Exploring Mouse Movements for Inferring Query Intent

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ABSTRACT

Clickthrough on search results have been successfully used to infer user interest and preferences, but are often noisy and potentially ambiguous. We explore the potential of a complementary, more sensitive signal –mouse movements– in providing insights into the intent behind a web search query. We report preliminary results of studying user mouse movements on search result pages, with the goal of inferring user intent - in particular, to explore whether we can automatically distinguish the different query classes such as navigational vs. informational queries from mouse move trajectories. Our preliminary exploration confirms the value of studying mouse movements for user intent inference, and suggests interesting avenues for future exploration.

Categories and Subject Descriptors

H.3.3 [**Information Systems**]: Storage and Retrieval: Evaluation

General Terms

Design, Experimentation, Evaluation

Keywords

query intent inference; user behavior modeling; mouse movement analysis

1. OVERVIEW

Inferring query intent is an important yet very difficult problem. While past studies have primarily focused on indicators such as clickthrough to disambiguate queries and attempt to infer the original user intent, we focus on the less explored area of using *mouse movements* to attempt to disambiguate, classify, and infer intent of queries. Previous work on mouse movements has shown a correlation between eye movement and mouse movements (e.g., [4]). In other work, researchers have shown the value of mouse movement tracking for usability analysis [3] and user activity tracking [2]. However, we are not aware of prior work on using mouse movements to automatically classify queries into broad classes such as navigational vs. informational or to infer and disambiguate query intent.

We hypothesize that mouse movements provide more information about user's interactions than only using clicks and page dwell time as indicators. For example, while the time a user spent on a page is a good indicator of her interests, there is inherent noise if the user switches tasks. In these cases, mouse trajectories can not only easily distinguish whether the user is active on the page, but also tell which parts of the page interest the user (by using the mouse position as a proxy for gaze position). In the following experiments, we explore the possible utility of using mouse movements for inferring user intent.

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2. EXPERIMENTAL SETUP

To capture the mouse movements, we used a method similar to that described in previous work [4]. Specifically, we inserted a piece of Javascript code into a Firefox toolbar to track the user behavior of searching and browsing. For mouse movements, our code captured the user's mouse coordinates on every one out of ten "onMousemove" events (which is fired each time a user moves the mouse one pixel; however, if the user moves too fast, 10 "onMousemove" events can result in a trajectory with more than 10 pixels). In this study, we focused on the analysis of the mouse movements in Google search results page.

The data was gathered from mid-January 2008 until mid-February 2008 from the public-used machines in a major university library. The dataset statistics are reported in Table 1. The population was primarily undergraduate college students, somewhat restricting the applicability of our preliminary results.

For this preliminary study we randomly sampled 300 query instances (without replacement, only including the first instance of each query) into our sample. The number was chosen as a reasonable initial pilot study – large enough to be interesting, and small enough to allow careful human labeling of the "correct" classification of the intent.

Statistic	*Total*
Number of users	860
Number of search sessions	1,597
Number of queries	3,214
Average trajectory length (px)	1,068
Average vertical range (px)	324
Average horizontal range (px)	537

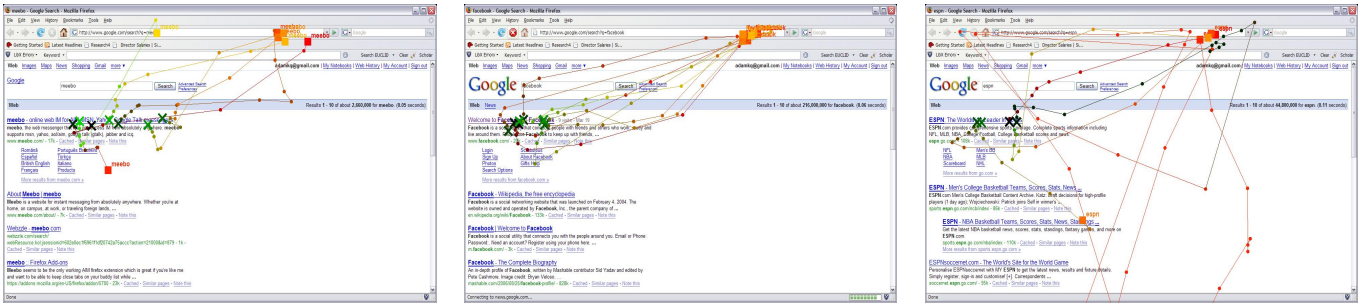
Table 1: Dataset statistics

3. RESULTS AND DISCUSSION

We now present preliminary results of comparing mouse trajectories for different query intent.

