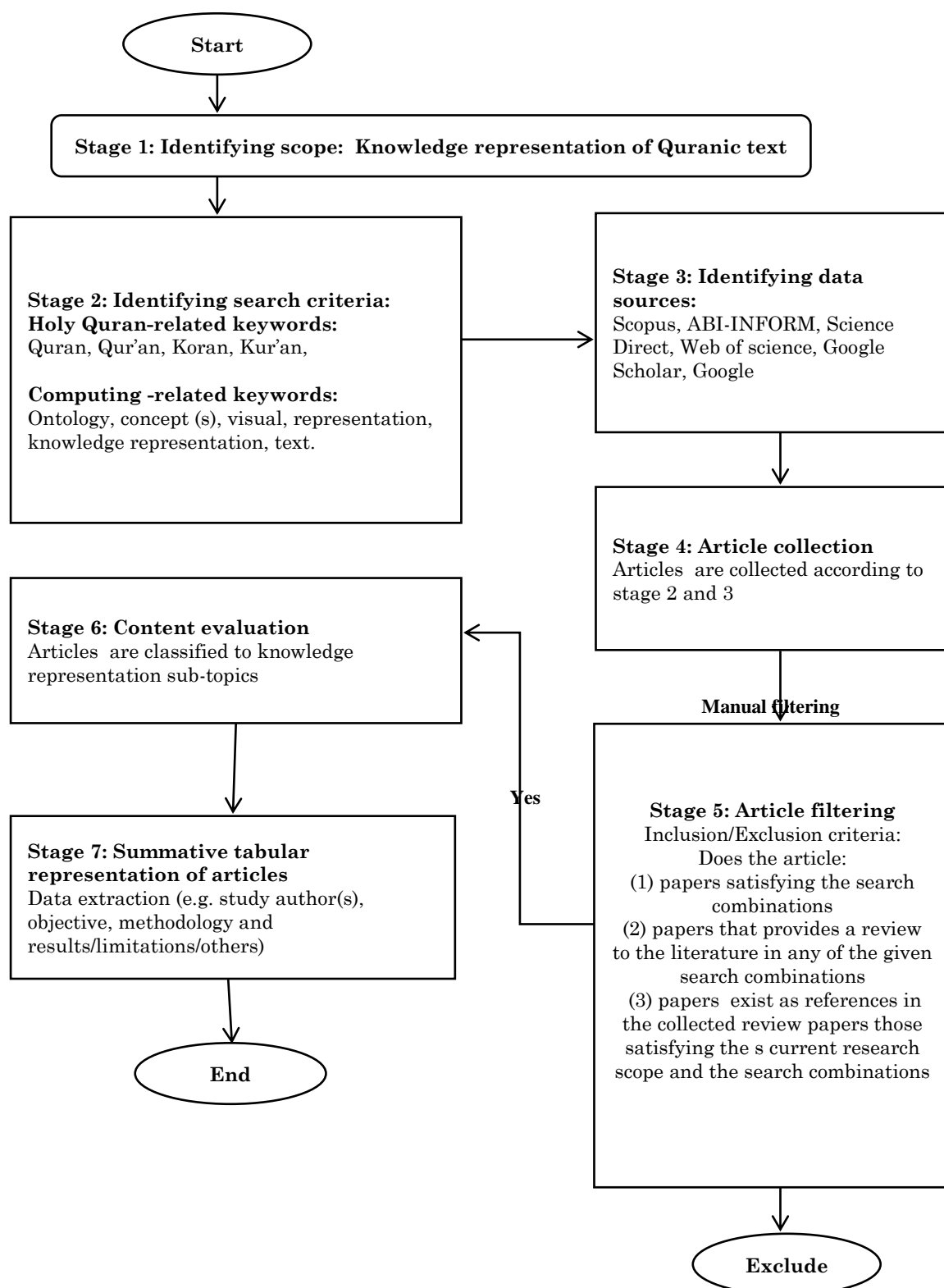
End

Exclude

Figure 2: Research methodology

Ahmad et al. [5] summarized and compared 11 Quranicresearch-based ontologies for 8 criteria which are Purpose or benefits, Role of ontology, Supporting technology, Actors, Maturity, Neutral Authoring, Common access to knowledge and Indexing for search.

