Lecture 1:
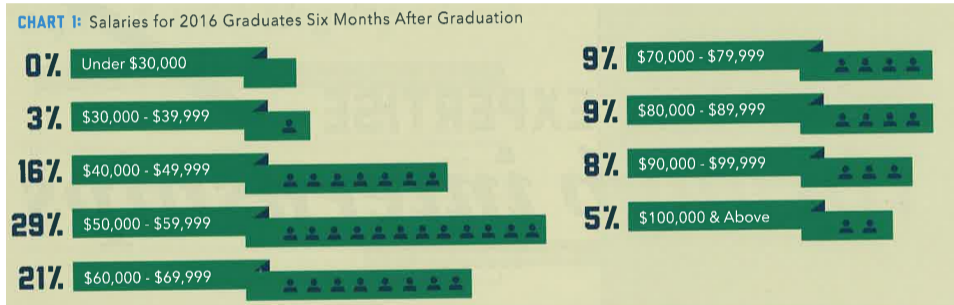# Welcome to Data Visualization Using R
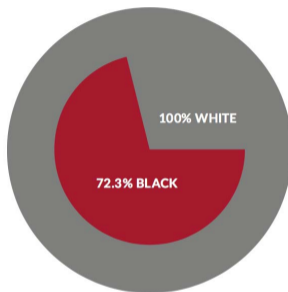
January 23, 2023

Take This Class So You Won't Make This Graphic

CHART 1: Salaries for 2016 Graduates Six Months After Graduation

0% Under $30,000	9% $70,000 - $79,999
3% $30,000 - $39,999	9% $80,000 - $89,999
16% $40,000 - $49,999	8% $90,000 - $99,999
29% $50,000 - $59,999	5% $100,000 & Above
21% $60,000 - $69,999	

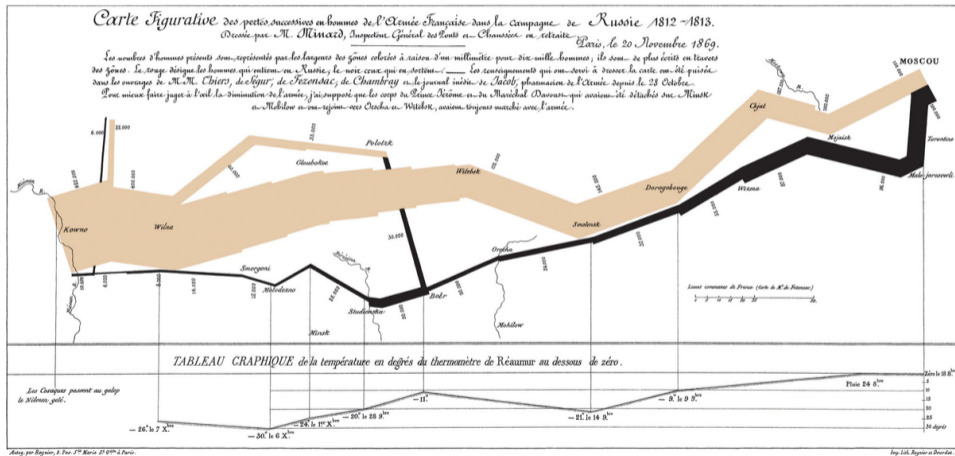From Trachtenberg's 2018 magazine.

Or This One, 2 of 3

"U.S. Metros Ranked on Black-White Income Inequality," *Next City*, May 2, 2017

Or This One, 3 of 3
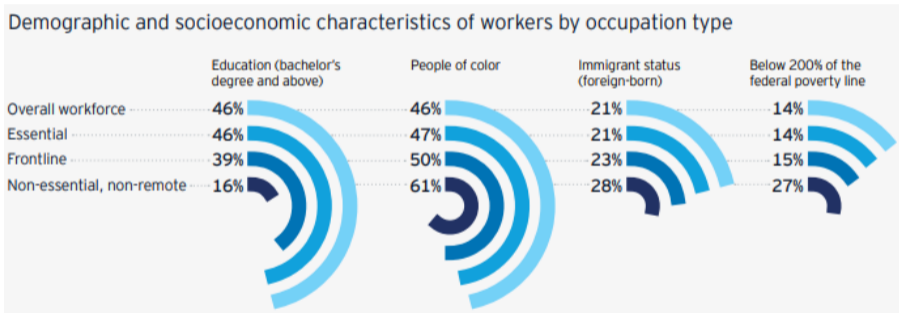
Remote Work in the Capital Region, 2021, Greater Washington Partnership.

Instead, Aspire to This

See Tufte for citation.

To Create Memories

- Journalists frequently start articles with anecdotes because they are
  - relateable
  - memorable
  - compelling (?)

