Fuzzy Qualitative Models to Evaluate the Quality on the Web

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Abstract. The problem of finding quality information and services on the Web is analyzed. We present two user-centered evaluation methodologies to characterize the quality of the Web documents and Web sites that contain these Web documents. These evaluation methodologies are designed using a fuzzy linguistic approach in order to facilitate the expression of qualitative and subjective judgements. These methodologies allow to obtain quality evaluations or recommendations on the accessed Web documents/sites from linguistic judgements provided by Web visitors. Then, these recommendations can aid other visitors (information or service searchers) to decide which Web recourses to access, that is, to find quality information and services on the Web.

Keywords: *Web documents, Web services, quality evaluation, fuzzy linguistic modelling, XML*

1 Introduction

Nowadays, we can assert that the Web is the largest available repository of data with the largest number of visitors searching information. Furthermore, because the Internet has become easily accessible to millions of people around world, a vast range of Web services have emerged for the most diverse application domains, e.g., business, education, industry, and entertainment. Therefore, we can also affirm that the Web is an infrastructure on which many different applications or services (such as e-commerce or search engines) are available. In fact, in last few years the Web has witnessed an exponential growth of both information and services [14, 12]. These Web challenges generate new research issues, amongst we can cite [3, 12, 7, 28]: to identify Web information and services of good quality, to improve the query language of search engines, and to develop the Semantic Web. In this paper, we focus on the first one, and in particular we address the problem of how to evaluate the quality of both the Web documents that store information and the Web sites that provide services, in order to aid the users to decide on the best Web recourses to use.

There exists a large debate on the quality of the recourses available on the Web [2, 26]. How to recognize useful and quality recourses in an unregulated market place as the Internet is becoming a serious problem in diverse domains as Medicine [4, 15, 6, 20], Organizations [17, 23, 33], Government [24], Education [27] or Law [21]. However, there is not yet, in our opinion, a clearly cut definition of the concept of quality. The ISO defines quality as "the totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs" [18]. Web document and Web site quality evaluation is neither simple nor straightforward. Web quality is a complex concept and its evaluation is expected to be multi-dimensional in nature. There are two different kinds of requirements for Web document and Web site quality evaluation that emerge from the above definition:

1. *Design and technical requirements*: These imply the general evaluation of all the characteristics of Web documents/sites. In this category we find evaluation criteria that are indicators of an objective and quantitative nature, e.g., clear ordering of information, broken links, orphan pages, code quality, navigation, etc.
2. *Informative content requirements*: These imply the evaluation of how well the Web documents/sites satisfy the specific user needs. In this category we find evaluation criteria that are indicators of a subjective and qualitative nature, e.g., consistency, accuracy, relevance, etc.

A robust and flexible Web quality evaluation methodology should properly combine both kinds of requirements. However, although some authors [17, 23] have proposed Web quality evaluation methodologies which combines both informative and technical design aspects, the majority of suggested Web evaluation methodologies tend to be more objective than subjective, quantitative rather than qualitative, and do not take into account the user perception [5, 22]. An additional drawback of these Web evaluation methodologies is that their evaluation indicators are relevant to Web providers and designers rather than to the Web users [1].

A global Web quality evaluation methodology cannot entirely avoid users' participation in the evaluation strategy. User judgments can help to evaluate the quality of accessed Web documents/sites. The problem here is that the users do not frequently make the effort to give explicit feedback. Web search engines can collect implicit user feedback using log files. However, this data is still incomplete. To achieve better results of evaluation on the Web, the direct participation of the user is necessary, i.e., a user-centered Web quality evaluation methodology is a necessity. For example, the use of a user-centered approach to evaluate Web sites would mean that users are more pro-actively approached to determine their needs -both technical and in terms of information-, their perceptions of Web site organization, terminology, ease of navigation, etc, which could be used in a redesign of the site [17].

