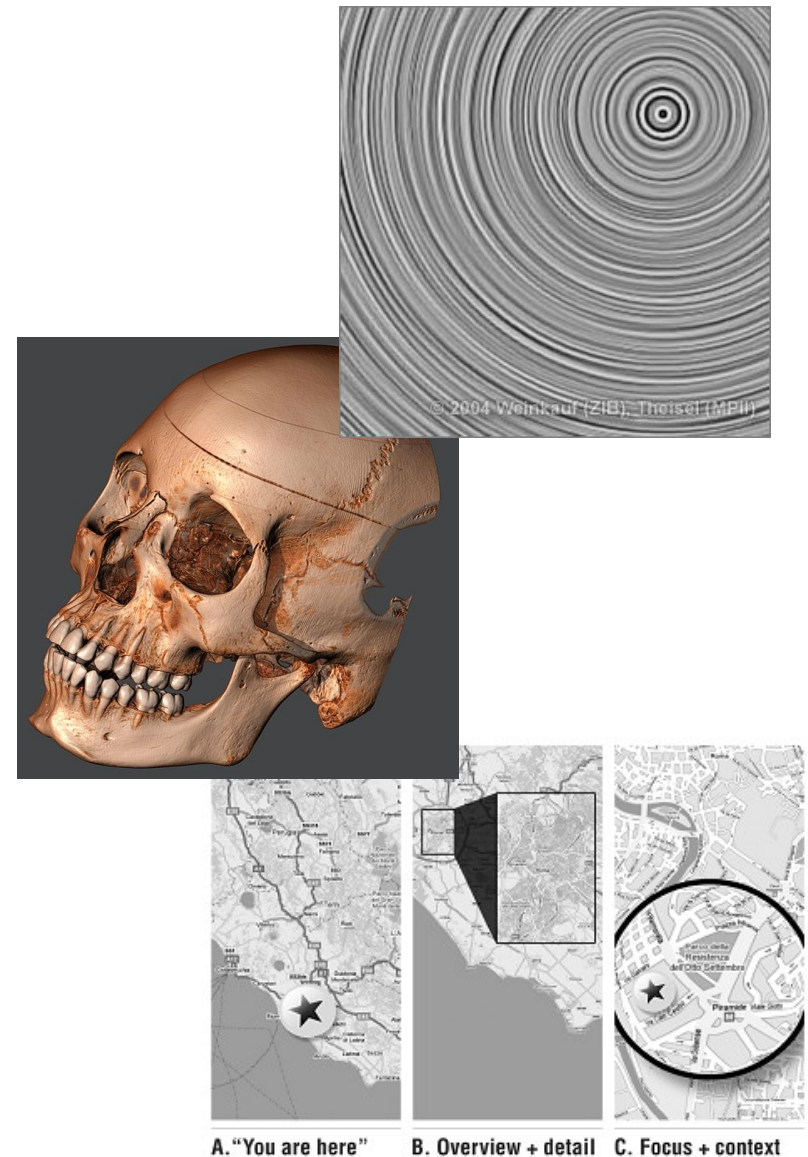


**Visual Correctness  
or  
How do we measure the quality of a visualization?**

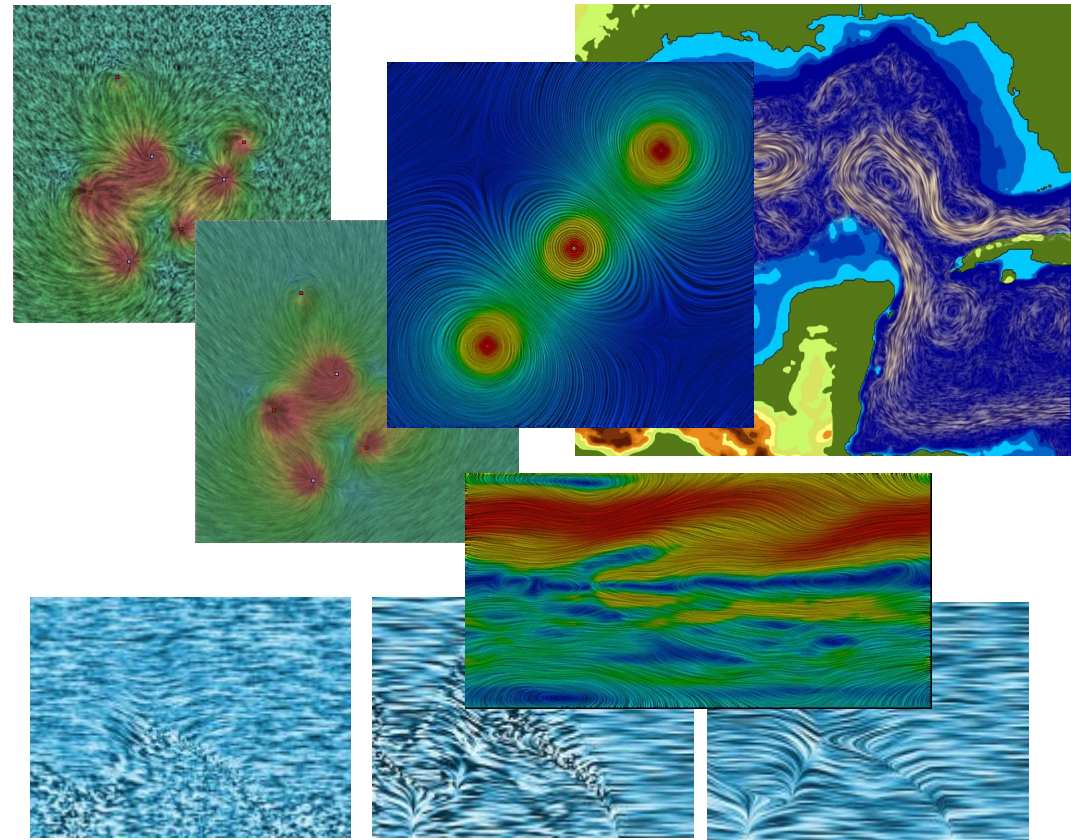
Heike Leitte

*Computer Graphics and Visualization  
Heidelberg University*

- GoogleScholar – IEEE search in CG&A and TVCG
  - **line integral convolution**  
→ 148,000 vs. 100
  - **volume rendering**  
→ 883,000 vs. 3,308
  - **focus and context**  
→ 3,270,000 vs. 2,533



- Standard LIC (with many different parameter settings)
- FastLIC
- ProLIC
- OrientedLIC
- EnhancedLIC
- HyperLIC
- VolumeLIC
- UFLIC
- AUFLIC
- parallel LIC
- LIC on special grids



(info & pics: <http://www.zhanpingliu.org/research/flowvis/LIC/LIC.htm>)

- Where to find comparisons of different techniques:
  - **Textbooks**
    - commonly cover only foundations
  - **Surveys and STARS**
    - not always up to date, not many topics covered
  - **Paper itself**
    - biased presentation and selection of material

- What to compare?
  - Varieties of same technique
  - Same purpos (→ taxonomy)
  - Technical requirements (special requirements)
- How to compare?
  - Implementation costs
  - Runtime (Performance):
    - computational costs
    - memory footprint
  - Results:
    - Image-based (e.g. different settings, looks better)
    - Task-driven (e.g. analysis is easier/faster, see new things)
    - Precision/Correctness

