
popHistory: Animated Visualization of Personal Web Browsing History

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Abstract

Web browsing is an essential component of creativity, productivity, and recreation, but users may fall into undesired patterns if they do not realize their habits. Because reflection has been shown to improve control over behaviors and ability to develop goals, we emphasize reflection for self-improvement, without explicitly requiring it. In this paper, we present the design and development of a prototype which collects and visualizes users' browsing histories over time. We explore the use of animation in the visualization and learn how users analyze and reflect on their browsing behaviors. Through a formative study using this prototype with 11 participants, we find that an animated visualization allows users to better reflect on their browsing habits and discover patterns of which they were previously unaware, especially when compared to the traditional history list view in most browsers. We discuss specific findings across six areas and their implications for future design and research.

Author Keywords

Web history; visualization; reflection; personal informatics.

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

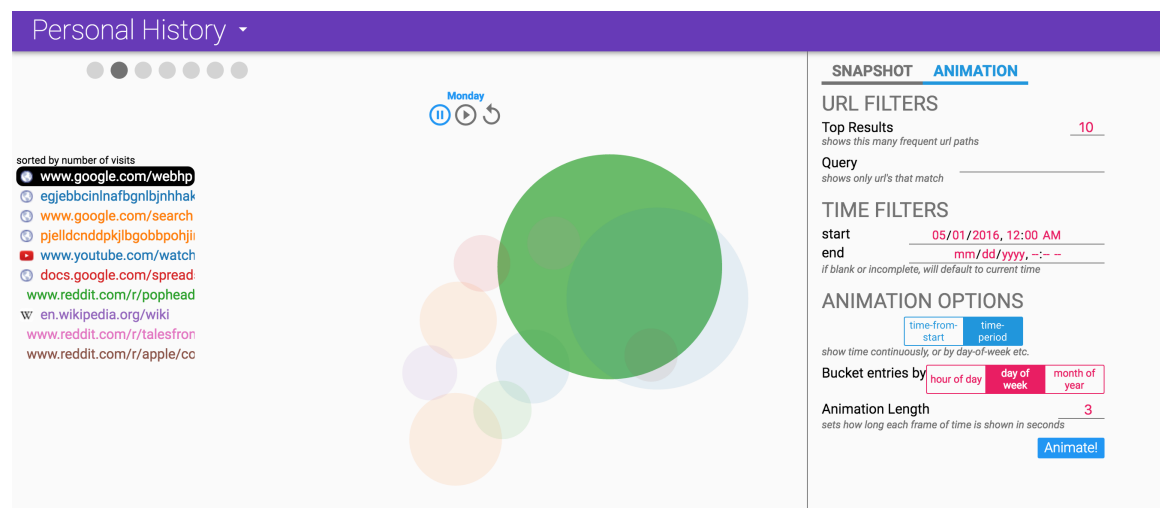


Figure 1: popHistory Bubble displays an aggregated view of a user's browsing history using a bubble chart. Users can easily view their most visited websites (left) and set options for the visualization and animation (right).

Introduction

Web browsing is a critical part of daily life, as the Internet is a place for productivity, creativity, recreation, and socializing. However, users may unknowingly fall into unwanted patterns that may be harmful for their health or productivity. For example, excessive social network service (SNS) usage can increase stress and distract from work-related tasks [18]. Aside from work-related productivity, the Internet is also a place where ideas are made and collected [9] and unwanted behaviors can similarly detract from these tasks. Prior research has primarily focused on how to support existing habits and re-find tasks [10]; however, these approaches do not necessarily help users to 1) analyze their current patterns and behaviors, or 2) discover potentially unhealthy or unproductive web browsing habits. The traditional browsing history list view available in most

browsers supports a textual search for re-finding previously browsed sites, but does not assist users in seeing their browsing patterns. We emphasize reflection as a tool for self-improvement, because though reflection is not necessarily of benefit to users [1], it has been shown to increase sensation of control over SNS usage [18]. Outside of web browsing, reflection has also been shown to help Fitbit users come up with better goals [7].

