Appraising the Interface Features of Web Search Engines Based on User-defined Relevance Criteria*

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ABSTRACT

Although research has shown a significant amount of work identifying various dimensions of relevance along with exhaustive lists of relevance criteria, there seem to have been less effort to apply the findings to improve actual systems design. Based on this assumption, this paper investigates to what extent those relevance criteria have been incorporated into the interface features of major commercial Web search engines, suggesting what can/should be done more. Before stepping into the actual system features, this paper compares recent relevance research in Information Science with other human factor studies both in Information Science and its neighboring discipline (HCI), as an attempt to identify studies that are conceptually similar to the relevance research, but not named as such way. Similarities and differences between these studies are presented. Recommendations suggested to support applicable interface features include: 1) *further personalization of interface designs*; 2) *author-supplied meta tags for the Web contents*; and 3) *extensions of beyond-topical representations based on link structure*.

초 록

이용자 정의형 적합성 연구가 적합성의 유형 및 기준 식별에 큰 진전을 이룬 반면, 그 결과를 실제 시스템 디자인에 적용시키는데는 큰 발전이 없었다. 이러한 전제하에 본 연구는 식별된 적합성기준이 주요 웹검색엔진의 인터페이스 기능에 어느정도 접목되었는지를 조사하고 무엇이 더 이루어져야 하는지를 제안하였다. 시스템 기능에 접근하기전에 본 연구에서는 적합성연구와 정보학 및 HCI에서 이와 유사한 이용자중심 연구를 비교하여 제시하였다. 인터페이스기능을 지원하기위한 제안점은 (1) 인터페이스 디자인의 추가적인 개인화, (2) 웹 컨텐츠를 위한 저자제공 메타 태그, 그리고 (3) 링크구조에 입각한 비주제적 표현의 확장 등이다.

키워드: User Study, Relevance Criteria, Interface, Human Computer Interaction, Web Search Engines
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1. Introduction

There has been a significant amount of empirical studies upon *user-based relevance*, identifying various dimensions of relevance along with the exhaustive lists of criteria as the results of user-defined relevance (Park, T. 1993; Cool, Belkin, Frieder & Kantor 1993; Barry 1994; Park, H. 1997; Wang & Soergel 1998; Savolainen & Kari 2005, Taylor, Zhang & Amadio 2009). Yet the efforts to directly apply those dimensions and criteria into the design of actual IR systems seem to have been insufficient.

No doubt, the notion of relevance has greatly contributed to the evaluation of IR systems - e.g., providing the concepts of recall and precision, and also significantly contributed to *user need analysis* and *task analysis*. But its contribution to actual systems design has been less obvious than its contribution to the other aspects of IR systems.

As the first step, upon this ground, this paper investigates the possibility of applying those relevance criteria into the design of actual IR systems. In so doing, this paper attempts to pursue two things as follows.

One is to compare recent relevance research in Information Science with other human factor research both in Information Science and in its neighboring discipline such as Human-Computer Interaction (HCI). Upon the field of HCI, the broad domain of its area is briefly introduced and compared with the characteristics of relevance research in Information Science. On the other area of Information Science, an emphasis is put on the developments of interactive IR models. In both discussions, comparisons with relevance research are presented in the way to identify human factors that are conceptually similar to the relevance criteria, but not named as such way. By doing so, those empirical studies upon relevance provided more extensive discussions on interactions between users and texts than any other studies.

The other is to relate relevance criteria identified in the previous empirical studies into the interface features of Web-based IR systems. In other words, the paper investigates to what extent those relevance criteria have been incorporated into the current features of major commercial Web search engines. Based on this, recommendations are presented: 1) to further incorporate relevance criteria into interface features and 2) to provide methods to support applicable interface features.

This effort will be meaningful in that systems will have better mechanisms to understand users' needs while most systems are quite often misled by users' query inputs, resulting in a considerable number of irrelevant items returned.

