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The Study on Qur’anic *Sūrahs*’ Structuredness and Their Order Organization Using NLP Techniques

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ABSTRACT: Original Paper

The study of *sūrah*s’ structure has attracted researchers’ attention in recent years. One of the theories herein is the theory of Topic Sameness which acknowledges that each *sūrah* of the Qur’an has formed on a single topic. The theory of Introduction and Explanation as one of the most important branches of Topic Sameness, proposes that the Almighty states the topic of each *sūrah* at the first section, elaborates it at different parts of the *sūrah* in the forms of stories, signals of nature, and future predictions, and concludes from the stated contents at the final part. In this paper, we accordingly intend to study the two theories using NLP techniques for the first time. In this regard, based on the three methods of tf-idf, word2vec and roots’ accompaniment in verses, the similarity of Qur’anic roots is computed. Then, the amount of similarity of the concepts within *sūrah*s to each other is calculated and compared with the random mode. The results show that the studied *sūrah*s hold the inner coherence between the concepts such that they have been formed on a single topic or a few topics related to each other. In addition, the study on the similarity between the first and the body sections of each *sūrah* shows that the structure of Introduction and Explanation seems to be true for many *sūrah*s by the designed methodology. At the end, by comparing the similarity of *sūrah*s to each other versus their order distance in the Qur’an and their revelation time distance, we realized that the whole Qur’an is also relatively organized in terms of the *sūrah*s’ ordering.

KEYWORDS: Natural Language Processing, Word2vec, Qur’an, Topic Sameness, *Sūrah*s’ Structuredness; Tf-idf.

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1. Introduction

The structural vision on the Qur'anic *sūrah*s, effort towards the detection of the core title of *sūrah*s, organizing the *sūrah*s based on a single topic, and finally interpretation based on the structure of the *sūrah*s have seriously appealed to some recent Qur'an researchers (Khamehgar 2006). The major basis and presumption of the analysis of the structure of the Qur'anic *sūrah*s is the order of the verses in the *sūrah*s being protected and revelatory (Khamehgar 2008). From these researchers' viewpoint, the Qur'an is an integrated and organized system for the understanding of which the relationships between the elements including the concepts, verses, and the sections inside the *sūrah*s should be known. Based on this and the elaborate studies carried out by recent researchers of Qur'anic sciences such as Khamehgar and Lesani Fesharaki, the Qur'an is an integrated and accurate system the elements of which (*sūrah*s, sections, and verses) also have a revelatory organization (Khamehgar 2002b). The analysis of this structured system can lead to many gains such as the discovery of new horizons of Qur'anic miracles, extraction of the rich Qur'anic knowledge, exploitation of the major goal and core topic of the *sūrah*s, and the order system of the *sūrah*s. Based on these presumptions, many researchers have dealt with the study of the structure of many *sūrah*s, such as structural study on *Surah al-Mā'idah* (Q. 5) by Aram and Layeqi (2017), the structure of *Sūrah al-Kahf* (Q. 18) by Fatahizadeh and Zakeri (2016), the structure of *Sūrah al-Inshiqāq* (Q. 84) by Dehghani Farsani (2008), and the structure of *Sūrah al-Infiṭār* (Q. 82) by Jigareh and Sadeghi (2017). In addition, some individuals such as Khamehgar (2006) have dealt with the translation of the Qur'an based on the structuredness of the *sūrah*s.

In spite of different signs discovered by Muslims of the structuredness of the *sūrah*s, some orientalists, based on signs such as the style of the Qur'an's speech, and on the presumption of the Prophet's close friends having affected the order of verses and even the Qur'an not being revelatory, have concluded that the content of the Qur'an is disintegrated and without logical connection. Richard Bell (1953), a European Qur'an researcher, for instance, has stated at the introduction of his accredited Qur'an translation into English that one of the original attributes of the Qur'an's style is that it is disintegrated, and it is rarely possible to see coherence through a *sūrah*'s major section. Arthur John Arberry (1996) has also written somewhere in the introduction of his Qur'an translation that the Qur'an is far away from whatever integration related to the order of its descent and also from the logical coherence. The Qur'an's reader would definitely get astonished by the apparently disordered status of many *sūrah*s especially if limited to one translation only, although the translation is linguistically accurate. These researchers' emphasis on disintegration and disorder of the Qur'an's verses reminds the reader about the fact that the Qur'an has not stayed away from humane manipulations and at least the order of the verses is not revelatory. This is while numerous sensible reasons based on the study of the structure of the *sūrah*s as well as historical documents explicitly state that the order of the verses is revelatory and has remained the same over time (Khamehgar 2008).

Although different works have been done about the *sūrah*s' organization and the structure of some *sūrah*s have been studied by Qur'anic Sciences researchers (Khamehgar 2006; Fatahizadeh & Zakeri 2016), it seems that none of the work has utilized text-mining and natural languages processing algorithms.

In the present paper, we intend to study the Qur'an's system in an integrated way and to study the *sūrah*s' structuredness in terms of their both intra- and inter-*sūrah* status by the NLP techniques and algorithms. On the one hand, the intra-structures are examined in terms of topic sameness and Introduction and Explanation theories. On the other hand, the inter-structure is examined based on the order of *sūrah*s. In this regard, the current research deals with two major questions: (1) Do the Qur'anic *sūurah*s revolve around a single topic? (2) Is the order of Qur'anic *sūrah*s organized? The rest of the paper has been organized as follows: Section 2 presents some related works. Fundamental definitions are briefly explained in section 3. Section 4 contains materials and methods. Section 5 deals with pre-processing. In section 6, we explain our method and evaluation measure in more detailed. Then we present the results of our experiments in section 7. Finally, the conclusion is presented in section 8.

2. Related Works

Besides the works by Qur'anic sciences researchers as well as orientalists already mentioned, computer sciences' researchers have also carried out many works on Qur'an analysis. Due to the significance of semantic search in the Qur'an, many works have looked for new methods of semantic search. Among these, Yauri et al. (2013), Khan et al. (2013), Shoaib et al. (2009), and Alhawarat (2015) have presented methods based on ontology, word-net, and topic modeling, respectively, for Qur'anic semantic search. Different works have also dealt with building different Qur'an ontologies, most of which are focused on a particular field (Ismail et al. 2016). Iqbal et al. (2013) have highlighted the weaknesses of the existent Qur'an ontologies and have developed a new ontology. Safee et al. (2016) have also studied different methods of verse retrieval and have presented their weaknesses and strengths. Their findings show that there is the need for learning and building new Qur'an ontologies for correcting the contradiction between the existent ontologies.

A set of other works have dealt with the presentation of corpora suitable for analyzing the Qur'an. Among these, Dukes and Buckwalter (2010) and Atwell and Sharaf (2009) have exploited the treebank of Qur'an's verses with regard to Arabic grammar and have shown it by dependency graphs. Sharaf and Atwell (2012a) have presented a corpus which connects the verses which are conceptually similar. They named this corpus QurSim. This corpus could be used for different applications such as Qur'an translation. The Corpus QurAna has also tagged Qur'an's personal pronouns based on their referents (Sharaf and Atwell 2012b). Sherif and Ngonga Ngomo (2015) have extracted a dataset based on RDF from Qur'an translation into 43 different languages, which could be used for different applications in natural language processing. Besides the presented datasets, tools for searching and analyzing Qur'an's corpora have been presented so far. Alfaifi and Atwell (2016) have examined and compared these tools.

The approach of some research works is also the analysis of the Qur'an for different applications such as developing the Qur'anic question-answering system (Hamed & Aziz 2016) and the verses' classification. For instance, Sharaf,and Atwell (2012a) looked for the classification of Qur'anic *sūrah*s into the two classes of in-Mecca and in-Medina by decision tree classifier. They utilized some features such as the length of the *sūrah*, the words and phrases used in the *sūrahs*, and prostration verses.[1]

[1] There are some verses in the Qur'an, which are believed they must be followed by the reader's prostration.

3. Fundamental Definitions

3.1. Sūrahs' Topic Sameness

Some Qur'anic science researchers emphasize the structuredness of the Qur'anic *sūrah*s and have proposed theories by assessing the organization of different *sūrah*s, the most important of which is the theory of Topic Sameness. Based on this theory, each *sūrah* holds a core topic and all the verses and discussions stated in the *sūrah* relate to that topic.

3.2. Introduction and Explanation theory

The Introduction and Explanation theory states that the Almighty defines the core topic in the beginning verses, then in different sections of the *sūrah*, He explains it by analogies, anecdotes, and examples, and finally concludes based on the core topic (Khamehgar 2004; Khamehgar 2002a). Based on this theory, the core topic of each *sūrah* is introduced in the beginning section of the *sūrah*, to be called introduction. Similarly, the final section of the *sūrah* which is somehow a conclusion of the discussions included in the *sūrah* is referred to as *sūrah* conclusion.

3.3. Section

In this paper, the Qur'an's verses, which altogether talk about a particular topic, are called section.

3.4. Vector Space Models

There are different methods for representing texts and concepts in vectors. In vector space models, text is shown as a vector and each component of which is related to the estimated significance of the word in the text (Soucy & Mineau 2005). The method bag of words and its extension N-gram are among the most applicable methods to represent texts, which, despite simplicity, act suitably for many text mining applications (Zhang et al. 2010).

