Ch 3: Task Abstraction
Paper: Design Study Methodology

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CPSC 547, Information Visualization
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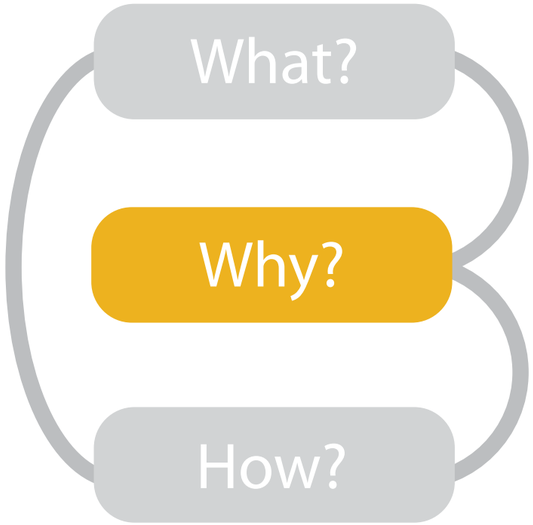
http://www.cs.ubc.ca/~tmm/courses/547-17

News

- marks for lecture 2 comments/questions sent out by email
  - see me after class if you didn't get them
  - order of marks matches order of questions in email
    - Q2: avg 85, min 73, max 94
  - only one question per reading required
    - no: two questions on one reading and no questions on the other
  - if you spot typo in book, let me know if it's not already in errata list
    - http://www.cs.ubc.ca/~tmm/vadbook/errata.html
    - (but don't count it as a question)
    - not useful to tell me about typos in published papers

VAD Ch 3: Task Abstraction



- {action, target} pairs
  - *discover distribution*
  - *compare trends*
  - *locate outliers*
  - *browse topology*

Why?

Actions

Analyze

→ Consume

→ *Discover* → *Present* → *Enjoy*

→ Produce

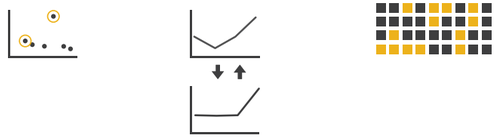
→ *Annotate* → *Record* → *Derive*

Search

	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

Query

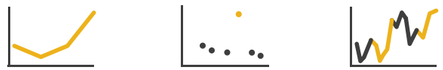
→ Identify → Compare → Summarize



Targets

All Data

→ Trends → Outliers → Features

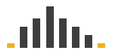


Attributes

→ One → Many

→ *Distribution* → *Dependency* → *Correlation* → *Similarity*

→ *Extremes*



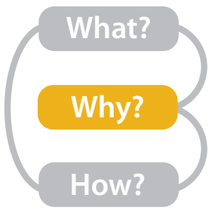
Network Data

→ Topology

→ *Paths*

Spatial Data

→ Shape



[VAD Fig 3.1]

High-level actions: Analyze

- consume
  - discover vs present
    - classic split
    - aka explore vs explain
  - enjoy
    - newcomer
    - aka casual, social
- produce
  - annotate, record
  - derive
    - crucial design choice

