

# Visualization in HCI

05 - 499 / 05 - 899 Section C



# Design Guidelines

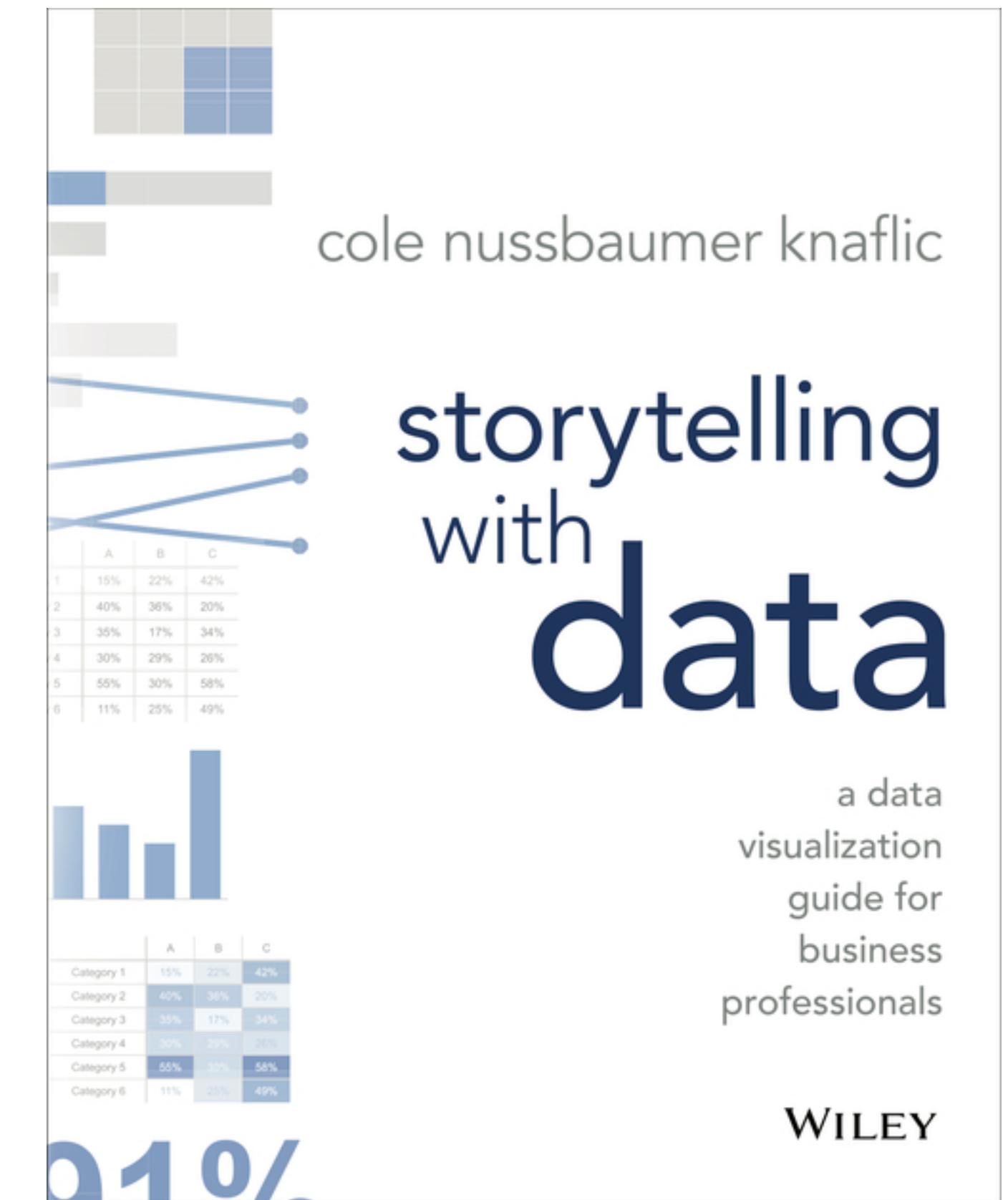
February 26, 2017

**Guiding Principle: Use the  
Best Visual Channel Available  
for the Most Important  
Aspect of your Data**

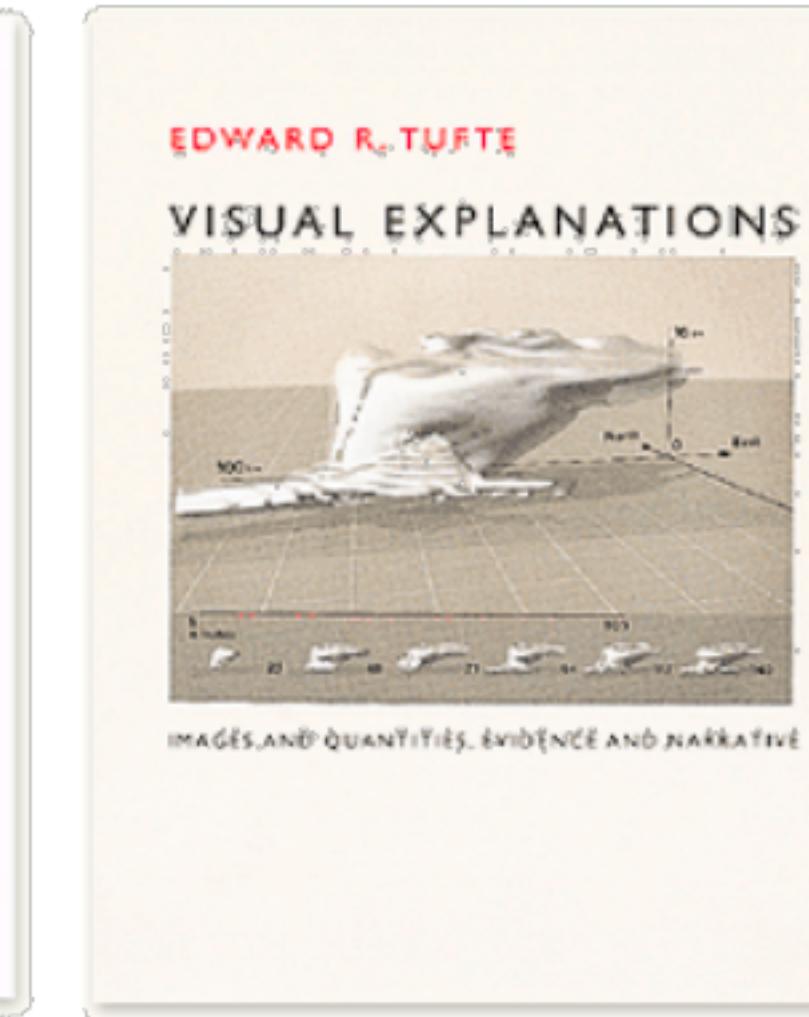
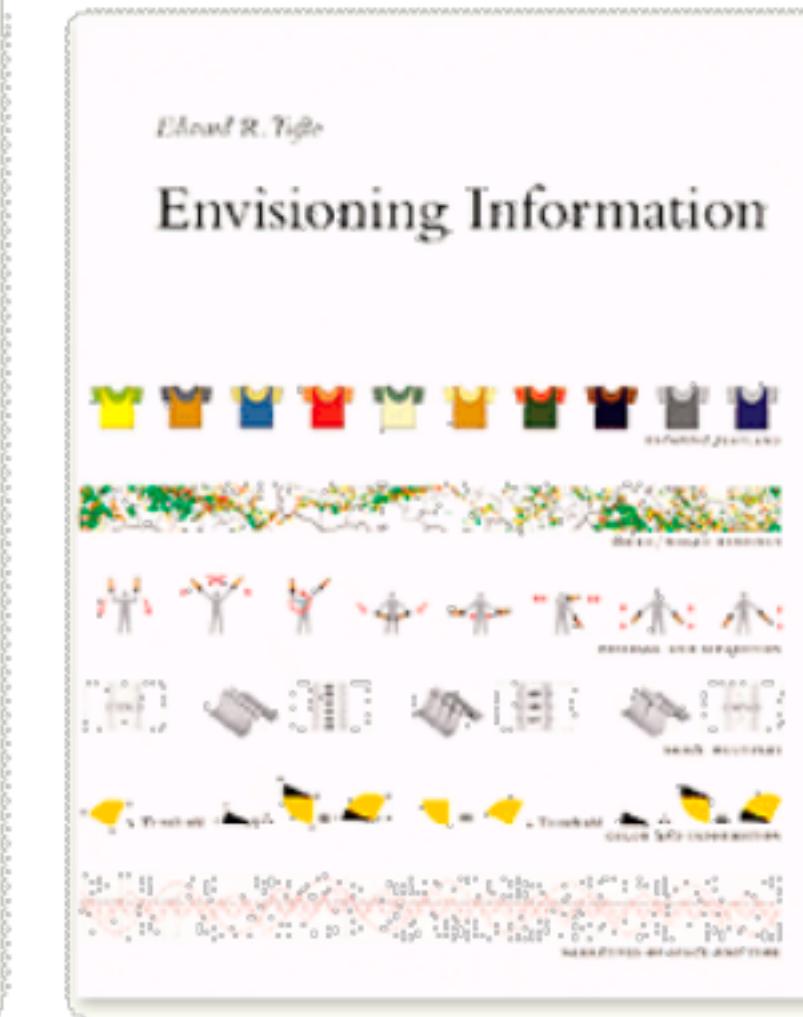
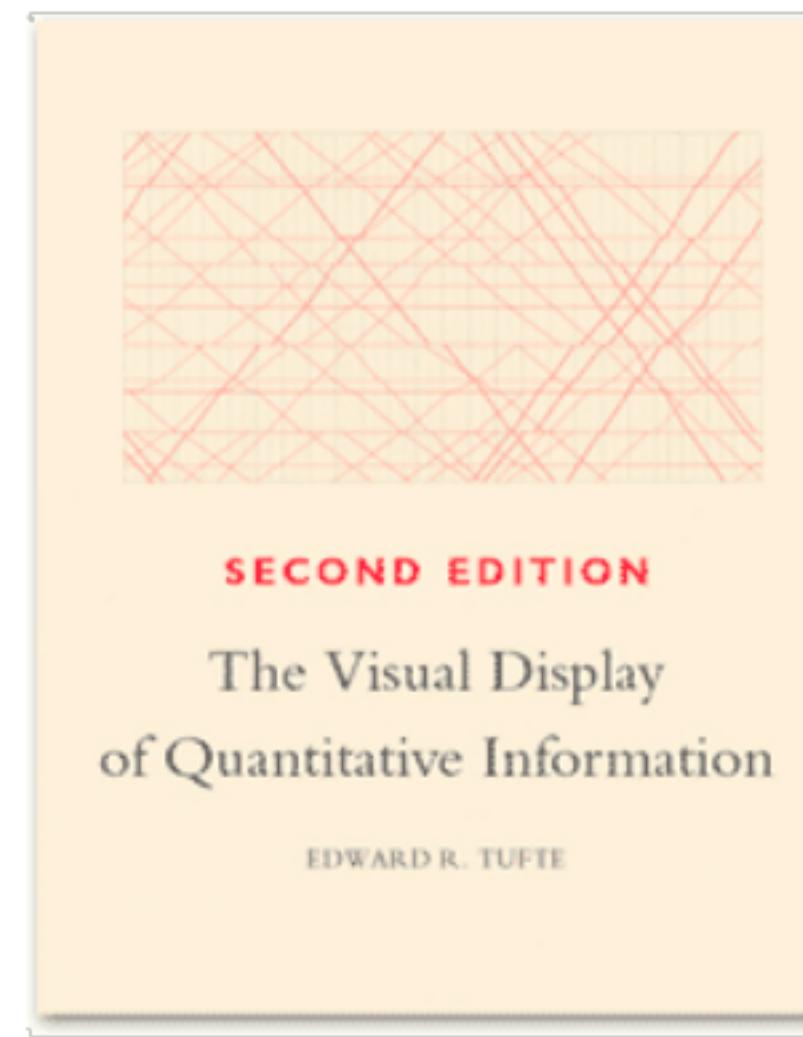
# Book Recommendation

Great book with simple design guidelines

Not a “Visualization” book, but a “charting” book



# Edward Tufte



graphical integrity and excellence

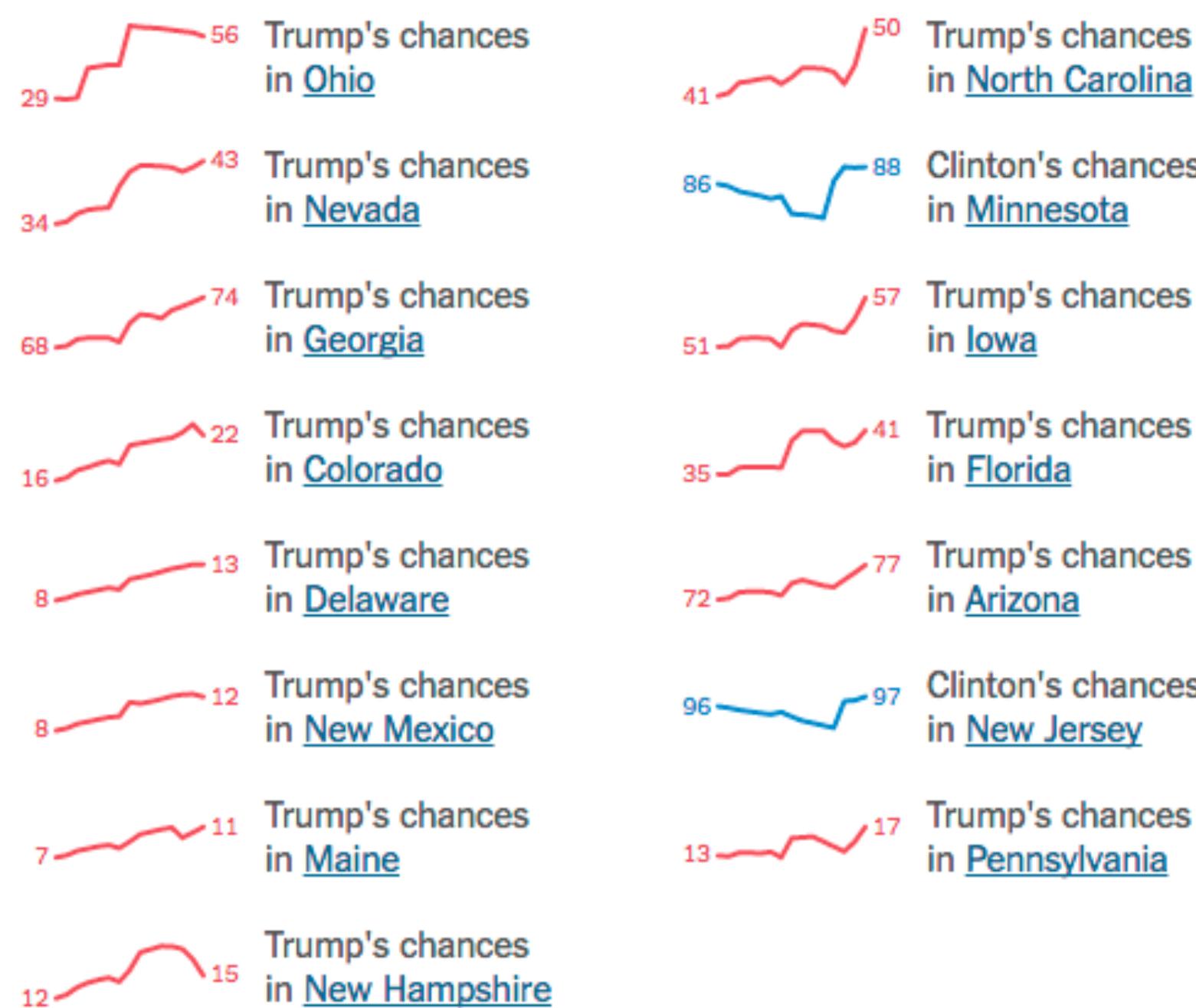
# Design Excellence

“Well-designed presentations of interesting data are a matter of substance, of statistics, and of design.”

# Tufte: Sparklines™

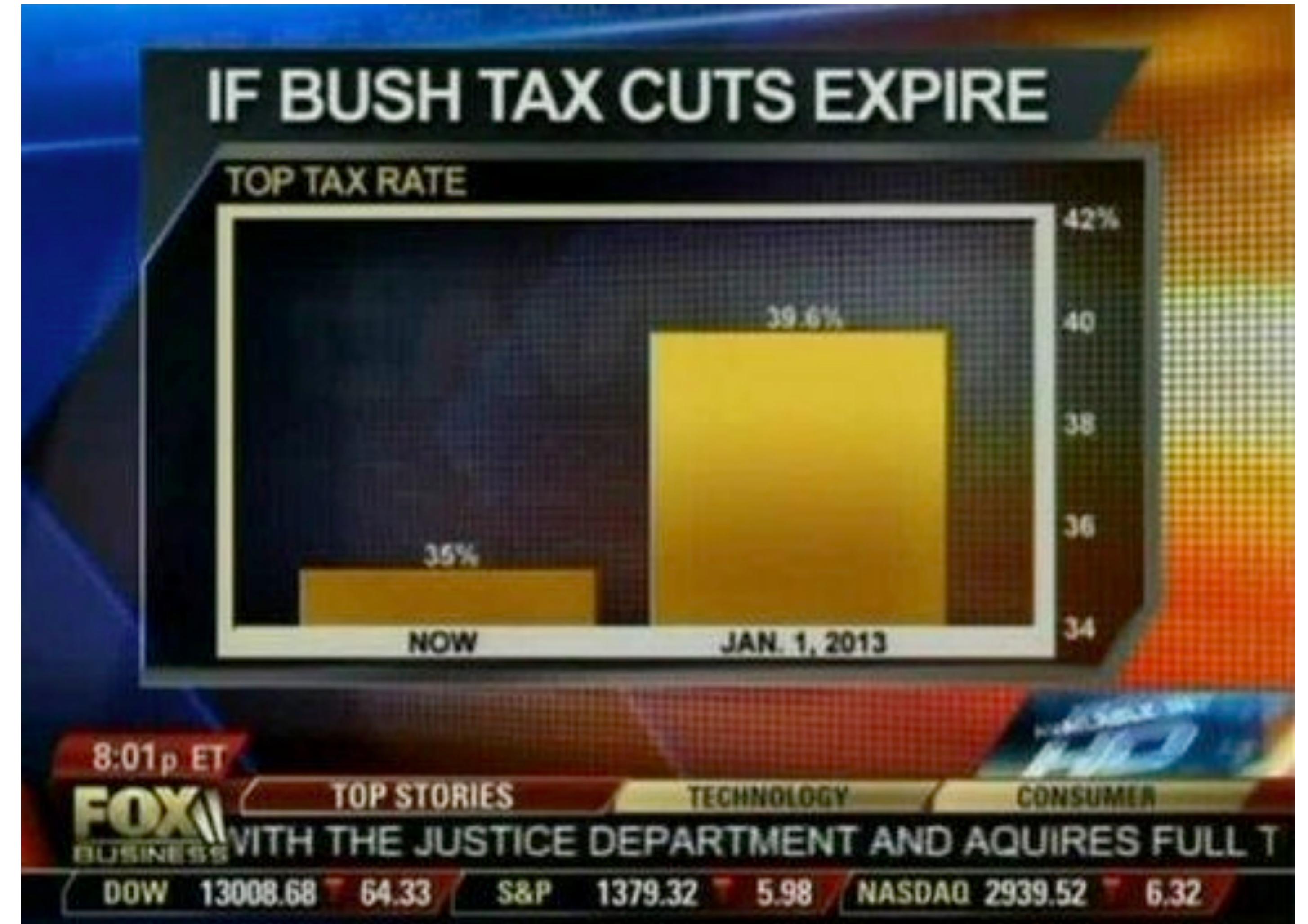
## Where the Race Has Shifted

To understand what is driving the national trend, it's worth taking a look at the states where the winning probabilities have changed most over the last two weeks:

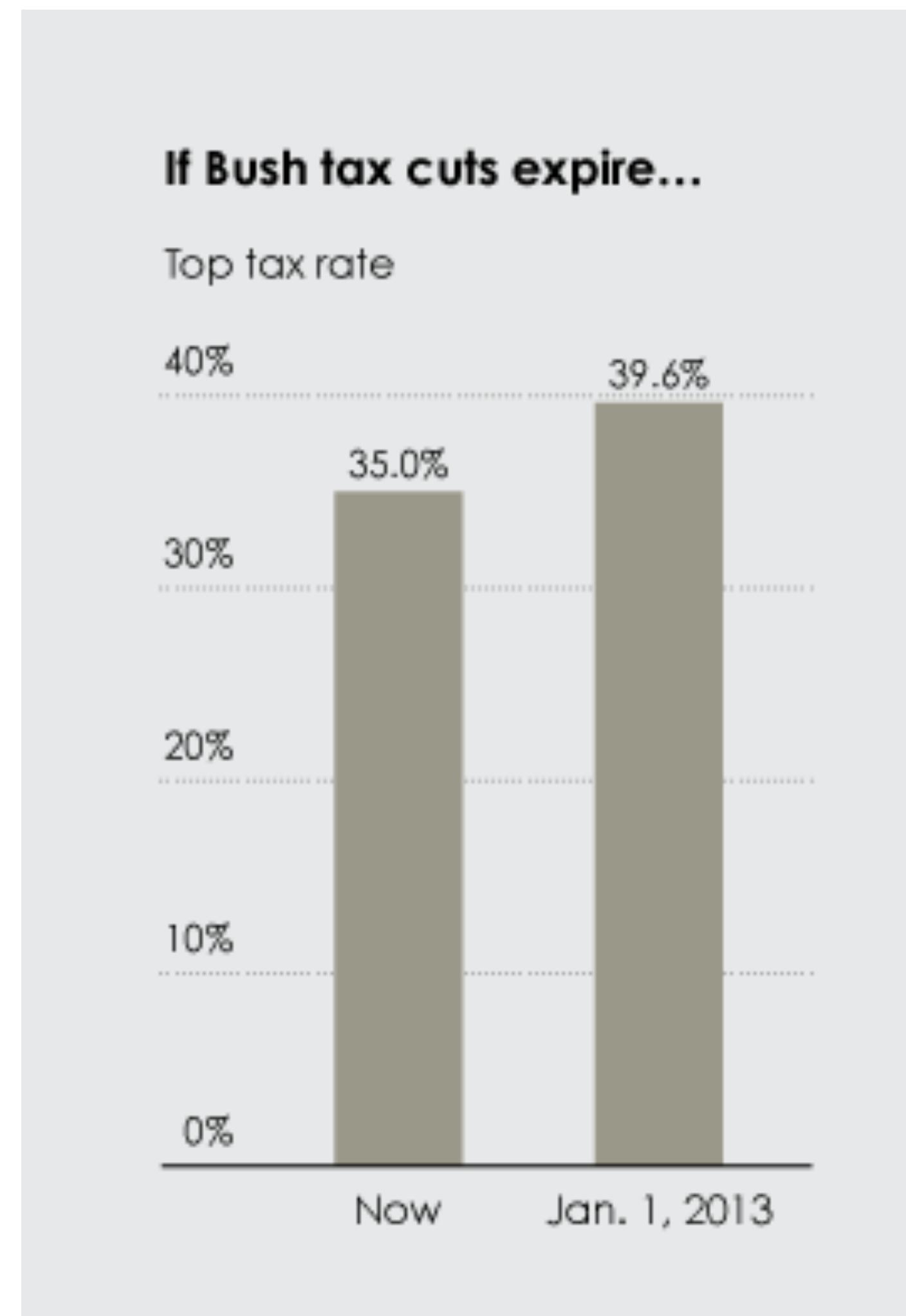


# Graphical Integrity

Magnitude in data  
must correspond to  
magnitude of mark



# Scale Distortions



# What's wrong?



Viele Bezieher mit "ungeklärter Staatsbürgerschaft"

Die größte Gruppe in der Liste der Mindestsicherungsbezieher ist aber jene der "ungeklärten Staatsbürgerschaft". Dass es sich bei den 16.712 Personen um

# What's wrong?



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# What's wrong?

## Grafik der Kronenzeitung



Viele Bezieher mit "ungeklärter Staatsbürgerschaft"  
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Grafik  
in echt



Viele Bezieher mit "ungeklärter Staatsbürgerschaft"  
Die größte Gruppe in der Liste der Mindestsicherungsbezieher ist aber jene der "ungeklärten Staatsbürgerschaft". Dass es sich bei den 16.712 Personen um

