The Effects of the Browser History Mechanisms on the Web Navigation

Tamer Nadeem
Department of Computer Science
University of Maryland
College Park, MD 20742
nadeem@cs.umd.edu

Bill Killam
User-centered Design, Inc.
20548 Deerwatch Place
Ashburn, VA 20147
bkillam@user-centereddesign.com

Abstract: Finding a previously visited page during web navigation is a very common and important process. Although most commercial browsers incorporate a history mechanism, when accessing pages that were recently visited users still rely mainly on the "Back" button. In this we studied the effectiveness of visually enhanced history browser mechanisms on web navigation.

We used three different history mechanisms as the experiment treatments. Twenty-one college students were the subjects of the experimental trials. With a between subject design, three experimental groups were equally divided according to subject profiles. Users read and completed the given scenario. A quiz was given to measure user performance on the tested mechanism. At the end of the quiz, a subjective questionnaire was given to measure user satisfaction.

The results showed that there is a significant statistical difference among the three mechanisms. The more visually enhanced history mechanism proved to be more effective in web browsing.

Keywords: World Wide Web, user interfaces, human-computer interaction, search, navigation, browsers, history mechanisms, cognitive, short-term memory, trees, null hypothesis, subjects and variables, ANOVA, subjective satisfaction.

Introduction

Experiment Motivation

Present browsers lack an efficient method for revisiting web pages. When navigating the World Wide Web (WWW), browser users experience difficulty in finding web pages that they have previously viewed. In fact, in a previous study it was found that 13% of subjects were unable to find web pages that they had recently visited [6]. Additionally, users largely depended on the "Back" button to access visited sites. In the results of the same study, "0.1% of page accesses were through the history list, 42% of page accesses used the Back-Button" for all web pages navigated by subjects.

Personal experience with history mechanisms of popular web browsers, such as Netscape and Internet Explorer has exposed many usability problems. Because of these problems, Netscape's history window usually is avoided completely, unless the user has given up on the back button or the "Go" menu selection. Also, a user may not even know that the history window is available, because it is not integrated into the user's browser display. Although Internet Explorer has a more organized history mechanism, it does not provide an efficient organization of the order in which the user has visited web pages. Accessing pages that were recently visited still relies on the "Back" button, and the back button does not contain all of the history.

As Kandogan and Shneiderman stated in one web browser study, "…current interfaces for browsing on the WWW are still primitive, in that they do not support many of the navigation needs of users…They do not…aid users in accessing already visited pages without much cognitive demands"[9]. One factor that may aid in browser history mechanism performance is providing a mechanism that is more graphically inclined to enhance user's short-term memory of the web pages visited [7].

The goal of this experiment was to determine if significant performance differences exist among several browser history mechanisms, including ones that are more visual. This experiment allowed us to gain insights about web browser history styles that would improve user performance in accessing visited pages. In this experiment, we also desired user's comments to gain knowledge of personal preferences and satisfaction levels associated with each browser history style.

Overview of the History Mechanisms Studied:

Following are brief descriptions of the studied history mechanisms. Only three mechanisms were selected for use in this study. They were chosen based on availability.

Netscape Browser

Netscape is one of the most common commercial browsers. It has a history window, separate from its browser window that appears when the user requests it. This history is textually organized into a list that includes titles (if any) of the web pages visited and the URL addresses of those pages. To access a web page, the user must locate the desired page by name or address, and select it. Netscape's mechanism also incorporates "Forward" and "Back" buttons used to move to the next page or the previous page in the history, respectively. In addition, a "Go" menu selection provides the user access to pages through a drop-down list with titles of the most recently visited sites.

GlobalTree Browser

The Global Tree Browser was developed at Sun. Its history mechanism is visually organized into a single tree. All web pages visited by the user are represented by thumbnail images of those pages and organized as tree nodes with a global root. Each page is represented only once on the tree, by the first link that was used to access the page. Branches of the tree represent links (paths) that the user has used. Each node can have multiple children, but cannot have more than one parent. Therefore, cycles cannot be formed on the tree; and if the user navigates links in cycles, the last link that causes the cycling is simply ignored and not displayed. The user then can access a visited web page by mouse-clicking the corresponding node on the tree. Additionally, the corresponding node is outlined for the current page that user is viewing. Figure 1 shows the GlobalTree browser window.

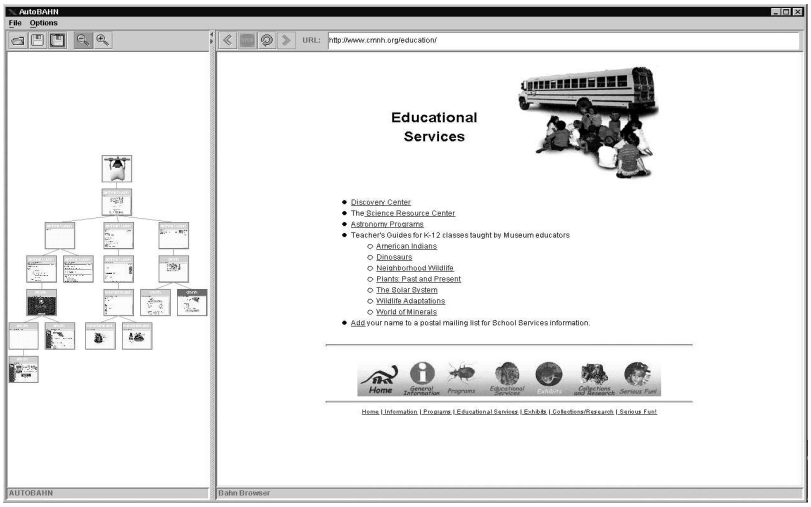

Figure 1: GlobalTree Browser Window (history tree is shown in the left panel)

DomainTree

DomainTree browser was developed at the University of Maryland, College Park (UMCP) [7]. Its history mechanism is similar to GlobalTree's mechanism; however, DomainTree's history is visually organized into domain trees. It has an extra panel to the left of the browser that contains the domains that the user has visited. Each domain can be selected, by the mouse, to view a specific tree consisting of only the web pages visited in that domain. Each tree's functionality is similar to that of GlobalTree's mechanism. The DomainTree browser window is shown in Figure 2.

