

Visual Analytics - Introduction

Eduard Gröller

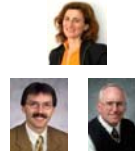
Institute of Computer Graphics and Algorithms
Vienna University of Technology

Outline

- Introduction to visual analytics
- Definition of visual analytics
- Technical challenges and agenda
- Application areas

- Most slides courtesy of

- ◆ Silvia Miksch
- ◆ Daniel Keim / Jim Thomas



Eduard Gröller

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Motivation: Main Problems

Data Unmanageable – Loss of Overview

Missing Integration of Various (Heterogeneous) Information Sources

Various Interdisciplinary Methods

Missing Involvement of Users and their Tasks



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Challenge of the Information Age

- 100 million FedEx transactions per day
- 150 million VISA credit card transactions per day
- 300 million long distance calls in AT&T's network per day
- 50 billion e-mails worldwide per day
- 600 billion IP packets per day DE-CIX backbone



Vis'07 – Scope and Challenges of Visual Analytics – Keim / Thomas

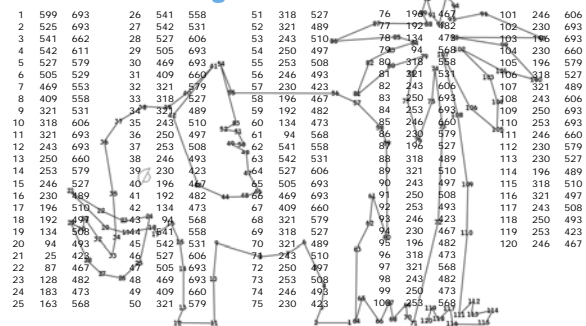
New Requirements Summary

- Volume of data, orders of magnitude larger and different levels of abstraction
- Complexity of information spaces into very high dimensions, 200 the norm
- Information often out of context, incomplete, fuzzy
- Information in all media types: text, imagery, video, voice, web, sensor data
- Time and temporal dynamics fundamentally change the approach
- Spatial, yet non-spatial abstract data
- Multiple ontologies, languages, cultures

For many applications:
we now turn to data-intensive visual analytics

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Visualization for Problem Solving



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Analytical Methods

Screen Resolution: 1024 * 768 = **786.432**
 Measurements of Water Level in LA Every Year: **5.256.000**
 Number of Cellular Phones in Austria (2005): **8.160.000**
 Transmitted Emails Every Hours (World-Wide): **35.388.000**

Whole Data often not Presentable

1. Applying Analytical Methods (*Data Reduction*)
2. Visualization of Most Important Data and Information

Analytical Methods

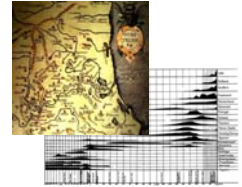
Statistics, Machine Learning & Data Mining



Interactions

Past

Only passive Observations
 Representation not Changeable
 „one fits all“



Today

Active Examination with Visualizations
 Dynamically Adaptable and Modifiable
 → Different Users, Tasks and Aims

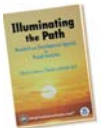


Visual Analytics – What is it?

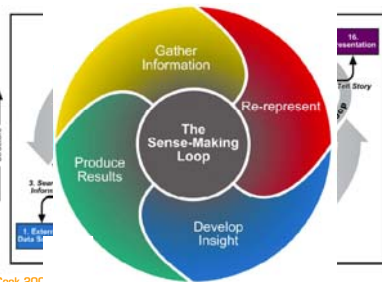
James Thomas & Kristin A. Cook:

NVAC (National Visualization and Analytics Center), Seattle, USA

„Visual Analytics is the science of analytical reasoning facilitated by interactive visual interfaces“



[Thomas & Cook 2006]



Visual Analytics Definition

Konstanz University

Visual Analytics is the science of analytical reasoning facilitated by interactive visual interfaces.

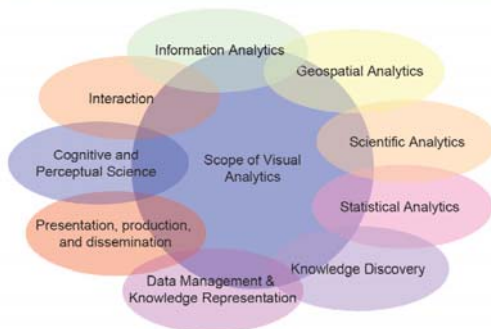
People use visual analytics tools and techniques to

- Synthesize information and derive insight from massive, dynamic, ambiguous, and often conflicting data.
- Detect the expected and discover the unexpected.
- Provide timely, defensible, and understandable assessments.
- Communicate assessment effectively for action.

