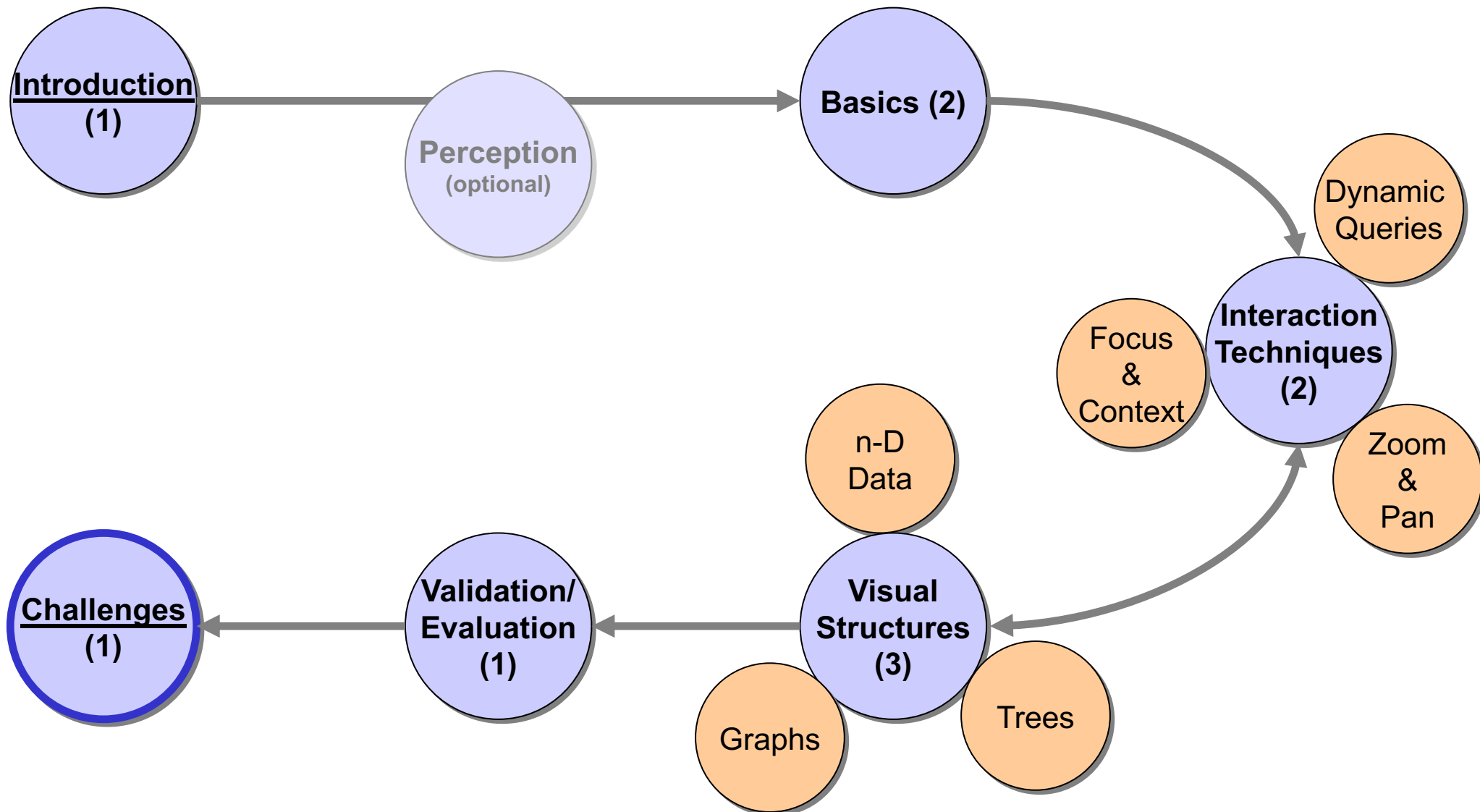


Information Visualization

8. InfoVis Research Challenges



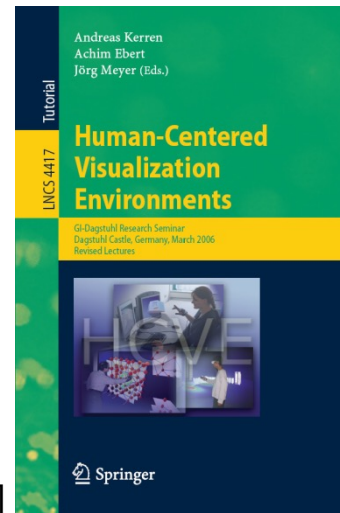
■ Human-centered challenges

- Interdisciplinary collaboration
- Evaluation of usability and effectiveness
- Understanding of elementary perception and cognition
- Previous knowledge (adaptability, ...)
- Education and training
- Development of effective visual metaphors
- Optimal abstraction level
- Effective interaction and exploration
- Representation of data quality
- Collaborative visualization
- Aesthetics
- Multimodality (sonification, haptics, ...)