➔ **Analyze**

➔ Consume

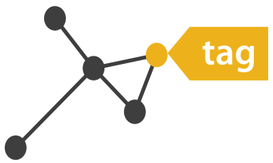
➔ *Discover*

➔ *Present*

➔ *Enjoy*

➔ Produce

➔ *Annotate*

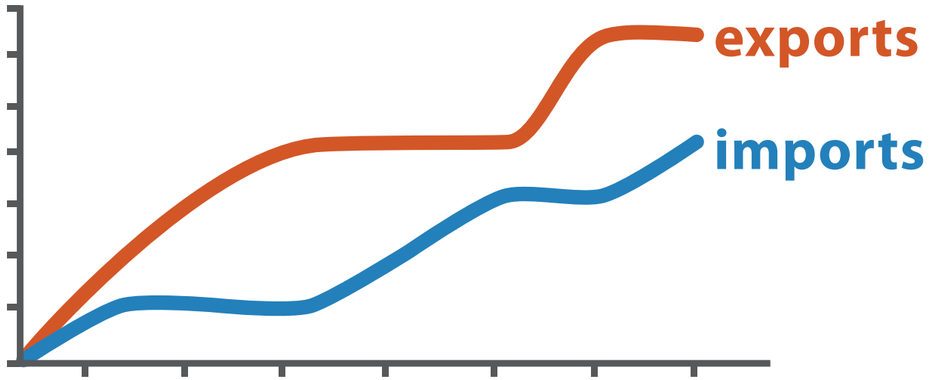


➔ *Record*

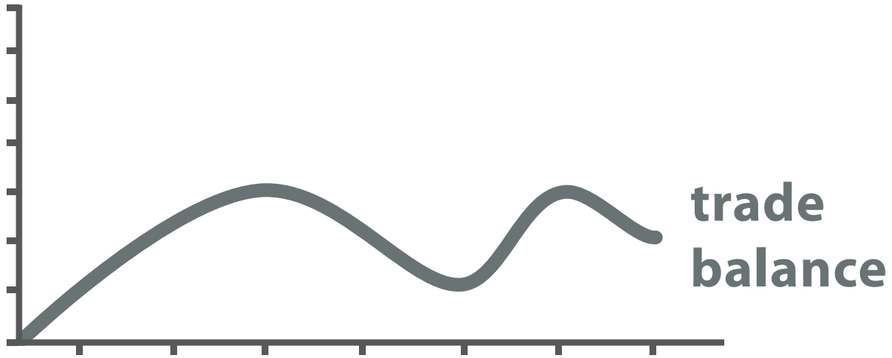
➔ *Derive*

Derive

- don't just draw what you're given!
  - decide what the right thing to show is
  - create it with a series of transformations from the original dataset
  - draw that
- one of the four major strategies for handling complexity



Original Data



trade balance = *exports* – *imports*

Derived Data

Actions: Mid-level search, low-level query

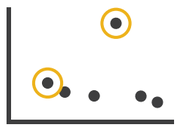
- what does user know?
  - target, location
- how much of the data matters?
  - one, some, all
- independent choices, mix & match
  - analyze, query, search

Search

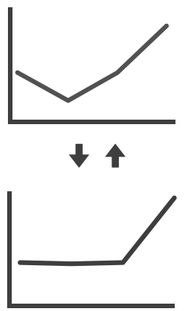
	Target known	Target unknown
Location known	*Lookup*	*Browse*
Location unknown	*Locate*	*Explore*

Query

→ Identify



→ Compare



→ Summarize

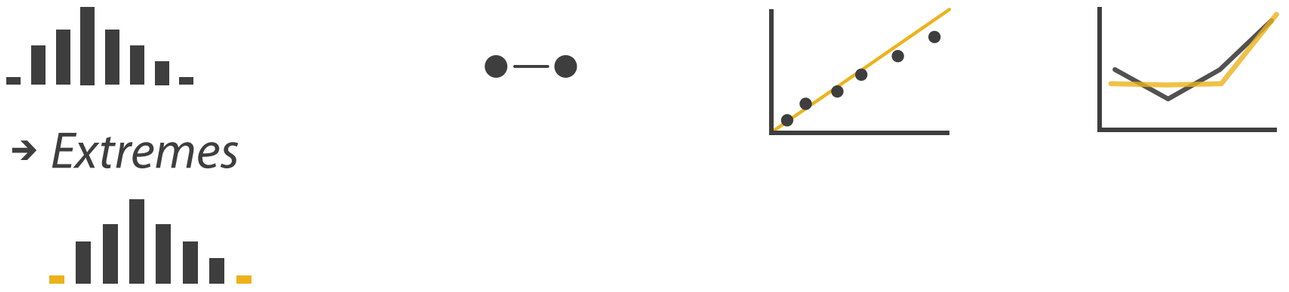
Targets

All Data

- Trends
- Outliers
- Features

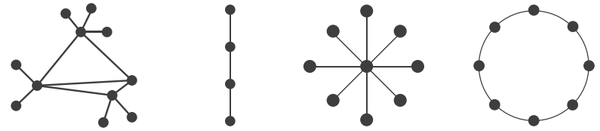
Attributes

- One
  - *Distribution*
  - *Extremes*
- Many
  - *Dependency*
  - *Correlation*
  - *Similarity*



