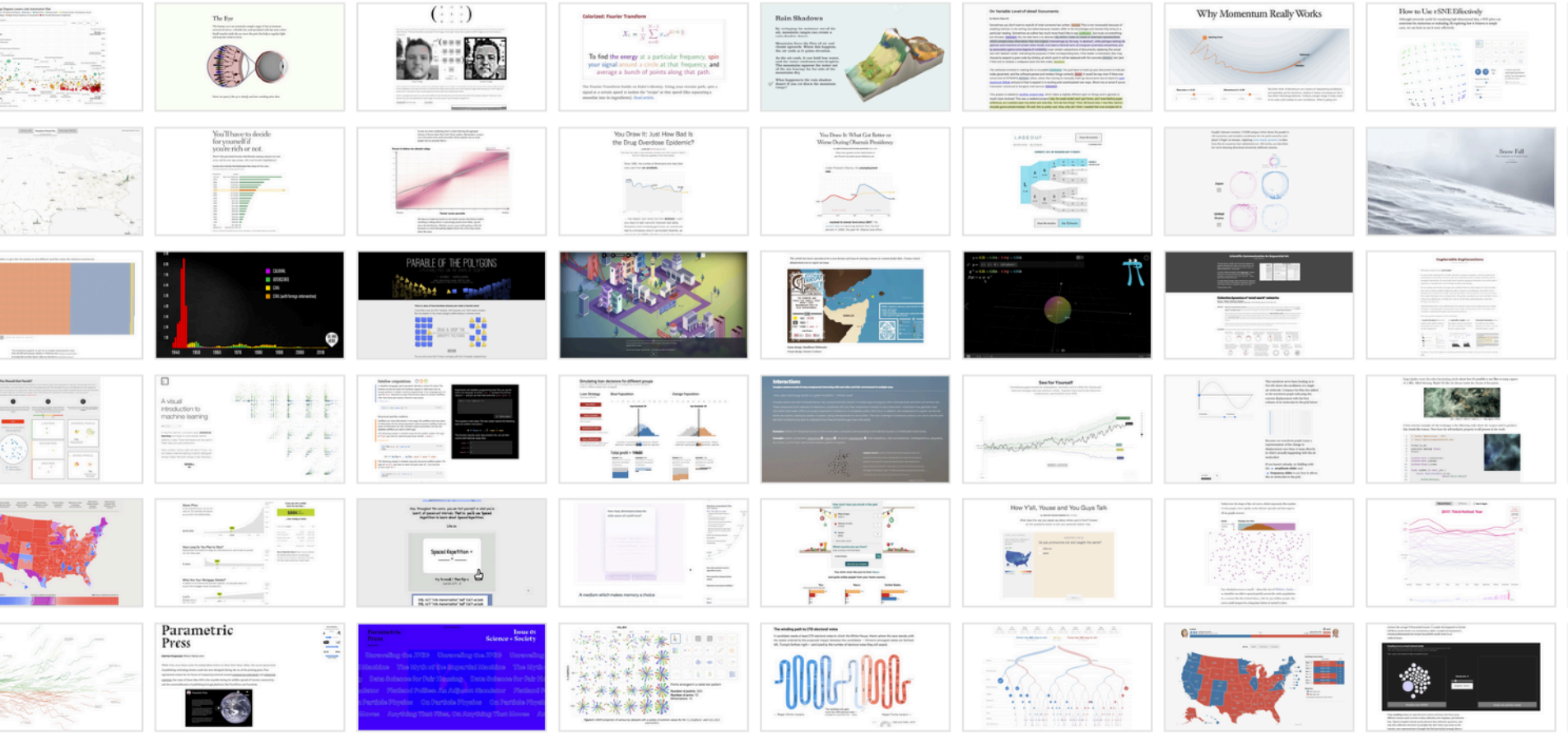
CSE 442

Narrative Visualization



Matthew Conlen

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

About Me

Ph.D. candidate @ UW computer science
- Advised by Jeff Heer

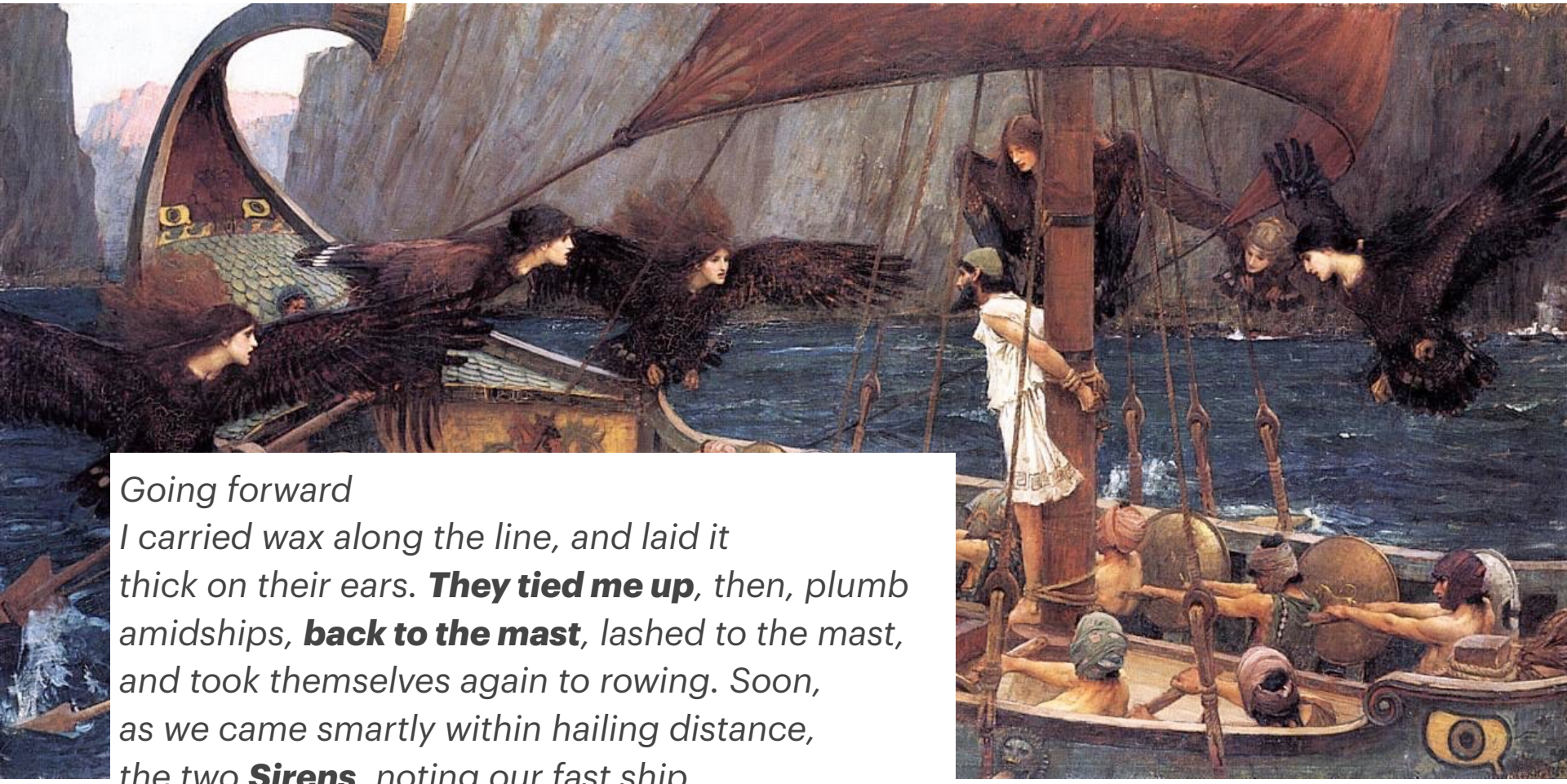
Background in data journalism
- FiveThirtyEight, CNN, New Yorker,
- New York Times (Elections, Covid-19)

Lecture will be biased toward data journalism but the material is more generally relevant (education, scientific publishing, policymaking).

@mathisonian
mathisonian.com

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

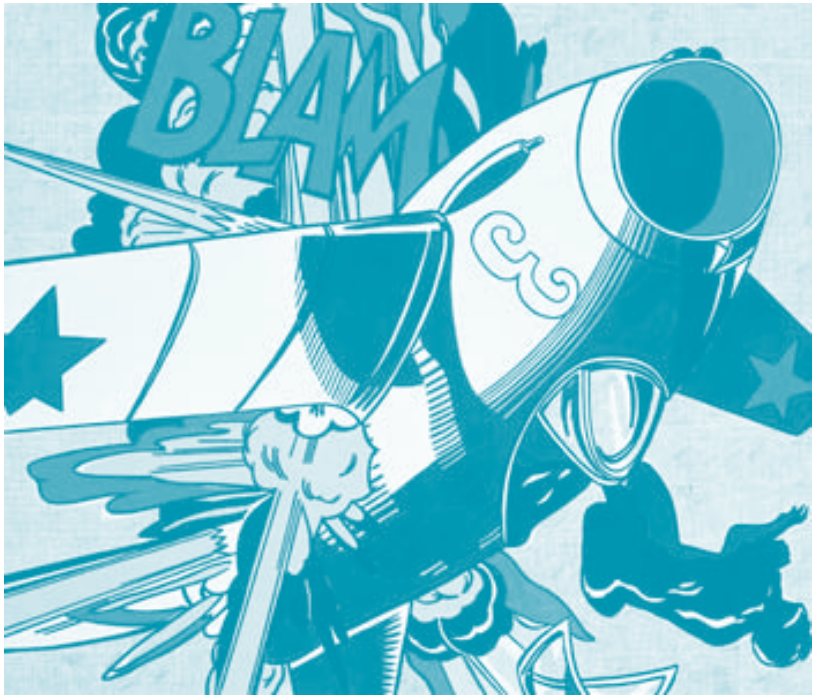
PEOPLE TELL STORIES

WORDS TELL STORIES

IMAGES TELL STORIES

COMICS TELL STORIES

MOVIES TELL STORIES



By Denise Grady and Carl Zimmer

April 14, 2021, 9:34 p.m. ET

The pause in the use of Johnson & Johnson's Covid-19 vaccine may continue for a week to 10 days, after expert advisers to the Centers for Disease Control and Prevention determined on Wednesday that they needed more time to assess a possible link to a rare but serious blood-clotting disorder.

The decision not to reinstate the vaccine has painful consequences, nationally and globally. It may further erode public confidence in vaccination in general and slow the rollout of desperately needed shots to rural and underserved areas and homebound people. The vaccine is considered ideal for hard-to-reach people and places because it requires only one shot and is more easily stored and shipped than the vaccines made by Moderna and Pfizer-BioNTech, which must be kept at very low temperatures.

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Lede (lead paragraph)

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Nut Graf (nutshell paragraph)

The decision not to reinstate the vaccine has painful consequences, nationally and globally. It may further erode public confidence in vaccination in general and slow the rollout of desperately needed shots to rural and underserved areas and homebound people. The vaccine is considered ideal for hard-to-reach people and places because it requires only one shot and is more easily stored and shipped than the vaccines made by Moderna and Pfizer-BioNTech, which must be kept at very low temperatures.


BLAM









Topics

Narrative visualization

Case Study: Coronavirus Testing

Design space

Interactive articles

Case Study: Herd Immunity

Affordances and challenges of the format

Research highlight

Authoring Tools

STORYTELLING

across various media

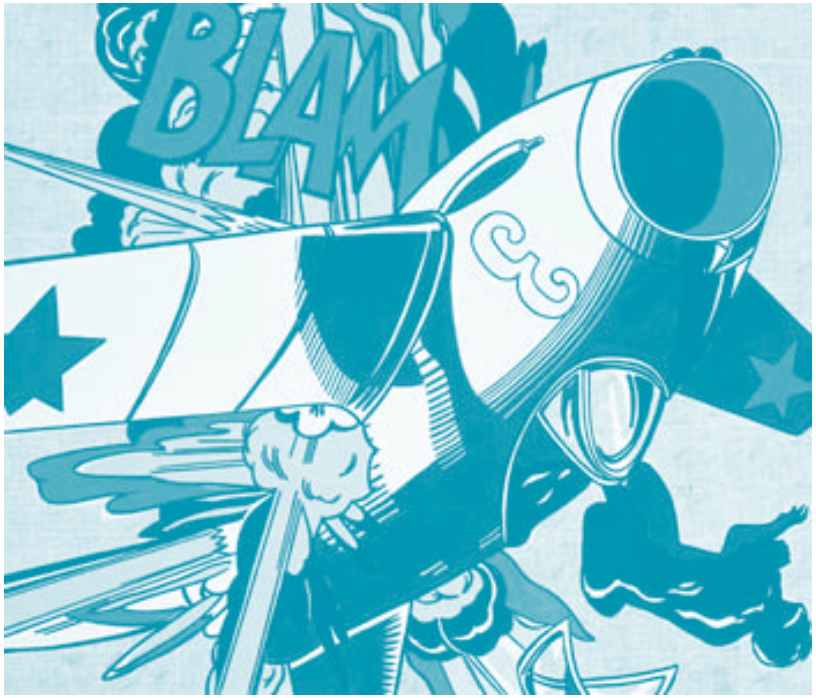
PEOPLE TELL STORIES

WORDS TELL STORIES

IMAGES TELL STORIES

COMICS TELL STORIES

MOVIES TELL STORIES



STORYTELLING

across various media

PEOPLE TELL STORIES

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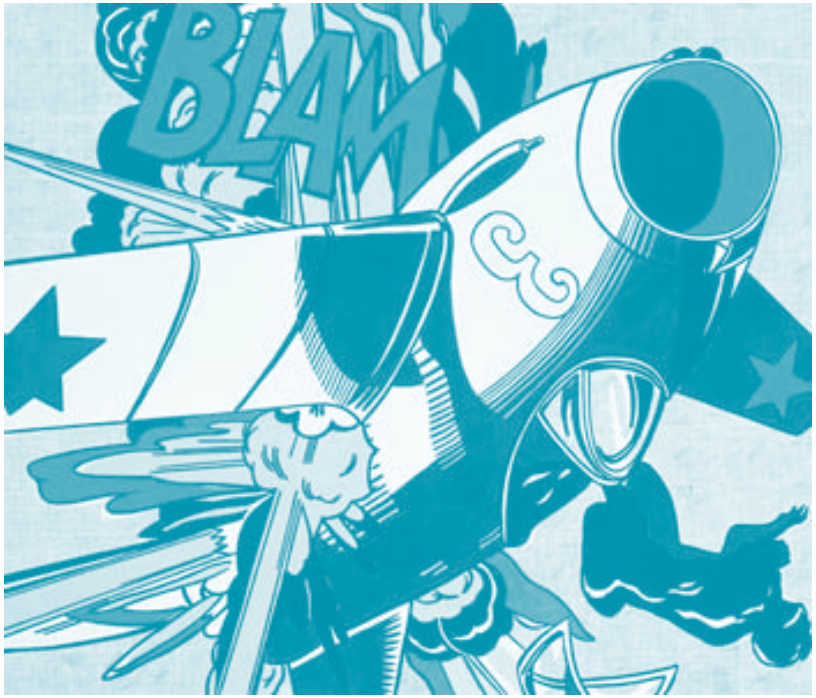
COMICS TELL STORIES

MOVIES TELL STORIES

DATA TELLS STORIES?