# OBAMACARE ENROLLMENT

7,100,000

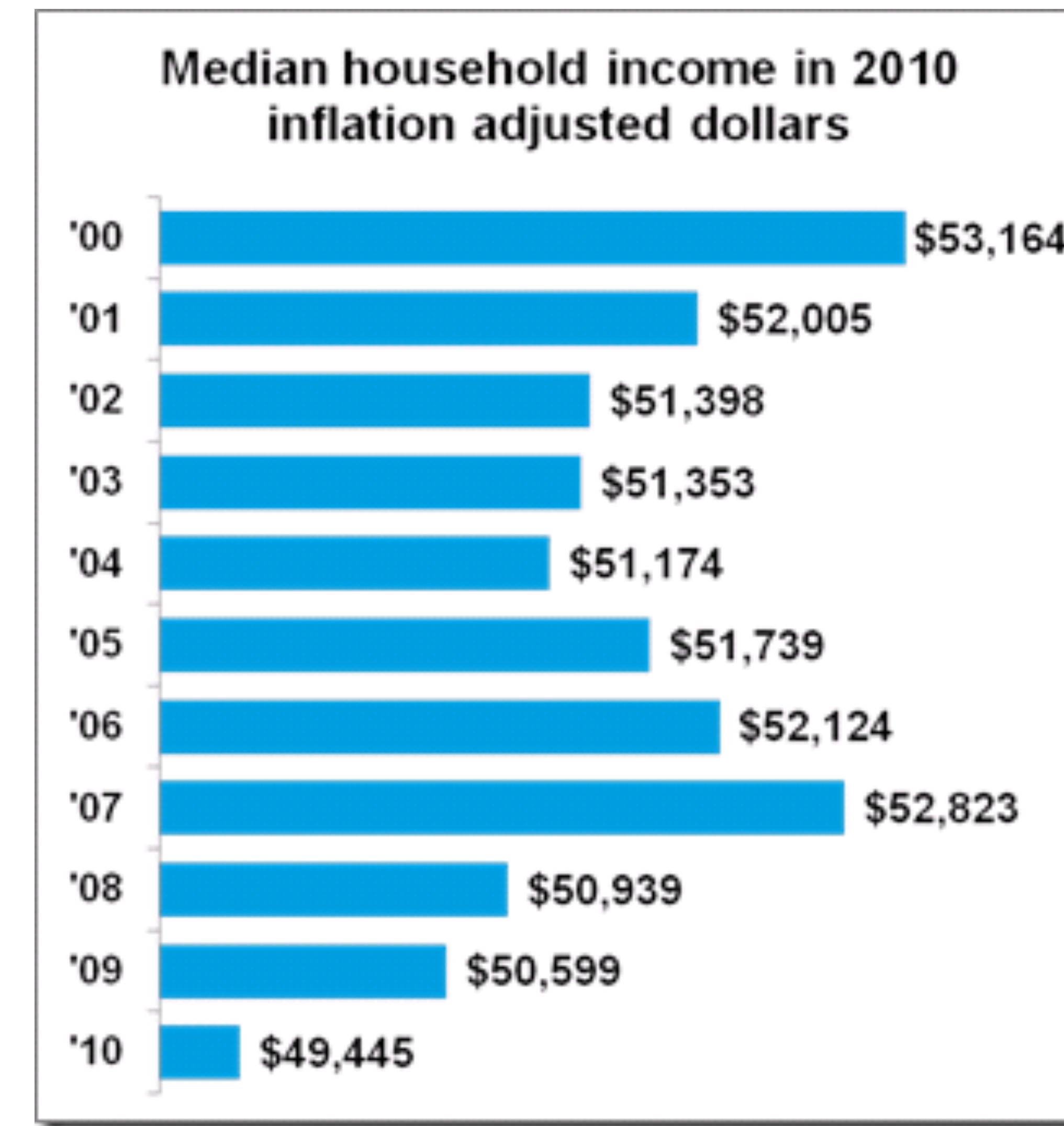
ACTUAL  
ENROLLMENT

7,000,000

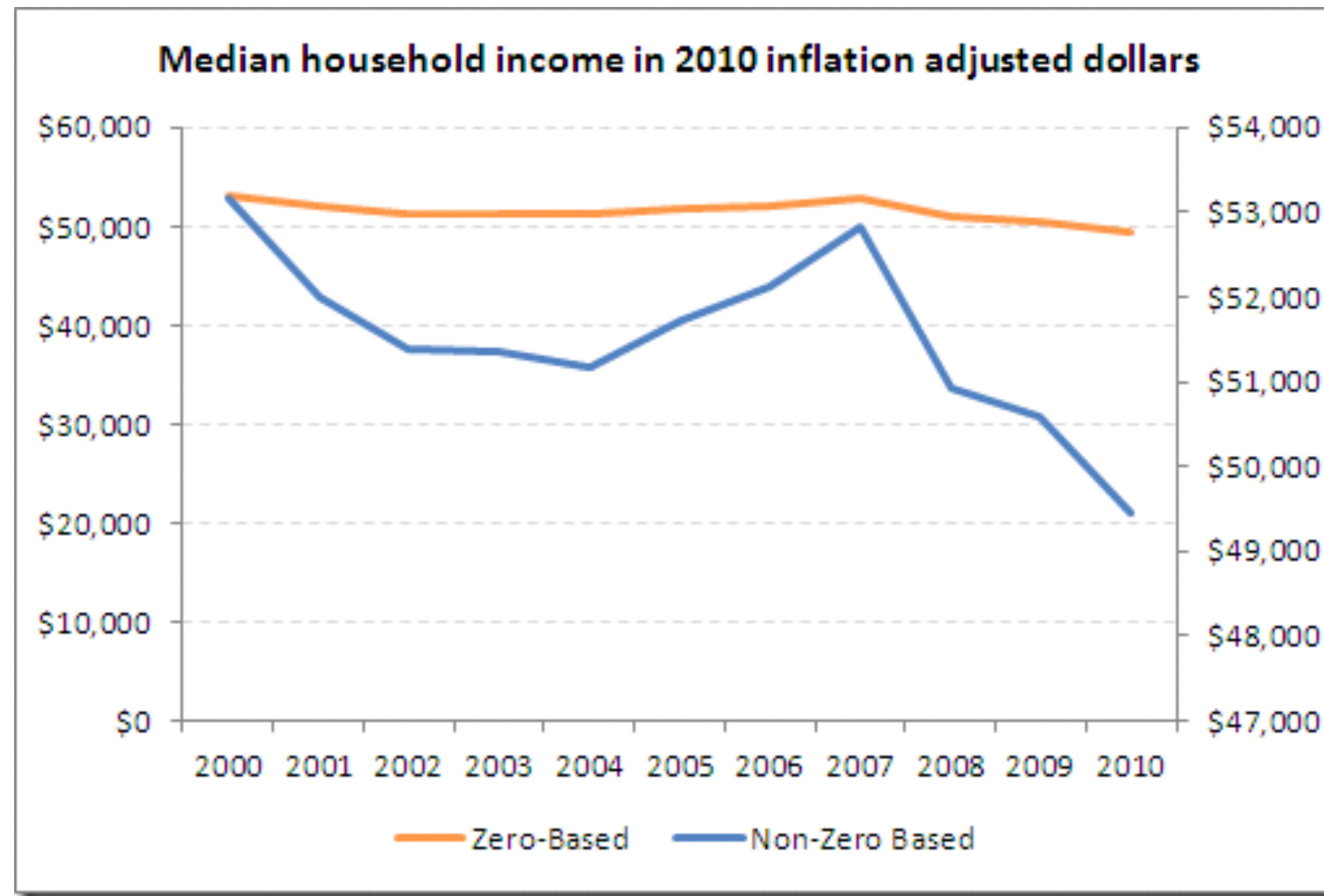
GOAL



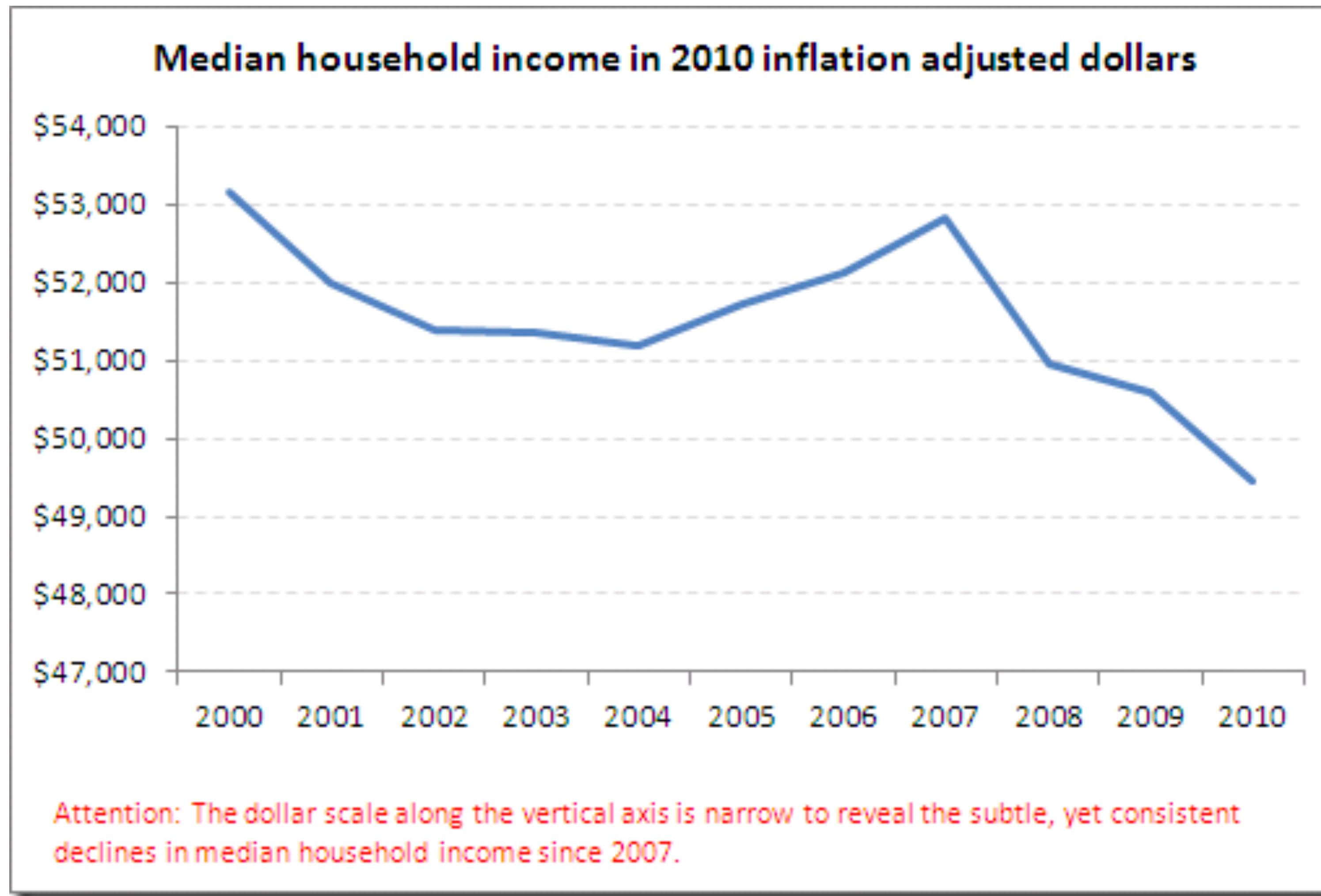
# Start Scales at 0?



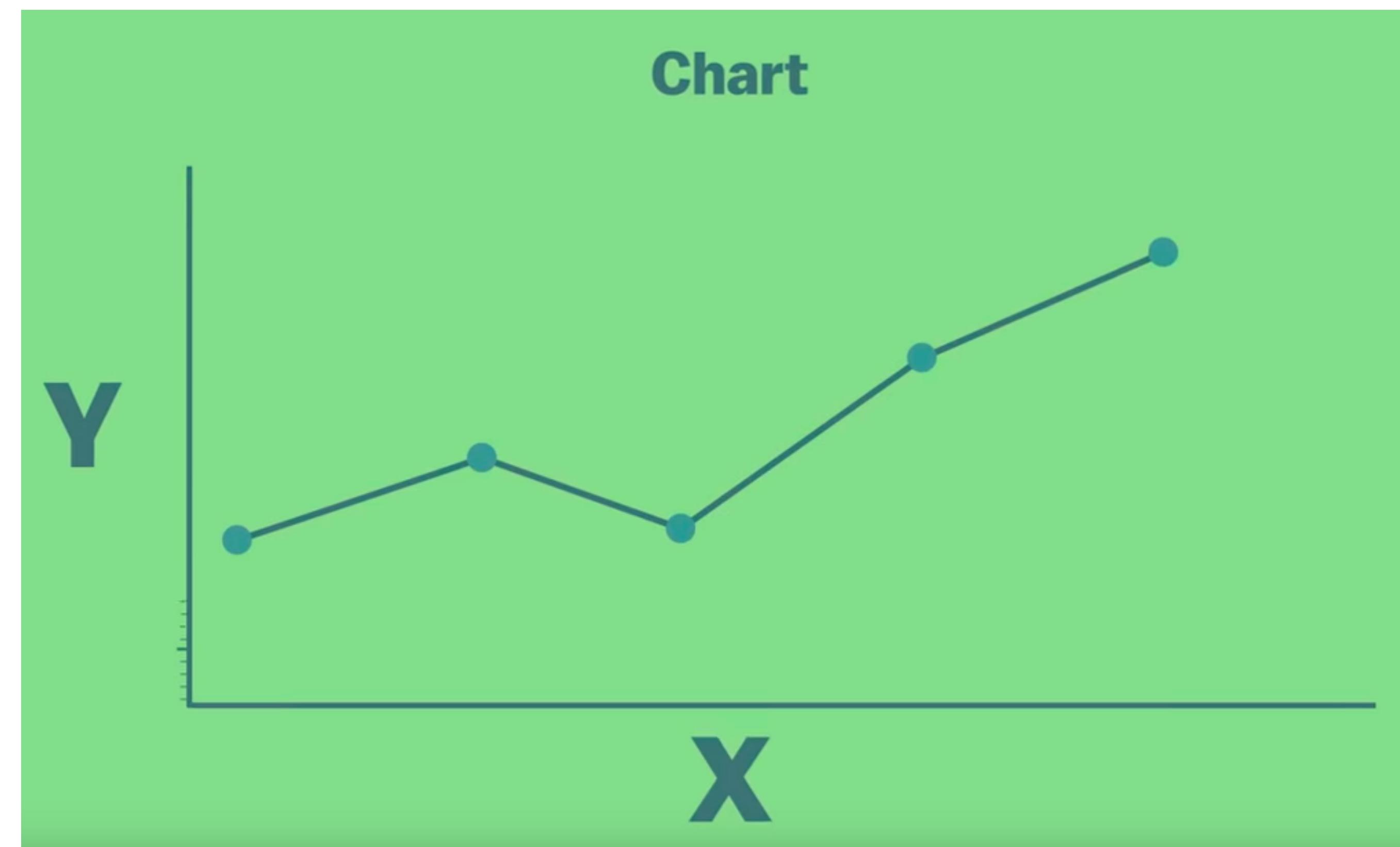
# Start Scales at 0?



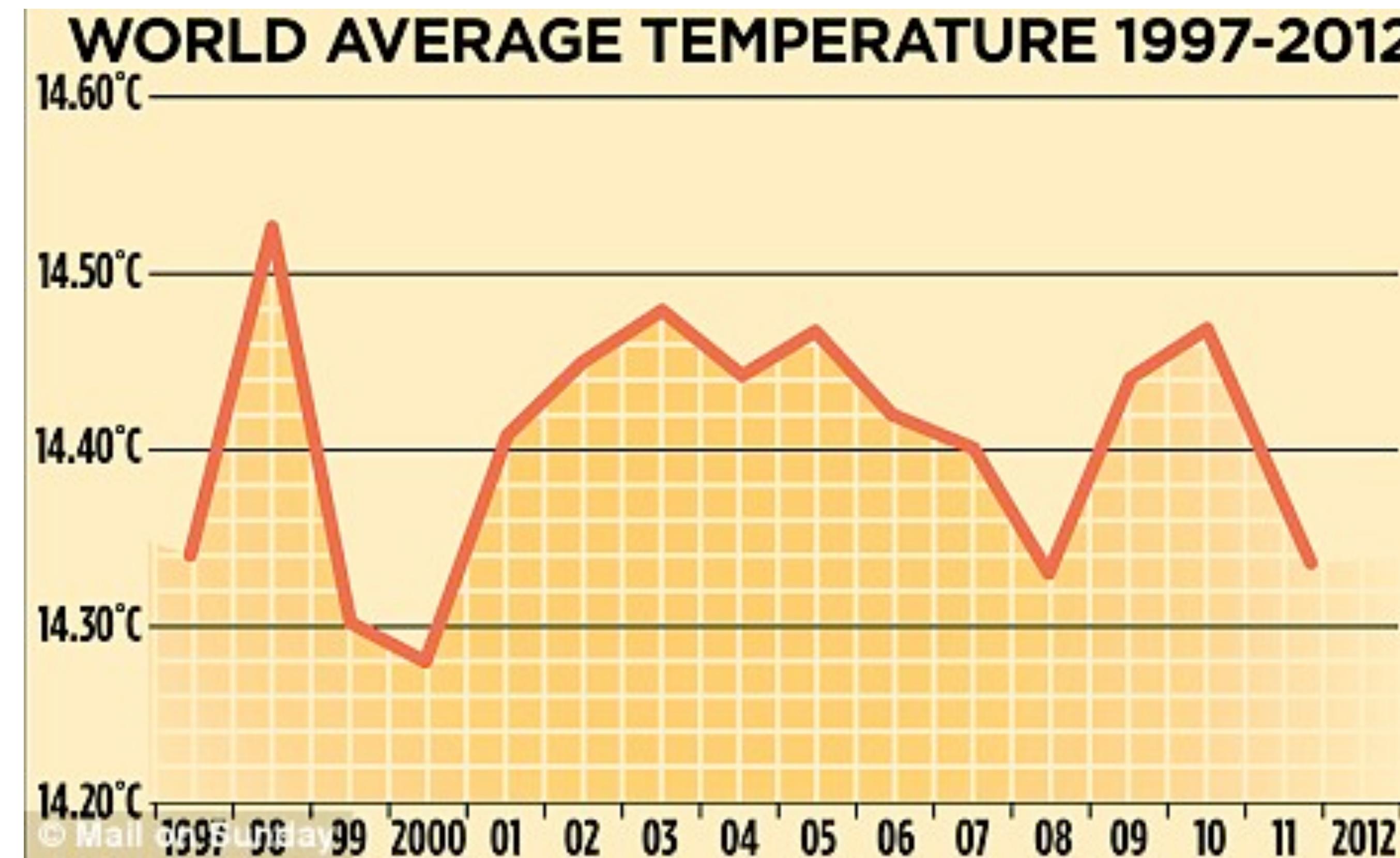
# Start Scales at 0?



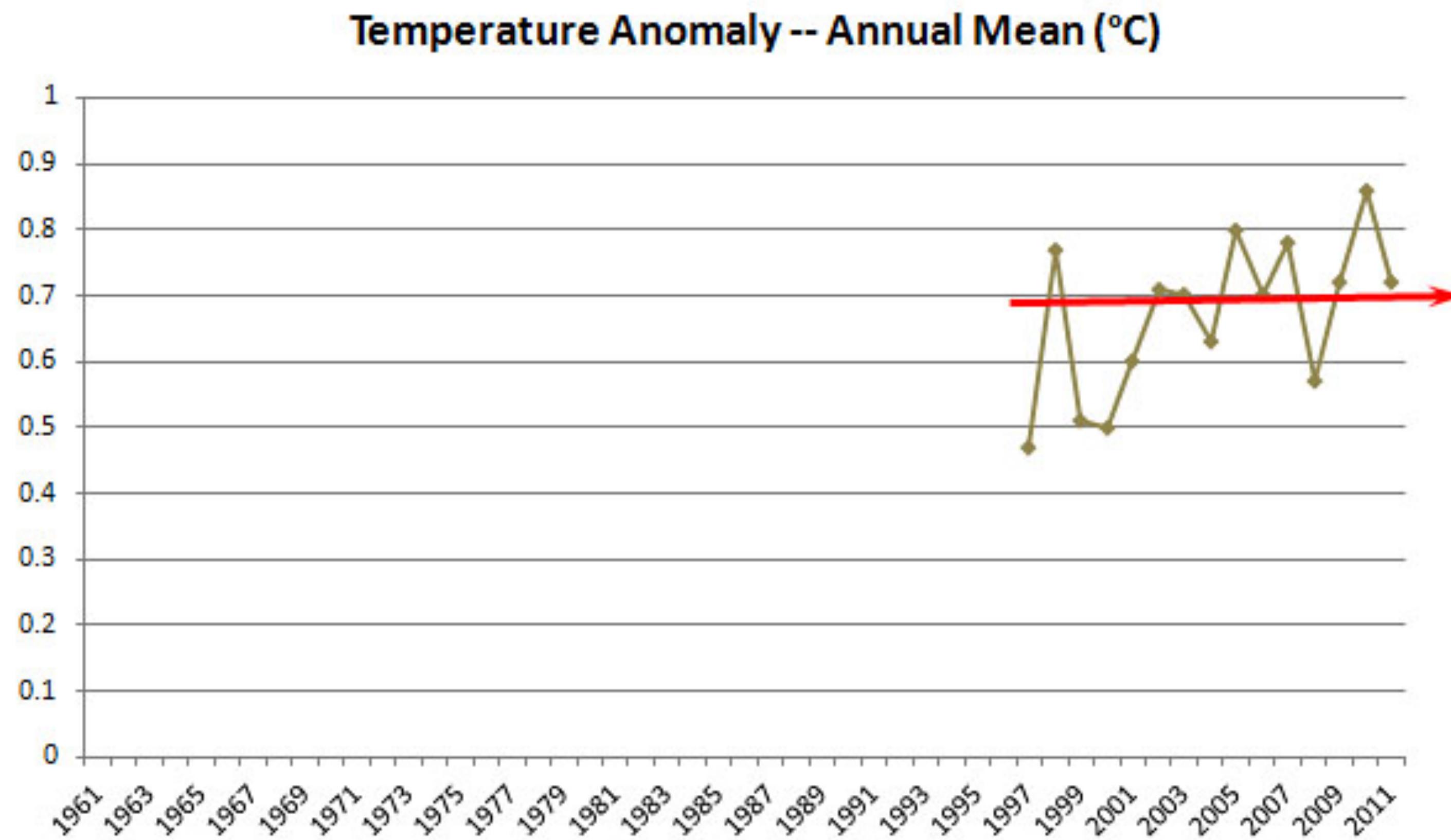
# Scales at 0



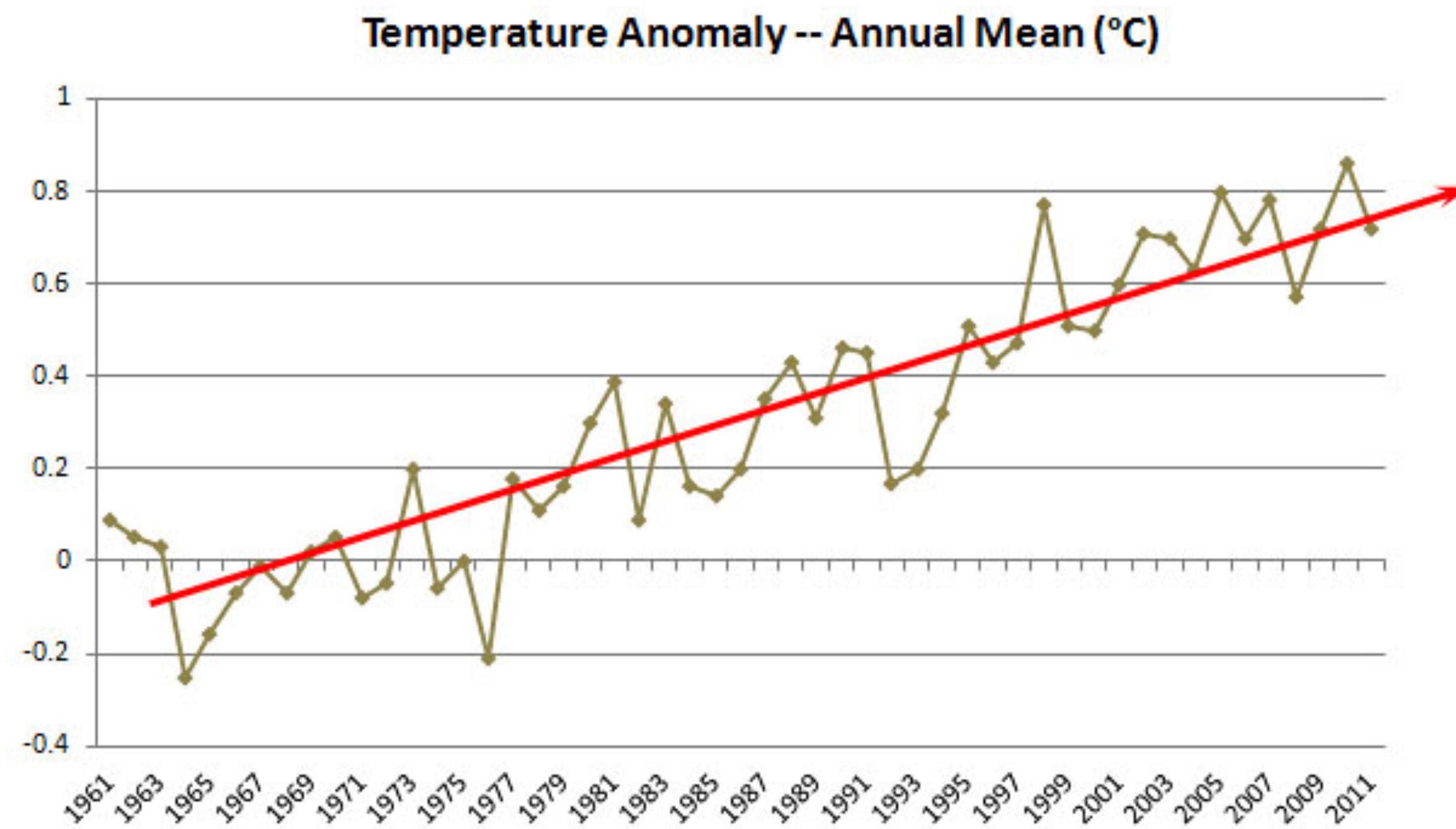
# Global Warming?



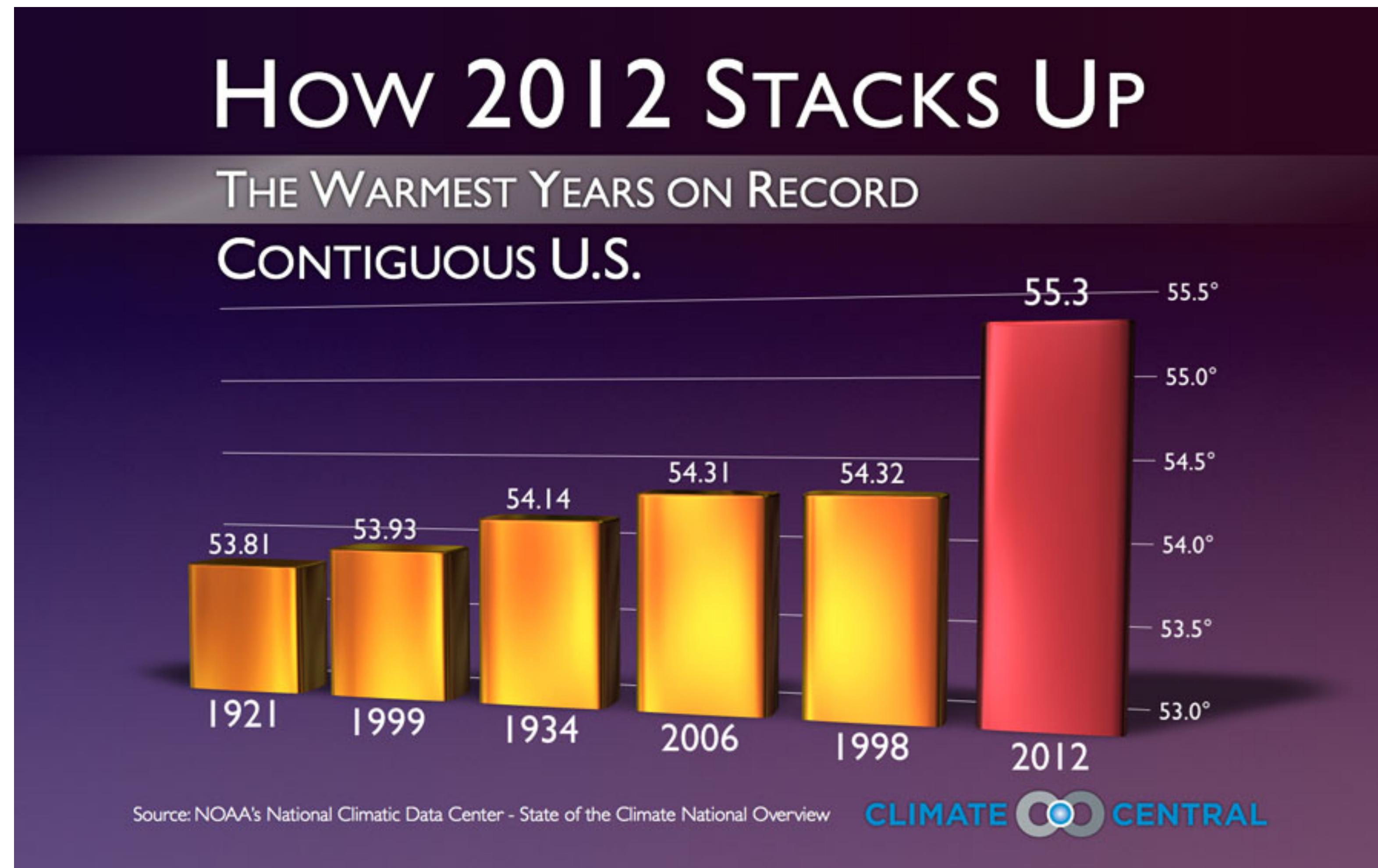
# Global Warming?



# Global Warming - Frame the Data



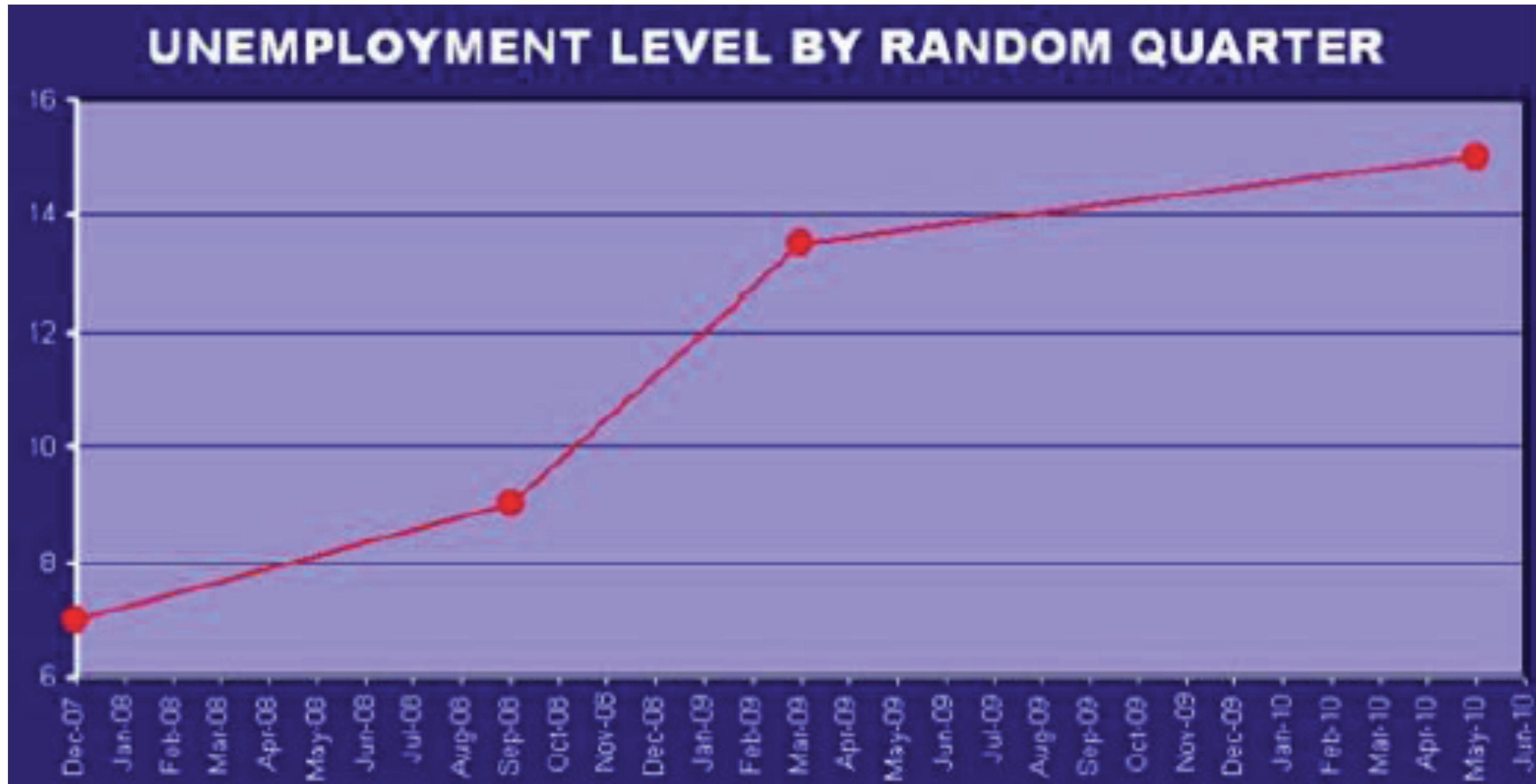
# What's wrong?



