Shared Sensemaking: Enhancing the Value of Collaborative Web Search Tools

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ABSTRACT
Current Web search tools, such as browsers and search engine sites, are designed for a single user, working alone. However, users frequently need to collaborate on information-finding tasks; for example, students often work together in groups on homework assignments. To address this need, we have prototyped and evaluated several collaborative web search tools (S^3, SearchTogether, and CoSearch) that enable synchronous, asynchronous, co-located, and remote collaboration on Web search tasks. Such tools could be further enhanced by enabling collaborators to transition from shared Web searching to joint sensemaking activities; the products of this sensemaking could in turn be offered to others in response to their queries, enabling a community-level search/sensemaking cycle.

Keywords
CSCW, collaborative search, collaborative sensemaking

INTRODUCTION
In this position paper, we first motivate the need for supporting collaborative Web search activities. Next, we briefly describe three prototype systems we have built for facilitating a variety of collaborative Web search scenarios. We then discuss sensemaking support offered by our prototype systems, and consider possible enhancements for enabling sensemaking experiences that can leverage the rich data provided by collaborative search tools.

MOTIVATION
Web search is generally envisioned as a single-user activity; Web browsers and search engine homepages, the primary user interfaces for Web search, are designed for single-user scenarios. However, there are many situations in which users collaborate on information retrieval tasks. For example, prior research has shown that students with group homework assignments collaboratively access the Web and other digital library resources at both the elementary school [3] and university [9] levels. Research on knowledge workers' information retrieval practices has also shown benefits of collaboration when using traditional materials (*e.g.*, reference books) that could transfer to modern Web search tools [1, 4].

Indeed, our own research, via a survey of 204 knowledge workers' Web search practices [7], showed that a surprisingly high percentage of respondents attempted to collaborate on Web search tasks, despite the fact that browsers and search engines are not currently designed to enable collaborative searching. For example, respondents reported using instant messaging or telephones in conjunction with Web browsers in order to coordinate synchronous, remote collaboration (*e.g.*, by sending query terms and URLs back and forth). Respondents also described using e-mail to coordinate asynchronous collaborative Web search (*e.g.*, by sending useful URLs back and forth amongst collaborators). However, respondents found these collaborative "work-arounds" frustrating, noting that such methods often resulted in redundant work being performed by different group members, and required a high overhead to achieve group awareness of individual collaborators' context and actions.

We have also conducted interviews with teachers, librarians, and experts on technology for the developing world, as these three groups of people work in settings where they frequently observe co-located collaboration around shared computers. From these interviews, we learned that co-located collaborative Web search is quite common, particularly among children and teenagers (who view computing as a social experience and are encouraged to work in groups in school for pedagogical benefits) and among senior citizens and new immigrants (who collaborate in order to receive assistance from more technically-experienced users). These interviews also elucidated limitations of current co-located collaborative Web search practices – several of these limitations related to sensemaking, such as group members' lack of awareness of the contributions of their teammates, lack of awareness of the process used to obtain information (for the group members not controlling the input devices), and difficulty retaining discovered content for later use.

COLLABORATIVE SEARCH TOOLS
In order to address the limitations of current Web search tools for collaboration, we have developed three prototype systems: S^3 (for remote, asynchronous collaboration), SearchTogether (for remote, synchronous or asynchronous collaboration), and CoSearch (for co-located, synchronous collaboration). Here, we briefly describe key features of such systems; the referenced citations include greater detail.

S^3
S^3, Storable, Shareable Search [6] (Figure 1), is a system that implicitly captures Web *investigations* (*i.e.*, multi-

query, exploratory Web searches). That is, S^3 records the queries issued during an investigation, the most-relevant search results discovered consequent to each query (as judged by either manual indications and/or AI techniques), and comments. This information is stored in an XML file that can be passed back and forth among users to facilitate asynchronous collaboration. When an S^3 investigation has been augmented by multiple users, their photos are used to indicate who has contributed each piece of content to the investigation. A stored investigation can be automatically updated via S^3's *standing query* feature, which proactively fetches newly available content relating to an investigation's constituent queries.

