Data Visualization (CSCI 627/490)

Interaction & Multiple Views

Dr. David Koop





What is wrong with here and how can it be fixed?

3D Category Scatter



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Good: Data magnitude <=> Mark magnitude











Show when the baseline is not zero









Tufte's Lie Factor

- Size of effect = (2nd value 1st value) / (1st value)
- Lie factor = (size of effect in graphic) / (size of effect in data)
- In the graphic:

Lie Factor =





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5.3 - 0.6 0.6 14.8 27.5 - 18









Avoid Chartjunk



No Unjustified 3D

- Occlusion hides information
- Perspective distortion dangers
- Tilted text isn't legible
- Can help with shape perception

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Validation at each level

- Ineffective encoding/interaction idiom
- Validate Test on target users, collect anecdotal evidence of utility Validate Field study, document human usage of deployed system

Five Design Sheet Method

Sheets 2-4

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[J. Roberts et al., 2016]

Project Design

- Work on turning your visualization ideas into designs
- Turn in:
 - Three Designs Sketches
 - One Bad Design
 - Progress on Implementation
- Options:
 - Try vastly different options
 - Refine an initial idea
- Due Friday, Nov. 13

Assignment 4

- Geospatial Visualizations & Treemap
 - Choose colormaps carefully
 - Add legend
- Due Nov. 2

Guidelines for Interaction Design

Interaction

- The view changes over time
- Changes can affect almost any aspect of the visualization
 - encoding
 - arrangement
 - ordering
 - viewpoint
 - attributes being shown
 - aggregation level

Interaction Overview

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[Munzner (ill. Maguire), 2014]

Sorting

- Allow user to find patterns by reordering the data
- Do this with tabular data all the time
- Note that categorical attributes don't really need sorting
 - We can compare these attributes no matter what order
 - Instead, sort categorical attribute based on an ordered attribute

Example: LineUp

		s	JM (Academic reputation, Employer	reputation, Faculty/student ratio, Inter	natio
2a	School Name	Country	45.23%	11.31% 32.16% Employer Faculty/student	ratio
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3.	Yale University	United States			
4.	University of Chicago	United States			
5.	University of Pennsylvania	United States			
6.	Columbia University	United States			
7.	California Institute of Technology (Caltech)	United States			
8.	Princeton University	United States			
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17.	University of California, Berkeley (UCB)	United States			
18.	University of California, Los Angeles (UCLA)	United States			
19.	Brown University	United States			
20.	University of North Carolina, Chapel Hill	United States			
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22.	University of Illinois at Urbana-Champaign	United States			
23.	Washington University in St. Louis	United States			
4.	University of Texas at Austin	United States			
25.	University of Washington	United States			
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27.	University of Pittsburgh	United States			
28.	University of California, San Diego (UCSD)	United States			
29.	Ohio State University	United States			
30.	University of Rochester	United States			
31.	Pennsylvania State University	United States			
32.	University of Maryland, College Park	United States			
33.	University of Southern California	United States			
34.	Vanderbilt University	United States			
35.	Dartmouth College	United States			
36.	University of Virginia	United States			
7.	Georgia Institute of Technology	United States			
38.	University of California, Davis	United States			
39.	Rice University	United States			
10	Emory University	United States			

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Slope Graphs

- Connection marks
- Link the same item appearing in different rows
- highlighted item
- Also called bump charts

Show changes for different attributes (parallel coordinates idea) but with one

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Side-by-side views

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Side-by-side views

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Animated Transitions

Animated Transitions

Animated Transitions

- "Jump cuts" are hard to follow
- Animations help users maintain sense of context between two states
- Empirical study showed that they work (Heer & Robertson, 2007)

Studying Animated Transitions

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Studying Animated Transitions

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Design Considerations

- Based on Tversky et al.'s Congruence and Apprehension Principles
- Congruence (Expressiveness):
 - Use consistent semantic-syntactic mappings
 - Respect semantic correspondence
 - Avoid ambiguity

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- Apprehension (Effectiveness):
 - Group similar transitions
 - Minimize occlusion
 - Maximize predictability
 - Use simple transitions
 - Use staging for complex transitions
 - Transitions as long as needed, but no longer

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Experiment 1 (Syntactic)

- of the objects in the final graphic
 - chart, scatter plot to bar chart, timestep in a scatterplot
- Tests: bar chart to donut chart, stacked to grouped bars, sorting a bar - Either a jump cut or an animated transition
- Users pick highlighted elements after transition (measure #pixels from correct)

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Object Tracking: Follow objects across a transition and identify the locations

Experiment 2 (Semantic)

- estimate the percentage change in value
 - Tesster a sresc ling + timester anim tions
- to 90% or click "?" for no idea)

Results/Conclusions Stacked Bars

• User Preferences: Staged animation > animation > static transitions

- Animation improves graphical perception
- Staging is better (do axis rescaling before value changes)
- Avoid axis rescaling when possible

Change Blindness

• <u>https://www.youtube.com/watch?v=uO8wpm9HSB0</u>

Change Blindness

• <u>https://www.youtube.com/watch?v=uO8wpm9HSB0</u>

Selection

- Selection is often used to initiate other changes
- User needs to select something to drive the next change
- What can be a selection target?
 - Items, links, attributes, (views)
- How?
 - mouse click, mouse hover, touch
 - keyboard modifiers, right/left mouse click, force
- Selection modes:
 - Single, multiple
 - Contiguous?

