Data Visualization (CSCI 627/490)

Design

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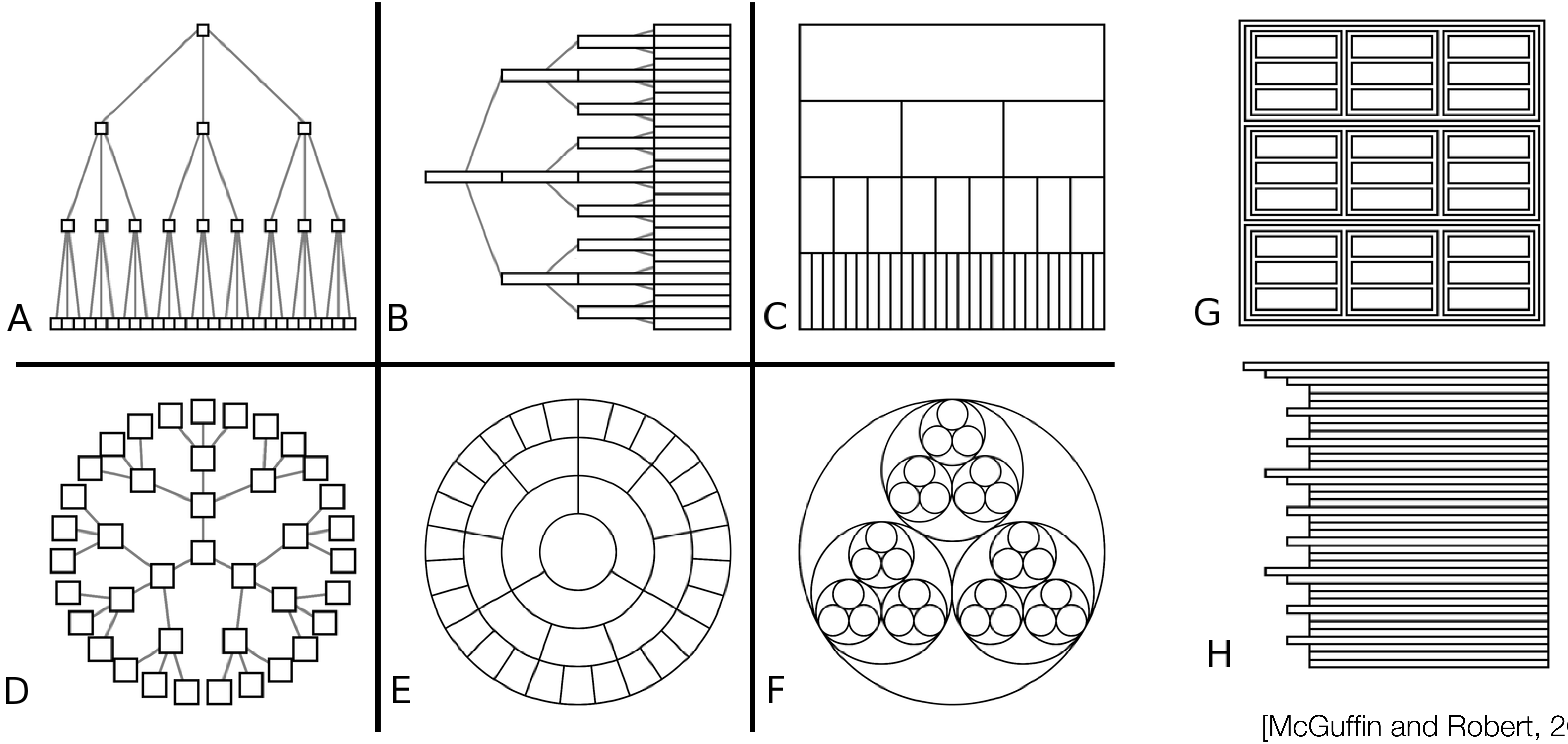
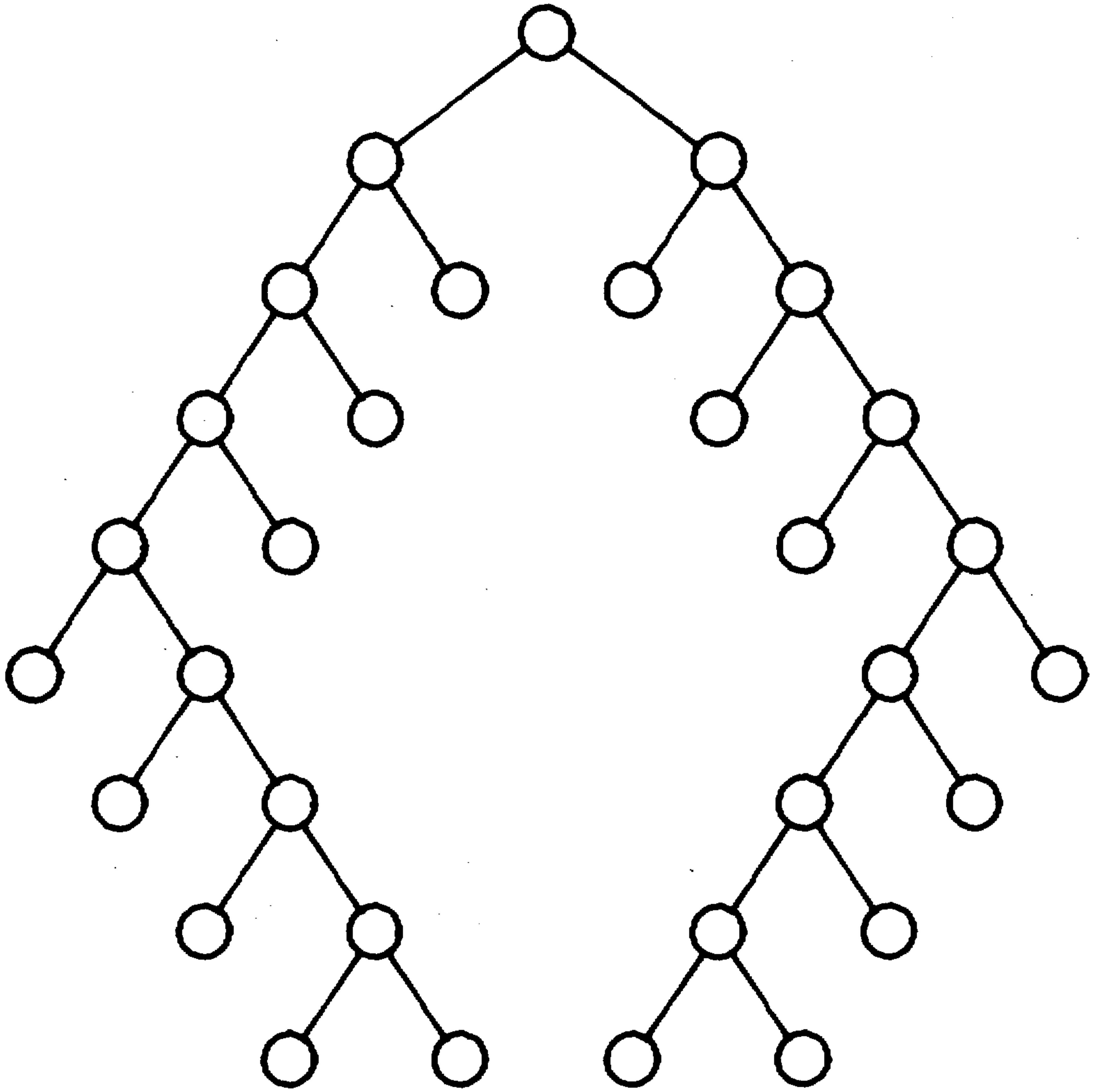
Tree Visualizations



[McGuffin and Robert, 2010]

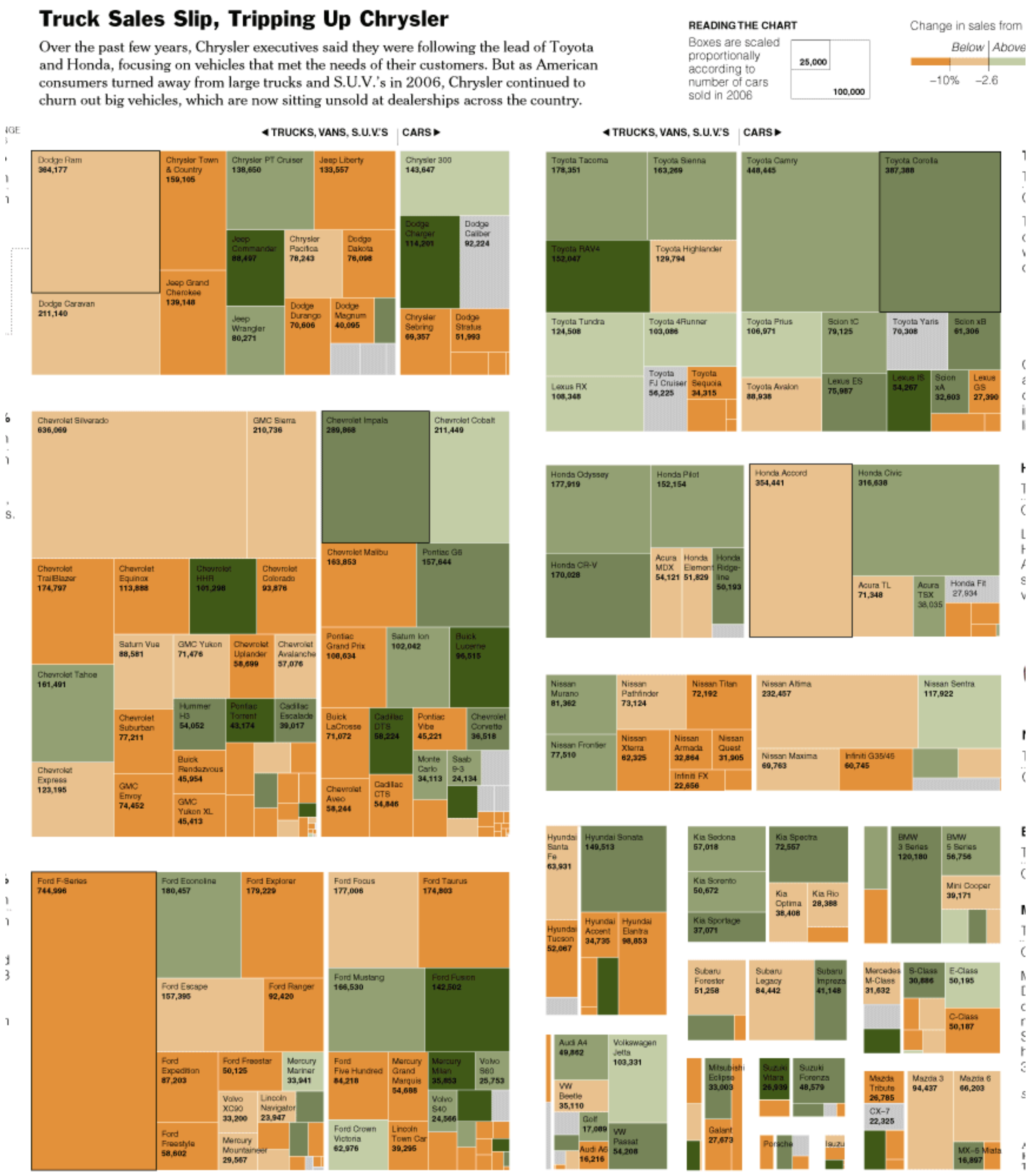
Reingold-Tilford Algorithm



- Recurse on left and right subtrees
- Shift subtree over as long as it doesn't overlap
- Place parent centered above the subtrees
- Originally, only binary trees, extended by Walker

[Reingold and Tilford, 1981]

Treemap

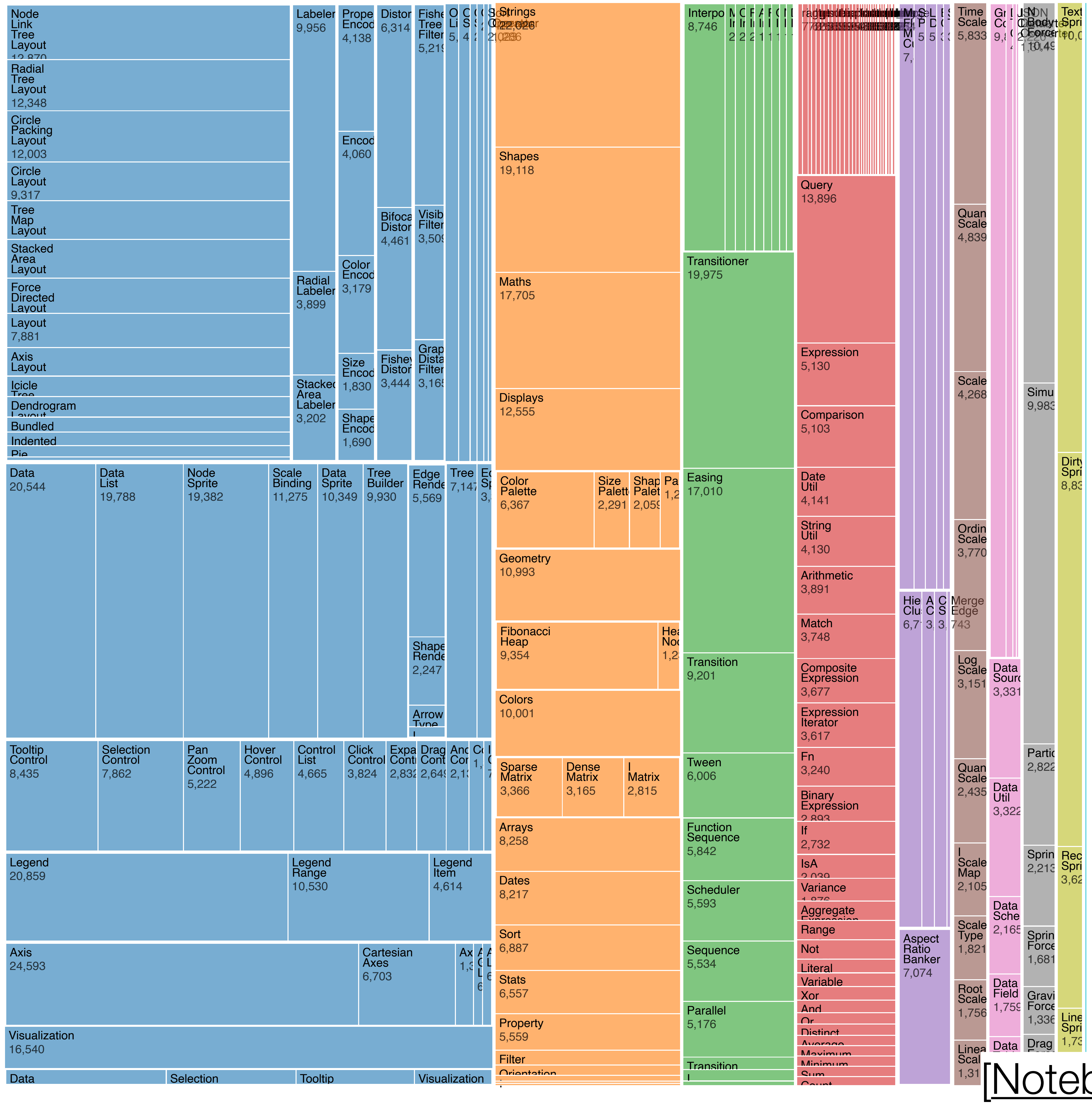


- Containment marks instead of connection marks—show hierarchy
- Encodes some quantitative attribute of the items as the **size** of the rectangles
- Not as easy to see the intermediate rectangles (hierarchy)
- Scalability: millions of leaf nodes and links possible

[A. Cox and H. Fairfield, NYTimes, 2012]

Treemap Layouts: Slice & Dice

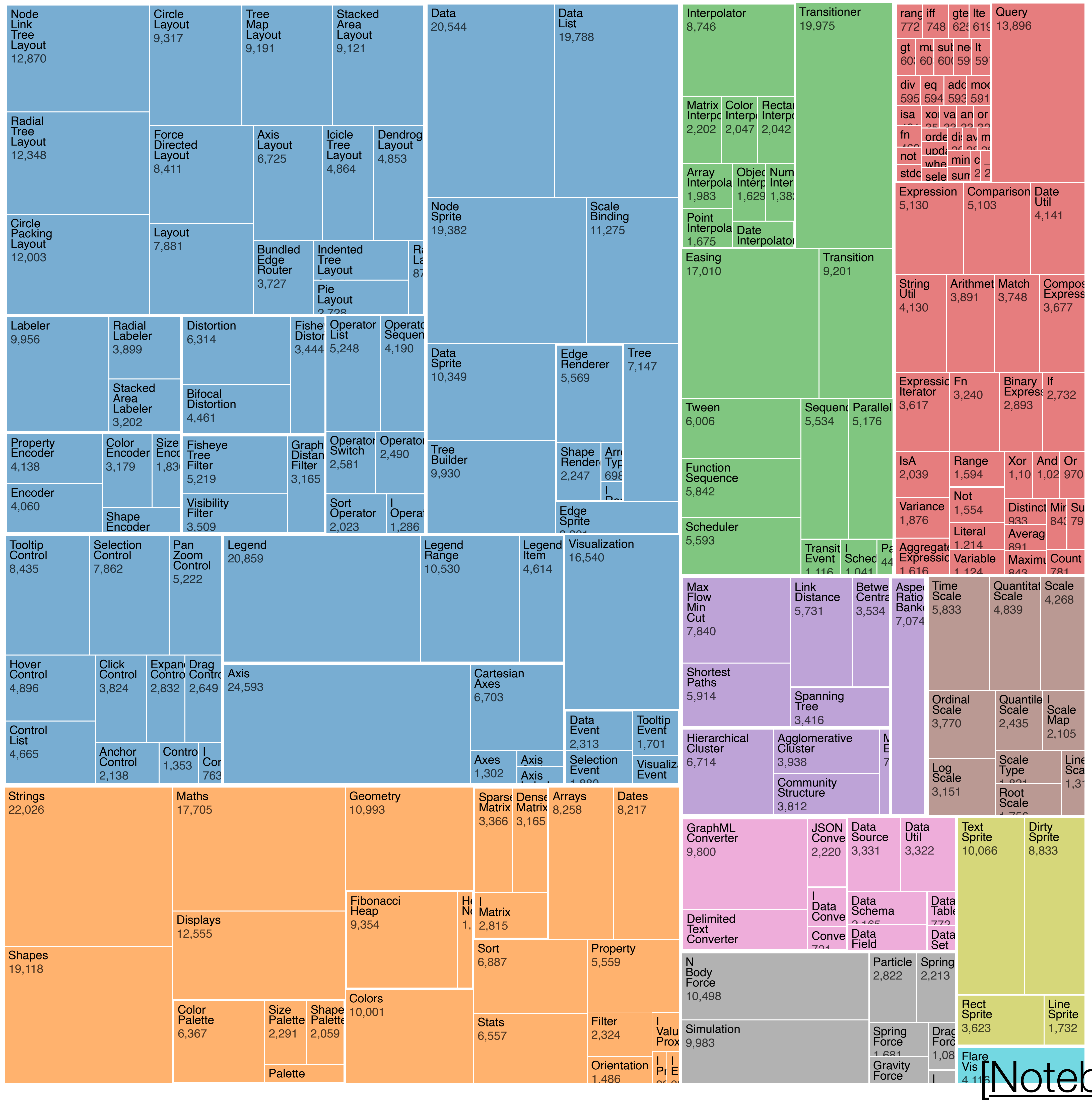
- Split at each level into strips
- At each step, orientation of division (horizontal/vertical) changes
- Better, but some rectangles still have bad aspect ratio



[Notebook]

