Representation Of Exceptional Sentence Using Conceptual Graph Interchange Format

Suaad Abdelsalam Alsanousi
Sebha University, Libya

Ku Ruhana Ku-Mahamud
School of Computing
Universiti Utara Malaysia,
Malaysia

Aniza Mohamed Din
School of Computing
Universiti Utara Malaysia,
Malaysia

Abstract—**This paper proposes a technique for representing the exceptional clauses of female-related issues in the Holy Quran. Verses are first extracted from www.surah.my, based on 18 female terms. Phrases abstracted from the verses are classified into one of the female issues. The exceptional sentences are then extracted based on the word "except". Using conceptual graph interchange format representation, a conceptual graph for each issue is constructed. The quality of the representation of exceptional sentences of the female issues are evaluated by using reasoning rules, which involved 240 phrases and 12 exceptional sentences that had been extracted from 228 verses. The findings rated that the proposed technique for exceptional clause has more useful reasoning than representing as a normal relation. The study suggests that the exceptional term is important for phrases classification and retrieval.**

> *Keywords— knowledge representation, conceptual graph interchange, natural language processing, exceptional clause, female issues.*

I. INTRODUCTION

Representing complex sentences is a challenging task that involves natural language understanding. Different aspects of complex sentences such as conditional sentences, exceptional sentences, and question sentences need to be considered [1]. The conditional sentences have been addressed in the literature.

Knowledge representation is a set of conventions about how to describe a class of human knowledge for the purpose of automatic processing. Over the past years, a wide variety of Knowledge Representation (KR) formalisms has been developed. In general, these formalisms fall into two categories. First, those that follow a "logical approach" like Description Logic [2], provide a general reasoning machinery and a representation language, which is usually a variant of the first-order predicate calculus. Second, those that follow a "non-logical approach" like Semantic Networks and Conceptual Graphs [3], which use graphical interfaces that enable knowledge manipulation according to ad-hoc data structures. A structure describes constraints on how the symbols can be arranged. However, graphical structures have some advantages over linear notations in both human factors and computational efficiency. Graphs also have a highly regular structure that can simplify many algorithms for reasoning. In the graphical representation, conceptual graphs (CG) are often identified as a key tool because of their simplicity and expressiveness [4].

In [4], the representation of conceptual graph models is presented in different concrete notations. For example, graphical notations, such as the conceptual graph display form (CGDF). A graphical notation is designed to enhance readability while representing the abstract syntax as closely as possible. A textual notation such as the first conceptual graph linear form (CGLF) is for the representation of common logic syntax, which has some similarities with conceptual graph interchange format (CGIF) [5]. The second CGIF is designed for communication between computer systems and was employed by Sowa for International Standards [6]. CGIF is appointed as the representation language for conceptual graphs to interchange CGs models between IT systems and across networks that use conceptual graphs as their various internal representations [7].

In the extended CGIF [4], special contexts have been defined. The representation of Boolean operators was defined in terms of negation and conjunction. To represent the negation, a CG should be included in a negation; while for the representation of conjunction, a CG should be included in the same context. In addition to that, another special context was defined in terms of the combinations of negation and conjunction, whereby semantics were defined by translation rules that convert them to the basic CGIF notation [7].

Several studies analyzed the semantics of exceptional phrases and displayed the exceptional rules. For example, the study of [8] as well as the works of [9][10], explained the exception and generalized quantifiers. Their works focused on describing the base of exceptional sentences. On the other hand, another study that addressed the exception in jurisprudential rules and mentioned controls is the study of [11]. In addition, [12] extended conceptual graph formalism in order to represent the default taxonomic knowledge and exceptions as part of the descriptions of concepts.

However, CGIF did not have a technique to deal with exception. The type labels in CGIF are used only to restrict the range of quantifiers. The absence of the representation of exceptional sentences may affect reasoning and information retrieval. There is a need for a representation that contains the restrictions that are

able to exclude some concepts from the sequences of symbols according to a specific situation.

This work is focused on representing exceptional sentences. The motive that these sentences are important is because they help to recognize the nature of the subject. The provisions of jurisprudence are not general and may be under the exception. Hence, the representation must be able to present the exclusions on some of the provisions to avoid confusion in reasoning. In this context, exception means removing some elements from their category to specialize what is being under generality. Thus, how can CGIF be used to exclude an element from the category?

