Visualization: Why It's Tricky, Where To Start

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ProK Workshop
20 Feb 2014, Bellairs Barbados

http://www.cs.ubc.ca/~tmm/talks.html#bellairs14

Vis Definition: Why It's Tricky

- vis systems provide visual representations of datasets designed to help people carry out tasks more effectively
- augment human capabilities
  - not replace people with computational decision-making
- design space of possible visualization idioms is huge
  - most possibilities ineffective
  - validating effectiveness of a design is both necessary and difficult
- three very different kinds of resource limitations
  - computers
  - humans
  - displays

Questions Answered Elsewhere *(VAD Ch 1)*

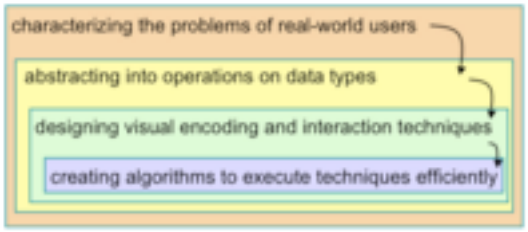
- why have a human in the decision-making loop?
- why have a computer in the loop?
- why use an external representation?
- why depend on vision?
- why show the data in detail?
- why use interactivity?
- what is the design space of visualization idioms?
- why focus on tasks?
- why are most designs ineffective?
- why care about effectiveness?
- why is validation difficult?

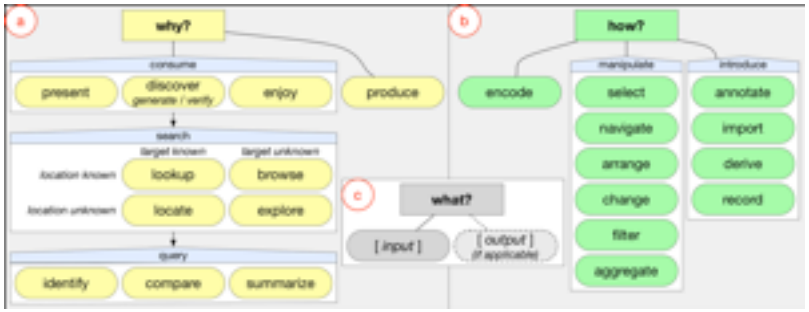
Where To Start: Five Flavors of Paper Types

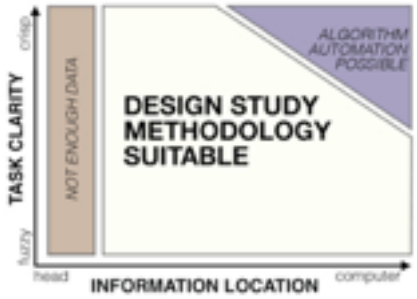
- Problem-driven work
  - design studies
- Technique-driven work
  - algorithms, idioms
- Systems
  - (as in other fields)
- Evaluation
  - lab/field/data studies
- Theoretical foundations
  - models

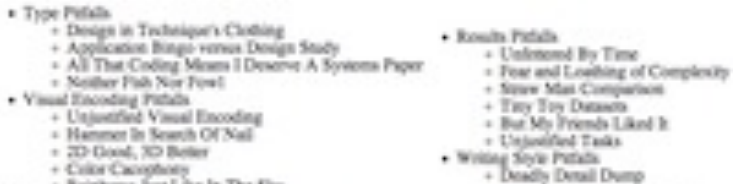
Theory/Models

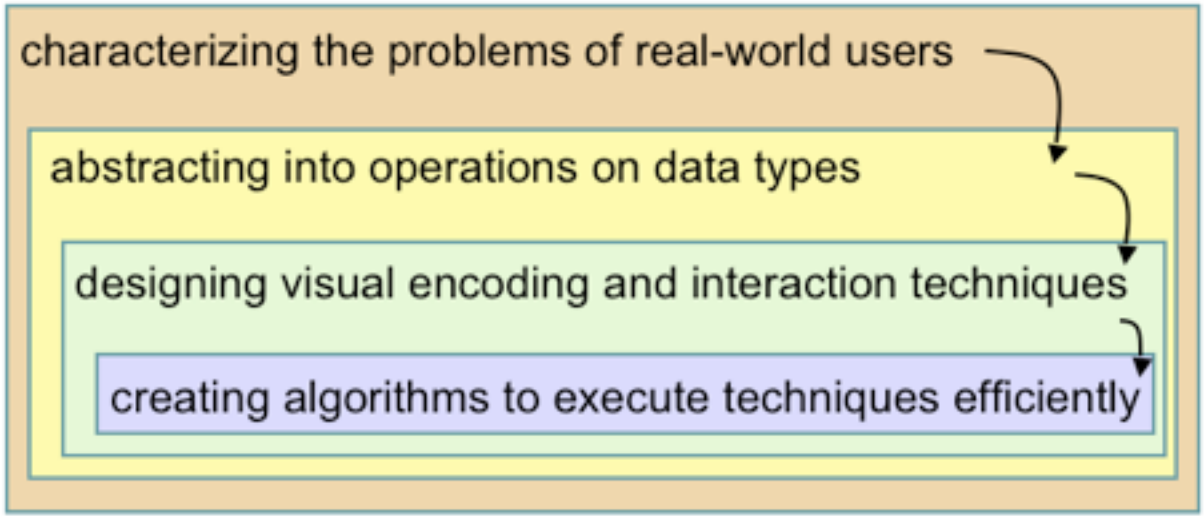
- nested model for vis design and validation
  - revisited: blocks and guidelines
- multi-level typology of abstract visualization tasks
- design study methodology
- papers process and pitfalls











A Nested Model

of Visualization Design and Validation

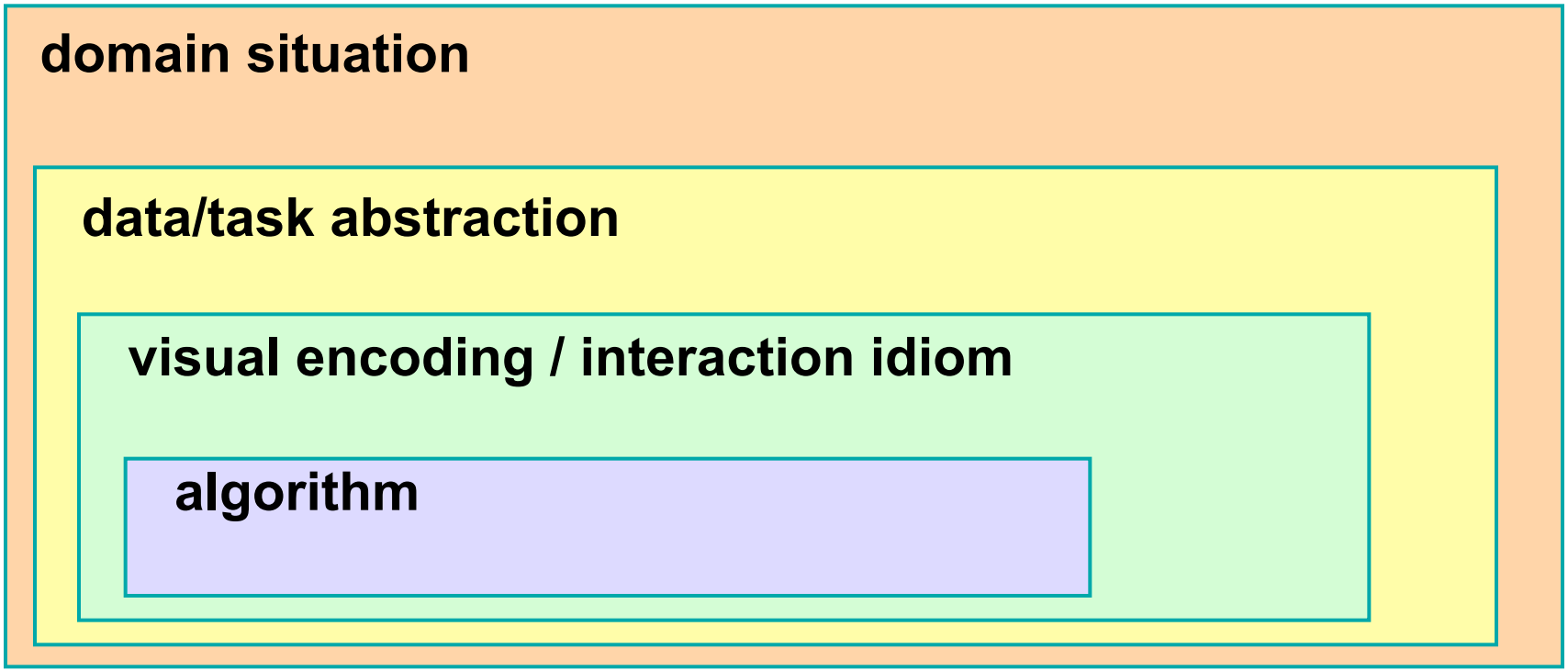
http://www.cs.ubc.ca/labs/imager/tr/2009/NestedModel/

A Nested Model of Visualization Design and Validation.

