Exploring Multi-session Web Tasks

Bonnie MacKay and Carolyn Watters
Faculty of Computer Science, Dalhousie University
Halifax, NS, B3H 1W5, Canada
{bmackay, watters }@cs.dal.ca

ABSTRACT

Users are now performing more sophisticated web tasks. In this work, we explore web tasks that require multiple web sessions to complete (multi-session tasks) to satisfy a goal. We conducted a web-based diary study and a field study that used a customized version of Firefox which logged the participants' interactions for multi-session tasks and all their web activity. We found that multi-session tasks occur frequently and that users utilize a variety of browser tools and actions to help complete these tasks.

Author Keywords

Web tasks, diary study, field study, multi-session tasks.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

There has been a growth of information available on the Web and as result there has been an evolution of the type of tasks that people perform. For example, today many tasks can be performed using services available on the Web (e.g., booking a flight, or buying a new dress). Despite this growth in how the Web is being used, most tools provided by the popular browsers have not changed much. Browser tools tend to still focus on supporting tasks that can be completed in a single web browser session and there are few standard browser tools available to users to support tasks that require multiple web sessions to complete.

While research has been conducted on user behaviour for single web session tasks, for specific web tasks, and for monitoring web information, we are exploring non-monitoring tasks that take multiple web sessions to complete (multi-session tasks). A multi-session task is goal-based, requires more than one web session to complete and, has a definable point as to when the task is over, such as a specific date, an event that occurs (e.g., you finally purchase the computer), or that it is abandoned. It is not a routine task (e.g., reading the news every day or checking your email on a regular basis).

In this research, we are interested in learning about the type of tasks that cross multiple web sessions, in finding out how users are performing these tasks (i.e., what browser tools they are using) and in determining what problems they encounter while performing these tasks. We anticipate that users will have some difficulties performing multi-session tasks while also doing other web activities in a single session (i.e., multi-tasking) and in resuming their task when they return to it at a later time. We expect that most multi-session tasks are expected, that is that when the user begins the task they know that it will continue over several sessions. We also expect that there will be occasions when a user begins a task that they assume will take a single session to complete but it unexpectedly turns into a multi-session task (i.e., there is not enough time to finish or the task is more complex than originally thought). We also anticipate that when users are performing these tasks, they use particular browser tools and possibly other applications to help organize the information that they find (such as print web pages), and that users may use other applications to interpret information (such as a calculator).

We use the results of a diary study and field study to determine how to better support users performing multi-session tasks. The contribution of this research includes a characterization of how users perform multi-session tasks, a characterization of these tasks, and it provides recommendations for browser tool features to help support multi-session tasks.

RELATED WORK

Web Tasks

There has been a lot of research conducted on user behaviour on the Web to try to understand and/or categorize the different types of web tasks in which people perform [1, 4, 5, 6, 7, 8, 12, 17]. For example, Choo et al. [6] outlined four task categories for the Web, and Sellen et al. [15] found six web task categories based on observation. Kellar, et al. [12], classified web tasks, similar to Sellen et al. [15] as fact finding (e.g., looking for specific information), information gathering (e.g., researching a paper), browsing (e.g., entertainment or passing time), transactions (e.g., online banking), communications (e.g., emailing), and maintenance (e.g., updating a web page). Kellar et al. [11] also explored web monitoring and found that monitoring of

information exists across all task types and involves revisiting web pages to view new or updated information (e.g., reading the news or checking Facebook).

Revisitation Web Activity

Some web tasks can be completed within a single session. Other web tasks need multiple sessions and may require a users to return to an already seen page or pages to continue with the task, complete the task or repeat the task (e.g., to monitor a page). Tauscher and Greenberg [17] found that 58% of pages visited by users had been previously accessed. Cockburn and MacKenzie [8] and Cockburn et al. [7] reported that 81% of visits to web pages are to pages that have been previously seen. Sellen et al. [15] found that many information gathering tasks (40%) took more than one session to complete and Kellar et al. [12] reported that 59% of information gathering tasks were repeated. Brown and Sellen [3] also found that many users' information needs spanned across several web pages which may be accessed in more than one session.

Current Web Browser Revisitation Tools

Despite the explosive growth of the Web and an increase in the number and type of web users the current browsers and the tools have changed little. For example, the web browser Mosaic (http://www.ncsa.uiuc.edu/Projects/mosaic.html) that was available with support from 1993 to 1997 had tools that were very similar to the tools found in most freeware browsers today (e.g., history list, hotlist, hotlist manager, home page, and forward/back buttons).

Some browser tools are designed to aid people to revisit web pages during a single session (i.e., to find pages in the current session) and others help users revisit pages over multiple sessions (i.e., to return to pages at a later date) [9]. The two most common browser tools for revisiting pages over multiple sessions are history lists and bookmarks.

History lists keep a record of all previously seen pages for a set period of time. Many studies have shown [2, 5, 7, 8, 12, 17] that users tend not to use history lists as problems exist such as, duplicate entries and inconsistent page names [7, 8]. Bookmarks (or Favorites) provide access to previously visited web pages. While bookmarks provide advantages as they can be grouped by categories and act as placeholders [1], there are disadvantages such as the need for managing these links [1] or refinding pages can be quite difficult. Despite these shortcomings people still use bookmarks [1, 2, 3, 4, 11, 12, 17], and other strategies [2, 3, 4, 15] including using search engines to relocate pages, printing or saving web pages, or emailing links to themselves or others.

