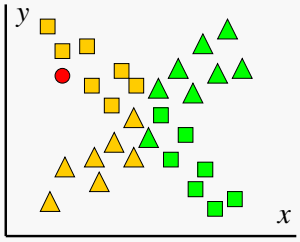
Information Visualization & Visual Analytics

Jack van Wijk
Technische Universiteit Eindhoven

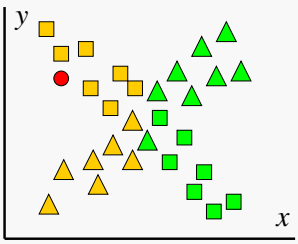
I-science for Astronomy, October 13-17, 2008
Lorentz center, Leiden

An example



30 items,
30 x 3 values

An example



30 items,
30 x 3 values

Visualization?

This talk

- InfoVis, Visual Analytics
- Examples & demos

- Quiz: What's the oldest type of vis?

- J.J. van Wijk.
  Unfolding the Earth: Myriahedral Projections.
  The Cartographic Journal, vol. 45, no. 1, p. 32-42, 2008.

Scientific Visualization

- Start: 1987
- Data: continuous on continuous domain
- Scalar, vector, tensor fields
- 2D, 3D, 3D dynamic
- Medical, chemical, geological, …
- Graphics & simulation

Information Visualization

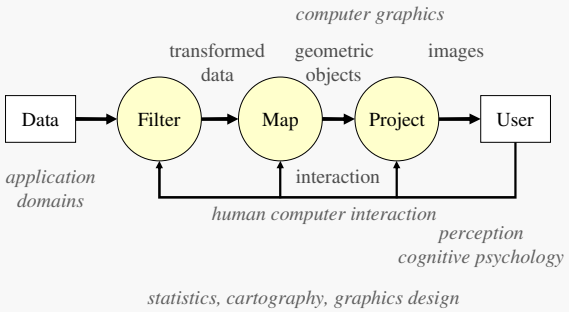
- Start: 1990
- Data: abstract
- Tables, trees, graphs, text, …
- Business, financial, statistics, home use
- Human computer interaction

Information Visualization

- Wide variety

- Many disciplines
- Many types of data
- Many applications
- Many aspects

Visualization pipeline



Applications

- Database visualization
- Software visualization
- Algorithm visualization
- Web visualization
- Document visualization
- Whateveryouwant visualization

Data

- Numerical, ordinal, categorical
- Also: Relations, text, images, ...
- Varying number of dimensions
- Static or dynamic
- Structured or not
- Abstract or not (geographic!)

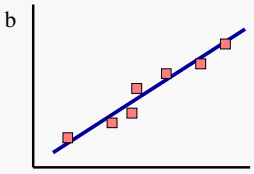
Each data its own vis

- multi-dimensional visualization
- tree visualization
- graph visualization
- geographic visualization
- ...
- often a mix

Multi-dimensional visualization

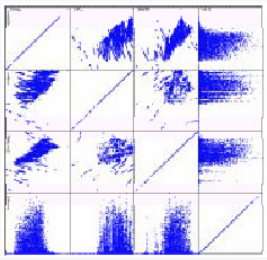
- Scatterplot
- Parallel coordinates
- (many more)

Scatterplot (2 variables)

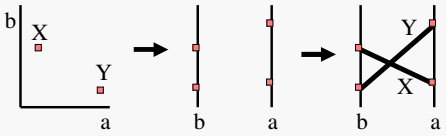


- Detect correlation, patterns, trends, etc.

