The Seventeen Theoretical Constructs of Information Searching and Information Retrieval

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In this article, we identify, compare, and contrast theoretical constructs for the fields of information searching and information retrieval to emphasize the uniqueness of and synergy between the fields. Theoretical constructs are the foundational elements that underpin a field's core theories, models, assumptions, methodologies, and evaluation metrics. We provide a framework to compare and contrast the theoretical constructs in the fields of information searching and information retrieval using *intellectual perspective* and *theoretical orientation*. The intellectual perspectives are *information searching*, *information retrieval*, and *cross-cutting*; and the theoretical orientations are *information*, *people*, and *technology*. Using this framework, we identify 17 significant constructs in these fields contrasting the differences and comparing the similarities. We discuss the impact of the interplay among these constructs for moving research forward within both fields. Although there is tension between the fields due to contradictory constructs, an examination shows a trend toward convergence. We discuss the implications for future research within the information searching and information retrieval fields.

Introduction

The fields of information searching and information retrieval both focus on the interaction between people and content in information systems. These two fields share common ground largely because both are concerned with the three perspectives of people, information, and technology in locating information stored in computer systems. *Information searching* refers to people's interaction with information retrieval systems, ranging from adopting search strategy to judging the relevance of information retrieved (Wilson, 2000). The term *search* denotes the specific behaviors of people engaged in locating information (Marchionini, 1995, p. 5). In contrast, *information retrieval* is finding material of an unstructured nature that satisfies an information need from within large collections stored on computers (Manning, Raghavan, & Schütze, 2008). This definition does not differ much from van Rijsbergen's (1979) much earlier statement that information retrieval is automatic (vs. manual), deals with information or documents (vs. data), and informs the user concerning the existence or nonexistence of information that is related to a query, versus changing the knowledge of the user. The term *retrieval* means the extraction of information from a content collection.

Fields are large areas of inquiry or research which may have a number of specialties (Wilson, 1983). As a field of study, information retrieval is well established, with its own conferences and journals focused exclusively on information retrieval research (e.g., ACM SIGIR Conferences, *Transactions on Information Systems*, *Information Retrieval*). Unlike the information retrieval field, the field of information searching has not gained a status as a distinct field. Its conferences (e.g., ASIS&T) and journals (e.g., *Journal of the American Society for Information Science and Technology*, *Journal of Documentation*) tend to encompass other information science fields. However, from the viewpoint of "production of new knowledge" (Wilson, 1983), the number of researchers engaged with information searching research is quite large, and the research community has been well established. Therefore, one may argue that information searching is a de facto research field.

These two research fields have maintained distinct research agendas, with limited exchange of research. Traditionally, information searching researchers tend to be trained in the library and information science discipline whereas many information retrieval researchers are trained in computer science or related programs. Most researchers

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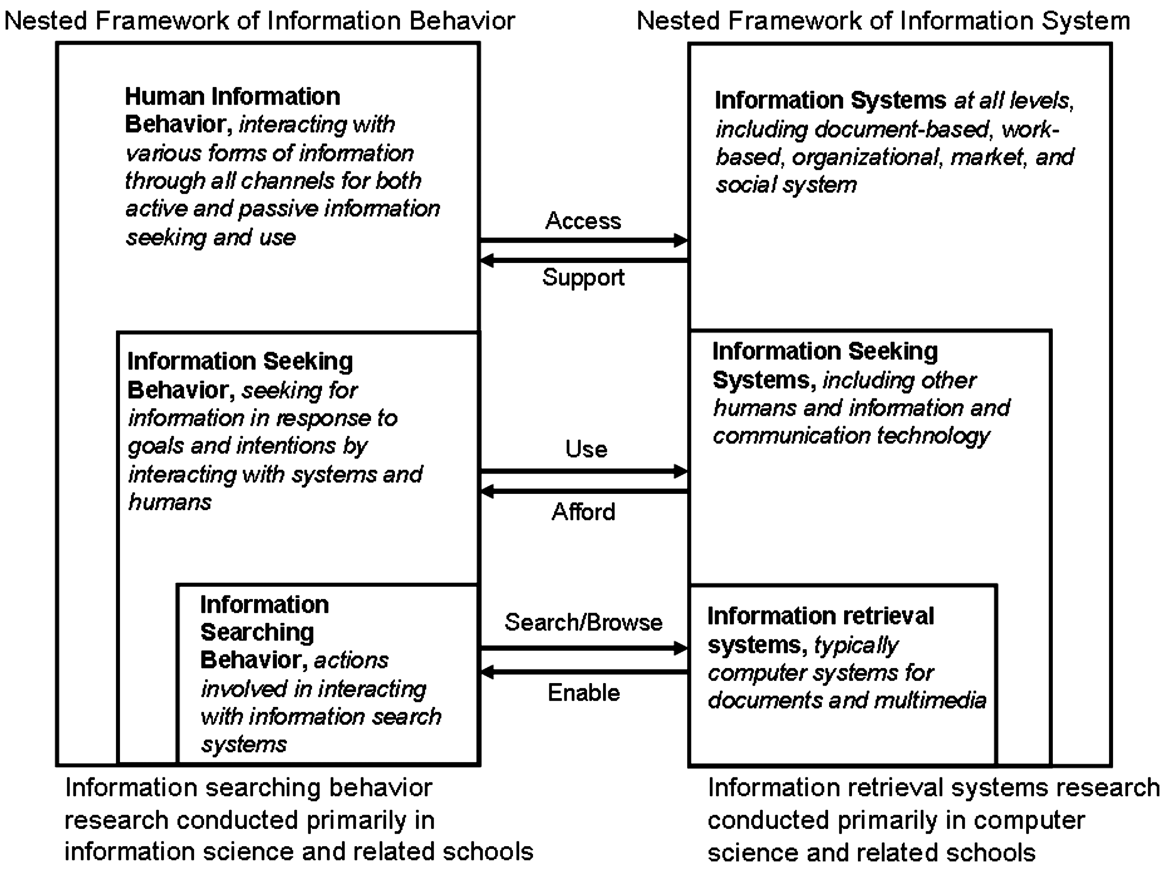

FIG. 1. Framework of human information behavior and information systems.

in each field tend to stay within their disciplinary circles by keeping their own venues for research publication and presentation, a common practice across many disciplines (Hjørland & Albrechtsen, 1995; Talja, 2005). As a result, the two fields seem to have developed different sets of assumptions and associated models despite the shared common ground, although conferences such as the Information Interaction in Context (IIiX) attempt to bring the two fields together.

The two fields approach the central issue of locating information within computerized information systems. However, efforts to place the fields within the larger domains of information science and computer science are impeded by different meanings associated with common terminologies. To clarify these fields and examine their relationship, we present a nested model of human information behavior based on T.D. Wilson's (1999) discussion, as shown in Figure 1.

From Figure 1, we present two nested frameworks in parallel. One outlines behaviors when people are using information systems, and the other illustrates the systems that support, afford, and enable the behaviors. On the information behavior side, human information behavior is the broadest, addressing all aspects of human information interactions with various forms of information. A subset is information seeking behavior, which encompasses the range of information seeking employed in discovering and accessing information resources (both humans and systems) in response to goals and intentions. Information searching behavior is a subset of information seeking, referring to the actions involved in interacting with an information search system. Parallel with this framework, there are information systems on which these behaviors interact. The highest level is information systems, which include all processes and technologies by which humans engage information. A subset of this is information seeking systems, including systems of both a technical and nontechnical nature by which people find and use information. Finally, there are information retrieval systems that typically refer to computer systems for documents and multimedia.

The two nested frameworks are not necessarily disconnected from each other. Indeed, these two frameworks are linked via various levels of interaction between the human side and the system side. At the highest level, humans access various information objects, and diverse information systems support human information behavior. At the middle level, the humans seek information and eventually use the information gained from information seeking systems. Either human resources or information from other resources provide affordances to support particular human information seeking behavior. At the microlevel, primary actions taken by humans during the process of interacting with information retrieval systems are searching and browsing. In response to actions from users, information retrieval systems enable the features and functionalities.

