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

D. Koop, CSCI 627/490, Spring 2025

– R. W. Hamming











The purpose of visualization is about insight, not pictures

D. Koop, CSCI 627/490, Spring 2025

– B. Shneiderman











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







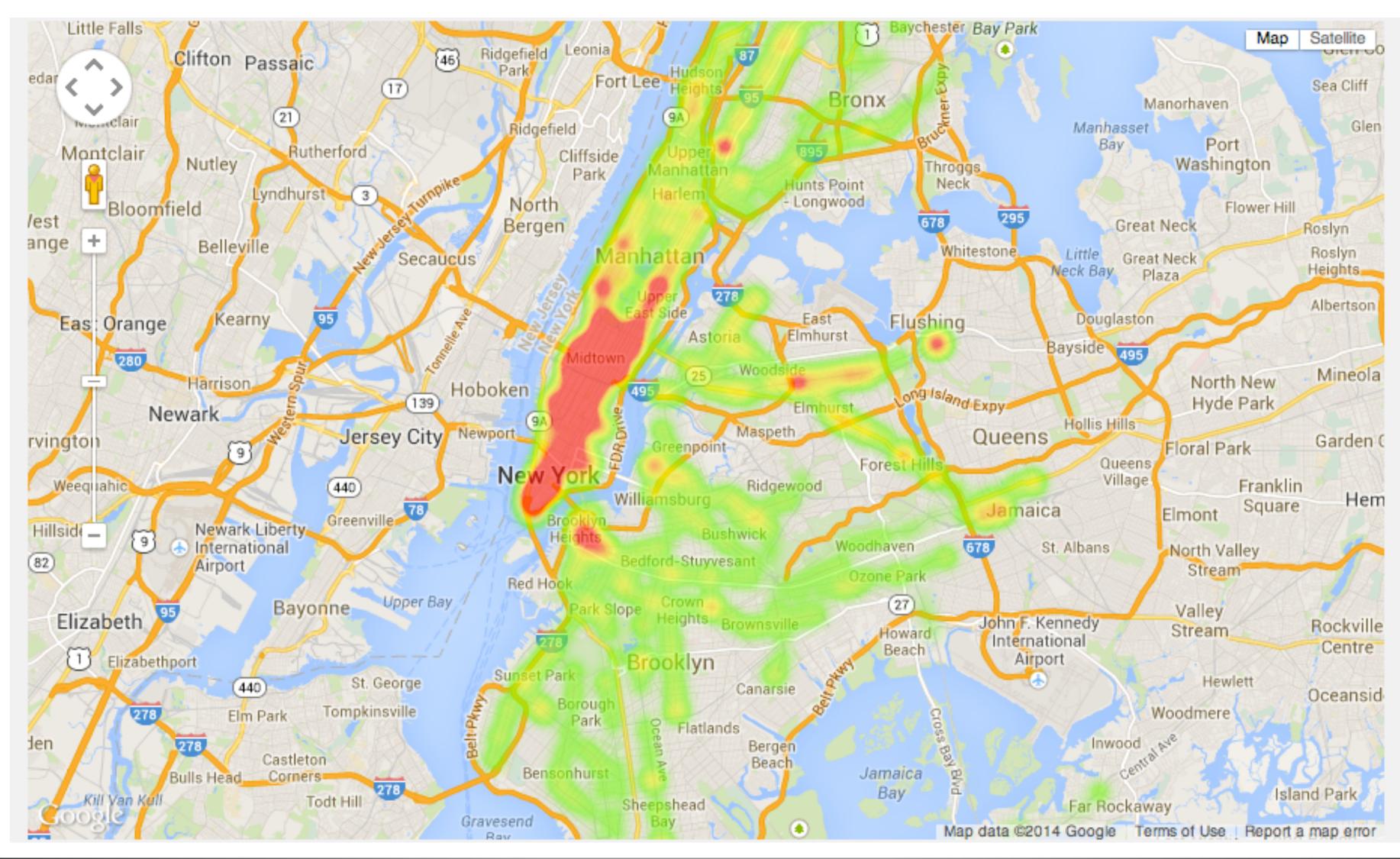
MTA Fare Data Table

	REMOTE	STATION	FF V	SEN/DIS	7-D AFAS UNL	D AFAS/RMF I	JOINT RR TKT	7-D UNL	30-D UNL
1 F	R011	42ND STREET & 8TH AVENUE	00228985	00008471	00000441	00001455	00000134	00033341	0007125
2 F	R170	14TH STREET-UNION SQUARE	00224603	00011051	00000827	00003026	00000660	00089367	00199843
3 F	R046	42ND STREET & GRAND CENTRAL	00207758	00007908	00000323	00001183	00003001	00040759	00096613
4 F	R012	34TH STREET & 8TH AVENUE	00188311	00006490	00000498	00001279	00003622	00035527	00067483
5 F	R293	34TH STREET - PENN STATION	00168768	00006155	00000523	00001065	00005031	00030645	00054376
6 F	R033	42ND STREET/TIMES SQUARE	00159382	00005945	00000378	00001205	00000690	00058931	00078644
7 F	R022	34TH STREET & 6TH AVENUE	00156008	00006276	00000487	00001543	00000712	00058910	00110460
8 F	R084	59TH STREET/COLUMBUS CIRCLE	00155262	00009484	00000589	00002071	00000542	00053397	0011396
9 F	R020	47-50 STREETS/ROCKEFELLER	00143500	00006402	00000384	00001159	00000723	00037978	0009074
10 F	R179	86TH STREET-LEXINGTON AVE	00142169	00010367	00000470	00001839	00000271	00050328	0012525
11 F	R023	34TH STREET & 6TH AVENUE	00134052	00005005	00000348	00001112	00000649	00031531	0007504
12 F	R029	PARK PLACE	00121614	00004311	00000287	00000931	00000792	00025404	0006536
13 F	R047	42ND STREET & GRAND CENTRAL	00100742	00004273	00000185	00000704	00001241	00022808	0006821
14 F	R031	34TH STREET & 7TH AVENUE	00095076	00003990	00000232	00000727	00001459	00024284	0003867
15 F	R017	LEXINGTON AVENUE	00094655	00004688	00000190	00000833	00000754	00020018	0005506
16 F	R175	8TH AVENUE-14TH STREET	00094313	00003907	00000286	00001144	00000256	00038272	0007466
17 F	R057	BARCLAYS CENTER	00093804	00004204	00000454	00001386	00001491	00039113	0006811
18 F	R138	WEST 4TH ST-WASHINGTON SO	00093562	00004677	00000251	00000965	00000127	00031628	0007445





MTA Fare Data Visualization



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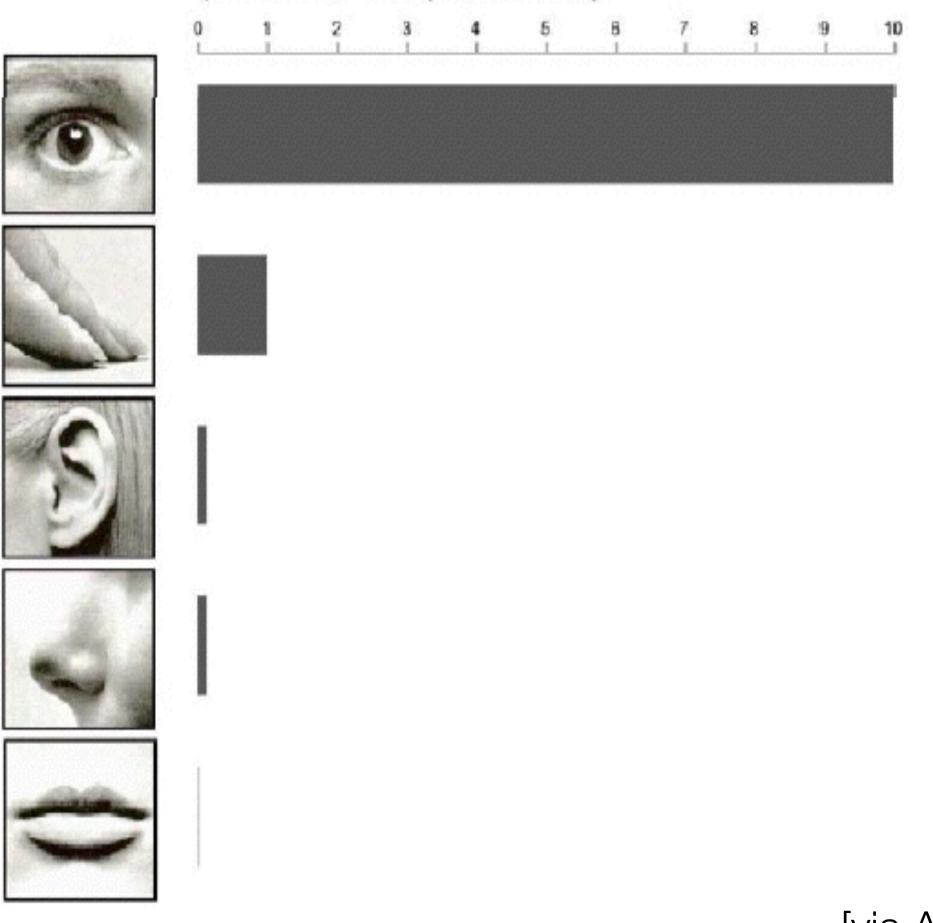


