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CONTENTS

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PAGE RANK ALGORITHMS BASED ON WEB CONTENT MINING AND WEB STRUCTURE MINING

N.KANCHANA
ASST. PROFESSOR & RESEARCH SCHOLAR
SCHOOL OF INFORMATION TECHNOLOGY & SCIENCE
DR.G.R.DAMODARAN COLLEGE OF SCIENCE
COIMBATORE

ABSTRACT

The Web is a place where we can find lot of information. The main aim of the web site is to provide relevant information to the users to satisfy their needs. A major challenge in web mining research is to find relevant document or pages by neglecting the noise and outliers. In this paper we compare different type of page rank algorithms that supports web content mining and web structure mining.

KEYWORDS
Web Mining, Page Rank, Web Content Mining, Web Structure Mining, Outliers.

I. INTRODUCTION

Web Mining is one of the application of data mining techniques to extract knowledge from web content. The WWW is a place in which the information and contents expand in size and complexity. Retrieving the required web page on the WWW efficiently and easily is becoming a major challenge. The Huge amount of information becomes very difficult for the users to find, extract, filter or evaluate the relevant web page. This challenge rises to find some technique to solve these problems. Most of the popular search engine such as Google, yahoo, Amazon etc are famous because of their crawling and ranking methods. These search engines download, index and store millions of web pages. So, web content mining and web structure mining becomes very important for effective information retrieval. Existing web mining algorithms do not consider documents containing outliers. Generally, Outlier mining is dedicated to finding data objects, which differ significantly from the rest of the data. Outlier mining has been extensively studied in statistics and recently data mining. However, exploring the Web for outliers has received very little attention in the mining community. Web content outliers are documents with 'varying contents' compared to similar Web documents taken from the same domain. Mining Web content outliers may lead to the identification of competitors and emerging business patterns in electronic commerce. This paper proposes Signed approach page rank algorithm for mining Web content outliers using a domain dictionary.

II. WEB MINING

Web Mining is the application of data mining techniques to extract knowledge from web data, including web documents, hyperlinks between documents, usage logs of web site etc.

A.Categories of Web Mining

Web Mining is broadly divided into three distinct categories, Web Content Mining, Web Structure Mining, and Web Usage Mining.

1) Web Content Mining: Web Content Mining is the process of extracting useful information from the contents of web page. The web page is unstructured and contains a mix of text, images, audio, video or structures records such as tables and lists. Web Content Mining is concerned with the retrieval of information from WWW into more structure form and indexing the information to retrieve it quickly. The technologies that are normally used in web content mining are Natural Language Processing and Information Retrieval.

2) Web Structure Mining: Web Structure Mining is the process of discovering structure information from the WWW and finds the similarity and relationships between different web sites. It is the processes by which we can also find the link structure of hyper links at inter document level and the intra document level. Page Rank also falls in to this category.

3) Web Usage Mining: Web Usage Mining is the process of data mining techniques to predict the user behavior while the user interacts with the web. Usage data captures the identity or origin of web users along with their browsing behavior at a web site. It extracts data stored in server access logs, referrer logs, agent logs, client-side cookies, user profile and meta data. It also uses the secondary data on the web.

III. KEY CONCEPTS

A. Outlier Mining

Outliers are the data that obviously deviate from others, disobey the general mode or behavior of data and disaccord with other existing data. Web content outliers are such as noise, irrelevant and redundant page from the web documents. Also, Web content outliers mining can be used to determine pages with entirely different contents from their parent web sites.

B. Page Rank

Ranking is important as it helps the users to look for "Quality" pages that are relevant to the query. Page Rank is a numeric value that represents how important a page is on the web. It is the Google's method of measuring a page's "important" when all other factors such as Title tag and Keywords are taken into account, Google uses page rank to adjust results so that more "Important" pages move up in the results page of a user search result display.

