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QoS Based Ranking Methodology for Semantic Search System

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ABSTRACT

The huge amount of data is making search more and more difficult with traditional search methods as they return vast data for a given query which is containing of related or unrelated data. So, users are not satisfied with searching the information by current search engine. Subsequently the problem of re-ranking searches or results has become one of the main problems in web search. Currently searching methods are mainly based on traditional technique but this technique has some problem. The first problem is that web users cannot express their search intention accurately or properly using several keywords. Therefore most of the time, the duly matched results do not gratify the web users and the next problem is that keyword matching cannot sure the selected candidates have high correlation with the users query, given the unlike meaning of the keywords. Hence it is expected that the proposed QoS ranking methodology would yield better results than the existing approaches. The objectives are to enhance the search performances of semantic search system.

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INTRODUCTION

Ranking functions are the core parts of information retrieval systems. The ranking challenge has gained growing attention in information retrieval with the fast development to ranking methods on recommender systems, service discovery, and search engines. Ranking method is aiming to find a score function such that the predicted ranking relation is consistent as possible as the true order. From various perspectives, a number of ranking algorithms have been proposed including Hyperlink-Induced Topic Search (HITS) (Kleinberg 1999), RankSVM (Herbrich *et al* 2000, Joachims 2002), RankNet (Burges *et al* 2007), RankBoost (Freund *et al* 2003), the gradient descent ranking (Vikas *et al* 2008, Chen *et al* 2013), the Bayes subset ranking (Cossock *et al* 2008), and semantic search (Wei *et al* 2011).

The user tries to analyze and find information through the search engines or browsing information space. Search engine based systems generally trace documents based on keywords. Even though they do return documents involving keywords inputted by user, a lot of retrieved documents have very less to do with user's needs. The duty lies on the user to decide about the relevance of the retrieved documents using their rational model in order to obtain desired information. Efforts are consistently being made to extend or identify alternatives to traditional search mechanisms focused on finding documents based on classical approaches. With the advent of the semantic web along with enabling technologies, a stage has been set which will help in getting relevant documents from the huge data sources thus assisting information analysis.

Ranking Algorithms:

The classical ranking approaches are those content-based ranking algorithms such as the vector space model (Salton 1963), the probabilistic model (Robertson 1976), etc. The most classical algorithm is the TFIDF-based vector space model in which measurements such as term frequency (tf) and inverted document frequency (idf) are used. Many other ranking algorithms exploit different parts of the content of the pages, but they all compare the similarity values between the query and the document vectors in the collection to find the most relevant documents (Zareh *et al* 2010). The structured text ranking strategy (Fan *et al* 2005, Arasu *et al* 2001) is another example of content-based ranking algorithm. The methodologies analyze the hypertext structural information of the candidate page, such as title, header and body. If the token from the query appears in the title of a page, that page is likely to be more relevant than the page in which the term appears in the body. Based on positions in

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which the term appears, different weights are assigned to calculate the term frequency before they are used in the latter ranking method. For example, if the term appears in the title of the web page, the weight will be higher so that it will have a higher term frequency. After calculating the term frequency in all positions where the term performs can get the overall term frequency based on the structure information and then use this data to measure the relevancy of the candidate pages.

One of the most notable and popular ranking model for the ordering of retrieved documents is PageRank (Brin&Lawarence 1998)] are other types of widely used ranking strategies. PageRank is the key ranking algorithm currently used in the popular search engine - Google. It exploits the hyperlink structure of web documents to rank those web pages. The fundamental idea is that, if a web page is linked by many other web pages, the linked web page is more important, thereby a higher rank score is assigned. The linked web page is called authoritative page. However, Google considers not only the value of PageRank, but also the content of the web page. If the page matches the query better, it means that the page is more important in the content, thereby the value of the PageRank from this page will get higher weight during evaluation. Furthermore, PageRank is valuable in past events where many pages were created and well linked, although it might not work very well for web pages related to new and real time events owing to their high updating frequencies. Jihyun *et al* (2014) proposed search and ranking techniques for web resources considering semantic relationships in on ontology. This experiment ranking user traditional IR to semantic search rank. However those approaches can't perfectly measure a page and content with many in-coming links as well as many out-going links.

Due to these causes, the result might not be accurate for all the cases. On account of in this thesis applied a QoS based ranking methodology for improving semantic search performance with QoS factors such as reputation, trust, ranking are defined with an explanation about how to measure and calculate them.