■ Technical and other challenges

- Scalability
- Coordinated views
- Representation of high-dimensional and time-dependent data
- Research must be better transformed into practice
- Data filtering
- Benchmarks
- Quality metrics
- Display devices
- ...

[LNCS 4417, 2007]



8.2 Top 10 Challenges

- The given 10 big InfoVis problems/challenges are based on my LNCS 4417 book, recent research trends, and the following paper from 2005:
 - [C. Chen. „Top 10 Unsolved Information Visualization Problems“. IEEE Computer Graphics and Applications, 25(4), pp. 12-16, 2005.]
- Problems 1-4 are *human-centered* challenges
- Problems 5-9 are more *technical* challenges
- The remaining problem 10 focuses on challenges of a specific *application area*

- Empirical studies are still challenging, even though nobody has doubts about their benefits
- We need new evaluation methods that are especially designed for InfoVis
 - Problem: Currently, we use standard techniques from other fields (cp. Chapter 8)
 - In InfoVis, the user interacts with the visualization exploratively, i.e., the process of the better understanding is affected by a stepwise approach to find the needed information

- The general understanding of perception and cognition must be inspected in context of InfoVis and, if necessary, adapted
- There is often a disparity between complex user tasks (e.g., browsing and searching) and the evaluation of single visual components (e.g., preattentive perception)
- Increased *cognitive load*
 - Recent VA tools support a large number of complex visual representations that can easily become overwhelming for users
 - People may refuse to use them in worst case

- How does InfoVis handle prior knowledge of the users?
- One distinguish
 - Prior knowledge how the user uses an InfoVis system
 - Prior knowledge from the application domain, i.e., how the user interprets information
- How can we support a better use of prior knowledge?
 - Design decisions during the development process of a visualization
 - Adaptive InfoVis systems, ...

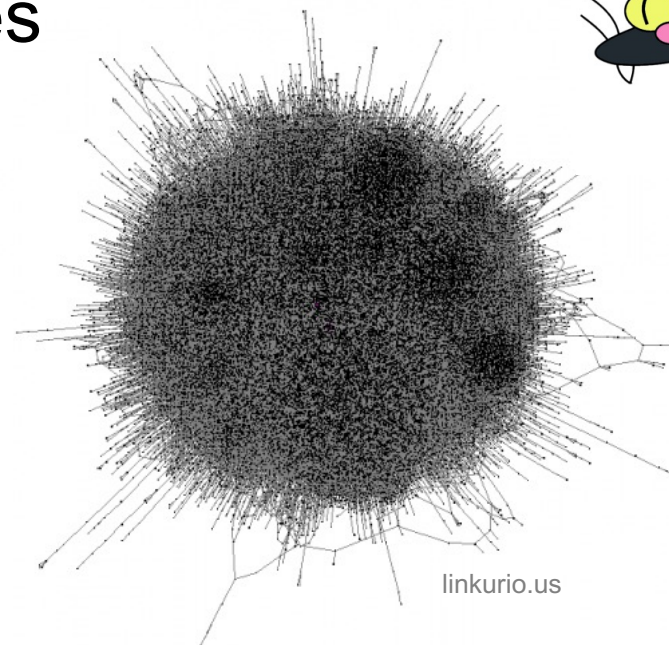
- Researchers and users should know basic principles from visual communication and semiotics (internal aspect)
- For an insider, the value of InfoVis is clear. That is usually not the case for people who are *not familiar* with InfoVis ideas and tools
- We need case studies that are visible to outside the community, tutorials (also for non-experts) and the knowledge of problems in the application domains that can be solved by InfoVis techniques

- The lack of quantifiable quality measures will delay the development progress of the whole field of InfoVis, especially its evaluation and selection of suitable algorithms/techniques
- Example for a general quality metric
 - Stress level (minimization of global distortion) with Multidimensional Scaling (MDS)
 - Aim of MDS: Projection of high-dimensional data to 2 or 3 dimensions
 - The lower the stress level is, the better the MDS-solution

- Scalability is a well-known problem in InfoVis

- There are many examples

- Huge networks
- Huge n-dimensional data
- Data streams
- ...