2. Human factor research in HCI

There has been a significant amount of research, in the field of HCI, to incorporate human factors into the design of computer systems. Driven by the development of computer technology as well as research on information seeking, the design of

interfaces that support the process of information seeking has become more user-centered. In so doing, the domain of user-centered research in HCI is quite broad and rich.

As stated, this paper attempts to compare research trends of human factors in two different fields, Information Science and HCI. It is not too easy to present a clear-cut boundary between the two disciplines even with the specific domain of human factor related areas since a considerable amount of work have been done in interdisciplinary approaches. Yet some authors presented ideas by which a rough picture can be drawn upon explaining the boundary. Marchionini (1995) is one of them.

The two dimensions of interface elements (*conceptual* and *physical* elements) presented by Marchionini (1995) seem to provide a good framework to account for a basic difference between the two fields. Whereas the interface research in HCI has encompassed both *conceptual* (representations and mechanisms) and *physical* elements (input and output devices that control interaction) with an equal priority, the human factor research in Information Science has put more emphasis on the *conceptual* elements. According to Marchionini (1995), the main categories of *conceptual* interfaces include interaction styles, representational structures and search mechanisms, which all provide fundamental research issues on the discipline of Information science.

Reflecting the wide domain of interests, the field of HCI has encompassed a broad area of work including user interfaces for hardware (i.e., Mac, PC), software (i.e., word processors, spreadsheets, databases) and skill level (i.e., typing) (Hix & Hartson 1993).

Similarly, Shneiderman (1998) has discussed various issues of human factors in HCI, dealing with both *conceptual* elements (i.e., the need for simple display due to the limitation of human information processing in short-term memory) and *physical* elements (i.e., interfaces for physically handicapped user).

There also have been some attempts to relate the theories of psychology onto the systems design in the field of HCI. For example, Shneiderman (1980) presented the Myers-Briggs Type Indicator (MBTI) as "an appealing psychological test which gives insight to programmers and their interaction," (p.57). Yet he did not extend the discussions, explaining how the four dimensions of MBTI (Extroversion/Introversion, Sensing/Intuition, Thinking/Feeling, Judging/Perceptive) could influence a computer programmer (Shneiderman 1980; 1998).

Perhaps, the human memory issue is an area that can be easily applicable to various computer interface designs especially in the *conceptual* level. In addition to Shneiderman (1998), some other authors discussed this issue (Hix & Hartson 1993; Marchionini 1995).

Whereas the HCI literature provides various aspects of interface designs in both *physical* and *conceptual* level, it is not easy to locate similar research in the field of HCI to relevance research in Information Science, which mainly investigates Users' perceptions of information objects in an

IR process.

It is even so in the area of HCI named as *User and Task analyses*. While Hix & Hartson (1993) offered, on this area, some practical suggestions for assessing the tasks that users bring to computer system, Shneiderman (1998) has provided a rational for mapping user tasks and needs onto the syntax and semantics of interface designs. Although these studies presented various aspects to analyze users' tasks, they did not particularly deal with situations to retrieve textual documents from IR systems (unlike the relevance studies).

Earlier, Booth (1989) offered a detailed list of user characteristics that clustered user variance into five broad dimensions: user data, job characteristics, background, usage constraints, and personal traits. In a similar approach, Nielsen (1993) proposed a less detailed dimensional analysis of users that drew distinctions in terms of domain knowledge, computing experience, and application experiences. Yet, like *user and task analyses* mentioned above, these dimensional analyses did not discuss the relationship between user characteristics and document characteristics in detail in the process of IR.

More recently, Shackel (1997) presented various taxonomy (dimensions) of HCI research with extensive literature review on the field. Yet no research was explicitly pointed out, to discuss the relation between users and the information objects (i.e., textual document) they attempt to retrieve.

Perhaps, the most relevant discussion comes from the work of Shneiderman, Byrd and Croft (1997). They proposed a four-phase framework (formulation; action; review of results; refinement) to encompass an entire search process of a textual database in the Web environment. Among various discussions they represented, the most closely related one to the application of user-based relevance criteria, -- perhaps the only explicitly related to those - seems to be *display features* to provide different *sequences of documents*, based on various attributes of the Web site (i.e., alphabetically; chronologically; and relevance ranked).