Example scatterplot matrix

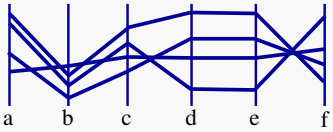


Parallel coordinates



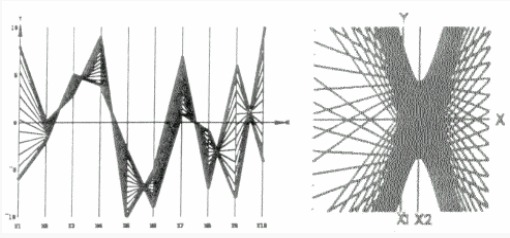
Axes are positioned parallel
Point transforms in a line

Parallel coordinates



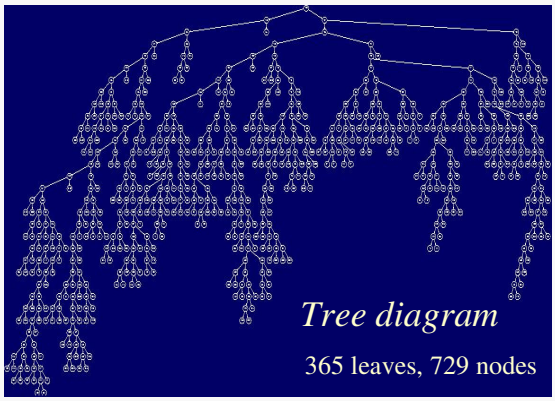
four points, six dimensions
dimension d and e: positive correlation
dimension e and f: negative correlation

Example parallel coordinates

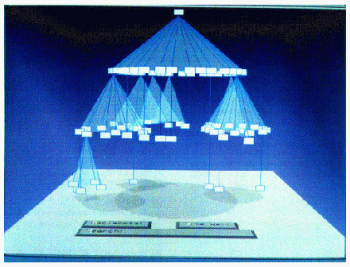


Tree Visualization

- Tree diagram
- Treemap
- Cushion treemap
- Botanical tree
- (many more)



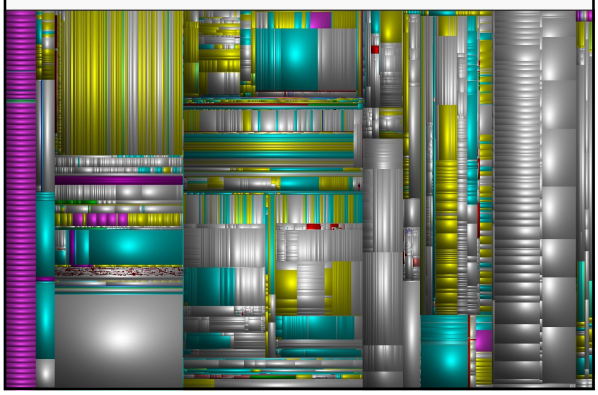
Cone tree



- Robertson, Mackinlay, Card, CHI 1991

Treemap (Shneiderman, 1990)

Cushion treemap (Van Wijk, 1999)



SequoiaView

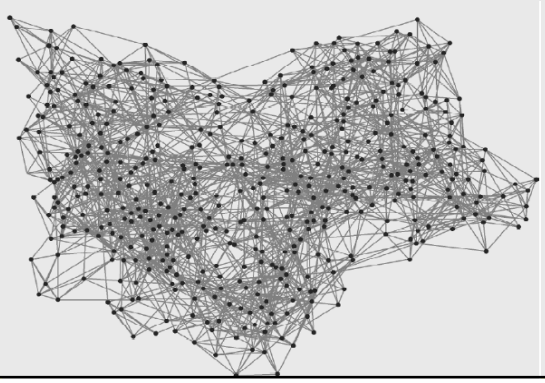
- www.win.tue.nl/sequoiaview
- www.magnaview.com

Botanic tree (Kleiberg, 2001)