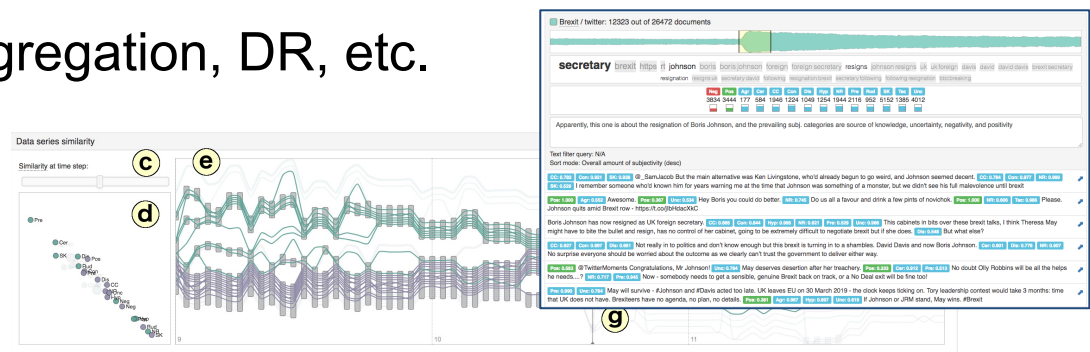


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- Problems can be found in the *computability* (supercomputers are not very common in InfoVis) as well as in the *visual representation*

- Critical real-world analytical problems are often based on large heterogeneous data sets
 - Networks, nD-data, texts, original data, derived data, ...
 - Scalability is an issue here (cf. previous slide), but also the heterogeneity itself
- Example: Visual Text Analysis
 - Original texts plus derived data (bag of words, similarity measures, topic networks, ...) and their visualization

- Overviews based on aggregation, DR, etc.
- Provide textual context
- Distant/close reading
- ...



- In the 90s, the visual structure was in the center of interest

- For example, cone trees, parallel coordinates, etc.

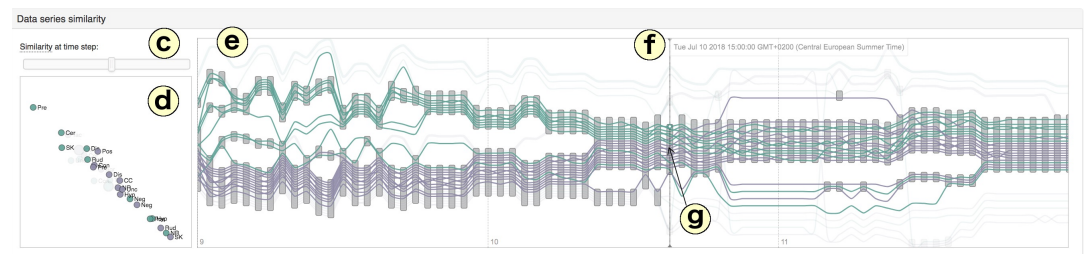
- \exists tendency to focus on dynamic properties

\Rightarrow *Time-series* (cf. TNM098)

- Important tasks that must be addressed

- Trend analyses of gigantic temporal data sets
 - Discovering of changes within the data

- ...



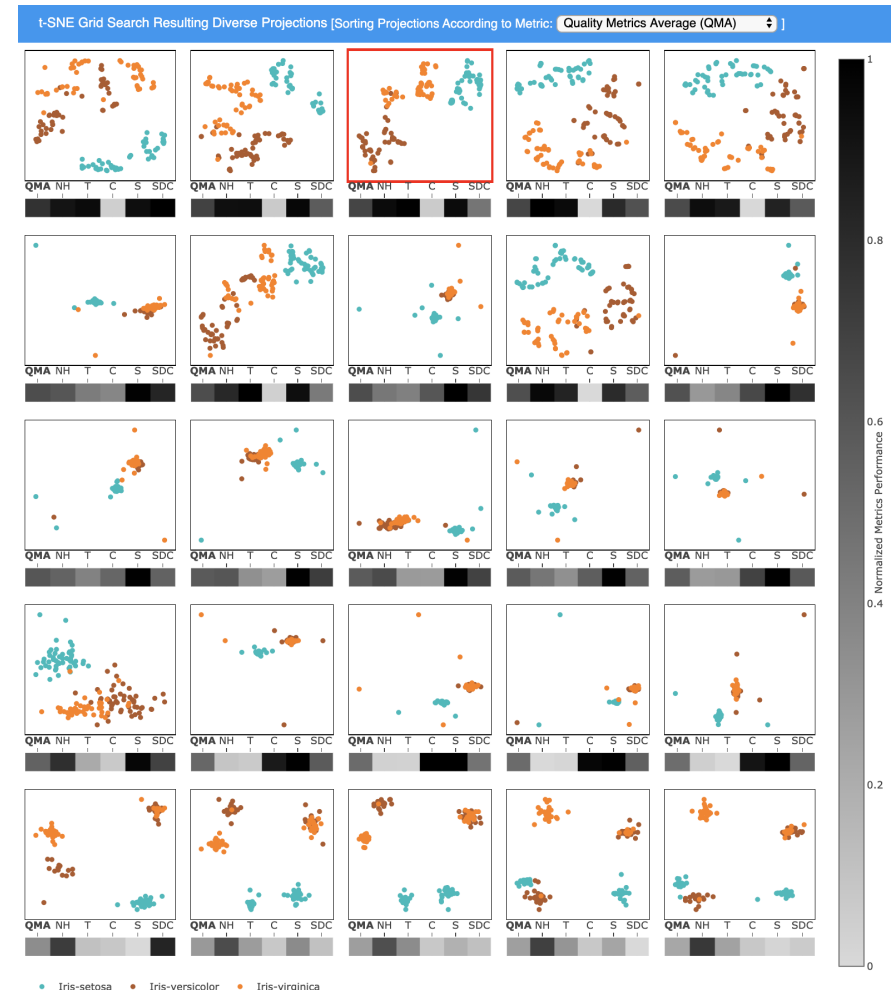
- Going beyond the standard approach of sitting (alone) in front of a standard PC with a mouse
 - Immersive analytics
 - Novel interaction possibilities
 - Collaboration
 - ...
- Taking into account the current working situation, emotional state of the user (measured by devices), etc.

