

# Data Visualization (CSCI 627/490)

---

## Introduction

Dr. David Koop

# What is Data Visualization?

# How is it different from Computer Graphics?

The purpose of computing is about insight, not numbers

— R. W. Hamming

The purpose of **visualization** is about **insight**, not pictures

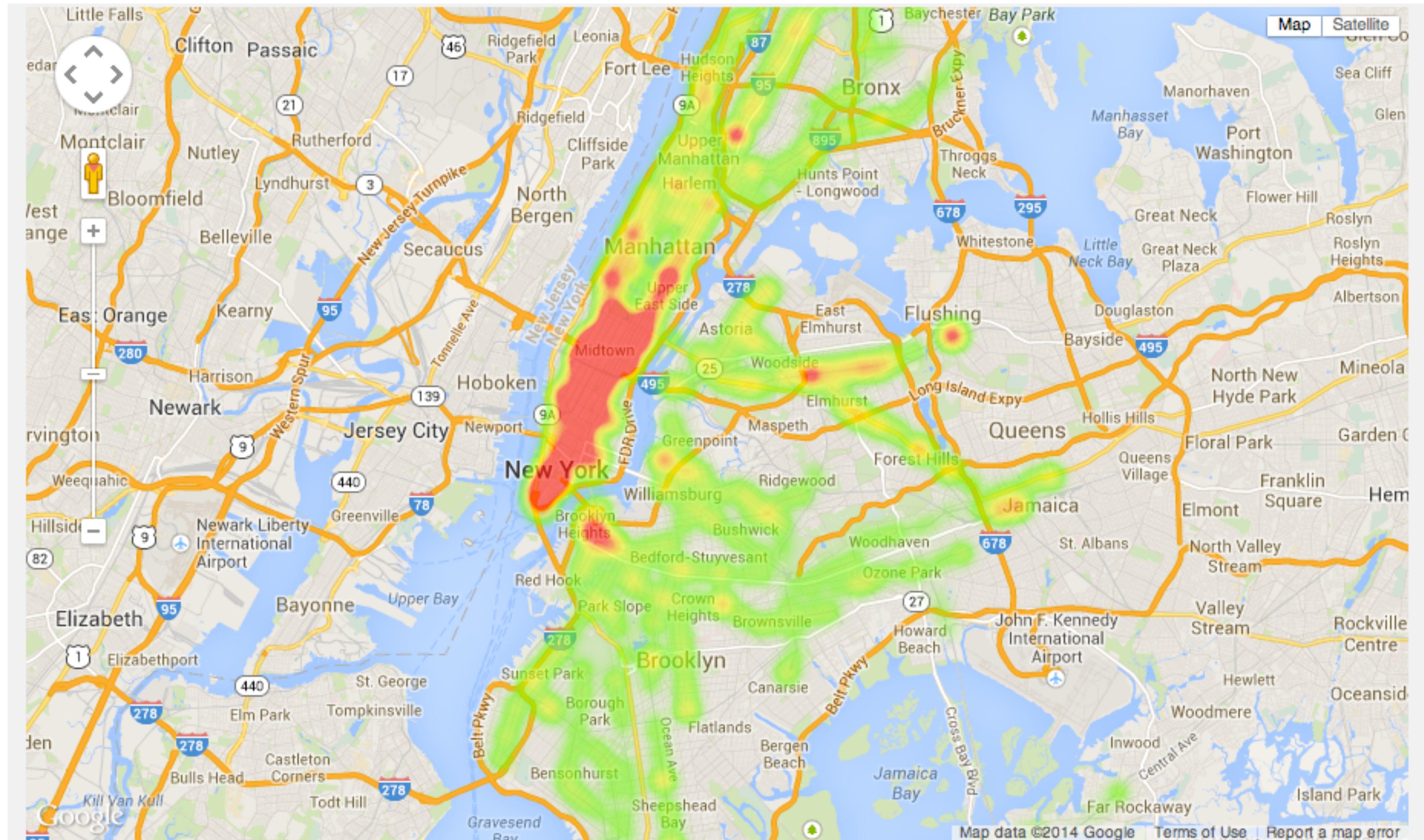
— B. Shneiderman

Why do we visualize data?  
(vs. looking at tables?)

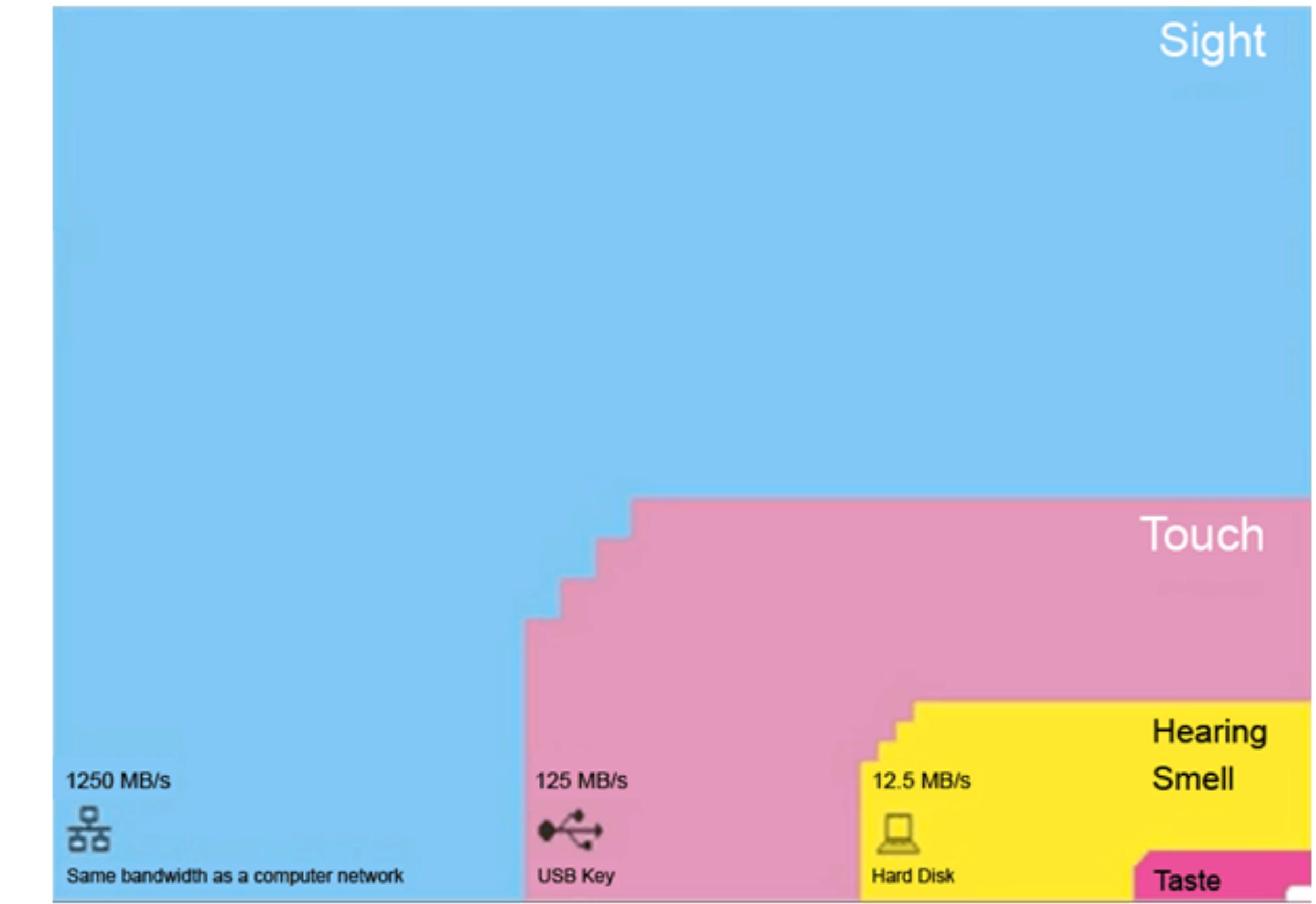
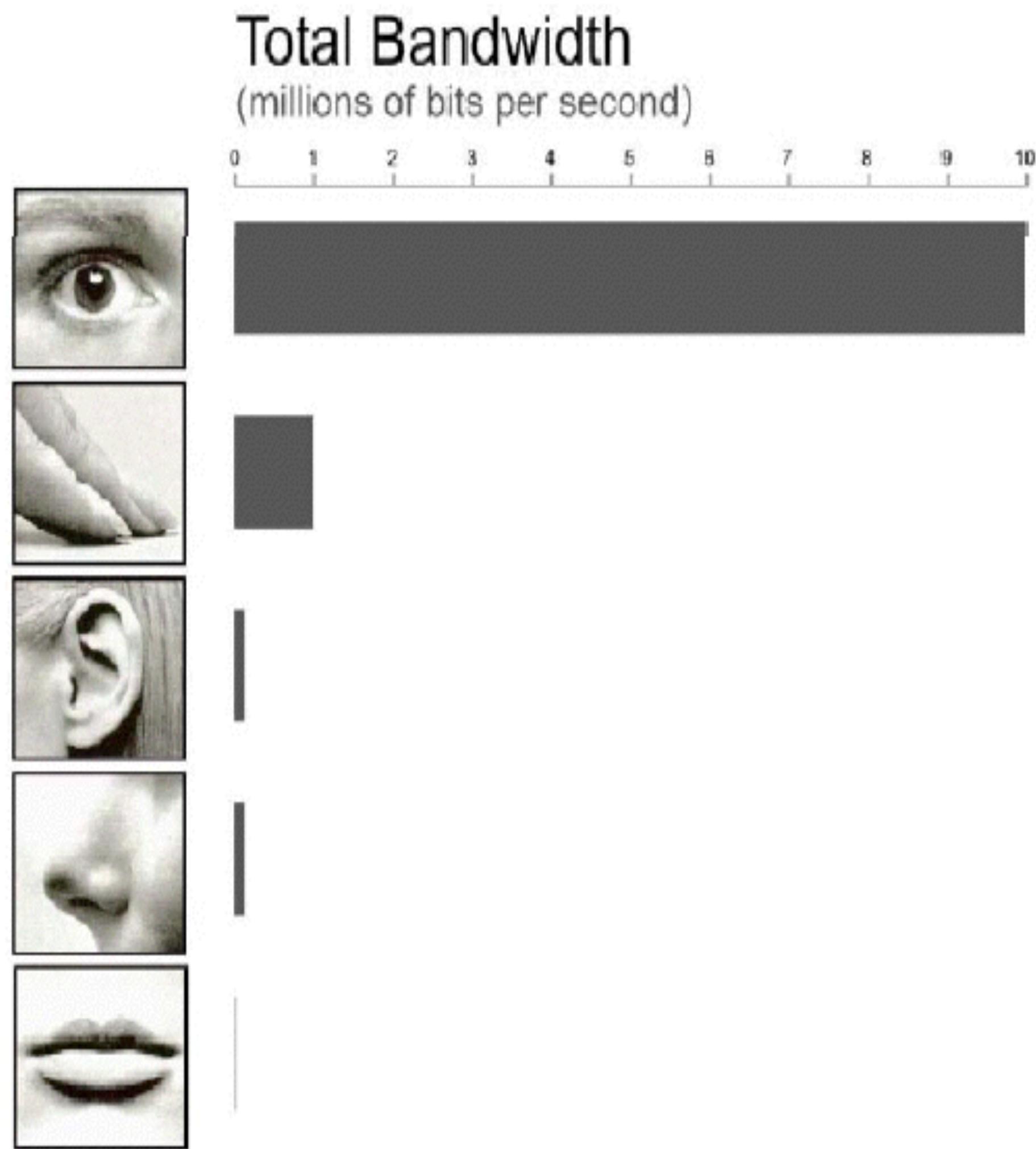
# MTA Fare Data Table

