

A Link Back to MemoryLane: The Role of Context in Bookmarking and Refinding

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ABSTRACT

Refinding information is a frequent yet difficult task on the Web. Various Web tools have demonstrated that context plays an important role in memorizing cues for retrieval. However, it is not yet sufficiently explored, which type of context is useful for which situations. We carried out a three-stage study to observe how users approach context in bookmarking and retrieval. First, an on-line survey revealed that most users identified some types of context helpful for refinding. Further, an analysis of bookmarks created with a prototypical tool showed that users' choice of types of context depended on the personal relevance of the content. Finally, the success of retrieval depended on the accuracy and specificity of users' recall. Contextual cues seem to improve success rates when there is a gap in semantic memory. These results tentatively imply that contextual indicators should become part of both the bookmarking and retrieval process.

CCS CONCEPTS

•Information systems →Users and interactive retrieval; *World Wide Web*; •Human-centered computing →Human computer interaction (HCI);

KEYWORDS

Bookmarking, information refinding, user context, episodic memory, user experiment

ACM Reference format:

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1 INTRODUCTION

One of the most challenging aspects of “keeping up with the Web” is to refind the information we have found useful with minimal effort when needed. Users have been observed to revisit already-seen information in both work-related and personal contexts, varying from 81% [10] to 40% [40]. Several studies showed that users apply

various refinding techniques, such as using history, bookmark and url auto-completion or even searching again [3, 23, 30].

Bookmarking is the most common way of preserving information and services that users come across on the Web. However, users tend not to use these bookmarks when it comes to refinding [3, 23, 30]. Some researchers have argued that it is a problem of bookmark organization [1, 37], but recent studies seem to point another underlying problem as the root cause: human memory. As more time passes by, users often fail to recall specific and accurate information they need to retrieve target information [13, 28, 31, 40] and end up being lost.

Refinding on the Web is an arduous task equivalent to looking for a particular needle of a certain shape and color in a haystack that is ever increasing in size. Natural decay in human memory over time renders it even harder, as we forget crucial hints that could lead us back to the target information. However, episodic memory - when, where, how, who and why - is generally recalled with less cognitive effort and thus can be used as powerful cues for refinding tasks [11, 12, 26]. Episodic memory has been used in the form of “context” in numerous information search and retrieval systems in recent years [2, 11, 12, 15, 16, 20, 24, 39, 43].

However, these tools offer a limited and arbitrarily-chosen set of contextual cues, which may not be most effective for retrieving different type of information sources catered to individual needs and preferences. Existing tools, such as PivotBar [24] and YouPivot [20], do this job to a certain degree, but it is still unclear for which situations context can play a role in refinding and what types of context are most useful in such situations.

In this paper, we present the results of our experiment, carried out in three stages with a prototypical tool, MemoryLane [22], to gain in-depth and qualitative insight into the usage and potential impact of different type of context on bookmark organization and retrieval. Our results showed that different types of context have varying degrees of usefulness in bookmark retrieval. Furthermore, we discovered that the type of context users choose to use depended on the actual content of the Web page and personal relevancy.

This paper is organized as follows: we first review the literature on the importance and role of context in memory retrieval and its use in context-based tools in Related Work. The methodology and result analysis of our experiment are provided next. Finally, we conclude the paper by summarizing the experiment results and how they could be applied to future context-based tools to maximize the benefits of using context to improve refinding over a long term.

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2 RELATED WORK

One of the most intriguing and constant user behavior observed on the web is that they revisit previously-seen information after various time-intervals. Users have adopted several techniques to make refinding less strenuous, largely thanks to the advance in technology and improvement in browser tools. Nevertheless, the difficulty users face in long-term refinding seems to have lingered because of the natural decay of memory over time. In this section, we provide literature review on the relationship between the memory and refinding and how context can be used to improve memory recall. Then we provide an overview of the existing PIM tools that offer context as retrieval cues.

2.1 Memory and Refinding

Back in the 1990s, it was believed that the non-linear character of hypertext, which allows users to jump from one space to another, caused user disorientation [27, 32, 42]. However, the initial fears that users would get ‘lost’ in hyperspace turned out to be unfounded [4, 14], most likely thanks to the rise of search engines like Google that made even obscure sites and pages findable through a query-based interface and linear result lists [18].

Ironically enough, the same problem seems to have emerged, instead, for refinding specific information seen before, now that each user has too large a pile of sites and services (e.g. hotel booking sites) that are of direct relevance to our daily lives. While finding information asks for “recognition”, refinding demands both “recognition” and “recall” in our brains [9]. Not surprisingly, successful refinding is closely tied to our “memory”. With the constant updates and addition of new resources to the Web, remembering sufficient and accurate details about the target information is crucial when it comes to retrieval. However, several psychologists have claimed that people tend to remember only the top-level summary rather than the details needed to construct effective refinding queries [28, 34, 35].

