Ch 4: Validation
Paper: D3

Tamara Munzner
Department of Computer Science
University of British Columbia

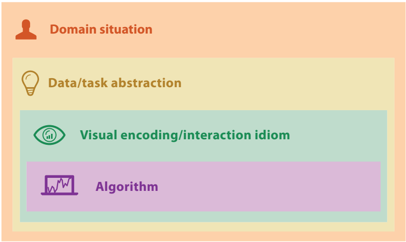
CPSC 547, Information Visualization
Day 6: 29 September 2015

http://www.cs.ubc.ca/~tmm/courses/547-15

News

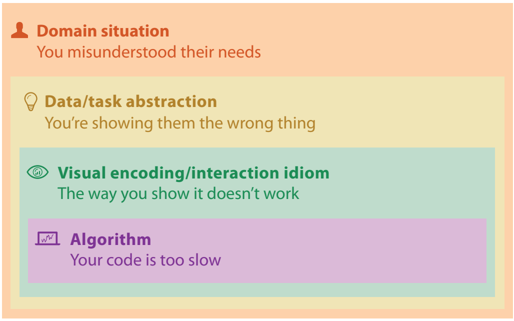
- LAVA Hackathon Oct 24-25
  - http://blogs.ubc.ca/lava/
  - Learning Analytics, Visual Analytics
  - there are no lectures in this class that week
    - if you want to avoid withdrawal :-)

VAD Ch 4: Analysis: Four Levels for Validation

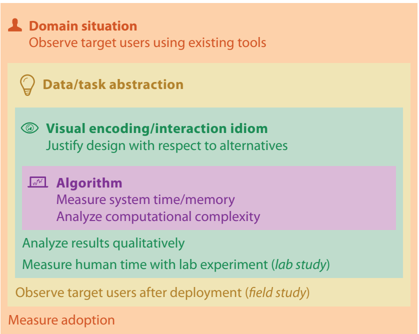

Domain situation
Data/task abstraction
Visual encoding/interaction idiom
Algorithm

Four Levels of Design and Validation

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

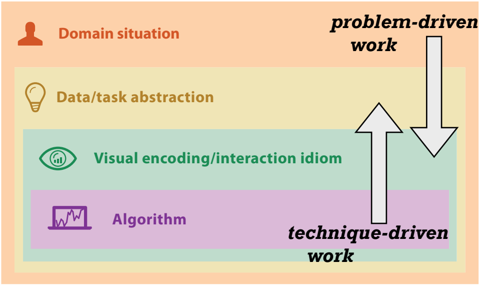

Domain situation
You misunderstood their needs
Data/task abstraction
You're showing them the wrong thing
Visual encoding/interaction idiom
The way you show it doesn't work
Algorithm
Your code is too slow

Nested Levels of Design and Validation


Domain situation
Observe target users using existing tools
Data/task abstraction
Visual encoding/interaction idiom
Justify design with respect to alternatives
Algorithm
Measure system time/memory
Analyze computational complexity
Analyze results qualitatively
Measure human time with lab experiment (*lab study*)
Observe target users after deployment (*field study*)
Measure adoption

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

Directionality


Domain situation
Data/task abstraction
Visual encoding/interaction idiom
Algorithm
problem-driven work
technique-driven work

Paper: D3

- paper types
  - design studies
  - technique/algorithm
  - evaluation
  - model/taxonomy
  - **system**
    - today's emphasis

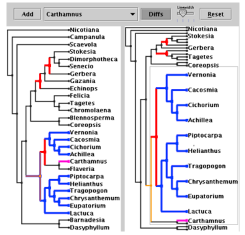
[D3: Data-Driven Documents. Bostock, Ogievetsky, Heer. IEEE Trans. Visualization & Comp. Graphics (Proc. InfoVis), 2011.]

Toolkits

- imperative: how
  - low-level rendering: Processing, OpenGL
  - parametrized visual objects: prefuse
    - also flare: prefuse for Flash
- declarative: what
  - Protoviz, D3, ggplot2
  - separation of specification from execution
- considerations
  - expressiveness
    - can I build it?
  - efficiency
    - how long will it take?
  - accessibility
    - do I know how?

