

## 1 Introduction

The Laboratory Model of Information Retrieval (IR) evaluation has its origins in the Cranfield II project (Cleverdon 1967). It is the paradigm of the Computer Science oriented IR research, seeking to develop ever better IR algorithms and systems. In recent years, the TREC conferences (Voorhees and Harman 2000) have been the major forum for research based on the Laboratory Model – Fig. 1.1. An essential component in evaluation based on the Model is a test collection consisting of a document database, a set of fairly well defined topical requests, and a set of (typically binary) relevance assessments identifying the documents that are topically relevant to each request. IR algorithms are evaluated for their ability of finding the relevant documents. The test results are typically expressed in terms of average recall and precision, and recall-precision curves for each algorithm.

The Laboratory Model has recently been challenged by progress in research related to *relevance* and *information seeking* as well as by the growing need for accounting for interaction or human involvement in evaluation. Recent work in analyzing the concept of relevance has resulted in identifying higher order relevances, such as cognitive relevance and situational relevance, in addition to algorithmic and topical relevance (Borlund 2000b; Cosijn and Ingwersen 2000; Saracevic 1996; Schamber et al. 1990). Real human users of IR systems introduce non-binary, subjective and dynamic relevance judgments into IR processes, which affect the processes directly.

Recent theoretical and empirical work in Information Seeking and Retrieval (IS&R for short; Belkin 1993; Byström and Järvelin 1995; Ellis and Haugan 1997; Ingwersen 1996; Kuhlthau 1993a; Schamber 1994; Vakkari 2001a; Wilson 1999) suggests that IR is but one means of information seeking which takes place in a context determined by, e.g., a person's task, its phase, and situation. For larger tasks one may identify multiple stages, strategies, tactics or modes of information access, and dynamic relevance. IR strategies, tactics and relevance assessments are affected by the stages of task performance. Also some user-oriented research in IR, e.g., by Bates (1989; 1990), points out the variety of strategies people might use in information access, topical retrieval being only one.

Because of these empirical findings and theoretical arguments, the traditional Laboratory Model of IR evaluation has been challenged for its (lack of) realism. There are proposals (Borlund 2000a) concerning how IR evaluation should be done validly under these circumstances – realistically and at the same time retaining as much control as possible. There also is empirical work (e.g., Vakkari 2001a) tracing interactive information seeking and IR processes and providing models and methods for the analysis of IS&R. Developers of IR algorithms should therefore consider how the algorithms are to be evaluated – in which frameworks and how guaranteeing validity.

This book reviews the literature in IS&R, discusses the developments of the respective research areas and proposes an extended *cognitive viewpoint* to integrate the results and further work in these areas. We believe that research in IS&R needs new models to formulate its research programs and methodology. Our proposal is based on understanding the situational nature of information and on assuming persons' work tasks or cultural interests, and information needs based on them, as the basis for IS&R.

We begin this chapter by introducing the Laboratory Model of IR evaluation, its criticism and defense as a starting point for exploring broader approaches to research within IS&R (Sects. 1.2 - 1.4). We then follow by discussing some basic principles for designing models for the IS&R research area. Finally, we close the chapter by presenting an overview of the book's contents (Sect. 1.6) and definitions of some central concepts used in the book (Sect. 1.7).

## 1.1 Motivation and Intention

Research in Information Seeking and Information Retrieval constitute two disparate research areas or camps. Generally, Information Seeking is rooted in Social Science with a background in Library Science whereas much of IR is based on Computer Science approaches. The two camps do not communicate much with each other and it is safe to say, that one camp generally views the other as too narrowly bound with technology whereas the other regards the former as an unusable academic exercise. Ingwersen (1996, p. 13) notes, that "the two predominant research communities do not really explore the ideas, methods and results of each other". We believe that both research areas can be, and should be, extended to capture more of each other and of context. Therefore this book seeks to integrate Information Seeking and Information Retrieval into IS&R.

The goals of a research are may be classified as (a) theoretically understanding the phenomena of the domain of interest, (b) empirically describing and explaining (predicting) phenomena in the domain of interest, and (c) supporting the development of technology – in the broad sense, covering both tools, systems and social practices – in the domain of interest. Much of research in IS&R is applied, driven by a technological interest of developing new tools, systems and/or social practices. However, the applied technological interest is blind if the theoretical and empirical goals are not met.

