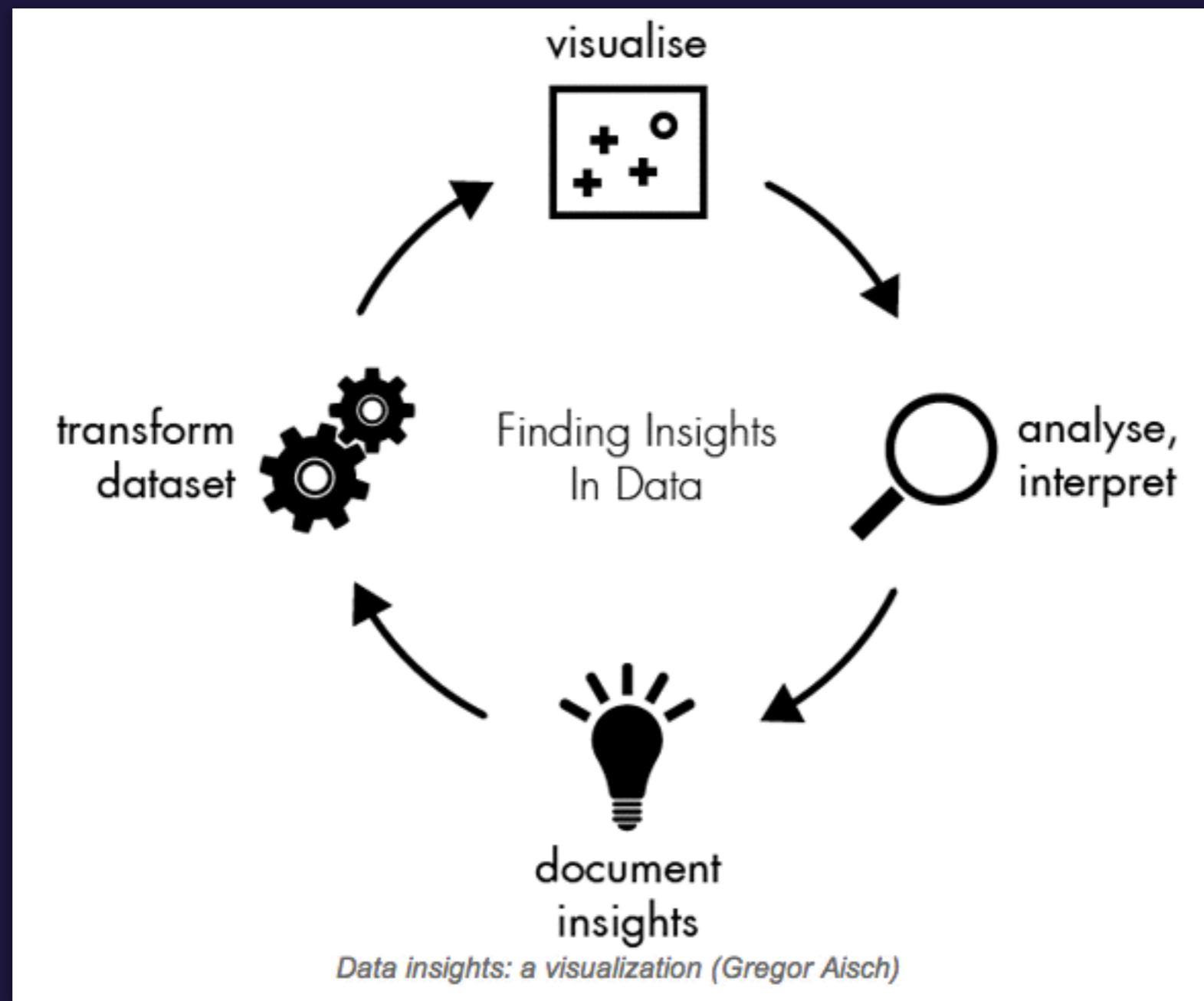


Design for Interactive Data Visualization

Lynn Cherny

lynn@ghostweather.com

@arnicas



Shneiderman's Infovis mantra (1996)

Heer & Shneiderman (2012)

TABLE 1: Taxonomy of interactive dynamics for visual analysis

Data & View Specification	<p>Visualize data by choosing visual encodings.</p> <p>Filter out data to focus on relevant items.</p> <p>Sort items to expose patterns.</p> <p>Derive values or models from source data.</p>
View Manipulation	<p>Select items to highlight, filter, or manipulate them.</p> <p>Navigate to examine high-level patterns and low-level detail.</p> <p>Coordinate views for linked, multi-dimensional exploration.</p> <p>Organize multiple windows and workspaces.</p>
Process & Provenance	<p>Record analysis histories for revisit, review and sharing.</p> <p>Annotate patterns to document findings.</p> <p>Share views and annotations to enable collaboration.</p> <p>Guide users through analysis tasks or stories.</p>

More Design Guidelines...

- Use smooth animated transitions between states
- Provide immediate visual feedback
- Reward interaction
- Ensure the interaction never “ends”

Plan for Today

- Visual encodings reminder
- Overview & Zoom
- Sort and Filter
-  “Recast” / “Rescale”
- Details on Demand
- Coordinated Views
- Annotation
- StoryTelling
- Reward Interaction - induce “flow”

Choosing Visual Encodings

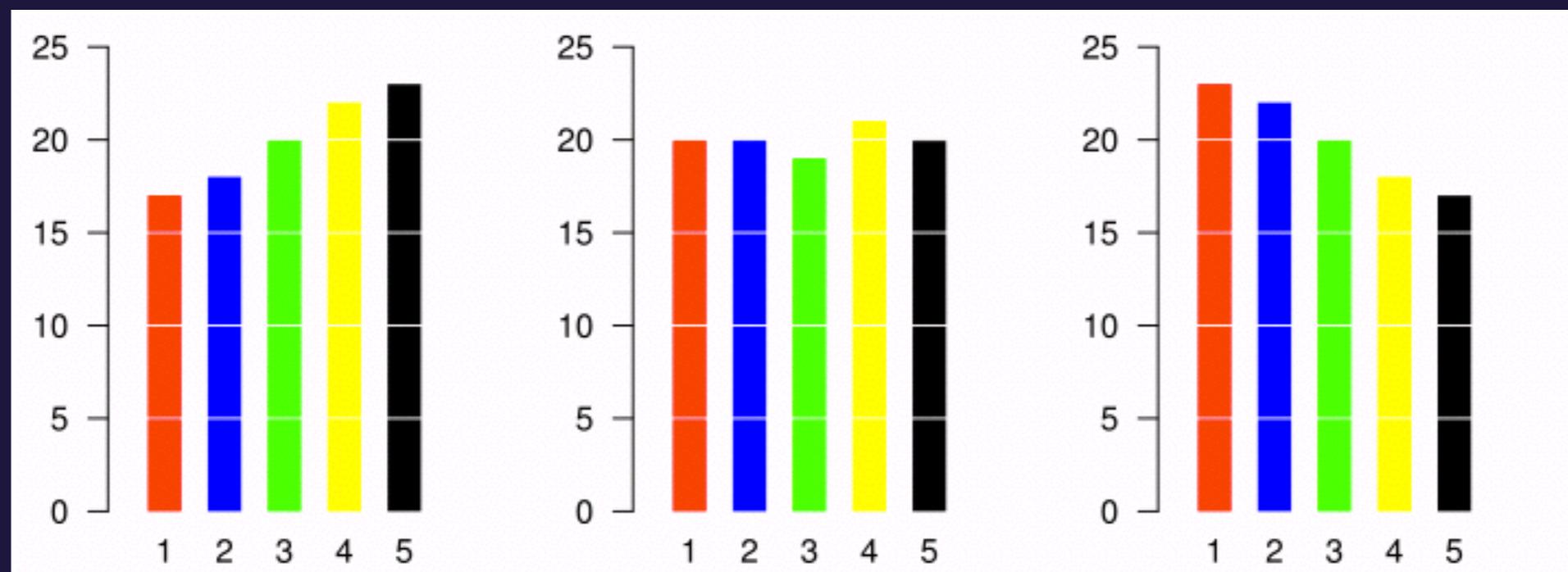
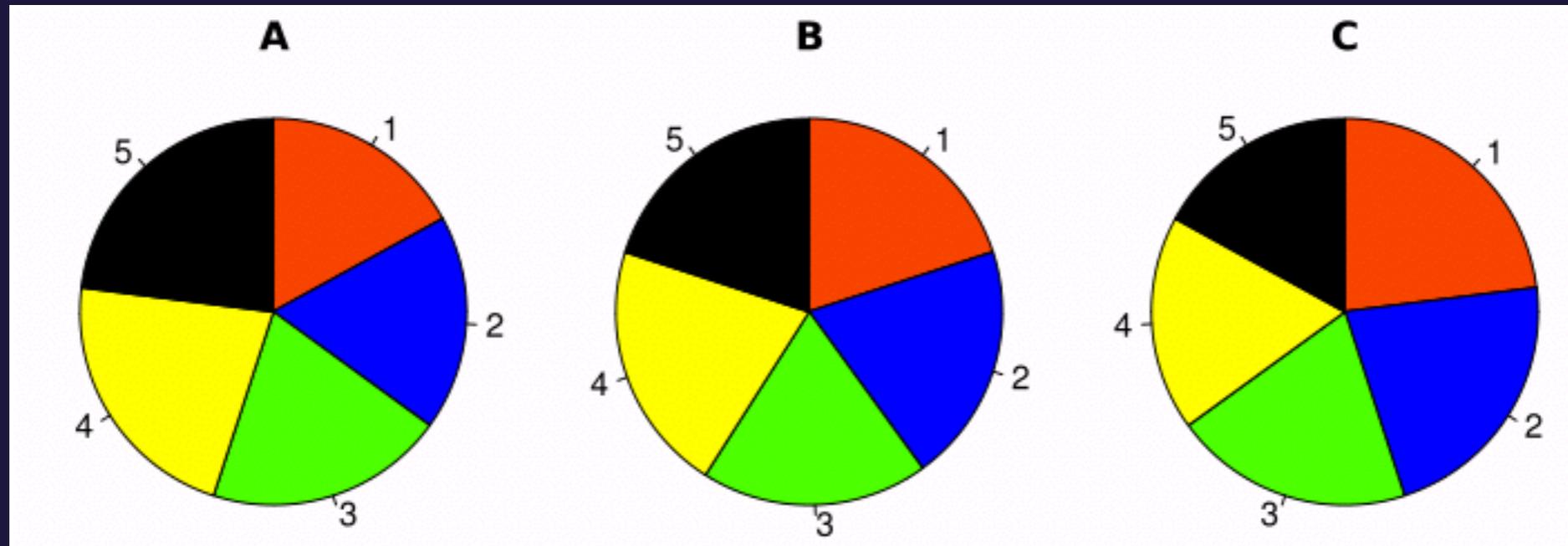
Cleveland-McGill Hierarchy of Perception

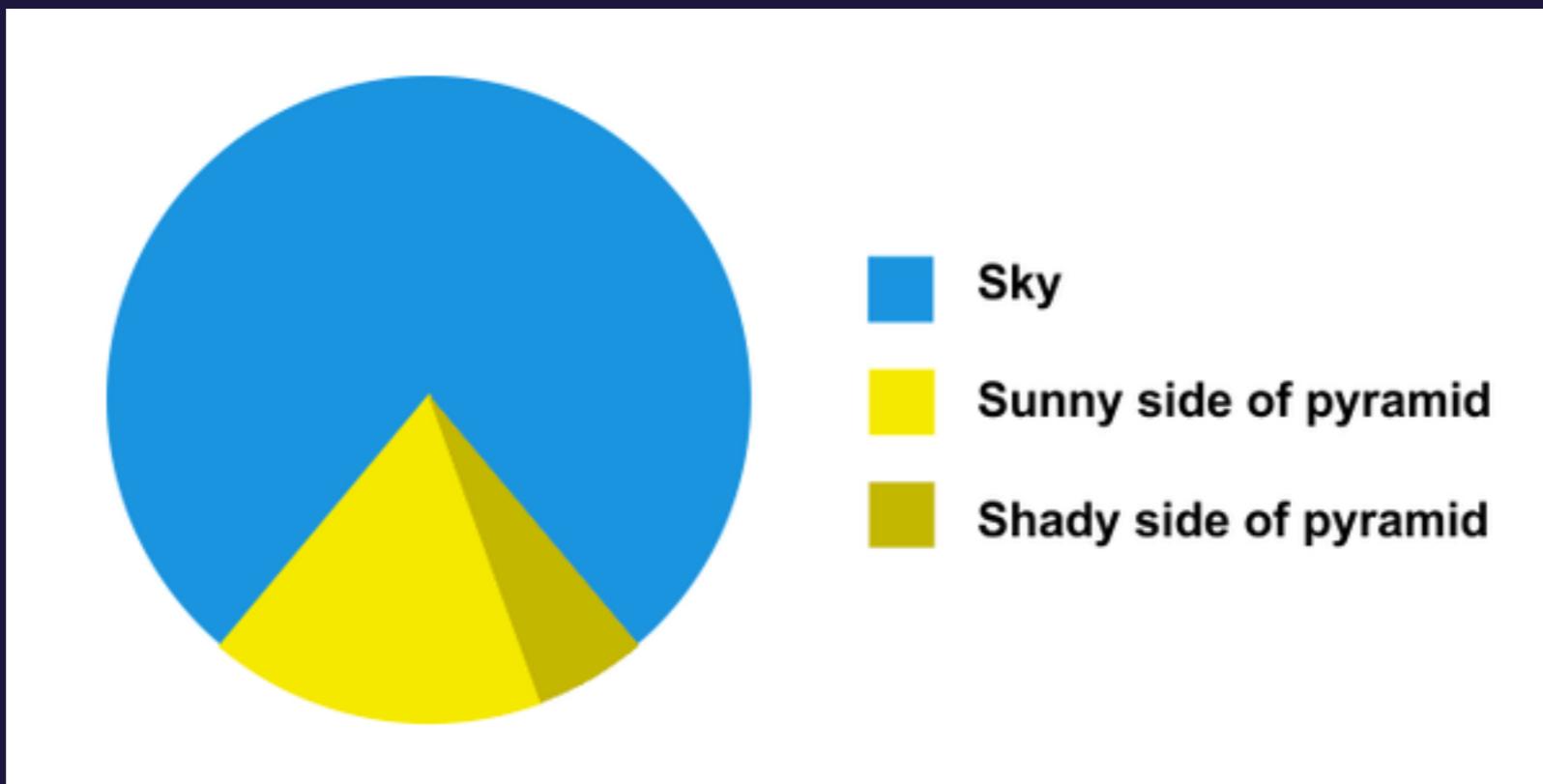
More Accurate Judgments

Less Accurate Judgments



Aka, “Why pie charts are (often) bad”

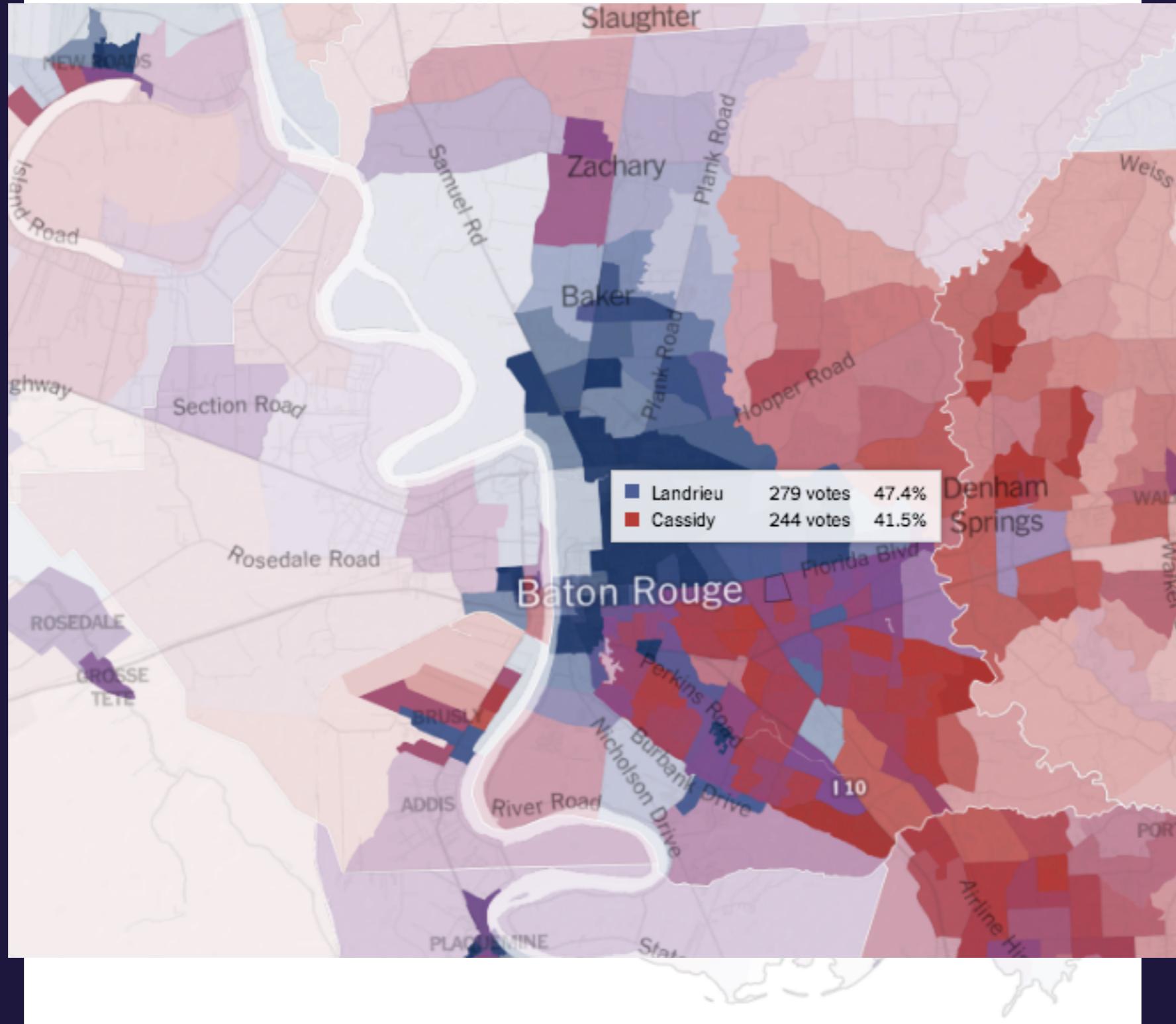




Overview & Zoom

Louisiana

Dem.	Mary Landrieu	42.1%
Rep.	Bill Cassidy	41.0%



But Sometimes: Start Small, Zoom Out

342,000 Swings
Later, Derek Jeter
Calls It a Career

By SHAN CARTER, JOE WARD and DAVID WALDSTEIN

The Times, with an assist from Jeter, has attempted to calculate the number of times he has swung a bat in his professional career — in practice and in games.

