Designing a Visual Analytic System to Represent Bookmark Sharing Data

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Abstract

Internet users can find the appropriate and useful information by reviewing their shared bookmarks [1]. We have developed a visual analytic system that represents bookmark-sharing data among the relative users and sites based on the extensive social bookmarking data of Delicious.com (also known as del.icio.us). The system enables users to explore sites and other users' blogs that may supply them with the information they need more efficiently. The system provides interactive view options of the bookmark entities through its User View and Site View. To improve the user's information search and sense-making process on social bookmarking, the system supports diverse visual analytic options utilizing its color scheme, dynamic interactions, scalable factors and tag clouds.

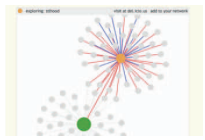
Introduction

An increasing number of Internet users are saving their meaningful resources as bookmarks and are obtaining valuable information from shared bookmark data [1, 4]. Delicious.com is one of the well-known social bookmarking sites that enable users to share their bookmarks with others. However, it lacks a clear way of organizing and displaying a large amount of bookmark sharing information. To remedy this situation, we have designed an interactive system that visualizes the extensive data of Delicious.com. Our system presents connections among the bookmark-related entities across different sites and users. By visualizing this connection, the system creates an organized portrait of information-searchable bookmark repository. As the number of sites they search and visit increases, it becomes increasingly difficult for users to remember each source and the connection among them. By giving them clear views of the bookmarked sites and relational users, the system can support the user's process of making sense of bookmark sharing and searching activities. Sense-making activities certainly include the types of investigations on which we focus, but they also include other activities [6], such as deciding which site or author has the most appropriate information. We expect that visual representations of bookmark-sharing data can help them to find, analyze, and use the most valuable information. For example, Norman [5] described how visual representations could enhance people's thinking and analysis processes. Card et al. [2] placed an emphasis on the visuals used in this manner as 'external cognition aids'. Therefore, we created a visual analytic system that depicts connections among the elements of Delicious.com including users, sites, tags and categories that reduce the time it takes for users to analyze, perceive and utilize information.

Related Work

Existing systems utilize the limited scope of Delicious.com data (e.g., only user or tag) or undefined overall information (e.g., *looks del.icio.us* (Figure 4)). The reason is that entities such as users, tags, and sites have their own structures. Besides, it's hard to configure relationships and balance among them. Kunal Anand created *looks del.icio.us* as an art piece which was incapable of clarifying the number of users, the data type or the meaning of each node or edge. It could only show the complexity of Delicious.com data.

Figure 2.



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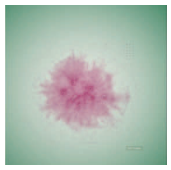

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Figure 6.

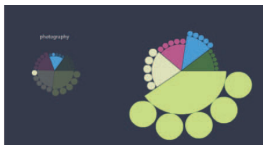


Figure 5.

Figure 2. – Figure 6. Related works: 2. Delicious Tag Cloud; 3. del.icio.us Network Explorer; 4. looks del.icio.us; 5. Delicious Main Map; 6. Browse.delicious (Clock wise).

If a project focuses on users, it becomes a social network visualization like that of Facebook. Michael Schieben mapped relationships among users registered in Delicious.com's friend network to the directed graph on his *del.icio.us network explorer* (Figure 3). If a project concentrates on tags, its main purpose is to show the hierarchy of tags. Inan Olcer visualized the tags of Delicious.com in his system,

Delicious Tag Cloud (Figure 2), but it was unable to represent the dynamically changing data of Delicious.com. Pietro Speroni di Fenizio created *Delicious Main Map* (Figure 5), a clustered interactive mind map of a particular user's tags, but it couldn't visualize the relationship among users. *Browse. delicious* (Figure 6) is a visual browser that lets users browse through a dataset of Delicious.com to see relationships among its entities; however, the browser couldn't recognize each user as an individual attribute, so its data is aggregated into a dataset of just one user.

Bookmark-Sharing Data

Delicious.com has an ever-changing list of bookmark data. Whenever the web page is refreshed, the list is rearranged. This update process not only accumulates new information but also change the list of information in a random order. Thus, a user is unable to get user-specific information directly from Delicious.com; there is no option for users to retrieve and compare bookmark-sharing data by popularity, connectivity, update, etc.

