



INFORMATION-SEEKING SUPPORT SYSTEMS

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Seeking information for learning, decision making, and other complex mental activities that take place over time requires tools and support services that aid people in managing, analyzing, and sharing retrieved information.

The emergence of the World Wide Web (WWW) and the various search engines that index its content has made information retrieval a daily activity for most people. Whether at work, school, or play, people have come to expect instant access to information on any topic at any place and time.

Retrieval is sufficient when the need is well-defined in the searcher's mind; however, when searchers are seeking information for learning, decision making, and other complex mental activities that take place over time, retrieval is necessary but not sufficient. These tasks require tools and support services that aid people in managing, analyzing, and sharing sets of retrieved information.

The information needs of people grappling with chronic illness, work teams creating services or products, learners studying topics over time, families making long-term plans, scientists investigating complex phenomena, and hobbyists tracking developments over a lifetime are well-served at only the most superficial levels by today's Web-based search engines. In complex and exploratory search scenarios, information seekers require support that extends beyond the provision of search results. Information-seeking support systems (ISSSs) provide search solutions that empower users to go beyond single-session lookup tasks.

The research community and the search engine companies are directing increasing attention to designing and implementing systems that meet the broader requirements of information seekers. This attention is manifested in R&D workshops, papers, and prototypes that use a variety of terms—exploratory search, interactive search, human-computer information retrieval—to describe this more comprehensive information-seeking problem and possible solutions.

In this special issue, we provide an overview of progress to date and offer a précis for what is to come as the R&D

community moves beyond search alone and focuses on ISSSs that help users find, understand, and use information as part of a holistic process.

THE INFORMATION-SEEKING PROCESS

Information seeking is a fundamental human activity that provides many of the “raw materials” for planned behavior, decision making, and the production of new information products. People search for information objects that embody ideas, use cognitive effort to understand what they find, and employ additional effort to use these understandings to create problem solutions.

The information-seeking process has been characterized as having seven subprocesses—recognize the need, accept the problem, formulate the problem, express the need, examine results, reformulate the problem, and transition to use—that recur according to the information seeker’s ongoing sensemaking and reflective monitoring of progress.¹ Peter Pirolli and Stuart K. Card’s information foraging theory models these processes as highly adaptive to the information environment.² These views of information seeking admit ranges of needs from known item instances such as locating a phone number to order a pizza to life-long efforts to conduct research in a rapidly changing domain. They also admit the possibility that people reject the problem at any iteration, either through avoidance of traumatic information or due to feelings of information overload as they discover more information.

Additionally, the combination of our natural inclinations toward gathering information to inform behavior and the computational tools that underlie the WWW broadens the trend toward computational thinking in everyday life. The WWW and associated search tools have accelerated our capabilities for information seeking, brought this activity front and center as a skill that all literate individuals must have, and dramatically raised expectations about access and use of information in all aspects of our lives.

In addition to having transformational impact on the roles of major information services such as newspapers and directory services such as the yellow pages, this ready access to facts, images, and documents realizes an important element of computing as augmentation of the intellect envisioned by Douglas Engelbart nearly 50 years ago.³ Today’s search engines combined with mobile access to the Web are augmenting our memories, presumably freeing us to focus more mental effort on interpreting and using information to learn and make decisions.

The easier access to information becomes, the greater become our expectations for ubiquitous access in all kinds of situations. The snowballing effect of ubiquitous access to information, coupled with the expected growth in the range of search task types being attempted, brings new

challenges to information-seeking theory and the design of ISSSs.

There are three mutually interdependent aspects of this challenge: more robust models of human-information interaction; new tools and services to meet the expanding expectations in ever-increasingly comprehensive information problem spaces; and better techniques and methods to evaluate information seeking across communities, platforms, sources, and time. This dynamic view of information seeking—where people, information sources, and systems change continually, and search becomes a seamless component of computationally augmented life rather than a discrete activity—requires new models, tools, and measures. The articles in this issue represent some of the current approaches to these emergent requirements.