Because people typically fail to remember specific queries, researchers have investigated the types of things that people do recall about their target information after a time-elapse. A user study conducted in Japan revealed that users’ refinding performance increased if they were asked questions about the main characters, events or their initial emotion, as this helped them to better recall the key nouns they needed to formulate effective search queries [31]. Further, [26] investigated what people remember for different items from their personal digital archives, which includes anything stored digitally in their personal collection space. During their experiment, they separated “content” (i.e. semantic information) from “context” (i.e. episodic experience such as location, time and weather) and tested which of the combinations resulted in best retrieval performance after 6 months. The results showed that the combination of content and context performed significantly better than content only, especially with the source of information, surrounding events and time. They further highlighted the importance of “context” by arguing that, over time, the quality of recalled “content” degraded and the important keywords were likely to be forgotten.

2.2 Use of Context for Retrieval in PIM Tools

Context has long been recognized as a key factor in various fields, including information retrieval, computational linguistics, mobile and pervasive computing and automatic image analysis [29]. Especially in information retrieval, context is crucial, because it helps to provide expedient delivery of content relevant to people’s information needs [17]. Above all, context is paramount to the retrieval of memory in human brains, as purported by prominent researchers in the field of psychology [38, 41].

Notwithstanding the significance of context in the retrieval of information, it is still a relatively new idea in the research field of refinding. Yet recently, it is gaining a momentum. The first type of context used was *temporal context* in the form of date-time (LifeStreams [15] and HayStack [2]), typically extracted automatically by the tools. This temporal context has been persistently used as an important context factor [11, 12, 16, 20, 43], although the granularity has been redefined to include more meaningful time-blocks indicated by specific user activities as seen in YouPivot [20]. Location was also used in [2, 16] though only as in “storage location” of the information. Refinder [11] offers geographical location as contextual metadata but asks for users’ direct input rather than detecting the GPS location of the users.

The internal context - users’ goals, tasks or mental state - is somewhat less exploited, mainly due to the difficulty in automatically capturing users’ hidden intents. Some tools such as Research [39], Pivotbar [24] and YouPivot [20] attempt to capture users’ intentions by observing users’ browsing activities or previous search queries. Still tools like Refinder [11] directly asks users to provide such context to help them refind information.

Though using context, as seen in these tools, is a right step towards better organization and retrieval of digital resources, there still is much more room for improvement. First of all, the context used in these tools is somewhat limited. Several studies have discovered that there were other types of context that can aid in information retrieval [7, 13, 19, 26, 31]. For instance, purposes (goals) and emotions are some examples that could be added to increase the synergy contextual cues can bring to information retrieval. The purpose was discovered as the most resistant to time-related decay [13, 19] and emotions are another area one could explore to improve contextual retrieval of information [31]. Further, capturing emotions is gradually getting easier, as more and more users are acquainted with expressing emotions using emoticons on social media and on-line communication channels.

Furthermore, all tools presented previously seem to take a one-solution-for-all approach, offering a mixture of contextual cues that must work for all types of personal information, regardless of resource type. Even for Web-only tools, it is assumed that all Web pages are of one type, which can easily be retrieved by the same type of context. But some of the studies have shown that different types of context works the best for different types of resources. For instance, a study carried out by Elswiler et al. showed that, the purpose, sender of the email (people) were useful retrieval cues for emails [13], while some other recent studies [6, 36] showed that usage context (purposes) for general web pages; location, time for pictures; and, opinion (subjective feelings included) for songs and movies were also useful. Hence, we could tentatively conclude that

some contextual cues are more appropriate than others for certain types of documents and one should take this into consideration when choosing contextual cues to offer.

3 EXPERIMENTATION ON THE USE OF CONTEXT FOR BOOKMARKS

In this section, we provide the motivation, research objectives and the experimental methods that have been carried out in three different stages to discern how, when and in which way contextual information could be used to improve the organization and retrieval of bookmarked Web pages. Specifically, the study is focused on discerning how important people perceive context to be for information retrieval, how people actually use context in their bookmarks, and finally how people use context to retrieve their bookmarks.

3.1 Motivation and Research Questions

As previously argued in Memory and Refinding, the underlying difficulty in refinding information after a longer period is not so much the method of organization, but memory loss. In other words, over time people forget accurate or complete (semantic) information - such as keywords, folder names or tags - to refind what they need. Current bookmarking tools that rely on semantic information come to little aid in such situations, as there are no other alternative cues to navigate around the bookmark collection.

While context is being progressively considered paramount to effective information retrieval in fields like PIM, search and history tools, its importance is barely acknowledged in bookmarking tools. Furthermore, the types of context used in various existing tools are not only limited, but also arbitrarily selected, without sound empirical grounds. In this experiment, we aim to answer the following research questions in a tentative pursuit of discovering the positive impact contextual cues, as well as which contextual cues, can bring to improving organization and retrieval of bookmarks, especially as the antidote to semantic memory loss.

