Lecture 11: Tabular Data

Information Visualization
CPSC 533C, Fall 2011

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UBC Computer Science

Mon, 17 October 2011

Required Readings

Metric-Based Network Exploration and Multiscale Scatterplot. Yves Chiricota, Fabien Jourdan, Guy Melancon. Proc. InfoVis 04, pages 135-142. Hierarchical Parallel Coordinates for Exploration of

Large Datasets Ying-Huey Fua, Matthew O. Ward, and Elke A. Rundensteiner, IEEE Visualization '99.

Parallel sets: visual analysis of categorical data. Fabien Bendix, Robert Kosara, and Helwig Hauser. Proc. InfoVis 2005, p 133-140.

Further Reading

Hyperdimensional Data Analysis Using Parallel Coordinates. Edward J. Wegman. Journal of the American Statistical Association, Vol. 85, No. 411. (Sep., 1990), pp. 664-675.

Parallel Coordinates: A Tool for Visualizing Multi-Dimensional Geometry. Alfred Inselberg and Bernard Dimsdale, IEEE Visualization '90, 1990.

Big Picture

- covered so far
  - design levels
    - problem, abstraction, encoding/interaction, algorithm
  - methods
    - taxonomy of visualization design concerns
    -
- next stage: use these ideas for analysis and design
  - analyze previously proposed techniques and systems
  - design new techniques and systems
- me: this lecture as example (and graphs/trees)
- you: project proposal, topic presentations

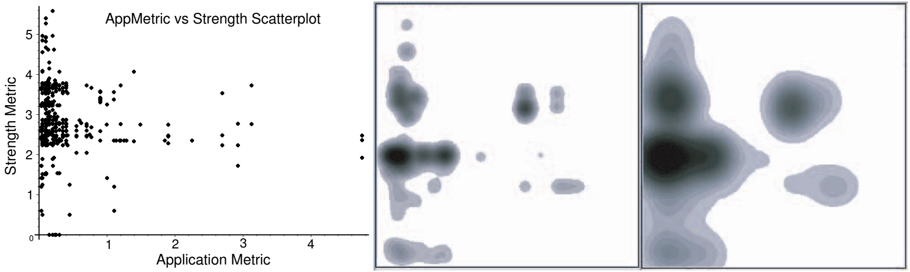
Analysis Via Levels and Methods

- examples in this and graphs/trees lecture
- note: only sometimes does this analysis occur in paper itself!
  - you need to interpret

- (also something to do in your own project!)

Multiscale Scatterplots

- blur shows structure at multiple scales
  - convolve with Gaussian
  - slider to control scale parameter interactively
- easily selectable regions in quantized image



[Figs 3,4,5. Chiricota, Jourdan, and Melancon. Metric-Based Network Exploration and Multiscale Scatterplot. Proc. InfoVis 2004, p 135-142.]

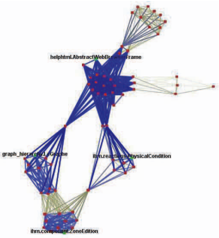
Problem and Abstraction Levels

- (problem characterization: generic network exploration)
  - minimal problem context; paper is technique-driven not problem-driven

- task abstraction: selection and filtering at different scales
  - within scatterplots

Abstract Level: Data

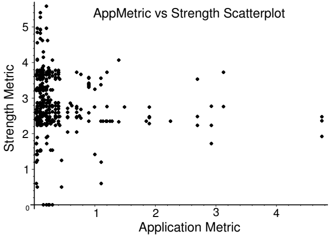
- original data: relational network
  - links between Java classes
- derived attributes: 2 structural metrics for network
  - edge strength: cluster cohesiveness
  - sw engr: logical dependencies between classes
    - edges below color-coded by metric
  - thus: table of numbers



[Fig 2. Chiricota, Jourdan, and Melancon. Metric-Based Network Exploration and Multiscale Scatterplot. Proc. InfoVis 2004, p 135-142.]

