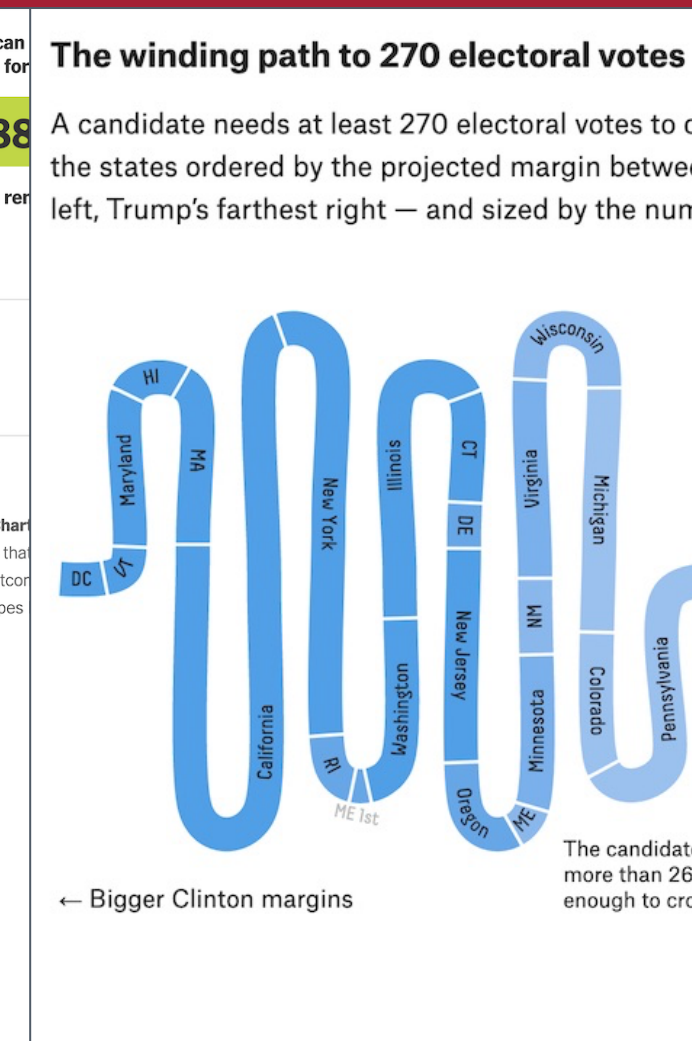
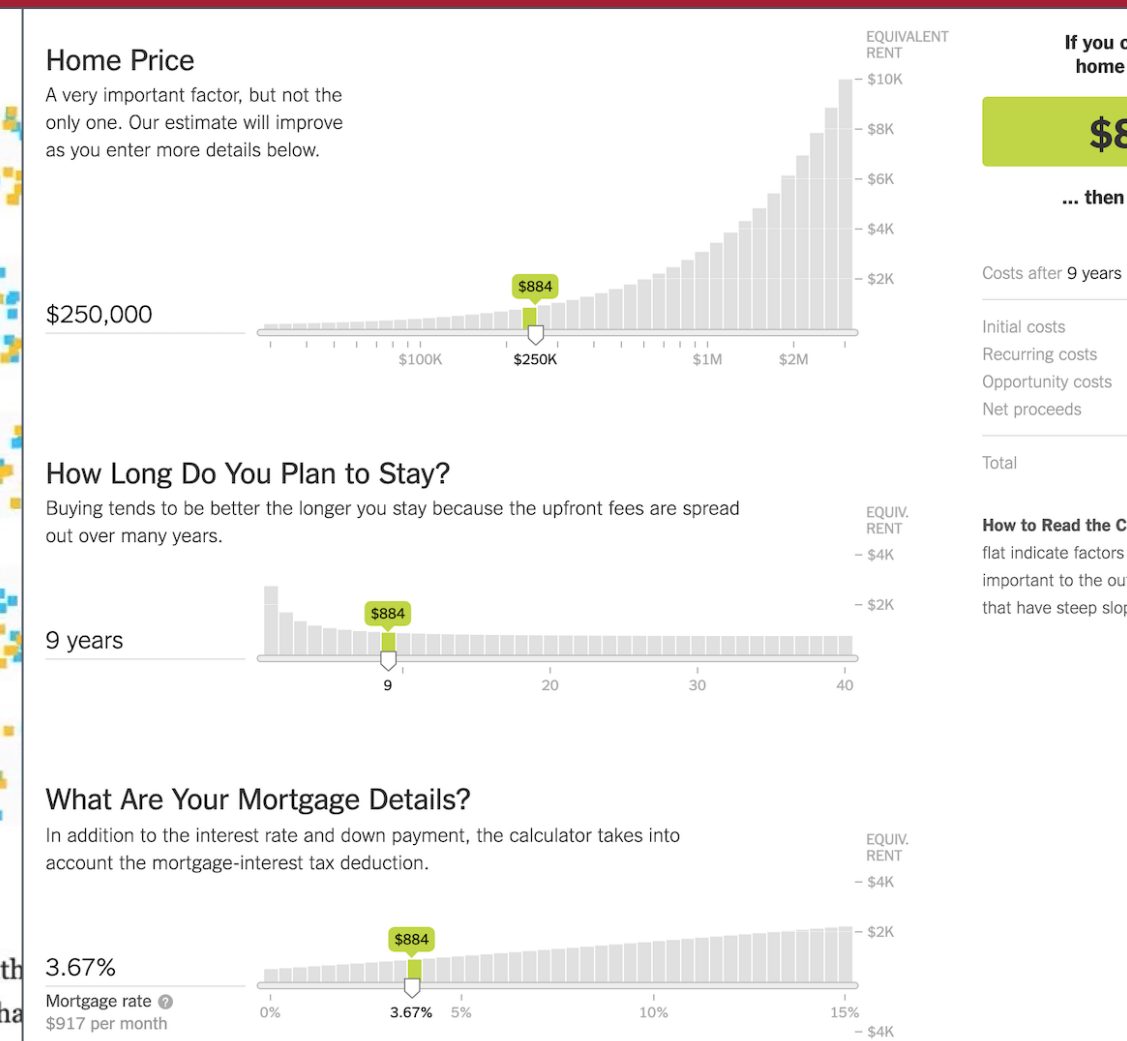
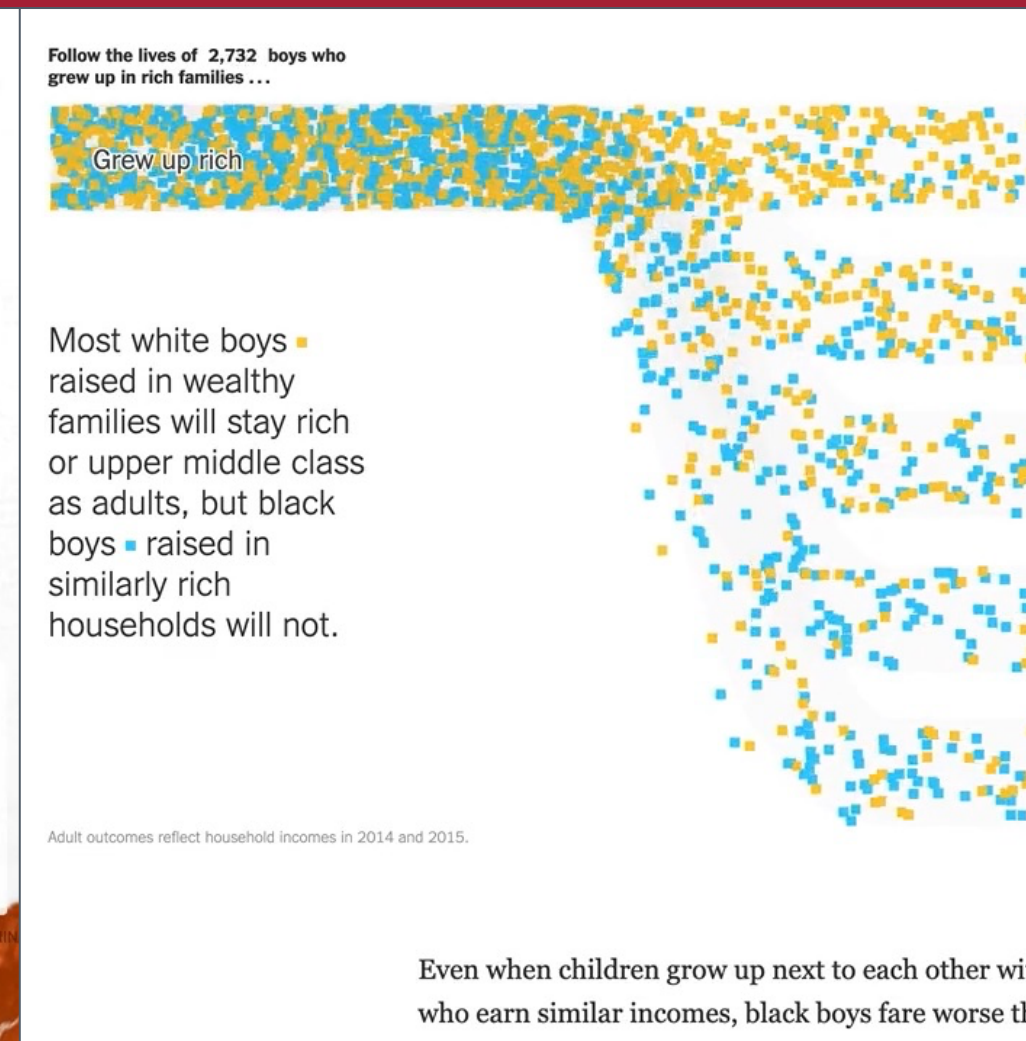
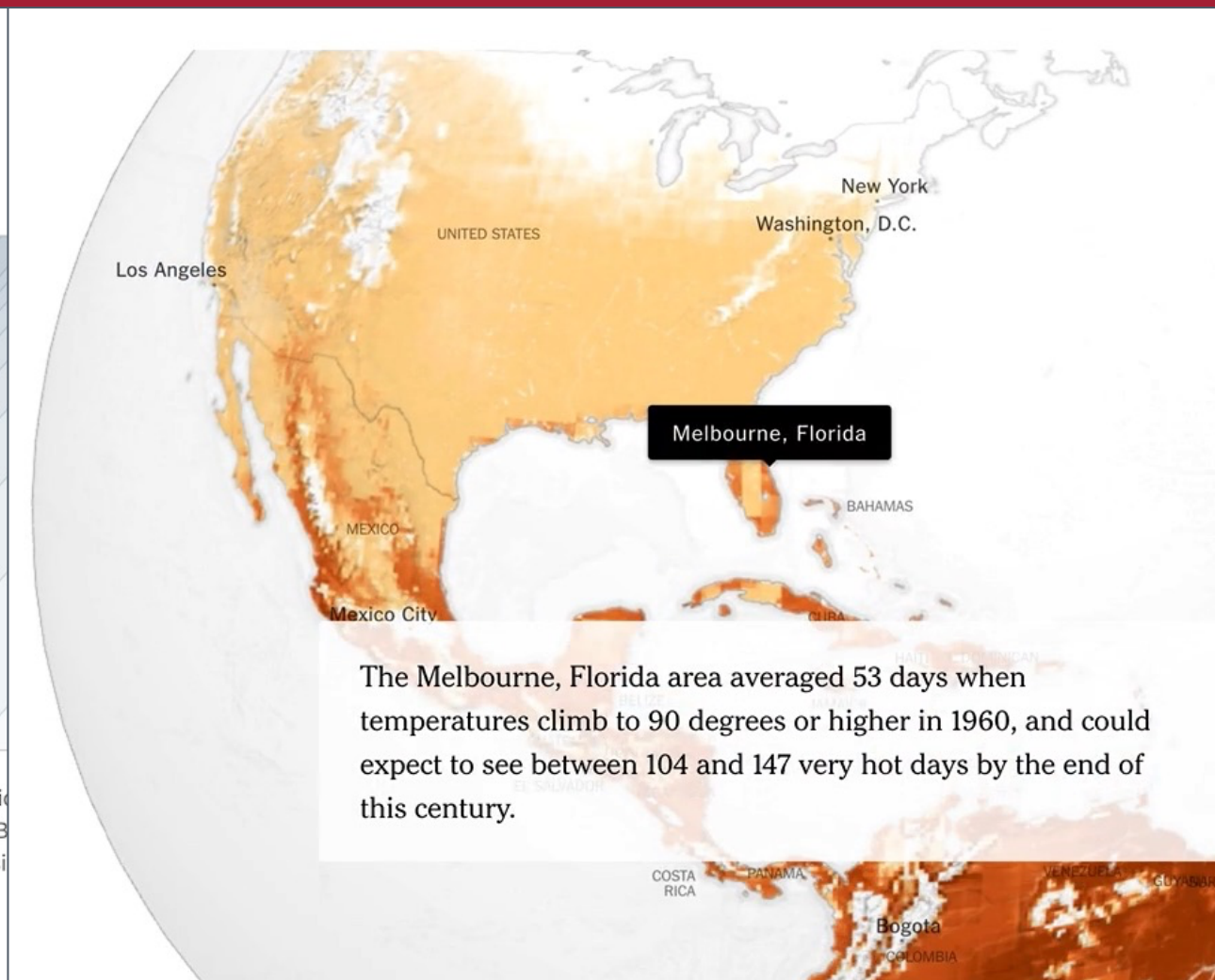
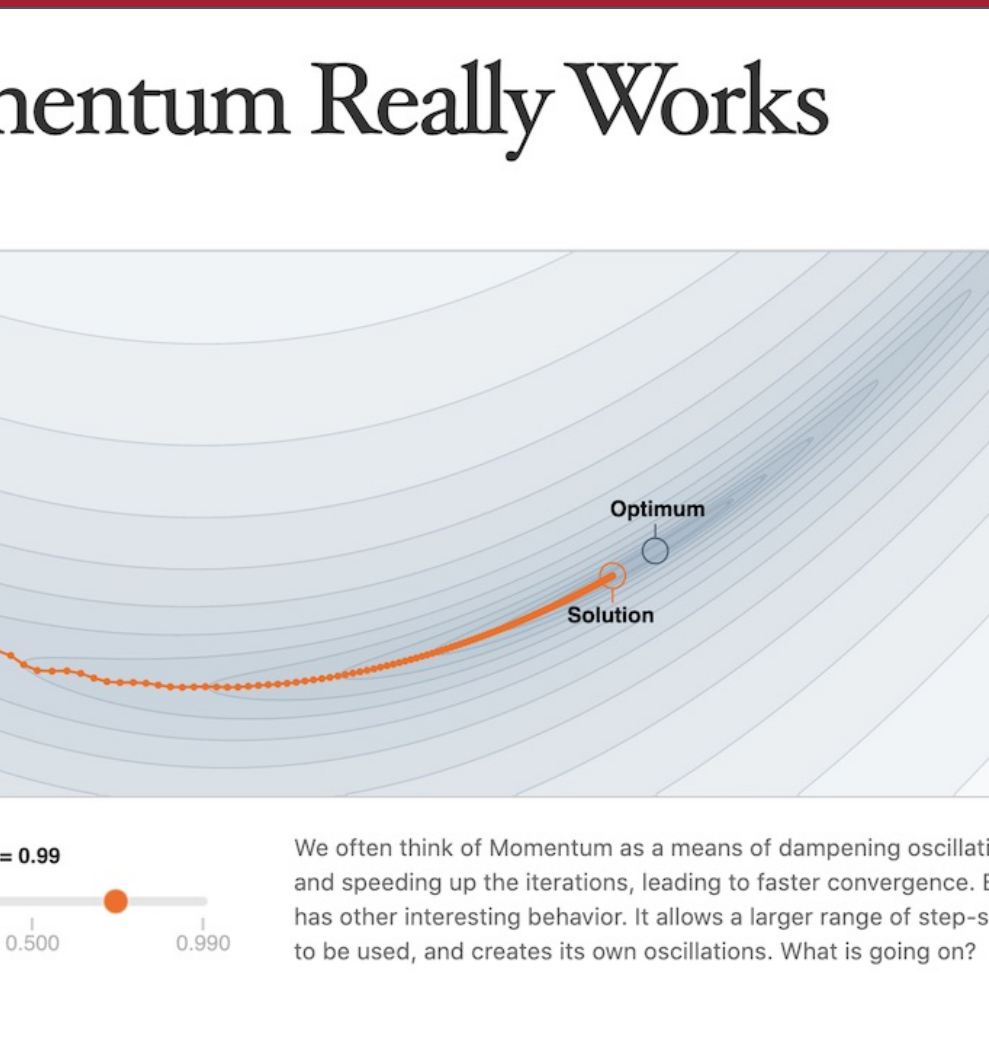


6.859: Interactive Data Visualization

Narrative Visualization

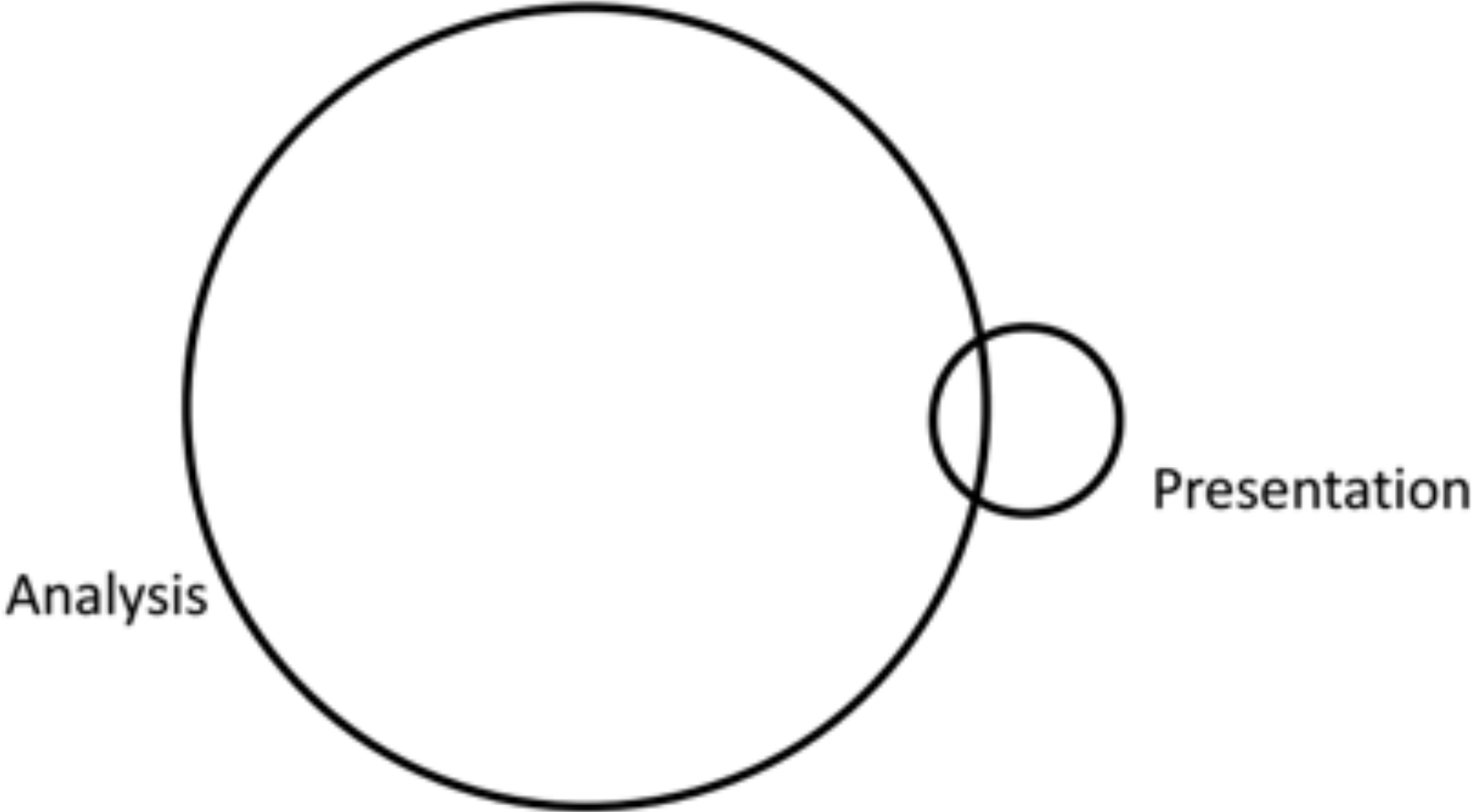
Arvind Satyanarayan



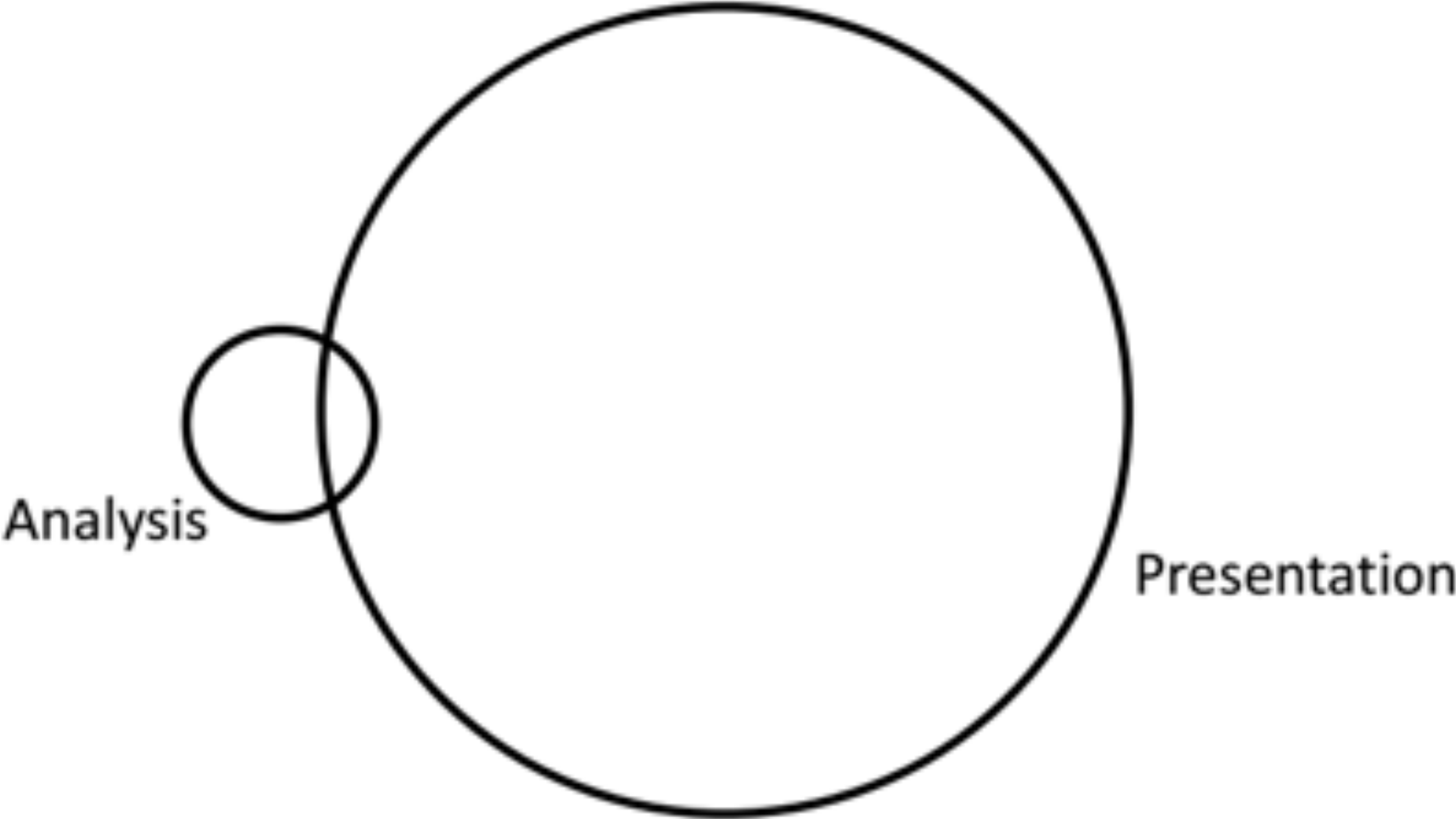
Views of the World

[John Stasko 2016]

Vis researchers



Everyone else



[Ennedi Plateau, Chad. ~2000 BCE]



Narrative Visualization

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

– Oxford English Dictionary



Narrative Visualization

"You have before you, my Lords and Gentlemen, a chart of the prices of wheat for 250 years [...] the main fact deserving of consideration is, that never at any former period was wheat so cheap, in proportion to mechanical labour, as it is at the present time" — William Playfair, 1822 letter to Parliament.