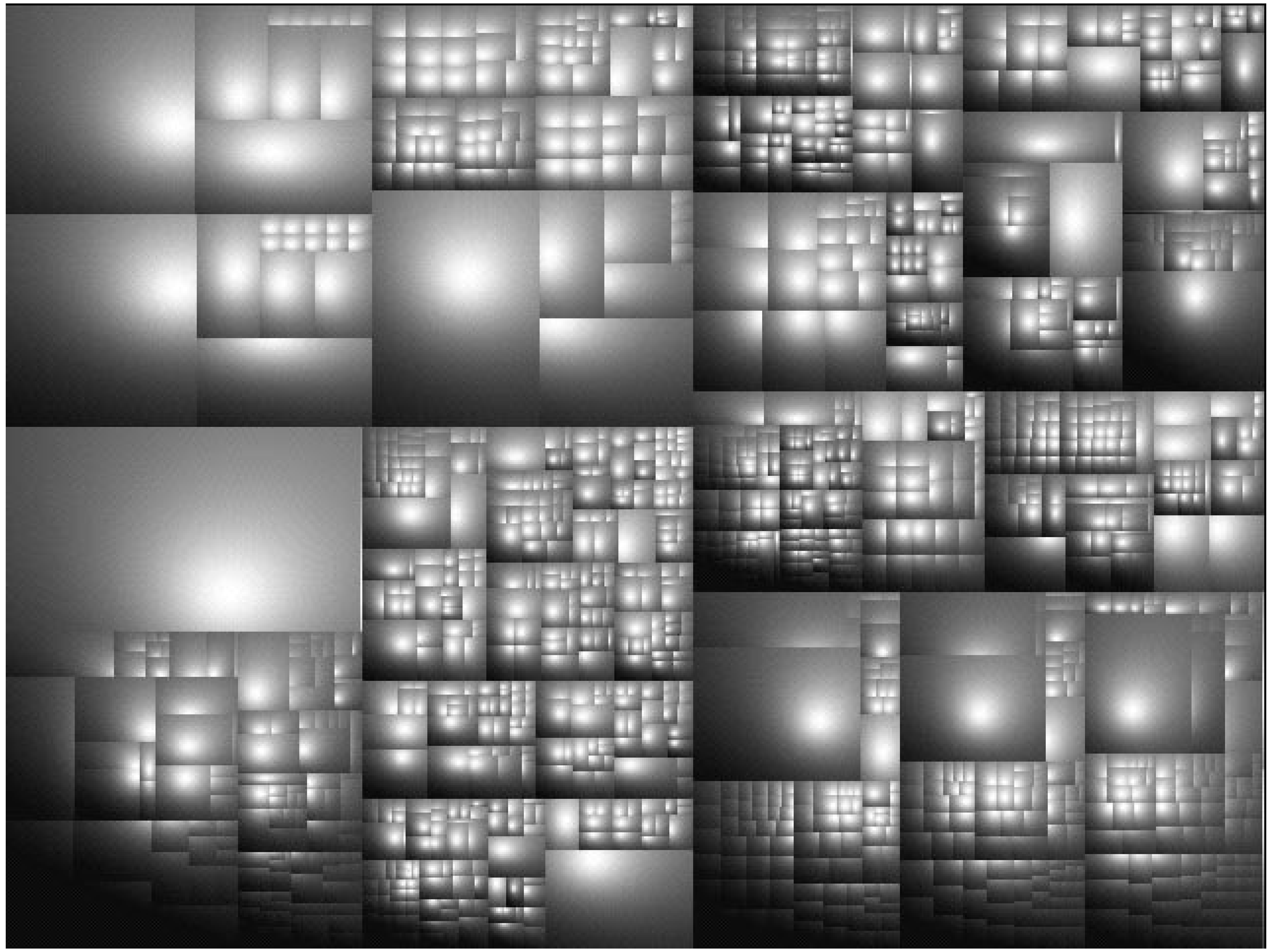
Treemap Layouts: Squarify

- Slice & Dice and Strip can lead to bad **aspect ratios**
- Solution: Strip only uses rows, allow columns to be used, too
- Choose divisions (x/y) based on the width/height of region in order to maintain good aspect ratios
  - Use left and right side
  - Process large rectangles first
- Ordering not preserved which may cause issues if the data is updated

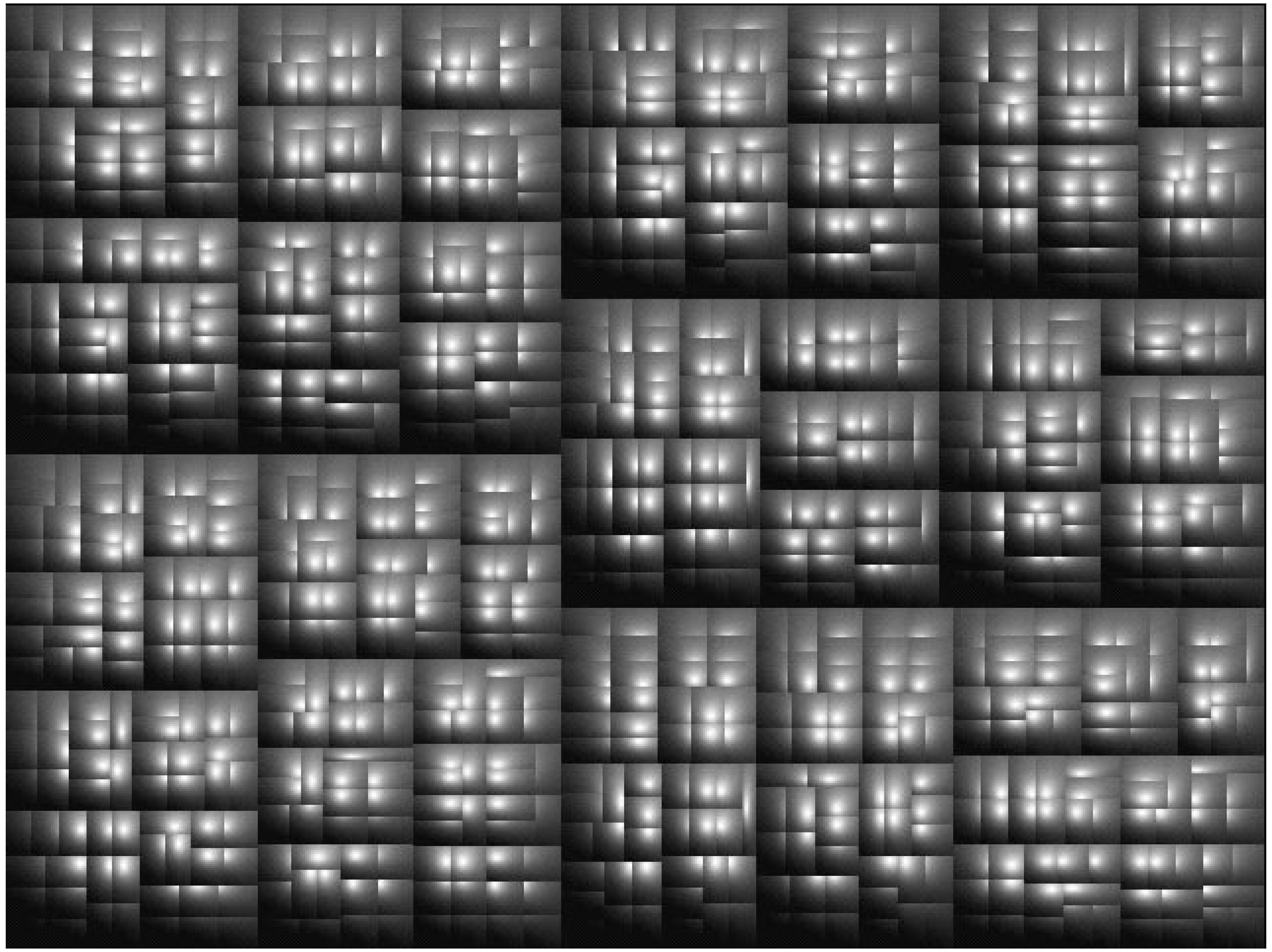


[Notebook]

Squarified + Cushioned Treemaps



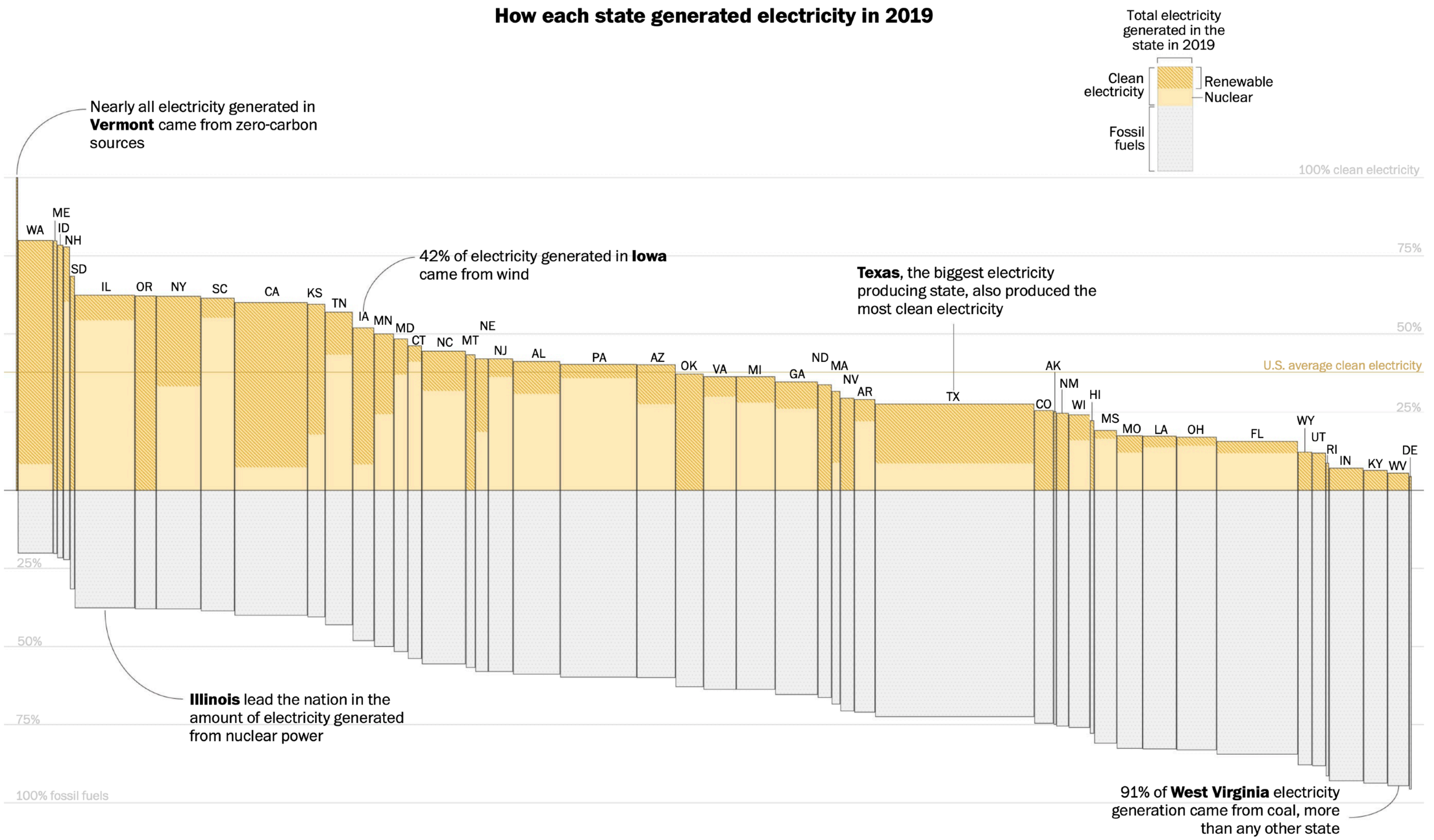
(a) File system



(b) Organization

[Brus et al., 1999]

Variations: Marimekko Chart



[J. Muyskens, Washington Post]

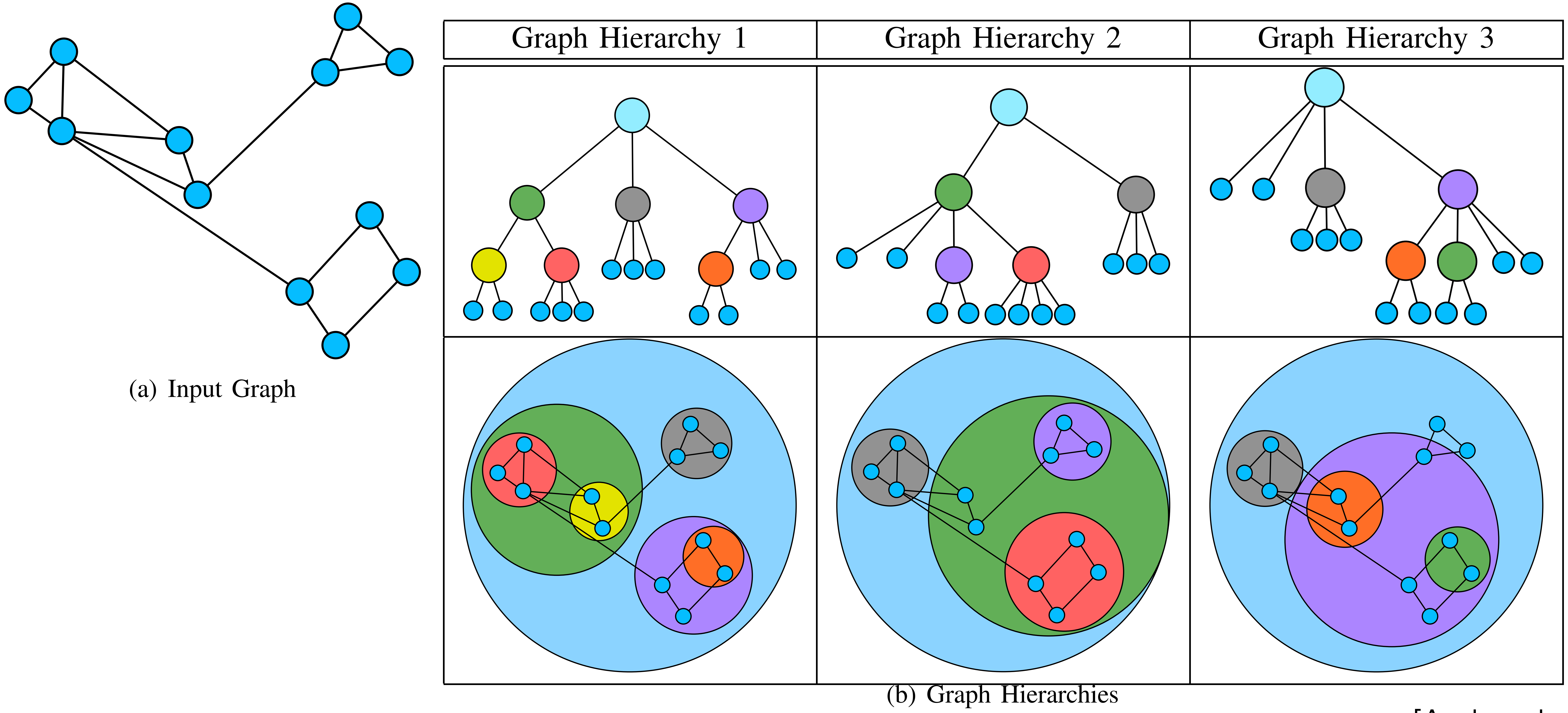
Nested Circles

- Looks more like cluster diagram, but shows hierarchy
- Containment shown by the layering of semi-transparent circles
- Labeling becomes more difficult

[Bostock, 2012]

Compound Networks

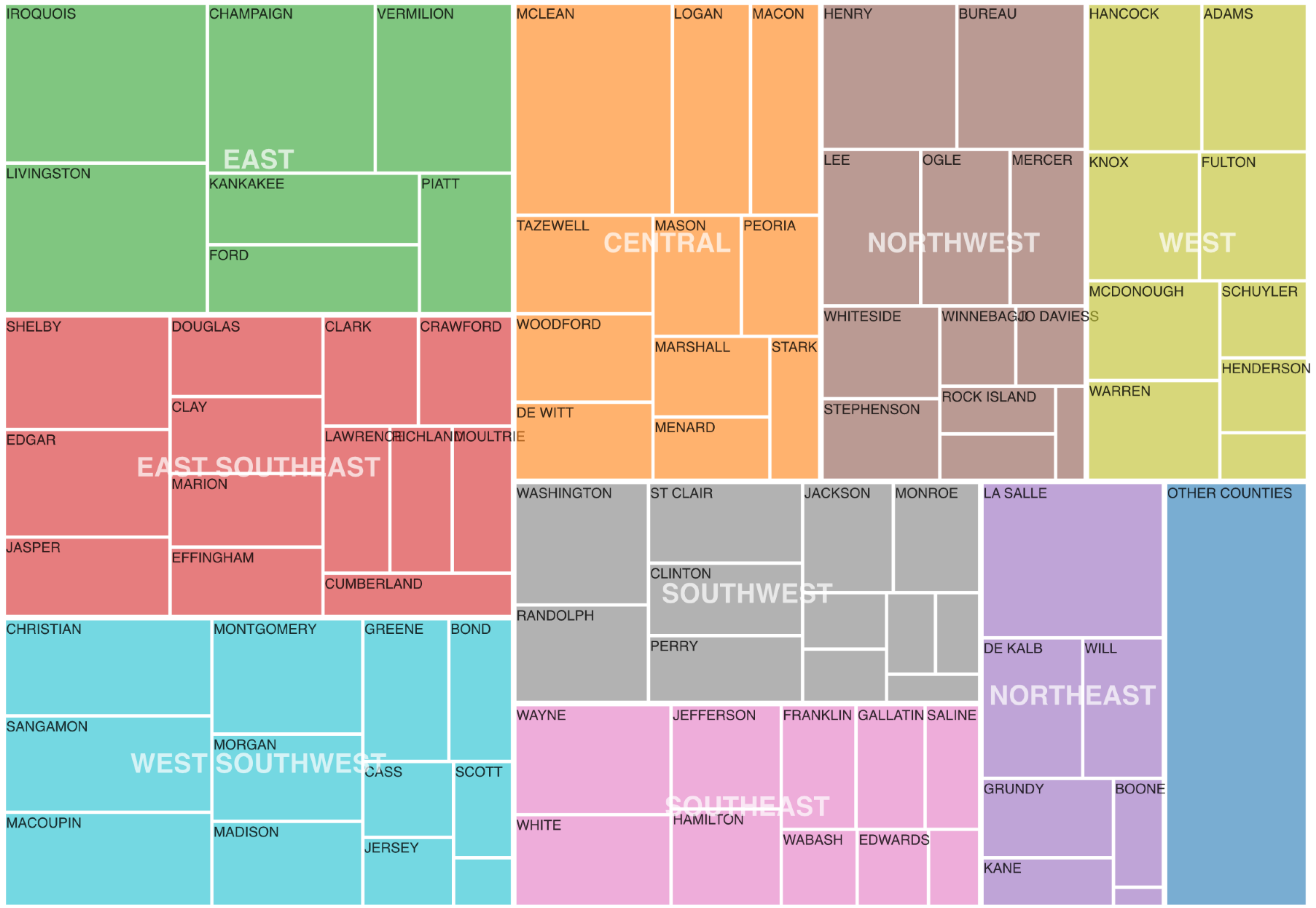
- Add a hierarchy to the network (e.g. from clustering)
- GrouseFlocks: uses nested circles with colors



[Archambault et al., 2008]

Assignment 4

- Corn & Soybean Production in Illinois
- Geospatial Visualizations & Treemap
  - Choose colormaps carefully
  - Add legend
- You may use D3 or Observable Plot
  - Part 1a: D3
  - Part 3 will require some D3 for treemap layout

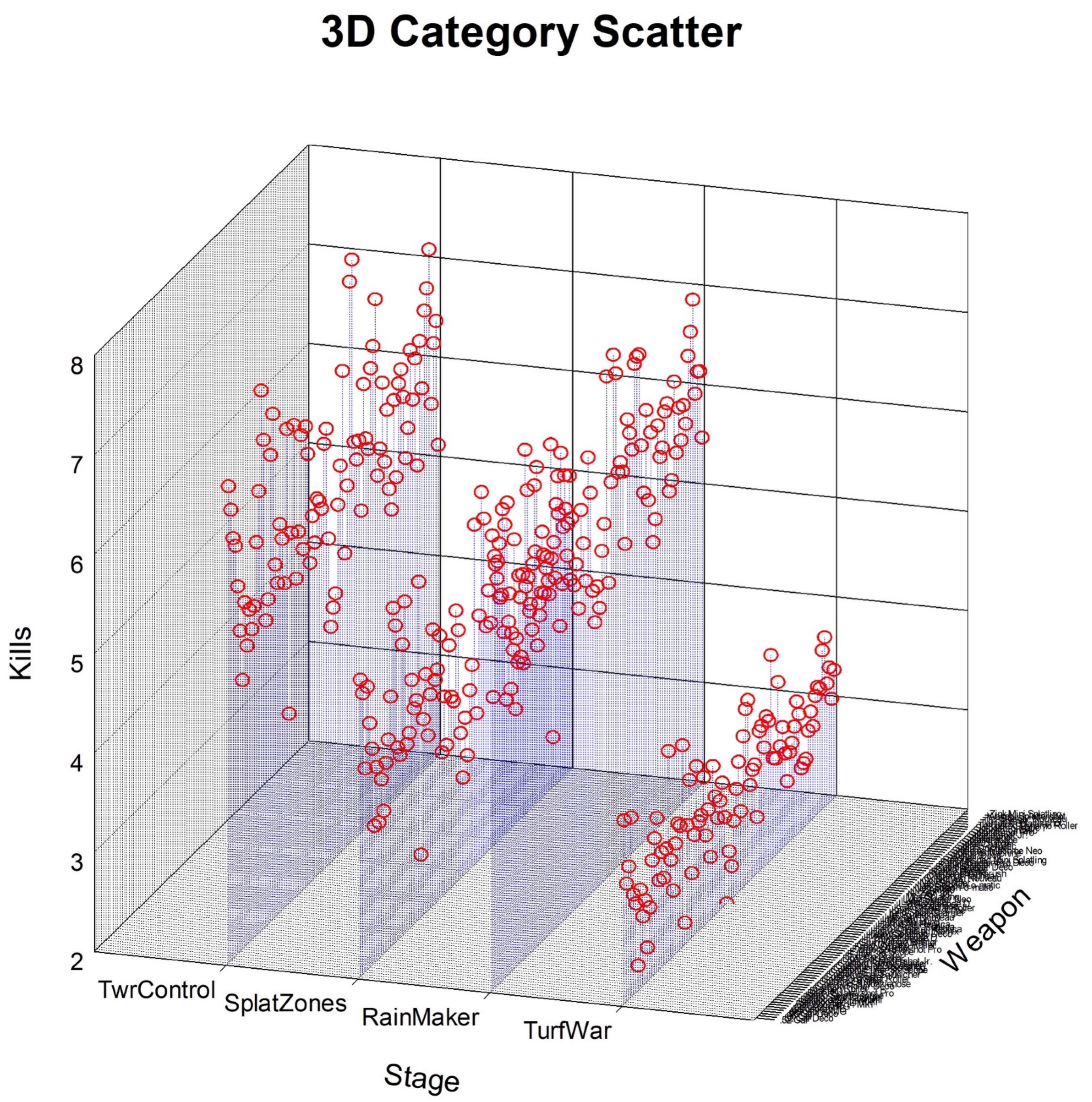


Project

- Next steps:
  - Start thinking about the designs that help answer the questions
  - Tasks should drive your design
  - Different designs are great
    - Multiple views
    - Single view with details on demand
    - Interaction design (linked highlighting, navigation)
    - In general, don't force the user to make choices without first seeing an overview

