HOCHSCHULE
HANNOVER
UNIVERSITY OF
APPLIED SCIENCES
AND ARTS
–
Fakultät IV
Wirtschaft und
Informatik

Visualization as a Playground for Innovative Teaching Methods

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Outline

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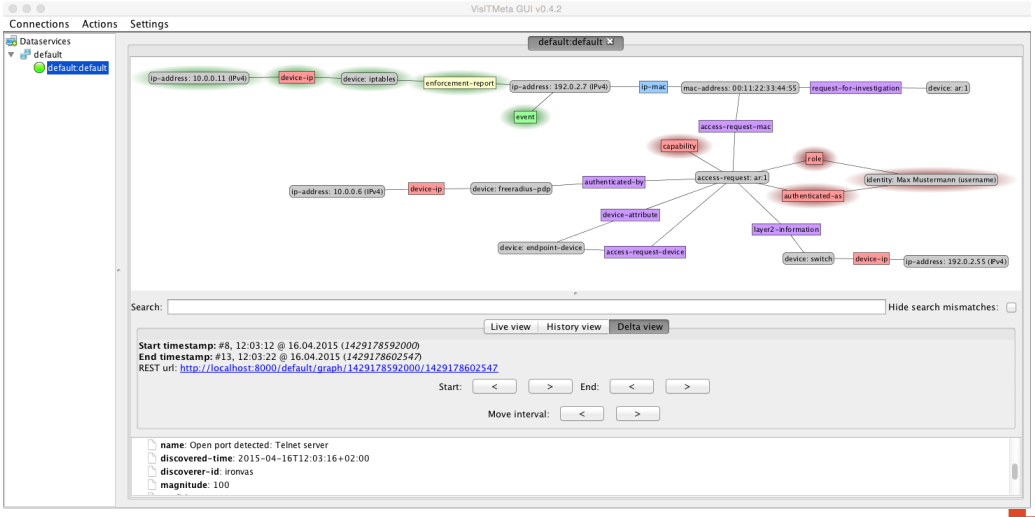
What is Visualization?

> *The purpose of computing is insight, not numbers.*
>
> RICHARD W. HAMMING, 1962

> *Visualization offers a method for seeing the unseen.*
> *It enriches the process of scientific discovery and is revolutionizing the way scientists do science.*
>
> BRUCE H. MCCORMICK, 1987

VisITMeta: Visualization of Network Security Metadata



V. Ahlers, F. Heine, B. Hellmann, C. Kleiner, L. Renners, T. Rossow, R. Steuerwald: Integrated visualization of network security metadata from heterogeneous data sources. GraMSec 2015.

http://trust.f4.hs-hannover.de/

Module Visualization and HCI

M.Sc. Computer Science (*Angewandte Informatik*), 2nd semester

- Concepts common to information and scientific visualization
  - visual perception
  - fundamentals of human computer interaction
  - data representation, interpolation
  - color mapping, contouring
- Information visualization techniques
  - focus+context
  - tree and graph drawing, glyphs
  - applications
- Scientific visualization techniques
  - volume rendering
  - flow visualization

Module Visualization and HCI

Week	Date (Fr)	Lecture (Fr)	Exercises (following Mo/Fr)
1	11.03.16	Introduction, visualization processing chain, data types, scales of measurement, charts (2 lectures, 07./11.03.)	Charts
2	18.03.16	Data representation, datasets, interpolation, cells	Data representation and interpolation in Java
3	25.03.16	– Easter holidays –	– Easter holidays –
4	01.04.16	Color mapping	Color mapping in Java
5	08.04.16	Contouring 2D, 3D	Marching squares in Java
6	15.04.16	InfoVis overview, toolkits, D3.js	Scatterplot in D3.js
7	22.04.16	Hierarchies and networks, graph drawing	Graph drawing in D3.js
8	29.04.16	Visual perception, five design-sheet methodology	Project
9	06.05.16	Project	Project, discussion of ideas (09./13.05.)
10	13.05.16	Human-computer interaction (HCI)	– Whit Monday –
11	20.05.16	– Conference NKIF 2016 –	Project, discussion of designs (23./27.05.)
12	27.05.16	Volume rendering, vector field and flow visualization	Project, discussion of realization (30.05./03.06.)
13	03.06.16	Project	Project
14	10.06.16	Project	Project (submission: 13.06.)
15	17.06.16	Review, project presentation (17.06.)	