4. Material and Methods

In this paper, the structuredness of Qur'anic *sūrah*s is examined based on the theory of Topic Sameness. The methodology of the current research comprises seven parts including pre-processing and preparing data, the *sūrah*s' partitioning into sections, calculating the similarity of Qur'anic roots, calculating the similarity of sections and *sūrah*s, study on the relationship between *sūrah*s' title and their content, study on the topic sameness of the *sūrah*s, and finally study on the structuredness of the Qur'an in terms of the *sūrah*s' order.

Based on this, the corpus was initially prepared and cleaned for later processes. Then the similarity between different Qur'anic roots was calculated by applying different NLP techniques to the Qur'an corpus. The amount of relationship between the *sūrah*'s title and the words within the *sūrah* was also studied. Afterwards, topic sameness of the *sūrahs* was studied. For this, the similarity of intra-*sūrah* concepts was gained and compared with the random mode. Then, for examining the introduction and explanation theory the similarity of the first section to other sections of the sūrah and also the first section to the *sūrah*s' conclusion of different *sūrah*s were calculated and the result was compared with the random mode. At the end, the organization of the Qur'an in terms of the *sūrah*s' order was studied in such a way that the similarity of the different *sūrah*s was measured and the relationship between the order distance of the *sūrah*s as well as their descent time distance and the amount of the *sūrahs'* similarity was studied.

4.1. Dataset

Since the number of the Qur'an's distinct words is very high, we focused on the Qur'anic roots rather than the derivatives. The first data were a table at each line of which there were Qur'anic words fully voweled,[1] the sūrah where the word is located, the verse related to the word, and finally the root corresponding to the considered word. At the data preparation phase, the prepositions and conjunctions as well as the vowels were initially removed from the dataset. Then, the words were replaced with Qur'anic roots, and the Qur'anic roots were numbered. Besides this data set, another dataset was built, in which the Qur'anic roots related to each

[1] In Arabic, the vowels may be be written or not.

verse were saved for each verse. In addition, the data sets of the number of roots' repetition and also the order number of *sūrah*s were created.

5. Pre-processing

Figure 1 shows the frequency distribution of the roots in the whole Qur'an.

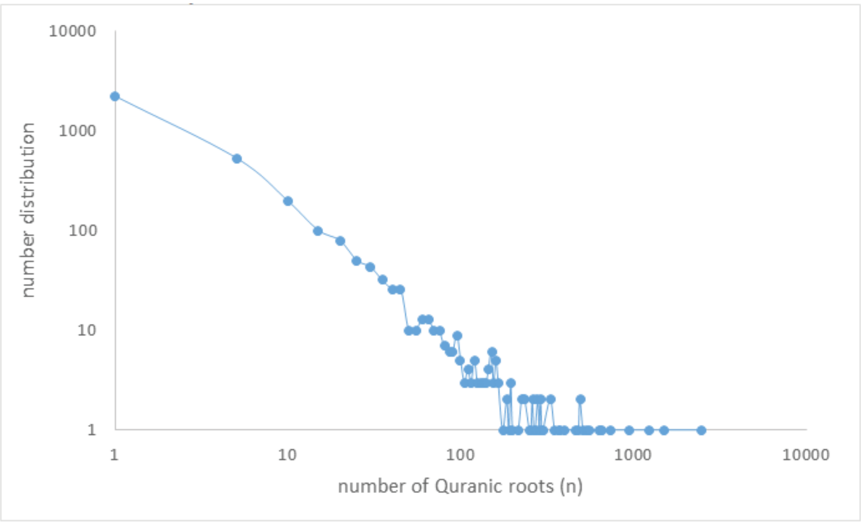


Figure 1. The frequency distribution of the number of Qur'anic roots in the whole Qur'an.

Since the distribution of the number of roots in log-log scale is almost linear, the number of Qur'anic roots in the whole Qur'an follows the power-law distribution. It is possible that the frequency distribution fit into lognormal (Mitzenmacher 2004) or power-law with exponential cutoff (Clauset et al. 2009) distributions, but the diagram shown in figure 1 is distinct from both of the mentioned distributions. The distinction reason of this distribution with the lognormal is the high number of roots with very low frequency. In addition, the tail of the distribution is long enough so that it is not necessary to fit it to power-law with exponential cutoff.

Figure 2 shows the number of roots in some large *sūrah*s of the Qur'an such as *al-Baqarah* (Q. 2), *Āli ʿImrān* (Q. 3), *al-Nisāʾ* (Q. 4), *al-Māʾidah* (Q. 5), *al-Anʿām* (Q. 6), *al-Aʿrāf* (Q. 7), *al-Anfāl* (Q. 8), *al-Tawbah* (Q. 9) and *Yūnus* (Q. 10).

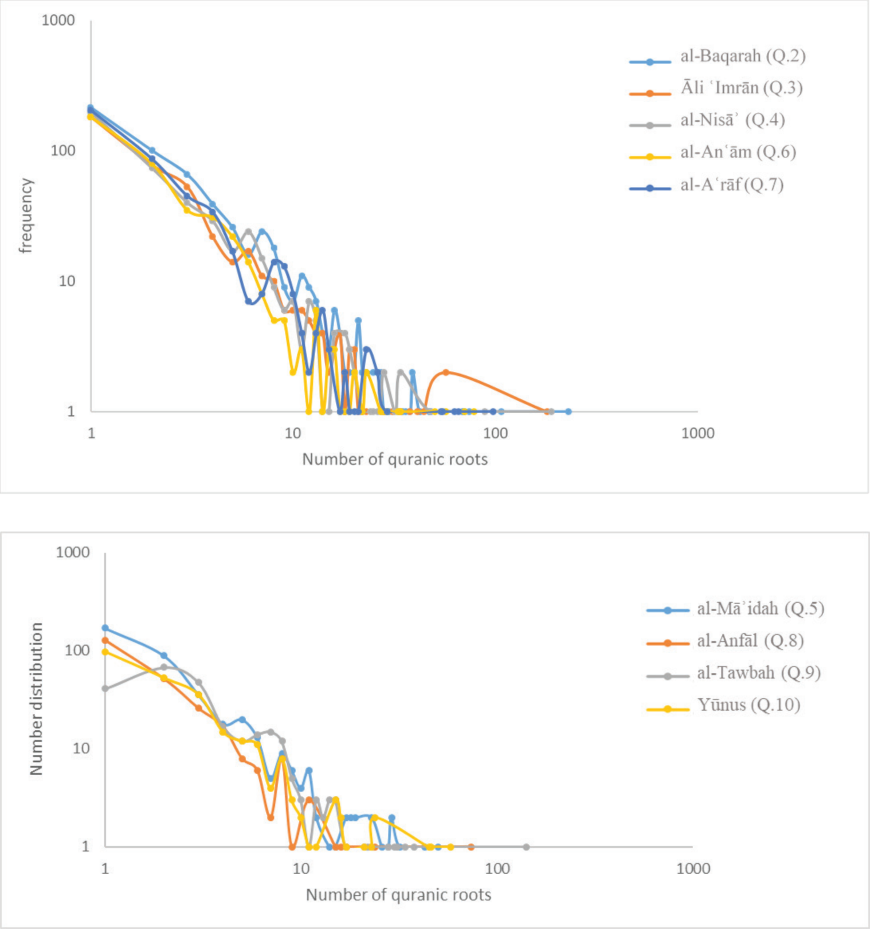


Figure 2. Frequency distributions of the number of Qur’anic roots in the large Qur’anic *sūrah*s.

As seen herein, frequency distributions follow the semi-power-law distribution almost for all large *sūrah*s. The frequency distribution of roots in the whole Qur’an shows that many roots have low frequency in the Qur’an; that is, around 50% of the roots have a frequency equal to or less than three. In addition, there are few roots such as ‘ALH’ and ‘RBB’ which are repeated many times in the different *sūrah*s and are present in the whole Qur’an. The same issue is true for the different *sūrah*s as well; that is, some roots are repeated much in particular *sūrah*s. The distinction of some of these roots shows that the *sūrah*s’ important topics and concepts could be exploited by algorithms such as tf-idf, etc.

6. The Proposed Method

After preparing the data, the different *sūrah*s were initially partitioned. In this paper, the *sūrah*s' sections proposed by Ṭabāṭṭbā'ī (1996) has been employed with some modifications. Based on the proposed methods below, the similarities of Qur'anic roots, sections, and *sūrah*s are obtained.

6.1. Calculating Qur'anic Roots' Similarity

Tf-idf can be calculated by the combination of term frequency in the document and the inverse document frequency. The frequency of the term t in the document d shown by $\mathrm{tf}_{t,d}$ is the weight assigned to the

term in proportion to the number of the occurrence of t in d. The inverse frequency of the document is also gained as below, where N is the total number of documents in the dataset and df_t equals the number of documents from the dataset which contain the phrase t.

$$\mathrm{idf}_t = \log \frac{N}{\mathrm{df}_t}$$

Based on this, tf-idf of the term t in the document d is calculated according to the equation below (Larson 2010).

$$\mathrm{tf} - \mathrm{idf}_{t,d} = \mathrm{tf}_{t,d} \times \mathrm{idf}_t$$

For calculating the amount of similarity between two roots based on tf-idf, it is only needed to gain tf-idf vector of the roots based on the gained weight for the different *sūrahs*. The cosine similarity of tf-idf vector of the roots can be a suitable measure for the similarity of roots.