QoS in Semantic Search:

Recently various number of QoS methods being designed, it is depending on numerous application domains and user needs. The QoS focuses on the various research fields for example mobile information systems (Bohnert *et al* 2008); networking (Gelenbe, *et al* 2004); real time applications (Pedreiras *et al* 2005); currently, QoS also becomes a very important issue in web service area (Vu *et al* 2006). Our research focuses on the web service area because how they use QoS in web services is similar to how can use QoS for web search. Kapidakis *et al* (1998) provided the resource allocation and the distributed searching and retrieval based on QoS attributes, such as the server load, network load and reliability, etc. They focused on how to provision, monitor and manage QoS in such an environment. Ran (2003) described a list of QoS attributes and how they can be used in web service discovery. Chen & Ding (2008) proposed QoS based ranking for web search and defined search-related QoS attributes. The QoS attributes are mainly define to performance related and are especially important to internet users with slow connection and mobile users. In this approach score combination methods not improved both QoS and the precision value. Dong *et al* (2009) proposed a QoS-based service retrieval methodology for digital ecosystem.

Problem Formulation And Objectives:

The huge retrieved results from knowledge base (KB) may be relevant and irrelevant. A critical problem is occurred to the user, how to make the appropriate selection from amongst retrieved metadata. So the problem of re-ranking searches or results has become one of the main problems in IR field. To fulfil the requirement of users this research using QoS based ranking method which will search the data semantically and holds the capability to re-rank search results effectively and try the best to arrange the results which are most relevant for the users.

QoS Ranking Methodology:

The QoS Based ranking methodology applied in two types of semantic search system to enhance search performance which is generic semantic search technique (Palaniammal&Vijayalakshmi 2013) and specific semantic search technique (Palaniammal&Vijayalakshmi 2014).

Process Flow Diagram:

The process flow diagram of the QoS ranking methodology is shown in Fig.1 the QoS ranking methodology applied to two types of search techniques which is generic semantic search and specific semantic search to enhance search performance. The QoS ranking methodology is functional to re-rank the results of semantic search system (Palaniammal&Vijayalakshmi 2013) in a multi-linear manner. The reputation database is designed to store QoS evaluation criteria values and QoS regarding metadata information then it values keeps to KB.

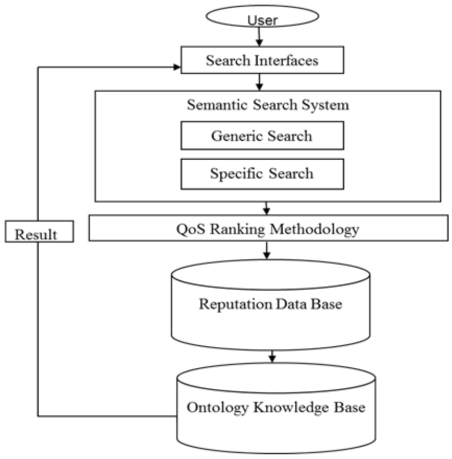

Fig. 1: Process Flow Diagrams.

QoS Based Ranking Methodology:

The QoS methodology is functioned at re-ranking development in our proposed system. The methodology is originate on CCCI metrics (Correlation of interaction, Correlation of criterion, Clarity of criterion, and Importance of criterion) developed by Chang *et al* (2005), Hussain *et al* (2004) and Dong *et al* (2009). The CCCI metrics measures the re-rank of retrieving information on a search entity by evaluating the level of different QoS factors which previous requesters have committed for the same query communications. At this juncture this proposed work suggests ranking algorithm and metric for enhancing search performance for semantic search system based on the trust and reputation. Trust is commonly defined as a faith of confidence certainly that one to other thing or person in work together. In the context, trust defined as numeric value that estimates the level of trust in a search interaction. Reputation is defined as the aggregation of the retrieving of information in reply to a search user's query with respect to the quality of information retrieved from KB.

