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Information und Wissen: global, sozial und frei?

Proceedings des 12. Internationalen Symposiums für Informationswissenschaft (ISI 2011)

Hildesheim, 9.—11. März 2011

vwh
Verlag Werner Hülsbusch
Fachverlag für Medientechnik und -wirtschaft

Usefulness Evaluation on Visualization of Researcher Networks

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Abstract

This study aims to analyze and evaluate usefulness on the visualization of researcher networks from the user's perspective. We selected the following four academic information services in the viewpoint of data set and level of functionality; Authoratory, Researchgate, Biomedexperts, and Academic.research. By six IT technology researchers and professors with doctorate, the services were evaluated based on functional quality criteria of information visualization elements and on information quality criteria served by the elements as a user study, and we concluded that it is necessary to overcome visual complexity in information visualization of researcher networks by showing additional information and by including additional attributes.

Key Words

Researcher network, Information visualization, Evaluation criteria, Functional and information quality

1 Introduction

Today's Web is cementing its place as core infrastructure of information services, and with the massive penetration of smart phones and advancements in mobile Web, information services are undergoing evolution in order to enable use them anytime, anywhere in any way, and by anyone. However, text-oriented information services require attention for reading, and domain knowledge and ability of reasoning for understanding correctly. This is one of the main factors undermining the user's ability to acquire information on the Web. Therefore, efforts have been made to maximize the usefulness of information perception by efficiently delivering a massive amount of information accumulated on the Web at an amazing speed, and information visualization is one of the fruits of such efforts [1]. In particular, information visualization and the use of graphic metaphors to that end have become major HCI design concepts involving information services.

Scientific visualization is a concept similar to information visualization [2] [3]. Scientific visualization differs from information visualization in that it visualizes real objects using computer graphic technology. Just like topography maps that show mapped, visualized information, information visualization can be designed in conjunction with scientific visualization. Information visualization can be explained with the following characteristics [4].

- Information visualization helps users quickly understand a massive amount of data.
- Information visualization helps users recognize important information instantly.
- Information visualization allows recognition of new attributes that are embedded in the information and are difficult to understand. For instance, users can recognize specific patterns embedded in information through visualization.
- Information visualization may cause problems with data themselves – because visualization may accompany quality control issues.

This study aims to analyze and evaluate usefulness on the visualization of researcher networks from the user's perspective. To this end, representative researcher networks that have been developed and operated as part of Web information services are chosen. By doing so, this study ultimately aims to contribute to practical development of technologies for information visualization that can enhance the usefulness of Web information services.

2 Visualization of Researcher Networks

2.1 Evaluation Targets

We have examined popular Web information services that are successfully serving information on researcher network-based academic research, and selected the following four academic information services in the viewpoint of data set and level of functionality.

- http://www.authoratory.com (Authoratory)
- http://researchgate.com (Researchgate)
- http://biomedexperts.com (Biomedexperts)
- http://academic.research.microsoft.com (Academic.research)

Authoratory uses a computer program for analyzing millions of academic papers available in PubMed and puts the analyzed results into a database, while providing information on 969,189 scientists including researcher profiles, research trends, researchers' social networks, and published papers. As a professional network for scientists, Researchgate has about 400,000 scientists registered, and provides information on published papers, participating research groups, and researchers' social networks. Meanwhile, Biomedexperts is a literature-based, scientific social network site that automatically analyzes millions of papers published in over 20,000 scientific journals and extracts information on authors, co-authors, and their affiliations. In so doing, the service has identified co-author relations of researchers working at over 3,500 organizations in more than 190 countries. Biomedexperts provides expert lists for each research area, as well as information on researchers' social network, research trends, and locations of their organizations. Finally, Academic.research provides information on researchers, researchers' social networks, and research trends, as well as information indicating a researcher's productivity including published papers, number of citations, G-index, and H-index, based on information extracted automatically from over 6 million papers. All of them are representative services that provide visualized researcher networks as well as academic information that is commonly required in the scientific and technological fields.

