User Interface Considerations for Browser-Based Just-in-Time-Retrieval

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Abstract—With the availability of free online enrichment services injection of additional, external resources in existing Web content becomes more and more widespread. For the specific area of just-in-time retrieval of digital resources based on web page content, there are no specific guidelines of how to design and integrate the additional user interface components. In this paper, we conceptualise related user interface issues, investigating the central questions: (i) how can a user be visually notified that additional results are available, and (ii) with which user interface elements should the results be presented. Concretely, we identified four different notification styles and six different result presentation styles. In a survey-based study with 75 participants we elicited the users' preferences, revealing a clear preference for the representation style (split pane) and a strong preference for three notification styles (notification bubble, icon appearance and change of icon's appearance). The latter preferences are related to the preferred browser. The results can serve as guideline for designing web-based user interfaces for just-in-time retrieval.

Keywords-just-in-time retrieval; user issues; web browser

I. INTRODUCTION

With the advent of the Web 2.0 and the development of corresponding Web technologies, online services for automatic web page enrichment became available. Prominent examples are Freebase[1], an enrichment service to retrieve general knowledge facts, or OpenCalais[2] for enriching content with facts, events or named entities. While it seems straightforward how to present detected named entities, namely as a hyperlink to its surface form, the presentation of more complex results, like event details or additional digital resources is more challenging. In this paper we identify and investigate user interface issues related to just-in-time retrieval [1] of digital resources. In just-in-time retrieval, resources, which are considered relevant, are retrieved automatically without explicit user interaction. Depending on the user's task and the quality of the context detection and retrieval mechanism, the presentation of the retrieved resources may or may not be desired by the user. Thus, we propose a 2-stages approach: first, the user is notified about the retrieval of new resources, and second, the resources are presented. More specifically, we investigate the following core questions: (i) How can a user be visually notified that additional results are available? (ii) With which user interface elements should the results be presented? The first question relates to notification

[1]https://www.freebase.com/
[2]http://www.opencalais.com/

styles, and the second question relates to representation styles. Additionally, a transition from the notification to the result representation is required. This transition may be fully automatic and with no visible delay in the user interface, e.g. when the user is notified about the existence of new resources, the resources are automatically displayed alongside. Alternatively, the transition can be explicit or manual, e.g., the user needs to perform an action in the user interface to see the retrieved results.

In this paper, we categorise interface issues for web-based just-in-time retrieval, and identify different interface types. In order to define notification and interface styles we make the following assumptions:

- Focus on web-based scenarios, i.e., results should be integrated in web browser.
- Focus on visual interfaces, ignoring for instance, audio or haptic interfaces.
- Retrieval service is external to web-application, i.e. there is no internal access to the current web site (apart from JavaScript injection inside the browser).

Further, we present results of a survey-based user study to elicit user preferences for the derived interface styles.

The rest of the paper is structured as follows: The next section presents related work on issues of search and awareness interface design relevant in a just-in-time retrieval setting. The user interface considerations are described on a conceptual level in section III, deriving four notification styles and six presentation styles. Section IV then presents the survey design and results, followed by a discussion in section V. Finally, section VI concludes the paper and presents an outlook on future work.

II. RELATED WORK

In this section we review related work w.r.t to human information seeking models, design of search user interfaces and awareness interfaces.

A. Models of Human Information Seeking:

Andrei Broder proposed a taxonomy of web search, classifying searches either as navigational, transactional, or informational [2]. Among these, informational web search is the most common and assumes an initial information need of the searcher. Shneiderman's model of human information seeking encompasses four basic steps [3], [4] and has been

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extended to seven steps by Marchionini and White [5]: (i) recognition of information need, (ii) accepting challenge to take action, (iii) formulating the problem, (iv) expressing the information need in search system, (v) examination of results, (vi) reformulation, and (vii) usage of results. Mulhem and Nigay applied Norman's stages-of-action model [6] to information retrieval [7], identifying the stages: (i) goal or problem setting, (ii) intention (information need), (iii) action specification, (iv) execution of actions, (v) perception of system state, (vi) interpretation of system state, (vii) evaluation of the state with respect to initial goal. Common to these models is a stage or a set of stages that correspond to the formulation and *execution* of a search, and a stage or a set of stages that correspond to the *evaluation* of the received results. In just-in-time-retrieval [1] settings, the execution step is automatically performed and replaced by a "notification of results" step for the user. Once the results are retrieved, the subsequent steps of evaluation are the same in traditional search and just-in-time-retrieval. In terms of Norman's stages-of-action model [6] automatic retrieval is minimising the gulf of execution, but might enlarge the gulf of evaluation if the automatically inferred query does not match the initial user goal. In this paper we investigate interface guidelines for a browser-based user interface supporting human information seeking with a fully automatic query execution stage.

