Visualization for Communication

cs109a

(CNN)

HISTORY OF O-RING DAMAGE ON SRM FIELD JOINTS

	SRM No.	Cross Sectional View: Erosion Depth (in.)	Cross Sectional View: Perimeter Affected (deg)	Cross Sectional View: Nominal Dia. (in.)	Top View: Length Of Max Erosion (in.)	Top View: Total Heat Affected Length (in.)	Clocking Location (deg)
61A LH Center Field**	22A	None	None	0.280	None	None	36° --66°
61A LH ~~CENTER~~ FIELD**	22A	NONE	NONE	0.280	NONE	NONE	338°-18°
51C LH Forward Field**	15A	0.010	154.0	0.280	4.25	5.25	163
51C RH Center Field (prim)***	15B	0.038	130.0	0.280	12.50	58.75	354
51C RH Center Field (sec)***	15B	None	45.0	0.280	None	29.50	354
41D RH Forward Field	13B	0.028	110.0	0.280	3.00	None	275
41C LH Aft Field*	11A	None	None	0.280	None	None	--
41B LH Forward Field	10A	0.040	217.0	0.280	3.00	14.50	351
STS-2 RH Aft Field	2B	0.053	116.0	0.280	--	--	90

*Hot gas path detected in putty. Indication of heat on O-ring, but no damage.
**Soot behind primary O-ring.
***Soot behind primary O-ring, heat affected secondary O-ring.

Clocking location of leak check port - 0 deg.

OTHER SRM-15 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY AND NO SOOT NEAR OR BEYOND THE PRIMARY O-RING.

SRM-22 FORWARD FIELD JOINT HAD PUTTY PATH TO PRIMARY O-RING, BUT NO O-RING EROSION AND NO SOOT BLOWBY. OTHER SRM-22 FIELD JOINTS HAD NO BLOWHOLES IN PUTTY.

Engineer deck, the previous day…

BLOW BY HISTORY

SRM-15 WORST BLOW-BY
- 2 CASE JOINTS (80°), (110°) ARC
- MUCH WORSE VISUALLY THAN SRM-22

SRM 22 BLOW-BY
- 2 CASE JOINTS (30-40°)

SRM-13A, 15, 16A, 18, 23A 24A
- NOZZLE BLOW-BY

HISTORY OF O-RING TEMPERATURES (DEGREES-F)

MOTOR	MBT	AMB	O-RING	WIND
DM-1	68	36	47	10 MPH
DM-2	76	45	52	10 MPH
QM-3	72.5	40	48	10 MPH
QM-4	76	48	51	10 MPH
SRM-15	52	64	53	10 MPH
SRM-22	77	78	75	10 MPH
SRM-25	55	26	29 27	10 MPH 25 MPH

(PCSSCA)

CONCLUSIONS :

- TEMPERATURE OF O-RING IS NOT ONLY PARAMETER CONTROLLING BLOW-BY

  SRM 15 WITH BLOW-BY HAD AN O-RING TEMP AT 53°F
  SRM 22 WITH BLOW-BY HAD AN O-RING TEMP AT 75°F
  FOUR DEVELOPMENT MOTORS WITH NO BLOW-BY WERE TESTED AT O-RING TEMP OF 47° TO 52°F

  DEVELOPMENT MOTORS HAD PUTTY PACKING WHICH RESULTED IN BETTER PERFORMANCE

- AT ABOUT 50°F BLOW-BY COULD BE EXPERIENCED IN CASE JOINTS

- TEMP FOR SRM 25 ON 1-28-86 LAUNCH WILL BE 29°F 9 AM
  38°F 2 PM

- HAVE NO DATA THAT WOULD INDICATE SRM 25 IS DIFFERENT THAN SRM 15 OTHER THAN TEMP

RECOMMENDATIONS :

- O-RING TEMP MUST BE $\geq$ 53°F AT LAUNCH

  DEVELOPMENT MOTORS AT 47° TO 52°F WITH PUTTY PACKING HAD NO BLOW-BY
  SRM 15 (THE BEST SIMULATION) WORKED AT 53°F

- PROJECT AMBIENT CONDITIONS (TEMP & WIND) TO DETERMINE LAUNCH TIME

(PCSSCA)

the previous day…

MTI ASSESSMENT OF TEMPERATURE CONCERN ON SRM-25 (51L) LAUNCH

- CALCULATIONS SHOW THAT SRM-25 O-RINGS WILL BE 20° COLDER THAN SRM-15 O-RINGS
- TEMPERATURE DATA NOT CONCLUSIVE ON PREDICTING PRIMARY O-RING BLOW-BY
- ENGINEERING ASSESSMENT IS THAT:
  - COLDER O-RINGS WILL HAVE INCREASED EFFECTIVE DUROMETER ("HARDER")
  - "HARDER" O-RINGS WILL TAKE LONGER TO "SEAT"
    - MORE GAS MAY PASS PRIMARY O-RING BEFORE THE PRIMARY SEAL SEATS (RELATIVE TO SRM-15)
      - DEMONSTRATED SEALING THRESHOLD IS 3 TIMES GREATER THAN 0.038" EROSION EXPERIENCED ON SRM-15
  - IF THE PRIMARY SEAL DOES NOT SEAT, THE SECONDARY SEAL WILL SEAT
    - PRESSURE WILL GET TO SECONDARY SEAL BEFORE THE METAL PARTS ROTATE
      - O-RING PRESSURE LEAK CHECK PLACES SECONDARY SEAL IN OUTBOARD POSITION WHICH MINIMIZES SEALING TIME

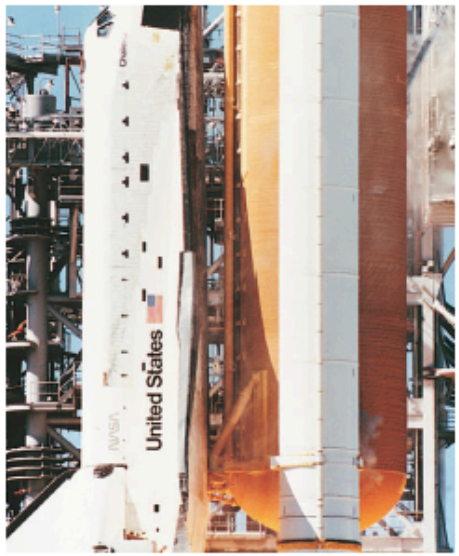
- MTI RECOMMENDS STS-51L LAUNCH PROCEED ON 28 JANUARY 1986
  - SRM-25 WILL NOT BE SIGNIFICANTLY DIFFERENT FROM SRM-15

JOE C. KILMINSTER, VICE PRESIDENT
SPACE BOOSTER PROGRAMS

MORTON THIOKOL INC.
Wasatch Division

INFORMATION ON THIS PAGE WAS PREPARED TO SUPPORT AN ORAL PRESENTATION AND CANNOT BE CONSIDERED COMPLETE WITHOUT THE ORAL DISCUSSION

(PCSSCA)



Less than 1 second after ignition, a puff of smoke appeared at the aft joint of the right booster, indicating that the O-rings burned through and failed to seal. At this point, all was lost.

On the launch pad, the leak lasted only about 2 seconds and then apparently was plugged by putty and insulation as the shuttle rose, flying through rather strong cross-winds. Then 58.788 seconds after ignition, when the Challenger was 6 miles up, a flicker of flame emerged from the leaky joint. Within seconds, the flame grew and engulfed the fuel tank (containing liquid hydrogen and liquid oxygen). That tank ruptured and exploded, destroying the shuttle.

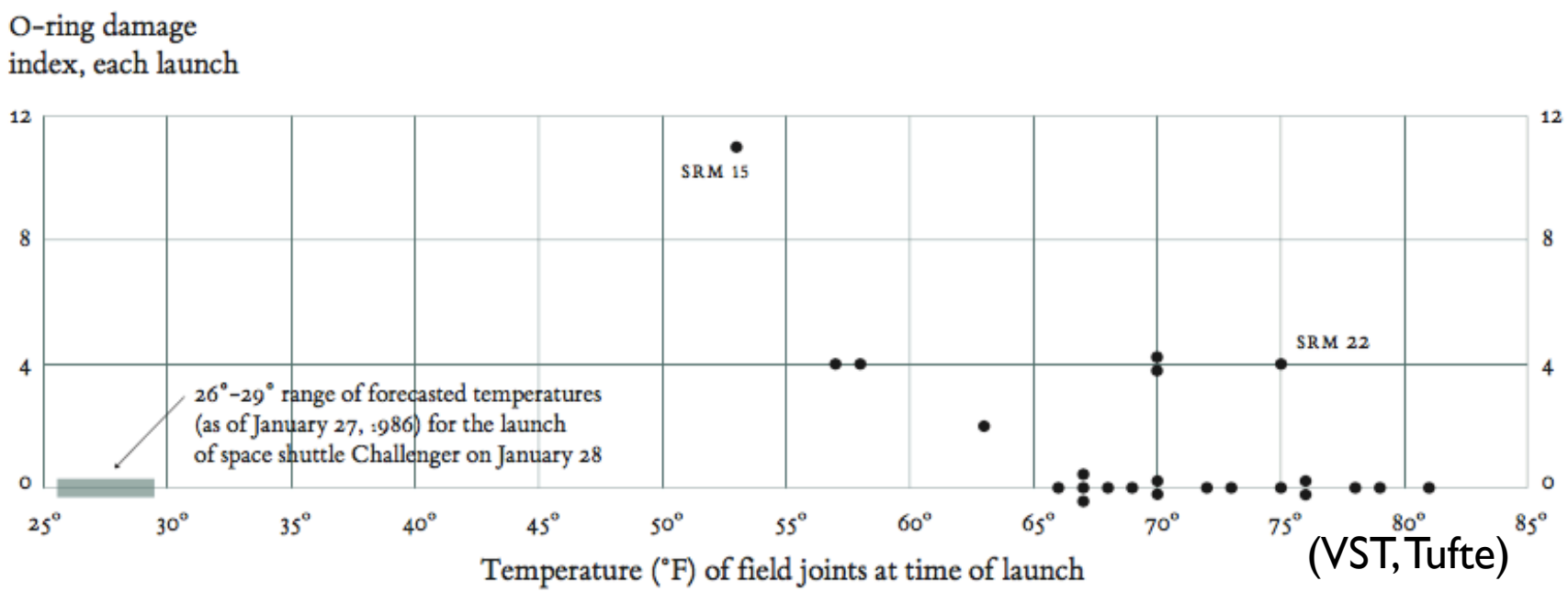
As the shuttle exploded and broke up at approximately 73 seconds after launch, the two booster rockets crisscrossed and continued flying wildly. The right booster, identifiable by its failure plume, is now to the left of its non-defective counterpart.

The flight crew of Challenger 51-L. Front row, left to right: Michael J. Smith, pilot; Francis R. (Dick) Scobee, commander; Ronald E. McNair. Back row: Ellison S. Onizuka, S. Christa McAuliffe, Gregory B. Jarvis, Judith A. Resnik.

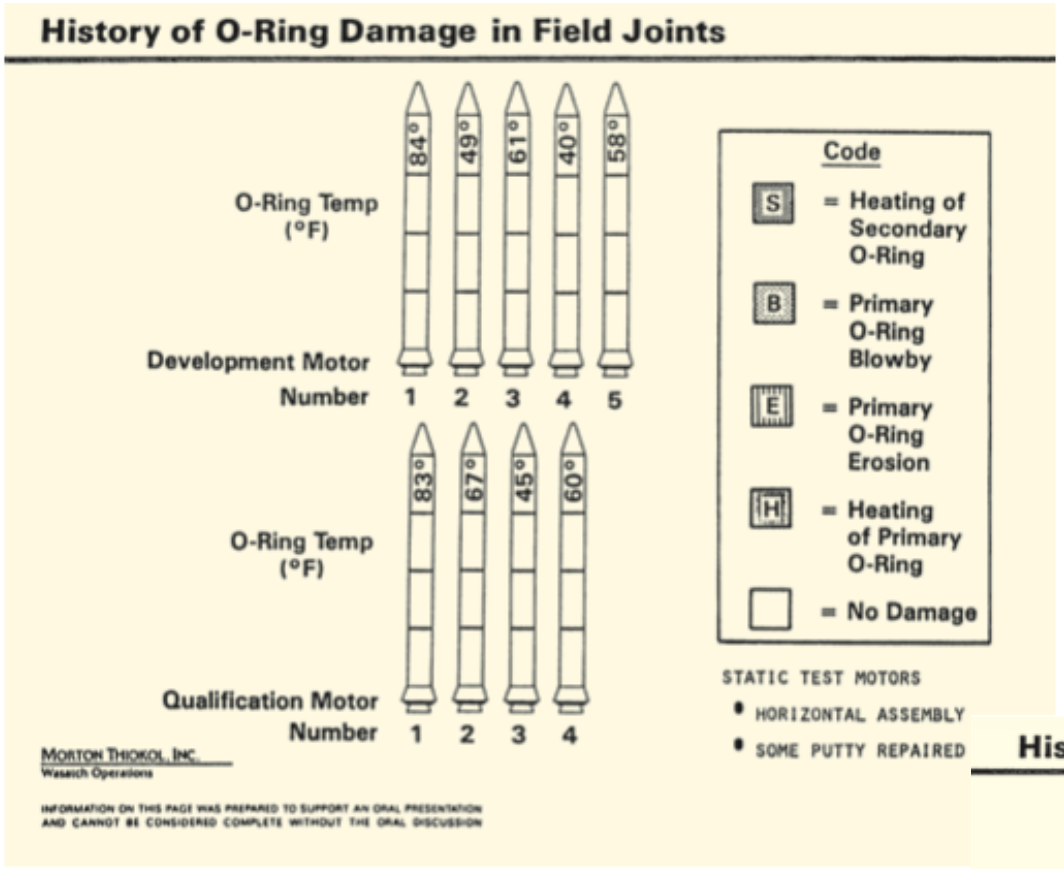
(VST, Tufte)

Flight	Date	Temperature °F	Erosion incidents	Blow-by incidents	Damage index	Comments
51-C	01.24.85	53°	3	2	11	Most erosion any flight; blow-by; back-up rings heated.
41-B	02.03.84	57°	1		4	Deep, extensive erosion.
61-C	01.12.86	58°	1		4	O-ring erosion on launch two weeks before Challenger.
41-C	04.06.84	63°	1		2	O-rings showed signs of heating, but no damage.
1	04.12.81	66°			0	Coolest (66°) launch without O-ring problems.
6	04.04.83	67°			0	
51-A	11.08.84	67°			0	
51-D	04.12.85	67°			0	
5	11.11.82	68°			0	
3	03.22.82	69°			0	
2	11.12.81	70°	1		4	Extent of erosion not fully known.
9	11.28.83	70°			0	
41-D	08.30.84	70°	1		4	
51-G	06.17.85	70°			0	
7	06.18.83	72°			0	
8	08.30.83	73°			0	
51-B	04.29.85	75°			0	
61-A	10.30.85	75°		2	4	No erosion. Soot found behind two primary O-rings.
51-I	08.27.85	76°			0	
61-B	11.26.85	76°			0	
41-G	10.05.84	78°			0	
51-J	10.03.85	79°			0	
	06.27.82	80°			?	O-ring condition unknown; rocket casing lost at sea.
51-F	07.29.85	81°			0	

RISK ASSESSMENT?

