User Browsing Behavior in New Tabs of Firefox

ABSTRACT

In this paper we present a user study on Firefox Test Pilot platform to detect how users navigate within new tabs of Web browsers. The results help us form a better understanding of new tab usage and also provide a fundamental and solid quantitative analysis for the re-design process of Firefox new tab pages. Three basic research questions are: (1) What do users browse (Content)? (2) How do users load Web pages to navigate (Method)? (3) How long do users stay in and how fast do they interact with new tabs (Timing)? According to our study, users browse a broad set of distinct domains but only a small proportion of them attract most visits. The URL bar is heavily utilized to start a page load in new tabs. Many study participants are either exclusively keyboard-centric users or mouse-centric ones, and they behave differently in several respects.

Author Keywords

Web browser, browsing, navigation, Firefox, Test Pilot, user study, data analysis, behavior

ACM Classification Keywords

H.1.2 Models and Principles: User/Machine Systems—*Human factors*; H.4.3 Information Systems Applications: Communications Applications—*Information browsers*; H.5.2 Information Interfaces and Presentation: User Interfaces

General Terms

Experimentation, Measurement, Design, Human Factors

INTRODUCTION

Mozilla Firefox is a popular open-source Web browser, a type of software application specifically designed for browsing the Web. A Web browser consists of multiple tabs; users can navigate a Web page in each tab. Tabs can be dynamically opened or closed at any time. In this paper, a *new tab* is defined as a tab newly created by the user, in which a web page has yet to be loaded with further actions. Different browsers have different ways of customizing new tabs with settings and content. Chrome shows three lists of browser extensions, most visited pages and recently closed sites respectively. Safari has top sites or pages in the browsing history. Unlike others, Firefox intentionally leaves new tab blank instead of filling them with information.

The decision to leave new tab pages in Firefox blank was driven, in part, by a suspicion that too much information in the new tab may distract users from getting to the destination intended for the new tab. However, the reliability of the suspicion is still unverified. Therefore, the Mozilla User Research team [3] has recently released several user studies through the Test Pilot [2] platform. The aim of the studies is to understand user behavior patterns of managing and using new tabs of Firefox, and ultimately to inform the re-design process of Firefox new tabs. The first user study tracks participants' daily usage of new tabs without any modification of the new tab design; another following study has users divided into several testing groups each provided with a different new tab design so as to compare the influences and efficiency of various designs. This paper will focus on the first one. Several interesting results discovered through the study will be discussed in detail in the following sections.

BACKGROUND

A good design of the new tab in Web browsers should be able to facilitate users in reaching their desired destination quickly, while minimizing the possibility of distracting users from their original targets. These two basic concerns seem to be contradictory, since the former one requires some mechanisms to provide Web page recommendations which may distract users' initial focuses. To find a balance between the two demands, we must better understand how users are browsing in newly opened tabs with the current interface. We use Firefox Test Pilot as the primary tool to launch user studies to quantitatively study this problem.

Test Pilot [2, 5] is a platform collecting structured user feedback through Firefox. It explores how people use their Web browsers and the Internet by tracking user behavior in the browser for quantitative data, or releasing survey questions for qualitative data. Test Pilot currently has about 3 million users. All the studies are opt-in for privacy reasons, so there is a known self-selection bias. The Mozilla Metrics [1] team has compared the group of general Firefox users to Test Pilot users, confirming that Test Pilot users tend to be slightly more skillful; but Test Pilot data is still very valuable for better understanding users and building better products.

USER STUDY DESIGN

A prior-stage Test Pilot user study was released to explore users' browsing behavior in new tabs and to prepare for the re-design of Firefox new tabs. It tracks when and how users open new tabs, how they navigate Web pages in new tabs and when they leave those tabs, but does not change the interface design. Specifically, the study keeps a set of records for each participant (See Fig. 1). Notice that with tracking `tabID`, we can recover the sequence of page loads in each tab and therefore first and second page loads can be identified separately.