- (1) Which type of context information do users perceive as important about the Web pages they visit?
- (2) Which type of context information do users use for their bookmarks and are there any differences in the types for different type of Web content?
- (3) Which type of context information do users use to retrieve their bookmarks and are there any discernible reasons for doing so?

3.2 MemoryLane - Prototypical Tool

For this experimentation, we used a context-based bookmarking tool, MemoryLane, initially proposed by Hwang and Ronchetti in 2016 [22]. MemoryLane makes context-specific tags available, using which users can organize and retrieve bookmarks in an intuitive and graphical interface. Unlike other available context-based tools, MemoryLane treats each bookmark as a block of “episodic memory” that are made up of both semantic and contextual information, which can be effectively traced back via multiple pathways by anything users remember over long term.

MemoryLane aims to maximize the likelihood of users’ finding a viable path back to the source of information, as demonstrated by

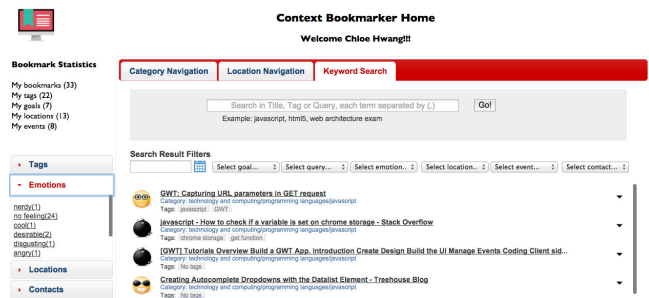


Figure 1: MemoryLane: User Interface of Keyword Search with Contextual Filters

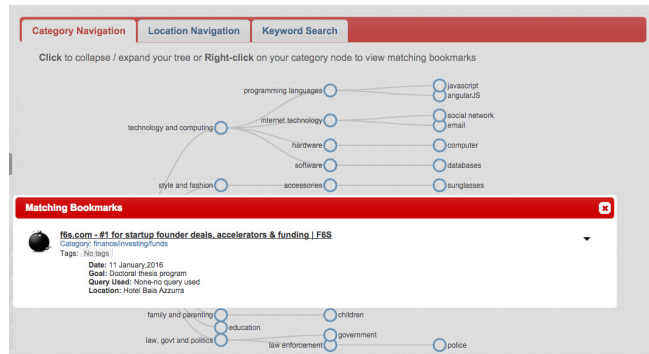


Figure 2: MemoryLane: User Interface of Category Navigation

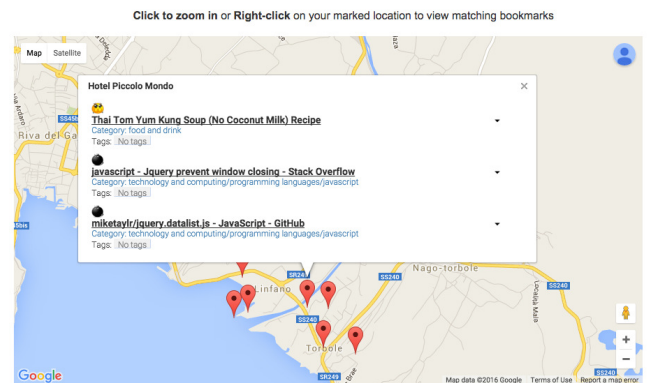


Figure 3: MemoryLane: User Interface of Location Navigation

the study done by Kelly and Chen, in which they showed people recalled best when both content-based and contextual cues were provided [26]. Users are given freedom as to which type of context they choose to use. Furthermore, the tool provides intuitive search interfaces where users can look for their bookmarks with any keywords or contextual information they recall (see Figure 1). The tool also offers navigation by location or category as demonstrated in Figure 2 and Figure 3.

Table 1: Stage II: Premeditated Questions Given to 6 Participants

No.	Question
1	Where would you like to go this summer?
2	I bought a new battery for my laptop but it does not charge, what could be the solution?
3	What can you do when you drop your phone in water?
4	I am looking for a new phone to buy, can you recommend me phones?
5	What is the most interesting news of today in your opinion?
6	What are you working on these days? Can you bookmark web pages that are most related to what you are working on?
7	What are the things you would like to receive as gifts?
8	Which songs are your favorite?
9	Please find good recipes that you would like to try.
10	Please find web pages about the latest health/technology trends.

3.3 Methodology

This section outlines the three different stages of user experimentation carried out to gain understanding of the perceived and actual role of contextual cues in the organization and retrieval of bookmarks. The detailed methodology of each phase is described in detail in subsequent sections.

3.3.1 Stage I: Online Survey. An online survey was carried out to gain understanding of how users are making use of existing bookmarks. Moreover, participants were asked to provide the reason for difficulty in refinding their bookmarks and what other types of information they believed they would remember about web pages after a time-elapse. A total of 120 users participated in the survey. All participants were experienced Web users, though not all were in IT-related fields. The full list of questions used for this survey is available online ¹.

