Solving problems on the World Wide Web

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Introduction

The Web is a digital environment that exists as a parallel universe to the physical. To exploit the Web users may be required to choose between a myriad of different paths. It could thus be argued that the time people spend on the Web is more active and challenging than the time spent engaged in media like television or books. The Web has only existed for 7 years and it is constantly expanding, for this reason both its authors and readers struggle to create fitting mental models of it. Several factors influence this model building, these include the complexity of the problem; at what stage of the process he is in; his educational background and previous experience; the psychological and emotional constraints put upon him by himself and his surroundings; and the information sources and channels available. These are factors that are often addressed in the information seeking literature. Additionally there are constraints set during actual Web interaction. A fully computerised medium strongly depends on the possibilities to smoothly present its preconceived properties. It is a great diversity in the computer equipment available to the users as well as the capacity of their Internet connection.

The research problems

Users' problem solving with the Web are dependent on some information seeking factors and some information searching factors where the latter is a subset of the former. "Web interaction" is here preferred used to Web "information searching". Originally it was thought that the focus should be on the interrelationships between high-level information seeking factors and the low-level Web interaction. A review of the literature reveals that very few studies have been performed that focus on actual use of the Web. It was therefore decided that the project was to be concentrated on this.

Web interaction should be viewed in the light of the problem at hand. Problems are of different complexity and they are solvable with different means. Since individuals' knowledge structures are dynamic (see Ingwersen 1992) the problem may change constantly, not only as a results of information retrieval. A problem may in fact "disappear", not necessarily because it is solved, but because during the problem solving process the individual discovers, as the result of information retrieval or other actions – be they internal or external – that the problem needs to be replaced by a new and more fitting one. Metaphorically one may say that a change somewhere in the user's knowledge structure indirectly, or by a "chain reaction", *restructures* the knowledge structure and thus causes him to see things from a new point of view. In other instances the individual may discover that the problem is unsolvable and choose to spend his time in a more fertile way.

It is further thought that a problem can be divided into several tasks, which may be of different complexity. Task complexity depends on several properties, including difficulty; domain; duration; importance; and repetitiveness. Routine tasks are often performed in no time without the need of any information seeking behaviour. The more complex task may on the other hand be divided into several subtasks. The results from Byström & Järvelin's study (1995) indicates that the more complex a task gets the more necessary it is to enact in information seeking, they say "as the tasks grow more complicated, the information needs also become more complicated." (p. 208) From this one should think that individuals only engage in Web interaction to perform tasks above a certain level of complexity.

The subject domain to which a problem belongs is interesting because the extent – both quantitatively and qualitatively – to which different domains are presented on the Web reflects the development of the Web itself. The harder sciences (like computer science, mathematics) started to publish on the Web early and it is still a bias in Academia's Web publishing.

When individuals decide to engage in Web interaction I believe that it is possible to identify distinct tasks with identifiable beginnings and ends. A Web session may consist of one or several task performances, and these performances may in turn belong to different problem solving processes or they may all be performed to solve a single problem. Examples of task may rank from the simple "finding out what is the capital of Ireland" to the complex, e.g. "purchase the newest album by Madonna, but make sure to get it at a good price and have it sent here by the end of the next week". Some tasks may originate during interaction. Meta-problems exemplify this, e.g. a user wishes to use an IR tool, but has problems understanding how it works. The first task to be accomplished is "find out how to use IR tool".

By Web interaction I mean activities involved in accessing and reading pages on the Web. The factors mentioned above obviously play a role also during Web interaction, but here factors directly influenced by the interaction also come into play. These are partly system and partly user dependent. System dependent interaction factors include the effect of functionalities embedded in the client program (the "browser") as well as usability and interface issues. The performance of IR tools is another important factor. Additionally it is clear that the individual authors' ability to use the hypertext format in text structuring is important. In her master thesis Elisabeth Grylling (1997) proposes the following criteria to evaluate the quality of Web resources: authority; accuracy; objectivity; actuality; topicality; coverage; linking; stability; context dependency; and accessibility. Although the criteria originally was developed to make rules for including Web resources in a database I believe they are usable as descriptors of how individuals verify the content of Web resources. The degree to which users are critical in evaluating Web resources are of course also dependent on their previous Web experience.

An important factor that influences interaction is the ability of the active Web page to change or restructure the user's knowledge structures in such a way that it helps him getting closer to solving his problem. In other words, if the page contains the needed information the user may choose to end the interaction or he may start working with another problem or task. It is hypothesised that such changes in interaction are observable.

Different Web resources may also influence how interaction takes place. Some resources have a content and form that is familiar to the user from the physical world, e.g. monographs and journals. Users with long experience probably have used a larger variety of resources and feel familiar with them, but it may also be that the specific groups of users publish and reads specific kinds of Web resources.

