RESEARCH PAPER

ASSOCIATION RULE MINING ALGORITHM FOR WEB SEARCH RESULT OPTIMIZATION: A REVIEW

By

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ABSTRACT

The web is an enormous information space where large number of a individual article or unit such as documents, images, videos or other multimedia can be retrieved. In this context, several information technologies have been developed to assist users to gratify their searching needs on web, and the most used by users are search engines as Yahoo, Google, Netscape, e-Bay, e-Trade, Expedia, Amazon, Bing, Ask, and so on. The search engines allow users to find web relevant resources by setting up their queries and reviewing a list of answers. In this paper, a search result optimization method for search engine optimization by page rank updating, query recommendation and query reformulation are proposed. It explores the users queries registered in the search engine's query logs in order to learn how users search and also in order to design algorithms that can improve the correctness of the answers suggested to users. The proposed method starts by exploring the query logs to find query clusters and identify session of queries, then it examines the query logs to discover useful relationship among pages, keywords and queries within clusters using association rule mining algorithms such as apriori algorithm and automated apriori algorithm. The authors also showed that automated apriori algorithm generates more strong rules as compared to apriori algorithm.

Keywords- Web Mining, Apriori Algorithm, Automated Apriori Algorithm, Clustering, Rank Improvement Algorithm, Page, Keyword, and Query Association

INTRODUCTION

The web is a great deal and rich repository of documents, images, video etc that grows at an astoundingly quick pace. These distinctive characteristics carry several new challenges for Internet and Web researchers that embrace among alternative things, high data dimensionality and extremely volatile and perpetually evolving content. In this regard, recognizing and separating automatically interesting and valuable information, has become a very relevant problem when processing such huge quantities of data. The key issues in this matter are:

- How do we know which information is interesting (fascinating) and helpful (useful) for users? Or how do we find closely connected information from web?
- How can we discover this information automatically for users? Or how can we extract new knowledge from the web?

Due to this problem, it's become necessary to make a new and improved method that may be applied to the Internet and Web. In this order to investigate such techniques, some ideas are associated with web mining and data mining known as query log, association rules, and clustering that are recently used by various web applications and tools. The brief introductions of these ideas are used by most of the web applications and tools which are as follows:

Web Mining (WM) is based on the application of data mining techniques such as clustering, classification, and association to search patterns from the World Wide Web (WWW). The web mining can be classified into three categories as Web Structure Mining (WSM), Web Content Mining (WCM), and Web Usage Mining (WUM).

A web search engine is an application designed to seek

out helpful information on WWW. The search engine allows one to evoke content meeting specific criteria and retrieving a listing of references that match those criteria.

Search query is that the methodology in which expression of the user information that the user would like to retrieve within the input language is provided by information system.

Query log is a text file consisting of a consequence of requests which can have a fresh query or a new result screen for an earlier submitted query.

Clustering is a collection of objects which are grouped or clustered based on the concepts of maximizing the intraclass similarity within clusters and minimizing the interclass similarity with other clusters.

Association rules mining are used to find all rules that meet according to user defined restriction on MS (minimum support) and confidence with respect to a given item or dataset. The most commonly used association rule finding algorithm that searches the frequent items set strategy is illustrated by the apriori algorithm. This algorithm was the first suitable one to work well when they are used on a large scale of data set to find the frequent items.

Page rank algorithm is a link analysis algorithm that assigns a numerical weighting to every part of document collection, like WWW, with the aim of measuring its importance inside the set.

In this paper, a novel method to optimize search result has been proposed which uses association rule mining technique, and clustering. The method provides query recommendation, query reformulation and improved page ranking based on association rules construct from query log.