In this paper, we explore how visualizing users' personal web browsing histories can enable reflection and discovery of their behaviors. We begin by designing and implementing an animated visualization, popHistory, as a technique for prompting users to reflect on habits from their web browsing history and contribute implications for further study of reflection for web browsing. We then conducted a formative

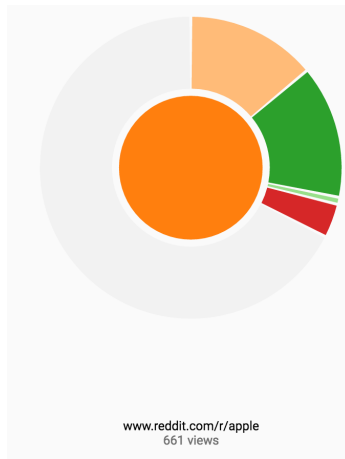


Figure 2: popHistory Sunburst shows the relative page visits for top-level domains and their subpaths. In this example, www.reddit.com/r/apple has 661 visits and four subpaths.

study with 11 participants using our prototype to compare the user experience of the animated visualization to a traditional list-view and to investigate what users saw when they reflected on their habits. This paper contributes (1) an understanding of how using an animated data visualization can promote reflection on web browsing habits in six areas, and (2) implications for further research into how users utilize knowledge of web browsing habits.

Related Work

Previous workshops regarding personal informatics [8] have discussed designing interfaces and developing devices, applications and infrastructures to collect and reflect on personal data to improve self-understanding. Cuttone et al. [4] developed a mobile interactive visualization system for personal mobility and social interaction data, and show that the system allowed new insights into participants' behavior patterns. Users viewed the visualizations as "storytelling props," because "viewing a browsing session as a story can provide reflection on what was done and why" [6].

RescueTime [12] is a commercial tool for helping users track their browser history, set goals, block unwanted websites, and receive automated feedback for reaching or failing to reach their goals. However, such systems can be counterproductive if they promote dependency which may introduce fragility to users' behavior change efforts as abandoning the app, and subsequently disengaging with behaviors, was common [3, 11]. Similarly, Kim et al. [11] compared positive versus negative framing in providing productivity feedback and differentiated between wanted and unwanted behaviors. Our visualization does not include any trackers or goal-setting systems, but instead focuses on providing a means for reflection.

meTime [17] shows recent (past half hour) application and

website usage in a persistent, and on-screen window. Whitaker et al. found that users reduced the amount of time spent on non-work activities when using meTime despite not requiring users to specify goals or which apps were unproductive. Our visualization carries forward the simplicity and low barrier of engagement meTime demonstrated, but improves upon meTime by showing habits over a customizable time-frame (e.g., days, weeks, or months), utilizing animation, and showing periodic trends.

Wang et al. explored visualizing web browser history with a barcode chart [16] by showing relative frequency (by changing the size of entries) and temporal information (by the ordering of entries). Viégas et al. [15] explored animation as a technique for showing trends in a user's email logs. Our visualization also uses scale to represent visit counts, and our animation also communicates temporal information. However, by using animation, we allow users to infer stories from their data.

popHistory: Description of the System

The popHistory prototype has three components: a Google Chrome extension [5], which queries and processes the Chrome History, an animated visualization of the user's history (popHistory Bubble), and an interactive sunburst visualization of that history (popHistory Sunburst).

Processing the Browser History

History entries are aggregated collections of page visits from the Chrome History API based on URLs. At any stage, only the n most-viewed *history entries* are kept (where n is user-selected). Page views from the Chrome History API are first aggregated into *history entries* by the top-level domain. The n -th most-viewed entry is used as a baseline and any subpaths or subdomains that are viewed more often than the baseline are split from their parent

and become their own entry. For example, a heavy user of www.reddit.com might view www.reddit.com/r/food and www.reddit.com/r/programming often enough that those subparts become their own history entries, to increase the salience of what is shown, as suggested in [3].

popHistory Bubble

popHistory Bubble in Figure 1 is an animated visualization displaying each history entry as a semi-transparent circle, colored by the entry and sized by the number of page visits. Most frequently visited entries are larger than uncommon entries. The bubbles have the same opacity and are placed with a force-directed layout to minimize overlaps.

