Laura Bassi Centre of Expertise
Centre for Visual Analytics Science & Technology

# Visual Analytics –

*Detect the Expected and Discover the Unexpected*

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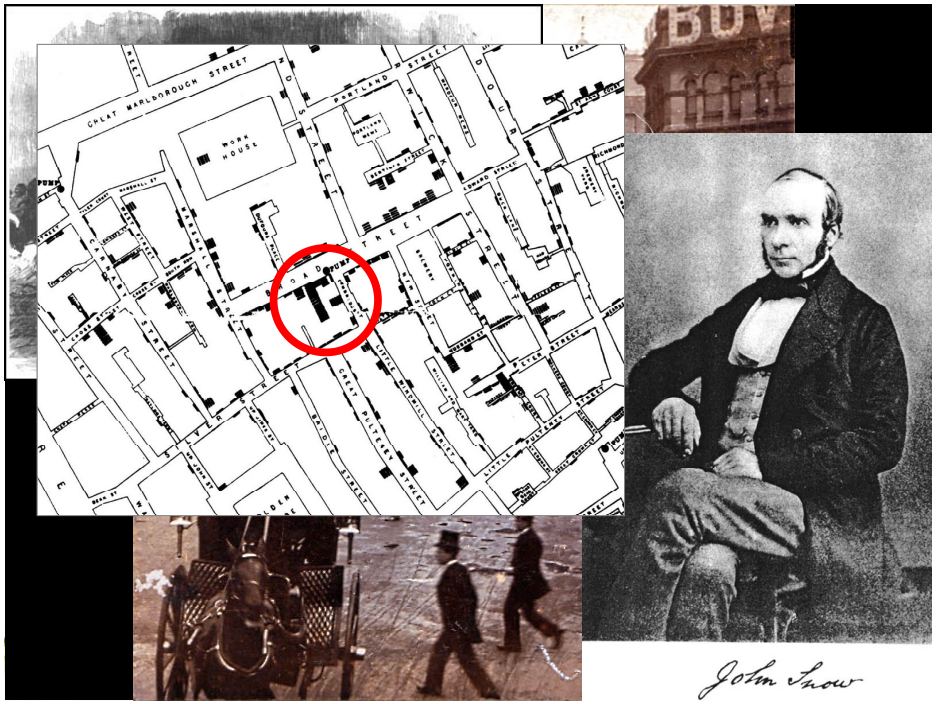
## Content



*[Tufte, 1997]*
*adapted from [Hearst , 2004]*

## One Visualization Success Story

Mystery:
What is causing a cholera epidemic in London in 1854?



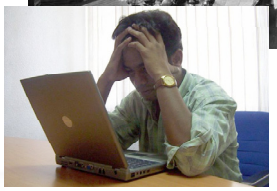
## Motivation: Main Problems

Data Unmanageable – Information Overload

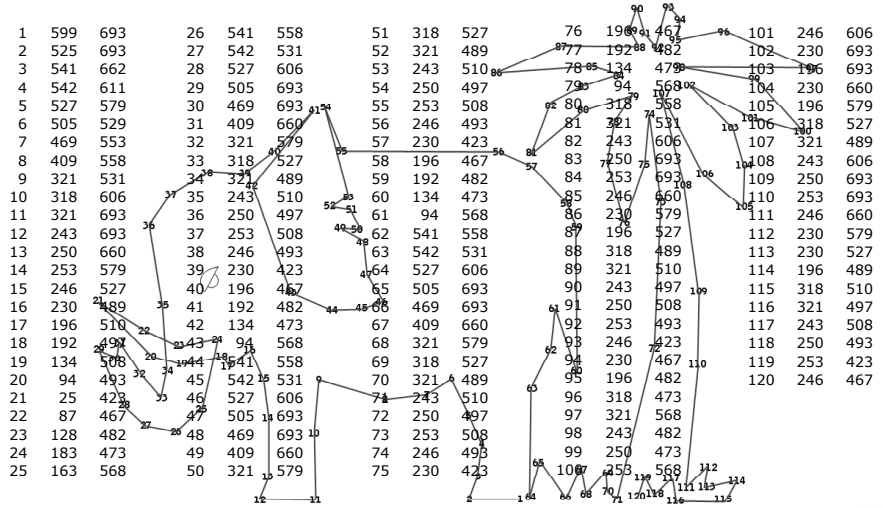
Missing Integration of

- Various (Heterogeneous) Information Sources
- Various Interdisciplinary Methods

Missing Involvement of Users and their Tasks



## Visualization for Problem Solving



| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 599 | 693 | 26 | 541 | 558 | 51 | 318 | 527 | 76 | 198 | 467 | 101 | 246 | 606 |
| 2 | 525 | 693 | 27 | 542 | 531 | 52 | 321 | 489 | 77 | 192 | 482 | 102 | 230 | 693 |
| 3 | 541 | 662 | 28 | 527 | 606 | 53 | 243 | 510 | 78 | 134 | 479 | 103 | 196 | 693 |
| 4 | 542 | 611 | 29 | 505 | 693 | 54 | 250 | 497 | 79 | 94 | 568 | 104 | 230 | 660 |
| 5 | 527 | 579 | 30 | 469 | 693 | 55 | 253 | 508 | 80 | 318 | 558 | 105 | 196 | 579 |
| 6 | 505 | 529 | 31 | 409 | 660 | 56 | 246 | 493 | 81 | 321 | 531 | 106 | 318 | 527 |
| 7 | 469 | 553 | 32 | 321 | 579 | 57 | 230 | 423 | 82 | 243 | 606 | 107 | 321 | 489 |
| 8 | 409 | 558 | 33 | 318 | 527 | 58 | 196 | 467 | 83 | 250 | 693 | 108 | 243 | 606 |
| 9 | 321 | 531 | 34 | 321 | 489 | 59 | 192 | 482 | 84 | 253 | 693 | 109 | 250 | 693 |
| 10 | 318 | 606 | 35 | 243 | 510 | 60 | 134 | 473 | 85 | 246 | 660 | 110 | 253 | 693 |
| 11 | 321 | 693 | 36 | 250 | 497 | 61 | 94 | 568 | 86 | 230 | 579 | 111 | 246 | 660 |
| 12 | 243 | 693 | 37 | 253 | 508 | 62 | 541 | 558 | 87 | 196 | 527 | 112 | 230 | 579 |
| 13 | 250 | 660 | 38 | 246 | 493 | 63 | 542 | 531 | 88 | 318 | 489 | 113 | 230 | 527 |
| 14 | 253 | 579 | 39 | 230 | 423 | 64 | 527 | 606 | 89 | 321 | 510 | 114 | 196 | 489 |
| 15 | 246 | 527 | 40 | 196 | 467 | 65 | 505 | 693 | 90 | 243 | 497 | 115 | 318 | 510 |
| 16 | 230 | 489 | 41 | 192 | 482 | 66 | 469 | 693 | 91 | 250 | 508 | 116 | 321 | 497 |
| 17 | 196 | 510 | 42 | 134 | 473 | 67 | 409 | 660 | 92 | 253 | 493 | 117 | 243 | 508 |
| 18 | 192 | 497 | 43 | 94 | 568 | 68 | 321 | 579 | 93 | 246 | 423 | 118 | 250 | 493 |
| 19 | 134 | 508 | 44 | 541 | 558 | 69 | 318 | 527 | 94 | 230 | 467 | 119 | 253 | 423 |
| 20 | 94 | 493 | 45 | 542 | 531 | 70 | 321 | 489 | 95 | 196 | 482 | 120 | 246 | 467 |
| 21 | 25 | 423 | 46 | 527 | 606 | 71 | 243 | 510 | 96 | 318 | 473 | | | |
| 22 | 87 | 467 | 47 | 505 | 693 | 72 | 250 | 497 | 97 | 321 | 568 | | | |
| 23 | 128 | 482 | 48 | 469 | 693 | 73 | 253 | 508 | 98 | 243 | 482 | | | |
| 24 | 183 | 473 | 49 | 409 | 660 | 74 | 246 | 493 | 99 | 250 | 473 | | | |
| 25 | 163 | 568 | 50 | 321 | 579 | 75 | 230 | 423 | 100 | 253 | 568 | | | |

## Analytical Methods

| | |
|---|---|
| **Screen Resolution:** | **1024 * 768 = 786.432** |
| **Yearly Measurements of Water Level in Low.Austria:[1]** | **5.256.000** |
| **Number of Cellular Phones in Austria (2005):[2]** | **8.160.000** |
| **Transmitted Emails Every Hours (World-Wide):[3]** | **35.388.000** |

**Whole Data often not Presentable**

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

today: peta ($10^{15}$)
tomorrow: exa ($10^{18}$) & zeta ($10^{21}$)

**Analytical Methods**

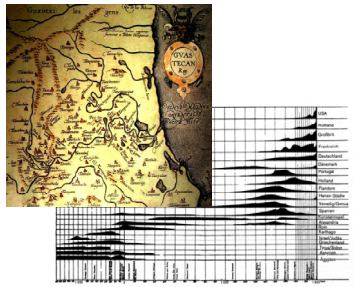
Statistics, Machine Learning & Data Mining

1 ... Amt der NÖ Landesregierung, Abt. WA5 - Hydrologie, http://www.noel.gv.at/SERVICE/WA/WA5/htm/wnd.htm
2 ... CIA Factbook, https://www.cia.gov/cia/publications/factbook/
3 ... How Much Information?, UC Berkeley, http://www2.sims.berkeley.edu/research/projects/how-much-info-2003/

## Interactions

### Past

Only passive Observations
Representation not Changeable
"one fits all"



### Today

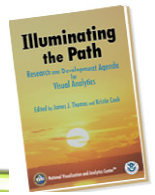
Active Examination with Visualizations
Dynamically Adaptable and Modifiable

→ *Different Users, Tasks, and Aims*

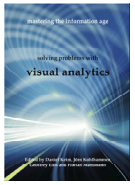
## Visual Analytics – What is it?

**James Thomas & Kristin A. Cook**
NVAC (National Visualization and Analytics Center), Seattle, USA

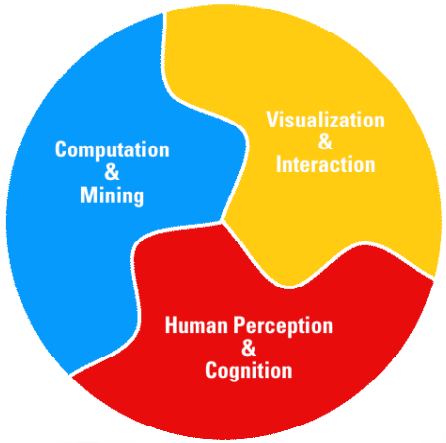
***"Visual Analytics is the science of analytical reasoning facilitated by interactive visual interfaces"***




[Thomas & Cook 2005]




[Keim, et al. 2010]




## Visual Analytics Agenda

*[Thomas & Cook 2005]*

### 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

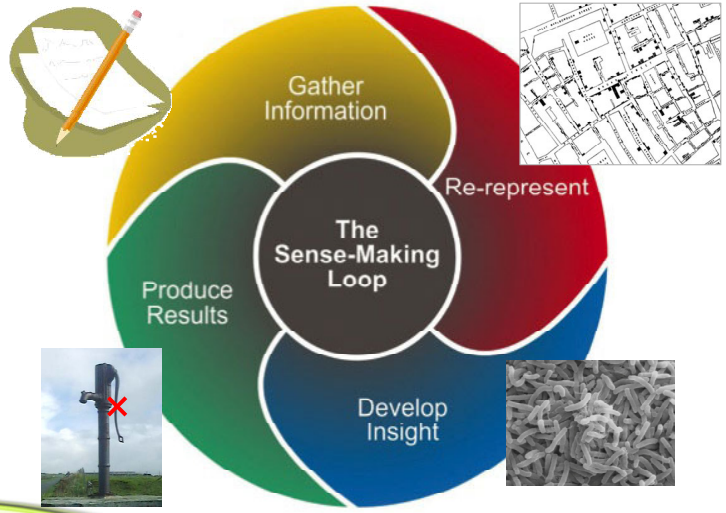
*"... **covert** all types of conflicting and dynamic data in ways that support visualization and analysis."*

### Production, Presentation, & Dissemination

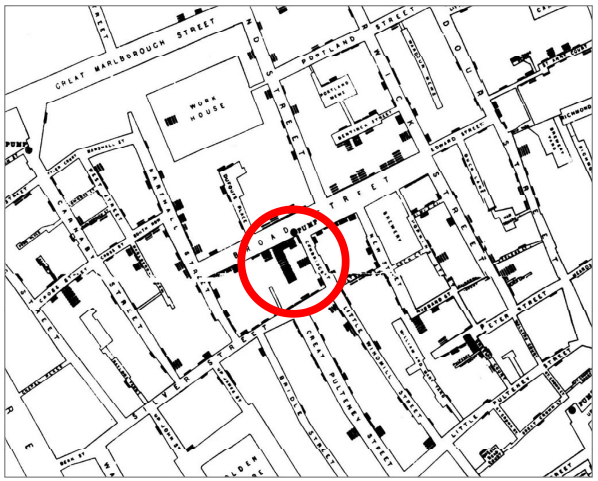
*"... **communicate** information in the appropriate context to a **variety of audience**."*

## Analytical Reasoning Process

*[Thomas & Cook 2005]*

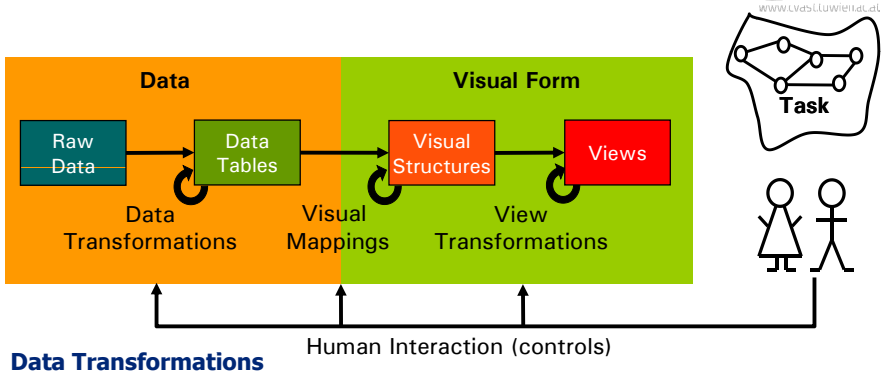



## Cognition



## Visualization Reference Model

[Card, et al., 1999]




**Data Transformations**
Mapping raw data into an organization fit for visualization

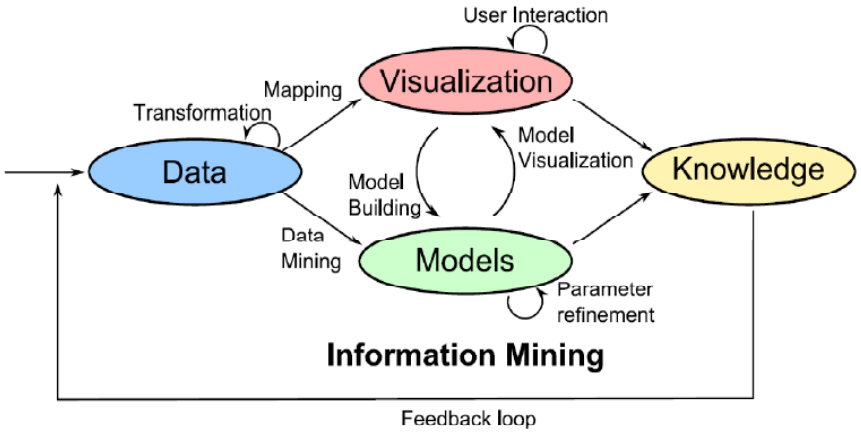
**Visual Mappings**
Encoding abstract data into a visual representation

**View Transformations**
Changing the view or perspective onto the visual representation

**User interaction can feed back into any level**

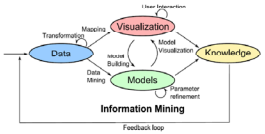
## Visual Analytics – Process

[Keim, et al. 2008]



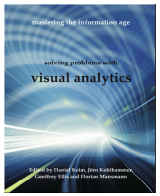

## Visual Analytics – Definition

[Keim, et al. 2008]



"Tight Integration of Visual and Automatic Data Analysis Methods for Information Exploration and Scalable Decision Support"

"Visual analytics combines automated analysis with interactive visualisations for an effective understanding, reasoning and decision making on the basis of very large and complex datasets".