Network Data

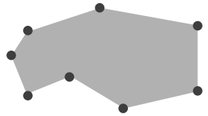
- Topology



- *Paths*

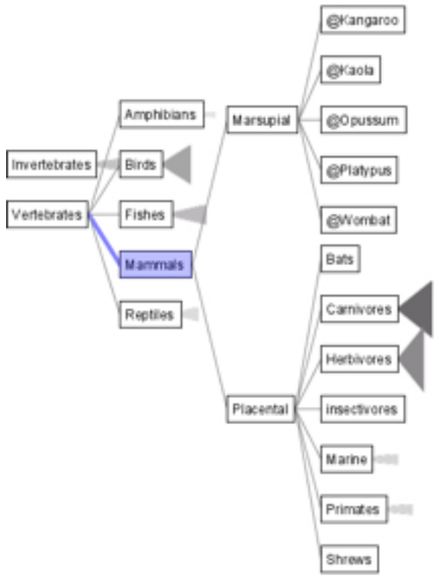
Spatial Data

- Shape

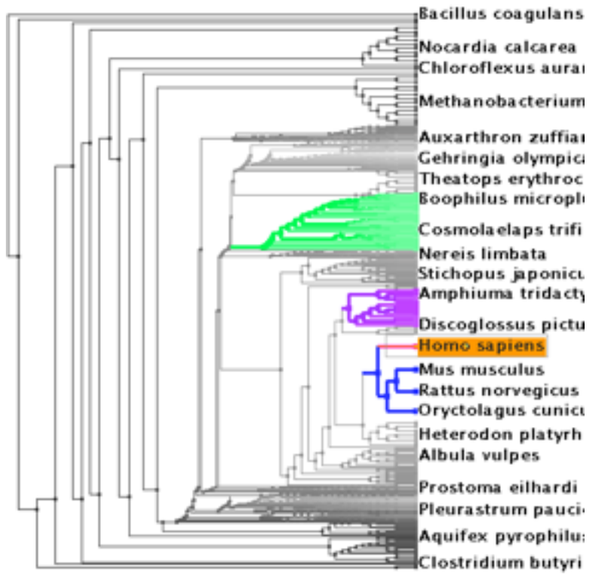


Analysis example: Compare idioms

SpaceTree

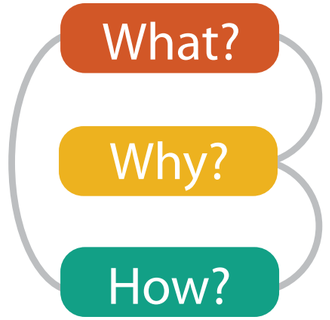


TreeJuxtaposer



[SpaceTree: Supporting Exploration in Large Node Link Tree, Design Evolution and Empirical Evaluation. Grosjean, Plaisant, and Bederson. Proc. InfoVis 2002, p 57–64.]

[TreeJuxtaposer: Scalable Tree Comparison Using Focus +Context With Guaranteed Visibility. ACM Trans. on Graphics (Proc. SIGGRAPH) 22:453– 462, 2003.]



What?

- Tree

Why?

- Actions
  - Present
  - Locate
  - Identify

- Targets
  - Path between two nodes

How?

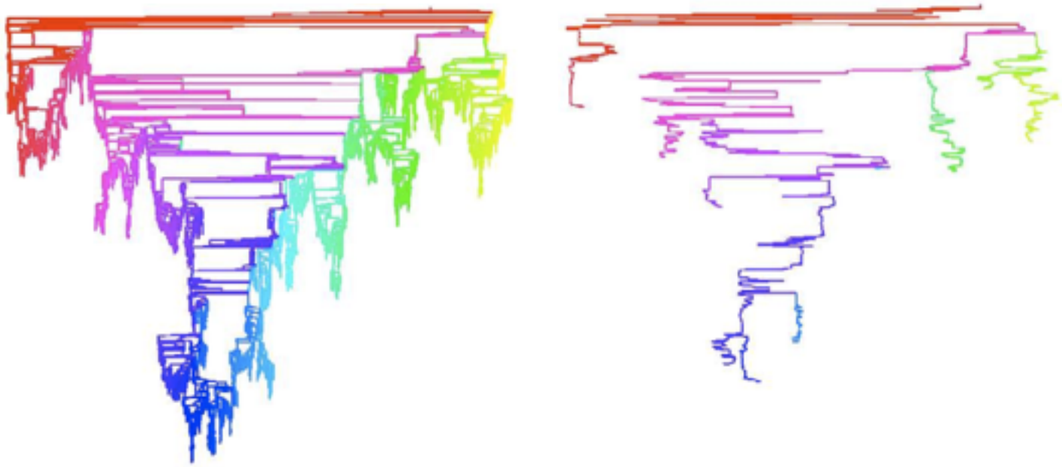
- SpaceTree
  - Encode
  - Navigate
  - Select
  - Filter
  - Aggregate

- TreeJuxtaposer
  - Encode
  - Navigate
  - Select
  - Arrange

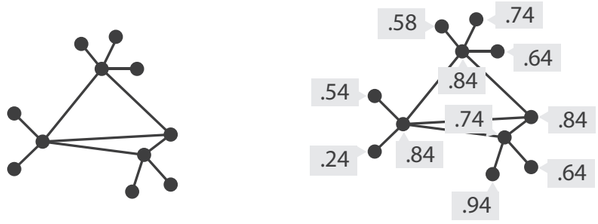
Analysis example: Derive one attribute

- Strahler number
  - centrality metric for trees/networks
  - derived quantitative attribute
  - draw top 5K of 500K for good skeleton

[Using Strahler numbers for real time visual exploration of huge graphs. Auber. Proc. Intl. Conf. Computer Vision and Graphics, pp. 56–69, 2002.]



Task 1



In
Tree

Out
Quantitative attribute on nodes

What?

- In Tree
- Out Quantitative attribute on nodes

Why?

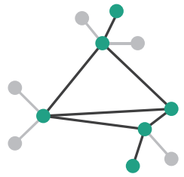
- Derive

Task 2

In
Tree

+

In
Quantitative attribute on nodes



Out
Filtered Tree
Removed unimportant parts

What?

- In Tree
- In Quantitative attribute on nodes
- Out Filtered Tree

Why?

