Patterns between interactive intentions and information-seeking strategies

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Abstract

In order to design information retrieval (IR) systems to support various information-seeking strategies across a variety of contexts, it is important to explore what leads to the selection of different types of information-seeking strategies. This study addresses the issue by investigating the relationships between users' information-seeking goals and their information-seeking behaviors. The particular focus of this study is to specify hierarchical levels of user goals, and to investigate the micro-level goal labeled "interactive intention" in relation to information-seeking strategies. A total of 40 users from four types of libraries were selected for this study, and the analysis illustrates how changes in interactive intentions are associated with changes of information-seeking strategies. The results present how eight types of interactive intentions, four types of entities, eight types of methods, and six types of resources constitute the patterns of interactive intentions and information-seeking strategies. The implications for IR system design are further discussed. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: User goal; Interactive intention; Information-seeking strategy; Pattern; Information retrieval; Information retrieval system

1. Introduction

It is essential to design information retrieval (IR) systems to support various information-seeking strategies across a variety of task environments, situations and contexts. Researchers have investigated information-seeking strategies from different levels, and identified tactics, moves, patterns, strategies and even developed models. However, it is impossible to implement all the information-seeking strategies into one system without knowing under what circumstances each

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strategy is employed. In order to support a variety of information-seeking strategies, we need to further investigate the information-seeking strategies of users to characterize them, and moreover, to identify what leads to the selection of information-seeking strategies across contexts.

User goals have been theoretically identified and empirically verified as important elements in defining the nature of information retrieval. This study attempts to understand the multiple information-seeking strategies users engaged within an information-seeking episode by investigating the relationships between users' information-seeking goals and their information-seeking strategies. The particular focus of this study is on the in-depth investigation of one micro-level – "interactive intention" in relation to information-seeking strategies. To be more specific, this study was designed to address the following question: what are *the relationships* between users' interactive intentions and their information-seeking strategies (intention-based strategies)?

2. Theoretical framework

2.1. Model of interactive information retrieval

In order to identify the relationships between user goals and information-seeking strategies, we have to first define user goals and intentions. Adapted from Daniels' (1986) classification of goals, for this study the author reconstructed user goals into four levels of hierarchical structure:
1. Long-term goal refers to a user's personal goal that he or she pursues for quite a long time, e.g., professional achievement, personal interest, etc.
2. Leading search goal refers to a user's current task-related goal that leads to a search, e.g., writing a paper, preparing for a class, etc.
3. Current search goal refers to what specific search results a user intends to obtain, e.g., looking for a model, looking for a specific book, etc.
4. Interactive intention refers to sub-goals that a user has to achieve in the process of accomplishing his or her current search goal, and will be discussed in Section 4.

This structure clearly connects user goals to the related task and information problem, and imposes the goal structure of these levels, that is, high levels of goals have effects on low-level goals. Task and goal are inseparable in the information-seeking process. Tasks, which are leading search goals, determine current search goals. They control both the kind of search results a user tries to obtain, and the means to obtain them. At the same time, leading search goals are influenced by long-term goals, and they have an impact on what kind of tasks a user is going to work on and how to accomplish these tasks. Moreover, this structure further investigates the micro-level of user goals – interactive intentions, which are the sub-goals that a user has to achieve in order to accomplish his or her current search goals.

Levels of user goals and their representations clearly define interactive intentions. However, the relationships between interactive intentions and information-seeking strategies cannot be identified without examining how interactive intentions and information-seeking strategies are generated in the information retrieval process. In a recently published paper, Xie (2000) proposed the model of interactive information retrieval (Fig. 1) by integrating three types of theoretical works: (1) the nature of IR and IR interaction (Ingwersen, 1992; Belkin, 1996; Saracevic, 1996), (2) the plan model and situated action (Newell & Simon, 1972; Suchman, 1987; Vera & Simon, 1993;
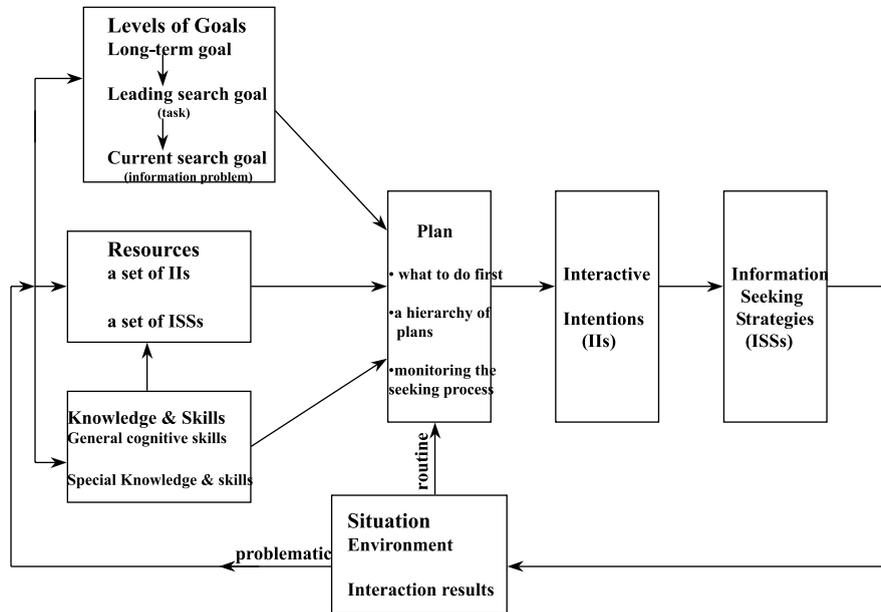
Fig. 1. Model of interactive information retrieval.

Hert, 1996), and (3) user goal and information-seeking behavior (Belkin, Marchetti, & Cool, 1993; Chang, 1995). This model specifies levels of user goals and their representations, and it demonstrates that interactive intentions and information-seeking strategies are the products of plans and situations. Additionally, it illustrates how users shift their interactive intentions and information-seeking strategies during the information-seeking process. The model of interactive information retrieval enables this study to further identify the relationships between interactive intentions and information-seeking strategies. Simultaneously, further clarifications of the relationships between user goals and information-seeking strategies are needed to understand the nature of interactive information retrieval.

2.2. Previous studies on information-seeking strategies

Researchers have examined information-seeking strategies from different levels. Tactics and moves represent information-seeking choices and actions in the information-seeking sub-processes, while information-seeking strategies highlight the most frequently employed approaches in the information-seeking process. Information-seeking model and patterns attempt to connect information-seeking strategies to the stages of information-seeking process.