There has been recent research into developing new tools to help users revisit and organize their information for use over several sessions, such as Session Highlights [2, 9] and Webscrapbooks [15]. Other tools stand alone or combine existing tools into one providing single or multi-session support (or both). For example, Kaasten and Greenberg [10] integrated the back key, history list and bookmarks

into a single tool and provided a visual representation of how often pages were visited. Landmarks [14] can be used to enhance the revisitation of a web page with the refinding of information on the page by automatically scrolling to the exact location of user marked text when the page is reopened.

METHODOLOGY

We designed a mixed methodology to better validate the results using two approaches: a diary study and a field study. A diary study has the advantage of allowing us to collect information in an unobtrusive manner as participants self report their behaviour to identify and discover patterns of user behaviour [16]. We performed interviews at the end of the diary study to help verify the diary entries [16]. In the diary study [13], participants self-reported their multi-session tasks using a web-based diary. In particular, we were interested in finding out how often participants engage in multi-session tasks, how often participants return to work on the task during the study period, the types of tasks that participants classify as multi-session, which browser functions or tools participants use for these tasks and the frequency of use of these tools.

We used the data in the diary study to help us better define multi-session tasks and to help in the design of the logging feature for the customized version of Firefox for the field study. For both studies, we tried to minimize the effort of the participants by providing tools to make the recording of tasks easier (a web-based diary for the diary study and a customized toolbar in Firefox for the field study). While we acknowledged that having participants explicitly record their multi-session tasks may influence their behaviour, we felt that this was a necessary trade off to gather the relevant data relating specifically to multi-session tasks.

We use the qualitative and quantitative data collected during the diary study, the field study and the interviews to determine how the participants are performing multi-session tasks. We also consider a set of relevant findings for developers and researchers to use when designing browser tool features to help support multi-session tasks.

The Diary Study

Twenty-two participants (12 male and 10 female) from a university community of students, faculty and staff took part in the web-based diary study. Half the participants used Internet Explorer (IE) as their main browser and half used Firefox. Participants ranged in age from 19 years old to 50 years old, with the average age being 28 years. There were 16 students (11 graduate and 5 undergraduates), and six university employees (1 being a faculty member). The majority of the students (11/16) were in computer science. Seventy-seven percent (17/22) of the participants indicated that they use the Web several times a day and about 64% (14/22) of participants reported that they spend at least 11 hours a week using the Web. Participants were compensated $25 for each week they took part in the study.
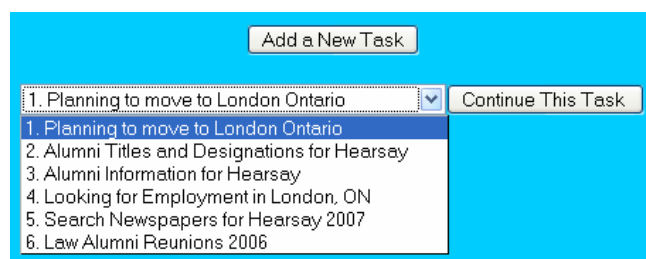
Figure 1: A Sample List of active Multi-session Tasks

Participants recorded their multi-session tasks using a web-based diary over the study period (18 participants for a one week study period, and four participants for a two week study period). We met with participants at the beginning to describe the study. We explained multi-session tasks (both expected and not expected) and demonstrated the web diary. Recorded multi-session tasks could be both expected and unexpected. For this study, participants were asked to record, as a session, each time they visited the Web to work on the task. Participants were asked to use their web diary each time they began and returned to a multi-session task. The tasks could have begun previously to the study and could continue after the study. At the end of the study, participants took part in a semi-structured interview.

We provided a password protected web-based worksheet to minimize the effort of the participants to record task information. The diary worksheet contained radio buttons, checks, comment boxes, and drop-down lists for easy input. When users added a new task, the task was added to their active task list for later selection (Figure 1).

Participants were encouraged to keep the diary open in a separate browser window or tab when they used the Web and to fill in the diary as the task occurred (although they could enter the information at a later time). The diary recorded: the task name, task description, if the task was expected or not, estimated finish date or time when the task would end, reason to stop working on the task, where the task was performed, what was worked on during the session, the browser tools they used during the session and finally if the overall task was complete. The name, description, expected finish date and whether it was expected or unexpected were only recorded once during the initial session of the task.

At the end of the study, participants took part in a semi-structured interview. Participants were asked to go through one of their multi-session tasks in detail and were asked questions regarding the concept of multi-session tasks in general (e.g., "Are the tools you use for multi-session tasks different than other tasks?"). We demonstrated up to four tools to get the participants' feedback as to their appropriateness for multi-session tasks: tabs to the IE users, session saver, Landmarks [14], and an annotation tool.

Based on the participants' diary entries and comments during the interviews, we were able to further refine our definition of multi-session tasks. We expanded our original definition of multi-session to be a task that is goal based, that often requires sub-tasks to complete, and that has a temporal element (i.e., the task has a deadline or is finished once the goal is achieved).