One possible way to facilitate that user participation is to embed in the Web quality evaluation methodology those tools of Artificial Intelligence that allow a better representation of subjective and qualitative user judgements, as for example, the fuzzy linguistic modelling [31]. The use of fuzzy linguistic modelling, to help users express their judgements, could increase their participation in the evaluation of the quality of Web documents/sites.

The aim of this paper is to present some models, based on fuzzy linguistic tools, to evaluate the informative quality of Web recourses. In particular, we present two fuzzy models, one to evaluate the informative quality of Web documents and another to evaluate the informative quality of Web sites used to publish those Web documents. The evaluation scheme of both models take into account both technical criteria and informative criteria, but both quality evaluation models are of a qualitative and subjective nature because:

- Their underlying evaluation strategies or schemata are user-driven rather than designer-driven, i.e., they include user-perceptible Web evaluation indicators such as navigation or believability, rather than quantifiable Web attributes such as code quality or design; that is, we consider Web characteristics and attributes easily comprehensible by a general Web visitor.
- Their measurement methods are user intuition-centered rather than model-centered, i.e., the evaluations are obtained from judgements provided by the Web visitors rather than from assessments obtained objectively by means of the direct observation of the model characteristics.

Both quality evaluation models are designed using an ordinal fuzzy linguistic approach [8, 9]. Visitors provide their evaluation judgements by means of linguistic terms assessed on linguistic variables [31]. After examining a document stored in a particular Web site, the users are invited to complete an evaluation questionnaire about the quality of the accessed document or site. The quality evaluation value of a Web document/site is obtained from the combination of its visitor linguistic evaluation judgements. This combination is carried out by using the linguistic aggregation operators: LOWA [9] and LWA [8]. The quality evaluation values or recommendations obtained are also of a linguistic nature, and describe qualitatively the quality of the Web documents/sites. In this way, when a user requires information, then not just retrieved documents or Web sites could be provided, but also recommendations on the informative quality of them and on Web sites that store similar documents that could be of interest to the user. This could be used by the user as an aid to make a decision on which Web recourses to access.

The rest of the paper is set out as follows. The ordinal fuzzy linguistic approach is presented in Section 2. The fuzzy qualitative model to evaluate the quality of Web documents is defined in Section 3. The fuzzy qualitative model to evaluate the quality of Web sites is defined in Section 4.

2 Ordinal Fuzzy Linguistic Approach

The *ordinal fuzzy linguistic approach* [8, 9] is a very useful kind of fuzzy linguistic approach used for modelling the computing with words process as well as linguistic aspects of problems. It is defined by considering a finite and totally ordered label set $S = \{s_i\}, i \in \{0, \ldots, \mathcal{T}\}$ in the usual sense, i.e., $s_i \geq s_j$ if $i \geq j$, and with odd cardinality (7 or 9 labels). The mid term represents an assessment of "approximately 0.5", and the rest of the terms being placed symmetrically around it. The semantics of the label set is established from the ordered structure of the label set by considering that each label for the pair $(s_i, s_{\mathcal{T}-i})$ is equally informative.

In any linguistic approach we need management operators of linguistic information. An advantage of the ordinal fuzzy linguistic approach is the simplicity and quickness of its computational model. It is based on the symbolic computation [8, 9] and acts by direct computation on labels by taking into account the order of such linguistic assessments in the ordered structure of labels. Usually, the ordinal fuzzy linguistic model for computing with words is defined by establishing i) a negation operator, ii) comparison operators based on the ordered structure of linguistic terms, and iii) adequate aggregation operators of ordinal fuzzy linguistic information. In most ordinal fuzzy linguistic approaches the negation operator is defined from the semantics associated to the linguistic terms as $Neg(s_i) = s_j \mid j = \mathcal{T} - i$; and there are defined two comparison operators of linguistic terms: i) *Maximization operator*, $MAX(s_i, s_j) = s_i$ if $s_i \geq s_j$; and ii) *Minimization operator*, $MIN(s_i, s_j) = s_i$ if $s_i \leq s_j$. In the following subsections, we present two operators based on symbolic computation.

