Specialized Search Engines for Arabic Language

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ABSTRACT: *This paper presents an attempt to show the efficiency of some search engines in handling Arabic keywords. To achieve this, a comparison was made among the number of retrieved pages, retrieving time, and stability (in both the number of retrieved pages and the order for each retrieved page) for each of the 20 Arabic keywords selected (with its roots) after being simultaneously entered to the selected four search engines. Search engines tested in this experiment were Google, Yahoo, Al-hoodhood and Ayna. Google was the best search engine among the four selected search engines according to the results obtained over 10 weeks of experimenting.*

Keywords: Search engines, World Wide Web, Arabic Keywords Arabic Roots, Information retrieval

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1. Introduction

Arabic is a language that is being increasingly used by Internet users despite many significant problems. First time users face many difficulties when trying to read Arabic web sites. In major part, these difficulties arise from the way of representing Arabic in multiple character sets and the characteristics of the Arabic script itself [1].

With the extremely rapid growth rate of the Internet and the spread of textual information in a whole host of languages other than English on the web, retrieval of documents in these languages is becoming problematic more and more. Rules, theories, algorithms, and retrieval methods designed and developed for English and other morphologically similar languages may not necessarily apply in different linguistic environments. In the context of languages that differ fundamentally from English in morphology and word-formation rules, the problem tends to be even more exigent. Being the essence of written and spoken information queries, words are hugely the most important elements of expression and are the building blocks of meaningful information exchanges [2].

Initially, most of the available electronic databases were in English. Search and retrieval software, indexing methods, and user interfaces were designed specifically for this language. Since English is no longer the sole language used on the Internet, Information Retrieval (IR) systems have been developed for languages other than English. In tandem, search engines were being progressively modified to handle these languages [3][4][5]. Traditional IR environment and popular search engines face real challenges when Arabic is the language used due to the radical differences in morphology and words formation rules between Arabic and English. These rules are based on a root and pattern system that has been long thought to be a major

factor in hindering IR operations. Finding all possible words that have a common Arabic root might not necessarily lead to better IR performance. Despite the use of advanced word stemming and root extraction algorithms in Arabic IR field, researchers still fail to answer many questions [6]. This paper investigates the handling of Arabic words in English and Arabic search engines. Retrieval environment is represented by Google, Yahoo, Al-hoodhood, and Ayna. Also, it presents specific approaches to assessing stemming and root-based retrieval methods to lodge the peculiarities of Arabic word formation rules within the skeleton of this environment. The following section will briefly present the information retrieval. Search Engines will be described in section 3 and the implementation that has been conducted will be dealt with in section 4. Experimental designs and their results are discussed in section 5, while section 6 gives the concluding notes of this work. Finally, some suggestions for future work will be highlighted in section 7.

2. Information Retrieval (IR)

Up until the 1990s, efforts of specialists in Arabic computing concentrated on presenting the language in a computer environment and finding solutions for display and coding problems. In the early 1990s, interest in Arabic IR became visible and research was conducted on the automation of Arabic online library catalogs and on IR issues [6]. IR involves many strategies each of which comes with its own features that can be used to retrieve information efficiently. *Boolean Search*, *Serial Search*, and *Cluster-Based Retrieval* are among these strategies [7].

Compared to English, redundancy in Arabic was assumed to be higher, because Arabic words are derived from roots according to certain patterns, depending on fixed rules, in addition to suffixes, prefixes and infixes [3]. Also by comparing the results with these from research on English, Arabic was found to have a greater redundancy, and the average word length for Arabic is greater than English, making Arabic potentially more compressible than English [6].

Root indexing was used to index Arabic documents because root indexing increases recall and circumvents composite problems created by Arabic morphology. A root index term would retrieve all variations of this root and abolish the need to use complex queries while searching [8].

3. Search Engine

Search engine technology has to advance hugely in order to keep pace with the web growth. Examples of web growth include the increased number of web pages, documents and web queries posted on the Internet [9] [10].

It is not easy to evaluate the information retrieval system for the World Wide Web (WWW) environment. The difficulty originates from the lack of standard test data and it can also be attributed to the highly subjective nature of the conception of relevancy of WWW pages retrieved in relation to the user's information needs [11].

