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State of the art review

Research agenda for social and collaborative information seeking

Chirag Shah[a,*], Rob Capra[b], Preben Hansen[c]

[a] School of Communication and Information, Rutgers University, 4 Huntington Street, New Brunswick, NJ 08901, United States
[b] School of Information and Library Science, University of North Carolina at Chapel Hill, 100 Manning Drive, Chapel Hill, NC 27599, United States
[c] Borgarfjordsgatan 12 (Nodhuset), Campus Kista, SE-164 07 Kista, Sweden

A B S T R A C T

Scholars in diverse fields of inquiry have identified the need to expand individual-based information seeking and behavior models and systems to incorporate social as well as collaborative dimensions. However, the research areas of Social Information Seeking (SIS) and Collaborative Information Seeking (CIS) have been largely disconnected from one another despite a few notable attempts to study them under one umbrella. Researchers in these communities have recently realized the value of bringing SIS and CIS together for two main reasons: often it is impossible to separate social and collaborative dimensions in a project; and by considering these two aspects of information seeking, we may be able to support human information behavior in ways not previously possible. A brief synthesis of work in the domains of SIS and CIS is presented here. Then, an integrated view is presented to consider *Social and Collaborative Information Seeking* (SCIS) as an intersection and extension of SIS and CIS. Benefits of this approach are discussed and the integrated view is used as the basis to present a research agenda that outlines opportunities and challenges unique to SCIS.

1. Introduction

Today it is increasingly common for people to utilize collaboration and communication technologies to address needs in their professional and personal lives. As the importance of information access and processing becomes even more critical in everyday life, there are many problems that require the use of social and collaborative ties to search, retrieve, and use information. Examples include corporate teams doing business intelligence gathering, a couple planning their vacation, and a diabetes patient looking for information and support regarding treatment options.

For the past few years, many scholars in the fields of information and computer science have been investigating how people work in social and collaborative situations to seek and process information, and how information systems can support these users' needs. These investigations and related efforts for design and development have resulted in new tools and services for social and collaborative information seeking, as well as the development of systems for studying social or collaborative search behaviors. However, research that incorporates social or collaborative aspects, or both, in information seeking is still young, and there are many challenges to be addressed. These include creating suitable data collection and analyses methods, constructing new evaluation frameworks, and developing integrated systems that incorporate people's social and collaborative behaviors. There is a need to consolidate some of the past efforts in the fields of social information seeking (SIS) and collaborative information seeking (CIS) and provide a more unified path for future research that can potentially have a greater impact. Here, this unified domain is referred to as Social and Collaborative Information Seeking (SCIS).

Why should people care about SCIS? What impact can it have? A straightforward answer to these questions is that SCIS can allow people to address problems that are too difficult or even impossible for one person to solve. SCIS allows people with different skills, knowledge, and backgrounds to share information and work together to solve problems (Talja & Hansen, 2006). SCIS technologies and tools should efficiently and effectively support people in many information seeking activities across a range of collaborative situations. Studying SCIS can offer insight into users' needs and behaviors in collaborative situations, enabling researchers to respond by creating tools that support both individuals and groups in their daily life and work situations. SCIS also has an impact on situations in which tools are needed to support human activities and responses during difficult situations such as emergencies, disasters, and logistical situations. The broad application of SCIS highlights its potential importance in focusing not only on leisure or everyday life situations or traditional work tasks, but also on situations in which SCIS tools and systems may act as part of a larger system of responsive or reactive tools. In these situations, useful tools include those that support intrinsic and implicit collaborations through estab-

* Corresponding author.
E-mail addresses: chirags@rutgers.edu (C. Shah), rcapra@unc.edu (R. Capra), preben@dsv.su.se (P. Hansen).

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lishing formal or informal contracts between parties without the need to preprocess the procedures of an established network of collaborators (Bjurling & Hansen, 2010).

