

# Data Visualization: Design Principles and Processes

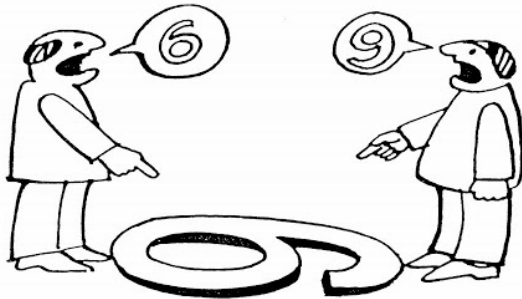
SMM635 - Week 1

Prof. Simone Santoni

Bayes Business School

# What is Good Data Visualization?

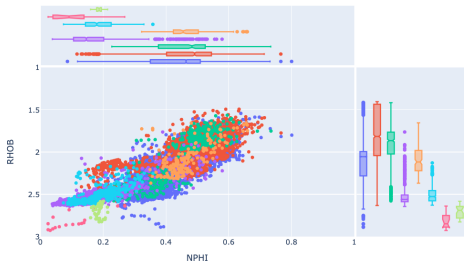
The fundamental question every data analyst must ask



*“Excellence in statistical graphs consists of complex ideas communicated with clarity, precision, and efficiency.” - Edward Tufte*

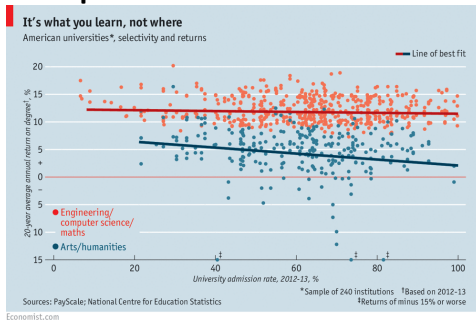
# Tale of Two Visualizations

## Example A: Technical Plot



Shows data relationships  
Cluttered interface  
Distracting elements

## Example B: The Economist



Clean, focused design  
Clear narrative  
Professional aesthetics

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Figure 1: Edward Tufte

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- ▶ **Serve a clear purpose**: description, exploration, or decoration
- ▶ **Integrate** with statistical and verbal descriptions



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# The Power of “Show the Data” - Anscombe's Quartet

## Four datasets with identical summary statistics

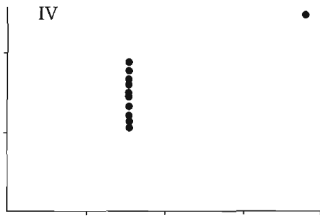
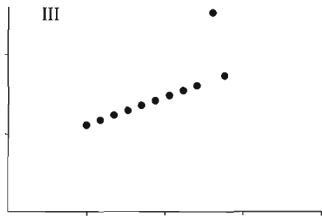
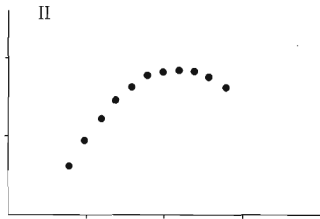
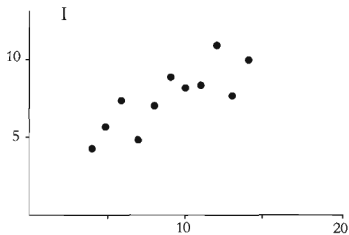
I		II		III		IV	
X	Y	X	Y	X	Y	X	Y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

$N = 11$   
mean of X's = 9.0  
mean of Y's = 7.5  
equation of regression line:  $Y = 3 + 0.5X$   
standard error of estimate of slope = 0.118  
 $t = 4.24$   
sum of squares  $X - \bar{X} = 110.0$   
regression sum of squares = 27.50  
residual sum of squares of Y = 13.75  
correlation coefficient = .82  
 $r^2 = .67$

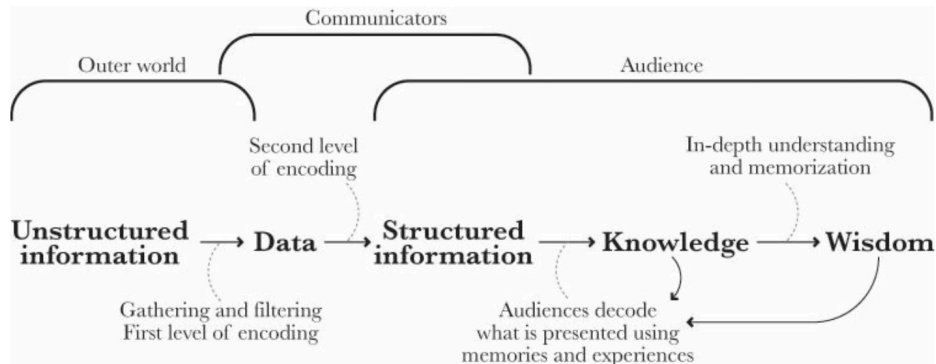
Same means, same correlations, same regression lines...