2.1 The LOWA Operator

The *Linguistic Ordered Weighted Averaging* (LOWA) is an operator used to aggregate non-weighted ordinal linguistic information, i.e., linguistic information values with equal importance [9].

Definition 1. *Let* $A = \{a_1, \ldots, a_m\}$ *be a set of labels to be aggregated, then the LOWA operator,* ϕ*, is defined as* $\phi(a_1, \ldots, a_m) = W \cdot B^T = \mathcal{C}^m\{w_k, b_k, k = 1, \ldots, m\} = w_1 \odot b_1 \oplus (1 - w_1) \odot \mathcal{C}^{m-1}\{\beta_h, b_h, h = 2, \ldots, m\}$*, where* $W = [w_1, \ldots, w_m]$*, is a weighting vector, such that,* $w_i \in [0, 1]$ *and* $\Sigma_i w_i = 1$*.* $\beta_h = w_h / \Sigma_2^m w_k, h = 2, \ldots, m$*, and* $B = \{b_1, \ldots, b_m\}$ *is a vector associated to A, such that,* $B = \sigma(A) = \{a_{\sigma(1)}, \ldots, a_{\sigma(m)}\}$*, where,* $a_{\sigma(j)} \leq a_{\sigma(i)}\ \forall\ i \leq j$*, with* σ *being a permutation over the set of labels A.* $\mathcal{C}^m$ *is the convex combination operator of m labels and if m=2, then it is defined as* $\mathcal{C}^2\{w_i, b_i, i = 1, 2\} = w_1 \odot s_j \oplus (1 - w_1) \odot s_i = s_k$*, such that,* $k = min\{\mathcal{T}, i + round(w_1 \cdot (j - i))\}\ s_j,\ s_i \in S,\ (j \geq i)$*, where "round" is the usual round operation, and* $b_1 = s_j,\ b_2 = s_i$*. If* $w_j = 1$ *and* $w_i = 0$ *with* $i \neq j\ \forall i$*, then the convex combination is defined as:* $\mathcal{C}^m\{w_i, b_i, i = 1, \ldots, m\} = b_j$*.*

The LOWA operator is an "or-and" operator [9] and its behavior can be controlled by means of W. In order to classify OWA operators in regard to their localisation between "or" and "and", Yager [30] introduced a measure of *orness*, associated with any vector W:$orness(W) = \frac{1}{m-1} \sum_{i=1}^{m} (m - i) w_i$. This measure characterizes the degree to which the aggregation is like an "or" (MAX) operation. Note that an OWA operator with $orness(W) \geq 0.5$ will be an *orlike*, and with $orness(W) < 0.5$ will be an *andlike* operator.

An important question of the OWA operator is the determination of W. A good solution consists of representing the concept of *fuzzy majority* by means of the weights of W, using a *non-decreasing proportional fuzzy linguistic quantifier*

[32]Q in its computation [30]:$w_i = Q(i/m) - Q((i-1)/m), i = 1, \ldots, m$, being the membership function of Q: $Q(r) = \begin{cases} 0 & \text{if } r < a \\ \frac{r-a}{b-a} & \text{if } a \le r \le b \\ 1 & \text{if } r > b \end{cases}$ with $a, b, r \in [0,1]$. When a fuzzy linguistic quantifier Q is used to compute the weights of LOWA operator, ϕ, it is symbolized by ϕ_Q.

2.2 The LWA Operator

The *Linguistic Weighted Averaging* (LWA) operator is another important operator which is defined to aggregate weighted ordinal linguistic information, i.e., linguistic information values with non equal importance [8].

Definition 2. *The aggregation of a set of weighted linguistic opinions,* $\{(c_1, a_1), \ldots, (c_m, a_m,)\}$, $c_i, a_i \in S$, *according to the LWA operator* Φ *is defined as* $\Phi[(c_1, a_1), \ldots, (c_m, a_m)] = \phi(h(c_1, a_1), \ldots, h(c_m, a_m))$, *where* a_i *represents the weighted opinion,* c_i *the importance degree of* a_i*, and* h *is the transformation function defined depending on the weighting vector* W *used for the LOWA operator* ϕ*, such that,* $h = MIN(c_i, a_i)$ *if* $orness(W) \ge 0.5$ *and* $h = MAX(Neg(c_i), a_i)$ *if* $orness(W) < 0.5$.