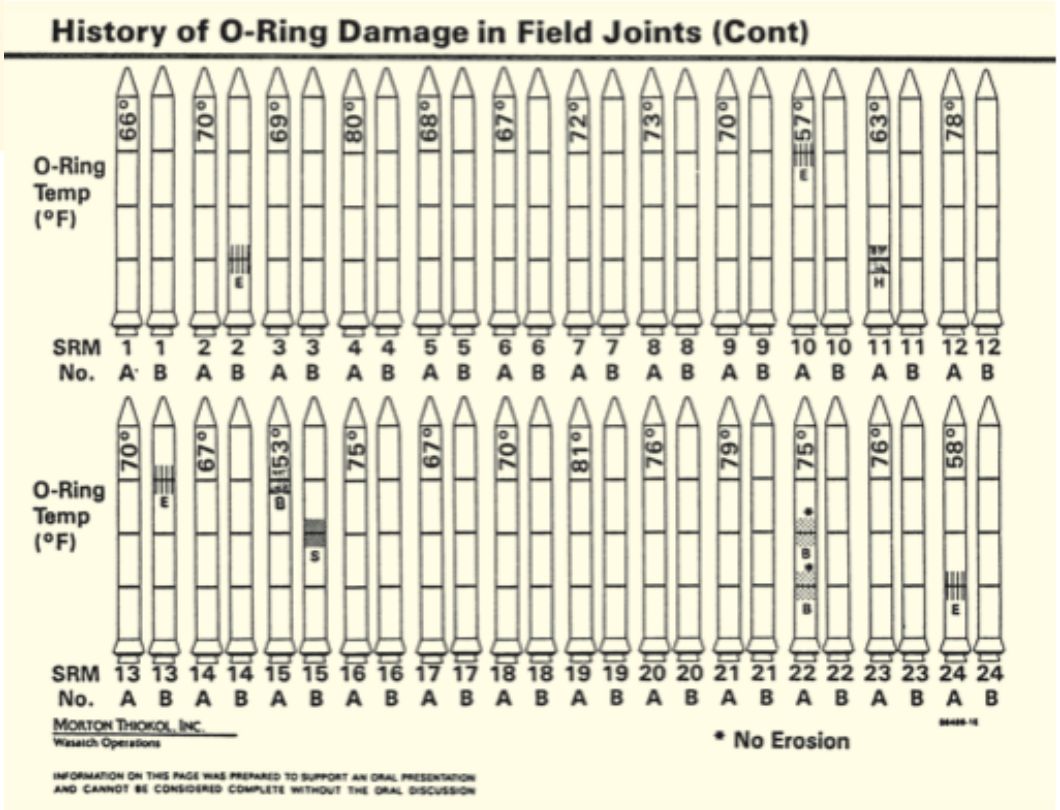


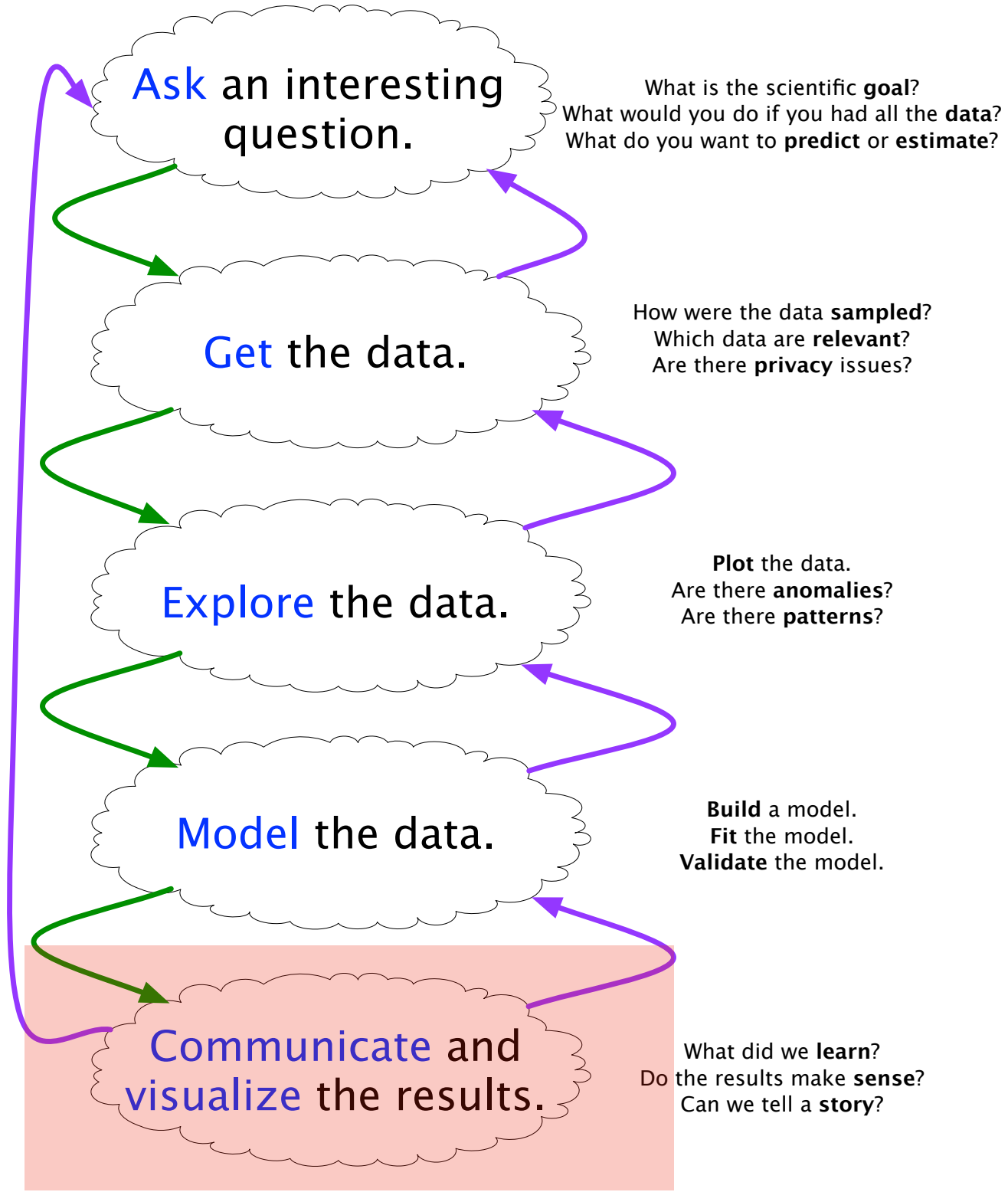
(VST, Tufte)



Chartjunk at hearings

(PCSSCA)




Ask an interesting question.
What is the scientific goal?
What would you do if you had all the data?
What do you want to predict or estimate?
Get the data.
How were the data sampled?
Which data are relevant?
Are there privacy issues?
Explore the data.
Plot the data.
Are there anomalies?
Are there patterns?
Model the data.
Build a model.
Fit the model.
Validate the model.
Communicate and visualize the results.
What did we learn?
Do the results make sense?
Can we tell a story?

Visualization Goals

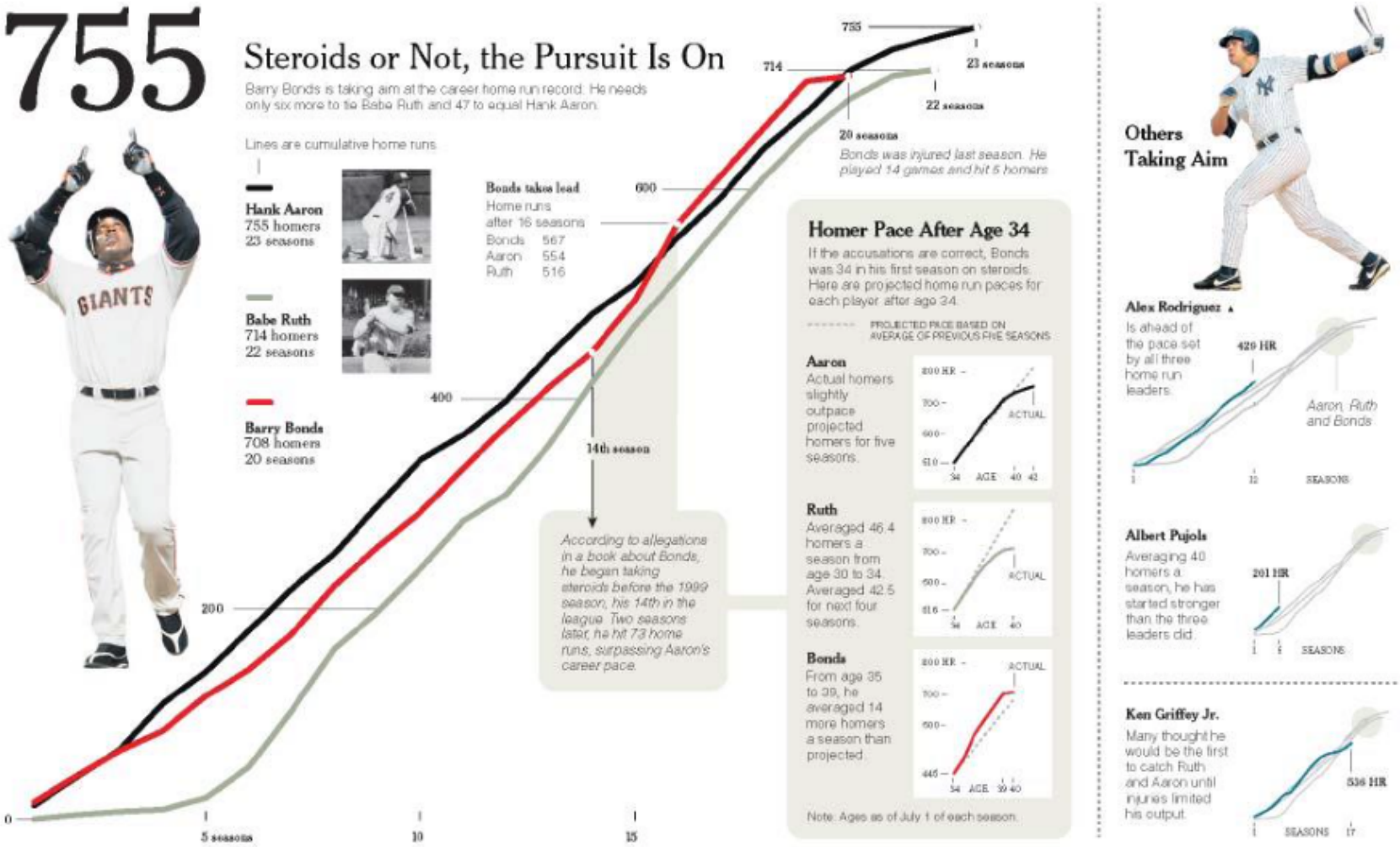
Communicate (Explanatory)

- Present data and ideas
- Explain and inform
- Provide evidence and support
- Influence and persuade

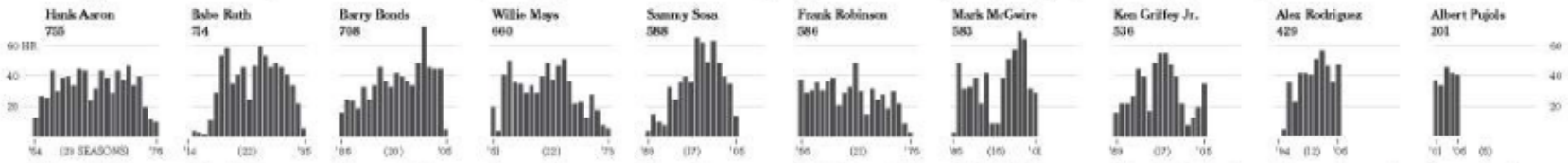
Analyze (Exploratory)

- Explore the data
- Assess a situation
- Determine how to proceed
- Decide what to do

Communicate

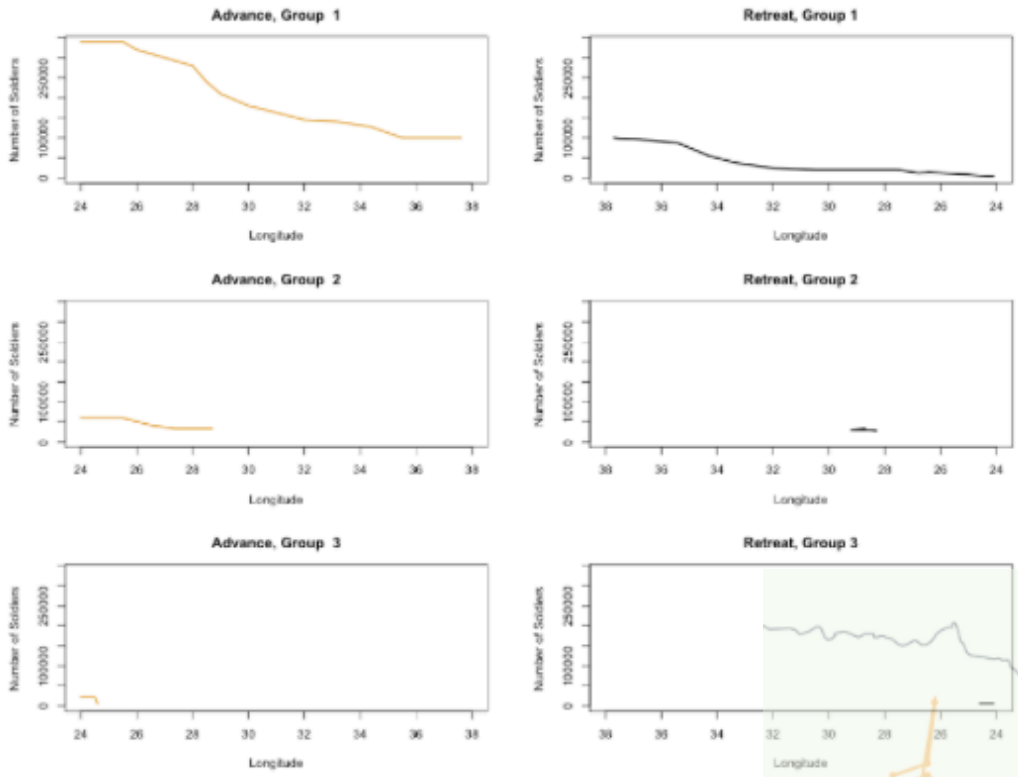


Differing Paths to the Top of the Charts The top seven players on the career home run list, along with a look at Griffey (12th), Rodriguez (37th) and Pujols (tied 257th).

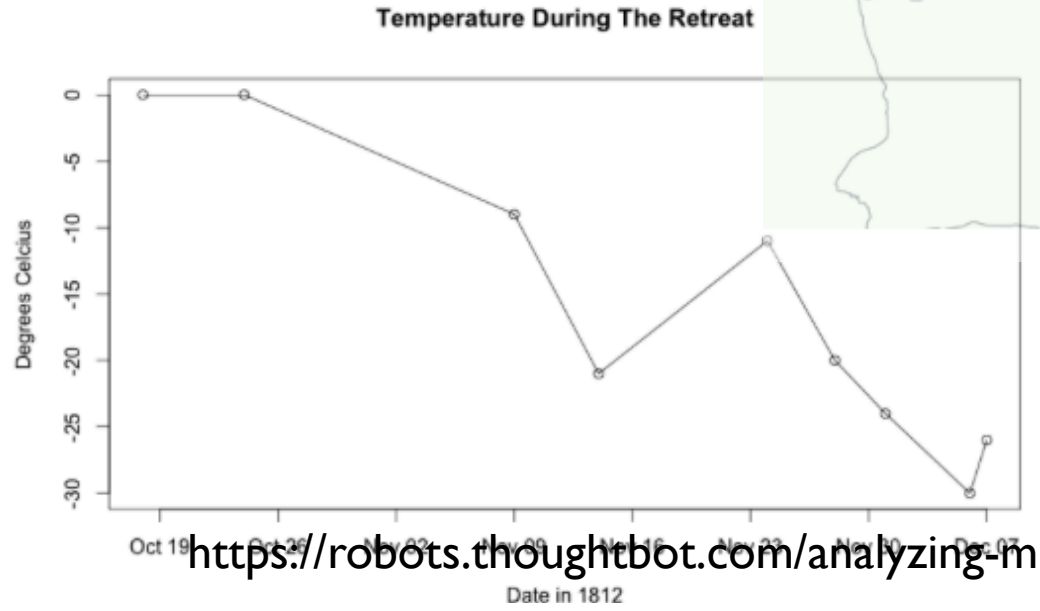


New York Times

Napoleon's March to Russia

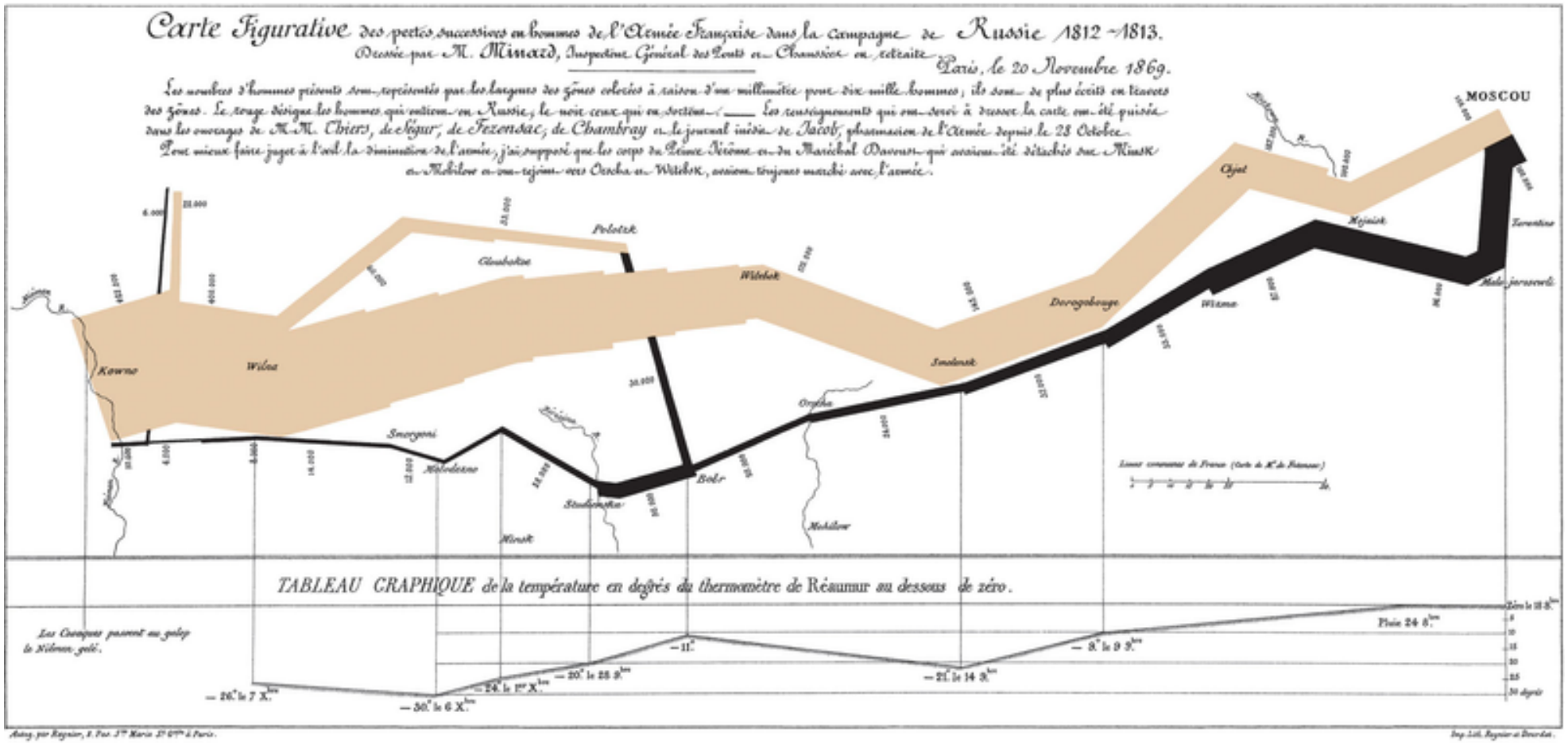


Next, the temperature experienced by his troops when winter settled in on the return trip.