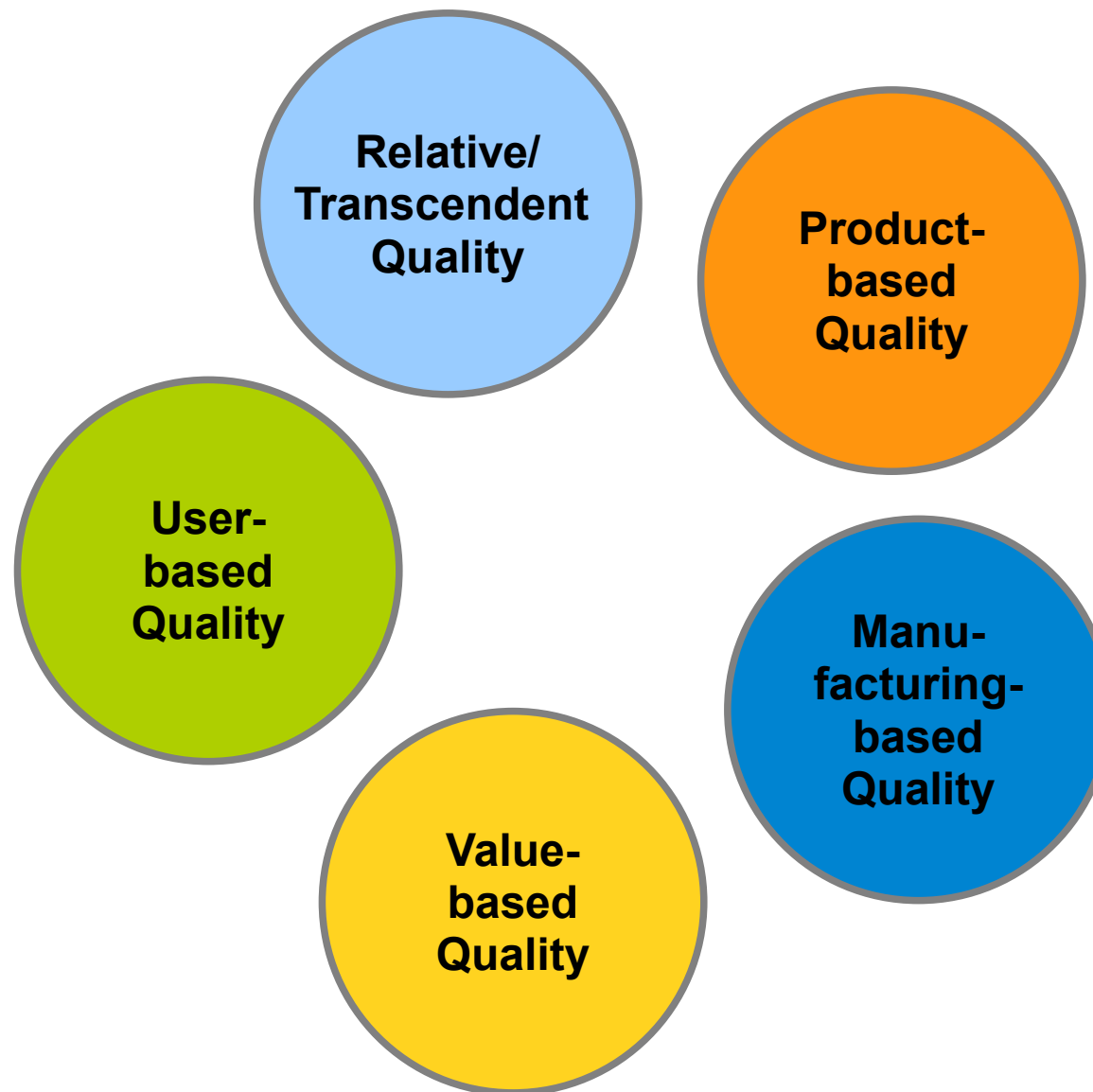


- What to compare?
  - Varieties of same technique
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  - Technical requirements (special requirements)
- How to compare?

## Quality of a Visualization

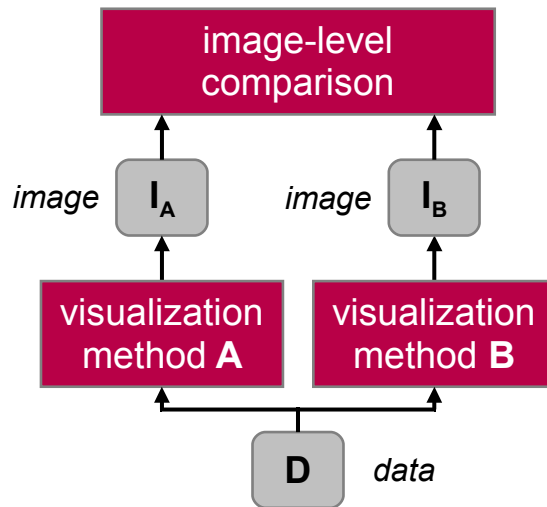
- Implementation costs
- Runtime (Performance):
  - computational costs
  - memory footprint
- Results:
  - Image-based (e.g. different settings, looks better)
  - Task-driven (e.g. analysis is easier/faster, see new things)
  - Precision/Correctness

- **Webster:** “That which makes something what it is; characteristic element; basic nature, kind; the degree of excellence of a thing; excellence, superiority.”
- **ANSI-ASQ:** “The totality of features and characteristics of a product or service that bears on its ability to satisfy given needs.”
- **American Society for Quality:** "A subjective term for which each person has his or her own definition. In technical usage, quality can have two meanings:
  - a) The characteristics of a product or service that bear on its ability to satisfy stated or implied needs;
  - b) A product or service free of deficiencies."