3.3.2 Stage II: Bookmarking with MemoryLane. The second part of the experimentation was performed with 10 users bookmarking Web pages with MemoryLane tool over a period of 4 weeks. The focus of this phase was to find out what type of contextual cues users actually associate with their bookmarks when they were given the free choice. Before the experiment, users were provided with a user guide on how to use the tool. A total of 160 bookmarks were saved at the end of the experiment. The participants were advanced Web users, aged between 25 to 35, from the department of Computer Science at University of Trento, Italy. All participants were given freedom to bookmark any Web page they wanted or re-bookmark with MemoryLane some of the existing bookmarks saved with another tool. Additionally, six selected participants were given a list of 10 premeditated questions for which they bookmarked Web pages as answers, in order to take part in the third part of the experiment. The given set of questions covered areas ranging from work-related to personal ones, as demonstrated in Table 1.

¹Online survey form: <https://goo.gl/forms/u50lW2lYppEq5Js63>

3.3.3 Stage III: Bookmark Retrieval. The last phase of the experimentation was performed with six selected participants, 3 females and 3 males aged between 25 to 35, who were advanced Web users. During Stage II, they were asked 10 specific questions (see table 1) for which they bookmarked two different answers per question: each user bookmarked a total of 20 unique pages, of which 10 were done with MemoryLane and the rest with the default bookmarking tool in Google Chrome browser. This controlled user testing was intended to find out if there is any noticeable qualitative differences in the performance of bookmark retrieval with MemoryLane in comparison with another tool after a time-elapse of 3 weeks. The comparison tool was not specified but all participants chose to use the Chrome browser tool, because that is what they normally use. Users were asked to perform specific tasks as shown below. The experiment was carried out as individual interview-session for each participant and each session lasted about 40 minutes on average.

- Users were asked to retrieve the answers they had bookmarked 3 weeks earlier for each question. Questions were asked in a random sequence.
- When each question was presented, users were asked to speak loud what they recalled about the answer.
- Then users were asked to retrieve their bookmarks using both MemoryLane and Chrome browser tool. The moderator recorded time of both attempts and also how users retrieved their bookmarks using MemoryLane.

4 RESULTS

In this section, we attempt to answer our research questions by reporting the results from the experiment with a focus on the role and impact of contextual cues in the organization and retrieval of bookmarks. The results and our analysis are divided into three parts according to the stages. The key findings and their implications are discussed at the end of this section.

4.1 Online Survey Results

The results of our survey with 120 participants confirmed many of the findings from previous studies. The following list details each finding along with some insights into the contextual information users considered important.

- (1) **Bookmarking is still the primary refinding method:** the majority of users used bookmarking as their primary method of keeping useful or interesting information found on the Web: they relied solely on bookmarks and they normally used the default bookmarking tool available on their favorite browsers. This confirmed the finding by earlier studies that most users use the bookmarking tools found in their browsers; however, the figure (70.8%) is lower than 80% [33] and 92.4% [3]. Interestingly, 14.9% said that “they do nothing” because they were confident they would refind information using search engines or auto-completion of url in browser. The remaining alternative refinding techniques were writing down urls, keeping tabs open or downloading the Web pages into a local folder.
- (2) **Users face difficulty in refinding because they cannot remember:** 33.1% of participants experienced difficulty in refinding, and of which 57.8% due to “memory

Table 2: Online Survey: Perception of Importance for Recall

Type of Information	Average
Topic	69.15%
Goal	64.2%
Source	34.7%
Next time of visit	16.45%
Emotion	8.75%
Location	6.55%
Time	3.4%

problem” - they forgot the name of folders or tags they used. About 38% said that they remembered the name of folders or tags but they got lost because there were too many bookmarks in the folder or by the same tag to sift through. This finding re-affirms the proposition that long-term re-finding is rather a “memory problem” as we discussed in Memory and Refinding.

- (3) **Users rely on search engines when they cannot find what they are looking for:** 77% of participants said that they try to re-find using search engines when they get lost in their bookmark collection. They added that they usually try to recall the keywords and perform several searches until they locate what they are looking for.
- (4) **Users perceive different types of context with varying importance:** participants were asked about the information they believe they would remember after a significant time-elapse. They were given a list of options to choose from and the results are shown in Table 2 - since multiple choices were allowed, the total percentage does not tally to 100%. Topic and goal (purpose) were considered most important, 69.2% and 64.2% respectively. How they found the Web page (i.e. search query they used, shared by a friend or a random encounter) was also considered important (34.7%), followed by the expected time of revisit, emotions, location and time.

4.2 Bookmark Collection Analysis

A total of 160 bookmarks were collected over a period of a month using the MemoryLane tool. Below outlines the analysis of bookmarks and findings. Interestingly, users used different sets of contextual information based on the content being bookmarked while semantic information was used rather consistently, regardless of the type of content. Furthermore, the type of contextual cues used for different category of bookmarks were also discernible, as demonstrated in Table 3, and explained in more details below.