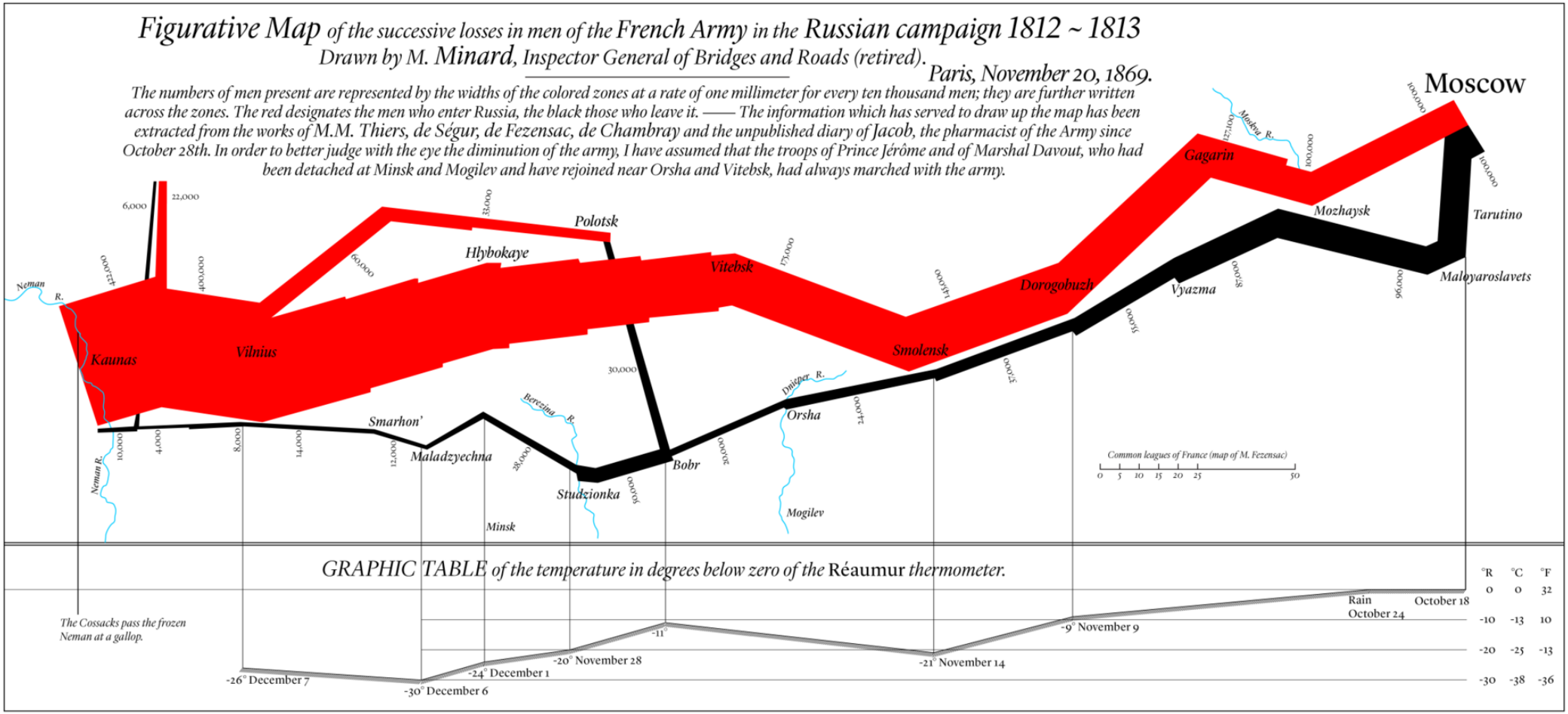
https://robots.thoughtbot.com/analyzing-minards-visualization-of-napoleons-1812-march

Minard's Graphic on Napoleon's Russia Campaign



(from wikipedia)

Minard's Graphic on Napoleon's Russia Campaign



(from wikipedia)

Key Considerations

- Who is your **audience**?
- What **questions** are you answering?
- Why should the audience **care**?
- What are your major **insights** and surprises?
- What **change** to you want to affect?

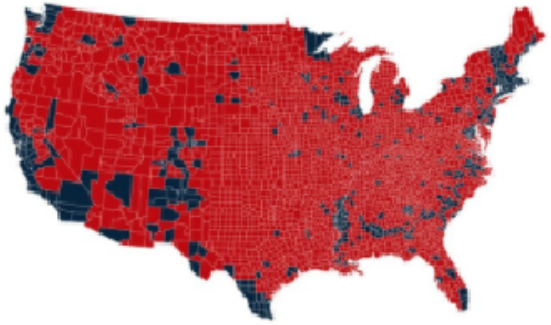
Effective Visualizations

1. Have graphical integrity
2. Keep it simple
3. Use the right display
4. Use color strategically
5. Know your audience

Have graphical integrity

WRONG

CITIZENS FOR TRUMP



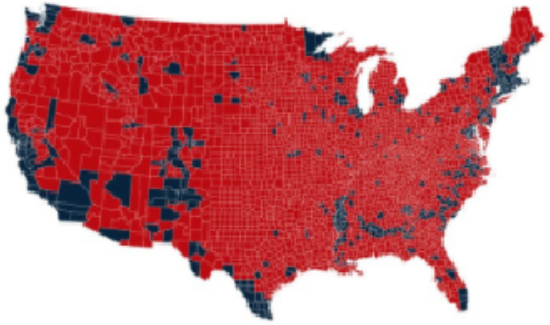
THE INSIDE STORY
OF THE PEOPLE'S MOVEMENT
TO TAKE BACK AMERICA

★ ★ ★ ★ ★

JACK POSOBIEC

RIGHT

COUNTIES FOR TRUMP



THE INSIDE STORY
OF 46% OF VOTERS' MOVEMENT
TO TAKE BACK AMERICA

★ ★ ★ ★ ★

JACK POSOBIEC

The Persuasive Power of Data Visualization

Anshul Vikram Pandey
New York University

Anjali Manivannan
New York University

Oded Nov
New York University

Margaret L. Satterthwaite
NYU School of Law, satterth@exchange.law.nyu.edu

Enrico Bertini
New York University

After looking into common effects in attitude formation and change we searched for specific mentions to the graphical appearance of charts as a driver for persuasion. Some of the comments we collected seem to back up the findings we found in our results. Some participants explicitly mention the charts as being the main reason for their change: "*I already knew that increased incarceration didn't lower crime, but I wasn't sure of the statistics. To see it on the graphs is really eye opening.*"; "*I was influenced by the bar graph showing the reasons why the survey respondents played video games.*"; "*I would not know exact numbers on this issue - the graphs gave a visual and helped identify the numbers*"; "*Seeing the graphs conflicted with my previous opinion, so I feel like I need to reevaluate my stance in a way.*"

It is also important to mention that the graphical appearance of charts is not the only factor that has a strong impact on people's attitude. In our collected feedback, we found numerous references to statistics and numbers, suggesting that mere exposure to data does have a persuasive effect – maybe at least partially due to the increased sense of objectivity evidence supported by numbers carries. We found comments like: "*It was concrete data that seemed compelling.*; "*Seeing numbers is a good indicator of change rather than just reading what someone has to say*"; "*It showed a large amount of different sources, which made it more credible*". More research is needed to disentangle what kind of specific effects each of these components have on persuasion.

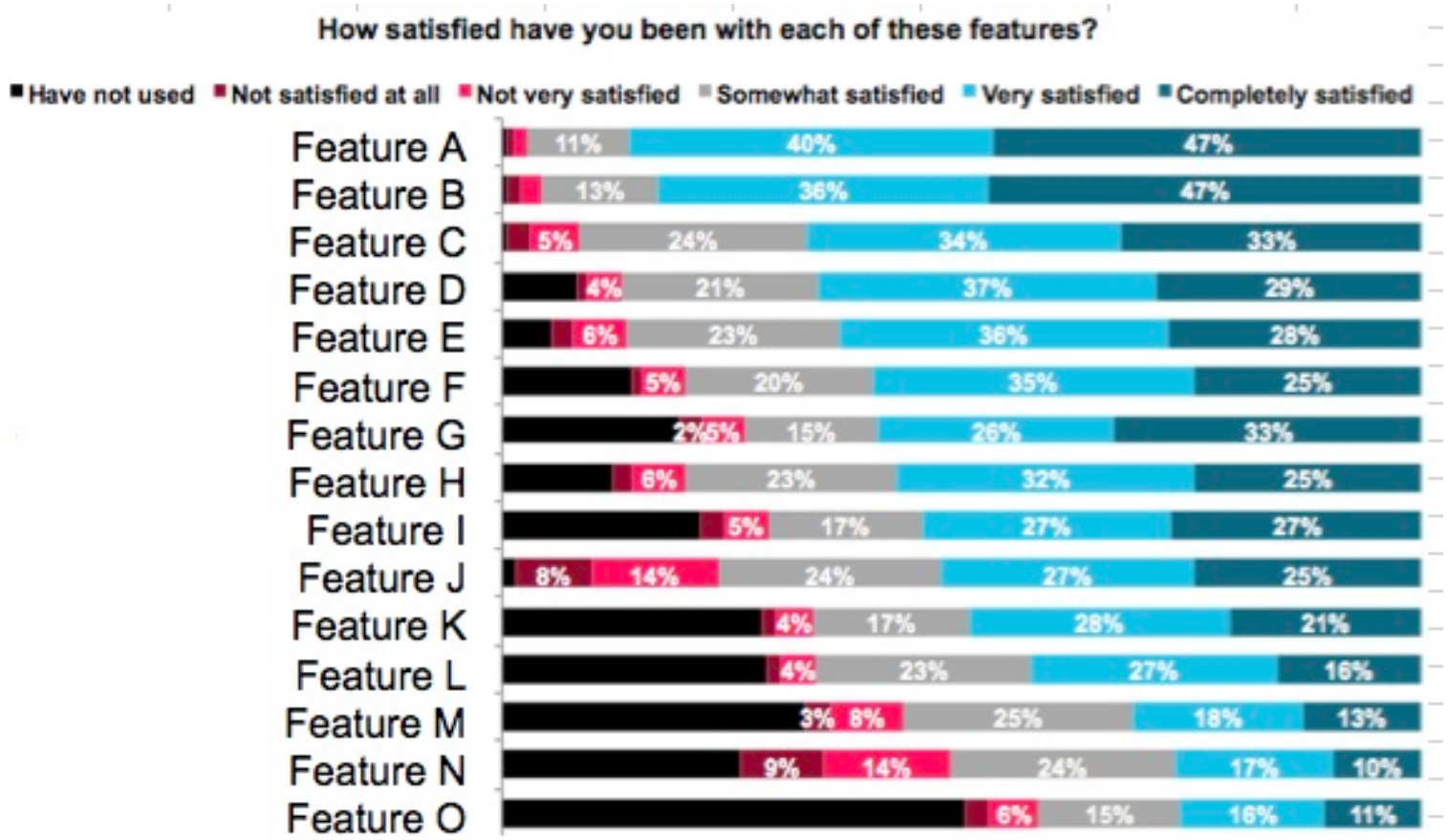
http://lsr.nellco.org/cgi/viewcontent.cgi?article=1476&context=nyu_plltwp

Keep it Simple

Don’t Make Them Think!

- Your audience does not want to spend cognitive effort on things you know and can just show them
- Lead them through the major steps of your story
- Point out interesting key facts and insights using captions and annotations

