By Ryen W. White, Bill Kules, Steven M. Drucker, and M.C. schraefel, Guest Editors

# SUPPORTING EXPLORATORY SEARCH

Online search has become an increasingly important part of the everyday lives of most computer users. Search engines, bibliographic databases, and digital libraries provide adequate support for users whose information needs are well defined. However, there are research and development opportunities to improve current search interfaces so users can succeed more often in situations when: they lack the knowledge or contextual awareness to formulate queries or navigate complex information spaces, the search task requires browsing and exploration, or system indexing of available information is inadequate. For example, what if we want to find something from a domain where we have a general interest but not specific knowledge? How would we find classical music we might enjoy if we do not know what Beethoven or Berlioz sound like? What about the difference between Baroque and Romantic? What do we type into a search engine? [2].

Illustration by Marlena Zubar

The answer is we usually submit a tentative query and take things from there, exploring the retrieved information, selectively seeking and passively obtaining cues about where the next steps lie. Researchers from diverse communities, such as information retrieval, user interface design, information visualization, and library sciences have been working on techniques to support these kinds of queries in what is becoming known as "exploratory search."

This special section presents the thinking of informed scholars and leaders in the field based on their work in this area. We present a collection of different perspectives, reflections, and future visions on exploratory search. (The section was inspired by discussions at a workshop held at the University of Maryland in June 2005 [3]). The recurring themes throughout this section include: interactive search and browsing, user needs, user models, visualization, and dynamic workspaces.

Designing interfaces to support exploratory search presents unique demands over designing for searches where the target is well known or where a single document or fact will suffice. Systems such as the mSpace Explorer, the Relation Browser, CitiViz, and the Phlat browser—all described in this section—try to make search more effective by providing a broader range of interface functionality and dynamically updating how search results are presented. Other options include the use of interfaces employing categorization or clustering (see the sidebar by Hearst for more details).

Most of this research has been prototyped in restricted domains that are generally limited in size. However, emergent protocols, such as the Semantic Grid [1], are promising to enable data to be associated and reasoned over in new ways at Web scale. There is an imperative, therefore, to design interfaces that will take advantage of these new protocols, and that will thereby provide new mechanisms to support richly associated search across heterogeneous spaces.

The provision of tools to support the exploration of such information spaces can yield great rewards for users, especially when contextual factors such as user emotion, task constraints, and dynamism of information needs are considered. Determining whether an exploratory search system is effective is a challenge in itself. No metrics exist to determine how well a system supports exploration, yet users will undoubtedly be able to tell what works well for them. Although some articles in this section mention evaluation, the issue is worthy of more discussion than possible here; our primary aim is to provide an overview of advances in techniques to support exploratory search.

The development of new search tools requires novel research and collaborative efforts among computer scientists, social scientists, psychologists, library and information scientists, and practitioners who may lead the way with novel search applications on the Web. The authors featured here leverage their skills and experience to provide different perspectives, but with the same objective: to improve the search experience for computer users. For researchers, this section will shine a light on potentially new research areas; for practitioners, it will illustrate ongoing work and demonstrate why exploratory search is an area worthy of attention.

Defining what constitutes an exploratory search is challenging. Indeed, almost all searches are in some way exploratory. As many of the examples in this section illustrate, an exploratory search may be characterized by the presence of some search technology and information objects that are inherently meaningful to users (for example, their images, email messages, and music files). Although there may be circumstances where exploratory strategies are used continually to allow people to discover new associations and kinds of knowledge, they are often motivated by a complex information problem, and a poor understanding of terminology and information space structure.

In some respects, exploratory search can be seen as a specialization of information exploration—a broader class of activities where new information is sought in a defined conceptual area; exploratory data analysis is another example of an information exploration activity. In exploratory search, users generally combine querying and browsing strategies to foster learning and investigation. Although the exploration of information to reduce uncertainty is addressed in many fields, we focus on three areas: information retrieval (how information is found), information studies (how needs are described and information is used), and information visualization (how information is presented). The articles do not discuss fields such as knowledge management and cognitive psychology. Although both fields contain relevant research, they are beyond the scope of this editorial project.

Marchionini opens the discussion with an article

describing the difference between exploratory search and lookup or retrieval search. He argues that exploratory search is based on learning and investigation, and requires support for browsing strategies, whereas lookup or retrieval can be best supported by analytic strategies. Marchionini uses the phrase "Human-Computer Information Retrieval" to describe more active user involvement in the search process, and illustrates practices and trends with examples from user interaction that support retrieval and exploration strategies.

Fox et al. describe their efforts to support exploration using the metaphor of stepping stones and pathways. Through tailored visualization they make searchers aware of the "big picture," help them make new insights, follow alternative pathways, find helpful connections, and discover more relevant items. They demonstrate the importance of visualization interfaces as a natural and efficient way to support exploratory search through navigation and hypotheses generation.

Gersh et al. focus on the role of exploratory search in the intelligence analysis process. They advocate the use of rich information collections to help information analysts understand, synthesize, and present a coherent explanation of world events. Rich information collections and a general concept for using such collections in analysis are defined. The authors illustrate how such collections can benefit analysts as they explore information represented by complex graphs, such as social networks.

Sidebars are interspersed throughout the section briefly describing research and techniques complementary to the three feature articles in domains such as music, photography, and email. The sidebar by schraefel et al. describes mSpace, an interaction model and software framework that brings together a variety of mechanisms to improve information access by supporting multiple ways of exploring information. Shneiderman et al. describe their research on helping searchers find photographs through interface strategies to help them annotate, browse, and share information. Cutrell and Dumais describe their work with the Phlat browser for exploring personal information. Jansen describes research on providing automated assistance to users engaged in exploration when they are likely to be most receptive to it. Hearst compares and contrasts clustering and faceted categorization approaches to organize information retrieved from search engines and facilitate exploration to focus an initially vague query and improve retrieval.

The articles here exemplify the growing interest in supporting exploratory search and illustrate, through descriptions of research in multiple domains, the importance of the challenge. As search technologies become more pervasive they will be used more intensively for an increasingly diverse range of activities. It is vital that as user requirements evolve from using search for lookup to using it to learn, investigate, and explore, that search support tools also evolve.

As our understanding of how users explore, and what they need during this exploration grows, new modalities will emerge that use the context of search activity and contextual information available in the target documents, and beyond, to aid searcher understanding, and reduce uncertainty about the nature of the problem and the information being searched. Systems will support a diverse range of user search strategies such as recall and recognition, facet-based search and domain selection, and contain workspaces to support a spectrum of activities, from unstructured note-taking to integrated authoring environments.

Search is only a partially solved problem. The new directions we have proposed represent a subset of the grand challenges that await those interested in enhancing the search experience for users. Supporting exploratory search is an exciting multidisciplinary area that will have a profound effect on how information is gathered, used, and shared. Rather than just providing search results, search systems should help users explore, overcome uncertainty, and learn. To accomplish this, researchers and practitioners must leverage their skills and experience to develop search systems that actively engage searchers by using semantics, inherent structure, and meaningful categorization to organize intuitive visual workspaces. C

## References


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