



School of Computer Science
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Prof Name: Dr. Mahdi Firoozjaei

Group Project by:
Group 11

Hamza Baig (110089314)
Dipen Vinodbhai Kalal (110094706)
Talha Mohammed Shamoon Choudhary (110087321)
Adeel Ahmed (110091296)

What is Web Search Engine?

A place where user searches their query such as set of words or some meaningful words to look for on the internet. Which eventually results in the list of the webpages, Images, videos, content, or the material that gives some meaningful content related to performed search query.

How does it work?

It performs various operation to reach it's end results. Firstly, the crawling is done to get added to the searching index. Which basically scans the entire web pages on that website. Hyperlinks plays the crucial role in linking the pages whether its internally linking or the external linking which supports the web page to reach the higher ranking on the search engine.

Features of this web search engine.

- Crawling
- Cache
- Searching Keyword
- Ranking
- Auto Correct
- Auto Complete

Crawling

Crawling is the method that search engine web crawlers use to explore, download, and extract links from a page to find other pages.

Search engine-recognized pages are frequently crawled to see if their content has changed since the last time it was indexed. After a page has been crawled, a search engine may notice changes, in which case it may update its index.

Typically, search engines will try to crawl and index every URL they come across.

However, search engines will often be unable to read the content of a file other than the associated filename and metadata if the URL is for a non-text file type as an image, video, or audio file.

Non-text file types may only be able to have a small amount of information extracted by a search engine, but they can still be indexed, appear in search results, and get traffic.

Implementation of crawling in Java

```
int depth =1;
String uri="";
Utility.log("Selected option: " + options.get(option-1));

input.nextLine();
// user input
Utility.log("Enter Uri");
uri = input.nextLine();

Utility.log("Enter Depth");
depth = input.nextInt();

// check if valid Uri
if(Pattern.matches(webCrawler.urlPattern, uri))
{
    // check if present in cache
    if (!Cache.existsInCache(uri))
    {
        // calling crawler
        try {
            webCrawler.checkCrawl(1, uri, new ArrayList<String>(),depth);
        } catch (IOException e) {
            Utility.log(e.getMessage());
        }
    } else
    {
        Utility.log("This URL has already been crawled.");
    }
}
```

```

public class webCrawler{

    // URL Regex
    public static final String urlPattern = "https?:\\/(?:www\\.?)[-a-zA-Z0-9@:%_\\+~#={1,256}\\.[a-zA-Z0-9()]{1,6}\\b(?:[-a-zA-Z0-9@:%_\\+~#={1,256}\\.[a-zA-Z0-9()]{1,6}\\b(?:[-a-zA-Z0-9@:%_\\+~#={1,256}\\.[a-zA-Z0-9()]{1,6}\\b|localhost))|localhost(?:[\\/:?&@=\\-_.~!@&*(){}$%|'\"]+/?|)$";

    public static void checkCrawl(int depth, String uri, ArrayList<String> urisVisited, int depthMax) throws IOException
    {
        //limiting crawling by depth
        if(depth <= depthMax && uri != null)
        {
            //call JSoup crawler
            Document doc = crawl(uri, urisVisited);
            //Element to traverse and manipulate the HTML.
            //Select to choose hyperlink
            Elements allEle = doc.select("a[href]");
            // for each element in allEle
            for (Element ele : allEle) {
                //abstract Uri
                String link = ele.absUrl("href");
                // check if Uri already visited
                if (!urisVisited.contains(link)) {
                    // crawling the Uri if not visited
                    checkCrawl(depth++, link, urisVisited, depthMax);
                }
            }
        }
    }
}

```

```

public static Document crawl(String uri, ArrayList<String> urisVisited)
{
    //JSoup connection
    Connection conn = Jsoup.connect(uri);

    try {
        //ignore invalid content type
        Document doc = conn.ignoreContentType(true).get();
        // if success
        if (conn.response().statusCode() == 200) {
            //storing to text file
            toText.convert(uri);
            // adding Uri to visited list
            urisVisited.add(uri);
            return doc;
        }
    } catch (IOException e) {
        e.printStackTrace();
    }

    return null;
}

