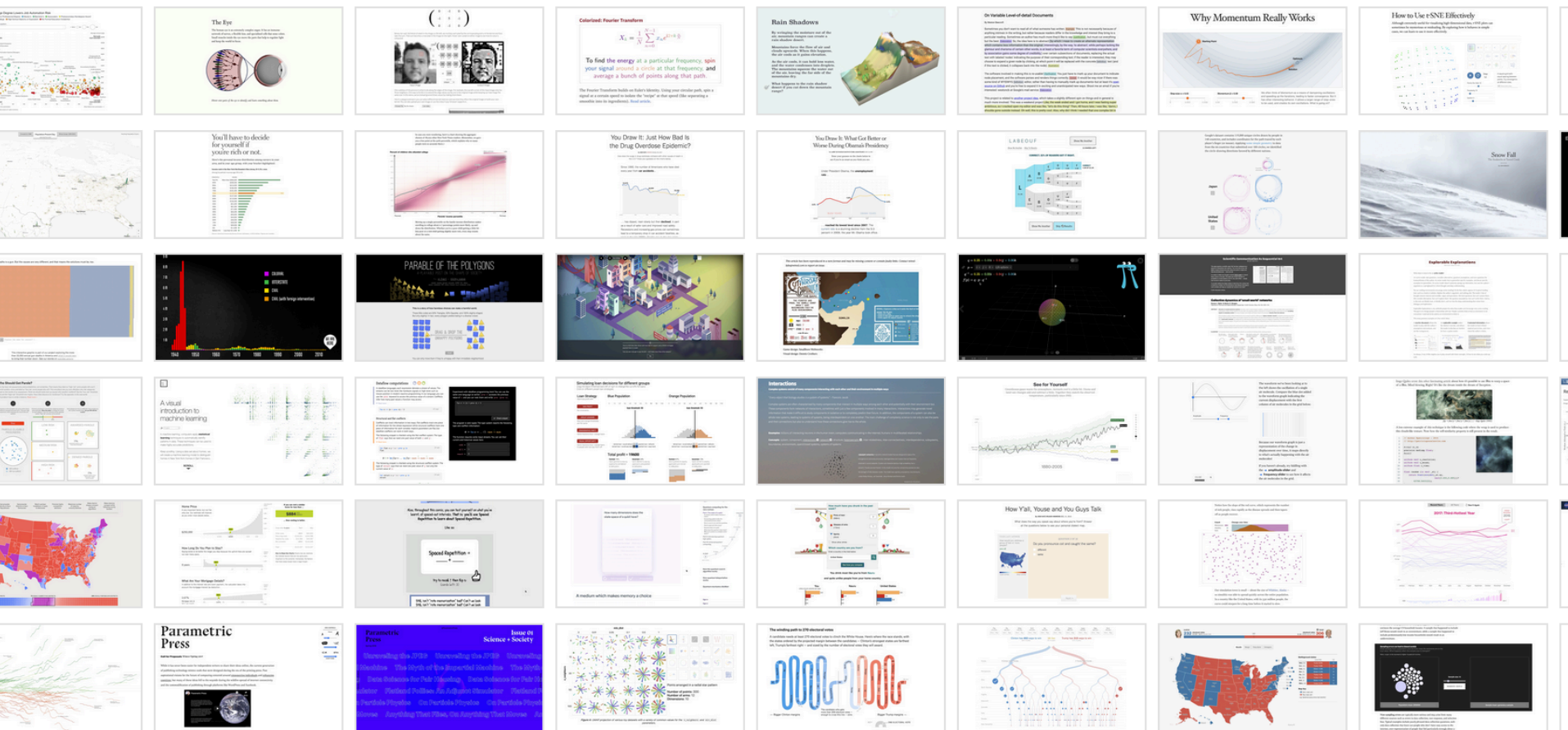


# Narrative Visualization



# Matthew Conlen

(with material from Jeff Heer, Edward Segel, and Jessica Hullman)

## About Me

Ph.D. student @ UW

Advised by Jeff Heer

Background in data journalism

FiveThirtyEight, CNN, New Yorker,  
New York Times (current)

Lecture will be biased toward that

# STORYTELLING

as ancient as mankind



Going forward

I carried wax along the line, and laid it thick on their ears. **They tied me up**, then, plumb amidships, **back to the mast**, lashed to the mast, and took themselves again to rowing. Soon, as we came smartly within hailing distance, the two **Sirens**, noting our fast ship, off their point, **made ready, and they sang...**

# Narrative Storytelling

**narrative** (n): An account of a series of events, facts, etc., given in order and with the establishing of connections between them.

Effective storytelling “require[s] skills like those familiar to movie directors, beyond a technical expert’s knowledge of computer engineering and science.” - Gershon & Page ‘01

# STORYTELLING

across various media

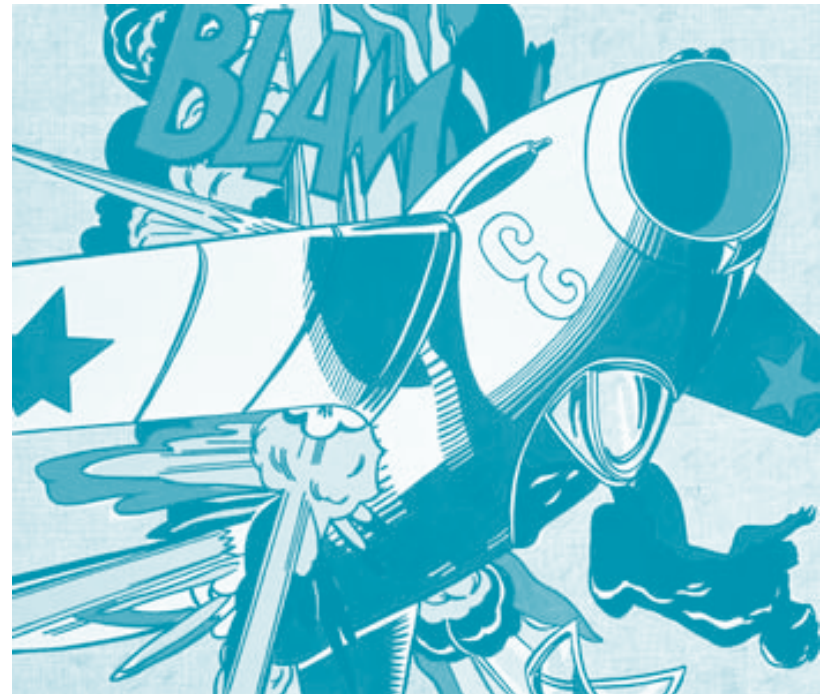
PEOPLE TELL STORIES

WORDS TELL STORIES

IMAGES TELL STORIES

COMICS TELL STORIES

MOVIES TELL STORIES



August 26, 2010

# Generals Wary of Move to Cut Their Ranks

By [GINGER THOMPSON](#) and [THOM SHANKER](#)

WASHINGTON — Maj. Gen. Paul D. Eaton, a retired Army officer, is familiar with the perks and pitfalls of power, having commanded tens of thousands of troops at Fort Benning, Ga., managed budgets exceeding \$2 billion in Iraq, and overseen layers upon layers of staff members who helped manage both his professional duties and his personal life.

He has experienced the full range of lifestyles that come with military leadership, living at one point in an elegant antebellum mansion, and at another, with eight other officers crowded in a marble bathhouse behind one of [Saddam Hussein's](#) old palaces.

When he traveled, he was occasionally able to justify the use of military aircraft, but most times, he said, he flew coach. And today he lives on a pension worth 75 percent of his military salary, with health benefits that cover everything except dental and eye care for himself and his wife.

“We are well compensated, and we live very comfortable lives,” General Eaton said, referring to the military’s most senior leaders. “But when you look at all the things going on around a general, the nation is getting a very, very high return on its money.”

Not everyone at the Pentagon agrees. Two weeks ago, Defense Secretary [Robert M. Gates](#) announced a sweeping effort to improve efficiency that, among other things, takes aim at the military’s sacrosanct corps of generals and admirals, ordering his staff to cut at least 50 positions, and making clear that he would be happier if they cut more.

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## Anecdotal Lead

August 26, 2010

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## Nut Graph

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# Topics

## Narrative visualization

*Case Study: Coronavirus Testing*

Design space

Recent research in narrative visualization

## Interactive articles

*Case Study: Carbon Footprint*

Authoring tools

## Design Prompt: Elections

**Storytelling  
... with data?**



### Privacy and the internet

## Lives of others

BY JAMES HAMILTON

Facebook and Google face a backlash, from users and regulators alike, over the way they have handled sensitive data

**J**OHNNIE STOCOMET, Canada's privacy commissioner, interviews with Facebook in August over the social networking site's track record, agreeing to change its policies within a year to comply with the country's privacy law. Now, says Mr Stocomet, the company appears to be moving in an important part of that deal, which involved giving users a clear and easy-to-implement choice over whether to transmit data with third parties. "It doesn't seem to me that Facebook is going in the right direction on this issue," he says, noting that, without a change of course, the firm could soon become the subject of another formal investigation by his organisation.

Facebook is not the only internet giant to provoke the ire of data watchdogs. Google endured scathing criticism this week following news that it had received some personal communication sent over unsecured Wi-Fi data networks in homes and offices in some 30 countries. On May 23rd Peter Schaar, Germany's federal commissioner for data protection, called for an independent investigation into Google's behaviour, claiming that it had "deeply disrupted normal rules in the development and usage of software."

The cases highlight rising tension between guardians of privacy and internet firms. And they reflect concern among web users about how private data are made public. Several prominent internet

ty moguls such as Cory Doctorow, a science-fiction author, and Iain Stewart, a politician, have abandoned Facebook. Sites such as Quia/Facebook Dismantle are urging others to do so, and linking May 26th to a mass Facebook "boycott".

This is unlikely to stop the momentum of Facebook, which is poised to claim half a billion members and which drove even more visitors as a whole to its site last month. Firm revenues have been raised at the company's headquarters in Menlo Park, where bosses are mulling over how to respond. Several online folk are now linking that Facebook will soon roll out stricter privacy controls to make it easier to keep more data hidden. MySpace, a rival, is already making its controls stricter in an effort to woo disaffected Facebookers to its service.

A revolt over Facebook's handling of privacy has been brewing for some time. In December the social network changed the default settings on its privacy controls so that individuals' personal information would be shared with "everyone" rather than selected friends. Facebook argued this reflected a shift in society towards greater openness and noted that users could still adjust privacy settings back again. But frustrated privacy activists lobbied hard to be heard.

The switch should not have come as a surprise: truly 60, many social networks

### Also in this section

- 68 Spring companies
- 80 The recovery of General Motors
- 86 Business crime in China
- 70 Italian retail
- 70 Japan's drug firms are the model
- 74 Brazil on tobacco
- 74 Schumpeter: Duernmattel

See July 2011's special section on business, and [www.economist.com/business-finance](http://www.economist.com/business-finance)

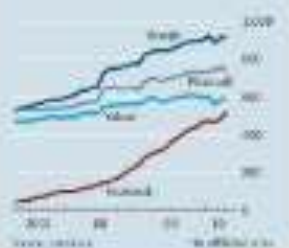
reportedly tough privacy policies in order to attract and increase users. But as more joint controls are gradually loosened to encourage more sharing, as people share more, Facebook can increase the traffic against which it sells advertising. And the more it learns about users' lives and habits, the better it can target ads that generate hundreds of millions of dollars.

