Reading between the lines: identifying user behaviour between logged interactions

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ABSTRACT
Log analyses are often used simply to quantify interactions with different aspects of a user interface. The position held here is that much of a user's search experience does not involve direct interaction with the interface, and may not be logged at all. Many models highlight the cognitive aspects of searching behaviour, and many consider that if a user does not like a user interface, then they do not interact with it very much. Consequently, we suggest that a grand challenge for logging searcher experiences should be to study the gaps in usage logs rather than the entries alone.

INTRODUCTION
Searching involves both mental and physical actions [1, 3, 4, 6, 8-10, 16]. Whether a user is reading, scanning, choosing, or thinking of query terms, there are many agreed elements of the search process, or search experience, which do not involve interacting directly with the computer. The problem with logging user interactions, therefore, is that it provides only half of the picture. When a user finds it hard to use a search interface, they may not find it hard to click or type, but instead find it hard to work out what to do first, where to go next, or why something happened. The issue is further highlighted when we consider interface features that are primarily for orientation or feedback, like breadcrumbs.

The think aloud approach is one example method used for eliciting qualitative details of user experience, but both the experimenter effect and the weaknesses of introspection are well known [14]. Some physiological logging approaches, such as eye tracking, heart rate, body temperature, and pupil-size monitoring can also be used if the participant is in a lab environment. Studies even consider brain scanning methods to estimate user cognitive load [5]. Can we elicit cognitive aspects from logs of distant users? This position paper explores the potential of eliciting cognitive actions from usage logs, which we know are part of search.

COGNITIVE ACTIONS DURING SEARCH
Many models of information seeking assume that there are cognitive stages in the search process. Marchionini [10], Ellis [4], and Kuhlthau [9], all identify stages such as need identification, examining results, and reflecting on whether a task has been completed. Similarly relevance judgments [11] are presumed to be a key part of searching as a user chooses which search results to view.

Many analytical evaluation methods for interfaces define cognitive actions. The Keystroke Level Model (KLM) [3] was designed to estimate how long it would take to perform a task with a user interface, by providing time estimates for actions like clicking and typing. Further, KLM suggests that the average time for a mental action is around 1.2 seconds and may include actions such as: initiating a task, making a strategy decision, retrieving a chunk from memory, visual search on the screen, thinking of a task parameter (like a keyword for a query), and verifying that something has happened. The GOMS method (Goals, Operators, Methods, and Selection rules) identified two types of non-interactive actions: cognitive and perceptual. Cognitive actions include initiating, choosing, planning. Perceptual actions include reading and performing visual search. These were later made more explicit in a variation called CPM-GOMS (Cognitive-Perceptual-Motor GOMS – also Critical Path Method GOMS), suggesting these cognitive, perceptual and motor (interactive) actions may occur in parallel [7].

Bates discussed both mental and physical actions in an analysis of different levels of search strategies [1]. Her model, which was operationalised in a recent information seeking evaluation framework [16], suggests that there are four levels of strategy: Strategies, Stratagems, Tactics, and Moves. She defines these moves as 'An identifiable thought or action that is a part of information searching'. Tactics, such as comparing, narrowing results, expanding results, varying queries, etc, are made up of moves. Stratagems, such as checking journal issues or searching for citations, are made up of a combination of tactics and joining moves. Finally strategies, which are similar to realistic work tasks like verifying a citation, or researching for a report, are made up of a combination of stratagems, tactics, and moves. Consequently, all four levels involve cognitive actions. Bates' definition of moves, and subsequently the information seeking evaluation method by Wilson and colleagues, takes a much less rigid view of mental actions compared to timeframe analyses like KLM and GOMS.

INTERFACE ELEMENTS FOR FEEDBACK
Elements or features of user interfaces are often designed to provide feedback to users or support orientation. Although these often-passive elements, like breadcrumbs, *can* be used to navigate around an interface, they may be often used without any direct interaction. Anecdotally, Pickens has

blogged about the dependence on usage logs[1] and the value that can be gained from classifications without direct interaction[2]. This topic was discussed in the CHI09 Sensemaking workshop. Further, at CHI09, an audience question asked whether tag clouds are better for aiding retrieval or providing contextual information about results. Empirically, Wilson and colleagues have shown that users can recall labels from faceted classifications that did not receive direct interaction [15].

IDENTIFYING COGNITIVE ACTIONS IN USAGE LOGS

The solution for identifying cognitive actions from usage logs is by no means obvious. Several existing studies, however, can provide some insights into how we might begin to do so. Multiple studies have, for example, noted that users sometimes move their mouse to the most relevant result seen so far while continuing to scan results [2, 12]. The combination of eye tracking and mouse tracking used tells us more about both perceptual actions (scanning the results) and cognitive actions (judging relevance), before interaction occurs (clicking). Further this reinforces the notion that we can use triangulation of, in this case, logging methods to build richer pictures of search experiences.

Similarly, in a study performed by schraefel and colleagues [13], audio previews were provided with labels in the facets of a classical music dataset. The hypothesis was that multiple previews would improve user choices while browsing, and would 'back out' of their decisions less often. This mental action of 'backing out' on a decision was measured in logs by a pattern of interactions showing the user clicking on higher levels of the classifications from their previous position. In this case, therefore, certain cognitive actions were modeled as a sequence of physical interactions, in an environment where mouse and eye tracking were not used. Although schraefel and colleagues identified specific mental actions, it may be possible to identify common interaction patterns that abstractly represent known perceptual and cognitive search Moves.

CONCLUSIONS

Search is irrefutably made up of both mental and physical actions: we cannot interact with a system without first choosing how to interact with it. The challenge, therefore, is to try to elicit common mental actions from logs of physical interactions. There are two key avenues that we envisage for beginning to do so. First, triangulation of multiple measures is already known to provide a richer understanding of user experiences and applies to logging too. Second, modeling sequences of physical interactions may allow us to estimate what has happened in the gaps. Regardless of how it is eventually achieved, the key position held here is that evaluating searcher experiences with usage logs should focus on what happens between the captured physical interactions.

[1] http://irgupf.com/2009/05/26/machine-learning-and-search-action-or-reaction/

[2] http://thenoisychannel.com/2009/03/24/google-offers-more-and-better-search-refinements/

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