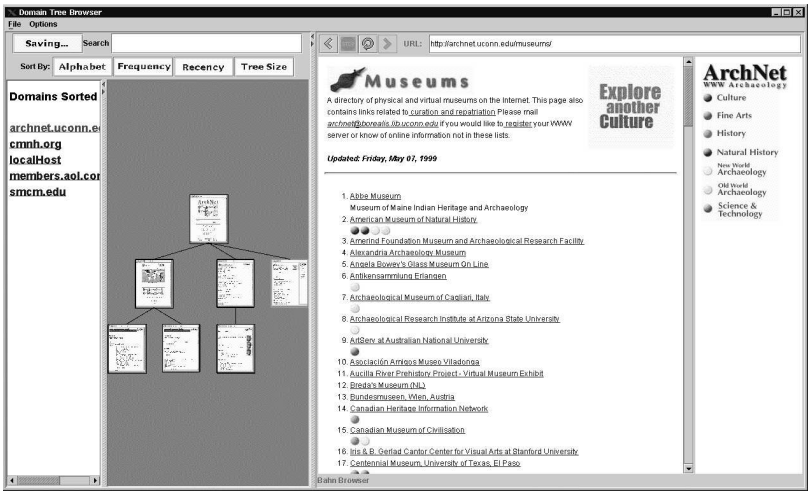

Figure 2: DomainTree Browser Window (from left to right: domains list, current domain tree and the current web page)

Review of related experiments:

There have been many responses to the usability problems of current history mechanisms. Most approached solutions involve graphical interfaces.

One study done by Bederson and his colleagues included a zooming web browser, called Pad++. Pad++ has a multi-scaling graphical environment, so instead of having a single page visible at a time, multiple pages and the links between them are depicted on a large zoomable information surface [9]. The results of this experiment showed that users answered questions 23% faster with Pad++ over Netscape [3].

Another involved Padprints, a browser companion that dynamically builds a graphical history-map of visited web pages [4] as in GlobalTree Browser. It was found that Padprints allowed users to complete tasks 61.2% quicker than those who used the browser without PadPrints and to reduce the number of pages accessed.

Other approaches included WebTOC, which was an attempt to visually depict the contents of a web site with a hierarchical table of contents through Java applets, and MosaicG, which provided a two-dimensional graphical view of the history [10, 1].

Relevant psychological or other theories

Graphical over textual representations of web page history emphasizes recognition over recall for revisiting web pages. GlobalTree and DomainTree provide images of the web pages visited and visual information about the page's contents. By using a tree to represent the history, GlobalTree and DomainTree visually show relationships between one visited web page and other web pages stored in the history. Meanwhile, Netscape's mechanism relies on the user to recognize the content of a web page either by identifying the web page's title or by recalling the location of the page when using the "Back" button. Additionally, when utilizing Netscape's history window, window motion frequency becomes a factor and then short-term memory of the user becomes involved; whereas GlobalTree's and DomainTree's mechanisms are integrated into a panel are constantly visible.

DomainTree also provides a level of hierarchy by separating the action of accessing a page into two smaller action steps: first, knowing in which domain the page is located and second, choosing the page within that tree. This permits the history to be more manageable if the tree happens to be very large. GlobalTree's and Netscape's history mechanism, on other hand, would overload the user with information if the history was relatively large.

Experiment

Hypothesis and Variables

Hypothesis

The null hypothesis of the experiment was: There is no significant difference in user performance and satisfaction among the different browser history mechanisms. According to the results of the experiment, we would either accept or reject this null hypothesis. The dependent variables would be recorded, and then statistically analyzed to determine the significance.

Independent variable

There was one independent variable in this experiment, the web browser history mechanism. We had three distinct treatments Netscape Browser, GlobalTree Browser, and DomainTree Browser.

Each variable treatment was discussed in the introduction of this paper. We chose Netscape Browser because it readily was available in most of our laboratory's computer systems. GlobalTree and DomainTree were chosen for their visually enhanced history mechanisms. The difference between GlobalTree and DomainTree allowed the testing of the same type of mechanism each with different display features. For example, the DomainTree Browser allows users to have several history trees maintained through different domain names, whereas GlobalTree incorporates only a single history tree.

Dependent variables

The experiment measured user's performance and satisfaction relevant to of the web browser history mechanism. Therefore, tools had to be developed to capture these inherently qualitative attributes.

The first dependent variable was the time elapsed during completion of each task. (The nature of the task will be explained later in the paper.) The second variable was the number of pages visited for each task. The last variable measured was subjective satisfaction.

These three variables captured user performance and satisfaction associated with the history mechanisms. Analysis of these dependent variables is discussed in the result portion of this paper.

Pilot Study

The pilot study was conducted with three UMCP students. Each student used a separate and distinct web browser history mechanism.

The pilot study was used to determine user feedback and also, to answer some key questions in the experimental design. For example, we wanted to know how long the user would take to complete the experiment. Also, we wanted to make sure if the directions and written instructions would be clear to follow and understand. The last question we wanted to know was if the experiment would progress smoothly.

