Bookwall: Visualizing Books Online Based on User Experience in Physical Bookstores

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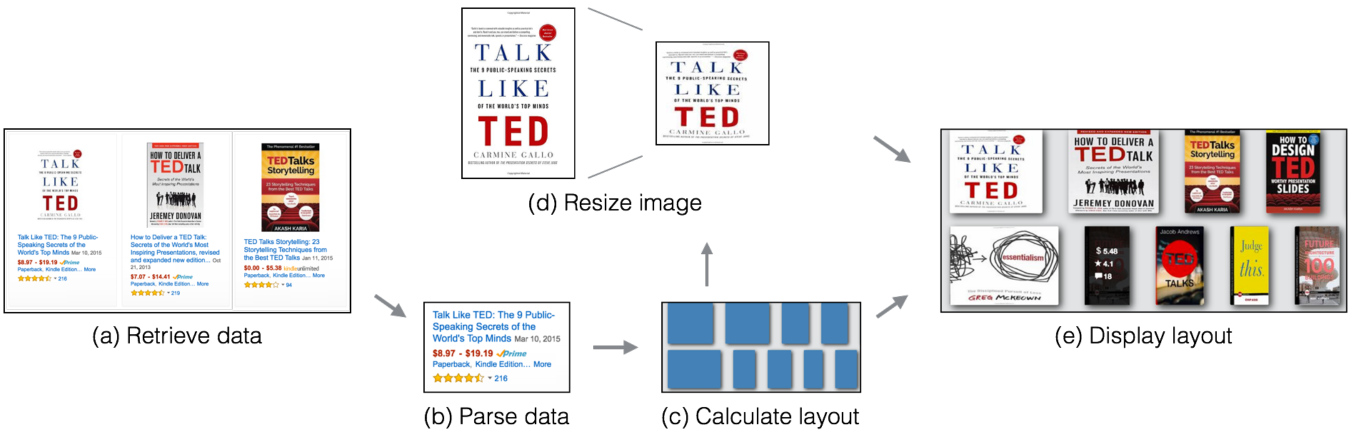

Figure 1: The system-flow of wall view generation. (a) we retrieved book data, including cover, title, price, score and number of reviews from amazon.com; (b) we parsed the text data; (c) we utilized the parsed data, e.g., reviews and scores, to calculate the layout; (d) after calculating, we obtain grid size in layout, then using these information to resize covers; (e) is the result.

Abstract

Online bookstores have highly thrived and changed consumer behaviors in these years. However, most customers go to online bookstores only when they have specific targets. One reason is that the current web interfaces are usually too complex and cluttered for users to browse. In addition, current visualization interfaces only display the results associated with a single attribute, thus requiring users to interact intensively to find their targets. Inspired by the user experiences (UX) in physical bookstores, we present Bookwall, an online bookstore interface which comprises two components: Category Map and Wall View, enabling users to find their targets more efficiently and releasing users from the burden of complicated operations. Specifically, the category map produces a map with a "natural" map-like look, providing an overview of the clusters and neighborhood of book categories. The wall view enables displaying query results satisfying dual query attributes simultaneously. The results show that Bookwall can provide the users a favourable alternative visualization.

Index Terms: I.3.8 [Computer Graphics]: Applications—; H.5.2 [Information Interfaces and Presentation]: User Interfaces—

1 Introduction

Online bookstores have gained much popularity with consumers in recent years. They offer savvy shoppers a host of benefits, from customer convenience and access to a great variety of books and significant cost savings. Without being constrained by limited shelve space, they attract consumers who prefer variety and efficiency.

To display a vast number of products, current layouts of online bookstores usually follow a list style of elements, which are arranged in sequence[1]. By giving proper keywords or right categories, users can find their desired books with the aid of search engines. However, searching and browsing books online from millions of titles, bestsellers, and old classics still requires intensive user interaction due to the following difficulties. First, to find the correct category for a specific target, users must select different categories of search filters to traverse the hierarchy (of search results) (Fugure 2). Second, since the number of items which can be displayed in a singe page is limited, one option to check the relevance of search results would be to manually screen results for each query. That might be pretty time consuming. Finally, traditional interfaces offer a natural way to list books according to their relevance to a single attribute query (e.g., customer review, price, etc.), however, a direct visualization of query items satisfying multiple attributes is still missing.