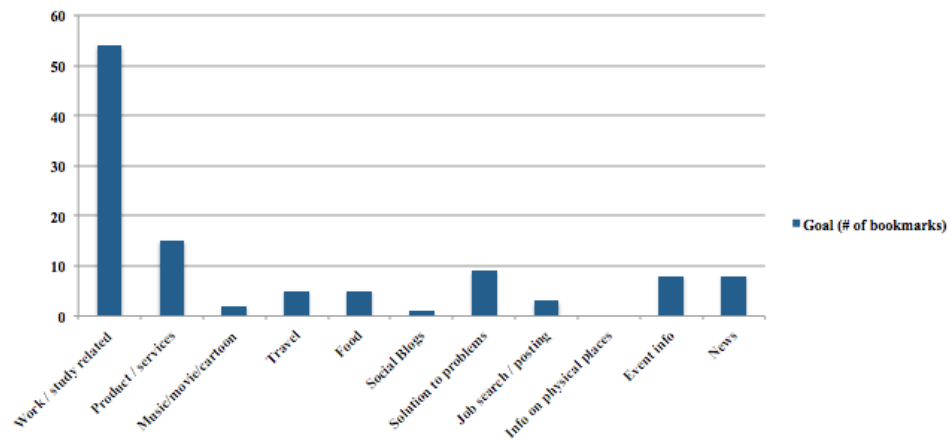
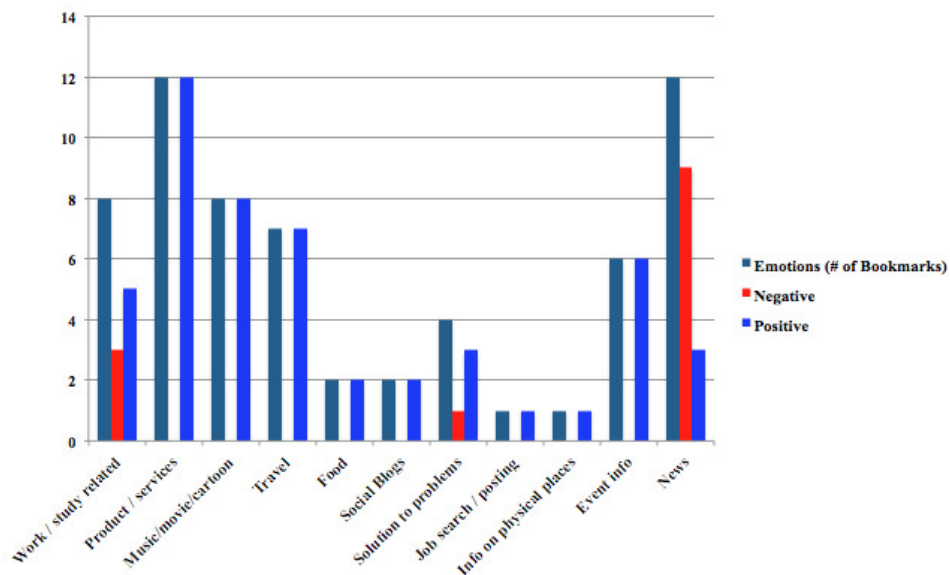
- (1) **Frequently used bookmark metadata:** Category, search query and tags were added frequently, but this could have been caused by the tool providing such information automatically to users. Among the information needed to be inserted or selected manually, the goal was most frequently used, followed by emotion and location. These results are similar to what was perceived as “memorable” by the users shown in Table 2, albeit with some differences. Notably, emotion and location were used more frequently than users had considered. Time, which is used in most

available context-based systems, was used least; reminders of predicted future revisits were used for some work or study related bookmarks. Similarly, people and related files were used rarely and mainly for work or study related bookmarks.