Precision is always reported in formed information retrieval experiments. However, there are variations in the way it is calculated depending on how relevance judgments are made [12] Search engine stability problems were investigated in several studies performed by Bar-IIan, and several measures to evaluate search engine functionality over time were outlined in these studies [12]. Bar-IIans' measures are based on the technical relevance concept which is the document defined to be technically relevant if it fulfils all the conditions posed by the query [13]. For the purpose of updating search engines, a tool, generally called a spider, is used. Spiders clean hundreds of thousands of pages a day. To find information independently, many spiders also track the links on a page hence it is possible for a spider to index a web site even if that web site was not submitted to the search engine [14].

A search engine such as Google is designed to avoid disk seeks whenever possible, and this has a substantial effect on the design of data structures [15] [16]. In Google, several distributed crawlers do the web crawling (downloading of web pages). Web crawling is the backbone to the search engine. There is a URL (Uniform Resource Locator) server that sends lists of URLs to the crawlers to be fetched. Fetched web pages are then sent to the store server which then compresses and stores the web pages into a reservoir [17].

They may only use a small database from which to create a set of results to the users (Yahoo for example only indexes a very small proportion compare to a billion pages indexes by Google) or they may not be updated particularly quickly (All the web is updated every fortnight or so, while Google is updated monthly). These spider programs may not be very fast, which means that their currency might not be a real reflection of the state of play on the Internet [8] [18].

4. Experimental Setup

In this research study, four search engines were selected in order to sustain a good comparison for Arabic keywords. Of the search engines selected, two are general search engines (Google [19][20][21][22] and Yahoo [23]) while the remaining are Arabic language search engines (Al-hoodhood [24] and Ayna [25]) that employ stemming and root indexing. These search engines were chosen because they are broadly used as general search engines. 20 words together with their roots were selected to be entered into those four search engines. Table 1 shows those selected words and their roots.

The test included using these search engines to search for a specified word, search for a specified word by its root, and then evaluating the stability of each search engine in terms of the number of retrieved pages and the order of each one. Search was designed to compare the performance of Google with Yahoo, Al-hoodhood and Ayna, and evaluate stemming as an alternative to root retrieval. Experiments were conducted using a computer with 1.7 GHz processor, 256 MB RAM, and windows XP operating system.

Keyword	Root
يبدأ	بدأ
قتلت	قتل
مظلوم	ظلم
علمنا	علم
منطق	نطق
الموتى	مات
شهادة	شهد
الصاعقة	صعق
بكاء	بكى
حكماً	حكم
مخطوف	خطف
بيوت	بيت
كتابة	كتب
نجوم	نجم
تنزيل	نزل
صورة	صور
اخبار	خبر
زمان	زمن
ايام	يوم
سلام	سلم

Table 1. The Selected 20 Arabic Keywords together with their roots

5. Results and Discussion

This study has been conducted in two phases. The first part was intended to determine the speed of loading results. In this phase, after selecting twenty different Arabic words (each with its root); each word was entered as an input in the four selected search engines simultaneously. A record was kept for the total number of pages resulted and the retrieval time. Table (2) shows the selected (20) words which were entered simultaneously to the four search engines and the number of results from each search engine with the relative time spent for searching and retrieving the results.

This process was repeated for the roots of the selected words (as shown in table 3). The purpose of this phase was to maintain a good comparison between the selected search engines in the number of retrieved pages and time. To achieve this, the total number of retrieved pages (Total-Pages) was calculated by summing up the number of the retrieved pages for all the entered search keywords. Similarly, the total time of retrieving (Total-Time) was calculated by summing up the time required to retrieve each keyword. Then, Total-Pages were divided over Total-Time and the results obtained were collated in an

ascending order for the four search engines to know which of the selected four search engines is faster in retrieving (the first one is faster than the second and so forth).