Providing efficient and effective data visualization for visual exploration is a difficult challenge for online bookstores. One challenge lies in developing efficient methods to visualize large numbers of book items. Another challenge is to develop an effective visualization that makes the underlying search patterns and book attributes easy to see. All of these tasks become even more difficult with the incresing size of data. Motivated by the user experiences in physical bookstores, we present Bookwall, a visual exploration system for online bookstores, that solves aforementioned problems and helps readers to find desired books more efficiently.

There are two components in our system, namely *category map* and *wall view*. The category map is a map representation, which

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[1] `http://www.amazon.com/`

Figure 2: In conventional online bookstore interface, the category is usually arranged as a drop-down list while containing levels of search hierarchies. It requires extra attention to navigate.

provides visual clues to navigate a selection of categories, assisting readers to retrieve and remember desired categories and traverse the hierarchy. The usefulness of our proposed category map is supported by psychological studies that the human brain has a remarkable ability to memorize visual images and positions better than keywords. The wall view allows us to encode two different the search results under two different attributes, namely relevance and popularity. We present BookWall, a visualization system for representing books in online bookstores. Our work has the following contributions: (1) We introduce the *category map* and *wall view* that transfer user experiences from a physical bookstore to an online bookstore to enhance the efficiency of online navigation. (2) We proposed a visual exploration interface that supports dual attributes search to improve meaningfulness of search result.

2 Related Work

2.1 Search Result Visualization

Search visualization for the search content requires a structured information space to relate the search results to the overall space. Clarkson *et al.* [6] introduced ResultMaps concept, a treemap-based search visualization system to enhance query-based search engines. We also adopted the treemap representation [1] [11] for layout generation, but our work is different from theirs in two aspects. First, node sizes in ResultMaps are unweighted, and this reduces the amount of information of ResultMaps convey. In contrast, node sizes and positions in BookWall are simultaneously adjusted according to different query attributes. Secondly, the entire repository hierarchy are encoded via the space-constrained treemap technique in ResultMaps. In our BookWall, it allows to dynamically change the number of items displayed by the treemap, thus supporting scrollable panel interface of online bookstores.

2.2 Image Browsing

The challenge of more efficiently browsing a large image dataset has generated a vast literature of different solutions. Dork *et al.* introduced VisGets [5] with visual overviews of multiple aspects of Web resources to facilitate the exploration of blog entries by time, geographic location and tags. Brivio *et al.*[2] proposed a thumbnail-based interface to browser large collections of images. Their method closely fills a freely shaped thumbnail area with a large number of significant images, however, the generated irregular shapes are not suitable for displaying book covers. Our work is also related to serendipitous discoveries through information visualization. Hinrichs *et al.* [10] described EMDial and discussed the potential for, and challenges of, information visualization in the museum context based on the practical experience. Thudt *et al.* [13] presented the Bohemian bookshelf that consisted of five interlinked visualizations that that each offers a unique perspective on a digital book collection. In our system, we aim to support serendipitous exploration of digital book collection through a more integrated interface.

3 Bookwall Design

Online bookstores attract a large proportion of consumers who prefer variety and cheaper price. In addition, they also provide easy access to customer reviews and offer price comparison. Nevertheless, these advantages do not make customers spend lot of time browsing online bookstores. For customers, the design and operation of a web interface are still too complex to explore. In Bookwall, we are interested in integrating the experience from physical bookstores, enabling better navigation for users, and discovering and comparing information using the web interface.

3.1 Observational Study to Inform Interface Design

We conducted a field study to develop a more in-depth understanding of the differences between online and physical bookstores in terms of visual exploration. We went to a physical bookstore and had the following observations: (1) It is intuitive for people to map the location of a region via a map structure, thus making exploring a bookstore and going back and forth to different areas easily. (2) People can glance around the bookstore to get the basic information, e.g. bookcovers and titles of a vast amount of products in a short time. This information is useful for browsing experience and also facilates their search process. We also interviewed 13 customers in a physical bookstore and asked the following questions during our interview:

- Why do you visit physical bookstores?
- Why do you visit online bookstores?
- What's the differences between real bookshelves and virtual book lists?