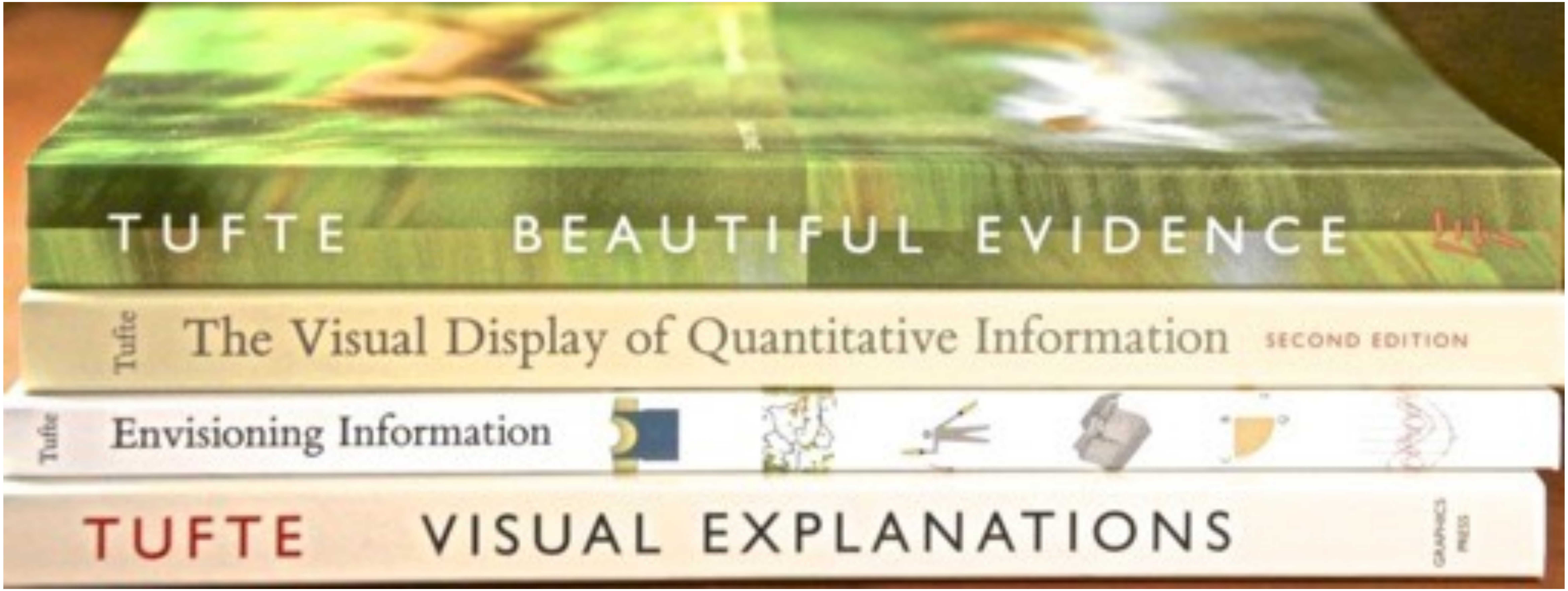
Guidelines for Visualization Design

WTF Visualizations (wtfviz.net)



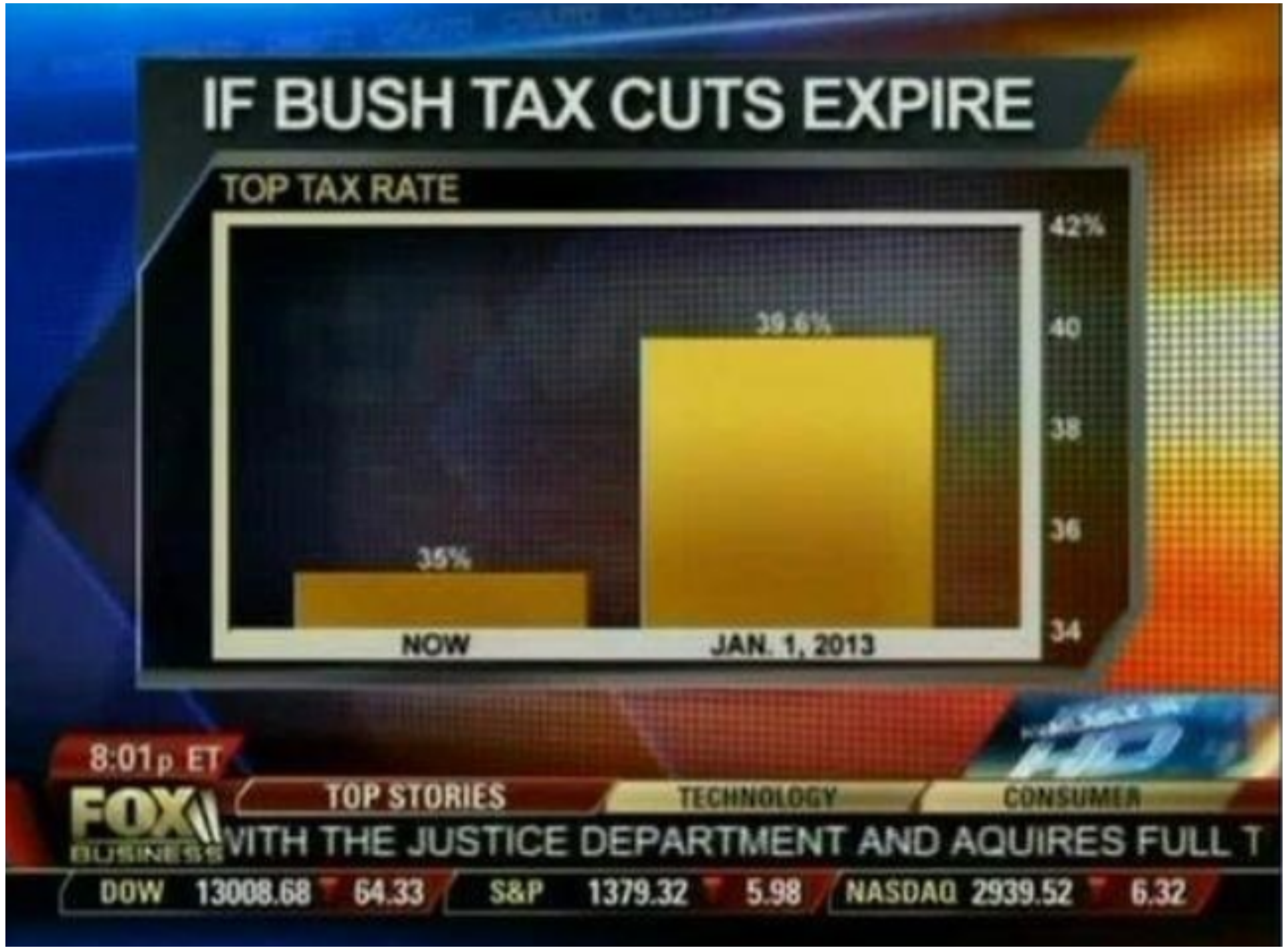
[WTF Visualizations, 2017]

Tufte: "The da Vinci of Data" —NYTimes



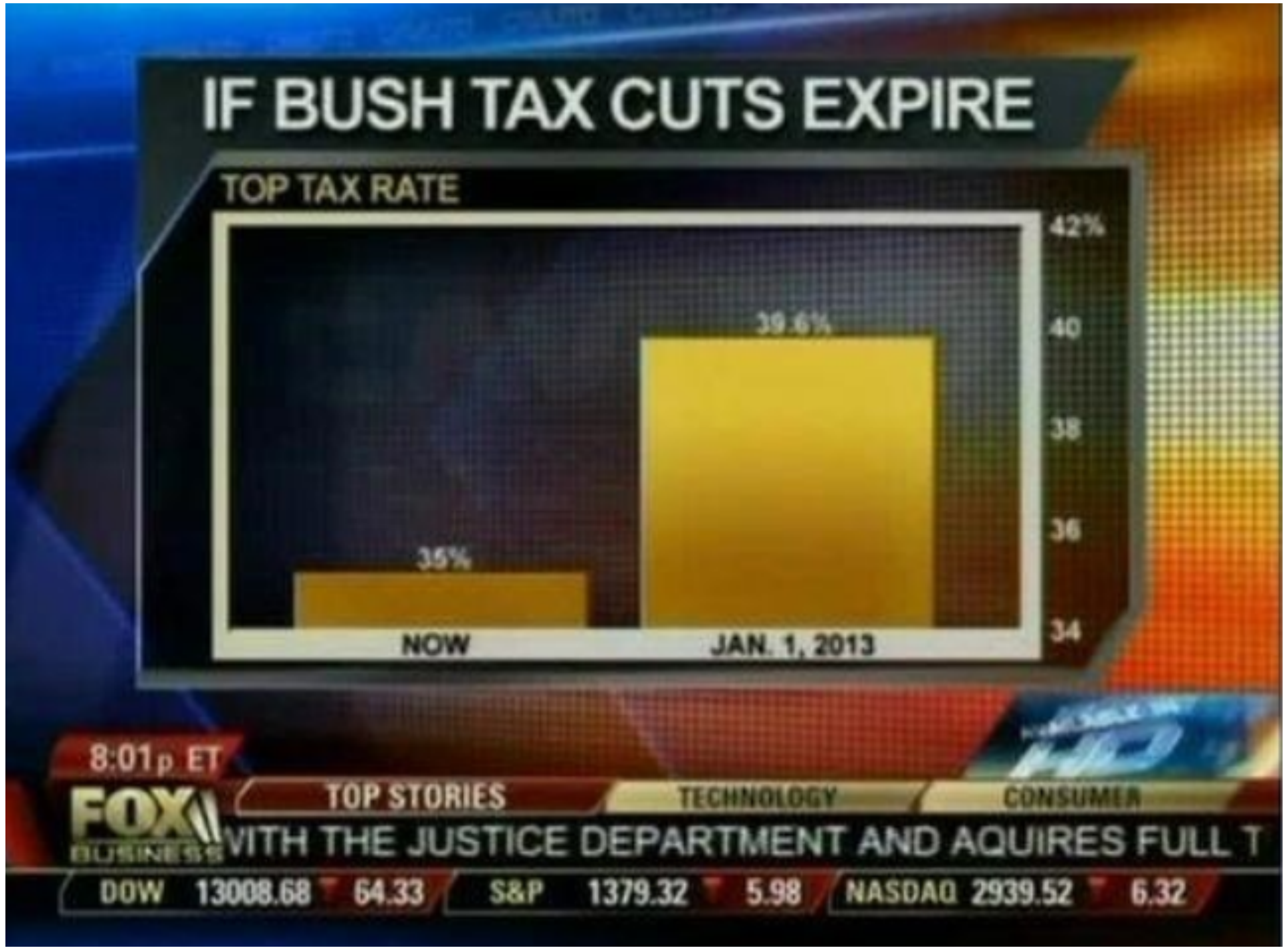
[https://www.edwardtufte.com/tufte/, 2017]

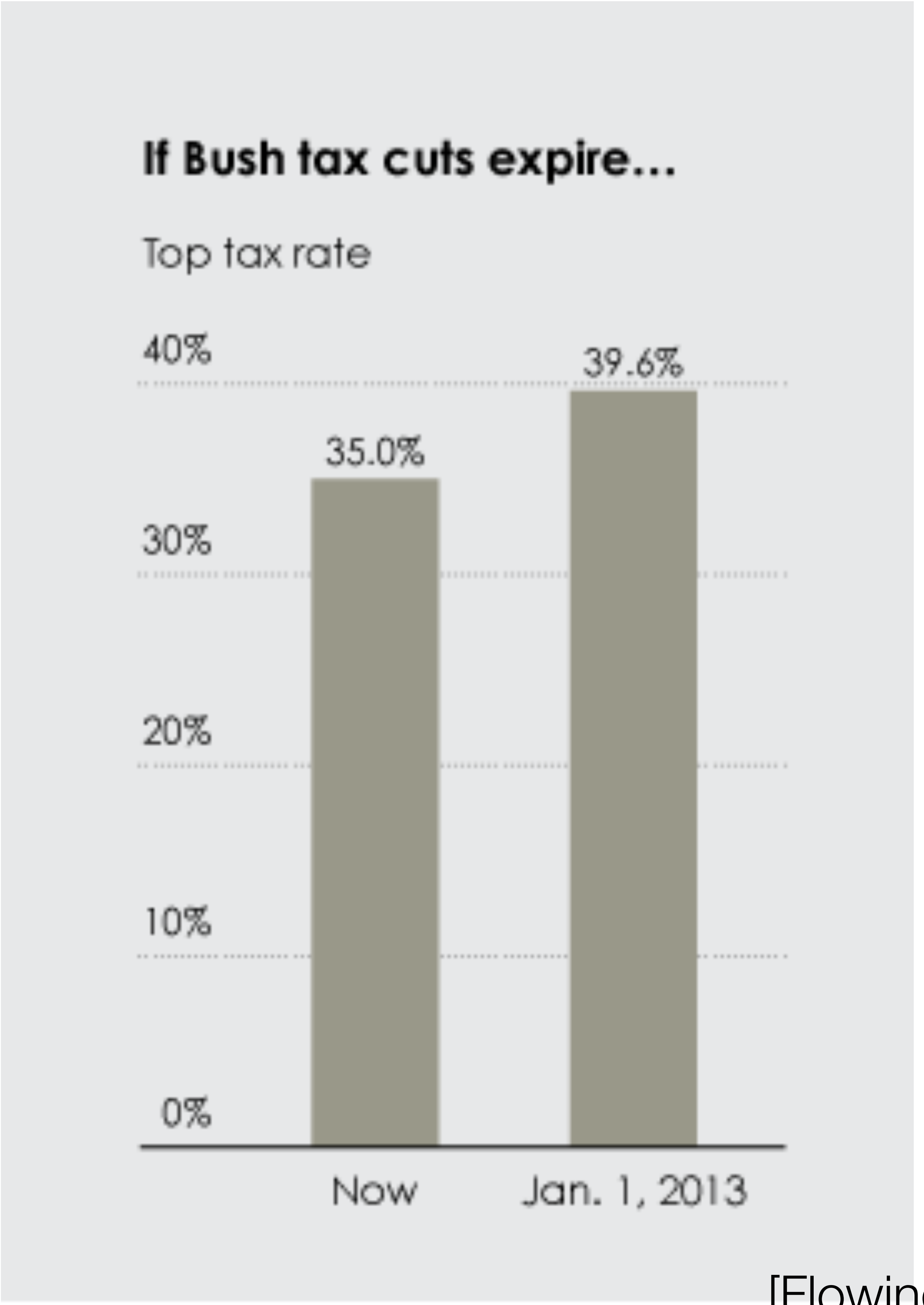
Bad: Data magnitude <≠> Mark magnitude



[Flowing Data, 2012]

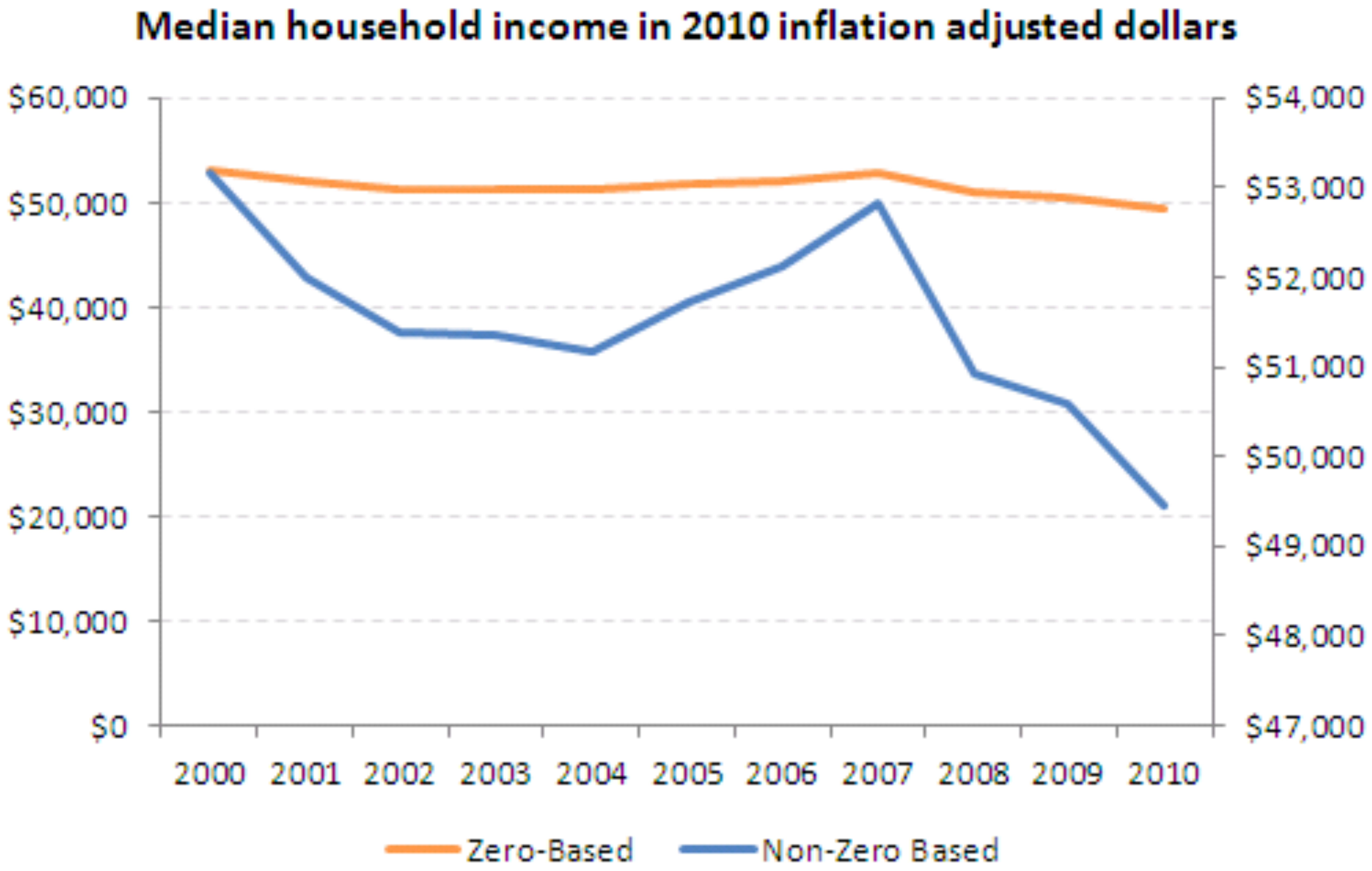
Good: Data magnitude <=> Mark magnitude





[Flowing Data, 2012]

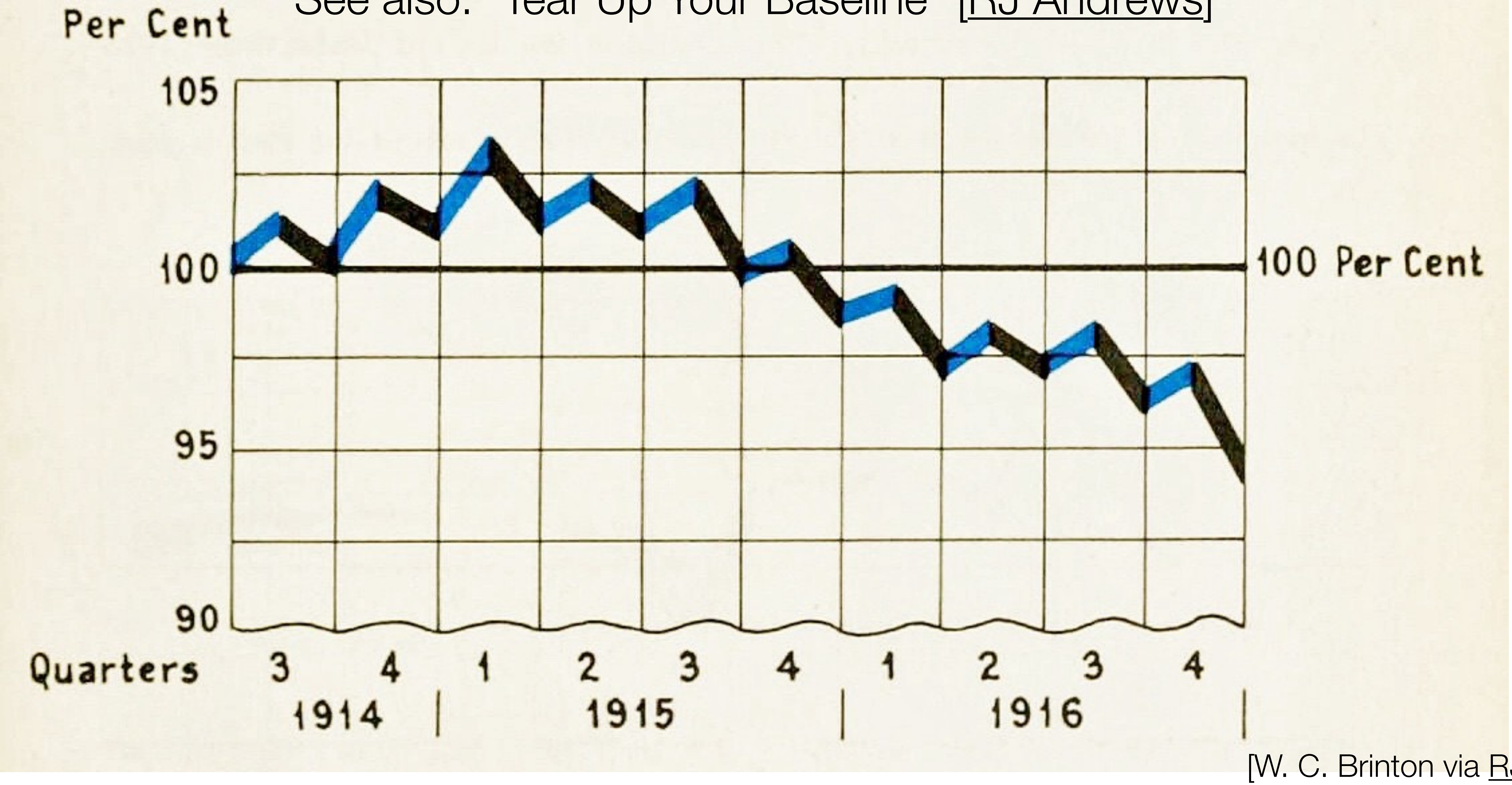
Starting Scales at Zero?



