DATA VISUALIZATION

Visual Design and Storytelling

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APPLICATIONS OF VISUALIZATIONS

ANALYSIS **EXPLORATORY**

PRESENTATION **EXPLANATORY**

See also https://vimeo.com/98986594

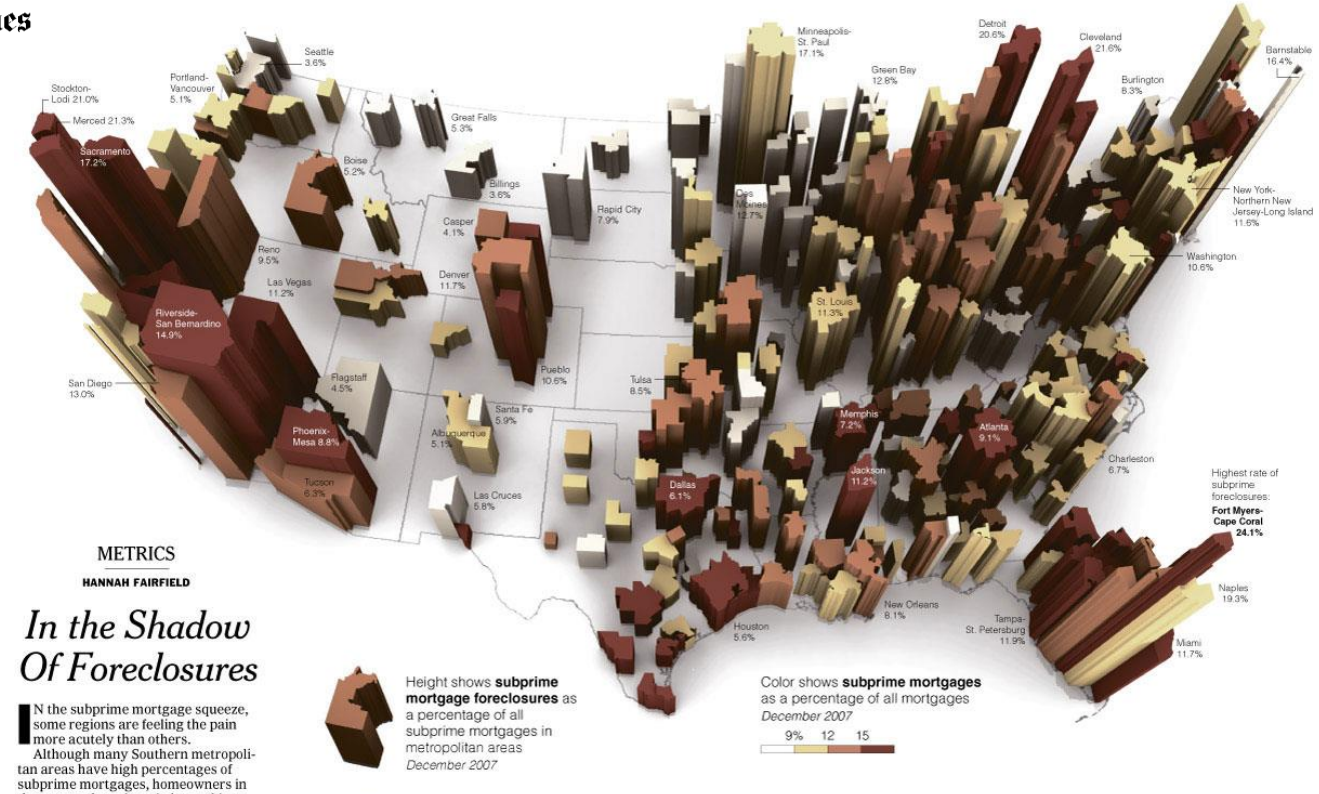
“Data journalism is not graphics and visualizations. It's about telling the story in the best way possible. Sometimes that will be a visualization ...But sometimes it's a news story. Sometimes, just publishing the number is enough.”

SIMON ROGERS, THE GUARDIAN // 2011

“I think people have begun to forget how powerful human stories are, exchanging their sense of empathy for a fetishistic fascination with data… The human stuff is the main stuff, and the data should enrich it.”

JONATHAN HARRIS // 2008

The New York Times



METRICS

HANNAH FAIRFIELD

In the Shadow Of Foreclosures

IN the subprime mortgage squeeze, some regions are feeling the pain more acutely than others.

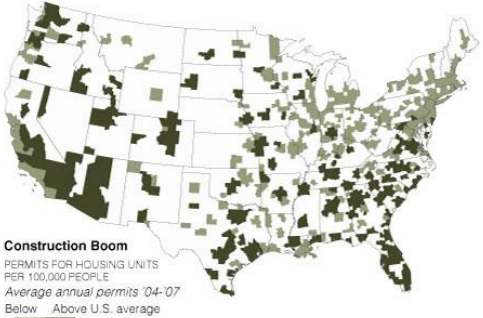
Although many Southern metropolitan areas have high percentages of subprime mortgages, homeowners in those areas have largely been able to pay their bills, so subprime foreclosure rates are low.

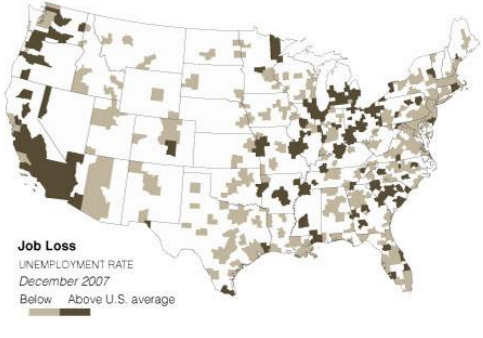
Not so in the Rust Belt, where subprime mortgages are less common but foreclosure rates are sky-high, mostly a result of rising unemployment.

And overbuilding in regions of Florida, California and other states with housing bubbles lured overeager residents to become speculators, buying up several homes with the expectation that their values would rise. Getting subprime loans was all too easy.

But paying the loans as housing prices fall is all too hard, and many economists believe that foreclosures will continue to rise.

"The collapse will affect other markets, like New York, Boston and D.C.," said Dean Baker, co-director of the Center for Economic and Policy Research. "Suburban areas near those cities are already seeing prices plunge."





Sources: First American CoreLogic, LoanPerformance; Bureau of Labor Statistics; Census Bureau

THE NEW YORK TIMES

VISUAL DESIGN AND STORYTELLING

- putting what we learned to use
  - principles of data visualization
  - main forms visual representations
  - visual perception guidelines
  - etc.
- to get the design right and to make stories work

A FEW MISTAKES THAT WE ALL MAKE

- making (non-)meaningful comparisons
- inferring trends and differences from noise
- (wrong) assumptions about the meaning of correlations
- (wrong) claims of “significance”

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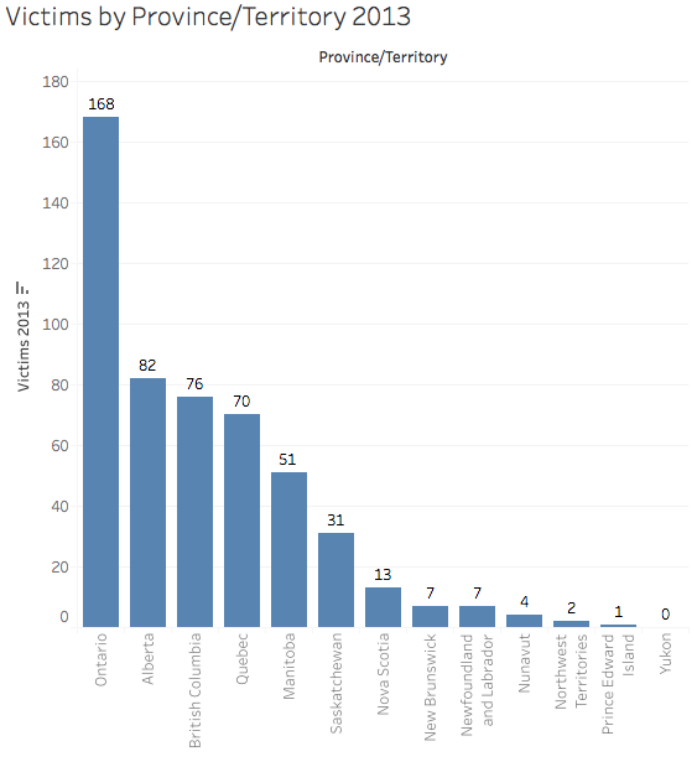
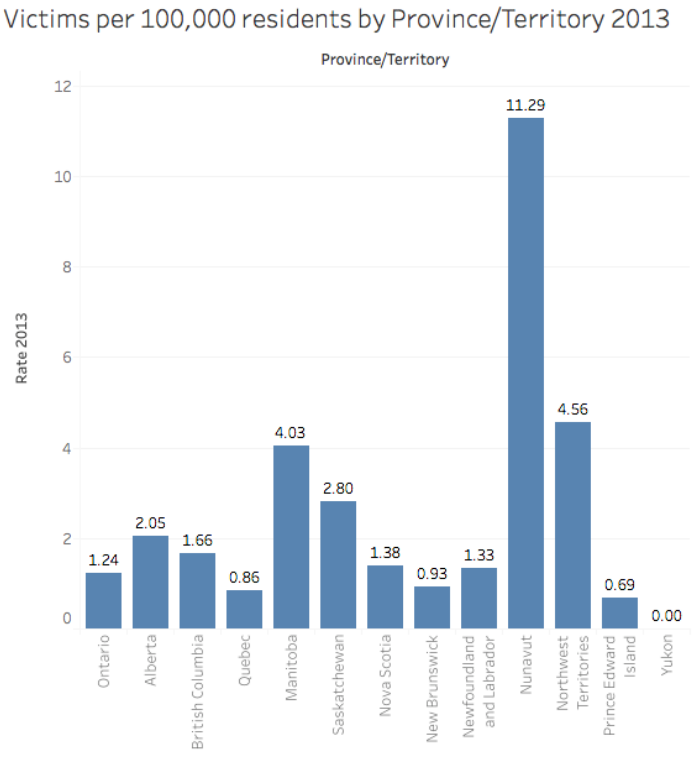
MAKING MEANINGFUL COMPARISONS

- non-normalized vs. normalized counts
  - murders vs. murders / capita
  - failing grades vs. failing grades / 100 students
  - etc.

- counts vs. distinct counts
  - # visits vs. # of customers

WHAT IS THE MOST DANGEROUS PROVINCE?





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LOOKING FOR PATTERNS IN STATIC

- almost all data has noise, errors, and variability

- we are great at seeing patterns
  — even when we shouldn't

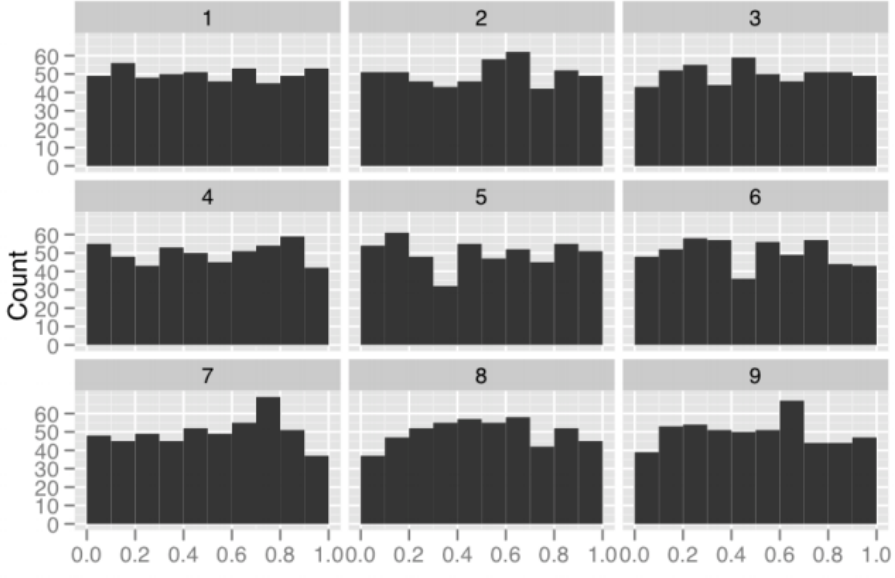
Rorschach test

IT’S VERY EASY TO TELL STORIES AROUND DATA

… but it’s harder to show that those stories are robust!

RANDOM DATA VS. REAL DATA

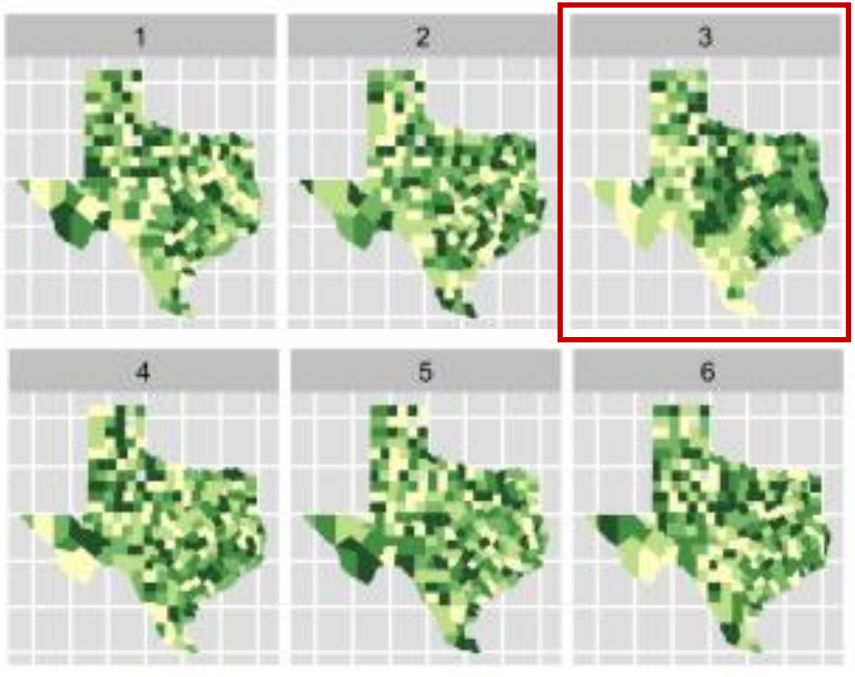
→ show normal variability in data to prepare analysts



~~accuracy of 500 ppl. performing 9 tasks~~

simulation, normally distributed accuracy in [0, 1]

[Wickham et al. 2010]

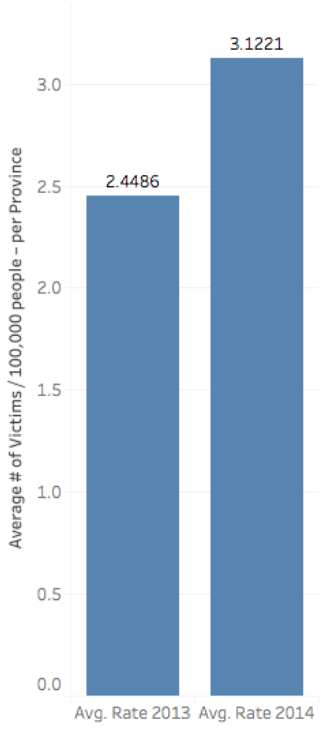


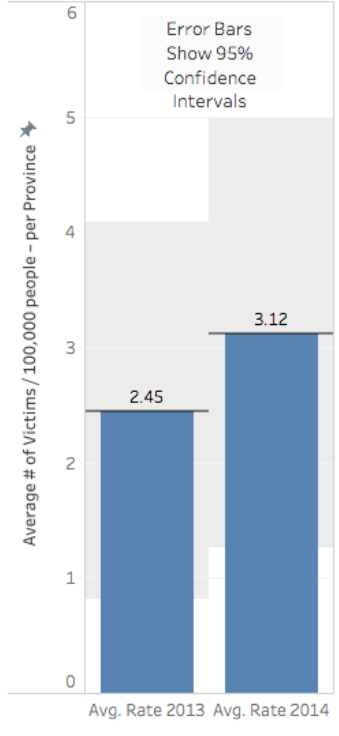
A “RORSCHACH” PROTOCOL

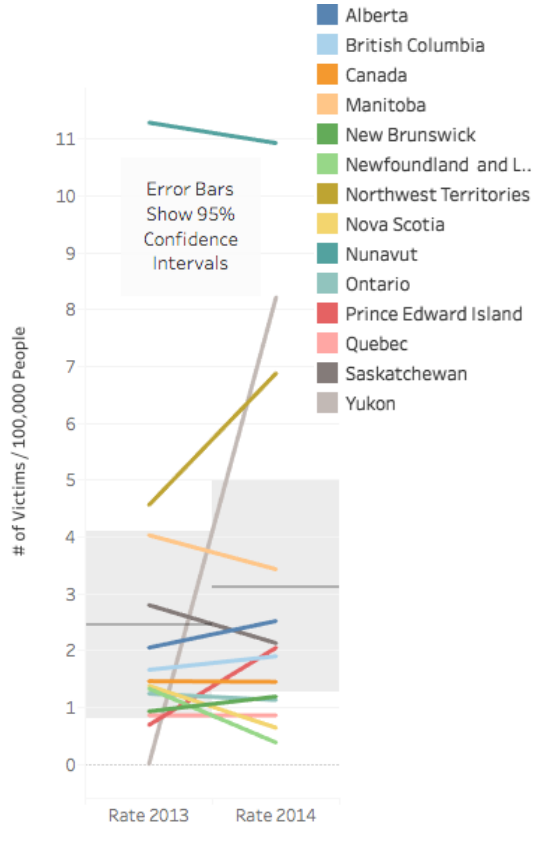
IGNORING EFFECT SIZE AND VARIABILITY

Victims by Province Territory Table

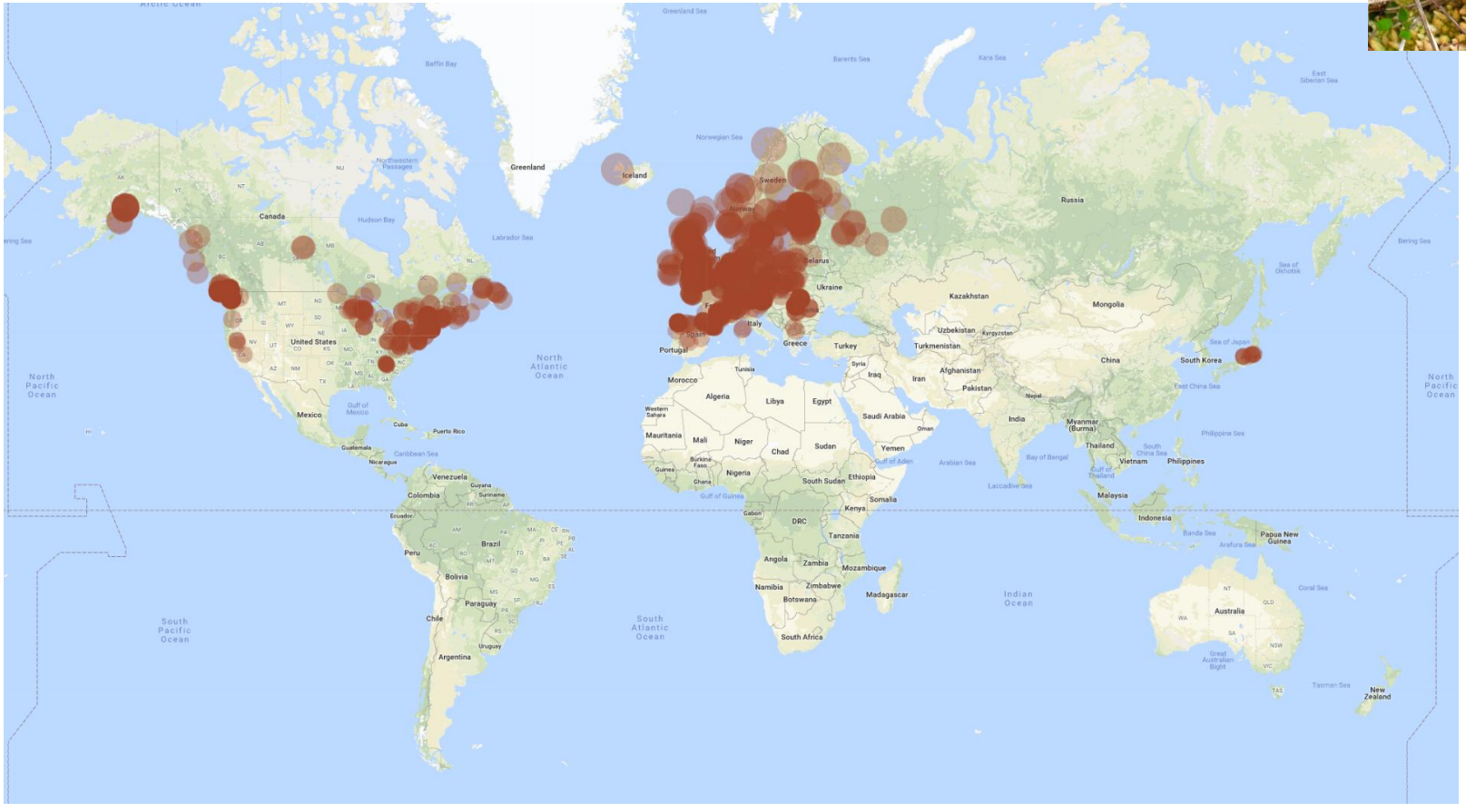
Province/Territory	Rate 2013	Rate 2014
Alberta	2.05	2.52
British Columbia	1.66	1.90
Manitoba	4.03	3.43
New Brunswick	0.93	1.19
Newfoundland and Labra..	1.33	0.38
Northwest Territories	4.56	6.88
Nova Scotia	1.38	0.64
Nunavut	11.29	10.93
Ontario	1.24	1.13
Prince Edward Island	0.69	2.05
Quebec	0.86	0.86
Saskatchewan	2.80	2.13
Yukon	0.00	8.22







BIAS IN DATA SOURCES



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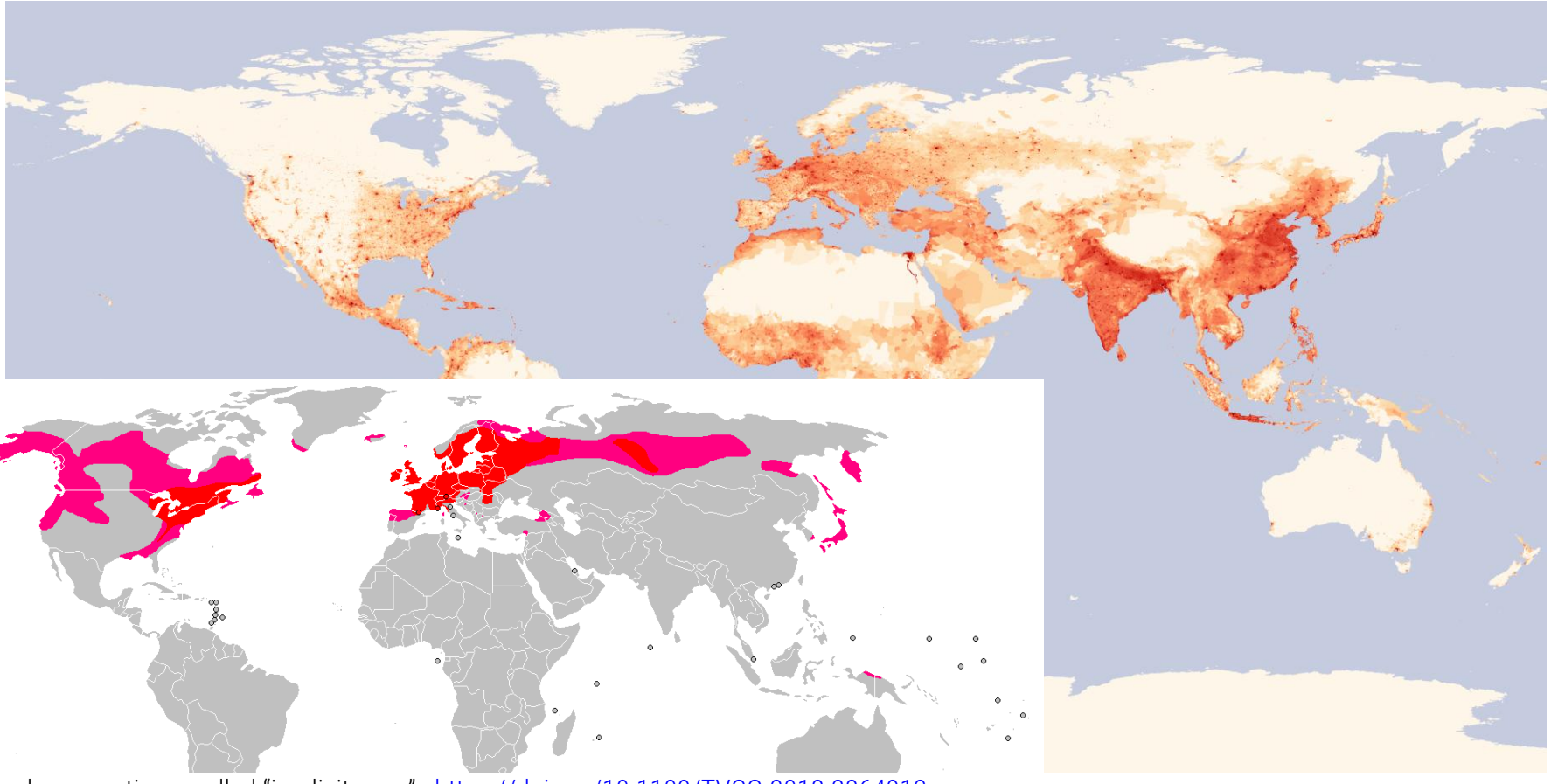

also sometimes called “implicit error”: https://doi.org/10.1109/TVCG.2018.2864913

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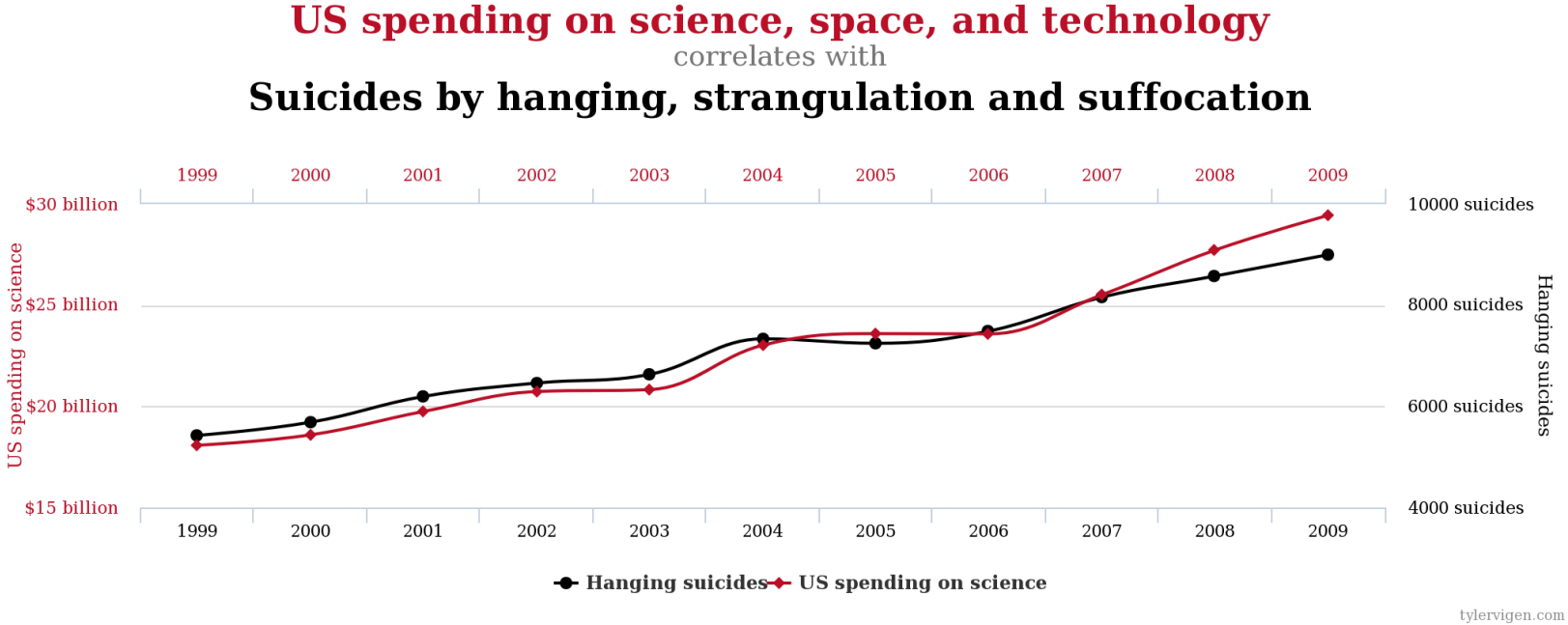
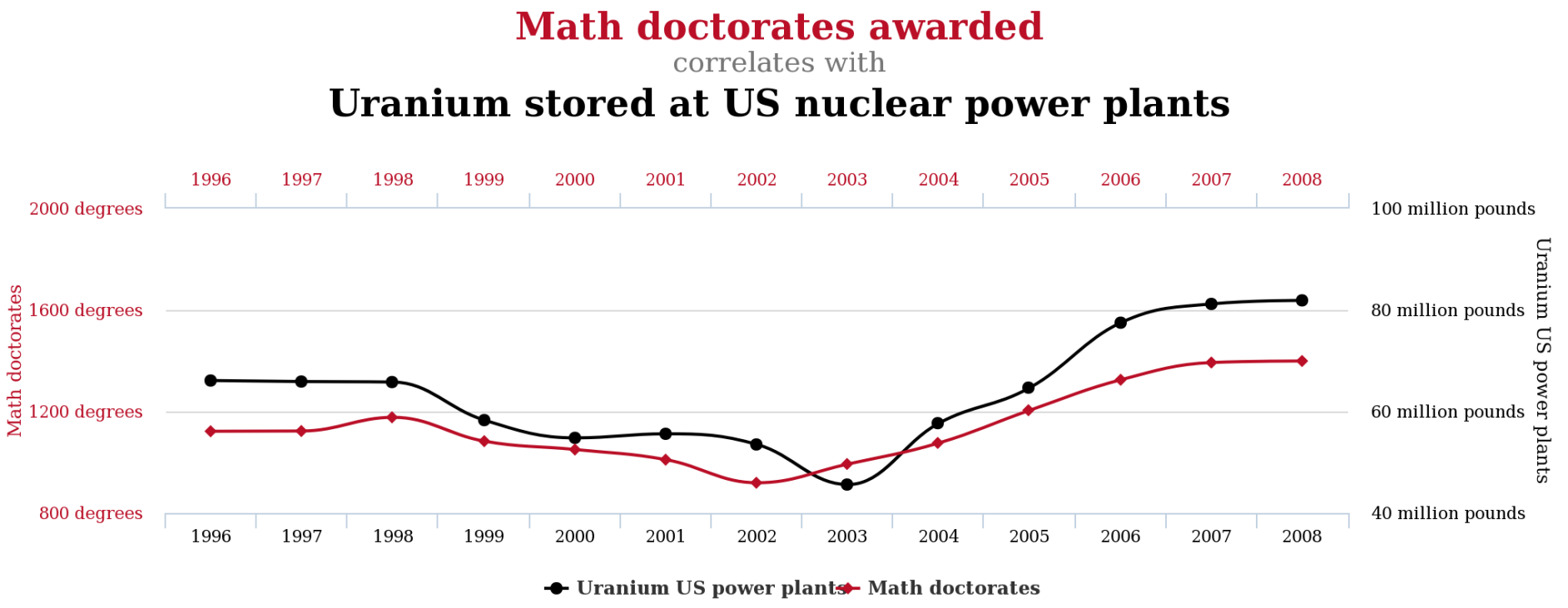
CORRELATIONS

correlation: relationship(s) between two or more dimensions in the data

- Is there really a correlation?
- How strong is it?
- Is it corroborated by other data?
- Does it make sense?

EVEN STRONG CORRELATIONS MIGHT NOT MEAN ANYTHING!





correlation does **not** imply causation!

correlation does **not** imply causation!

- other data that supports the same correlation?
  - other sources
  - future or past data
  - different data, …
- can you explain the causation?
- external factor that explains both?

YOU CAN TRY THIS!

http://tylervigen.com/view_correlation

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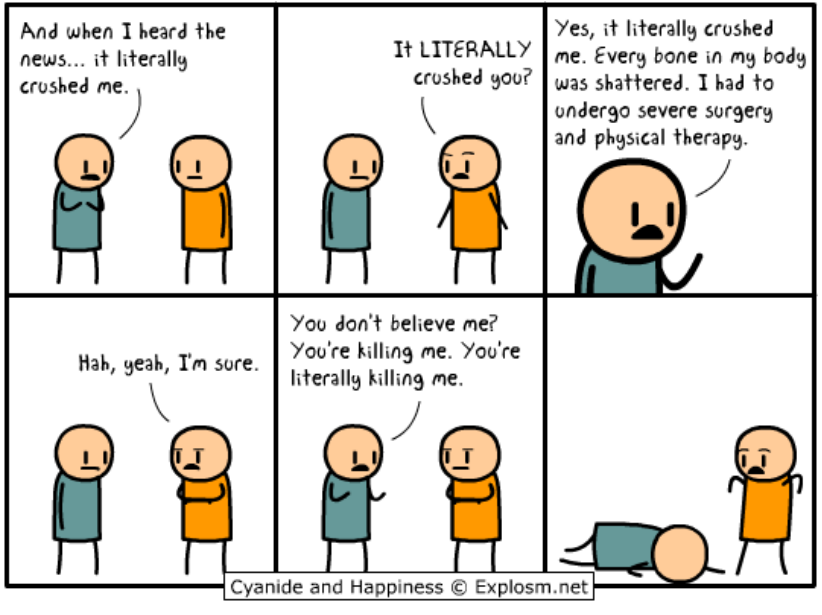
“SIGNIFICANTLY”

THE “LITERALLY” OF DATA ANALYSIS



“SIGNIFICANTLY…

DIFFERENT

NEVER SAY THIS …

UNLESS YOU’RE SURE THAT YOU HAVE PERFORMED THE CORRECT **STATISTICAL** SIGNIFICANCE TEST AND CAN REPORT P-VALUES, EFFECT SIZES, ETC.

