Cheese: Tracking Mouse Movement Activity on Websites, a Tool for User Modeling

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ABSTRACT
Conventional web interfaces respond to and consider only mouse clicks when defining a user model. We have extended this and take into account all mouse movements on a page as an additional layer of information for inferring user interest. We have developed a straightforward way to record all mouse movements on a page, and conducted a user study to analyze and investigate mouse behavior trends. We found certain mouse behaviors, common across many users, which are useful for content providers in increasing the effectiveness of their interface design.

Keywords
Mouse movements, mouse activity, web page design, context, user study, mouse tracking, design guidelines.

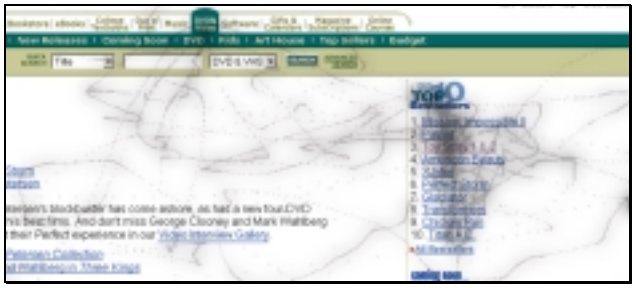

Figure 1: Mouse tracking data: deciding from a list

INTRODUCTION
We called our system Cheese since we are following the mouse, like a mouse follows cheese. More than just a fun name, this reference points out the distinct feature of our work, tracking all mouse movements.

There has been much work in navigation interest inference and many techniques have proven useful. Letiza looks at where you are and where you've been to anticipate where you will go [3]. WebWatcher acts as a web tour guide

Figure 2: A typical page, density expectation maximization used to visualize the users' areas of interest

once you tell it what you are looking for [2]. The work of Goecks and Shavlik took into account mouse activity and use of the scrollbar as interest evaluation metrics [3]. In this work, mouse activity is a function of the number of times the status-bar text changes. We take these ideas further by recording the changes in mouse location through the duration of the user's visit.

AUDIENCE & MOTIVATION
Content providers have a vested interest in the results of mouse movement data analysis. Our system provides the means to find out exactly how users navigate their page, and thus affords an extensive user model. If this data were analyzed in real time, behavior trends could be recognized as they occur. Dynamic content could then be provided according to the model of user interest obtained from the mouse data, thus allowing providers to create a more personal experience for users. This paper goes through the initial investigation of this technique and illustrates mouse behavior trends content providers could utilize for both personalization and general interface design evaluation.

SYSTEM ARCHITECTURE

Our system posts mouse movement data (position, time) automatically with embedded scripting, and the data is

analyzed and stored on a server. This collection technique is implemented using current technology and does not require any additional software on the user's browser.

USER STUDY

To evaluate the benefits of mouse movement data, we conducted a user study to uncover mouse behavior trends in web browsing. This study involved 17 people all of whom are familiar with computers and web browsing. They come from diverse backgrounds and have different jobs. We recorded the mouse activity as the users performed a list of tasks common in web browsing, (e.g. ordering a CD, browsing for specific information).

Page and Task selection

We selected pages from a two dimensional spectrum in which the dimensions can be characterized as the user's current knowledge of the page and the specificity of the task definition. Users visited 18 different pages some of which were familiar pages and others were not. On both of these types they were asked to perform specific tasks and tasks which were vague ("Choose a TV link that interests you"). We feel this selection aptly covers a broad range of browsing behavior and resulted in an inclusive data set.

DATA EVALUATION

We evaluated the collected data by redrawing the mouse movements on each page for each user and then visually comparing the patterns [Figure 2]. In future applications this pattern recognition will be done automatically, but in this initial study we were analyzing general trends and deciding what patterns are recognizable. The rest of this section details the most prominent features found in the data set.

Hesitation on other interesting links/text areas before clicking

Upon observing that some users move the mouse cursor according to where the eye is focused, we hypothesized that hesitations on links or text could potentially provide information about what else interests the user on the page.

People use the mouse as a marker when they are looking through a list of links. 30% of the time that pages had lists the mouse pointer was used to read along vertically [Figure 1]. While this does not represent a majority of users, the ability to tell what other options users were considering is fairly high.

Two of the tasks in our study yielded particularly interesting results. Users were asked on both "Barnes&Noble.com" and "amazon.com" to buy a CD/DVD of their choice. We then predicted, using the mouse movement data, what their second choice would have been by determining the link on which they hesitated longest before clicking their first choice. Users moved their mouse pointer over the various alternative CD/DVD links before choosing the one they wanted to buy. We found that this behavior reflects the choices the user was considering in their decision process. When comparing our guesses to what each user claimed was their second choice (asked afterwards) we had 65% accuracy on one page, and 75% on the other.

Intentionality of mouse movements

Some users occasionally moved the mouse straight to the link of interest without hesitation. We believe this behavior exhibits a familiarity with the task of finding that link on that page. Cheese makes this type of information readily accessible, and therefore makes it possible to determine when a user was familiar with their task.

White space

Including enough white space in a web page is a common rule of web page design; for it is necessary to give the eye a place to rest [4]. There is an analogous need for white space in order to provide the mouse a place to rest. We found that a large number of people use white space on a page in this manner. After the study, one of the users explained, "I move the mouse to white space because I don't want to accidentally click on a link."

FUTURE WORK

In the future, we plan to implement a web site to exemplify the utility of these findings. In this example site we will attempt to provide content dynamically based on mouse behavior. We hope that this exercise will further solidify our conclusions about the trends in mouse behavior.

ACKNOWLEDGMENT

Figure 1 is an excerpt of a Barnes and Noble page, Figure 2 was taken from ashford.com. We like to thank Henry Lieberman and Ted Selker for their support.

CONCLUSION

We developed a method for tracking mouse movements on a web page in order to build a more extensive user interest model. Tracking movements enhances, does not replace, the current practice of tracking mouse clicks. We conducted a user study to analyze these movements and investigate behavior trends. We found that when users do move the mouse around the page, certain mouse behaviors are common across many users and allowed us to make a more accurate prediction of user interest.

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