[A. Kirebel, VizWiz]

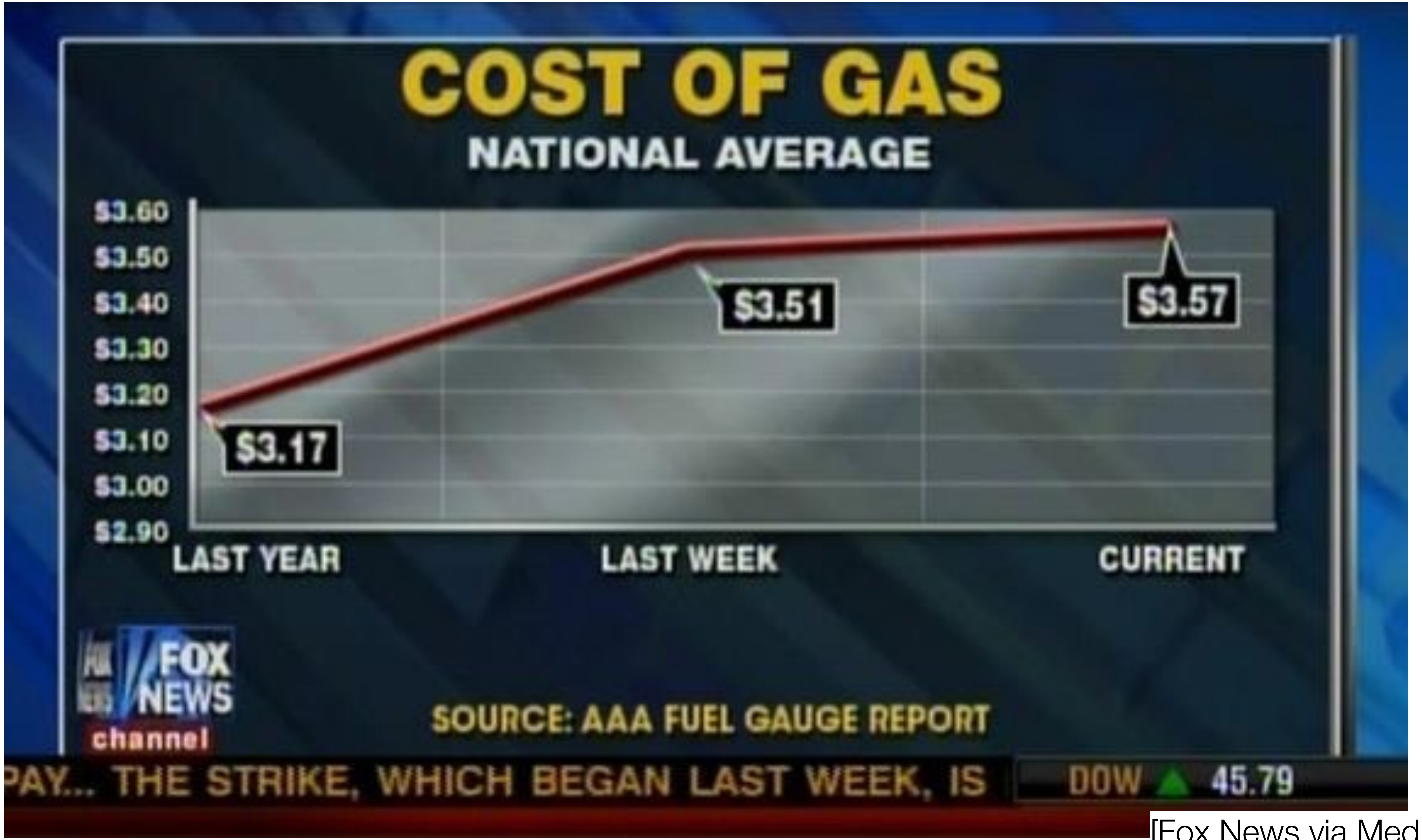
Wavy baselines for non-zero starts

See also: "Tear Up Your Baseline" [RJ Andrews]



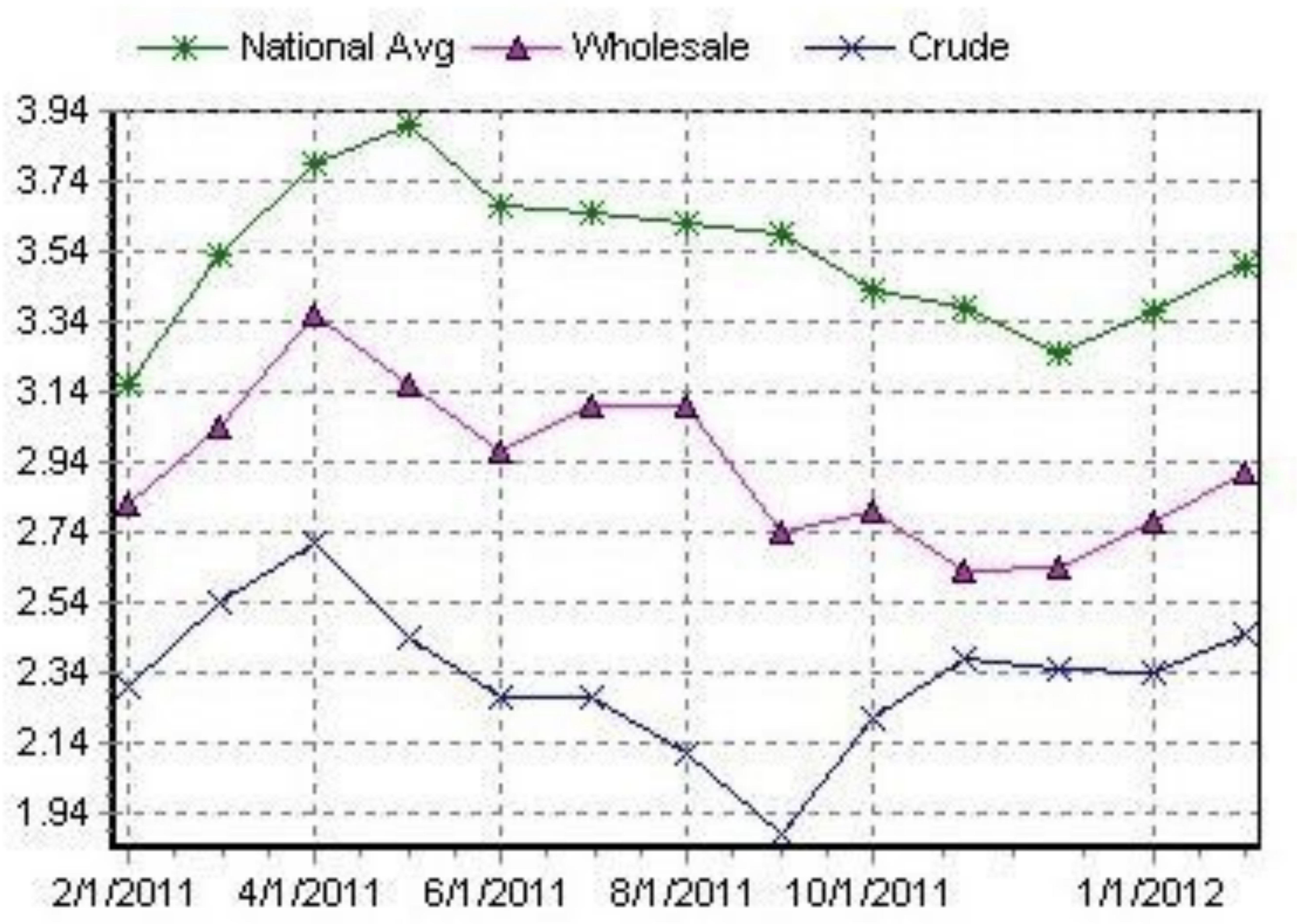
[W. C. Brinton via RJ Andrews]

Cherry-picking data



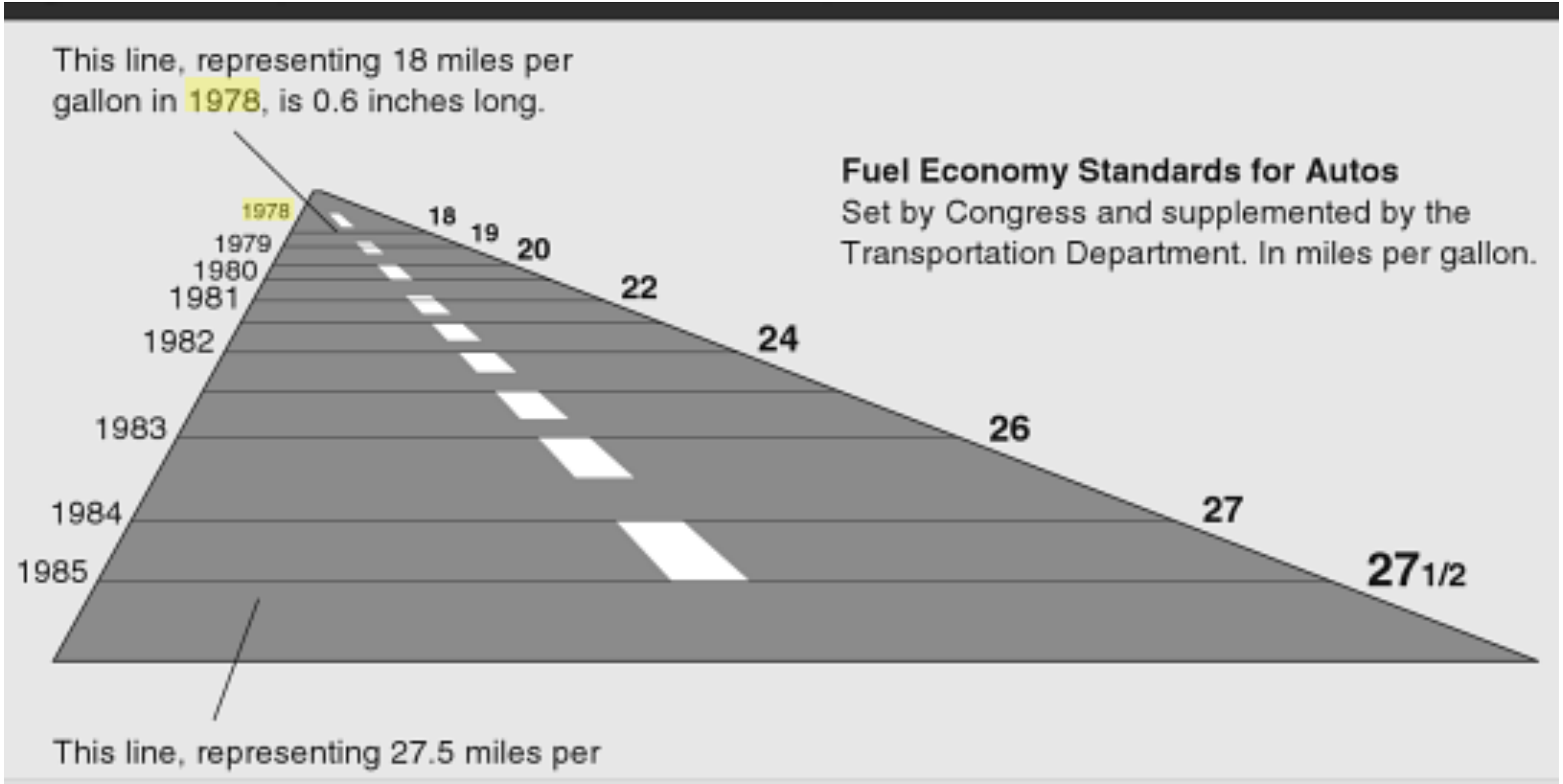
[Fox News via Media Matters, 2012]

Show **all** the data



[AAA via Media Matters, 2012]

Tufte's Lie Factor

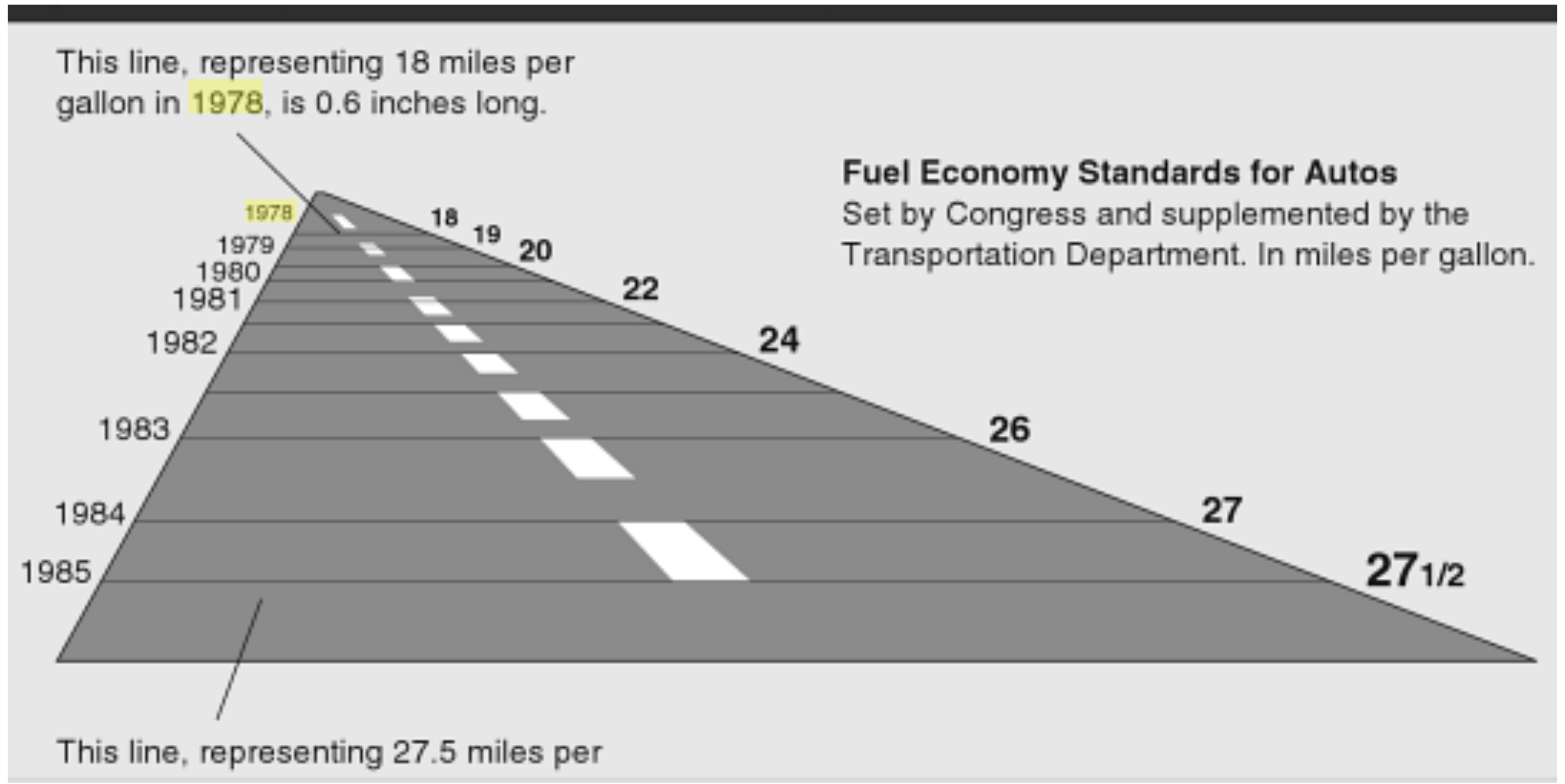


[NYTimes via Tufte, 1991]

Tufte's Lie Factor

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

$$\text{Lie Factor} = \frac{\frac{5.3 - 0.6}{0.6}}{\frac{27.5 - 18}{18}} = 14.8$$

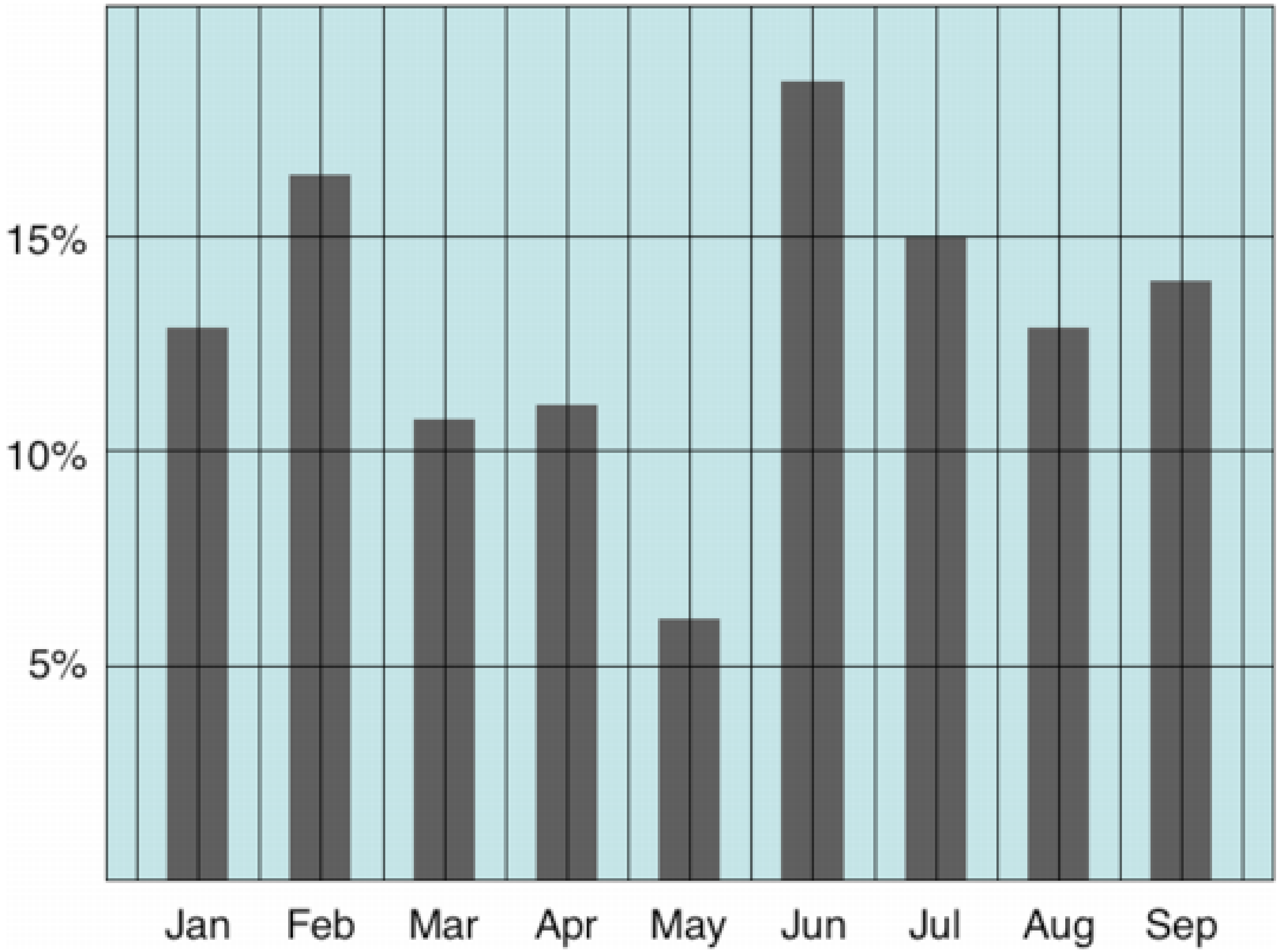


[InfoVis Wiki]