The study was released to a random 20% of Test Pilot users in order to control the dataset size. Once a user begins participating, the study runs for 5 days. We collected more than $250,000$ valid submissions of 5-day new tab usage data. We were able to discover several interesting patterns of new tab

Table 1: The structure of data records.

Attribute	Explanation
timestamp	Unix time stamp.
tabID	A new tab will be assigned with an ID which is unique for tabs of each user.
event	It includes three types of predefined values, *start*, *navigation* and *leave*. They are all operations with tabs.
method	Detailed actions that triggers the event.
hashedDomain	The domain of the URL in the URL bar, hashed with MD5 to hide the actual domain for privacy rasons. We record this because we would like to see how broadly users browse and the distribution of visitation frequencies across domains.
numTabs	The number of opened tabs.

usage through the data analysis.

BROWSING BEHAVIOR ANALYSIS

Data collected through Test Pilot demonstrates browsing behavior patterns and habits of browser users from several perspectives. We have three basic research questions while exploring and analyzing the data: (1) What do users browse? (Content), (2) How do users load Web pages to navigate? (Method) and (3) How long do users stay in and how fast do they interact with new tabs? (Timing). Basic statistics show that users on average open 11 new blank tabs, load 7 Web pages, and visit 2 distinct domains per day.

What do users browse?

Confirmation of the 80-20 law

The popular 80-20 law, also known as the Pareto principle, states that, for many events, roughly 80% of the effects come from 20% of the causes [4]. The 80-20 law in Web browsing means that users browse a broad set of domains, but only a small proportion of the domains attract most visits. We can check whether the empirical data confirms this principle, both globally and individually.

Globally, we examine the global visit frequencies of each domain, and identify that globally only 17.38% domains $(461, 133$ in total) take 80% of the total page loads $(8, 291, 541$ in total). This verifies the 80-20 law of long-tail phenomena. On the individual level, we are interested in whether a single user browses different Web domains according to the 80-20 law. For each user, top domains taking 80% of the total page visits are defined as *primary domains*. A single users can be said to follow 80-20 law if the number of his primary domains is around 20% of the total number of distinct domains. However, we find that individual users behave quite differently, with a broad distribution of proportions of primary domains. In Fig. 1, each point represents a single user and it is positioned according to the number of opened tabs while navigating and the proportion of primary domains of this user. Active users browse more web pages everyday, but the number of primary domains they go to decreases proportionally. This

suggests that when users open more and more tabs, they prefer to go to the same sites more frequently. A large amount of page visits are generated by a few top popular domains, which is consistent with the idea of the 80-20 law.
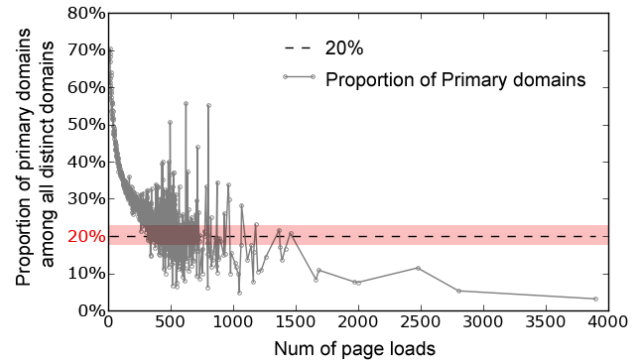

Figure 1: Active Users have higher preferences for top sites.

URLs in Clipboards

Almost 14% of new tabs $(13, 941, 404$ in total) are opened while the clipboard contents start with "http" or "www": text very likely to be URL strings. When users have URLs in their clipboards, they may be trying to copy a link from an existing tab, open a new tab, paste it into the URL bar and finally load that page. Since this process is so inconvenient with many steps, many users could benefit if the browser were able to facilitate the copy and paste of URL strings. Furthermore, in this case, a new tab filled with site suggestions will be very likely to distract users from their original destinations and slow them down.

How do users navigate?