2. Background

Several scholars have argued that seeking information, despite how it is currently perceived by most researchers, is a social activity (Twidale, Nichols, & Paice, 1997). While most of the systems for accessing or retrieving information are designed for individual users, people are increasingly seeking information with the help of others (Hansen & Järvelin, 2005; Morris, 2008; Morris, 2013).

Two related research areas have focused on studying how people seek information with the help of others: research on social information seeking (SIS) and research on collaborative information seeking (CIS). While these two areas have commonalities, SIS has largely focused on situations in which people seek information through or from other people, whereas CIS focuses on seeking information in conjunction with other people. Participants in SIS may have different roles and goals (information seeker or information provider, for example), but in CIS there are often shared goals or similar roles. Examples of SIS include people asking for advice and opinions on Yahoo! Answers, or someone looking for restaurant suggestions from friends and followers on Facebook or Twitter. These cases often include one person who is looking for information and consulting the crowd to receive answers or advice. SIS can be further subdivided into situations where information is sought through unknown people (that is, the crowd or community through avenues such as Yahoo! Answers), or where it is sought through known people (that is, through social networks such as Facebook). By contrast, CIS considers situations where people are working together to seek information. Examples of CIS include a group of students collecting relevant information for a term project or a team of analysts looking for interesting patterns by analyzing newswire data. In these cases the collaborators often have shared goals, although their specific roles and skills may differ.

Given the natural connection between the social and collaborative dimensions of information seeking, a few scholars have attempted to incorporate them into a single definition of a concept being studied. For instance, while talking about the concept of social search, Evans, Kairam, and Pirolli (2010) used “social search” as “an umbrella term used to describe search acts that make use of social interactions with others. These interactions may be explicit or implicit, co-located or remote, synchronous or asynchronous” (p. 657). This is an example of an attempt to generalize a very specific concept – here “search” is a specific form of method for information seeking, and “social” is an attribute of that method. One can imagine several scenarios where such a specific concept and technique could then transform into a more generalized form of information seeking that incorporates social and collaborative components. Similarly, Shah (2014a) argued that study of CIS should include (or could be expanded to) areas such as social media or networking, giving, or at least hinting at, another example of how scholars with a specific focus see the concept studied (in this case, CIS) as connected to something bigger.

In contrast, the analysis presented here considers both SIS and CIS as part of a larger model of social and collaborative information seeking (SCIS). Both SIS and CIS involve groups of people in the process of finding, identifying, and making sense of information. Figs. 1–4 outline how SCIS is considered here. The proposed research agenda for SCIS will include individual-based information seeking activities (single episode or several episodes over time) as well as group-based CIS and SIS as special cases of a comprehensive model of SCIS.

Fig. 1 depicts the dominant model of information seeking in which a single individual looks for specific information over time. Over the past few decades several scholars have explored this persistent or iterated information need, moving to the right along the T axis as shown here.

The proposed research agenda extends the space of information seeking activities into two important additional dimensions, as shown in Figs. 2 and 3. The first, shown in Fig. 2, is the collaborative dimension. The black dot represents a team of three who search on five different occasions. Fig. 3 adds the crucial third dimension which represents the social nature and degree of affiliation among the several searchers. It is shown as orthogonal to the other axes to indicate that it will vary independently of the other two characteristics of the search. Unlike the first two axes, the social axis represents possible relations among people, and is not necessarily expressible on a ratio scale, or even an ordinal scale.

The various components of the proposed research agenda can be situated in the three-axis conceptual space shown in Fig. 4. For example, the red dot represents an information seeking activity involving 3 collaborators, who share a strong and persistent emotional social relation, and have five episodes of information seeking. Note that collaboration can also be quite independent of social relations. In fact, much of the work in CIS has focused on characterizing collaborative activities along dimensions such as time (synchronous v. asynchronous) and space (remote v. co-located) (Twidale & Nichols, 1996), depth of collaboration (Golovchinsky, Qvarfordt, & Pickens, 2009), kind of mediation (Pickens, Golovchinsky, Shah, Qvarfordt, & Back, 2008), and intentionality of the collaborators (Golovchinsky, Pickens, & Back, 2008).