In her classic work, Bates (1979a,b) specified and grouped a set of 29 **information tactics** into the following four categories: monitoring tactics, file structure tactics, search formulation tactics, and term tactics. Shute and Smith (1993) discovered 13 **knowledge-based search tactics** in relation to broadening topic scope, narrowing topic scope and changing topic scope. By observing and analyzing online searches, Fidel (1985) identified a list of **moves** that modify query formulations. Among them, 18 operational moves keep the meaning of query components unchanged, and 12

conceptual moves change the meaning of query components. Studies of tactics and moves characterize users' search process in the micro-level, but they only concentrate on one dimension of that level. Bates (1990) further expanded tactics and moves into "**stratagem**" which is a complex of number of moves and/or tactics, and involving both information domains and the modes of seeking.

Focusing more on online search, Markey and Atherton (1978) analyzed users' **online search strategies**, and identified five basic types: building block, pearl-growing, successive-fractions, most-specific-facet-first, and lowest-postings-facet-first. Hawkins and Wagers (1982) labeled a frequently used **strategy** as "interactive scanning" which requires more user interaction with the system and information based on online bibliographic study. After investigating the cognitive processes of users, Chen and Dhar (1991) found five types of **strategies** employed by users: the known-item instantiation strategy, the search-option heuristic strategy, the thesaurus-browsing strategy, the screen-browsing strategy, and the trial-and-error-strategy. Marchionini (1995) classified **information-seeking strategies** into two high levels of categories: analytical and browsing strategies. Analytic strategies are more goal-oriented and systematic while browsing strategies are more informal and interactive. Studies of information seeking strategies illustrate the information-seeking process and emphasize the high level of information-seeking approaches that users take, but they fail to answer how appropriate information-seeking strategies are selected under different situations.

Ellis (1989) developed a behavioral model of the **information-seeking patterns** of academic social scientists. He suggested that "if researchers' information-seeking behaviors are broken down into their basic behavioral characteristics – and the retrieval system is provided with facilities that reflect those characteristics – then users should be able to recreate their own information-seeking patterns while interacting with the system (p. 172)". Ellis and Haugan (1997) also identified the information-seeking patterns of engineers and research scientists in relation to their research activities in different phases and types of project. They further related the stage of the research process to certain information-seeking patterns. Kuhlthau (1991) developed a **model** of the information search process based on a series of studies of users in information-seeking situations. Six stages of information **search process** were identified with associated **actions** common to each stage. Studies of patterns and models of information seeking begin to explore what determines the information-seeking behavior, but are limited to identifications of the relationships between stages of the research or search process and their corresponding information-seeking strategies.

The above studies identify tactics, moves, stratagem, search strategies, patterns, and also develop models. These studies have contributed greatly to the understanding of information-seeking strategies. This research builds upon these earlier findings. However, most of the studies on information-seeking strategies focus on what strategies users apply in the information-seeking process, and are limited to the exploration of one dimension of information-seeking strategies. They only answer the first part of the question: what kinds of information-seeking strategies are employed by users. Further research is needed to investigate under what circumstances these search strategies are applied, and to characterize information-seeking strategies in multi-dimensions.

Generally speaking, because these strategies are highly interactive, it is difficult to identify relations between actions in the information-seeking process. Therefore, it is difficult to predict users' information-seeking strategy use. Hoppe and Schiele (1992) pointed out that highly

interactive, flexible and underdetermined strategies only impose weak constraints on the relation between the actions in a sequence, therefore, it is difficult to generate help and advice from them. However, if we can identify relations between information-seeking behaviors and goals and/or sub-goals of users, it will be easier for an IR system to predict and suggest appropriate strategies for users to solve their information problems.

2.3. User goals – essential in defining user information-seeking behavior and incorporating into IR system design

User goals and intentions have been theoretically identified as important factors in defining information-seeking behavior. In most of the literature, user goals are defined as the kind of search results a user intends to obtain. User intentions are either used as the synonyms of user goals, or as sub-goals that a user has to achieve in the process of accomplishing his or her current search goal.

Research in the area of information retrieval generally explores user goals, user information needs, and user information problems. Saracevic (1983) studied the structure and nature of requests in information retrieval based on the ASK concept, and identified five basic elements in information seeking in which user intent was one of the essential elements. Adapting Saracevic's model, Shenouda (1990) defined the variables related to the problematic situation which affect a user's information-seeking behavior, and one of the most important variables was a user's objective (goal) with regard to the use of potential search results. Belkin et al. (1993) proposed an information-seeking behavior model based on the space of information-seeking strategies. According to them, information-seeking strategies arise from Wersig's (1979) problematic situation. The characteristics of the problematic situation, especially a user's state of knowledge and information-seeking goals, affect information-seeking strategies. Hert (1996) suggested that understanding these goals and their roles in the IR process could provide an insight into retrieval strategies and general system design. Her study of user goals and interactions in searching an online public access catalog (OPAC) further proves it.

Based on the above analysis, we can conclude that user goals and intentions have been theoretically identified as important factors affecting a user's information-seeking behavior. Simultaneously, research and studies verify that user goals and intentions should be incorporated into IR system design to guide effective information retrieval.

Belkin et al. (1991) described four information system user interface projects in progress. Each project demonstrates a somewhat different approach to interface design, but all share the commonality of responding to user goals, tasks and characteristics. They suggested that design of information systems, including their interfaces, should be based on a multi-level analysis of user goals, tasks and domain views. After successfully designing a new OPAC system called The Book House, Pejtersen (1993) claimed that OPAC systems would only be really useful when end-user intentions and needs were matched and when the search strategies of users were matched.

User goals and intentions are often implemented in the design of functionalities for query formulation and query expansion. Based on a conceptual model for user-guided knowledge discovery, Chen and Zhu (1998) explored one approach to incorporate user intentions to solve the query formulation problem. As a result, a user could start from the highest-level goal and refine queries with the assistance of an incrementally constructed causal network. After the evaluation of

automatic query expansion in an online library catalog, the findings showed that user intentions were identified as one of the main factors affecting the take-up of the query expansion facility (Hancock-Beaulieu, 1992).

In order to incorporate user goals into IR system design, we need to investigate the pattern between user goals, especially user intentions, and information-seeking strategies.