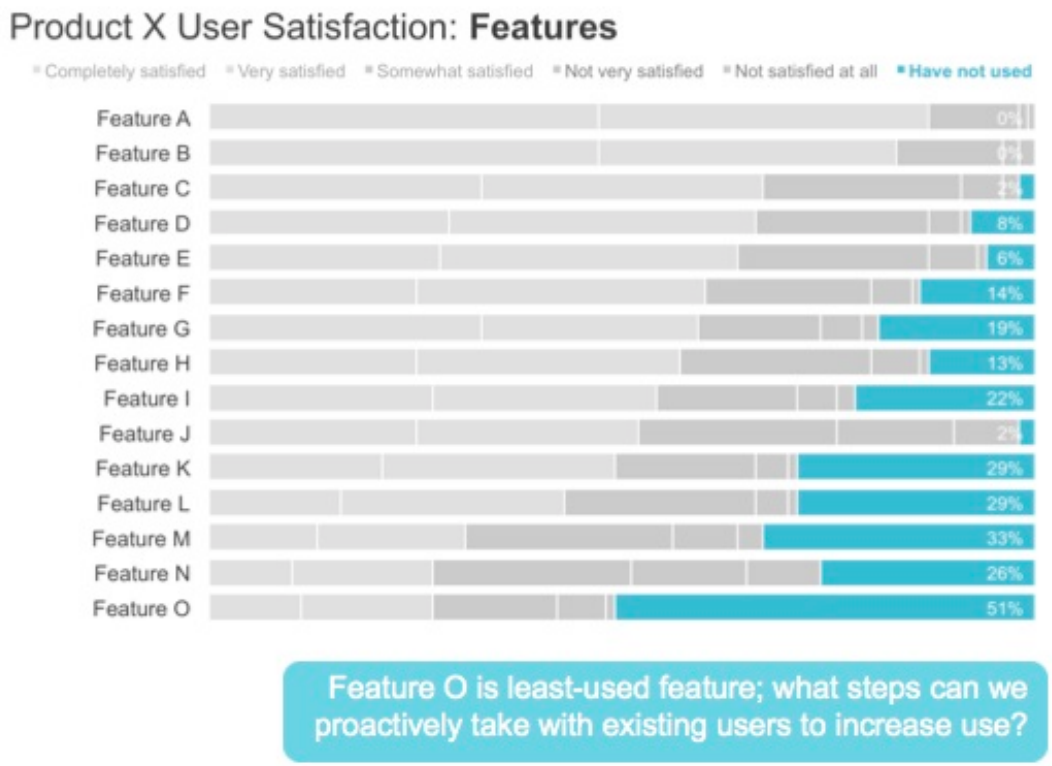
Don’t Bury the Lead



Cole Nussbaumer

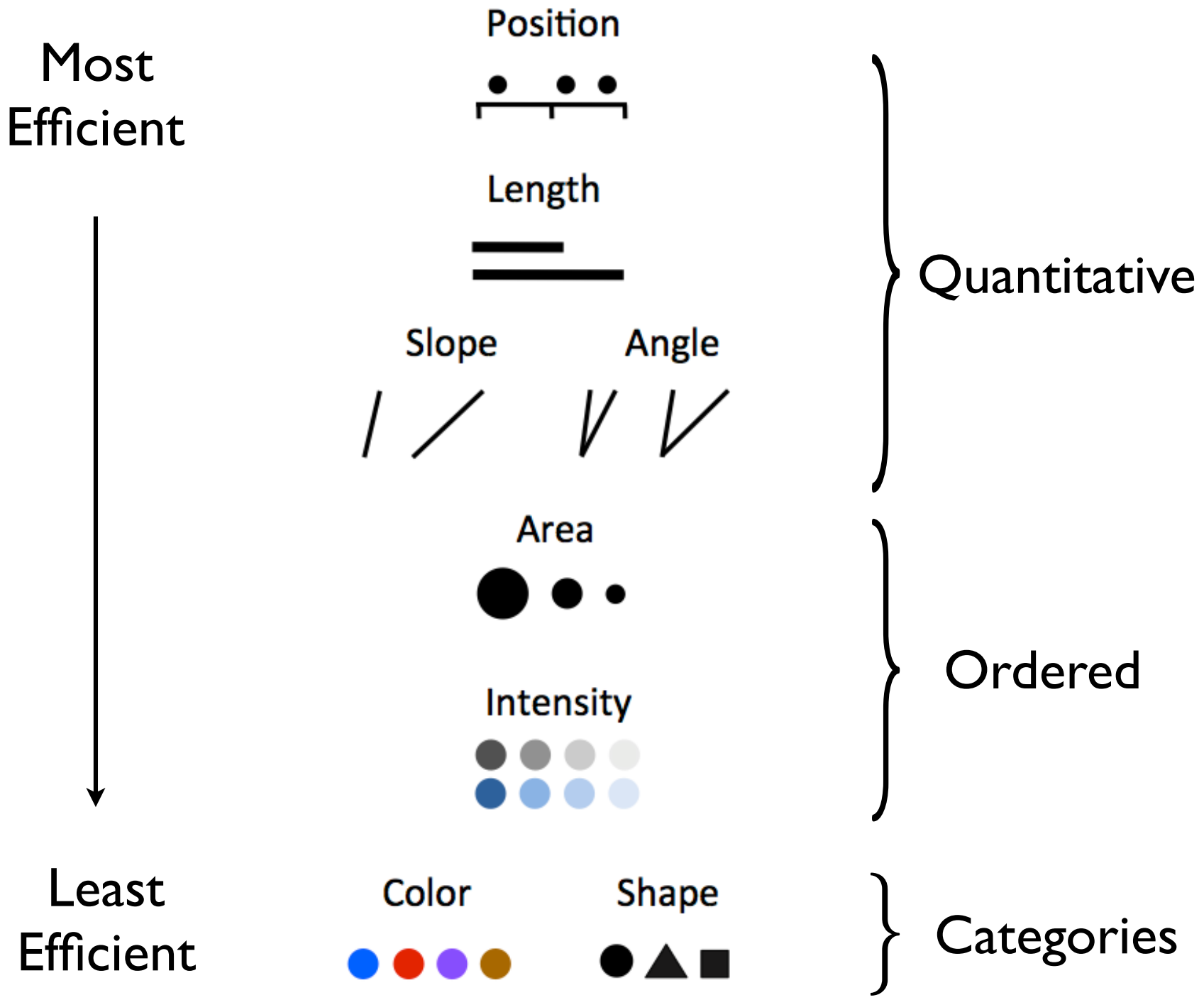
Don’t Bury the Lead

User satisfaction varies greatly by feature



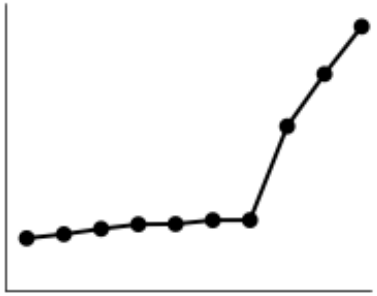
Cole Nussbaumer

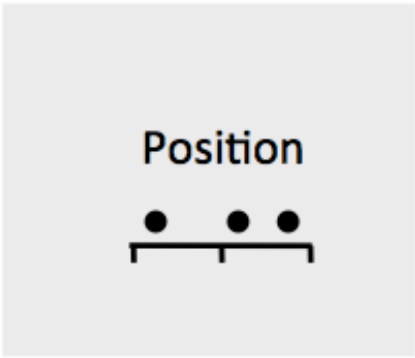
Use the right display

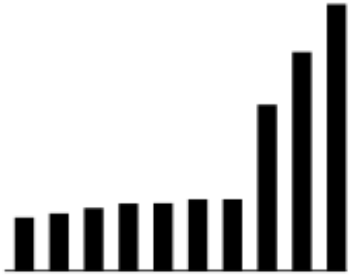


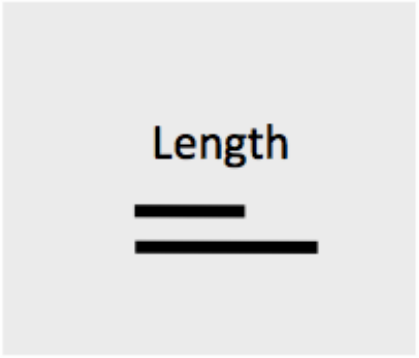
C. Mulbrandon
VisualizingEconomics.com

Most Effective

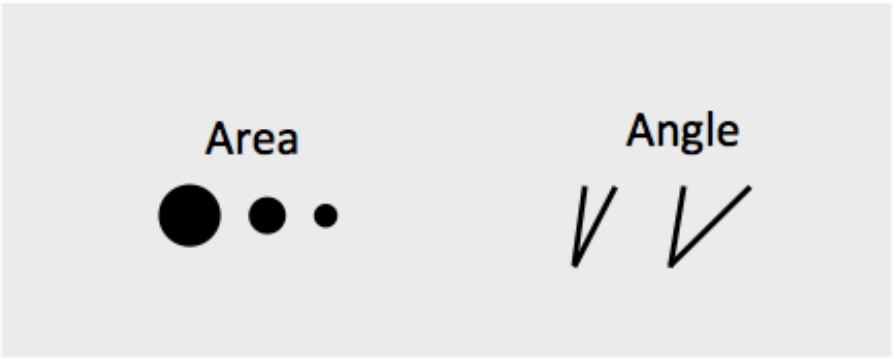


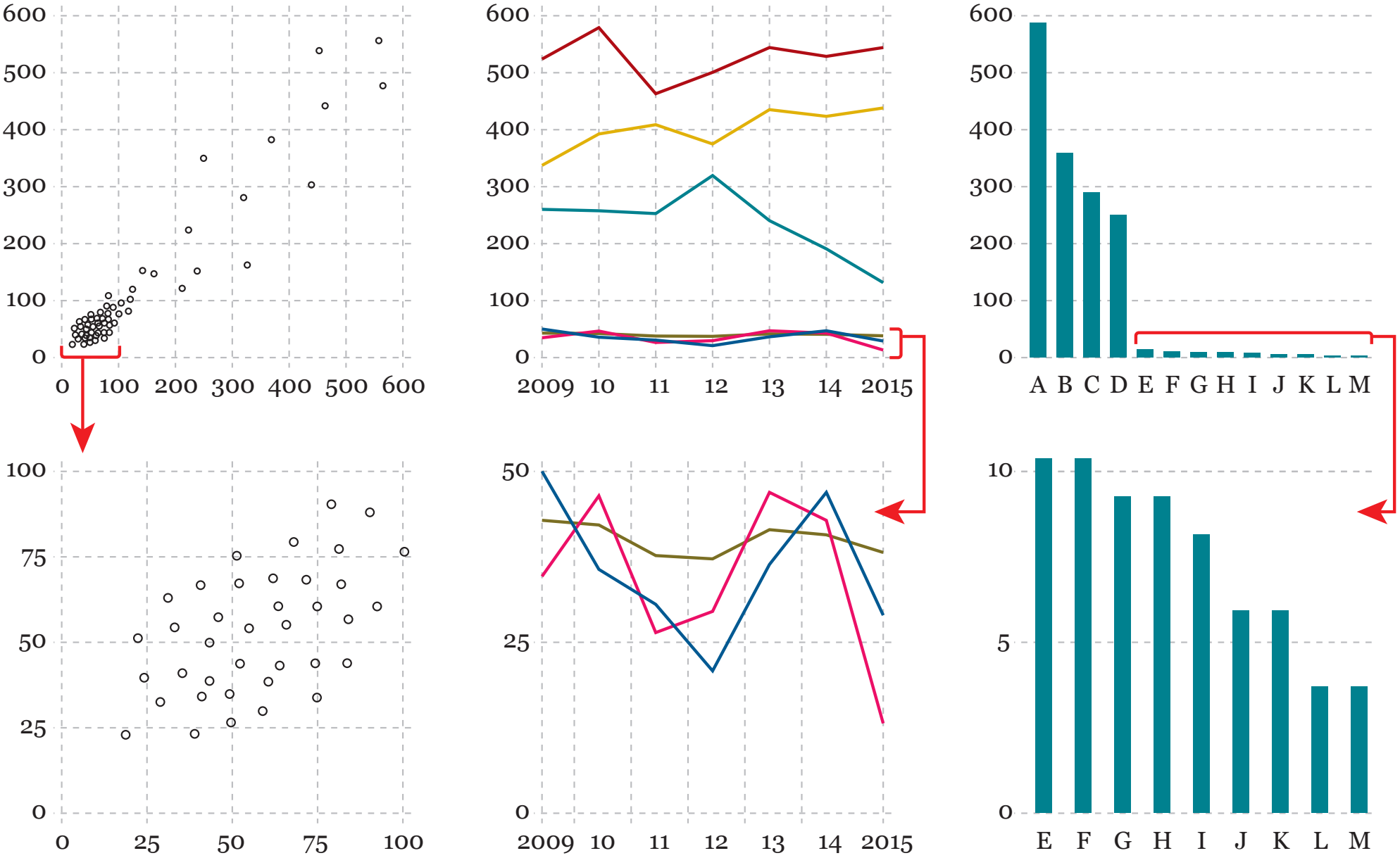






Less Effective





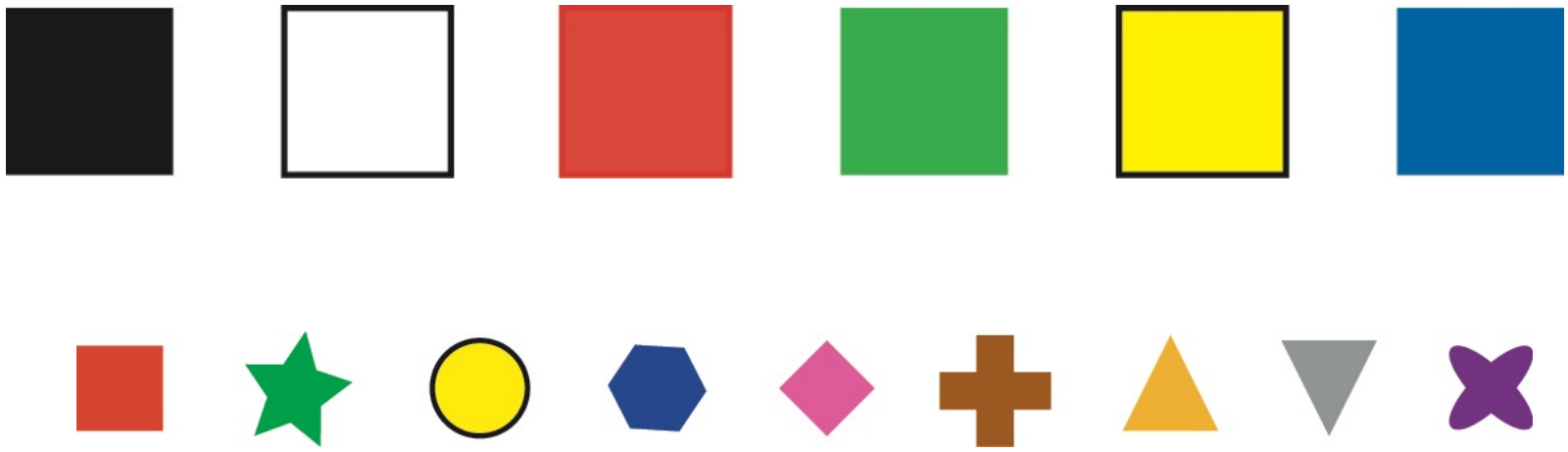
Possible solution to cases when you have data that diverge a lot

Alberto Cairo • University of Miami • www.thefunctionalart.com • Twitter: @albertocairo

Use color strategically

Colors for Categories

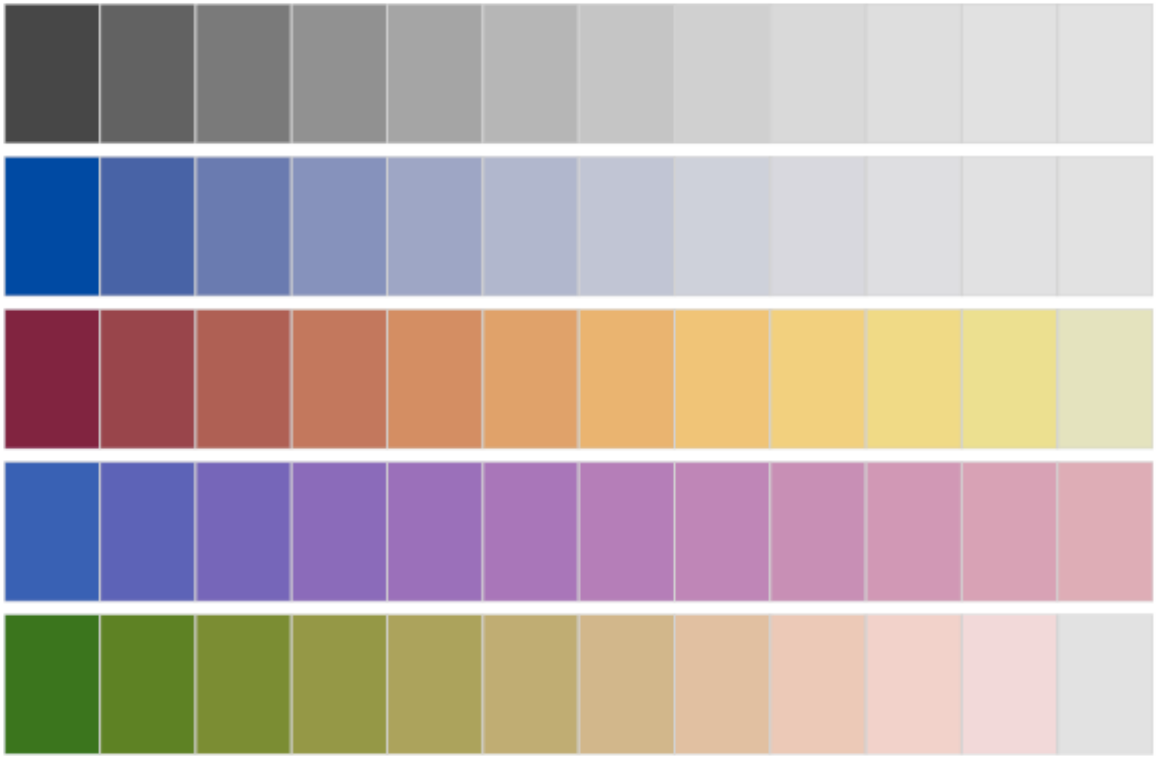
Do not use more than 5-8 colors at once



Ware, "Information Visualization"

Colors for Ordinal Data

Vary luminance and saturation

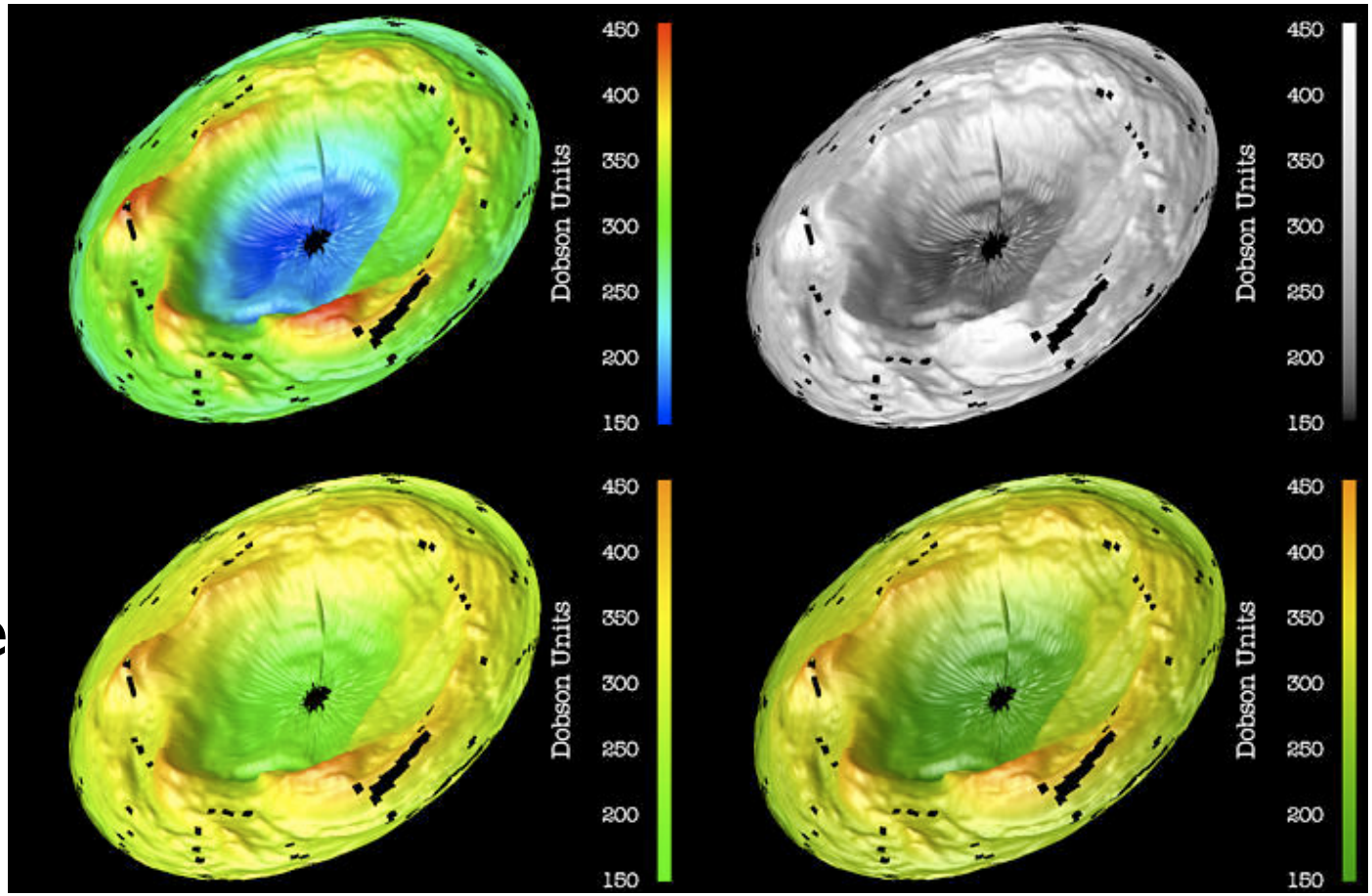


Zeilis et al, 2009, "Escaping RGBland: Selecting Colors for Statistical Graphics"

