

# Week 2: Arrange Tables

**Tamara Munzner**  
 Department of Computer Science  
 University of British Columbia

JRNL 520H, Special Topics in Contemporary Journalism: Data Visualization  
 Week 2: 20 September 2016

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

## Finding us

- office hours in Sing Tao bldg
  - 1-ish to 3-ish pm Tuesdays in Room 313: Tamara and/or Caitlin
  - by appointment: Tamara in ICICS/CS bldg Room X661
- email other times
  - [tmm@cs.ubc.ca](mailto:tmm@cs.ubc.ca), [caitlin@discoursemedia.org](mailto:caitlin@discoursemedia.org)
- course page is font of all information
  - don't forget to refresh, frequent updates
  - <http://www.cs.ubc.ca/~tmm/courses/journ16>

## Last Time

## Demo 1: Basic Visual Encoding & Dashboarding

- Tableau Lessons
  - Dimensions (categorical) and Measures (quantitative)
  - drag and drop to create visual encodings
  - combining multiple charts side by side into dashboards
- Big Ideas
  - see different patterns with different visual encodings

## Demo 2: Vancouver Election Results

- Tableau Lessons
  - sorting along axis
  - disaggregate into multiple charts
- Big Ideas
  - absolute numbers can sometimes mislead
  - check hunches with relative percentages!

## Demo 3: Vancouver Crime

- Tableau Lessons
  - multiple pills on a shelf, pill ordering
  - show filters
  - undo
  - duplicate & rename tabs
- Big Ideas
  - underlying causes can be tricky to understand

## Arrange Tables

**How?**

- Encode**
  - Arrange
    - Express
    - Separate
    - Order
    - Align
    - Use
- Manipulate**
  - Map from categorical and ordered attributes
    - Color
      - Hue
      - Saturation
      - Luminance
    - Size, Angle, Curvature, ...
    - Shape
      - +
      - 
      - ▲
    - Motion
      - Direction, Rate, Frequency, ...
  - Change
  - Select
  - Navigate
- Facet**
  - Juxtapose
  - Partition
  - Superimpose
- Reduce**
  - Filter
  - Aggregate
  - Embed

What? Why? How?

**How?**

- Encode**
  - Arrange
    - Express
    - Separate
    - Order
    - Align

**Encode**

- Arrange
  - Express
  - Separate
  - Order
  - Align

## Keys and values

- key
  - independent attribute
  - used as unique index to look up items
  - simple tables: 1 key
  - multidimensional tables: multiple keys
- value
  - dependent attribute, value of cell
- classify arrangements by key count
  - 0, 1, 2, many...

Express Values → 1 Key List → 2 Keys Matrix → 3 Keys Volume → Many Keys Recursive Subdivision

## Idiom: scatterplot

- express values
  - quantitative attributes
- no keys, only values
  - data
    - 2 quant attribs
  - mark: points
  - channels
    - horiz + vert position
  - tasks
    - find trends, outliers, distribution, correlation, clusters
  - scalability
    - hundreds of items

[A layered grammar of graphics. Wickham. Journ. Computational and Graphical Statistics 19:1 (2010), 3–28.]

## Some keys: Categorical regions

→ Separate → Order → Align

- **regions**: contiguous bounded areas distinct from each other
  - using space to *separate* (proximity)
  - following expressiveness principle for categorical attributes
- use ordered attribute to **order** and **align** regions

→ 1 Key List → 2 Keys Matrix → 3 Keys Volume → Many Keys Recursive Subdivision

## Idiom: bar chart

- one key, one value
  - data
    - 1 categ attrib, 1 quant attrib
  - mark: lines
  - channels
    - length to express quant value
    - spatial regions: one per mark
      - separated horizontally, aligned vertically
      - ordered by quant attrib
        - » by label (alphabetical), by length attrib (data-driven)
  - task
    - compare, lookup values
  - scalability
    - dozens to hundreds of levels for key attrib

## Separated and Aligned but not Ordered

LIMITATION: Hard to know rank. What's the 4<sup>th</sup> most? The 7<sup>th</sup>?