Alrehaili and Atwell [10] compared 12 of the existing computational ontologies for semantic tagging of the Holy Quran according to 9 criteria which are Quranic text language (Arabic, English and Malay), Coverage area (specific topic), Coverage proportion (Entire the Qur'an (A), Some parts (B) and Specific topic (C)), Underlying format (plain text, XML files, and RDF or OWL), Underlying technology used (tools), Availability (Yes (A) or No (B)), Concepts number (number of abstract and concrete concepts in the ontology), Relations type (Meronymy (Part-of) (A), Synonyms (similar) (B), Antonymy (opposite) (C), Hyponymy (subordinate) (D)) and Verification method used (Domain experts scholarly sources (Bin Kathier)).

With regard to the Arabic Semantic Web (ASW) based Applications, Al-Zoghby et al. [5] surveyed the Arabic ontology-basedresearch that addressed the construction or the usage of the Arabic ontologies as well as Arabic WordNet (AWN) based research that used or intended to improve it as an alternative to the ontology. The review included a few Holy Quran and Islamic Knowledge semantic representation studies as the main focus was on the Arabic language.

As a part of the objectives of the current research, and following other scholars in reviewing literature for Quranicontology-based semantic Quranic researches, 25 ontology-basedresearch are summarized and compared for 4 criteria (objective, Scope, Relationship types and the limitations) as shown in Table 2.

Table 2. Ontology-based research

Citation	Objective	Concepts Scope	Relation-ship Types	Limitation(s)
[11]	Developing an ontology to retrieve relevant verses from the Holy Quran for given keywords.			The search criteria are restricted to a given set of keywords.
[12]	SemQ- Developing A framework for recognizing and identifying semantic opposition terms in Quranic verses. It uses Natural Language processing and uses the domain ontologies (Semantic Web technologies)			The ontology works well for concrete concepts, nouns; but it didn't work well with abstract concepts and concepts that have polarities (Al-Khalifa et al., 2012).
[13]	Developing an ontological model (data-driven model). Two approaches for building Quranic ontologies; class-based ontology and an instance-based ontology, were evaluated to be used in building a Quranic ontology for Quranic words.	The time nouns in the Holy Quran (in 18 classes).	Lexical relations 1- Is_a 2- Sub-class 3- Has	1- The ontology is restricted to the Holy Quran "time" noun vocabulary that is associated with the Arabic language vocabulary. 2- The study didn't conclude definitely with the best suitable approach for building a Quranic ontology for Quranic words. However, it emphasized that instant based approach is easily scalable while the class-based approach has more efficiency.

Table 2. (Continued) Ontology-based research

Citation	Objective	Concepts Scope	Relationship Types	Limitation(s)
[14]	Evaluation of the SemQ linguistic ontology by formulating evaluation questions related to the inner structure of the ontology.			
[15]	Developing ontology-based model for Arabic language vocabulary for the place nouns in the Holy Quran using Web Ontology Language (OWL) and the Protege-OWL editor.	The "Place Nouns" in the Holy Quran	Semantic relations such as: 1- Is_a 2- Is part_of 3- Is located_in 4- Has_part 5- Is_synOf 6- Same_as 7- Is kindOf 8-isinAreaOf	The ontology is restricted to the place noun dimension in the Holy Quran. The ontology was not used or tested in an implemented IR application to the Holy Quran text.
[16]	To develop Quranic topics Ontology	Nearly 1,100 Quranic concrete and abstract concepts linked to all verses of the Holy Quran	An aggregation relationship	The hierarchy of concepts is non-reflexive, nonsymmetric, and transitive (Alqahtani& Atwell, 2016).
[17]	To develop Arabic Quran Corpus Ontology	300 concepts and 350 relations extracted from the Holy Quran	Use predicate logic: 1. Part-of 2. IS-a	Limited in scope as it is mainly about the morphological annotation in the Holy Quran in accordance with the rules of the Arabic language. Further annotations are required to expand the work.
[18]	To develop QuranAna ontology in the scope of pronoun Antecedents.	consists of 1,050 concepts and more than 2,700 relations	1. Has antecedent 2. Has-concept 3. Has–a segment	A limited layer of annotation (only pronoun annotations for the entire Holy Quran). Other layers are needed.