1. Literature Review

Ther has been several developments that have affected how information technology is talked about and used. The foremost vital one of them are the expansion of the Internet and also the accessibility of low cost hardware. The technologies for the massive information systems discussed today include the Internet (and intranets and extranets), Web search, portals, agents, collaborative filtering [1], XML and metadata, and data mining using Association Rule to create massive item-set as keywords for sites. Recent investigations have proposed ranking methodologies [2] to use linkage structure of the web, and query log instead of using the content, to improve the search result suggested pages. The recent research work concentrated on web search engines [3] such as GOOGLE and YAHOO! But there are still many cases, in which the users report about disagreeable and non-relevant pages in the top most suggested outcome of the ranked lists. Nowadays, the power of abstract that to get the set of web pages based on user query expression is not a serious problem in search engines, rather the problem comes into view at the user side as he has to filter through the long result list to find his desired content. This problem is mentioned to as the Information overkill (overabundance) problem [4].

The significance of search query logs to extract needful information about the users' searching behavior are mentioned in the seminal works [5, 6]; such analysis has found helpful results application in many different circumstances such as query recommendation [7, 8] and document ranking [9].Most of the work on query recommendation has focused on count of query similarity [8, 10] that can be used for query clustering [7, 11].

Baeza-Yates et al. [7] have presented the solution of the related queries as an important topic by other users and query expansion methods to build factitious queries.

Wen et al. [11] have worked on a clustering methodology for query recommendation that is occur mainly on four notions of query distance: keywords of the queries; string matching of keywords; common clicked URLs; and by measuring the distance of the clicked documents for searching desired quires on web in some pre-defined hierarchy structure.

Jones et al. have focused on the notion of query substitution [12].

In this paper the purpose of web log mining is to improve performance of the search engine by utilizing the mined knowledge as proposed by the authors.

2. Web Mining

Web mining is the methodology of applying data mining techniques such as clustering, classification, and association to automatically find and extract needful information from the WWW. The web mining research is actually a forced area from many research communitites, such as large database, IR, artificial intelligence, and statistics as well.

Web mining can be generally split into three categories as stated by the type of data to be mined for the web [4]:

- Web content mining
- Web Structure mining
- Web usage mining

In this paper the authors uses the web usage mining's process to put in an application of data mining techniques to extract the interesting patterns from web usage log. The web usage mining provides a more desirable understanding for supporting the needs of web-based applications [13].

3. Apriori and Automated Apriori Algorithm

In Apriori, the key principle is that the subset of any frequent itemsets must also be frequent i.e., if {P=bread and Q=egg} is a frequent itemsets, both {Bread}and {egg}should be a frequent itemsets. It means that if an itemset does not meet the expectations of the minimum support (MS), then item (I) is not frequent; that is, P (I) <MS (minimum support). If an item P is added to the itemsets I, then the resulting itemsets (i.e., IUA) cannot occur more frequently than. Therefore, IUP is not frequent either; that is, X(PUA) <MS. This property is called antimonotone. The Apriori algorithm repeatedly finds frequent itemsets with range from 1 to n-itemsets. And then frequent itemsets are used to generate association rules.

The steps involved in Apriori algorithm are as follows:

Step1. In first pass, algorithm simply counts item occurrences to determine frequent itemsets. Therefore, all singleton items are the candidates and the items that have the supports values less than a threshold is eliminated from the candidate item-list. Call this list I1.

Step2. The singleton items are combined to form two member candidate item-sets (call it I2) and support values of these candidates are then determined by scanning the data sets again. This pass is shorter than the previous one as the items eliminated in first pass are not considered again. Also, the candidates with support value higher than threshold are only considered.

Step3. In next pass, the algorithm creates three member candidate itemsets (I3) and the process is repeated again. When all frequent itemsets are accounted then the process stops.

Step4. The itemsets are then used to generate association rules which have confidence values greater than or equal to the threshold.

Step5. It first creates the rules for frequent itemsets and then the rule for subsets is created recursively.

Associative classification uses association rules for data classification. Association rule mining discovers the hidden, interesting relationship between the items in the database based on the support and confidence thresholds. An approach to identify suitable support threshold for frequent item set generation without consulting the users has been proposed [18, 19].