	Google		Yahoo		Al-hoodhood		Ayna	
	Results	Time (sec.)	Results	Time (sec.)	Results	Time (sec.)	Results	Time (sec.)
بدأ	2,630,000	0.55	1,480,000	0.22	41,904	2.000	3,182,550	0.991
قتل	531,000	0.37	338,000	0.14	13,007	1.000	641	0.7369
مظلوم	810,000	0.35	291,000	0.17	1,879	1.000	599,270	0.5383
علمنا	625,000	0.38	342,000	0.11	8,058	1.000	715	0.2934
منطلق	1,620,000	0.18	621,000	0.13	10,543	1.000	1,308,300	0.4291
الموتى	378,000	0.17	300,000	0.17	8,715	1.000	5,366,480	0.4687
شهادة	2,260,000	0.19	1,060,000	0.17	29,384	1.000	5,488,980	0.2081
الصاعقة	109,000	0.21	59,400	0.10	11,480	1.000	326	0.4435
بكاء	320,000	0.02	213,000	0.16	3,728	1.000	1,058,400	0.3454
حكما	227,000	0.08	348,000	0.12	4,298	1.000	301	0.2497
مخطوف	20,000	0.36	8,190	0.45	158	1.000	182	0.0489
بيوت	835,000	0.90	456,000	0.12	12,210	1.000	15,224,790	0.396
كتابة	8,400,000	0.35	7,290,000	0.15	281,677	1.000	26,972,050	1.154
نجوم	3,240,000	0.55	1,850,000	0.10	19,879	1.000	11,157,300	0.2697
تنزيل	1,490,000	0.53	725,000	0.08	7,249	1.000	3,369,240	0.2071
صورة	11,700,000	0.07	4,770,000	0.12	124,130	2.000	68,771,010	0.2313
اخبار	23,000,000	0.64	18,600,000	0.11	50,881	1.000	69,492,290	0.308
زمان	11,600,000	0.49	4,530,000	0.10	22,911	1.000	7,636,160	0.2994
ايام	3,600,000	0.57	5,240,000	0.11	28,853	1.000	8,698,480	0.2855
سلم	9,220,000	0.34	3,460,000	0.12	69,798	1.000	25,194,820	0.1831

Table 2. Loading speed of the selected search engines on Arabic Keywords

	Google		Yahoo		Al-hoodhood		Ayna	
	Results	Time (sec.)	Results	Time (sec.)	Results	Time (sec.)	Results	Time (sec.)
بدا	3,490,000	0.45	2,720,000	0.11	78,448	3.000	4,975,460	0.2354
قتل	4,080,000	0.44	2,920,000	0.23	87,941	4.000	5,375,300	0.2518
ظلم	1,650,000	0.09	730,000	0.16	11,548	1.000	2,130,520	0.227
علم	9,520,000	0.14	4,310,000	0.27	210,369	9.000	45,192,700	0.8705
نطق	624,000	0.26	266,000	0.22	5,301	1.000	676,690	0.5099
مات	2,790,000	0.11	1,240,000	0.20	43,565	2.000	2,681,770	0.1814
شهد	1,530,000	0.43	947,000	0.11	26,478	2.000	2,329,950	0.4935
صعق	28,800	0.12	23,800	0.38	156	1.000	86	0.2234
بكى	331,000	0.14	240,000	0.15	3,661	1.000	415	0.708
حكم	5,250,000	0.24	3,440,000	0.27	149,919	7.000	12,096,630	1.7774
خطف	403,000	0.18	280,000	0.13	6,412	1.000	886,410	0.2275
بيت	6,800,000	0.04	3,850,000	0.27	89,188	1.000	15,808,970	0.6742
كتب	10,400,000	0.04	5,222,000	0.24	304,339	1.000	33,520,410	0.504
نجم	1,730,000	0.26	1,090,000	0.18	18,752	1.000	10,378,200	0.3234
نزل	1,180,000	0.28	755,000	0.21	26,647	1.000	941,290	0.2456
صور	17,000,000	0.19	7,330,000	0.09	140,149	2.000	74,913,160	0.1938
خبر	20,200,000	0.51	8,630,000	0.15	39,221	1.000	70,907,410	0.4054
زمن	2,940,000	0.25	1,620,000	0.22	42,182	2.000	186	0.0449
يوم	19,500,000	0.37	12,900,000	0.03	291,731	15.000	91,490,840	0.5056
سلم	1,520,000	0.34	982,000	0.20	44,441	5.000	5,410,090	0.3271

Table 3. Loading speed of the selected search engines on Arabic roots

In the second phase of the work, three words were taken out of the selected 20 words with their roots. Each of the selected three words and its root were entered simultaneously into the selected four search engines and the process was repeated for ten weeks. A record was kept for the first twenty retrieved pages resulted for every week of the ten weeks period. The retrieving time was omitted at this part of the study as the aim of this phase was to compare the selected search engines from the results retrieval stability standpoint. Tables (4-9) and Figure (1-6) illustrate the stability of each search engine in terms of the number of the retrieved web pages for each word of the selected three words.