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Privacy and the internet

Lives of others

SAN FRANCISCO AND LONDON

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

JENNIFER STODDART, Canada's privacy commissioner, has tangled with Facebook. In August 2009 the social-networking site struck a deal, agreeing to change its policies within a year to comply with the country's privacy laws. Now, says Ms Stoddart, the company appears to be reneging on an important part of that deal, which involved giving users a clear and easy-to-implement choice over whether to share private data with third parties. "It doesn't seem to me that Facebook is going in the right direction on this issue," she says, hinting that, without a change of course, the firm could soon become the subject of another formal investigation by her organisation.

Facebook is not the only internet giant to provoke the ire of data watchdogs. Google endured withering criticism this week following news that it had recorded some personal communications sent over unsecured Wi-Fi data networks in homes and offices in some 30 countries. On May 17th Peter Schaar, Germany's federal commissioner for data protection, called for an independent investigation into Google's behaviour, claiming that it had "simply disobeyed normal rules in the development and usage of software."

The news 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 types such as Cory Doctorow, a science-fiction author, and Leo Laporte, a podcaster, have abandoned Facebook. Sites such as QuitFacebookDay.com are urging others to do so, nominating May 31st for a mass Facebook "suicide".

This is unlikely to stop the meteoric rise of Facebook, which is poised to claim half a billion members and which draws even more visitors as a whole to its site (see chart). But nerves have been rattled at the company's headquarters in Silicon Valley, where bosses are mulling over how to respond. Several senior folk are now hinting that Facebook will soon roll out simpler privacy controls to make it easier to keep more data hidden. MySpace, a rival, is already making its controls simpler in an effort to woo disaffected Facebookers to its service.

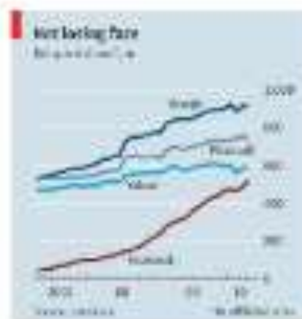
A revolt over Facebook's handling of privacy has been brewing for some time. In December the social network changed the default settings on its privacy controls so that individuals' personal information would be shared with "everyone" rather than selected friends. Facebook argued this reflected a shift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

The switch should not have come as a surprise. Early on, many social networks impose fairly tough privacy policies in order to attract and reassure users. But as more join, 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' likes and dislikes, the better it can target ads that generate hundreds of millions of dollars.

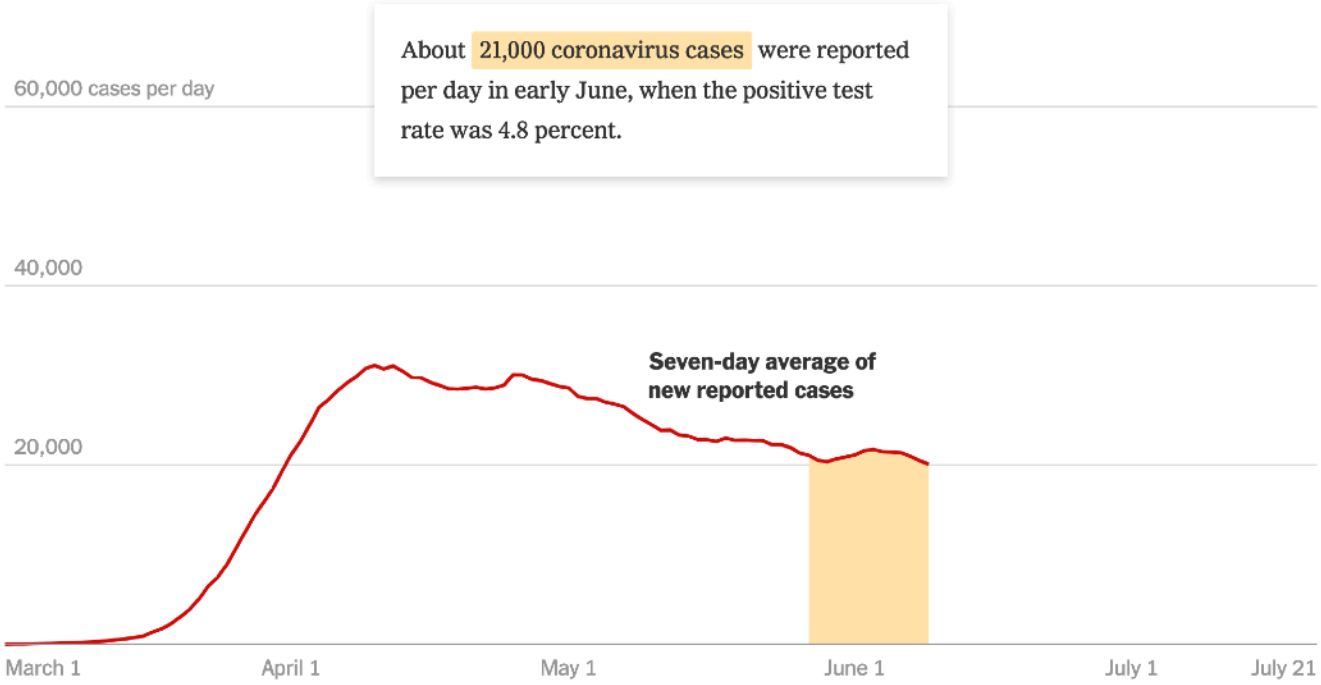
Protests grew louder still following a developers' conference last month at which Mark Zuckerberg, Facebook's boss, announced yet another series of policy changes. One that caused irritation was an "instant personalisation" feature that lets certain third-party websites access Facebook data when people visit. Critics say that Facebook has made it tricky to disable this feature, which may explain why Ms Stoddart dislikes it so much.

European officials are grumbling about Facebook too. This month a group of data-protection experts who advise the European Commission wrote to the social network, calling its decision to loosen the default settings "unacceptable". And in the ►

Not losing face



The New York Times U.S. | The Rise in Testing Is Not Driving the Rise in U.S. Virus Cases



CASE STUDY COVID-19 TESTING

Conlen, 2020

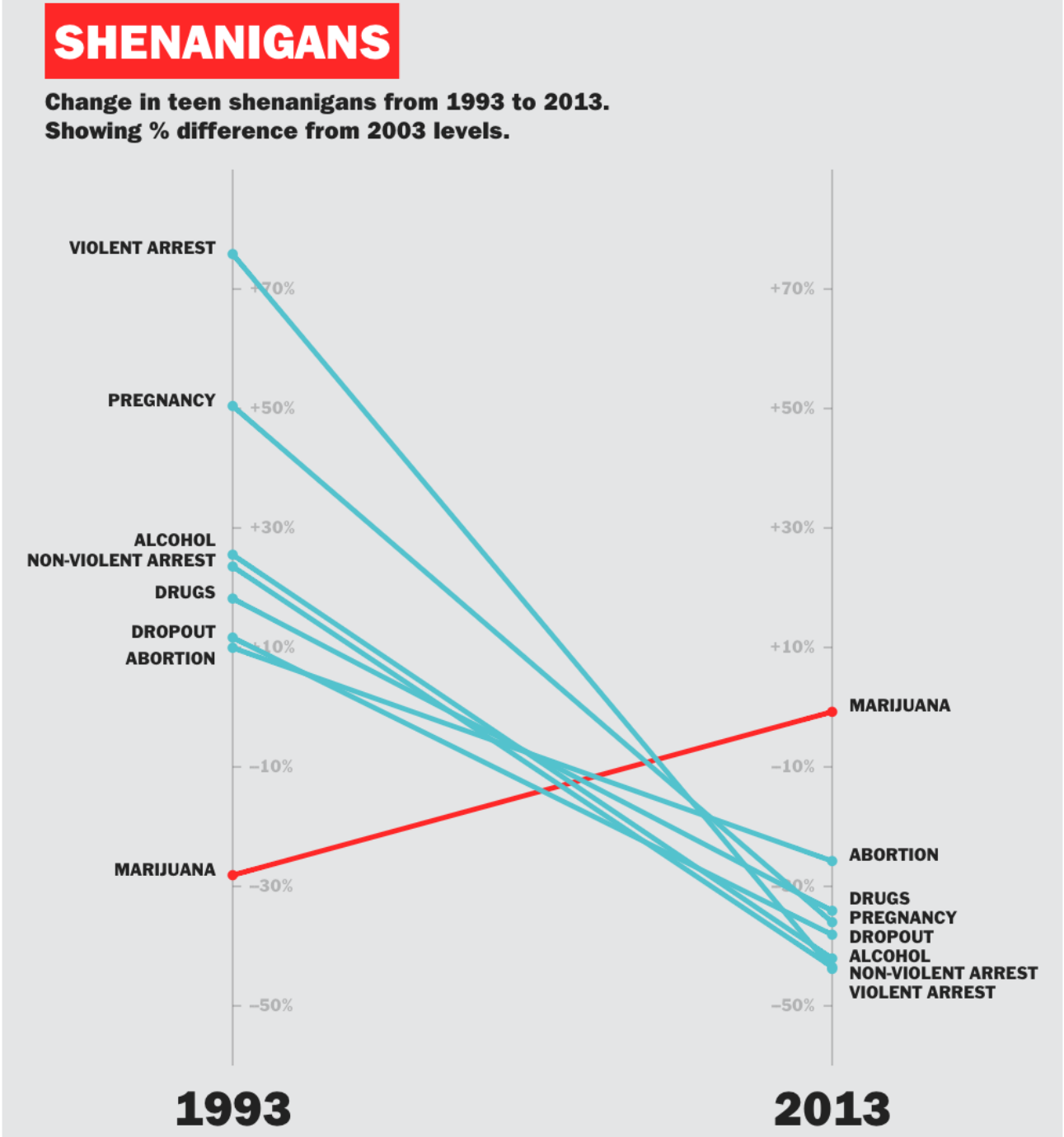
CASE STUDY COVID-19 TESTING

Input Data

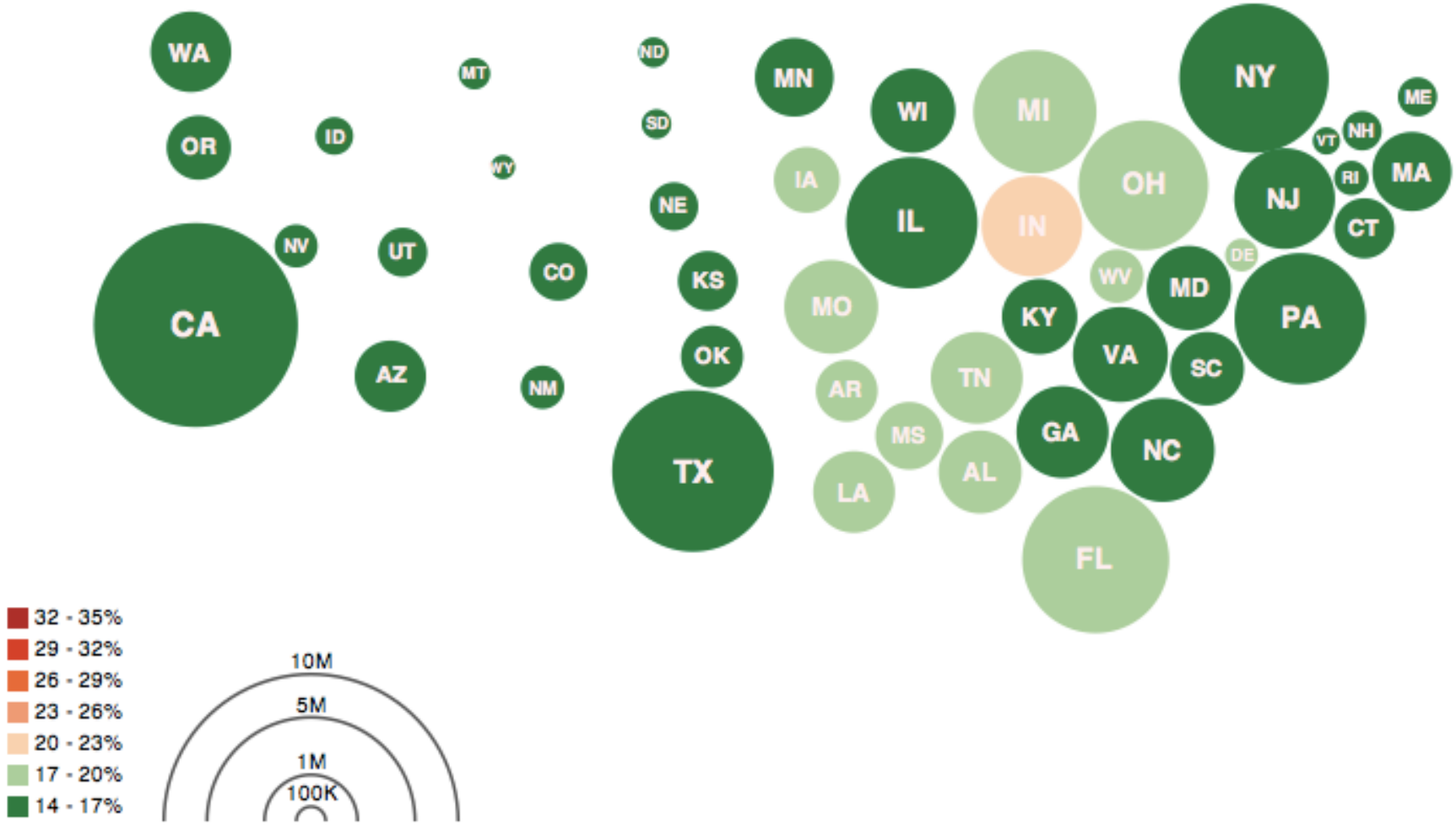
Daily case and test counts.