3. Current state of SCIS research

The literature is filled with terms and works that address searching or seeking for information by multiple people. Examples include collaborative search (Morris & Horvitz, 2007; Smyth, Balfe, Briggs, Coyle, & Freyne, 2003; Smyth et al., 2005), collaborative information retrieval (Fidel et al., 2000; Karamuftuoglu, 1998), concurrent search (Amershi & Morris, 2008; Blackwell, Stringer, Toye, & Rode, 2004), collaborative exploratory search (Pickens & Golovchinsky, 2007; Pickens et al., 2008), co-browsing (Esenther, 2002; Han, Perret, & Naghshineh, 2000), collaborative navigation (Esenther, 2002; Laurillau & Nigay, 2002), collaborative information behavior (Karunakaran, Reddy, & Spence, 2013; Reddy & Jansen, 2008), collaborative information synthesis (Blake & Pratt, 2006; Olson, Olson, Carter, & Storrøsten, 1992; Olson, Olson, Storrøsten, & Carter, 1993), and collaborative information seeking (Foster, 2006; Shah, 2012). These works address some form of CIS, focusing on information seekers working in small groups (often pairs). Researchers have also pointed out that CIS is different than collaborative filtering (Shah, 2008), an area of research in information retrieval (IR). Collaborative filtering can involve passive participation and less coordination among participants, whereas true CIS entails participants' explicit and intentional involvement.

Other studies focus on various forms of online question and answer (Q & A) exchanges, referred to as social Q & A (Gazan, 2011; Shah, Oh, & Oh, 2009), community-based Q & A (Agichtein, Castillo, Donato, Gionis, & Mishne, 2008), or collaborative Q & A (Shah, Kitzie, & Choi, 2014). While these and social search (Evans & Chi, 2009) are all examples of SIS, they could also have a component of collaboration as shown by Gazan (Gazan, 2010). In other words, researchers have missed opportunities that extend CIS with a social dimension, or SIS with a collaborative dimension.

It is clear from these works that social and collaborative dimensions of information seeking must be studied and supported as integrated aspects of information seeking. First, both social and collaborative behaviors share certain characteristics, including communication, coordination, and cooperation. Second, they both are often hard to separate in situations involving multi-session and multi-modal work. Finally, by studying SIS and CIS as a continuum with varying degrees of connection-strength among the involved participants, seamless solutions could be created that integrate individual, community-based, socially oriented, and small-group focused informational activities.

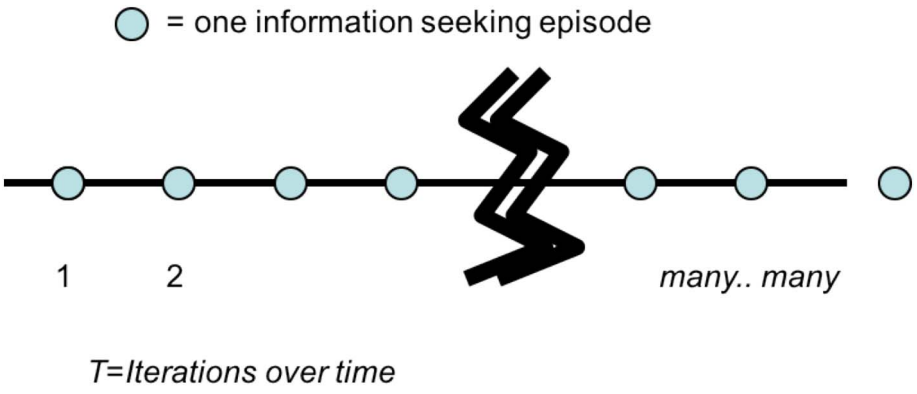

Fig. 1. Individual information seeking over multiple episodes.