OpenGL

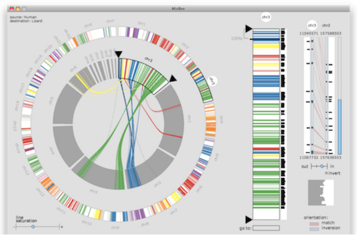
- graphics library
  - pros
    - power and flexibility, complete control for graphics
    - hardware acceleration
    - many language bindings: C, C++, Java (w/ JOGL)
  - cons
    - big learning curve if you don't know already
    - no vis support, must roll your own everything
  - example app: TreeJuxtaposer



[Fig 5. Munzner et al. TreeJuxtaposer: Scalable Tree Comparison using Focus+Context with Guaranteed Visibility. Proc SIGGRAPH 2003, pp 453-462.]

Processing

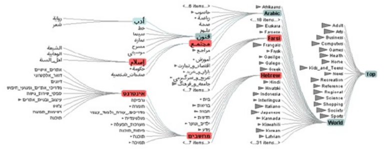
- layer on top of Java/OpenGL
- visualization esp. for artists/designers
- pros
  - great sandbox for rapid prototyping
  - huge user community, great documentation
- cons
  - poor widget library support
- example app: MizBee



[Fig 1. Meyer et al. MizBee: A Multiscale Synteny Browser. Proc. InfoVis 2009.]

prefuse

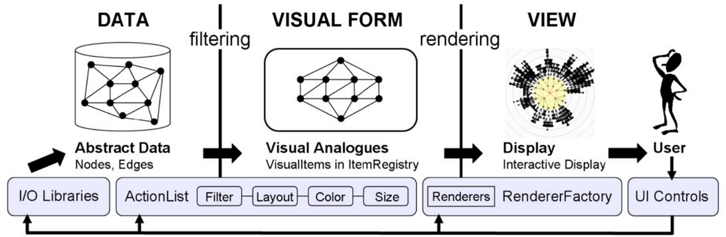
- infovis toolkit, in Java
- fine-grained building blocks for tailored visualizations
- pros
  - heavily used (previously)
  - very powerful abstractions
  - quickly implement most techniques covered so far
- cons
  - hasn't been under active development for
  - nontrivial learning curve
- example app: DOITrees Revisited



[DOITrees Revisited: Scalable, Space-Constrained Visualization of Hierarchical Data. Heer and Card. Proc. Advanced Visual Interfaces (AVI), pp. 421–424, 2004.]

prefuse

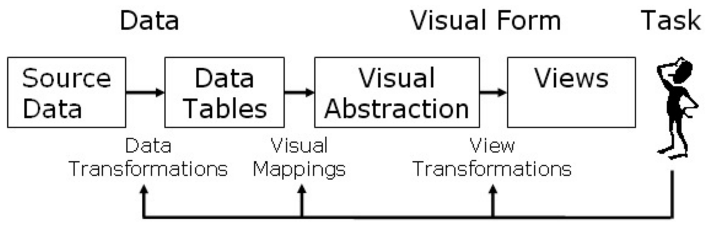
- separation: abstract data, visual form, view
  - data: tables, networks
  - visual form: layout, color, size, ...
  - view: multiple renderers


DATA
filtering
VISUAL FORM
rendering
VIEW
Abstract Data
Nodes, Edges
Visual Analogues
VisualItems in ItemRegistry
Display
Interactive Display
User
I/O Libraries
ActionList
Filter
Layout
Color
Size
Renderers
RendererFactory
UI Controls

[Fig 2. Heer, Card, and Landay. Prefuse: A Toolkit for Interactive Information Visualization. Proc. CHI 2005, 421-430]

InfoVis Reference Model

- conceptual model underneath design of prefuse and many other toolkits
- heavily influenced much of infovis (including nested model)
  - aka infovis pipeline, data state model