Word2vec which was presented by Mikolov et al. (2013) in Google is a novel model to compute continuous vector representations of words. When the goal is representing larger elements, the generalized word2vec named sent2vec is usable (Le and Mikolov 2014).

The other method used in this paper is the Roots' Accompaniment in verses (in short RA method). This method focuses on the accompaniment of roots in the verses and is based on this presumption that if two roots in a verse are placed beside each other, they are related to each other, and the more the proportion of the two roots' accompaniment becomes, the more the amount of their relationship will be. Based on this presumption, the similarity of two roots can be calculated according to the following equation:

$$S_{ij} = \frac{N_{ij}}{\sqrt{N_i N_j}}$$

where N_{ij} is the number of the accompaniment of the roots i and j.

The bottom of the fraction is also the geometric mean of the frequency of the two roots i and j in the Qur’an. Then, the resulting matrix is normalized again so that the sum of elements of the similarity matrix at each row would be equal to one.

$$W_{ij} = \frac{S_{ij}}{C_i}$$

$$\sum_i W_{ij} = 1$$

The value of C_i equals the sum of elements at each row of the matrix. This normalization is in order that the sum of the value of each root’s similarity to other Qur’anic roots equals one.

6.2. Calculation of Similarity of Sections and Sūrahs

In this paper, the similarity of two sections, or two *sūrah*s, i and j is defined by averaging the similarity of all the roots which are in section i with all the roots in section j two by two. Therefore, the similarity of two sections can be calculated by the equations below.

$$\mathrm{sim}_{i,j} = \frac{\sum_{m \in i, n \in j} M_{sim}[m,n]}{l_i l_j}$$

,

$$\mathrm{sim}_{i,j} = l_i l_j \sqrt{\prod_{m \in i, n \in j} M_{sim}[m,n]}$$

The first is the arithmetic mean and the second is the geometric mean. In these two formulae, i and j respectively show the *sūrah* or section i and j, l_i and l_j show the number of the roots in the two sections, and M_{sim}

shows the similarity matrix of roots, which is gained according to the methods mentioned above. It must be noticed that the arithmetic mean has been used in this paper.

The other solution to measure the similarity of two sections is the number of the same roots and its generalization cosine similarity. In this method, a vector is initialized for each *sūrah* as big as the number of Qur'anic roots. The elements of the vector are initialized by the number of Qur'anic roots existent in the surah. Based on this, the cosine similarity between the two vectors can use as the similarity between the two surahs. In some experiments of this paper, the simplified version of this method is used, i.e., the number or the ratio of common roots.

6.3. Evaluation

To assess different methods, the results of similarities (such as between *sūrah* title and content, between different *sūrah*s, between the first and last section of a *sūrah*, and between the concepts within a *sūrah*) have been compared to the random mode. In this paper, for selecting the random parts, we employ the selection of Qur'anic roots based on the probability of each root's occurrence in the Qur'an, as below:

1. Calculate the frequency of different roots in the Qur'an,
2. Take step 3 as many as the value of the length part, and
3. Select a root based on the frequency of roots in the Qur'an.

Therefore, it is more probable to select the roots with more frequency. In this method, to calculate the similarity with the random mode, 100 random couples have been selected and their similarities have been calculated and averaged.

6.4. Examining the Structuredness of Qur'anic Sūrahs

In this paper, three sets of experiments have been designed for answering the first major question. The first set intends to calculate the similarity between the *sūrahs'* title and their contents. The second set intends to assess topic sameness in the Qur'anic *sūrah*s and studies the similarity between the concepts within a *sūrah*. The third and the most important set intends to assess the amount of relationship between the first section as an important section and the next sections.

For this, by the methods of Qur’anic roots’ Accompaniment in verses and word2vec, the similarity of different Qur’anic roots was calculated and saved in a matrix called similarity matrix. Then, to calculate the similarity of the concepts within the *sūrah*, some Qur’anic *sūrah*s were selected in the way that the *sūrah*s with different sizes exist among them. In addition, when the similarity between the sections of *sūrah*s is considered, short sūrahs and the *sūrah*s in the 30th section (*juz*) of the Qur’an were not selected. It must be noticed that since the Qur’anic acronyms (*al-ḥurūf al-muqaṭṭaʿah*) have repeated only once in the Qur’an, the *sūrah*s such as *Yā Sīn*[1] (Q. 36) and *Qāf*[2] (Q. 50), the name of which has been adopted from the Qur’anic acronyms, were not selected either. As a summary, the following similarities were calculated for the selected *sūrah*s:

1. Similarity between the *sūrah*’s title and the Qur’anic roots within the *sūrah*,
2. Similarity between the Qur’anic roots within the *sūrah*,
3. Similarity between the first and the last sections of the *sūrah*, and
4. Mean similarity between the first section and different sections of the *sūrah*.

It must be noticed that since very frequent roots such as “Allāh” and “RBB” have repeated in different sections and make fewer distinctions, and that the presence of these roots in a section caused a rise in the similarity of the section with other sections, the very frequent roots were removed for RA method so as to calculate the similarity between sections.

The similarities were initially calculated by removing the roots with the frequency of above 800, and at the next stage by removing those with the frequency of above 600, 400, and 200. Then, the calculated similarities were compared with the random mode and the *sūrah*s’ structuredness was accordingly assessed in terms of topic sameness.

6.5. Study of Introduction and Explanation Theory

Each of the Qur’anic studies’ researchers has presumed a particular structure for *sūrah*s based on their own viewpoint and ideological

[1] يس

[2] ق

background and each is seeking signals for proving their own claim in their own way (Fatahizadeh and Zakeri 2016; Jigareh and Sadeghi 2017). Based on the commonest theory of the *sūrah*s' structuredness, the Almighty proposes the topic and main idea of the *sūrah* at the first section, then explains that in different sections, and finally presents the conclusion. This structure, in this paper, has been called the structure of Introduction and Explanation. In this section, we intend to examine the structuredness of *sūrah*s in terms of Introduction and Explanation theory.

To study this theory, we initially calculate the similarity of the first section which contains the main topic based on the theory, and the final section, which concludes from the proposed topics within the sūrah, then compare it to random mode. Then we calculate and show the similarity between the first section and the different sections of the *sūrah*, which are an explanation of the first section according to the theory of Introduction and Explanation.

6.6. Study of the Organization of Qur'anic Sūrahs' Order

To answer the second question about the organization of the *sūrah*s' order, an experiment was designed as follows:

1. The similarity of Qur'anic *sūrah*s was initially measured two by two and saved in the *sūrah*s' similarity matrix. For measuring the similarity of the *sūrah*s, tf-idf and RA similarity matrices were used.

2. Based on the order number of the *sūrah*s, the place of each *sūrah* was defined. Therefore, the place of the *sūrah*s *al-Fātiḥah* (Q. 1), *al-Baqarah* (Q. 2) and *al-Nās* (Q. 114) were considered 1, 2, and 114, respectively. Based on this, the place distance of two *sūrah*s was computed as below:

$$PD_{s_1,s_2} = \left|P_{s_1} - P_{s_2}\right|$$

, where P_{s_1} is the place of the *sūrah* s_1 and P_{s_2} is the place of the surah s_2.

3. Based on the revelation order of the different *sūrah*s, the time distance of *sūrah*s s_1 and s_2 was computed as follows:

$$TD_{s_1,s_2} = \left|T_{s_1} - T_{s_2}\right|$$

, where T_{s_1} and T_{s_2} are the descent time of the *sūrah*s s_1 and s_2.

4. At this stage, the average similarity of the *sūrah*s with place distance $0 < pd < 114$ was calculated as follows:

$$AveDisSim(pd) = \frac{\sum_{PD_{s_1,s_2}=pd} Sim(s_1,s_2)}{114 - pd}$$

, where $114 - pd$ is the number of *sūrah*s the distance of which is equal to pd.

Similarly, the average similarity of the *sūrah*s with the time distance $0 < td < 114$ was calculated as follows:

$$AveDisSim(td) = \frac{\sum_{TD_{s_1,s_2}=td} Sim(s_1,s_2)}{114 - td}$$

We plotted the diagram of *sūrah*s' similarity versus the place distance and also the *sūrah*s' similarity versus the time distance was drawn and the change of the *sūrah*s'' similarity was studied based on their place and time distance and the result thereof was informed.

7. Experimental Results

The experimental results on studying topic sameness, Introduction and Explanation structure, and the *sūrah*s' order are presented in this section.

7.1. The Connection between the Sūrah's Title and the Sūrah's Content

Figure 3 shows the frequency of the title of *sūrah*s repeated in the *sūrah* itself versus the random mode.

