Evaluating User Effectiveness in Exploratory Search with TouchGraph Google Interface

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Abstract. TouchGraph Google Browser displays connectivity of similar pages around search results returned by Google. A major research question is: to what extent does this graph help improve user effectiveness during exploratory search? This paper reports on our user study with TouchGraph visualization. This study has interesting implications for designing user interfaces of search applications.

1 Introduction

Search engines generally do a good job in finding information that is easy to label, like “calories in apples.” However, information is not always easy to articulate. In some cases users may not even know what the correct answer looks like until they have seen it. Learning, navigation and exploration play important parts in information seeking. A user generally starts with an initial query and successively refines it until desired information is found. Each new query in this progression reflects something learned along the way.

Exploration by successive query-refinement is difficult. Users frequently give-up searches in frustration. A key area that has become a hot research topic in recent literature [6,7] is determining the right set of tools that will help users during exploratory search. It is not known what interface tools would support exploration. User-interface research [1] suggests that use of symbols and graphics improves cognition and perception. Visualizations can highlight aspects of information not comprehensible with plain text. For example, TouchGraph Google Browser¹ displays connectivity of similar pages around search results. An interesting research question is to what extent does this graph help improve user effectiveness during exploratory search. This paper reports on our user study with TouchGraph visualization.

2 Related Work

Earlier work has focused on display and navigation of search results. Koshman [5] studied TouchGraph interface for Amazon.com and examined user ability to select similar items. Their user test with 17 participants showed that there was a high overlap between system-suggested similar items and user-discovered similar items.

¹ <http://www.TouchGraph.com>

Efe, Asutay, and Lakhoria [2] evaluated a visualization interface that allows following the links forward and backward. Additional tools allowed changing the scope of displayed graph, orientation support and backtracking. User tests with 50 participants showed that, given equal time, users were able to successfully complete twice as many search tasks as the users of a traditional interface.

Heo and Hirtle [3] investigated different methods for visualizations of category information with 80 participants using distortion, zoom, and expanding outline. The study showed that performance did not improve with visualization tools, however the expanding outline was shown to be more useful to users than other visualizations.

Hightower et al [4] studied visualizations of visited paths displayed in a tree structure. User tests based on 37 participants showed that users with the visualization tool completed the given set of search tasks nearly twice as fast as the control group without the visualization tool.

3 Research Question

In this research we hypothesized that visualization can support exploratory search by displaying relationships among documents and by enhancing user interaction with the system. The major research question in this context is how well can users navigate a graphical presentation of related documents to reach desired information. Two aspects of this question are: a) how well can users navigate visualizations to reach multiple sources of related information on a subject, b) To what extent does this ability translate to reaching desired information.

4 Study Design

4.1 System

TouchGraph is well suited for the research questions we consider. It supports exploratory search by displaying connections between related web sites. Web sites are displayed as nodes of a graph related to search results. Clicking on a node retrieves other related nodes and displays around the selected node. Additional information about a node is displayed by moving the mouse over the node. Display area also contains a list of search results in a vertical box on the left side of the screen. Selecting an item from the list highlights the corresponding graph node. It also displays site description in a special text area. An example screen generated in response to query “book sellers” is shown in Figure 1.

4.2 Participants

Thirty-five computer science graduate students participated in the experiments. All of them said that they used Google on a daily basis, but none of them had knowledge of TouchGraph before the experiment. We randomly divided participants into two groups based on the parity of their student Id numbers. Students with even Id numbers were told to use Google and students with odd Id numbers were told to use TouchGraph. It turned out that there were 16 Google users and 19 TouchGraph users. Before the experiment, participants were given a five-minute training on TouchGraph to demonstrate different functionalities available.

Fig. 1. TouchGraph visualization

4.3 Experiments

Two experiments were designed. In both experiments, participants were free to use any queries they wished. User effectiveness is measured by the number of successful searches completed within a fixed period of time.

The first experiment is designed to measure ability of users to reach a multiplicity of related documents. Participants were provided the URLs of 20 web sites on used books (sales, exchange, collector clubs, etc) and they were asked to find as many of these sites as possible by entering queries to the system and by exploring related pages. Table 1 shows the list of URL's the participants were required to find.

Table 1. The list of related pages used in user test

Addall.com	Bookspot.com	Booktalk.com	Biblio.com
Bkdirectory.com	Resourcehelp.com	Iblist.com	Fetchbook.info
Booksalefinder.com	Edifyingspectacle.org	Clresource.com	Book-Smith.tripod.com
Digital-librarian.com	Bookwire.com	Bookrecycler.org	Book-Clubs-Resource.com
Abaa.org	Pbfa.org	Bookfinder.com	Booksweep.com

The second experiment contained 10 search tasks specifically designed to require exploration before reaching a document with the correct answer. Topics of search were selected to be specialized enough that a layperson is not likely to have independent knowledge. Participants were asked to record the URL of the required

document when they find it. For most search tasks, we tried to make sure that the required web source described in search question was unique in its information content. When in doubt, we provided page-specific information as part of search task specification. An example question in this test is as follows:

Find a web site that offers thematic online maps relating to various topics. Upper-right corner of the page contains links for interesting maps available there. Examples of maps include population maps, economic maps, airport locations, travel maps, and others. This site also has detailed information about various topics of interest, such as top-10 countries in the world (in the sense of various criteria), map of top 100 hotels in the world, map of top 100 wonders of the world, etc.

The expected answer for this question was <http://www.mapsofworld.com>. When queried on Google with “thematic world maps,” this particular URL comes up as the top item². The specification about upper-right corner of page was intended to distinguish the “correct” document from others. Among 16 Google users, all but one found this URL as the correct answer. Of the 19 TouchGraph users, only four missed the correct answer.

Another question, which had close to fifty percent success rate for both groups, was the following:

Find a web site that provides a URL-based search over the billions of archived pages on the web. Here a user can enter the URL of a page and retrieve different versions of the same page as it was on different dates. The site doesn't support keyword searching like search engines. The user must enter the URL of a page as input.

The expected answer was <http://www.archive.org>. The “correct” answer is unique since there is no other web site providing this service. It shows up as the top result when searched on Google with query “internet digital library.” 5 Google users and 6 TouchGraph users gave the correct answer.

Another question with somewhat lower success rate was:

Find a web site that sells prehistoric monuments like fossils, meteorites, and other items that are related with dinosaurs. The monuments are displayed in a gallery. There is a diversity of prehistoric monuments in this exhibition like a two hundred million year old petrified wood slice, a dinosaur claw, eggs, toys and etc.

The expected answer for this search task was <http://www.dinosaurstore.com/>. This URL shows up as the top item in the list of search results when searched with “dinosaur teeth fossils.” Notice that the word “teeth” does not appear in page description we provided. This may have made it harder to find the page, and search may require a good deal of exploration. We had found this web site by searching with

² It should be noted that Google ranking of pages may vary over time. Generally, this variation is less for well-established web sites. Page rankings mentioned in this paper were true as of the date of user experiments.

“fossils meteorites dinosaurs” and clicking on “similar pages” link of the second item on the list (which was www.arizonaskiesmeteorites.com/Dinosaur_Fossils_For_Sale). The page appears as the sixth item on the similar pages list. The “correct” answer was unique as of the date of tests because of the two hundred million year old petrified wood slice that none of the similar pages had. While six Google participants found this URL as the correct answer, among TouchGraph users only one participant found this URL. This was surprising because we had expected TouchGraph users to be more successful on this question due to the way we had reached it.

The only question with no correct answer from any participant in either group was the following:

Find a web site whose primary purpose is to maintain a comprehensive listing of African-Diaspora-related Web pages. The site provides a directory and a full text search of the indexed pages at a central site.

Here, any one of several possibilities can be considered as being the correct answer, like <http://www.ubp.com/>, www.blackpages.com/, www.blackpgs.com/, and possibly others. All three of these pages are returned on the first page of Google when queried with “black pages.” Our original expectation was that most participants would suggest <http://www.ubp.com/> as the correct answer, because it is the only site that explicitly states its mission, as “The primary purpose of the UBP is to maintain a comprehensive listing of African-diaspora-related Web pages at a central site.” Moreover, it comes up as the second item when searched with “African Diaspora pages,” or as the fifth item in response to “diaspora related pages.”

This was one of the few search tasks with multiple acceptable answers in our experiments. Yet, it turned out to be the only one with no correct answer from any participant. After close inspection, we found that in Google search engine, “diaspora” seemed to retrieve (mostly academic) pages that study the concept of Diaspora, and history of diaspora. Using the keywords “black pages” was essential for Google to retrieve sites with directory or search facilities, but participants didn’t try these keywords from the provided description of search task.

5 Statistical Evaluation of Results

5.1 Related Items Test

In finding related items, TouchGraph users were more successful than Google users. This result concurs with Koshman’s findings [5] where users of TouchGraph were highly effective in finding related items in Amazon.com. This is expected since TouchGraph user interface graphically displays relationships between pages. Figure 2 shows the user scores obtained, and Table 2 shows the group statistics.

We performed Mann-Whitney significance test on these results by using SPSS statistical package. Significance measures are reported in Table 3 below. As can be seen, the difference between user performances was highly significant.

Fig. 2. User scores in searching for related pages

Table 2. Group Statistics in finding related pages

Interface	N	Mean	Std. Deviation	Std. Error Mean
Google	16	3.5000	2.03306	.50827
TouchGraph	19	5.5263	1.38918	.31870

Table 3. Significance Statistics

	URL found Count
Mann-Whitney U	54.500
Wilcoxon W	190.500
Z	-3.274
Asymp. Sig. (2-tailed)	.001
Exact Sig. [2*(1-tailed Sig.)]	.001

5.2 Exploratory Search

User scores in exploratory search are plotted in Figure 3 below. Table 4 shows the corresponding group statistics.

Contrary to the first test, Google users were more effective in exploratory search than TouchGraph users. Mann-Whitney test on these results showed the performance difference to be significant, rejecting null hypothesis with 95 percent confidence. Mann-Whitney significance measures are reported in Table 5 below.

Fig. 3. User scores in exploratory search

Table 4. Group Statistics

Interface	N	Mean	Std. Deviation	Std. Error Mean
Google	16	3.5000	1.59164	.39791
TouchGraph	19	2.4211	1.26121	.28934

Table 5. Significance Statistics

	Correct Count
Mann-Whitney U	89.000
Wilcoxon W	279.000
Z	-2.138
Asymp. Sig. (2-tailed)	.033
Exact Sig. [2*(1-tailed Sig.)]	.037

6 Discussion

The purpose of our experiments were to find answers to two key questions: a) how well can users navigate visualizations to reach multiple sources of related information, b) To what extent does this ability translate to reaching desired information in exploratory search. The first test showed that TouchGraph interface positively helps users reach a multiplicity of related pages. However, the second test showed that this ability did not necessarily translate to more effective searches.

The results appears counter-intuitive at first because we would expect that enhanced ability to reach a multiplicity of related documents would translate to enhanced ability to reach desired information. However, our interviews with users showed that they had difficulty in comprehending the graphical display. When the question only asked about page URL, they performed well because they could readily see the URL associated with each graph node displayed on the screen. However, there was a semantic gap between the URL of a page and its information content. They couldn't see enough content description to meaningfully navigate their way toward required information. Consequently, they made very little use of related page information.

Google user also admitted that they didn't make much use of "similar pages" facility. Both groups tried to use query refinement as the primary mechanism for exploration.

One month after the test, we asked participants: "Now that you are aware of its existence do you use TouchGraph instead of Google for search?" None of the participants acknowledged using it even occasionally.

Effective tools that help users to explore related pages are essential in web search. In real life, learning and reasoning about related information is a primary method of discovering the unknown. There is no reason why this should not be the case for exploratory search on the web. We only know that TouchGraph is not the right tool for this purpose.

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