After the pilot study, subjects were asked to evaluate the experiment. Their overall impression was that the instructions needed to be made clearer. In response, we simplified the directions and made them more direct. Also, we complemented the written instructions with oral explanations. To ensure undesired delays, we offered to answer any questions users might have prior to the start of the task scenarios.

Preliminaries

Environment and System

All trials were conducted on five systems in the same on-campus computer lab. The five systems that were used were standard Sun System Ultra workstations. They had the identical screen size, mouse, chair, and keyboard. The trials were performed at approximately the same time of day. To accommodate the problem of network delays, a proxy server was developed to cache all the pages during the scenario part of the experiment.

Informed Consent

Informed consents forms were given to each subject. Subjects were required to sign and accept the terms of the experiments before continuing. The form requested subject's permission to use the results for research purposes, and it informed them that the data would be anonymous. It was made clear that participation was voluntary, and that the subject may leave at any time during the experiment.

Background survey

A background survey was given to subjects to identify their individual profiles and to help determine experimental groupings. The survey asked the subject's age, experience with web browsers, time using browsers, and computer background.

Training

Each subject was given a written and oral explanation of the specific history mechanism that he or she was to test and time to become familiar with that mechanism. The written explanation of the history mechanism was designed to quickly orient the user to certain aspects of the history tool. During the training, each subject could go to any site, explore the site, and use the history mechanism until they felt comfortable with its usage. Training took approximately 10 – 15 minutes.

Subjects

Profile

All subjects were UMCP students with:

- > 2 years of web browsing experience
- > 4 years of computer experience
- > 2 hours per week spent on web browsing

Subject Design

A between subject design was used in the experiment. A within subject design would be impractical to use, because more subjects would be needed. Also, three comparable scenarios would have to be made for each treatment. As a result, the experiment would take three times as long as the current experiment.

The experiment had 21 subjects divided into 3 treatment groups. Age and education level were considered when constructing the treatment groups.

Experimental Setup

Introduction

After training on the browser, the subject was given further information about the experiment. Specifically, the introduction described the idea or purpose of the scenario and the subject's goals and objectives during the scenario. For this experiment, the subject was instructed to research certain archaeological information by going to the Archeology Virtual Library. The goals and objectives were to get the gist of the information on each web page and then, to move on.

Scenario

The scenario was a list of 29 instructional steps. Subjects were expected to read each step, follow it, obtain the gist of the information, and move on to the next instruction.

There were several considerations when creating the scenario list. The first was that the information on each web page had to be distinctive and useful. Therefore, users more likely would recognize the information on a certain page when questioned later about it. Also, the scenario was to be logically sequenced. A natural method of exploration was critical in attempting to emulate a real life situation. Random links were not accessed, and so the sequence of links was sensible. Finally, the most important consideration was to create a non-linear history. A tree with several branches would create a realistic exploration that users would normally do, and therefore would give a distinct advantage towards using a visually enhanced history mechanism. The scenario took 20 – 25 minutes to complete.

Quiz

Setup

After completing the task scenario, the subject took a quiz. The quiz was constructed to measure user performance and was administered via computer. The quiz measured the time elapsed and the number of pages visited for each scenario question. There were 22 questions, each shown on a separate frame. The figure below shows the first question of the quiz. The dialog box allowed the subject to respond to each question on the computer screen. After each question was answered, a pause box was displayed. The subject moved on when he or she was

ready to answer the next question. The subject was expected to use the history mechanism to answer the question. The bottom two figures are examples of questions and pause boxes, respectively.

Format

The quiz was in a multiple-choice format (Figure 3). This format was used to eliminate possible confounding variables (for example, typing speed) that might affect the data. Other potential problems that were avoided through application of a multiple-choice format include handling of misspelled words and imprecise answers.

The multiple choice-format also reduced the experimental time, which was another advantage. Overall, the time range for the quiz was approximately 20 – 25 minutes.

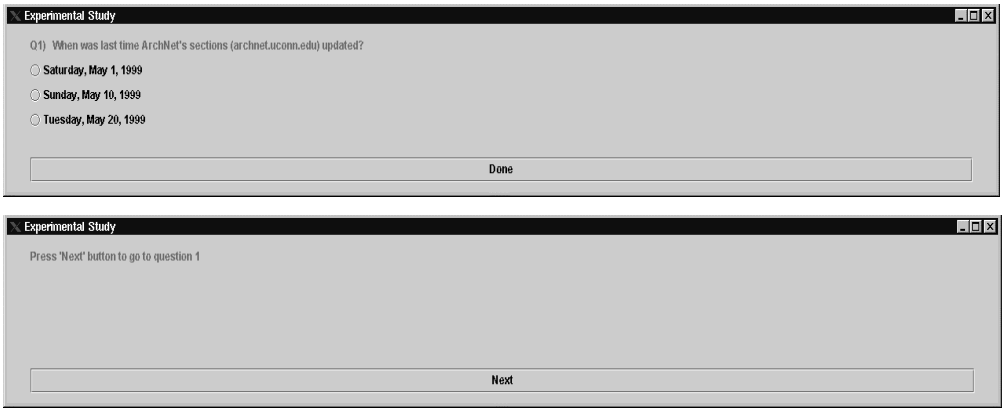

Figure 3: An example of the quiz screen and pause screen

Subjective Questionnaire

After finishing the quiz and before answering the subjective questionnaire, the subject familiarized himself or herself with the other two browsers they had not used during the initial experiment. Subjects then repeated the task scenario using the other web history mechanisms. For example, half of the group that first used DomainTree (the DomainTree group), now performed the same tasks using GlobalTree. Finally, they repeated the same scenario with Netscape. The other half of the DomainTree group, on the other hand, worked with GlobalTree first, then the Netscape browser. Nothing was timed or measured when the subjects tested other history mechanisms. After working with the other two mechanisms, a subjective questionnaire designed to compare and rate the mechanisms was completed. The rating scale was 1-9. The subjective questionnaire took approximately 20 minutes to complete.

