# Week 4:

# Manipulate, Facet, Reduce

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JRNL 520H, Special Topics in Contemporary Journalism: Data Visualization Week 4: 4 October 2016

http://www.cs.ubc.ca/~tmm/courses/journ16

### Whereabouts

- Caitlin on travel this week and next week - don't expect email answers until she returns; email Tamara instead!
- Tamara on travel Thu Oct 6 Mon Oct 10 -in Portland Fri/Sat to give another keynote, will still be answering email -short office hours in Sing Tao next week: 12:30-1:30pm

#### News

- Assign 2 marks not out yet
  - -stay tuned, just got back from Stanford late last night
- Today's format
  - -interleave foundations & demos
    - Tamara will walk through Tableau demos
    - you follow along step by step on your own laptop
    - Tamara will take breaks to rove the room to help out folks who get stuck

# Last Time

### Demo I: Stone Color Workbook

Credit: Maureen Stone, Tableau Research

-designer of Tableau color defaults, author of A Field Guide to Digital Color

- -workbook from Tableau Customer Conference 2014 talk Seriously Colorful: Advanced Color Principles & Practices
- Tableau Lessons
  - -more visual encoding practice
  - -color palettes, univariate & bivariate
  - -discrete (categorical) vs continuous (quantitative)
- Big Ideas
  - Tableau has many built-in features to get color right, but care still needed

### Demo 2: Intro to Maps

- Tableau Lessons
  - -handling spatial data
  - -multiple data sources
  - -paths on maps
  - -more on handling missing data: filtering

• Big Ideas

-integrating visual encoding design choices with given spatial data

#### How?





# How to handle complexity: I previous strategy + 3 more



### Manipulate



#### → Attribute Reduction



→ Cut



→ Project



### Change over time

- change any of the other choices

   encoding itself
  - -parameters
  - -arrange: rearrange, reorder
  - -aggregation level, what is filtered...
  - -interaction entails change

#### Idiom: Re-encode

# System: Tableau









made using Tableau, <u>http://tableausoftware.com</u>

### Idiom: Reorder

- data: tables with many attributes
- task: compare rankings



[LineUp:Visual Analysis of Multi-Attribute Rankings. Gratzl, Lex, Gehlenborg, Pfister, and Streit. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2013) 19:12 (2013), 2277–2286.]

### System: LineUp

# Idiom: Realign

- stacked bars
  - -easy to compare
    - first segment
    - total bar
- align to different segment -supports flexible comparison





![](_page_12_Figure_8.jpeg)

[LineUp:Visual Analysis of Multi-Attribute Rankings.Gratzl, Lex, Gehlenborg, Pfister, and Streit. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2013) 19:12 (2013), 2277–2286.]

## System: LineUp

### Idiom: Animated transitions

smooth transition from one state to another

-alternative to jump cuts

- -support for item tracking when amount of change is limited
- example: multilevel matrix views
- example: animated transitions in statistical data graphics
  - <u>https://vimeo.com/19278444</u>

![](_page_13_Figure_7.jpeg)

[Using Multilevel Call Matrices in Large Software Projects. van Ham. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 227–232, 2003.]

## Select and highlight

- selection: basic operation for most interaction
- design choices
  - -how many selection types?
    - click vs hover: heavyweight, lightweight
    - primary vs secondary: semantics (eg source/target)
- highlight: change visual encoding for selection targets -color
  - limitation: existing color coding hidden
  - -other channels (eg motion)
  - -add explicit connection marks between items

![](_page_14_Figure_10.jpeg)

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### Navigate: Changing item visibility

- change viewpoint
  - -changes which items are visible within view
  - -camera metaphor
    - zoom
      - geometric zoom: familiar semantics
      - semantic zoom: adapt object representation based on available pixels
        - » dramatic change, or more subtle one
    - pan/translate
    - rotate
      - -especially in 3D
  - -constrained navigation
    - often with animated transitions
    - often based on selection set

#### Navigate

 $(\rightarrow)$ 

#### → Item Reduction

![](_page_15_Figure_16.jpeg)

# Idiom: Semantic zooming

- visual encoding change
  - -colored box
  - -sparkline
  - -simple line chart
  - -full chart: axes and tickmarks

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[LiveRAC - Interactive Visual Exploration of System Management Time-Series Data. McLachlan, Munzner, Koutsofios, and North. Proc. ACM Conf. Human Factors in Computing Systems (CHI), pp. 1483–1492, 2008.]