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Although theoretical work within each field has occurred, development of theories across both fields is limited (Robertson, 2000; Rosenberg, 1974; Wilson, 1999). This may be because both the information searching and the information retrieval fields are pragmatic and empirical by nature (for a discussion, see Rosenberg, 1974). In general, information science domains are strongly driven by practical problems and issues (Belkin & Robertson, 1976), and one often evaluates information retrieval systems via practical criteria (Robertson, 2000). Such pragmatic concerns have attracted the majority of the research attention in the fields. As a result, theoretical constructs encompassing the two fields have not been well articulated or much acknowledged in prior publications.

Theoretical constructs can be seen as fundamental elements that drive a field's research. The purpose of this article is to identify and characterize theoretical constructs in information searching and information retrieval to gain a deeper understanding of each field and to better comprehend the relationship between the fields. In this article, we define a theoretical construct as *the conceptual underpinnings that influence key research and practices in the field*. As such, theoretical constructs are fundamental to driving a field's research. Vakkari (1998) stated that constructs (referred to as *theoretical perspectives*) offer guidelines for actual theory construction. The examination of theoretical constructs is important for several reasons. First, researchers can benefit from examining the underlying fundamentals of their research within or between the fields. The two fields give rise to different paradigms about how best to provide useful information. Thus, researchers can better place their research in the broad spectrum of the fields. Second, an understanding of the underlying constructs can motivate research that has stronger theoretical foundations, thereby enabling researchers to better facilitate communication and analysis between the two fields. Finally, recognizing the strengths, shortcomings, and propositions of each field will provide more opportunities for cross-field research collaboration and may enhance the impact of research.

Theories and Constructs

Theoretical constructs, which are the focus of this article, differ from theories and models in their simplicity, resilience, and limited scope. Constructs are concepts from which researchers build theories, develop models, evaluate results, and measure impact. Rosenberg (1974) stated that constructs (The researcher used the phrase "scientific paradigm.") serve as the structure for organizing knowledge and perceptions. DePoy and Gitlin (1998) proposed that a construct is not directly observable but rather is made up of parts or components that can be observed or submitted to measurement. Kuhlthau (1988) stated that theoretical constructs are simpler knowledge structures that enable one to anticipate events and predict outcomes in specific contexts. Theories are a set of statements (which we refer to as *constructs*) presenting a systematic view of phenomena and relationships with the purpose of explanation or prediction. T.D. Wilson (1999) stated that a set of constructs and their relationships may eventually evolve into a theory. Bates (2005) also stated that a set of constructs can form a theory. These constructs are founded typically on repeated scientific experiments or observation over an extended period by a variety of researchers. Therefore, constructs are less likely to change than are theories, and constructs have nearly universal acceptance within a given scientific field.

Theories may have components and are likely to evolve as the body of empirical research continues to develop. In addition, a theory not only accounts for the observation but also attempts to explain it, relate it to other observations, and make hypotheses based upon it for other observations. Models tend to focus on more specific problems than do theories, typically making their content more concrete or illustrating causal processes (Case, 2007). In the information searching literature, Bates (2005) discussed some of the differences between models and theories, stating that theories are a body of constructs while models are used as testing devices. T.D. Wilson (1999) stated that a model is a framework for thinking about a problem and may evolve into a theory (i.e., a statement of the relationships among theoretical constructs). Both Bates (2005) and T.D. Wilson (1999) stated that most of what passes for theory in information science is really at the modeling stage. In the information retrieval literature, a corresponding discussion of methods and methodologies brings its own set of theoretical underpinnings. Methods are the systematic steps or procedures employed by a discipline to achieve some end. A methodology is a body of methods employed by a discipline. Similar to Bates' (2005) and T.D. Wilson's (1999) critiques of information science, we argue that much of what passes for theory in information retrieval tends to be methodology. Like models, theoretical constructs usually underlie these methods.

K.G. Wilson (2001) defined two types of constructs: abstract and hypothetical. Abstract constructs are those that refer to events or event properties and are produced via analytic effort. Abstract constructs are direct statements that *something* happens in a given context. In other words, they explain events. The second type of construct is hypothetical (Wilson, 2001). Hypothetical constructs aim to explain events in terms of some proposed unobserved variable; furthermore, they explain *why* and *how* something happens. In this article, we focus on abstract constructs that describe various aspects of information searching and information retrieval.

Core theoretical constructs of a field are sometimes addressed explicitly by the literature within a field. For example, in the field of Newtonian physics, mass, momentum, and acceleration are key constructs of the field. For the explicitly stated theoretical constructs, one can take a literature-review approach, looking for explicit mentions and occurrences. Often though, a theoretical construct is so central to a domain that literature only states it implicitly. These constructs are so ingrained that they are, for lack of a better term, "assumed" by the field. Again using the field of physics, force is a central

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construct of Newtonian physics and appears in a variety of mathematical models and equations involving mass, momentum, and acceleration. However, one can only observe force indirectly through its effects on the movement of objects (Heylighen, 1999). There is no external evidence that "force" exists, but it is a construct central to the field of physics. For these implicit constructs, one must look to literature outside of the given field to understand the fundamental perspectives or conduct in-depth critiques of a field's body of literature to highlight the constructs. For this article, we examine both explicit and implicit constructs.

Literature Review

Prior work in examining the theoretical aspects has focused on the overall field of information science rather than on the subfields of information searching or information retrieval. A significant volume of information searching and information retrieval articles exist, and many of these address basic concepts; however, there has been little work in presenting these concepts within a framework showing the relationships of theoretical constructs between the two fields as drivers of research.

In a series of articles, Brookes (1980a, 1980b, 1980c, 1981) examined aspects of the information science field. Brookes (1980a) outlined Popper's view of a three-world ontology as a foundation for the information science discipline, and he proposed a fundamental equation for information science [i.e., $[K(S) + \delta I = K(S + \delta S)]$. He was critical of information science for its lack of theoretical bases and identified philosophical issues concerning qualitative and quantitative measures as they pertain to translating information into knowledge. In the fourth part of the series, Brookes (1981) posited what information science might look like based on his paradigms. As such, the series is a review and critique of the broad field of information science.

The concept of construct surfaced in Boyce and Kraft (1985), who defined construct (The authors used the term *principle.*) as "a single fundamental law, generally an empirical regularity based on continued observation" (p. 154). They consider a theory "to incorporate a body of such principles and to suggest new principles that can be tested as hypotheses, both to increase knowledge and to invalidate or to strengthen the basic theory itself" (p. 154). Their article provides a somewhat narrow view of information science because Boyce and Kraft limited their reviews to information theory, methods of indexing, and models of information retrieval rather than characterizing fundamental underpinnings describing information science.

In a discussion of theory and meta-theory, Hjørland (1998) noted that meta-theories are broader than theories and serve as a basis of conscious or unconscious assumptions behind theoretical, empirical, and practical work. He noted that the most dominant theoretical approaches in information science have been the physical paradigm and the cognitive paradigm. Hjørland showed that there are limitations in those paradigms; thus, information science researchers need to look for alternative approaches. He proposed epistemological theories as alternative viewpoints in information science, emphasizing that epistemological theory can have fundamental impact on information retrieval as well as on users' cognition and information seeking behaviors. He also stated that information science should not be driven by empiricism and rationalism. Rather, according to Hjørland, philosophical knowledge and meta-theoretical views need to be further analyzed.

Ingwersen and Järvelin (2005) noted the disconnection between system-oriented information retrieval and cognitive and user-oriented information retrieval, and proposed the integrated information seeking and research framework. Their framework regarded interaction and perception as the central processes of information seeking behavior and interactive information retrieval. They discussed the complexity of information retrieval processes by bringing information seekers' situations, work and search task, task complexity, knowledge types, and interactions into their framework. The core idea of Ingwersen and Järvelin's framework is "how evidence of a searcher's information behavior may be applied to guide or adjust algorithmic information processing in system components through IR interaction" (p. 275). Ingwersen and Järvelin noted that conceptual models of a research area are *constructed* rather than simply being positioned. According to them, construction of new conceptual models often requires conceptual and terminological development. Good concepts should be able to represent critical features such as objects, relationships, and events of the research area. Furthermore, the concepts should differentiate and classify the phenomena in ways that can lead to interesting research questions or hypotheses. Concepts also need to support research methods.

