

Information Visualization

Tables

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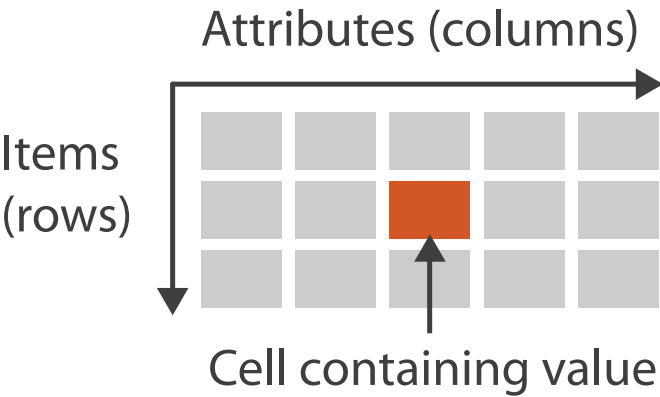
<https://www.cs.ubc.ca/~tmm/courses/436V-20>

Tables

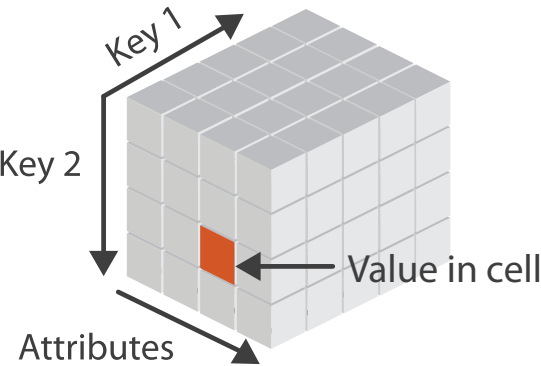
Focus on Tables

→ Dataset Types

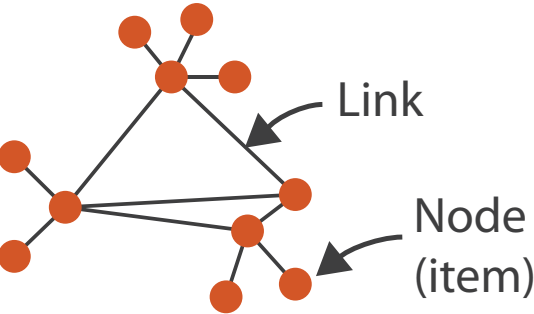
→ Tables



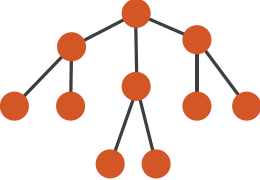
→ Multidimensional Table



→ Networks

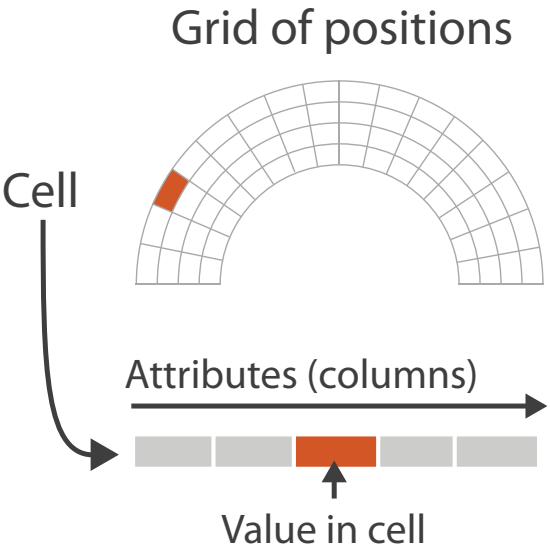


→ Trees



→ Spatial

→ Fields (Continuous)



→ Geometry (Spatial)



Exercise: Sketch 2 ways to visualize each table

	Age	Best 100 m	Furthest Jump	Sex
Amy	16	13.2	5.2	F
Basil	18	12.4	4.2	F
Clara	14	14.1	2.5	F
Desmond	22	10.01	6.3	M
Charles	19	11.3	5.3	M

	BPM T1	BPM T2	BPM T3
Amy	90	130	150
Basil	70	110	109
Clara	60	140	141
Desmond	84	100	108
Charles	81	110	130

- socrative: answer when done

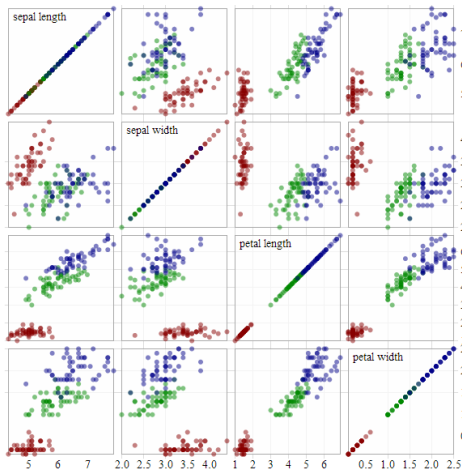
Tackling tables

- homogeneity
 - same data type? same scales?
- need different approaches based on scale
 - how many attributes?
 - up to ~50: tractable with direct visual encoding
 - thousands: need transformations / analytical methods
 - how many items?
 - up to 1K: tractable with direct visual encoding
 - >> 10K: need transformations / analytical methods

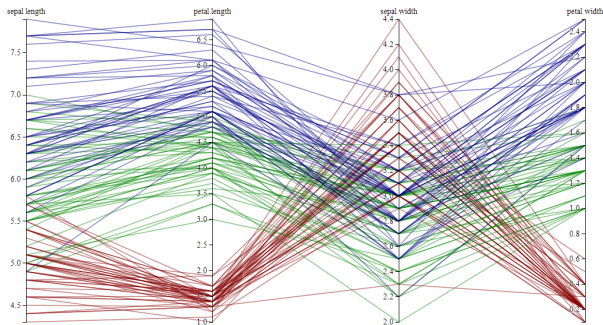
	Age	Gender	Height
Bob	25	M	181
Alice	22	F	185
Chris	19	M	175

	BPM 1	BPM 2	BPM 3
Bob	65	120	145
Alice	80	135	185
Chris	45	115	135

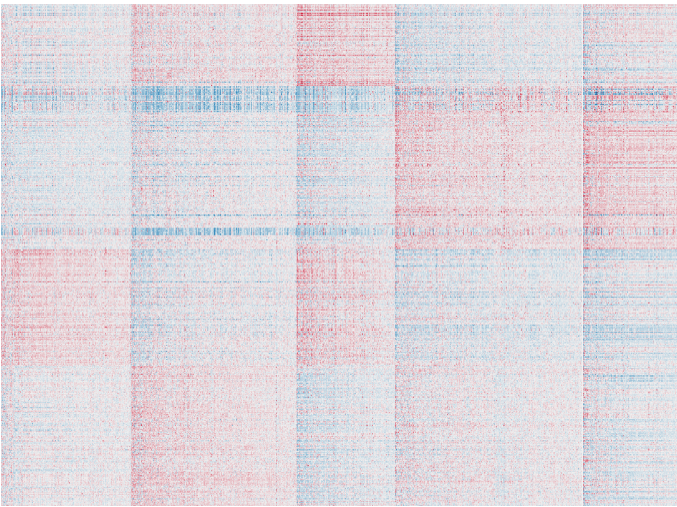
Analytic component



Scatterplot Matrices
[Bostock]



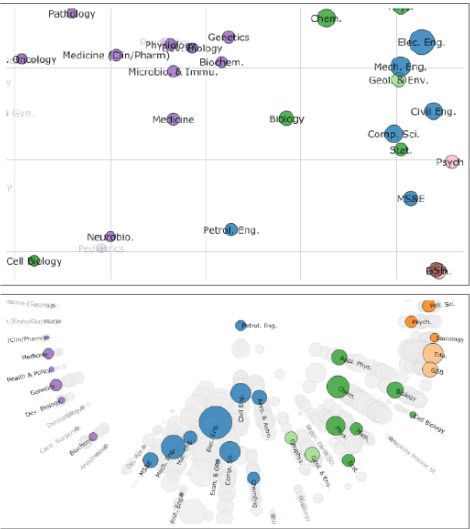
Parallel Coordinates
[Bostock]



Pixel-based visualizations /
heat maps



Multidimensional Scaling
[Doerk 2011]



[Chuang 2012]

no / little analytics

strong analytics
component

Tasks and techniques

Magnitude

Distribution

Deviation

Correlation

Ranking

Part to whole

Change over Time

Deviation

Deviation variables are 1 from a fixed reference point. Usually, the value can be positive or negative. Can describe change in a variable.

Example IT use:
Track temperature change

Emerging bar

A simple bar chart to show the value of a variable.

Emerging stacked bar

Pattern of emerging values over time.

Signs

Shows a sign value over time.

Simple bar chart

The value of a variable over time.

Correlation

Shows the relationship between two or more variables. Can be positive or negative.

Example IT use:
Correlation between temperature and time.

Scatter plot

A plot of two variables over time.

Correlation coefficient

A measure of the strength of the relationship between two variables.

Scatter plot

A plot of two variables over time.

IT use

A plot of two variables over time.

Ranking

Use when an item is ranked in a list. Can be positive or negative.

Example IT use:
Ranking of items in a list.

Bar chart

A plot of a variable over time.

Scatter plot

A plot of two variables over time.

IT use

A plot of two variables over time.

Distribution

Shows the distribution of a variable. Can be positive or negative.

Example IT use:
Distribution of a variable in a dataset.

Bar chart

A plot of a variable over time.

Scatter plot

A plot of two variables over time.

IT use

A plot of two variables over time.

Change over Time

Shows the change in a variable over time. Can be positive or negative.

Example IT use:
Change in a variable over time.

Bar chart

A plot of a variable over time.

Scatter plot

A plot of two variables over time.

IT use

A plot of two variables over time.

Magnitude

Shows the magnitude of a variable. Can be positive or negative.

Example IT use:
Magnitude of a variable in a dataset.

Bar chart

A plot of a variable over time.

Scatter plot

A plot of two variables over time.

IT use

A plot of two variables over time.

Part-to-whole

Shows the part-to-whole relationship of a variable. Can be positive or negative.

Example IT use:
Part-to-whole relationship of a variable in a dataset.

Bar chart

A plot of a variable over time.

Scatter plot

A plot of two variables over time.

IT use

A plot of two variables over time.

Spatial

Shows the spatial relationship of a variable. Can be positive or negative.

Example IT use:
Spatial relationship of a variable in a dataset.

Bar chart

A plot of a variable over time.

Scatter plot

A plot of two variables over time.

IT use

A plot of two variables over time.

Flow

Shows the flow of a variable over time. Can be positive or negative.

Example IT use:
Flow of a variable over time.

Bar chart

A plot of a variable over time.

Scatter plot

A plot of two variables over time.

IT use

A plot of two variables over time.

Visual vocabulary

Designing with data

There are so many ways to visualise data - how do we know which one to pick? Use the categories across the top to decide which data relationship is most important in your story, then look at the different types of chart.

Deviation

Correlation

Ranking

Distribution

Change over Time

Magnitude

Part-to-whole

Spatial

Flow

<https://github.com/ft-interactive/chart-doctor/tree/master/visual-vocabulary>

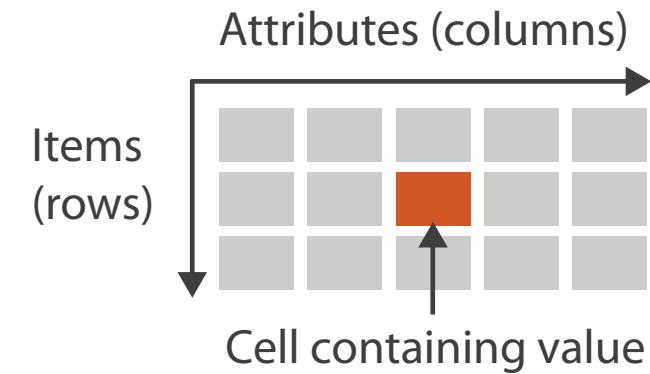
<https://gramener.github.io/visual-vocabulary-vega/#/Magnitude/>

7

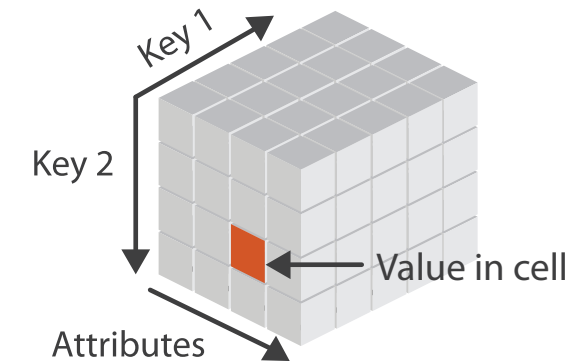
Keys and values

- 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...

→ Tables



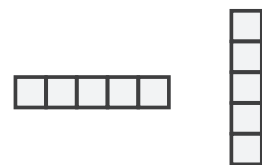
→ *Multidimensional Table*



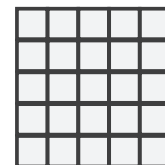
➔ Express Values



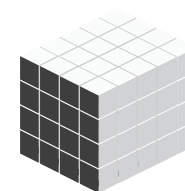
➔ 1 Key
List



➔ 2 Keys
Matrix



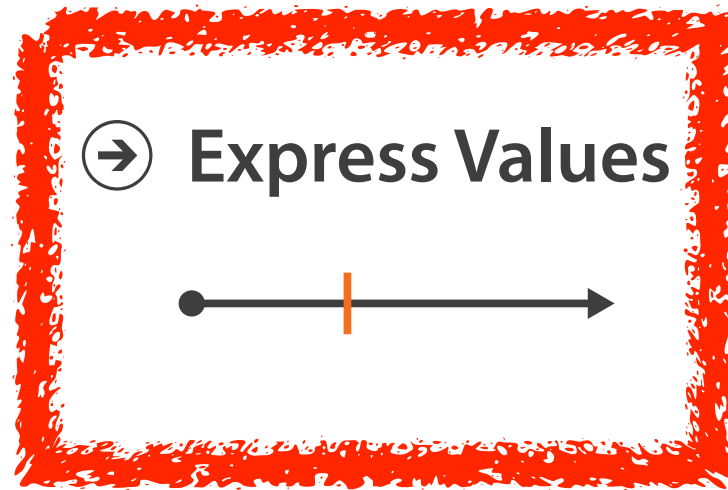
➔ 3 Keys
Volume



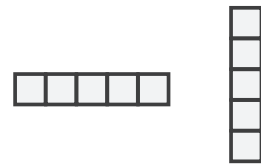
➔ Many Keys
Recursive Subdivision



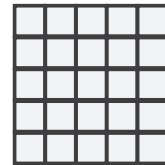
0 Keys: Express values (magnitudes)



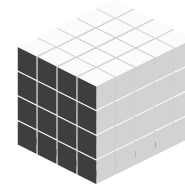
→ 1 Key
List



→ 2 Keys
Matrix



→ 3 Keys
Volume



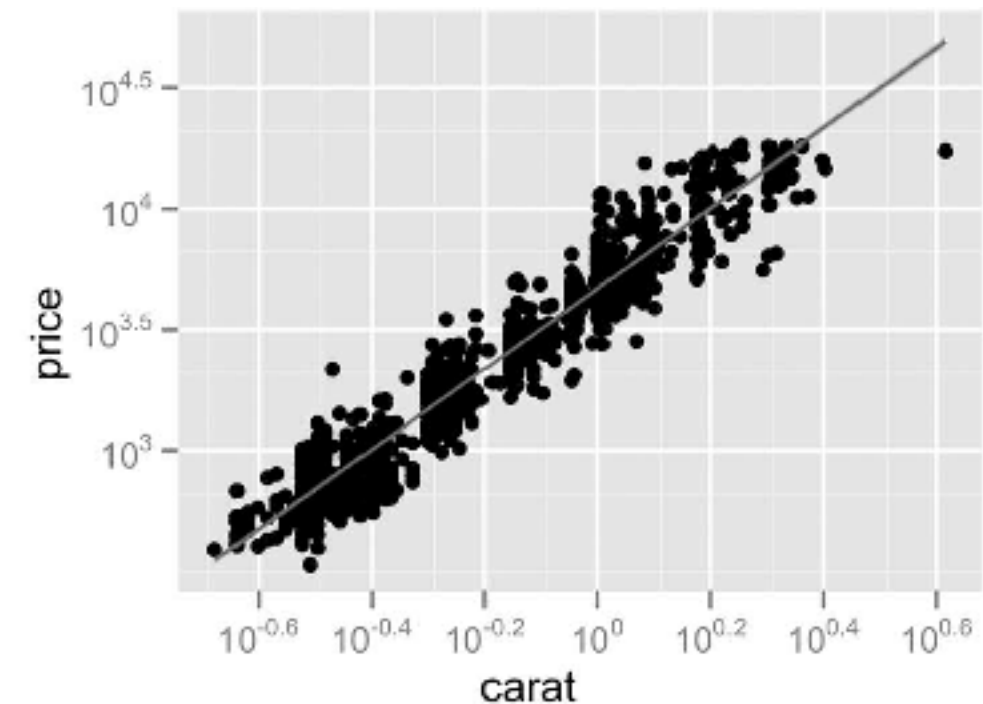
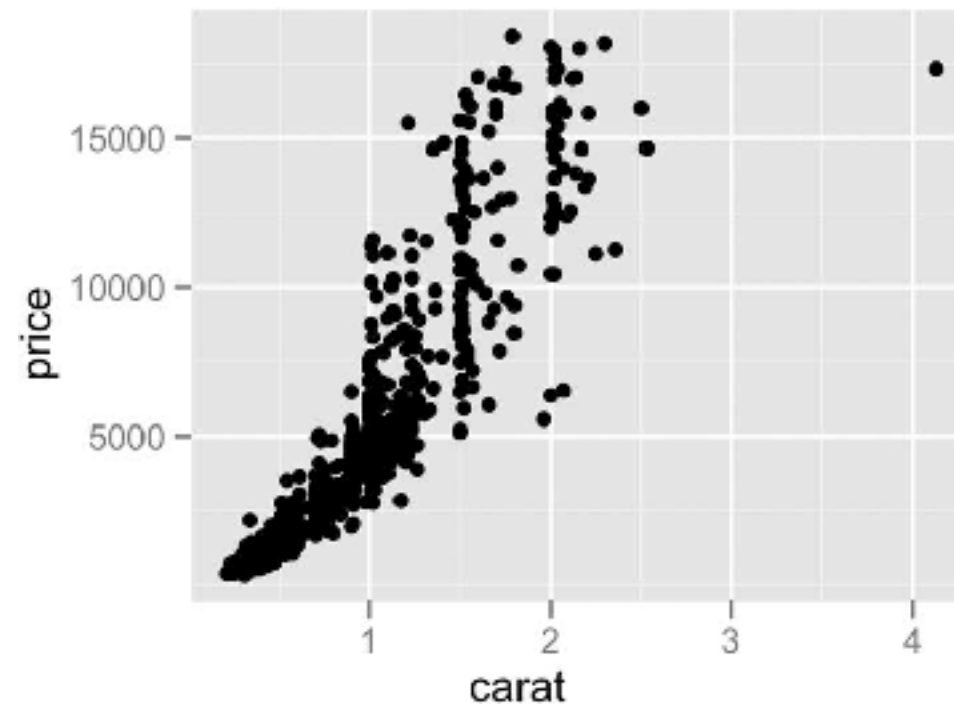
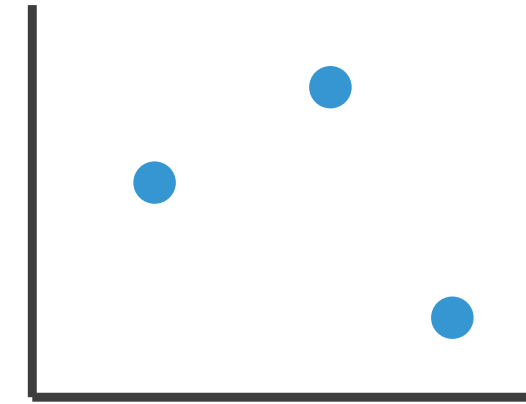
→ Many Keys
Recursive Subdivision



Idiom: scatterplot

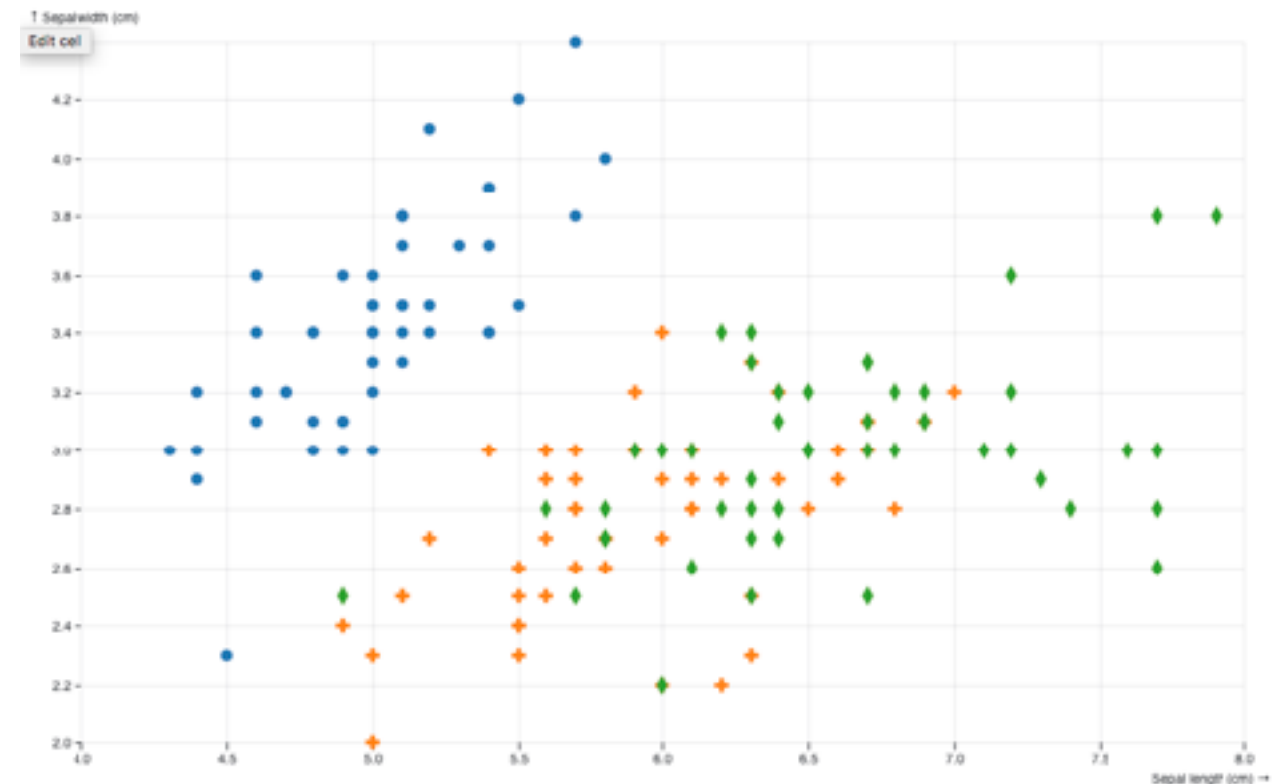
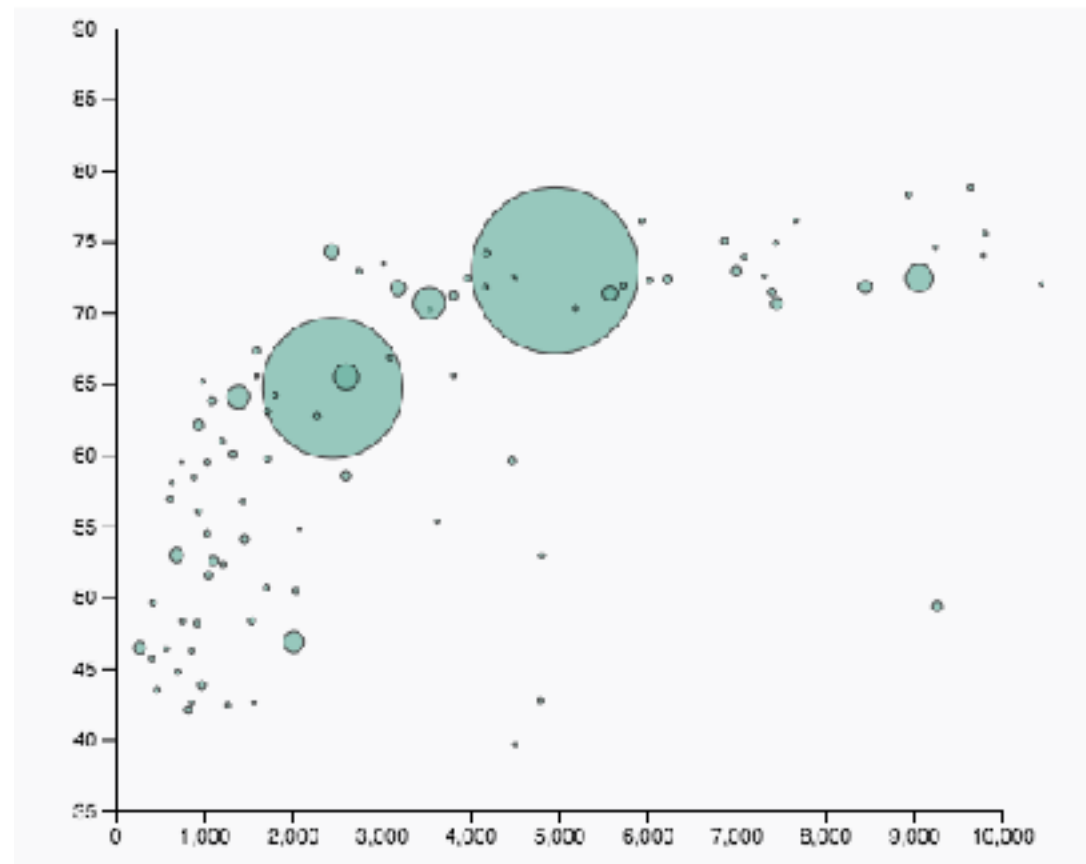
- **express** values
 - quantitative attributes
- no keys, only values
 - data
 - 2 quant attribs
 - mark: points
 - channels
 - horiz + vert position
 - tasks
 - find trends, outliers, distribution, correlation, clusters
 - scalability
 - hundreds of items