Encoding/Interaction Level

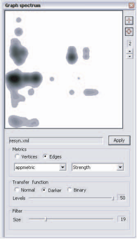
- basic solution:
  - visual encoding technique: scatterplots
    - mark: points. channels: horiz and vert position
  - interaction technique: range sliders to filter max/min
- limitations
  - interesting areas might not be easy to select as rectangular regions, esp for complex derived attributes



[Fig 3. Chiricota, Jourdan, and Melancon. Metric-Based Network Exploration and Multiscale Scatterplot. Proc. InfoVis 2004, p 135-142.]

Multiscale Scatterplot Selection Technique

- new encoding: derived space created from original scatterplot image
  - greyscale patches forming complex shapes
  - enclosure of darker patches within lighter patches
- new interaction:
  - simple: sliders for filter size s and number of levels k
  - complex: single click to select all items $>= k$



[Fig 4. Chiricota, Jourdan, and Melancon. Metric-Based Network Exploration and Multiscale Scatterplot. Proc. InfoVis 2004, p 135-142.]

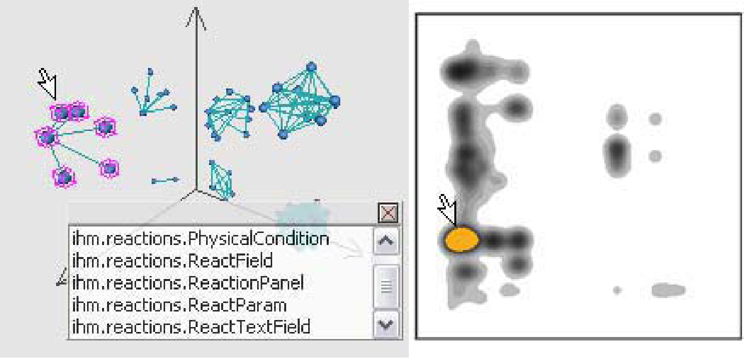
Multiscale Scatterplot Selection Technique

- algorithm level: creating derived space
  - greyscale intensity is combination of
    - blurred proximity relationships from original scatterplot image: convolve with Gaussian filter
    - point density in original scatterplot image
  - quantize image into k levels

[Fig 3. Chiricota, Jourdan, and Melancon. Metric-Based Network Exploration and Multiscale Scatterplot. Proc. InfoVis 2004, p 135-142.]

Method: Linked Views

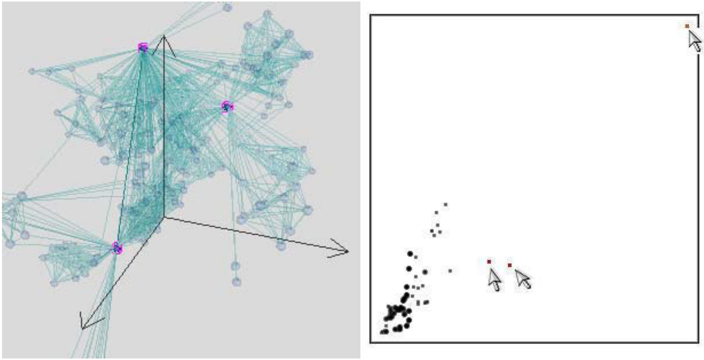
- second linked view: 3D node-link network
  - patch selection in blurred scatterplot view shows corresponding components in network view
  - selection in one view filters what is shown in the other



[Fig 6. Chiricota, Jourdan, and Melancon. Metric-Based Network Exploration and Multiscale Scatterplot. Proc. InfoVis 2004, p 135-142.]