Several researchers have written literature reviews to examine core theories. Pettigrew and McKechnie (2001) reviewed 1,160 articles from 1993 to 1998 that appeared in six information science journals. They found that theory was discussed in 34.1% of the articles (0.93 theory incidents per article; 2.73 incidents per article when considering only those articles employing theory). The majority of these articles rely on existing theories from the social sciences (45.4%), followed by information science (29.9%), the sciences (19.3%), and the humanities (5.4%). Seventy-one of the authors proposed new information science theories. Pettigrew and McKechnie noted discrepancies in how researchers who are in different subfields define theory.

Sawyer and Huang (2007) identified differences and patterns relative to conceptualizations of information communication technology (ICT) in information science and management information science research. They focused on information and people as well as on the level of analysis and types of research methods that researchers employed. Their analysis was premised on two beliefs: (a) These two areas of research share three common concepts: a focus on ICT, information, and people; and (b) more explicit recognition of the patterns of relationships relative to the five conceptualizations of ICT can help researchers to better position their

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TABLE 1. Theoretical constructs of information searching and information retrieval.

		Intellectual perspective		
		Primarily information searching	Cross-cutting/domain spanning	Primarily information retrieval
Theoretical Orientation	Information	• Multiple definitions of information • Hierarchical relationship of information • Perceived benefits of information	• Relevance	• Information representation • Information ranking • Document similarity
	People	• Principle of Least Effort • Searching as an iterative process	• Uncertainty principle • Interaction	• Information provision
	Technology	• Preference of channel	• Information obtainability	• Query • Neutrality of technology • Memex vision

work and maximize its value for others. They found a lack of focus on the person in ICT research.

Bawden (2008) investigated the information discipline, the foundations of that discipline, the nature of information, relations between discipline and profession, and education for information science. Bawden focused on a subset of articles and editorials published in the first two volumes of the *Journal of Information Science*, covering the years 1979 and 1980. The author commented on issues and developments highlighted in these publications, and stated that these developments could be foundational research for the information science field.

Although the previous work can be helpful in understanding the overall direction of information science, there is limited and uneven work in articulating various theoretical aspects. Information science has many disparate subfields, and each subfield contains unique constructs. To our knowledge, no prior work exists to provide insights into the constructs underlying the fields of information searching and information retrieval. Second, much of the prior work on theoretical documentation has focused on an empirical review, such as counting mentions of theory within a subset of prior work. Although this can shed light on aspects of information science research, the approach focused only on the explicit elements and missed the constructs embedded in the fields that they are not mentioned explicitly. Finally, none of the prior work provided a framework for incorporating constructs for comparison and contrast. Some researchers (e.g., Ingwersen & Järvelin, 2005; Meadows, 1990; Saracevic, 1997b) have called for work on an integration of the various theories of information science.

As such, many open questions remain. What are the theoretical constructs within the fields of information searching and information retrieval? How do the theoretical constructs compare and contrast between the fields? What constructs do these fields have in common? Can these constructs be integrated into a defining framework? What do these constructs say about the two fields? Addressing these questions, which motivate this research, involves more than just a "count" of references in prior literature. Thus, we conducted a systematic review of themes across publications both within the fields and from related fields along with critiques of the fields from outside the disciplines.

Integration of Theoretical Constructs

Given the extensive body of published work within the fields of information searching and information retrieval, an integrative framework is needed to narrow the focus and keep the presentation of the analysis manageable. We developed the framework (i.e., a logical organization of elements) presented in Table 1 to focus attention on the critical constructs of the information searching and information retrieval fields.

As seen in Table 1, we use two dimensions to arrange the selected theoretical constructs. The *intellectual perspective* from which the construct originates (i.e., *information searching*, *information retrieval*, *cross-cutting*) aligns the constructs to the research fields of interest. The *theoretical orientation* by construct groupings (i.e., *people*, *information*, *technology*) sheds light on the primary focus of each. For clarity, we offer the following definitions:

- *Intellectual Perspective:* the scholarly viewpoint of the construct of the disciplines of information searching, information retrieval, or both
- *Theoretical Orientation:* the focus of the construct in terms of the three core elements in both fields: people, technology, and information.

The rationale for selecting the two dimensions as an organizing theme for the theoretical constructs is based on the aims of this article as well as on the research focus of the fields themselves. The choice of the intellectual perspective dimension was rather straightforward. We are interested in the fields of information searching and information retrieval. We acknowledge that the fields have some overlap. Therefore, we chose the three intellectual perspective dimensions, one for each field and one for domain-spanning constructs. We defined the categories of intellectual perspective as:

- *Information Searching:* the field of academic study concerned with information searching; specifically interaction with information searching systems. Examples of such

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research include those investigating user goals/tasks for using searching systems, information searching behaviors/strategies during the interactions with a Web search engine or an experimental retrieval system, as well as those examining the criteria for the evaluation of a searching system, among others.
- *Information Retrieval:* the field of academic study concerned with information retrieval; specifically representing, storing, and finding information objects with information technology. Examples of such research include retrieval modeling, document processing and clustering, filtering, link analysis of a collection, and matching algorithms, among others.
- *Cross-Cutting:* refers to the concepts that span both the fields of information searching and information retrieval, which we highlight later.

The *theoretical orientation* dimension is based on the three distinct objects from a general systems theory view that emerged from a literature review. Collectively, most prior literature in the fields have focused on at least one, maybe two, and sometimes three of the objects: information, people, and technology. We define the categories of theoretical orientation as:

- *People:* the user of an information system with associated characteristics as defined by the researcher
- *Information:* the content that is stored in a computer system as defined by the researcher
- *Technology:* the hardware or software associated with computer information systems at all levels of granularity, from algorithmic to conceptualization, as defined by the researcher.

As the intersection between the columns and rows, the table cells assist in highlighting the commonality and the differences across the fields. The two dimensions yielded nine categories of theoretical constructs: information–information searching, information–information retrieval, information–cross-cutting, people–information searching, people–information retrieval, people–cross-cutting, technology–information searching, technology–information retrieval, and technology–cross-cutting.

Identification of the 17 constructs was an intertwined and iterative process. We began the process by identifying all possible constructs from the literature review which spanned not only information searching and information retrieval but also the fields of communication, learning, and economics. For inclusion, the construct had to describe a central phenomenon or concept associated with either the field of information searching, information retrieval, or both. The process involved many rounds of concept identification, definition, revisions, and feedback from our peers. Once we identified 17 constructs, we then classified them with respect to nine categories, as displayed in Table 1. We acknowledge that the identification of these 17 constructs may not be exhaustive, but we do believe that Table 1 includes most of the key constructs across the two fields.

Brief definitions of the 17 theoretical constructions follow:

- *Multiple Definitions of Information:* Information is a fundamental concept with a range of definitions.
- *Hierarchical Relationship of Information:* There is a hierarchical relationship among data, information, knowledge, and wisdom from the perspective of an information searcher.
- *Perceived Benefit of Information:* An information system will tend not to be used when it is more painful and troublesome for a user to have information than for the user not to have it (Mooers, 1960/1996).
- *Relevance:* Relevance is a foundational criterion for evaluating the performance of searching or retrieval.
- *Information Representation:* Information can be represented algorithmically by the sum of its attributes.
- *Information Ranking:* Information that addresses an information need as expressed by a query can be ranked in order of some predicted measures (e.g., relevance, usefulness, freshness, authority, etc.).
- *Document Similarity:* If a document is relevant to a given query, then similar documents also will be relevant.
- *Uncertainty Principle:* A user engaged in information searching is in the process of attempting to resolve some uncertainty in knowledge (Kuhlthau, 1993).
- *Principle of Least Effort:* A user of an information system will adopt a course of action that the user perceives will involve the expenditure of the least effort to locate the desired content (Zipf, 1949).
- *Searching as an Iterative Process:* Searching may involve multiple processes of interacting with information systems until the underlying information need is satisfied or met.
- *Interaction:* Information searching and information retrieval involve interactions between a user and a system or information.
- *Information Provision:* Providing information to a user is beneficial for the user to accomplish a certain task.
- *Preference of Channel:* People have preferences of media and technologies when attempting to obtain information.
- *Information Obtainability:* Information is used in direct proportion to how easy that information is to obtain (Summit, 1993).
- *Query:* A user's information need is represented as a question and then transformed into a query that an information retrieval system accepts.
- *Neutrality of Technology:* Information retrieval systems present unbiased content.
- *Memex Vision:* Technology is the solution for making information available to people (Bush, 1945).