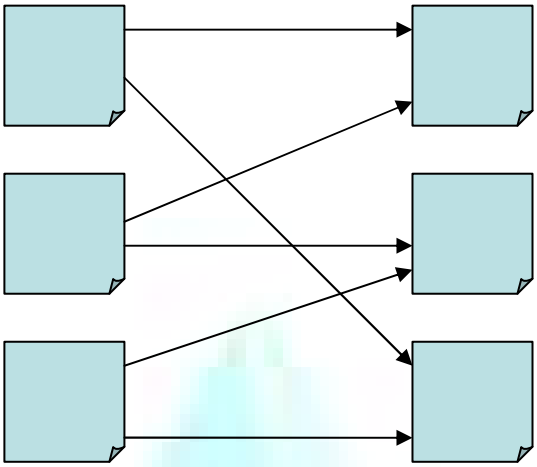
IV. PAGE RANK ALGORITHMS

With the increasing number of web pages and users on the web, the number of queries submitted to the search engines are also increasing rapidly. Therefore, the search engines needs to be more efficient in its process. Web mining techniques are employed by the search engines to extract relevant documents from the web database and provide the necessary information to the users. The search engines become very successful and popular if they use efficient ranking mechanism. Page ranking algorithms are used by the search engines to present the search results by considering the relevance, importance and content score and web mining techniques to order them according to the user interest. Some ranking algorithms depend only on the link structure of the documents i.e. their popularity scores (Web Structure Mining), whereas others look for the actual content in the documents (Web Content Mining), while some use a combination of both i.e. they use content of the document as well as the link structure to assign a rank value for a given document. If the search results are not displayed according to the user interest then the search engine will loose its popularity. So the ranking algorithms become very important. There are number of algorithms proposed based on Web Content Mining and Web Structure Mining. Three important algorithms HITS (Hyper-link Induced Topic Search), Weighted Page Content Rank, and Signed Approach Page Rank algorithm.

A.HITS

Klienberg gives two forms of web pages called as hubs and authorities. Hubs are the pages that act as resource lists. Authorities are pages having important contents. A good hub page is a page which is pointing to many authoritative pages on that content and a good authority page is a page which is pointed by many good hub pages on the same content. A page may be a good hub and a good authority at the same time[8,9]. The HITS algorithm treats WWW as directed graph G(V,E), where V is a set of vertices representing pages and E is set of edges corresponds to link. Figure 1 shows the hubs and authorities in web .

FIG. 1 HUBS AND AUTHORITIES



Hubs Authorities
It has two steps:
1. Sampling Step:- In this step a set of relevant pages for the given query are collected.
2. Iterative Step:- In this step Hubs and Authorities are found using the output of sampling step.
Following expressions (1,2) are used to calculate the weight of Hub *(Hp)* and the weight of Authority *(Ap)*.

$$H_p = \sum_{q \in I(p)} A_q \quad \text{.....(1)}$$

$$A_p = \sum_{q \in B(p)} H_q \quad \text{.....(2)}$$

where H_q is Hub Score of a page, A_p is authority score of a page, I*(p)* is set of reference pages of page p and B*(p)* is set of referrer pages of page p, the authority weight of a page is proportional to the sum of hub weights of pages that link to it. Similarly a hub of a page is proportional to the sum of authority weights of pages that it links to.

1) Constraints with HITS Algorithm

Following are some constraints of HITS algorithm

- Hubs and authorities: It is not easy to distinguish between hubs and authorities because many sites are hubs as well as authorities.
- Topic drift: Sometime HITS may not produce the most relevant documents to the user queries because of equivalent weights.
- Automatically generated links: HITS gives equal importance for automatically generated links which may not have relevant topics for the user query.
- Efficiency: HITS algorithm is not efficient in real time.

HITS was used in a prototype search engine called Clever for an IBM research project. Because of the above constraints HITS could not be implemented in a real time search engine.

B.Weighted Page Content Rank

Weighted Page Content Rank Algorithm (WPCR) is a proposed page ranking algorithm which is used to give a sorted order to the web pages returned by a search engine in response to a user query. WPCR is a numerical value based on which the web pages are given an order. This algorithm employs web structure mining as well as web content mining techniques. Web structure mining is used to calculate the importance of the page and web content mining is used to find how much relevant a page is? Importance here means the popularity of the page i.e. how many pages are pointing to or
are referred by this particular page. It can be calculated based on the number of in links and out links of the page. Relevancy means matching of the page with the fired query. If a page is maximally matched to the query, that becomes more relevant.

Algorithm: WPCR calculator
Input: Page P, In link and Out link Weights of all back links of P, Query Q, d (damping factor).
Output: Rank score
Step 1: Relevance calculation:
a) Find all meaningful word strings of Q (say N)
b) Find whether the N strings are occurring in P or not?
Z= Sum of frequencies of all N strings.
c) S= Set of the maximum possible strings occurring in P.
d) X= Sum of frequencies of strings in S.
e) Content Weight (CW)= X/Z
f) C= No. of query terms in P
g) D= No. of all query terms of Q while ignoring stop words.
h) Probability Weight (PW)= C/D
Step 2: Rank calculation:
a) Find all back links of P (say set B).
b) PR(P)=(1-d)+d (PR(T1)/C(T1)+.....PR(Tn)/C(Tn))
c) Output PR(P) i.e. the Rank score
Using the Weighted Page Content Rank user can get relevant and important pages easily as it employs web structure mining and web content mining. The input parameters used in Page Rank are Backlinks, Weighted Page Rank uses Backlinks and Forward Links as Input Parameter and Weighted Page Content Rank uses Backlinks, Forward Link and Content as Input Parameters.