➔ Express Values



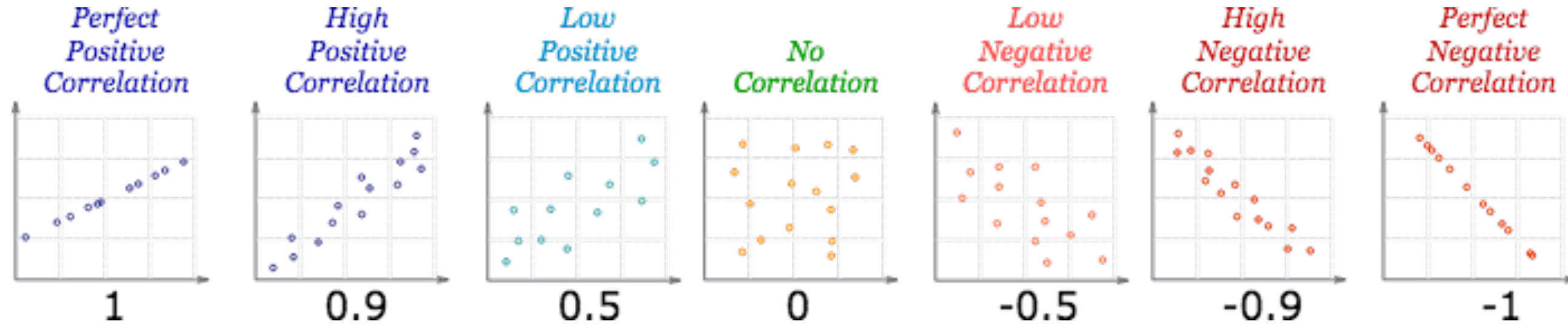
Scatterplots: Encoding more channels

- additional channels for point marks
 - color
 - size (bubbleplots)
 - square root since area grows quadratically, radius is misleading
 - shape



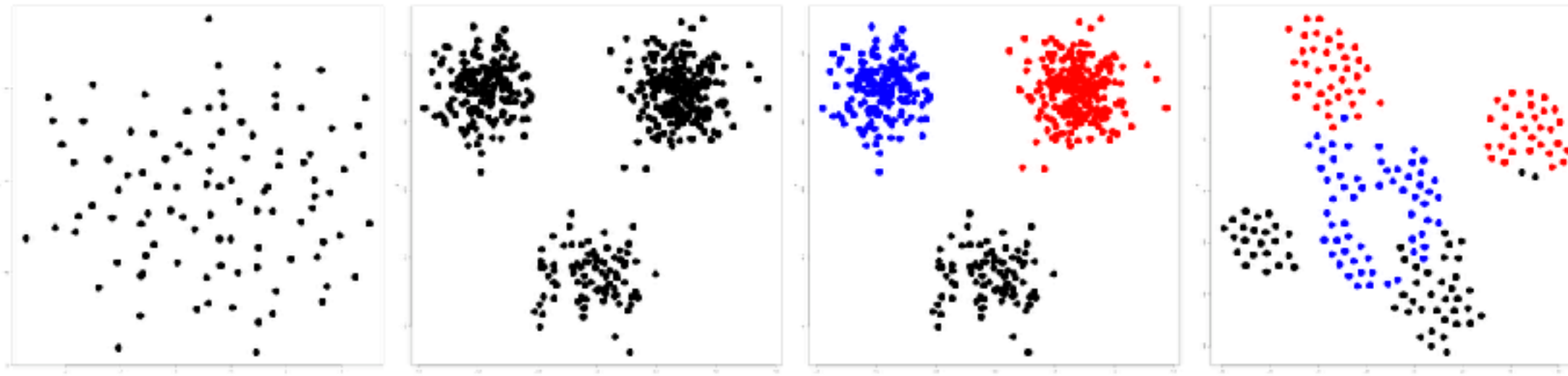
Scatterplot tasks

- correlation



<https://www.mathsisfun.com/data/scatter-xy-plots.html>

- clusters/groups, and clusters vs classes

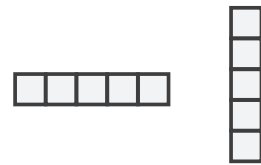


Some keys

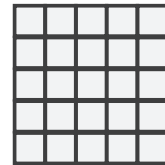
➔ Express Values



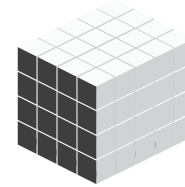
➔ 1 Key
List



➔ 2 Keys
Matrix



➔ 3 Keys
Volume



➔ Many Keys
Recursive Subdivision

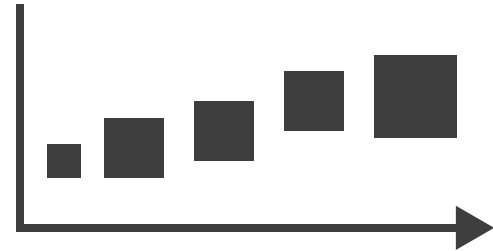


Some keys: Categorical regions

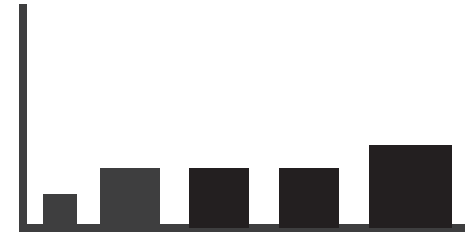
→ Separate



→ Order

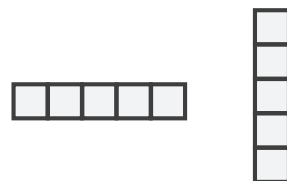


→ Align

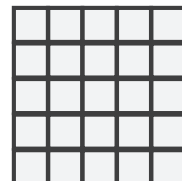


- **regions**: contiguous bounded areas distinct from each other
 - using space to **separate** (proximity)
 - following expressiveness principle for categorical attributes
- use ordered attribute to **order** and **align** regions

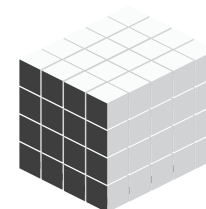
→ 1 Key
List



→ 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

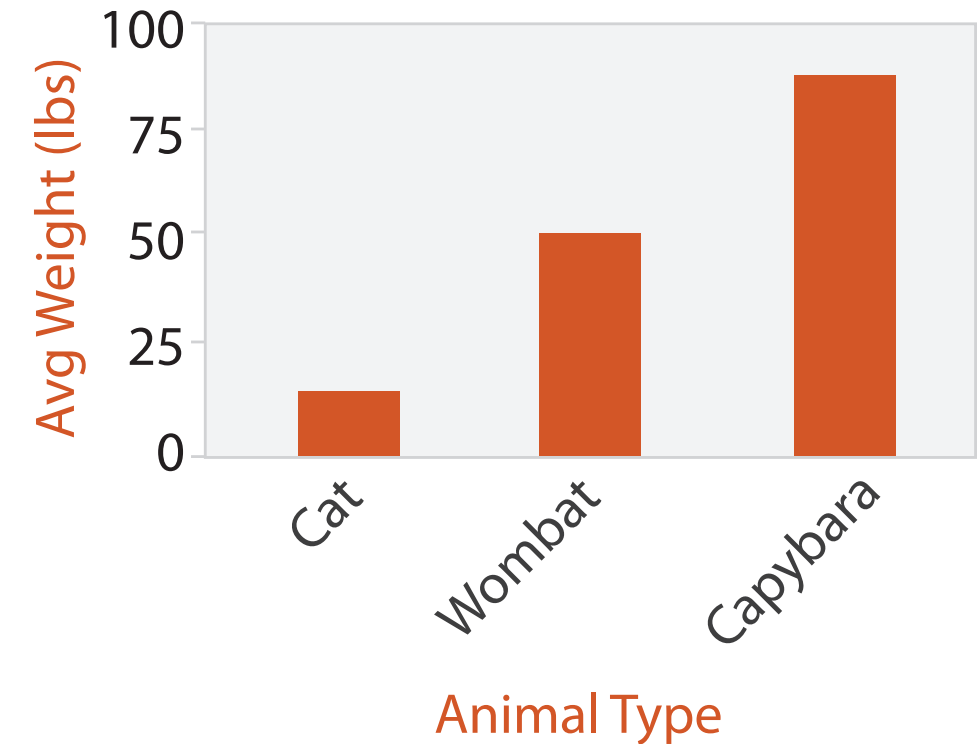
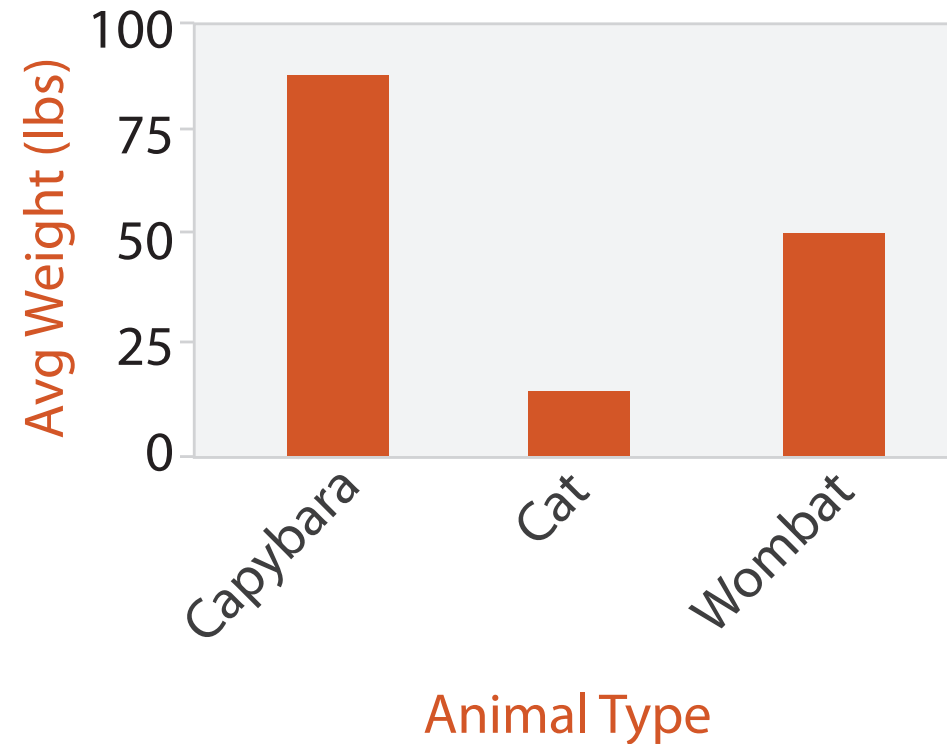
- » by label (alphabetical), by length attrib (data-driven)

- task

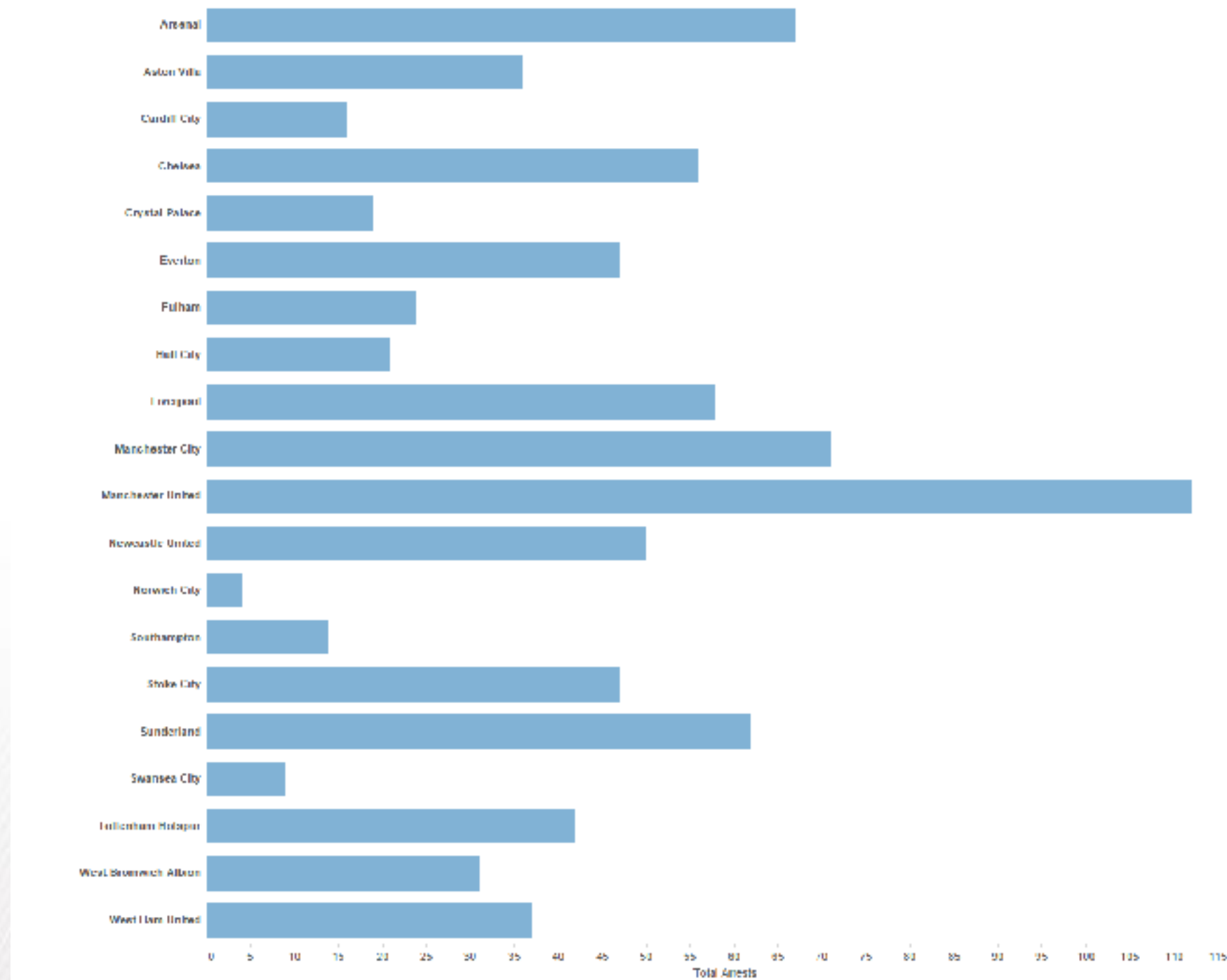
- compare, lookup values

- scalability

- dozens to hundreds of levels for key attrib



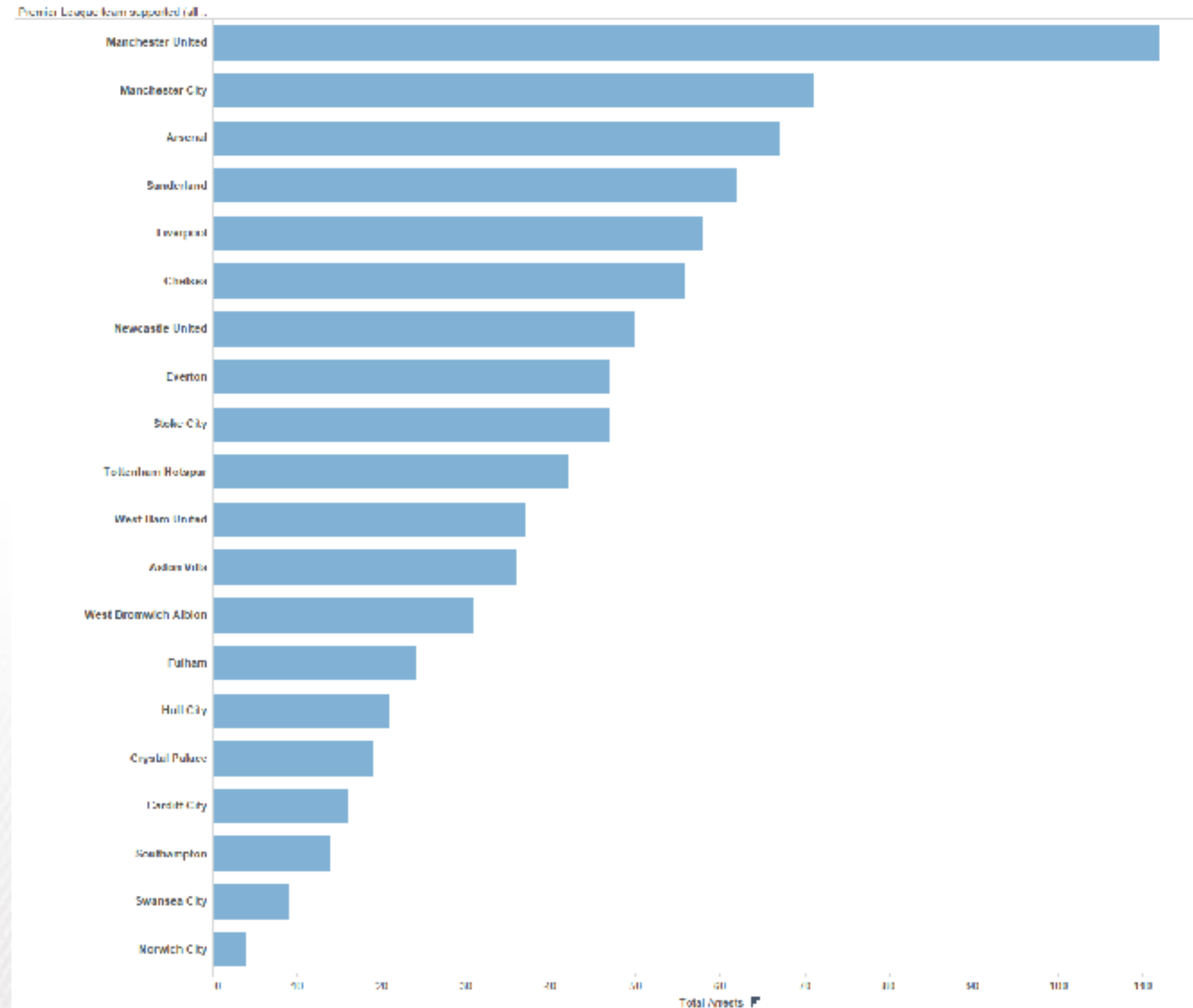
Separated and Aligned but not Ordered



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

[Slide courtesy of Ben Jones]

Separated, Aligned and Ordered



[Slide courtesy of Ben Jones]

Separated but not Ordered or Aligned

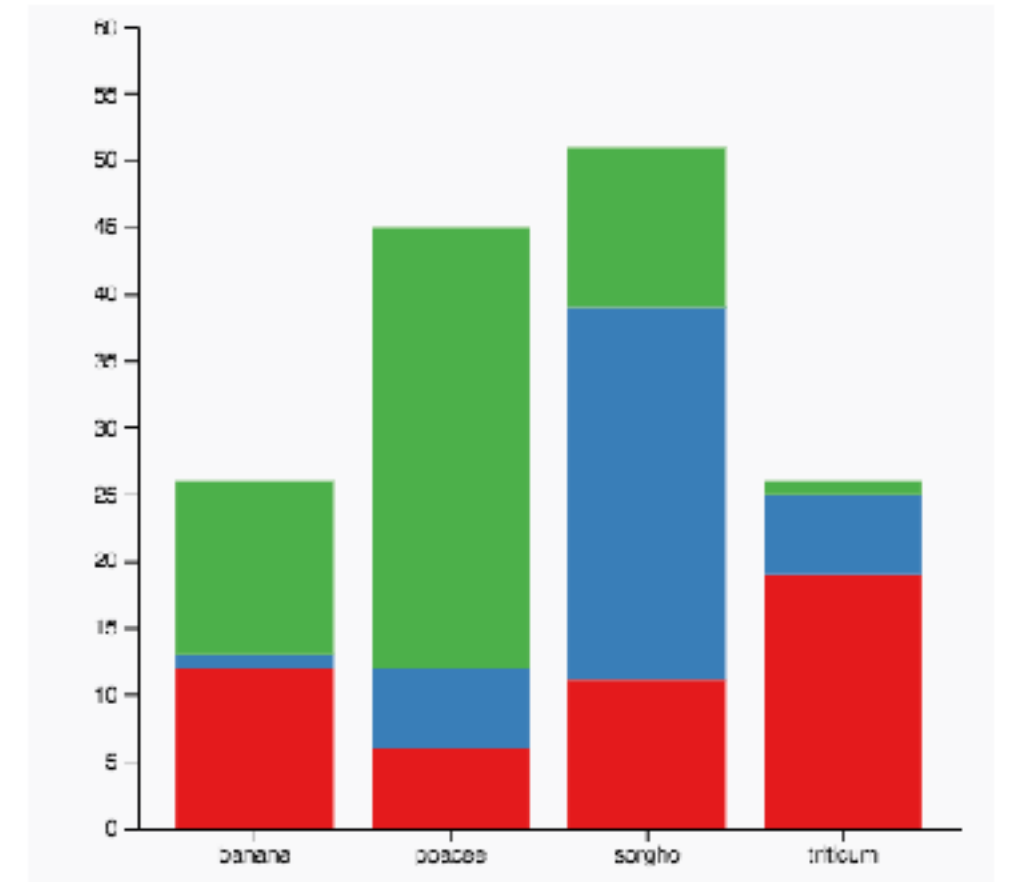


LIMITATION: Hard to make comparisons

[Slide courtesy of Ben Jones]

Idiom: stacked bar chart

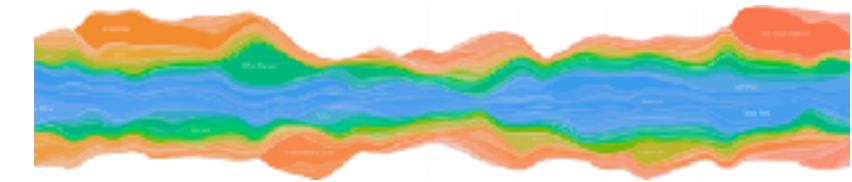
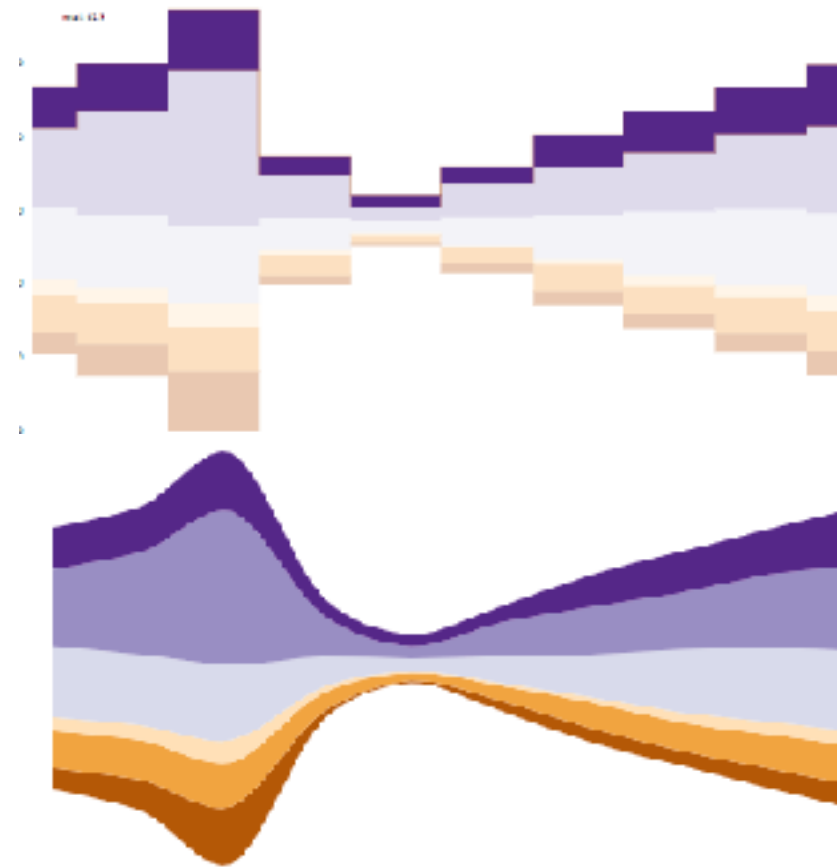
- one more key
 - data
 - 2 categ attrib, 1 quant attrib
 - mark: vertical stack of line marks
 - **glyph**: composite object, internal structure from multiple marks
 - channels
 - length and color hue
 - spatial regions: one per glyph
 - aligned: full glyph, lowest bar component
 - unaligned: other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



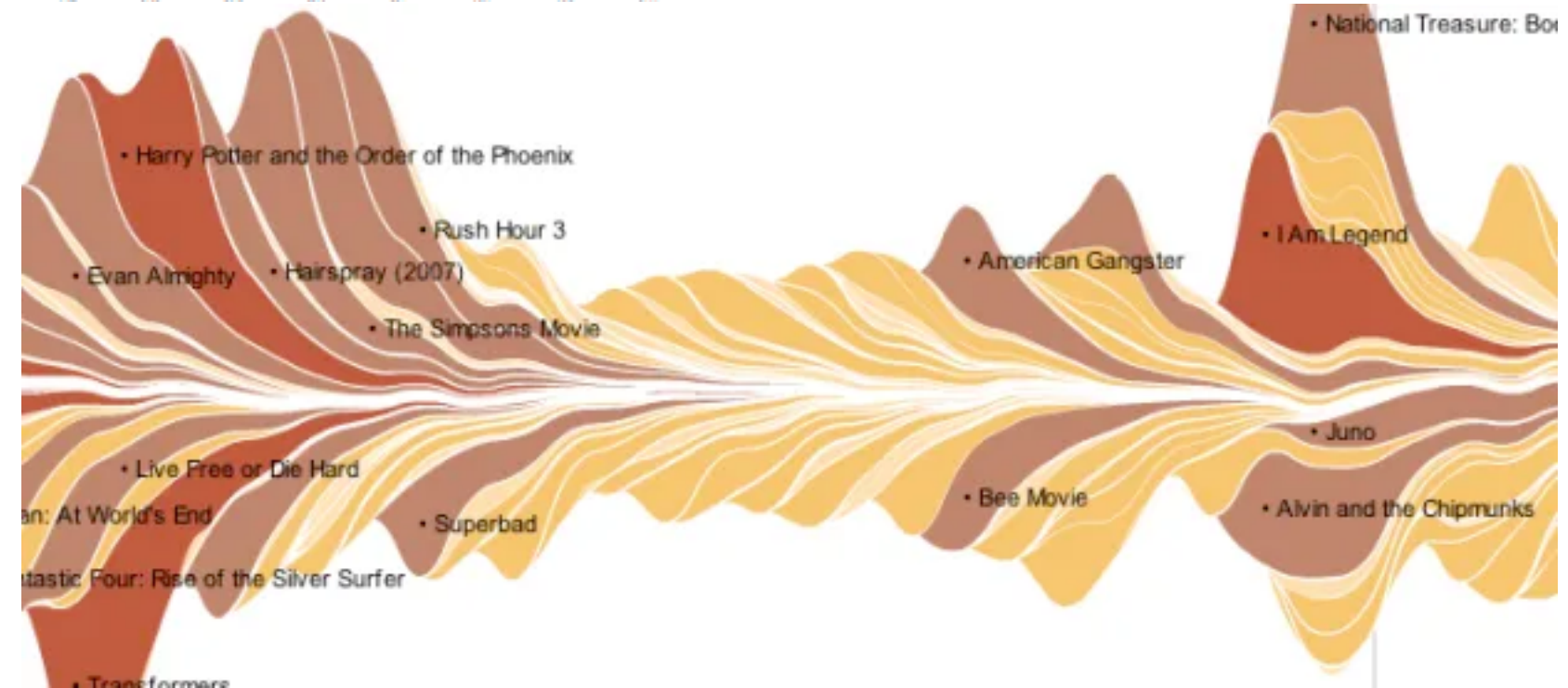
https://www.d3-graph-gallery.com/graph/barplot_stacked_basicWide.html