Results: IMDB

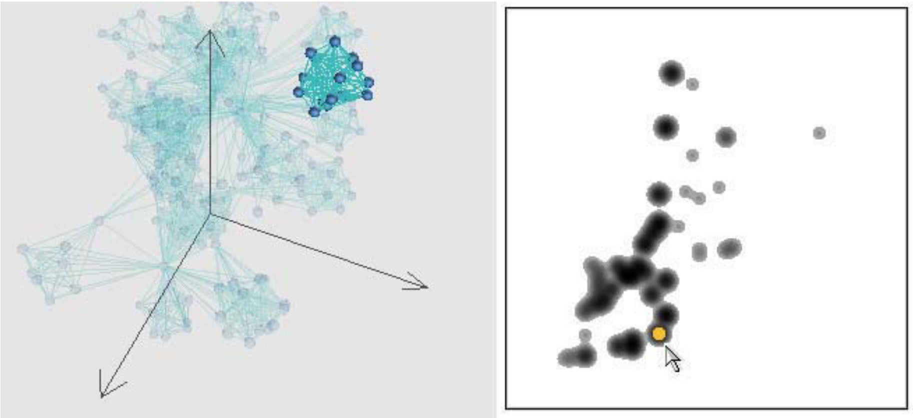
- original data: IMDB graph
- metrics: network centrality, node degree
- 3 hubs selected in network view



[Fig 7. Chiricota, Jourdan, and Melancon. Metric-Based Network Exploration and Multiscale Scatterplot. Proc. InfoVis 2004, p 135-142.]

Results: IMDB 2

- single click in blurred scatterplot view selects entire clique



[Fig 8. Chiricota, Jourdan, and Melancon. Metric-Based Network Exploration and Multiscale Scatterplot. Proc. InfoVis 2004, p 135-142.]

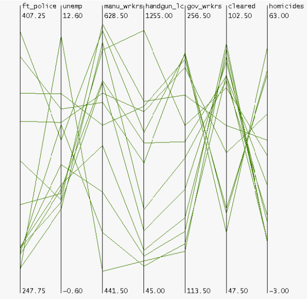
Critique

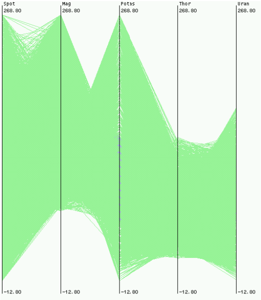
Critique

- strengths
  - successful construction and use of derived space
  - appropriate validation
    - qualitative discussion of result images to show new technique capabilities
  - synergy between encoding and interaction choices
- weaknesses
  - somewhat tricky to follow thread of argument since intro/framing focuses on network exploration, but fundamental technique contribution more about scatterplot encoding/interaction

Hierarchical Parallel Coordinates

- technique-driven paper
  - (no problem characterization)
- scale up parallel coordinates to large datasets
  - limitation: overplotting/occlusion

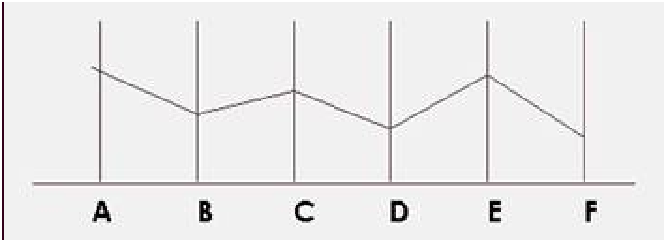




[Figs 1,2. Fua, Ward, and Rudensteiner. Hierarchical Parallel Coordinates for Visualizing Large Multivariate Data Sets. IEEE Visualization 99.]

Parallel Coordinates: Basics

- scatterplot limitation: vis enc with orthogonal axes
  - only 2 attribs with spatial position channel in plane
- instead, line up axes in parallel to show many attribs with position channel
  - item shown with line with k segments (not as point)



Par Coord Tasks: Showing Correllation

- pos corr: straight lines; neg corr: all cross at single point

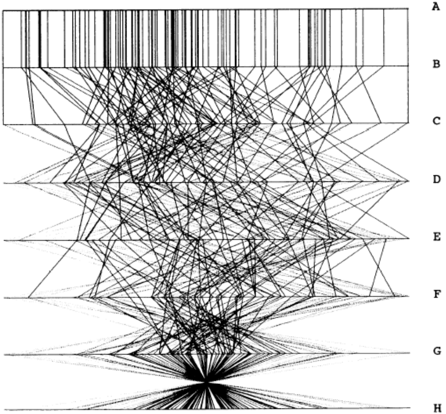
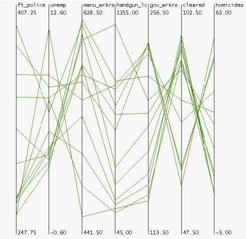


Figure 3. Parallel Coordinate Plot of Six-Dimensional Data Illustrating Correlations of ρ = 1, .8, .2, 0, −.2, −.8, and −1.