3 A Fuzzy Qualitative Model to Evaluate the Quality of Web Sites

In this Section, we present a fuzzy qualitative model to evaluate the quality of Web documents in XML format with the aim of assigning them quality evaluation values or recommendations. It is defined from the user perception, and therefore, it is qualitative and subjective. It establishes two elements to achieve the quality evaluation values or recommendations: i) an user-driven evaluation scheme of Web documents which is associated with their respective DTDs, and ii) a user-centered generation method which is based on the LWA and LOWA operators.

In the following Subsections, we analyze both elements.

3.1 The User-driven Evaluation Scheme for Web Documents in XML Format

We propose a user-drive evaluation scheme to evaluate the informative quality of the Web documents, i.e., the user-driven evaluation scheme is based on relevance judgements provided by the users that access to Web documents. Therefore, it is defined from the informative elements that compose the DTD of Web documents in XML format.

Given a kind of XML based Web document, for example a "scientific article" with the DTD <!DOCTYPE article [

<!ELEMENT article (title, authors, abstract?, introduction, body, conclusions, bibliography)>

```
<!ELEMENT title (#PCDATA)>
<!ELEMENT authors (author+)>
<!ELEMENT (author | abstract | introduction) (#PCDATA)>
<!ELEMENT body (section+)>
<!ELEMENT section (titleS, #PCDATA)>
<!ELEMENT titleS (#PCDATA)>
<!ELEMENT conclusions (#PCDATA)>
<!ELEMENT bibliography (bibitem+)>
<!ELEMENT bibitem (#PCDATA)> ]
```

we can establish an user-driven evaluation scheme composed by a subset of set of elements that define its DTD (e.g. "title, authors, abstract, introduction, body, conclusions, bibliography"). We assume that each component of that subset has a distinct informative role, i.e., each one affects the overall evaluation of a document in a different way. This peculiarity can be easily added in the DTD by defining an attribute for each meaningful component that contains a relative linguistic importance degree. Then, given an area of interest (e.g. "web publishing"), the quality evaluation value for an XML based document is obtained by combining the linguistic evaluation judgements provided by a non-determined number of Web visitors that accessed to Web documents and provided their opinions on the more important elements of DTD associated with Web documents.

3.2 The User-centered Generation Method for Web Documents in XML Format

Suppose that we want to generate a recommendation database for qualifying the information of a set of XML Web documents $\{d_1, \ldots, d_l\}$ with the same DTD. These documents can be evaluated from a set of different areas of interest, $\{\mathcal{A}_1, \ldots, \mathcal{A}_M\}$. Consider an evaluation scheme composed by a finite number of elements of DTD, $\{p_1, \ldots, p_n\}$, which will be evaluated in each document d_k by a panel of Web visitors $\{e_1, \ldots, e_m\}$. We assume that each component of that evaluation scheme presents a distinct informative role. This is modelled by assigning to each p_j a relative linguistic importance degree $I(p_j) \in S$. Each importance degree $I(p_j)$ is a measure of the relative importance of element p_j with respect to others existing in the evaluation scheme. We propose to include these relative linguistic importance degrees in the DTD. This can be done easily by defining in the DTD an attribute of importance "rank" for each component of evaluation scheme.