C. Signed Approach Page Rank Algorithm

In the proposed Algorithm, web documents are extracted from the search engines by giving query by the user to the web. Then the obtained web documents D is preprocessed, i.e., stop words, stem words and except text other data such as hyperlinks, sound, images etc are removed. The output is a set of documents with white-spaced separated words and it is indexed in two dimensional format (i,j), where 'i' represent web pages and 'j' represent words. Therefore, first word from first web page is indexed as (1,1), second word from the first page is indexed as (1,2) etc,. The domain dictionary is arranged in such a way that, all 1-letter word will be indexed first, followed by 2-letter words, then 3-letter words similarly up to 15-letters word which is a very reasonable upper bounds for number of characters in a word. Each page is mined individually to detect relevant and irrelevant documents using signed approach. Finally, a relevant web document is obtained which contains required information catering to the user needs.

The proposed algorithm explores the advantages of full word matching and signed approach using organized domain dictionary where the indexing is done based on the length of the word. First, the input web document is preprocessed and separated into white spaced words. The full word profile for the document is generated in matrix form (i.e., $_{W1,4}$ - represents 4th word in 1st page). Then the jth word from ith page is taken and its length is calculated (i.e., | Wji |) and depending on the number of characters, the respective index on the domain dictionary is searched. Using Binary search If the word ($_{Wji}$) is found in the dictionary, then positive count is incremented by one else negative count is incremented by one. This process is carried out for all words in that web page. Finally, positive count is compared with the negative count to check the relevancy of that web page. If the positive count is less than the negative count, then that page is irrelevant, otherwise it is considered as more relevant and rank is calculated for that page.

Algorithm : Signed Approach Page Rank
Input: Domain Dictionary, Web Document D, In link and Out link Weights of all back links of P.
Output: Relevant Pages, Rank Score and Irrelevant Pages.
OtherVariable: Pos_count, Neg_count

a) Extract the input web document D after preprocessing. Where
b) D contains Pages P1,P2,…….Pn.
c) Read the contents of web pages P1 to Pn
d) Generate full word profile in to matrix for Wij (Where i represent Page and j represent Word)

```
for ( i=1;i<=n;i++)
{
Pos_count=0; Neg_count=0;
for(j=1;j<=m;j++)
{
Using BINARY SEARCH find W(i,j) word exists in dictionary
If so { Pos_count++:}
else { Neg_count++; }}
if (Pos_count++>=Neg_count)
{
```

i) Print Pi as relevant web page ;
ii) Find all back links of Pi (say set B).
iii) Calculate the Rank using the formula PR(Pi)
=(1-d)+d(PR(T1)/C(T1)+…..PR(Tn)/C(Tn))
iv) Output PR(Pi) i.e. the Rank score } else Print Pi as irrelevant web page.

This signed approach ensure that memory space, search time and run time gets reduced by using domain dictionary, Binary search, and rank calculation than other approaches for checking the relevancy of the web documents. As the efficiency of web content is increased, the quality of the search engines also gets increased. This method is very simple to implement. The proposed method is can be used by business personals to keep track of all the positive and negative aspects related to their business.

V. COMPARISON OF VARIOUS PAGE RANK ALGORITHMS

Table1 shows the difference between above three algorithms

TABLE I: COMPARISON OF HITS, WEIGHTED PAGE RANK AND SIGNED APPROACH PAGE RANK

Content	HITS	Weighted Page Content Rank	Signed Approach Page Rank Algorithm
Mining Technique used	WSM and WCM	WSM and WCM	WSM and WCM
Complexity	<O(log N)	<O(log n)	<O(log n)
Working Procedure	Computes scores of n highly relevant pages on the fly	Gives sorted order to the web pages returned by a search engine as a numerical value in response to a user query	Gives sorted order to the web pages returned by a search engine as a numerical value in response to a user query and domain dictionary
Input/ output parameters	Back links, Forward links and content	Backlinks, forward links and content	Backlinks, forward links and content
Advantages	Relatively small, some times rich in relevant pages about the query	It provide important information and relevancy about a given query by using web structure and web content mining	It provide important information and relevancy about a given query by using web structure and web content mining
Search Engine	IBM Search engine Clever	Research Model	Research Model
Limitations	Topic drift and efficiency problem	No limitation best as comparison to Page Rank and Weighted Page Rank	Needs to work along with page rank and best as compared to Weighted page content

VI. CONCLUSION

Web mining is the Data Mining technique that automatically discovers or extracts the information from web documents. HITS, Weighted Page Rank algorithms, and Signed approach page rank are used in Web Structure Mining to rank the relevant pages. In this paper HITS and Weighted Page Rank algorithms may not produces the required relevant documents easily, but in the new algorithm Singed approach page rank user can get relevant and important pages easily as it employs web structure mining and web content mining. As part of the future work is to carry out performance analysis for Singed approach page rank and to work on finding required relevant and important pages more easily and quickly using any mathematical tools for mining the web content.

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