We now discuss these constructs grouped by each of the nine categorizations as presented in Table 1, with particular emphasis on their prominence and occurrence in the respective fields. We begin with each of the fields (information searching, then information retrieval), followed by the cross-cutting constructs, starting with the intellectual perspective of information searching and the theoretical orientation of information.

Information–Information Searching Category

Multiple definitions of information. A reoccurring concept in information searching literature is that information is difficult, if not impossible, to define separately from a given context. Belkin and Robertson (1976) emphasized how to conceptualize information as a core concept for information

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science, and Capurro and Hjørland (2003) provided an overview of the concept, with both sources discussing the centrality of information to the broad information science field. Depending on the situation, information has a physical aspect, a cognitive aspect, or an affective aspect. Being influenced by Shannon (1948), information from a physical view involves little or no cognitive processing. Information is treated "as the property of a message, which can be estimated by some probability" (Saracevic, 1999, p. 1054). The cognitive view interprets how that information affects or changes the state of a mind. From a cognitive perspective, Ingwersen (1992) stated that any processing of information has to transform both the generator's and the recipient's state of knowledge, expounded on in polyrepresentation (Ingwersen, 1996). Belkin (1990) noted that the cognitive viewpoint explicitly considers that the state of knowledge of human beings interacts with what they receive and perceive. He also suggested that the cognitive viewpoint is a framework which has led to advances in the theoretical and practical development of information science. The affective aspects focused on motivation or intentionality as well as additional social context such as culture, work, or problem-at-hand (Saracevic, 1999). Schrader (1986, p. 179) counted 134 nuances of information in the field of information science, a field that has generated a lot of work to provide frameworks or taxonomies to the term "information." Attempting to provide the structure to the concept of "information," Buckland (1991) proposed three meanings of information: "Information-as-process," "information-as-knowledge," and "information-as-thing," plus an attribute use of information to denote things that are informative.

The field of information searching seems to accept the notion that information can be defined with a wide range of multiple aspects, with only a few exceptions (cf. Meadow & Yuan, 1997). However, the field of information retrieval traditionally holds an information-as-thing view of information (i.e., information is a unit that physically exists, such as a document, an image, a snippet, a passage, etc.).

Hierarchical relationship of information. Ackoff (1989) proposed a continuum of knowledge where: *data* are symbols that represent properties of objects or events, *information* is a description of a given thing, *knowledge* is the level of instruction, *understanding* is the explanation or why of certain events, and *wisdom* is the level of evaluation or judgment. Kochen (1984) proposed a similar structure as a question: "What is the process of learning, of growth in knowledge, growth in understanding and growth in wisdom?" (p. 198), although the earliest mention of this concept appears to be by Eliot (1934). This learning paradigm has been the backdrop for much information searching research. Ackoff's original proposal has generally been reduced to the data–information–knowledge–wisdom (DIKW; a.k.a., Learning Continuum, Knowledge Hierarchy, Information Hierarchy, Knowledge Pyramid) hierarchy, and it is one of the fundamental, widely recognized, and "taken-for-granted" frameworks in the information science literature. The use of this hierarchy has assisted in somewhat resolving the inconsistent views of information.

Several researchers have proposed modeling information systems based on the DIKW hierarchy, focusing on the relationship among data, information, and knowledge (Meadow & Yuan, 1997; Teskey, 1989; Thow-Yick, 1994). T.D. Wilson (2000) also discussed the relationship of data subsumed under information and the distinction of information from knowledge. Kari (2007) addressed the mental outcome of information (i.e., knowledge) into a hierarchical taxonomy. Oppenheim, Stenson, and Wilson (2003) identified some of the definitional aspects of viewing data, information, and knowledge as separate, but related, categories. The DIKW concept represents a fundamental construct of the field, although it is not always stated explicitly.

The focus in the information searching field is typically on data and information, occasionally knowledge, and seldom wisdom (Rowley, 2007). The information retrieval field is generally focused on information, leaving data to the database researchers and knowledge to the artificial intelligence researchers. Although the information retrieval field typically decomposes information-as-thing (Buckland, 1991) into data (i.e., terms of a document, links in a node, etc.), information retrieval is not concerned with aspects of changes to a user's knowledge or wisdom based on the information retrieved.

Perceived benefits of information. Originally proposed at the annual meeting of the American Documentation Institute in 1959 (Mooers, 1960), Mooers' Law suggests that there are situations or contexts where people may not want information, even if available (Mooers, 1960/1996). Moreover, in some situations, people will avoid using an information system precisely because they know it will provide the desired information. Mooers' insight into these situations is that having information can sometimes be painful, costly, or troublesome. Mooers' article (1960) was centered on the individual within an organizational setting, and this organizational level of analysis was central to Mooers' original statement. In these organizational situations, an individual's avoidance of information could be less troublesome than would be having and using the information (Mooers, 1960/1996). This is one of the few constructs in either information searching or information retrieval that has implications beyond the individual, involving an organizational or policy level.

Several studies have investigated aspects of Mooers' Law. Austin (2001) proposed to expand Mooers' Law to include not only the organizational aspect Mooers (1960) addressed but also the situations in which the effort required from having information and not having it is balanced. Borko (1983) examined the productivity of knowledge workers using information technology within an organizational context. Koenig (1987) used an application of Mooers' Law to predict the design of information systems. Hertzum and Pejtersen (2000) explored the interplay of engineers seeking information concerning a task for a given organization. Ryker, Nath, and Henson (1997) discussed the complexities of managing user

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expectations of information systems within organizations. Hall's (2001) investigations revealed that employees will not feel encouraged to provide content until they believe that what they provide will be used. Gillard and Johansen (2004) reviewed verbal and nonverbal communication issues that impact information-resource project managers.

Although significantly studied in information searching, Mooers' Law has little influence in the field of information retrieval. Concerns of organizational culture, setting, policy, and group interactions are too far from the algorithmic focus of the information retrieval field.

We now move to the information retrieval intellectual perspective of information.

Information–Information Retrieval Category

Information representation. Information retrieval researchers generally take an information-as-thing view, which suggests that one can do things with information, such as index it, encode it, break it into segments, parse it, and so on. This view is based on the tenet that information is inherently concrete, definable, and encodable. Information retrieval follows the positivist or rationalistic tradition (Winograd & Flores, 1986) by considering information to be something objective in the external reality. As van Rijsbergen (1979) stated, an information retrieval system is concerned solely with statistical analysis of a document, although he later somewhat modified this statement to include broader aspects of the user and context (van Rijsbergen, 1986). Since then, information retrieval researchers have acknowledged that the context, task, or situation also is important (cf. Shen, Tan, & Zhai, 2005).

A great number of information retrieval studies dating from the early work in the field of developing information retrieval systems (Salton & McGill, 1983) concern the encodability of information. These concepts and methods include the statistical decomposition of a document, indexing documents within a collection, including the vector space model and the probabilistic model, and efforts to mathematically integrate all three models using Hilbert spaces (van Rijsbergen, 2004). Such a belief in the encodability of information has led to a host of related research, such as inverted file indices and term frequency/inverse document frequency (tf-idf) to relate queries to documents with the collection (Robertson, 2004; Spärck Jones, 1972), and the concept also continues in nontextual information retrieval. Research continues on all of these fronts, including efforts in the image, audio, news stories, WebPages, and video areas.