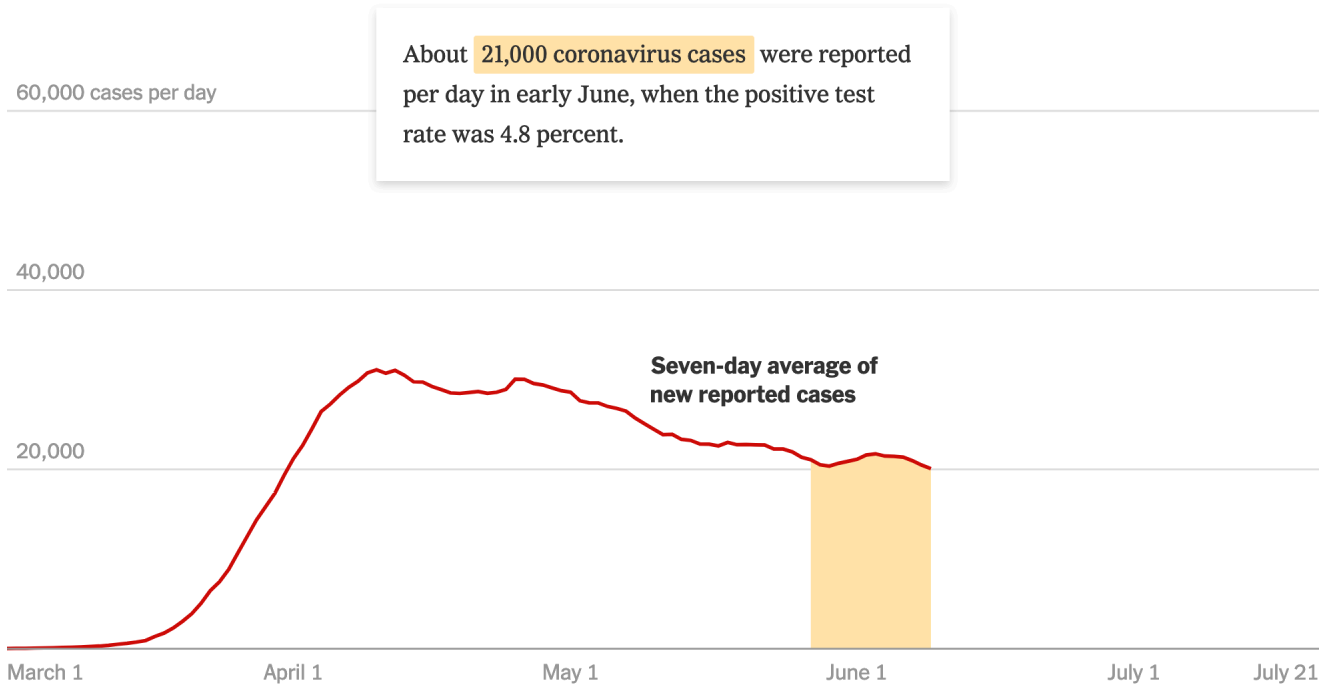
Privacy groups have been following a developers' conference last month at which Mark Zuckerberg, Facebook's boss, announced yet another series of policy changes. One that raised irritation was an "opt-out personalisation" feature that lets remote third-party websites access Facebook data when people visit. Critics say that Facebook has made it tricky to disable this feature, which may explain why its standard default is so much.

European officials are questioning both Facebook's use. This month a group of data-protection experts also asked the European Commission to look at the social network, calling its default controls the default settings "unacceptable". And as the

### Not looking fare

By David Colquhoun





## **CASE STUDY** COVID-19 TESTING

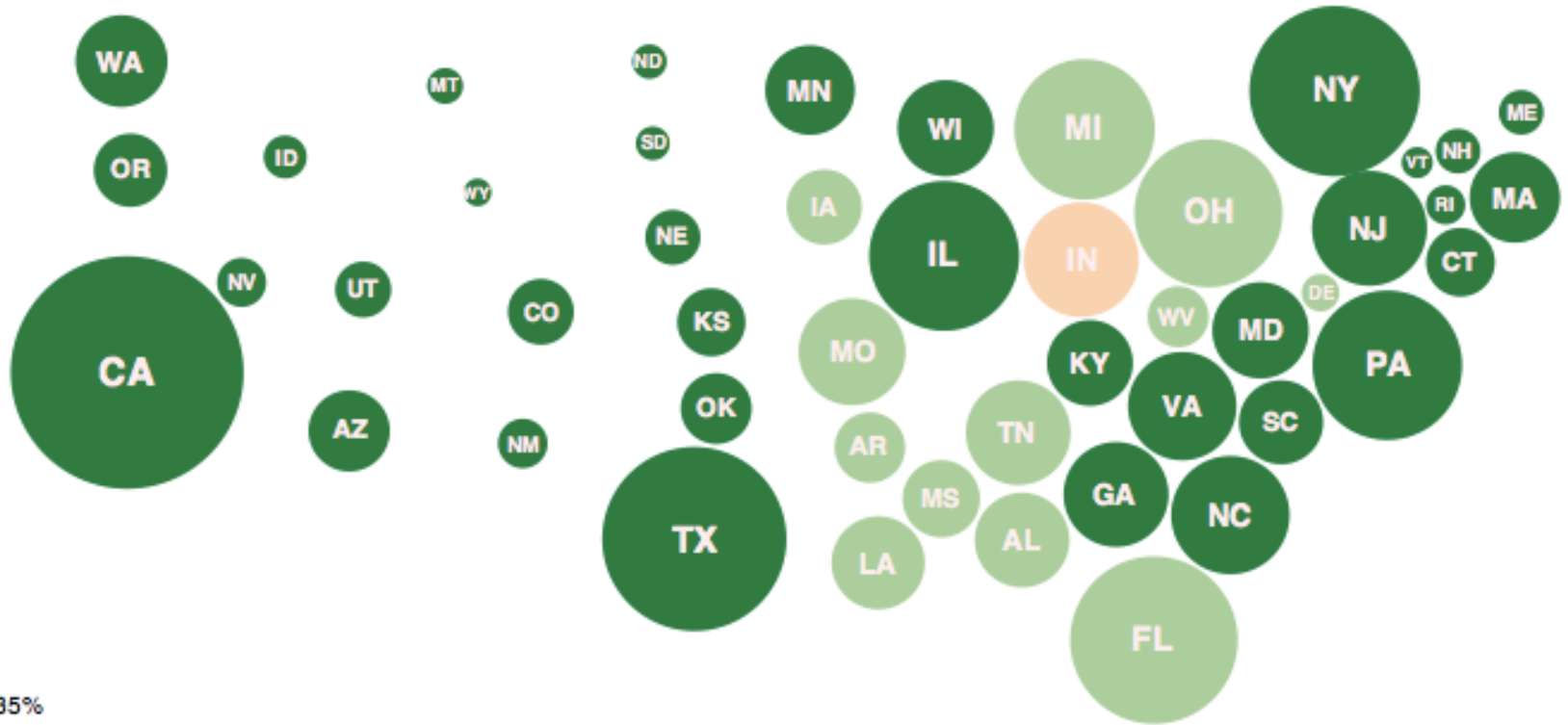
### **Input Data**

Daily case and test counts.

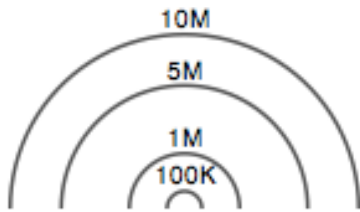
### **Points of Focus**

1. Baseline (smoothed average of daily cases)
2. Counterfactual case curve  
(baseline positivity rate \* daily test counts),
3. Actual case curve (daily cases)