Field Study

We then ran a four week field study where participants used a customized version of Firefox for all of their web browsing sessions. This customized version logged all of their interactions in the browser. Twenty-four university students (20 male and 4 female) were recruited to participate. We recruited participants who used the Web daily, and who used Firefox as their main web browser. There were 14 computer science students, 6 commerce students, and 4 were from health profession studies (kinesiology, occupational therapy, health informatics, health and human performance). Six of the 24 participants were graduate students. The age of participants ranged from 18 to 35 years old with an average age of 24. A large majority of participants (21/24) indicated that they use the Web several times a day, and 58% (14/24) checked that they used the Web at least 11 hours a week. Participants were compensated $50 for finishing the study.

We met with participants at the beginning of the study to explain the details of the study, to demonstrate and install our browser and to define multi-session tasks. We used the modified definition from the diary study. For this study, a session was logged each time they opened and closed the browser. Consequently, we captured both the times of all activities and periods of inactivity.

Over the study period, participants used our browser for all their web use. The browser not only logged all of the participants' interactions with the browser but also had an additional toolbar Figure 2 (a) that was used by participants only when they worked on multi-session tasks. Participants were asked to submit daily web logs using a submit button built into the toolbar. If there were any problems with submitting the log electronically, the log was stored on their hard drive, although no problems occurred during the study.

Our customized version of Firefox captured all user interactions in a log format as shown in Table 1. All logged data was stored on a secure server only accessible by the researchers. Each participant accessed the browser with a unique username/password to ensure that the logs only contained the study participants' data. The log contained the following information: Computer, Event Id, Window Id, Tab Id, Date, Time, Name, URL and Session Description.

Participants could install the browser on multiple computers thereby providing access to their multi-session tasks from any location. *Computer* was a self chosen name by the participant representing the computer that the browser was installed on. Each action that the participant did on the browser was given a unique *Event Id* number. When a new window or tab was opened during a session they were numbered (*Window Id* and *Tab Id* respectively) starting at 0. The *Date* and *Time* were recorded for each action. The

comp-uter	event Id	window Id	tab id	date	time	name	url	session (description)
Laptop	2506	0	0	22-Oct-06	5:01:36 PM	Included this tab in the current task: Switched into task		
Laptop	2506	0	0	22-Oct-06	5:01:36 PM	Resumed Task		Autism Centre of Nova Scotia
Laptop	2508	3	0	22-Oct-06	5:01:38 PM	Window Popped Up at	https://my3.dal.ca/webmail/imp/compose.php	
Laptop	2509	3	0	22-Oct-06	5:01:46 PM	Closed Window		
Laptop	2510	0	0	22-Oct-06	5:01:47 PM	Followed Link	javascript:openMailWin('https://my3.dal.ca/webmail/imp/redirec	
Laptop	2511	4	0	22-Oct-06	5:01:48 PM	Window Poped Up at	https://my3.dal.ca/webmail/imp/redirect.php	
Laptop	2512	4	0	22-Oct-06	5:01:51 PM	Opened Find In Page Bar		
Laptop	2513	4	0	22-Oct-06	5:01:57 PM	Looked In Page For		Judie
Laptop	2514	4	0	22-Oct-06	5:02:44 PM	Followed Link	javascript:open_compose_win('to=jdroos%40dal.ca&thismailbox	
Laptop	2515	5	0	22-Oct-06	5:02:49 PM	Included this tab in the current task: Switched into task		
Laptop	2516	4	0	22-Oct-06	5:02:51 PM	Included this tab in the current task: Switched into task		
Laptop	2517	5	0	22-Oct-06	5:03:12 PM	(Context Menu) Paste from		Word
Laptop	2518	5	0	22-Oct-06	5:04:28 PM	Closed Window		
Laptop	2519	4	0	22-Oct-06	5:04:33 PM	Closed Window		
Laptop	2520	0	0	22-Oct-06	5:04:38 PM	Stopped Task		Autism Centre of Nova Scotia
Laptop	2521	0	0	22-Oct-06	5:04:38 PM	Stopped Task		Subtask: *None given*
Laptop	2522	0	0	22-Oct-06	5:04:38 PM	Stopped Task		Subtask complete? No
Laptop	2523	0	0	22-Oct-06	5:04:38 PM	Stopped Task		Stop Reason: *None given*
Laptop	2524	0	0	22-Oct-06	5:04:38 PM	Stopped Task		Other Applications Used: *None*
Laptop	2525	0	0	22-Oct-06	5:04:38 PM	Stopped Task		Is Stopped Task6-Finished? *No*
Laptop	2526	0	0	22-Oct-06	5:04:40 PM	Followed Link	https://my3.dal.ca/uPortal/tag.2758ff563ea092da.render…	

Table 1. An Excerpt from a Log File (Event Id 2506 to 2525 represent the continuation of a multi-session task and at Event Id 2526 the participant returns to their other web activities)

name was the actual action that the participant performed (e.g., opened bookmark or followed link) and, when appropriate, how the action was performed (e.g., from the menu, using control keys, from the toolbar, etc.). The *URL* is the web page address for any pages visited on a browser action. *Session Description* recorded additional information on the multi-session tasks (e.g., when they were started, resumed and stopped).