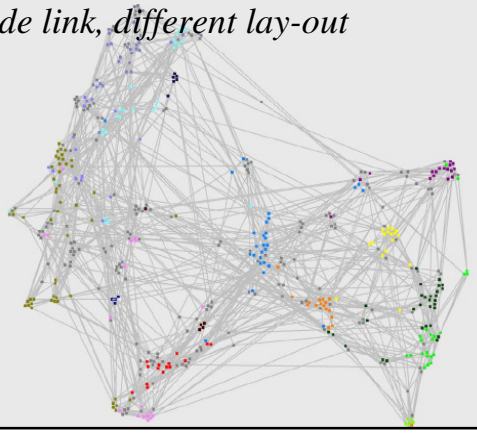
Graph and network visualization

- Node link diagrams
- BIG TOPIC,
- separate graph drawing community

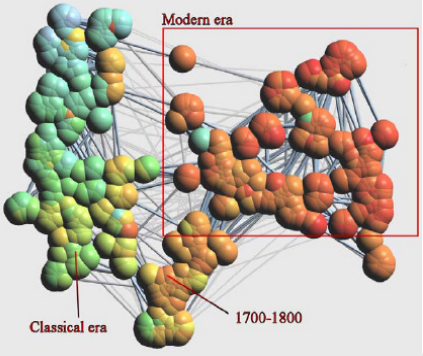
Node link



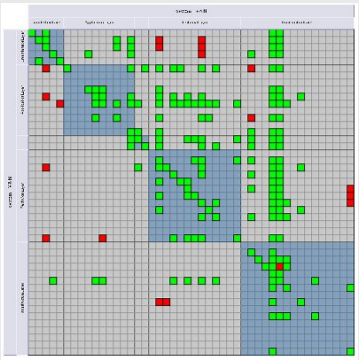
Node link, different lay-out



Node link (Van Ham, 2004)



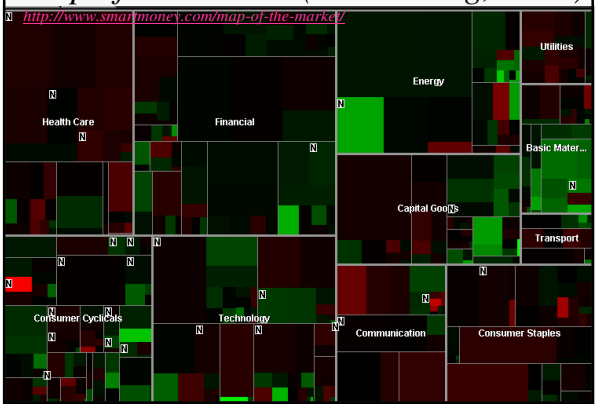
MatrixView (Van Ham, 2003)



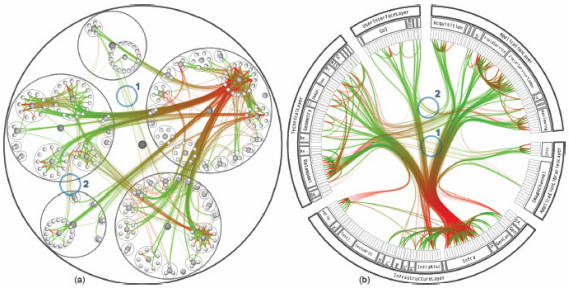
Combinations of data

- Multi-variate and Tree
- Tree and Graph
- …

Map of the Market (Wattenberg, 1999)



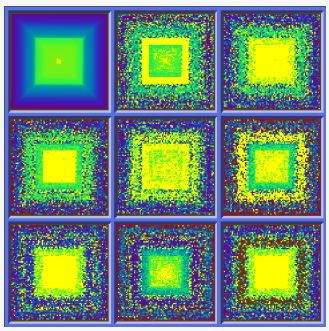
Hierarchical Edge Bundles (Holten, 2006): tree + graph



The Ultimate InfoVis Challenge

There is (too) much data to be shown.
How to solve this?

Use every pixel



Keim, 1994

Use more pixels

- Powerwall, Univ. Konstanz
- 4640x1920 pixels, 5.20 x 2.15 m

Interaction

- If not all data can be shown simultaneously:
  - Use interaction
  - Enable user to navigate through data space
- How to do this?