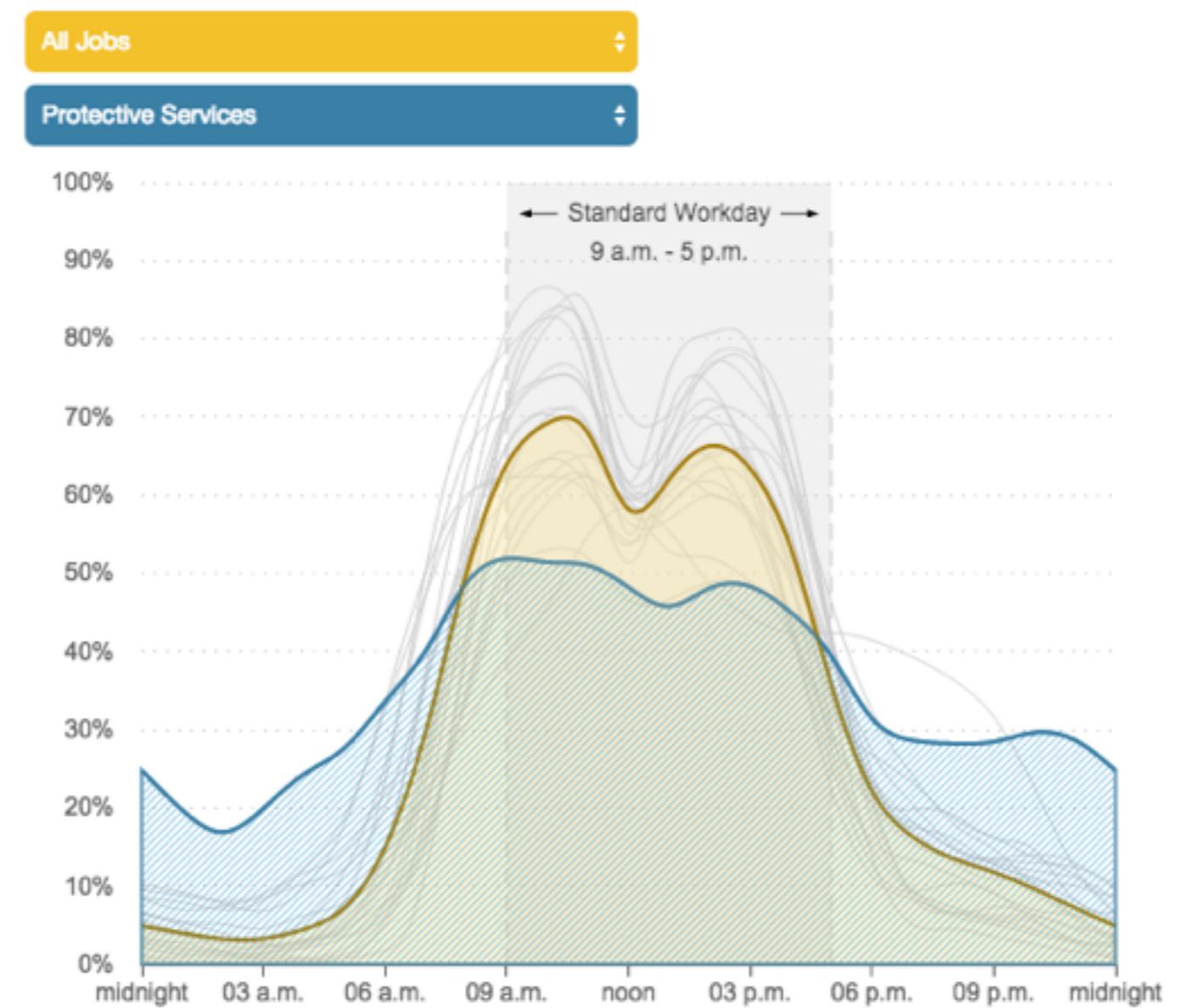
September 14, 2014



Sort and Filter



Compare different workdays using the drop-down menus below or by clicking on each line individually.



School district	Annual salary for a first-year teacher (\$)	Master's degree, highest step of pay scale (\$)	Scheduled workday (hours)	Test scores used in evaluations
Chicago, Ill.	49.2k	85.2k	7:30	
Dallas Independent, Texas	45.1k	70.2k	8:30	
Montgomery County, Md.	46.4k	97.0k	8:00	
Harrison Two, Colo.	35.0k	90.0k	8:00	
Long Beach Unified, Calif.	49.8k	82.9k	8:00	
Aldine Independent, Texas	45.1k	71.3k	8:00	
Jefferson County, Colo.	32.6k	70.6k	8:00	N.A.
Gwinnett County, Ga.	38.0k	69.6k	8:00	
Fulton County, Ga.	39.1k	69.5k	8:00	N.A.
Cypress-Fairbanks Indepen	45.3k	69.1k	8:00	
Dekalb County School Syste	41.0k	67.8k	8:00	
Cobb County, Ga.	39.0k	66.3k	8:00	
Hillsborough County, Fla.	37.0k	64.5k	8:00	
Lee County, Fla.	38.2k	63.7k	8:00	
Kansas City, Mo.	32.9k	61.8k	8:00	N.A.
Denver, Colo.	37.6k	61.1k	8:00	



Tale of 100 Entrepreneurs

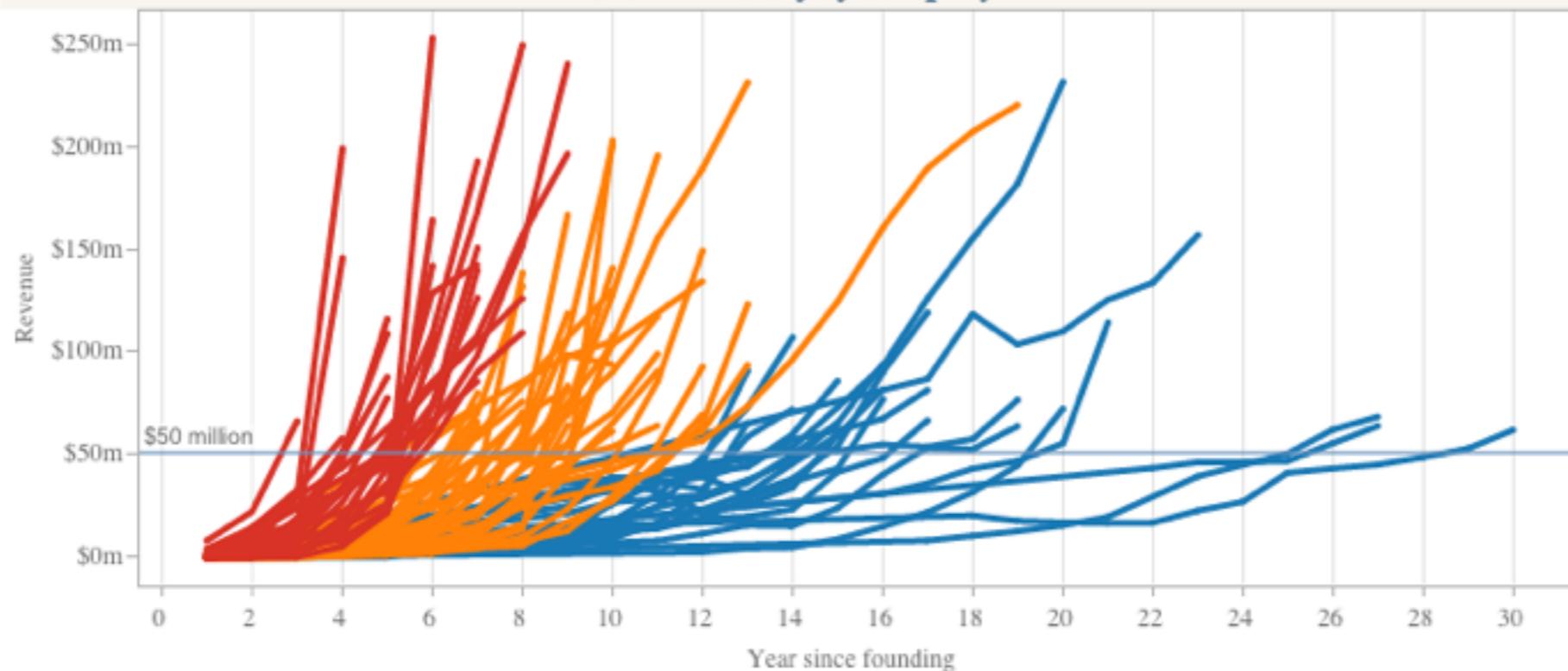
■ Rocket Ship

■ Hot Company

■ Slow Burner

Inflation adjusted revenue growth for 100 of the largest public software companies.
Despite the optimistic projections of new start ups, this shows that getting to \$50m in revenue can take many years.

Growth History by Company



Select Growth Group:

- (All)
- Hot Company
- Rocket Ship
- Slow Burner

Select Segment:

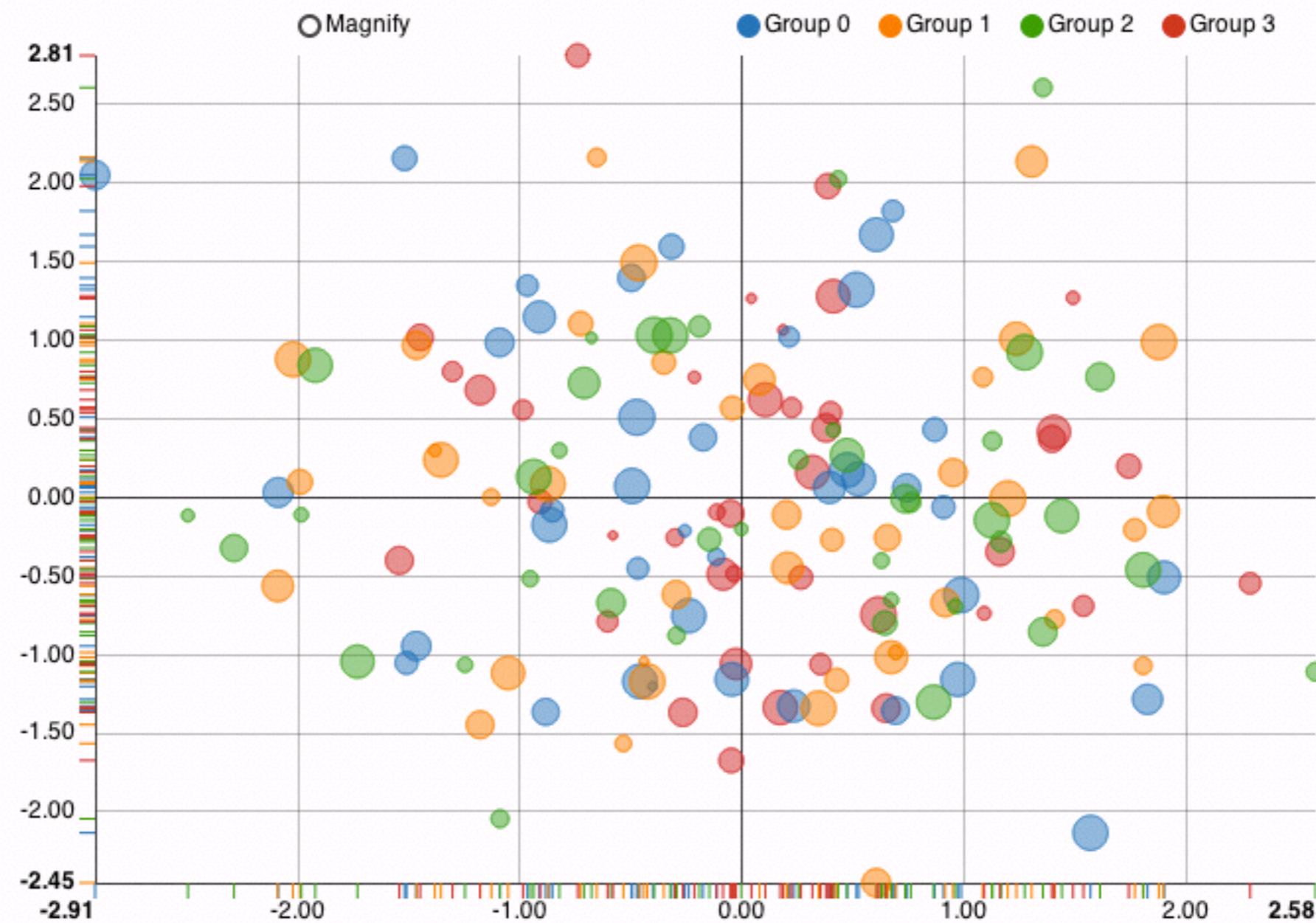
- (All)
- Business Intelligence
- CAD / EDA
- Communications
- Content Management
- CRM
- Database
- Entertainment
- ERP
- Network / Infrastructure/ EAI
- Operating Systems
- Security
- Services
- Supply Chain
- Systems Management
- Vertical Application

Company Details

		Year Founded	Years to \$50m	Revenue	Net Income
Rocket Ship	China Digital TV Holding Co., ..	2004	4	\$55m	\$34m
	MedAssets, Inc.	1999	5	\$189m	(\$10m)
	salesforce.com, inc.	1999	5	\$749m	\$18m
	Taleo Corporation	1999	6	\$128m	\$4m
	Rackspace Hosting, Inc.	1998	6	\$532m	\$22m
	Blackboard Inc.	1997	5	\$312m	\$3m
	OpenTV Corp.	1996	6	\$116m	\$10m
	Interwoven, Inc.	1995	6	\$260m	\$32m
	Verisign, Inc.	1995	4	\$962m	\$88m
	Cognizant Technology Solutio..	1994	5	\$2,816m	\$431m
	RealNetworks, Inc.	1994	5	\$605m	(\$244m)
	Check Point Software Technol..	1993	5	\$808m	\$324m

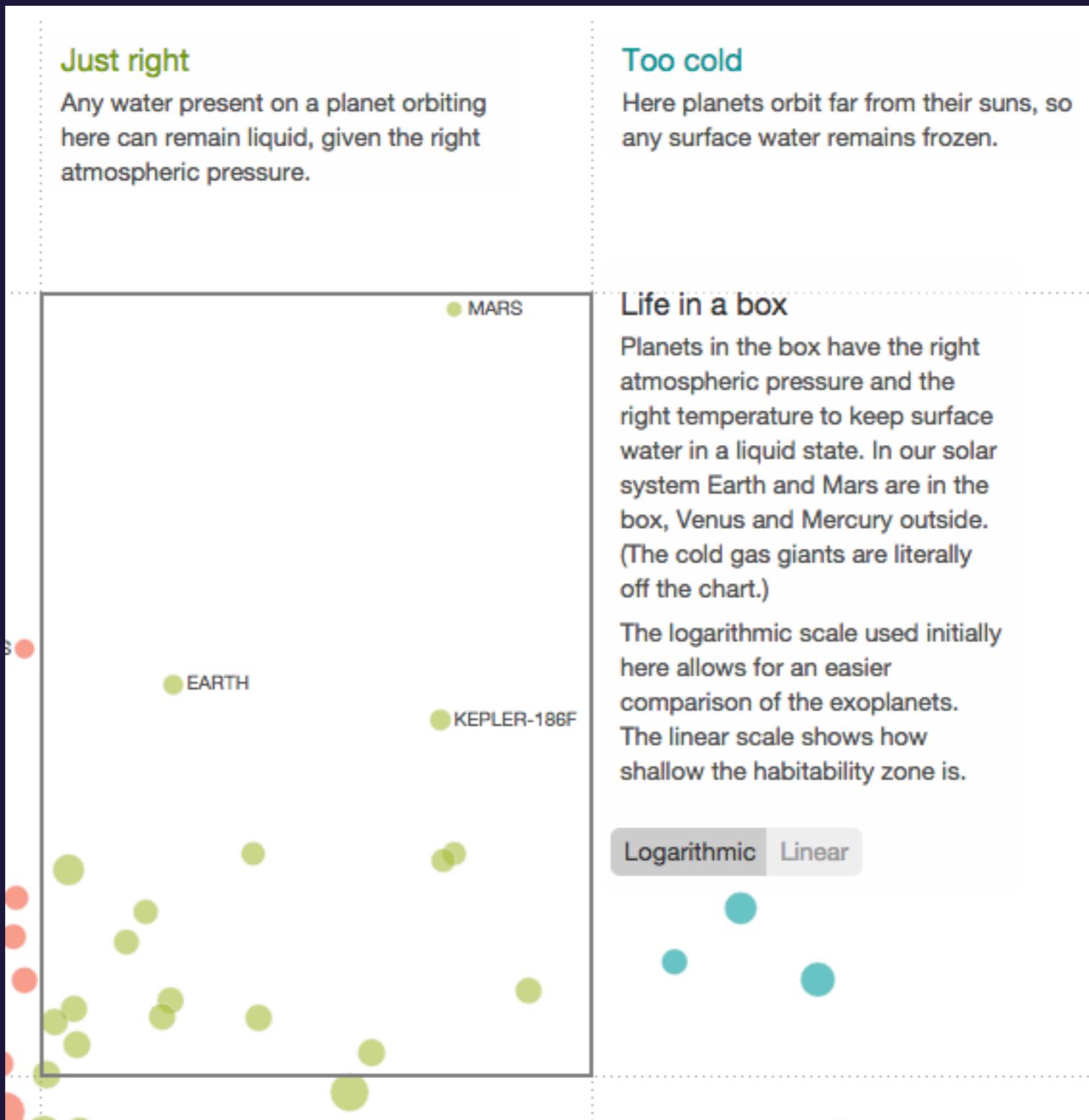
Search by Company:

Scatter / Bubble Chart



“Recast” / “Rescale”
re-categorize...