```

Output

```
Added :https://www.techopedia.com/ 1669696026871.txt
Added :https://www.techopedia.com/dictionary 1669696027375.txt
Added :https://www.techopedia.com/definition/34896/soft-skills 1669696027688.txt
Added :https://www.techopedia.com/definition/30915/electronic-data-capture-edc 1669696028642.txt
Added :https://www.techopedia.com/definition/28104/app 1669696029405.txt
Added :https://www.techopedia.com/definition/5411/website 1669696030320.txt
Added :https://www.techopedia.com/definition/658/online 1669696031090.txt
Added :https://www.techopedia.com/definition/7199/file 1669696031483.txt
Added :https://www.techopedia.com/definition/2185/device 1669696032347.txt
Added :https://www.techopedia.com/definition/5240/tag-metadata 1669696032671.txt
Added :https://www.techopedia.com/definition/5558/soft-copy 1669696033626.txt
Added :https://www.techopedia.com/definition/24152/information-and-communications-technology-ict 1669696033989.txt
Added :https://www.techopedia.com/definition/4607/computer 1669696034404.txt
Added :https://www.techopedia.com/it-terms/l 1669696034960.txt
Added :https://www.techopedia.com/it-terms/a 1669696035363.txt
Added :https://www.techopedia.com/it-terms/b 1669696035947.txt
Added :https://www.techopedia.com/it-terms/c 1669696036691.txt
Added :https://www.techopedia.com/it-terms/d 1669696037166.txt
Added :https://www.techopedia.com/it-terms/e 1669696037680.txt
Added :https://www.techopedia.com/it-terms/f 1669696038318.txt
Added :https://www.techopedia.com/it-terms/g 1669696038762.txt
Added :https://www.techopedia.com/it-terms/h 1669696039241.txt
Added :https://www.techopedia.com/it-terms/i 1669696040044.txt
Added :https://www.techopedia.com/it-terms/j 1669696040504.txt
Added :https://www.techopedia.com/it-terms/k 1669696040944.txt
Added :https://www.techopedia.com/it-terms/l 1669696041390.txt
Added :https://www.techopedia.com/it-terms/m 1669696042284.txt
Added :https://www.techopedia.com/it-terms/n 1669696042748.txt
Added :https://www.techopedia.com/it-terms/o 1669696043333.txt
Added :https://www.techopedia.com/it-terms/p 1669696043784.txt
Added :https://www.techopedia.com/it-terms/q 1669696044123.txt
Added :https://www.techopedia.com/it-terms/r 1669696044499.txt
Added :https://www.techopedia.com/it-terms/s 1669696045336.txt
```

Cache

(Taking example of google caching)

A type of preserved duplicate of a website that may be obtained from the servers is the Google cache. As soon as a robot accesses the page, a copy of it is made. There are two different types of caches: the proxy cache and the browser cache (such as Firefox, Chrome, etc.). Google therefore caches, indexes, and categorizes all websites. To determine its relevance to a query, Google evaluates the cached version. In general, Google's servers are substantially faster than many other web servers, so accessing a page's cached version is frequently quicker than accessing the page directly. Each organic result (blue link) typically includes a link to the cached version.

Implementation of caching in Java

After crawling it automatically caches the crawled web pages in the cache.txt file for the next time, so it doesn't have to load the link again and again.

```
1 https://www.javatpoint.com/ 1669689937002.txt
2 https://www.javatpoint.com 1669689939054.txt
3 https://www.javatpoint.com/python-tutorial 1669689940057.txt
4 https://www.javatpoint.com/python-if-else 1669689942747.txt
5 https://www.techopedia.com/ 1669696026871.txt
6 https://www.techopedia.com/dictionary 1669696027375.txt
7 https://www.techopedia.com/definition/34896/soft-skills 1669696027688.txt
8 https://www.techopedia.com/definition/30915/electronic-data-capture-edc 1669696028642.txt
9 https://www.techopedia.com/definition/28104/app 1669696029405.txt
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15 https://www.techopedia.com/definition/5558/soft-copy 1669696033626.txt
16 https://www.techopedia.com/definition/24152/information-and-communications-technology-ict 1669696033989.txt
17 https://www.techopedia.com/definition/4607/computer 1669696034404.txt
18 https://www.techopedia.com/it-terms/l 1669696034960.txt
19 https://www.techopedia.com/it-terms/a 1669696035363.txt
20 https://www.techopedia.com/it-terms/b 1669696035947.txt
21 https://www.techopedia.com/it-terms/c 1669696036691.txt
22 https://www.techopedia.com/it-terms/d 1669696037166.txt
23 https://www.techopedia.com/it-terms/e 1669696037680.txt
24 https://www.techopedia.com/it-terms/f 1669696038318.txt
25 https://www.techopedia.com/it-terms/g 1669696038762.txt
26 https://www.techopedia.com/it-terms/h 1669696039241.txt
27 https://www.techopedia.com/it-terms/i 1669696040044.txt
28 https://www.techopedia.com/it-terms/j 1669696040504.txt
29 https://www.techopedia.com/it-terms/k 1669696040944.txt
30 https://www.techopedia.com/it-terms/l 1669696041390.txt
31 https://www.techopedia.com/it-terms/m 1669696042284.txt
```

Searching and Ranking

Each search engine ranks websites in a different way. Each and every search engine will use its own algorithm to determine the ranks in a unique way. Additionally, no Search Engine will return the same results due to the various algorithms each Search Engine employs. For instance, it's quite unlikely that Google and Yahoo will ever return the identical search result. The pages of the website are ranked by search engines based on a number of parameters.

