

Revisitation Patterns and Disorientation

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Abstract

The non-linear structure of web sites may cause users to become disorientated. In this paper we describe the results of a pilot study to find measures of user revisitation patterns that help in predicting disorientation.

1 Introduction

One of the most common problems in the field of hypermedia is that users tend to become disoriented. A typical result of disorientation is degradation in performance. Therefore, it is no wonder that this problem has been addressed in several research projects, both from qualitative and quantitative perspectives.

In this paper we present the results of a pilot study to find links between revisitation patterns and disorientation. The concept of disorientation is explained in the next section, followed by an overview of methods to predict disorientation. The pilot study is described in section four. The paper ends with a discussion of the results and some conclusions.

2 Disorientation

Disorientation is the tendency to lose one's sense of location and direction in a web site. People who feel disoriented may become frustrated, may lose interest and may work less efficiently [Ahuja and Webster, 2001].

Readers need knowledge about the overall document structure and must keep track of their moves through that structure [Thüring *et al.*, 1995]. The non-linear structure of web sites may cause disorientation, if no orientation clues are given. Following the common travel metaphor for web sites, these orientation clues should help a user in [Thüring *et al.*, 1995]:

- identifying their position in the web site
- reconstructing the way that led to this position
- distinguishing among different options for moving on from this position

Disorientation is closely related to *cognitive overhead*, the additional effort and concentration necessary to maintain several tasks or trails at one time [Park and Kim, 2000]. Both disorientation and cognitive overhead may lead users to feel 'lost in hyperspace'. Typical examples of the resulting degradation in performance are losing track of ones tasks, not returning from a side track and forgetting which sections have already been visited [Otter and Johnson, 2000]. Even the most experienced internet users often have difficulty in finding

the information of products they want [Ahuja and Webster, 2001].

3 Prediction of Disorientation

Although disorientation is a common problem in hypermedia, it is hard to measure. This is mainly due to the fact that users who are *exploring* a web site can be rated as disoriented, even though they may be experiencing no disorientation at all. As user navigation behavior may vary from goal-directed to explorative, it is hard to tell from their actions whether or not they feel disoriented [Herder, 2003a].

When assessing disorientation, researchers generally examine logs of users' actions when browsing [Ahuja and Webster, 2001]. In this paragraph we explain what different sorts of metrics can be calculated from these logs. Specific attention is given to previous attempts at predicting disorientation from revisitation patterns.

3.1 Measures of Disorientation

Hypermedia documents can be seen as a collection of interconnected pages. This node-and-link structure is commonly modeled as a *directed graph*. User navigation can be seen as an overlay of this graph, consisting of only the pages visited and the links followed [Herder, 2002].

In the site graph, different types of pages can be recognized by the linkage to and from the page, for example navigational hubs and pages that mainly provide content [Herder and Van Dijk, 2003]. Interesting features of a web site's structure include its size, the distances between pages, the way the pages are clustered and the linear order of reading that it imposes on the user [Herder, 2003a].

Similar measures can be calculated from the user navigation paths. It is expected that user navigation strategies as well as problems encountered while navigating will be reflected in these quantitative measures. Therefore, it is important to distinct between the general navigation patterns and deviations from these patterns, which might indicate usability problems such as disorientation [Herder, 2003a]. Comparison with the site structure can improve these predictions: did a user return to a navigational landmark or to a content page?

According to Ahuja and Webster [2001], it is easier, more accurate and quicker to directly measure users' perceived disorientation than to infer disorientation from their actions. Based on both literature and empirical results, they constructed a survey that users can complete in a short period [Ahuja and Webster, 2001].

This survey is extremely convenient in controlled experiments; however, it can obviously not be used to measure disorientation in real-world situations.

3.2 Revisits and Disorientation

Although disorientation and the problem of ‘lostness in hyperspace’ are considered as an important issue, very few attempts have been made to quantify these issues [Otter and Johnson, 2000]. Moreover, these few attempts have led to contradictory results.

Pauline Smith [1996] takes as a starting point for her lostness measure the assertion that lostness should be viewed in terms of degradation of user performance. She proposes a *lostness rating*, based on the relative amount of revisits while searching, and on the number of navigation actions compared to the minimum number required. In other words, any form of revisitation is used as a piece of evidence for lostness.

John McEneaney [2001], on the other hand, concludes that users that employ shallow, hierarchical search strategies are more successful in their search than those that followed more linear paths. In other words, revisits to navigational landmarks can be seen as a sign that users have formed an accurate model of a web site.

Both studies report that their lostness measures are validated by user studies, in both cases making use of a system that provides teenagers with study advices. Although the results provide evidence that metrics of user navigation can be used to predict disorientation, it appears that a single measure is insufficient for this purpose and that it might make sense to use a ‘battery of measures’ [Otter and Johnson, 2000] that have been shown to measure disorientation to some degree.