The field of information retrieval has a relatively stable view that one can decompose information maintaining a relation to documents (Rosenberg, 1974), which has permitted the advance of several algorithmic approaches. In the field of information searching, the lack of a central definition of information has allowed advances along several nuanced fronts, but it also has been a limiting factor for information searching in developing more formal models. There are certainly exceptions, such as polyrepresentation (Ingwersen, 1996).

Information ranking. In delineating information retrieval systems from other information systems, probably the notable differentiation is the aspect of results ranking or scoring function. Ranking is the ordering of retrieved documents in response to user input, typically a query. For database systems, there is a set of results, all of which are correct. For question and answering systems, there is a set of answers that address the topic. With information retrieval systems, there may be a set of results that one can algorithmically rank to the degree that they match a query. The amount of work that has gone into studying the concept of ranking and various methods of improving ranking is voluminous.

The underlying concept of ranking is that all results retrieved do not have equal value based on a metric, such as relevance. One can see this concept in what is known as the probability ranking principle, which is typically stated as:

> If a reference retrieval system's response to each request is a ranking of the documents in the collection in order of decreasing probability of relevance to the user who submitted the request, where the probabilities are estimated as accurately as possible on the basis of whatever data have been made available to the system for this purpose, the overall effectiveness of the system to its user will be the best that is obtainable on the basis of those (as presented in van Rijsbergen, 1979).

Information retrieval researchers tend to focus on rank-based algorithmic matching to the query or relevance feedback. When implemented, the document is not ranked in decreasing probability of relevance to the user but rather to the query based on the matching algorithm. In information searching, information ranking also is a notion well accepted; however, information searching researchers tend to focus more on the cognitive, affective, or contextual factors that determine the evaluation of search results and eventually the usefulness of information.

Document similarity. Closely related, but somewhat in conflict, is the *Rule of Document Similarity*, meaning that if one can associate a query with a relevant document, other documents that have similar characteristics also will be relevant. Portions of this concept are expressed in the cluster hypothesis (Jardine & van Rijsbergen, 1971; van Rijsbergen, 1970), which states that closely associated documents tend to be relevant to the same requests. This has resulted in a large body of research in the information retrieval field on clustering (cf. Crestani & Wu, 2006; Jardine & van Rijsbergen, 1971; van Rijsbergen, 1970). van Rijsbergen (1979, pp. 77–81) implied that document clustering should result in more effective as well as more efficient retrieval, although this has not held in all contexts and systems. Naturally, the most relevant other documents would resemble the one already found; however, from the user side, this new document would be of little value since it may not contain new information. Therefore, for the Rule of Document Similarity to be effective, some kind of noise must exist in the system in practice. That is, the user would usually want documents similar, but

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not the same. Given that limitation, however, the Rule of Document Similarity permeates a wide range of information retrieval research, most notably document clustering as well as relevance feedback, ranking, and performance improving in traditional information retrieval and Web systems.

Although similarity among documents is a key concept in information retrieval, it has received little attention in the information searching field. There is merely an acknowledgment that the rule is generally worthy, with some accepted caveats as stated.

We now focus on the cross-cutting intellectual perspective of information.

Information–Cross-Cutting

Relevance. It is difficult to find a concept that has generated more discussion in or had more impact on the fields of information searching and information retrieval than has relevance. Relevance plays a most significant, fundamental, and central role in all aspects of information retrieval and information searching, including theory, implementation, and evaluation (Mizzaro, 1997; Saracevic, 1975, 2007a), as a key component of information behavior (Fisher & Julien, 2009). Relevance is both a relation and a measure. Saracevic (2007b) defined relevance as a relation between information and contexts (e.g., information need, intent, topic, problem) based on some property reflecting a relevance manifestation (e.g., topicality, utility, cognitive match).

The field of information retrieval holds that information retrieval systems predict relevance. The system takes a query, matches it to information objects stored in the system using some algorithms, and provides a set of document results. The focus is on the connection between information objects retrieved and a query submitted, typically known as topical relevance. Tying the concept of relevance to a model indexing appeared fairly early in algorithmic development (Maron & Kuhns, 1960). Precision and recall have been most widely used as performance measures for information retrieval systems, and relevance is an underlying criterion for recall and precision.

Information searching researchers embrace user relevance, which focuses on users' cognitive state of knowledge, intention, goals, and motivation with respect to information to be used. According to Schamber, Eisenberg, and Nilan (1990), relevance depends on users' judgments on the relation between information and information need situations in a certain time or situational relevance. Borlund (2003) expanded the concept of situational relevance by emphasizing the aspect of dynamic relevance, which refers to how the same user's perception of relevance may change over time. Therefore, even though relevance is a construct central for both fields, one needs to be careful when comparing studies between the two fields by clearly determining how the concept of relevance is defined and treated in each study.

We now examine the intellectual perspective of information searching and the theoretical orientation of people.

People–Information Searching Category

Principle of Least Effort. In striving for a goal, the proposition that an organism generally seeks a method involving the minimum expenditure of energy (Zipf, 1949) is one of the most enduring tenets in a number of empirical information searching studies, including Web searching, library studies, and traditional information retrieval systems. The Principle of Least Effort states that when solving problems, a person tends "to minimize the probable average rate of his or her work-expenditure (over time), meaning use the least amount of effort" (Zipf, 1949, p. 1).

Zipf's principle is related to the psychology principle of satisficing by Simon (1981). Simon's (1981) view was that people had evolved to quickly make decisions. To make quicker decisions, people choose from a subset of options instead of considering all possible options before acting. By applying some general rules, statistically, the best option in that a subset should be close to the best option in the whole set of options. This concept has been borne out in empirical research (cf. Berryman, 2008).

The Principle of Least Effort is embedded in information foraging theory (Pirolli, 2007) as well. Like animals foraging for food with time and energy constraints, humans forage for information, looking for answers according to this searching theory. Given the abundance of information and the increasing growth rate of new information, information foraging states that humans adopt adaptive strategies to optimize their intake of useful information per unit cost. The information foraging theory illustrates the application of the Principle of Least Effort, as people take actions that get the information they want or think they need with the expenditure of the least cost.

In the field of information retrieval, the Principle of Least Effort is generally acknowledged; its direct impact on the design of information retrieval systems is more difficult to determine because it is referenced rather indirectly. Efforts in meta-search (Gauch, Wang, & Gomez, 1996), contextual help (Xie & Cool, 2009), and design of results pages (Pirolli, 2007) are examples of indirect outcomes of the Principle of Least Effort; however, this principle does not appear to be a central concern of the information retrieval field.

Searching as an iterative process. The view of searching for information as an iterative process is central to the information searching field. In information searching, searching is viewed a dynamic, ever-changing process that may cover a rather lengthy temporal span. This concept of searching as an iterative process appears in nearly every model of information searching (Xie, 2008). For example, Taylor (1968) presented levels of information needs that were further developed as Belkin, Oddy, and Brooks (1982) ASK concept. Belkin et al. (1982) noted that information needs are dynamic because the user's ability to articulate requests to the information can be expected to change. The iterative process also is the underlying assumption for a number of information searching models, including Belkin, Cool, Stein,

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and Thiel's (1995) multiple information searching strategies, Choo and Turnbull's (2000) information seeking model, T.D. Wilson's (1999) information seeking model, Marchionini's (1995) information seeking in electronic environments, sense making (Klein, Moon, & Hoffman, 2006; Russell, Stefik, Pirolli, & Card, 1993), and consumer searching (Schmidt & Spreng, 1996). The view of the iterative searching process focuses on the change in the user's cognitive and affective states. As Hider (2006) noted, a considerable amount of search goal revision can take place during and between user–system interaction.

The focus of iteration in information retrieval is much narrower than that in information searching (Ruthven, 2008) because most techniques are centered on query expansion and query reformulation. Some of the earliest models of information retrieval contain elements of an information retrieval cycle: query–evaluating results–query (Robertson, 1977). Relevance feedback techniques (Rocchio, 1971) have been developed in information retrieval that support single or multiple iterations to improve the representation of information need based on user feedback indicating that some results are relevant and others are not. Expanding on the ranking aspect, Fuhr (2008) noted that theoretical foundations of interactive information retrieval are still in an infancy stage.