Calculation Metrics:

The CCCI metrics is a set of metrics with the purpose of re-ranking based on trust and reputation. These metrics are focused on the premise that a query communication between certain quality information and a requester takes place in a given context which in fit could be de-composed into a finite number of criteria. A criterion is measured to be a conclusive factor of the mutually agreed search performance between the quality information and requester quality estimation purposes. It is important to note that the requester and the quality information occupy in a conciliation phase before the interaction and agree on the mutually agreed service or the service level agreement. By creating use of the CCCI metrics, the service requester can evaluate the performance of the quality information according to the decisive factors after the query communication. The criteria are often a series of accomplishments. Thus, the measurement of the QoS for the quality information in the communication becomes the measurement of each criterion involved in the search communication.

The metrics for calculate the ranking, which are extended from CCCI metrics. The evaluation is made by assigning different criterion values, to find out the ranking of reputation values (0 to 6), to find correlation of criterion (0 to 1), to find out the performance for clarity of criterion (ranging 0 to 1), and to evaluate the relevance of criterion (ranging 0 to 2).

The QoS criteria of a metrics are determined for the assigning the rank value from the retrieving list of information of both generic and specific search technique along with it contain seven metrics definition as follows.

Definition 1:

Correlation of a reputation *(corre*$_{reput}$*)*: *Corre*$_{reput}$in the context of reputation assessment is defined as a metric that express the degree of comparison between the actual information of a reputation and the mutually agreed information of a reputation which can be mathematically expressed as follows,

$$corre_{reput} = \frac{Actual\ \ information\ _{reput}}{MutuallyAgreed\ \ \ information\ _{reput}} \quad (1)$$

Definitions 2:

Actual information of a reputation (*Actual information*$_{\text{reputation}}$): the metric that evaluates be suitable and expresses the actual list of information retrieved from KB in the given criterion for the searched query.

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Definitions 3:
Mutually agreed information of a reputation ($Mutually\ Agreedinformation_{\text{reputation}}$): the metric that evaluates be suitable and expresses the mutually agreed retrieving list of information from KB in the given criterion for the searched query.

Definition 4:
Correlation of a criterion ($Corre_{Criterion}$): $Corre_{Criterion}$ in the context of correlation criterion is defined as a metric that express the succeeds the actual information extent of a reputation to a given criterion. The possibility of $Corre_{Criterion}$ has two levels as follows 0- None, 1- Exact.

Definition 5:
Clarity of Criterion ($Clarity_{Criterion}$) : $Corre_{Criterion}$ in context of clarity criterion assessment is defined as a metric that express the extent to which a criterion has been mutually agreed upon by criteria list of information. $Clarity_{Criterion}$ has two level as follows 0-this criterion is not mutually agreed upon by both sides, 1- this criterion is mutually agreed upon by both sides.

Definition 6:
Relevance of a criterion($Relevance_{Criterion}$): $Relevance_{Criterion}$ is defined as a metric expresses the relevance of a criterion has three level as 0-Not relevant, 1-relevant, 2-very relevant.

Definition 7:
Ranking of a reputation($Ranking_{reput}$): $Ranking_{reput}$ in the context of ranking reputation assessment is defined as a metric that express the degree of comparison between the actual information of a reputation and the mutually agreed retrieving information of a reputation. As a result of this rank value of retrieved information would be the same as the correlation of the reputation (*$corre_{reput}$)*.
Thus the equation for assessing the rank status as follows

$$Ranking_{reput} = \frac{1}{r}\sum_{i=1}^{n} Corre_{reputation} = Corre_{reputation} \qquad (2)$$

$$= \frac{Actual\ information_{reput}}{Mutually\ Agreed\ information_{reput}}$$

$$= \left| \frac{\sum_{i=1}^{n} Corre_{Criterion\ \ i} \times Clarity_{Criterion\ \ i} \times\ relevance_{Criterion\ \ i}}{\sum_{i=1}^{n} MACorre_{Criterion\ \ i} \times Clarity_{Criterion\ \ i} \times relevance_{Criterion\ \ i}} \right|$$

Where, n is the number of criteria drawn in the search query, r is the level of relevancy, $MACorre_{Criterion}$ in the context of task rank assessment is defined as the mutually agreed retrieving information of a task according to a given criterion, and $MACorre_{Criterion} = 6$
Ranking has seven levels as shown below;
0- Cannot determine ranking
1- Extremely bad ranking
2- Bad ranking
3- Minimally good ranking
4- Partially good ranking
5- Good ranking
6- Extremely good ranking

This metric enables the ranking of a set of quality information according to their reputation value. The above formulations could be computed reputation values context-based ranking. The allevaluation criteria value, reputation value and user evaluation value is stored in reputation database.