4 Pilot Study

As described in the previous section, many quantitative measures of web navigation can be thought of. However, it is not clear how they relate to usability matters – such as disorientation. We conducted a pilot study to learn more about these relations. Subjects were asked to carry out specific tasks on the web. Our purpose was to compare their logged navigation behaviors with performance measures, employing data gathered from questionnaires and audio recording.

A second goal of the pilot study was to find relations between usability problems and differences between subjects – such as cognitive abilities, moods and motivations. We will deal with these factors in this paper only when relevant in this context.

4.1 Experimental Setup

We randomly recruited thirty graduate and undergraduate students from two Dutch universities, mixed male and female, ranging in age from 19 to 27. All followed a study that is closely related to computer science. The subjects were paid for their contributions.

Each individual session lasted 2½ hours. In the first 1½-hour we collected data on the subject’s

- cognitive style, emotion and trust
- domain expertise and internet use
- spatial abilities, episodic memory and working memory
- demographics

The actual navigation tasks took forty minutes. The subjects were asked to answer questions by browsing through different web sites on a laptop computer. Two of these web sites provided information and tools in the field of personal finance; the third web site was an online store. Some questions were meant to invite open-ended browsing, other questions were more goal-directed – see figure 1.

What are the definitions of personal budget and financial goal as they are presented within this web site.

Calculate how much the real value of £ 7.826 will decrease in five years given an annual inflation of 3%

Suppose you are given \$ 75 to buy something for yourself. Find some products that you like in the section ‘books, music and dvd’.

Figure 1 – Some web navigation tasks used in the pilot study

After the navigation session, the subjects were asked to evaluate their performance, their satisfaction and the usability of the different web sites used.

4.2 Measures

In the analysis phase many different measures have been calculated. For the purpose of this paper, we focus on those navigation metrics that are related to disorientation.

Perceived Disorientation

The evaluation forms contained questions on perceived disorientation from the Ahuja and Webster survey [2001]. Subjects were asked to indicate whether they agreed or disagreed with the statements on a Likert scale of 1 to 7. Some example statements are:

- it was difficult to find my position after navigating for a while
- quite often I unexpectedly returned to a page I have visited before
- the overall structure of the site is clear and easy to work with (reverse-coded)

Our measure of disorientation was the sum of user ratings of these statements.

Revisits

We adopted the recurrence measure of Catledge and Pitkow [1997], who calculated the probability that any URL visited is a repeat of a previous visit, using the following formula:

$$Revisits = \left(1 - \frac{DifferentURLsVisited}{TotalURLsVisited} \right) \times 100\%$$

According to Smith [1997], a higher amount of revisitation indicates that a user is more likely to be lost.

Back Button

This metric indicates the percentage of back button clicks among the navigation actions. We expect that the back button is one of the most common means of revisitation.

Return Rate

This metric indicates the average number of times that a page will be revisited. A higher return rate indicates

that a user makes more intensive use of a selected number of pages, expectedly navigational landmarks such as index pages.

The return rate is calculated by averaging the number of visits on all pages that have been visited at least twice.

Average connected distance

The average connected distance (ACD) is a notion from graph theory. It indicates the average length of a path between any two connected pages x and y .

When applied to the navigation graph, or *path matrix* [McEneaney, 2001], it is not directly clear what the ACD should indicate. Visual analysis of the navigation graphs revealed the following: as revisits are common in user navigation, there is a directed path between most nodes. A higher ACD indicates that users do not return to a page very soon, but only after having browsed for a while. They also return using a link rather than using the back button.

In short, the average connected distance indicates users' tendency that 'they will find their way back later'.

Median View Time

Although the average time that users look at a page is not related to revisitation behavior, it is reported to be an important indicator for user interest and human factors [Shahabi *et al.*, 1997]. People who are disoriented might speed up their browsing – comparable to anxiously running from one point to another – or they might just slow down. We expect there will be an 'optimal' average view time, which indicates that users feel at ease while browsing.

The median view time proved to correlate better with perceived disorientation than the average view time did. This is due to the fact that users spend only little time on the large majority of pages – they take a quick glance at a page and click a link that might bring them closer to their goals. Therefore, the average view time is overly influenced by the minority of 'high content' pages that they read carefully; the median view time indicates the average view time while browsing, not while reading.

4.3 Results

As expected, a large amount of user navigation actions were revisits. The revisit percentage of 38% that we recorded is lower than the 58% as reported by Tauscher and Greenberg [1997]. However, this can be explained by the fact that users continue to add pages into their 'revisitation repertoire'. One forty-minute session is simply too short to generate such a broad repertoire. We found a significant difference between revisitation percentages while performing tasks on the personal finance web sites (40,7%) and while browsing for interesting items in the online store (25,2%).

