Effectiveness of Web Search Engines Using a Query Sample in the Field of Technology

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Abstract

Purpose -The study aims to provide a systematic evaluation of the select search engines on the basis of two information retrieval parameters, precision and recall.
Design/methodology/approach - The study preferred 'Web of Science' as a source to collect data (web queries) from top listed authors who have contributed in the field of Technology. Furthermore, search engines were selected on the basis of Alexa (Actionable Analytics for the Web) Rank. Alexa listed top 500 sites, viz., search engines, directories, social networking sites, and so on. But the scope of study is confined to only top two general search engines, viz., Google and Yahoo on the basis of language which is confined to English.
Findings - The study calculated the precision and relative recall of informational queries by using the top two general search engine known as "Google" and "Yahoo". Queries were selected from the top authors of web of science in the field of Technology and were divided into informational one-word, two-word, and three-word queries. Finally, it was revealed that the mean precision of search engine Google was (1.11) for informational queries and the mean precision of search engine Yahoo was (1.04) for informational queries respectively while as, Google attained highest mean relative recall with value of (0.85) followed by search engine Yahoo with (0.14).
Research limitations -The study tests retrieval effectiveness of only two general search engines and have only selected terms from the field of Technology.
Practical implications - Users should use Google as it provides better results for informational queries as compared to Yahoo. Google is able to

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provide more relevant information where a user can fulfill his/her information desire more efficiently and effectively.
Originality/value - This study shows the importance of search engines and their retrieval effectiveness particularly to informational queries where a user is looking for detailed information.
Paper Type – Research

Keywords - Search engines; Google; Yahoo; Effectiveness; Precision; Recall; Informational queries; Web queries.

Introduction

Web is an important part of our life where search engines are considered a paramount tool available nowadays by which users can search for the information which they desire to get online by giving their queries into a search engine (Kaur, Bhatia, & Singh, 2011). However, it has been seen that there exists a large number of search engines which are integrated with a multiple features like Google, Yahoo, Bing, AltaVista, and so on. Hence, the size of database of a search engine and the services which it provides to its users varies from one search engine to another (Oppenheim, Morris, Mcknight, & Lowley, 2000). Meanwhile it has been revealed that from last few years search engines have attained almost the same level of quality to some extend in terms of results which users get back while giving their queries to search engines (Dudek, Mastora, & Landoni, 2007). As search engines vary from one another in terms of searching interface, algorithm, features, and so on, it becomes difficult sometimes for a user to decide which search engine he/she should use to get more relevant results. Thus, three important techniques can be used by the users of search engines which can help them to distinguish one search engine from another, viz., "crawling reach, frequency of updates, and relevancy analysis" (Spink, Jansen, Kathuria, & Koshman, 2006). Search engines provide its users a number of search services like "web search, image search, audio search, video search" where users make use of web search the most as compared to other search services offered by the search engines. However, in all search engines basic search feature is same but special search features in all search engines are different from one another (Zhang, Fei, & Le, 2012). Introna and Nissenbaum (2000) highlight that search engines provide essential access to the web equally to those with something to

communicate and recommend and to those who are desire to discover (particularly information users). According to Mukherjea, Hirata, and Hara (1999) Google and Yahoo perform better in terms of retrieving textual information rather than retrieving image based information from the web. In view of Kumar (2012), search engines offers information in different forms like audio, video, text, and so on, which can be searched on one single information channel and most of the users adopt same strategies for retrieving text, audio, video information. However, users should be aware about the formulation of queries because queries play an important role while retrieving information from the web. A number of web queries can be divided into informational, navigational and transactional queries.

According to Kim and Carvalho (2011), queries can be identified in various categories with evidently diverse instability profiles which clearly point out that navigational queries are significantly more constant than non-navigational queries, while as longer queries (which are those queries that exceeds in length from six to ten words) are extensively less constant than shorter ones. In the context of query taxonomy, Jansen, Booth, and Spink (2008) classify queries in three-level taxonomies, viz., informational queries are considered as top most level, on the other hand navigational queries at the second level while as transactional queries at the bottom in this given taxonomy. Tann and Sanderson (2009) highlight that the linkage of navigational aspects with informational queries is a significant utilization of navigational queries because it shows that when a user submits a query as informational query he/she somehow expects that they will get a precise web site as their end result. Thus, these queries are basically informational queries having informational intent including a facet of a navigational anticipation and expectation (as cited in Kathuria, Jansen, Hafernik, & Spink, 2010). Informational queries are definitely paying attention on the user target of attaining information about the query topic because in this category both open and close ended questions are answered by the search engines (Broder, 2002).