3. Methodology

3.1. Sampling and data collection

Forty cases were selected for this study from the 150 cases collected in the research project "Taking Account of User Tasks, Goals and Behavior for the Design of Online Public Access Catalogs" led by Professor N.J. Belkin and Professor T. Saracevic from the Rutgers University (Belkin, Chang, Downs, Saracevic, & Zhao, 1990). Ten cases each were randomly chosen from four types of libraries, one academic library of science and medicine, one academic library of social sciences and humanities, one public library and one special library, to represent a variety of users and their library uses for this study.

Multiple methods were used to collect the data: questionnaire survey, semi-structured interview, transaction logs, and unobtrusive observations. In each library, researchers approached patrons as they entered the library and asked them their purposes in coming to the library. If their activities were related to the use of library materials, they were asked to participate in the project. These participants were real users with real problems, and they came to the library to use the library to solve their own problems. The data collection procedures were:

1. First, the subjects were interviewed briefly and also asked to complete a questionnaire regarding the purposes of their library visits, types of information being sought for, and the projected uses of library catalogs.
2. Then, the transaction log recorded the users' complete search sessions if they used OPAC.
3. After this, the investigators observed all users' subsequent information-seeking behaviors in the library.
4. Immediately after their search sessions, the subjects were first interviewed to verify their information-seeking behaviors and then asked to comment on their interactive intentions and corresponding information-seeking activities in the library. The transaction logs and observation data served as stimuli for the interviews.

The transaction logs and observation data were the basis for the interviews. The interviewers always started with describing data obtained from the transaction log or observation data, and then asked the subjects about their intentions behind each information-seeking activity. Open-ended interviews recorded how the transaction logs and observation data played roles in the verifications of users' information-seeking behaviors, and allowed investigators to inquire about the intentions of every move. For example, "I saw you entered a particular subject (describing data from the transaction log), what was your intent there?" or "I saw you browsed that area, selected a book, you looked at the jacket of the book, and then you kept it (describing data from the observation data). What were your intentions at that point?" Most importantly, the data set tracked user intentions behind every move within an information-seeking episode. The

information-seeking activities and associated intentions recorded are the keys to investigate the research question.

3.2. Data analysis

In order to address the research problem, Strauss and Corbin's (1990) open coding was introduced to analyze the data to identify concepts and develop categories. It is the process of breaking down, examining, comparing, conceptualizing, and categorizing. Furthermore, "process" was brought into the analysis to determine the relationship among these categories. The unit of analysis was each information-seeking activity of a user and its associated interactive intention within an information-seeking episode.

3.2.1. Coding category identification

In the process of data analysis, four types of coding categories emerged from the analysis of 40 representative cases. The coding procedures are as follows:
1. developing coding categories of leading search goals;
2. developing coding categories of current search goals;
3. developing coding categories of interactive intentions;
4. developing coding categories of information-seeking strategies.
As leading search goals and current search goals are not the focus of this paper, the author concentrates on the discussion of the development of coding categories of interactive intentions and information-seeking strategies.

Interactive intentions refer to sub-goals that a user has to achieve in the process of accomplishing his or her current search goal. Eight categories of interactive intentions were developed based on the transcripts of the interviews and supplemented with data from the observation data and transaction logs. Each interactive intention was embedded in the answer to the interviewer's question: what did you intend to do here?" These answers with corresponding observation data or transaction logs were identified and analyzed. Categories were developed by making comparisons. Similar answers were grouped into one category and sub-category based on their properties. If users combined several interactive intentions together, each interactive intention was coded separately.

For example, evaluating refers to assessing: (a) correctness of an item(s), (b) specificity of an item, (c) usefulness of an item(s), (d) fitness of an item(s), or (e) duplication of an item(s). As "evaluating" is to make sure that different types of "finding" intentions are satisfied, "evaluating" is highly correlated to "finding". "Checking", "double checking" and "making sure" are the alternative terms for "evaluating".

"Evaluating correctness of an item(s)" is often a follow-up of "finding a known item(s)" to make sure the item is the one a user is looking for. "Evaluating specificity of an item(s)" is normally related to "finding specific information", and it double-checks whether the item has the specific information a user is looking for. "Evaluating usefulness of an item(s)" is more related to "finding items with common characteristics", and "finding items without pre-defined criteria" is to check whether each item is worth keeping. Examples of this intention are to determine whether the book/article covers the topics of interest, whether the item has enough details, and whether the

item is interesting to read, etc. However, users do not always stop after evaluating each of the items, sometimes, they have to further choose one or several items from all the useful ones. "Evaluating the fitness of an item(s)" is to pick up the best item(s) from a group of items based upon certain criteria. Additionally, in the evaluating process, users have to check whether an item is a duplicate of another one when they suspect they have read or used it before, and that is "evaluating duplication of an item(s)". The operational definitions of categories and sub-categories of interactive intentions with examples are discussed in Section 4.

Categories of **information-seeking strategies** were developed based on the transaction logs, observation data and transcripts of interview. The observation data and transaction log recorded every activity of a subject, and the transcript of an interview verified and clarified the data of information-seeking activities. Information-seeking behaviors were first identified and analyzed for each activity. Methods and resources emerged as two dimensions of information-seeking strategies. Similar methods and resources were compared and analyzed to develop categories of methods and resources. Types of information-seeking strategies of different combinations of methods and resources were identified from the data. For example, scanning refers to looking through an item or a series of items, flipping through, etc. Meta-information is information about information. Examples of meta-information are citations in OPAC, citations in secondary resource, table of contents in a book or a journal, index of a newspaper, descriptors of an item, signs and floor plan in the library, etc. The operational definitions of types of methods, resources and information-seeking strategies with examples are presented in Section 4.

3.2.2. Relationships identification

In order to identify the relationships between interactive intentions and information-seeking strategies, for each subject, every interactive intention and its associated information-seeking activity were recorded and marked within an information-seeking episode. Patterns between interactive intentions and information-seeking strategies were identified through the following procedures:

1. list each type of interactive intention;
2. identify all the information-seeking strategies corresponding with each type of interactive intention;
3. identify the most frequently occurring information-seeking strategies for each type of interactive intention via descriptive analysis.

Eight types of interactive intentions and their corresponding information-seeking strategies are discussed in detail in Section 4.

To test the reliability of the above coding categories and their relationships, two judges randomly selected and coded 8 (two from each of the four libraries) of the 40 cases independently based upon the coding scheme with examples. The inter-coder reliability was 0.91 according to Holsti's (1969) reliability formula. [1] The high degree of reliability demonstrates the credibility of this study.