“The beginning of knowledge is the discovery of something we do not understand.”
 – Frank Herbert (1920 - 1986)

Research Areas Related to Visual Analytics

Konstanz University



Why is the topic highly relevant today?

Konstanz University

- Very Large Data Collections are available in Databases and Data Warehouses
- On the Basis of the Data Complex Decisions have to be made in a timely fashion
- Pure Visualization Methods (Information Visualisation) do not work for Billions of Data Records
- Full Automatic Knowledge Discovery Approaches only work for well-defined and clearly specifiable problems.
- Especially for adversarial situations:
Fraud, Viruses, SPAM, Attacks, Competition, ...

What is new ?

What do we have?

- Automatic Knowledge Discovery & Information Mining
- Interactive Visual Data-Exploration

What do we need?

Tight Integration of Visual and Automatic Data Analysis Methods with Database Technology for a Scalable Interactive Decision Support

Visual Data-Exploration

Feedback loop

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Technical Challenges

Real-time Analysis of

- very large, complex, dynamic information
- from many diverse data sources
- in diverse formats and resolutions
- in uncertain, potentially life-threatening, and time-critical situations.

“Discovery consists of seeing what everybody has seen and thinking what nobody has thought.”
- Albert von Szent-Gyorgyi (1893 - 1986)

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Technical Challenge: Scalability

Scalability w.r.t.

- Amount of Data and Dimensionality
- Number of Data Sources and Heterogeneity
- Data Quality and Data Resolution
- Dynamicity and Novelty
- Data Representation and Visual Resolution
- User Interface and Interaction
- Display Devices

“All truths are easy to understand once they are discovered; the point is to discover them.”
- Galileo Galilei (1564-1642)

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Visual Analytics Agenda

[Thomas & Cook 2006]

The Science of Analytical Reasoning
“... enable users to obtain *deep insights* that directly support assessment, planning, and decision making.”

Visual Representations & Interaction Technologies
“... take advantage of human eye's broad bandwidth pathway into the mind to allow users to *see, explore, and understand large amount of information* at once.”

Data Representations & Transformations
“... *cover* all types of conflicting and dynamic data in ways that support visualization and analysis.”

Production, Presentation, & Dissemination
“... *communicate* information in the appropriate context to a *variety of audience*.”

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Application Areas

Economic & Business Data

- Business Intelligence
- Market Analysis

Medicine & Biotechnology

- Patients' Data Management
- Epidemiology
- Genetics

Security & Risk Management

- Disaster Management
- Computer Networks
- Transportation
- Reducing Crime and Terror Rate
- Fraud Detection

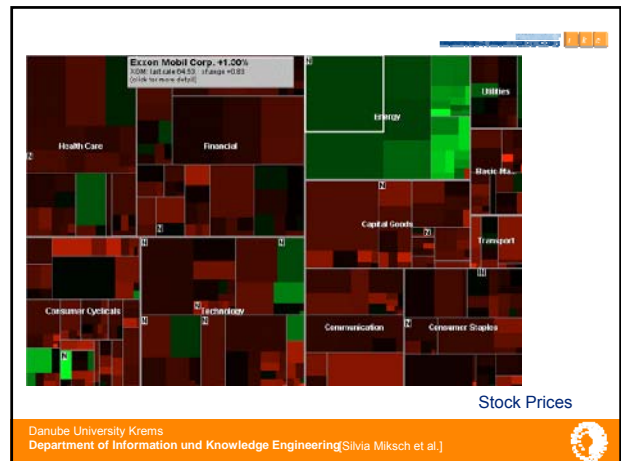
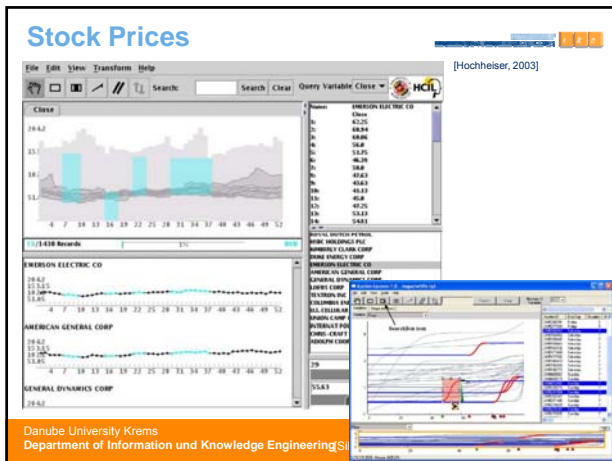
Environment & Climate Research

etc.