The unaddressed problems and unmet opportunities caused by conducting only SIS or CIS research only strengthen the argument for studying SCIS as a topic on its own. There are several works in CIS that investigate the effects of roles (Soulier, Shah, & Tamine, 2014), and there are works in SIS that look at information seeking through peers (Gazan, 2007) or experts (Shah et al., 2014), However, it is not known if or when, and how, people can or should switch from or assume roles with their collaborators and the outside world. As another example of how combining studies of CIS and SIS could be beneficial, CIS works have focused on awareness and its influence on search behaviors (Chen, Capra, & Wu, 2014; Shah & Marchionini, 2010), and SIS works have focused on privacy (Evans et al., 2010). Perhaps these are two sides of the same coin should be studied together to provide better support for people working together. Bringing these research activities under a larger umbrella of SCIS and creating a framework that supports them could not only lead to solutions to these problems, but could also lead to better insights into CIS and SIS processes, even if studied separately.

4. Research agenda

While a substantial amount of work has already been done in SCIS, CIS, SIS, and other related areas as presented in the previous two sections, many questions and challenges remain. The following research agenda is grounded in ideas, discussions, and challenges identified in a series of workshops on SCIS that the authors have organized in recent years (Shah, Capra, & Hansen, 2015; Shah, Hansen, & Capra, 2011; Shah, Hansen, & Capra, 2013; Shah, Reddy, & Twidale, 2010).

Collaborative aspects of life in general, and more specifically of situations where people handle and exchange information and make decisions, have changed dramatically in the last 10–15 years. Innovative tools, systems, and apps can be used to support both new types of collaboration as well as traditional collaborative situations and behaviors. While some technologies are specifically targeted toward supporting explicit collaborative work, there is also a range of more generally focused tools that implicitly enable and support collaboration (Capra, Marchionini, Velasco-Martin, & Muller, 2010). This mixture means that in order to study and design for collaboration in different situations, researchers need to approach SCIS from new angles and examine traditional modes of collaboration from the perspective of new technologies. Some of these situations are well known while others emerge for the first time. Therefore, it is important to remain open minded when developing and using frameworks, tools, and methods that can study these phenomena.

4.1. Methodological issues and challenges

Studying SCIS presents a number of methodological challenges for researchers. The apparently simple move from studying how one person engages in information seeking to how two or more people do so actually adds many additional factors and challenges to the research process. For example, SCIS can involve multiple people, knowledge sharing, coordination, and different roles and motivations. Goals and outcome measures may vary depending not only on the task scenario, but also on an individual's role in the collaboration. In prior work, a variety of different methods have been utilized to study CIS. Even though both ethnographic and empirical research exists, few works

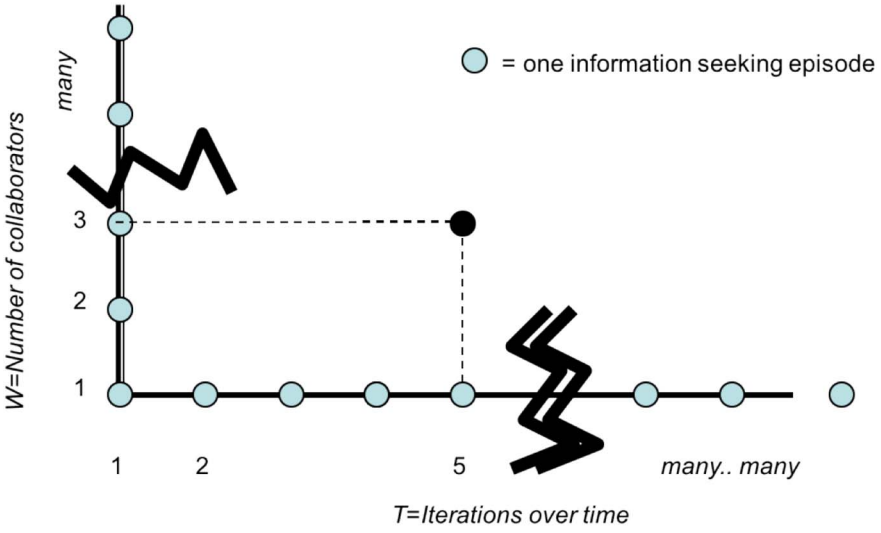

Fig. 2. Collaborative information seeking (CIS).

