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CHANGE THE WORLD FROM HERE

Multivariate Data Visualization

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Outline

- Bubble Chart
- Heatmap
- Scatterplot Matrix
- Small Multiples
- Parallel Coordinates
- Spider Plots

- *Encoding Data*
- *Examples from Books*
- *Examples from D3*
- *Examples from R*
- *Examples from Web*
- *Discussion*

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DATA TYPES

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Data Types

- **Numerical**
  - Continuous (-11.2, -1.3, 0.4, 4.8, 14.9, …)
  - Discrete (-2, -1, 0, 1, 2, …)
- **Categorical**
  - Ordered (January, February, March, April, …)
  - Unordered (Red, Blue, Green, Purple, …)

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Data Types

- **Special/Structured**
  - Time (1998-01-27 12:00, 1999-04-13 22:10, …)
  - GPS (37.77679 latitude, -122.45117 longitude, …)
  - Social Security Numbers (555-55-5555, …)
- **Unstructured/Semi-Structured**
  - Free-Form Text (Twitter Feed, Screenplay, …)

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BUBBLE CHART

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Encoding Data

- **Horizontal position**
  – Continuous data
- **Vertical position**
  – Continuous data
- **Circle area**
  – Numerical data
- **Circle color**
  – Numerical or categorical

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.

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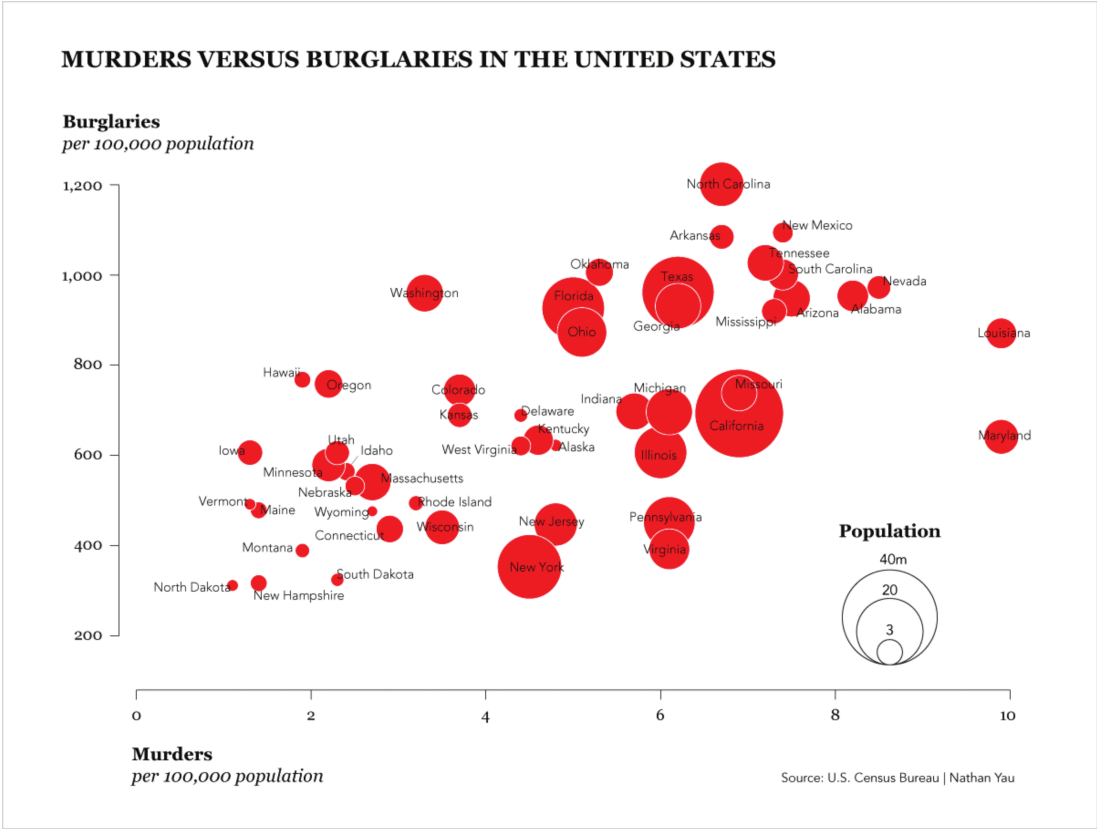
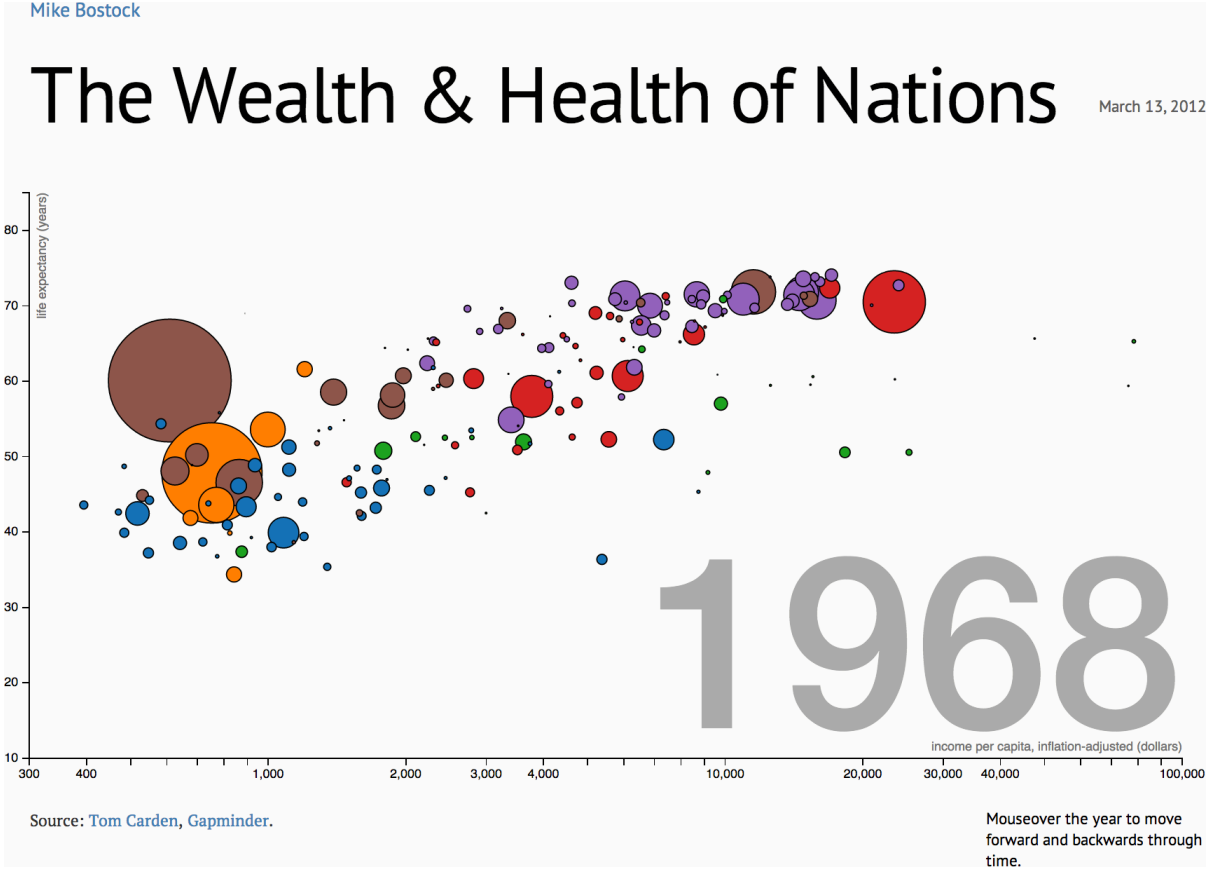


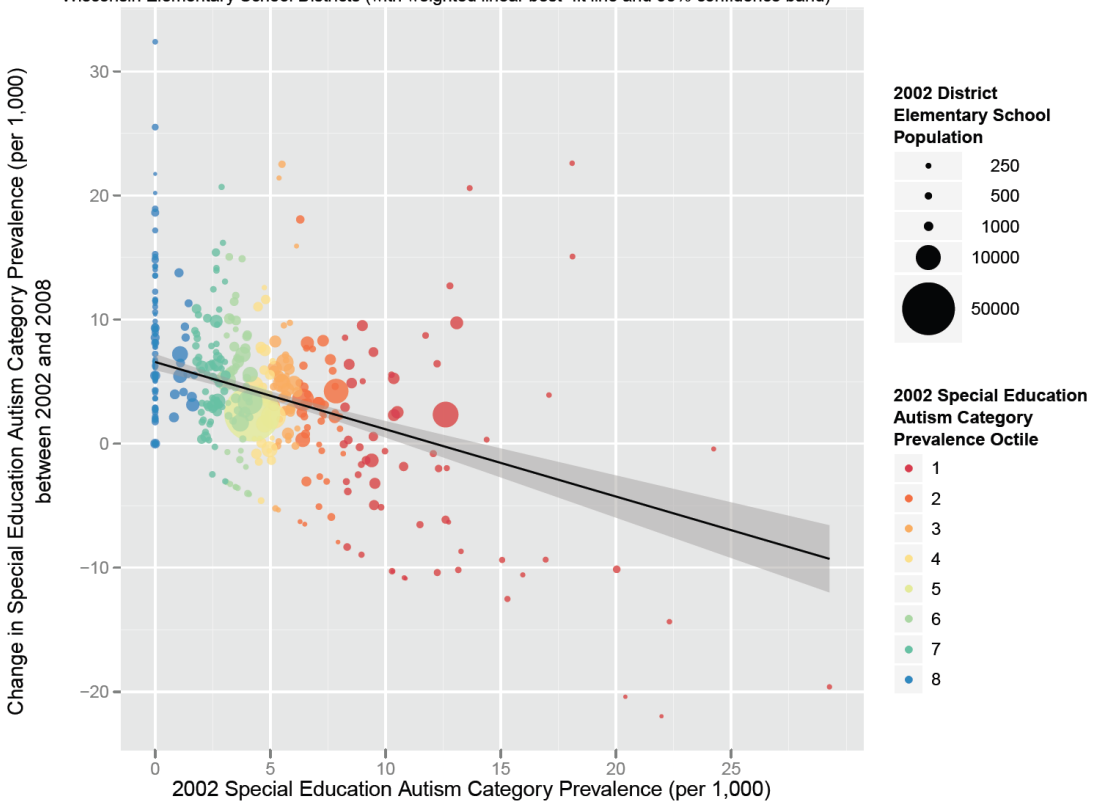
FIGURE 6-15 Bubble plot showing crime in the United States

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.