[Hyperdimensional Data Analysis Using Parallel Coordinates. Edward J. Wegman. Journal of the American Statistical Association, 85(411), Sep 1990, p 664-675.]

Par Coord Tasks: Showing Correllation

- strong neg corr between two final axis pairs



[Fig 1. Fua, Ward, and Rudensteiner. Hierarchical Parallel Coordinates for Visualizing Large Multivariate Data Sets. IEEE Visualization 99.]

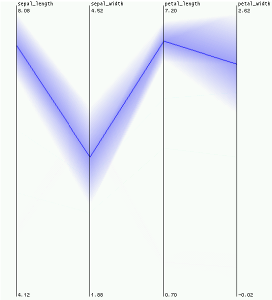
- visible patterns only between neighboring axis pairs
- how to pick axis order?
  - usual solution: reorderable axes, interactive exploration
    - same weakness as many other techniques
    - downside: human-powered search
  - not directly addressed in HPC paper either

Hier Par Coords: Abstraction

- data abstraction
  - original data: table of numbers
  - derived data:
    - hierarchical clustering of items in table
    - cluster stats: # points, mean, min, max, size, depth
    - cluster density: points/size
    - cluster proximity: linear ordering from tree traversal
- task abstraction
  - finding correlations
  - finding trends, outliers at multiple scales

HPC: Encoding Derived Data

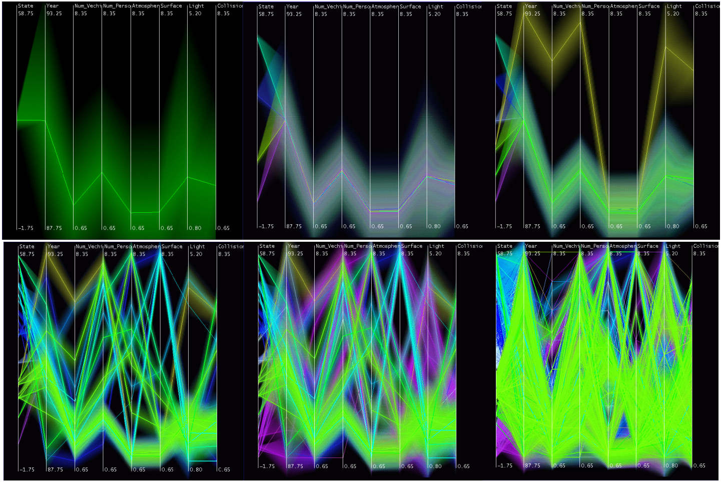
- vis enc: variable-width opacity bands
    - show whole cluster, not just single item
    - min/max: spatial position
    - cluster density: transparency at mean point
        - interpolate transparency between these



[Fig 3. Fua, Ward, and Rudensteiner. Hierarchical Parallel Coordinates for Visualizing Large Multivariate Data Sets. IEEE Visualization 99.]