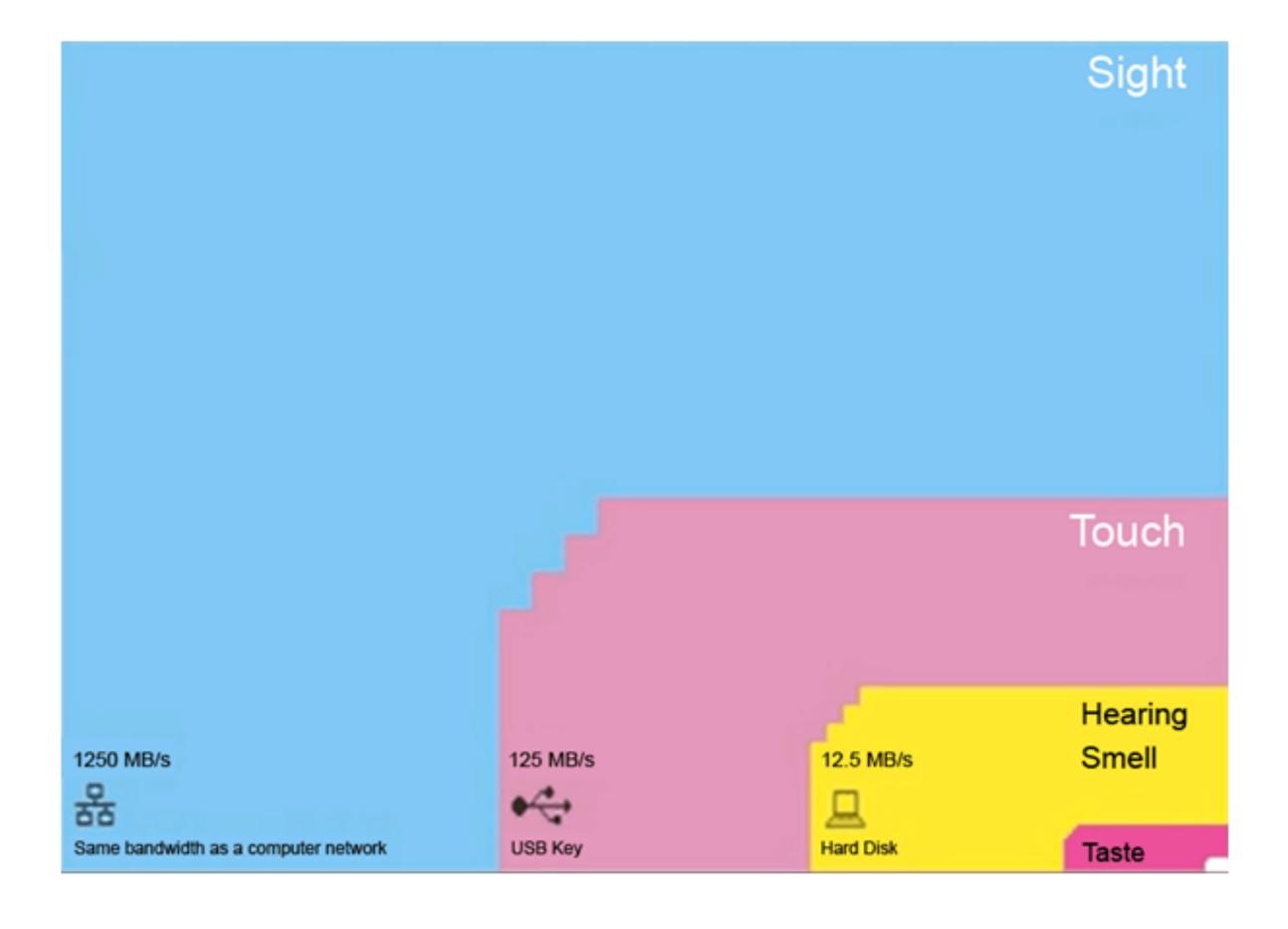
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Why do we visualize data?

Total Bandwidth

(millions of bits per second)













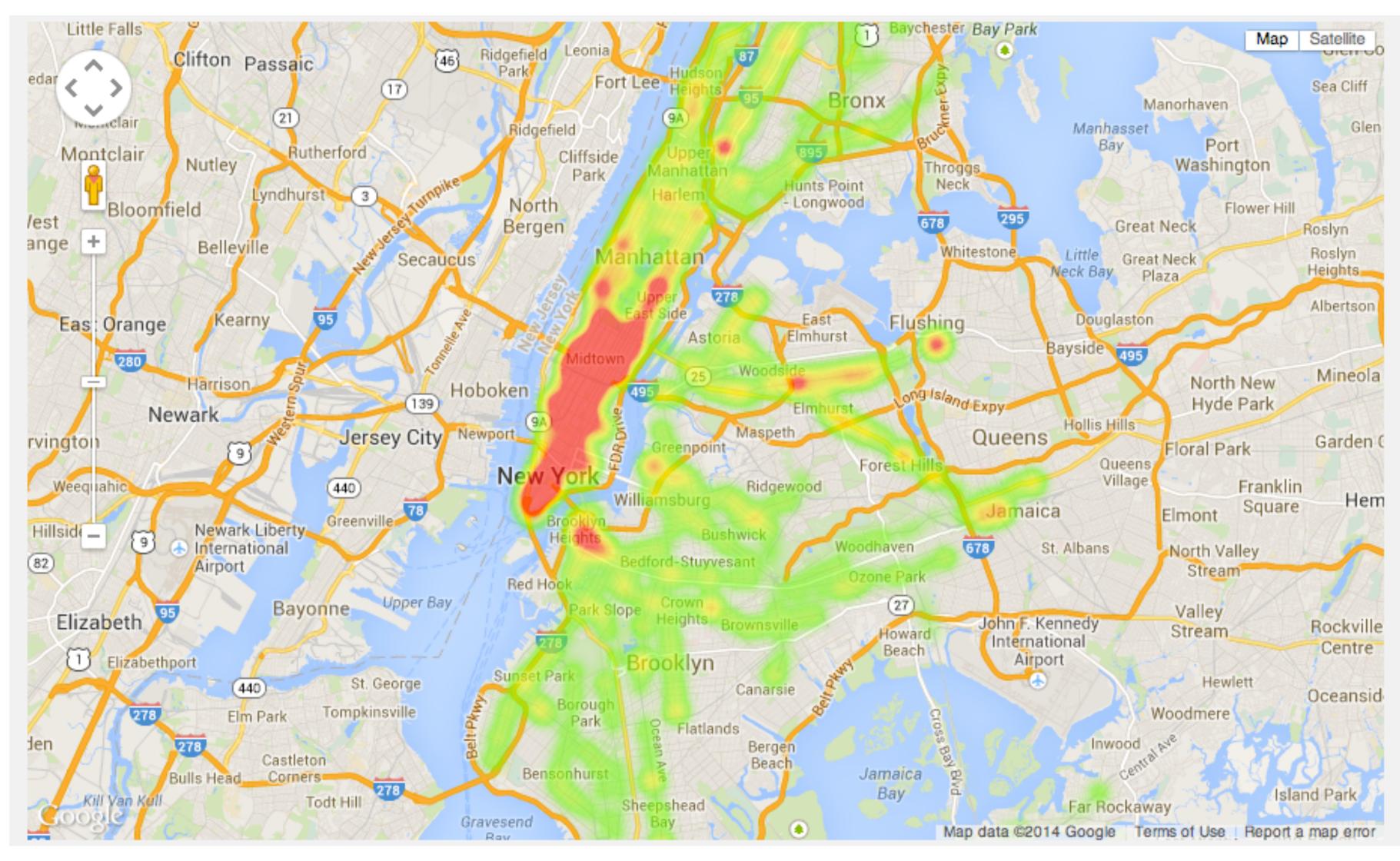


What are the goals of visualization?