REMOTE	STATION	FF	SEN/DIS	7-D AFAS UNL	D AFAS/RMF I	JOINT RR TKT	7-D UNL	30-D UNL	
1	R011	42ND STREET & 8TH AVENUE	00228985	00008471	00000441	00001455	00000134	00033341	00071255
2	R170	14TH STREET-UNION SQUARE	00224603	00011051	00000827	00003026	00000660	00089367	00199841
3	R046	42ND STREET & GRAND CENTRAL	00207758	00007908	00000323	00001183	00003001	00040759	00096613
4	R012	34TH STREET & 8TH AVENUE	00188311	00006490	00000498	00001279	00003622	00035527	00067483
5	R293	34TH STREET - PENN STATION	00168768	00006155	00000523	00001065	00005031	00030645	00054376
6	R033	42ND STREET/TIMES SQUARE	00159382	00005945	00000378	00001205	00000690	00058931	00078644
7	R022	34TH STREET & 6TH AVENUE	00156008	00006276	00000487	00001543	00000712	00058910	00110466
8	R084	59TH STREET/COLUMBUS CIRCLE	00155262	00009484	00000589	00002071	00000542	00053397	00113966
9	R020	47-50 STREETS/ROCKEFELLER	00143500	00006402	00000384	00001159	00000723	00037978	00090745
10	R179	86TH STREET-LEXINGTON AVE	00142169	00010367	00000470	00001839	00000271	00050328	00125250
11	R023	34TH STREET & 6TH AVENUE	00134052	00005005	00000348	00001112	00000649	00031531	00075040
12	R029	PARK PLACE	00121614	00004311	00000287	00000931	00000792	00025404	00065362
13	R047	42ND STREET & GRAND CENTRAL	00100742	00004273	00000185	00000704	00001241	00022808	00068216
14	R031	34TH STREET & 7TH AVENUE	00095076	00003990	00000232	00000727	00001459	00024284	00038671
15	R017	LEXINGTON AVENUE	00094655	00004688	00000190	00000833	00000754	00020018	00055066
16	R175	8TH AVENUE-14TH STREET	00094313	00003907	00000286	00001144	00000256	00038272	00074661
17	R057	BARCLAYS CENTER	00093804	00004204	00000454	00001386	00001491	00039113	00068119
18	R138	WEST 4TH ST-WASHINGTON SO	00093562	00004677	00000251	00000965	00000127	00031628	00074458

# MTA Fare Data Visualization



# Why do we visualize data?

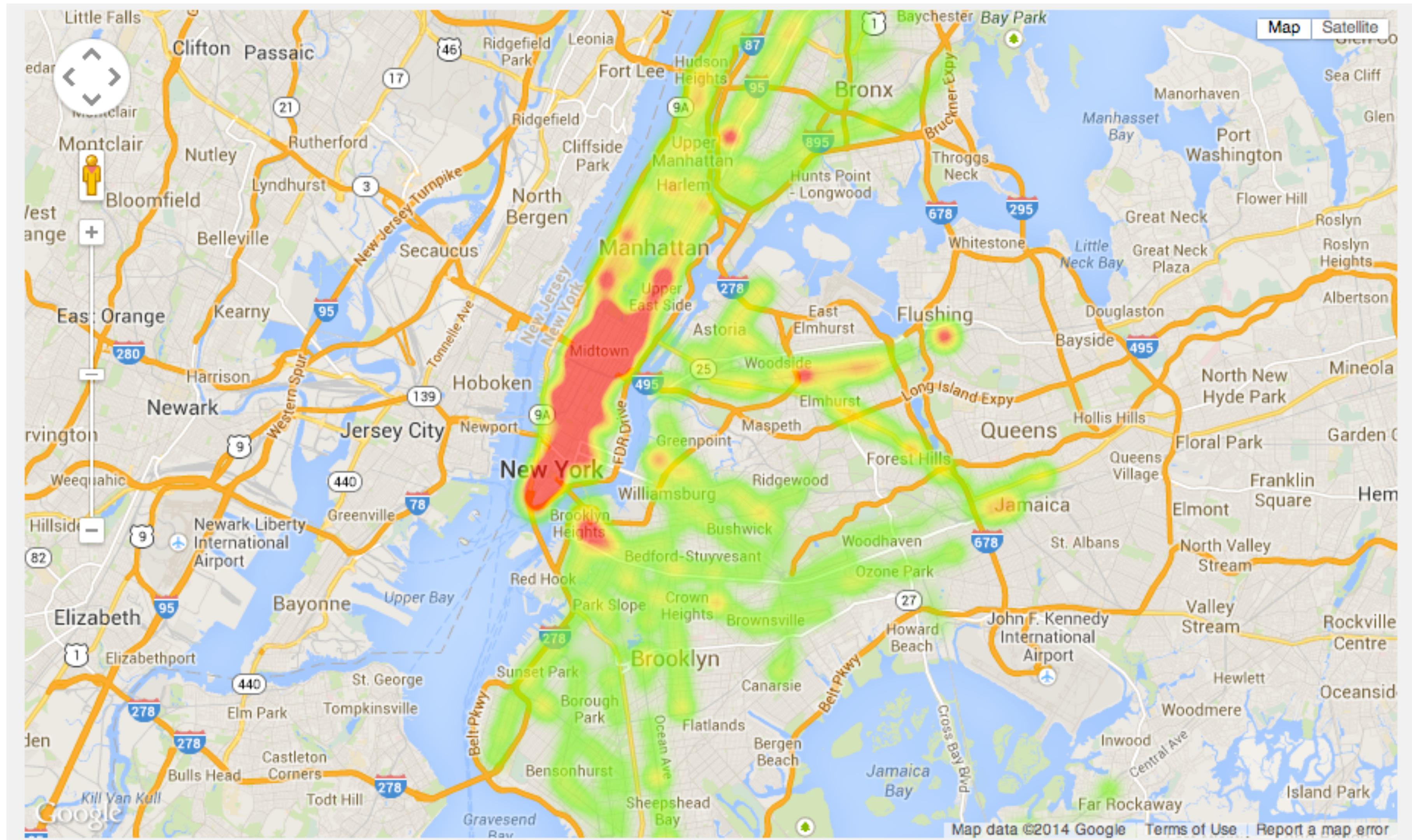


[via A. Lex]

[T. Nørretranders]