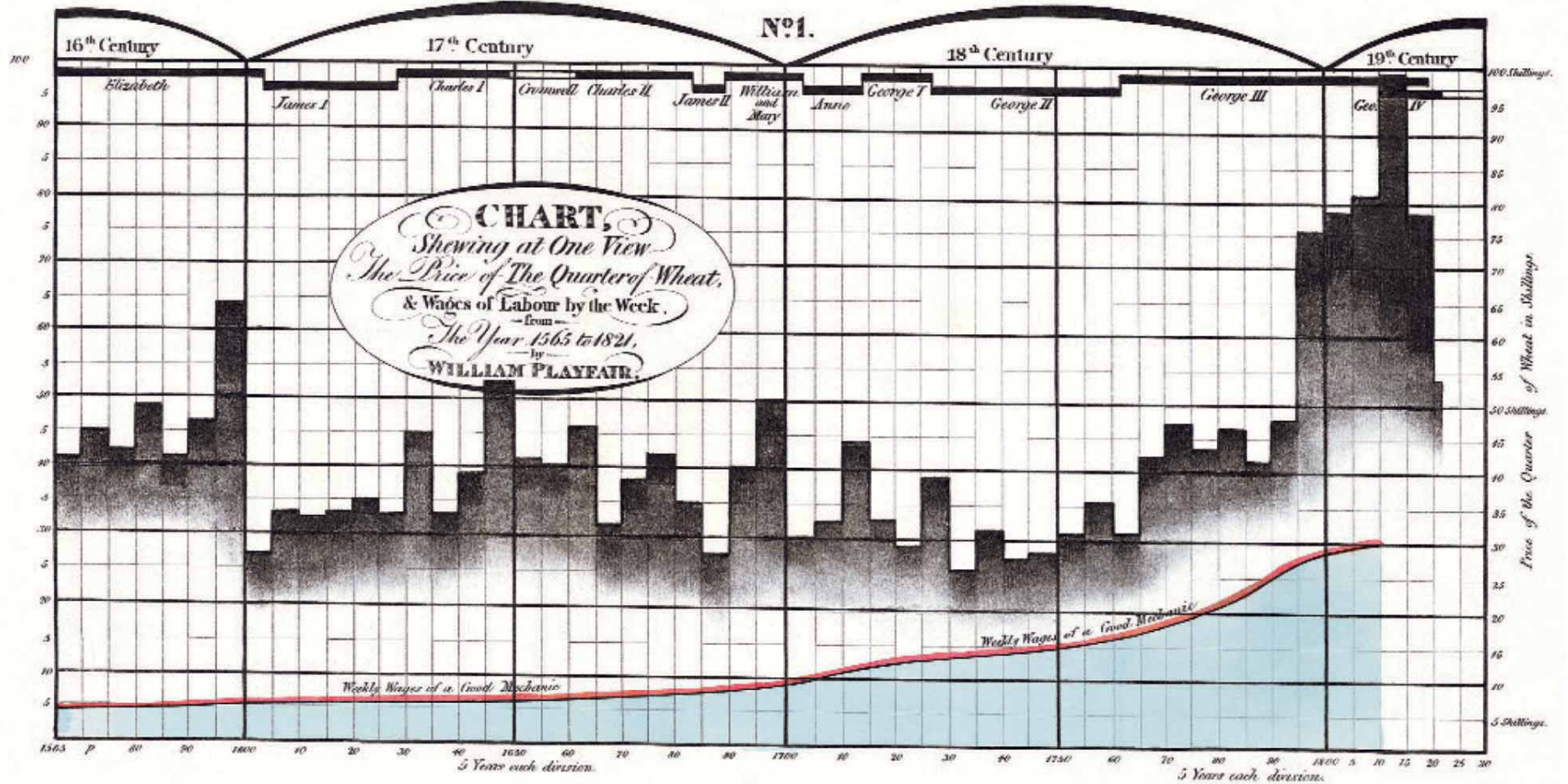
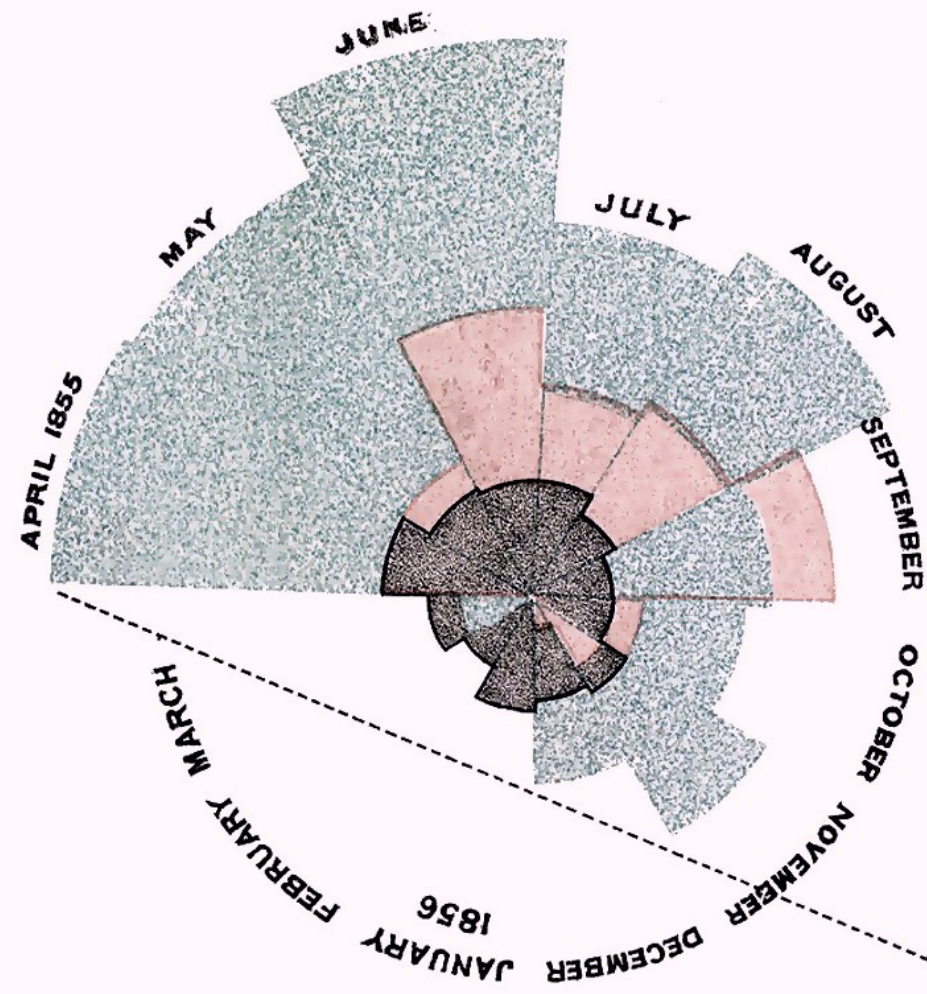
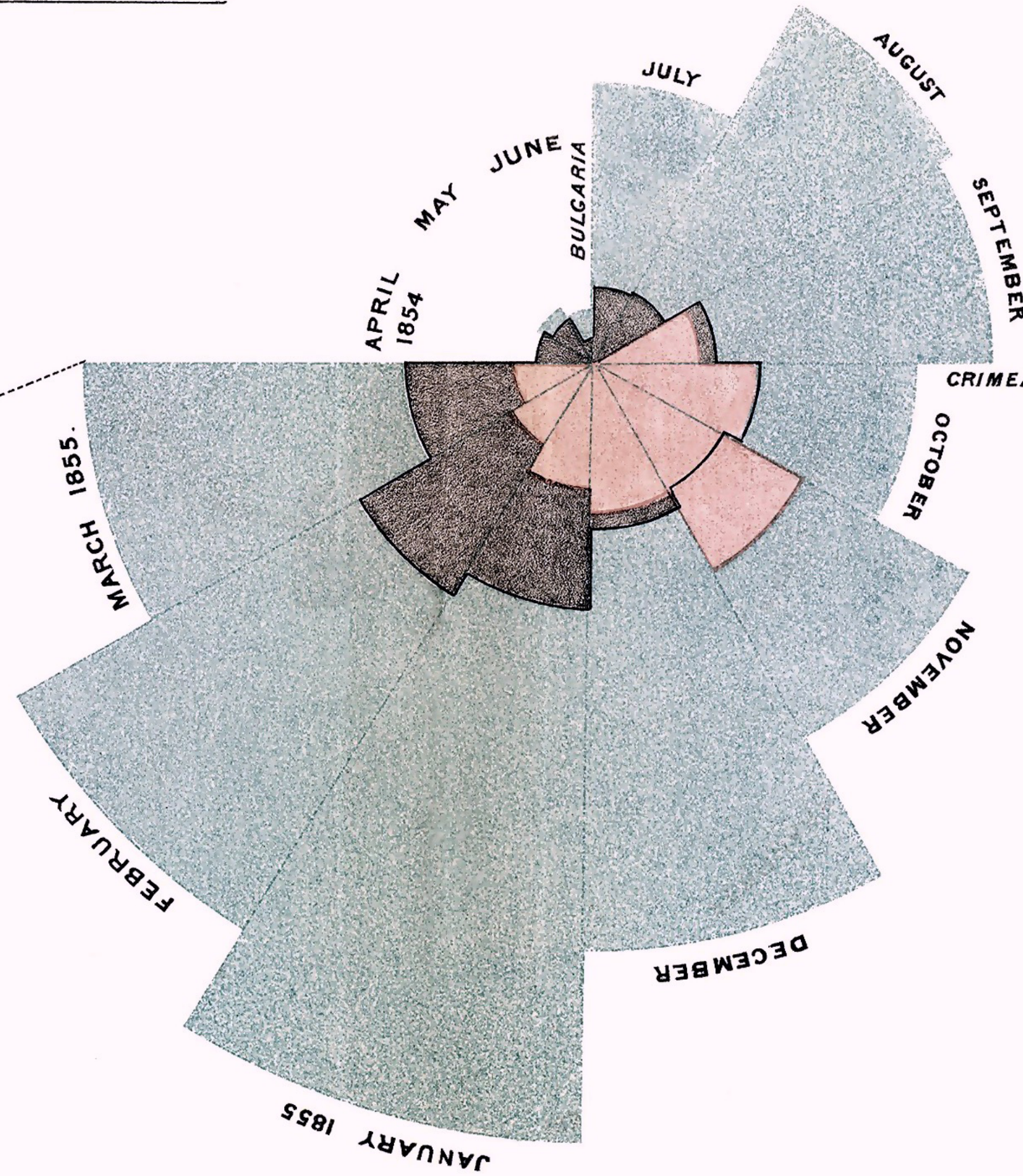


DIAGRAM OF THE CAUSES OF MORTALITY
IN THE ARMY IN THE EAST.

2.
APRIL 1855 TO MARCH 1856.



1.
APRIL 1854 TO MARCH 1855.



The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex.
The blue wedges measured from the centre of the circle represent area for area the deaths from Preventible or Mitigable Zymotic diseases; the red wedges measured from the centre the deaths from wounds; & the black wedges measured from the centre the deaths from all other causes.
The black line across the red triangle in Nov. 1854 marks the boundary of the deaths from all other causes during the month.
In October 1854, & April 1855, the black area coincides with the red; in January & February 1856, the blue coincides with the black.
The entire areas may be compared by following the blue, the red & the black lines enclosing them.

"to affect thro' the Eyes what we fail to convey to the public through their word-proof ears"

— Florence Nightingale on her "coxcomb" of Crimean War Deaths (1856).

Chart vividly depicts that the main cause of deaths was not war wounds but unsanitary conditions.

Returned to Britain and led a successful campaign for better conditions in barracks and hospitals.

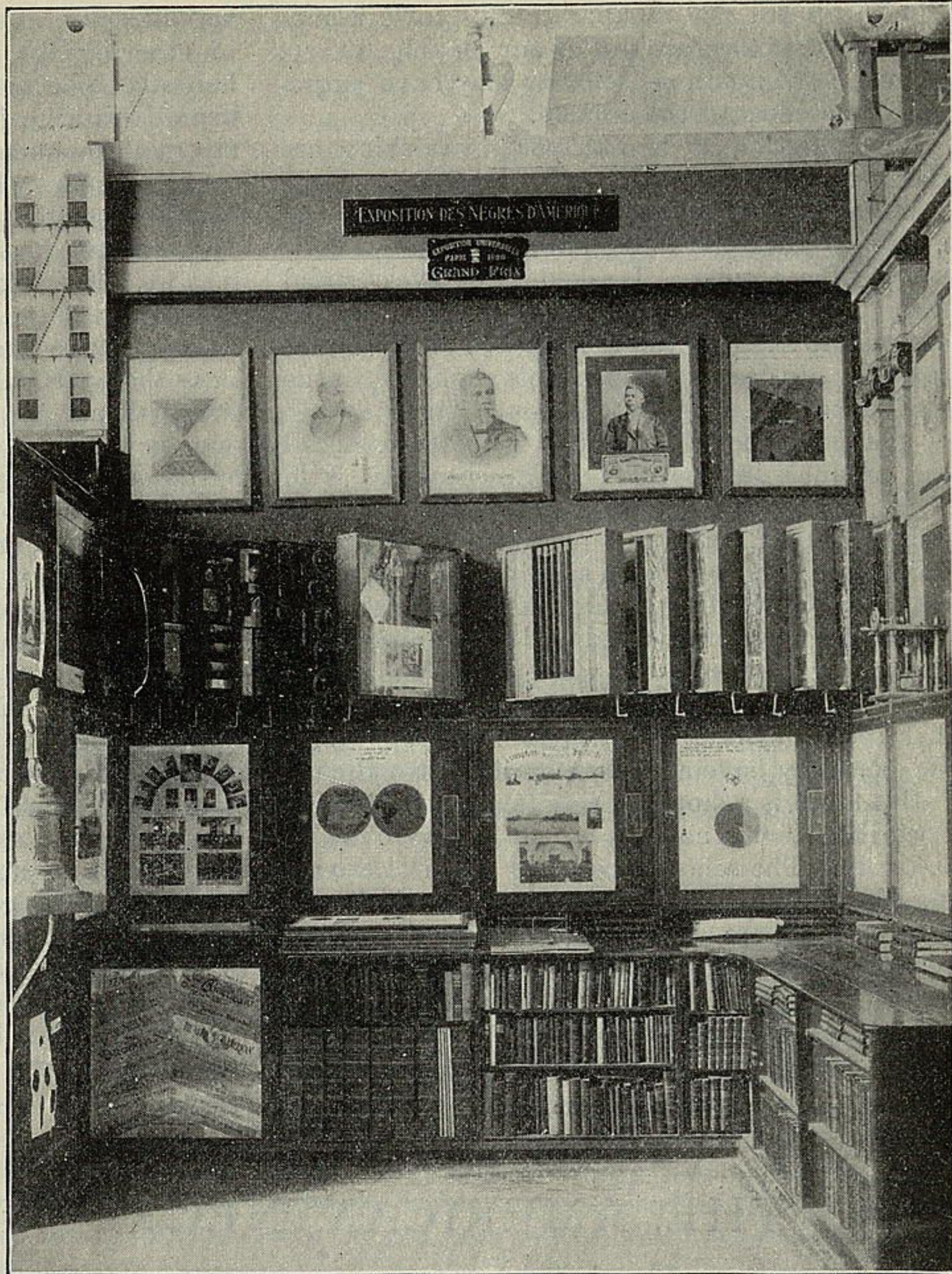


EXHIBIT OF AMERICAN NEGROES AT THE PARIS EXPOSITION.

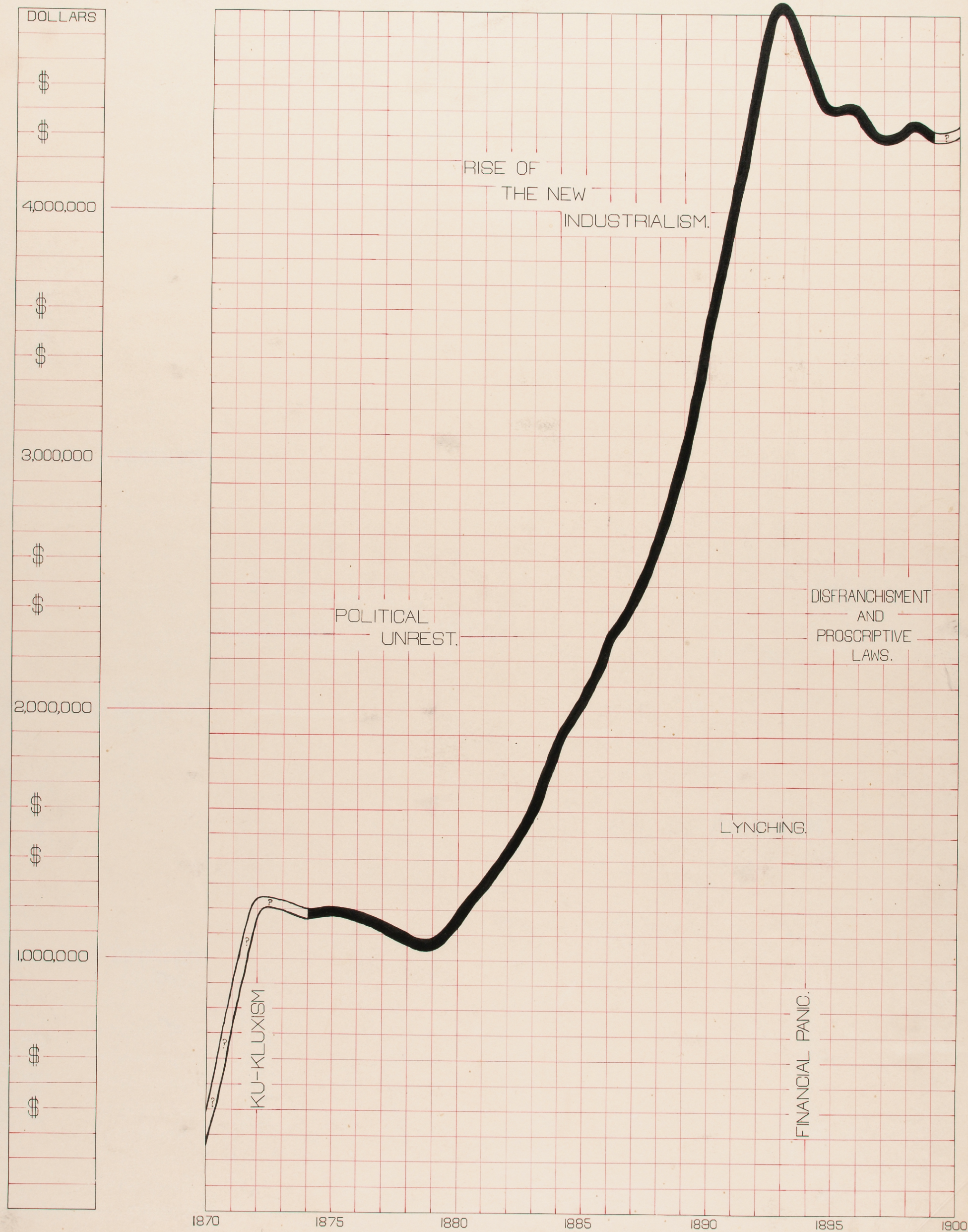
PROPORTION OF FREEMEN AND SLAVES AMONG AMERICAN NEGROES .