To Create Memories

- Journalists frequently start articles with anecdotes because they are
  - relateable
  - memorable
  - compelling (?)
- Raw data is none of these things
- Goal of this course is to create graphics that are
  - compelling
  - clear
  - memorable
  - succinct

Course Administration

1. Syllabus
   - Policy brief handout
   - Fully composed chart handout
   - Good/bad/ugly assignments handout
2. Bring a name tent to class
3. Questions/issues with readings?

4. Make sure you're signed up for Piazza
5. Introductions
   - name and degree
   - why this course?
   - what you do now
   - what you'd like to do when you're done

Today

1. R examples
2. Tufte
3. Getting started with R
4. R tools

R Examples

R Examples

1. From a project about the long-run impacts of DC's 1968 civil disturbance
2. From a project about whether and why infrastructure costs are increasing
3. From a project about working from home in the DC region

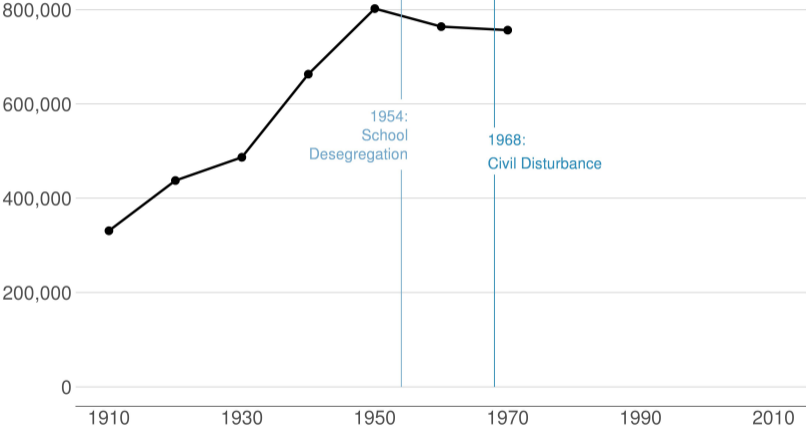From a Project about the Long-Run Impacts of DC's 1968 Civil Disturbance
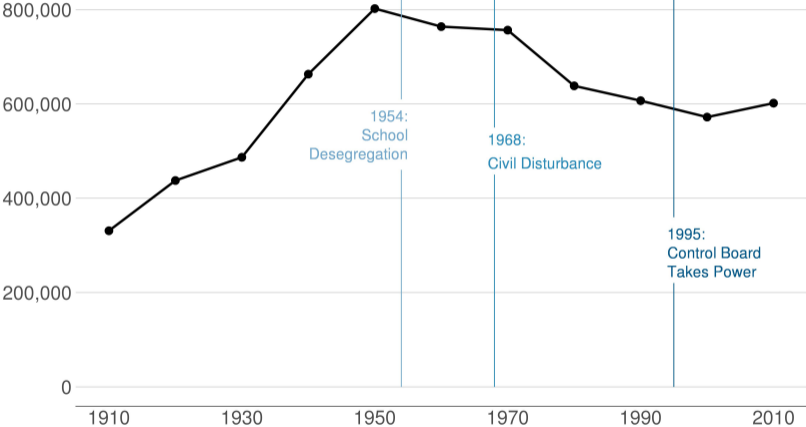
DC Gains Population Through 1950
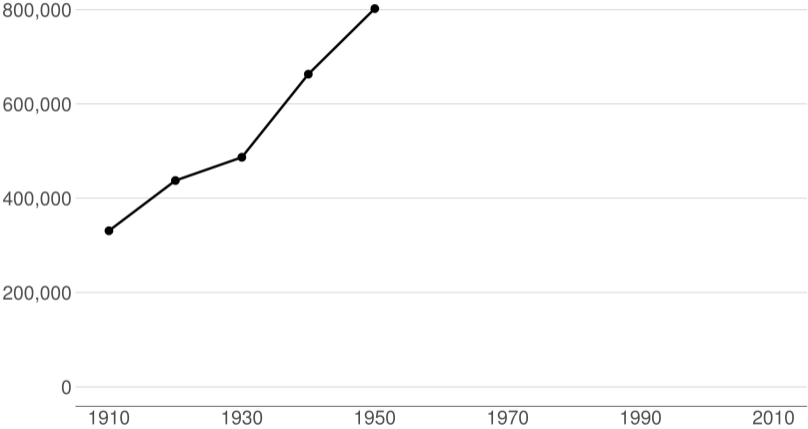
Population Loses Start with Desegregation
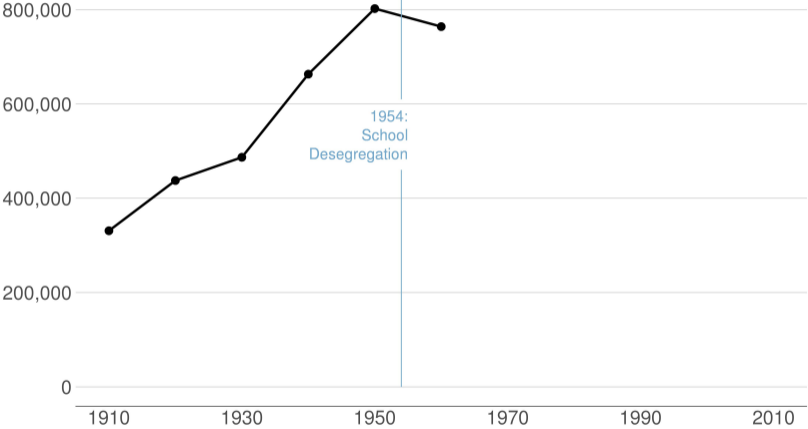
Continue After Civil Disturbance