Colors for Quantitative Data

Hue (Rainbow)

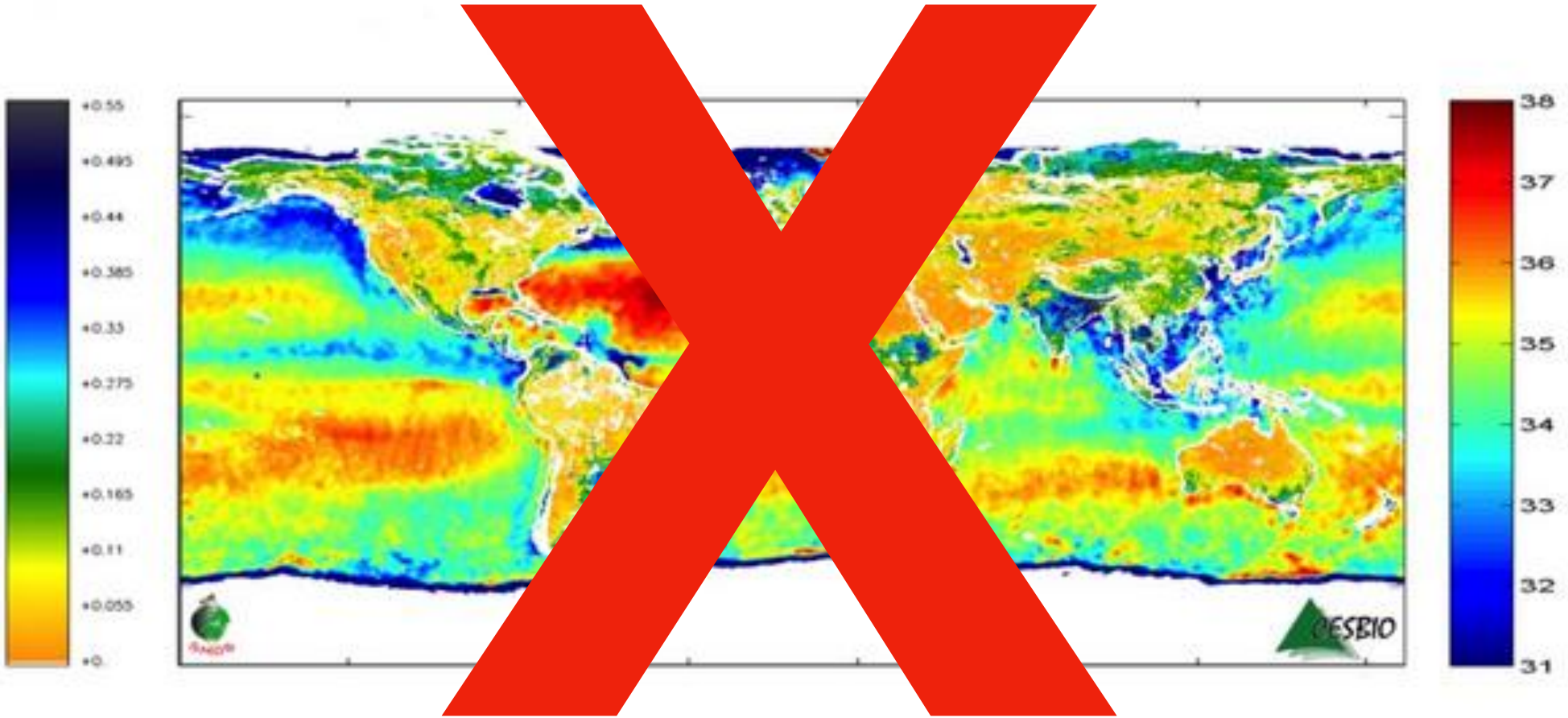
Luminance & Hue



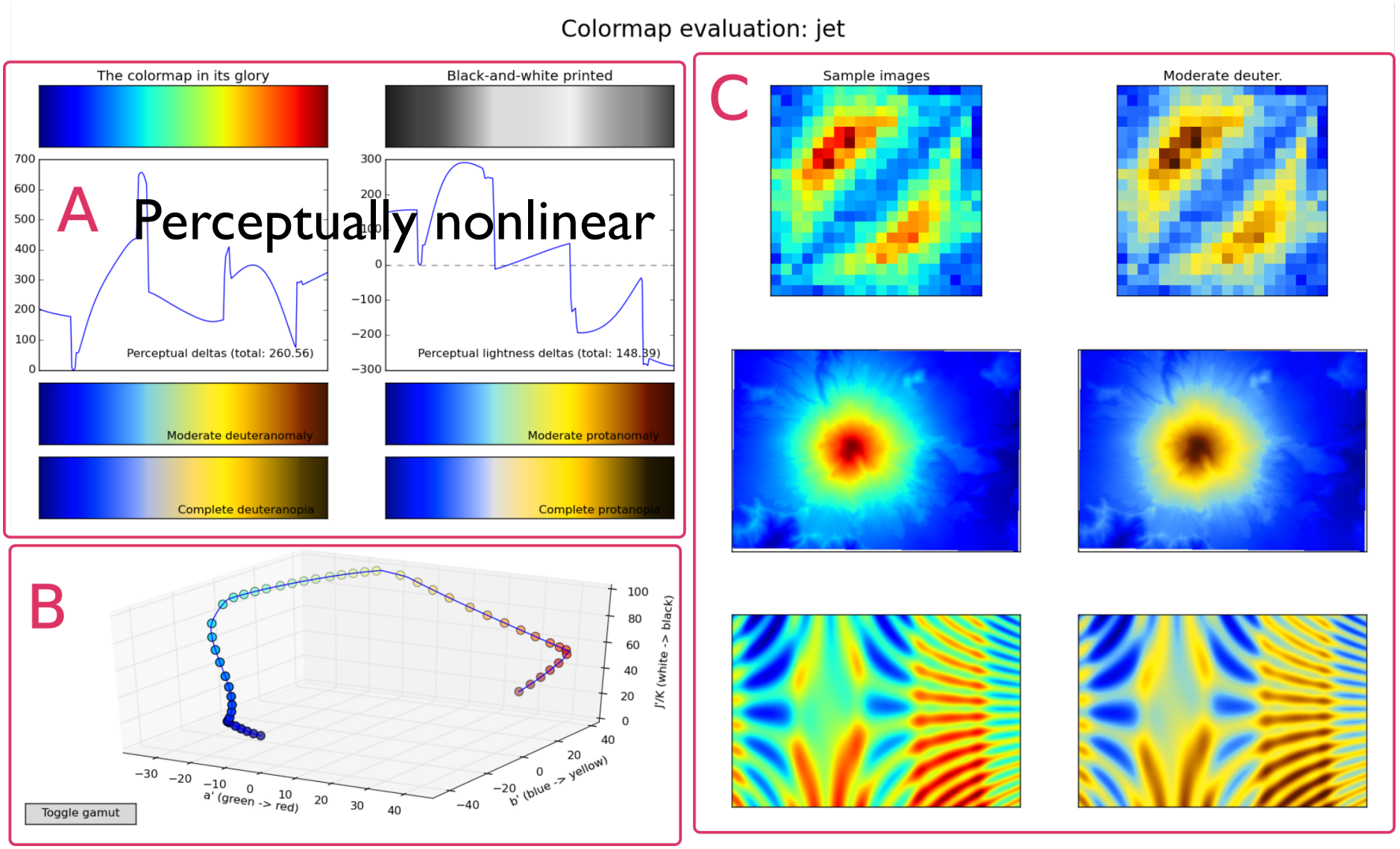
Luminance

Rogowitz and Treinish, Why should engineers and scientists be worried about color?

Rainbow Colormap

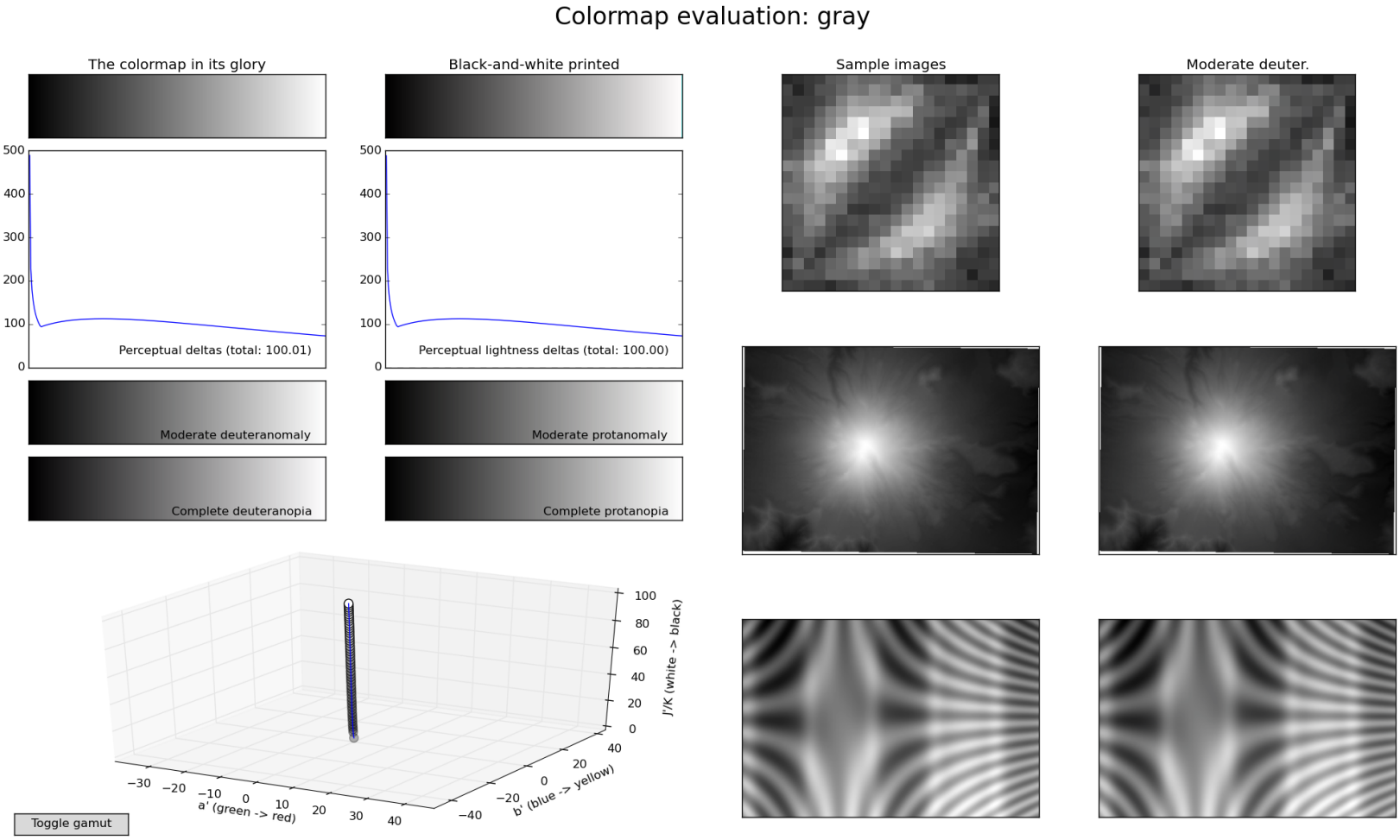


Rainbow Colormap

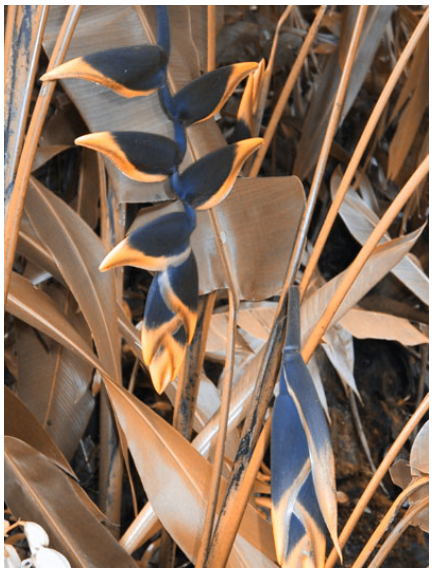


R. Simmon

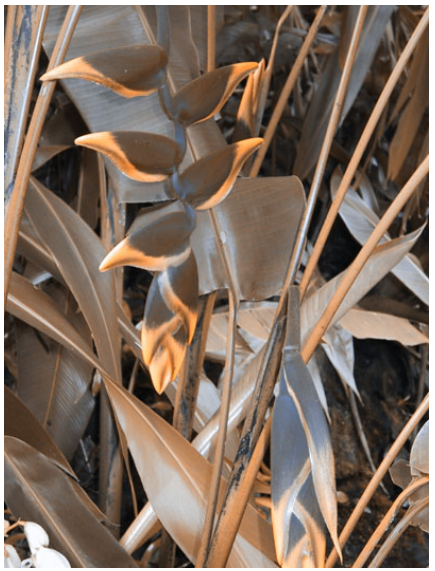
Gray


Colormap evaluation: gray
The colormap in its glory
Black-and-white printed
Sample images
Moderate deuter.
500
400
300
200
100
0
Perceptual deltas (total: 100.01)
Perceptual lightness deltas (total: 100.00)
Moderate deuteranomaly
Moderate protanomaly
Complete deuteranopia
Complete protanopia
−30
−20
−10
0
10
20
30
40
a′ (green -> red)
−40
−20
0
20
40
b′ (blue -> yellow)
100
80
60
40
20
0
J′/K (white -> black)
Toggle gamut