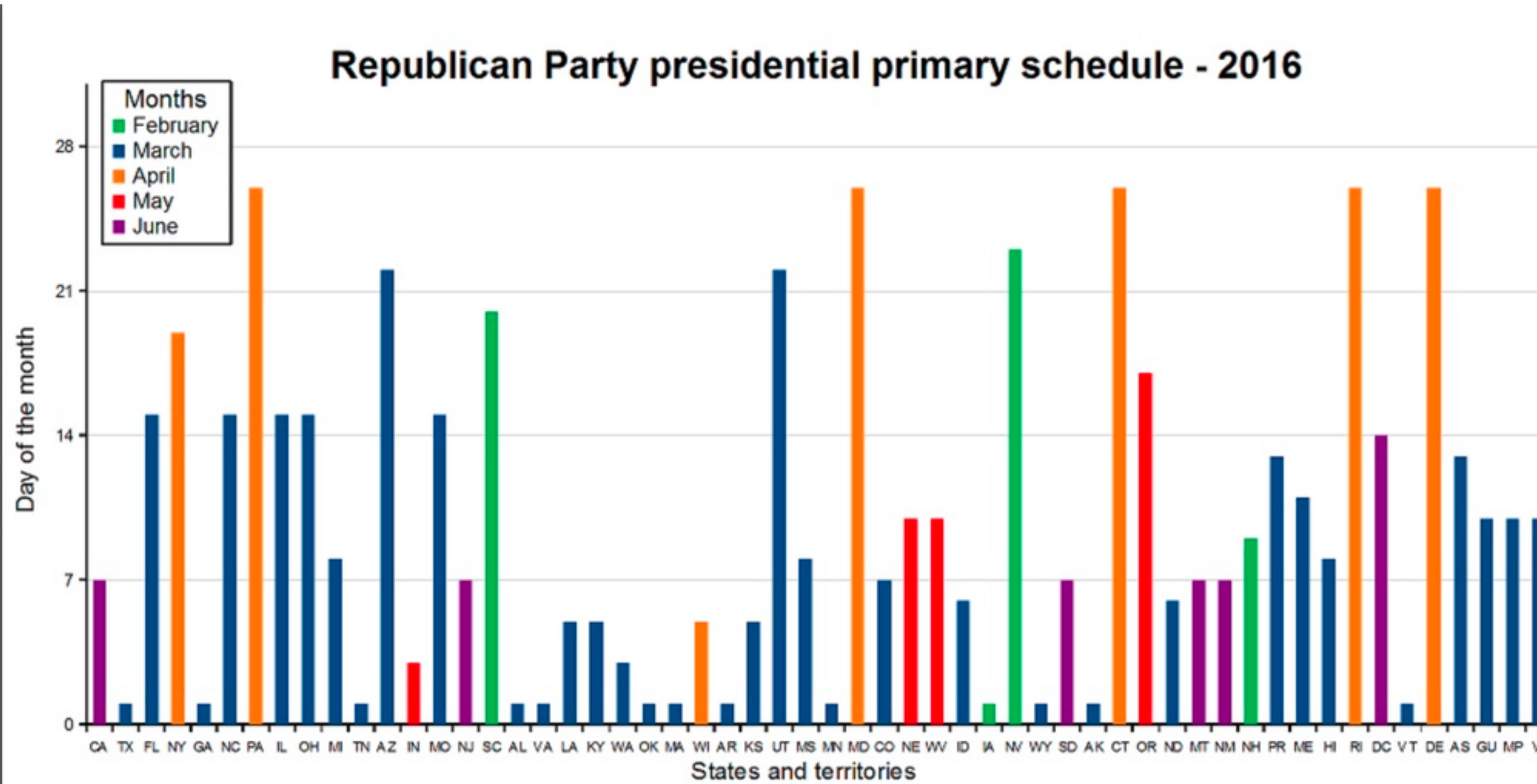
# Scale Distortions



# Temporal Data



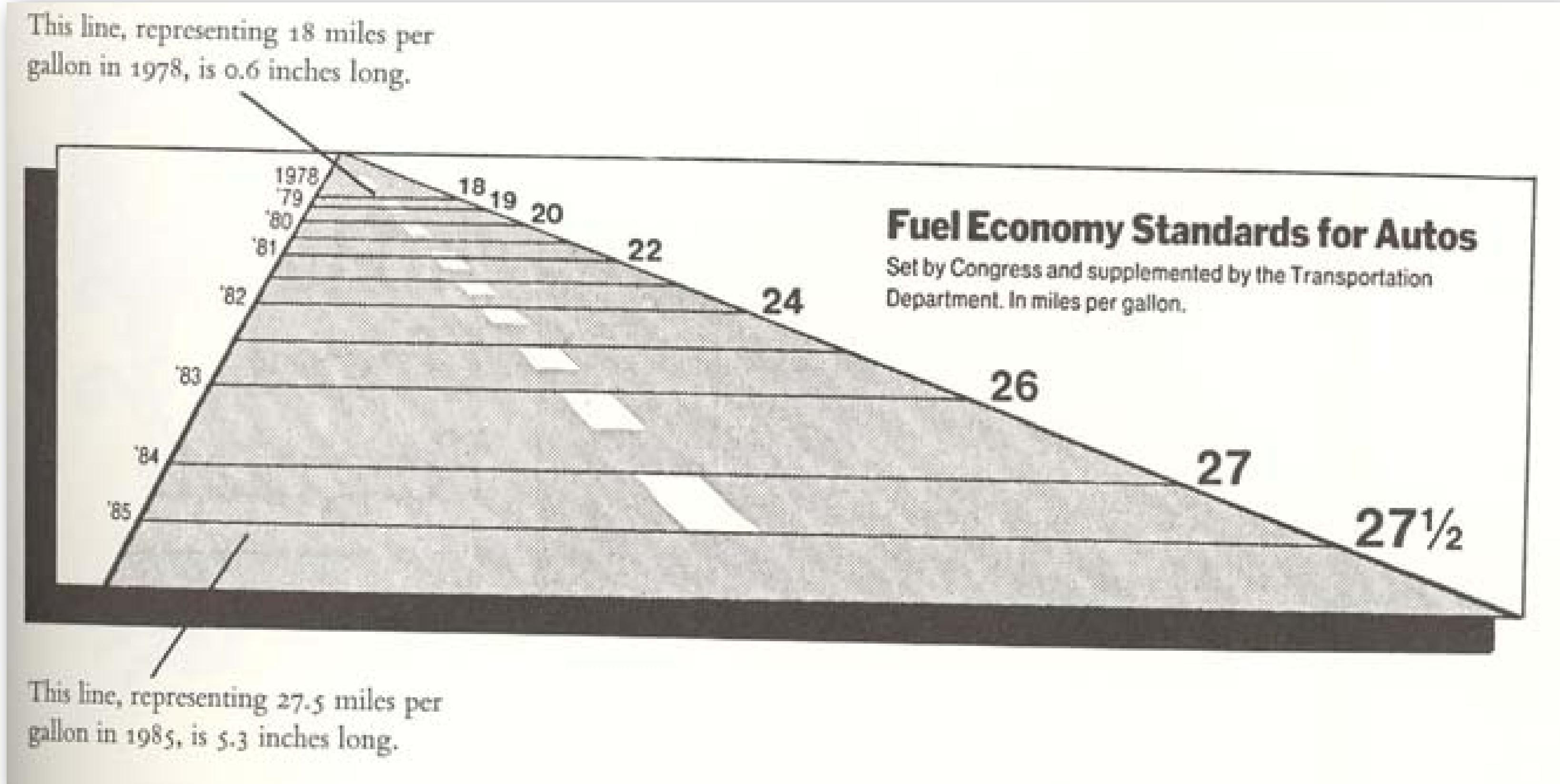
# What's wrong?



# The Lie Factor

Size of effect shown in graphic

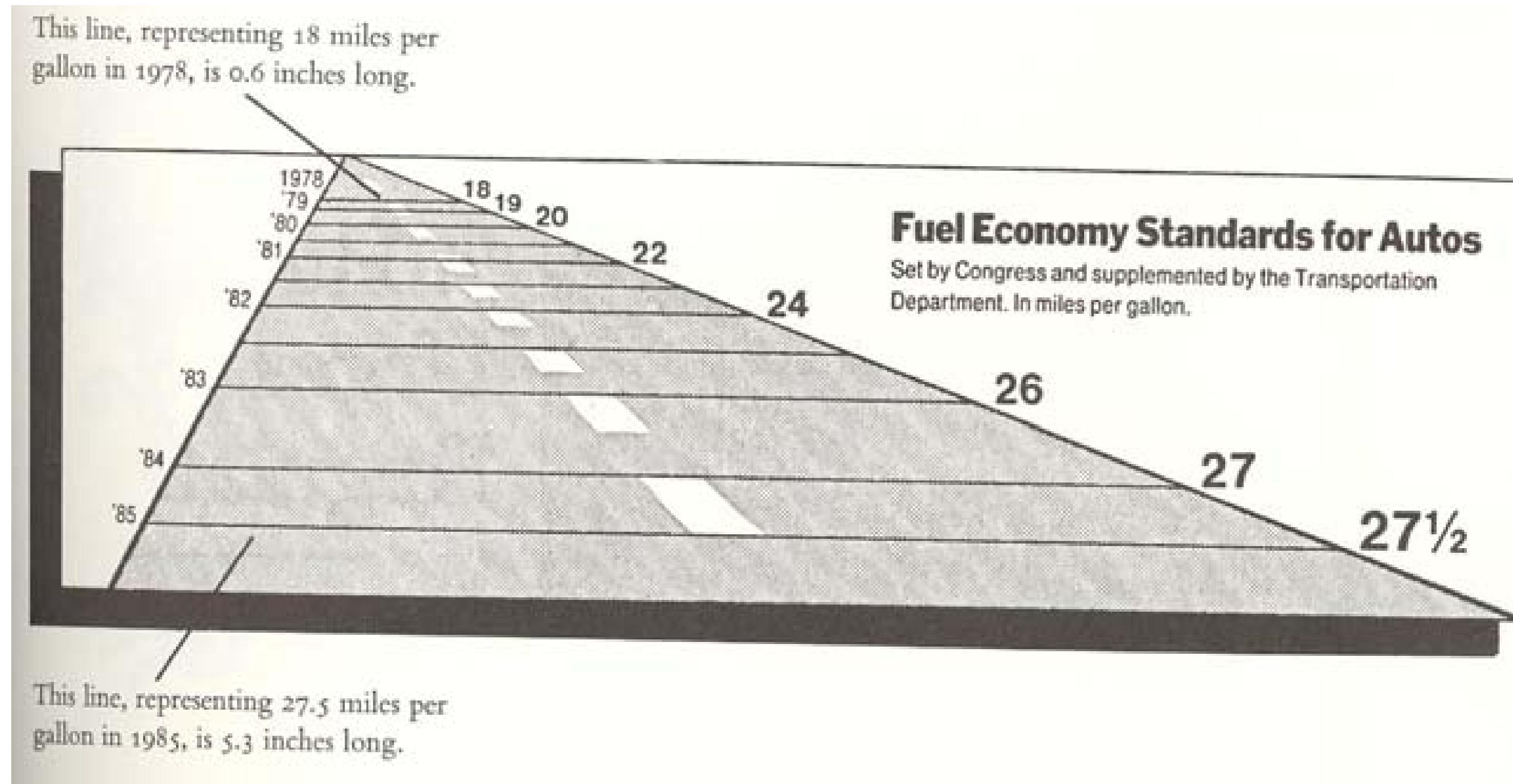
Size of effect in data



# The Lie Factor

$$\frac{5.3 - 0.6}{0.6} / \frac{27.5 - 18}{18} = 14.8$$

(Size of effect in graphic)/(size of effect in data)



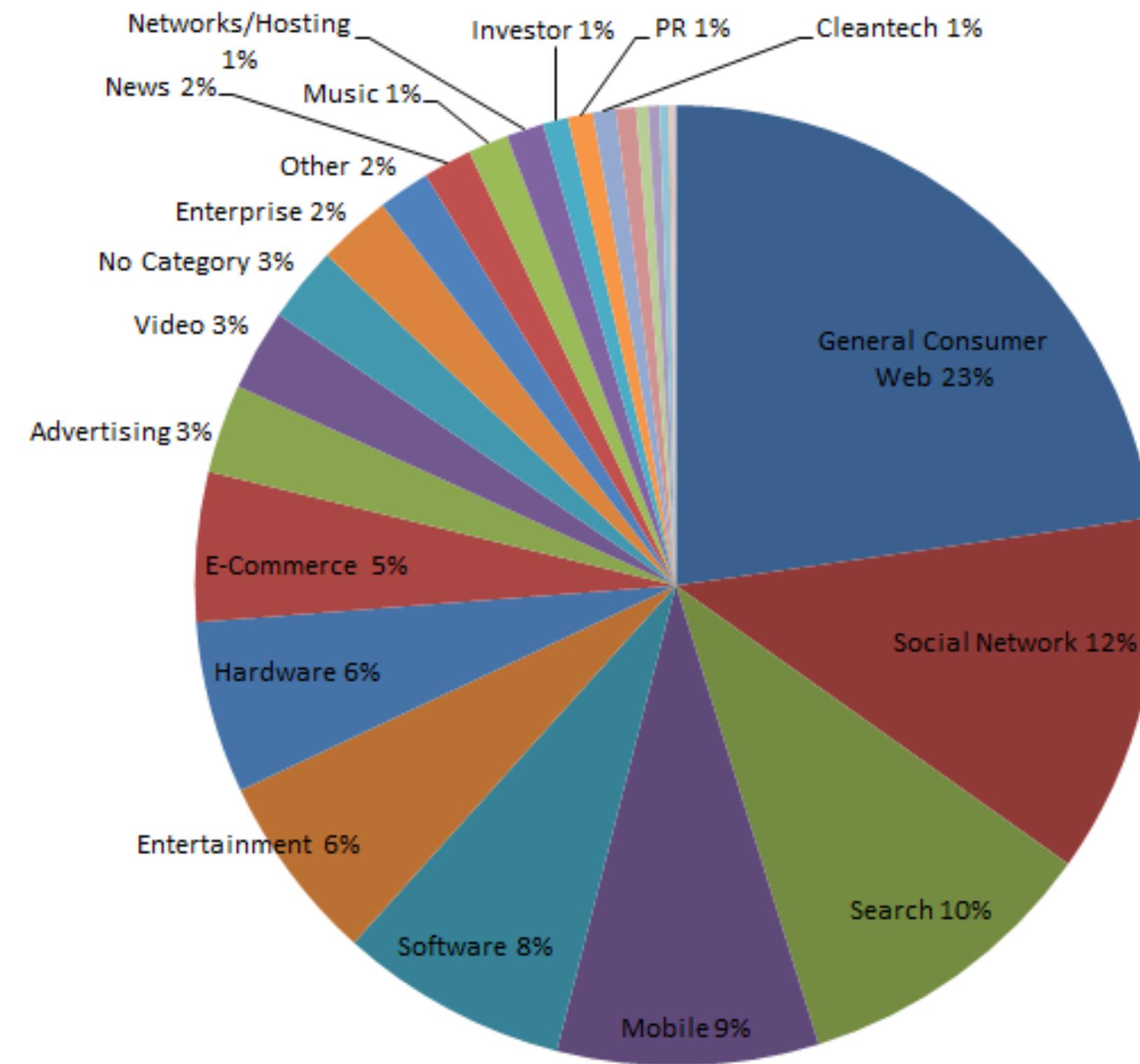
# Tufte's Integrity Principles

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”)

# Death to Pie Charts

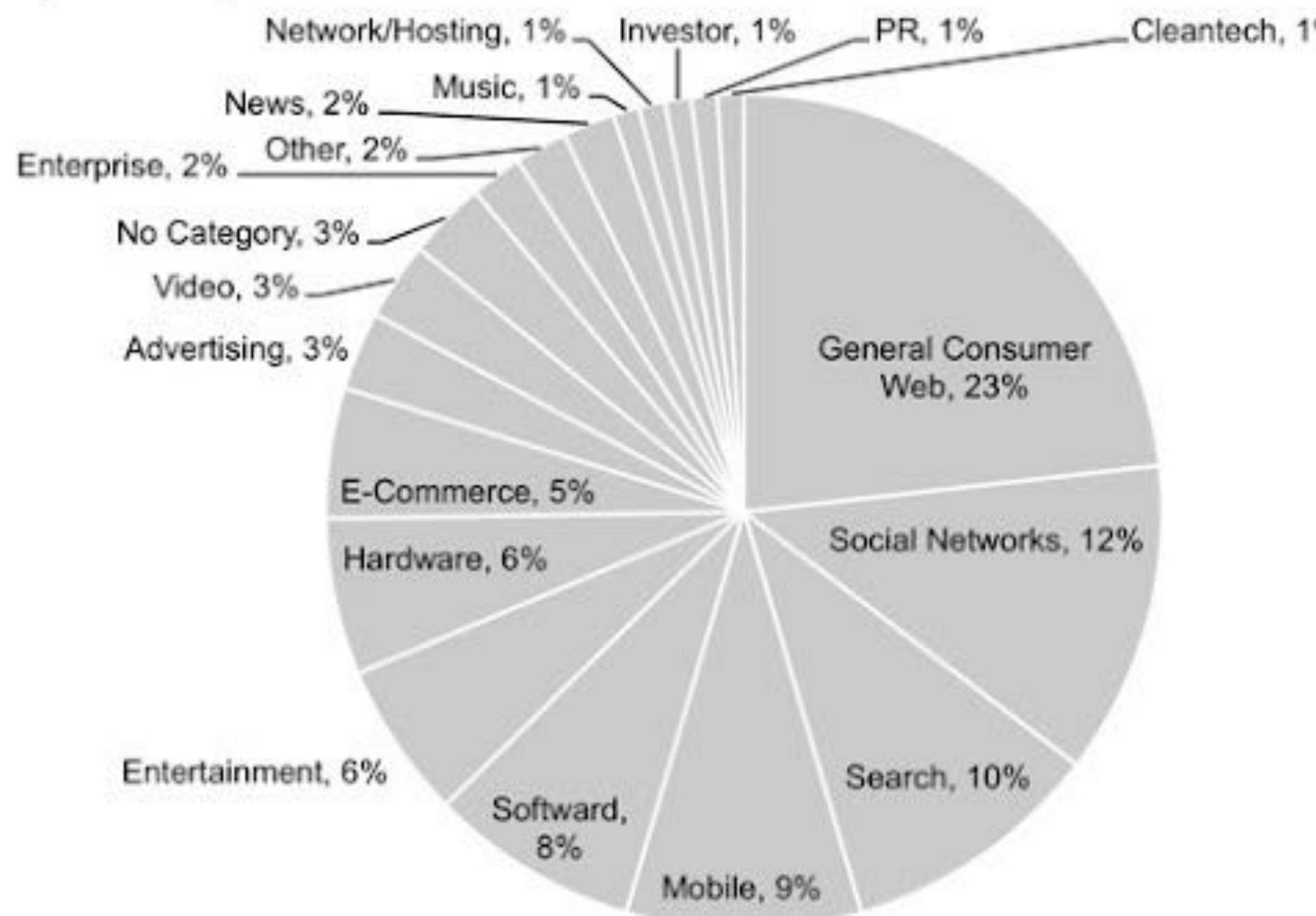


Share of coverage  
on TechCrunch

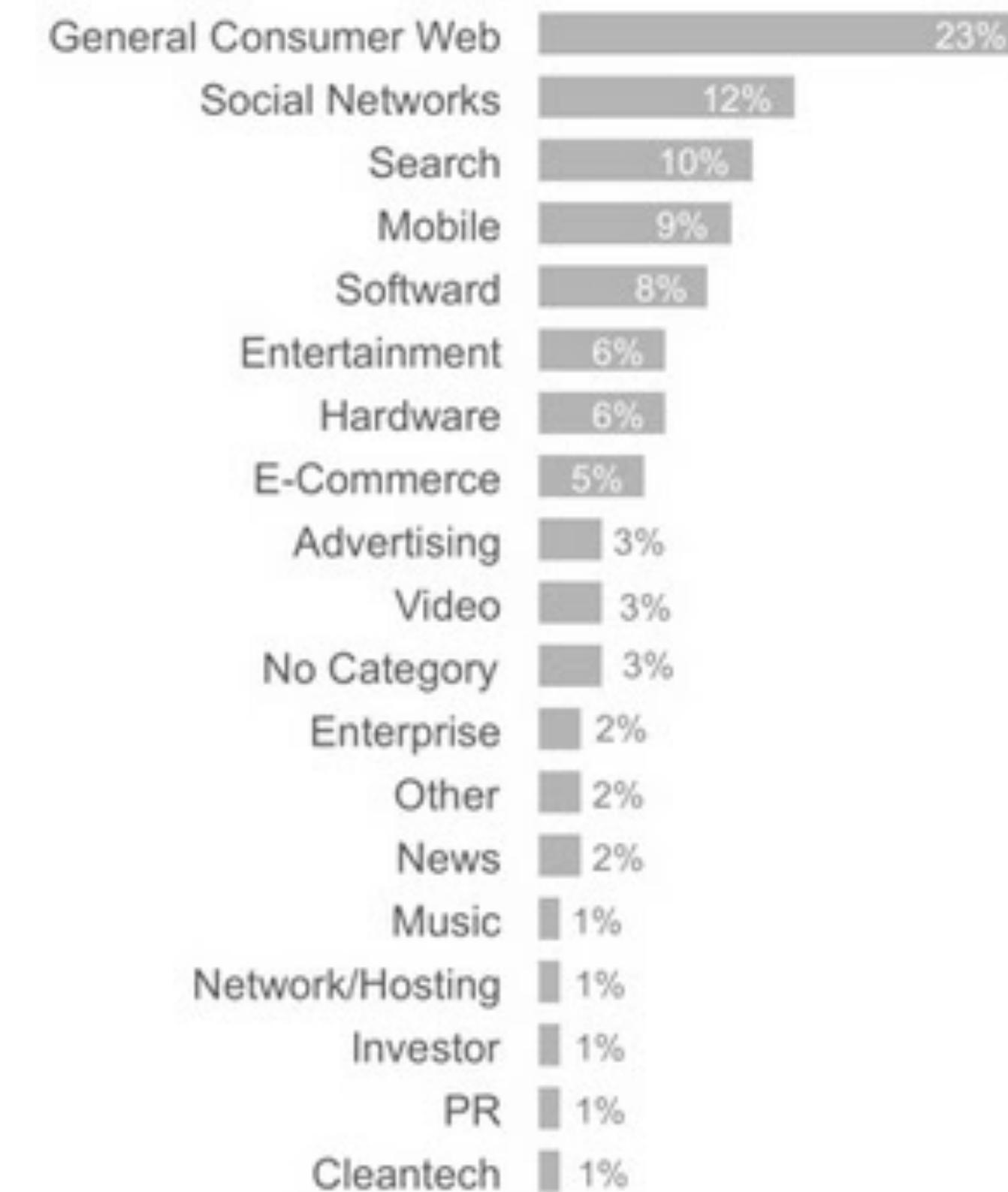
“I hate pie charts.  
I mean, really hate them.”