The animated view has two modes: it can either playback a user's history in sequence (*timeline view*) or it can aggregate history entries to show a user their typical day, week, or year (*periodic view*). For either method, the number of key frames are generated based on the user-specified date range and bucketing option. In the *timeline view*, each key frame represents an absolute slice of time and shows entries from that time, whereas in the *periodic view*, each key frame represents a certain hour of day, day of week, or month of year and shows aggregated data for that slice. A *periodic* day-of-week view, for example, buckets history entries into 7 frames, one for each day of the week, and aggregates each day across the entire selected time period.

A list of the top n URLs is shown on the left of the interface in Figure 1. The list and bubble chart uses brushing and linking, so the user can hover over a URL or bubble to highlight the associated URL. Users can also click on a bubble to see the exact number of visits or click on a URL to open that link. By allowing users to focus on a particular entry while retaining a view on the overall key frame, we provide a focus+context view [2].

When the user hits play, the animation transitions between frames by growing and shrinking entries. Users can click on a timeline to switch between frames at will. Hovering over entries will pause playback temporarily. popHistory affords for a hands-off animation of web browser history, but also includes tools for manual inquiry.

popHistory Sunburst

Users can also see a snapshot of their history across a selected time period rendered as an interactive sunburst chart in Figure 2. The first layer shows the user's top n paths (e.g., www.reddit.com/r/funny) and the second layer shows any significantly large subpaths from those parents (e.g., www.reddit.com/r/funny/comments). Each slice is assigned a randomly chosen color to differentiate them.

Hovering over a slice highlights the selected piece and clicking it shows additional details (e.g., the full URL and number of visits). We use this top-down approach, as suggested by the *Visual Information-Seeking Mantra* [14]: "overview first... details on demand".

Formative Study

Methodology

We conducted a formative study with 11 participants (7 male, 4 female) to understand the benefit of a visual, animated history view over the traditional history list view. All participants were either data scientists or data science interns. Eight participants were graduate students and three had a Master's degree or higher. All participants were familiar with the Chrome's list history. Ten participants had never seen the interface before (P1-P10) and one participant (P-repeat) participated in a pilot study for the interface a few weeks prior. The participants were given a \$10 gift card after they completed the study.

User Study Questions

Q1: It was easier to see which sites I use frequently with the popHistory Bubble view than with the standard history.

Q2: It was easier to see how my habits change over time with the popHistory Bubble view as compared to the normal history.

Q3: The popHistory Sunburst enhanced my ability to see what sites I visit frequently compared to the normal history.

Q4: It was easier to see my browsing habits throughout a day with the popHistory Bubble.

Q5: I learned more about my habits from seeing a month of my history instead of a week.

Each user was first shown the built-in browser list history view, followed by the popHistory visualization. For each condition, users were asked to write down what trends, activities, or phenomena they saw from one week of their web browsing history. The order of conditions was not alternated because the users had all used Chrome's history view previously. During the popHistory condition, users were first shown popHistory Sunburst. Then, when users start to use popHistory Bubble, they were asked to use a *periodic* hour-of-day view at least once during their exploration, but were otherwise allowed to use popHistory freely. Finally, they used popHistory Bubble to see the last month of their history with a *timeline view*. We did not ask them to view a month of history with a list-view, because in a pilot study the participants quickly became bored.

After the study, we administered a short, semi-structured interview. All interview data was processed first with an in vivo (live) coding. Additionally, participants completed a survey with five 5-point Likert scale questions on the left sidebar. Users' interactions were also logged during the study for 9 of the 11 participants.

Results and Discussion

From the user logging data, we found that participants on average used 4.88 animations ($SD=2.02$), and scrubbed to a particular point on their timeline an average of 10.7 times ($SD=6.4$). This indicates that users are interested in investigating specifics. Future work should include a breakdown of site titles or queries on demand.