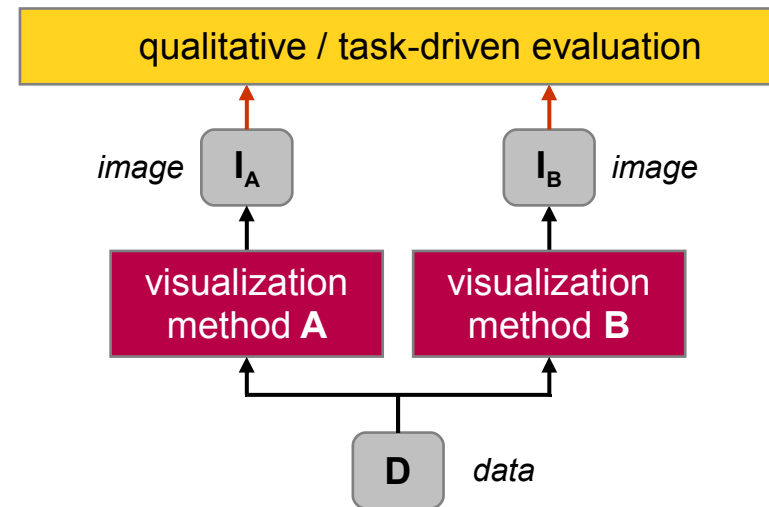




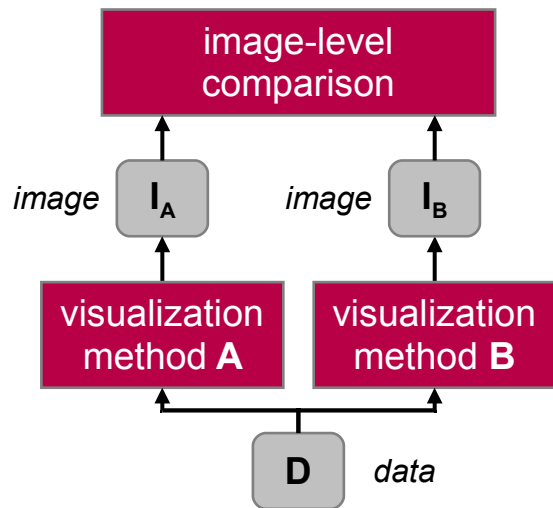
## Manual Comparison



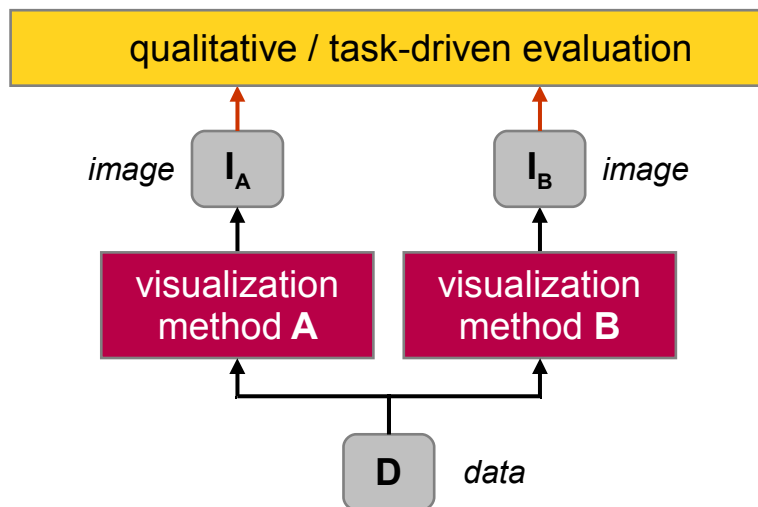
## User Study



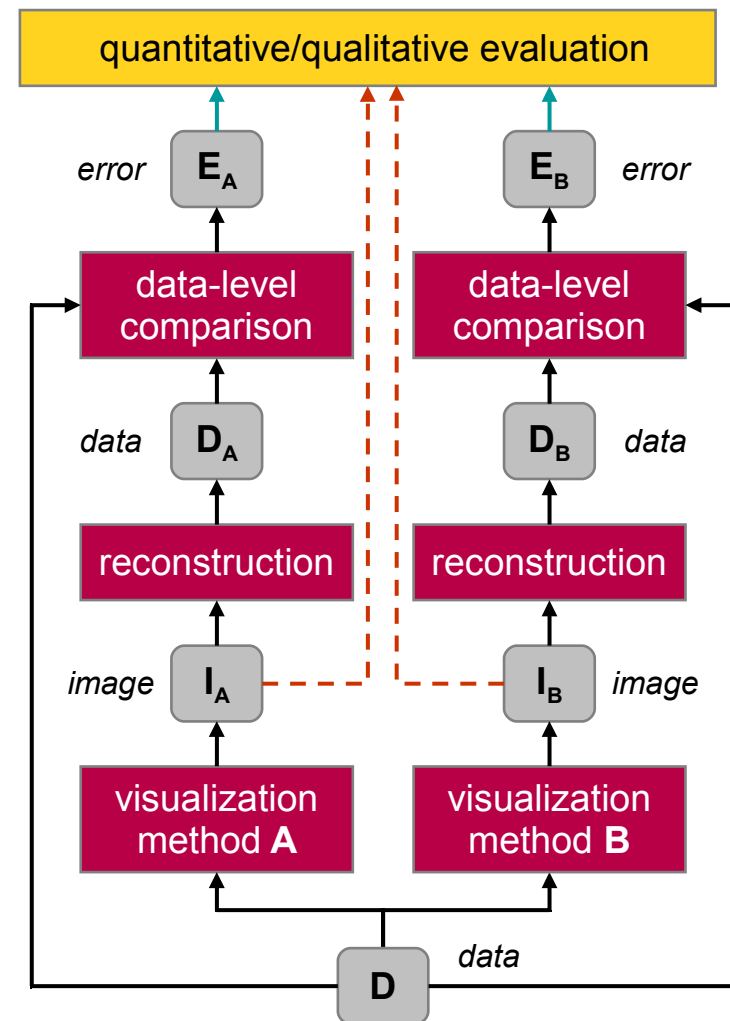
## Manual Comparison



## User Study



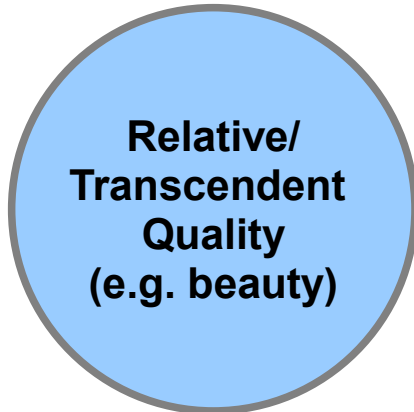
## Quality Metrics / Automatic Comparison



## User Study



## (Automatic) Metric



Filonik&Baud: aesthetics  
Santucci: visual effectiveness.



