The Interactive Stardinates

Monika Lanzenberger

Institute of Software Technology and Interactive Systems,
Vienna University of Technology,
Favoritenstr. 9-11/E188, A-1040 Vienna, Austria

lanzenberger@ifs.tuwien.ac.at

Abstract: We introduce an interactive Information Visualization method called the Stardinates and describe the users' tasks. This is a basis for the development of a tool applied in medicine, in particular, to evaluate a psychotherapeutic clinical study.

Keywords: Information Visualization method, users' tasks, design considerations

1 Introduction

Information Visualization (InfoVis) is the use of computer-supported, interactive, visual representations of abstract data in order to facilitate cognition. The goal of InfoVis is to promote a more intuitive and deeper level of understanding of the data under investigation by using graphical representations such as Glyphs (compare InfoBug (Chuah & Eick, 1997)) or other techniques (Card, Mackinlay & Shneiderman, 1999). We introduce the concept of the Interactive Stardinates. This is a novel visualization technique, which combines aspects of Parallel Coordinates (Inselberg & Dimsdale, 1990) with the advantages of Glyphs. The development of the Stardinates is done in close cooperation with two psychologists. They apply the Stardinates to medical data, particularly, data derived from a clinical study of anorectic girls comparing individual with group therapy. Based on this application scenario we describe users' tasks in order to draw some conclusions for the design of the Stardinates. The Stardinates are a hybrid visualization technique integrating geomeric and glyphbased visualization with Focus+Context techniques (Pirolli, Card & Van Der Wege, 2001).

2 The Stardinates

The Stardinates are an interactive InfoVis technique, which combines the strenghts of Parallel Coordinates with the advantages of Glyphs. The name results from a compound of "Star" and "Coordinates" because the axes are arranged in a circle. Thus, the visualization looks like a star. The user can arrange four up to about twenty axes within one instance of the Stardinates. Each axis represents one attribute of the data thus every data record is visualized by a line (record line) along the corresponding data points. In contrast to Star plots (Chambers) this technique can display many records within one instance. Like Glyphs a number of instances of the Stardinates are displayed side by side. This enables the user to visualize highly structured and multidimensional data. We think that the principles of the Gestalt laws (Benjafield, 1992) are a good starting point to create intuitively understandable visualizations. Therefore, the shapes of the Stardinates offer some advantages over Parallel Coordinates. Moreover, they can handle more complex data especially time-dependent data whereas the visualization does not look complex. However, our hypotheses about the perception of the Stardinates and their abilities and functionality have to be proven by user studies.

In InfoVis three different types of investigation techniques are distinguished: Presentation, exploration, and analysis. Presentation aims to emphasize specific characteristics of the data in respect to the needs of the author whereas in exploration and analysis the audience has a more active role. Exploration means that the user manipulates the visualization or navigates through

data sets in order to get new insights into the data under investigation. In contrast to the process of analysis she or he has no concrete hypotheses to prove. We focus on exploration and analysis. In both interaction plays a very important role. Static visualization techniques could be suitable for presentations. Anyhow, InfoVis becomes more interesting if exploration is supported by direct interaction techniques. Therefore, we want to put the Stardinates interaction techniques in concrete terms in order to draw some conclusions for the design of the user interface.

To mention one possible application we name the visualization of patient records in medicine. If the user wants to focus on temporal patterns and compare patients at the same time, she or he generates one instance of the Stardinates for every important day in the patients' history. Every record line of one instance representes one patient. The user can compare the patients according to their therapeutic progress easily. Figure 1 depicts an example with a data set of five patients and three days based on five medical attributes. Patient A is highlighted.

3 Applied to Medical Data

In close cooperation with two psychologists we develop a tool based on the Stardinates in order to evaluate a clinical study of anorectic girls. This study contains mainly data from questionnaires - about 150 for every patient. Such a tool needs to support the users' tasks adequately. Therefore, we describe the tasks of this application in more detail. Generally, we see the tasks of the users as a basis for implementing tools and methods. Shneiderman developed the 'Visual Information Seeking Mantra' ('overview first, zoom and filter, then details on demand' multiple times) as a starting point for designing graphical user interfaces and for improving the interactivity of InfoVis techniques. Furthermore, he described a 'Task by Data Type Taxonomy' using seven data types and seven tasks (Shneiderman, 1996). Based on his approach, we identified three groups of tasks containing 12 specific actions, which we describe in the following.

3.1   Choose, Combine, and Map Dimensions

- Selecting dimensions for visualization

Sometimes the user has specific questions of the questionnaires in mind, but mostly she or he will scroll through the lists of questions contained in the questionnaires. In order to build a specific data set she or he can choose up to 20 questions. A selected question is represented by one dimension of the Stardinates. The user may choose a keyword for labelling a specific question. Selecting dimensions is thus crucial for further examining the data.