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[1] Reliability $= 2M/(N1 + N2)$, where M is the number of coding decisions on which two coders agree, and $N1$ and $N2$ refer to the total number of coding decisions by the first and second coder, respectively.

4. Results

Based on the analysis of 40 cases, results are presented in the following sections: (1) types of interactive intentions, (2) types of information-seeking strategies, and (3) patterns between interactive intentions and information-seeking strategies.

4.1. Types of interactive intentions

Even though users have different leading search goals and current search goals, they share similar interactive intentions in the information-seeking process. Eight categories and sub-categories of interactive intentions emerged from the data. Table 1 presents types of interactive intentions with definitions and examples. Empirical examples of eight categories of interactive intentions are presented in Section 4.3 "Patterns between interactive intentions and information-seeking strategies".

Interactive intentions can be further defined by their entity. As part of interactive intentions, entity refers to types of information or information objects users intend to acquire or work on. Table 2 presents types of entities with definitions and examples. Eight types of interactive intentions can be characterized based upon four types of entities. Fig. 2 presents dimensions of interactive intentions with examples.

4.2. Types of information-seeking strategies

In this study, the author tries to characterize information-seeking strategies that users engage in to achieve their interactive intentions. Methods and resources emerged as the two dimensions that constitute information-seeking strategies. Methods refer to the techniques users apply to interact with information, information objects, and humans, and they are scanning, searching, tracking, selecting, comparing, acquiring, consulting and trial and error. Table 3 presents the types of methods with definitions and examples. Resources are information, information objects, and humans with whom users interact, which include meta-information, part of an item/specific information, a whole item, a series of items/one location, one system/multiple databases, and a human. Table 4 presents the types of resources with definitions and examples. The integration and combination of these two dimensions represents a variety of information-seeking strategies employed by users.

Methods and resources are two dimensions of information-seeking strategies. Different types of information-seeking strategies employ different combinations of methods and resources. Fig. 3 presents the dimensions of information-seeking strategies and examples of the information-seeking strategies. These dimensions of information-seeking strategies are further discussed with dimensions of interactive intentions by applying real examples from the data in Section 4.3.

4.3. Patterns between interactive intentions and associated information-seeking strategies

Belkin et al. (1993) proposed a multi-faceted classification of information-seeking strategies based on four "behavioral" dimensions which constitute the goal of interaction, method of interaction, mode of retrieval and type of resource interacted with. They suggested that this could

Table 1
Types of interactive intention

Types of interactive intentions	Definition	Examples of interactive intentions
Identify Identify something to get started (A) Identify something more to search (B)	Identify information as search leads at the beginning or in the middle of information seeking process	Identifying a reference to get started (A) Look for more information to search (B)
Learn Learn system feature (A) Learn system structure (B) Learn domain knowledge (C) Learn database content (D)	Gain knowledge of system features, system structure, domain knowledge and database content	Learn how to go back to the index in OPAC (A) Figure out the floor plan of a library (B) Learn synonyms of a specific term (C) Know about the coverage of a database area (D)
Find Find a known item (A) Find specific information (B) Find items with common characteristics (C) Find items without pre-defined criteria (D)	Look for information/item(s)	Look for an item that a user knows the title (A) Look for the stock quotes of a company (B) Find items on a same topic (C) Find something that might hold one's interest (D)
Locate Locate a specific item (A) Locate items with common characteristics (B) Locate an area/location (C)	Find out where a specific item is placed	Track down a specific journal (A) Find out the location of items on a specific topic (B) Find out where is the reference desk (C)
Keep record Keep record of bibliographical information	Keep record of the bibliographic information of an item(s) before accessing it	Keep record of the call number of an item
Access Access a specific item (A) Access items with common characteristics (B) Access an area/location (C)	Get access to an item(s) based upon the location of an item(s)	Go to a specific shelf to get a specific item (A) Go to the fiction area to get some fictions (B) Go to the circulation desk (C)
Evaluate Evaluate correctness of an item (A) Evaluate specificity of an item (B)	Assess the correctness of an item(s), specificity of an item, usefulness an item(s), fitness of an item or duplication of an item(s). Evaluating is to make sure different types of "finding" intentions are satisfied	Make sure an item is the one a user is looking for (A) Double check whether the item has the specific information a user is looking for (B)

Table 1 (Continued)

Types of interactive intentions	Definition	Examples of interactive intentions
Evaluate usefulness of an item(C)	Check whether each item is worth keeping (C)	Evaluate fitness of an item (D)
Pick up the best item(s) from all the useful ones (D)	Evaluate duplication of an item (E)	Check whether an item is a duplicate of another one that was read or used before (E)
Obtain Obtain specific information (A)	Take hold of specific information, part of the item, or a whole item(s)	Write down the stock quote of a company (A)
Obtain part of the item (B)		Copy several pages of an article (B)
Obtain a whole item(s) (C)		Check out a video tape (C)

Table 2
Types of entity

Types	Definitions	Examples
Specific	Specific information or a specific object	A picture, a system feature, a synonym, a citation, etc.
Common	Information or information objects with similar characteristics	A topic, a format, a method, an author's works, etc.
Area/location	A defined area/location of an item or in the library	Preface of a book, back of a bound journal, non-fiction area, reference desk, etc.
General	General knowledge on something or something without pre-defined criteria	Content of a database, general knowledge of a system structure, something holding one's interest, something to satisfy one's curiosity, etc.

represent a space of possible information-seeking strategies within an information-seeking episode. Chang (1995) focused on one type of information-seeking strategy – browsing, and further identified the underlying common dimensions of browsing: scanning, resource, goal, and object. Based on these four dimensions, she classified five themes and nine patterns of browsing.

The above studies of dimensions of information-seeking strategies have considered user sub-goal as one of the dimensions, but do not further explore the relationships between user goal and other dimensions of information-seeking strategies. Even though it is clear that users' goals are strong determiners of their information behaviors, researchers still understand very little about the range and nature of interactive intentions and even less about how they relate to information-seeking strategies. Moreover, there is not enough empirical data to illustrate the relationships between user goals and information-seeking strategies. This study tries to offer some empirical evidence for the identification of the pattern between interactive intentions and information-seeking strategies.