Ranking factors for search engines:

- 1) On-Page Elements
- 2) Off-Page Elements

➔ On-Page Elements

The website page and the keywords are affected by on-page elements. Each website must include on-page elements in order to rank. The publisher has some influence on these variables. factors like the website's page content, title tags, and Meta tags

➔ Off-Page Elements

These elements are those that enhance a website's ranking outside the confines of individual web pages. The publisher has no direct influence on these ranking variables. Off-page factors don't involve text or other content found on a website's page.

Here in our code the searching and ranking works on the max number of the occurrence of the keyword used for searching the crawled URL and so. The Maximum repetition the higher the page rank.

Implementation of Searching and Page Ranking in Java

```

27     private static final String path_to_file = "Textfiles/";
28
29     /**this method is created to read the files in the specified directory
30      * @throws IOException
31      */
32
33     public static void read_files() throws IOException {
34         // creating the instance of specified directory
35         File directory = new File(path_to_file);
36         Scanner scan = new Scanner(System.in);
37         String operation_restart;
38
39         // making the string array for the list of the files
40         String[] name_of_file = directory.list();
41
42         // map is created to store the the text file names for mapping the word occurrence
43         Map<String, Integer> hash_mapping = new HashMap<String, Integer>();
44
45         do {
46             System.out.println("Please enter the Keyword to be searched: ");
47             String word_searching = scan.nextLine(); // Read user input
48
49
50             // using the loop for reading the file contents
51             for (String file_name : Objects.requireNonNull(name_of_file)) {
52
53                 String str_file = path_to_file + file_name;
54                 Utility.log(str_file);
55                 File current_file = new File(str_file);
56                 if (current_file.exists() && current_file.isFile() && current_file.canRead()) {
57                     Path path = Paths.get(str_file);
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Output

```

1. Search URL
2. Remove Cache
3. Search word
4. Auto-correct word
5. Auto-fill word
6. Exit
Please select one option:
3
Selected option: 3. Search word
Please enter the Keyword to be searched:
IT
TextFiles/1669689937002.txt
TextFiles/1669689939054.txt
TextFiles/1669689940057.txt
TextFiles/1669689942747.txt
TextFiles/1669696026871.txt
TextFiles/1669696027375.txt
TextFiles/1669696027688.txt
TextFiles/1669696028642.txt
TextFiles/1669696029405.txt
TextFiles/1669696030320.txt
TextFiles/1669696031090.txt
TextFiles/1669696031483.txt
TextFiles/1669696032347.txt
TextFiles/1669696032671.txt
TextFiles/1669696033626.txt
TextFiles/1669696033989.txt
TextFiles/1669696034404.txt
TextFiles/1669696034960.txt
TextFiles/1669696035363.txt
TextFiles/1669696035947.txt
TextFiles/1669696036691.txt
TextFiles/1669696037166.txt
TextFiles/1669696037680.txt
TextFiles/1669696038318.txt
TextFiles/1669696038762.txt
TextFiles/1669696039241.txt
TextFiles/1669696040044.txt
TextFiles/1669696040504.txt
TextFiles/1669696040904.txt

```

Page Ranking