Let $e^{ij}_{kt} \in S$ be linguistic evaluation judgement provided by the visitor e_k measuring the informative quality or significance of element p_j of document d_i with respect to the area of interest $\mathcal{A}_t$. Then, the evaluation procedure of an XML document d_i obtains a recommendation $r^i_t \in S$ using the LWA-LOWA based aggregation method in the following steps:

1. Capture the topic of interest ($\mathcal{A}_t$), the linguistic importance degrees of evaluation scheme fixed in the DTD $\{I(p_1), \ldots, I(p_n)\}$, and all the evaluation judgements provided by the panel of visitors $\{e^{ij}_{kt},\ j = 1, \ldots, n\},\ k =$

$1, \ldots, m$. To do so, we associate with each XML document an evaluation questionnaire of relevance that depends on the kind of document. For example, if the XML document is the above "scientific article" with that DTD, then we can establish the relevance evaluation questionnaire on the following set of elements of DTD : "title, authors, abstract, introduction, body, conclusions, bibliography". In this case, the relevance evaluation questionnaire would have 7 questions, and for example, a question could be "What is the relevance degree of the title with respect to the search topic?". In other kinds of XML documents we have to choose the set of elements of DTD, $\{p_1, \ldots, p_n\}$, to be considered in the relevance evaluation questionnaire.
2. Calculate for each e_k his/her individual recommendation r^i_{kt} by means of the LWA operator as

$$r^i_{kt} = \Phi[(I(p_1), e^{i1}_{kt}), \ldots, (I(p_n), e^{in}_{kt})] = \phi_{Q_2}(h(I(p_1), e^{i1}_{kt}), \ldots, h(I(p_n), e^{in}_{kt})).$$

Therefore, r^i_{kt} is a significance measure that represents the informative quality of d_i with respect to topic $\mathcal{A}_t$ according to the Q_2 evaluation judgements provided by e_k.
3. Calculate the global recommendation r^i_t by means of an LOWA operator guided by the fuzzy majority concept represented by a linguistic quantifier Q_1 as

$$r^i_t = \phi_{Q_1}(r^i_{1t}, \ldots, r^i_{mt}).$$

In this case, r^i_t is a significance measure that represents the informative quality of d_i with respect to topic $\mathcal{A}_t$ according to the Q_2 evaluation judgements provided by the Q_1 recommenders. r^t_i represents the linguistic informative category of d_i with respect to the topic $\mathcal{A}_t$.
4. Store the recommendation r^t_i in a recipient in order to assist users in their later search processes.

In the evaluation procedure the linguistic quantifiers Q_1 and Q_2 represent the concept of fuzzy majority in the computing process with words. In such a way, the recommendations on documents are obtained by taking into account the majority of evaluations provided by the majority of recommenders.

4 A Fuzzy Qualitative Model to Evaluate the Quality of Web Sites

In [16, 19, 25, 29] it was proposed an information quality framework by considering that the quality of the information systems cannot be assessed independently of the information consumers' opinions (people who use information). This framework establishes four major information quality categories to classify the different evaluation dimensions [16, 19, 25, 29]:

1. *Intrinsic information quality*, which emphasizes the importance of the informative aspects of the information itself. Some dimensions of this category are: accuracy of the information, believability, reputation and objectivity.

2. *Contextual information quality,* which also emphasizes the importance of the informative aspects of the information but from a task perspective. Some dimensions of this category are: value-added, relevance, completeness, timeliness, appropriate amount.
3. *Representational information quality,* which emphasizes the importance of the technical aspects of the computer system that stores the information. Some of its dimensions are: understandability, interpretability, concise representation, consistent representation.
4. *Accessibility information quality,* which emphasizes the importance of the technical aspects of the computer system that provides access to information. Some dimensions of this category are: accessibility and secure access.

Using this information quality framework we develop an fuzzy qualitative model to evaluate the quality of the Web sites that provide information stored in XML documents. It is defined from the information consumers' perspective, and therefore, it is also qualitative and subjective. It is composed of two elements:

1. *A user-driven evaluation scheme,* that contains dimensions easily comprehensible to the information consumers (e.g. relevance, understandability) rather than dimensions that can be objectively measured independently of the consumers (e.g. accuracy measured by the number of spelling or grammatical errors).
2. *A user-centered generation method,* that generates linguistic recommendations on Web sites from the evaluations provided by different visitors to Web sites.