Munzner. IEEE TVCG 15(6):921-928, 2009 (Proc. InfoVis 2009).

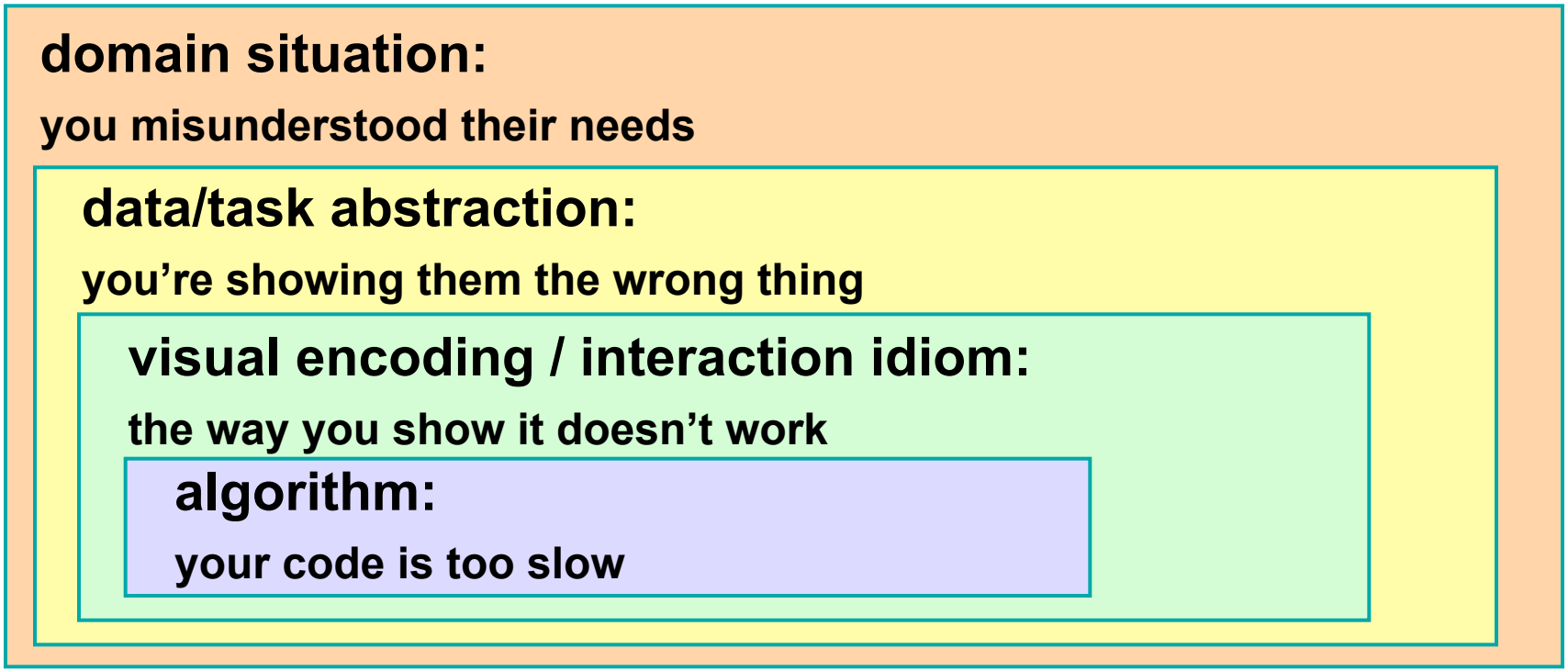
Nested Levels of Design

- four levels of design problems



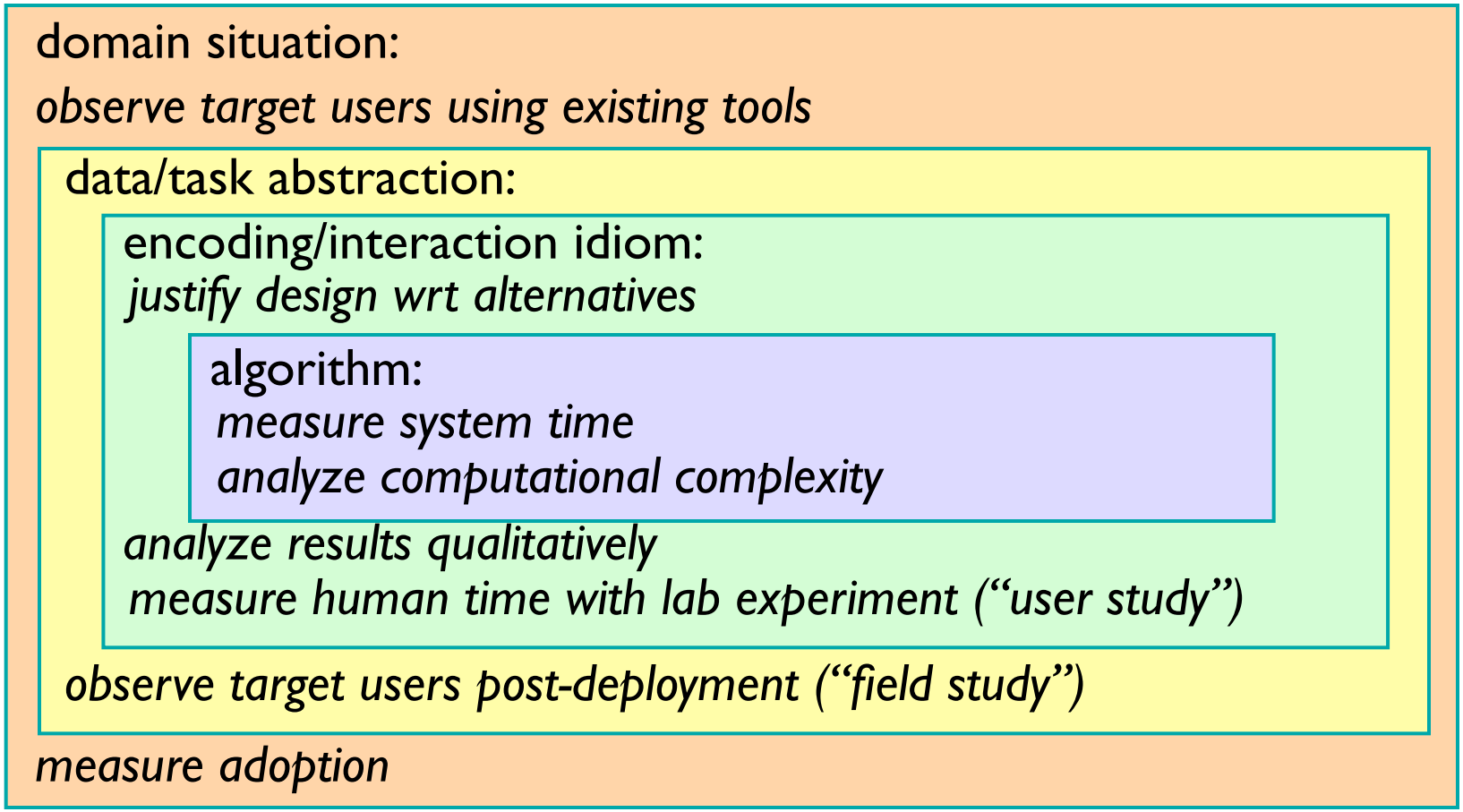
Nested Levels of Design

- four levels of design problems
  - different threats to validity at each level

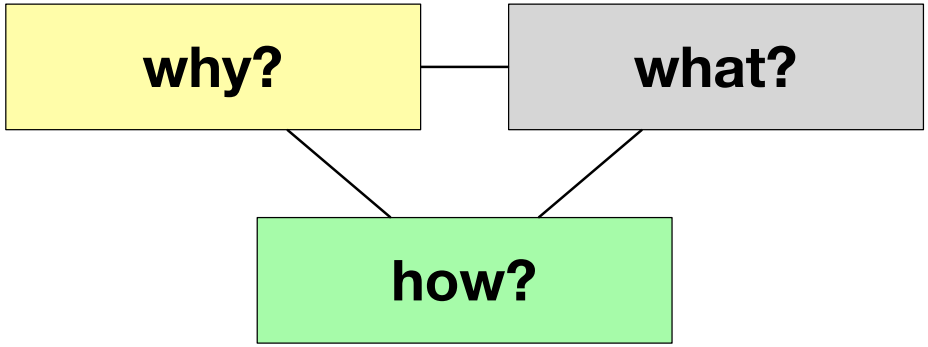


- data abstraction: don't just use what you're given, derive the right thing!

Nested Levels of Design and Validation



- mismatch: cannot show idiom good with system timings
- mismatch: cannot show abstraction good with lab study