http://bost.ocks.org/mike/nations/

Figure 3. Change in Special Education Autism Category Prevalence between 2002 and 2008 vs Baseline (2002) Prevalence, Wisconsin Elementary School Districts (with weighted linear best−fit line and 95% confidence band)



http://www.matthewmaenner.com/blog/?p=150

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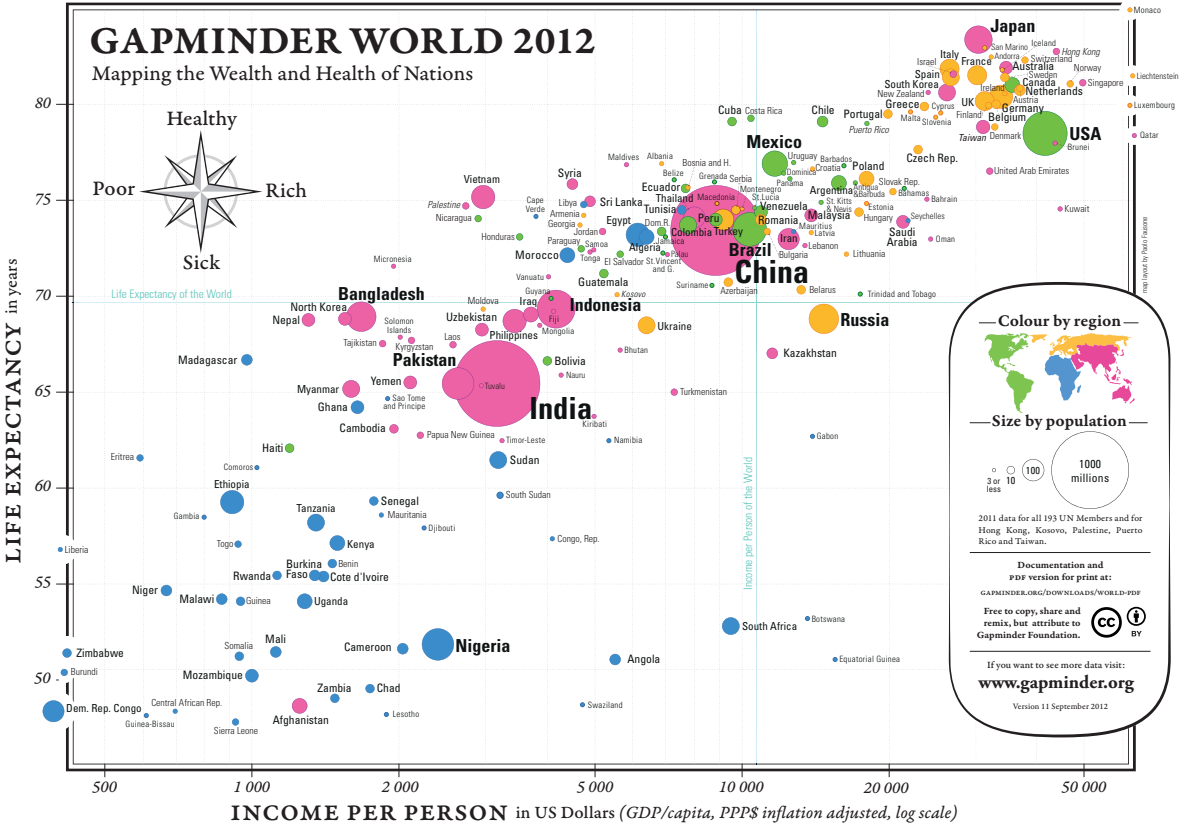

http://www.gapminder.org/downloads/world-pdf/

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Discussion

- Able to encode four dimensions of data
  - Ideal if one dimension is categorical (color)
- Rough comparison possible
  - Beware comparing circle areas
- Obscuring data may be an issue
  - Large circles should be behind smaller ones
  - Issues increases with density

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HEATMAP

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Encode Data

- **Horizontal position**
  - Column from dataset
- **Vertical position**
  - Row from dataset
- **Box color**
  - Value from row, column in dataset
  - Numerical or categorical

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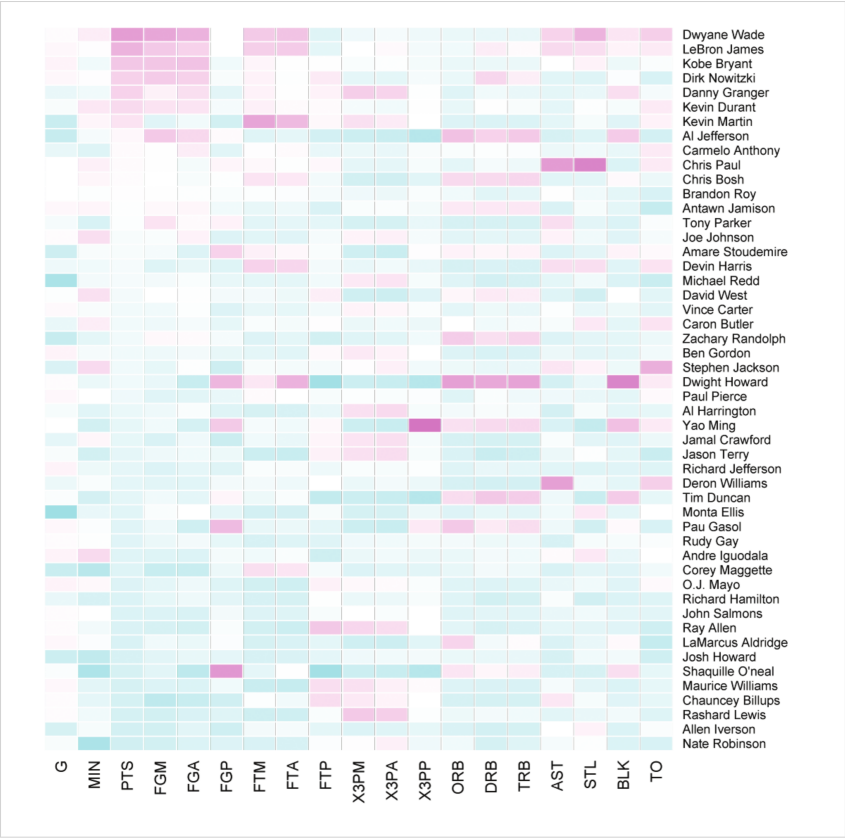

FIGURE 7-3 Default heatmap ordered by points per game

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.

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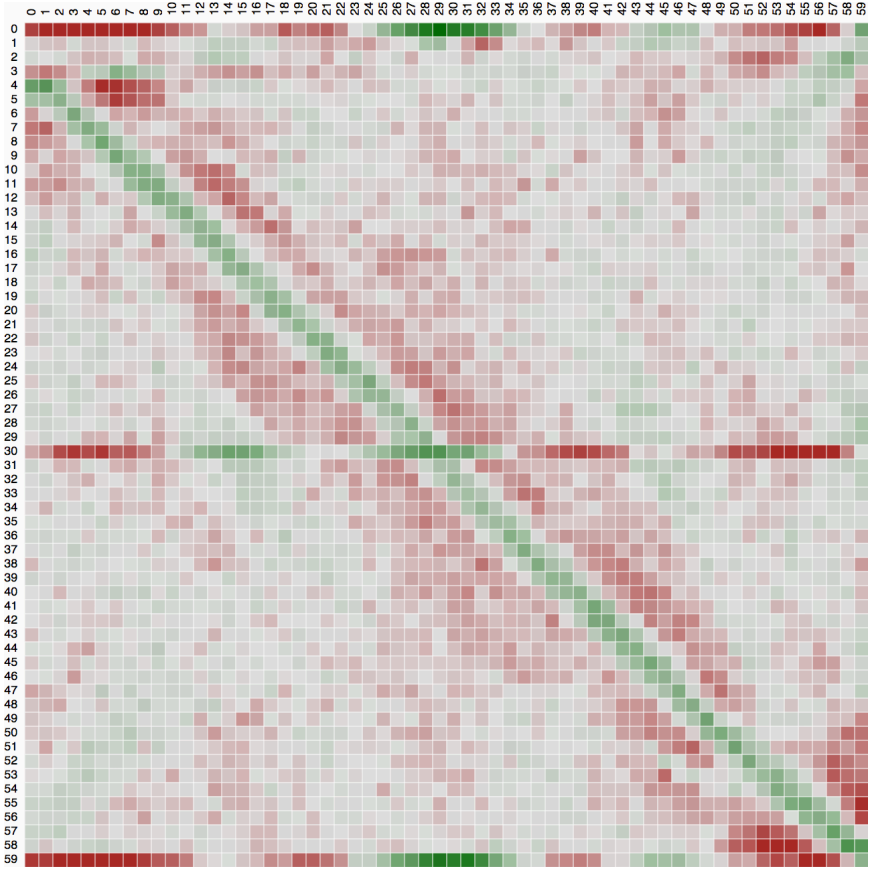

http://bost.ocks.org/mike/shuffle/compare.html

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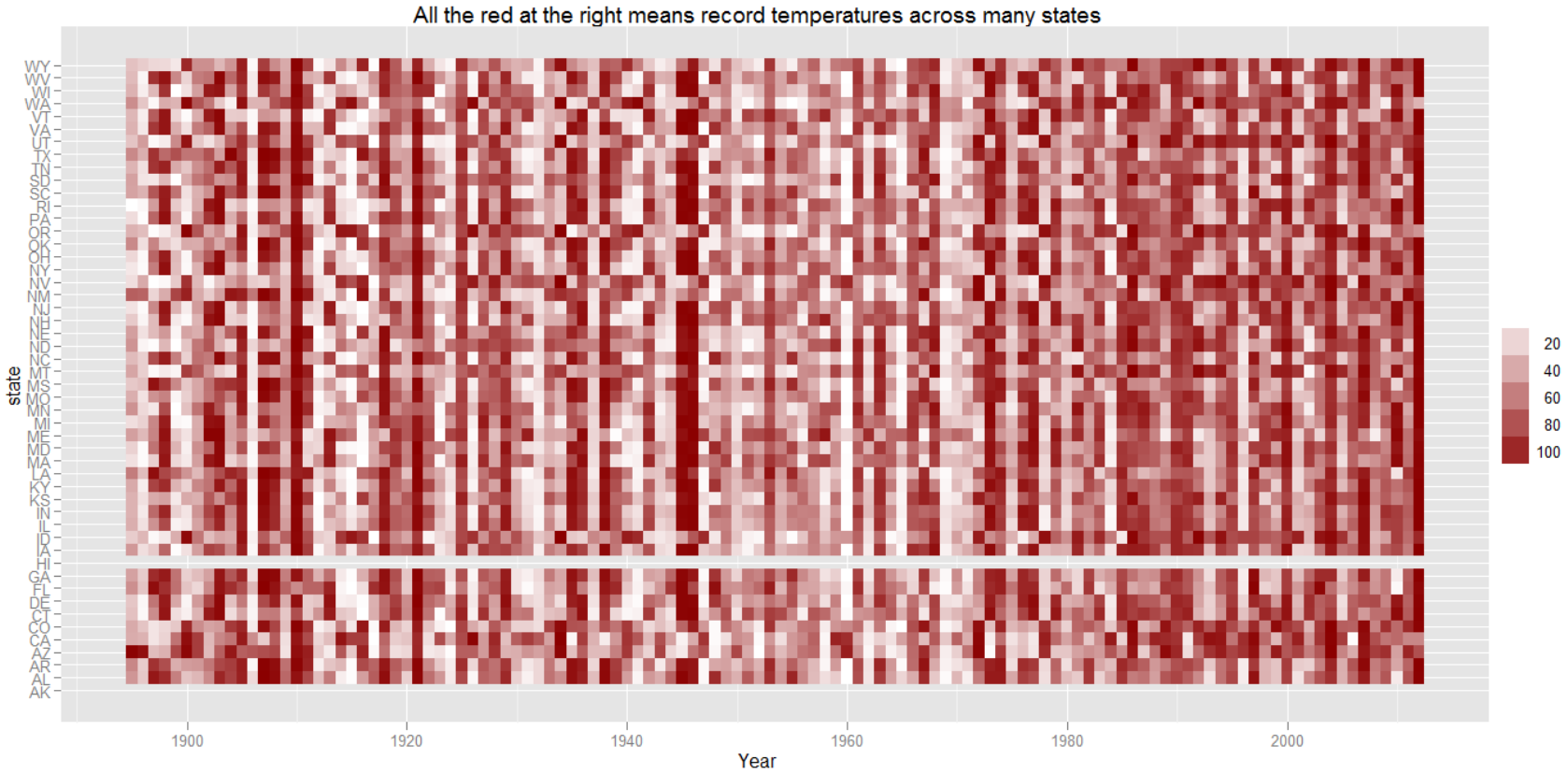