Population Turns Up After 2000

Profound Changes: Share African American by Neighborhood
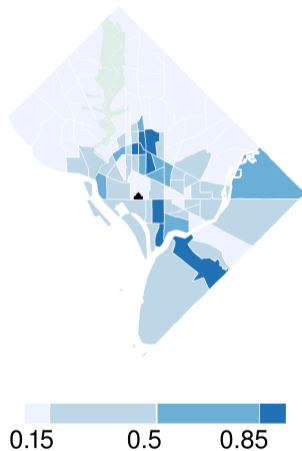

1930
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2000
2010

0.15   0.5   0.85

Profound Changes: Share African American by Neighborhood

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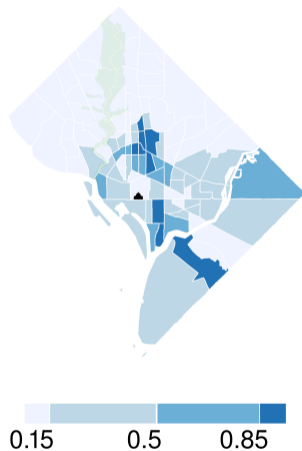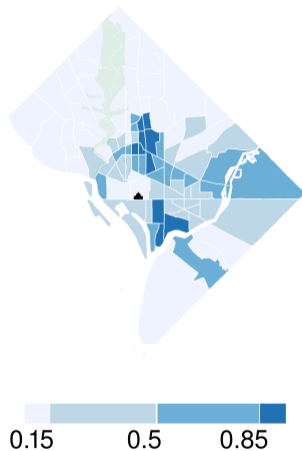# Profound Changes: Share African American by Neighborhood

1930
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0.15   0.5   0.85

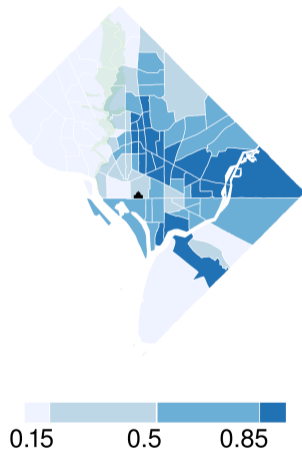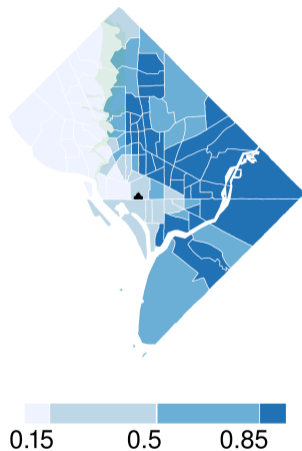# Profound Changes: Share African American by Neighborhood

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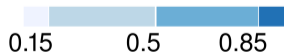
0.15   0.5   0.85
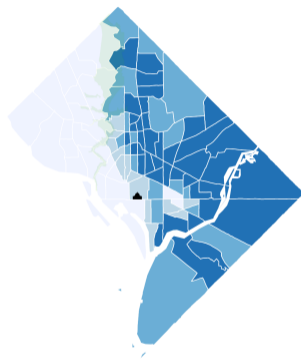
Profound Changes: Share African American by Neighborhood

1930
1940
1950
1960
1970
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2010