For example, user studies of the 1970s in Library and Information Science were heavily criticized for blindness for other means of information access people actually use. However, it is still blind to study plain (documentary) information seeking without a work task (or leisure interest) context, a look into information use / generation, and the modern tools supporting this. Likewise, Laboratory IR research has been criticized for its lack of realism. Indeed, it is also blind to develop IR engines for artificial search tasks (topics) without a look into how people seek information and use various tools – without a look into the use context of the engines. Therefore Information Seeking and Information Retrieval research need each other – and an understanding of their context.

To us it seems prohibitive for the development of IR research if the IR community continues to consider the Laboratory Model in isolation of context. The present monograph attempts to provide perspectives from/to context by presenting a research framework that incorporates contextual components, situational factors as well as the traditional search engine and document based approaches. It broadens the scope of IR research towards searcher and task contexts at the same time as demonstrating to information seeking research how to extend its perspective towards both tasks and technology.

A cognitive turn took place in IR in early 1990s. In connection with the OKAPI project and the initiation of the large-scale TREC experiments on IR, Robertson and Hancock-Beaulieu (1992) see the turn to consist of three facets (or revolutions) that are crucial to understand in order to proceed towards a more integrated (holistic) theory of IR: the cognitive; the relevance; and the interactive revolutions. The cognitive and interactive revolutions combined entail the ideas that personal information needs ought to be treated as potentially dynamic, not static, and hence may change over time – probably due to learning and *cognition* in context during IR interaction. Relevance assessments hence also become dynamic and may take place in a variety of dimensions, so that the traditional topicality as a measure of relevance does not stand-alone. It becomes enhanced with the influence of the situational context into situational relevance, i.e., the usefulness of information objects to the user's situation. According to Robertson and Beaulieu the interactive revolution itself points to the fact that (even experimental) IR systems have become increasingly interactive, due to actual application of dynamic relevance feedback and other query modification techniques by searchers over session time. This calls for a new kind of experimental *realism* in evaluative IR research as well as in Information Science in general. The revolutions combined can thus be seen as a real challenge to the various research groupings making up the IR and seeking communities.

The present monograph is based on the cognitive viewpoint developed since the late 1970s (see Chapt. 2 for more details). However, also the cognitive viewpoint has been heavily criticized in the Information Seeking literature as asocial and individualistic – not meeting the standard of modern Social Science understanding of human behavior. In this monograph we seek to take this criticism into account and extend the cognitive viewpoint to cover both technological, human behavioral and cooperative aspects in a coherent way. Ingwersen (1996, p. 13) notes that there exists in the IS&R literature "an inherent and silent agreement

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that information behavior, seeking and retrieval mainly take place among academics". We aim at integrating research on academic, professional and other (leisure, cultural) information access within the same theoretical approach.

Intermediate sections are omitted.

## 1.6 The Structure of the Book

Chapt. 2 presents our Cognitive Framework for Information. We review the development of the epistemological Cognitive Viewpoint and discuss the Cognitive Information Concept for IS&R in relation to processes of information interaction. The focus of the cognitive viewpoint applied to interactive IR has shifted from quite an individualistic and user-driven approach to information transfer during the 80s to a holistic perception in the 90s. All actors participating in IS&R are viewed as contributors in the process via their cognitive states as represented by information objects, database structures, indexing structures and retrieval algorithms, interface designs, human work task perceptions and request representations, etc. Each representation is regarded situated in a context, predominantly of social, cultural or emotional nature. The chapter introduces a principle of complementary social and cognitive influence on the acts of interpretation. A second dimension of the view is the emphasis of the different levels of information processing that humans and computers can perform, also during interaction. This leads to a conditional cognitive information conception with strong elements of intentionality. The cognitive conception is used as a vehicle for understanding human-computer interaction, automatic indexing viewed as the Chinese Room Case (Searle 1984b), and how meaning of messages is lost at sign level and reconstructed during communication and interpretation.

Chapt. 2 also discusses alternative information conceptions. The conditions of the cognitive information conception make a workable framework for understanding the consequences of alternative conceptions. Historically, the information concept was first situated in the technology and system or in the documents stored in systems; over time the conceptions move towards the user, the information seeker's work situation and knowledge state - and towards a social and cultural context. The relationships between information and meaning are discussed. Finally, the chapter views information acquisition as fundamental to IS&R and analyses three cases: To acquire information from (Japanese) signs, unknown to the seeker; to become informed by sensory data in daily-life situations; and information acquisition during scientific discovery.