http://www.r-bloggers.com/118-years-of-us-state-weather-data/

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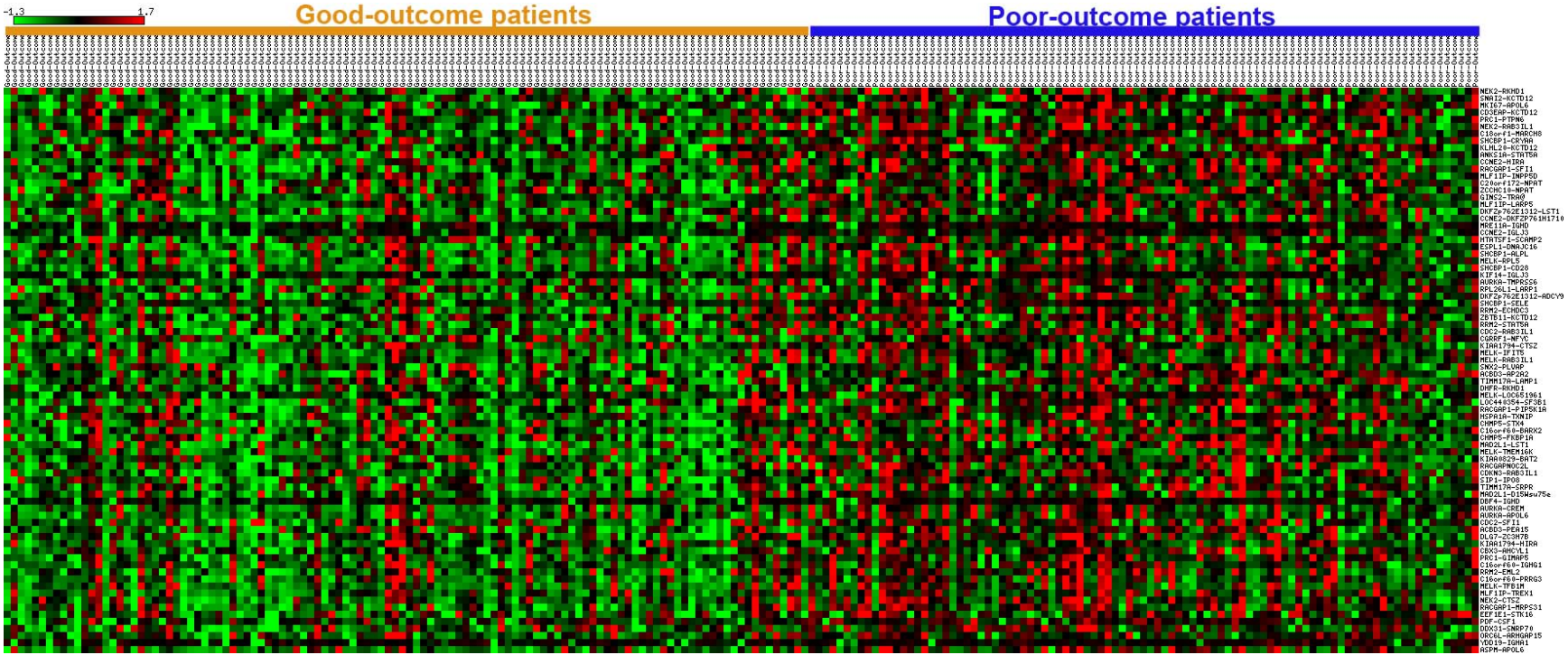

http://www.biomedcentral.com/1471-2105/9/125

Discussion

- Essentially showing the data set, but replaces numbers by color values
- Good for certain types of data
  - Continuous data well-suited
  - Unordered categorical limited to 7 categories
- Encourages comparison and pattern finding
  - Sorting changes patterns!

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SCATTERPLOT MATRIX

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Encode Data

- **Scatterplot**
  - Horizontal position maps to one variable
  - Vertical position maps to another variable
- **Matrix of scatterplots**
  - Each scatterplot focuses on one pair
  - Which pair is determined by row and column

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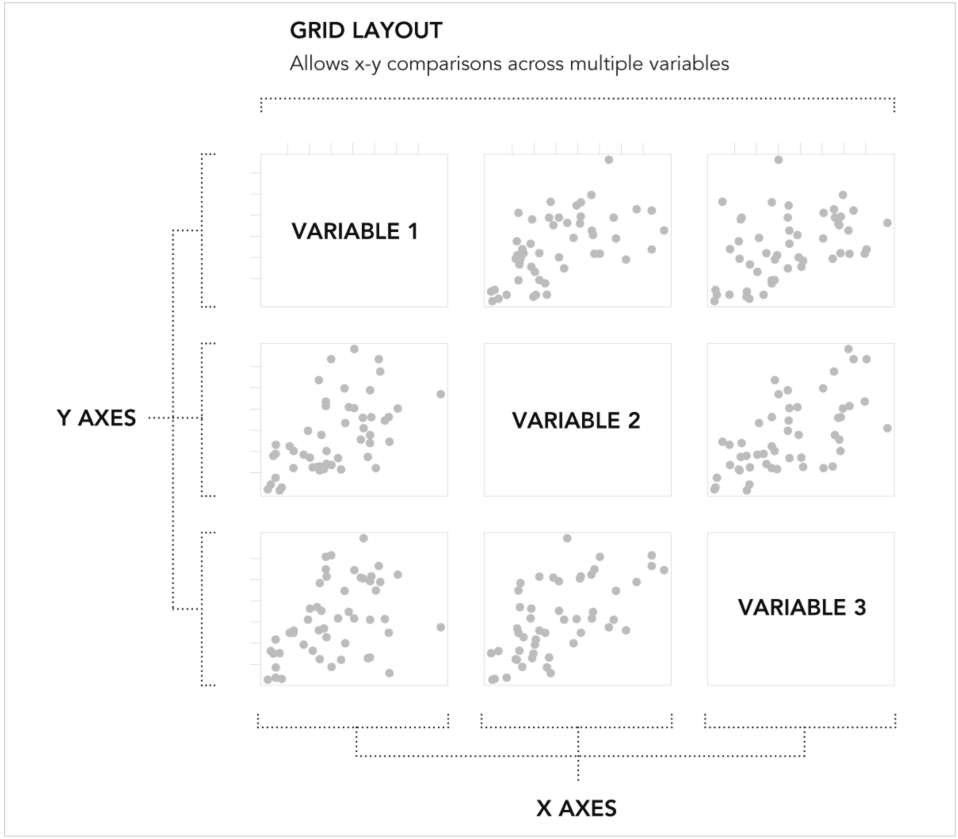

FIGURE 6-8 Scatterplot matrix framework

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.

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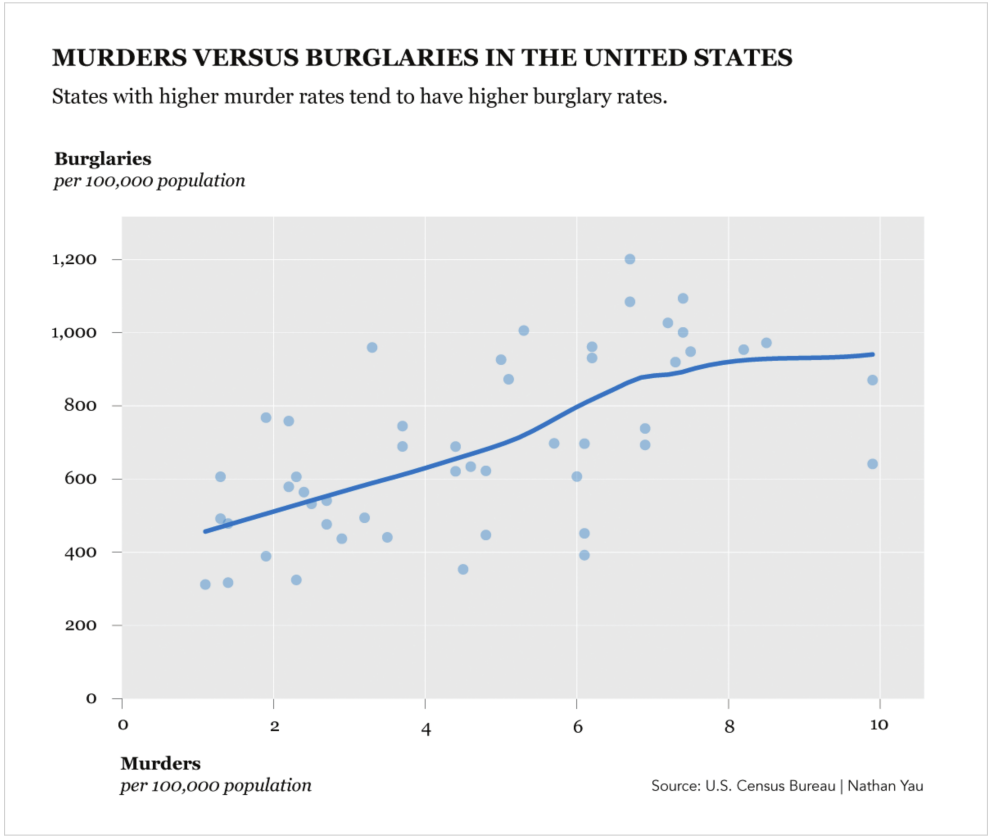

FIGURE 6-7 Revised scatterplot on murder versus burglary

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.