# What are the goals of visualization?

# Analysis: Subway Ridership Density

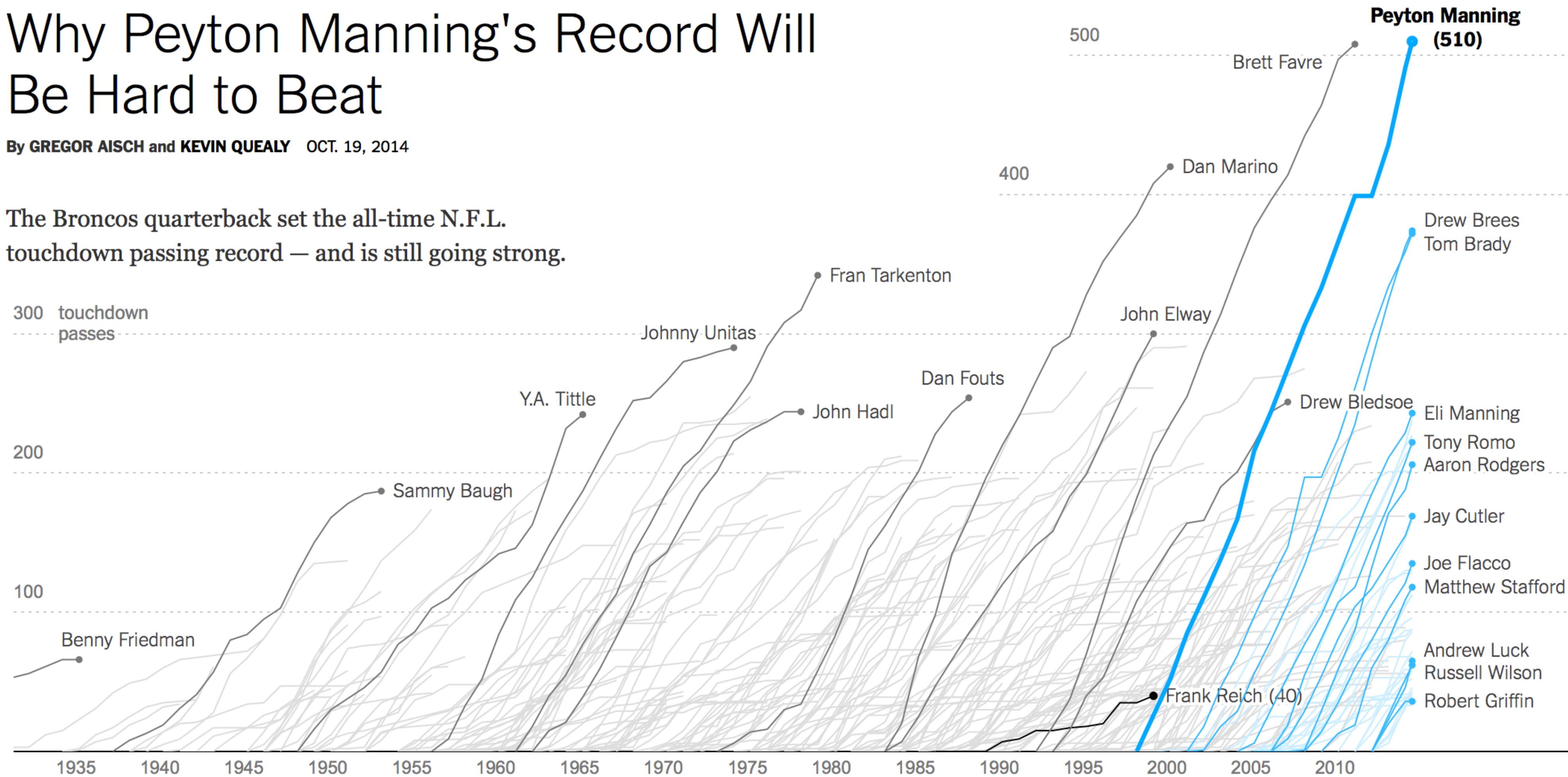


# Communication: Peyton's Records

## Why Peyton Manning's Record Will Be Hard to Beat

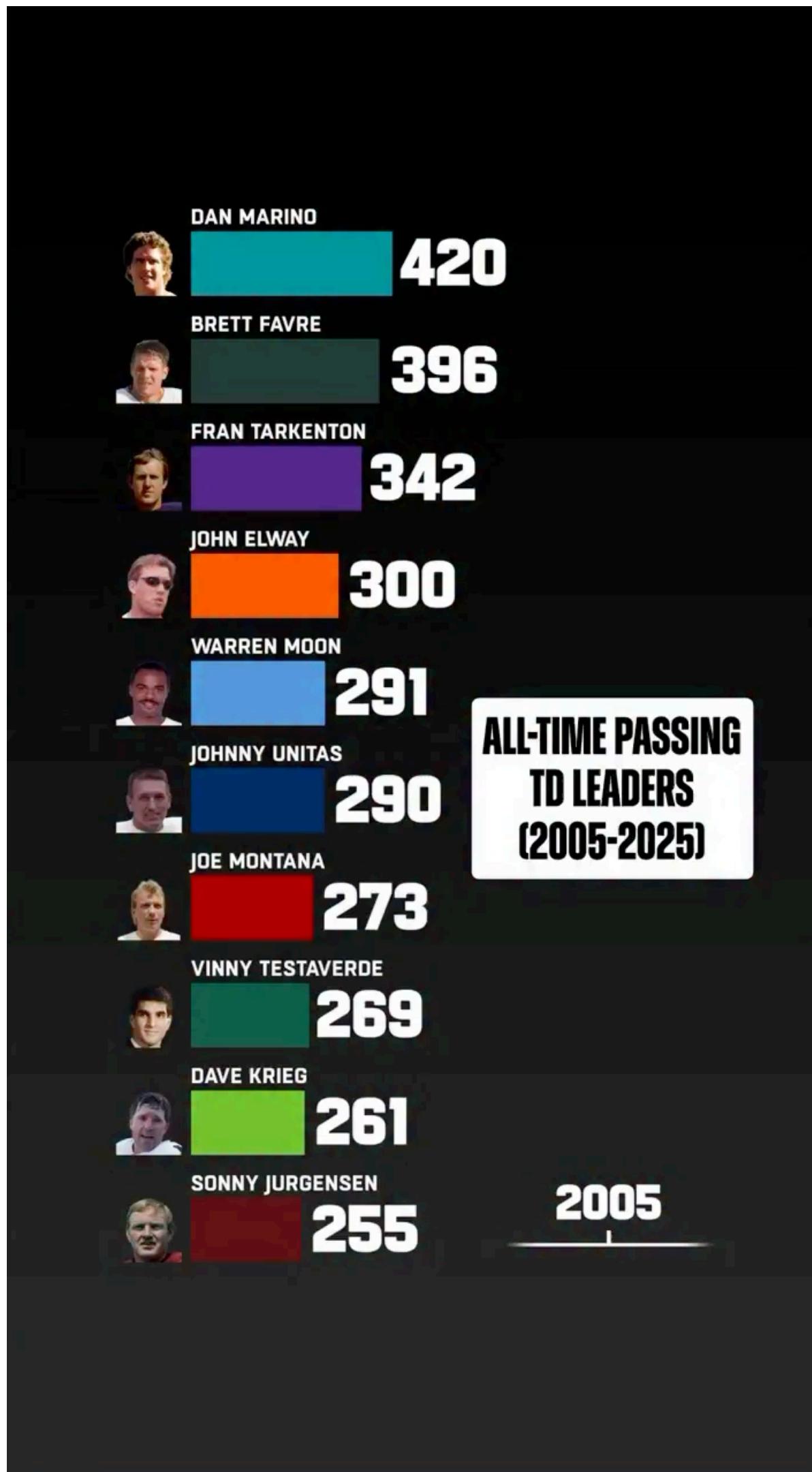
By GREGOR AISCH and KEVIN QUEALY OCT. 19, 2014

The Broncos quarterback set the all-time N.F.L. touchdown passing record — and is still going strong.



[G. Aisch and K. Quealy, [NYTimes](#)]

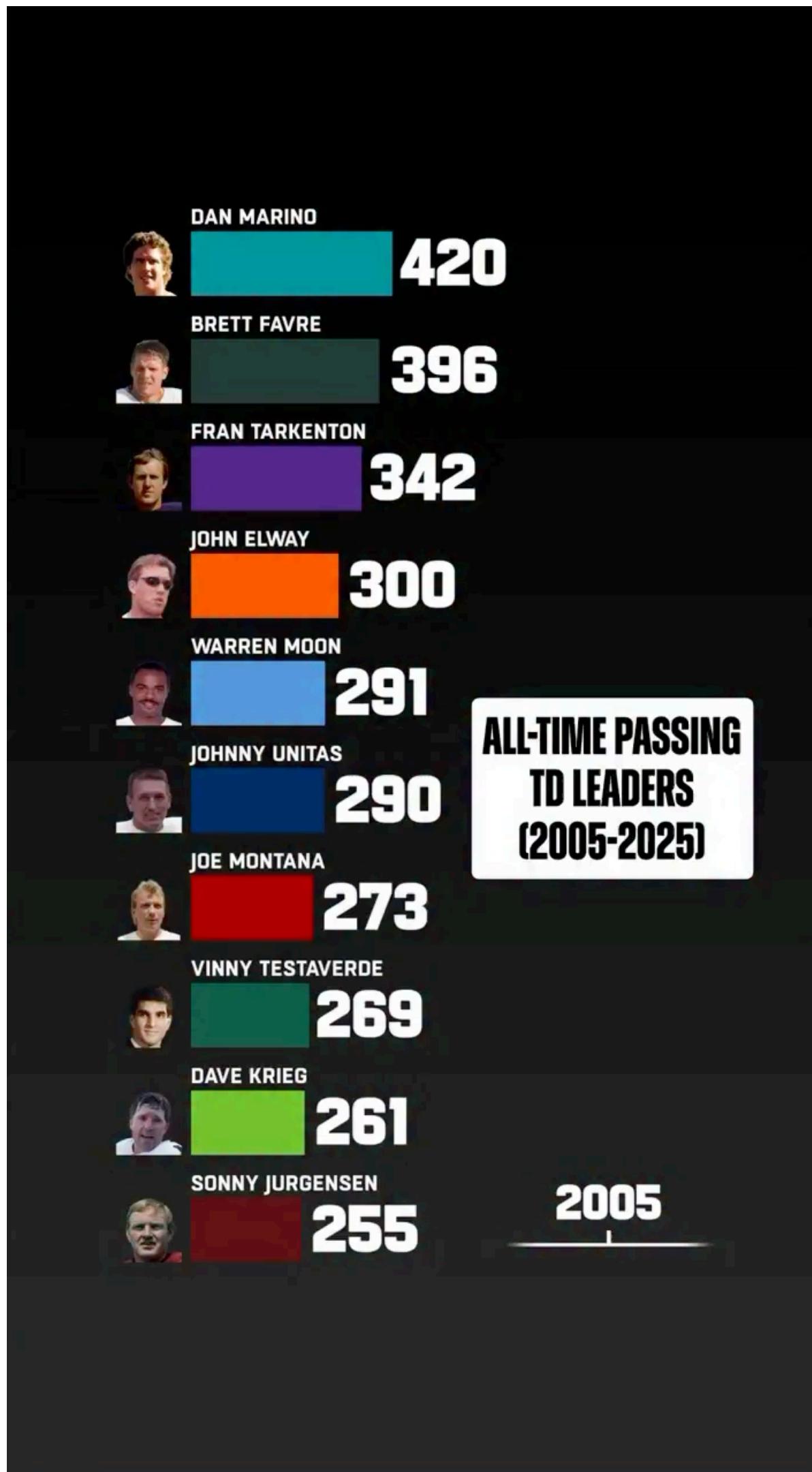
# Communication: Peyton's Record Has Been Eclipsed



- Bar chart race
- Use motion to encode changes
- Video much more common today

[NFL]