Data
Visual Form
Task
Source Data
Data Tables
Visual Abstraction
Views
Data Transformations
Visual Mappings
View Transformations

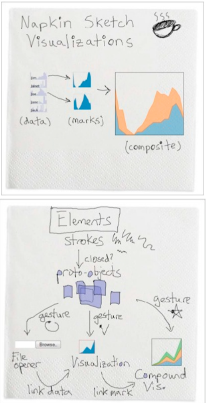
[Redrawn Fig 1.23. Card, Mackinlay, and Shneiderman. Readings in Information Visualization: Using Vision To Think, Chapter 1. Morgan Kaufmann, 1999.]

Declarative toolkits

- imperative tools/libraries
  - say exactly **how** to do it
  - familiar programming model
    - OpenGL, prefuse, ...
- declarative: other possibility
  - just say **what** to do
  - Protovis, D3

Protovis

- declarative infovis toolkit, in Javascript
  - also later Java version
- marks with inherited properties
- pros
  - runs in browser
  - matches mark/channel mental model
  - also much more: interaction, geospatial, trees,...
- cons
  - not all kinds of operations supported
- example app: NapkinVis (2009 course project)



[Fig 1, 3. Chao. NapkinVis. http://www.cs.ubc.ca/~tmm/courses/533-09/projects.html#will]

Protovis Validation

- wide set of old/new app examples
  - expressiveness, effectiveness, scalability
  - accessibility
- analysis with cognitive dimensions of notation
  - closeness of mapping, hidden dependencies
  - role-expressiveness visibility, consistency
  - viscosity, diffuseness, abstraction
  - hard mental operations

[Cognitive dimensions of notations. Green (1989). In A. Sutcliffe and L. Macaulay (Eds.) People and Computers V. Cambridge, UK: Cambridge University Press, pp 443-460.]

D3

- declarative infovis toolkit, in Javascript
- Protovis meets Document Object Model
- pros
  - seamless interoperability with Web
  - explicit transforms of scene with dependency info
  - massive user community, many thirdparty apps/libraries on top of it, lots of docs
- cons
  - even more different from traditional programming model
- example apps: many

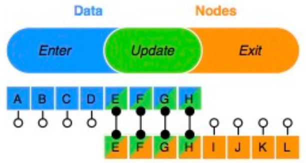
D3

- objectives
  - compatibility
  - debugging
  - performance
- related work typology
  - document transformers
  - graphics libraries
  - infovis systems
    - general note: all related work sections are a mini-taxonomy!

[D3: Data-Driven Documents. Bostock, Ogievetsky, Heer. IEEE Trans. Visualization & Comp. Graphics (Proc. InfoVis), 2011.]

D3 capabilities

- query-driven selection
  - selection: filtered set of elements queries from the current doc
    - also partitioning/grouping!
  - operators act on selections to modify content
    - instantaneous or via animated transitions with attribute/style interpolators
    - event handlers for interaction
- data binding to scenegraph elements
  - data joins bind input data to elements
  - enter, update, exit subselections
  - sticky: available for subsequent re-selection
  - sort, filter



[D3: Data-Driven Documents. Bostock, Ogievetsky, Heer. IEEE Trans. Visualization & Comp. Graphics (Proc. InfoVis), 2011.]

D3 Features

- document transformation as atomic operation
  - scene changes vs representation of scenes themselves
- immediate property evaluation semantics
  - avoid confusing consequences of delayed evaluation
- validation
  - performance benchmarks
    - page loads, frame rate
  - accessibility
    - everybody has voted with their feet by now!

Next Time

- to read
  - VAD Ch. 7: Tables
  - Visualizing Sets and Set-typed Data: State-of-the-Art and Future Challenges, Bilal Alsallakh, Luana Micallef, Wolfgang Aigner, Helwig Hauser, Silvia Miksch, and Peter Rodgers. EuroVis State of The Art Report 2014.
    - paper type: survey

Now

- guest lectures on tools & resources
  - Matt Brehmer
  - http://www.cs.ubc.ca/group/infovis/resources.shtml