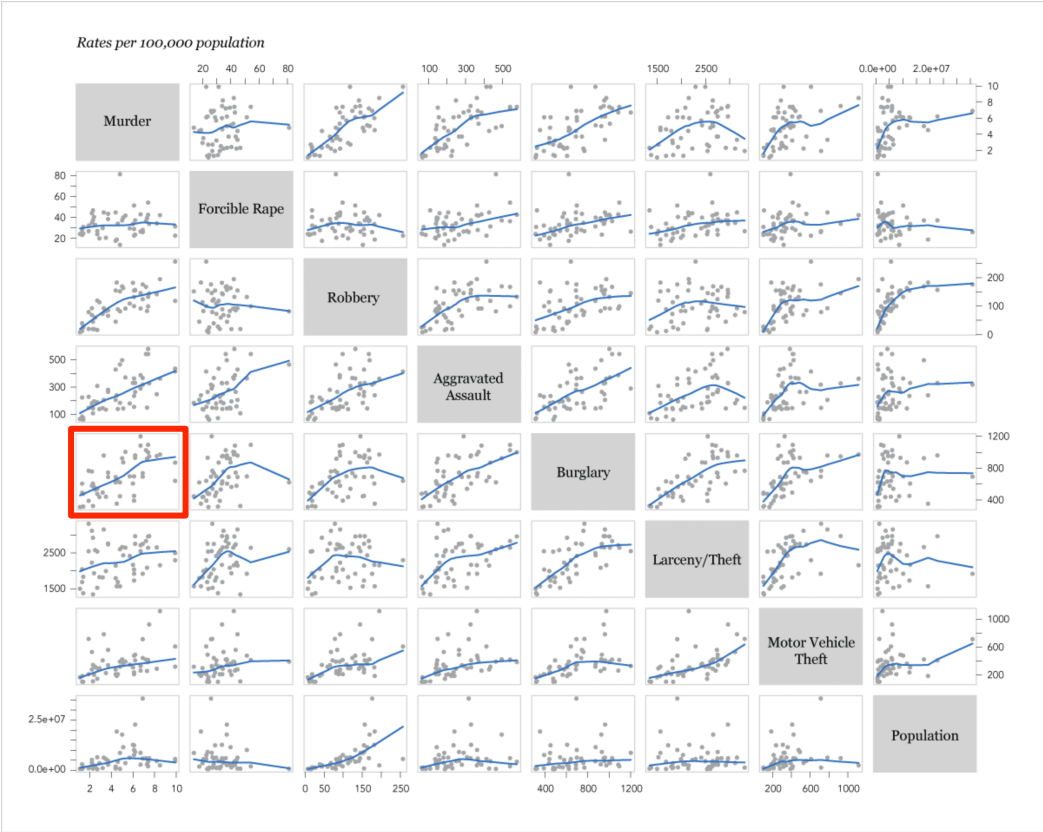

FIGURE 6-9 Scatterplot matrix of crime rates

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.

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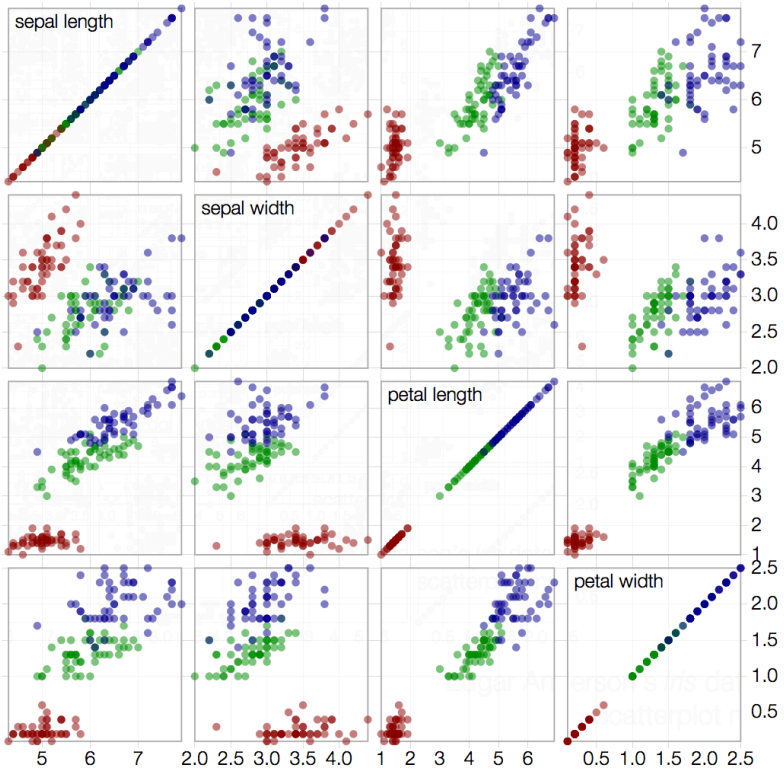

- *Iris setosa*
- *Iris versicolor*
- *Iris virginica*

Edgar Anderson's *Iris* data set
scatterplot matrix

http://mbostock.github.com/d3/talk/20111116/iris-splom.html

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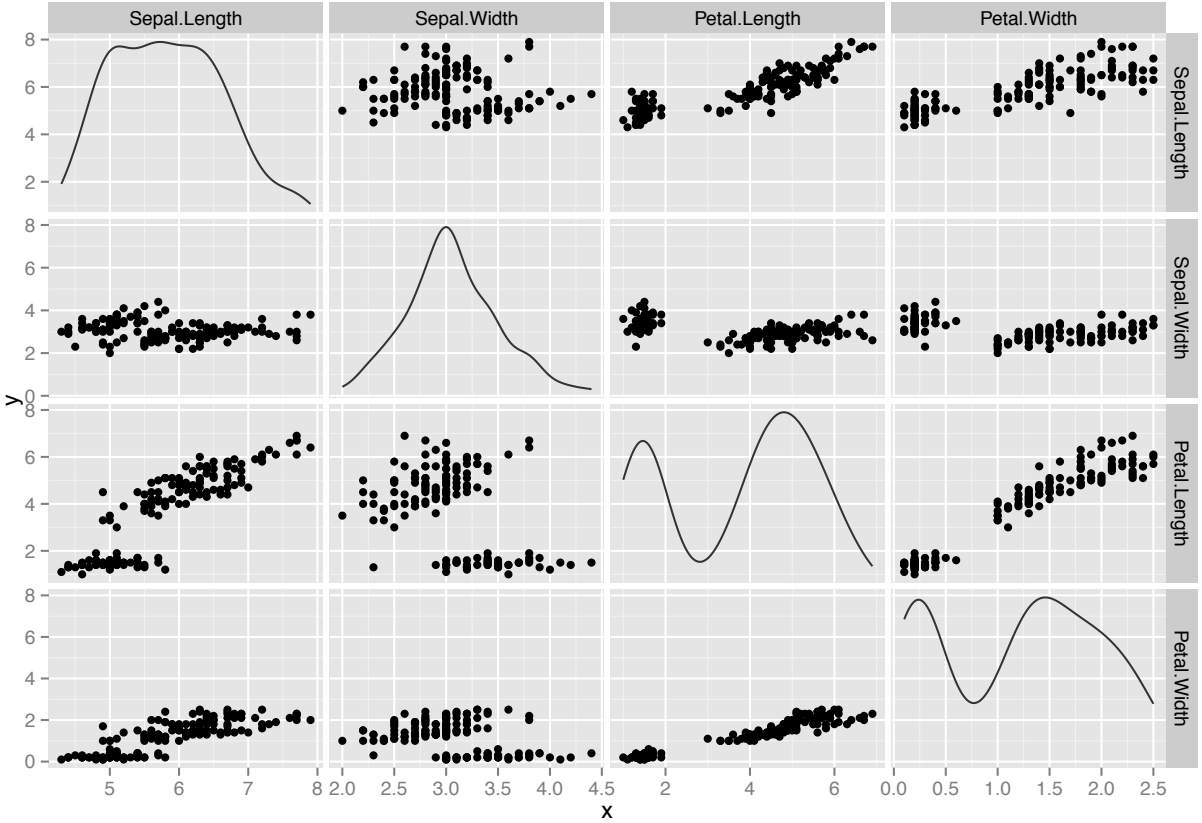

http://gettinggeneticsdone.blogspot.com/2011/07/scatterplot-matrices-in-r.html

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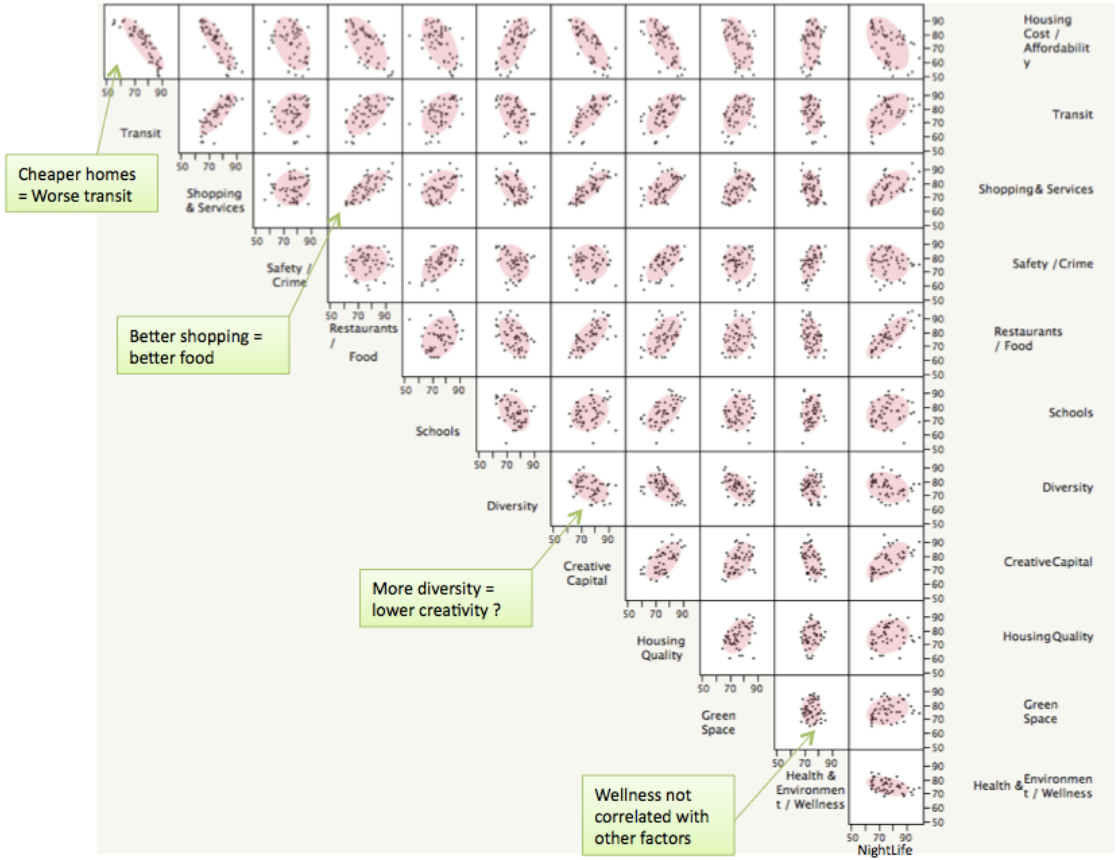

http://junkcharts.typepad.com/junk_charts/2010/06/the-scatterplot-matrix-a-great-tool.html

Discussion

- Good for exploration and comparison
  - Can be a little overwhelming at first
- Works with numerical or ordered data
- Form of small-multiples plot
  - Multiple scatterplots

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SMALL MULTIPLES

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Encode Data

- Group data by a variable to divide it into subsets
  - Usually a categorical variable
- Create a small plot for each subset
- Show all subset plots on same page
  - Encourages comparison