The results show that each type of interactive intention has its own associated information-seeking strategies. Simultaneously, several types of information-seeking strategies also apply to different types of interactive intentions. Fig. 4 illustrates four dimensions of interactive intentions
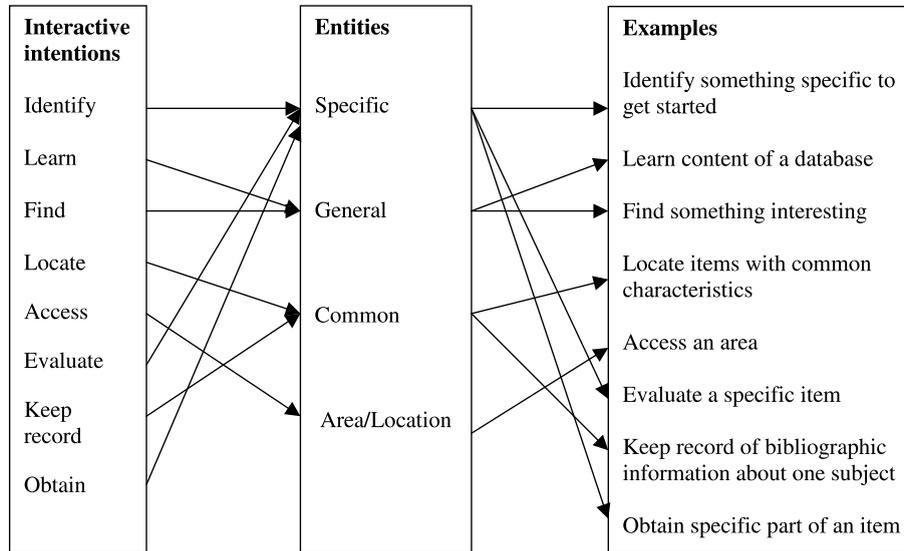
Interactive intentions	Entities	Examples
Identify	Specific	Identify something specific to get started
Learn	General	Learn content of a database
Find	Common	Find something interesting
Locate	Area/Location	Locate items with common characteristics
Access		Access an area
Evaluate		Evaluate a specific item
Keep record		Keep record of bibliographic information about one subject
Obtain		Obtain specific part of an item

Fig. 2. Examples of interactive intentions.

Table 3
Types of methods

Types	Definitions	Examples
Scanning	Look through an item or a series of items	Look at, look through, flip through, etc.
Searching	Examine a database(s) and identify item(s)/information that matches certain criteria	Author searching, title searching, subject searching, keyword searching, etc.
Tracking	Follow meta-information to get to specific location, specific page, specific information, etc.	Follow, turn to a specific page, trace, etc.
Select	Pick up an item among a series of items or from a location	Enter a number, pull out, pick up, choose, etc.
Comparing	Identify some information from different items and making a comparison	Make a comparison, associate, relate, compare, etc.
Acquiring	Write down, copy specific or meta-information or check out items, etc.	Take notes, copy, check out, etc.
Consulting	Direct questions to a human	Ask questions, talk to, seek advice, consult, etc.
Trial and error	Figure out something, especially system functions or system structures by trying different possibilities/approaches without following specific instructions	Wander around, try, play around, etc.

and information-seeking strategies. Table 5 presents the patterns between each type of interactive intention and its associated information-seeking strategies. In the table, *N* refers to the number of times each information-seeking strategy was used by participants to achieve each type of interactive intention in this study.

Table 4
Types of resources

| Types of resources	Definition	Examples of resources
Meta-information	Information about information	Citations in OPAC Citations in secondary resource Table of contents in a book
Part of an item/specific information	Sections of an item, pages of an item or specific information embedded in the item	Chapters of a book Columns of a newspaper Stock quotes on a given day
A whole item	An information object that contains information	A journal A magazine A videotape
A series of items/one location	Several items bound together or in a specific location or one area or location in the library	A stack of newspaper Fiction or nonfiction area HG area
One system/multiple databases	One system that contains one or more databases	OPAC
Human	Human serving as a resource	A librarian A friend A classmate
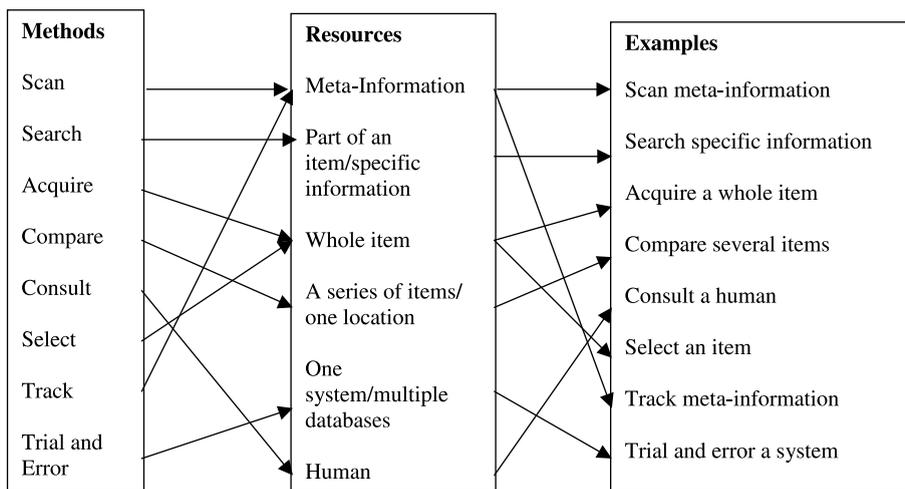
Fig. 3. Dimensions of information-seeking strategies and examples.

Eight types of interactive intentions and their frequently applied information-seeking strategies are summarized as follows. Most frequently/commonly used information-seeking strategies for each type of interactive intention were identified by examining the percentage of each type of

Intentions	Entities	Methods	Resources
Identifying	Specific	Scanning	Meta-Information
Learning	Common	Searching	Part of an item/ specific information
Finding	Area/location	Tracking	Whole item
Accessing	General	Selecting	A series of items/ one location/ one database
Locating		Comparing	
Evaluating		Acquiring	One system/multiple databases
Keeping		Consulting	
Obtaining		Trial and Error	human

Fig. 4. Dimensions of interactive intentions and information-seeking strategies.

strategy used in achieving each type of interactive intention. For an easy explanation, I selected some of the examples to illustrate the relationships between types of interactive intentions and information-seeking strategies. In all examples, dimensions of interactive intentions and information-seeking strategies are underlined while dimensions of information-seeking strategies are also italicized.

