USING TEMPORAL PATTERNS OF INTERACTIONS to Design Effective Automated Searching Assistance

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Web search engines effectively support searching of short queries, with session durations of typically 15 minutes, while providing limited searching assistance to the user. However, Web search engines are less effective in the more complex searching situations in which users lack the domain knowledge or contextual awareness to use the system effectively. User uncertainty about the information needs, the content space, or the system's capabilities typify these types of searches. The interactions among searcher, system, and content are more multifaceted. Current research indicates that approximately 15% of user sessions on the Web are more complex searching episodes [3].

Assistance from the search engine can improve the searching experience for the user. There has been considerable work on developing contextual help and recommender systems to aid searchers. However, prior work has noted that searchers seldom utilize this support, resulting in ineffective or inefficient searches. Issues hindering the use of these automated assistance systems may result from a lack of understanding, on the part of the system, about the information task, and when users desire assistance. The negative aspects of task interruption for searchers may negate whatever benefits the assistance provides.

Prior research indicates there are typical patterns of interactions between searchers and systems [4]. It would seem reasonable to leverage these patterns to provide searching assistance to aid the user, with the goal of improving the outcome of the search process. However, beyond simple assistance (for example, spelling corrections for query terms), the results have been mixed [1]. Certainly, the cognitive load of information seeking in these contextual situations is high. The interjection of assistance into the search process may be too much of a cognitive load, requiring a task switch from focusing on the search process to mentally processing the assistance. Therefore, searchers ignore or improperly implement the assistance.

Some researchers are investigating an approach that is more synergistic with the search process. Assistance is offered when the searcher is most receptive to it. This is in contrast to system intervention at every step in the search process or when the system deems there is a need for assistance. Assistance synchronized with the user's searching process helps reduces the cognitive effort required for task

switching and can increase the implementation of system assistance.

We have conducted a series of research experiments examining temporal patterns of interaction between searchers and system assistance. Specifically, we gauged the temporal interactions of when searchers seek and implement searching assistance. Results from these investigations on searching assistance indicate that patterns of user-system interaction styles are short, typically only two or three interactions. Previous research also supports this finding [2, 4].

In our experiments, we have identified a taxonomy of 26 interactions, which we categorized into nine groups (see the accompanying table). The majority of interactions are with result listings (approximately 20%) and selection of documents (approximately 15%). Interactions with system assistance are approximately 4%. Searchers typically seek out assistance after interactions with the results listings, submitting the initial query, and browser navigation.

Using this knowledge, we designed a middleware application that provides automated assistance (such as result management, relevance feedback, query reformulation, query syntax, and error detection) at critical points in the search process when searchers have the highest probability of being receptive to this intervention. The application integrates with the searcher's browser (see the figure).

The application relies solely on searcher interactions for determining intervention timing and type of assistance. The application recognizes the interaction patterns of the current searcher, comparing them to preprogrammed patterns. Assistance is provided when a match between these patterns occurs. The application is client-side, so the searcher is not limited to one search engine.

	Interaction Types
1	**View results** (with scrolling, without scrolling)
2	**Selection** (view document, select results listing)
3	**View document**
4	**Execute** (query, find, create folder)
5	**Navigation** (Forward, Back)
6	**Browser** (open new browser, close browser)
7	**Relevance Action** (bookmark, copy, print, save)
8	**View assistance**
9	**Implement Assistance**

Taxonomy of user-system interactions.

We evaluated the effectiveness of automated assistance in a user study with complex searching tasks, namely the National Institute of Standard and Technology's Text Retrieval Conference searching topics and content collections. We compared a system with pattern-based searching assistance to a system with assistance provided at every point in the search process.
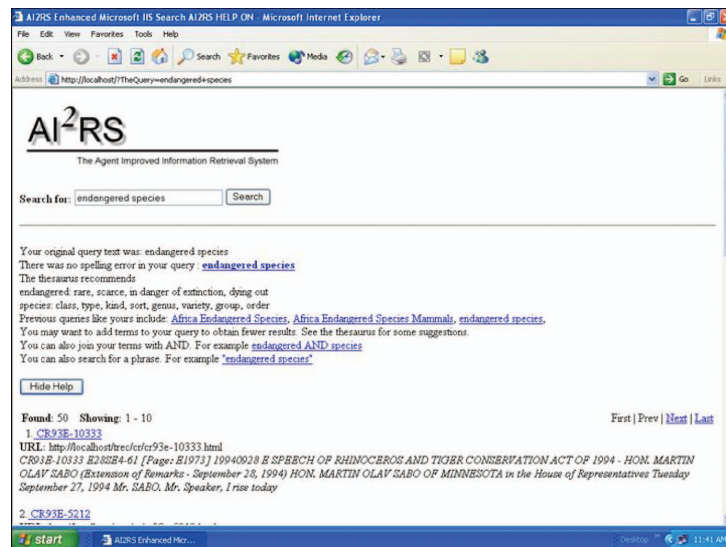
Automated-assistance displayed in browser window.

Results based on the number of relevant documents identified indicated that searching assistance synchronized with the manner in which users search can improve the performance of the searching process. In 70% of the cases, searchers on the system with the pattern-based searching assistance performed better than searchers on the other system. Results also indicate that users most commonly implemented assistance to manage results (38% of implementations), overwhelmingly acting to restrict the query. This signifies that precision is a key issue for

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exploratory searching.

The implications are that one can develop systems to support exploratory searching, and one can design these systems so that searchers use them. The next step is personalizing these systems at the individual level, based on user preferences and searching tactics. Effectively designing Web searching systems to assist the searcher can improve exploratory searching in a variety of domains including e-commerce, data analysis, and competitive intelligence. **C**

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