Log Scale Switches



One Report, Diverging Perspectives

Friday's jobs report is the second-to-last of the presidential campaign. Each party will interpret the numbers in a way to convince voters that its policies will help economic growth. [Related Article »](#)



How a **Democrat**
Might See Things

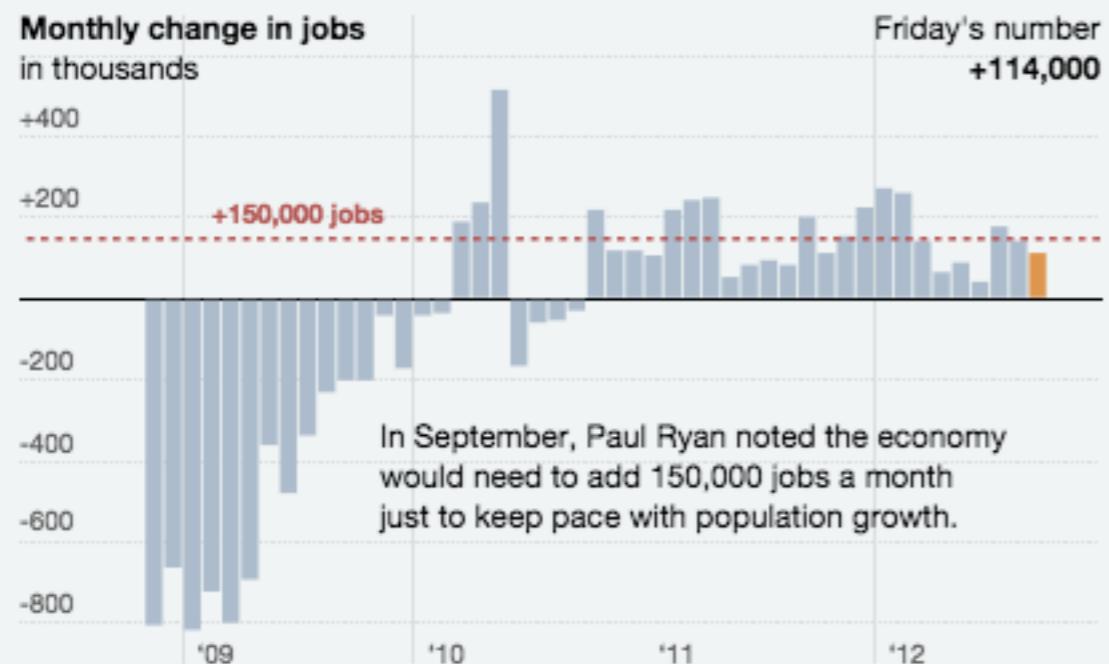


September Jobs Report



How a **Republican**
Might See Things

Job growth has been weak.



The rate was above 8 percent for 43 months.



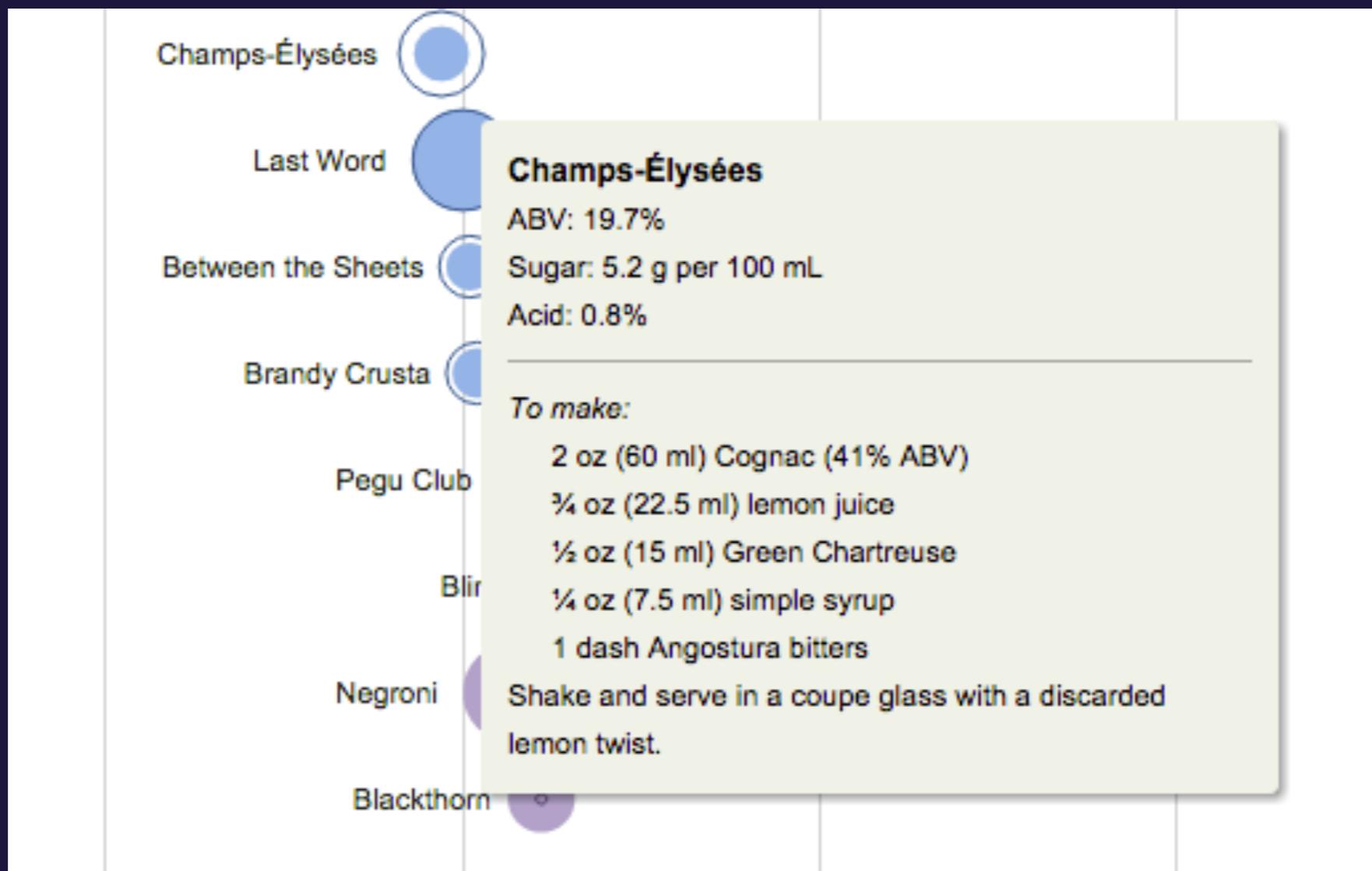
By MIKE BOSTOCK, SHAN CARTER, AMANDA COX and KEVIN QUEALY | [Send Feedback](#)

Groupings



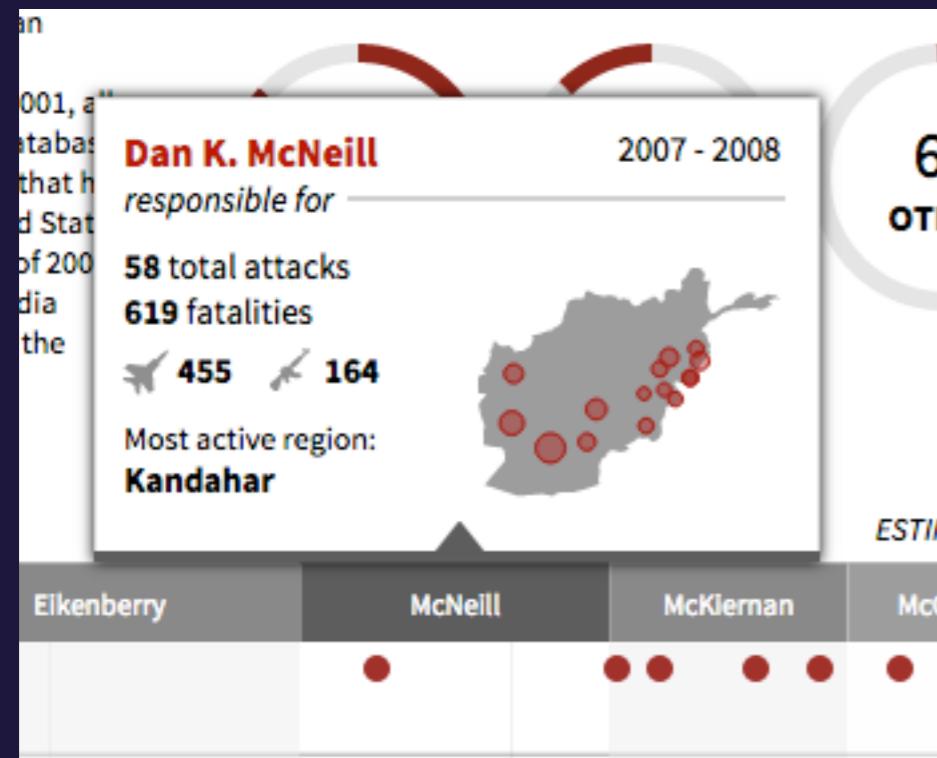
“Details on Demand”

Tooltips can be beautiful!

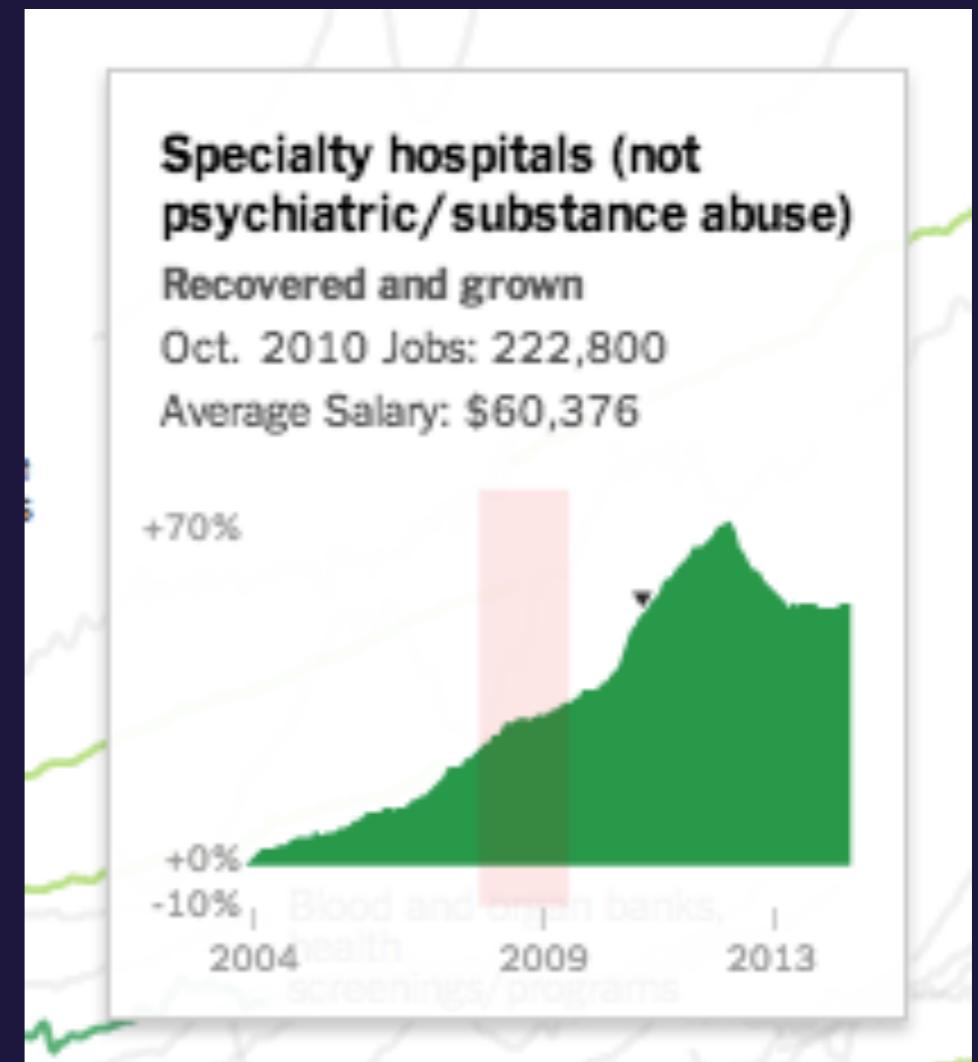


Tooltips can have charts too!

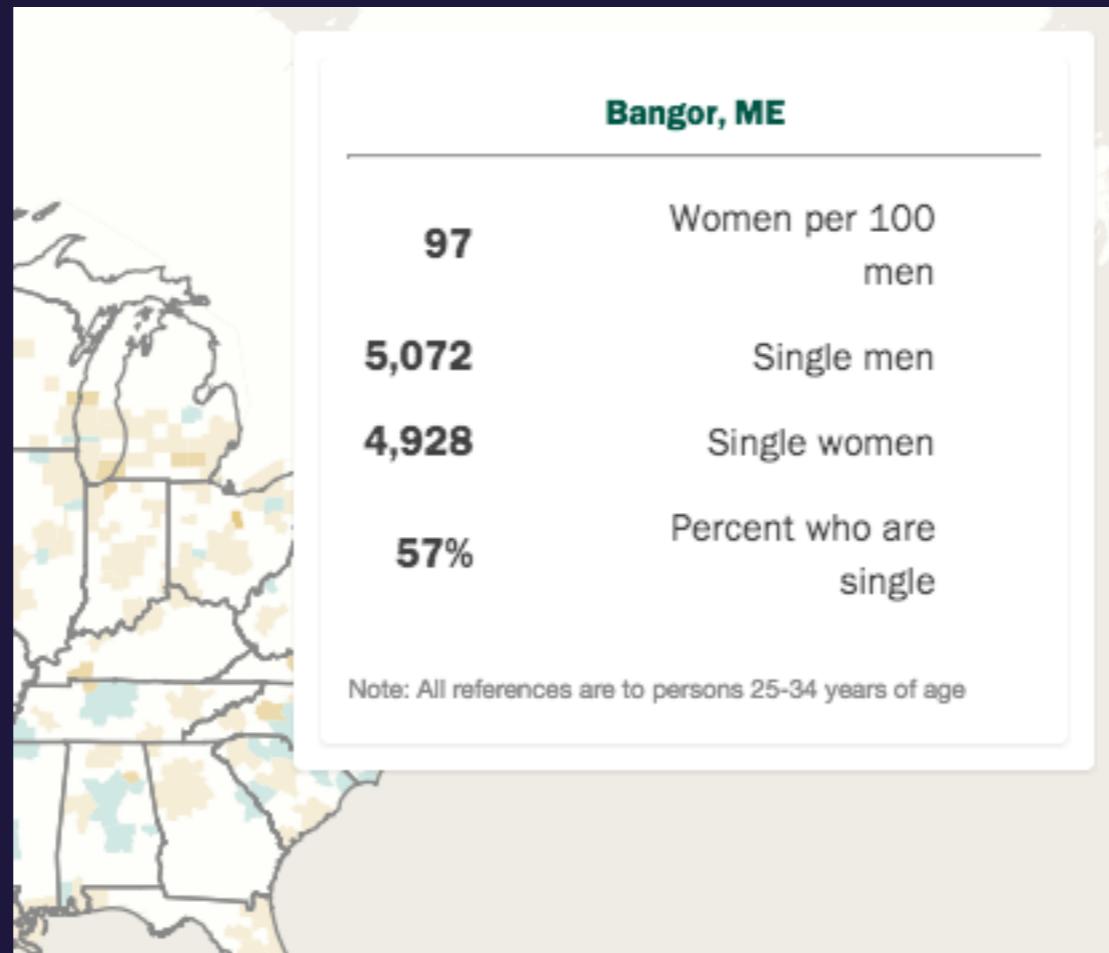
That are interactive!