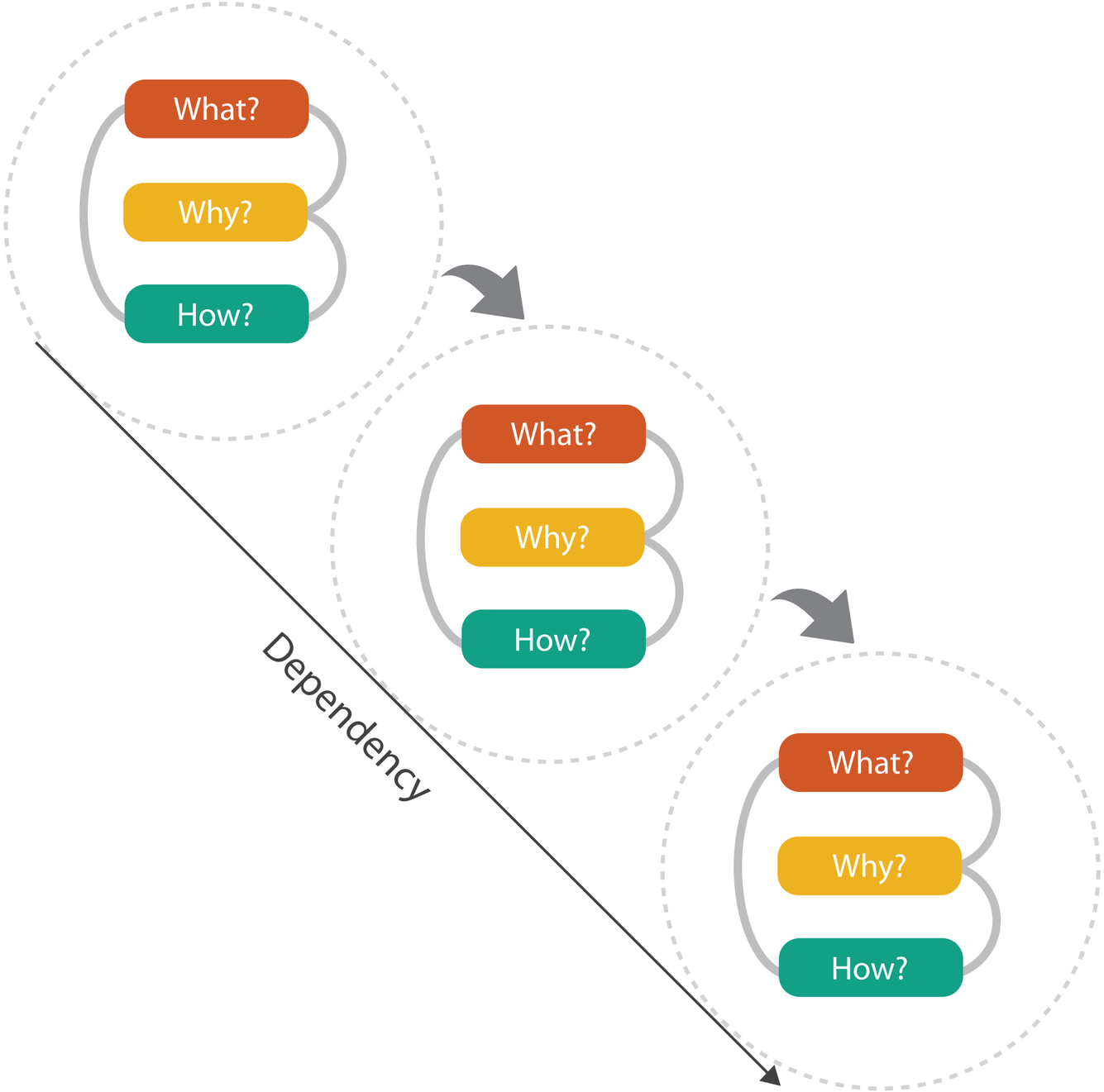
- Summarize
- Topology

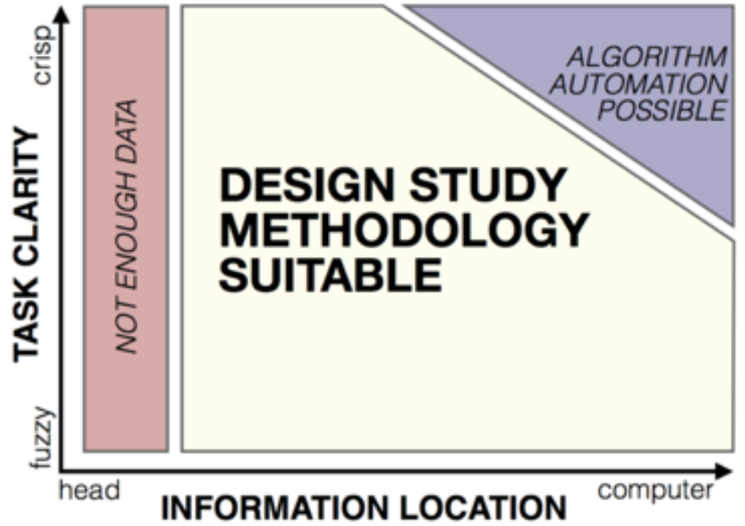
How?