The Associations will be found out by Automated Apriori algorithm with cumulative support which generates more strong rules as compared to Apriori algorithm. The steps followed in Automated Apriori algorithm are as follows:

Step1. Calculate support of each item.

Step2. Arrange items in ascending order according of their support.

Step3. Calculate MS of each item.

Step4. Generate all frequent item sets

Step5. Calculate cumulative support (cs) of each item sets

Step6. Calculate mini. Support (ms) of each item sets

Step7. Selection of frequent item sets

Step8. Generation of strong association rules from frequent item sets

4. Proposed Optimization System

One of the most challenging goals for the web community is to design search engines that allow users to find resources semantically connected to their queries.

The huge size of the web and the vagueness of the most commonly used terms to formulate queries still poses a huge problem to achieve this goal Figure 1. shows the proposed system. In this paper, a search result optimization method has been proposed. It explores the users' query registered in search engine logs in order to learn how users search and also in order to design algorithms that could improve the precision of the answers suggested to users.

The proposed system follows the following steps to accomplish the above tasks:

- The module M0 shows the query log of user searching behavior as a text file.
- In the second step module M1; we create a cluster based upon the query log's text file obtained from M0.
- The module M2 is used to apply the association rule algorithms, mainly apriori and automated Apriori on the clusters created with M1.The module M2 finally creates an association of page, query, and keyword.
- The module M3 is used to improve the page rank of pages obtained from M2.
- The next and final step is using the output of all the previous all steps to optimize and get the relevant pages for suggested list to the searching users.

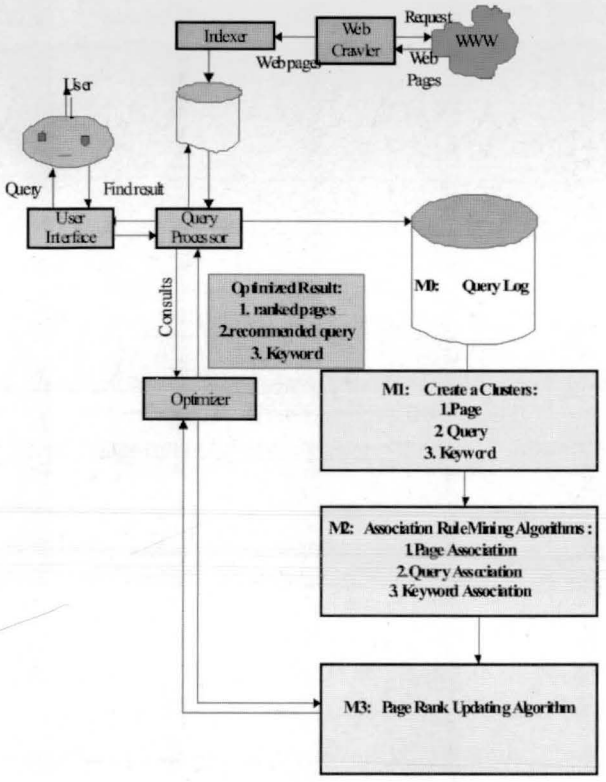


Figure 1. Architecture of Proposed Optimization System

4.1 Implementation of Proposed Optimization System on Java platform

The apache tomcat 7.0.22, MySQL Server 5.0, and JDK1.7.0 are used to implement the purposed system's modules for the development of a new search engine. The steps involved in proposed search engine are given below:

Step1:

Firstly, we have to create a folder of Seach_Engine in C:\Program Files\Apache Software Foundation\Tomcat 7.0\webapps\Seach_Engine. To run this search engine page (http://localhost:8080/Search_Engine/Link_Registration.jsp) on any browser like Internet Explorer, Mozilla Firefox etc. for registration of new websites. This registration page consists of link or URL name, link descriptions, and link keywords as shown in Figure 2(a), 2(b), 2(c), 2(d)