# Communication: Peyton's Record Has Been Eclipsed

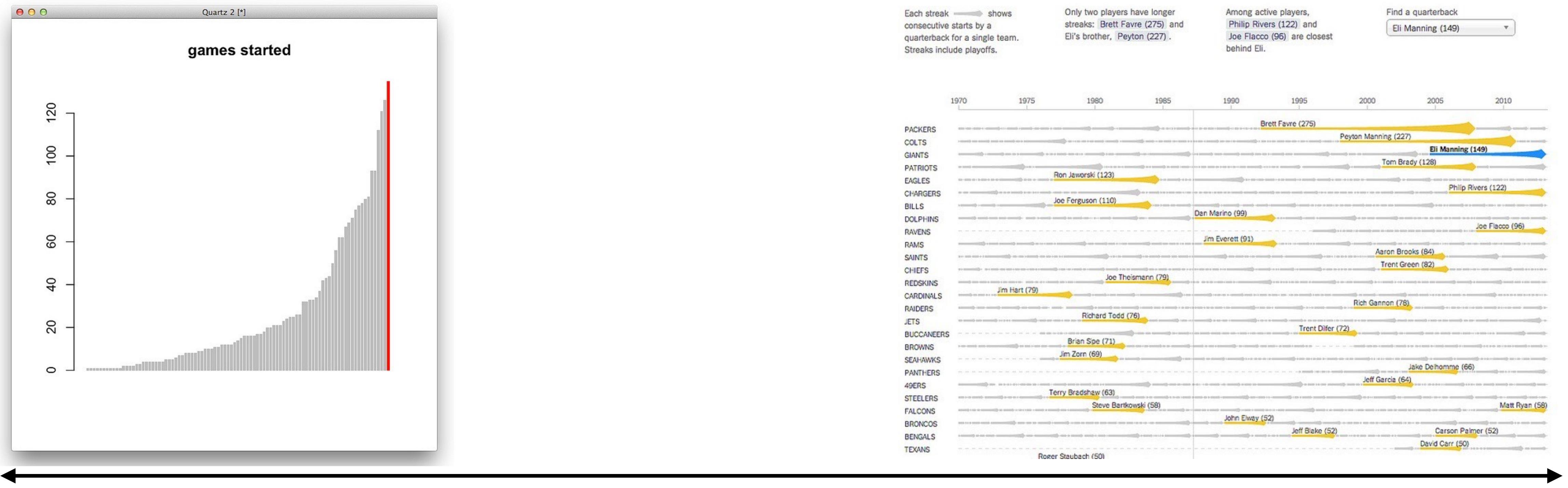


- Bar chart race
- Use motion to encode changes
- Video much more common today

[NFL]

# Exploration <-> Communication Spectrum

## Consecutive Starts by a Quarterback for a Single Team



# What types of data can we visualize?

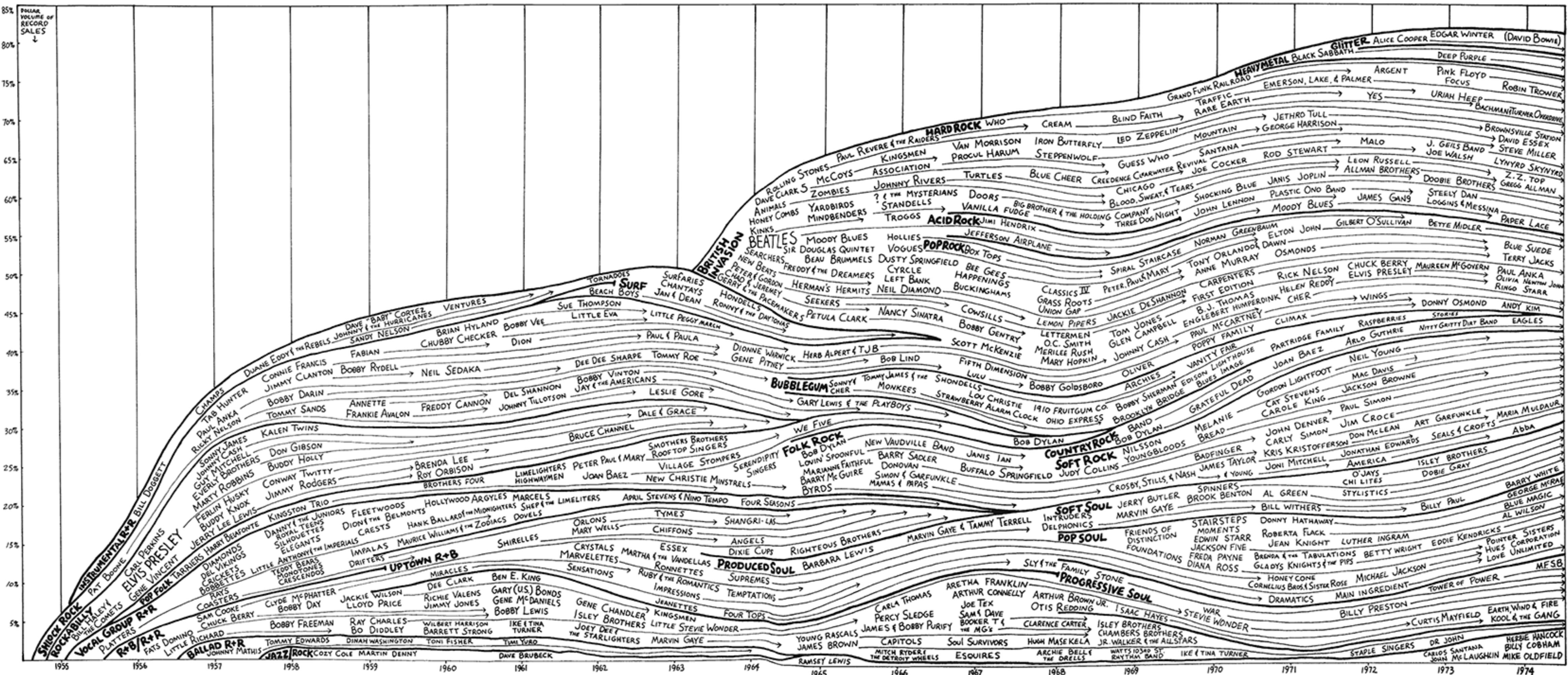
# Types of Data

---

- Tables
- Networks (Graphs)
- Spatial Data
  - Geography
  - Physical (e.g. Scientific, Medical)
- Text
- Sets

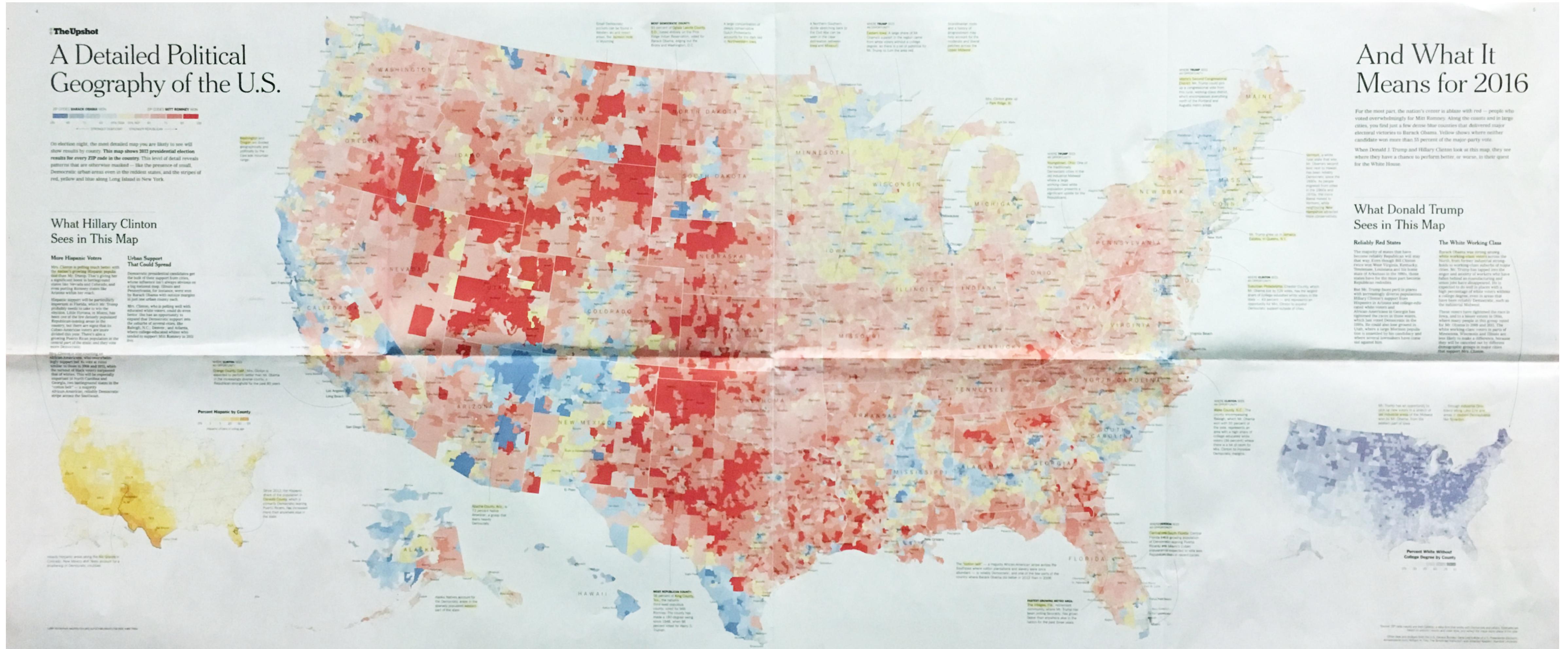
# Where have you seen visualizations?