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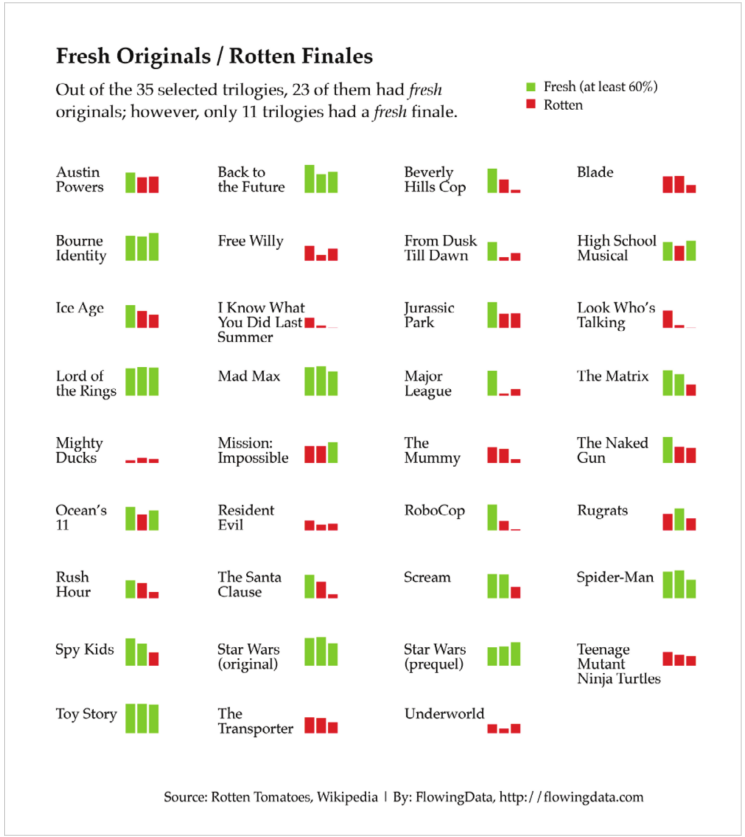
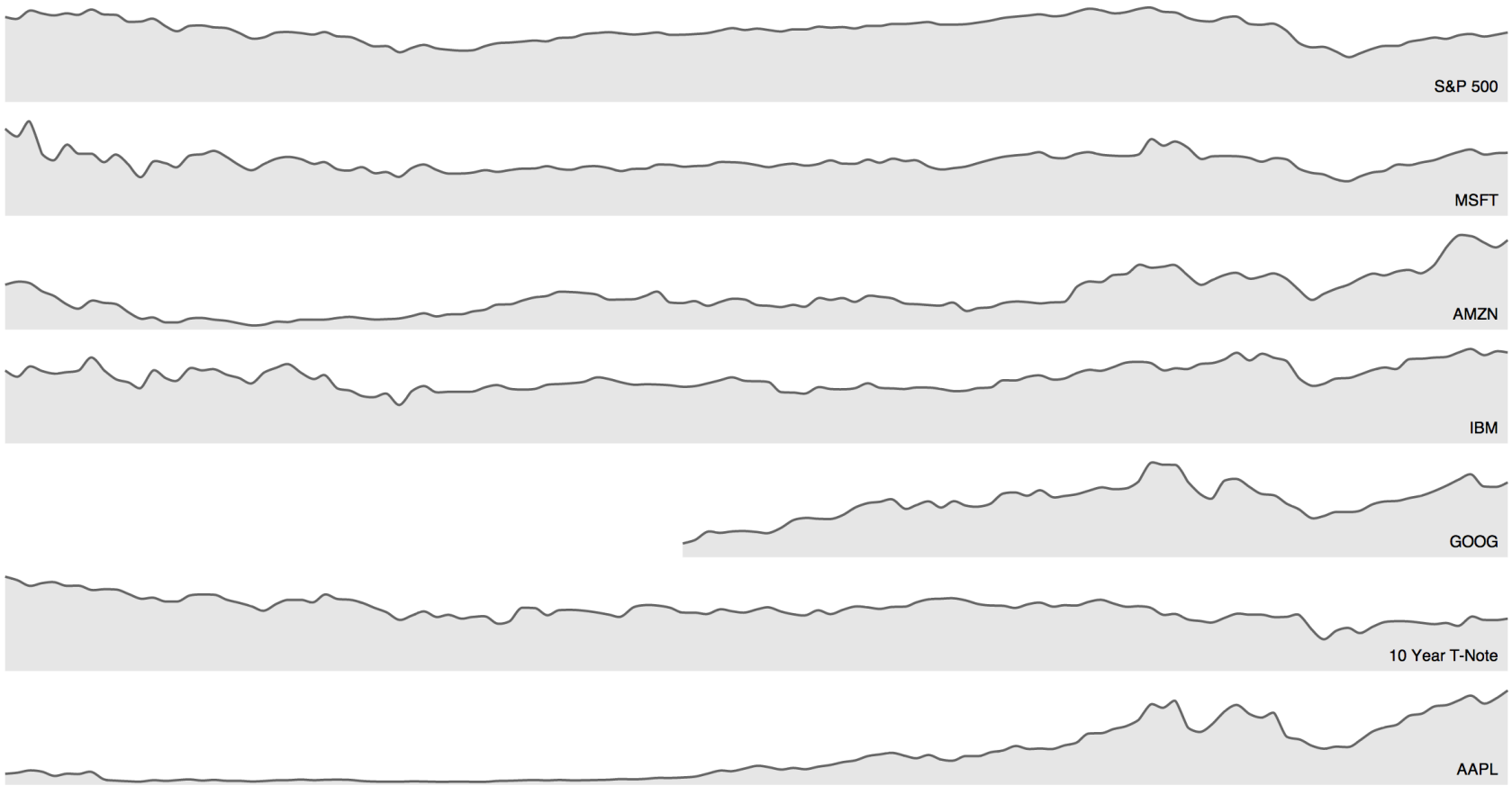


FIGURE 6-40 Small multiples for ratings of trilogies

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.



http://bl.ocks.org/1157787

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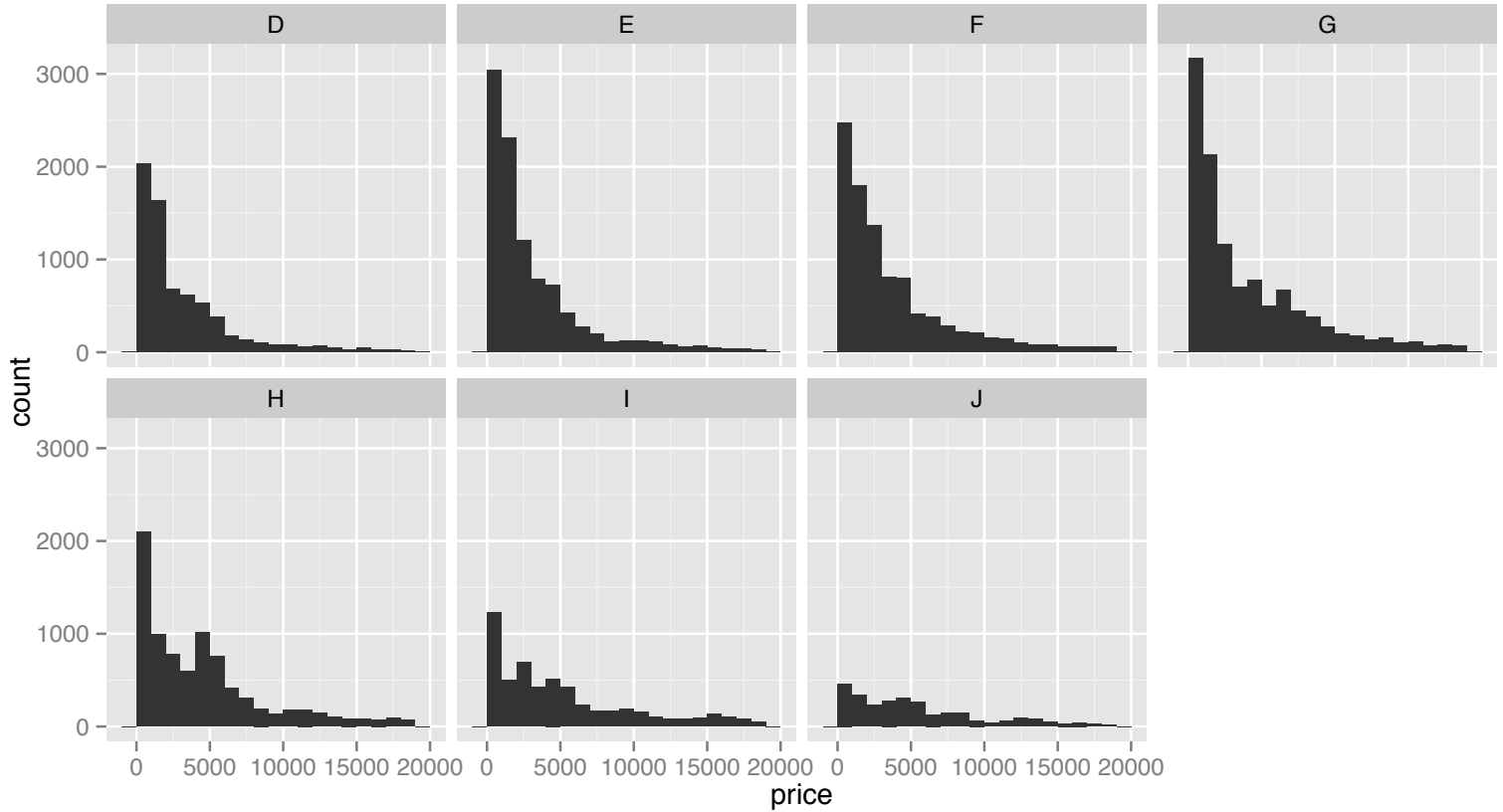

http://docs.ggplot2.org/current/facet_wrap.html

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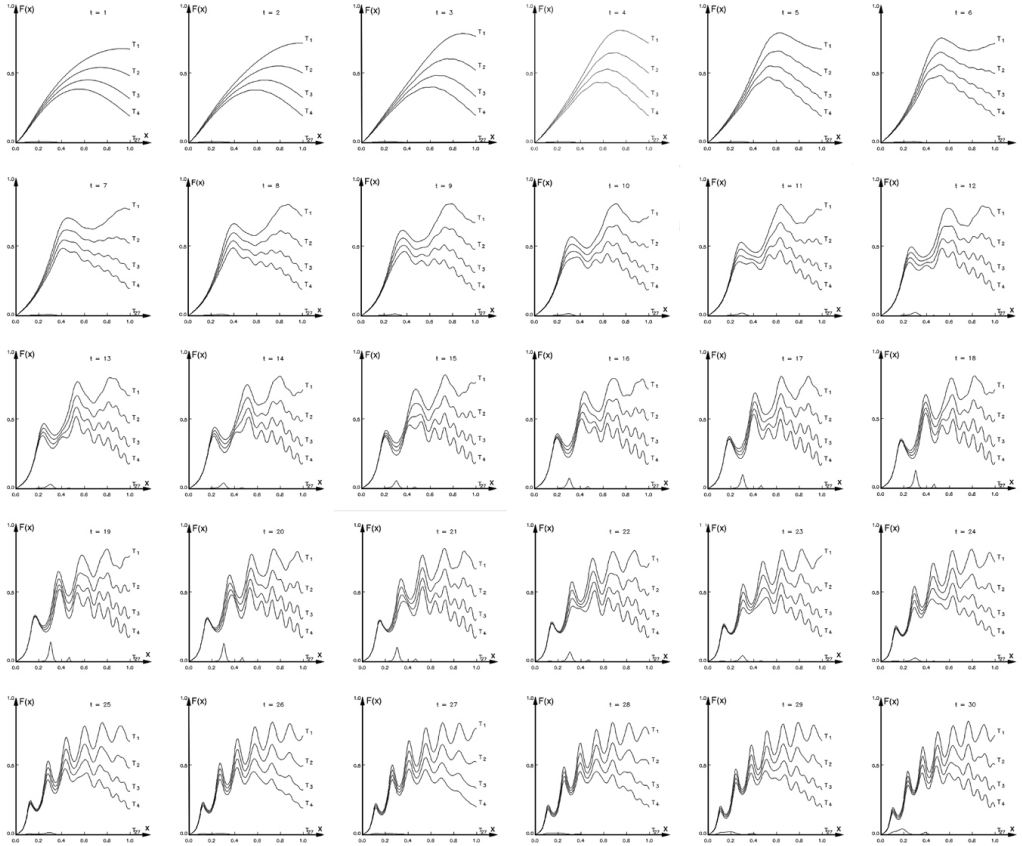

http://www.sv.vt.edu/classes/ESM4714/methods/CogVizCmp.html

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Discussion

- Excellent for comparison
  - Depends on how to place the multiples!
- Requires a variable to use for grouping
  - Discrete or categorical data
- Can use with any type of plot
- Harder to tell exact values