In addition to capturing the user interactions, participants indicated when they started and continued to work on a multi-session task by using the interactive toolbar. To start a new task, participants pressed the "Start New Transient Task" button (note, for this study, we used our earlier label 'transient task' to refer to multi-session task). Participants then filled in a web form shown in Figure 2 (b) that described the multi-session task (task title, task description, whether it was expected or not and estimated completion date). Once they selected the "Start" button on the web form, the name of the task would appear on the toolbar highlighted in yellow (Figure 2 (c)). Participants also indicated when a window or tab was included in the task with the "include/exclude" toggle buttons on the toolbar.

When the participants stopped the task ("Stop Task" button), another web form appeared in which the participants recorded information on the task they just worked on (what sub-task they worked on, whether they finished the sub-task, why they stopped for that session, other applications used and if the task was finished). To resume a task later, the participant could select a task name from a drop-down list of active tasks that appeared when they selected the "Resume Task" button.

Participants also used the toolbar to submit their web logs. To submit their daily logs, they pressed the "Submit Log" button on the toolbar. Participants could view their logs ("View Log") and could delete any URLs they did not want the researchers to see with the "Manage Log URLs" button.

At the end of the study, we met again with participants for a semi-structured interview that was formatted similarly to the interview given after the diary study, to discuss one of their multi-session tasks in more detail and multi-session tasks in general. This interview also gave us the opportunity to demonstrate and receive feedback for possible types of tools that may be useful for multi-session tasks. We demonstrated the same tools as in the diary study (with the exception of tabs) and also included 'Google Notebook'.

Limitations of the Studies

While we did use a 'convenient sample', this provided us with an experienced set of web users. Our population and sample numbers are comparable to other studies [3, 6, 12, 15] which also reported on experienced users (office workers or students) to acquire a deeper understanding of

(a) The Interactive Toolbar
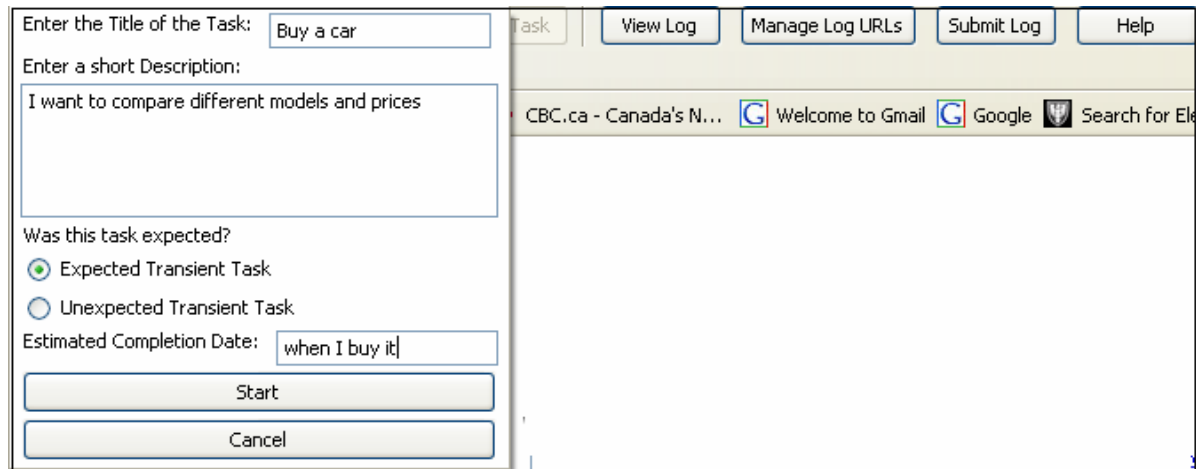
(b) Start a new multi-session task web form
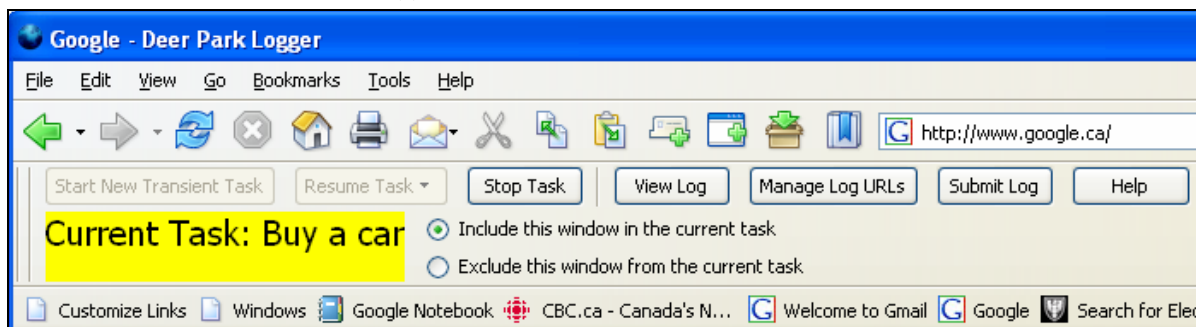
(c) The task title is highlighted in yellow and the user can check if a web page from a tab or window is included/excluded from the task

Figure 2. The customized toolbar for recording multi-session tasks

how these users perform web tasks. Students tend to be early adaptors of technologies and are heavy users of the Web. We felt for an initial exploration into multi-session tasks, that this population would provide a robust picture with a mix of techniques and approaches to the task.