Chapt. 3 discusses the development of Information Seeking Research from about 1960 to about 2000. The sixties were the time when the information seeking research expanded. A major event boosting information seeking research was the 1958 Conference on Scientific Information. In 1977 Wilson and Streatfield moved the research into the working place. The year 1986 brought the landmark review publication in the Annual Review of Information Science and Technology (ARIST) by Dervin and Nilan (1986) which signifies the start of the new user-oriented (or actor-oriented) approach to information seeking. Several user-centered approaches to information seeking developed. Among the major ones were Dervin's Sense-Making Approach, Ellis' (1989; et al. 1993) behavioral model of information seeking strategies, and Kuhlthau's Information Seeking Process Model (1991; 1993a). All these approaches also provided empirical findings. The chapter also looks into conceptual development and research methodologies in information seeking research, as well as the current limitations and open problems exposed by the literature.

Chapt. 4 discusses the development of systems-oriented IR research 1960 - 2000. Several major mathematical retrieval models were developed and the paradigm of laboratory-based evaluation developed. The experiments based on best-match IR methods were carried out originally in small test collections but become extended to large collections. On the practical/industry side, the online IR industry developed systems utilizing Boolean logic that provided global access to large bibliographic and later full-text and web collections. Chapt. 4 begins by a discussion of laboratory-oriented IR models. This is followed by a discussion of issues and findings in the systems-oriented IR research regarding (1) documents, requests, and relevance, (2) indexing, classification and clustering, (3) interfaces and visualization, (4) interaction and

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query modification, (5) natural language processing, as well as (5) expert systems and interfaces for IR. We focus on research relevant for the cognitive viewpoint. Therefore we bypass much research that is otherwise important to IR. The chapter closes by a discussion of research methods in IR, mainly IR evaluation, and limitations and open problems in contemporary IR research.

Chapt. 5 discusses the development of user-oriented and cognitive IR research 1960 to about 2000. The rise of the online IR industry created user communities. This resulted in the development of the user-oriented IR approach, focusing on intermediaries and later end-users of commercial Boolean IR systems. The Cognitive Approach started in the late 1970's with the aim of understanding human information (retrieval) behavior and bridging the two former approaches. We shall first review some central models of user-oriented and cognitive IR research. Then we discuss issues and findings in (1) cognitive theory building and poly-representation, (2) searchers' cognitive styles, (3) standard online interaction, (4) web IR interaction, (5) searcher-associated best match IR interaction, and (6) relevance. At the end of the section we shall review research methods in user-oriented and cognitive IR before finally considering the limitations and open problems of this research area. The development of expert systems for IR made researchers in both systems and cognitive-oriented approaches to collaborate. These issues are discussed in both Chapt. 4 and 5.

Chapt. 6 proposes our integrated framework for IS&R, based on the cognitive view. We discuss requirements for such models, and its major components: tasks, contexts, situations, and seeking and retrieval processes/tools. We also demonstrate the applicability of the framework from the viewpoint of several partakers of IR processes. Secondly, the complexity of IR processes is discussed. Issues related to information seekers, their situations, work and search tasks, task complexity, knowledge types, and interaction are among others brought forward. The chapter closes with a summary of the characteristics of the proposed framework.

In Chapt. 7 we consider the implications of the proposed cognitive framework in the design and evaluation of IS&R. Discussing 9 broad dimensions: the natural work task and organization dimensions, the perceived work and search task dimensions, the actor dimension, the document dimension, the algorithmic search engine dimension, the algorithmic interface dimension, and the access and interaction dimension, we propose two action lines as needed. On the one hand, IR research needs to be extended to capture more context but without totally sacrificing the laboratory experimentation approach – the controlled experiments. Only by this line of action one may approach real *IR engineering*. On the other hand, current information seeking research needs to be extended both toward the task context *and* the technology. Figuratively, the two action lines induce a space for IS&R research to explore and so far, as we argue: only a small part of that space has been investigated.

Chapt. 8 proposes a research program for further research in IS&R. It analyzes four distinct research setups in detail as avenues for extending current research IS&R toward capturing more context.

Chapt. 9 is the conclusion of the book followed by a list of definitions for concepts used, an integrated list of references and an index.