(Some of) Tufte's Integrity Principles

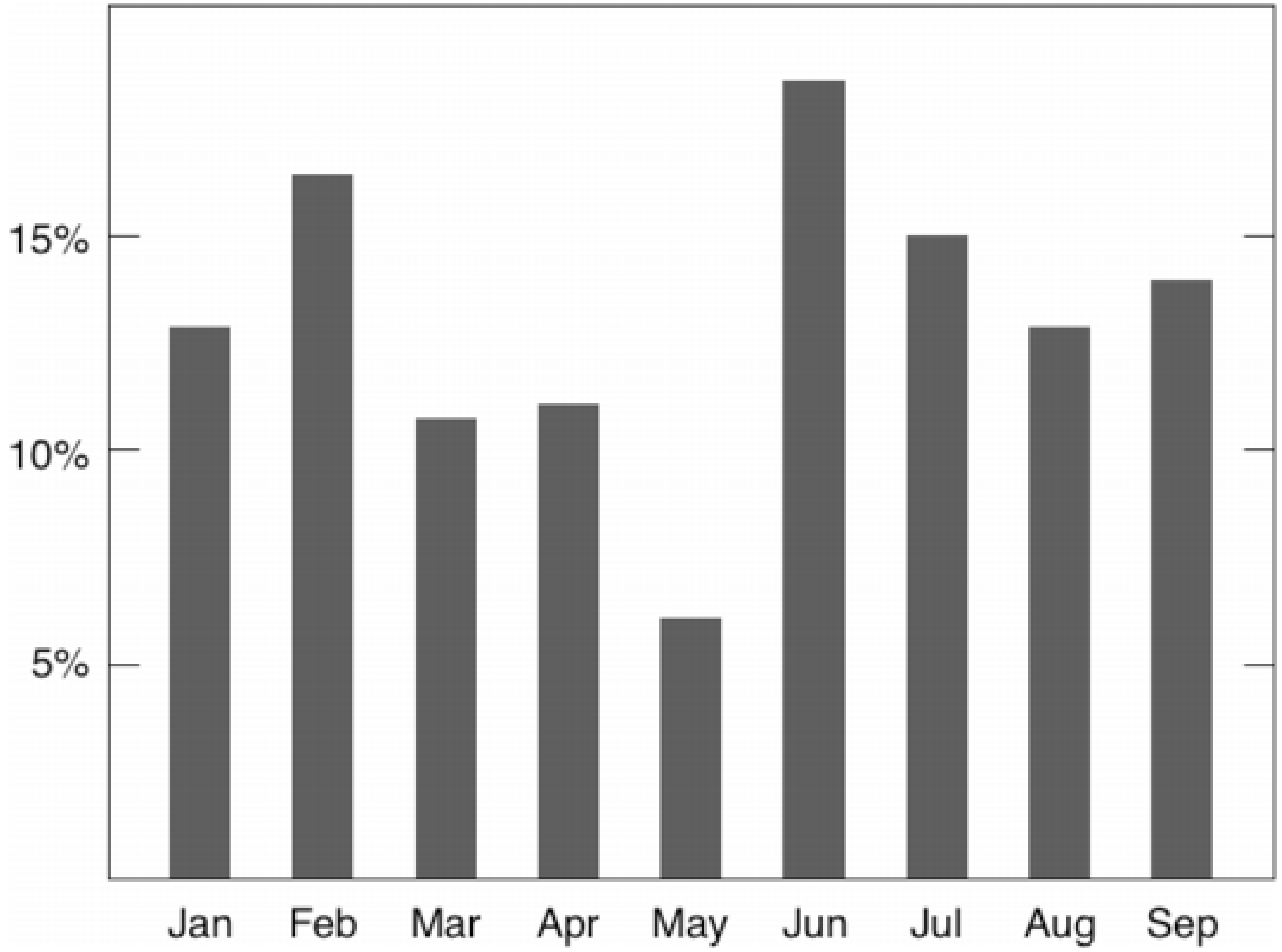
- Show data variation, not design variation
- Clear, detailed, and thorough labeling and appropriate scales
- Size of the graphic effect should be directly proportional to the numerical quantities ("lie factor")

Avoid Chartjunk



[T. Brey via A. Lex]

Avoid Chartjunk



[T. Brey via A. Lex]

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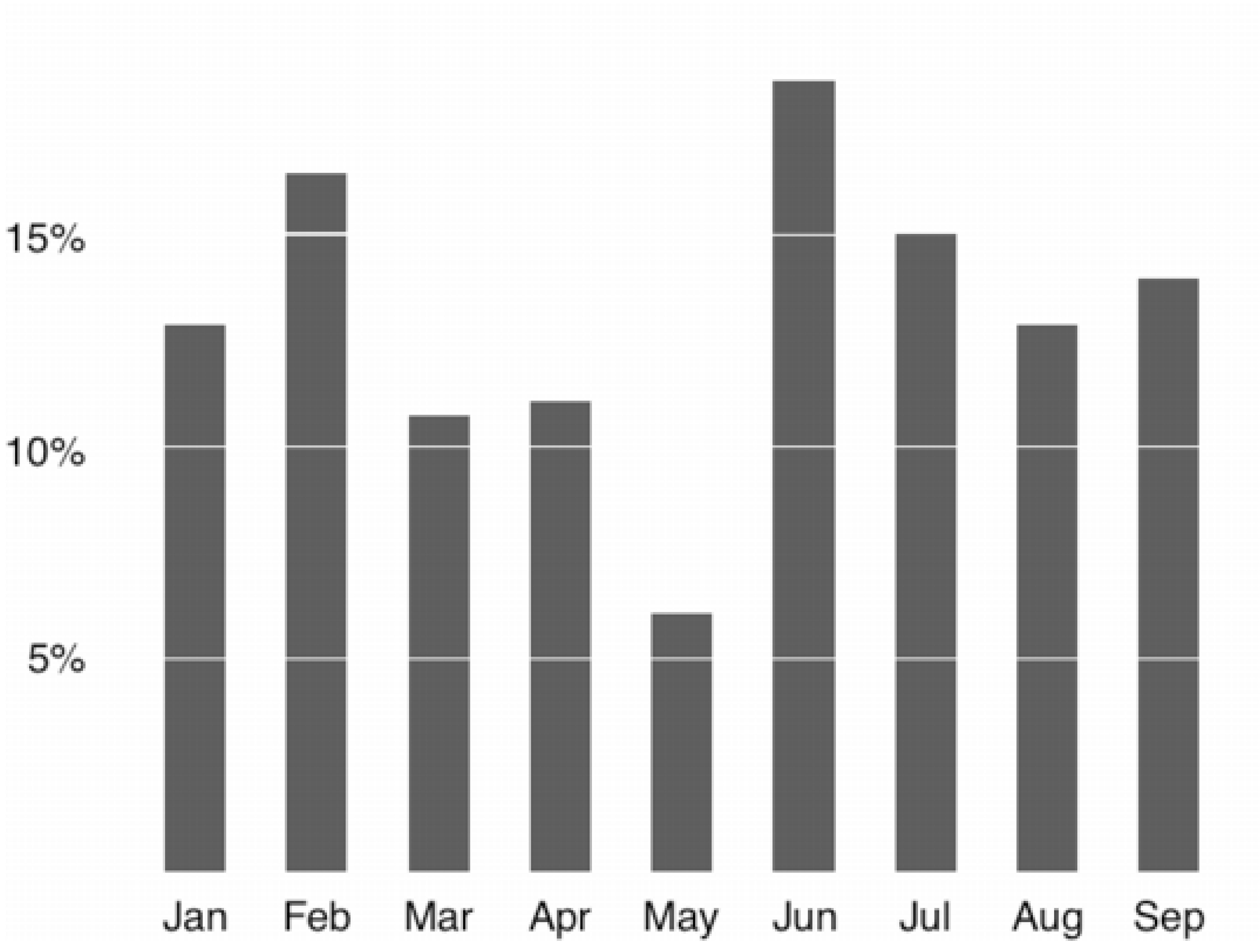
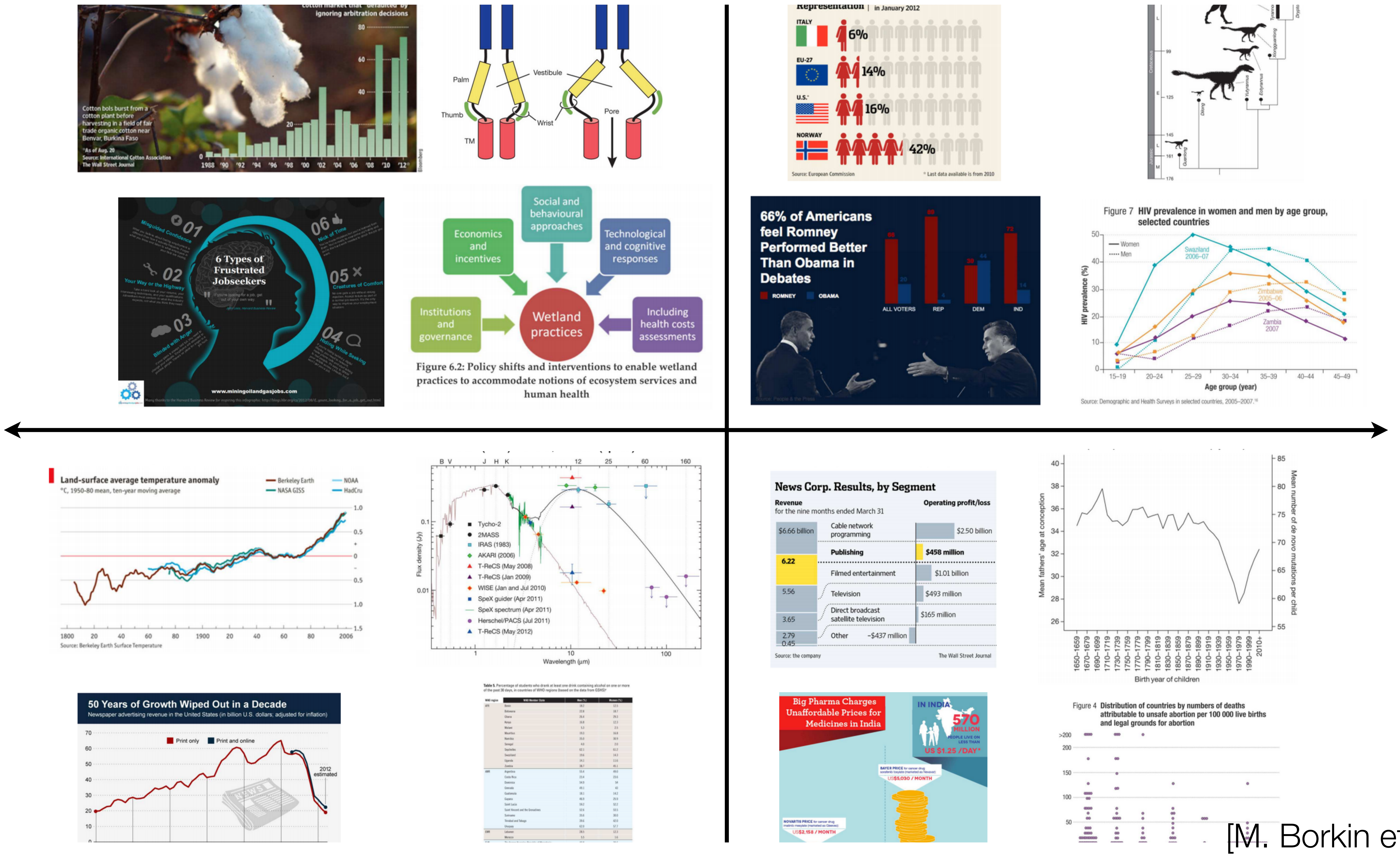


[T. Brey via A. Lex]

Avoid Chartjunk?

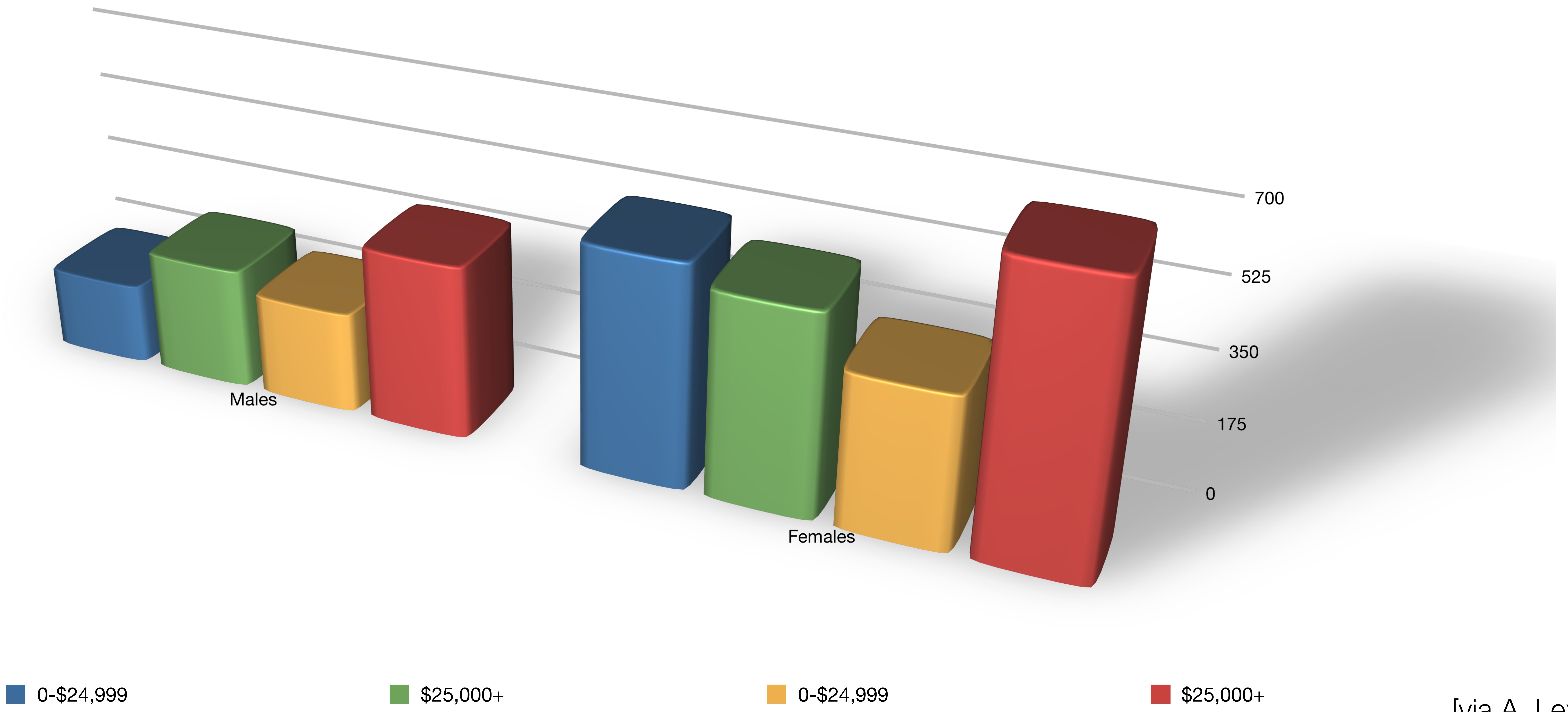
Low Quality Description



High Quality Description

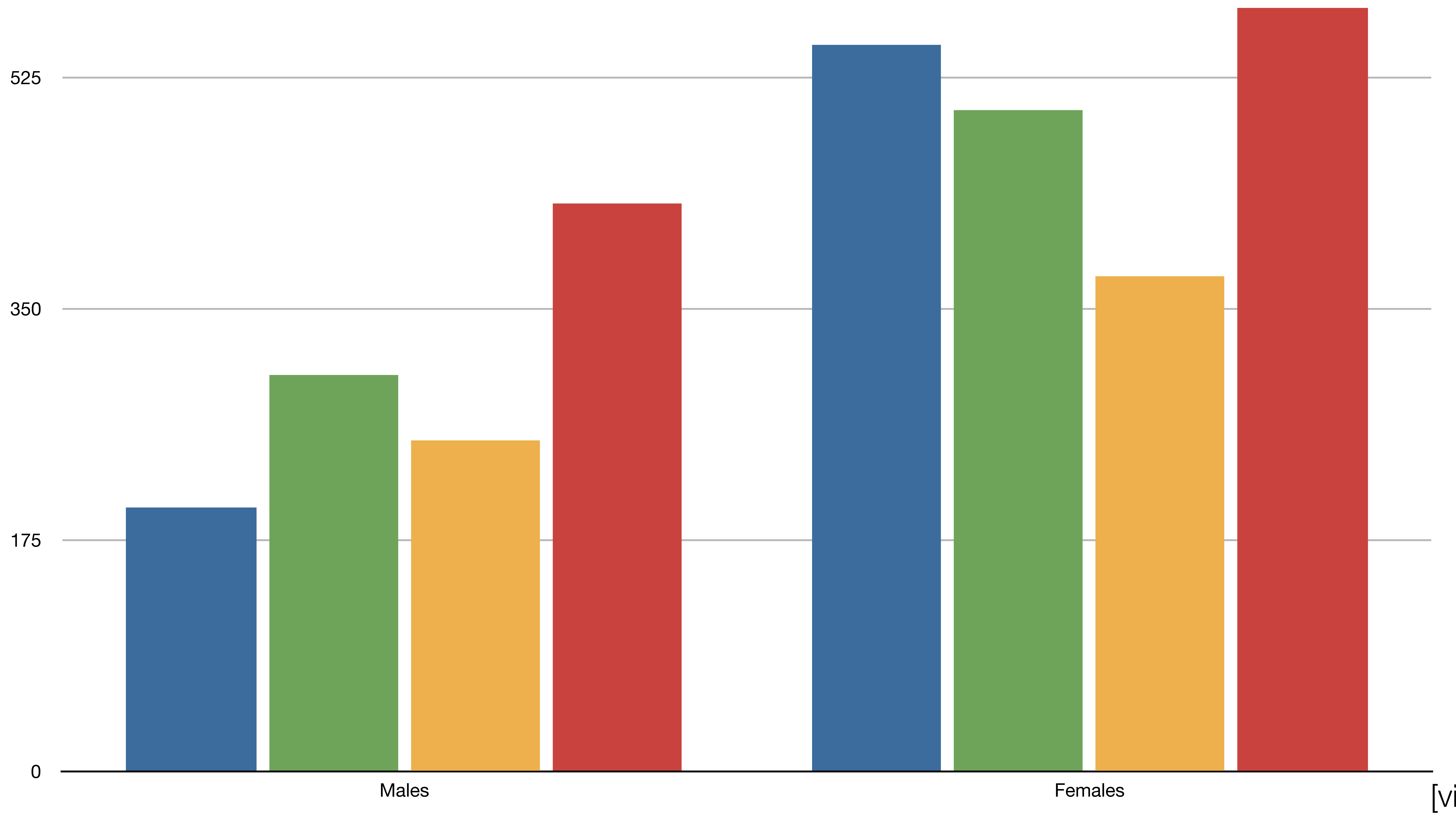
[M. Borkin et al., InfoVis 2015]

Data-to-Ink Ratio (Also Unjustified 3D)



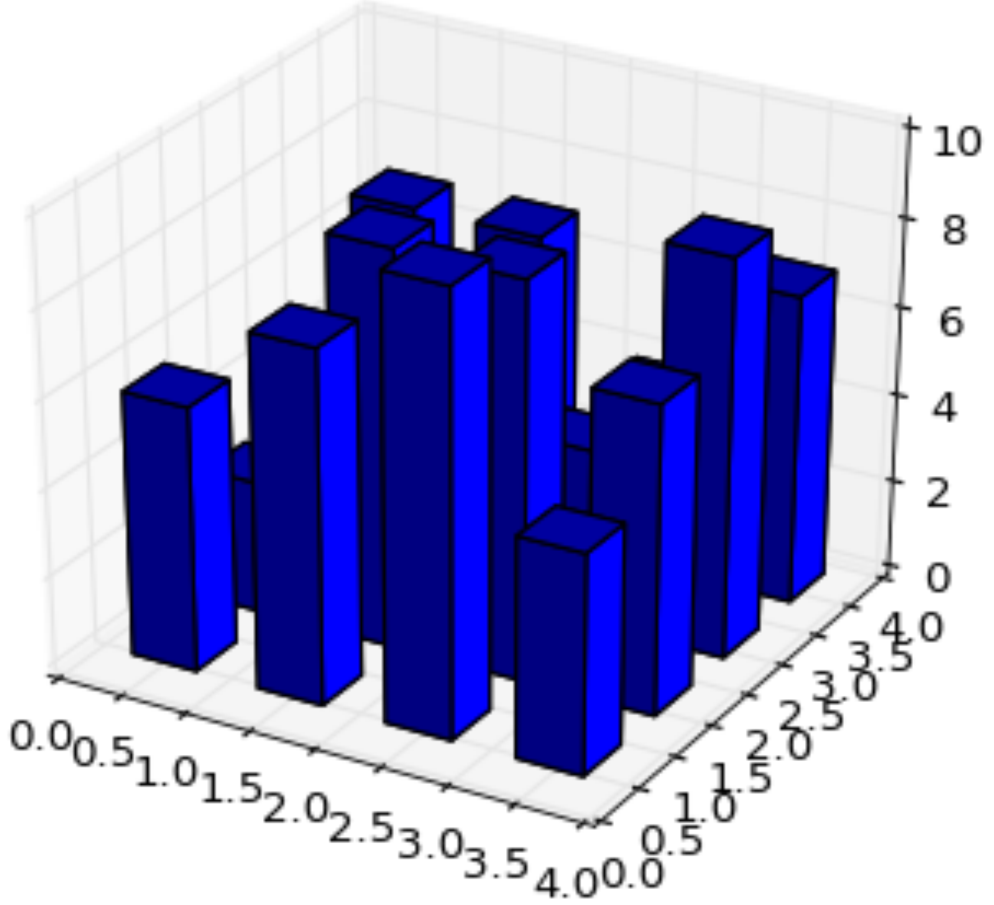
[via A. Lex]