The result of our field study is shown in Figure 3. Most participants visit physical bookstores because they want to find new books or to relax and experience the atmosphere. They usually do not have specific books to buy in mind. In contrast, people go to online bookstores usually when they have specific books in mind and would like to search from a variety of source to get a better price.

Besides the above questions, the participants also mentioned the problems of online interfaces. First, current available interfaces for browsing products are usually complicated. To find the books, people actually have to figure out under which data field the right category is, where in the hierarchy they currently are. Or, people have to first think through how to specify a necessary keyword to see the product they want. Second, space in product display list is limited, thus only a few number of items are shown in a single page. In order to traverse the long product list, it requires users to click multiple pages, which is time-consuming. Finally, products are listed according to a single search criterion. However, when people want to compare the products full-filling different search criteria simultaneously, they need to remember results from different query attributes separately. In conclusion, we attempt to improve the following flaws to improve the user experience in online bookstores.

- Categories are complex to traverse and hierarchy are too deep to remember.
- The number of books being displayed is limited and scrolling and page turning are time-consuming.
- Visualization interfaces do not support visualizing search items satisfying multiple query attributes concurrently.

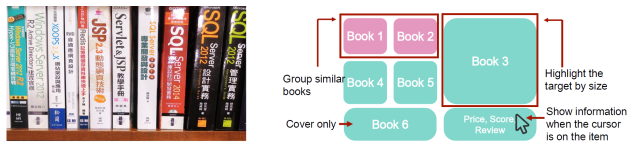
4 Designing Bookwall

The basic idea behind Bookwall is to adapt the design principal of a physical bookstore for an online interface in order to enhance the efficiency and user experience of book browsing. In particular, we aim to provide:

- A visual exploration interface that helps users to browse category lists intuitively.

(a) (b)

Figure 3: The result of our field study. Reasons to go physical bookstores by participants in (a) and online bookstores in (b).



(a) (b)

Figure 4: The book covers are shown in the physical bookstores(a). The concept of our wall view (b); books of similar topics are put together and a book's popularity is highlight by its representative size.

- A compact use of screen space that allows more books to be displayed than conventional list layouts without negatively impacting the readability of products.
- A dual attribute visualization interface enabling users to compare products fulfilling various search criteria.

4.1 Scenarios

4.1.1 Keeping track of the category

Benson loves reading. When Benson browsed online bookstores, he usually found the product by clicking categories from a drop-down list. He needed to keep several tabs open, but in fact, it required him to keep track of different product items and switch back and forth between his open pages. He often remembered the position of each category, but he still had trouble recalling all of them and which hierarchy he currently browsed, as well as keeping tracking of the related topics, especially because he wanted to compare the books of similar book categories.

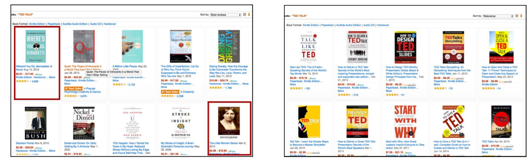
4.1.2 Displaying dual attributes in a single view

Susan is a student and recently got interested into photography. She goes to Amazon.com to find books for beginners. Besides the price, she also cares about book's popularity. In order to find the products with both low price and high popularity, she had to choose different query attributes to dive into, and made a note of items that ranked high. While this helps her find out the qualified and affordable items, it takes her a lot of time. Being able to display the products satisfying multiple attributes in a single view might have helped her increase the efficiency in her shopping experience. An illustration of this problem can be found in Figure 5(a) and (b).

4.2 Design Rationale Summary

Our primary goal with Bookwall is to preserve the advantages of online bookstores, while incorporating more direct interface and the ability to display the products fulfilling dual search attributes. We also aim at supporting the two usage scenarios described above.

- Benson found the drop-down list complicated; the order and sub-fields of categories changed when he browsed different hierarchies and Benson may not have remembered all the field names from previous level. He needs to have an overview of all categories to remember the location and neighborhood structure of similar categories.
- Susan is familiar with web interfaces. She has a good memory of the previous search results. However she may need to dive into different pages and cross-reference previous search results to get a understanding of what products that fulfill multiple search conditions.



