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
Polygon's properties give quick access to the represented taste

Glenfiddich
The Balvenie (12 y.)
[http://www.scotchwhisky.com]

Example 2: Chemical Elements

Periodic Table
- Invented 1869 by Dimitri Mendeleev and Lothar Meyer
- Structured and classified
- Representation of all chemical elements and their properties
- Predicted the existence of several elements before they were discovered

Periodic Table

Main Group 

atomic number symbol

Key:

Period

[Pictures: Miksch Slide]
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 1: inxight TableLens

Example 2: TouchGraph GoogleBrowser (Outdated)

Example 3: The Challenger Disaster

Data indicate temperature and O-ring damage for 24 successful launches prior to Challenger. Curve shows increasing damage & result in cooler temperatures.
Information Visualization

InfoVis 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).


Information Visualization is ...

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., 2000]
InfoVis: Using space

- 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.

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]

Mapping

Visualization Reference Model

SciVis

- deals with physical data (e.g., human body, tourist maps, molecules, weather forecast, ...)

- abstract data may be involved

- spatial reference is determined
### Types of InfoVis

Visualizations are characterized by their purpose for ...

#### Exploration
the user searches for structures and unknown relations which provide her or him with new insights about the data under investigation.

#### Analysis
starting with certain hypotheses about the data the user tries to prove them by goal-oriented investigations.

#### Presentation
static visualization of facts which are fixed a priori.

[Schumann et al., 2000]

### InfoVis: Kinds of Data

- 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
- Category data (nominal),
- Integer data (ordinal),
- Real-number data (interval & ratio)

- High-frequency versus high-structural

[Ware: Information Visualization, 2000]

### 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

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

Topics VO.01
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!
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[Shneiderman: The eyes have it, 1996]

Classification

Data Visualization Techniques
- Geometric
- Icon-based
- Pixel-oriented
- Hierarchical
- Graph-based

Distortion Techniques
- Complex
- Simple

Interaction Techniques
- Mapping
- Projection
- Filtering
- Link & Brush
- Zooming

[Keim, 2001]

Human Abilities versus Computers

abilities of the computer

Data Storage ↑
Numerical Computation
Searching

Planning
Logic

Diagnosis
Prediction

Perception
Creativity →
General Knowledge →

human abilities

[Keim, 2001]

Tasks Taxonomy

High-level Tasks

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

[Shneiderman: The eyes have it, 1996]
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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

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

[Card, Mackinlay & Shneiderman, 1999]
Visual Encoding Techniques

• **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

[Card, Mackinlay & Shneiderman, 1999]


- 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.

Visual Encoding Techniques

- 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

[Mackinlay & Shneiderman, 1999]