WebScout: Support for Revisitation of Web Pages Within a Navigation Session

Natasa Milic-Frayling & Ralph Sommerer
Microsoft Research Ltd
{natasamf, som}@microsoft.com

Kerry Rodden
Instrata Ltd
kerry@instrata.co.uk

Abstract

WebScout is a system that creates a personal archive of Web pages seen by the user and a rich record of the user's navigation, including various types of user and system generated annotations. In this paper we explore how this rich archive can be used to provide support for user navigation, in particular, for revisitation of pages within a navigation session. We describe the WebScout SessionNavigator feature that enhances the current browser functionality by providing both sequential and graph representation of the user navigation. It introduces the concept of a WebTrail which designates a sequence of navigation steps, started by a particular event, such as search, or explicit specification of a URL by typing into the address bar, or executing a link from a bookmark list. We present details of a user study that explores how users perceive and remember their navigation on the Web.

1. Introduction

The most fundamental activity when browsing the Web is the navigation through pages along the embedded hyperlinks. The Web content forms a complex graph of links and pages. Paths through the Web that users follow are subsets of that graph and therefore inherit the same complexity. To retrace their steps through the Web, or to inspect their browsing "history", users of current browsers have to rely on linear representations of their navigation structure that the browser provides. For example, the *back* and *forward* buttons allow users to navigate only along the Ariadne's thread of the most recent path. Similarly, the browser's history feature usually provides only a linear list of pages, e.g. in temporal order. None of these representations record the type of navigation that occurred, or take into account the context in which the pages have been seen. For instance, there is no distinction between a navigation that has occurred within a search session from, say, a navigation that was initiated by an explicit URL request, either by typing a URL into the address bar or by accessing the URL from a bookmark list.

Another important aspect of the Web is the transient nature of its content. While in the early days of the Web, a hyperlink served as an address of usually a static page, it has more and more turned into a parameter for a process that computes page content on-the-fly. For example, Web site administrators and authors are increasingly adopting facilities for dynamic content management to be able to incorporate dynamic content easily.

In the context of a single navigation session the issue of content persistence is not generally apparent unless it involves highly dynamic pages, such as news site content, weather information, and financial reports, which may change several times during the day. Current browsers' cache mechanisms, designed to optimize page loading time, provide a limited content persistence through the temporary storage of pages. Thus, when using the Back button, one is likely to access the same content as seen earlier in the session, unless the page is marked as non-cacheable and has changed in the meantime. However, the user generally does not have direct control of what is stored in the cache. In particular, if a dynamic page is revisited multiple times it is still only the recent copy of the content that is directly accessible from the cache. To guarantee that the page will be accessible for later use the user has to save it explicitly.

Most browsers provide access to the history of the user's navigation, with or without search capability. Typically, the history includes the complete set of hyperlinks visited by the user for a limited number of days. These may be organized into folders by day or by site, and sorted according to attributes such as title, URL, date of first visit, date of last visit, or visit count. However, current implementations do not address the issue of content persistence on the Web, since they only store links, and these point to the 'live' content on the Web.

In order to provide a consistent experience during browsing we have implemented WebScout [8], a system that creates a rich record of the content and navigation as experienced by the user at the time of interaction with the Web. The content of the WebScout archive is exposed through two client applications, SessionNavigator and HistoryExplorer.

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In the following sections we present a detailed description of WebScout and the browser enhancements, SessionNavigator and HistoryExplorer. We provide an overview of related work and discuss a user study of Web navigation, focusing on how people remember a Web session. We conclude with an outline of our future work.

2. WebScout System Description

WebScout is designed to address two issues related to user navigation on the Web:

- Easy access to pages that the user has seen during a navigation session (recent history)
- Reliable and versatile access to pages that the user has seen in the more distant past.