# Redesign

**TechCrunch Coverage: 2005 - 2011**  
*A slightly better pie?*

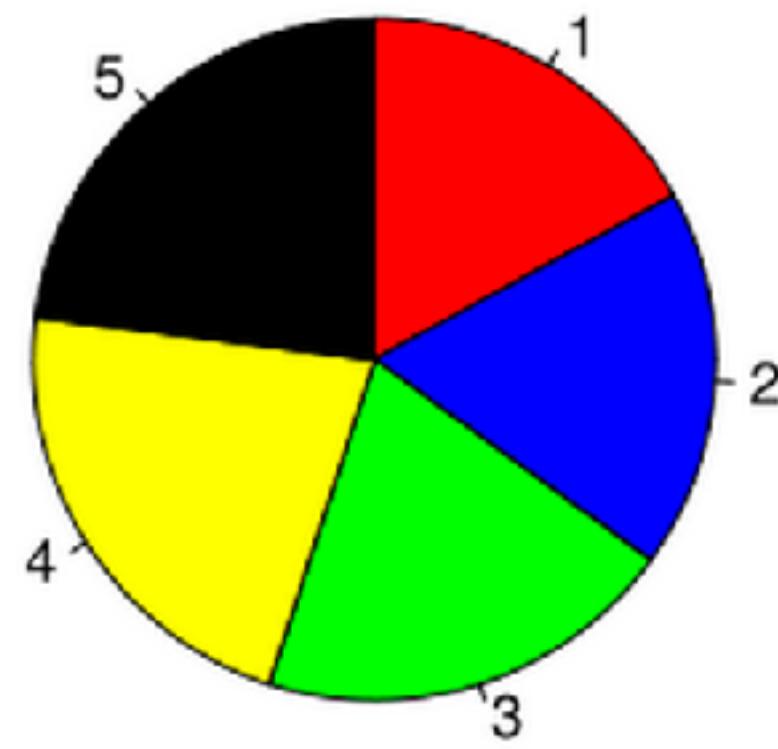


**TechCrunch Coverage: 2005 - 2011**  
*Bars are best!*

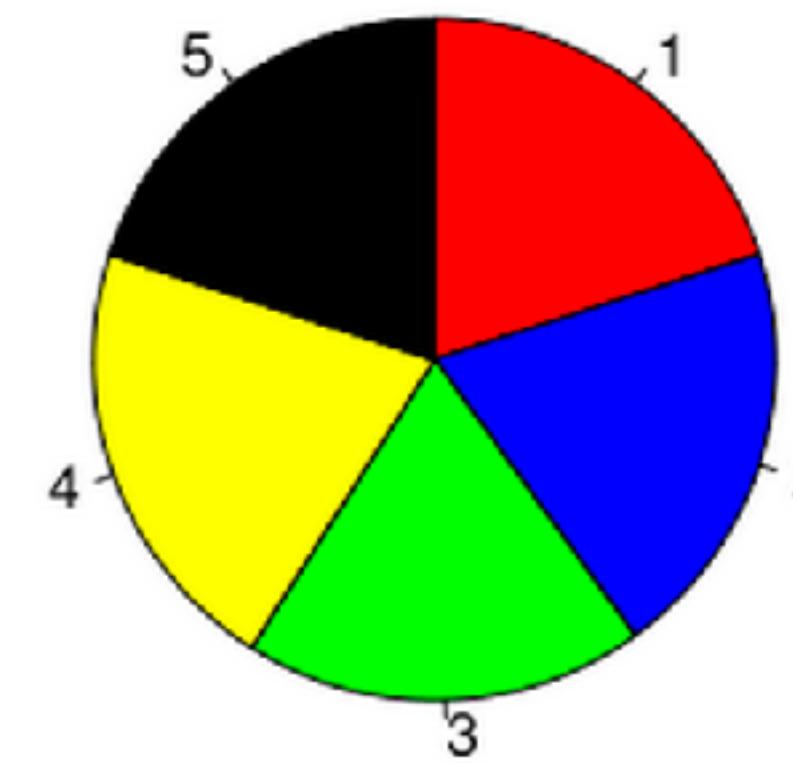


# Can you spot the differences?

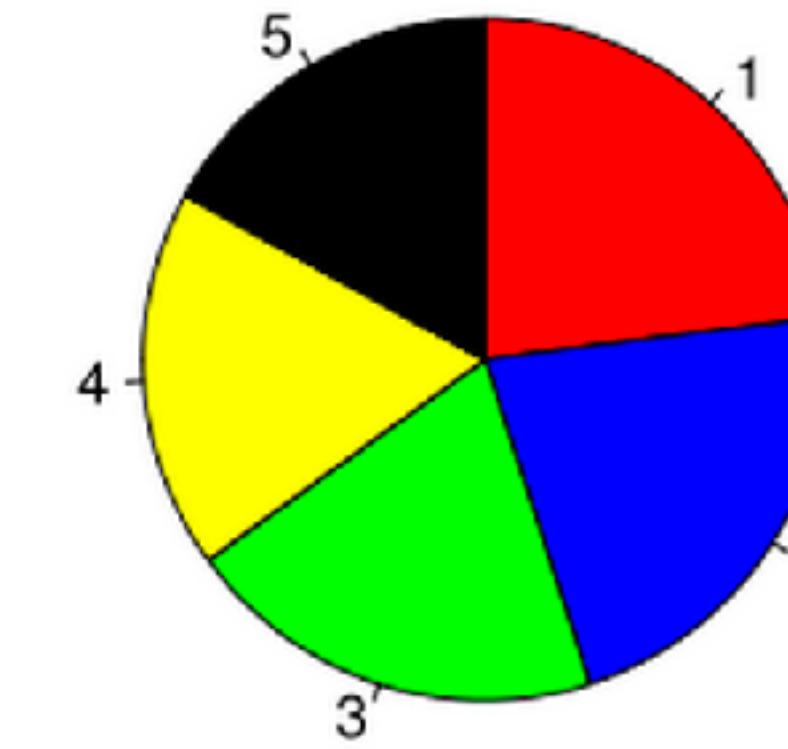
**A**



**B**



**C**

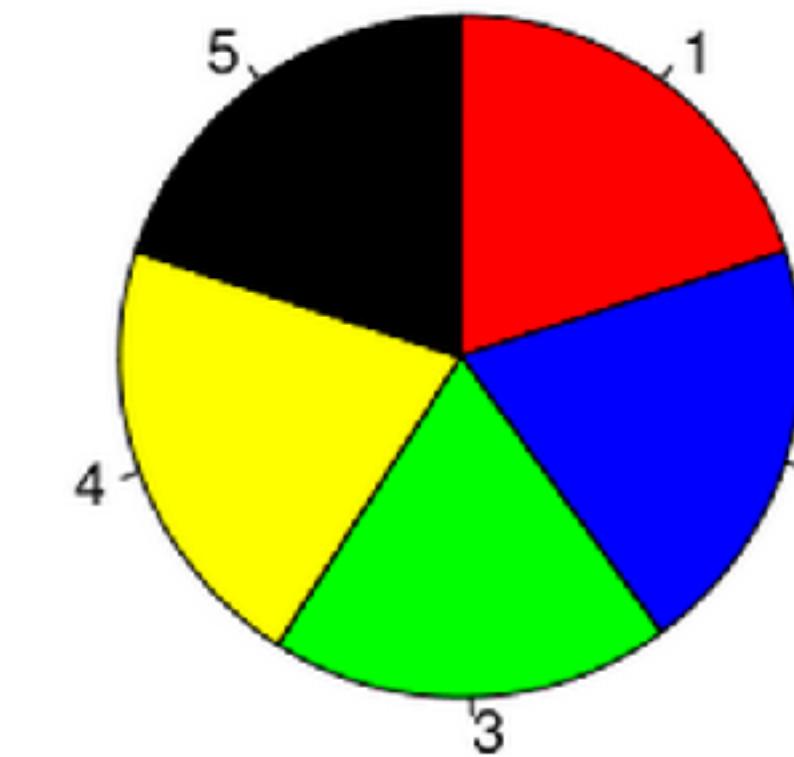


# Can you spot the differences?

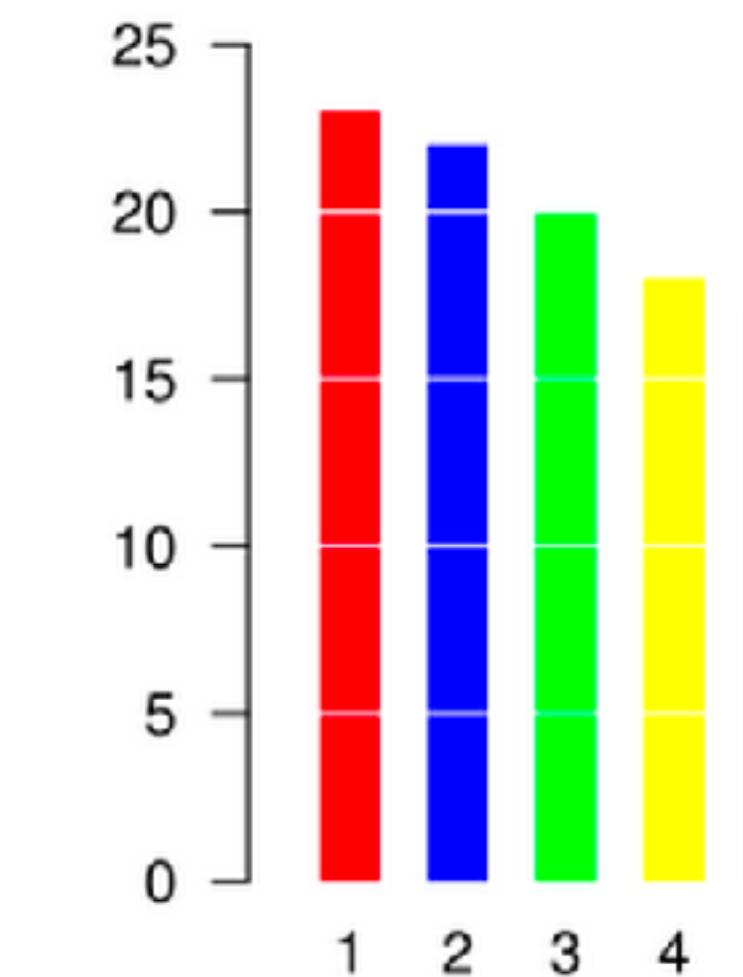
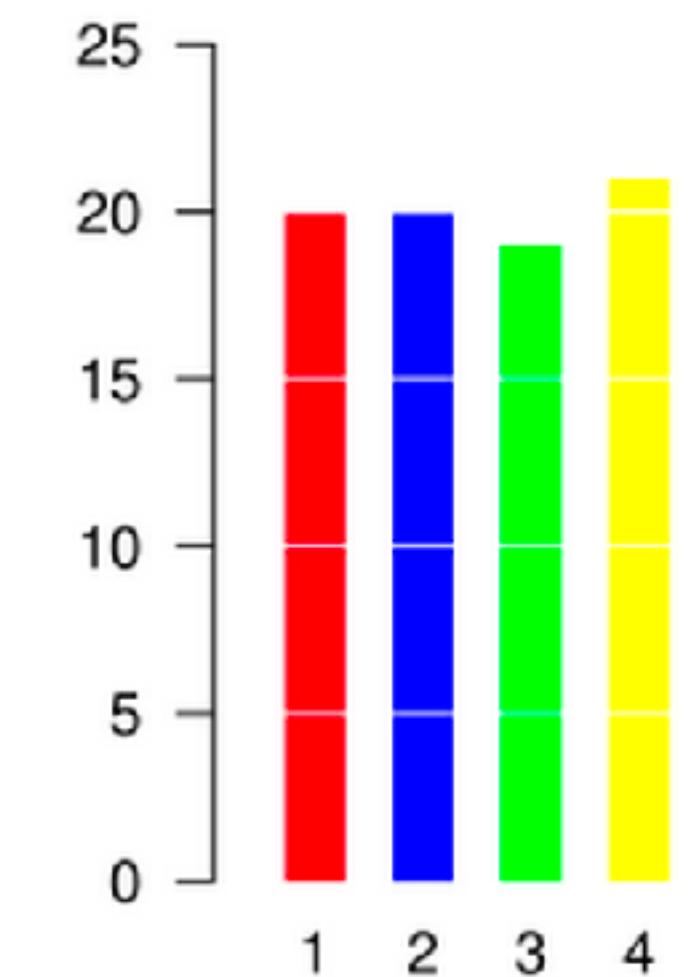
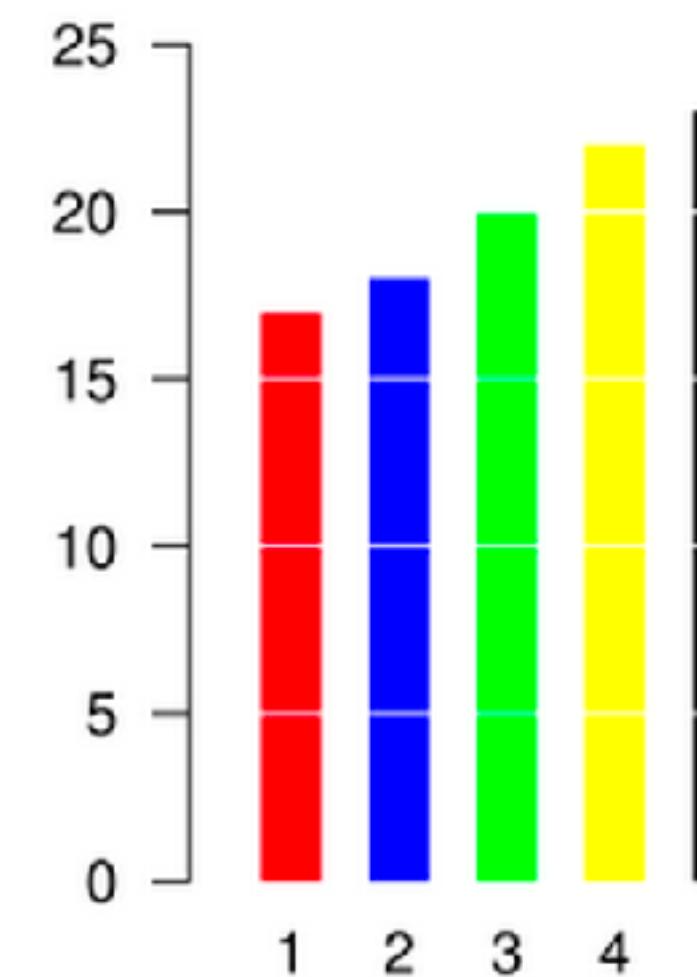
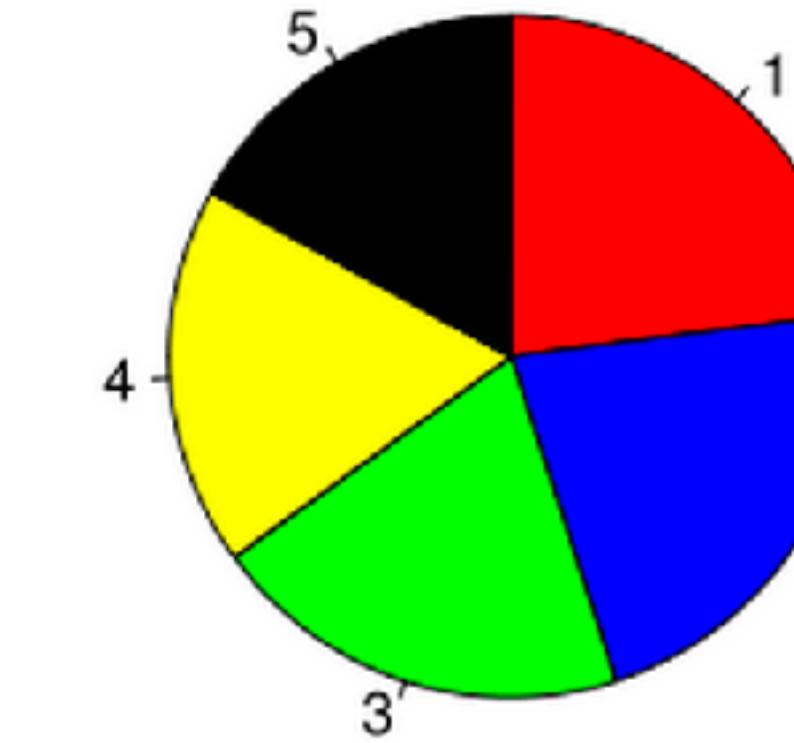
A



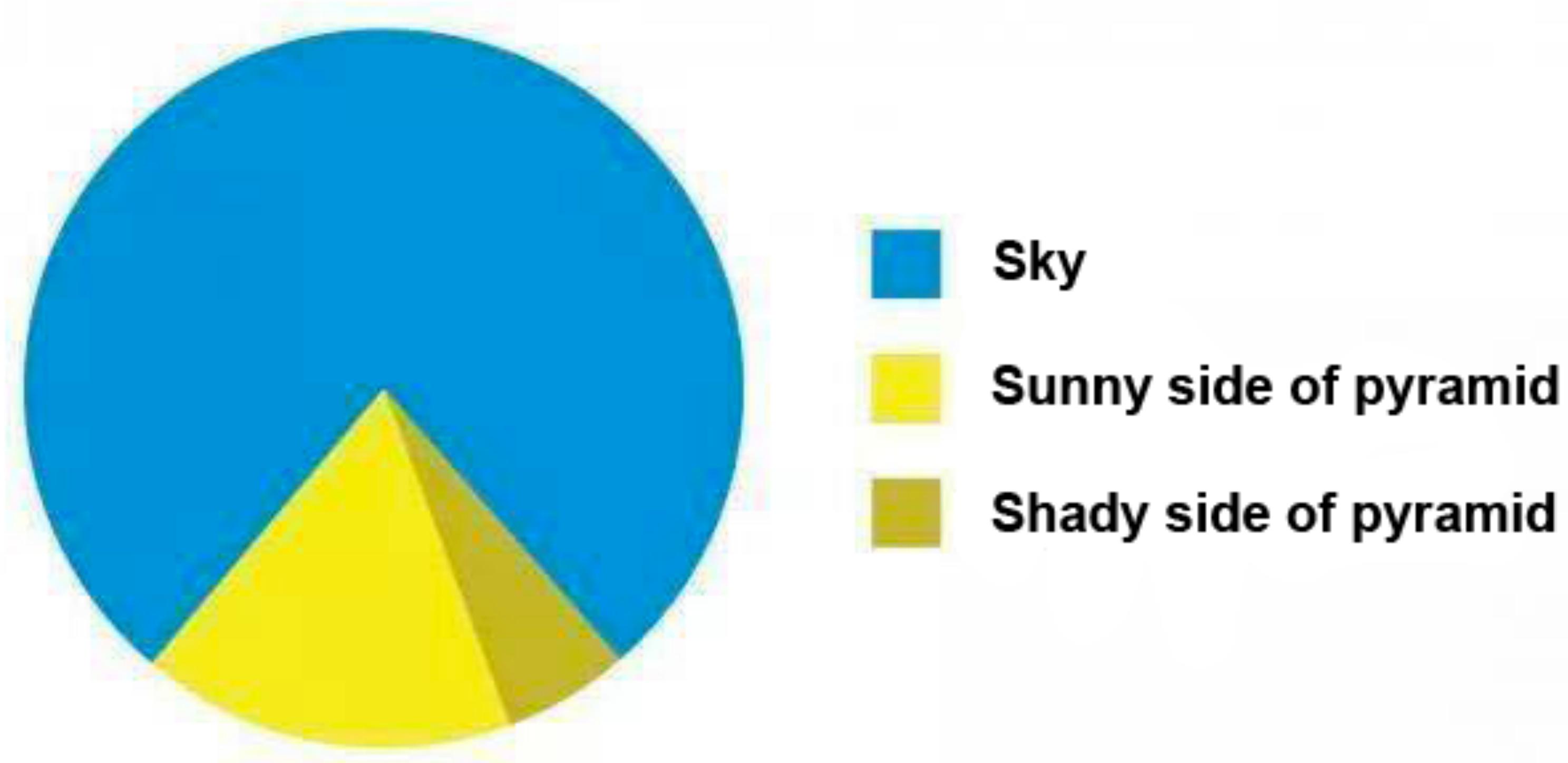
B



C



# A favorite pie chart



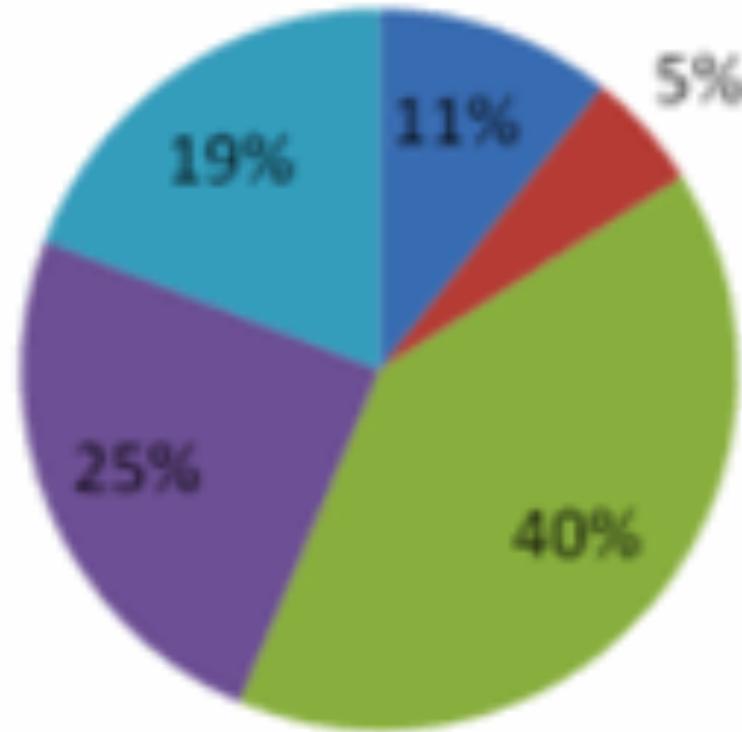
# Another favorite pie chart



# So, what to use instead?

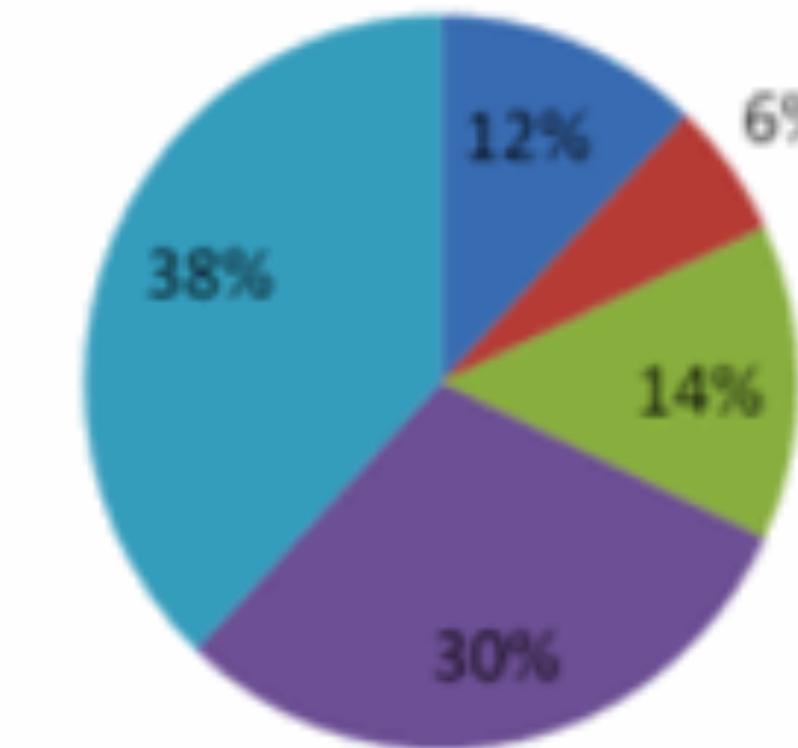
**PRE: How do you feel about doing science?**

■ Bored ■ Not great ■ OK ■ Kind of interested ■ Excited



**POST: How do you feel about doing science?**

■ Bored ■ Not great ■ OK ■ Kind of interested ■ Excited



imagine you just completed a pilot summer learning program on science aimed at improving perceptions of the field among 2nd and 3rd grade elementary children

# Alternative #1: Show the Number(s) Directly

After the pilot program,

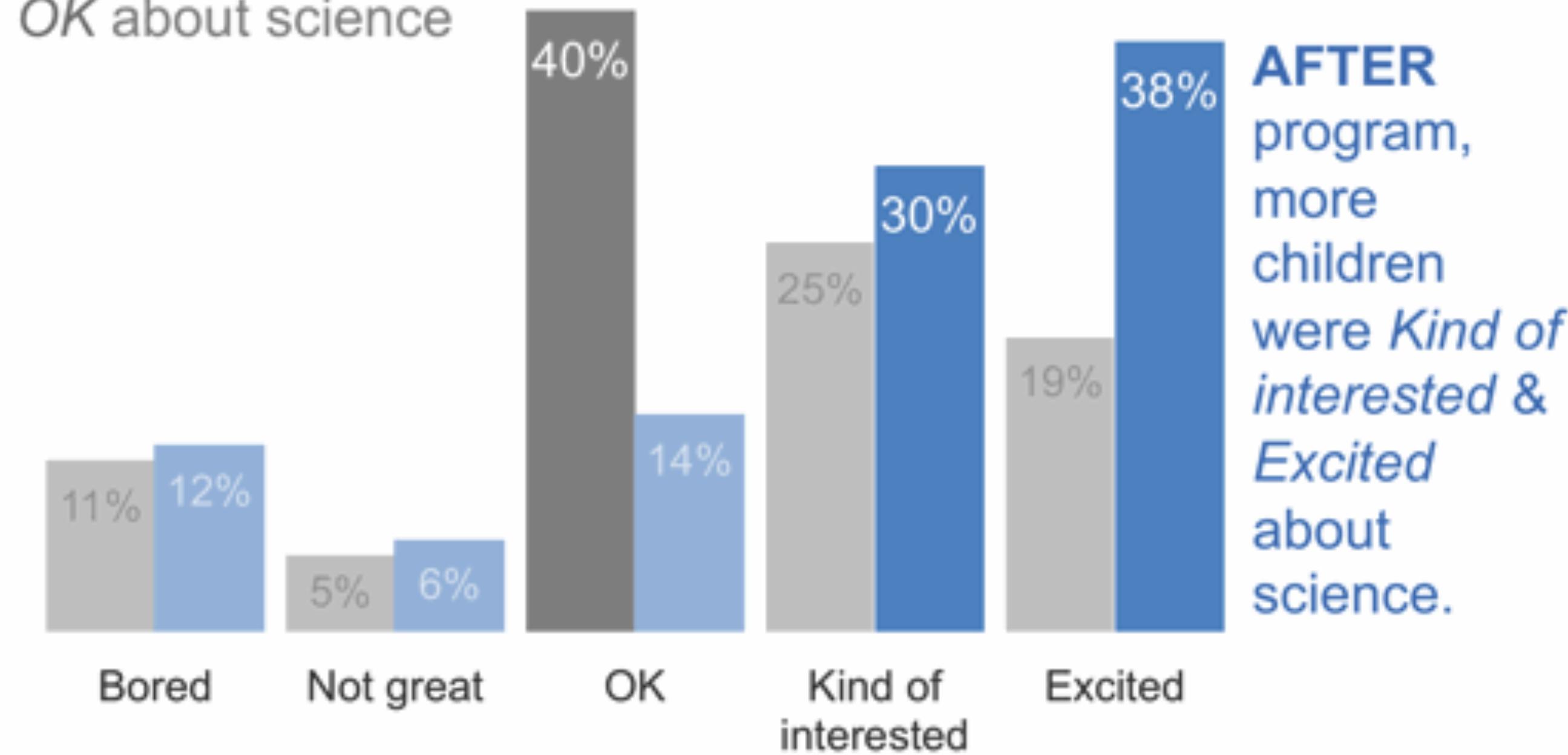
**68%**

of kids expressed interest towards science,  
compared to 44% going into the program.

# Alternative #2: Simple Bar Graph

How do you feel about science?

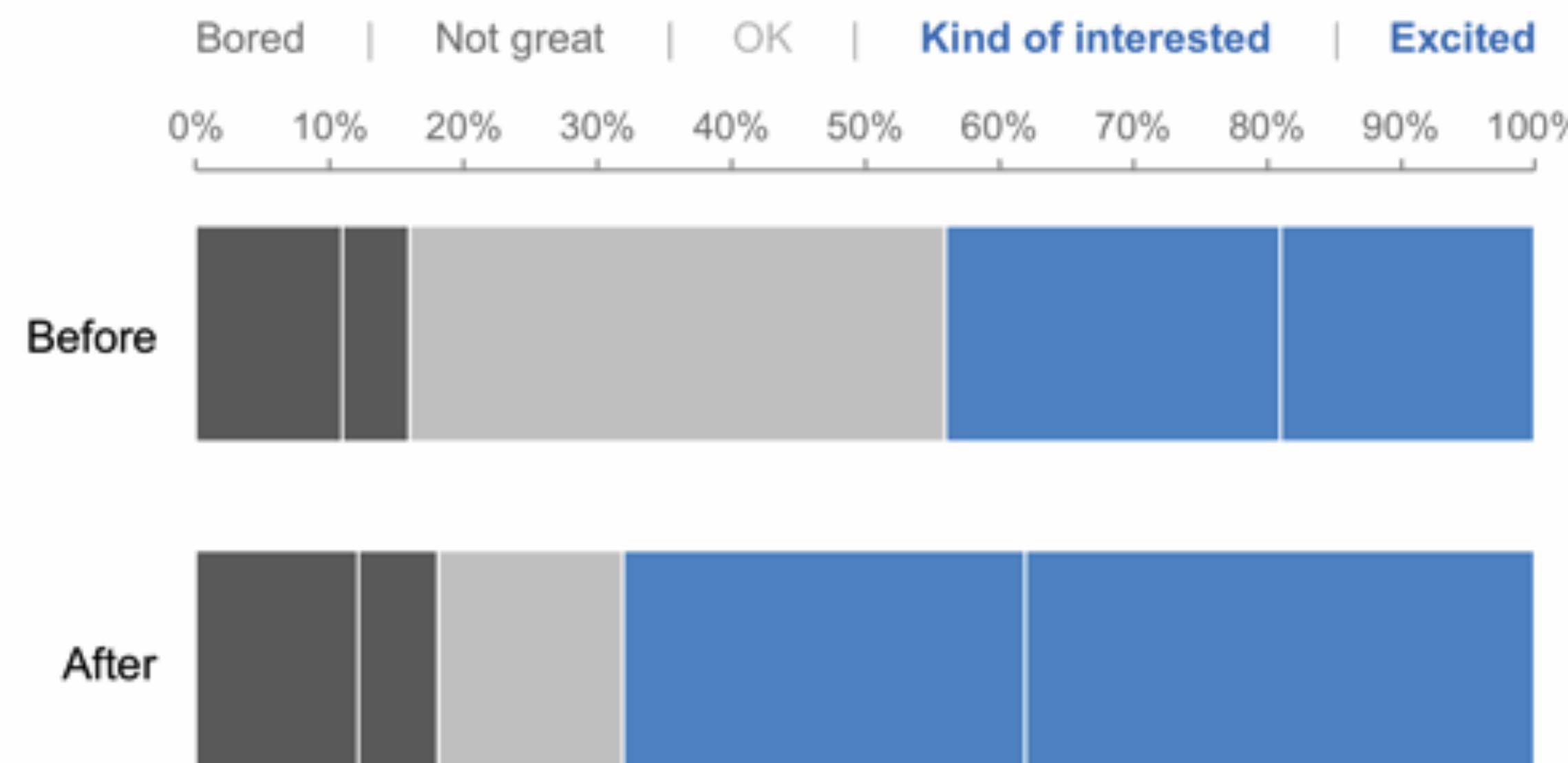
**BEFORE** program, the majority of children felt just OK about science



**AFTER** program,  
more  
children  
were *Kind of  
interested &  
Excited*  
about  
science.

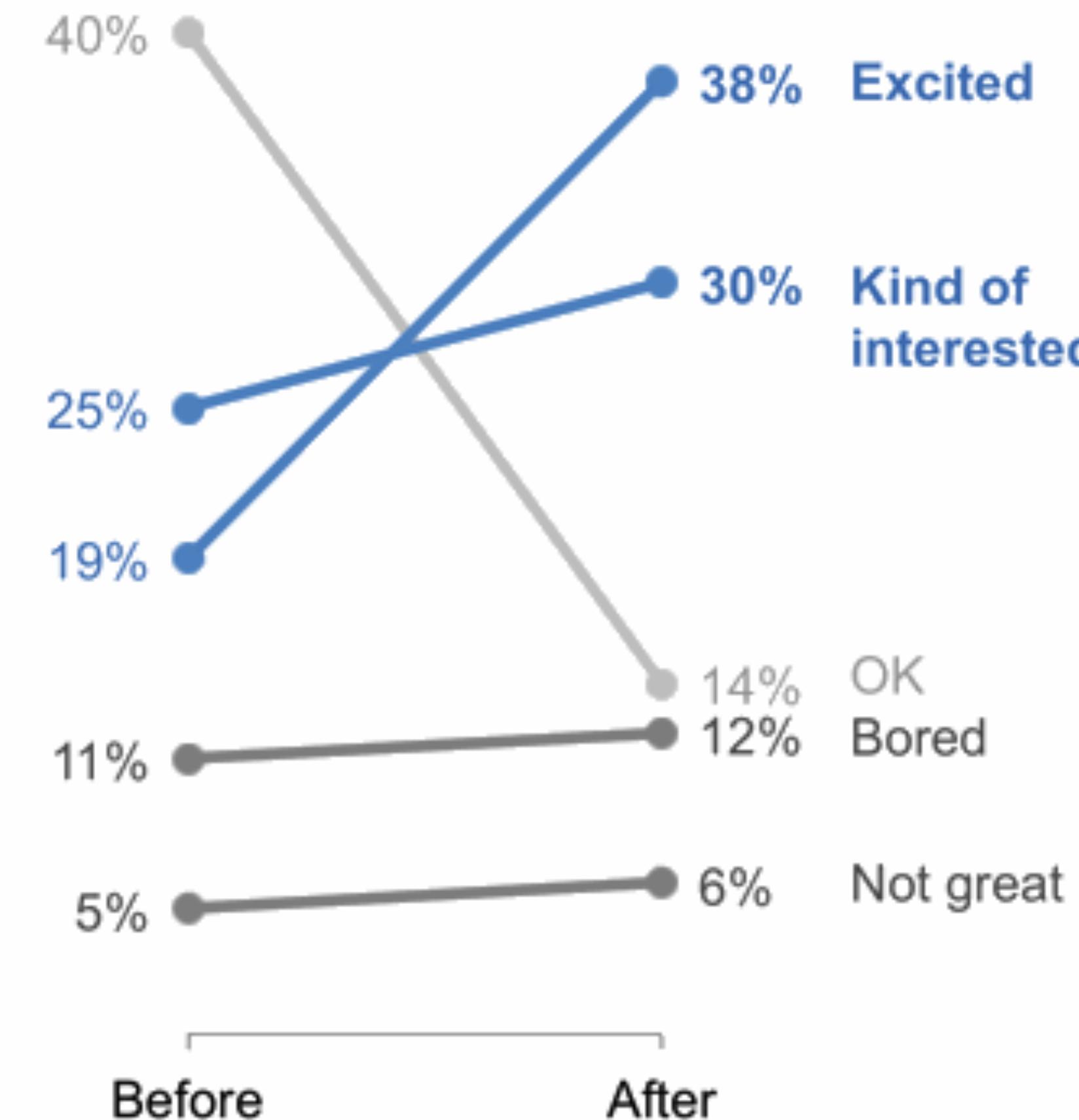
# Alternative #3: 100% Stacked Horizontal Bar Graph

How do you feel about science?