2.2 Researcher Networks

Researcher network visualizes relationships between researchers by symbolizing nodes and links with diagrams. It has emerged as a kind of social network, which is a representative service of Web 2.0. It also expresses desired information by using radial visualization technology and presents the correlations of each piece of information dynamically with images to help users visualize, compare, and recognize the relationships between information, flows, and characteristics in an intuitive manner. However, a larger number of nodes and worse too many induced links between the nodes undermine the ability to express and convey information.

A researcher network consists of two basic attributes, i.e. nodes and links, and the following additional attributes added on to control the two or to enhance information recognition.

- Color to discriminate nodes and links
- Link attribute to express strength of the relationships between nodes using width and length
- Information filtering control to constrain what to be displayed in the network
- Node metaphor to express a node's meaning using text or image
- Browsing control to change the shape of the network

Figure 1 shows an example of a researcher network offered by Biomedexperts. It provides information filtering control that filters information by selecting the number of Co-publications, Publications, and Connections. When a user moves the mouse over to a semi-transparent window, it displays relevant information such as the author's research profile, timeline, and publications (see the right screen of Figure 1).

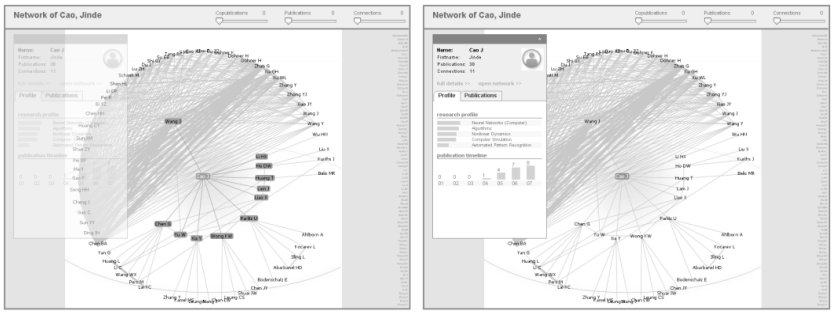

Fig. 1 Researcher network of Biomedexperts

In addition, when the mouse is brought over to the author's name shown on the network browser, the link between the author and co-authors connected at the 1st depth is displayed in blue, and the line becomes thicker if co-authorship is greater than average.

Fig. 2 shows a researcher network of Authoratory, which offers a simple service that displays the number of co-authored papers over the link between researchers. It supports relatively simple browsing control such as moving the node's axis, and if a user selects a specific node, a new network around the centered node is re-drawn.

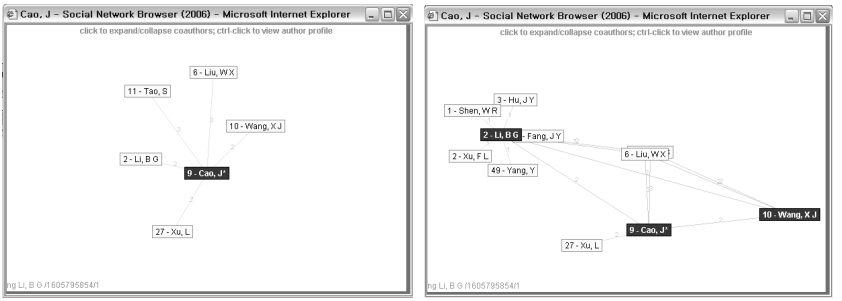

Fig. 2 Researcher network of Authoratory

Fig. 3 shows a researcher network of Researchgate. On this network, users can sort co-authorship relations by group or by interest area (See the right part of Fig. 3) using information filtering control located at the top of the browser.