For that purpose WebScout contains a rich archive of personal navigation that includes navigation events, full content of pages, and various annotations. The latter may include the user specified bookmarks, or annotations that result from a task, such as search, where queries or user's relevance assessment are used to annotate search result pages. The archive also includes visual representations of pages in the form of thumbnail images. These are further used in applications, in conjunction with content elements such as titles and URLs.

While an obvious benefit of an archive of all Web content seen by the user is the ability to re-examine information at later dates, the archive can also enable a more reliable user profiling than the navigation patterns (see [3], [6]) or search topics alone (see [7]).

In the current implementation, the pages are archived independently from the standard browser cache. The archived information is utilized by two WebScout features that extend the capabilities of Microsoft Internet Explorer (IE): SessionNavigator and HistoryExplorer.

2.1. SessionNavigator

One dominant feature of Web browsing is the user's 'linear' experience of navigation, as determined by the sequence of access to Web pages. However, in order to be effective, the user has to keep a mental note of both the hierarchical structure and the access sequence of the Web pages. This mental overload is to a large extent due to current navigation features provided in commercial browsers. In our attempt to address this issue we capture the user navigation events and use thumbnails as visual representation of pages. However, we also explore two additional ideas.

First, we partition the user's navigation into logical units, referred to as *WebTrails*. Our hypothesis is that a navigation session can be divided into sequences of page visits that form groupings which are meaningful to users. In the current implementation, a WebTrail is a sequence of pages that begins with the user's request for a page by specifying its URL. This can be done explicitly by typing a URL or implicitly by activating a link from a bookmark list. Alternatively, the trail begins with an activity such as search. Each WebTrail is marked by the title of the initiating URL or the search query.

Second, we provide a linear view of the navigation by 'flattening' the navigation graph into a sequence of 'branches' (Figure 2). We repeat a branching point whenever showing the new branch, thus enforcing the user's linear experience of the navigation and providing easy access to pages that serve as 'hubs'. This basic view is facilitated by the *SessionNavigator* toolbar that shows a sequence of thumbnails in the order of page access, with a clear demarcation of WebTrails. As the user navigates, the thumbnail images are appended to the current WebTrail. The user can also choose to view a graphical representation of individual WebTrails (Figure 2). The SessionNavigator toolbar fulfills a dual role: first, it provides the overview and support for navigation and second, it enables direct access to pages that are stored in the archive.

2.2. HistoryExplorer

In the HistoryExplorer, we implemented a search facility that enables the user to filter page visits by date and URL, pose text queries over the content of the Web pages and stored search queries, and specify a predominant color on the page. The results of the search are given in the form of folders which, for a particular URL, show all the visits to the URL that match the query. For each page visit, the user can view and replay the corresponding WebTrails. Alternative views include graphical organisation of sites, i.e., sitemaps, as experienced by the user over various navigation sessions.

3. Related work

A number of other researchers have built browser extensions with similarities to SessionNavigator. Using thumbnails of pages to assist users in recognising them has been explored in Data Mountain [9], for access to bookmarked pages.

Kaasten and his colleagues [5] created their own history panel for Internet Explorer; it displays a list of visited page titles with a thumbnail for each page. They conducted a page recognition experiment and concluded that thumbnails were marginally more effective than titles or URLs as a memory aid.

Furthermore, various graphical overviews for the browsing history have been proposed, including MosaicG [1] and PadPrints [4]. They both use a tree structure to show the path that the user has taken through the Web,

representing each page with a thumbnail. PadPrints is the only one of these systems that has been subjected to a user study; this showed that people were able to return to pages visited in the current session more quickly using PadPrints than using a conventional browser alone.

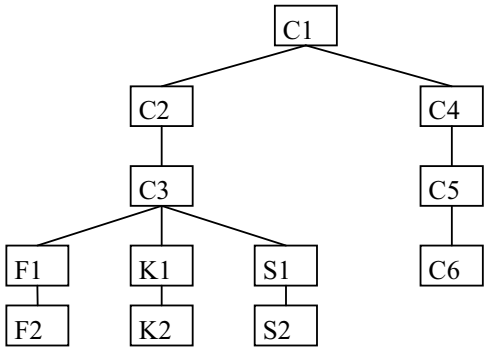

Figure 1: The structure of the set of web pages used in the study.