Idiom: streamgraph

- generalized stacked graph
 - emphasizing horizontal continuity
 - vs vertical items
 - data
 - 1 categ key attrib (movies)
 - 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 movies keys
 - more than stacked bars, since most layers don't extend across whole chart



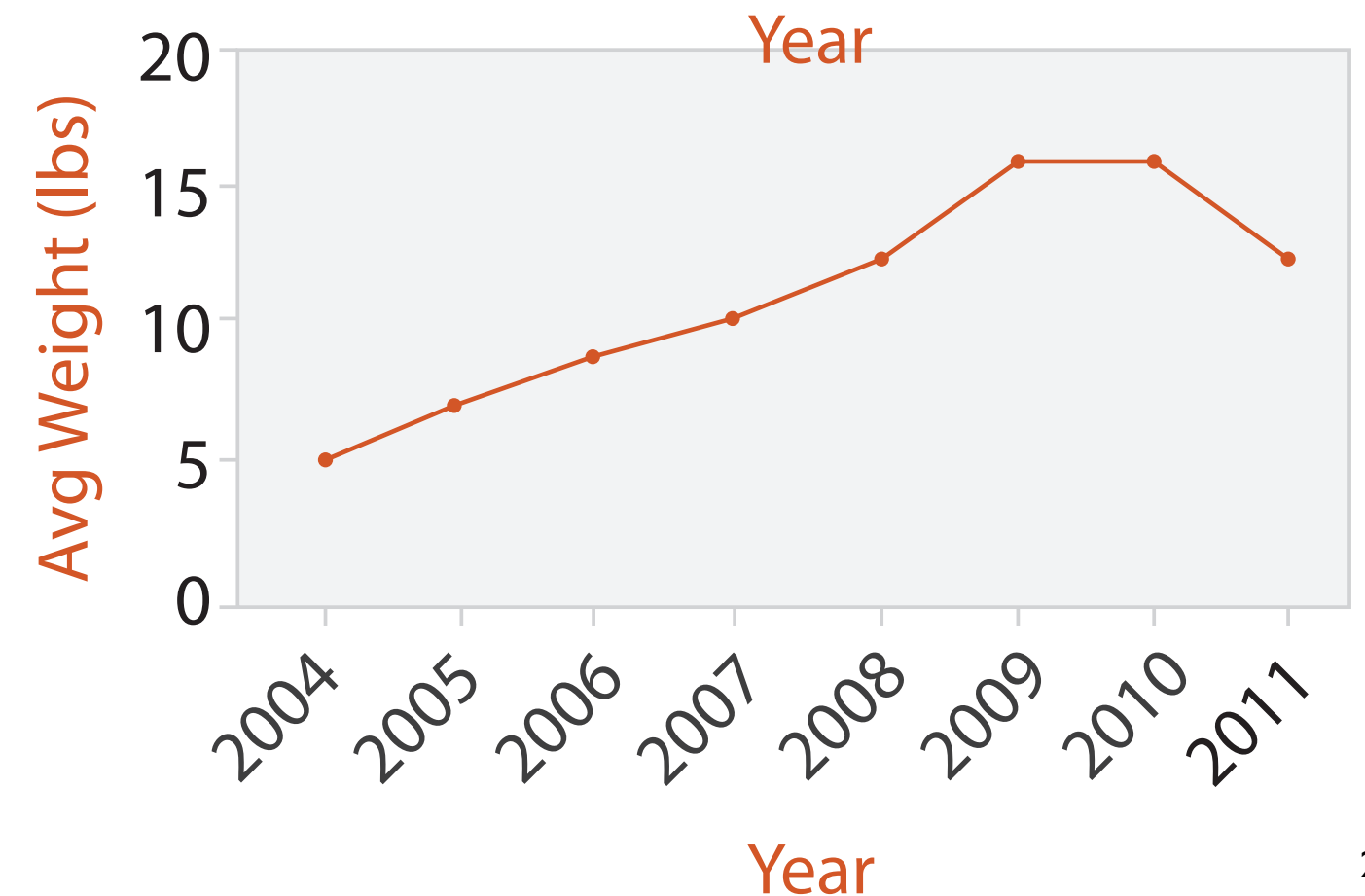
[Stacked Graphs Geometry & Aesthetics. Byron and Wattenberg. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14(6): 1245–1252, (2008).]



<https://flowingdata.com/2008/02/25/ebb-and-flow-of-box-office-receipts-over-past-20-years/>

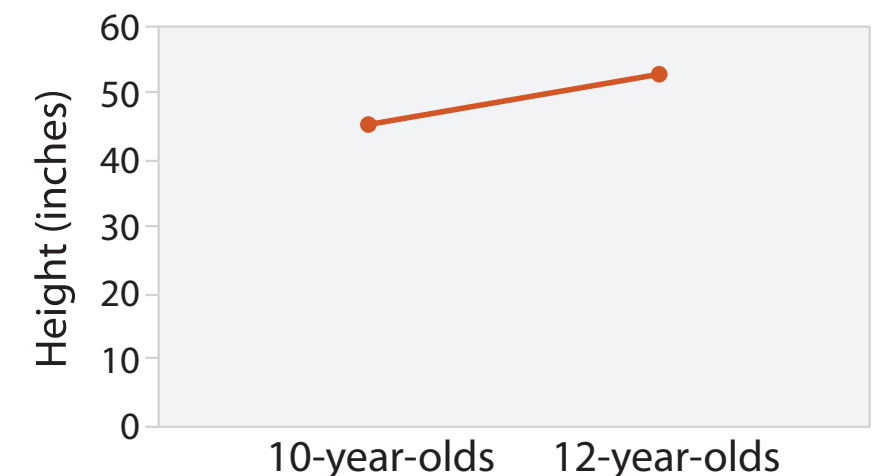
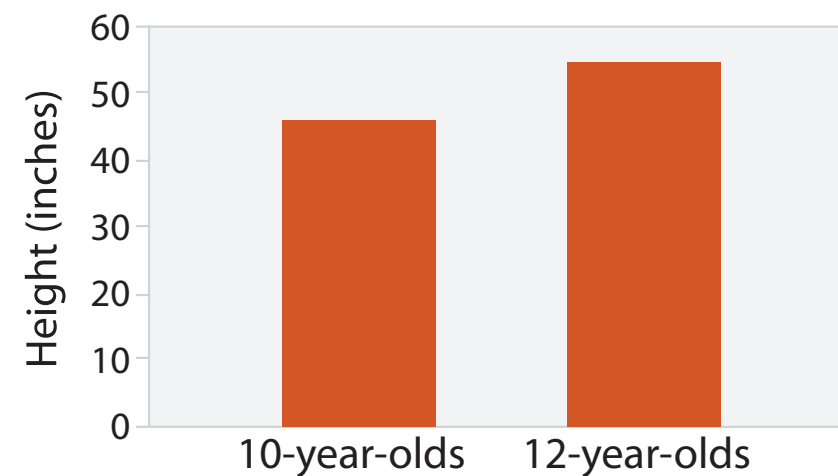
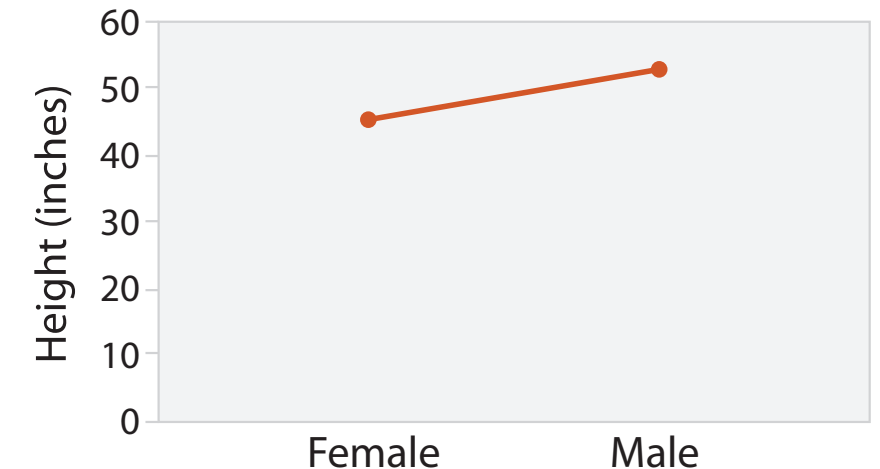
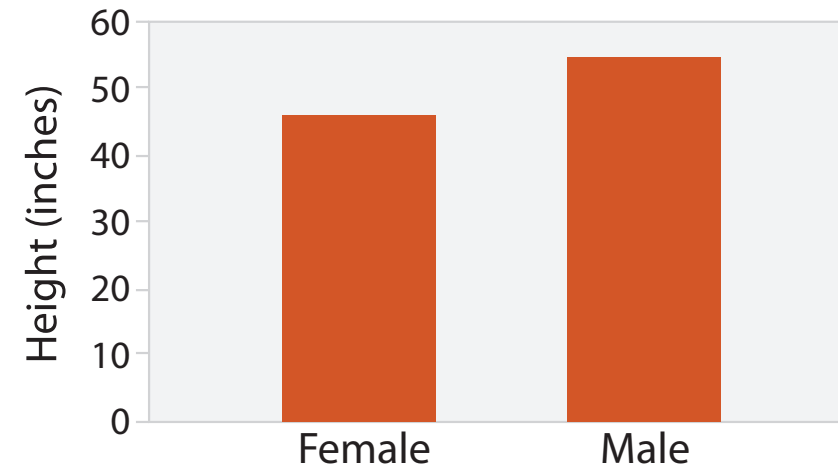
Idiom: dot plot / line chart

- one key, one value
 - data
 - 2 quant attribs
 - mark: points
AND 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
 - scalability
 - hundreds of key levels, hundreds of value levels



Choosing bar vs line charts

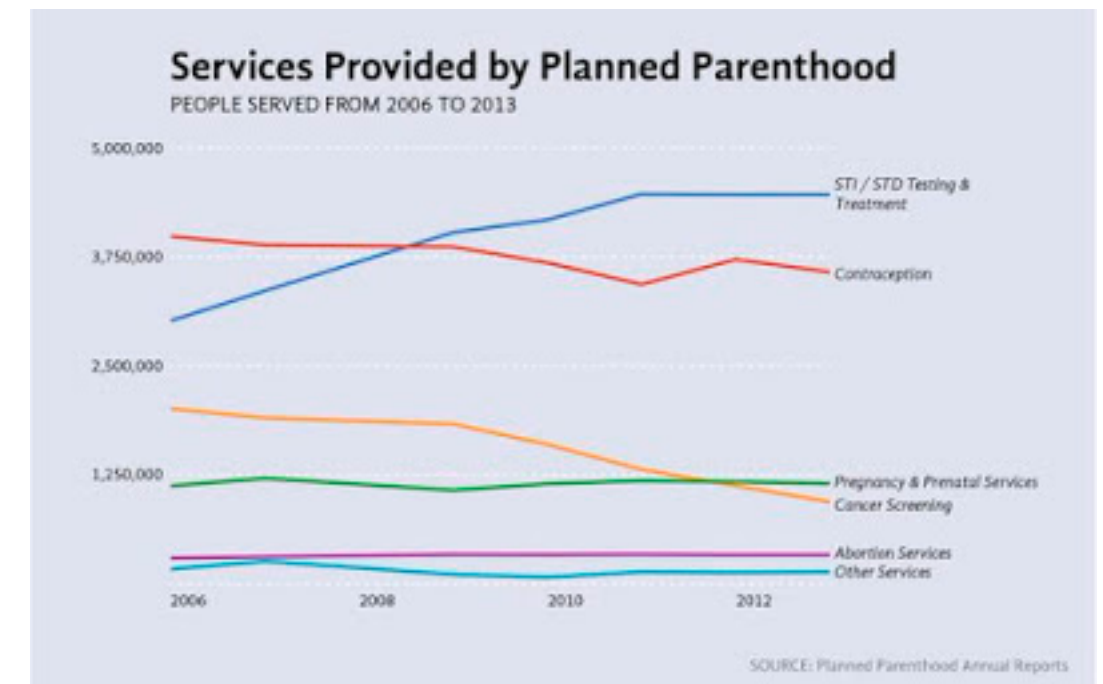
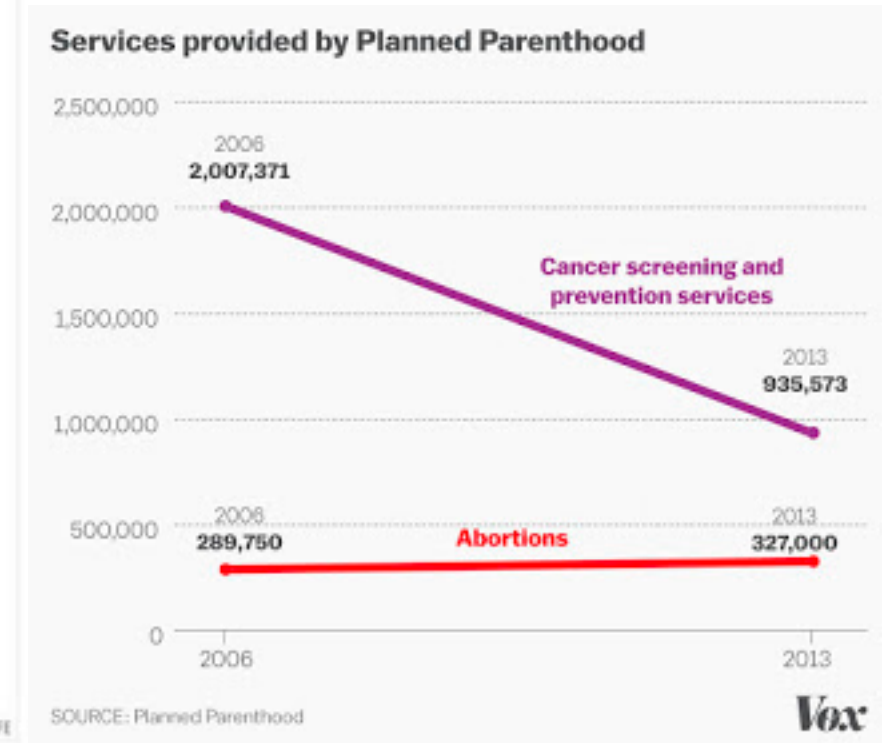
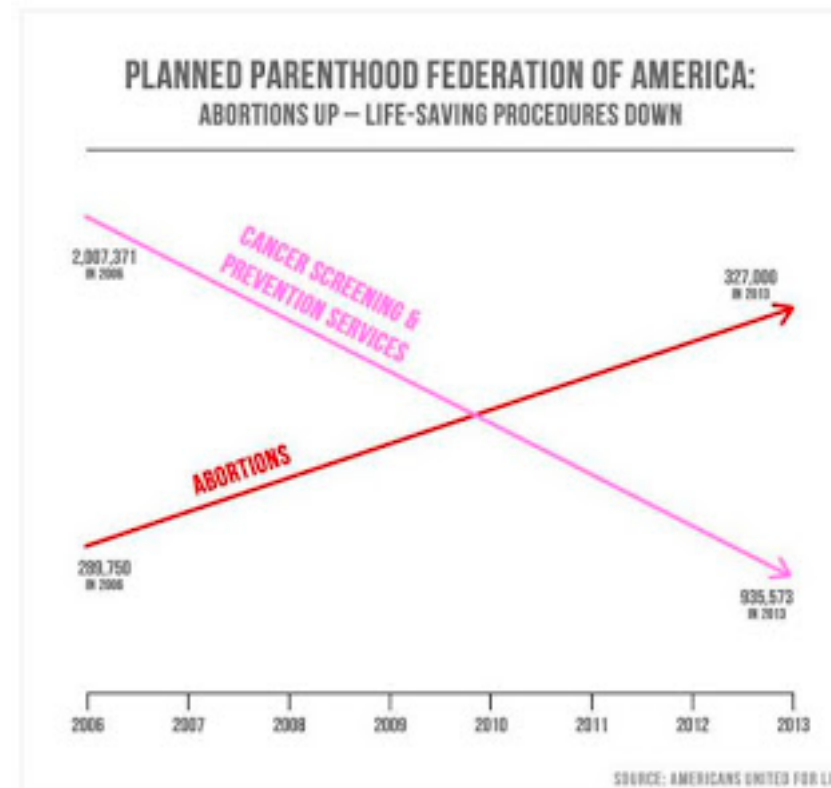
- depends on type of key attrib
 - bar charts if categorical
 - line charts if ordered
- do not use line charts for categorical key attribs
 - violates expressiveness principle
 - implication of trend so strong that it overrides semantics!
 - “The more male a person is, the taller he/she is”



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

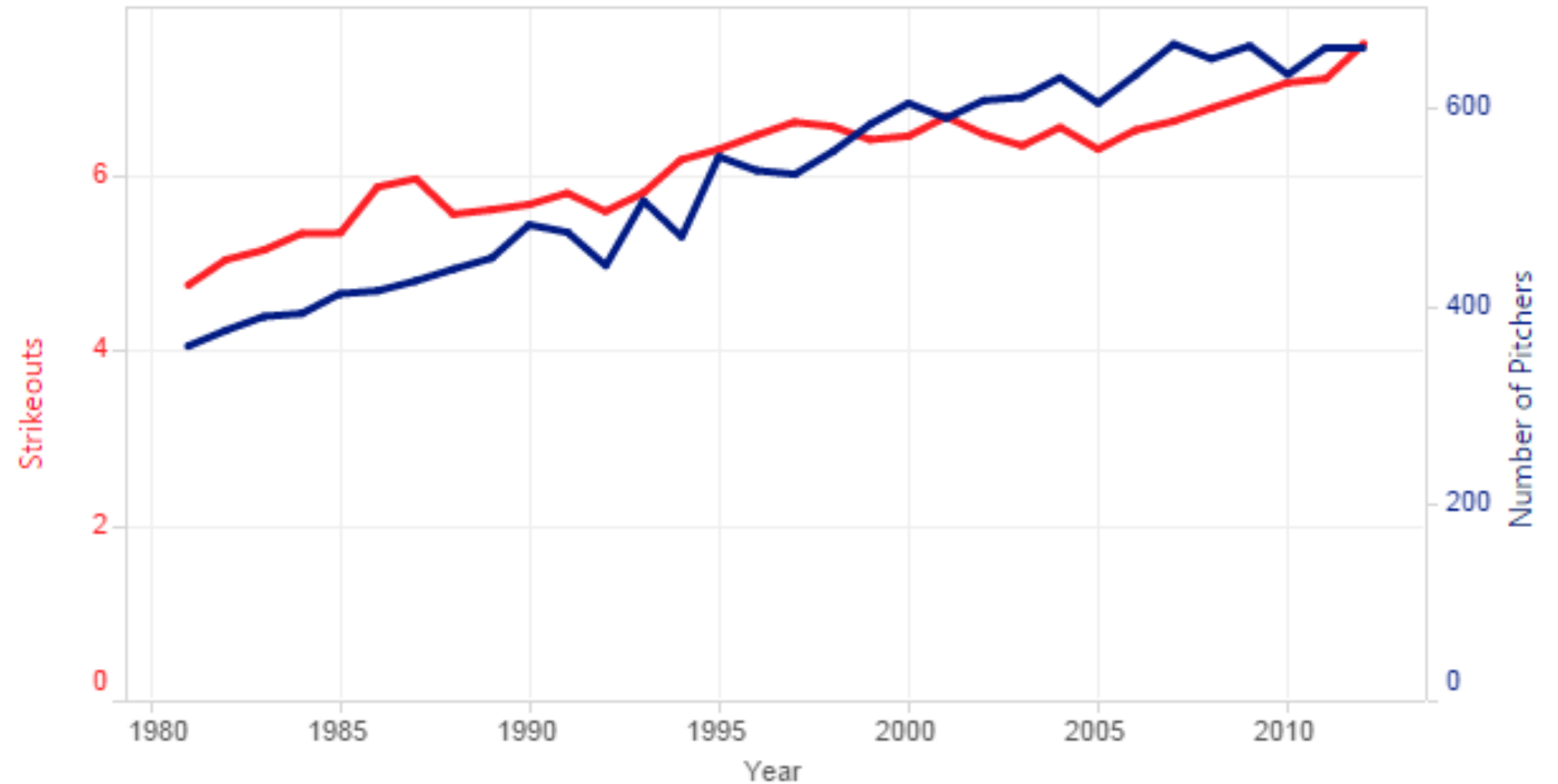
Chart axes

- labelled axis is critical
- avoid cropping y-axis
 - include 0 at bottom left
 - or slope misleads



Idiom: dual-axis line charts

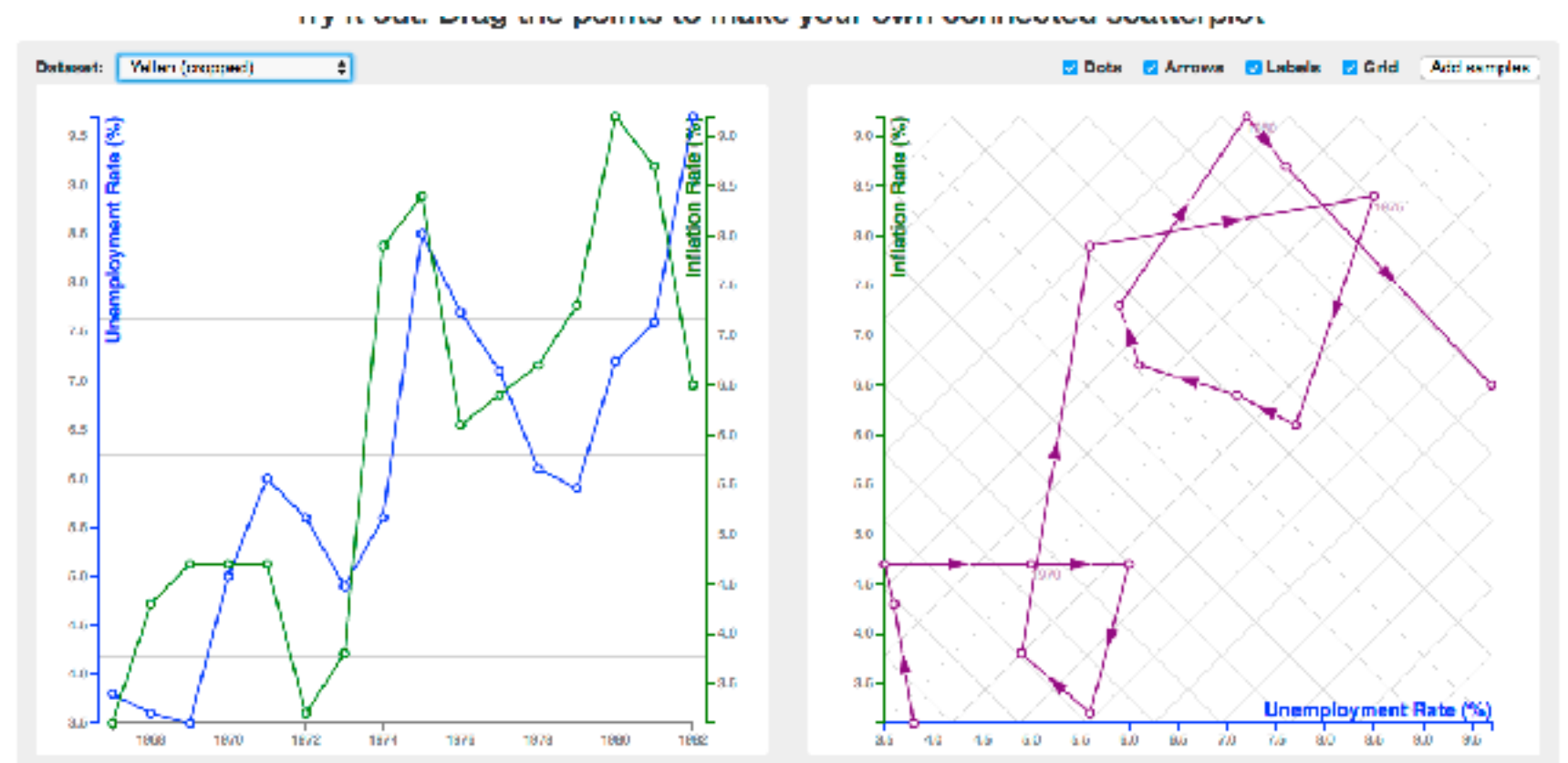
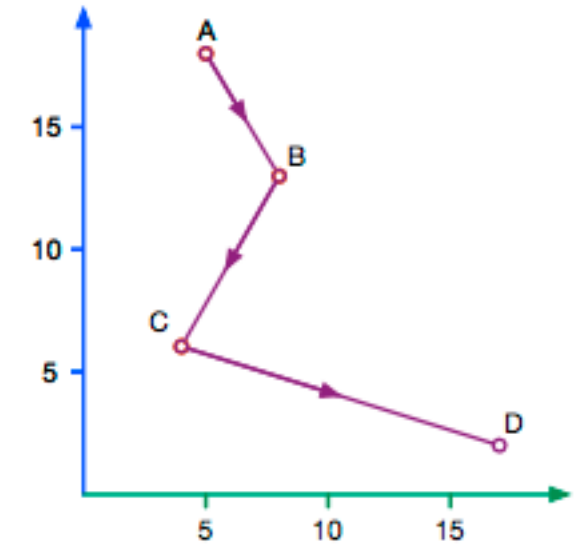
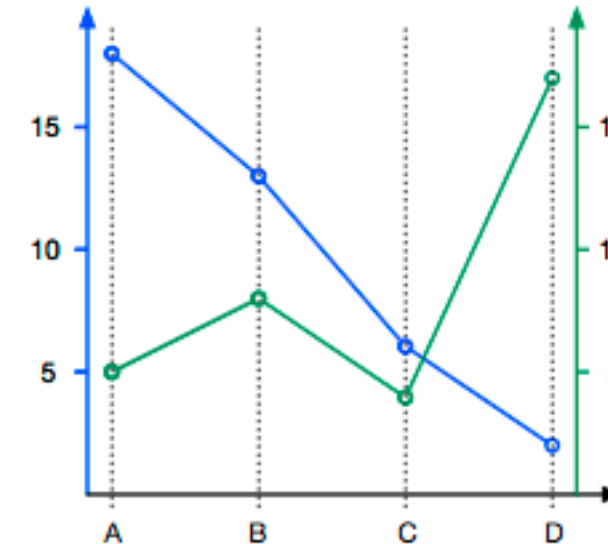
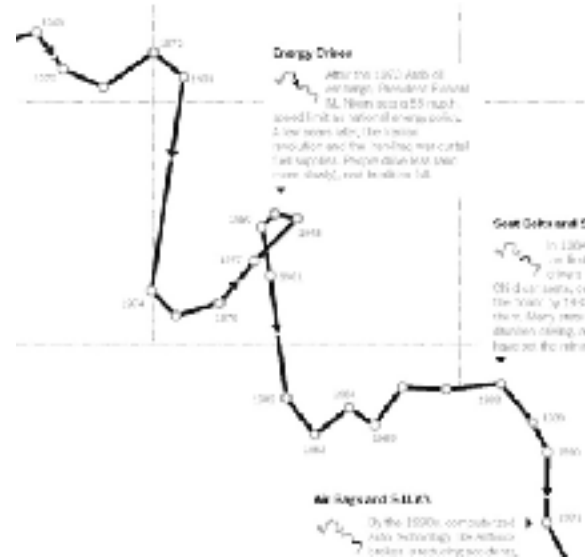
- controversial
 - acceptable if commensurate
 - beware, very easy to mislead!