Both elements are presented in the following Subsections.

4.1 The User-driven Evaluation Scheme for Web Sites

We analyze Web sites that store information in multiple kinds of documents structured in the XML format (e.g. scientific articles, opinion articles) when users visit them occasionally because they store documents which meet their information needs. Therefore, user opinions on the informative quality of these documents (e.g. the relevance) must be an important dimension in the evaluation scheme. Taking into account these considerations, we define an evaluation scheme of Web sites oriented to the user that contemplates four quality categories with the following evaluation dimensions:

1. *Intrinsic quality of Web sites.* Accuracy of information is the main determinant of the intrinsic information quality of information systems. We discuss accuracy of Web sites by considering what visitors think about the believability of the information content that the Web site provides. Given that we consider Web sites as information sources that are visited occasionally, we are not interested in evaluating the accuracy by means of grammatical and spelling errors or relevant hyper-links existing on the Web site.

2. *Contextual quality of Web sites.* This is the most important category in the evaluation scheme. We propose to evaluate this category by considering what visitors think about the relevancy, timeliness and completeness of documents that the Web site provides them with when they search for information about particular topic, i.e., if documents are relevant to the search topic, if documents are sufficiently current and up-to-date with regards to the search topic, and if documents are sufficient complete with regards to the topic.
3. *Representational quality of Web sites.* We analyze this category for the Web sites that provide information stored in XML documents from two aspects: i) representational aspects of Web site design and ii) representational aspects of documents stored in the Web site. In the first case, we consider what visitors think about the understandability of the Web site, i.e., whether or not the Web site is well organized in such a way that visitors can easily understand how to access stored documents. In the second one, we consider what visitors think about the understandability, originality and conciseness of the information content of XML documents used.
4. *Accessibility quality of Web sites.* We consider that this category must be assessed as to whether or not the Web site provides enough navigation mechanisms so that visitors can reach their desired documents faster and easier. Lacking effective paths to access the desired documents would handicap visitors, therefore navigation tools are necessary to help users locate the information they require. We evaluate this category by considering what visitors think about the navigational tools of the Web site. The security dimension is not a key aspect on the Web sites that we are considering.

The evaluation scheme is summarized in Table 1.

INFORMATION QUALITY CATEGORIES	EVALUATION DIMENSIONS
Intrinsic quality of Web sites	believability
Contextual quality of Web sites	relevancy, timeliness, completeness
Representational quality of Web sites	understandability of Web sites, originality, understandability of documents, conciseness
Accessibility quality of Web sites	navigational tools

Table 1. User-driven evaluation scheme of Web sites

4.2 The User-centered Generation Method for Web Sites

In this Subsection, we present a generation method of linguistic recommendations for evaluating the informative quality of Web sites. These linguistic recommendations are obtained from the linguistic evaluation judgements provided by a non-determined number of Web visitors. After a visitor has used an XML document stored in a Web site, he/she is invited to complete a quality evaluation questionnaire as per the quality dimensions established in the above evaluation scheme. The recommendations are obtained by aggregating the linguistic evaluation judgements by means of the LWA and LOWA operators.

The quality evaluation questionnaire provides questions for each one of the dimensions proposed in the evaluation scheme, i.e., there are nine questions: $\{q_1, \ldots, q_9\}$. For example for the quality dimension *believability* the question q_1 can be: "What is the degree of believability of this Web site in your opinion?". The concept behind each question is rated on a linguistic term set S. We should point out that the question $q_2 = relevancy$ is not evaluated directly by means of a particular value supplied by a user. This dimension is evaluated applying the fuzzy qualitative model to evaluate the quality of Web documents presented in Section 3. Furthermore, we assume that each quality dimension does not have the same importance in the evaluation scheme, i.e., it is assigned a relative linguistic importance degree for each quality dimension: $\{I(q_1), \ldots, I(q_9)\},\ I(q_i) \in S$. To assign these degrees, the quality dimensions related to the Web site content itself (those included in the first and second category of evaluation scheme) should have more importance than the remaining ones. In particular, the *relevancy* has the greatest degree of relative importance.