SearchTogether

SearchTogether [5] (Figure 2), enables both synchronous and asynchronous remote collaboration on Web search. Group query histories provide awareness of query keywords used by other group members, and enable inspection of cached result lists. Visitation information provides awareness about whether other group members have previously visited the current webpage. Ratings and comments augment visitation information with subjective details, and integrated chat facilitates discussion of the search process and the materials discovered. Automatic-division-of-labor mechanisms enable a single query to provide non-overlapping results to different group members to facilitate parallel exploration.

CoSearch

CoSearch (Figure 3) enhances the experience of synchronous, co-located collaborative Web search by augmenting a shared computer with multiple mice and/or Bluetooth-enabled mobile phones. The CoSearch software enables group members to queue up content. For example, group members can send query terms via SMS from their mobile phones, which are added to CoSearch's query queue. Users can also use their mobile phones joysticks (or additional mice) to control multiple cursors and simultaneously select different links or search results, which are added to a color-coded (based on user identity) set of browser tabs, the Page Queue, in CoSearch. This queuing model enables all group members to engage with the search technology and contribute ideas for eventual exploration, while preserving shared context.

SHARED SENSEMAKING

Sensemaking [8] is an integral component of Web investigations. Users must reflect on the content they have found, integrating information from a variety of sources, and synthesize their findings to answer their initial questions and possibly form additional inquiries.

Our three prototypes offer some sensemaking features. All three tools allow group members to associate free-form textual comments or notes with individual Web pages, which can assist the sensemaking process by providing additional context indicating why group members found the page interesting. SearchTogether also provides the ability to rate pages (thumbs-up or thumbs-down); such subjective ratings can assist the sensemaking process by encouraging users to spend more effort reflecting on highly rated content and/or as a reflection of confidence in the quality or trustworthiness of found content. All three tools also provide a summary view of the entire investigation that include page titles, URLs, comments (and ratings, if available), and an indication of which group member(s) contributed each bit of content. These summaries can facilitate sensemaking by enabling users to see an overview of the best content found, re-find the source documents mentioned in the summary, and launch further investigations.

Our initial evaluation of the summary feature in SearchTogether showed that it was quite useful, but users wanted even richer sensemaking experiences to complement their collaborative search activities. For example, subjects in our study requested the ability to manually edit the summaries in order to group together related pages, to re-order items in the summary to tell a story or illustrate a point, and to add higher-level comments (*i.e.*, comments on groups of pages or the investigation as a whole, rather than merely page-level comments).

In addition to providing a richer sensemaking experience through manipulation of summary artifacts, which can enable groups to make sense of the *products* of their shared Web search, we are interested in exploring ways to enable groups to make sense of the shared *process* of collaborative information retrieval. Vannevar Bush [1] envisioned a system that would allow users to follow information "trails." Visualizing the paths that group members follow to find information, can enhance group sensemaking by allowing collaborators to understand the trustworthiness of content found by others and to learn about the search strategies that others employ. SearchTogether's group query histories and CoSearch's query queue are initial steps in this direction. However, richer representations of information-finding paths could include information on the search engine(s) used, query term iteration and refinement, the choice of which search results to explore and which to ignore, the process of identifying relevant content within webpages, and the process of evaluating the reliability of the found content.

It may be possible to automatically extract information from collaborative search tools, such as the prototypes we described, in order to further enhance the sensemaking experience. For example, stored transcripts from integrated chat clients, such as in the SearchTogether system, could be used to automatically assign comments or tags to webpages by correlating the timestamps of conversation snippets with the times at which webpages were viewed in the SearchTogether browser.

We are also interested in viewing collaborative sensemaking as a hierarchical and/or cyclic activity. The first level of the hierarchy is the small-group level, *i.e.*, the group of immediate collaborators who have undertaken an

investigation – this is the level at which our prototypes' summary features currently operate. However, the community at large, *i.e.*, all Web users, could also participate in the sensemaking process, such as via the publication of collaborative search summaries as information artifacts unto themselves, which could then be retrieved in response to other users' queries and augmented further.