None of the previous work has considered the decomposition of the navigation session into logical sections such as WebTrails. Furthermore, none of them have made a clear distinction between the URL as a resource or a broadcast medium versus the content of the URL at the particular point in time, i.e., the page observed by the user during a particular visit to the URL.

4. User study of SessionNavigator

In the user study, we were interested in investigating whether SessionNavigator's graphical representations of prior navigation would be helpful to users, and whether they could yield an acceptable trade-off between effectiveness in supporting web page revisitation, and screen space occupied. We also wanted to gain more insight into people's understanding of current browser facilities, and how they remember a particular Web session.

Our four participants (2 male and 2 female) all had about 6-7 years of Web browsing experience, but were not computer scientists. The study had four parts, and was based on a set of 12 web pages (details in Figure 1 and Table 1). These were cached on a laptop, so that no network connection was necessary. We recorded the participants on video, and transcribed the tapes for analysis.

The four parts of the procedure were as follows:

1. Perform task navigating a set of web pages
2. Explain operation of standard browser controls
3. Propose a useful layout of the history just seen in the experimental task
4. View the same history as presented in the SessionNavigator prototype and interpret the alternative views.

Table 1: Details of the set of web pages used in the study.

Code	Seq	Site	Page
C1	1	Cambridge University	Home page
C2	2	Cambridge University	The local area
C3	3	Cambridge University	Tourist information
C4	9	Cambridge University	Departments
C5	10	Cambridge University	Brief history
C6	11	Cambridge University	Through the centuries
F1	4	Fitzbillies Bakery	Home page
F2	8	Fitzbillies Bakery	About us
K1	5	King's College Chapel	Home page
K2	12	King's College Chapel	Tourist admission
S1	6	Scudamore's Punting	Home page
S2	7	Scudamore's Punting	What is punting?

Part 1: Navigation

As part of a given scenario about trying to find local information, the participants were asked to do six tasks, involving browsing through the 12 pages, 'thinking aloud' as they did so. The tasks were of different types, as defined by Cockburn and his colleagues [2].

1. Hub and spoke navigation: from C1 to C2 to C3, then to each of F1, K1, and S1 in turn.
2. Spoke revisitation: from S1 to S2, then to F1 and then F2.
3. Parent revisitation: from F2 to C1.
4. Depth first search and back: from C1 to C4, C5, and C6, then C1 again.
5. Depth first forward revisitation: from C1 to C6 again.
6. Distant revisitation: From C6 to K1, and then K2.

The "Seq" column in Table 1 shows the order in which the 12 pages were actually visited.

Only tasks 2 and 6 gave the participants any problems. In task 2, when at page S2, each participant was asked to revisit the first of the spokes (F1), a page which could not be directly accessed by clicking on the Back button – it was removed from the stack as soon as they visited the second spoke (K1). Despite their experience, three out of the four participants were confused by this, pressing the Back button repeatedly and expressing surprise when the target page did not appear.

In task 6, the same three participants had some trouble remembering how they had got to page K1 in the first place. One went to the address bar and started typing, using AutoComplete to return to the page. Another said that given the choice, she would probably use Google at this point, but instead used the Back menu to return to C1,

then was able to follow links to return to K1. The third participant could not remember how to proceed from C1, tried various routes, and eventually had to be given some assistance.

Part 2: Standard browser controls
The participants were asked to explain how a number of existing browser features worked, and to say how often they would normally use them. Our findings were largely consistent with previous studies of Web browser usage, so due to lack of space we have chosen not to discuss them in this paper.

Part 3: Paper arrangements
The participants were given small printed thumbnails of the Web pages they had just visited, and were asked to arrange these in a way that they felt would assist them in returning to the pages, if displayed on the screen.