[Keim, et al. 2010]

## Visual Information Seeking Mantra

[Shneiderman, 1996]

**overview first, zoom and filter, then details-on-demand**

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**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**

***... 10 times ...***

## Visual Analytics Mantra

*[Keim, 2005, presentation, Keim, et al., 2008]*

**Analyze first,**
**show the important,**
**zoom filter & analyze,**
**then details-on-demand**

**Analyze first,**
**show the important,**
**zoom filter & analyze,**
**then details-on-demand**

**Analyze first,**
**show the important, …**

***… 10 times …***

## Goals of Visual Analytics …

*[Keim, et al. 2010]*

**… is design and create methods to enable users to**

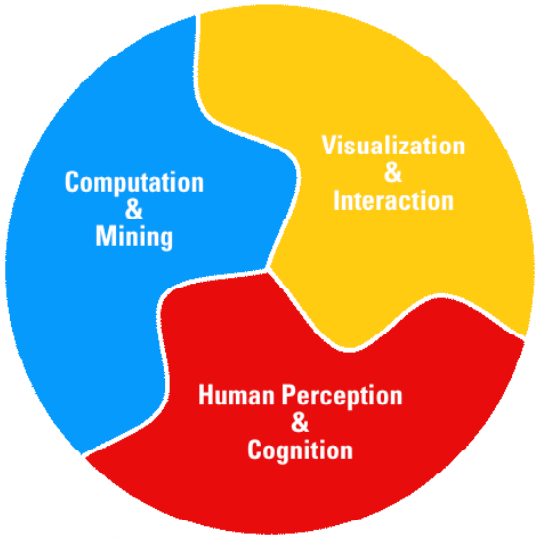
**synthesize** information and **derive insight** from massive, dynamic, ambiguous, and often conflicting data

detect the **expected** and discover the **unexpected**

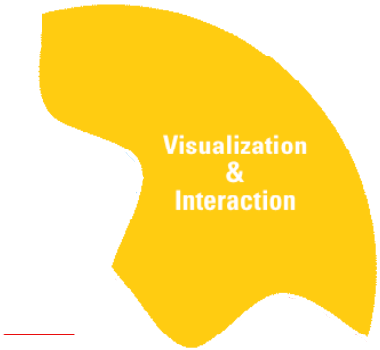
provide timely, defensible, and understandable **assessments**

**communicate** these assessments effectively for action

## Visual Analytics

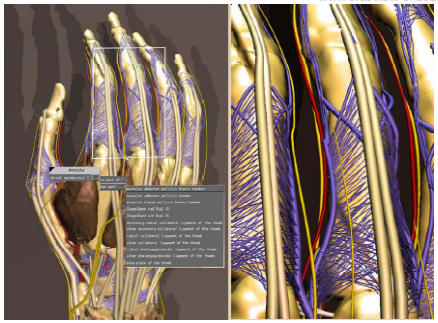


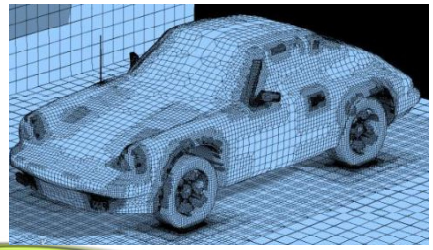

## Visual Analytics

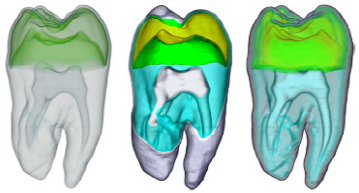


## Visualization: Classical Areas

### Volume Visualization

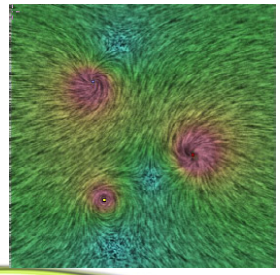


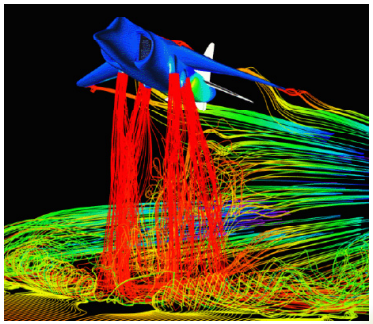




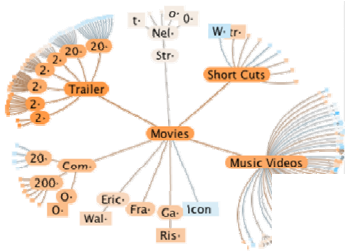
## Visualization: Classical Areas

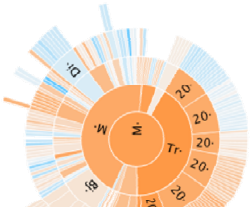
### Flow Visualization

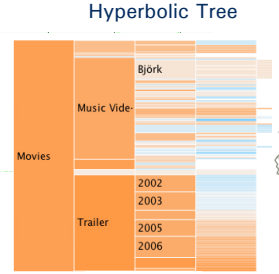


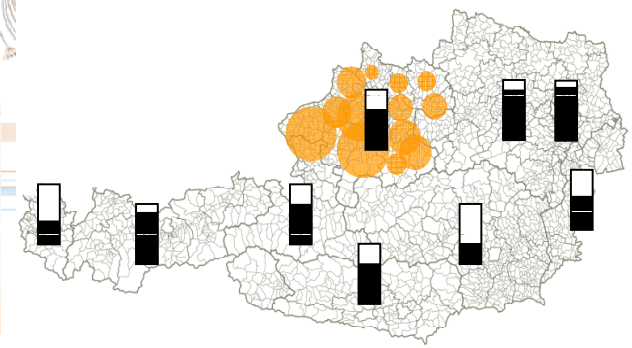


## Visualization: Classical Areas

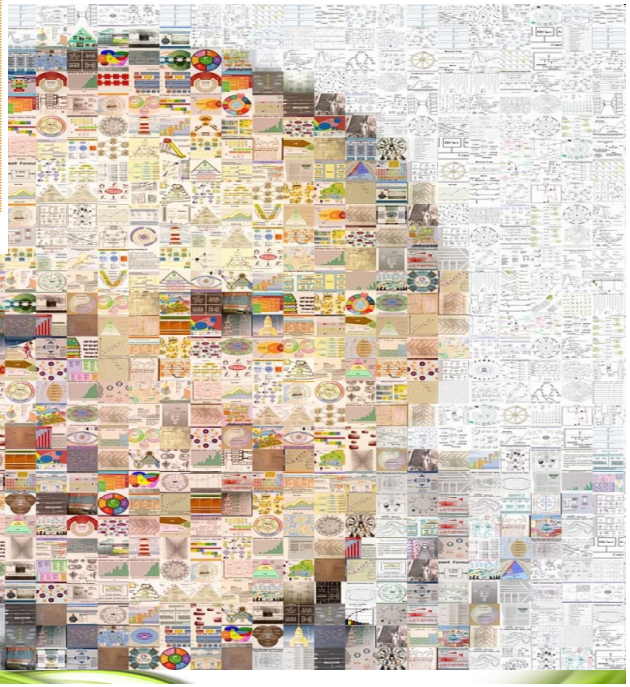




Interactive Homage to Ben Shneiderman



## Visual Analytics

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

*[Thomas & Cook, 2005]*

## Science of Interaction

"Too often in the visual analytic process, researchers tend to focus on visual representations of the data but interaction design is not given equal priority. We need to develop a `**science of interaction**' rooted in a deep understanding of the different forms of interaction and their respective benefits."

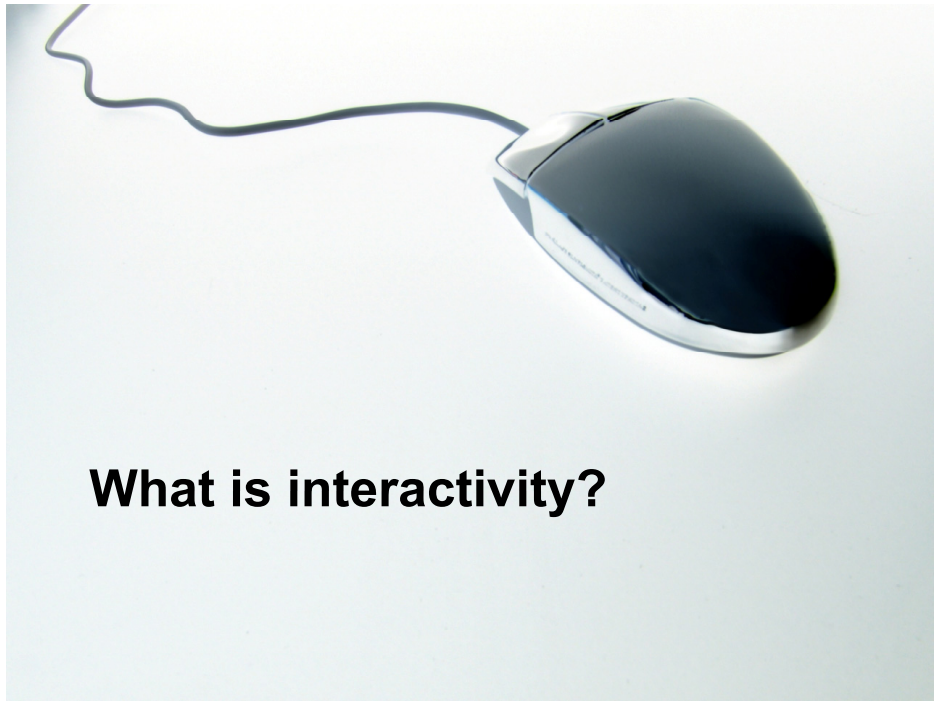
*[Thomas & Cook, 2005, p. 73]*

## Why Interaction?

"Interaction between human and computer is at the heart of modern information visualization and for a single overriding reason: the enormous benefit that can accrue from **being able to change one's view** of a corpus of data. Usually that corpus is so large that no single all-inclusive view is likely to lead to insight. Those who wish to acquire insight must **explore, interactively,** subsets of that corpus to find their way towards the view that triggers an 'a ha!' experience." *[Spence, 2007]*

Users prefer **inferior visualizations with interaction** over superior static visualizations … through the **combination** of visual representations ad appropriate interaction mechanisms, the users achieve **insights** into the data

*Study in [Saraiya, North, Lam & Duca, 2006]*



## Value of Interaction

**Reduction of distance**

Reducing the gulfs of execution and evaluation

**Reduction of cognitive load**

Cognitive offloading, external anchoring, information foraging

**Higher engagement**

Feeling of being in control / first person-ness

**Higher expressiveness of the user interface language**

Richer possibilities for input and output

## Interaction Levels

**Physical Level**

How does the user physically interact?
*E.g., Mouse Wheel, Touch Screen*
→ **Interaction Devices**

**Control Level**

How can it be carried out by the user?
*E.g., Move Scrollbar*
→ **User Interface**

**Conceptual Level**

What to be done?
*E.g., Scrolling / Navigating*
→ **Task**

## Visual Information Seeking Mantra

[Shneiderman, 1996]

***Overview first, zoom and filter, then details-on-demand.***

**Overview:** Gain an overview of the entire collection.

**Zoom:** Zoom in on items of interest.

**Filter:** Filter out unintetresting items.

**Details on demand:** Select an item or group and get details when needed.

**Relate:** View relationships among items.

**History:** Keep a history of actions to support undo, replay, and progressive refinement.

**Extract:** Allow extraction of sub-collections and of the query parameters.

## Interaction Taxonomy

Based on 1) [Yi et al., 2007] and 2) [Raskin, 2000]

| | | |
|---|---|---|
| **Indicate:** | show me where I am pointing at | 2) |
| **Select:** | mark something as interesting | 1,2) |
| **Explore:** | show me something else | 1) |
| **Reconfigure:** | show me a different arrangement | 1) |
| **Encode:** | show me a different representation | 1) |
| **Abstract/Elaborate:** | show me more or less detail | 1) |
| **Filter:** | show me something conditionally | 1) |
| **Connect:** | show me related items | 1) |
| **Activate:** | trigger action | 2) |
| **Modify:** | manipulate elements | 2) |

## **Indicate:** show me where I am pointing at

Adapted [Aigner, Presentation 2010]

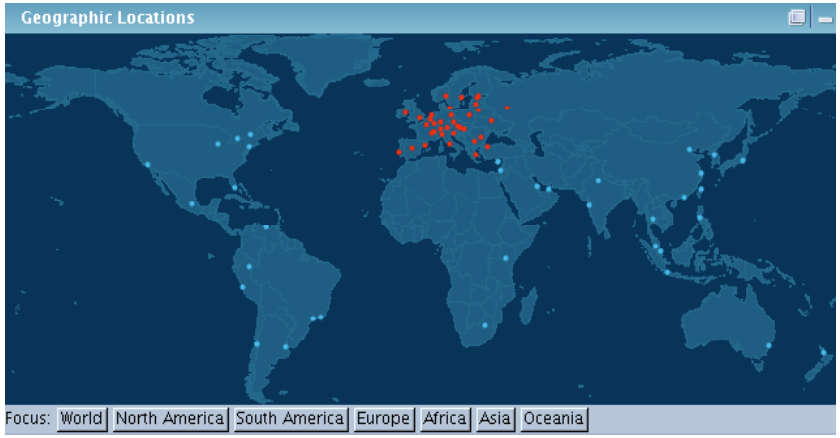
### E.g., Visual Feedback, Pop-Up Tooltips (Mouse Over)