Statement of the Problem

From last few years the concept of information retrieval has emerged tremendously which result in the effortless and quick discovery of information. Nowadays a huge number of people from every corner of world are engaged in creation, execution, dissemination of information and exploit that information by using different search engines. A huge

amount of information is available on the internet but it has become difficult for users to find the relevant information. The problem taken in hand evaluates the selected search engine on the basis of two parameters, viz., precision and relative recall taking into account informational queries and compare the retrieval effectiveness of queries on the basis of their frequency.

Objectives of the Study

1. To identify various informational queries in the field of technology given by top ranked authors of Web of Science (WoS).
2. To assess search engine competence and effectiveness based on various parameters.
3. To contrast retrieval effectiveness of search engine in terms of Precision and Relative Recall.

Literature Review

This section provides the review of literature pertaining to various aspects of search engines with particular reference to informational queries.

Green (2000) highlights the web emerging from a nascent stage and is evolving into a more multifaceted miscellaneous and structured environment. In the current era user's desire for information has become very important where users make use of different search engines to retrieve information from the web. Chowdhury and Soboroff (2002) state that a number of search engines exist nowadays and these search engines vary in their searching interface but some of the search engines are generally quite similar in terms of effectiveness and there exists a significant gap among the most excellent and poorer. As researched by Kumar (2012), users make use of search engines to achieve their information needs because most of the users view search engines as a basic tool for retrieving information where users get the results back from search engines. However, most of the users are not aware about the search strategies offered by search engines to assist their users in order to get the relevant results back and hence such users lack relevance in the results provided by search engines. Meanwhile, it has been seen that a number of users in the current era look for the information while using search engines frequently and only a very small percentage of users gaze for the information on the web rarely. In view of Kaur, Bhatia and Singh

(2011) one of the best tools available for seeking online information is a search engine which acts as a platform where the people can search for any kind of information. It has been revealed that most of the users make use of Google while looking for the information as it provides better interface, features and ease of use to the users as compared to any other search engine available. Dijck (2010) states that search engines have become vital creators of knowledge where knowledge is not only disseminated to its users but also manufactured by ranking system of search engines. Gonzalez-Caro (2011) analyzes the impact of the query intent in the search behavior of the users and observes that the distribution of the query intent along the topics diverge for each intent which is the intent of the query influences the associated topic of that query. Lewandowski (2012) highlights that a retrieval performance of search engines can be enhanced or improved by applying various quality factors like "index quality, quality of the results, quality of search features and search engine usability".

According to Kumar and Prakash (2009), there is a variation in search aptitude, user interface and also in the quality of information among two search engines, viz., Google and Yahoo. However, both these search engines get more relevant sites as compared to irrelevant sites when comparing with other search engines. It has been seen that a search engine Google make use of web graph and link structure to become mainly inclusive and consistent search engine. Bar-Ilan (2007) reveals that web is growing as everyday a number of web pages are added to it and thus sites are rising continuously. Hence, users adopt top general search engine called "Google" because of its enormous authority on the web panorama and thus users optimize their web pages to enhance and increase the rankings of the pages on Google. According to Liu, Zhang, Ru, and Ma (2006), it is very much difficult for the search engines to provide enough information when the length of query is shorter and thus users receive low quality result list. According to Moukdad and Large (2001), Spink, Wolfram, Jansen, and Saracevic (2001), users of search engines do not make use of sophisticated search features offered by the search engines and thus lacks the relevance among the results they get back while looking for any information. Furthermore, it has also been revealed that a large number of users utilize only a small number of search queries and thus scrutinize only a small number of Webpages. Maabreh, Al-Kabi, and Alsmadi (2012), in order to categorize queries as per needs of different users, build up an automatic method. With the help of this method, users categorize different Arabic queries in three types, viz., navigational, informational, and transactional. Broder (2002) reveals

that informational and navigational queries are well treated by the latest search engines and current search engines are appearing in the most efficient way to provide most relevant results to its users. Lewandowski (2011) found that the performance of two search engines, viz., Google and Yahoo is better as compared to any other search engine e.g MSN. Furthermore, while checking the retrieval effectiveness of these two search engines it has been revealed that in case of informational queries the execution of Google and Yahoo is better than any other search engine.