There are trade offs when designing studies. While web server logs can contain large amounts of quantitative data on a large population, the data does not include an understanding of the motivation of the user. Our studies were selected to record a rich data set consisting of self-motivated tasks collected within the participants' own environment. Our results established that there are different types of multi-session tasks that often contain several sub-tasks. We also captured other interesting data points, such as reasons to stop and restart the tasks and task switching within each session. The interviews helped to refine how we can support experienced users perform these tasks.

RESULTS

We present the results according to User Behaviour and Task Characteristics. Where appropriate we report on the self-reported web diary entries, the field study automatic system logs and the interviews from both studies. Before presenting the results, we have included a sample of both a dairy and a field study log to show what multi-session task information was recorded and to also display how participants approached multi-session tasks.

Multi-session Task Samples

Diary Study

In the Diary Study, there was an expected task named "Planning a Vacation to PEI" (see Table 2). The task was first recorded on May 19th (although this task actually started before the study) and was expected to be finished in

Title:	Planning a Vacation to PEI [Prince Edward Island]
Short Description:	To start planning a family trip to PEI in the summer
Date	May 19 (11:00) for 10-15 minutes
Subtask (ST):	Checked PEI site for accommodations available
ST complete:	No
Stop Reason:	Need to wait for a response from an email to get more information and review the web site further when have more time
Tools/Actions:	Opened windows, used history, typed URL, used a search engine, searched within the page, Email to others.
Task Finished:	No
Date	May 19 (11:11) for 5-10 minutes
Subtask (ST):	Found another link within the residence web page that provides more tourist related information that want to review and realized that I had sent an email to the wrong place
ST complete:	No
Stop Reason:	Need more time to review new links found. Waiting for response to email
Tools/Actions:	Opened windows, added a bookmark, searched within page
Task Finished:	No
Date	May 19 (3:15) for 10-15 minutes
Subtask (ST):	Received response to previous email. Checked information on prices and accommodations
ST complete:	No
Stop Reason:	Need to review with family
Tools/Actions:	Opened windows, used history, printed a page, searched within page
Task Finished:	No

Table 2. A Sample of a Task recorded in the Diary Study

June (after the study period). The participant recorded working on the task three times during the study, at different times during the day. For example, on May 19th at 11:00 the participant submitted their web diary information. The participant worked on the task for 5-15 minutes each time to look for accommodations. The participant indicated that they opened windows, used their history list, typed a web address, used a search engine, searched within a page and emailed someone else during these sessions. It is interesting to note that on the last entry, it would seem as though a response to a previous email prompted the participant to return to the task.

Field Study

In the field study, one participant recorded a task titled "Physics A4" (see Table 3). This was an expected task, described as "4th Physics Assignment". The task started on September 30th and finished on October 6th. The participant worked on the task five times. Table 3 contains information that the participant recorded each time they stopped working on the task (using the interactive toolbar). Using the logged data, we determined what actions they performed during each visit. For example, on September

Title:	Physics A4		
Short Description:	4th Physics assignment		
Date:	Sept. 30	Date:	Oct. 6
Subtask (ST):	Several problems	Subtask (ST):	All remaining problems
ST complete:	No	ST complete::	Yes
Stop Reason:	*None given*	Stop Reason:	Class
Other Apps:	Calculator	Other Apps:	Calculator
Task Finished:	No	Task Finished:	No
Date:	Oct. 3	Date:	Oct. 6
Subtask (ST):	Problems 1-9	Subtask (ST):	remaining two problems
ST complete:	Yes	ST complete:	Yes
Stop Reason:	Sleep required	Stop Reason:	*None given*
Other Apps:	Calculator	Other Apps:	Calculator
Task Finished:	No	Task Finished:	Yes
Date:	Oct. 5		
Subtask (ST):	Problems 2-33		
ST complete:	Yes		
Stop Reason:	Dinner		
Other Apps:	Calculator		
Task Finished:	No		

Table 3. A Sample of a Task recorded in the Field Study

30th the participant worked on the task for about an hour and a half and submitted a form 20 times, followed links 15 times, copied into the browser two times, excluded a tab once and switched back into the task once (that is went from an excluded tab to an included tab). We can also anticipate from the gaps in time between the actions recorded in the browser (at most, 10 minutes) that the participant, while working on the task, was also either reading material on the Web related to the task (as there was only one occurrence of switching from the task), working on the assignment (e.g., they recorded also using a calculator while working on the task), or perhaps doing something unrelated to the task (e.g., taking a short break).

User Behaviour

We explored the behaviour of participants with respect to multi-session tasks. We examined how many multi-session tasks participants recorded, the number of web sessions in which participants performed multi-session tasks and how often participants executed multi-session tasks while working on other web tasks We also examined the actual browser tools and actions that participants used to perform multi-session tasks.