Surprisingly, all four participants' paper arrangements of the session were done according to site structure, and not the sequence in which the pages were visited, although this was sometimes used as a secondary means of ordering. Photographs of two of the arrangements are shown in Figures 3 and 4; the overlaid numbers indicate the order in which the participants originally saw each of the pages, and correspond to the sequence numbers in Table 1.

They were then asked to alter their arrangement so that it would fit into one dimension, either a row or a column, because of the lack of available screen space (SessionNavigator has both a graph view and a linear view). They all had difficulty with this task, and usually just wanted to keep key pages, not the whole sequence, and suggested that they could then click on these pages and re-navigate from there, or see an expanded view with the other pages from that site (see Figures 5 and 6).

Part 4: SessionNavigator
In the last part of the procedure, the participants were asked to watch while the experimenter repeated the browsing task, this time with SessionNavigator enabled, and then interpret what it was showing. At first only the linear view was displayed; at the end, the participants were also introduced to the graph view (Figure 2).

The participants understood SessionNavigator's linear representation of the session, and thought that it was interesting, but didn't think they would want to sacrifice the screen space to have it visible at all times. A preferred option was to launch it when doing an activity that involves a lot of jumping back and forth through the history.

They were a lot more enthusiastic about the graph view than the linear view, recognising it as being similar to their own arrangements of the pages.

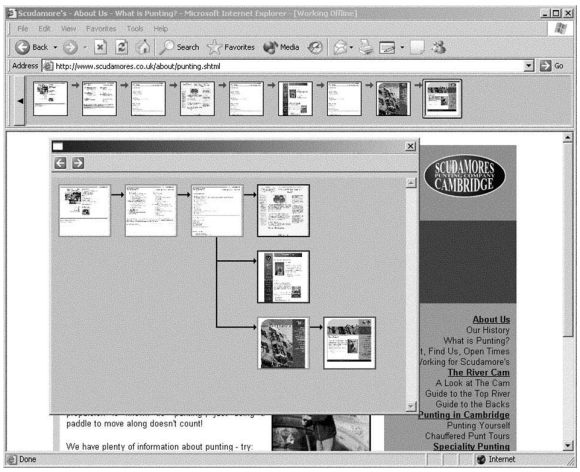

Figure 2: SessionNavigator with task 2 in progress, showing both the linear and graph versions of the session so far.

They also seemed to feel that the context it offered them (in terms of the structure of the set of pages shown) was more valuable than the simple chronological ordering of the linear view.

5. Future work

Our objective in the refinement of SessionNavigator design is to explore alternative interface solutions, ranging from simple enhancements of the Back button navigation to alternative user interfaces. Furthermore, we plan to extend the user study to a longer term observation of Web usage, and identify characteristics of the users' longer term recollection of Web content and navigation. We expect that this will also reveal how critical the current lack of persistence of Web content is, and what type of personal archive would address the associated issues.

6. Acknowledgment

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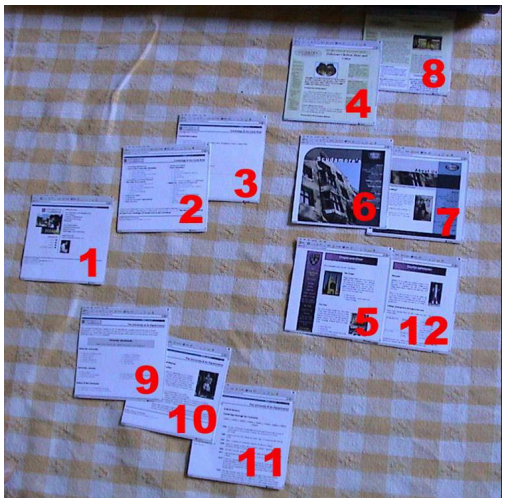

Figure 3: Participant A (original layout)

Figure 4: Participant B (original layout)

Figure 5: Participant A (linear layout)

Figure 6: Participant B (linear layout)