HPC: Interacting With Derived Data

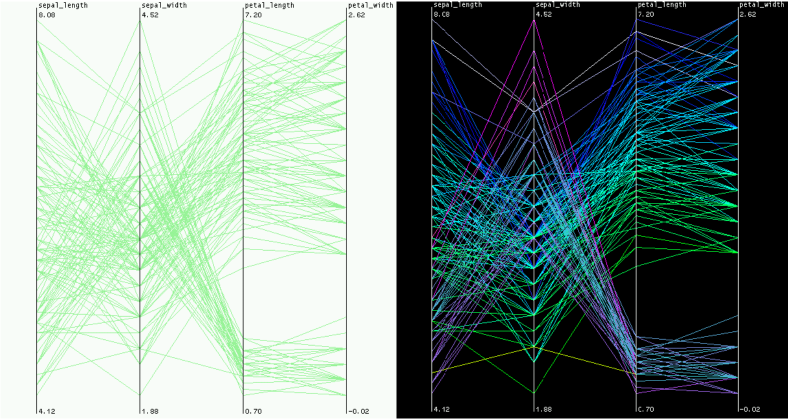
- interactively change level of detail to navigate cluster hier



[Fig 4. Fua, Ward, and Rudensteiner. Hierarchical Parallel Coordinates for Visualizing Large Multivariate Data Sets. IEEE Visualization 99.]

HPC: Encoding Derived Data

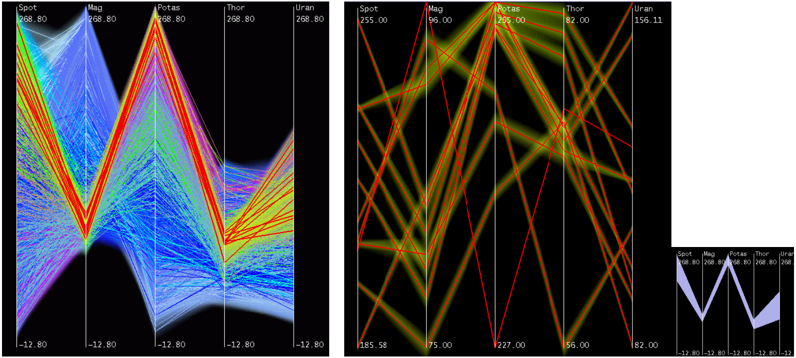
- vis enc: color based on cluster proximity derived attrib
    - resolves ambiguity from crossings, clarifies structure



[Fig 6. Fua, Ward, and Rudensteiner. Hierarchical Parallel Coordinates for Visualizing Large Multivariate Data Sets. IEEE Visualization 99.]

HPC: Magnification Interaction

- dimensional zooming: use all available space
    - method: linked view to show true extent



[Fig 8. Fua, Ward, and Rudensteiner. Hierarchical Parallel Coordinates for Visualizing Large Multivariate Data Sets. IEEE Visualization 99.]

Critique

Critique

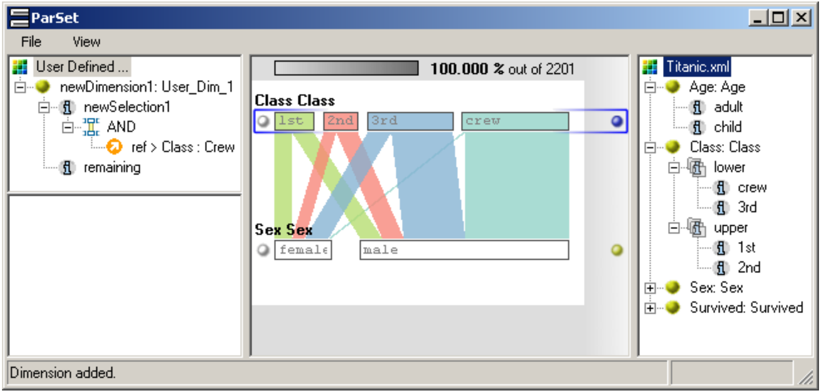
- par coords
  - strengths
    - can be useful additional view
    - (rare to use completely standalone)
    - now popular, many follow-on technique refinements
  - weaknesses
    - major learning curve, difficult for novices
- hier par coords
  - strengths
    - success with major scalability improvement
    - again, careful construction and use of derived space
    - again, appropriate validation (result image discussion)
  - weaknesses
    - interface complexity (structure-based brushing)