First of all, to interconnect the entity-related information of Delicious.com and configure the information as visual objects, all entities of delicious.com are represented as nodes. Thus, entities – such as websites, users, and tags – have nodes and corresponding edges that are consistent with their attributes. In addition, to create edges in order to thereby connect the nodes, we have made the fundamental structure of connective interactions with the following classifications: website to user, user to website, tag to user, and user to tag.

System Description

To provide multiple perspectives on the bookmark-sharing data of Delicious.com, our system presents the bookmark data through two distinct visual representations, which are called 'views'. Each view focuses on different entities. *User View* visualizes the users that are connected with the current system user's selections on tags and sites, whereas *Site View* visualizes the connected sites. The system utilizes the shared *tag* as a bridge or a mediation point to show the relationship among sites. We made these views to reflect two different types of insights in Delicious.com's data: (1) We classified quantitative records, such as the number of bookmarks and bookmark history of each site, as objective data, since Delicious.com gathers the records automatically. In comparison, (2) users assign their bookmarked sites to the tags based on their own opinions or intentions. We categorized this user-to-tag information as subjective data.

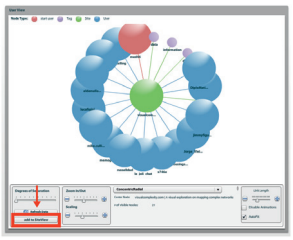
To visualize these two different types of data effectively, we developed the User View and the Site View. In both views, we chose graph representation as our data visualization method. Since those views need to show the connections among the user, site, and tag elements, a graph is the most effective way to depict their relationship. During the interactive transitions, each node represents a different entity, so we assign a distinguishable color to each entity. Two views interchange their filtered information on bookmark sharing data for a user to find the most suitable information from the best source(s).

User View

User view shows the connection between the Me-user (the current system user) and other users (Delicious.com users). (1) First, the Me-user is shown as the center node, and all tags which the Me-user has used for his bookmarked sites are presented as child nodes. In order to find the expert users in the specific field in which he is interested, the Me-user clicks one tag. (2) The selected tag then becomes the center node, and its related sites are represented as child nodes. (3) After one site is chosen, it moves to the center place, and other users who bookmarked the same site are displayed as child nodes. With these interactive transitions, the Me-user can see those related users who have similar interests and bookmarks. To find the experts, and not just the related users, we need to extract more information on users utilizing the Site View. The Me-user should send the information on the current center node, website, from the User View to the Site View by clicking the "Add to site view" button.

Filtering Process

When the Me-user selects any website in the Site View and clicks the "Add to user view" button to send the site information to the User View, the system then examines whether the related users in the User View also have that site as their bookmark or not. If any one of the related users also contains the same site as a bookmark, then the user's node color is changed from blue to gray; if not, then the color is not changed in the User View. If the Me-user repeats this process, she can narrow down her view to a few of the gray nodes. Since the gray-colored users have bookmarks of all sites which the Me-user selected from the Site View, the Me-user can assume that these filtered users are more expert. For the final step, the Me-user can select one of the gray-colored user nodes to visit the user's blog and get more information.



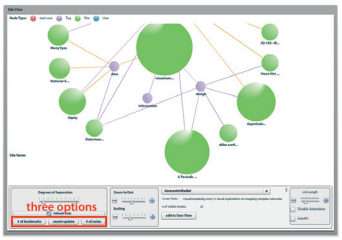


Figure 7. User View **Figure 8.** Site View
Figure 7. User View and its Add to Site View button.
Figure 8. Site View and its three visual analytic options.

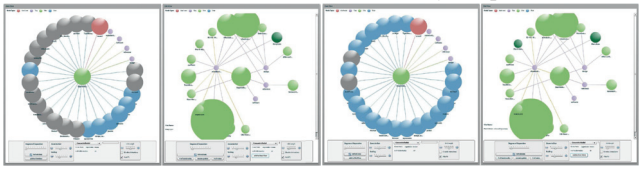


Figure 9. Filtering Process

Site View

If the current Me-user chooses a site in the User View, that site appears in the Site View as the center node with connections to related sites based on its tag category. When the Me-user selects one of the related sites and clicks the "Add to user view" button, the selected site information is sent to the User View, and the filtering process occurs in the User View. In order to optimize the filtering process, the Me-user needs to select a more important and interesting website as opposed to any random site that he knows. Thus, our system provides three visual analytic options to help the Me-user determine the most suitable websites.