Multi-Session Tasks and Web Sessions

Diary Study

As can be seen in Table 4, in the diary study, participants (22 total) recorded 85 different multi-session tasks (80 tasks

Study	Total Tasks	Total Visits	Total Repeat Visits	Avg. # of Tasks/ Participant	Avg. # of Sessions/ Task
Diary Study	85	204	119	3.86	2.40
Field Study	150	391	241	6.25	2.61

Table 4. Multi-session Tasks and Web Sessions for the Diary and Field Studies

during the first week). Ten of these tasks were recorded as unexpected. The average number of multi-session tasks for each participant was 3.86 tasks. The tasks (85) were worked on over a total of 204 sessions (the number of web sessions that participants worked on multi-session tasks). Participants worked on each task on average over 2.4 sessions.

Field Study
Over the field study, 150 multi-session tasks were recorded (see Table 4), with 16 reported as unexpected. The average number of tasks per participant was 6.25. Participants worked on each task over an average of 2.61 sessions.

Since the field study was run over a four week period, it makes sense that there would be more tasks recorded and that number of tasks per participant was larger. It is interesting that the average number of sessions per task did not increase much, indicating that multi-session tasks for both studies are similar in the number of times the participants worked on a multi-session task.

In the diary study, we were only able to count how often a participant worked on their multi-session tasks. In the field study, however, we were also able to determine the total number of web sessions that took place over the study and what proportion of sessions contained multi-session tasks. There were a total of 1183 web sessions (which for this study, was each time the browser was opened and closed), of which 391 sessions contained multi-session tasks. There were 226 sessions in which participants worked solely on multi-session tasks, although occasionally they worked on more than one multi-session task during these sessions.

We were also able to determine when participants switched between a multi-session task and other web activities from the log that captured the toggling of the include/exclude radio buttons on the toolbar (see Figure 2 (c)). All 24 participants switched from their multi-session tasks during the study. When a participant was working on a multi-session task they could include or exclude a web page in a tab or window from that task (see Table 1 for an example in the log of including a tab into the task). For example, when the participant had a web page open that was not being used for the current multi-session task they would exclude that tab. By default, the tab or window that a multi-session task was started or continued from was included in the current task along with any tabs or windows opened from an included tab/window. We logged four different actions that indicated a switch between tasks (see Table 5).

Logged Action	Count
Included this tab in the current task: Switched into task	196
Excluded this tab from the current task: Switched away from task	129
Switched into task	136
Switched away from task	166
TOTAL	627

Table 5. Switching between Tasks

The action "Included this tab…" and "Excluded this tab…" was logged every time a participant used the include/exclude button on the toolbar. The "Switched into task" and "Switched away from task" was logged every time a participant switched to a previously defined tab/window (included or excluded). In total, 627 task switching actions were recorded.

Browser Tools and Actions
The results presented below are based on diary entries (in terms of counts as recorded by participants), field study logs (actual counts as recorded by the browser logger) and post-study interviews (for specific revisitation tools).

Diary Study
For the diary study, participants were asked to record which browser tools or actions that they used while working on their multi-session tasks. While we can not track how often the tools or actions were used within each session, it does indicate what tools/actions were used for the multi-session tasks. This was useful in deciding what tools and actions we needed to track during the field study, and it did give us an indication as to the most common tools and actions used for their multi-session tasks. Overall there were 35 different tools or actions recorded by participants. Table 6 shows the top twelve tools and actions. Opening a window was the most often reported action during a multi-session task, as recorded 62 times by a variety of participants, followed by using a search engine and typing in a web page address.

In the post study interviews, we questioned participants on their use of bookmarks or other tools that they may have used to revisit information while working on multi-session tasks. Similar to other studies [1, 2, 3, 4, 15], the use of bookmarks and reasons for not using them varied among the participants. Half of the participants had used bookmarks for the task which was examined in the interview. Firefox users (whether they frequently used

Tool/Action	Num.	Tool/Action	Num.
Open Window	62	Open Tabs	24
Use a Search Engine	57	Add Bookmarks	23
Type a URL	42	Use auto complete	18
Search within a Web Page	37	Save a Web Page	18
Paste To	31	Print a Web Page	17
Open a Bookmark	26	Use History	16

Table 6. Top Tool or Actions Reported in the Diary Study

bookmarks or not) used Firefox's toolbar bookmarks for sites they revisit regularly but not, interestingly, for the multi-session tasks we were interested in (as they did not want to clutter their toolbar with sites that were considered temporary). Participants who did not use bookmarks tended to revisit pages by retyping URLs (often with auto complete) and re-searching terms. Participants also used other applications to help with their tasks. For example, several participants cut and pasted information into Word or Notepad to compare details and in order to store only relevant information.

Field Study

During the field study, 102 different browser tools and actions were captured (as recorded in *Name* in the logs, as seen in Table 1) which also included the way the action or tool was used (e.g., if a new tab was opened from the menu, control keys or buttons). In Table 7, we present the most common actions and tools as recorded in the field study logs. We also organized the use of tools and the actions used by multi-session tasks and by all other web activity. We present the counts and the percentage of the actions.