Although revisitation patterns were similar between the personal finance sites, the usage of the back button was not (3,3% and 15,9% respectively, and 7,75% for the online store). Despite the large difference in back button usage between the personal finance sites, the general tendencies were similar ($r=0,386$; $p<0,035$). These differences are most likely due to differences in site structure or site design, as the personal finance site that invited the lowest back button usage is small com-

pared to the other site and its menus are clearer defined.

The return rate (the number of times that a page will be revisited) was about the same for all pages (3,1), as well as the average connected distance (3,6). Apparently these aspects of revisitation behavior are not influenced by the site designs; users recognize and find their way to navigational landmarks anyway – with more or with less ease.

Most subjects did not complete all tasks successfully. In general, they found correct answers for only two to four out of six questions. Therefore, it is not surprising that the subjects felt slightly disoriented. However, this did only influence their satisfaction about their performance to a certain extent ($r=-0,310$; $p<0,096$). Neither did disorientation automatically lead to frustration.

The return rate proved to be a good indicator of disorientation ($r=-0,417$; $p<0,022$). This provides evidence for McEneaney's [2001] observation that users that are better able to make use of the site structure – and of navigational landmarks – are more successful in navigation. The percentage of revisits did *not* correlate with perceived disorientation. Apparently, revisitation is a natural navigation behavior that does not necessarily indicate that a user is disoriented.

The median view time is correlated with perceived disorientation, although not very strongly ($r=0,365$; $p<0,047$ – see figure 2). Apparently, users who feel disoriented spend more time on pages while browsing. The average connected distance of those people with a higher median view time becomes lower ($r=-0,412$; $p<0,022$) – which indicates shallower backtracking.

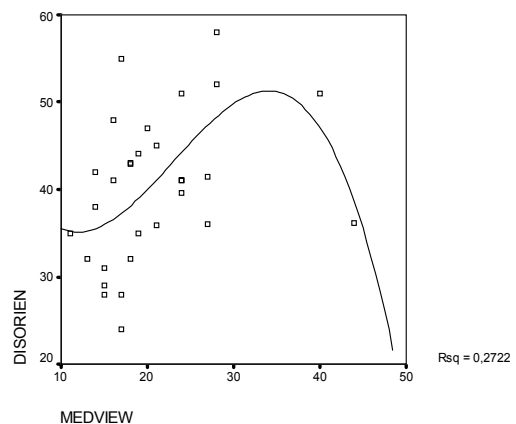


Figure 2 – Correlation between disorientation and median view time (in seconds), scatter plot and cubic regression

The average connected distance is correlated with some cognitive factors as well. Subjects with a higher working memory score tended to extend their revisitations ($r=0,375$; $p<0,041$), as well as subjects that indicated to be in an active mood ($r=0,413$; $p<0,023$). Based on this combined evidence, we think that the average connected distance, combined with other metrics such as the median view time, will prove to be a good predictor of disorientation.

5 Discussion

The results of the pilot study show that there is more to user revisitation behavior than just the amount of revis-

ited pages. Therefore, it is not surprising that we have found contradictory results in the literature. It appears that we do need a ‘battery of measures’ [Otter and Johnson, 2000] to capture all that it means to be lost.

Besides the revisitation metrics as reported in this paper, we have calculated numerous other metrics, such as the navigational stratum and the navigational compactness [McEneaney, 2001]. Unfortunately, most of them did not help in predicting usability issues such as disorientation.

The largest obstacle for inferring disorientation from navigation actions is that users may employ different navigation strategies. The distinction between exploration and disorientation appears to be a very subtle one. The metrics as reported in this paper promise to make the recognition of disorientation – or ‘lostness in hyperspace’ – more accurate. However, we are still far away from a perfect ‘measure of lostness’.

However, this does not mean we should stop looking at metrics for disorientation, as the problem will remain. Even with slightly imperfect mechanisms it is still possible to offer accurate added navigation support. When an adaptive system is uncertain about its user model, it can decide to employ unobtrusive means [Herder, 2003b], or even to *ask* users whether they would appreciate some support.

Adaptive contextual navigation support is reported to prevent disorientation or cognitive overload. One can improve a user’s *spatial context* using – amongst others – local or global site maps, contextual menus and direct guiding. The *temporal context* is commonly supported by a visualization of a user’s navigation history [Herder, 2003a].

6 Conclusions

In this paper we presented a pilot study that was aimed at discovering relations between users’ perceived disorientation in hypermedia documents and their revisitation behavior. Although it is possible to ask users directly whether they feel disoriented in laboratory studies, this strategy does not work for adaptive systems – as users need to interrupt their tasks to answer. Therefore, it is desirable to have an accurate prediction mechanism.

Although we did not succeed in obtaining a 100% accurate measure of disorientation, we have found evidence that combined metrics on revisitation and median view times do a good job. However, it may be inevitable having to deal with a certain amount of uncertainty – for example by providing unobtrusive contextual navigation aids when uncertain.

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