Lectures 7&8: Usability & Case Studies

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DSCI 532: Data Visualization II
Lectures 7&8: 10 & 12 April 2017

https://github.ubc.ca/ubc-mds-2016/DSCI_532_viz-2_students

Guerilla/Discount Usability

- grab a few people and watch them use your interface
  - even 3-5 gives substantial coverage of major usability problems
  - agile/lean qualitative, vs formal quantitative user studies
    - goal is not statistical significance!
- think-aloud protocol
  - contextual inquiry (conversations back and forth) vs fly on the wall (you're silent)
- normally: generate tasks, scenarios
  - shortcut in this week's lab, since whole cohort understands data/scenario

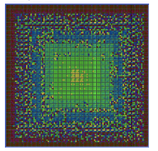
Further reading

- 7 Step Guide to Guerrilla Usability Testing, Markus Piper
  - https://userbrain.net/blog/7-step-guide-guerrilla-usability-testing-diy-usability-testing-method
- The Art of Guerrilla Usability Testing, David Peter Simon
  - http://www.uxbooth.com/articles/the-art-of-guerrilla-usability-testing/
- Discount Usability: 20 Years, Jakob Nielsen
  - https://www.nngroup.com/articles/discount-usability-20-years/
- Interaction Design: Beyond Human-Computer Interaction
  - Preece, Sharp, Rogers. Wiley, 4th edition, 2015.
- About Face: The Essentials of Interaction Design
  - Cooper, Reimann, Cronin, Noessel. Wiley, 4th edition, 2014.
- Task-Centered User Interface Design. Lewis & Rieman, 1994
  - http://hcibib.org/tcuid/
- Designing with the Mind in Mind. Jeff Johnson. Morgan Kaufmann, 2nd, 2014.

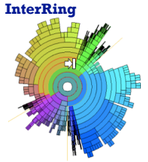
Analysis Case Studies

Scagnostics

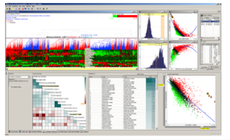
VisDB



InterRing

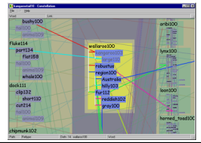


HCE



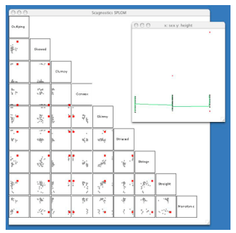
PivotGraph

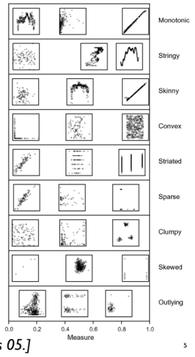
Constellation



Graph-Theoretic Scagnostics

- scatterplot diagnostics
  - scagnostics SPLOM: each point is one original scatterplot





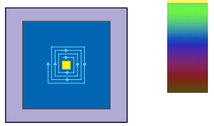
[Graph-Theoretic Scagnostics Wilkinson, Anand, and Grossman. Proc InfoVis 05.]

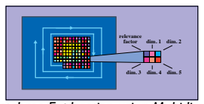
Scagnostics analysis

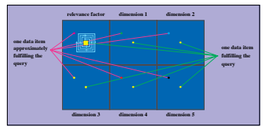
System	Scagnostics
What: Data	Table.
What: Derived	Nine quantitative attributes per scatterplot (pairwise combination of original attributes).
Why: Tasks	Identify, compare, and summarize; distributions and correlation.
How: Encode	Scatterplot, scatterplot matrix.
How: Manipulate	Select.
How: Facet	Juxtaposed small-multiple views coordinated with linked highlighting, popup detail view.
Scale	Original attributes: dozens.