HIGHER/LOWER

BIGGER/SMALLER

MORE/LESS

MORE IMPORTANT

ETC…

Better: don’t use the word but talk about “evidence”

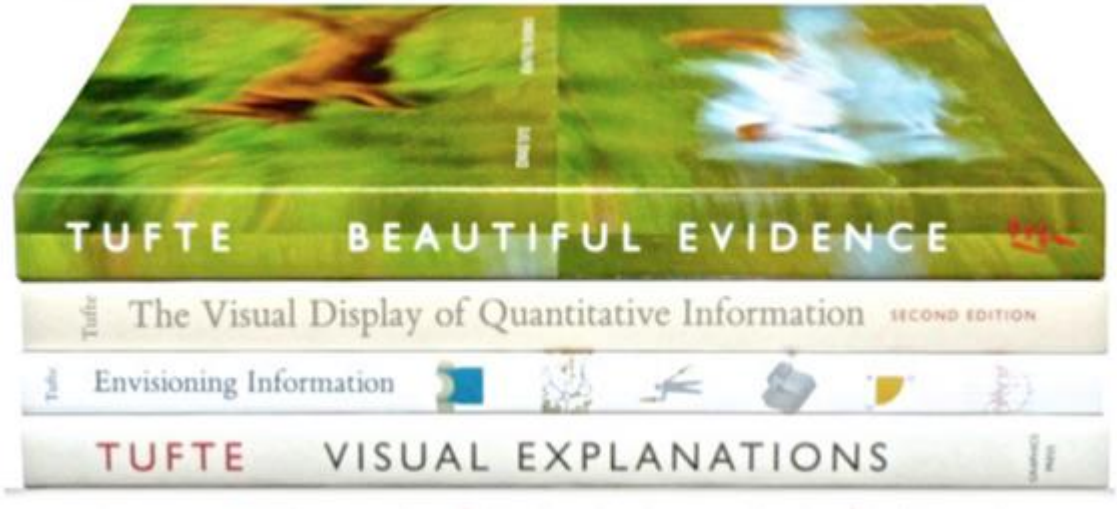
COMMUNICATING ASSUMPTIONS AND LIMITATIONS

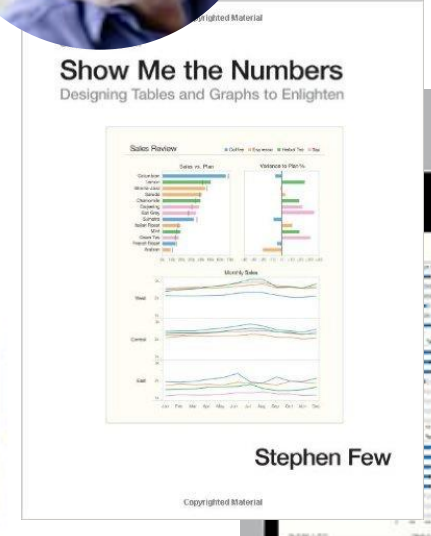
A good analysis must **avoid overstating** claims, and be **aware** of and be **honest** about what you don't or can't know!

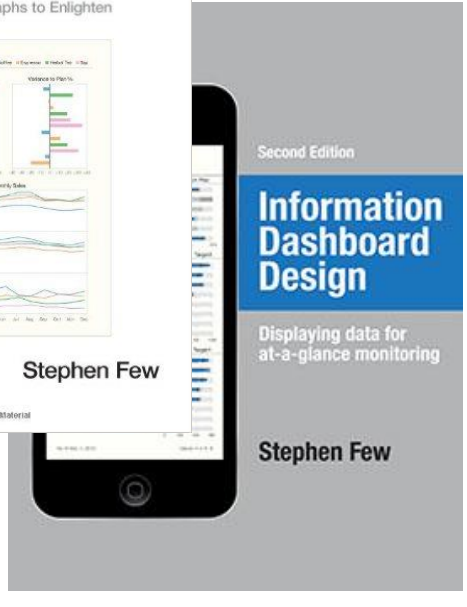
FURTHER READING

Edward Tufte

Stephen Few







GRAPHICAL INTEGRITY

- well-designed presentation of interesting data
  - substance, statistics, and design
- complex ideas communicated with clarity, precision and efficiency
- gives the viewer **greatest number of ideas** in the shortest amount of time, with the **least ink** and smallest space
- nearly always multivariate
- requires telling the truth

Edward Tufte

TUFTE'S INTEGRITY PRINCIPLES

- maximize the data-ink ratio
- avoid chart junk (sometimes)
- layer information
- maximize the data density
  - shrink the graphics
  - maximize the amount of data shown (sometimes)

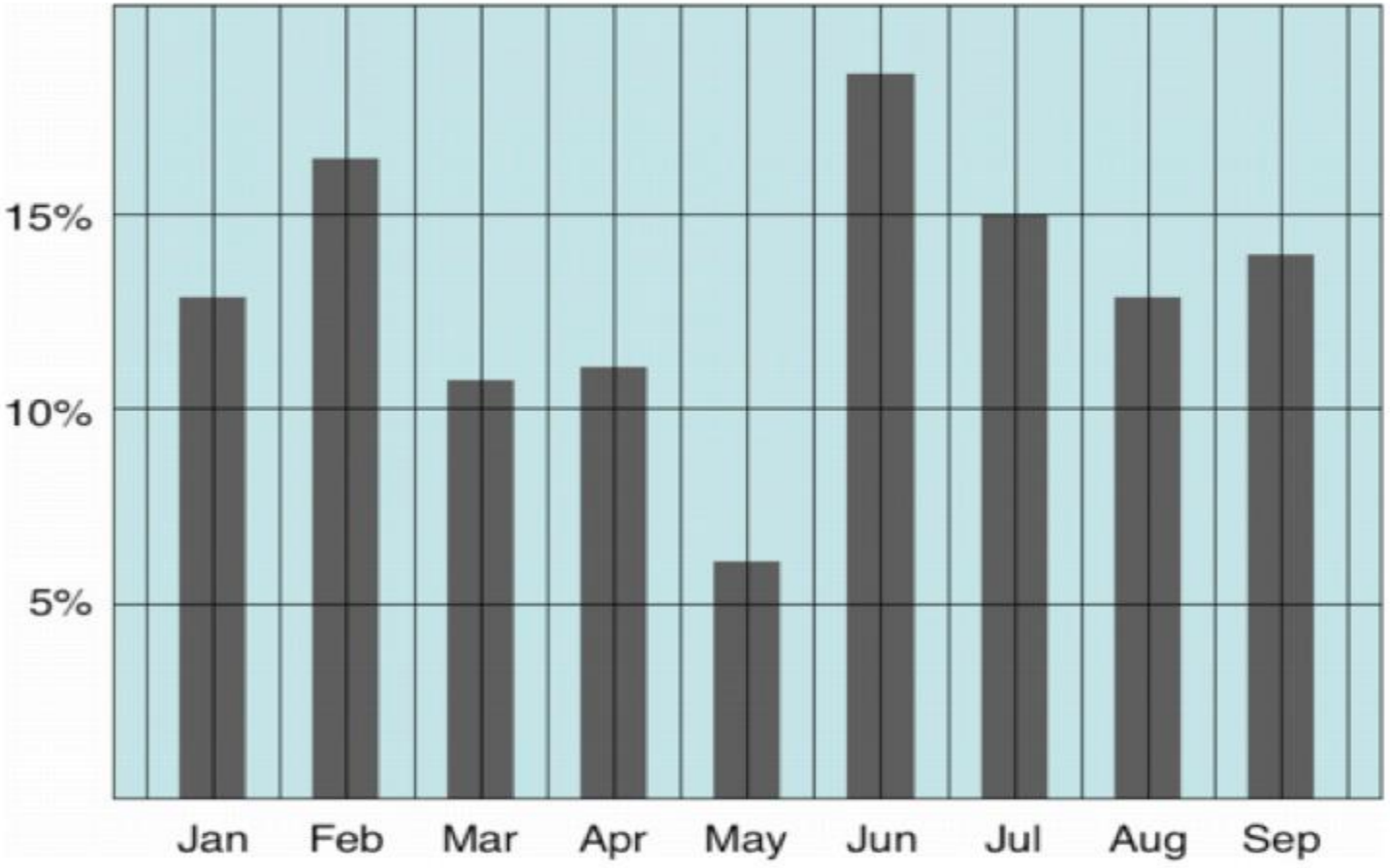
EDWARD TUFTE

DATA-INK RATIO

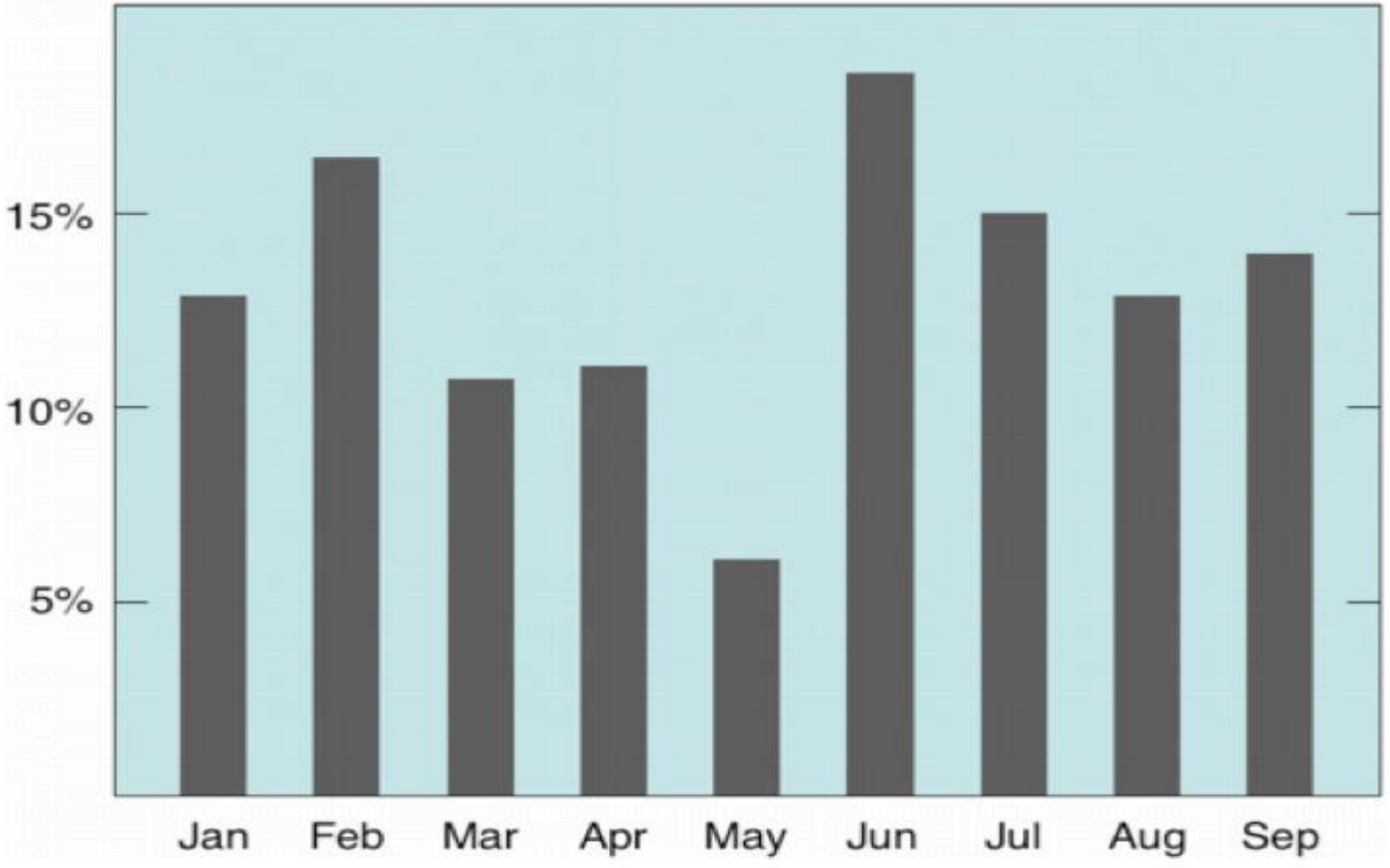
MAXIMIZE THE RATIO OF

$$\frac{\text{(INK USED TO SHOW DATA)}}{\text{(TOTAL INK USED)}}$$

DATA-INK RATIO



DATA-INK RATIO



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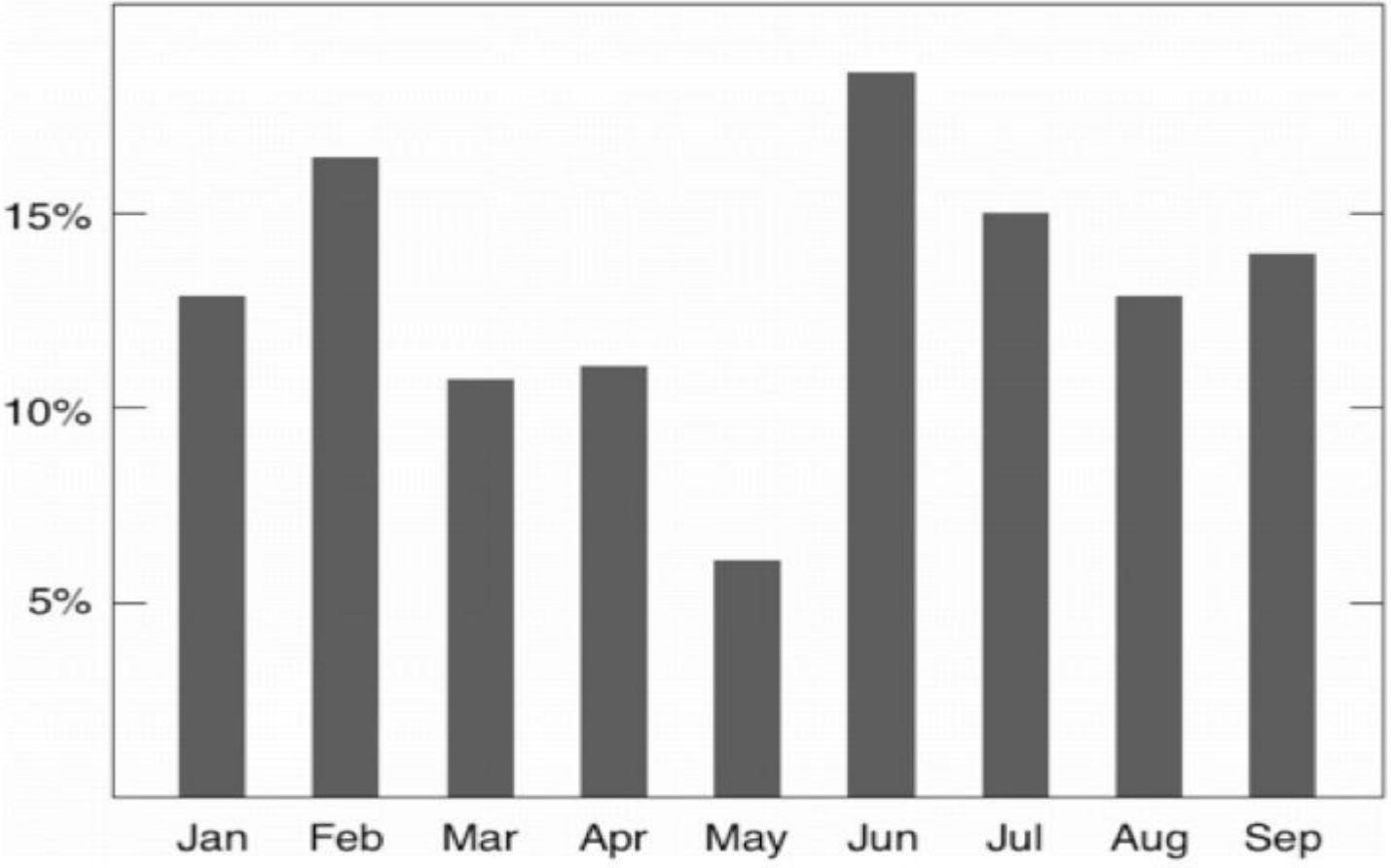

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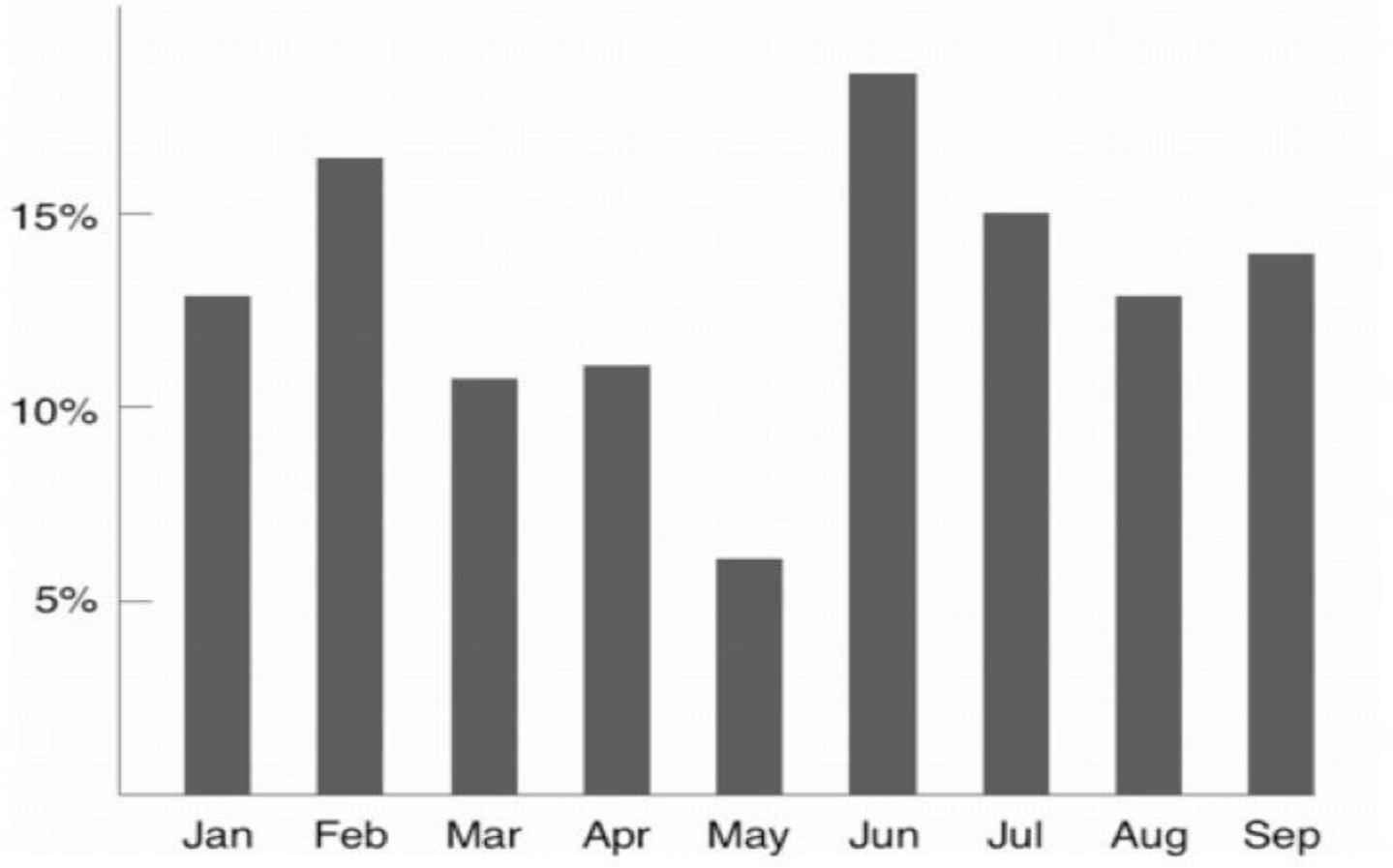

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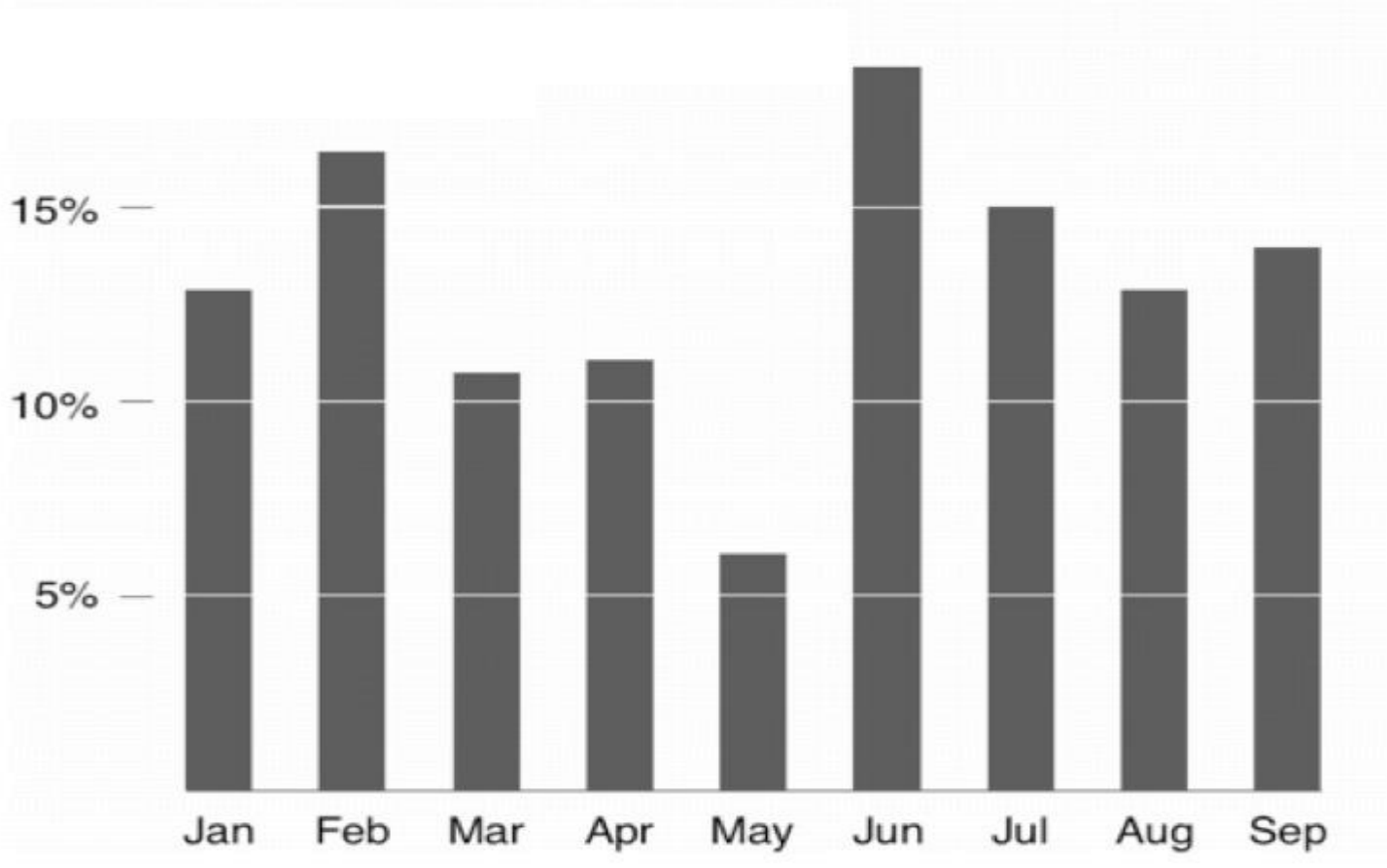

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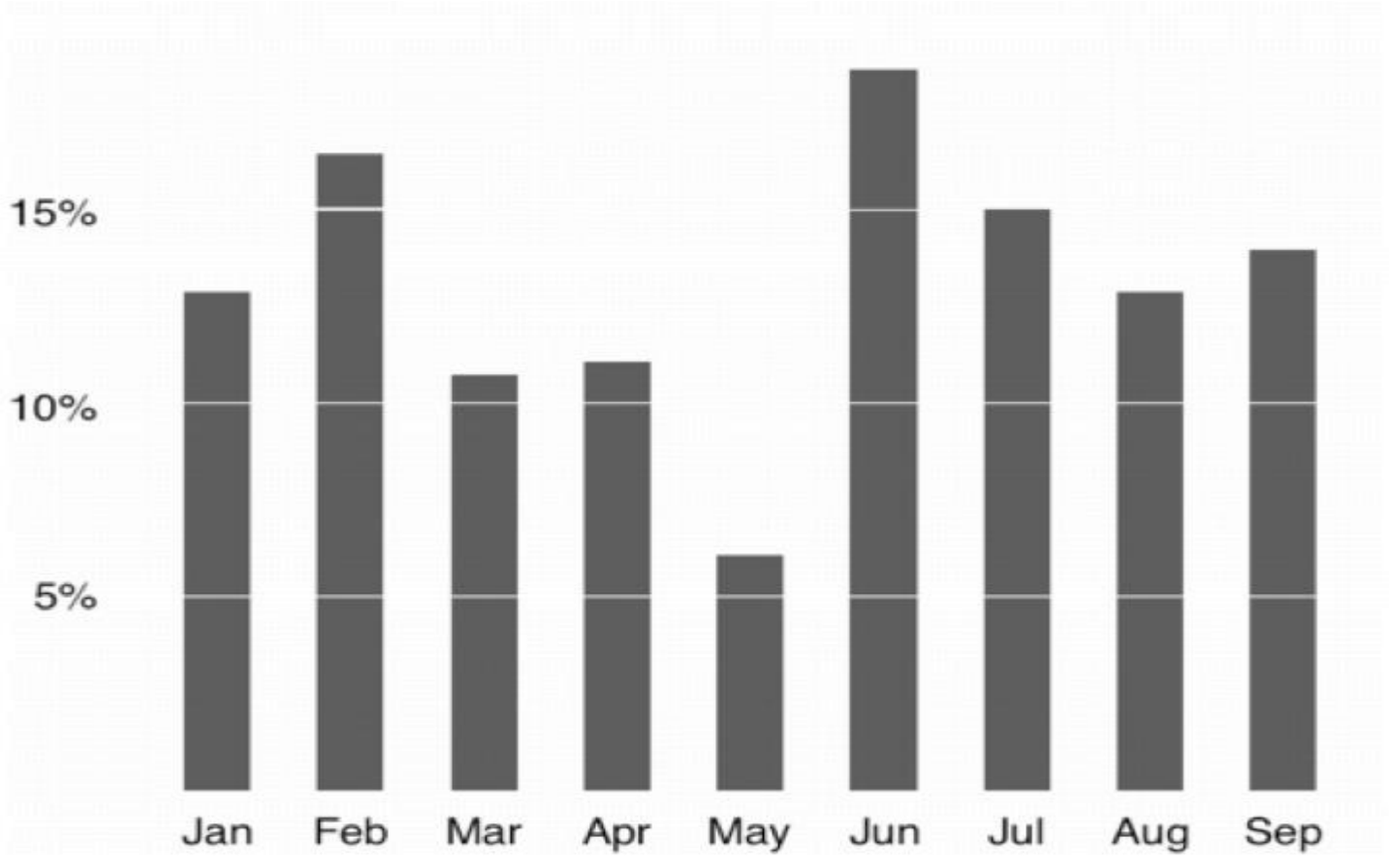

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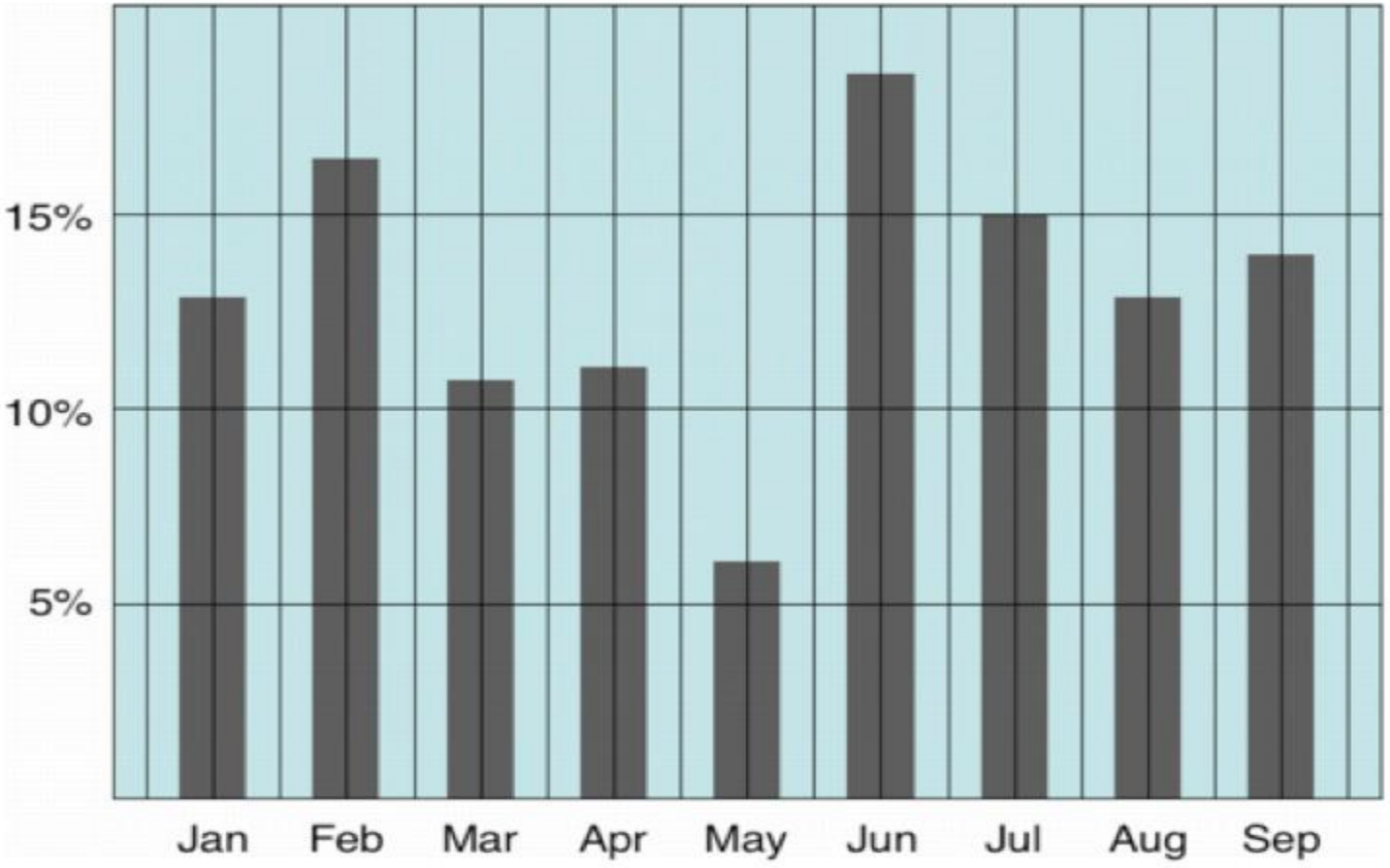

