Study on Providing Multi-faceted Information on Technology Intelligence Service

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Abstract. In this study, we propose an information visualization method that provides multi-faceted information about technologies, research agents and research results on technology intelligence service supporting researchers to facilitate strategic planning and decisions. We consider selecting a suitable type among existing visualization types to increase the efficiency of information delivery and then customizing it for multi-faceted information. In this manner, we select an appropriate visualization type and then add meaningful information by using additional features such as color and size of node. As further work, we would like to develop an automatic explanation module for all visualizations in the technology intelligence service.

Keywords: Multi-faceted Information, Technology Intelligence Service, Information visualization.

1 Introduction

Due to the flood of information on the web, researchers require a system that enables them to analyze high volumes of data and subsequently valuable information that will be helpful to their research. We have developed a technology intelligence service that supports researchers in decision making and strategic planning by analyzing bibliographic information and implicit data in large-capacity academic literatures[1]. The technology intelligence service is a decision-making support system mainly composed of technologies, research agents (countries, institutions, and researchers), and research results (papers and patents). Information visualization displays high volumes of information on screens in the form of graphics, helping users to understand the information intuitively [2].

This paper describes an information visualization method that provides a large scale of information in an effective and intuitive manner, which is required to effectively express multi-faceted information on the technology intelligence service.

2 Types of Visualization for Multi-faceted Information

Types of visualization commonly used include tables, graphs, plots, maps, matrixes, and trees. A service developer selects a type of visualization that is suitable for the

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characteristic of data to effectively provide information to the user. As seen in the Table1, types of visualization can be divided by the characteristics of the data [3].

Table 1. Types of visualization divided by the number of dimension

One dimension	Two dimensions	Three dimension
Scatter plot	Table	Scatter plot
Line graph	Scatter plot	Heat map
Bar graph	Box plot	Rubber sheet
Tree	Matrix	Parallel coordinates
Basic chart	Bubble chart	

In general, most types of visualization tend to encompass difficulties in supplying comparison and analysis of multi-dimensional objects, because they are primarily designed to intuitively understand analysis of a single object and comparison between two objects. The reason for difficulties in displaying a multi-dimensional data lies in the 2D nature of the computer screen. Therefore, when 3D and higher data are represented on a 2D screen, some information is likely to be missed. Furthermore, users are more accustomed to 2D-visualization than 3D, and consequently have difficulties in understanding 3D data [3]. Multi-dimensional data can be represented in 3D by utilizing motions such as space or rotation, but due to restrictions on screen, the data is likely to be occluded by other points that might be in front of it. Accordingly, it is more effective to represent data in several 2D-data sets rather than in a single 3D-data set.

Hence, we exploit a method that combines several types of existing 2D visualization to represent multi-dimensional information of the technology intelligence service, rather than designing a new type of visualization. This is based on the idea that efficiency in information delivery can be maximized as the user is able to grasp the service intuitively.

3 Information Visualization on Technology Intelligence Service

In this chapter, we describes a method of visualizing multi-faceted information by citing a case of a Technology/Agent Map service that offers an analysis of correlations among technologies, research agents, and research results. The Technology/Agent Map service searches its related technologies and compares research results of the technologies by their technologies and also by their major researcher agents and also provides competitive/cooperative relations among research agents.

We adopted 'Bubble chart' that can show the multi-faceted relation among technologies, research agents and research results by three aspects such as a vertical axis, a horizontal axis and a node. That is, the X axis refers to research agents, the Y axis to technologies, and the node to research results. The amount of research results that a research agent achieved on a technology is represented with the size of the node. In addition, the user is allowed to change conditions so that he or she can get analyzed results from different points of views. More specifically, a select box and a

sliding bar are placed on the X axis, Y axis, and node to change the technology relations (association relations, element relations), a granularity of research agents (researchers, institutes, and countries), and the type of research results (academic-centered, business-centered). However, it was difficult to represent competition and cooperation relations among agents researching a specific technology, and a paper/patent in research results on a screen. In order to resolve these difficulties, we considered adding explanatory notes on a node or representing the node as an image. However, in the case of a small node, this is likely to decrease discrimination of the node. Hence, we decided to display the information with color and chroma of a node.

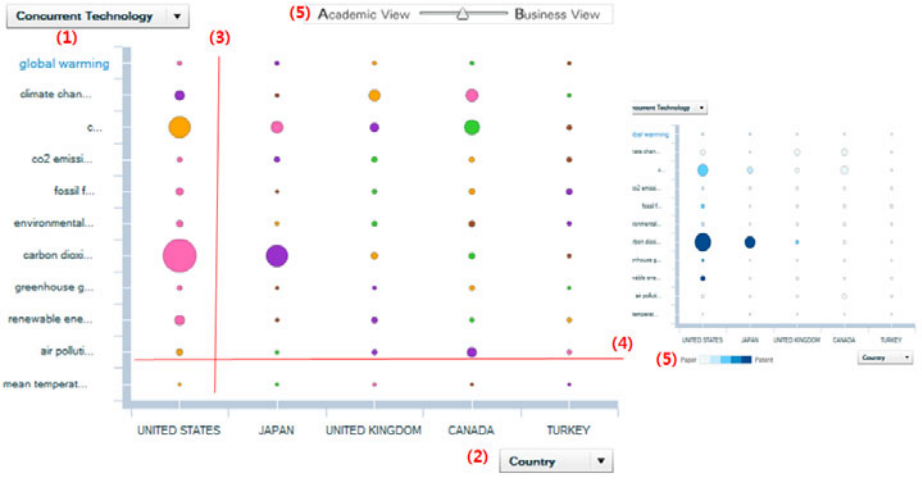

Fig. 1. Technology/Agent Map of Technology Intelligence Service shows as follows. (1) The technologies related to the searched technology, (2) Major agents researching the searched technology, (3) R&D results concentration of major research agents on each technology, (4) Competition/cooperation relations among research agents on each technology, (5) Research/business dependency of research agents on each technology.

Figure 1 shows a snapshot of the Technology/Agent Map when the 'global warming' technology is given as a target.

- The Y axis and the X axis display the target technology and its related technologies and leading countries researching those technologies, respectively. Research results can be compared among the research countries and also technologies.
- The level of concentration on research results can be compared by each node size of technologies and research agents. It is possible to understand which one among the technologies a specific research agent concentrates on. In the case of the US and Japan, they are found to concentrate on 'carbon dioxide' technology.
- The color of a node provides information on the competition/cooperation relations among research agents for each technology. Research agents whose nodes have the same color have cooperative relations while those otherwise have

competitive relations. It is found that the US and Canada maintain cooperative relations in the 'air pollution' field.

- The chroma of a node is divided in five stages to provide the paper/patent ratio of research results, based on which research type of agents (academic- centered or business- centered) can be identified.

4 Conclusion

In this paper, we proposed an information visualization method where a technology intelligence service supporting researchers to make decisions can effectively provide massive amounts of multi-faceted information to a user. We selected a visualization type that suits the purposes and enables the user to understand the information intuitively and subsequently gave information by utilizing all functions of the visualization selected. This makes it possible to represent the visualization of multi-faceted such as technologies, research agents and research results. However, if a lot of information is delivered at once, intuition could be decreased, consequently making it difficult to provide clear information. When the information is represented with node colors in the "Bubble Chart" we chose, if there is no additional description on the color, a user could not be aware of the color information. In the future, we will additionally develop an automatic description module on the technology intelligence service to address this problem.

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