Points of Focus

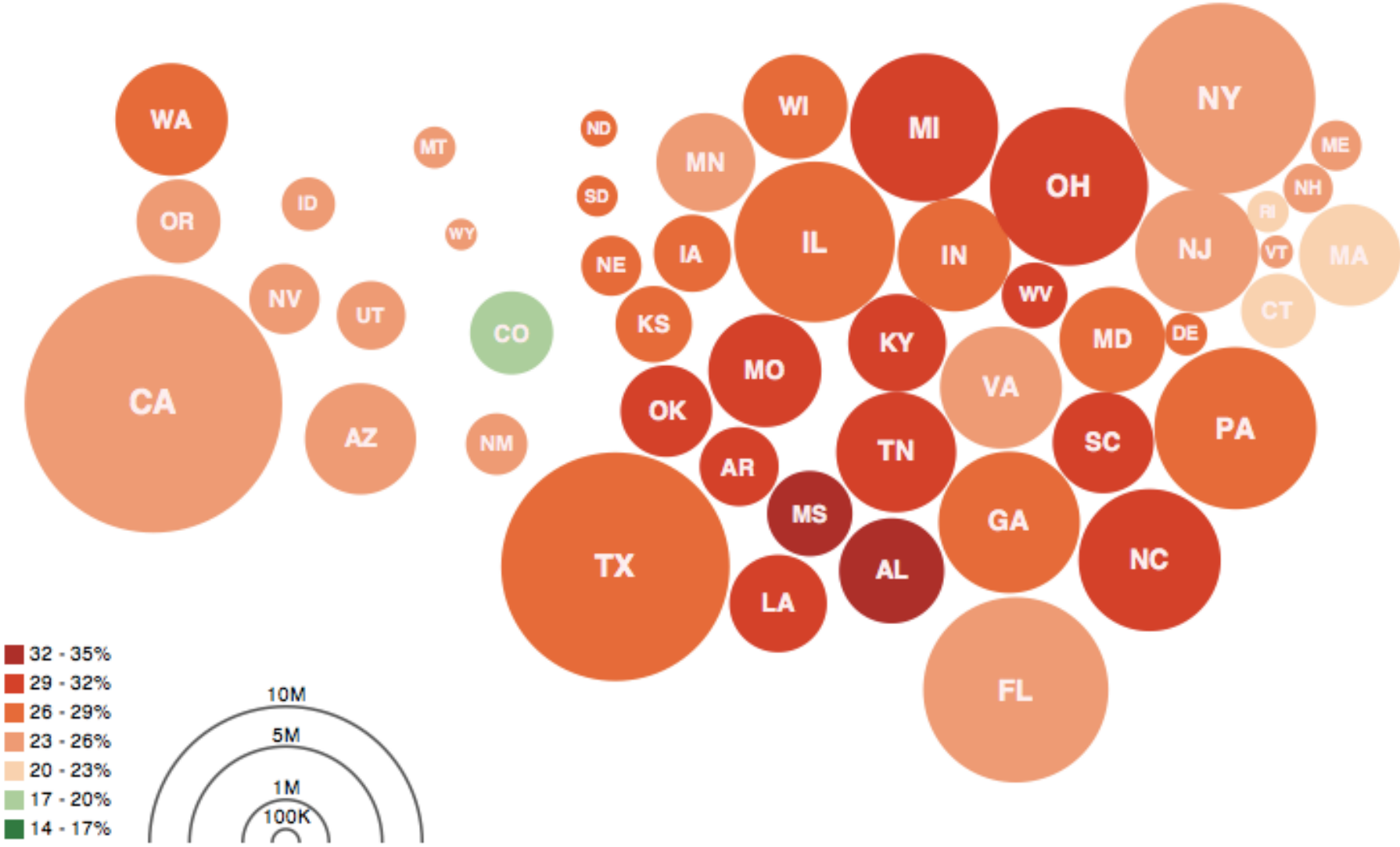
1. Baseline (smoothed average of daily cases)
2. Counterfactual case curve
   (baseline positivity rate * daily test counts),
3. Actual case curve (daily cases)


SHENANIGANS
Change in teen shenanigans from 1993 to 2013.
Showing % difference from 2003 levels.
VIOLENT ARREST
PREGNANCY
ALCOHOL
NON-VIOLENT ARREST
DRUGS
DROPOUT
ABORTION
MARIJUANA
+70%
+50%
+30%
+10%
–10%
–30%
–50%
MARIJUANA
ABORTION
DRUGS
PREGNANCY
DROPOUT
ALCOHOL
NON-VIOLENT ARREST
VIOLENT ARREST
1993
2013

Conlen
2014



Obesity Map Vadim Ogievetsky



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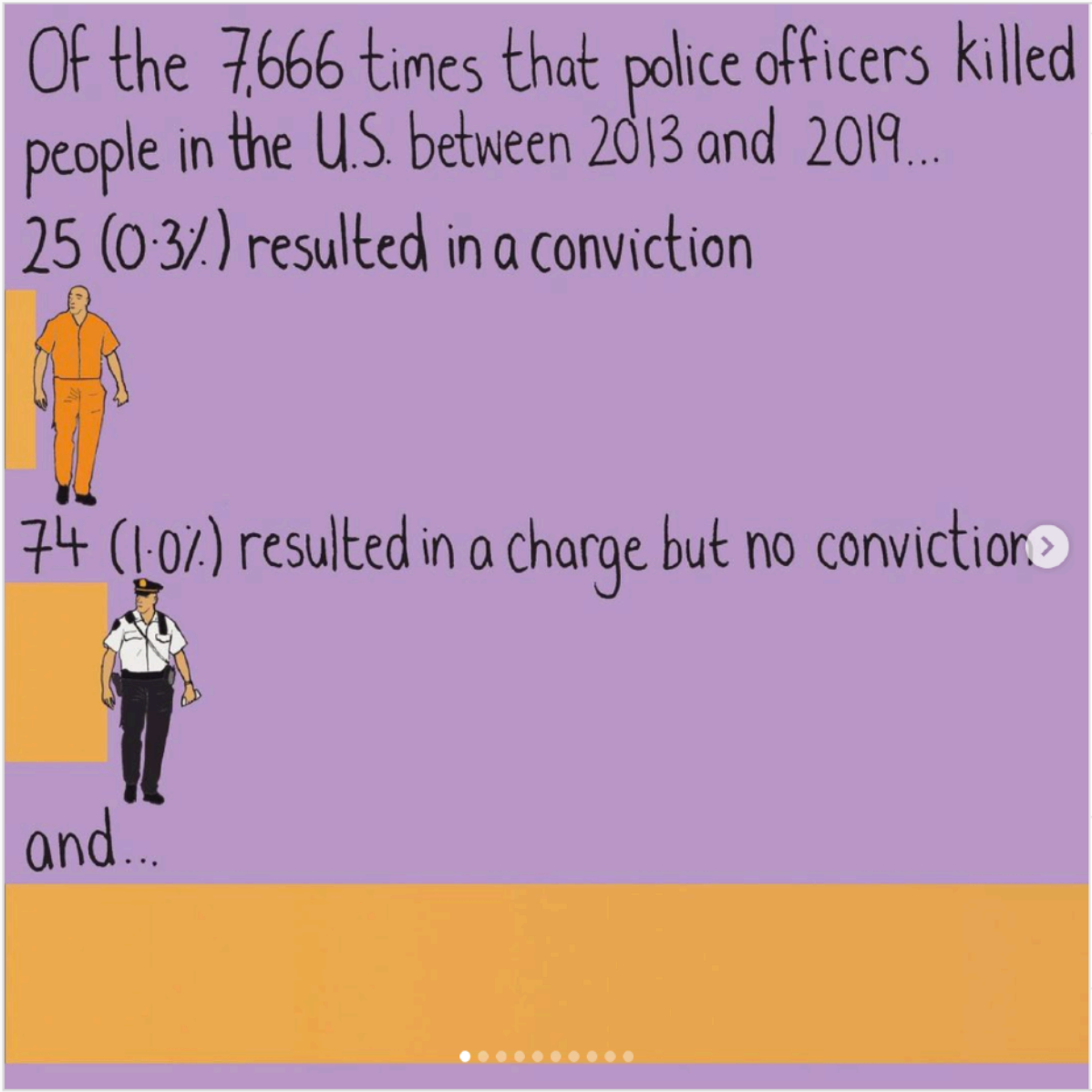


monachalabi • Follow
United States

monachalabi Total disbelief about the system doing the bare minimum. George Floyd deserved so much more than this, he deserved to live.

Some detail about those 25 sentences:
Unknown sentence = 4 police killings
Just probation = 3
3 months in jail = 1
1 year in jail, 3 years suspended = 1
1 year in prison = 1
18 months in prison = 1
2.5 years in prison = 1
4 years in prison = 1
5 years in prison = 1
6 years in prison = 1
16 years in prison = 1
20 years in prison = 1
30 years in prison = 2

22,976 likes

3 HOURS AGO

Narrative Devices

What devices communicates best?

Highly dependent on: audience, context, format

Format

Interactive Article

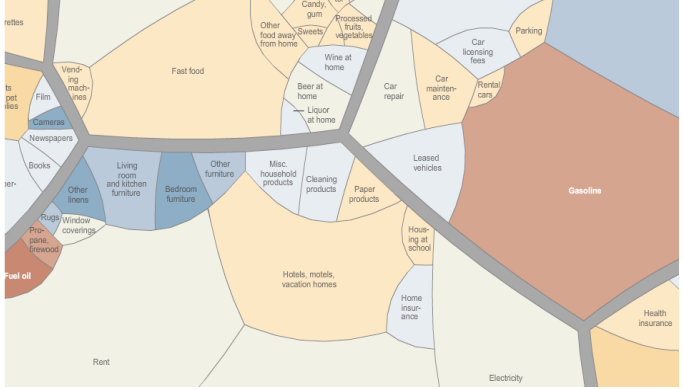
Animation

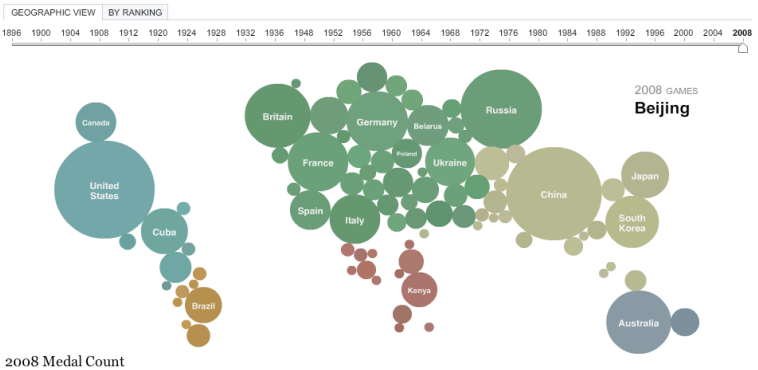
Lecture

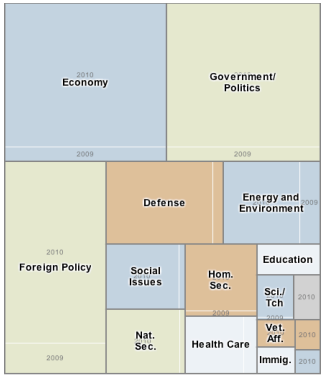
Still Image

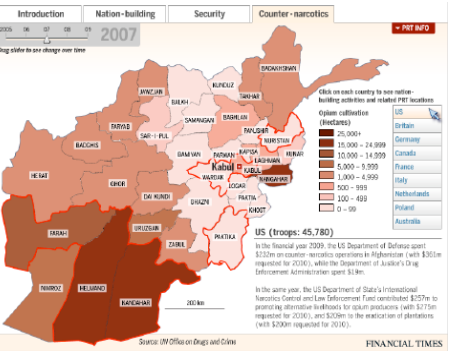
Video

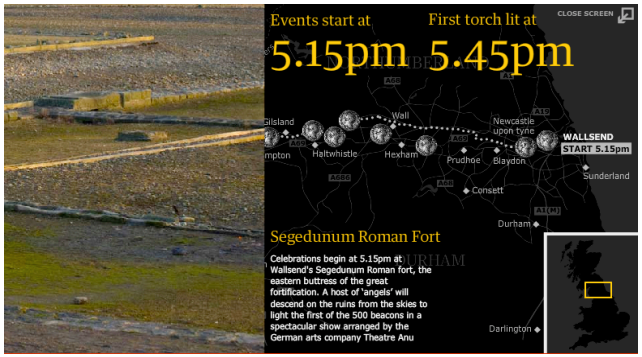
Narrative Visualization Design Space

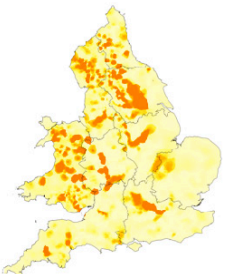


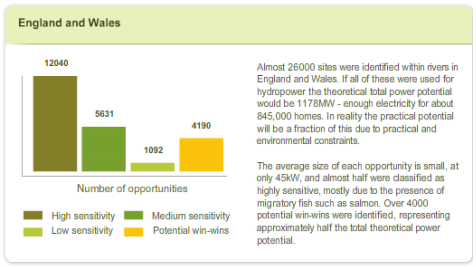












58

CASE STUDIES

70% Journalism

20% Business

10% Research

Segel & Heer, 2010

755

Steroids or Not, the Pursuit Is On

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

Lines are 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

755
714
23 seasons
22 seasons
20 seasons
600
400
200
0
14th season
5 seasons
10
15

Bonds was injured last season. He played 14 games and hit 5 homers.

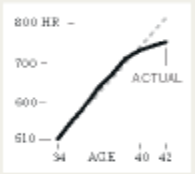
According to allegations in a book about Bonds, he began taking steroids before the 1999 season, his 14th in the league. Two seasons later, he hit 73 home runs, surpassing Aaron's career pace.

Homer Pace After Age 34

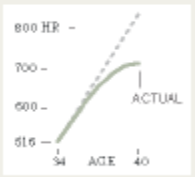
If the accusations are correct, Bonds was 34 in his first season on steroids. Here are projected home run paces for each player after age 34.

PROJECTED PACE BASED ON AVERAGE OF PREVIOUS FIVE SEASONS

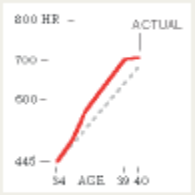
Aaron
Actual homers slightly outpace projected homers for five seasons.



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



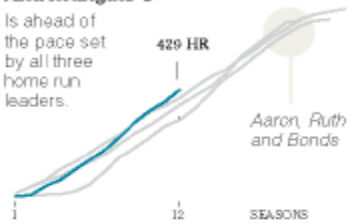
Bonds
From age 35 to 39, he averaged 14 more homers a season than projected.