0.15   0.5   0.85

From a project about whether and why infrastructure costs are increasing

Spending Per Mile has Tripled Since 1960s
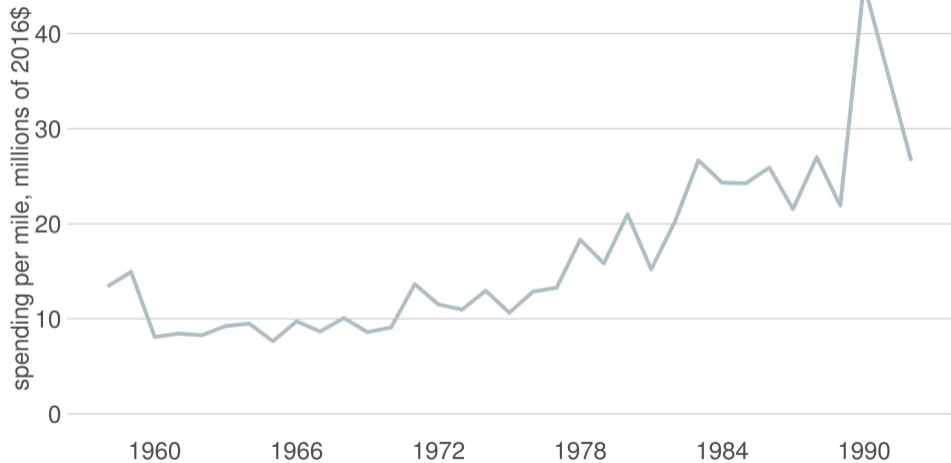
Spending Per Mile has Tripled Since 1960s
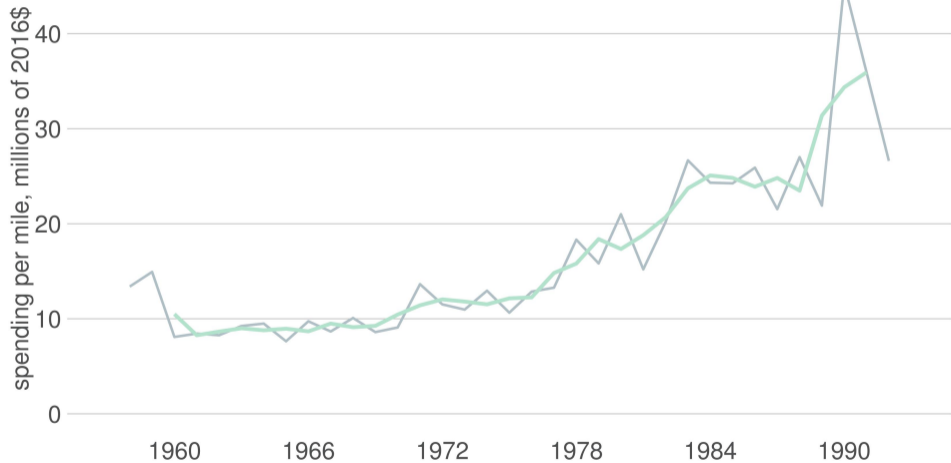
Spending Per Mile has Tripled Since 1960s
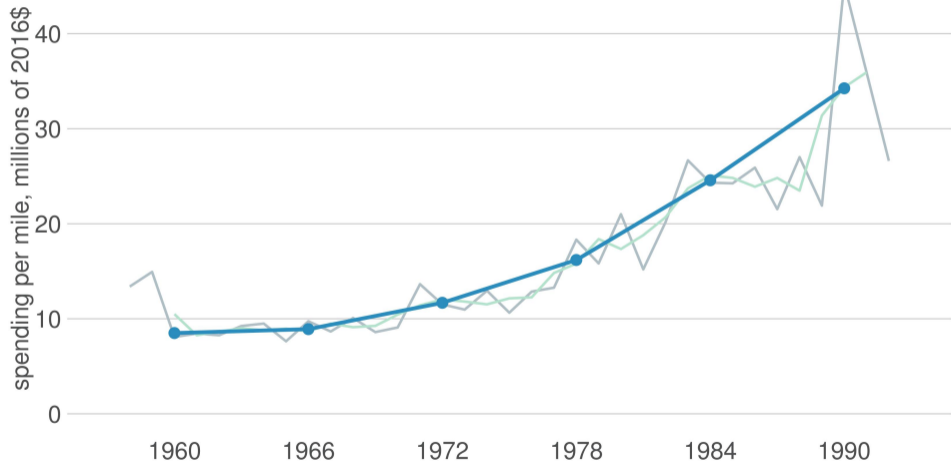
Interstate Spending Per Mile, Indexed to 100 in 1961
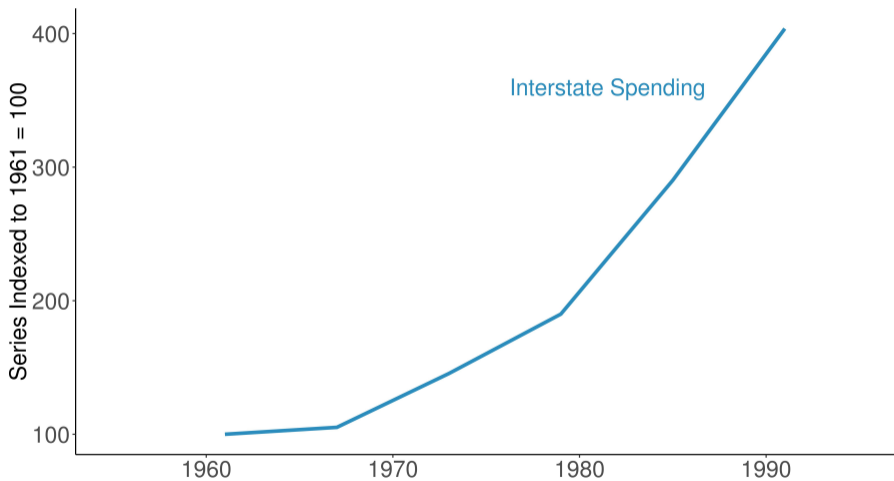
Materials Prices are Roughly Flat Over the Period

