

# Chapter 7

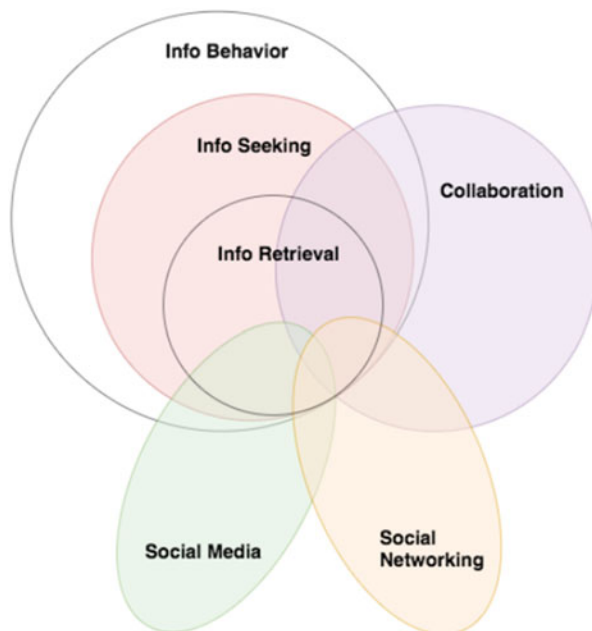
## Social and Collaborative Information Seeking

**Abstract** The social and collaborative aspects of information seeking described in the previous chapters are often hard to separate. This chapter presents the notion of social and collaborative information seeking (SCIS) that attempts to study both of those aspects at the same time. There are two main reasons to bring the areas of social information seeking (SIS) and collaborative information seeking (CIS) together: it is often difficult to separate a project's social and collaborative dimensions, and their combination could greatly improve our ability to support human information behavior. This chapter will first present a brief synthesis of SIS and CIS work. Next, it will consider SCIS as a new field that integrates and extends SIS and CIS. The chapter will explore the many benefits of this approach and finally present a research agenda that outlines the opportunities and challenges unique to SCIS.

### 7.1 Introduction

The need to use social and collaborative ties to search, retrieve, and use information pervades multiple dimensions of our everyday lives. Consider this scenario from a day in Carol's life. Carol is part of a corporate team that must gather business intelligence. When she returns home exhausted from work, she and her husband Mark spend their evening planning a relaxing vacation. Before she goes to bed, Carol spends time online trying to find information and support regarding treatment options for her aging parents' diabetes diagnoses. As her activities demonstrate, the importance of information access and processing is becoming only more critical to our daily activities.

Scholars in the fields of information and computer science have recently been investigating both individuals' engagement in social and collaborative information seeking and processing and information systems' ability to support these needs. Though this research is in its early stages, it has resulted in new tools for information seeking and new models for studying SIS and CIS. Future research, however, must address a slew of challenges that include creating suitable data collection and analysis methods, constructing new evaluation frameworks, and developing integrated systems that incorporate people's social and collaborative behaviors.



**Fig. 7.1** A schematic view of social and collaborative information seeking (SCIS) as a union of SIS and CIS

Before we can confront these challenges, we need to establish a clear path for future research directions. It would be immensely productive to combine some of the past efforts in both SIS and CIS in order to create a unified domain. We'll call that domain social and collaborative information seeking (SCIS). Conceptually, SCIS sits at the union of SIS and CIS as shown in Fig. 7.1.

You may be wondering why SCIS is so important. After all, can combining two already-popular research fields really have an impact on SIS? The answer is “yes.” SCIS allows people to address problems that are too difficult or even impossible for one person to solve because it allows people with different skills, knowledge, and backgrounds to share information and work together to solve problems [53]. And to support these collaborations, SCIS technologies and tools can efficiently and effectively assist information seeking activities across a range of situations. With SCIS studies, we can gain insight into collaborative workers' needs and behaviors and then respond to those needs with supportive tools that impact a variety of situations and contexts.

If the scenario that begins this chapter doesn't excite you, consider this: SCIS can impact situations in which tools are needed to support human activities and responses during difficult events. Imagine better plans, systems, and responses during emergencies, disasters, and logistical situations. SCIS need not solely focus on the mundane or the leisurely; tools and systems may act as a part of a larger system of responsive relief. For example, instruments may support intrinsic and

implicit collaborations through establishing formal or informal “contracts” between parties without the need to preprocess the procedures of an established network of collaborators [3]. That’s potential that needs to be realized, don’t you think?