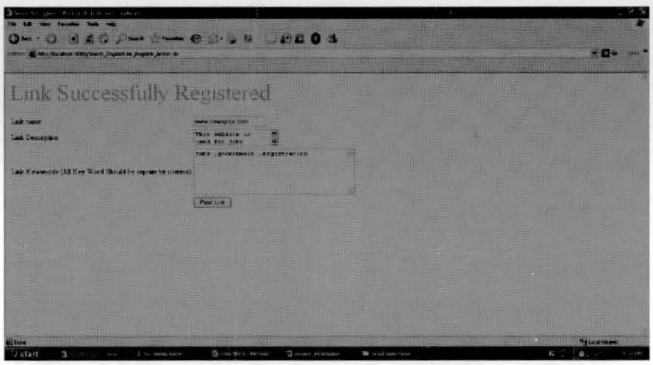


Figure 2 (a) Link Registration of timesjobs.com

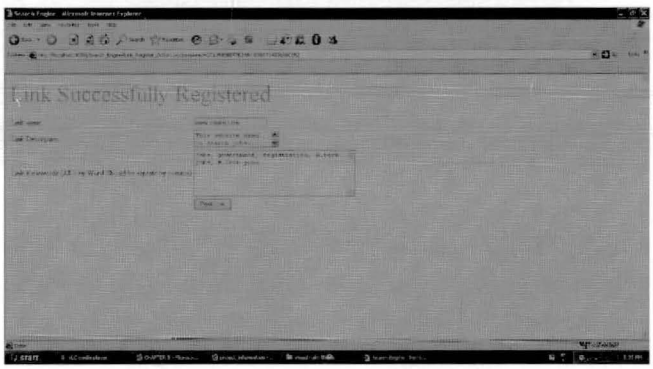


Figure 2. (b) Link Registration of naukari.com

Step2:

In the second step, we have to run search query page (http://localhost:8080/Search_Engine/.) to enter search queries, which you want to search through search engine. as the search page shown in Figure 3(a), 3(b).