Color Blindness



Protanope



Deuteranope

Tritanope

Red / green deficiencies

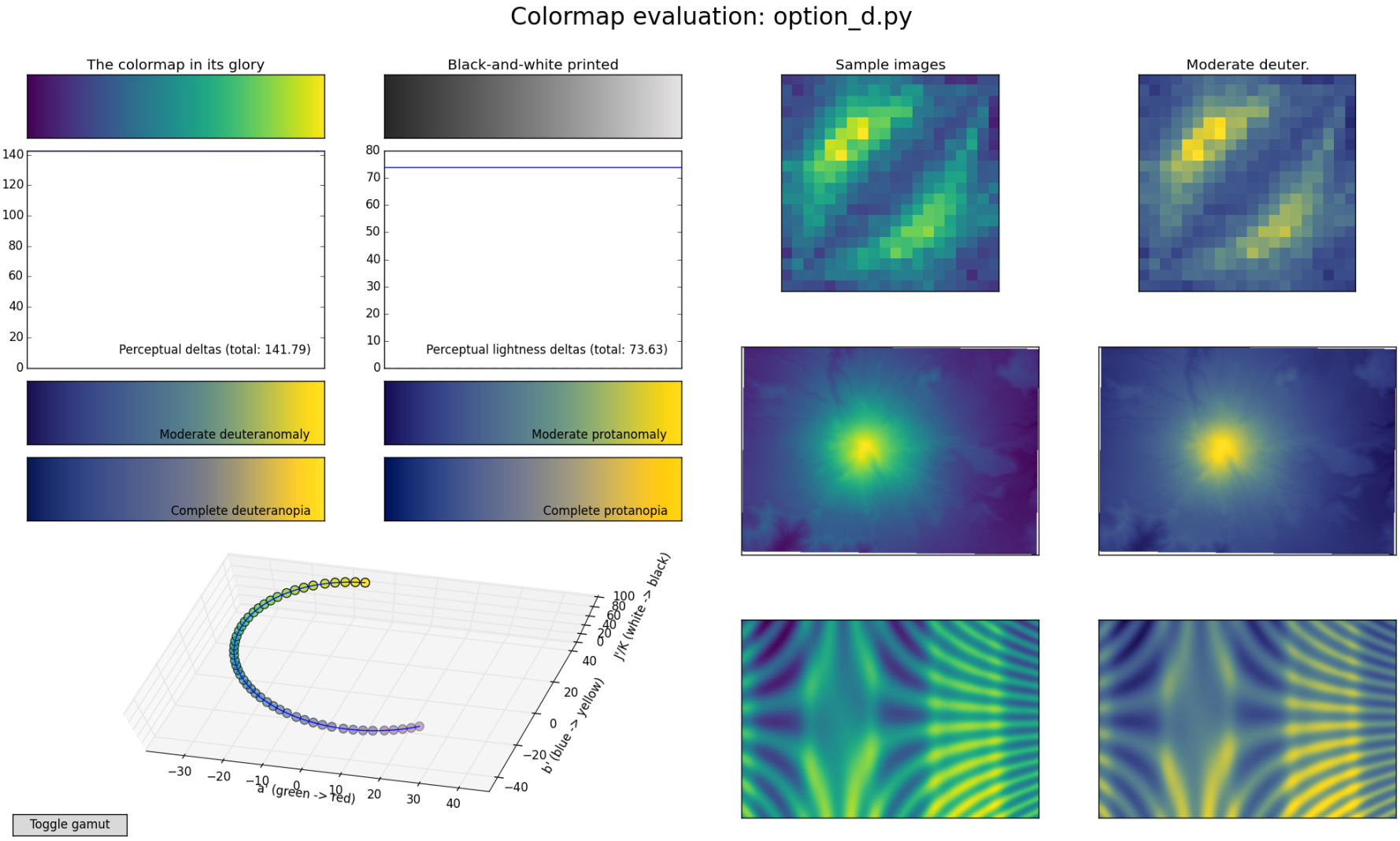
Blue / Yellow deficiency

Based on slide from Stone

Color Blindness

Based on slide from Stone

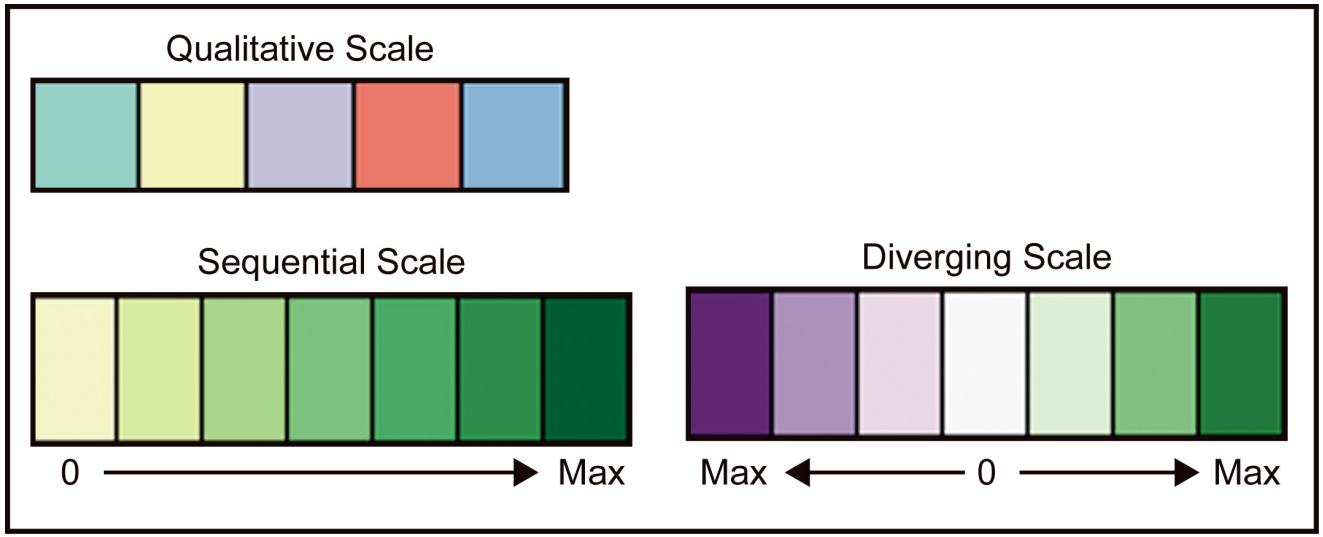
Viridis


Colormap evaluation: option_d.py
The colormap in its glory
Black-and-white printed
Sample images
Moderate deuter.
Perceptual deltas (total: 141.79)
Perceptual lightness deltas (total: 73.63)
Moderate deuteranomaly
Moderate protanomaly
Complete deuteranopia
Complete protanopia
a' (green -> red)
b' (blue -> yellow)
J'/K (white -> black)
Toggle gamut

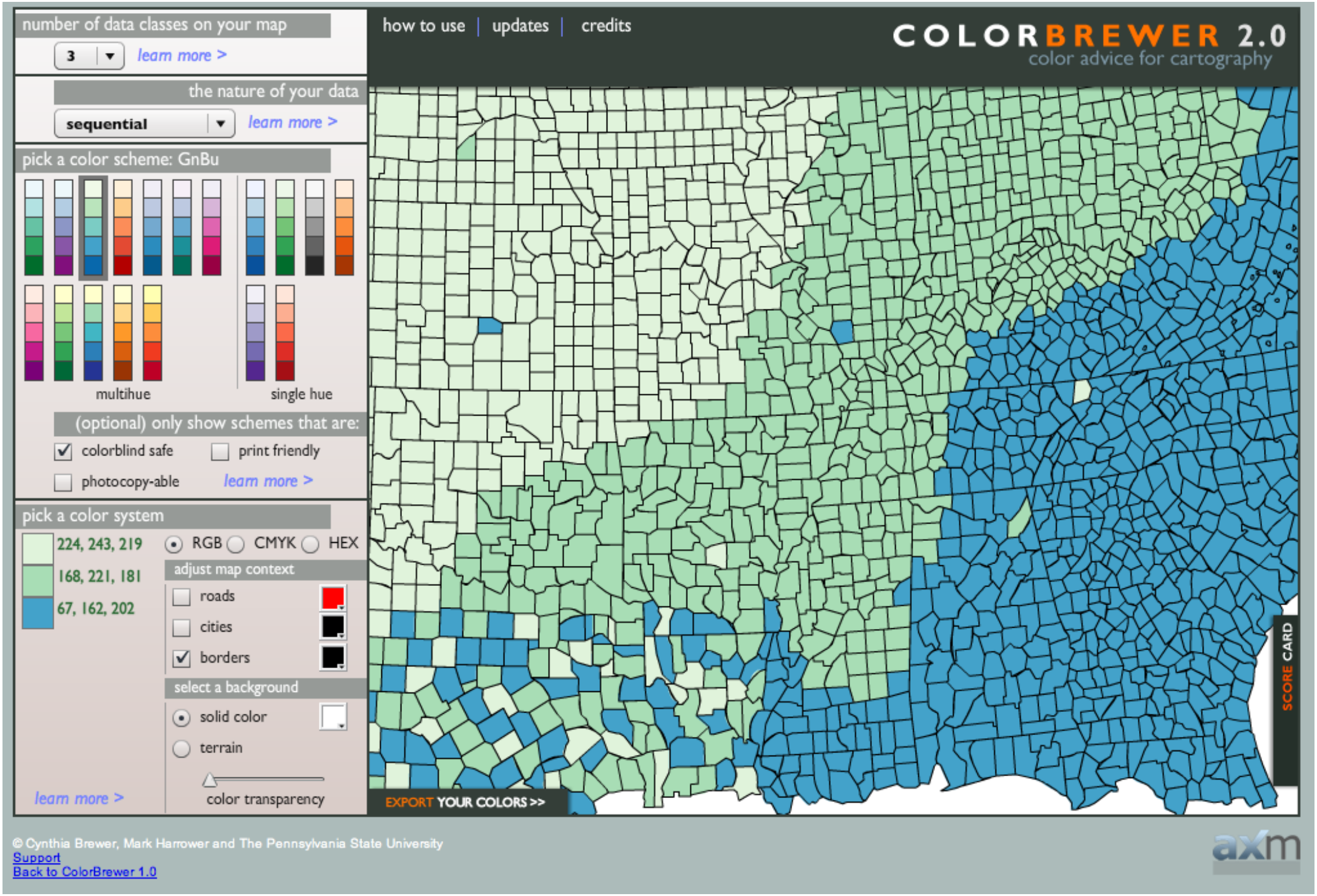
Color Brewer

Nominal

Ordinal



Cynthia Brewer, Color Use Guidelines for Data Representation



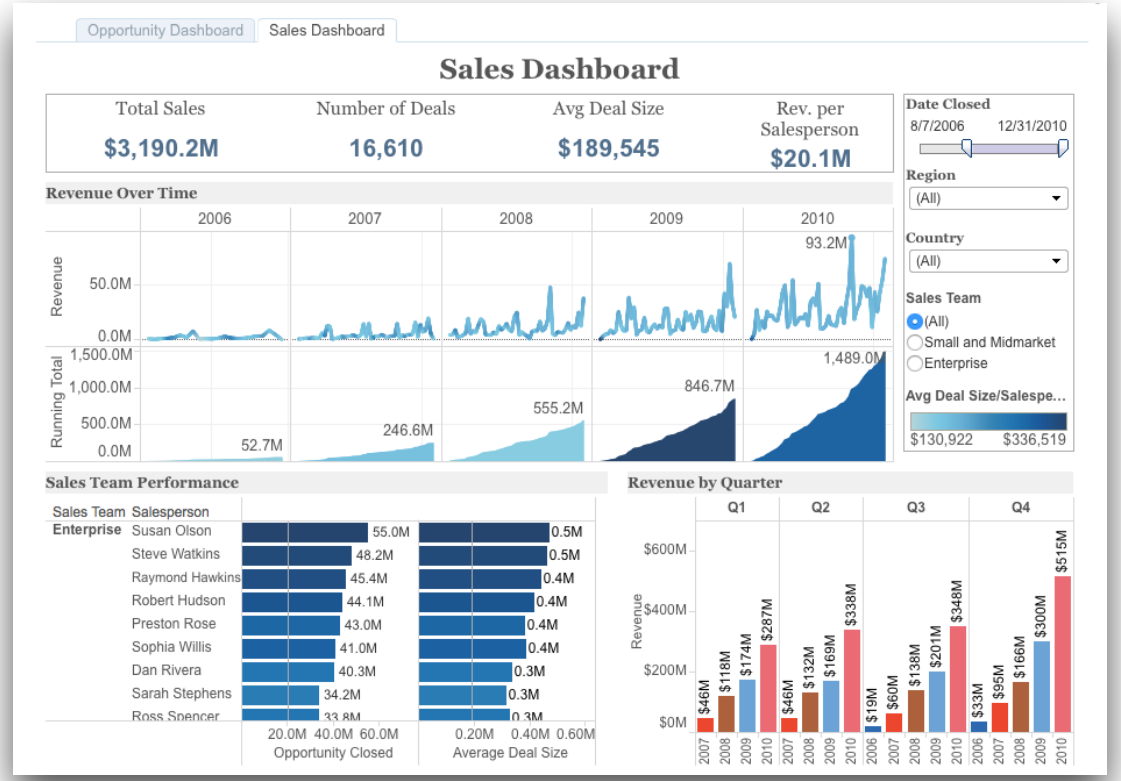
Support
Back to ColorBrewer 1.0

Know your audience

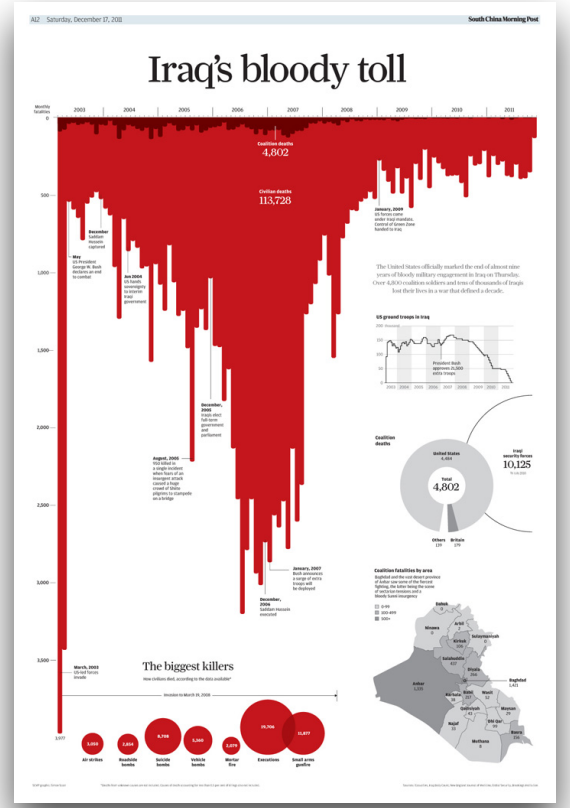
- What do they know?
- What motivates them? What do they desire?
- What experiences do you share? What are common goals?
- What insights can you give them? What tools and “magical gifts”?

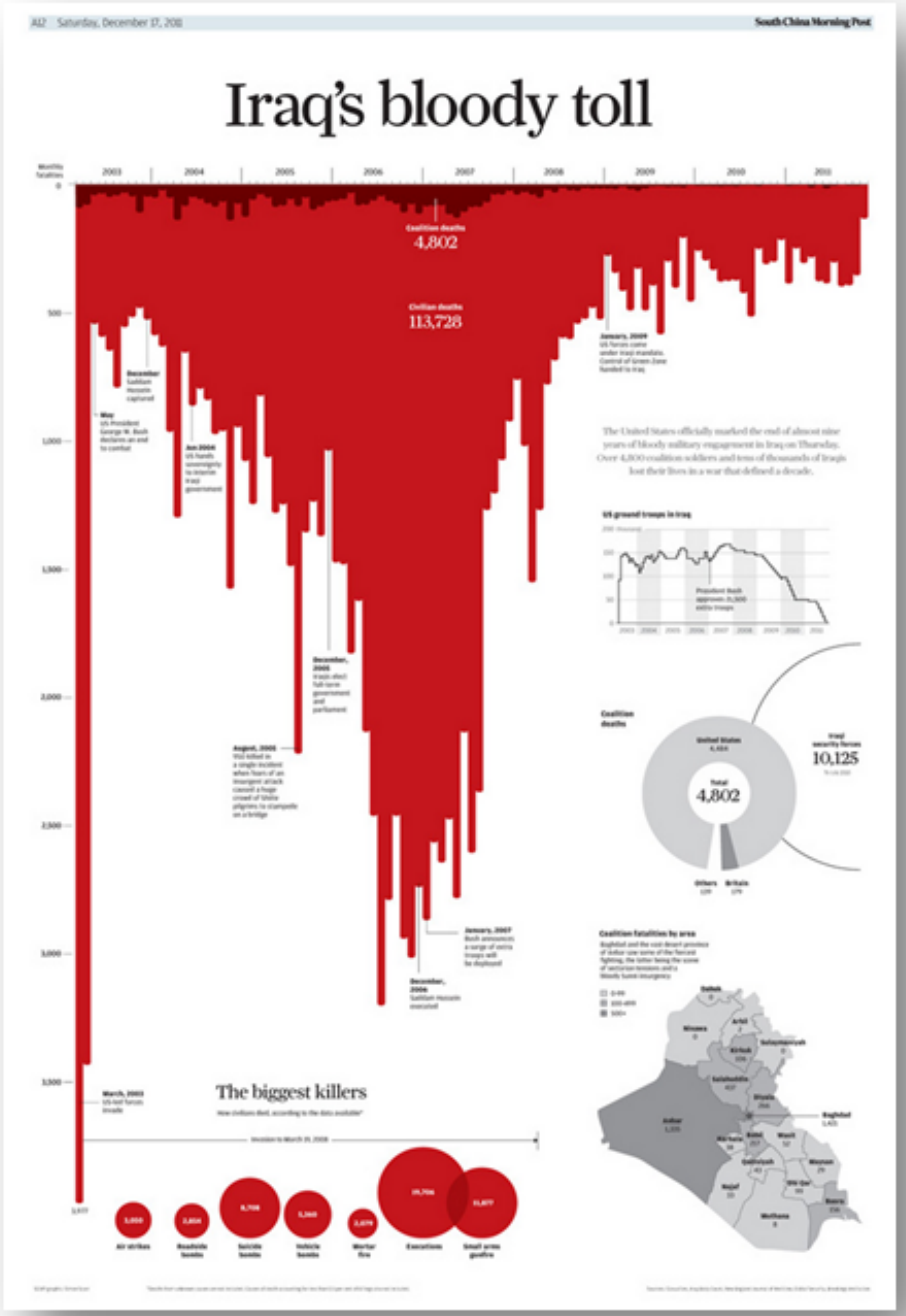
What is the message?