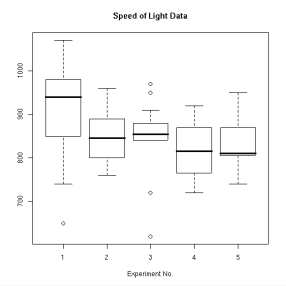
Shneiderman's InfoVis Mantra

Overview first, then zoom & filter, then details on demand

Overview

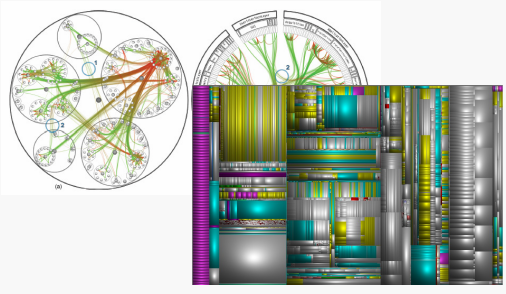
- Derive summary from data
  - Calculate aggregate quantities, clustering
- Via visualization
  - Emphasize global structure

Summarize and aggregate

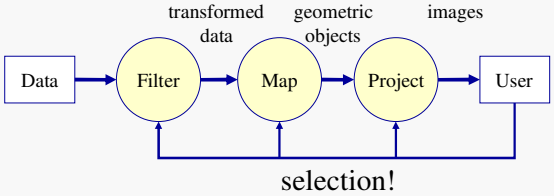


- Box plot (Tukey)
- Show distribution instead of individual points

Overview from image



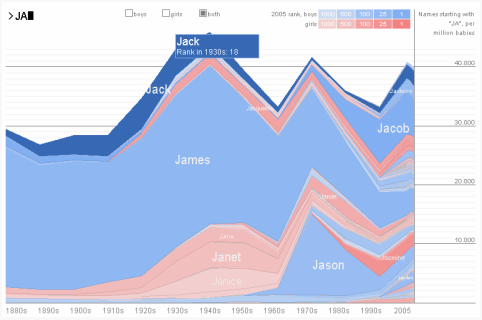
Interactive selection



- If you can't show all data, enable the user to make a selection.

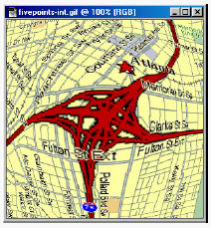
babynamewizard.com/namevoyager

(Wattenberg, 2005)



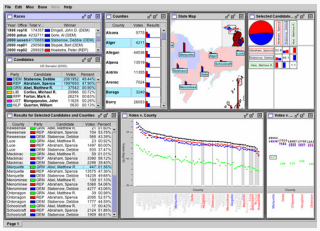
Overview and detail, focus + context

Magnifying glass



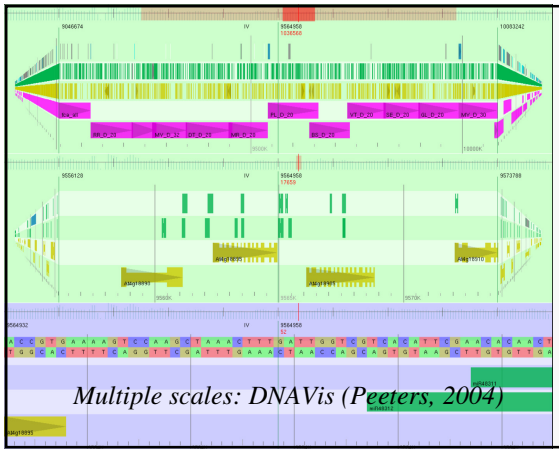
Fish-eye view

Multiple Views



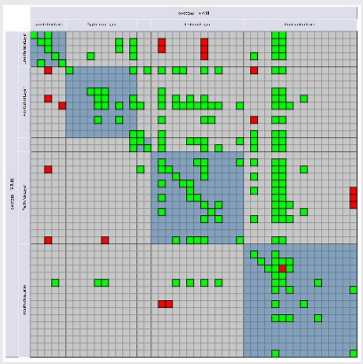
Improvise
(Chris Weaver)