### System: LiveRAC

![](_page_16_Figure_9.jpeg)

# Navigate: Reducing attributes

- continuation of camera metaphor
  - -slice
    - show only items matching specific value for given attribute: slicing plane
    - axis aligned, or arbitrary alignment
  - -cut
    - show only items on far slide of plane from camera

![](_page_17_Picture_7.jpeg)

- change mathematics of image creation
  - orthographic
  - perspective
  - many others: Mercator, cabinet, ...

[Interactive Visualization of Multimodal Volume Data for Neurosurgical Tumor Treatment. Rieder, Ritter, Raspe, and Peitgen. Computer Graphics Forum (Proc. EuroVis 2008) 27:3 (2008), 1055–1062.]

![](_page_17_Picture_13.jpeg)

![](_page_17_Picture_14.jpeg)

#### → Attribute Reduction

![](_page_17_Figure_16.jpeg)

## Previous Demos

#### Tableau Lessons

- -changing visual encoding
- -changing ordering (sorting)
- -navigation
  - zoom/translate in maps

#### How?

![](_page_19_Figure_1.jpeg)

![](_page_19_Figure_2.jpeg)

#### Facet

![](_page_20_Picture_1.jpeg)

![](_page_20_Picture_2.jpeg)

#### Partition

![](_page_20_Picture_4.jpeg)

![](_page_20_Picture_5.jpeg)

![](_page_20_Figure_6.jpeg)

### Juxtapose and coordinate views

- → Share Encoding: Same/Different
  - → Linked Highlighting

![](_page_21_Figure_3.jpeg)

→ Share Data: All/Subset/None

![](_page_21_Picture_5.jpeg)

→ Share Navigation

![](_page_21_Picture_7.jpeg)

# Idiom: Linked highlighting

- see how regions contiguous in one view are distributed within another
  - -powerful and pervasive interaction idiom
- encoding: different -multiform
- data: all shared

![](_page_22_Figure_5.jpeg)

[Visual Exploration of Large Structured Datasets.Wills. Proc. New Techniques and Trends in Statistics (NTTS), pp. 237–246. IOS Press, 1995.]

#### System: **EDV**

### Demo I: Seattle Construction

- Credit: Ben Jones
- Tableau Lessons
  - -linking views with actions: highlight on hover
  - -global filtering
- Big Ideas

-linking views possible but somewhat clunky in Tableau

# Idiom: bird's-eye maps

- encoding: same
- data: subset shared
- navigation: shared -bidirectional linking
- differences
  - -viewpoint
  - -(size)
- overview-detail

![](_page_24_Figure_8.jpeg)

[A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41:1 (2008), 1-31.]

# System: Google Maps

# Idiom: Small multiples

- encoding: same
- data: none shared
  - -different attributes for node colors
  - -(same network layout)
- navigation: shared

![](_page_25_Figure_6.jpeg)

[Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14:6 (2008), 1253–1260.]

#### System: Cerebral

### Coordinate views: Design choice interaction

![](_page_26_Figure_1.jpeg)

- why juxtapose views?
  - -benefits: eyes vs memory
    - lower cognitive load to move eyes between 2 views than remembering previous state with single changing view
  - -costs: display area, 2 views side by side each have only half the area of one view

## Why not animation?

- disparate frames and regions: comparison difficult
  - -vs contiguous frames
  - -vs small region
  - -vs coherent motion of group
- safe special case

   animated transitions

![](_page_27_Figure_6.jpeg)

# System: Improvise

- investigate power of multiple views
  - -pushing limits on view count, interaction complexity
  - -how many is ok?
    - open research question
  - -reorderable lists
    - easy lookup
    - useful when linked to other encodings

![](_page_28_Figure_8.jpeg)

[Building Highly-Coordinated Visualizations In Improvise. Weaver. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 159–166, 2004.]

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### Partition into views

- how to divide data between views 
   Partition into Side-by-Side Views
  - -split into regions by attributes
  - -encodes association between items using spatial proximity
  - -order of splits has major implications for what patterns are visible
- no strict dividing line
  - -view: big/detailed
    - contiguous region in which visually encoded data is shown on the display
  - -glyph: small/iconic
    - object with internal structure that arises from multiple marks

![](_page_29_Figure_10.jpeg)

![](_page_29_Figure_11.jpeg)

![](_page_29_Picture_13.jpeg)

# Partitioning: List alignment

- single bar chart with grouped bars
  - -split by state into regions
    - complex glyph within each region showing all ages
  - -compare: easy within state, hard across ages

![](_page_30_Figure_5.jpeg)

- - -split by age into regions
    - one chart per region
  - -compare: easy within age, harder across states

![](_page_30_Figure_10.jpeg)

![](_page_30_Figure_11.jpeg)