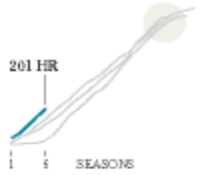
Note: Ages as of July 1 of each season.

Others Taking Aim

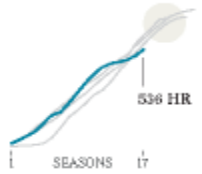
Alex Rodriguez ▲
Is ahead of the pace set by all three home run leaders.



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

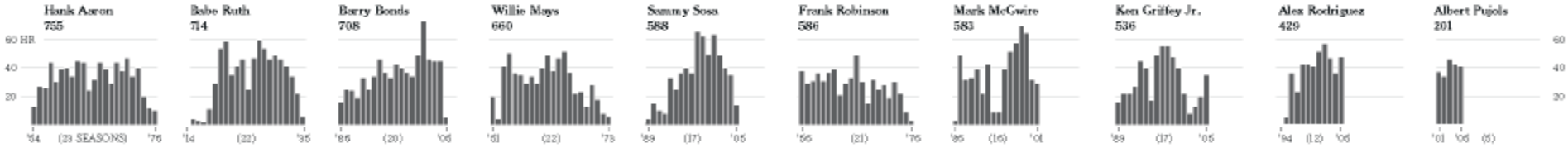


Ken Griffey Jr.
Many thought he would be the first to catch Ruth and Aaron until injuries limited his output.



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).



Amanda Cox and Joe Ward/The New York Times

Beginning

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755 homers
23 seasons

Babe Ruth
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Bonds takes lead
Home runs after 16 seasons

Bonds	567
Aaron	554
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23 seasons
22 seasons
20 seasons

Bonds was injured last season. He played 14 games and hit 5 homers.

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.

5 seasons 10 15

Middle

Homer Pace After Age 34

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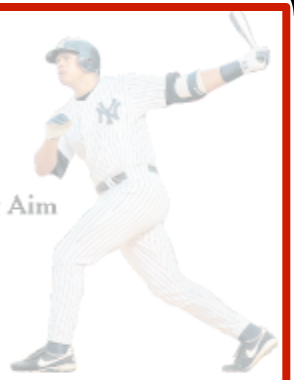
Bonds
From age 35 to 39, he averaged 14 more homers a season than projected.

End



Others Taking Aim

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Epilogue

Differing Paths to the Top of the Charts

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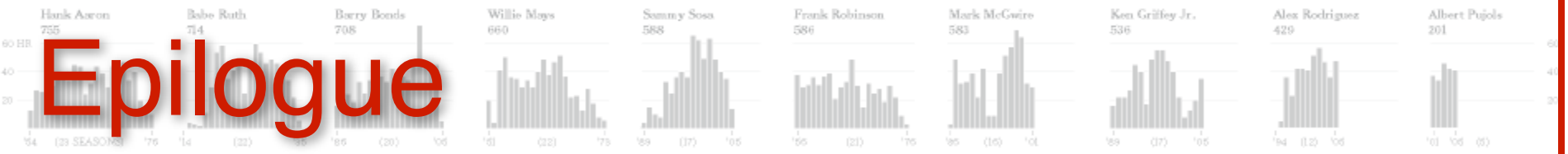
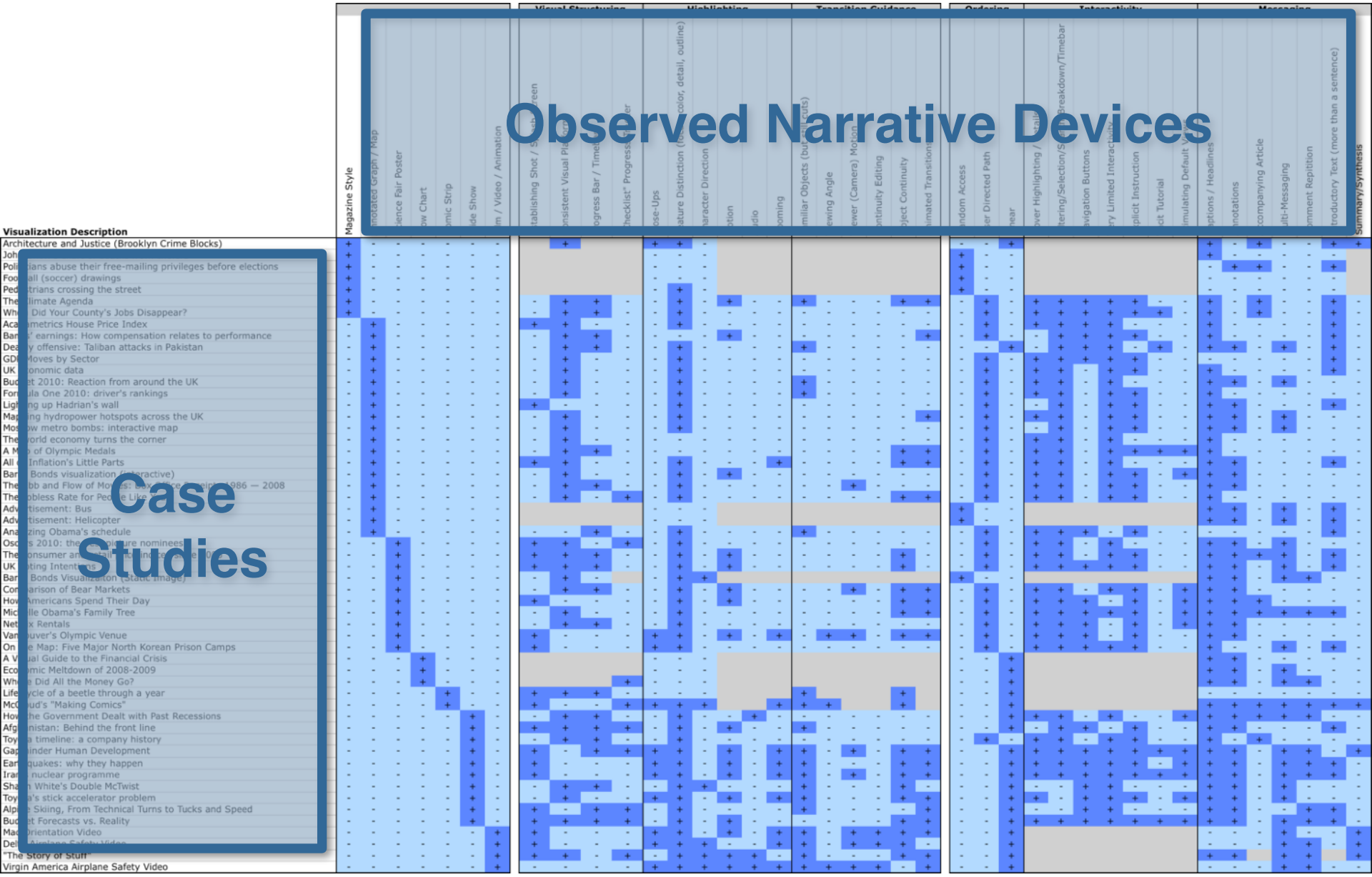
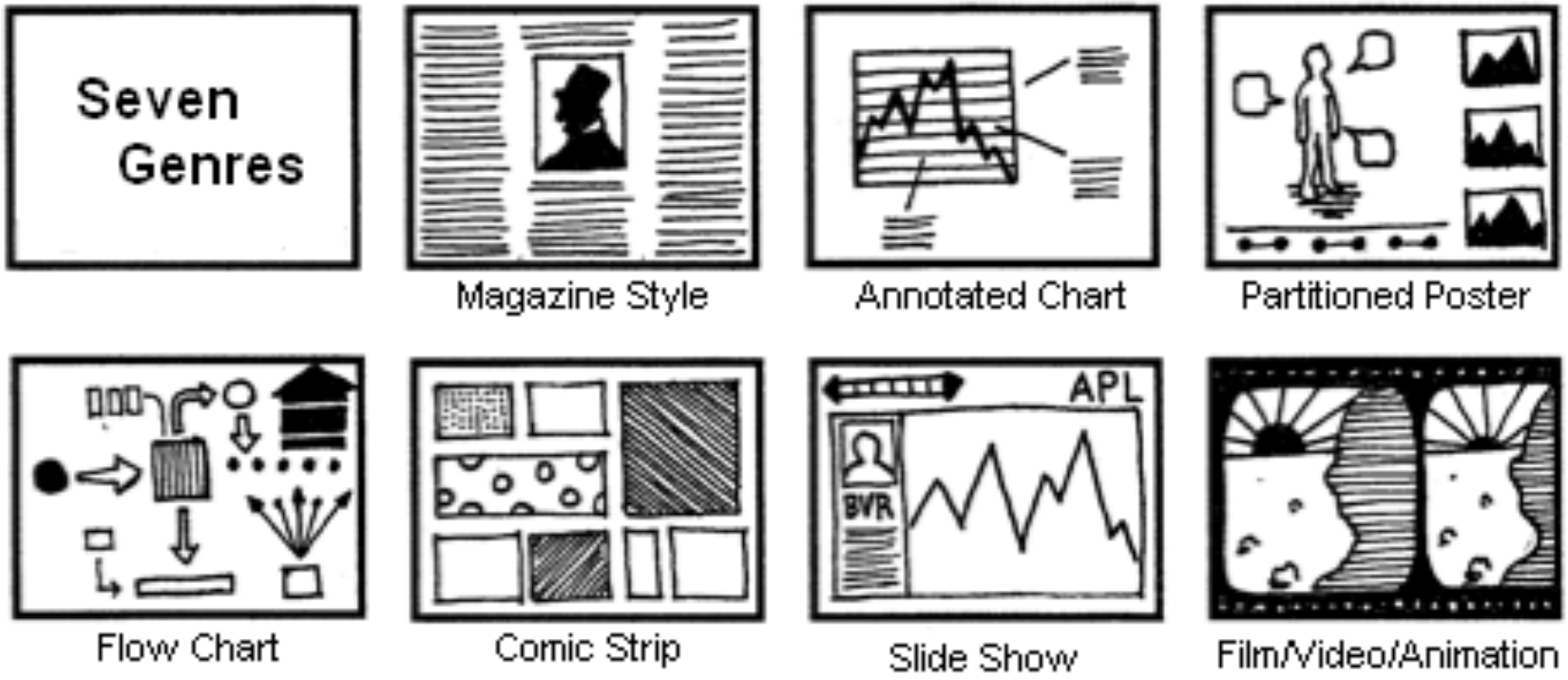


Observed Narrative Devices

Case Studies





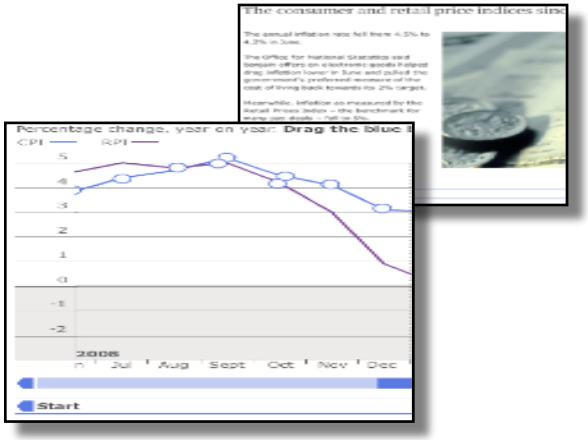
Genres for Narrative Visualization (2010)

Genres + Interactivity + Messaging =

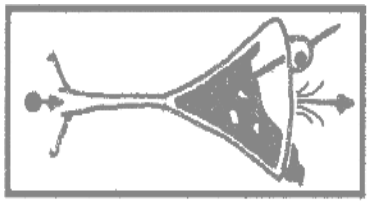
DESIGN SPACE

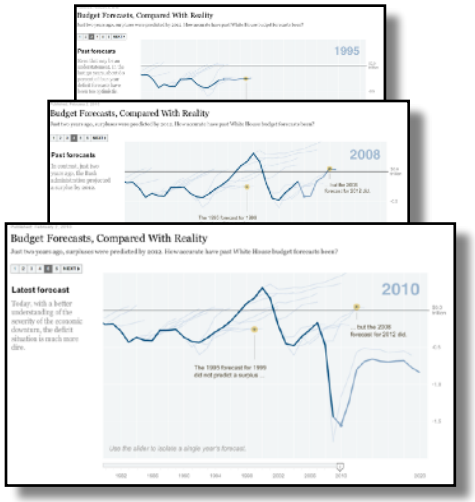
STORYTELLING	**Author Driven** strong ordering heavy messaging limited interactivity	**Reader Driven** weak ordering light messaging free interactivity
CLARITY		
SPEED		