CONCLUSION

New tools that address users' needs to collaborate on Web search tasks, such as S^3, SearchTogether, and CoSearch, provide exciting opportunities for research into group sensemaking tools. Such tools could enhance understanding of both the process and products of a shared search, among immediate collaborators and among a larger community of Web users. We look forward to participating in the CHI 2008 Sensemaking Workshop in order to learn more about others' research regarding collaborative sensemaking tools, and to receive feedback on our ideas for enriching collaborative Web search via shared sensemaking.

ACKNOWLEDGMENTS

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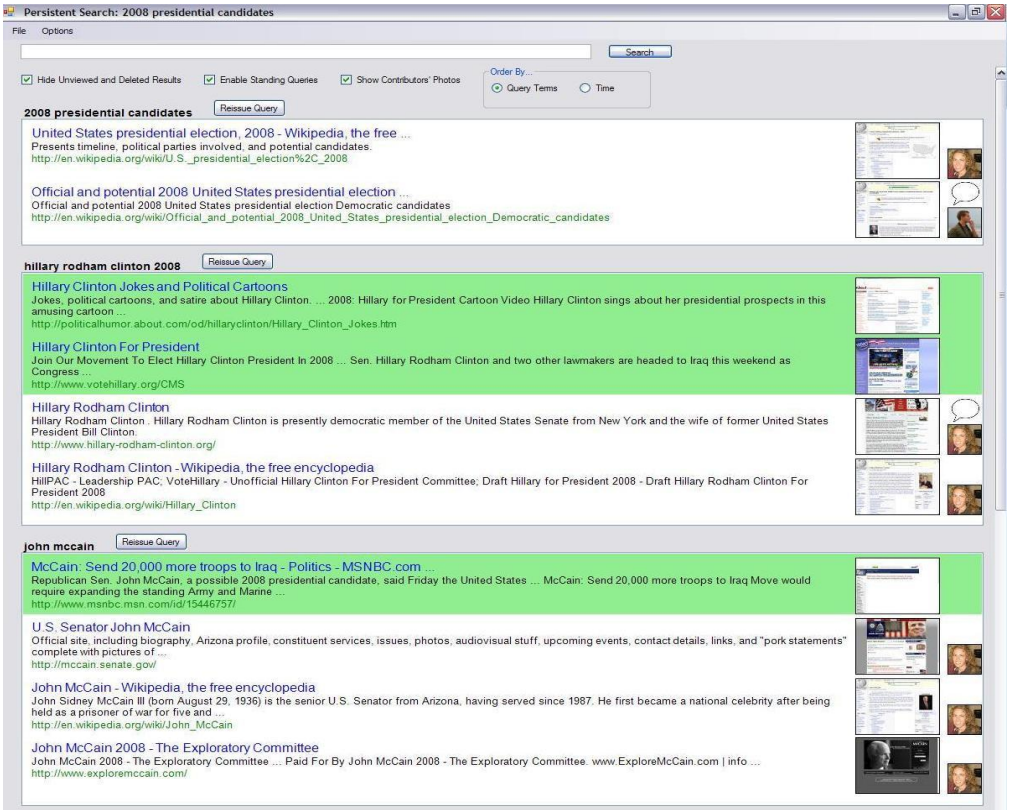

Figure 1. Investigation summary view in S^3, showing a set of queries (and subsequently discovered webpages) on the topic of the U.S. presidential election. Green highlighting indicates newly available content proactively fetched by the system. Photos indicate who contributed each piece of content, and hovering over "speech bubble" icons reveals that contributor's comments.

Figure 2. SearchTogether client (top) and close-up view of an automatically-generated shared summary (bottom). By default, summaries include any webpages that at least one group member has rated positively. Summaries show a page's title, URL, and thumbnail, and which group members have already viewed each page. The group members' comments and ratings for each page, if they exist, are also displayed.