- Reduce
- Filter

Chained sequences

- output of one is input to next
  - express dependencies
  - separate means from ends





Design Study Methodology

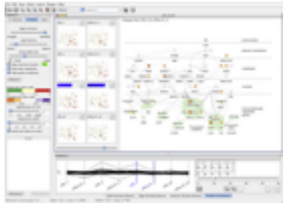
Reflections from the Trenches and from the Stacks

joint work with:
Michael Sedlmair, Miriah Meyer

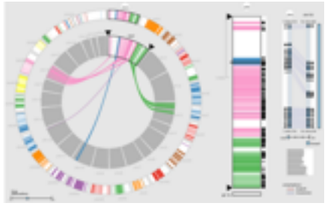
http://www.cs.ubc.ca/labs/imager/tr/2012/dsm/

Design Study Methodology: Reflections from the Trenches and from the Stacks.
Sedlmair, Meyer, Munzner. IEEE Trans. Visualization and Computer Graphics 18(12): 2431-2440, 2012 (Proc. InfoVis 2012).

Design Studies: Lessons learned after 21 of them

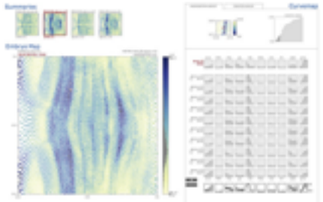


Cerebral
genomics

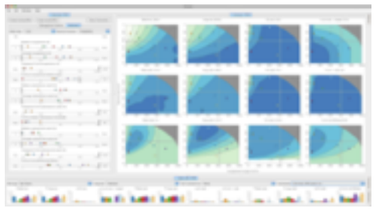


MizBee
genomics

Pathline
genomics



MulteeSum
genomics

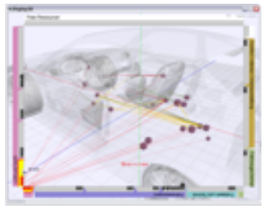


Vismon
fisheries management

QuestVis
sustainability

WiKeVis
in-car networks

MostVis
in-car networks



Car-X-Ray
in-car networks

