Visualization Tools for Self-Organizing Maps

Christopher C. Yang[1]
Department of Computer Science and Information Systems
The University of Hong Kong
Pokfulam Road, Hong Kong
(+852) 2859 2173
yang@csis.hku.hk

Hsinchun Chen
Department of Management Information Systems
The University of Arizona
Tucson, AZ 85721, U.S.A.
(520) 621-2748
hchen@bpa.arizona.edu

K. K. Hong
Department of Computer Science and Information Systems
The University of Hong Kong
Pokfulam Road, Hong Kong
kkhong@csis.hku.hk

ABSTRACT

Various statistical and pattern recognition techniques, such as concept spaces and category maps in the Illinois Digital Library project, has been explored to solve the semantic interoperability problem in DLI-1. Self-organizing category map is identified as a powerful tool for information summarization. However, visualizing a large-scale self-organizing map in a restricted size of window is difficult. For smaller regions, displaying labels is infeasible. In this paper, two visualization tools, fisheye view and fractal view, are presented. It assists users to visualize a large-scale self-organizing map geographically and semantically.

Keywords

Information visualization, fisheye view, fractal view, self-organizing map, semantic interoperability, information retrieval, clustering.

1. INTRODUCTION

In digital library project, large-scale information is organized in the forms of self-organizing map or neural networks. Specifically, a self-organizing map (SOM) algorithm is utilized for building category map [8] . In category map, documents that are similar (in noun phrase terms) to each other are grouped together in a neighborhood on a two-dimensional display. Each colored region represents a unique topic that contains similar documents. Topics that are more important often occupy larger regions.

To visualize the details of a large-scale SOM effectively is a difficult task. Displaying all details of a large scale SOM in a limited size of window interface is impossible. For example, to display 100 regions of a SOM in 1000 by 1000 pixels window, it is impossible to visualize the details in each region or even display the corresponding noun phrase terms on all regions.

DL 99, Berkeley, CA USA

There are several possible solutions for visualizing the SOM, however, they all have their drawbacks:

- Display all information to show the global structure
  - the details are typically too small to be seen clearly.
- Zoom into parts of the SOM to view the local details
  - lose the global structure.
- Use two or more windows where one is displaying the global structure and others are displaying the local details
  - it requires additional screen space to fit multiple windows and the users have to mentally integrate windows together to get the whole picture.

In this paper, fisheye view and fractal view are proposed to visualize the SOM. Fisheye view is helpful in visualizing the local details in the areas of interest without losing global structure. Fractal view helps to remove the less relevant information automatically.

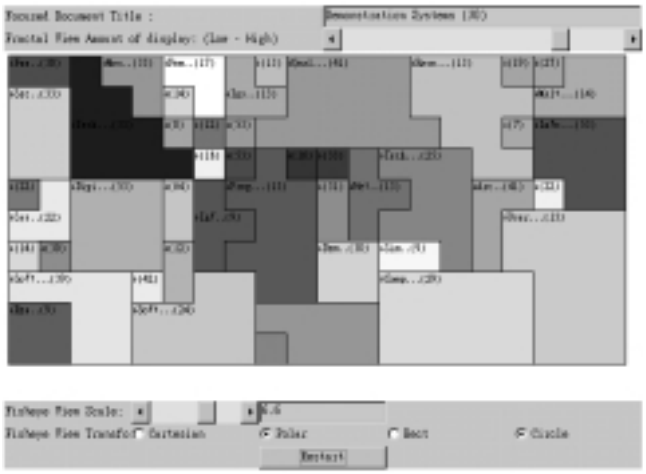

Figure 1 An example of an initial display of a SOM with 10×20 regions.

[1] Starting from January of 2000, the affiliation of Christopher C. Yang is Department of Systems Engineering and Engineering Management, The Chinese University of Hong Kong, Shatin, N.T., Hong Kong. Email: yang@se.cuhk.edu.hk.

2. Self-Organizing Map

Artificial neural network based self-organizing map (SOM), developed by Kohonen [3] , has been applied to large-scale textual analysis. Lin [5] adopt the self-organizing cluster of important concepts in a small database of several hundreds documents for textual analysis. Chen [1] developed a scalable multi-layered and graphical SOM approach to Internet categorization. Approximately 110,000 homepages were used in the prototype.

The SOM category map clusters similar documents together and automatically assigns label to the categories. Similar documents, which are represented by similar noun phrase terms, are grouped together in a neighborhood on a two-dimensional display. Figure 1 shows a sample of a self-organizing category map.

3. Fisheye View

Fisheye view is developed by Furnas [2] . Sarkar and Brown [7] further improved the method by introducing layout considerations into the fisheye formalism. In this paper, we develop the fisheye view using both Cartesian transformation and polar transformation to support the visualization of self-organizing map. Users are able to visualize local details but will not lose global structure.