A Multi-Level Typology of Abstract Visualization Tasks

joint work with:
Matt Brehmer

http://www.cs.ubc.ca/labs/imager/tr/2013/MultiLevelTaskTypology/

A Multi-Level Typology of Abstract Visualization Tasks

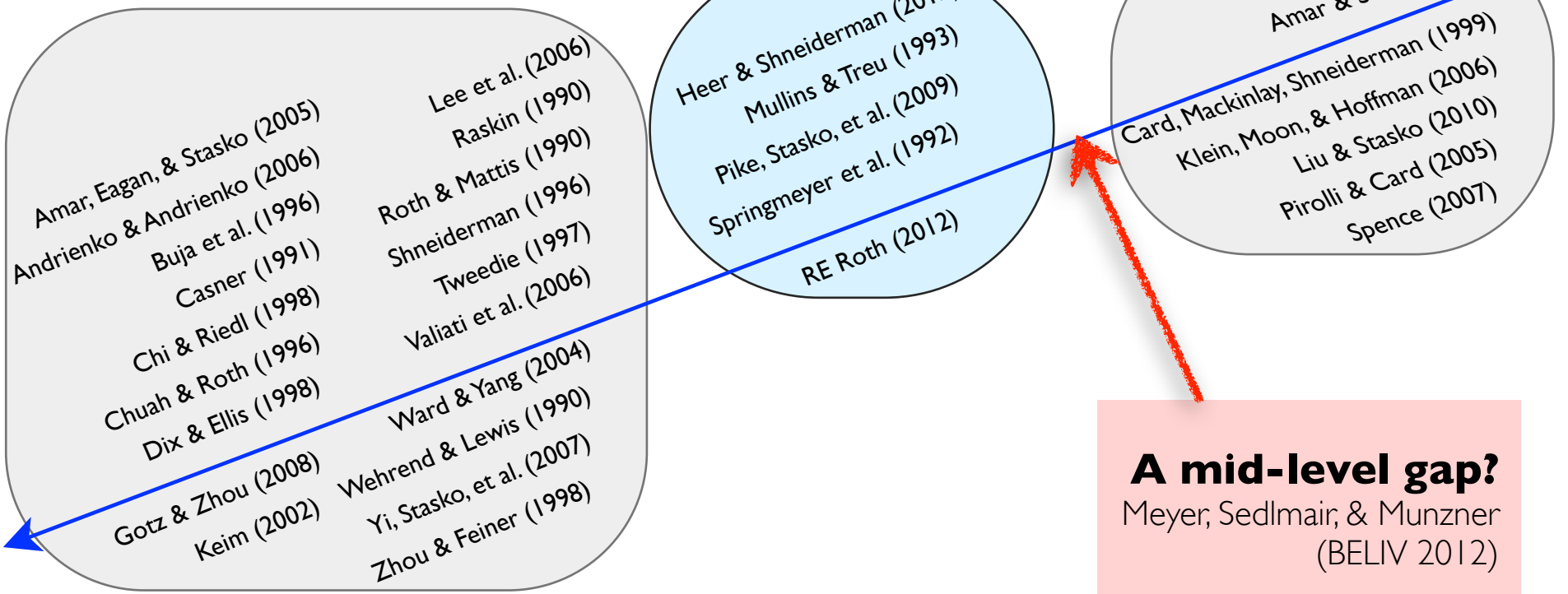
Brehmer, Munzner. IEEE TVCG 19(12): 2376-2385, 2013 (Proc. InfoVis 2013).

Previous Work

Classifying Tasks, Goals, Intentions, Objectives, Activities, Interactions

low level of abstraction
e.g. *"retrieve value"*

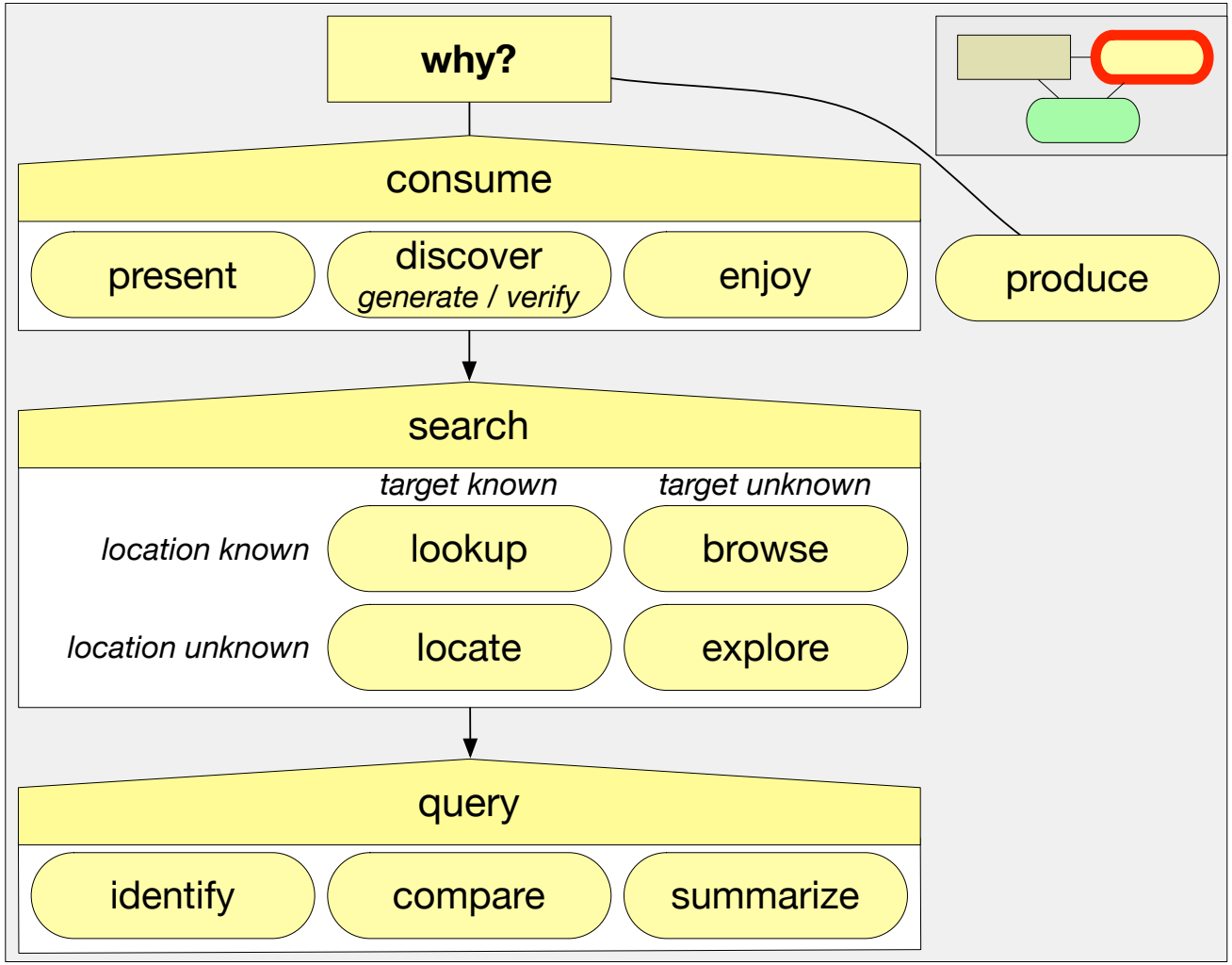
high level of abstraction
e.g. *"integration of insight"*