ProgSpy2010
in-car networks

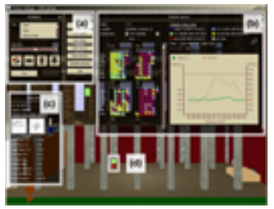
RelEx
in-car networks

Cardiogram
in-car networks

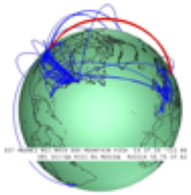
AutobahnVis
in-car networks

VisTra
in-car networks

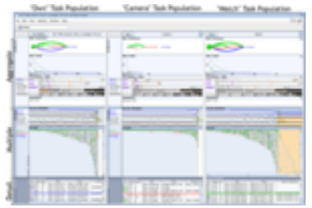
Constellation
linguistics



LibVis
cultural heritage

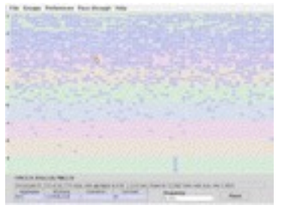


Caidants
multicast

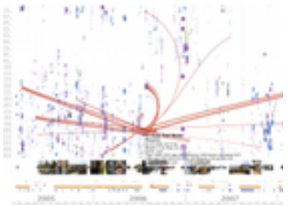


SessionViewer
web log analysis

LiveRAC
server hosting



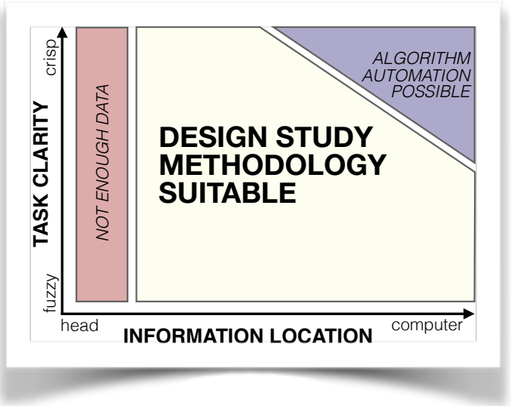
PowerSetViewer
data mining



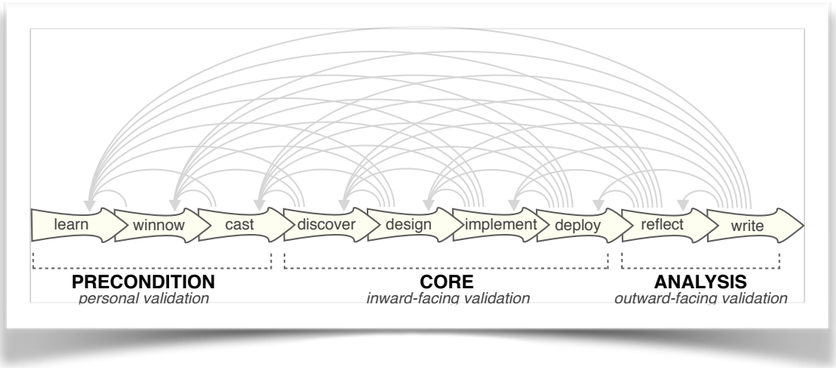
LastHistory
music listening

Methodology for Problem-Driven Work

- 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

Methodology

ingredients

Methods

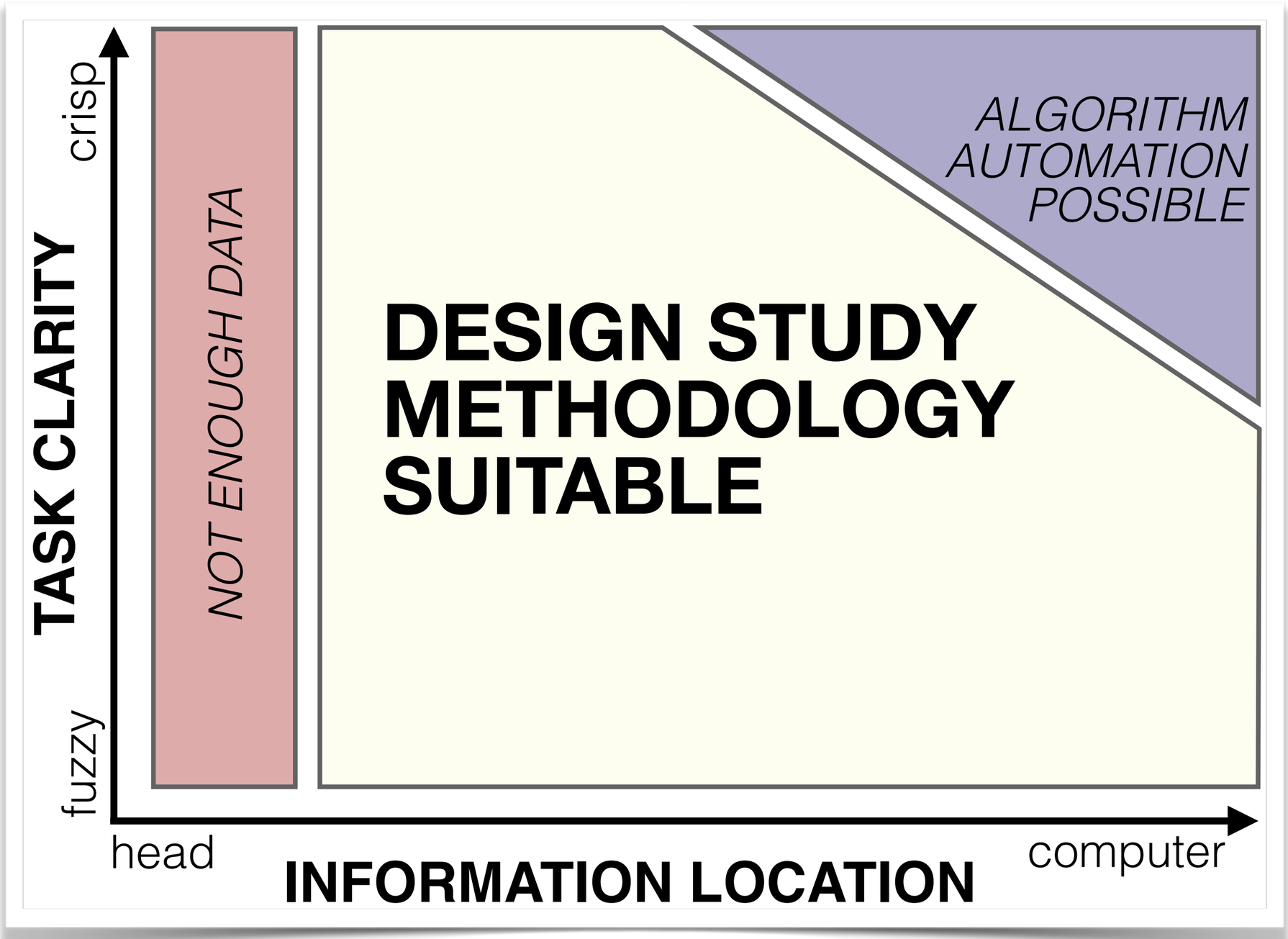
recipes

Methodology

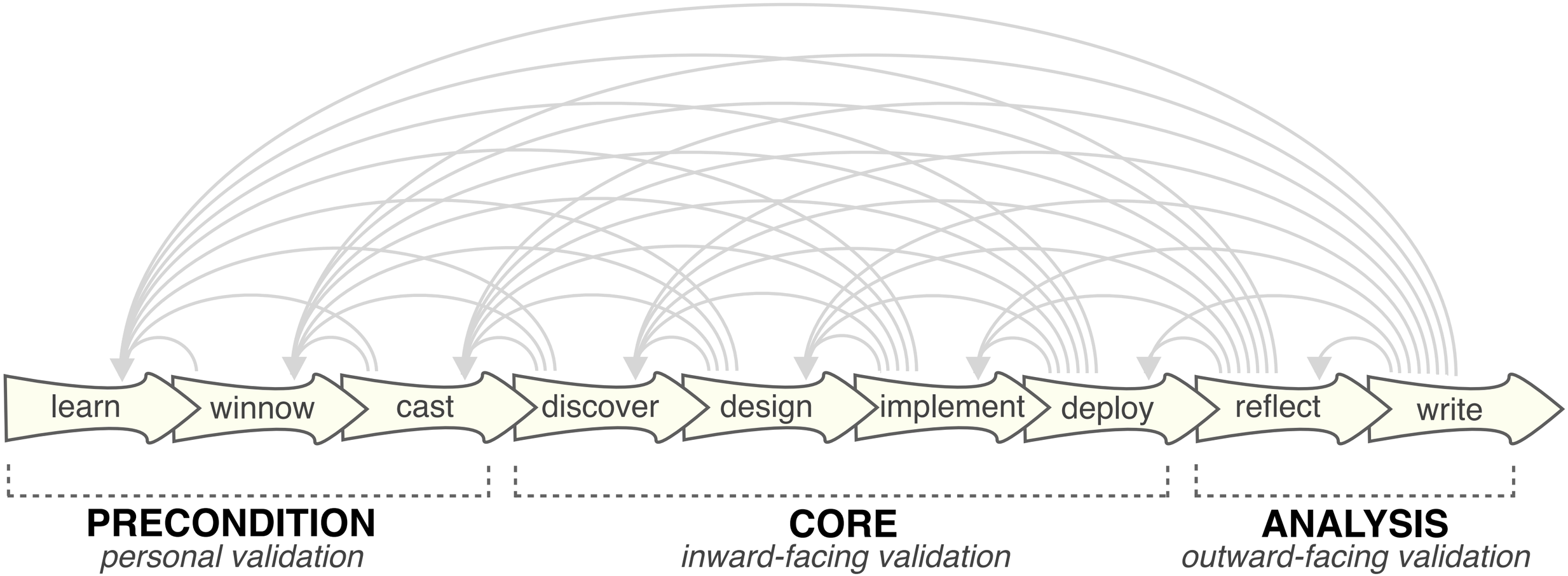
Design studies: problem-driven vis research

- a specific real-world problem
  - real users and real data,