Fisheye view is similar to the wide-range fisheye camera. It magnifies objects that are close to the focus and shrinks distant objects. Fisheye view for SOM uses this concept to visualize all information of SOM in one window by magnifying area of interest while other areas are successively diminished.

Figure 2 and 3 show the fisheye view of the SOM as shown in Figure 1 using Cartesian transformation and polar transformation.

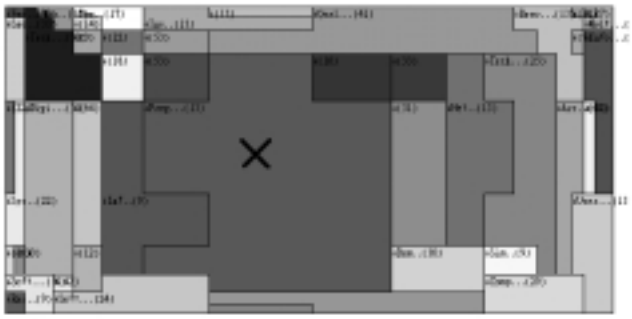

Figure 2 Fisheye view using Cartesian transformation applied on the SOM in Figure 1. "X" denotes the focus point.

4. Fractal View

Fractal view [4] is derived based on the fractal theory [6] to abstract displaying objects as well as controlling amount of information to be displayed. The importance of a node in SOM depends on geographical distance and the semantic relevance between the corresponding node and the focus node. A fractal value is calculated in terms of the fractal dimension, the relevance between the corresponding node and the focal point, and the fractal value of the focus node for each node. Such value is used as the scaling factor for controlling amount of information to be displayed. Figure 4 shows an example of fractal view on the SOM as shown in Figure 1.

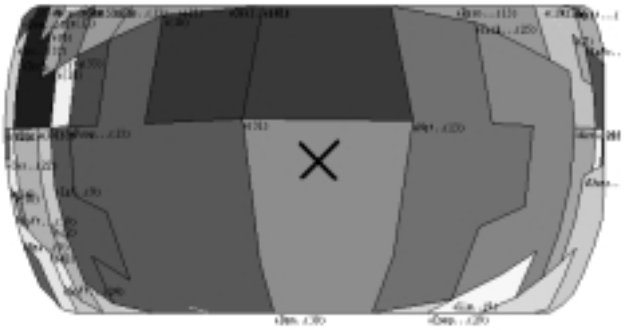

Figure 3 Fisheye view using Cartesian transformation applied on the SOM in Figure 1. "X" denotes the focus point.

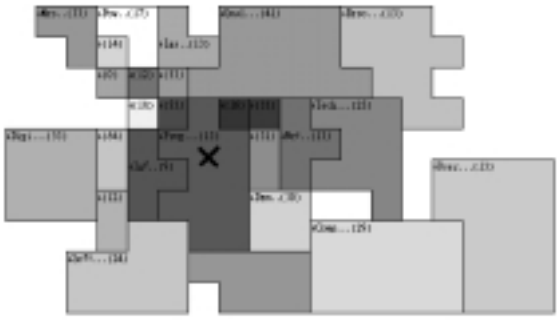

Figure 4 Fractal view applied on the SOM in Figure 1. "X" denotes the focus point.

5. Conclusion

Visualization tool, fisheye view and fractal view, for visualizing the self-organizing category map is presented. Fisheye view is useful for focusing on the area of interest without losing global structure. Fractal view cuts off less relevant information automatically based on semantic relevance.

6. REFERENCES

[1] Chen, H., Shuffels, C., and Orwig, R., "Internet Categorization and Search: A Machine Learning Approach," *Journal of Visual Communications and Image Representations*, 7(1), pp.88-102, March 1996.

[2] Furnas, G.W. "Generalized fisheye views." *Proceedings of the ACM SIGCHI '86 Conference on Human Factors in Computing Systems*, pp. 16-23, 1986

[3] Kohonen, T., *Self-Organization Maps*, Springer-Verlag, Berlin Heidelberg, 1995.

[4] H. Koike, "Fractal Views: A Fractal-Based Method for Controlling Information Display". *ACM Transactions on Information Systems*, vol.13, no.3, July, 1995.

[5] Lin, X., Soergel, D., and Marchionini, G., "A Self-Organizing Semantic Map for Information Retrieval," *Proceedings of the Fourteenth Annual International ACM/SIGIR conference on Research and Development in Information Retrieval*, pp.262-269, Chicago, IL, October 13-16, 1991.

[6] B. B. Mandelbrot, *The Fractal Geometry of Nature*, W. H. Freeman and Company, New York, 1977.

[7] Manojit Sarkar and Marc H. Brown, "Graphical Fisheye Views". *Communications of the ACM*,. Vol.37 No.12, December 1994.

[8] B. R. Schatz and H. Chen, "Building Large-scale Digital Libraries," *IEEE Computer*, 29(5):22-27, May 1996.