• *Number of Bookmarks* – If the site has a larger number of bookmarks, then the node size is bigger. The default display attribute of the site view is the number of bookmarks.

• *Recent Update* – If a site has been recently updated, it indicates that the site has new information. The node size of the recently updated site is bigger than the others. The more recent the update, the bigger the node size.

• *Number of Notes* – Delicious.com users can write their comments as notes when they bookmark websites. In this view, the number of notes determines the node size of a site. Users can also see the word cloud of each site. If a user clicks a site node, its word cloud, which is made up of notes, pops up. This helps user by providing some brief information about the site, because the notes contain the site's keywords.

The node size of each site is changed in correspond to one of the visual analytic options. These three different view options could enable the Me-user to find the most appropriate site(s) for the consecutive user-filtering process in the User View.

More Features of the Visual Representation

For more effective navigation, we developed various types of visualization. The default type of view is a radial graph. However, if a user selects the hierarchical view instead, then the bookmark sharing data is represented in a tree structure. This view is a useful way to see the steps of link expansion from one site to other related sites. Since the sites are categorized by tags, the user can check how the sites are connected by tag-bridge. Furthermore, the user can zoom in/out to control the graph size and drag each node in any direction. When some nodes overlap, the user can enlarge a specific part of the graph and see each node by moving the overlapped nodes.

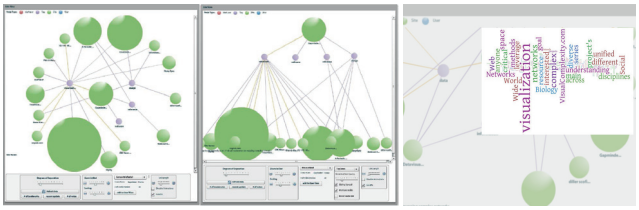


Figure 10. Radial Graph & Tree Structure. **Figure 11.** Word Cloud.

The user can increase/decrease the degree of separation, which indicates how deep the graph is. The default degree of separation of the User View and the Site View is one. If a user increases the degree of separation, she can see more complex connections of data in a wider range (Figure 12, 13). We made each view interactive so that it changes its status with animated transitions so users can see and follow the steps involved in their selection of data.

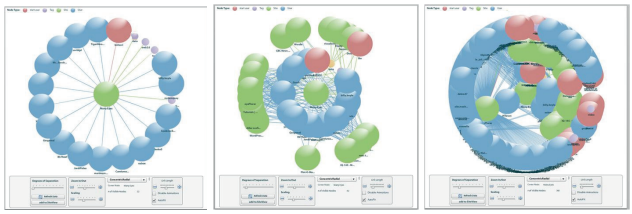


Figure 12. User View. Degree of Separation from 1 to 3.

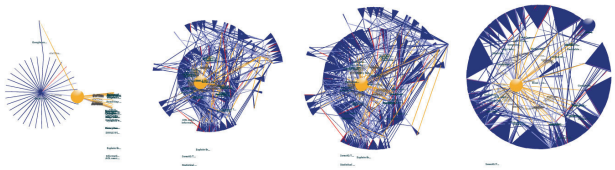


Figure 13. Higher Degree of Separation.

Conclusion

Delicious.com enables users to share bookmarks with other users; however, it does not offer any hidden insight of users and websites, which is more valuable than the mere sharing of data. We developed our system based in an effort to show all connections, not just partial relationships, and make it possible for users to gain an analytical understanding of this information. We used two interactive visualization mechanisms to show each value and relationship. In support of the visual analytic methods of the Site View, users can find a more refined group of experts in the User View. The system can provide insights as to who are the experts and what are the best sources from which to attain user-specific information as easy and effective as possible. Our approaches on bookmark visualization may suggest ways to improve the Web user's sense-making process and help to find the most proper information.

References

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