# Books/Posters



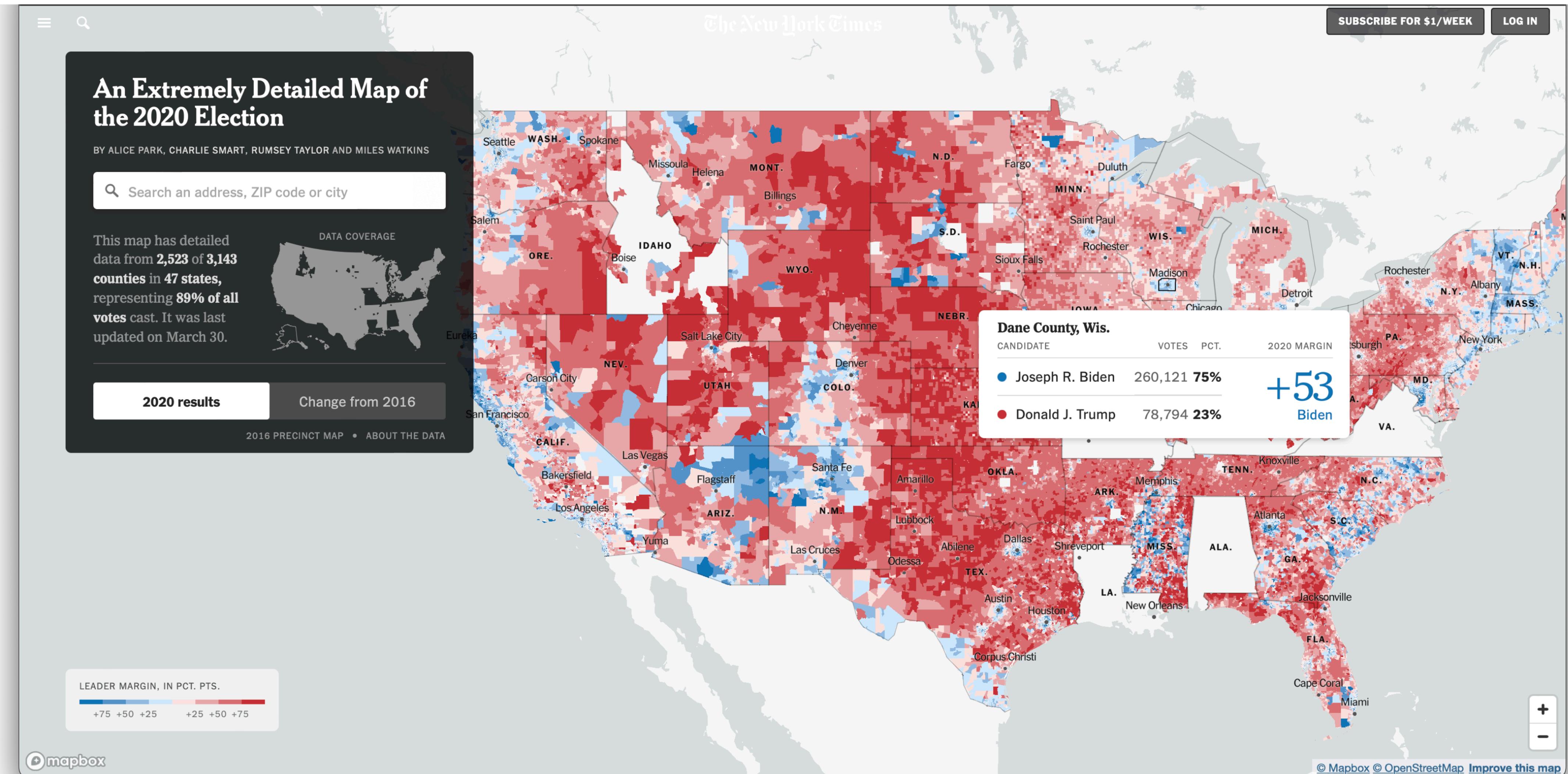
[Rock 'N' Roll is Here to Stay, R. Garofalo, 1977 (via Tufte)]

# Newspapers

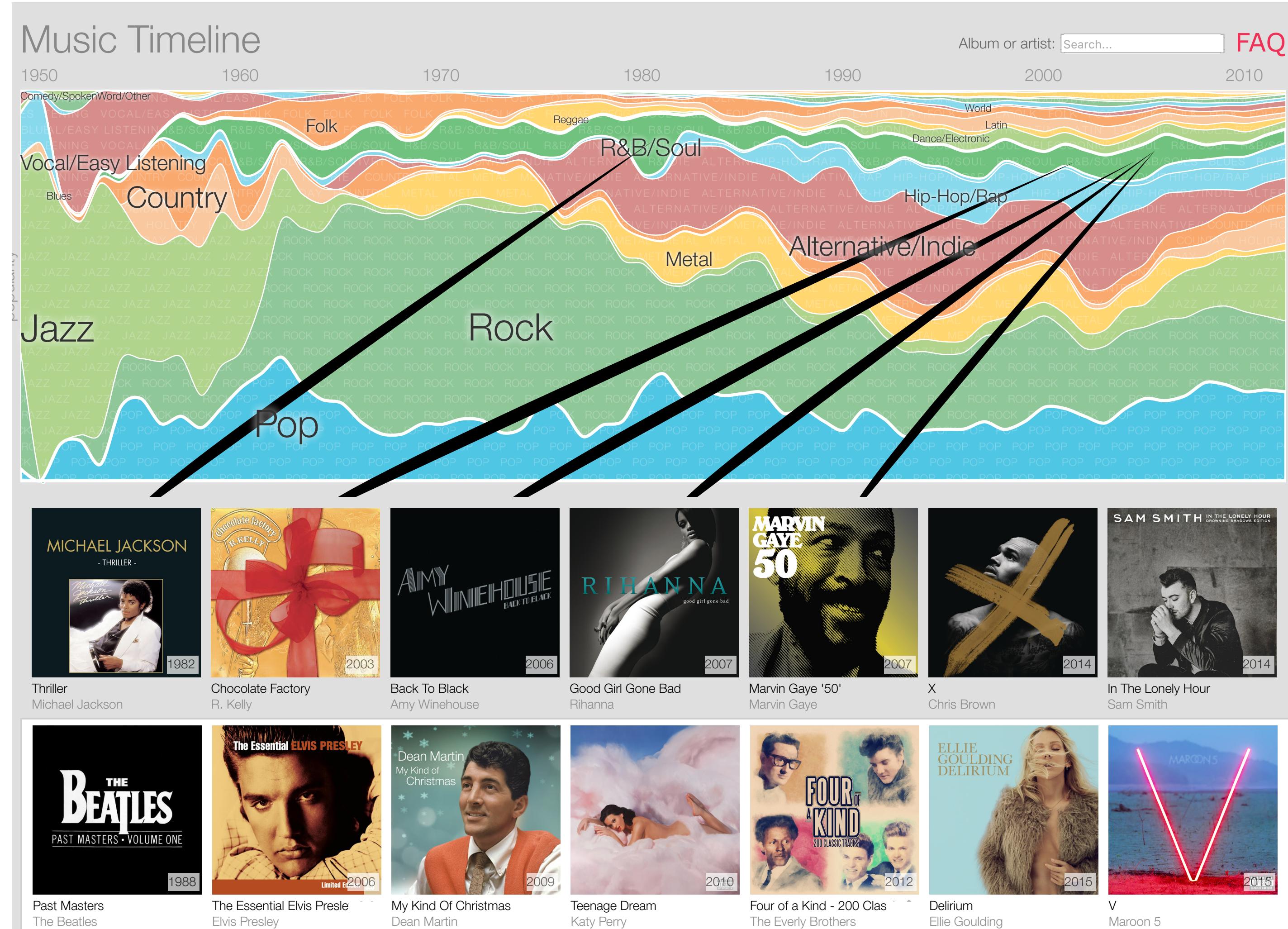


[NYTimes]

# Web



# Web



# [Music Timeline, Google Research (No Longer Working)]

# What is the advantage of the second versions?

# Interaction

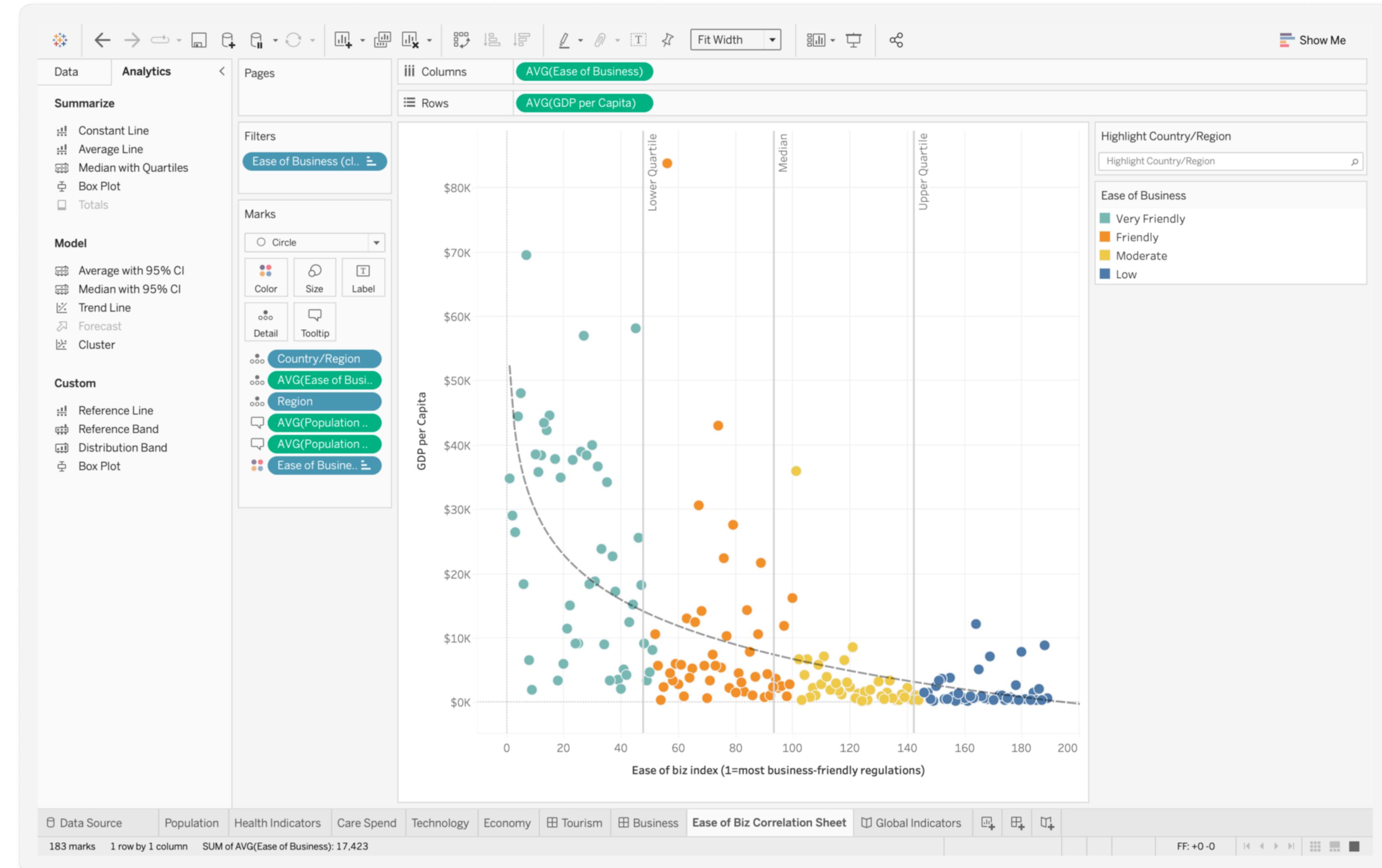
# How do we create modern visualizations?