Pitch Interactive for
<http://www.thenation.com/afghanistan-database>



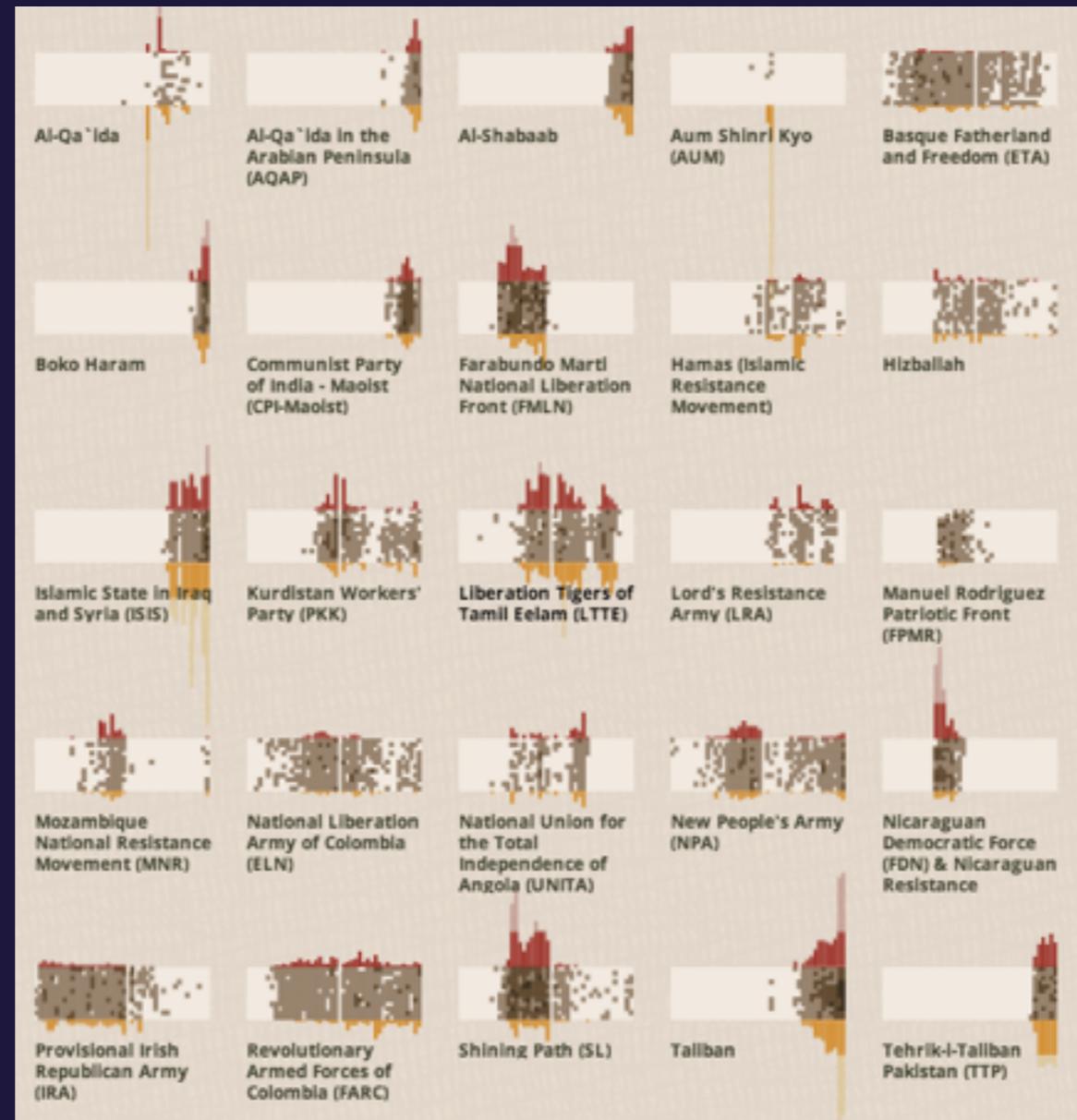
Tooltips can occlude :(



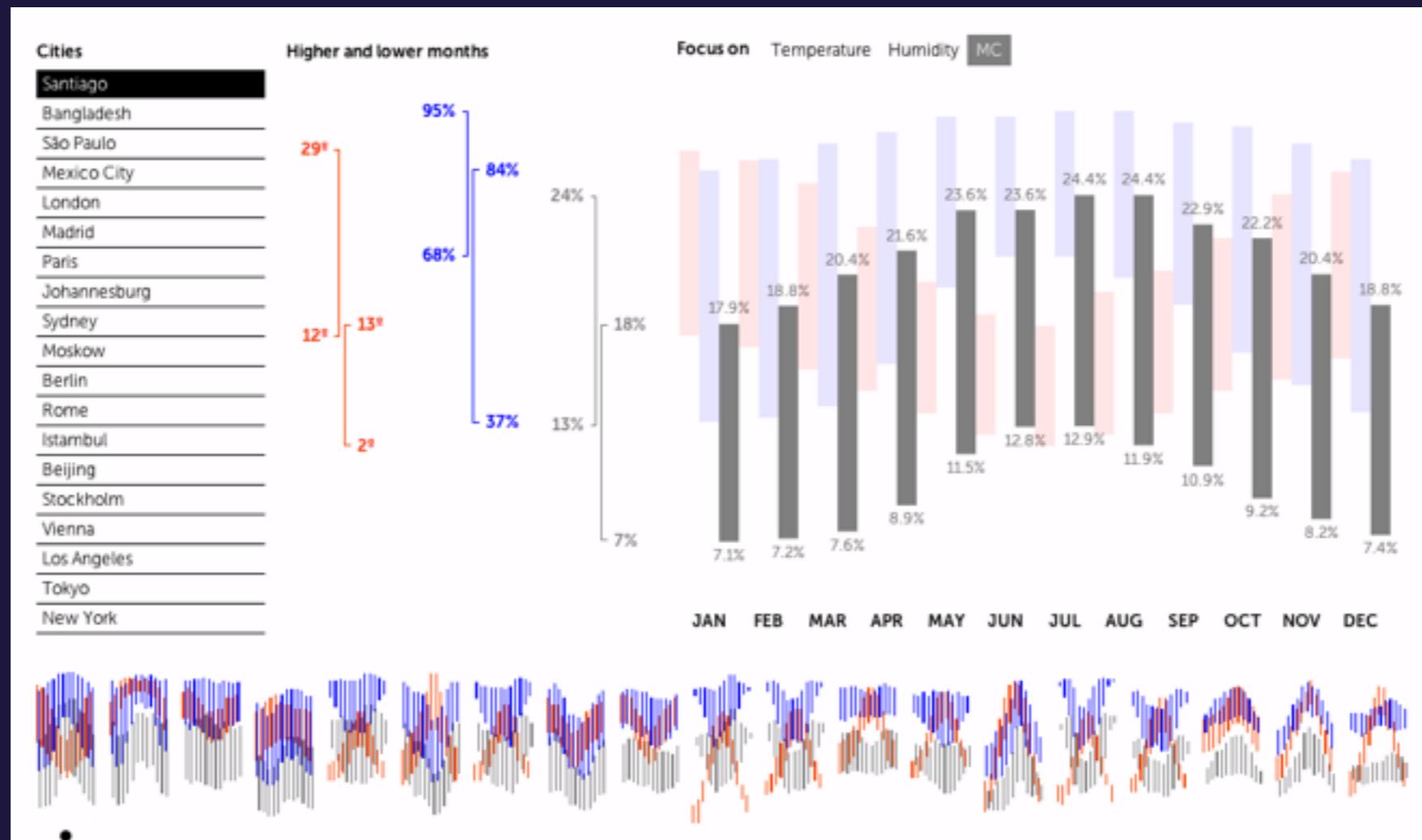
Small Multiples

as a form of “overview” and “detail”

As sorting and nav device



For nav and comparison



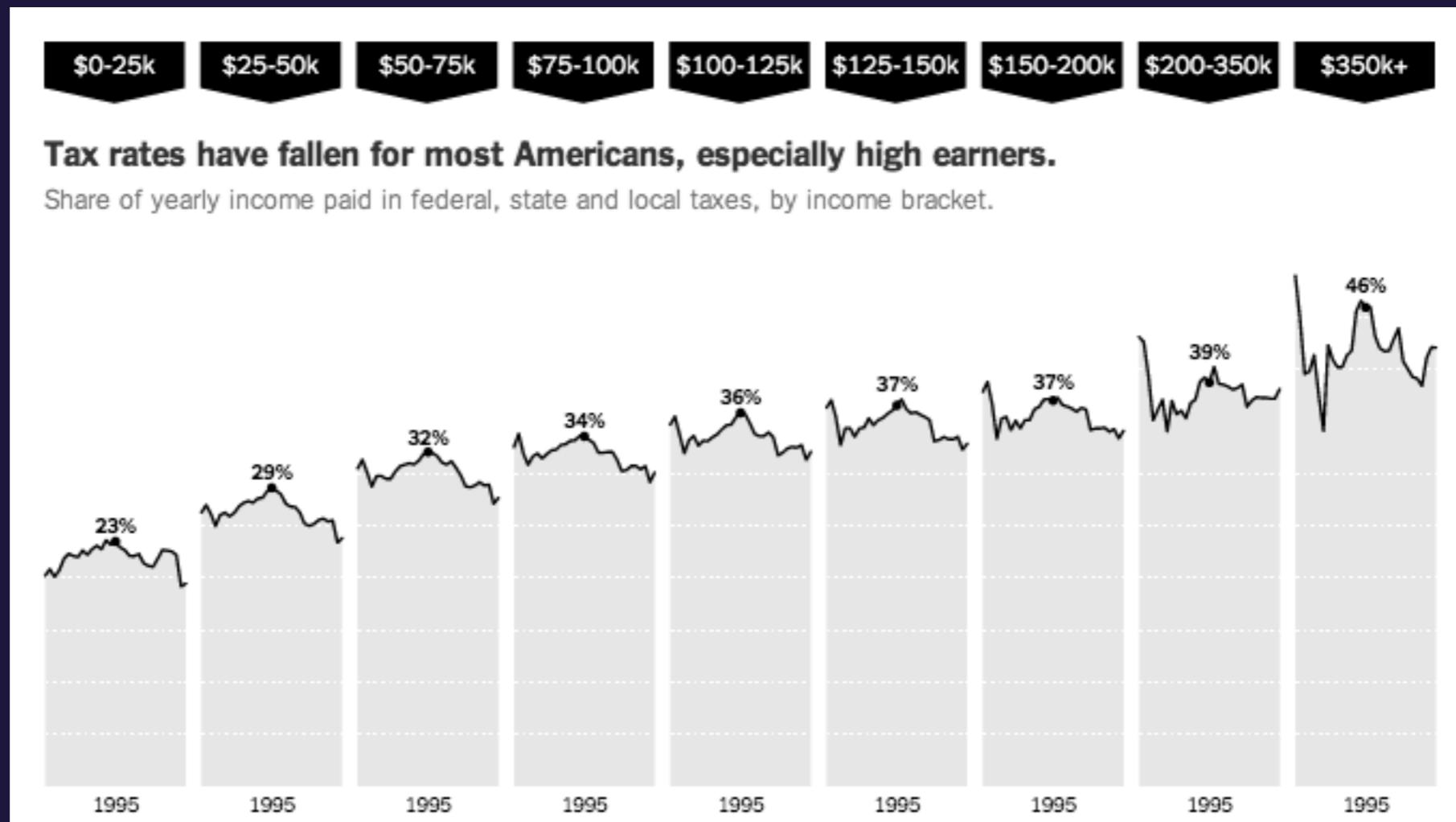
Small Multiples after The Big Story



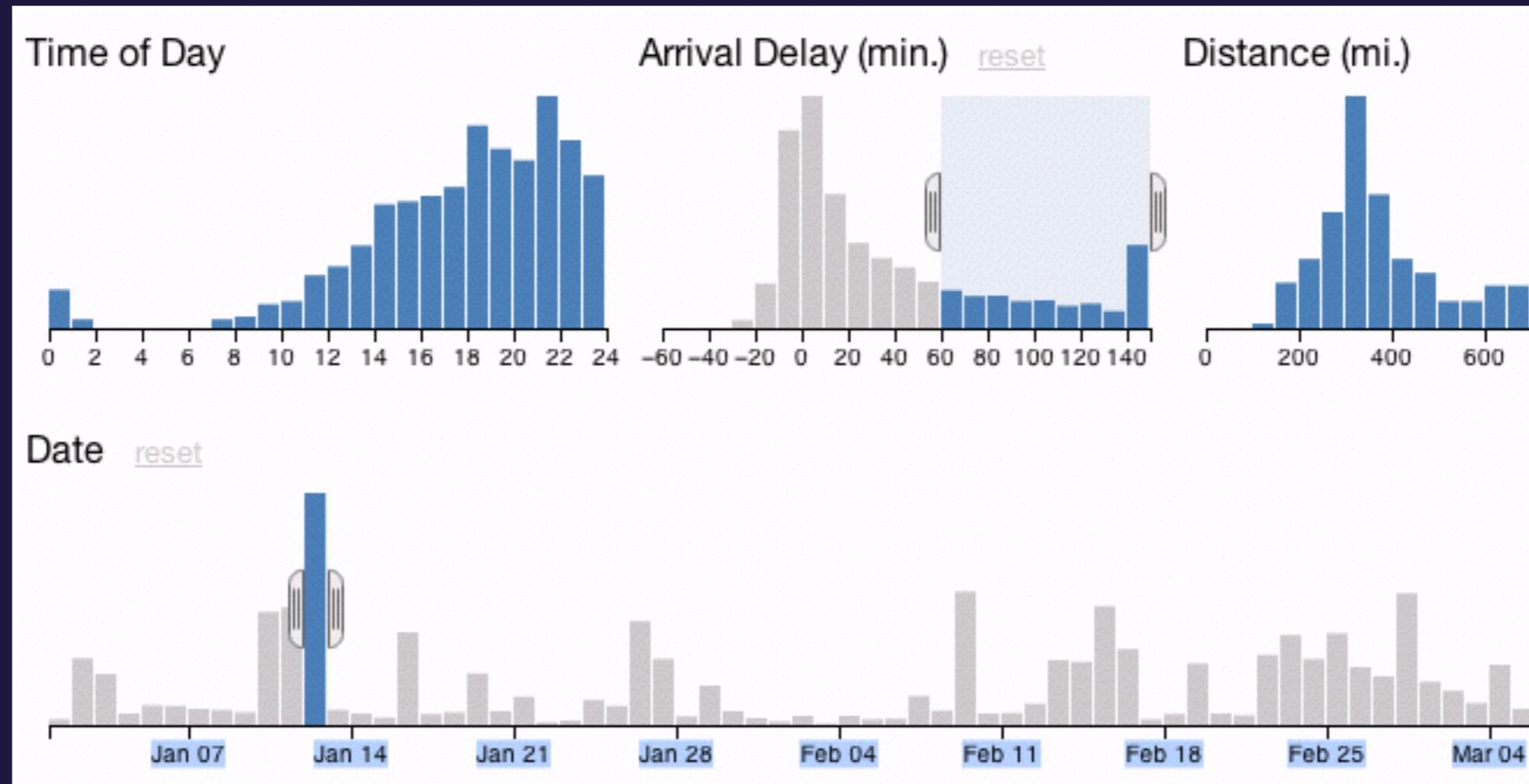
“Coordinate views for linked, multi-dimensional exploration”