ASK QUESTIONS
EXPLORE
FIND

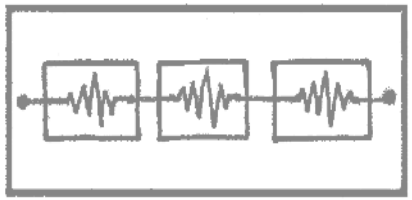


martini glass

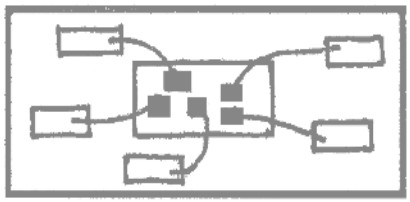




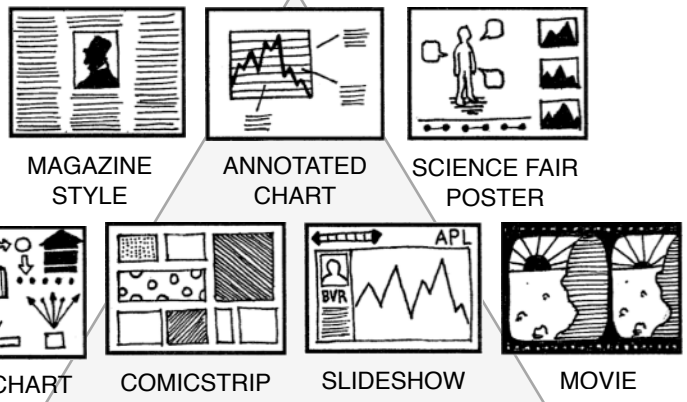
interactive slideshow



drill-down story



Visual Design



Duo-Specific
Captions
Annotations
Attached Article
Summaries
Interpret
Headlines

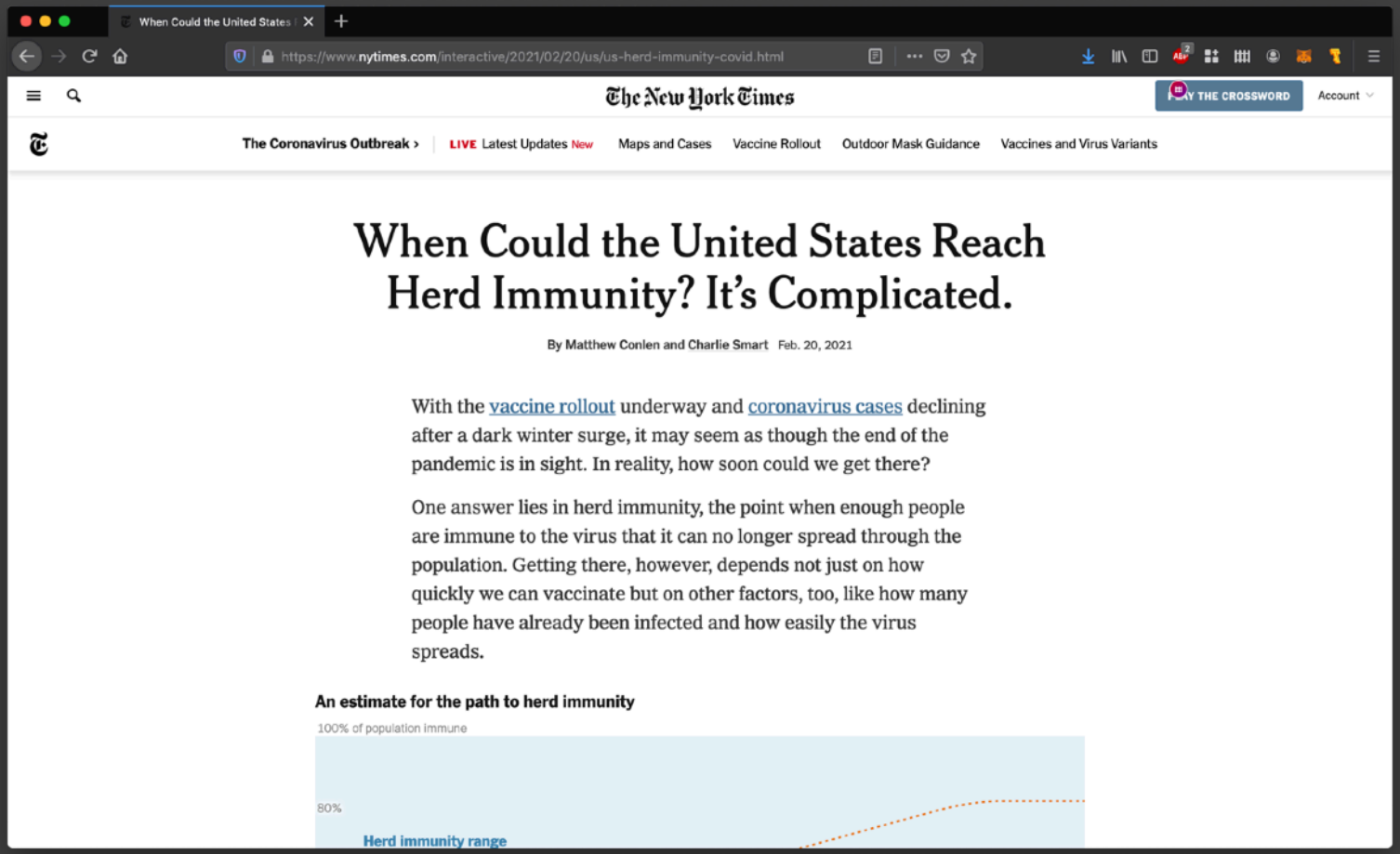
Tacit Tutorial
Selection
Navigation
Details on Demand
Timelines
Filtering
Highlighting

Messaging

Interactivity

MORE

Interactive Articles



When Could the United States Reach Herd Immunity? It's Complicated.
Conlen & Smart, New York Times 2021

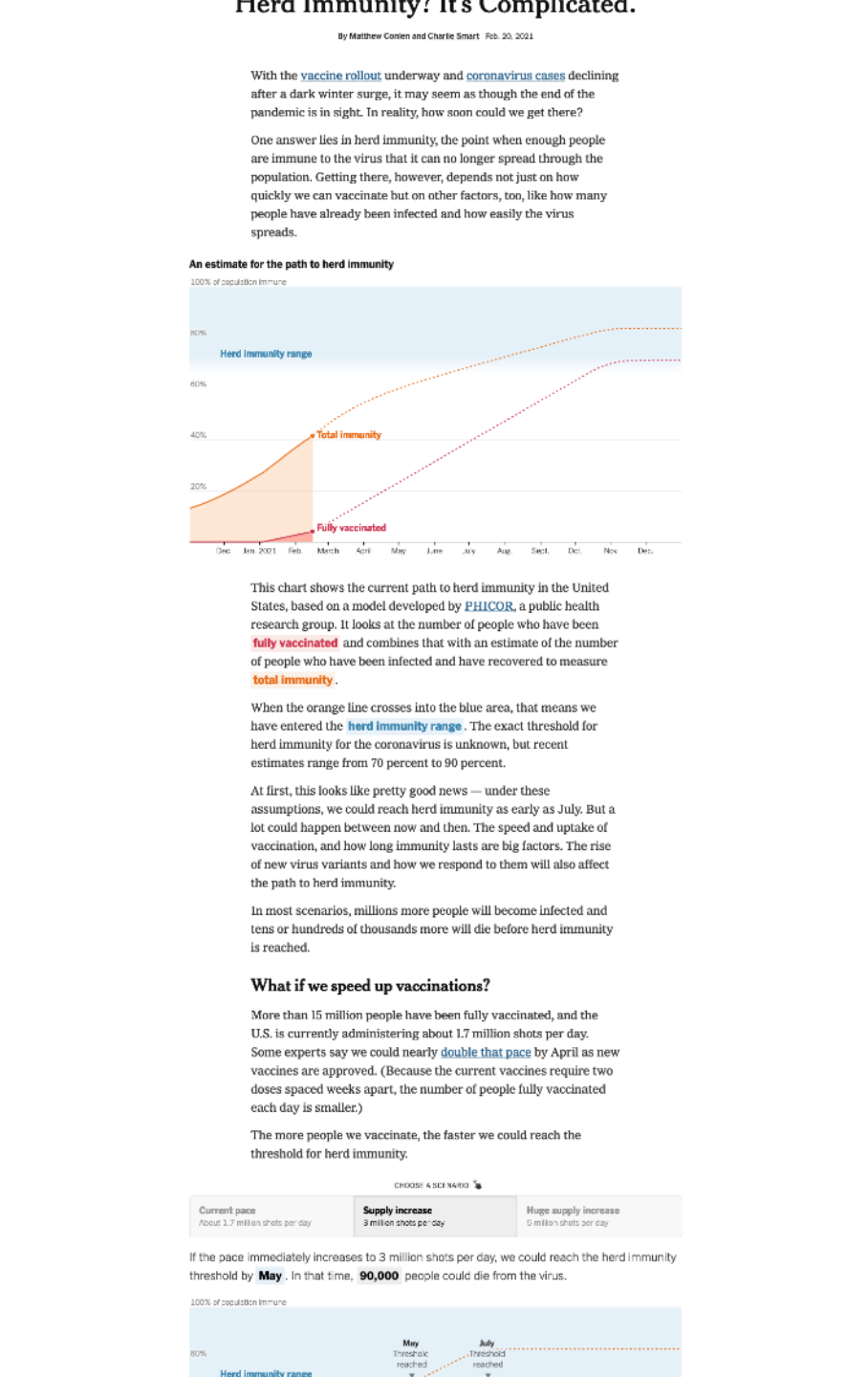
Motivation

- More engaged audience
  - Greussing & Boomgaarden, *Digital Journalism 2019*

- Better learning outcomes
  - Mayer's Multimedia Principles, 2005

- Promote active reading
  - Bret Victor's "Explorable Explanations", 2011

- Transparency in journalism
  - "A sense of the tentativeness of truth."
    - *Philip Meyer, Precision Journalism, 2002*



Herd Immunity? It's Complicated.

By Matthew Conlen and Charlie Smart Feb. 20, 2021

With the vaccine rollout underway and coronavirus cases declining after a dark winter surge, it may seem as though the end of the pandemic is in sight. In reality, how soon could we get there?

One answer lies in herd immunity, the point when enough people are immune to the virus that it can no longer spread through the population. Getting there, however, depends not just on how quickly we can vaccinate but on other factors, too, like how many people have already been infected and how easily the virus spreads.

An estimate for the path to herd immunity

This chart shows the current path to herd immunity in the United States, based on a model developed by PHICOR, a public health research group. It looks at the number of people who have been **fully vaccinated** and combines that with an estimate of the number of people who have been infected and have recovered to measure **total immunity**.

When the orange line crosses into the blue area, that means we have entered the **herd immunity range**. The exact threshold for herd immunity for the coronavirus is unknown, but recent estimates range from 70 percent to 90 percent.

At first, this looks like pretty good news — under these assumptions, we could reach herd immunity as early as July. But a lot could happen between now and then. The speed and uptake of vaccination, and how long immunity lasts are big factors. The rise of new virus variants and how we respond to them will also affect the path to herd immunity.

In most scenarios, millions more people will become infected and tens or hundreds of thousands more will die before herd immunity is reached.

What if we speed up vaccinations?

More than 15 million people have been fully vaccinated, and the U.S. is currently administering about 1.7 million shots per day. Some experts say we could nearly double that pace by April as new vaccines are approved. (Because the current vaccines require two doses spaced weeks apart, the number of people fully vaccinated each day is smaller.)

The more people we vaccinate, the faster we could reach the threshold for herd immunity.

If the pace immediately increases to 3 million shots per day, we could reach the herd immunity threshold by **May**. In that time, **90,000** people could die from the virus.

Challenges

- Integration between text and media
- Data-driven
- Computation
- Interactivity
- Multiple output targets (desktop, mobile, homepage, print, social)

- Many people working together
  - two authors, multiple editors, designers, researchers, interviewees

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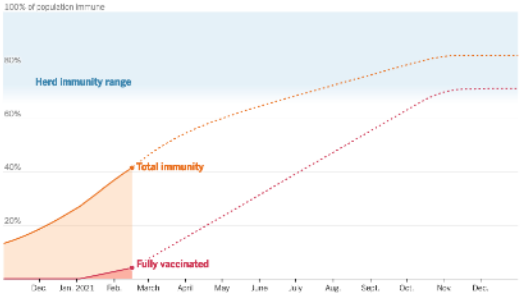

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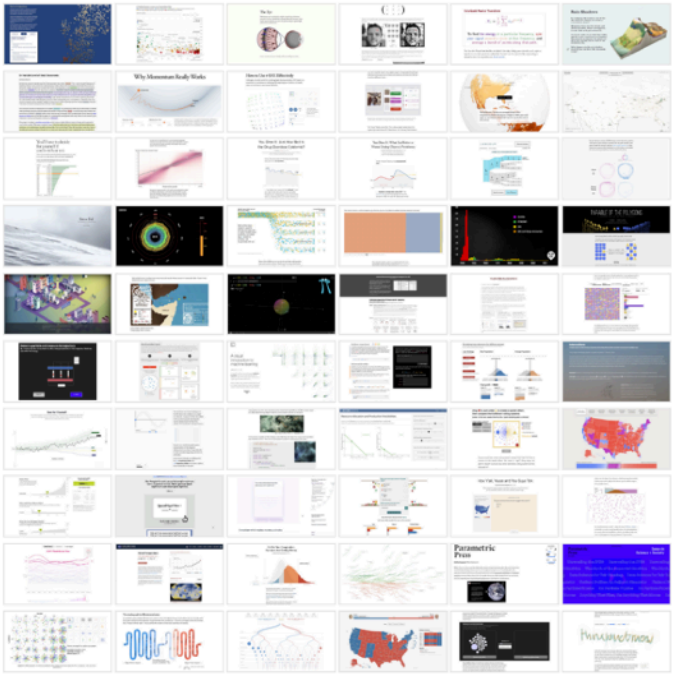
Communicating with Interactive Articles

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

Tied together research from HCI, multimedia learning, infovis, digital journalism

Hohman, Conlen, Heer, Chau, Distill, 2020

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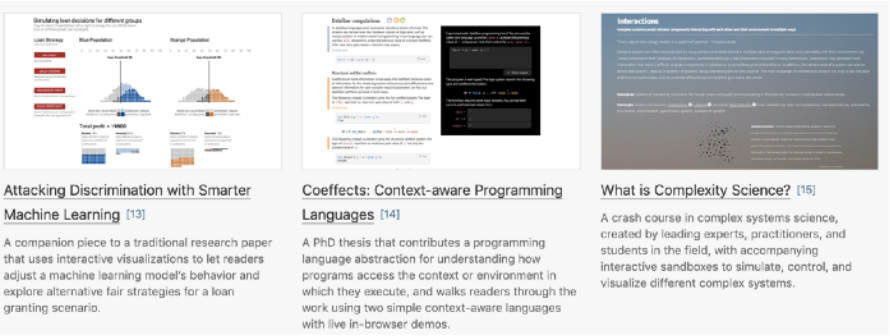

Attacking Discrimination with Smarter Machine Learning [13]

A companion piece to a traditional research paper that uses interactive visualizations to let readers adjust a machine learning model's behavior and explore alternative fair strategies for a loan granting scenario.

Coeffects: Context-aware Programming Languages [14]

A PhD thesis that contributes a programming language abstraction for understanding how programs access the context or environment in which they execute, and walks readers through the work using two simple context-aware languages with live in-browser demos.

What is Complexity Science? [15]

A crash course in complex systems science, created by leading experts, practitioners, and students in the field, with accompanying interactive sandboxes to simulate, control, and visualize different complex systems.

Let's Learn About Waveforms [19]

An interactive guide that introduces and explores waveforms without requiring prior knowledge. The article lets readers play with different waveforms using sound to understand their basic physics and relationship to music and harmony.

The Book of Shaders [20]

A step-by-step guide that walks a reader through the notoriously challenging topic of computer graphics fragment shaders using interactive code examples.

EconGraphs [21]

While most interactive textbooks are about mathematics, this collection of key concepts from economics using interactive visualization to help econ teachers illustrate important underlying relationships within economic models.

60+ Interactive Articles

NYTimes, WaPost

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Areas of Application

Research Dissemination

Journalism

Education

Policy & Decision Making

Communicating with Interactive Articles

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60+ Interactive Articles
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Connecting People and Data.
Make data pleasant to work with. Happy readers are engaged readers.

Making Systems Playful.
Run interactive simulations directly in the browser. No setup required.

Prompting Self-Reflection.
Help readers learn by asking them to reflect in a low pressure environment.