Outline

Classroom Response Systems (CRS, aka Clickers)

Traditional use: ConcepTests

- prior knowledge and misconceptions
- understanding of concepts taught in lecture

Our additional approach:

- interactive demonstration of perception phenomena
- test of effectiveness of visualization concepts
- evaluation of visualization solutions

CRS Statistics

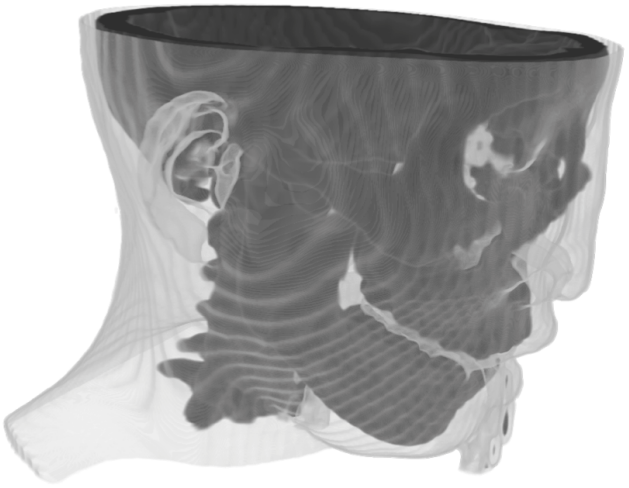
How old are you?

1. below 26
2. 26 to 30
3. 31 to 35
4. 36 to 40
5. 41 to 45
6. 46 to 50
7. 51 to 55
8. 56 to 60
9. above 60

Have you used CRS before?
(select highest level)

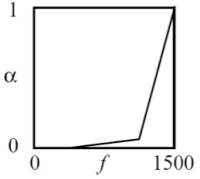
1. no
2. as part of an audience
3. as an instructor

CRS ConcepTest: Volume Rendering



Which alpha transfer function is used?

1.



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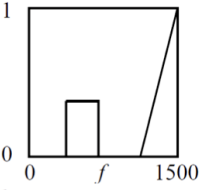

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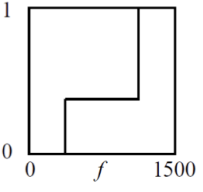
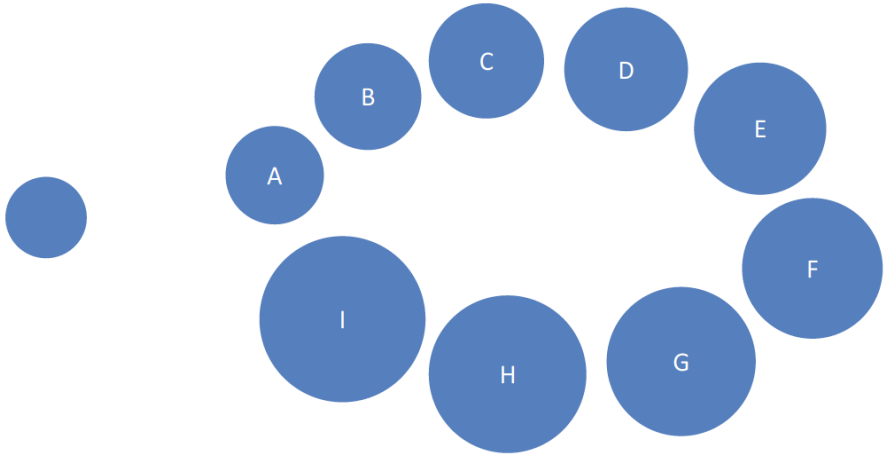


CRS Perception Test: Steven's Law



Which circle on the right corresponds to an attribute value twice as large as the circle on the left?

