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SEMANTIC META SEARCH ENGINE USING SEMANTIC SIMILARITY MEASURE

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ABSTRACT

Many people use search engines to find their requirements on the web. But, research showed that each search engines covers some parts of the web. Therefore, Meta search engines are invented to combine results of different search engines and increase web search effectiveness due to a larger coverage of indexed web. Additionally, given query should be more specific to retrieve the more relevant web pages. By considering all these factors, semantic Meta search engine is proposed using semantic similarity measure that refines the input query in a more specific way. Initially, query given by the user is input to Wordnet ontology to obtain the neighbor keywords. Then, the query and neighbors are given to semantic similarity measure to choose the most suitable query words. Then, the selected query is given to different search engine like Google, Bing and Yahoo. After retrieving web pages from the web, the ranking of those pages are carried out using the ranking measure. Finally, the experimentation is carried out to prove the efficiency of the semantic Meta search engine using precision, recall and F-measure.

Keywords:-Meta Search Engine, Similarity Measure, Wordnet Ontology.

1. INTRODUCTION

The ubiquity of the internet and web has led to the development of several web search engines with varying capabilities. Among them, meta search engines provide a single unified interface, where user can enter a specific query that is forwarded to a list of search engines in parallel, and results are collated and ranked[3, 4,8]. Usually, meta-search engines do not crawl the internet themselves to build an index of web documents. Instead, a meta-search engine sends queries simultaneously to multiple web search engines, retrieves the results from each, and then combines the results from all into a single results listing, at the same time avoiding redundancy. In effect, web meta-search engines are not using just one engine, but many search engines at once to effectively utilize web searching [9]. Although one could certainly query multiple search engines, a metasearch engine distills these top results automatically, giving a comprehensive set of search results to the searcher within a single listing, all in real time [9].

Generally, Meta search engine is a kind of system which is useful for internet users to search

for information. Therefore, Meta search engines are invented to combine results of different search engines and increase web search effectiveness due to a larger coverage of indexed web [1]. Today's Meta search engine's activities are more than a simple combination of search engine results. They try with more user specific results from their component search engines. The methods include different strategies to form the queries to be specific for particular search results. The recent studies are on customizing the queries in relevant to the user needs for providing the best results from the search. Subsequently, the design and performance of meta-search engines have become an ongoing area of study [15-20]. Some methods [15] are introduced with overlap results, which described a meta-search engine as useful, since different engines employ different means of matching queries to relevant items, and also have different indexing coverage. In general, search engines admits a fixed number of characters in their queries, for which the document needs to be chopped into several parts, and then delivered in parts to the search engine [4]. For concentrating on the recent studies and researches [10-14], we have planned to develop a Meta search engine, which

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will give importance to the user query and the system supplies quick and relevant results according to the given query.

In this paper, a query specific meta-search engine is proposed for providing the most relevant results for the user. The proposed method uses a set of queries instead of a single query with the help of WordNet ontology.The ontology is used for extracting the similar words to the given query for forming the query set. The extracted queries, known as associated queries, are selected by the query formation phase. The query formation phase includes process like, query formation, extraction, comparison and selection. Once the query set is formed, then it is subjected to search in different general search engines and the top results are selected on the basis of a ranking algorithm defined by the proposed approach. The ranking algorithm specifically depends on the query set provided for the search. The main contributions in this paper are,

- WordNet ontology is used for query set formation
- A query specific page ranking algorithm is used

The rest of the paper is organized as follows:Section 2 gives a review of some related works regarding web search and Metasearch engines. Section 3 contains Motivational algorithms behind this research. 4^{th} section gives details of the proposed method with mathematical models.The 5^{th} section includes the evaluation based on the experimental results and a conclusion part is added in the 6^{th} section.

2. REVIEW OF RELATED WORKS

In this section, we have discussed some of the latest researches regarding the Metasearch algorithms. Kumar. P [1] has proposed a Meta search engine, called SEReleC that provided an interface for refining and classifying the search engines' results so as to narrow down the search results in a sequentially linked manner. Akhlaghian. F and Moradi. P [2] has proposed a multi-agent architecture for personalizing meta-search engine using the fuzzy concept networks. The goal of their work was to use automatic fuzzy concept networks to personalize results of a meta-search engine provided with a multi-agent architecture for searching and quickly retrieving. Experimental results indicated that the personalized meta-search results of the system were more relevant than the combined results of the search engines. Felipe Bravo-Marquez et al.[4] have proposed webservices architecture for the retrieval of similar documents from the web. They focused on software engineering to support the manipulation of users' knowledge into the retrieval algorithm. A human evaluation for the relevance feedback of the system over a built set of documents was presented. They showed that the architecture can retrieve similar documents by using the main search engines.