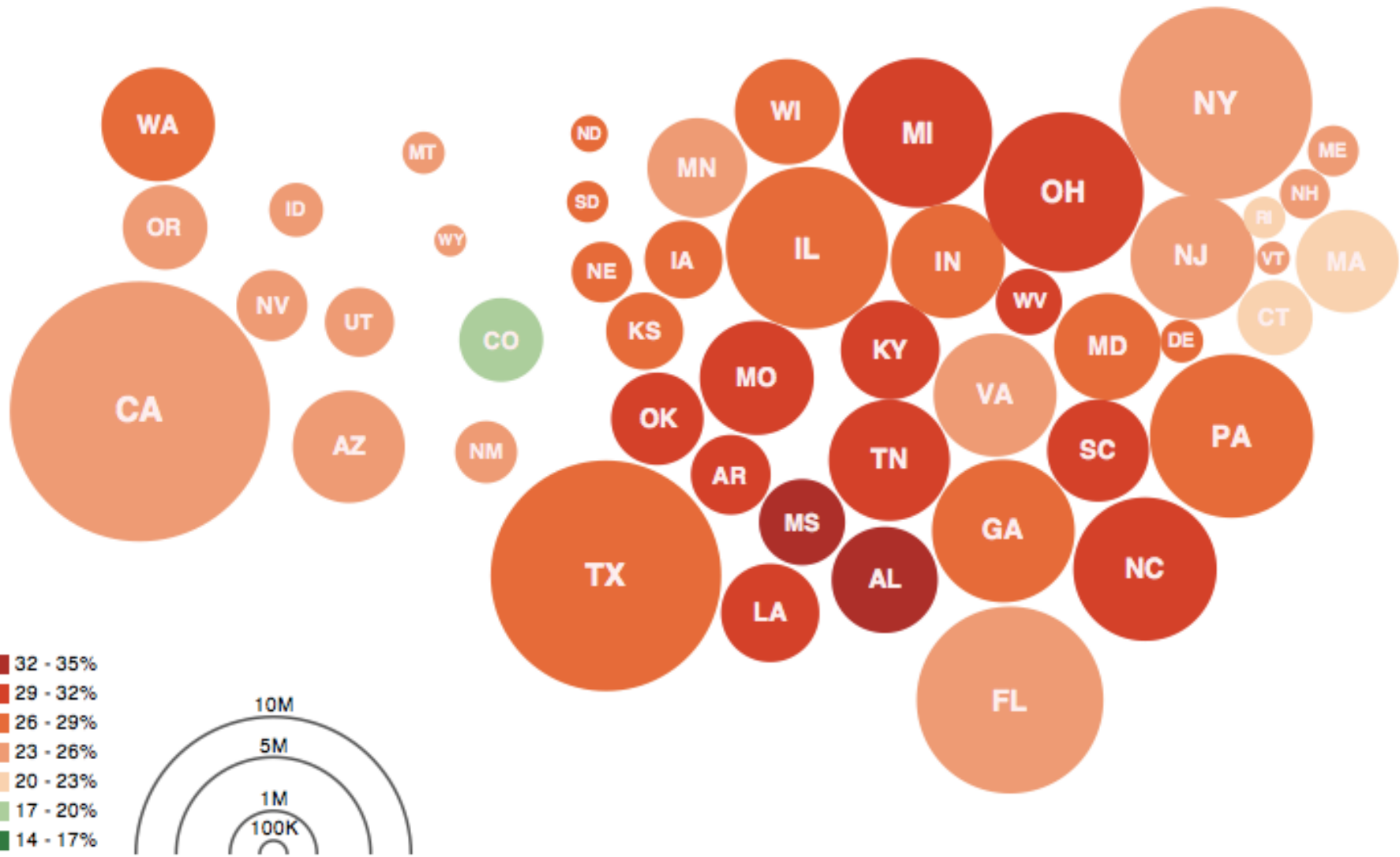




- 32 - 35%
- 29 - 32%
- 26 - 29%
- 23 - 26%
- 20 - 23%
- 17 - 20%
- 14 - 17%



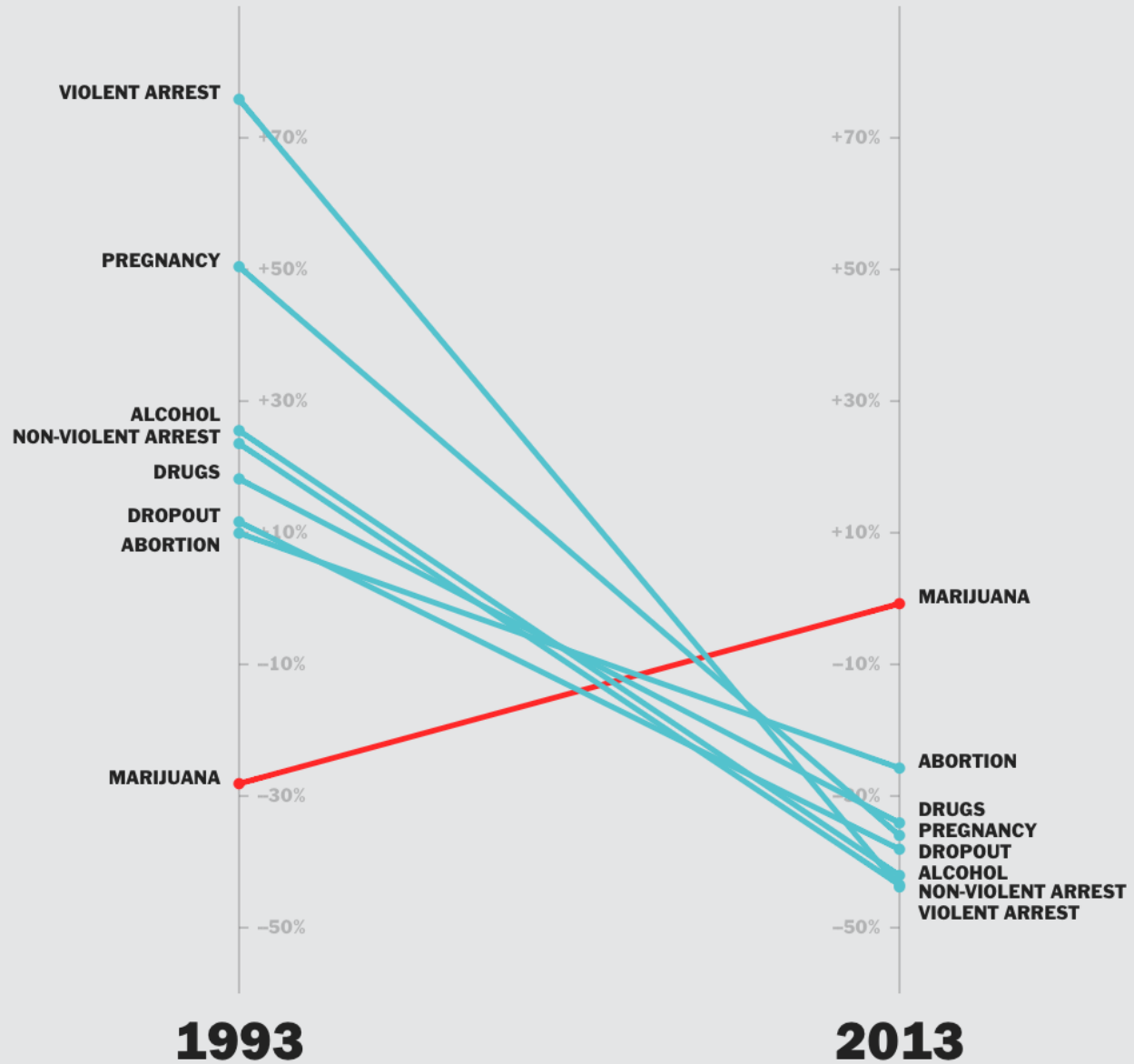
Obesity Map Vadim Ogievetsky



Obesity Map Vadim Ogievetsky

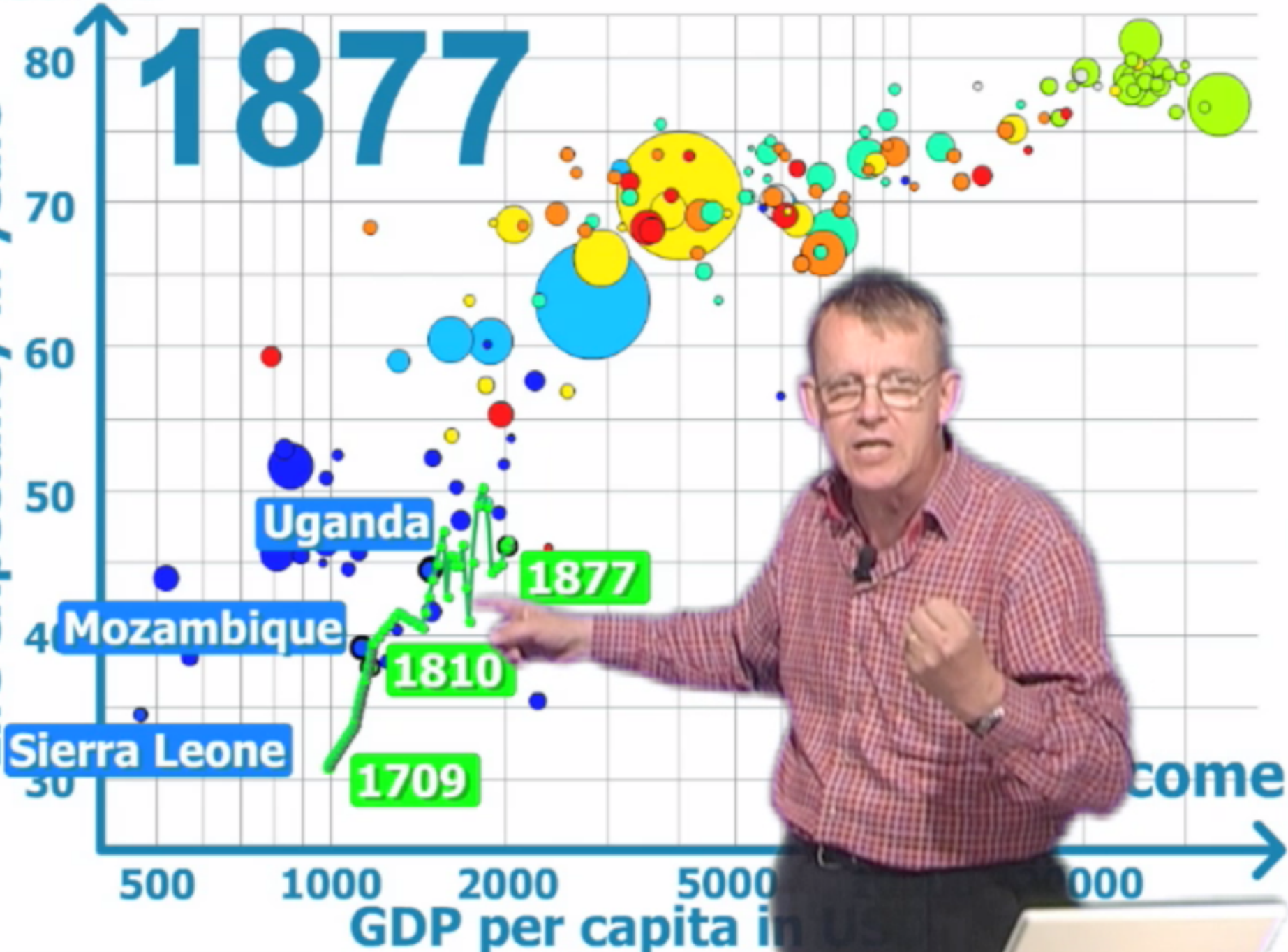
# SHENANIGANS

Change in teen shenanigans from 1993 to 2013.  
Showing % difference from 2003 levels.



Health

Life expectancy in years



# **Narrative Devices**

What devices communicates best?

Highly dependent on: audience, context, format

## **Format**

Interactive Article

Animation

Lecture

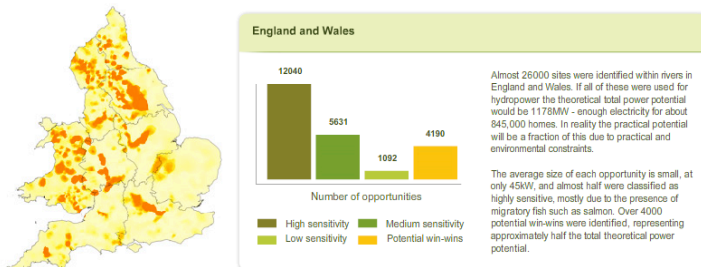
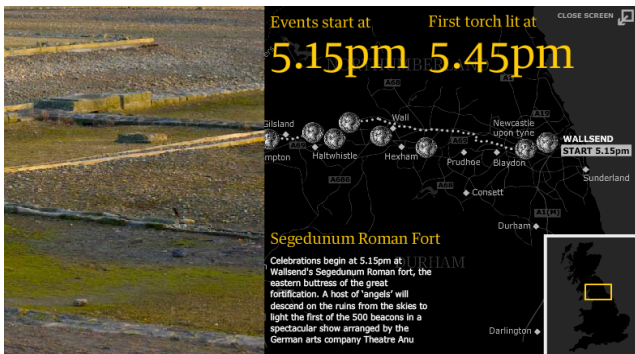
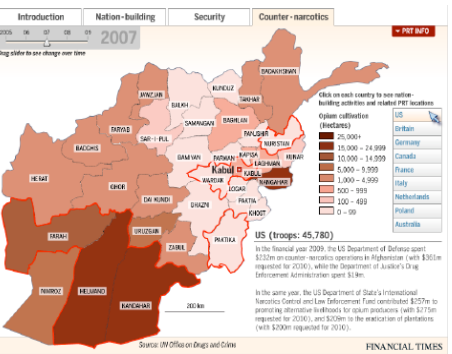
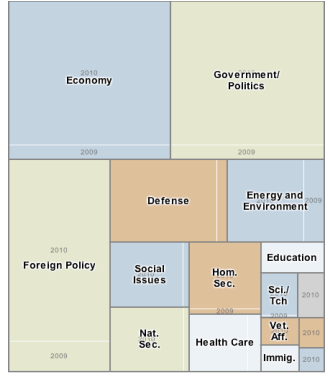
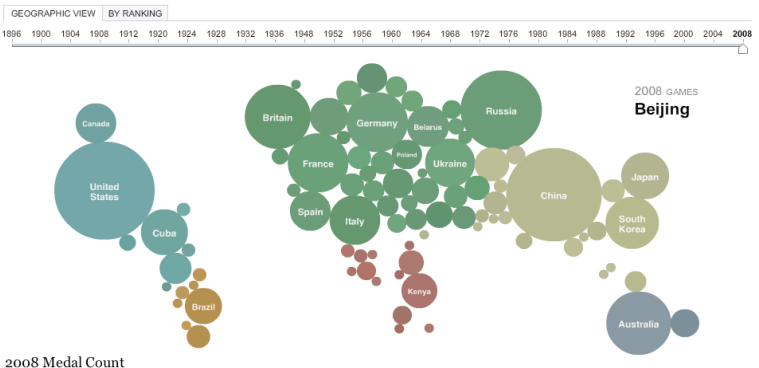
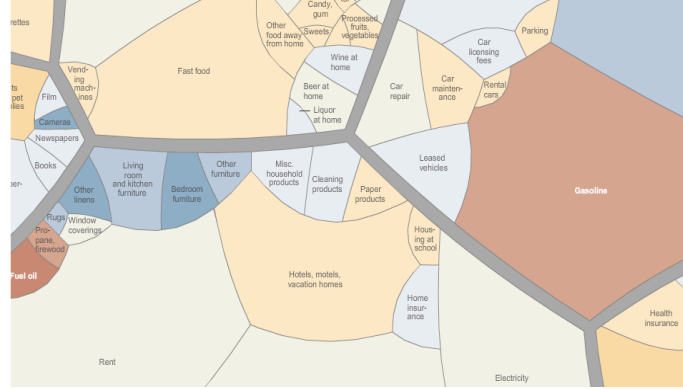
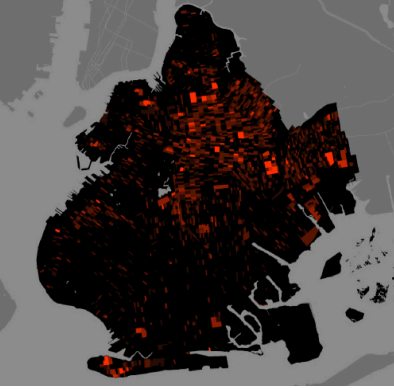
Still Image

Video

# Narrative Visualization Design Space

# 58 CASE STUDIES

70% Journalism  
20% Business  
10% Research



Segel & Heer, 2010

# 755

Grab attention with image and position



Line chart of cumulative home runs.