B. Design of Search User Interfaces

As a query in a just-in-time retrieval setting is issued automatically, the primary focus of the search interface is on the presentation of search results. In general, nowadays search interfaces are (and should be) kept as simple as possible. Hearst identifies one of the main reasons therefor in search being "a means toward some other end, rather than a goal in itself. When a person is looking for information, they are usually engaged in some larger task, and do not want their flow of thought interrupted by an intrusive interface." [8]. This background nature of the search task becomes even stronger in a just-in-time retrieval setting, when the search is performed automatically, emphasizing the simplicity claim. Hearst proposes the presentation of the search results as a vertical list, with so called document surrogates, containing summary information, such as document snippets, abstracts or metadata [5]. There is no distinct advice on the surrogate length, but Cutrell and Guan discovered, that more information in the surrogates improves informational tasks, while degrading performance for navigational tasks [9].

C. Awareness Interfaces

In order to keep distraction low, while making users aware of additional information, Rhodes introduced "ramping interfaces" [1], that convey information on different stages of granularity. The amount of information conveyed increases on higher levels, posing less cognitive load on the user in the early stages. The concept of awareness is also researched by Cadiz et al [10]. They present a system, that shows high-level information from various applications in a permanent sidebar and is capable of delivering notifications from specific applications. Yamada et al. [11] exploit human cognitive properties, such as visual field narrowing and inattentional blindness. When a user concentrates on a task, the visual field narrows and changes outside are not recognised. Hence, positioning the awareness interface outside this area, allows for easily ignoring notifications when concentrating on a task, while recognising them afterwards. According to McFarlane et al., "people are more interruptible for a brief signal that announces the existence of an interruption than they are for the full interruption itself" [12]. Therefore, we follow a two-staged approach, with notifications in the first and result presentation in the second stage.

III. User Interface Styles

In just-in-time retrieval (JITR), the current user context is exploited to automatically retrieve relevant resources without explicit user interactions [1]. Figure 1 depicts the general
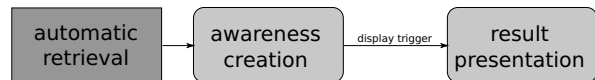

Figure 1. Overview of general procedure to present JITR results to users

process, ignoring the context detection and pre-processing steps necessary for automatic generation of a search query. First, relevant resources are automatically retrieved by a process that is viewed as a black box for the discussion in this paper. Once resources are available, the user has to be notified of their availability. In this stage, the user does not need to get any details about the results, just the information, that there are results available. After the user has been notified, she might decide to view the result list, and perform some interaction in the user interface to indicate this decision (e.g., move the mouse over the notification item, or click on the item). The type of the transition from notification to presentation is denoted "display trigger" in figure 1. This means, we have to investigate the different possibilities for notifications, display trigger, and result presentation. The *Notification Interface Style* refers to the visual method presenting the availability of new resources to the users. The goal of the notification is to make users aware that new resources are available. The *Representation Interface Style* refers to the visual method presenting the actual resources. The building block for this is the document surrogate. The *Display Trigger Style* refers to the interaction possibilities for showing or updating the representation of results after a notification has been received. In the following these styles are discussed in more detail.

A. Notification Interface Styles

We restricted the notification styles to those which are implementable in current Web browsers and would work for arbitrary web sites. Further, we only focused on visual notification styles, because audio for instance would require a not muted loudspeaker which can not be generally ensured. The notification should be unobtrusive, and requires little space, since the encoded information is either binary (there are new results or not) or one number (the number of new results). We identified four different notification interface styles, which are sketched in figure 2:

N-1. A notification icon appears in the browser task bar (see figure 2a).

N-2. The notification icon changes its appearance (see figure 2b).

N-3. A notification bubble appears in the browser task bar (see figure 2c).

N-4. A line appears within the current web page (see figure 2d).

B. Representation Styles

This style reflects the way in which the search results are represented. Because each result may be a larger document, not the actual content is displayed, but rather a summary, the so called document surrogate [5]. The minimal information contained in a document surrogate is the title of the document. Depending on the application, additional information, so called faceted meta data, may be helpful, such as the document's author, origin or creation data, Further, a short description of the content may be available. But even with the shortest possible document surrogate (containing only the title), the representation of a result list requires more screen space than the notification. We identified six different representation interface styles, which are sketched in figure 3:

R-1. Results are displayed in a pop-up window (see figure 3a).

R-2. Results are displayed using a split pane (see figure 3b).

R-3. A new tab is opened for the results (see figure 3c).