## 7.2 Background

Despite the predominant focus on individual information seeking, several scholars have argued that information seeking is a social activity [55]. And although the systems for accessing/retrieving information are designed with individual information seekers in mind, users are increasingly turning to others for information seeking assistance [22, 30, 31].

Both SIS and CIS trace this phenomenon. But despite their 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. Thus, CIS participants tend to set mutual goals, while those in SIS may have different goals depending on their roles (e.g., information seeker vs. provider). SIS examples include engaging in question-answering on Yahoo! Answers or reaching out to a social network for restaurant suggestions. In these scenarios, one person typically consults the “crowd” to receive answers or advice that will satisfy their information need. Two types of SIS emerge in the literature: situations where people seek information from known sources (social networks, e.g., Facebook) or situations where people seek information from unknown sources (crowd/community, e.g., Yahoo! Answers). CIS, on the other hand, encompasses situations where participants work together to seek information. A group of students may need to collect information for a term project, or a team of advertisers may need to analyze market data. Although collaborators’ specific roles and skills may differ, CIS cases are typically driven by shared goals.

We do find a few cases in which scholars have connected the dots between social and collaborative dimensions to form one concrete concept. For instance, Evans and Chi [11] 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). “Search” refers to a specific method of information seeking, while “social” is one quality of that method, though here they are morphed into a more generalized form of information seeking that could incorporate both social and collaborative components. Shah [41] builds on this concept to argue that CIS could (and should) encapsulate areas such as social media/networking. Again, we see that a concept with a specific focus (e.g., CIS) can connect to a larger idea.

This chapter actually strives to subsume both SIS and CIS into a larger model of SCIS, which captures the common components of both concepts: they involve groups of people in the process of finding, identifying, and making sense of information.

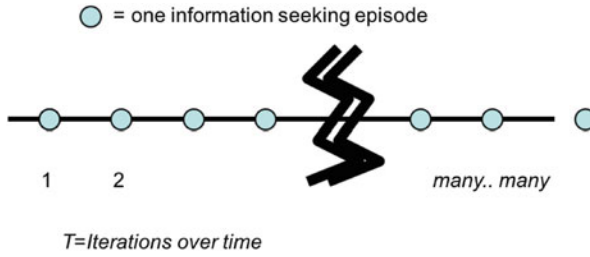


Fig. 7.2 Individual information seeking over multiple episodes

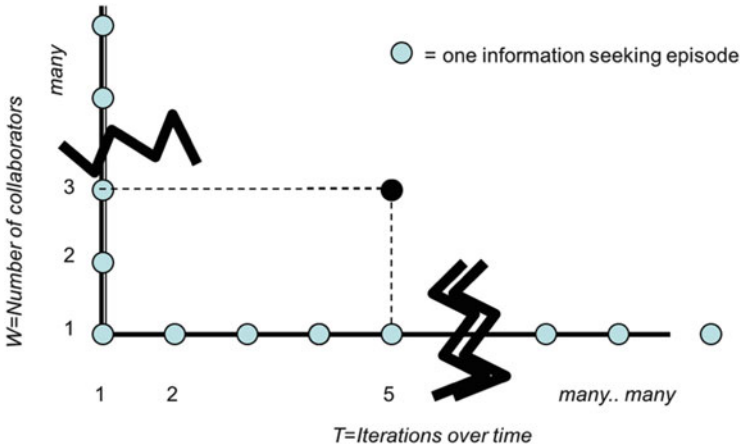


Fig. 7.3 Collaborative information seeking (CIS)

Figures 7.2, 7.3, 7.4, and 7.5 illustrate a gradual buildup of SCIS behavior. As shown, the SCIS research includes both individual-based information seeking activities (either single episodes or several episodes over time) and group-based activities as special cases of the overall SCIS model.

Figure 7.2 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.

Things start to get interesting with Figs. 7.3 and 7.4. Here, we demonstrate how SCIS can extend the space of information seeking into two innovative additional dimensions. Figure 7.3 depicts the collaborative dimension. The black dot represents a team of three who search on five different occasions. Figure 7.4 adds the crucial third “dimension” that represents the social nature and degree of affiliation among the 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.