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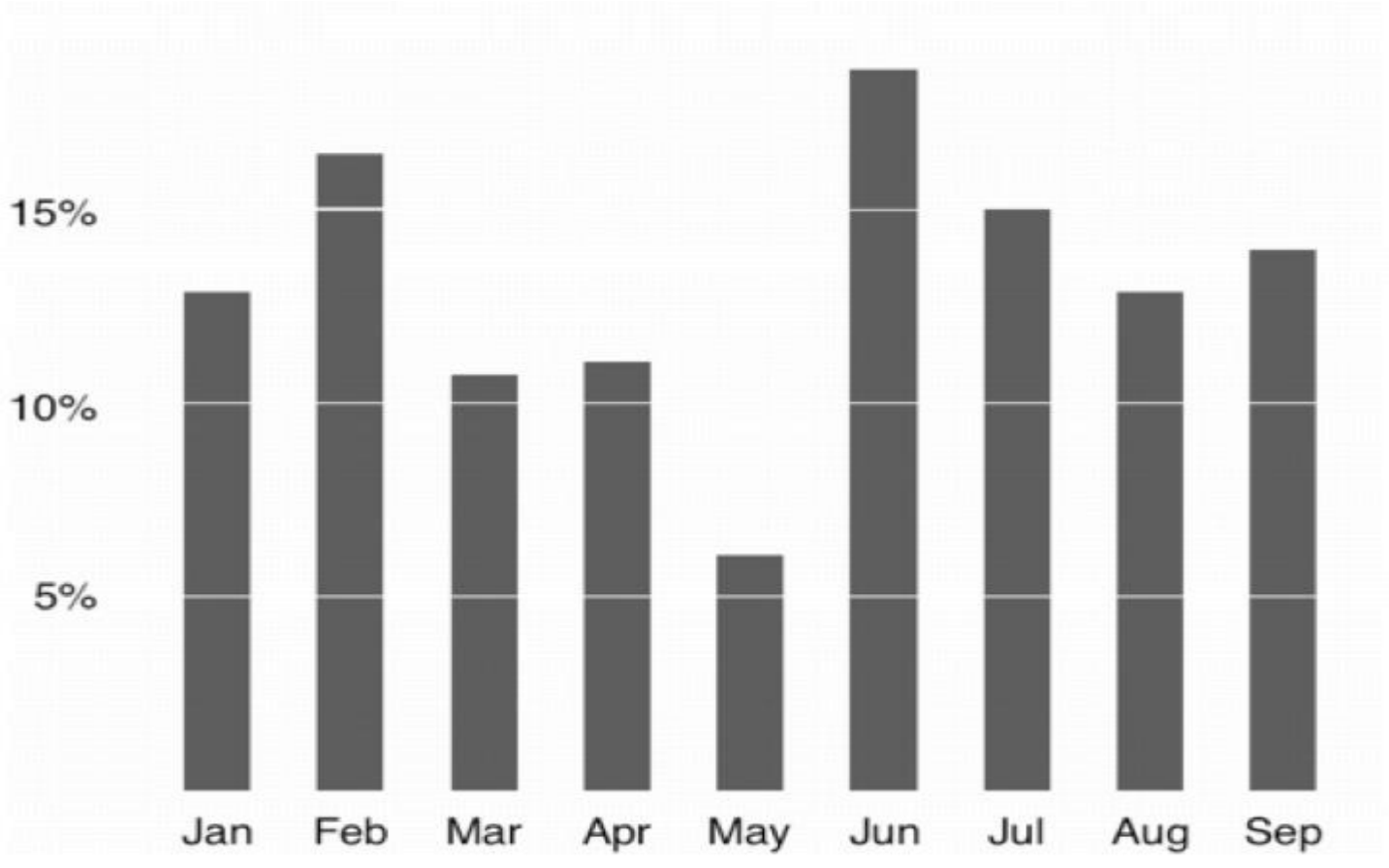
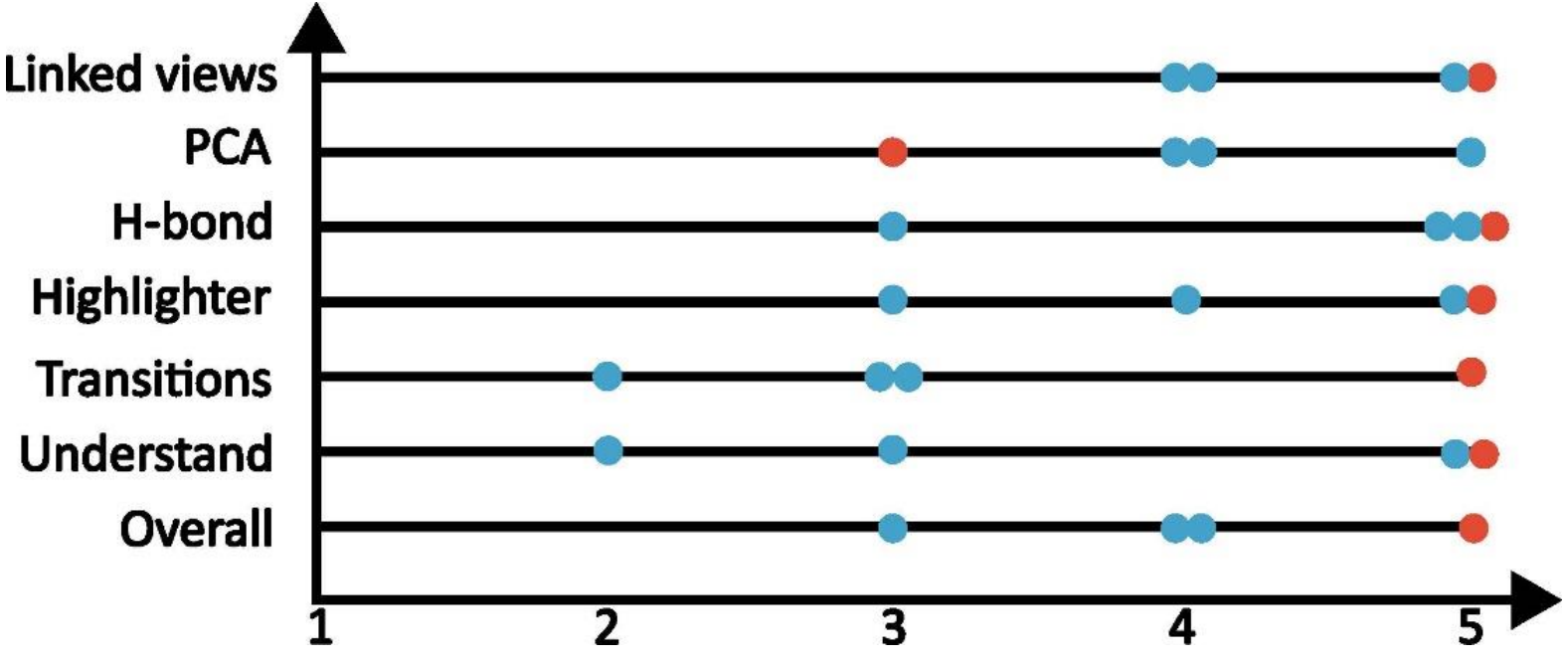
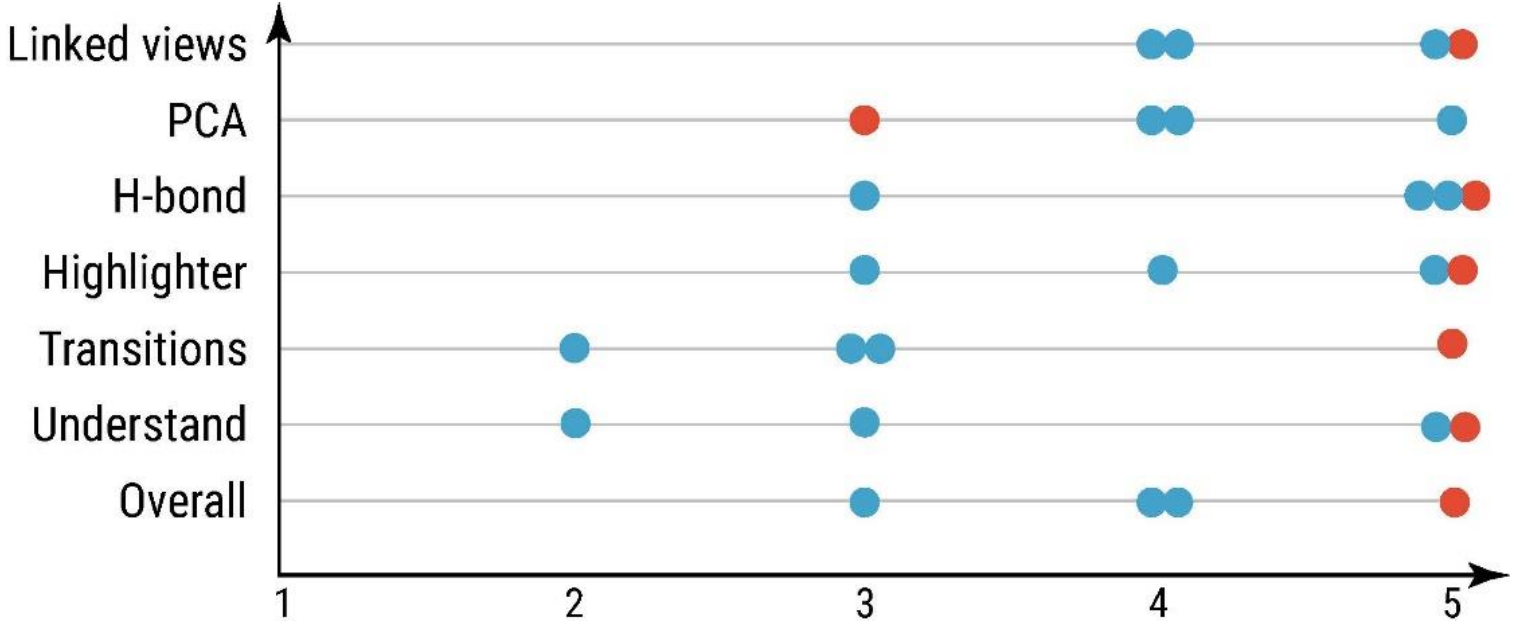


WHISPER, DON'T SCREAM



general idea: Bartram and Stone [2011]
https://doi.org/10.1109/TVCG.2010.237

WHISPER, DON'T SCREAM



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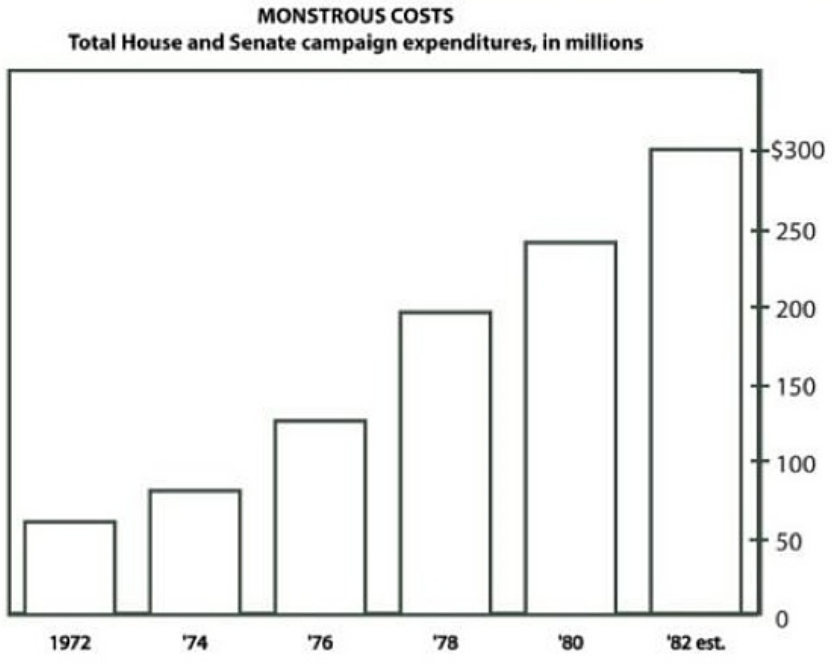
MINIMIZE CHART JUNK



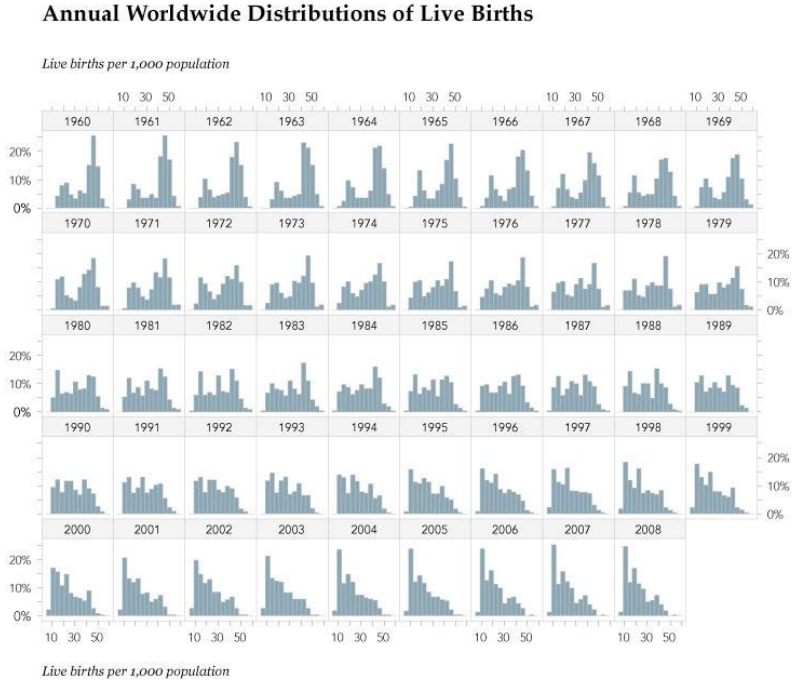
https://www.youtube.com/watch?v=fP-7rhb-qMg

DATA DENSITY

MAXIMIZE THE RATIO OF:

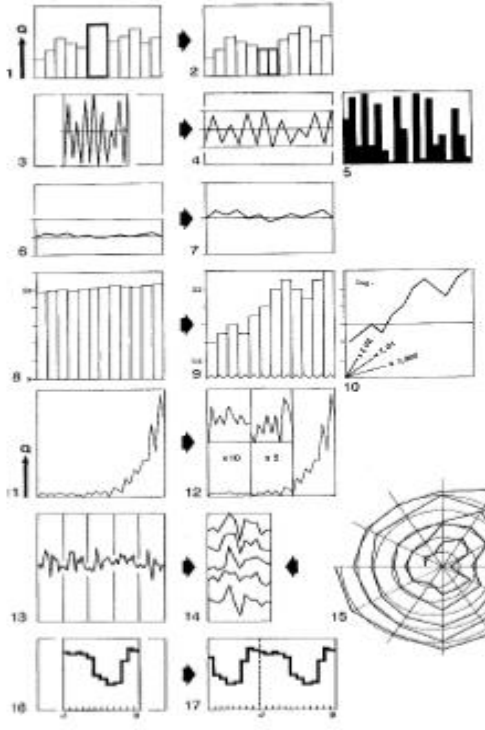
$$\frac{\text{(NUMBER OF ENTRIES IN DATA)}}{\text{(AREA OF THE GRAPHIC)}}$$

DATA DENSITY – SHRINK THE GRAPHICS



"SMALL MULTIPLES"

DATA DENSITY – SHRINK THE GRAPHICS



GRAPHIC PROBLEMS POSED BY TIME SERIES

Scale in years
With a scale in years, a two-year total (figure 1) should be divided by 2 (figure 2). A total for six months should be multiplied by 2.

Pointed curves
For overly pointed curves (figure 3), the scale of the Q should be reduced; optimum angular perceptibility occurs at around 70 degrees (figure 4).
If the curve is not reducible (large and small variations), filled columns can be used (figure 5).

Flat curves
For overly flat curves (figure 6), the scale of the Q should be increased (figure 7).

Small variations
For small variations in relation to the total (figure 8), the total loses its importance, and the zero point can be eliminated, provided the reader is made aware of this elimination (figure 9). The graphic can be interpreted as an acceleration if a precise study of the variations is necessary; here, we use a logarithmic scale (figure 10). (See also page 240.)

Large range
For a very large range between the extreme numbers (figure 11), we must either:
(1) leave out the smallest variations;
(2) be concerned only with relative differences (logarithmic scale), without knowing the absolute quantities;
(3) select different parts (periods) within the ordered component and treat them on different scales above the common scale (figure 12).

Obvious periodicity
If there is obvious periodicity (figure 13), and the study involves a comparison of the phases of each cycle, it is preferable to break up the cycles in order to superimpose them (figure 14). A polar construction can be used, preferably in a spiral shape (figure 15), but we should not begin with too small a circle. As striking as it seems, it is less efficient than an orthogonal construction.

Annual curves
For annual curves of rainfall or temperature, if a cycle has two phases (figure 17), why depict only one (figure 16)?

A contrast
Unlike what we see in figure 18, the pertinent or "new" information must be separated from the background or "reference" information. The background involves: (a) the invariant, highlighted by a heading (Port St. Michel); (b) the highly visible identification of each component (tonnage and dates). The new information (the curve) must stand out from the background (figure 19).

Reference points
It is impossible to utilize a graphic such as figure 20, except in a general manner. There is confusion concerning the position of the points, and no potential comparison is possible, as it is in figure 21.

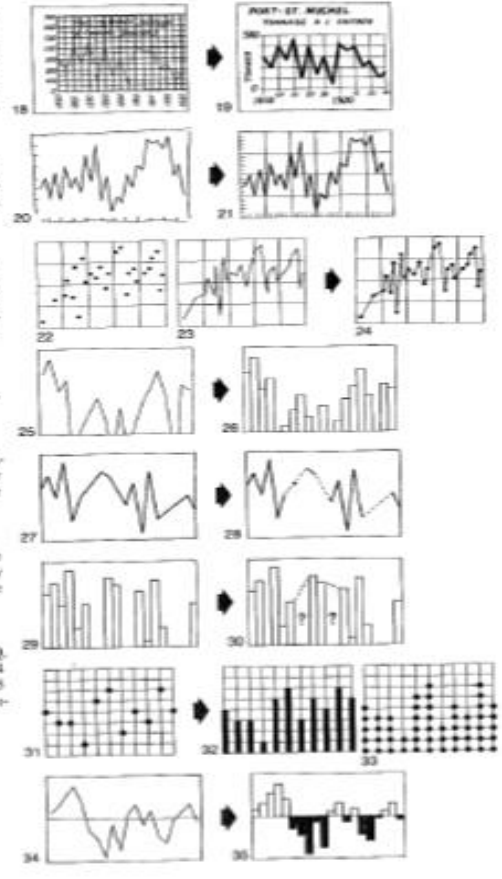
Precision reading
A precision reading (utilization on the elementary level, as in figure 24) is difficult in figure 22, which results in a poor reading of the order of the points, and in figure 23, where there is ambiguity concerning the position of the points. On the other hand, figure 22 does favor overall vision (correlation).

Null boxes
Curves accommodate null boxes poorly (figure 25). Columns (figure 26) are preferable.

Unknown boxes
The drawing must indicate the unknowns of the information in an unambiguous way (figures 28 and 30).The reader might interpret figure 27 as a change in the structure of the curve and figure 29 as involving null values.

Very small quantities
Except in seeking a correlation (quite improbable here) the number of ships entering into a port is represented better by figure 33 than by figures 31 or 32. The reader can perceive the numerical values at first glance.

Positive-negative variation
This is in fact a problem involving three components O, Q, ≠ (+ –), and it must be visually treated as such. Figure 34 can be improved by utilizing a retinal variable (in figure 35 a value difference: black–white) to differentiate the ≠ component and thus highlight positive-negative variation.



Bertin 1967

DATA DENSITY – SHRINK THE GRAPHICS

Placed in the relevant context, a single number gains meaning. Thus the most recent measurement of glucose should be compared with earlier measurements for the patient. This data-line shows the path of the last 80 readings of glucose:

glucose 6.6

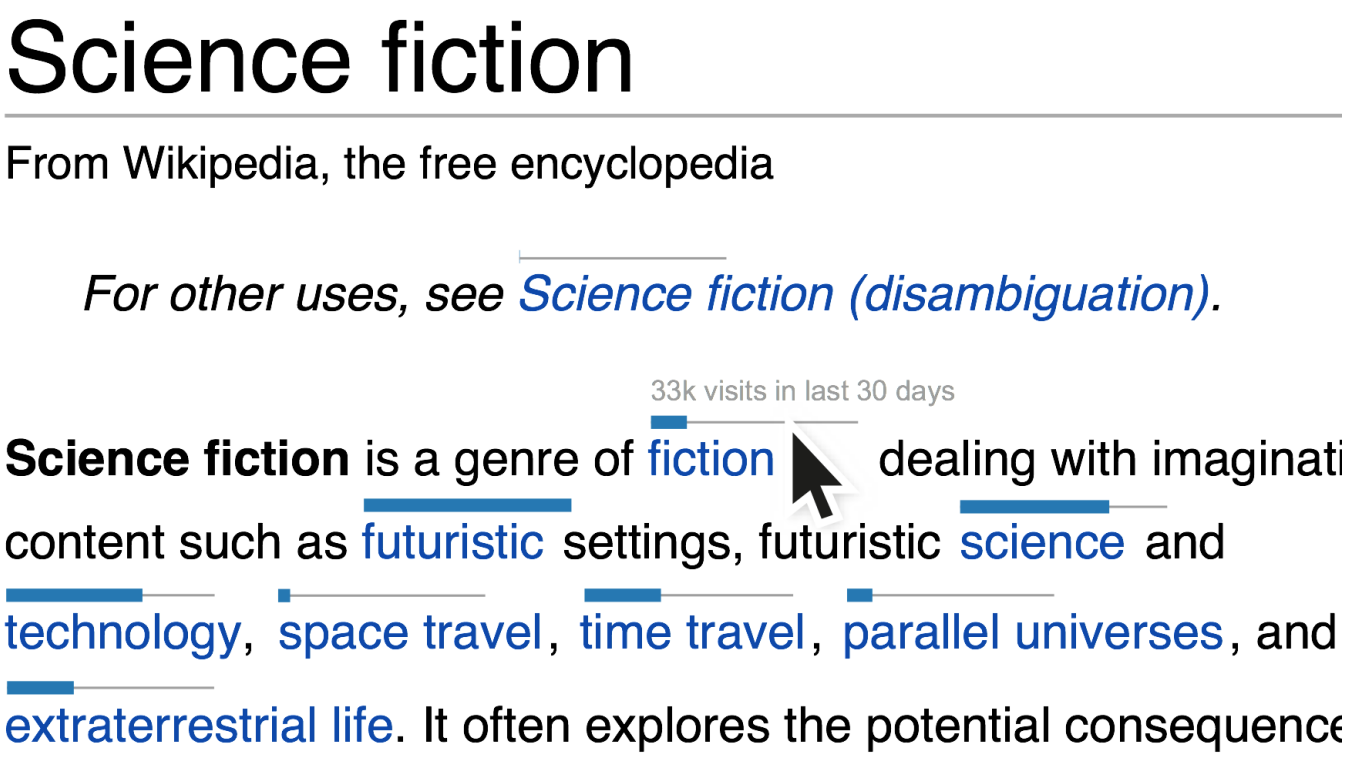
Lacking a scale of measurement, this free-floating line is dequantified. At least we do know the value of the line's right-most data point, which corresponds to the most recent value of glucose, the number recorded at far right. Both representations of the most recent reading are tied together with a color accent:

glucose 6.6

Some useful context is provided by showing the *normal range* of glucose, here as a gray band. Compared to normal limits, readings above the band horizon are elevated, those below reduced:

glucose 6.6 or glucose 6.6

SPARKLINES & WORD-SCALE VIS



SPARKLINES & WORD-SCALE VIS

EASTERN EUROPE

Soviet cult and pragmatism in Transnistria

Experts worry that the next "Crimea" could be the breakaway region of Transnistria Many locals there don't share that f[illegible]r, and if the last referendum holds, a large majority would welcome a Russian annexation.

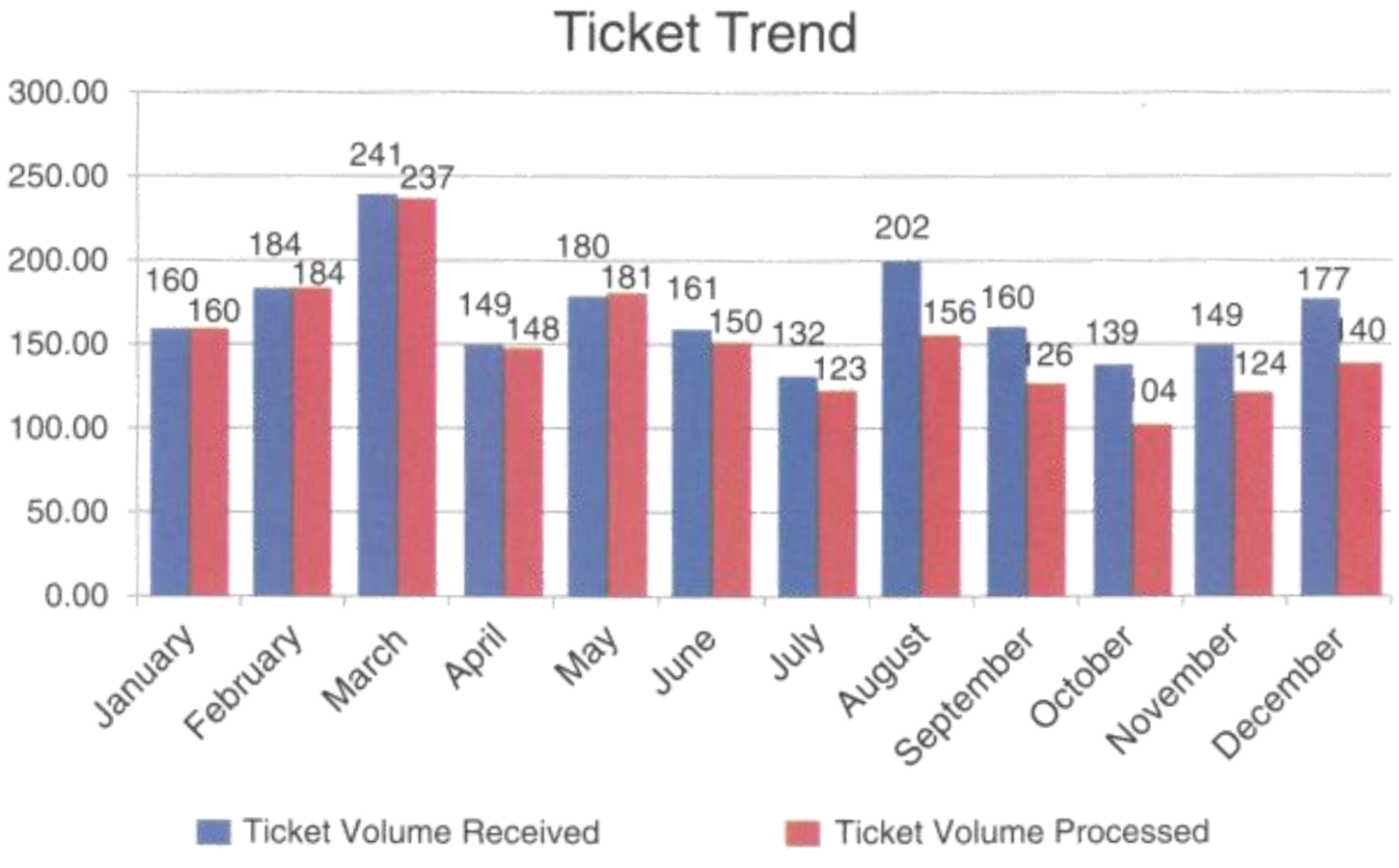
SPARKLINES & WORD-SCALE VIS

Gonzalo Higuaín slides a cross in from the right and Ronaldo, at the front post, shoots off target.

STORYTELLING WITH DATA

Design of Visualization for Communication

The chart was designed to argue for the hire of two new, additional employees

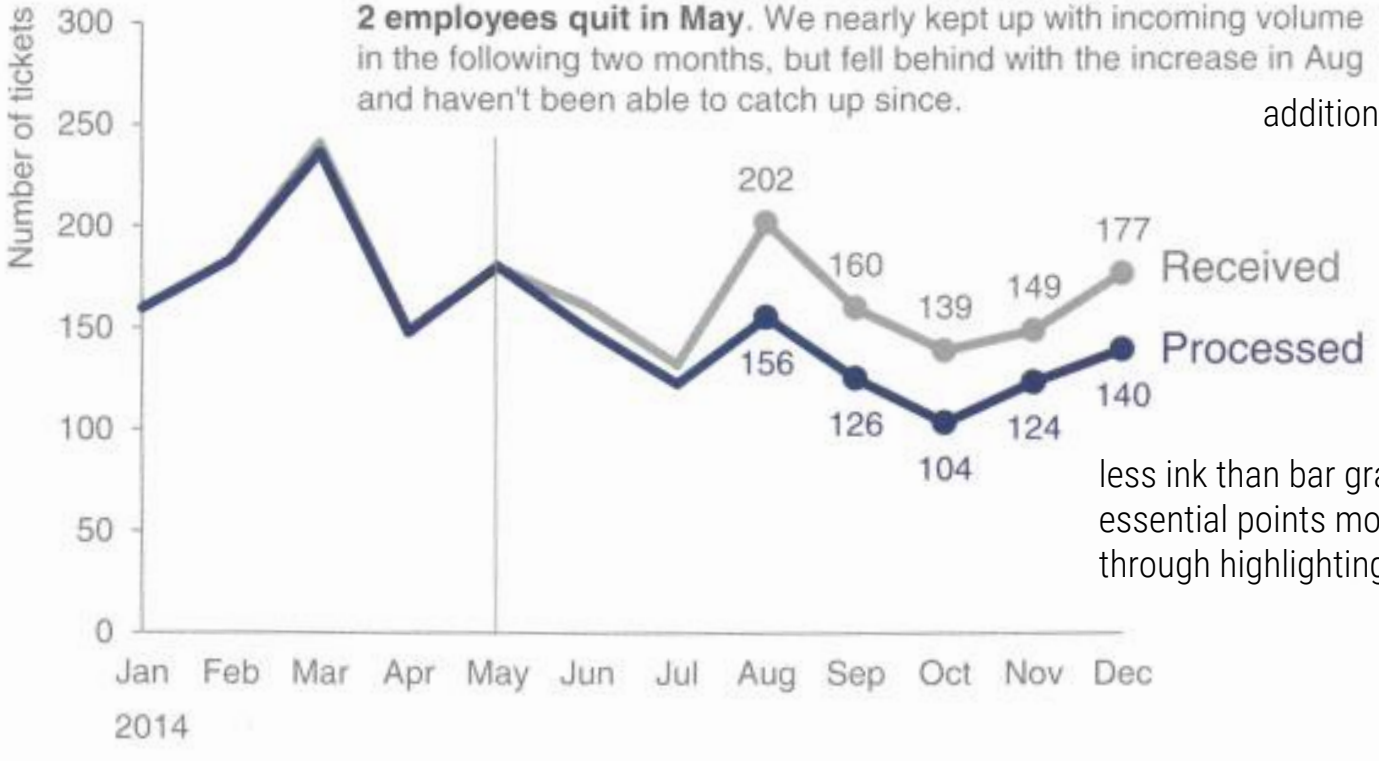


Please approve the hire of 2 FTEs

to backfill those who quit in the past year

title(s) to say what it's about, clear explanation of goal

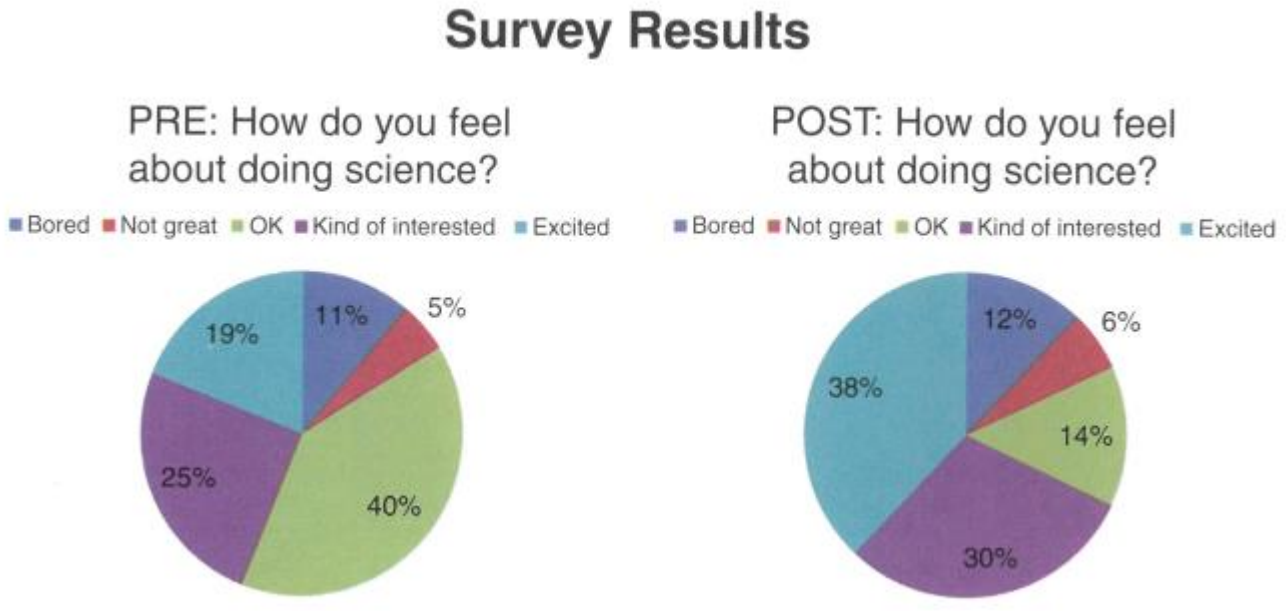
Ticket volume over time



additional context

less ink than bar graphs, essential points more clear through highlighting

think about how to improve this visualization for a few moments …



survey conducted on 100 students before and after a pilot program

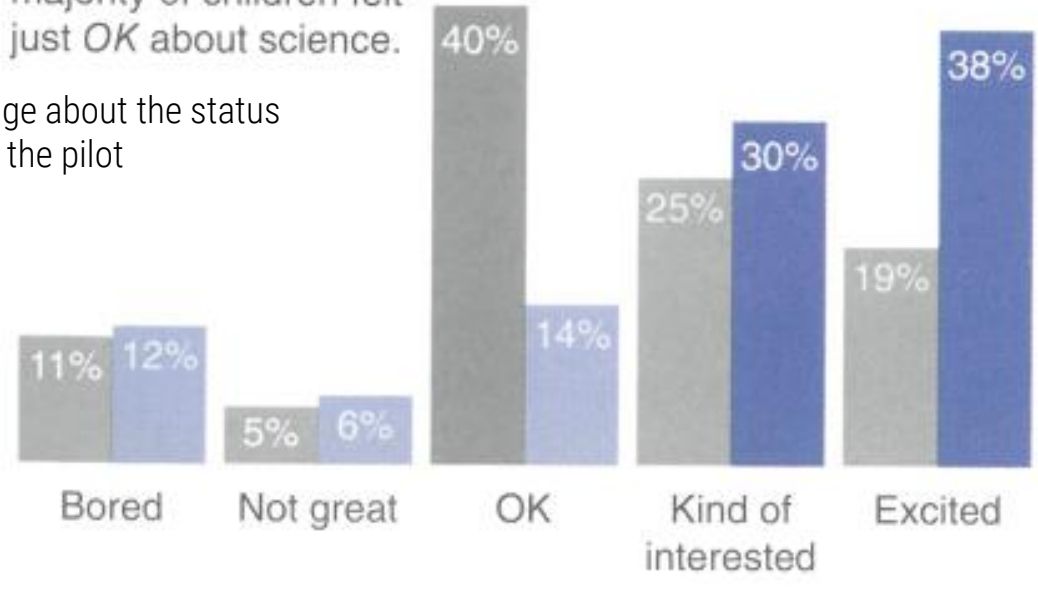
Pilot program was a success

title(s) to say what it's about, clear explanation of goal

How do you feel about science?

BEFORE program, the majority of children felt just *OK* about science.

message about the status before the pilot



AFTER program, more children were *Kind of interested* & *Excited* about science.

message about the status after the pilot

less ink in form of bar graphs and only one color, highlighting to show the important take-aways

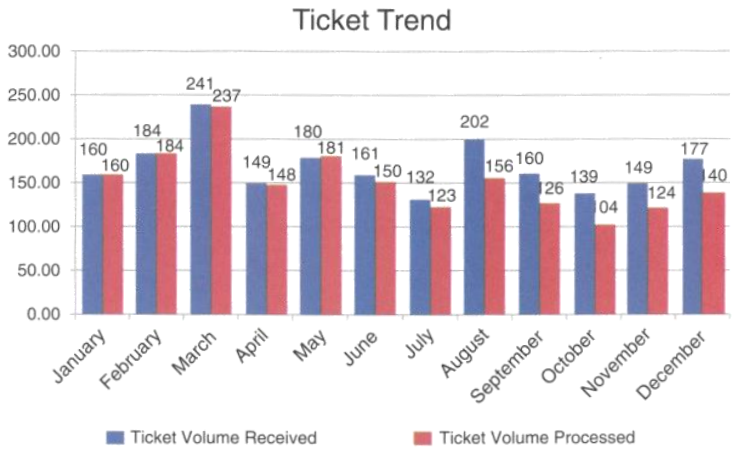
KNOW YOUR CONTEXT

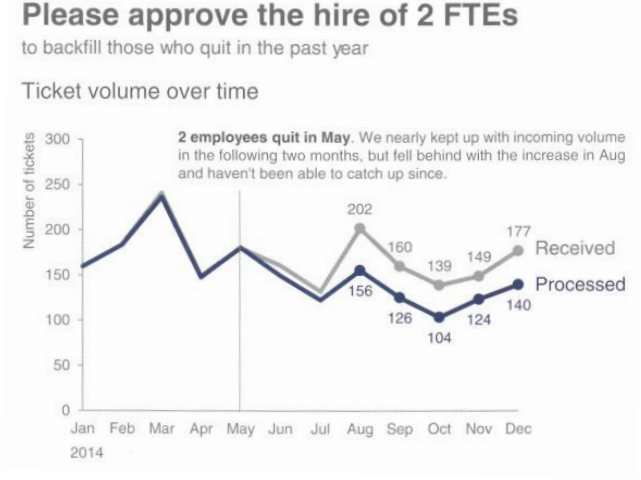
AUDIENCE, MEDIUM, MESSAGE

WHO DO YOU WANT TO COMMUNICATE TO?