The remainder of the article is structured as follows. Section 2 presents the case study for the research. Section 3 presents the research methodology of the study. Section 4 discusses the representation of exceptional sentences. Section 5 describes the results and discussion. Section 6 concludes the study and suggests the lines of future work.

II. FEMALE-RELATED ISSUES IN THE HOLY QURAN: A CASE STUDY

The Holy Quran is the basis of all beneficial knowledge, which has prescribed a law fully to the lives of Muslims. Its verses provide the guidelines and instructions in worships, moralities, and transactions. The issues of women in the Quran sources discuss the matters from which every Muslim woman derives her rights and duties.

Collecting and classifying knowledge related to female issues in the Quran and distinguishing between the general and special provisions is a key part in presenting an integrated visualization for figuring out these issues. Unfortunately, extracting an integrated concept on those issues needs a lot of effort. This article presents the provision of representing the exceptional clause to specify from the generality of the female issues in the Quran.

There are several Surah (chapters) that have entire contents that address female issues, for example An-Nisaa, Maryam, At-Talaaq, At-Tahriim, and An-Nuur. The verses that are related to female issues can be identified using female-related terms, such as aunt, consort, damsel, daughter, divorcee, female, girl, lady, maid, mother, maiden, niece, queen, sister, whore, widow, wife, and woman. While these terms refer to the verses that are related to female issues, there is a need to describe and classify the relationships between key concepts in these verses that exist in different chapters of the Quran.

The goal of this research is to use CGIF to represent the female-related issues in the Holy Quran. However, using CGIF representation to construct the conceptual graphs of women's issues is difficult, where the verses include diverse, simple, and complex sentences. Many studies have tended towards representing Quranic knowledge in understanding the content of the Quran. Most of these studies have developed the knowledge of Quran as an ontological structure such as the study of [13], who represented Quranic knowledge in a theme-based approach by using ontology. Others tended towards graphical representation such as the study of [14], who developed a semantic network of female issues on Surah An-Nisaa's verses to describe the inheritance system.

III. RESEARCH METHOD

The extraction of Quranic verses has been performed using the Quran search engine provided by Surah.My (www.surah.my). The verses have been extracted using 18 female-related terms as presented in the earlier section. In extracting the terms, the plural and singular forms of the words were taken into consideration, as the plural form of some terms are irregular and totally different. Then, with an absence of irregular plural terms, the verses retrieval results will be extracted partly.

For the development of CGIF representation, the extracted verses were subjected to the phrase classification process, as shown in Figure 1. In the first process (a), each verse was split into phrases. The study adopted the fragmentation of the verses on punctuation and conjunction. Then in process (b), the phrases with the same meaning were given a natural language description that provides its explicit intended meaning. This corresponds to the suggestion by [15], which is called the natural language level.
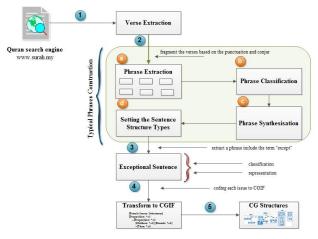

Fig. 1. *Development of CGIF Representation for Female Issues.*

To classify the associated phrase in the third process (c), the phrases in each issue were further organized into sub-groups of homogeneous concepts. Process (d) dealt with the creation of a functional classification of concepts. The structure of concepts and their relations in each sentence were made more explicit. This allows the differentiation among the concepts and their behaviour.

To transform contexts to the CGIF format, the CharGer tool [16] has been used to map the CG graphs. Each sentence has been taken one by one. The sentences that are related by conjunction words

are considered as one sentence based on Sowa's definition.

IV. REPRESENTING EXCEPTIONAL SENTENCE

The representation of exceptional sentence is described in the following subsections.

A. Semantic Analysis for Exceptional Sentences

The contextual logic semantics for exceptional sentences is based on the notions and results of contextual implication logic by [8]. For basic notions from a formal concept analysis, the works of [9][10][17] and [11] have been referred.
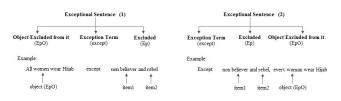

Fig. 2. *Exceptional Clause Components*

An important distinction that has been made in the literature is between syntactically different types of exceptional terms: "except", "except for", "but", and "other than". This study only focused on the exceptional sentences that include the term "except". In addition, the impact of the quantifiers (i.e., "all", "most", "every", "each") as well as the state of a sentence, whether positive or negative in exceptional sentences, were also considered.