Source | <http://www.baseball-reference.com/leagues/MLB/pitch.shtml> Ben Jones (@DataRemixed) | 5/4/2013

Idiom: **connected scatterplots**

- scatterplot with line connection marks
 - popular in journalism
 - horiz + vert axes: value attribs
 - line connection marks: temporal order
 - alternative to dual-axis charts
 - horiz: time
 - vert: two value attribs
- empirical study
 - engaging, but correlation unclear



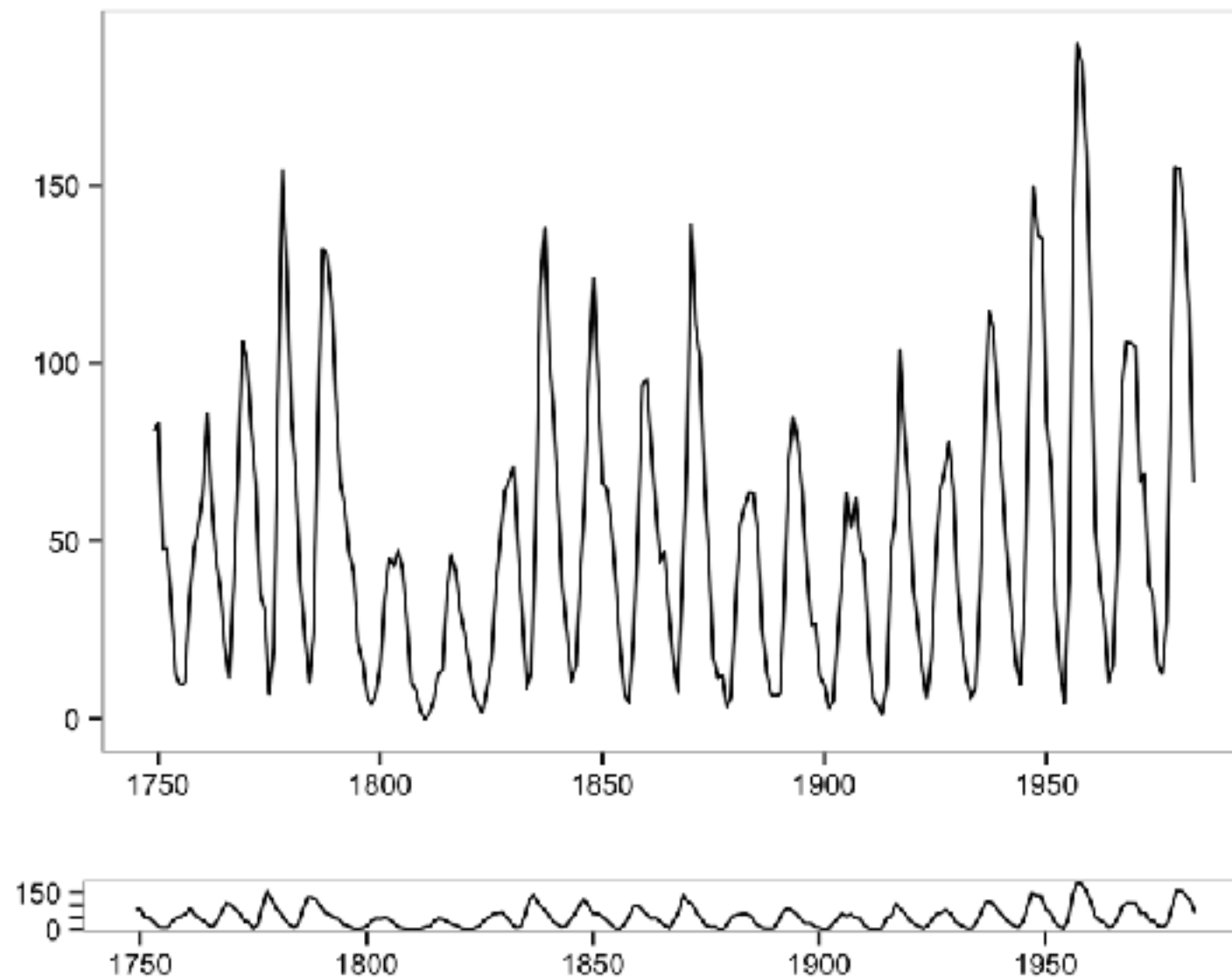
[The Connected Scatterplot for Presenting Paired Time Series.
Haroz, Kosara and Franconeri. IEEE TVCG 22(9):2174-86, 2016.]

http://steveharoz.com/research/connected_scatterplot/

Choosing line chart aspect ratios

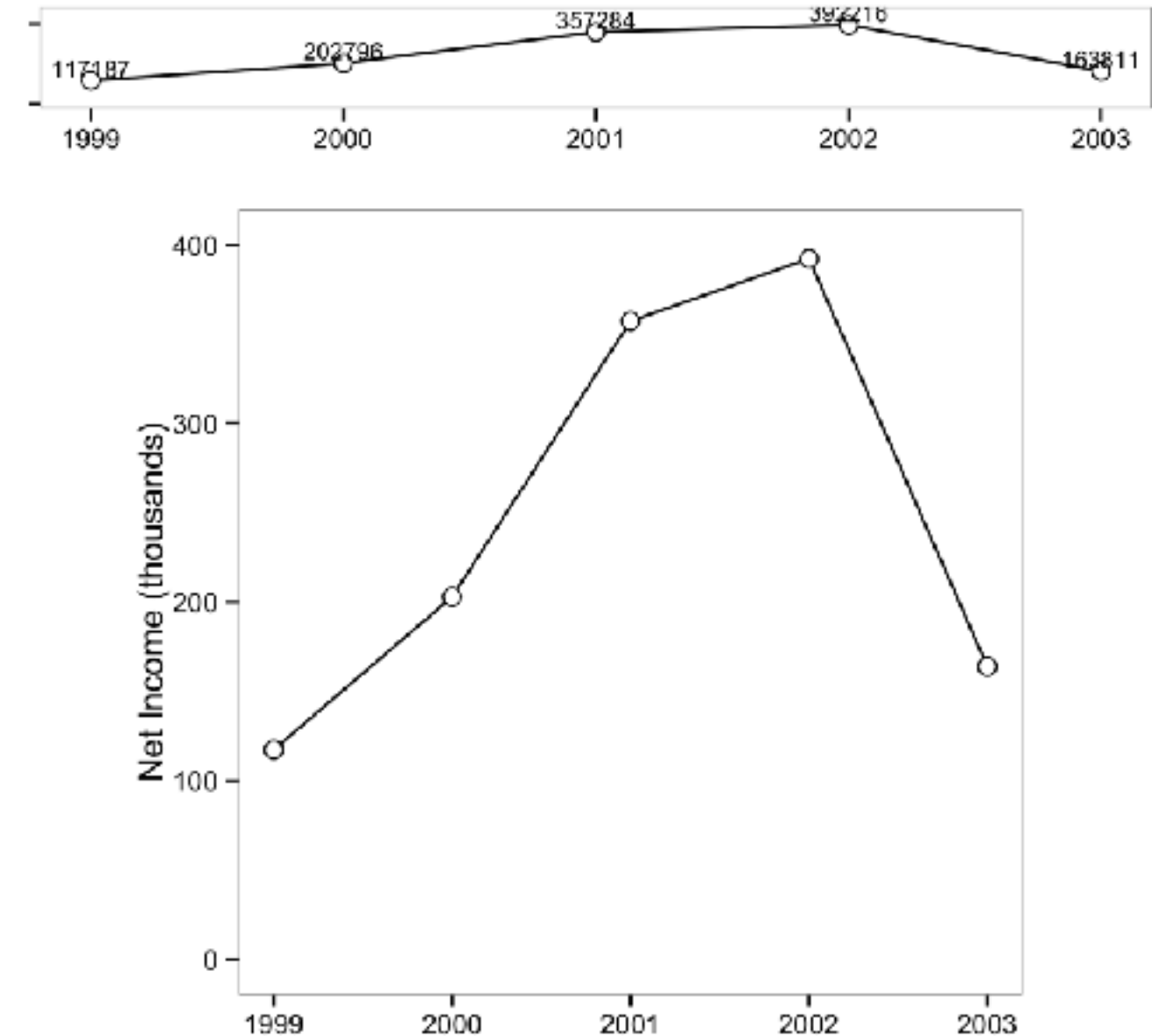
- 1: banking to 45 (1980s)
 - Cleveland perceptual argument: most accurate angle judgement at 45

Fig 7.1 Sunspot Data: Aspect Ratio 1



https://github.com/jennybc/r-graph-catalog/tree/master/figures/fig07-01_sunspot-data-aspect-ratio-1

Fig 7.2 Annual Report: Aspect Ratio 2



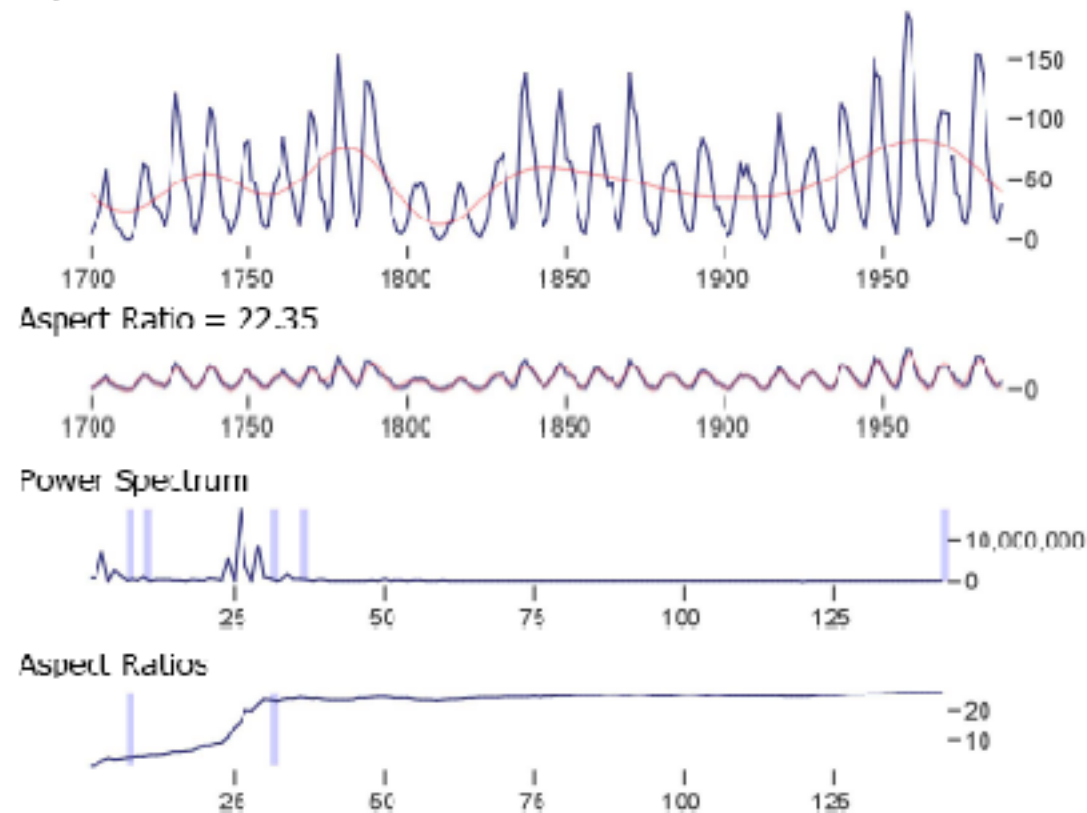
https://github.com/jennybc/r-graph-catalog/tree/master/figures/fig07-02_annual-report-aspect-ratio-2

Choosing line chart aspect ratios

- 2: multi scale banking to 45 (2006)
 - frequency domain analysis to find ratios
 - FFT the data, convolve with Gaussian to smooth
 - find interesting spikes/ranges in power spectrum
 - cull nearby regions if similar, ensure overview
 - create trend curves (red) for each aspect ratio

Sunspot Cycles

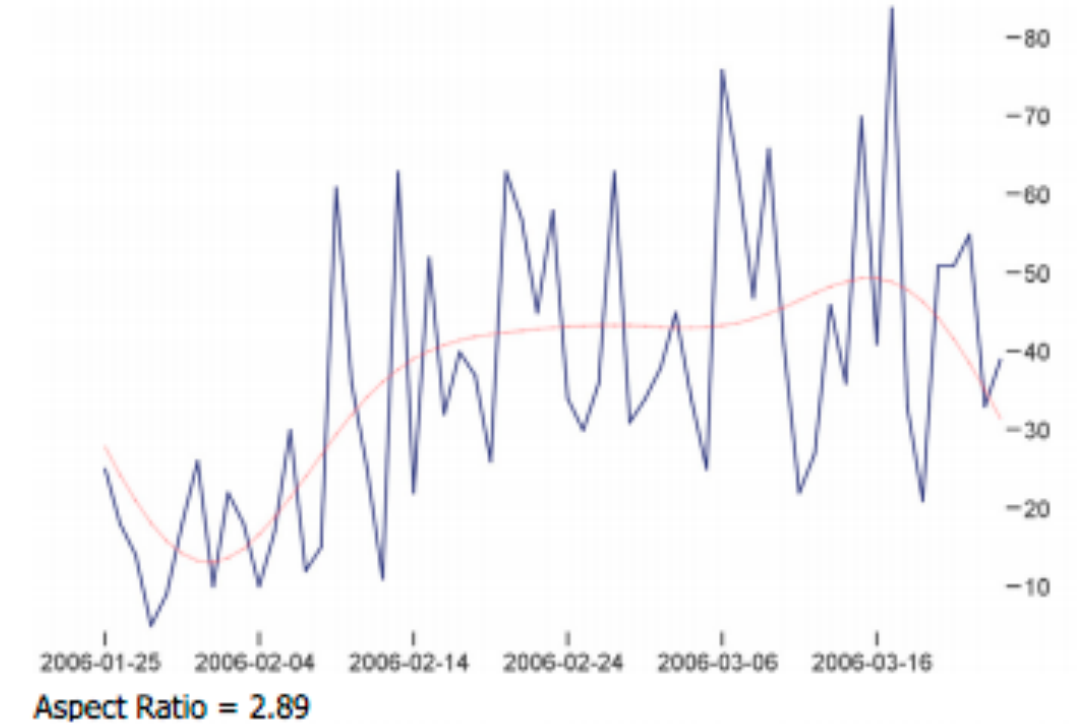
Aspect Ratio = 3.96



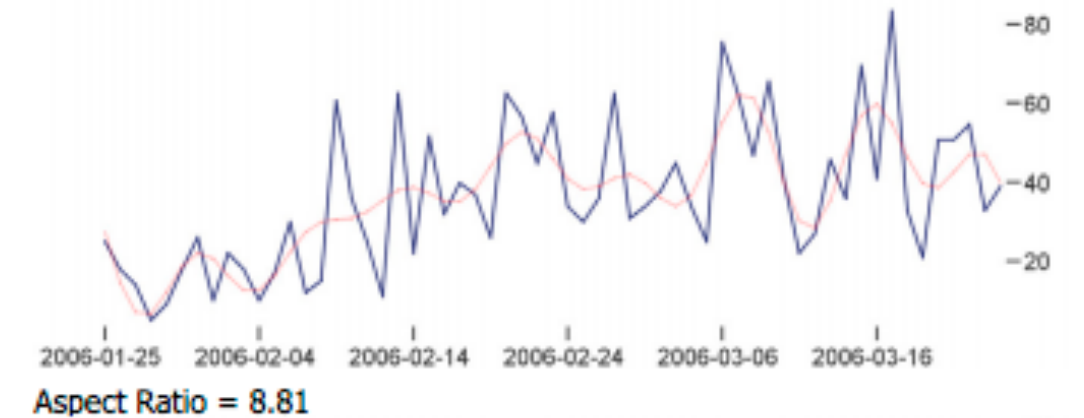
overall

Downloads of the prefuse toolkit

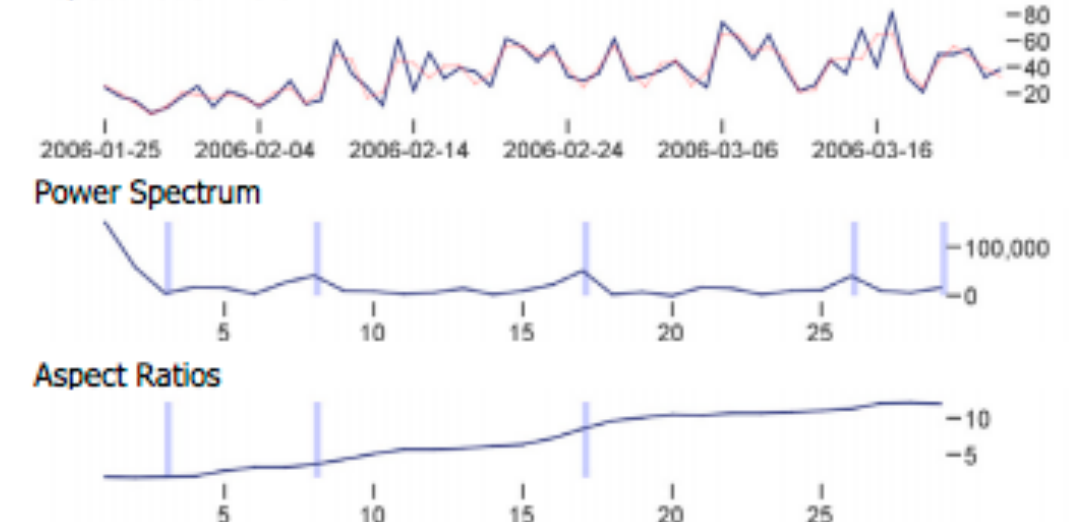
Aspect Ratio = 1.44



weekly



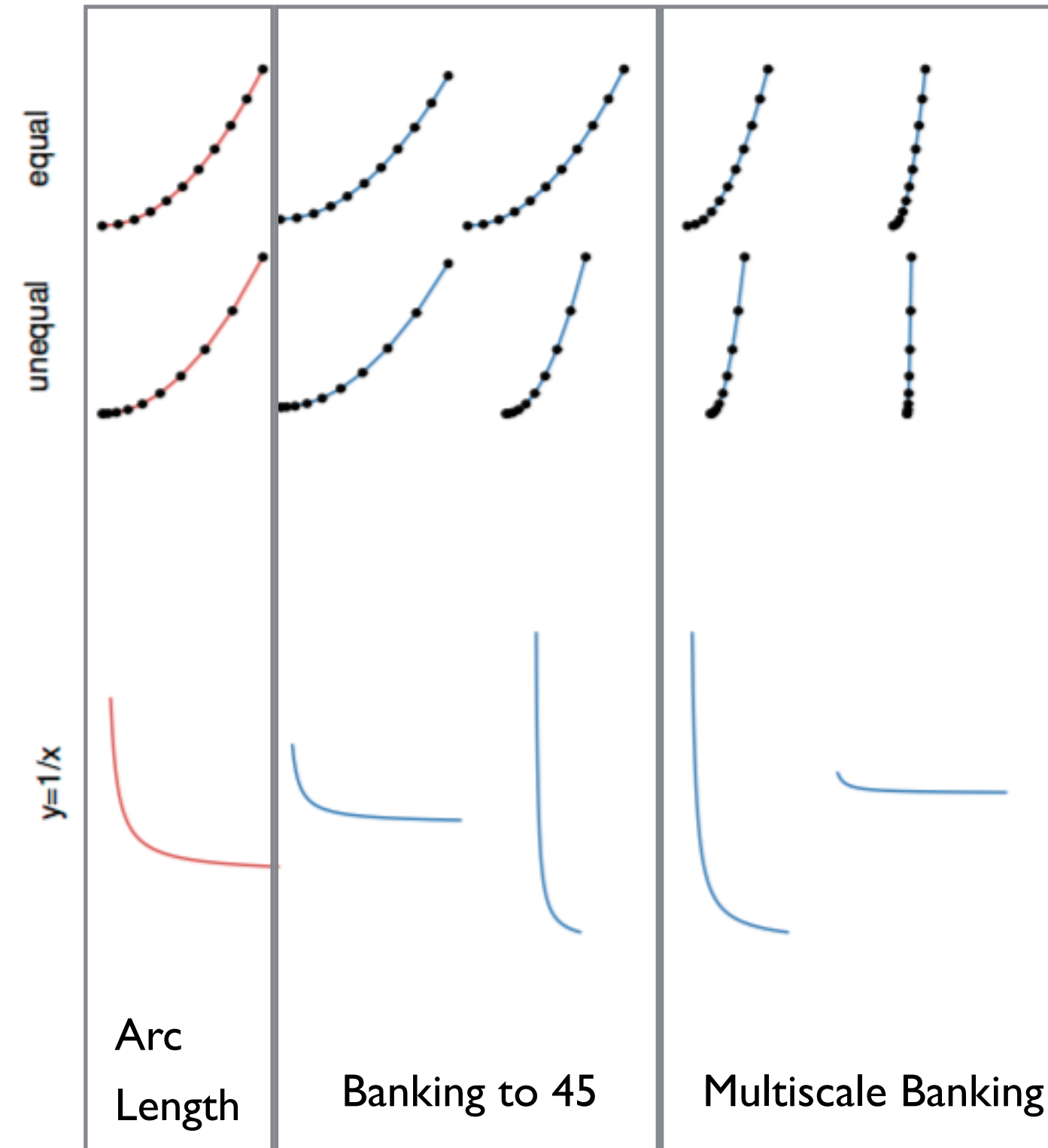
daily



[Multi-Scale Banking to 45 Degrees.
Heer and Agrawala, Proc InfoVis 2006]

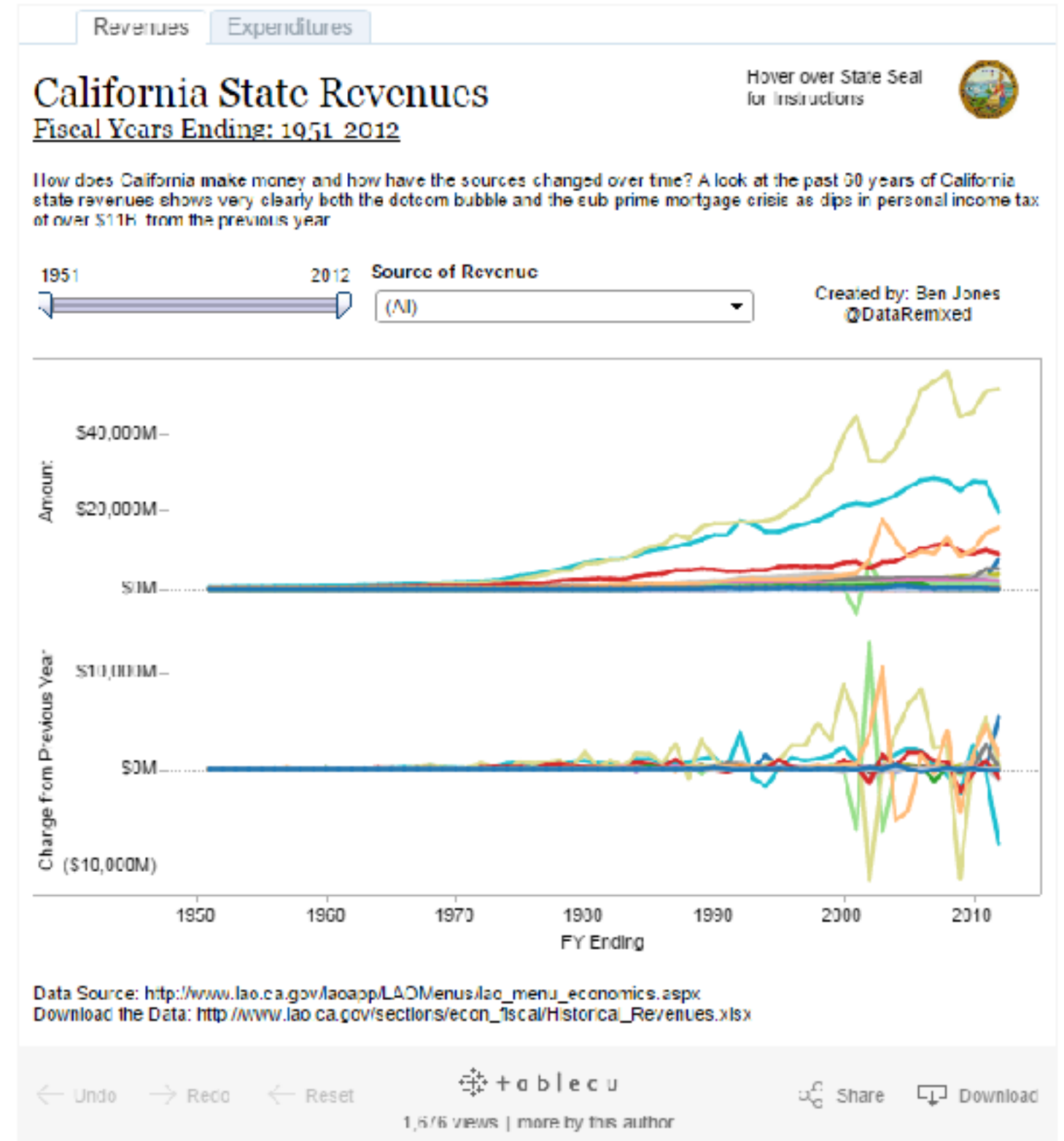
Choosing line chart aspect ratios

- 3: arc length based aspect ratio (2011)
 - minimize the arc length of curve while keeping the area of the plot constant
 - parametrization and scale invariant
 - symmetry preserving
 - robust & fast to compute
- meta-points from this progression
 - young field; prescriptive advice changes rapidly
 - reasonable defaults required deep dive into perception meets math