Ranking Algorithm:
The ranking algorithm to find more accurate results the procedure as follows,

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Algorithm QoS Semantic Searching and Ranking (Search List L, Search Query Q)

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1. Derive the list of QoS requirements in $Q{:}\, L_q = \{[q_1, r_1, n_1], \ldots., [q_s, r_s, n_s]\}$
2. Initialize $Ranking\ [R_{ij}] = 0.0\ for\ all\ searches R_{ij} \in L;$
3. **For** each quality concept $q_j \in$ L $\boldsymbol{do}$
4. **For** each searches$R_{ij} \in L$ $\boldsymbol{do}$
5. find the list L_{qos} of q_j for R_{ij} **;**

6. **If** R_{ij} is found **then**

$$Ranking\left[R_{ij}\right] = \frac{\sum_{q=1}^{n} Corre_{reputation}}{r}$$

7.
8. else

9. Remove R_{ij} from L;
10. End if
11. End for
12. End for
13. Return the list L arranged in descending sort out through Ranking [R_{ij}] s;

Define QoS requirements in a user query as a vector Q of triple $\{q_j, r_j, n_j\}$ where n_j represents for the required QoS attribute, r_j is the level of relevance of this quality attribute to the user and q_j is the minimal delivered QoS value that this user queries. To rank facilities giving its perspective level of satisfying user QoS requirements utilize trust in CCCI metrics, which produces rank results more accurate to the user. Thus the QoS rank of results R_{ij} in fulfilling all quality criteria depends on $Corre_{reputation}$. Giving the list L_{qos} has records. In order to accelerate the selection of results fulfilling all required QoS parameters; use the idea of (Chang *et al* 2005, Hussain *et al* 2004 and Dong *et al* 2009) to choose the metadata with the topmost quality results.

Reputation Database:

The QoS database is shown in Figure 2 also known as reputation database and it contain three types of table values: This is evaluation criteria table, metadata ranking table and evaluation table. The evaluation table used to store QoS evaluation criteria information for each actual information in a ontology. Ranking table are store the reputation and criterion values of all semantically related metadata for each actual perception and user evaluation table store all user evaluation record values of metadata in the semantics of a concept. It is parallels to a row in reputation table that relates to concept.

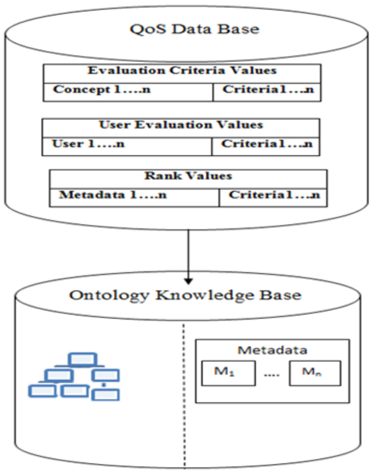

Fig. 2: QoS Data Base.

Performance Analysis And Discussion:

In the section made performance evaluation of the two different search techniques is illustrated below after QoS ranking methodology. The results of after QoS methodology as shown table and graph results compared with the before and after QoS methodology. The users submit the query, the semantic search system retrieved results from KB and the QoS metrics analyze re-rank the retrieving results. The score are calculated again according to the QoS from the QoS table and a new ranked list is generated and returned top quality information to low quality information to the user with same experimental set up of generic and specific semantic search techniques.

Table 1 presents QoS ranking results, after QoS ranking methodology, the experimental results are improved in both generic search and specific search performance. In generic semantic search, the maximum values of precision 98.52% mean average precision 99.55%, recall 90.50%, f-measure71.45% and in specific semantic search technique, the highest percentage value of precision 97.72%, recall 91.49%, mean average precision 98.60% and f-measure 72.28% results achieved.

Table 1: Testing Results of QoS Ranking Methodology.