Demo *[InfoScope, 2007]*

## **Select:** mark something as interesting

*Adapted [Aigner, Presentation 2010]*

### E.g., Selecting, Highlighting, Brushing




Demo *[InfoScope, 2007]*

## **Explore:** show me something else

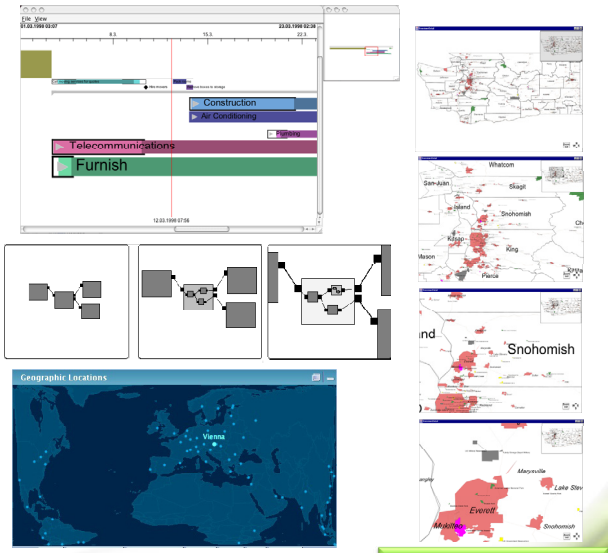
*Adapted [Aigner, Presentation 2010]*

***Zooming + Panning, Overview + Detail***

**E.g.,**
**Size + Position of Viewport**

**Geometric Zoom**
e.g., Photoshop
**Semantic Zoom**
e.g., Google Maps

**Overview+Detail**
**Focus+Context**
e.g., Fisheye Zoom
**Panning**
**Navigation & Browsing**
in Space
in **Time**

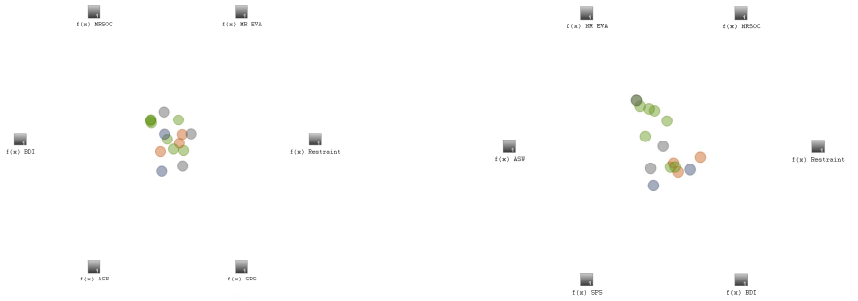



Demo: VisuExplore

## **Reconfigure:** show me a different arrangement

*Adapted [Aigner, Presentation 2010]*

E.g., Swap x and y Axis of a Scatter Plot; Axis of Parallel Coordinates; Rearrange View, Move View Position, Sorting Items in a Table, Switch Scale on Axes



Demo *[gravi++, 2006]*

## **Encode:** show me a different representation

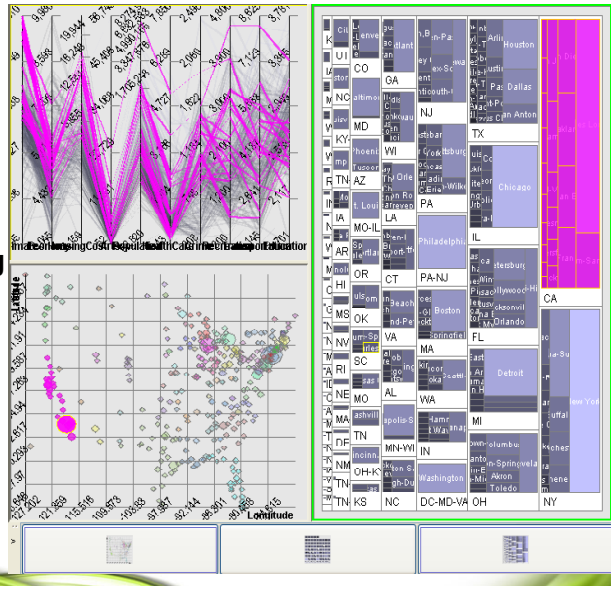
*Adapted [Aigner, Presentation 2010]*

Switching to a Different Visualization Method

**Multiple Views: Brushing & Linking**

*A multiple view–system uses two or more distinct views to support the investigation of a single conceptual entity*

*[Baldonado et al., 2000]*



## **Abstract/Elaborate:** show me more or less detail

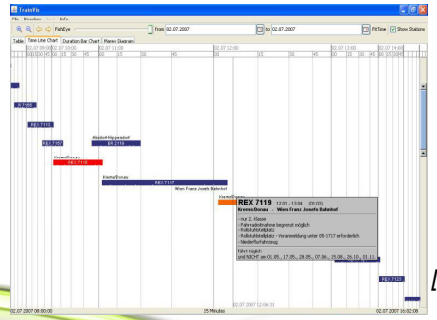
*Adapted [Aigner, Presentation 2010]*

**E.g., Details on Demand**

**Displaying detailed information about data case(s) on demand to the user**

May just be more info about a case

May be moving from aggregation view to individual view



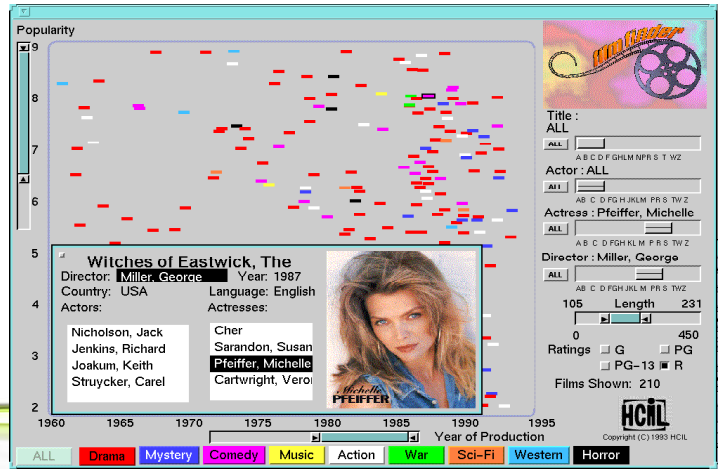
*[TrainVis, Weishapl, Aigner, 2007]*

## **Filter:** show me something conditionally

*Adapted [Aigner, Presentation 2010]*

**E.g., Dynamic Queries**

Selecting value ranges of variables via controls with real time feedback in the display. *[Shneiderman, 1994 ff]*




## **Connect:** show me related items

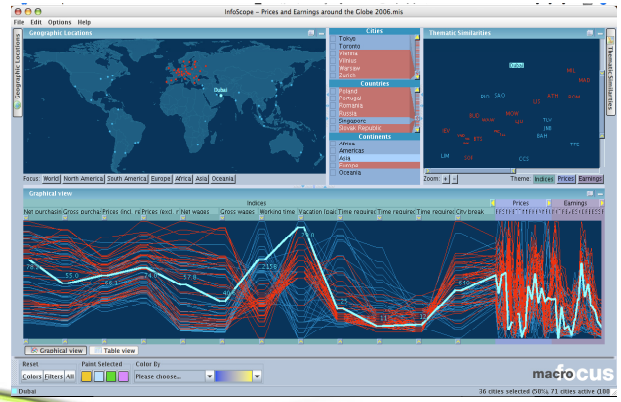
*Adapted [Aigner, Presentation 2010]*

**E.g., Linking**

Connection between multiple views of the same data space

Updating one view means updating all

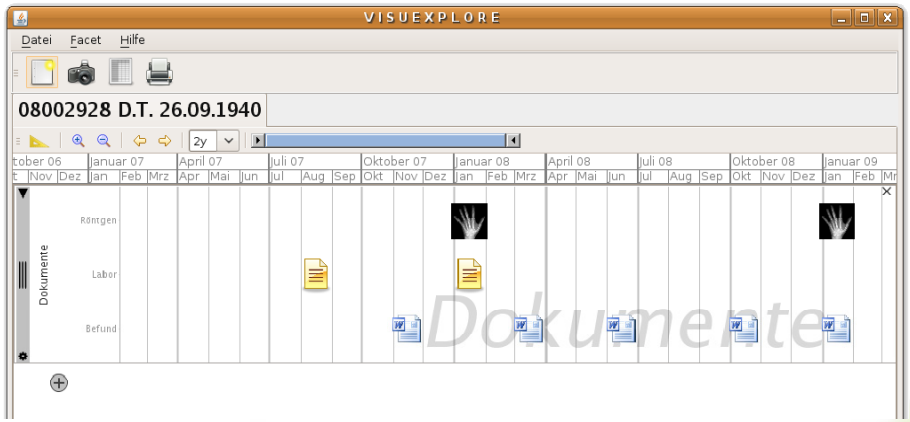
Often mentioned in conjunction with “brushing” (Linking + Brushing)



## **Activate:** trigger actions

*Adapted [Aigner, Presentation 2010]*

**E.g., open document, go to webpage**




## **Modify:** manipulate elements

*Adapted [Aigner, Presentation 2010]*

**generate**

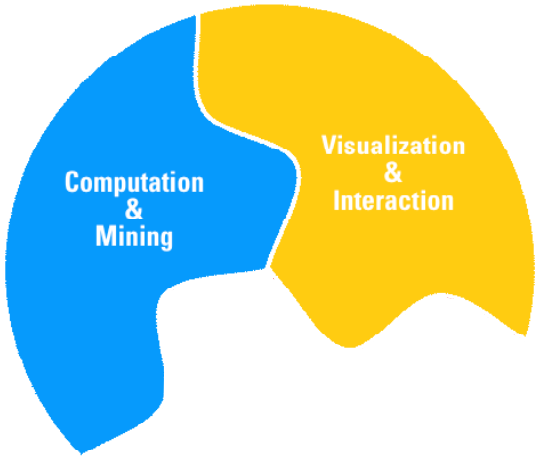
**delete**

**move**

**transform**

**copy**

## Visual Analytics

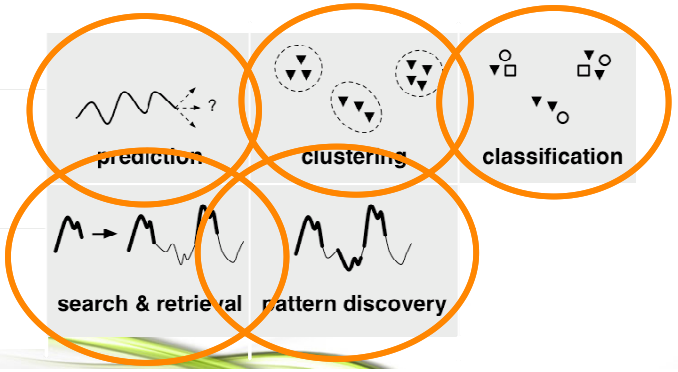



## Computation & Mining

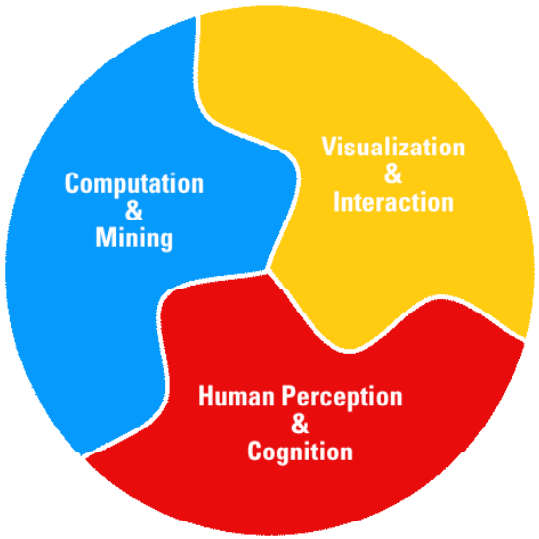
**→*Data Reduction***

**Statistics**

**Data Mining & Knowledge Discovery in DB**



## Visual Analytics




# Gestalt Laws

1. **Proximity**
2. **Similarity**
3. **Pragnanz**
4. **Good Continuation**
5. **Closure**
6. **Common fate**
7. **Familiarity**

[Max Westheimer, Kurt Koffka, and Wolfgang Kohler (1912)]

*--> published in [Kurt Koffka (1935), Principles of Gestalt Psychology, Harcourt-Brace, New York]*

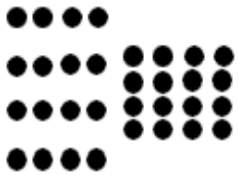
*--> used from [Ware, 2000]*

# Gestalt Laws

[Max Westheimer, Kurt Koffka, and Wolfgang Kohler (1912)]

**1. Proximity**

The tendency of objects near one another to be grouped together into a perceptual unit.

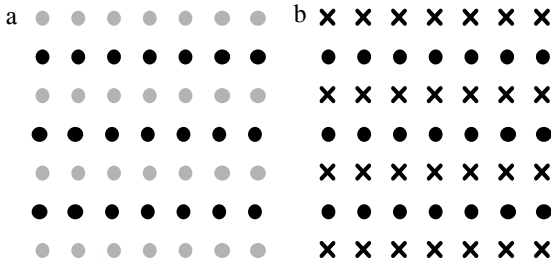


# Gestalt Laws

[Max Westheimer, Kurt Koffka, and Wolfgang Kohler (1912)]

**2. Similarity**

If several stimuli are presented together, there is a tendency to see the form in such a way that the similar items are grouped together.



# Gestalt Laws

[Max Westheimer, Kurt Koffka, and Wolfgang Kohler (1912)]

**3. Pragnanz**

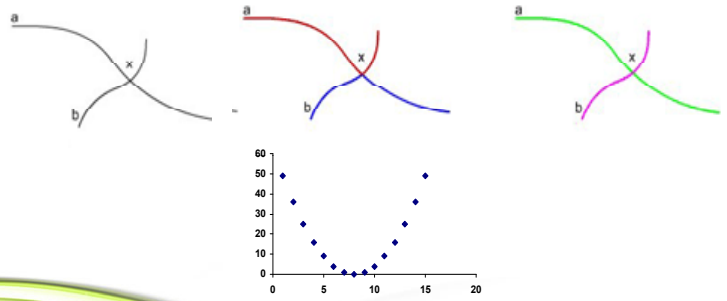
Every stimulus pattern is seen in such a way that the resulting structure is as simple as possible.

# Gestalt Laws

[Max Westheimer, Kurt Koffka, and Wolfgang Kohler (1912)]

**4. Good Continuation**

Neighboring elements are grouped together when they are potentially connected to straight or smoothly curved lines.