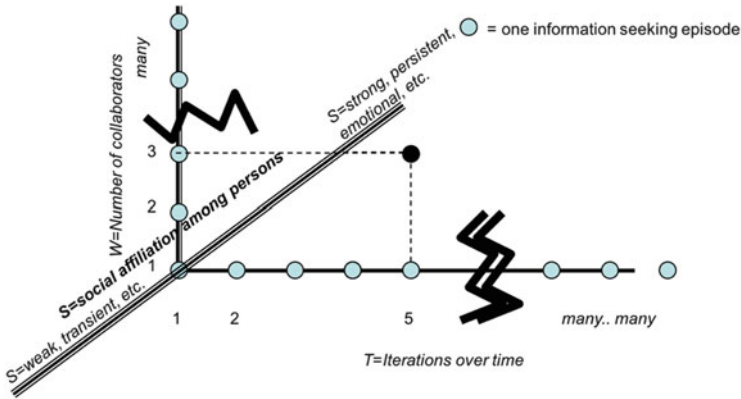


Fig. 7.4 Adding the social dimension to CIS

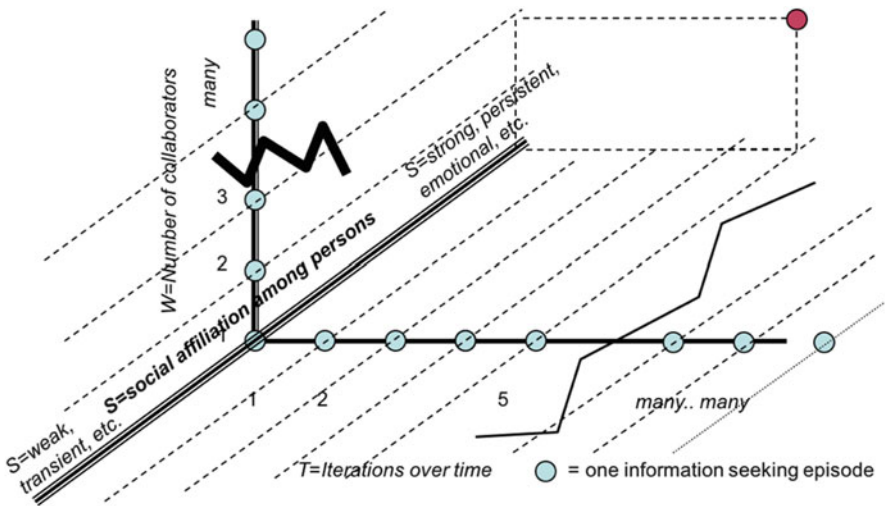


Fig. 7.5 Incorporating social and collaborative dimensions in information seeking activities

The three-axis conception space shown in Fig. 7.5 situates the various components of SCIS. For example, the red dot represents an information seeking activity involving three collaborators who share a strong, persistent emotional social relationship and engage in 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 vs. asynchronous) and space (remote vs. colocated) [54], depth of collaboration [19], kind of mediation [37], and intentionality of the collaborators [18].

### 7.3 Current State of SCIS Research

The previous few chapters have shown that we already have quite a few terms and works that address seeking/searching for information by multiple people. Examples include collaborative search [32, 51], collaborative information retrieval [13, 24], concurrent search [2, 4], collaborative exploratory search [36, 37], co-browsing [9, 20], collaborative navigation [9, 26], collaborative information behavior [25, 38], collaborative information synthesis [5, 34, 35], and collaborative information seeking [14, 40, 41]. All address some form of CIS, though most focus on small groups of information seekers (often pairs). Researchers have also distinguished CIS from collaborative filtering [39], an area of research in IR. CIS involves participants' explicit and intentional involvement, whereas collaborative filtering may involve passive participations and/or scant coordination among participants.

Some studies focus on various forms of online Q&A, referred to as social Q&A [17, 45], community-based Q&A [1], or collaborative Q&A [49]. While these and social search [10] are all examples of SIS, they could also have a collaborative component as shown by Gazan [16]. So as you may have guessed, the opportunity to extend CIS with a social dimension, or extend SIS with a collaborative dimension, has been missed!

The literature implies that social and collaborative dimensions of information seeking must be studied and supported as integrated aspects of information search and retrieval. We can distinguish between three important drives. First, social and collaborative behaviors share certain characteristics, such as communication, coordination, and cooperation. Second, it's difficult to separate the two in situations involving multi-session and multimodal work. Finally, if we situate CIS and SIS on a continuum with varying degrees of connection strength among the involved participants, we could create seamless solutions to ultimately integrate individual, community-based, socially oriented, and small group-focused informational activities.

And if that potential doesn't excite you, consider the following unaddressed problems and unmet opportunities apparent in SIS and CIS research. There are several works in CIS that investigate the effects of roles (e.g., [52]), and there are works in SIS that look at information seeking through peers (e.g., [15]) or experts [49], but we do not know if/when and how people can/should switch from or assume roles with their collaborators and the outside world. Another example: CIS works have focused on awareness and its influence on search behaviors (e.g., [8, 44]), and SIS works have focused on privacy (e.g., [12]). Perhaps these are two sides of the same coin and should/could 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 even lead to better insights into respective CIS and SIS processes.