Table 2. (Continued) Ontology-based research

Citation	Objective	Concepts Scope	Relationship Types	Limitation(s)
[19]	Merging 3 Quranic ontologies proposed by Abbas (2009) (Quranic topics), Dukes (2013) (Arabic Quran Corpus) and Muhammad (2012) (QuranAna) in order to 1.Help in understanding the concepts of the Holy Quran 2.Increase the coverage of the domain of the Holy Quran in various scopes. 3.Enhance the knowledge extraction from the Holy Quran.			The proposed combined ontology is not tested and evaluated by the researchers yet.
[20]	Applying the concepts of the ontology of semantic web for Creating ontology for conducting a semantic search in Holy Quran	The ontology is based on animals and birds mentioned in the Holy Quran		The created ontology is restricted to the domain of animals in the Holy Quran. This ontology was used to develop a Quranic semantic search tool
[21]	Developing an ontology of English translation of the Quranic text	English Quran Corpus		The developed ontology doesn't reflect the patterns in the Arabic language,
[22,23,24,25]	Automatic generation of an ontology of Islamic knowledge by a proposed system.	374 concepts/instances		The designed system focuses on verses that involve the Salat or prayer phrases in the Holy Quran while no other concepts are tested.
[26]	Al-Quran Ontology is developed to represent themes of the Holy Quran	Theme-based approach		The developed ontology is restricted to 2 Quranic themes Iman and Akhlaq
[27]	Al-Quran Ontology is developed to represent themes of the Holy Quran	Theme-based approach		1. The developed ontology is restricted to 2 Quranic themes Faith, Deed 2. The developed theme-based ontology is restricted to the Malay language.

Table 2. (Continued). Ontology-based research

Citation	Objective	Concepts Scope	Relationship Types	Limitation(s)
[28]	Al-Quran Ontology	Themes of the Holy Quran	1. Can be 2. Has 3. Is that 4. By way 5. Is a	The search is tested by using only one pre-defined test case (Allah) to test one theme with its sub-themes
[29,30]	1- QurAna corpus; 2- "QurSim" dataset	QurAna corpus consists of pronoun antecedents in the Holy Quran (24,000 pronouns with their antecedents) And 1,050 concepts and more than 2,700 relations(Alqahtani and Atwell, 2016b) "QurSim" dataset consists of more than 7,600 pairs of related verses based on their similarity	1. has-antecedent 2. has-concept 3. has–a-segment.	This QurAna corpus was developed for classical Arabic text. "QurSim" dataset was built based on scholarly works and has a challenge with verses varied in size and the ability to link 2 long verses together.
[31]	Proposing an approach for the automatic generation of Quranic ontology. Concept/instances and relations were extracted from an English translation of the Holy Quran	Salat related verses	1- Is part of 2- Is-a 3- Believe(4- give 5- Fulfill 6-Givewealth to 7-Accept 8-SeekHelpin 9-Perform 10-Obey 11-Fear	The scope of the proposed ontology is limited to Salat verses

Table 2. (Continued) Ontology-based research

Citation	Objective	Concepts Scope	Relationship Types	Limitation(s)
[32]	A system for Islamic ontology extraction based on a hybrid method that combines lexico-syntactic patterns and association rules for the English translation of the meaning of the Quranic text	English translation of the meaning of the text of the Holy Quran	A- Taxonomic Relations Extraction 1- IS-A relation pattern 2- Compound Nouns Relations Such as: - The N1N0 - N0'sN1 - NP→JJ, NP0 - head of Noun where N0 is-part-of N1N0 /The N0 of N1 B- Non-Taxonomic Relations Extraction 1- Subject Verb Object Relations 2- Association Rules	The proposed system scope is limited to the English translation of the meaning of the Quranic text.
[33]	Building an axiomatic Quranic ontology Proposing a sound ontology learning technique	An English translation of the meaning of the Quranic text [34] was utilized to develop the proposed axiomatic ontology	1- is_a 2- has 3-does / perform(4-give 5-fulfill	This research is still in progress.