- Each window shows a different view
- Coupling via selection



Multiple scales: DNAVis (Peeters, 2004)

MatrixView (Van Ham, 2003)



InfoVis

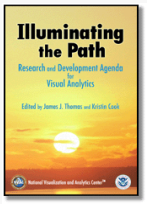
- Overview:
  - Data presentation
  - Interaction
  - Examples
- Much more: perception, cognition, evaluation, …

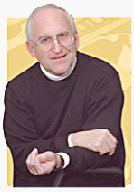
Visual Analytics

- Start: 2004
- "*The U.S. Department of Homeland Security chartered the National Visualization and Analytics Center (NVAC™) in 2004 with the goal of helping to counter future terrorist attacks in the U.S. and around the globe.*"

Visual Analytics

- Founder: Jim Thomas, NVAC
- *Illuminating the Path*, 2004





Visual Analytics

Visual analytics are valuable because the tool helps to detect the expected, and discover the unexpected. Visual analytics combines the art of human intuition and the science of mathematical deduction to perceive patterns and derive knowledge and insight from them. With our success in developing and delivering new technologies, we are paving the way for fundamentally new tools to deal with the huge digital libraries of the future, whether for terrorist threat detection or new interactions with potentially life-saving drugs.

Jim Thomas, NVAC Director

Visual Analytics

- Data: highly varied. Documents, text, multi-media, streaming data, tables, etc.
- Security, fraud detection, …
- Integration of visualization with:
  - Application domain
  - Other data analysis methodologies
  - Knowledge discovery process

VisMaster

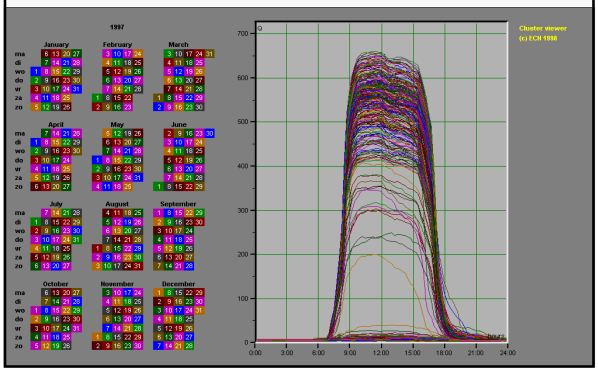
- EU FP7 Coordinated Action
- 2008-2010
- Mission: Get Visual Analytics on the European research agenda
- 30 partners

Example: vis + clustering

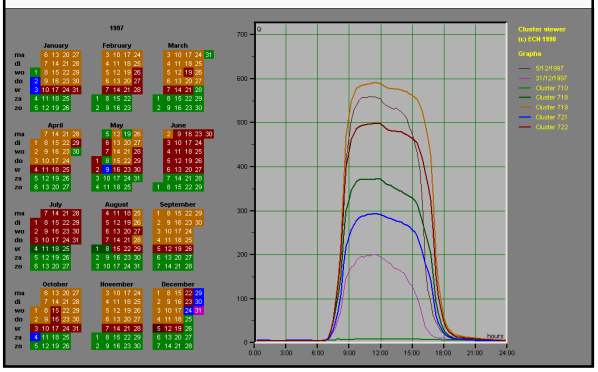
- Time series data:
  - 1 year, 1 sample / 10 minutes
  - #employees in office
- Find the patterns…
- Use of well-known graphical metaphors
- Clustering of similar days