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PARALLEL COORDINATES

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Encode Data

- Create one vertical line for every column
  - Numerical or ordered data
- Plot every row
  - x position is column
  - y position is value for that column
  - line connects values for a single row
- Picture an xy scatterplot, but putting both axis lines vertically

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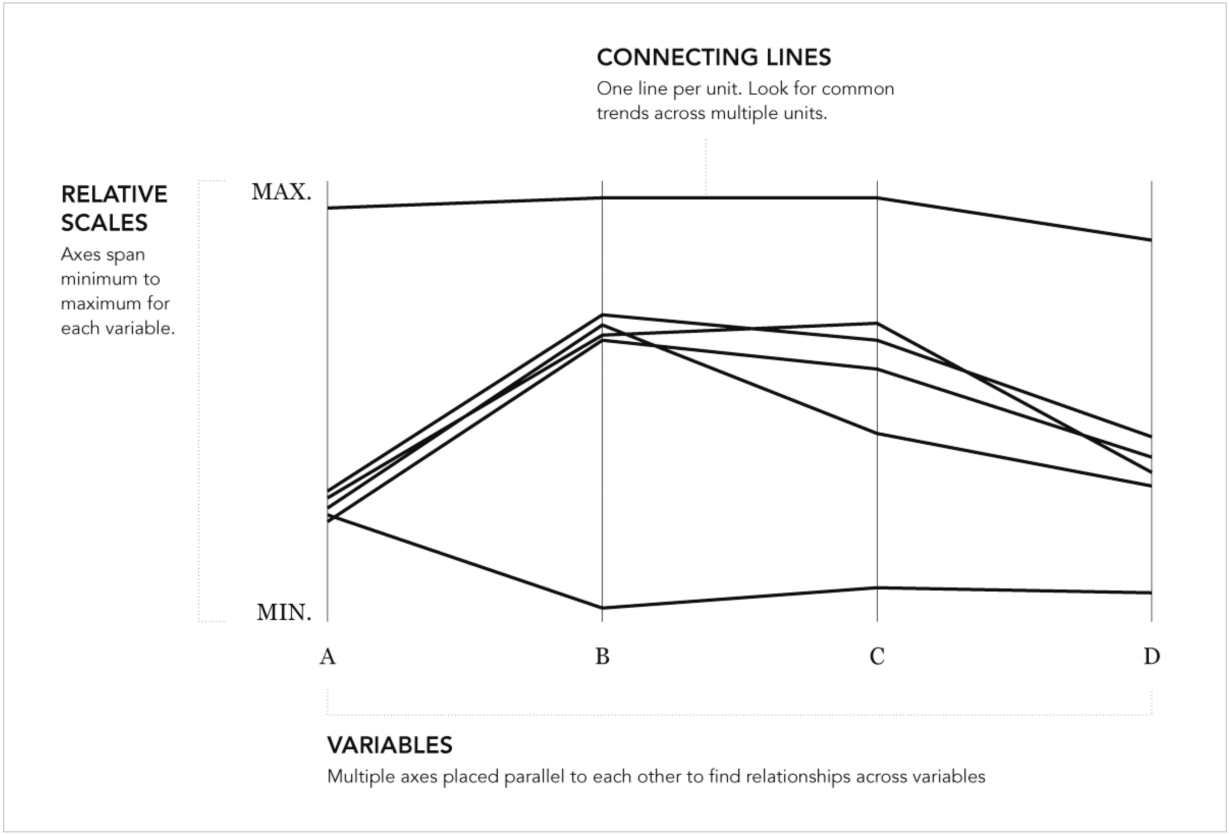


FIGURE 7-20 Parallel coordinates framework

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.

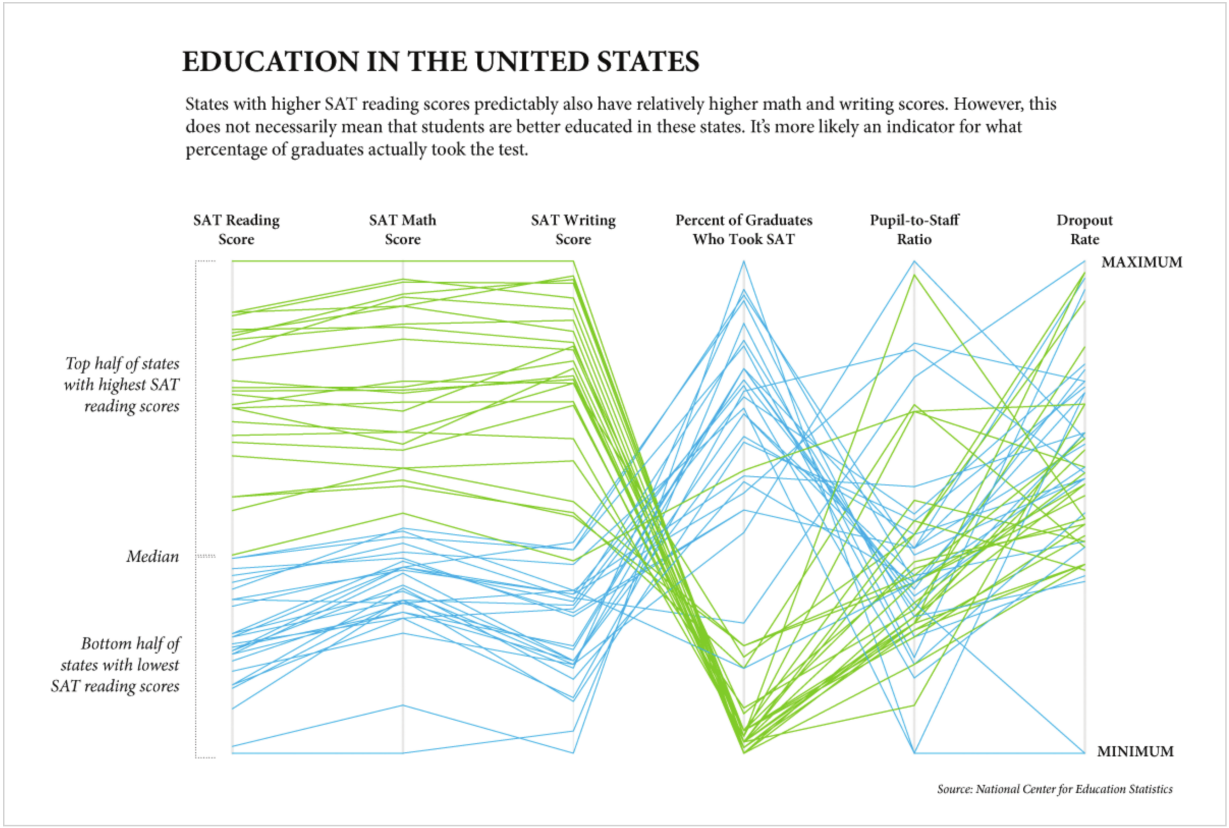
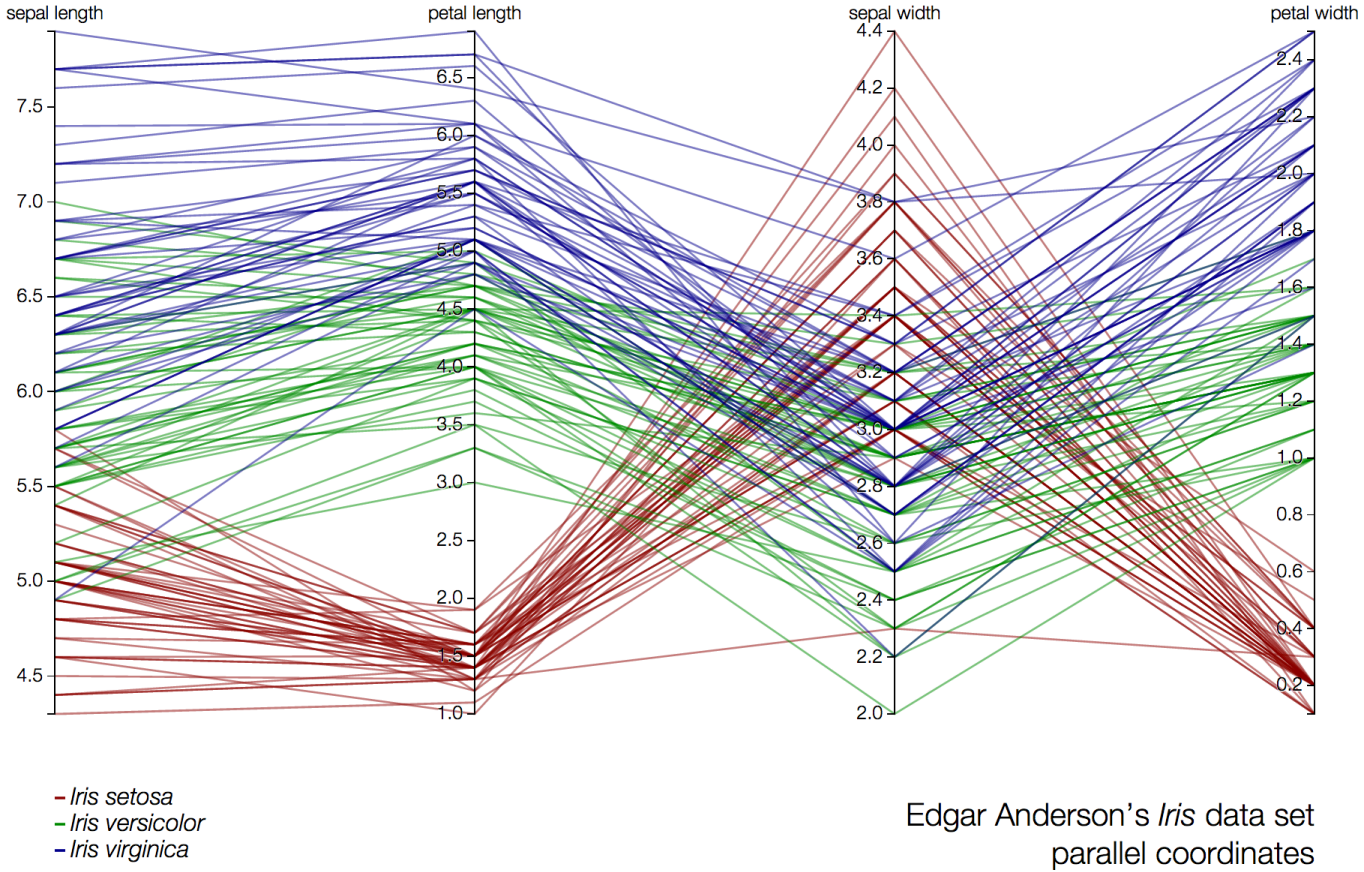


FIGURE 7-26 Standalone parallel coordinates plot on SAT scores

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.