Results

Data Gathering

We used an automated mechanism for timing. We measured the ***time*** needed by a subject to answer a question from the moment the subject pressed the "**Next**" button on the pause screen to the moment he or she pressed the "**Done**" button on the question screen. Also, we counted the ***number of pages*** the subject visited to answer each question starting from the moment he or she pressed "**Next**" to the moment he or she pressed "**Done**". We used a proxy server, in addition to its caching feature, to count the pages visited or accessed by the subject. The process of timing and counting were transparent so that subjects were less likely to be affected by performance anxiety.

Data Analysis

Questions with incorrect answers or an extremely large number of accessed pages (compared to the average number of pages visited by the other subjects for the same question) were removed from the analysis. We categorized the questions, according to the effort needed to answer them, into two categories:

Simple Questions (8 questions): Simple question was defined as a question in which the correct answer is clearly defined and easy to reach by the subject. In this type of question, a hint was given to the subject about on which page he could found the answer. Example:

The Archaeological Society of Maryland Inc. web page was designed by:

a) AppNet
b) Net Impression
c) Windy's Design Studio

Complex Questions (14 questions): Complex question was defined as a question in which the correct answer locates on multiple web pages. This includes the comparison kind questions and the questions that need to search for their answer since no hint were given to the subjects about were was the answer. Example:

Which page was recently revised and updated: the Museum page, or the Picture Gallery of Ceramics page?

a) Museums page
b) Picture Gallery page
c) Can't say, some information is missing

User Perfomrance

Time

For each treatment the performance times for the corresponding trials of all 21 subjects were compiled and the mean, standard deviations, maximum, and minimum for each question category were computed. The following table shows these results.

	Simple Questions			**Complex Questions**		
	NetScape	**GlobalTree**	**DomainTree**	**NetScape**	**GlobalTree**	**DomainTree**
Mean	52.66	37.58	31.25	72.06	53.29	39.32
Standard Dev.	12.18	12.07	4.98	12.83	8.64	6.55
Maximum	66.06	48.10	38.73	88.78	68.30	52.79
Minimum	35.58	20.23	24.67	49.14	39.10	34.54

Table 1: Time measurements (in seconds)

Figure 5 shows shows these statistics in the graph format:

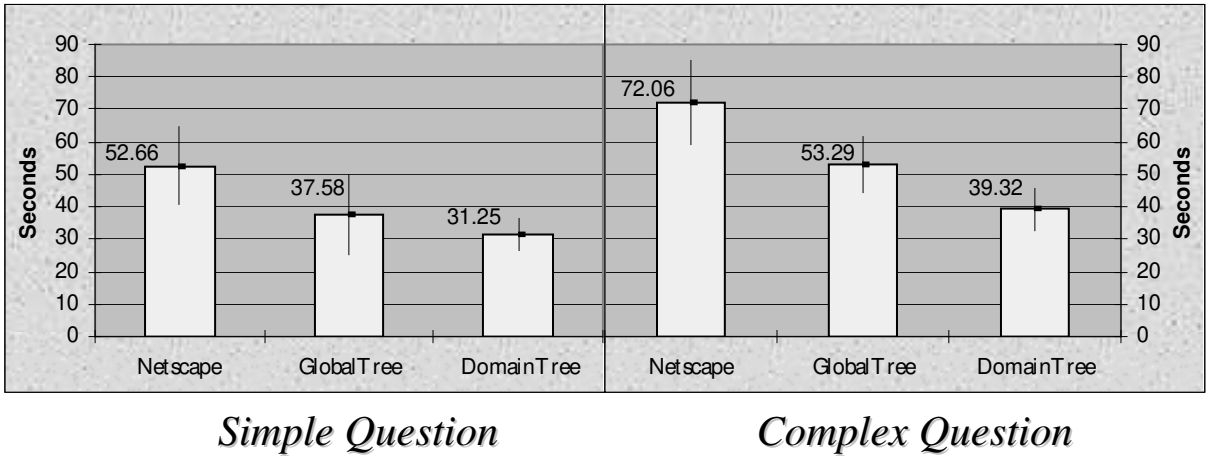

Figure 5: Time measurements of simple question category and complex questions category

To determine if the history mechanism had a significant effect on performance time, a 3x1 (single factor) analysis of variance was computed. The ANOVA determined that the different types of history mechanisms ***had a statistically significant difference*** on performance time at alpha=0.01 level for both the ***simple question*** category ($F_{2,18}$=7.96, p<0.005), and the ***complex question*** category ($F_{2,18}$=19.67, p<0.00001).

To determine the effects of the different history mechanisms, a t-test for the independent samples (for each possible pair) was computed as shown in Table 2. The following table shows the results for each question category. The ***significant difference*** is shown for both levels (alpha=0.01, and alpha=0.05):

	Simple Questions				**Complex Questions**			
	t_{12}	$P_{one\text{-}tail}$	**Significant**		t_{12}	$P_{one\text{-}tail}$	**Significant**	
			0.01	**0.05**			**0.01**	**0.05**
NetScape-GlobalTree	2.33	0.01917		✓	3.21	0.00374	✓	✓
NetScape-DomainTree	4.30	0.00051	✓	✓	5.95	0.00003	✓	✓
GlobalTree- DomainTree	1.28	0.11189			3.32	0.00304	✓	✓

Table 2: The t-test of the time performance

Number of Pages

As we did with performance time, for each treatment the number of pages for the corresponding trials of all 21 subjects were compiled and the mean, standard deviations, maximum, and minimum for each question category were computed. The following table shows these results.