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Analysis of Business Data

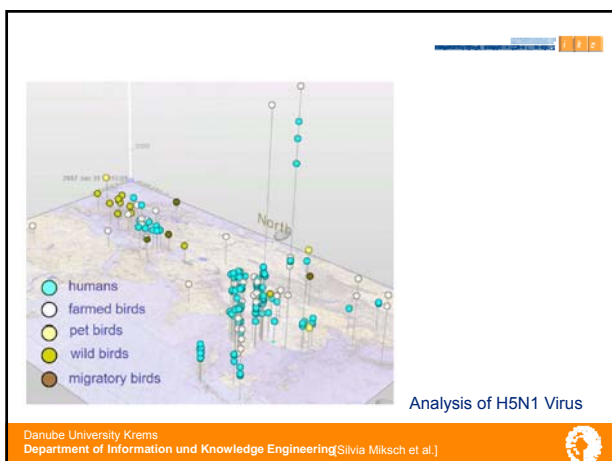
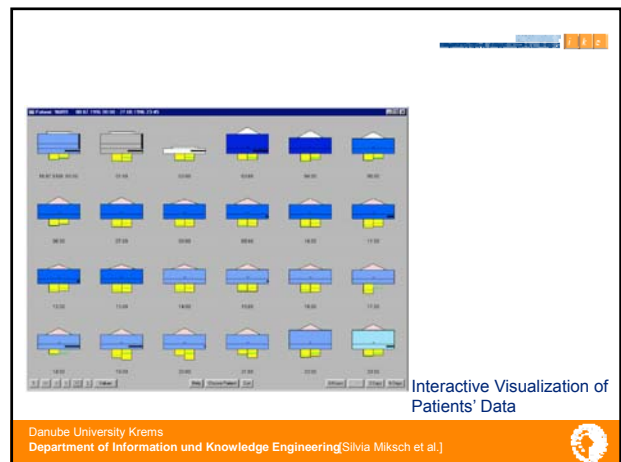
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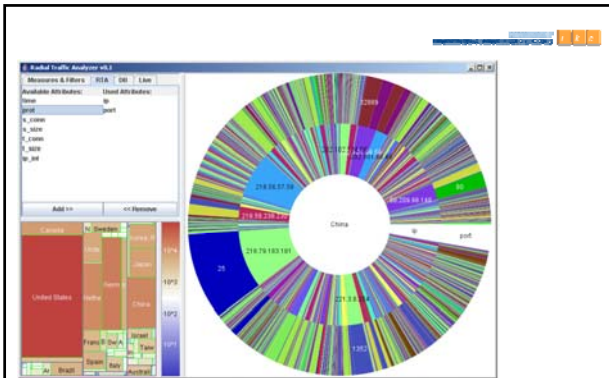
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Application Areas

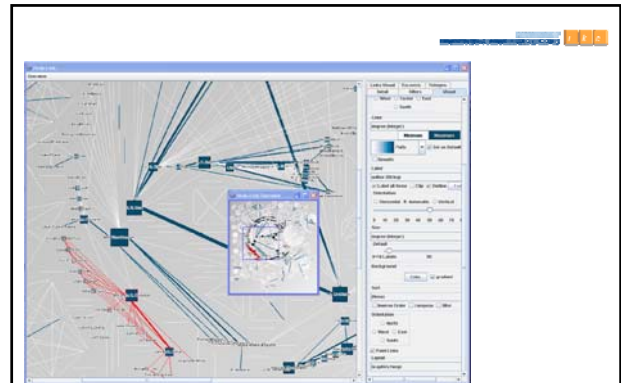
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Monitoring of Computer Networks

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Interactive Analysis Social Networks

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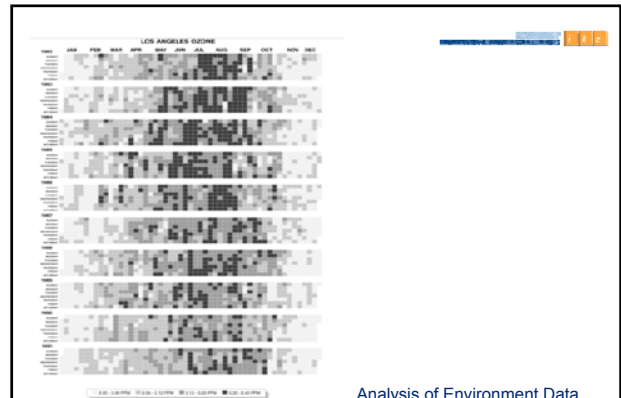
Security & Risk Management

- Disaster Management
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Environment & Climate Research

etc.

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Analysis of Environment Data

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Application Areas

Economic & Business Data

- Business Intelligence
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Medicine & Biotechnology

- Patients' Data Management
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Security & Risk Management


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etc.

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Conclusions



- Visual Analytics is an opportunity worth considering
- Collaboration between academia, industry, national laboratories, and government (national and international) is key
- For each of you:

The best is yet to come...

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