	Google	Yahoo	Al-hoodhood	Ayna
Week1	2,630,000	1,480,000	41,904	3,182,550
Week2	2,690,000	1,450,000	41,904	7,083,930
Week3	2,930,000	1,100,000	41,904	5,225,850
Week4	2,510,000	1,110,000	41,904	4,981,830
Week5	2,770,000	1,170,000	41,904	10,224,340
Week6	2,640,000	1,170,000	41,904	10,224,340
Week7	2,550,000	1,180,000	41,904	9,058,140
Week8	2,550,000	1,340,000	41,904	7,727,790
Week9	2,610,000	1,380,000	41,904	2,527,420
Week10	2,520,000	1,440,000	41,904	2,527,420

Table 4. The stability of the four search engines in terms of the retrieved pages for the word "بدأ"

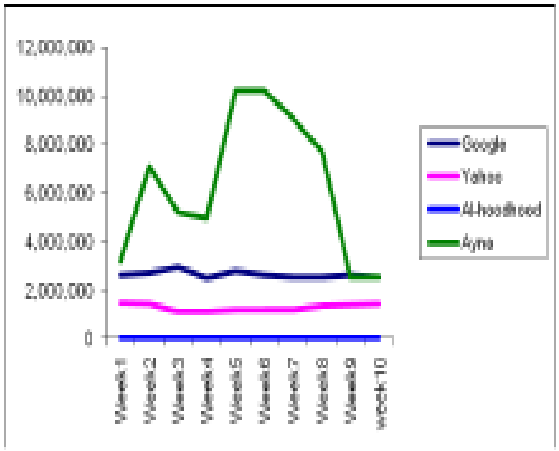

Figure 1. The stability of the four search engines in terms of the retrieved pages for the word "بدأ"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	531,000	338,000	13,007	641
Week2	524,000	355,000	13,007	665,910
Week3	548,000	266,000	13,007	898
Week4	548,000	276,000	13,007	879
Week5	560,000	298,000	13,007	871,220
Week6	495,000	274,000	13,007	871,220
Week7	543,000	321,000	13,007	782,040
Week8	502,000	357,000	13,007	700,700
Week9	595,000	356,000	13,007	543
Week10	520,000	384,000	13,007	544

Table 5. The stability of the four search engines in terms of the retrieved pages for the word "فتت"

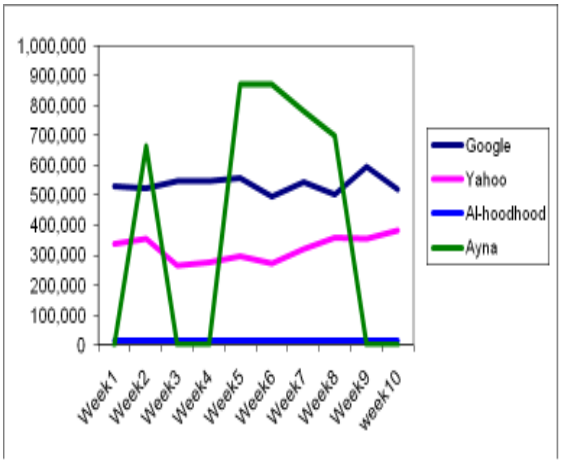

Figure 2. The stability of the four search engines in terms of the retrieved pages for the word "فتت"

Tables (10-15) and figures (7-12) show the stability of each search engine in terms of the order of the retrieved web pages for each word of the selected three words. Results in tables (10-15) were calculated by taking the first twenty pages resulted in the first week as a measure to assess how stable the search engine was in retrieving the same web pages in the coming weeks. For example, as it is clear in table 13, in the second week, Google retrieved eleven pages from the twenty that were retrieved in the first week; while Yahoo retrieved only four. Al-hoodhood retrieved 20 and Ayna retrieved 13 for the same week. These results underline two points; one is that Al-hoodhood and Ayna are more stable than Google and Yahoo. The other is that Google and Yahoo are more flexible in updating their databases (by adding new pages for the same subject).