Summarizing, the quality evaluation questionnaire that a visitor must complete is comprised of 8 questions, given that the relevance is associated with the accessed Web document assessed according to the evaluation model presented in Section 3.

Suppose that we want to generate a recommendation database for qualifying the informative quality of a set of Web sites $\{Web_1, \ldots, Web_L\}$ which stores information in XML documents. These Web sites can be evaluated from a set of different areas of interest or search topics, $\{\mathcal{A}_1, \ldots, \mathcal{A}_M\}$. Suppose that D_l represents the set of XML documents stored in the Web site Web_l. We consider that each XML document $d_j \in D_l$ presents an evaluation scheme composed of a finite set of elements of its DTD, $\{p_1, \ldots, p_n\}$, and its respective relative linguistic importance degrees $\{I(p_1), \ldots, I(p_n)\}$. Let $\{e_1^{m,l}, \ldots, e_T^{m,l}\}$ be the set of different visitors to the Web site Web_l who completed the quality evaluation questionnaire $\{q_1, \ldots, q_9\}$ when they searched for information about the topic $\mathcal{A}_m$. In the quality evaluation scheme each question q_i is associated to its respective linguistic importance degree $I(q_i)$. Let $\{q_1^t, \ldots, q_9^t\}$ be a set of linguistic assessments provided by the visitor $e_t^{m,l}$. We must point out that the assessment q_8^t is achieved from the set of linguistic evaluation judgements $\{e_{t1}^{ml}, \ldots, e_{tn}^{ml}\}$ provided by the visitor $e_t^{m,l}$ regarding the set of elements of DTD, $\{p_1, \ldots, p_n\}$, associated to the XML document accessed d_j. Then, q_8^t is obtained using the LWA operator as follows: $q_8^t = \Phi[(I(p_1), e_{t1}^{ml}), \ldots, (I(p_n), e_{tn}^{ml})] = \phi_{Q_3}(h(I(p_1), e_{t1}^{ml}), \ldots, h(I(p_n), e_{tn}^{ml}))$, being Q_3 the linguistic quantifier used to calculate the weighting vector W. If we assume that Q_3 represents the concept of fuzzy majority then q_8^t is a measure of significance that represents the relevance of d_j with respect to the topic A_l according to Q_3 linguistic evaluation judgements provided by $e_t^{m,l}$ on the meaningful elements of DTD associated with d_j. Then, given a search topic $\mathcal{A}_m$, the generation process of a linguistic recommendation $r^{m,l} \in S$ for a Web site Web_l is obtained using a LWA-LOWA based aggregation method in the following steps:

1. Calculate for $e_t^{m,l}$ his/her individual recommendation $r_t^{m,l}$ by means of LWA Φ: $r_t^{m,l} = \Phi[(I(q_1), q_1^t), \ldots, (I(q_9), q_9^t)] = \phi_{Q_2}(h(I(q_1), q_1^t), \ldots, h(I(q_9), q_9^t))$. $r_t^{m,l}$ is a measure that represents the informative quality of the Web site Web_l with respect to topic $\mathcal{A}_m$ according to the Q_2 linguistic evaluation judgements provided by the visitor $e_t^{m,l}$.
2. Calculate the global recommendation $r^{m,l}$ by means of an LOWA operator guided by the fuzzy majority concept represented by a linguistic quantifier Q_1 as $r^{m,l} = \phi_{Q_1}(r_1^{m,l}, \ldots, r_T^{m,l})$. In this case, $r^{m,l}$ is a measure that represents the informative quality of the Web site Web_l with respect to topic $\mathcal{A}_m$ according to the Q_2 evaluation judgements provided by the Q_1 visitors or recommenders. $r^{m,l}$ represents the linguistic informative category of Web_l with respect to the topic $\mathcal{A}_m$.
3. Store the recommendation $r^{m,l}$ in order to assist user future search processes.

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