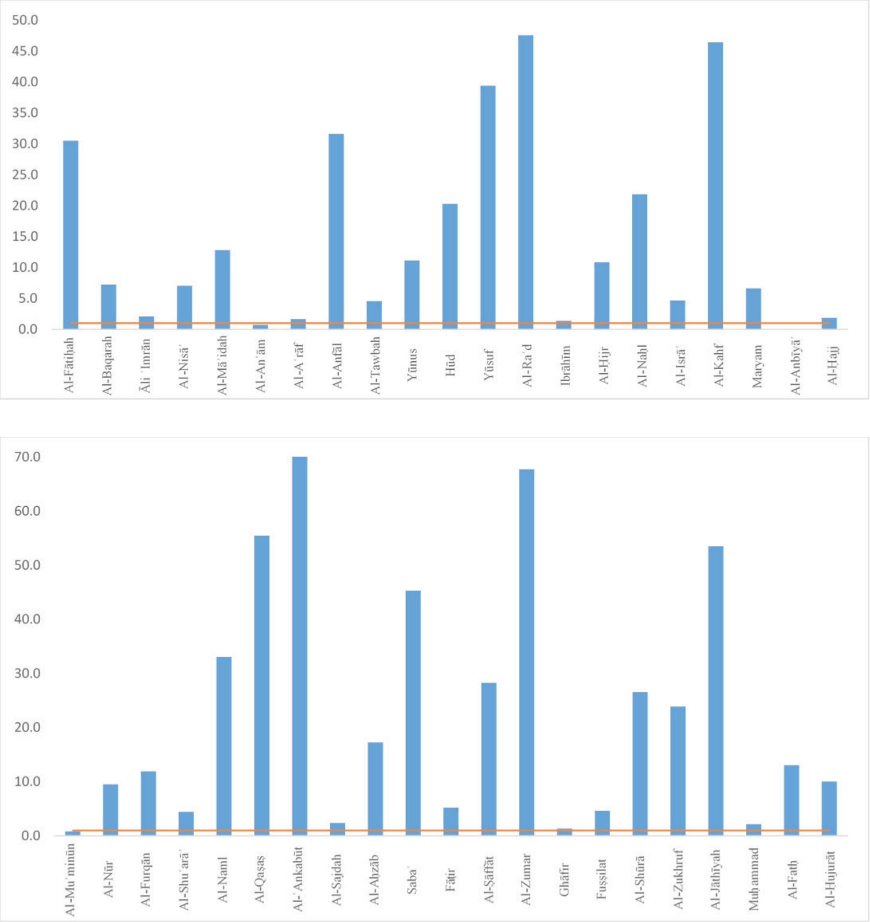


Figure 3. The frequency of titles of *sūrah*s in comparison to the random mode. The red line shows the random mode.

As shown, in most *sūrah*s, the frequency of the title within the *sūrah* is much higher than the random mode. This fact, however, is not true about all the *sūrah*s and the frequency of the title is also very low for some *sūrah*s. For instance, while most of *Sūrah al-Anbīyā'* (Q. 21) is about the prophets, the related root[1] has not been repeated at all. However, the names of different prophets such as Idrīs, Noah, Abraham, Ismāʿīl, Isaac, Jacob, Lūṭ, Yūnus, Moses, Aaron, David, Solomon, Zechariah, and Yaḥyā have been mentioned in this *sūrah*,. Therefore, it could be said that it is possible that the title of the *sūrah* is low-frequency in the *sūurah*,

[1] "NBW" which means message.

but concepts similar or related to the title are repeated in the *sūrah* over and over.

To solve the above problem, the mean similarity of the *sūrah*'s title with the concepts within the *sūrah* was taken into the study. Figure 4 shows this similarity based on the RA method versus the random mode.

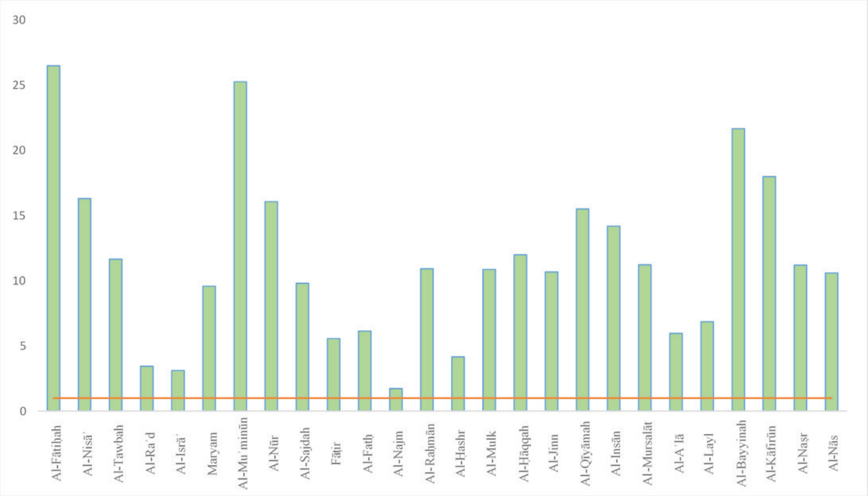


Figure 4. The similarity of the *sūrah*s' titles with the concepts within the *sūrah*s based on RA similarity.

In figure 4, contrary to Figure 3, the similarity and relationship between the *sūrah*s' titles and inner concepts is much higher than the random mode for all *sūrah*s. For example, this similarity for *Sūrah al-Anbīyā'* (Q. 21) is seven times that of the random mode.

If we use the algorithm word2vec for measuring the similarity, the similarity between the *sūrah*'s title and concepts therein will be as shown in Figure 5.

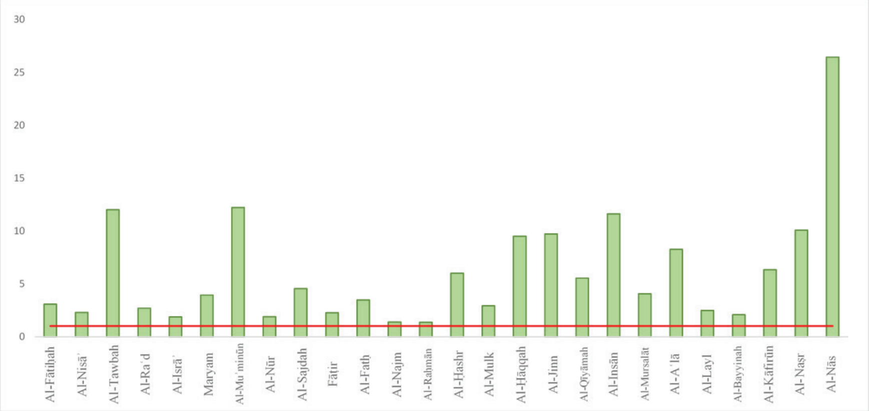


Figure 5. The similarity between the *sūrah*s' title and concepts therein based on the algorithm word2vec.

According to figures 4 and 5, it could be said that the *sūrah*'s title has been similar and tightly related to the inner concepts of the *sūrah* for almost all *sūrah*s. Therefore, the selection of the sūrah's title has been a logical issue and cannot have come up merely based on the ordinary public's selection. However, the similarity gained by word2vec is lower, which seems to be due to the small training data set (Qur'an).

7.2. Experimental Results on Topic Sameness Theory

After examining the *sūrah*'s titles, topic sameness or, in other words, the structuredness of the *sūrah*s' inner concepts was studied. Figure 6 presents the similarity of intra-*sūrah* concepts versus the random mode.

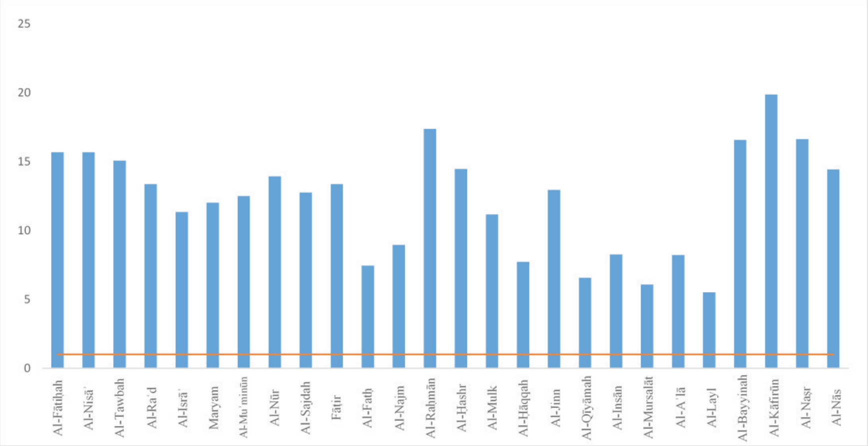


Figure 6. The amount of similarity between intra-surah concepts versus the random mode.

As seen above, the similarity of the intra-*sūrah* concepts for all examined *sūrah*s is much higher than the random mode. On the average, the similarity of these concepts is above 12 times that of the random mode. This shows that the intra-*sīrah* words in all examined *sūrahs* are coherent to each other. This observation shows that each sūrah has formed around an explicitly single topic or several interrelated topics, although not explicitly supporting a major topic.