YOUR AUDIENCE

- What do they want to know?
- What do they need to do?
- What level of information do they have already?





WHAT IS YOUR MEDIUM?

MEDIUM

- how much control does the audience have over the presentation?
- how much detail can they get?

LIVE PRESENTATION vs. ONLINE VISUALIZATION

WHAT DO YOU WANT TO SHOW?

QUESTIONS

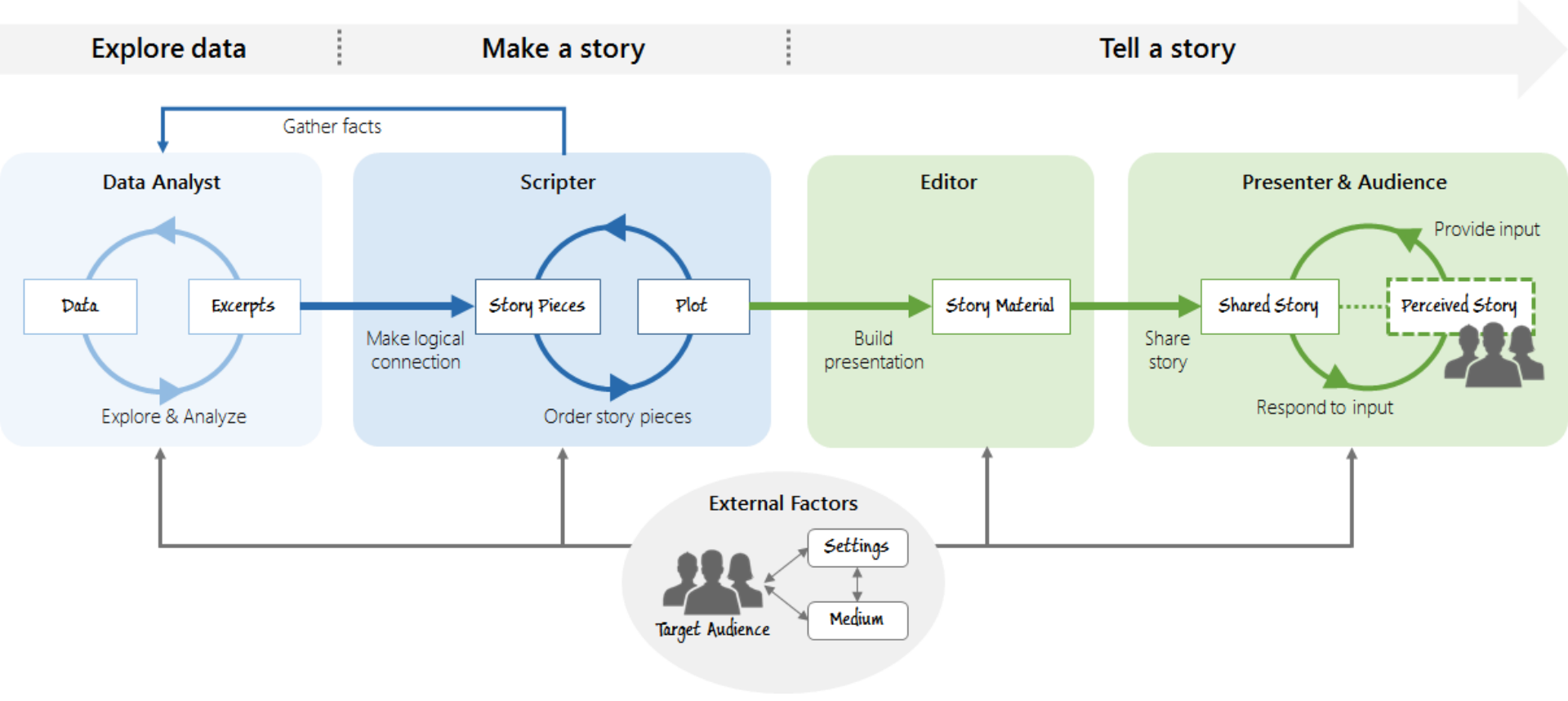
IN A SINGLE SENTENCE

IN 3 MINUTES

WHAT IS YOUR MESSAGE?

WHAT DOES YOUR AUDIENCE NEED TO KNOW?

FIGURE THIS OUT BEFORE YOU IMPLEMENT ANYTHING



Lee et al. 2015

LAYOUT

catch attention

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FEATURED

U.S. Says It May Not Need Apple's Help to Unlock iPhone

By KATIE BENNER and MATT APUZZO 2:51 PM ET

Marcio Jose Sanchez/Associated Press

A court hearing set for Tuesday was canceled in the Justice Department's bid to gain access to phone data in the San Bernardino mass shooting inquiry.

404 Comments

- **Breaking Down Apple's iPhone Fight With the U.S. Government**
- **White Collar Watch: Apple May Be Willing to Risk Contempt Charge**

MORE NEWS

Chip-Card Payment System Delays Frustrate Retailers

By RACHEL ABRAMS 3:53 PM ET

Many complications were widely predicted, but a lag in certifying payment terminals has added an unexpected wrinkle — and lots of finger-pointing.

TECH TIP

Keeping Up With Android Security Patches

By J. D. BIERSDORFER

After a nasty Android bug surfaced last summer, Google has been sending out monthly updates for the software on its Nexus hardware.

Apple and Yahoo Each Struggle for Control of Their Futures

Daily Report

By QUENTIN HARDY

Apple is in a courtroom fight with the Justice Department, while Yahoo is contending with a sliding stock price and an activist hedge fund.

CrowdSignals Aims to Create a Marketplace for Smartphone Sensor Data

By STEVE LOHR

A new project seeks to collect, label and pay for mobile sensor data and encourage innovation in many fields.

Andrew S. Grove, Intel Chief Who Spurred Semiconductor Revolution, Dies at 79

By JONATHAN KANDELL

The semiconductor chip was a development as momentous as hydrocarbon fuels, electricity and telephones were in

BITS

Insight and analysis on Silicon Valley and the technology industry.

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PERSONAL TECHNOLOGY

Instagram May Change Your Feed, Personalizing It With an Algorithm

By MIKE ISAAC

As our online networks of friends have grown and the social media companies have matured, feeds are evolving, too.

APP SMART

Checklists and Tips to Help Streamline Spring Cleaning

By KIT EATON

It's time for spring cleaning again, and some apps can help users stay organized while getting their homes in order.

TECH TIP

Speaking Your Mind to Google Docs

By J. D. BIERSDORFER

An external microphone can help you be better understood by Google's online word-processing program when you type by talking.

TECH TIP

Marking Up a Mac's iBook Pages

By J. D. BIERSDORFER

Apple's e-books program for OS X includes tools for making margin notes, highlighting passages and sharing your favorite parts of the story.

TECH TIP

Recording Live Television in Windows 10

By J. D. BIERSDORFER

If you miss the digital-video recording functions of Windows Media Center, you can find other ways to watch and record your favorite broadcast shows.

TECH TIP

Getting the Weather Report From Windows

By J. D. BIERSDORFER

Windows 10 offers several ways to get a forecast on your screen.

APP SMART

Mobile Games to Make Time Fly

By KIT EATON

Here are some of the best games to take the boredom out

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U.S.

The Terminator and the Washing Machine

What the legendary matches between supercomputer Deep Blue and chess grandmaster Garry Kasparov reveal about today's artificial intelligence and machine learning fears.

catch attention

LIAR LIAR

Most of us like to think we can get ahead in life while keeping our noses clean. But, as ***Ian Leslie*** *explains, we only got to the top of the evolutionary tree because we had a gift for misrepresentation*

You could call it humanity's dirty little secret. What helped to make us the most intelligent species on Earth was, to be honest, our talent for deception.

The human brain, possibly evolution's most impressive achievement, is also a bit of a mystery. We have much bigger brains, relative to our bodies, than any other mammal. Our hominid ancestors had brains about a third the size of ours. At some point between 2 and 1.5 million years ago, our ancestors' brains began to expand, and at quite a rate. Scientists have never been sure why.

For a long time, the nearest thing to an accepted explanation was that our intelligence resulted from our facility for making tools. But in the early 1980s, two young primatologists at the University of St Andrews began to wonder if it wasn't linked to something less flattering to our self-image: a capacity for deceit.

Richard Byrne and Andy Whiten had read descriptions of chimpanzee trickery in the works of Jane Goodall, and during their own fieldwork in the Drakensberg mountains of South Africa they noticed baboons engaging in deceptive behaviour. For instance: a young baboon gets in trouble with several elders, including his mother, for attacking another member of the group. When he hears them coming for him, grunting aggressively, he stands and stares into the distance. The elders, thinking that a predator or rival troop must be approaching, stop and stare too. There is no threat. But the elders are distracted enough to forget what they came running over for.

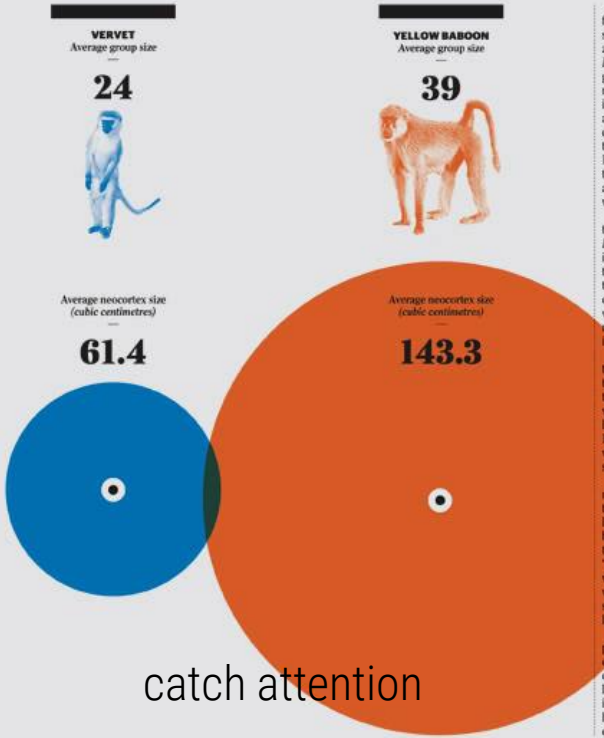
Another example: an adult male baboon shoves a female off her feeding patch. Rather than protest or retreat, she flicks her gaze in a characteristic way from him to a younger male who is happily feeding nearby. The first male charges over to the younger one and chases him away. The female, meanwhile, returns to her patch and resumes feeding.

When Byrne and Whiten asked around, their colleagues regaled them with similar anecdotes. The two developed a hunch: that these stories represented something beyond aberrant aspects of primate behaviour, and that our closest relatives — chimps, gorillas and orang-utans — are practised, habitual deceivers. Byrne and Whiten also began to suspect that such behaviour might be linked to the development of primate intelligence: those animals with the mental sophistication to trick their way into getting more food, as our female baboon did, would have had a reproductive edge. Through the slow work of natural selection, the primate brain evolved to cope with the demands of such trickery.

So a connection between deception and mental capacity in our primate ancestors might help to explain the development of our own brains. This was an exciting thought. But initially, Byrne and Whiten found it hard to get any of their research published despite amassing a substantial body of evidence. Deception just was not a subject that many in their field took seriously.

BRAIN SIZE

2.5-1.6 million years ago	1.8-1 million years ago	600,000 years ago	200,000 years ago
(Homo habilis)	*(Homo erectus)*	*(Homo neanderthalensis)*	*(Homo sapiens)*



catch attention

In 1982, however, they gained new impetus from a book that gave a gripping account of the shifting relationships within a colony of chimpanzees in a Dutch zoo. Franz de Waal's *Chimpanzee Politics* reads like the script of a soap opera or gangster movie. Alliances are formed, broken and re-formed, individuals are manipulated, violence is selectively employed, females are fought over and seduced. De Waal prefaced his book with quotes from Hobbes and Machiavelli, suggesting that this was a vision of human politics in the raw. Byrne and Whiten were fascinated, particularly by those episodes that showed deceptive behaviour, as when a chimp, presenting himself as a friend, would suddenly attack an unsuspecting rival.

In 1988 the two primatologists finally published their work in the form of a book, *Machiavellian Intelligence*. An unsettling read, it explored "the idea that intelligence began in social manipulation, deceit and cunning co-operation", showing that animals, far from living in a state of innocence, are as manipulative and underhand as the worst of our own species. It was persuasive too, making a big impact not only in primatology but in psychology, anthropology and medicine.

Byrne and Whiten believed that what they termed Machiavellian intelligence was linked to the size of the group an animal lived in: the bigger the group, the more complex the calculations individuals needed to make to survive. But there was little hard evidence for this until 1992, when Robin Dunbar, at the University of Liverpool, came up with a way to demonstrate a link between brain size and the complexity of an animal's social life.

Dunbar, too, had noticed that the size of a primate's brain appeared to be related to the size of the group it lived in. Baboons have big brains and live in big groups; vervets, who have smaller brains, live in smaller groups. He decided to investigate by looking at the neocortex. This is the "thinking" part of the brain: the part that deals with abstraction, self-reflection and planning. It was also the part that showed such rapid expansion in primates — especially humans — two million years ago.

Dunbar plunged into the vast accumulation of primate data from around the world, looking for a correlation between the size of an animal's neocortex and the size of its social groups. He found a link so strong that he was able to predict, with impressive accuracy, the group size of a species he hadn't looked at, just by knowing its brain size. He even came up with a prediction for human →

SEEING IS DECEIVING

Many species, not just primates, practise deception as one of their survival strategies. The eastern hognose snake will, if threatened, fake its own death by rolling over on its back, emitting a foul stench and letting its tongue loll out of its mouth. The mimic octopus, found in the waters off Bali in Indonesia, can disguise itself as one of several other sea creatures, all the better to lure its prey.

Even plants deceive. The mirror orchid of North Africa produces small flowers to attract potential pollinators. The flowers have no nectar, but the orchids have a special ruse to seduce the wasps that pollinate them: they impersonate female wasps. The blue-violet centre of the flower resembles the wings of a female wasp at rest, while a thick set of long red hairs imitates the hairs on the insect's abdomen. It's bait — insect porn for horny male wasps.

THE MIMIC OCTOPUS...

... as a sea snake

... as a lion fish

... and a flatfish

further information

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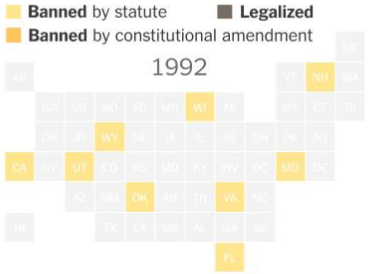
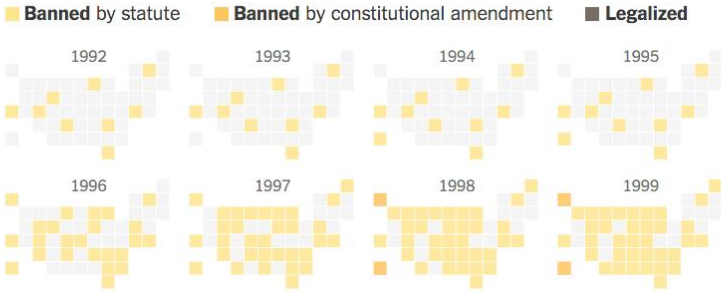


Gay Marriage State by State: From a Few States to the Whole Nation

By HAEYOUN PARK

The Supreme Court in June said that same-sex couples had a constitutional right to marry, effectively requiring that the 13 states that prohibit such unions reverse those bans. Over the last two years, the number of states authorizing gay marriage had expanded rapidly because of legislative decisions, referendums or court orders.



A ruling by the Hawaii Supreme Court in 1993 allowing same-sex marriage, along with rising demands for marriage equality nationwide, prompted a backlash. A majority of states, including Hawaii, adopted laws or constitutional amendments that limited marriage to a man and a woman. In 1996, Congress passed the Defense of Marriage Act, banning federal recognition of same-sex marriage.

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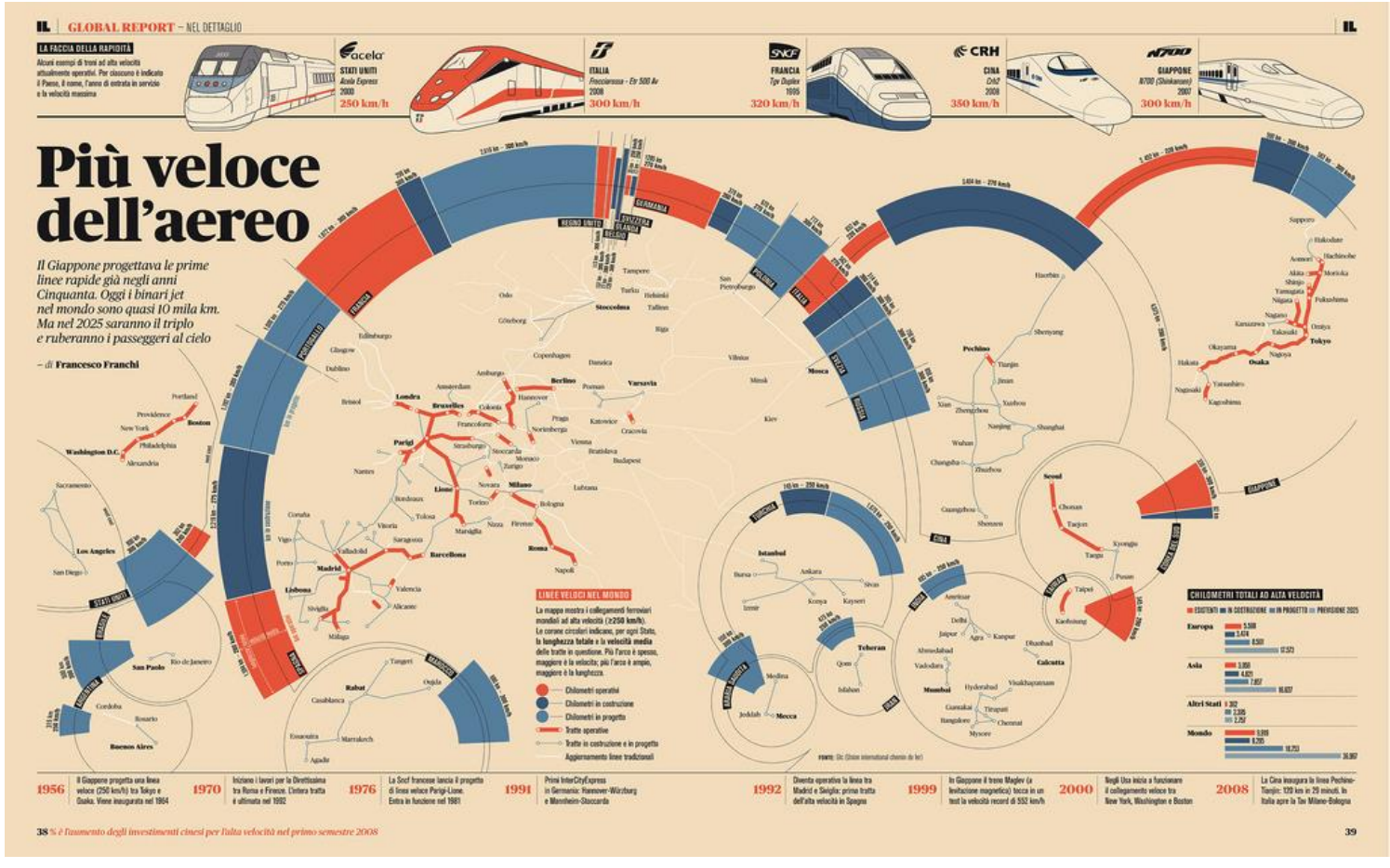
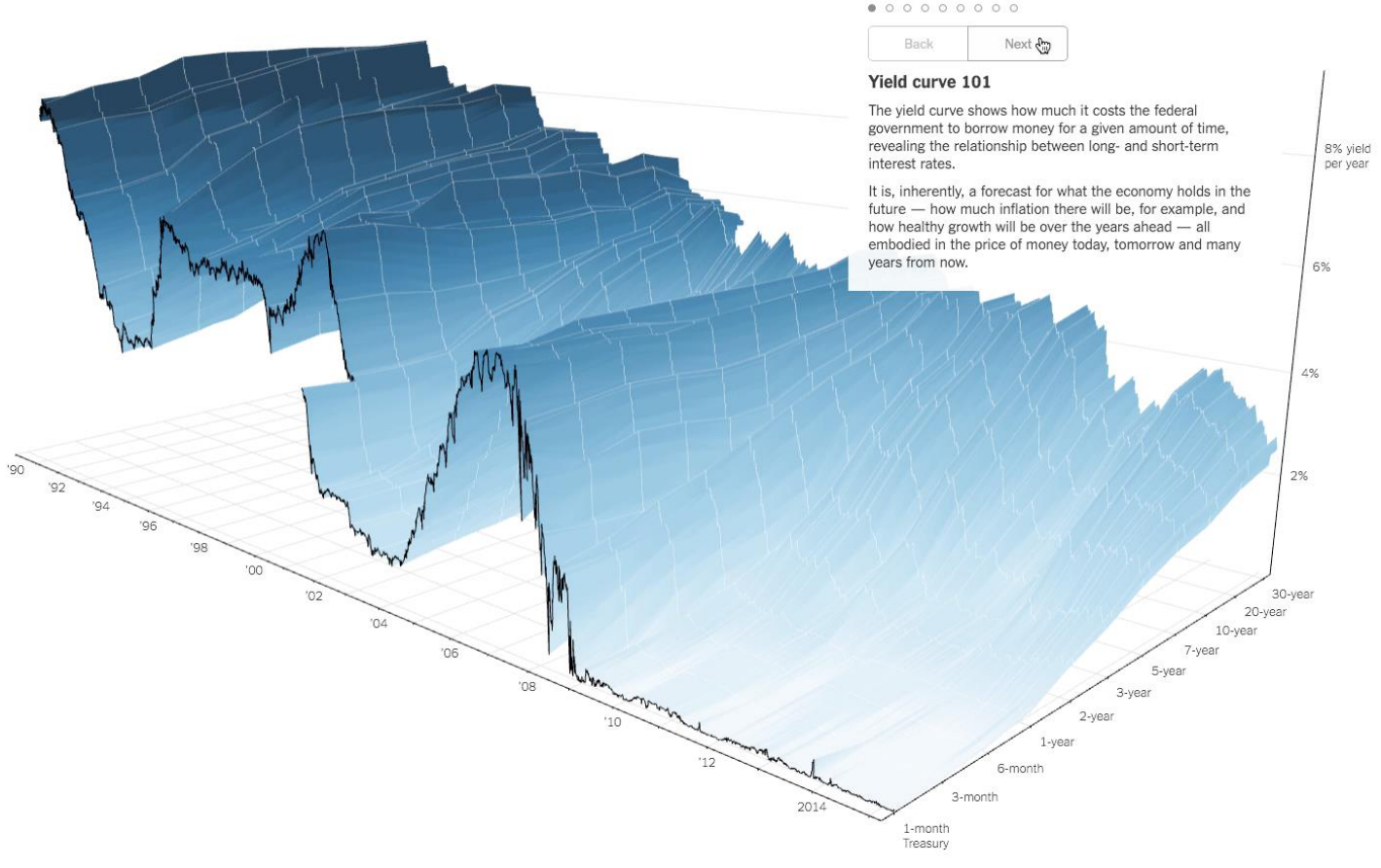
BUT LAYOUT IS ALSO IMPORTANT FOR INTRODUCING SELF-CONTAINED **INFOGRAPHICS** AND **INTERACTIVE CHARTS**



A 3-D View of a Chart That Predicts The Economic Future: The Yield Curve

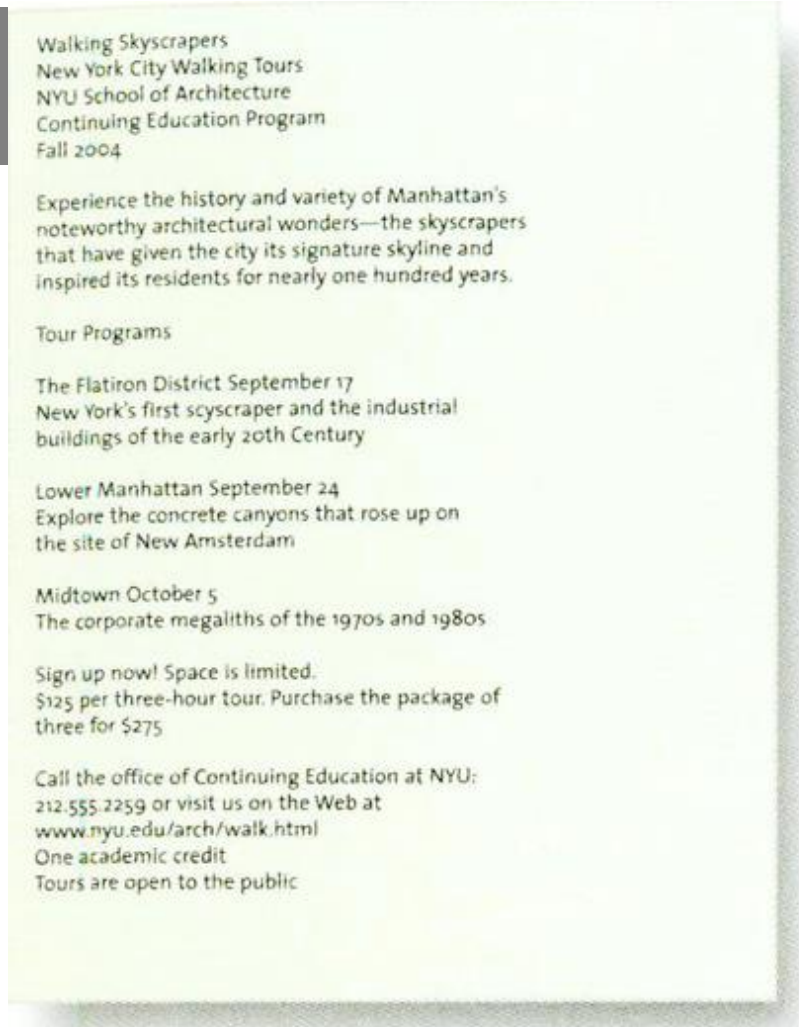
By GREGOR AISCH and AMANDA COX MARCH 18, 2015



DIRECT ATTENTION

DRAW ATTENTION TO ONE THING FIRST.

THEN USE COLOR, SIZE, SPACE, AND PLACEMENT TO DIRECT VIEWERS TO THE NEXT IMPORTANT POINT.



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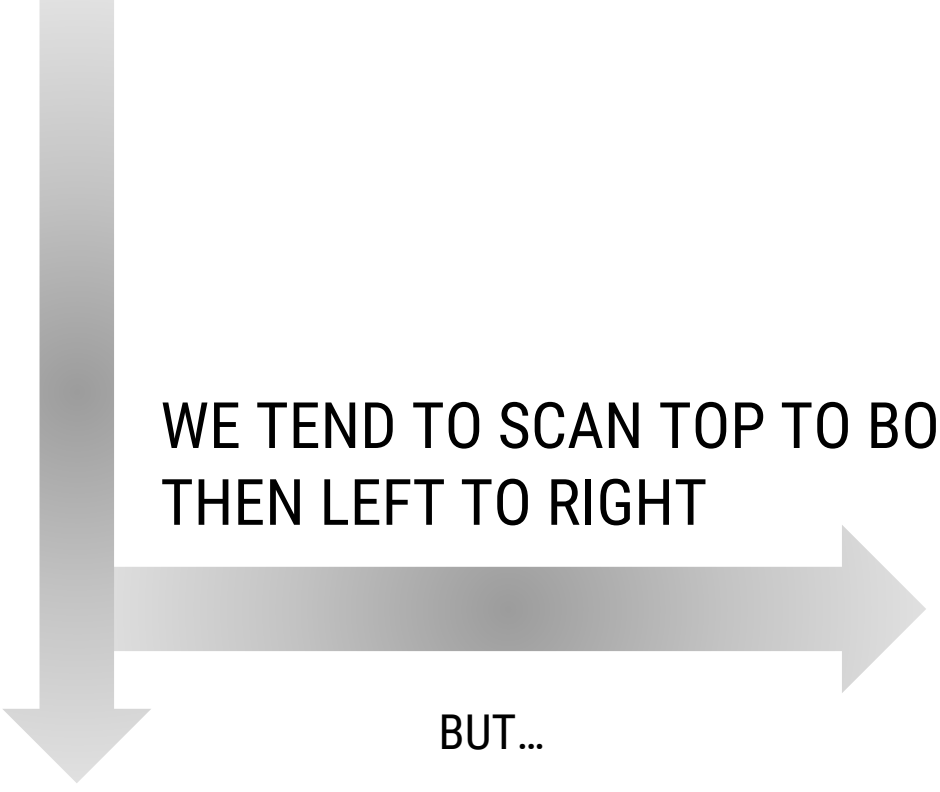


WE TEND TO SCAN TOP TO BOTTOM
THEN LEFT TO RIGHT

BUT…

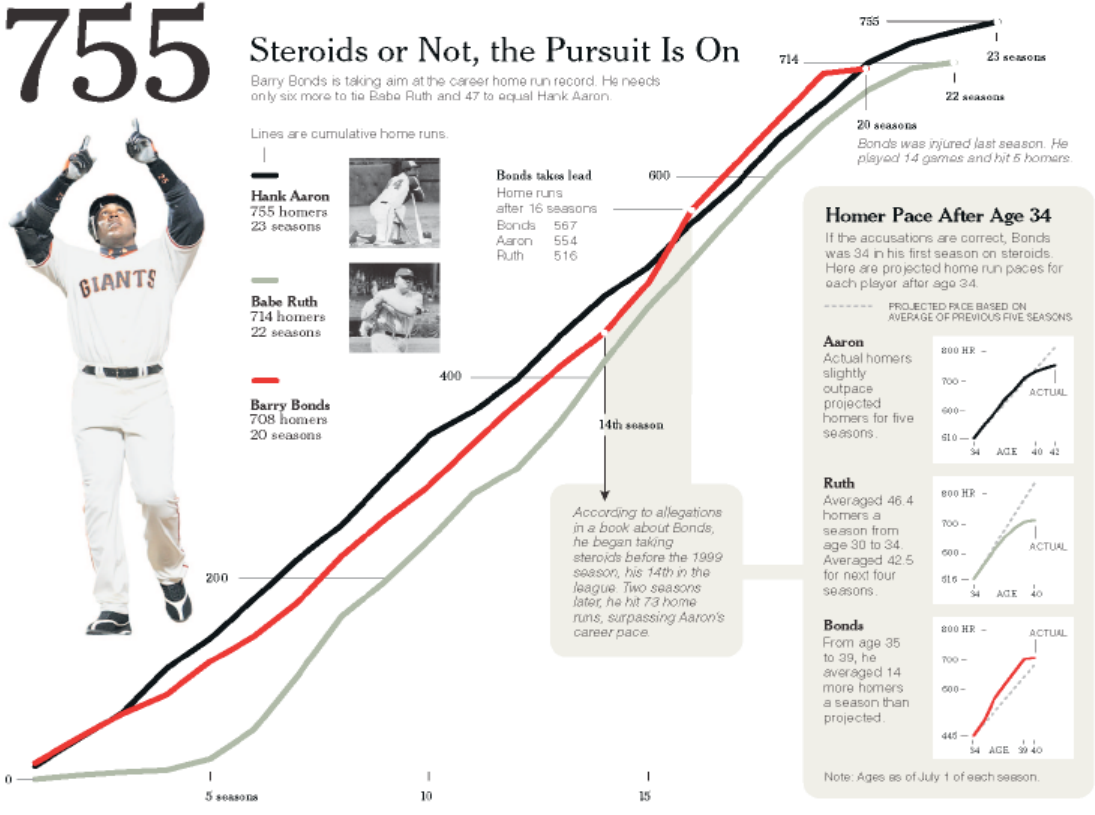
SIZE & COLOR CAN PREEMPT

THAT ORDER

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.



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.

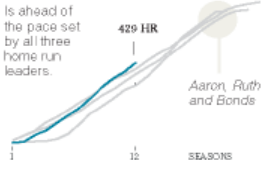
Ruth
Averaged 46.4 homers a season from age 30 to 34. Averaged 42.5 for next four seasons.

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

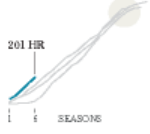
Note: Ages as of July 1 of each season.

Others Taking Aim

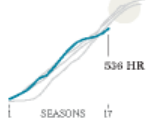
Alex Rodriguez ▲
Is ahead of the pace set by all three home run leaders.



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

Lines are cumulat… 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
…onds 567
… 554
… 516

755
714
23 seasons
22 seasons
20 seasons
Bonds was injured last season. He played 14 games and hit 5 homers.

600
400
200
0
14th seas…
5 seasons
10
15

Homer Pace After Age 34

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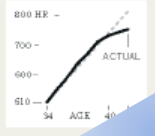
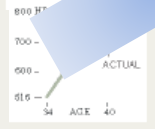


Ruth



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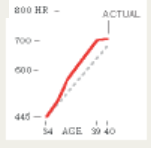

Note: Ages as of July 1 of each season.

MIDDLE

Others Taking Aim

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END

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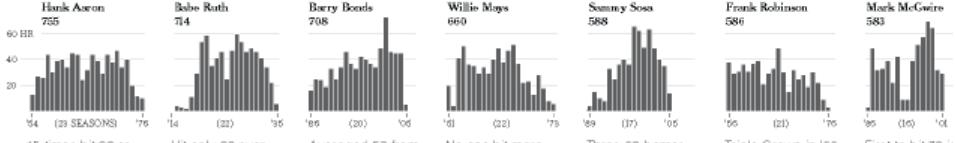


15 times hit 30 or more (M.L. most).

Hit only 20 over first five seasons.

Averaged 52 from 2000 to 2004.

No one hit more from 1950-69.

Three 60-homer seasons is record.

Triple Crown in '66 (49, 122, .316).

First to hit 70 in a season.

more in the 90's.

400 homers.