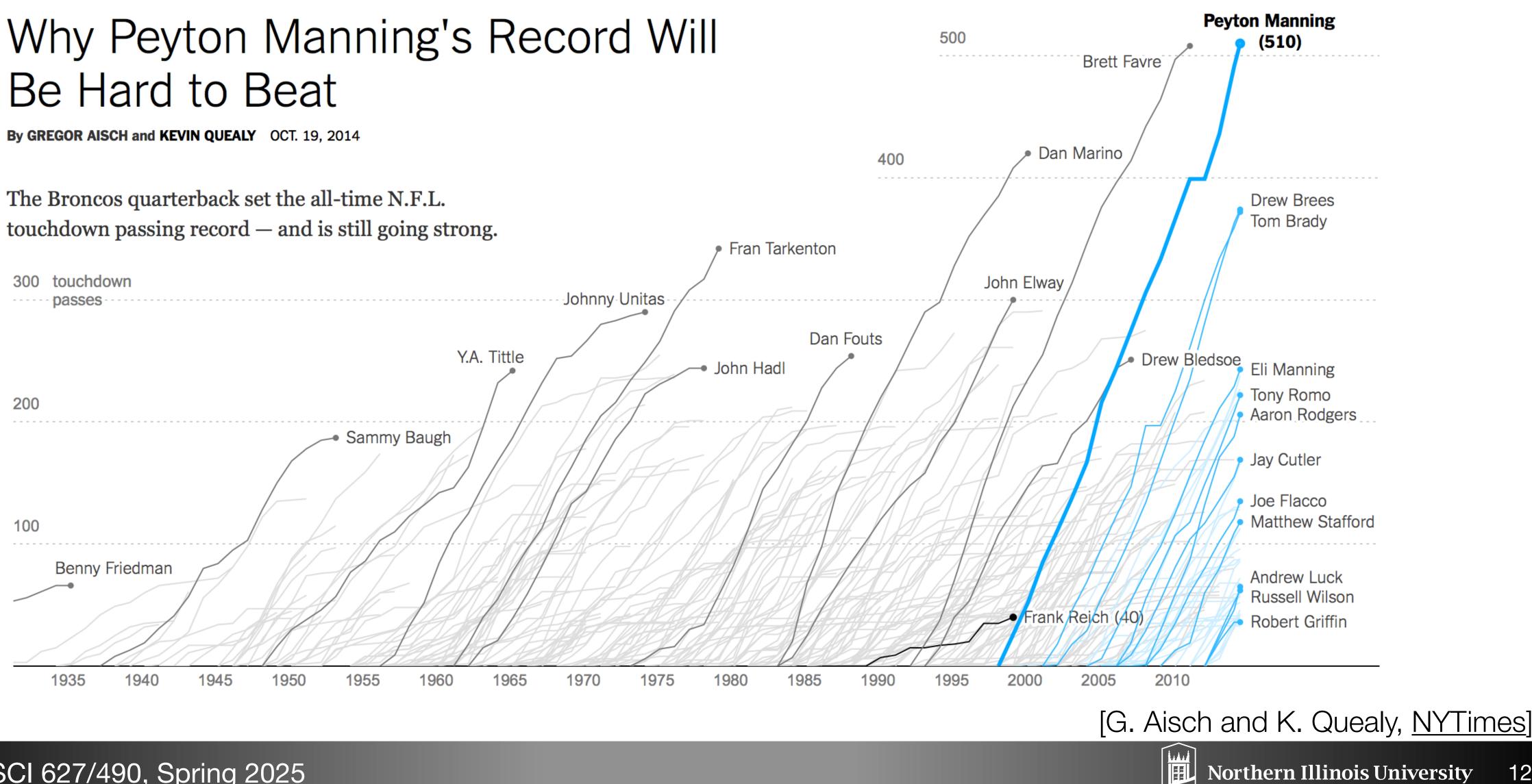
Analysis: Subway Ridership Density







Communication: Peyton's Records



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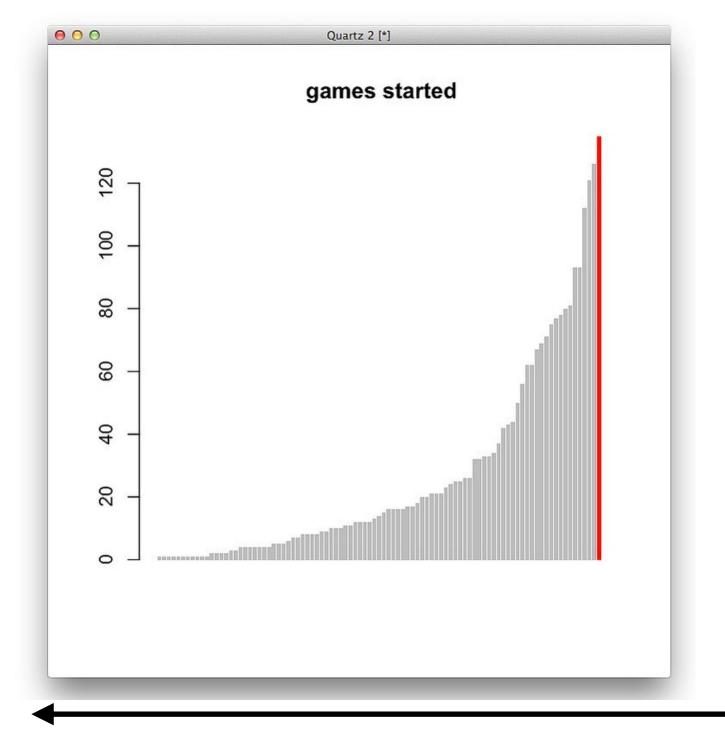




Exploration <-> Communication Spectrum

Consecutive Starts by a Quarterback for a Single Team

Each streak ------ shows

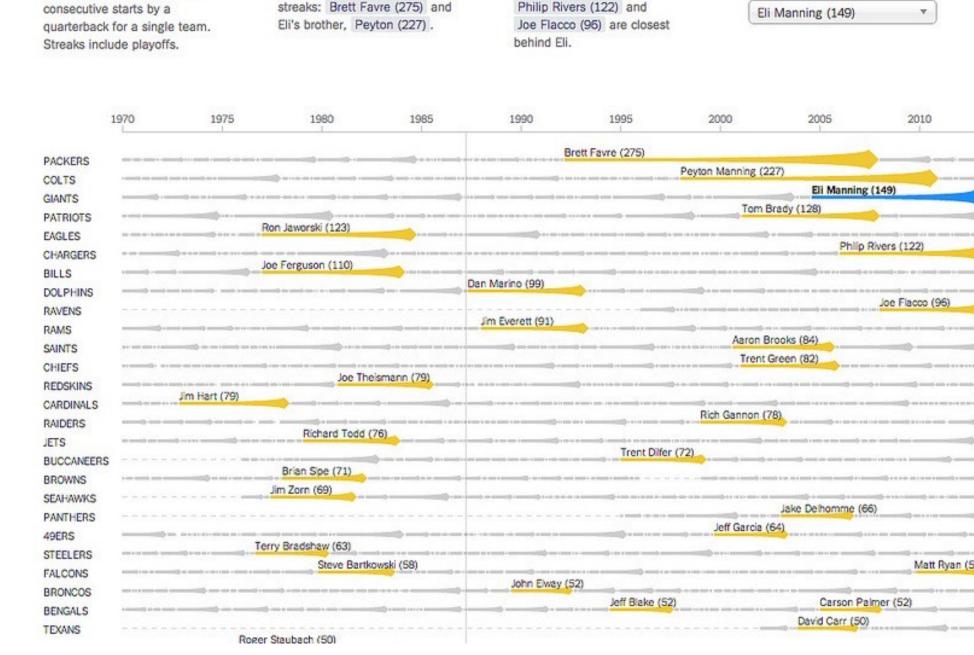


Exploration



Questions

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Only two players have longer

streaks: Brett Favre (275) and

Among active players,

Philip Rivers (122) and

Confirmation

Communication

Answers/Persuasion





Find a quarterback



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What types of data can we visualize?