Search System	Optimal Threshold Value	Precision %	Mean Average Precision %	Recall %	F-Measure
Generic Semantic Search Using QoS Methodology	>0	42.93	83.56	90.50	58.23
	>0.1	44.95	84.18	87.56	59.40
	>0.2	46.23	85.21	85.31	59.96
	>0.3	59.62	88.22	80.41	68.47
	>0.4	64.34	91.18	75.34	69.40
	>0.5	77.41	92.39	66.35	71.45
	>0.6	85.54	94.35	60.29	70.72
	>0.7	90.26	96.26	57.37	70.15
	>0.8	95.37	97.37	53.55	68.58
	>0.9	98.52	99.55	50.49	68.76
Specific Semantic Search Using QoS Methodology	>0	35.48	82.99	91.49	51.13
	>0.1	46.77	83.92	90.21	61.60
	>0.2	55.32	85.31	88.27	68.01
	>0.3	58.32	88.42	85.39	69.30
	>0.4	67.47	90.28	77.38	72.08
	>0.5	70.59	93.43	70.39	70.48
	>0.6	76.74	95.67	68.31	72.28
	>0.7	85.46	97.62	60.37	70.75
	>0.8	90.17	98.57	59.54	71.72
	>0.9	97.72	98.60	50.95	66.97

Graph Results of Generic Semantic Search:

Figure 3, 4, 5, 6 shows that evaluation results of generic semantic search before and after QoS methodology. The blue color indicates before QoS and red color for after QoS results. To compare the after and before QoS ranking results select optimal threshold value based on highest f-measure score that aggregating scale of precision and recall. Therefore the highest f-measure value is 71.45% at the threshold value 0.5.

Figure 3 displays the performance of before and after QoS ranking results on precision. The highest thresholds filter non relevant metadata. After QoS, the evaluation results improved 10% at the threshold value 0 and 72.39 % to 77.41 % results improved at the threshold value 0.5.

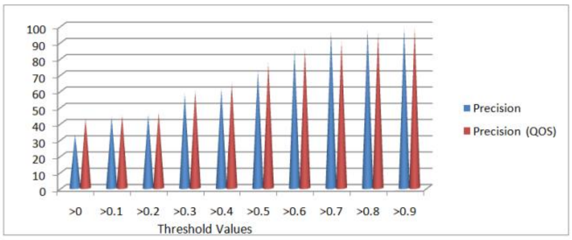

Fig. 3: Precision of Generic Semantic Search.

Figure 4 shows the performance results of before and after QoS ranking methodology on mean average precision. The two performance result depicts same results 92.39% at the threshold value 0.5.

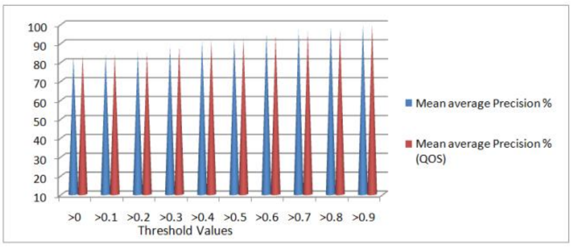

Fig. 4: Mean Average Precision of Generic Semantic Search.

Figure 5reveals the performance of before and after QoS ranking results on recall. There is an 8% results improved in after QoS ranking method at the threshold value 0.6.

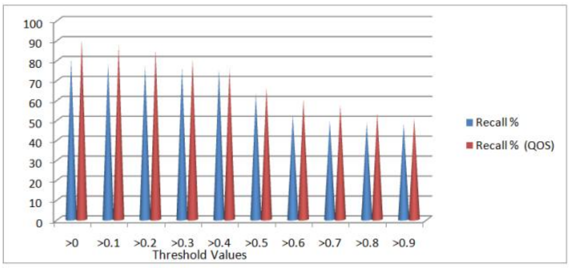

Fig. 5: Recall of Generic Semantic Search.

Figure 6 presents the comparison of before and after QoS ranking results on f-measure. At the threshold value the f-measure value is increased from 67.56% to 71.45% at the threshold value 0.5.

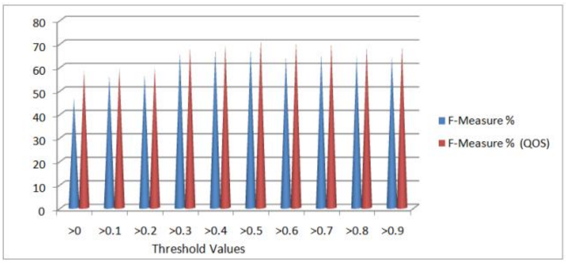

Fig. 6: F-Measure of Generic Semantic Search.

Graph Results of Specific Search:

Figure 7, 8, 9, 10 show that specific semantic search results before and after QoS results. The blue color indicates before QoS and red color for after QoS results. From the graph results this research analysis the QoS methodology will improve the semantic search performances.