	Simple Questions			**Complex Questions**		
	NetScape	**GlobalTree**	**DomainTree**	**NetScape**	**GlobalTree**	**DomainTree**
Mean	3.19	1.76	2.06	5.65	3.27	2.97
Standard Dev.	0.61	0.58	0.33	0.89	0.74	0.36
Max	3.93	2.86	2.36	7.12	4.12	3.29
Min	2.23	1.18	1.38	4.37	2.13	2.25

Table 3: Number of pages accessed

Figure 6 shows these statistics:

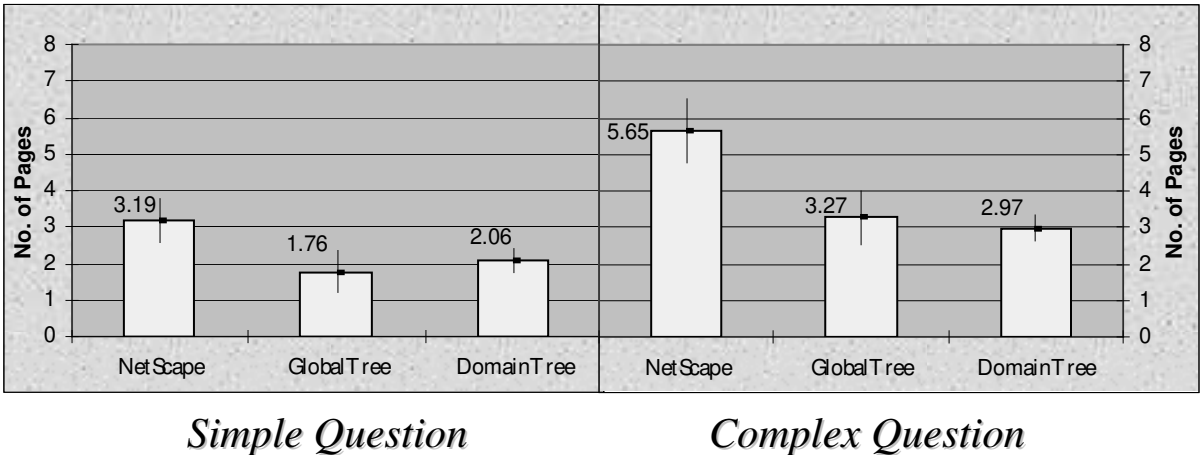

Figure 6: Number of pages accessed of simple question category and complex questions category

The reason for having the average of the GlobalTree less than the average of the DomainTree in the simple questions category is: for most of the questions, in using DomainTree you have to move first to the specific domain which contains the target page and then access the target page. But in GlobalTree, you can get to the target page directly since all the pages are reachable by single click of a mouse. This means that for most of the questions, users used DomainTree had to access one more page than the optimal number than can be reached by using GlobalTree history mechanism.

To determine if the history mechanism had a significant effect on performance time, a 3x1 (single factor) analysis of variance was computed. The ANOVA established that the different history mechanisms also have ***statistically significant difference*** in reference to the number of pages accessed at the alpha=0.01 level for both the ***simple questions*** category ($F_{2,18}$=13.54, p<0.0005), and the ***complex questions*** category ($F_{2,18}$=30.31, p<0.00001).

Also, a t-test for the independent samples (for each possible pair) was computed to determine if there was a difference between each pairing of the history mechanism. The following table shows the results for each question category. The ***significant difference*** is shown for both alpha levels (alpha=0.01, and alpha=0.05). This is shown in Table 4.

	Simple Questions				**Complex Questions**			
	T_{12}	**$P_{one\text{-}tail}$**	**Significant**		**t_{12}**	**$P_{one\text{-}tail}$**	**Significant**	
			0.01	**0.05**			**0.01**	**0.05**
NetScape-GlobalTree	4.49	0.00036	✓	✓	5.40	0.00008	✓	✓
NetScape-DomainTree	4.30	0.00051	✓	✓	7.32	0.00000	✓	✓
GlobalTree-DomainTree	-1.21	0.12541			0.96	0.17919		

Table 4: The t-test for the number of pages accessed

The results showed a significant difference in the time measurement between GlobalTree and DomainTree and no difference when analyzing the number of pages accessed. One possible explanation is that because GlobalTree displays more visual information (nodes) than DomainTree, users prefer to spend more time identifying their correct target node instead of exploring nodes of which they are less certain.

User Satisfaction

The subjective satisfaction ratings were also compiled and analyzed. The means and standard deviations were calculated for all the 5 scores of the subjective questionnaire. The results are in table 5.

	NetScape	**GlobalTree**	**DomainTree**
Mean	5.11	7.42	8.04
Standard Dev.	1.87	1.07	0.94
Max	8.20	9.00	9.00
Min	1.00	5.00	5.00

Table 5: User Satisfaction

The following graph (Figure 7) shows these statistics:

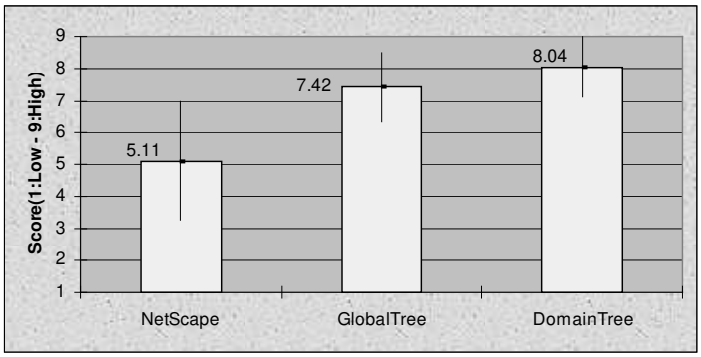

Figure 7: User Satisfaction

As with performance time, a 3x1 (single factor) analysis of variance was used for each treatment to detect if the history mechanisms significantly affected users' satisfaction. The ANOVA showed that there ***is statistically significant difference*** at the alpha = 0.01 level ($F_{2,60}$=29.95, p<0.00001)