#### • small-multiple bar charts

	_	_		
K	NY	FL	IL	PA

- split by neighborhood
- then by type
- then time
  - -years as rows
  - -months as columns
- color by price
- neighborhood patterns -where it's expensive -where you pay much more for detached type

[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

![](_page_31_Figure_9.jpeg)

- switch order of splits -type then neighborhood
- switch color
  - -by price variation
- type patterns
  - -within specific type, which neighborhoods inconsistent

![](_page_32_Figure_6.jpeg)

[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

 different encoding for second-level regions -choropleth maps

![](_page_33_Figure_2.jpeg)

[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

- size regions by sale counts -not uniformly
- result: treemap

![](_page_34_Figure_3.jpeg)

[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

## **Previous Demos**

- Tableau Lessons
  - -partitioning: drag multiple pills into Row or Column
  - -disaggregation: drag field into Detail/Color
    - aggregation is automatic and aggressive in Tableau

# Superimpose layers

- *layer*: set of objects spread out over region

   –each set is visually distinguishable group
   –extent: whole view
   Superior
- design choices
  - -how many layers, how to distinguish?
    - encode with different, nonoverlapping channels
    - two layers achieveable, three with careful design
  - -small static set, or dynamic from many possible?

![](_page_36_Figure_7.jpeg)

# Static visual layering

- foreground layer: roads -hue, size distinguishing main from minor -high luminance contrast from background
- background layer: regions -desaturated colors for water, parks, land areas
- user can selectively focus attention
- "get it right in black and white" -check luminance contrast with greyscale view

[Get it right in black and white. Stone. 2010. http://www.stonesc.com/wordpress/2010/03/get-it-right-in-black-and-white]

![](_page_37_Picture_6.jpeg)

![](_page_37_Picture_7.jpeg)

![](_page_37_Picture_8.jpeg)

## Superimposing limits

- few layers, but many lines
  - -up to a few dozen
  - -but not hundreds
- superimpose vs juxtapose: empirical study
  - -superimposed for local, multiple for global
  - -tasks
    - local: maximum, global: slope, discrimination
  - -same screen space for all multiples vs single superimposed

![](_page_38_Figure_9.jpeg)

![](_page_38_Picture_10.jpeg)

[Graphical Perception of Multiple Time Series. Javed, McDonnel, and Elmqvist. IEEE Transactions on Visualization and Computer Graphics (Proc. IEEE InfoVis 2010) 16:6 (2010), 927–934.]

![](_page_38_Figure_12.jpeg)

![](_page_38_Figure_13.jpeg)

## Dynamic visual layering

- interactive, from selection
  - –lightweight: click
  - -very lightweight: hover
- ex: I-hop neighbors

[Cerebral: a Cytoscape plugin for layout of and interaction with biological networks using subcellular localization annotation. Barsky, Gardy, Hancock, and Munzner. Bioinformatics 23:8 (2007), 1040–1042.]

![](_page_39_Figure_6.jpeg)

#### System: Cerebral

### Reduce items and attributes

- reduce/increase: inverses
- filter
  - -pro: straightforward and intuitive
  - to understand and compute
     –con: out of sight, out of mind
- aggregation
  - -pro: inform about whole set
  - -con: difficult to avoid losing signal
- not mutually exclusive

   combine filter, aggregate
   combine reduce, change, facet

**Reducing Items and Attri** 

![](_page_40_Figure_10.jpeg)

![](_page_40_Figure_11.jpeg)

→ Attributes

![](_page_40_Figure_13.jpeg)

![](_page_40_Figure_14.jpeg)

![](_page_40_Figure_15.jpeg)

![](_page_40_Figure_16.jpeg)

→ Attributes

![](_page_40_Figure_18.jpeg)

butes	Reduce					
	<ul><li>→ Filter</li></ul>					
	<u>L.I.I.u.u</u>					
	K <u>h.hh</u>					

![](_page_40_Picture_20.jpeg)

# Idiom: dynamic filtering

- item filtering
- browse through tightly coupled interaction
  - -alternative to queries that might return far too many or too few

![](_page_41_Figure_4.jpeg)

[Visual information seeking: Tight coupling of dynamic query filters with starfield displays. Ahlberg and Shneiderman. Proc. ACM Conf. on Human Factors in Computing Systems (CHI), pp. 313–317, 1994.]

#### System: FilmFinder

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## Idiom: DOSFA

- attribute filtering
- encoding: star glyphs

![](_page_42_Picture_3.jpeg)

![](_page_42_Picture_4.jpeg)

[Interactive Hierarchical Dimension Ordering, Spacing and Filtering for Exploration Of High Dimensional Datasets. Yang, Peng, Ward, and. Rundensteiner. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 105-112, 2003.]