A mid-level gap?
Meyer, Sedlmair, & Munzner (BELIV 2012)

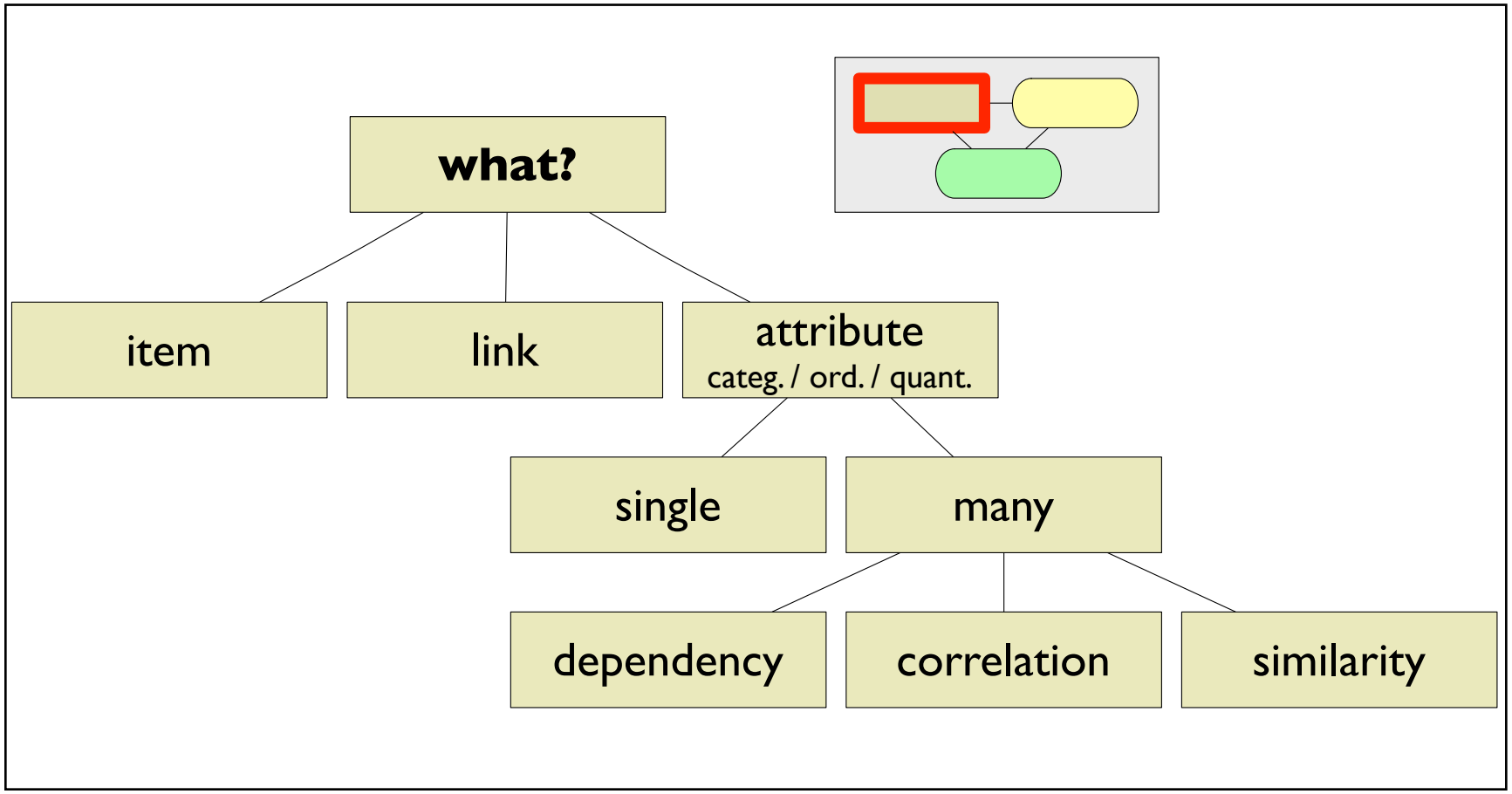
Multi-Level Typology of Abstract Visualization Tasks

{ *why* , *what* , *how* }



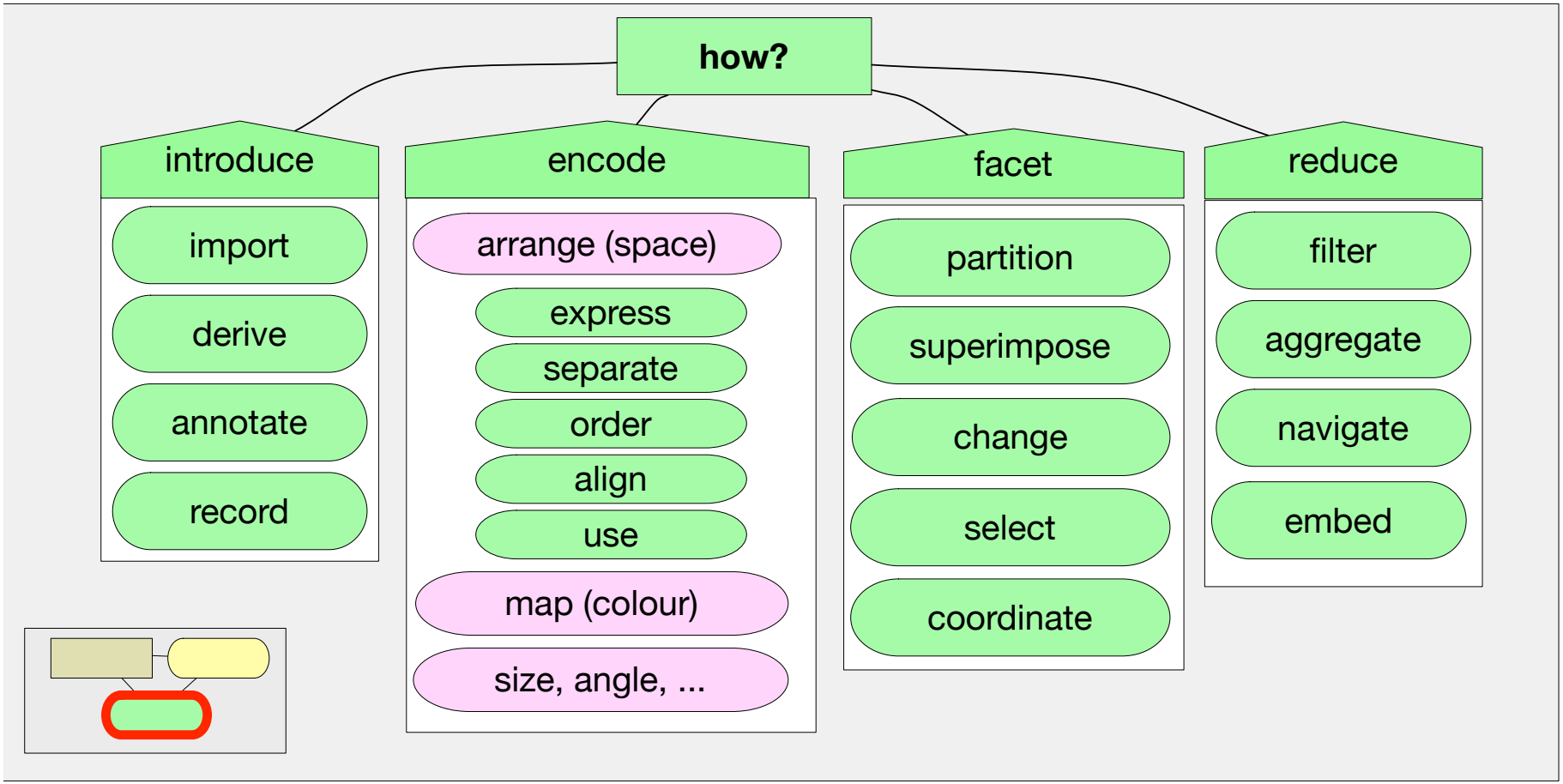
Multi-Level Typology of Abstract Visualization Tasks *(VAD version)*