Overall, it should be apparent that no research in the field of HCI has investigated the relation between users and textual documents more rigorously than relevance studies in Information Science have done. In a sense, this is not surprising in that only the latter examined this relation with real documents, real users and real systems in an exhaustive manner.

3. User-oriented research in information science

During the decade of 1980s, the discipline of library and information science witnessed a fundamental transition on its view, from the traditional to the alternative one, upon the *user* of information services and systems. Dervin and Nilan's (1986) ARIST (Annual Review of Information Science and Technology) review should be a landmark work on analyzing this trend. Reviewing literature of various aspects on this transition, the authors named

it as a "paradigmatic shift" in the discipline. According to Dervin and Nilan, the alternative paradigm posits information as something constructed by human beings unlike the traditional view in which information is seen as objective and user are seen as input-output processors of information.

The growing interests on the human factor as the fundamental element in the discipline have been reflected on the design of IR model. Reflecting the trend, three scholars have presented interactive IR models indicating the shortcomings of the traditional IR model. All emphasizing the human aspects of IR, they include Ingwersen (1992), Belkin (1993) and Saracevic (1996a; 1996b; 1997).

Ingwersen (1992) considered the IR interaction in a broad view. According to Ingwersen, IR interaction is a set of processes of cognition occurring in all the information processing elements in IR (Saracevic 1996a, p.5). Whereas Ingwersen named interactive aspects between the information objects and the users as "Cognitive space," Belkin (1993) used the term of "Interaction" to describe these aspects.

Both Ingwersen (1992) and Belkin (1993) presented various elements of the interactive aspects. Ingwersen's "cognitive space" includes work task/interest, current cognitive state, problem/goal, uncertainty, information need, and information behavior. Elements on the "Interaction" from the Belkin's model are more concise. They include: judgment, use, interpretation, and modification.

While Ingwersen and Belkin's models are more focused on the cognitive aspects of IR interaction, Saracevic's (1996a; 1996b; 1997) model explicitly illustrates various elements from the two components of IR interaction, equally encompassing the two components (*user* and *computer*). The *user* domain includes elements such as *situational* (task), *affective* (intent), *cognitive* (knowledge structure), and query (characteristics); the *computer* domain has interface, engineering (hardware), processing (software), and content.

The study of relevance is another area that has been influenced by the growing emphasis on the human factor. Reflecting the trend, some authors criticized the notion of relevance as a fixed concept bridging a query and a document, suggesting that it is dynamically changing and never permanent (Schamber, Eisenberg, and Nilan 1990; Harter 1992; Barry 1994).

In addition, a number of authors conducted empirical studies to identify relevance criteria, presenting the exhaustive list of *user-defined relevance criteria*. They include: Park (1993); Cool, et al. (1993); Barry (1994); Park (1997); and Wang & Soergel (1998).

The dimensions or classifications of relevance criteria presented on these empirical studies include: internal, external, and problem context (Park 1993); six faucets of relevance criteria (Cool, et al. 1993); seven groups of criterion categories (Barry 1994); relevance dimensions consisting of three orientations, problem, use, and value (Park 1997); and five dimensions including epistemic, functional, conditional, social, and emotional values along with 11 relevance criteria (Wang &

Soergel 1998).

While these studies provided rich discussions on the relevance dimensions along with the extensive lists of relevance criteria, they presented ideas for actual system improvements only in limited aspects. For instance, while Wang & Soergel (1998) provided a greater scope of implications for systems design and indicated users' need to have more customized interface with a system in both aspects of query formulation and display of retrieval results, they did not further develop these ideas with specific examples of interface features and methods to support those features.

Marchionini, Plaisant, and Komlodi (1998) have proposed a more concrete idea to improve the Web-based system for end-users. They have discussed *Display options* in digital library, emphasizing the need to distinguish different level of representation and to provide some sense of the volume of material returned.

