Kolline: a task-oriented system for collaborative information seeking

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ABSTRACT

This paper presents results of an exploratory study which observed Linux novice users performing complex technical tasks using Google's search engine. In this study we observed that information triage is a difficult process for unexperienced users unless well structured information is provided which results in better satisfaction and search effectiveness. Providing a well structured information allows users to browse through different pieces of documentation without depending exclusively on the keyword search. Based on these observations, this research prototyped Kolline, a system that aims to facilitate information seeking for unexperienced users by allowing more experienced users to collaborate together. Users in Kolline create a task-oriented navigation structure based on web annotations. In this paper we discuss the potential benefits of this technique on helping unexperienced users to solve complex search tasks and present improvements for future work.

Categories and Subject Descriptors

H.5.3 [**Information Interfaces and Presentation**]: Group and Organization Interfaces—*web-based interaction, collaborative computing, organizational design*

General Terms

Human factors

Keywords

social search, collaborative information seeking, user study, interface prototype, hypertext.

1. INTRODUCTION

Search systems have become essential tools since the invention of the Web. Although search efficiency and efficacy have dramatically improved lately, the interaction paradigm used to search for information has been the same for years: users type keywords into a search box and get back a ranked result list of web documents to be analyzed. A common practice for users is to screen through the retrieved list of documents and individually analyze web pages in order to fulfill their information needs. While this paradigm has been proven to suffice for specific fact finding and other types of lookup search activities, it does not suit exploratory search tasks that well, such as answering open-ended questions and learning about unfamiliar topics [10, 14, 17].

We conducted a pilot study to better understand the difficulties faced by Linux novices when looking for information to solve technical problems. We observed that greater task difficulty and lack of expertise have a significant impact on how they interact with the search system and how they examine a large collection of web documents to compare, aggregate and synthesize information. During this process, search context is built upon keywords that are matched against web documents within the search system. As such, the interaction between users and system is largely based on queries, which may lead to imprecise, ambiguous results, thus leaving to users the role of making sense between the provided information and their needs. In brief, this interaction paradigm forces users to individually analyze matched web pages to sort relevant information that may be spread throughout different portions of distinct web documents, which can be a time-consuming and frustrating activity.

This paper proposes a cooperative approach for information seeking, which aims at providing system support for users to interactively build, refine and reuse search context by cooperatively constructing a web of semantically-related and task-oriented information on top of the available web of documents. To this purpose, this research seeks to answer the following research questions:

- How can we facilitate retrieval of related pieces of information within the web of documents?
  - Can these pieces of information be interlinked using web annotations as metadata, by highlighting text snippets within web pages and adding notes that can be easily viewed by other users?
  - Can we create a user interface that focuses on the information embedded in the page instead of on the page itself?

With the aim of answering these questions, this paper prototyped Kolline, a system that aims to facilitate information

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seeking for unexperienced users by allowing more experienced users to collaborate together. Users in Kolline create a task-oriented navigation structure based on web annotations. Section 2 presents some background which helps the reader to understand our approach. Section 3 presents the results of a exploratory study with Linux novices and Section 4 describes our prototype. We discuss the potential benefits of our technique on helping unexperienced users to solve complex search tasks in Section 5 and present improvements for future work in Section 6. The paper finishes with conclusions in Section 7.

2. BACKGROUND

User disorientation and cognitive overhead are well recognized problems of hypertext systems, even before the invention of the Web. Many researchers early recognized these issues and some solutions were proposed. Zellweger [19] introduced Scripted Documents, a system that implements the concept of paths in hypertext systems. Paths bring together an interlinked collection of documents which are ordered in the form of a presentation. As such, most of the decisions about the transversal order of links are made by the author in advance, rather than by the reader during the path playback. This concept is orthogonal to the way that we search the Web today. Although search engines have dramatically improved recall and precision, the unit of retrieval is still the web document. Using this approach, users have to analyze different matched documents or transverse the link structure to find relevant information. The path approach exempt the information consumer of this work, thus having the potential to provide an already filtered collection of documents that can be integrated and used in the context of a particular search task. However, one implementation of this concept has to consider how the path is actually produced and consumed. Albeit one can assume that paths may be produced either automatically or collaboratively, it is not clear how retrieving paths instead of web documents would make the overall search process more efficient.

To address this issue, social search comes up as an alternative search paradigm which is facilitated by the rise of social media and has the potential to change the way by which users filter information. People can easily ask for help in their social networks and share web resources. Information needs are usually communicated through message exchange between peers within the same social network. Morris et al. [11] analyzed benefits of searching using search engines over asking in social networks. Participants revealed preference for using search engines, but the study highlights a growing use of social networks for asking subjective questions, in which the answer depend on tacit knowledge that is shared between peers. While promising, social search is in an early stage of development and different approaches are emerging, such as the Aardvark system[1], which is a question answering system that integrates instant messaging functionality to support asynchronous collaboration within social networks.

In the pursuit of enabling collaboration in the searching process, some systems have also supported synchronous collaboration. For instance, SearchTogether [12] implements group awareness through shared query histories and a “summary” displaying participants’ comments and ratings of web pages. CoSense [13] provides enhanced group awareness by including a timeline view of all queries executed during the search process. Even though these features help to enhance participants’ communication and sense making during their search activities, users still have to sort among different documents and analyze them one by one to find relevant information. As our results indicate, users spend a long time reading web pages when learning about unfamiliar topics. Our approach aims at saving this time by letting users annotate and share web content. The annotations follow the concept of a path and are shared within the scope of a social network, i.e. using the social search paradigm. The next section presents more details about our study.

3. EXPLORATORY STUDY

Studies were conducted to elucidate the following research question: given users’ lack of experience on Linux, what sort of difficulties they would face to search the Web for technical documentation? Six graduate students of the informatics department with little experience on Linux enrolled to participate in individual sessions during which their activity was recorded using screen-capturing software. Audio recording and the think-aloud protocol also contributed to capture important steps about the reasoning behind participants’ actions. Each participant also had one version of the Ubuntu Linux distribution running on the experiment computer.

During each session, participants were presented to five tasks in the domain of Linux systems. They were asked to use Google to look up for information. We aimed at observing differences in subjects’ behavior according to tasks characteristics, such as type, i.e. lookup and exploratory, and difficulty, i.e. simple and complex tasks. To this purpose, we created task instructions that were presented to users during the session, in a counter-balanced order. A moderator was in the same room as an observer, asking questions to the participant when a better verbal explanation would help to clarify some point of interest left behind. Each session also included a pre-test time dedicated to the introduction of the environment to the participant and to present other study details. There were also, at the end of each task, a time dedicated to review the difficulties that were found.

3.1 Preliminary results

3.1.1 Information seeking activities

We identified three distinct activities during participants’ observation, namely query formulation, screening and content analysis. *Query formulation* is composed of the interactive process of elaborating and typing keywords into a text box and of the subsequent clicking on a search button to retrieve search results. *Screening* is the activity of analyzing these results and performing relevance judgments over a ranked list of documents. *Content analysis* encompasses examining each document separately and using the information contained into them. Content analysis often demands an additional step, which is the verification of the information found, e.g. running commands using a Linux terminal to accomplish a certain task. We measured the total time spent on each activity, considering all tasks. Indeed, subjects spent a lot of time analyzing and validating information, as shown in Fig. 1.

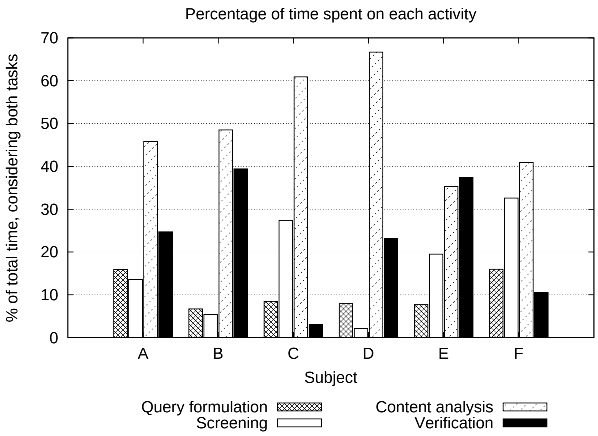

Figure 1: Percentage of time spent on each activity, considering all tasks.

3.1.2 Lack of experience and uncertainty

In our study we found that Linux novices usually have a hard time determining the qualities of an information source, e.g. usefulness and completeness, just by screening the result page provided by Google. This page typically shows a ranked list with page results, each one represented by a title, a brief summary which highlights query's matched terms and the information source's url (*uniform resource locator*). Because subjects cannot easily determine in advance if a given information source is useful to the task at hand, they often have to click on each result and load the referred page, which our experiments revealed to be a time-consuming process (Fig. 1). For instance, subjects were asked to find a possible cause for a bug that was crashing their computers after logging on the machine. One subject queried "ubuntu freezes after login" and after being confronted with a search result page containing a series of links to threaded discussions in web forums, the participant said:

> P03: There is a lot of links. Now, whether the information in those links is meaningful at all is just a matter of reading one by one.

Therefore, we found that lack of experience on a particular knowledge domain leads to greater levels of uncertainty regarding which results to visit from Google's result page. On the many cases in which titles and summaries did not help, a common strategy was to analyze results separately, thus improving the understanding about the task domain. After learning something useful such as a new keyword or the name of a command, subjects often reformulated the query, so a refined result set could be obtained.

3.1.3 Information and its preferred sources

Byström [4] points out that there is a relatively strong preference relationship between types of information and types of sources. Accordingly, we noticed that effect on exploratory tasks which include open-ended questions, e.g. finding three good reviews about the latest Ubuntu Linux distribution release version. For instance, after several unsuccessful attempts to find a reliable information source for a review, one participant found an article and mentioned "this is what I am looking for" as soon as the page finished loading. Before analyzing the content in detail, the subject commented about how the information is presented and structured, with a table of contents and links to different sections. Moreover, we found that when subjects are stuck formulating queries, they naturally start browsing for information. For this reason, Linux novices relied more on well structured documents produced by experts in the form of articles than on documents in the form of threaded discussions. As an example, while searching about the possible causes for a crash after logging in, another subject criticized the way the information is presented in web forums:

> P05: I actually randomly look at the tech forums. Because it is like the same format, the titles... ah! That is one of the things that I would say pro, in general, commercial software... in the open-source [community] more people comment to help you out with the problem, but it is so time-consuming to look for what you need.

Also, Byström [4] also found that the effects of task complexity made experts more attractive as a source. In our study, when comparing information found in a question answering (QA) site with the one found in threaded discussions, subjects revealed a greater preference for the former and the reasons for this behavior are twofold. First, in QA sites, best ranked answers are presented upfront, exempting the user from analyzing several pages with information. Second, best answers are peer-reviewed, thus increasing the information credibility from the novice user perspective. To some extent, these results confirm many aspects of what was pointed out by Dutta-Bergman [5] in the e-health domain. These two factors, i.e. (i) well structured and detailed information that counts for completeness and (ii) expertise associated with content that counts for credibility, when associated with the information source, had a positive impact on subjects' satisfaction levels and search effectiveness. The next section explores these findings and introduces the design of a collaborative system which aims at facilitating technical information scrutiny in the Web for unexperienced users.

4. USAGE SCENARIO AND INTERFACE

Maria logs into Kolline to ask for help. She starts by creating a task to explain her problem in a short text message which is viewable by all users within the system (Fig. 2a). John is an expert Linux user and one of Maria's friends within the system's social network. John looks up relevant web pages in order to help Maria solve her problem and replies to her question (Fig. 2b). John can search on Google and select results using the embedded browser window depicted in Fig. 2g. When clicked (Fig. 2h), each result is rendered in the right side of the interface (Fig. 2j). John can help Maria in two ways: (1) he can create floating notes that are persistently attached to a region on a web page (Fig. 2d). Notes associated to the question are highlighted, while others are shown using less contrasting colors (Fig. 2e); (ii) John can also select text snippets, (e.g. words, phrases or even paragraphs). He can then link these snippets, to create a task-oriented navigation structure that can be browsed

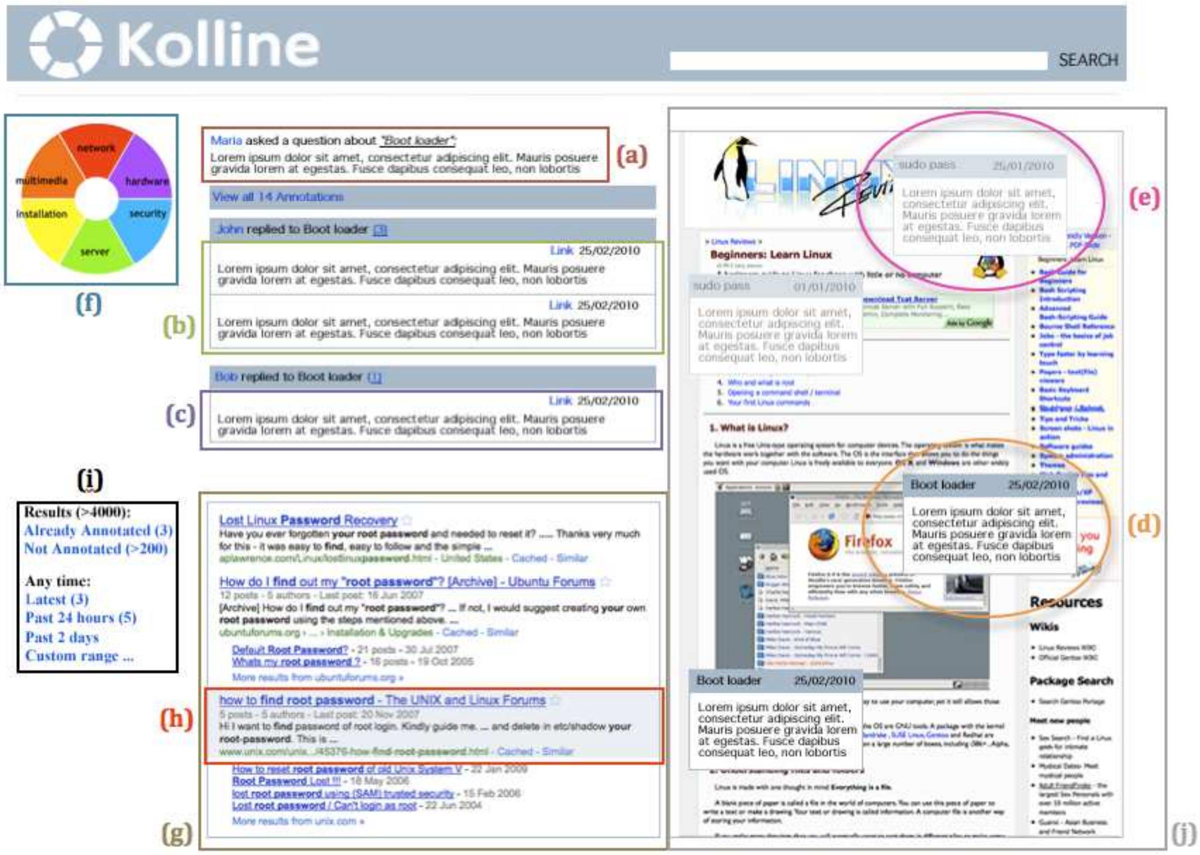

Figure 2: Kolline's interface: (a) Question; (b) and (c) answers; (d) and (e) annotations; (f) browsing tool; (g) Web page results; (h) selected Web page; (i) filters and (j) rendered Web page.

using the tool depicted in Fig. 2f (see [6] for more details). This navigation structure (or path) can be shared among friends, so other users can take advantage of previously created annotations to solve similar problems. Maria can visualize annotations in a preview window within the interface (Fig. 2j). To browse for annotations, she can either click on the answers to her questions, which automatically shows a list of related annotated pages, or browse per category using the colored interface (Fig. 2f). She can also filter for annotations using the menu depicted in (Fig. 2i). In this manner she can analyze each content associated with an annotation and browse the navigation structure at the same time, thus avoiding browser window switching. While she checks John's suggestions, other friends in Maria's social network continue to contribute in solving her problem, e.g. Bob realizes that she still needs help on "boot loader", so he replies to her answer (Fig. 2c) and creates another set of annotations.

Another important aspect in the interface is that every control is centralized in the same browser window. Iqbal and Horvitz [8] discovered that, when switching between tasks, a greater visibility of each task context is associated with faster recovery from one task to another. In other words, tasks associated with application windows that were not focused had longer recovery times. Kolline interface takes advantage of today's higher resolution displays and uses all the available area to show relevant information. The interface provides group awareness by notifying the user when a new message arrives or annotation is created (Fig. 2b and c).

In our browsing interface (Fig. 3), the colors have the purpose of enhancing the user's working memory. Wichmann et al. [18] shows that recognition memory is 5%–10% better on colored images in comparison to black & white images. Thus, one important design decision is based on the idea that colors may have an important role on helping the user to memorize previous steps when interacting with the interface. Another important design decision is to avoid scrolling. Schwarz et al. [15] points out that this approach provides a better experience, especially for novice users. The colored pie functionality is illustrated in Fig 3. On selection of one of the general terms displayed by the interface, a transition changes the tool's shape. It becomes a quadrant through a smooth transition to transmit the idea of changing the focus. Each previous level of the hierarchy, i.e. inner circle, keeps the color of the previously selected term. At each new selection, new paths are recommended in the outer side of the quadrant. The user can move the mouse over the inner circles to view the context, which causes the previously selected terms to be highlighted. Each new interaction with the tool show newer discussions and newer annotations which in turn gives an instant feedback, so the user can make a decision to continue transversing the path structure or to read web

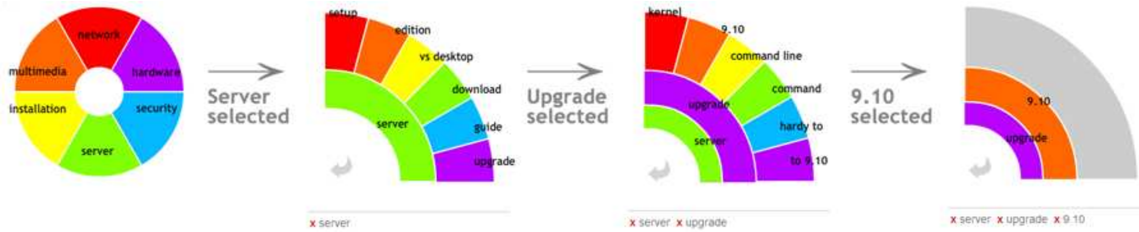

Figure 3: Kolline's browsing interface.

pages and annotations individually. Another important design decision is to avoid scrolling. Our browsing tool stays static and within a single, limited area of the screen, showing just the two previously selected levels as inner circles, i.e. context, and new term recommendations in the outer circle, i.e. focus. The path below the quadrant shows all previously selected terms and allows the user to go directly to a certain level. This has an important role in keeping the user's attention on the focus, without loosing the visual contact of the context.

5. DISCUSSION

In our study we found that (i) well structured and detailed information and (ii) expertise associated with the web content are factors that have a positive influence on user satisfaction and search effectiveness, especially when the searcher is unfamiliar with the search topic. This provided us with a chance to reflect about how the effort of analyzing relevant and irrelevant content starting from the Google's result page can be amortized. Kolline uses a cooperative approach to distribute the problem of information filtering and content analysis among peers within the scope of a social network, i.e. social search. The approach also takes advantage of the fact that people have an intrinsic motivation to cooperate [16] and that friends or acquaintances might share tacit knowledge to some degree, which might help to build content upon subjective information needs that cannot be easily expressed using queries and keywords.

Another measure toward creating design alternatives to save users' time when analyzing content is the use of the path concept. Collaborators can link web pages through their annotations, thus creating a navigation structure which, in turn, facilitates content analysis when the user is disoriented, i.e. not knowing what query is more appropriate or what document more relevant. Users can browse through previously created paths and add their own annotations, so paths are collaboratively created and shared within the social network. By using collaborative design for information seeking purposes, Kolline offers the following contributions. First, unexperienced users can harvest the wisdom of the crowds for complex tasks [9], so they can be solved by a joint effort among users. Second, it is possible to build a task-oriented hypertext structure which can be browsed, so users may benefit from well-known advantages of technologies such as wikis to aggregate collaboratively generated information. Third, although users may use tags to categorize paths, our approach does not suffer from the same disadvantages of other tagging systems [7]. Tags are primarily used for user navigation, not for keyword search matching, so the tags associated with paths serve to a particular situation which is shared among users involved in solving another user's question. Fourth, differently from other previous systems, Kolline provides a way for experienced users to leave visual clues for unexperienced users to reach and visualize the information faster, freeing them from having to analyze irrelevant information to accomplish the task at hand.

The technologies to implement our system are easily available. Social media sites such as Twitter [2] can aggregate user generated content to inform and entertain people according to their preferences. Wikis allow for collaboratively creating and linking web content and have already reached enormous success with examples like Wikipedia [3]. The proposed design uses the content aggregation feature as a means of easily communicating experts and novices in collaborative information seeking tasks without overloading any participating part with information. Kolline also makes use of the collaborative content generation of wikis, but instead of creating new web documents, users are allowed to create content over existing web pages.

6. FUTURE WORK

For future work, we plan to run one pilot and a validation study using the controlled experiments method. Because Kolline is based on the asynchronous communication between experts and novices, we will separate participants into two groups, namely the expert and the novice group. Participants' experience will be measured in a pre-test questionnaire. Tasks will be presented in a counter-balanced order to mitigate learning transfer effects. Each task comprises of two rounds and each round consists of two non-concomitant individual sessions. Before the beginning of each round, experts and novices will be randomly arranged using pairs, so each novice will have help from one expert Linux user to accomplish the task at hand. On each round, experts will annotate web pages and then novices will execute the same task benefiting from the annotations previously created by the expert. Novice users who could not solve the problem in the first round are assigned to a different expert and the procedure is repeated. The difference between the two rounds is that second round expert will be able to see the annotations created by the first round expert and change them. We want to analyze how one expert can improve on another's existing annotations.

7. CONCLUSION

In this paper, we presented preliminary results of an exploratory study, in which we observed Linux novice users performing complex technical tasks using Google's search engine. We found that the information triage is a difficult process for unexperienced users. Based on these observations, we presented a system design which allows experts to collaborate by annotating web content. This system aims at facilitating complex problem solving even when proper experience is lacking by employing asynchronous collaboration between peers in a social network. The tool also provides a way for users to create paths among annotations. Each annotation is attached to a web document, an author and a question. We discussed the benefits of our approach and provided directions for evaluation.

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