Dynamic Compositions: Recombining Search User Interface Features for Supporting Complex Work Tasks

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ABSTRACT

Due to the tremendous advances in information retrieval in the past decades, search engines have become extremely efficient at acquiring useful sources in response to a user's query. However, for more sustained and complex information seeking tasks, these search engines are not as well suited. During complex information seeking tasks, various *search stages* may occur, which imply varying support needs for users. However, the implications of theoretical information seeking models for concrete search user interfaces (SUI) design are unclear, both at the level of the individual features and of the whole interface. Guidelines and design patterns for concrete SUIs, on the other hand, provide recommendations for feature design, but these are separated from their role in the information seeking process. This paper addresses the question of how to design SUIs with enhanced support for the macro-level process, first by reviewing previous research. Subsequently, we outline how three types of SUI features can be recombined to form a supportive framework for complex tasks. We provide concrete recommendations for designing more holistic SUIs which potentially evolve along with a user's information seeking process.

KEYWORDS

information seeking; search user interfaces; search stages

1 INTRODUCTION

Tremendous advances in information retrieval technology have occurred during the past decades. We now have arrived at the point where systems may actually *solve* problems for users. For instance, via common search engines on the web we get 'instant answers' for factual questions ranging from the weather in the next weekend to the birthdate of the current prime minister. Information seeking in the context of more complex tasks, however, is not as straightforward: broader inquiries cannot be directly answered in a succinct snippet of information. For instance, gaining novel ideas for research, or finding the appropriate sources for writing an essay requires intensive interaction with information sources.

During the process of information seeking and use, as occurring in complex research-based tasks, the needs and understanding of a user may evolve, moving from broad conceptualizations to a focused perspective. To create more supportive systems for complex tasks featuring sustained information interaction, current *ad-hoc* approaches to search-based interaction should be rethought. Instead of optimizing results displayal to singular queries, we propose a fundamentally different approach, involving support for a user's information seeking **process**.

The non-trivial question which follows is how to concretely achieve this enhanced process support. In the context of this paper, we focus on the presentation of results from search engines via their constituent SUI features. Creating compositions of interface features with a high *usability* is no easy task. As Oddy [13] already argued in 1977, the "art" of information system design is to "find the form and timing of information presentation which will best aid the system user in whatever task he has in hand." In this paper, we focus on the timing and form of SUI features, assessing how they fit in different stages of the information seeking process, and how they can potentially be recombined in dynamic ways.

To this end, we first discuss background literature related to process support for complex tasks (Section 2). Based on previous research, we then outline our supportive framework for designing task support in terms of SUI features (Section 3), followed by the discussion and conclusion (Section 4).

2 BACKGROUND

This paper focuses on cognitively complex tasks, during which search systems may act as a mediator between user & information.

2.1 Complex Tasks

Unlike simple lookup tasks, complex work tasks [16] may involve learning and construction, understanding and problem formulation [3]. These tasks can be performed by topic novices, but also by more experienced actors. For instance, a student may perform a task involving a topic she knows little about, but this knowledge advances over time, or a researcher may start with a loose research question, which becomes more focused after interaction with a set of information. Besides their obvious occurrence in a work and study contexts, complex tasks are also performed in leisure settings, e.g. shopping for products which are inherently complex. The complexity of information seeking and searching has been captured in a wide variety of models (see e.g. [18]).

2.2 Information Seeking Models

In this paper, we focus on models looking at information seeking as a temporal *process*. Kuhlthau's *Information Search Process* model is an influential model [10], based on several longitudinal studies. A key aspect of the model is that it looks at information searching as a process of knowledge construction, during which a user's uncertainty fluctuates. The model focuses on the evolution of users' thoughts, feelings and actions across six broad stages. These include early stages of *initiation* and *topic selection*, as well as

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exploration. At a certain point, a *focus* is formulated, after which information seeking changes, and stages of *collection* and *presentation* follow. Based on other longitudinal studies, Vakkari [15] observed implications for information sought, assessed relevance and search tactics, terms and operators. He grouped Kuhlthau's stages into three stages: *pre-focus*, *focus formulation* and *post-focus*.