Table 2. (Continued) Ontology-based research

Citation	Objective	Concepts Scope	Relationship Types	Limitation(s)
[35]	Building a Quranic ontology called "QuranOntology"[http://quranontology.com] to facilitate semantic search in the Holy Quran. The ontology was created using Protégé-OWL. SPARQL queries were used to query the ontology. A search engine was developed by utilizing this ontology.the developed search tool can conduct various types of search including Search by word, by root, by synonym, in topics, by a pronoun,and by Tafsir.	The ontology covers the pronouns in the Holy Quran text in order to define their antecedents. then concepts like people, events, and places cited on the Qur'an were also added to the ontology. the ontology describes 11000 resources using over 1 million RDF triple.	topic extraction approach was used to create the ontology. Ontology classes are Topic, Chapter, Verse, Word, PronounRef, Living Creation, and location. Relationships include: 1- Is a 2- Has part 3- Is part of 4-Refer to object 5-Refer to 6- Discuss topic	The developed search tool only supports the Arabic language. The user is allowed to query the search engine using only text written in the Arabic language.
[36]	Applying Ontological Modeling on Quranic "Nature" Domain. SPARQL-OWL queries were used to retrieve relevant verses and concepts from the predefined Quranic domain ontology.	"Nature" Domain in the Holy Quran	1- Is part of 2- Has part	The proposed ontological model was applied limitedly on a single Quranic domain, the "nature" domain.

Ontology-based information retrieval is a semantic-based technique which depends on the meaning of the concept in the context in which it exists then retrieves the relevant verse(s). The synonyms-set technique [37], and the cross-languageinformation retrieval (CLIR) technique[38] are other examples of the existing semantic based techniques [39]. The construction of ontology is developed in different languages as a way to define a set of concepts and the relationship between them to be used by other systems or search [40].

Extracting ontologies from the Holy Quran is not an easy task. The existing ontologies were either extracted or constructed manually or automatically. While the manual extraction and construction guarantees a high level of accuracy but at the same time is very costly in terms of time and efforts. The automatic extraction and construction of the ontologies from the Holy Quran have been a core research area in the literature [2]. The created ontologies may lack some features such as the contextual information that is necessary for understanding each concept according to the context in which it exists. Iqbal et al. [41] addressed this feature when developed Juz' Amma based ontology, which is the last chapter of the Quran. The

Contextual information includes the Quran exegeses or Tafseer and also Hadiths. Alfonseca&Manandhar's and Gupta &Colleagues's are two approaches used for extracting ontologies (Ontology learning) from the Quranic text. Yong et al.[42] proposed an assessment system for evaluating these two approaches against the manual text extraction (Gold Standard) method. The results of the assessment revealed the shortcomings of the two methods and the difficulty to combine them.

As can be seen from the reviewed ontology-based literature, only the focus is on words (concepts) in the Holy Quran regardless of the context in which those words are used for. In this study, a comprehensive methodology will be adopted to link concepts in the same context together by identifying the relationship among them across the Holy Quran. For example, although the word "الغيث" and the word "المطر" could be retrieved from an ontology-based search engine if any of them is entered to the engine as input, however, the context in which each word exists is totally different in meaning. We can see that the word "الغيث" is mentioned in goodness context while the word "المطر" is used in the punishment context [43] (translated from the Arabic original).

From all the previous detailed approaches, it can be inferred that there are several ways to search the Holy Quran such as searching by indexing, metadata, content-based, semantic, keywords and ontologies. The most popular ways of retrieving knowledge from the Holy Quran are keyword based retrieval and semantic-based retrieval [39]. Most of the evaluation of these approaches and tools are based on the precision and recall method. One of the common limitations of all the ontology-based approaches for searching the Holy Quran is the lack of the retrieval of relationships between concepts across the Holy book. Another limitation is that the most of the proposed ontologies of the Holy Quran come in different format and scope and also deal with a specific part, chapter, while fewer developed ontologies cover all chapters of the Holy Quran [10]. The existing ontologies can't be aligned with each other the thing that forms another limitation [39].