Jänicke&Chen:  
salience



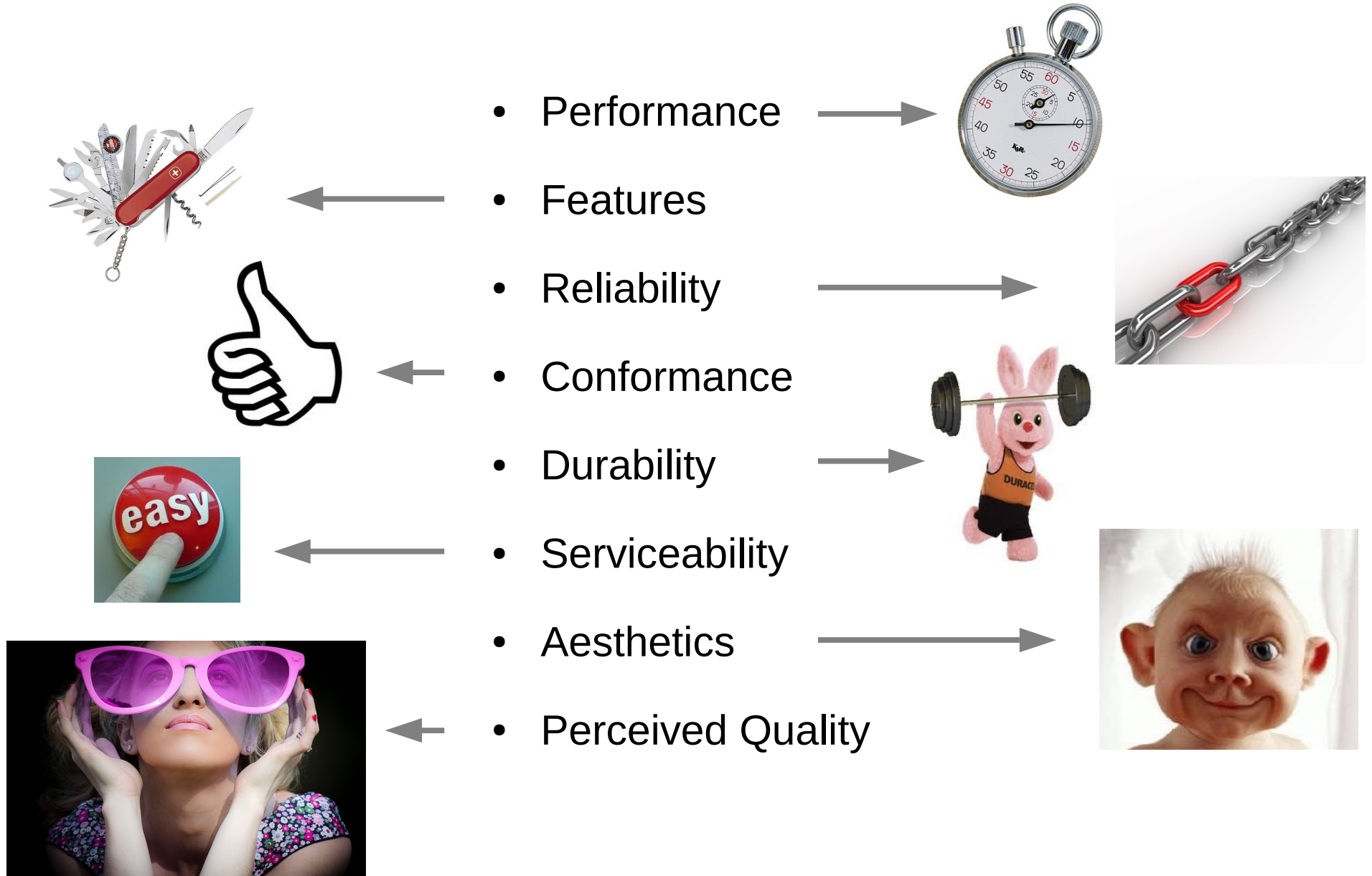
Cui et al.: abstraction  
Jänicke et al.: reconstructability  
Bertini et al.: HighD Vis



van Wijk: value of vis



timings (interactive)  
memory footprint





- Challenges:
  - Visualization literacy (novice vs. expert user)
  - Preferences and habits
  - What is in the data, what is rendered, and what is seen

- **Making my life easier (my wish list):**
  - Benchmark datasets
  - More surveys, STARs, taxonomies
  - Visualization textbook(s)
- **Future research in quality analysis**
  - How much evaluation/validation/comparison/quality analysis do we need (in a paper)?
  - Which questions can be answered with user studies?
  - How to conduct them properly? Do we need to train our students better?
  - What can/do automatic techniques answer?
  - (Where) Can they substitute user studies?



- David A. Garvin: What Does „Product Quality“ Really Mean?, Sloan Management Review, Fall 1984, pp. 25–45.

- quality measures in vis
  - user study
  - automatic metrics
  - benchmark data sets (
- overview over existing techniques
  - surveys (we need more)
  - text book (same)
- is there a universal quality for all users?
  - novices vs. expert user
  - Correctness (what is in the data, what is rendered, and what is seen)