Asserting that display result is one of the most underdeveloped aspects of Web-based searching, they proposed that this need should be fulfilled to accommodate heterogeneous materials in a various format (photographs, manuscripts, motions pictures, letters from a person, one issue of a periodical, etc.). Although the authors did not use the terminology of relevance, their approach apparently has common aspects with some of the relevance criteria such as the *formats of documents*.

Marchionini and Komlodi (1998) have also indicated as follows the contribution of the technology onto the improved access (search) mechanisms of the information systems. " Multimedia retrieval challenges and Web-based resources allow information seekers to focus on information objects at many levels of granularity rather than only at the document or bibliographic pointer levels." (p.108). Yet, interface features of current IR systems sill have lots of rooms to reflect relevance criteria identified from the previous empirical studies. Surly, those criteria provide more ideas for access mechanisms "at many levels of granularity."

4. Rationales: applying relevance criteria onto systems design

This part of the paper presents three different grounds of applying relevance criteria to the design of IR systems as an attempt to improve the interactive aspects of the systems.

The first rational deals with the previous remark of this paper that no other research areas either in Information Science or its neighboring disciplines has accomplished more rigorous level of study than the relevance study have done to investigate the relation between *users* and *information objects in* the process of IR.

If this is the case, there will not be a minimum level of skepticism on this approach (applying relevance criteria to the designs of IR systems) because a major purpose of IR systems is to retrieve *information objects* which best fulfill the information needs of *users*. Again, if this is the case, the rele-

vance criteria should yield rich implications on the design of both search and display interfaces of IR systems.

Another rational for applying relevance factors onto system designs is based on the relationship between the *notion of relevance* and *interaction* in (IR). Two major concepts in IR, the *notion of relevance* and *interaction* are not independent. Nevertheless, there have not been many attempts to connect theses two in the literature of IR.

This might be because "researchers have paid less attention to understanding the nature of judgment while they paid much more attention to the nature of relevance and criteria of relevance" (Rieh 2000, p.17) Rieh's argument seems to be quite appropriate in accounting for insufficient relation between the two concepts (the notion of relevance and Interaction) even though it does not explain every aspects of the insufficiency.

One author who explicitly discussed this issue (the relationship between relevance and Interaction) is Saracevic (1996b). He presented *the interactive framework* as the fifth framework of relevance in addition to the existing frameworks of system, communication, situational, and psychological. In this framework, Saracevic defines relevance as "an attribute or criterion reflecting the effectiveness of interactive exchange of information between people (i.e. users), and information systems in a communicative contact (p.210)." In this sense, the application of relevance criteria onto system designs should improve the interactive aspects of IR interfaces.

Finally, there have been some indications from a number of authors to consider the findings of empirical studies on relevance as being generalizable to a broader user group. Indicating remarkable similarity among criteria identified from earlier studies (i.e., Cuadra & Katter 1967), Schamber (1994) insisted that "a finite range of criteria exists at some level for users in all types of information problem situations" (p.26).

Barry (1994) made a similar remark upon more recent studies (Park 1993; Schamber 1991; and her own study), indicating "a great deal of overlap in the criteria identified by the three studies" (p.157). Extending Barry's discussion, Froehlich (1994) pointed out that "relevance judgements for a set of users for a set of tasks entail a finite set of criteria dynamically evoked" (p.129). If this is the case, those relevance criteria should be applicable -- with an acceptable level of generalizability -- to the design of IR systems that will be used by heterogeneous user groups.

5. Relevance criteria and interface features of Web search engines

This part of the paper illustrates to what extent the relevance criteria have been reflected to the interface features of major Web-based IR systems, commercial Web search engines. This analysis is based on the assumption that it would be a significant forward if a system can present interface features by which a user can input various in-

formation needs related to the *relevance criteria*. This idea should be a convincing one in that the notion of relevance deals with the relation between certain attributes in the user-side and *texts in the file of system not only the texts actually retrieved by a system* as indicated by Saracevic (1996b).