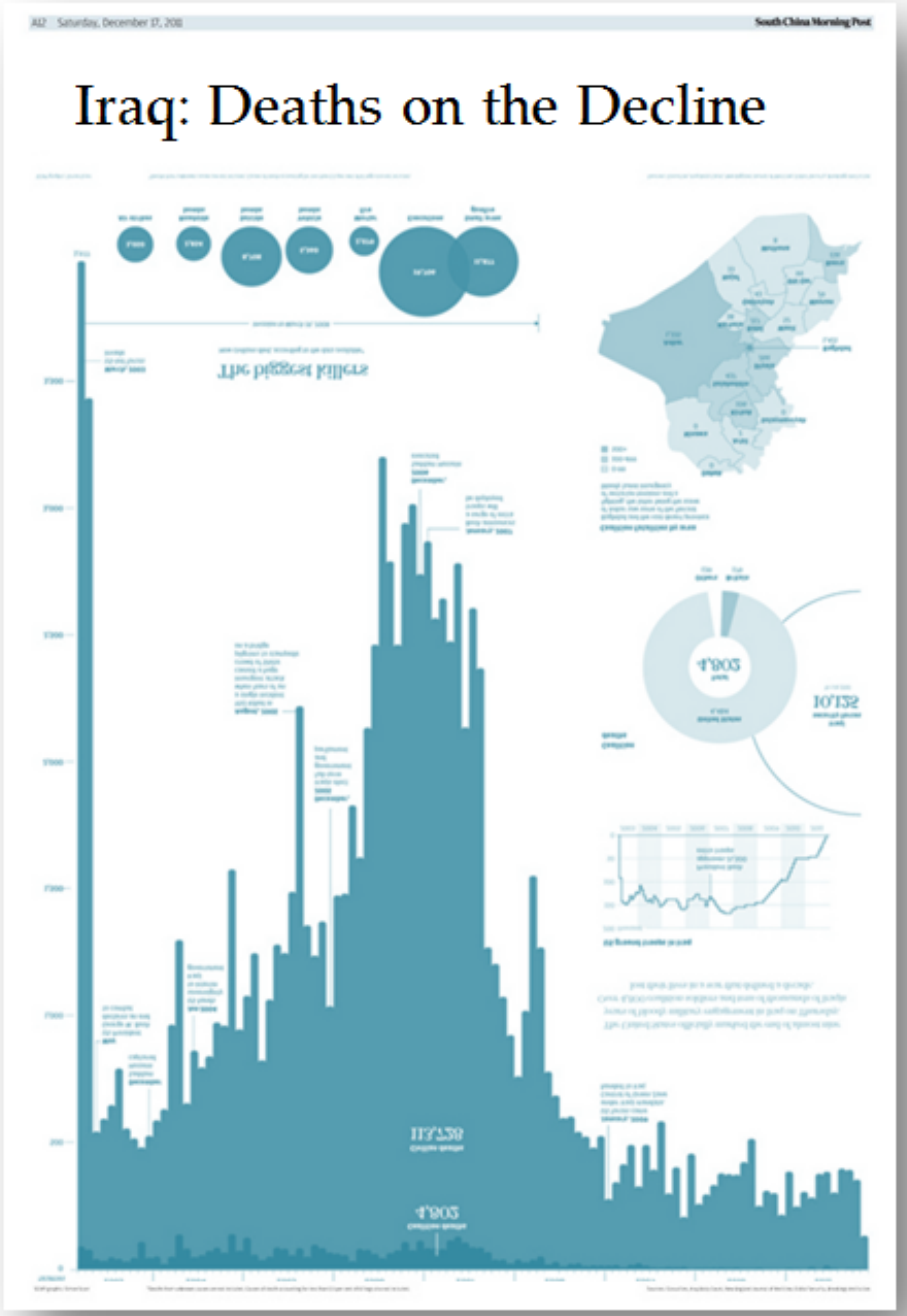
Exploratory
Neutral



Explanatory
Opinionated





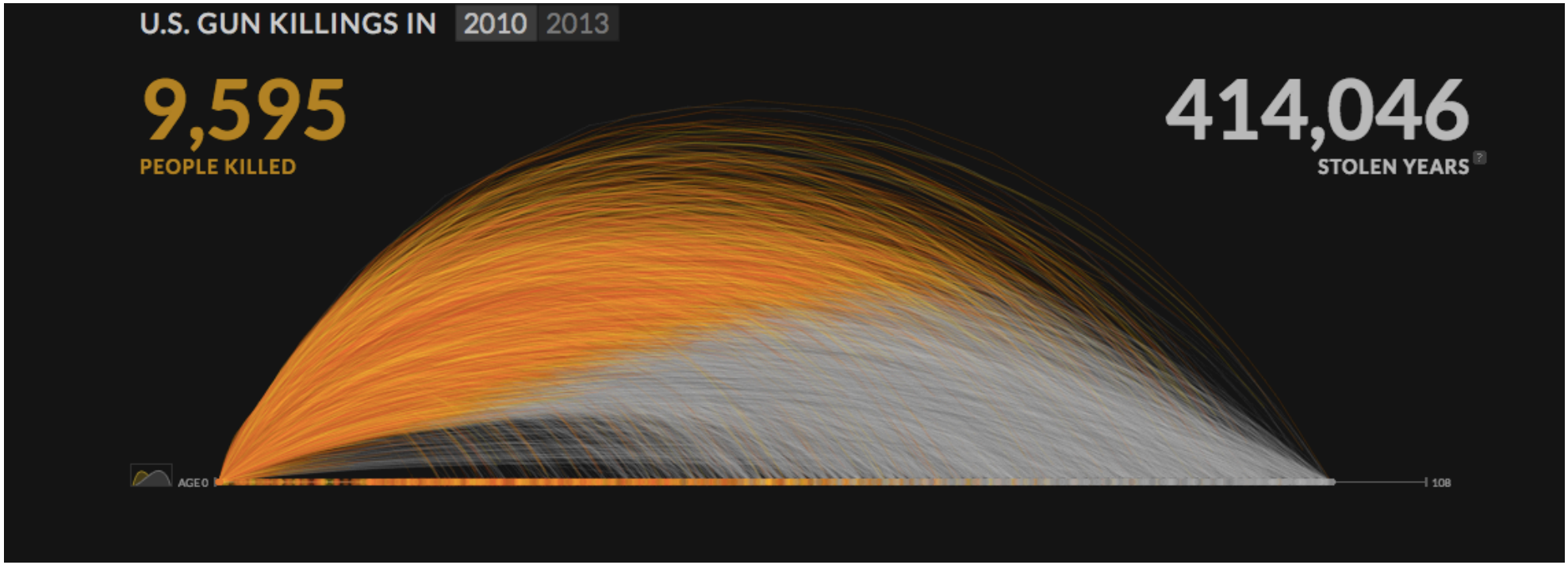


Andy Cotgreave, Tableau

Framing - Why should I care?

- Tell the audience: “Here is the right way to think about the problem I was trying to solve.”
- Catch the audience’s attention and frame the story using captions and annotations
- If done well, your insights will seem obvious given this framing. And that’s a good thing!

Gun Deaths in 2010



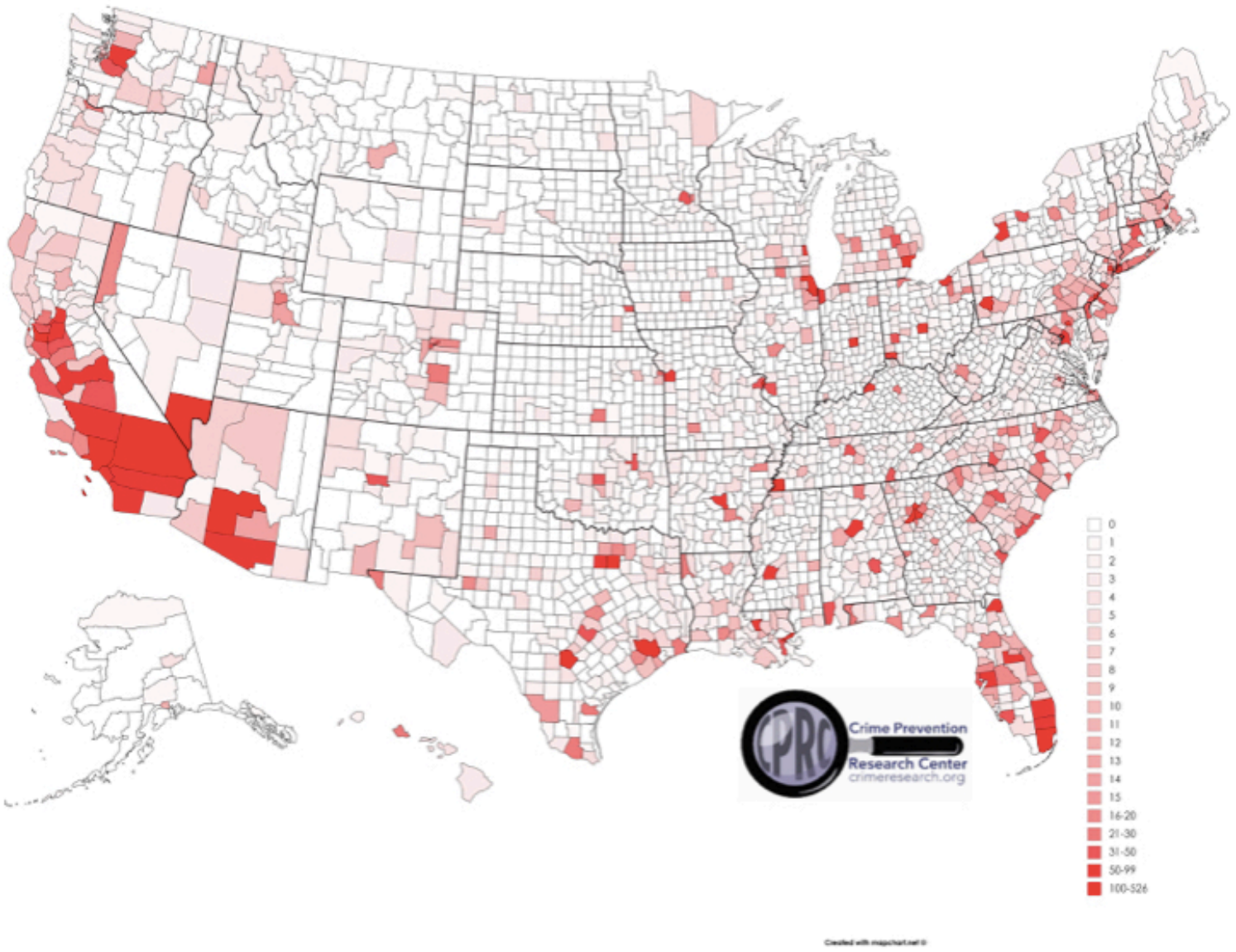
Tools for interactive graphics

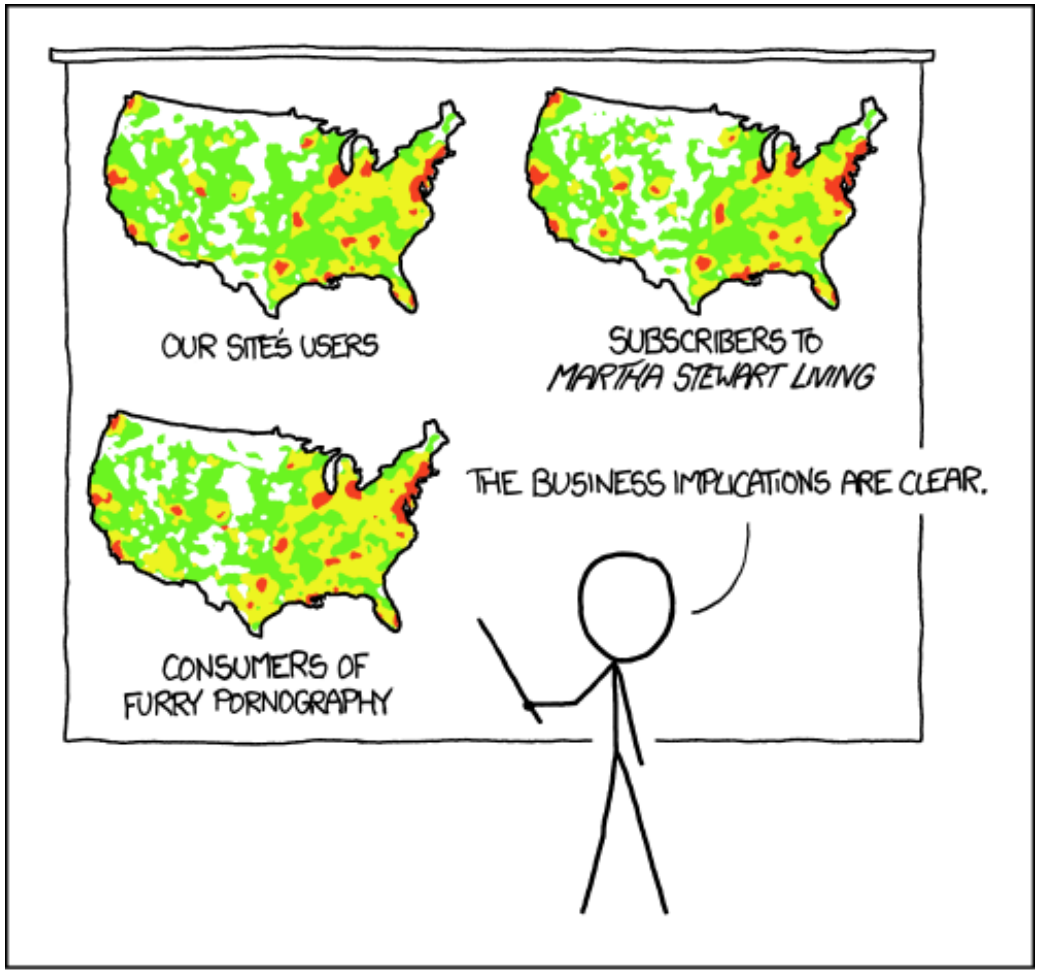
- R/shiny
- plotly/dash
- Tableau
- d3.js
- vega-lite/vega

Is there a story?