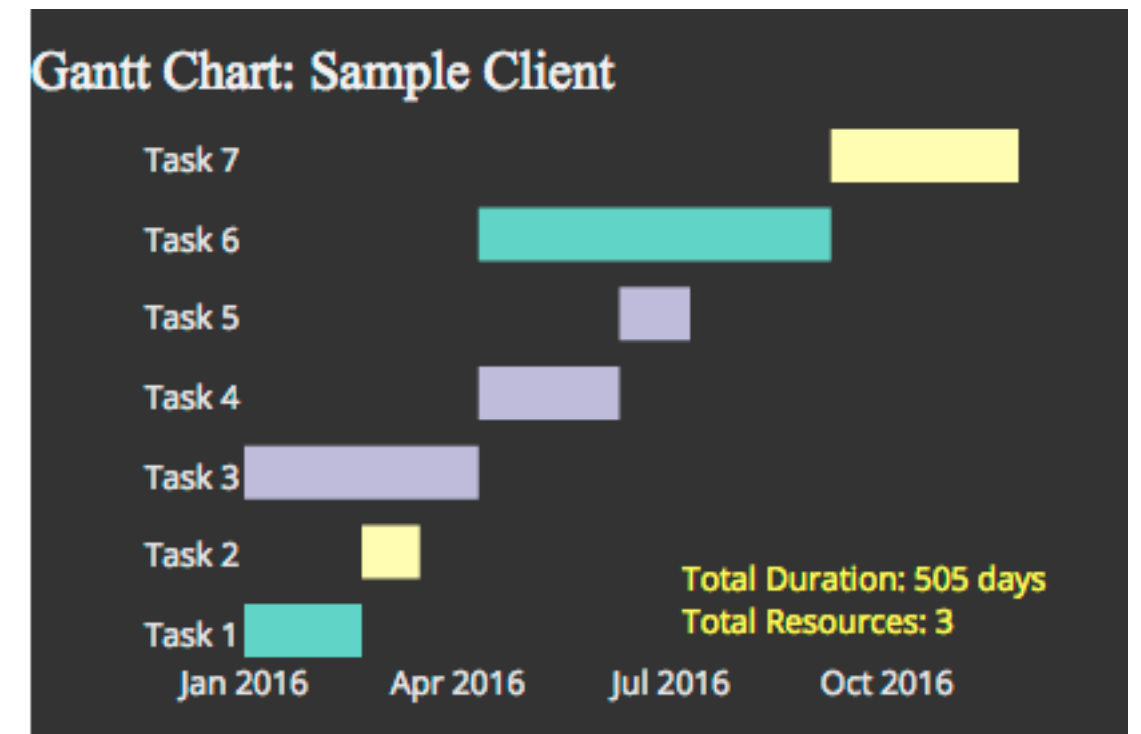
Idiom: Indexed line charts

- data: 2 quant attires
 - 1 key + 1 value
- derived data: new quant value attrib
 - index
 - plot instead of original value
- task: show change over time
 - principle: normalized, not absolute
- scalability
 - same as standard line chart

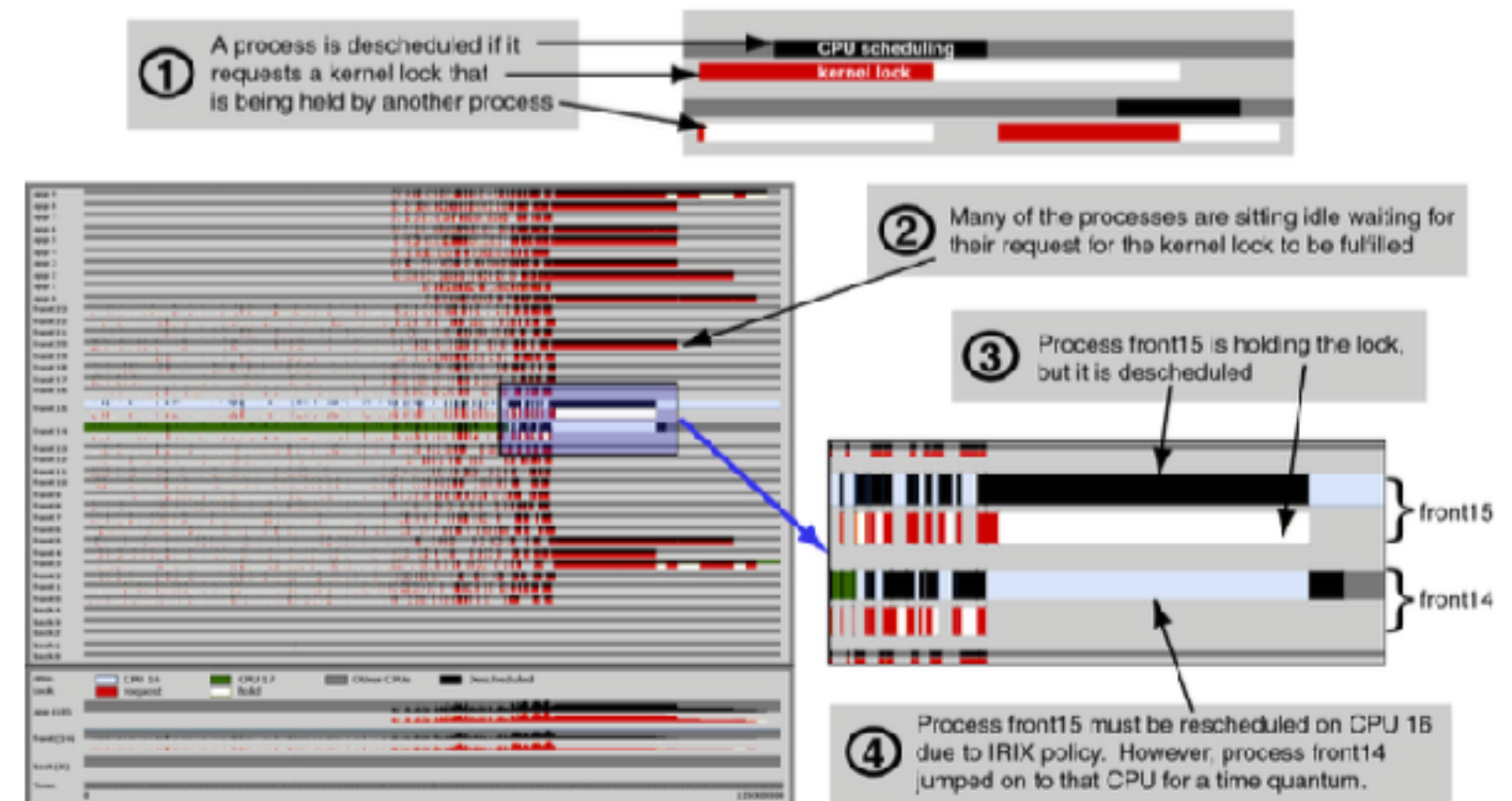


Idiom: Gantt charts

- one key, two (related) values
 - data
 - 1 categ attrib, 2 quant attribs
 - mark: line
 - length: duration
 - channels
 - horiz position: start time (+end from duration)
- task
 - emphasize temporal overlaps, start/end dependencies between items
- scalability
 - dozens of key levels
 - hundreds of value levels



<https://www.r-bloggers.com/gantt-charts-in-r-using-plotly/>

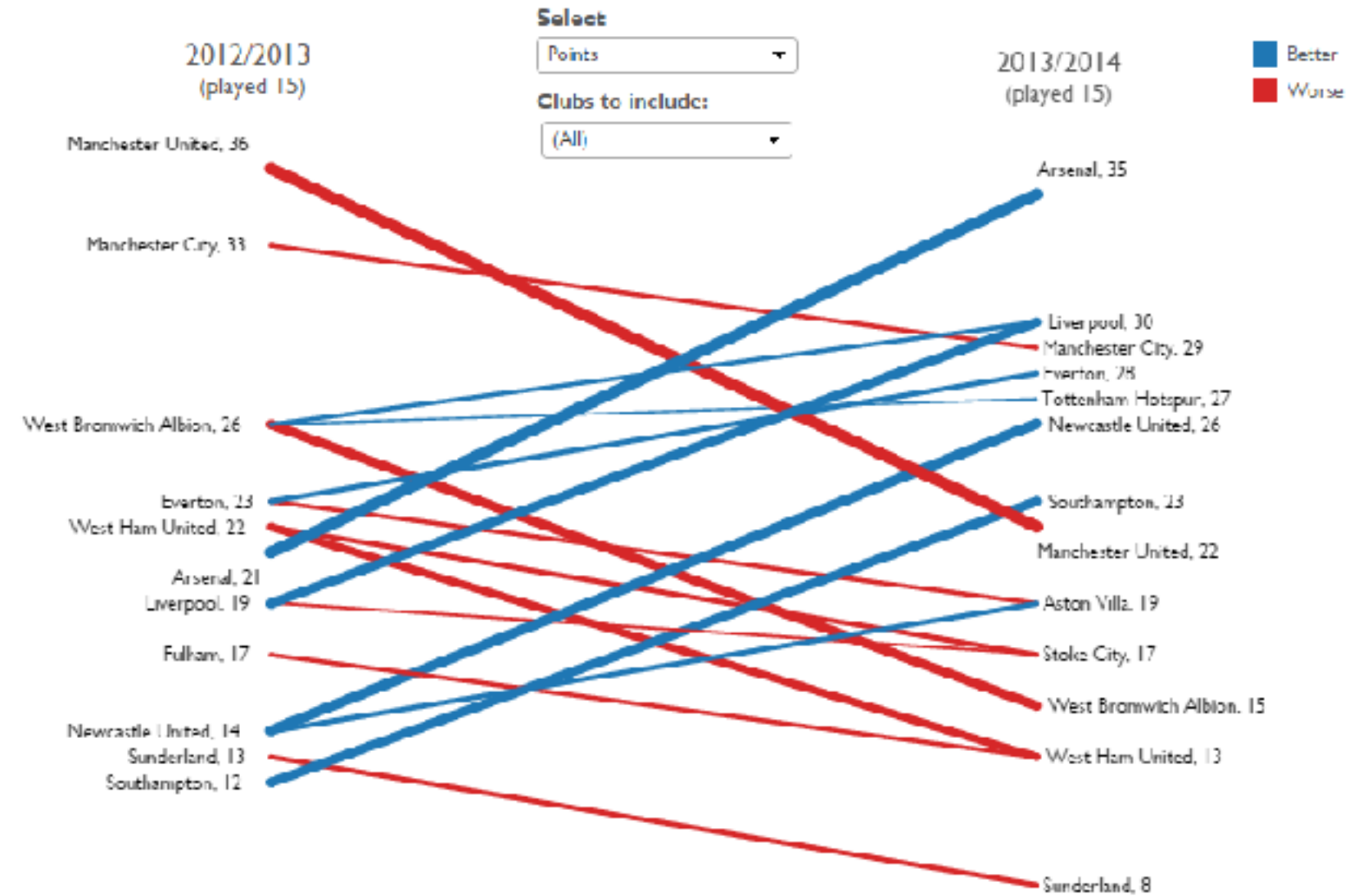


[Performance Analysis and Visualization of Parallel Systems Using SimOS and Rivet: A Case Study. Bosch, Stolte, Stoll, Rosenblum, and Hanrahan. Proc. HPCA 2000.]

Idiom: Slopegraphs

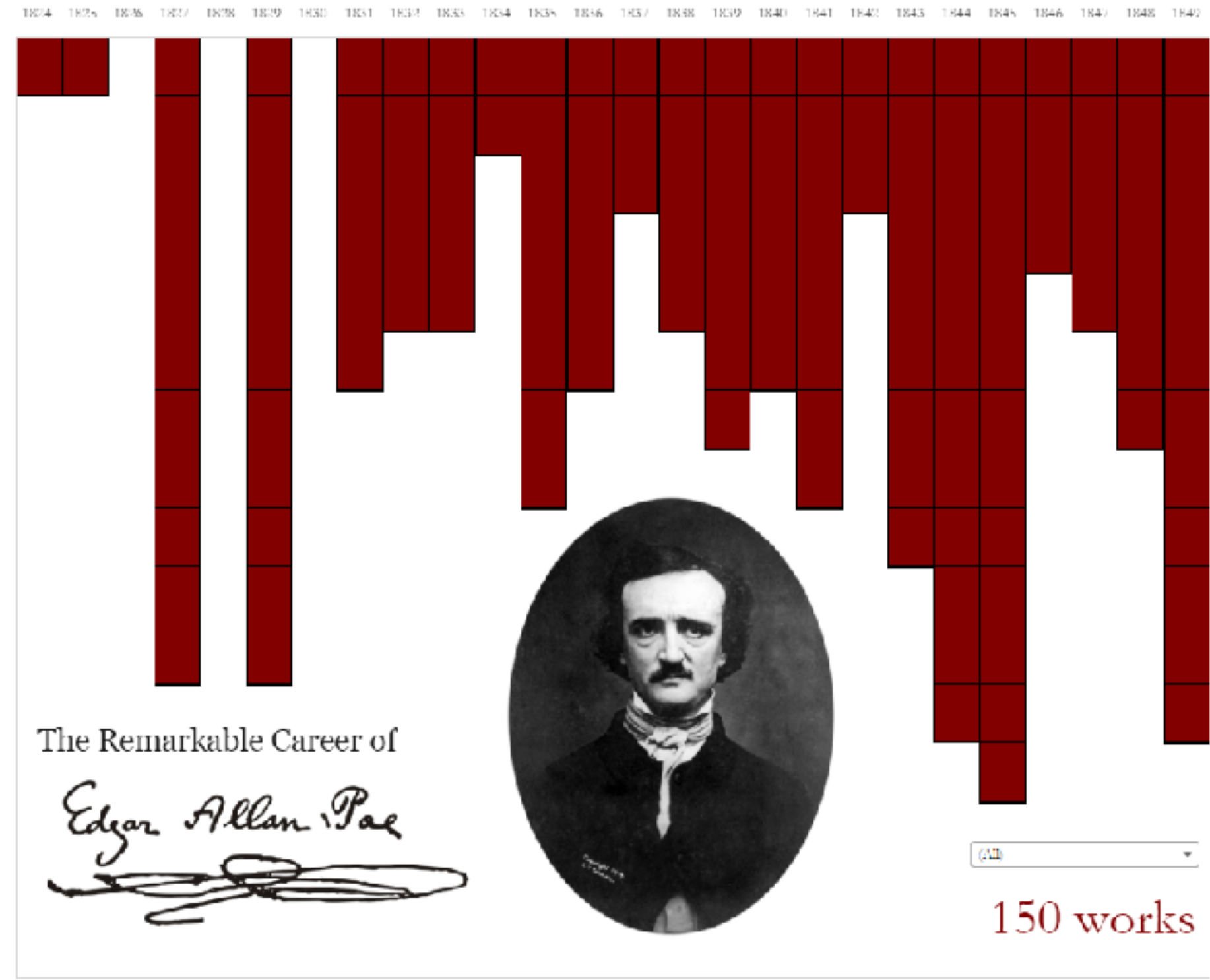
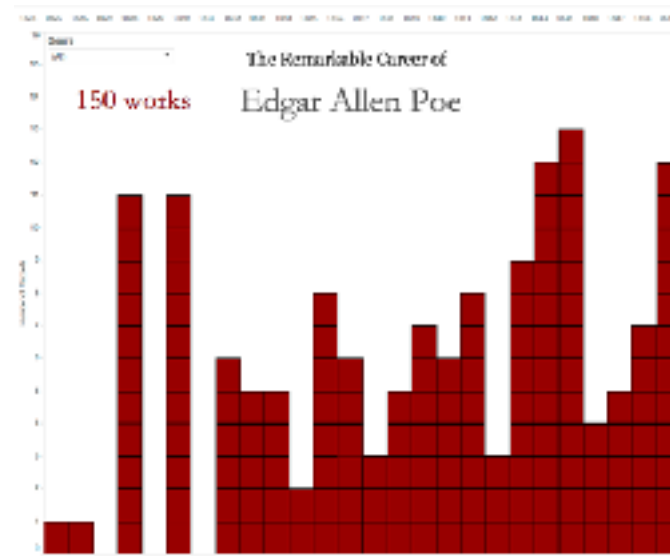
- two values
 - data
 - 2 quant value attribs
 - (1 derived attrib: change magnitude)
 - mark: point + line
 - line connecting mark between pts
 - channels
 - 2 vertical pos: express attrib value
 - (linewidth/size, color)
 - task
 - emphasize changes in rank/value
 - scalability
 - hundreds of value levels

Barclay's Premier League Tables: Comparing 2012/2013 Starts to 2013/2014 Starts



Breaking conventions

- presentation vs exploration
 - engaging/evocative
 - inverted y axis
 - blood drips down on Poe



Source: https://en.wikipedia.org/wiki/Edgar_Allan_Poe_bibliography

Ben Jones, 7 October 2015

<https://public.tableau.com/profile/ben.jones#!/vizhome/EdgarAllanPoeBoring/EdgarAllenPoeBoring>

<https://public.tableau.com/profile/ben.jones#!/vizhome/EdgarAllanPoeViz/EdgarAllanPoeViz>

[Slide inspired by Ben Jones]

2 Keys

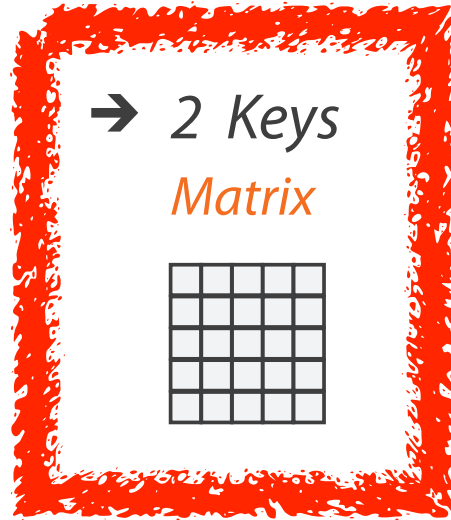
➔ Express Values



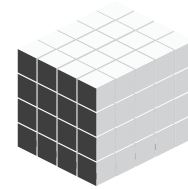
➔ 1 Key
List



➔ 2 Keys
Matrix



➔ 3 Keys
Volume



➔ Many Keys
Recursive Subdivision



Idiom: heatmap

- two keys, one value

- data

- 2 categ attribs (gene, experimental condition)
 - 1 quant attrib (expression levels)

- marks: point

- separate and align in 2D matrix
 - indexed by 2 categorical attributes

- channels

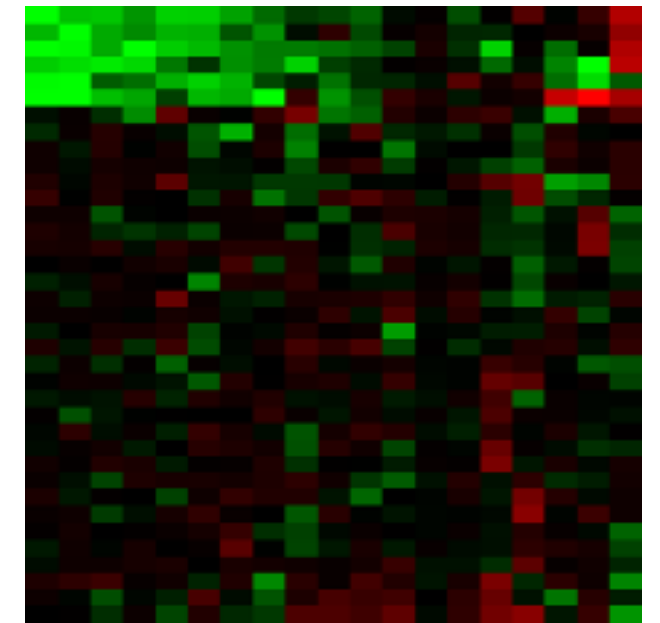
- color by quant attrib
 - (ordered diverging colormap)

- task

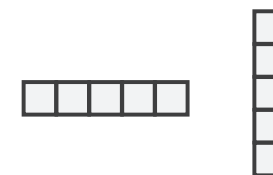
- find clusters, outliers

- scalability

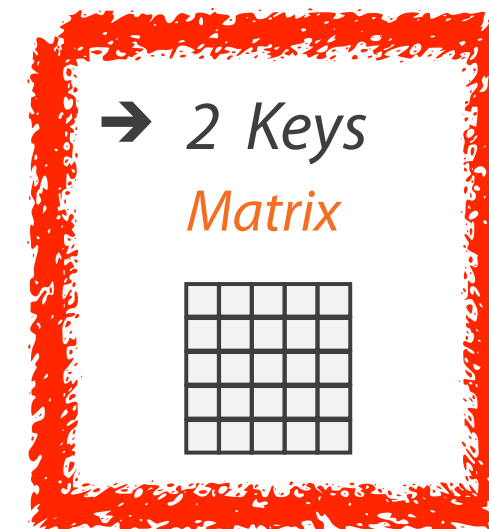
- 1M items, 100s of categ levels, ~10 quant attrib levels



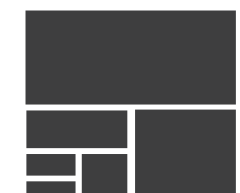
→ 1 Key
List



→ 2 Keys
Matrix

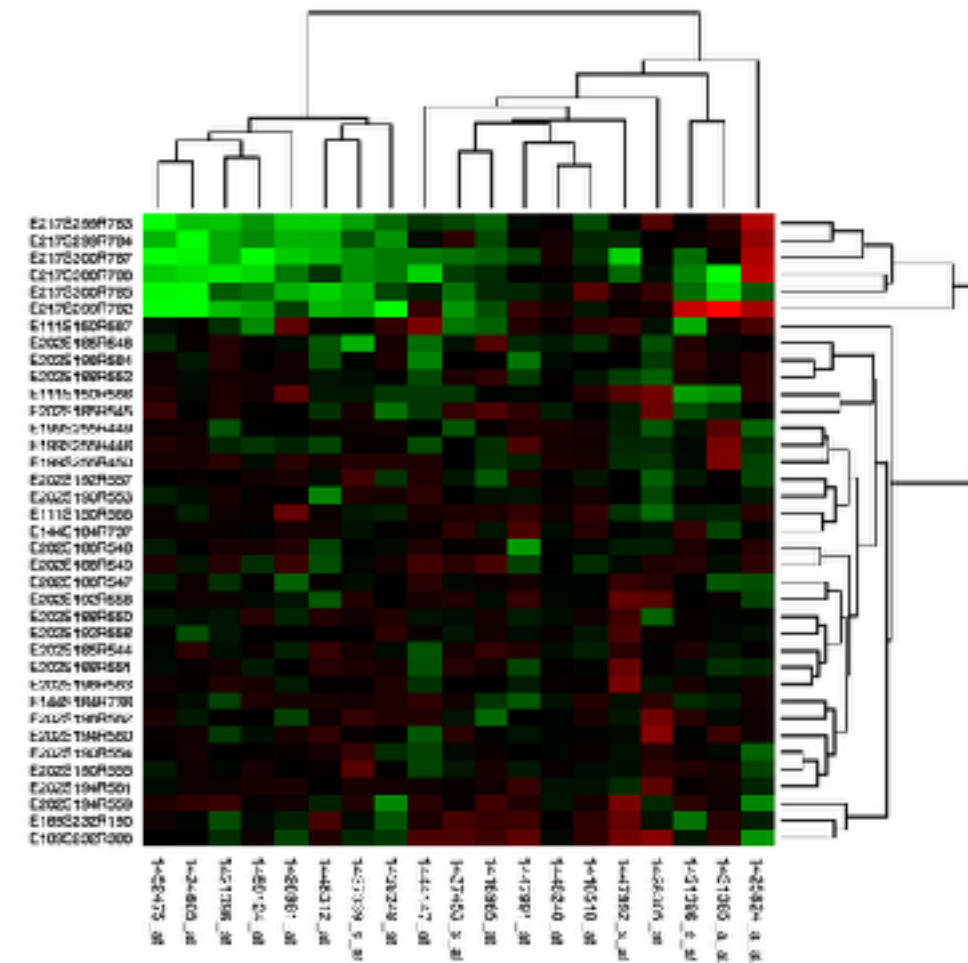


→ Many Keys
Recursive Subdivision



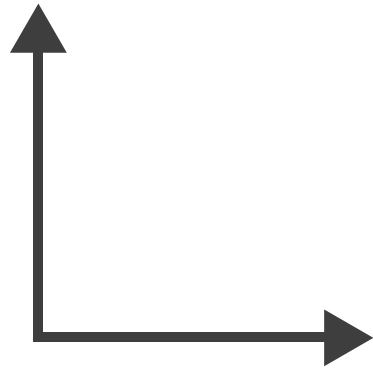
Idiom: cluster heatmap

- 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
 - task: assess quality of clusters found by automatic methods