# Tools

---

- Desktop Applications:
  - Excel (see [excelcharts.com](http://excelcharts.com))
  - Tableau
  - PowerBI
- Grammars:
  - Vega-Lite
- Programming Frameworks
  - d3.js
  - Observable Plot, [plot.ly](http://plot.ly), [deck.gl](http://deck.gl)
  - ...
- Tradeoffs
  - Speed
  - Customization
  - Understanding
  - Dissemination

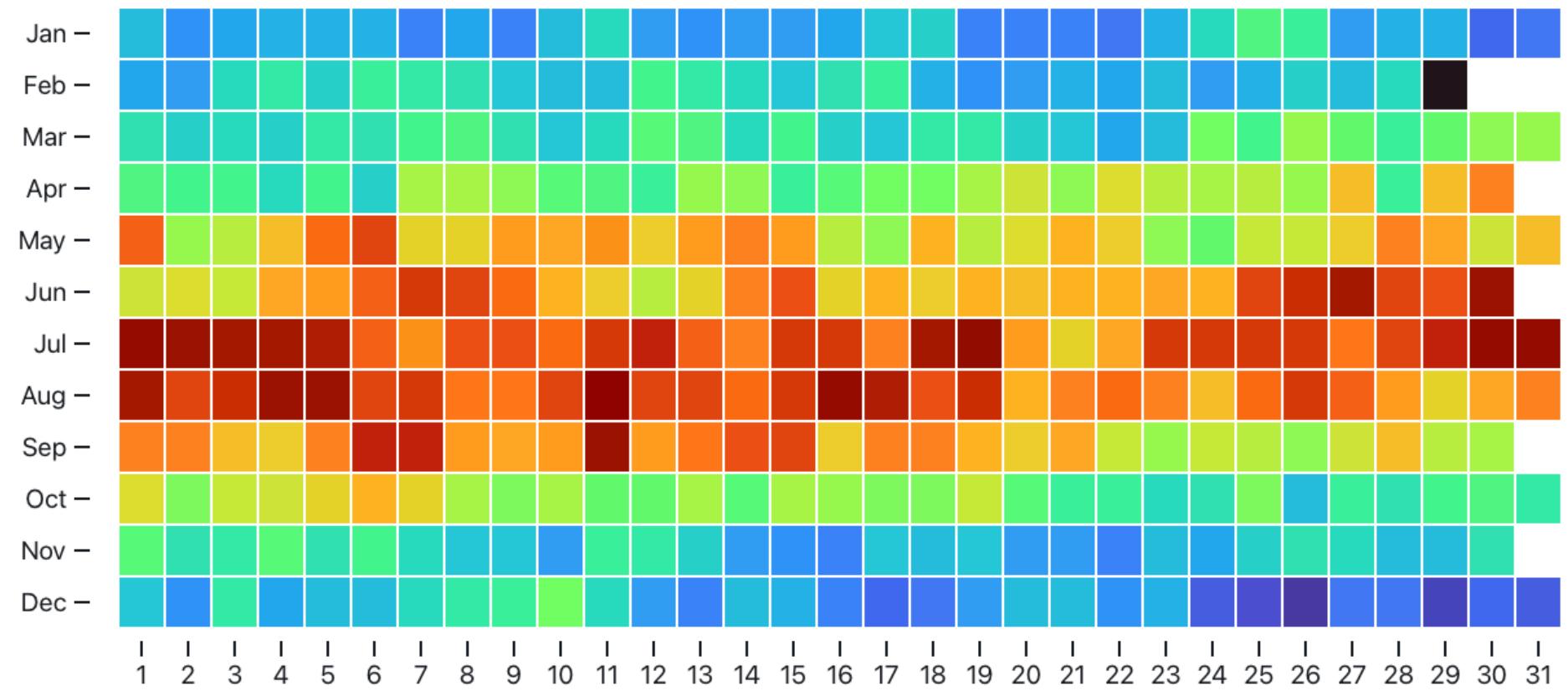
# Tableau



[Tableau Desktop]

# Observable Plot

```
seattle = ► Array(1461) [Object, Object,  
seattle = FileAttachment("seattle-weather.csv").csv({typed: true})
```



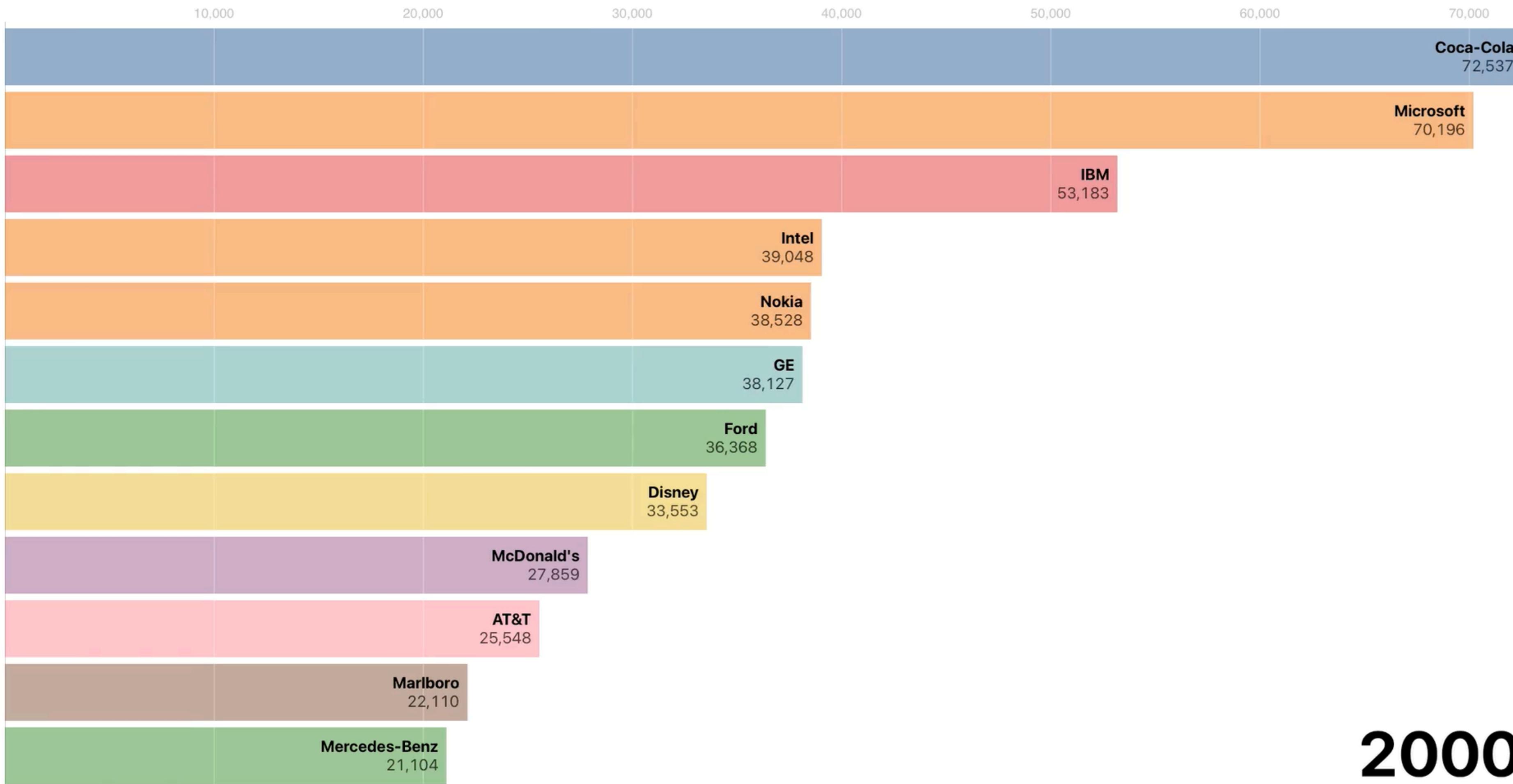
```
Plot.plot({  
  height: 300,  
  padding: 0,  
  y: {  
    tickFormat: Plot.formatMonth("en", "short")  
  },  
  marks: [  
    Plot.cell(seattle, Plot.group({fill: "max"}, {  
      x: d => d.date.getUTCDate(),  
      y: d => d.date.getUTCMonth(),  
      fill: "temp_max",  
      inset: 0.5  
    }))  
  ]  
})
```

[Observable]

# d3.js

## Best Global Brands

Value in \$M; color indicates sector. Data: [Interbrand](#)