Identify includes identifying information to get started and identifying more information for searching. According to the data, of all the information-seeking strategies (100%), *scanning a whole item* (28%), *scanning meta-information* (19%), *and scanning part of an item/specific information* (19%) were the most common information-seeking strategies used for this type of interactive intention. Here *scanning a whole item*, *scanning meta-information* and *scanning part of an item/specific information* mostly refer to scanning personal materials. Users brought their personal materials to the library to help them identify a search topic or specific search items, and that included "reading notes", "looking at bibliography", "scanning reading list", etc. Sometimes, users also *searched a system and scanned meta-information* (14%) from the OPAC to identify search leads. Occasionally, users *consulted with a human* (10%) to identify some information to get started or to search.

Here is an example of **identifying** something in **general** to get started by *scanning a whole item*:

I: The first thing that you did was after you sat down you took out a notebook and *looked at* (a) *set of handwritten papers*, I couldn't see exactly, what did you intend at that time?

U: I had written a preliminary paper, a proposal and I was *going over* *my ideas* that what I wanted to look at, and also I handed the proposal in to the professor and she made comments on it and I wanted to look at those comments and see where I should start and what was most important and what my priorities were. (a064)

Learning contains learning about system functions, system structures, database content, and domain knowledge. "*Consulting a human*" (39%) was the most frequently used strategy in this category, and it included *consulting experts and peers*. Here "*consulting peers*" refers to consulting

Table 5
Patterns between each type of interactive intention and its associated information-seeking strategies

Interactive intentions	Information-seeking strategies (*N*)
Identify Identify something to get started Identify something more to search	*Scan a whole item* (6) *Scan meta-information* (4) *Scan part of/specific information* (4) *Search a system and scan meta-information* (3) *Consult a human* (2) *Other* (2)
Learn Learn system feature Learn system structure Learn domain knowledge Learn database content	*Consult a human* (12) *Scan meta-information* (10) *Trial and error* (6) *Other* (3)
Find Find a known item	*Search a system and scan meta-information* (43) *Scan a series of items/an area/location and select specific* (27) *Consult a human* (14) *Other* (5)
Find Find items with common character- istics	*Scan an area/location* (47) *Search a system and scan meta-information* (36) *Track meta-information* (7) *Other* (5)
Find Find specific information	*Scan a whole item* (18) *Scan part of an item* (13) *Search meta-information and track meta-information* (11) *Consult a human* (4) *Other* (2)
Find Find items without pre-defined cri- teria	*Scan an area/location* (30) *Scan meta-information* (4) *Other* (2)
Access Access a specific item Access items with common characteristics Access an area/location	*Track meta-information* (44) *Consult human* (5) *Trial and error* (4) *Other* (2)
Locate Locate a specific item Locate items with common characteristics Locate an area/location	*Search a system and scan meta-information* (26) *Consult a human* (5) *Scan an area/location* (4) *Other* (3)
Evaluate Evaluate correctness of an item Evaluate specificity of an item Evaluate usefulness of an item Evaluate fitness of an item Evaluate duplication of an item	*Scan meta-information* (59) *Scan a whole item* (38) *Compare meta-information* (14) *Search meta-information and track meta-information* (9) *Other* (6)

Table 5 (Continued)

Interactive intentions	Information-seeking strategies (*N*)
Keep record	*Acquire meta-information* (33)
Keep record of bibliographical information	*Other* (4)
Obtain	*Acquire part of an item/specific information* (12)
Obtain specific information	*Acquire a series of items* (8)
Obtain part of the item	*Acquire a whole item* (8)
Obtain a whole item(s)	*Other* (3)

classmates, friends, etc. In addition, *scanning meta-information* (32%) and *trial and error* (19%) were the important information-seeking strategies to learn about system function, system structure, database content, and domain knowledge.

Here is an example of **learning structure in general** by consulting an expert:

I: You *talked with* the *librarian*, what did you intend to do?

U: I'm not familiar with the library or where they keep everything. I wanted to know about that. (f033)

Finding includes finding a known item, finding specific information, finding items with common characteristics and finding items without pre-defined criteria. In the following examples, information-seeking strategies in [ ] are optional.

Finding a known item(s) refers to finding an item(s) for which a user has bibliographical information. *Searching a system* and [*scanning meta-information*] and [*select*] (48%) and *scanning an area/location* and [*selecting specific*] (30%) were the most frequently used search strategies for this intention. In addition, users also *consulted experts* (16%) to find a known item. According to the data, users did not always have the complete information of a known item, therefore, they had to try different versions of a title or an author in the search process.

Here is an example of **finding a specific item** by *searching* a *system* and *scanning meta-information*:

I: You went to *IRIS* and *searched*, what did you intend to do?

U: I knew the complete title so I simply *typed it in* and *move forward and backward* of the *list* to look for the book. (l010)

Finding items with common characteristics refers to finding items with shared similarities. *Scanning an area/location* (50%), *searching a system* and *scanning meta-information* (38%) and *tracking meta-information* (7%) were the three types of most commonly employed information-seeking strategies for this type of interactive intention. In order to find items with shared characteristics, users might scan an area to check items with the same call number, try subject search and scan the results or trace the citation of a relevant item to find more documents like this.

Here is an example of **finding items with common subject** by *scanning* an *area/location*:

U: I didn't find the book I was looking for in the room.

I: Okay, and you also *browsed spines on the shelf*?

U: Yeah, because I didn't find the book I was looking for so I was just looking for other books because it was the same material. (l004)

Finding specific information refers to finding specific information embedded in an item that a user needs to know. *Scanning a whole item* (38%), *scanning part of an item/specific information* (27%) and *searching meta-information* and [*tracking meta-information*] (23%) were the most frequently used information-seeking strategies. Sometimes, searching meta-information occurred without tracking meta-information when users could not find what they needed from the meta-information. Users also employed *consulting a human* (8%) to find specific information.

Here is an example of **<u>finding</u> <u>specific</u> information** *by <u>searching meta-information</u>* and *<u>tracking meta-information</u>*:

> **I**: It looked like you *<u>paged through the back of that bound book</u>*, and *<u>turned to middle of the book</u>*, what was the intention there?
>
> **U**: Well, to <u>find</u> <u>where the car was being reported</u> and *<u>turn to page 660</u>* which had to do with that car model. (w054)

Finding items without pre-defined criteria refers to exploring to find something that might be interesting or useful while users do not have a very clear idea of what specifically they are looking for. *Scanning an area/location* (83%) was the most frequently applied information-seeking strategy for this intention. When users did not know what to search, they usually scanned an area, a location or meta-information (11%) to find something interesting or useful.