- (2) **Usage of goals:** Goals were used predominantly for work/study related bookmarks, followed by product/services and the category ‘solutions to problems’. This is consistent with our expectations, as people search for information with a clear goal in a working environment. This can be closely related to the study results on university email retrieval, where people remembered the purpose of the work emails more clearly over a long period of time [13]. As far as products/services category is concerned, people used goals to represent their intention of purchase, for instance, “buy a new phone” or “birthday gifts”. Finding a solution to a problem is also a targeted search for information; hence users put goals such as “fix battery problem”. The other categories of web contents - such as entertainment (music, movie, cartoon), news, travel and food - did not often have any associated goals probably because this type of content is frequently discovered by non-directed free browsing rather than a focused search. Figure 4 depicts the usage of goals per category type.
- (3) **Usage of emotions:** Emotions were more often used than initially expected. Specifically, emotions were strongly expressed for news and product/services web contents. Positive emotions were observed across all categories, whereas negative emotions depended on the tone of the web pages, such as news, or the level of user satisfaction for content related to their work or solution to problems. For instance, news articles about Brexit or the refugee crisis were associated with “angry” or “sad” emotions while users expressed “happy” for contents about gifts, music and vacation places. Work or study related contents were mostly associated with no emotion. Overall, users mainly expressed emotions for contents related to them on a personal level. The complete results of usage of emotions is shown in Figure 5.
- (4) **Usage of locations:** Locations were used for two different purposes: the current location of the user and the geographical location expressed in the web page content. The bookmarks showed that most of the work or study related contents were tagged with current location of the user, but the web pages with specified locations like global news, location-specific events and travel destinations were marked with the geographical locations, as shown in Figure 6.
- (5) **Usage of events, reminders, people and related files:** Events, reminders, people and related files were among the least used contextual information, mainly used for work or study related content. Few reminders were set, although the survey results showed that about 16% of the participants said they would remember the next time of visit (see Table 2). This could point to the fact that users do not often anticipate when they would revisit bookmarked web pages, but tend to keep them for unknown future needs. People were also rarely used nor were considered

Table 3: Usage of Contextual Cues per Content Category of Collected Bookmarks

Bookmark Category	Total (160)	Goals	Emotions	Locations	People	Reminders
Work /Study-Related	61	54	8	18	11	15
Products /Services	24	15	12	1	2	0
Music /Movie /Cartoon	11	2	8	0	0	0
Travel	8	5	7	4	0	0
Food	7	5	2	1	2	0
Social Blogs	2	1	2	2	0	1
Solution to Problems	18	9	4	3	1	1
Job Search /Posting	4	3	1	1	0	0
Info on Physical Places	2	0	1	2	0	0

**Figure 4: Number of Bookmarks with Goal per Category****Figure 5: Number of Bookmarks with Emotion per Category**

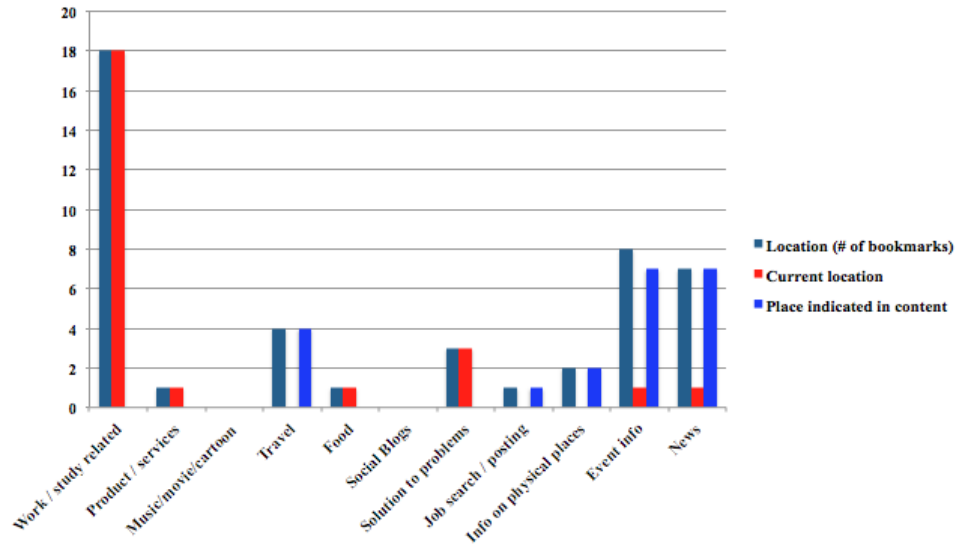


Figure 6: Number of Bookmarks with Location per Category

Table 4: Retrieval Success Rate per Quality of Semantic Information Recalled

Quality of Recall	Total	Failed	Success Rate (%)	
			Chrome	MemoryLane
Specific & Accurate	17	0	100%	100%
Vague	28	8	69%	96%
None	15	7	46%	100%

important in the earlier survey. One reason for this might be that web pages are not often associated with a particular person in comparison to other digital resources, such as emails, which require people as “senders”. This further strengthens the argument, as put forward in Use of Context for Retrieval in PIM Tools, that one-package-for all solution, as often seen in current context-based tools, is probably not the optimal approach.

4.3 Bookmark Retrieval Results

In this section, we discuss the findings from 60 retrieval attempts by six selected participants. We present the results from two different angles. First, we discuss how contextual cues were instrumental to successful retrievals of bookmarks when participants could not remember accurately the specific keywords or the topic. Next, we lay out which type of semantic and contextual metadata were used as retrieval cues from the most to the least frequently.