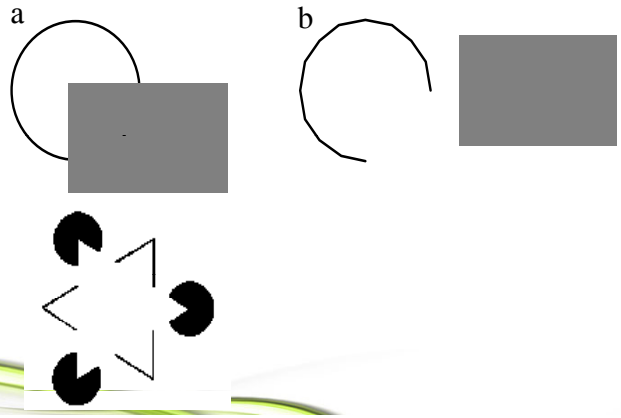



# Gestalt Laws

[Max Westheimer, Kurt Koffka, and Wolfgang Kohler (1912)]

**5. Closure**

The tendency to unite contours that are very close to each other.

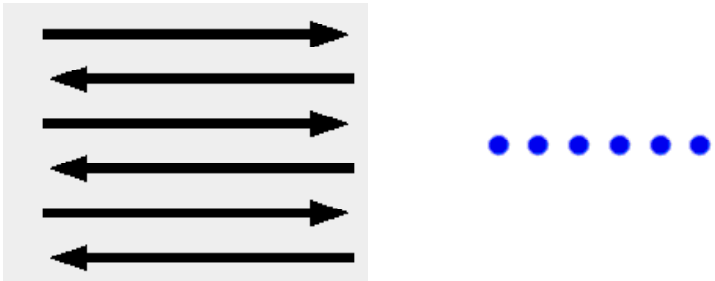



# Gestalt Laws

[Max Westheimer, Kurt Koffka, and Wolfgang Kohler (1912)]

**6. Common Fate**

Elements that are moving in the same direction seem to be grouped together.

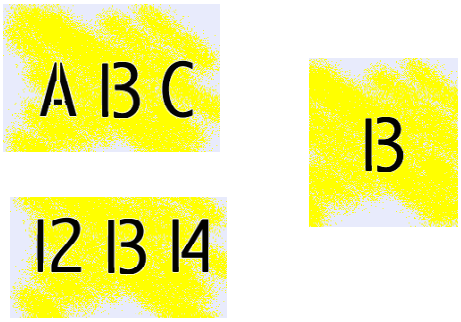


# Gestalt Laws

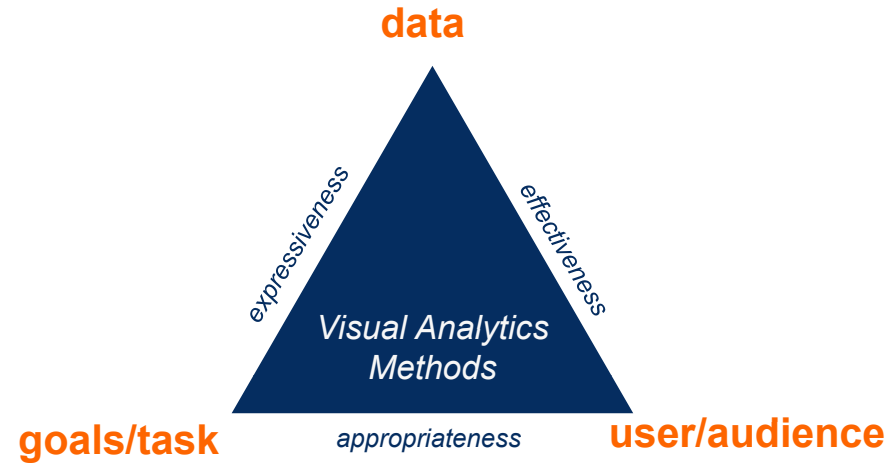
[Max Westheimer, Kurt Koffka, and Wolfgang Kohler (1912)]

**7. Familiarity (Effect of Past Experience)**

Elements are more likely to form groups if the groups appear familiar or meaningful.




## User-Centered Design

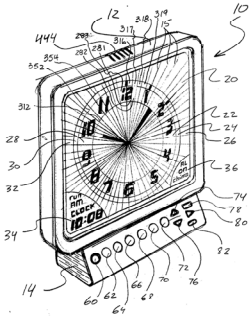



## Video

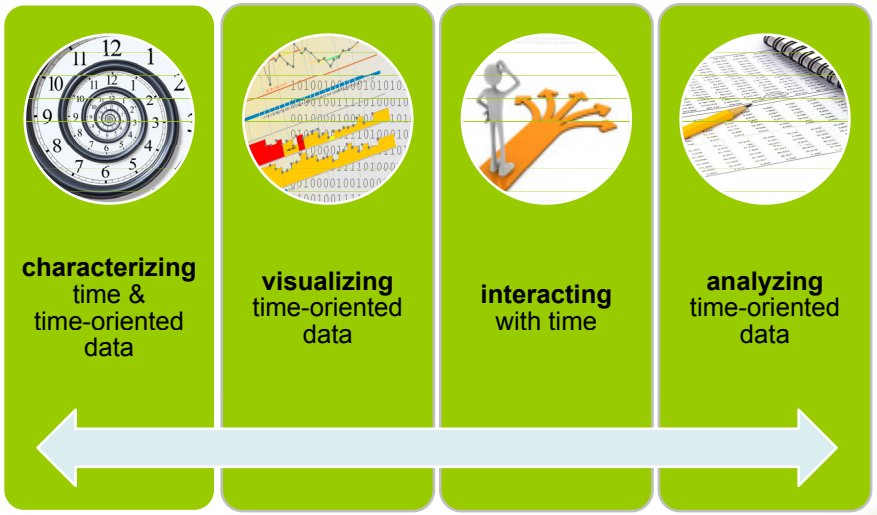
VisMaster
Visual Analytics - Mastering the Information Age


## Content

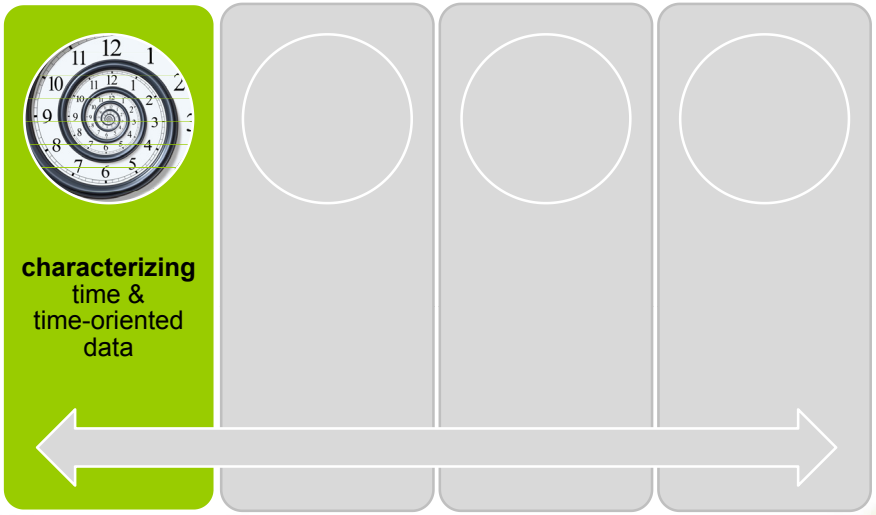
## Time has a Complex Structure



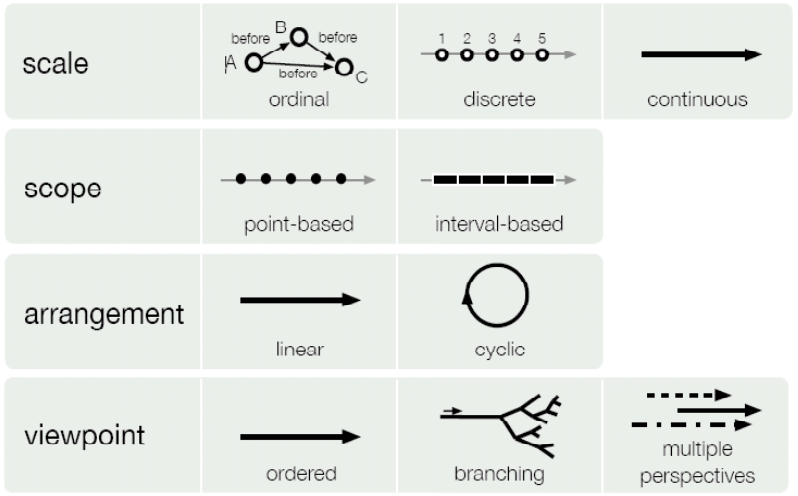

## Visual Analytics of Time-Oriented Data




## Visual Analytics of Time-Oriented Data




## Modelling Time

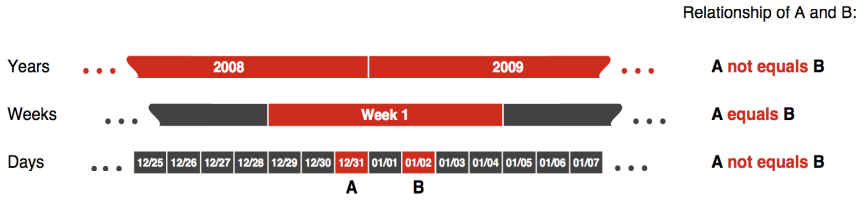


## Modelling Time

Abstractions

| | | | |
|---|---|---|---|
| granularity & calendars | none | single | multiple |
| time primitives | instant | interval | span |
| determinacy | determinate | indeterminate | |

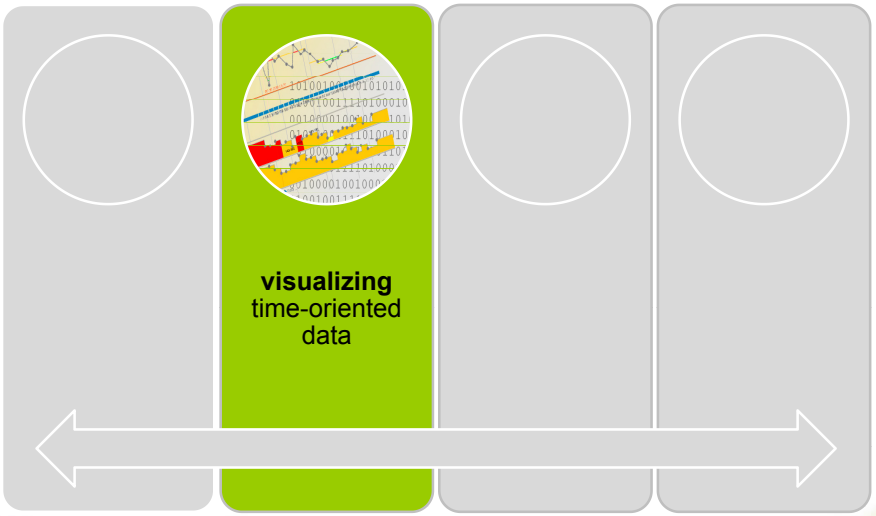
## Example: Granularity Paradoxon




## Modelling Time-Oriented Data

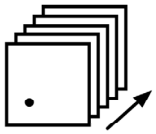
| | | |
|---|---|---|
| scale | 3.14<br>3.27<br>4.88<br>quantitative | coconut<br>banana<br>apple<br>qualitative |
| frame of reference | abstract | spatial |
| kind of data | events | states |
| number of variables | univariate | multivariate |

## Visual Analytics of Time-Oriented Data



# Visualizing Time

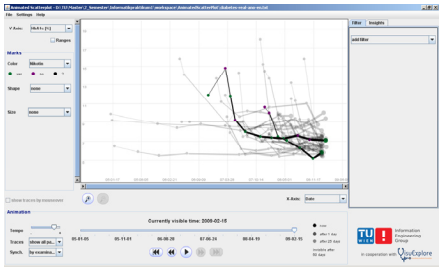
**Time → Time (Animation)**



**Time → Space**

# TimeRider

*[Rind, et al., 2011]*



**Users**

Medical Experts and Physicians

**Data**

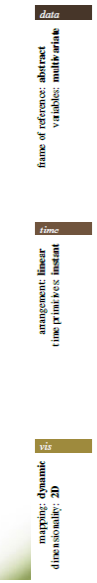
Patient Cohorts

*Data:* multivariate, abstract

*Time*: linear, instant

**Task**

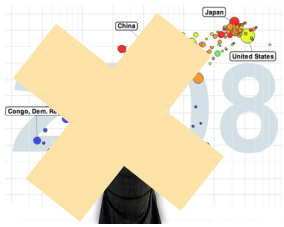
Finding Patterns in Multivariate Data over Time (Patient Cohorts)




Demo

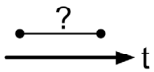
# Patient cohorts pose additional challenges for animated scatter plots