We now look at the intellectual perspective of information retrieval for the theoretical orientation of people.

People–Information Retrieval Category

Information provision. Information retrieval research is based on the assumption that having information is beneficial for the user. As stated by Israel and Perry (1990), people whose behavior is guided or controlled by information are more likely to succeed than those people who are not guided. Although rarely, if ever, explicitly stated in information retrieval publications, with Repo's (1989) work being a notable exception, it is presented in other fields such as finance (Easley & O'hara, 2001) and the natural sciences (Stephens, 1989). Marin and Poulter (2004) argued that access to information is a vital function, and Konow (2005) supported the position that increased information can contribute to fairness and less bias.

Much, if not all, of the effort in information retrieval research aims at developing ways to provide more relevant information to users. These efforts include increasing efforts at digitizing information, more effective methods of storing information, more successful methods of indexing and retrieving information, and more efficient ways for people to use information. The assumption is that users know information is beneficial; therefore, they want additional relevant information (Frants & Brush, 1986). Of course, at the system level, the focus in information retrieval is to provide information that is useful to the users; however, the move is to store and index as much information as possible. There is the notion, although rarely discussed, that having information is beneficial not only to an individual but to society as well (Israel and Perry, 1990).

Information retrieval researchers rarely question whether more information is better in a given context, whether it leads to more informed decisions, or whether people want more information. This view of more information always being good is in stark contrast to information searching researchers, who draw on research acknowledging that people may actively avoid information in a certain situation. Research has shown that special populations (e.g., cancer patients, people who live in retirement housing, small business owners, etc.) sometimes avoid information that they do not want to know (Case & Johnson, 2005). Research in other fields also has shown that information provisioning does not always hold. For example, Oskamp (1965) found that more information does not necessarily improve decision making, although it does increase confidence in decisions made. Furthermore, Bruner and Potter (1964) showed that more information can lead to incorrect decisions. Finally, information searching researchers do not assume that people are always rational in weighing the costs and benefits of information (Feldman & March, 1981). As such, the view of the benefit of information is one of the constructs where there is tension between the two fields.

Next, we discuss the cross-cutting intellectual perspective for the people theoretical orientation.

People–Cross-Cutting

The Uncertainty Principle. Several researchers have introduced the aspect of uncertainty into information searching literature (Belkin et al., 1982; Dervin, 1998; Kuhlthau, 1993), and uncertainty is present in numerous aspects of information retrieval (Kelly & Teevan, 2003; Rocchio, 1971; van Rijsbergen, 2004). T.D. Wilson (1999) stated that uncertainly is always there from a user perspective. Kuhlthau's (1993) uncertainty principle explicitly states that the earlier stages of information searching are initiated by a lack of understanding or a limited knowledge, and this cognitive state is uncertainty. The affective symptoms of uncertainty are associated with being vague and unclear about a search topic. Vakkari (2001) showed that the level of uncertainty is connected to information desired and search tactics. As the information search progresses, people develop a clearer focus of the topic, and a shift occurs from feelings of uncertainty, confusion, and frustration to feelings of increased confidence. Kuhlthau's (1993) uncertainty principle is closely related to Dervin's (1976) concept of a gap or discontinuity, which the individual conceptualizes in a certain situation. This situation does not permit the individual to move forward without obtaining new knowledge and constructing a changed sense. Based on new information obtained, the individual can move to bridge the gap and proceed after crossing the gap.

The uncertainty principle also is associated with the ASK model (Belkin et al., 1982). The ASK model defines the user's problem or information need as an anomalous state of knowledge. The user recognizes that there is an inadequacy in his or her state of knowledge and resolves to address the inadequacy or anomaly through information searching. In the initial stage

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of a problem, it may be impossible for the user to specify precisely what is lacking in his or her knowledge state. Generally, uncertainty deals with a state of limited knowledge by a user in a given context. This uncertainty may be how to express a need, what that need means, or the changing of previously held beliefs.

We see a related concern in the field of information retrieval. The inability of the searcher to perhaps inaccurately articulate the underlying need as query causes this uncertainty, permeating the entire information retrieval process. There have been significant information retrieval research efforts focusing on uncertainty in algorithmic implementation in the areas of query reformulation, query refinement, vocabulary problems, and relevance feedback, all of which aim to assist the user in more clearly defining the query. There is certainly a focus on the uncertainty in the algorithmic matching of the query to documents, as noted by the works of Fuhr (2008) and Sanderson (1994) with query vocabulary problems.

Principle of Interaction. A cross-cutting construct embedded in both information searching and information retrieval is the fundamental concept of interaction. It is a key element in the process and execution of information searching. Interactions are a central component in almost every model and paradigm of information searching (cf. Belkin et al., 1982; D. Ellis, 1989; Kuhlthau, 1988, 1989, 1991; Saracevic, 1997a, 1997b; Wilson, 1999). Belkin and Vickery (1985), D. Ellis and Haugan (1997), Ingwersen (1996), Marchionini (1992), and others studied information seeking or searching behavior with respect to information retrieval systems and have developed models based on interaction. C. Ellis and Gibbs (1989) described their interest in information-seeking behavior as a way to derive recommendations systemically from the analysis of people's information-seeking behavior. Vakkari (1999) called this stream of research the "interactionistic approach" because it "supposes that information searching is an inherently interactive process between humans and texts intermediated by an IR system" (p. 823). Jansen, Taksa, and Spink (2008) stated that the interactions between user and system are rooted in a behaviorism tradition of research.

An interaction is a sequence of reciprocal events that require at least two objects and two actions (Wagner, 1994). Interactions occur when these objects and events mutually influence one another (Wagner, 1994). As Xie (2008) noted, interactivity is a basic human characteristic, and in the digital environment, people interact increasingly with various information systems. Ingwersen's (1992, 1996) cognitive model, Belkin's (1993) model of interaction with text, and Saracevic's (1997a) stratified model all emphasize the importance of interaction in the process of information searching. While Belkin's (1993) model focuses on users' interaction with text, Saracevic's (1997a) model concentrates on the interplay among different levels of users and systems. All three models agree that information needs can be clarified and improved through a series of interactions (Xie, 2008).

Efthimiadis and Robertson (1989) categorized interaction at various stages in the information retrieval process. Bates (1990) presented four levels of interaction (move, tactic, stratagem, and strategy). Belkin and colleagues (1995) extensively explored user interaction within an information session. Lalmas and Ruthven (1999) distinguished between interactions that occur across sessions and those that occur within a session. Jansen and Spink (2005) considered an interaction as any specific exchange between the searcher and the system. The searcher may be multitasking (Spink, 2004) within a searching episode, or the episode may be an instance of the searcher engaged in successive searching (Lin, 2002; Spink, Wilson, Ellis, & Ford, 1998). Interaction also encompasses the concept of implicit feedback, which has been the basis of much effort in the information retrieval field (Jansen & McNeese, 2005; Joachims, 2002; Kelly & Teevan, 2003; Oard & Kim, 2001).

There is probably more agreement between the two fields concerning the concept of interaction than there is with any other theoretical construct.

We now shift to the intellectual perspective information searching and the technology theoretical orientation.

Technology–Information Searching Category

Preference of channel. A construct that appears in information searching research is the notion that people have preferred channels when searching for information. Channel is a mechanism through which a person can search, find, select, and receive information. Some of these channels are not even technology-based. Several information searching studies (cf. Peterson, Balasubramanian, & Bronnenberg, 1997) have indicated that depending on information need and other factors, including context, the person may go to different sources for information.