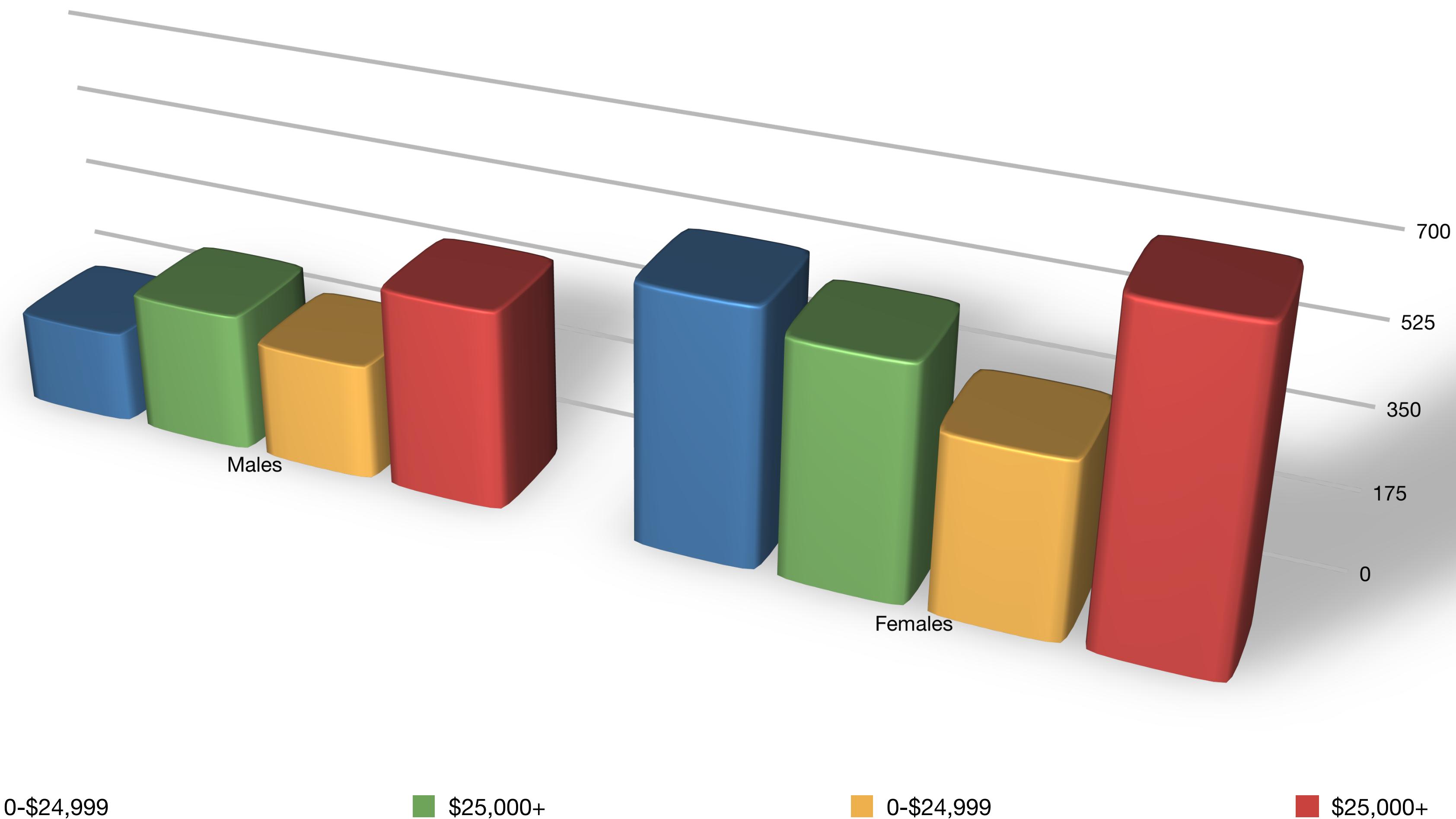
# Alternative #4: Slopegraph

How do you feel about science?

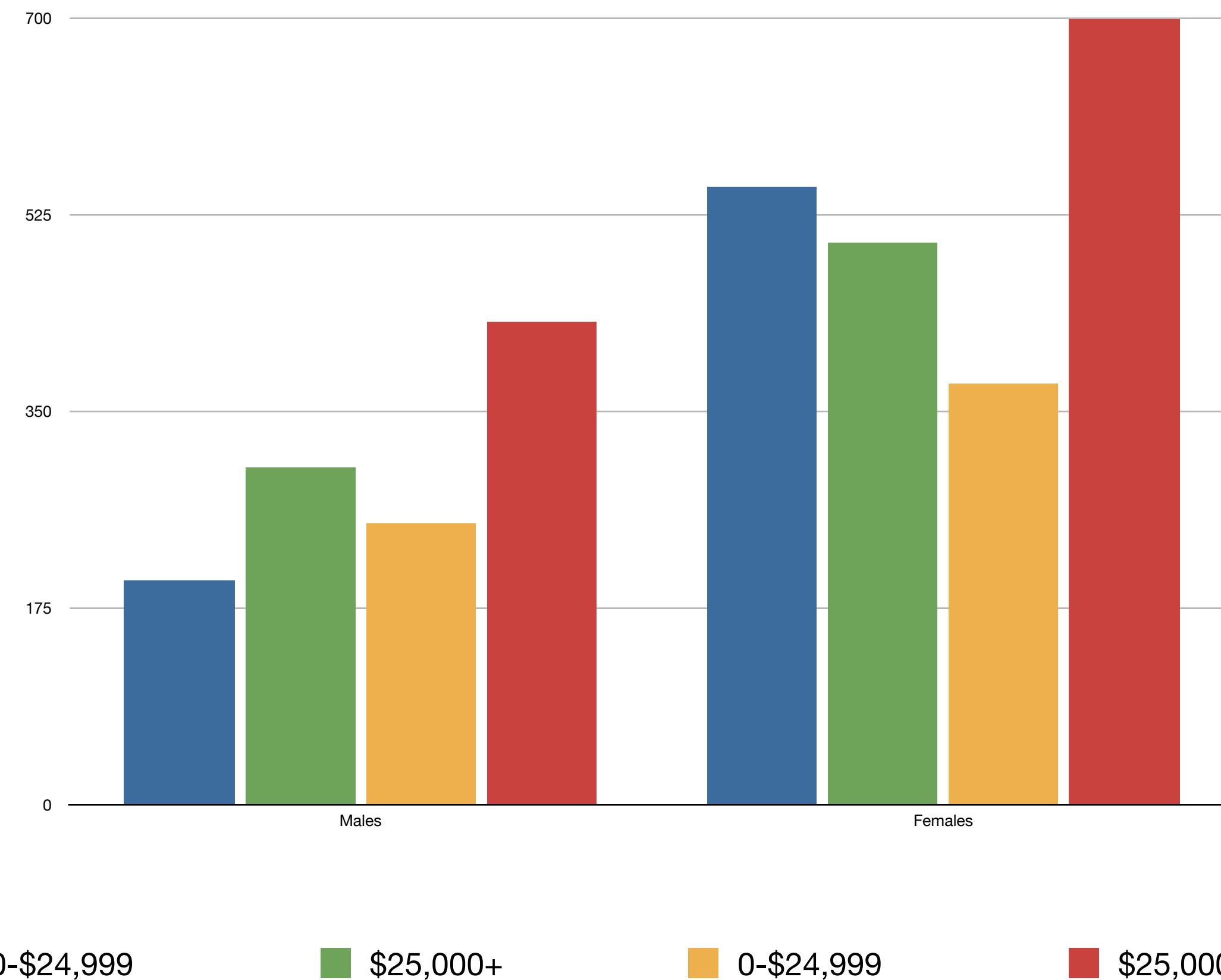


# Visualization Design Principles

# Maximize Data-Ink Ratio

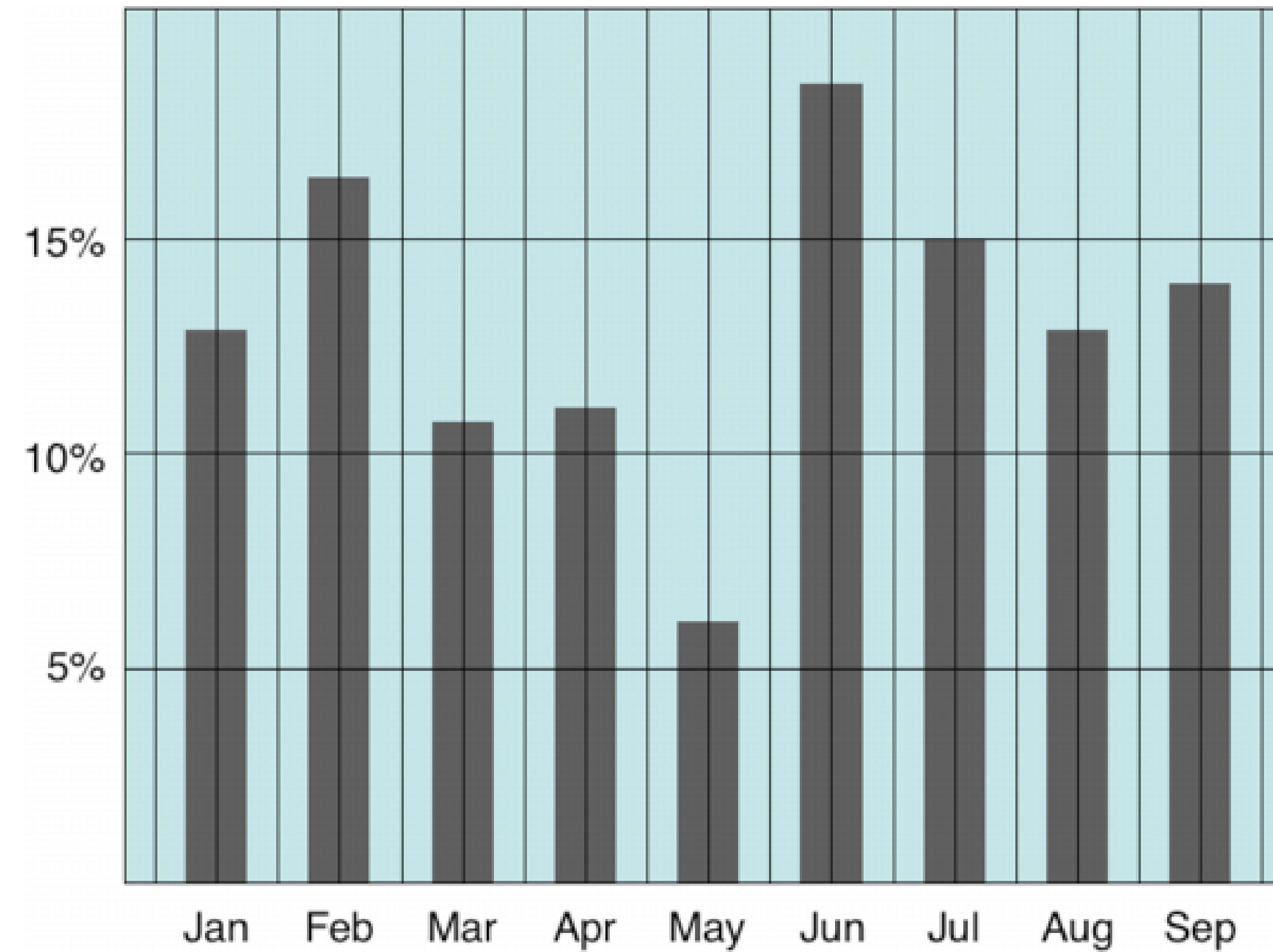


# Maximize Data-Ink Ratio

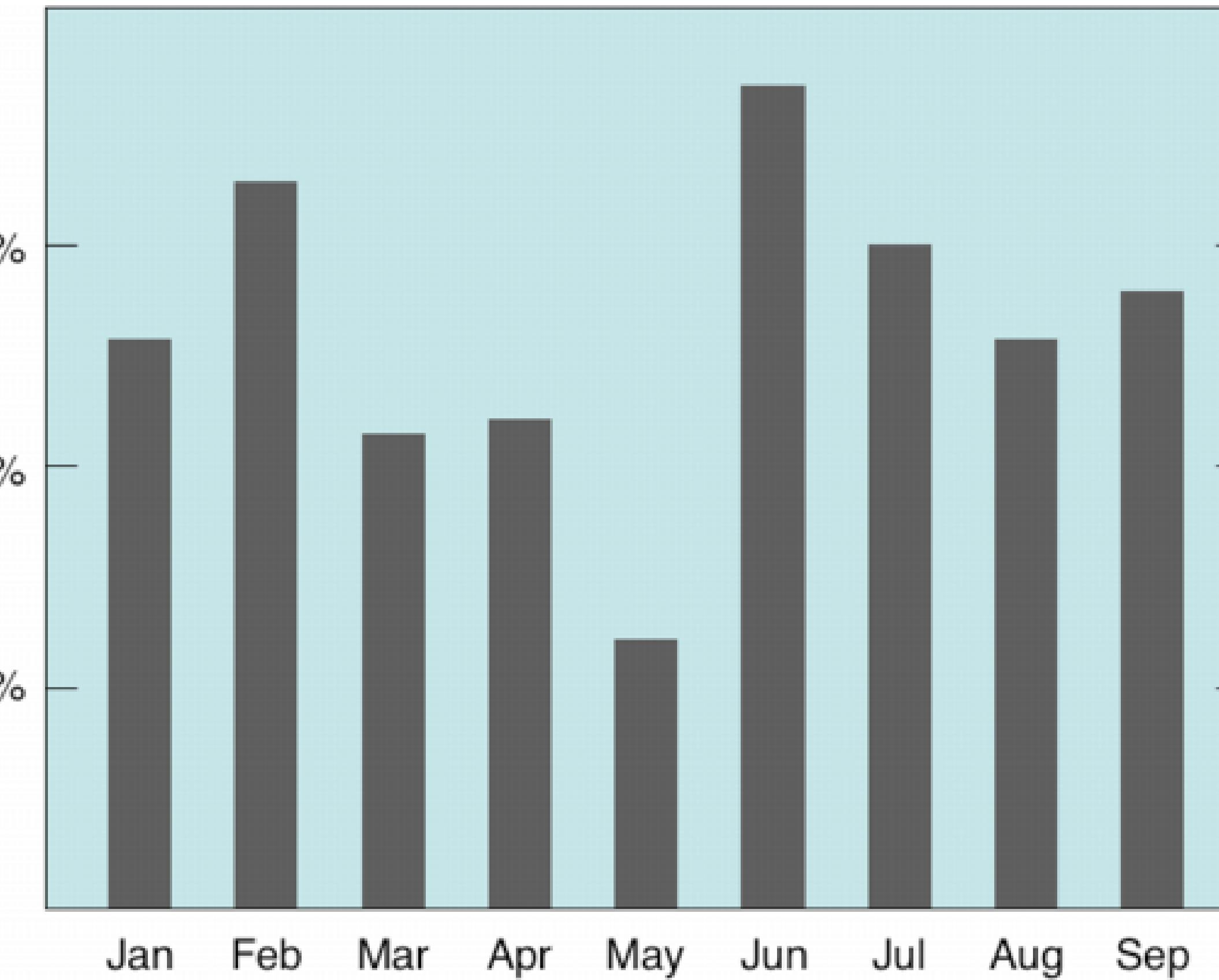


# Avoid Chartjunk

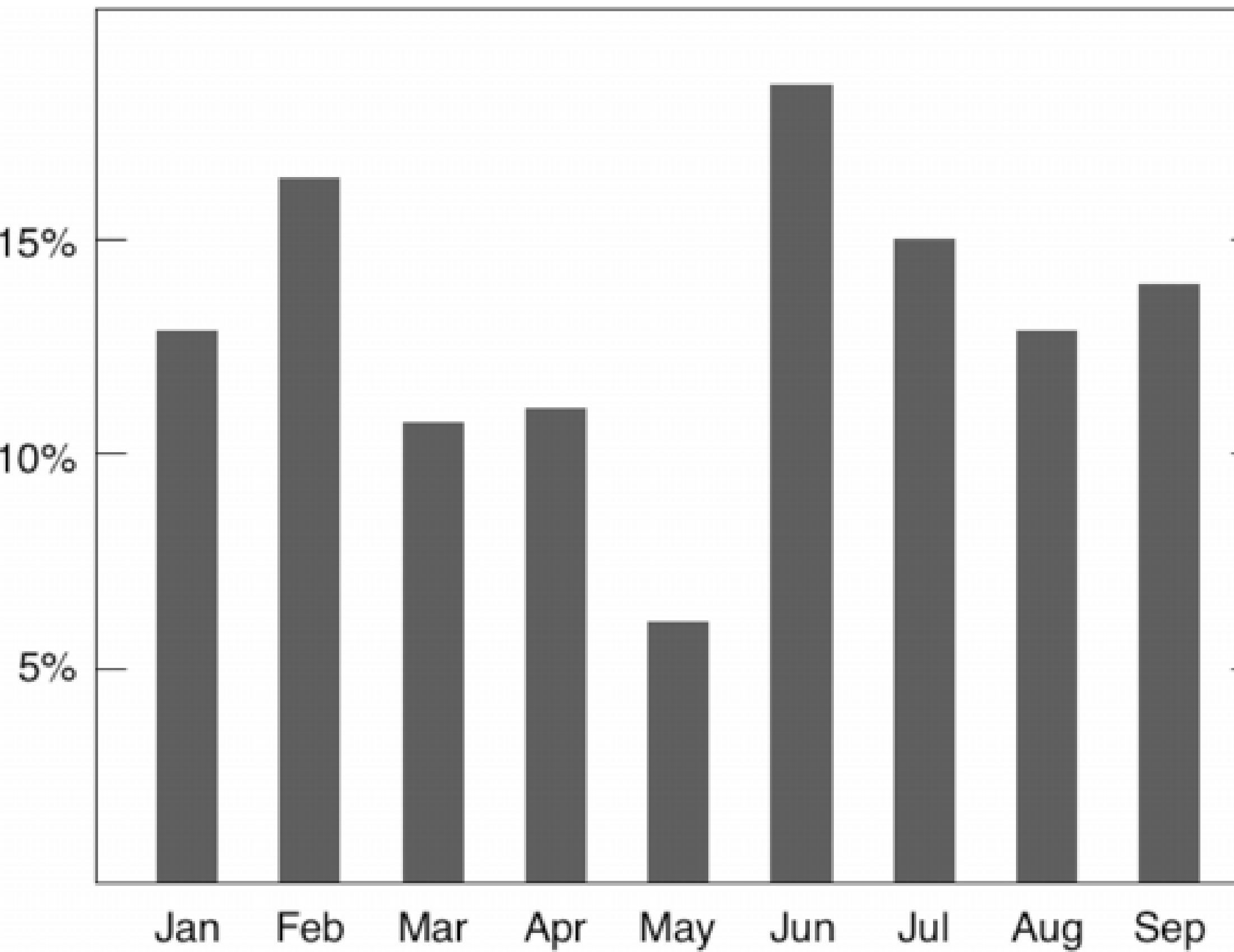
Extraneous visual elements that distract from the message