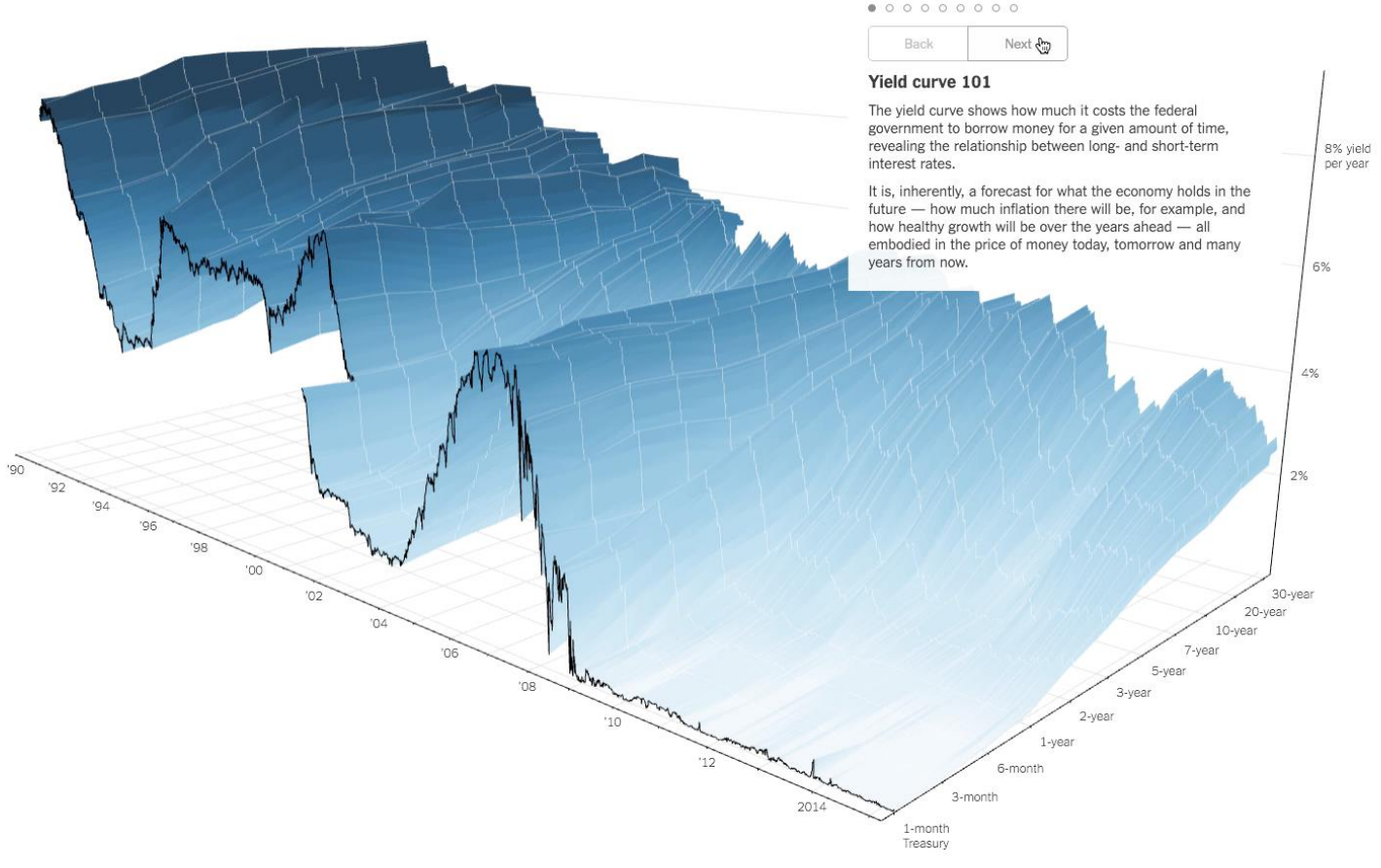
in first five seasons.

Amanda Cox and Joe Ward/The New York Times

EPILOGUE

A 3-D View of a Chart That Predicts The Economic Future: The Yield Curve

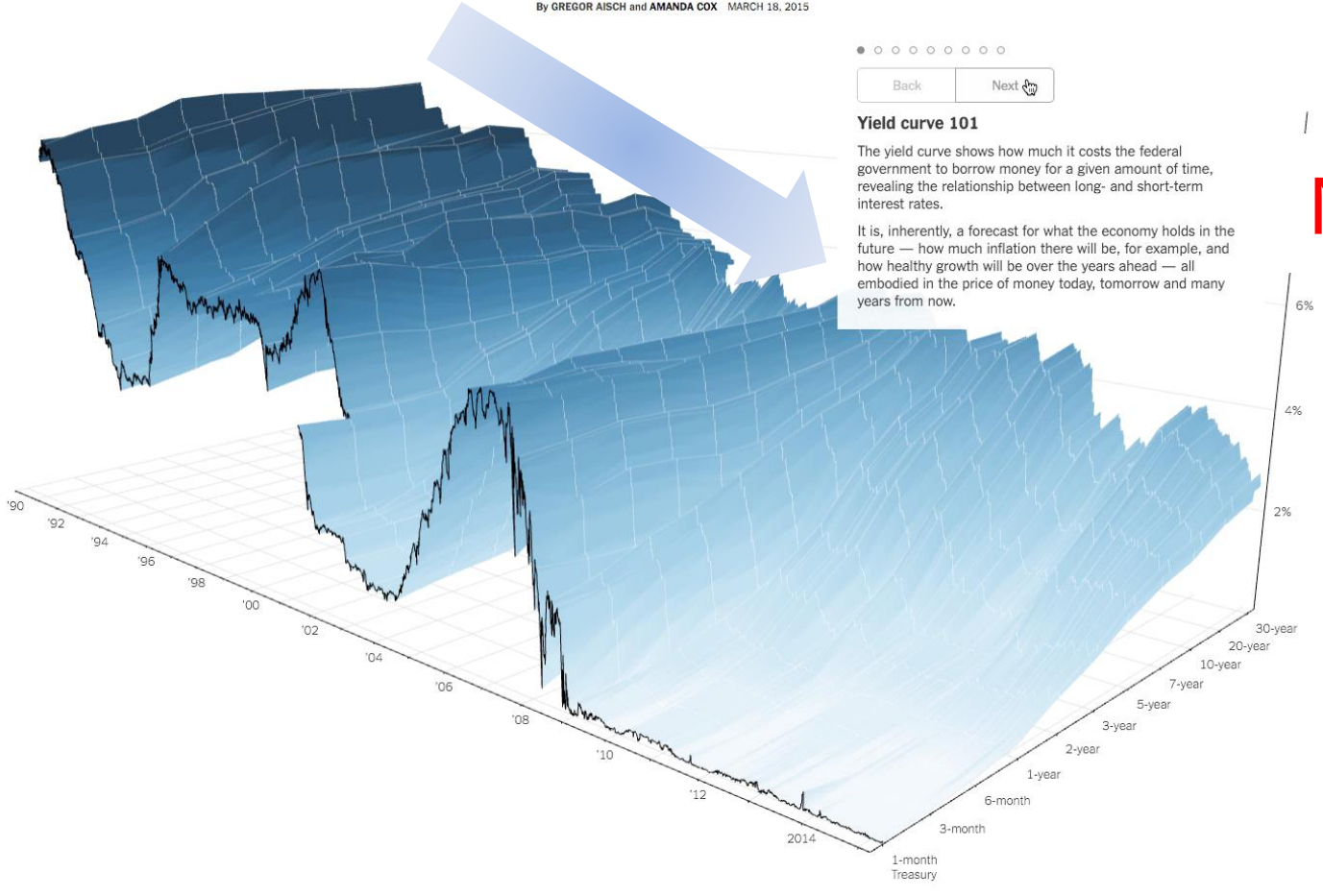
By GREGOR AISCH and AMANDA COX MARCH 18, 2015



BEGINNING

A 3-D View of a Chart That Predicts The Economic Future: The Yield Curve

By GREGOR AISCH and AMANDA COX MARCH 18, 2015



NEXT

MINIMALISM

IF YOU CAN DO IT WITH LESS, DO IT!

TRY TO SHOW ONLY WHAT'S NECESSARY

USE DESIGN TO COMMUNICATE, NOT DECORATE

TYPOGRAPHY

ALMOST EVERY VISUALIZATION
USES TEXT

…AND ALMOST EVERY VISUALIZATION
CAN BENEFIT FROM GOOD USE OF
TYPOGRAPHY

Serif

Sans Serif

TYPE ON THE WEB

USED TO BE VERY LIMITED

Arial
Arial Black
Comic Sans MS
Courier New
Georgia
Impact
Times New Roman
Trebuchet MS
Verdana

NOW…LOTS OF GREAT OPTIONS

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

Open Sans, 10 Styles by Steve Matteson

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

Noto Sans, 4 Styles by Google

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

Roboto, 12 Styles by Christian Robertson

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

PT Serif, 4 Styles by ParaType

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

Lato, 10 Styles by Łukasz Dziedzic

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

Alegreya Sans, 14 Styles by Juan Pablo del Peral

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

Slabo 27px, 1 Style by John Hudson

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

Titillium Web, 11 Styles by Multiple Designers

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

Roboto Condensed, 6 Styles by Christian Robertson

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

Passion One, 3 Styles by Fontstage

Normal 400

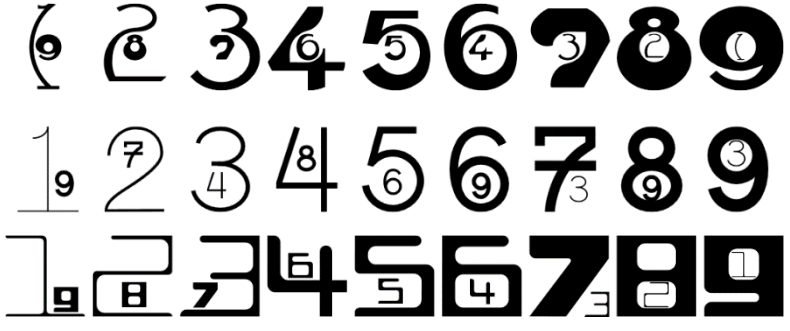
Grumpy wizards make toxic brew for the evil Queen and Jack.

Normal 400

Grumpy wizards make toxic brew for the evil Queen and Jack.

NUMBERS

CHOOSE FONTS AND WEIGHTS TO MAXIMIZE LEGIBILITY AT THE SIZE THEY'LL BE DISPLAYED



fat fonts: Nacenta et al., 2012

For Numbers...

Din

0123456789

Helvetica Neue

0123456789

Myriad

0123456789

Gills Sans

0123456789

Tahoma

0123456789

Azuro

1 2 3 4 5 6 7 8 9 0

Lucida Sans

0123456789

USE TWO TYPEFACES MAXIMUM

(OFTEN EVEN ONE IS ENOUGH.)

YOU CAN ALSO USE:

WEIGHT

COLOR

Italics

SIZE

KEEP TYPE LARGE AND LEGIBLE

40-60pt (or Bigger) for Headlines

12-16 for body text, captions, and visualization text.

You should almost **never** use 10pt or smaller.
(Even IN your visualizations.)

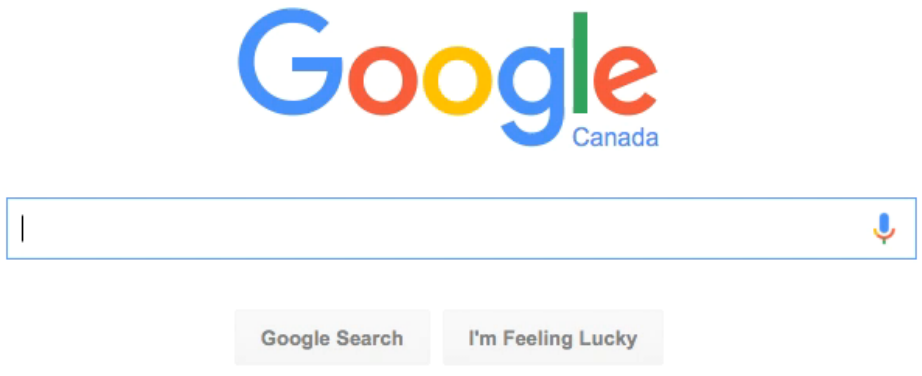
TYPE AND CONTRAST

Be careful with small differences in luminosity.

What works on your display may not work in general.

TYPE CAN SUGGEST INTERACTION

YEARS AGO

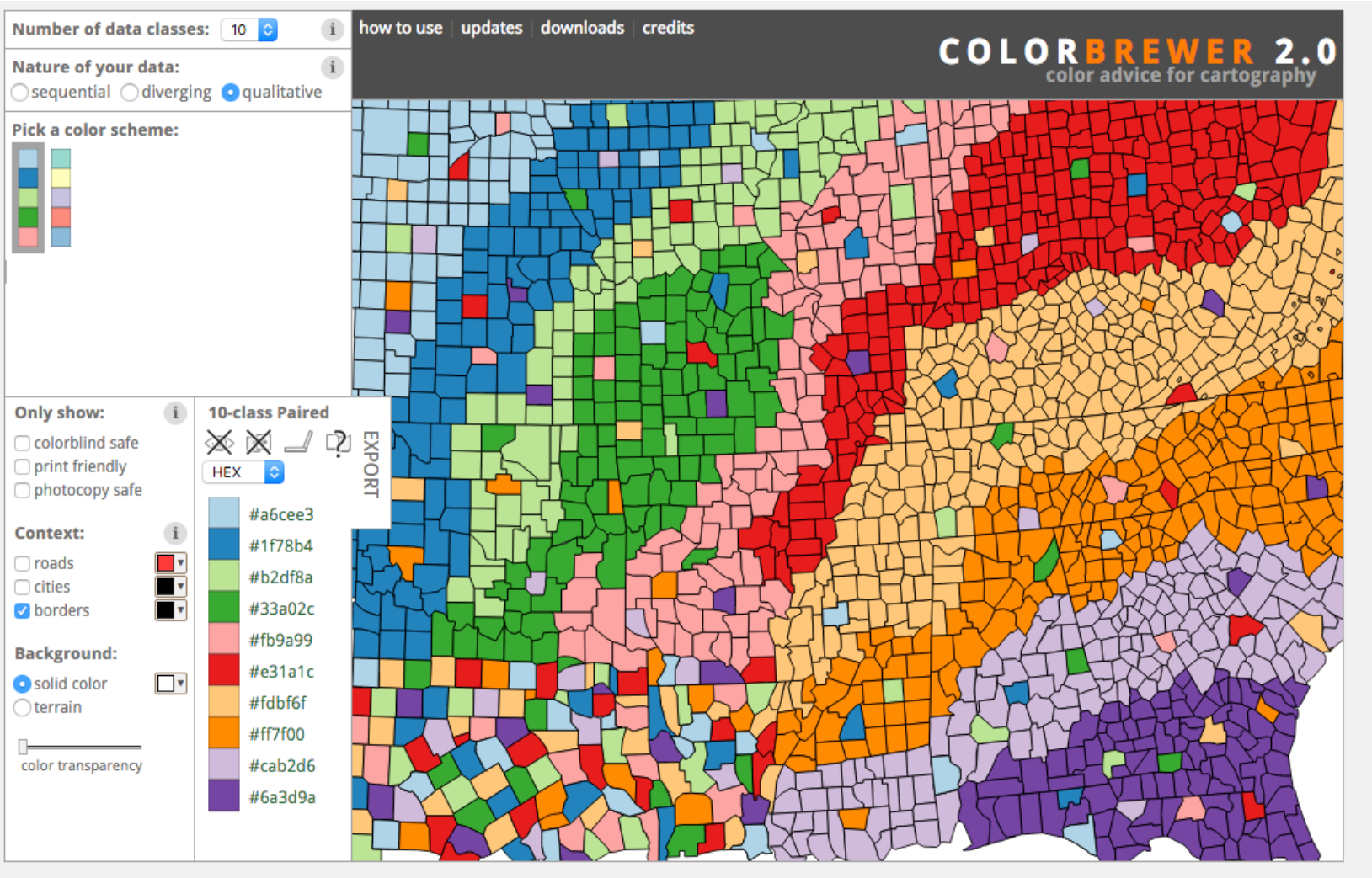


TODAY

(CUES CAN BE SUBTLE)

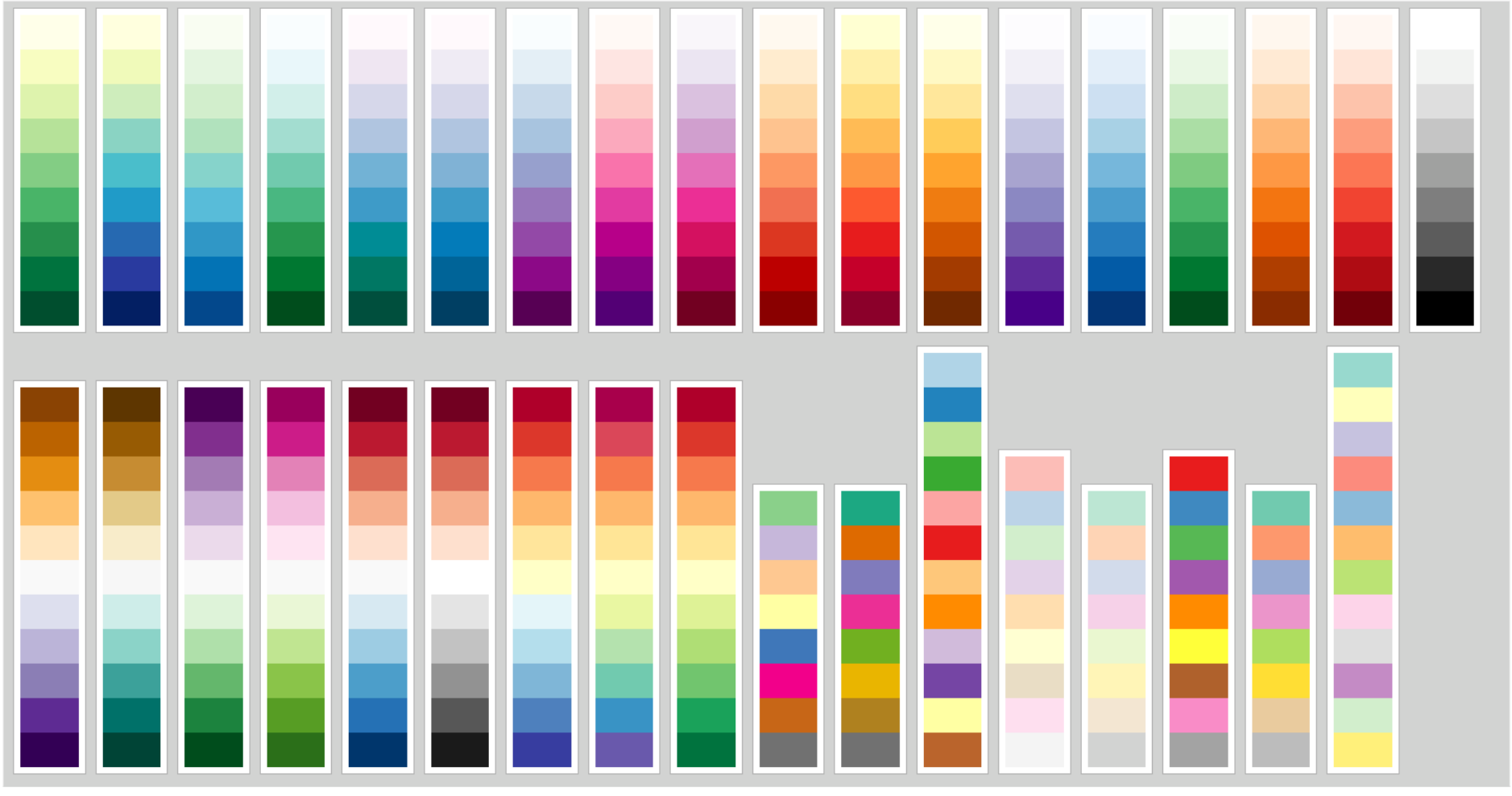
COLOR

(we’ve talked about it before)



USE COLORBREWER!

Every ColorBrewer Scale



MIKE BOSTOCK

SYMBOLS AND ICONOGRAPHY

SEMIOTICS (THE STUDY OF SIGNS)

SIGNIFIED
A THING OR IDEA

SIGNIFIER
A REPRESENTATION
OF THE THING OR IDEA
(A WORD, PICTURE, SOUND, ETC.)

warmth
heat
danger
etc.

SENSE
THE UNDERSTANDING A
VIEWER GETS FROM
SEEING THE SIGNIFIED
(OR THE SIGNIFIER!)

TYPES OF SIGNS

ICON
PHYSICALLY
RESEMBLES
WHAT IT STANDS
FOR

INDEX
IMPLIES / POINTS TO
SOMETHING
(CORRELATION)

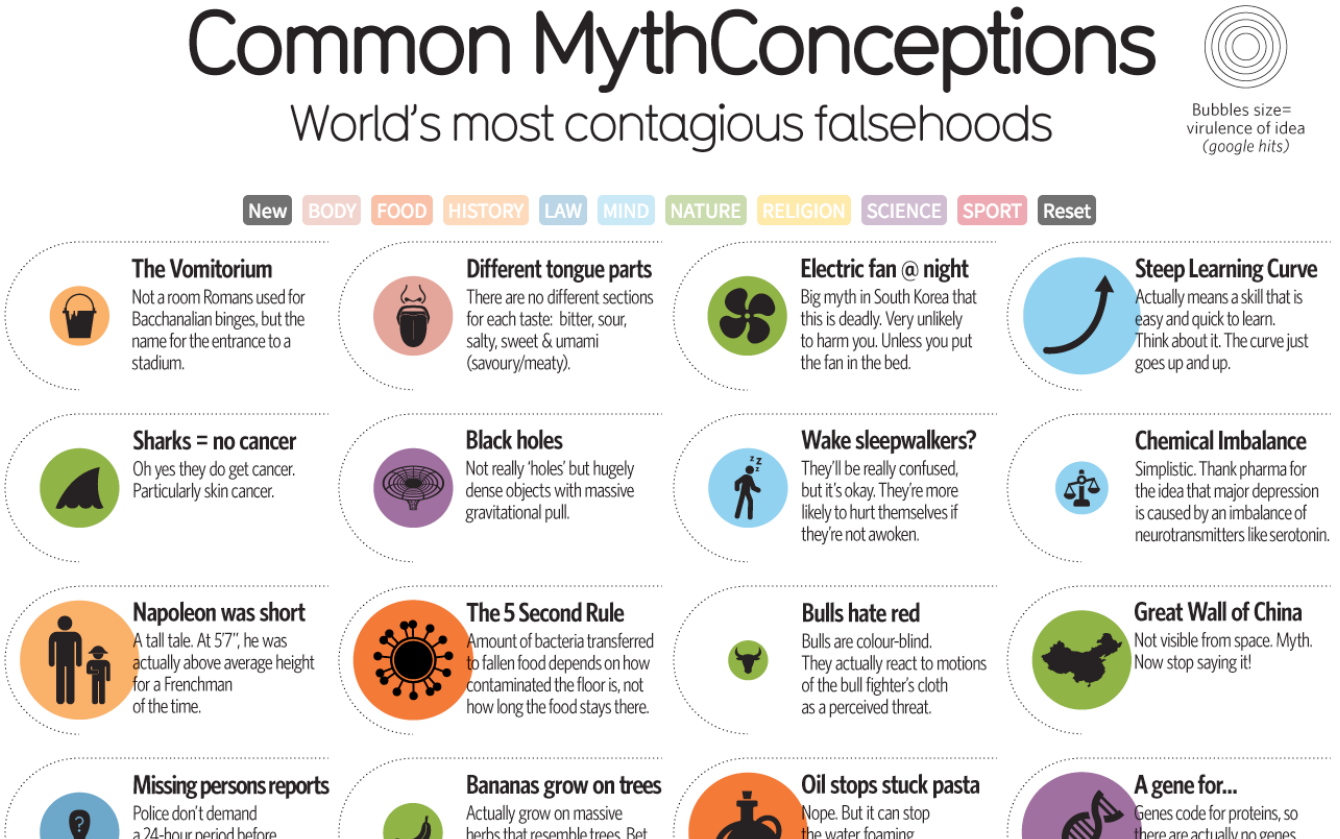
SYMBOL
POINTS TO
SOMETHING

RELATIONSHIP HAS
TO BE LEARNED

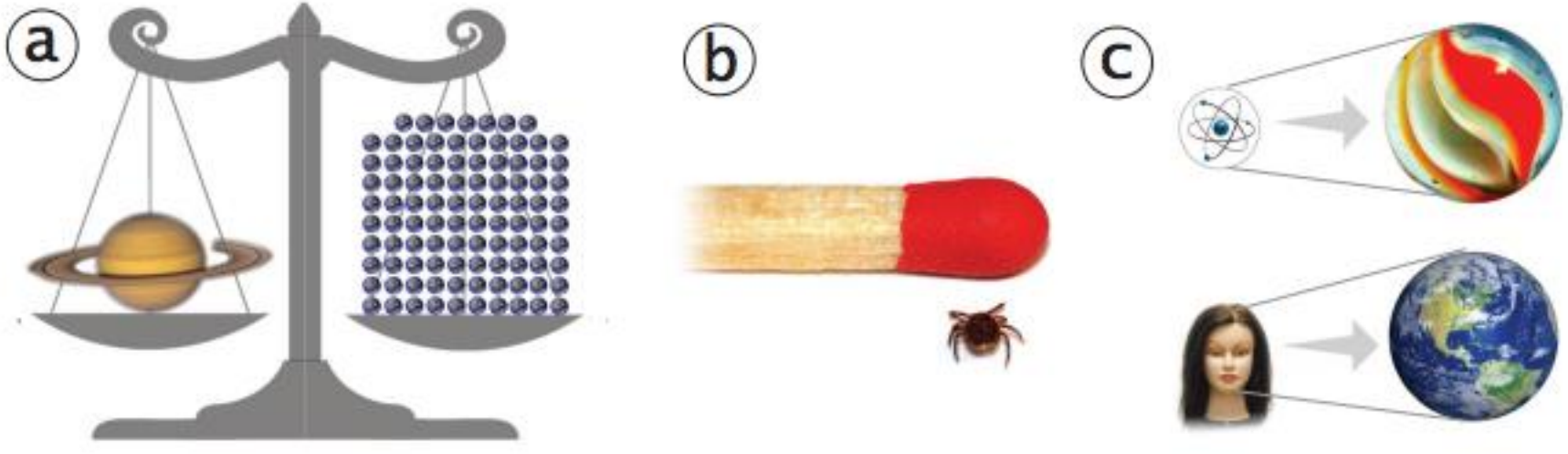
USING SIGNS TO **ILLUSTRATE** AND **PROMPT RECOGNITION**

DAVID MCCANDLESS

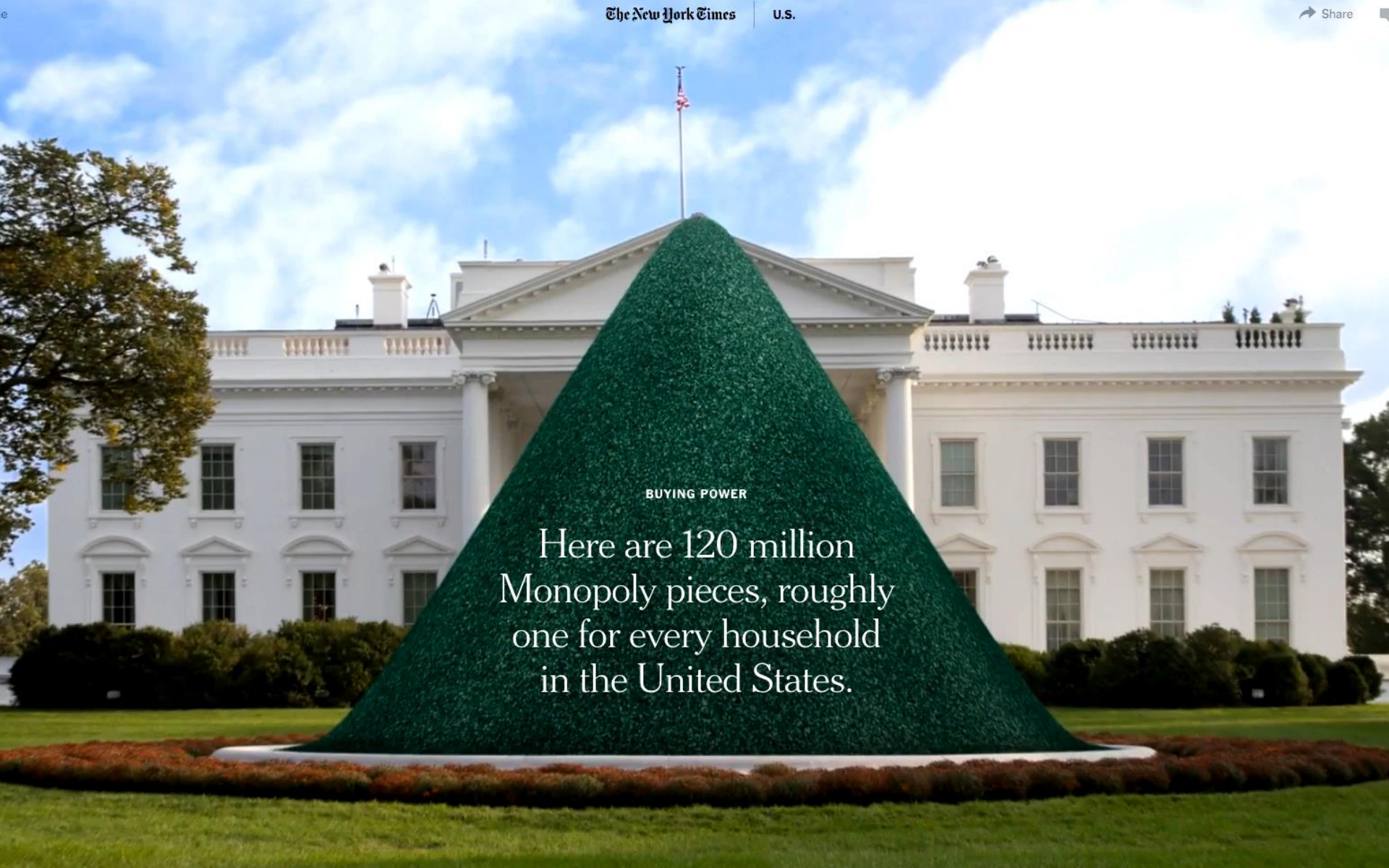
LINK



USING SIGNS TO MAKE DATA **RELATABLE**



USING CONCRETE SCALES
CHEVALIER ET AL. 2013 LINK


BUYING POWER
Here are 120 million Monopoly pieces, roughly one for every household in the United States.

Mainly in Finance and Energy

Finance 64
Majority in hedge funds, private equity or venture capital.

Energy and natural resources 17
Mostly oil and gas.

Real estate and construction 15

Media and entertainment 12
Hollywood moguls like Steven Spielberg, J.J. Abrams and Jeffrey Katzenberg.

Health 12
Woody Johnson, owner of the New York Jets, whose family founded Johnson & Johnson.

Technology 10

Transportation 9
Trucking, autos, cruise ships.

Retail and manufacturing 6

Food, beverage, agriculture 5
Includes citrus, poultry and sugar magnates.

Insurance 3

Other/unknown 5

DEATH IN SYRIA

By KAREN YOURISH, K.K. REBECCA LAI and DEREK WATKINS

SEPT. 14, 2015

More than **200,000** people

have been killed in the four-and-a-half-year Syrian civil war.

The death toll in the Gaza-Israel conflict

By Lazaro Gamio and Richard Johnson, Updated: Aug 7, 2014

Statistics on death tolls during active conflict are often difficult to track accurately. A note on our sourcing:

For death toll numbers from within Gaza, we receive daily or sometimes twice daily updates from the head of the Information Management Unit in the United Nations Office for the Coordination of Humanitarian Affairs in the Occupied Palestinian Territories field office in the West Bank. The field office gets updates from multiple sources within Gaza, including U.N. agencies and the Palestinian Medical Authorities. They then create and continually update a spreadsheet of all available data. These numbers are often not complete, but represent the best available data and do tend to clarify over time. Israel disputes the numbers provided by the United Nations, saying that a large number of those killed, particularly males over 18, were armed terrorists and not civilians.

For death toll numbers of Israeli soldiers, we rely on Israel Defense Forces press releases and their Twitter account. For Israeli civilian deaths, we rely on news reports and our reporters in Israel and Gaza. These numbers are similarly tentative initially but clarify over time.

Related articles: Reporters grapple with politics, erratic sources in reporting Israeli/Gaza death toll (Washington Post) | Caution needed with Gaza casualty figures (BBC) | Civilian or Not? New Fight in Tallying the Dead From the Gaza Conflict (New York Times)

1,958 Deaths up to **Aug. 6**

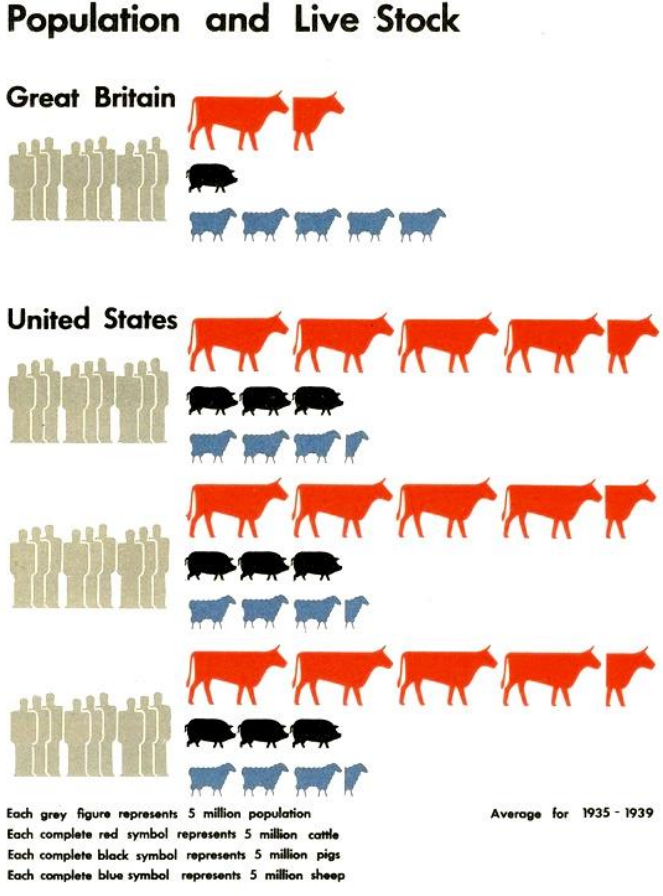
65 were Israeli soldiers.

3 were Israeli civilians.

