

An Exploration of Different Web Search Algorithms for the Improvement of Web Crawler

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ABSTRACT- The crawler is a vital module of a web search engine. The effectiveness of a crawler directly affects the searching quality of the web search engines. As the crawler interacts with millions of hosts or servers over a period of weeks or months, the issues of validity, flexibility and manageability are of major importance. Also crawler could retrieve some other information, which may be of unimportant to the search from the HTML files as it is parsing them to get the new URLs. In this paper, an attempt has been made to improve the performance of the Web Crawler by comparing certain features of several algorithms such as best-first, breadth-first, pagerank, shark search and Hits. For this, various performance parameters such as precision, recall, accuracy and F-Score are taken into consideration. Based on the output parameters, an analysis is made for the improvement of web crawler towards web searching.

Keywords: WebCrawler, best-first, breadth-first, pagerank, shark-search, HITS, precision, recall, accuracy and F-measures

I. INTRODUCTION

Web crawlers are said to be spiders or robots, they are the programs that automatically retrieve the Web pages when a query is placed in the search engine. Since information on the Web is scattered among billions of pages served by millions of servers around the globe, users who browse the web can follow hyperlinks to access information, virtually moving from one page to the next.

A crawler can visit many sites to collect the information that can be analyzed and mined in a central location [1]. A lot of machine learning

approaches are being employed to estimate their significance with respect to the user queries. This is a critical task because it greatly influences the perceived effectiveness of a search engine. Users often look at only a few top hits, making the precision achieved by the ranking algorithm of dominant importance.

Many search engines ranked pages principally based on their lexical similarity to the query. The main objective of this work is to compare five Crawler Algorithms such as PageRank, Breadth-First, Best-First to assess their performance measures like precision, recall, accuracy and F-Score.

II. FUNCTIONALITY OF A CRAWLER

A crawler starts from a set of seed pages (URLs) and then uses the links within them to fetch other pages. The links in these pages are, in turn, extracted and the corresponding pages are visited. The process repeats until a sufficient number of pages are visited or some other objective is achieved. In fact, Google founders Sergey Brin and Lawrence Page, in their seminal paper [2], identified the Web crawler as the most sophisticated yet fragile component of a search engine.

Frontier [1] is the one where the Crawler maintains a list of unvisited URLs. The list is initialized with seed URLs which may be provided by the user or another program. In each iteration of its main loop, the crawler picks the next URL from the frontier, fetches the page corresponding to the URL through HTTP, parses the retrieved page to extract its URLs, adds newly discovered URLs to the frontier,

and stores the page in a local disk repository. The crawling process may be terminated when a certain number of pages have been crawled.

A crawler is, in essence, a graph search algorithm. The Web can be seen as a large graph with pages as its nodes and hyperlinks as its edges. A crawler starts from a few of the nodes (seeds) and then follows the edges to reach other nodes[3]. The process of fetching a page and extracting the links within it is analogous to expanding a node in graph search. The frontier is the main data structure, which contains the URLs of unvisited pages[8].

Typical crawlers attempt to store the frontier in the main memory for efficiency. Based on the declining price of memory and the spread of 64-bit processors, quite a large frontier size is feasible. Yet the crawler designer must decide which URLs have low priority and thus get discarded when the frontier is filled up[9]. Note that given some maximum size, the frontier will fill up quickly due to the high fan-out of pages. Even more importantly, the crawler algorithm must specify the order in which new URLs are extracted from the frontier to be visited[4]. These mechanisms determine the graph search algorithm implemented by the crawler.

III. CRAWLER ALGORITHMS

This chapter deals with various crawler algorithms such as PageRank, Breadth-First, Best-First, Shark search and HITS under comparison in this study.