The following table shows the result for the t-test on the independent samples:

	T_{40}	$P_{one\text{-}tail}$	Significant	
			0.01	0.05
NetScape-GlobalTree	5.16	0.000004	✓	✓
NetScape-DomainTree	6.73	0.000000	✓	✓
GlobalTree-DomainTree	2.11	0.02075		✓

Table 6: The t-test for the user statisfaction

Rate of Error

We calculated the number of questions in each treatment that were either answered incorrectly or that resulted in an extremely large number of pages accessed. Table 7 shows these counts:

	Netscape	GlobalTree	DomainTree
Wrong Answer	4	2	4
Large Number of Pages	2	5	2

Table 7: Number of incorrect answers

Discussion

History Mechanism and Performance Issues

The statistics rejected our null hypothesis. The study's results indicates the existence of statistically significant differences in the user's performance in terms of time and number of visited pages among the three treatments. From the above statistics, we can see that the DomainTree history mechanism is the best when assessing performance by time and number of pages visited. The t-test proved that there is a significant difference associated with performance time between DomainTree's and GlobalTree's history mechanisms for the complex questions category. One interpretation for having a significant difference on the user time performance and not having that difference on the number of pages between GlobalTree and DomainTree is: GlobalTree display more visual information (nodes) than DomainTree which make users prefer to spend more time to recognize their correct target node instead of going to suspicious wrong node.

From the error counts, use of the GlobalTree mechanism resulted in the largest number of incorrect answers. Most likely this is due to the extremely high number of visited pages by GlobalTree users. (Subject were free to skip any question for which they could not find an answer). It also might reflect the nature of the history mechanism that shows all accessed pages. Subjects using GlobalTree may have been tempted or forced to find the answer even if they had to visit a very large number of pages.

History Mechanism and Subjective Satisfaction

Results from the subjective satisfaction questionnaire showed existence of statistically significant differences between the three treatments. Users preferred the visual effect of the history mechanism. None of the subjects demonstrated any difficulty in using the three history mechanisms, and they rated the mechanisms with similar ease-to-use scores. Thirteen of the 21 subjects indicated a preference for the DomainTree history mechanism, while 5 wanted to have the GlobalTree history mechanism implemented in their browsers. Following are some of the comments

- "The tool of having all the pages visible is VERY useful."
- "DomainTree and GlobalTree are far better in terms of history but they cut space which lead to scrolling."
- "DomainTree is more logical in representing the history."
- "I like the performance of the DomainTree. It would be nice if I could bookmark the pages from the history tree or save the history itself."
- "The visual history tree was very helpful. Branching definitely assisted with retention of where I could quickly access desired information."
- "The "Back" button in DomainTree is not needed."
- "I personally liked DomainTree's history tool more than GlobalTree because it separated the trees by domain. It would be best to make this as an option of the browser."
- "The pages in the tree of the GlobalTree are so small that you might get confused to figure which is which."
- "The technique of DomainTree allows the use of separate trees resulting in bigger icon images that showing more information in these images thus helping in accessing the targeted page."
- "GlobalTree is more complicated. Images become tiny and hard to differentiate between them."

Comment

The overall experiment went smoothly. The environment was stable and quiet. Subjects were very cooperative. Although we tried our best to counter-balance the environment, we were not able to hold all the experiments at the same time. This was due to resource limitations of the lab and availability constraints of the subjects. All subjects used the DomainTree and GlobalTree for their first time during the experiment. We believe we could obtain more impressive results, if subjects had a longer time (for example, two weeks) to familiarize themselves with the browsers.

Negative feedback from subjects about the experience were in reference to the small size of the GlobalTree images and the overall length of the experiment.

Some also noticed a slow down in GlobalTree and DomainTree due to the their nature in drawing the history tree images. One main reason for the slow down may due to their implementation language. Java is used to implement DomainTree and GlobalTree, while Netscape is implemented by C. At present, C is more efficient than Java. In the future if C implements GlobalTree and DomainTree, or if Java become faster and more efficient, a significant increase in performance of these history mechanism will be noticeable.

Conclusions

Impact for practitioners

The experiment's results showed that the use of history mechanisms in web browsers may have a direct effect on user performance or satisfaction when revisiting web pages. Statistics indicated that the use of visual aids in a history mechanism is more powerful than using text or the current history methods. In addition, our experiment demonstrate that DomainTree is better than GlobalTree. Research needs to be conducted on individual components of web history mechanisms to see what impact they may have on web revisitation patterns. In our experiment, we noted that the subjects mainly depended on layout out of their navigation paths while completing the scenario. They, also relied on web page titles, URLs provided as tooltips, or status bar information as reference points for identification of previously visited web pages.

Suggestions for Future Researchers

We believe that we could obtain more impressive results by increasing the speed of DomainTree and GlobalTree and by letting subjects gain greater familiarity with the browsers before the start of the experiment. Some subjects recommended that DomainTree's usability could be improved by making the list of domains more informative. Some subjects suggested questions for future browser research:

- "For someone who likes to stay on [the Internet] for four hours, it is very easy to have an enormous and unmanageable tree!"
- "When opening multiple windows, how will this be handled by DomainTree and GlobalTree?"