2.3 Search User Interfaces

Already in the 1970s, researchers looked at challenges in designing interfaces for (bibliographic) search systems [2], including the characteristics of searchers, the search environment and feedback to searchers. However, even though various early experiments resulted in "intelligent intermediary systems" [9, p.137], this research in the 1990s gave way to streamlined IR systems, often focusing on query formulation and inspection. Motivations behind the simple design are multifold: search tasks are usually part of larger work tasks, and the interface should distract as less as possible [6]. Notwithstanding the apparent simplicity of current search interfaces, the "art" of designing them is still complex. Over the years, however, a number of frameworks, guidelines and design pattern libraries have been created [14]. Despite the immediate value of those frameworks for creating appropriate search user interfaces, they mainly focus on designing the functionality of SUI elements in the best way[1]. It is unclear at which moments of complex tasks these features are most useful, and how they can be combined to support (and not impede) complex searches. A higher-level system perspective has been provided by Bates [1]. The "degree of user vs. system involvement in the search" encompasses a continuum, ranging from fully manual search activities to fully automated searches. Furthermore, she distinguishes various levels of search activities. The lower level activities are *moves* (simple actions) and *tactics* (one or more moves to further a search), while higher level activities include *stratagems* (a complex set of tactics and moves), and *strategies* (a plan for the entire information search). Bates' work may provide inspiration for a better understanding of system support across stages.

2.4 From Stages to Interfaces

As we argued in [7, 8], there are issues in the translation from the rich stages in the information seeking literature to concrete support in terms of search system features. These papers looked at the stages in which SUI features would provide support, also taking into account previous literature [4, 12, for example]. Huurdeman et al. [8] used a feature categorization from Wilson [17] to more broadly group different types of SUI features, and assessed their value over time using a multistage task design. *Informational features*, showing search results or information about results, were naturally useful in all information seeking stages. *Input* and *control features*, to express needs and modify input, on the other hand, could be categorized as search stage sensitive features. The value of these features was highest in the initial pre-focus stage, and decreased over time. This reflects a user's increasing understanding of a topic, during which the value of features to help formulating a query and delimiting a resultset may decrease. *Personalizable features* tailor the experience to a user, based on her actions. Contrary to input and control features, personalizable features became more useful over time [8].

[1]For instance, how to design a 'pagination control' feature for a search engine, https://developer.yahoo.com/ypatterns/navigation/pagination/search.html (accessed: 01/08/16)

3 TOWARDS A HELPFUL FRAMEWORK FOR COMPLEX TASKS

As illustrated by the information seeking models discussed in the previous section, a searcher's conceptual framework about a topic may evolve over time. During a novice user's information journey, knowledge structures evolve, just as during a scholars' research process, conceptualizations of a topic may undergo changes. Keeping this evolution in mind, the system should form a "helpful framework within which the user can make problem-solving decisions" [13]. However, current search interfaces typically do not evolve with a user's knowledge – to become truly 'helpful', a system should ideally support the information seeking *process* of a user, moving from exploratory *pre-focus*, to *focus formulation* and final *post-focus* stages. Our proposed framework is visualized by Figure 1, and consists of three dimensions. As context, we use SUI features listed in [17], augmented with more recently introduced features.

3.1 First Dimension

The first dimension of a system constituting a 'helpful framework' consists of features offering automatically generated suggestions to users. This support typically takes place at Bates [1]'s search activity level of the 'move' (e.g. entering search terms), and 'tactic' (e.g. choosing a broader term). For instance, a word cloud feature may suggest keywords for a query, or a query suggestion feature may propose a broader formulation of a query. The need for this *low-level* support, embodied in various *input* and *control* features, generally decreases over time. When a user's conceptualization of a topic grows, she becomes increasingly able to express herself precisely in the context of that topic [8, 10], and support at the level of moves and tactics becomes more superfluous.