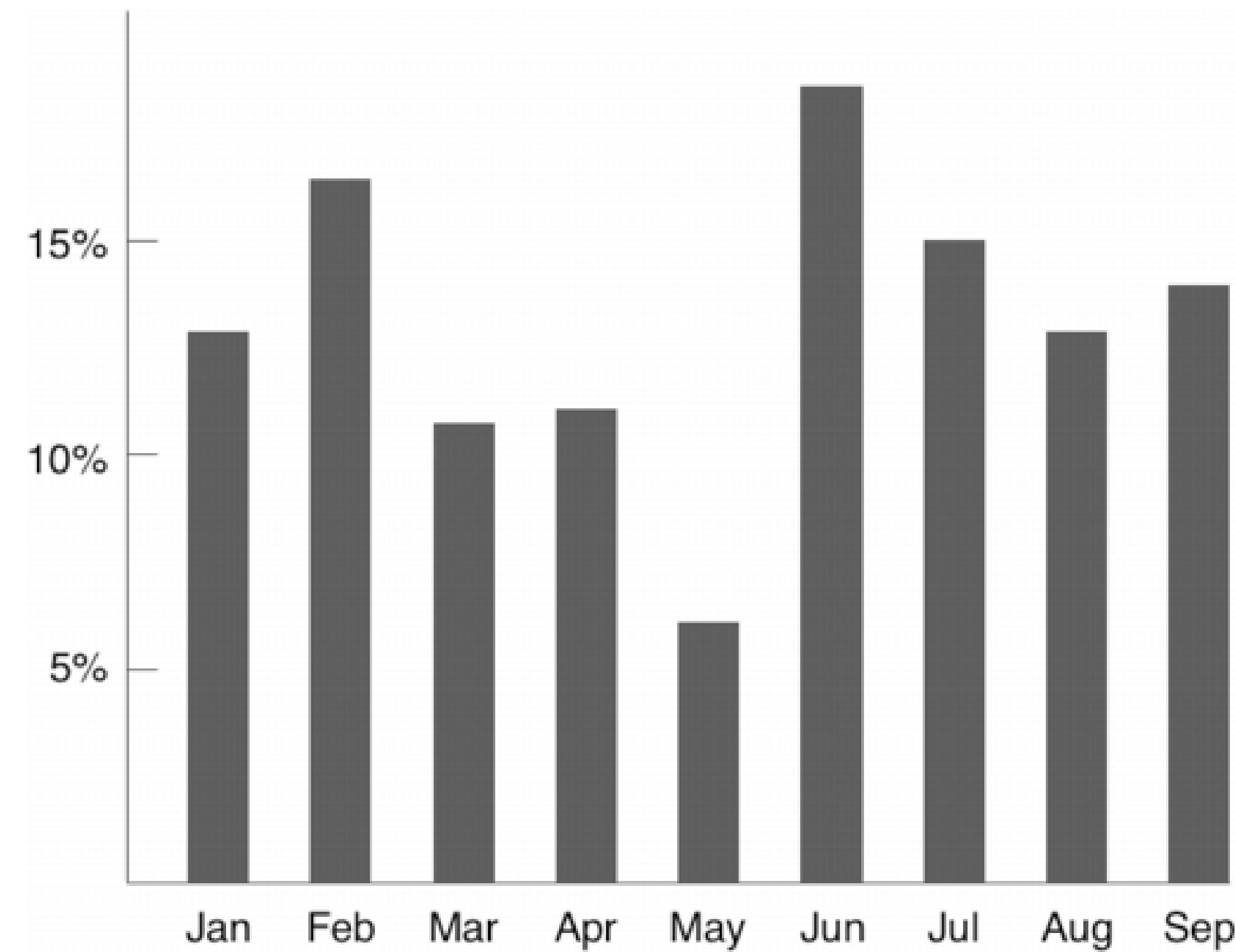
# Avoid Chartjunk



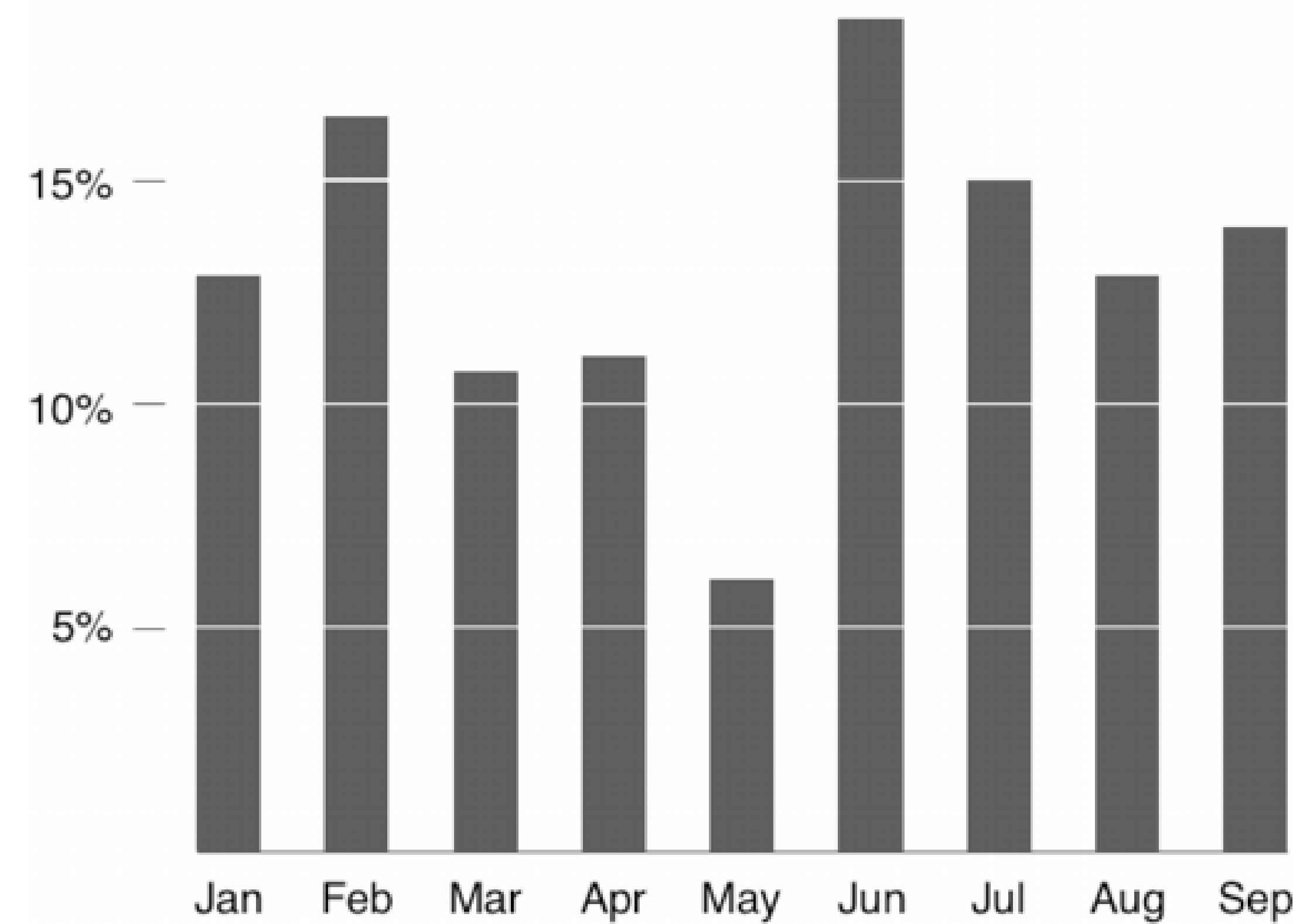
# Avoid Chartjunk



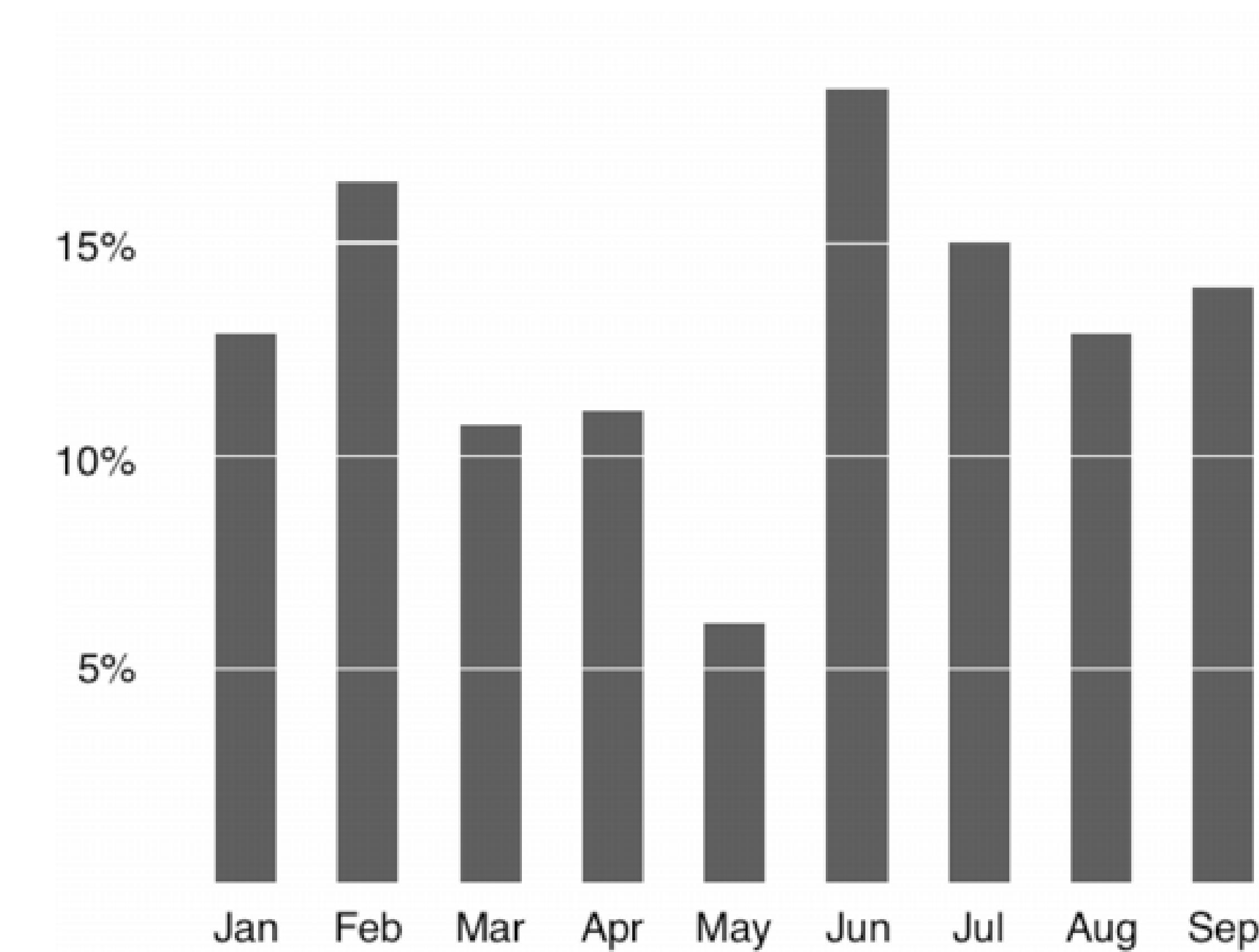
# Avoid Chartjunk



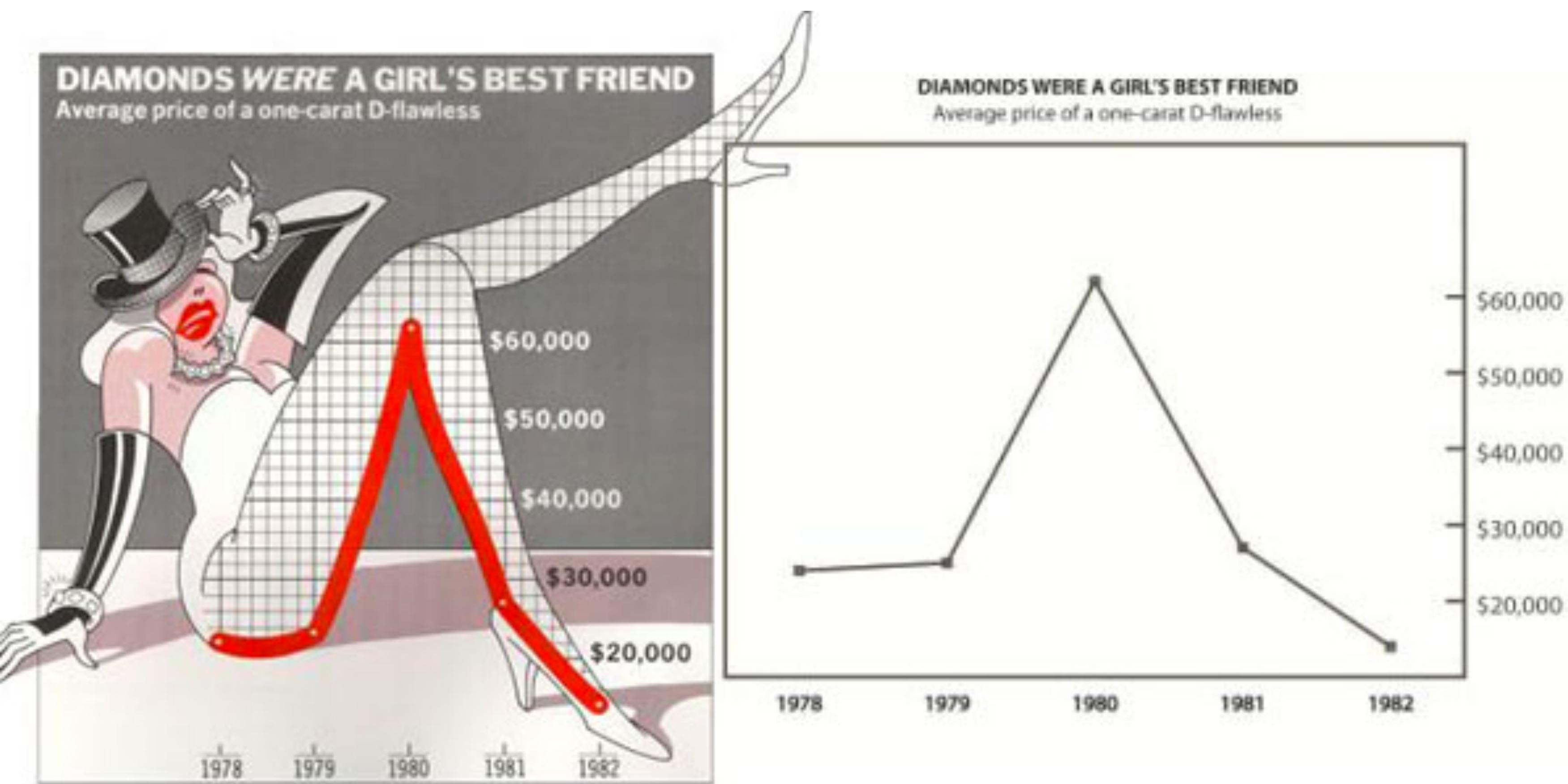
# Avoid Chartjunk



# Avoid Chartjunk

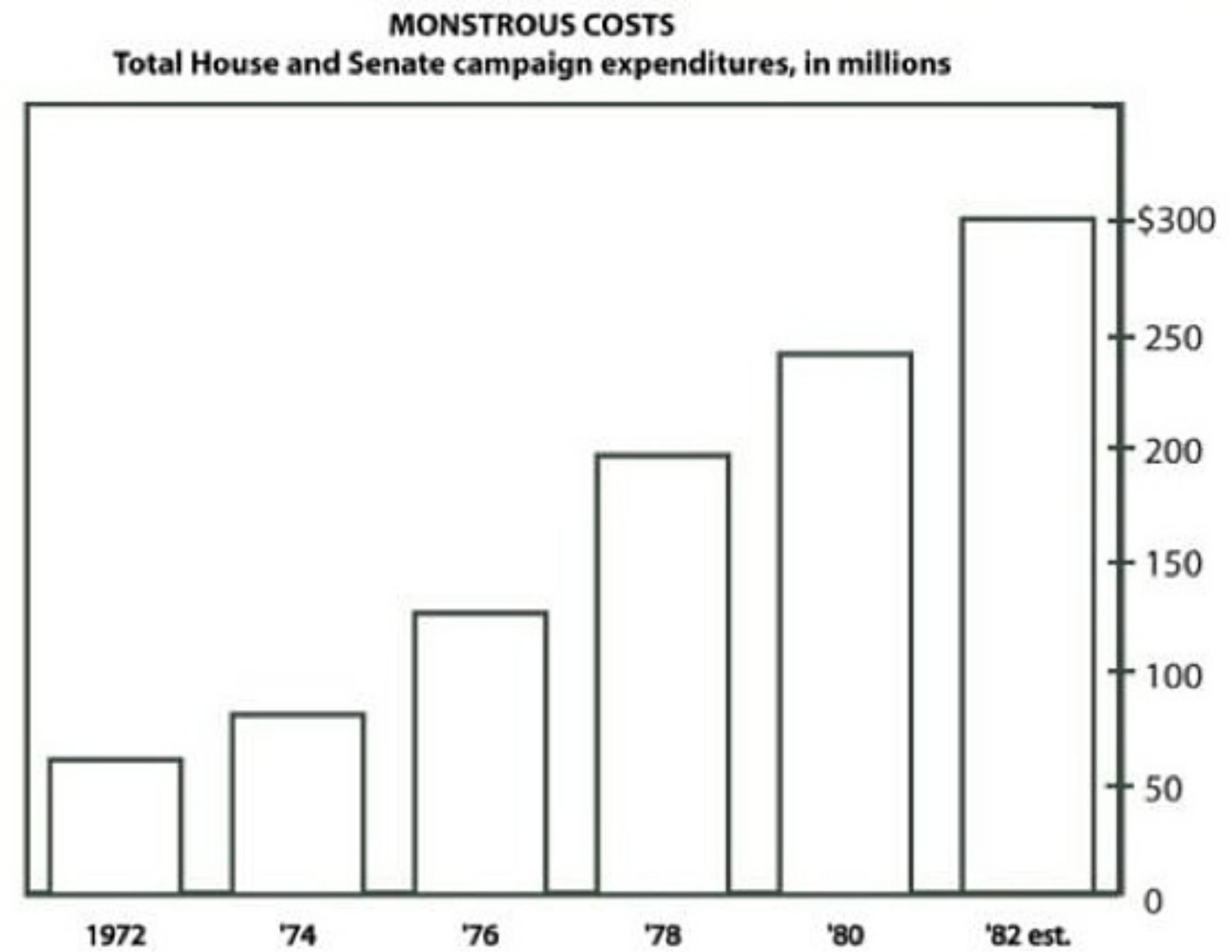


# Which is better?



[Bateman et al. 2010]

# Which is better?



# Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts

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Aaron Genest, David McDine, Christopher Brooks

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[aaron.genest@usask.ca](mailto:aaron.genest@usask.ca), [dam085@mail.usask.ca](mailto:dam085@mail.usask.ca), [cab938@mail.usask.ca](mailto:cab938@mail.usask.ca)

## ABSTRACT

Guidelines for designing information charts often state that the presentation should reduce ‘chart junk’ – visual embellishments that are not essential to understanding the data. In contrast, some popular chart designers wrap the presented data in detailed and elaborate imagery, raising the questions of whether this imagery is really as detrimental to understanding as has been proposed, and whether the visual embellishment may have other benefits. To investigate these issues, we conducted an experiment that compared embellished charts with plain ones, and measured both interpretation accuracy and long-term recall. We found that people’s accuracy in describing the embellished charts was no worse than for plain charts, and that their recall after a two-to-three-week gap was significantly better. Although we are cautious about recommending that all charts be produced in this style, our results question some of the premises of the minimalist approach to chart design.

## Author Keywords

Charts, information visualization, imagery, memorability.

## ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI):  
Miscellaneous.

## General Terms

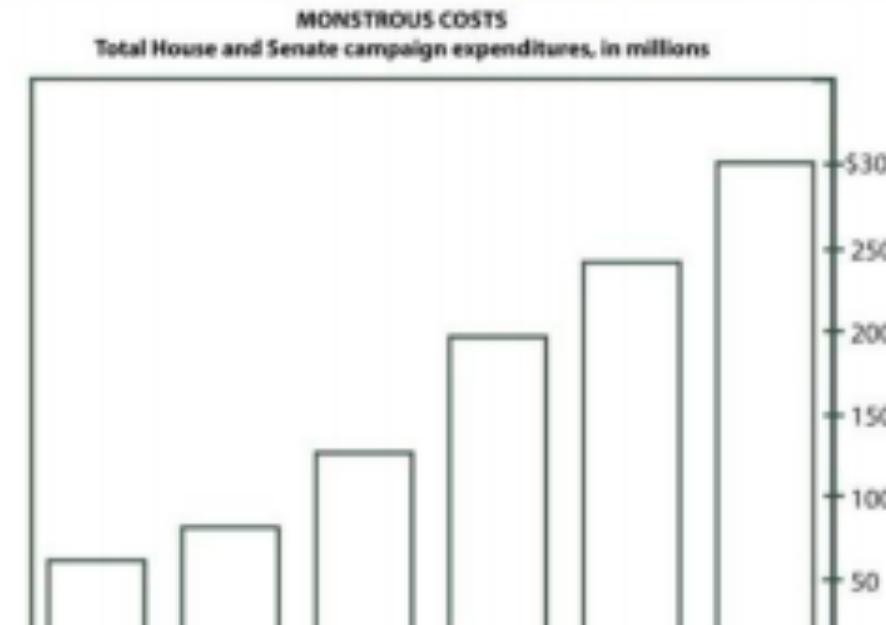
Design, Human Factors

## INTRODUCTION

Many experts in the area of chart design, such as Edward Tufte, criticize the inclusion of visual embellishment in charts and graphs; their guidelines for good chart design often suggest that the addition of *chart junk*, decorations and other kinds of non-essential imagery, to a chart can make interpretation more difficult and can distract readers from the data [22]. This *minimalist* perspective advocates

*data-ink* – or the ink in the chart used to represent data.

Despite these minimalist guidelines, many designers include a wide variety of visual embellishments in their charts, from small decorations to large images and visual backgrounds. One well-known proponent of visual embellishment in charts is the graphic artist Nigel Holmes, whose work regularly incorporates strong visual imagery into the fabric of the chart [7] (e.g., Figure 1).



# EXPERIMENTAL RESULTS

1. No difference for **interpretation accuracy**
2. No difference in **recall accuracy after a five-minute gap**
3. Significantly **better recall for Holmes charts** of both the chart topic and the details (categories and trend) **after long-term gap (2-3 weeks)**.
4. Participants **saw value messages** in the Holmes charts significantly more often than in the plain charts.
5. Participants found the Holmes charts **more attractive, most enjoyed them, and found that they were easiest and fastest to remember.**

# Use Chart Junk? It depends!

## PROS

persuasion

memorability

engagement

## CONS

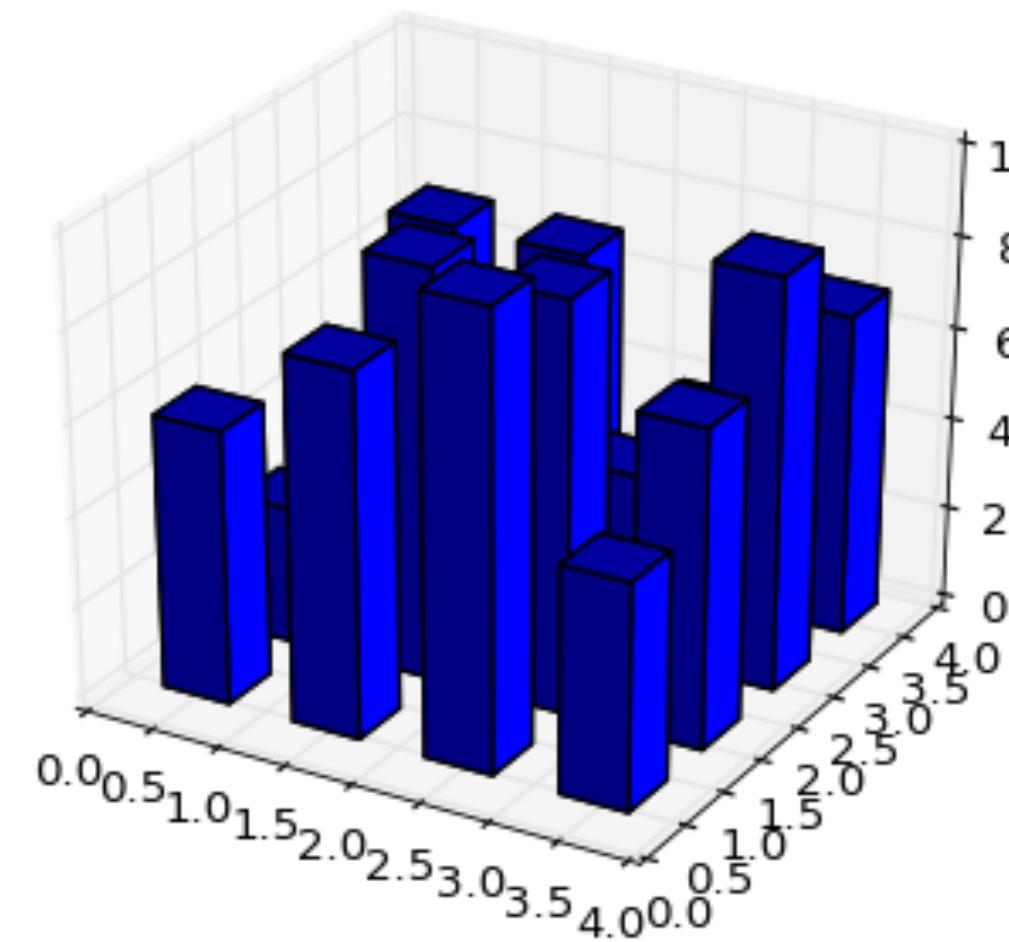
unbiased analysis

trustworthiness

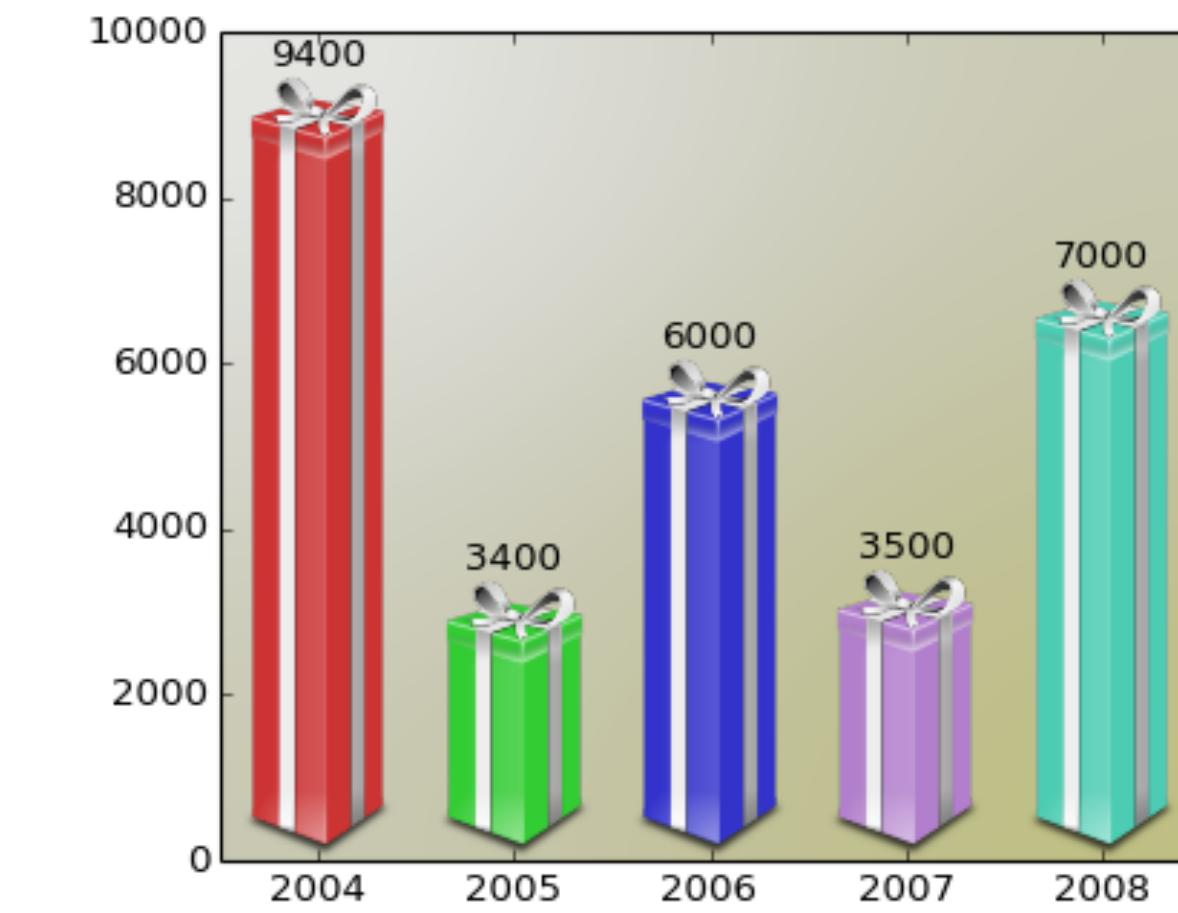
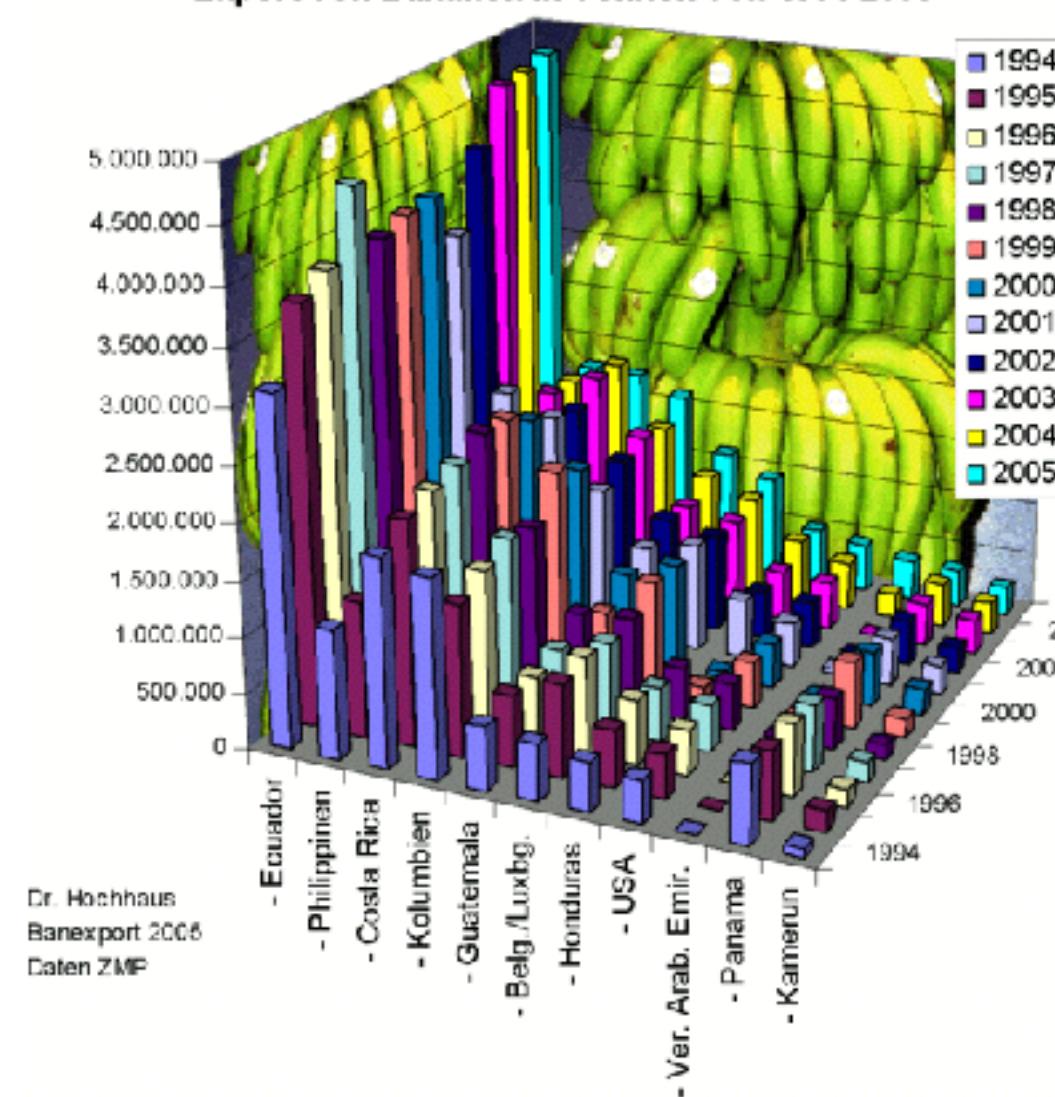
interpretability