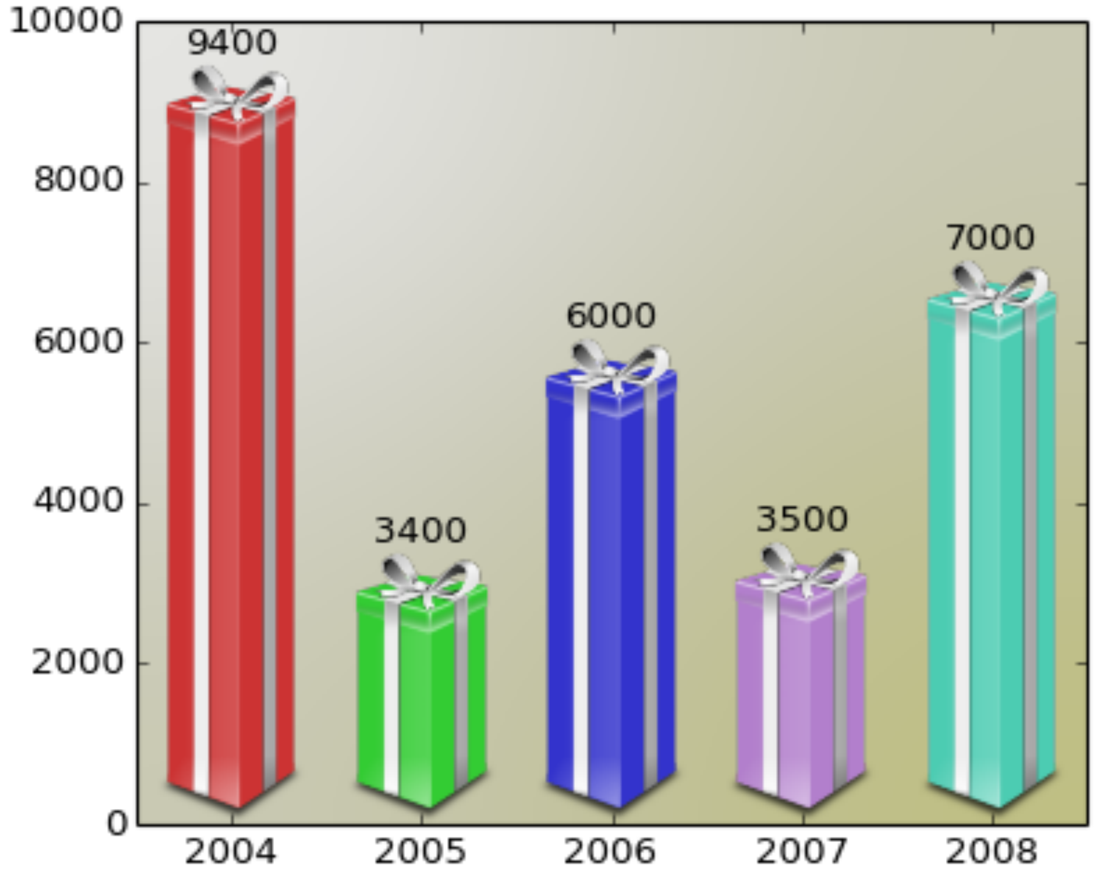
Maximize Data-to-Ink Ratio



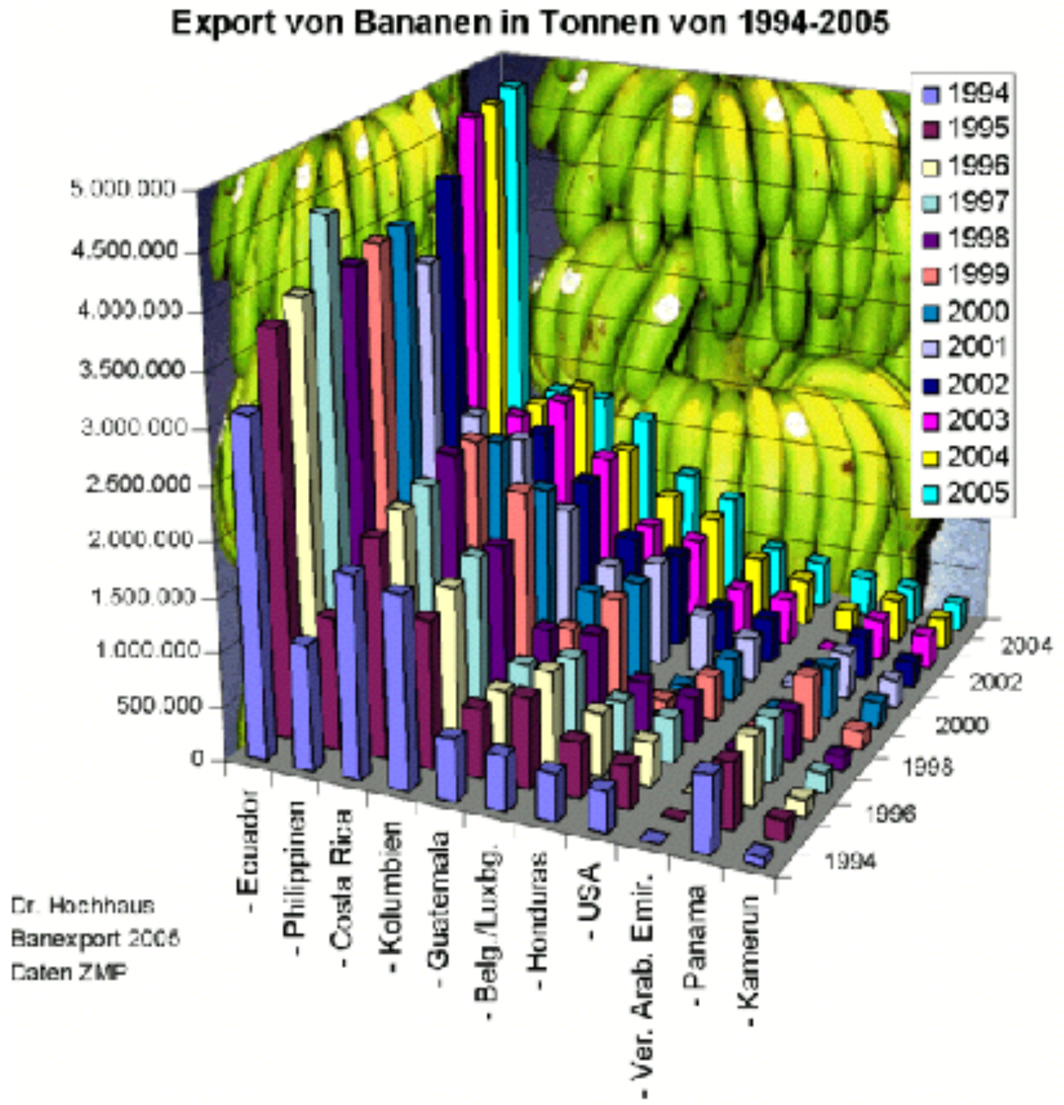
[via A. Lex]

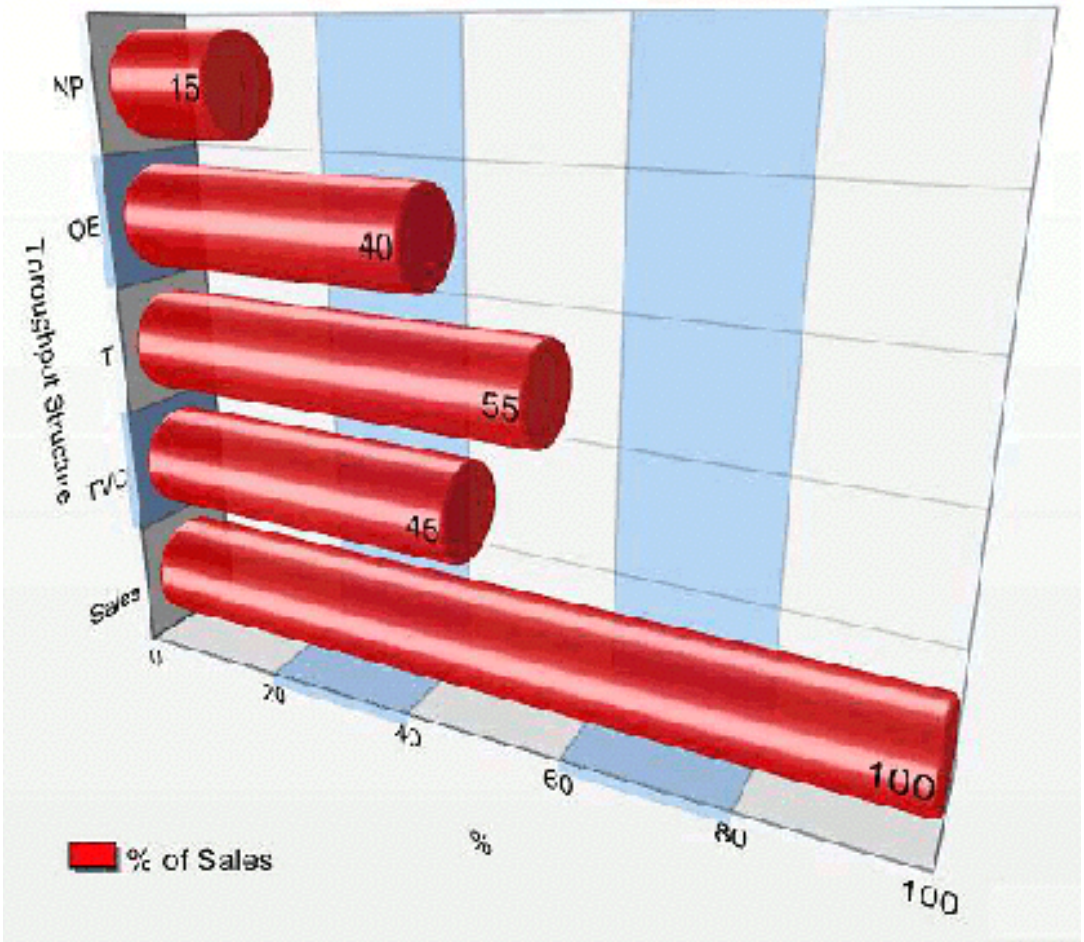
No Unjustified 3D





matplotlib gallery





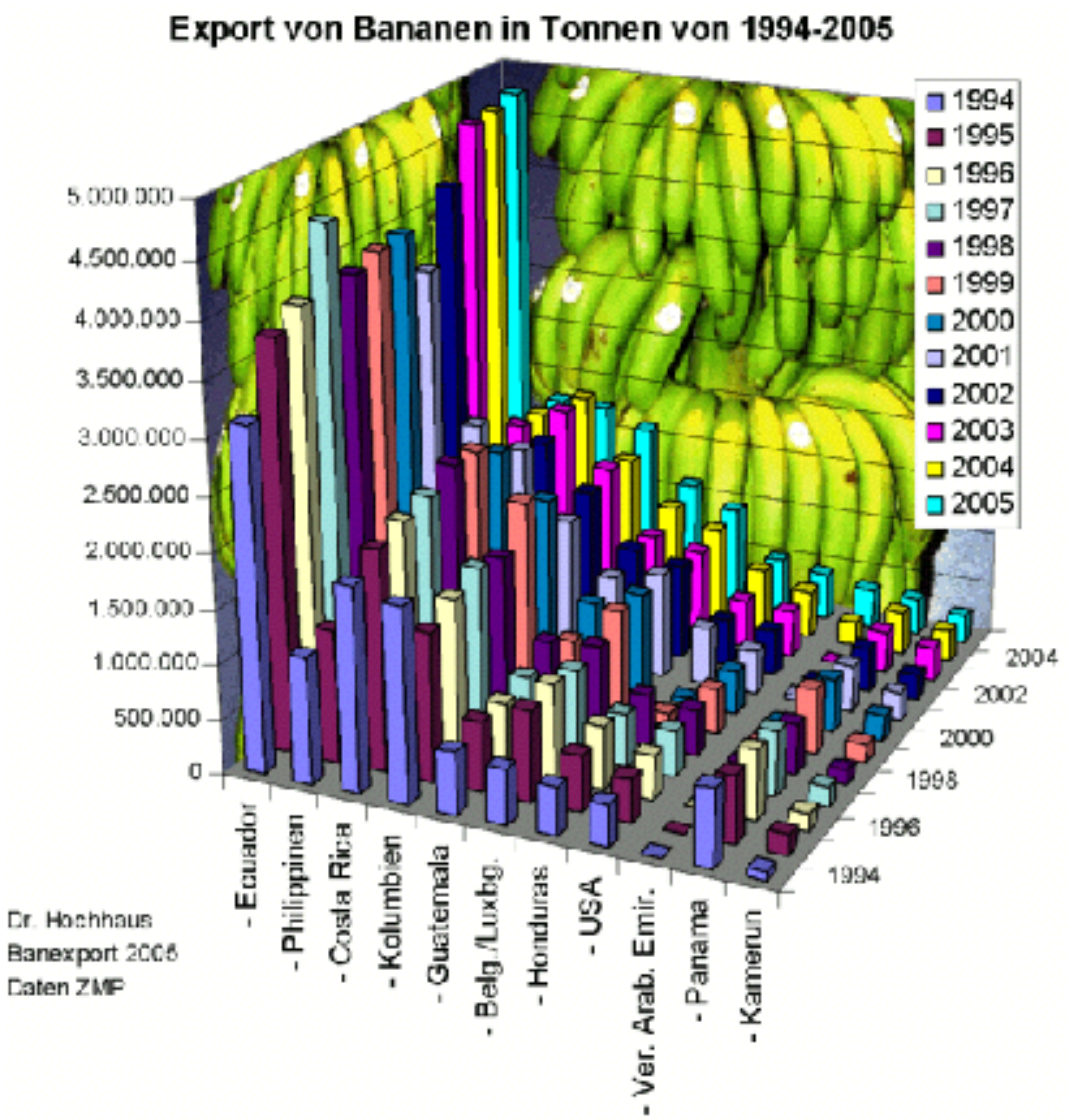
Excel Charts Blog

[via A. Lex]

No Unjustified 3D

- Occlusion hides information
- Perspective distortion dangers
- Tilted text isn't legible

- Can **help** with shape perception



[via A. Lex]

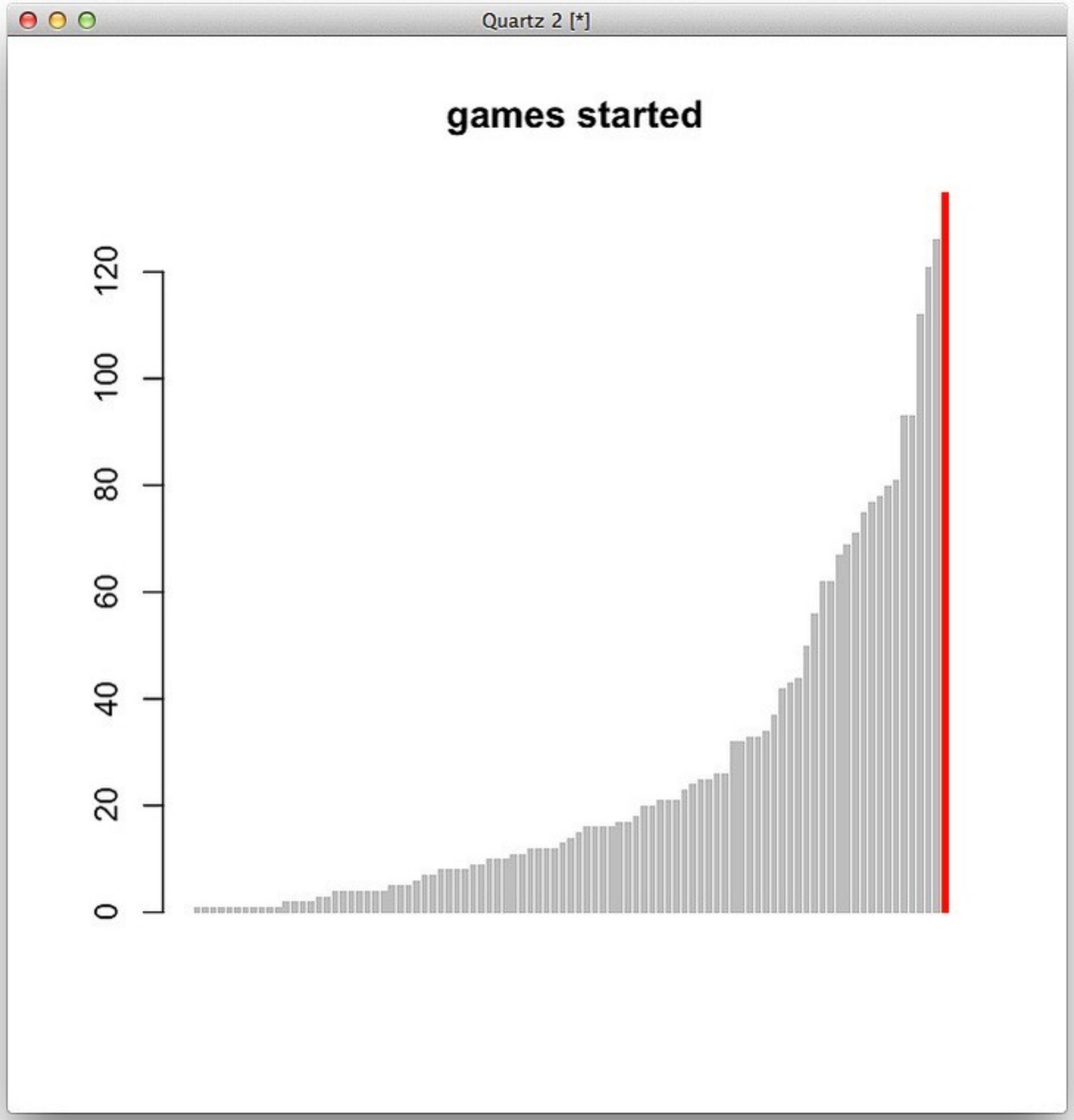
Eyes Beat Memory

- Reduce cognitive load (using up working memory)
- Animation versus side-by-side views
- Change blindness

"Computer-based visualization systems provide visual representations of datasets **designed** to help people carry out tasks more effectively."

