Users' Eye Gaze Pattern in Organization-based Recommender Interfaces

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ABSTRACT
In this paper, we report the hotspot and gaze path of users' eye-movements on three different layouts for recommender interfaces. One is the standard list layout, as appearing in most of current recommender systems. The other two are variations of organization interfaces where recommended items are organized into categories and each category is annotated by a title. Gaze plots infer that the organization interfaces, especially the quadrant layout, are likely to arouse users' attentions to more recommendations. In addition, more users chose products from the organization layouts. Combining the results with our prior works, we suggest a set of design guidelines and practical implications to our future work.

Author Keywords
Recommender interfaces, layout design, eye-tracking study.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Experimentation, Human Factors.

INTRODUCTION

Recommender systems have been increasingly adopted in online environment, as a personalized service to facilitate users in efficiently locating items that they are interested in. However, most researches have emphasized the algorithm's accuracy [11], less on studying the efficacy of interface usability from users' perspective. In fact, current systems basically follow a list structure (see Figure 1.a), where all recommended items are listed one by one, according to the order of their prediction scores as computed by the system.

Given the usability studies conducted in other areas, users indeed likely adapt their behavior when being presented with different information layouts. For instance, Kammerer and Gerjets recently found that the presentation of Web search engine results by means of a grid interface seems to prompt users to view all results at an equivalent level [7]. Braganza *et al.* indicated that users spent less time scrolling when they were with the multi-column presentation of large textual documents in web-browsers [1].

Unfortunately, little is known about the effect of different recommender layouts on users' interaction behavior. In particular, as users tend to focus on the top of a list due to their cognitive limitations [5], items that lie farther down in the list layout would attract little attention even though they may better satisfy the user's true interests. With this concern, we conducted an eye-tracking study to compare users' visual searching pattern in the organization layouts against in the list layout. In the organization interface, recommended items are grouped into categories and each category is annotated by a title. The generation algorithm is called the *preference-based organization technique* that we have developed in order to discovering similar tradeoff properties among recommendations (e.g., "these products are cheaper and lighter, but have slower processor speed") [2]. Prior simulations proved the algorithm's significantly higher accuracy in producing recommendations relative to other classification approaches. Therefore, in this current work, we mainly focus on its interface's usability aspect and aim to study the effect of layout change on users' fixation distribution.

ORGANIZATION-BASED RECOMMENDER INTERFACE

Specifically, the organization-based recommender interface is generated to categorize recommended products, and use the category title to explain the representative properties of a group of products (see Figure 1. b). Each presented title essentially details why these products are recommended, by revealing their superior values on important attributes and compromises on less important ones, in comparison with the top candidate (which is the best matching product according to the user's current preferences).

Therefore, there are three key elements in the interface: 1) the top candidate, 2) the categories' titles, and 3) the products recommended within each category. This then leads to the decision about how to arrange these elements in