*Gapminder Trendalyzer*

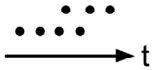




**Irregular sampling**



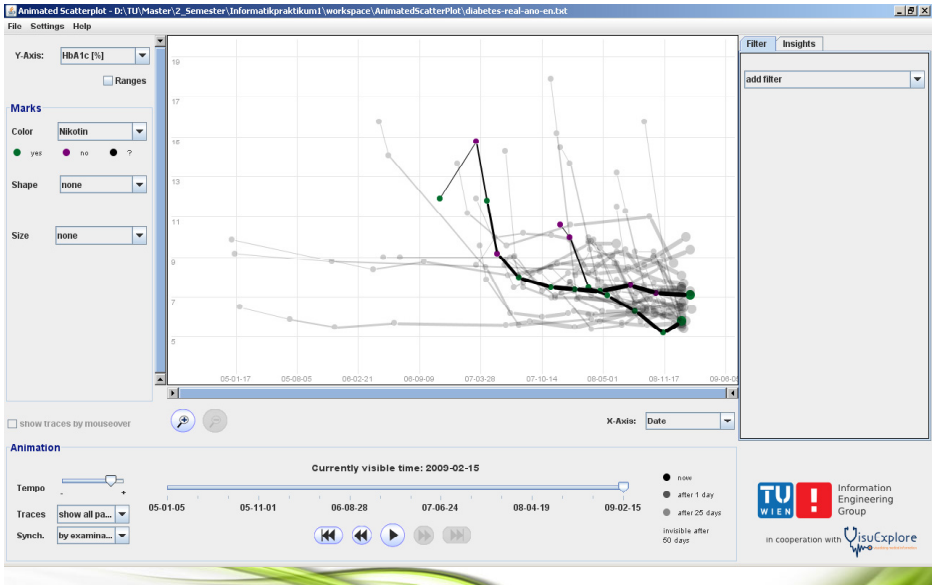

**Data wear**




**Data sets covering different portions of time**

# Visualizing Time: Time → Time (Animation)

*[Rind, et al. : TimeRider]*

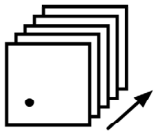


# Visualizing Time: Time → Space

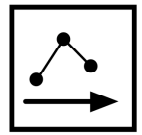
*[Rind, et al.: VisuExplore]*


# Visualizing Time

**Time → Time (Animation)**

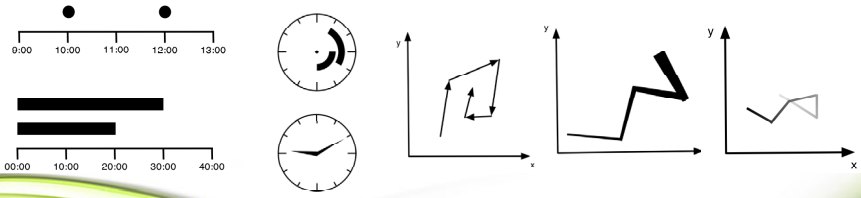


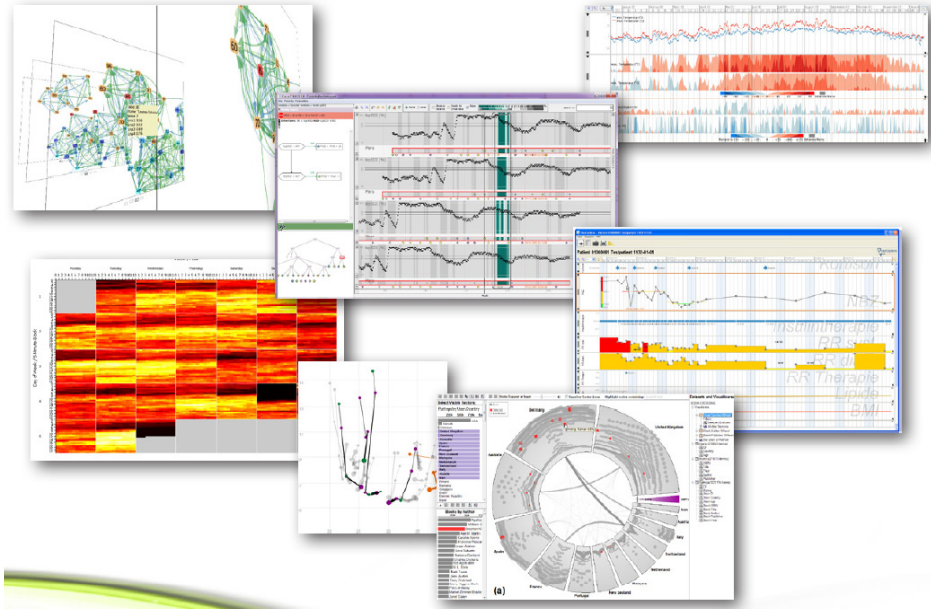
**Time → Space**



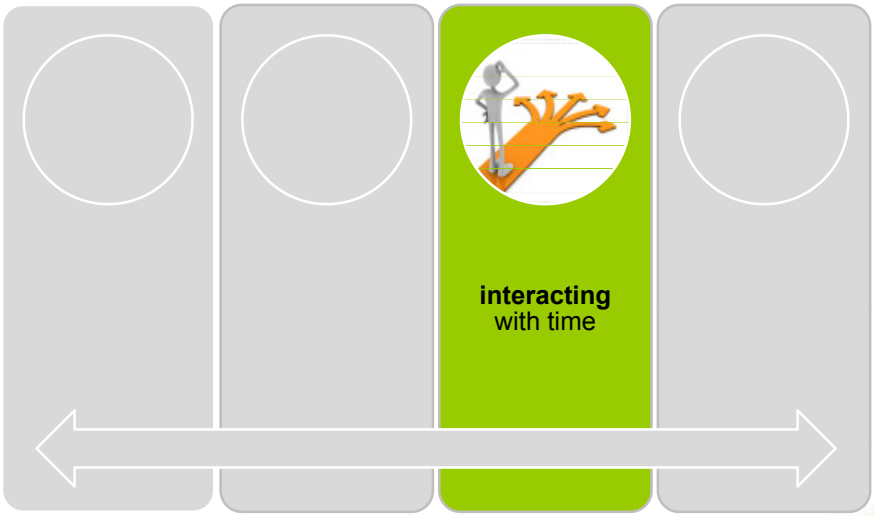
## Visual Variables

**Position, Length, Angle, Slope, Connection, Thickness, ...**

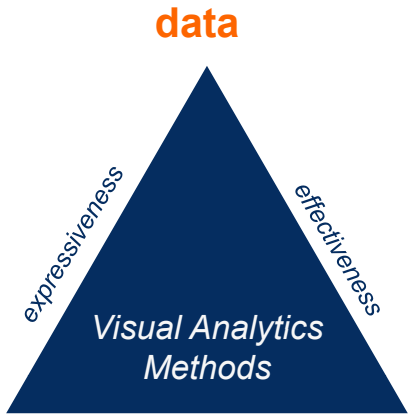


# Visual Analytics of Time-Oriented Data



## User-Centered Design




## CareCruiser

*[Gschwandtner, et al., 2010, 2011]*

**Users**

Medical Experts and Physicians

**Data**

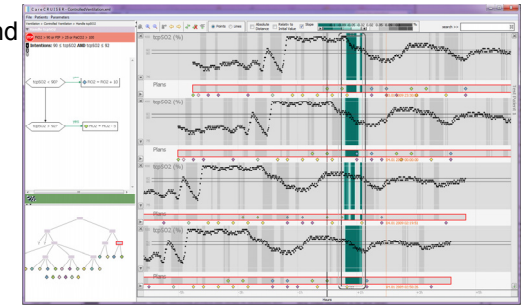
Patient Data and Treatment Plans

*Data*: multivariate, abstract

*Time*: linear, instant

**Task**

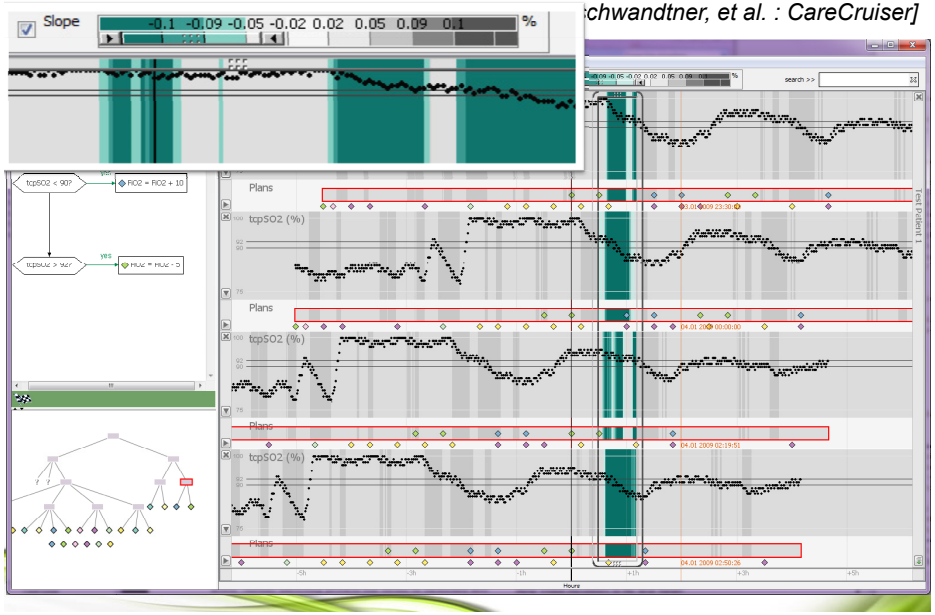
Exploring the Effects of Clinical Actions on a Patient's Condition



Demo | Video Patterns | Video Range Slider

## Interacting with Time

*[Gschwandtner, et al. : CareCruiser]*




## VisuExplore

*[Rind, et al., 2010, 2011]*

**Users**

Medical Experts and Physicians

**Data**

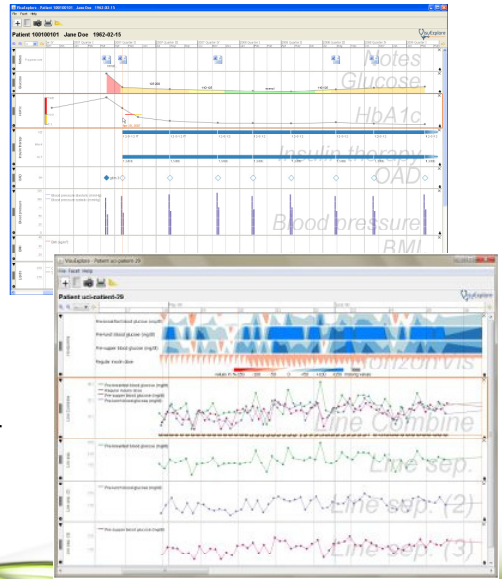
Heteregeneous

*Data*: multivariate, abstract

*Time*: linear, instant and intervall

**Task**

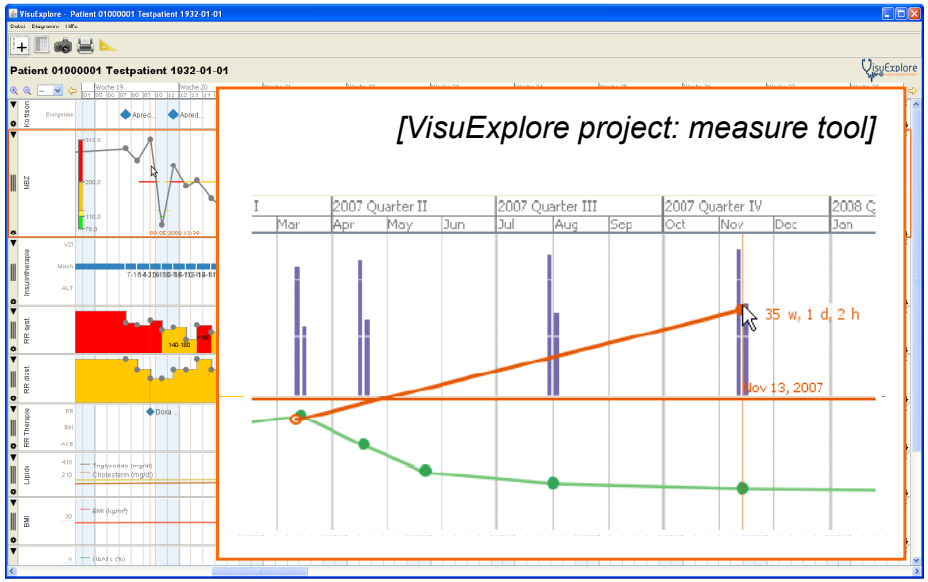
Finding Patterns in Multivariate Data over Time



Demo

## Interacting with Time

*[Rind, et al.: VisuExplore]*



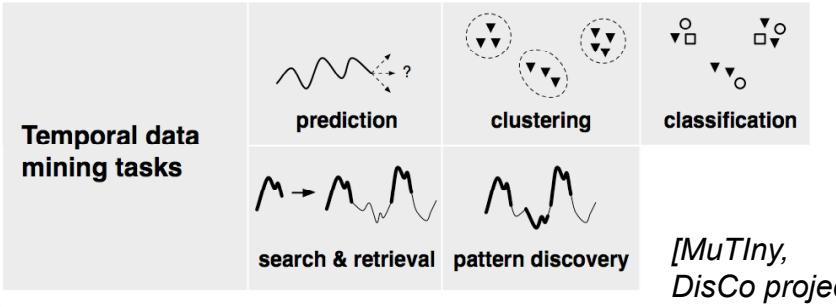

## Visual Analytics of Time-Oriented Data


## Automatic Analysis of Time-Oriented Data

**Temporal Data-Abstraction**

**Statistics**

**Temporal Data-Mining**

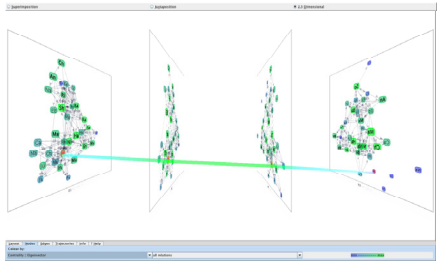



*[MuTIny, DisCo project]*

## Dynamics of Enterprise Networks

*[Frederico, et al., 2010, 2011]*

VIENA
VISUAL ENTERPRISE NETWORK ANALYTICS



**Users**

- Network Experts/Consultants
- Business Users with Managing Functions

**Data**

- Organizational Information: Roles, Skills, Processes, etc
- *Data*: multivariate, abstract
- *Time*: linear, instant

**Task**

- Exploring Organizational Changes over Time
- Dynamic Network Analysis (DNA)