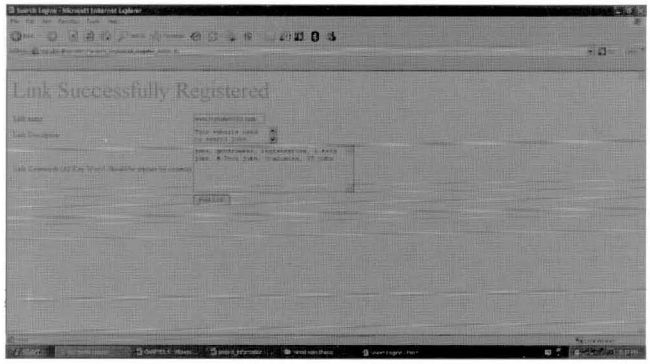


Figure 2© Link Registration of monstersindia.com

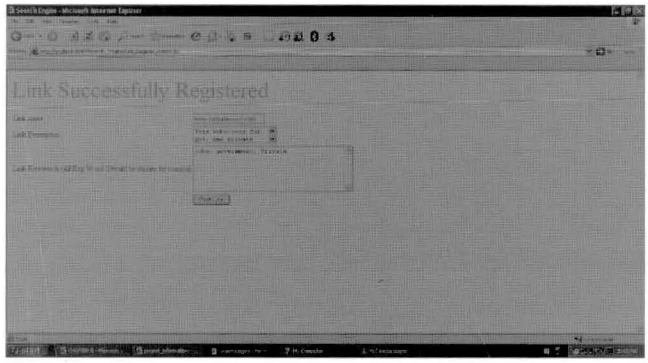


Figure 2 (d) Link Registration of sarkarnaukari.com

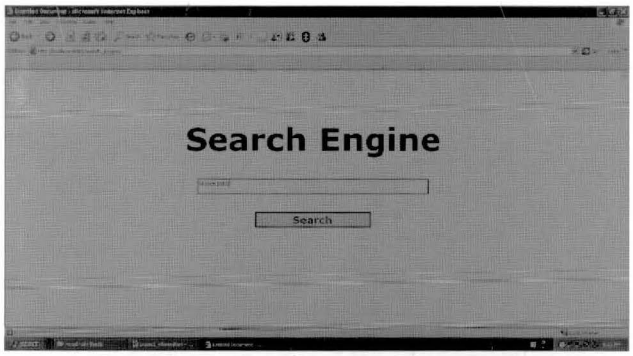


Figure 3(a) Search Query for M.Tech jobs

Figure 3(b) Search Query for jobs and private

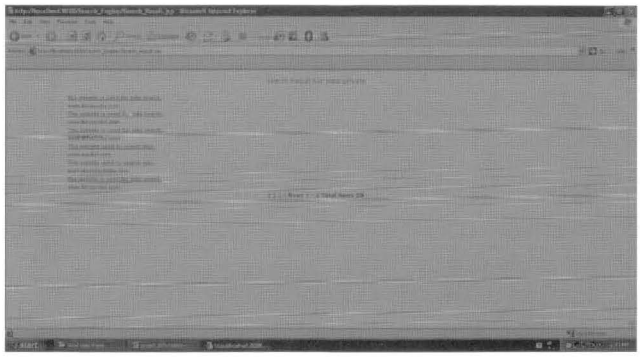


Figure 4 (a) Search Result for jobs private

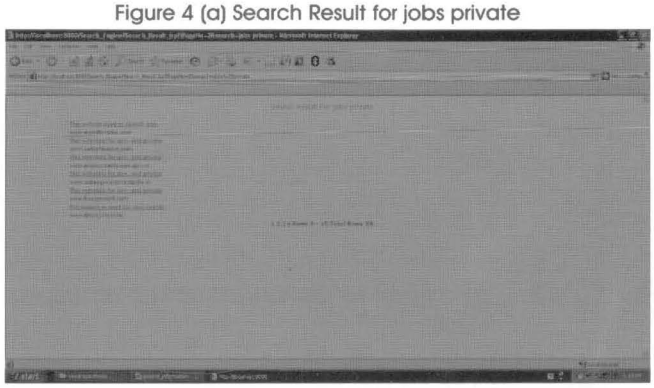


Figure 4 (b) Search Result for jobs private

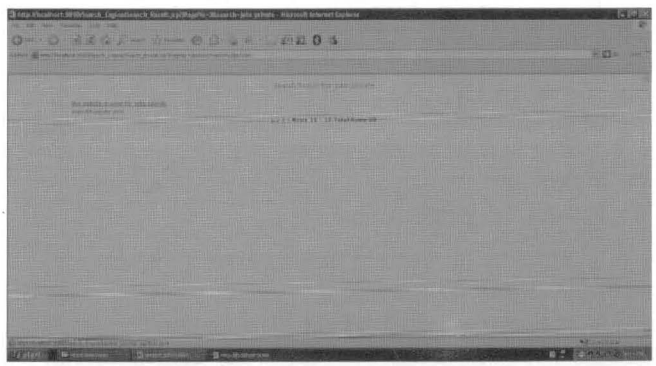


Figure 4© Search Result for jobs private

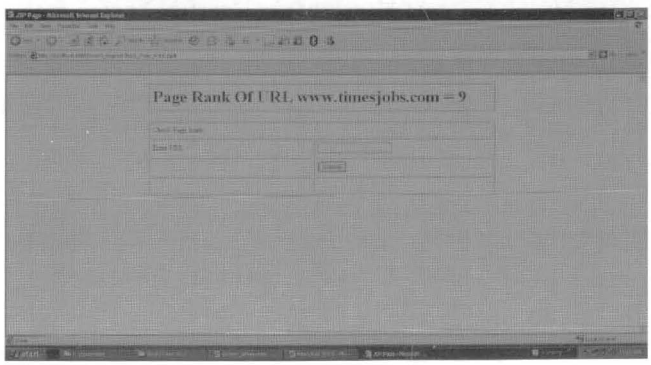


Figure 5 (a) Page rank of www.timesjobs.com

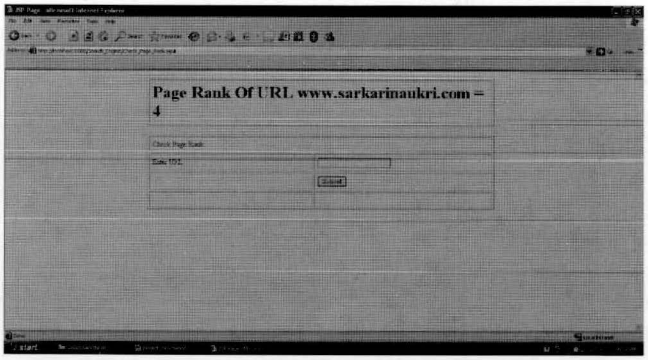


Figure 5 (b) Page rank of www.sarkarinaukari.com

Step3:

In the step3 it shows search results pages (with URLs) for query such as jobs private as shown in Figure 4(a), 4(b), 4(c).

Step4:

To check the page rank of each URL for query that is entering on the search engine, we can check out this using http://localhost:8080/Search_Engine/Check_Page_Rank.jsp. Figure 5(a), 5(b) shows the rank of Url .

5. Methodology used in the Proposed System

To implement the proposed architecture, sample query log is considered which is given in table 1. In this paper, the authors only presented four queries sessions.

The following proposed modules are performed on the 4 query sessions:

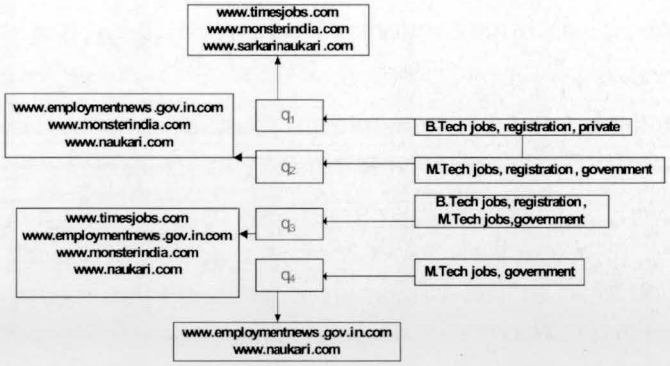
- Query clustering
- Finding page associations
- Finding keyword associations
- Finding query associations
- Rank Improvement

5.1 Clustering

Clustering is used to divide queries log into groups. As query logs are dynamic in nature, query clustering algorithm should be incremental in nature. The Page, query, and keyword association modules will use eq.1 to eq. 3 to create a cluster. We can apply the clustering equations to create the cluster for the proposed system according to the searching pattern of users which is given in Figure 1.

5.1.1 Similarity Based On Query Keywords

S.No	USER- ID	QUERY	QUERY DATE/TIME	CLICKED URL
1	101021 asdgsahd	jobs private registration	23/01/2014 06:30	1. www.timesjobs.com 2. www.monsterindia.com 3.www.sarkarinaukri.com
2	1010 ascdgssa 22	registration	23/01/02014 07:30	1.www.employmentnews.gov.in 2. www.monsterindia.com 3. www.naukri.com
3	101 safsafasfsa 022	M.tech jobs, government	24/01/2014 07:30	1. www.timesjobs.com 2. www.monsterindia.com 3.www.employmentnews.gov.in 4. www.naukri.com
4	1010 afasdsaas 23	private	24/01/2014 07:31	1. www.naukri.com 2.www.employmentnews.gov.in



If two user queries, suppose p and q contain the same word terms, they represent similar information needs. The following equation (1) is used to calculate the content similarity between two queries p and q.