Types of Data

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



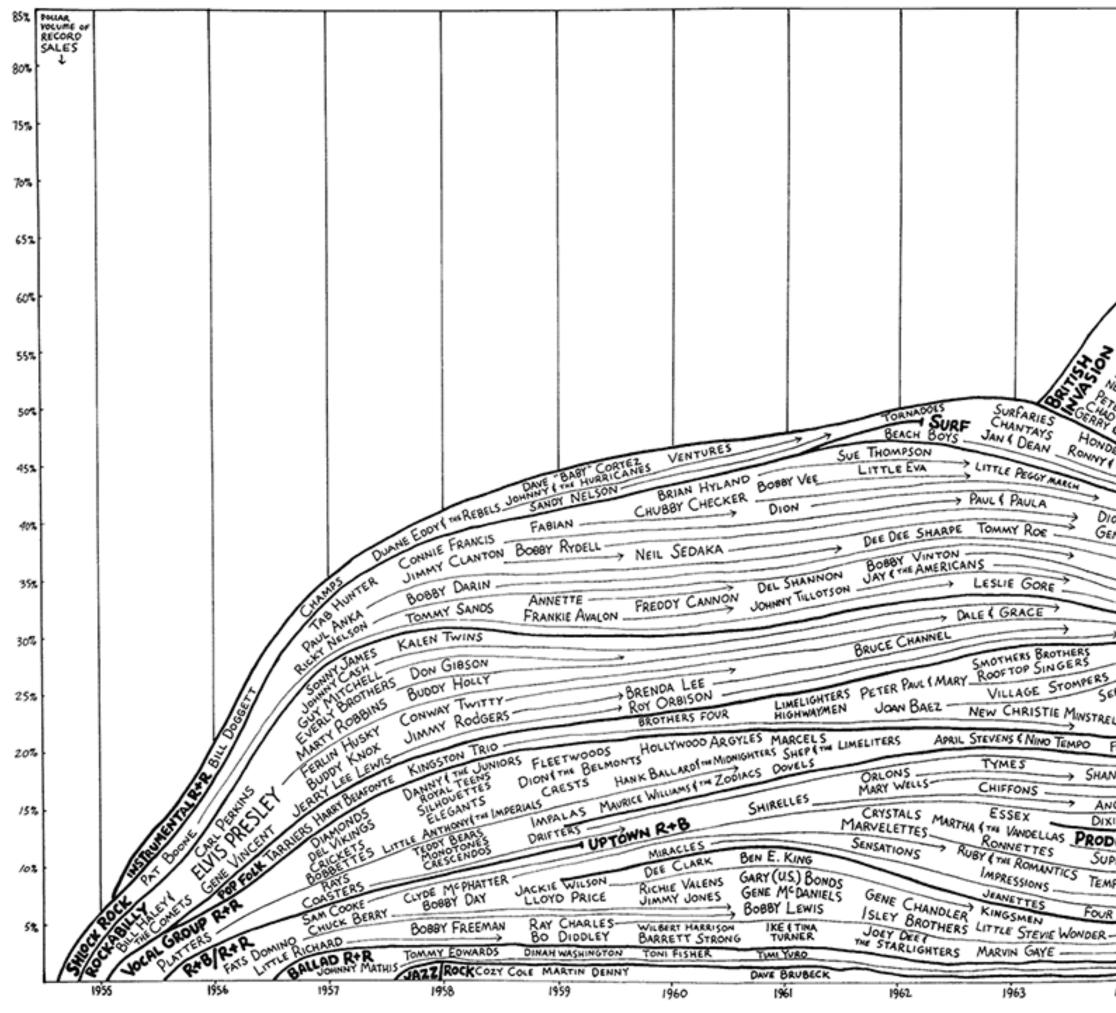


Where have you seen visualizations?

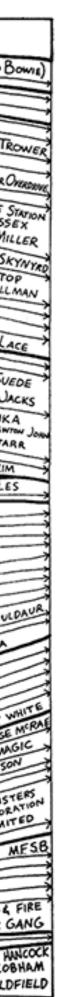




Books/Posters



			GRAND FUNK RAILROAD		ALICE COOPER	EDGAR WINTER	(DAVID BOWIE)
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			HEAV	YMEINE C	ARGENT	PINK FLOYD -	
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ROLUNKS ZOMBIES			CUOLE .	JANIS JOPLIN PLASTIC OND BAND MODDY BLUES	James Cure S	DOBIE BROTHERS	REGG ALLMAN
DAVIALS VIDORIROS	STANDELLS VANILLA BIO	BROTHER (THE HOLDING COMPAN	Y NICHT JOHN LENNON	MOODI OLVES	Grand CANS L	OGGINS & MESSINA	
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TER GORATS TREODY & THE DREAMERS	LEFT BANK BUCKINGS	SpiRAL Out	MARY ANNE ANTERS	RICK NELSON	CHUCK BERRY MAN		UL ANKA
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DIONINE WARNICK HERB ALPERT & TJB GENE PITNEY	BOB LIND FIFTH DI	MARY HOPKIN JOHN	CASH POPPY FAIR R VANITY FAIR VANITY FAIR	PARTRID	NEIL YOUNG		
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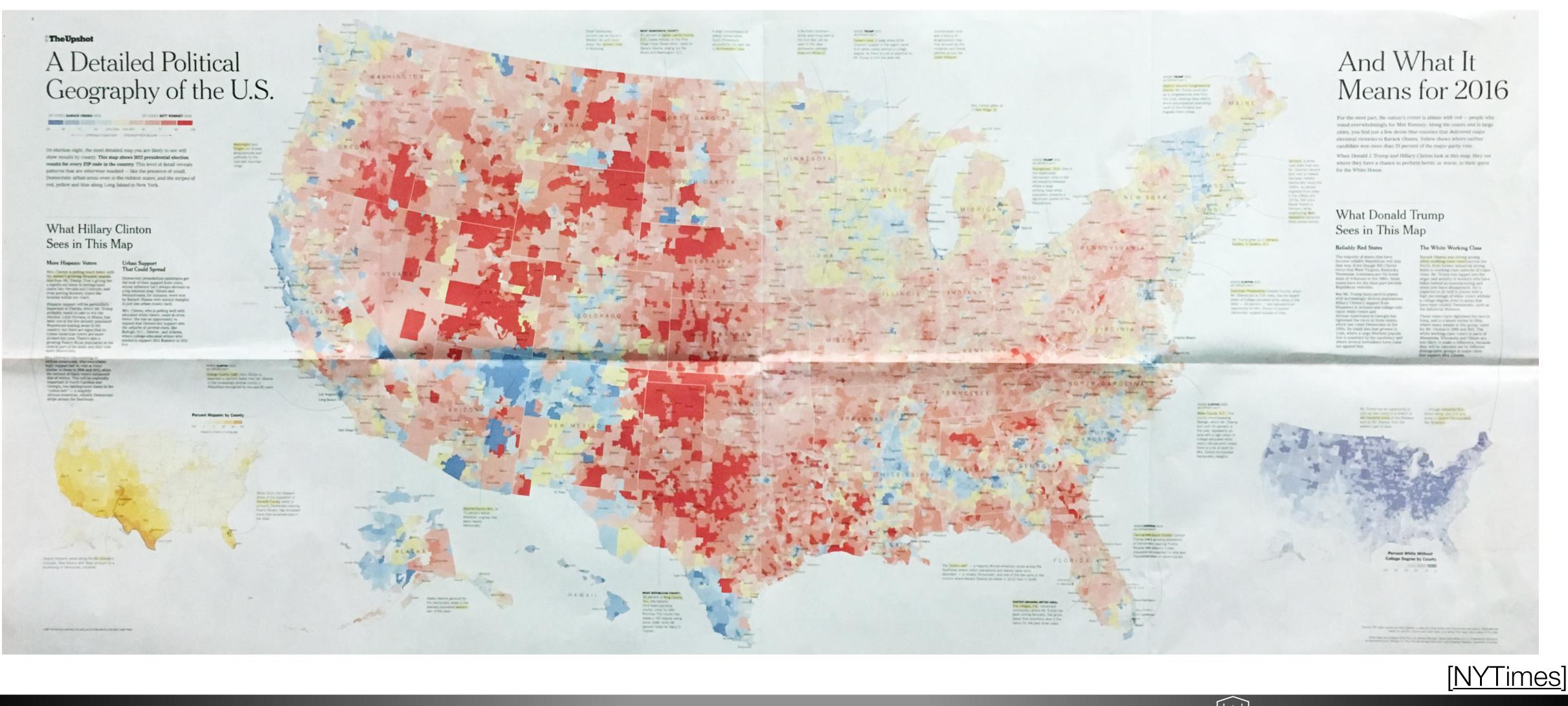