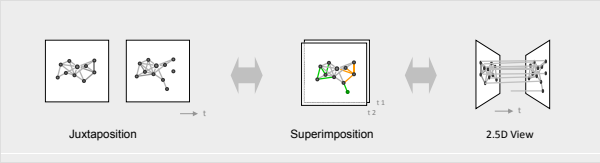
video

VIENA
VISUAL ENTERPRISE NETWORK ANALYTICS

# Visual Analytics Approach to Dynamic Social Networks

CVAST
www.cvast.tuwien.ac.at

**3 Views:** animated smooth transition between them




**Interactive Dynamic Layout**

User controlled stability & consistency

**Dual-mode highlighting**

**Integration of Social Network Analysis metrics**

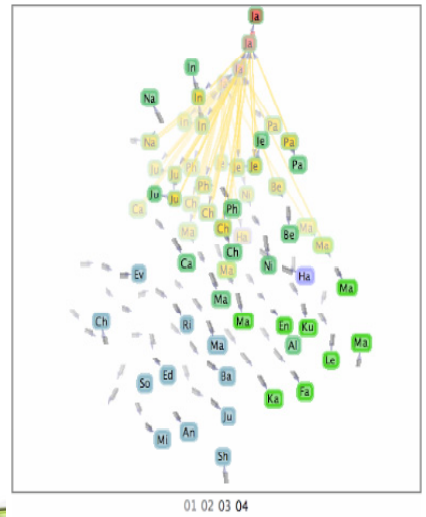
**Visualization of node 'trajectories**

VIENA
VISUAL ENTERPRISE NETWORK ANALYTICS

# Superimposition

CVAST
www.cvast.tuwien.ac.at

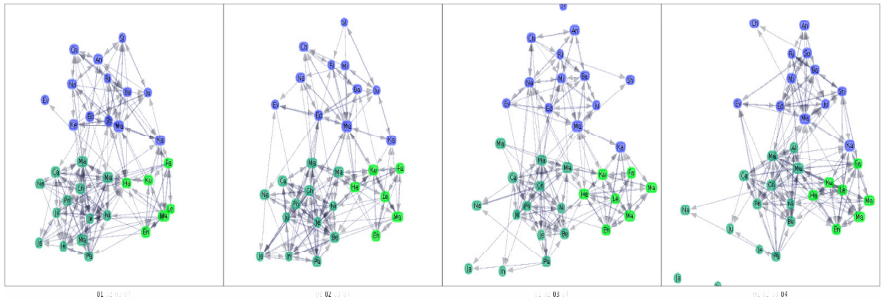
**Mapping time to a visual variable**




VIENA
VISUAL ENTERPRISE NETWORK ANALYTICS

# Juxtaposition

CVAST
www.cvast.tuwien.ac.at

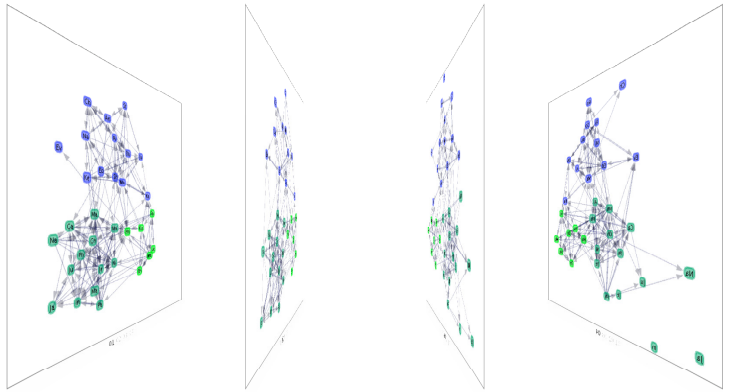


**Mapping time to space (horizontal axis)**

VIENA
VISUAL ENTERPRISE NETWORK ANALYTICS

# 2.5 Dimensional View

CVAST
www.cvast.tuwien.ac.at



**Mapping time to space (3rd dimension)**

VIENA
VISUAL ENTERPRISE NETWORK ANALYTICS

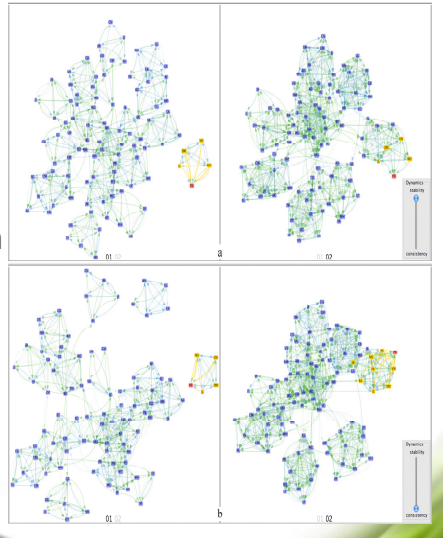
# Specific Interactions

CVAST
www.cvast.tuwien.ac.at

**Layout Control**

**Dual Mode Highlighting**

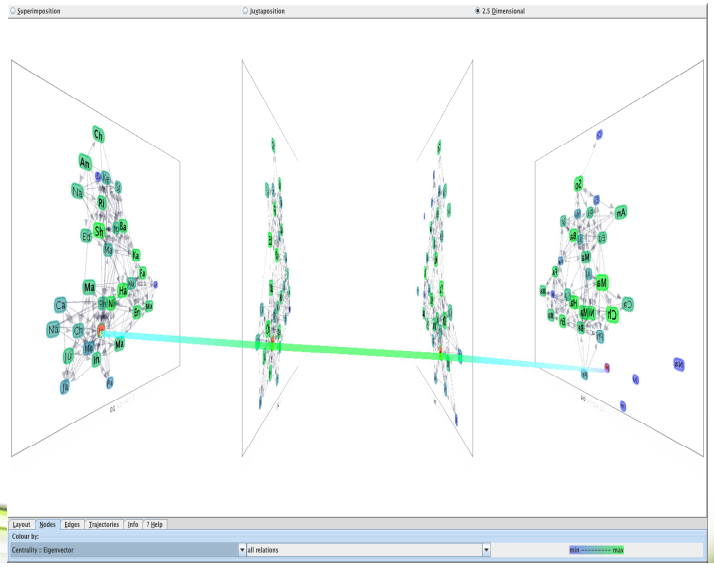
**2D and 3D pan, Zoom, Rotation**



VIENA
VISUAL ENTERPRISE NETWORK ANALYTICS

# SNA Computation + Trajectories

CVAST
www.cvast.tuwien.ac.at



# VAST 2011 Best Paper

CVAST
www.cvast.tuwien.ac.at

**From Movement Tracks through Events to Places: Extracting and Characterizing Significant Places from Mobility Data**


Gennady Andrienko[1], Natalia Andrienko[1], Christophe Hurter[2], Salvatore Rinzivillo[3], Stefan Wrobel[1]

[1] Fraunhofer Institute IAIS (Intelligent Analysis and Information Systems) and University of Bonn, Germany
[2] DGAC/DTI R&D, ENAC and the University of Toulouse, France
[3] KDDLab. ISTI – CNR. Pisa. Italy

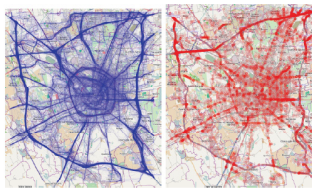



Figure 1. Left: all trajectories are drawn with 5% opacity; right: extracted low speed events are drawn with 50% opacity

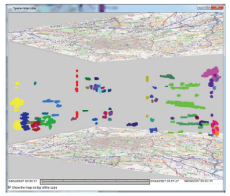


Figure 3. After removing the noise, the low speed events have been clustered by spatial proximity and direction.

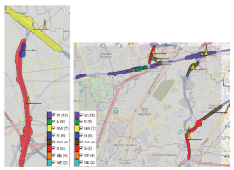
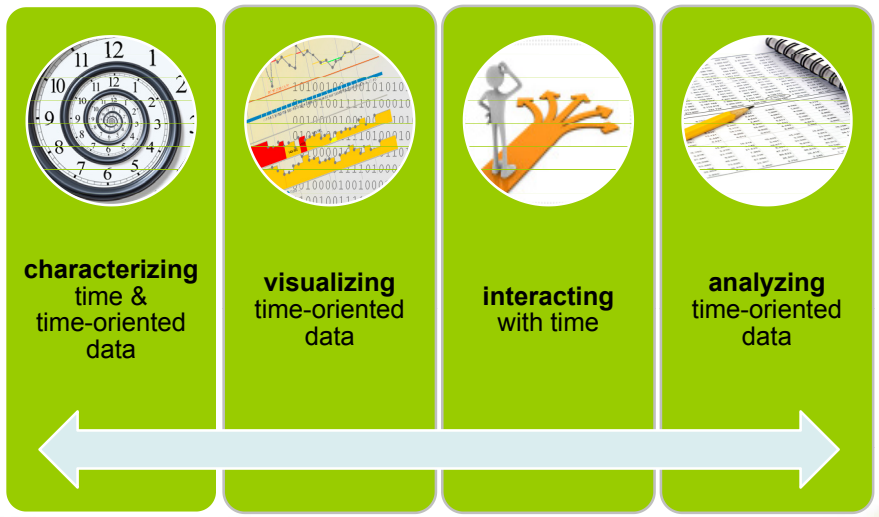


Figure 6. The temporal profiles of the traffic jam occurrences.

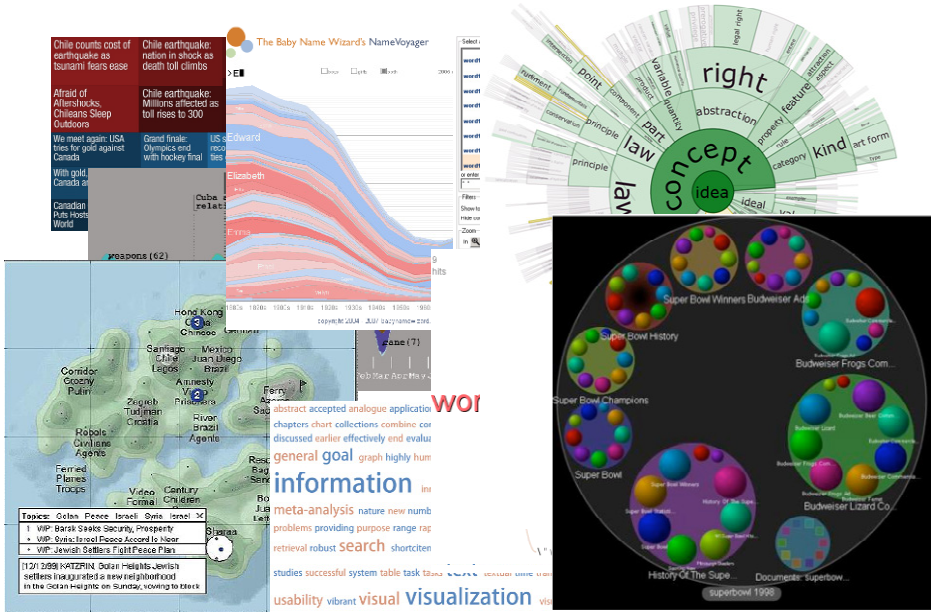
Extracting events from trajectories
Determining relevant places (clustering + treesholds)
Aggregating events and trajectories
Analysis of aggregated data (Traffic congestions in Milan, Flights in France)

# Visual Analytics of Time-Oriented Data

CVAST
www.cvast.tuwien.ac.at



# Text Visualizations/ Visual Analytics




# Text Visualizations/ Visual Analytics

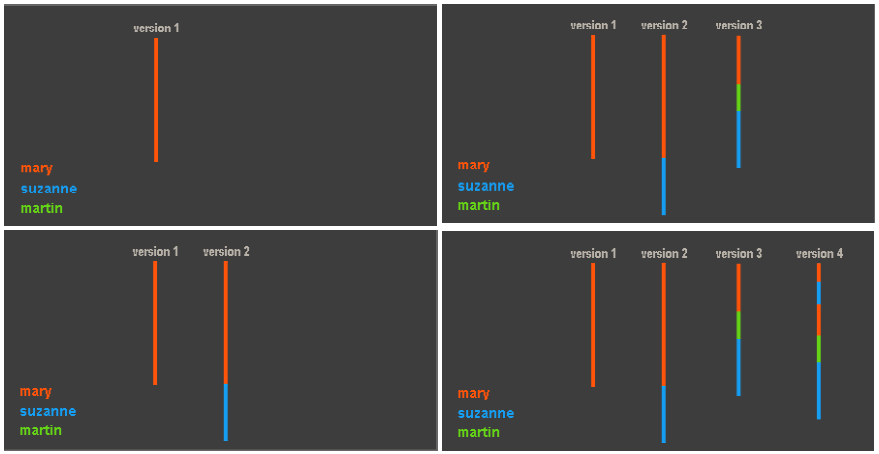
History Flow Visualization

Readability Analysis

Document Cards

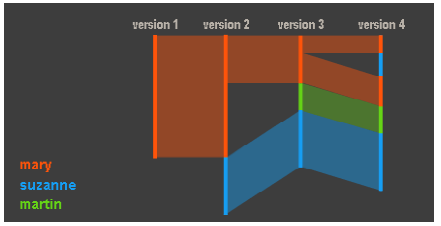
# History Flow Visualization

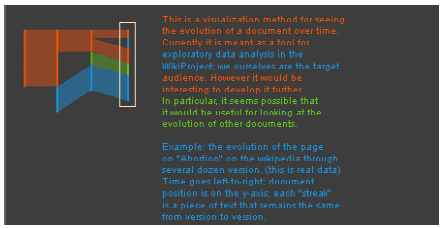
*[Wattenberg & Viégas, 2006]*




# History Flow Visualization

*[Wattenberg & Viégas, 2006]*



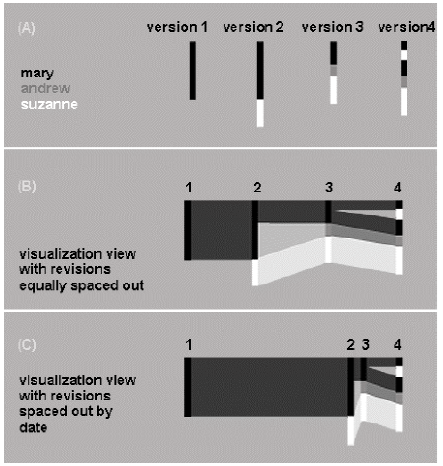
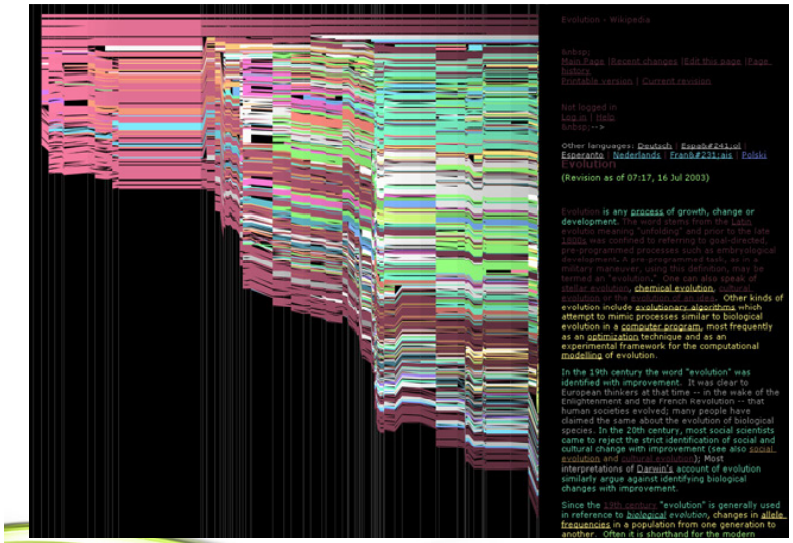




*Fig 2: explanation of history flow's visualization mechanism*

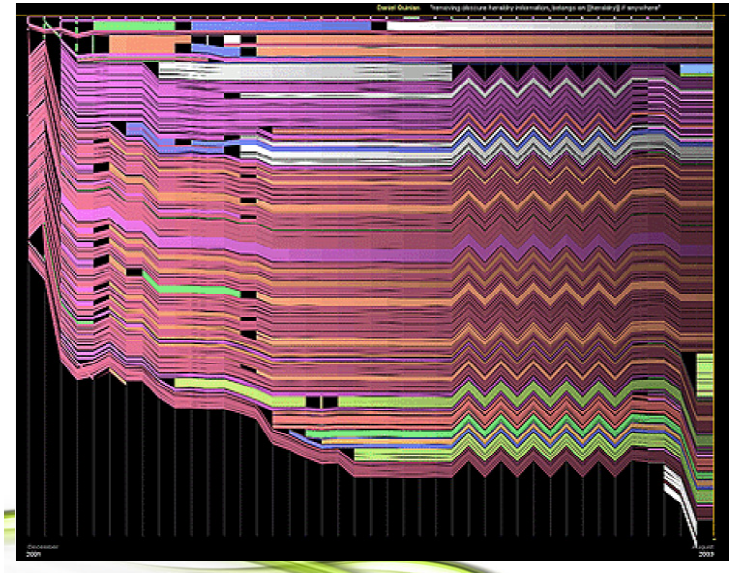
# History Flow Visualization

*[Wattenberg & Viégas, 2006]*



# History Flow Visualization

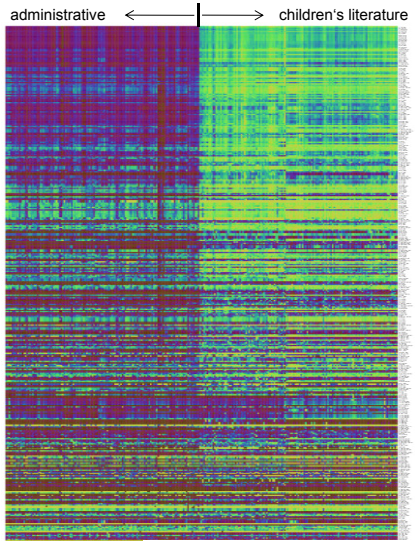
*[Wattenberg & Viégas, 2006]*

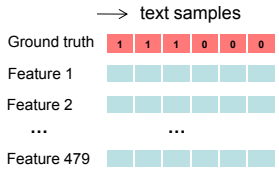


# Readability Analysis

**VAST 2010 Best Paper**

*[Keim, presentation TAVA 2011]*




➔ 479 feature vectors with one value for each text sample

Method: Pearson Correlation Coefficient

removed if correlation < 0.7


D. Oelke, D. Spretke, A. Stoffel and D. A. Keim. Visual Readability Analysis: How to make your writings easier to read. In Proceedings of IEEE Conference on Visual Analytics Science and Technology (VAST '10), 2010.