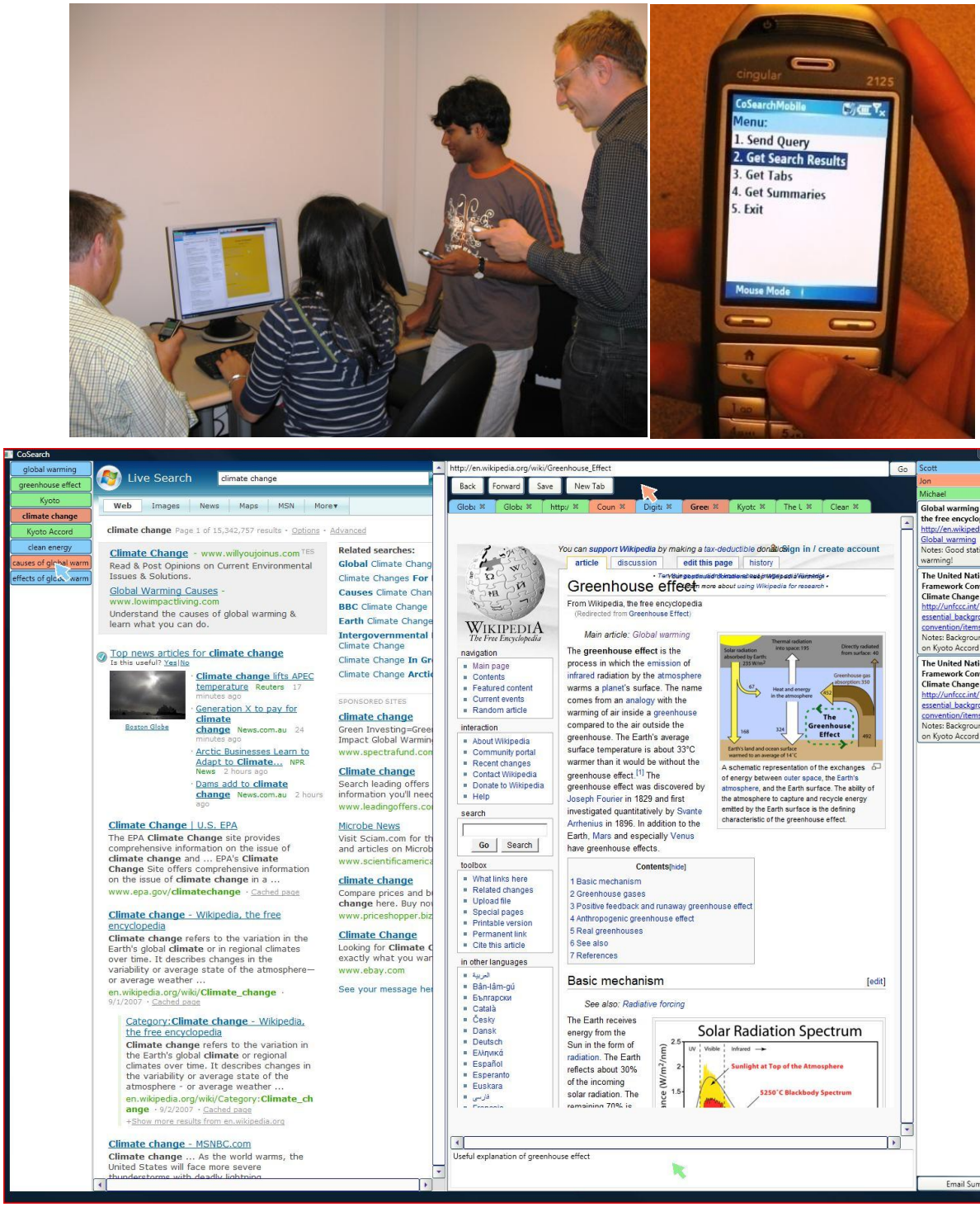

Figure 3. CoSearch facilitates co-located collaborative Web search (top left), via the CoSearchMobile (top right) and CoSearchPC (bottom) UIs. The "summary region" on the right-hand side of CoSearchPC displays the title, URL, and user-generated comments for any pages saved by the group. These summaries can be downloaded to group members' cell phones via CoSearchMobile's "get summaries" option.