space efficiency

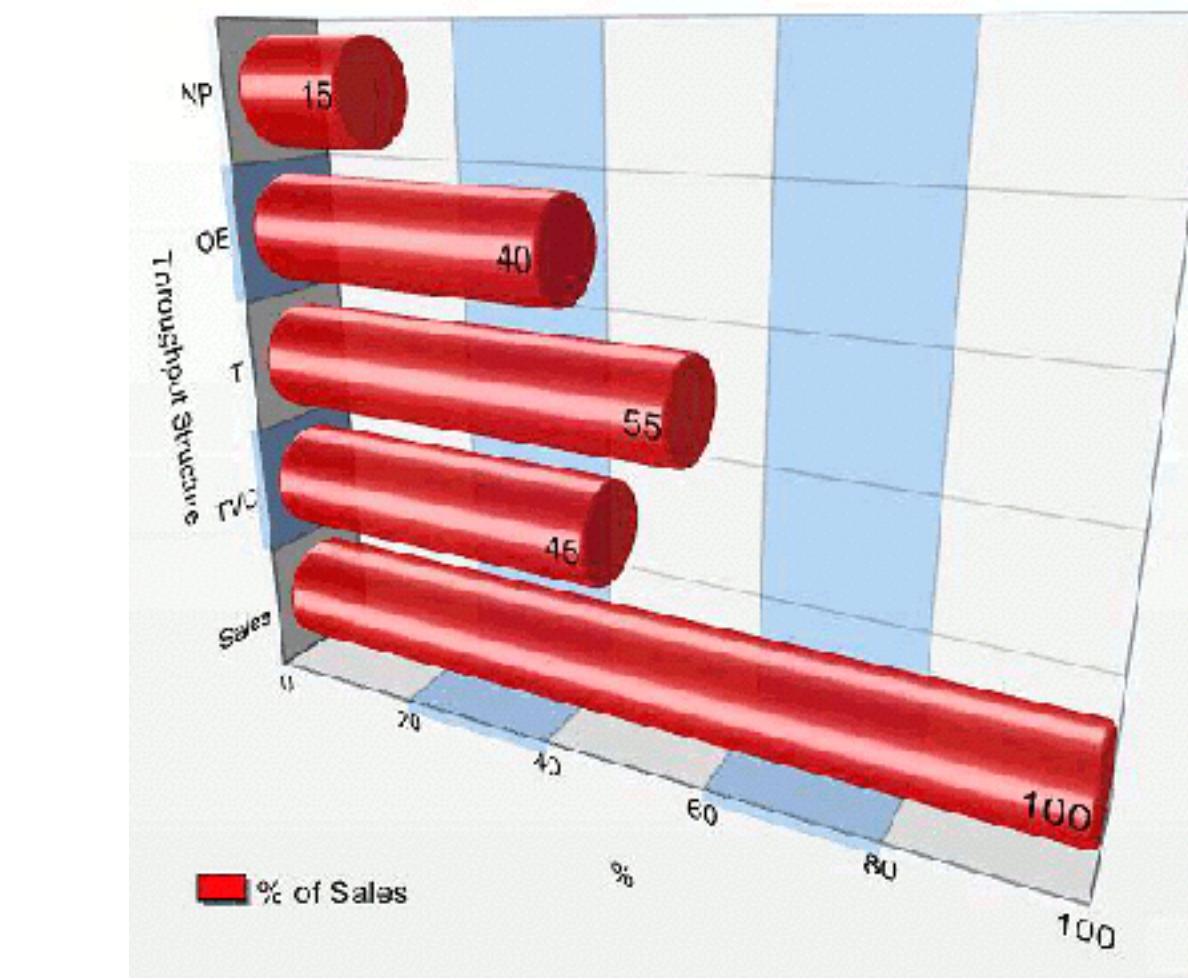
# Don't



Export von Bananen in Tonnen von 1994-2005



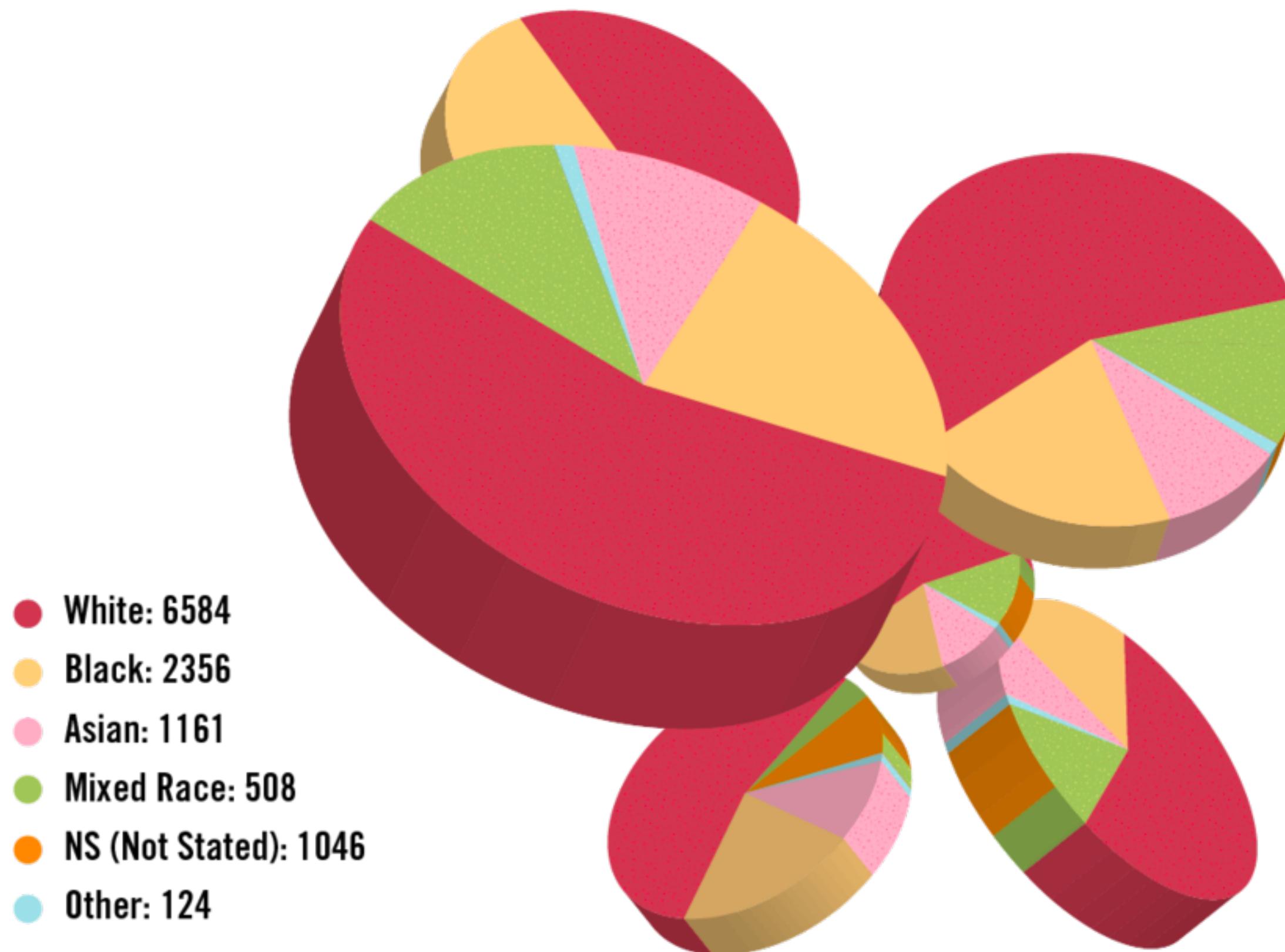
matplotlib gallery



Excel Charts Blog

# Don't

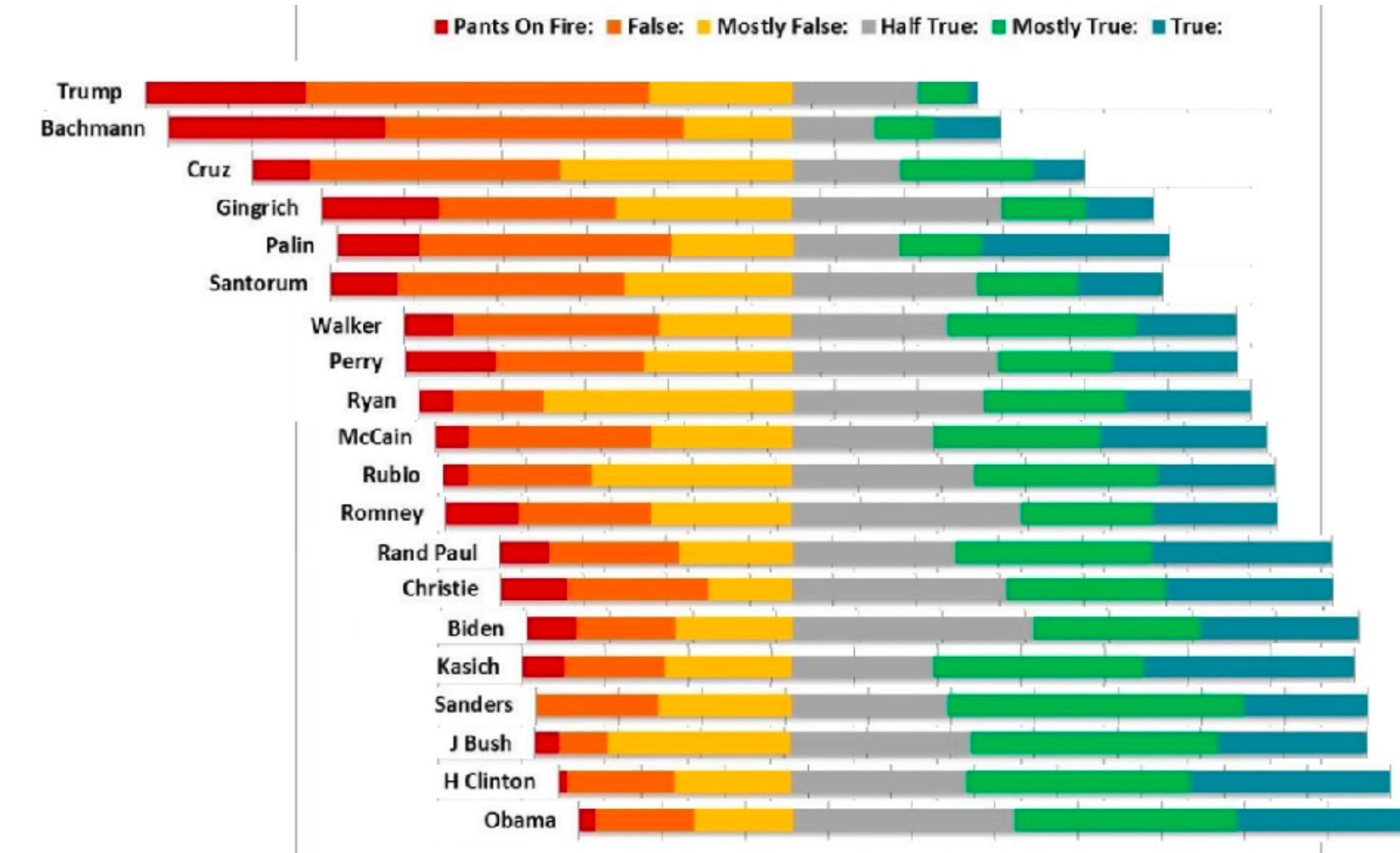
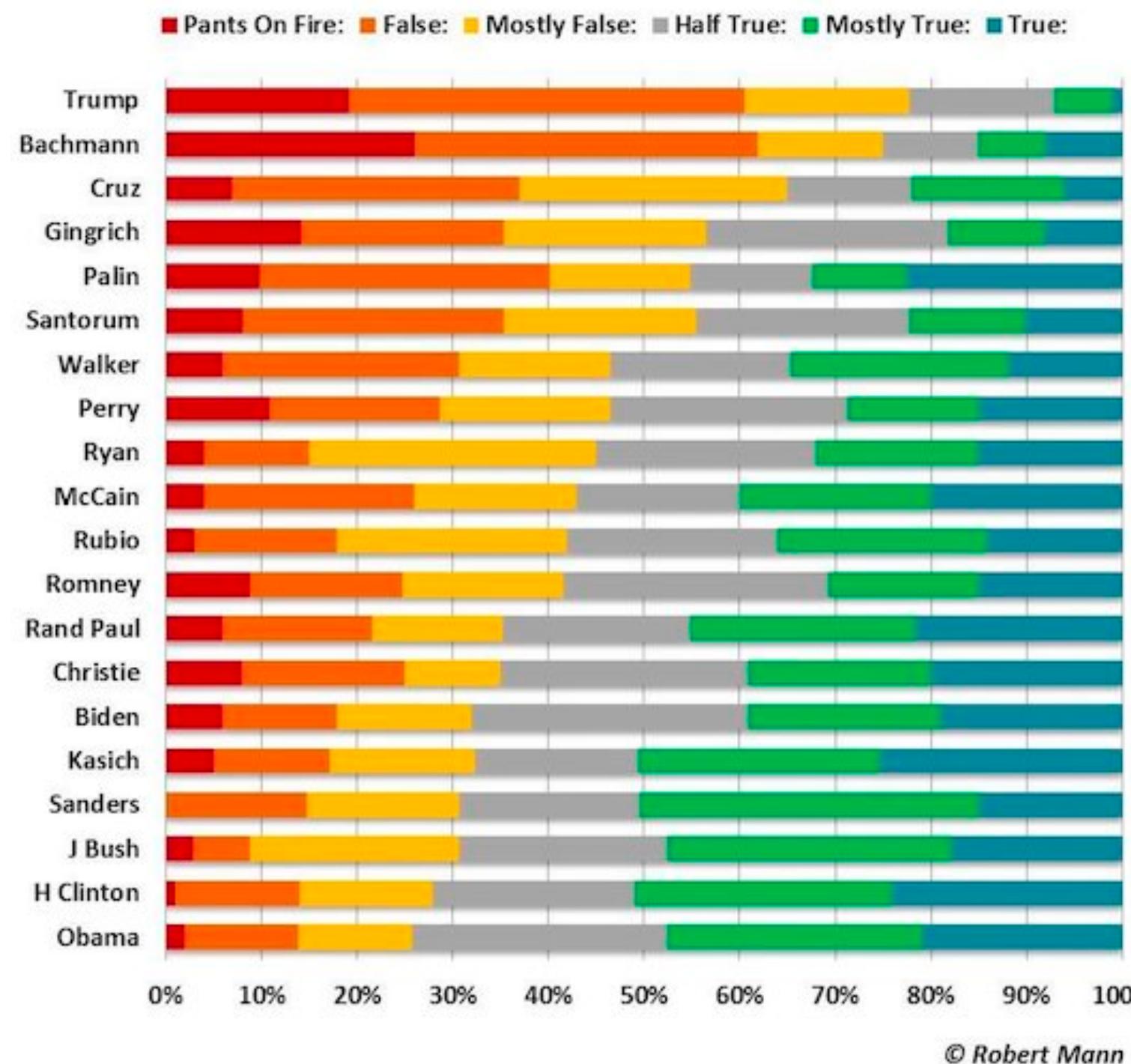
Convictions in England and Wales for class A drug supply.



# Alignment Matters

## Who Lies More: A Comparison

PolitiFact, an independent fact-checking website, has graded more than 50 statements since 2007 from each of these candidates. Here is how they rank.



# No Unjustified 3D

Depth judgment is bad

$$N = 0.67 \text{ Sensation} = \text{Intensity}^N$$

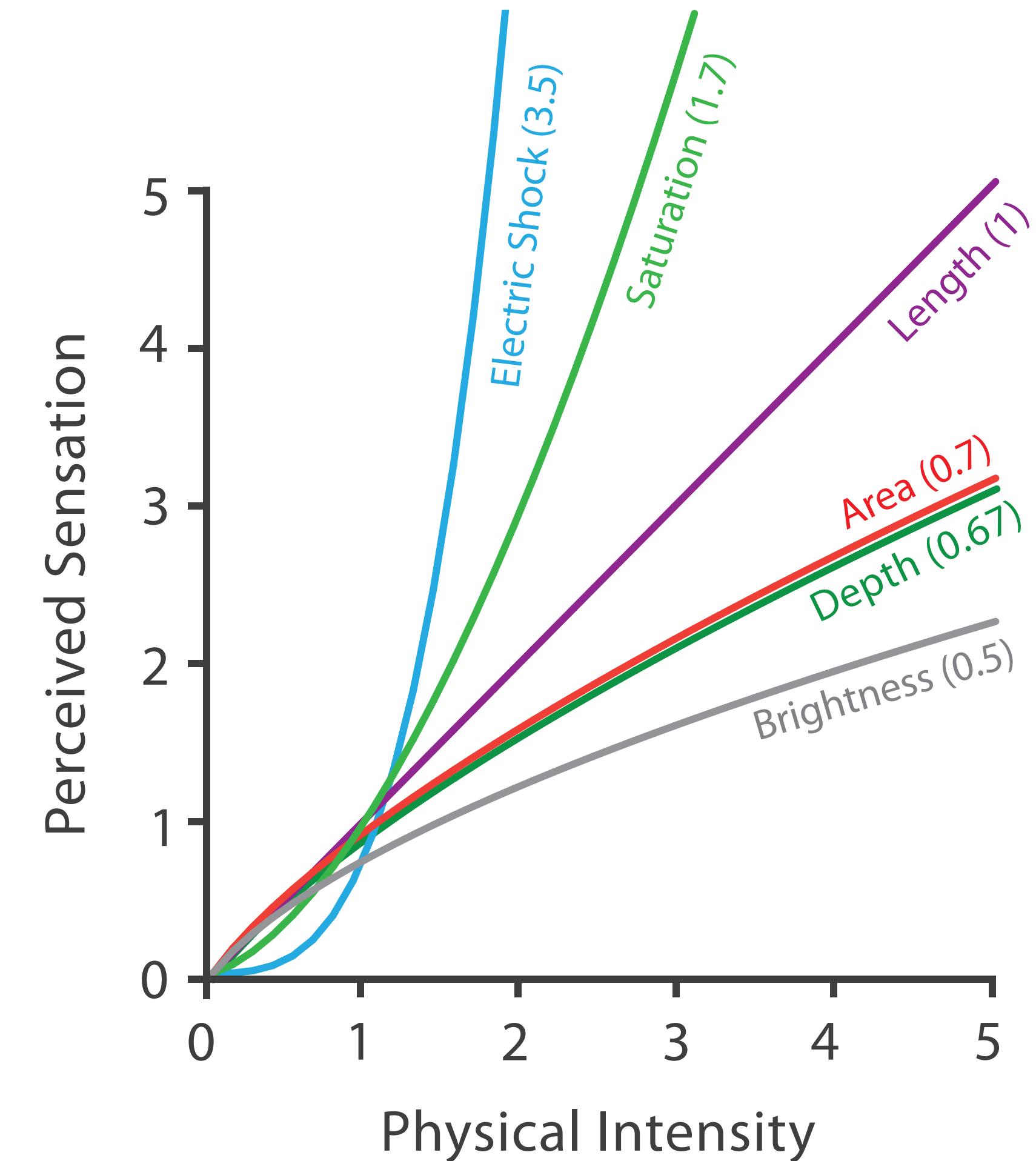
Occlusion

Perspective Distortion

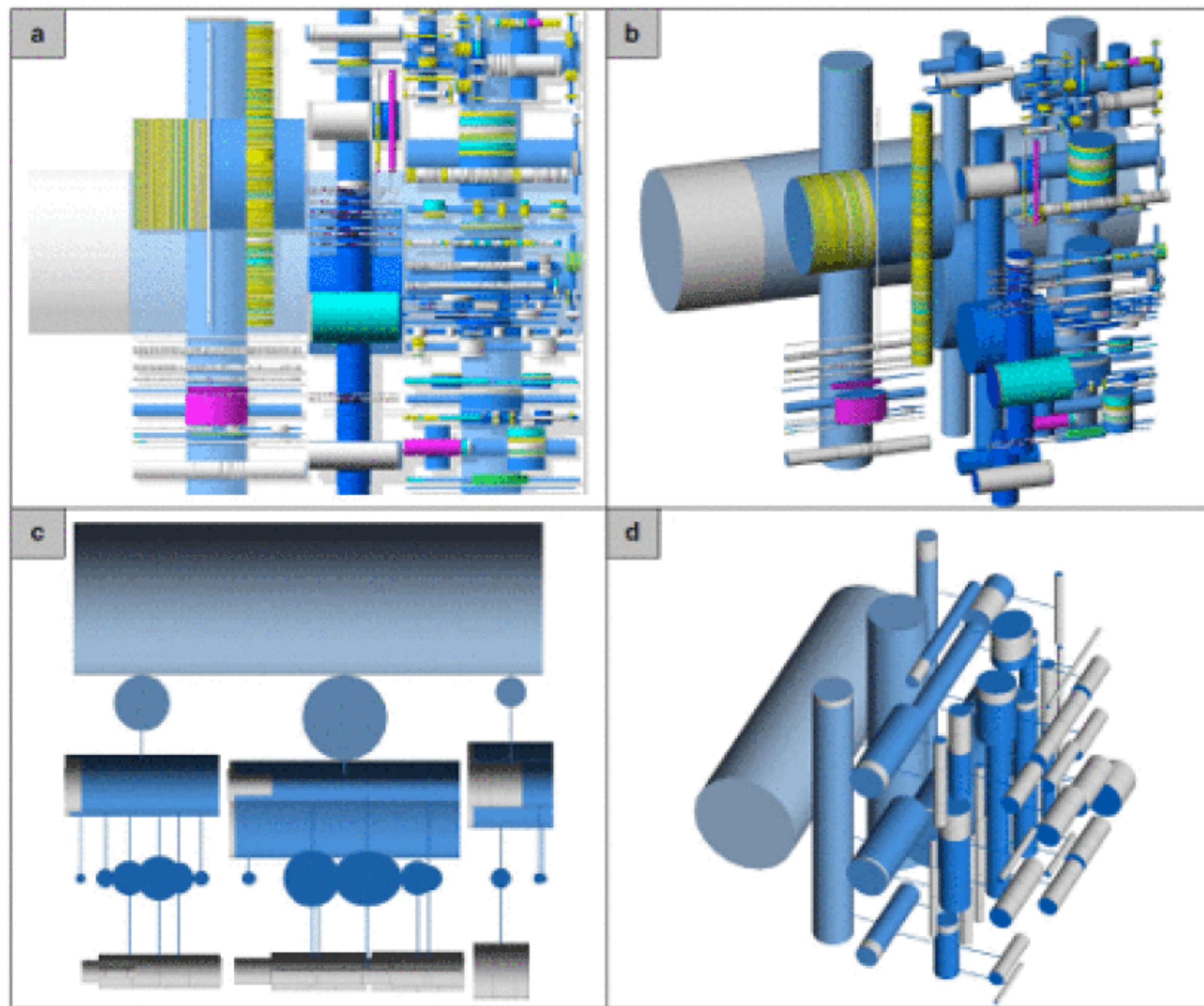
Color: Lighting / Shadows /  
Shading

Tilted Text illegible

Steven's Psychophysical Power Law:  $S = I^N$



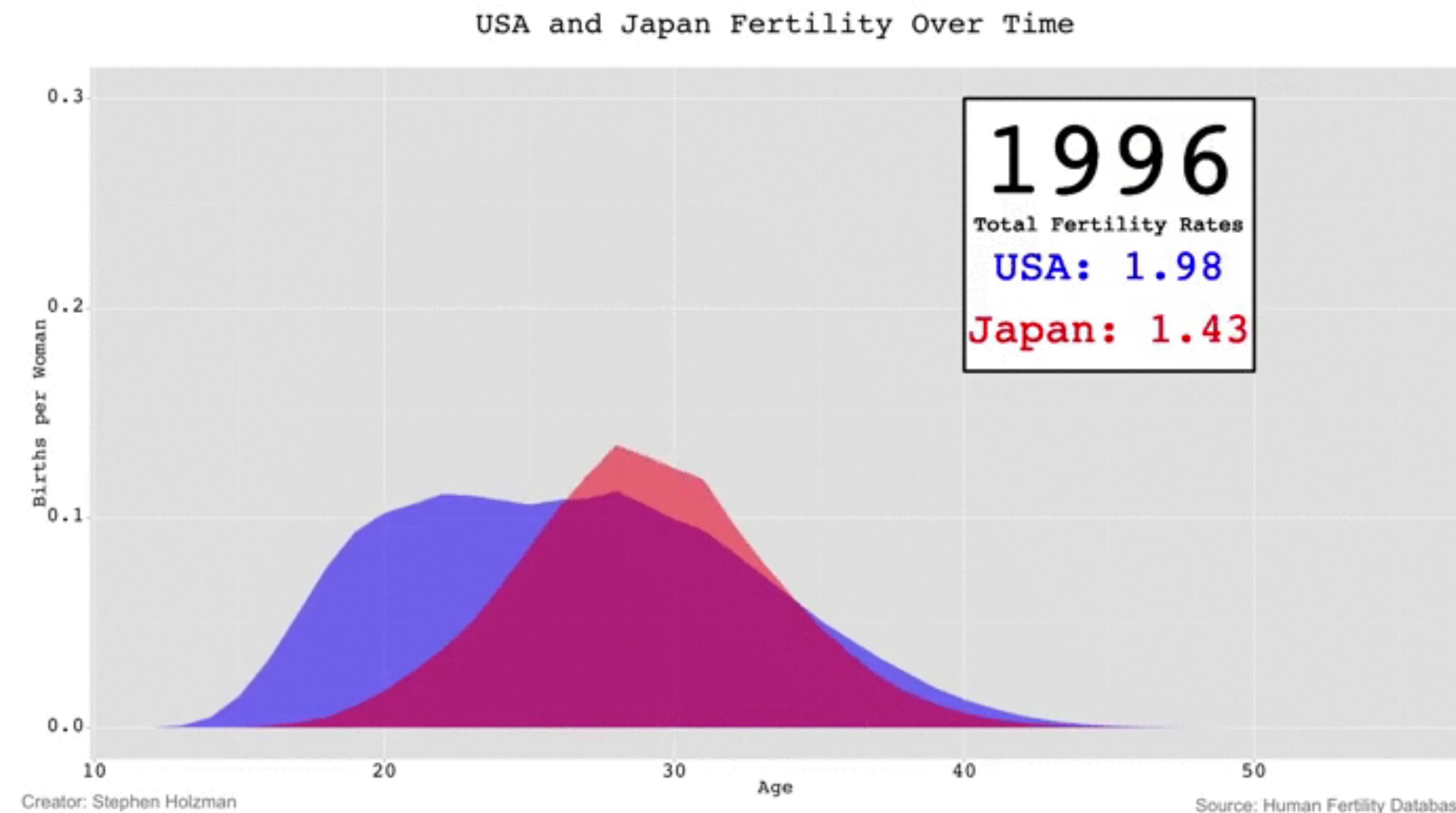
# Example: Hierarchy Visualization



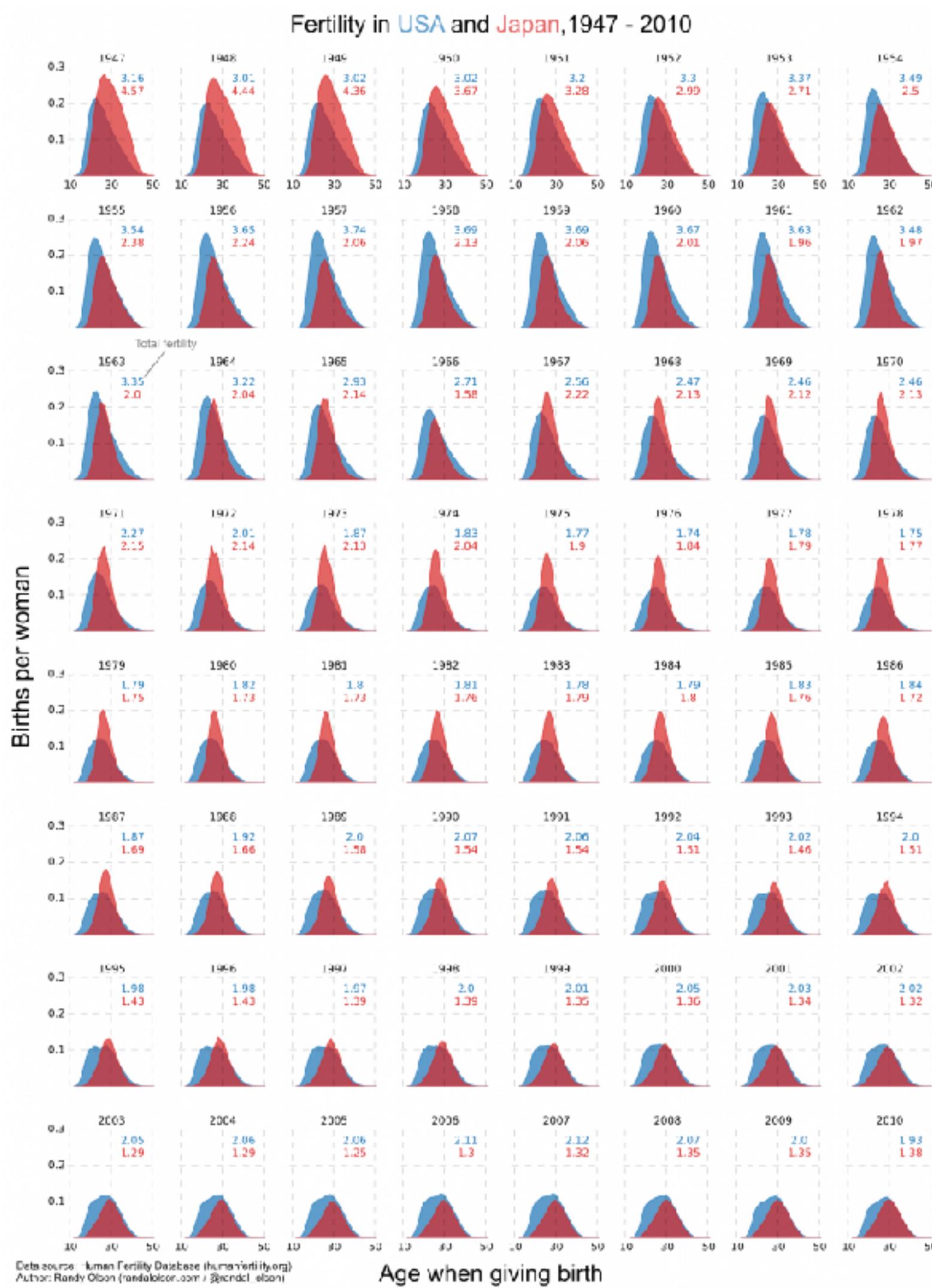
[F. van Ham ; J.J. van Wijk, 2002]