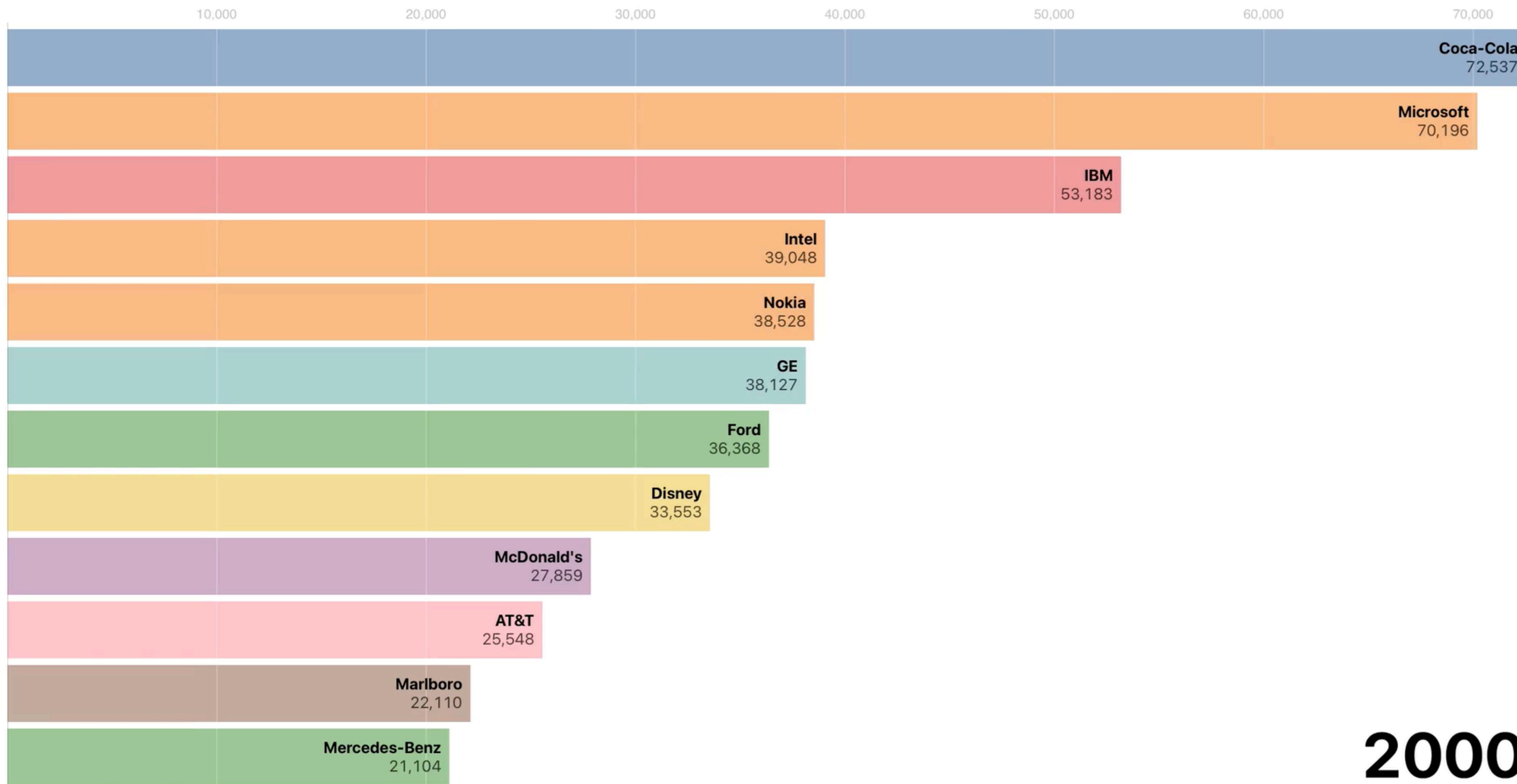
2000

[M. Bostock]

# d3.js

## Best Global Brands

Value in \$M; color indicates sector. Data: [Interbrand](#)

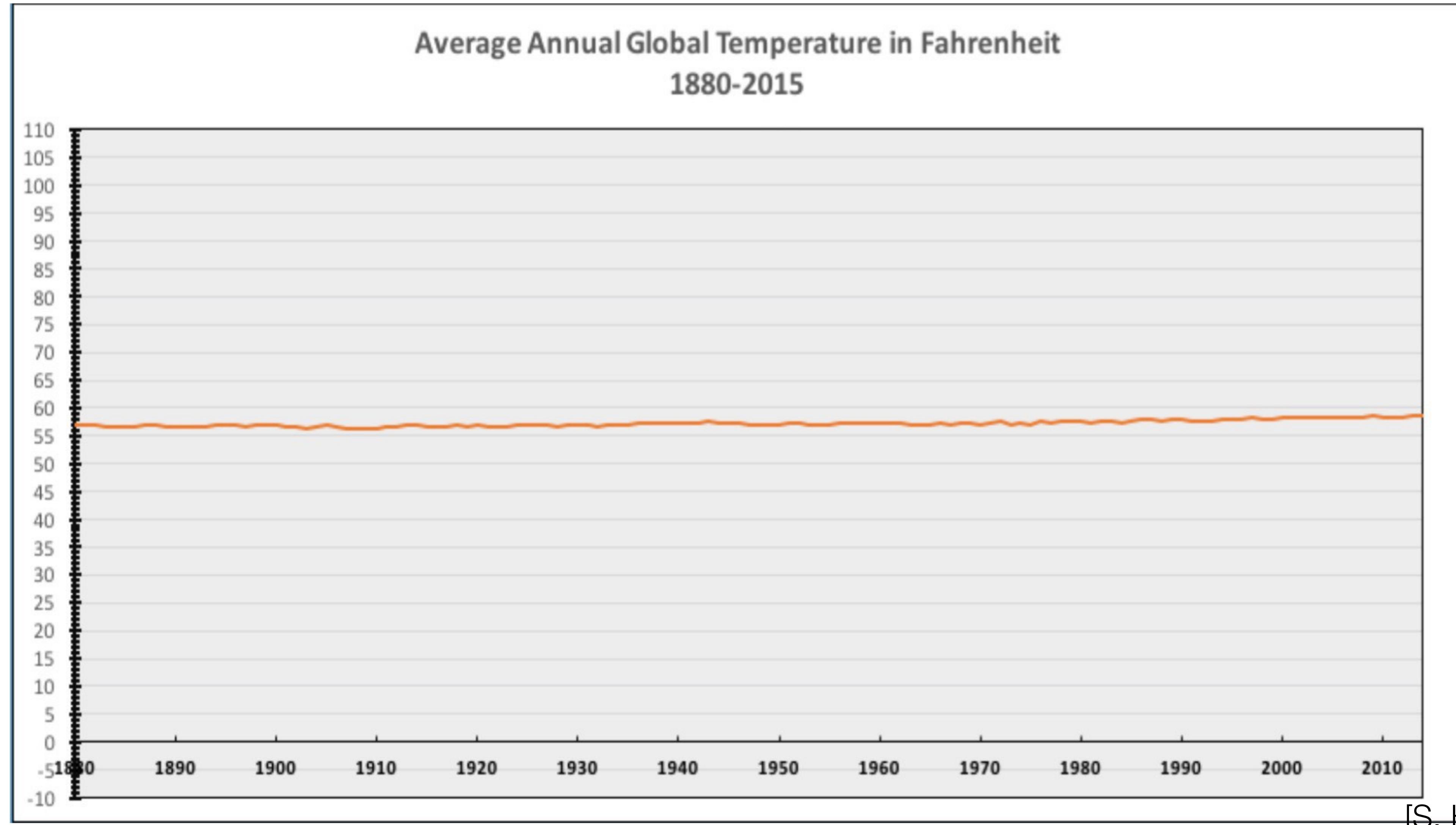


2000

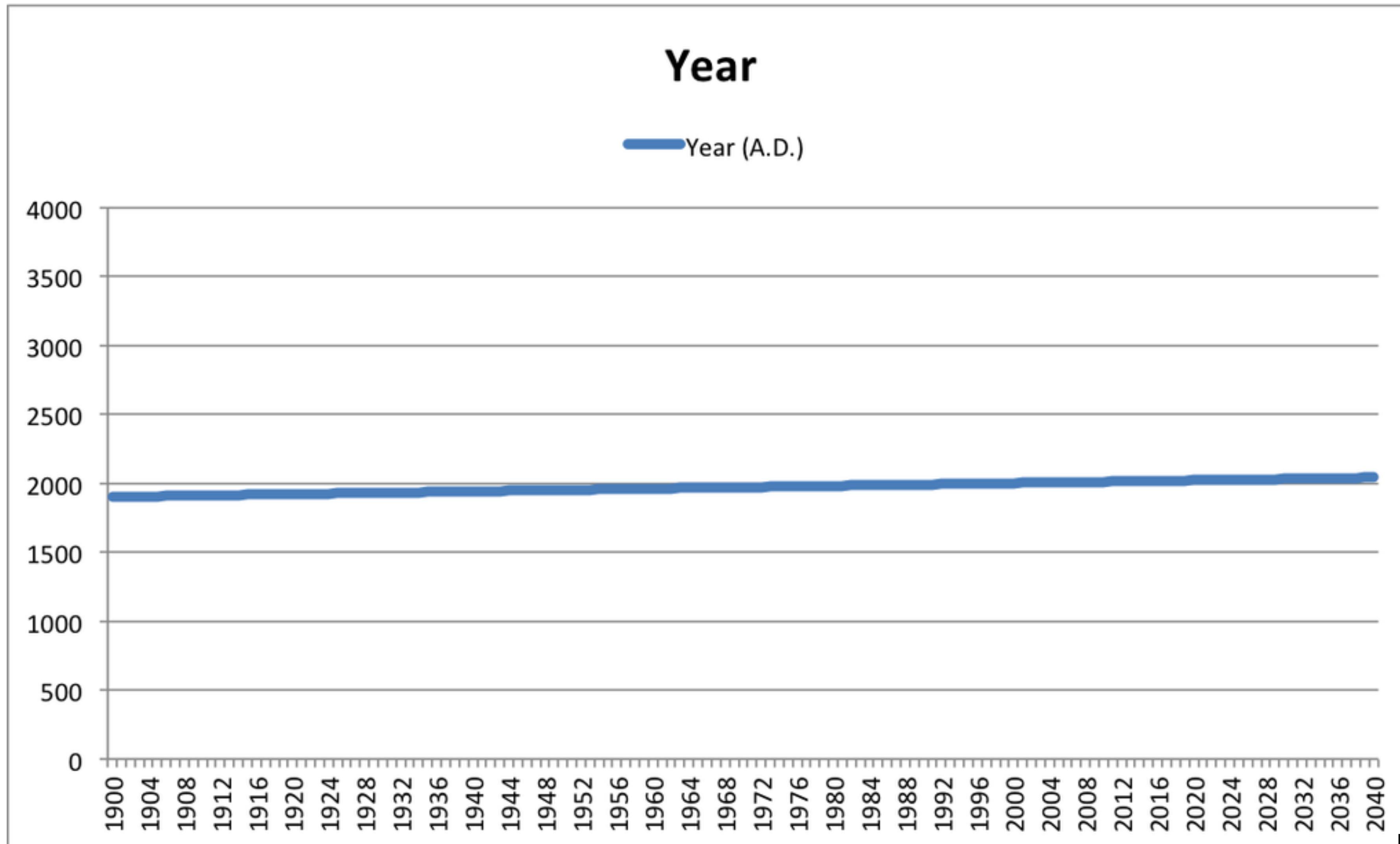
[M. Bostock]