This construct is supported by a wealth of empirical work. For example, fact-finding tasks lead people to certain types of content (Gerstberger & Allen, 1968; Hertzum & Pejtersen, 2000) while process tasks take people to other sources (Milewski, 2007). Sometimes, people use a technology; other times, they use a person (McDonald & Ackerman, 1998). Some studies have tried to explain the decision to select one particular channel over another. It is a long-known trait in information science that people's preferred channel is usually another person who shares similar beliefs, values, educational level, and social status (D. Ellis & Haugan, 1997; Harris & Dewdney, 1994). Among the factors affecting this decision are accessibility (Fidel & Green, 2004; Gerstberger & Allen, 1968), trust (Hertzum, 2002), task complexity (Byström & Järvelin, 1995), and minimizing effort (Hardy, 1982). From an information searching perspective, understanding the preference for and use of channels is a key to addressing people's underlying information needs (Brown & Duguid, 2002).

The concept of channel preference is generally out of scope for the information retrieval field, although discussions and studies about aggregate search results do reflect the view

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of presenting information from multiple sources, including vertical or federated content collections.

Technology–Information Retrieval Category

Query. Although acknowledged as an inexact expression of the user's underlying information need, the query is the key construct for information retrieval (Callan & Croft, 1993; Croft, 1986; Croft & Thompson, 1987; Salton, 1983). Regardless of the possible nuances, implementation in information retrieval holds a systematic definition of a query (Korfhage, 1997). For information retrieval, a query is a set of one or more symbols that is combined with other syntax and used as a command for an information retrieval system to locate possibly relevant content indexed by that system. A symbol in a query can be word, phrase, group of words, sample document, example image, or many other possibilities.

The query is the basis of the general forms of information retrieval techniques, including Boolean, probabilistic, and vector space models. The query is the key element in information retrieval that affects result ranking, document clustering, and almost all key information retrieval areas (Baeza-Yates, Caldeŕon-Benavides, & Gonźalez, 2006; Callan & Croft, 1993; Croft, 1986; Salton & McGill, 1983). The query is especially a key construct in research areas such as query expansion, query reformulation, and relevance feedback techniques.

Information searching researchers also view the query as central to the information searching process, thus signifying considerable agreement between the two fields. However, for information searching researchers, the query holds a range of meanings from the expression of the information need in a compromised form to the actual underlying need itself. Taylor (1968), for example, discussed the limitations of the query in expressing the underlying information need. As such, similar to the construct of relevance, researchers must carefully consider how "query" is defined within a given study, particularly when comparing research across the two fields.

Neutrality of technology. The majority of research in information retrieval has focused on improving the performance of the technology, with little reference to the inherent biases of technology design decisions, although there is an acknowledgment of misrepresentation (Schrader, 1986) and adversarial information retrieval (Couvering, 2004; Fetterly, 2007).

In other fields, significant research has shown that technology can have detrimental effects. Postman (1993) warned that we tend to be "surrounded by the wondrous effects of machines and are encouraged to ignore the ideas embedded in them. Which means we become blind to the ideological meaning of our technologies" (p. 94). Fogg (2002) noted that technology can change the way that we think. As the power and ubiquity of the Web 2.0 infrastructure rises, it becomes increasingly difficult for users to recognize its externalities, taking the design of such tools simply "at interface value" (Turkle, 1995, p. 103). Similarly, several researchers have commented on the inherent biases of search engines (e.g., Goldman, 2006; Introna & Nissenbaum, 2000).

Information retrieval does not pay much attention to these unintended consequences (Merton, 1936) of technology decisions (Tenner, 1996). To our best knowledge, no information retrieval research has discussed the concept of technology biases extensively nor has it been a major research focus of the information searching field. Note, however, that only a limited number of studies in information searching have explored technology's unintended consequences (Fortunato, Flammini, Menczer, & Vespignani, 2008; Gerhart, 2004).

Memex vision. A thread that runs through information retrieval research is the optimistic reliance on the use of technology to leverage and make information available. This may be "the" most influential construct of information retrieval (cf. Landry & Rush, 1970, p. 358). The construct goes back to Bush's (1945) challenge to place the sum total of human knowledge at a person's fingertips. This mantra runs through literature in the information retrieval field, from the Memex to Google's mission of organizing the world's information, thus making it universally accessible and useful (http://www.google.com/corporate/).

One can say that the whole field of information retrieval research is deeply influenced by this technological imperative. Much of the early work in the field by Luhn, Moore, and others (as cited in Salton, 1987) has focused on leveraging the benefits of using technology, although with some dissent along the way (Blair & Maron, 1985). It has been shown that the use of technology has certain advantages for the individual (Conole & Dyke, 2004) and for society (Hart, 1992). There also is a similar element of technological determinism in the information searching field; however, it is less directly apparent. By nature though, both fields focus on the benefits of the use of technology, with little consideration of other options. As Rosenberg (1974) stated, the computer is not just a tool or machine but rather it is "a way of looking at the world" (p. 264) for these fields.

We now discuss the cross-cutting intellectual perspective for the technology theoretical orientation.

Technology–Cross-Cutting Category

Information obtainability. A construct that appears throughout the literature of both fields of information searching and information retrieval is the notion of information obtainability. That is, the more accessible the information, the more likely it is that people will use that information. As Pemberton (1989) explicitly stated, "The more difficult and time consuming it is for a customer to use an information system, the less likely it is that he [sic] will use that information system" (p. 46). Phrased more succinctly, *information will be used in direct proportion to how easy it is to obtain* (Summit, 1993). Bierbaum (1990) set forth this as a "unifying principle" for library and information science. T.D. Wilson (2008) stated that virtually every development in the field has been concerned with making it easier for the user to access documents or information.

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TABLE 2. Theoretical constructs of information searching and information retrieval with effect on collaboration between the two fields.

Construct	Effect on fields of information searching and information retrieval	Status
Multiple definitions of information	Central to information searching. Antithetical in information retrieval.	Static
Hierarchical relationship of information	Organizing framework for information searching. Given little attention in information retrieval.	Divergence
Perceived benefit of information	Organization and policy focus in information searching. Generally insignificant in information retrieval.	Divergence
Relevance	Universally held in both fields, although meanings differ.	Convergence
Information representation	One of the foundations for algorithmic research in information retrieval; a minor area in information searching.	Convergence
Information ranking	Key algorithmic area in information retrieval. Used as evaluation criteria in information searching.	Convergence
Document similarity	Central concept in information retrieval. Limited focus in information searching.	Static
Uncertainty principle	Central to many information search models. Information retrieval focuses on the expressions (or lack thereof) of this uncertainty.	Static
Principle of Least Effort	Well documented in information searching. Acknowledged in information retrieval, although its impact is difficult to determine.	Convergence
Searching is iterative	Accepted in information searching. Acknowledged in information retrieval, although the focus is on individual stages of the process.	Convergence
Interaction	Universally held in both fields.	Convergence
Information provision	A driving construct in information retrieval. Generally acknowledged in information searching, albeit with some notable caveats.	Divergence
Preference of channel	Acknowledged in information searching. Limited impact in information retrieval.	Convergence
Information obtainability	Universally held in both fields.	Convergence
Query	A generally systematic view in information retrieval; a more nuanced view in information searching.	Static
Neutrality of technology	Implicitly assumed in information retrieval; less so in information searching, but little research focus.	Static
Memex vision	The basis for the field of information retrieval. Accepted in information searching, but recognized as one of multiple possible mediums.	Static

The lines of research in both fields hone in on making information easier to access, in terms of interfaces, expression of need or query, contextual help, and information visualization. Although related to the Principle of Least Effort, the construct of information obtainability is focused on technology rather than people. It is especially germane to the field of information retrieval, with its focus on designing and developing system artifacts. Much work in information searching aims at improving the ease of access. Therefore, this construct is central to both fields.

Discussion and Implications

From an examination of these 17 constructs and their relationship to the fields of information searching and information retrieval, we can now reflect on the effects of these constructions on the relationship between these two associated disciplines. Specifically, we now discuss the effect of each theoretical construct on the relationship between the fields of information searching and information retrieval focusing on whether the two fields are in a status of *convergence*, *divergence*, or *static* relative to a particular given construct. For this research, we classify status as one of three states defined as:

- *Convergence:* tending to come closer relative to the given construct
- *Divergence:* evolving in different directions relative to the given construct
- *Static:* showing little, if any, change relative to the given construct.