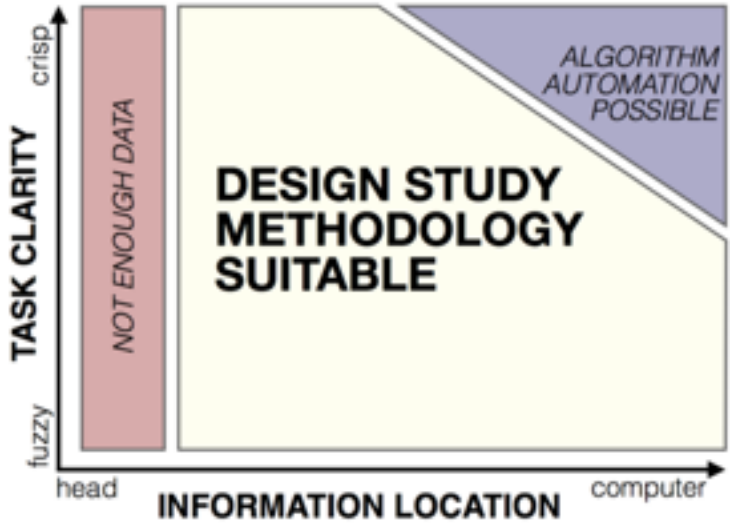
{ ***why*** , ***what*** , ***how*** }



Multi-Level Typology of Abstract Visualization Tasks *(VAD version)*

{ ***why*** , ***what*** , ***how*** }





Design Study Methodology

Reflections from the Trenches and from the Stacks

joint work with:
Michael Sedlmair, Miriah Meyer

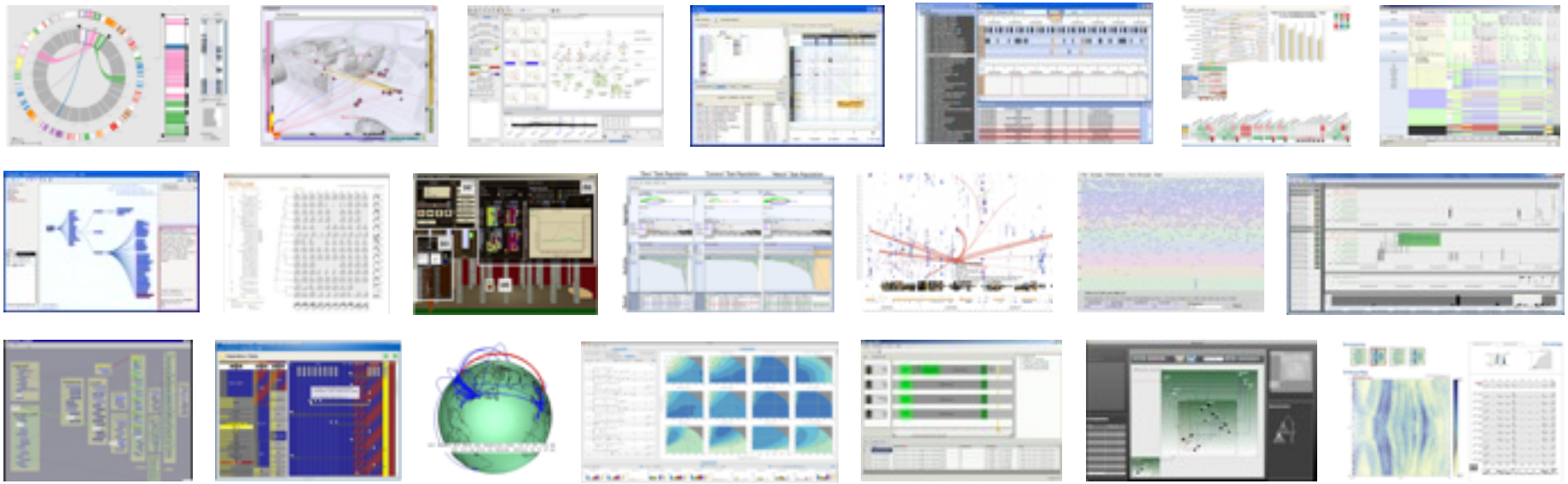
http://www.cs.ubc.ca/labs/imager/tr/2012/dsm/

Design Study Methodology: Reflections from the Trenches and from the Stacks.

Sedlmair, Meyer, Munzner. IEEE TVCG 18(12): 2431-2440, 2012 (Proc. InfoVis 2012).

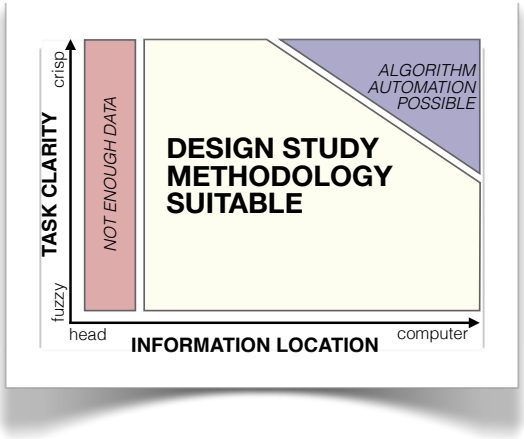
Design Studies

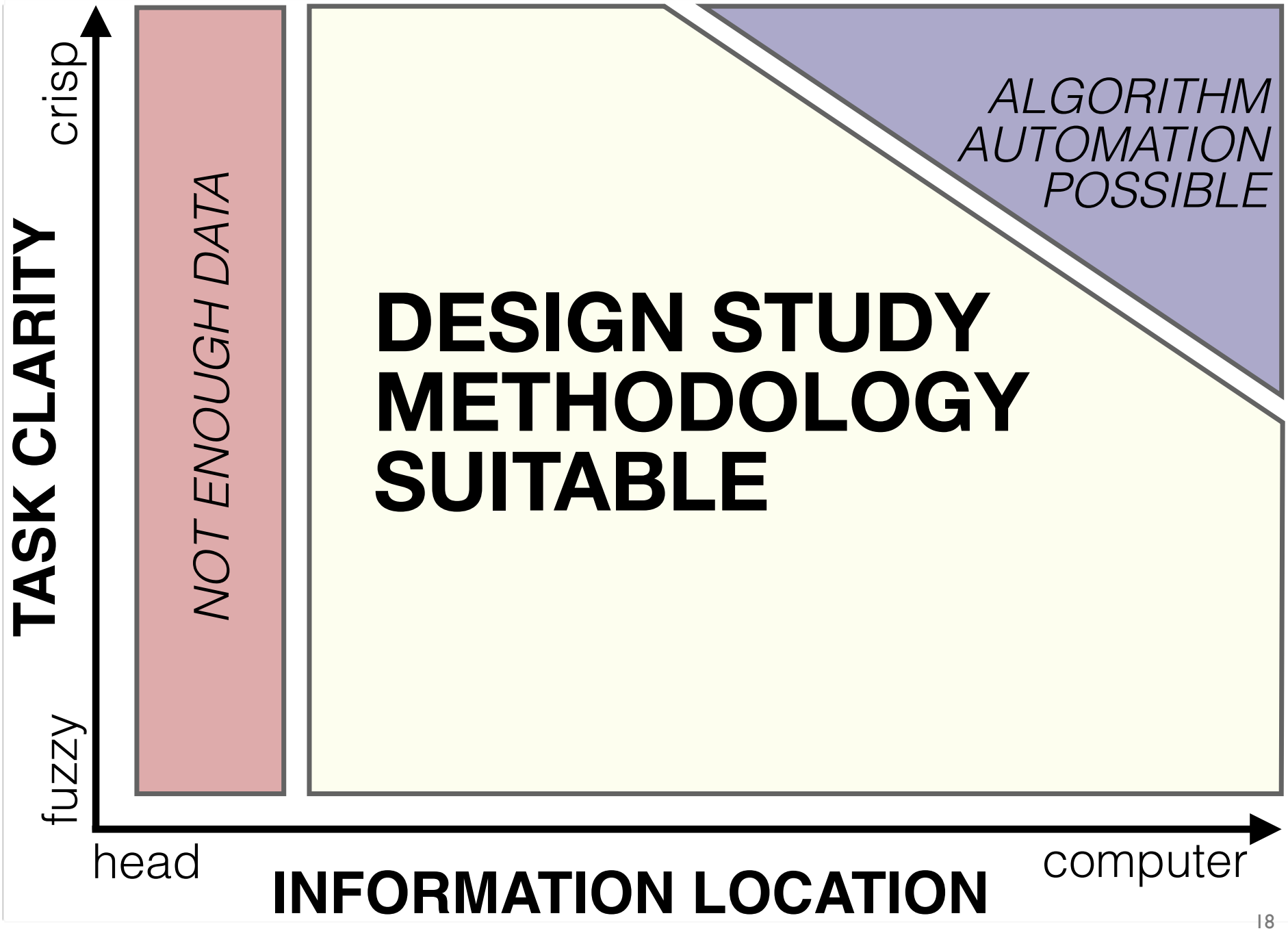
- long and winding road with many pitfalls
  - reflections after doing 21 of them
    - many successes, a few failures, many lessons learned