Interstate Spending

Materials

Series Indexed to 1961 = 100

400

300

200

100

1960   1970   1980   1990
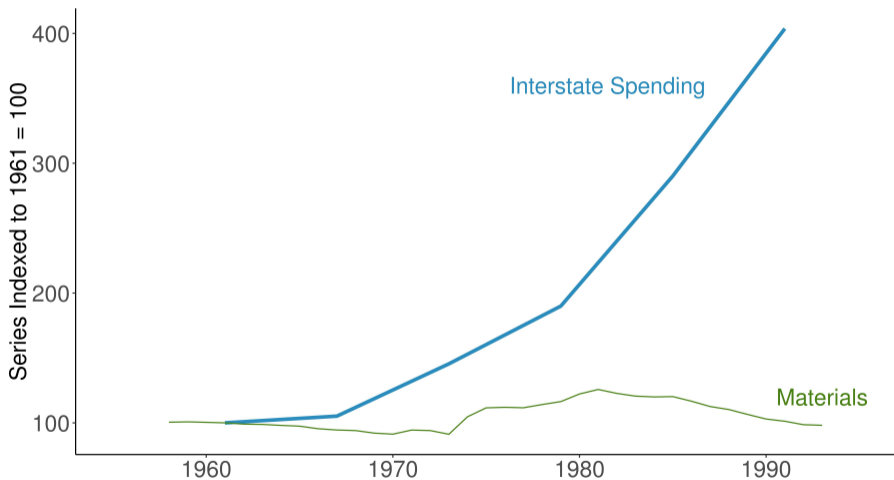
Wages Are Flat, Too → Input Prices Cannot Explain Increase
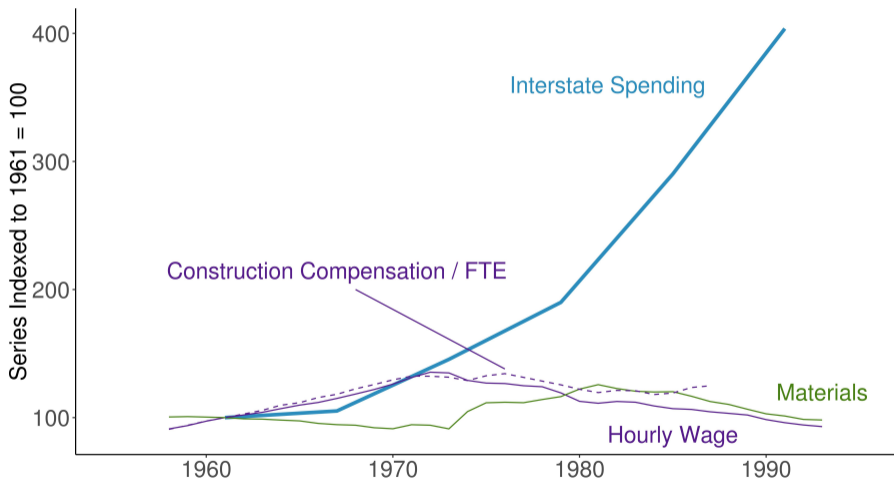
From a project about the likely impacts of Covid on the DC region

Capitol Region Strong in Work-from-home Sectors

Share Jobs w/o Telework — Share of All Jobs in Capital Region

Prof'nl, Scientific & Tech Services
Health Care and Social Assistance
Educational Services
Accomd. and Food Services
Retail Trade
Public Administration
Administration/Waste Management
Other Services
Construction
Finance and Insurance
Transportation & Warehousing
Information
Wholesale Trade
Manufacturing
Real Estate/Rental/Leasing
Arts/Entertainment/Recreation
Management
Utilities
Agriculture
Mining/Gas