The survey Likert results in Figure 3 shows that most of participants agree or strongly agree that it was easier to see their browsing habits with popHistory than with normal browsing history. Regarding the different loopback period, seven participants said that they learned more about their browsing habits with a month history than a week his-

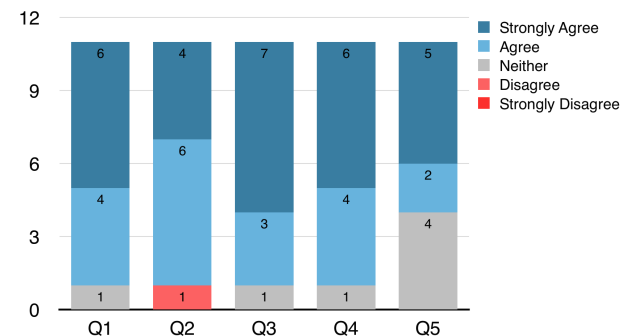


Figure 3: Users agreed that the popHistory was better for helping them see habits and trends.

tory. The interview responses produced 32 focused codes across 6 categories: seeing habits, list view history use, behavior goals, overviews, history details, and UI complaints.

Seeing Habits. popHistory Bubble helped users reflect on how their browsing habits changed throughout the day or week by showing the distribution of their browsing activities over time. When asked about what habits and patterns they saw in their browser histories, participants often gave self-reflective answers about their mood or surprising activities: *"I didn't think I was working that late. I know I have on some days but not all the time. Browsing history says no, you've been sleeping late pretty often"* (P-repeat).

"I liked the correlation between the time and the website that I visited. For example, when I was tired I listened to more music to make me cheer up and... work better" (P5).

Chrome History Use. Although it is possible to see when a website is visited with a list-view of history, most (10/11) participants believed the Bubble view provided a better view of how their habits changed throughout the day. Unlike a list of history entries, which requires manual effort to traverse,

the Bubble view did the work for participants, note that *"I guess you could see [usage throughout the day] with the old history too, but... you'd have to scroll through pages and pages"* (P6) and *"Scrolling down... is very boring"* (P9).

Many users identified the Bubble view as helpful in seeing trends in their behaviors over time, but some also appreciated the static Sunburst view for getting an immediate sense of their time distribution. P1 said the Sunburst view *"helped me understand the breakdown [between sites]"*.

Behavior Goals. By seeing an animated view of their history, many participants reflected on their habits, appraising them as either positive or negative. Many participants wanted to increase productivity by reducing time spent on sites such as Facebook or improve work task efficiency. P6 said *"I notice that I'm lost for hours at a time and it would be nice if I was better at searching the web."*

P-Repeat had the unique opportunity to see whether or not he was able to achieve his goals. After the first, informal session, he sought to reduce his YouTube usage. During the formal study, he reported mixed results: *"I definitely believe I've reduced the amount of YouTube watching, but I also notice I still am watching a lot of YouTube."*

The reflective desires expressed by participants, points towards a space for research on the effect of visualizations designed to promote reflection on user's behaviors over a long period of time.

Overviews, History Details, and UI Complaints. popHistory is useful as summary of the browser history, but lacks the details necessary for comprehending search trends. In general, the lack of upfront detail was perceived as a benefit for understanding the history. *"I think it's a report on the history without giving me a lot of details to get lost in"* (P1).

We asked participants what they were able to see in the list history that they could not see in popHistory Bubble, and many said that they missed being able to see finer details. For example, in the aggregated overview, participants could see they were searching on *www.google.com*, but could not see their specific search terms. *"If I want to see how many times I Googled a certain word... it's hard"* (P8).

Conclusion

We developed popHistory, a web browsing history visualization that incorporates animation as a means to promote reflection on browser history habits. In a formative study, participants responded positively to our interface in comparison to traditional history list views, due to more easily being able to view and discover trends in their usage histories.

Our study design is not without its limitation: particularly, we did not compare our animated visualization directly with a static, graphical visualization of the same data like previous work [13] and more work would be required to understand the role of animation specifically in the context of self-reflection. Additionally, we would like to recruit a more diverse set of participants beyond data scientists and data science interns. Despite these limitations, the formative study shows promise in using animation for reflecting on web browsing habits and points towards several directions for future studies.

Future work should attempt a longer-term study so that users who set goals and we can evaluate the system's effect on reaching those goals, or users can rediscover and reflect on previous forgotten moments involved with browsing activities. Web browsing is a key part of daily life for many, and with popHistory, we seek to reclaim the web browser history for the user.

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