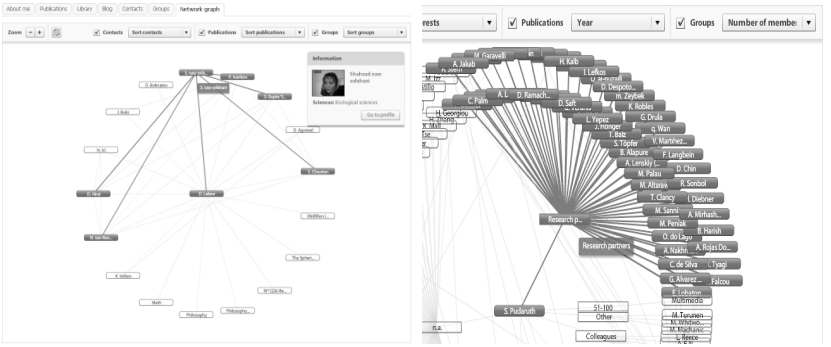

Fig. 3 Researcher network of Researchgate

Fig. 4 shows a researcher network offered by Academic.research. Users can press the buttons on the upper right part of the browser to reduce/enlarge or move it up and down and left and right. The length between nodes indicates the level of closeness in co-relationship. When a user clicks on co-authored publications, another pop-up window displays the list (See the right part of Fig. 4). The researcher network of Academic.research supports browsing control, node metaphor, link attributes among the above-mentioned additional attributes.

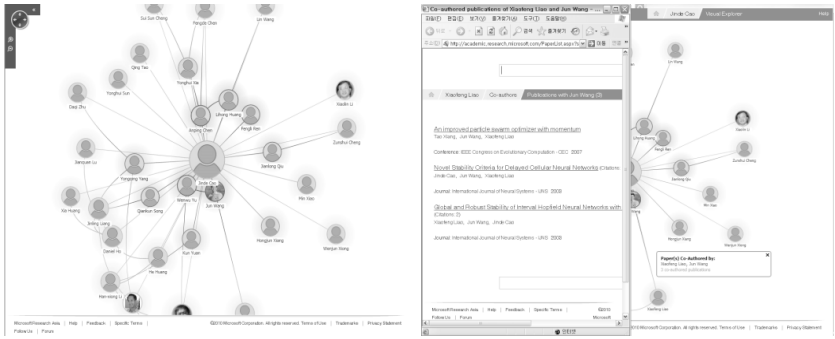

Fig. 4 Researcher network of Academic.research

3 Usefulness Evaluation on Visualization of Researcher Network

3.1 Evaluation Criteria

The usefulness of information visualization in Web information services can be evaluated based on functional quality criteria of information visualization elements and on information quality criteria served by the elements as a user study [5]. More specifically, the usefulness of elements for information visualization can be defined by the efficiency, effectiveness, and satisfaction of the set of functions and actions used to achieve the results desired by users as well as the visualized results. This study defines the functional quality criteria and information quality criteria, as follows, to evaluate the usefulness of the elements by referring to ISO9241-11 and ISO9126-1 [6] [7].

- Minimal action: Is it possible to acquire a desired result with minimal actions?
- Resource utilization: Are visualization elements sufficiently utilized for performing a given task? (ISO9126-1: Efficiency-Resource behavior)
- Operability: Are essential efforts to operate and control the information service performed with ease? (ISO9126-1: Usability-Operability)
- Feedback: Does the information service give feedback for the user's action?
- Navigability: Can users move and use the service environment easily from the perspective of functional quality?
- Time behavior: How fast can functions be performed and how much time does it take for information to be loaded and visualized? (ISO9126-1: Efficiency-Time behavior)
- Consistency: Are visualization elements consistent and do they deliver their meanings to users sufficiently?
- Accurateness: Do functions bring about a desired result or effect? (ISO9126-1: Functionality-Accurateness)
- Completeness: Can users perform and complete a given task clearly?
- Attractiveness: How attractive is the environment of the information service to users?
- Flexibility: Can users customize the user interface of the information service according to their preferences?
- User guidance: Does the information service give feedback for the user's action appropriately and supportively?
- Visualization type: Is it possible to visualize information in the format desired by users?
- Report type: Is it possible to create reports in the format desired by users?
- Information accuracy: Does visualized information meet the user's needs accurately?
- Information completeness: Is served information complete enough to satisfy the user's needs?
- Information navigability: Can users navigate in served information easily and quickly?
- Information individualization: Can served information be utilized to meet individual needs such as email transfer, saving files, sharing through Twitter and use group?

3.2 Evaluation Process

Six IT technology researchers and professors with doctorate were involved as test persons (TPs). Each TP performed the following task on the four services introduced in Chapter 2 and evaluated information visualization for researcher network services according to the evaluation criteria mentioned in 3.1 [8] [9].