Where k (p) and k (q) are the position of keywords in p and q and K (p, q) is the position of common keywords (words) in two queries as p and q.

5.1.2 Similarity Based On User Feedback

If two queries p and q access a common document suppose D, then similarity value is measured by equation (2).

Where LC (p, Di) and LC (q, Di) are the number of clicks on D which correlate with queries p and q respectively. CD (p) and CD (q) are the position of clicked documents that

correlate with queries p and q. An example illustration is shownin Figure. 6.

5.1.3 Combined Similarity Measure

The combined similarity has its own advantages. In using the first measure, queries of similar structure can be combined together. In using the second measure, benefit can be taken from user's sense. A simple way to measure it is to combine both measures of eq. (1) and eq (2):

A simple way to measure it is to combine both measures of eq. (1) and eq (2):

$$Sim_{Combined}(p,q) = \alpha . Sim_{Keyword} + \beta . Sim_{ClickURL}(p,q). \quad (3)$$

Where α and β are constants with range from $0 \leq \alpha, \beta \leq 1$ and $\alpha + \beta = 1$

In this paper for implementation, these parameters are set to be α and β as 0.5.In equation (3) the values of $Sim_{Keyword}$ and $Sim_{ClickURL}$ are measure from eq. (1) and eq. (2) respectively. Table 2. shows Cluster id of queries and Table 3 shows Assignment of Temporary Variables of each URL. Figure 6 shows Query Similarity Graph. Table 4 shows frequent item sets List.

6. Page Association Module

For each cluster C_1, C_2 corresponding URLs from the query log database are extracted and association rules are derived. Three columns (cluster ID, Query and URL) need to be retrieved to apply Apriori algorithm and Automated Apriori algorithm for finding page association database.

Cluster id	Queries
C_1	$\{q_1, q_2, q_3, q_4\}$ threshold value (<.5)
C_2	$\{q_2, q_3, q_5\}$

Table 2. cluster id of queries

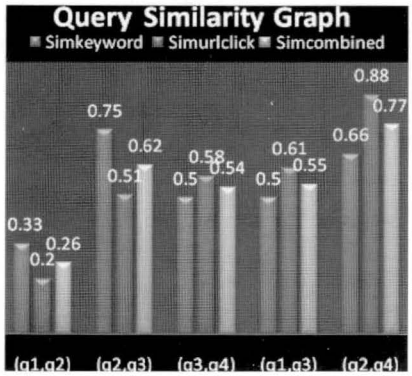


Figure 6. Query Similarity Graph

To simplify the calculations, URLs are assigned to different variables. For example, from the sample fragment, association rules found for each cluster after applying Apriori algorithm considering minimum support count 2 and also applying Automated Apriori algorithm(without using minimum support) generated more rules as compared to Apriori algorithm, given by Table 5.

7. Query Association Module

Once queries log file has been found out, query association rules are derived. Two columns (user ID (session tracking id) and query) are needed to be retrieved to apply Apriori algorithm for finding query association database. From the sample fragment, query associations found after applying apriori algorithm and automated apriori algorithm considering minimum support count 2 are given by Table 6.

8. Keyword Association Module

For each cluster C_1 and C_2 corresponding query keywords from the query log database are extracted and association rules are derived. Two columns (cluster id, query and keywords) need to be retrieved to apply Apriori algorithm for finding keyword association.

From the sample fragment, association rules are found for each cluster are after applying apriori algorithm and automated apriori algorithm considering minimum support count 2 are given by Table 7.