Edgar Anderson's *Iris* data set
parallel coordinates

http://mbostock.github.com/d3/talk/20111116/iris-parallel.html

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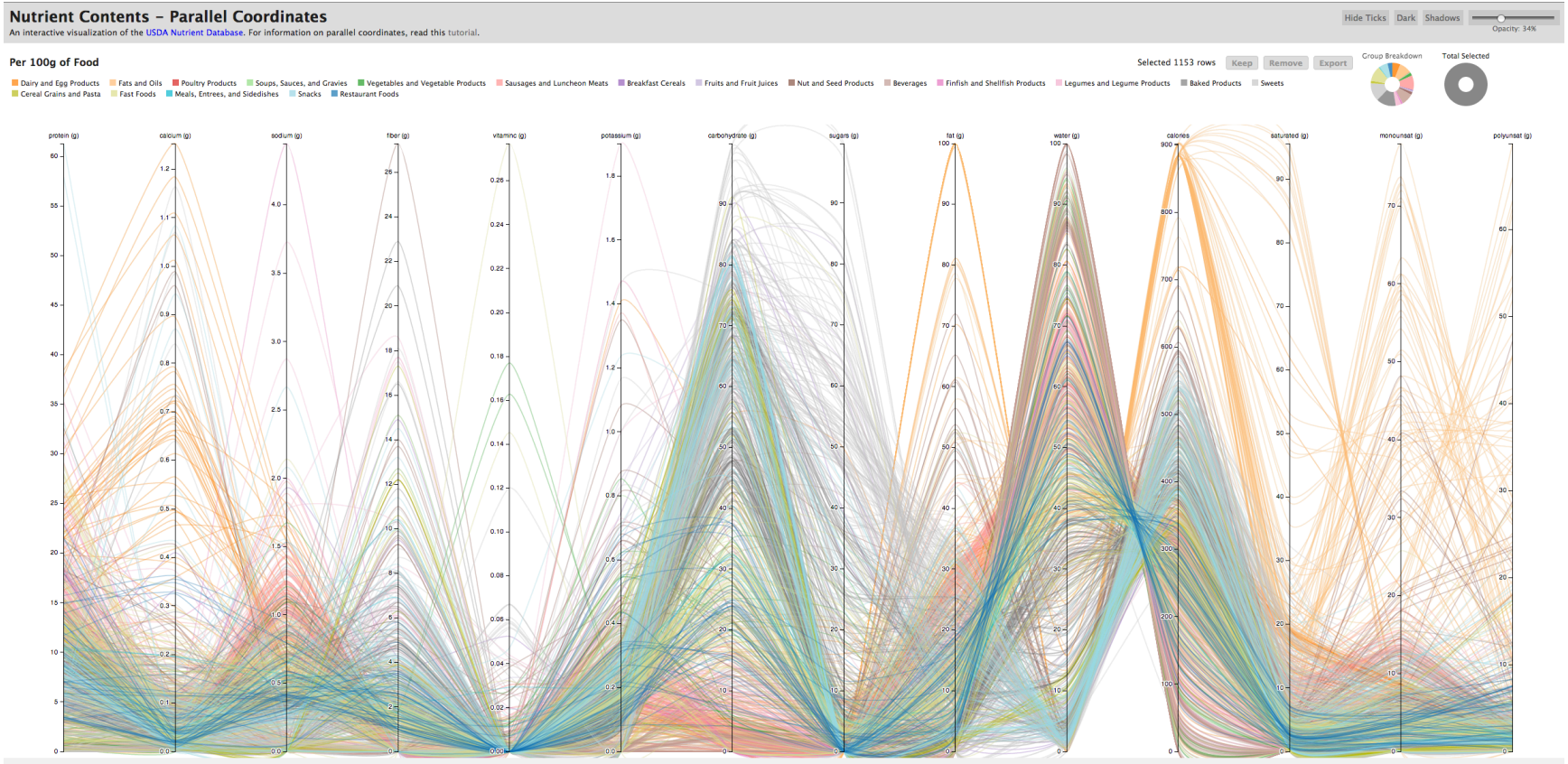

http://exposedata.com/parallel/

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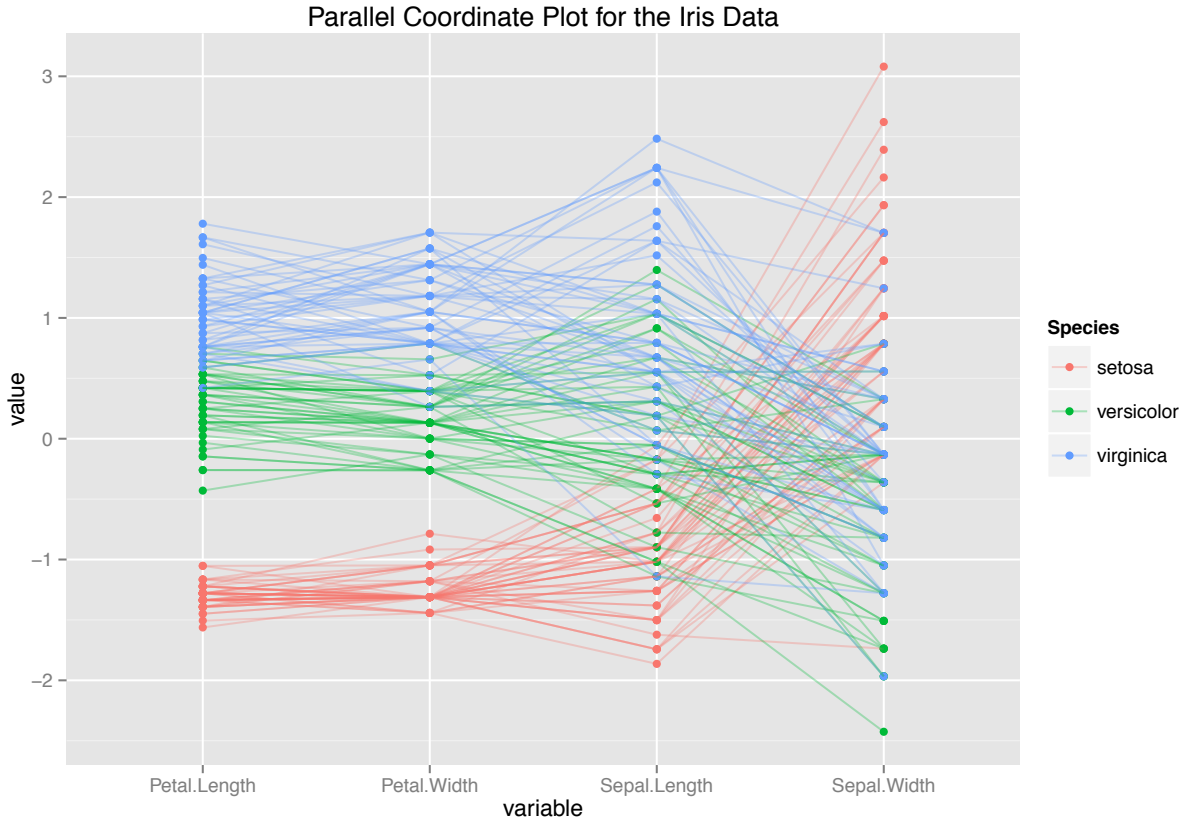

http://www.inside-r.org/packages/cran/GGally/docs/ggparcoord

Custom R and ggplot2 Implementation

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Discussion

- Long startup time
- Almost always requires interactivity
  - Choose column to color by
  - Choose how to sort
  - Highlighting (brushing)
  - Clustering
- Very high density and data ink ratio, low lie factor

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RADAR/STAR PLOT

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Encode Data

- Same as a parallel coordinate plot, but drawn radially

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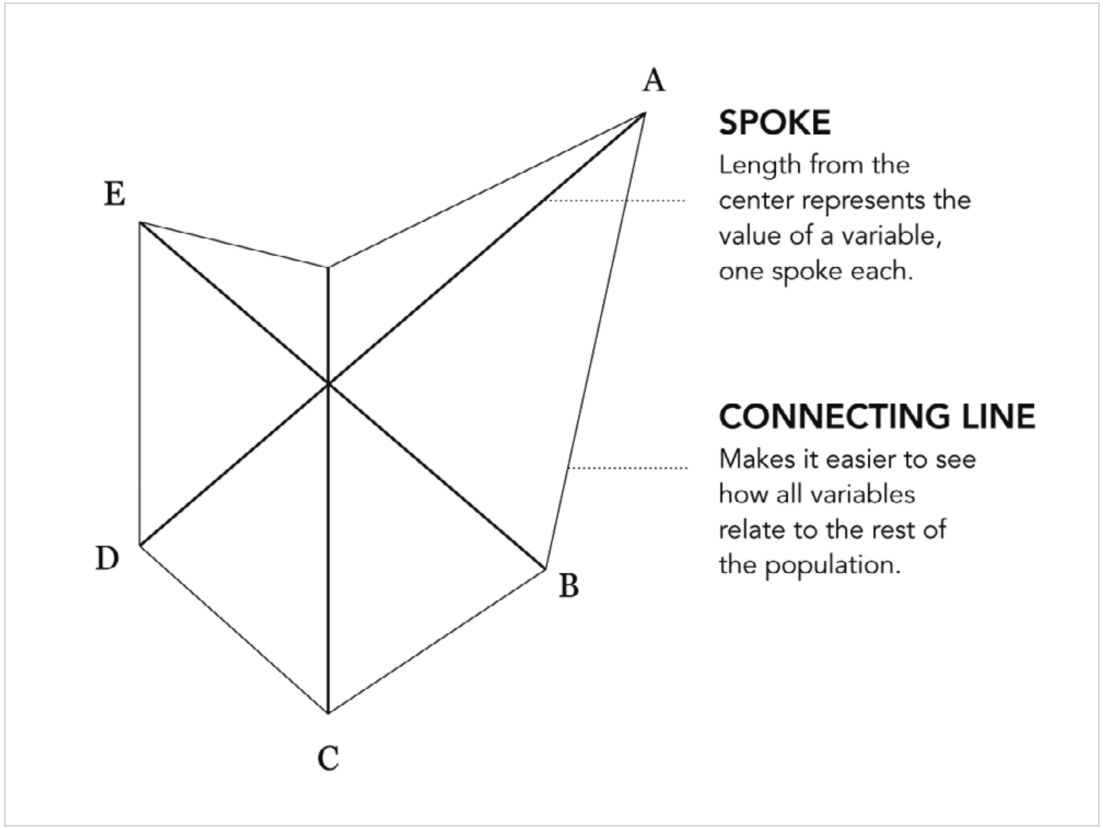

FIGURE 7-14 Star chart framework

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.