Personalizing Reading.
Let readers choose the content that is relevant to their own experience.

Reducing Cognitive Load.
Use effective representations to make complex topics more intuitive.

Five affordances of the format

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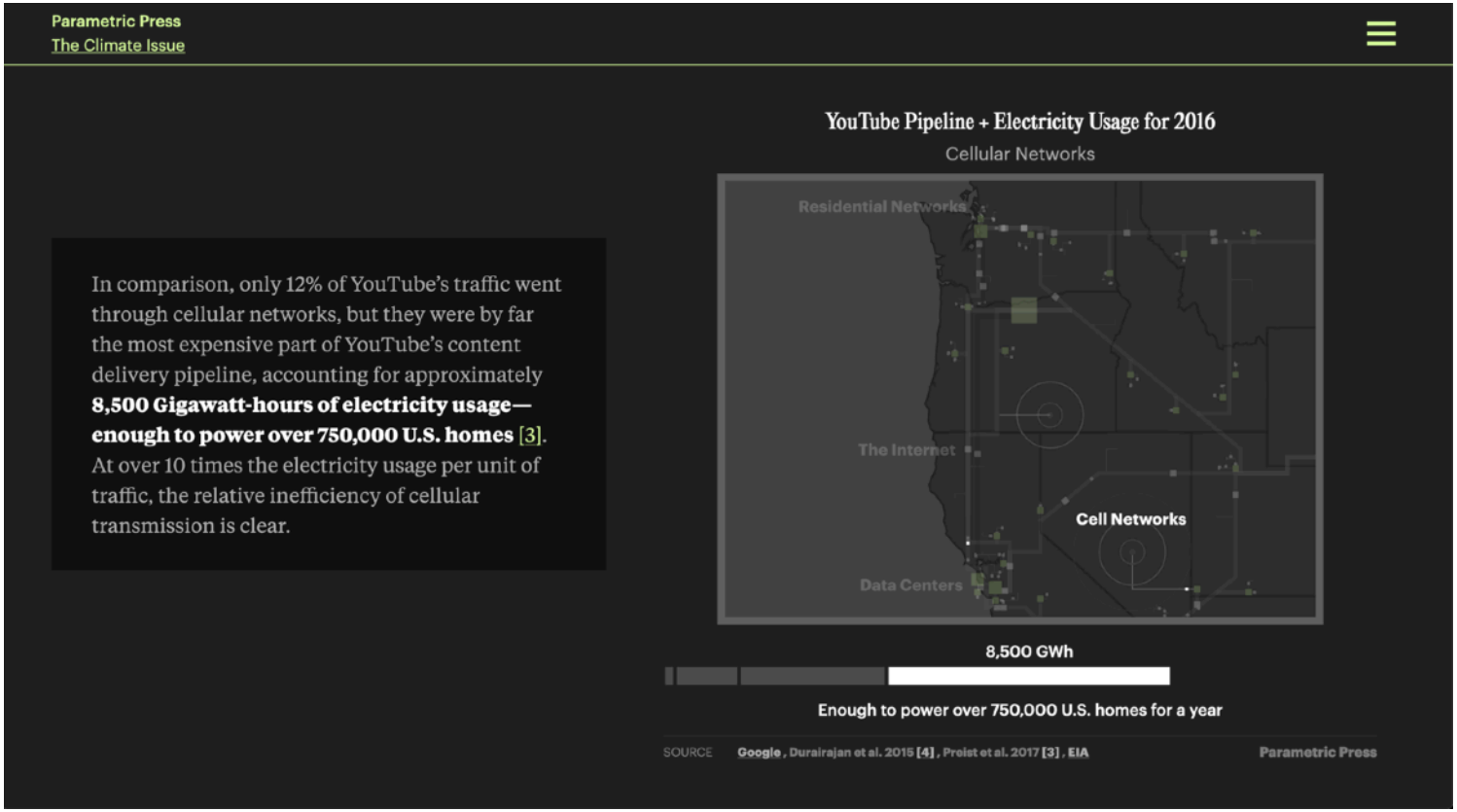

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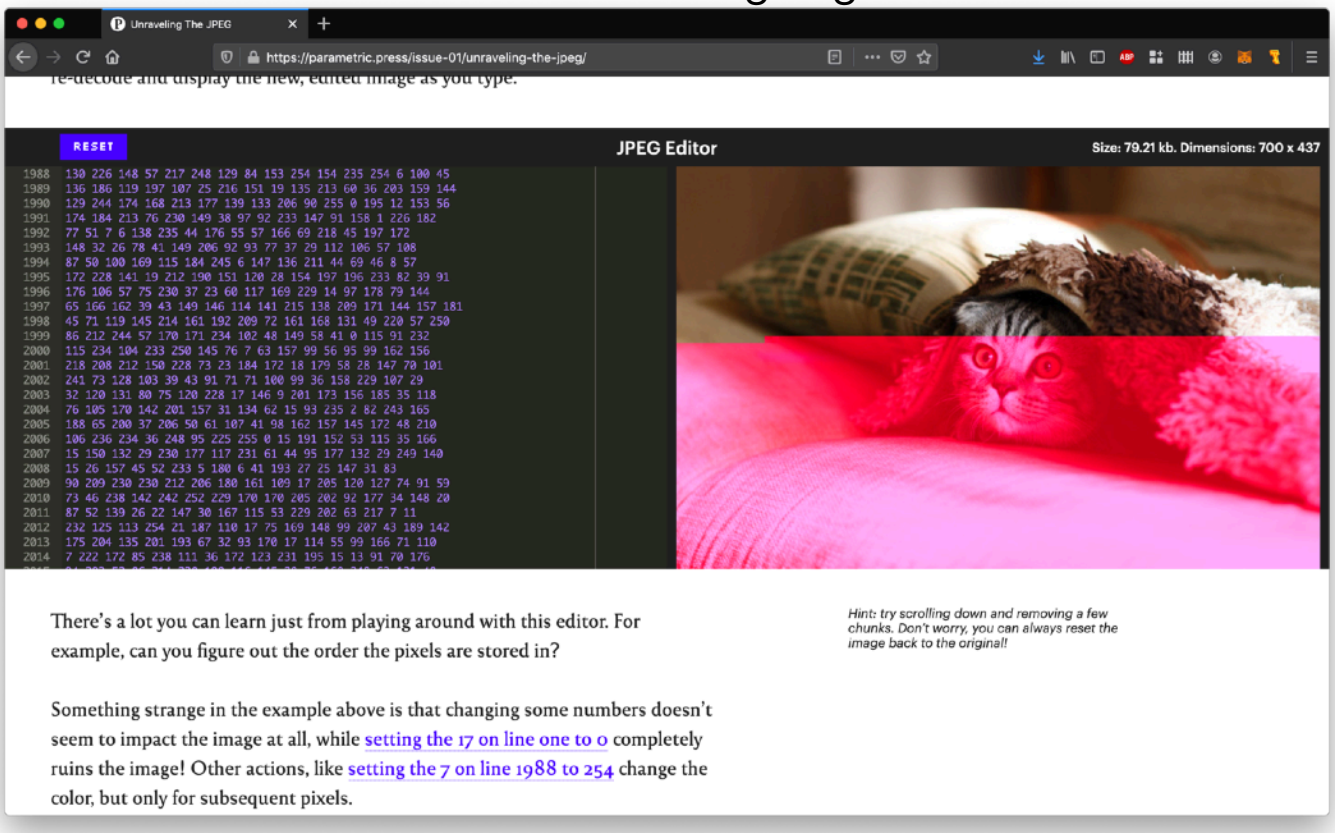

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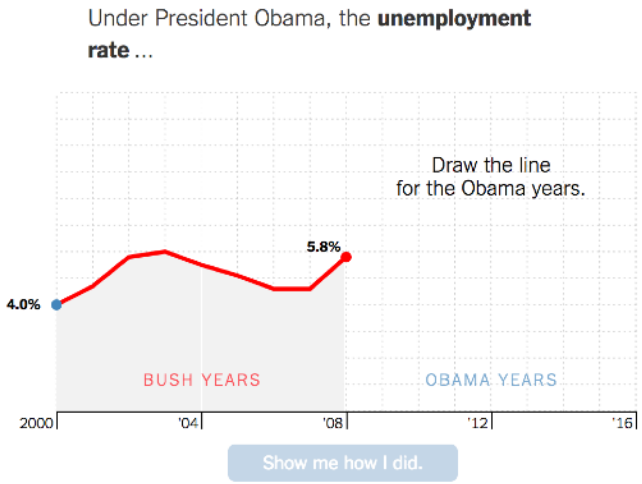
You Draw It: What Got Better or Worse During Obama's Presidency

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.



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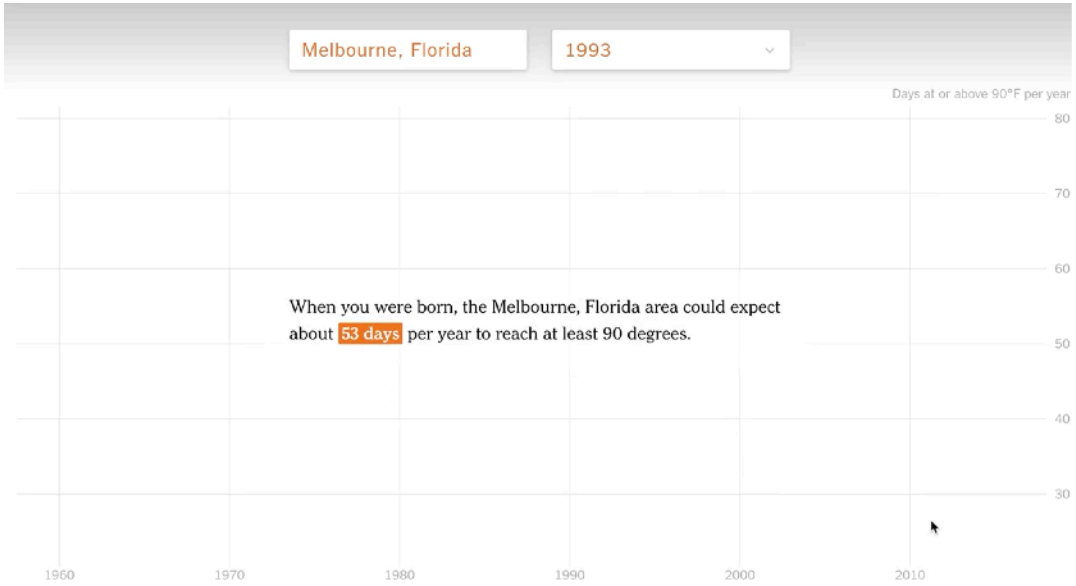

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Explorable explanation

From Wikipedia, the free encyclopedia

An **explorable explanation** (often shortened to *explorable*) is a form of informative media where an interactive computer simulation of a given concept is presented, along with some form of guidance e can learn from the simulation. Explorable explanations encourage users to discov their expectations of its behaviour against its actual behaviour, promoting a more activ

A **simulation** is the imitation of the operation of a real-world process or system over time. Simulations require the use of models; the model represents the key characteristics or behaviors of the selected system or process, whereas the simulation represents the evolution of the model over time. Often,

Screenshot from *Parable of the Polygons* by Nicky Case, an explorable explanation that simulates racial segregation, which allows the audience to control how "shapist" the entities in the simulation are.

Contents [hide]
1 Definition
2 History
3 Subject matter
4 Use in media
5 Structure
6 See also
7 References
8 External links

Definition [edit]

The term "explorable explanation" was first used in passing by er into common use until 2011, when Bret Victor published an eponymous essay[2] (the essay included an explorable explanation of a dig s from isolated interactive widgets and visualizations by the fact that they deliberately guide the attention of their audience towards partic zing the concept, Victor explains:[2]

> Explorable Explanations is my umbrella project for ideas that *enable and encourage truly active reading*. The goal is to change people's relationship with text. People currently think of text as *information to be consumed*. I want text to be used as an *environment to think in*.

Some of the ideas Victor espoused in the essay occurred to him while during work with Al Gore on the app version of the 2009 book Our Choice.[3] He had proposed that the app should contain interactive models, but this idea was rejected on the basis that all numerical values proposed regarding climate change needed to have a citation, and the interactive models would generate un-cited numbers.[4]

ation e term has since also been characterized as being about learning through play.[5] The related term "active essays" was used by Alan Kay to refer to text-based explorable explanations.[6] and a

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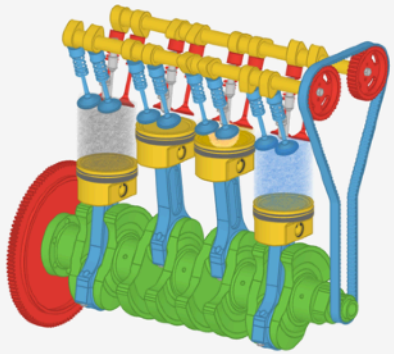
Internal Combustion Engine

The invention of the internal combustion engine in the 19th century has revolutionized transportation over land, water, and air. Despite their omnipresence in modern day, the operation of an engine may be cryptic. Over the course of this article I'd like to explain the functionality of all the basic engine parts shown in the demonstration below. You can drag it around to see it from other angles:



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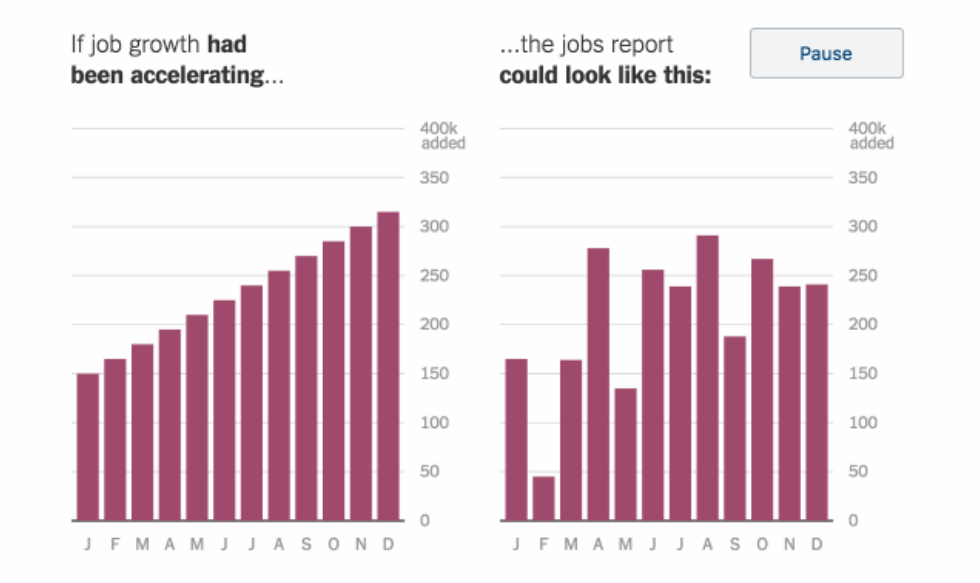

Challenges

Turned a writing task into a web development task

Breadth of skills required

Multiple output targets

Accessibility

Misaligned Incentives

Hard to evaluate success

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Opportunities

	Research	Practice
Authoring	Next generation tooling	Evaluate in production setting, identify bugs
Designing	Developing theory, conducting laboratory studies	Evaluate specific design decisions in the wild, understand constraints
Publishing	Tools, guidelines, and best practices	Concrete examples for others to follow, available source code, accessible archives, DOI, branding

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.