Figure 2 shows the components of an exceptional sentence, where the term "except" may exist within the phrase such as exceptional sentence (1) or may exist at the beginning as exceptional sentence (2). In this study, the object that will be excluded from it is released as EpO. The elements that will be excluded is released as Ep, which is located after "except".

This study has drawn on some of the constraints on exceptional sentences as mentioned in [8][11]. These constraints have been derived based on the sentences stated in their context. In addition, the logical basis from each of these constraints was derived and summarized as follows:

Constraint 1: An excluded element Ep must be the type of object that is excluded from its EpO.

Constraint 2: If the EpO is negative, then the Ep is positive.

Constraint 3: Not valid to exclude all the elements, because the exception is specification, and the specification being at some elements, and not all elements.

Constraint 4: Not valid to exclude a family object from a child member.

Constraint 5: It is possible to exclude several members even if a single one remains.

Constraint 6: If there are multiple exceptions with a conjunction, then both are excluded.

Constraint 7: If the multiplicity is excluded without a conjunction, then the second exception is exempted from the excluded Ep, because it is the closest.

B. Proposed Representation for the Exceptional Clause

The study proposes a representation for the exceptional clause as an exception function, which is called (Actor) in CGIF. This is considered as an exception definition, since it means the process that pulls out something from something else, i.e., pulling several expressions from the speech. This process is subject to several controls and restrictions, to be right to call it an exception. The subtraction process is performed by deducting/subtracting some elements Ep from an object EpO. The purpose to define a new function, instead of using the minus operator, is that the exception process is not an arithmetical concept; however it is a process that deducts a specific member by certain conditions.

CGIF has Concept, Relation, Actor, and Context. Actor is defined as a relation, because there is no function in a conceptual graph. Thus, Actor is a relation that links concepts and conducts a few processes based on the actor name and that is suitable to solve the problem. Hence, based on all these reasons, the study proposes to represent an exceptional phrase as "Actor" rather than "Context", "Concept", or "Relation".

> **Actor. Definition**. "A conceptual relation that is used to represent functional dependencies. Its semantics may be computed or otherwise determined by an IT system external to the current module.
>
> An actor begins with "<""followed by a type. It continues with zero or more input arcs, a separator "|", zero or more output arcs, and an optional comment. It ends with ">".Actor ::= "<" Type(N) Arc* "|" Arc* Comment?""">"
>
> The arcs that precede the vertical bar are called input arcs, and the arcs that follow the vertical bar are called output arcs. The valence N of the actor type must be equal to the sum of the number of input arcs and the number of output arcs".

According to the constraints presented in Section 4.1, the exception has the following properties:

1) $Ep \subset EpO$; 2) $ER != 0$ or $ER >= 1$; 3) $EpO < 1$; 4) $EpO != Ep$; 5) $Ep >= 1$; and $Ep < EpO$.

From the properties, it follows that the object excluded from its EpO differs essentially from the excluded items Ep, but the items Ep are a kind of the object EpO. Thus, formally, EpO is a generalization of Ep. EpO should at least carry two items. The number of items for Ep should be less than the items in EpO.

Definition (Exceptional Clause Function): An Exceptional Clause Function is ER = s(EpO) + s(Ep), where EpO is an object that is excluded from it, Ep is an excluded element(s),and ER is an exception result, while s is the status of the item, whether positive or negative. The level of exception of nodes is called k(i). The function is with respect to $EpO(x) \neq Ep(x)$ and $Ep(x) \in EpO(x)$); and in which the input and the output shall be a concept or a context.

The logical semantics for exceptional clause function:

$$k = \{0,1,\ldots, n\}, s = (+/-)$$

$$EpO(x) = \{ epc0, epc1, epc2, \ldots ,epcn\},$$

$$Ep(x) = \{ ep0, ep1, ep2, \ldots, epn\text{-}1\}$$

$$ERk(x) = [s \times EpO(x)] + [s \times Ep(x)].$$

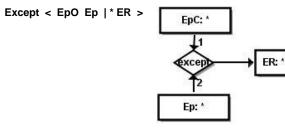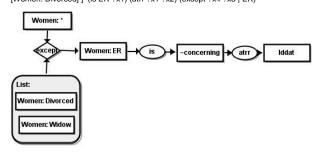Figure 3 shows the display for the exceptional clause function. The representation in CGIF is as follows:

Except < EpO Ep | * ER >

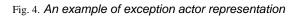Fig. 3. *Proposed Exception Actor*

To explain the proposed representation and reasoning over conceptual graphs, the graphs can be visualized in the exceptional clause that can exist in different contexts, which are as follows:

I) Positive Exceptional Clause

Positive exception means when the object that is excluded from its EpO is a positive phrase. Assuming the following sentence: "Every woman is not concerning 'Iddat, except widows and divorced". However, this sentence carries an exceptional sense where it takes out the widows and divorced from the object of woman. Considering constraint six, both items should be excluded. The representation according to the proposed representation is as follows:

[~concerning: *x1] [Women: ER] [Iddat: *x2] [Women: *x3] ~[List: *x4 [Women: Widow] [Women: Divorced]] (is ER ?x1) (atrr ?x1 ?x2) (except ?x4 ?x3 | ER)
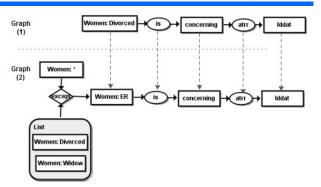

Fig. 4. *An example of exception actor representation*

Fig. 5. *An example of reasoning over the proposed exceptional graph*

As can be seen in Figure 4, some concepts have been excluded (based on their category). Moreover, Figure 4 is easier in the inference. To assess the validity of this assumption, a reasoning over the conceptual graphs is used. It is easily seen that in the example of the reasoning graph in Figure 5, there is no need to consider other rules for both relations of "rotate" and "except" in the reasoning graph since it directly matched the rule.

II) Conditional Exceptional Clause

Conditional exception refers to the exception which is based on some conditions, i.e., the exception does not occur until the condition is valid. Assuming the sentence: "Parents except fathers get one-third when Deceased have children".
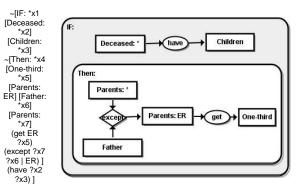
~[IF: *x1
[Deceased: *x2]
[Children: *x3]
~[Then: *x4
[One-third: *x5]
[Parents: ER] [Father: *x6]
[Parents: *x7]
(get ER ?x5)
(except ?x7 ?x6 | ER)]
(have ?x2 ?x3)]

Fig. 6. *An example of conditional exception representation*

III) Multiple Exceptions Clause

Multiple exceptions refer to when there are multiple exceptions in a representation. For example: "No person except heirs get share. Except children, every heir gets one-sixth. Except fathers, the heirs get one-third". The graph in Figure 7 shows the representation of multiple exceptions. Thus, each exception level will deduce some elements. The last level of exception will be stopped when the ERi set has one item.

[Person: Father] [Person: ER2] [One-third: *x1] [Share: *x2] [Person: ER0] [Person: *x3] [Person: heir] [One-sixth: *x4] [Person: ER1] [Person: Children] (get ER0 ?x2) (get ER2 ?x1) (get ER1 ?x4) (except ER0

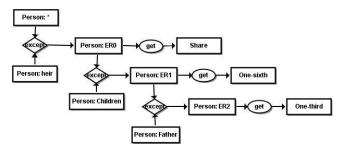Children | ER1) (except Father ER1 | ER2) (except ?x3 heir | ER0)

Fig. 7. *An example of multiple exceptions representation*

At the end of these illustrative examples and reasoning over graphs that present function exceptional sentences, the study concentrates on how to use the proposed technique to represent the exceptional phrases that were extracted from Quranic verses related to female issues.

V. RESULT AND FINDING

In the verse extraction stage, the study extracted 228 unique verses from 279 verses, which were retrieved from the Holy Quran. This excludes 51 duplicate verses (which occurs when, for example, the same verse was extracted from two terms).

A typical problem is on the level of understanding and incomplete for the extracted verses 4 and 6 from Surah An-Nuur. When these verses were examined in their chapters, the study found that these verses are related to other verses followed, in which 5 began with "except" and 7 began with "and". Furthermore, verse 14 is related to the following verse 15 of Surah Luqman, which began with "but", whereas, verse 30 from Surah Al-Ma'aarij that presents the marriage issue began with "except".

Thus, it is clear that using only a female term in the verses extraction is not enough to retrieve all the verses that are related to female issues in the Holy Quran and to present a complete sense. The study found that some related verses are discarded because they do not have any female terms. Hence, the verses need to be examined and to consider the verses that are connected by conjunctions as well as those which are connected with the term "except". Therefore, it is important to say that the term "except" is given a larger share in the extraction and classification accuracy of the sentences.