[Slide courtesy of Ben Jones]

## Separated, Aligned and Ordered

[Slide courtesy of Ben Jones]

## Separated but not Ordered or Aligned



LIMITATION: Hard to make comparisons

[Slide courtesy of Ben Jones]

## Idiom: stacked bar chart

- one more key
  - data
    - 2 categ attrib, 1 quant attrib
  - mark: vertical stack of line marks
    - glyph: composite object, internal structure from multiple marks
  - channels
    - length and color hue
    - spatial regions: one per glyph
      - aligned: full glyph, lowest bar component
      - unaligned: other bar components
  - task
    - part-to-whole relationship
  - scalability
    - several to one dozen levels for stacked attrib

[Using Visualization to Understand the Behavior of Computer Systems. Bosch, Ph.D. thesis, Stanford Computer Science, 2001.]

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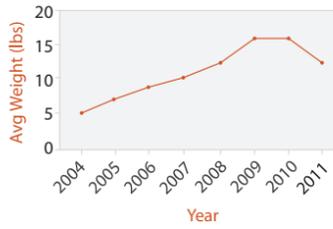
## Idiom: streamgraph

- generalized stacked graph
  - emphasizing horizontal continuity
    - vs vertical items
  - data
    - 1 categ key attrib (artist)
    - 1 ordered key attrib (time)
    - 1 quant value attrib (counts)
  - derived data
    - geometry: layers, where height encodes counts
    - 1 quant attrib (layer ordering)
  - scalability
    - hundreds of time keys
    - dozens to hundreds of artist keys
      - more than stacked bars, since most layers don't extend across whole chart

[Stacked Graphs Geometry & Aesthetics. Byron and Wattenberg. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14(6): 1245–1252, (2008).]

## Idiom: line chart

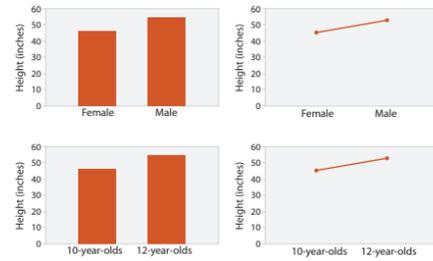
- one key, one value
  - data
    - 2 quant attribs
  - mark: points
    - line connection marks between them
  - channels
    - aligned lengths to express quant value
    - separated and ordered by key attrib into horizontal regions
  - task
    - find trend
      - connection marks emphasize ordering of items along key axis by explicitly showing relationship between one item and the next



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## Choosing bar vs line charts

- depends on type of key attrib
  - bar charts if categorical
  - line charts if ordered
- do not use line charts for categorical key attribs
  - violates expressiveness principle
    - implication of trend so strong that it overrides semantics!
      - “The more male a person is, the taller he/she is”

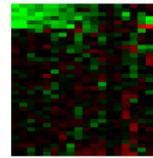


after [Bars and Lines: A Study of Graphic Communication. Zacks and Tversky. Memory and Cognition 27:6 (1999), 1073–1079.]

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## Idiom: heatmap

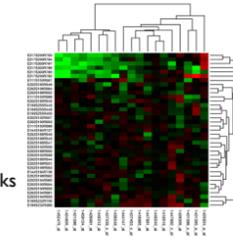
- two keys, one value
  - data
    - 2 categ attribs (gene, experimental condition)
    - 1 quant attrib (expression levels)
  - marks: area
    - separate and align in 2D matrix
      - indexed by 2 categorical attributes
  - channels
    - color by quant attrib
      - (ordered diverging colormap)
  - task
    - find clusters, outliers
  - scalability
    - 1M items, 100s of categ levels, ~10 quant attrib levels



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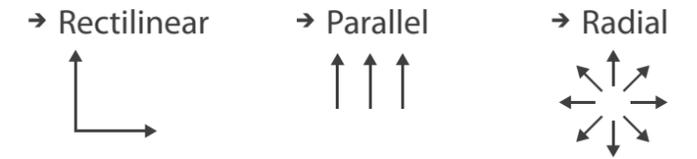
## Idiom: cluster heatmap

- in addition
  - derived data
    - 2 cluster hierarchies
  - dendrogram
    - parent-child relationships in tree with connection line marks
    - leaves aligned so interior branch heights easy to compare
  - heatmap
    - marks (re-)ordered by cluster hierarchy traversal



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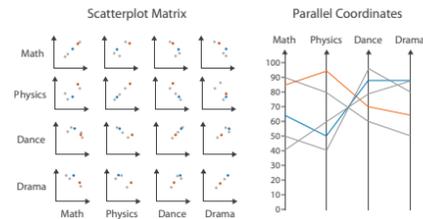
## Axis Orientation