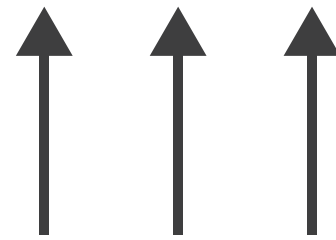


➔ Axis Orientation

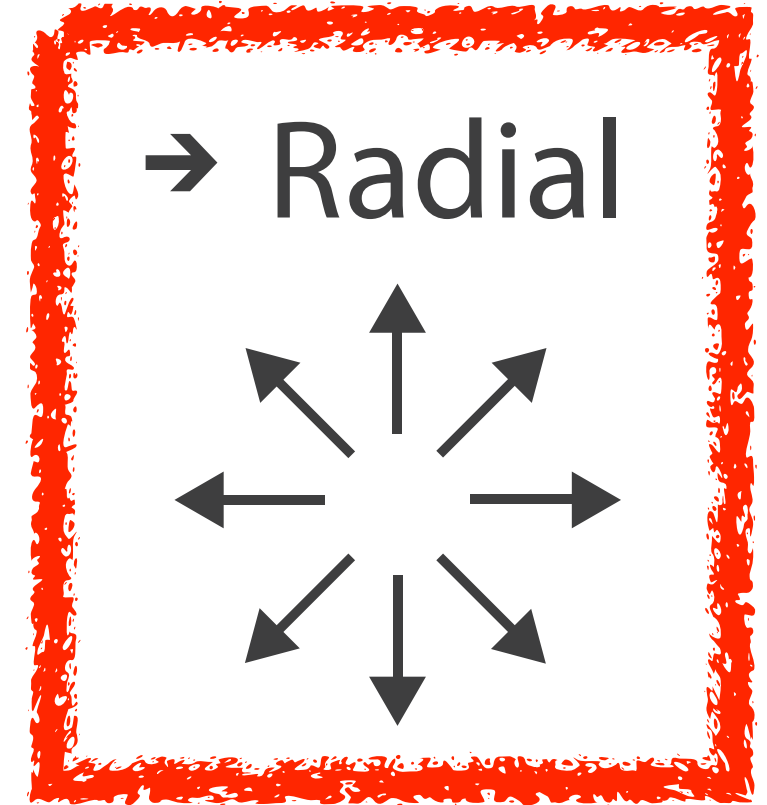
➔ Rectilinear



➔ Parallel

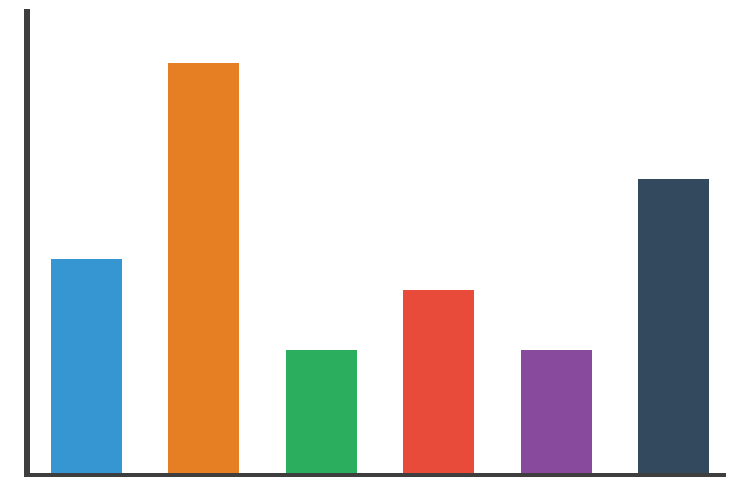


➔ Radial

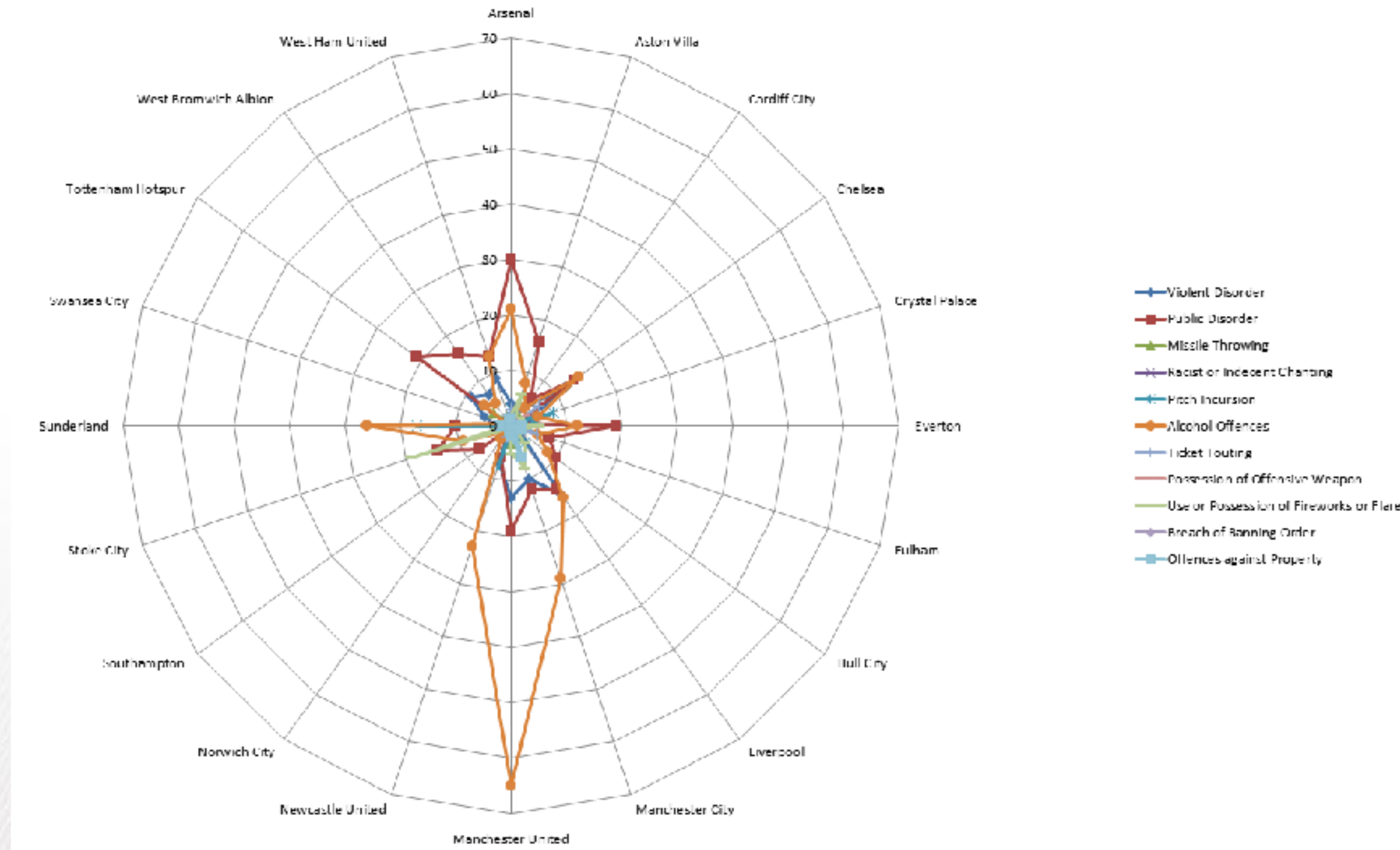


Idioms: **radial bar chart**, **star plot**

- 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



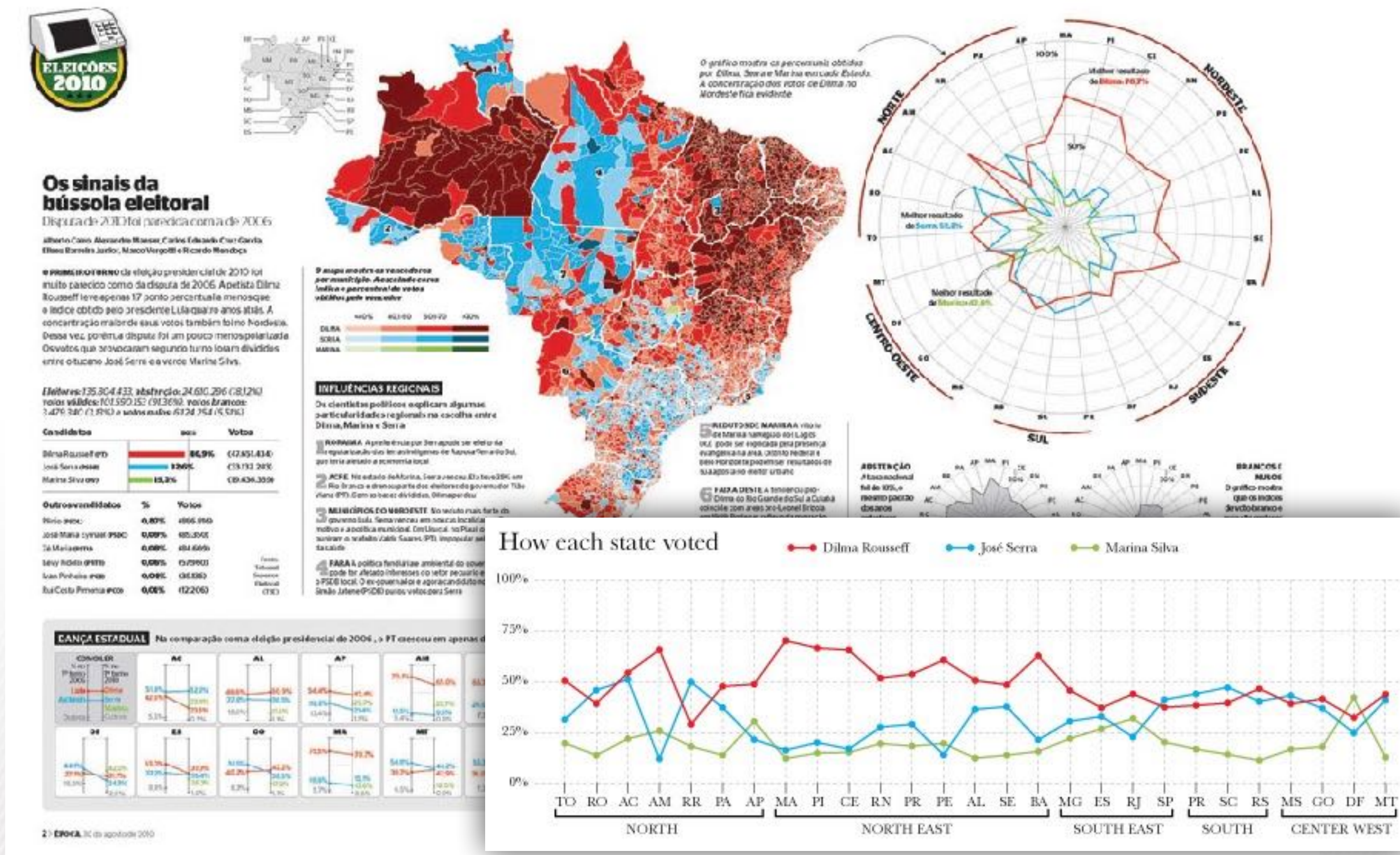
Radial Orientation: Radar Plots



LIMITATION: Not good when categories aren't cyclic

[Slide courtesy of Ben Jones]

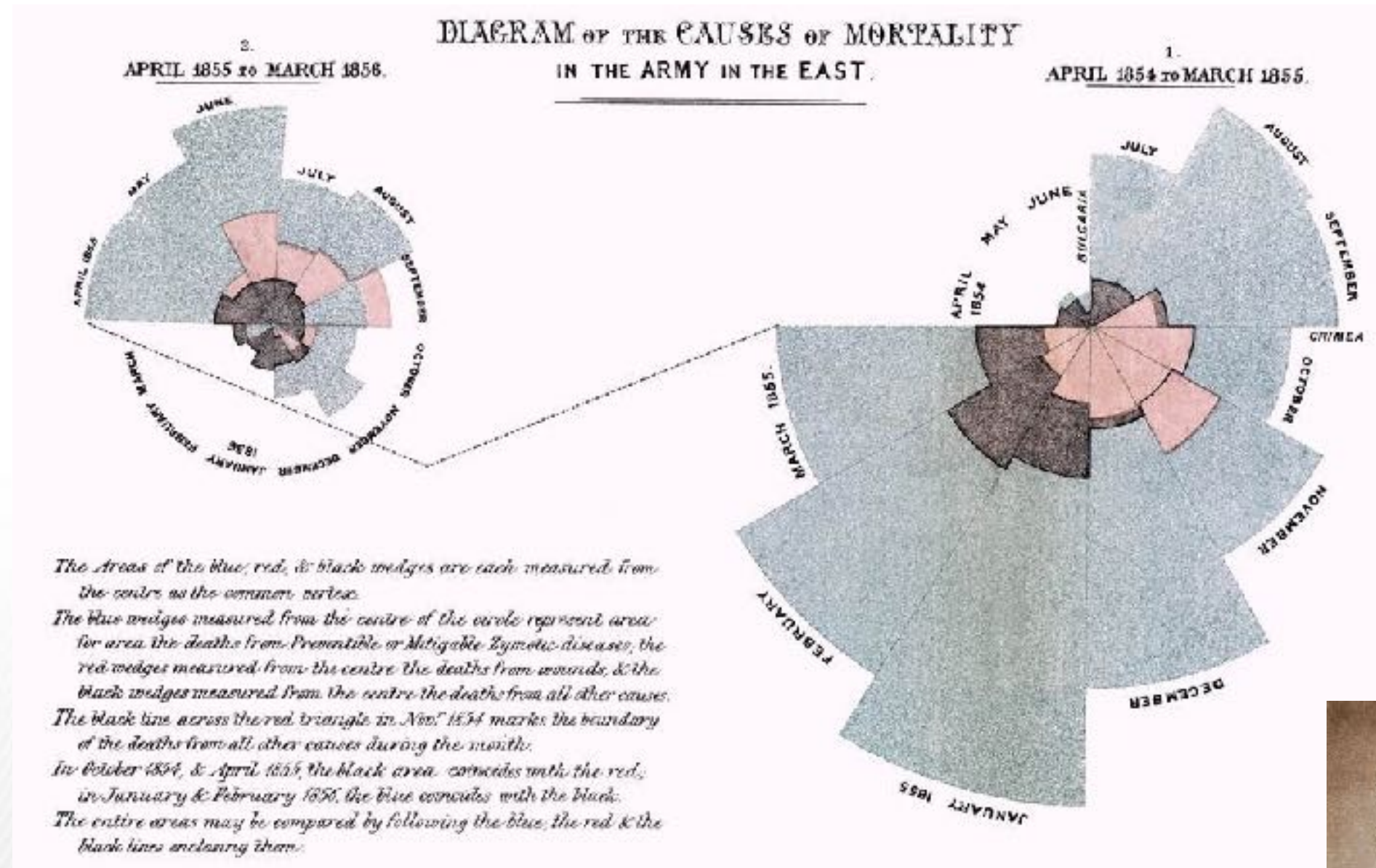
“Radar graphs: Avoid them (99.9% of the time)”



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

[Slide courtesy of Ben Jones]

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



Idioms: pie chart, polar area chart

- pie chart

- line marks with angle channel: variable (sector) width
- separated & aligned radially, uniform height
- perceived: probably not angle! maybe area or arc length
- accuracy: all are less accurate than line length

- polar area chart

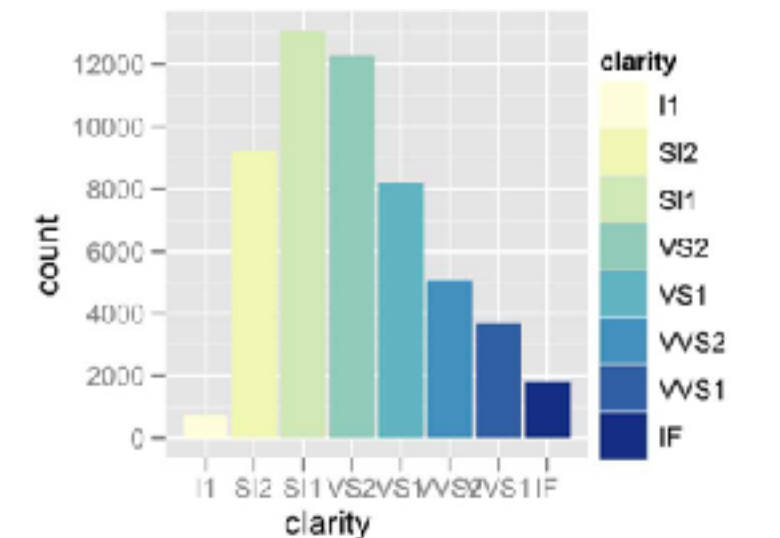
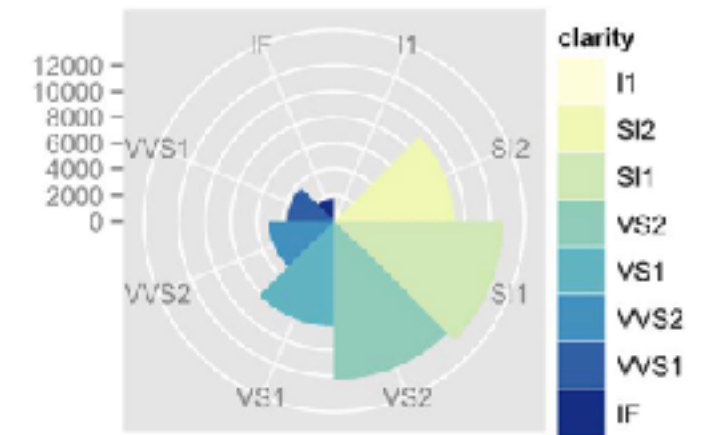
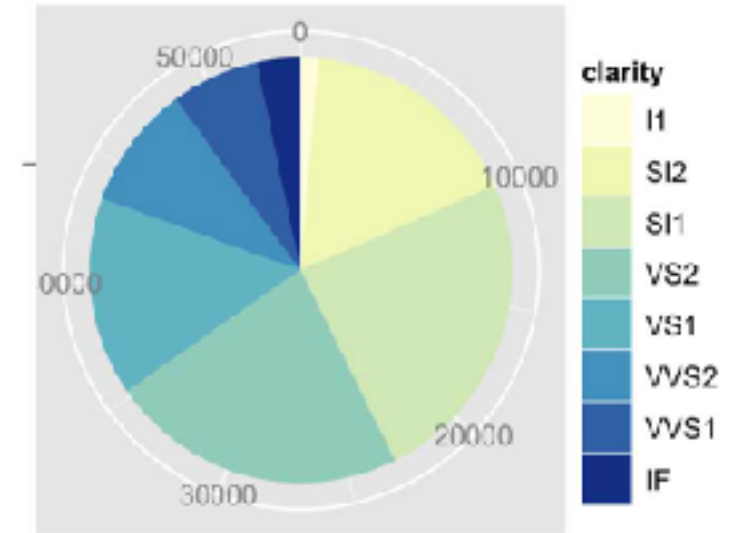
- line marks with length channel: variable length
- separated & aligned radially, uniform width
- more direct analog to bar charts

- data

- I categ key attrib, I quant value attrib

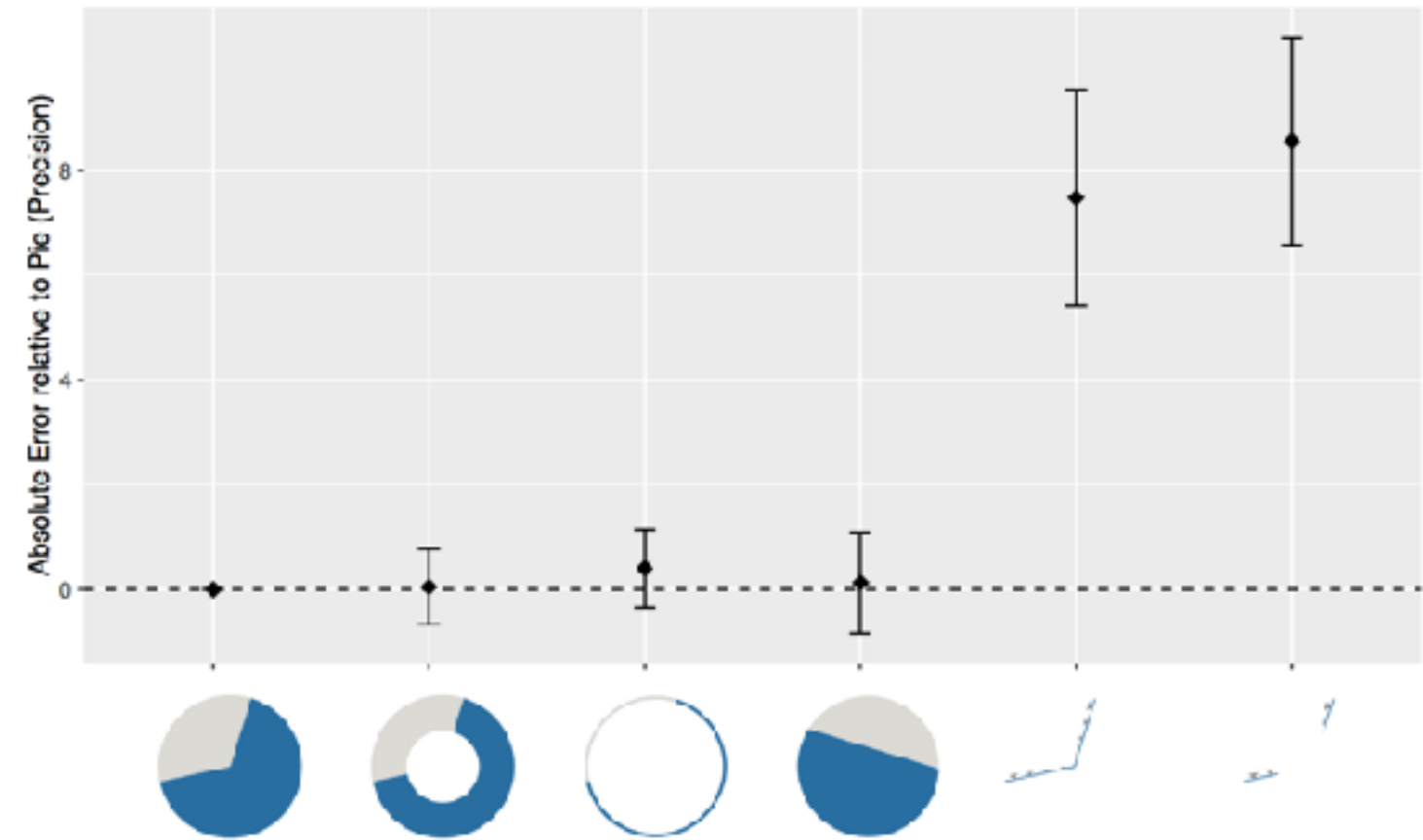
- task

- part-to-whole judgements



Pie chart perception

- some empirical evidence that people respond to arc length
 - not angles
 - maybe also areas?...
- donut charts no worse than pie charts

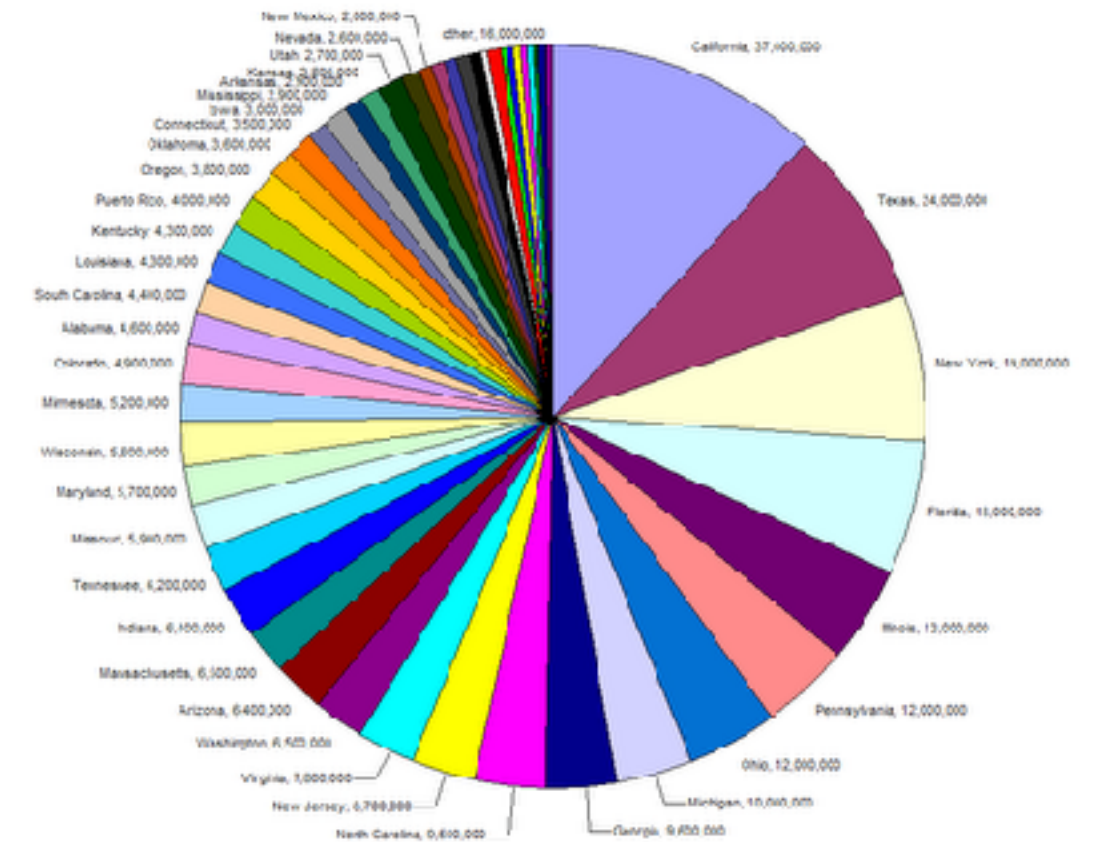
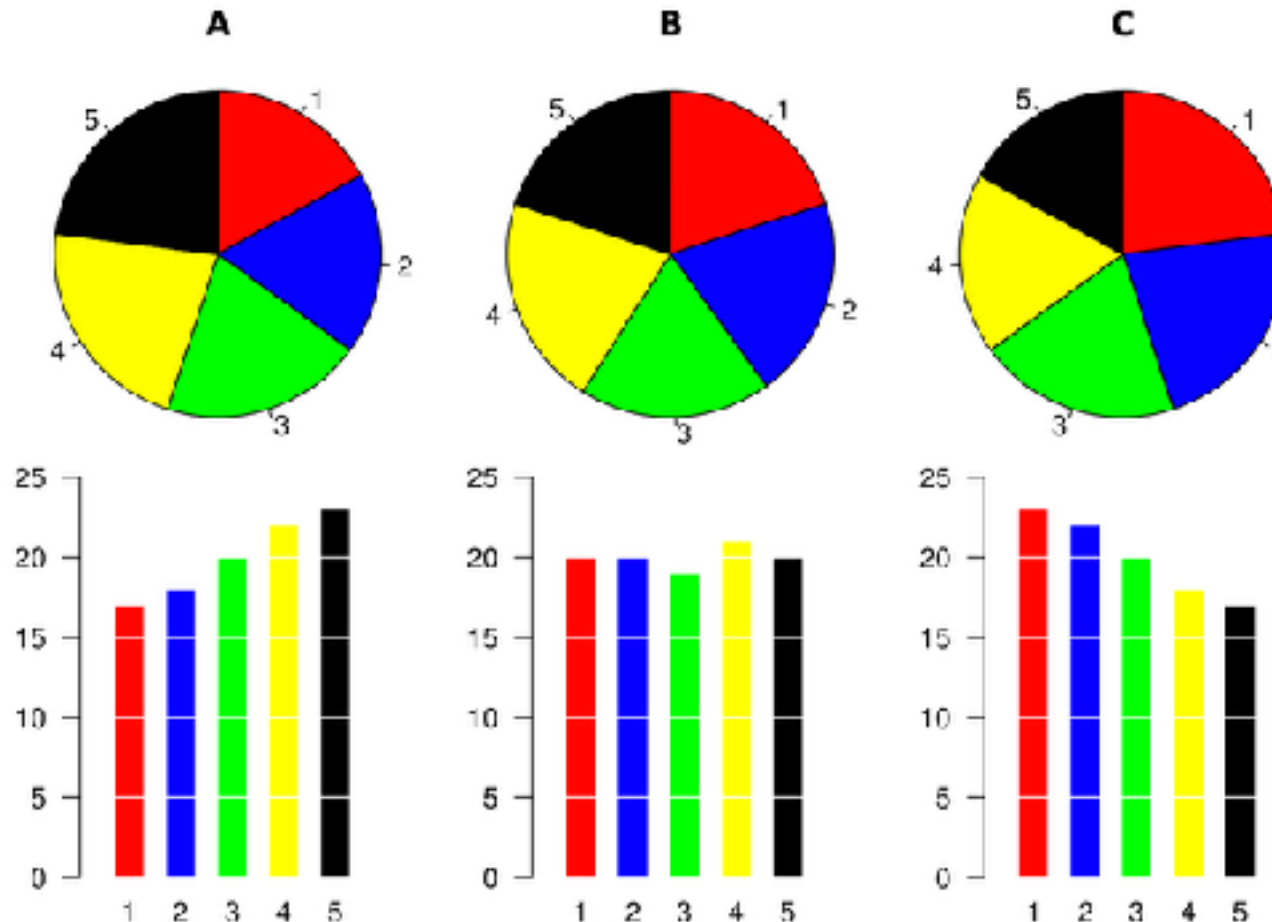


[Arcs, Angles, or Areas: Individual Data Encodings in Pie and Donut Charts. Skau and Kosara. Proc. EuroVis 2016.]