VisDB

- table: draw pixels sorted, colored by relevance
- group by attribute or partition by attribute into multiple views



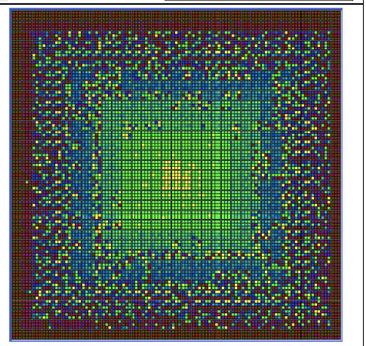




[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994]

VisDB Results

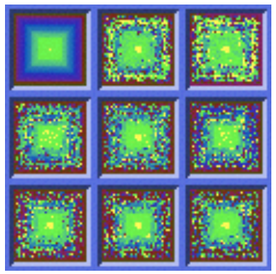
- partition into many small regions: dimensions grouped together



[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994]

VisDB Results

- partition into small number of views
  - inspect each attribute



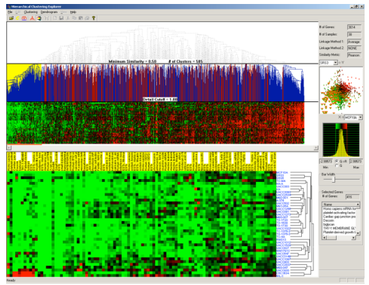
[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994]

VisDB Analysis

System	VisDB
What: Data	Table (database) with k attributes; query returning table subset (database query).
What: Derived	$k+1$ quantitative attributes per original item: query relevance for the k original attributes plus overall relevance.
Why: Tasks	Characterize distribution within attribute, find groups of similar values within attribute, find outliers within attribute, find correlation between attributes, find similar items.
How: Encode	Dense, space-filling; area marks in spiral layout; colormap: categorical hues and ordered luminance.
How: Facet	Layout 1: partition by attribute into per-attribute views, small multiples. Layout 2: partition by items into per-item glyphs.
How: Reduce	Filtering
Scale	Attributes: one dozen. Total items: several million. Visible items (using multiple views, in total): one million. Visible items (using glyphs): 100,000

Hierarchical Clustering Explorer

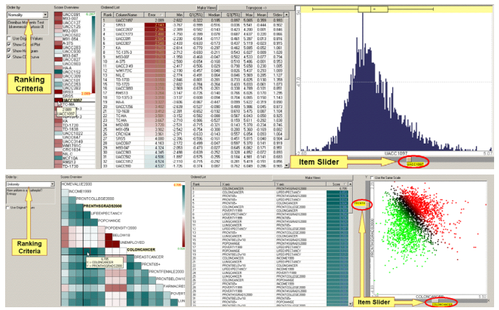
- heatmap, dendrogram
- multiple views



[Interactively Exploring Hierarchical Clustering Results. Seo and Shneiderman, IEEE Computer 35(7): 80-86 (2002)]

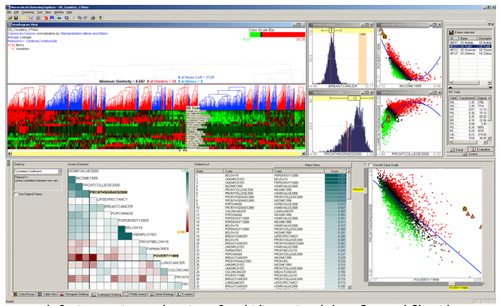
HCE

- rank by feature idiom
  - 1D list
  - 2D matrix



A rank-by-feature framework for interactive exploration of multidimensional data. Seo and Shneiderman. Information Visualization 4(2): 96-113 (2005)

HCE

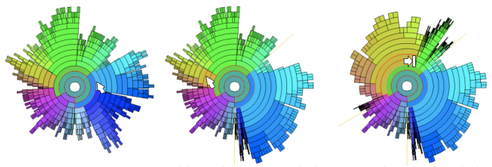


A rank-by-feature framework for interactive exploration of multidimensional data. Seo and Shneiderman. Information Visualization 4(2): 96-113 (2005)