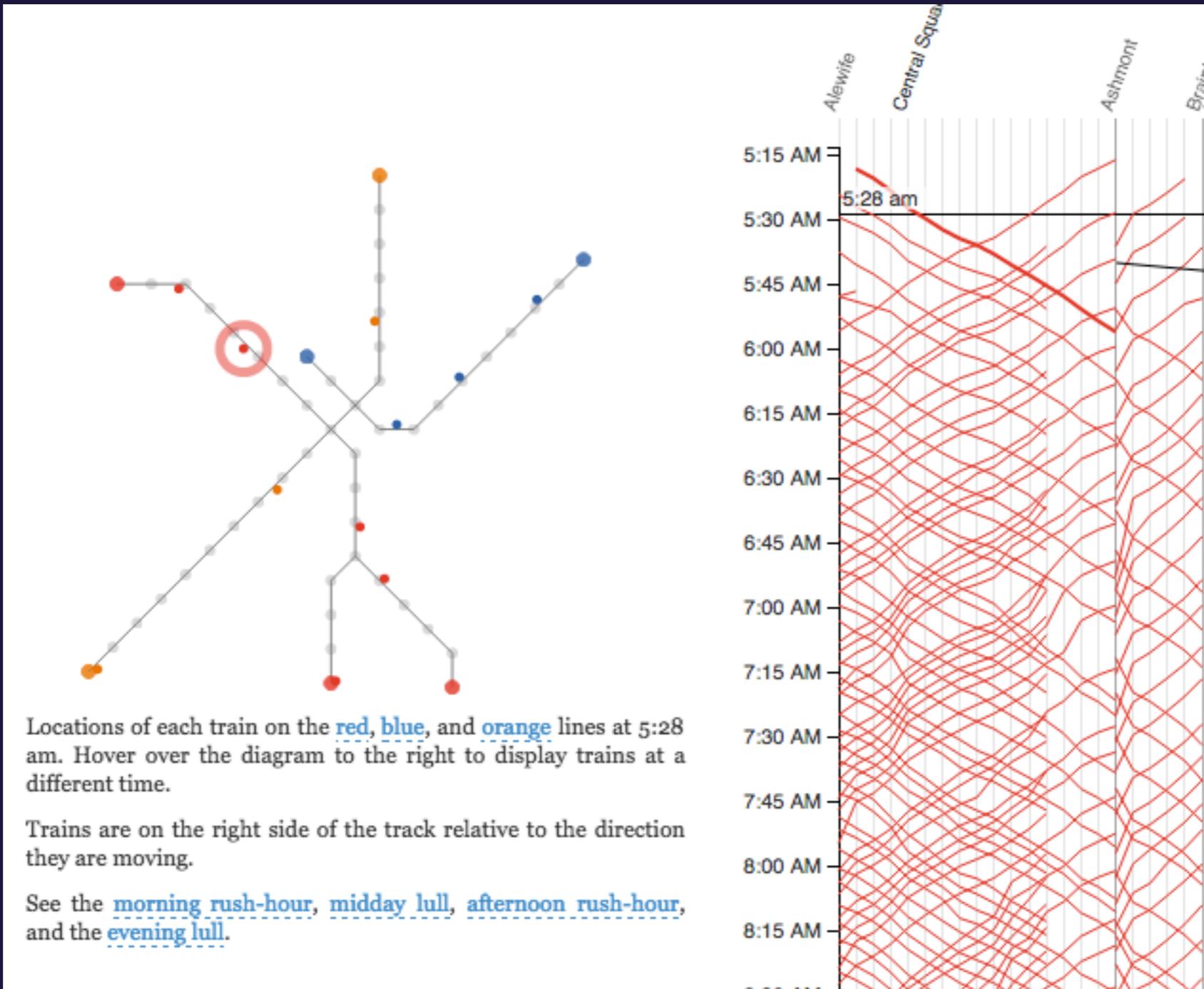
Heer & Shneiderman (2012)

Linked Small Multiples

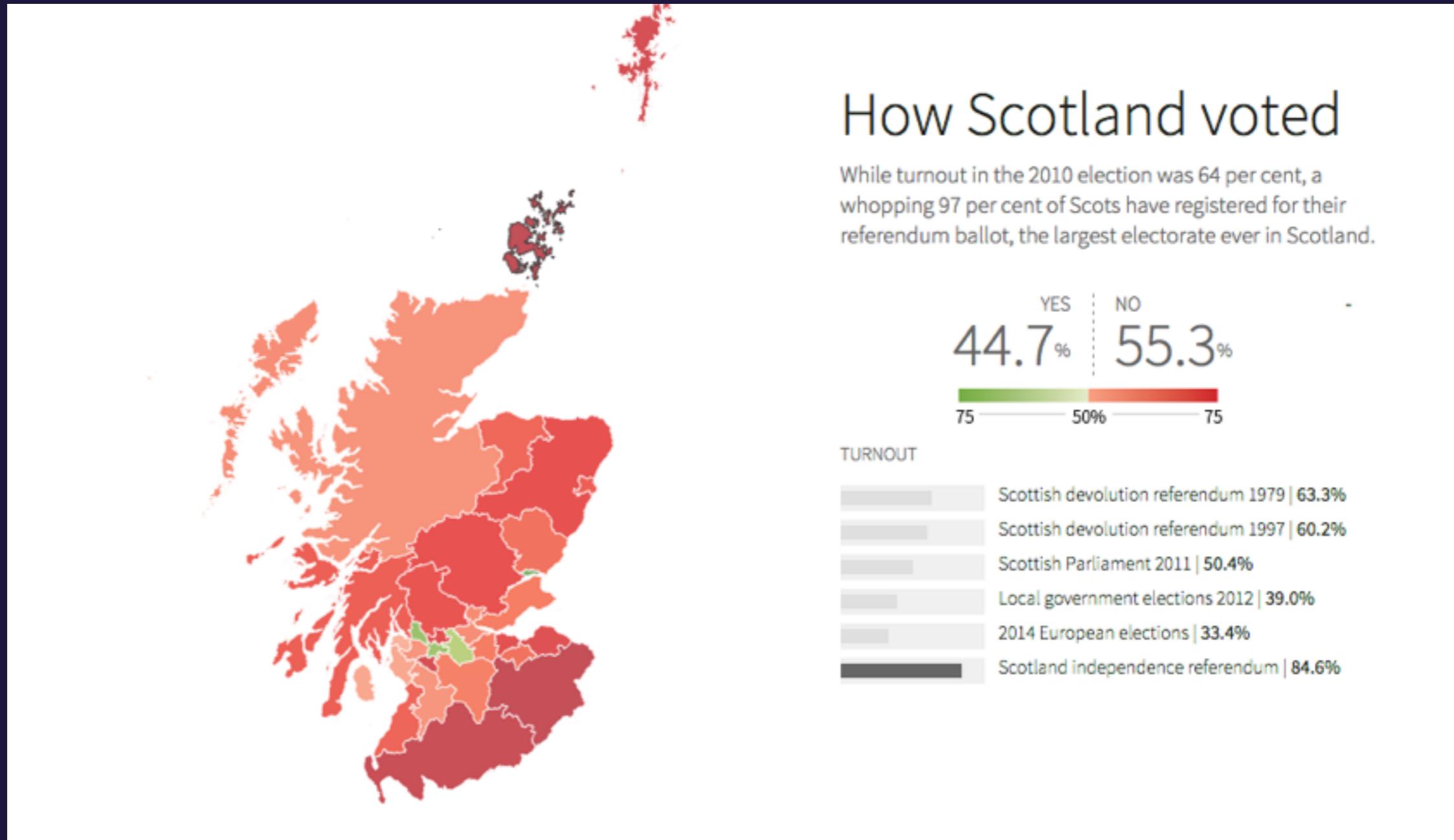


Coordinated During Filtering





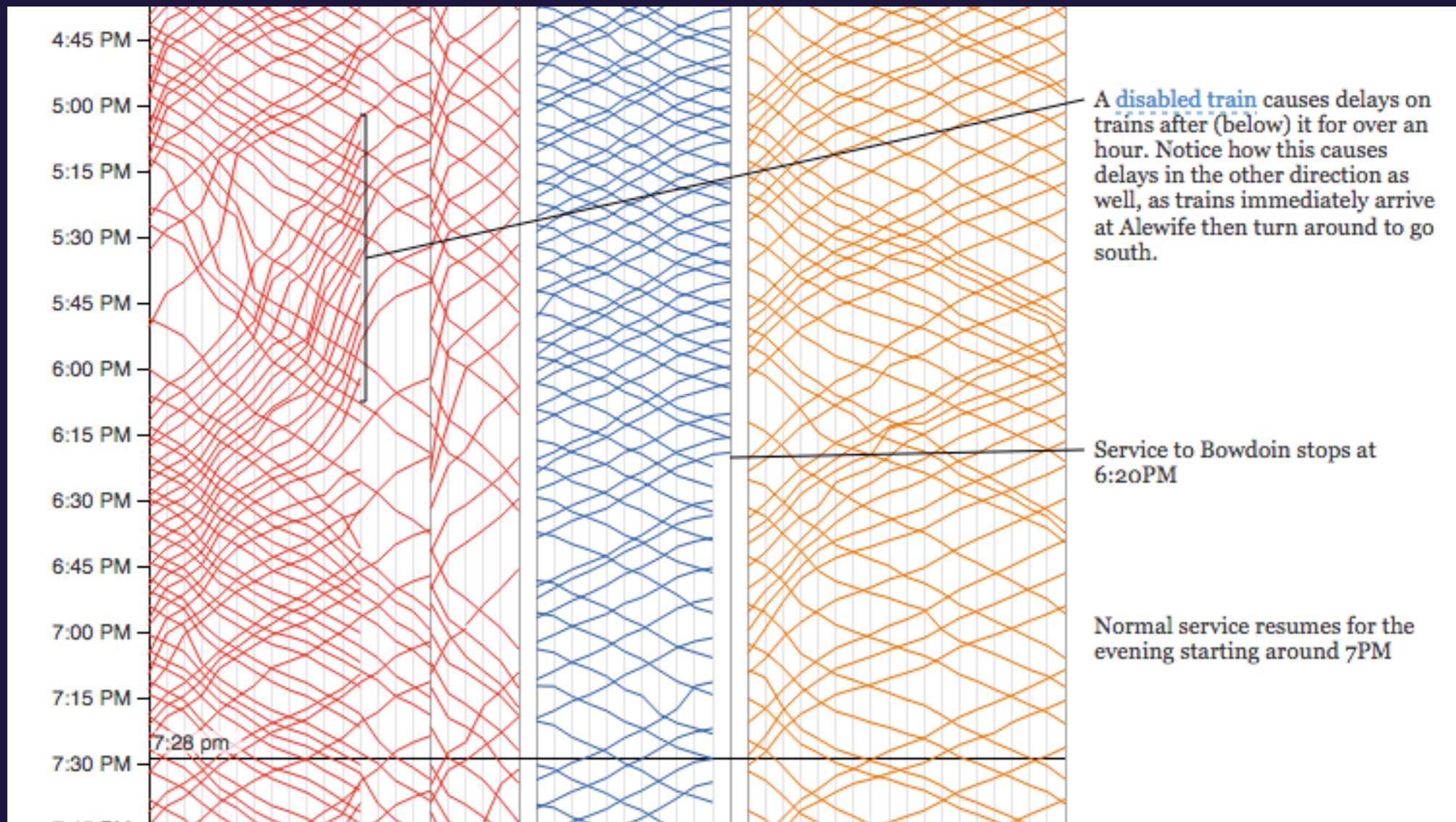
Beware Off-Screen Issues!

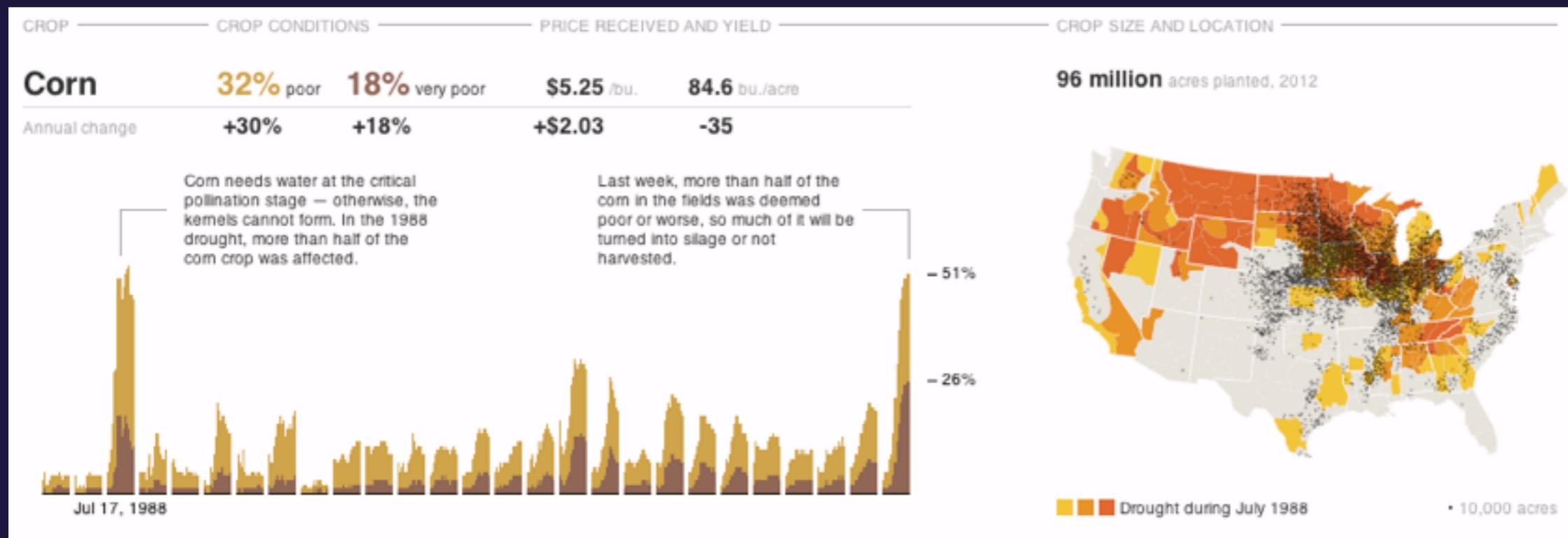


Annotate (to show your findings, explain)

“What we don’t do: here’s a bunch of data, we hope you find something interesting in it.”

-- paraphrase of Amanda Cox, NYT





One Report, Diverging Perspectives

Friday's jobs report is the second-to-last of the presidential campaign. Each party will interpret the numbers in a way to convince voters that its policies will help economic growth. [Related Article »](#)



How a **Democrat**
Might See Things

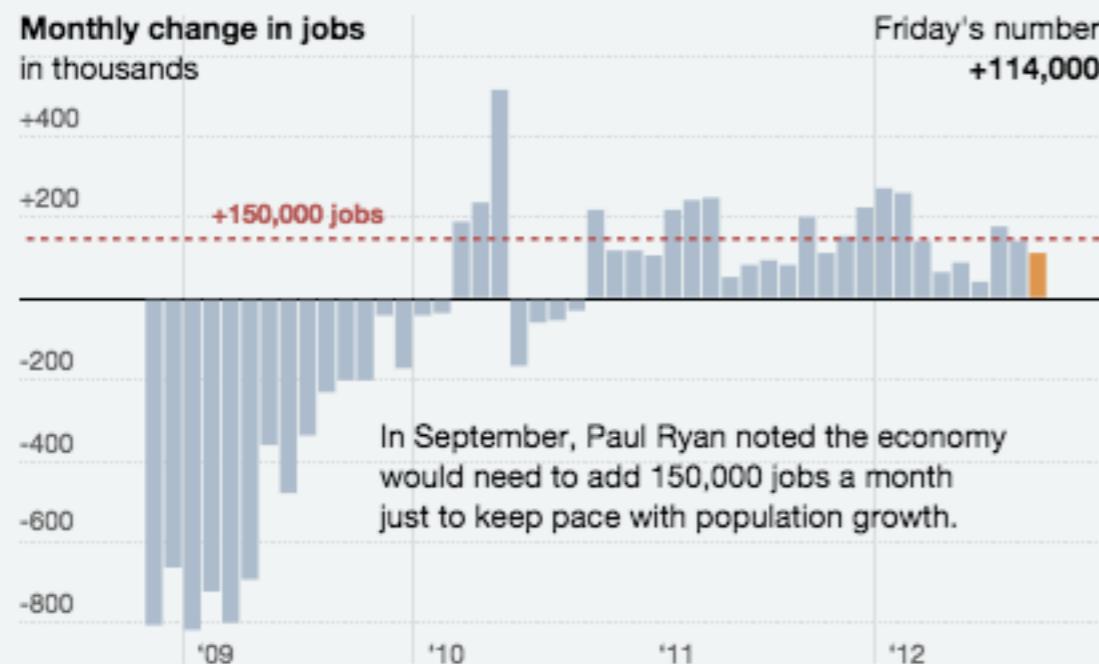


September Jobs Report



How a **Republican**
Might See Things

Job growth has been weak.



The rate was above 8 percent for 43 months.



By MIKE BOSTOCK, SHAN CARTER, AMANDA COX and KEVIN QUEALY | [Send Feedback](#)

StoryTelling Mechanisms

- Personalization
- Bookmarks/Steppers (user does it)
- Animation (designer does it)
- “Scrollytelling” (designer does it to the user)

Personalization

Let them find themselves... to make it relevant & interesting!

CYOA: Personalize to Draw Them In

Published: June 17, 2011

How Many Households Are Like Yours?

Explore different types of American households and see how they have changed over time. [Related Article »](#)

Who else lives with the single female?

- + Child under 18
- + Child over 18
- + Child-in-law
- + Foster child
- + Parent or parent-in-law
- + Siblings or siblings-in-law
- + Grandchild
- + Other relative
- + Housemate or roommate
- + Roomer, boarder or lodger
- + Other non-relative

17,205,731
households like this in the U.S.