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## Idioms: scatterplot matrix, parallel coordinates

- scatterplot matrix (SPLOM)
  - rectilinear axes, point mark
  - all possible pairs of axes
  - scalability
    - one dozen attribs
    - dozens to hundreds of items
- parallel coordinates
  - parallel axes, jagged line representing item
  - rectilinear axes, item as point
    - axis ordering is major challenge
  - scalability
    - dozens of attribs
    - hundreds of items



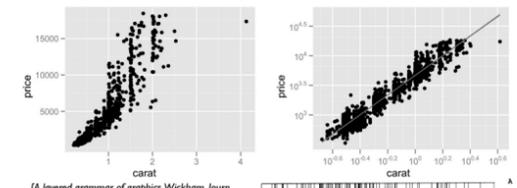
	Math	Physics	Dance	Drama
Math	85	95	70	65
Physics	90	80	60	50
Dance	65	50	90	90
Drama	50	40	95	80
	40	60	80	90

after [Visualization Course Figures. McGuffin, 2014. <http://www.michaelmcguffin.com/courses/vis/>]

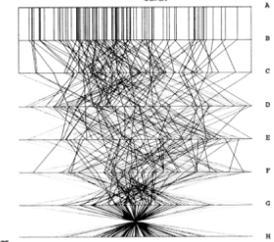
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## Task: Correlation

- scatterplot matrix
  - positive correlation
    - diagonal low-to-high
  - negative correlation
    - diagonal high-to-low
  - uncorrelated
- parallel coordinates
  - positive correlation
    - parallel line segments
  - negative correlation
    - all segments cross at halfway point
  - uncorrelated
    - scattered crossings



[A layered grammar of graphics. Wickham. Journ. Computational and Graphical Statistics 19:1 (2010), 3–28.]



[Hyperdimensional Data Analysis Using Parallel Coordinates. Wegman. Journ. American Statistical Association 85:411 (1990), 664–675.]

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## Idioms: radial bar chart, star plot

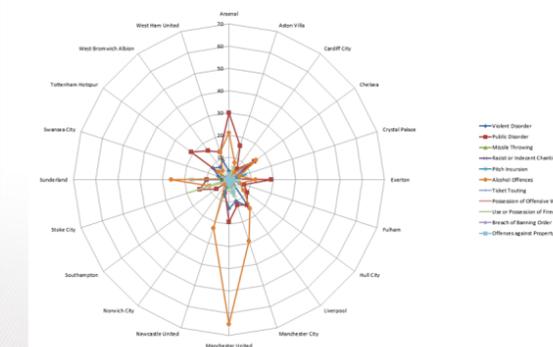
- radial bar chart
  - radial axes meet at central ring, line mark
- star plot
  - radial axes, meet at central point, line mark
- bar chart
  - rectilinear axes, aligned vertically
- accuracy
  - length unaligned with radial
    - less accurate than aligned with rectilinear



[Vieman: Facilitating Risk Assessment and Decision Making In Fisheries Management. Booshehrian, Möller, Peterman, and Munzner. Technical Report TR 2011-04, Simon Fraser University, School of Computing Science, 2011.]

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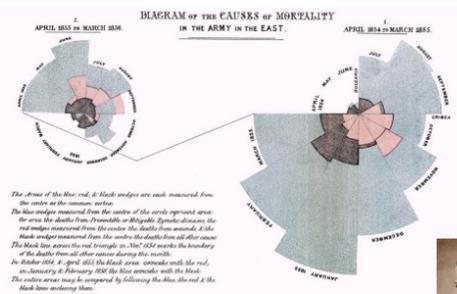
## Radial Orientation: Radar Plots



LIMITATION: Not good when categories aren't cyclic

[Slide courtesy of Ben Jones]

## "Diagram of the causes of mortality in the army in the East" (1858)

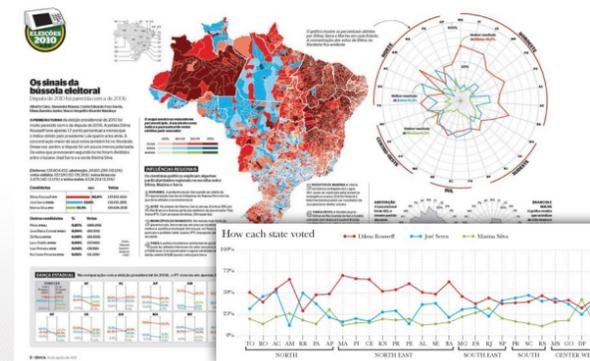


The areas of the blue, red, & black wedges are each measured from the center to the outer circle. The blue wedges measured from the center of the circle represent area. The red wedges measured from the center of the circle represent area. The black wedges measured from the center of the circle represent area. The black line across the middle represents the boundary of the circle. The blue line across the middle represents the boundary of the circle. The red line across the middle represents the boundary of the circle. The black line across the middle represents the boundary of the circle.