HCE Analysis

System	Hierarchical Clustering Explorer (HCE)
What: Data	Multidimensional table: two categorical key attributes (genes, conditions); one quantitative value attribute (gene activity level in condition).
What: Derived	Hierarchical clustering of table rows and columns (for cluster heatmap); quantitative derived attributes for each attribute and pairwise attribute combination; quantitative derived attribute for each ranking criterion and original attribute combination.
Why: Tasks	Find correlation between attributes; find clusters, gaps, outliers, trends within items.
How: Encode	Cluster heatmap, scatterplots, histograms, boxplots. Rank-by-feature overviews: continuous diverging colormaps on area marks in reorderable 2D matrix or 1D list alignment.
How: Reduce	Dynamic filtering; dynamic aggregation.
How: Manipulate	Navigate with pan/scroll.
How: Facet	Multiform with linked highlighting and shared spatial position; overview–detail with selection in overview populating detail view.
Scale	Genes (key attribute): 20,000. Conditions (key attribute): 80. Gene activity in condition (quantitative value attribute): 20,000 × 80 = 1,600,000.

InterRing



original hierarchy | blue subtree expanded | tan subtree expanded

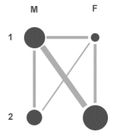
[InterRing: An Interactive Tool for Visually Navigating and Manipulating Hierarchical Structures. Yang, Ward, Rundensteiner. Proc. InfoVis 2002, p 77-84.]

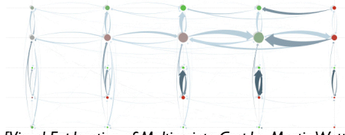
InterRing Analysis

System	InterRing
What: Data	Tree.
Why: Tasks	Selection, rollup/drilldown, hierarchy editing.
How: Encode	Radial, space-filling layout. Color by tree structure.
How: Facet	Linked coloring and highlighting.
How: Reduce	Embed: distort; multiple foci.
Scale	Nodes: hundreds if labeled, thousands if dense. Levels in tree: dozens.

PivotGraph

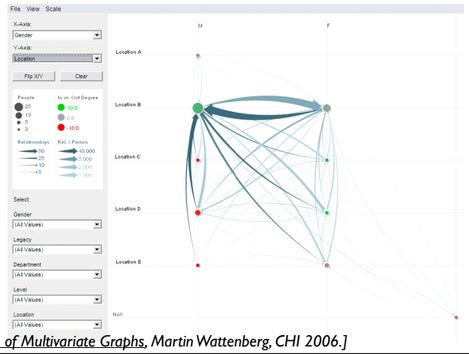
- derived rollup network





[Visual Exploration of Multivariate Graphs, Martin Wattenberg, CHI 2006.]

PivotGraph



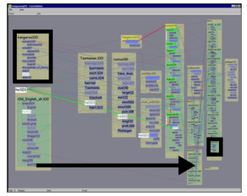
[Visual Exploration of Multivariate Graphs, Martin Wattenberg, CHI 2006.]

PivotGraph Analysis

Idiom	PivotGraph
What: Data	Network.
What: Derived	Derived network of aggregate nodes and links by roll-up into two chosen attributes.
Why: Tasks	Cross-attribute comparison of node groups.
How: Encode	Nodes linked with connection marks, size.
How: Manipulate	Change: animated transitions.
How: Reduce	Aggregation, filtering.
Scale	Nodes/links in original network: unlimited. Roll-up attributes: 2. Levels per roll-up attribute: several, up to one dozen.

Analysis example: Constellation

- data
  - multi-level network
    - node: word
    - link: words used in same dictionary definition
    - subgraph for each definition
      - not just hierarchical clustering
  - paths through network
    - query for high-weight paths between 2 nodes
      - quant attrib: plausibility

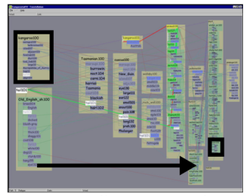


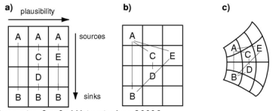
[Interactive Visualization of Large Graphs and Networks. Munzner. Ph.D. Dissertation, Stanford University, June 2000.]

[Constellation: A Visualization Tool For Linguistic Queries from MindNet. Munzner, Guimbretière and Robertson. Proc. IEEE Symp. InfoVis 1999, p. 132-135.]