**Hank Aaron**  
755 homers  
23 seasons



**Babe Ruth**  
714 homers  
22 seasons



**Barry Bonds**  
708 homers  
20 seasons

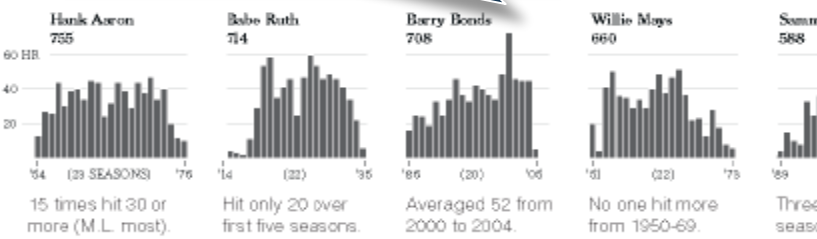
**Bonds takes lead**  
Home runs  
after 16 seasons  
Bonds 567  
Aaron 554  
Ruth 516

Major concern

According to a book, he began using steroids in the 1990s, league-wide later, he runs, su career p

Reduced visual priority

Differing Paths to the Top of the Charts The top seven players on the career h

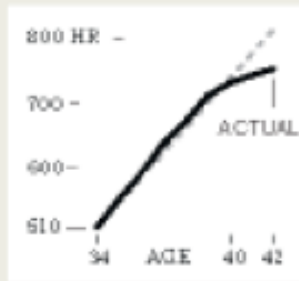


## Homer Pace After Age 34

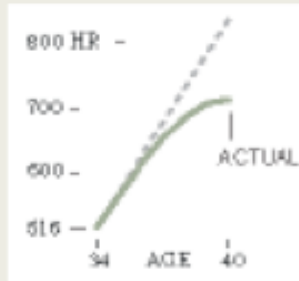
If the accusations are correct, Bonds was 34 in his first season on steroids. Here are projected home run paces for each player after age 34.

----- PROJECTED PACE BASED ON AVERAGE OF PREVIOUS FIVE SEASONS

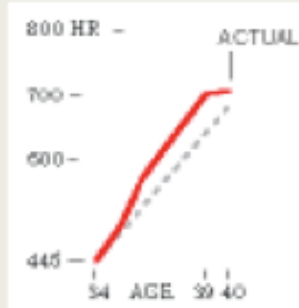
**Aaron**  
Actual homers slightly outpace projected homers for five seasons.



**Ruth**  
Averaged 46.4 homers a season from age 30 to 34. Averaged 42.5 for next four seasons.



**Bonds**  
From age 35 to 39, he averaged 14 more homers a season than projected.

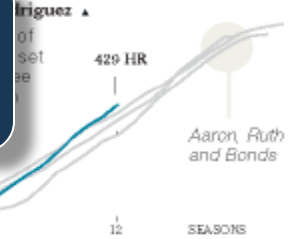


Note: Ages as of July 1 of each season.

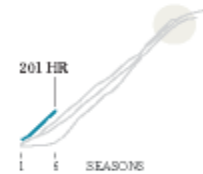
## Others Taking Aim



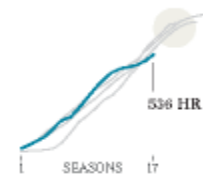
Major concern



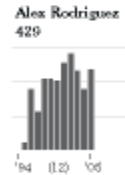
**Albert Pujols**  
Averaging 40 homers a season, he has started stronger than the three leaders did.



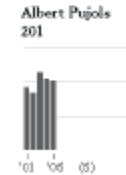
**Ken Griffey Jr.**  
Many thought he would be the first to catch Ruth and Aaron until injuries limited his output.



(257th).



Youngest to reach 400 homers.



Second most ever in first five seasons.



# Beginning

## Steroids or Not, the Pursuit Is On

Barry Bonds is taking aim at the career home run record. He needs only one season to tie Babe Ruth and 47 to equal Hank Aaron.

Here are cumulative home runs for the three players.

**Hank Aaron**  
755 homers  
23 seasons



**Babe Ruth**  
714 homers  
22 seasons



**Barry Bonds**  
708 homers  
20 seasons

**Bonds takes lead**  
Home runs after 16 seasons:  
Bonds 567  
Aaron 554  
Ruth 511

14th season

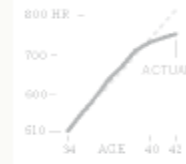
According to allegations in a book about Bonds, he began taking steroids before the 1999 season, his 14th in the league. Two seasons later, he hit 73 home runs, surpassing Aaron's career pace.

### Homer Pace After Age 34

If the accusations are correct, Bonds was 34 in his first season on steroids. Here are projected home run paces for each player after age 34.

----- PROJECTED PACE BASED ON AVERAGE OF PREVIOUS FIVE SEASONS

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**Bonds**  
From age 35 to 39, he averaged 14 more homers a season than projected.



# Middle

## Others Taking Aim



### Alex Rodriguez

Is ahead of the pace set by all three home run leaders.



### Albert Pujols

Averaging 40 homers a season, he has started stronger than the three leaders did.



### Ken Griffey Jr.

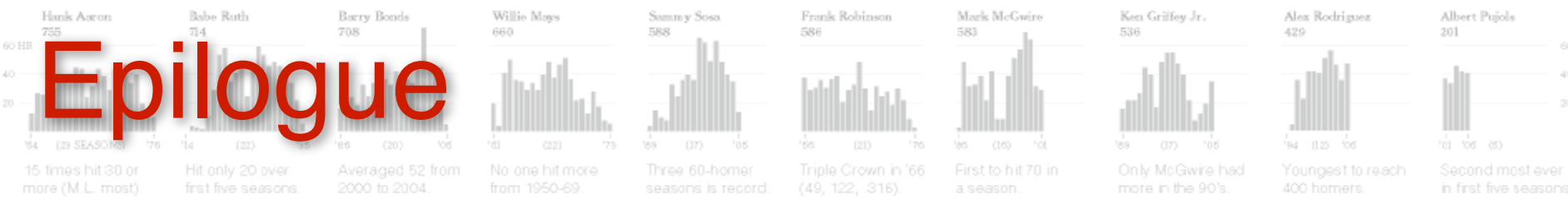
Many thought he would be the first to catch Ruth and Aaron until injuries limited his output.



# End

## Differing Paths to the Top of the Charts

The top seven players on the career home run list, along with a look at Griffey (12th), Rodriguez (37th) and Pujols (tied 257th).



# Epilogue

**Visualization Description**

Architecture and Justice (Brooklyn Crime Blocks)
John Deere: How farmers abuse their free-mailing privileges before elections
Football: Soccer ball (soccer) drawings
Pedestrians: Pedestrians crossing the street
The Climate Agenda
White Collar Crime: Did Your County's Jobs Disappear?
Academy Awards: Metrics House Price Index
Barney's Diner: \$ earnings: How compensation relates to performance
Death: Deadly offensive: Taliban attacks in Pakistan
Google: Moves by Sector
UK: Economic data
Budget 2010: Reaction from around the UK
Formula One 2010: driver's rankings
Light: Lighting up Hadrian's wall
Map: Mapping hydropower hotspots across the UK
Moscow: How metro bombs: interactive map
The World: World economy turns the corner
A Medal: Top of Olympic Medals
All About Inflation's Little Parts
Barney's Diner: Bonds visualization (Interactive)
The World: Job and Flow of Money: Best Jobs in Britain 1986 - 2008
The World: Unemployment Rate for People Like You
Advertisement: Advertisement: Bus
Advertisement: Advertisement: Helicopter
Analysis: Analyzing Obama's schedule
Oscar: Oscars 2010: the people's picture nominees
The World: The consumer and retail trade in the UK since 2000
UK: Voting Intentions
Barney's Diner: Bonds Visualization (Static Image)
Comparison: Comparison of Bear Markets
How: How Americans Spend Their Day
Michelle: Michelle Obama's Family Tree
Net: Net x Rentals
Variant: Vancouver's Olympic Venue
On the Map: On the Map: Five Major North Korean Prison Camps
A Visual: A Visual Guide to the Financial Crisis
Economic: Economic Meltdown of 2008-2009
Why: Why Did All the Money Go?
Life Cycle: Life Cycle of a beetle through a year
McDonald's: McDonald's "Making Comics"
How: How the Government Dealt with Past Recessions
Afghanistan: Afghanistan: Behind the front line
Toy: Toy: A timeline: a company history
Gap: Gap: Under Human Development
Earthquake: Earthquakes: why they happen
Iran: Iran: nuclear programme
Shanghai: Shanghai White's Double McTwist
Toy: Toy: A's stick accelerator problem
Alpine: Alpine Skiing, From Technical Turns to Tucks and Speed
Budget: Budget Forecasts vs. Reality
Map: Map: Orientation Video
Delaware: Delaware: Airplane Safety Video
"The Story of Stuff"
Virgin America: Virgin America Airplane Safety Video

Magazine Style	Visual Structuring	Highlighting	Transition Guidance	Ordering	Interactivity	Messaging
Illustrated Graph / Map						
Science Fair Poster						
Power Chart						
Comic Strip						
Slide Show						
Form / Video / Animation						
Establishing Shot / Still / Screen						
Consistent Visual Placement						
Progress Bar / Timeline						
Checklist* Progress Tracker						
Close-Ups						
Feature Distinction (font, color, detail, outline)						
Character Direction						
Attention						
Audio						
Zooming						
Familiar Objects (bullet points)						
Zooming Angle						
Zoomer (Camera) Motion						
Continuity Editing						
Subject Continuity						
Animated Transitions						
Random Access						
User Directed Path						
Zoom						
Zoom Highlighting / Still						
Zooming/Selection/Scrolling/Breakdown/Timebar						
Navigation Buttons						
Zoom Limited Interactivity						
Explicit Instruction						
Click Tutorial						
Simulating Default Views						
Annotations / Headlines						
Annotations						
Accompanying Article						
Alert-Messaging						
Comment Repetition						
Introductory Text (more than a sentence)						
Summary/Synthesis						