Some of the Quran based ontologies had been adopted by other researchers to generate ontologies in a different scope. The SemQ ontology proposed by [44] had been adopted to develop a linguistic-based ontology from of the Arabic version of the Wikipedia [45]. A total of 760,000 triples had been extracted using different types of relationships between concepts like Has Category (له تصنيف), Is Related To (له علاقه ب), Has Feature (له سمه) and Has value (له قيمه).

4.2. Concepts Representation

There is a number of researches in the Holy Quran utilize some of the different representation methods as a complementary part of a given feature such as representing an output of a system, module or search results (e.g. [46-49], or in representing Quranic corpus and ontologies (e.g. [50]) and others. In the current review, 20 studies are detailed and compared to each other in terms of their representation method, objective and limitations as shown in Table 3.

Table 3.Quranicconcepts representation-based research

Citation	Representation Method (s)	Objective(s)	Limitation(s)
[50]	AFS (Apriori for Frequent Subpaths) Frequent sub-path mining algorithm	Graphical representing of theQuranic text corpus	Although the produced frequent patterns can be used for indexing and clustering similar Quranic verses, both finding frequent subtrees of a collection of trees and the level of abstraction and inheritance are not covered by the algorithm [51].
[14]	1. Class-based ontology 2. Instance-based ontology	Developing two approaches for building Quranic ontologies based on the field of componential Analysis.	1. No practical implementation of the proposed approaches is presented. 2. It contributes to the literature as a planned application.
[52,53]	Quranic Arabic Dependency Treebank (QADT). A dependency graph to visualize Quranic Grammar online at (http://corpus.quran.com).	1. Use contextual links to provide a graphical visualization of syntax using dependency graphs 2. Provides additional links to other online grammatical analyses for the Quranic verse at related Arabic grammar and Quran websites.	1. Limited in scope as both more refined segmentation rules adapted from traditional Arabic grammar and further morphological annotation is required. 2. The visualization is restricted only to the grammatical relationship between text components. The visualization of the relationship between concepts is not addressed.
[49]	Concept map	Is created as an output of the Tokenizer and Sentence splitting phase in the Language Processing Agent in the proposed system	1. Deals with the Separate individual. 2. It is just an intermediate step that is aggregated later with other outputs to form an ontology. 3. The presentation is not an ultimate goal.

Table 3. (Continued). Quranic concepts representation-based research

Citation	Representation Method (s)	Objective(s)	Limitation(s)
[48]	Force-directed graph (FDG)	Is created as an output of the search result. It includes the concepts that are either found in the query terms or in the returned verses text	The presented graph is poor in terms of the relationship between concepts across all the retrieved verses (both the type and direction of relationships are not clear). Moreover, this feature is not working on the website of the proposed system.
[54,55]	Interactive scatter plots and tables.	Scatter plots and tables are created as a graphical representation of the search results.	The presented scatter plot graph is poor in terms of the possibility of clearly reading the results (extremely crowded).
[38]	Using SpaceTree to visualize retrieved documents for a speech query and vice versa.	Visualizing Quran Documents Results by Stemming Semantic Speech Query (SSQ)	1- Multiple inheritance, Role relations, and properties are not supported by the graph [56,57] 2- For many retrieved results, The graph could be so crowded and limited to the screen space [58]
[59]	Using Mashup website to visualize the Quran verses with their metadata and annotations	An annotated meta-model is used to represent the knowledge base created from the Holy Quran religious text, maintained by a Content Management System and visualized by Mashup website.	The limitations of the Web Mashup are as follows [60]: 1. The quality and the features of the application component is not guaranteed by the user. 2. Scalability issue which is very important in the case of the Holy Quran Knowledge where the knowledge gets bigger and bigger.