An SUI designer has a wide variety of features at her disposal to provide low-level support for searching. First of all, at the level of the query, **Query Corrections**, **Query Autocomplete**, and **Query Suggestions (a)** can provide help in formulating the right query, and suggesting alternative queries. Especially in initial stages, **Facets and Filters (b)** can be useful to delineate resultsets, and adapting **Results Ordering (c)** may initially help to find the right items. **Word Clouds (d)**, even though their effectiveness in information searching has shown fluctuating results, may also provide inspiration. Finally, current search interfaces often contain **Entity cards (e)**, an information panel with brief information and related entities for an intended query target.

3.2 Second Dimension

The second dimension of a 'helpful framework' is formed by *informational* features. These features provide the actual results, or information about encountered result items. For instance, a search system may show the title of a document, a short snippet and basic metadata. As evidenced in previous experiments (e.g. [8]), these features may be useful throughout the process. They provide low-level support at the move and tactic level, for instance selecting

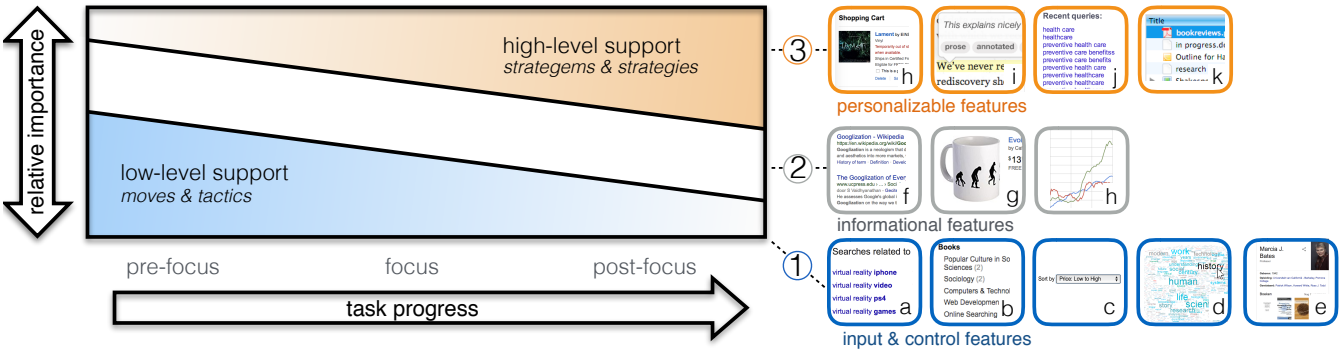

Figure 1: Schematic overview of a supportive framework for designing 'stage-aware' search user interfaces for complex tasks: low-level support for moves and tactics gradually gives way to higher level support for stratagems and strategies.

and opening information sources, but also higher level support (e.g. offered by visualizations of result sets).

Informational features may provide both low and high-level support. These features contain the **Search Results (f)** themselves (commonly shown by their title and short textual snippet). Especially in e-commerce systems, also **Thumbnails (g)** depict resultset items. **Visualizations (h)** provide more insights into retrieved resultsets. These may initially be useful for a researcher to explore a set of data, but also to visualize a gathered set of focused results.

3.3 Third Dimension

The third dimension of a 'helpful framework' consists of features which can support seeking at a higher level. While these types of features may include automated functionality, the main aim is to provide insights into a user's process *through her actions*. As Kuhlthau's model has indicated, processes of hypothesis generation, data collection, information organization and the preparation of a personalized synthesis of a topic take place during processes of knowledge construction [10, p.194]. This reflects the highly personalized nature of such complex activities, meaning that automated support may not suffice. Instead, the aim of *personalizable* features should be to aid users in performing their task. In different experiments, demand for and use of annotation, saving and organization features by both students and graduate researchers has been evidenced. As opposed to low-level features, these higher-level features may support Bates' 'stratagems' and 'strategies' (planning in the context of an entire search). On the one hand, through logging user's actions and potentially gathering data about the actors' domain knowledge or task at hand, they provide a trail of activities, which may (passively) aid users in locating where they are in the process. On the other hand, they also allow a user to 'work with results', and thus encourage reflection on encountered results. As such, they become increasingly useful throughout a task.