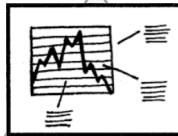
# Observed Narrative Devices

## Case Studies

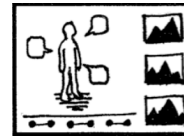
# Visual Design



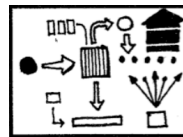
MAGAZINE  
STYLE



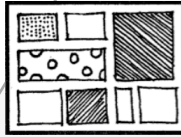
ANNOTATED  
CHART



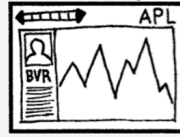
SCIENCE FAIR  
POSTER



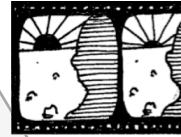
FLOWCHART



COMICSTRIP



SLIDESHOW



MOVIE

Duo-Specific

Captions

Annotations

Attached  
Article

Summaries

Interpret

Headlines

Tacit  
Tutorial

Selection

Navigation

Details on  
Demand

Timelines

Filtering

Highlighting

## Messaging

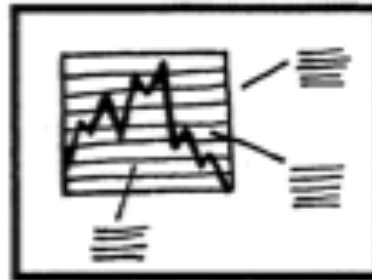
## Interactivity

MORE

# Seven Genres



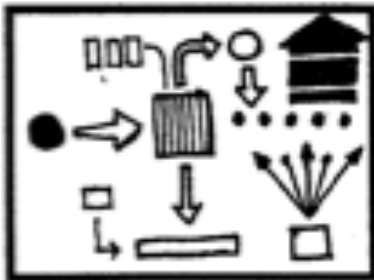
Magazine Style



Annotated Chart



Partitioned Poster



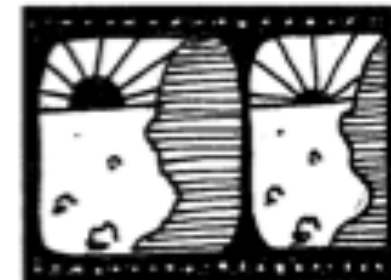
Flow Chart



Comic Strip



Slide Show



Film/Video/Animation

## Genres for Narrative Visualization (2010)

*Missing "scrolly-telling" designs...*

# Genres + Interactivity + Messaging =

# DESIGN SPACE

STORYTELLING

CLARITY

SPEED

**Author Driven**

strong ordering  
heavy messaging  
limited interactivity

**Reader Driven**

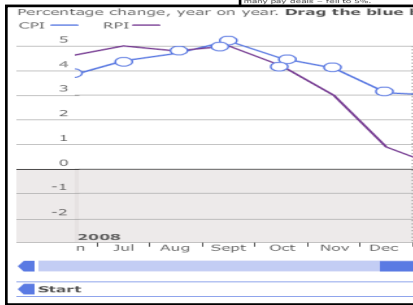
weak ordering  
light messaging  
free interactivity

ASK QUESTIONS

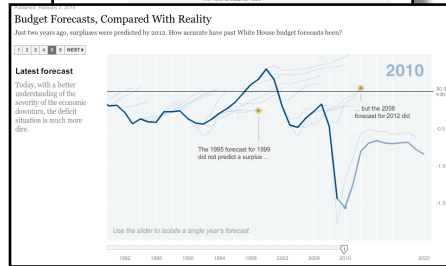
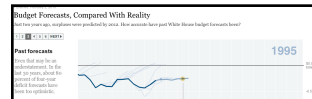
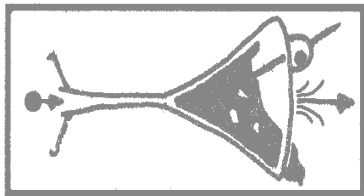
EXPLORE

FIND

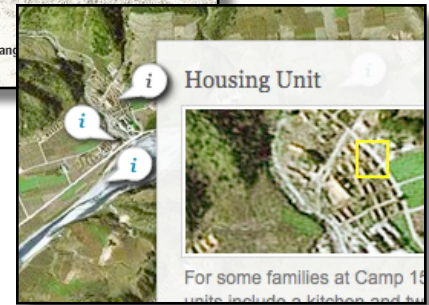
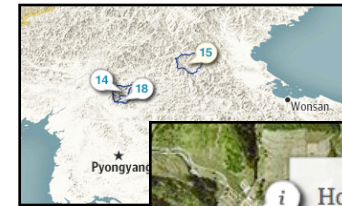
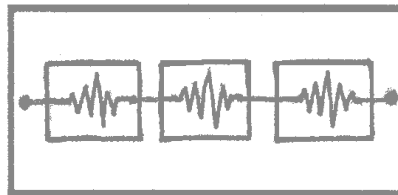
The consumer and retail price indices since 2008. The annual inflation rate fell from 4.5% to 0.2% in June. The Office for National Statistics said bargain offers on electronic goods helped drag inflation lower in June and pulled the government's preferred measure of the cost of living back towards its 2% target. Meanwhile, inflation as measured by the Retail Price Index - the benchmark for many day-to-day costs - fell to 5%.



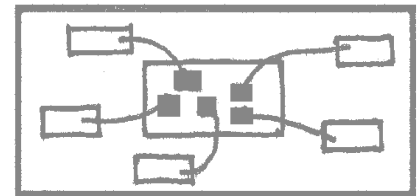
martini glass



interactive slideshow



drill-down story

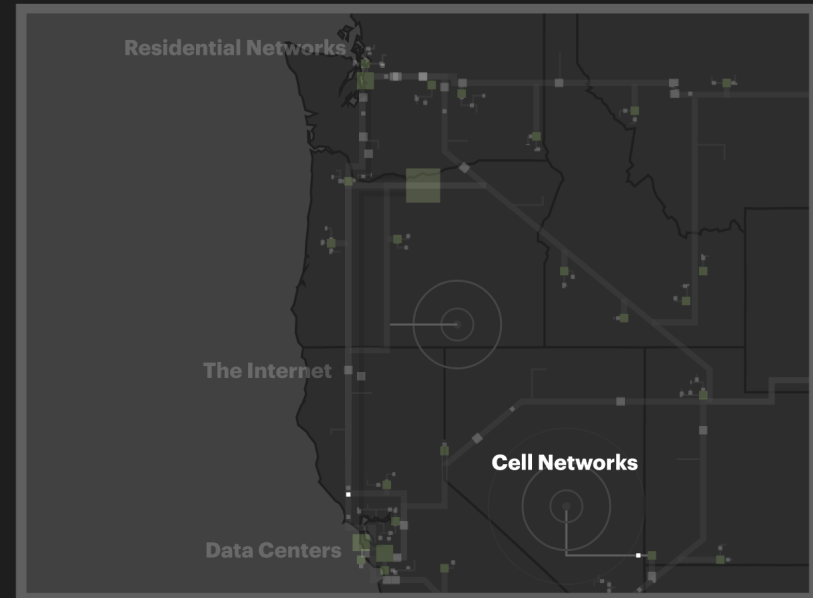


# **Interactive Articles**

## YouTube Pipeline + Electricity Usage for 2016

Cellular Networks

In comparison, only 12% of YouTube's traffic went through cellular networks, but they were by far the most expensive part of YouTube's content delivery pipeline, accounting for approximately **8,500 Gigawatt-hours of electricity usage—enough to power over 750,000 U.S. homes [3]**. At over 10 times the electricity usage per unit of traffic, the relative inefficiency of cellular transmission is clear.



8,500 GWh

Enough to power over 750,000 U.S. homes for a year

SOURCE [Google](#), [Durairajan et al. 2015 \[4\]](#), [Preist et al. 2017 \[3\]](#), [EIA](#)

Parametric Press

## CASE STUDY DIGITAL CARBON FOOTPRINT

*Lin, Nirmal, Hathi, Liang, 2020*

# Communicating with Interactive Articles

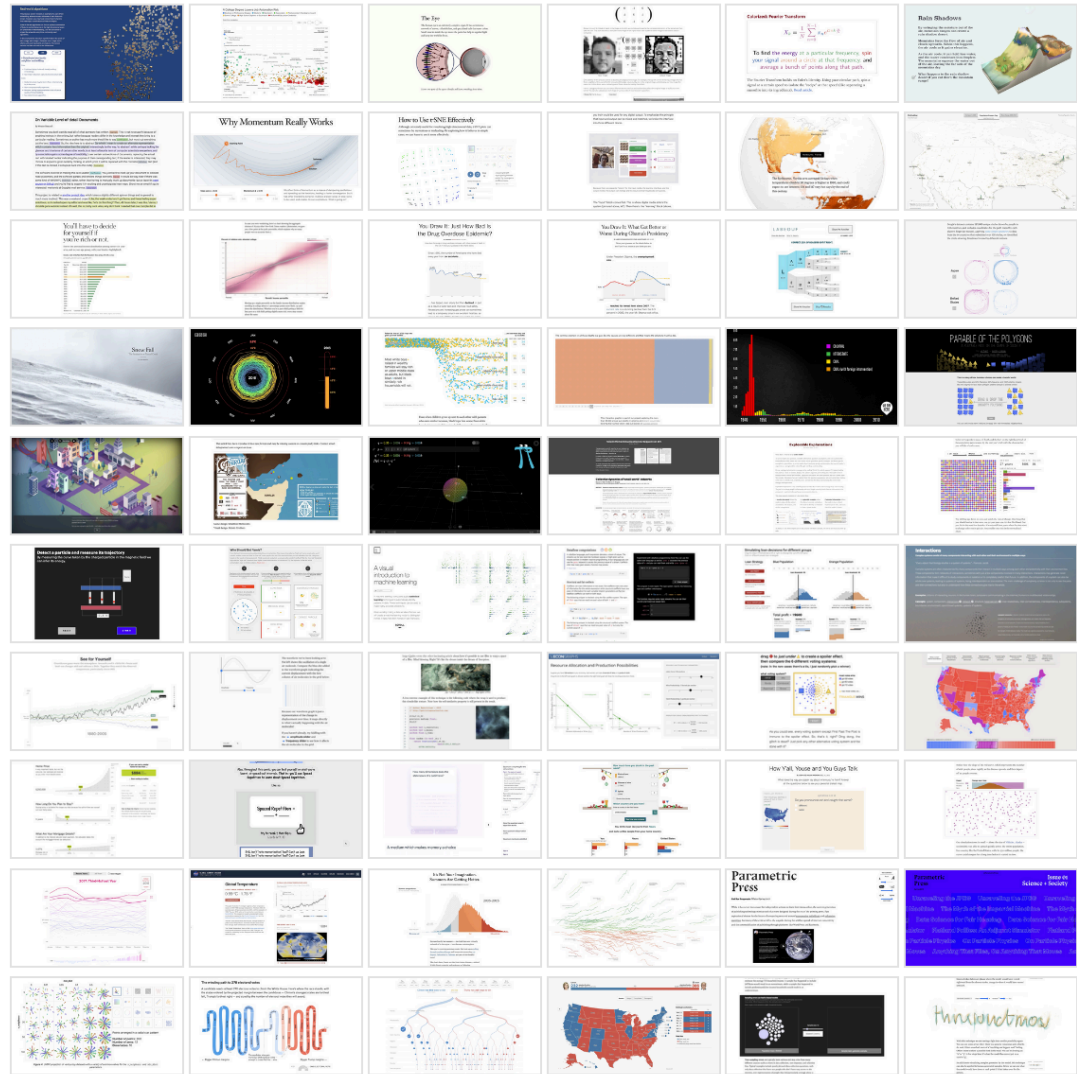
Examining the design of interactive articles by synthesizing theory from disciplines such as education, journalism, and visualization.