How To Do Design Studies

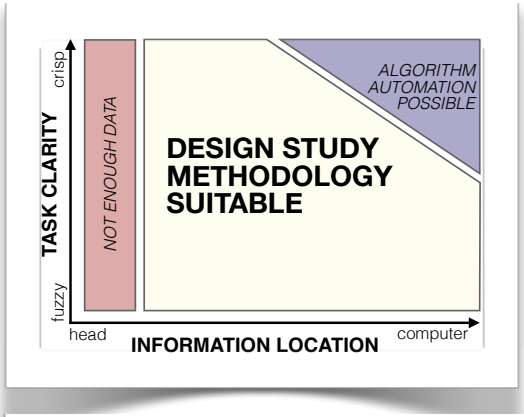
- definitions



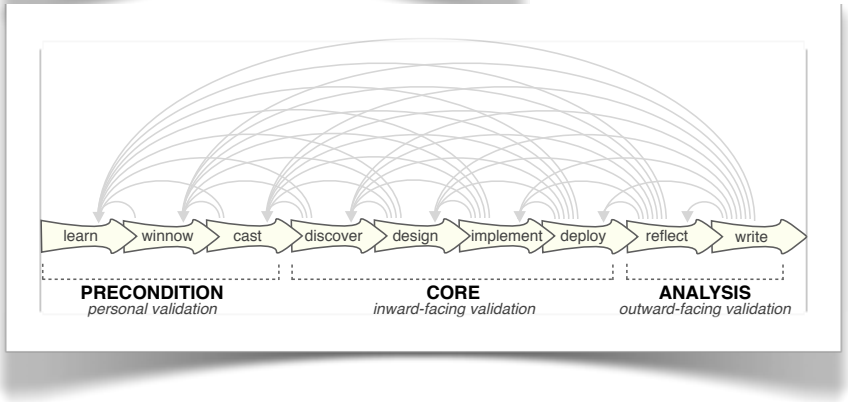

TASK CLARITY
crisp
fuzzy
NOT ENOUGH DATA
ALGORITHM
AUTOMATION
POSSIBLE
DESIGN STUDY
METHODOLOGY
SUITABLE
head
computer
INFORMATION LOCATION

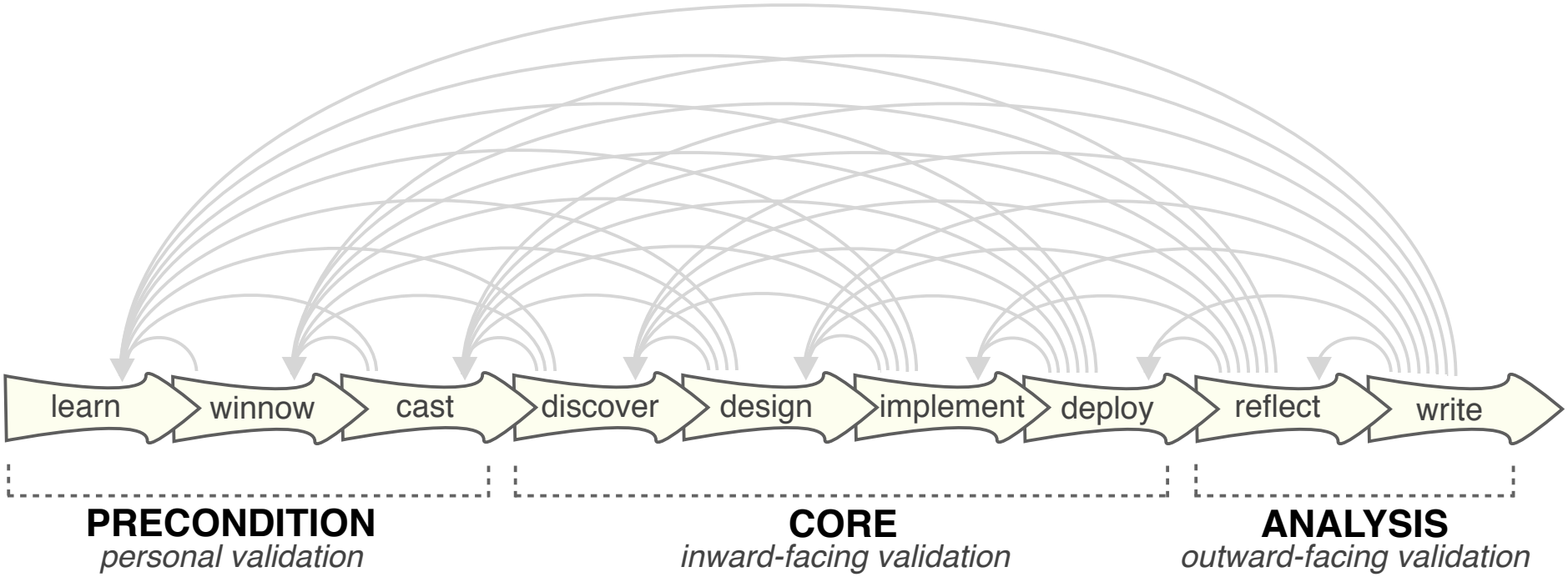
How To Do Design Studies

- definitions



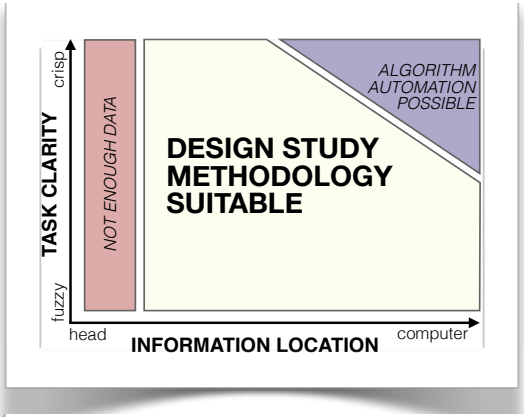
- 9-stage framework

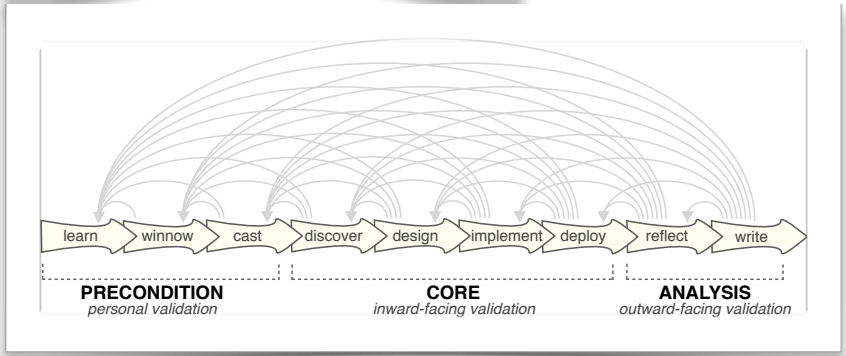



learn
winnow
cast
discover
design
implement
deploy
reflect
write
PRECONDITION
personal validation
CORE
inward-facing validation
ANALYSIS
outward-facing validation

How To Do Design Studies

- definitions
- 9-stage framework
- 32 pitfalls and how to avoid them





PF-1	premature advance: jumping forward over stages	general
PF-2	premature start: insufficient knowledge of vis literature	learn
PF-3	premature commitment: collaboration with wrong people	winnow
PF-4	no real data available (yet)	winnow
PF-5	insufficient time available from potential collaborators	winnow
PF-6	no need for visualization: problem can be automated	winnow
PF-7	researcher expertise does not match domain problem	winnow
PF-8	no need for research: engineering vs. research project	winnow
PF-9	no need for change: existing tools are good enough	winnow

Pitfall Example: Premature Publishing

technique-driven

problem-driven

Must be first!