Jack van Wijk, Ed van Selow, InfoVis 1999

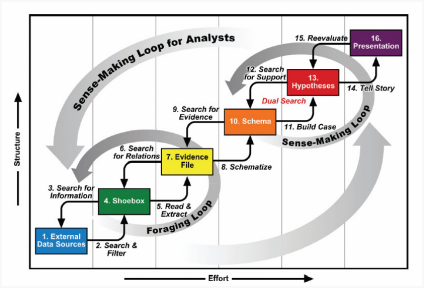
Clustering Time series (Van Wijk, 1999)



Clustering Time series (Van Wijk, 1999)



Knowledge discovery (Pirolli & Card, 2005)

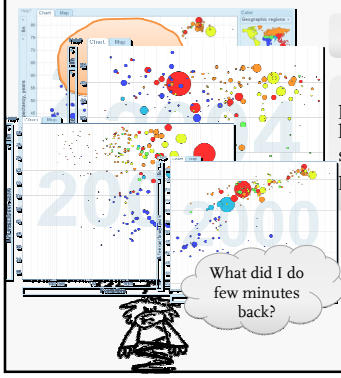


Problem

How to support the user's reasoning process in information visualization?

Yedendra Shrinivasan, CHI 2008

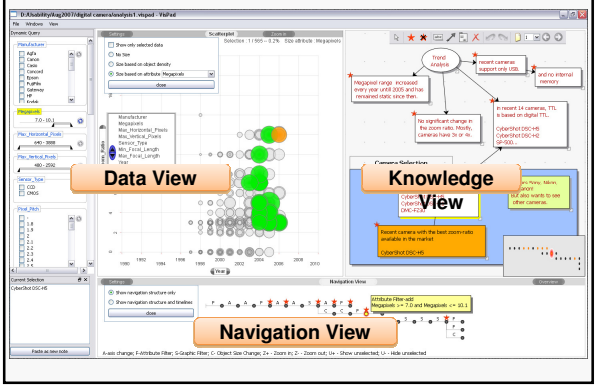
Interactive visualization



helps to explore data rapidly

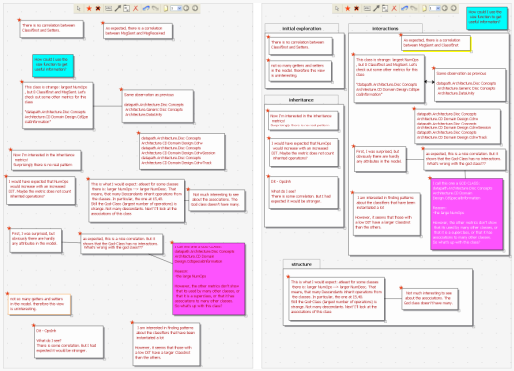
patterns, relations, outliers ... help to reason about data to solve or understand a problem

More support



Aruvi (Shrinivasan, 2008)

Aruvi (Shrinivasan, 2008)



Finally

Overview and examples of:

- Scientific Visualization (Jos)
- Information Visualization
- Visual Analytics

Challenges

How can visualization help astronomers?

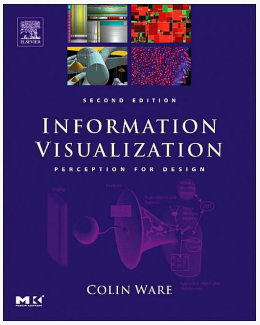
- What are the requirements?
- How to get maximal leverage?
- What to automate, what to visualize?
- What are useful methods from Xvis?
- What are challenges for Xvis?

Jack van Wijk, The Cartographic Journal, 2008

Books

- Tufte, E.R. (1990) Envisoning Information, Graphics Press
- Card, S.K., Mackinlay, J.D. and Shneiderman, B. (1999) Readings in Information Visualization, Morgan Kaufman
- Spence, R. (2000) Information Visualization, Addison Wesley
- Ware, C. (2004) Information Visualization: Perception for Design, Morgan Kaufman

My favourite



Ware, C. (2004) Information Visualization: Perception for Design, (2nd ed.), Morgan Kaufman

Links

- www.infovis-wiki.net
- www.visualcomplexity.com