Acknowledgments

We would like to thank Dr. Ben Shneiderman for his support and encouragement for this study. A lot of thanks to Dan Kim and James Ahn for their help during this experiment. Also, we would give a warm thanks to our friends who were able to help us out with our experiments.

References

[1] Ayers, Eric Z. and John T. Stasko. *Using Graphic History in Browsing the World Wide Web.* Proceedings of the Fourth International World Wide Web Conference, Boston, December 1995.

[2] Bederson, Ben B., and McAlister, Britt. *Jazz: An Extensible 2D+Zooming Graphics Toolkit in Java*. HCIL Technical Report No. 99-07 (May 1999).

[3] Bederson, B.B, Hollan, J. D., Stewart, J., Rogers, D., Druin, A., Vick, D., Ring, L., Grose, E., Forsythe, C., *A Zooming Web Browser.* Human Factors in Web Development , Eds.: Forsythe, C., Ratner, J., and Grose, E., Lawrence Earlbaum, New Jersey , 1997.

[4] Bederson, Ben B., Jonathan I. Helfman, Ron R. Hightower, James D. Hollan, and Laura T. Ring. *Graphical Multiscale Web Histories: A Study of PadPrints*. ACM Hypertext '98 Conference, Pittsburgh, 1998.

[5] Catledge, Lara D., and Pitkow, James E., *Characterizing Browsing Strategies in the World-Wide Web*. In Computer Networks and ISDN Systems 27. Elsevier Science, 1995

[6] GVU's WWW Surveying Team. "GVU's 6th WWW User Survey," 1996.

[7] Gandhi, Rajiv, and Kumar, Girish, *Domain Name based Visualization of Web Histories*. http://www.cs.umd.edu/class/fall1999/cmsc838s/Project/girish/webHistory.html

[8] Greenberg, Saul and Linda Tauscher. *Revisitation Patterns in World Wide Web Navigation*. CHI '97. ACM. http://www.acm.org/sigchi/chi97/proceedings/paper/sg.htm.

[9] Kandogan, Eser and Ben Shneiderman. *Elastic Windows: A Hierarchical Multi-Window World-Wide Web Browser.* UIST 97. ACM.

[10] Komlodi, Anita, David A. Nation, Gary Marchioni, and Catherine Plaisant. *Visualizing websites using a hierarchical table of contents browser: WebTOC.* , Proc. 3rd Conference on Human Factors and the Web, Denver, CO (June 1997).

[11] Mukherjea, S., Foley, James D. *Visualizing the World-Wide Web with the Navigational View Builder*. In Computer Networks and ISDN Systems 27. Elsevier Science, 1995. http://www.igd.fhg.de/www/www95/proceedings/papers/44/mukh/mukh.html

[12] Wexelblat, Alan, and Maes, Pattie. *Footprints: History-Rich Tools for information foraging.* CHI '99. ACM, 15-20, May 1999.

Appendices

Background Survey:

1) Age?

below 15 15-20 20-25 25-30 above 30

2) Education Level?

Undergraduate (year? 1, 2, 3, 4) Graduate

3) Sex?

Male Female

4) How many years have you been using computers?

Never used Less than 1 2-4 More than 4

5) For how long have you been using the World Wide Web?

Never used Less than 6 months 6 months-2years more than 2 years

*If you answered Never used to questions 4 and/or 5, please skip the rest of the questionnaire***.**

6) How many hours per week (on average) do you spend browsing the Web?

Less than 2 2-5 More than 5

7) How much time (on average) do you spend browsing the Web in one sitting?

5-20 min 20- min-1 hour More than 1 hour

8) Which products (if any) have you used (check all that apply)?

__Netscape __Pad++ Web Browser __Elastic Windows

__Internet Explorer Other_____

Training

PadPrints

A quick review will help you use and utilize the web browser. Any questions can be asked during this time. However, after the experimental section has begun, questions cannot be asked.

1. Observe the layout: At the left is an empty area where the sites that you visit will be recorded in a tree form. The buttons above this panel are controls that manipulate the magnification of the tree diagram.
2. Enter the UM computer science site at www.cs.umd.edu by typing it in your browser.
3. Now look at the left panel. You will see a square image representing the page you are visiting. It is now recorded in the history.
4. Enter another page: click on "Class Pages" under the heading "Courses." You can now observe another square image connected to the page you previously visited. Note that the page you are currently at will be highlighted.
5. Click on any class' page. Observe changes in diagram window.
6. You do not need to use the back and forwards button to visit previous pages. Instead, you can "jump" to pages by mouse-clicking the square image on the tree diagram. Try it: go to the initial CS homepage, and then to CS class page you previously went by using the history tool.
7. Choose a different class page by clicking another link at the CS class page. Observe the way that the diagram branches. The diagram draws connections based on how you linked to the page.
8. You can scale the tree diagram to observe the pages from afar and up close. Try zooming in and out the tree diagram by pressing the appropriate buttons at the top of the left panel.
9. You may now experiment with the browser on your own. Try visiting other pages and going back to them. If you have any more questions, please ask them now.

AutoBahn

A quick review will help you use and utilize the web browser. Any questions can be asked during this time. However, after the experimental section has begun, questions cannot be asked.