<https://eagereyes.org/blog/2016/an-illustrated-tour-of-the-pie-chart-study-results>

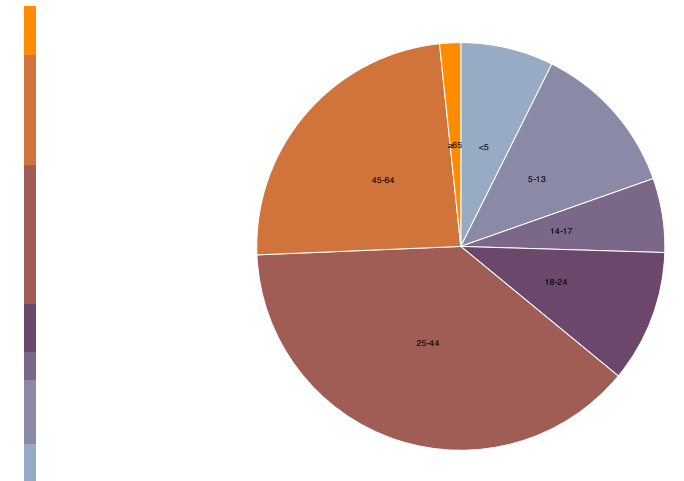
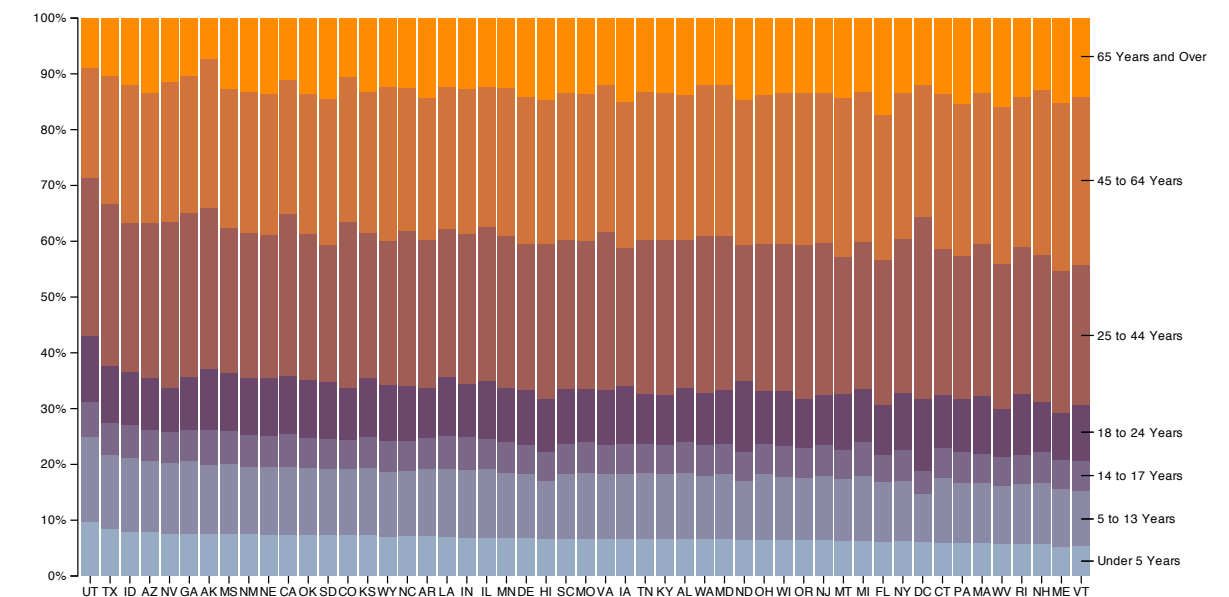
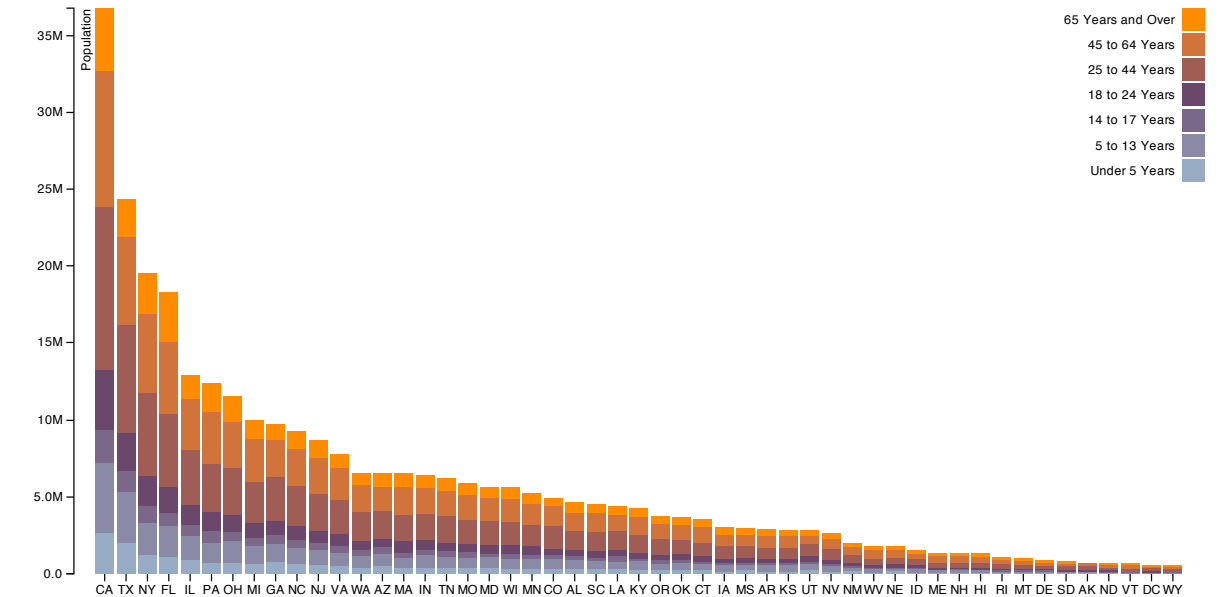
Pie chart best practices

- not bad for two (or few) levels, for part-to-whole task
- dubious for several levels if details matter
- terrible for many levels



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/3886208>,

<http://bl.ocks.org/mbostock/3887235>,

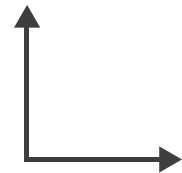
<http://bl.ocks.org/mbostock/3886394>.

Idiom: **glyphmaps**

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

➔ Axis Orientation

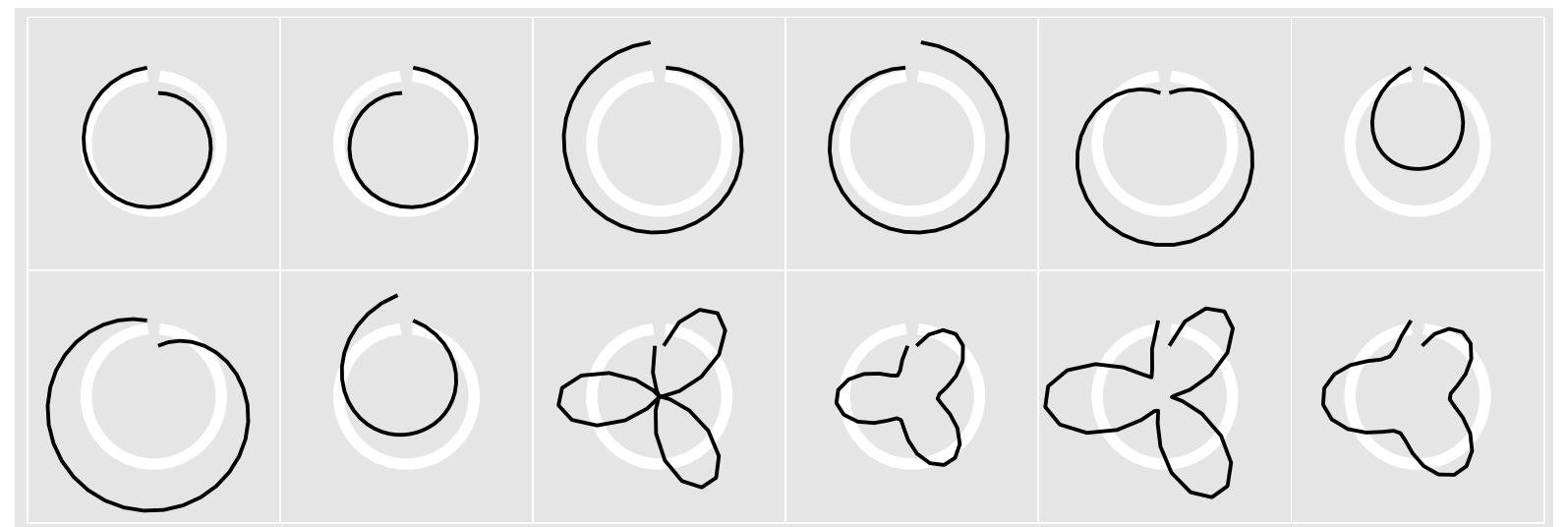
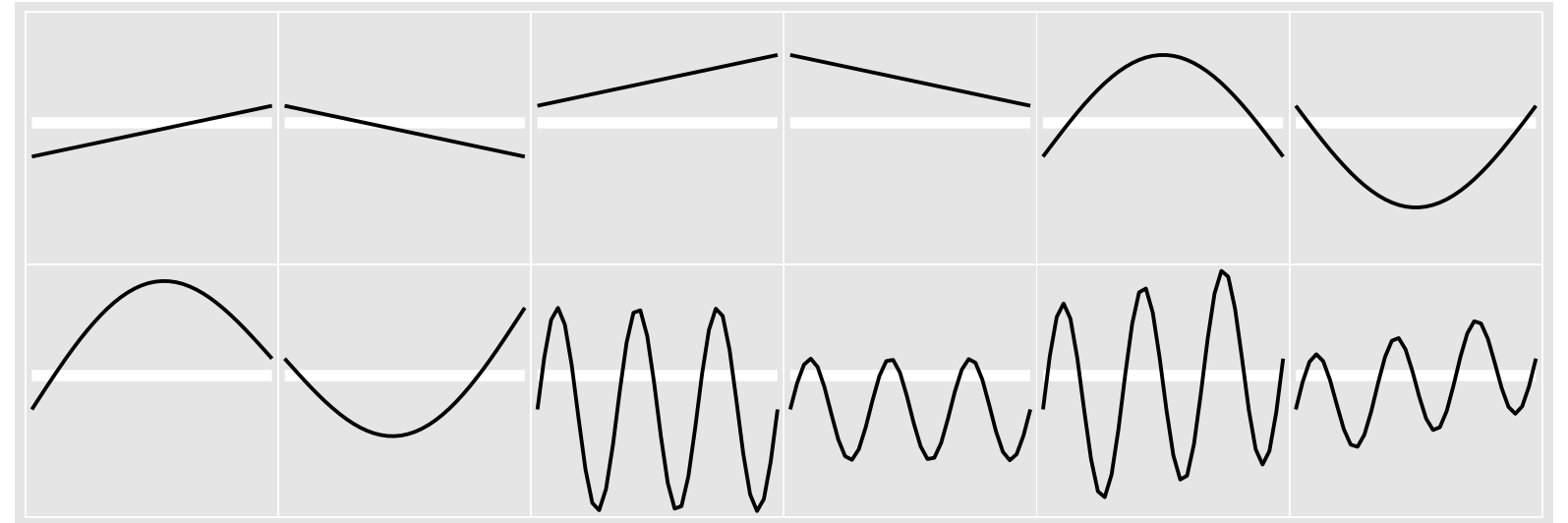
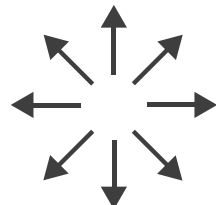
➔ Rectilinear



➔ Parallel



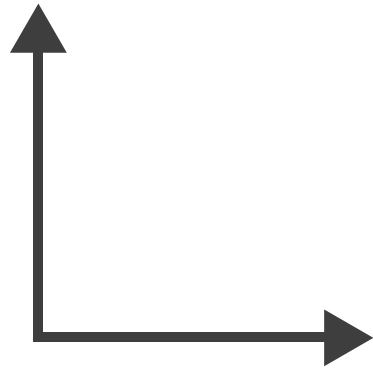
➔ Radial



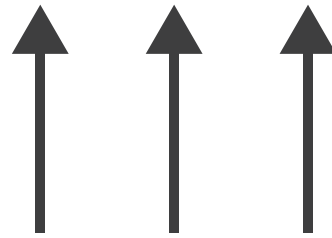
[Glyph-maps for Visually Exploring Temporal Patterns in Climate Data and Models. Wickham, Hofmann, Wickham, and Cook. *Environmetrics* 23:5 (2012), 382–393.]

➔ Axis Orientation

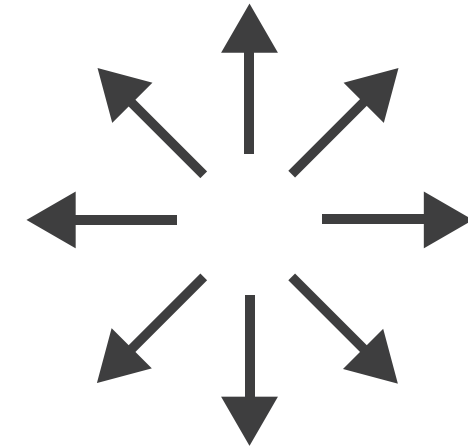
➔ Rectilinear



➔ Parallel

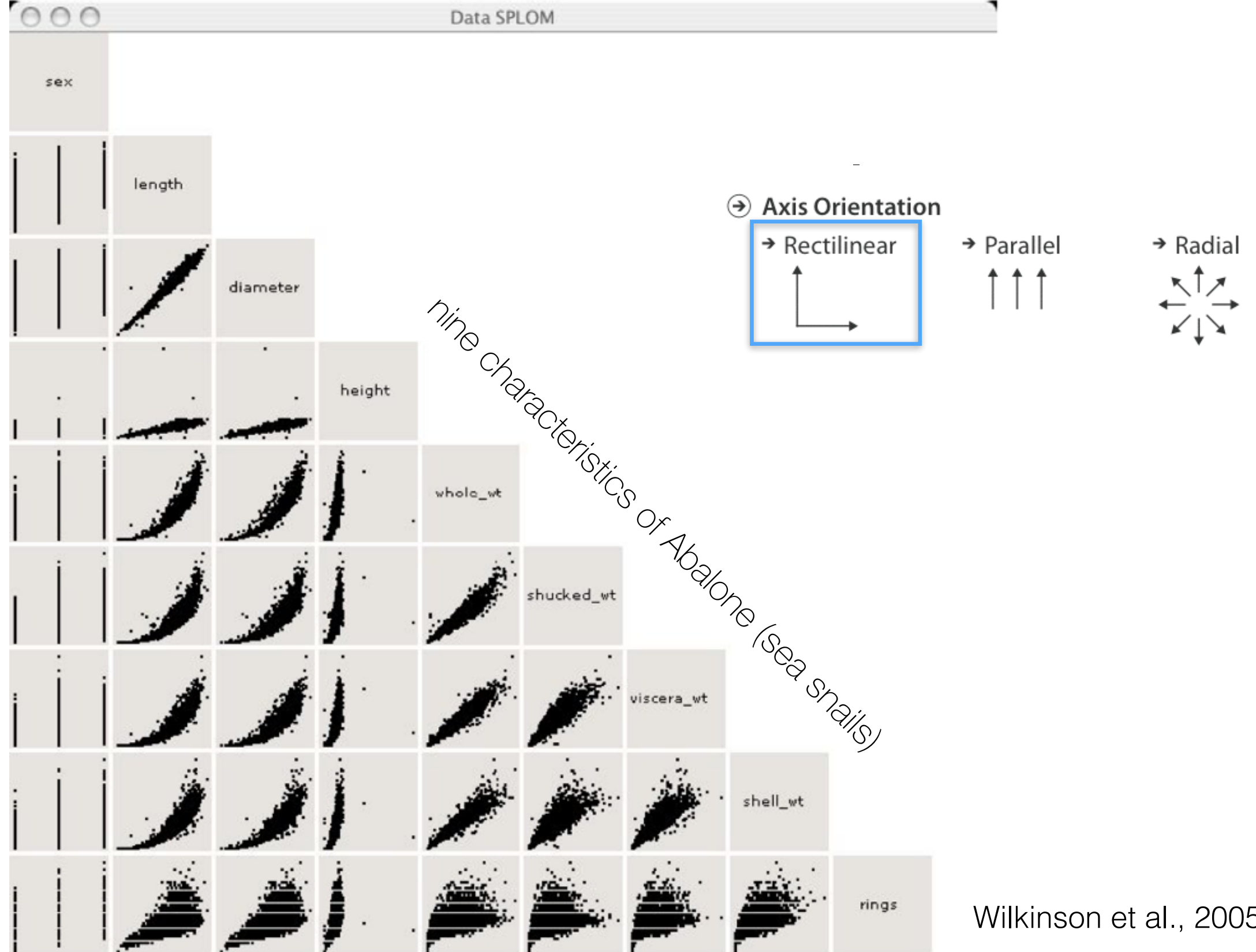


➔ Radial



Idiom: **SPL**OM

- scatterplot matrix (SPL**OM**)
 - rectilinear axes, point mark
 - all possible pairs of axes
 - scalability
 - one dozen attribs
 - dozens to hundreds of items



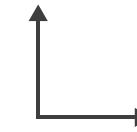
Wilkinson et al., 2005

Idioms: parallel coordinates

- scatterplot limitation
 - visual representation with orthogonal axes
 - can show only two attributes with spatial position channel
- alternative: line up axes in parallel to show many attributes with position
 - item encoded with a line with n segments
 - n is the number of attributes shown
- parallel coordinates
 - parallel axes, jagged line for item
 - rectilinear axes, item as point
 - axis ordering is major challenge
 - scalability
 - dozens of attribs
 - hundreds of items