4.3.1 Quality of recall and its relationship with retrieval success.

Participants were asked to speak aloud any information they recall about the target web page before their retrieval attempts. The quality of recall was then measured based on the self-reported specificity and accuracy of recalled information and was divided

into three cases: “Accurate and specific”, “Vague”, and “None”. Out of 60 retrieval attempts, 17 were recorded as “specific and accurate”, 28 “vague” and 15 were “none”. Below snippets provide real user examples for each of the cases:

- **Case “Specific and Accurate”:** participant remembered specific keywords accurately and was confident.

Interviewer: Can you tell me something about the most interesting news you bookmarked?

Eleonora: Yes, it was about Brexit. I am sure of it.

- **Case “Vague”:** participant recalled something, but was not sure if it was correct or the recalled information was too general to be a useful search keyword.

Interviewer: Can you tell me about the recipes you wanted to try?

Zeno: Mmmmm.... I am not sure about it. I think I found it on a news website like BBC or on a food blog, but I am not sure.

I: Can you remember the folder name you might have used?

Z: No. I have probably chosen something like “Food”, but I am not sure.

- **Case “None”:** participant could not recall anything.

Interviewer: Can you tell me about the new phones you wanted to recommend?

Cristina: New phones... I remember googling it, but I cannot remember anything about the phones I liked.

When users recalled specific and accurate information, the success rate of retrieval was at 100% equally with MemoryLane and Chrome bookmarking tool. However, there was a difference in the success rate when users recalled little or none, as shown in Table 4.

In particular, context served as “starting points” of navigation when participants felt lost due to lack of semantic recall. We present the real user cases observed during the retrieval attempts using both tools below.

- (1) **Retrieval with the Chrome bookmarking tool:** with the Chrome browser bookmarking tools, participants mainly retrieved their bookmarks by finding the right folder to look into or by looking at the default page titles. Four out of six participants used folders to organize their bookmarks, while the other two preferred to leave all bookmarks in a long unordered list. As seen in Table 4, the fewer details participants recalled, the harder it became to retrieve the bookmark with success. When participants could not recall much or none, they either read through all the folder names and tried to guess the “correct one”, or scanned through all bookmark titles. Regrettably, folder names or the titles were of little use when users recalled inaccurate information (i.e. a participant recalled the target page must be about “Internet of Things” but he could not find any folder or title related to this) or when they recalled nothing.
- (2) **Retrieval with MemoryLane:** In contrast, MemoryLane maintained high success retrieval rates even when participants could not recall accurate and specific information about their target pages. Participants explored different strategies when they could not recall much or none, depending on the type of information they were trying to find. For instance, below examples illustrate how participants used location and emotion to find their target pages.

Interviewer: can you find me the Web page about the place you wanted to go this summer?

Eleonora: I think it was a place where I could do rock climbing... somewhere in England but I do not remember the name of the place.

E: I found it! I went to the Location Navigation and looked at England and there was a marker on Sheffield. Yes, that was where i wanted to go.

I: can you find me the Web page you saved, which was related to what you were working on at that time?

Zeno: I think it was something about my PhD work... “coding” or “SOM” - the name of my project - but I am not very sure.

Z: I found it. I remembered I was a bit frustrated with my project so I searched for bookmarks with “angry” emoticon. Yes, that was the page I was looking for.

4.3.2 Retrieval cues used for bookmarks with MemoryLane. This section provides an overview of the type of retrieval cues that participants used to retrieve target bookmarks with MemoryLane. The most frequently used methods were to use the goal with 43% of the successful attempts, followed by category with 22%. Emotions and direct browsing were sparingly used for retrievals: 9% and 12% respectively. A few users also made use of images, search queries with 3% each. However, tags and location were used rarely with

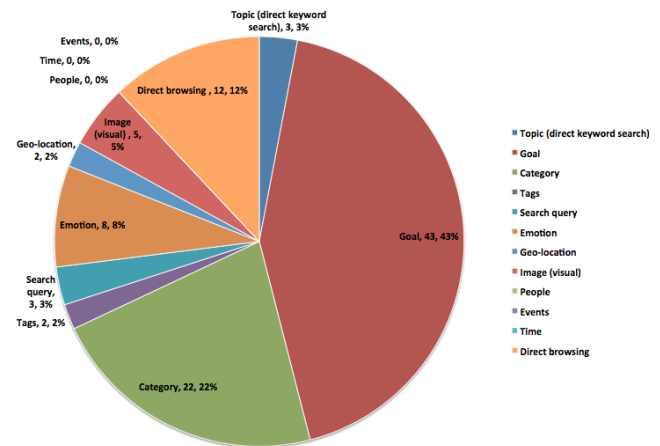


Figure 7: MemoryLane: Usage of Semantic and Contextual Cues Used for Retrieval

2%. Although some bookmarks were saved with people and event information, there were never used for bookmark retrieval. Figure 7 summarizes the results visually.