Navigation actions

There are 11 different actions on 4 UI elements that can lead to page loads, as listed in Fig. 2. For each user, we compute the *usage percentage* of each action and determine which actions are more heavily used. Then the average usage percentage of each action across all users can be calculated as well, representing the global popularity of certain elements (See Fig. 2).

Fig. 2 exhibits usage percentages of detailed actions for first and second page loads separately. The URL bar dominates usage, as 60% of first page loads and 45% of second page loads come from interaction with the URL bar. The search bar is second-most popular, used for another 20% and 40% page loads. Users prefer the bookmark toolbar to the bookmark menu button. The history menu button is seldom clicked. Notice that search bar drop-down clicks grow to be the most popular navigation method for second page loads. The search bar drop-down provides a list of search word suggestions after users typing in a few letters. Its heavy usage for second page loads indicates that users may turn to the search bar if they do not initially find what they are looking for, and that the search word suggestions are widely adopted.
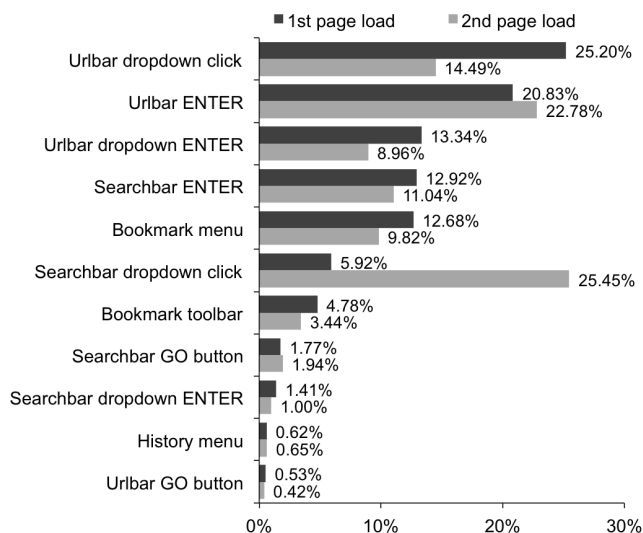
Figure 2: Usage percentages of navigation actions in new tabs for first and second page loads.

Keyboard-centric vs Mouse-centric
Actions leading to page loads can be classified into two groups based on whether they require mouse or keyboard to perform. To quantitatively compare mouse and keyboard usage, we define a *keyboard-centric ratio* r as the fraction of the number of keyboard actions to the number of total actions, representing the user's preference for using the keyboard. We can compute a r for each user; $r = 0.0$ indicates a completely mouse-centric user and $r = 1.0$ represents a keyboard-centric user.
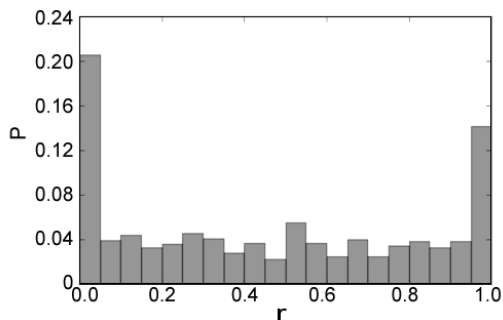

Figure 3: Histogram of keyboard-centric ratio.

According to the histogram of all users' keyboard-centric ratios (See Fig. 3), there are slightly more mouse-centric users. Two peaks at the two extreme values indicate users' strong preferences for either mouse or keyboard: 20% are using mouse exclusively and 14% using keyboard exclusively. It implies that once a user develops into a habit of heavily relying on either mouse or keyboard, she may stick with using it and therefore form a very small or large r. Users with a balanced mixture of mouse and keyboard usage ($r \approx 0.5$) are comparatively fewer.

If we compute usage percentages of different navigation actions for users with different preferences for mouse or keyboard, we can see how usage of UI elements varies as users

go from more mouse-centric to more keyboard-centric (See Fig. 4). Due to the space limit, we will not discuss this in detail here.