Wealthier People More Likely to Be Able to Telework
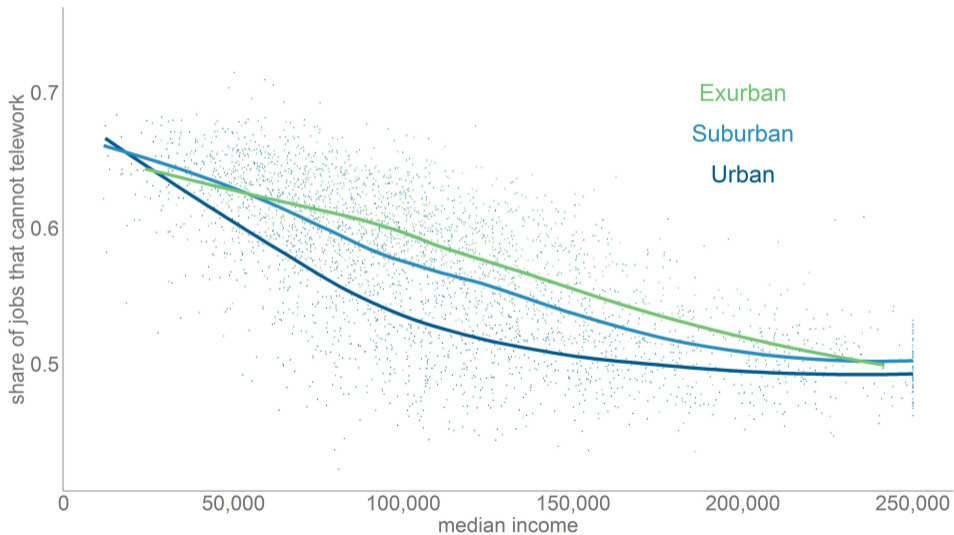
Tufte

Tufte

1. Why Tufte?
2. Beginnings of graphics
3. Why visualizations help

4. Tufte's four types of graphs, with examples
5. Tufte's problems with graphics
6. Rules of graphic integrity

Edward Tufte

- A quantitative political scientist
- Writing in the mid-1970s
- Became interested in visualization by working with pioneering statistician John Tukey
- Remember that this is the pre-Excel era, in which data graphics are difficult to make

Why Do We Read This?

- Among the first to take the field as a whole seriously
- Greatest popularizer of a now-accepted set of conventions
- Highlights that visualizations only began
  - 1765 with Joseph Priestley
  - 1786 with William Playfair

Priestely's Sensation

Joseph Priestley (1733-1804), chart from 1765. [Public domain via Wikipedia]. See discussion here.
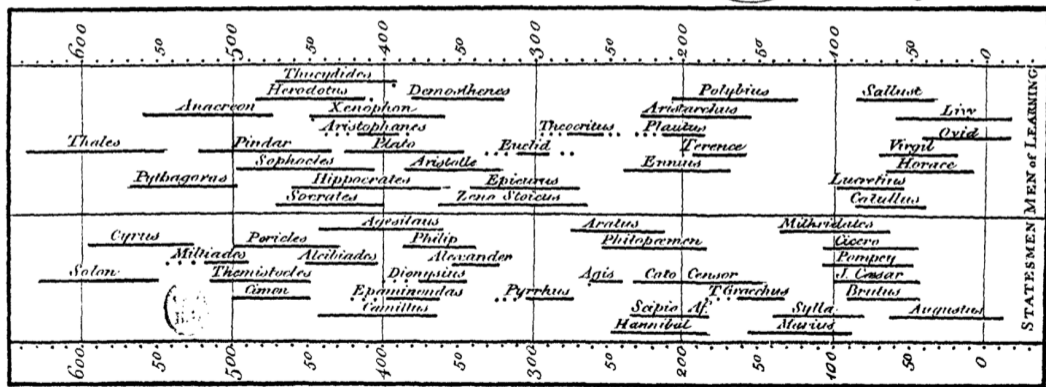
The World's First Bar Chart
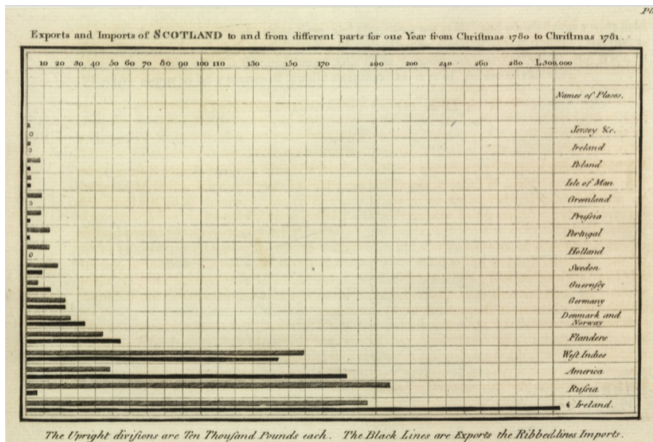
William Playfair (1759-1823), 1786. [Public domain via Wikipedia]

An Argument for Better Visualization

Anscombe's quartet

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

All series have the same

- mean of X
- variance of X
- mean of Y
- variance of Y
- corr(X, Y)
- $\hat{\beta}$
- R^2

An Argument for Better Visualization

Anscombe's quartet

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
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11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
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All series have the same

- mean of X
- variance of X
- mean of Y
- variance of Y
- $\text{corr}(X, Y)$
- $\hat{\beta}$
- R^2

Which one is a vertical line?