Conlen & Heer, *UIST, 2018*

Text + Parameterized Visuals

Write articles in *markdown*.

Connect *reactive variables* to user input widgets to add interactivity.

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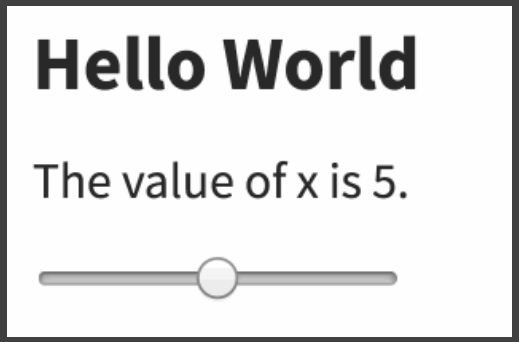
Write articles in *markdown*.

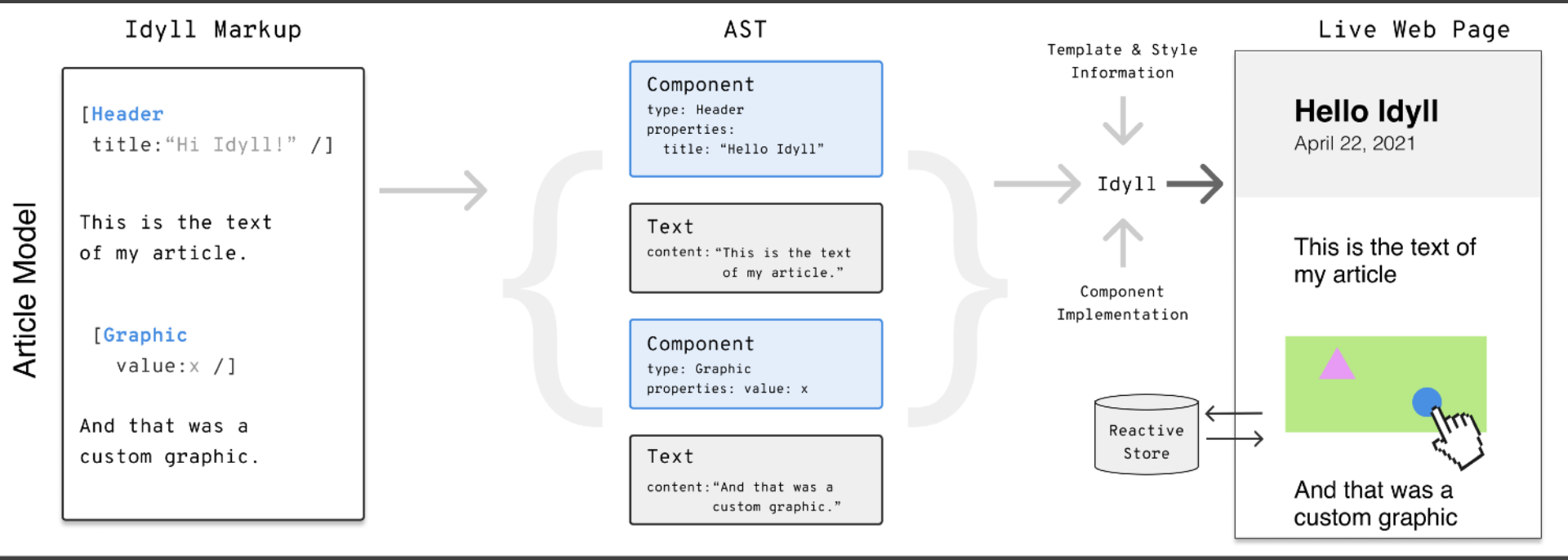
Connect *reactive variables* to user input widgets to add interactivity.

INPUT (EDITABLE)