  - collaboration is (often) fundamental
- design a visualization system
  - implications: requirements, multiple ideas
- validate the design
  - at appropriate levels
- reflect about lessons learned
  - transferable research: improve design guidelines for vis in general
    - confirm, refine, reject, propose

When To Do Design Studies

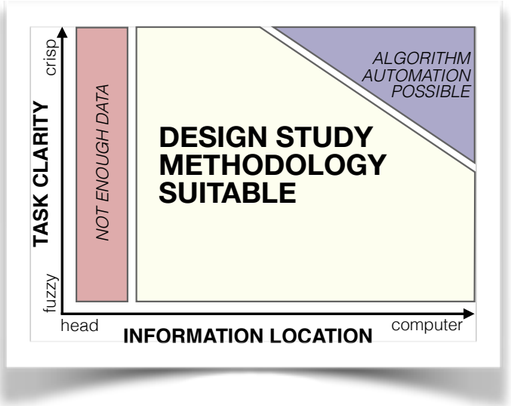


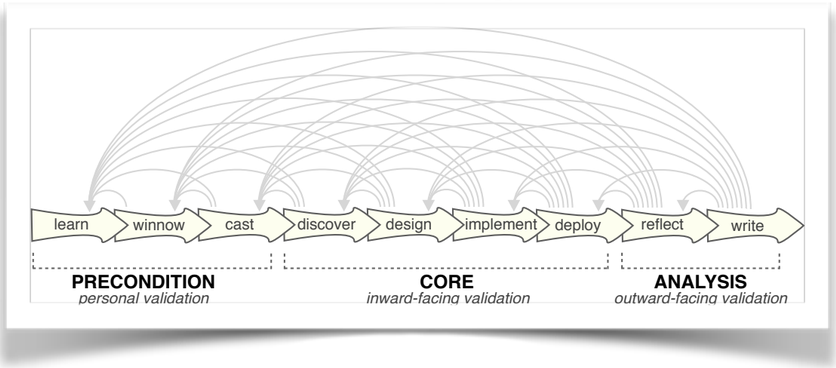
Nine-Stage Framework



How To Do Design Studies

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





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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

algorithm innovation

design studies

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

Further reading: Books

- Visualization Analysis and Design. Munzner. CRC Press, 2014.
  - Chap 3: Task Abstraction
- Information Visualization: Using Vision to Think. Stuart Card, Jock Mackinlay, and Ben Shneiderman.
  - Chap 1