# Eyes Beat Memory

Don't make people memorize: Show them

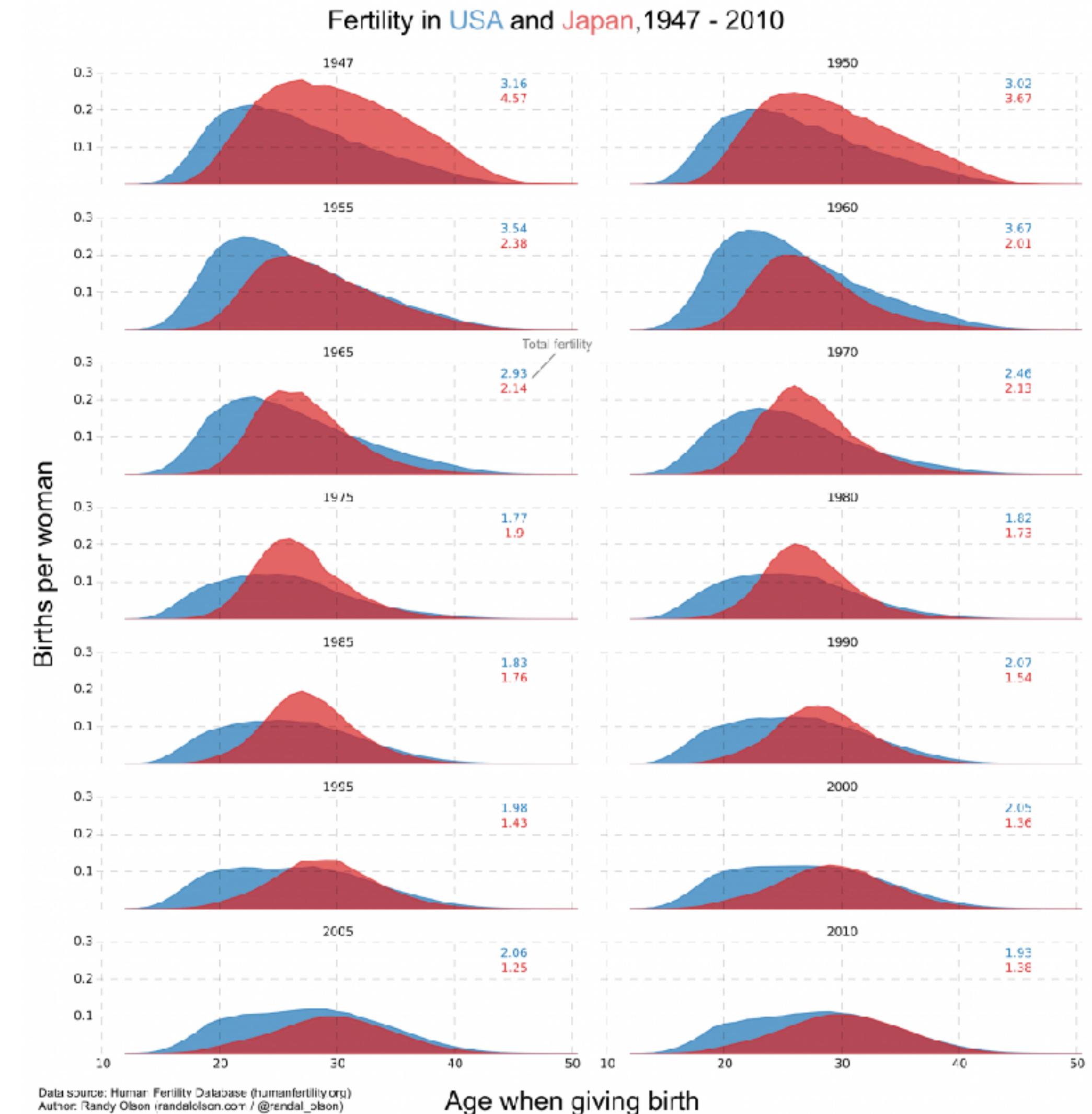


# Eyes Beat Memory: Small Multiples



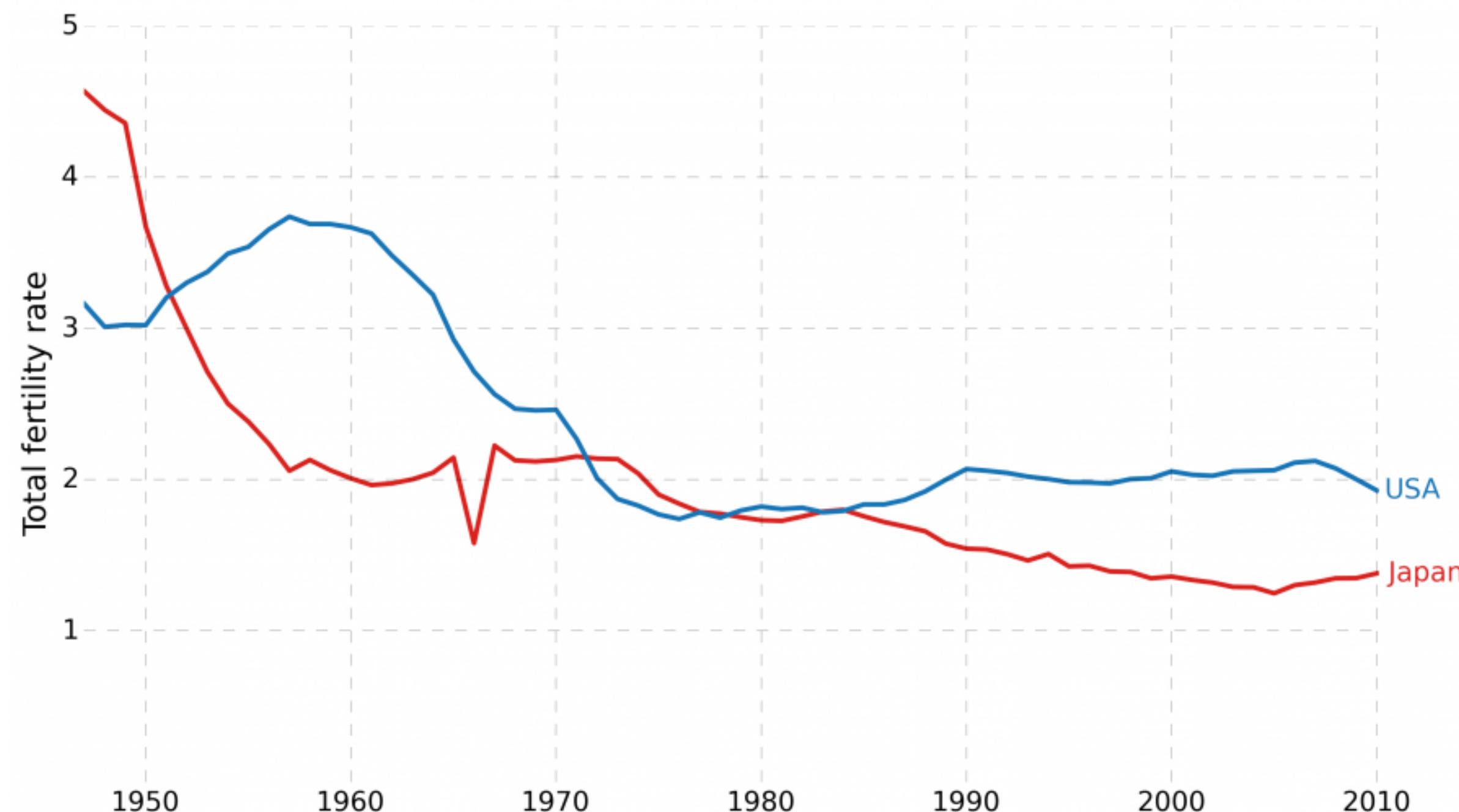
A lot of charts  
Do we need all of them?

# Eyes Beat Memory: Small Multiples



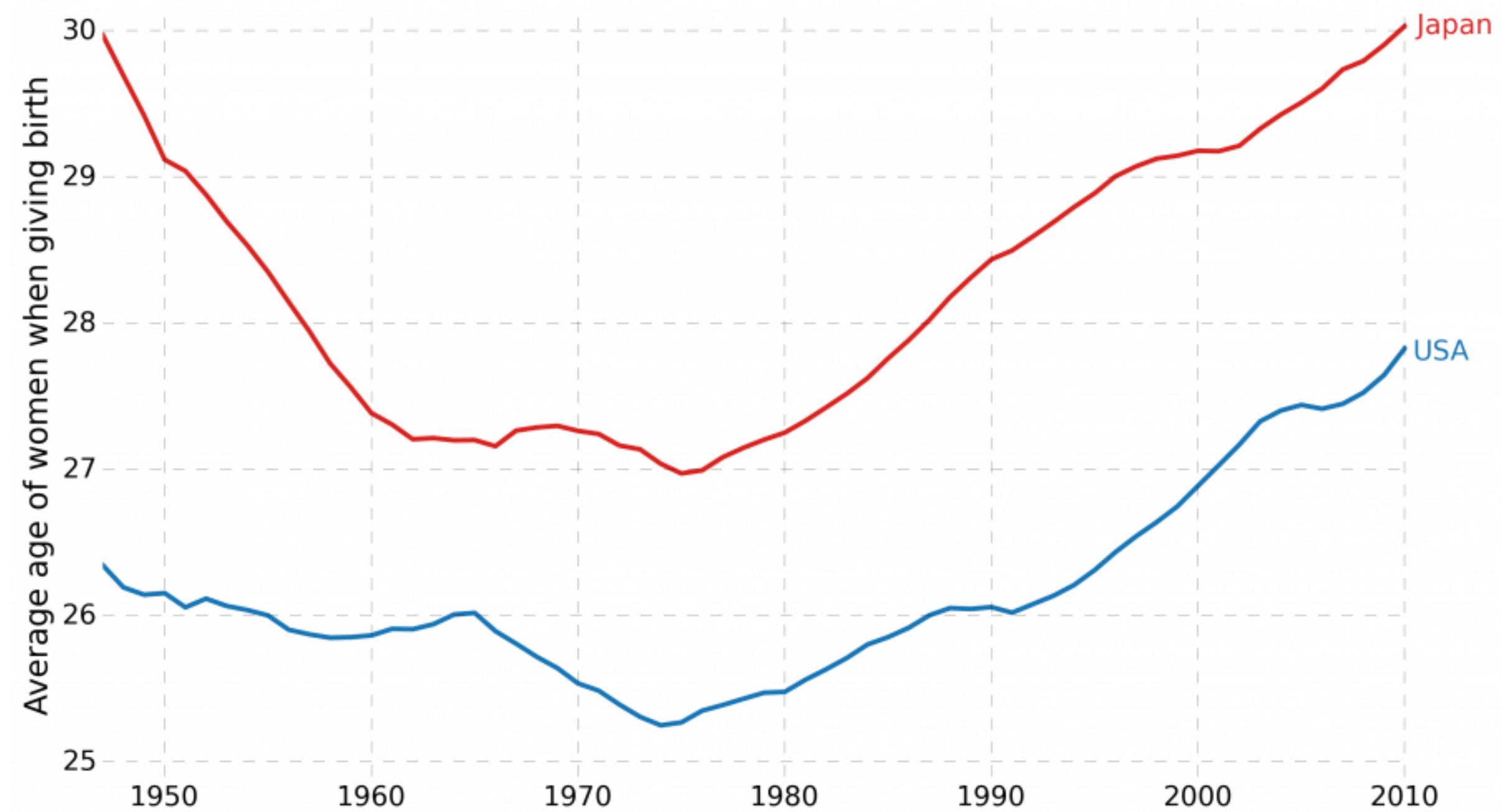
# Simplify!

Total fertility rate in USA and Japan, 1947 - 2010



Data source: Human Fertility Database ([humanfertility.org](http://humanfertility.org))  
Author: Randy Olson ([randalolson.com](http://randalolson.com) / [@randal\\_olson](https://twitter.com/randal_olson))

Average age when giving birth in USA and Japan, 1947 - 2010



Data source: Human Fertility Database ([humanfertility.org](http://humanfertility.org))  
Author: Randy Olson ([randalolson.com](http://randalolson.com) / [@randal\\_olson](https://twitter.com/randal_olson))

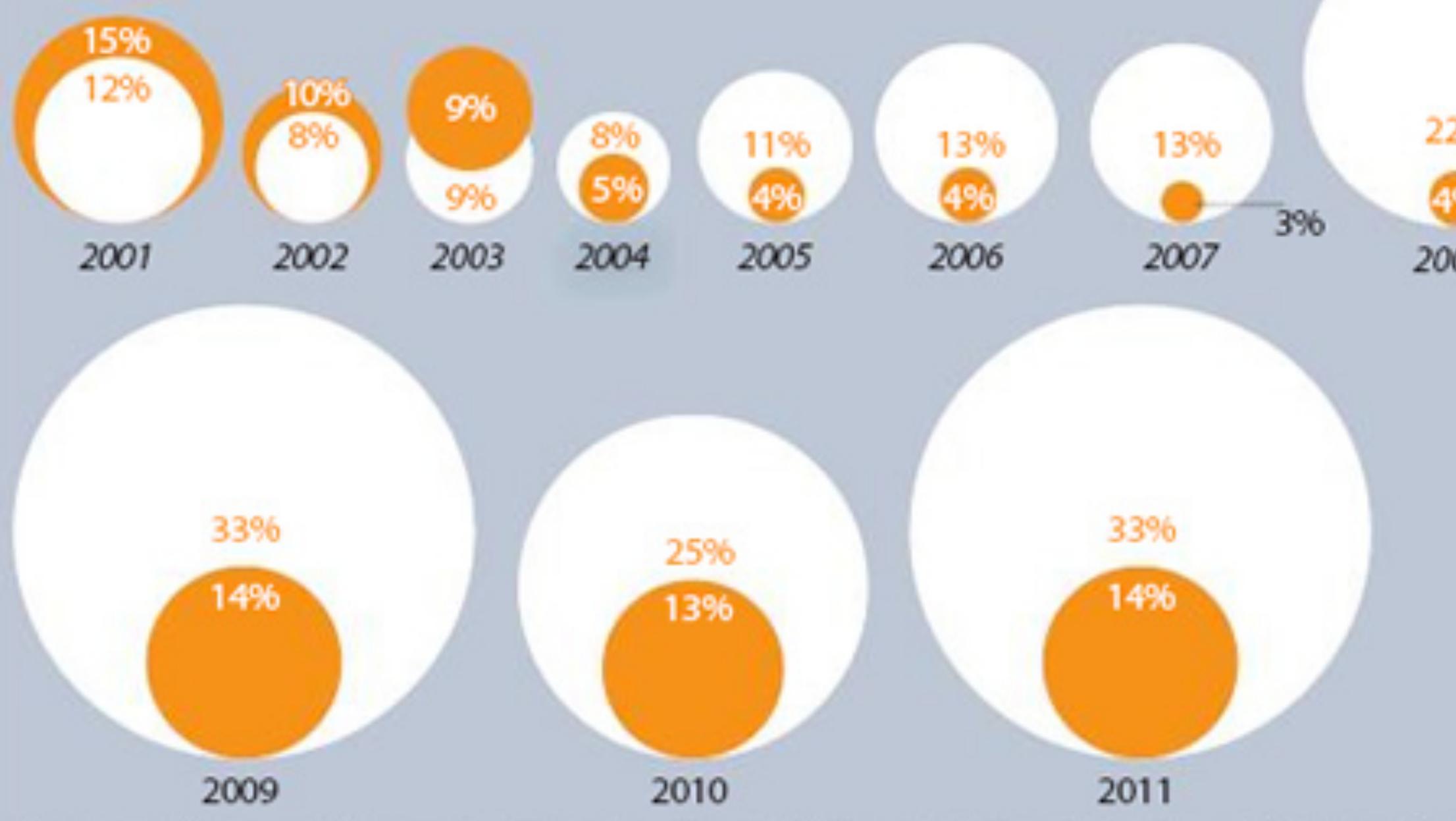
# Design Critique / Redesign

## Most important issues

What do you think is the most important problem facing New Zealand today?

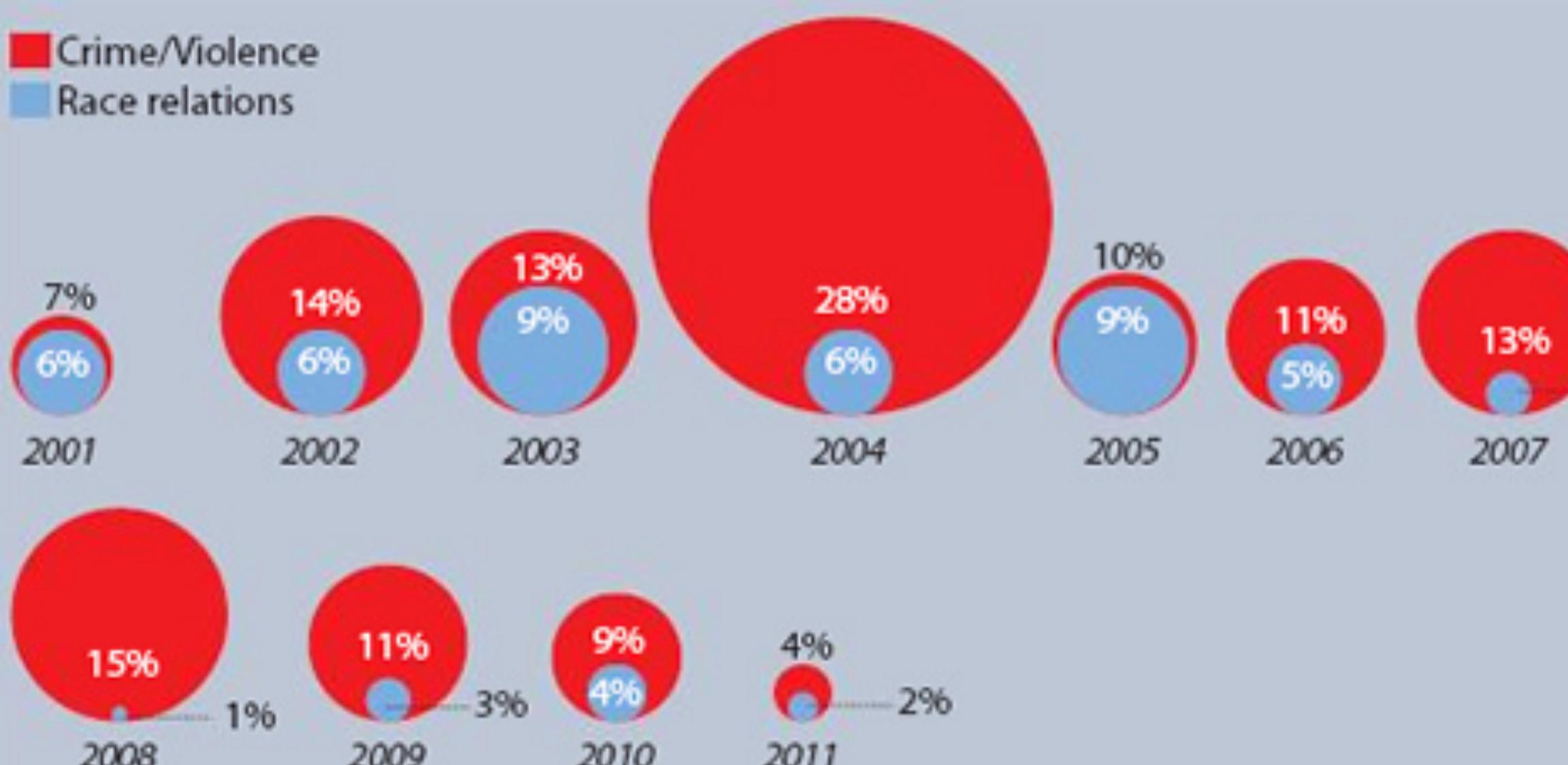
■ Unemployment/Jobs

■ Economy



■ Crime/Violence

■ Race relations



In this exercise, you will first discuss the visualization and then produce a redesign.

Analysis:

In your breakout group, discuss the following questions:

What questions does this visualization answer?

What data is represented in this visualization? Be specific.

How is each data type visually encoded?

Is the visual encoding appropriately chosen?

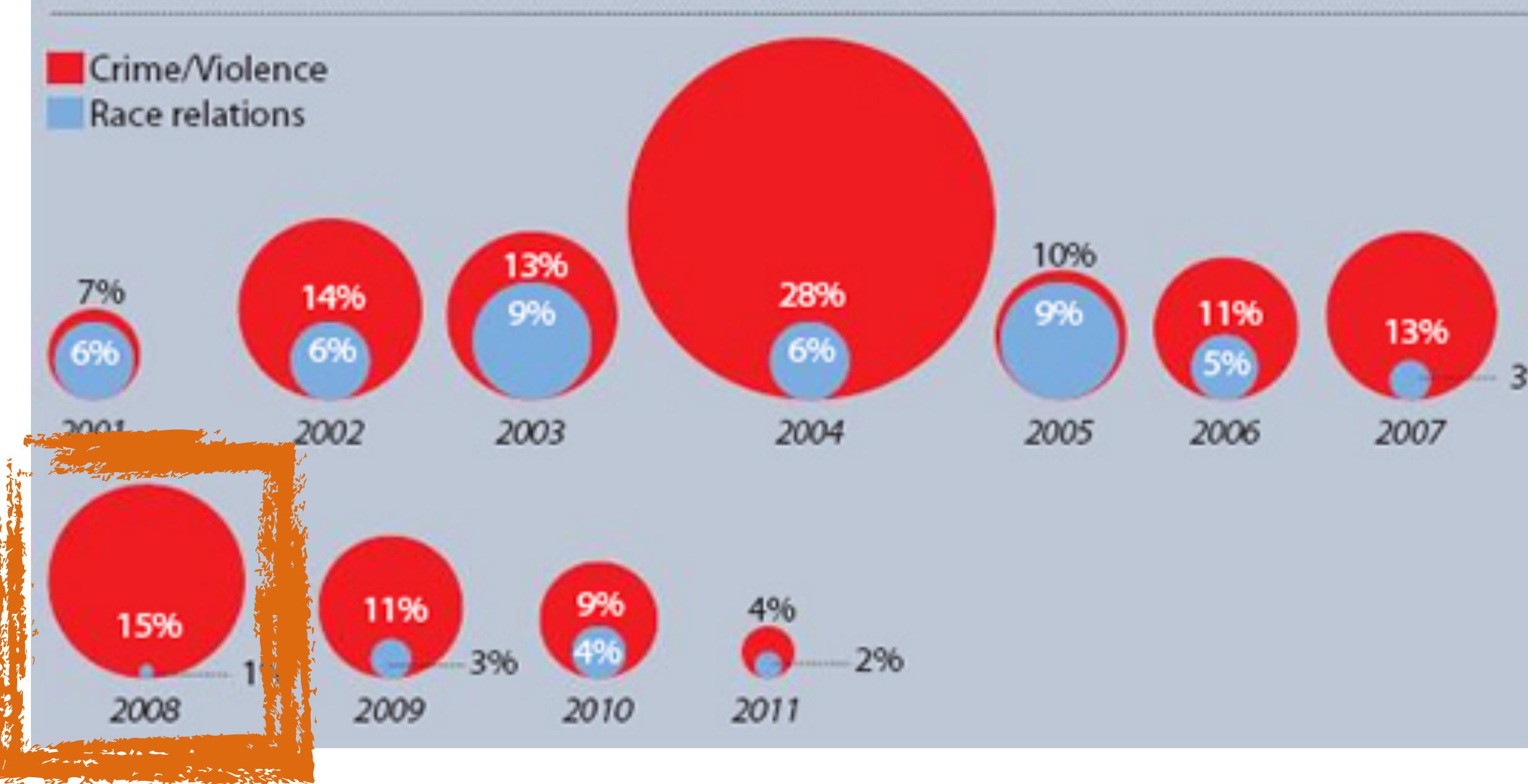
What could be the goals of the designer?

Can you read the data precisely? Would this work without labels?

Why do you like / dislike this visualization?

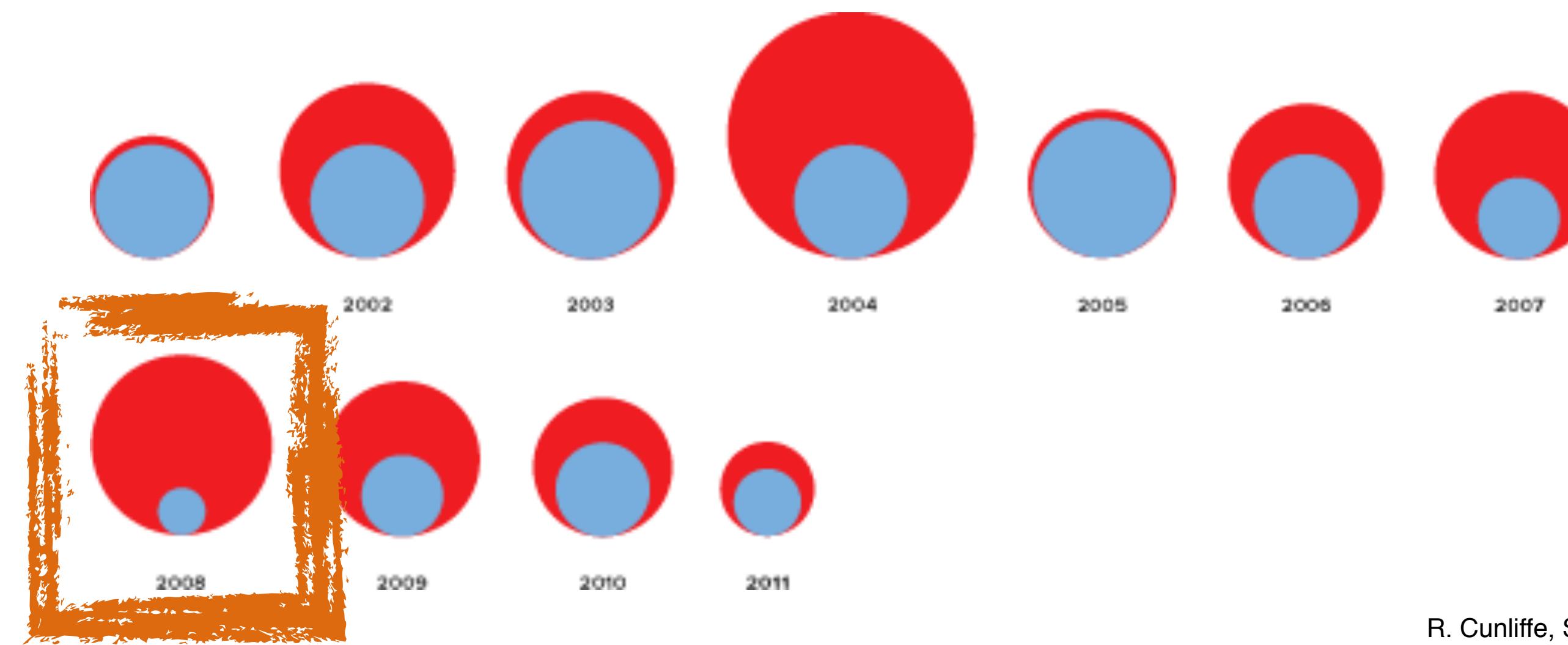
Redesign:

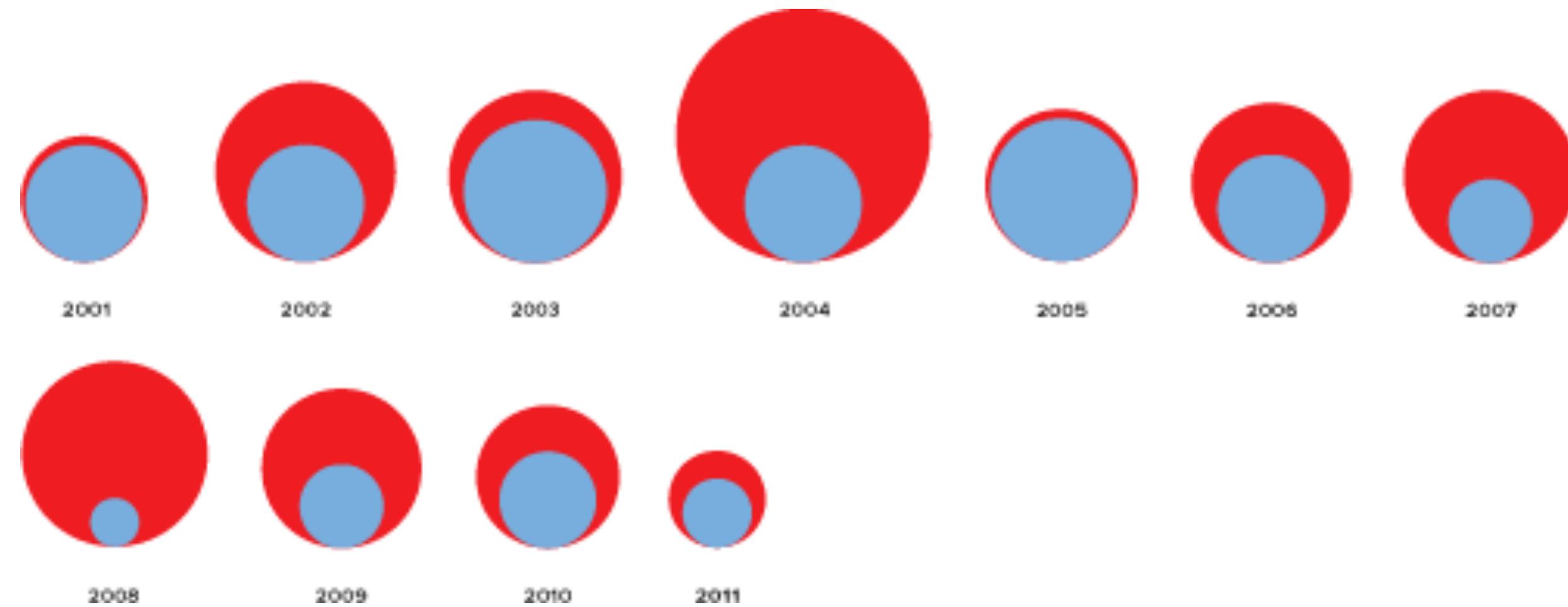
Develop two alternative designs to visualize this data. Mark your best design and briefly note why you think it is good on the back of it.



Quantity encoded by diameter, not area!

Fixing that:





But is this visual encoding appropriate in the first place?