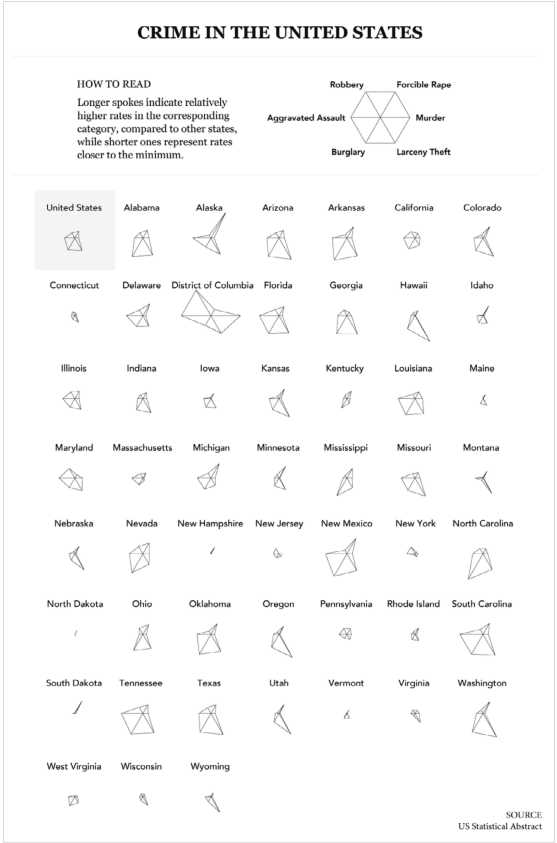

FIGURE 7-19 Series of star charts showing crime by state

"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics" by Nathan Yau, 2011.

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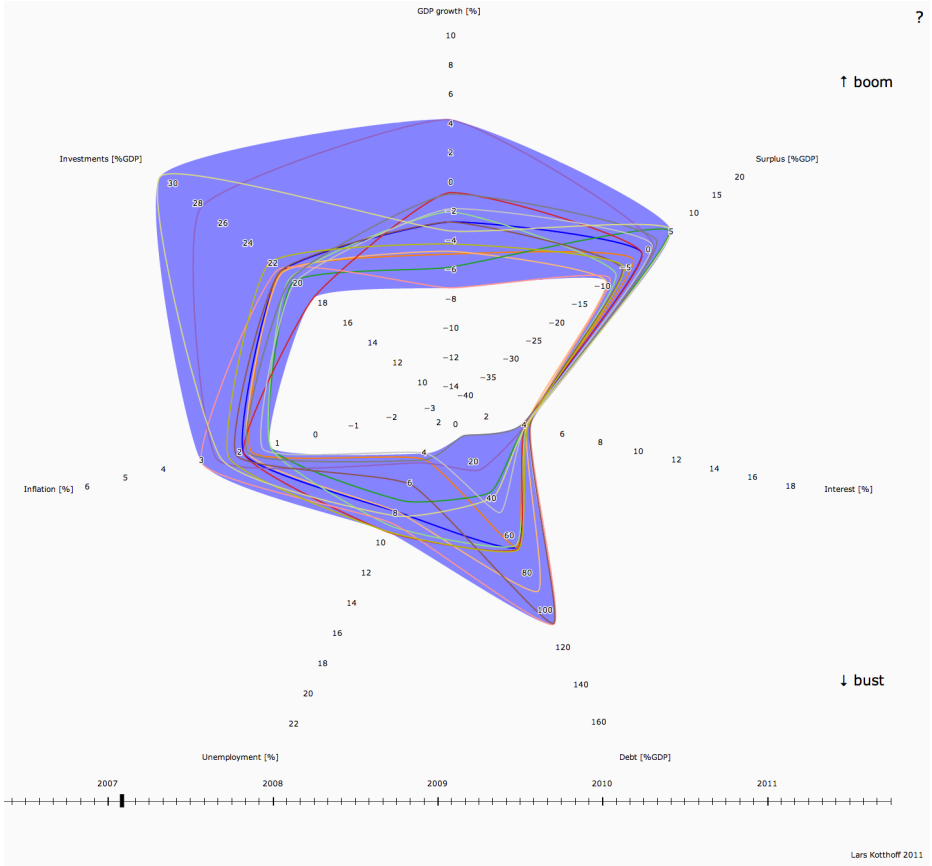
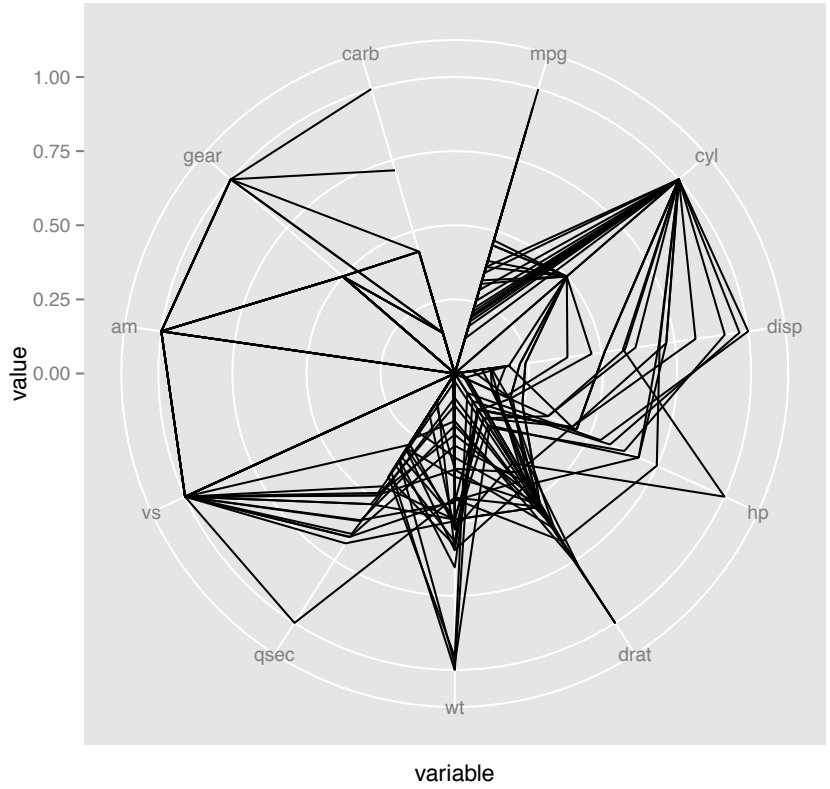


http://www.larsko.org/v/euc/



https://github.com/hadley/ggplot2/issues/516

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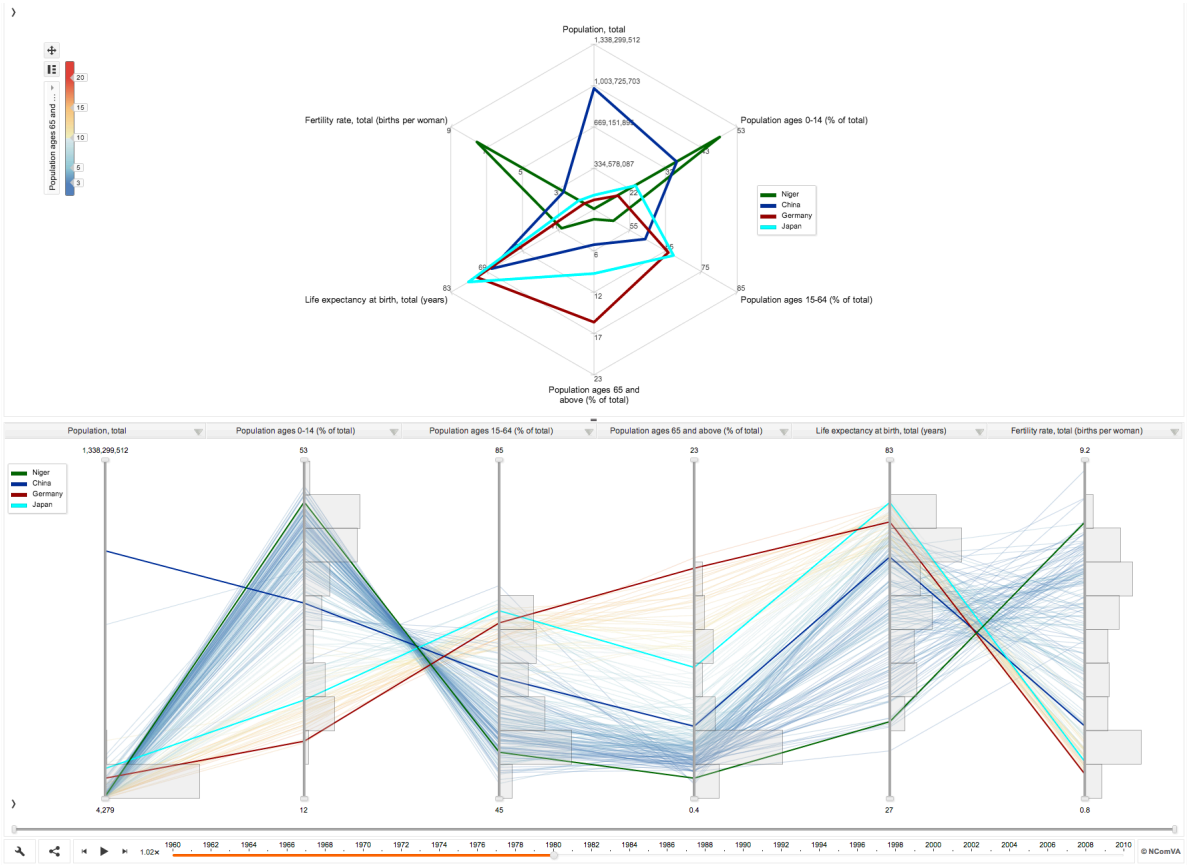

http://www.ncomva.se/html5/dynamic/index.html?layout=(radarchart,pcp)

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Discussion

- Gives a shape to the data
- When plotted on top of each other, must have some ability to highlight and filter
- Works decently for small multiples?
  - Requires small number of rows
- Better for data with a circular aspect?
  - Monthly temperature time series

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CONCLUSION

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Other Techniques

- **Parallel Sets**
  - http://eagereyes.org/parallel-sets
- **Rose Diagrams**
  - http://dd.dynamicdiagrams.com/2008/01/nightingales-rose/

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References

- Nathan Yau, **Visualize This: The FlowingData Guide to Design, Visualization, and Statistics**, Wiley Publishing, 2011.
- Mike Bostock, **Data Driven Documents** (D3.js)
  - https://github.com/mbostock/d3/wiki/Gallery
  - http://bl.ocks.org/mbostock
- Other references sourced on slides

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QUESTIONS

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