Newspapers

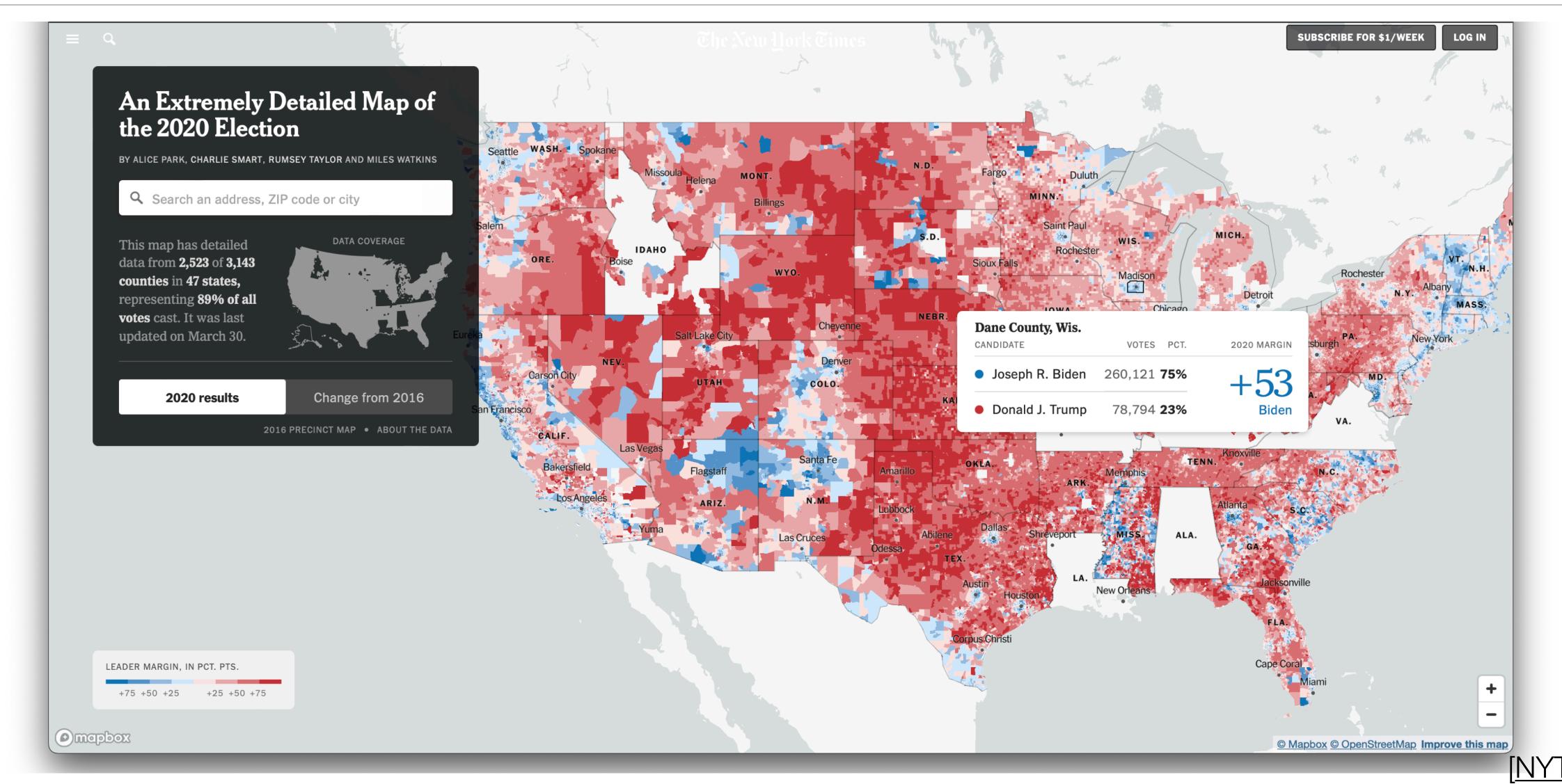








Web



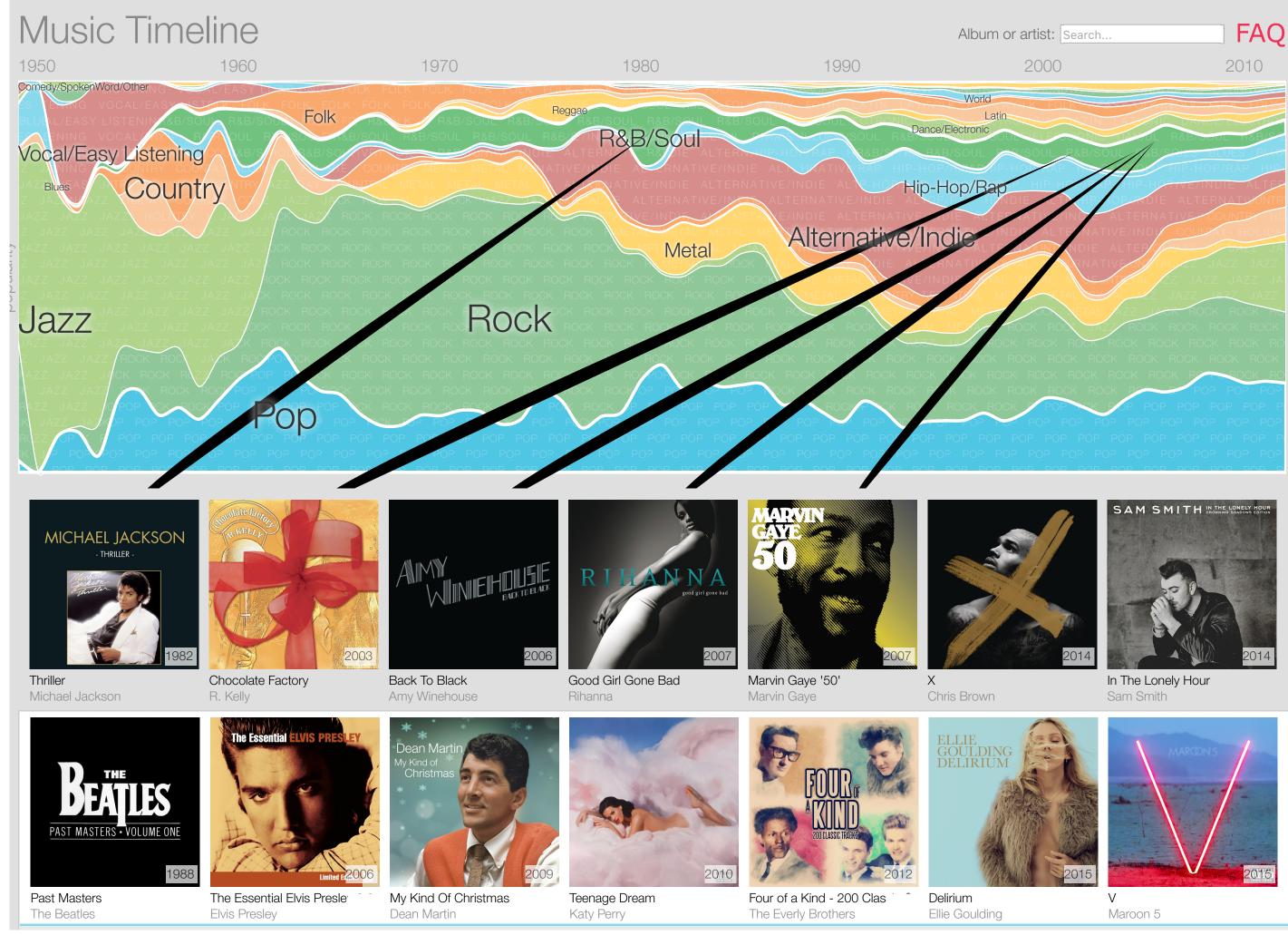








Web



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





What is the advantage of the second version?







Interaction







How do we create modern visualizations?







Tools

- ...

- Desktop Applications:
 - Excel (see <u>excelcharts.com</u>)
 - Tableau
- Grammars:
 - Vega-Lite
- Programming Frameworks
 - d3.js

. .