Table 3. (Continued). Quranic concepts representation-based research

Citation	Representation Method (s)	Objective(s)	Limitation(s)
[61]	Semantic Network	Representing the Female Related issues from the Holy Quran using semantic network	1. The main problem of the semantic networks is that different levels of abstraction are mixed together (concepts/relations/examples/values) 2. There is no standard about concept nodes values. 3. There is no formal semantics
[62]	Concept hierarchy	1. Organizing the main concepts of the Holy Quran hierarchically by using term reduction approach. 2. Compares the data reduction methods, the entropy method, the transition point method and the hybrid of transition point and entropy methods with the Vector Space Model (VSM).	1. The representativeness percentage is only 45.14 %. 2. The approach is tested only on a very short text from a set of Quran corpus from Al-Bayan CD-ROM
[63]	Mind Maps	Using Mind Maps for improving the memorization of the Holy Quran in a Quranic memorization application	1. Hard to be understood by others and always radial [64] 2. The absence of clear links between concepts as failure to representing complex relationships between these concepts [65].
[66]	A computer font for writing the Holy Quran according to ALDANI Uthmanic script	Unicode Encryption was used to generate the proposed computer font (ALDANIQuranic font).	The estimated time duration to write the whole Holy Quran using this technique is long and depends on the number of the writers to be included in the writing process.

Table 3. (Continued) Quranic concepts representation-based research

Citation	Representation Method (s)	Objective(s)	Limitation(s)
[67]	AQILAH: A Visualization system for Quranic text	Using a dialogue-based information system for the visualizationofQuranic text. It retrieves the relevant content based on a need-to-know basis The system adopts a simple keyword-based parsing to parse the human natural language text input. Then it responds in natural language.	The visual output of Quranic text of the proposed system prototype was not provided in this study.
[46]	Quranic code system for representing the Holy Quran (Rasm Al-'Uthmani)	Quranic Code was generated in three levels: 1- character level translated by extracting all the Arabic characters with all diacritics available in the Holy Quran and adding a new character that has a symbol in the Holly Qur'an (Rasm Al-'Uthmani) 2-Word level: translated by extracting all the duplicated Words and then generating a special code for these words. 3- Phrase level: extracting all similar patterns of variable lengths using N-GRAM and fast pattern extraction algorithm, Lempel, Ziv, and Welch (LZW).	There is a drawback in using LZW technique in the phrase level as the shortest pattern may be repeated in the longer pattern.

Table 3. (Continued) Quranic concepts representation-based research

Citation	Representation Method (s)	Objective(s)	Limitation(s)
[61]	A conceptual graph (CG) and Semantic Network were utilized to represent concepts related to female issues in the Holy Quran	(i) identifying appropriate Quran search engine website, ii) verse extraction, (iii) verse analysis and issue identification, and (iv) development of Semantic Network and CG representations. 18 female related concepts were identified in this study including an aunt, consort, damsel, daughter, divorcee, female, girl, lady, maid, maiden, mother, niece, queen, sister, whore, widow, wife and woman. Issues related to these concepts were identified and represented in CG and semantic network.	CG representation scheme is more complex compared to Semantic Network The Semantic network provides less clarity than CG particularly in issues that require logic predicates and calculus.
[68]	Parallel plot visualization technique	the parallel plot visualization technique in the Parallel Coordinate for the Qur'an (PaCQ) interface was used to visualize Quranic words and was compared against the scatter plot visualization technique.	The parallel plot did not score well in the graphical perceptibility among users who found that it was difficult to understand.
[69]	A web-based visualization application prototype using the new element of HTML5 (SVG)	The Visualization of Indonesian Translation of the Holy Quran Index	This work is still in progress. This is an initial study.
[70]	Frame semantics (FrameNet frames)	Building a knowledge representation model of the Holy Quran, FrameNet frames, for Arabic Quranic verbs in an attempt to build a Quranic corpus linguistics	The proposed FrameNet is still under development and the work faces many challenges such as the representation of idioms and metaphors as well as the automation.

For further research, some of the existing applications like Conceptual Knowledge Markup Language (CKML) application [71] which uses XML to represent ontology can be further investigated for its suitability to representing the Holy Quran ontology.