It must be noticed that although the results presented in this paper are related to 26 *sūrah*s, i.e., a quarter of the Qur’an, they can be, for two reasons, true for the whole Qur’an with the exception of some special *sūrah*s. First, it was tried to select the *sūrah*s in a way that *sūrahs* with different sizes be studied so that if the size of the *sūrah* influences the result of the calculations, it would be recognized. Second, more than 26 *sūrahs* were studied in this paper, where the same results were also true about some other *sūrah*s, but they were not included herein due to space shortage. However, it must be noticed that the *sūrah*s the name of which has derived from the Qur’anic acronyms or the *sūrahs* the title of which has low frequency in the Qur’an are exceptions to this result. This is simply because there is not adequate knowledge about their titles, so it is not possible to calculate the similarity of these *sūrah*s’ titles to other roots correctly by the existent NLP methods.

7.3. Experimental Results on Introduction and Explanation Theory

Figure 7 shows the proportion of the average similarity of the first and the last sections of the *sūrah*s to that of the random mode. For this diagram, RA method was used. For example, RAccomp800 shows RA without consideration of roots with the frequency higher than 800.

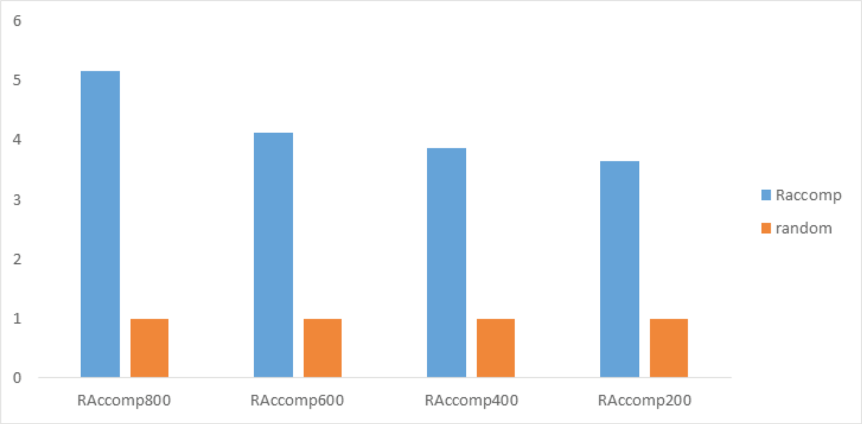


Figure 7. Comparing the average similarity of the first and the last sections of the *sūrahs* with the random mode.

As seen in figure 7, the average similarity of the first and last sections of the *sūrah*s is much higher than the random mode. The average similarity is more than four times based on RA method. Although the average similarity is higher than that of the random mode, its value is not considerable enough to be able to conclude that the structure of all Qur'anic *sūrah*s is conforming to the theory of Introduction and Explanation. It seems that this issue is due to the averaging over all the *sūrah*s and since it is possible that some *sūrah*s may not follow the Introduction and Explanation, the final result is less than the prediction. Therefore, the similarity of the sections for different *sūrah*s should be studied separately.

Figure 8 shows the similarity of the first and last sections of each *sūrah* based on RA method.

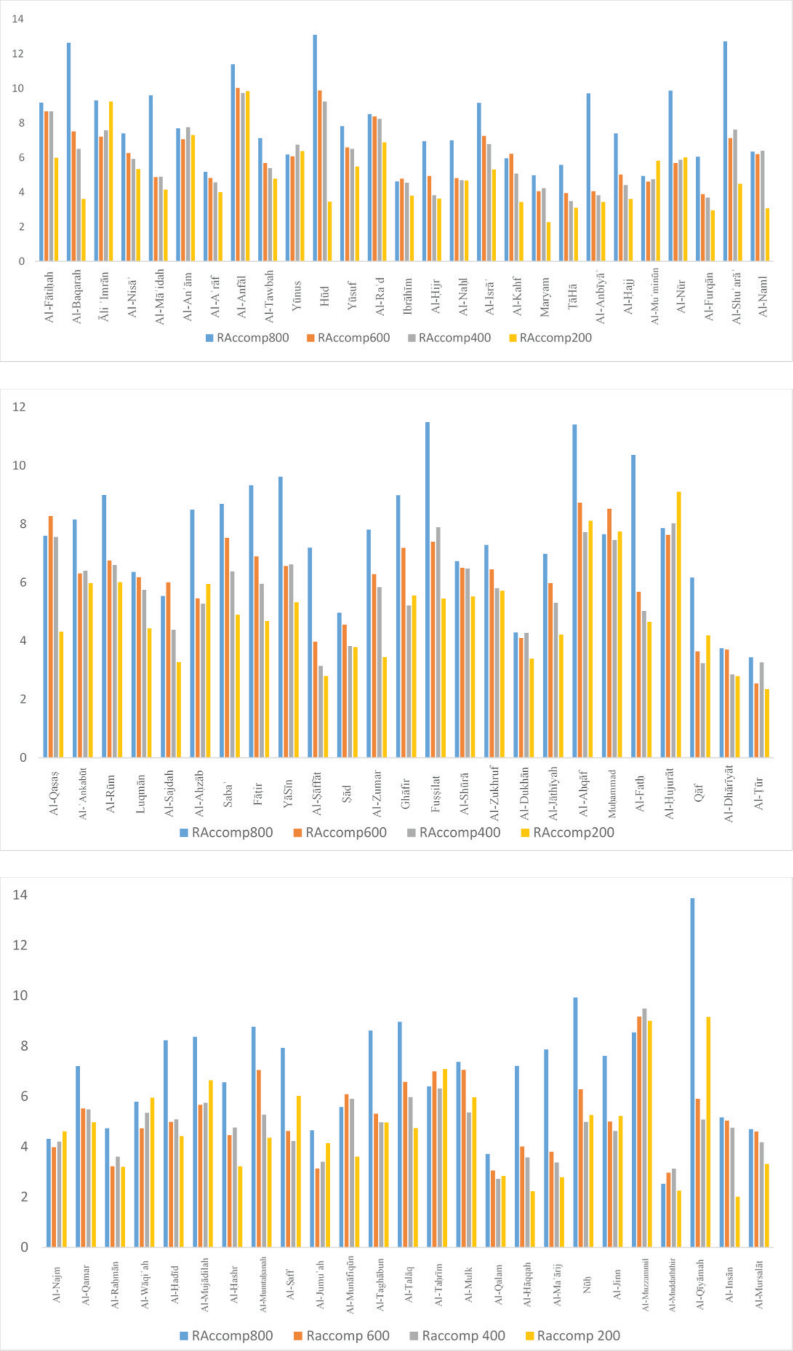
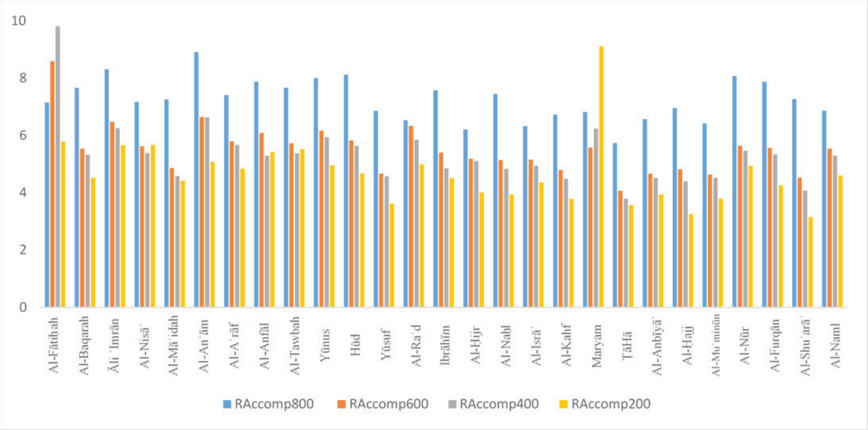
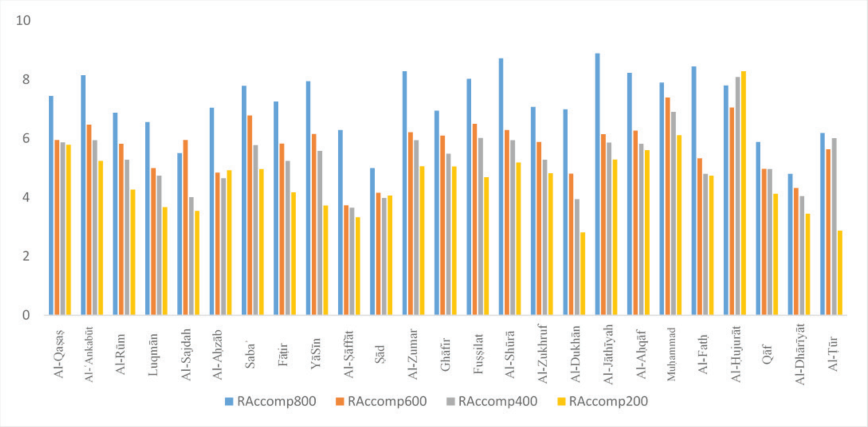


Figure 8. The proportion of the similarity of the first section and last sections of the *sūrah*s to the random mode.