6. Conclusion

Analysis of tables 2 and 3 was performed by summing up the results of each search engine and dividing it by the sum of the retrieving time. It is concluded that Google is the best search engine in dealing with Arabic keywords. Yahoo is the second,

	Google	Yahoo	Al-hoodhood	Ayna
Week1	20,000	8,190	158	182
Week2	31,000	18,600	158	240
Week3	46,200	15,100	158	151
Week4	24,700	13,900	158	133
Week5	21,500	13,100	158	284
Week6	19,600	12,400	158	284
Week7	20,600	12,300	158	254
Week8	20,300	10,300	158	240
Week9	21,300	10,300	158	89
Week10	22,800	10,900	158	89

Table 6. The stability of the four search engines in terms of the retrieved pages for the word "خطف"

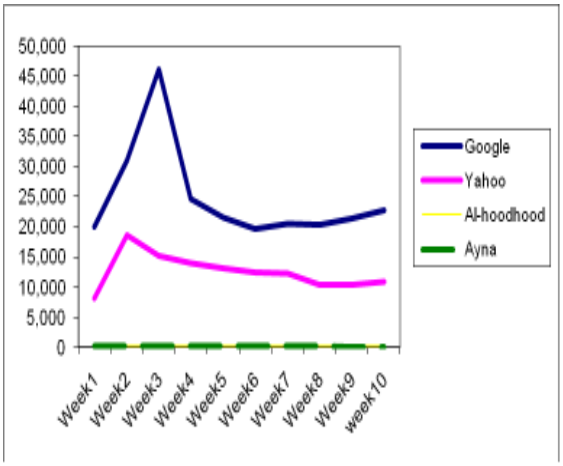

Figure 3. The stability of the four search engines in terms of the retrieved pages for the word "خطف"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	3,490,000	2,720,000	78,448	4,975,460
Week2	4,380,000	2,640,000	78,448	6,632,150
Week3	4,490,000	2,000,000	78,448	4,587,380
Week4	4,040,000	2,048,000	78,448	4,365,900
Week5	3,830,000	2,010,000	78,448	8,968,960
Week6	4,330,000	2,070,000	78,448	8,968,960
Week7	3,480,000	2,230,000	78,448	8,125,180
Week8	3,780,000	2,470,000	78,448	2,660,700
Week9	3,540,000	2,520,000	78,448	2,659,720
Week10	3,760,000	2,580,000	78,448	2,659,720

Table 7. The stability of the four search engines in terms of the retrieved pages for the word "بدأ"

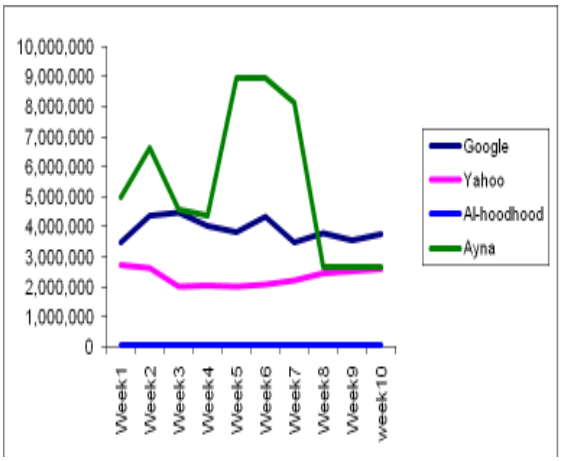

Figure 4. The stability of the four search engines in terms of the retrieved pages for the word "بدأ"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	4,080,000	2,920,000	87,941	5,375,300
Week2	4,840,000	3,010,000	87,941	6,618,430
Week3	4,790,000	2,300,000	87,941	4,432,540
Week4	4,820,000	2,350,000	87,941	4,137,070
Week5	4,570,000	2,270,000	87,941	8,580,880
Week6	4,590,000	2,500,000	87,941	8,580,880
Week7	4,230,000	2,630,000	87,941	7,720,930
Week8	4,100,000	2,880,000	87,941	6,923,700
Week9	4,020,000	2,940,000	87,941	2,659,720
Week10	3,860,000	2,910,000	87,941	2,604,350

Table 8. The stability of the four search engines in terms of the retrieved pages for the word "شق"