(a) (b)

Figure 5: In (a), it shows the product list according to the keyword relevance (*TED Talk*), we highlight the top 1 and the top 10 relevant items by red rectangles. After sorting by review number, these two high relevant items are not shown in the top list (b).

4.2.1 Category map

Inspired by a psychological study, most people can remember images better than abstract knowledge, e.g., text. We propose the category map, which is a map representation and a powerful visual feature that helps people to recall or relate to memories of complicated and various abstract knowledge, thus helping users navigate categories with ease and find the target category rapidly,

Our category map is generated by grouping and clustering the text information from a drop-down list. In the proposed category map, each block represents a specific category. The categories of related domains are put nearby each other. In addition, they are also assigned by the same color while the colors are chosen based on color psychology in the hope that people can quickly associate them with the corresponding categories. The positions of each block are chosen based on our field study in the physical bookstore and also the arrangement of list in online bookstores.

4.2.2 Wall view

Information Hiding. Book covers are commonly made prominent and customers are attracted to the design and thus drawn to these books. Inspired by this fact, to give people an overview of the products, it is critical to not impose additional cognitive demands required for explicitly checking the details. In our design, the space in the container is partitioned into rectangles. For each rectangle, only the book cover is used to represent the book. Other information, like price, reviewer number and scores is hidden unless the cursor is placed over the rectangle. This provides an overview and makes more compact use of the space.

Dual attribute visualization. Most search interfaces developed so far usually display the products associated with a single search criterion that users apply, e.g., relevance, average customer review, price, etc. When users want to find those products matching multiple attributes, they need to cross-reference different search results. A straight forward solution is to normalize score for each attribute. However, it is difficult to combine the scores. To leverage different visual cues, we utilize the rectangle position and its size to encode the different attributes. In particuly, we use the rectangle's location to represent the relevance associated with the keyword and the size to indicate the book's popularity. In this way, people can focus on those items that are displayed early on in the product lists and skip those books with small representation. The concept of our design is illustrated in Figure 4.

5 Bookwall Generation

5.1 Data Pre-processing

We collect data from Amazon.com[1], which is the best-known name in the online bookstore industry, to generate representative samples.

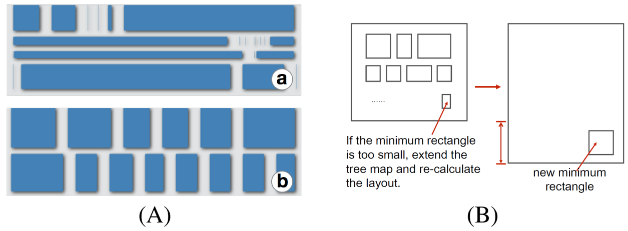


Figure 6: Grid layout before adjustment (a) and after adjustment (b) in (A). The height of the container is extended till the minimum grid size generated by treemap algorithm is larger than the threshold (B).

We retrieved data via Amazon Product Advertising API[2] and parsed the information within the product list, including book covers, book titles, scores, prices, reviews and drop-down category list.

5.2 Wall View Generation

We initialize our wall view with a grid of uniformly sized rectangles. We aim to utilize the location and size to represent independent attributes, namely relevance and popularity respectively. To achieve this, we partition the space into differently sized rectangles and generate a layout suitable for online book browsing. The steps include: (1) calculating representation size of each book according to its popularity, (2) generating the page layout, (3) then applying an image resizing technique to the resulted layout. We now explain these steps in detail:

Grid Size Encoding. While the position of a rectangle depicts a book's relevance, its popularity is encoded by its size. For a popular book, its average score and review number should have both high ranking. Thus, to reflect the level of popularity of a book i, its grid size A_i is calculated as:

$$A_i = (s_i - 3) * r_i, \tag{1}$$

where s_i is the average reader score and r_i is the review number for a book i. Note that the average scores range from $0 \sim 5$, thus books with a score of less than 2 are generally not popular thus are not recommended in the resulted list. We subtract 3 (the average) to enforce this constraint. However, if the distribution of the result is too diverse, there will be some rectangles with extreme sizes. We solve the problem by adjusting the sizes of rectangles with extreme values, which are identified with the help of the Hampel Identifier algorithm [8] [9]. We use $O = \{o_j\}_{j=1}^{n}$ to denote the grid index with extreme sizes. The adjusted size A'_{o_i} is obtained by:

$$A'_{o_j} = A_{rm} + \lambda_1 * \frac{A_{o_j}}{A_{rm}}, \tag{2}$$

where A_{rm} is the maximum size among all non-outlier grids, and λ_1 is the predefined constant. Finally, the final rectangle size of each book B_i is computed as follow:

$$B_i = \begin{cases} \sqrt{A'_i + \lambda_2}, & \text{if i} \in O \\ \sqrt{A_i + \lambda_2}, & \text{otherwise,} \end{cases} \tag{3}$$

where λ_2 is a constant. The comparison of unadjusted and adjusted layout can be found in Figure 6(A).

Layout Generation. After each grid size is estimated, we create the page layout for compact use of space. Although the squarified treemap [3] can be used to generate a layout where rectangles are approximated by squares, however, it is developed under the constraint that all the data are displayed in a fixed container, thus it is not suitable for unlimited web data as found in an online bookstore. To generate the layout in a scrollable container, we propose the following procedure:

[2]http://docs.aws.amazon.com/AWSECommerceService/latest/DG/Welcome.html

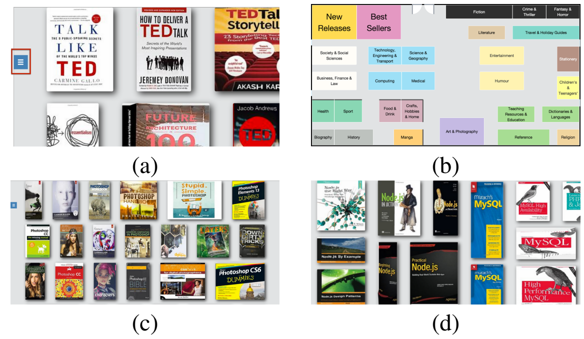


Figure 7: Bookwall demo. (a) and (b) is our category map. (a) The category map is hidden as an icon; (b) When the cursor is on the icon, the category map will slide out. (c) and (d) are the dataset *PhotoShop* under price and score-review mode respectively.

1. Determine grid size according to Eq. 1 and generate the layout using the squarified tree map algorithm.
2. Find the minimum rectangle size τ in the initial layout.
3. If this size (τ) is smaller than the predefined threshold, extend the height of treemap container. Then, recalculate the layout using tree map algorithm.
4. Repeat step 3, until the minimum rectangle size is larger than the predefined threshold.

Through the above procedure, the tree map container can be extended and achieve infinite scrollable tree map effect, thus avoiding generating representation with extreme sizes. An illustrated of the procedure can be found in Figure 6(B).

Image Resizing. After the page layout is generated by the above procedure, we apply the structure-preserving image resizing technique [4] to resize each book cover into the corresponding dimension. Since the book cover can greatly influence the purchase intention, we preserve important information on each, such as book title and author as complete as possible after resizing. We use a saliency detection method [7] to detect important regions in book covers and an OCR technique [12] to preserve book title and author name in the resizing process.

6 Result and Discussion

The results of our wall view are shown in Figure 7 (a) $\sim$ (d), where our wall view can exhibit more items than a traditional interface. The books from related domains are also placed to each together in our wall view. In Figure 7(d), the books on the left side are related to Node.js, while the books on right side are related to MySQL. This feature enables users to see the books from different yet related topics more easily. In contrast, these books are not grouped in conventional interfaces .

7 Conclusion and Future Work

We have presented a novel visual exploration system based on the user experience in physical bookstores. We propose two designs for online bookstore interface: category map and wall view. For the future work, the category map should offer to display the category hierarchy; the wall view design should support more than two attributes. Since the book covers are still distorted in the BookWall view, which might have negative effect for reading off information from that. The tree-map algorithm should be modified to consider the original aspect ratio accordingly.

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