Am I ready?

http://www.prlog.org/10480334-wolverhampton-horse-racing-live-streaming-wolverhampton-handicap-8-jan-2010.html

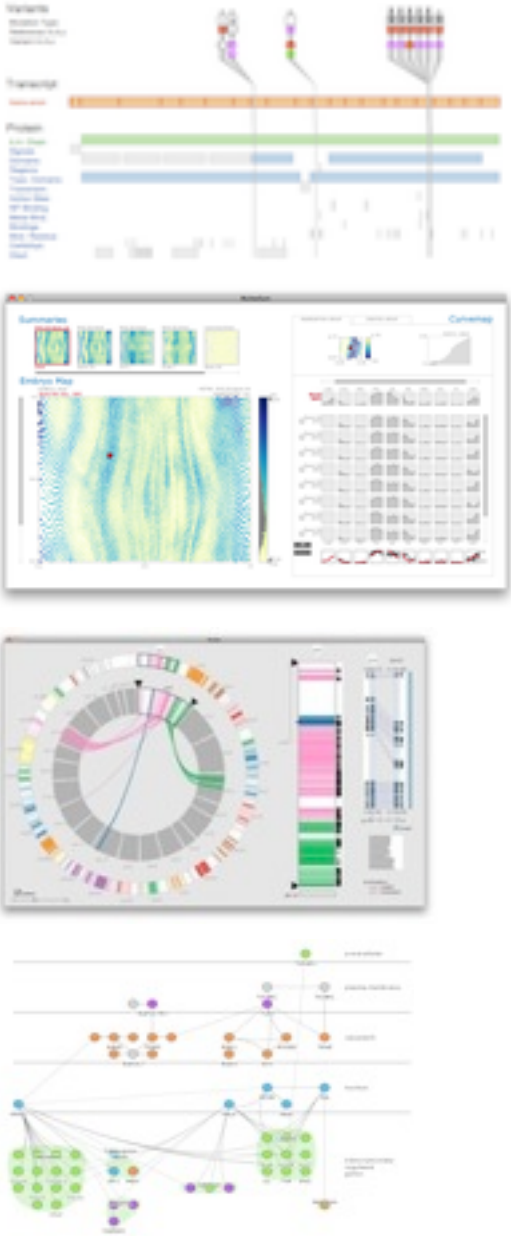
http://www.alaineknipes.com/interests/violin_concert.jpg

Where To Start: Many Flavors of Work

- Problem-driven work
  - design studies
- Technique-driven work
  - algorithms, idioms
- Evaluation
  - lab/field/data studies
- Theoretical foundations
  - models

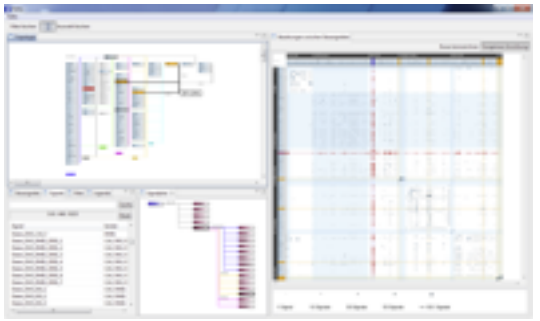
Design Studies: Biology Domain

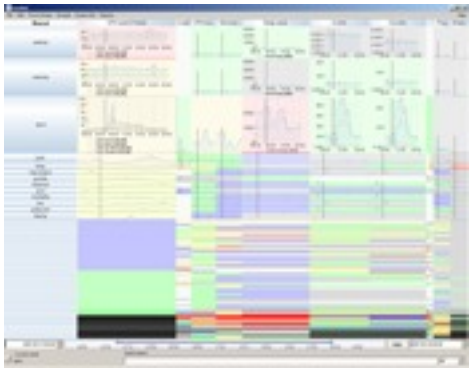
- Variant View: gene sequence variants
- MulteeSum, Pathline: comparative functional genomics
- MizBee: comparative genomics (synteny)
- Cerebral: gene expression + interaction network

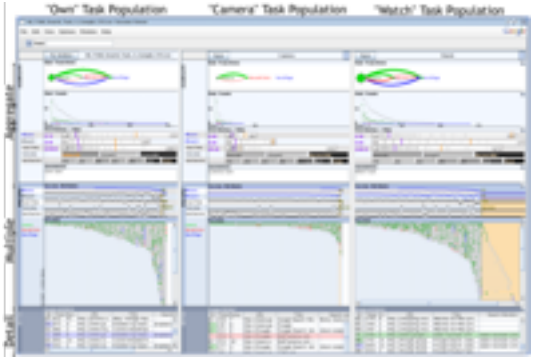


Design Studies: Other Domains

- RelEx: automative networks
- Vismon: fisheries simulation/mgmt
- LiveRAC: large-scale system monitoring
- SessionViewer: web logs

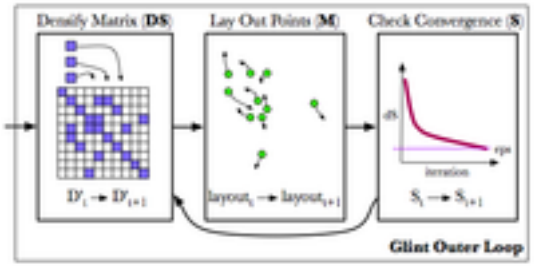






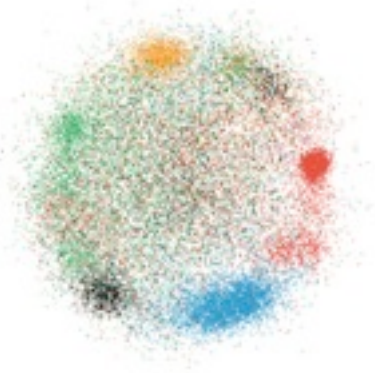
Techniques/Systems: Dimensionality Reduction

- Glint: costly distance functions



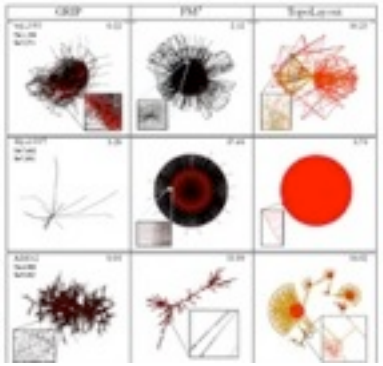
- DimStiller: visual dimensional analysis and reduction toolkit