As seen in the figure, the similarity of the first and last sections in the different *sūrah*s is much more than the random mode. Obviously, the similarly of the different *sūrah*s to that of the random mode is different. Herein, except for RAcompp800 mode, *Sūrah al-Anfāl* held the most similarity. As per the RAcompp800 mode, the *sūrah*s *al-Qīyāmah* and *Hūd* showed the most similarities. In addition, with regard to the average of all modes, the *sūrah*s *al-Anfāl*, *al-Muzzammil*, *al-Aḥqāf*, and *Hūd* held the most similarity of the first and last sections respectively.

After studying the similarity between the first and last sections, we studied the presence of the first section concepts throughout the whole *sūrah*. Figure 9 shows the average similarity between the first section and all sections of the *sūrah*s from *al-Fātiḥah* to *al-Mursalāt*.





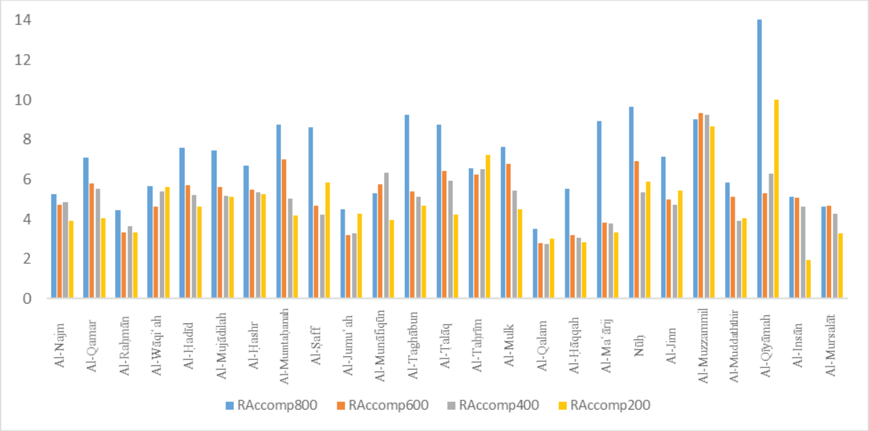


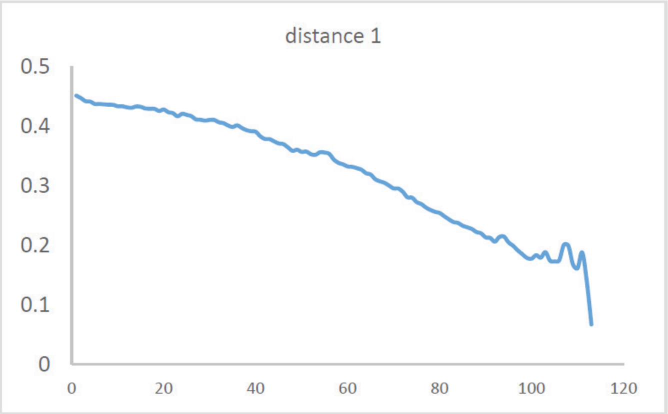
Figure 9. The proportion of the similarity of the first section and all other sections of the *sūrah*s to the random mode.

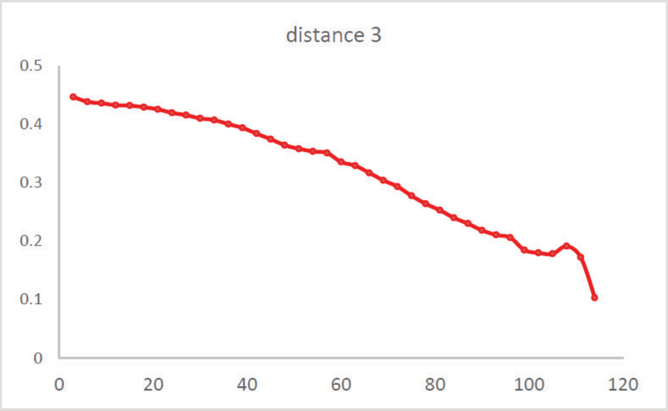
As seen in the figure, almost in all Qur’anic *sūrah*s, the similarity of the first section to the other sections is much more than the random mode. For the lowest case, which is related to *al-Qalam*, the similarity is more than three times that of the random, and above nine times, for *al-Muzzammil*, as the highest case. The *sūrah*s *al-Qīyāmah*, *al-Ḥujurāt*, and *Muḥammad* are located next. This shows that the concepts stated in the introduction of the *sūrah*s are running throughout each of them to some extent, being explained. Although this is more or less true for different surahs, it strengthens the Introduction and Explanation theory, while more study is required for the *sūrah*s where the similarity is lower than that of other *sūrah*s.

7.4. Experimental Results on Sūrahs’ Order

Some researchers of Qur’anic studies regard the Prophet’s companions (*ṣaḥābah*)as one of the factors of the *sūrah*s’ order of the Qur’an, so do not approve any logical or special order for the *sūrah*s. Others believe in the organization of the Qur’anic *sūrah*s’ ordering, to be either logical or occasionally revelatory. However, the organization of the *sūrah*s’ order is a complex problem for which the logical relationships between adjacent clusters of the *sūrah*s in the Qur’an must be studied using different methodologies, which are not studied in this paper. In this section, we compare the similarity of close *sūrah*s in terms of their order in the Qur’an to close *sūrah*s in terms of their order of revelation with resolutions 1, 3, 5, 10, and 20. What is meant by resolution r is the size of the window in which the average similarity of the *sūrah*s is calculated for those with the distance less than or equal to r. For instance, resolution 1 calculates the average similarity of the adjacent *sūrahs* and resolution 3 calculates the average similarity of the *sūrah*s the maximum distance of which is three.

Figure 10 shows the similarity of Qur'anic *sūrah*s versus their place distance from each other for the different resolutions.





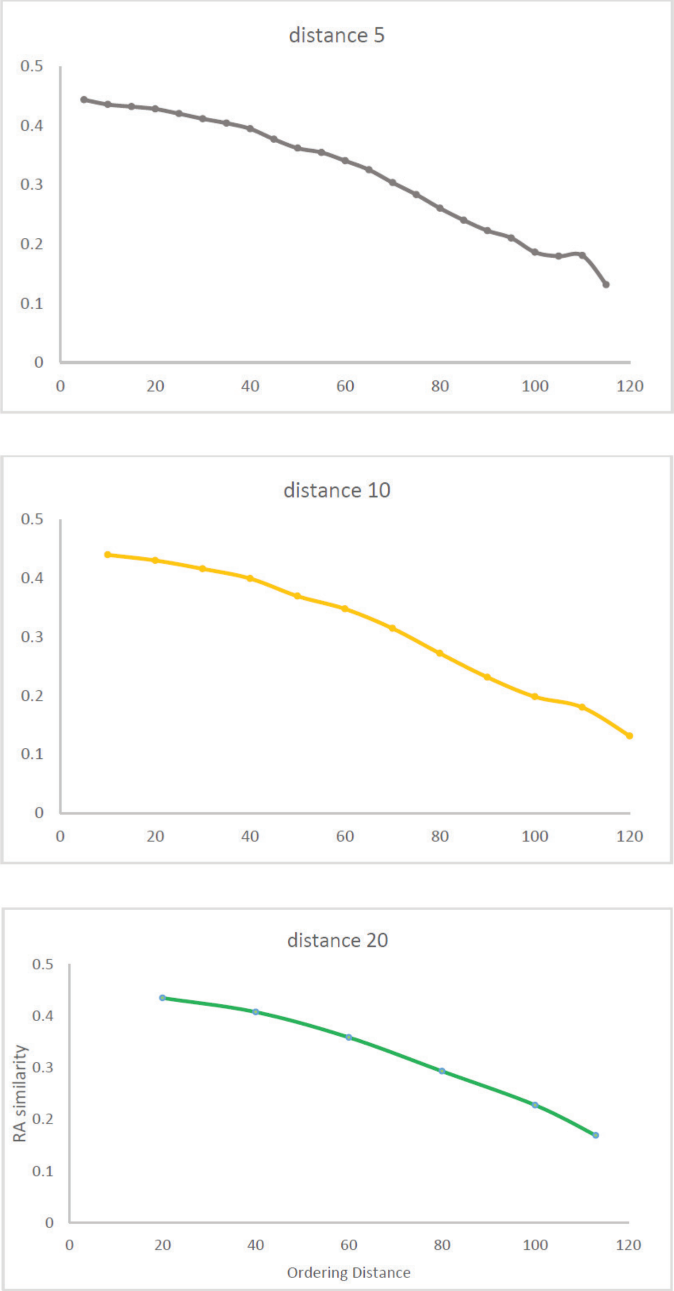
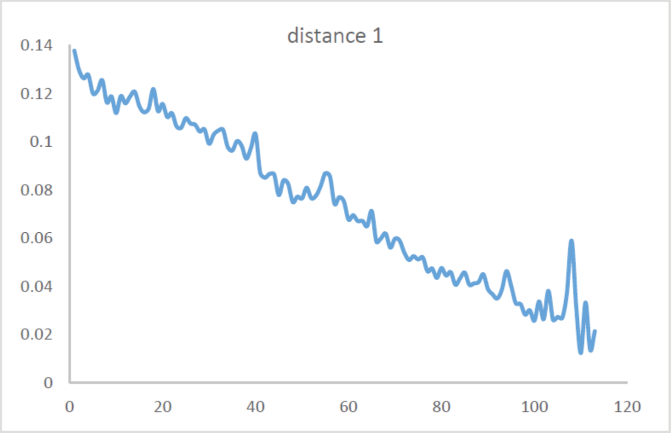
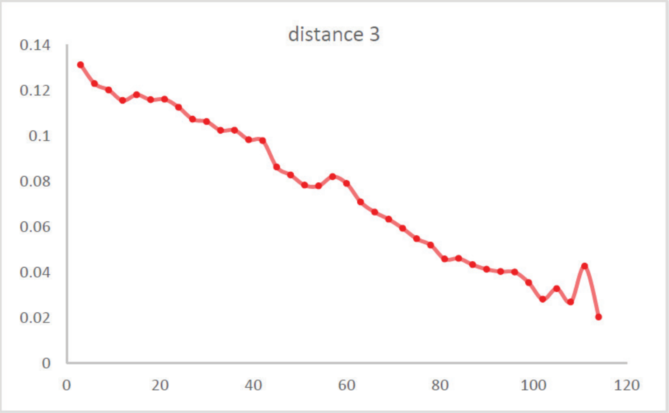


Figure 10. Similarity of the different *sūrah*s versus their distance from each other based on RA similarity.