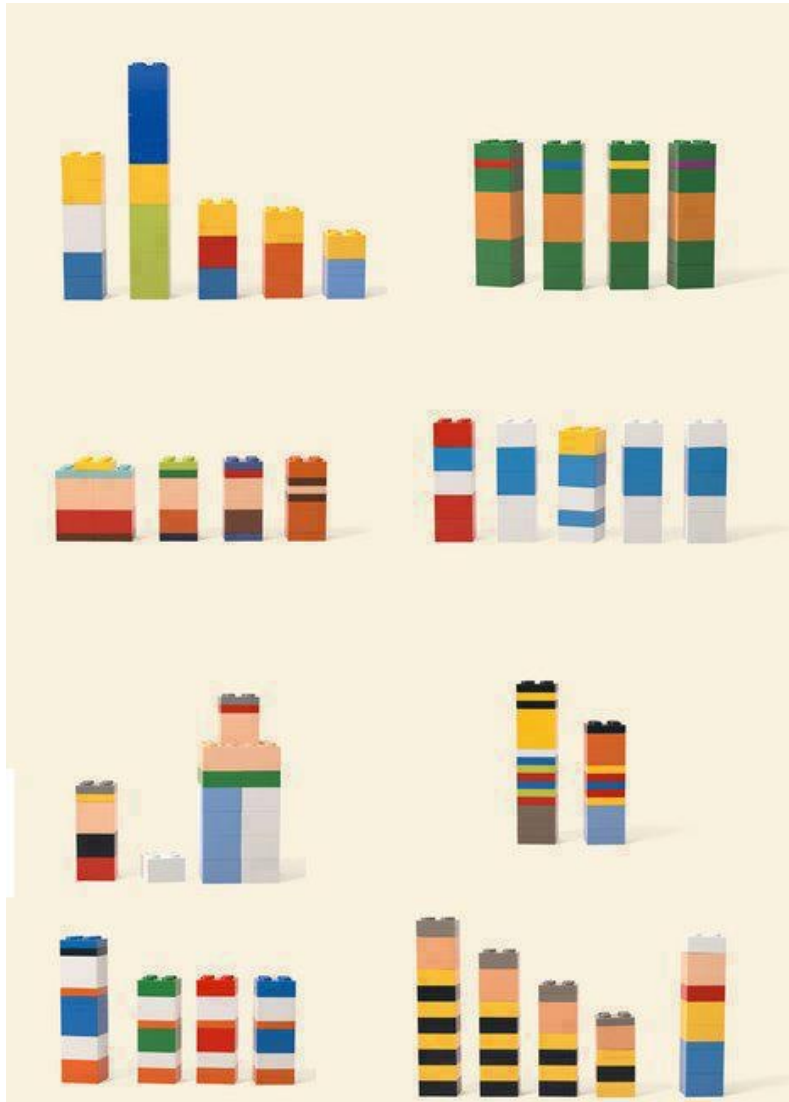


[2014 Workshop on Affective Agents]

■ Using visualization for *Explainable AI* (XAI) is a recent research challenge

- Visualizing (real-time) online training processes for steering these processes themselves
- Vis for hyperparameter exploration
- Vis for model comparisons
- Visualization for minimizing the impact of bias
- ...





THE
END