- (1) **Semantic cues** (category, tags, search queries, direct keyword search) 22% of the successful retrieval was done via using categories. These categories were automatically extracted from the content and suggested to users at the point of saving/bookmarking web pages. When users were not sure or only recalled vague or no information, they tried to find the target web pages using categories as the orientation point. Nevertheless, searching for bookmarks based on other types of semantic cues were not popular. For instance, all bookmarks had at least one tag associated with them but it was used only 2% of the time as the retrieval method. Direct keyword search was not much sought after either, as it also constituted only 3% of the time. This is in line with the results of several previous studies: direct search is not the preferred method of re-finding, but browsing is [5, 8]. Despite the fact that most users said they would remember the search queries in the on-line survey, the actual use of search queries as retrieval cues was negligible.

- (2) **Contextual cues** (goal, emotion, time, location) More than 50% of the successful retrieval results were achieved with contextual cues. Of these cues, *goal* was most frequently used, followed by emotion. Other types of contextual cues - such as location, people, events and time - were rarely or not used at all.

- **Goal:** goal was perceived important by the participants in the on-line survey and, in fact, was used most frequently as the retrieval cue. This result highlights the importance of the reasons for which web pages are saved and how they persist in memory even after a long time elapse. Current context-based tools are not making use of this important contextual information, most probably because goal is an internal intention

of users, making it hard to make an accurate “guess” by the tool. The alternative way would require direct input from the users, which, in return, may reduce the usability of the tool.

- **Emotion:** The participants of the survey did not assign much importance to emotions; however, emotions were more often used than expected for both bookmarking and retrieval. In most cases, participants did not recall correctly which emoticon they had used to bookmark the target web pages, but they did remember if the emotion they had felt was strongly positive or negative, which they subsequently used that to narrow down their search results. As an example, when a participant was asked to retrieve a web page about his favorite song, he failed to find it with goal. Then he used “happy” emoticon to filter only those with happy emoticon and he found what he was looking for. Expressing emotions about web content is a fairly new phenomenon spurred by social platforms such as Facebook. The idea that emotions can be used for refinding information may sound outlandish at first, but a recent study done in Japan showed that emotions do play a role in memory recall [31]. Users use emoticons as an “aid for personal expression” among other reasons [25], which might be the reason for its prolonged preservation in memory as it makes the web content something “personal”.
- **Location:** Although location is one of the most exploited context nowadays, it was not used much for bookmark retrieval. This is understandable, as MemoryLane was available only on stationary computers. For the few cases where participants used location as the retrieval cue, the location mentioned in the Web content was exclusively used. Participants were observed to recall general area of a location rather than a specific names. For example, when asked to refine Web pages about places to go for the next vacation, the participants recalled general information (e.g. “a place by the sea”, “somewhere in Great Britain where I can do climbing”) and used the location navigation provided by MemoryLane (see Figure 3 to get the specific names).
- **Time** (date-Time, events): surprisingly, no retrieval attempt was made using the time context in our experiment, even though most existing context-based tools use it as a key contextual feature, as discussed in Use of Context for Retrieval in PIM Tools. However, our experiment revealed that, when a significant amount of time has passed - 3 weeks -, participants remembered little about the time when they saved their bookmarks.

5 CONCLUSION

Context features have been shown to play a significant role in the retrieval process and they have been successfully used in several existing tools. Nevertheless, there has been no comprehensive study

on which type of context can be most effective and how it should be used to yield best leverage. Our experiment was carried out to gain further insight into the perceived importance and the actual usage of contextual meta-data at the point of bookmarking as well as retrieval. Our results showed that *goal* - the purpose - was perceived as the most important contextual cue for recall. The usage of contextual cues varied depending on the type of Web content. *Goal*, *people* and past and future *events* were most frequently used for work or study-related Web content, while *location* and *emotion* were mainly used for personal Web content, such as entertainment, news or travel. Our results also hinted that context played a role in leading to successful retrieval when users could not recall sufficient semantic information to use as a cue. Furthermore, goal was an important retrieval cue across various types of content but other peripheral types, such as emotion and location, were effective for retrieving Web content of high personal importance to the user. In conclusion, contextual metadata does not replace semantic metadata; rather, context can aid users in refinding when there are gaps in the semantic memory, provided that the contextual features used are relevant for the specific type of Web content.

Moving forward, these contextual cues should be collected as automatically if possible, as otherwise users might bookmark to a lesser extent due to the time it takes. Goal extraction is quite hard, but it might be good to find out how well goals can be formulated based on a combination of previous queries combined with other users’ queries and pages. Providing emotions does not cost that much perceived effort, as seen by the smooth Transition in Facebook from just likes to ‘reacting’ via emoticons/emojis. Tagging might be another generic method for providing contextual metadata. Users have been shown to provide different types of metadata as tags, including contextual ones, on various tagging platforms [6, 21, 36]. Explicit labelling such tags as contextual metadata, as we did in our experiment, can guide users to add more information that is likely to be recalled over a long term. Increased time and efforts from the users’ side is a concern, but this can be somewhat mitigated by (semi-)automatic categorization of tags.

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