Parallel Sets

- technique-driven (problem char not main concern)
- data abstraction
  - table with categorical (not quant) attributes
    - discrete
    - small number of distinct values
    - ordering between attribs not given
  - cross-tabulation (multi-way frequency/contingency table)
- task abstraction
  - identify hotspots and major trends
  - find relationships between dimensions and correlations between categories
  - **not** outlier detection

Visual Encoding

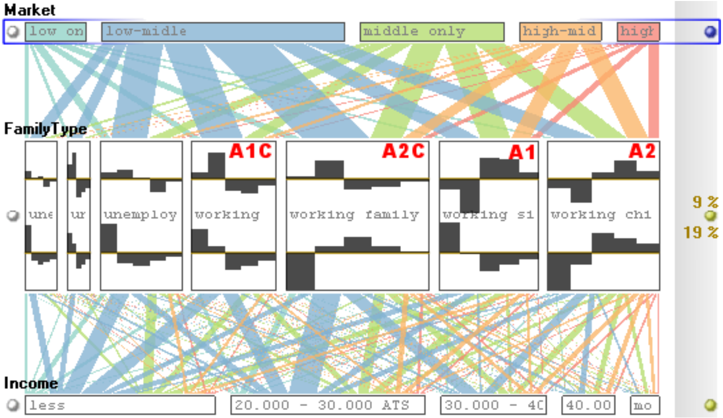
- like par coords but with boxes scaled by frequency values
- color coded by values for current active dimension



[Fig 4. Bendix, Kosara, Hauser. Parallel sets: visual analysis of categorical data. Proc. InfoVis 2005, p 133-140.]

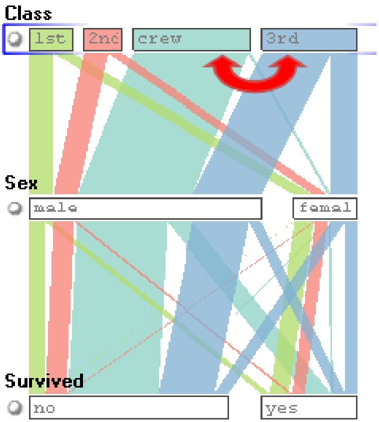
Visual Encoding

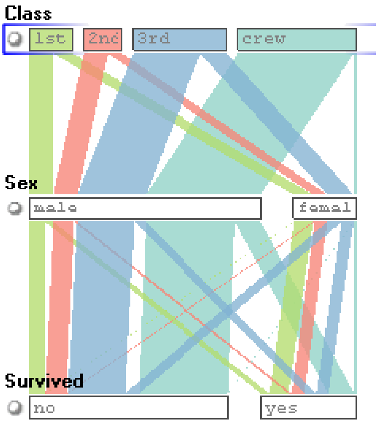
- boxes can expand to show histograms



[Fig 7. Bendix, Kosara, Hauser. Parallel sets: visual analysis of categorical data. Proc. InfoVis 2005, p 133-140.]

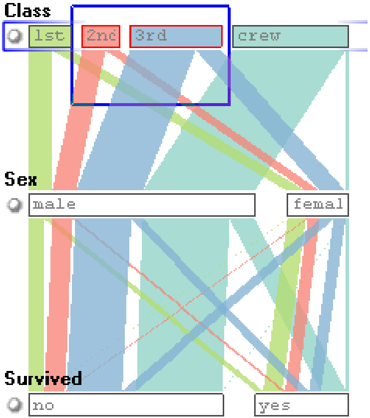
Interaction: Reordering





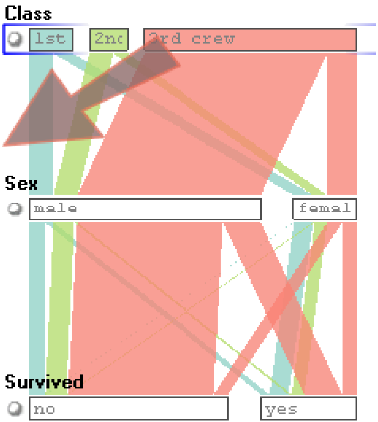
[Fig 5. Bendix, Kosara, Hauser. Parallel sets: visual analysis of categorical data. Proc. InfoVis 2005, p 133-140.]