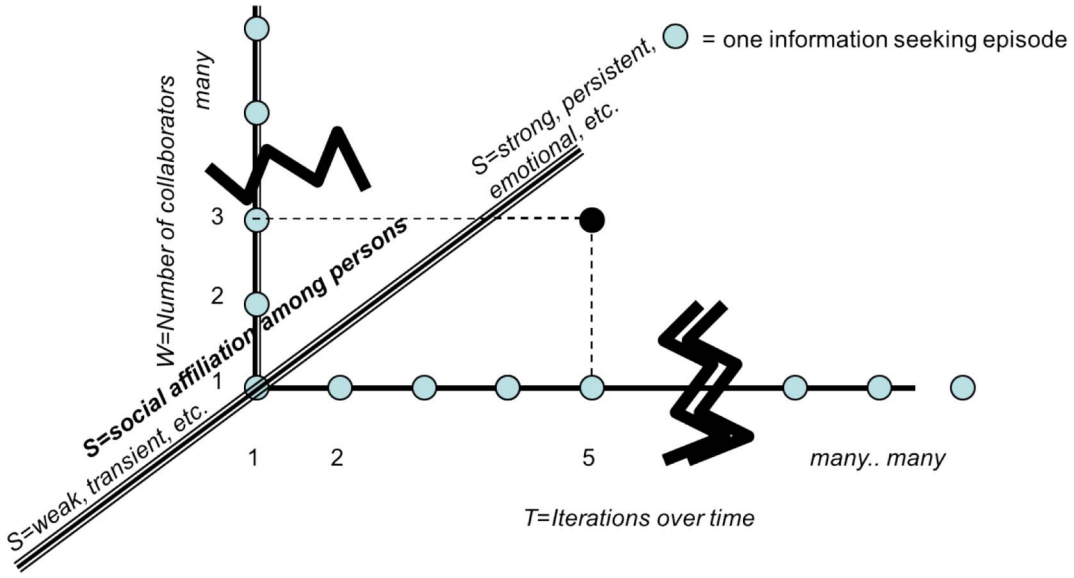

Fig. 3. Adding the social dimension to CIS.

present in-depth and thorough discussions of how to study CIS on a general level. One such work was by Shah (2014b) who proposed a new framework for studying CIS problems and evaluating CIS systems by presenting a structure of evaluation that included measures for both the system side and the user side in a CIS environment.

Hyldegård, Hertzum, and Hansen (2015) put forward another attempt at providing a general CIS framework. They describe three different and predominantly qualitative longitudinal methods: multi-dimensional exploration, task-structured observation, and condensed observation. Multidimensional exploration involves using several general-purpose methods in concert at several stages when studying. For example, an assignment process could be examined in order to explore behavior over time. Task-structured observation involves observing a set of selected work tasks. The method is based on task-based structuring of a process, and could be used in any domain that uses a work task as the unit of observation and involves a set of supporting data-collecting methods. Condensed observation consists of observing a regularly recurring event—for example a series of meetings—that is a CIS activity which includes an account of the period since the previous instance of the event (Hyldegård et al., 2015).

Methods can also be discussed as means of collecting different types of data. For example, researchers may wish to gather qualitative data, quantitative data, or use mixed methods. For studies of SCIS, more discussion is needed as to what types of data collection and data analysis methods are best suited for specific types of SCIS research with diverse theoretical goals and research questions.