R-4. A box showing the results is inserted into the website (see figure 3d).

R-5. A marginal note on the right-hand side of the page contains the results (see figure 3e).

R-6. A marginal note on the bottom of the page contains the results (see figure 3f).

C. Display Trigger Styles

Given a notification, the user may either decide to view the results, or the results may be automatically displayed, leading to two possible display trigger styles:

T-1. Explicit or manual, requiring a user interaction (click, mouse-over, key, key combination, menu selection),

T-2. Implicit or automatic, requiring no user interaction (pop-up with recommendation content, automatic update of recommendation display).

With an automatic transition, the notification and the presentation may be either indistinguishable for users (i.e. a notification icon appears and the results are displayed alongside) or the presentation of results is itself the notification (only showing the result list). Conceptually, however, notification and display trigger to presentation remain two different stages.

IV. EVALUATION

With an online survey we wanted to evaluate whether users have a preferred notification and/or a preferred representation style for recommendations. Knowing the preferences for notification and representation style, the design process for the application user interface can be guided already early in the development stage by only implementing the mostly preferred versions. If we additionally found a clear preference to one of the possibilities for the majority of users it would reduce the design and development effort for the interfaces even more. Concretely we wanted to test the following hypotheses:

H1 The majority of users has a clear preference towards one of the suggested *notification* interface styles.

H2 The majority of users has a clear preference towards one of the suggested *representation* interface styles.

Additionally, we wanted to assess whether users have additional suggestions for notification or presentation styles.

We further wanted to evaluate whether there is a difference between participants working with web-based learning management systems (e.g. moodle [3]) and the general public. In learning management systems, relevant resources, which are retrieved automatically are of interest for users, who would like to investigate the learning topic more deeply and beyond the provided content. We assumed, that the requirements for displaying just-in-time retrieval content in learning management systems differ from those in the general web browser setting.

Therefore we distributed two identical copies of the online survey, one to people working with learning management systems (developers, managers, project coordinators and teachers), and one for the general public. We did not evaluate preferences for display trigger styles in the survey, for two reasons. First, we wanted to keep the survey short (completion time below 5 minutes). Second, we found in a pre-test that intent behind the question was hard to convey to users and led to wrong answers. This led us to the conclusion that the survey form is not appropriate for eliciting preference on trigger styles, and we therefore plan to perform A/B testing or comparative user studies to this extent.
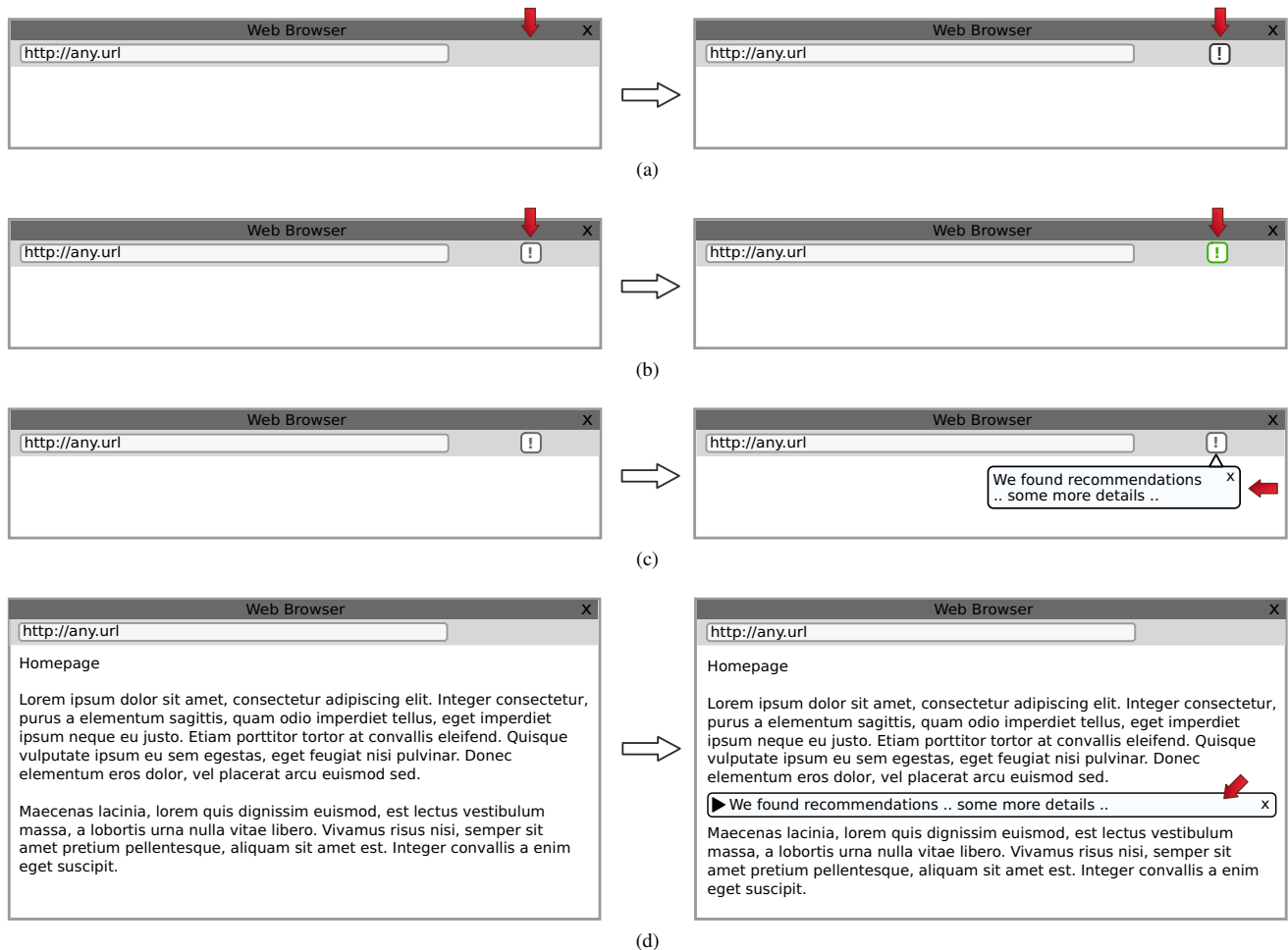
[3]https://moodle.org/