Methodology

The study is based on top two general search engines Google and Yahoo which are listed by the Alexa (Actionable Analytics for the Web) at the top among all search engines. Alexa listed top 500 sites, viz., search engines, portals, directories, social networking sites, networking tools, and so on. But the scope of study is confined to only top two general search engines, viz., Google which is ranked at 1 and Yahoo which is ranked at 2 among all other search engines on the basis of language which is confined to English. Furthermore, the study preferred 'Web of Science' as a source to collect data (web queries) from top listed authors who have contributed in the field of Technology (as per web of science categorization) across a period of 2000-2015. A total of 100 authors listed by Web of Science (WoS) based on their scientific productivity were selected for the period of 1st May, 2016 to 20th June, 2016. Search queries were selected from top cited paper of each author in their area of specialization. A total of 12 informational queries were collected in the field of Technology from WoS. Informational queries are basically categorized as those queries where a user is searching or looking for some detailed information on a particular topic.

Scope/Limitation

The scope of study is confined to only top two general search engines, viz., Google which is ranked at the position of 1 and Yahoo ranked at position 2 among all search engines listed by Alexa and the selection of queries was confined to the field of Technology.

Findings

Table 1 reveals that queries are classified in three categories, viz., "one-word informational queries, two-word informational queries and three-word informational queries" respectively. A total of 12 informational queries were selected from top authors listed by web of science in the field of Technology from the period of 1st May, 2016 to 20th June, 2016.

Table 1. *Query Frequency*

S. No.	Query intent	Occurrences	Percentage
1.	Informational (one-word)	5	41.66%
2.	Informational (two-word)	4	33.33%
3.	Informational (three-word)	3	25%
	Total queries	**12**	**100%**

Precision of Search Engines:

1. "If the web pages is related to the subject matter of the search query is grouped as "more relevant" and is given a score of 2.
2. If a web pages includes only some relevant ideas to the subject matter of the search query is grouped as "less relevant" and is given a score of 1.
3. If a web page is not associated to the subject matter of the search query is grouped as "irrelevant" and is given a score of 0.
4. If there is a web pages where a message appears "Links can't be accessed" that page is grouped as "site can't be accessed" and is given a score of 0.5".

According to Shafi and Rather (2005), the formula for estimation of precision of selected search engine for each of the search queries can be used as:

$$\text{Precision} = \frac{\text{Sum of the scores of sites retrieved by a search engine}}{\text{Total number of sites selected for evaluation}}$$

Table 2. *Precision for Informational One-word Queries*

Search query	Total sites retrieved		Sites selected for evaluation		More relevant		Less relevant		Irrelevant		Sites can't be accessed		Precision	
Q#	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo
1.1	12,600,242	96,700	20	20	8	7	5	6	7	7	0	0	1.05	1
1.2	8,764,300	253,000	20	20	8	7	6	6	6	7	0	0	1.10	1
1.3	14,600,000	791,000	20	20	9	8	5	6	6	6	0	0	1.15	1.10
1.4	16,432,000	6,810,000	20	20	8	8	5	5	7	7	0	0	1.05	1.05
1.5	98,700,000	55,500,000	20	20	7	6	6	7	6	6	1	1	1.03	0.98
Total	**151,096,542**	**63,450,700**	**100**	**100**	**40**	**36**	**27**	**30**	**32**	**33**	**1**	**1**	**1.07**	**1.03**

The mean precision for informational one-word queries in case of search engine Google was highest with precision value of 1.07 as compared to search engine Yahoo which attained precision value of 1.03. In case of Google, search query (Q 1.3) attained highest precision with (1.15) while as, the stumpy precision was obtained for search query (Q 1.5) with (1.03). However, in search engine Yahoo the highest precision value of 1.1 was observed for query (Q 1.3) and lowest precision of 0.98 value was attained for query (Q 1.5) respectively (Table 2).