CRS Perception Test: Steven's Law

Typical classroom response:

Answer option	A	B	C	D	E	F	G	H	I
Frequency ($N = 12$)	0	0	4	2	3	1	0	1	1

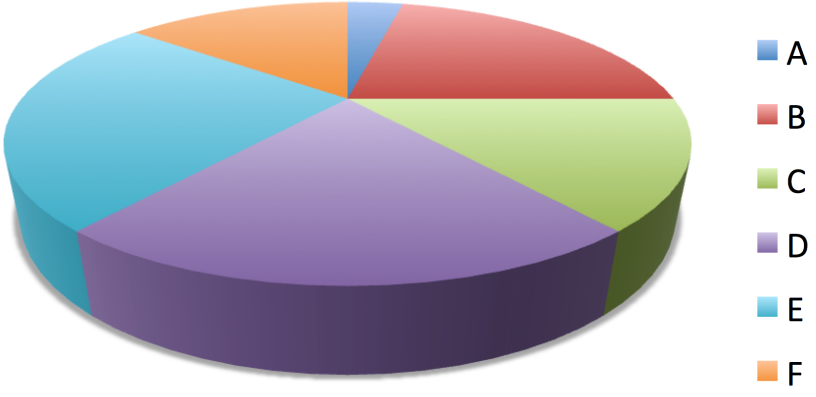
"Correct" answer (double area): C

Steven's law: size of quantity x is perceived as $p(x) = c\,x^{\beta}$

- area: $\beta \in [0.6, 0.9]$, typically $\beta \approx 0.7$
- double area is perceived as $2^{0.7} \approx 1.62$, i. e., underestimated

CRS Effectiveness Test: Pie Chart

Which product has the highest market share?



CRS Effectiveness Test: Pie Chart

Take-home message: Avoid 3D diagrams (better still: avoid pie charts at all).

Outline

Declarative Programming Projects

Aim: put learned techniques into practice

- get a feeling for good visualizations and for the benefit of interactivity

Terms and conditions

- second half of semester (7 weeks)
- teams of two to three students
- subject, data, and visualization approach of students' own choice
- recommended use of D3.js $\rightarrow$ experience declarative programming (and JavaScript)

M. Bostock, V. Ogievetsky, J. Heer: D^3: Data-driven documents. InfoVis 2011.
https://d3js.org/

Student Project: Wikipedia References

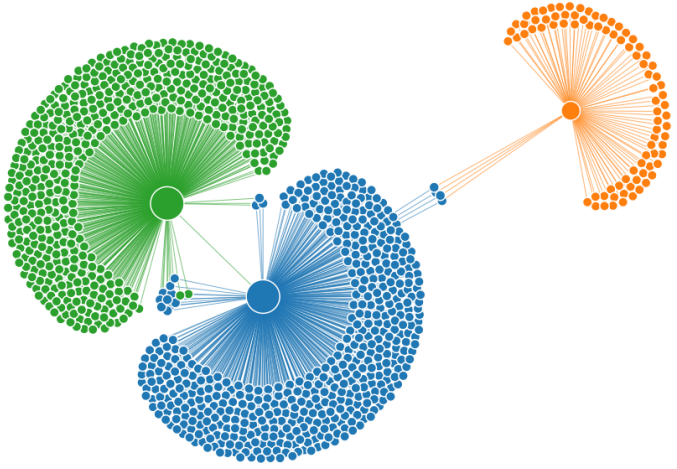
Title: Scientific modelling

Extract:

Scientific modelling is a scientific activity, the aim of which is to make a particular part or feature of the world easier to understand, define, quantify, visualize, or simulate. It requires selecting and identifying relevant aspects of a situation in the real world and then using different types of models for different aims, such as conceptual models to better understand, operational models to operationalize, mathematical models to quantify, and graphical models to visualize the subject.

Linkcount: 2

Picture:



Students: Simon Beckstein, Julian Scheichel, Dominik Schöner

Student Project: Wikipedia References

```
// JavaScript with D3.js
var svgNodes =
    svg.append("svg:g")
      .attr("id", "nodes");
// ...
svgNodes.selectAll(".node")
  .filter(
      function(d) { return d.level == loadLevel - 1; })
  .append("svg:circle")
  .attr("r",
      function(d) { return rScale(d.weight); })
  .style("fill",
      function(d) { return nodeColors(d.level); });
```

Students: Simon Beckstein, Julian Scheichel, Dominik Schöner

Outline

Five Design Sheet Methodology

Aim: foster divergent (or lateral) thinking

- ... using a user-centered design approach

Five stages, five sheets of paper, five sections per sheet:

- Stage 1: consider task and data with client (or with yourself)
- Stage 2: ideate and sketch small ideas – sheet 1
- Stage 3: sketch and plan three alternative designs – sheets 2 to 4
- Stage 4: consider solutions with client (or with yourself)
- Stage 5: generate realization sheet and implement prototype – sheet 5

J. C. Roberts, C. Headleand, P. D. Ritsos: Sketching designs using the Five Design-Sheet methodology. InfoVis 2015.
http://fds.design/

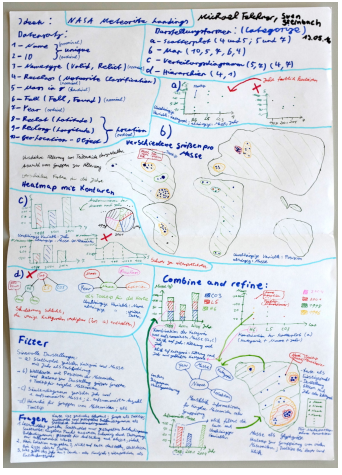
Five Design Sheet Methodology

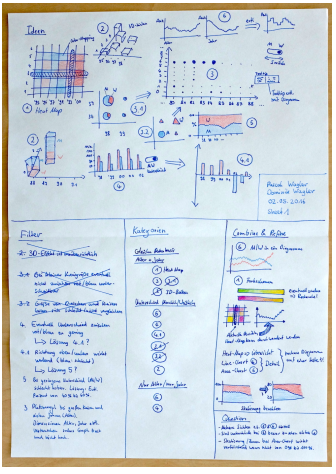
> *The way to get good ideas is to get lots of ideas, and throw the bad ones away.*
>
> LINUS PAULING

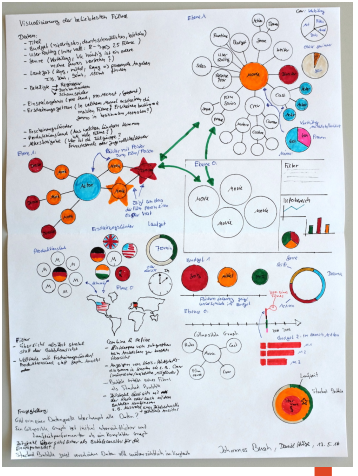
Design Sheet 1: Ideation

1. Ideate: sketch as many ideas (“mini-ideas”) as possible.
2. Filter:
   - Remove duplicate or irrelevant ideas (e. g., by crossing out).
   - Try to fix impossible ideas.
3. Categorize:
   - Group similar ideas together (e. g., by annotation).
   - Find missing categories.
4. Combine and refine:
   - Organize mini-ideas into bigger designs.
   - Look for complementing visualizations (e. g., spatial view plus timeline).
   - Refine the ideas.
5. Question:
   - Reflect on ideas and designs: advantages and disadvantages.
   - Select three different designs to expand.

Student Projects: Ideation







Students: Michael Felchner, Sven Steinbach (left), Dominic & Pascal Wagler (center), Johannes Busch, Daniel Hülse (right)

Outline

Conclusion

Evaluation in 1st year master classes

Main observations:

- Using CRS in innovative ways enhances the understanding of perception phenomena and visualization concepts, which manifests itself in more knowledgable use of visualization techniques.
- D3 has a motivating effect due to its declarative programming model unknown to most students.
- Letting students sketch solutions on paper exposes creative potential.

Outline

Literature

Ahlers, V.: *Teaching information visualization: A playground for classroom response systems and declarative programming projects*.

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In Mauw, S., B. Kordy, and S. Jajodia (eds.): *Graphical Models for Security. Second International Workshop, GraMSec 2015, Verona, Italy, July 13, 2015, Revised Selected Papers, LNCS 9390*, pp. 18–34, Springer International Publishing, Cham, 2015.

Bostock, M., V. Ogievetsky, and J. Heer: *D^3: Data-driven documents*.

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Kerren, A.: *Information visualization courses for students with a computer science background*.

IEEE Computer Graphics and Applications, 33(2):12–15, 2013.

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Prentice Hall, Upper Saddle River, NJ, 1997.

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IEEE Transactions on Visualization and Computer Graphics, 22(1):419–428, 2016.