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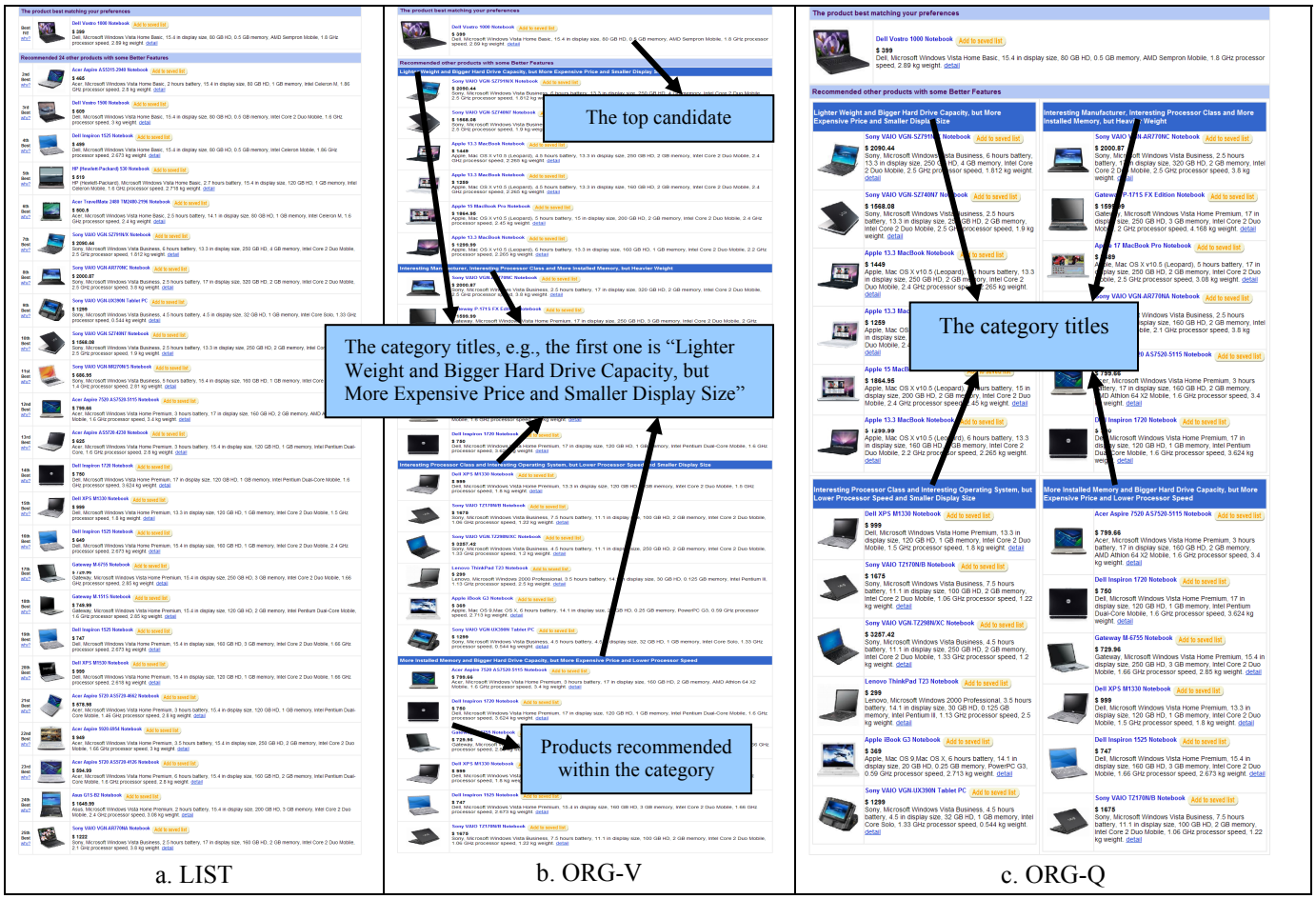

Figure 1. The three recommender interfaces: LIST – the ranked list interface, ORG-V – the organization interface with a vertical layout, ORG-Q – the organization interface with a quadrant layout.

the interface. In our experiment, we have prepared two organization layouts: the vertical layout and the quadrant layout.

In the vertical layout (see Figure 1. b "ORG-V"), except for the ranked first item positioned as the top candidate, the remaining recommendations are organized into *k* categories (e.g., $k = 4$ in our experiment). These categories are vertically placed one after another.

In the quadrant layout, the *k* categories are displayed with two categories laid out in parallel (e.g., the 1st & 2nd categories are placed at the same horizontal level. See Figure 1. c "ORG-Q"). The inspiration for this design actually came from [6], which states that eye movements are likely to shift to nearby objects. We were hence interested in seeing whether users would be stimulated to notice more products from adjacent categories in this quadrant layout, and hence conduct more comparison actions across categories.

The standard list layout (see Figure 1. a "LIST") was used as the baseline in the experiment, for which recommended products are ordered by their weighted utilities which indicate their matching degrees with the user's stated criteria [9]. The highest ranked item is placed on the top, followed by other recommended products. Each product is further attached with a "why" tool tip that explains the recommending rational (e.g., "This laptop matches your criteria on processor speed and hard drive size, but is heavier").

EXPERIMENT

21 participants (3 females) were recruited to participate in the experiment. Their ages range from 20 to 40, and were mainly students/employees in the university, but of various nationalities (e.g., USA, China, Switzerland, Italy, Canada, India, etc.). Each subject was randomly assigned one type of interface to evaluate. The main user task was to "*find a laptop that you would purchase if given the opportunity*". After they stated initial criteria on product attributes, they would see a set of 25 recommendations displayed in the assigned interface. These products were retrieved from a catalog that comprises 100 laptops.

A Tobii 1750 eye-tracking monitor was used in the study to trace users' eye-movement behavior. It is with resolution setting of 1290x1024 pixels, and is capable of sampling the position of the user's eyes every 20ms.

HOTSPOT PLOT

Three participants were screened out after the experiment due to calibration difficulties, leaving us with 18 users (2 females) for producing the hotspot and gaze path.