While the tools and actions recorded for other web activities tended to be higher than for multi-session tasks, there were fewer multi-session tasks in relation to the other logged web activities. Following a link was the most common activity logged. This count included links followed in the current page, links opened in a new window, and links opened in a new tab. Submitting a form commonly indicated when a participant was performing a search. The two most common forms submitted were to Google and to Google Scholar (93.55% for multi-session tasks) (both of which were used more often for multi-session tasks). Participants recorded using a number of different web search bars (e.g., IMDb and Wikipedia) but the most common was Google. Participants used cut/copy and paste into outside documents and into the browser itself in both single and multi-session tasks. Participants used the search within a page more often for multi-session tasks (53.27% vs. 46.73%) but typed in URLs less frequently for multi-session tasks (28.91% vs. 71.09%).

Using post-study interviews and the logs, we found similar results to the diary study with regard to participants using bookmarks. Only half of the participants said that they use bookmarks, and many of these participants indicated that they did not use bookmarks for multi-session tasks as they considered them too temporary and for some they did not want to clutter their bookmark list with transitory pages. Almost all of those who said that they use Firefox's toolbar bookmarks reserved these for those pages that were frequently accessed. In the browser logs, the most common way that the participants opened their bookmarks was from the toolbar (987 of the 1441 incidences). We found support for the interview comments as only 15% of opening toolbar bookmarks were logged during multi-session tasks. Similar to the diary study interview comments, participants who did

Browser Tool or Action	All Counts	For other Web use	For multi-session tasks	% other Web Use	% of Multi-session
Followed Link	31028	23388	7640	75.38%	24.62%
Go Back to	6672	3829	2843	57.39%	42.61%
Go Forward to	188	94	94	50.00%	50.00%
Submitted form	5843	4244	1599	72.63%	27.37%
Used Search Engine (Google)	*3538*	*1526*	*2012*	*43.13%*	*56.87%*
Used Google Scholar	*279*	*18*	*261*	*6.45%*	*93.55%*
New Tab	5820	4377	1443	75.21%	24.79%
New Window	4134	3202	932	77.46%	22.54%
Used Bookmarks	1629	1274	355	78.21%	21.79%
Opened Bookmark	*1441*	*1187*	*254*	*82.37%*	*17.63%*
Created Bookmark	*154*	*69*	*85*	*44.81%*	*55.19%*
Managed Bookmarks	*34*	*18*	*16*	*52.94%*	*47.06%*
Opened User Typed URL	1207	858	349	71.09%	28.91%
Opened Auto-complete URL	926	661	265	71.38%	28.62%
Cut, Copy and Paste	1049	550	499	52.43%	47.57%
Look for in page	978	457	521	46.73%	53.27%
Used Web Search Bar	503	341	162	67.79%	32.21%
Used Google Web Search Bar	*375*	*253*	*122*	*67.47%*	*32.53%*

Table 7. Browser Tools and Actions Recorded in the Logs

not use bookmarks reported using other means to revisit web information (e.g., typing in the URL from memory, re-searching the topic in Google, saving links, printing pages, coping information to a text editor, or using their history).

Task Characteristics

For Task Classification we used the information that the participants self-reported on their multi-session tasks. As such we were to compare and report results from both the diary study and the field study. We found that participants from both studies reported comparable task characteristics. Using this information we were able to organize the multi-session tasks into eight types according to common themes. Furthermore, we found that the sub-tasks for the multi-session tasks could be classified using the web tasks categories as defined by Kellar et al. [12].

Task Types

Although the specific goals of the tasks recorded (235 tasks total from both studies) varied we were able to group the tasks using their task title and description into eight general types: school work (67), general topic search (66), research (25), travel/tourism (21), projects (19), action-based (18), shopping (14), and status checking (5). As Table 8 shows, the largest task type was *school work* (28.51%), which is not surprising as the majority of participants were students. There is a large difference between tasks classified as *school work* by the diary participants (7.06% of diary study

Task Categories	Diary Study		Field Study		Totals	
	#	%	#	%	#	%
school work	6	7.06%	61	40.67%	67	28.51%
general topic search	29	34.12%	37	24.67%	66	28.09%
Instruction or directions	*19*	*22.35%*	*14*	*9.33%*	*33*	*-*
Looking up Information	*0*	*0.00%*	*23*	*15.33%*	*23*	*-*
Relocation	*9*	*10.59%*	*0*	*0.00%*	*9*	*-*
Entertainment	*1*	*1.18%*	*0*	*0.00%*	*1*	*-*
research	11	12.94%	14	9.33%	25	10.64%
travel/tourism	13	15.29%	8	5.33%	21	8.94%
projects	12	14.12%	7	4.67%	19	8.09%
action-based	5	5.88%	13	8.67%	18	7.66%
shopping	7	8.24%	7	4.67%	14	5.96%
status checking	2	2.35%	3	2.00%	5	2.13%
Totals	85	100%	150	100%	235	100%

Table 8. Task Types

tasks) and the field study participants (40.67% of field study tasks) which we believe is due to the timing of each study; the diary study was run after a winter/spring term and the field study was run in the middle of a fall term.