Figure 2. Notification Interface Styles. A notification (a) icon appears, (b) icon changes its appearance, (c) bubble appears, (d) line appears. The left column shows the interface before new results were discovered and the right column shows the interface after new results have been found.

A. Test Material

The survey was implemented using the open source survey application Limesurvey[4]. The questions were prepared in two languages, English and German. The survey's core questions relate to the above introduced hypotheses. The question related to hypothesis **H1** was:

> How would you like to be notified if relevant resources were available?

The answer possibilities are introduced in section III-A, multiple choices were possible. The question related to hypothesis **H2** was:

> In which principle way would you like the relevant resources to be presented? The following shows example sketches. Please note, that the number of recommendations is arbitrary as well as the information shown for each recommendation.

[4]https://www.limesurvey.org/

The answer possibilities are introduced in section III-B, multiple choices were possible. For both questions, interface mock-ups were presented to users for better understanding of the presented choices.

B. Procedure

The survey was distributed via mailing lists and at scientific conferences. Potential participants were given the survey URL and needed to register with their email address. They then received a token and could access the survey. By requiring an email address we tried to ensure that each participant could answer the survey only once. Although we could not guarantee that single users did not register with multiple email addresses this procedure was the best with respect to both, anonymity of users and uniqueness of responses.

The survey was structured as follows: First we presented a short introduction summarising the goal of the survey and framing the context. Framing the context was implemented
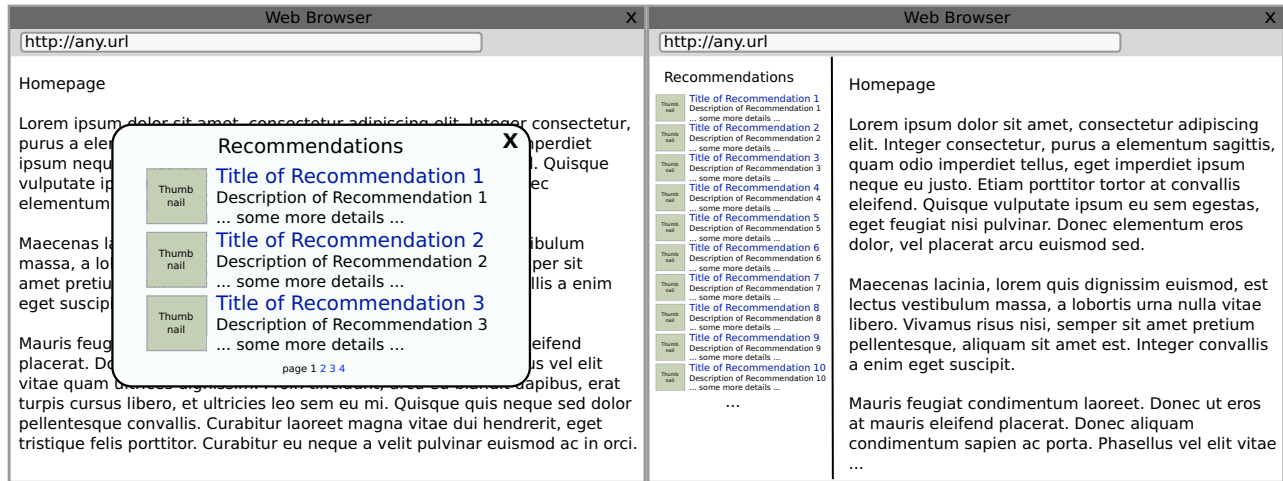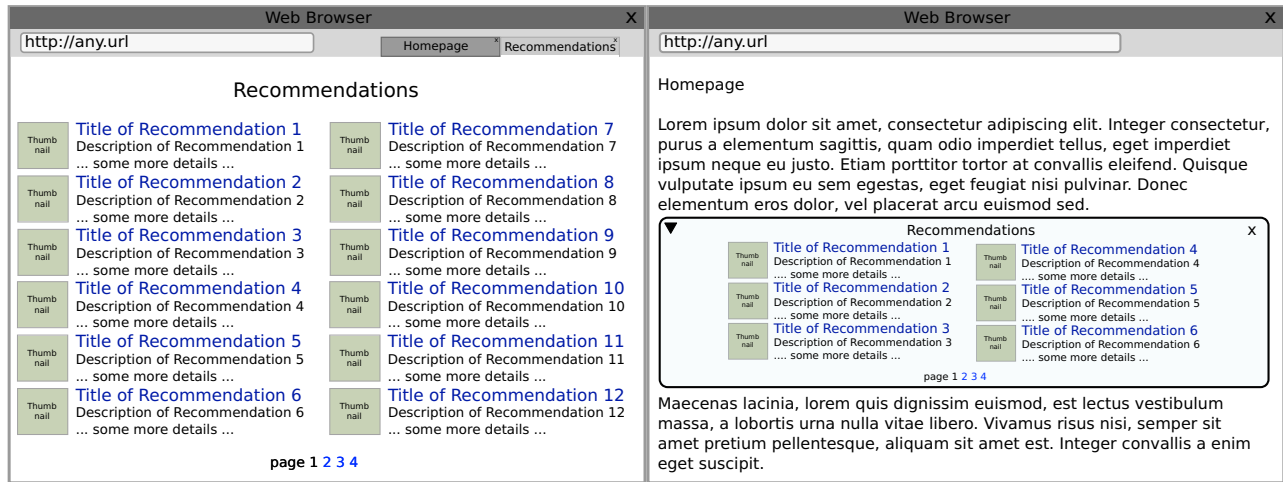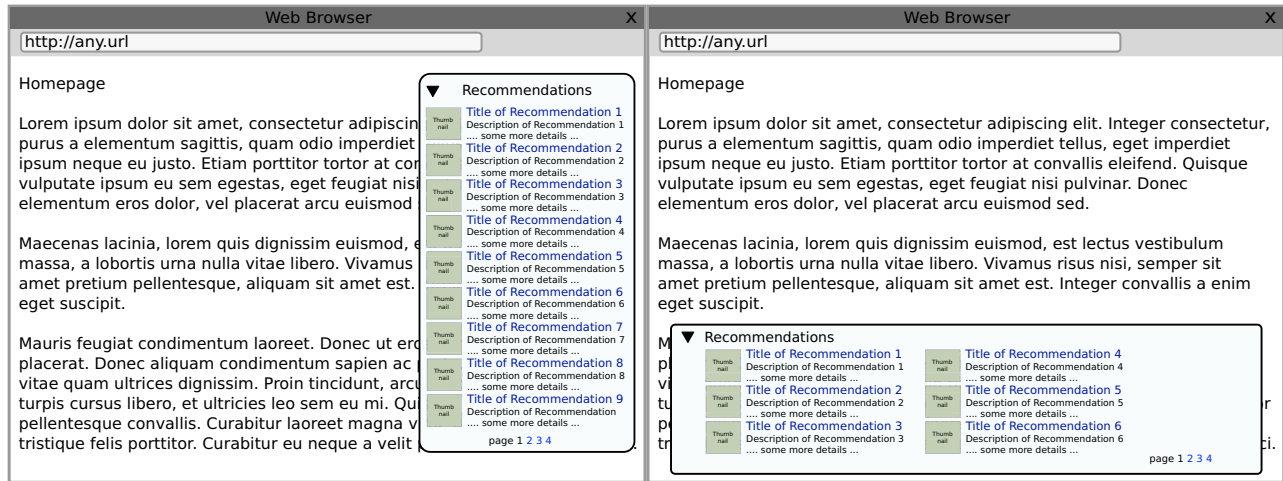
Figure 3. Representation interface styles. Principles ways of injecting additional resources on a web page. Results might appear (a) in a pop-up window, (b) a split pane, (c) a new browser tab, (d) inline the web page, (e) in a margin note on the right, (f) in a margin note at the bottom

by setting up the following scenario (the mentioned screenshot is omitted in this paper):

> For answering the next two questions imagine the following scenario. You are browsing the web with your favourite browser (Internet Explorer, Firefox, Chrome,..). For some of the visited web sites interesting, additional information is found by the software. See the following screenshots for an example showing the Wikipedia page for "loom" and related cultural resources.