PROPORTION DES NÈGRES LIBRES ET DES ESCLAVES EN AMÉRIQUE .

DONE BY ATLANTA UNIVERSITY .



VALUATION OF TOWN AND CITY PROPERTY OWNED BY GEORGIA NEGROES.

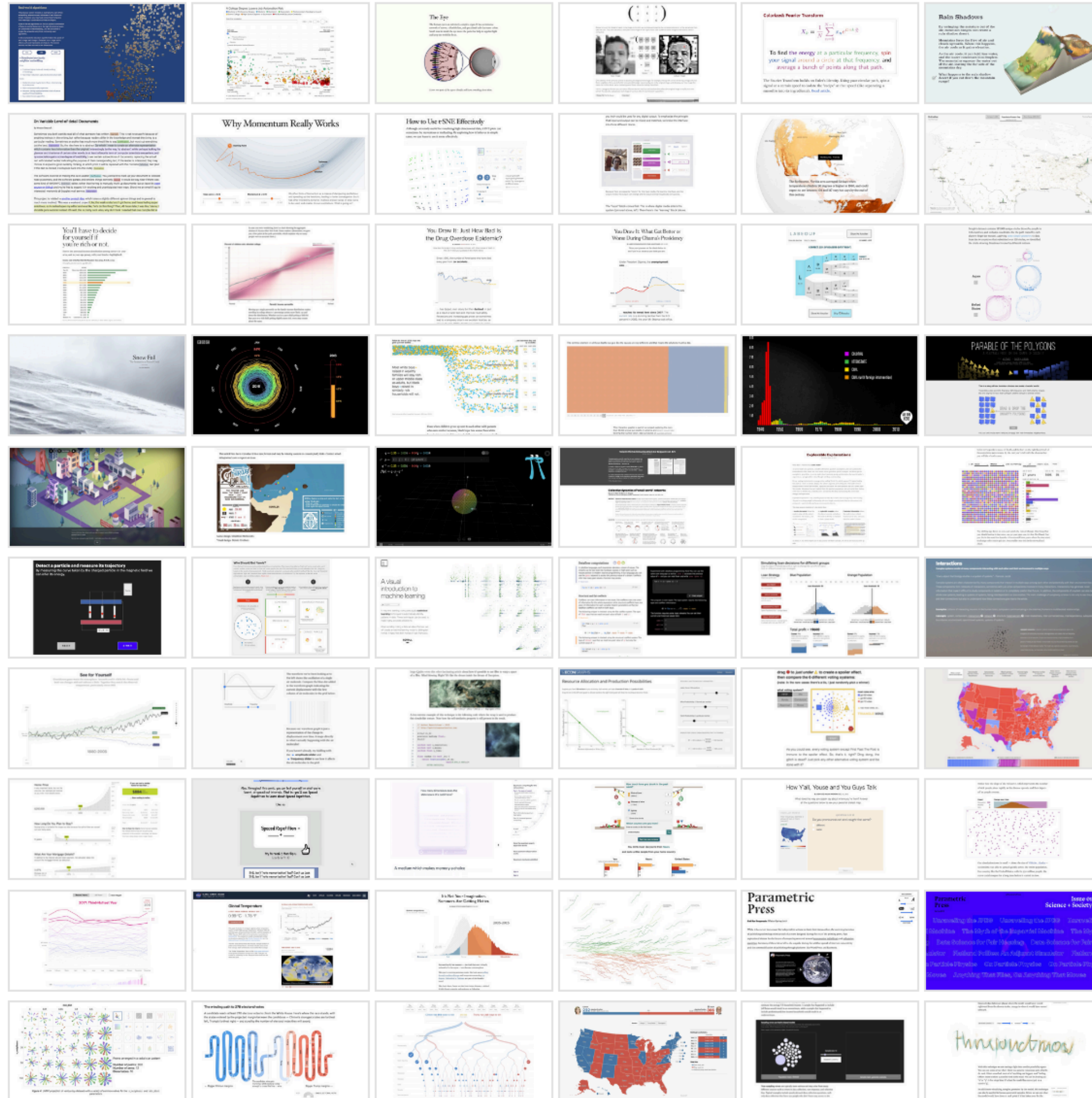


CITY AND RURAL POPULATION. 1890.



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

4 affordances of the format

Connecting people and data

Making systems playful

Promoting self reflection

Personalizing reading

(based on slides from Matt Conlen)

[Hohman, Conlen, et al., *Distill* 2020]

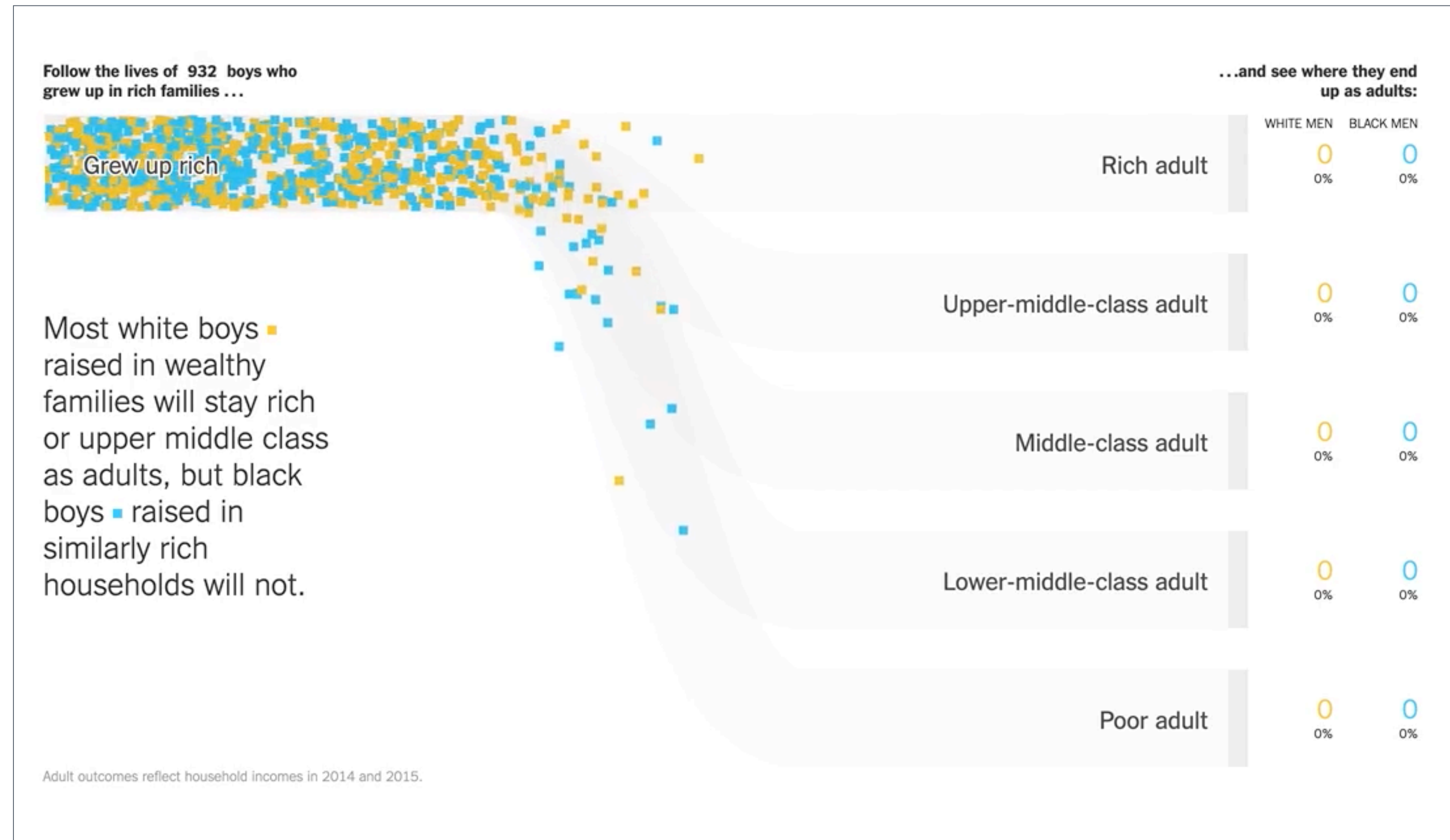
4 AFFORDANCES OF THE FORMAT

Connecting people and data

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Promoting self reflection

Personalizing reading



[Emily Badger, et al., *The New York Times* 2018]

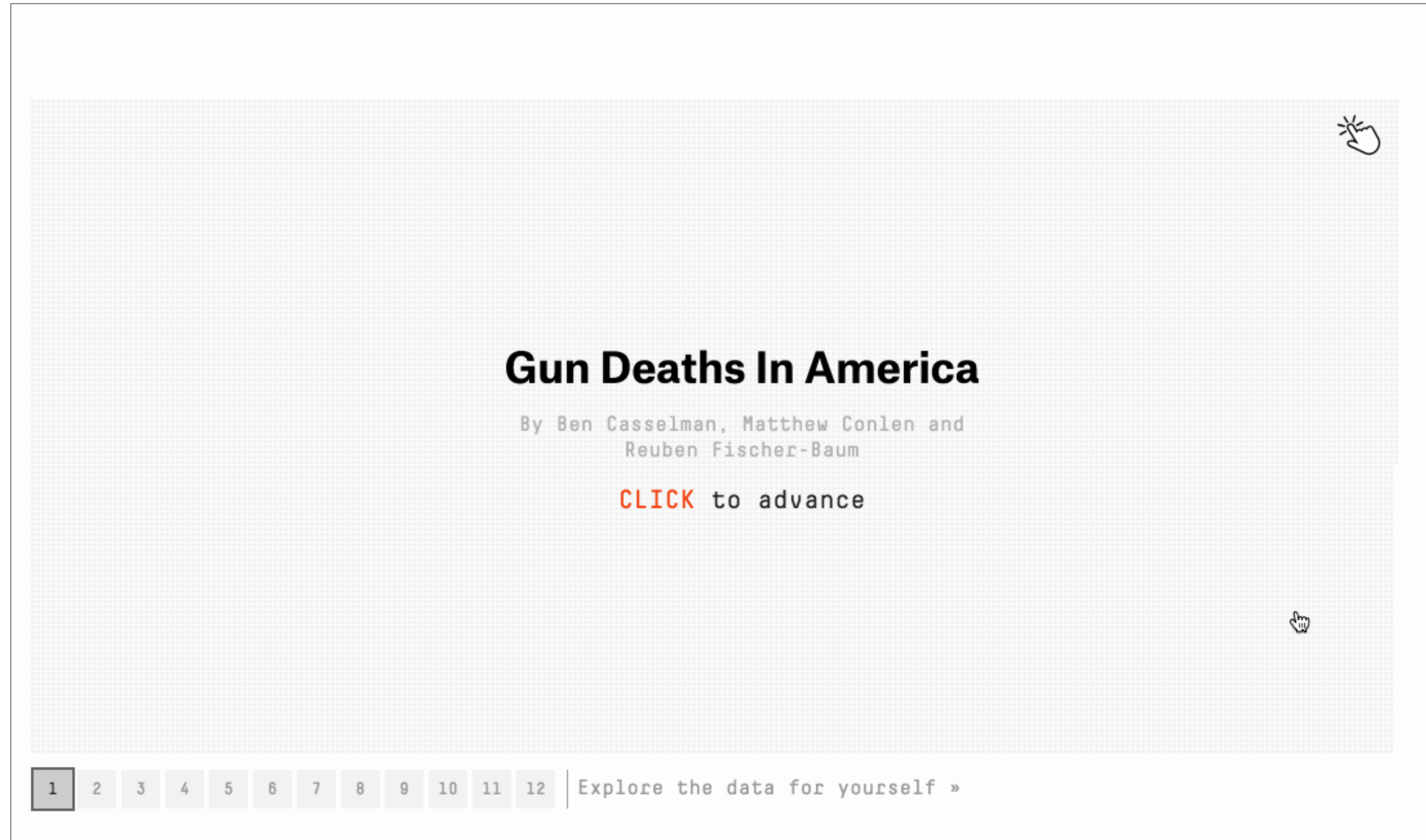
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Personalizing reading



[Ben Casselman, et al., *FiveThirtyEight* 2017]

4 AFFORDANCES OF THE FORMAT

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Personalizing reading

Tinker With a **Neural Network** Right Here in Your Browser.
Don't Worry, You Can't Break It. We Promise.

The interface is divided into several sections:

- Controls:** Includes a play button, a refresh button, and sliders for Epoch (000,000), Learning rate (0.03), Activation (Tanh), Regularization (None), Regularization rate (0), and Problem type (Classification).
- DATA:** A section for selecting a dataset, with a 'REGENERATE' button and sliders for 'Ratio of training to test data: 50%', 'Noise: 0', and 'Batch size: 10'.
- FEATURES:** A list of input features including X_1 , X_2 , X_1^2 , X_2^2 , $X_1 X_2$, $\sin(X_1)$, and $\sin(X_2)$.
- HIDDEN LAYERS:** A diagram showing 4 neurons in the first hidden layer and 2 neurons in the second hidden layer. Lines of varying thickness connect neurons between layers, representing weights. A tooltip states: 'The outputs are mixed with varying weights, shown by the thickness of the lines.' Another tooltip points to a neuron: 'This is the output from one neuron. Hover to see it larger.'
- OUTPUT:** A scatter plot showing data points (orange and blue) and a decision boundary. It displays 'Test loss 0.525' and 'Training loss 0.517'. A color scale legend indicates 'Colors shows data, neuron and weight values' ranging from -1 (orange) to 1 (blue). There are checkboxes for 'Show test data' and 'Discretize output'.

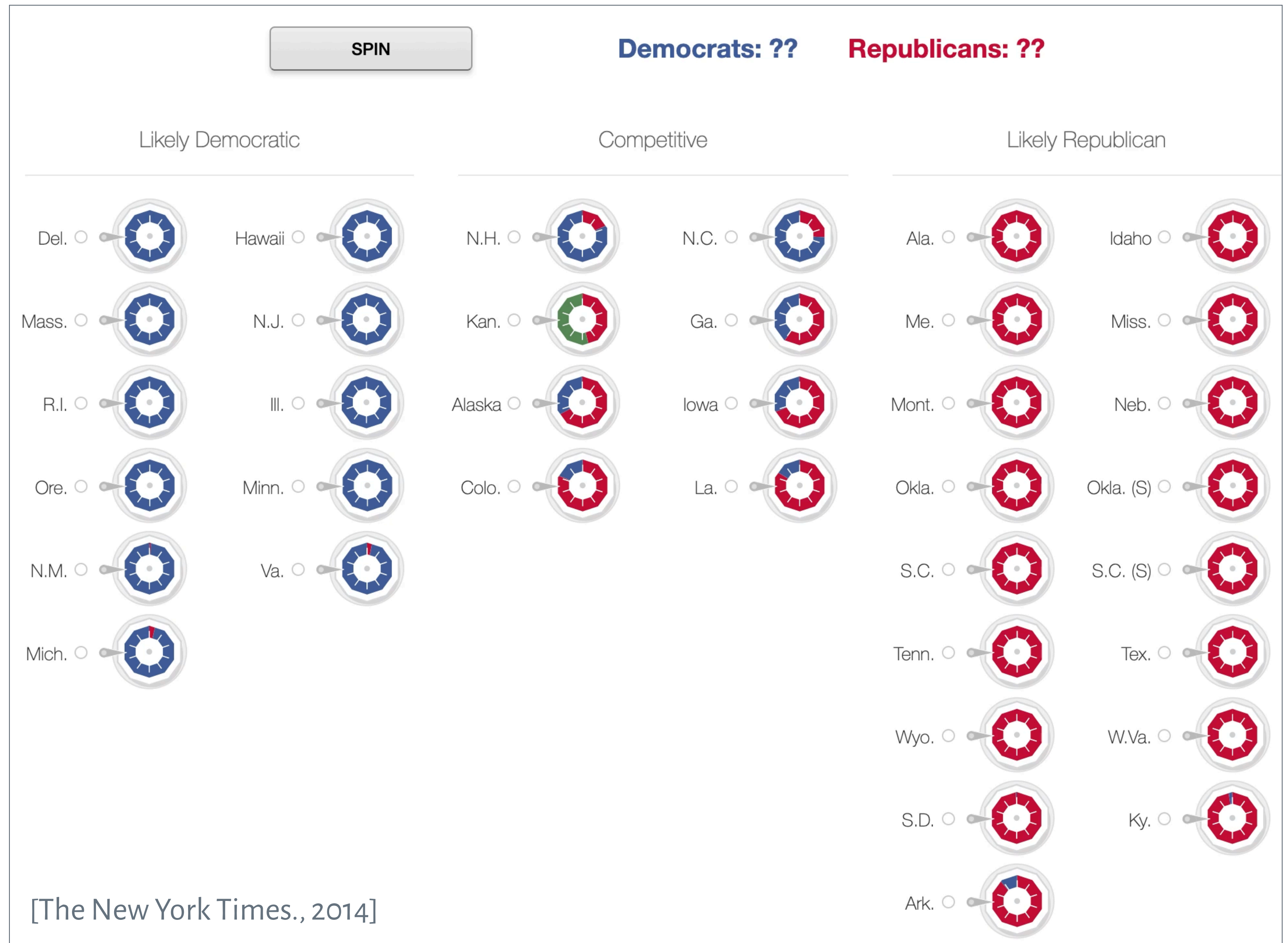
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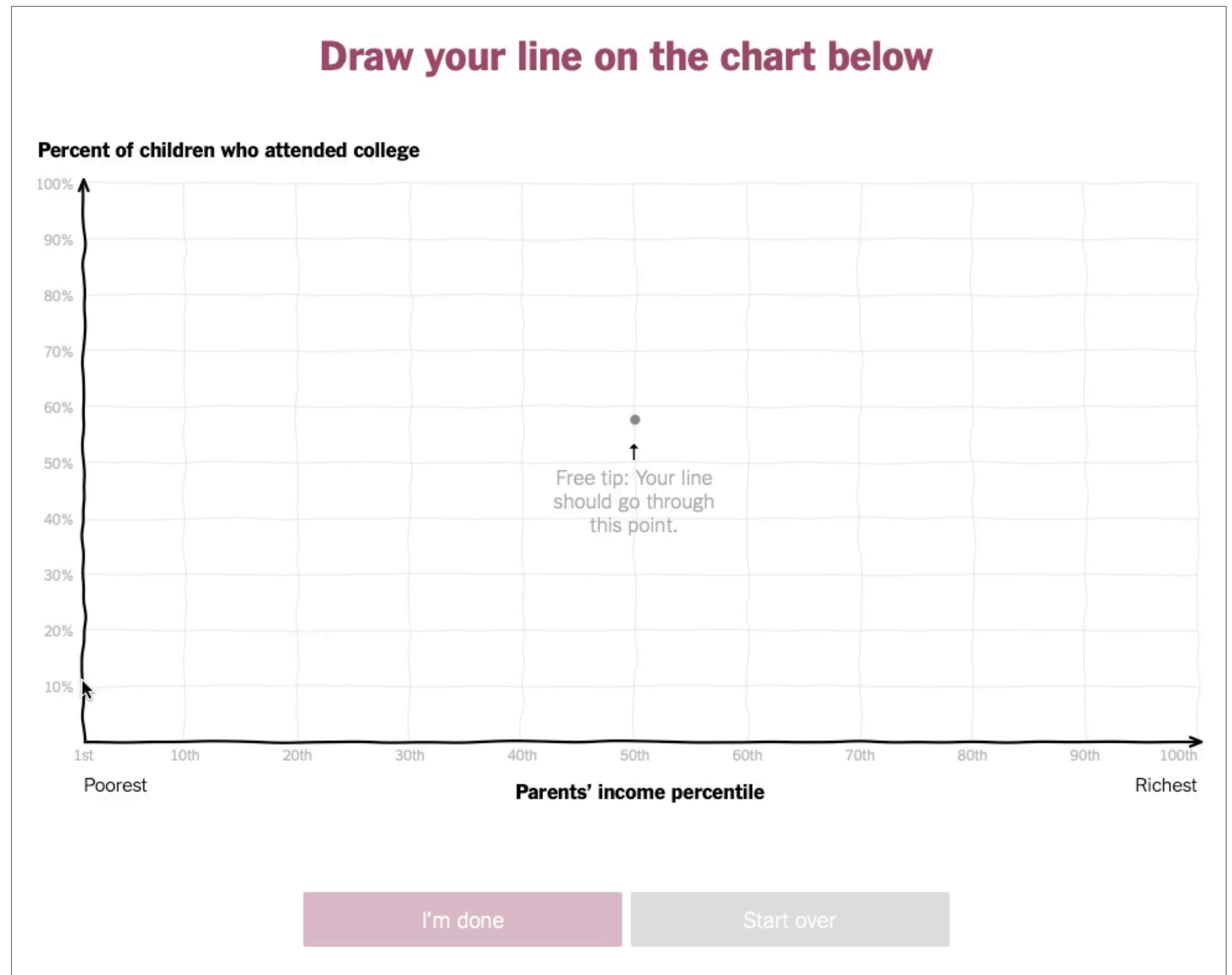
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[Gregor Aisch, Amanda Cox, and Kevin Quealy., *The New York Times*, 2015]

4 AFFORDANCES OF THE FORMAT

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The screenshot shows a game interface. At the top, there is a photo of Zooey Deschanel with the label 'ACTRESS' below it. Below the photo is a text input field containing 'ZOOEY' followed by a series of underscores and a speaker icon. Underneath this field is the text 'Phonetic Spelling'. In the center, there is a large blue-bordered input field containing the letter 'D' followed by a vertical line. To the right of this field is a button labeled 'I Think I've Got It'. Below the 'D' field are two links: 'Show Me Another' and 'Skip To Results'. To the right of the 'I Think I've Got It' button is the text '12 NAMES LEFT'. On the left side of the screen, there is a vertical blue bar with the letter 'D' and the text 'YOUR PATH' next to it. At the bottom of the screen, there are two buttons: 'Show Me Another' and 'Skip To Results'.