An Argument for Better Visualization

Anscombe's quartet

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
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9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
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- mean of X
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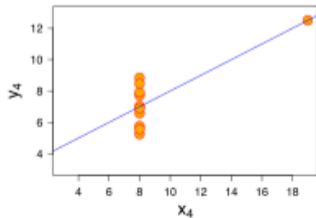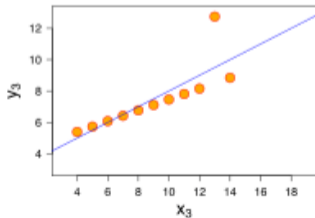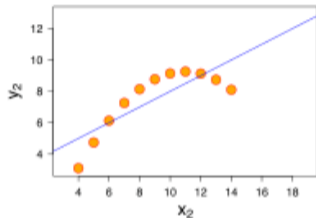- $\mathrm{corr}(X, Y)$
- $\hat{\beta}$
- R^2

Which one is a vertical line?
Which one is an upside-down U?

Thanks for Wikipedia for quartet table.

An Argument for Better Visualization

Because good visualizations tell the most compelling story
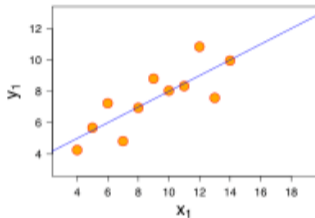
Tufte's Types of Graphs

1. Data maps
2. Time series
3. Space-time narrative designs
4. Relational graphs – the holy grail

Data Maps

- Describe the location of numbers
- This can be revealing or obfuscating
- We will make these in this class
- A product of the mid-1800s

John Snow on the Location of Cholera in London, c. 1850
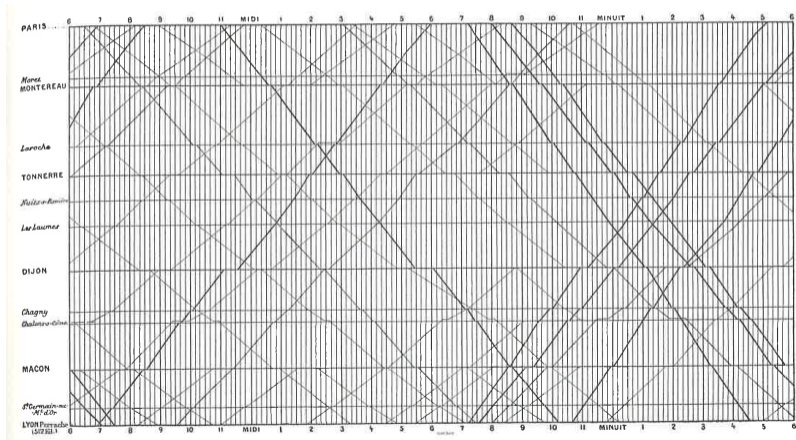
Time Series

- Time on the horizontal axis
- Something else on the vertical axis
- One of the first types of data graphics

Train, Paris to Lyon

See Tufte for citation.

Space-Time Narrative Designs

- Move over space and time at the same time
- A time series plus

Space-Time Narrative Example
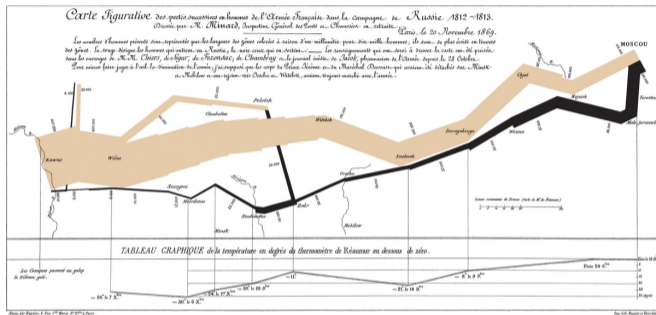
Which dimensions?

Space-Time Narrative Example
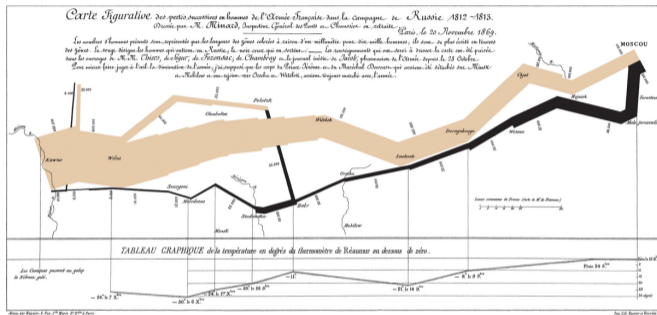
Which dimensions?