Highlighting

- Selection is the user action
- Feedback is important!
- How? Change selected item's visual encoding
 - Change color: want to achieve visual popout
 - Add outline mark: allows original color to be preserved

_ _ _ _ _

- Change size (line width)
- Add motion: marching ants

(II)	Contacts
- 6	Dashboard
Aa	Dictionary
- 😵	Dropbox
8	DVD Player
3	Emacs
-0	FaceTime
Æ	FileZilla
8	Firefox

Highlighting

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Highlighting

Selection Outcomes

- Selection is usually a part of an action sequence
- Can filter, aggregate, reorder selected items

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on sequence ed items

Responsiveness Required

- Delays are perceived by users
- Visual feedback
 - Show the user they did something (highlighting, etc)
 - Interaction should happen quick!
- Latency: mouse click versus mouse hover
- Popup versus detail displays

Interaction Latency

- The Effects of Interactive Latency on Exploratory Visual Analysis, Z. Liu and J. Heer, 2014
- Brush & link, select, pan, zoom

- 500ms added latency causes significant cost - decreases user activity and dataset coverage - reduces rate of observations, generalizations, and hypotheses

Interaction Overview

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[Munzner (ill. Maguire), 2014]

Navigation

- change
- Camera analogy: only certain features visible in a frame
 - Zooming
 - Panning (aka scrolling)
 - Translating
 - Rotating (rare in 2D, important in 3D)

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• Fix the layout of all visual elements but provide methods for the viewpoint to

Navigation

→ Item Reduction

→ Pan/Translate

→ Constrained

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→ Attribute Reduction

→ Project

[Munzner (ill. Maguire), 2014]

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Zooming

Geometric Zooming

Zooming

Semantic Zooming

Zooming

- Geometric Zooming: just like a camera
- scales Manua
- LiveRAC Example: (focus + context)

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• Semantic Zooming: visual appearance of objects can change at different

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Navigation Constraints

- environment

 - Fairly standard in computer games to go where you want - Constrained by walls, objects (collision detection)
- Constrained navigation:
 - 3D: camera must be right-side up
 - Limit pan/zoom to certain areas
 - corresponds to a selection in another view

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• Unconstrained navigation: walking around in the world or an immersive 3D

- Comes up often with multiple views: want to show an area in one view that

van Wijk Smooth Zooming

van Wijk Smooth Zooming

Multiple Views

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	Newaygo MI Oakland MI	0.248	47874 12.80	02.75	Belleville Birch Run	MI Wayne County 3997 MI Saginaw County 1653
	Oceana MI	0.157	26873 14.00	02.66	Centre Hall Chesaning	PA Centre County 1079 MI Saginaw County 2548
	Ogemaw MI Ontonagon MI	0.168	7818 21.60	02.49 01.57	Dearborn	MI Wayne County 97775
	Osceola MI Osceola MI	0.167	23197 14.20 9418 20.20	02.53	Detroit	MI Wayne County 951270
	Otsego MI	0.155	23301 13.70	02.59	Ecorse Flat Rock	MI Wayne County 11229 MI Wayne County 8488
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$+ \Box \downarrow \uparrow \downarrow$	Sanilac MI	0.146	44547 15.40	02.61	Grosse Pointe Park Grosse Pointe Shores	MI Wayne County 12443
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Multiple Views

- Why have just one visualization?
- Sometimes data is best examined in more than one view
 - Clutter/visual overload
 - Different attributes (cannot show all attributes in one view)
 - Different scales (task requires overview or detail)
 - Different encodings (no single encoding is optimal for all tasks)
- Eyes Beat Memory (Ch. 6)
 - Aiding working memory:
 side-by-side/layers > animated > jump cuts
 - Showing all visual elements at once \rightarrow don't need to remember

Multiple Views

- Big questions:
 - How to partition display or layer views?
 - How to coordinate views (e.g. navigation, selection)?
 - What data is shared?

ews? rigation, selection)?

Design Space of Composite Visualization

- Composite visualization views (CVVs)
 - Includes Coordinated multiple views (CMV)
 - + More!
- Design Patterns:
 - Juxtaposition: side-by-side
 - Superimposition: layers
 - Overloading: vis meshed with another
 - Nesting: vis inside a vis (recursive vis)
 - Integration: "merge" views + links

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Juxtaposition

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Juxtaposition

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Juxtaposition Guidelines

- Benefits:
 - without interference
 - Easy to implement
- Drawbacks:
 - objects are selected
- combined.

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- The component visualizations are independent and can be composed

- Implicit visual linking is not always easy to see, particularly when multiple

- Space is divided between the views, yielding less space for each view

• Applications: Use for heterogeneous datasets consisting of many different types of data, or for where different independent visualizations need to be

[W. Javed and N. Elmqvist, 2012]

Integration

Integration

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[VisLink, Collins and Carpendale, 2007]

Superimposition

is composed of:

Ireland

Portugal

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Overloading

Nesting

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D. Koop, CSCI 627/490, Fall 2020

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