**60+ Interactive Articles**

NYTimes, WaPost

Distill, VisXAI

+more

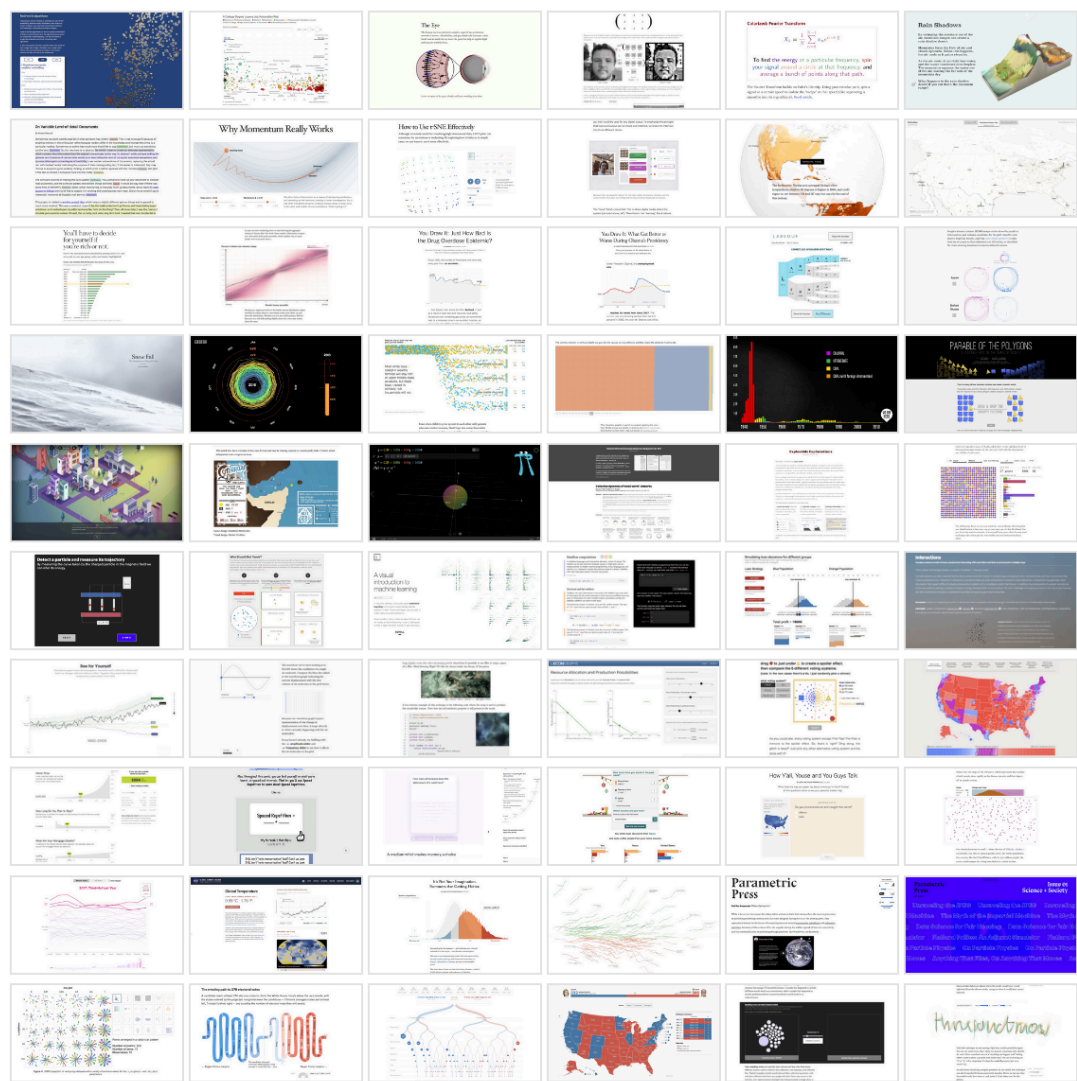


*Hohman, Conlen, Heer, Chau*  
2020



# Communicating with Interactive Articles

Examining the design of interactive articles by synthesizing theory from disciplines such as education, journalism, and visualization.



## 60+ Interactive Articles

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## 5 affordances of the format

Connecting people and data

Making systems playful

Promoting self reflection

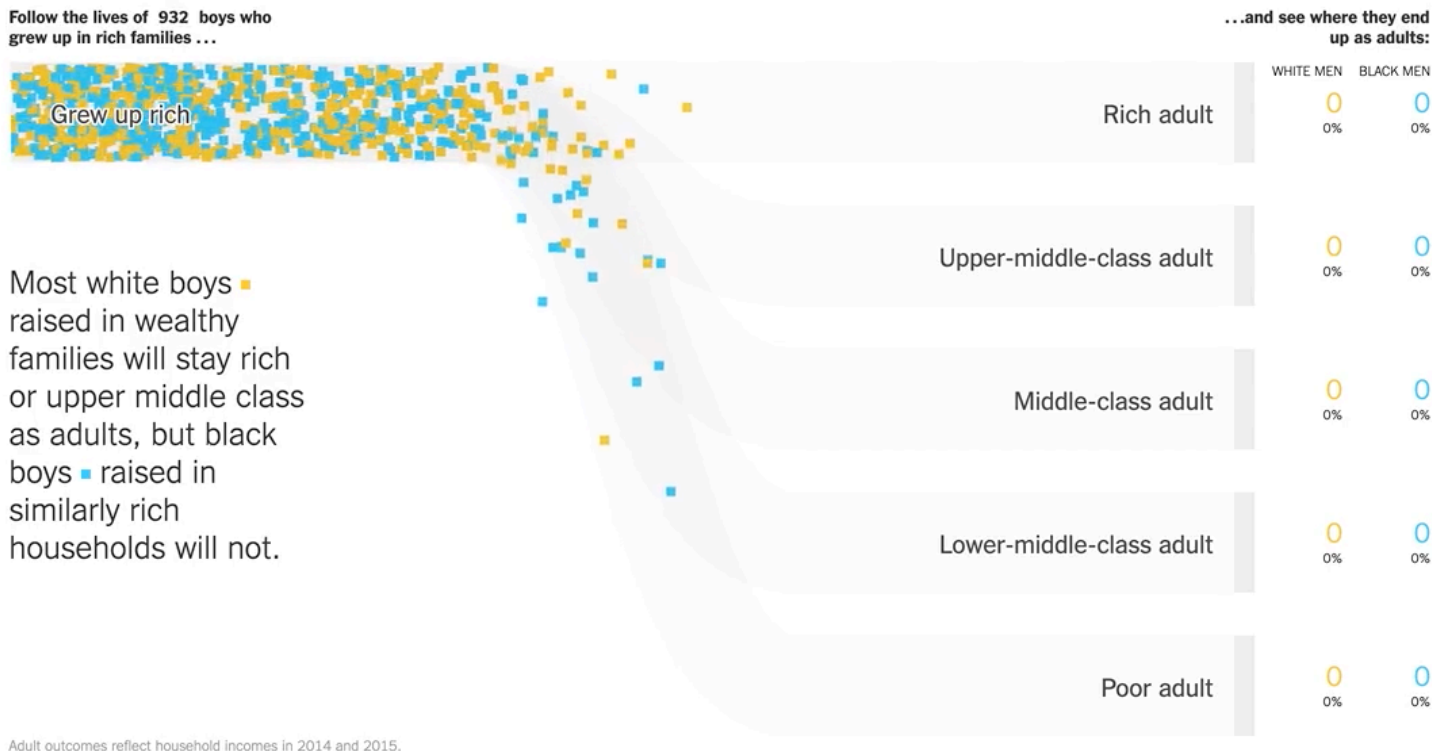
Personalizing reading

Reducing cognitive load

Hohman, Conlen, Heer, Chau  
2020

## 5 AFFORDANCES OF THE FORMAT **Connecting people and data**

Making systems playful  
Promoting self reflection  
Personalizing reading  
Reducing cognitive load



Even when children grow up next to each other with parents who earn similar incomes, black boys fare worse than white

boys in a segment of America. And the same is true in the

## 5 AFFORDANCES OF THE FORMAT



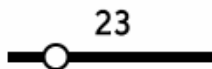
Connecting people and data

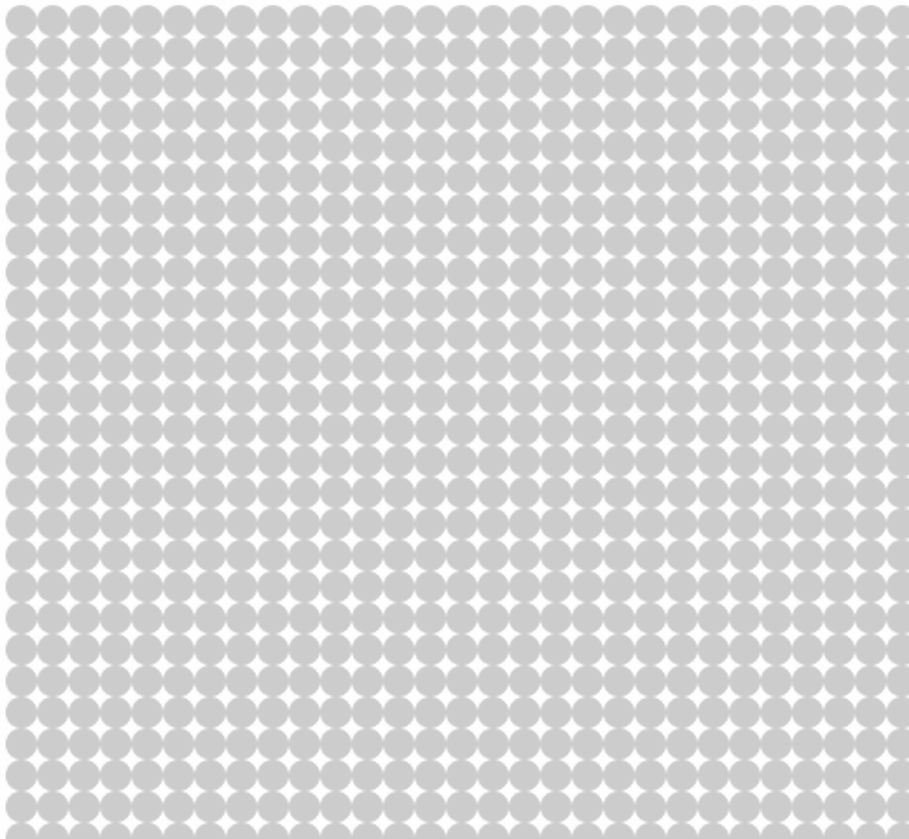
**Making systems playful**

Promoting self reflection

Personalizing reading

Reducing cognitive load

I am **female**  **White**  and currently  **23** years old. LIVE



AGE OF DEATH	DIED SO FAR	STILL ALIVE
23 years	1%	99%

### CAUSE OF DEATH SO FAR

- 0% Infection
- 0% Cancer
- 0% Blood
- 0% Endocrine
- 0% Mental
- 0% Nervous
- 0% Circulatory
- 0% Respiratory
- 0% Digestive
- 0% Musculoskeletal
- 0% Genitourinary
- 0% Perinatal
- 0% Congenital
- 0% External Causes
- 0% Other

Connecting people and data

Making systems playful

**5 AFFORDANCES OF THE FORMAT Promoting self reflection**

Personalizing reading

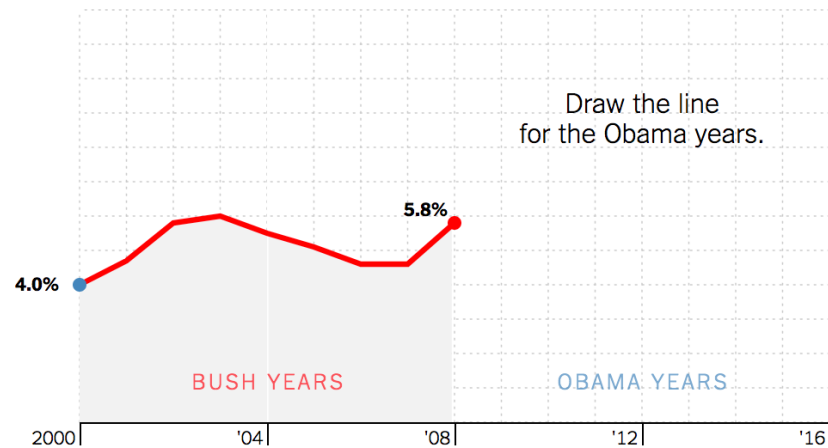
Reducing cognitive load

## You Draw It: What Got Better or Worse During Obama's Presidency

By LARRY BUCHANAN, HAEYOUN PARK and ADAM PEARCE JAN. 15, 2017

Draw your guesses on the charts below to see if you're as smart as you think you are.