15.28%
of all households

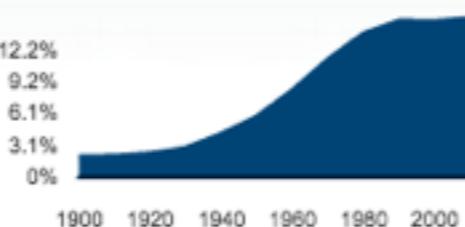


Single female

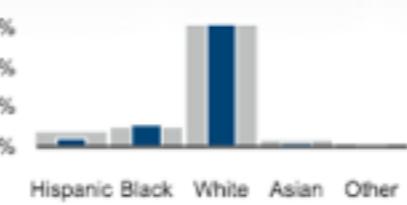
Or choose some predefined families.

- + Couple, two children
- + Single female, two children
- + Single male
- + Couple, two parents
- + Male unmarried partners

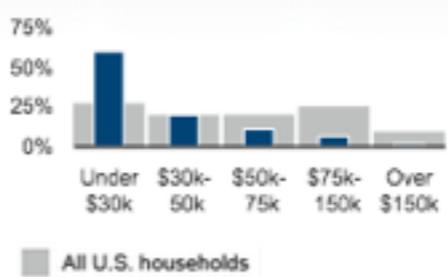
These households were most likely to occur in 2009.



Compared to other groups, a higher proportion of blacks live in these households.



The greatest number of these households have incomes under \$30,000.



■ Distribution of these households

■ All U.S. households



Bookmarks / “Steppers”

UPDATED February 12, 2012

Four Ways to Slice Obama's 2013 Budget Proposal

Explore every nook and cranny of President Obama's federal budget proposal.

All Spending

Types of Spending

Changes

Department Totals

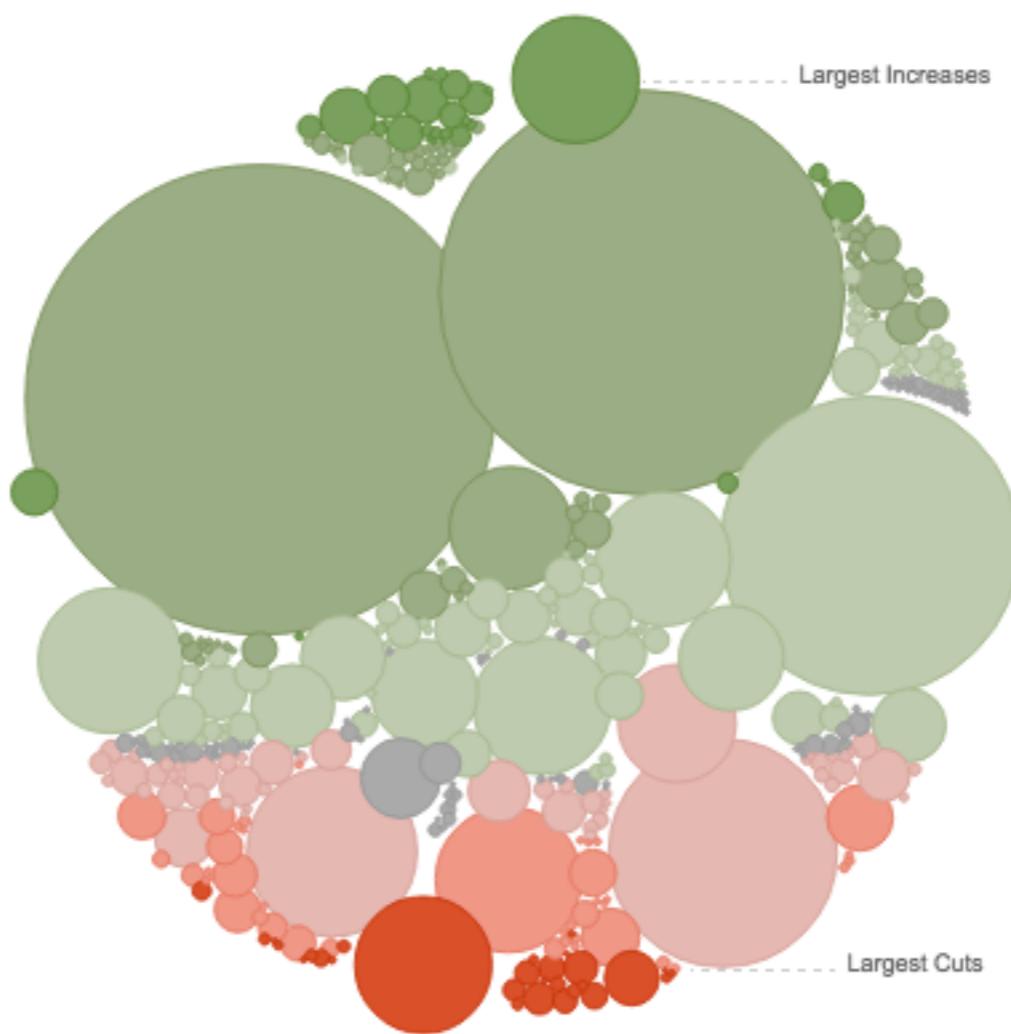
How \$3.7 Trillion Is Spent

Mr. Obama's budget proposal includes \$3.7 trillion in spending in 2013, and forecasts a \$901 billion deficit.

Circles are sized according to the proposed spending.



Color shows amount of cut or increase from 2012.



Flooding, Power Failures, Rainfall and Damage From Hurricane Irene

Hurricane Irene caused widespread flooding and power failures. More than 5.8 million customers lost electricity.

SCROLL TO LOCATION:

New England

New York

New Jersey-Pennsylvania

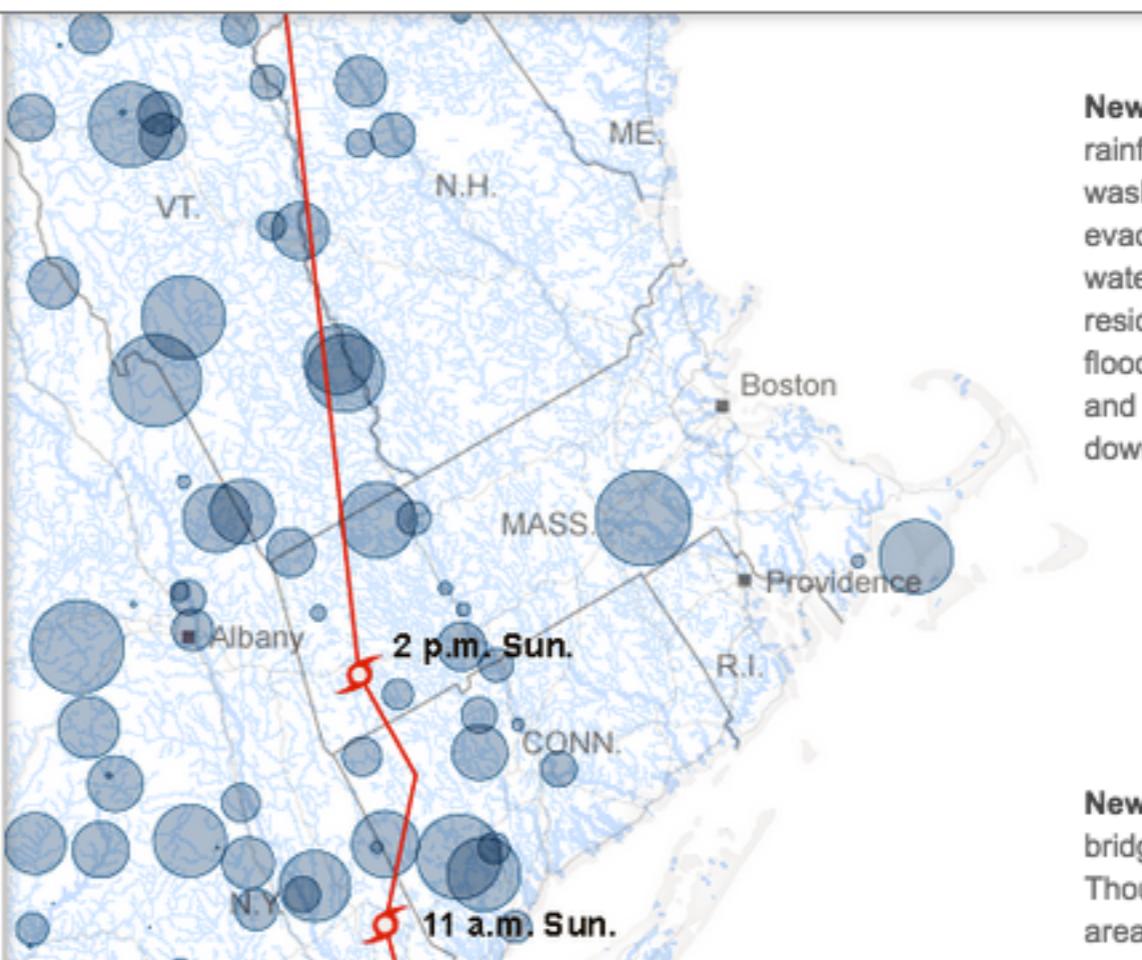
Maryland-Delaware-Washington

Virginia

North Carolina

CHANGE MAP TO SHOW:

- River gauges where buildings and roads have flooded. Circles represent the percentage above a moderate flood level.



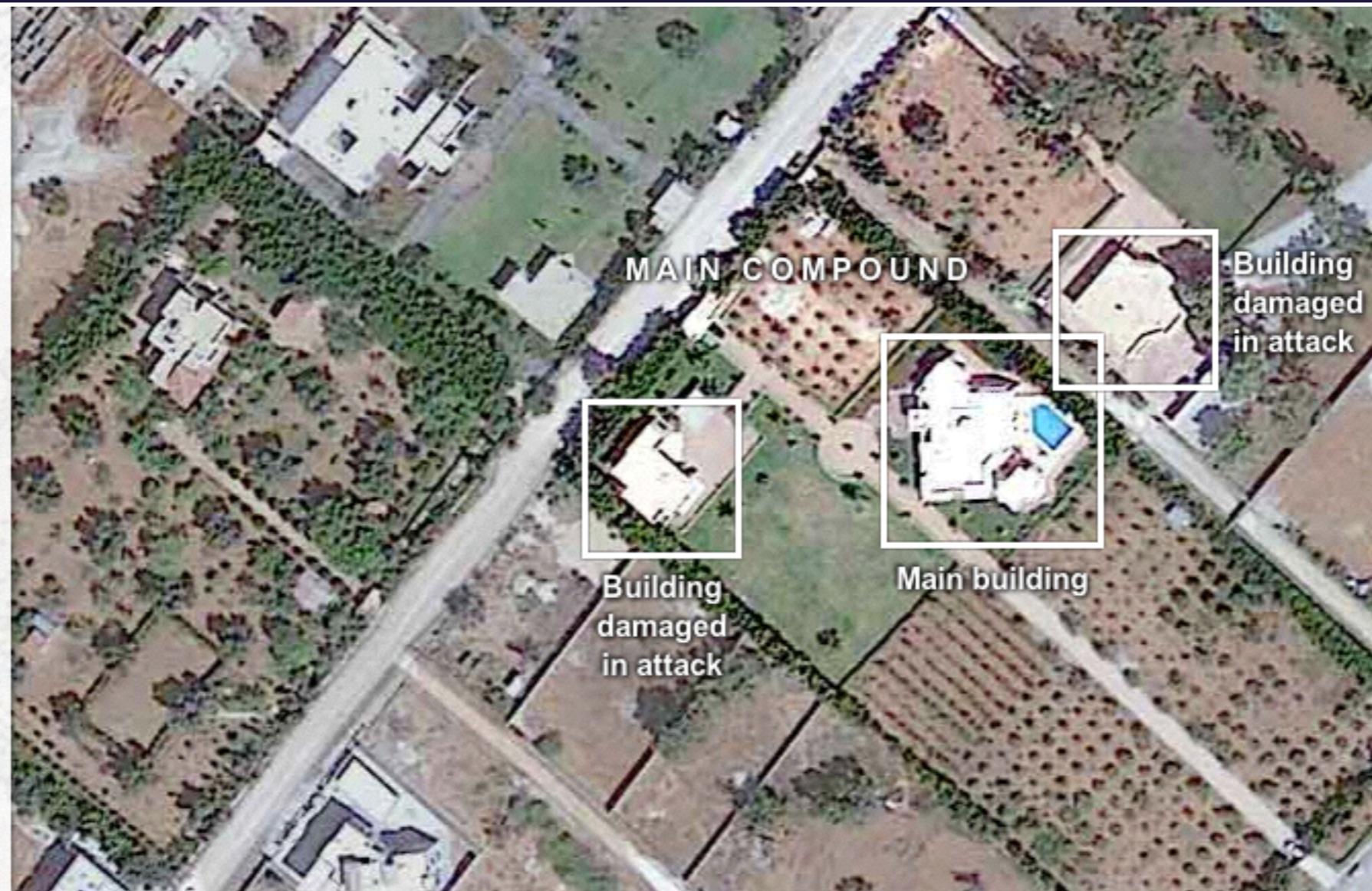
New
rainf
wash
evac
water
resid
flood
and
down

New
bridg
Thou
area

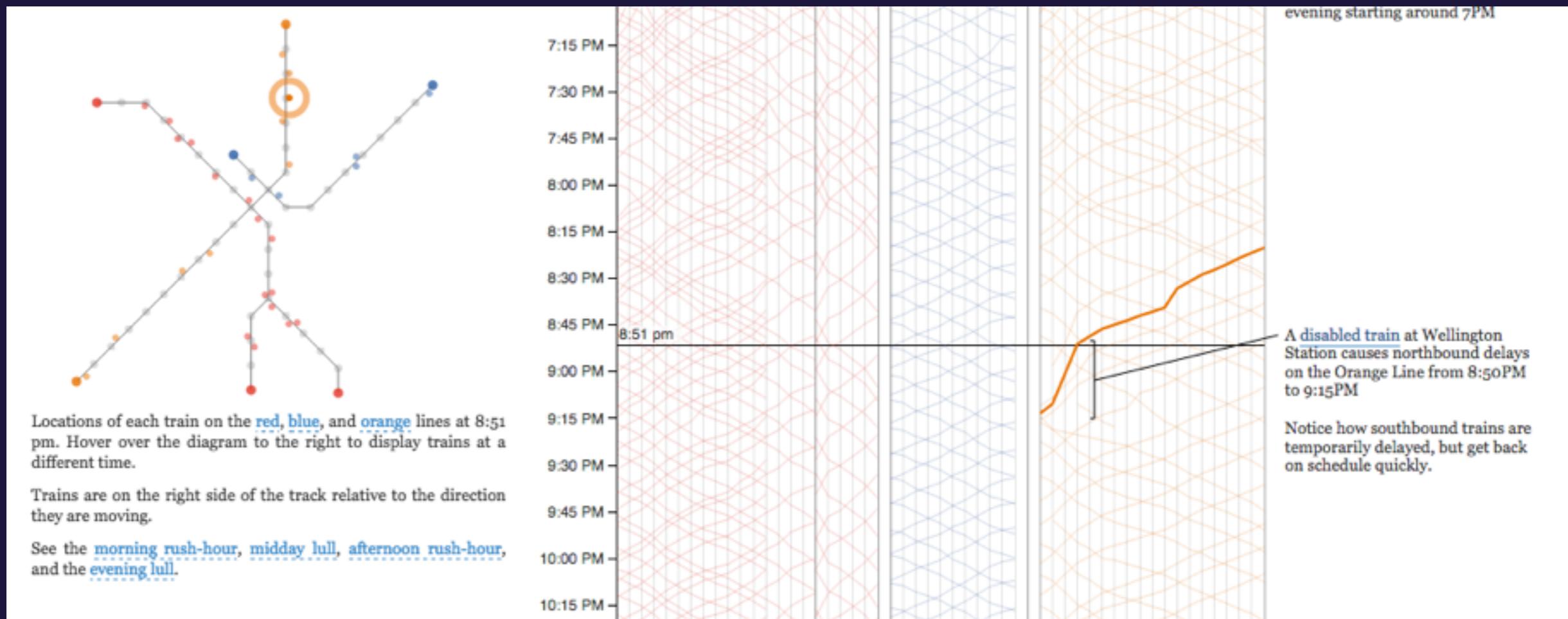


**Sept. 11, 9:30 p.m.
Benghazi time**

The main compound comes under fire. The entrance is protected by three armed and four unarmed Libyan guards. No more than seven Americans are in the compound, including three civilians and four who have guns. Mr. Stevens is alone in one building, according to guards interviewed later. The militants enter the compound, backed by truck-mounted artillery. They fire rocket-propelled grenades into the main building. Armed Libyan and American guards resist from the roofs.