According to Figure 10, similarity of the different *sūrah*s reduces almost linearly by increasing their distance, as the average similarity of the adjacent *sūrah*s is 0.45 and that of the *sūrah* with the most distance from each other is 0.06. The same fact is true for other resolutions.

Figure 11 also presents the diagram for the similarity of the *sūrah*s based on the tf-idf versus the *sūrah*s' distance.





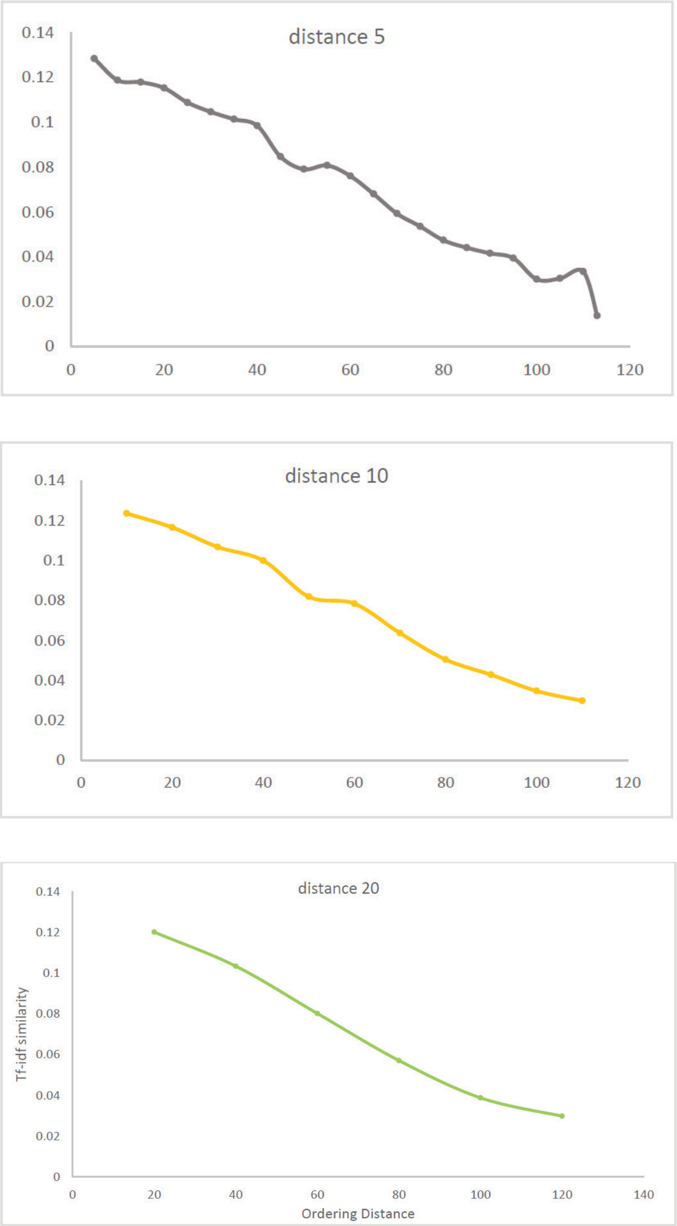


Figure 11. Similarity of the different *sūrah*s versus their distance from each other based on tf-idf similarity.

Based on this figure, the *sūrah*'s similarity by tf-idf also shows a descending trend by increasing ordering distance.

It can be concluded from Figures 10 and 11 that the *sūrah*s' distance and their similarity are correlated at least at the macroscopic level, such that the more the distance between the *sūrah*s are, the less their average similarity will be. This finding shows a kind of macroscopic organization of the *sūrah*s ordering beside each other. Due to space limit, we conduct the microscopic analysis of the *sūrah*s similarity in another paper and consider it enough to only mention that two hypotheses are imaginable based on this result: that most of the adjacent *sūurah*s are conceptually related, and that the Qur'anic *sūrah*s are in the form of different interrelated clusters and categories the *sūrah*s of each of which are tightly interrelated, and the category of the related *sūrah*s in the Qur'an are also located beside each other.

For a more detailed study, we compared the gained results to the Qur'anic *sūrahs'* similarity versus the time distance of their revelation order. Figure 12 presents the *sūrahs'* similarity versus the time distance of their revelation.

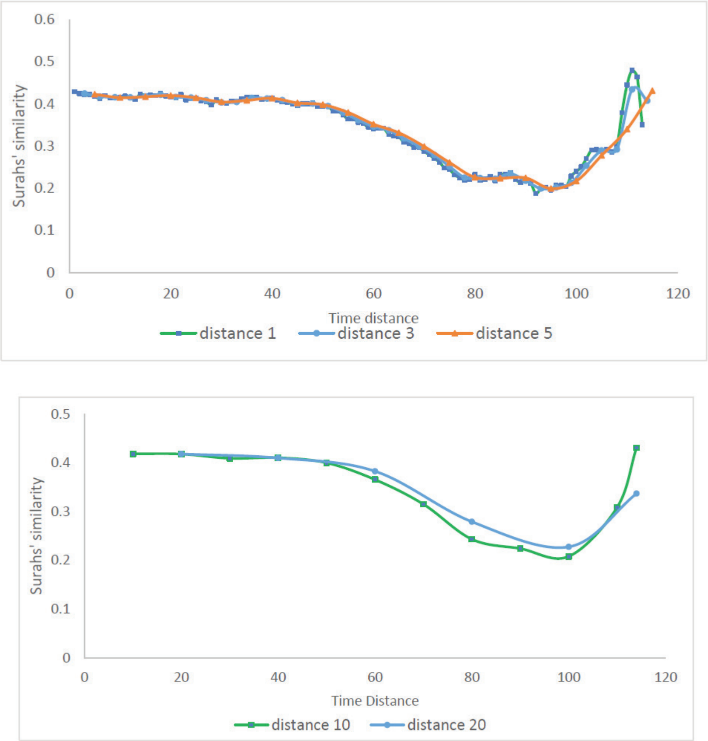


Figure 12. Similarity of the different *sūrah*s versus their revelation ordering distance from each other based on RS similarity.

This diagram will be as follows for the tf-idf similarity:

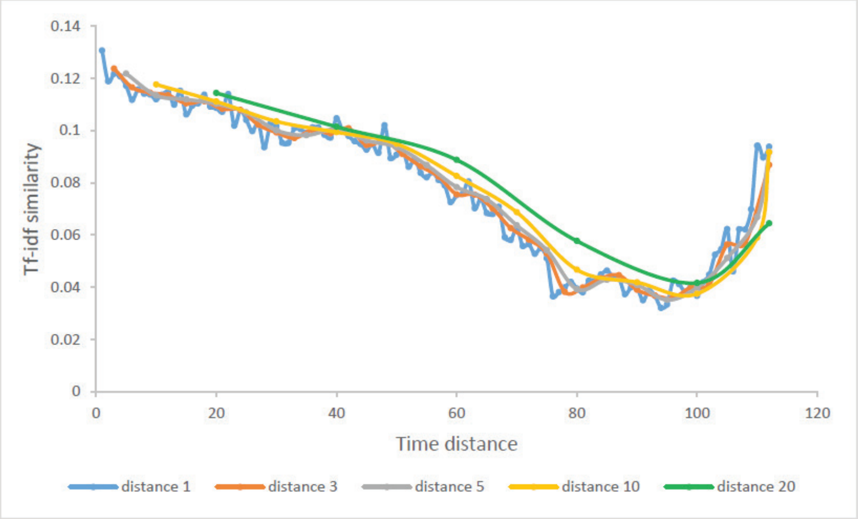


Figure 13. Similarity of the different *sūrah*s versus their revelation ordering distance from each other based on RS similarity.

As shown, the *sūrah*s' similarity versus the order of their revelation especially based on RA similarity does not follow a special trend. In RA method, the similarity does not initially change much by the increase in two *sūrah*s' distance of revelation order. The similarity decreases for the distances between 60 and 100, then increases. The same description is true with a less intensity for tf-idf.