Then, the question about preferred notification style was asked, followed by the question about the preferred presentation style. Finally, the survey closed with questions about demographic data, such as age, gender, occupation, nationality and the preferred browser.

C. Participants

We received 75 completed responses, composed of 61 from the general public subgroup and 14 from the educational staff (see also table I). 34 (45%) categorised themselves as female and 41 (55%) as male. 43 (58%) surveys were completed in German language and 32 (42%) in English. The age distribution is shown in Figure 4, note that the age categories were predefined as shown in the figure. The majority of users (61%) were between 20 and 39 years old. The responses to the multiple choice question about the preferred browser version are depicted in figure 5, revealing that Chrome and Firefox were the mostly used browser, while users rarely used Opera.
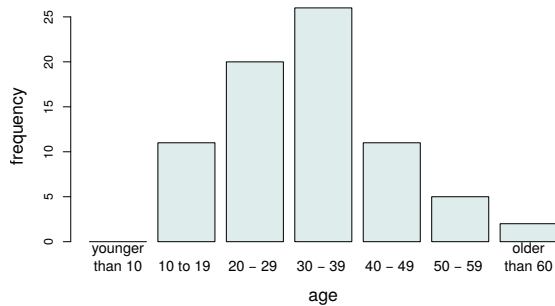
Figure 4.   Age distribution of participants.

D. Results

Table I summarises the meta information of the survey responses. In total, 89 users requested a survey token, out of which 75 (84%) completed the survey. The survey took approx. $3\frac{1}{2}$ minutes to complete on average. The survey was available over 4 months, the duration reported in the table refers to the time difference between the first and the last response.
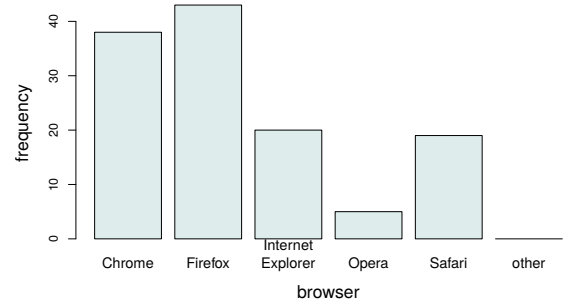
Figure 5.   Browser distribution of participants. Multiple preferred browsers could be chosen.

	Educational	General	Total
duration [months]	2.5	1	
avg. interview time	205 s	214 s	
total responses	19	70	89
full responses	14	61	75
completion rate	74%	87%	84%

Table I
RESPONSE OVERVIEW FOR BOTH USER GROUPS.

1) Notification Style: Figure 6a summarises the results for the notification styles. For the total population, the most preferable notification would be the appearance of a notification bubble (28 positive responses), followed by change of icon's appearance (25 positive responses) and the appearance of the icon (18 positive responses). Only 3 users would like to manually request resources. The results are slightly different for general public users, mostly they preferred the change of the icon's appearance (25 positive responses) followed by the appearance of a bubble (18), and icon or line appearance (16 positive responses each). On the contrary, the educational staff had a clear preference for the appearance of a bubble (10 positive responses).

2) Representation Style: Figure 7a summarises the responses for the preferred representation styles. In total, the preferences are more distinct for the representation style than for notification style. The majority of users (39 positive responses), preferred a split pane like representation, while the other alternatives received 62 positive responses in total (excluding "other"). The tendency is the same for general public users with 34 positive responses for the split pane like representation. On the contrary, the educational staff preferred the style with a marginal note on the right (6 positive responses).