1. army size
2. army location, N/S
3. army location, E/W

4. direction of movement
5. temperature
6. by date

Relational Graphics

- One variable on the vertical, another on the horizontal
- A conceptual advance in graphics
- A more sophisticated way of thinking

Relational Graphics Example
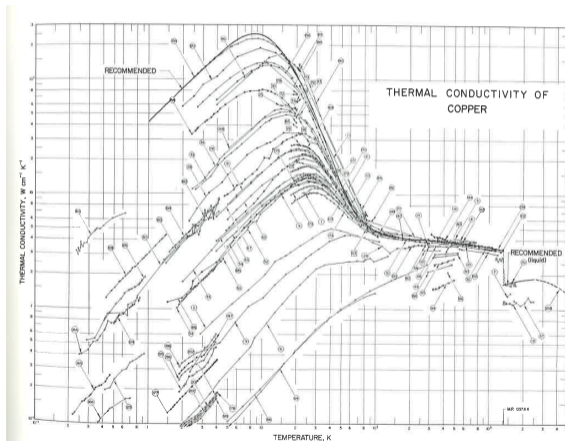
Tufte's Main Causes of Distortion in Graphics

1. Data are bad
   - should be per capita and are not
   - data are not consistent over time
   - don't adjust for inflation
2. Graphics are rotten
   - size doesn't match the numbers
   - colors and styles are misleading
   - graphic fails to highlight key point

3. Graphics are irrelevant
   - too much extraneous stuff

Ex. of 2: Size and Number Don't Match
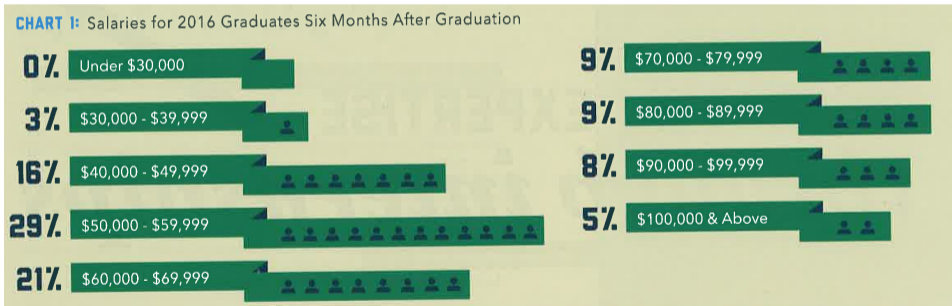
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29% $50,000 - $59,999	5% $100,000 & Above
21% $60,000 - $69,999	

Ex. of 3: Graphics are Irrelevant
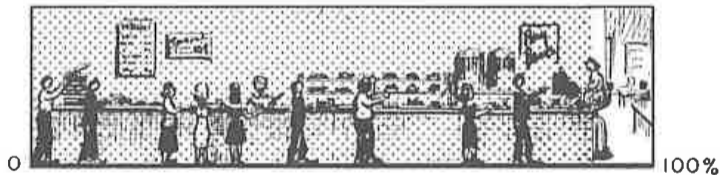
Tufte's Six Rules of Graphic Integrity, 1 to 3 of 6

1. The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.

2. Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.

3. Show data variation, not design variation.

Tufte's Six Rules of Graphic Integrity, 4 to 6

4. In time-series displays of money, deflated and standardized units of monetary measurement are nearly always better than nominal units.

5. The number of information-carrying (variable) dimensions depicted should not exceed the number of dimensions in the data.

6. Graphics must not quote data out of context.

Getting Started with R

What is R?

- A programming language
- Developed by statisticians from New Zealand
- Open source, and therefore free
- Based on "S," developed by Bell Labs

Strengths of R

- Free
- Open-source, so packages by all kinds of users are available
- There are frequently many ways to do the same task
- Very good graphics
- Very flexible
- Can have many datasets in memory at once
- Can analyze large datasets
- Can do maps **and** spatial analysis
- Big user community and lots of online help

Weaknesses of R

- Not always enterprise-ready: packages break and there is no central help
- There are frequently many ways to do the same task
- Syntax can be challenging
- Syntax is inconsistent across packages

Today's Goals

- Digest info and ask questions to me about R
- When you finish today's tutorial, you will be able to
    - run a R script
    - create a R dataframe
    - do basic operations with a R dataframe
- Please work together! Now and later
- And turn in **your own work in your own words**

R Tools

Rest of Today's Class

- Download today's tutorial from lectures page
- I'll put you into breakout groups to work together
  - I will check on groups
  - Feel free to return to main room for help as needed
- You'll continue work at home on your own and turn in a problem set next lecture

Next Lecture: Lecture 2

- Turn in work for tutorial 1
- Read Few Chapters 3 and 5
- Look at "Graph Choice Chart"