9. Page Rank Improvement

Whenever a query is fired, its cluster is identified. From the page association database, the weight of each URL

URLs	Temporary Variables Names
www.timesjobs.com	A
www.naukri.com	B
www.monsterindia.com	C
www.sarkarinaukri.com	D
www.employmentnews.gov.in	E

Table 3. Assignment of Temporary variables for each URL

S.No	Transaction ID	Itemsets List
1	T_1	A,C,D
2	T_2	B,C,E
3	T_3	A,B,C,E
4	T_4	B,E

Table 4. Frequent Itemsets List for each transaction id

Cluster id	Page Association Rule	
	Strong Rules generation using Apriori Algorithm	Strong Rules generation using Automated Apriori Algorithm
C_1	R 1: {A- >C}	R 1: {A- >C}
	R 2: {B- >E}	R 2: {D- >A}
	R 3: {E- >B}	R 3: {D- >C}
	R 4: {C, B - >E}	R 4: {B- >E}
	R 5: {C, E - >B}	R 5: {E- >B}
		R 6: {A,B- >C}
		R 7: {D- >A,C}
		R 8: {A,D - >C}
		R 9: {C,D - >A}
		R 10: {A,B - >E}
		R 11: {A,E - >B}
		R 12: {A,E - >C}
		R 13: {B,C - >E}
		R 14: {C,E - >B}
		R 15: {A,B - >C,E}
		R 16: {A,B,C - >E}
		R 17: {A,E - >B,C}
		R 18: {A,B,E - >C}
C_2	R 1: {B- >C}	R 1: {A- >C},
	R 2: {B- >E}	R 2: {B- >E},
	R 3: {E- >B}	R 3: {E- >B},
	R 4: {C, B - >E}	R 4: {A,B - >C},
	R 5: {C, E - >B}	R 5: {A,B - >E},
		R 6: {A,E - >B},
		R 7: {A,E - >C},
		R 8: {B,C - >E},
		R 9: {C,E - >B},
		R 10: {A,B - >C,E},
		R 11: {A,B,C - >E},
		R 12: {A,E - >B,C},
		R {A,B,E >C}

Table 5. Association Rules Comparison of Apriori and Automated Apriori Algorithm in Cluster1 and Cluster2

Cluster id	Keyword Association rules
C_1	Jobs Government Registration->jobs government etc.
C_2	Jobs->government private registration etc.

Table 6. Query Association derived from sample log file

Cluster id	Keyword Association rules
C_1	Jobs->government, registration
C_2	Jobs->government, private, registration

Table 7. Keyword Association Database Derived From Sample Log

appearing in the page association rules in clusters can be determined. Below is an example of weight of the URLs for

Page/URL	Previous Rank	Weight	New rank
A	9	0.3010	9.3010
B	8	0.3010	8.1505
C	7	0.1505	7.1505
E	7	0.1505	7.1505
.....	.....	.....	.....

Table 8. Rank Modification Relative to Page Weight in Cluster C2

querying Jobs government private registration. The authors of this paper only show the page improvement of some Strong rules that belongs to cluster C2 as the page association rule in cluster C2 is A, B->CE

Weight (A) =0.3010

Weight (B) =0.3010

Weight (E) =0.1505

Weight (C) =0.1505

Table 8 shows the optimized rank values of the pages. The improved page rank is used only for the result presentation and does not affects the page rank stored in the search engine's repository.

The old as well as new ranks are depicted here. It may be observed that some pages retain the same rank as before, while the pages which are in association rule exhibit a change in their rank values. It can be evaluated from these results that, the ranking of many web pages may be modified. Thus, more relevant web pages can be presented on the top of the result list according to the above implementation.

Conclusions

The proposed system uses Clustering and Association rule discovery concepts of data mining to achieve search engine optimization by means of effective page re-ranking, query recommendation. By the proposed new approach of search engine optimization, many advantages can be achieved which are summarized as follows:

- Returning relevant pages at a high rank to user.
- Recommending more semantically related queries.
- Improve the page rank of each URL.

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