- Task: Give a name of an expert in your own field into each service and investigate the expert's researcher network it provides. (e.g.) Search for "Jinde Cao" who is an expert in 'neutral network' field.

TPs quantitatively assigned each evaluation criterion with a value between 0 ~ 5, with one unit being 0.5, and were allowed to discuss pros and cons of visualization elements qualitatively. The following heuristics were used to perform the user test.

- Visibility of system status: The test environment was prepared so that both TPs and an observer can simultaneously monitor how the task is being performed.
- Match the system to the real world: Ensure that the test environment matches the TP's actual work environment as closely as possible.
- User control and freedom: TPs have the freedom to use the test environment and to perform the test.
- Help and assistance: If required by TPs, the observer can provide answer to their questions as long as such support will not affect test results.

3.3 Evaluation Results

For Biomedexperts, TPs judged that the list on the right side and the additional information on the left side shown in conjunction with a researcher network explain the network in a very efficient manner. Also, they suggested that additional attributes such as color and information filtering control are adequately applied to enhance the user's ability of information recognition, and the graphic chart provided with a co-author list helps users recognize a researcher's research trend easily. They also gave a high score on the feature that the service does not require screen changes.

Table 1. Evaluation Results on the four Researcher Networks
(FQ: Functional quality, IQ: Information quality)
Resource utilization was not evaluated since it cannot be evaluated by users.

Evaluation criteria		Biomed-experts	Authoratory	Researchgate	Academic. research
FQ	Minimal action	4.50	3.42	2.25	4.00
	Operability	4.75	3.08	2.08	3.75
	Feedback	4.83	3.08	2.42	4.17
	Navigability	4.92	3.00	2.50	4.33
	Time behavior	5.00	3.67	4.33	4.50
	Consistency	4.50	3.58	3.25	4.58
	Accurateness	4.83	3.33	2.92	4.75
	Completeness	4.83	3.67	2.75	4.75
	Attractiveness	4.67	3.83	2.08	3.83
	Flexibility	4.25	3.50	2.00	4.00
	User guidance	4.42	3.42	2.17	3.83
	Average	**4.68**	**3.42**	**2.61**	**4.23**
IQ	Visualization type	4.17	4.00	1.83	4.42
	Report type	N/A	4.00	N/A	N/A
	Information accuracy	5.00	4.50	1.25	4.67
	Information completeness	5.00	4.75	1.17	4.67
	Information navigability	4.42	4.25	1.25	4.17
	Information individualization	3.75	4.75	1.00	N/A
	Average	**4.47**	**4.38**	**1.17**	**4.48**

While TPs assigned a rather high score to information quality, they gave a relatively low score to functional quality for Authoratory. They pointed out the limitation in displaying co-authorship of a specific year only, the difficulty of recognizing the entire researcher network, and confusion caused by excessive and redundant presentations of the same information with various visual elements. In other words, the more information is provided from the researcher network, the more complex it becomes due to the absence of additional attributes to resolve this issue. However, the contribution of Authoratory to user satisfaction received a positive evaluation, as it provides a method to personalize search results.

Researchgate received relatively poor scores from TPs because it provides a network service for researchers that are in contact with a given researcher in the viewpoint of social network, rather than researcher network based on co-authorship or citation relationship.

Academic.research provides a researcher network service with a relatively simple structure. In other words, it provides an intuitive service function; a node is shown as a picture image when its corresponding researcher's image file is available.

4 Conclusion

We defined functional quality criteria and information quality criteria and then evaluated four major information services focused on researcher network. The researcher networks evaluated through this study commonly use diagrams to represent nodes for researchers and links for the relationships between them, thereby visually indicating their correlations to users. They present an issue of diminished ability to express information with a larger number of nodes and more complicated links between the nodes. Therefore, as in the case with Biomedexperts, we concluded that it is necessary to overcome this challenge by showing additional information and by including additional attributes such as information filtering control. As another conclusion, such services should carefully consider the functions that can complement limitations of visualization elements rather than aesthetics of design.

In the future, this study will be expanded to additionally evaluate visualized graphs and lists that provide information on researchers and research trends.

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