Further reading: Articles

- Low-Level Components of Analytic Activity in Information Visualization. Robert Amar, James Eagan, and John Stasko. Proc. InfoVis 05, pp. 111-117.
- A characterization of the scientific data analysis process. Rebecca R. Springmeyer, Meera M. Blattner, and Nelson M. Max. Proc. Vis 1992, p 235-252.
- Task taxonomy for graph visualization. Bongshin Lee, Catherine Plaisant, Cynthia Sims Parr, Jean-Daniel Fekete, and Nathalie Henry. Proc. BELIV 2006.
- Interactive Dynamics for Visual Analysis. Jeffrey Heer and Ben Shneiderman. Communications of the ACM, 55(4), pp. 45-54, 2012.
- What does the user want to see?: what do the data want to be? A. Johannes Pretorius and Jarke J. van Wijk. Information Visualization 8(3):153-166, 2009.
- An Operator Interaction Framework for Visualization Systems. Ed H. Chi and John T. Riedl. Proc. InfoVis 1998, p 63-70.
- Nominal, Ordinal, Interval, and Ratio Typologies are Misleading. Paul F. Velleman and Leland Wilkinson. The American Statistician 47(1):65-72, 1993.
- Rethinking Visualization: A High-Level Taxonomy. Melanie Tory and Torsten Möller, Proc. InfoVis 2004, pp. 151-158.
- SpaceTree: Supporting Exploration in Large Node Link Tree, Design Evolution and Empirical Evaluation. Catherine Plaisant, Jesse Grosjean, and Ben B. Bederson. Proc. InfoVis 2002.
- TreeJuxtaposer: Scalable Tree Comparison using Focus+Context with Guaranteed Visibility Tamara Munzner, Francois Guimbretiere, Serdar Tasiran, Li Zhang, and Yunhong Zhou. SIGGRAPH 2003.
- Feature detection in linked derived spaces. Chris Henze. Proc. Vis 1998, p 87-94.
- Using Strahler numbers for real time visual exploration of huge graphs. David Auber. Intl Conf. Computer Vision and Graphics, 2002, p 56-69.

Further reading: Design studies

- BallotMaps: Detecting Name Bias in Alphabetically Ordered Ballot Papers. Jo Wood, Donia Badawood, Jason Dykes, Aidan Slingsby. IEEE TVCG 17(12): 2384-2391 (Proc InfoVis 2011).
- MulteeSum: A Tool for Comparative Temporal Gene Expression and Spatial Data. Miriah Meyer, Tamara Munzner, Angela DePace and Hanspeter Pfister. IEEE Trans. Visualization and Computer Graphics 16(6):908-917 (Proc. InfoVis 2010), 2010.
- Pathline: A Tool for Comparative Functional Genomics. Miriah Meyer, Bang Wong, Tamara Munzner, Mark Styczynski and Hanspeter Pfister. Computer Graphics Forum (Proc. EuroVis 2010), 29(3):1043-1052
- SignalLens: Focus+Context Applied to Electronic Time Series. Robert Kincaid. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2010), 16(6):900-907, 2010.
- ABySS-Explorer: Visualizing genome sequence assemblies. Cydney B. Nielsen, Shaun D. Jackman, Inanc Birol, Steven J.M. Jones. IEEE Transactions on Visualization and Computer Graphics (Proc InfoVis 2009) 15(6):881-8, 2009.
- Interactive Coordinated Multiple-View Visualization of Biomechanical Motion Data. Daniel F. Keefe, Marcus Ewert, William Ribarsky, Remco Chang. IEEE Trans. Visualization and Computer Graphics (Proc. Vis 2009), 15(6):1383-1390, 2009.
- MizBee: A Multiscale Synteny Browser. Miriah Meyer, Tamara Munzner, and Hanspeter Pfister. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 09), 15(6):897-904, 2009.
- MassVis: Visual Analysis of Protein Complexes Using Mass Spectrometry. Robert Kincaid and Kurt Dejgaard. IEEE Symp Visual Analytics Science and Technology (VAST 2009), p 163-170, 2009.
- Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Aaron Barsky, Tamara Munzner, Jennifer L. Gardy, and Robert Kincaid. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2008) 14(6) (Nov-Dec) 2008, p 1253-1260.
- Visual Exploration and Analysis of Historic Hotel Visits. Chris Weaver, David Fyfe, Anthony Robinson, Deryck W. Holdsworth, Donna J. Peuquet and Alan M. MacEachren. Information Visualization (Special Issue on Visual Analytics), Feb 2007.
- Session Viewer: Visual Exploratory Analysis of Web Session Logs. Heidi Lam, Daniel Russell, Diane Tang, and Tamara Munzner. Proc. IEEE Symposium on Visual Analytics Science and Technology (VAST), p 147-154, 2007.
- Exploratory visualization of array-based comparative genomic hybridization. Robert Kincaid, Amir Ben-Dor, and Zohar Yakhini. Information Visualization (2005) 4, 176-190.
- Coordinated Graph and Scatter-Plot Views for the Visual Exploration of Microarray Time-Series Data Paul Craig and Jessie Kennedy, Proc. InfoVis 2003, p 173-180.
- Cluster and Calendar based Visualization of Time Series Data. Jarke J. van Wijk and Edward R. van Selow, Proc. InfoVis 1999, p 4-9.
- Constellation: A Visualization Tool For Linguistic Queries from MindNet. Tamara Munzner, Francois Guimbretiere, and George Robertson. Proc. InfoVis 1999, p 132-135.

In-class exercise: Abstraction

Next Time

- to read
  - VAD Ch. 4: Validation

- reminder: my office hours are Tue right after class