Here is an example of **<u>finding items</u> in <u>general</u>** by *<u>scanning</u>* an *<u>area/location</u>*:

> **I**: After I talked to you by the door, you went right over the new nonfiction area, that's where I found you. I saw you *<u>browsed</u>* that *<u>area</u>*, selected a book, you looked at the jacket at the inside of the book and then you kept it. What were your intentions at that point?
>
> **U**: It <u>held my interest</u>, that's all, ah.
>
> **I**: Were you specially looking for a book about art?
>
> **U**: No, No, when I come in here I never really know what I'm going to read.
>
> **I**: Okay, so you don't have anything in mind?
>
> **U**: No, I just thought, to <u>find</u> <u>something that would hold my interest</u>. (w032)

Locating refers to finding out where an item(s) is placed. As locating and finding are highly correlated to each other, information-seeking strategies that are used for "finding" also apply to "locating". The results show that *searching a system* and *scanning meta-information* and [*select*] (68%) was the most frequently used information-seeking strategy for this type of interactive intention. Users also applied *consulting a human* (13%) and *scanning an area/location* (11%) to locate an item(s).

Here is an example of **<u>locating</u> a <u>specific</u> item by *<u>searching a system</u>* and *<u>scanning meta-information</u>* and *<u>selecting</u> <u>a whole item</u>*:

> **I**: I saw you *<u>entered</u>* a *<u>particular subject</u>*, what was your intent at this point?
>
> **U**: Well, that was I put in the subject for which I was looking.
>
> **I**: You *<u>went through</u>* the list and *<u>entered</u> <u>a number</u>*, what was your intention?
>
> **U**: Well, I, now I wanted to find out whether the book was in the library at this point.
>
> **I**: And after you *<u>entered</u>* the *<u>particular number</u>*, you got some more information on that one particular book, when you saw this screen, what was your intention?
>
> **U**: Ah, just to continue on to <u>find the location of the book</u>. (w046)

Accessing refers to getting access to an item(s) based upon the location of an item(s). *Tracking meta-information* (80%) was the first choice for users to access a specific item, items with common

characteristics, or an area/location. Here *tracking meta-information* refers to following call numbers or floor map, etc.

Here is an example of **accessing items with common characteristics by *tracking meta-information***:

I: Right, then you were *looking at* the *floor map*, right? What did you intend at that time?

U: I intended to <u>go straight to where the book was located</u> instead of making another mistake? (a143)

Evaluating consists of assessing usefulness of an item(s), correctness of an item(s), specificity of an item(s), duplication of an item(s), and fitness of an item. The results show that major information-seeking strategies employed in "evaluating" were *scanning meta-information* (47%), *scanning a whole item* (30%), *comparing meta-information/specific information* (11%), and *searching meta-information* and *tracking meta-information* (7%). *Comparing meta-information* or *specific information* was essential for evaluating the correctness and specificity of an item/information. *Scanning meta-information* and *scanning a whole item* were two approaches chosen for the evaluation of the usefulness and duplication of an item. *Searching meta-information* and t*racking meta-information* was the major information-seeking strategy applied to the evaluation of the specificity of an item(s). *Scanning meta-information* and *selecting specific* was used in the evaluation of fitness of an item.

Here is an example of **evaluating items with common characteristics by *scanning meta-information***:

I: The clinical trials. Here comes the citation list. What did you intend here?

U: Well, I was *reading* the *titles* to see <u>what fit with my intentions</u> (be)cause I was looking for basic information really. (l077)

Here is an example of **evaluating items with common characteristics** by *scanning meta-information* of each item and *selecting* a *specific* item:

I: You pulled out green books, then you *looked at front pages* of each book and *picked up* one *book*, what did you intend?

U: They were four of the exact same book, I was checking to <u>get</u> the <u>newest printing</u> of it, in case there were any additional authors' prefaces that they added on, say in second or third edition of the book. I wanted to get all of the additional authors' notes too. So I ended up *going through* all the *prefaces* of all the editions, I found one new edition, but I ended up taking up the original edition of the book. (a068)

Keeping record refers to recording bibliographic information of a specific item, items with common characteristics or an area/location. A*cquiring meta-information* accounted for 89% of information-seeking strategies applied for this type of interactive intention. Generally, users just wrote down the title, author and call number of an item to keep a record for access purposes.

Here is an example of **keeping record of a specific item** by *acquiring meta-information*:

I: I saw you staring around at the beginning, and then you *wrote down something* on a piece of paper. What's your intention here?

U: I was *trying to write down* the *author name and title*. I wanted to <u>get</u> the <u>call number</u> also because that way I can go straight to the stack, so when I go over to Kilmer I don't have to go punching up their computer and running around the library. (l10)

Obtaining refers to taking hold of part of an item, an item or a set of items. *Acquiring part of an item/specific information* (38%), *acquiring a whole item(s)* (26%) and *acquiring a series of items*

(26%) were the major information-seeking strategies applied to obtain part of an item, an item or a set of items.

Here is an example of **obtaining specific part of an item** by *acquiring part of an item*:

I: You went to photocopy machine, what did you intend to do?

U: I wanted to <u>copy</u> <u>two pages of statistics</u> on NBA players 1988 season. So rather than copying that down I just *photocopied* *two pages*. (w78)

5. Design adaptive information retrieval systems to support multiple types of interactions

Information-seeking behaviors are determined by levels of user goals. Users' leading search goals lead to their current search goals, and interactive intentions are the sub-goals of current search goals. More importantly, every type of interactive intention has its own corresponding information-seeking strategies. This study goes beyond the previous research which simply characterizes information-seeking strategies, and further investigates the relationships between interactive intentions and information-seeking strategies. The results of this study enable researchers to understand and identify the patterns between interactive intentions and information-seeking strategies. The analysis of patterns between interactive intentions and information-seeking strategies has its theoretical as well as empirical implications.

The results show that the eight types of interactive intentions and their associated information seeking strategies occur in almost every type of current search goal and leading search goal. In other words, the eight types of interactive intentions represent all the interactive intentions within the current search goals and leading search goals. The only differences are that the order and frequency of the interactive intentions might occur differently in different high levels of user goals. The reason for these differences is that the information retrieval process is interactive and is the product of both plans and situations. To be more specific, interactive intentions and information-seeking strategies are the products of hierarchical levels of user goals, plans and interactions between users and information or system (Xie, 2000).