A. Phrases Extraction and Classification

In the phrase extraction stage, the study fragmented 240 phrases from the 228 verses. The natural language description that was given to each phrase obtained 23 female issues, which are presented from 97 verses that are related to female issues from 228 verses. As shown in Figure 8, marriage and divorce issues have been mentioned with the same number of verses in the Quran with a percentage of 6% and are also the highest of all other issues. This is followed by the hijab issue with 4%.

There is a challenge to find out the reasons behind the high rate of verses extracted, 131 that are non-related to the female issues versus 97 female-related verses.
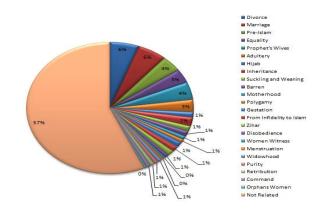

Fig. 8. *Female-related issues in the Holy Quran*

The classification process where nesting sentences, conditional sentences, and exceptions on each end is practical and has greatly helped in organizing sentences and represented well without falling into confusion and overlap as shown in Table 1. These are samples of organized sequences of phrases and their relationship to each other. Each phrase belongs to one of five predefined conceptual categories: Normal, Nested, Exception, Condition, and Actor. The classification result on the 240 phrases shows that there are more Normal (103) and Nested (84) phrases than Condition (20) and Exception (12).

TABLE 1: CLASSIFICATION OF PHRASES EXTRACTED FROM THE VERSES.

Phrase	Surah: Verse	Conceptual Graph Type			
		Normal	Nested	Condition	Exception
Issue (3) – Inheritance					
– "From what is left by parents and those nearest related there is a share for men and a share for **women**"	4:7	✓	✓		
– " to the male, a portion equal to that of two **female**s:	4:11		✓	✓	
– if the deceased left children:				✓	
– if only **daughter**s, two or more, their share is two-thirds of the inheritance;					

B. Coding to CGIF Format

This study has transformed 10 of the issues and from this corpus, 240 phrases were represented. All graphs are mapped using the CharGer tool [16]. From this corpus, ten structures were developed from these phrases, where each structure contains one issue. Thus, once the female issues were modelled within

conceptual graphs, graph rules are used to reason them. There is a problem in overlapping sentences, when one verse is matched with more issues. For example, take the verse (4:23). This verse is matched with the marriage issue. It is also matched with the adultery issue. Hence, the representation of the repeated sentence or misrepresentation in this case affects the precision index.

C. Representing Exceptional Sentences

In the representation of the exceptional sentences, 12 exceptional phrases that have the term "except" were retrieved from 240 phrases. The result of representation shows that there are six phrases that have conditional exceptions, and one phrase has multiple exceptions. There are nine phrases that are negative, while three phrases are positive. The examples of the structures that show an exception case, the graph of the issue of hijab, are shown in Figure 9. Thus, it is clear that exceptional sentences give indications on customization. Furthermore, exception helps to directly match the reasoning graph.

However, there is one problem in representing three exceptional phrases that are found in their objects to be excluded from them and the excluded elements, which are not from the same category. One of limitations of the current method is to deal with a set of items in the input and output of an actor. Currently, to overcome this problem, the study simply represented these items by graphing them in a context.
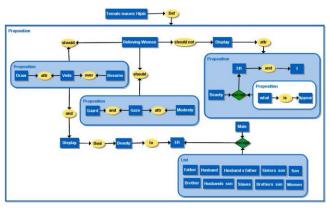

Fig. 9. *Conceptual graphs representation for Hijab issue*

VI. CONCLUSION AND FUTURE WORK

The representation of female-related issues in the Holy Quran and the proposition for supporting the representation of exceptional sentences have been proposed. The representation is based on conceptual graph interchange format for mapping the conceptual graphs. This study has adopted "Exceptional Clause Actor" to represent the exceptional clauses. The exception actor is intended to prevent part of the elements of a concept to be linked with other concepts according to certain conditions. The reasoning over the graphs was used to evaluate the representation of exceptional sentences. The representation was perceived to be useful. The findings of this study also suggested that exception can play an important role in identifying the relevant phrases in the phrases extraction. In addition, the nested graphs were considered as to be more contracted as compared to basic graphs representation.

Future works could focus on further analysis on other predicate sentences to derive more constraints of the exceptional clause that exist in the linguistic context. This will include comparisons between compositions that include "except" and compositions that are without it.

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