The hotspot plot is a powerful way to visualize the gaze behavior of an entire group of recordings. We chose the "fixation length" to produce the hotspot, which sums all fixations from users' recordings. The red/orange color in the plot shows that almost all subjects halted their gaze at a specific part of the page, for at least a fraction of a second (100ms).

Concretely, from Figure 2 (a~c), it can be seen that users looked at more products in both of the two organization layouts. Relative to a single big 'F' pattern on the top area of the standard list layout, in ORG-V and ORG-Q, small 'F' patterns appeared almost in all categories, giving rise to fixations on more recommended products.

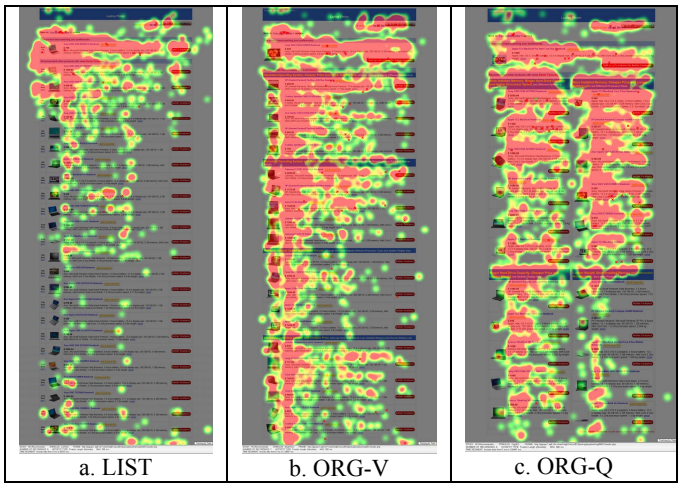

Figure 2. Hotspot plots in the three interfaces.

Specifically, in ORG-V (i.e., the vertical layout), the first two categories were carefully examined with respect to both of their titles and products. The fixations in the other two categories were relatively less, but still showed a certain amount of interests. In ORG-Q (i.e., the quadrant layout), the four categories' titles were all in red color, indicating that most users noticed them. Moreover, most products in the first two categories were reviewed in depth. In comparison, in LIST, only the top area is covered by red spots, and the remaining part is of very few green spots, indicating few fixations.

The hotspot differences among the three interfaces were further significantly supported by an in-depth analysis based on Area of Interest (AOI). Due to the space limit, please refer to [3] for the AOI results.

The results hence infer that the organization layouts are likely to facilitate users to pay attention to and examine more recommended products.

GAZE PATH

The gaze path plot displays a visualized view of users' scan paths. In this plot, each fixation is illustrated with a semi-transparent dot and its radius represents the length of the fixation. For instance, in Figure 3, the blue circle indicates the duration of a fixation, with larger circle representing longer fixation, and the blue lines that connect dots indicate the saccade path.

Since people may have varied behaviour in their observed scan paths, we selected three typical trials. Concretely, for each interface, we chose one gaze path plot from a typical participant to show how this user moves his/her eyes on it. The chosen examples are highly supported by other users' plots, which are 66.7%, 71.4%, and 60% on LIST, ORG-V and ORG-Q respectively. The gaze plot of LIST shows that longer fixations were first centered on the top candidate, and then moved to a few products below (see Figure 3. a). The user then made quick "Z" style saccade paths from the top to the bottom, but did not expose strong interests in the passed products. In ORG-V (see Figure 3. b), the longer fixation appeared on three or more products' details within the first two categories, right after on the top candidate. It also sometimes came to items in the third and fourth categories. ORG-Q exhibits similar behaviour (Figure 3. c), but more come-and-go scan paths appeared between products from adjacent categories. It hence implies that the parallel layout might enable users to notice products nearby and thus stimulate them to do more comparison actions.

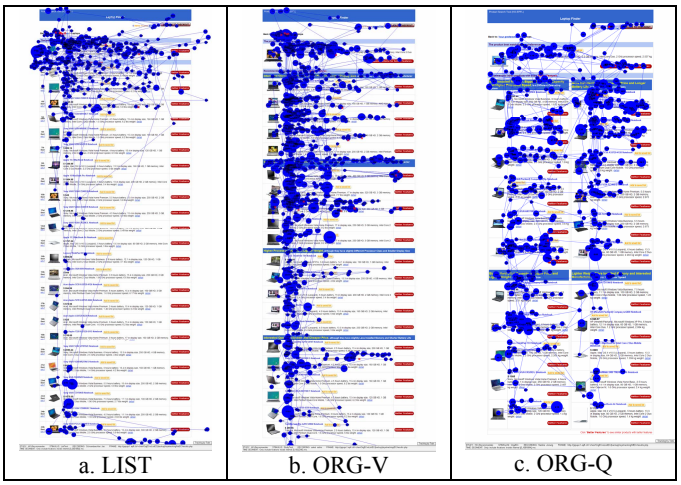

Figure 3. Typical gaze paths in the three interfaces.