I believe it is fruitful to look at both the "hows" and the "whys" of Web interaction.

How a person physically act when interacting depends on the system's ability to fit his cognitive actions, i.e. his thoughts. Since the hypertext format is based on a notion of associative access it is therefore very interesting to try to classify navigation by both functional and cognitive facets. In the section on methods a possible way of doing this is examined.

The Web is one out of many possible information sources available to problem solvers. In certain circumstances problem solvers may choose to use the Web as their information source, this, among other things, depends on the kind of problem they have and the tasks that need to be accomplished to solve the problem. The research problems I seek to answer are the following:

1. Is it possible to identify patterns of cognitive and physical nature in Web interaction?
2. If it is possible to identify such Web interaction patterns, is there any correlation between the nature of these interaction patterns and particular kinds of Web resources?

In this section I present the collection methods hitherto used, and the methods I plan to use in the data analysis.

Data collection and analysis

LIS students on the brink of ending their education have been chosen as objects of study. They constitute an actual group of problem solvers; they need to write a final thesis to have their diploma. Although the students do not have a long experience in use of IR tools, their training in this area is up-to-date. Additionally the students have quite a long experience in Web use; the Web is used actively in several courses followed by the students and they have had Web access for three years. For a second study I have planned to use graduate students in LIS who are working on their master thesis.

I believe that using experts (Ingwersen, 1992 p. 141) as my objects of study may help to reveal whether there are specific properties embedded in their IR knowledge that are of particular help during Web interaction. On the other side it could be the exact opposite, perhaps their IR knowledge in some ways actually hinder them from efficiently exploiting the Web. This is not a main research question in my project, but it may be a potential interesting spin off effect to follow up.

Data collection

To collect my data I made agreements with the students to contact me when they want to use the Web as part of their thesis work. I put no constraints on the number of students working together, i.e. if two students wanted to conduct a Web session together they were allowed to do so.

I have equipped one computer with a GrandArt video converter, which is a little black box that converts computer screen signals to video format. The converter also has a microphone connected to it, which makes it possible to record sound data simultaneously. The only external equipment needed is a VCR to record the data.

The computer is connected to the faculty's local area network and the students may log in to their own accounts and thus use a browser, which to a certain degree may be individually configured. The students' default browser is set to be Netscape, version 3.03.

In order to learn more about the problem at hand and the users' intention with the

forthcoming session an unstructured open-ended interview is conducted in front of each Web session. Here the students are asked to tell about what they have done since the last session; how they feel about the progress of their work; why they want to use the Web today and similar questions.

A second short and unstructured open-ended interview is performed after the session. In this interview the students are asked how they felt about the session and whether they could have used other sources to answer their questions/accomplish their task(s). The follow-up interview is also used to clarify whether the user was able to do what he intended. It is also possible for the observer to ask questions that may help him in clarifying the intentions behind particular interaction activities.

The student's are asked to *talk-aloud* while interacting with the Web. It is an important distinction between talk-aloud and *think*-aloud, since the latter method demands that the user formulate thoughts that are not verbal, but e.g. visual. When a user is asked to talk aloud he is only to voice those thoughts that are already encoded in verbal form (Ericsson & Simon 1996). The problem with the think-aloud technique is that it prolongs the sessions since the user is required to encode and utter every thought verbally. Talk-aloud protocols on the other hand do not intercept mental processes that are not encoded verbally.

During the session an observer watches the sessions and makes sure the computer and recording equipment work satisfactory. The observer is not to engage in any conversation with the user, but he may ask the users to "keep talking" to keep the loud-talking process going.

Data analysis

The model developed by Belkin, Marchetti & Cool (1993) has been used to analyse a few tasks. This is a four-dimensional model focusing on both functional and cognitive aspects of information strategies. The dimensions were *method* (scan|search), *goal* (learn|select), *mode* (recognise|specify) and *resource* (information|meta-information). The analyses performed revealed problems related to the different dimensions. Some of these problems are directly related to the hypertext format and some could be of a more general nature. Below one task is analysed.

The example shows a task performed by users who are apparently quite uncertain about the topic they try to find more information about. They look for information on "Index translatonium", which appears to be a database on translation. The task starts with an intermezzo where the users try to find an entry for Alta Vista in the bookmark file (ISS 8), without success. They then inspect the page currently in the browser and finds and select the link directly to Alta Vista, this is also classified as ISS 8 since they look for the link in a list of links to various IR tools.