A. Page Rank

PageRank was proposed by Brin and Page [2] as a possible model of user surfing behavior. The PageRank of a page represents the probability that a random surfer (one who follows links randomly from page to page) will be on that page at any given time[5]. A page's score depends recursively upon the scores of the pages that point to it.

```
PageRank(Topic,StartingUrls[],frequency)
{
for(i=0;i<=StartingUrl;i++)ENQUEUE(Frontier,Link);
do
{
if(multiplies(visited,frequency))
{
recomputed_scores_pr;
}
}
while(visited<MaxPages);
Link = DequeueTopLink(frontier);Document=Fetch(Link);
ScoreSim = Sim(Topic,Doc);Enqueue(BufferedPages,Doc,Scor
```

```
eSim);if(BufferedPages>=MaxBuffer)
{
DequeueBottomLinks(BufferedPages)
}
Merge(Frontier,ExtractLinks(Doc),ScorePr);if(Frontier>MaxBuffer)
{
DequeueBottomLinks(Frontier)
}
}
```

B. Best First

Best-First crawlers have been studied by Cho et al. [2] and Hersovici et al. [2]. The basic idea is that given a frontier of URLs, the best URL according to some estimation criterion (Precision, Recall, Accuracy and F- core) is selected for crawling, using the frontier as a priority queue. In this algorithm, the URL selection process is guided by the lexical similarity between the topic's keywords and the source page of the URL[4]. Thus the similarity between a page p and the topic keywords is used to estimate the relevance of all the outgoing links of p.

```
BestFirst(StartingUrls)
{
for(i=0;i<=StartingUrl;i++)
ENQUEUE(Frontier,url,MaxScore);
do
{
url=Dequeue(Frontier);Page=Fetch(Url);Score=GetTopicScore(Page);Visited=Visited+1;Enqueue(Frontier,ExtractLinks(Page),Score);
}while(Visited<MaxPages&&Frontier!=Null);
}
```

C. Breadth First

Breadth-First algorithm is the simplest strategy for crawling. It does not utilize heuristics in deciding which URL to visit next. It uses the frontier as a FIFO queue, crawling links in the order in which they are encountered.

```
BreadthFirst(StartingUrls)
{
for(i=0;i<=StartingUrl;i++)
ENQUEUE(Frontier,url);
do
{
url=Dequeue(Frontier);Page=Fetch(Url);Visited=Visited+1;
Enqueue(Frontier,ExtractLinks(Page));
}
while(Visited<MaxPages&&Frontier!=Null);
```


Table III-URLs with the lowest topic score

	#ofpagesvisited	# of relevantpages visited
BreadthFirst	100	32.95
BestFirst	100	33.78
PageRank	100	35.18
SharkSearch	100	34.2
HITS	100	31.0

Based on the data set experiments with the following performance measures like precision, recall, accuracy and F-Score are taken into account for their assessment [7].
Precision [10] is defined as the fraction of the documents retrieved that are relevant to the user's information need.

$$\text{Precision} = \text{TP} / (\text{TP} + \text{FP})$$

Accuracy [10] is defined as the proportion of true results (both TP and TN) in the population

$$\text{Accuracy} = (\text{TP} + \text{TN}) / (\text{TP} + \text{FP} + \text{FN} + \text{TN})$$

F-Score [10] is defined as the weighted harmonic mean of precision and Recall

$$\text{F-Score} = 2 * (\text{Precision} * \text{Recall}) / (\text{Precision} + \text{Recall})$$

Recall [10] is defined as the fraction of the documents that are relevant to the query that are successfully retrieved.

$$\text{Recall} = \text{True Positive} / ((\text{True Positive} + \text{False Negative}))$$

Table IV

	BreadthFirst				BestFirst				SharkSearch			
	Precision	Recall	Accuracy	F-Score	Precision	Recall	Accuracy	F-Score	Precision	Recall	Accuracy	F-Score
MostLinks	28.8	40.4	43.12	33.61	33.93	47	47.7	39.41	27.05	41.23	44.25	32.66
Highest TopicScore	32.5	46	47.49	38.12	34.23	47.7	48.34	39.85	31.5	44.33	44.98	36.83
Lowest TopicScore	33	46	47.51	38.41	33.78	47.1	47.03	39.34	34.28	46.82	47.67	39.58
Average	31.43	44.3	46.04	36.71	33.98	47.3	47.69	39.54	30.94	44.13	45.63	36.36

Table V

	PageRank				HITS			
	Precision	Recall	Accuracy	F-Score	Precision	Recall	Accuracy	F-Score
MostLinks	35.09	44.63	45.78	39.29	31.23	46.77	47.85	37.45
Highest TopicScore	35.363	45.37	46.41	39.75	32.6	46.47	47.53	38.32
Lowest TopicScore	35.181	46.21	47.12	39.95	30.78	45.63	46.86	36.76
Average	35.21	45.4	46.44	39.66	31.54	46.29	47.41	37.51

Based on the experiment results shown below Table IV and Table V, an analysis is made on the various algorithms. In the first case (with most links) we observe that precision is better in

Page rank, Recall is better in Best First, Accuracy is better in HITS and F-Score is better in Page Rank. In the second case (Highest Topic Score), we found that, precision is better in Page rank, Recall

is better in Best First, Accuracy is better in Shark search and F- Score is better in Page Rank. From the third case(Lowest Topic Score), it is observed that precision is better in Page rank, Recall is better in Best First, Accuracy is better in Shark search and F-Score is better in Page Rank.