PRODUCT SELECTION

We also counted the percents of users who have finally made choices while using the three interfaces respectively. The results show that 71.43% and 100% of users successfully accomplished the task of *finding a product to "buy"* respectively in ORG-V and ORG-Q, against 50% users in LIST (see Figure 4).

Another interesting finding is that more products were selected by the average user to put in his/her shopping cart in ORG-V and ORG-Q (1.86 and 3.2 products respectively,

versus 1.33 in LIST). The difference between LIST and ORG-Q is even moderately significant by t-test (p = 0.089, t = 1.89). These results hence suggest that when users paid attention to more options in the organization interfaces, they would be motivated to select more near-satisfactory items, which however might be ignored in the list layout.

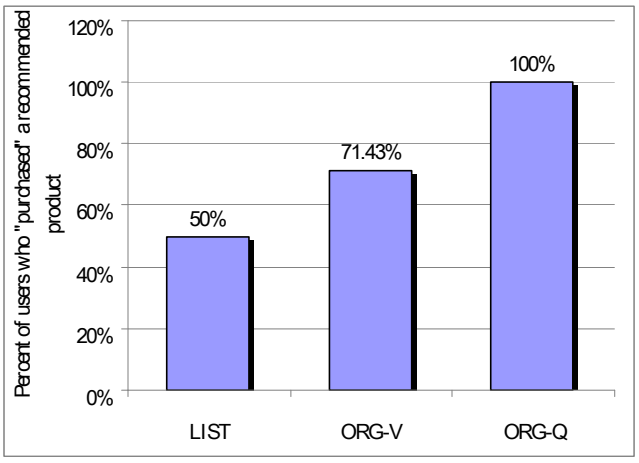

Figure 4. Percents of users who made product choice in the three interfaces.

PRACTICAL IMPLICATIONS

Based on the eye-tracking study, and combining it with our prior testing on organization interfaces [9,3], we are able to derive several design guidelines: 1) adopting a recommender layout that groups items into categories rather than a flat structure; 2) highlighting improvements and compromises in the category title to attract users' attention to the category; 3) including a few actual products within each category to further grab users' attention; and 4) placing categories in the quadrant layout if space allows, because it can stimulate eye fixations on more items and facilitate the comparison of products from different categories.

After this experiment, we have been starting to implement a commercial-like prototype system, in order to further embody implications as suggested from it. One is applying the organization-based recommender in various product domains including the public taste products (e.g., perfumes, movies). As a matter of fact, it has long been recognized that for different product categories, consumer-buying behavior will likely differ [4]: people will make decisions differently when they are involved in buying a high-value product like a laptop, compared to buying a low-value product like a movie. A recent pilot trial showed that the organization interface can also improve the system's ease of use and users' decision performance in the low-value product domain [10]. The preliminary results drive us to conduct more evaluations, especially through eye-tracking investigation, to verify the organization interface's actual benefits across different product domains.

Another suggestion from the eye-tracking study is that we may further conduct similar layout experiment to evaluate the role of organization-based recommendations when they perform as a part, as a whole, in the product page (i.e., displayed with other contents such as the product's detailed specifications, user reviews, etc.). In existing e-commerce sites, the part of recommendation is either placed on the right side of the product (e.g., in Yahoo Shopping), or in the middle or lower section of the page (e.g. in Amazon). The question is then which page layout would behave more effectively in terms of absorbing users' attention to the recommendation unit. Ozok *et al.* have recently launched a user survey, in which subjects were asked of their preference on the position of recommendation when it is integrated into the product page [8]. The survey showed that, though most of subjects want recommendations in an easily reachable and visible, yet non-distracting location, their preferred positions varied, but the survey did not measure users' interaction behavior with the page layouts. In our planned study, we will record users' fixation distribution on the recommendation part when it is positioned at different places, and hence discover its role and identify the most effective arrangement to be suggestive to current e-commerce site design.

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