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IN THIS ISSUE

In “Powers of 10: Modeling Complex Information-Seeking Systems at Multiple Scales,” Peter Pirolli argues that rational and predictive models of information seeking that operate across time and space scales are beginning to replace traditional descriptive models of information seeking. Adopting utility-based models from ecology (foraging) and psychology (sensemaking), he presents a model that predicts human behavior for specific information-seeking conditions. This model resonates with current views of cognition as embodied in natural and built environments,⁴ including social environments that are responsive to longer time scales.

“Information Seeking Can Be Social” by Ed H. Chi and “Collaborative Information Seeking” by Gene Golovchinsky, Pernilla Qvarfordt, and Jeremy Pickens provide examples of social and collaborative search, respectively, and indicate new directions for leveraging the collective search experience during information seeking.

These evolving models of information seeking and the rapidly evolving interactive Web technologies are spawning a variety of new tools and services that address one or more aspects of the overall information-seeking process. In “Building Knowledge: What’s beyond Keyword Search?,” m.c. schraefel puts today’s tools in the historical context of pre-Web computation and argues that emerging tools that support flexible browsing and navigation represent a return to the desiderata defined in the pre-Web

era. She illustrates her argument with examples of faceted search tools that tightly couple selections and results and add visual representations that support highly interactive information seeking.

One particularly thorny issue that a more holistic attack on information seeking entails is evaluation. The complexity of human behavior over time defies simple metrics for effectiveness, efficiency, and satisfaction. When evaluating information-seeking support tools, it is impossible to completely separate the human behavior from system effects because the tools are so closely coupled with human acts that they become symbiotic. The classical metrics of time, mouse clicks, or precision alone are too granular to assess the effects of our tools. Thus, new evaluation techniques and metric suites are emerging. In "Evaluation Challenges and Directions for Information-Seeking Support Systems," Diane Kelly, Susan Dumais, and Jan O. Pedersen provide an overview of evaluation strategies that aim to get inside the black box between query and result. They raise the possibility of distributed evaluation in a living laboratory that allows the Web populace to be both users and investigators in service to the greater good of all.

One interesting challenge parallels the translational science problem in the biomedical domain where interdisciplinary teams of scientists collaborate with healthcare professionals to apply the fruits of basic research to healthcare practice. In the case of ISSSs, the challenge is how scientists in academic settings with distinct work practices and reward systems can work collaboratively with industry to keep up with the rising expectations and demands of information consumers. In "Industry-Academic Relationships," Daniel M. Russell highlights the importance of collaborations among corporate and academic scientists. For example, search engine companies have enormous amounts of proprietary data at their disposal, and academic teams are equipped to create and apply novel approaches to analyzing and interpreting these data. These collaborations are a metaexample of the way the Web leverages social systems—for example, hyperlinks between documents, tags and annotation, usage-based recommendations—and the results of such collaborations promise to propel research and development forward.

Several sidebars are included in these articles to give examples or alternatives for the ideas presented here.

We have outlined major ongoing developments in information-seeking theory and design meant to address an increasingly diverse set of user demands. It is clear from the range of research covered in this theme issue that both interdisciplinary collaboration and partnerships between academia and industry

are essential for the successful development and deployment of effective ISSSs.

Increasing the power of search systems and improving the availability of information can create an informed citizenry and help drive the information economy. When we consider information rather than material resources, the tragedy of the commons becomes the treasures of the commons. We may all be consumers of information, but we will never deplete this resource that is the fruit of human imagination and intellectual effort.

The development and widespread adoption of WWW-based information and associated search engines have opened the door to new kinds of systems that are more powerful and integral to the full range of information-seeking activities. Research and development on these ISSSs will help support our increasingly complex information needs and fulfill our desire for anytime, anywhere information access and use. ■

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