1. Observe the layout: At the left is an empty area where the sites that you visit will be recorded in a tree form. At the far left is a panel that will list the main sites that you have visited. The buttons above this panel are controls that manipulate the magnification of the tree diagram.
2. Enter the UM computer science site at www.cs.umd.edu by typing it in your browser.
3. Now look at the left panel. You will see a square image representing the page you are visiting. It is now recorded in the history. Also observe the far left panel, where the site you visited has been listed.
4. Enter another page: click on "Class Pages" under the heading "Courses." You can now observe another square image connected to the page you previously visited. Note that the page you are currently at will be highlighted.
5. Click on any class' page. Observe changes in diagram window.
6. You do not need to use the back and forwards button to visit previous pages. Instead, you can "jump" to pages by mouse-clicking the square image on the tree diagram. Try it: go to the initial CS homepage, and then to CS class page you previously went by using the history tool.
7. Choose a different class page by clicking another link at the CS class page. Observe the way that the diagram branches. The diagram draws connections based on how you linked to the page.
8. "Jump" to the CS main homepage, and click the link "Schedule '00" under the heading "Courses." Observe the far left panel. It has listed the new site that you are visiting. Also, the tree diagram panel has now been cleared for recording pages that you visit at this site.
9. Refer to tree diagram of the last site by clicking the site listed at the far left panel.
10. You may now experiment with the browser on your own. Try visiting other pages and going back to them. If you have any more questions, please ask them now.

Netscape Navigator

A quick review will help you use and utilize the web browser. Any questions can be asked during this time. However, after the experimental section has begun, questions cannot be asked.

1. Enter the UM computer science site at www.cs.umd.edu by typing it in your browser. Click on "Class Pages" under the heading "Courses." Click on any class' page.
2. At the upper left are two arrow buttons. Use them to shift back and forwards through the sites you have visited. Try pressing these buttons and observe results.
3. To view a list of the history, go to "Communicator" in the menu bar, "tools", and then click "History." Another window will open, showing the names and the web addresses that you have visited. Double click any of the listed sites to visit that site.
4. You may also use the menu item "Go" to visit sites. This lists the names of some of the recent pages you have visited. Click the corresponding name of the page you desire to visit.
5. You may now experiment with the browser on your own. Try visiting other pages and going back to them. If you have any more questions, please ask them now.

The Scenario

No questions will be answered during this section. If you still have any questions, do not start this part.

Introduction

You become interested in Archaeology area. But since you have no information about that field before, you searched the net and hit site: Archaeology WWW Virtual Library – ArchNet (archnet.uconn.edu). ArchNet serves as the World Wide Web Virtual Library for Archaeology. This server provides access to archaeological resources available on the Internet. Information is categorized by graphical regions and subjects.

Your objective is to explore various pages and resources about Archaeology. A scenario will be given to you next to guide you in exploring the site.

At the end, you will answer questions about the information contained in the visited pages. You are not required to know the answer at that time but we encourage you to revisit the necessary pages as many as you need to answer question.

Scenario

1. Visit the main page http://archnet.uconn.edu/
2. You want to find the available resource in your local area, so you start this by checking the Regional View link.
3. You will click on the North America link to go to the resource page exists in northern America.
4. Scroll the page to see if there are any resources in the Northeast (the area you are in).
5. Since you are looking for something local especially in Maryland, you click on The Archaeological Society of Maryland, Inc.
6. Note that you transferred to a new domain (www.smcm.edu) which is the main page for Archeological Society of Maryland, Inc.
7. You want to check the activities for that society, so you click on Activities
8. Down the activity page is a link for the annual field & lab work activity. Click on that links to know more about that activity. The link you have to click on is Field Sessions in Maryland Archeology.
9. At the end of ASM Field Session page, there is an information about the place the 1999 ASM Field Session was held at. Check it for more information.
10. Use the History tree to go back to the Activities page.
11. From the Meetings section, at the top of the page, check the next Spring Symposium on Archeology meeting.
12. Go back to the main page of ASM, and check the chapters page resource.
13. Go back to the Regions View Page again, by clicking on the domain name of the ArchNet page (archnet.uconn.edu) to move to ArchNet history tree. Then click on the Regions page.
14. You want to take an overview view of the amount of resources available in South America, since you may visit it soon. You click on the South America Link to move to the resource page.
15. Since you have enough information about the resource in your region, you want go back and check what other types of information you can gain from ArchNet. Use History mechanism to go back to the main page in the ArchNet (archnet.uconn.edu) history tree.
16. You want to find out what subject areas within Archaeology. You click on Subject Areas link
17. Look for Ceramics and try to find more about it.
18. One of the catalogues you have about ceramics is a picture gallery of ceramics from the Osmore drainage, Peru. Click on this link to go there.
19. You will find different styles for ceramics jars and bowls. Check images of the jar from Early Chiribaya style and the jar from The Tumilaca style.
20. Since you interested to know about Archeological Museum, you will visit the Museums resource page from the main page of Archeology (ArchNet)
21. Visit Cleveland Museum of Natural History. Museum #24
22. You will move to a separate domain name for that Museum (www.cmnh.org)
23. Click on general information link to know more about it.
24. Click the Mission Statement link and read about their mission statement.

25. Back to the general information page using the history tree.
26. Click on Gallery map to know how many levels that museum has.
27. Since you have small brother/sister, you want to check the Educational Services available. Use the main page of the museum to go there.
28. Check the Solar System class there.
29. Get familiar with the history you built.

1. **The training given for learning the history tool was sufficient.**

   1 2 3 4 5 6 7 8 9 10

1. **I felt comfortable using this web browser history tool.**

   1 2 3 4 5 6 7 8 9 10

1. **The format of the navigation tool was helpful in determining the pages I visited.**

   1 2 3 4 5 6 7 8 9 10

1. **I felt that the tool made navigating previous pages generally quick.**

   1 2 3 4 5 6 7 8 9 10

1. **I feel that there is room for improvement for this history tool.**

   1 2 3 4 5 6 7 8 9 10

1. **I would like to have the browser that I currently use to have the same, or similar history browser tool in the future.**

   1 2 3 4 5 6 7 8 9 10

Comments: