Learning Design Principles for a Collaborative Information Seeking System

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Abstract
While collaboration is a natural choice in many situations, there is a lack of specialized tools for collaboratively seeking information. We present design specifications and implementation of a collaborative information seeking system. We test this system through several pilot studies and cognitive walkthroughs. User interactions and feedback from these studies help us refine our design specifications for a better collaborative information seeking system.

Keywords
Collaborative information seeking, Interface design and testing

ACM Classification Keywords
H.5.3. Information Interfaces and Presentation (e.g., HCI): Group and Organization Interfaces - *Computer-supported cooperative work*.

Introduction
Several situations call for us to work together, and not just because we are *social animals*, but due to many reasons that make collaborations a necessity. For one, sometimes a problem is just too complex for a single

individual to tackle. Denning and Yaholkovsky [1] regard such problems as "messy" or "wicked" and argue that collaboration is essential for resolving such messes. Another common situation of collaboration is in an office environment where colleagues working on the same project collaborate to achieve a goal. For instance, Hansen and Jarvelin [2] studied collaborative behavior among co-workers in a patent office. From their studies, it became clear that collaboration in such an environment was inevitable. They concluded that the assumption that information retrieval performance is purely individual needs to be reconsidered. Morris [6] showed from a survey of 204 knowledge workers that the majority of them wanted to collaborate. Her further explorations [7] also demonstrated that collaboration in many situations is vital to success. In the field of information seeking, Twidale *et al* [10] argued that it makes sense to consider browsing as a collaborative process unlike how it is presented by majority of search engines, *i.e.*, single-user process. They further claimed that a truly user-centered system must acknowledge and support collaborative interactions between users and showed that users often desire to collaborate on search tasks. In this paper we aim to address the need of having such a user-centered system for collaboratively seeking information. This is done by sketching design guidelines for such a system, implementing it, and evaluating it with pilot runs and cognitive walkthroughs.

Design

Collaborative Information Seeking (CIS) falls in the intersection of IR, HCI, and CSCW. Not surprisingly, a majority of the approaches to build a CIS system have tried to extend an existing system from one of these three fields. For instance, in a study of information seeking and retrieval in a group-based educational setting, Hyldegard [3] applied Kuhlthau's Information Search Process model [4], a model, which was developed, based on single-person information seeking and retrieval. Laurillau and Nigay [5], similarly, took their *Vitesse* interface for browsing and created *Co-Vitesse* system, which allowed a group of people to browse information together. In perhaps one of the most holistic studies on collaborative search systems to date, Morris and Horvitz [8] introduced *SearchTogether*, a prototype to let a group of remote users collaborate when searching the Web. While such recent approaches have generated quite a bit of interest, a more generalized understanding of user needs in a CIS environment is needed. Our approach to the design of a CIS system is to analyze the notion of collaboration during information seeking and investigate the support functionalities that a CIS system should have.

In order to come up with initial design specifications, two works are particularly helpful: one based on a general notion of collaboration, and the other more specific to designing a collaborative system. Surowiecki [9] lists four conditions for a successful collaboration: (1) diversity of opinion, (2) independence, (3) decentralization, and (4) aggregation. Morris and Horvitz [8] presented the *SearchTogether* system based on supporting (1) awareness, (2) division of labor, and (3) persistence for collaboration. Based on these works, we inferred the following set of guidelines for designing a user-centered CIS system.

1. The system should provide an effective way for users to communicate with each other.

2. The system should allow (and encourage) each user to make individual contributions to the collaborative.
3. The system should coordinate user actions, information requests, and responses to support an active and interactive collaboration. This collaboration could be synchronous or asynchronous, and co-located or remote.
4. Users need to agree to and follow a set of rules to carry out a productive collaboration. For instance, if they have a disagreement on the relevancy of an information object, they should discuss and negotiate; they should arrive at a mutually agreeable solution rather than continuing to dispute it. The system needs to support discussion and negotiation processes among the users.
5. The system should provide a mechanism to let the users not only explore their individual differences, but also negotiate roles and responsibilities. There may be a situation in which one user leads the group and others follow (cooperate), but the real strength of collaboration lies in having the authority vested in the collective.

Using the above guidelines, we developed a prototype system called *Coagmento*[1] that allows two people to work together for seeking information. Collaborators can work synchronously or asynchronously, and they may be co-located or remotely connected. The main screen of *Coagmento* is shown in Figure 1. As we can see, *Coagmento* includes a search interface, chat, and document space (the same space where the results are displayed in the figure), as well as various marking facilities (discussed later) - all in one place. *Coagmento* displays the partnership information and provides visual feedback based on one's partner's as well as one's own actions. For instance, if a document is already viewed by either of the persons in a pair, it will be highlighted anywhere it appears in a rank-list for both of them. *Coagmento* keeps a log of all the queries used during a search session. The list of these queries is presented on the interface. (Unlike *SearchTogether*, clicking on a query executes fresh results, and not its history.) Users of *Coagmento* can save any document that they find useful or flag it to be discussed with their partners. Once again, these two lists are readily available on the interface and clicking on the name of a document displays it. If users are working alone, they may not see much use in writing notes about everything that they save if they have a good understanding about the relevance of those results. While working with a partner, on the other hand, the user may need to specify which aspects of a document are useful and why. *Coagmento* allows users to add notes to any document (Figure 2). Morris and Horvitz [8] found such a feature useful, but they also realized that they needed a way for users to simply highlight and save portions of pages. *Coagmento* provides a way for users to 'snip' passages of documents (Figure 2). *Coagmento* saves the state information. This means a user can leave a session and when he comes back, he will find the session as it was, with some possible updates in case his partner kept working while he was gone. This allows the users to collaborate in either synchronous or asynchronous mode. There is an indication on the interface to let a user know if his partner is online or not.

[1] Latin for "working together" or "joining together".

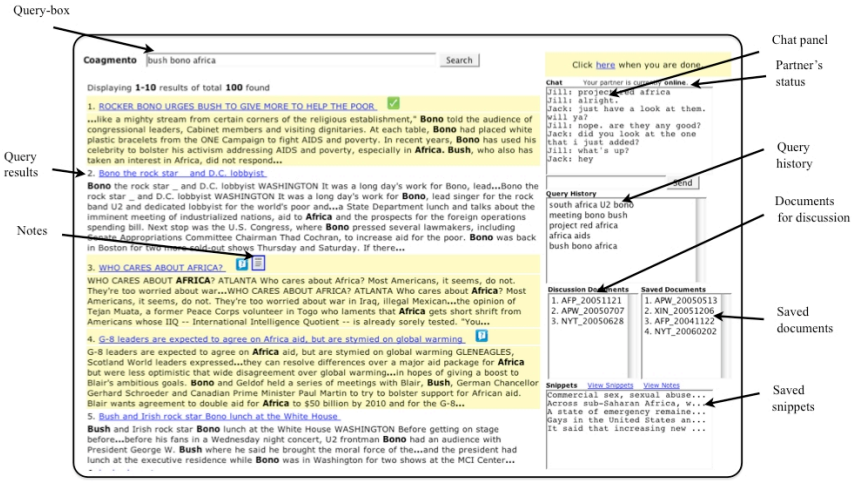

Figure 1: The main interface and its components in Coagmento

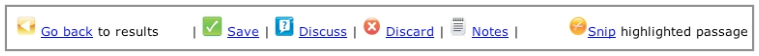

Figure 2: Toolbar available while viewing a document in Coagmento

Based on the description above, it should be clear that in principle, *Coagmento* builds on the framework of other tools such as *SearchTogether*, and extends them in certain ways. One aspect of *SearchTogether* that *Coagmento* does not implement fully is the division of labor. There are three ways in which this feature is realized in *SearchTogether*: (1) chat, (2) recommendations, and (3) split search. *Coagmento* has a chat feature, which can be used to talk about the distribution of the work. As far as the recommendations feature is concerned, the authors of *SearchTogether* found it underutilized. They concluded that rather than providing a "recommend" option, providing a "share this" option would allow a better way of sending pages back and forth. *Coagmento* does this through its "discuss this document" feature. For the *SearchTogether* system, it was found that the automatic division of labor features such as split search was not heavily used. The usefulness of such a feature needs further investigation.

Pilot runs

To evaluate the effectiveness of our system in collaborative information seeking, we conducted two pilot runs - one with seven pairs of users and another with four pairs. These users were undergraduate students in the field of information and library science who were enrolled in two separate courses with non-overlapping students. The pilot studies were administered during a normal class period. We used the TREC ciQA (Complex Interactive QA) 2007 data set as the collection. This data set had nearly one million documents from various news sources. The collection was indexed using the Lemur Toolkit and a modified Indri search service served the requests in the background.

We first presented a brief overview of *Coagmento.* When the participants logged into the system, they could see that they had a partner from the class, but did not know who this was. Users were given a 5-minute drill task for practice. Following this, they were given the actual task that involved finding news stories giving evidence of a possible link between President Bush and Bono, the U2 Rock Star. Users were also given a printed copy of this task, to which they could refer during the task. They were not allowed to talk or look at each other's screen even if they happened to sit next to each other. As they began their practice task, one of the first things they all did was identify their partners using chat.

We gave 15 minutes to each pair to complete their task, at the end of which they were provided with an online evaluation questionnaire. This questionnaire included a set of items that asked them to rate *Coagmento* along several dimensions and a set of open-ended questions. Figure 3 plots the averages of users' evaluations for the various dimensions, with '1' being the least, and '5' being the most for a given factor. In general, the feedback was positive.

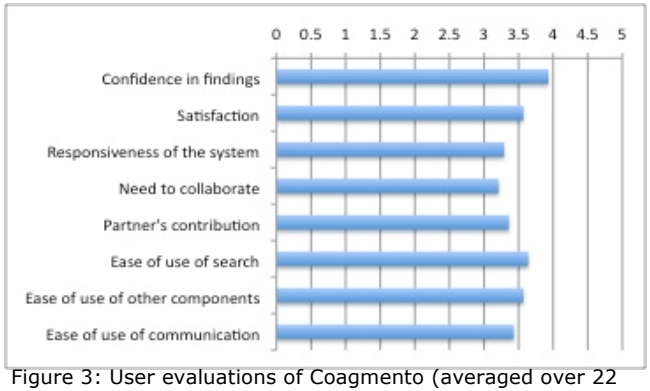

Figure 3: User evaluations of Coagmento (averaged over 22 users)

We also mined our logs for further analysis. We found that most users made use of the snippet feature. From the feedback that we received, it appeared that saving snippets was one of the most appealing features of this system. Users did not seem to use `discuss' feature much; they either did not put many documents in the discussion box or did not review the documents in that box often. This can be attributed to the short amount of time given to them for finishing the task.

Cognitive walkthrough

In addition to the pilot tests, we realized the need to acquire more qualitative feedback. We, therefore, interviewed a set of people individually and asked them to participate in a cognitive walkthrough of *Coagmento.* This set included 11 users from age 25 to 58 and with diverse backgrounds. While our users in the pilot runs were undergraduate students, the users for cognitive walkthrough were graduate students and faculty members in the fields of information science, library science, social science, and journalism.

After demonstrating how *Coagmento* can be used, we asked the participants questions regarding the usability and functionality of the system. One of the first questions asked was about identifying the components of the interface that they had seen or not seen before. Not very surprisingly, no one had seen all of the components in the same place. Most people had not seen color-coding of the documents (based on views) or the query history. Most of the subjects were also not aware of a system where they could collect the snippets, save the documents that are useful or keep them for later discussion. These are also the features that these participants found most appealing. Almost everyone appreciated having all the components and saw the value of them even in the situations where one was not doing collaboration.

On the flip side, some subjects felt the need to extend certain features. For instance, about half the subjects reported that they would like to see more metadata about the queries and the saved/discussion documents, especially time-stamps. Similarly, one subject asked for a way to track progress of the collaborative group by means of a timeline of the events (query issued, document viewed or saved, etc.). Three of the subjects suggested having a workspace such as Google Docs to

consolidate viewed, discussed, and collected information.

Conclusion

In this paper we (1) offered a set of guidelines for designing a CIS system, (2) introduced *Coagmento,* a CIS system implementation based on the proposed guidelines, and (3) presented an analysis of the usability and effectiveness of our system with pilot runs and cognitive walkthroughs with personal interviews. Unlike several of the previous approaches that extended existing search systems to accommodate multiple users, we designed a system specifically keeping collaboration in mind. While demonstrating our system to the users, we asked them not only to evaluate our system and provide us feedback on how the system could be improved, but also what else they would expect from such a system. What we learned from this experience helps us not only in improving our existing system, but also in enhancing our understanding of the design of a CIS system in general. For instance, while we had not considered incorporating elaborate metadata of various objects in the system, we learned from the users that such a feature is highly desired for a CIS system.

In general, we realized that while certain features are useful/desired in a single-user situation, they are essential for CIS. For instance, query history can be useful for personal information management, but it should be one of the required components of a CIS system. It became clear to us that for a successful CIS system, we need to have (1) an effective method of communication, (2) an ability to see everyone's actions, (3) a way to distribute tasks and aggregate information, and (4) a mechanism to record user interactions, processes, and results. Starting with collaborative search as a design goal led to a successful design that can now be extended and refined to better support collaborative information seeking tasks.

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