# Readability Analysis

**VAST 2010 Best Paper**

*[Keim, presentation TAVA 2011]*

**Word Length**
**Vocabulary Complexity**
**Nominal Forms**
**Sentence Length**
**Sentence Structure Complexity**

➔ **Average = Overall readability score**

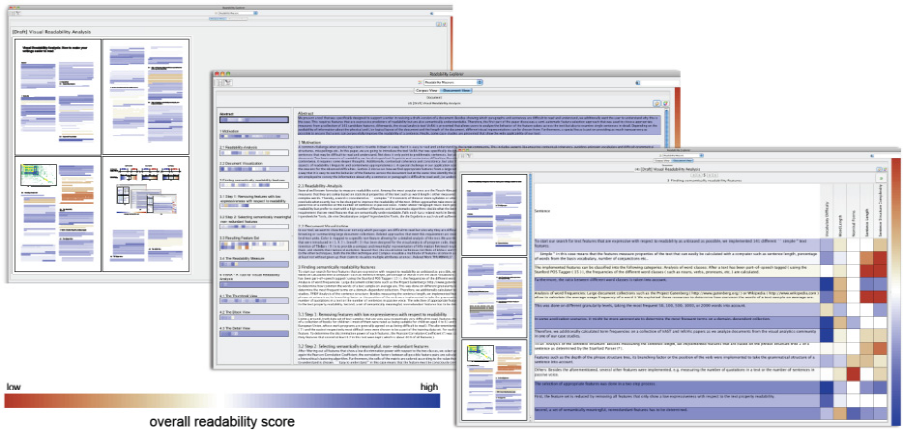
**Normalization with respect to:**
**Sentence length**
**the ground-truth data set (mapping between 0 and 1)**

D. Oelke, D. Spretke, A. Stoffel and D. A. Keim. Visual Readability Analysis: How to make your writings easier to read. In Proceedings of IEEE Conference on Visual Analytics Science and Technology (VAST '10), 2010.

# Readability Analysis

Universität Konstanz

*[Keim, presentation TAVA 2011]*




D. Oelke, D. Spretke, A. Stoffel and D. A. Keim. Visual Readability Analysis: How to make your writings easier to read. In Proceedings of IEEE Conference on Visual Analytics Science and Technology (VAST '10), 2010.

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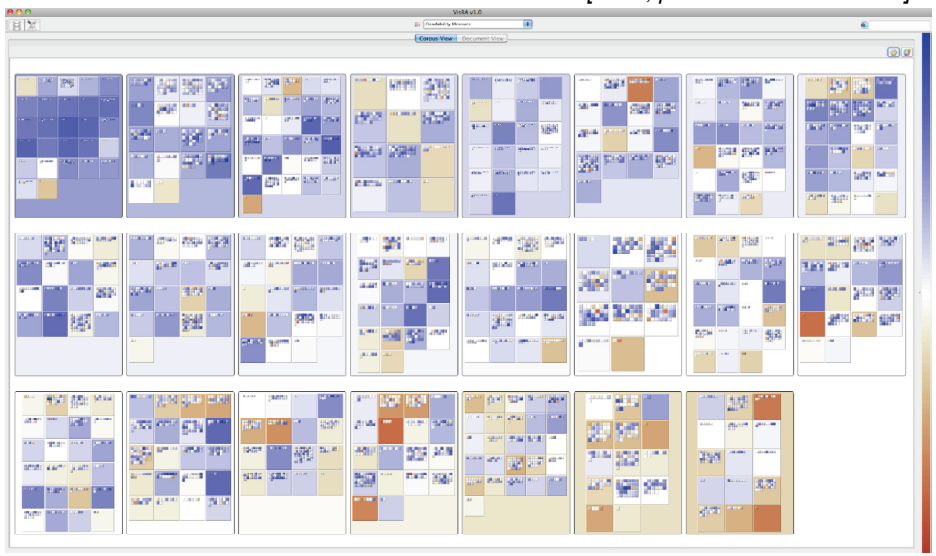
*[Keim, presentation TAVA 2011]*



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Universität Konstanz

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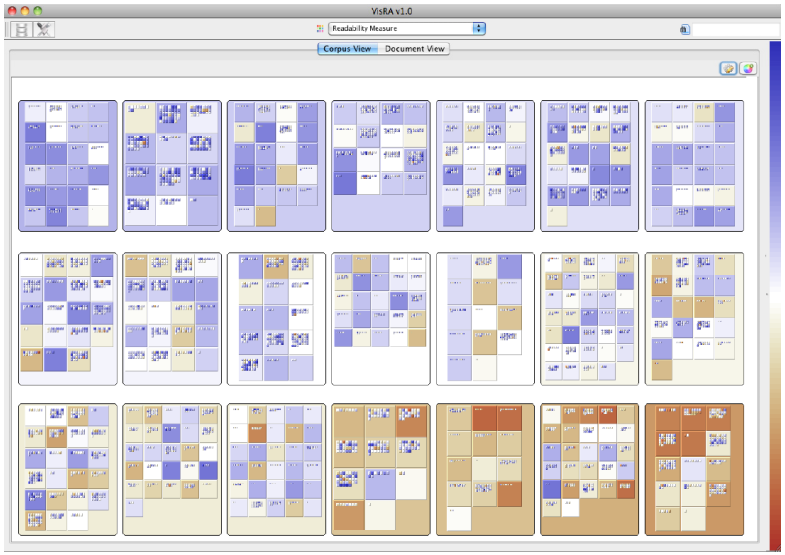


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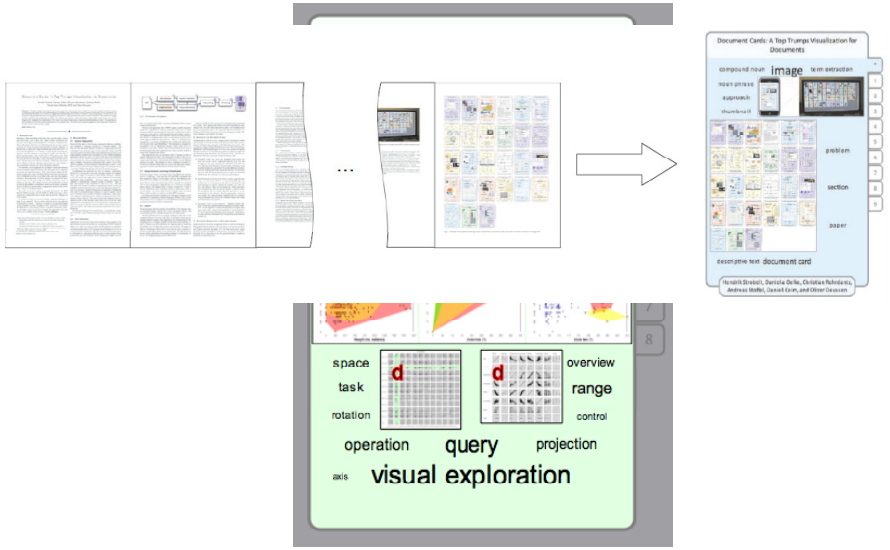
# Document Cards

Universität Konstanz

*[Keim, presentation TAVA 2011]*

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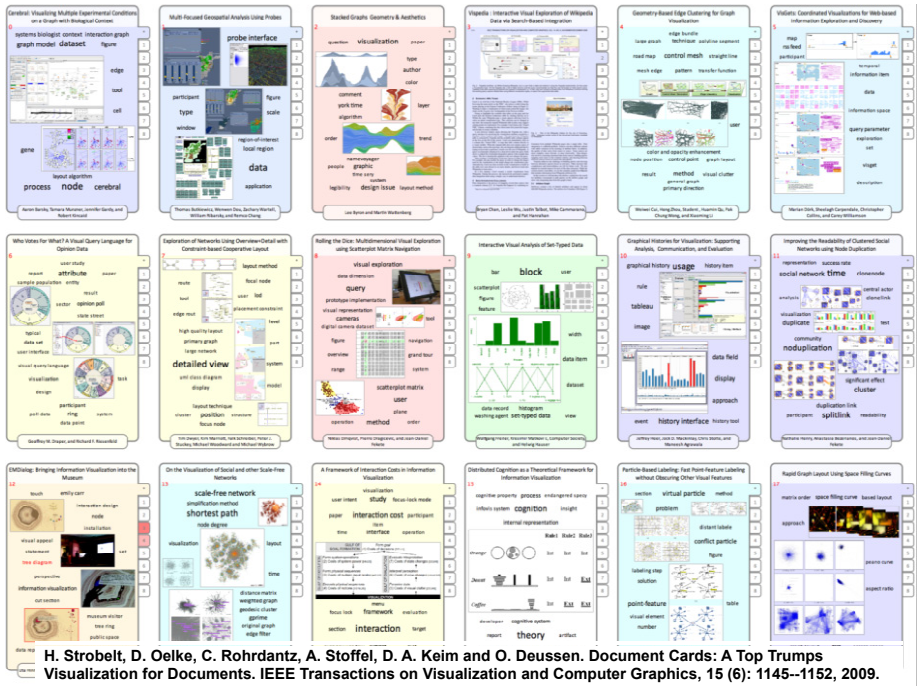

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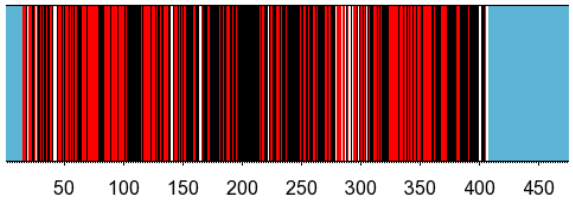


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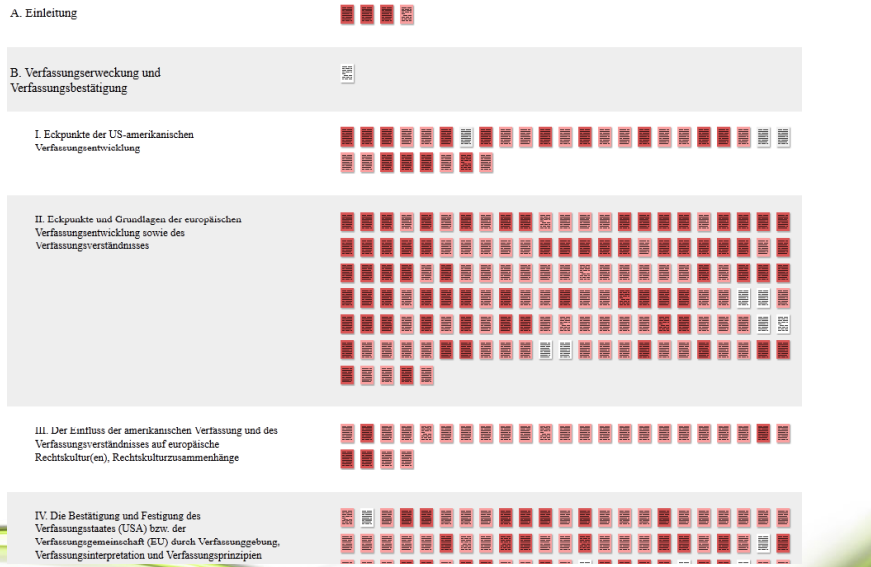


## Conclusion :: Challenges

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**Visual Analytics –**

*Detect the Expected and Discover the Unexpected*

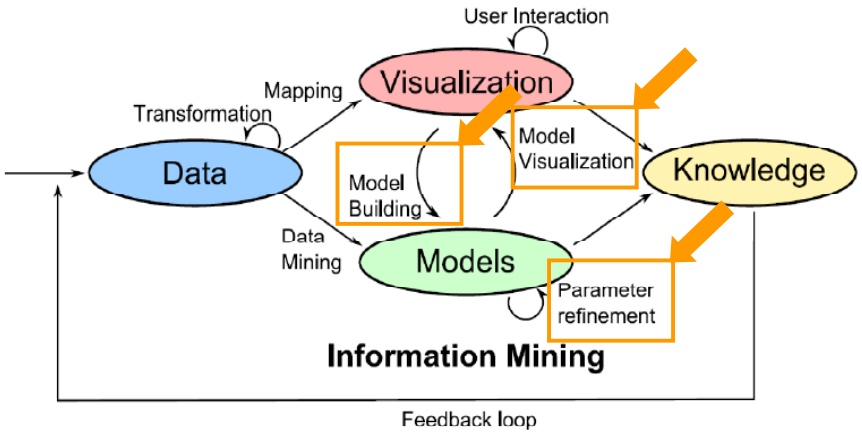
**Technical Challenges in Visual Analytics**

- Data Quality and Uncertainty
- Data Provenance
- Data Streams
- Scalabilty in Problem Size
- Process Intergration
- Evaluation

**Application Challenges in Visual Analytics**

## Visual Analytics – Process

[Keim, et al., 2008]



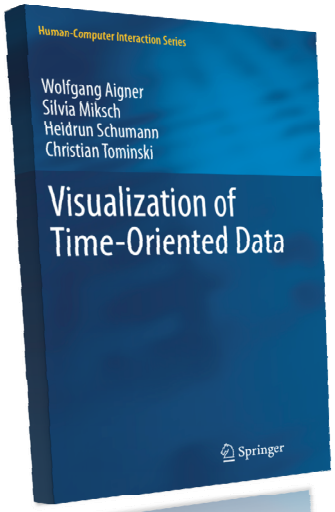

## Conclusion

[Keim, presentation TAVA 2011]