[Russell Goldenberg & Matt Daniels., *The Pudding*, 2019]

4 AFFORDANCES OF THE FORMAT

Connecting people and data

Making systems playful

Promoting self reflection

Personalizing reading

The screenshot shows a web page from The New York Times. At the top left is a 'Home' link with a small icon. In the center is the 'The New York Times' logo, and to its right is the word 'CLIMATE'. At the top right is a 'Share' button with a right-pointing arrow icon. The main headline is 'How Much Hotter Is Your Hometown Than When You Were Born?' in a large, bold, serif font. Below the headline is a short introductory paragraph: 'As the world warms because of human-induced climate change, most of us can expect to see more days when temperatures hit 90 degrees Fahrenheit (32 degrees Celsius) or higher. See how your hometown has changed so far and how much hotter it may get.' At the bottom of the page, there is a dark grey bar containing two white input fields. The first field is labeled 'Your hometown' and the second is labeled 'Birth year' with a small downward arrow icon. Below these fields, the text 'Please enter your information to continue.' is displayed in a light grey font. In the bottom right corner of the dark grey bar, the number '350' is visible.

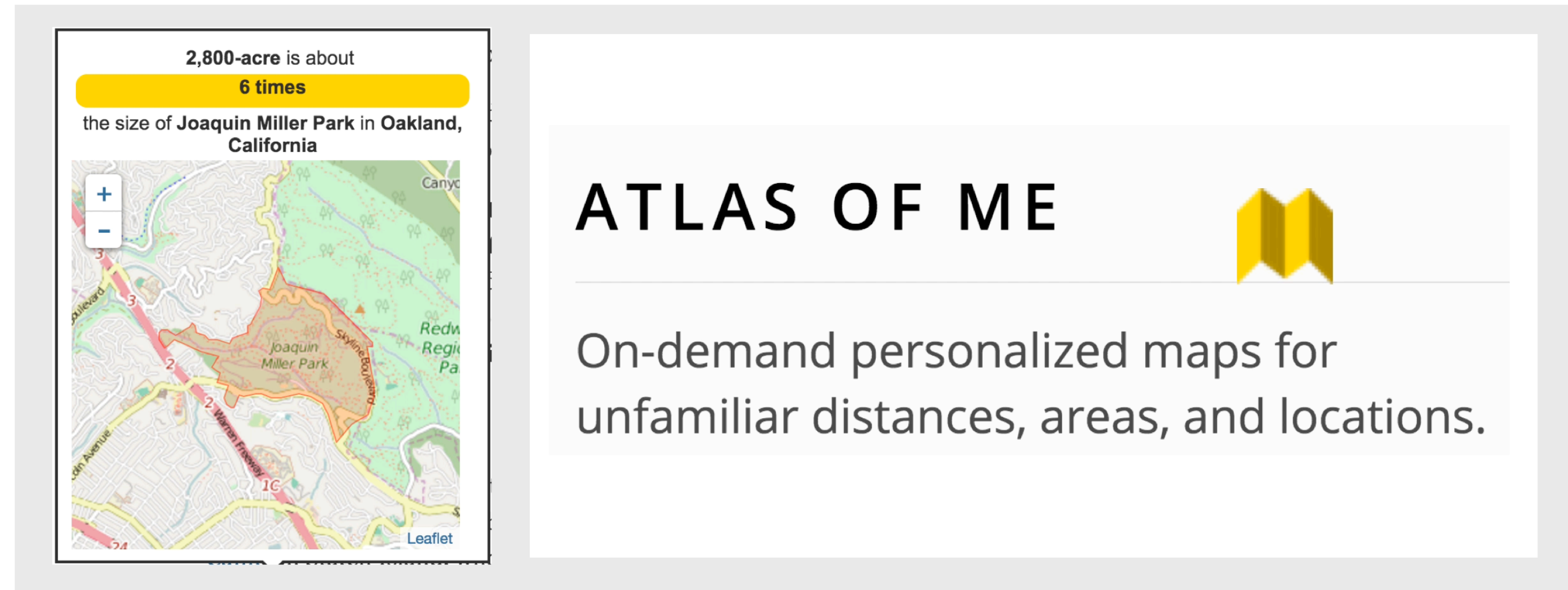
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Personalizing reading



2,800-acre is about
6 times
the size of Joaquin Miller Park in Oakland,
California

ATLAS OF ME

On-demand personalized maps for
unfamiliar distances, areas, and locations.

Created by Yea-Seul Kim, Francis Nguyen, and Jessica Hullman, University of Washington

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

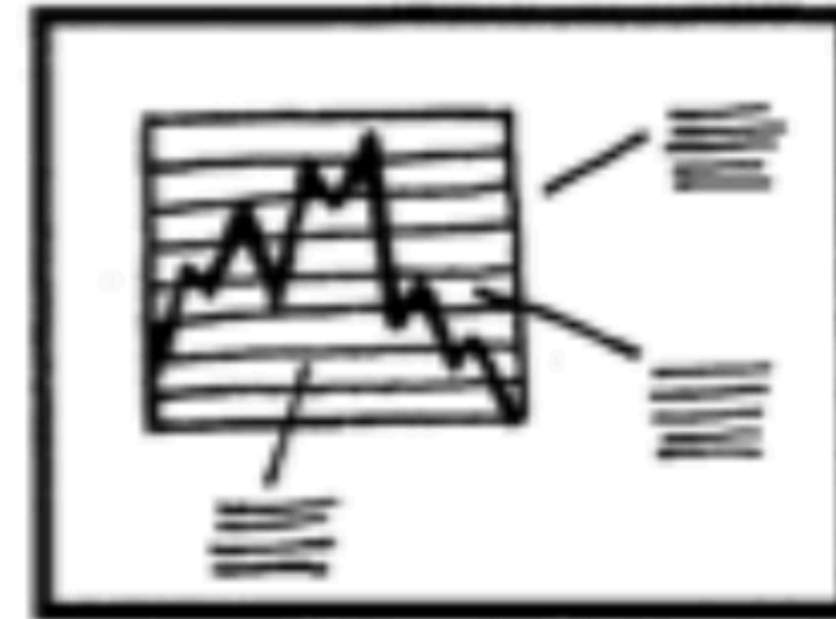
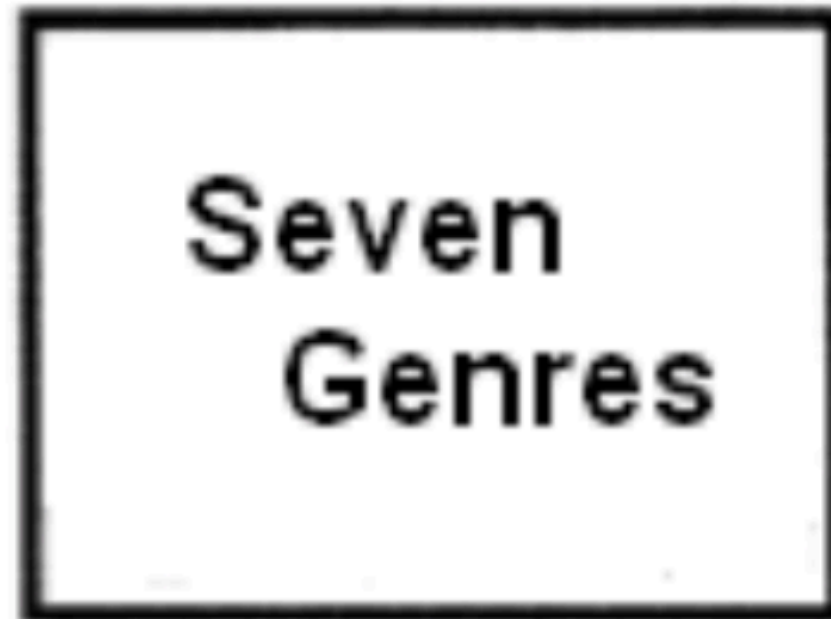
– Oxford English Dictionary



Narrative Visualization

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

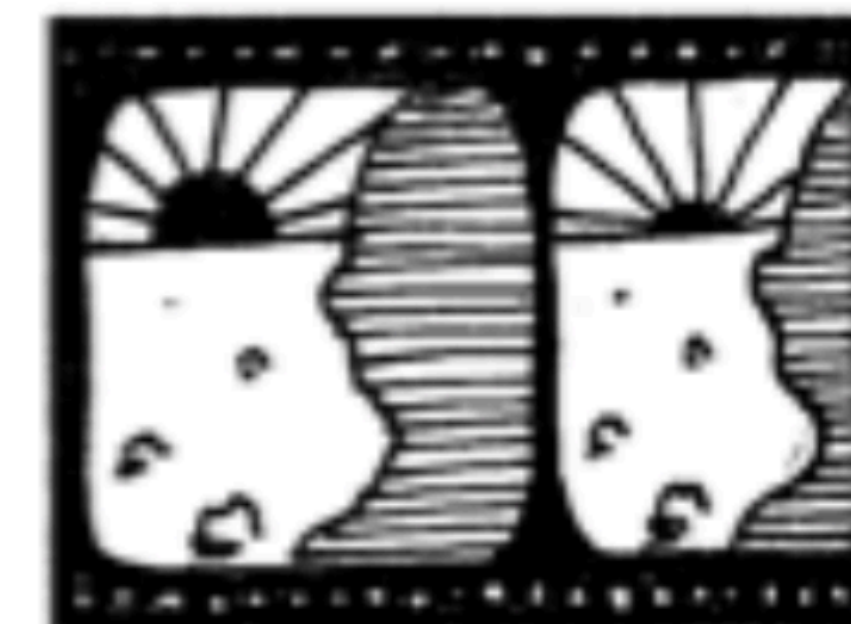
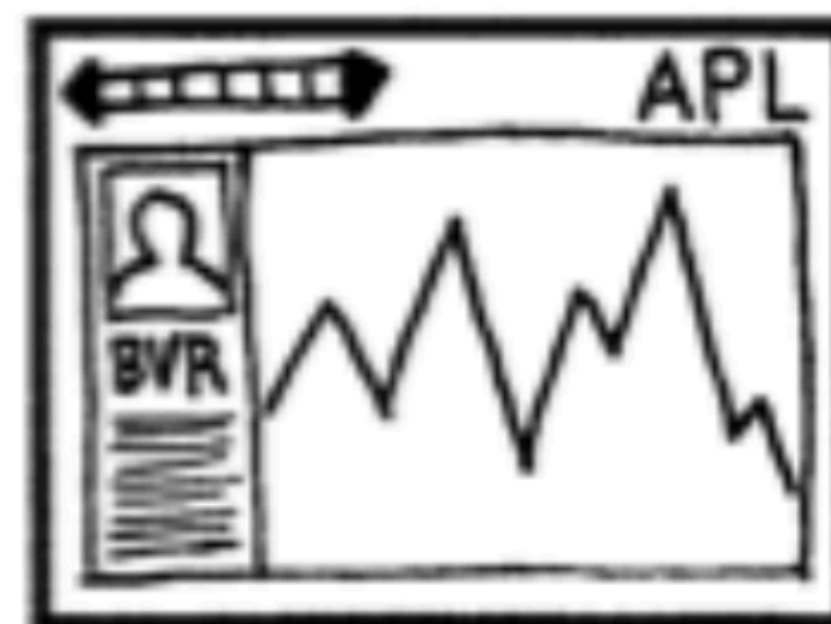
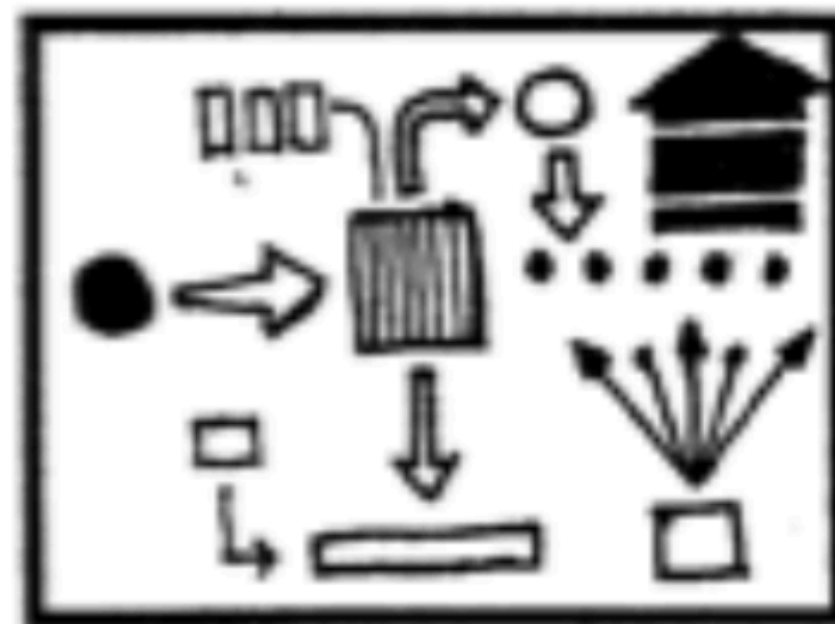
Narrative Visualization Genres



Magazine Style

Annotated Chart

Partitioned Poster



Flow Chart

Comic Strip

Slide Show

Film/Video/Animation

[Segel & Heer, *InfoVis 2010*]

Genres



Magazine Style

www.economist.com/finance-and-

The Economist Topics Current edition More Subscribe Welcome Search

even more sharply in Germany than in Italy, which is in recession, note economists at Goldman Sachs, a bank. Yet Germany's service sector appears to be growing strongly, as does that of the euro zone as a whole.

Production lines

Purchasing managers' indices*

The figure consists of two line charts. The top chart is titled 'Manufacturing' and the bottom chart is titled 'Services'. Both charts show the Purchasing Managers' Index (PMI) from 2017 to 2019. The y-axis ranges from 45 to 60. The x-axis shows the years 2017, 18, and 19. Three lines are plotted in each chart: Euro area (blue), United States (orange), and China (red). In the Manufacturing chart, the Euro area starts at approximately 58 in 2017 and declines to about 46 by early 2019. The United States starts at about 52 and remains relatively stable around 50-52. China starts at about 48 and remains stable around 48-49. In the Services chart, the Euro area starts at about 55 and declines to about 48 by early 2019. The United States starts at about 50 and remains stable around 50-52. China starts at about 48 and remains stable around 48-49.

Year	Manufacturing Euro area	Manufacturing United States	Manufacturing China	Services Euro area	Services United States	Services China
2017	58	52	48	55	50	48
2018	52	52	48	52	52	48
2019	46	50	48	48	50	48

Sources: IHS Markit; Caixin *Based on surveys of executives. A reading above/below 50 indicates an expansion/contraction compared with the previous month

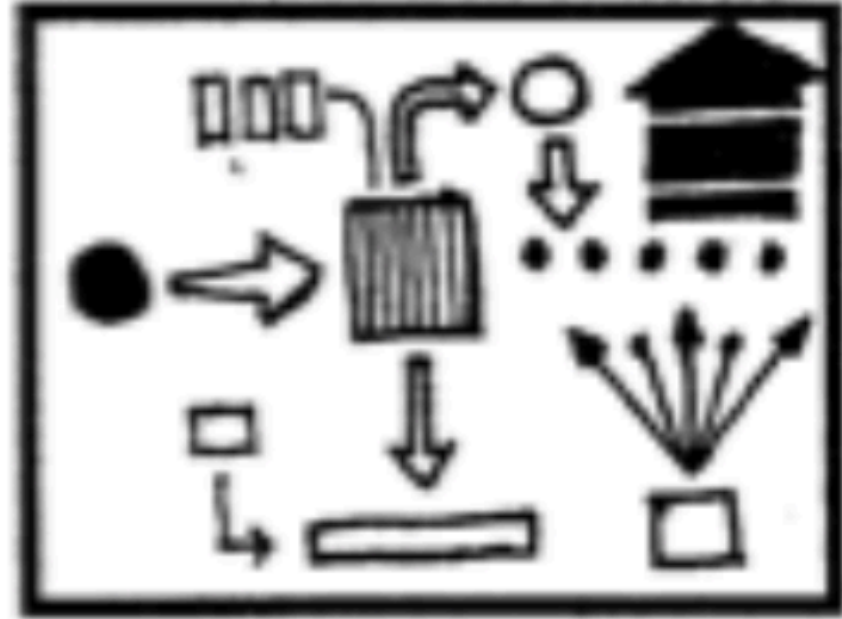
The Economist

Service industries are less volatile than manufacturing, make up a bigger slice of rich-world GDP and, by their nature, trade less. That they remain strong largely reflects relatively buoyant labour markets and consumers (German unemployment is only 3.1%). One exception has been Britain, where survey data released on April 1st and 3rd appear to show growth in manufacturing at its strongest in over a year and services shrinking. Both findings are Brexit-related. The British economy is suffering from falling confidence, while manufacturing appears so strong only because firms are stockpiling in case Britain soon crashes out of the EU without a deal.

In the 2000s some economists speculated that the growing weight of

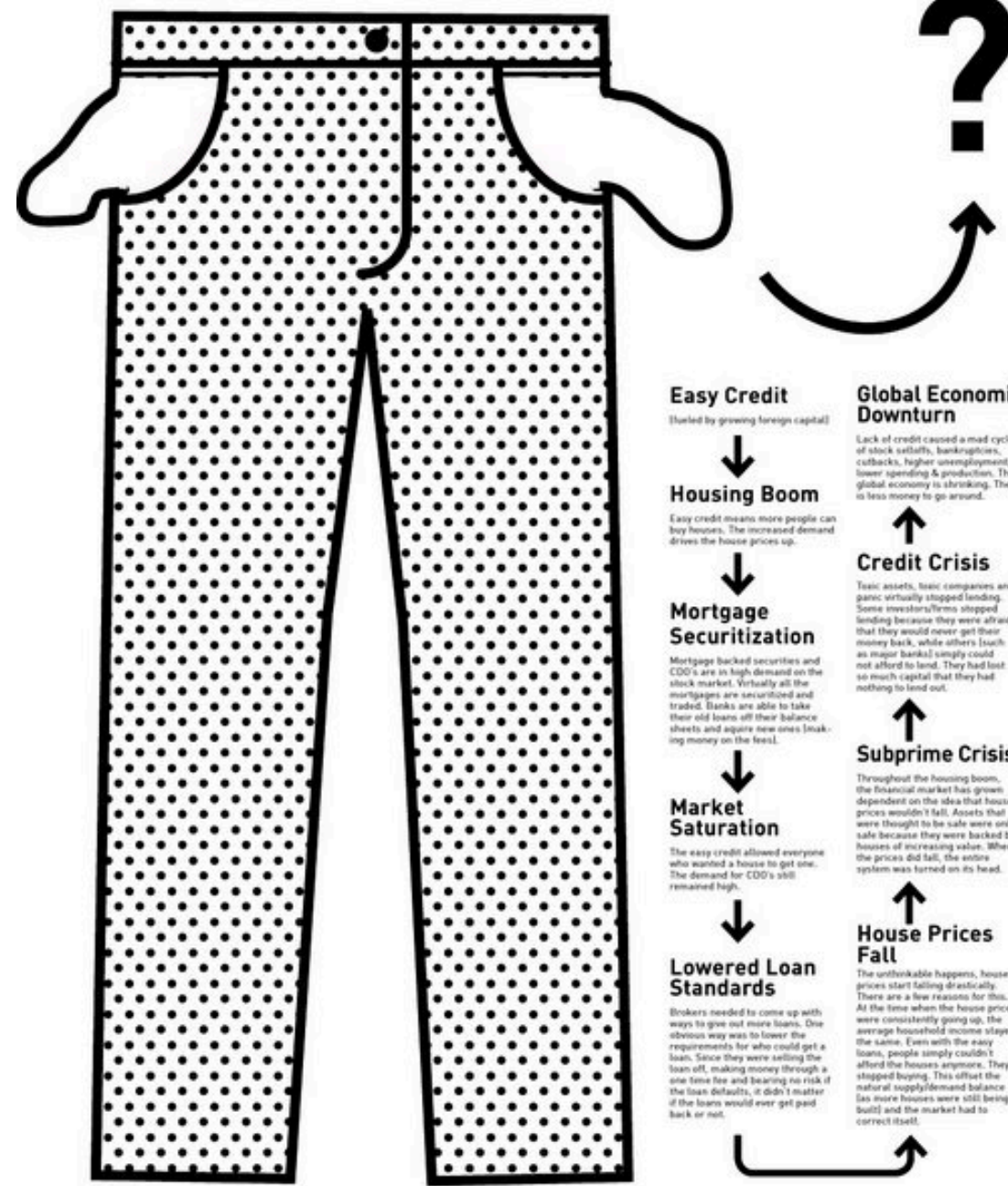
Display a menu

Genres



Flow Chart

WHERE DID ALL THE MONEY GO?



Easy Credit

Started by growing foreign capital

Housing Boom

Easy credit means more people can buy houses. The increased demand drives the house prices up.

Mortgage Securitization

Mortgage backed securities and CDOs are in high demand on the stock market. Virtually all the mortgages are securitized and traded. Banks are able to take their risk and move off their balance sheets and acquire new ones lending money on the loan.

Market Saturation

The easy credit allowed everyone who wanted a house to get one. The demand for CDO's still remained high.

Lowered Loan Standards

Borrowers needed to come up with ways to get out more loans. One obvious way was to lower the requirements for who could get a loan. Since they were selling the loan off, making money through a one time fee and bearing no risk of the loan default, it didn't matter if the loans would ever get paid back or not.

Global Economic Downturn

Lack of credit caused a mad cycle of stock selloffs, bankruptcies, cutbacks, higher unemployment, lower spending & production. The global economy is shrinking. There is less money to go around.