Table 3 revealed that the results of Google and Yahoo for informational two-word queries. It is apparent from the table that overall precision of the Google for informational two-word queries is (1.11) and overall precision of Yahoo for informational two-word queries is (1.04). However, in case of Google the highest precision was observed for query (Q 2.2) and (Q 2.3) each with same precision value of 1.15 while as, in

search engine Yahoo the highest precision was achieved for query (Q 2.3) with precision value of 1.1.

Table 3. *Precision for Informational Two-word Queries*

Search query	Total sites retrieved	Sites selected for evaluation	More relevant	Less relevant	Irrelevant	Sites can't be accessed	Precision	
Q#	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo
2.1	164,300,000	2,990,000	20	20	8	7	6	7	6	6	0	0	1.1	1.05
2.2	12,846,400	3,590,000	20	20	8	7	7	6	5	7	0	0	1.15	1
2.3	18,676,000	15,600,000	20	20	9	8	5	6	6	6	0	0	1.15	1.1
2.4	23,432,000	69,700	20	20	7	6	7	8	6	6	0	0	1.05	1
Total	**219,254,400**	**22,249,700**	**80**	**80**	**32**	**28**	**25**	**27**	**23**	**25**	**0**	**0**	**1.11**	**1.04**

From Table 4 it can be seen that the overall precision of the Google for informational three word queries was (1.14) and overall precision of the search engine Yahoo was (1.05). In case of Google, search query (Q 3.1) and (Q3.2) attained highest precision with value of (1.15) and in case of Yahoo the highest precision was observed for query (Q 3.3) with value of 1.08.

Table 4. *Precision for Informational Three-word Queries*

Search query	Total sites retrieved		Sites selected for evaluation		More relevant		Less relevant		Irrelevant		Sites can't be accessed		Precision	
	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo	Google	Yahoo
Q3.1	84,673,200	25,800	20	20	8	7	6	6	5	6	1	1	1.12	1.03
Q3.2	67,578,900	11,700	20	20	9	8	5	5	6	7	0	0	1.15	1.05
Q3.3	125,436,000	15,700,000	20	20	8	7	7	7	5	5	0	1	1.15	1.08
Total	**277,688,100**	**15,737,500**	**60**	**60**	**25**	**22**	**18**	**18**	**16**	**18**	**1**	**2**	**1.14**	**1.05**

Table 5 revealed for informational queries that the mean precision of search engine Google was (1.11) and Yahoo was (1.04), which is evident from the fact that the search engine Google provides better results for informational queries in comparison to Yahoo.

Table 5. *Mean Precision for Informational Queries*

Search engine	One-word queries	Two-word queries	Three-word queries	Mean Precision
Google	1.07	1.11	1.14	1.11
Yahoo	1.03	1.04	1.05	1.04

Relative Recall of Google and Yahoo

According to Shafi and Rather (2005), the formula for estimation of Relative Recall can be used as:

$$\text{Relative recall} = \frac{\text{Total number of sites retrieved by a search engine}}{\text{Sum of sites retrieved by a search engine}}$$

Table 6. *Relative Recall for Informational One-word Queries*

Search Query	Google		Yahoo	
	Total sites	**Relative Recall**	**Total sites**	**Relative Recall**
Q 1.1	12,600,242	0.99	96,700	0.01
Q 1.2	8,764,300	0.97	253,000	0.03
Q 1.3	14,600,000	0.94	791,000	0.05
Q 1.4	16,432,000	0.71	6,810,000	0.29
Q 1.5	98,700,000	0.64	55,500,000	0.36
Total	**151,096,542**	**0.70**	**63,450,700**	**0.29**

For informational one-word queries the recall was calculated and presented for search engine "Google" and search engine "Yahoo" in Table 6. The overall relative recall calculated for both Google and Yahoo was (0.70) and (0.29) respectively. In case of Google, the highest relative recall of (0.99) was observed for the search query (Q 1.1) followed by the search query (Q 1.2) with (0.97) relative recall value. While as, the lowest relative recall (0.64) was achieved for search query (Q 1.5). In case of Yahoo, search query (Q 1.5) attained the highest relative recall (0.36) and the least relative recall (0.01) was observed for search query (Q 1.1).