Much of the existing research in SCIS has been accomplished by observing SCIS phenomena in a variety of different domains (Newman, Knight, Hansen, & Elbeshausen, 2015) using a variety of different methods. Even though both empirical and experimental studies have been conducted, it may be beneficial to consider a more systematic and focused approach to researching SCIS. The research community should start to discuss and create SCIS test collections, categories of tasks, scenarios, and frameworks for evaluation and measurement that can be shared within the community and used to inspire future work. Currently, experimental platforms open to the general research public can be found at the National Institute of Standards and Technology (NIST)'s Text Retrieval Conference (TREC), the European Conference

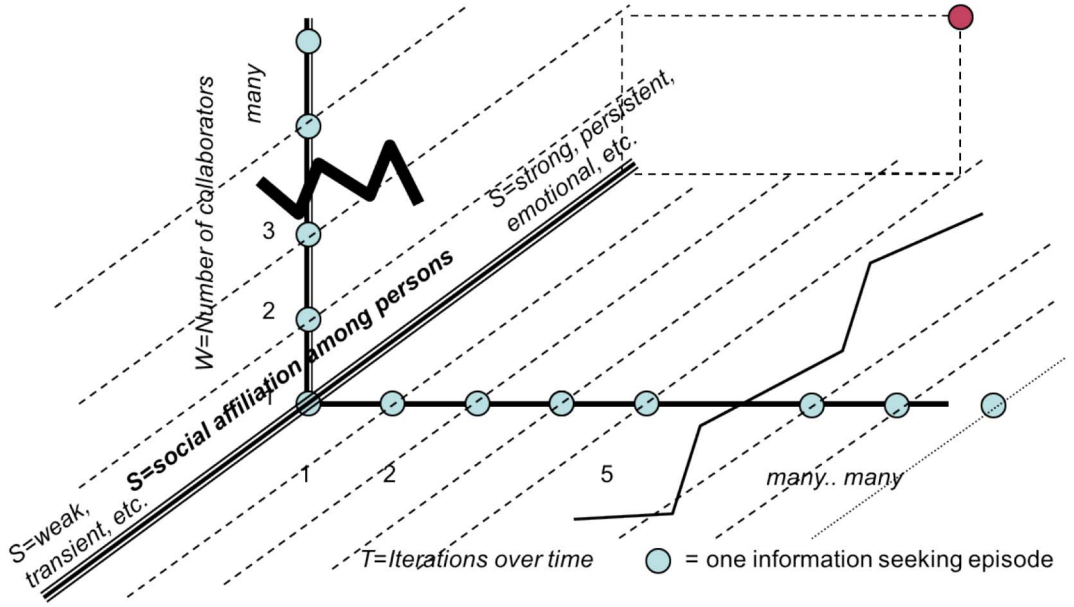

Fig. 4. Incorporating social and collaborative dimensions in information seeking activities.

and Labs of the Evaluation Forum (CLEF) platform, the NII Testbeds and Community for Information Access Research (NTCIR) in Japan, and the Forum for Information Retrieval Evaluation (FIRE) in India. Establishing SCIS-focused tracks at these worldwide research events could both focus SCIS research and send it in new directions. SCIS could, for example, be part of a TREC track or part of the CLEF environment, encouraging research to explore algorithmic approaches and tasks that have a more user-oriented and interactive approach. However, these efforts involve building needed resources and locating dedicated partners.

4.2. Studying SCIS in specific domains

At a recent workshop on SCIS (Shah et al., 2015), several specific domains were identified as promising areas for future SCIS research. These include education, health, cross-language information retrieval, and e-discovery. These domains have important challenges that SCIS could help to address. Scholars see great potential benefits in focusing the next generation of SCIS research around specific domains. SCIS research benefits from having specific, real-world problems to address, and the individual domains benefit from the tools and knowledge that are developed by studying SCIS in specific domains.

4.2.1. SCIS support for education

SCIS could be applied in the domain of educational platforms. This could be done in different ways. For example, SCIS research could explore ways to support various known and established educational tasks: (a) helping teachers and students with their need to communicate and coordinate as part of the learning processes; (b) supporting teachers in their individual and collaborative tasks with other teachers (that is, administrative and educational processes); (c) supporting students in their learning process through tools that help with sharing information and data, co-writing assignments, and peer-reviewing procedures (Hansen & Hansson, 2015); and (d) supporting educational analytics to help teachers, students, and administrators in their use of educational and learning components.