The free-text input for "other" suggestions contained answers like "drop down box" (once), "dialog box over the relevant text" (twice), and "separate split pane (if it is expandable and collapsible) (three times)". The latter is similar to the split pane type, but requests additional interaction possibilities, which were not indicated in the survey questions.
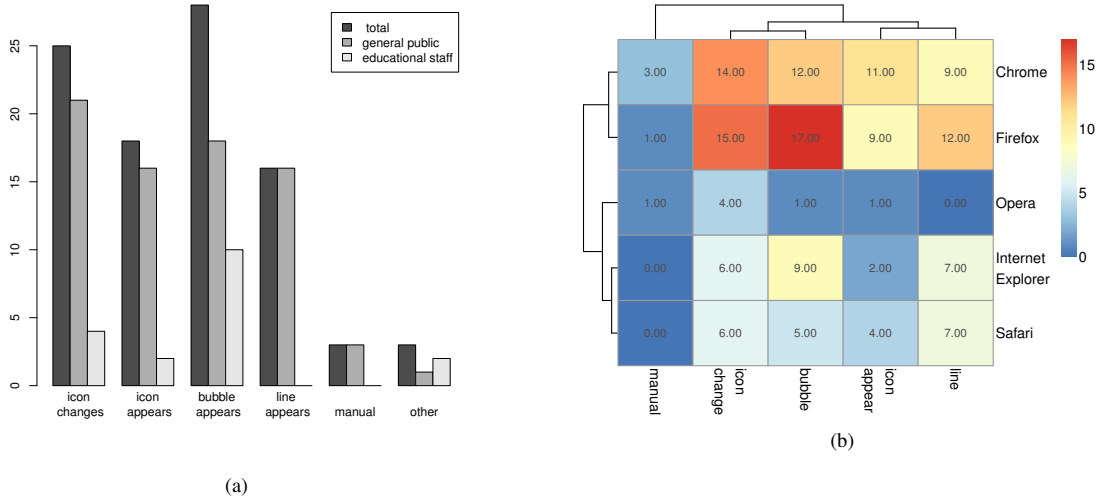
Figure 6. Results for preferred notification styles (a), and relation to the preferred browser (b). Both questions allowed multiple answers.
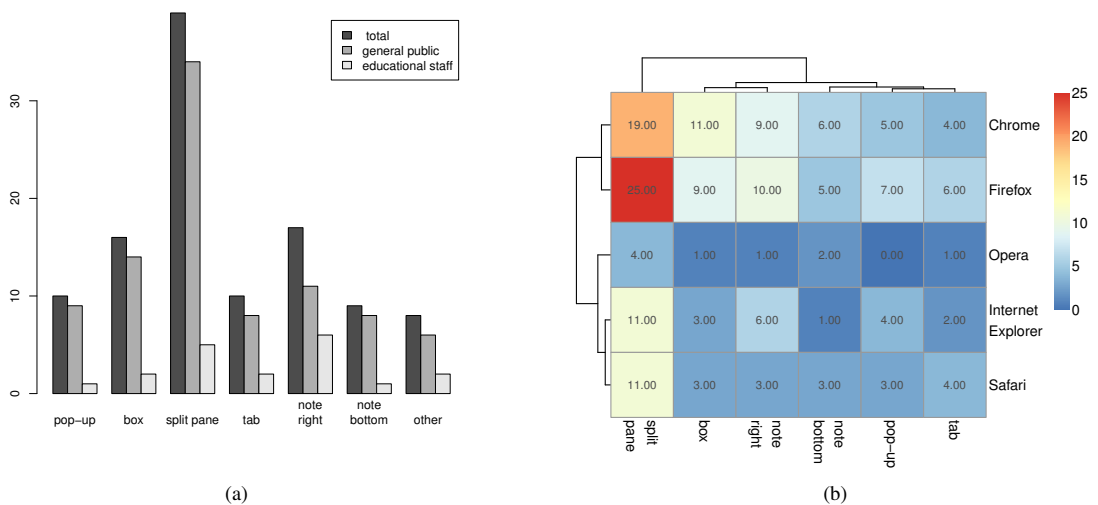

Figure 7. Results for preferred representation styles (a), and relation to the preferred browser (b). Both questions allowed multiple answers.

3) Relation of Styles and Browsers: Figures 6b and 7b show an overview heatmap of the relation between preferred notification styles and preferred browsers. The numbers in the figure represent positive responses. Note that both questions in the survey were multiple choice questions, thus a survey of one user could potentially contribute to multiple squares in the heatmap. In the margin of both figures the cluster tree is shown, calculated using hierarchical agglomerative clustering on the similarity of row and column vectors, respectively.

For the relation of browser and notification style, it can be seen in figure 6, that users who use Firefox and Chrome also have similar preferences in notification style, bubble appear-

ance and notification icon change being the most preferred ones. Similarly users of Internet Explorer and Safari tend to prefer an appearing bubble or line, or a change of the icon's appearance. The most prominent combination across all browsers and notification styles is the Firefox/Chrome and bubble appearance/icon change (corresponding to the orange and red area in the figure).

There is less variance for the relation of browser and representation style (see figure 7). Across all browsers users prefer the split pane style (corresponding to the left column), with the other styles being much less preferred across all browsers.

