Grundlagen methodischen Arbeitens Informationsvisualisierung

[WS0607 | 01 ]

Monika Lanzenberger
lanzenberger@ifs.tuwien.ac.at
25. 10. 2006

Current InfoVis Research Activities: AlViz

• Motivation - Examples
• Definitions and Goals
• Knowledge Crystallization
• Exploration Techniques
• Visual Encoding Techniques
• Summary
Example 1: Whisky-Tasting

- Taste is very abstract
- 10 basic tastes
- Intensity [0, 3]

Wheel chart
Points - form a polygon
Polygon's properties give quick access to the represented taste

Glenfiddich

The Balvenie (12 y.)

Example 2: Chemical Elements

Periodic Table
- Invented by Dimitri Mendeleyev
- Structured and classified
- Representation of all chemical elements and their properties
- Predicted the existence of several elements before they were discovered

Period Main-Group

colour-encoded

3D version by Timmothy Stowe

Key:
- atomic name
- atomic number
- symbol
- atomic weight (mean relative mass)
Example 2: Chemical Elements

Example 3: The Challenger Disaster

January 27, 1986 - Space shuttle Challenger explodes 72 seconds after launch.

Sealing-rings in the right booster were damaged due to weather conditions.

Reliability-problems of the so called O-rings were known.

The manufacturer of the boosters warned NASA before launch that the expected cold temperatures might be an extra risk.

NASA did not see any correlation between the failing of O-rings and the temperatures.
Example 3: The Challenger Disaster

Example 4: inxight TableLens

Example 5: TouchGraph GoogleBrowser

Motivation - Examples
Definitions and Goals
Knowledge Crystallization
Exploration Techniques
Visual Encoding Techniques
Summary
Definitions ...

Data
“input signals to sensory and cognitive processes”

Information
“data with an associated meaning”

Knowledge
“the whole body of data and information together with cognitive machinery that people are able to exploit to decide how to act, to carry out tasks and to create new information” [Schreiber et al., 1999]

InfoVis

Information Visualization is ...

... the process of transforming data, information, and knowledge into visual form making use of humans’ natural visual capabilities.

... the computer-assisted use of visual processing to gain understanding.

... providing the user with an overview first and then details on demand (<> text).

... based on pre-attentive features (< 200ms).


InfoVis versus Scientific Visualization

„It is important to distinguish information visualization from scientific visualization (SciVis).

In scientific visualization what is seen primarily relates to, and represents visually, something physical. Thus, the flow of a water in a pipe or the nature of the weather in a mountainous area [...] are displayed directly superimposed on or at least close to a realistic representation of the physical thing.

By contrast, information visualization tends to deal with abstract quantities such as baseball scores, connections between known criminals, fluctuating exchange rates and electrical voltages.”

[Spence: Information Visualization. 2001]
SciVis 21

• deals with physical data (e.g., human body, tourist maps, molecules, weather forecast, ...)
• abstract data may be involved
• spatial reference is determined

InfoVis: Using space 22

• Visualization of abstract data (e.g., financial transactions, insurance risks, etc.) means to find spatial representations (2D, 3D).

• No inherent spatial structure available, so the designer / user needs to decide which dimensions are represented by space: Mapping.

Mapping 23

Visualization Reference Model

InfoVis: Kinds of Data 24

• Entities (e.g., people, terms) and relations (e.g., part-of, is-a)
• Both can have sets of attributes (duration, color, time, etc.)

• Types of attributes
  1. nominal, ordinal, interval, ratio
  2. Category data (nominal), integer data (ordinal), real-number data (interval & ratio)

• High-frequency versus high-structural
InfoVis: Heterogeneous Data ...

Multi-Dimensionality
... contain more than three dimensions and are multi-variate

Multi-Modality
... a combination of data from different sources

Structural Complexity
... ranging from low-structured (simple data structure, but many instances, e.g., flow data, volume data) to high-structured data (complex data structure, but only a few instances, e.g., business data)

Disparity
... contain different types of information in the different dimensions

Largeness
... consist of at least hundreds of thousands of data points

Spatiality
... contain at least one (non-scalar) spatial component and non-spatial data

Time-Dependency
... data is given at several points in time

InfoVis & Cognition

Visualization can facilitate cognition by ...