## 7.4 Research and Development Trajectory for SCIS

Even with the advancements that have been made in SCIS, CIS, SIS, and related areas, we still have our work cut out for us regarding remaining questions and unmet challenges. In this section, you'll find an overview of important questions and challenges in SCIS. The resulting research agenda is grounded in ideas, discussions, and challenges identified in a series of SCIS-focused workshops organized by a number of scholars (present author included!) in recent years (e.g., [46–48, 50]).

Over the last 10–15 years, collaborative aspects of life in general—or, more specifically, situations where people handle, exchange, and make decisions about or based off information—have radically changed. Innovative tools, systems, and apps support emerging types of collaboration and traditional collaborative situations and behaviors. Some of these technologies are specially geared toward supporting collaborative work, but others can be reasonably applied to enable and support group efforts [6]. Thus, to study collaboration and design systems in different situations, we need to determine new angles from which we can approach SCIS and examine traditional models from the perspective of new technologies. These situations may be known or unknown, meaning we have to remain open-minded when developing and utilizing frameworks, tools, and methods that can study these phenomena.

### 7.4.1 *Methodological Issues and Challenges*

Preparing to study information seeking carried out by two or more people certainly diverges from studying how one person engages in searching behaviors. SCIS inherently adds many additional factors and challenges to the research process. Consider the wide array of factors that can affect SCIS-related activities: multiple people and personalities, knowledge sharing, coordination, different roles and motivations, etc. Goals and outcome measures do not only vary based on the task scenario; an individual's role may also be a factor. In prior work, a variety of different methods have been utilized to study CIS. Even though both ethnographic and empirical research exist, fewer works present in-depth and thorough discussions of how to study CIS on a general level. Shah wrote one such work [42] to propose a new framework for studying CIS problems and evaluating CIS systems. The study presented a structure of evaluation that could measure both the system side and the user side in a CIS environment.

Another general CIS framework hails from Hyldegård et al. [23]. Their work identifies three distinct, predominantly qualitative longitudinal methods: multi-dimensional exploration, task-structured observation, and condensed observation. When conducting multidimensional exploration, researchers would use several general-purpose methods at different stages in concert. This, for example, could apply to an assignment process in order to explore behavior over time. On the other hand, a researcher conducting task-structured observation would need to observe a

set of selected work tasks. This method is based on task-based process structuring, and could be used in any domain that uses work task as the unit of observation and involves a set of supporting data-collecting methods. Finally, a researcher utilizing condensed observation would observe a regularly recurring event—a series of meetings, for example—that constitutes a CIS activity and includes an account of the period since the previous instance of the event [23]. So if a group of students met once a week to work on a final project, and reviewed their previous meetings' occurrences before beginning their new session, they could provide a sample for condensed observation.

Other methods are constructed around different types of data collection. Researchers may wish to gather qualitative data, quantitative data, or use mixed methods. We need to foster discussions of data collection for studies of SCIS. What types of data collection and data analysis methods are best suited for specific types of SCIS scholarship? Given the diverse theoretical goals and research questions within the field, this is a pressing issue.

Most of the existing research in SCIS has been accomplished by observing SCIS phenomena in a variety of different domains [33] using a variety of different methods. Though we do have a small sample of empirical and experimental studies, it is worth considering a more systematic, focused approach to SCIS research. As a research community, we should start to discuss and create SCIS test collections, categories of tasks, scenarios, and evaluation/measurement frameworks that can be collectively shared and used to inspire future work. Currently, experimental platforms open to the general research public can be found at NIST TREC, the European CLEF platform, NTCIR in Japan, and 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 NIST TREC track or part of the CLEF environment. It could even encourage researchers to explore algorithmic approaches and tasks that have more user-oriented and interactive approaches. But to actualize these potentials, we need to build resources and locate dedicated partners. So if you're interested, we could use you!

### ***7.4.2 Studying SCIS in Specific Domains***

Several specific domains were identified as promising areas for future research at a recently held SCIS workshop [50]. Education, health, cross-language information retrieval, and e-discovery all hold possibilities. Each field hosts important challenges that SCIS could help overcome. In fact, prominent scholars believe that we should focus the next generation of SCIS research around several specific domains. Theory and practice suggest that SCIS research benefits from having specific, “real-world” problems to address, while the individual domains it tackles benefit from the tools and knowledge that such studies develop. Consider the following outline of directions for SCIS research in each of these areas.