V. Discussion

The survey revealed a strong user preference for the representation style (supporting hypothesis **H2**) and multiple equally important preferences for notification styles (not supporting hypothesis **H1**). The preferred representation style is the split pane, which has the advantage that it does not overlay current web page content, and no scrolling is required on the page to view its content. The three preferred notification styles are the appearance of a bubble, and icon appearance or change. The latter two can be implemented rather easily in a similar fashion, since an appearing icon can be simulated with an icon changing its appearance from invisible (or 100% transparent) to visible.

From the survey, we can derive two suggestions for designing user interfaces for web-based JITR. The first suggestion is to implement a collapsible and expandable split pane for presenting results. Second, we suggest to implement three different notification styles, and let users select their own preferred style. The three styles are a bubble-like notification, an icon which appears and an icon which changes its appearance on retrieval of new results. If the implementation resources are limited only implement the icon change/appear styles, which are technically very similar.

VI. Conclusion and Future Work

In this paper we investigated user interface considerations for web-based just-in-time retrieval (JITR). In JITR related resources, which are considered relevant, are retrieved automatically without explicit user interaction. We proposed an interface approach with 2 stages, notification about new results and representation of the results. Further, we identified four different notification styles, six different representation interface styles, and two different possible result display trigger styles for a web-based setting. In an online survey with 75 participants we elicited user preferences for the notification and representation styles. From the results we derived the following interface guidelines for web-based JITR:

- Implement a collapsible and expandable split pane for presenting results.
- Implement three different notification styles and let users select their own preferred style, a bubble-like notification, an icon which appears and an icon which changes its appearance on retrieval of new results.

In the future we will implement these suggestions within a browser extension and plan to evaluate the preferences on a larger user group using A/B testing.

Acknowledgments.

References

[1] B. J. Rhodes, "Just-in-time information retrieval," Ph.D. dissertation, Massachusetts Institute of Technology, 2000.

[2] A. Broder, "A taxonomy of web search," *SIGIR Forum*, vol. 36, no. 2, pp. 3–10, Sep. 2002. [Online]. Available: http://doi.acm.org/10.1145/792550.792552

[3] B. Shneiderman, D. Byrd, and W. B. Croft, "Clarifying search: a user-interface framework for text searches," *D-lib magazine*, vol. 3, no. 1, pp. 18–20, 1997.

[4] ——, "Sorting out searching: A user-interface framework for text searches," *Commun. ACM*, vol. 41, no. 4, pp. 95–98, Apr. 1998. [Online]. Available: http://doi.acm.org/10.1145/273035.273069

[5] G. Marchionini and R. White, "Find what you need, understand what you find," *Int. J. Hum. Comput. Interaction*, vol. 23, no. 3, pp. 205–237, 2007.

[6] D. A. Norman, *The Design of Everyday Things*. Basic Books, 2002.

[7] P. Mulhem and L. Nigay, "Interactive information retrieval systems: From user centered interface design to software design," in *Proceedings of the 19th Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, ser. SIGIR '96. New York, NY, USA: ACM, 1996, pp. 326–334. [Online]. Available: http://doi.acm.org/10.1145/243199.243280

[8] M. A. Hearst, *Search User Interfaces*, 1st ed. New York, NY, USA: Cambridge University Press, 2009. [Online]. Available: http://searchuserinterfaces.com/book/

[9] E. Cutrell and Z. Guan, "What are you looking for?: An eye-tracking study of information usage in web search," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ser. CHI '07. New York, NY, USA: ACM, 2007, pp. 407–416. [Online]. Available: http://doi.acm.org/10.1145/1240624.1240690

[10] J. J. Cadiz, G. Venolia, G. Jancke, and A. Gupta, "Designing and deploying an information awareness interface," in *Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work*, ser. CSCW '02. New York, NY, USA: ACM, 2002, pp. 314–323. [Online]. Available: http://doi.acm.org/10.1145/587078.587122

[11] S. Yamada, N. Mori, and K. Kobayashi, "Peripheral agent: Implementation of peripheral cognition technology," in *CHI '13 Extended Abstracts on Human Factors in Computing Systems*, ser. CHI EA '13. New York, NY, USA: ACM, 2013, pp. 1701–1706. [Online]. Available: http://doi.acm.org/10.1145/2468356.2468661

[12] D. C. McFarlane and K. A. Latorella, "The scope and importance of human interruption in human-computer interaction design," *Hum.-Comput. Interact.*, vol. 17, no. 1, pp. 1–61, Mar. 2002. [Online]. Available: http://dx.doi.org/10.1207/S15327051HCI1701_1