Accordingly, it could be concluded that the order distance of the *sūrah*s in the Qur'an is related to their similarity such that those closer to each other in terms of ordering are also more similar with relatively high probability. Opposite to the order distance of the *sūrah*s, such organization is not true for the time distance of the *sūrah*s' revelation. Therefore, it could be concluded that the *sūrah*s' ordering in the Qur'an follows a logical organization, which requires more accurate and detailed study. In addition, it is accordingly recognizable why the Qur'anic *sūrah*s are not ordered by their revelation order. Numerous annotating results would be gained upon more accurate study of this issue, results such as why the first *sūrah* is at the beginning of the Qur'an named *al-Fātiḥah*, which means "The Book's Opener", or what relationship there is between the close clusters of the *sūrah*s.

8. Conclusion

This research was carried out with two purposes: examining each *sūrah*'s inner organization according to theories Topic Sameness and Introduction and Explanation, as well as the *sūrah*s' ordering in the whole Qur'an. In this regard, the Qur'anic data were initially prepared and cleared. Then by applying tf-idf, word2vec, and the roots' accompaniment in the verses, the similarity of Qur'anic roots was obtained. By the calculated similarities, the link between the *sūrah*'s topic and the body content was firstly calculated. Second, the Topic Sameness of each *sūrah* was examined by calculating the similarity between the inner concepts of each *sūrah*. Third, the existence of the structure of Introduction and Explanation was assessed in the Qur'anic *sūrah*s. The results compared to those of the random mode showed that the similarity of both the topic of each *sūrah* to the body concepts and between concepts to each other is much more than that of the random mode. This translates that the Qur'anic *sūrahs* have been mostly formed around a single topic. In addition, the *sūrah*s' organization based on the Introduction and Explanation structure is examined by computing the similarity between the first and last sections and also the first section and other sections of the different *sūrah*s. Finally, based on the study of the correlation between the *sūrah*s' order in the whole Qur'an and their revelation order with the *sūrah*s' similarity, we conclude that the *sūrah*s' ordering in the whole Qur'an is relatively organized as well.

Future Works

As this paper is the first work on algorithmic study on the Qur'an's organization, it is reasonable that some similar works be done on each individual *sūrah* in more details. In addition, study of the similarity between the structure of the different *sūrah*s or *sūrah* clusters seems to be of interest. On the other hand, as the section-definition by Ṭabāṭabā'ī turned out to be imperfect, it is very important for the future works to involve manual or automatic section-definition as the prerequisite for studying the organization of the *sūrah*s accurately. In addition, by involving a humane expert, rather than NLP similarity algorithms, more accurate results are available in the study of the sūrah's organization. Finally, other possible future works accordingly include those based on other methods of similarity calculation, comparing the Qur'an's organization to other books, and studying organization of the Qur'anic clusters.

References

Alfaifi, A. and Atwell, E. (2016), Comparative evaluation of tools for Arabic corpora search and analysis, International Journal of Speech Technology, 19, 347-357. https://doi.org/10.1007/s10772-015-9285-5

Alhawarat, M. (2015), Extracting Topics from the Holy Qur'an Using Generative Models, International Journal of Advanced Computer Science and Applications, 6(12), 288-294. DOI:10.14569/IJACSA.2015.061238.

Aram, M. R. and Layeqi, F. (2017), A Study of the Structure of Surah al-Ma'idah Based on the Tree Structure Approach, Pazhouhesh Name-ye Qur'an va Hadith, 10(19), 55-77.

Arberry, A. J. (1996), The Koran interpreted: A translation, New York: Simon and Schuster.

Atwell, E. and Sharaf, A. (2009), A Corpus-based Computational Model for Knowledge Representation of the Qur'an, Proceedings of CL2009 International Conference on Corpus Linguistics, University of Liverpool.

Bell, R. (1953), Introduction to the Qur'an, University Press.

Clauset, A., Shalizi, C., Newman, M., (2009), Power-law distributions in empirical data," SIAM review, 51(4), 661-703.

Dehghani Farsani, Y. (2008), The Structure of Surah al-Inshiqaq, Balagh Mobin, 14, 3-14.

Dukes, K., and Buckwalter, T. (2010), A dependency treebank of the Qur'an using traditional Arabic grammar, 2010 The 7th International Conference on Informatics and Systems (INFOS), Cairo, Egypt, 1-7.

Fatahizadeh, F. and Zakeri, M. (2016), A Structuralist Approach toward Surah Al-Kahf, Journal of the Holy Qur'an and Islamic Texts, 7(25), 101-120.

Hamed, S. and Aziz, M. (2016), A Question Answering System on Holy Qur'an Translation Based on Question Expansion Technique and Neural Network Classification, Journal of Computer Science, 12(3), 169-177. DOI:10.3844/jcssp.2016.169.177

Iqbal, R., Mustapha, A., Yusoff, Z. (2013), An experience of developing Qur'an ontology with contextual information support, Multicultural Education & Technology Journal, 7(4), 333-343.

Ismail, R., Bakar, Z. A., Rahman, N. A. (2016), Ontology Learning Framework for Qur'an, 2016 Advanced Research in Engineering and Information Technology International Conference (AREITIC), Bandung, Indonesia.

Jigareh, M. and Sadeghi, Z. (2017), Investigation and analysis of Sura al-Enfetar, relying on Structuralism theory, Journal of Critique of Arabic Literature, 7(1), 50-74.

Khamehgar, M. (2002a). An Introduction to Structural Interpretation of the Qur'an, Qru'anic Reserches, 8(29-30), 208-271.

Khamehgar, M. (2002b), The Geometric Structure of Qur'an's Chapters: An Introduction to the Structural Interpretation of Qur'an, Golestan Qur'an, 138, 9-13.

Khamehgar, M. (2004), The Phrasing of Qur'an's Anecdotes and the Chapters' Objectives, Golestan Qur'an, 179, 13-17.

Khamehgar, M. (2006), A Look into the First Structural Translation of the Holy Qur'an, Bayyenat, 49, 278-291.

Khamehgar, M. (2008), Theory of Purposefulness of Sūras; Principles and Backgrounds, Qru'anic Reserches, 13(54-55), 182-213.

Khan, H. U., Saqlain, S. M., Shoaib, M., Sher, M. (2013), Ontology based semantic search in Holy Qur'an, International Journal of Future Computer and Communication, 2(6), 570-575. DOI:10.7763/IJFCC.2013.V2.229

Larson, R. (2010), Book Review: Introduction to information retrieval, Journal of the American Society for Information Science and Technology, 61(4), 852-853. DOI:10.1002/asi.21234

Le, Q. and Mikolov, T. (2014), Distributed Representations of Sentences and Documents, Proceedings of the 31st International Conference on Machine Learning, PMLR 32(2), 1188-1196.

Mikolov, T., Chen, K., Corrado, G., Dean, J. (2013), Efficient estimation of word representations in vector space, arXiv preprint arXiv:1301.3781. DOI:10.48550/arxiv.1301.3781

Mitzenmacher, M. (2004), A Brief History of Generative Models for Power Law and Lognormal Distributions, Internet Mathematics, 1(2), 226-251. DO I:10.1080/15427951.2004.10129088.

Safee, M., Saudi, M., Pitchay, S., Ridzuan, F. (2016), A Systematic Review Analysis for Qur'an Verses Retrieval, Journal of Engineering and Applied Sciences, 11(3), 629-634.

Sharaf, A. and Atwell, E. (2012a), QurSim: A corpus for evaluation of relatedness in short texts, Proceedings of the Eight International Conference on Language Resources and Evaluation (LREC'12), Istanbul, Turkey, 2295-2302.

Sharaf A. and Atwell, E. (2012b), QurAna: Corpus of the Qur'an annotated with Pronominal Anaphora, Proceedings of the Eight International Conference on Language Resources and Evaluation (LREC'12), 130-137.

Sherif, M. and Ngonga Ngomo, A. (2015), Semantic Qur'an: A multilingual resource for natural-language processing, Semantic Web, 6(4), 339-345.

Shoaib, M., Yasin, M., Hikmat, U., Saeed, M., Khiyal, M. (2009), "Relational WordNet model for semantic search in Holy Qur'an, 2009 International Conference on Emerging Technologies, 29-34, DOI:10.1109/ICET.2009.5353208.

Soucy, P. and Mineau, G. (2005), Beyond TFIDF weighting for text categorization in the vector space model, Proceedings of the 19th international joint conference on Artificial intelligence (IJCAI'05), San Francisco: Morgan Kaufmann Publishers Inc.,1130–1135.

Tabataba'i, M. H. (1996), al-Mīzān fī Tafsīr al-Qur'an, vol. 2, Qom: Daftar enteshārāt islāmī.

Yauri, A., Kadir, R., Azman, A., Murad, M. (2013), Qur'anic verse extraction base on concepts using OWL-DL ontology, Research Journal of Applied Sciences, Engineering and Technology, 6(23), 4492-4498. DOI:10.19026/rjaset.6.3457

Zhang, Y., Jin, R., Zhou, ZH. (2010), Understanding bag-of-words model: a statistical framework, International Journal of Machine Learning and Cybernetics, 1, 43–52. DOI:10.1007/s13042-010-0001-0