Under President Obama, the **unemployment rate ...**



Show me how I did.

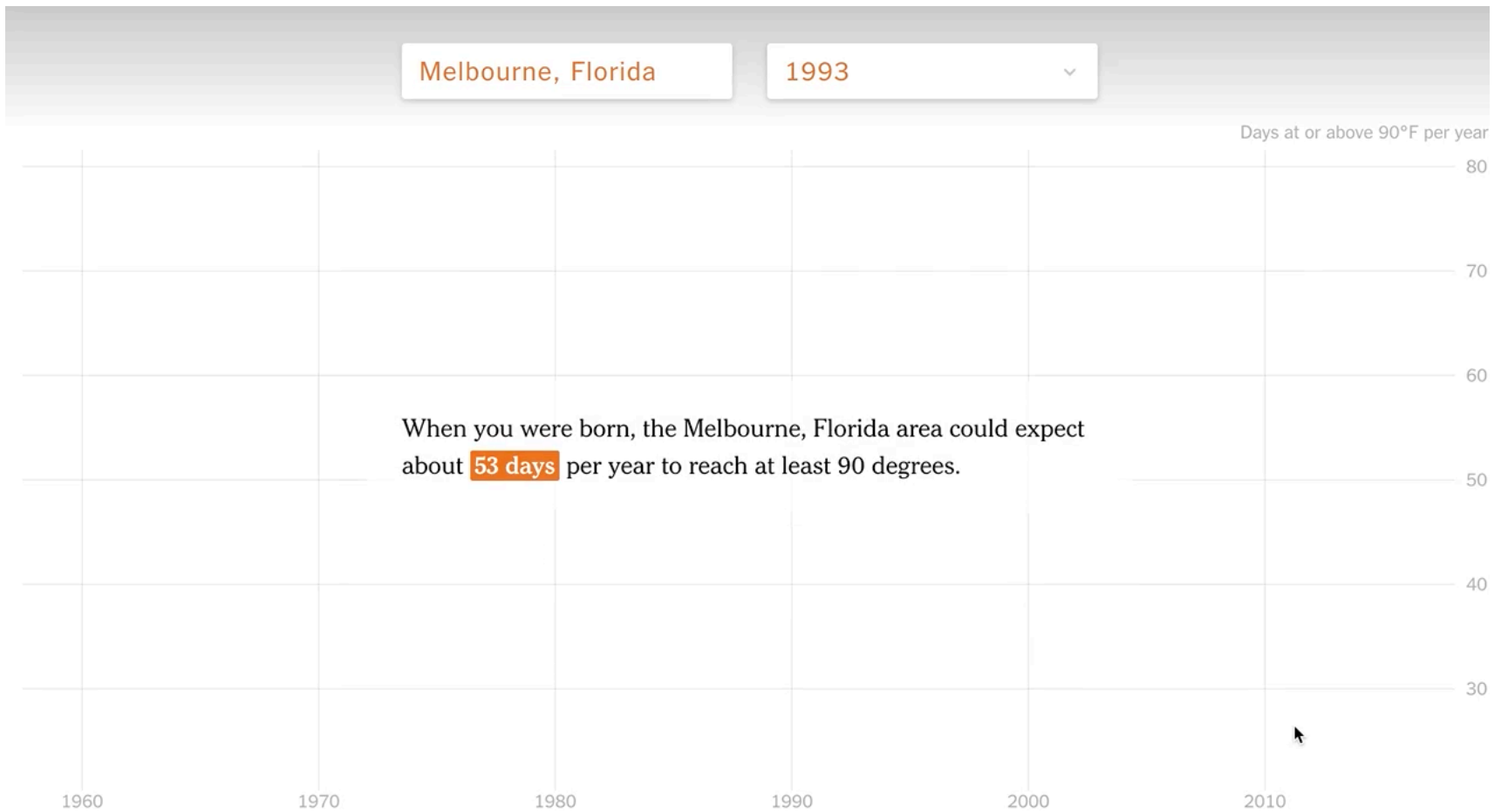
Connecting people and data

Making systems playful

Promoting self reflection

**5 AFFORDANCES OF THE FORMAT** **Personalizing reading**

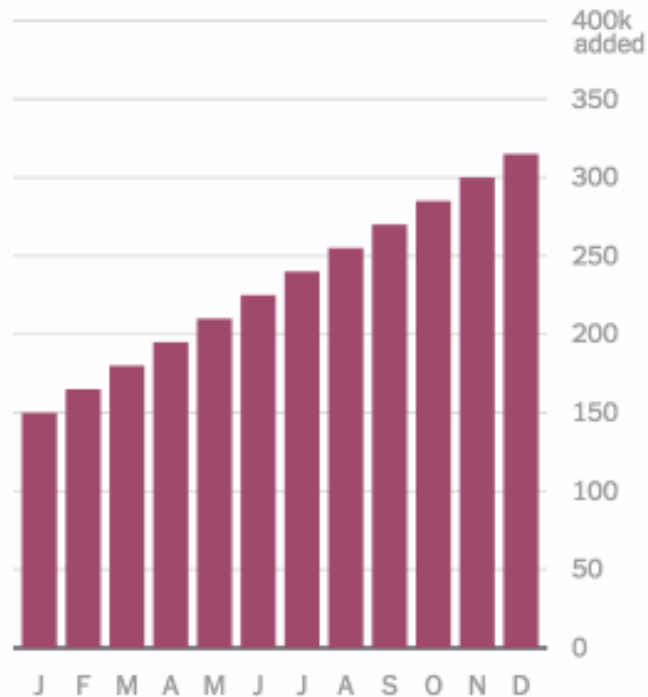
Reducing cognitive load



Connecting people and data  
Making systems playful  
Promoting self reflection  
Personalizing reading

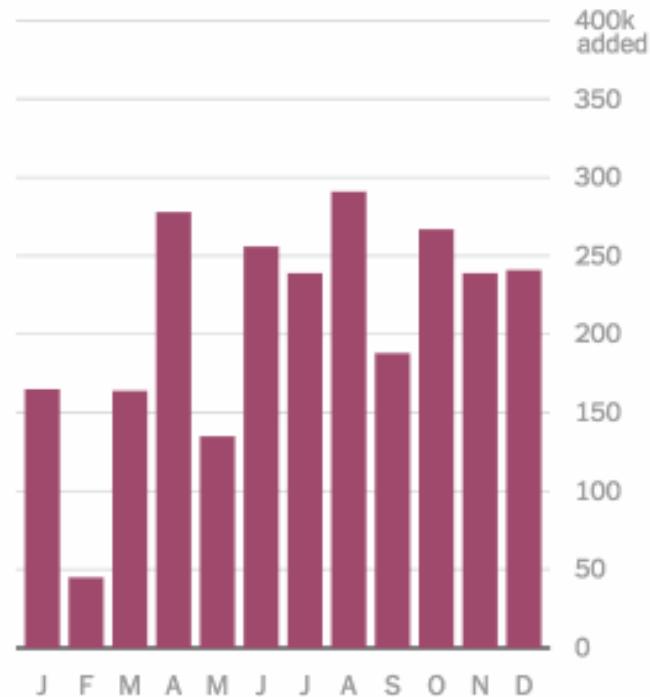
## 5 AFFORDANCES OF THE FORMAT **Reducing cognitive load**

If job growth **had**  
**been accelerating...**



...the jobs report  
**could look like this:**

Pause



# Interactive Documents: Steppers, Scrollers, ...



# Gun Deaths In America

By Ben Casselman, Matthew Conlen and  
Reuben Fischer-Baum

CLICK to advance



1

2

3

4

5

6

**Stepper**

12

| Explore the data for yourself »



### Ramadi: The Government Provides an Opening for ISIS **ISIS Control**

Tensions between this city's residents, who are mostly Sunni, and the central government had been brewing here for at least a year. Then in December, Iraq's prime minister, Nuri Kamal al-Maliki, ordered security forces to dismantle a protest camp — an outlet for disenchanting Sunnis angered at their treatment by the Shiite-dominated government. The action ignited days of violence and created the opening ISIS needed to seize parts of the city, the provincial capital.

Lake Tharthar

### Falluja: A Symbolic Fall **ISIS Control**

Just days after the raid on the camp in Ramadi, ISIS fighters destroyed the Police Headquarters and mayor's office here, planted their flag on government buildings and decreed the city to be theirs. Ten years earlier, American forces had captured this city from Qaeda-style insurgents at a considerable cost of American lives.

Lake Habbaniya

Balad

Scroll



17 MILES TO BAGHDAD

# Discrete step vs. Continuous scroll

Different means for narrative navigation.

A source of debate among practitioners!

**Step:** sequential frames as in a slideshow

Simple and familiar, but less engaging?

**Scroll:** continuous navigation of page

Parameterize content by scroll position

May cause usability / scrolljacking issues

# Narrative Implementation

## Do-It-Yourself

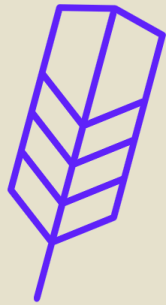
Monitor scroll position & element positions

Guidance: M. Bostock, J. Vallandingham

## Third-Party Support

Helper Libraries

Interactive Document Formats: Idyll



# idyll

A toolkit for creating data-driven stories  
and explorable explanations.

## INPUT (EDITABLE)

```
## Hello World

[var name:"x" value:5 /]

The value of x is [Display value:x format:"d" /].

[Range value:x min:0 max:10 /]
```

## OUTPUT

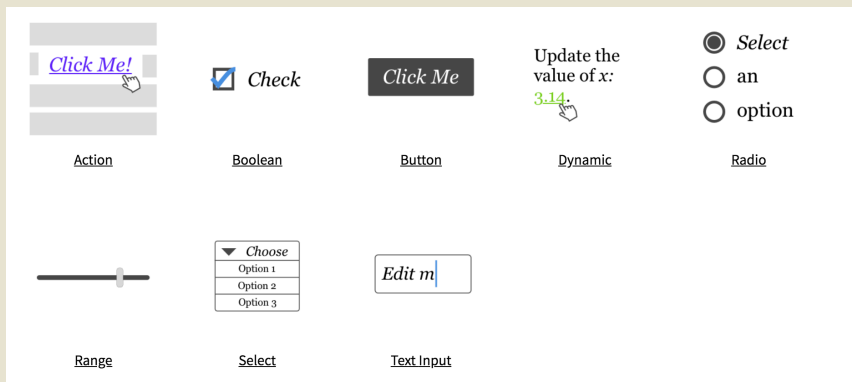
# Hello World

The value of x is 6.