- Observable Plot, plot.ly, deck.gl

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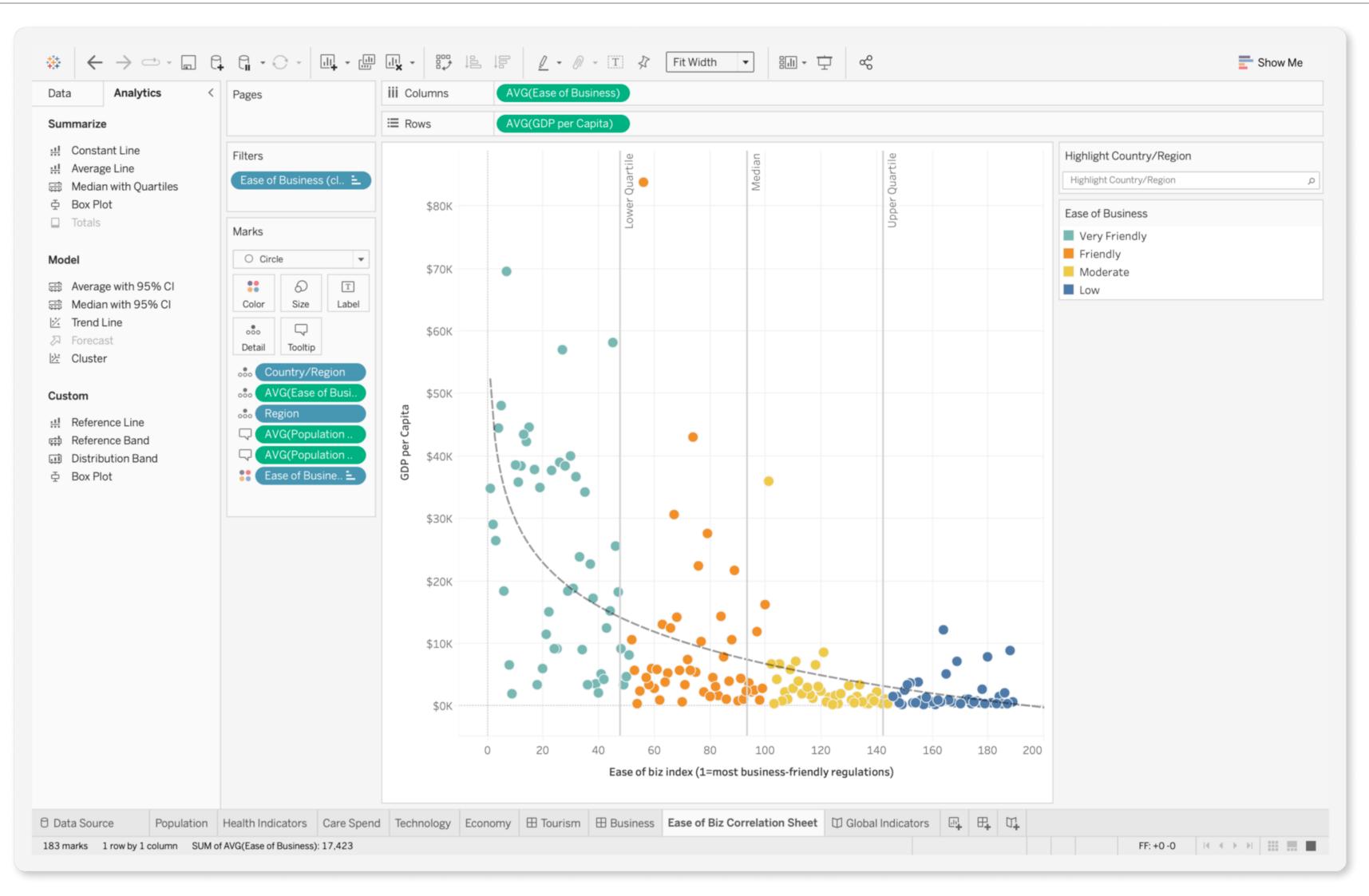
- Tradeoffs
 - Speed
 - Customization
 - Understanding
 - Dissemination





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Tableau







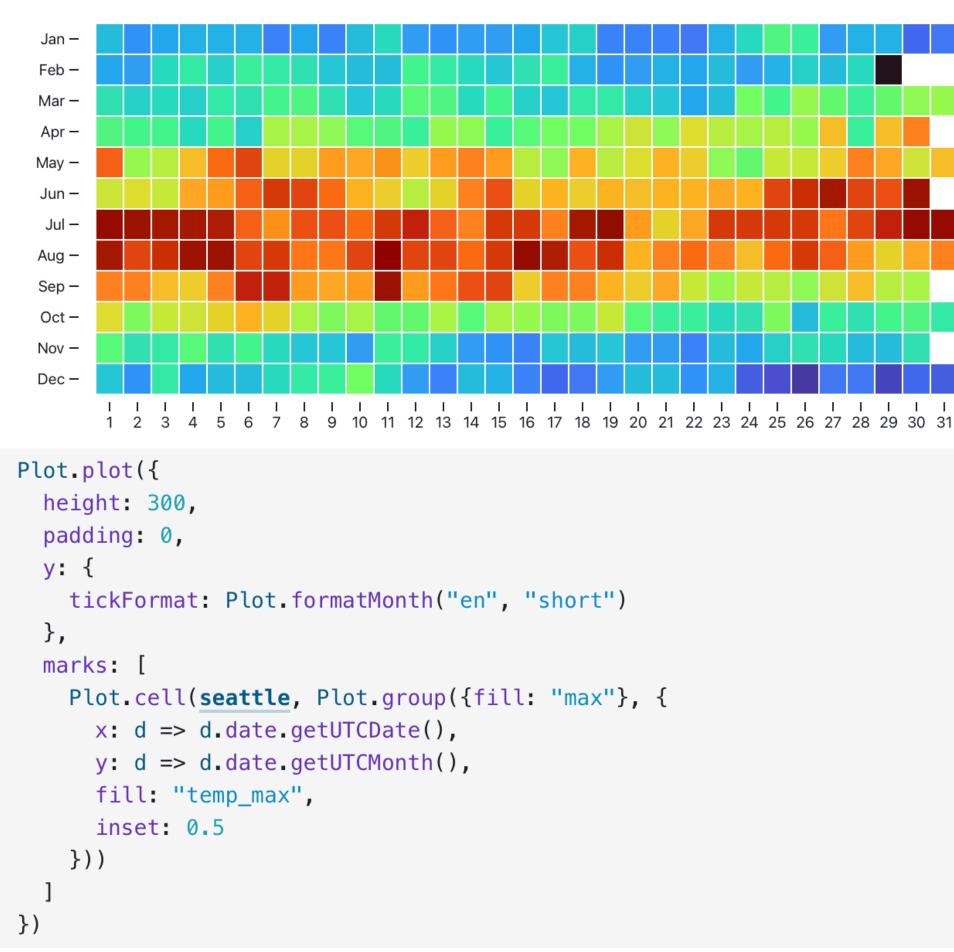






Observable Plot

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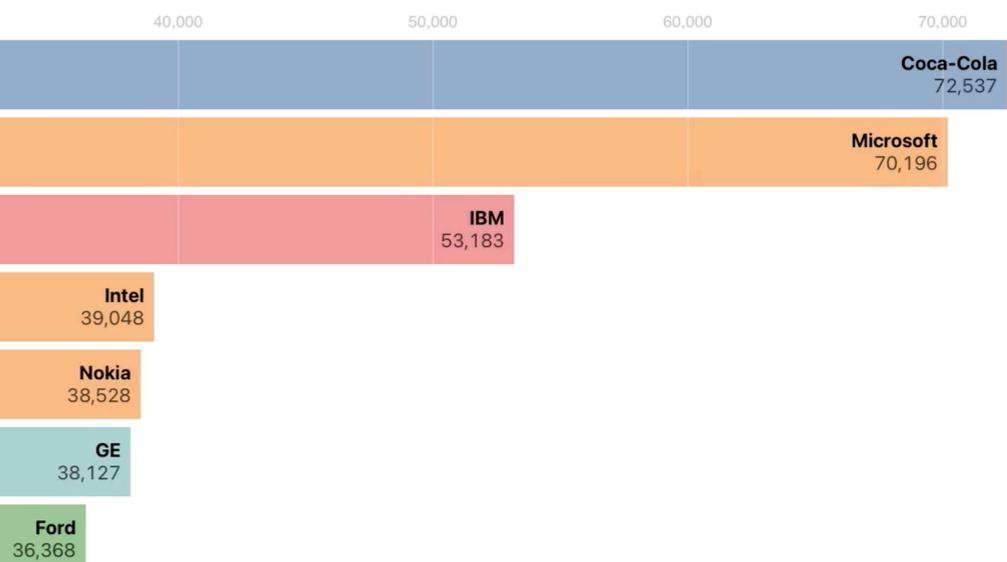


d3.js

Best Global Brands

Value in \$M; color indicates sector. Data: Interbrand

10	,000 20,0	000	30,000
			Disney 33,553
		McDonald 27,85	s 9
		AT&T 25,548	
	Marl 22	boro 2,110	
	Mercedes-Ber 21,10	nz)4	