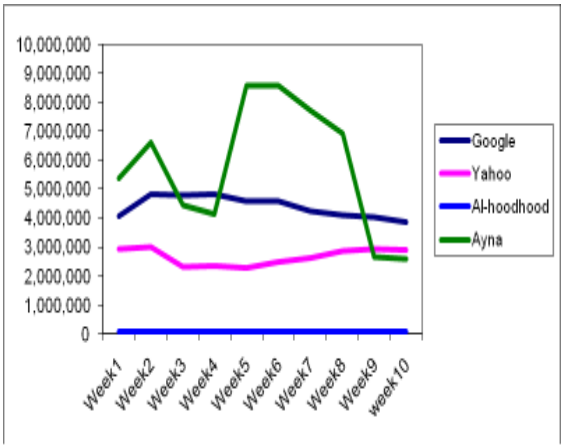

Figure 5. The stability of the four search engines in terms of the retrieved pages for the word "شق"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	403,000	280,000	6,412	886,410
Week2	445,000	329,000	6,412	1,046,640
Week3	493,000	238,000	6,412	677,670
Week4	482,000	252,000	6,412	1,335,250
Week5	667,000	338,000	6,412	1,335,250
Week6	510,000	240,000	6,412	1,335,250
Week7	402,000	220,000	6,412	1,214,710
Week8	475,000	304,000	6,412	1,089,760
Week9	462,000	335,000	6,412	861
Week10	423,000	300,000	6,412	862

Table 9. The stability of the four search engines in terms of the retrieved pages for the word "شفى"

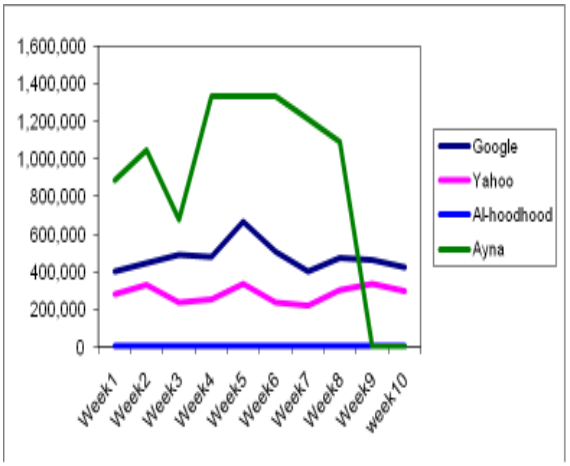

Figure 6. The stability of the four search engines in terms of the retrieved pages for the word "شفى"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	20	20	20	20
Week2	6	3	20	6
Week3	0	8	20	4
Week4	0	9	20	3
Week5	0	14	20	9
Week6	6	11	20	20
Week7	6	11	20	18
Week8	0	1	20	18
Week9	9	16	20	7
Week10	13	19	20	13

Table 10. The stability of the four search engines in terms of the order of retrieved pages for the word "بيدأ"

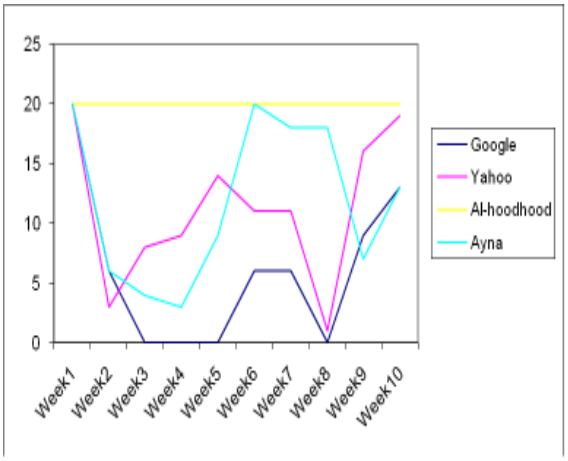

Figure 7. The stability of the four search engines in terms of the order of retrieved pages for the word "بيدأ"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	20	20	20	20
Week2	7	5	20	9
Week3	4	11	20	5
Week4	0	13	20	2
Week5	0	13	20	12
Week6	3	9	20	20
Week7	5	11	20	18
Week8	0	1	20	15
Week9	7	13	20	6
Week10	12	16	20	12

Table 11. The stability of the four search engines in terms of the order of retrieved pages for the word "شفى"