Before stepping into interface features in actual systems, relevance criteria identified from a number of empirical studies (Schamber 1991; Cool, et al. 1993; Park 1993; Barry 1994; Wang & Soergel 1998) have been collected and classified into three categories (Table 1). The idea to categorize these factors came from *manifestations of relevance* proposed by Saracevic (1996b).

The original five dimensions (manifestations) of relevance discussed by Saracevic (1996b) include: 1) *system relevance* - relation between a query and information objects (text); 2) *topical relevance* - relation between the subject or topic expressed in a query and topic or subject covered

〈Table 1〉 Types of relevance and relevance criteria

Types of relevance	Related relevance criteria*
Topical relevance	Topicality (topic itself); on/not one topic; part of topic.
Cognitive relevance	Document-side Point of view. Quality; clarity; simplicity/complexity; specificity. Content novelty; expertise; scientificness; technicality. Treatment (deep/superficial); depth/scope; level (of detail). Authority (source quality); source novelty; source reputation; origin User-side Background experience of user; user's level of expertise in problem area; stage/purpose of research.
Situational / Motivational relevance	Document-side Recency; age of document. Content (facts/factual; methodology; interview; survey; history, etc). Format (writing style; lists; diagrams; statistics; pictures). Cost; availability; accessibility. Amount; reading time. Entertainment value. User-side Time constraints

* Relevance criteria from previous empirical studies (Schamber 1991; Cool, et al. 1993; Park 1993; Barry 1994; Wang & Soergel 1998).

by retrieved text; 3) *cognitive relevance* (or pertinence) - relation between the state of knowledge and cognitive information need of a user and the text retrieved; 4) *situational relevance* (or utility) - relation between the situation, task, or problem at hand and text retrieved by the system; 5) *motivational relevance* (or affective relevance) - relation between the intents, goals and motivations of a user and texts retrieved by a system.

Among the five dimensions of relevance, *system relevance* was not appropriate as one of the categories to classify the interface features because it concerned the relation between information objects and the query itself, which can be related to any interface features of the systems. Thus, this particular type of relevance was excluded.

In addition, *situational relevance* and *motivational relevance* were put together to make a single category because the two types of relevance dealt with similar elements in the user-side, perhaps similar enough to classify the interface features of IR systems under a same category. The relevance criteria classified based on the three categories of relevance (*topical, cognitive*, and *situational / motivational relevance*) are shown on <Table 1>. Since some relevance criteria can belong to more than one category, these categories are complementary to each other rather than mutually exclusive.

Based on the Table 1, interface features of major commercial Web search engines were illustrated in order to show to what extent the relevance criteria have been reflected to the system(Table 2). In addition, some suggestions were made as *recommended features* as shown as ® in the table. The Web search engines selected include Alta vista, Hot Bot, NorthernLight, Excite, and Google.

This analysis shows that some relevance criteria (i.e., part of topic, age of document) have been more completely reflected on the systems than others whereas some differences were identified among the Web-based systems in adopting the relevance criteria as the interface features. The next part of the paper presents more detailed discussions on those recommended features.

6. Recommendations

The following part of the paper mainly discusses possible methods to support interface features recommended in <Table 2> as shown as ®. Recommendations suggested here to improve current interface designs and to support applicable interface features include: 1) *further personalization of interface designs*; 2) *author-supplied meta tags for the Web contents*; and 3) *extensions of beyond-topical representations based on link structure*. While the first recommendation suggests a new approach on interface designs, the latter two discuss methods and mechanisms to support the interface features recommended in <Table 2>.