# Anscombe's Quartet Revealed

...but completely different data patterns!



# The Design Process Framework

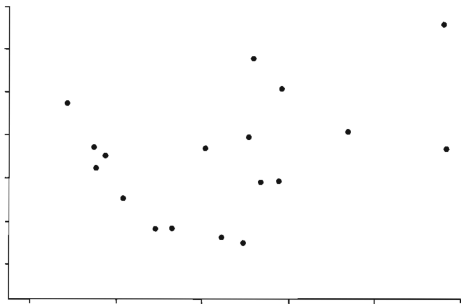


**Figure 1.8. From reality to people's brains.**

*Source: Cairo, A. (2012). The Functional Art*

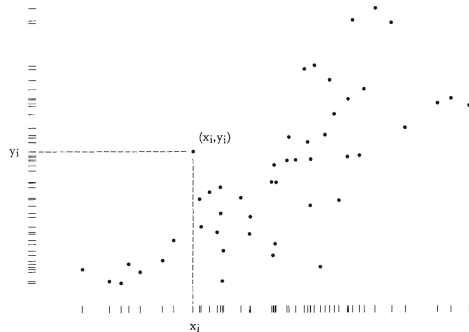
# Design Principles in Action

## Traditional Approach



Heavy gridlines, excessive decoration

## Tufte's Approach

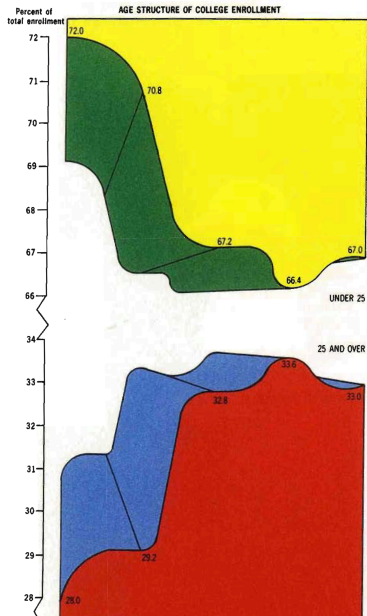


Minimalist, data-focused design

**Principle:** Maximize the **data-ink ratio** - every mark should represent data



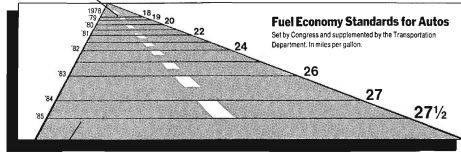
# Chart Junk - What Not to Do



# Before and After - Redesign Example

## Before: Cluttered Design

This line, representing 18 miles per gallon in 1978, is 0.6 inches long.

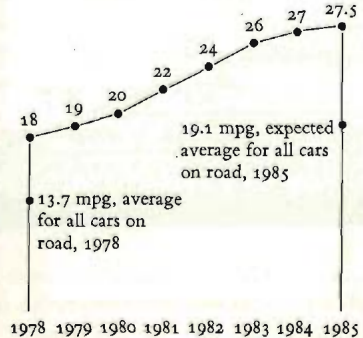


This line, representing 27.5 miles per gallon in 1985, is 5.3 inches long.

Issues: 3D effects, poor labeling, distracting elements

## After: Clean Redesign

**REQUIRED FUEL ECONOMY STANDARDS:**  
**NEW CARS BUILT FROM 1978 TO 1985**



Solutions: Clear hierarchy, direct labeling.

# Key Takeaways for Week 1

## Your visualization design checklist

**Purpose:** Does your chart serve a clear analytical goal?

**Data:** Does your visualization accurately represent the data?

**Clarity:** Can viewers understand the message quickly?

**Simplicity:** Have you removed unnecessary elements?

**Aesthetics:** Is the design professional and appropriate?

**Iteration:** Have you tested and refined your design?

***Remember:** Good visualization design is both art and science - it requires understanding your data, your audience, and your design principles.*

## Next Steps

**For next week:** Read Tufte Chapter 1 and Cairo Introduction and Chapter 1

**Practice:** Complete the Data visualization and communication exercise

### Resources

- ▶ Course GitHub: [github.com/simoneSantoni/data-viz-smm635](https://github.com/simoneSantoni/data-viz-smm635)
- ▶ Design principles checklist in Moodle
- ▶ Office hours: Wednesdays 15:00-17:00