News
- LAVA Hackathon Oct 24-25
  - [http://blogs.ubc.ca/lava/](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

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

Four Levels of Design and Validation

- declarative: what
  - Protovis, D3, ggplot2
  - separation of specification from execution
- considering
  - expressiveness
  - ease/hard of evaluation
  - accessibility
- do I know how?

Protovis

- declarative infovis toolkit, in Javascript
- fine-grained building blocks for tailored visualizations
- pros
  - heavily used (previously)
  - very powerful abstractions
  - quickly implement most techniques covered so far
- costs
  - hasn’t been under active development for:
    - non-trivial learning curve
    - accessibility

Example app: NapkinVis (2009 course project)

Chao. NapkinVis. [http://www.cs.ubc.ca/~tmm/courses/533-09/projects.html#will](http://www.cs.ubc.ca/~tmm/courses/533-09/projects.html#will)


Protovis Validation

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


Declarative toolkits

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

OpenGl

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

InfoVis Reference Model

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

InfoVis

- data: tables, networks
- visual form: layout, color, size, ...
  - close to alchimist

Protovis

- declarative infovis toolkit, in Javascript
  - also later Java version
  - marks with inherited properties
  - pros
  - runs in browser
  - matches marks/shadow 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](http://www.cs.ubc.ca/~tmm/courses/533-09/projects.html#will)

Paper: D3

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

Camera-ready Edits (2014)


Prefuse

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

Processing

- layer on top of Java/OpenGL
- visualization esp. for artists/designers
- pros
  - huge sandbox for rapid prototyping
- cons
  - poor library support


Directionality

- problem-driven task
- data/task abstraction
- Visual encoding/interaction idiom
- Algorithm

Domain situation

- Technical situation


Nested Levels of Design and Validation

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

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D3: Data-Driven Documents


D3: Objectives
- Compatibility
- Debugging
- Performance

D3: Related Work Typology
- Document Transformers
- Graphics Libraries
- Infovis Systems

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
  - Page loads, frame rate
    - Accessibility
    - Performance benchmarks

D3: Now
- Guest lectures on tools & resources
  - Matt Brehmer
  - http://www.cs.ubc.ca/group/infovis/resources.shtml

D3: Next Time
- To Read
  - VAD Ch. 7: Tables
  - Paper type: survey

D3: Pros
- Seamless interoperability with Web
- Explicit transforms of scene with dependency info
- Massive user community, many third-party apps/libraries on top of it, lots of docs

D3: Cons
- Even more different from traditional programming model
- Example apps: many

D3: 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}

D3: Data Binding to Scenegraph Elements
- Dynamic data from input data
  - Enter, update, exit subselections
  - Sticky: available for subsequent re-selection
  - Sort, filter

D3: Document Transformation as Atomic Operation
- Selection: filtered set of elements queries from the current doc
- Scene changes vs representation of scenes themselves
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  - Avoid confusing consequences of delayed evaluation
- Validation
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