6.1 Further personalization of interface designs

As summarized in the <Table 2>, various new

〈Table 2〉 Relevance criteria and corresponding interface features in major Web search engines

Relevance criteria	Related interface features of the Web search engines
Topical relevance	
Topicality (topic itself)	Search word/phrase features. Available in all search engines.
On/not one topic; part of topic.	Exact phrase search (Alta vista); N/A (Hot Bot); limiting subject to a specific area (NorthernLight); N/A (Excite); Without the word OR Exact phrase search (Google).
Cognitive relevance	
Document-side	
Point of view.	N/A in all search engines. ® This feature might be workable for a limited volume of collections such as a digital library collection or a part of a digital library collection.
Level of clarity, simplicity/complexity, and specificity.	Available as Reading level (Google); N/A in other search engines as a separate search feature (to indicate these particular characteristics of the Web content). Yet some of these attributes can be influenced by the combination of various search features such as *required part of the topic, medium of information object, limiting subject to a specific area.*
Level of content novelty; expertise; scientificness, and technicality.	N/A in all search engines. ® Separate search features can be helpful, explicitly indicating the level of each criterion for the document. Novelty and expertise based on the characteristics/quality of linked sites; scientificness and technicality based on author-based meta tags.
Level of depth/scope.	Available as Reading level (Google); N/A in other search engines.
Authority (source quality/reputation).	N/A in Alta Vista, Excite and NothernLight. In Hot bot and Google, search can be limited by a specific domain (i.e., .com, .org, .gov). This feature can affect the *authority of the source* to a certain extent because some domains of sites(i.e., government sites) are generally more trustworthy than regular commercial site.
User-side	
User's level of experience and expertise on the area.	N/A in all search engines. ® Personalized interface based on different level of experience or expertise.
Situational/ Motivational relevance	
Document-side	
Recency (or age of document).	Available in all search engines by the search feature to specify

Relevance criteria	Related interface features of the Web search engines
	date/month/year of the publication (modification). Further functions available - Last modified (Alta Vista); Specifying the date by the periods of time (i.e., in last 2 weeks, after January 1, 2000) (Hot Bot) selecting date range - starting date, end date and display based on the age of the site (LothernLingt; Google)
Content (facts/factual; methodology; interview; survey; history, etc).	N/A in all search engines; need to use the main search term function. ® separate features for each of the item(i.e., methodology).
Format (writing style; lists; diagrams; statistics; pictures).	Partially available in most search engines. Inclusion of specific data types (types of information objects) available in some search engines - selecting photos, graphics, color, black and white, etc. (Alta Vista); Selecting image, audio, JavaScript, etc. (Hot Bot); Finding PDF files or maps (Google).
Cost; availability; accessibility.	N/A in all search engines. ® Limiting search, depending on the (required amount of) payment (i.e., Not search if the document is accessible with payment; not search if payment over a specific amount needed; not search if the site requires membership) OR Limiting search based on system requirement (i.e., Not search if a certain system requirement needed).
Amount; reading time.	Available by the number of return results (i.e., Alta Vista, Google). ® Limiting search by the length of the site.
Entertainment value.	N/A in all search engines.
User-side	
Time constraints	Again, available by the number of return results; the feature of *Best page only* available in Hot Bot. ® The feature of searching for only highly relevant one.

* N/A stands for *Not Available*. ** ® stands for *recommended feature*.

inter face features are necessary to support the relevance criteria. The basic idea illustrated in the <Table 2> suggest the need of a wider range of interface features (both in query formulation and in display of retrieval results) by which end-users can inform the system of various preference and style on their informant needs. Overall, further personalization of the interface features is recommended in that not all users will need all interface features in similar ways.

Current versions of search engines such as Google enables users to eliminate sites related to

specific domains (i.e., adult sites) during the search. This is possible as their filtering technology checks keywords, phrases, URLs and Open Directory categories.

Perhaps, different ways of personalization is possible based on various characteristics of users including gender, age, previous knowledge and experience. For instance, male users might prefer to have *News and Sports* on the upper part of its browsing directories while female users wish to see *Life and Beauty* before other links.

6.2 Author-supplied meta tags for the Web contents

The current state of art provides a very limited capability on identifying the intellectual aspects of text contents (e.g., level of scientificness, point of view) while the implementation of most relevance criterion-based interface features recommended in this paper requires a significant level of sophistication on this capability. Whereas there have been some ongoing efforts to improve this capability of system for IR, this paper suggests a full utilization of meta tags as a supplementary tool to support this capability.