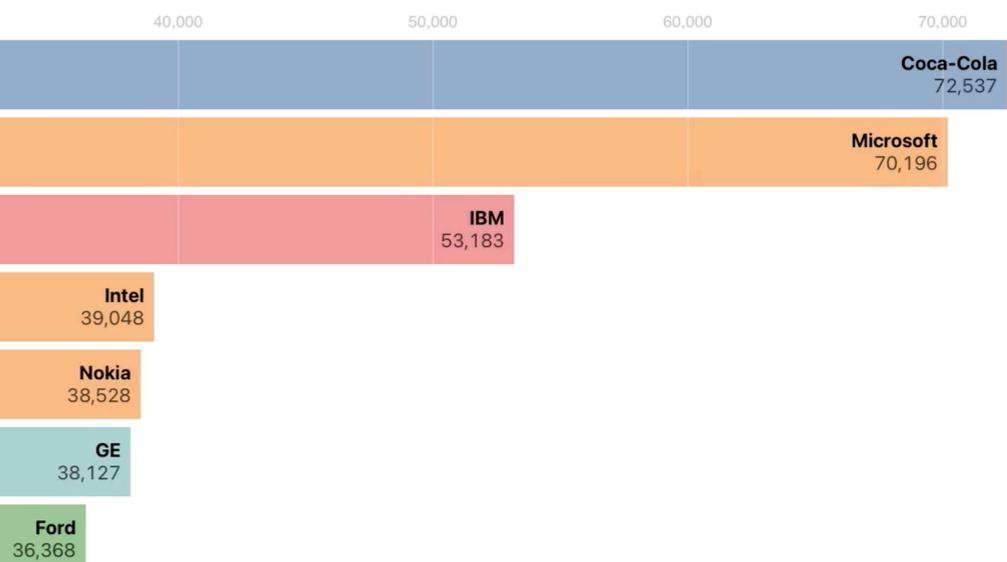


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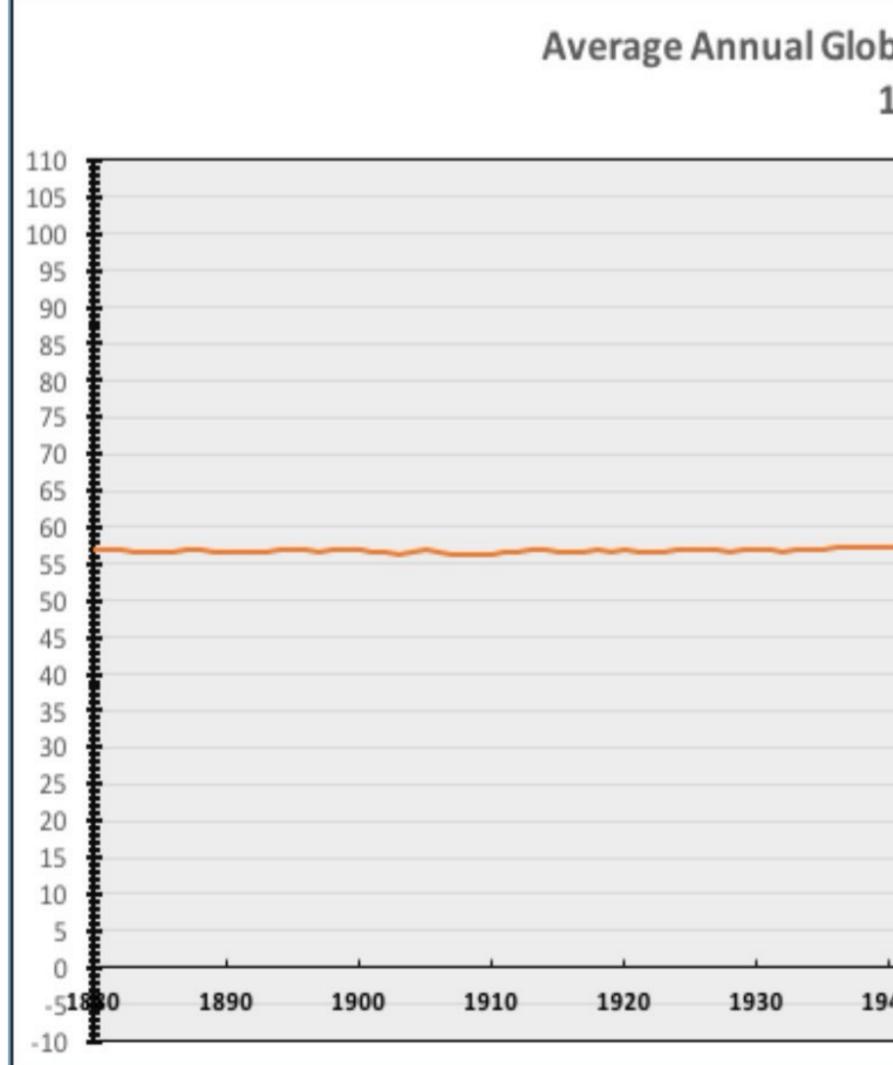
Why do we care about the design of visualizations?







Design: Focus on only the y-axis

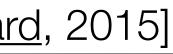


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Average Annual Global Temperature in Fahrenheit 1880-2015

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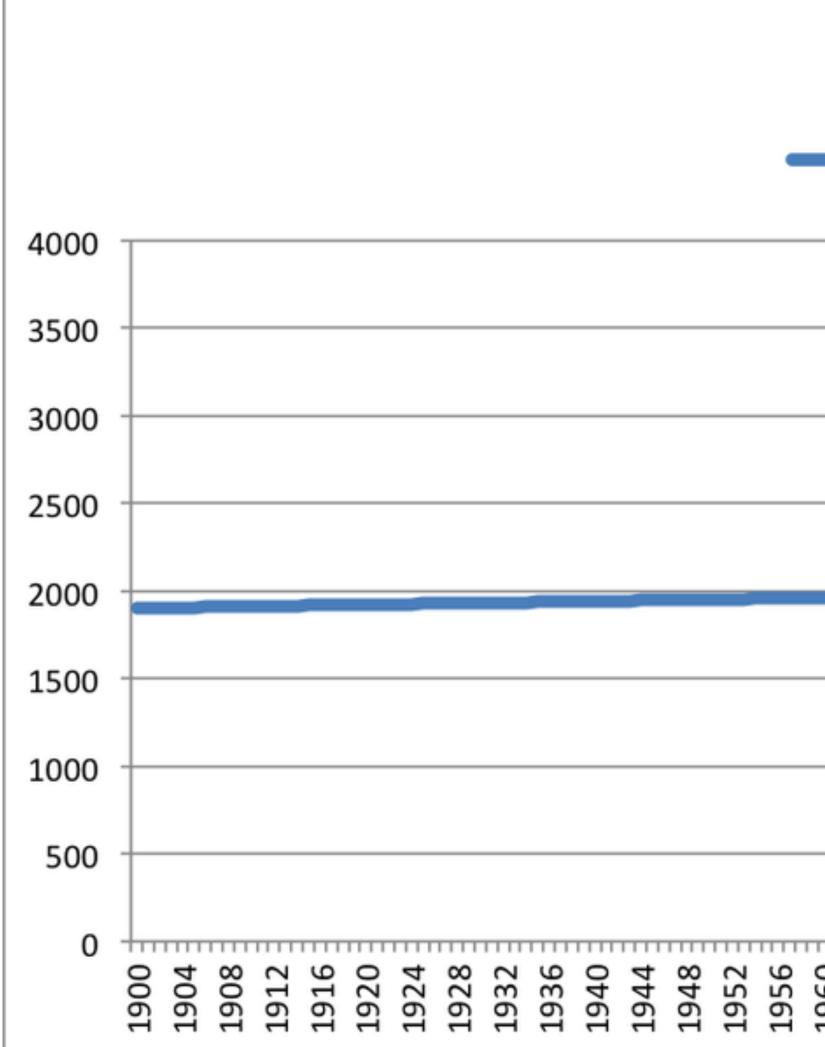