In Alta Vista the users enter the query "Index translatonium" (ISS 16), thereafter they examine and follows the first entry in the results list (ISS 8). Thereafter they read the page to learn more about what order to learn more about what "index translatonium" is (ISS 3). The users look through the page, they are obviously uncertain about how to proceed ("What's this? [pause] only information about?" [a CD-ROM database]), they end up choosing a random link ("but can't you just push on of those [buttons] and see what happens?"), this is an example of ISS 1. The next two pages are accessed similarly (ISS 1), then they find and follow an explicit link to "Index translatonium" (7), but this turns up to be a link to the page they originally found. They have now obviously learnt that it is a database, and they do a half-hearted attempt at finding a way to search it by following a link saying "New search" (ISS 7). This leads them to an irrelevant page and they continue trying to solve another task.

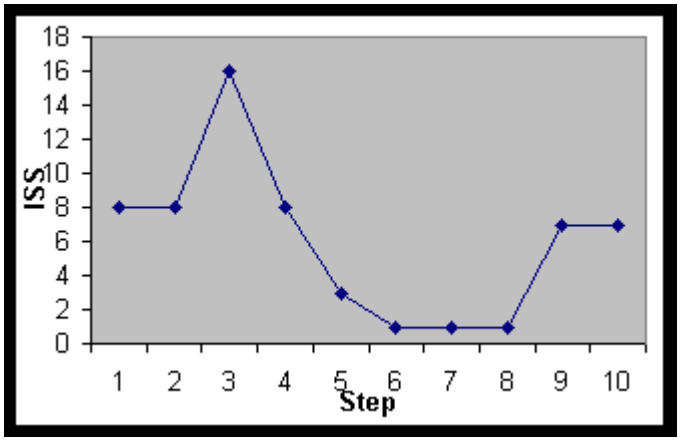

Figure 1 Graphical display example

For the purpose of analysing Web session it is felt that the mode dimension is the most difficult to value. It does characterise an important aspect of IR interaction – *uncertainty*, if the user knows what he wants to find, i.e. he can *specify* it, his uncertainty is low. Similarly he or she is probably more uncertain when he/she does not exactly know what to look for. It is perhaps easier to identify users' level of uncertainty than the recognise/specify mode they are in during searching.

The limitation of method to "scanning" and "searching" is problematic when it comes to dealing with following links. Following links can be seen as a parallel to picking a book from a shelf, thus it has been characterised as scanning. This, however, makes it impossible to distinguish the reading or overlooking of a page from the selection of a link to access a new page. These are clearly different kinds of interaction methods and it is probably wise to treat them differently.

This raises two further questions: Should we distinguish between the following of different kinds of links? And how should we treat predefined searches implemented as links? These questions illuminate some features that characterise Web authoring and thus affect the ways people are able to interact with the Web.

When analysing the sessions it became apparent that the distinction between the two resource-types wasn't as clear as it was thought to be. In a fully digitised environment like the Web every page or resource is in principal only a mouse-click away, while in the "real" world IR systems and documents are physically separated. Belkin et al. (1995 p. 381) exemplifies the use of ISS 5 by a user scanning the shelves in a library, i.e. the resource is classified as information. Web IR tools include direct links to the resources, the results lists could thus be compared to a shelf of books where each document can be picked out, looked at and returned. It should not be controversial to claim that when a user inputs a query in a search engine the resource he uses is to be classified as meta-information. How to treat the output of a search is, however, not unproblematic. Should it be focused on the entries' role as resource surrogates, or should the entries be treated like anchors to the "real thing", i.e. "similar" to the back of books on a shelf? Since the surrogates that are presented in the results lists are generated from a database and because this database will never be fully updated and thus in theory do not represent the current content of the page it seems natural to treat them as meta-information. Manually generated subject indices like, for instance, Yahoo! do not cause the same problem. As long as the subject indices contain intellectually created descriptions of the entries they should be treated like meta-information. The same is usually true for those privately generated "favourite" pages, which thus are defined as meta-information.

Possible interdependencies between dimensions are not treated here.

Work plan and current status

The project is scheduled to run over a period of four years, 75 % of the time is to be devoted to the project, i.e. 36 months. The following time schedule is approximate and some parts of the work will undoubtedly be overlapped:

Literature and methods studies	6 months
Development of methods, pre-surveys, method evaluation	4 months
Survey and interviews	8 months
Handling of results, writing down results	4 months
Analysis of results	3 months
Conclusion	3 months
Thesis production and other forms of documentation	8 months
Sum	**36 moths**

Throughout the period I will also need to follow courses and seminar to claim the necessary credit points from Tampere University.

At this point I have been able to claim 31 out of the 40 credit units necessary. To no surprise the different points on the work plan to a certain degree merge. I have performed literature studies in the fields of IR, information seeking, hypertext, and related areas. The collection methods are developed and I have collected approximately 14 hours of data. I also plan to collect some more data. I have started to transcribe the data and done a pre-analysis of a small amount of data to test a method of analysis.

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