### 7.4.2.1 SCIS Support for Education

We can develop SCIS support for educational platforms in a variety of ways. For example, SCIS research could explore ways to support known, established educational tasks such as: (a) helping teachers and students with their need to communicate and coordinate as part of the learning process; (b) supporting teachers in their individual and collaborative tasks with other teachers (e.g., administrative and educational processes); (c) supporting students in their learning process through tools that help with sharing information and data, cowriting assignments, and peer-reviewing procedures [21]; and (d) supporting educational analytics to help teachers, students, and administrators with their use of educational and learning components.

But can SCIS really encourage, foster, and measure learning? Believe it or not, yes. If we integrate learning dimensions into information seeking processes, we can extend the usage of information access systems into different learning contexts [27–29, 43]. We must also acknowledge that information access systems do not only apply to collaboratively “searching and browsing” for information. On the contrary, research could investigate collaborative seeking as one wheel of a larger vehicle for learning in both academic and professional contexts.

By nature of their job descriptions, information workers must be able to effectively work with others on search tasks. SCIS can sometimes support learning through an intentional flow of information from a knowledge holder to a knowledge seeker. Within social Q&A sites, for example, information flow is intentional and prescribed through the mechanisms of posting and responding to questions. Outside of these platforms, individuals may want to work in a close group to mutually help each other discover and learn new information. Future research could help identify how collaborative search systems and tools can support users in these group-learning settings.

But what if people indirectly work together? SCIS has us covered. Another exciting opportunity involves support of indirect collaborative learning. Consider this: in many situations, people learn from observing others. So if a user does not know how to begin a search in a new domain, they could benefit from exposure to search trails utilized by previous information seekers for similar topics [7].

### 7.4.2.2 SCIS Support for Health Information Seeking

When supporting a patient with a medical condition, multiple people assume multiple roles to seek health-related information. These roles may be played by the patient, their family, caregivers, and health-care providers, all of whom work in an ongoing CIS process. At the recent SCIS workshop, a breakout group proposed that “exemplary cases” were needed to help generalize and characterize these kinds of tasks [50]. Defining tasks, roles, relevance cues, and evaluation criteria are all challenges to be addressed in this area.

Across many of the outlined application areas, the need for mediated collaboration [18, 52] is an important future area for SCIS research. After all, systems

can help mediate information seeking processes that involve humans with varying skill sets, languages, roles, and goals. Health information seeking exemplifies the salience of this task. As we said, these scenarios tend to involve many different bodies with many different roles, skills, and backgrounds. Already tense by nature, the uncertainty that can ensue from these interactions can be unproductive and, depending on context, frightening. Imagine what could happen if a system efficiently and effectively helped all parties engage in meaningful CIS!

#### **7.4.2.3 SCIS Support for Cross-Language Information Retrieval**

Cross-language information retrieval (CLIR) is an important area of IR that could greatly benefit from SCIS. CLIR has gained traction in a variety of contexts that either currently involve SCIS or could profit from its incorporation. Consider this: machine translation (MT) can be applied to many CLIR situations, but it currently has its limits. These boundaries could be broken by human translators/interpreters that could help users design meaningful queries, explain the nuances and dimensions of retrieved results, and provide translations to help tune and refine MT systems. Perhaps the inclusion of features to help users chat with document curators—who may very well use a different language than the searcher—could be useful. Even a simple option to help users improve their queries could have significant results.

#### **7.4.2.4 SCIS Support for E-Discovery**

E-discovery is a legal process employed to request relevant evidence/documents in a legal proceeding. Its current practices involve keyword searching and manual document review, but SCIS holds great potential for its future. The domain 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 [50] for more details).

#### **7.4.2.5 SCIS Support for Other Domains**

The above examples are not the only areas that could benefit from systems that include and support socio-collaborative connections. It may seem silly, but try placing the word “collaborative” in front of an existing area to explore this opportunity. What about collaborative analytics? We could explore new possibilities of doing analytics processes with a group of workers (e.g., analysts) who strive to address the needs of an organization (perhaps a government agency) in analyzing streams of data and producing insights for decision-making [56].

We can even find SCIS embedded in other social media or professional and commercial collaborative platforms for co-work and team/group project work, especially within business processes. Take e-governance, where SCIS may be explored to create more open discussion and communication among local and national governmental authorities. It follows that SCIS platforms could serve to enhance and empower individual or group-wide democratic values and processes. These systems may become community builders that shift the ways in which citizens collaborate, debate, and communicate at various social and political levels.