⌚ Axis Orientation

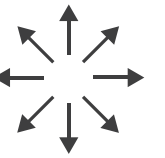
→ Rectilinear



→ Parallel



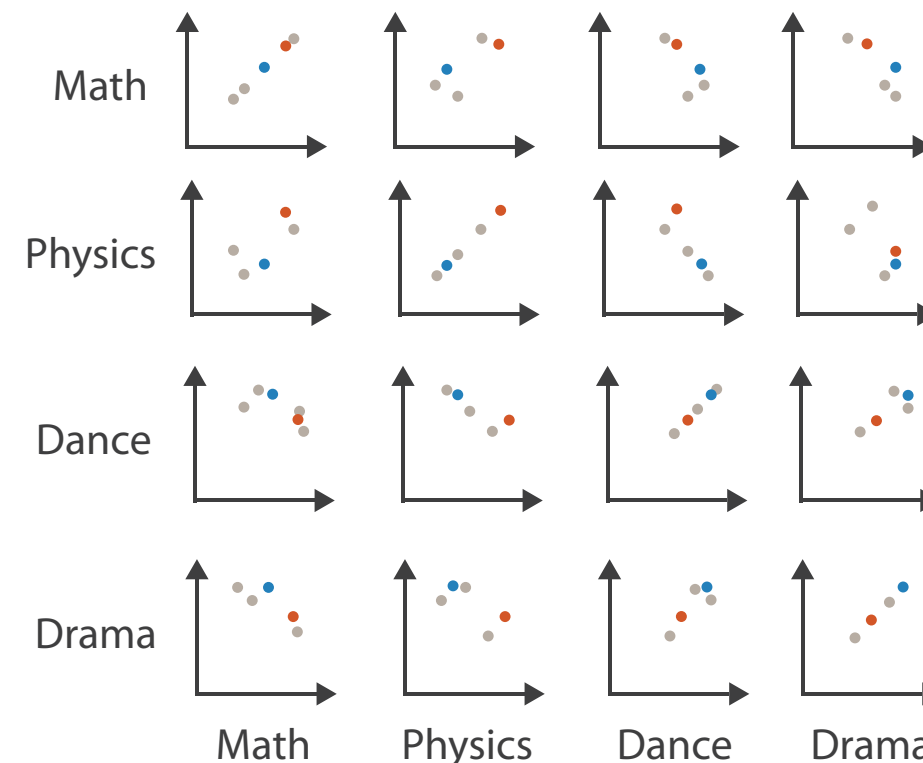
→ Radial



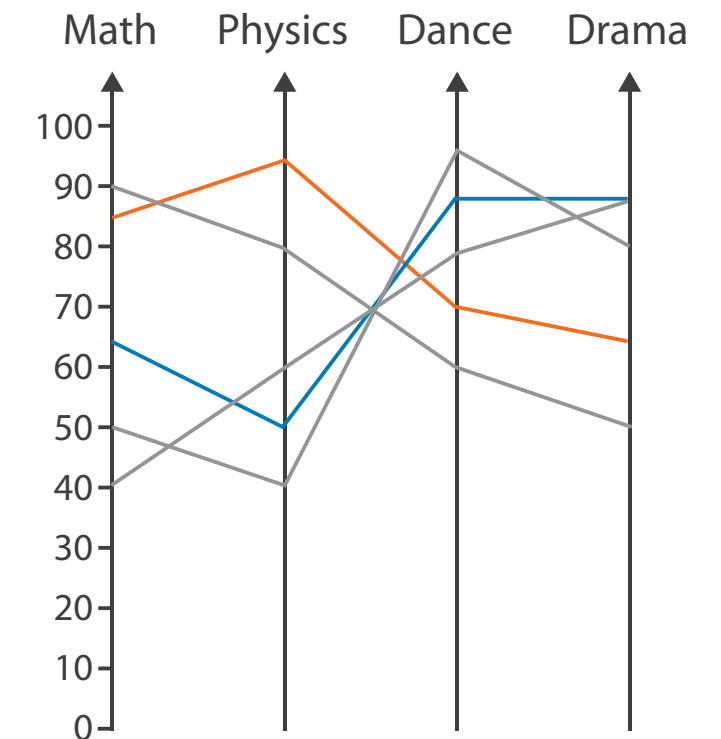
Table

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

Scatterplot Matrix

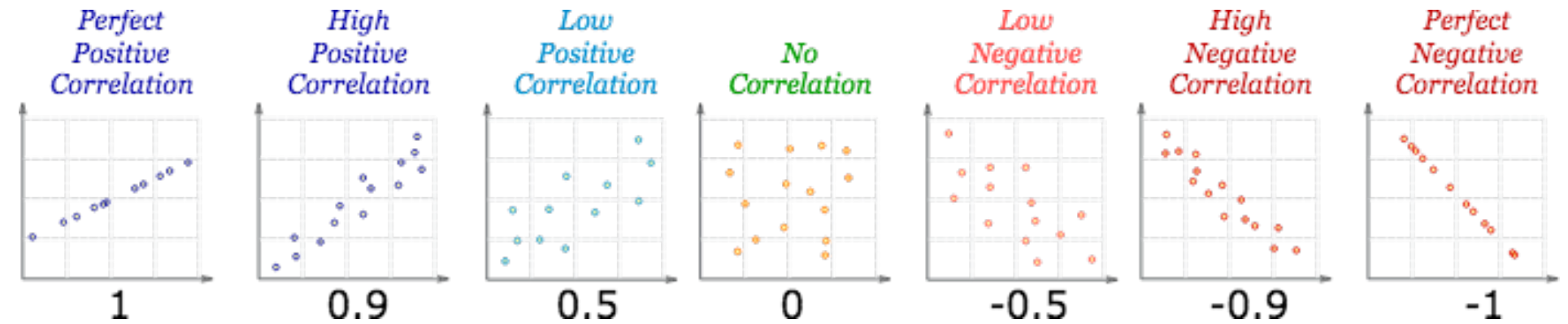


Parallel Coordinates



Task: Correlation

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



<https://www.mathsisfun.com/data/scatter-xy-plots.html>

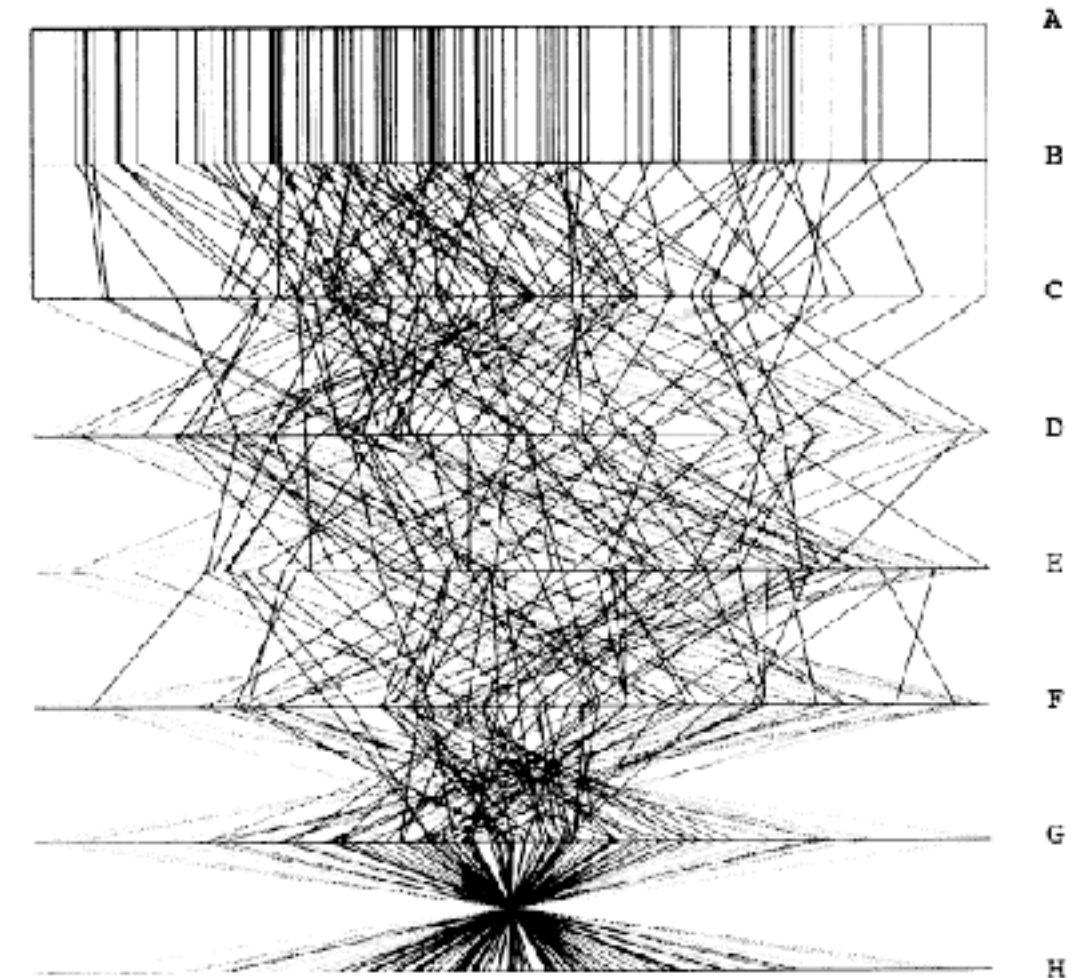
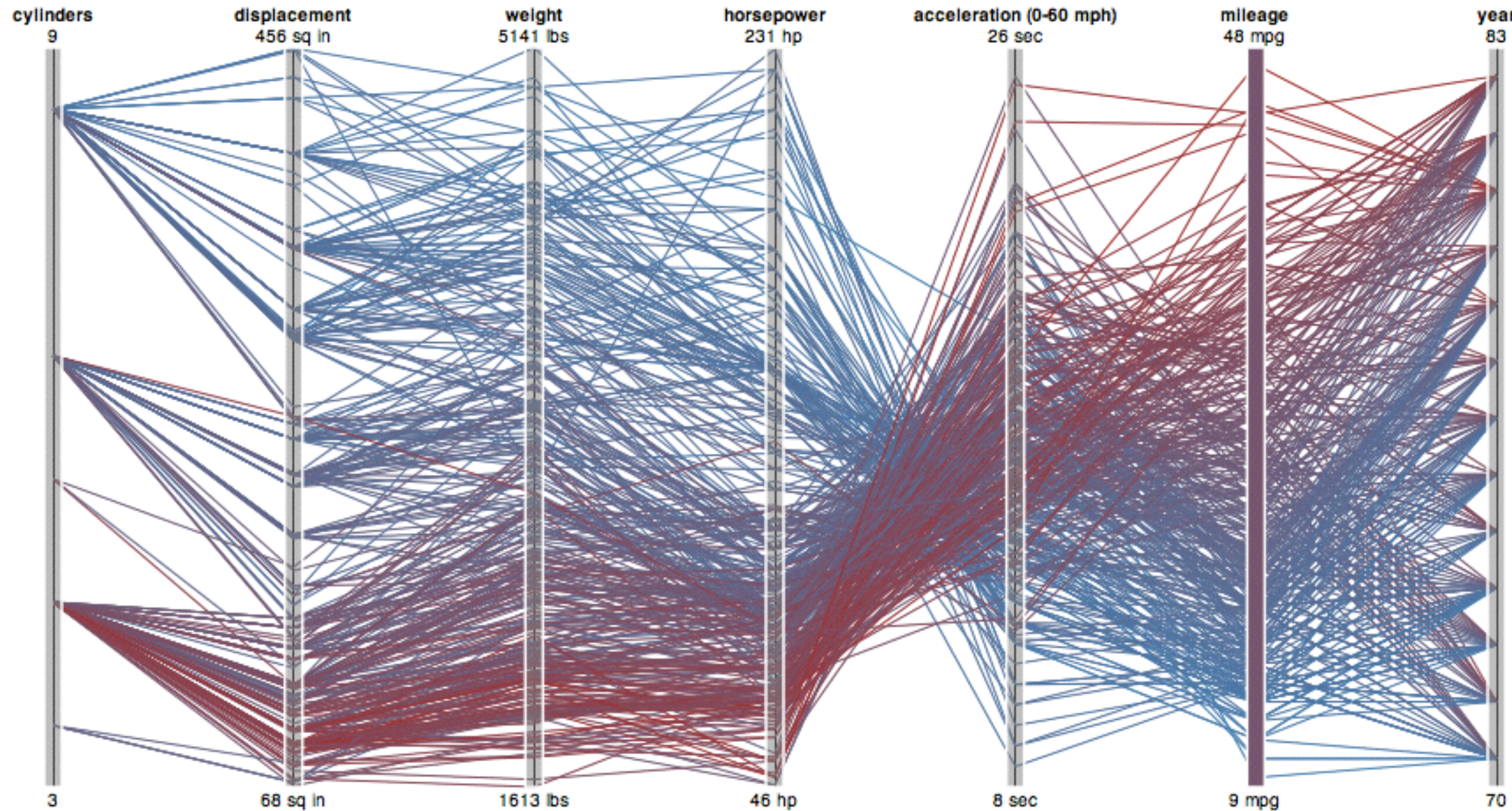


Figure 3. Parallel Coordinate Plot of Six-Dimensional Data Illustrating Correlations of $\rho = 1, .8, .2, 0, -.2, -.8, \text{ and } -1$.

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

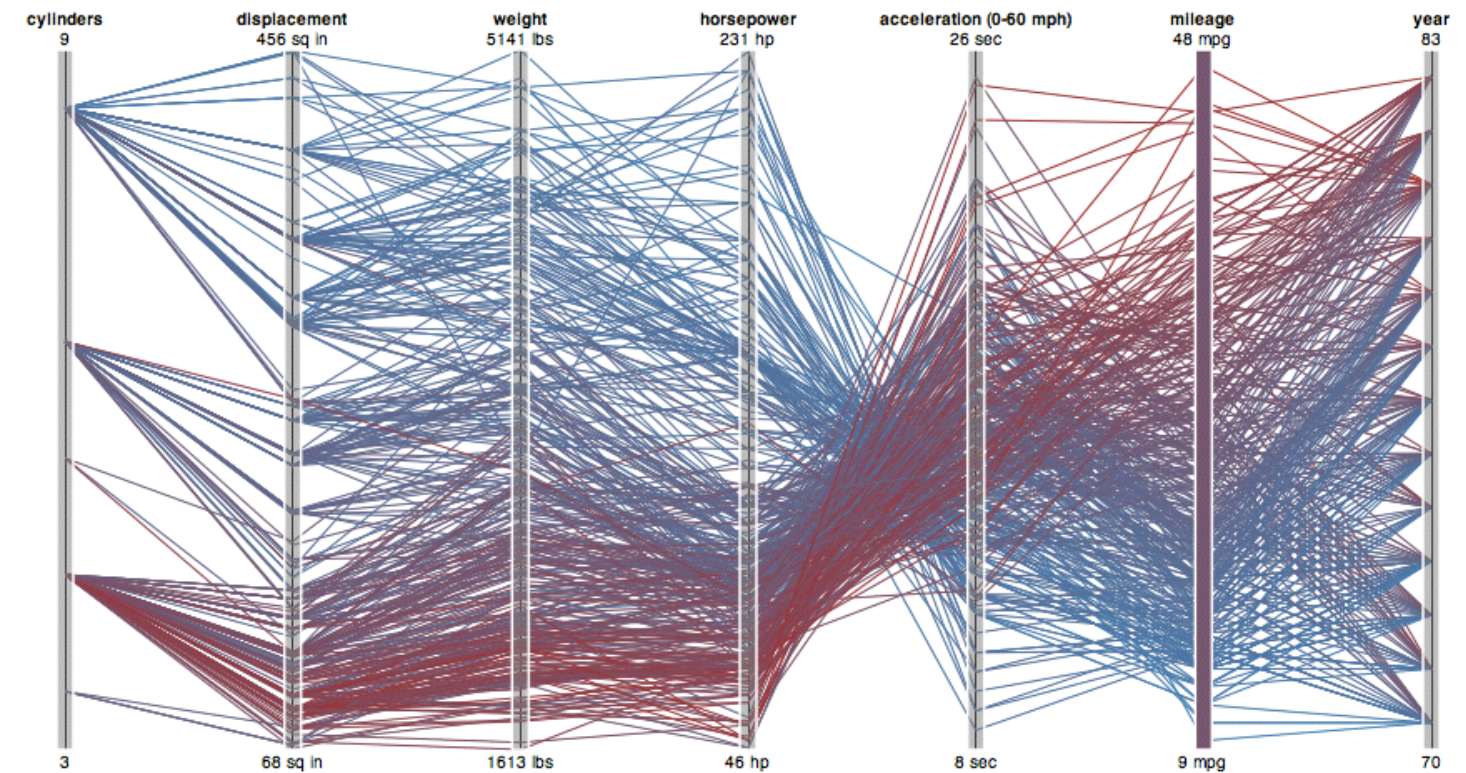
Parallel coordinates quiz: car data

- What correlations do you see?
 - positive?
 - negative?
 - none?
 - not sure?
- horsepower to acceleration
- weight to mileage?



Parallel coordinates, limitations

- 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 of interaction: human-powered search
 - some algorithms proposed, none fully solve

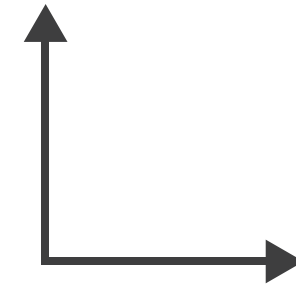


Orientation limitations

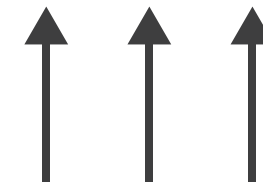
- rectilinear: scalability wrt #axes
 - 2 axes best
 - 3 problematic
 - 4+ impossible
- parallel: unfamiliarity, training time

➔ Axis Orientation

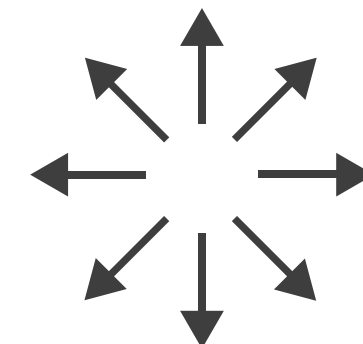
➔ Rectilinear



➔ Parallel

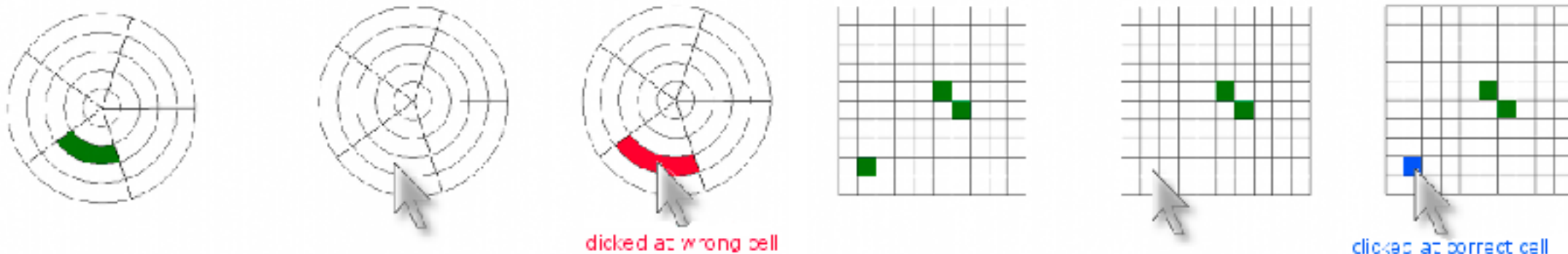


➔ Radial



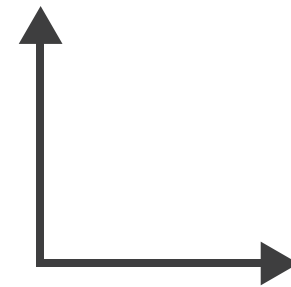
Radial orientation

- perceptual limits
 - polar coordinate asymmetry
 - angles lower precision than length
 - nonuniform sector width/size depending on radial distance
 - frequently problematic
 - sometimes can be deliberately exploited!
 - for 2 attribs of very unequal importance

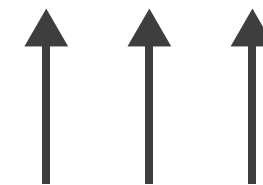


➔ Axis Orientation

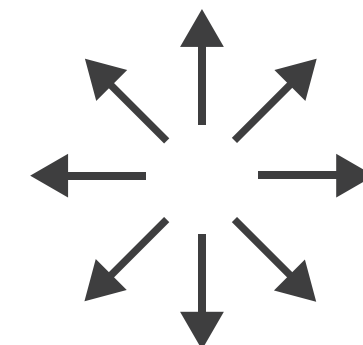
➔ Rectilinear



➔ Parallel



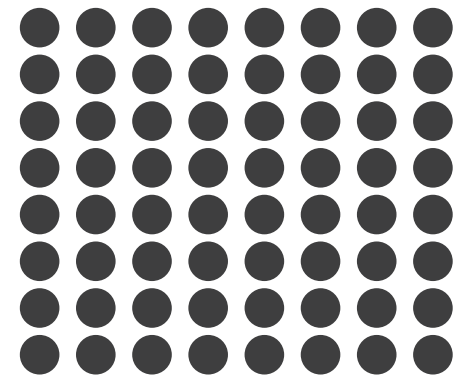
➔ Radial



Layout density

➔ Layout Density

➔ Dense



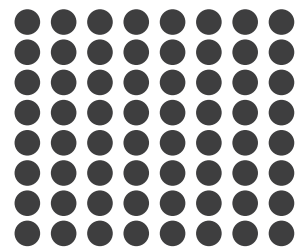
➔ Space-Filling



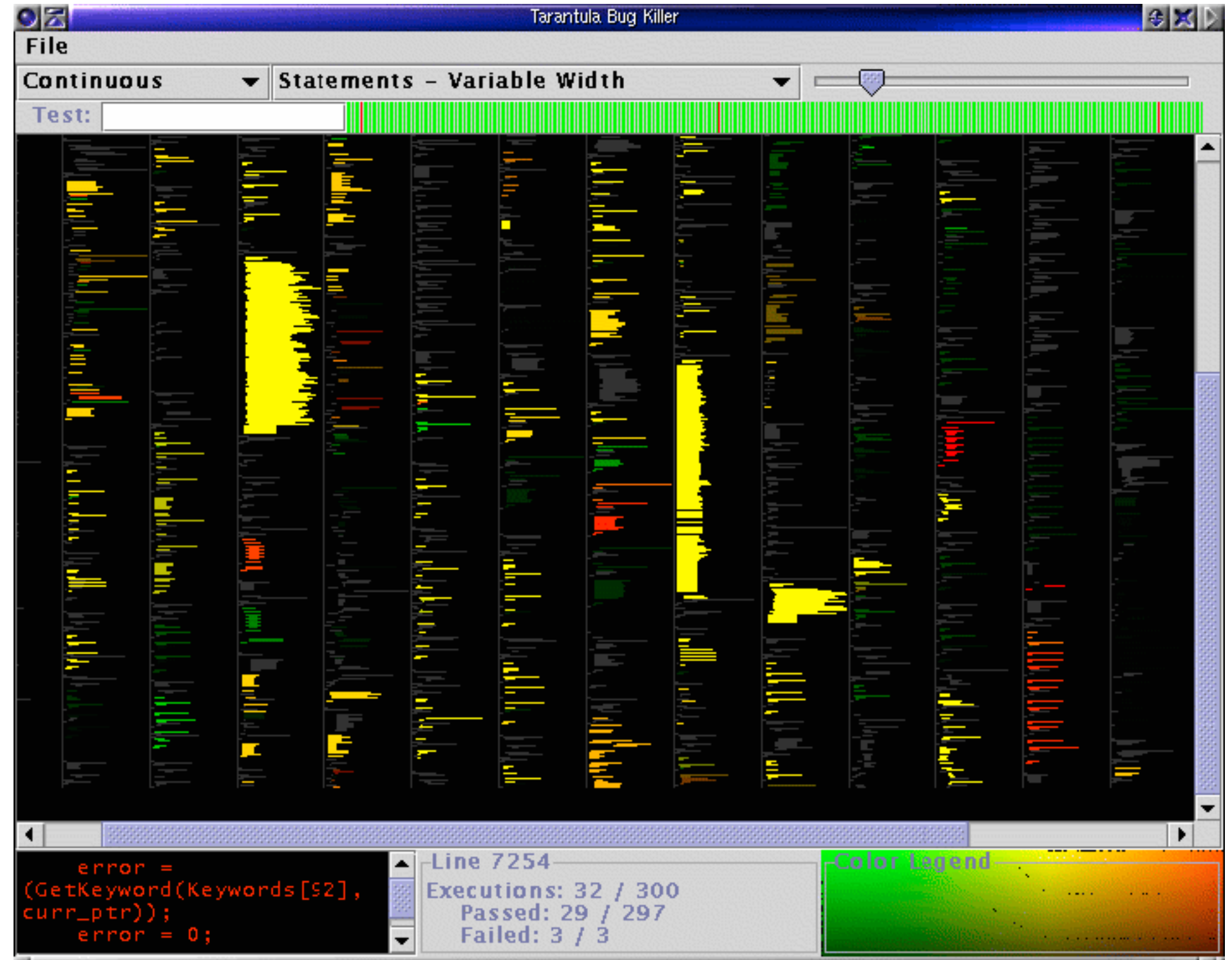
Idiom: Dense software overviews

→ Layout Density

→ Dense



- data: text
 - text + 1 quant attrib per line
- derived data:
 - one pixel high line
 - length according to original
- color line by attrib
- scalability
 - 10K+ lines



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

Encode tables: Arrange space

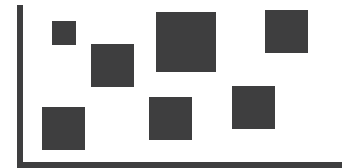
Encode

➔ Arrange

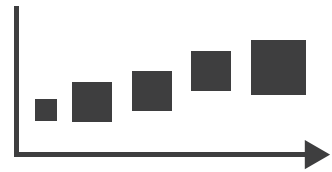
➔ Express



➔ Separate



➔ Order



➔ Align



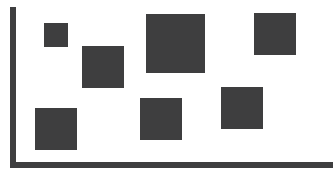
Arrange tables

② Express Values

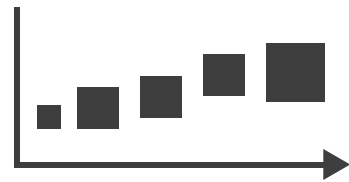


② Separate, Order, Align Regions

→ Separate



→ Order



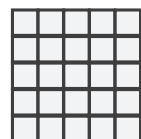
→ Align



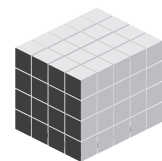
→ 1 Key
List



→ 2 Keys
Matrix



→ 3 Keys
Volume

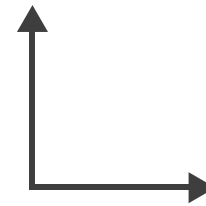


→ Many Keys
Recursive Subdivision

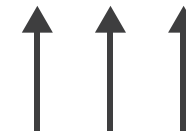


② Axis Orientation

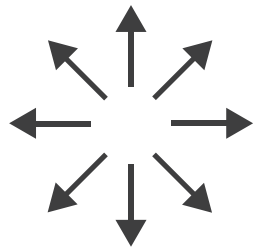
→ Rectilinear



→ Parallel

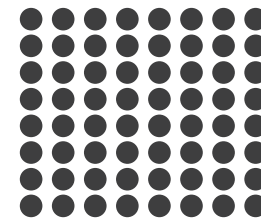


→ Radial



② Layout Density

→ Dense



→ Space-Filling



How?

Encode

➔ Arrange

➔ Express



➔ Separate



➔ Order



➔ Align



➔ Use



➔ Map

from **categorical** and **ordered** attributes

➔ Color

➔ Hue



➔ Saturation



➔ Luminance



➔ Size, Angle, Curvature, ...



➔ Shape



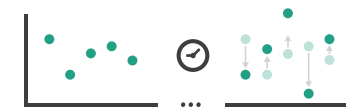
➔ Motion

Direction, Rate, Frequency, ...

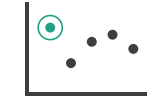


Manipulate

➔ Change



➔ Select



➔ Navigate

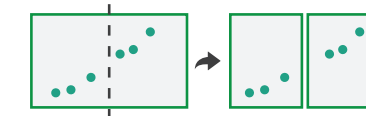


Facet

➔ Juxtapose



➔ Partition



➔ Superimpose



Reduce

➔ Filter



➔ Aggregate



➔ Embed



What?

Why?

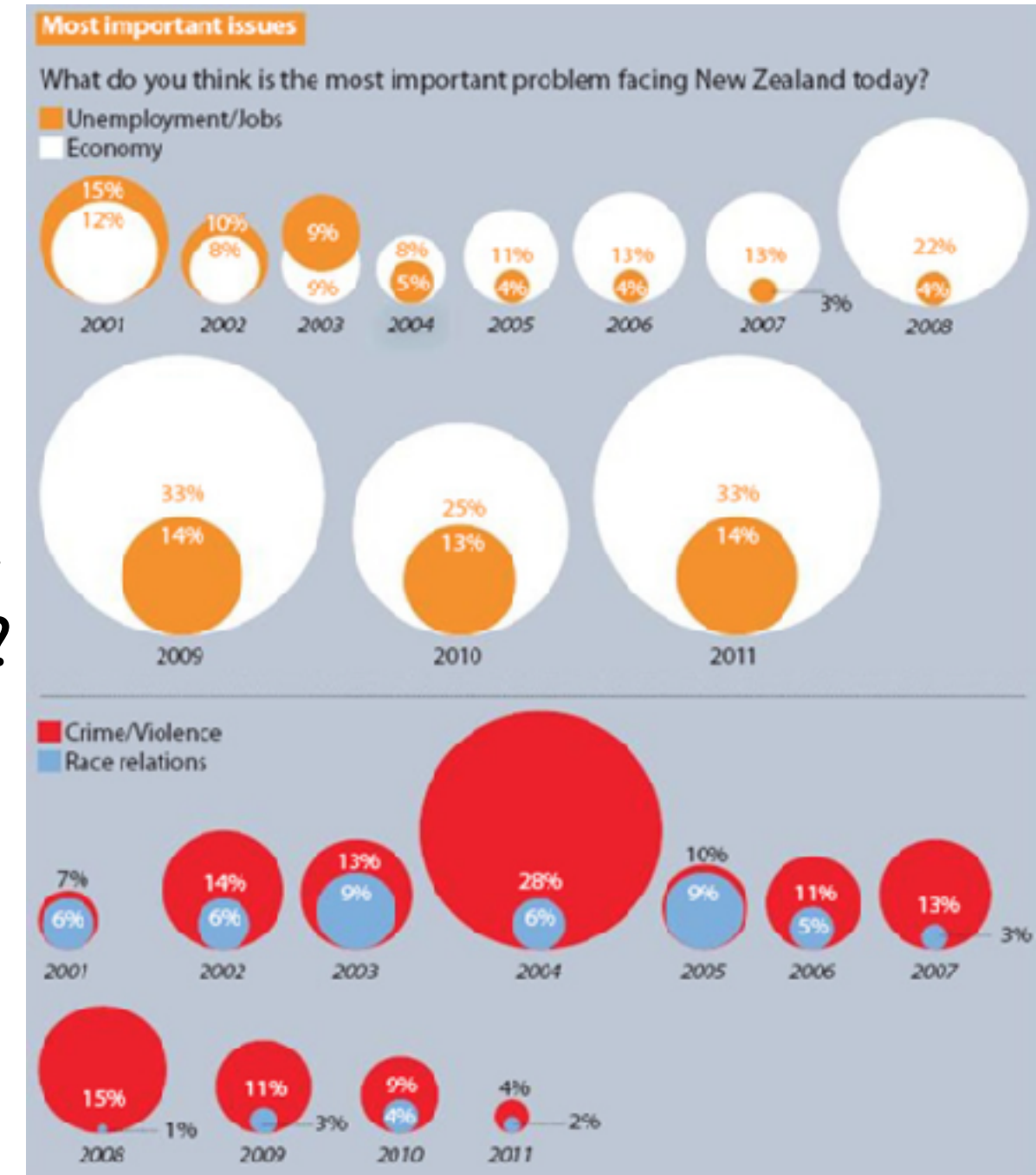
How?

Upcoming

- D3 videos week 3
 - Making a Bar Chart with D3 and SVG [30 min]
- Quiz 3, due by Fri Jan 24, 8am
- Programming Exercise 1, due Wed Jan 29
- Foundations 3, out Thu Jan 30
- D3 videos/readings week 4
 - The General Update Pattern of D3.js [60 min]
 - Interaction with Unidirectional Data Flow [16 min]
 - Read: Reusable D3 Components

Design critique & redesign: NZ

- Consider the following questions:
 - 1 What could be the goals of the designer for questions that this visualization answers (domain-specific & abstract)?
 - 2 What data is represented in this visualization? Be specific.
 - 3 How is each data type visually encoded (marks/channels)?
 - 4 Can you read the data precisely? Is the visual encoding appropriately chosen?
 - Hint: how would this work without numeric labels?
- Develop two alternative designs to visualize this data.
 - fine to discuss with your peers, but draw your own solution.
 - mark your best design, briefly note why you think it's better.



Credits

- Visualization Analysis and Design (Ch 7)
- Alex Lex & Miriah Meyer, <http://dataviscourse.net/>
- Ben Jones, UW/Tableau