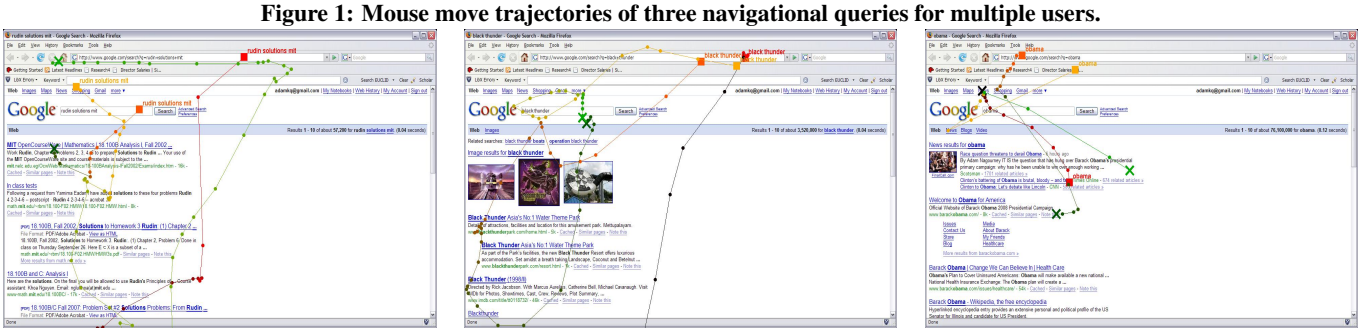
To manually classify query intent, we "replayed" the user interactions with the results for each query in the sample drawing the corresponding mouse trajectories and query terms on a snapshot of the result page. Using these clues and our intuition we then labeled the query intent into one of the classes, also marking searches that had ambiguous intent (e.g., we could not determine whether a query was navigational or informational). The statistics of the labeled dataset are reported in Table 2. Note that 17% of the searches were discarded as we did not have reasonable way of labeling the corresponding "correct" query intent.

The trajectories statistics for this set are reported in Table 3. As we can see from the table, the average trajectory length of navigational queries are shorter than that of informational queries; and while the average vertical range of the informational queries are



"meebo" "facebook" "espn"

Figure 1: Mouse move trajectories of three navigational queries for multiple users.



"rudin solutions mit" "black thunder" "obama"

Figure 2: Mouse move trajectories of the three informational queries for multiple users.

larger, their horizontal range are relatively smaller than that of navigational ones. We observe that for navigational queries, users often go directly to the interested result (spending little time on reading); in contrast, for informational queries, users spend more time reading the result page, which tends to result in longer and more complex mouse trajectories.

Figure 1 shows the mouse trajectories for three navigational queries for multiple users. Note that while queries "meebo" and "facebook" follow a relatively consistent pattern, the query "espn" exhibits a much more complex behavior. This suggests that some queries that are commonly considered navigational (and may exhibit similar click patterns) actually result in quite different user behavior and result examination patterns.

Figure 2 shows trajectories for different users for three informational queries: "rudin solutions mit", "black thunder", and "obama". Note that while patterns for the first two queries are relatively consistent, where users examine multiple results before clicking, the query "obama" is actually both informational and navigational – exhibiting mouse trajectory patterns of both types of queries for different users. This confirms our hypothesis that for queries with multiple possible intents (e.g., navigational and informational for query "obama") mouse trajectories can disambiguate the intent.

Table 4 reports preliminary results on automatically classifying a query intent into informational or navigational. As a baseline we use a simple classifier trained on click logs obtained from the MSN Search engine, implemented using decision trees and simple click-through features such as average deliberation time and maximum fraction of clicks on any result, similar to those described in [1]. As we can see, even our simple mouse movement representation improves on the accuracy of server-side intent classification alone, and suggests promising directions for future work.

Label	*Number*	*Percentage*
Navigational	102	34.00%
Informational	147	49.00%
Discarded	51	17.00%

Table 2: Distribution of query intent in our labeled sample (300 queries).

Type	*Navigational*	*Informational*
Average trajectory length (px)	738 (σ=325)	1,297 (σ=1,162)
Average vertical range (px)	253 (σ=77)	374 (σ=177)
Average horizontal range (px)	552 (σ=228)	526 (σ=244)

Table 3: Statistics for navigational and informational queries

Method	*Accuracy (%)*	*F1*		
		Nav	*Info*	*Average*
Clicks	67.87	49.40	76.50	62.95
MouseMove	70.28 (+4)	68.60	71.80	70.20 (+12)

Table 4: Accuracy of intent inference using clicks vs. mouse movement-based classifiers.

4. CONCLUSIONS

We presented a preliminary exploration of using mouse movements on web search results to infer and disambiguate query intent. As we have shown, some queries, while they may appear to be navigational or informational, are in fact ambiguous – and the mouse trajectories maybe used to identify such cases and ultimately to help infer the underlying intent. Furthermore, we present our preliminary results in classifying user intent into navigational and informational categories. Our current and future work focuses on automatically analyzing the mouse trajectories for more accurate prediction of query intent, and on automatically detecting information seeker success in web search and discovery.

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