Trailblazing Information: An Exploratory Search User Interface

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Abstract. When conceptualizing user interfaces (UIs) to support exploratory search, designers need to take into account various aspects. In contrast to ordinary information retrieval UIs, exploratory search user interfaces (XSIs) need to support users in a more complex and often long-term use scenario. Therefore aspects of Personal Information Management need to be taken into consideration. An XSI needs to provide a visually appealing overview over retrieved search results, it should offer simple ways to interact with the result set and offer easy ways of interaction to enhance the user's search experience by direct or indirect query refinement options. In this paper we propose a possible solution to address these requirements, implemented a fully functional prototype and present the results of a conducted usability study.

1 Introduction

Adhoc-searches are well supported by current web search engines. Beyond that, complex information needs or investigations which often rely on multi-session search processes are not very well supported [12]. There is a growing need of users to be supported in complex search tasks like exploratory searches.

Noël et al. [16] modelled the exploratory search process in general by providing three axes of freedom a user usually selects from in order to navigate in an (unknown) information space (Fig. 1). Thereby, an overview visualization of search paths (search trails) is identified as a crucial aspect to support the XS process. New concepts to satisfy such requirements are being developed and investigated under the term *exploratory search (XS)* [12,23]. It is based on advances in technology as well as novel insights from psychology. Ergonomically designed user interfaces (UIs) should support users by easy-to-use switches between overview and context views [20] since this is one of the key tasks an *Exploratory Search User Interface* (XSI) should support [23]. In this work we present a possible solution to address this requirement. Furthermore several novel interaction techniques and methods are proposed that were evaluated as useful enhancements to support exploratory search tasks.

2 State-of-the-Art

Modern search engines have been engineered and tested to be good in finding answers to relatively straightforward questions. However, if the user has a more

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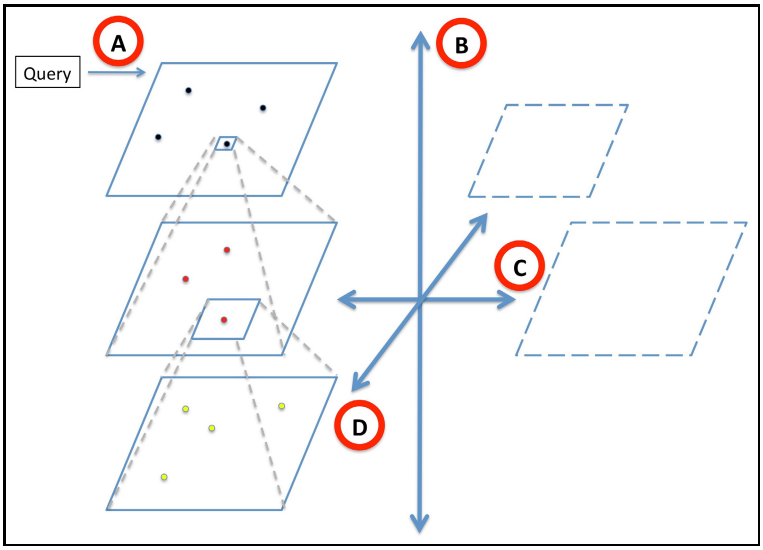

Fig. 1. 3D of movement in exploratory searches [16]: (A) query input, (B) vertical axis for filtering, (C) horizontal axis for similarity measures and (D) transversal axis

complex information need, traditional search engines can only partly - if at all - assist in finding sources that could satisfy the demand [8].

Beyond search user interfaces (SUIs) that are solely based on user queries, a myriad of systems to explore information spaces exist. One exemplary information exploration system is the dynamic queries interface by Ahlberg, Williamson & Shneiderman [1]. It is characterized as an interactive graphical visualization of a database and allows query formulation via direct manipulation of widgets such as sliders. While corresponding tasks differ in motivation, search objective, complexity, uncertainty, activities and task [6], exploratory search can be characterized by the problem context and the search process [23]. The searcher is aware that he needs information to solve an ill-structured problem or process [19]. Around 20-30% [18] of searcher's goals are undirected queries. Beyond knowledge acquisition, the search process yields higher-level intellectual capabilities of the searcher within a particular subject area [23]. The user experience suffers in these cases, as SUIs are not well equipped for exploratory behaviour, and thus users employ non-expedient strategies out of necessity [22].

"The goal of information exploration is the refinement of a vague information need that leads, through interaction with information objects and information resources, to a more thorough understanding of the problem" [21]. Further characteristics of this kind of exploration is a defined conceptual area [22] and the examination of metadata of information sources [7]. In this area, filtering techniques can be useful to reach the informational goals. Exploratory data analysis is an example for information exploration [22]. One exemplary information exploration system is the dynamic queries interface [1]. It is characterized by an

interactive graphical visualization of a database and a query formulation via direct manipulation of widgets such as sliders.

Although the focus on exploratory search has only arisen recently, the need to change the focus in research has been highlighted before, for example by Ingwersen [10] or O'Day & Jeffries [17]. Preceding the influential paper of Marchionini [12], this type of search tasks was called for instance "subject searches, general tasks, decision tasks, and open-ended tasks" [6]. Exploratory search can be characterized by the problem context and the search process [23], while the corresponding tasks differ in motivation, search objective, complexity, uncertainty, activities, and task product [6]. They are generally "more engaging, less well-defined, and require[s] more a priori information to be known" [6].

Exploratory searches are motivated by (personal) work tasks, e.g. writing a report [24], and these make up the problem context. The searcher is aware that he needs information in order to solve an ill-structured problem for proceeding in this task [19]. Moreover, the "actor's mental models lack concepts and relations between concepts for accurately representing the task" [19] and thus precisely defining the problem. This is also referred to as an anomalous state of knowledge [3] and mostly based on a lack of prior domain knowledge [23] and/or that the target of the search may be (partially) unknown [21]. Nevertheless, "the user defines the problem internally as a task with properties that allow progress to be judged and a search strategy to be selected" [23]. According to Rose & Levinson [18], around 20-30% of searcher's goals are undirected queries.

The objective is mostly to "create a knowledge product or shape an action" [23], or to "collect information through a variety of means, and to combine the discovered information to achieve a coherent understanding of some topic" [8]. Beyond knowledge acquisition, the search process yields higher-level intellectual capabilities of the searcher within a particular subject area [23].

Aula & Russell [2] distinguish between measures of (procedural) complexity and exploratiVeness, where the latter can be measured with a goal abstraction level. Prior to that, for instance Byström & Järvelin [5] studied the task complexity in a conceptual sense and its implications for information need. Complex tasks require understanding and sense-making to process results from different sources. The complexity and difficulty of the task, or the imprecisely defined problem context can result in uncertainty [6]. This generally decreases as the search progresses [11].

A lot of innovative interface ideas have been developed over the last years, but only the most promising ones have found their way into major search engines [9]. Many features have also come up and disappeared again, as one can see observing the permanent minor and major changes and optimizations taking place in Google's[1] interface. While this is also motivated by company policy - e.g. the integration of Google+[2] and YouTube[3] in the starting page - most modifications focus on the *usability* and *user experience*.

[1] `http://www.google.com` (03.02.2013)
[2] `https://plus.google.com` (03.02.2013)
[3] `http://www.youtube.com` (03.02.2013)

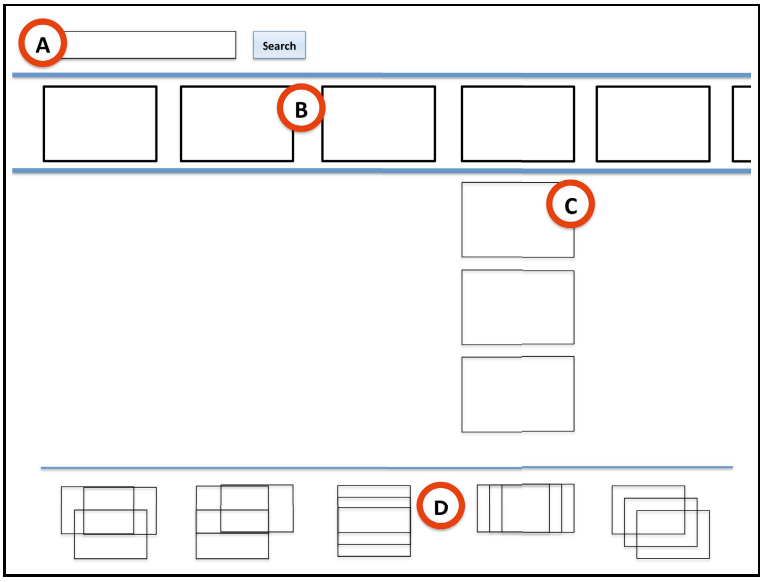

Fig. 2. Basic concept of "Trailblazer": A - text-based entry field, B - results ranked horizontal from left to right, C - orthogonal search trail (opens when result above is clicked), D - iconic representations of past search sessions

3 Trailblazer

In 1945, Vannevar Bush and Jingtao Wang described in their article "As we may think" the MEMEX system [4]. MEMEX (memory extender) is a theoretical system that was conceptualized to support users in "trailblazing": Trailblazing as a profession that establish "useful trails through the enormous mass of the common record" [4]. Since the proposed SUI here is also supposed to support users in trailblazing useful information out of the mass, we call the system "Trailblazer" in honor of Bush's early vision.

3.1 Concept

In our proposed solution, a domino metaphor (Fig. 2) is used to arrange single query results orthogonal to each other to visualize when and at which specific position a query refinement took place. Technically this happens by enhancing the original query with the secondary most representative term or multiple terms, derived from the actual selected search result. Thereby users become aware of their own search processes and firstly get the possibility to go back to a certain exploratory search step in order to choose an alternative path. This is realized (e.g.) by the design decision that path enhancements only take place in an orthogonal direction to the right or to the bottom. The such created search trails provide users with an interactive search history that can be easily enhanced.

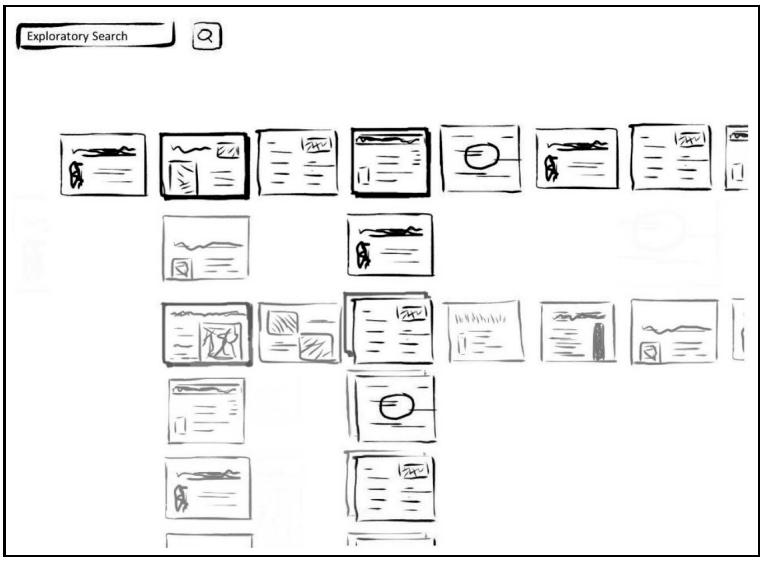

Fig. 3. Design Sketch: Multiple paths and overlapping issues

Using a domino metaphor, single query results will be arranged orthogonal to each other in order to visualize when and at which specific position a query refinement took place. Technically this might happen by simple enhancement of the original query by a representative term or multiple terms, derived from the selected search result. Thereby, users become aware of their own search processes and firstly get the possibility to go back to a certain exploratory search step in order to choose an alternative way, since path enhancements only take place in an orthogonal direction to right or to bottom, it is easy to navigate through and identify positions where query expansions took place. So-created search trails provide users with an interactive search history that can be easily enhanced.

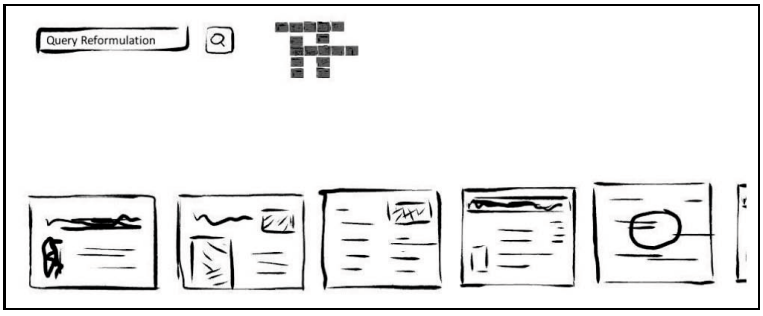

Fig. 4. Iconic representation of search trails. Here, the search trail of Fig. 3 is symbolized on top as a characteristic representation.

3.2 Design Follows Function

Following an old concept, the proposed XSI ...

- supports easy overviews of search results,
- shows interconnections between search results,
- provides users in keeping their focus while searching,
- provides easy ways to break out of known waters to explore unknown country (explore all three dimensions of exploratory search [16]),
- re-captures older researches in order to follow alternative paths,
- prevents users from switching between use modes (e.g. if PIM is necessary, directly support it in the XSI)

and

- supports easy query refinement / expansion.

3.3 Prototypic Implementation

The described concept has been implemented and features:

- horizontal instead of vertical result listing (Fig. 5),
- website preview in overview, interactive InFrame-Browsing [15] in detail view (Fig. 6),
- orthogonal layout of search refinements (implicit searches) - to right or to bottom to identify biunique starting points for the user's XS (Fig. 7),
- moving of whole research paths to the left upper corner of the UI, when new searches are started (easy resumption of previously started searches, Fig. 8),
- fading out non-followed paths to keep a clear UI design,

Fig. 5. Horizontal layout of first results as document previews

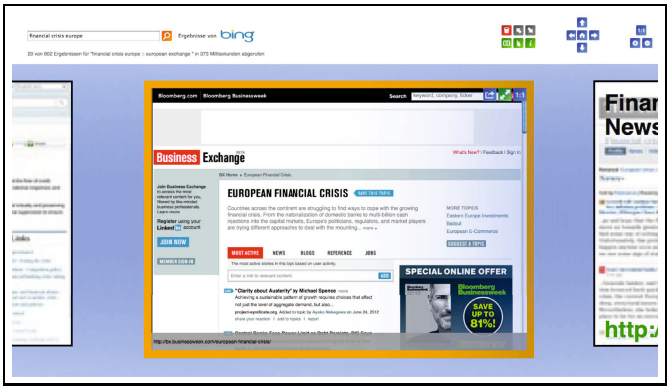

Fig. 6. Preview in context of other results (left and right) and InFrameBrowsing [15]

- automatic loading of further results if user reaches the right or bottom end of the display (infinite scrolling, no page turns necessary),
- support of explicit searches like user's expect of ordinary search user interfaces (in this case automatic archiving of previous search paths),
- saving & loading of search paths (supporting seamless switching between searches)

and

- enhancing search paths is done transparently (also in the implicit interaction mode) by showing the actual query send to the IR system.

Fig. 7. Orthogonal layout of results retrieved by an implicit query expansion

We implemented the proposed concept using HTML5 and connecting to the Bing API[4] by Microsoft. The working prototype (see also Fig. 5, 6, 7 and 8) was tested by various users to evaluate its usability.

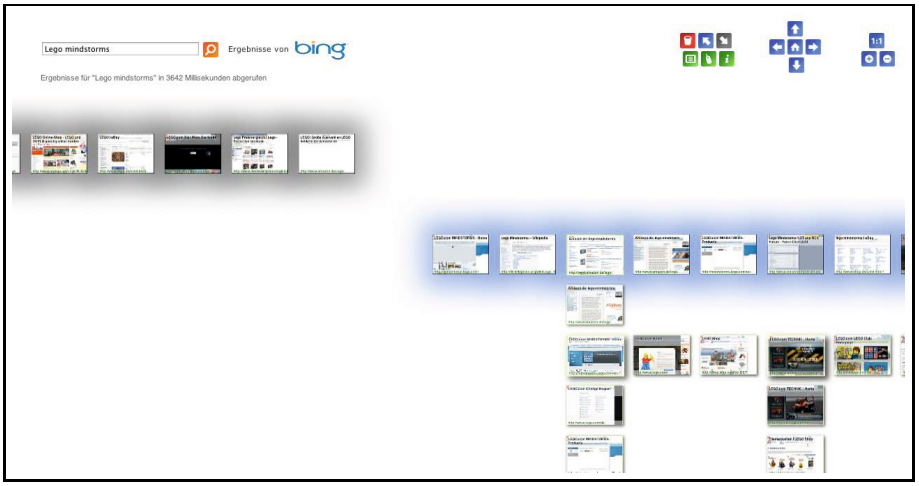

Fig. 8. Different searches: Selectable, reusable, comparably

4 Evaluation

Various studies have been conducted: A pre-study with a paper prototype to gain insights on the reception of the overall concept, a user study with a first running prototype and a final evaluation. In each study, different six participants were between 24 and 31 years old - with an average of 27.5 years -, three of them were female. The idea of search trails was received positive, even if it is a total new concept. Users liked the possibility to choose from alternative paths, but they suggested using the concept primarily for investigative tasks like exploratory searches, since it might overwhelm users when conducting simple look-up searches with this user interface concept.

Critic comments were to preserve clarity, let the interface be not so crowded, and provide only a minimum amount of animations and shifts. Another suggestion was to let the tool be a browser plug-in to ease integration into current practices. Five subjects would like most to test the system with a desktop computer or a laptop. Two would like to use a tablet. Many participants could imagine using the search interface on a regular basis. Four would use it daily instead of their current favourite search interface - not wanting to have separate systems to search. One test user stated, "if it provides more useful results than Google" as a reason, another one "if it's a customized perfect search engine".

[4] `http://www.bing.com/developers` (03.02.2013)

Three would use it for grounded specialist research, with one subject saying, "the system would be a good support, one only has to use one platform". Two of them would separate between their ad-hoc search system and a special tool for exploratory searches.

5 Conclusion and Outlook

In this paper the general requirements towards an ergonomic exploratory search user interface (XSIs) has been sketched. Furthermore, an XSI concept - called *Trailblazer* - that addresses a lot of these requirements was proposed. We evaluated the concept during a user study in different steps of the development process. Results reveal a potential for further improvement and enhancement of the concept.

In the near future, the system will be enhanced by features to manage in-between search results and options to save (parts of) exploratory search processes. Furthermore the performance while loading thumbnails and the algorithms for implicit query refinement will be improved.

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