How can researchers encourage, foster, and measure learning through collaborative information seeking? By integrating learning dimensions into the seeking processes the use of information access systems in different learning contexts can be extended. Also, if researchers acknowledge that information access systems are not just about searching and browsing for information as a collaborative action, they could investigate collaborative seeking as part of a vehicle for learning in both academic and professional contexts.

Being able to effectively find information and to work with others to do so are essential skills for information workers. In some cases, SCIS supports learning through an intentional flow of information from a knowledge-holder to a knowledge-seeker. For SCIS such as social Q & A sites, the flow of information is intentional and prescribed through the mechanisms of posting and responding to questions. In other situations, a group of people who want to learn may work in close collaboration to help each other and the group as a whole to discover and learn about a topic. Future research could help identify how collaborative search systems and tools can support users in these group-learning settings.

In addition to the intentional learning collaborations mentioned above, another exciting opportunity for SCIS involves supporting indirect collaborative learning. The idea here is that in many situations, people learn from watching what others have previously done. Users who are unsure of how to begin a search in a new domain, could benefit from seeing the search trails of previous users who had searched for similar topics (Capra, Arguello, Crescenzi, & Vardell, 2015).

4.2.2. SCIS support for health information seeking

Health information seeking often engages multiple people in different roles, all with a common goal of supporting a patient with a medical condition. The patient, their family, caregivers, and healthcare providers all have roles in an ongoing collaborative information seeking process. At the recent SCIS workshop, a breakout group proposed that “exemplary cases” were needed to help generalize and characterize tasks (Shah et al., 2015). Defining tasks, roles, relevance cues, and evaluation criteria are all challenges to be addressed in this area.

Across many of the application areas outlined, the need for mediated collaboration (Golovchinsky et al., 2008; Soulier et al., 2014) is an important future area for SCIS research. It is important to consider how systems can help mediate information seeking processes that involve humans with different skill sets, languages, roles, and goals. These aspects are especially relevant to collaboration around health information seeking. In these situations, there are multiple people involved who have different roles, skills, and background knowledge (that is, the patient, family, caregivers, and health care providers).

4.2.3. SCIS support for cross-language information retrieval

Cross-language information retrieval (CLIR) is an important area of IR that has the potential to greatly benefit from SCIS. CLIR is becoming increasingly important in a variety of contexts, many of which either currently involve SCIS or could benefit from incorporating aspects of it. Machine translation (MT) can be applied in many CLIR situations. However, MT currently has limitations. Human translators and interpreters could help users design good queries, explain nuances and dimensions of retrieved results, and provide translations that could be used to help tune and refine MT systems. One possible means of addressing this involves creating features allowing users to chat with document curators whose language may differ from the searcher's, potentially helping those searchers improve their queries.

4.2.4. SCIS support for e-discovery

E-discovery is a legal process employed to request relevant evidence or documents in a legal proceeding. Current practices for e-discovery involve keyword searching and manual document review. The domain of e-discovery provides several interesting challenges for SCIS, especially in the area of algorithmic mediation. At the recent SCIS workshop, a breakout group addressed these issues by outlining a Collaborative Technology Assisted Review (CTAR) system in which human annotators provide training data to an automatic classification system that then supports human assessors in reviewing future documents (see Shah et al., 2015 for more details).

4.2.5. SCIS support for other domains

Other domains and problems could benefit from systems that include and support socio-collaborative connections. Placing the word “collaborative” in front of an existing area is one way to explore these potential opportunities. For example, collaborative analytics could open up new possibilities for groups of workers (that is, analysts) performing analytic processes to address the needs of an organization, including a government agency, by analyzing streams of data and producing insights for decision-making (Widén & Hansen, 2012).

SCIS may also be embedded in other social media or professional and commercial collaborative platforms for co-work and team and group project work, especially within business processes. For example, in the field of e-governance, SCIS could create a more open discussion and communication with local and national governmental authorities. By extension, SCIS platforms could serve to enhance and empower individual or group-wide democratic values and processes, and thus serve as community builders that shift the ways in which citizens collaborate, debate, and communicate at various social and political levels.