![](_page_42_Picture_6.jpeg)

![](_page_42_Picture_7.jpeg)

![](_page_42_Picture_8.jpeg)

![](_page_42_Picture_9.jpeg)

![](_page_42_Picture_10.jpeg)

![](_page_42_Picture_11.jpeg)

![](_page_42_Picture_12.jpeg)

# Idiom: histogram

- static item aggregation
- task: find distribution
- data: table
- derived data

-new table: keys are bins, values are counts

bin size crucial

-pattern can change dramatically depending on discretization

-opportunity for interaction: control bin size on the fly

![](_page_43_Figure_9.jpeg)

### Continuous scatterplot

- static item aggregation
- data: table
- derived data: table
  - key attribs x,y for pixels
  - quant attrib: overplot density
- dense space-filling 2D matrix
- color: sequential categorical hue + ordered luminance

[Continuous Scatterplots. Bachthaler and Weiskopf. IEEE TVCG (Proc. Vis 08) 14:6 (2008), 1428–1435. 2008.]

![](_page_44_Picture_9.jpeg)

## Idiom: scented widgets

- augment widgets for filtering to show *information scent* -cues to show whether value in drilling down further vs looking elsewhere
- concise, in part of screen normally considered control panel

![](_page_45_Figure_3.jpeg)

[Scented Widgets: Improving Navigation Cues with Embedded Visualizations. Willett, Heer, and Agrawala. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2007) 13:6 (2007), 1129–1136.]

![](_page_45_Figure_6.jpeg)

# Idiom: **boxplot**

- static item aggregation
- task: find distribution
- data: table
- derived data
  - -5 quant attribs
    - median: central line
    - lower and upper quartile: boxes
    - lower upper fences: whiskers
      - -values beyond which items are outliers
  - -outliers beyond fence cutoffs explicitly shown

[40 years of boxplots. Wickham and Stryjewski. 2012. had.co.nz]

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![](_page_46_Figure_12.jpeg)

### Idiom: Hierarchical parallel coordinates

- dynamic item aggregation
- derived data: hierarchical clustering
- encoding:

-cluster band with variable transparency, line at mean, width by min/max values

-color by proximity in hierarchy

![](_page_47_Figure_6.jpeg)

![](_page_47_Figure_7.jpeg)

![](_page_47_Figure_8.jpeg)

[Hierarchical Parallel Coordinates for Exploration of Large Datasets. Fua, Ward, and Rundensteiner. Proc. IEEE Visualization Conference (Vis '99), pp. 43–50, 1999.]

![](_page_47_Picture_10.jpeg)

# Spatial aggregation

MAUP: Modifiable Areal Unit Problem

-gerrymandering (manipulating voting district boundaries) is one example!

![](_page_48_Figure_3.jpeg)

![](_page_48_Figure_4.jpeg)

![](_page_48_Figure_5.jpeg)

[<u>http://www.e-education.psu/edu/geog486/l4\_p7.html</u>, Fig 4.cg.6]

### **Dimensionality reduction**

- attribute aggregation
  - -derive low-dimensional target space from high-dimensional measured space
  - -use when you can't directly measure what you care about
    - true dimensionality of dataset conjectured to be smaller than dimensionality of measurements
    - latent factors, hidden variables

![](_page_49_Figure_6.jpeg)

Malignant DR

data: 9D measured space

![](_page_49_Picture_9.jpeg)

![](_page_49_Picture_12.jpeg)

#### derived data: 2D target space

## Idiom: Dimensionality reduction for documents

![](_page_50_Figure_1.jpeg)

![](_page_50_Picture_4.jpeg)

Out Labels for clusters

- → In Clusters & points

#### Why?

- → Produce
- → Annotate

## Demo 2: Internet Use

- Credit: Ben Jones
- Tableau Lessons
  - -more maps, dual axes
  - -linked views (apply filter to selected worksheets)
  - -actions: highlight/hover
- Big Ideas

- Tableau interactivity defaults not necessarily what you want

### **Demo 3: House Price Index**

- Credit: Robert Kosara, from TCC 2014 talk Recreating News Visualizations in Tableau
- Tableau Lessons
  - -more calculated field practice
  - -create parameter
  - -reference lines
  - -interactive sliders
- Big Ideas

-calculated fields plus interactivity gives you a lot of power and flexibility

# Assignment 4

- finish/review House Price Index workbook
- add interactivity to last week's story
  - -update workbook
  - -upload to Tableau Public
  - -revise story to include embedded interactive
- final project proposal