Graphical view of an analysis is shown in fig 1, 2, 3, 4. It is also realized that there is a strong need to develop a robust crawler algorithm for better performance in all the above mentioned counts.

Graphical View of the Performance Measures

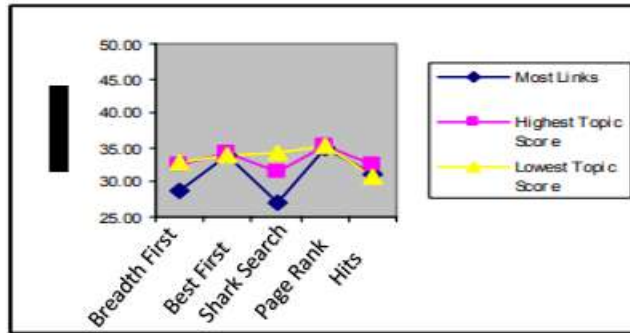


Figure 1: Performance measure by Precision

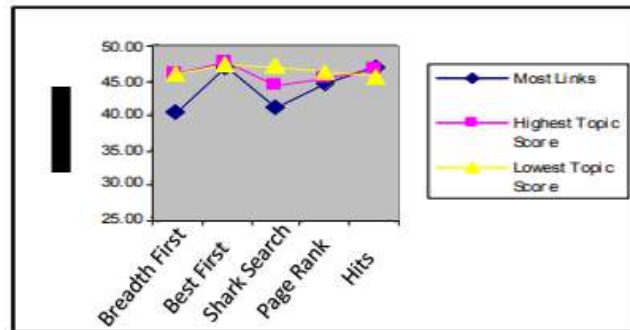


Figure 2: Performance measure by Recall

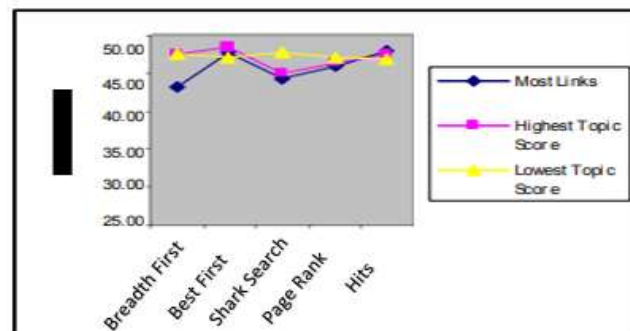


Figure3:Performance measure by Accuracy

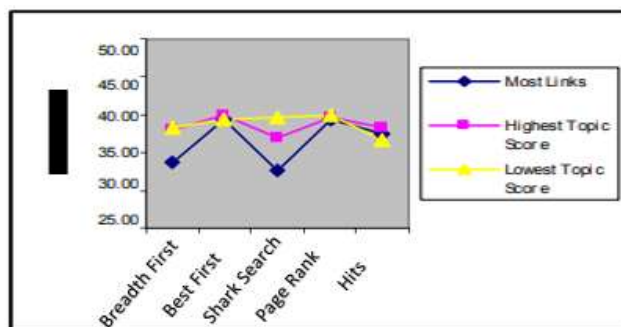


Figure 4: Performance measure by F-score

V. CONCLUSIONS:

In this paper, an attempt has been made to improve the efficiency of the Web Crawler for improving the web searching with the help of comparing certain features of several algorithms such as best-first, breadthfirst, pagerank, shark search and HITS. For this, various performance parameters such as precision, recall, accuracy and F- score are taken into consideration. Based on the output parameters, it is observed that pagerank algorithm outperforms over other algorithms by various performance measures. This result leads to the conclusion that the pagerank algorithm improves the performance of web crawler for quick information retrieval. Any efficient web search algorithm for web crawler should focus on precision and F-score for the betterment of web search.

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