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

• About Face: The Essentials of Interaction Design

• Task-Centered User Interface Design. Lewis & Rieman, 1994
  – http://hcibib.org/tcuid/

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

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

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

VisDB Results

• partition into many small regions: dimensions grouped together

VisDB Results

• partition into small number of views
  – inspect each attribute

# VisDB Analysis

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

- heatmap, dendrogram
- multiple views

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

<table>
<thead>
<tr>
<th>System</th>
<th>Hierarchical Clustering Explorer (HCE)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What: Data</strong></td>
<td>Multidimensional table: two categorical key attributes (genes, conditions); one quantitative value attribute (gene activity level in condition).</td>
</tr>
<tr>
<td><strong>What: Derived</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Why: Tasks</strong></td>
<td>Find correlation between attributes; find clusters, gaps, outliers, trends within items.</td>
</tr>
<tr>
<td><strong>How: Encode</strong></td>
<td>Cluster heatmap, scatterplots, histograms, boxplots. Rank-by-feature overviews: continuous diverging colormaps on area marks in reorderable 2D matrix or 1D list alignment.</td>
</tr>
<tr>
<td><strong>How: Reduce</strong></td>
<td>Dynamic filtering; dynamic aggregation.</td>
</tr>
<tr>
<td><strong>How: Manipulate</strong></td>
<td>Navigate with pan/scroll.</td>
</tr>
<tr>
<td><strong>How: Facet</strong></td>
<td>Multiform with linked highlighting and shared spatial position; overview–detail with selection in overview populating detail view.</td>
</tr>
<tr>
<td><strong>Scale</strong></td>
<td>Genes (key attribute): 20,000. Conditions (key attribute): 80. Gene activity in condition (quantitative value attribute): 20,000 $\times$ 80 = 1,600,000.</td>
</tr>
</tbody>
</table>
InterRing

## InterRing Analysis

<table>
<thead>
<tr>
<th>System</th>
<th>InterRing</th>
</tr>
</thead>
<tbody>
<tr>
<td>What: Data</td>
<td>Tree.</td>
</tr>
<tr>
<td>Why: Tasks</td>
<td>Selection, rollup/drilldown, hierarchy editing.</td>
</tr>
<tr>
<td>How: Facet</td>
<td>Linked coloring and highlighting.</td>
</tr>
<tr>
<td>How: Reduce</td>
<td>Embed: distort; multiple foci.</td>
</tr>
<tr>
<td>Scale</td>
<td>Nodes: hundreds if labeled, thousands if dense. Levels in tree: dozens.</td>
</tr>
</tbody>
</table>
PivotGraph

- derived rollup network

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

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


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

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

## Constellation Analysis

<table>
<thead>
<tr>
<th>System</th>
<th>Constellation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What: Data</strong></td>
<td>Three-level network of paths, subgraphs (definitions), and nodes (word senses).</td>
</tr>
<tr>
<td><strong>Why: Tasks</strong></td>
<td>Discover/verify: browse and locate types of paths, identify and compare.</td>
</tr>
<tr>
<td><strong>How: Encode</strong></td>
<td>Containment and connection link marks, horizontal spatial position for plausibility attribute, vertical spatial position for order within path, color links by type.</td>
</tr>
<tr>
<td><strong>How: Reduce</strong></td>
<td>Superimpose dynamic layers.</td>
</tr>
</tbody>
</table>
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

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/
Week 14 – Millions of UK workers at risk of being replaced by robots

Apr 7, 2017

During week 14 we looked at job automation and the potential impact of robots and AI on the UK employment market.

Week 13 – The Secret of Success

Mar 31, 2017

Week 13 took a look at a Russian survey about the secret of success. Dot plot, bump charts, bar charts, radar charts. This week had it all! Plus seven lessons to take on board.

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