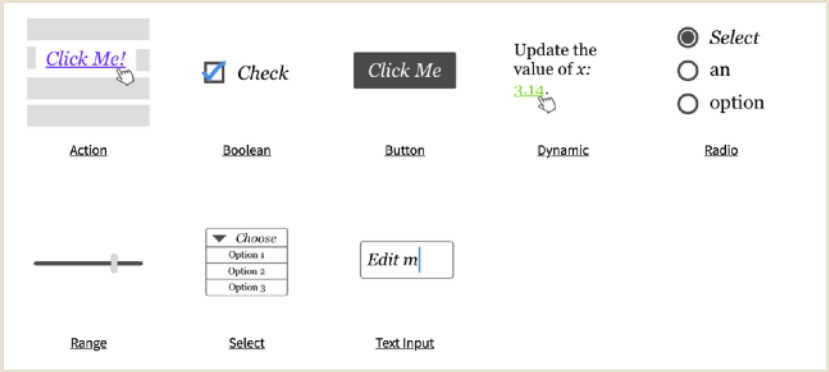
```
# Hello World

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

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

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



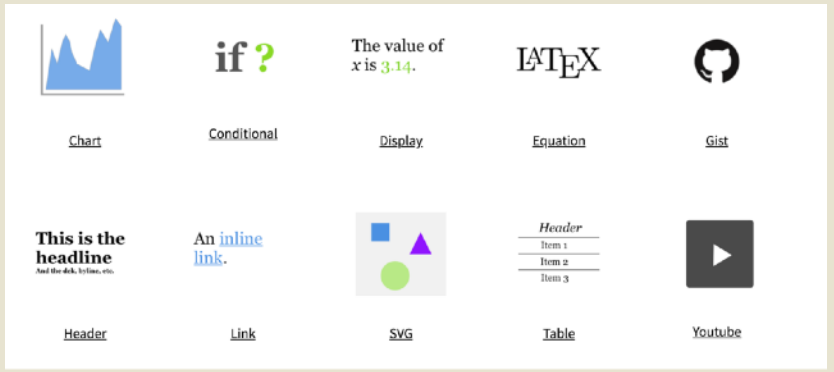
A *Model* of Interactive Articles



28 Built-in Components



Input



Presentation

Layout

Helpers

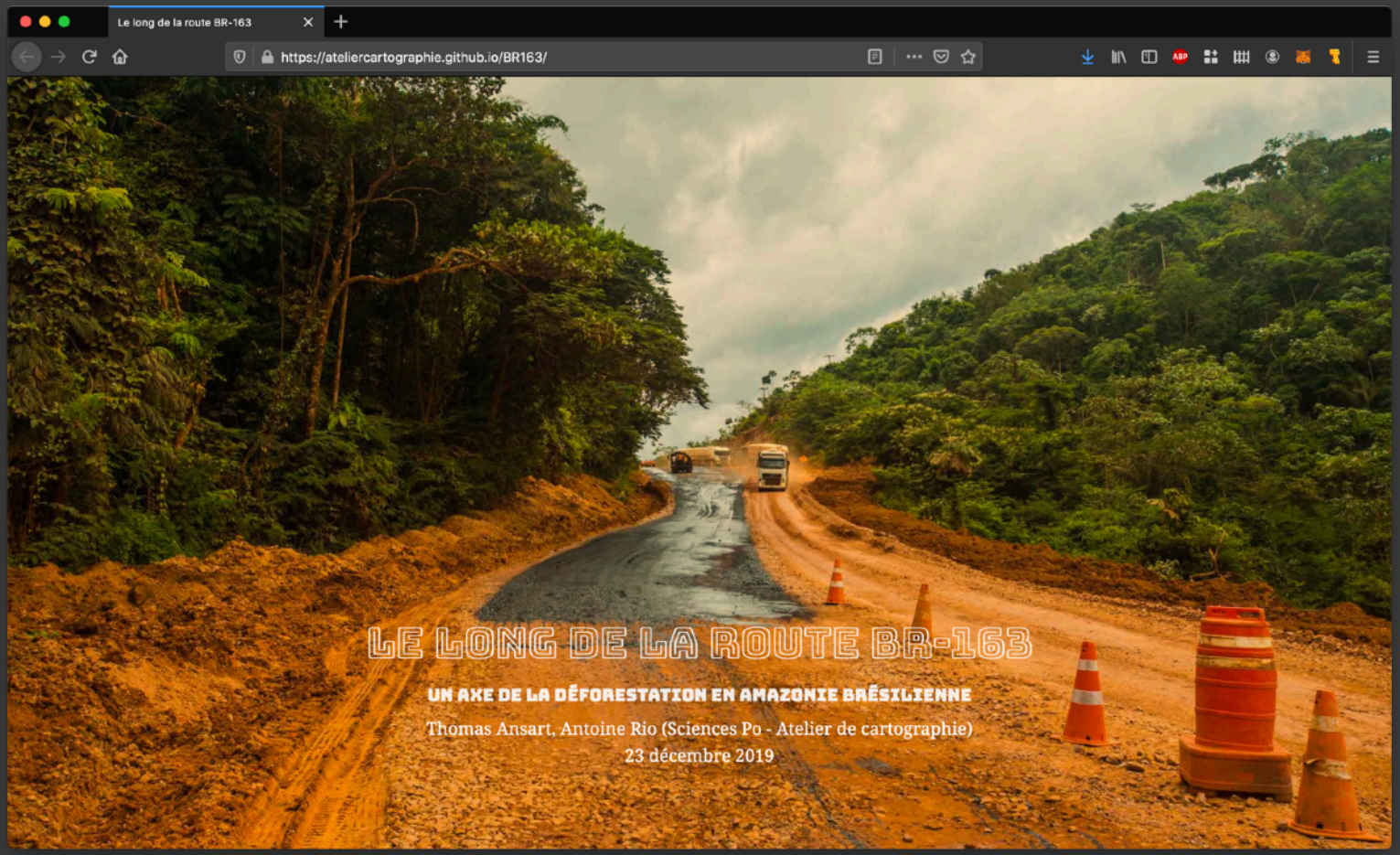
Bring your own graphics

A JavaScript component API is exposed to end users.

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

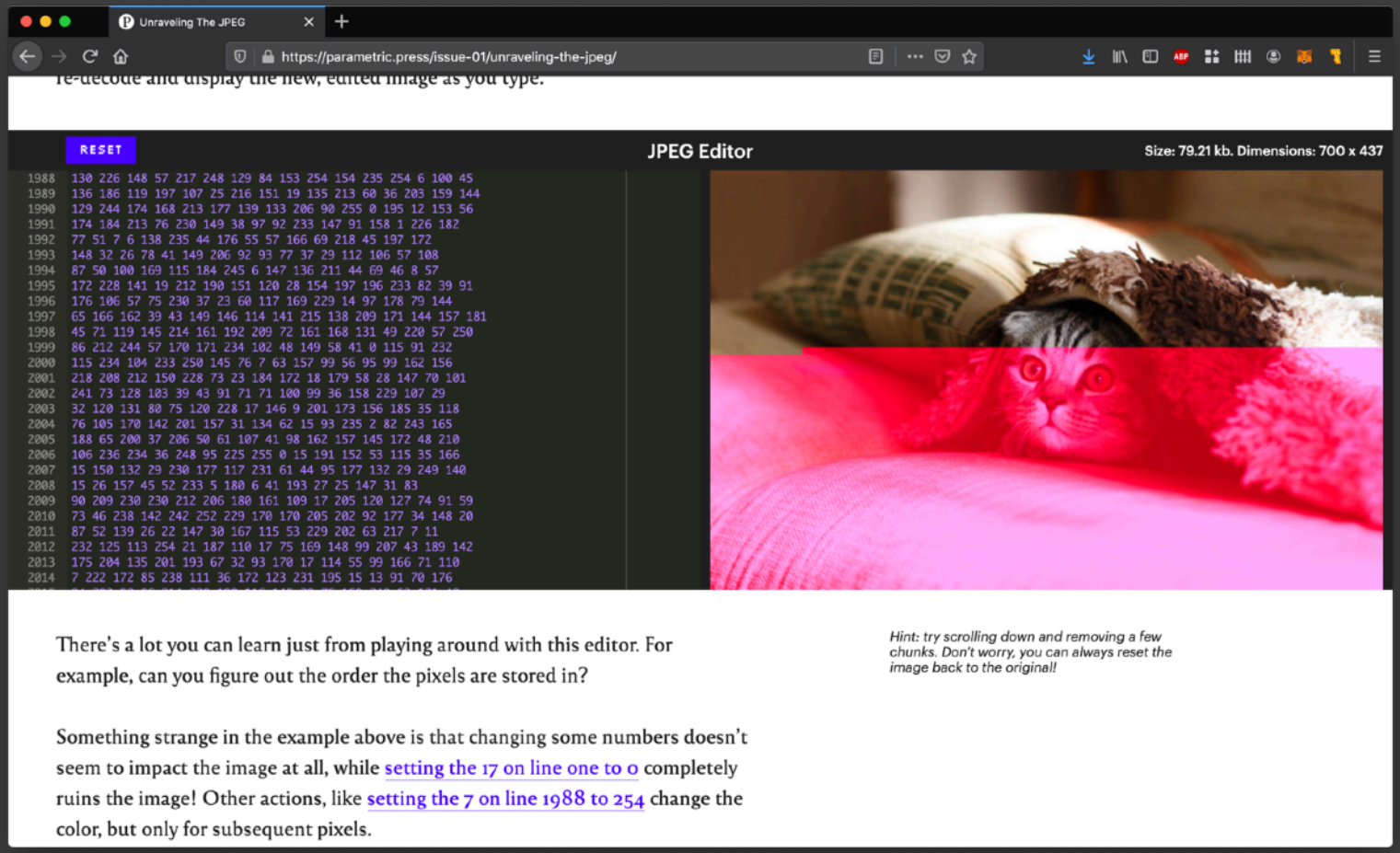
Examples

Le long de la route BR-163



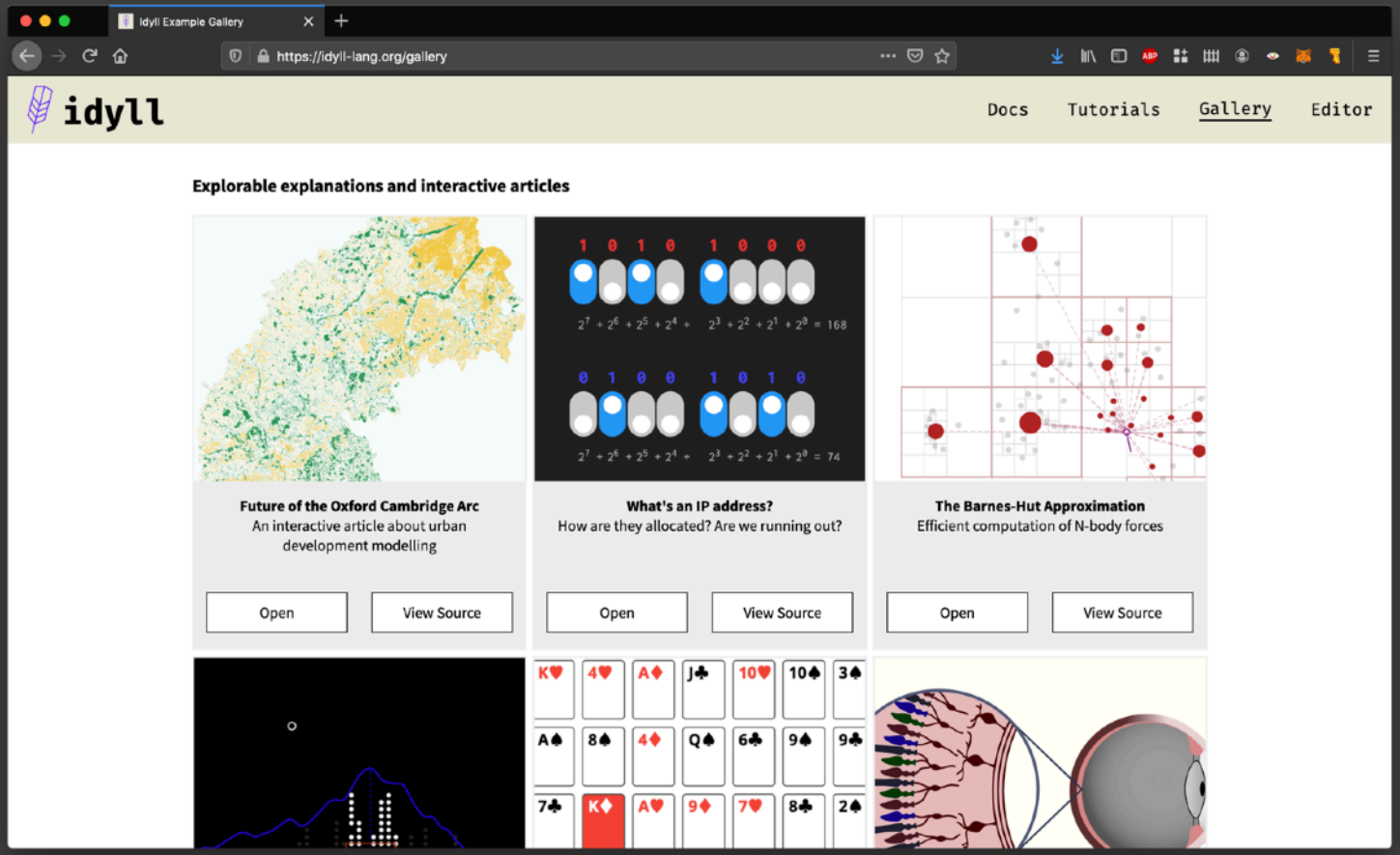
Examples

Unraveling the JPEG



Examples

idyll-lang.org/gallery



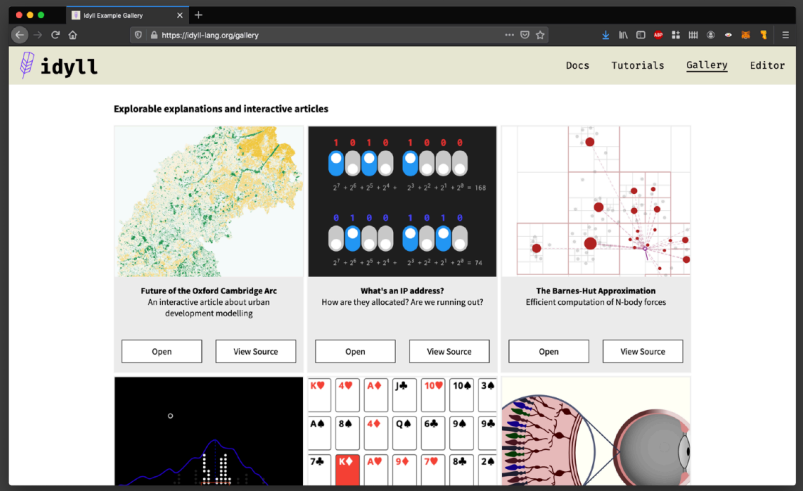
Usage

Open-source release

Pilot Studies

Usage in the wild

- UK Infrastructure Transitions Research Consortium
- Minneapolis Star Tribune
- Vis courses in universities (UMD, UIUC, UW, CMU, …)
- Teaching materials (CU Denver, UBC)
- IEEE VisXAI
- Texas2036
- Recurse Center
- Parametric Press - featured in FastCo Design
- *…and more!*



Idvll...

Seems great but...

…still requires learning and writing markup syntax

…requires use of general-purpose programming tools, e.g. to make a new post, run development server

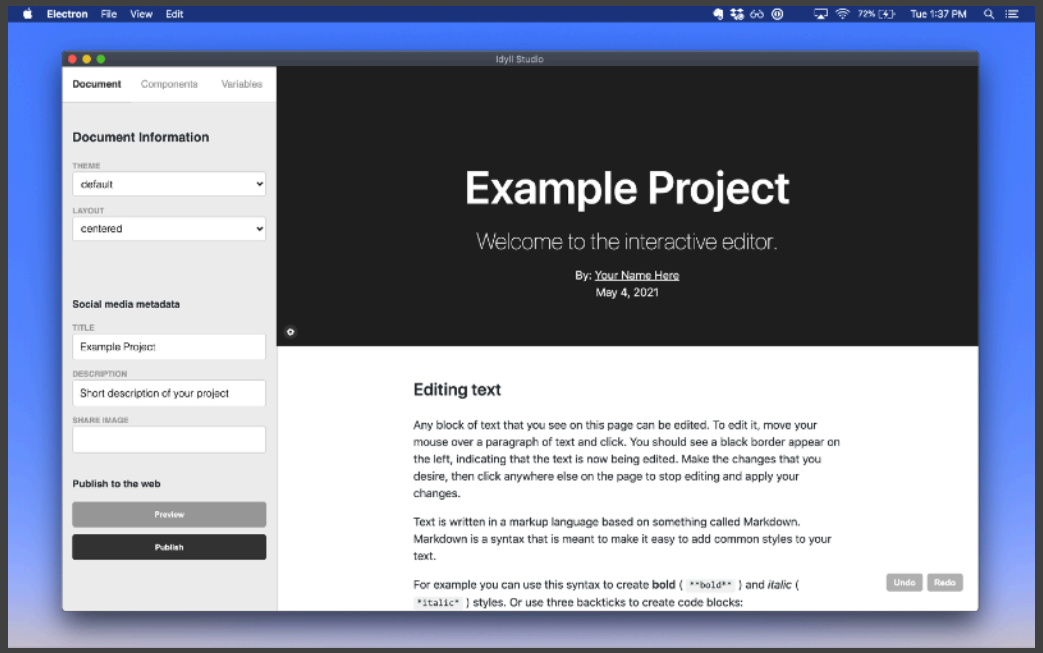
Idyll Studio

Built a **structured editor** for editing and creating Idyll programs

Reduce use of general-purpose programming tools.

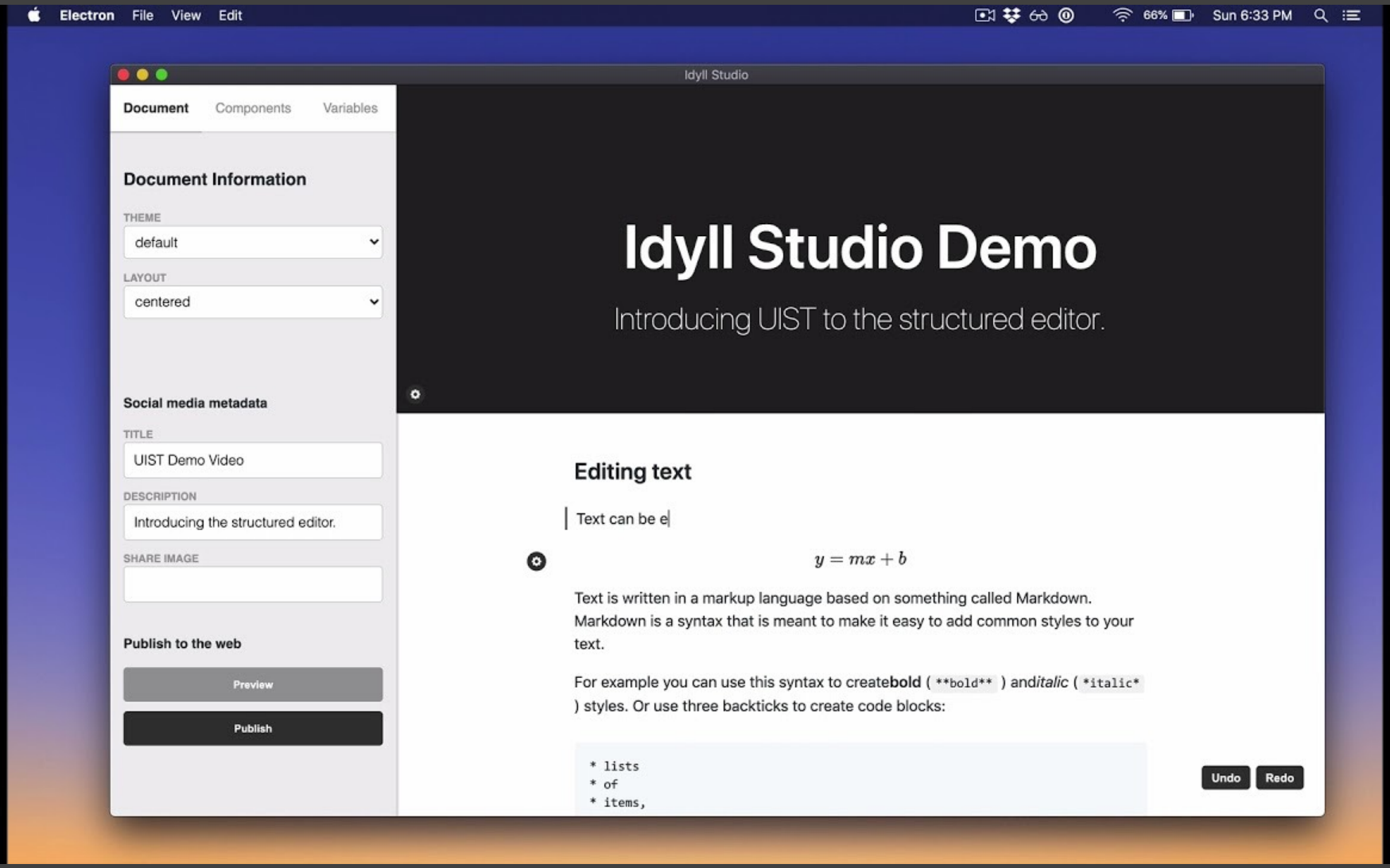
Eliminate syntax errors.

Reify Idyll model.



Conlen, Vo, Tan, Heer, *UIST 2021*

Idvll Studio - Demo



Thanks!

Feel free to reach out:

mconlen@uw.edu

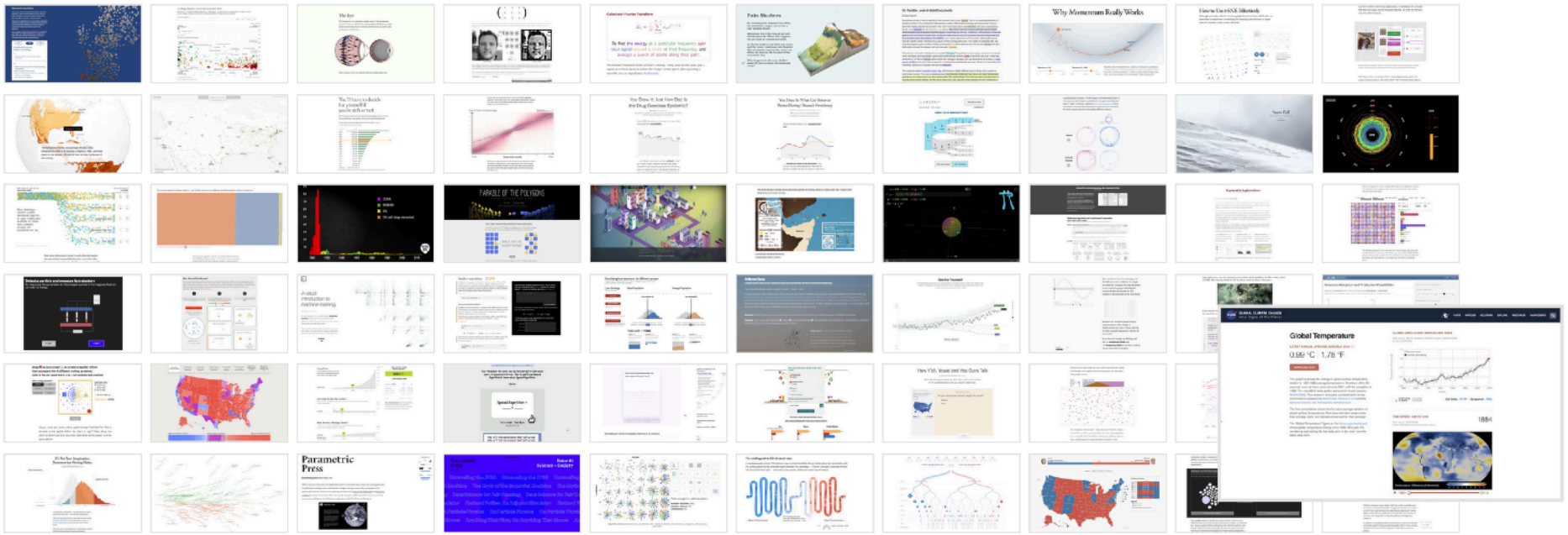


FIGURE 1: **"Global Temperature."** NASA. *NASA Global Climate Change, 2020.*

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mathisonian.com