How long do users stay and how fast do they interact?
We measure two timing factors during Web browsing, the time delay between the tab open and the first navigation (t_{delay}), and the time staying in a new tab (t_{stay}). Considering that both two measures have scale-free distributions and outliners or unexpected noises may vary the mean value a lot, the median number should be a better descriptor of the average situation than the arithmetic mean. By measuring median values, we find that users load the first Web page in 6 seconds after they open the new tabs, and stay in the tabs for 1 minute once they start browsing.

Users have several ways to open a new tab, including command+T, a double-click on the tab bar, the new tab toolbar button, and the new tab menu button. Command+T is a keyboard command, and the others are mouse-centric. Consequently, by dividing all recorded tabs into two groups of keyboard-induced or mouse-induced tabs, we can compare the timing factors of users in these two types of tabs. Users in keyboard-induced tabs generally start the first page navigation faster and concentrate for a longer time (See Table 2).

Table 2: Users in keyboard-induced tabs start navigation faster, and focus longer.

Tabs	t_{delay} (sec)	t_{stay} (sec)
Mouse-induced Tabs	6.28	54.76
Keyboard-induced Tabs	6.01	62.91

Correlations with number of opened tabs
Users are allowed to open multiple tabs in the browser at the same time. Some users prefer to keep a large group of tabs opened no matter whether they are currently in use or not; some are in favor of a clean browser interface with a few opened tabs. The number of opened tabs that users keep while browsing can influence some other browsing behavior.

Keyboard actions have special shortcuts, more convenient and easier for managing a large group of tabs. The empirical results of users' choices suggest the advantages of using keyboard to manage multiple tabs, since there is an explicit correlation between a large number of opened tabs and a strong preference for using keyboard (See Fig. 5a). In other words, the heaviest tab users may be the ones who are least likely to benefit from a mouse-centric interface of new tab design with site suggestions. Interestingly, more tabs are correlated with shorter navigation delays (See Fig. 5b). One possible explanation might be that users with many tabs are usually more skillful than others and therefore can use tabs more efficiently. The time the user remains in a tab does not seem to depend on the number of open tabs (See Fig. 5c).

CONCLUSION AND FUTURE WORK
This paper presents a user study for understanding user browsing behavior in new tabs of Web browsers, partly driven by the re-design requirement of Firefox new tab pages. We detect user behavior patterns of how they use new tabs, with
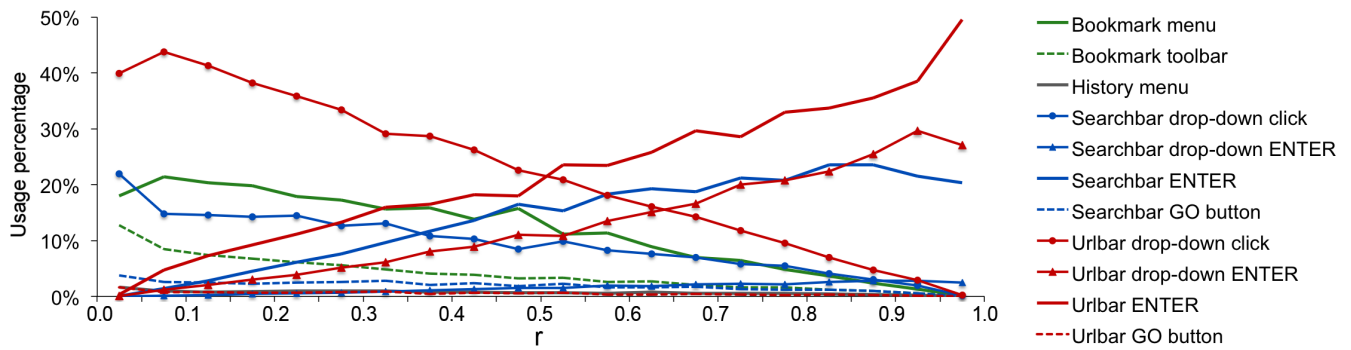
Figure 4: Users with different preferences for mouse or keyboard navigate differently.
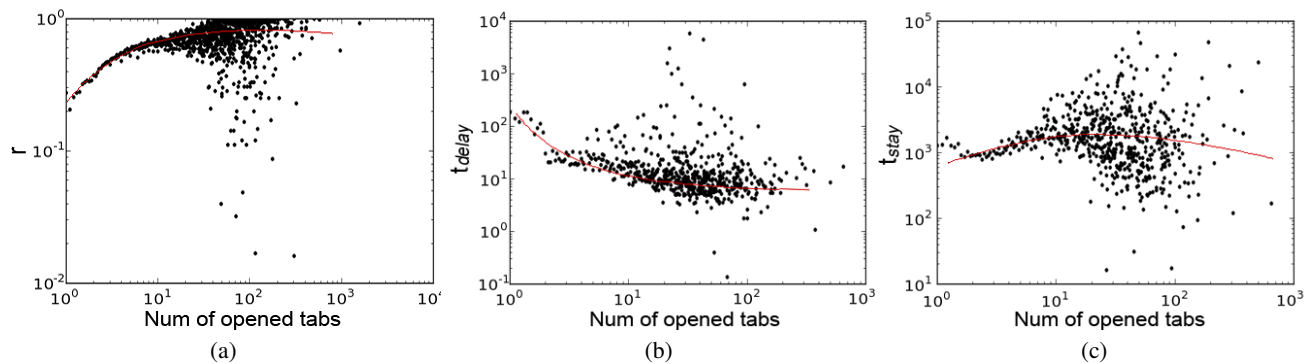