Using space: Constellation

- visual encoding
  - link connection marks between words
  - link containment marks to indicate subgraphs
  - encode plausibility with horiz spatial position
  - encode source/sink for query with vert spatial position
- spatial layout
  - curvilinear grid: more room for longer low-plausibility paths



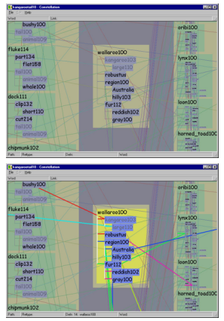


[Interactive Visualization of Large Graphs and Networks. Munzner. Ph.D. Dissertation, Stanford University, June 2000.]

Using space: Constellation

- edge crossings
  - cannot easily minimize instances, since position constrained by spatial encoding
  - instead: minimize perceptual impact
- views: superimposed layers
  - dynamic foreground/background layers on mouseover, using color
  - four kinds of constellations
    - definition, path, link type, word
      - not just 1-hop neighbors

https://youtu.be/7sJC3QVpSkQ



[Interactive Visualization of Large Graphs and Networks. Munzner. Ph.D. Dissertation, Stanford University, June 2000.]

Constellation Analysis

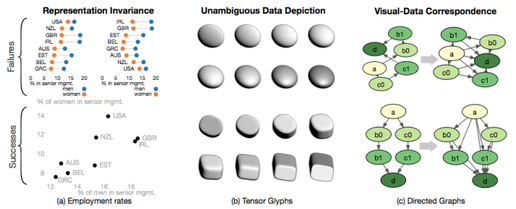
System	Constellation
What: Data	Three-level network of paths, subgraphs (definitions), and nodes (word senses).
Why: Tasks	Discover/verify: browse and locate types of paths, identify and compare.
How: Encode	Containment and connection link marks, horizontal spatial position for plausibility attribute, vertical spatial position for order within path, color links by type.
How: Manipulate	Navigate: semantic zooming. Change: Animated transitions.
How: Reduce	Superimpose dynamic layers.
Scale	Paths: 10–50. Subgraphs: 1–30 per path. Nodes: several thousand.

What-Why-How Analysis

- this approach is not the only way to analyze visualizations!
  - one specific framework intended to help you think
  - other frameworks support different ways of thinking
    - following: one interesting example

Algebraic Process for Visualization Design

- which mathematical structures in data are preserved and reflected in vis
  - negation, permutation, symmetry, invariance



[Fig 1. An Algebraic Process for Visualization Design. Carlos Scheidegger and Gordon Kindlmann. IEEE TVCG (Proc. InfoVis 2014), 20(12):2181-2190.]

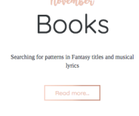
Algebraic process: Vocabulary

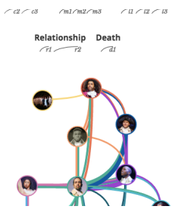
- **invariance** violation: single dataset, many visualizations
  - hallucinator
- **unambiguity** violation: many datasets, same vis
  - data change invisible to viewer
    - confuser
- **correspondence** violation:
  - can't see change of data in vis
    - jumbler
  - salient change in vis not due to significant change in data
    - misleader
  - match mathematical structure in data with visual perception
- we can X the data; can we Y the image?
  - are important data changes well-matched with obvious visual changes?

Visual Design Process In Depth: **Dear Data**

http://www.dear-data.com/by-week/

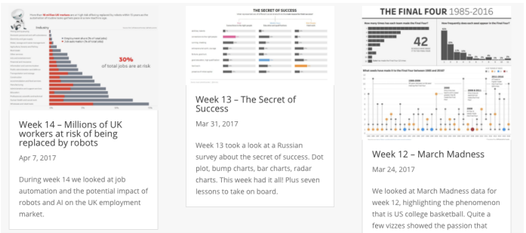
Visual Design Process In Depth: **Data Sketches**





http://www.datasketch.es/

Redesign En Masse: **Makeover Mondays**



http://www.makeovermonday.co.uk/blog/