Bret Victor-style “inline”



Animation

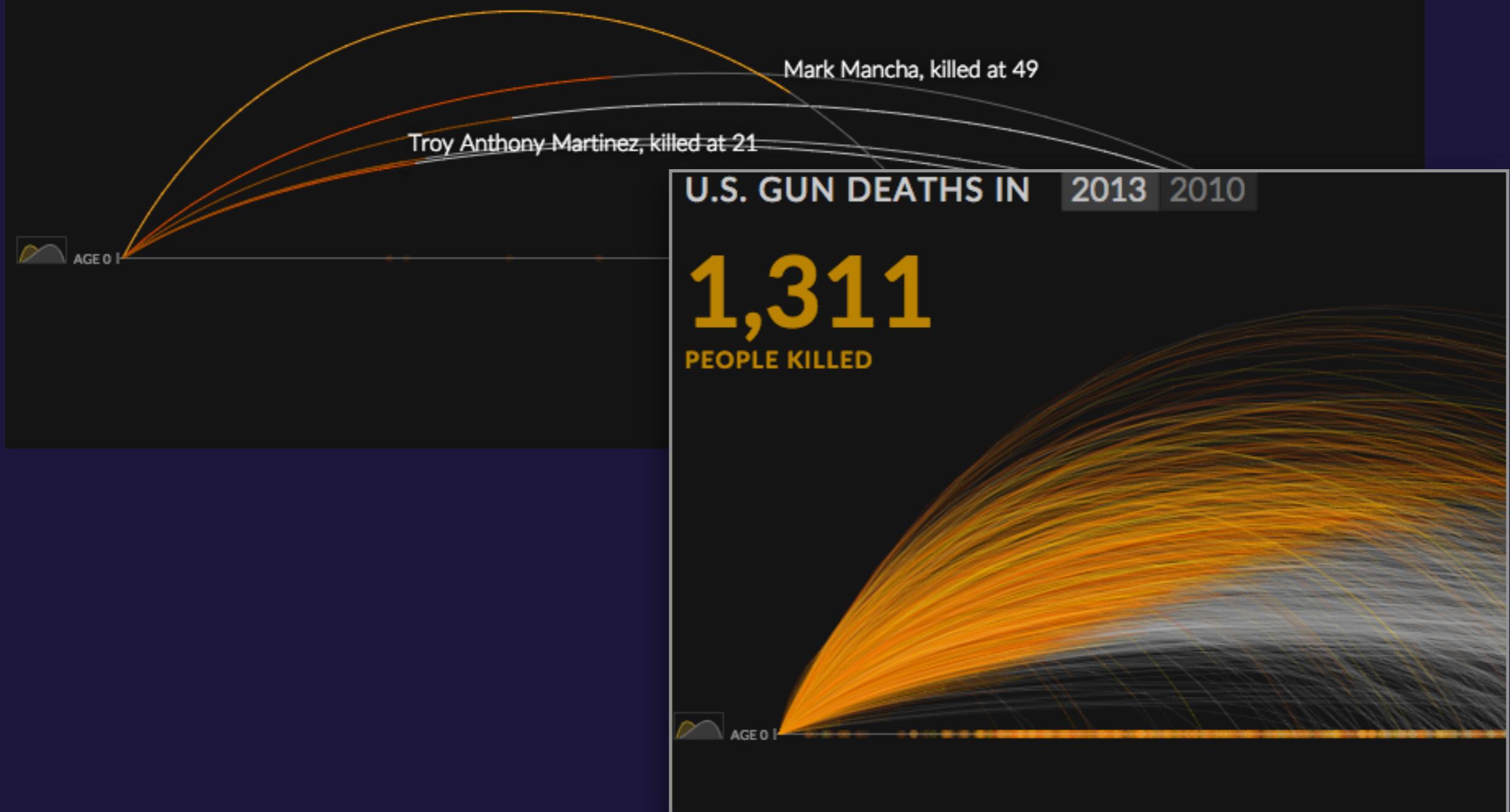
often for timeseries data, sometimes for effect / explanation/to show relationships.

(especially with “small” data)

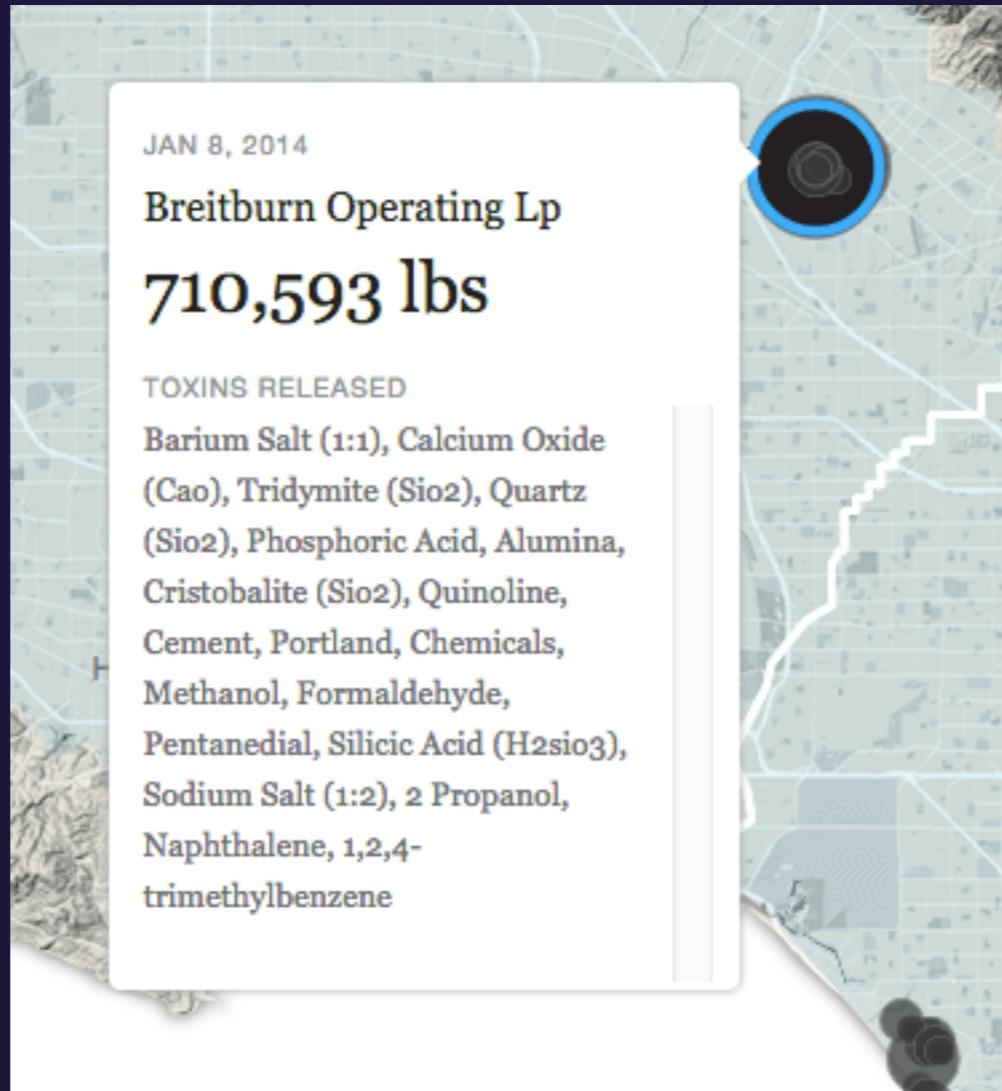


5

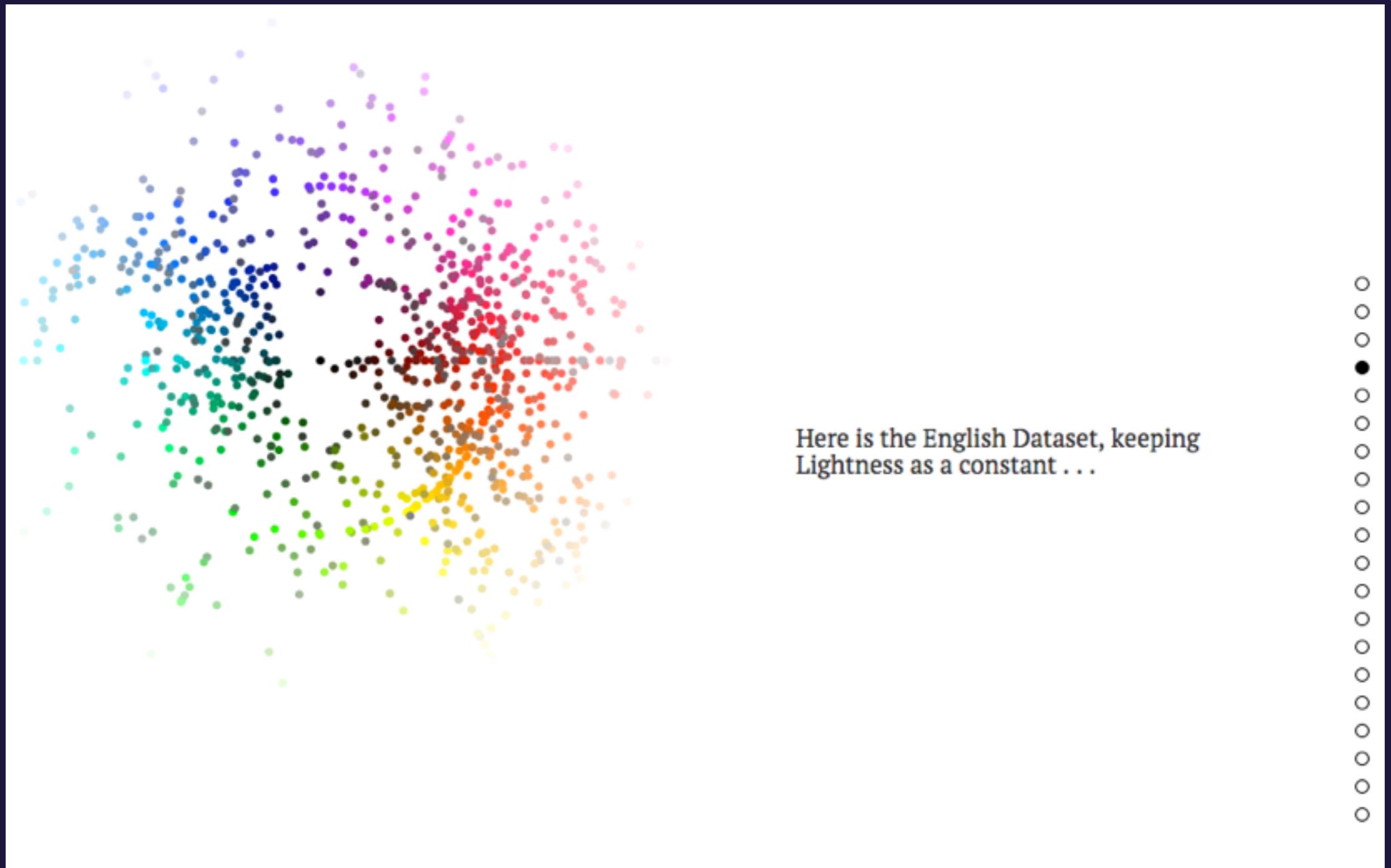
PEOPLE KILLED



Show off your UI Controls (& Preview of next topic...)



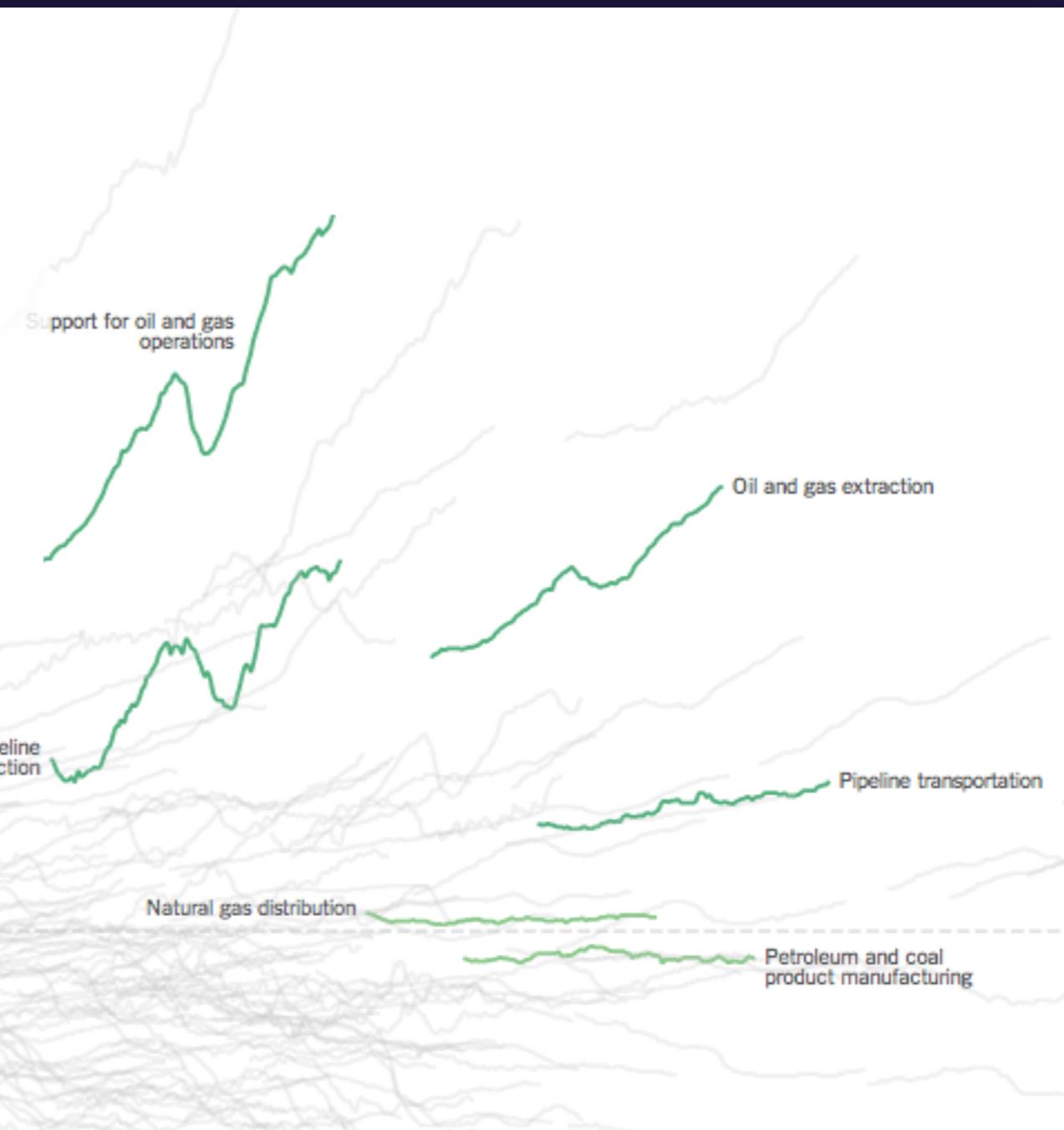
“Scrollytelling”



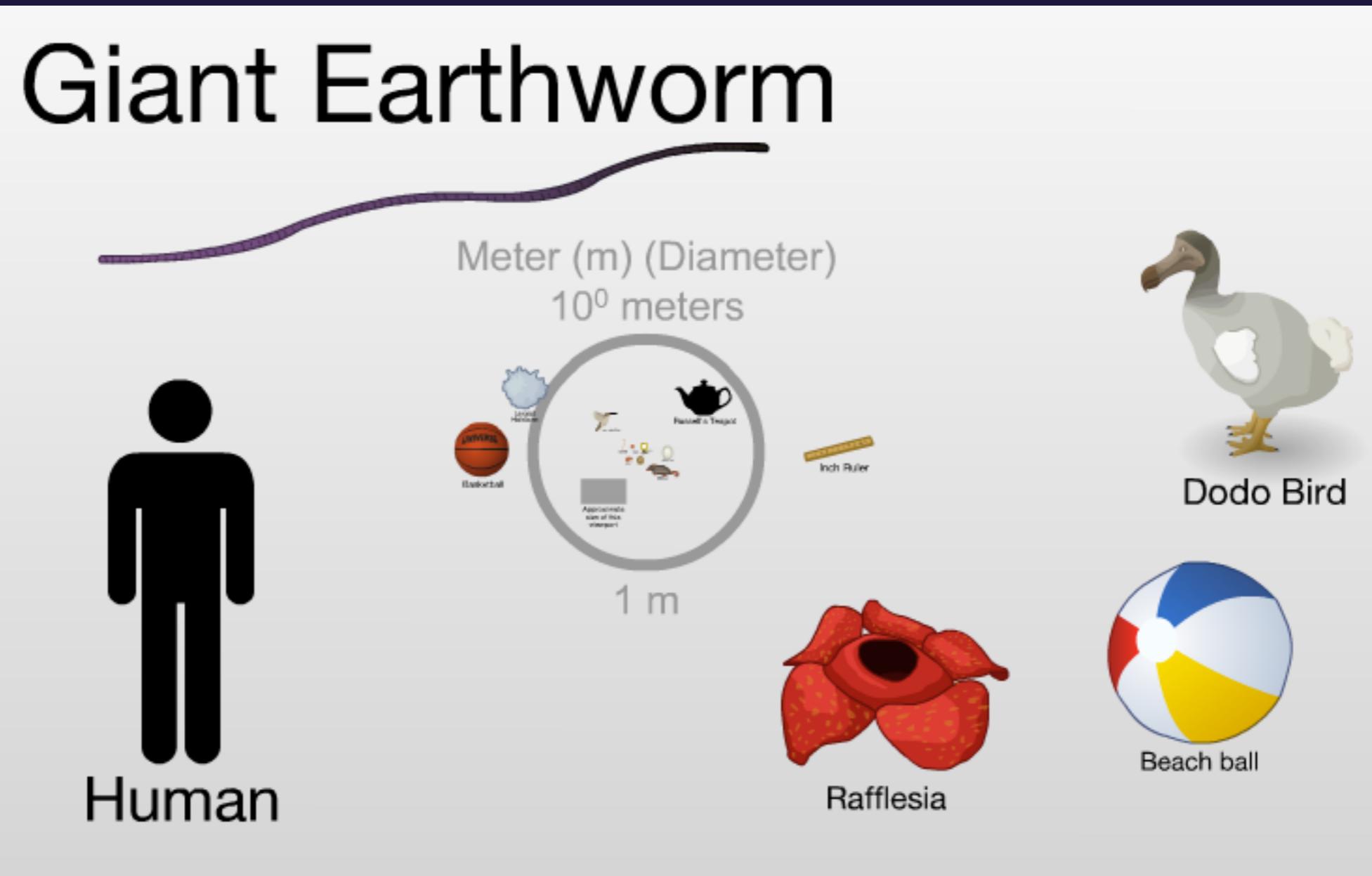
Here is the English Dataset, keeping
Lightness as a constant ...