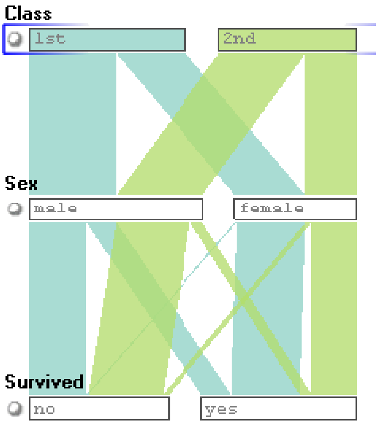
Interaction: Aggregation



[Fig 5. Bendix, Kosara, Hauser. Parallel sets: visual analysis of categorical data. Proc. InfoVis 2005, p 133-140.]

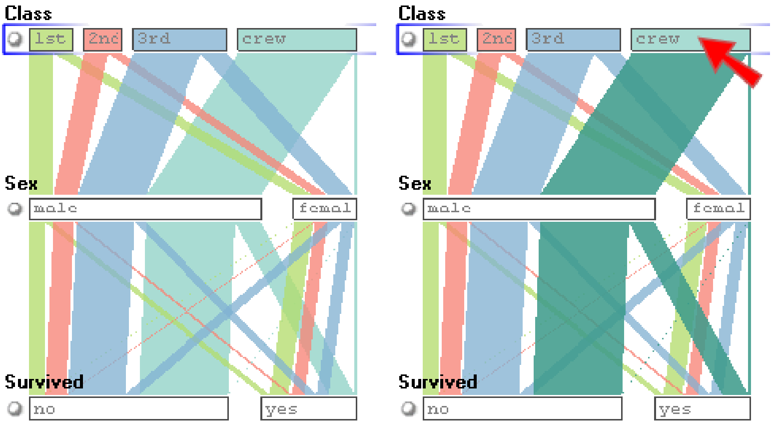
Interaction: Filtering





[Fig 5. Bendix, Kosara, Hauser. Parallel sets: visual analysis of categorical data. Proc. InfoVis 2005, p 133-140.]

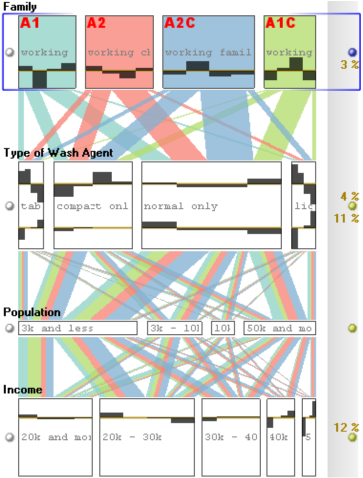
Interaction: Highlighting



[Fig 5. Bendix, Kosara, Hauser. Parallel sets: visual analysis of categorical data. Proc. InfoVis 2005, p 133-140.]

Results: Case Study

- corr between family type, city sizes, income, detergent?



[Fig 5. Bendix, Kosara, Hauser. Parallel sets: visual analysis of categorical data. Proc. InfoVis 2005, p 133-140.]

Critique

Critique

- strengths
  - handles categorical, frequencies
- weaknesses/limits
  - designed for few not many distinct values
  - designed for few not many attributes

Synthesis

- emphasis on derived spaces
  - multiscale scatterplot, hier par coord
- extending scope of data handled
  - hier par coord: handle more data
  - parallel sets: handle different data
- all three designed to show all attribs
  - in contrast to dimensionality reduction

Projects

- programming
  - problem-driven (design studies)
  - technique-driven (new technique idea)
  - implementation (of previously proposed technique)
- analysis
- survey

- team of two people requires scope*2
- new this year: submit source code along with final report

- pre-proposal meetings: deadline in two days
  - many already done (I signed off)
  - still a few to do (deadline in two days)