Vishwas Raval and Padam Kumar [21] have proposed a meta-search engine, called EGG (Enhanced Guided Google) that was intended to use the power of Google for more accurate and combinatorial search. They achieved through simple manipulation and automation of Google functions that were accessible from EGG through the Google. The proposed meta-search engine supported the search based on "Combinatorial Keywords" and "Normal Search". A detailed evaluation demonstrated how one was harness the capability of Google cluster architecture through its programmable Web services by creating advanced search features at a third party user application level. Brijesh kumar Chaurasia et al. [16] have presented the priority assisted and user profile based-meta search engine. The Meta search engine was able to improve search performance by querying multiple search engines at once. The work was to develop prioritizer based and profile assisted Meta search engine for merging the results extracted from two or more search engines. The results and analysis proved that the method improved the search quality of the database and specific search quality was also improved.

In [5], the idea of exploiting the scores of each search engine was proposed, where the main information was the relative rank of each result. In [5], different ranking approaches were analyzed, for example Borda-fuse which was based on democratic voting, the Borda count, or the weighted borda-fuse, in which search engines were not treated equally [6]. The document similarity-based retrieving problem has been studied by different researchers in [7]. These approaches proposed fingerprinting techniques for document representation. Also, these approaches used Meta search engine architectures for retrieving an extended list of similar candidate documents. On the other hand, document snippets were retrieved from search engines and compared with the query document using cosine similarity from their Vector Space Model.

3. MOTIVATIONS BEHIND THE APROACH

With the immense development of data resources in the WWW, the retrieval of information to the

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user with their specific needs is very important now-a-days. So, many search engines have been developed to obtain the specific information for the people. Here, the challenge behind all the search engines is to provide the right information with the proper ranking. Recently, some of the researchers tried to merge the results of multiple search engines to provide the most suitable information to the users. Recently, Kumar P [1] have proposed a Meta search engine, called SEReleC that provided an interface for refining and classifying the search engines' results so as to narrow down the search results.. In their work, they have not considered the semantic information to rank web documents obtained from different search engines. But, in our work, we have considered the ontology for semantic richness. Earlier, Akhlaghian. F and Moradi. P [2] have proposed a multi-agent architecture for personalizing meta-search engine using the fuzzy concept networks. They have used the same query given by the user to search through search engines Inspired from these researches; we have proposed ontology based multiple query method, which merge the results of multiple search engines using semantic similarity measure to obtain the most suitable query words to search through search engine.

4. SEMANTIC META SEARCH ENGINE USING SEMANTIC SIMILARITY MEASURE

The proposed method uses a set of keywords in a single query and WordNet ontology-based similarity measure is utilized to provide the most suitable query to search through the metasearch engine. The overall steps of the semantic meta search engine includes process like, (i) relevant query formation using semantic similarity measure. ii) extraction of web documents based on the relevant query, iii) ranking the web documents. At first, the ontology is used for extracting the similar words to the given query for forming the query set. The extracted queries, known as associated queries, selected by the query formation phase are subjected to different general search engines. Subsequently, the top results are selected on the basis of a ranking algorithm defined by the proposed approach.

4.1 Relevant Query Formation Using Semantic Similarity Measure

The query given by the user plays an important role in retrieving the relevant results from the internet space. Thus, the relevant query formation should be an important feature in the case of metasearch engines. Accordingly, ontology based method is used for making a query effective for the desired information search through search engine. The process of relevant query formation is discussed as follows:

At first, the query given by the user is supplied to ontology and the relevant nodes are extracted from the ontology. Once the neighborhood is extracted, a similarity measure is applied to it for selecting the most relevant associations of the query. The Figure 1 shows the process involved in forming the query for the meta-search. The proposed meta-search includes two types of queries, the main query and associated queries. The main query is the query given by the user itself, while associated query are those queries left after the similarity computation. The use of associated queries ensures a qualitative searching process and also improves the search results, but retrieving the results take much time. Keeping the difficulty in mind, we have selected most relevant otherwise most associated keywords of the given query for limiting the time complexity. The WordNet ontology is used for selecting the associated queries regarding the query given by the user.



Figure.1. Query Formation Process

Consider the query word q, which is given by the user and O_{wordnet} is the ontology. The query keyword $q \in \{q_1, q_2\}$ is searched into the ontology to find the neighborhood.

$$q_{1} \rightarrow O_{wordnet} \Rightarrow [q^{1}_{neighbors}]$$

$$[q^{1}_{neighbors}] \rightarrow [k_{1}^{1}, k_{2}^{1}]$$

$$q_{2} \rightarrow O_{wordnet} \Rightarrow [q^{2}_{neighbors}]$$

$$[q^{2}_{neighbors}] \rightarrow [k_{1}^{2}, k_{2}^{2}]$$

Here, $[k_1^{1}, k_2^{1}]$ is the neighbors of q_1 obtained from WorldNet ontology and $[k_1^{2}, k_2^{2}]$ is the 30th April 2013. Vol. 50 No.3

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neighbors of q_2 obtained from WorldNet ontology. Then, the possible combinations are formed based on the neighbors extracted as well as input query.

$$Q_N \to \{k_1^{1}, q_2\}, \{k_1^{2}, q_2\}, \{q_1, k_2^{1}\}, \{q_1, k_2^{2}\}$$

Where, Q_N contains a set of combinations formed from the neighbors as well as query.