More high-level support throughout the process may be offered by **Results Saving (h)** features, alternatively embodied in e.g. shopping carts and wishlists. Interfaces may also offer **Personal results Organization** opportunities. Furthermore, especially in a research context, **Annotations (i)** are used at different points in the process [11]. Other tools which may be useful, sometimes only in passive ways [8] are **Query History (j)** features. Finally, **External tools (k)** may provide high-level support, such as word and data processing, as well as reference management.

Summarizing, more dynamic support for complex research-based tasks may be achieved by differentiating SUI feature categories and their levels of support. In particular, functionality providing low-level support (i.e. *input* and *control features*), are useful in the initial stages of a complex research-based task. Searchers with low domain knowledge, but also researchers exploring a new topic and collection may utilize this functionality to bootstrap their searches. Features providing high-level support (in particular *personalizable* features), may invite searchers to explicitly reflect and interact with results, as well as seeing how these results fit in their process and strategy.

4 DISCUSSION AND CONCLUSION

The road towards designing optimal search user interfaces for complex tasks is long and winding. Indeed, the design of SUIs can be seen as an "art", involving numerous thorny issues and trade-offs in usability. For instance, combining excessive sets of features may overload the user, while a streamlined approach can be too limiting for supporting user needs in different stages of complex tasks. At each stage of a task, an optimal combination of features may exist. This paper provides initial handles to determine the **relative importance** of features when designing SUIs, thus connecting theoretical information seeking models and more concrete search user interface design.

At the level of the whole SUI, various approaches for the provision of dynamic support for information seeking stages can be suggested. First of all, a totally open approach is possible – searchers are free to choose a custom set of SUI features at any point of the process ("build your own SUI"). Second, predefined interface panels combining features can be offered to a user (e.g. for exploration and focused search), and a user can choose a panel she needs at any stage (as evaluated in [5]). Third, a totally adaptive approach may be followed: using evidence from usage data, interface features are

automatically offered or disabled. Hence, the potential adaptation of interfaces for complex tasks spans a continuum, ranging from fully manual to entirely automatic approaches.

It would be valuable to gain further insights into the influence of dynamic presentation of search stage-sensitive SUI features on user satisfaction (i.e. the features within the first and third dimension of the framework discussed in Section 3). In the CLEF Interactive Book Search Track, users were able to select interface panels representing different search stages, suggesting positive effects on user engagement [5]. Future studies should further look at the impact of dynamic and adaptive presentation of SUI elements, especially since this influences the consistency of an interface. This may be tested by adaptively enabling and disabling SUI features in experimental systems with rich functionality in a (simulated) complex work task setting.

At the level of atomic SUI features, this paper briefly outlined feature utility during the information seeking process, based on Bates [1] levels of search activities (i.e. *moves*, *tactics*, *strategies* and *strategems*). Further research is needed to allow for making more conscious choices of which features to include in an interface, based on the purpose they serve in the process. For instance, we may use Bates' levels of search activities as a 'lens' for analyzing existing SUI features.

Furthermore, as suggested in [8], individual features could be improved by taking previous user interactions as a basis and thus becoming more *personalizable*. For instance, query suggestions can lose their value over time due to a user's increased knowledge [8], but may provide more "intelligent" suggestions by taking into account previous user interactions.

The presented framework is just an initial step towards a more holistic approach for SUI design. First of all, it needs further grounding in actual SUI design practice, in particular with respect to current systems 'in the wild', and with respect to previous research studies and observations. Further research on the utility of SUI features, as well as more high-level SUI functionality in search systems is needed. For instance, explicit support for Bates' strategems and strategies is still rare, 27 years after her seminal paper. However, the ubiquitous presence of search engines in diverse manifestations may allow for more inclusive views on user activities in consecutive stages of complex search processes. By adapting low and high-level support, thus creating dynamic SUI compositions, we may be able to arrive at a more "intellectual symbiosis" between user and system as envisioned by Bates [1].

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