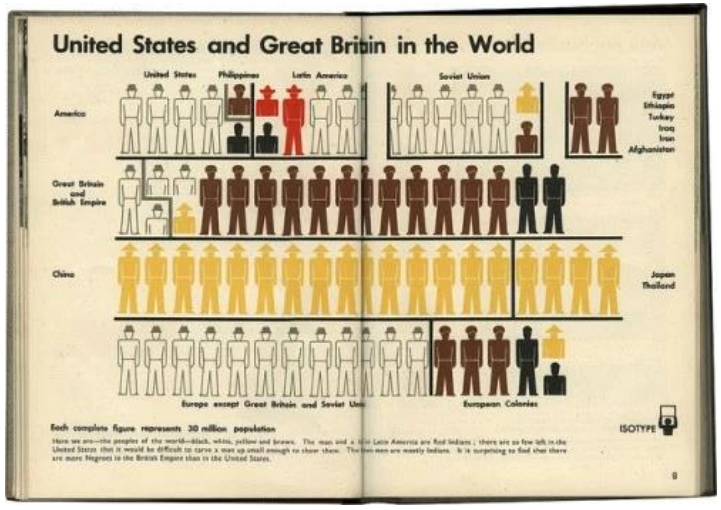
217 were armed Palestinian militants. Of those, **2** were children.

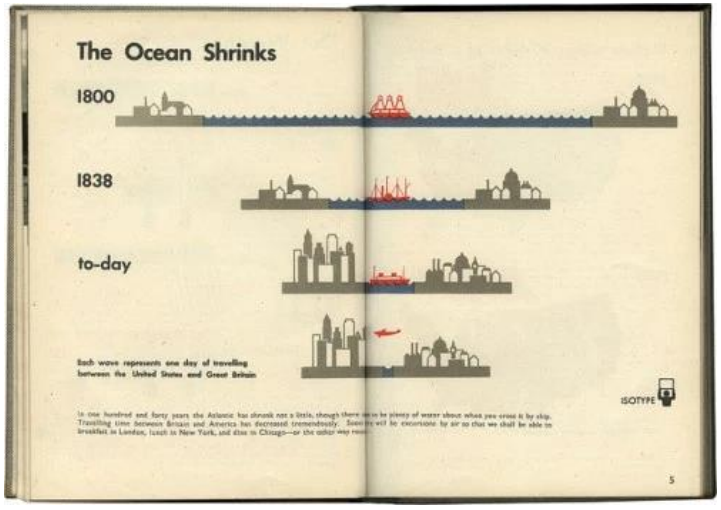
1396 were Palestinian civilians. Of those, **222** were women and **418** were children.

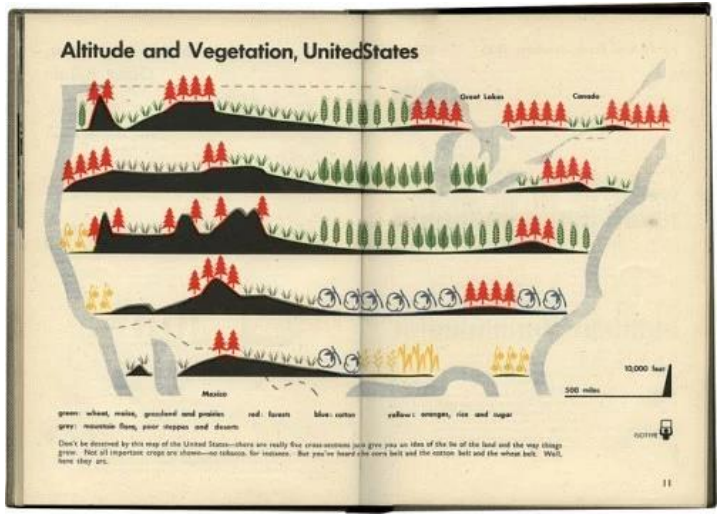
ISOTYPE VISUALIZATION

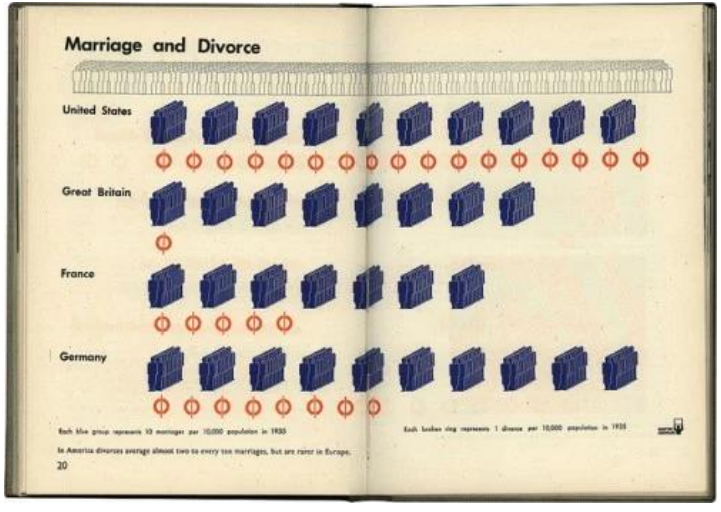


OTTO & MARIE NEURATH 1948









OTTO & MARIE NEURATH 1948 [MORE EXAMPLES]

ISOTYPE Visualization – Working Memory, Performance, and Engagement with Pictographs

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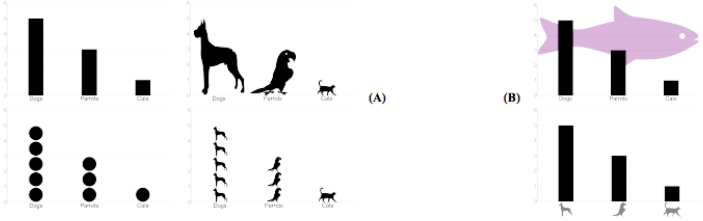

Fig. 1. Pictographic charts have been used for decades. (A) Which chart above most effectively conveys information? Which data is easiest to remember during a demanding task? Which is most engaging? (B) How integrated must a pictograph be to benefit the user? Do purely decorative background images offer the same benefits as simple axis labels? Or must they be used to convey data?

ABSTRACT
Although the infographic and design communities have used simple pictographic representations for decades, it is still unclear whether they can make visualizations more effective. Using simple charts, we tested how pictographic representations impact (1) memory for information just viewed, as well as under the load of additional information, (2) speed of finding information, and (3) engagement and preference in seeking out these visualizations. We find that superfluous images can distract. But we find no user costs – and some intriguing benefits – when pictographs are used to represent the data.

Author Keywords
Visualization; Psychophysics; Working Memory; User Performance; Pictograph; Embellishment; ISOTYPE

INTRODUCTION
The International System Of TYpographic Picture Education (ISOTYPE) uses simple pictographic elements to convey many types of information, including numerical data. Otto and Marie Neurath defined the term in the 1920s [21], though this type of chart was first described by Willard Brinton in 1914 [6]. Together with Gerd Arntz, the Neuraths created many ISOTYPE designs over several decades [1].

The goal was a universally understandable system for communicating quantities of commercial, social, or economic information (e.g., automobile production or number of children born per year). Symbols, each representing a fixed quantity, were stacked to provide an intuitive representation of a total amount (Fig. 2). Gerd Arntz's pictographs – simplified icons with minimal color – are highly recognizable and are still used in signs, traffic icons, and warning labels.

While the design community has largely embraced the simple style of ISOTYPE for pictographic embellishments [7, 17], the visualization and HCI communities tend to regard pictographs as 'chart junk' – a distraction from the data itself [24]. Here we examine how ISOTYPE-style embellishment affects viewer memory, speed, and engagement within simple visualizations.

Recent work suggests that extraneous pictographic information can indeed improve the effectiveness of visualizations. Bateman et al. found that visualizations that integrate data with illustrations yielded better memory of the data compared to minimalistic outlines of bar charts [2]. Borkin et al. found a related result – that people can better recall having seen a visualization that includes pictures [4], though it is not clear if they would better recall the data, per se. When images and clip-art are embedded in the visualization's data representation, Borgo et al. found occasional impact to work-

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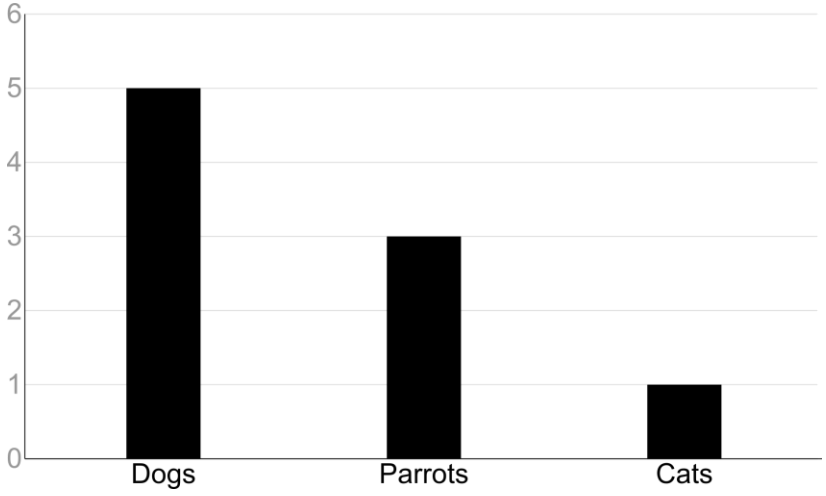
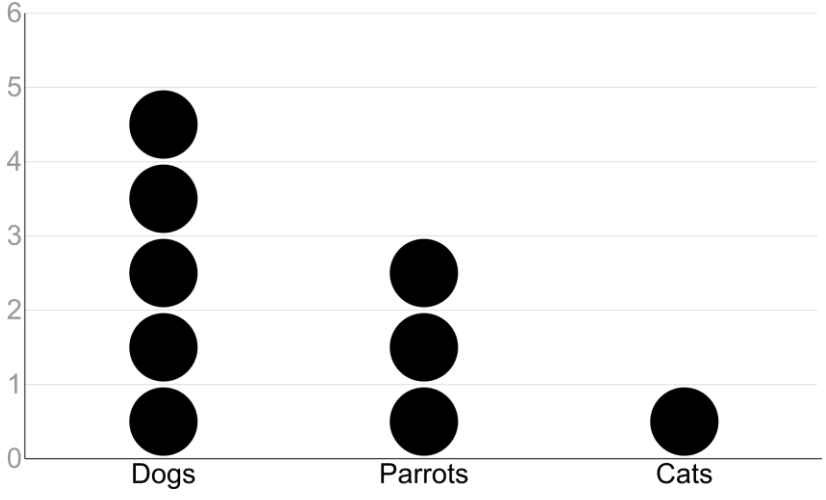
ACM 978-1-4503-3145-6/15/04…$15.00
http://dx.doi.org/10.1145/2702123.2702275

HAROZ ET AL. 2015 LINK





STACKED ICONS CAN:

ENCODE DATA AS BOTH LENGTH AND QUANTITY

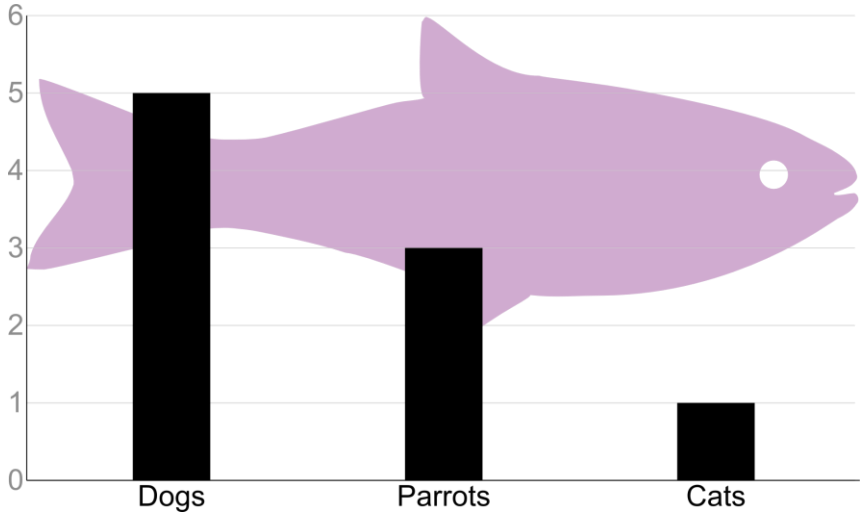
HAROZ ET AL. 2015 LINK

STACKED ICONS CAN:

ENCODE DATA AS BOTH LENGTH AND QUANTITY

(WHERE THIS WORKS) ICONS CAN SUPPORT MEMORY & ENGAGEMENT

HAROZ ET AL. 2015 LINK



STACKED ICONS CAN:

ENCODE DATA AS BOTH LENGTH AND QUANTITY

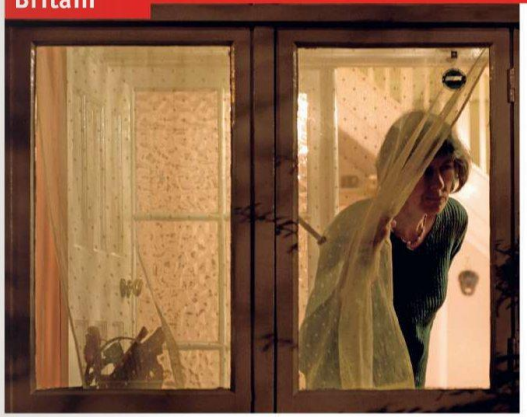
(WHERE THIS WORKS) ICONS SUPPORT MEMORY & ENGAGEMENT

BUT! OTHER IMAGES ARE DISTRACTING

HAROZ ET AL. 2015 LINK

HOW TO USE DATA TO TELL A STORY?

(THERE ARE MANY, MANY CHOICES TO MAKE.)



Also in this section
64 Bagehot: Electoral reform

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economist.com/britain

Britain's "broken society"

Through a glass darkly

Crime, family break-up, drunks and drugs: the Conservatives—and apparently plenty of voters—think that Britain has a "broken society". Does the claim stand up?

IT IS hard to believe that such appalling crimes could have been committed by anyone so young. Two boys in the north of England were subjected to a sadistic attack that caused parents across the country to shudder. The anguish of the children was awful enough. But in a grotesque twist, their tormentor was also a child, not yet even a teenager. The attacks had been carried out "solely for the pleasure and excitement" of it, the judge in the case said. What has society come to when such evil is found in those so young?

That was in 1968. Mary Bell, the daughter of a Tyneside prostitute and supposedly the victim of repeated abuse herself, became Britain's most famous child-killer when, just 11 years old, she was convicted of strangling two young boys. Now, a similar case is causing people to wonder again whether society has gone to the dogs. Two brothers from the South Yorkshire village of Edlington, aged ten and 11, were convicted on January 22nd of torturing and sexually abusing two younger boys in an ordeal that left one of them close to death.

The case was highlighted by David Cameron, the leader of the opposition, who on the day the boys were sentenced launched a chapter of his Conservative Party's election manifesto dedicated to dealing with what he calls Britain's "broken society". The Edlington case was not "just some isolated incident of evil", Mr Cameron said. Connecting it to four other infamous examples of callous brutality, he declared that it raised "deep questions about what is going wrong in our society". Britain is experiencing a social recession to match the economic one, he reckons.

Those good old days in full

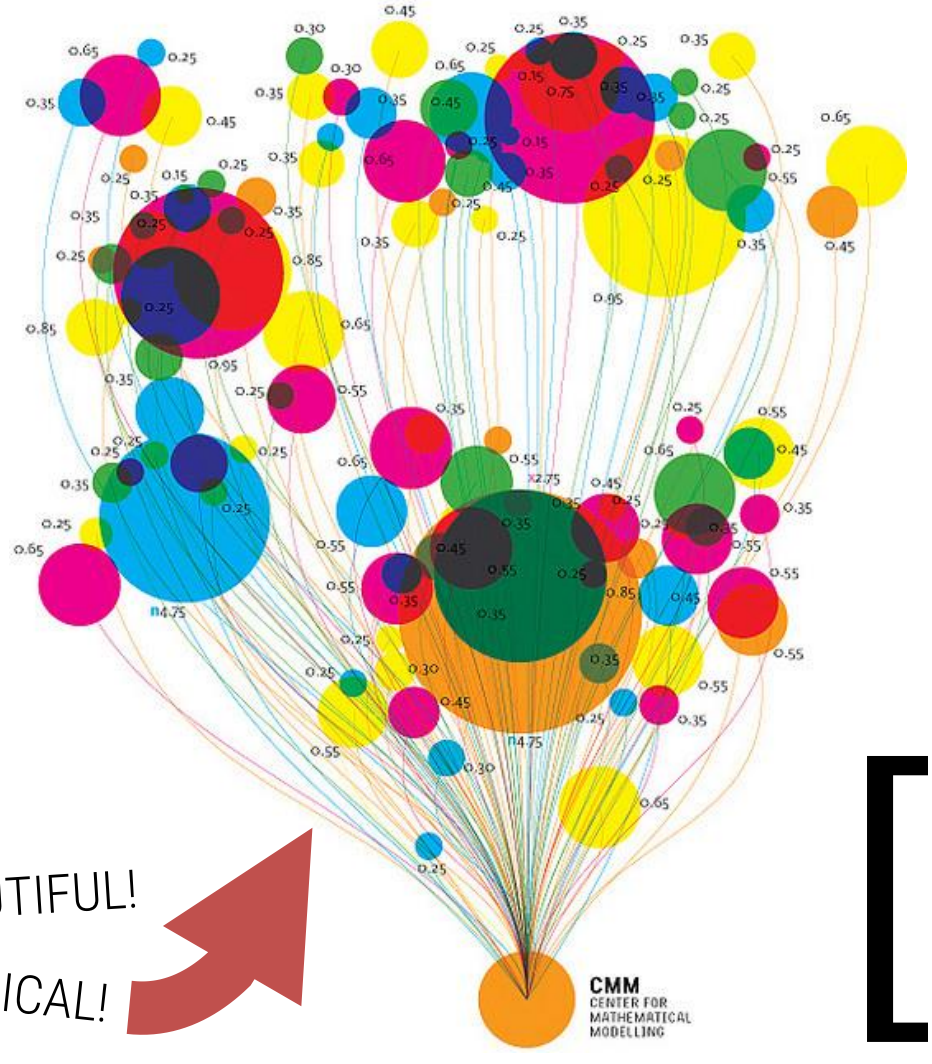
Was Mary Bell's Britain better than today's version? An increasing number of people seem to think so. Opinion pollsters around the world find that people are usually gloomy about the future, perhaps because it is inherently more uncertain than the past. But Britons are getting even more downbeat. When Labour came to power in 1997, 40% of the population thought the country was becoming a worse place to live in. By 2007 that had risen to 60%. A year on, and a year into Gordon Brown's spell as prime minister, the malcontents numbered 71%—and that was before the financial crash. There has been a "surge of nostalgia" for the good old days, says Ben Page, head of Ipsos-Mori, a polling firm.

Chief among people's worries is their security. Under Labour, fear of crime climbed until by 2007 it had become the issue that pollsters identified as the main complaint among voters. (Since then worries about the economy have eclipsed all else.) The heightened fears are a puzzle to criminologists, who point out that over the past 15 years Britain has experienced a steady, deep fall in crime. The statistics are notoriously hard to interpret, but according to the British Crime Survey, the Home Office's most reliable measure though still far from perfect, crime overall has dropped by 45% since its peak in 1995. A big chunk of that fall is owing to reductions in vehicle theft and domestic burglary, for which alarm manufacturers and increased householder vigilance probably deserve as much credit as the police. But violent crime has fallen too. It is now almost half what it was in 1995, and no higher than in 1981 (see chart 1).

Looking more carefully, the big fall in brutality has been in domestic violence, which has dropped by a staggering 70%. (No one is sure why; the best guess is that an improving economy has kept men out of the house and given women enough money to escape if they need to.) Violence

Powered

SMALL SUPPORT AFTERTHOUGHT BORING?



EXCITING!

BEAUTIFUL!

TECHNICAL!

[BUT]

WHAT DOES
IT MEAN?

Published: February 2, 2010

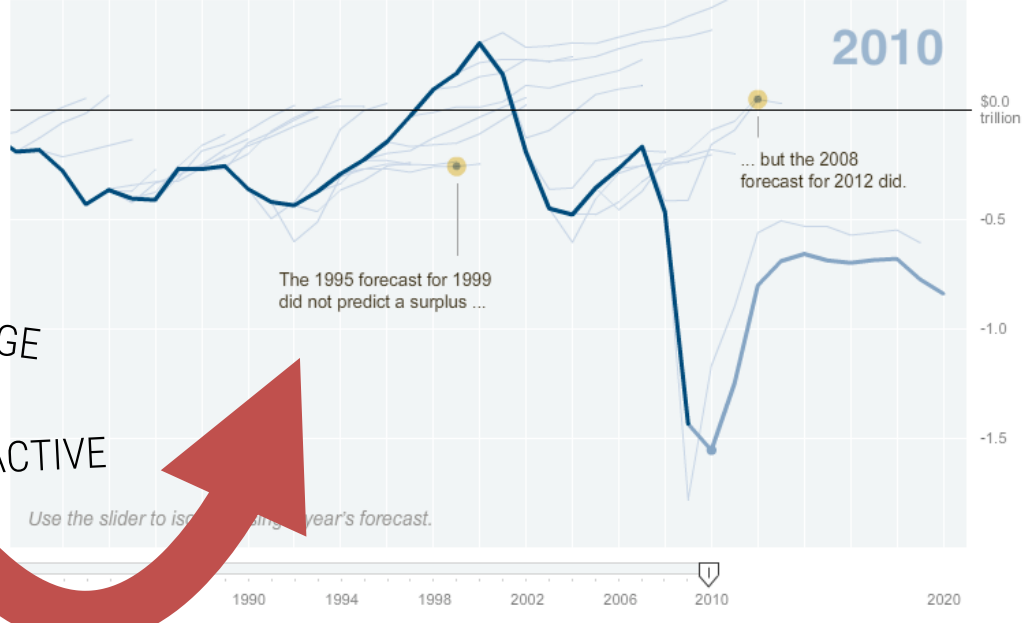
Budget Forecasts, Compared With Reality

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

Latest forecast

Today, with a better understanding of the severity of the economic downturn, the deficit situation is much more dire.

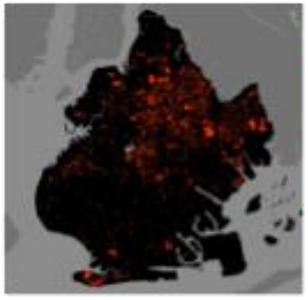


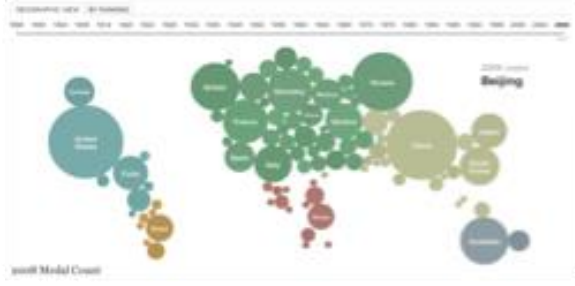
CENTER STAGE

STANDALONE

INTERACTIVE

GUIDED



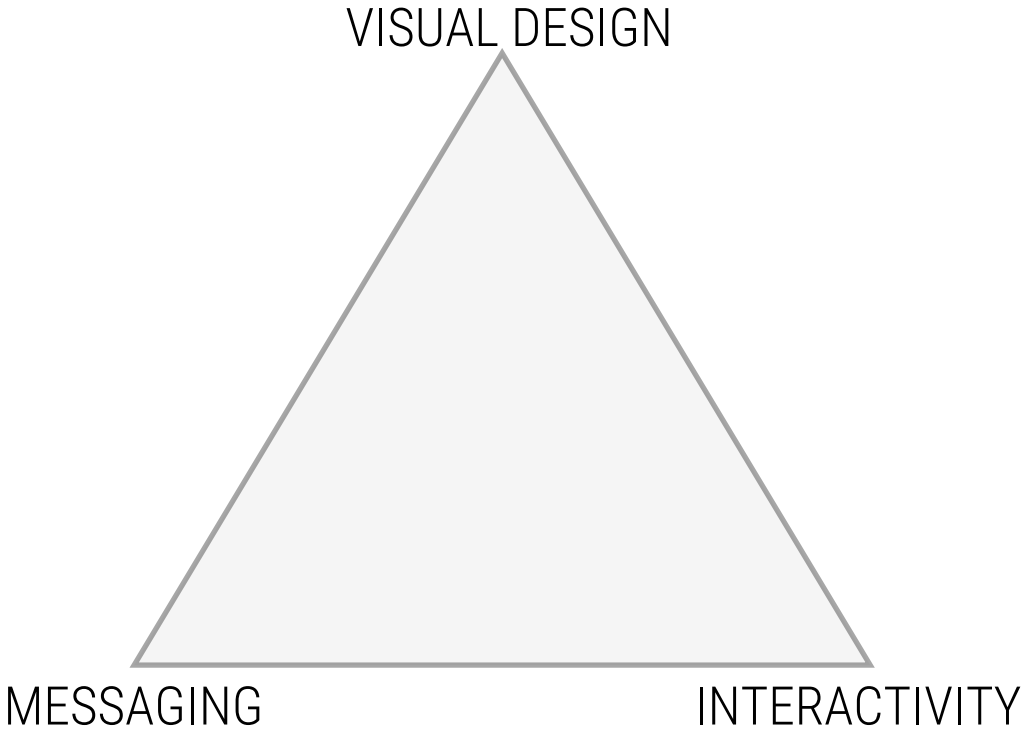


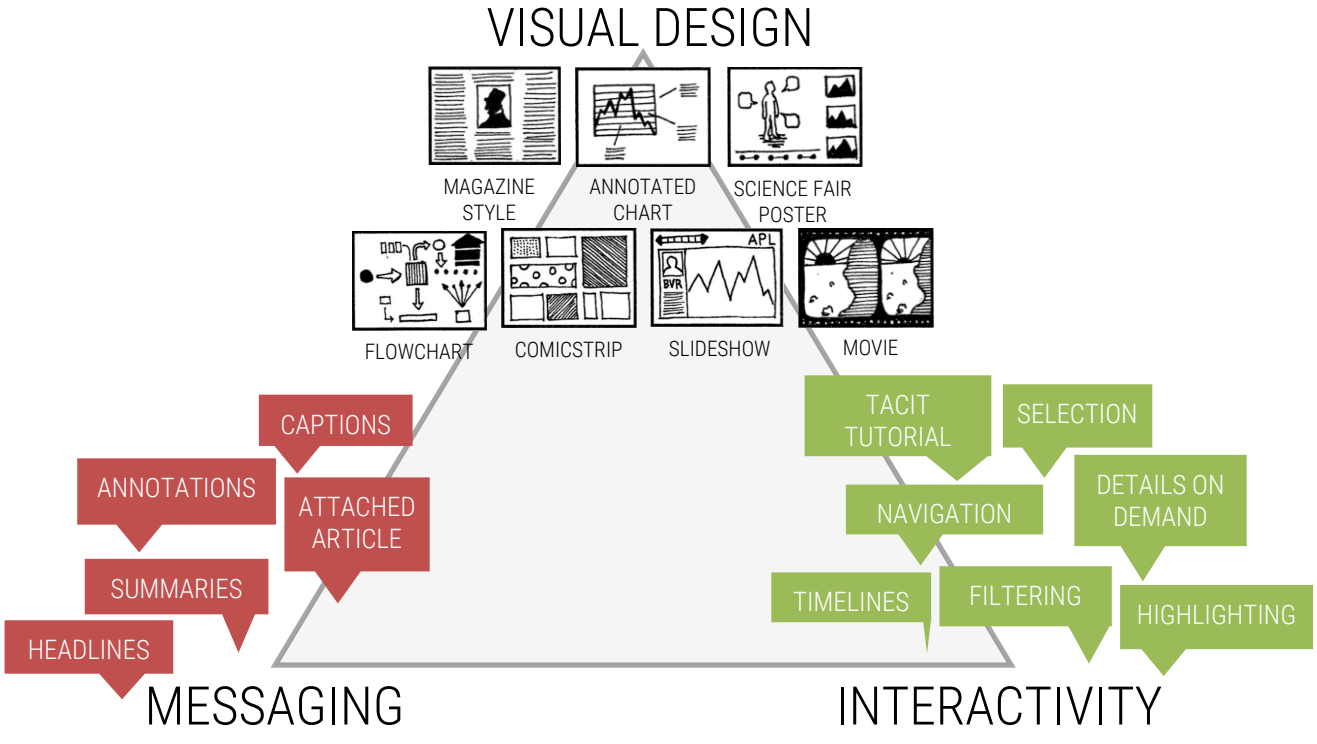
58

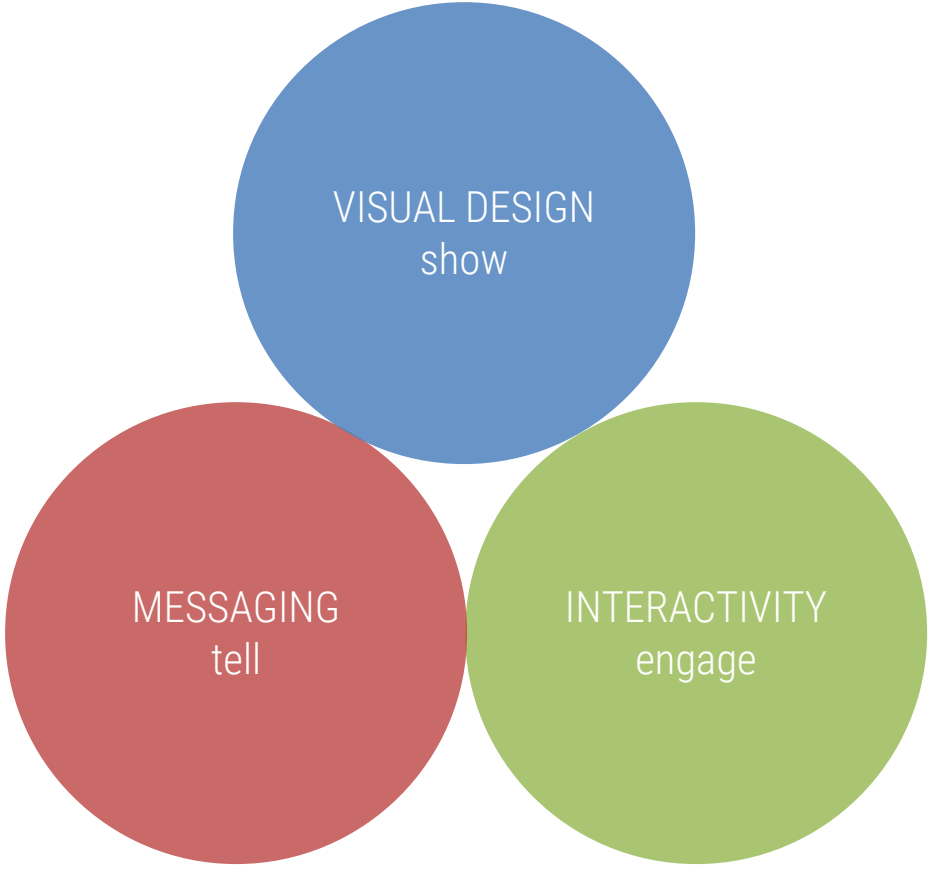
CASE STUDIES

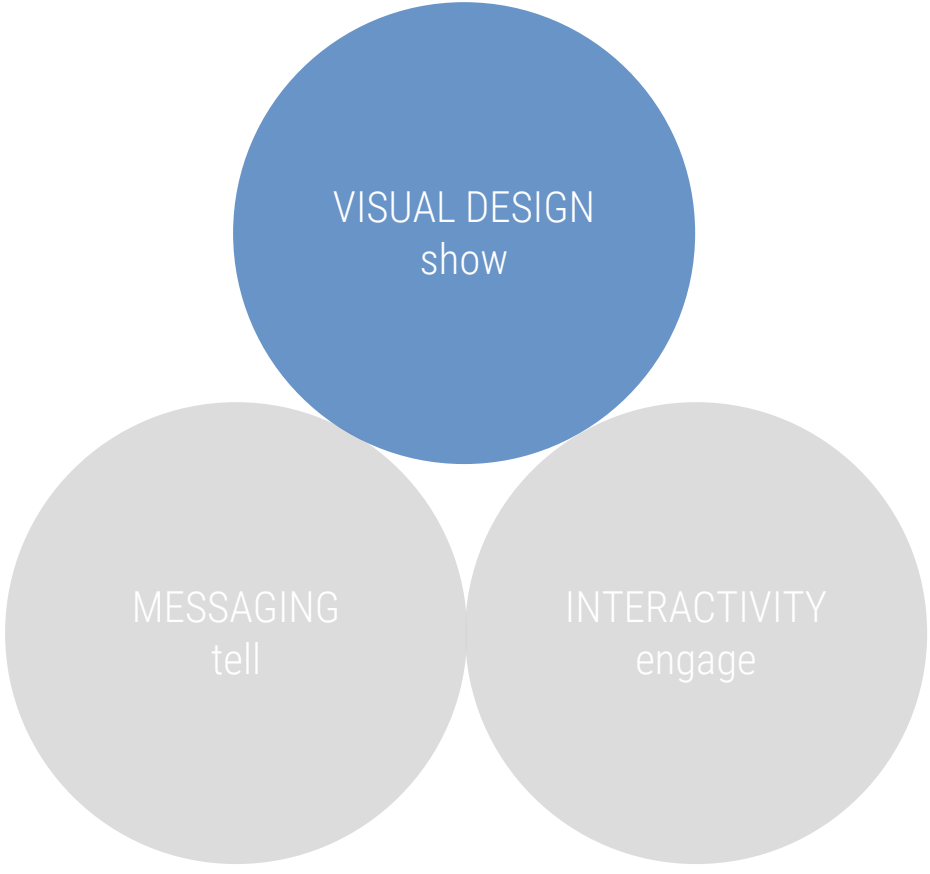
70% JOURNALISM
20% BUSINESS
10% RESEARCH

EDWARD SEGEL &
JEFFREY HEER 2010


VISUAL DESIGN
MESSAGING
INTERACTIVITY

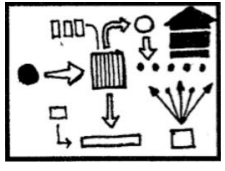

VISUAL DESIGN
MAGAZINE STYLE
ANNOTATED CHART
SCIENCE FAIR POSTER
FLOWCHART
COMICSTRIP
SLIDESHOW
MOVIE
APL
BVR
CAPTIONS
ANNOTATIONS
ATTACHED ARTICLE
SUMMARIES
HEADLINES
TACIT TUTORIAL
SELECTION
NAVIGATION
DETAILS ON DEMAND
TIMELINES
FILTERING
HIGHLIGHTING
MESSAGING
INTERACTIVITY