Credit Crisis

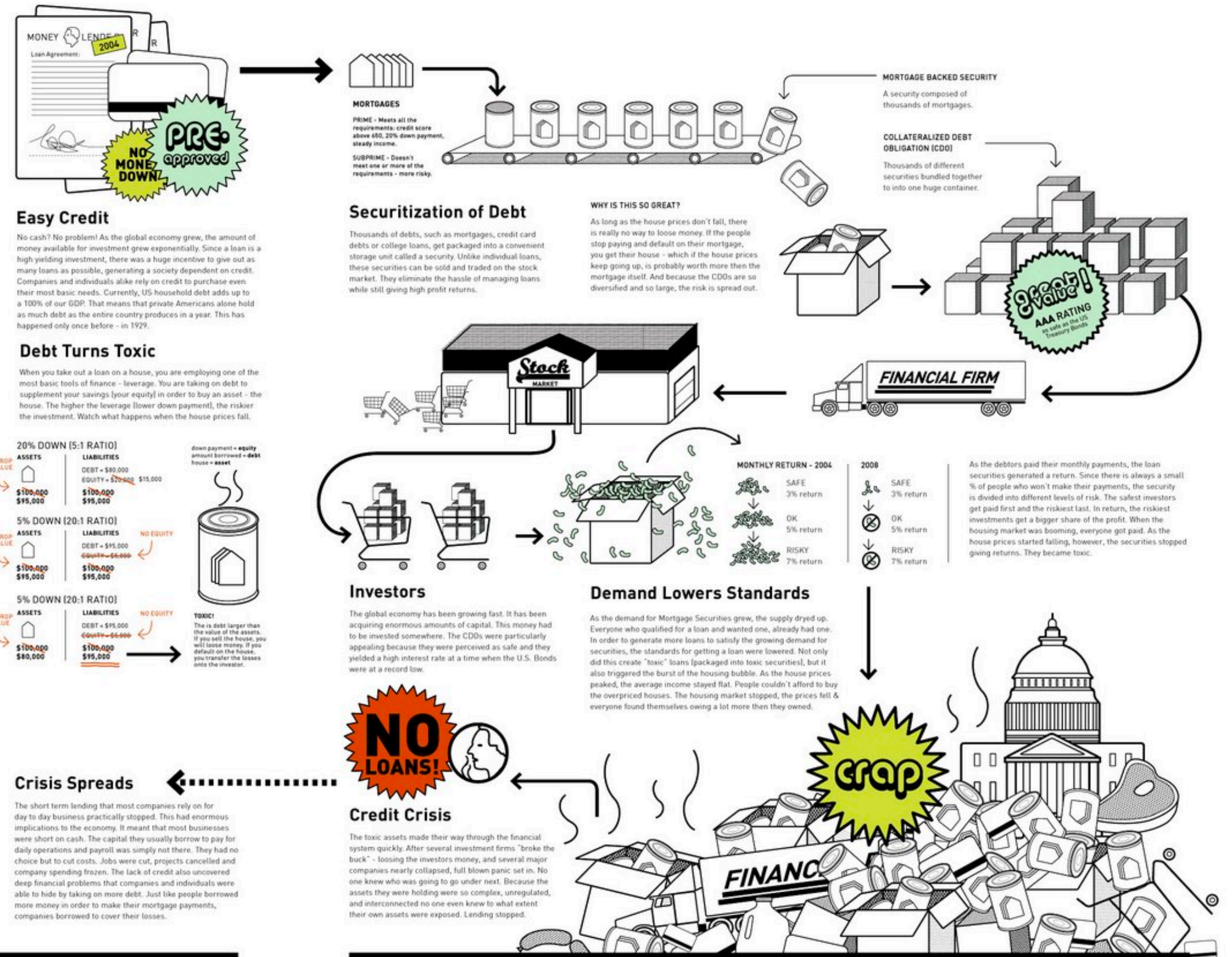
Basic assets, basic companies and basic, virtually stopped lending. Some investors/banks stopped lending because they were afraid that they would never get their money back, while others found an easier banked strategy could not afford to lend. They had lost so much capital that they had nothing to lend out.

Subprime Crisis

Throughout the housing boom, the financial market had grown dependent on the idea that house prices would rise. Assets that were thought to be safe were only safe because they were backed by houses of increasing value. When the prices did fall, the entire system was forced on its head.

House Prices Fall

The unthinkable happens, house prices start falling drastically. There are a few reasons for this. At the time when the house prices were consistently going up, the average household income stayed the same. Even with the easy loans, people simply couldn't afford the houses anymore. They stopped buying. The value of the natural supply/demand balance (as more houses were sold being built) and the market had to correct itself.



What is money?

Money can be anything. Rare & valuable resources have been used historically because they are easy to control, but anything that people collectively agree on can be used as money. There are four general functions money fulfills: medium of exchange, unit of account, store of value & standard of deferred payment. Money needs to have a perceived value. This is an overview of the different forms of money and where their value comes from.

Barter

In a barter, no money is used. People trade goods or services directly.

no money

Commodity Money

The value comes from the commodity it is made out of (gold, silver, diamonds). In other words, a \$1 coin made out of silver would have \$1's worth of silver in it.

money = commodity

Representative Money

Token money that stands in direct and fixed relation to the commodity which backs it, while not itself made of it. (eg. early paper money which originated as receipt for gold deposits).

money = tokens backed by a commodity

Credit Money

When you take out a loan, you agree to pay it back. In return the bank transfers money to your account. This money is not directly backed by a commodity. It is created when you take out the loan and is backed by your promise to pay it back.

money = promise to repay

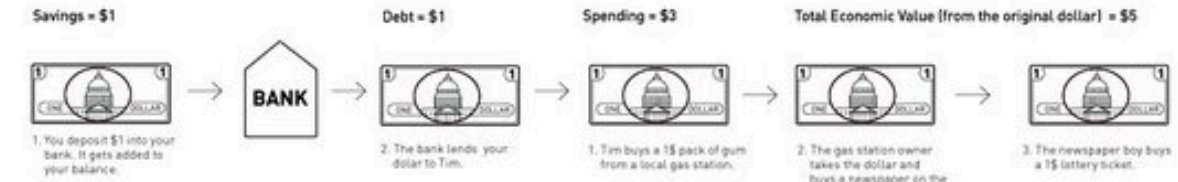
Fiat Money

Money which is not backed by a commodity, but by a government law declaring it to be legal tender (currency that must be accepted as payment). It is usually printed by the country's national bank (a private institution).

money = paper given value by law

Money Supply

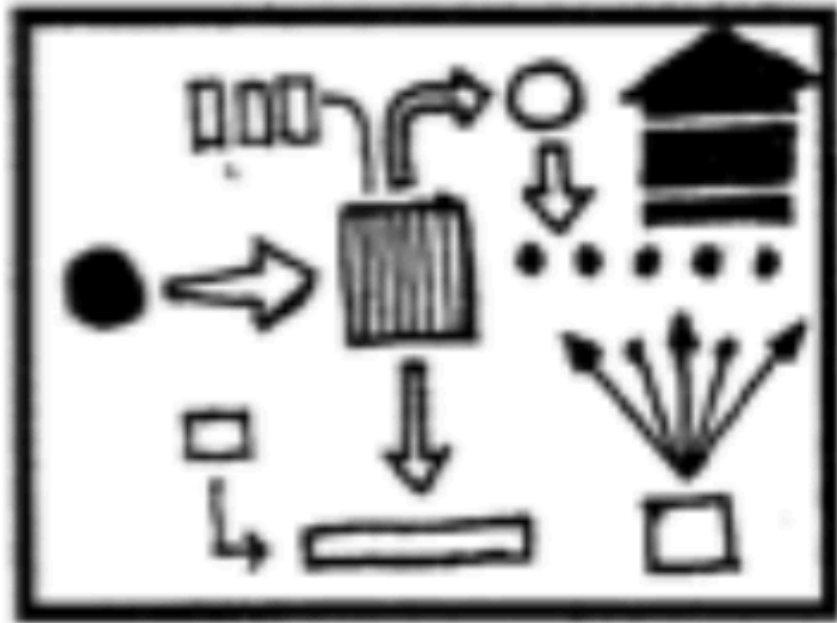
The Money Supply is the amount of available money in the economy. It fluctuates with the market. In times of economic growth, the money supply is high. In a recession, the money supply is low. Lending and spending are two major factors that influence the money supply.



Velocity of Money

As a \$1 bill circulates throughout the day, it multiplies its value in the economy. Every time it changes hands, it creates another \$1 in economic activity. In a recession, when lending & spending is lower, there is actually less money in the economy. While no cash disappears, the velocity of the dollar goes down.

Genres



Flow Chart



Partitioned Poster

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.

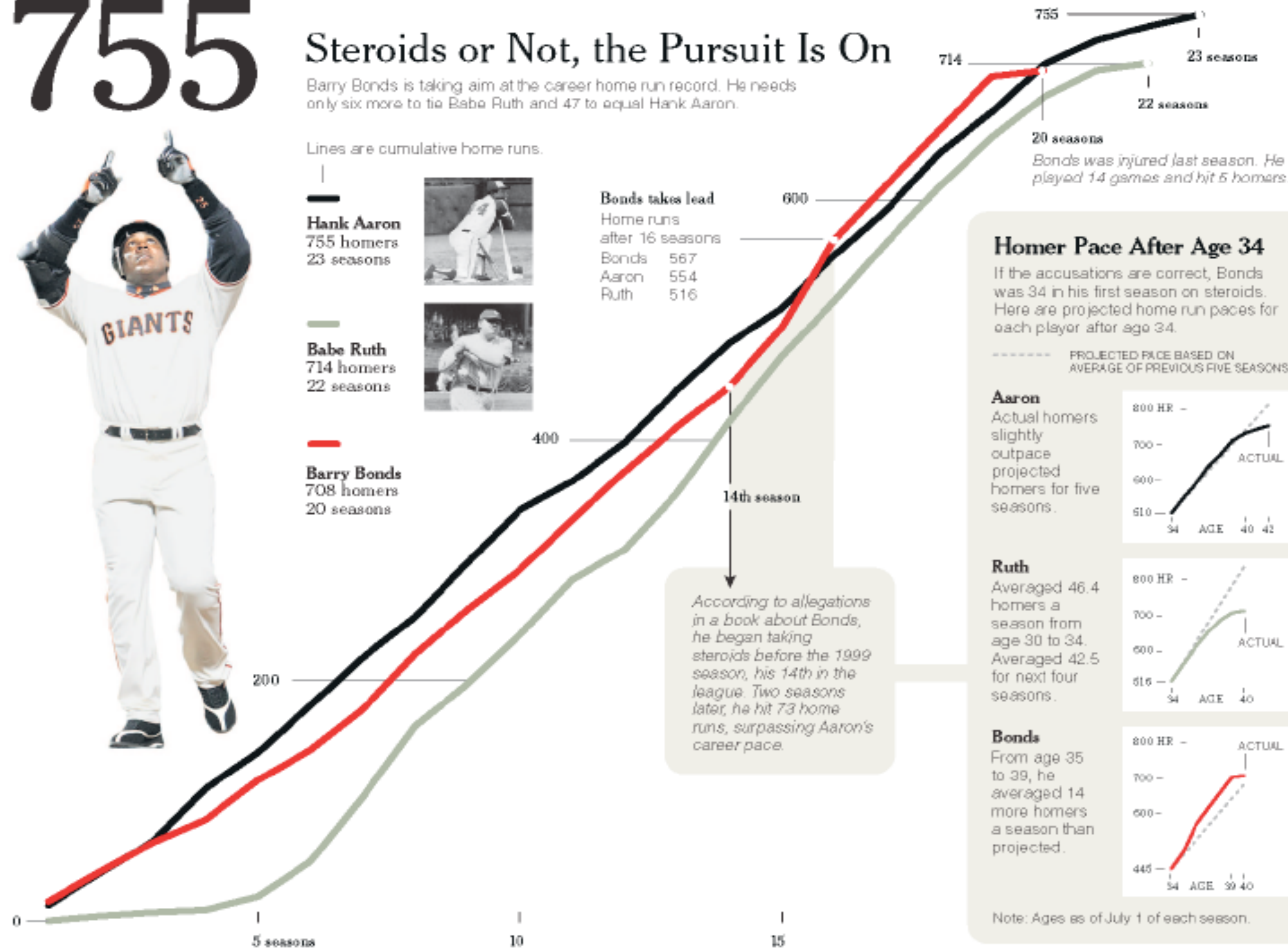
Hank Aaron
755 homers
23 seasons



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

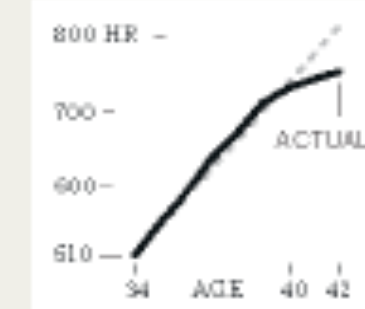
Homer Pace After Age 34

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

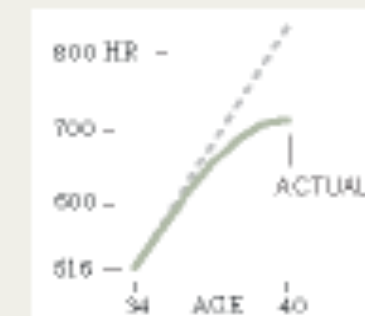
Aaron

Actual homers slightly outpace projected homers for five seasons.



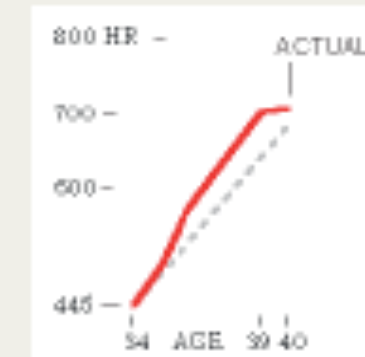
Ruth

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.



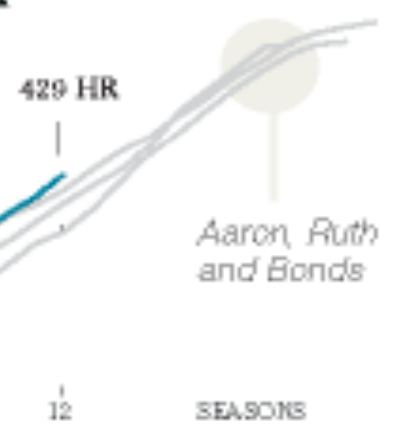
Note: Ages as of July 1 of each season.

Others Taking Aim



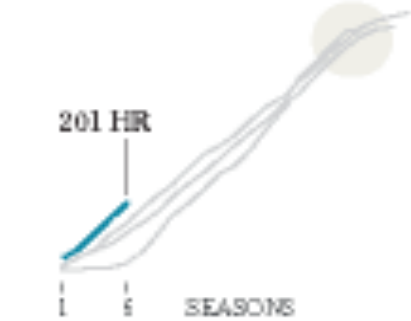
Alex Rodriguez

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



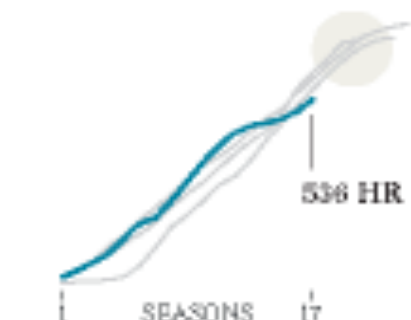
Albert Pujols

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



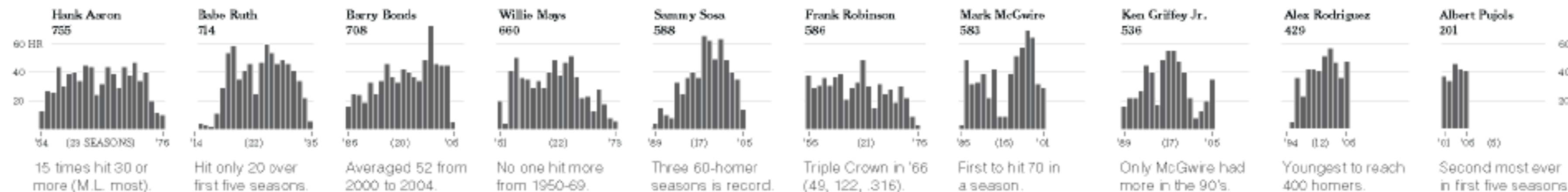
Ken Griffey Jr.

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

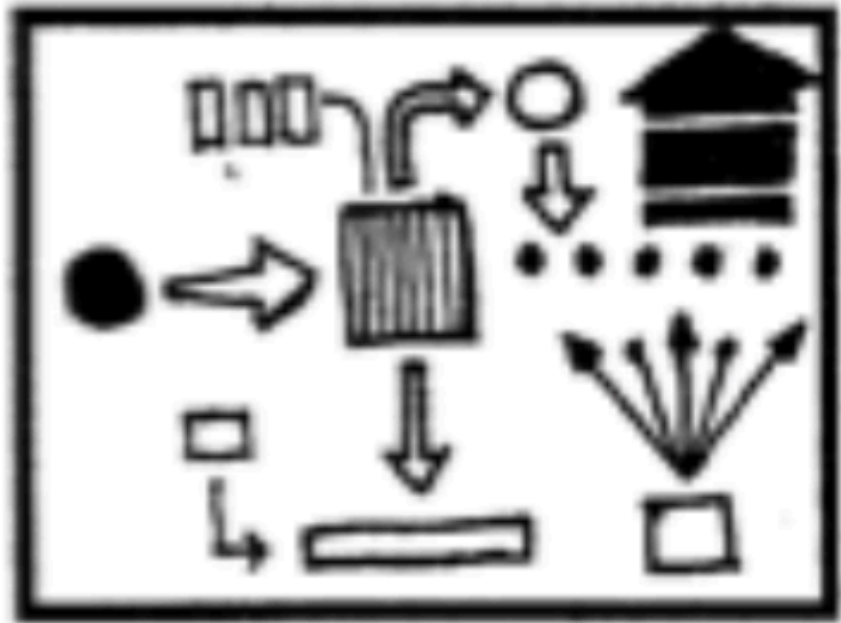


Differing Paths to the Top of the Charts

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



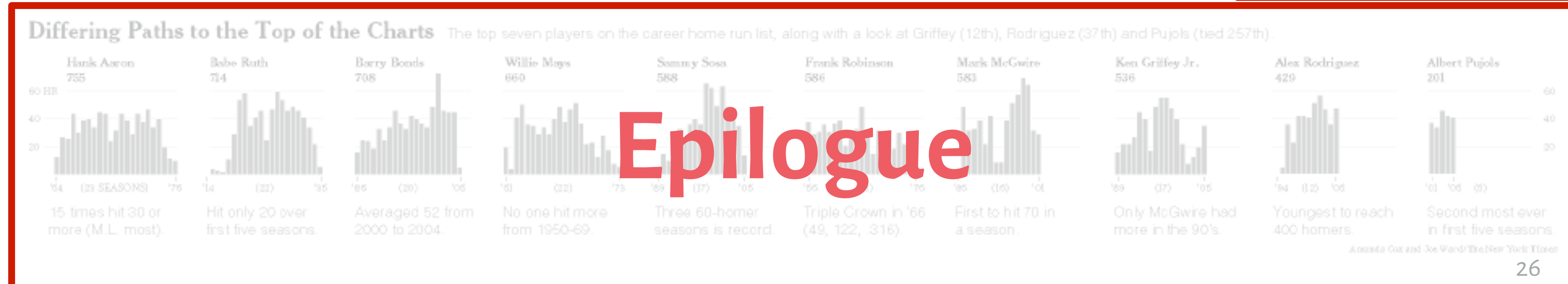
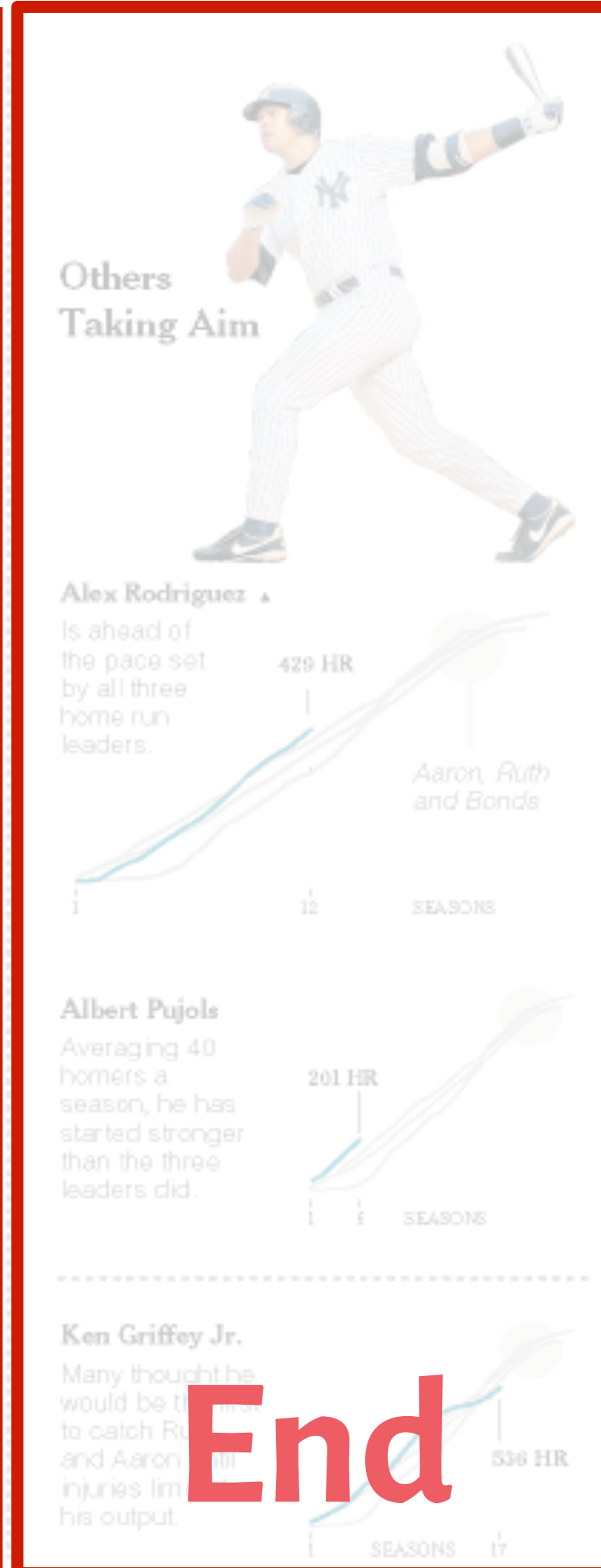
Genres