... increasing the memory and processing resources available to the user.
... reducing the search for information.
... using visual representations to enhance the detection of patterns.
... enabling perceptual inference operations.
... using perceptual attention mechanisms for monitoring.
... encoding information in a manipulable medium.

[Card, Mackinlay, Shneiderman: Readings in Information Visualization, 1999]
Knowledge Crystallization

Knowledge Crystallization Sub-tasks

- Overview
- Zoom
- Filter
- Details
- Browse
- Search
- Query

- Forage for Data
- Create, Decide, or Act
- Problem-Solve
- Instantiated Schema
- Reorder
- Cluster
- Class
- Average
- Promote
- Detect pattern
- Abstract

- Extract
- Compose
- Present

- Create
- Delete
- Manipulate
- Read fact
- Read pattern
- Read comparison

Human Abilities versus Computers

- Abilities of the computer:
  - Data Storage
  - Numerical Computation
  - Searching

- Logic
  - Planning
  - Diagnosis
  - Prediction

- Perception
  - Creativity
  - General Knowledge

Topics VO.01

- Motivation - Examples
- Definitions and Goals
- Knowledge Crystallization
- Exploration Techniques
- Visual Encoding Techniques
- Summary

[Card, Mackinlay & Shneiderman, 1999]

[Keim, 2001]
Tasks Taxonomy

High-level Tasks

1. overview  gain an overview of the entire set of data
2. zoom  adjust the size of items of interest
3. filter  remove uninteresting items
4. details-on-demand  select one or more items and get details
5. relate  identify relationships between items
6. history  keep a history of actions to support undo/redo
7. extract  extract subsets of items for separate analysis

Visual Information Seeking Mantra

"There are many visual design guidelines but the basic principle might be summarized as the Visual Information Seeking Mantra:

Overview first, zoom and filter, then details-on-demand!

- Overview first, zoom and filter, then details-on-demand!
- Overview first, zoom and filter, then details-on-demand!
- Overview first, zoom and filter, then details-on-demand!
- Overview first, zoom and filter, then details-on-demand!
- Overview first, zoom and filter, then details-on-demand!
- Overview first, zoom and filter, then details-on-demand!
- Overview first, zoom and filter, then details-on-demand!"
Linking & Brushing

Coupling views by:

• **Slaving**
  movements in one view are automatically propagated in the other views

• **Linking**
  connects the data items of one view with the data items of the other views e.g., done by **brushing**: user selects and highlights items in one view and the corresponding items are highlighted automatically

[Baldonado, 2000]

Visual Encoding Techniques

Different ways in encoding information visually:

• **Space**
  (See details next slide)

• **Marks (in space)**
  Points, lines, areas, volumes

• **Connections & enclosures**

• **Retinal properties**
  Crispness, shape, resolution, transparency, color, grayscale

• **Temporal changes**

• **Viewpoint transformations**

[Card, Mackinlay & Shneiderman, 1999]
- Composition
  The orthogonal placement of axes, creating a 2D metric space

- **Alignment**
  The repetition of an axis at a different position in the space

- **Folding**
  The continuation of an axis in an orthogonal direction

- **Recursion**
  The repeated subdivision of space

- **Overloading**
  The reuse of the same space
• Motivation - Examples
• Definitions and Goals
• Knowledge Crystallization
• Exploration Techniques
• Visual Encoding Techniques
• Summary

Summary: InfoVis ...  
• is a very complex task.  
• can help to get insight into data more quickly.  
• is a kind of abstraction.  
• requires preparation and sensible handling of the information.  
• should make use of the properties of human visual perception.  
• requires sensible handling, relative to the task.  
• is a big challenge, if you want to do it good.

Thanks to ...  
... Silvia Miksch and  
... Markus Rester

for making nice slides of previous classes available.