Project Proposals I

http://www.cs.ubc.ca/ tmm/courses/533-11/projectdesc.html

- title (mandatory)
- names/email for people on team
- description of problem you're targeting
  - prob-driv: domain, task, dataset
  - tech-driv: explain in terms of method taxonomy
- personal experience with this problem
- description of proposed solution
  - prob-driv:
    - **data and task abstraction**
    - encoding and interaction techniques
    - if refining/improving previous solution, also analyze that in same terms
  - tech-driv:
    - encoding and/or interaction techniques, in detail

Project Proposals II

- scenario of use
  - what user will do/see step by step in performing a task while using system
  - must include illustrations
- proposed implementation approach
  - high-level: platforms/language, toolkits if any
  - big picture of what you code vs what toolkit supports
  - ok to have set of alternatives if not narrowed down yet
- schedule: milestones with target dates
  - be specific not just generic (plan/code/writeup)
  - think agile: get basics working early, then augment
- previous work
  - not as complete as final, but you should have a start

- one per project due Oct 28 5pm as PDF by email
  - subject header: 533 submit proposal

Topic Presentations: Signing Up

- topic list

www.cs.ubc.ca/ tmm/courses/533-11/presentations.html

- choice can indeed be motivated by your project topic
- sign up by email by Fri 10/21 5pm
  - required: three topic choices
  - optional: one veto day that you do **not** want
    - Wed 11/9, Wed 11/23, Mon 11/28, Wed 11/30
- I will post final topic/date assignments by Mon 10/31
  - might have two people split one topic if it's popular
- I will post list of papers on topic 10 days in advance
  - you pick 3 papers total, at least 1 must be from my list

Presentations

- you present 3 papers in 25 minutes
  - aim for 20 minutes presentation, 5 minutes questions
- grading criteria
  - content summary: 50%
    - you explain papers to people who have not read them
    - **you analyze the work w.r.t design levels and methods**
  - synthesis/critique: 20%
    - for both individual papers, and across all three
  - presentation style: 15%
  - materials preparation: 15%
    - slides required
- logistics
  - you may use my laptop or yours
  - if my laptop slides due 11am (PDF or PPT)
  - if my laptop, check in advance for videos/demos

Presentations: Process Advice

- bad idea: make slides; give talk in class

Presentations: Process Advice

- bad idea: make slides; give talk in class

- good idea: start early and refine iteratively
  - make slides
  - practice talk out loud with timer
    - **realize it's too long**
    - realize it's too short
    - realize what you forgot to put on slide
    - realize why order of explanation is backwards
    - realize where you need more pictures/diagrams
    - realize where you haven't figured out what to say
  - refine slides
  - loop back up to practice; repeat until great!

Presentations: Process Advice 2

- tips on practicing
  - always time it (whole thing; ideal slide by slide)
  - best: give talk to somebody and get feedback
  - at least once practice standing like giving real talk
- tips on slides
  - ensure smallest text readable from back of room
  - use color correctly (sufficient luminance contrast)
  - early drafts often text-oriented; add pictures as refine
- tips on speaking
  - talk loud enough that we can hear
  - vary your tone of voice
  - it gets better; practice makes it less scary
- lots more useful tips
  - www.cs.ubc.ca/~tmm/courses/533-11/presentations.html#preparation

Reading For Next Time: NOTE CHANGE

Prefuse: A Toolkit for Interactive Information Visualization. Jeffrey Heer, Stuart K. Card, James Landay. Proc ACM CHI, 421-430, 2005.

Protovis: A Graphical Toolkit for Visualization. Michael Bostock and Jeffrey Heer. IEEE Trans. Visualization & Computer Graphics (Proc. InfoVis), 2009.

D3: Data-Driven Documents. Michael Bostock, Vadim Ogievetsky, Jeffrey Heer. IEEE Trans. Visualization & Computer Graphics (Proc. InfoVis), 2011.

Reminders

- Project meetings due 10/19
  - this Wednesday
- No class next week (Oct 24/26)