Design: Year on the y-axis



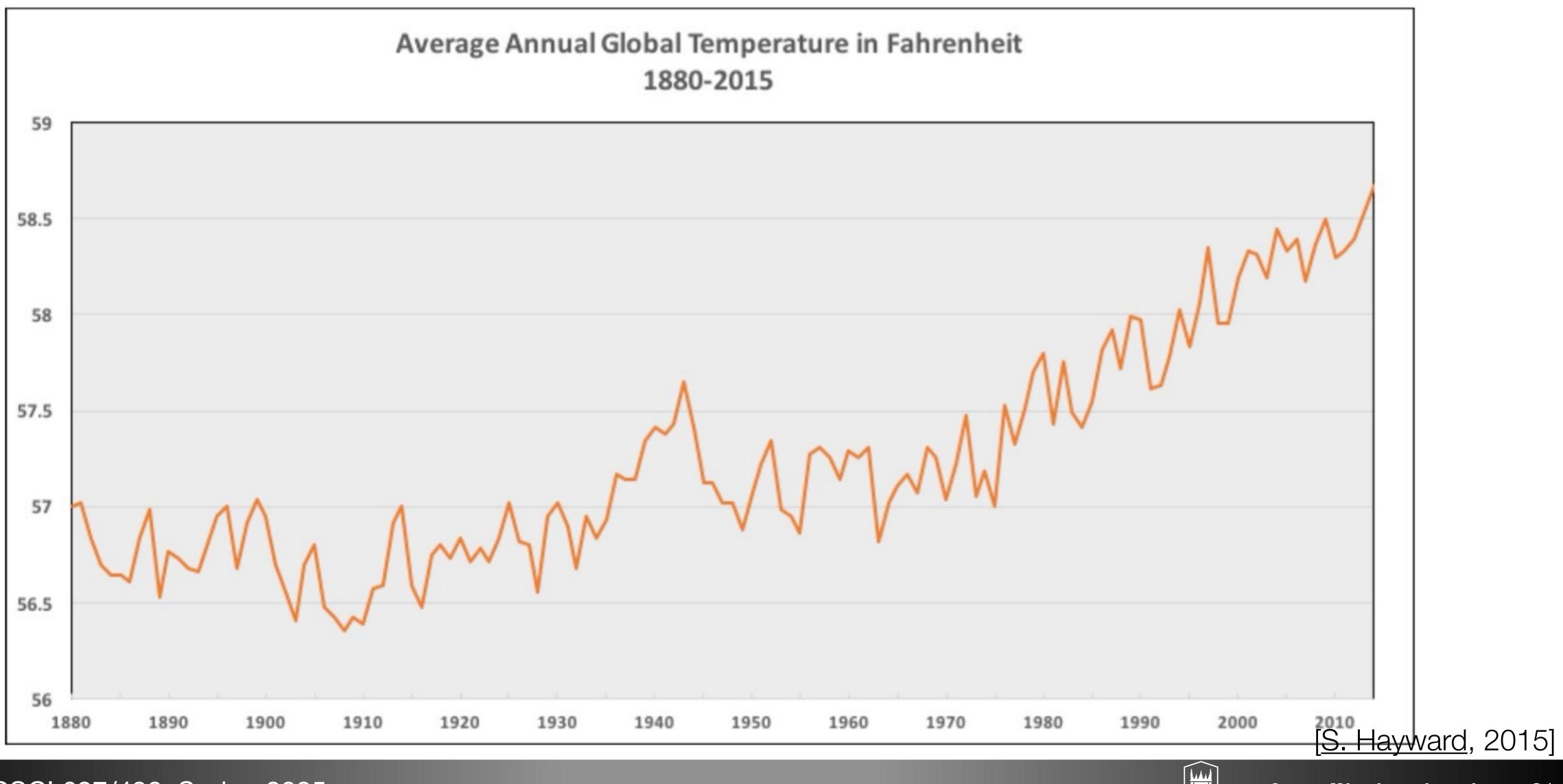
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	Iorthern Illinois University







Design: Different y-axis





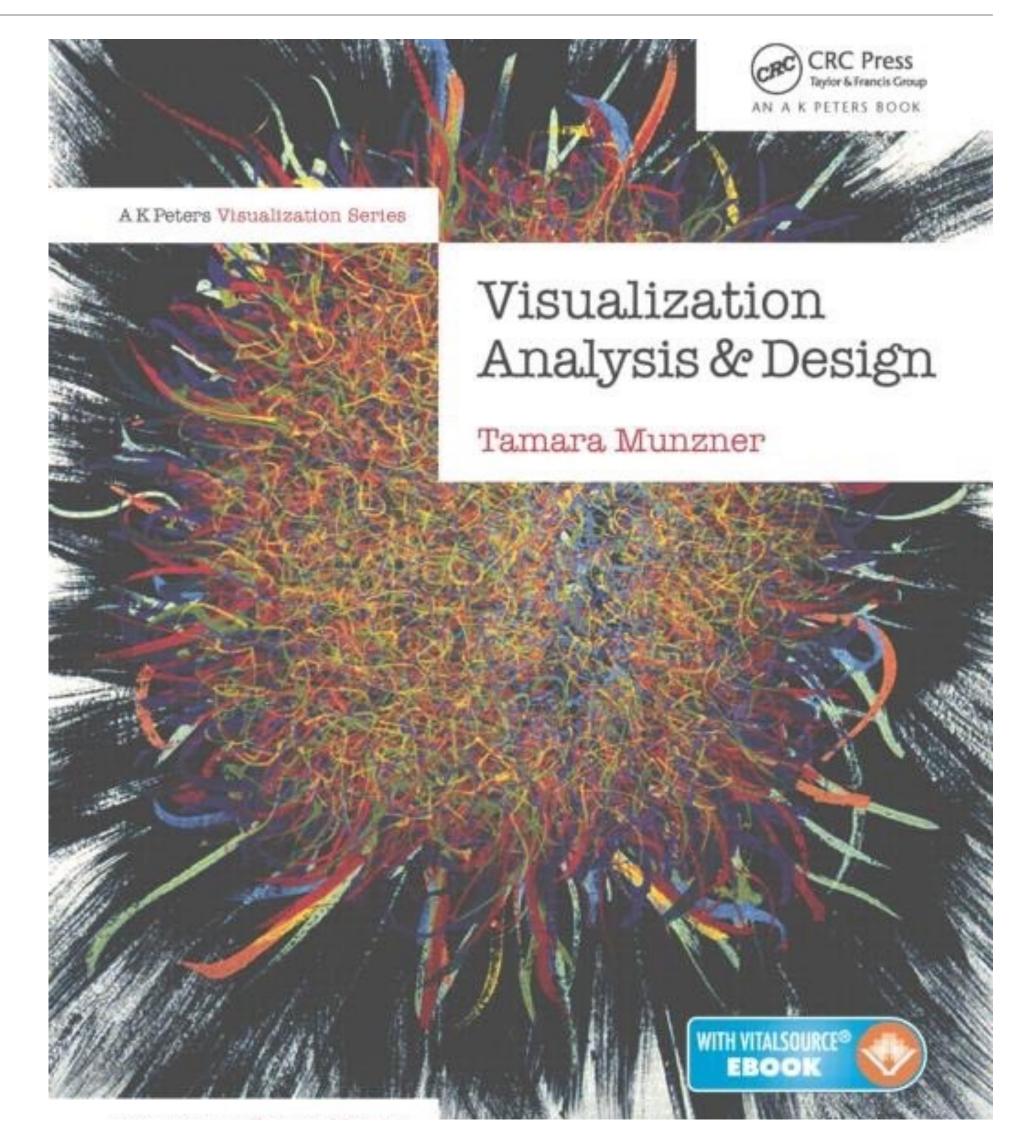






Administrivia

- <u>Course Web Site</u>
- Syllabus
 - Plagiarism
 - Accommodations
- Textbook:
 - Required: <u>Munzner</u> (VAD)
- Assignments
- Exams: Midterm (Mar. 5) and Final (May 7)







Administrivia

- Undergraduate (CSCI 490) and Graduate (CSCI 627) Course
 - Graduate: Extra reading, exam questions, project emphasis
- 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









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?