4.3. Concept and Mind Maps

Concept map is a research tool and instructional technique that can be utilized for an effective meaningful learning. According to Ausubel's learning theory, the researchers stated that meaningful learning is achieved when learners are able to relate new knowledge to relevant concepts they own [72]. In the current study, 12 studies in the Arabic language were collected and identified, although these studies are unpublished work, these studies contribute to identifying the current and future trends in applying knowledge representation techniques in order to improve learners' performance in the Quranic field. There are three observations about concept mapping studies [73-84]. Firstly, the usage of modern methodologies like Concept Maps in the research field of the Holy Quran had been limited to teaching the Islamic sciences courses like "Al-Fiqh (مادة الفقه)" and Islamic studies course (مقرر التربية الاسلامية). Secondly, the majority of these researcheswere conducted by graduate students for the fulfillment of the requirements for their Master or Ph.D. degrees. Thirdly, all of those studies were conducted in Arabic-speaking countries as the majority of those studies were conducted in Saudi Arabia.

According to [85], a mind map is a non-linear learning technique to represent knowledge using a central image that represents a main concept/issue then branching it to many branches where more related concepts are connected to it the same way as the human brain. From the collected literature, and in a unique effort to use the evolving knowledge representation techniques to represent the main themes of the Holy Quran chapters, Alsahibany[86] used mind maps to graphically represent each chapter of the 114 chapters of the Holy Quran.

5. Conclusions, Limitations and Future Directions

In this study, the objective was to understand the current major trends in the knowledge representation of Quranic text, and how the different knowledge representation topics have been addressed. The review reveals the current status of the knowledge representation in the Quranic domain. Three knowledge representation sub-topics were identified, ontology development, concepts representation, concept-mapping/mind-mapping. Such representation of Quranic text serves the goal and focus of any Holy Quran research in terms of understanding, representing and searching Quranic text.

The findings of this review can be summarized in three points. Firstly, this study contributes to the literature as a comprehensive study that can be considered as a reference for studies that employed knowledge representation topic/sub-topics in the Holy Quran domain. Secondly, it is believed that this study is unique in its representation of the literature in categories illustrated in a tabular form. Thirdly, the findings of the content analysis of the collected publications provide indications of the current and future research trends in such research.

This research may have some limitations. The data collection can't be claimed to be perfect. In other words, other research keywords/terms could have been used to identify the relevance of the literature. The comprehensive study was very limited and didn't cover many aspects of the topic. Arabic publications are very limited and many of them are not indexed in

different digital libraries. Most of the Arabic publications reviewed in this study were collected by personal communications and by searching local databases in some organizations like "Arabic Saudi Organization/ الهيئة السعودية العربية" and some local conferences particularly in Saudi Arabia (2013 Taibah University International Conference on Advances in Information Technology for the Holy Quran and Its Sciences, NOORIC 2013). Furthermore, the manual classification method can be considered problematic, since the retrieval of relevant items depended on the existence of the used search criteria in the titles and/or abstracts, and the entire process relied on the availability of such data.

Based on the results, the most dominant type of research domains of knowledge representation in the Quranic research is the development of Quranic ontologies, concepts representation, and concept-mapping/mind-mapping. Currently, the trendiest area of knowledge representation of Quranic text is the development of Quranic ontologies to represent Quranic concepts as well as the relationship between these concepts. We think the reason for that is the existing difficulty in searching traditional Quranic dictionaries such as Fouad Abdelbaqy dictionary. Searching in such dictionaries requires the usage of word root the thing that many people find it very difficult due to the nature of the Arabic language as a semantic language unlike the English language where stemming is different. In the Arabic language, many words can be generated from a root of a word like " كتب، كتاب، كاتب، مكتبة، مكتب ". This is totally different from the English language where some words root can be used to generate none or a very few and a limited number of related words. Similarly, the knowledge representation is the main goal of most ofthe recent types of research not just in the Holy Quran domain. Learners seek an easy and meaningful way to understand the knowledge especially visual representation of knowledge.

Analyzing the literature to identify how the computing field can benefit in other domains and disciplines in order to improve the knowledge acquisition and representation for learners is an idea for future work. Other future research directions include (1) enhancing the data collection methodology utilized in this study. (2) Automatic or semi-automatic document filtering, summarization, and classification. (3) Application of artificial intelligent techniques in handling Quran Interpretation (Tafseer). (4) Handling of different Quranic readings.

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