Let's think back to the idea that a great deal of previous information seeking scholarship examines tasks completed by individuals. Why couldn't we expand SCIS research to apply social and/or collaborative dimensions to improve these tasks' efficiency and effectiveness? That's certainly worth exploring. SCIS research could even expand into new domains, contexts, and situations that may include various everyday situations, manufacturing contexts, and consumer contexts. The possibilities are endless.

#### **7.4.2.6 Cross-Disciplinary Research**

SCIS is inherently cross-disciplinary. It draws from aspects of information science, HCI and interaction design, information retrieval, social networks, collaboration, and other areas. Given its vast expanse, its future success depends on the involvement of both system-focused and user-focused researchers, and there are benefits to bringing the two together. Integrated research could improve machine-learning classifiers and features, develop new methods for algorithmic mediation, and improve systems to support collaboration among participants with diverse skills and backgrounds (and among 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.

## **7.5 Summary**

Neither SIS nor CIS are static fields; they constantly evolve as new technologies and tools bring new challenges and opportunities. Changes in societal conditions also beget new ways of interaction and communication. If we think about SIS and CIS as part of an integrated model of SCIS rather than two concrete concepts, we can improve circumstances for technology scholars, practitioners, designers, and end users. The integrated model of SCIS introduced here includes explicit social and collaborative dimensions to help situate specific information seeking situations. If we want to help designers to better support groups of information seekers (and we do!), we must consider these combined dimensions. Collaborators will be able to find, identify, and make sense of information in more efficient and effective ways.

In this chapter, we identified a number of domains in which applied, cross-disciplinary SCIS research may hold significant practical importance, including education and learning, health information seeking, cross-language information retrieval, e-discovery, e-governance and community involvement, and other work/group settings that involve collaboration and coordination. But to reach maximum impact, we have also identified a strong need to develop methods, practices, and cross-disciplinary approaches to collaboratively address practical problems in these domains. To address these needs, researchers, practitioners, and developers working in SCIS-related areas must, funny enough, work collaboratively; structure and organization are needed to effectively share resources (e.g., tools, systems, study design templates), data sets, methods, and findings. In this chapter, we presented an integrated view of SCIS and a research agenda to provide a foundation for impactful, cross-disciplinary work. In the future, let's hope we improve tools, processes, and systems to support users in a variety of important information seeking situations.

## References

1. Agichtein, E., Castillo, C., Donato, D., Gionis, A., Mishne, G.: Finding high-quality content in social media. In: Proceedings of the International Conference on Web Search and Web Data Mining - WSDM'08, pp. 183–194. ACM Press, New York (2008)
2. Amershi, S., Morris, M.R.: CoSearch. In: Proceedings of the Twenty-Sixth Annual CHI Conference on Human Factors in Computing Systems - CHI'08, pp. 1647. ACM Press, New York (2008)
3. Bjurling, B., Hansen, P.: Contracts for information sharing in collaborative networks. In: ISCRAM 2010 - 7th International Conference on Information Systems for Crisis Response and Management: Defining Crisis Management 3.0, Proceedings, Seattle, WA (2010)
4. Blackwell, A.F., Stringer, M., Toye, E.F., Rode, J.A.: Tangible interface for collaborative information retrieval. In: Extended Abstracts of the 2004 Conference on Human Factors and Computing Systems - CHI'04, p. 1473. ACM Press, New York (2004)
5. Blake, C., Pratt, W.: Collaborative information synthesis I: a model of information behaviors of scientists in medicine and public health. *J. Am. Soc. Inf. Sci.* **57**(13), 1740–1749 (2006)
6. Capra, R., Marchionini, G., Velasco-Martin, J., Muller, K.: Tools-at-hand and learning in multi-session, collaborative search. In: Proceedings of the 28th International Conference on Human Factors in Computing Systems - CHI'10, pp. 951. ACM Press, New York (2010)
7. Capra, R., Arguello, J., Crescenzi, A., Vardell, E.: Differences in the use of search assistance for tasks of varying complexity. In: Proceedings of the 38th International ACM SIGIR Conference on Research and Development in Information Retrieval - SIGIR'15, pp. 23–32. ACM Press, New York (2015)
8. Chen, A.T., Capra, R., Wu, W.-C.: An investigation of the effects of awareness and task orientation on collaborative search. *Proc. Am. Soc. Inf. Sci. Technol.* **51**(1), 1–10 (2014)
9. Esenther, A.W.: Instant co-browsing: lightweight real-time collaborative Web browsing. In: Proceedings of the World Wide Web (WWW) Conference, Honolulu, HI, pp. 107–114 (2002)
10. Evans, B.M., Chi, Ed.H.: An elaborated model of social search. *Inf. Process. Manag.* **46**(6), 656–678 (2009)
11. Evans, B.M., Chi, Ed.H.: An elaborated model of social search. *Inf. Process. Manag.* **46**(6), 656–678 (2010)
12. Evans, B.M., Kairam, S., Pirolli, P.: Do your friends make you smarter?: an analysis of social strategies in online information seeking. *Inf. Process. Manag.* **46**(6), 679–692 (2010)