Every set of queries presented in Q_N is given to WordNet to find the new set of neighbors, then, the representative query is generated based on the frequency of term presented in every set. Suppose, every query set in Q_N generates 'k' neighborhood after matching with ontology. After that, unique terms are chosen from it to find the frequency. The terms which are having higher frequency is chosen as representative query, Q_R . Once the representative query is generated, the semantic similarity measure is computed for all the query combination given in Q_N using the measure given below.

$$S(Q_R, Q_N^{(i)}) = \sum_{i=1}^n w_i^{(q_1)} + \sum_{i=1}^m w_i^{(q_2)}$$

 $w_i^{(q_1)} = 1$ if neighbor in Q_R and $Q_N^{(i)}$ are equal Where, *n* is the number of neighborhood for the

query set in $Q_N^{(i)}$ belongs to q_1

m is the number of neighborhood for the query set in ${\cal Q}_N{}^{(i)}$ belongs to ${\cal q}_2$

$$O_{M}^{(i)}$$

For all query set in $\mathcal{Q}N$, the similarity measure is computed and the filtering is required to select the most relevant query set that is provided to the search engine.

$$Q_N \xrightarrow{filtering} \{q_{c1}, q_{c2}\}$$

The pseudo code of the above example is given in following Figure 2.

Pseudo code

Algorithm: Relevant query formationInput: Query, q (user)Output:Associate queries $\{q_{c1}, q_{c2}\}$

Step1. Accept query q

Step2. Input $q \in \{q_1, q_2\}$ to WordNet $O_{wordnet}$ Step3. Extract top neighbors

$$q_1 \rightarrow O_{wordnet} \Rightarrow [q^1 neighbors]$$

$$[q^1 neighbors] \rightarrow [k_1^1, k_2^1]$$

$$q_2 \rightarrow O_{wordnet} \Rightarrow [q^2 neighbors]$$

$$[q^2 neighbors] \rightarrow [k_1^2, k_2^2]$$

Step4. Generate new query set

$$Q_N \to \{k_1^1, q_2\}, \{k_1^2, q_2\}, \{q_1, k_2^1\}, \{q_1, k_2^2\}$$

Step5. Find neighbors of every sets of query $Q_{\rm N}$

Step6.**Select** representative query Q_R

$$S(Q_R, Q_N^{(i)}) = \sum_{i=1}^n w_i^{(q_1)} + \sum_{i=1}^m w_i^{(q_2)}$$

Step7. Find similarity between the neighbors Q_R and Q_N

Step8. Apply filtering threshold

$$Q_N \xrightarrow{filtering} \{q_{c1}, q_{c2}\}$$

Step9. Select associated neighbors $\{q_{c1}, q_{c2}\}$
Step10. Stop

Figure.2. Pseudo Code Of The Relevant Query Formation

4.2 Extraction of Web Documents based on the Relevant Query

The next phase of the proposed approach is to obtain the web pages according to the query selected using similarity measure. The query selected from the previous steps is given to the different search engine like Google, Bing, Yahoo, etc. The pages obtained from these search engines may contain redundant pages, so in order to obtain the most relevant search results; we combine search results of these search engines.

4.3 Ranking of Web Documents

After getting web pages from different search engines, the ranking is done according to the procedure given below. Here, a set of words from the web pages are extracted into a separate set of data S_i , which is represented as,

 $S_i = [wordset:t]$

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Where, the t represents the terms from each web document obtained from different search engines. Now,a query specific value of each query is calculated individually, based on each document extracted. i.e., a comparison of the word set by each document with the query set. The comparison of the word set and the query set produces a value, named as query specific value.

$$q_{meta} = \{q_{c1}, q_{c2}\}$$

$$q_{meta} \xleftarrow{comapres} S_i \Rightarrow P(S_i, q_{meta})$$

$$P(S_i, q_{meta}) = \frac{P(S_i) \cdot P(q_{meta} \mid S_i)}{P(q_{meta})} \cdot \prod P(q_{meta} \mid S_i) W$$

here, $P(q_{meta} | S_i)$ is the conditional probability of each term in the q_{meta} and the words in the web page *w*. $P(S_i)$ represents the importance of each word in the web page. $P(q_{meta})$ gives the importance of the query set q_{meta} in each of the web pages under

consideration. The obtained query specific value of each of the pages are then used to calculate the

query sensitive PageRankfor each of the web page.

$$QSPR(w_i) = \sum P(S_i, q_{meta})$$

Where, $QSPR(w_i)$ is the query sensitive PageRank for webpage w_i . $P(S_i, q_{meta})$ is the query specific value for the web page w_i . The QSPR value for all web pages is calculated and plotted a QSPR matrix (table 1) according to the ascending order of the QSPR values.