Research in SCIS may also expand when scholars apply social or collaborative dimensions to information-intensive tasks that are typically completed by individuals in order to improve the efficiency and effectiveness of tasks. Furthermore, SCIS research may explore new domains, contexts, and situations that could include various everyday

situations, manufacturing contexts, and consumer contexts.

4.3. Cross-disciplinary research

SCIS is a cross-disciplinary area that involves aspects of information science, human-computer interaction (HCI) and interaction design, information retrieval, social networks, collaboration, and other areas. Both system-focused and user-focused research is needed, and there are benefits of bringing researchers and developers in these areas together. Integrated research could improve machine learning classifiers and features, develop new methods for algorithmic mediation, and improve systems to support collaborators with diverse skills and backgrounds (and even potentially support collaboration between humans and algorithmic components). For SCIS to support complex multi-agent systems, it is important to involve researchers with algorithmic, computer science, and engineering backgrounds.

5. Conclusion

Social information seeking (SIS) and collaborative information seeking (CIS) are constantly evolving as new technologies and tools bring new challenges and opportunities. New ways of interacting and communicating can also evolve through changes in societal conditions. Considering SIS and CIS as part of an integrated model of social and collaborative information seeking (SCIS) has benefits for scholars, practitioners, designers, and end-users of technologies. The integrated model of SCIS introduced here includes explicit social and collaborative dimensions to help situate specific information seeking situations. Considering these combined dimensions will help designers to better support groups of people in the process of finding, identifying, and making sense of information.

There is also great potential for applied, cross-disciplinary SCIS research to have significant impacts on domains of great practical importance, including education and learning, health information seeking, cross-language information retrieval, e-discovery, e-government and community involvement, and other work or group settings that involve collaboration and coordination. Scholars working on SCIS have identified a strong need to develop methods, practices, and cross-disciplinary approaches to collaboratively address practical problems in these domains. This will require collaborative efforts among the researchers, practitioners, and developers working in SCIS-related areas. To support this, structures and organization are needed to effectively share resources (including tools, systems, and study design templates), data sets, methods, and findings. The integrated view of SCIS and the research agenda outlined here provides a foundation for cross-disciplinary work to improve tools, processes, and systems to support users in a variety of important information-seeking situations.

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Chirag Shah is an associate professor in the Department of Library and Information Science in the School of Communication and Information at Rutgers University, New Jersey. He received his PhD from the School of Information and Library Science at the University of North Carolina at Chapel Hill, and his master's in computer science from the University of Massachusetts, Amherst. His research interests include studies of interactive information seeking, especially in the context of online social networks and collaborations, contextual information mining, and applications of social media services for exploring critical socio-political issues. He has published in *Journal of the Association for Information Science & Technology*, *Journal of Information Science (JIS)*, *Information Processing & Management*, and *Library & Information Science Research*, among others.

Robert Capra is an assistant professor in the School of Information and Library Science at the University of North Carolina at Chapel Hill. He received his PhD in computer science from Virginia Tech, Blacksburg. His research interests include human-computer interaction, personal information management, and collaborative and exploratory search interfaces. He has been on the organizing committee for a series of workshops on personal information management, co-edited a special issue of ACM *Transactions on Information Systems*, and serves on the organizing committee for the annual ACM SIGIR Conference on Human Information Interaction and Retrieval. He is interested in developing tools to help support collaborative information seeking that integrate with existing workflows.

Preben Hansen is an associate professor at the Stockholm University, Stockholm. He holds a PhD from Tampere University, Finland. He is working closely with Swedish industries on applied research as well as participating in EU projects such as Promise, ASSETS, Companions, DELOS NoE, and Clarity. His research includes developing models of information storage and retrieval processes as well as empirical studies of users and use of interactive information access systems. Currently his focus is on collaborative information handling processes within different domains.