[Slide courtesy of Ben Jones]

## "Radar graphs: Avoid them (99.9% of the time)"

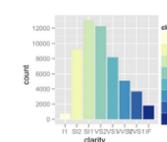
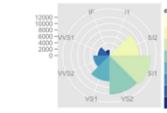
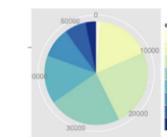


<http://www.thefunctionalart.com/2012/11/radar-graphs-avoid-them-999-of-time.html>

[Slide courtesy of Ben Jones]

## Idioms: pie chart, polar area chart

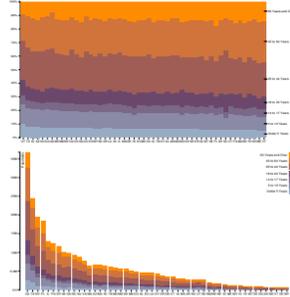
- pie chart
  - area marks with angle channel
  - accuracy: angle/area much less accurate than line length
- polar area chart
  - area marks with length channel
  - more direct analog to bar charts
- data
  - 1 categ key attrib, 1 quant value attrib
- task
  - part-to-whole judgements



[A layered grammar of graphics. Wickham. Journ. Computational and Graphical Statistics 19:1 (2010), 3–28.]

## Idioms: normalized stacked bar chart

- task
  - part-to-whole judgements
- normalized stacked bar chart
  - stacked bar chart, normalized to full vert height
  - single stacked bar equivalent to full pie
    - high information density: requires narrow rectangle
- pie chart
  - information density: requires large circle

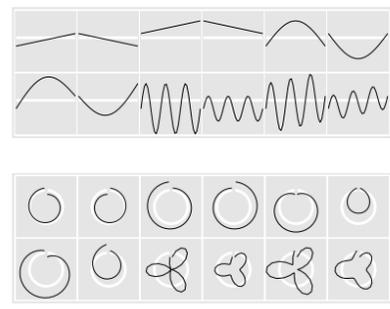


<http://bl.ocks.org/mbostock/3887235>  
<http://bl.ocks.org/mbostock/3886208>  
<http://bl.ocks.org/mbostock/3886394>

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# Idiom: glyphmaps

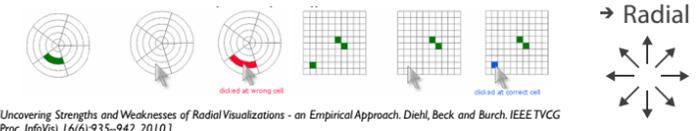
- rectilinear good for linear vs nonlinear trends
- radial good for cyclic patterns



[Glyph-maps for Visually Exploring Temporal Patterns in Climate Data and Models. Wickham, Hajnóczky, Wickham, and Cook. *Environmetrics* 23.5 (2012), 392-393.]

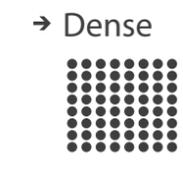
# Orientation limitations

- rectilinear: scalability wrt #axes
  - 2 axes best
  - 3 problematic
    - more in afternoon
  - 4+ impossible
- parallel: unfamiliarity, training time
- radial: perceptual limits
  - asymmetry: angles lower precision than lengths



[Uncovering Strengths and Weaknesses of Radial Visualizations - an Empirical Approach. Diehl, Beck and Burch. *IEEE TVCG (Proc. InfoVis)* 16(6):935-942, 2010.]

# Layout Density

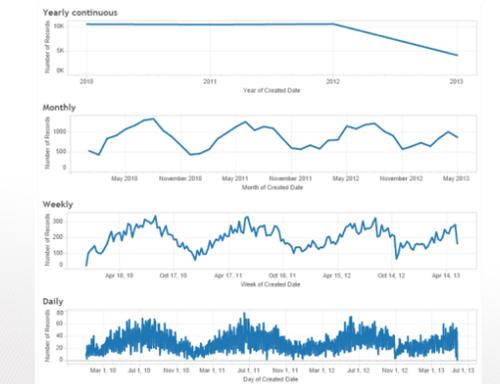


# dense software overviews



[Visualization of test information to assist fault localization. Jones, Harrold, Staska. *Proc. ICSE* 2002, p 467-477.]