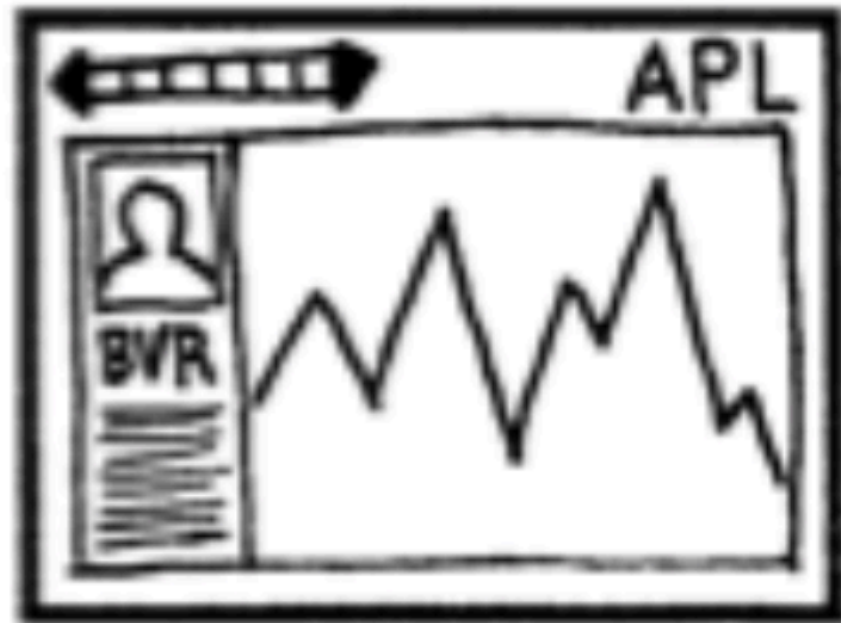
Flow Chart



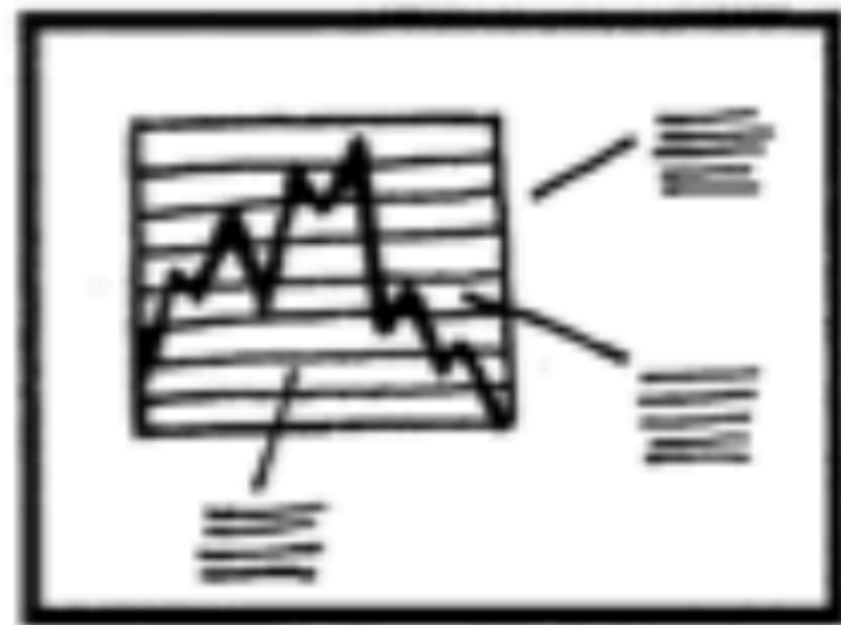
Partitioned Poster



Genres



Slide Show



Annotated Chart

Published: February 2, 2010

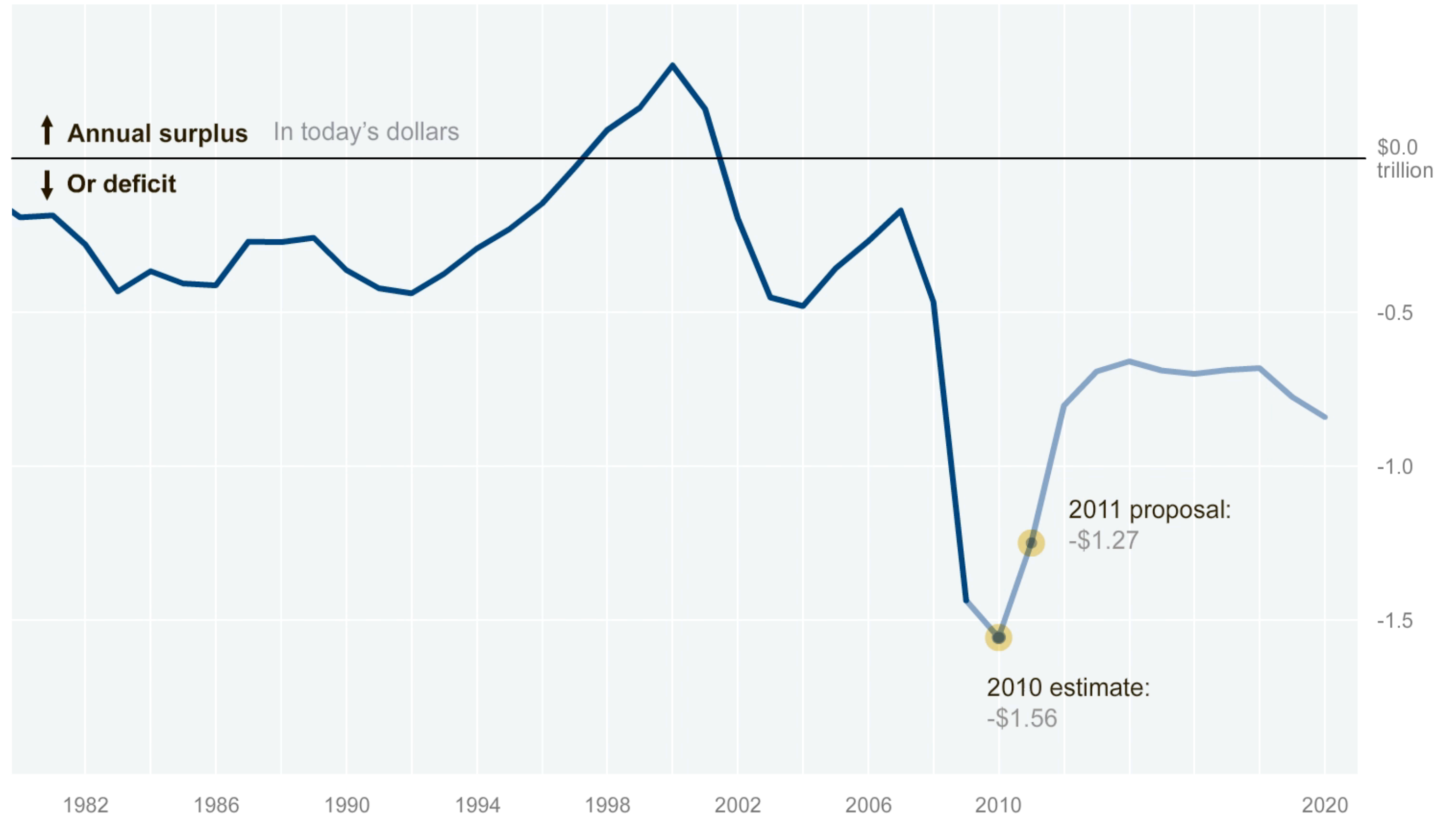
Budget Forecasts, Compared With Reality

Just two years ago, surpluses were predicted by 2012. How accurate have past White House budget forecasts been?

1 2 3 4 5 6 NEXT ▶

Falling short

President Obama's budget proposal estimates a deficit of \$1.6 trillion for the current fiscal year and \$1.3 trillion in 2011.

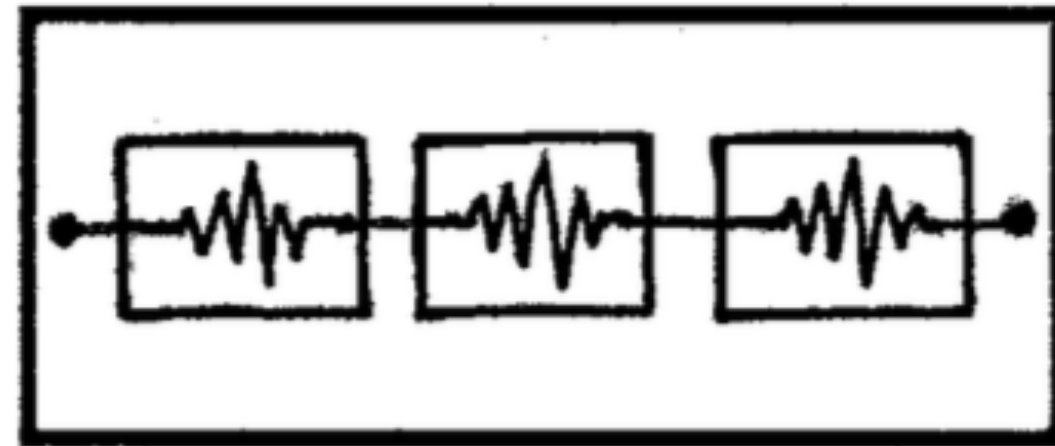


By AMANDA COX | [Send Feedback](#)

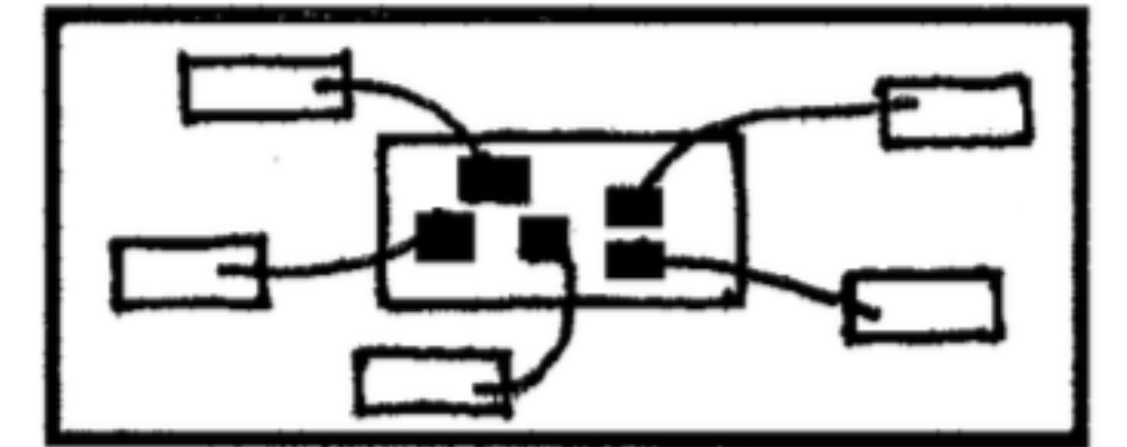
Source: Office of Management and Budget

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Interactive Slideshow



Drill-Down

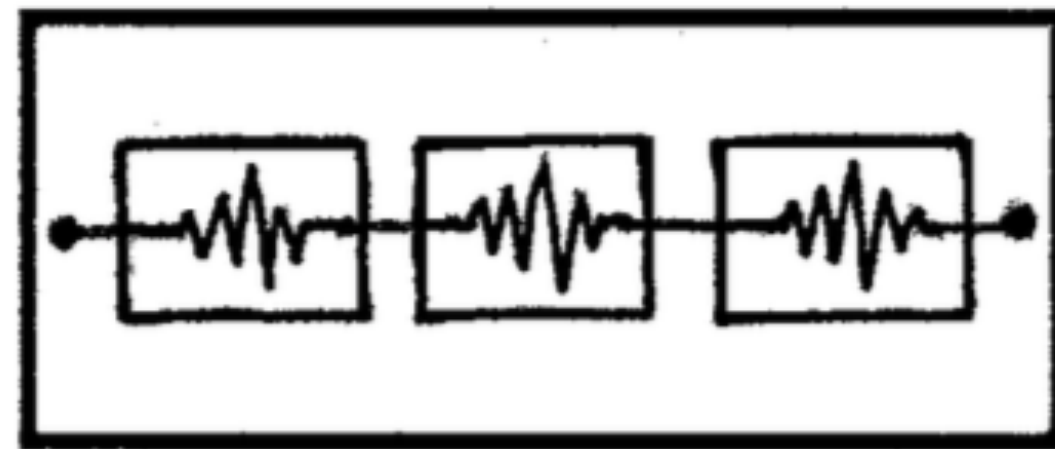


Author-Driven

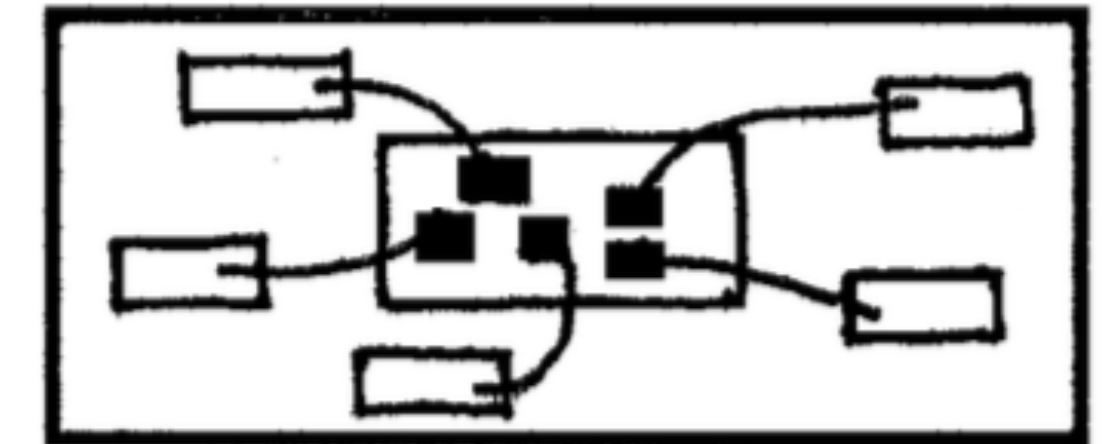
Reader-Driven

[Segel & Heer, *InfoVis* 2010]

Interactive Slideshow



Drill-Down



Author-Driven

Reader-Driven

[Segel & Heer, *InfoVis* 2010]

On the Map: Five Major North Korean Prison Camps

North Korea has operated political prison camps for more than 50 years, twice as long as the Gulag in the former Soviet Union. People suspected of opposing the government are forced to do slave labor in the camps, which hold an estimated 200,000 prisoners. North Korea's government says the camps don't exist, but high-resolution satellite images show otherwise.

Click on the  map markers below for more information on each site.

RELATED

- Article: [On the Diplomatic Back Burner](#)
- Google Earth: [North Korea Uncovered](#)

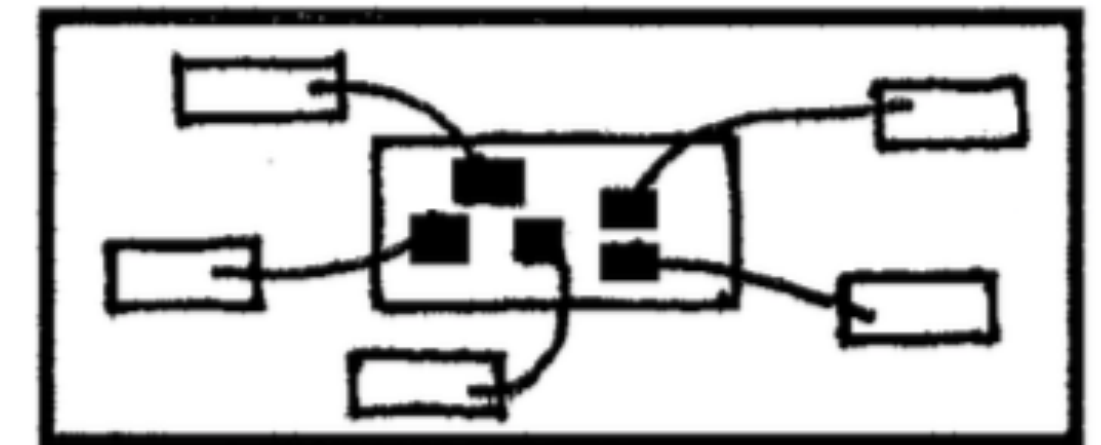
Now Viewing: Overview Up Close: Camp 15



Learn more about five major prison camps at right, or take a closer look at life in Camp 15.

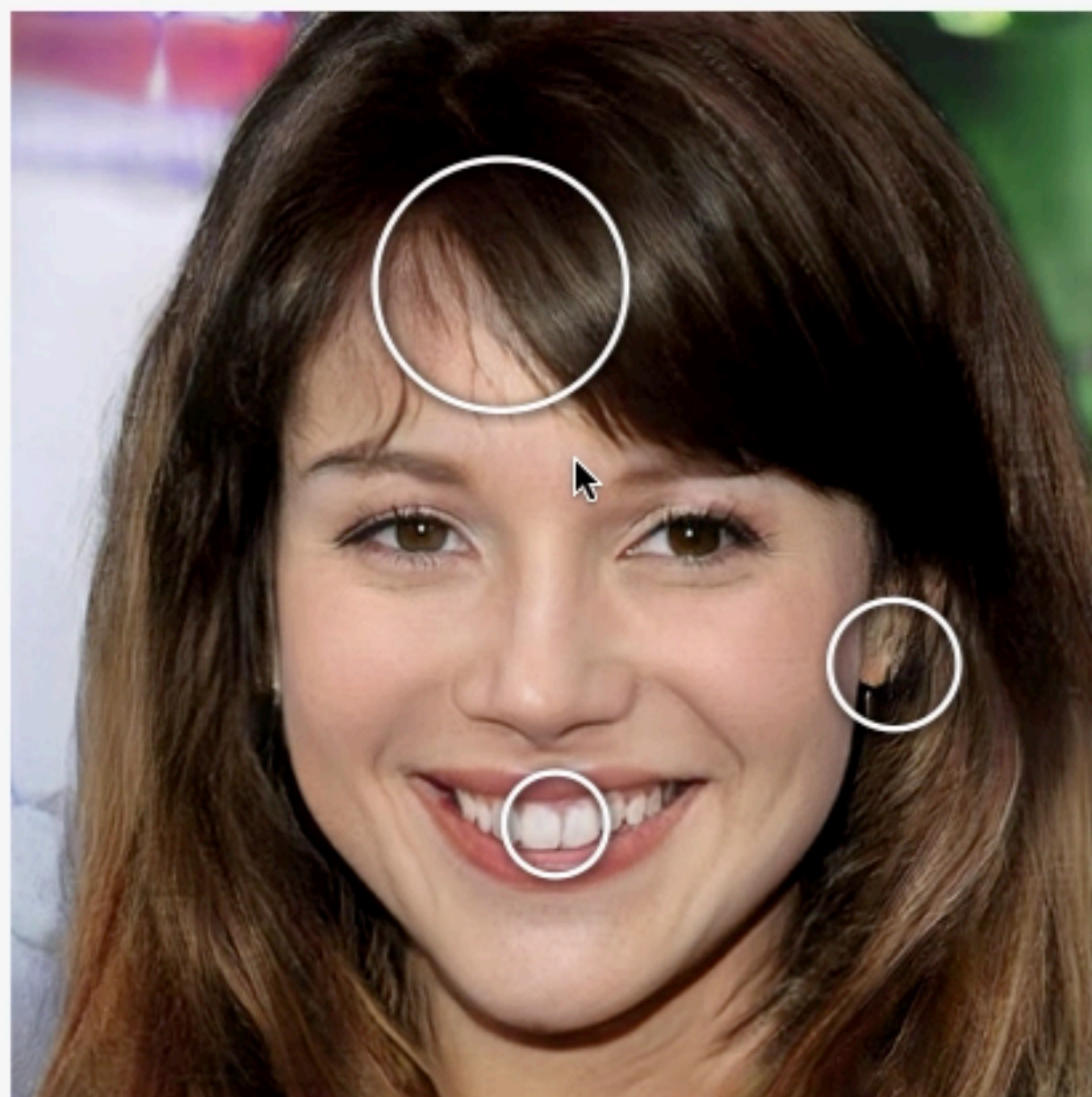
Scale varies in this perspective.
Distances from Pyongyang: 120 miles to Seoul, 427 miles to Vladivostok

Drill-Down



What gives away a machine-generated image?

Interactivity on illustrations can help people get more context around certain objects that may not have clear and separable boundaries.



Select region for more information.



FIGURE 7: Choose between 1 of 4 machine-generated images and brush over the circle callouts to display a short message about each region. Generated images from [128, 129].

The Universal Approximation Theorem in 3 levels of detail.

Readers come with different backgrounds. What if our content could be tailored to their level of knowledge about certain topics?