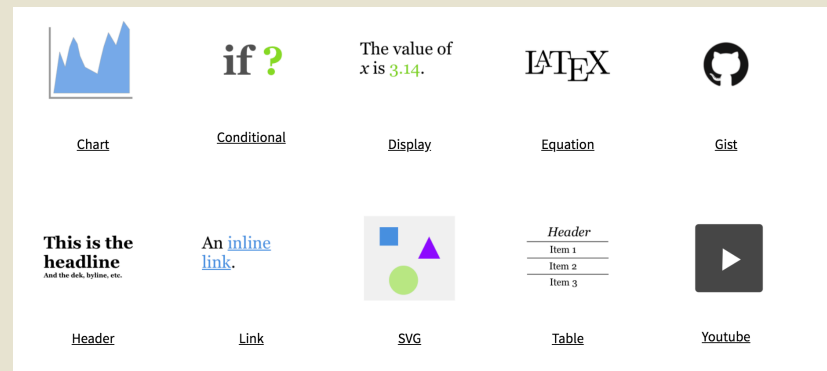


Try Idyll in your browser

# 28 Built-in Components



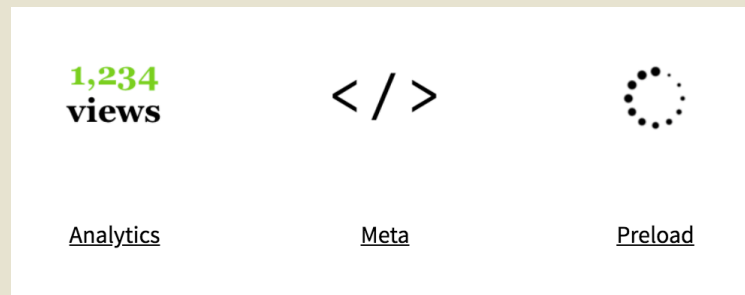
Input



Presentation

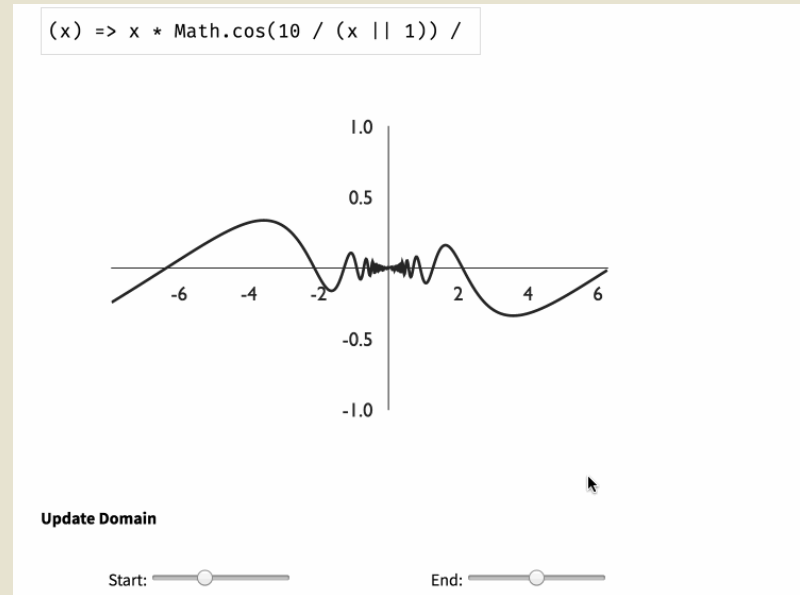


Layout

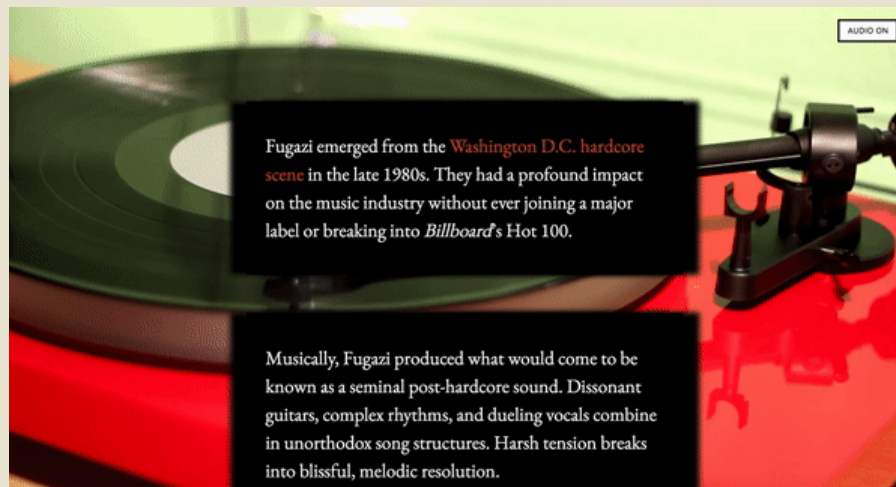


Helpers

# Input+ Presentation



# Layout+ Presentation



# Bring your own graphics

A JavaScript component API is exposed to end users.

Use with libraries like D3,  
Mapbox, Processing (P5), React,  
Vega-Lite



# Built-in static hosting

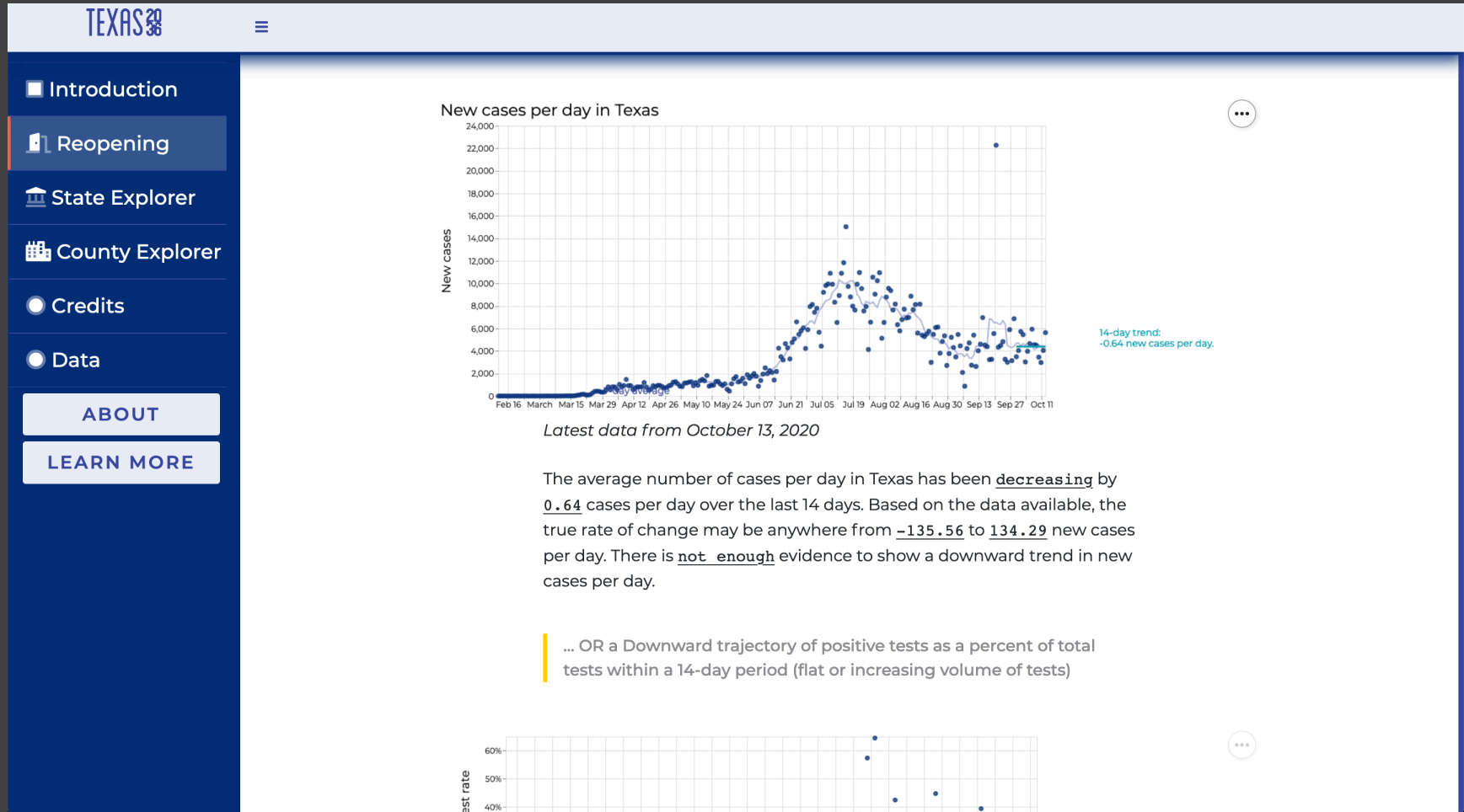
```
mathsonian in ~/projects/my-idyll-project
```



```
}
```

# Examples

## Texas 2020 COVID Reopening

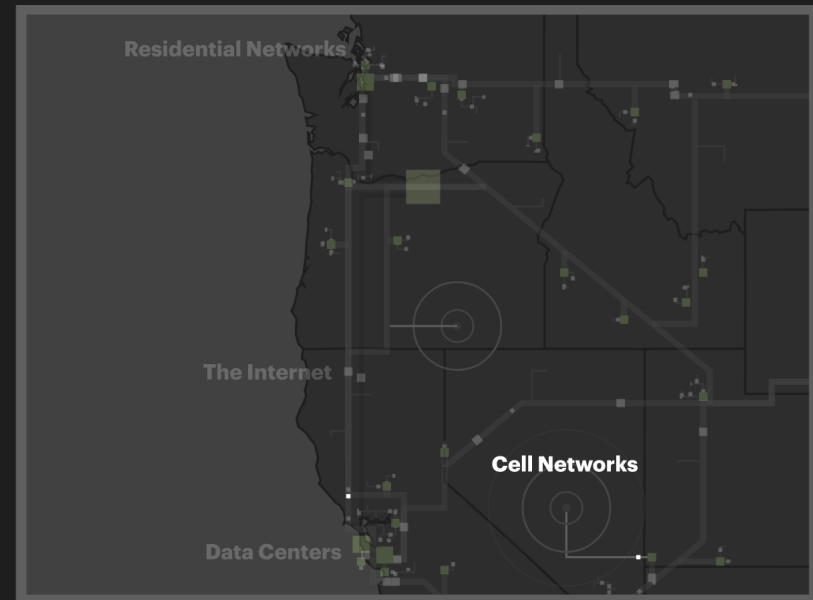


# Examples



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# Design Prompt

## **Design Prompt** PRESIDENTIAL ELECTIONS

You want to keep the public as informed as possible of the status of the 2020 presidential election while it happens.

May want to convey:

- current snapshot

- likely outcomes

- awareness of uncertainty

- historical context

- any unusual circumstances (e.g.

- delayed results).

# **Design Prompt** PRESIDENTIAL ELECTIONS

## **Input Data**

### Vote Counts

candidate, state, method, timestamp, # votes

### Race Calls

candidate, state, timestamp

## **Constraints**

Near-real time

Never seen the data before

Data may contain errors

Should not promote public distrust

or aid in the dismantling of U.S. democracy

## **Design Prompt** PRESIDENTIAL ELECTIONS

**HOW WOULD YOU  
VISUALIZE THIS?**

### **Input Data**

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**WHAT DATA WOULD  
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You want to keep public as informed as possible of the status of the race while it happens.

May want to convey:  
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awareness of uncertainty  
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(e.g. delayed results)