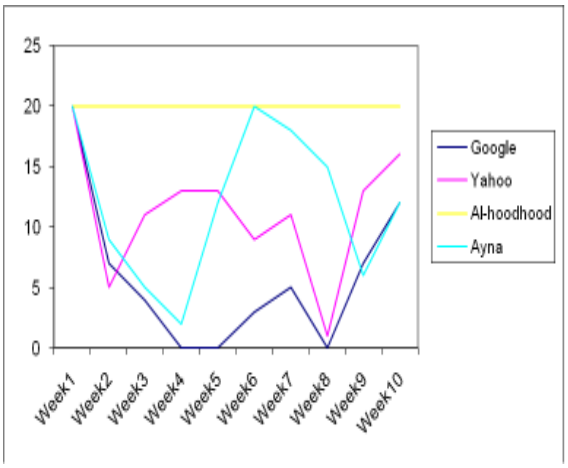

Figure 8. The stability of the four search engines in terms of the order of retrieved pages for the word "شفى"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	20	20	20	20
Week2	5	10	20	10
Week3	3	14	20	12
Week4	0	18	20	8
Week5	0	16	20	12
Week6	6	12	20	20
Week7	6	14	20	19
Week8	0	4	20	12
Week9	9	19	20	18
Week10	13	19	20	20

Table 12. The stability of the four search engines in terms of the order of retrieved pages for the word "مظروف"

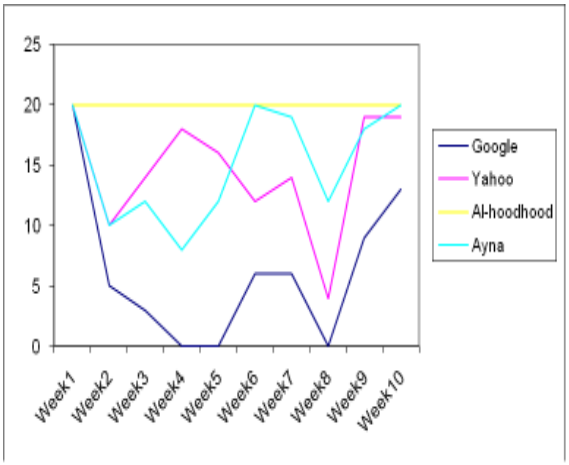

Figure 9. The stability of the four search engines in terms of the order of retrieved pages for the word"مظروف"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	20	20	20	20
Week2	11	4	20	13
Week3	11	7	20	11
Week4	0	15	20	5
Week5	0	16	20	14
Week6	14	13	20	20
Week7	11	6	20	18
Week8	0	2	20	6
Week9	8	14	20	20
Week10	15	18	20	20

Table 13. The stability of the four search engines in terms of the order of retrieved pages for the word "بدأ"

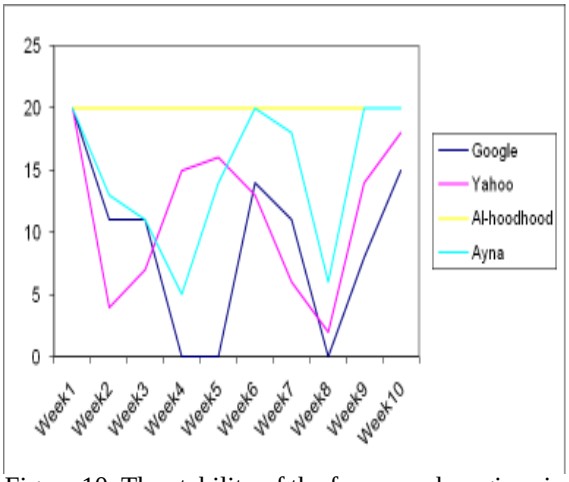

Figure 10. The stability of the four search engines in terms of the order of retrieved pages for the word "بدأ"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	20	20	20	20
Week2	9	6	20	13
Week3	3	15	20	5
Week4	0	18	20	5
Week5	0	14	20	13
Week6	1	11	20	20
Week7	6	13	20	18
Week8	0	4	20	17
Week9	13	18	20	7
Week10	17	18	20	15

Table 14. The stability of the four search engines in terms of the order of retrieved pages for the word "فقل"