Figure 7 shows the specific search performance of before and after QoS ranking results on precision. The precision results improved highest score 92.72 to 97.72% at threshold value 0.9.

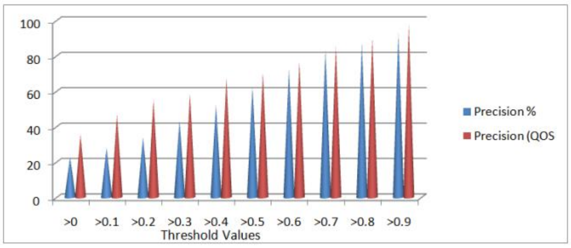

Fig. 7: Precision of Specific Semantic Search.

Figure 8 shows the specific search performance of before and after QoS ranking results on mean average precision. The mean average precision results improved highest score from 95.45 to 98.60% at threshold value 0.9.

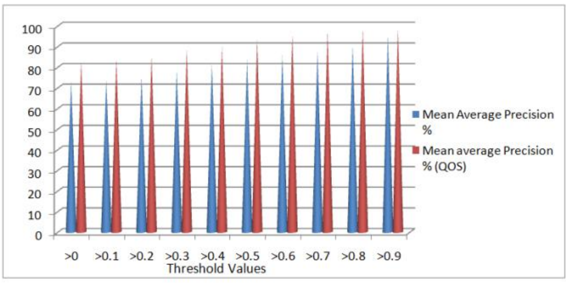

Fig. 8: Mean Average Precision of Specific Semantic Search.

Figure 9 shows the specific search performance of before and after QoS ranking results on recall. The recall results improved highest score from 77.49% to 91.49% at threshold value 0.

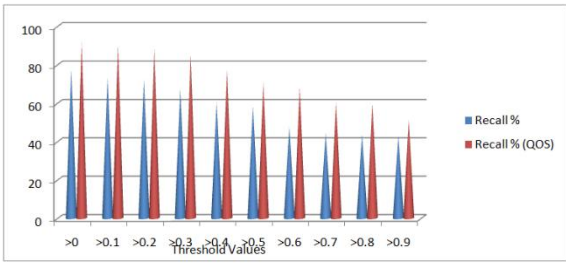

Fig. 9: Recall of Specific Semantic Search.

Figure 10 shows the specific search performance of before and after QoS ranking results on f-measure. The f-measure results improved highest score 60.41% 72.28% at threshold value 0.5.

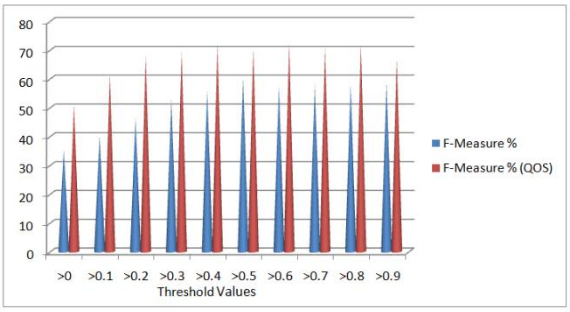

Fig. 10: F-Measure of Specific Semantic Search.

Discussion:

The proposed QoS ranking methodologies are contributing better performance occur in f-measure is 67.56% to 71.45%, recall 80.50% to 90.50% of generic semantic search technique and 5% in precision, 3.15% in mean average precision, 14% in recall and 11.41% in f-measure appearing in specific semantic search.

Conclusion:

This paper proposed a QoS based ranking methodology for enhancing semantic search performance. Usually, the user wishes to choose the metadata with the topmost quality results in order to apply this QoS ranking methodology. The QoS methodology is extended from CCCI metrics, which measures the ranking regarding retrieving metadata results by assessing the reputation from different criterion values such as Correlation of a reputation $(corre_{reput})$, Correlation of a criterion ($Corre_{Criterion}$), Clarity of Criterion ($Clarity_{Criterion}$), Relevance of a criterion ($Importance_{Criterion}$) and ranking of reputation. By aggregating the scores on all criteria for the metadata of reputation results towards the user can be measured the reputation value (*Reputation*) of the information on the metadata can be obtained. Thus, the proposed QoS ranking methodology shows an improved performance results in both semantic search system.

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