Table 7. *Relative Recall for Informational Two-word Queries*

Search query	Google		Yahoo	
	Total sites	**Relative Recall**	**Total sites**	**Relative Recall**
Q 2.1	164,300,000	0.98	2,990,000	0.02
Q 2.2	12,846,400	0.78	3,590,000	0.22
Q 2.3	18,676,000	0.54	15,600,000	0.46
Q 2.4	23,432,000	0.99	69,700	0.003
Total	**219,254,400**	**0.91**	**22,249,700**	**0.09**

The overall relative recall calculated for both Google and Yahoo for informational two-word queries was (0.91) and (0.09) respectively. In case of Google, the highest relative recall of (0.99) was observed for the search query (Q 2.4) followed by the search query (Q 2.1) with (0.98) relative recall value. While as, the lowest relative recall (0.54) was achieved for search query (Q 2.3). In case of Yahoo, search query (Q 2.3) attained the highest relative recall (0.46) and the least relative recall (0.003) was observed for search query (Q 2.4) in Table 7.

Table 8. *Relative Recall for Informational Three-word Queries*

Search query	Google		Yahoo	
	Total sites	**Relative Recall**	**Total sites**	**Relative Recall**
Q 3.1	84,673,200	0.99	25,800	3.04
Q 3.2	67,578,900	0.99	11,700	1.73
Q 3.3	125,436,000	0.88	15,700,000	0.11
Total	**277,688,100**	**0.95**	**15,737,500**	**0.05**

Table 8 showed relative recall of Google and Yahoo for three-word informational queries. The overall relative recall calculated for Google was (0.95) and overall relative recall for Yahoo was (0.05). However, the search engine Google achieved the highest relative recall of (0.99) for the query (Q 3.1) and (Q3.2) each respectively. While as, Yahoo attained highest relative recall for query (Q 3.1) with value of 3.04 followed by the search query (Q 3.2) with (1.73) relative recall value.

Table 9. *Mean Relative Recall for Informational Queries*

Search engine	One-word queries	Two-word queries	Three-word queries	Mean Relative Recall
Google	0.70	0.91	0.95	0.85
Yahoo	0.29	0.09	0.05	0.14

The mean relative recall of Google and Yahoo was (0.85) and (0.14) respectively for informational queries as seen in Table 9. Google had the highest mean precision (1.11) as well as the highest mean relative recall (0.85) followed by search engine Yahoo which attained mean precision value of (1.04) and mean relative recall of (0.14) respectively for informational queries.

Conclusion

Search engine is the most effective tool which can be used by the users while searching for any information and thus query analysis is an integral part of search engines. A huge number of search engines exist nowadays with the advanced features but still users are not satisfied with the results they get back and therefore, evaluation of these search engines is necessary to decide which search engine can provide better results. The study anticipated the precision and relative recall of two search engines

"Google" and "Yahoo" which are top two general search engines listed by Alexa ranking. The results revealed that the mean precision of search engine Google was (1.11) for informational queries and the mean precision of search engine Yahoo was (1.04) for informational queries respectively which is evident from the fact that the search engine "Google" provides better results for informational queries in comparison to search engine "Yahoo". The mean relative recall of Google for informational queries is high with value of (0.85) followed by Yahoo with (0.14). Google had the highest mean precision (1.11) as well as the highest mean relative recall (0.85) followed by search engine Yahoo which attained mean precision value of (1.04) and mean relative recall of (0.14) respectively for informational queries. It was observed that Google is able to provide more relevant and enhanced search results in comparison to search engine Yahoo and therefore, users prefer to use Google as the most efficient tool in order to retrieve more relevant results.

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Appendix 1: Informational Search Queries

1) **One-word queries**

   Q 1.1. Dzero

   Q 1.2. Excitotoxicity

   Q1. 3. Photoluminescence

   Q 1.4. Polymerase

   Q 1.5. Stroke

2) **Two-word queries**

   Q 2.1. Antimicrobial Effect

   Q 2.2. DNA Polymorphism

   Q 2.3. Gene Expression

   Q 2.4. Metal Dichalcogenide

3) **Three-word queries**

   Q 3.1. Poly Adp-Ribose Glycohydrolase

   Q 3.2. Tevatron Run Li

   Q 3.3. Two-Dimensional Materials