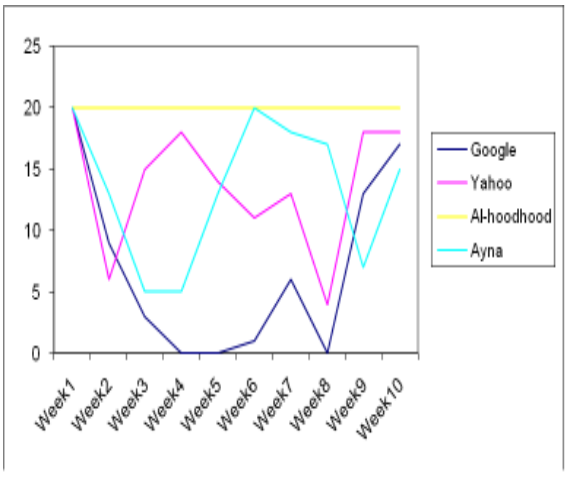

Figure 11. The stability of the four search engines in terms of the order of retrieved pages for the word "فقل"

	Google	Yahoo	Al-hoodhood	Ayna
Week1	20	20	20	20
Week2	8	5	20	14
Week3	5	14	20	14
Week4	0	13	20	19
Week5	0	17	20	20
Week6	2	11	20	20
Week7	5	18	20	19
Week8	0	3	20	18
Week9	7	17	20	5
Week10	10	19	20	16

Table 15. The stability of the four search engines in terms of the order of retrieved pages for the word "يطل"

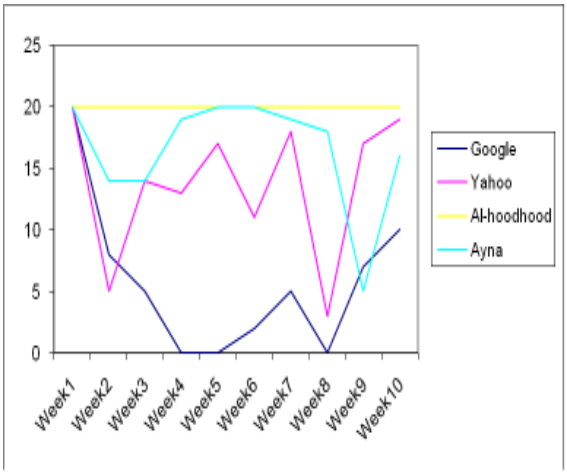

Figure 12. The stability of the four search engines in terms of the order of retrieved pages for the word "يطل"

while Ayna comes third and Al-hoodhood is the last one. The results show that Google is faster and can retrieve a large number of results comparing with others; also they reflect that although there are search engines specialized in Arabic keyword, they still have limited abilities in comparison with the general purpose ones (Google and Yahoo). Analysis of tables 4-9 revealed that Google is the best search engine when it comes to dynamic update of web pages with stability in dealing with Arabic keywords. Yahoo falls behind Google in the second position to be followed by Ayna which comes third while Al-hoodhood is the last one (no update occurred in Al-hoodhood during the search time). These results clearly show that Google is capable of rapid dynamic updating to its database in a short time compared with other search engines. Similarly, it is easily concluded that Al-hoodhood is the slowest one in that update. Conclusions drawn from analyzing tables 10-15 are compatible with the above and demonstrate that Google is the best search engine in maintaining the retrieval of the same results from week to week with dynamic update of web pages in dealing with Arabic keywords. Again, Yahoo follows Google as the second; while Ayna comes third leaving Al-hoodhood sitting at the bottom as the fourth (no update occurred in Al-hoodhood during the search time).

7. Future Work

Research ideas are plenty in the web search engines' rich environment. There are many issues that need to be looked at when attempting to define new methods to search the web in a more meaningful way. Recommendations to addressing present and future issues in developing a web search are:

1- Design a smart algorithm to decide what old web pages should be re-crawled and what new ones should be crawled.

2- Developing a metasearch engine that improves the efficiency of web searches by downloading and analyzing each document and then displaying results that show the query terms in context. This helps users to more easily decide on the relevancy of the document without having to download each page.

3- For solving Arabic language problems, Unicode must be possible to be handled, which is just one out of several possible encoding sets.

4- Supporting query refining.

5- Adding more search engines to be used in the experiments, and also consider more samples (Arabic keywords and roots) in order to have a broader idea.

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