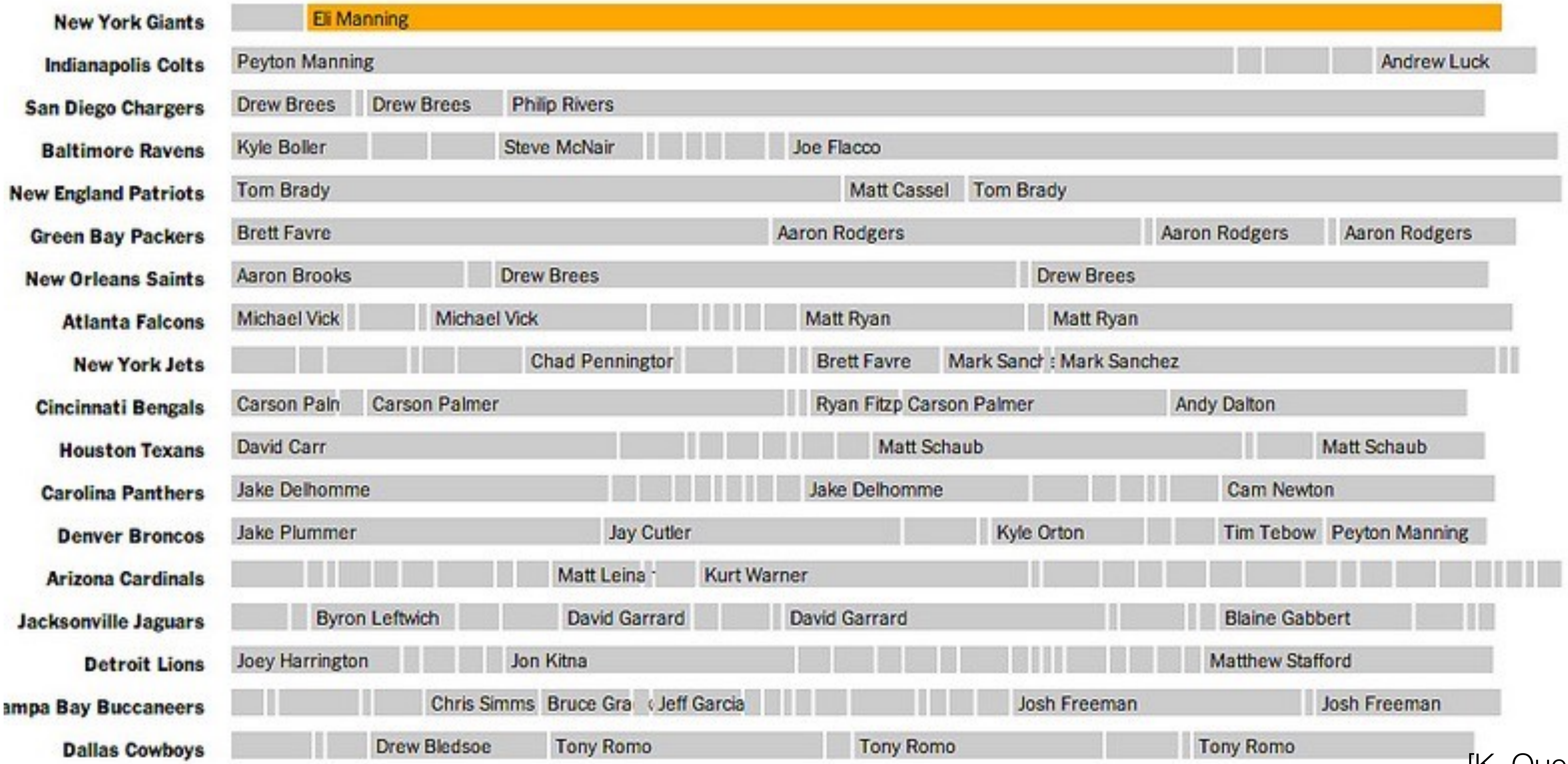
— T. Munzner

Design Iteration



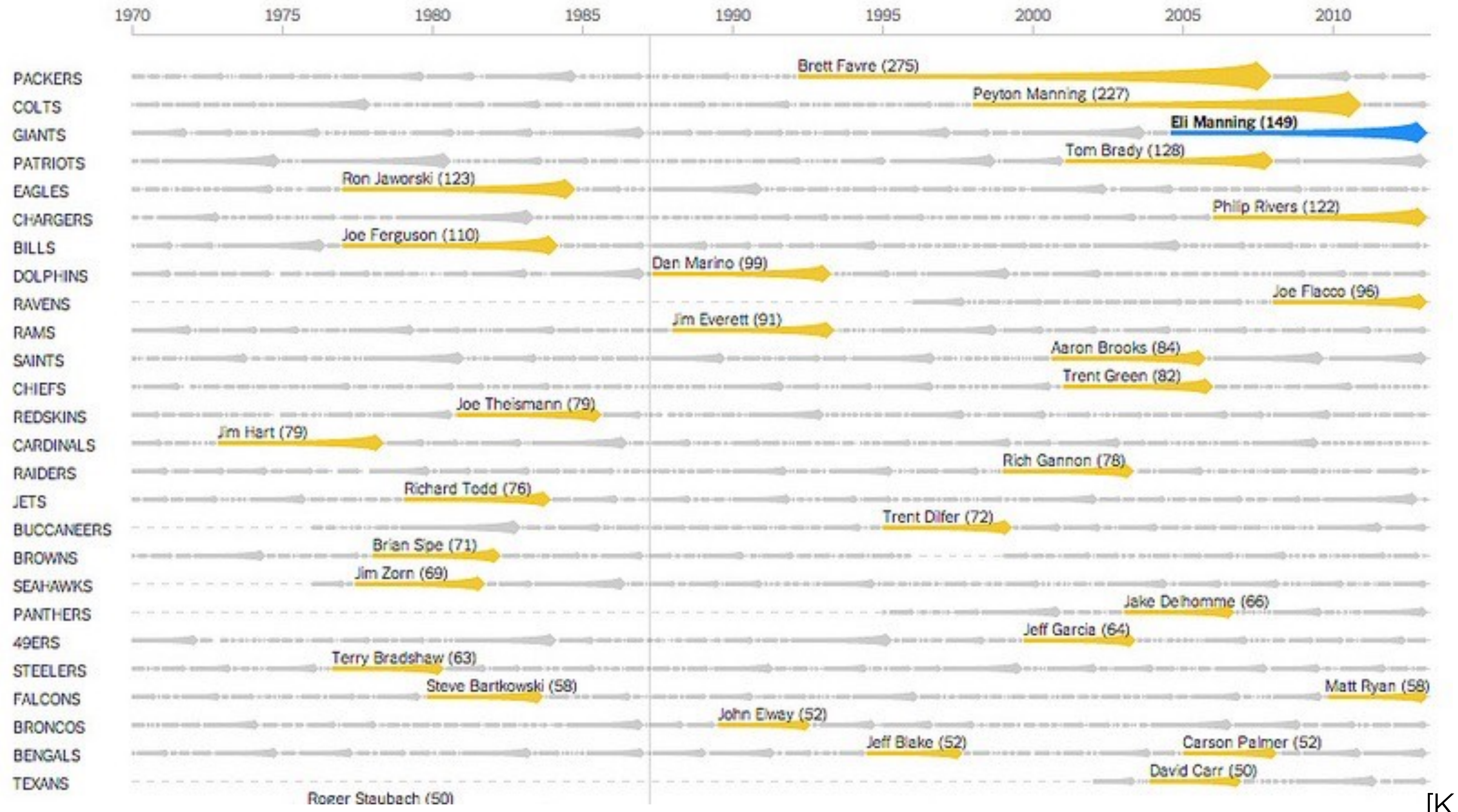
[K. Quealy, 2013]

Design Iteration



[K. Quealy, 2013]

Design Iteration

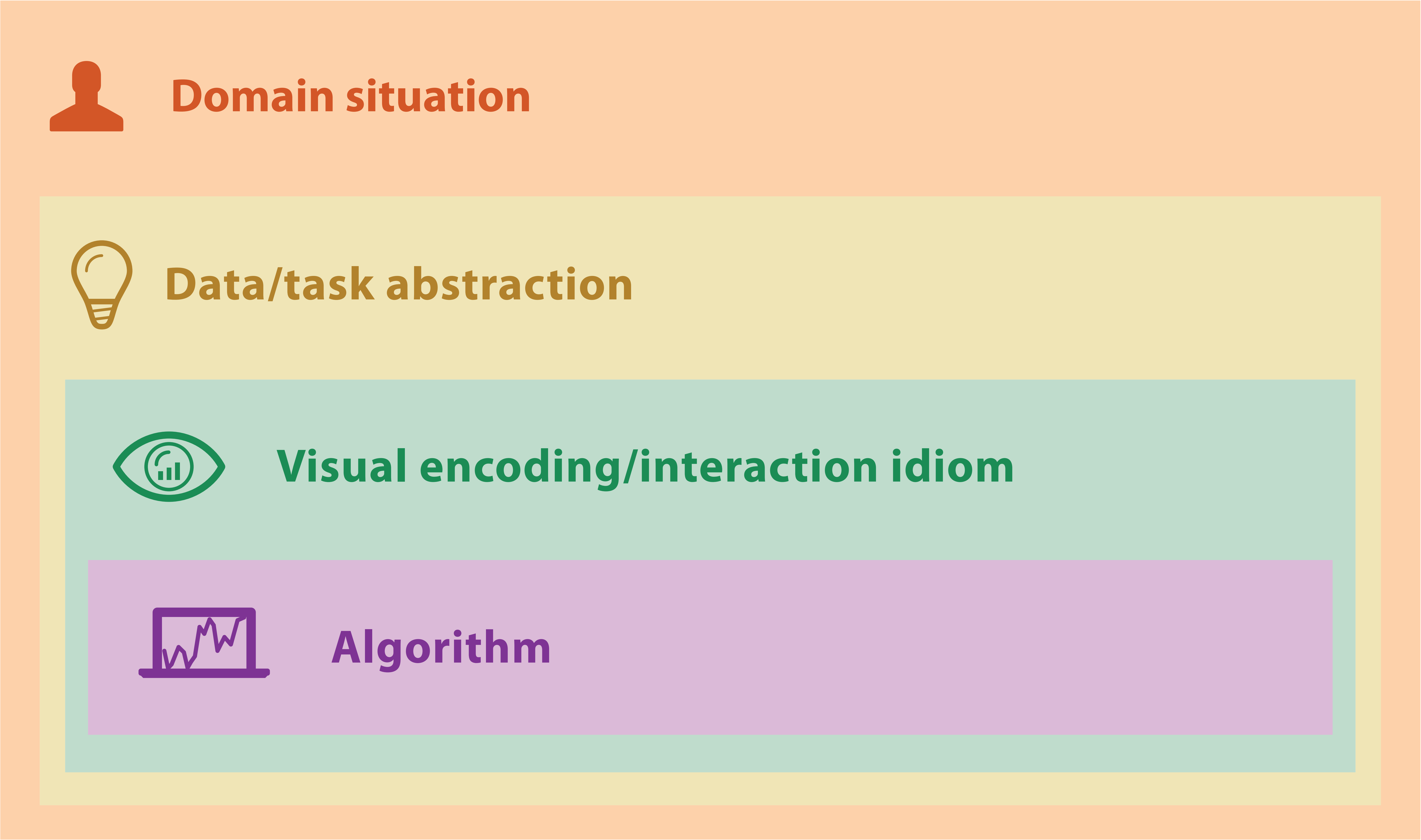


[K. Quealy, 2013]

Design

- Unlike a math problem, there are many different approaches for the visualization of some data
- Need to have some way to discuss how to determine whether a visualization is doing what we want
- Validation: Understand why a design is effective
  - What problems can be effective
  - Do this at different levels

Four Nested Levels of Design



[Munzner, 2014]

Potential problems at each level

Domain situation
You misunderstood their needs

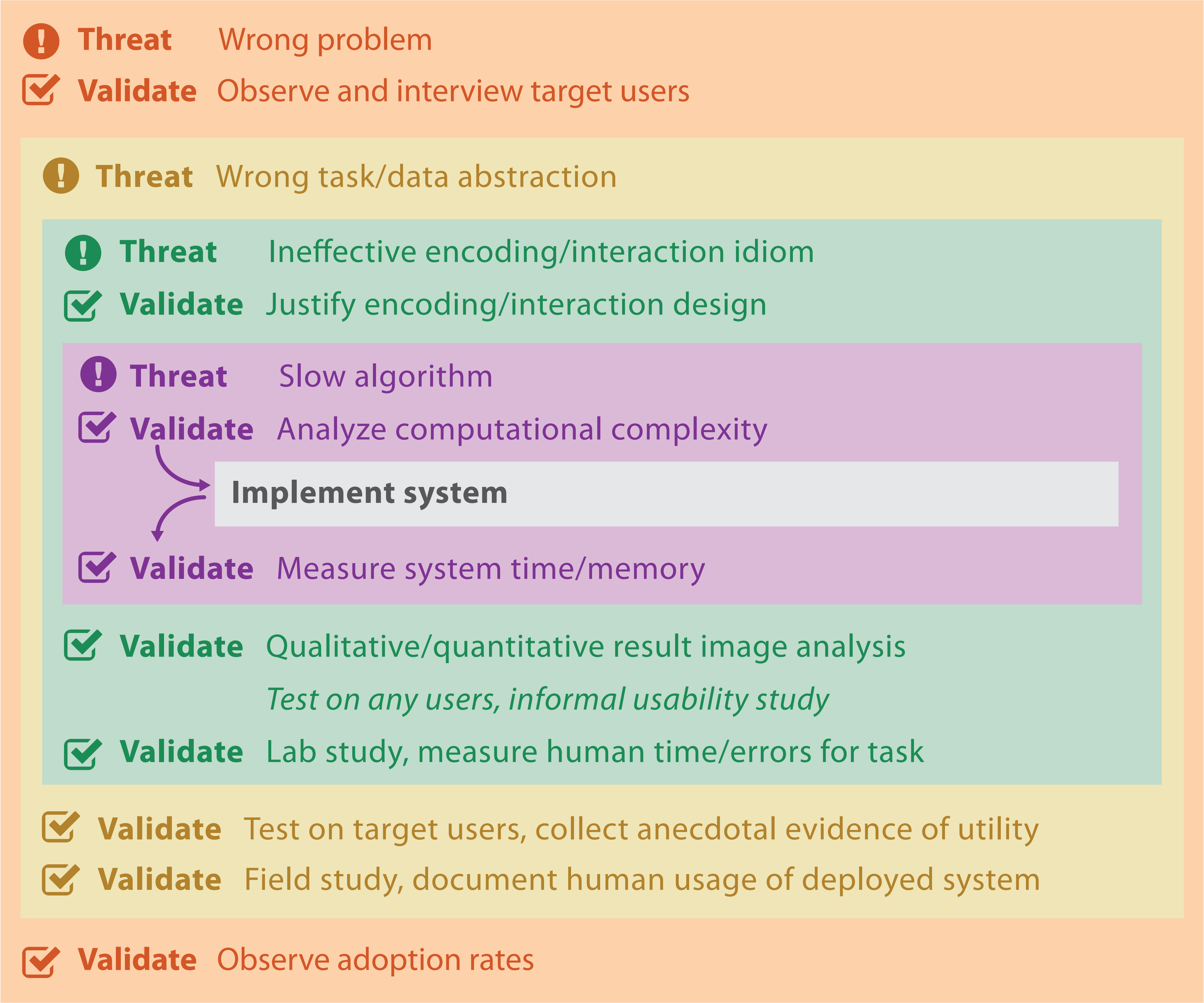
Data/task abstraction
You're showing them the wrong thing

Visual encoding/interaction idiom
The way you show it doesn't work

Algorithm
Your code is too slow

[Munzner, 2014]

Validation at each level



[Munzner, 2014]

Five Design-Sheet Methodology

FdS
- Sheet 1
- Sheets 2,3,4
- Sheet 5

TECHNIQUES
- Data Collection: *User Observation*, *Interviews*, *Workshops*
- Synthesis: *Sketching*, *Storyboarding*
- Explore & Ideate: *Quick sketching*, *User scenarios*, *Improvisation*
- Prototype: *Refined Sketching*, *Rendering*, *Animated sequences*, *Videos, model making*

DESIGN
- Data Collection
- Visualizing Context
- Exploration & ideation
- Concept Development
- Prototyping
- Solution

GOALS
- Document solutions Goals Requirements
- Validate Understand existing solutions
- Explore lots of solutions
- Communicate Demonstrate

GENEX
- COLLECT
- RELATE
- CREATE
- DONATE

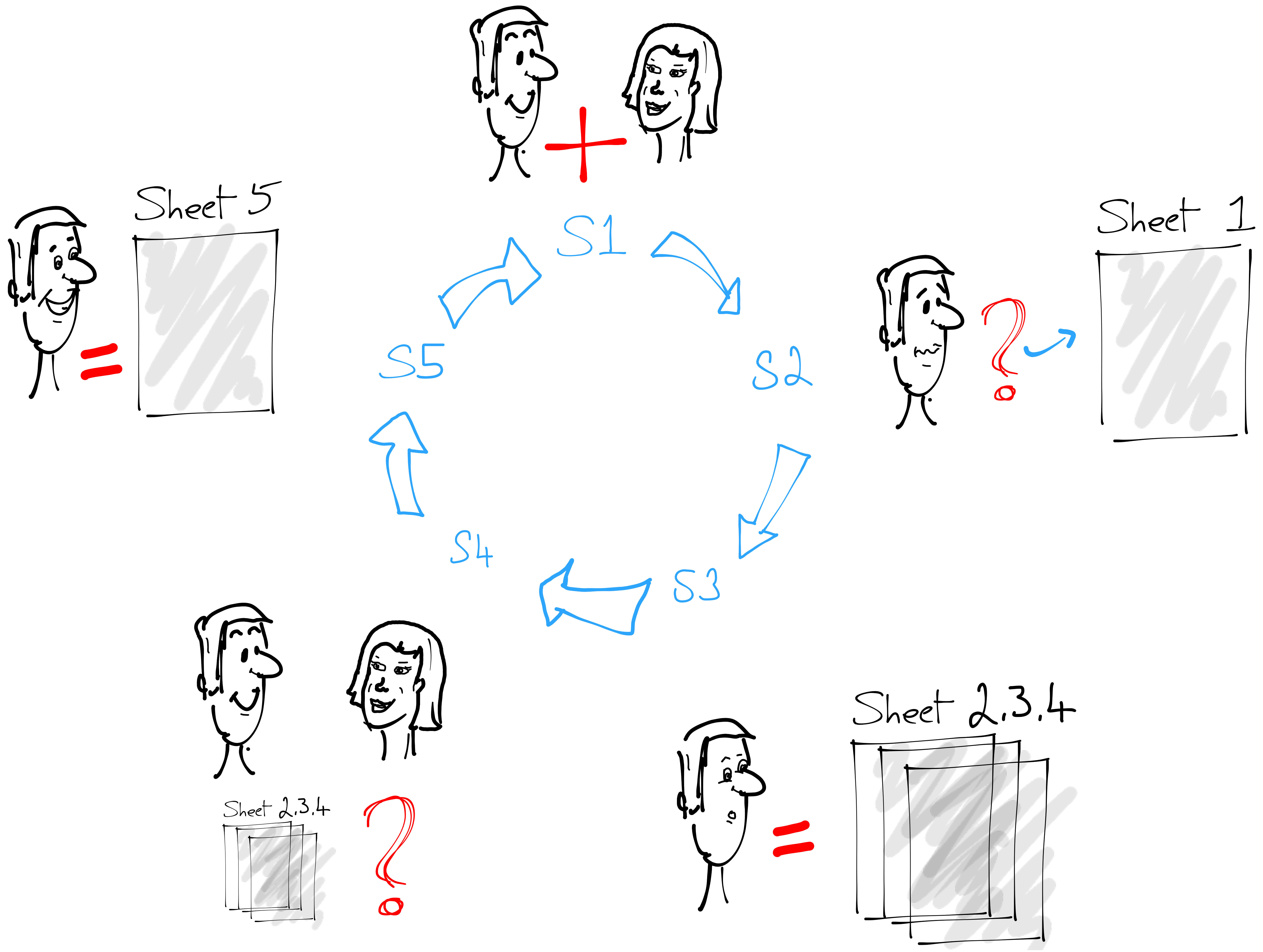
[J. Roberts et al., 2016]

Five Stages

1. Meet with client and consider task; or contemplate task on own.
2. Ideate and sketch small ideas.
3. Sketch and plan three alternative designs.
4. Consider solutions with client; or deliberate on own.
5. Generate realization sheet, and implement prototype. Discuss with client and re-iterate if necessary.

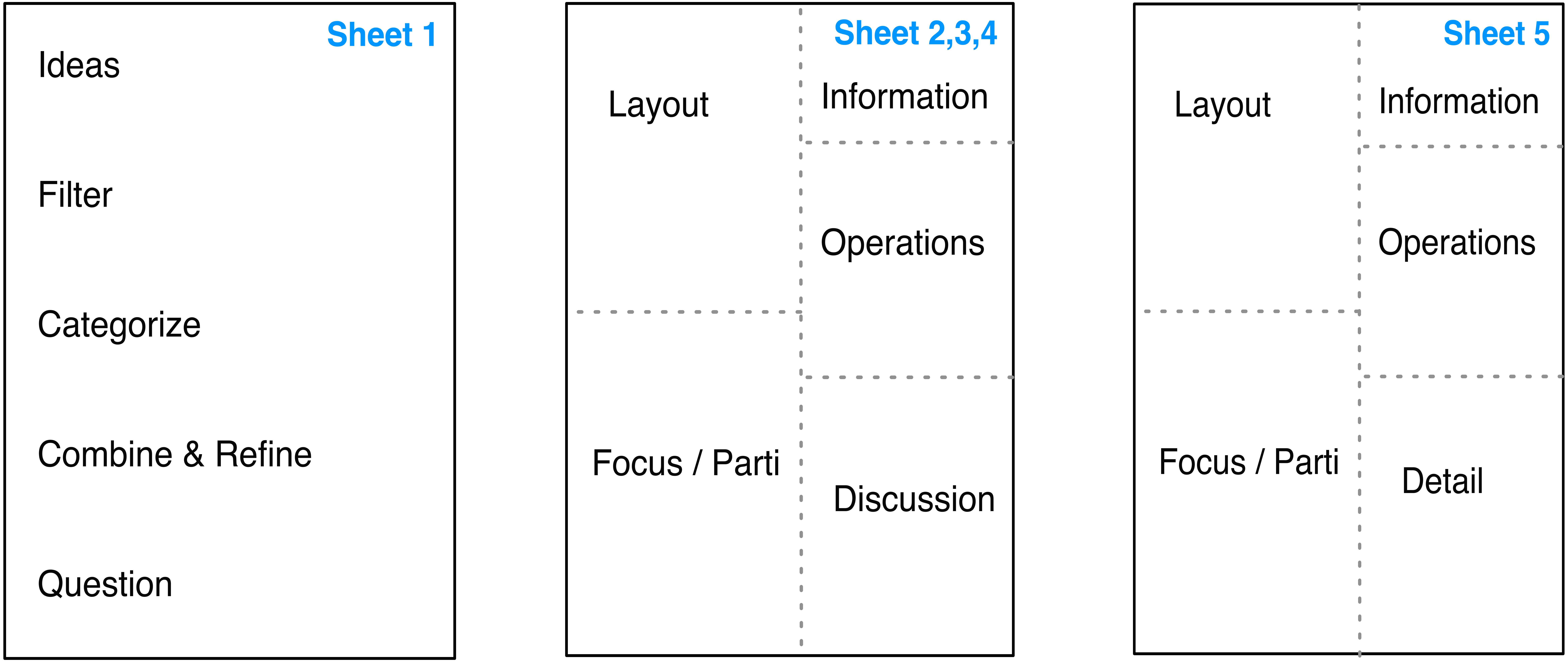
[J. Roberts et al., 2016]

Five Stages



[J. Roberts et al., 2016]