```

1. ||| number of word occurrence: 39 ||| Uniform Resource Locator (URL) https://www.techopedia.com/topic/118/it-careers
2. ||| number of word occurrence: 33 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/i
3. ||| number of word occurrence: 17 ||| Uniform Resource Locator (URL) https://www.techopedia.com/
4. ||| number of word occurrence: 12 ||| Uniform Resource Locator (URL) https://www.techopedia.com/definition/24152/information-and-communic
5. ||| number of word occurrence: 9 ||| Uniform Resource Locator (URL) https://www.techopedia.com/topic/5/networks
6. ||| number of word occurrence: 6 ||| Uniform Resource Locator (URL) https://www.techopedia.com/topic/1/cloud-computing
7. ||| number of word occurrence: 5 ||| Uniform Resource Locator (URL) https://www.techopedia.com/topic/4/cybersecurity
8. ||| number of word occurrence: 4 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/s
9. ||| number of word occurrence: 4 ||| Uniform Resource Locator (URL) https://www.techopedia.com/definition/34896/soft-skills
10. ||| number of word occurrence: 4 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/c
11. ||| number of word occurrence: 3 ||| Uniform Resource Locator (URL) https://www.techopedia.com/topic/20/data-management
12. ||| number of word occurrence: 3 ||| Uniform Resource Locator (URL) https://www.techopedia.com/topic/87/artificial-intelligence
13. ||| number of word occurrence: 3 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/v
14. ||| number of word occurrence: 3 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/h
15. ||| number of word occurrence: 3 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/w
16. ||| number of word occurrence: 3 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/b
17. ||| number of word occurrence: 3 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/e
18. ||| number of word occurrence: 3 ||| Uniform Resource Locator (URL) https://www.techopedia.com/definition/30915/electronic-data-capture--
19. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/q
20. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/y
21. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/d
22. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/definition/5240/tag-metadata
23. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/j
24. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/f
25. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/l
26. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/u
27. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/dictionary
28. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/p
29. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/m
30. ||| number of word occurrence: 2 ||| Uniform Resource Locator (URL) https://www.techopedia.com/it-terms/l

```

Auto Correct

Nowadays, many search engines rectify "mistakes" in your search phrases automatically when you conduct an online search: The websites adjust your search if it matches a more popular word or spelling when you submit it.

When looking for a more unusual term or phrase, this can get in the way but is useful if you make a typo. As a result, the search engines allow you to select which of the two searches you would like to perform in addition to informing you of any such correction.

Implementation of Auto Correct in Java

```
case 4:{  
    Utility.log("Selected option: " + options.get(option-1));  
    System.out.println("\nAUTOCORRECT SIMULATION\n");  
    loadWords();  
    sort(words);  
    startSimulation();  
    break;
```

Output

```
Enter a word: invalidword  
No suggestions.  
  
Enter a word to add to word bank: invalidword  
Correct. Congratulations, you can spell!
```

```
Enter a word: perfect  
Correct. Congratulations, you can spell!
```

AUTOCORRECT SIMULATION

Type "DONE" when finished.

```
Enter a word: jello  
Suggestions: jell
```

```
Enter a word: holle  
Suggestions: hole hello
```

Auto Complete

The search engine will make many predictions about how your question might be finished while you enter. On a university website, for instance, when you put in "course," it proposes "courses in English," "courses in geography," or "course catalogue." Because autocomplete also completes words, for example, if you type "lect," the engine will suggest "lecture" or "lecturer."

Here we have implemented the auto complete feature based on the user history, which allows user to find the related words from the search history performed.

Implementation of Auto Complete in Java

```



























    /
    case 6:{
        Utility.log("Selected option: " + options.get(option-1));
        Utility.log("History:");
        try {
            File myObj = new File("history.txt");
            Scanner myReader = new Scanner(myObj);
            while (myReader.hasNextLine()) {
                String data = myReader.nextLine();
                Utility.log(data);
            }
            myReader.close();
        } catch (Exception e) {
            Utility.log("Error: "+ e.getMessage());
        }
        break;
    }
    case 7:{
        Utility.log("Selected option: " + options.get(option-1));
        try {
            new FileOutputStream("history.txt").close();
            Utility.log("History has been cleared!");
        } catch (Exception e) {
            Utility.log("Error:"+e.getMessage());
        }
        break;
    }

```

Output

```
Selected option: 6. Show history
History:
java
javator
real
dead
reach
red
real
realtor
```

Folder Structure and Additional files used for dependency

- ✓  ACCWebSearchEngine [ACCWebSearchEngine main]
 - >  JRE System Library [JavaSE-1.8]
 - ✓  src
 - ✓  utility
 - >  Queue.java
 - >  StdIn.java
 - >  StdOut.java
 - >  TST.java
 - ✓  websearchengine
 - >  Cache.java
 - >  Driver.java
 - >  KeywordSearch.java
 - >  toText.java
 - >  Utility.java
 - >  webCrawler.java
 - >  Referenced Libraries
 - >  htmlfiles
 - >  lib
 - >  presentation
 - >  report
 - >  TextFiles
 - >  txtfiles
 -  cache.txt
 -  history.txt
 -  LICENSE
 -  README.md

Contribution List

Group 11	Hamza Baig	110089314	2/Tuesday
	Talha Mohammed Shamooun Choudhary	110087321	2/Tuesday
	Adeel Ahmed	110091296	2/Tuesday
	Dipen Kalal	110094706	2/Tuesday

110089314	2/Tuesday	Web Search Engine	Cache, history, auto fill
110087321	2/Tuesday		Web-Crawler, html to text conversion
110091296	2/Tuesday		Auto correct
110094706	2/Tuesday		Page Rank

HB