Some authors including Soergel(1985) and Fidel(1994) presented the idea of *requested - oriented indexing*(*user-centered indexing* in Fidel's term), emphasizing the need to represent the intellectual *aspects* of document contents. Weinberg (1988) showed some skepticism on this idea indicating the decline of emphasis on content analysis as well as its time-consuming procedures. In fact, high cost has been a major obstacle in further developing this idea since it requires work done by human indexers.

The Web seems to provide a good environment to cope with the high cost problem caused by human indexing. Meta tags consisting of author-supplied keywords or descriptions generate a very good mechanism to represent the intellectual aspects of site content. The logic is quite simple. The authors index their own documents. So, they can represent something beyond topical contents with reliable expertise, spending a reasonable mount of time.

Yet this advantage is not being fully utilized in current search systems in the Web environment. While OCLC has made a considerable progress on Dublin Core meta tags, the 15 elements of Dublin Core tags do not sufficiently deal with the intellectual aspects of site contents.

Another essential drawback of the Dublin Core tags is low usage rate among sites. Overall, meta tags have been used only to some limited number of search tools. For instance, FAST, Google, NortherLight do not support meta descriptions while Excite, FAST, Google, NortherLight do not use meta keywords. For ranking purpose, only a limited number of search engines (i.e., Go, Inktomi) give pages an extra boost if search terms appear in meta tags; many others (i.e., Alta Vista, Excite, FAST, Google, NortherLight) do not (Sullivan 2010).

The idea of adopting author-supplied meta tags to identify intellectual aspects of content seems

to be particularly effective to sites designed in academic environment. In general, this should be useful to represent non-commercial sites including a specific segment of a digital library. Searching these sites, careful users need to have less concern on *spam indexing*, which deals with profit-oriented manipulation of content descriptors by site providers.

6.3 Extension of beyond-topical representations based on link structure

One possible method of extending the idea of beyond-topical representation is to adopt it in relation to the link structure of sites. Google is certainly a front-runner in this area with advanced search and display algorithms using the link structure of the Web.

One of the key characteristics of "PageRank," the ranking system adopted in Google, is *not to count links from all pages equally*. Yet its detailed mechanism is not sufficiently known with little explanation on how to provide "an objective measure of its citation importance that corresponds well with people's subjective ideas of importance" (Brin & Page 1998).

Perhaps, the consideration of beyond-topical tags on incoming and outgoing linked sites can provide extra boost to locate and rank sites. Certainly, there is a need to have mechanisms to boost sites beyond the rank boost based on link popularity while this function (boost based on link popularity) is currently available in Google.

7. Conclusion

The design of information systems should take into account real-life information behaviors as completely as possible and the possibility of supporting those behaviors has been extended with rapidly improving information technology (Lin & Belkin 2000).

Yet it has been also indicated that the system designers, mainly from the discipline of the computer science, are not fully utilizing the findings of human elements in information science (Saracevic 1999). Surely, incorporating the human attributes into the system features should be an essential element in systems design. Closer interactions between the two disciplines will facilitate this process.

As an attempt to directly relate relevance criteria into systems design, this paper has presented those criteria with corresponding interface features of Web-based IR systems along with recommendations to improve the interface. Further efforts seem to be necessary in the following areas.

While this paper used different dimensions of relevance (topical, cognitive and situational /motivational relevance) to categorize available interface features, a better understanding of interaction between users and information objects will require understanding of the interplays between those levels or strata -- dimensions of relevance

as Saracevic (1997) suggested. Perhaps, it will be a challenging attempt to design interface features that can support user's interplays between those different strata.

Another area of necessary work deals more directly with search algorithms whereas this paper suggested an expanded use of author-supplied indexing to identify the intellectual aspects of text contents. The next research agenda should be on the use of computer algorithms to support this capability while there have been some ongoing efforts in IR research to improve this capability.

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