Table 2 presents a recap of the tensions (i.e., divergence) and the compatibilities (i.e., convergence) existing between the two fields, along with areas of little movement (i.e., static). First, note that there are eight constructs central to both fields, for which the fields continue to have increasingly similar perspectives (i.e., there is convergence to some degree). The construct of *Information Obtainability* is commonly accepted by researchers in both fields, as is *Interaction* and the Principle of Least Effort. There appears to be a considerable amount of synergy between the fields concerning these constructs, and they appear to lie at the core of both fields. Both fields strive to make information easy to obtain (Information Obtainability), view interaction between system and user as essential (Interaction), and seem to accept that users will follow a pattern of sufficing (Principle of Least Effort). With these three constructs, there also is a similarly accepted viewpoint between the fields of what each means.

Four constructs (*Information Representation*, *Searching is Iterative*, *Preference of Channel*, and *Information Ranking*) also show increasing similarities between the fields, but the similarities are still somewhat nascent research streams. With Information Representation, we see a view of information as something that one can address via algorithmic methods, such as term frequencies in information retrieval, but also increasingly via various surrogates in information searching. An algorithmic view of information is just another

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manifestation of information searching researchers accepting information. Searching is Iterative and Preference of Channel are acknowledged tenets in information searching and are of increasing interest in information retrieval, with growing focus on more complex information retrieval processes, aggregated search results, and meta-search. With these three constructs, we see a more systematic view of information in the information searching field, along with more nuanced views of searching and users in the information retrieval field. This is apparent in the cross-cutting research areas of personalization, adaption, and use of implicit measures to improve searching performance. In addition, the Information Ranking construct has broad agreement within both fields, with subtle discussions concerning the process of ranking and its impact on the user.

Similarly, there is general convergence concerning the construct of *Relevance*, with both fields defining relevance as a relation between information need and information objects. However, relevance is an overloaded term, and the two fields have long been using it with a variety of meanings, either focusing on a cognitive concept (information searching) or an algorithmic notion (information retrieval). Recently, multimanifestations of the relevance construct, such as algorithmic relevance, topicality, pertinence, usefulness, and situational relevance, are increasingly recognized; furthermore, the complexity of relevance assessment is better understood among both information searching and information retrieval researchers.

There are six concepts where the fields are relatively stable. Two of these constructs (Neutrality of Technology and Memex Vision) are central and nearly universally accepted by researchers in both fields; in most cases, these constructs remain unquestioned in either field. These constructs seem to represent the core of both fields and are the foundational assumptions of a combined information searching and retrieval discipline. The construct of *Document Similarity* is critical to much information retrieval research while researchers in information searching have paid it little attention. Conversely, the Uncertainty Principle is fundamental in many information searching models. Information retrieval researchers also have given consideration to the uncertainty of the user, focusing on the uncertainty within algorithmic implementations. The *Multiple Definitions of Information* is a construct in which the fields hold diametrically opposing viewpoints, with little change by researchers from either field. Concerning the construct of Query, there is general agreement that the query is the primary expression, with some nuanced research in each field concerning its level of importance, impact, and implementation. Information searching researchers hold the query more as the cognitive expression of information need while information retrieval researchers view the query in a more mechanical way.

Finally, there are three constructs where we noted *divergence* between the fields (*Hierarchical Relationship of Information*, *Perceived Benefit of Information*, and *Information Provision*). With the Hierarchical Relationship of Information construct, the field of information searching increasingly has focused on higher order cognitive and affective aspects of information processing, such as learning and knowledge. Conversely, information retrieval has continued a concentrated focus on algorithmic improvements centered on information and sometimes data. Similarly, while information searching researchers have moved into areas of organizational, cultural, and social contexts affecting or moderating the benefits of information use, information retrieval researchers have paid little attention to social aspects of information use. If one extends information retrieval research into recommender systems, collaborative searching, and social media, there has been some progress in algorithmic approaches. A third divergence is evident in the construct of Information Provision. This construct drives much, if not all, information retrieval research, with efforts to index more relevant information through more diverse mediums to deliver more content to the user. Despite the intention to provide information that is precise, the general trend in the information retrieval research community is that if there is information, one can and should design a system to provide that information to a person; however, this concept has not been pursued actively in the field of information searching.

Implications

What do these constructs mean for the fields of information searching and information retrieval, and what is the impact of the interplay among them? Overall, the identification of these constructs can aid new as well as established researchers in understanding their field and its research directions. However, there are other specific implications. First, there are obvious tensions between fields based on competing underlying constructs. Tension between the information searching and information retrieval fields resulting from conflicting constructs may not be a problem. In fact, this tension is probably healthy because it yields fodder for research. Moreover, interesting problems, issues, and opportunities exist in the fields as they each make their own unique contributions. Second, the similarities between the fields with the cross-cutting constructs point to the opportunities for continued and increased collaboration between the fields. Indeed, many of the similarities between the fields are areas of increased research activity. Third, constructs that impact primarily only one of the fields may be an area where that field can make its own unique contribution. However, an understanding of the foundational elements at the core of each field is essential to the objective evaluation of the field's contribution and the perception of each field's goals and objectives. We believe that the presentation of these constructions is an important step in this direction.

There are limitations to the work presented here. First, this article has its own assumption, which is that all scientific fields have theoretical constructs at their core, and empirical research has one or more constructs (explicitly or implicitly) employed. This is a difficult position to prove, perhaps not surprisingly. Information searching and information retrieval are empirical fields; yet, they have consistent streams of research. Empirical observations must be repeatable to refute

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theoretical positions when these theories make incorrect predictions (Heylighen, 1999). From this line of reasoning, the only way that one can decide if different observations confirm or refute a result is from a theoretical conception of what the results should be (cf. Rosenberg, 1974). Therefore, we believe our assumption that the fields of information searching and information retrieval have central constructs is reasonable. In a second possible limitation, we have made little mention of information theory (Shannon, 1948), which may need some explanation. Although certainly a successful, widely cited, and implemented theoretical framework, we do not believe that it is an information searching or an information retrieval theory; instead, it offers a foundation for networking and computer science. Other information science researchers have arrived at similar conclusions (cf. Hjørland, 1998; Lynch, 1977). Third, in discussing two fields with historical roots dating directly to the post-World War II era, there are many exceptions and qualifications to any discussion of constructs, associated trends, and assumptions. Although we have attempted to highlight many of these exceptions, we could not address them all due to constraints of space and flow. Finally, the fields of information retrieval and information searching are not as tightly defined spaces as we present here; instead, they are porous, with many venues of research. However, we believe that our articulation captures the essence of these fields.

There are several strengths of our work. We did not approach the identification of constructions from solely an empirical perspective based on mentions or counts of some subset of information searching and information retrieval articles. For our research goal, we believe that such an approach has limitations in that it ignores multiple meanings of the same term, overlooks potential implicit constructs, and overemphasizes the explicitly mentioned theories. Drawing first on questions generated from our empirical work, we analyzed research streams encountered in publications from the fields' leading conferences (e.g., SIGIR and ASIST, among others) and journals (e.g., *Journal of the American Society for Information Science and Technology*, *Journal of Documentation*, *Information Processing & Management*, and *ACM Transactions on Information Systems*, among others), along with the themes that underlie streams of research in these fields. This often led to reviews of literature from other fields to highlight constructs so ingrained that they would not have appeared on any empirical evaluation of literature. We believe that such an analysis will aid in a greater understanding of each field's theoretical strengths and weaknesses as well as revealing the relationship between the two fields.

Conclusion

In this article, we characterized the theoretical constructs underlying two subfields of information science: information searching and information retrieval. In the course of the research, we identified 17 critical constructs that serve as foundations for most major theories, models, empirical studies, and research efforts. We defined each construct and reviewed its impact by comparing and contrasting the similarities and differences. Identification of theoretical constructs presented in a comprehensive framework can provide insight into the contribution of research within each field. For future work, further characterizing one or more of these constructs could contribute to broadening the implications of information searching and information retrieval research.

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