# Basic Timelines – Working with Dates



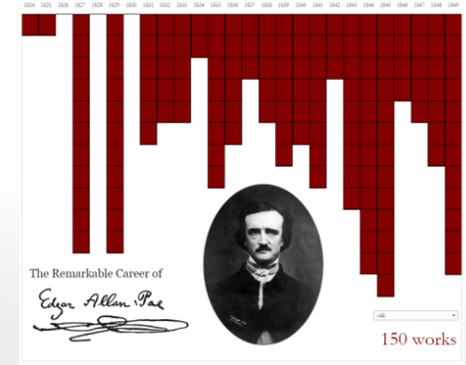
[Slide courtesy of Ben Jones]

# Column Charts



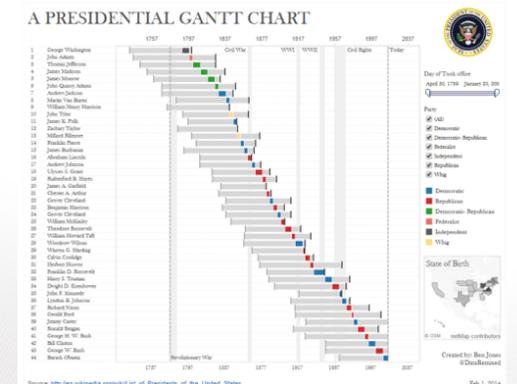
[Slide courtesy of Ben Jones]

# Inverted Column Charts



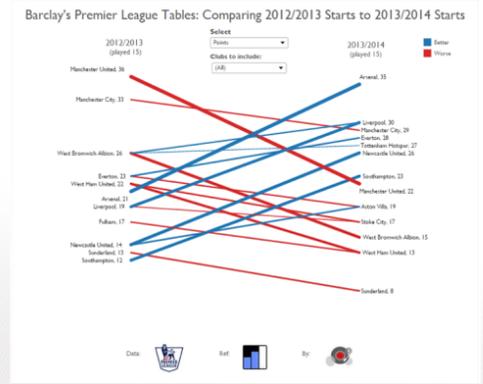
[Slide courtesy of Ben Jones]

# Gantt Charts



[Slide courtesy of Ben Jones]

# Slopegraphs



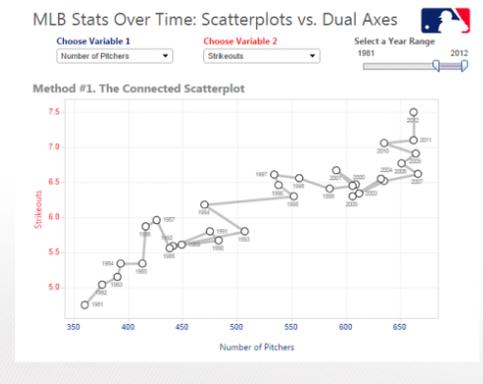
[Slide courtesy of Ben Jones]

# Change from Previous



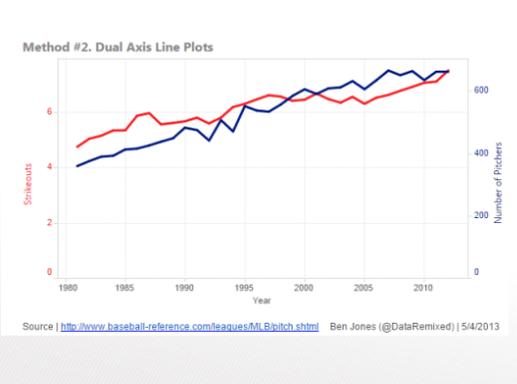
[Slide courtesy of Ben Jones]

# Connected Scatterplots



[Slide courtesy of Ben Jones]

# Dual Axis Line Plots



[Slide courtesy of Ben Jones]

# Next

- Break (15 min)
- Demos (45 min)
  - Caitlin will walk through Tableau demos
  - you follow along step by step on your own laptop
  - Tamara will rove the room to help out folks who get stuck
- Lab (30 min)
  - you'll get started on Tableau assignment