ILLUSTRATIVE PRECISE

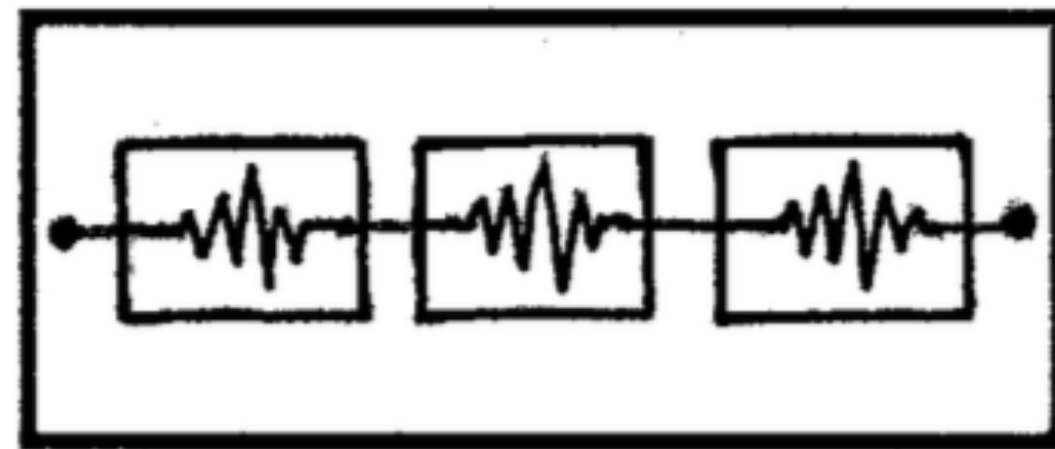
Neural networks can approximate any function that exists. However, we do not have a guaranteed way to obtain such a neural network for every function.

FIGURE 9: Drag the slider to display the theorem's statement in increasing levels of detail.

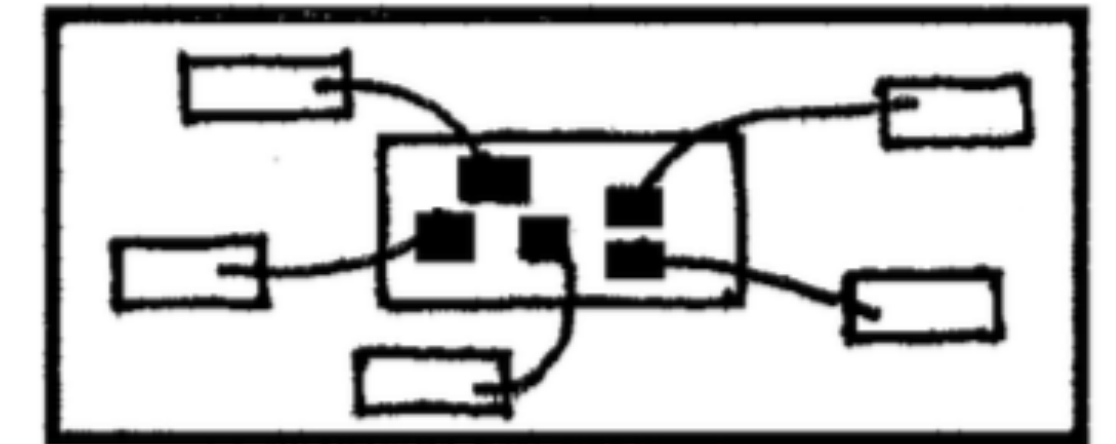
PREVIEWING CONTENT

Details-on-demand can also be used as a method for previewing content without committing to another interaction or change of view. For example, when hovering over a hyperlink on Wikipedia a preview card is shown that can contain an image and brief description: this

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Drill-Down

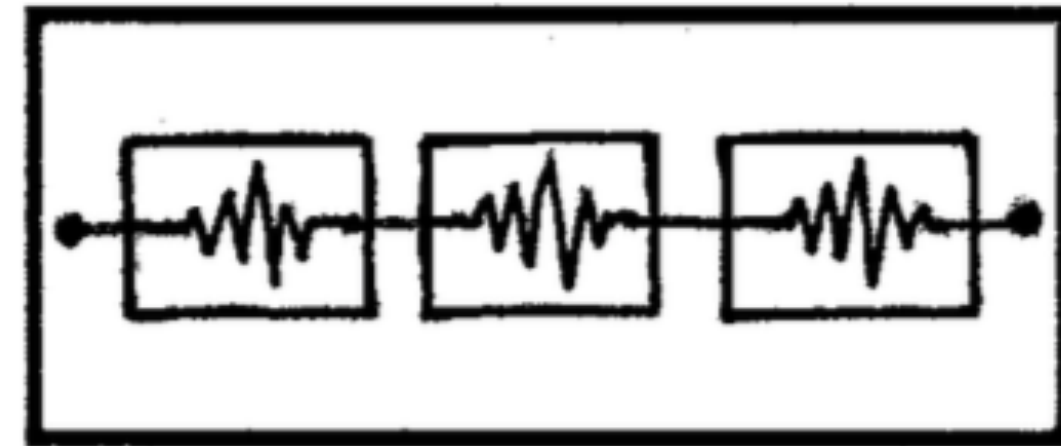


Author-Driven

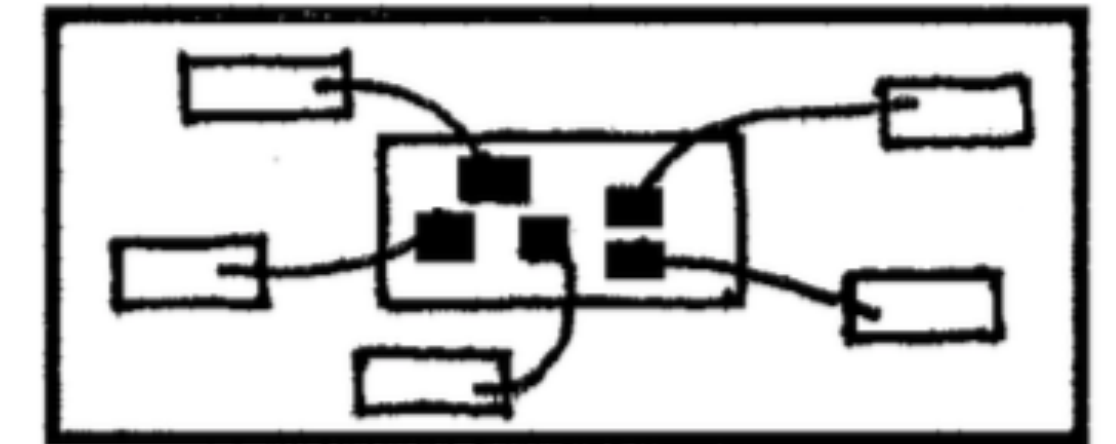
Reader-Driven

[Segel & Heer, *InfoVis* 2010]

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Author-Driven

Reader-Driven

[Segel & Heer, *InfoVis* 2010]

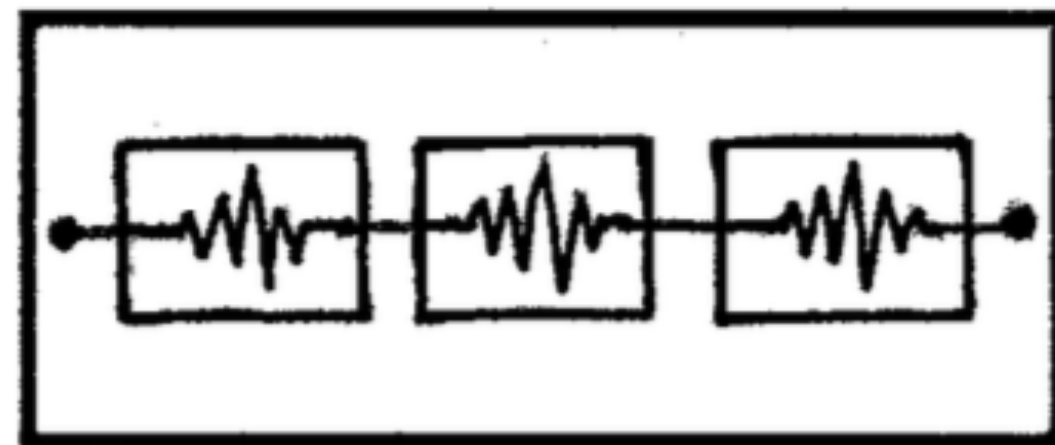
Copenhagen: Emissions, Treaties and Impacts

At the Copenhagen climate conference, discussions are likely to cover emissions levels, the legacy of the Kyoto Protocol and the risks of inaction on global warming. Explore each issue in the tabs below.

Global Emissions	Lessons From Kyoto	Possible Impact
<p>1 2 3 4 5 6 7 8 9 10 11 NEXT ▶</p> <p>Almost every country in the world signed and ratified the protocol. The treaty's aim was to provide a starting point for reducing global carbon dioxide emissions.</p> <p>Countries that ratified Kyoto</p>  <p><i>Roll over countries to learn more</i></p>		

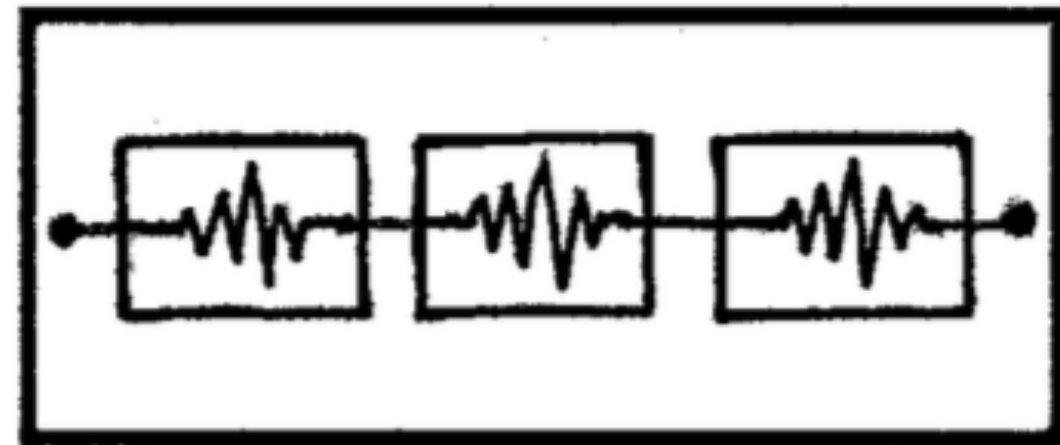
Stepper

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R2
D3

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A visual introduction to machine learning

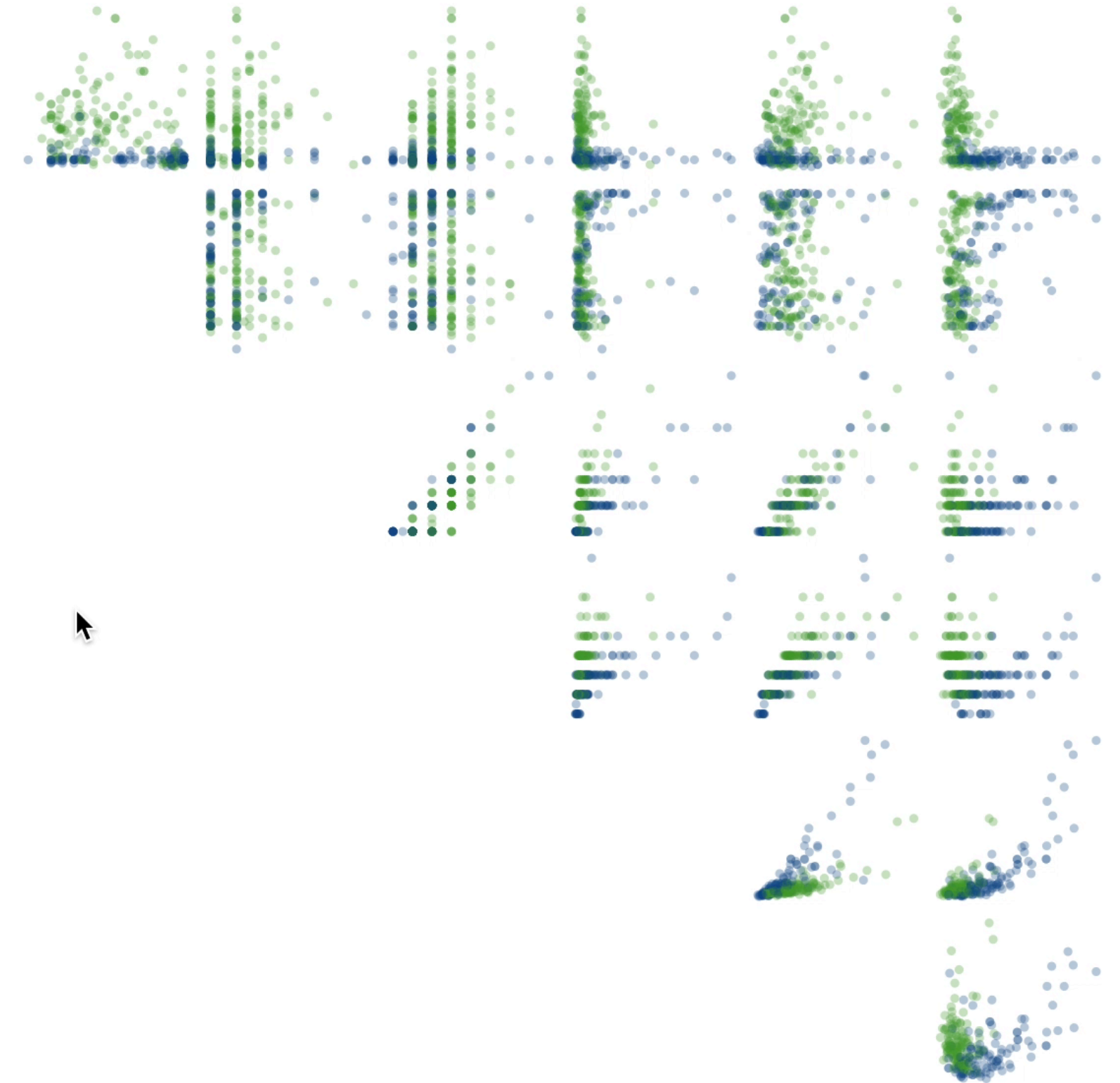
English

In machine learning, computers apply **statistical learning** techniques to automatically identify patterns in data. These techniques can be used to make highly accurate predictions.

Keep scrolling. Using a data set about homes, we will create a machine learning model to distinguish homes in New York from homes in San Francisco.

“Scrolly”-telling

SCROLL



Discrete vs. Continuous Steps

A source of debate among practitioners!

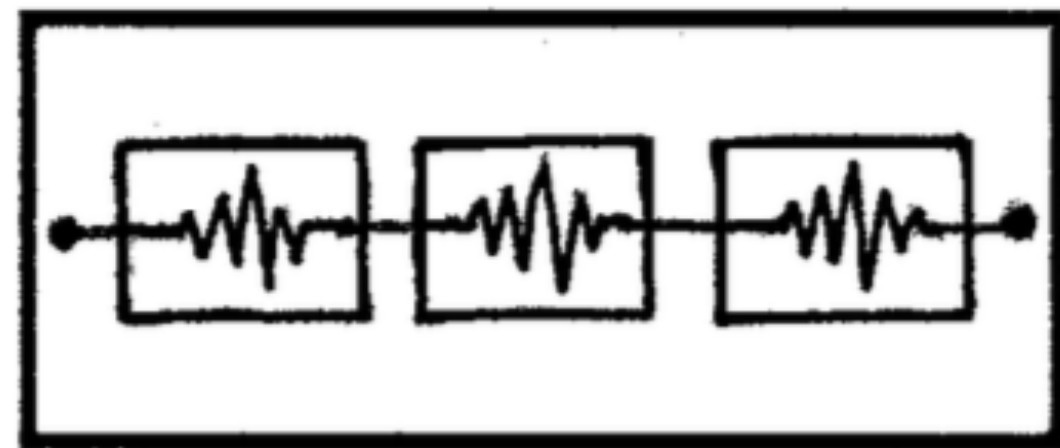
Discrete

- ✓ Simple & familiar.
- ✗ But less engaging?

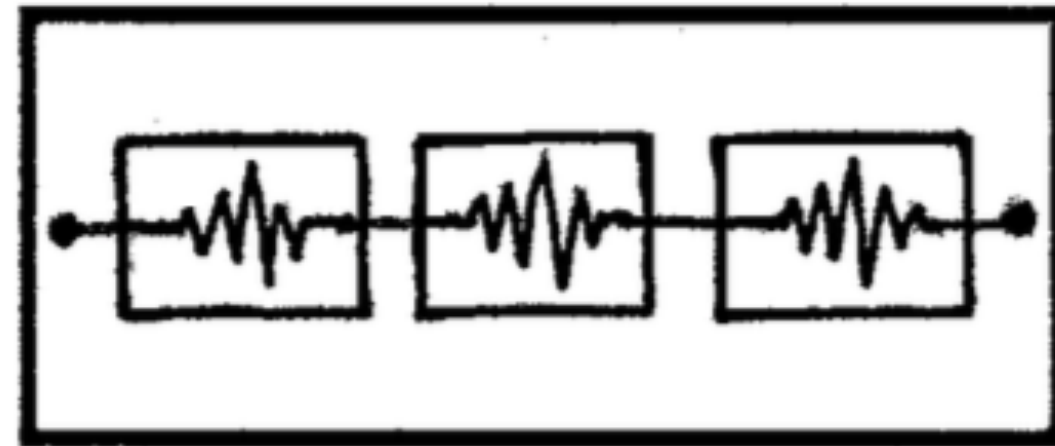
Continuous

- ✓ Less “activation energy” required.
- ✓ More fluid/direct: parameterized by scroll position = rapid, incremental experience.
- ✗ But, difficult to implement properly. Can result in “*scrolljacking*.”

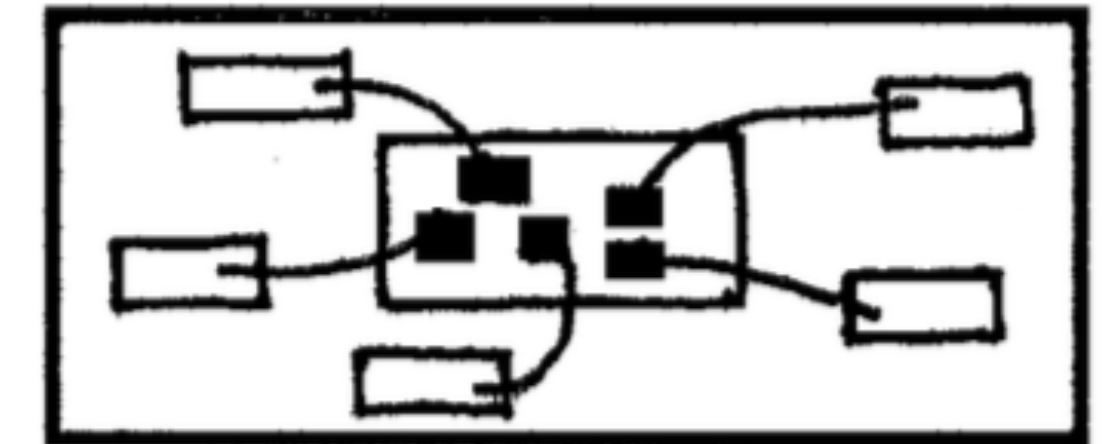
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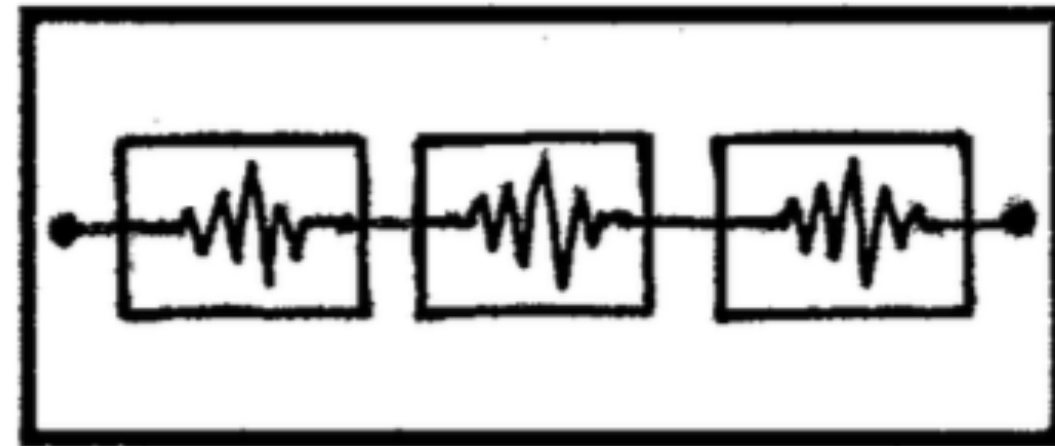


Author-Driven

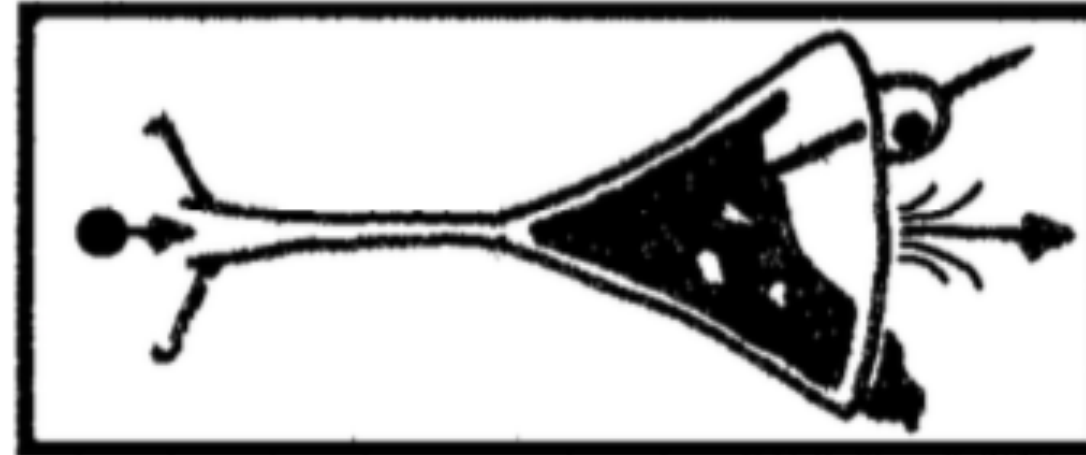
Reader-Driven

[Segel & Heer, *InfoVis* 2010]