Universität Konstanz

**Visual Analytics**
**is the**
***scientific discovery method***
**needed to solve some of**
**the Grand Challenge problems!**

> **"All truths are easy to understand once they are discovered; the point is to discover them."**
>
> **Galileo Galile (1564-1642)**




NEW BOOK

Wolfgang Aigner • Silvia Miksch
Heidrun Schumann • Christian Tominski

**Visualization of Time-Oriented Data**

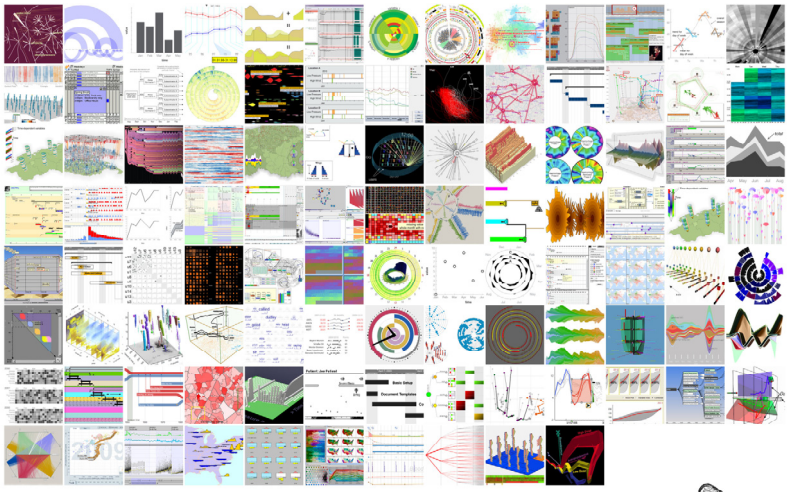
*with a foreword by Ben Shneiderman*

Springer

1st Edition., 2011, XVIII, 286 p. 221 illus., 198 in color.
**Hardcover**, ISBN 978-0-85729-078-6 Due: June 2011

**Table of Contents**
Introduction • Historical Background •
Time & Time-Oriented Data • Visualization Aspects •
Interaction Support • Analytical Support •
Survey of Visualization Techniques • Conclusion

**www.timeviz.net**



Wolfgang Aigner • Silvia Miksch • Heidrun Schumann • Christian Tominski
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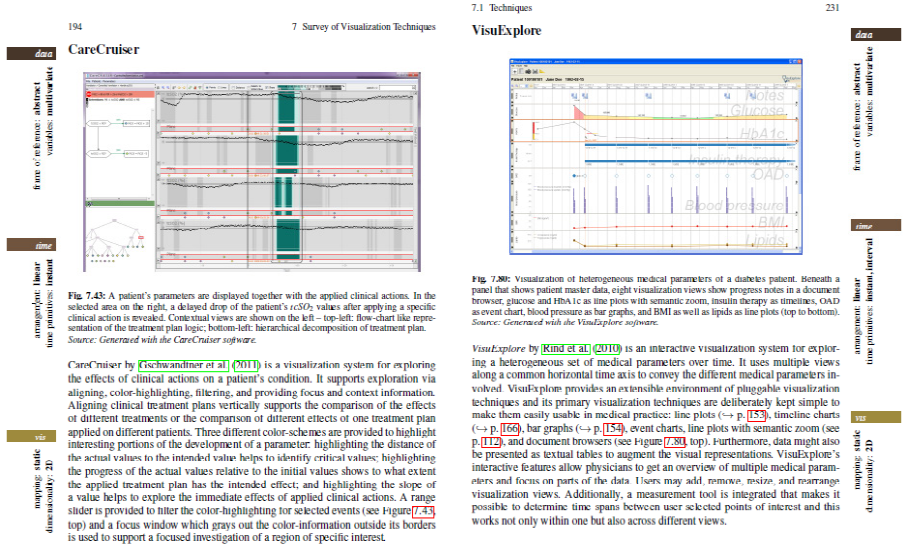


194 7 Survey of Visualization Techniques

**CareCruiser**

**Fig. 7.43:** A patient's parameters are displayed together with the applied clinical actions. In the selected area on the right, a delayed drop of the patient's $rcSO_2$ values after applying a specific clinical action is revealed. Contextual views are shown on the left – top-left: flow-chart like representation of the treatment plan logic; bottom-left: hierarchical decomposition of treatment plan. *Source: Generated with the CareCruiser software.*

CareCruiser by Gschwandtner et al. (2011) is a visualization system for exploring the effects of clinical actions on a patient's condition. It supports exploration via aligning, color-highlighting, filtering, and providing focus and context information. Aligning clinical treatment plans vertically supports the comparison of the effects of different treatments or the comparison of different effects of one treatment plan applied on different patients. Three different color-schemes are provided to highlight interesting portions of the development of a parameter: highlighting the distance of the actual values to the intended value helps to identify critical values; highlighting the progress of the actual values relative to the initial values shows to what extent the applied treatment plan has the intended effect; and highlighting the slope of a value helps to explore the immediate effects of applied clinical actions. A range slider is provided to filter the color-highlighting for selected events (see Figure 7.43, top) and a focus window which grays out the color-information outside its borders is used to support a focused investigation of a region of specific interest.

**References**

Gschwandtner, T., Aigner, W., Kaiser, K., Miksch, S., and Seyfang, A. (2011). CareCruiser: Exploring and Visualizing Plans, Events, and Effects Interactively. In *Proceedings of the IEEE Pacific Visualization Symposium (PacificVis 2011)*, Los Alamitos, CA, USA. IEEE Computer Society. To appear.

7.1 Techniques 231

**VisuExplore**

**Fig. 7.80:** Visualization of heterogeneous medical parameters of a diabetes patient. Beneath a panel that shows patient master data, eight visualization views show progress notes in a document browser, glucose and HbA1c as line plots with semantic zoom, insulin therapy as timelines, OAD as event chart, blood pressure as bar graphs, and BMI as well as lipids as line plots (top to bottom). *Source: Generated with the VisuExplore software.*

*VisuExplore* by Rind et al. (2010) is an interactive visualization system for exploring a heterogeneous set of medical parameters over time. It uses multiple views along a common horizontal time axis to convey the different medical parameters involved. VisuExplore provides an extensible environment of pluggable visualization techniques and its primary visualization techniques are deliberately kept simple to make them easily usable in medical practice: line plots (↪ p. 153), timeline charts (↪ p. 166), bar graphs (↪ p. 154), event charts, line plots with semantic zoom (see p. 112), and document browsers (see Figure 7.80, top). Furthermore, data might also be presented as textual tables to augment the visual representations. VisuExplore's interactive features allow physicians to get an overview of multiple medical parameters and focus on parts of the data. Users may add, remove, resize, and rearrange visualization views. Additionally, a measurement tool is integrated that makes it possible to determine time spans between user selected points of interest and this works not only within one but also across different views.

**References**

Rind, A., Miksch, S., Aigner, W., Turic, T., and Pohl, M. (2010). VisuExplore: Gaining New Medical Insights from Visual Exploration. In Hayes, G. R. and Tan, D. S., editors, *Proceedings of the 1st International Workshop on Interactive Systems in Healthcare (WISH@CHI2010)*, pages 149–152, New York, NY, USA. ACM Press.

*[Aigner, Miksch, Schumann, Tominski, 2011]*

# 3 Key Questions of the Visualization

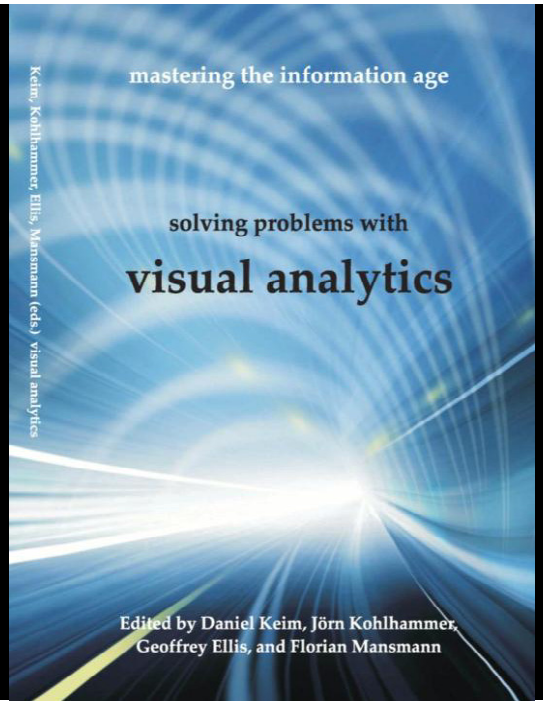
| | | | |
|---|---|---|---|
| What? | time | scale, scope, arrangement, viewpoint granularity & calendars, time primitives, determinacy *see Chapter 3* | |
| | data | scale, frame of reference, kind of data, number of variables *see Chapter 3* | |
| | time & data | internal time, external time *see Chapter 3* | |
| Why? | 1st level | individual values | sets |
| | 2nd level | lookup | comparison |
| | 3rd level | identification | localization |
| How? | mapping | static | dynamic |
| | dimensionality | 2D | 3D |

***1. What has to be presented?***
***– Time and data!***

***2. Why has it to be presented?***
***– User tasks!***

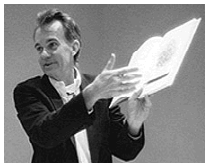
***3. How is it presented?***
***– Visual representation!***

Roadmap from the
VisMaster EU Project

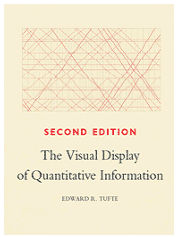



www.visual-analytics.eu

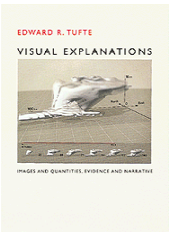
# Eduard Tufte



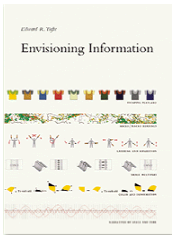
2006




2001

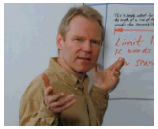


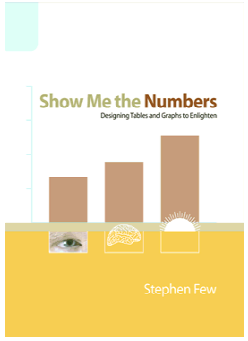

1990



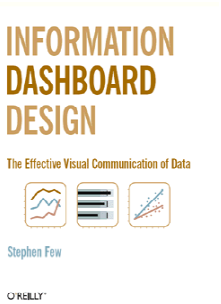

1997

## Stephen Few

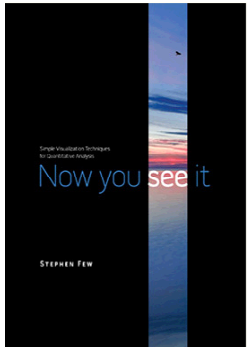





Show Me the Numbers: Designing Tables and Graphs to Enlighten, Analytics Press, 2004

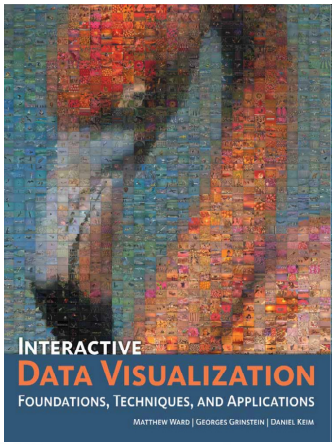



Information Dashboard Design: The Effective Visual Communication of Data, O'Reilly Media, 2006




Now You See It: Simple Visualization Techniques for Quantitative Analysis, Analytics Press, 2009

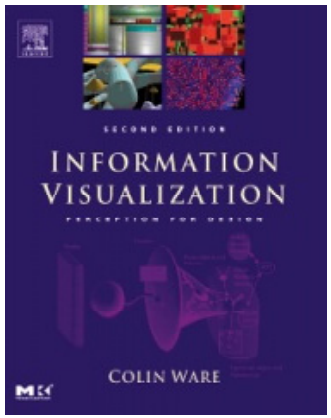
## Matthew Ward, Georges Grinstein, Daniel Keim




Ward, M, Grinstein, G., Keim, D.: Interactive Data Visualization: Foundations, Techniques, and Applications, A K Peters/CRC Press, 2010

http://www.idvbook.com/

## Colin Ware

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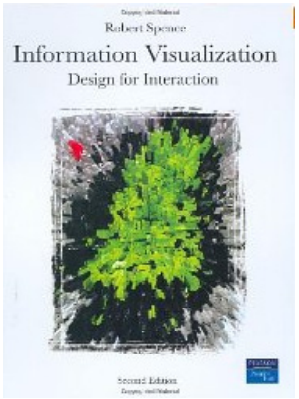
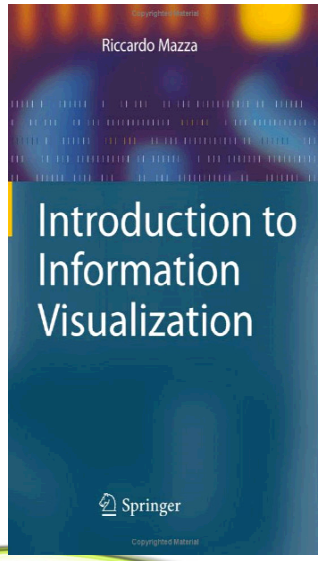
## Robert Spence




Spence, R.: Information Visualization: Design for Interaction Prentice Hall; 2 edition (January 15, 2007)

## Riccardo Mazza

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**http://www.springerlink.com/content/978-1-84800-218-0#section=43657&page=1**

## Thanks to


Laura Bassi Centres of Expertise

FFG Forschung wirkt.

bmwfj Bundesministerium für Wirtschaft, Familie und Jugend

FORTE

FWF Der Wissenschaftsfonds.

TU Wien

ISIS.

VisuExplore visualizing medical information

Laura Bassi Centre of Expertise
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## Thanks to


| | |
|---|---|
| Alessio Bertone | (Danube Universty Krems) |
| Thomas Turic | (Danube Universty Krems) |
| Heidrun Schumann | (University of Rostock) |
| Christian Tominski | (University of Rostock) |
| Wolfgang Aigner | (CVAST, Vienna University of Technology) |
| Bilal Alsallakh | (CVAST, Vienna University of Technology) |
| Paolo Federico | (CVAST, Vienna University of Technology) |
| Theresia Gschwandtner | (CVAST, Vienna University of Technology) |
| Klaus Hinum | (in2vis, Vienna University of Technology) |
| Katharina Kaiser | (CVAST, Vienna University of Technology) |
| Tim Lammarsch | (HypoVis, Vienna University of Technology) |
| Alexander Rind | (HypoVis, Vienna University of Technology) |
| Andreas Seyfang | (Brigid, Vienna University of Technology) |
| Margit Pohl | (CVAST, Vienna University of Technology) |
| Markus Rester | (Vienna University of Technology) |