- Combining and rating of questions
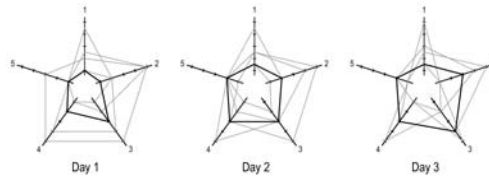The user can build-up a dimension by combining

Figure 1: Sketch of the Stardinates, axis 1: values range from 10 to 18; axes 2-4: values range from 1 to 5, starting at the inner point of the scale.

several questions, if she needs to consider more than 20 questions at a time. Several questions can be rated according to their effect on the aggregate value. The rating is based on a scale from '1' to '10' with whole-numbered graduations, where '10' means that the value is included unaltered, '9' means 90 percent included, etc. Only ordinal values are suitable for combining. However, combining and rating needs a thorough knowledge of the data.

- Rating of questions
Besides the rating of combined questions a dimension could be rated as a whole. Some questionnaires address the patients and their parents, so it could be interesting to compare their answers. If the user wants to focus on the questions which were answered differently, she can give the others lower ratings. This results in attenuation of the variances of the unimportant values.

- Defining the scales
The user defines the precision of the scale and the minimum and maximum values. According to this the data is displayed more or less in detail.

3.2   Exploration

- Visualizing the therapeutic course of a patient
The user can gain important information by visualizing the therapeutic progress of a specific

patient by comparing the state of the selected questions and looking for changes.

- Comparing family questionnaires

The user selects questions addressing patients and parents in order to compare them. Patients with the diagnosis of anorexia nervosa sometimes have the tendency to give socially desired answers that do not match their real feelings. There parents could have answered this questions differently. Therefore, such differences merit further investigation.

- Comparing the state of patients

Typically the user wants to compare the state of the patients based on the data set she or he has selected. Another question is to explore the influence of the group on the patients. This may be clarified by displaying data of the group members in parallel.

- Trends

Striking changes during the therapeutic course are an important information for the user, unchanged data are less interesting. Then the selection of variables is supported by a list of questions sorted by their variance. In addition, users can select less than 20 dimensions for visualizing trends.

- Details and overview

Data can be displayed in various degrees of accuracy. The standard arrangement consists of 20 dimensions every one representing one question. The user can get an overview of the data, if details are blinded out. She or he can do this by combining questions, or by displaying trends. If she wants to get more details she opens the context menu of a visualization attribute. This context menu offers access to every detail of patient data.

3.3 Handling Visualizations

- Visualization history

As details are often difficult to remember, the user can label specific visualizations by keywords for later recall.

- Storing data sets

Some data sets are used very often. It is therefore useful to provide standard views and enable the user to easily adapt these standard views according to specific needs.

- Undo changes

Every action of the user is stored for backup, enabling the user to change or repeat actions later on.

4   Design Considerations

Interaction should be directly and combined with immediate respond because this gives the user the experience of exploring the data. Therefore, fast graphic and data base technologies are needed. The tool mentioned above needs suitable features to support the manipulation processes adequately. Based on the users' interactions the interface should be both, functional and simple. Applying psychology to design (Card, 1986) cognition becomes a significant aspect of design decisions.

References

Benjafield, J.G. (1992), *Cognition*, Prentice-Hall Int. Ed.

Card, S.K., Moran, T.P. & Newell, A. (1986), *The Psychology of Human-Computer Interaction*, Lawrence Erlbaum Associates.

Card, S.K., Mackinlay, J. & Shneiderman, B. (eds.) (1999), *Readings in Information Visualization: Using Vision to Think*, Morgan Kaufmann, San Francisco.

Chambers, J., Cleveland, W., Kleiner, B. & Tukey P., Graphical Methods for Data Analysis, Wadworth.

Chuah, M.C. & Eick, S.G. (1997), Glyphs for Software Visualization, *Fifth Int. Workshop on Program Comprehension (IWPC'97),* pp.183-191.

Inselberg, A. & Dimsdale, B. (1990), Parallel Coordinates: A Tool for Visualizing Multi-Dimensional Geometry, *in Proceedings of the First IEEE Conference on Visualization*, IEEE CS Press, pp.361-378.

Lanzenberger, M., Miksch, S., Ohmann, S. & Popow, C. (2003), Applying Information Visualization Techniques to Capture and Explore the Course of Cognitive Behavioral Therapy, *in Proceedings of the Symposium on Applied Computing*, forthcoming.

Pirolli, P., Card, S.K. & Van Der Wege, M. (2001), Visual Information Foraging in a Focus & Context Visualization, *in ACM Conf. on Human Factors in Computing Systems, CHI Letters*, pp.506-513.

Shneiderman, B. (1996), The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations, *in Proceedings of the IEEE Symposium on Visual Languages*, IEEE CS Press, pp.336-343.