VISUAL DESIGN
show
MESSAGING
tell
INTERACTIVITY
engage

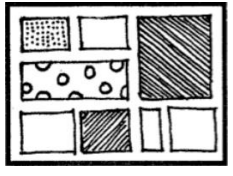

VISUAL DESIGN
show
MESSAGING
tell
INTERACTIVITY
engage

THE MORE LINEAR, THE MORE LIKE A TRADITIONAL STORY

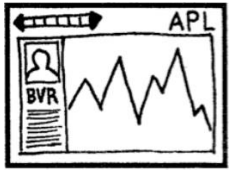
WITH A BEGINNING, MIDDLE, AND END



FLOWCHART

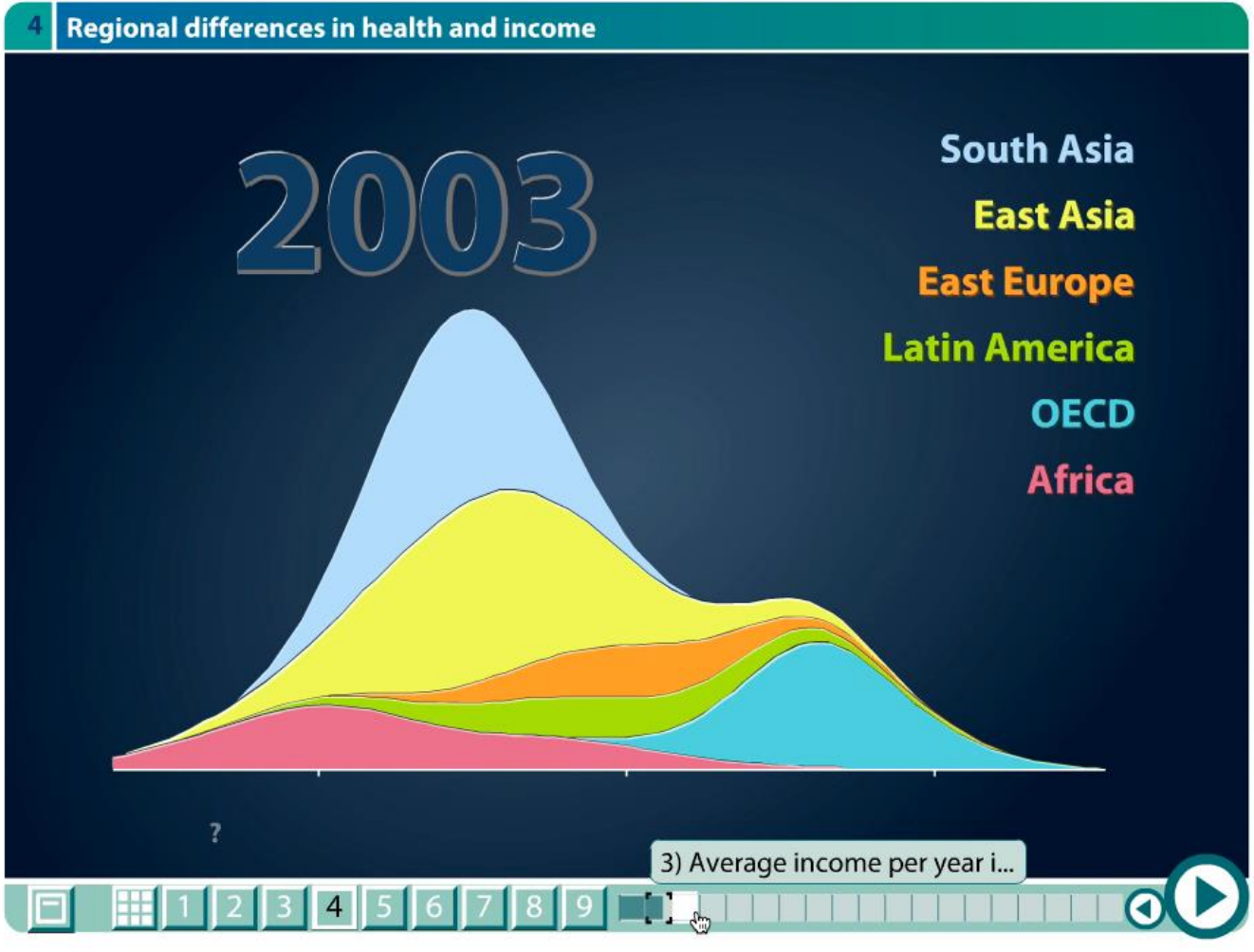


COMICSTRIP



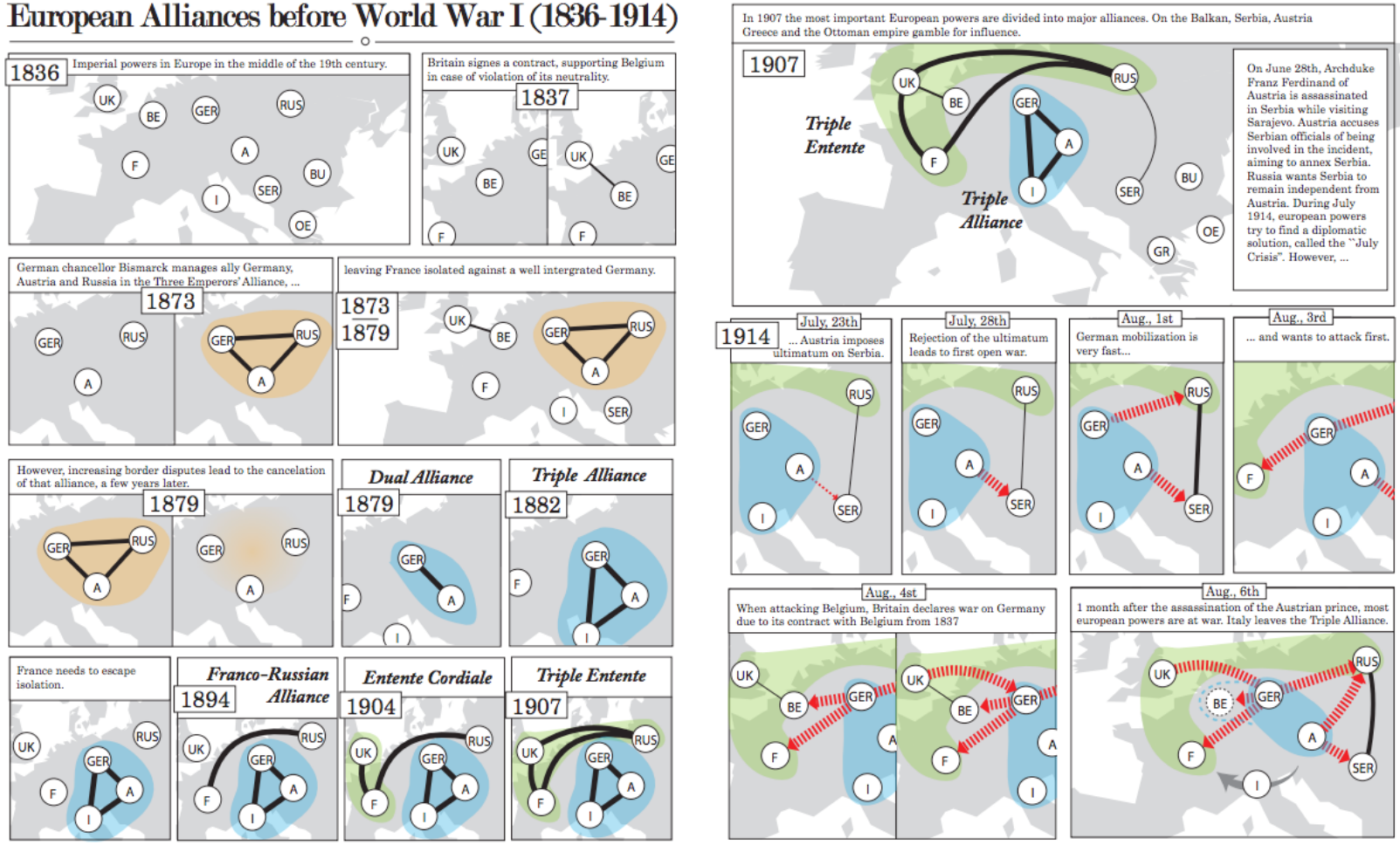
SLIDESHOW

USE STAGING AND ANIMATION FOR COMPLICATED TRANSITIONS TO AVOID CONFUSING READERS



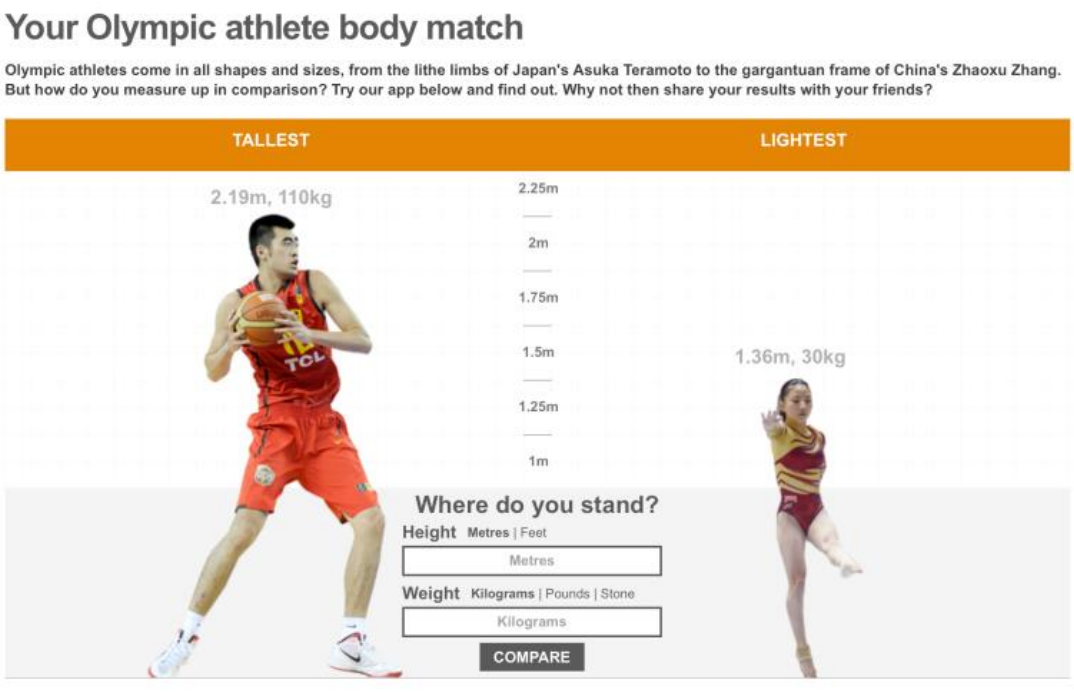
USE ESTABLISHING SHOTS

SITUATE THE VIEWER BEFORE DIVING IN



BACH ET AL 2016

Users find themselves

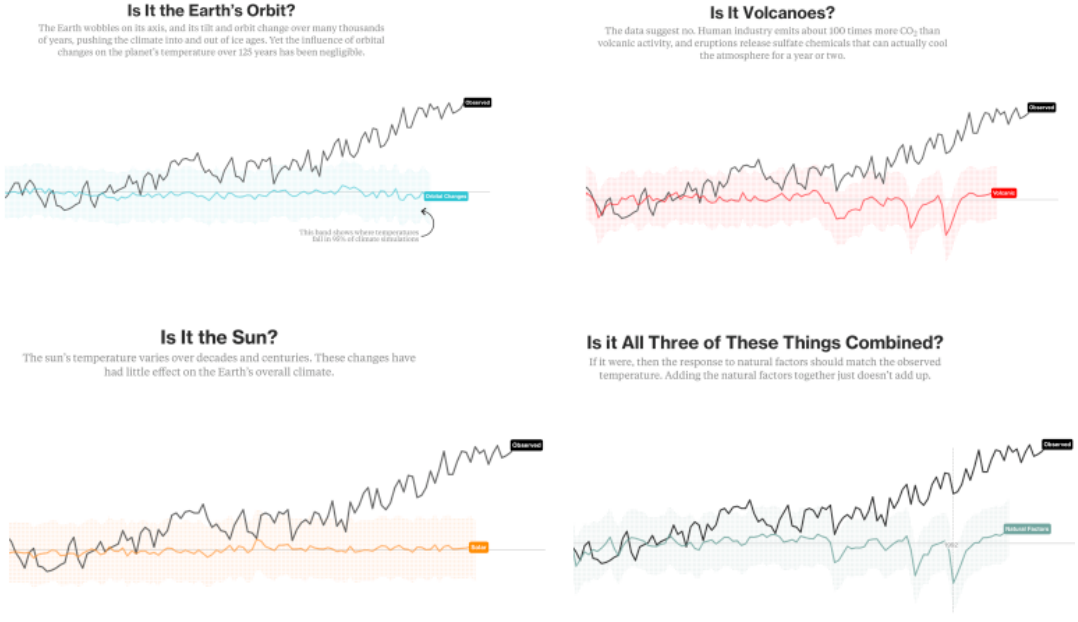


ANCHOR VIEWER IN THE PIECE

MAKES DATA MORE PERSONALLY RELEVANT

2016 LYN BARTRAM, BENJAMIN BACH, JEREMY BOY, PAULO CIUCCARELLI, STEVEN DRUCKER, YURI ENGELHARDT, ULRIKE KOEPPEN, MORITZ STEFANER, BARBARA TVERSKY, & JO WOOD.

Again, and again…



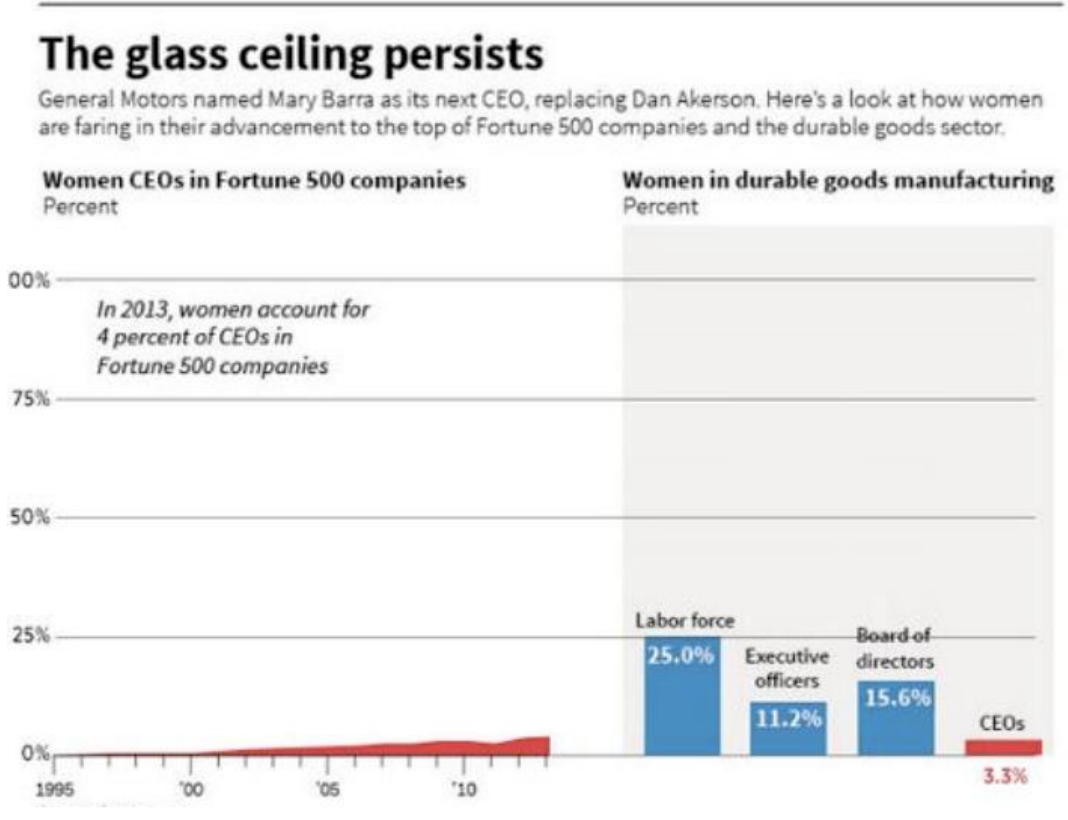
SHOW SAME PHENOMENON OVER AND OVER, CHANGING ONLY ONE VARIABLE

RHYTHM STRENGTHENS THE NARRATIVE

REPEATED DISAPPOINTMENT SETS UP THE FINAL REVEAL

2016 LYN BARTRAM, BENJAMIN BACH, JEREMY BOY, PAULO CIUCCARELLI, STEVEN DRUCKER, YURI ENGELHARDT, ULRIKE KOEPPEN, MORITZ STEFANER, BARBARA TVERSKY, & JO WOOD.

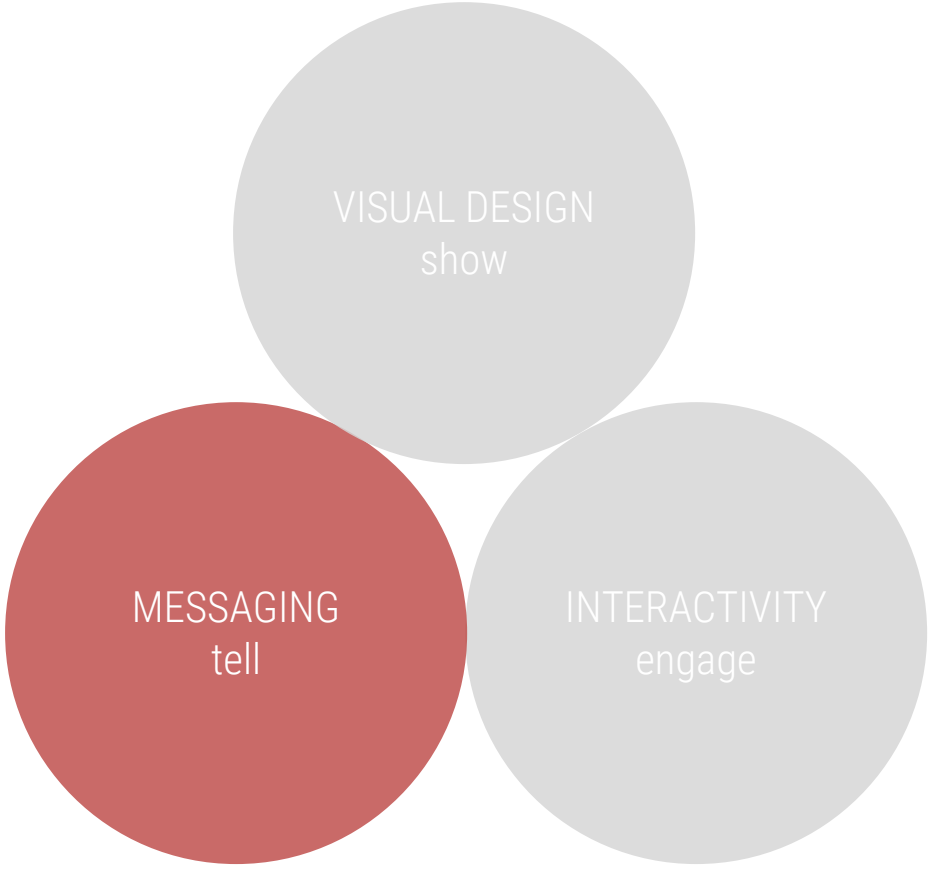
Break conventions



PURPOSEFULLY BREAK CONVENTIONS OF CHART DESIGN

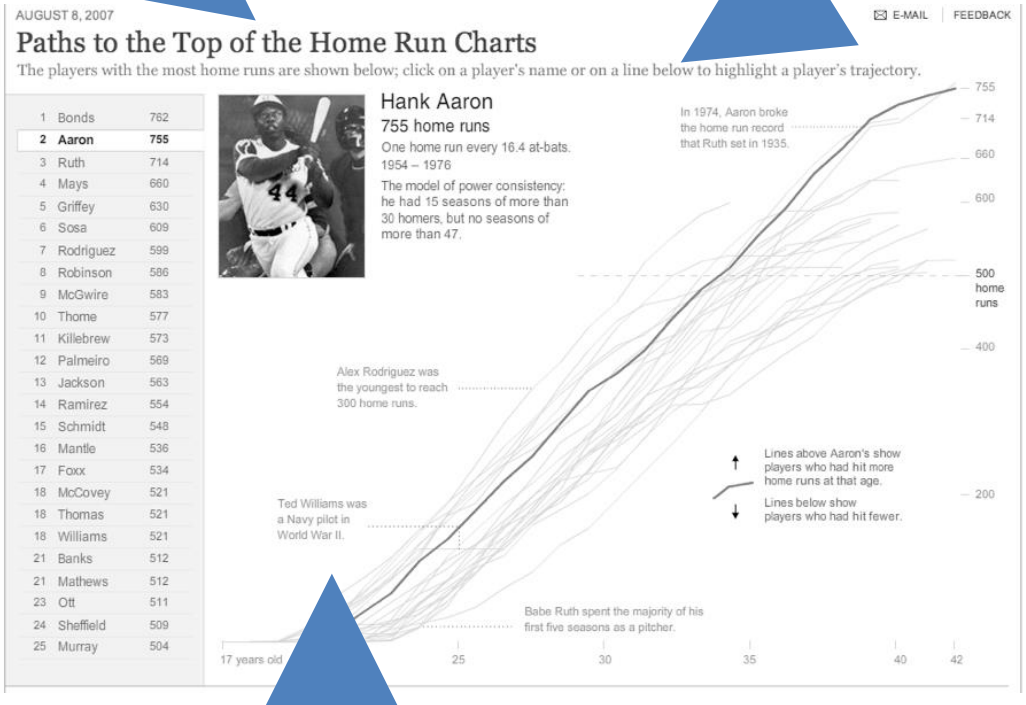
BREAKING EXPECTATIONS CAN BE USED TO UNDERLINE PARTICULAR INTERPRETATIONS

2016 LYN BARTRAM, BENJAMIN BACH, JEREMY BOY, PAULO CIUCCARELLI, STEVEN DRUCKER, YURI ENGELHARDT, ULRIKE KOEPPEN, MORITZ STEFANER, BARBARA TVERSKY, & JO WOOD.


VISUAL DESIGN
show
MESSAGING
tell
INTERACTIVITY
engage

HEADLINE

CAPTION

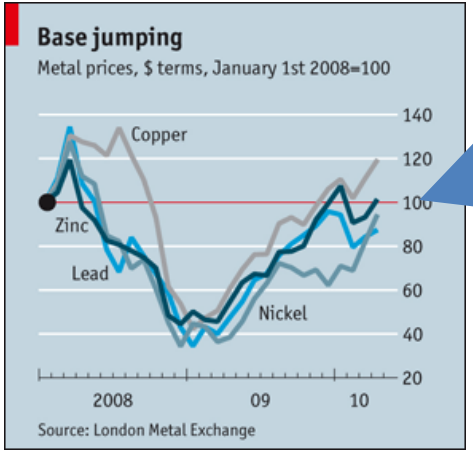


ANNOTATION

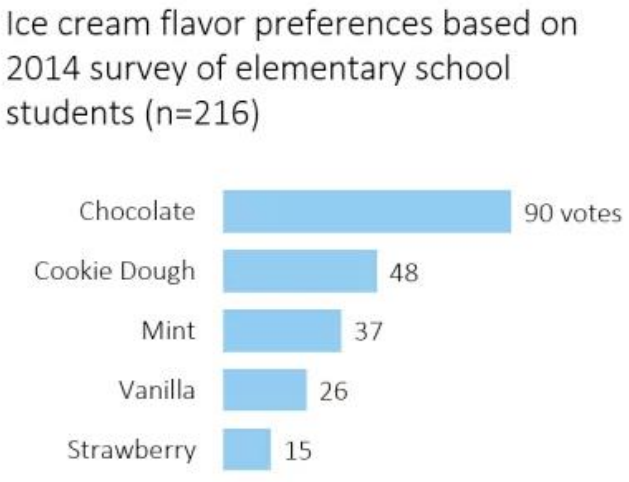
USE HEADLINES, CAPTIONS, & ANNOTATIONS

QUICKLY DRAW ATTENTION TO WHAT'S IMPORTANT

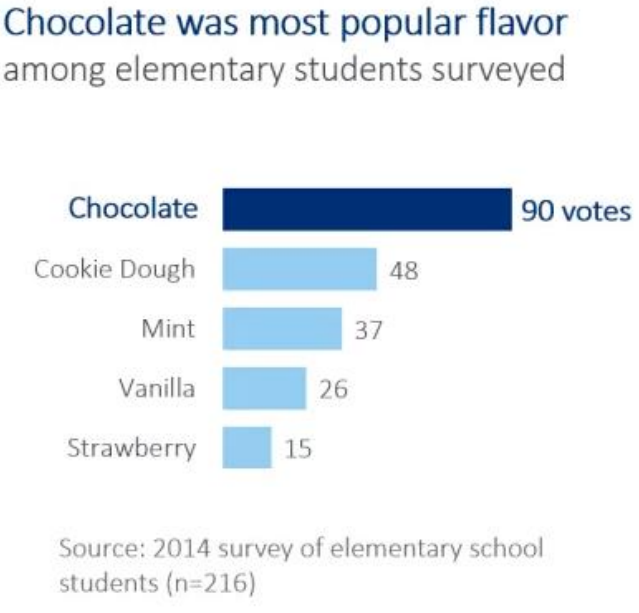
MARK FOR EMPHASIS



DESCRIPTIVE TITLES AND ANNOTATIONS CAN BE THE DIFFERENCE BETWEEN A CHART AND A STORY

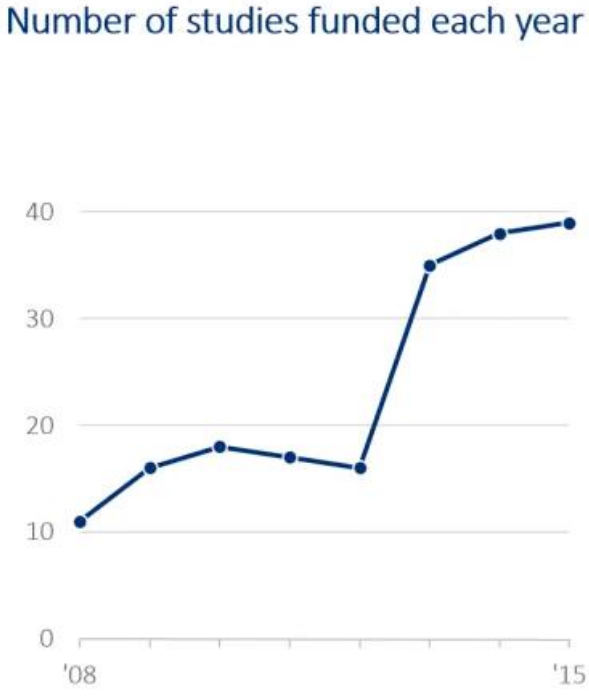


or



ANN K. EMERY 2016

DESCRIPTIVE TITLES AND ANNOTATIONS CAN BE THE DIFFERENCE BETWEEN A CHART AND A STORY



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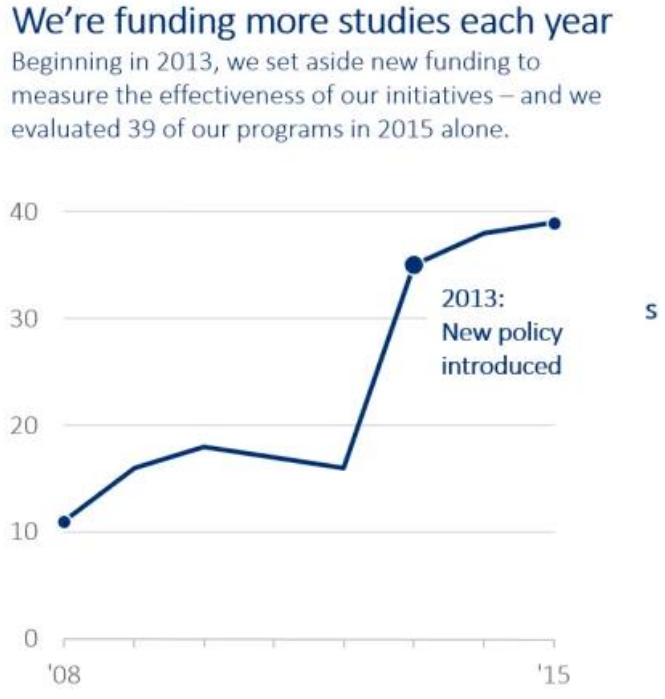

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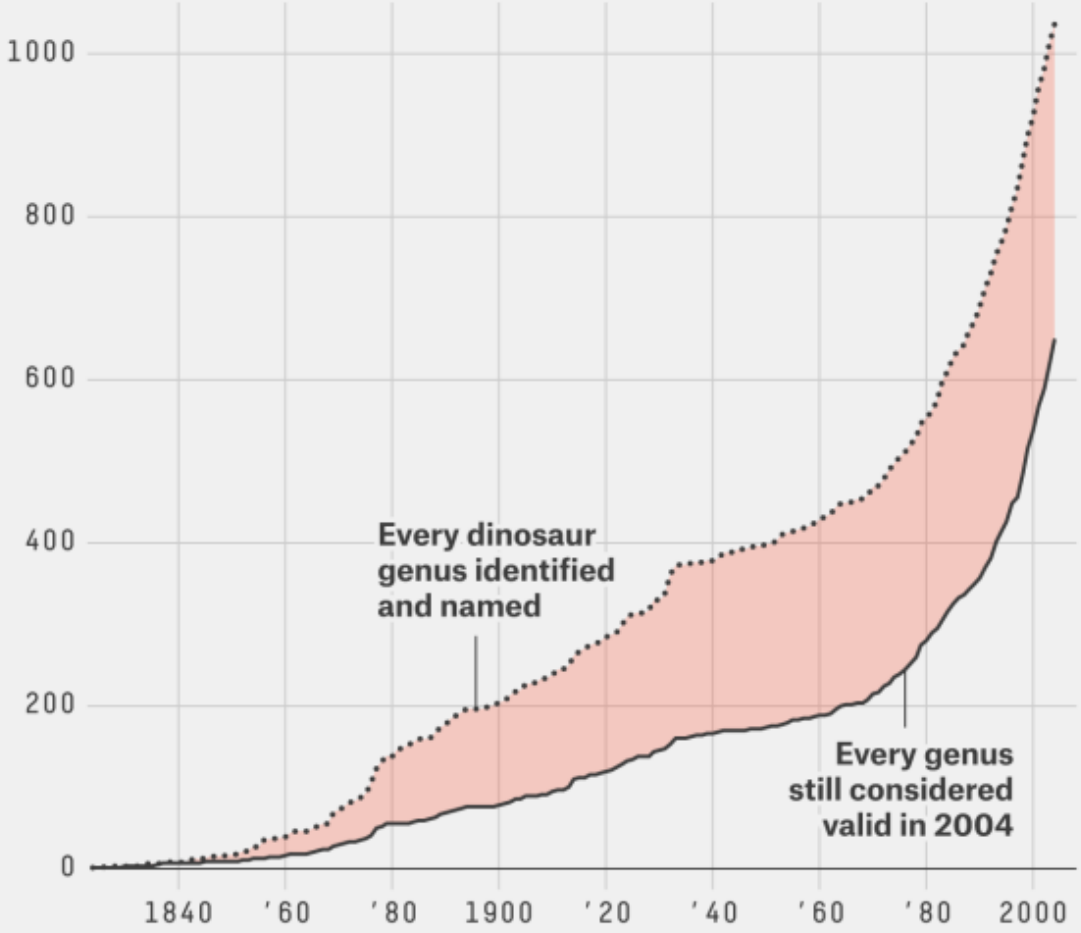
ANN K. EMERY 2016

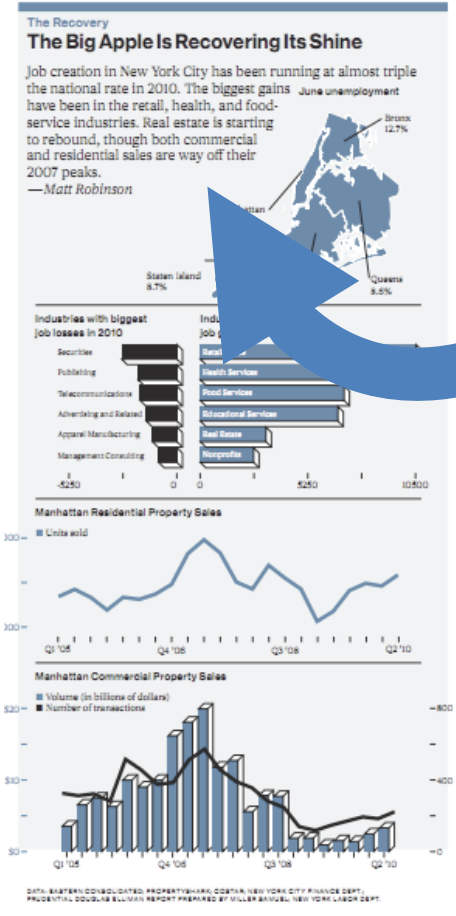
Dinosaurs named, then unnamed

By 2004, about 37 percent of every dinosaur genus ever identified and named had had its genus status revoked



FIVETHIRTYEIGHT

SOURCE: PALEOBIOLOGY



ISOLATED

WEAVE TEXT INTO THE GRAPHIC, NOT JUST AT THE BEGINNING

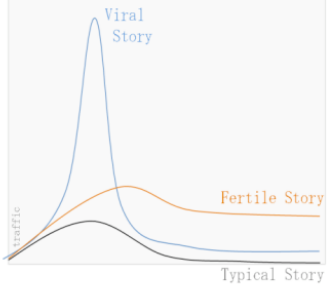
TEXT AND GRAPHICS WORK BETTER TOGETHER THAN APART

CONNECT THE TEXT TO RELEVANT GRAPHICS

"SEE FIG. 5"

this work economical, visualizations
at are either *persistent* or *viral* in order
g traffic. Persistent stories cover
" that maintain relevance over time
conomics, the housing market).
sistent themes "fattens and elongates"
s (which are already fatter and longer
g this slow-burn, these visualizations
of stories over several months and
l stories achieve heavy traffic
ikes of popularity. These stories tend
alities, or sensational news. To get the
e visualizations for editorial content

Fig. 5



The Endorsement Primary

In presidential primaries, endorsements have been among the best predictors of which candidates will succeed and which will fail. So we're keeping track.