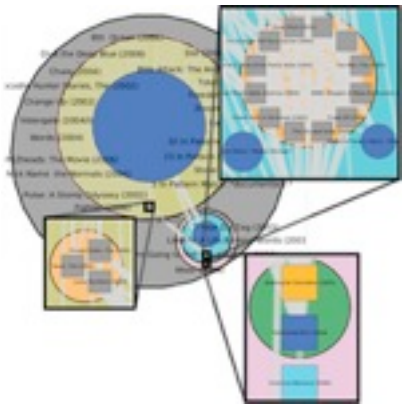
- Glimmer: GPU accelerated MDS

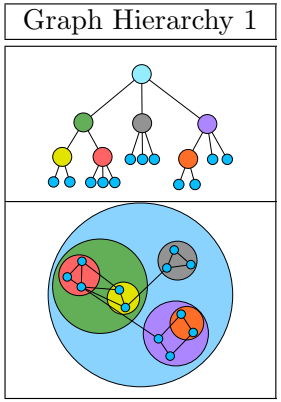


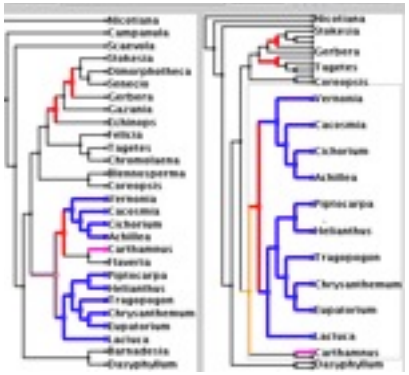
Techniques: Graphs/Trees

- general multilevel/compound graphs
  - layout
    - TopoLayout
  - interaction
    - Grouse
    - GrouseFlocks
    - TugGraph
- evolutionary tree comparison
  - TreeJuxtaposer



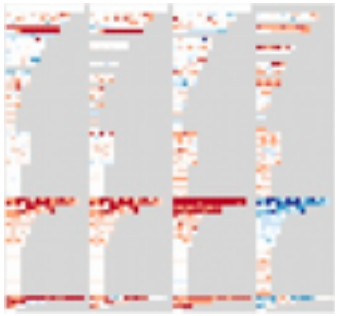




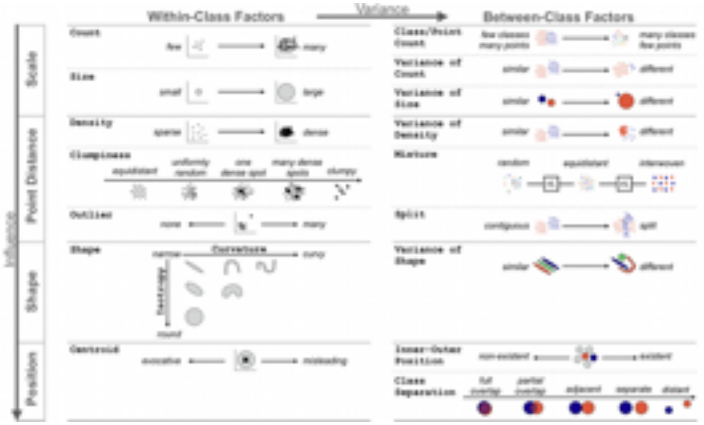


Evaluation: Dimensionality Reduction

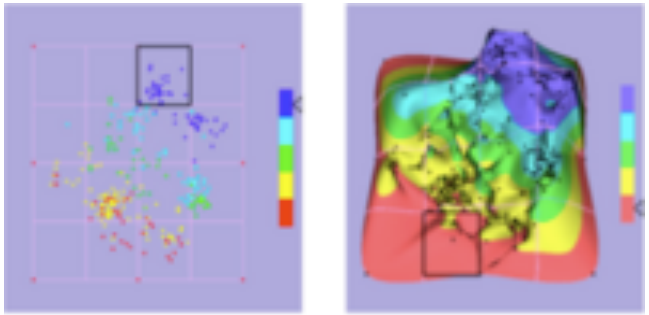
- guidance on scatterplot/DR choices



- taxonomy of cluster separation factors

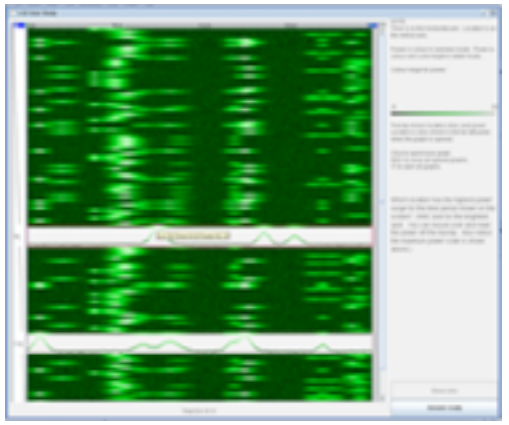


- 2D points vs 3D landscapes



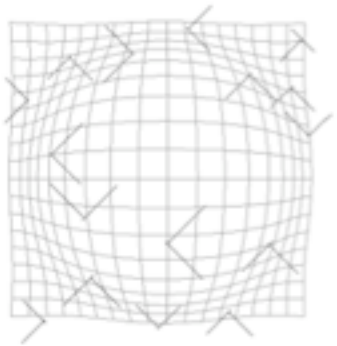
Evaluation: Focus+Context

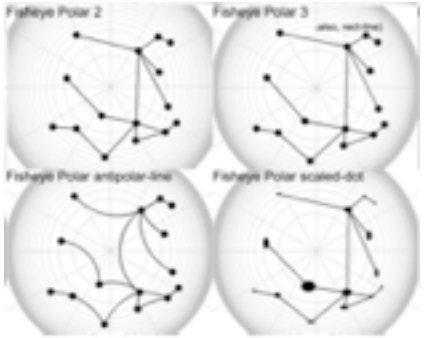
- overviews: separate vs. integrated views



- navigation: stretch and squish vs. pan/zoom navigation

- impact of distortion on visual search, visual memory





Evaluation, When and How
(excerpt)

Tamara Munzner
University of British Columbia

Evaluation: How Much Evaluation Is Enough?
Panel, VIS13

Victories and challenges: I

- evolving sophistication: the user study pendulum swings
- we've come a long way!
  - no user studies at all
  - a few dubious ones, lacking rigor
  - some good ones appear
  - rigorous studies are common

- but pushes to change culture often overshoot...
  - some reviewers expect all papers to have user studies
  - some authors do user studies without understanding why or how

http://www.biologycorner.com/resources/pendulum.jpg

Victories and challenges: II

- significance testing with controlled experiments
  - we've moved beyond "my friends liked it"
  - new frontier: multiple regression for comparison

    [Cognitive measurements of graph aesthetics. Ware, Purchase, Colpoys, and McGill. Information Visualization, 2002. 1(2): p. 103-110.]
  - new frontier: thinking beyond time and error
    - qualitative vs quantitative
      - different axis from lab/field
    - BELIV workshops
      - 06 AVI, 08 CHI, 10 CHI, 12 VisWeek

Victories and challenges: III

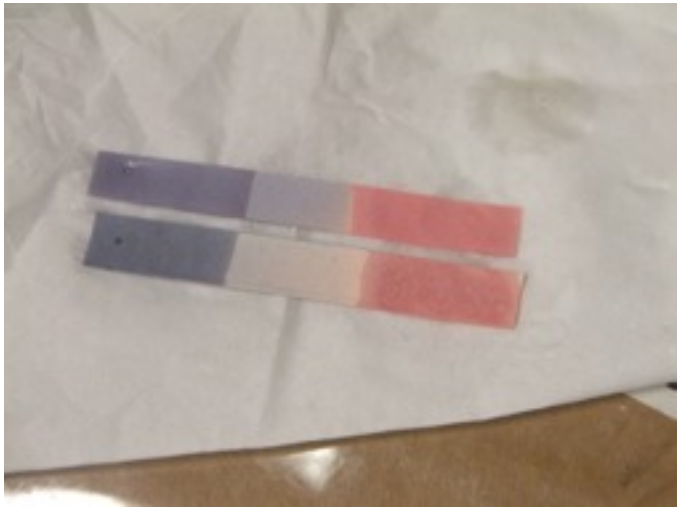
- post-deployment studies with target users
  - we've moved beyond "I'm the only one who's used it"
  - new frontier: post-adoption studies
    - Seven Scenarios: only 5 out of 800!

[Empirical Studies in Information Visualization: Seven Scenarios.
Lam, Bertini, Isenberg, Plaisant, and Carpendale.
TVCG 18(9):1520-1536, 2012.]

- what happens after you get that first paper out?...

Of course...

- ... you should evaluate your work
  - use appropriate methods!
- ... you should **not** have a user study in every paper
  - avoid litmus test and cargo cult thinking



http://en.wikipedia.org/wiki/File:Litmus_paper.JPG

http://blog.bhargreaves.com/wp-content/uploads/2010/04/cargo-cult.jpg