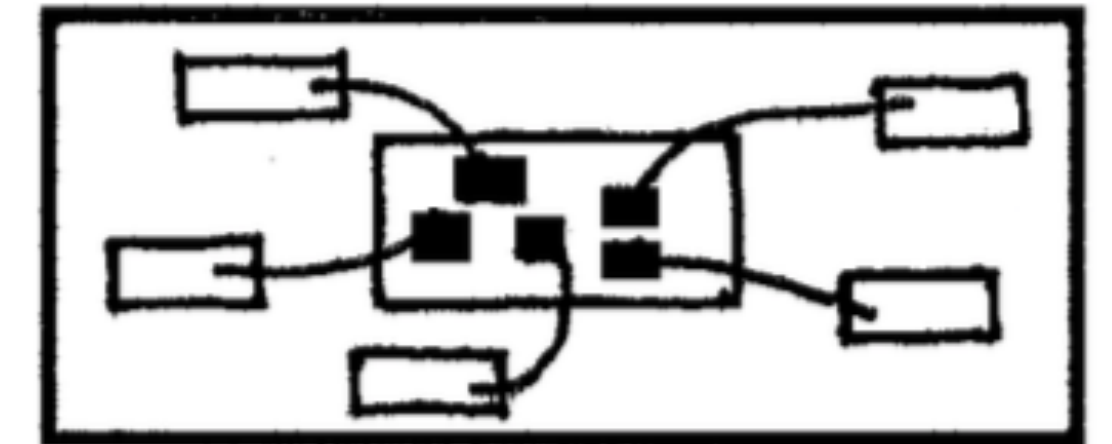
Interactive Slideshow



Martini Glass



Drill-Down



Author-Driven

Reader-Driven

[Segel & Heer, *InfoVis* 2010]

Published: February 2, 2010

Budget Forecasts, Compared With Reality

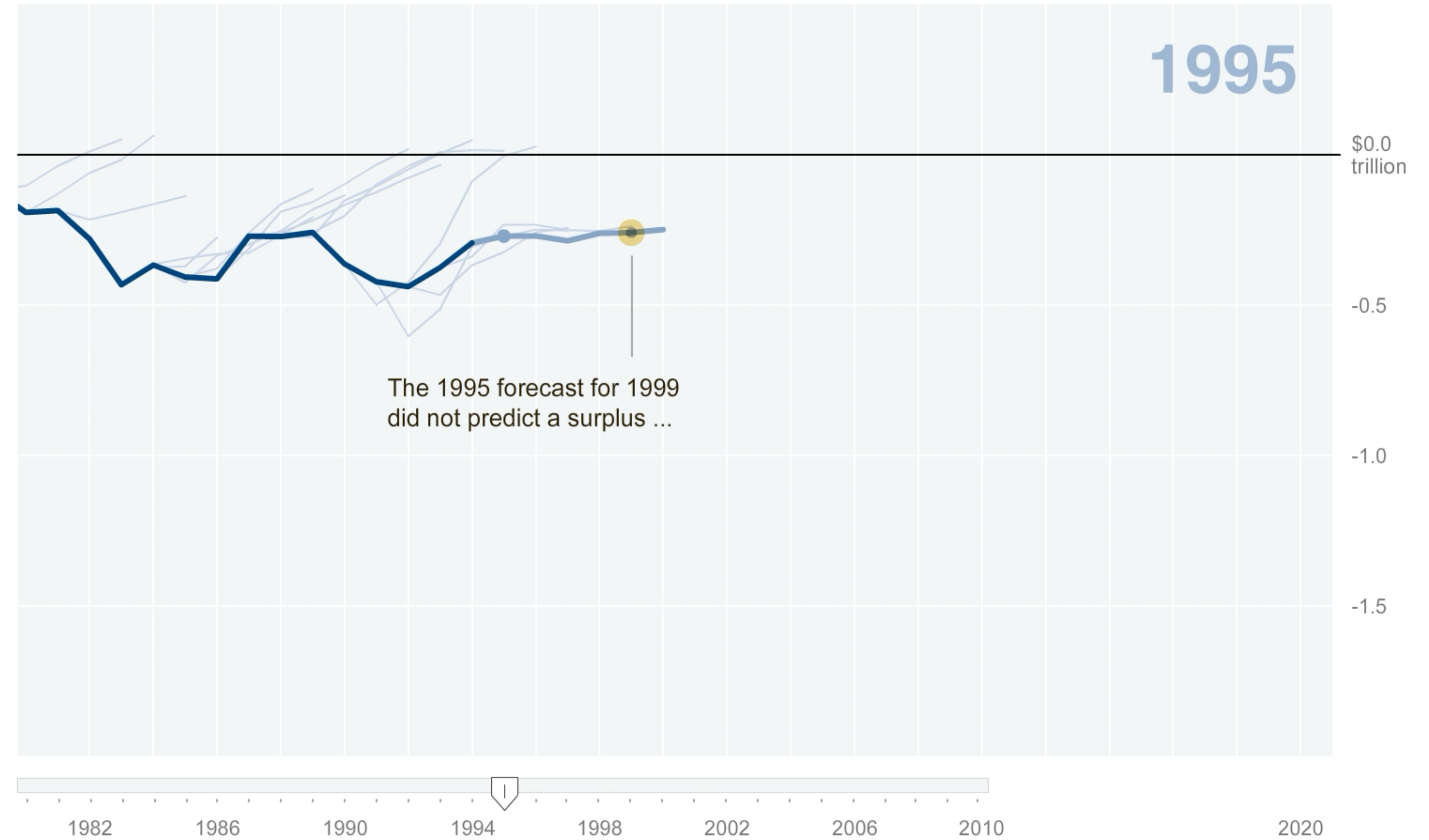
Just two years ago, surpluses were predicted by 2012. How accurate have past White House budget forecasts been?

1 2 3 4 5 6 NEXT ▶

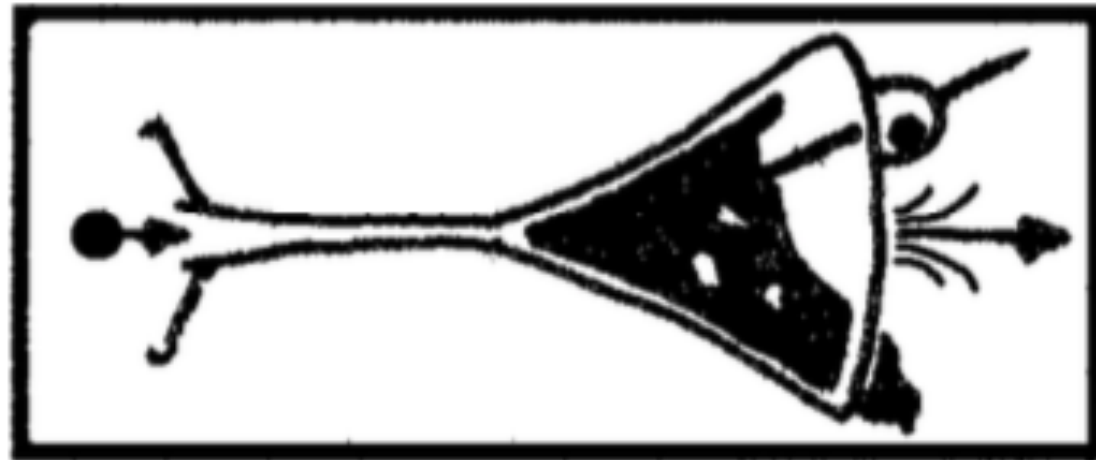
Past forecasts

Even that may be an understatement. In the last 30 years, about 80 percent of four-year deficit forecasts have been too optimistic.

The early Clinton budgets — which failed to predict the surpluses that were generated, in part, by a stock market bubble — are the only major exception.



Martini Glass



By AMANDA COX | [Send Feedback](#)

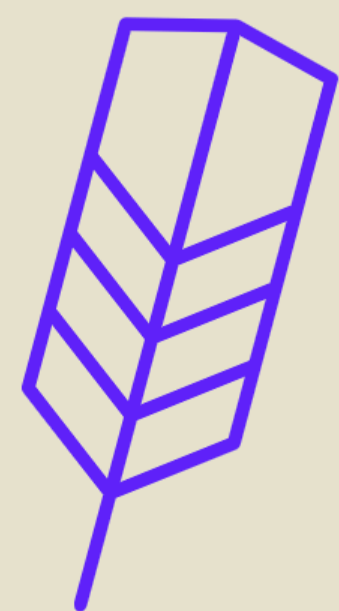
Source: Office of Management and Budget

[TWITTER](#) [LINKEDIN](#) [SHARE](#)

Kernel Density Estimation

By: [Matthew Conlen](#)





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 /]
```

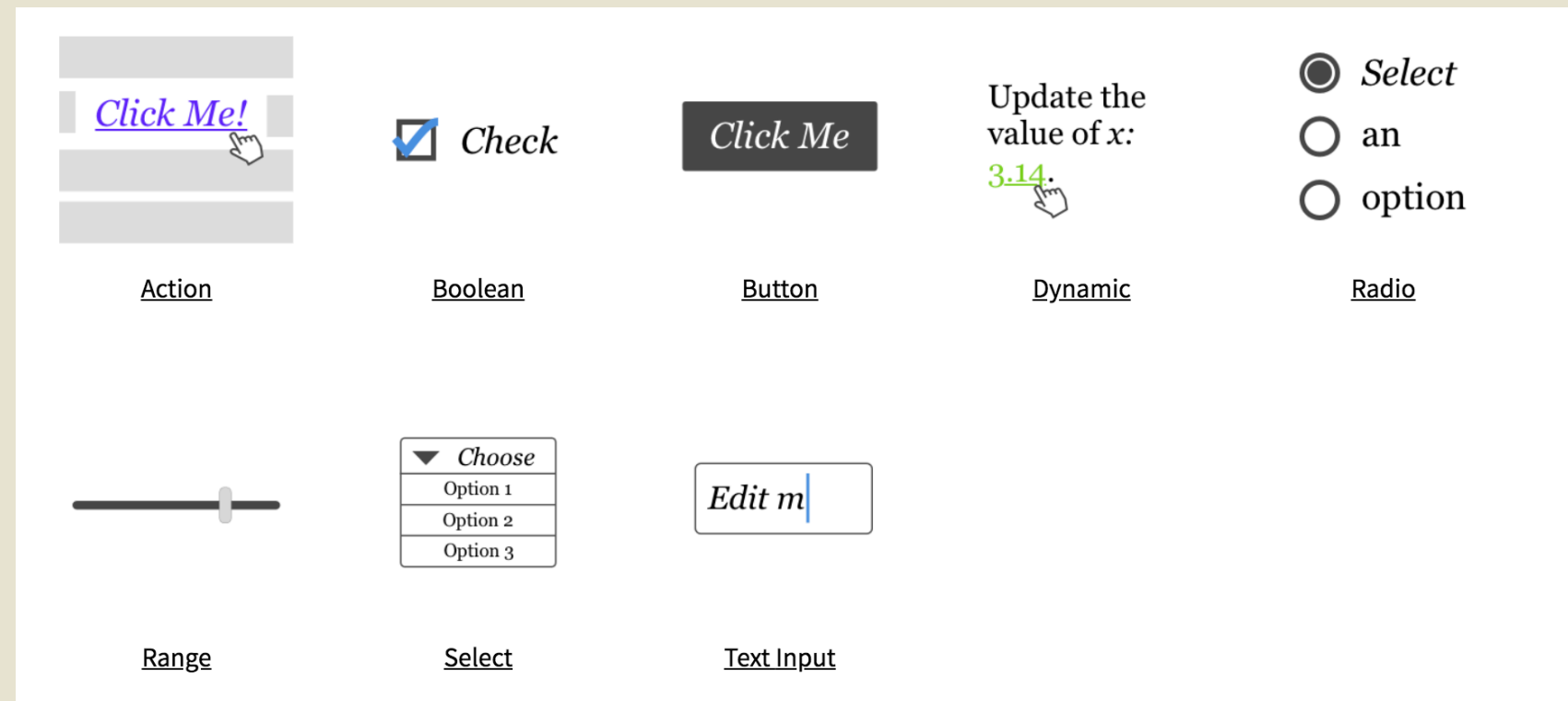
OUTPUT

Hello World

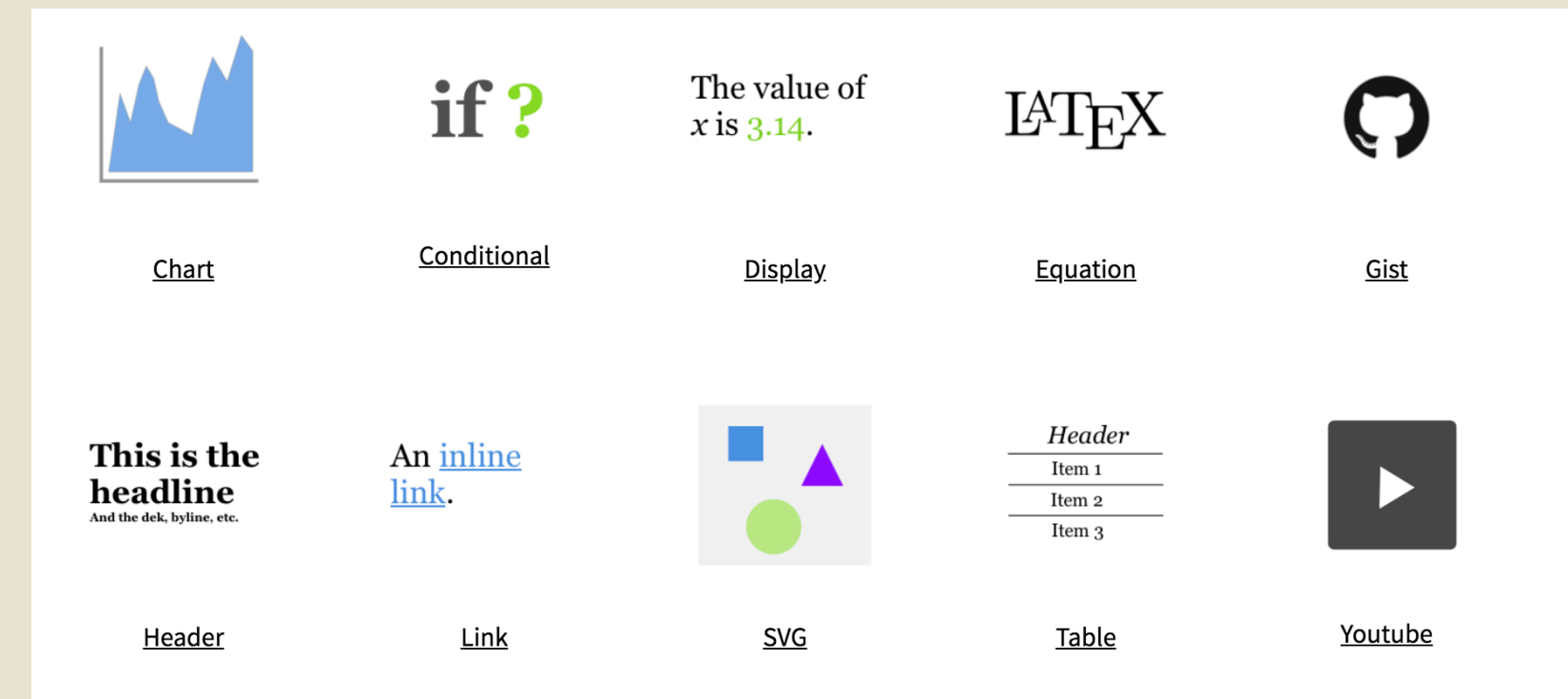
The value of x is 6.



28 Built-in Components



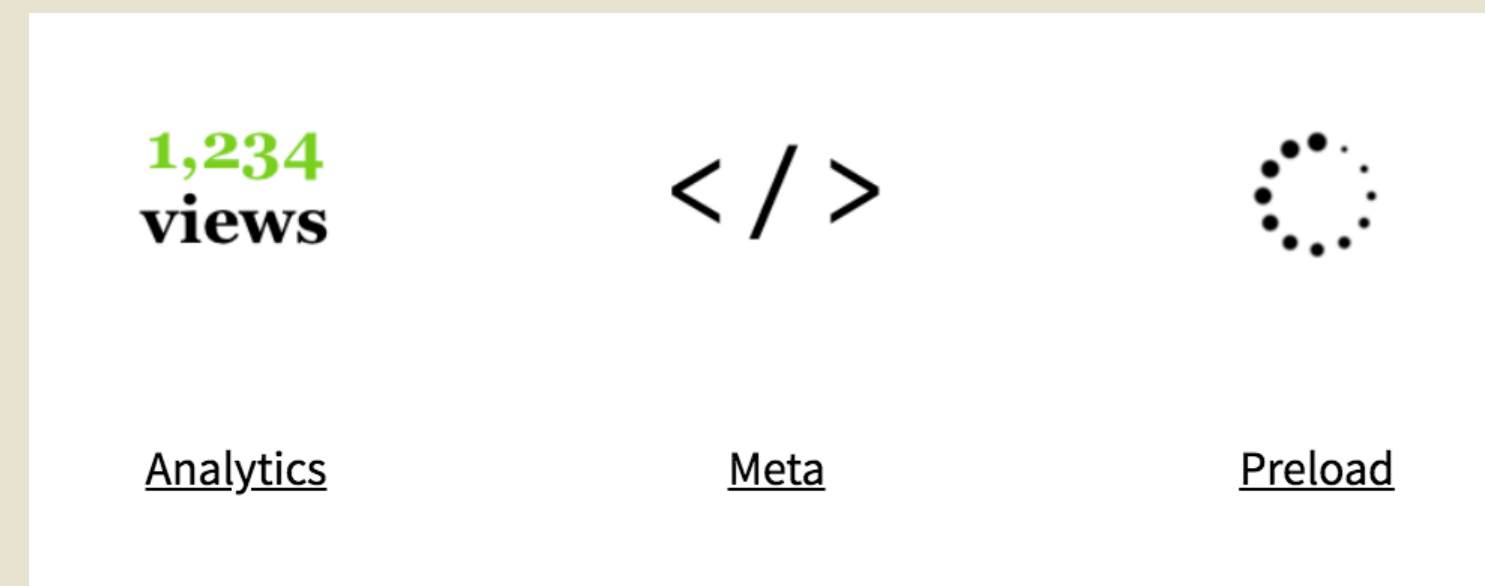
Input



Presentation

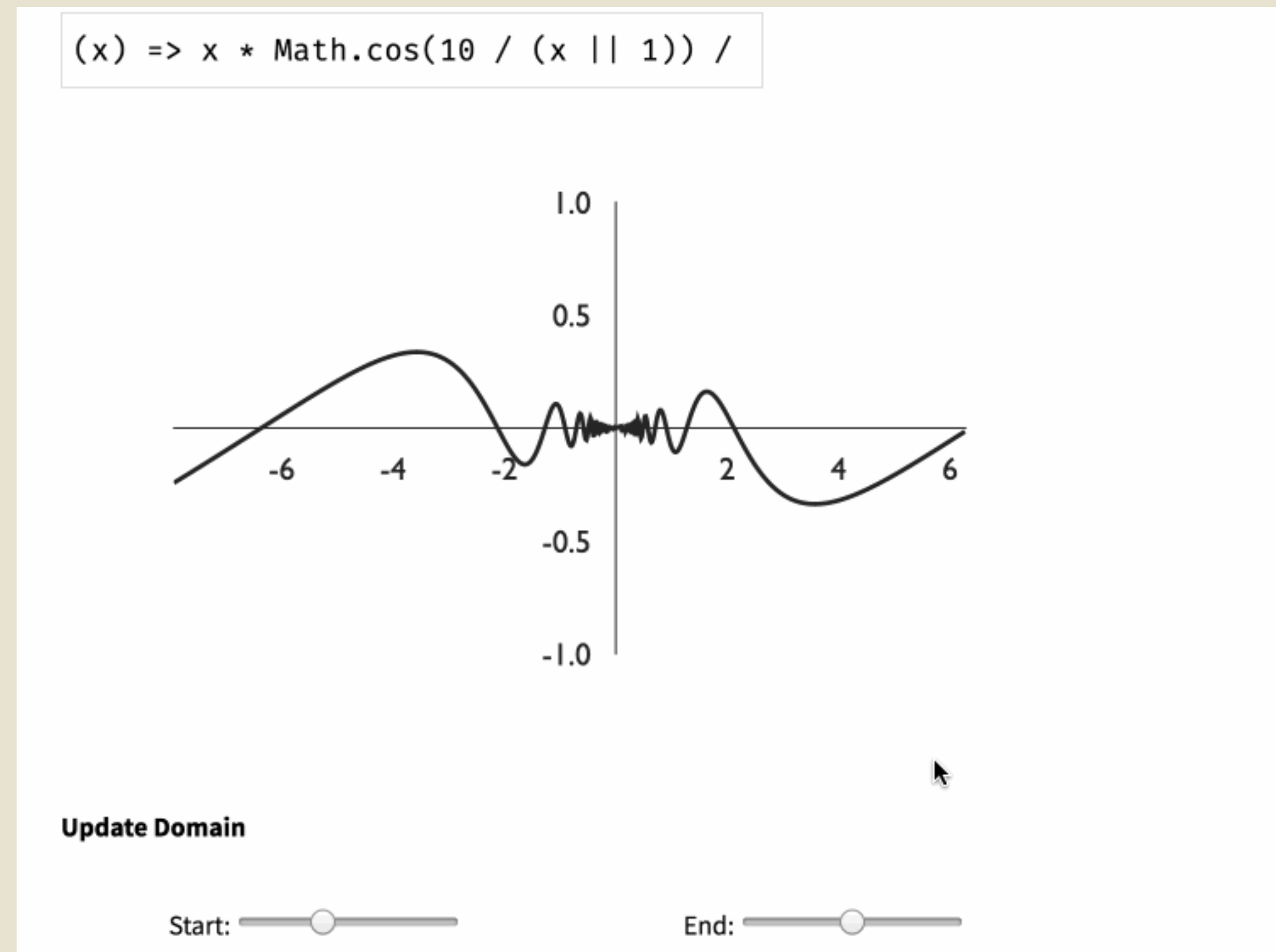


Layout



Helpers

Input + Presentation



Layout + Presentation