13. Fidel, R., Bruce, H., Pejtersen, A.M., Dumais, S.: Collaborative information retrieval (CIR). *New Rev. Inf. Behav. Res.* **1**, 235–247 (2000)
14. Foster, J.: Collaborative information seeking and retrieval. *Annu. Rev. Inf. Sci. Technol.* **40**(1), 329–356 (2007)
15. Gazan, R.: Seekers, sloths and social reference: homework questions submitted to a question-answering community. *New Rev. Hypermedia Multimedia* **13**(2), 239–248 (2007)
16. Gazan, R.: Microcollaborations in a social Q&A community. *Inf. Process. Manag.* **46**(6), 693–702 (2010)
17. Gazan, R.: Advances in information science social Q & A. *J. Am. Soc. Inf. Sci. Technol.* **62**(12), 2301–2312 (2011)
18. Golovchinsky, G., Pickens, J., & Back, M. (2009). A taxonomy of collaboration in online information seeking. Preprint, arXiv:0908.0704
19. Golovchinsky, G., Qvarfordt, P., Pickens, J.: Collaborative information seeking. *IEEE Comput.* **42**, 47–51 (2009)
20. Han, R., Perret, V., Naghshineh, M.: WebSplitter: a unified XML framework for multi-device collaborative Web browsing. In: *Proceedings of the 2000 ACM Conference on Computer Supported Cooperative Work*, pp. 221–230 (2000)
21. Hansen, P., Hansson, H.: Optimizing student and supervisor interaction during the SciPro thesis process: concepts and design. In: Li, F.W.B., et al. (eds.) *Advances in Web-Based Learning: ICWL 2015*, pp. 245–250. Springer, Cham (2015)
22. Hansen, P., Järvelin, K.: Collaborative information retrieval in an information-intensive domain. *Inf. Process. Manag.* **41**(5), 1101–1119 (2005)
23. Hyldegård, J., Hertzum, M., Hansen, P.: Studying collaborative information seeking: experiences with three methods. In: Hansen, P., Shah, C., Klas, C.P. (eds.) *Collaborative Information Seeking*, pp. 17–35. Springer, Cham (2015)
24. Karamuftuoglu, M.: Collaborative information retrieval: toward a social informatics view of IR interaction. *J. Am. Soc. Inf. Sci.* **49**(12), 1070–1080 (1998)
25. Karunakaran, A., Reddy, M.C., Spence, P.R.: Toward a model of collaborative information behavior in organizations. *J. Am. Soc. Inf. Sci. Technol.* **64**(12), 2437–2451 (2013)
26. Laurillau, Y., Nigay, L.: Clover architecture for groupware. In: *Proceedings of the ACM Conference on Computer Supported Cooperative Work*, New Orleans, LA, pp. 236–245 (2002)
27. Leeder, C., Shah, C.: Collaborative information seeking in student group projects. *Aslib J. Inf. Manage.* **68**(5), 526–544 (2016)
28. Leeder, C., Shah, C.: Measuring the effect of virtual librarian intervention on student online search. *J. Acad. Librariansh.* **42**(1), 2–7 (2016)
29. Leeder, C., Shah, C.: Practicing critical evaluation of online sources improves student search behavior. *J. Acad. Librariansh.* **42**(4), 459–468 (2016)
30. Morris, M.R.: A survey of collaborative Web search practices. In: *Proceedings of the Twenty-Sixth Annual CHI Conference on Human Factors in Computing Systems - CHI'08*, p. 1657. ACM Press, New York (2008)
31. Morris, M.R.: Collaborative search revisited. In: *Proceedings of the 2013 Conference on Computer Supported Cooperative Work - CSCW'13*, p. 1181. ACM Press, New York (2013)
32. Morris, M.R., Horvitz, E.: SearchTogether: an interface for collaborative Web search. In: *Proceedings of the 2007 ACM Symposium on User Interface Software and Technology (UIST 2007)*, pp. 3–12. ACM Press, New York (2007)
33. Newman, K., Knight, S., Hansen, P., Elbeshausen, S.: Situating CIS: the importance of context in collaborative information seeking. In: Hansen, P., Shah, C., Klas, C.P. (eds.) *Collaborative Information Seeking*, pp. 37–54. Springer, Cham (2015)
34. Olson, G.M., Olson, J.S., Carter, M.R., Sorrosten, M.: Small group design meetings: an analysis of collaboration. *Hum. Comput. Interact.* **7**(4), 347–374 (1992)
35. Olson, J.S., Olson, G.M., Storrøsten, M., Carter, M.: Groupwork close up: a comparison of the group design process with and without a simple group editor. *ACM Trans. Inf. Syst.* **11**(4), 321–348 (1993)