By AARON BYCOFFE

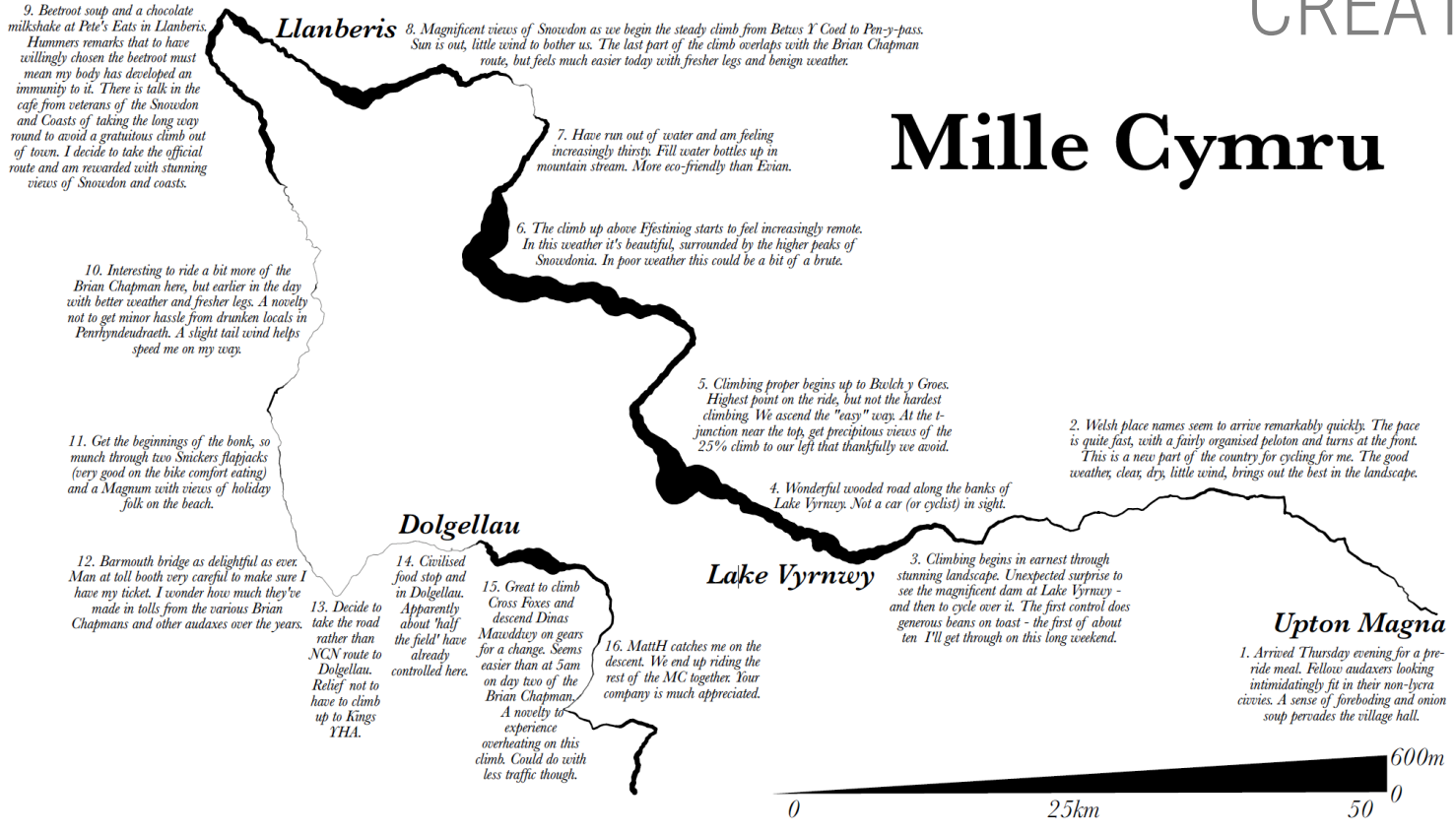
UPDATED 11:27 A.M. EST | MAR 3

CANDIDATE	REPRESENTATIVES 1 POINT EACH	SENATORS 5 POINTS EACH	GOVERNORS 10 POINTS EACH	TOTAL POINTS
Marco Rubio				168
Ted Cruz				34
John Kasich				31
Donald Trump				29

CANDIDATE	REPRESENTATIVES 1 POINT EACH	SENATORS 5 POINTS EACH	GOVERNORS 10 POINTS EACH	TOTAL POINTS
Hillary Clinton				478
Bernie Sanders				5

Before any votes are cast, presidential candidates compete for the support of influential members of their party, especially elected officials like U.S. representatives, senators and governors. During the period

REMOVE DETAIL TO CREATE SPACE FOR THE STORY



JO WOOD 2016

MIND YOUR PRECISION

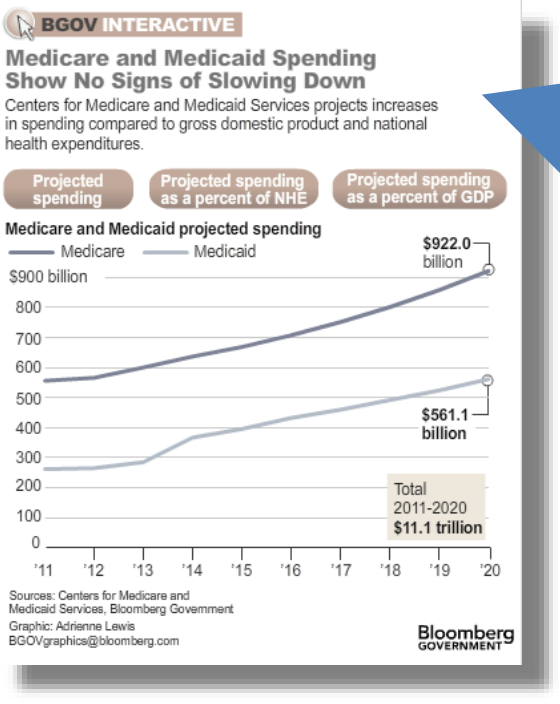
SIGNIFICANT DIGITS, TICK MARKS, AND LABELS SUGGEST WHAT DESERVES ATTENTION

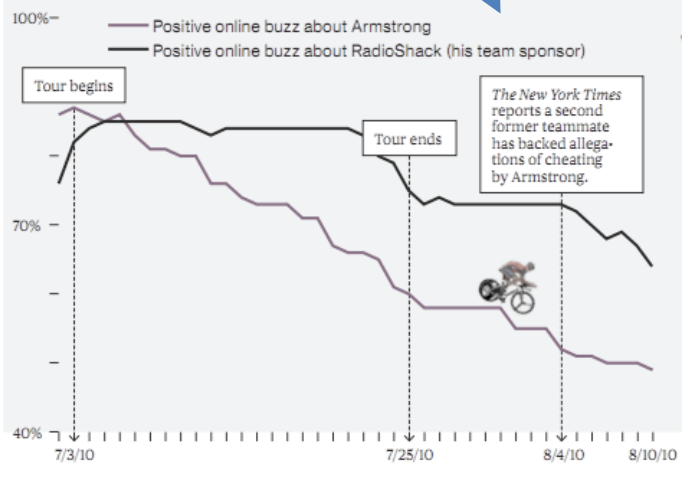
Representative	District	Fiscal 2010 contract spending
Mike Coffman	Colo. 6	$3.26 billion
Doug Lamborn	Colo. 5	2.98 billion
Rob Bishop	Utah 1	2.76 billion
Kenny Marchant	Texas 24	2.58 billion
Jeff Duncan	S.C. 3	2.40 billion
Sandy Adams	Fla. 24	2.36 billion
Lamar Smith	Texas 21	1.65 billion
Steve Scalise	La. 1	1.49 billion
Jeff Landry	La. 3	1.47 billion
Roscoe Bartlett	Md. 6	billion
John Carter	Texas 31	illion

TOO PRECISE

THOUGHTFUL

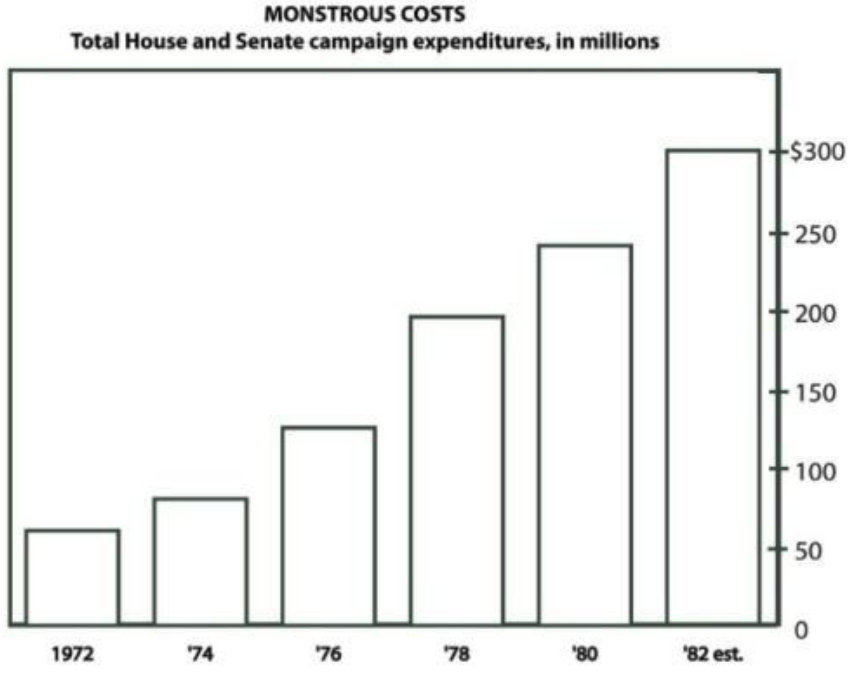
FINE





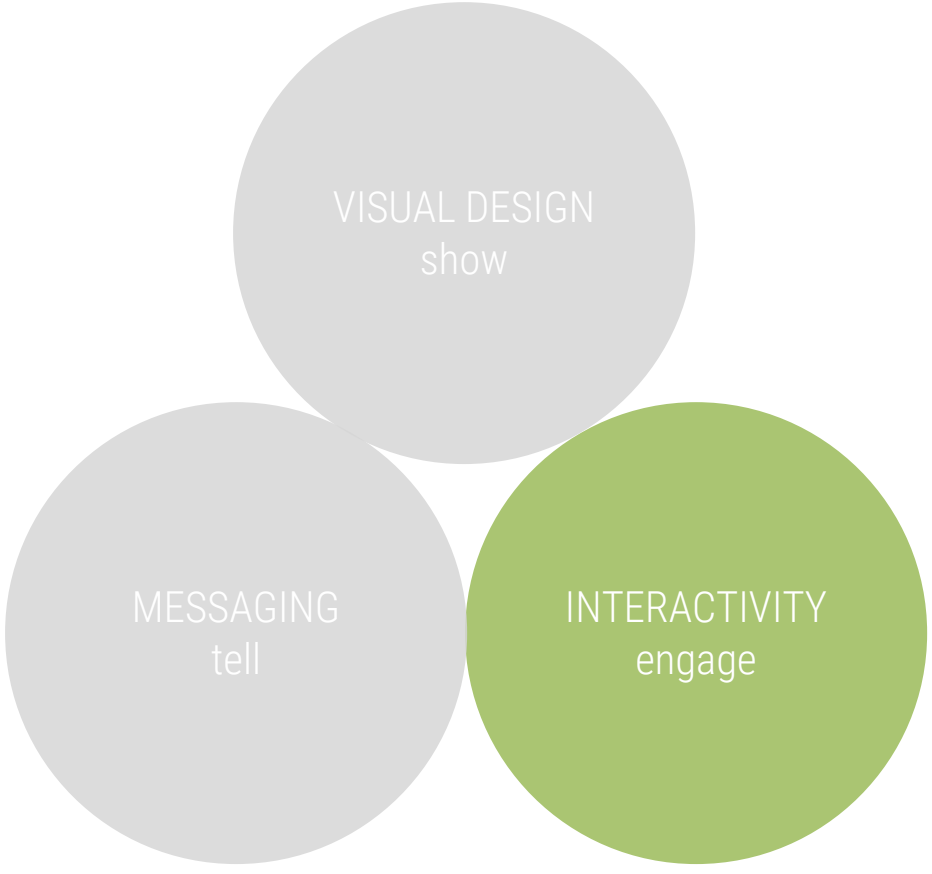
USE EMBELLISHMENTS SPARINGLY & CAREFULLY

STYLISED VISUALS CAN BE ENGAGING BUT ARE HARD TO GET RIGHT



NIGEL HOLMES

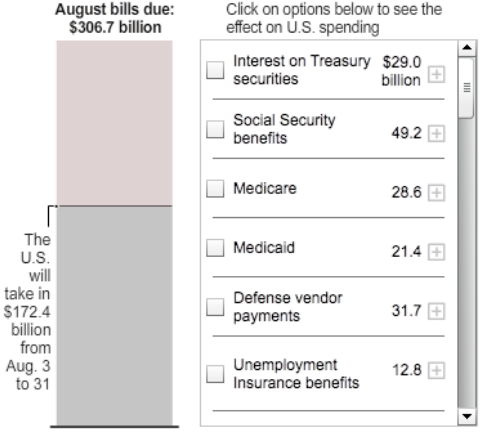
IT'S IMPORTANT TO REALLY UNDERSTAND THE RULES OF GOOD VISUAL COMMUNICATION BEFORE YOU TRY TO BREAK THEM


VISUAL DESIGN
show
MESSAGING
tell
INTERACTIVITY
engage

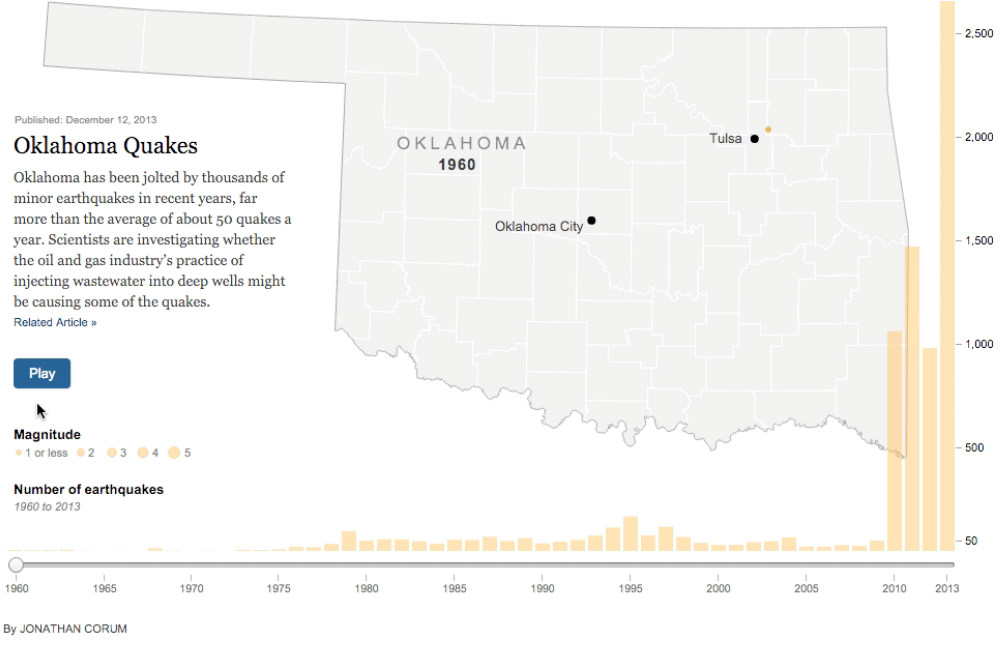
INTERACTIVE FEATURES SHOULD SUGGEST INTERACTIVITY

AVOID A CLICK-AND-SEEK EXPERIENCE

FAMILIAR WIDGETS



VISUAL FEEDBACK ON PAGE LOAD OR PLAY

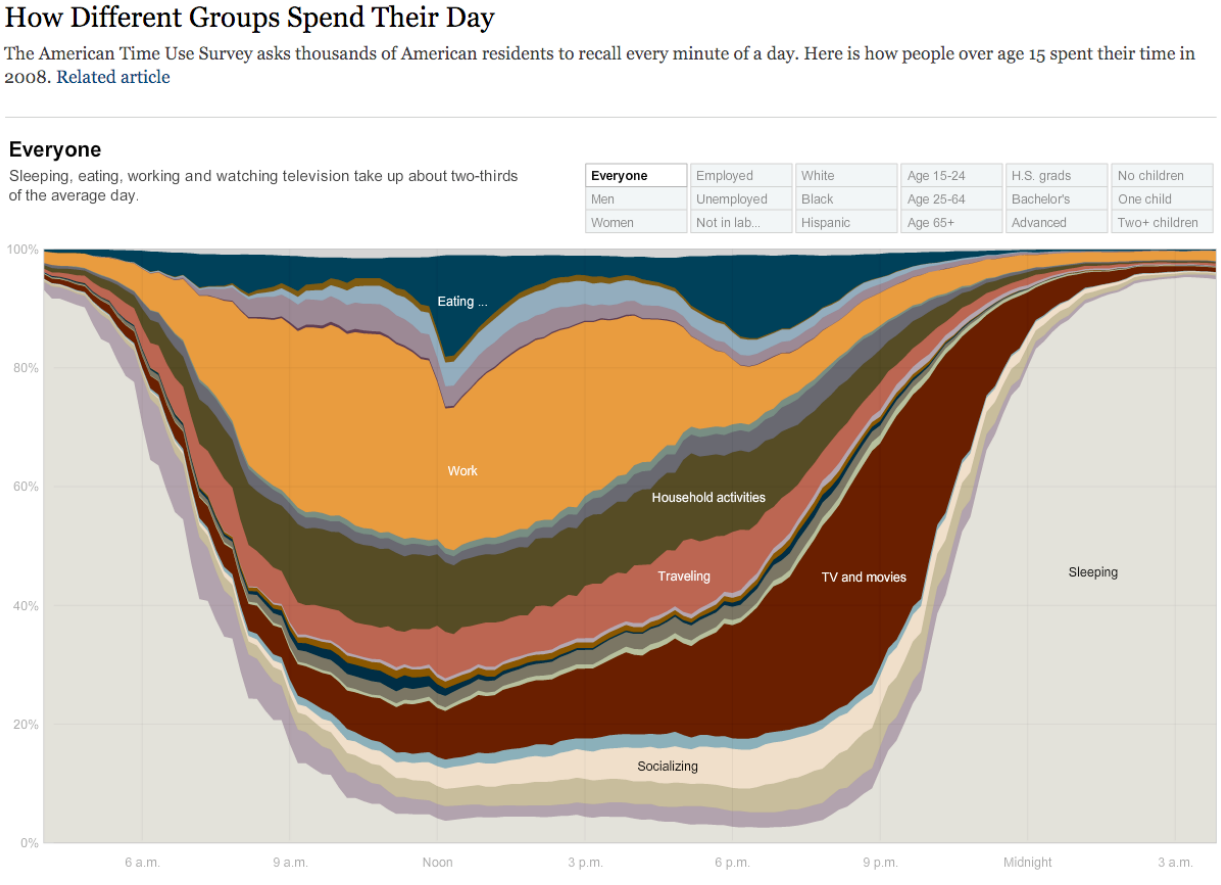


INCLUDE EASY WAYS TO GO BACK / RESET

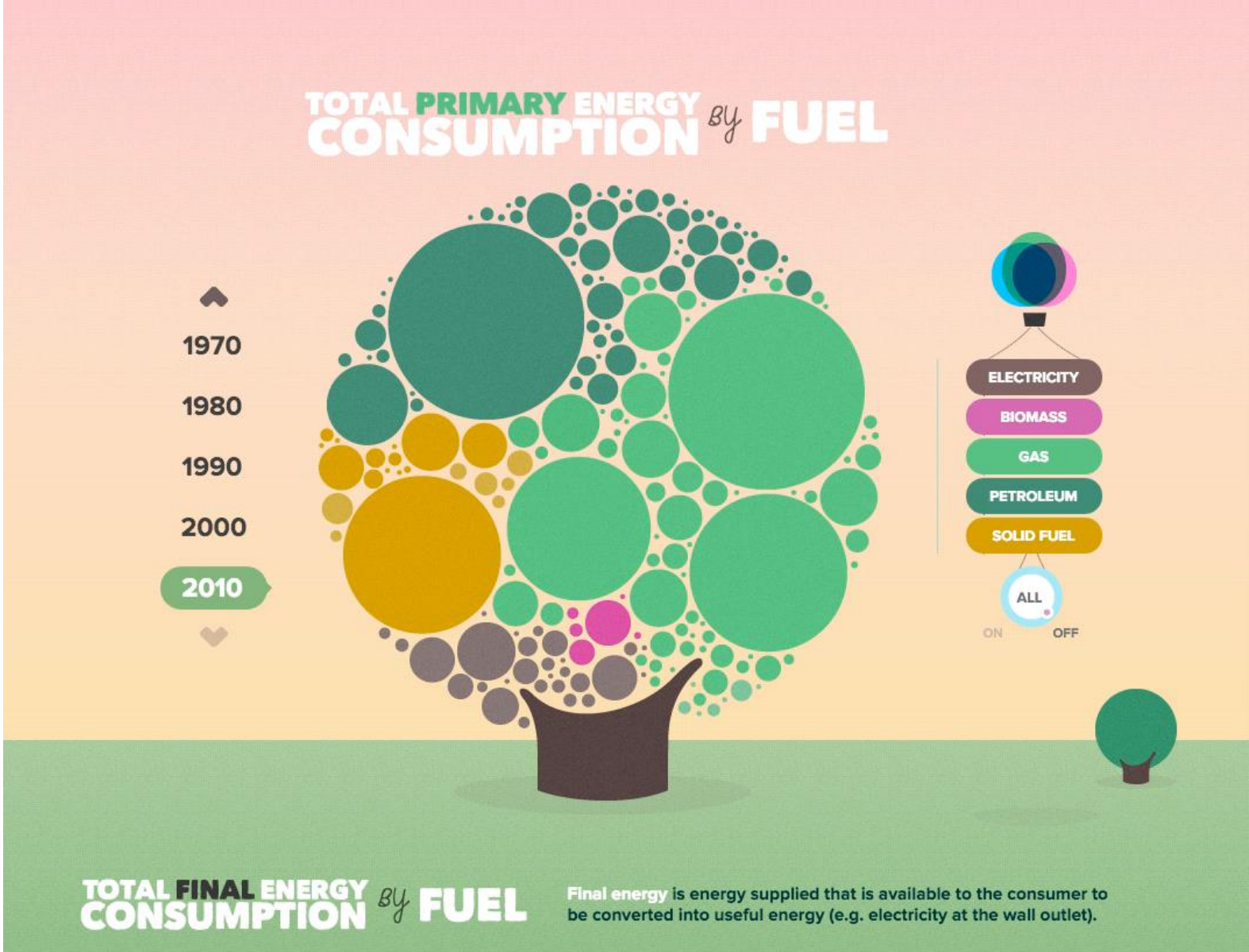
LINEAR NAVIGATION CAN SIMPLIFY THIS

RESTRICT INTERACTION TO KEY DIMENSIONS

THE MORE INTERACTIVITY, THE LESS STORY



USE MOTION & OTHER CUES TO SUGGEST INTERACTION



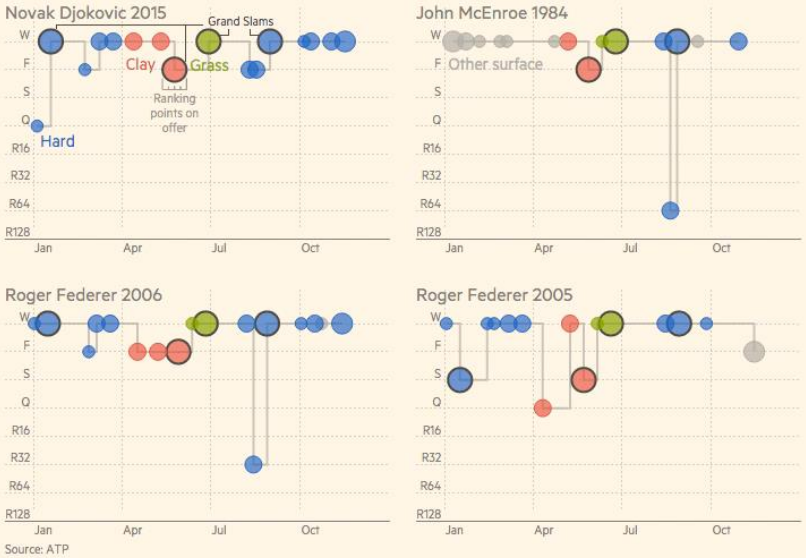
“SCROLLJACKING”

HIJACKING IN-BROWSER SCROLLING TO ADVANCE A LINEAR NARRATIVE

SMOOTH AND LINEAR
EASY FORWARD/BACK
MORE BROWSABLE THAN VIDEO
CROSS-PLATFORM
CAN BREAK THE SCROLLBAR

FINANCIAL TIMES

Djokovic’s 2015 was the greatest ever men's tennis season



John Burn-Murdoch • January 27, 2016

If Novak Djokovic wins the Australian Open title this weekend, he will in doing so extend the most impressive streak ever in men's tennis.

When the current world number one won the Qatar Open earlier this month, it marked the 16th consecutive tournament he had entered in which he reached the final -- a run stretching back exactly one year to a quarter-final defeat at the same event.

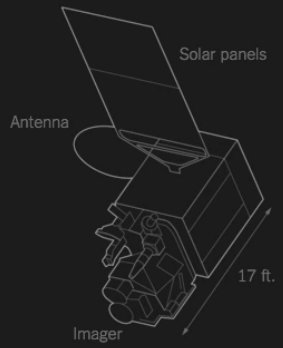
CLICKING IS A DECISION
SCROLLING IS A CONTINUATION

JOSHUA PORTER

Japan's New Satellite Captures an Image of Earth Every 10 Minutes

By DEREK WATKINS JULY 10, 2015

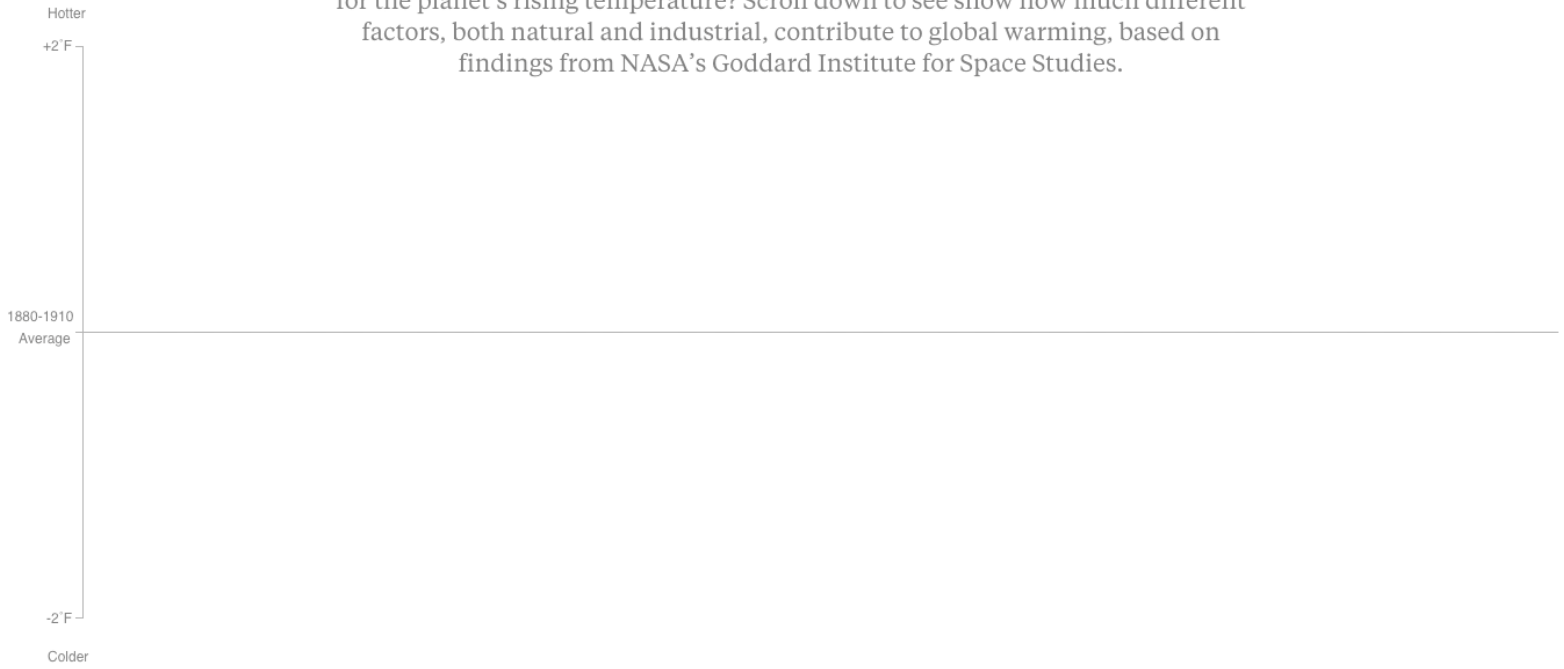
A sense of perspective is unavoidable from 22,000 miles out. Looking down at Earth from that distance — almost three times farther than the diameter of the planet itself — allows a view of the globe as a massive organic system, pulsing with continuous movement. Below, images from the Himawari-8 weather satellite's first official day paint a living portrait of the western Pacific, with Typhoons Chan-hom and Nangka spinning slowly westward.



What's Really Warming the World?

By Eric Roston and Blacki Migliozzi | June 24, 2015

Skeptics of manmade climate change offer various natural causes to explain why the Earth has warmed 1.4 degrees Fahrenheit since 1880. But can these account for the planet's rising temperature? Scroll down to see show how much different factors, both natural and industrial, contribute to global warming, based on findings from NASA's Goddard Institute for Space Studies.



Scroll Events

Detecting The Scroll

JIM VALLANDINGHAM http://vallandingham.me/scroll_talk/

RECAP: MISTAKES

- making (non-)meaningful comparisons
- inferring trends and differences from noise
- (wrong) assumptions about the meaning of correlations
- (wrong) claims of “significance”

RECAP: PRINCIPLES

- maximize the data-ink ratio
- avoid chart junk (sometimes)
- layer information
- maximize the data density
  - shrink the graphics
  - maximize the amount of data shown (sometimes)

EDWARD TUFTE

STORYTELLING WITH DATA

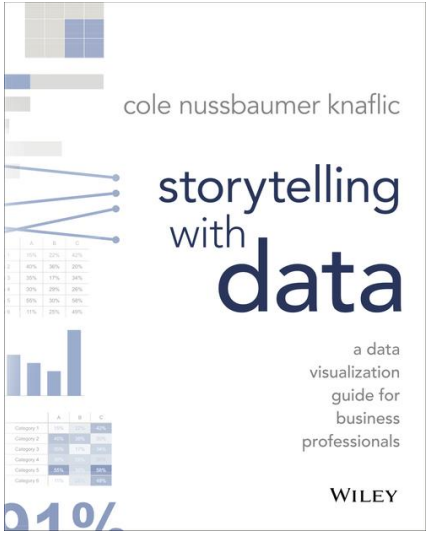
- know your context
- know your audience
- know your medium
- layout/typography/color/symbols
- design, messaging, interactivity

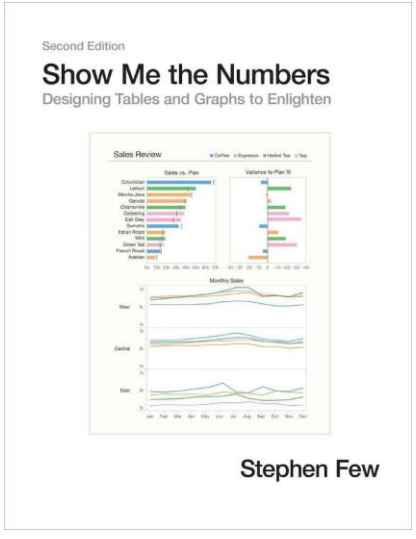
QUESTIONS?

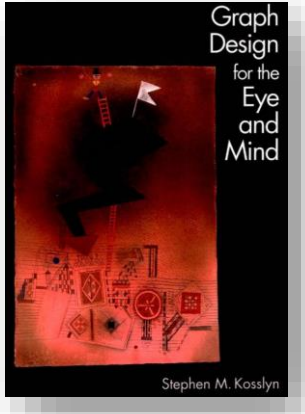
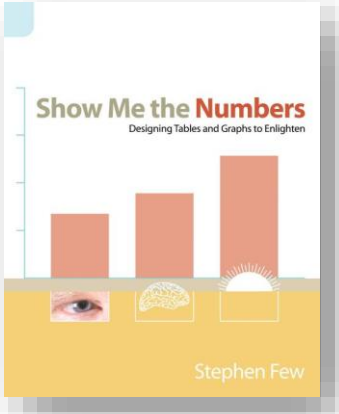
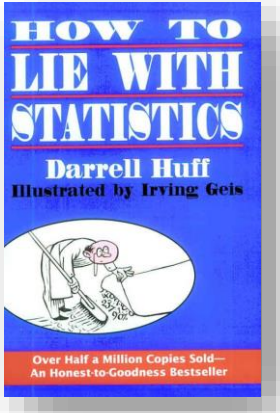
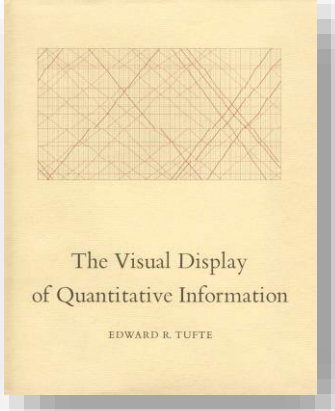
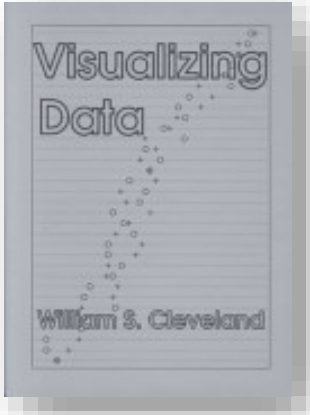
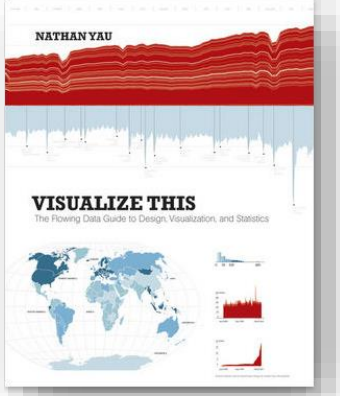
ACKNOWLEDGEMENTS

Slides in were inspired and adapted from

- slides by Wesley Willett (University of Calgary)
- content of the books on the right





DESIGN PRINCIPLES

MANY MORE EXIST…