# Why do we care about the design of visualizations?

# Design: Focus on only the y-axis

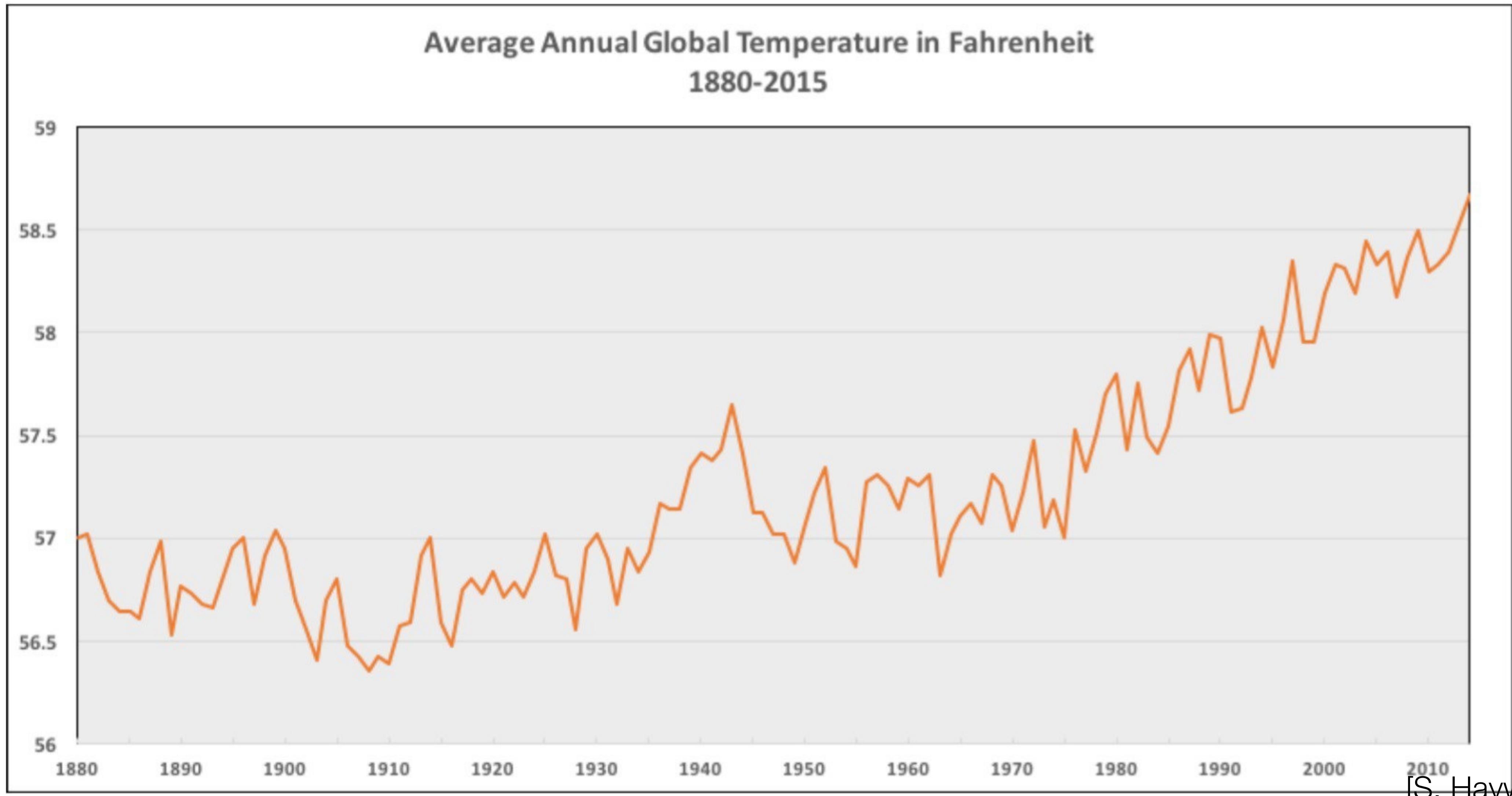


# Design: Year on the y-axis



[@bizweekgraphics]

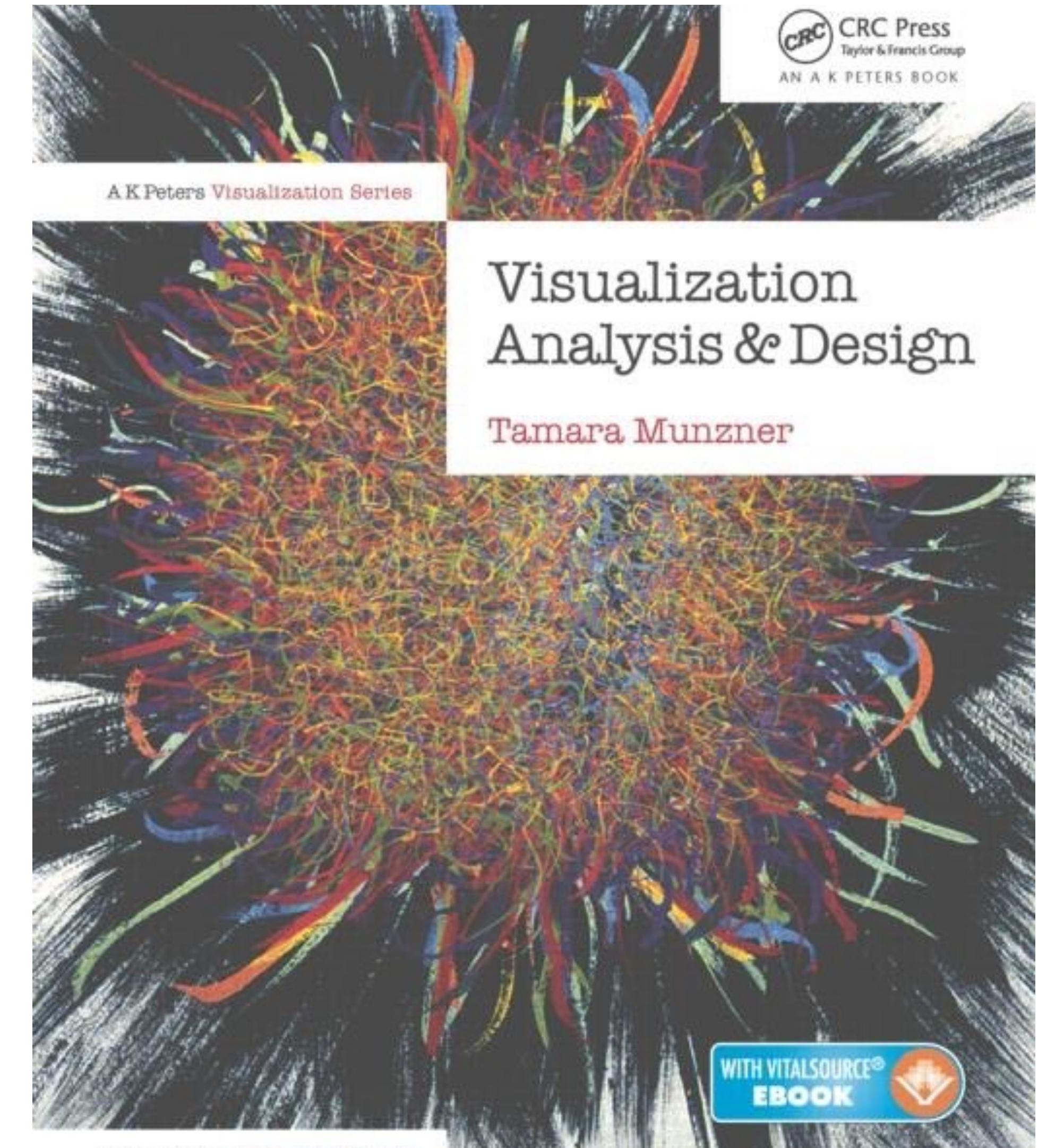
# Design: Different y-axis



# Administrivia

---

- Course Web Site
- Syllabus
  - Plagiarism
  - Accommodations
- Textbook:
  - Required: Munzner (VAD)
- Assignments
- Exams: Midterm (Mar. 4) and Final (May 4)



# Administrivia

---

- Undergraduate (CSCI 490) and Graduate (CSCI 627) Course
  - Graduate: Extra reading, exam questions
- Research Topics:
  - Also investigate some topics in depth
  - Research papers as assigned reading (CSCI 627)
- Project: Create an interactive visualization (or vis research)
  - Design
  - Data analysis
  - Insight
  - **Presentations:** Last week of class

# Exams, Quizzes, and Missed Classes

---

- All quizzes and exams are **in-person, closed-book, and closed-notes**
- **No makeup** quizzes or exams will be given\*
- You are responsible for all material presented in class and assigned readings.  
If you miss a lecture, be sure to obtain class notes from a classmate before the next class meeting
- Midterm: March 4
- Final: April 4

# Office Hours & Communication

---

- Office hours will be held **in person**
- Scheduled office hours are open to all students
  - M: 1:45-3pm, W: 10:45am-12pm, or by appointment
- You **do not** need an appointment to stop in during scheduled office hours
- If you need an appointment outside of those times, please email me with **details** about what you wish to discuss
- Many questions can be answered via email. **Please consider writing an email before scheduling a meeting.**
- **Do not send me screenshots of code!** (send code or Observable links)

# **Do not cheat!**

# Do not plagiarize

---

- It is **Academic Misconduct**
- Do your own work, do not copy anyone else's work, text, sentences, ...
  - Anyone = another student, an internet source, book, blog, ...
- Do not share your work with anyone else
- Never quote text unless there is a specific need.
  - "I think there is a world market for maybe five computers."  
— Thomas Watson (1874-1956), Chairman of IBM, 1943
- **Cite** sources that back up your claims or reflect the origin of an idea
  - Vertex cover is an NP-Complete problem [1]. ...  
[1] Garey, M. R., and Johnson, D. S., "Computers and intractability: a guide to NP-completeness." 1979.

# Do not cheat

---

- Cheating on assignments, projects, and exams is not allowed
- You will receive a **zero** for any assignment/exam/etc. where cheating has occurred
- You will **fail** the course if you cheat more than once
- Misconduct is reported through the university's system
- You **may** discuss problems and approaches with other students
- You **may not** copy or transcribe code from another source (includes generative AI)

# Do ask questions!

# Do ask questions

---

- If you are stuck on a specific issue with an assignment:
  - Do consult books, online documentation, tutorials
  - Do discuss that specific issue with a classmate
  - Do email me with **specific** questions
- If you are asked about a question:
  - Do not share your code
  - If the questioner is trying to cheat, walk away
  - If you see an obvious mistake, kindly point it out
  - Suggest a specific function or library that may be useful
  - Discuss approaches or techniques

# Questions?