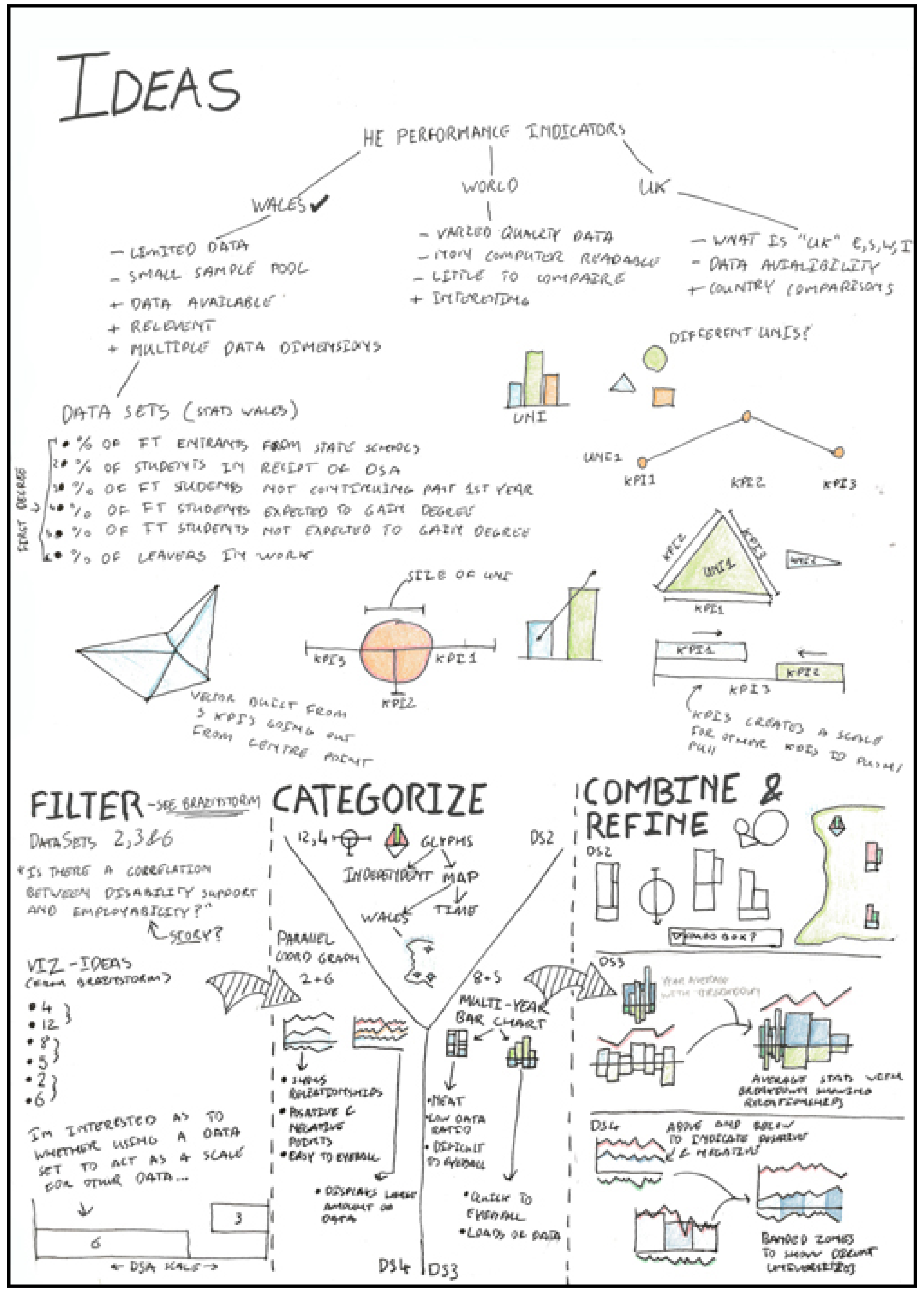
The Five Sheets



Ideation — Alternative Designs — Realization

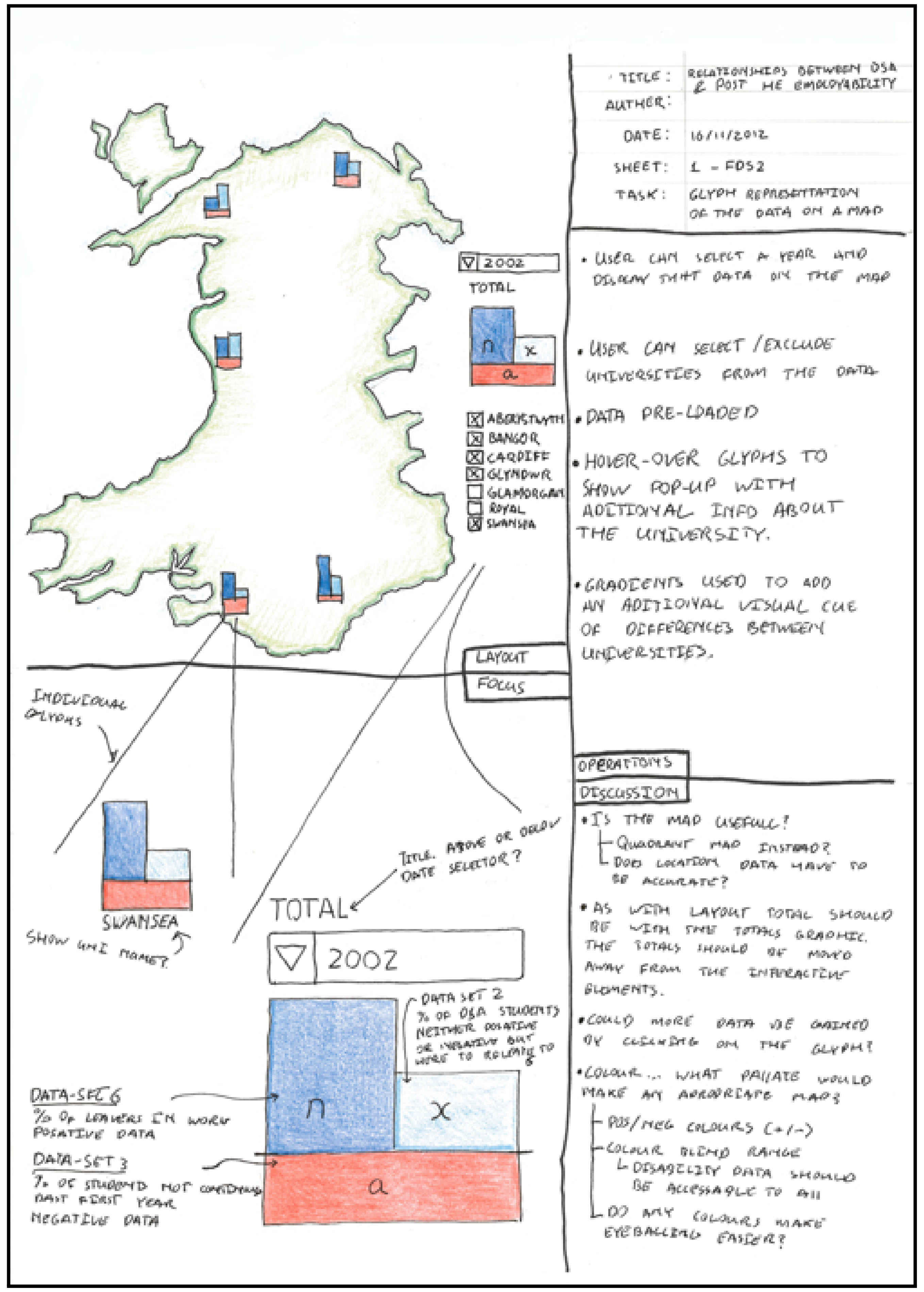
[J. Roberts et al., 2016]

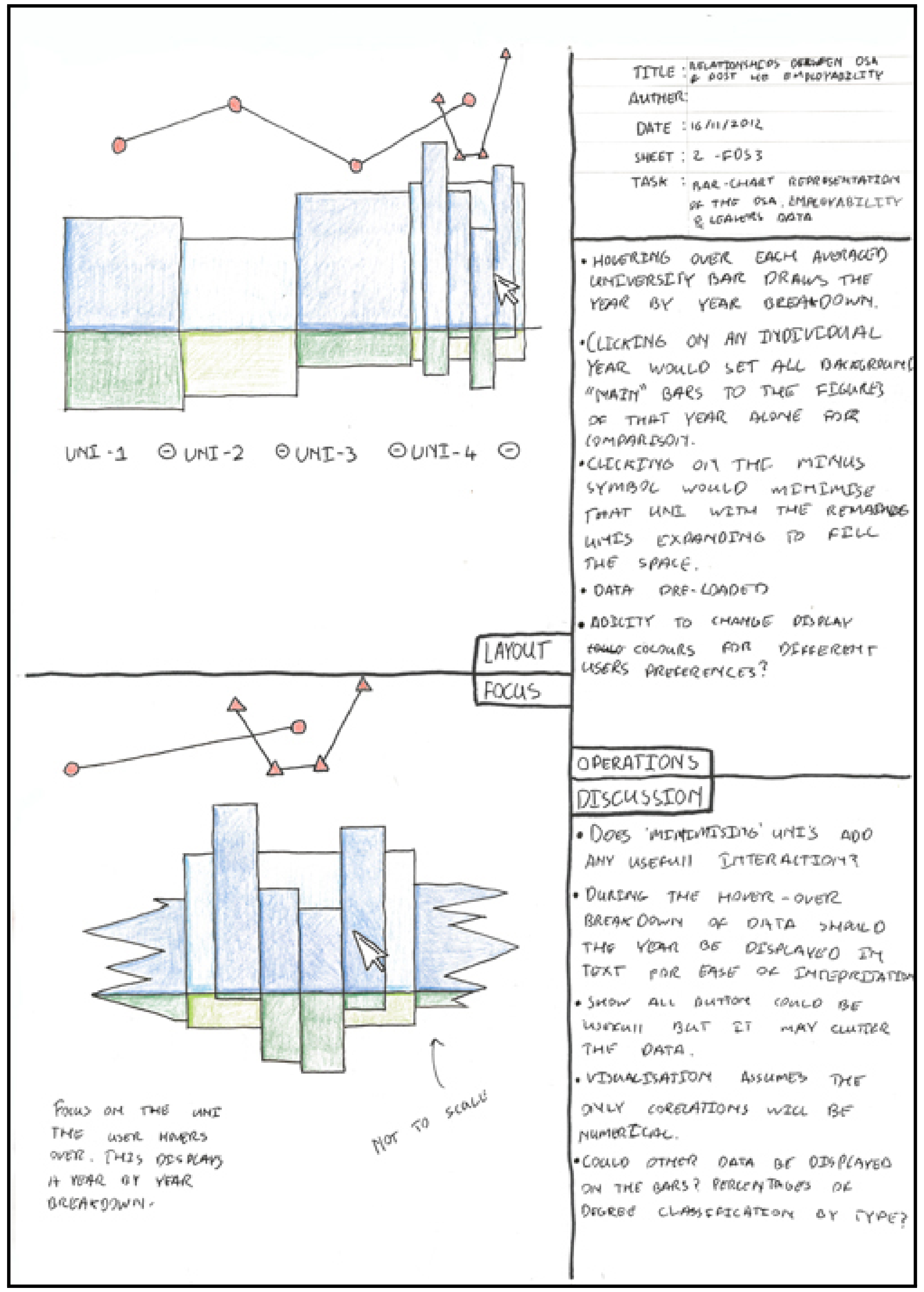
Example: University Access for Disabled Students

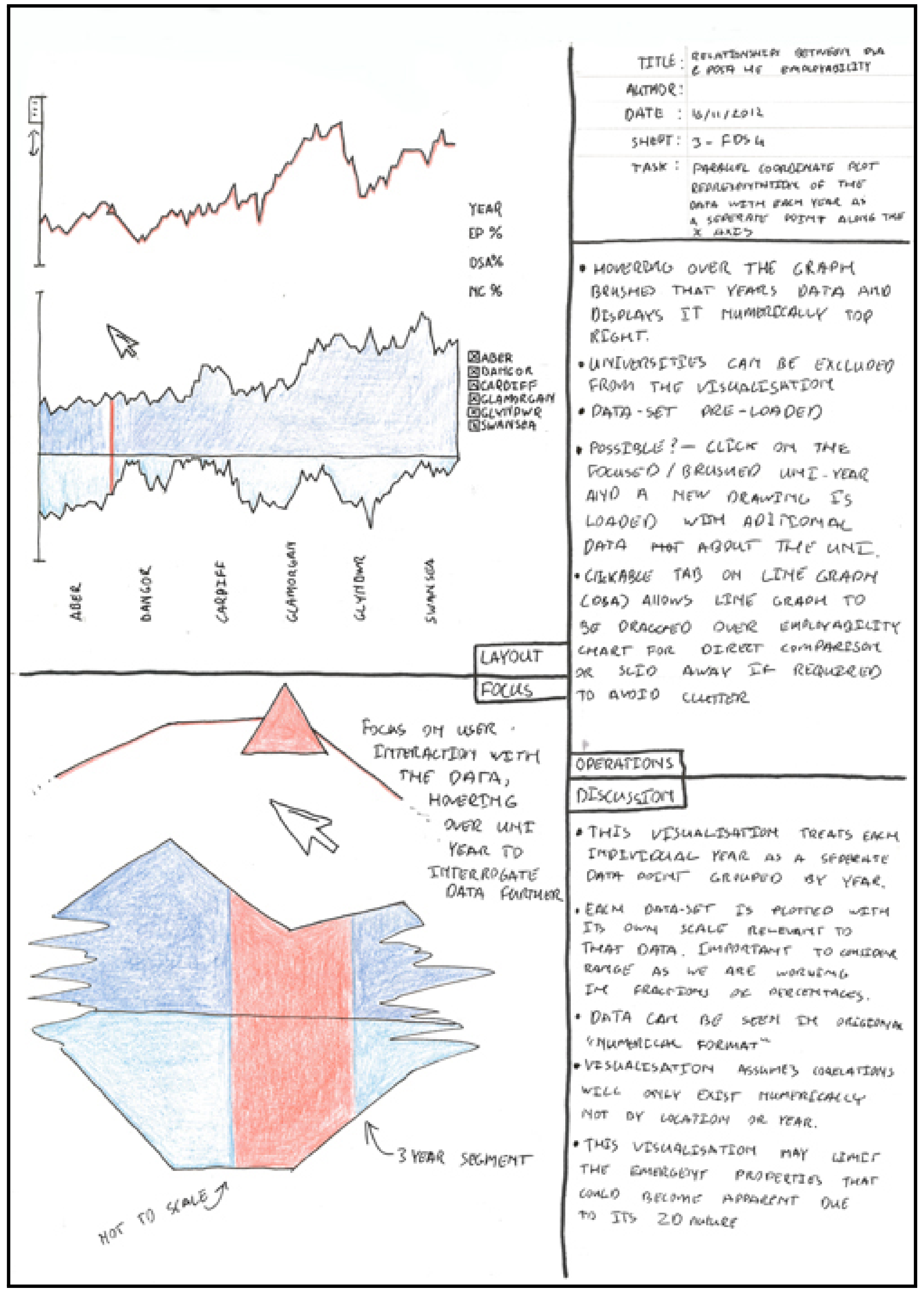


[J. Roberts et al., 2016]

Sheets 2-4

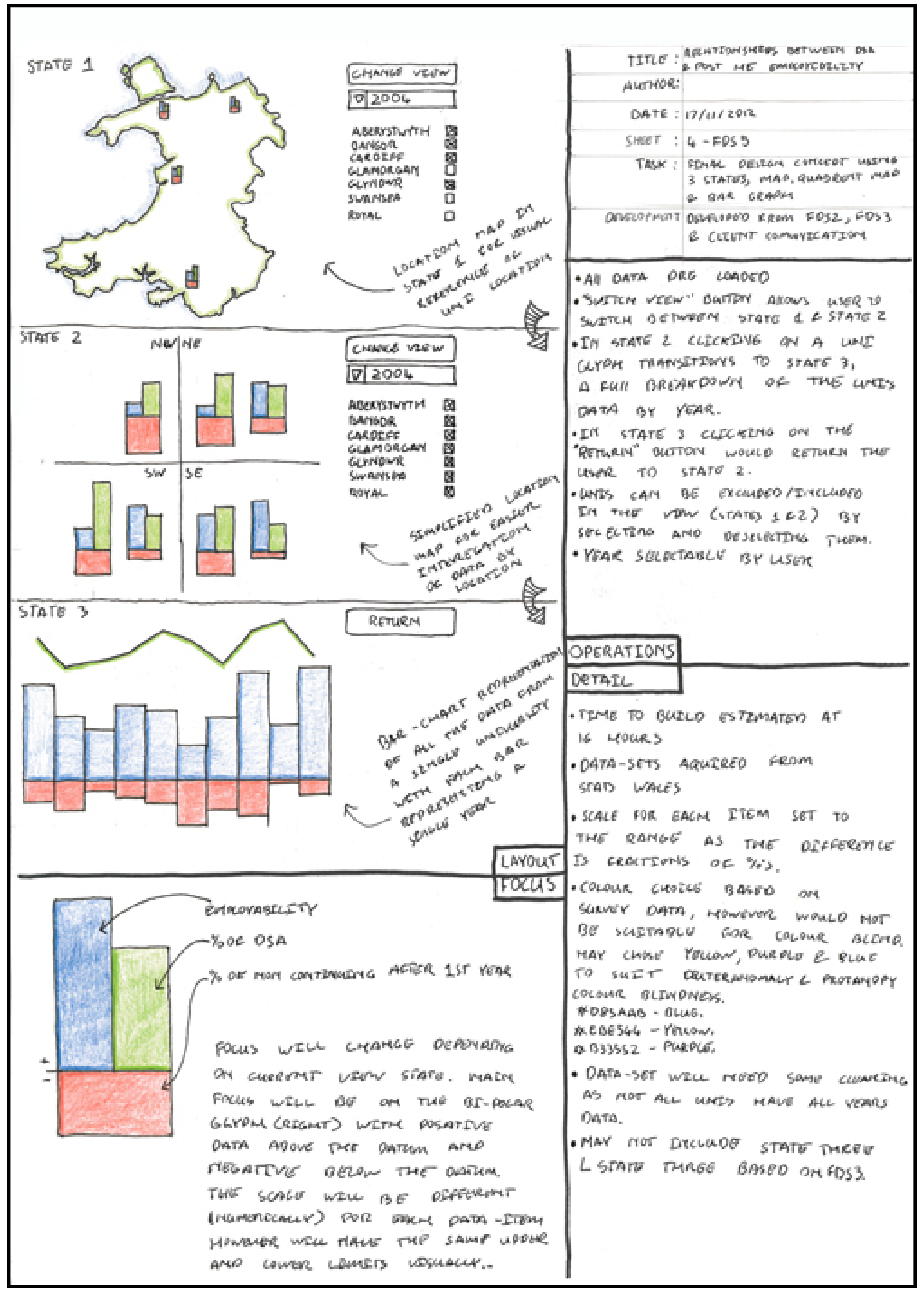






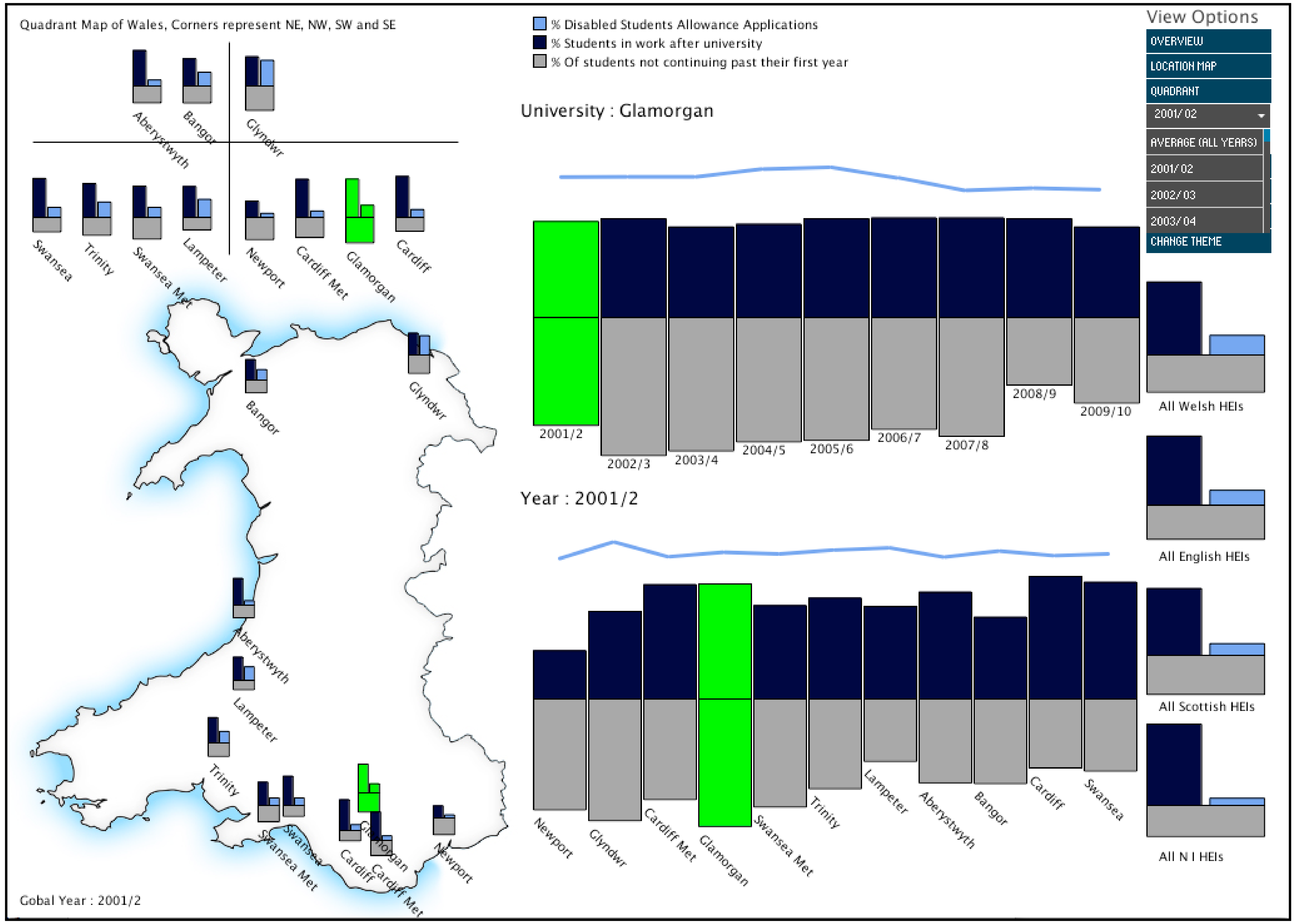
[J. Roberts et al., 2016]

Sheet 5



[J. Roberts et al., 2016]

Prototype



[J. Roberts et al., 2016]

Midterm