We subdivided *general topic search* (28.09% of the tasks) into four sub-groups: looking for instructions or directions (e.g., how to use Skype or how to start a university society), looking up information, relocation (e.g., job hunting), and entertainment (e.g., reading up on world soccer). *Research tasks* (10.64% of the total tasks) had longer time lines and involved searching for a similar topic over several sessions. *Travel/tourism tasks* (8.94%) involved such actions as planning vacations and making conference arrangements. *Project tasks* (8.09%) lasted for longer periods and always contained sub-tasks. *Action-based tasks* (7.66%) involved transactions, such as completing online surveys and transferring money. *Shopping* (5.96%) included a variety of products, such as sandals and a laptop and involved actions such as price comparisons between web sites, bidding on eBay, emailing friends for feedback, and tracking shipments. For *status checking* (2.13%), participants continually checked on some information (e.g., watching for a cheque that was to be deposited to their bank account or checking for an updated course schedule).

Sub-task Types
When examining how participants worked on the task during each web session, we found there to be a series of sub-tasks within each task (for example, see Table 2 and Table 3 for sample study tasks and their sub-tasks). As Table 9 illustrates, there were a total of 428 sub-tasks recorded over both studies and interestingly, some of these sub-tasks also occurred over more than one session (e.g., booking flights was often done over several sessions in order to compare schedules and cost). The sub-tasks were

Task Type	Diary Study		Field Study		Totals	
	#	%	#	%	#	%
Information Gathering	129	55.13%	99	51.03%	228	53.27%
Fact Finding	54	23.08%	65	33.51%	119	27.80%
Transactions	27	11.54%	19	9.79%	46	10.75%
Communication	11	4.70%	10	5.15%	21	4.91%
Maintenance	13	5.55%	1	0.52%	14	3.27%
Totals	234	100%	194	100%	428	100%

Table 9. Sub-task Types

classified using the previously defined categories of web tasks of Kellar et al.[12]. We arranged these sub-tasks as follows: 228 as information gathering (53.27%), 119 as fact finding tasks (27.80%), 46 as transactions (10.75%), 21 as communication (4.91%), and 14 as maintenance (3.27%). We did not include browsing as it is considered a serendipitous act [11] usually performed for entertainment purposes. While some counts differed, we saw similar numbers for the different types of subtasks in the studies. One reason for the larger number of maintenance type subtasks in the diary study may be because there were university employees who were responsible for tasks involving the Web. In some cases, more than one type of sub-task occurred during a single session (e.g., during one session for the task "Attend Conference" in the diary study, the participant filled in the registration form and gathered accommodation details).

DISCUSSION
The main goal of the diary study and field study was to gain a better understanding of how participants perform multi-session tasks and to help characterize these tasks. A secondary goal of these studies was to provide data for researchers, including ourselves, to help in designing browser tools and/or in designing improvements for existing browser tools for multi-session tasks.

For both studies, we conducted post-study interviews where we demonstrated browser tools that we felt might be useful when working on multi-session tasks. This demonstration of the tools prompted participants into a discussion on the types of tools or features of tools that they thought would be helpful in performing multi-session tasks. We demonstrated tabs (to diary study participants who never used tabs), session saver (a Firefox extension that saves and reopens tabs), Landmarks [14], page annotations (www.mystickies.com) and Google Notebook (adds snippets of different web pages that can be shared) to the field study participants only.

Many of the suggestions for tools were repeated by the participants. The different suggestions for tools included improving bookmarks to include an automated system to create bookmark folders (e.g., based on search terms) and to remove bookmarks based on a user inputted expiry date. Other suggestions included having text editors in the browser, associating and organizing different types of

documents (e.g., emails, web pages, word files) together based on a topic, a reminder tool or task scheduler for the tasks that you are working on, combining session saver with Landmarks to indicate not only the pages that you last saw but where you were on the pages, keeping a history of web pages where you could go back to where you were in the page, having a project management system, and having access to a log of web pages that you can visit from any computer.

Using the comments from the post-study interviews, and the information collected during the diary study and field study, we have identified three main features for browser tools that may assist users perform their multi-session tasks. First, participants indicated that they would like a reminder feature, such as the one shown in Figure 2 (c) to keep them on task and to remind themselves of tasks in progress during the current session. Participants liked using the browser for multi-session tasks because seeing the task name in the toolbar helped to keep them on task. Second, we found that participants, especially with the addition of tabbed browsing, typically worked on several tasks during a single web session and that any new tool should support multi-tasking. Third, participants commented that they would like to be able to manage their tasks between sessions, including being able to quickly return to viewed pages in their last seen state, to be able to better organize information associated with the task, and to easily manage the removal of saved web pages at the end of the task.

CONCLUSIONS

Using the information that we collected during the diary study, the field study, and the interviews we have been able to identify how experienced web users perform multi-session tasks and classify multi-session tasks.

While asking participants to self-report their multi-session tasks may have added bias into the studies; we felt it was necessary in order to gain a greater understanding of how users perform these tasks. We asked the field study participants if the customized browser influenced their web behaviour and the majority responded that it did not. The others mainly noted (as mentioned before) that the toolbar helped keep them on task. A few participants noted some technical difficulties that they experienced as well (such as the bookmark manager not working properly).

In the future, we will analyze the logged data from the field study to examine more closely how users switched between multi-session tasks and other web activities and to explore a better definition of session using the time data. We also plan to develop prototype tools based on our above findings and evaluate these in a field study.

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