Figure 5: Correlations between number of opened tabs with r, t_{delay} and t_{stay}.

three basic research questions related to browsing contents, navigation methods, and timing factors. Users browse a broad set of domains but only a small proportion of them attract most visits, which is unsurprising according to the 80-20 law. Before starting navigation, many users may have a clear target in mind, since many of them have URL-like strings in clipboards in advance. For loading Web pages, the URL bar is the most popular UI element, and the search word suggestions in the search bar drop-down menu are especially heavily used for the second page load. Users generally start the first navigation in 6 seconds (median), and stay in the tab for 1 minute (median). During the whole process, we classified users into mouse-centric and keyboard-centric groups based on their interactions with the browser. It turns out that many users would like to exclusively rely on either mouse or keyboard since they have formed their own habits of browsing. Users in keyboard-induced tabs seem to start navigation faster, focus longer and handle more open tabs at one time. The study results to some extent support the potential benefit of a top-site suggestion interface in the new tab, especially for active mouse-centric users, but this type of interface still requires further consideration for other groups of users.

As follow-up work, we will do an A/B test to compare several designs of Firefox new tab pages where more research questions can be better answered. One important goal is to answer whether too much information in the new tab can distract users from the original targets. It can be quantitatively measured through comparison of timing factors among differ-

ent designs. Another improvement should be done in detecting whether users often have targets in mind before starting the new tabs. The proportion of new tabs opened with URLs in the clipboard is surprisingly high. However, inappropriate URL detection or the influence of previous actions may be distorting this picture. To have a more accurate measure of URL validity and track the action sequences will be valuable for understanding the intentions that users have with these URL strings. For example, if we can detect that users often change focus onto the URL bar and then paste the URL string from the clipboard, we should be able to conclude with much higher confidence that users do often look for certain URLs while browsing.

REFERENCES

1. Mozilla metrics, http://blog.mozilla.com/metrics/.

2. Mozilla test pilot, https://testpilot.mozillalabs.com/.

3. Mozilla user research, http://blog.mozilla.com/userresearch/.

4. Newman, M. E. Power laws, pareto distributions and zipf's law. Arxiv preprint cond-mat/0412004, 2004.

5. Zhang, J., Xia, J., and Faaborg, A. Test pilot: Moving towards open source user research. In *Proc. of ACM SIGCHI Conference on Human Factors in Computing Systems* (2010).