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InfoVis08

Outward and Inward Grand Challenges

**VisWeek08 Panel:
Grand Challenges for Information Visualization**

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Grand Challenges: Definitions

- grand challenges in other fields
  - physics: build atom bomb
  - astro: man on the moon
  - biology: cure cancer
- "outward" grand challenges
  - high impact, broadly understandable, inspiring
  - clear milestone to judge success
  - concrete driving problems to galvanize field

Infovis Outward Grand Challenge: TPT

- total political transparency
  - goal: reduce government corruption through civilian oversight
  - data: campaign contributions, voting records, redistricting, earmarks, registered lobbyists, military procurement contracts, street repair records, real estate assessment records, ...
    - available in theory, not understandable in practice - yet
  - infovis-complete set of problems
- implication: need open software for open data
  - concern not only for truth, but also for justice
    - capability for analysis equally distributed in society

Inward GC: Towards Science

- not ready to solve this or any other outward grand challenge
- "inward" grand challenge for infovis: building it into a science
  - how can we accelerate the transition from a collection of papers to a body of work that constitutes a science?
    - need synthesis at scales larger than a single paper
      - textbooks
    - need common framework unifying all vis work
      - guide for doing good science within single paper
      - guide for creating papers that can interlock usefully others
      - some current thoughts as concrete example...

Validation Methods - How To Choose?

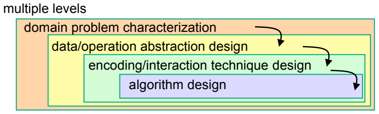
- unsatisfying flat list of validation methods when writing recent paper

  [Process and Pitfalls in Writing Infovis Papers. Munzner. Chapter (p. 134-153) in *Information Visualization: Human-Centered Issues and Perspectives*. Springer LNCS 4950, 2008.]

  - algorithm complexity analysis
  - implementation performance (speed, memory)
  - quantitative metrics
  - qualitative discussion of result pictures
  - user anecdotes (insights found)
  - user community size (adoption)
  - informal usability study
  - laboratory user study
  - field study with target user population
  - design justification from task analysis
  - visual encoding justification from theoretical principles
- how to choose?

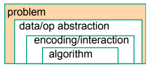
Separating Design Into Levels

- multiple levels



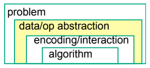
- three separate design problems
  - not just the encoding level
- each level has unique **threats to validity**
  - evocative language from security via software engineering
- dependencies between levels
  - outputs from level above are inputs to level below
  - downstream levels required for validating some upstream threats

Problem Characterization



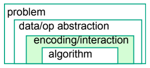
- you assert there are particular tasks of target audience that would benefit from infovis tool support
- did you get the problem right?
  - threat: your target users don't actually do this
  - immediate validation: you observe/interview target population
    - vs. assumptions or conjectures
  - downstream validation: adoption rates
    - you build tool, they choose to use it to address their needs

Abstraction Design



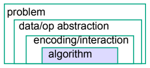
- for chosen problem, you abstract into operations on specific data type
  - often need to derive/transform data type from raw data
  - ex: choose coast-to-coast train route
    - abstraction: path following on node-link graph with initial node positions (lat, lon) and two sets of weights on edges (cost, beauty)
- can your abstraction solve the problem?
  - threat: bad choice of abstraction not felicitous for solving problem
  - downstream validation: observe whether useful with field study

Encoding/Interaction Design



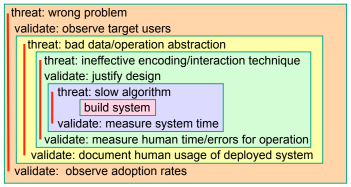
- for chosen abstraction, you design visual encoding, interaction techniques
  - path following ex:
    - visual encoding: maximize angular resolution, minimize edge bends, maintain quasi-geographic constraints
    - interaction: rearrange nodes as selected to make chosen path central
- can your encoding/interaction communicate your abstraction?
  - threat: design not effective for achieving operations
  - immediate validation: justify that choices do not violate known perceptual/cognitive principles
  - downstream validation: use system to do assigned tasks, measure human time/error costs

Algorithm Design



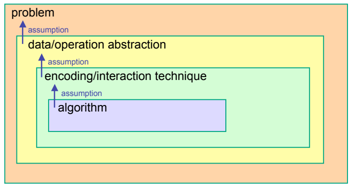
- for chosen encoding/interaction, you design computational algorithm
- is your algorithm better than previous approaches?
  - threat: algorithm slower than previous ones
    - immediate validation: analyze computational complexity
    - downstream validation: after implementation, measure wallclock time

Matching Validation To Threats



- common problem: mismatches between design+threat and validation
  - ex: cannot validate claim of good encoding design with wallclock timings
- guidance from model:
  - explicit separation into levels with linked threat and validation for each

Interlocking Between Papers



- common problem: difficult to make connections between individual papers at different levels
  - ex: read paper on specific graph layout algorithm, do I know what visual encoding approach is it good for?
- guidance from model:
  - explicitly state upstream assumptions