36. Pickens, J., Golovchinsky, G.: Collaborative exploratory search. In: Proceedings of Workshop on Human-Computer Interaction and Information Retrieval, Cambridge, MA, pp. 21–22 (2007)
37. Pickens, J., Golovchinsky, G., Shah, C., Qvarfordt, P., Back, M.: Algorithmic mediation for collaborative exploratory search. In: Proceedings of the 31st Annual International ACM SIGIR Conference: Research & Development in Information Retrieval, pp. 315–322 (2008)
38. Reddy, M.C., Jansen, B.J.: A model for understanding collaborative information behavior in context: A study of two healthcare teams. *Inf. Process. Manag.* **44**(1), 256–273 (2008)
39. Shah, C.: Toward collaborative information seeking (CIS). In: Proceedings of JCDL 2008 Workshop on Collaborative Exploratory Search, Pittsburgh, PA (2009)
40. Shah, C.: Collaborative Information Seeking: The Art and Science of Making the Whole Greater than the Sum of All. Information Retrieval Series. Springer, Berlin (2012)
41. Shah, C.: Collaborative information seeking. *J. Assoc. Inf. Sci. Technol.* **65**(2), 215–236 (2014)
42. Shah, C.: Evaluating collaborative information seeking: synthesis, suggestions, and structure. *J. Inf. Sci.* **40**(4), 460–475 (2014)
43. Shah, C., Leeder, C.: Exploring collaborative work among graduate students through the C5 model of collaboration: a diary study. *J. Inf. Sci.* **42**(5), 609–629 (2015)
44. Shah, C., Marchionini, G.: Awareness in collaborative information seeking. *J. Am. Soc. Inf. Sci. Technol.* **61**(10), 1970–1986 (2010)
45. Shah, C., Oh, S., Oh, J.S.: Research agenda for social Q&A. *Libr. Inf. Sci. Res.* **31**(4), 205–209 (2009)
46. Shah, C., Reddy, M., Twidale, M.: In: First Workshop on Collaborative Information Seeking (2010)
47. Shah, C., Hansen, P., Capra, R.: In: Second Workshop on Collaborative Information Seeking (2011)
48. Shah, C., Hansen, P., Capra, R.: In: Third Workshop on Collaborative Information Seeking (2013)
49. Shah, C., Kitzie, V., Choi, E.: Modalities, motivations, and materials - investigating traditional and social online Q&A services. *J. Inf. Sci.* **40**(5), 669–687 (2014)
50. Shah, C., Capra, R., Hansen, P.: Workshop on social and collaborative information seeking (SCIS). *SIGIR Forum* **49**(2), 117–122 (2015)
51. Smyth, B., Balfe, E., Briggs, P., Coyle, M., Freyne, J.: Collaborative Web search. In: Proceedings of the International Joint Conference on Artificial Intelligence (IJCAI), Acapulco, pp. 1417–1419. Morgan Kaufmann, San Francisco (2003)
52. Soulier, L., Shah, C., Tamine, L.: User-driven system-mediated collaborative information retrieval. In: Proceedings of the 37th International ACM SIGIR Conference on Research & Development in Information Retrieval - SIGIR'14, pp. 485–494. ACM Press, New York (2014)
53. Talja, S., Hansen, P.: Information Sharing. Springer, Dordrecht (2006)
54. Twidale, M.B., Nichols, D.M.: Collaborative browsing and visualization of the search process. *Aslib Proc.* **48**, 177–182 (1996)
55. Twidale, M.B., Nichols, D.M., Paice, C.D.: Browsing is a collaborative process. *Inf. Process. Manag.* **33**(6), 761–783 (1997)
56. Widen, G., Hansen, P.: Managing collaborative information sharing: bridging research on information culture and collaborative information behaviour. *Inf. Res. Int. Electron. J.* **17**(4), paper 538 (2012)