It is impractical to identify the sequences of interactive intentions and information-seeking strategies within a specific type of current search goal because of the interplay between planned and situated aspects. Despite changes in the order and frequency of different interactive intentions within current search goals, the occurrences of interactive intentions can be identified. As the results demonstrate, each type of interactive intention has its own corresponding information seeking strategies, and templates can be implemented on an IR system to support different types of interactive intentions based on the most frequently applied information-seeking strategies of each type of interactive intention.

The results indicate that users care about not only how an IR system effectively supports them to formulate queries but also how an IR system supports them to perform other forms of interaction. Eight types of interactive intentions represent eight types of interactions. If an IR system supports eight types of interactive intentions, it also supports multiple interactions. In addition to query formulation, users need IR systems to facilitate:

- identifying information to get started or search from their own personal leads;
- learning system features, structure, database content or domain knowledge;

- finding items/information without pre-defined criteria, find a known item with or without complete information, find specific information, or find items with common characteristics;
- accessing a specific item, access items with common characteristics, or access an area/location;
- locating a specific item, locate items with common characteristics, or locate an area/location;
- evaluating information/item in terms of its usefulness, correctness, specificity, duplication or fitness;
- keeping record of bibliographical information;
- obtaining specific information, part of the information, or a whole item;
- keeping informed about their search status and problems, etc.

Based upon the pattern of interactive intentions and their associated information-seeking strategies, the author further makes some suggestions for the design of an adaptive IR system to support users' multiple types of interactions:

- *Scanning different types of personal materials* is the information-seeking strategy applied for "**identifying**". **Suggestion**: set up a personal working space, provide access to users' personal leads and allow them to browse and link to these personal leads, such as an URL suggested by an expert, a disk containing the paper written by the user, etc.

- *Consulting experts/peers*, *scanning meta-information*, and *trial* and *error* are the most frequently used information-seeking strategies for "**learning**". **Suggestion**: provide a context-sensitive help mechanism to assist users to get "right to the question" answer for their questions of system function, system structure, database content, and domain knowledge. In addition to the table of content or index, the help mechanism should offer hyperlinks of information and examples of how to use different system features. The system should offer immediate access to the location information of any items as well as information about the general system structure and structure of any databases. The above information should be communicated to users via visualizations.

- *Searching* and *scanning* are used for "**finding known items**". The problem with this type of interaction is that users do not always have complete information on a known item. **Suggestion**: provide a browsing mechanism of partial search, such as partial title, partial author, etc.; provide other options of characteristics of a known item, such as image or text, date range, length of an item, etc. *Tracking meta-information* is a frequently applied information-seeking strategy for "**finding items with common characteristics**" that is not supported from the existing IR systems. **Suggestion**: provide positive feedback mechanism, such as offering "documents like marked", etc. *Scanning a whole item* and *searching meta-information* and *tracking meta-information* are the information-seeking strategies employed to "**finding specific information.**" **Suggestion**: in addition to full-text search, display format is another option to allow users to identify the specific information efficiently, such as keyword in context (KWIC), the most relevant passage, etc. *Scanning an area/location* is the most frequently used information-seeking strategy for "**finding items without pre-defined criteria**". **Suggestion**: provide browsing mechanisms of different subjects, different formats, different authors, etc. to help users find what they are interested in.

- As locating and finding are highly correlated, and information-seeking strategies applied to these two types of interactive intentions are quite similar. **Suggestions** for "finding" can also apply to "locating".

- *Tracking meta-information* is the first choice for users to "**access an item(s)/location**". **Suggestion**: provide direct links to help users easily access the item(s)/location. An alternative approach is to provide a visualized model to direct users to different locations.

• *Scanning meta-information*, *scanning a whole item*, *comparing meta-information* and *comparing specific information* are the major information-seeking strategies employed for different types **of "evaluating"**. **Suggestion**: recommend different display options for different types of evaluation with meta-information and search terms highlighted, furthermore, allow users to search for key terms within the text displayed, etc.

• *Acquiring meta-information*, *acquiring part of an item*, *acquiring a whole item* and *acquire a series of items* are the frequently used information-seeking strategies for "**keeping record and obtaining**". **Suggestion**: provide easy access to search history and search results as well as copying, downloading, printing, e-mail options for users to keep track of their searches and obtaining information/item(s), and further integrate these features and their personal working space into one entity.

6. Conclusion

This study demonstrates that users have to accomplish multiple types of interactive intentions in order to achieve their current search goals. Although they have different leading search goals and current search goals, users share the same types of interactive intentions within an information-seeking episode. In addition to finding items with common characteristics, users also try to identify information to get started, to learn system structure, find items/information without pre-defined criteria, locate or access items with common characteristics, evaluate the usefulness of an item, and obtain an item, etc. The results show that users do engage in multiple types of information-seeking strategies in their information-seeking process, and these information-seeking strategies can be characterized.

More importantly, this study identifies the patterns between interactive intentions and their corresponding information-seeking strategies. Intentions and entities can characterize interactive intentions while information-seeking strategies can be summarized by methods and resources. Eight types of interactive intentions can be further classified into four types of entities; eight types of methods associated with six types of resources represent different types of information-seeking strategies employed in the information-seeking process. Intentions, entities, methods and resources constitute the patterns of interactive intentions and information-seeking strategies. Even though some of the information-seeking strategies can be applied to several types of interactive intentions, each type of interactive intention has its own matching information-seeking strategies. Different users might not use the same information-seeking strategy for a specific interactive intention, but in general they employ information-seeking strategies associated with that type of interactive intention. By identifying patterns between interactive intentions and their associated seeking strategies, researchers are able to understand more about the nature of interactive information retrieval, and further implement these results into system design.

This study opens a new avenue for the research on the design of adaptive IR systems to support users in their interactive information retrieval process. The significance of this is at twofold. First, instead of supporting only query formulation, it calls for the IR systems to support multiple types of interactive intentions that users have to fulfill in order to achieve their current search goals. Second, it makes it possible for IR systems to assist users in their interactive information retrieval

processes by supporting eight types of interactive intentions that constitute different types of current search goals. It recommends that adaptive IR systems implement templates to support the most frequently employed information-seeking strategies for each type of interactive intention. However, this study also has its limitations. The design recommendation is based on the results of users' information-seeking process within different libraries; therefore the specific design examples suggested might be restricted and need more input from additional studies.

Further research should examine the patterns between interaction intentions and information-seeking strategies when people engage in different IR systems, such as Web search engines, online databases, etc. Further research also needs to explore how to design an adaptive IR system to support multiple types of interactive intentions and their associated information-seeking strategies.

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