Table.1. QSPR Matrix

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According to the obtained QSPR values, a threshold t_{QSPR} is defined to filter out the most relevant web pages according to the user query. Here, the threshold to filter out the relevant page from the similarity rank matrix will be the average of \sum (QSPR).Thus, the user will get more user query specific result according to the proposed metasearch engine.

Algorithm: QSPR Input: q_{meta} Output: Relevant web pages Step1: Set query= q_{meta} Step3: DefineS_i $S_i = [wordset:t]$ Step4: Calculate, $P(S_i, q_{meta})$ Step5: Calculte, QSPR, $QSPR(w_i) = \sum P(S_i, q_{meta})$ Step6: Generate QSPR matrix Step7: Set threshold t_{QSPR} Step8: If QSPR> t_{QSPR} ; Select those web pages as results Step9: List out relevant pages Step10: Stop

Figure.4. Pseudo Code Of Ranking Measure

5. RESULTS AND DISCUSSION

Here, the experimentation has been done with i3 processor of 4GB RAM and the results are evaluated with the evaluation metrics with the different top results.

5.1 Evaluation Metrics

An evaluation metric is used to evaluate the effectiveness of web page retrieved from the search

engines. Here, ranking of web pages is analyzed with the different number of top results so that the ranking efficiency can be easily evaluated. Some of the metrics that we have chosen for our evaluation purpose are Recall, Precision and the Fmeasure.

$$Precision,$$

$$P = \frac{|\{relevant documents\} \cap \{retrieved documents\}|}{|\{retrieved documents\}|}$$

$$Recall,$$

$$R = \frac{|\{relevant documents\} \cap \{retrieved documents\}|}{|\{relevant documents\}|}$$

$$F- Measure, F = \frac{2PR}{(P+R)}$$

As suggested by above equations, *Precision* is the fraction of retrieved web pages that are relevant to the search, *Recall* is the fraction of the web pages that are relevant to the query that are successfully retrieved and the *F-measure* that combines precision and recall is the harmonic mean of precision and recall.

5.2 Experimental Results

The sample queries given by the user is tabulated in table 2. Here, we have presented the sample queries like, knowledge management and data warehouse. For the query 'data warehouse', the associated queries like, data storehouse, data depot, collection storehouses are retrieved. Figure 5 presents the screenshot of the proposed Meta search engine. In the screenshot, the queries given by the user along with the associated queries are presented. Furthermore, the web pages ranked by the Meta search engine are also given along with the corresponding name of the search engine.

Table 2. Relevant Query

Query given by the user	Associated queries using semantic similarity measure		
Knowledge management	knowledge management, mind management, head management		
Data warehouse	data storehouse, data depot, collection storehouse		
Machine learning	machine learning, machine basic_cognitive_process, machine education		
Process management	process management, process administration, activity management		

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Figure.5. Screenshot

5.3 Performance Evaluation

The performance of the proposed Meta search engine is evaluated with the different queries and the precision, recall and F-measure is computed. In figure 6, precision recall and F-measure is computed for the search engines along with Meta search engine. Here, ranking efficiency is computed by taking the different number of top results for

evaluation purpose. From the figure 6, we can identify that proposed Meta search engine achieved

the precision of 70% but, the existing system [22] achieved only 60%. Here, the performance is improved in Meta search engines compared with the all the existing search engines. Similarly, figure 7, 8 and 9 are plotted for the queries like, data warehouse, machine learning and process management



Figure.6. Graphs For Query Q1 (Knowledge Management)

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Figure.8. Graphs For Query Q3 (Machine Learning)

6. CONCLUSION

We have proposed semantic measure for obtaining the relevant query to search through different search engines. The overall steps of the semantic meta search engine includes process like, (i) relevant query formation using semantic similarity measure, ii) extraction of web documents based on the relevant query and iii) ranking of web documents. Here, input query and neighbors extracted from ontology is used to select the most suitable query and then, ranking of web pages obtained from the different search engine was done using QSPR measure. The experimentation was performed with different set of queries and the performance of the results was analyzed with the help of precision, recall and F-measure. From the experimental results, we found that the proposed Meta search engine has performed better than existing work by achieving the precision of 0.8

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