Black Gold Rush

While it took a hit from the recession, oil and gas extraction — and its associated jobs — have been booming, transforming economies in resource-rich places like West Texas and North Dakota. Many of these industries have average salaries above \$70,000. [NEXT »](#)



"Zoomytelling?"



Reward Interaction: Induce “flow”

“...being completely involved in an activity for its own sake. The ego falls away. Time flies. Every action, movement, and thought follows inevitably from the previous one, like playing jazz. Your whole being is involved, and you're using your skills to the utmost.”

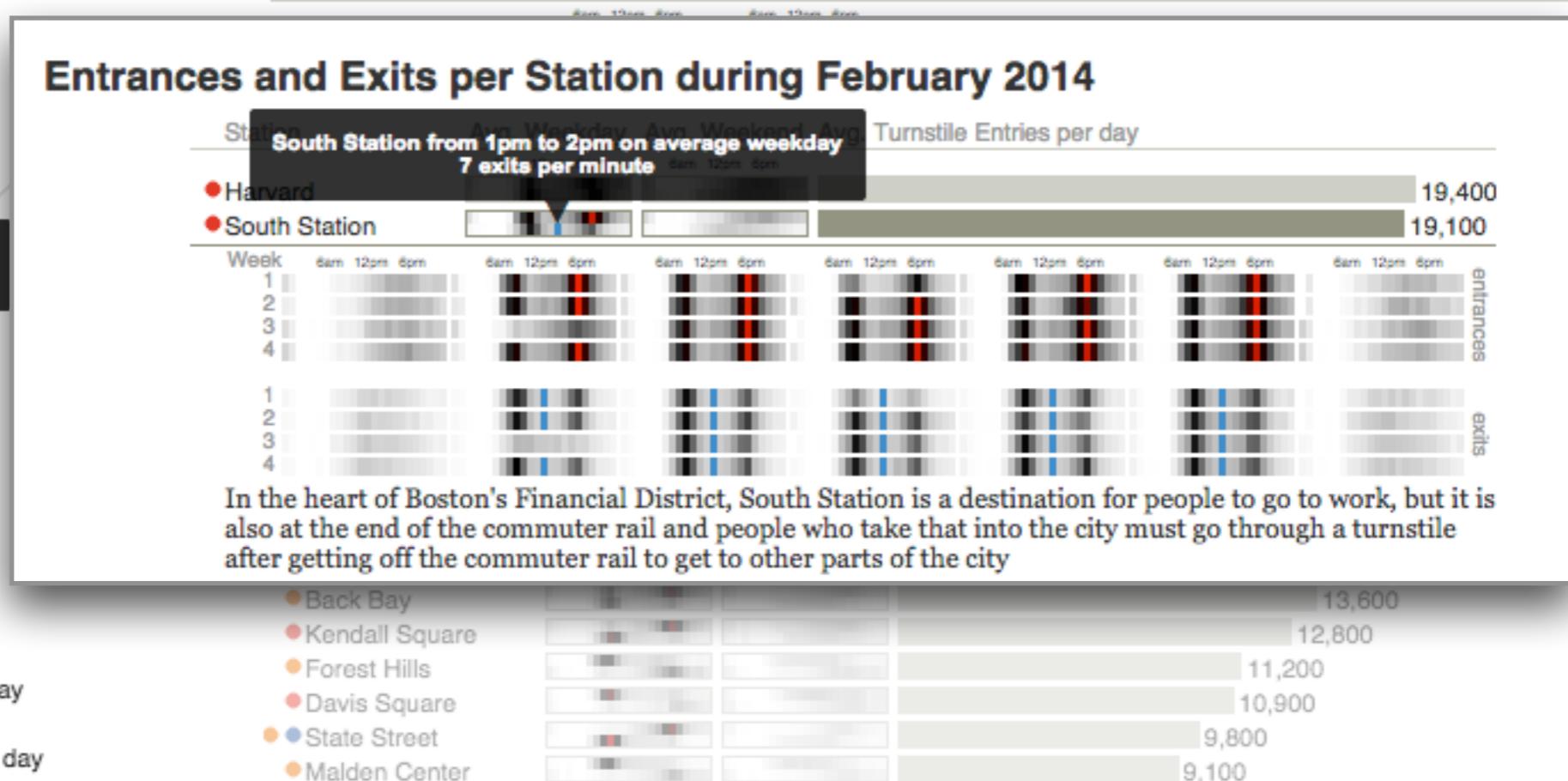
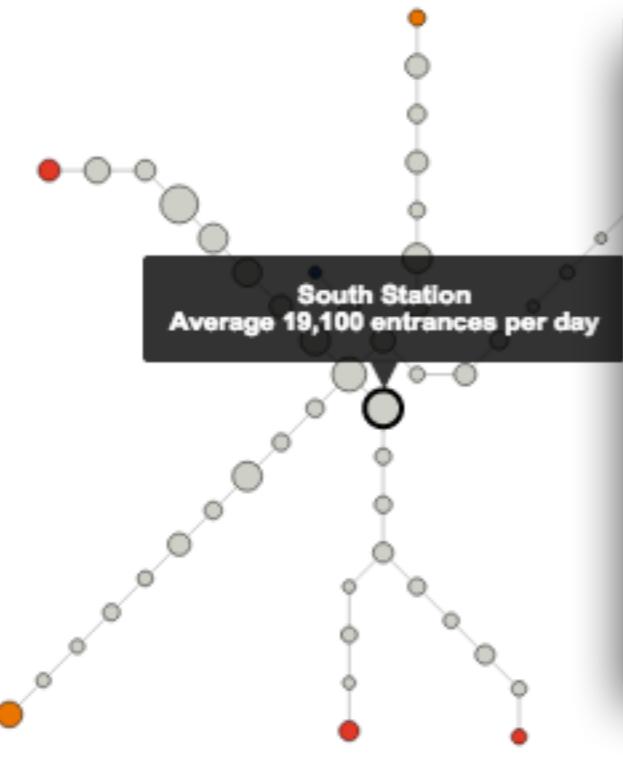
—Csikszentmihalyi

Entrances and Exits per Station during February 2014

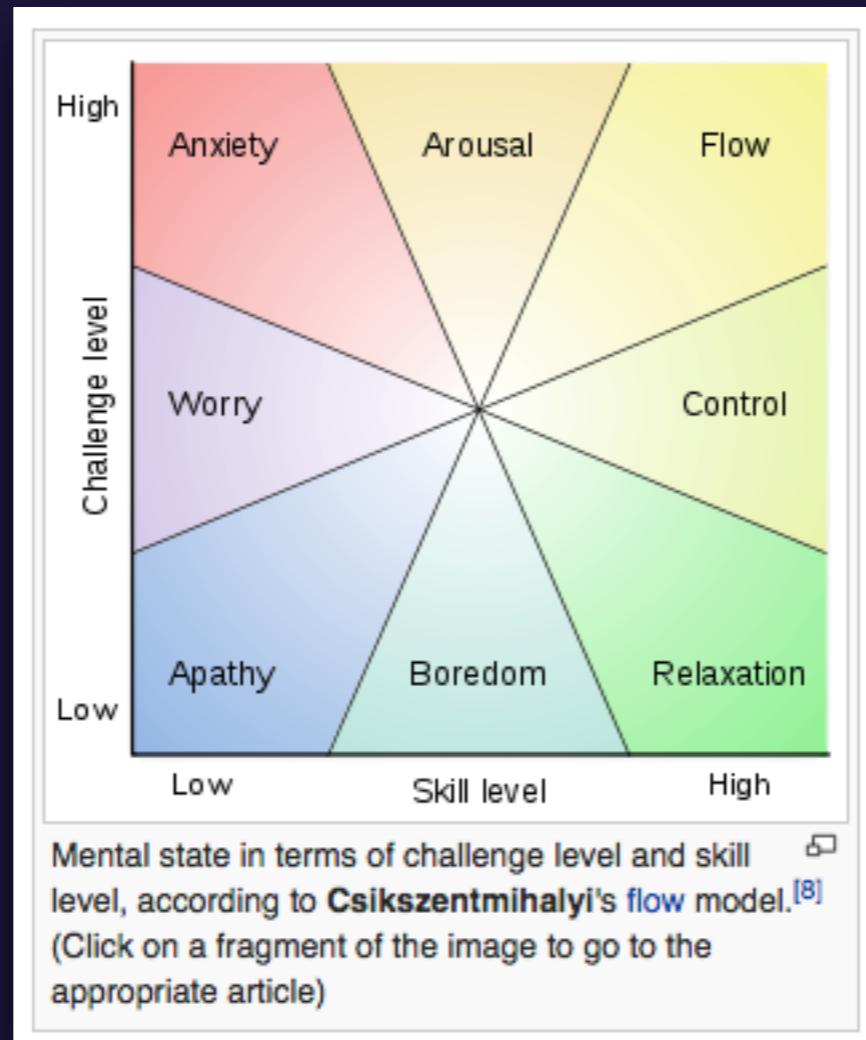
Entrances and Exits per Station during February 2014

Entrances and Exits per Station during February 2014

Station	Avg. Weekday	Avg. Weekend	Avg. Turnstile Entries per day
---------	--------------	--------------	--------------------------------



Where are we, usually?



“experiential” vs
“task directed”
flow states

Internet Archive's Map of Book Subjects by @quasimondo



Recommendation Tools Do It Best?

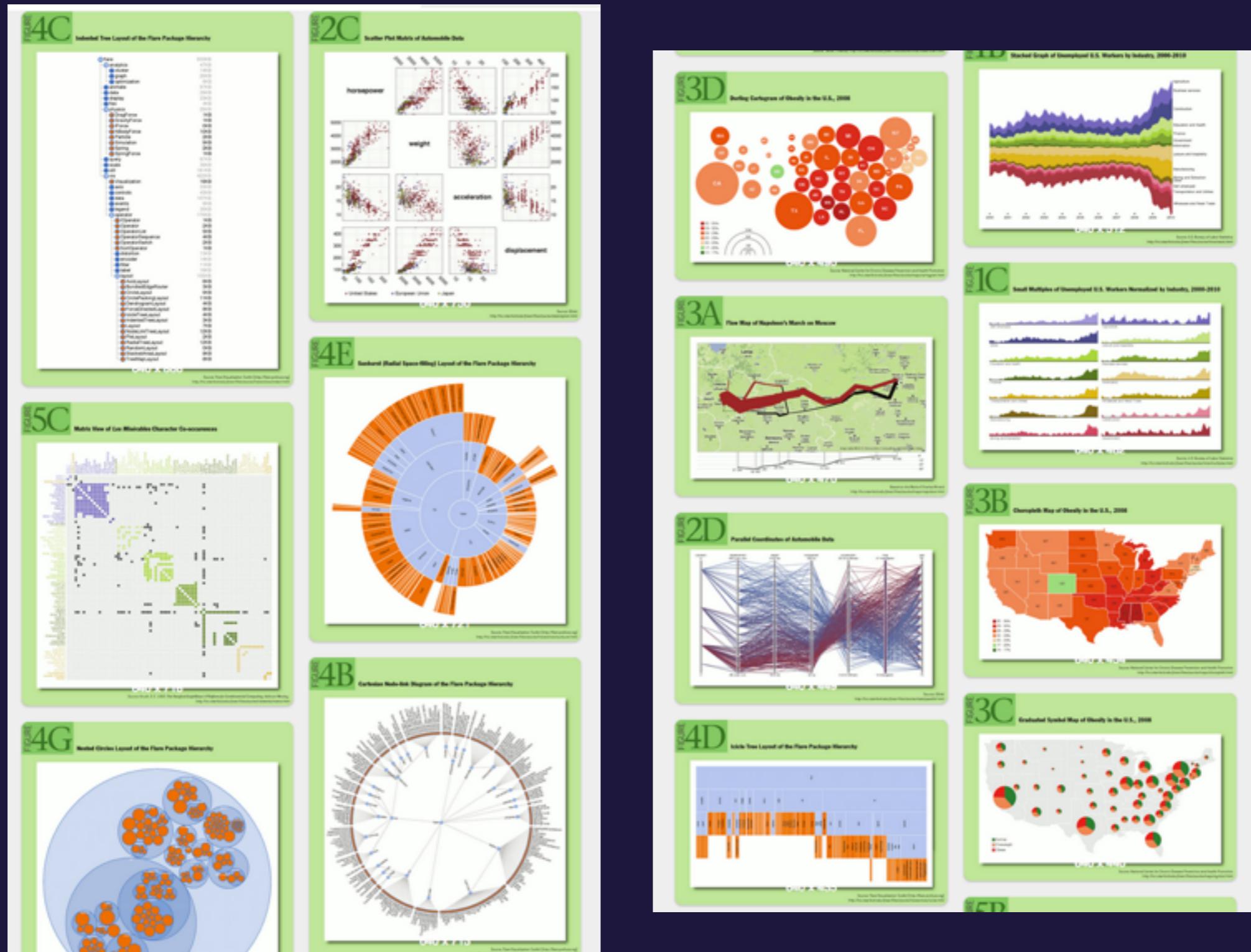
Pinterest search results for "geometric patterns".

Search results:

- Lilith: A circular geometric diagram with various symbols and numbers.
- Anna Hepler / Sacred Geometry: A complex geometric pattern.
- Aligned Spirit Pilates: Sacred Geometry: A geometric diagram.
- Lucrezia Borgia: A portrait of Lucrezia Borgia.
- My 5 Favorite Maps: Bill Rankin - CityLab: A map showing favorite maps.
- jonny sun: geometry & science: A geometric pattern.
- Susan Bones: A geometric pattern.
- 10 minutes prep, made completely in your CROCKPOT! (Slow Cooker) Sweet Potato Casserole - #GottitFree: A photo of a sweet potato casserole.
- Toni Wentworth: Good eats: A photo of a chocolate truffle tart.
- Chocolate Truffle Tart #glutenfree #grainfree #paleo: A photo of a chocolate truffle tart.
- Maja Sch: Gluten-free deserts: A photo of a dessert.
- 260 Degrees of Lake: Print Linus Kraemer did for his friend Liz's birthday. Gouche over brown paper, colour and text added on inkjet. Kraemer graduated from Camberwell in 2009.: A drawing of a lake with a grid overlay.
- Ella: Infographics: A geometric diagram.
- The Hague, MMW, 10 A 11, detail of fol. 351v ("True Religion liberating mankind from the gods: devils falling into hell; Christians praying"). Augustine, La Cité de Dieu (Vol. I). Translation from the Latin by Raoul de Presles. Paris: c. 1475 (c.) c. 1478-1480: A medieval illustration of people in a city.
- Lissa Ann Bai: MYTH & ALCHEMY: A geometric diagram.
- Progression in Sacred Geometry: A geometric diagram.
- Matthijs Kamstra: Computer generated art: A geometric pattern.
- many-bizarre-fish- al-Qazwini: A drawing of many fish.
- william hessel: Other shapes: A geometric diagram.
- 360 Degrees of Lake: Print Linus Kraemer did for his friend Liz's birthday. Gouche over brown paper, colour and text added on inkjet. Kraemer graduated from Camberwell in 2009.: A drawing of a lake with a grid overlay.
- Polynesian Stick Navigation Chart: A diagram of a stick navigation chart.
- Benjamin Gardner: no maps for these territories?: An infographic about storage.
- Ceyda Pektaş: Infographic?: An infographic about storage.
- Lübeck: Alfred Mahlau: A map of Lübeck.
- Alesia Novichkov: Maps: A map of Lübeck.
- Elizabeth (Nellie) Marks Nakamura - Travelling Women: An Aboriginal artwork.
- Pat Crucill: Aboriginal art: An Aboriginal artwork.
- Elements: A geometric diagram.
- Michael Rigley: DATA VIZ: A geometric diagram.
- In the end, the sun rises Art Print / Sacred Geometry: A photograph of a rising sun.
- Simon C Page: A geometric diagram.

Kind of a whirlwind...

"A Tour Through the Visualization Zoo" : A paper with many interactive examples



That's a wrap...

Thanks!

Questions?

@arnicas