Surface it….even if it is incomplete

2014 Gun Deaths

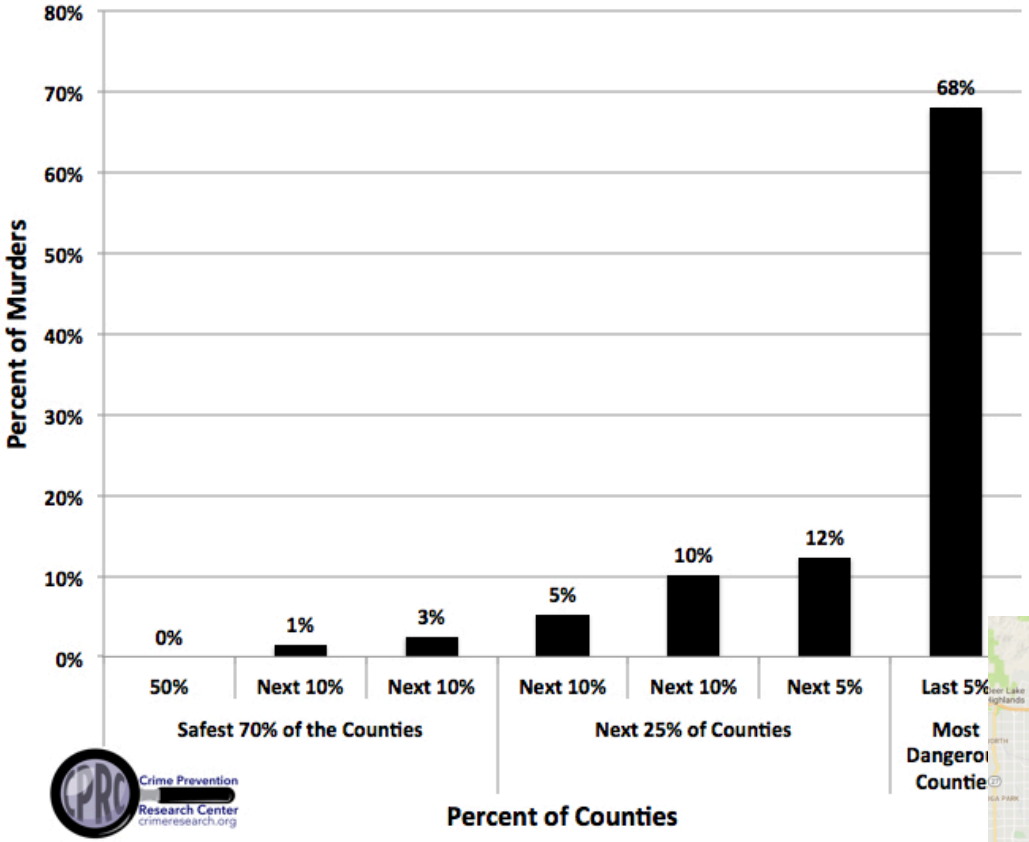


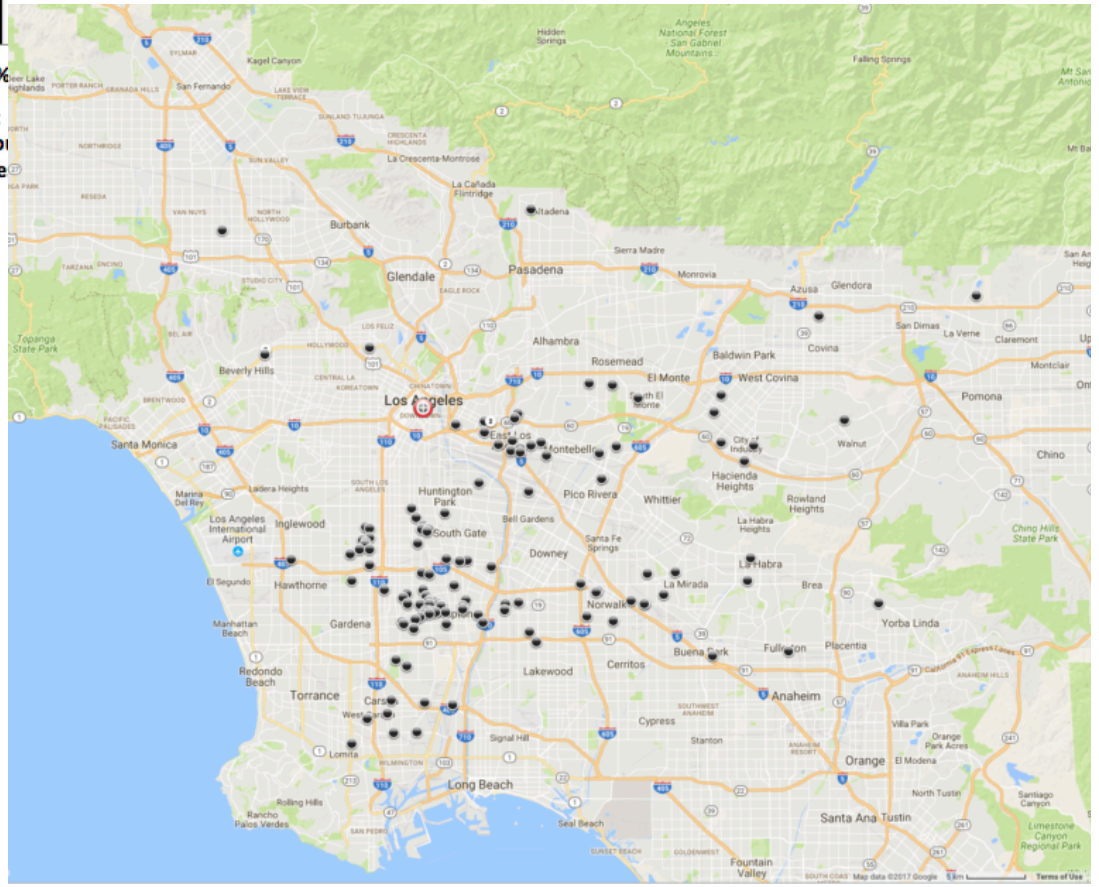


PET PEEVE #208:
GEOGRAPHIC PROFILE MAPS WHICH ARE BASICALLY JUST POPULATION MAPS

(XKCD)

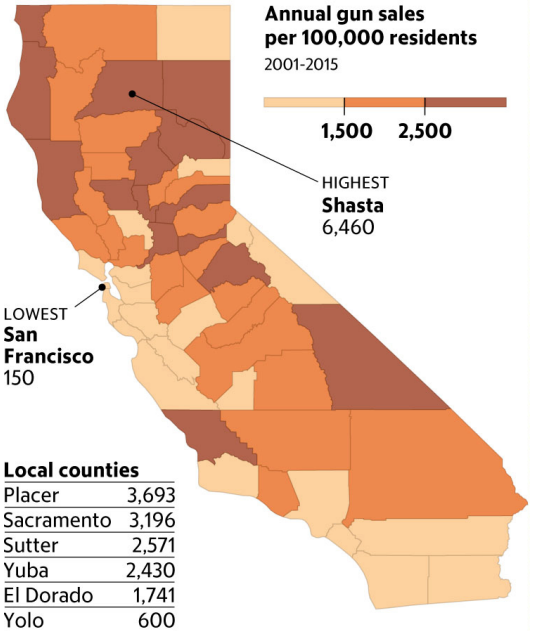
Figure 1: Percent of murders





Per capita sales by county

Annual gun sales per 100,000 residents are generally higher in California's rural and northern counties.

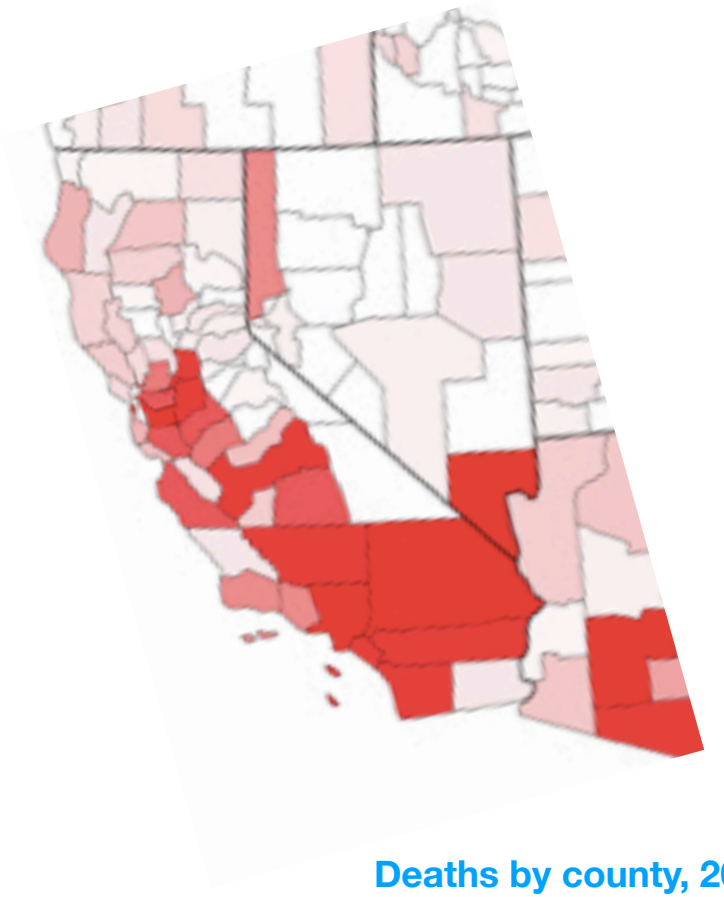


Local counties

Placer	3,693
Sacramento	3,196
Sutter	2,571
Yuba	2,430
El Dorado	1,741
Yolo	600

Source: California Department of Justice

The Sacramento Bee



Deaths by county, 2014

(crimeresearch.org)

Whether Crime Is Up or Down Depends on Data Being Used

By TIMOTHY WILLIAMS SEPT. 27, 2016

RELATED COVERAGE

U.S. Murders Surged in 2015, F.B.I. Finds
SEPT. 26, 2016

The news from the F.B.I. crime data was alarming: The murder rate rose sharply last year, driven by jumps in several major cities.

Four urban areas — Baltimore, Chicago, Milwaukee and Washington — accounted for about a fifth of the increase in homicides in 2015. Those cities, however, make up only about 1 percent of the nation's population.

But whether crime is up or down depends on what data is being looked at — and who is doing the looking.

The F.B.I. data showed that violent crime rose about 4 percent last year from 2014, and homicides increased 10.8 percent. Yet crime over all fell in 2015 for the 14th consecutive year.

And the total number of homicides last year was fewer than 20 years ago even as the country's population increased, criminologists said. There were 19,645 homicides in 1996 in a nation of 265 million; in 2015, there were 15,696 in a population of 321 million.

What that data means, criminologists and police officials said, is that the decline in homicides has been so significant in the last quarter century that sudden increases in the number of killings in just a few cities can skew the entire national picture, even as the country has one of its safest periods on record.

"It isn't a national trend, it's a city trend, and it's not even a city trend, but a problem in certain neighborhoods," said Richard A. Berk, a professor of statistics and criminology at the University of Pennsylvania. "Certainly, people around the country should not be worried. People in Chicago shouldn't be worried. But people in certain neighborhoods might be."

Criminologists and police officials point out that homicides do not usually disrupt entire cities. Instead, they occur in particular neighborhoods — and on the same blocks — leaving much of the rest of the city relatively untouched.

Explanations for the increase in homicides in certain American cities are largely guesswork. Criminologists acknowledge that the required analysis has not been done in the neighborhoods where killings are occurring — or even an agreement of what such a study should include — to arrive at any but the broadest conclusions.

Careful with amalgamation paradoxes and with outliers

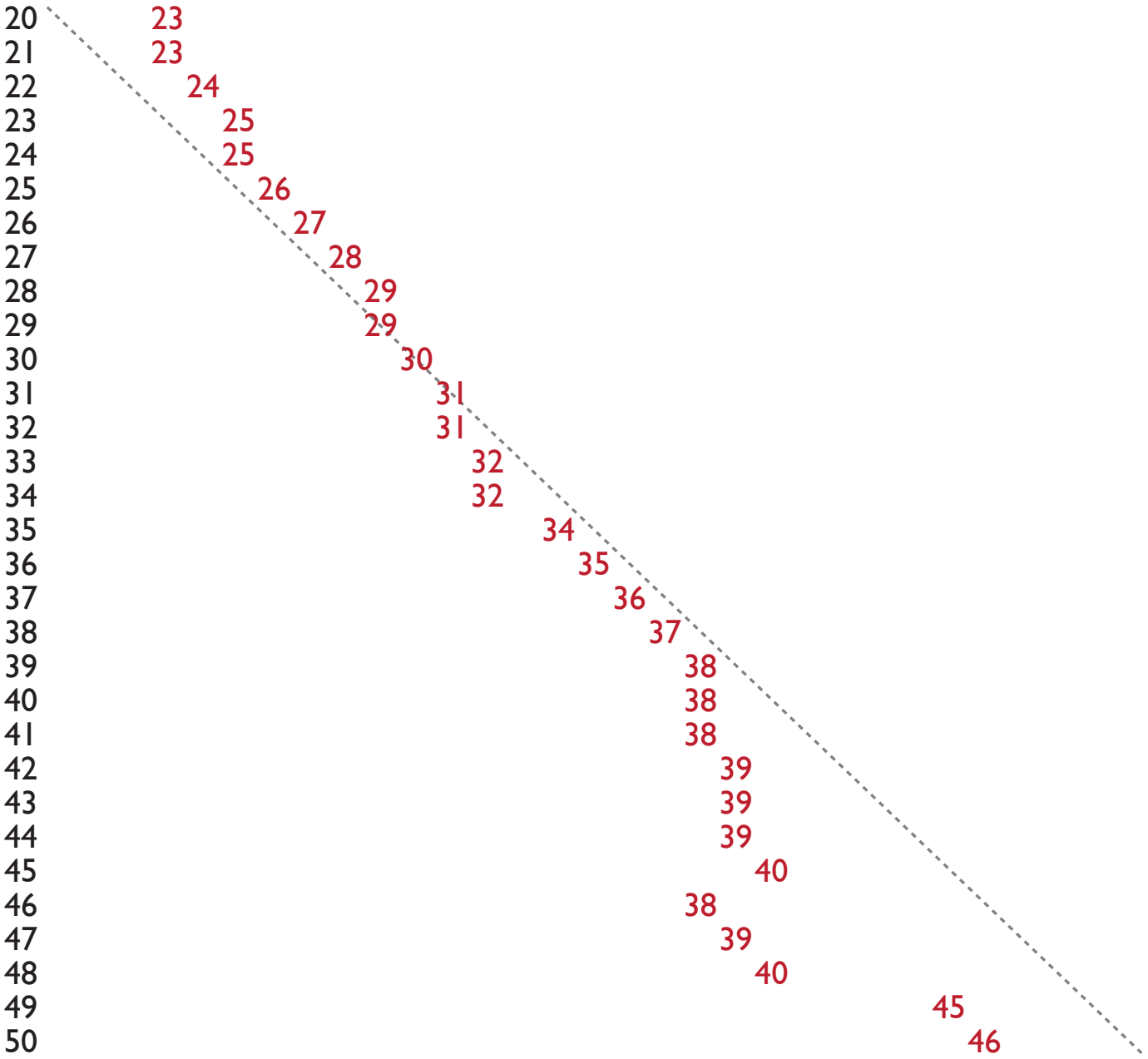
http://journal.frontiersin.org/article/10.3389/fpsyg.2013.00513/full

Ask-n-Ask: what is the story?

- Is the exact distribution of guns really the important concern?
- did we check the uncertainties?
- Should we be looking at this from a “risk” perspective?
- we tend to believe what we believe and look for confirmation.
- we need to be disciplined about interrogating ourselves
- it is ok (and not against simplicity) to surface our process

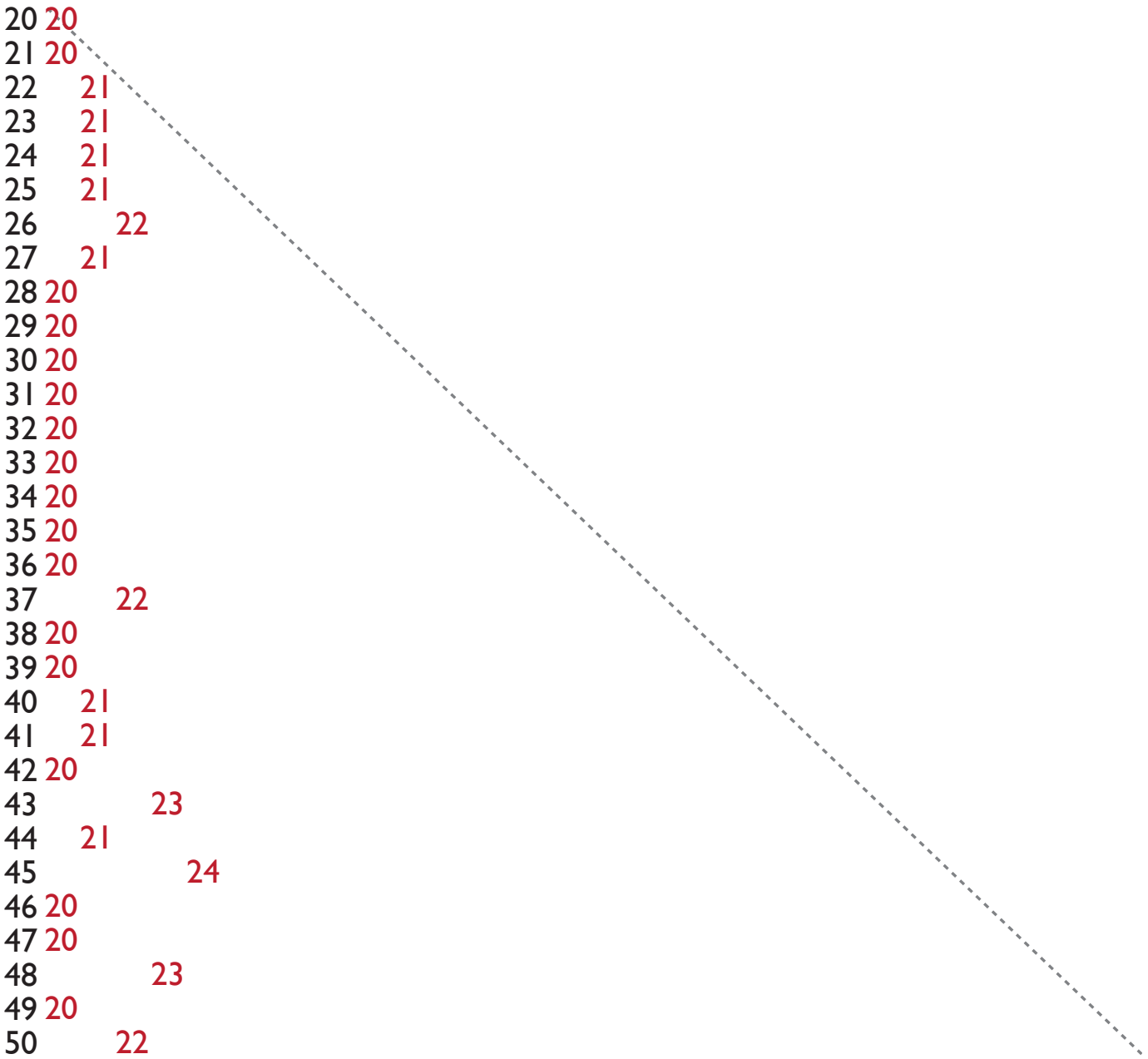
Another example: OKC data

a woman's age *vs. the age of the men who look best to her*



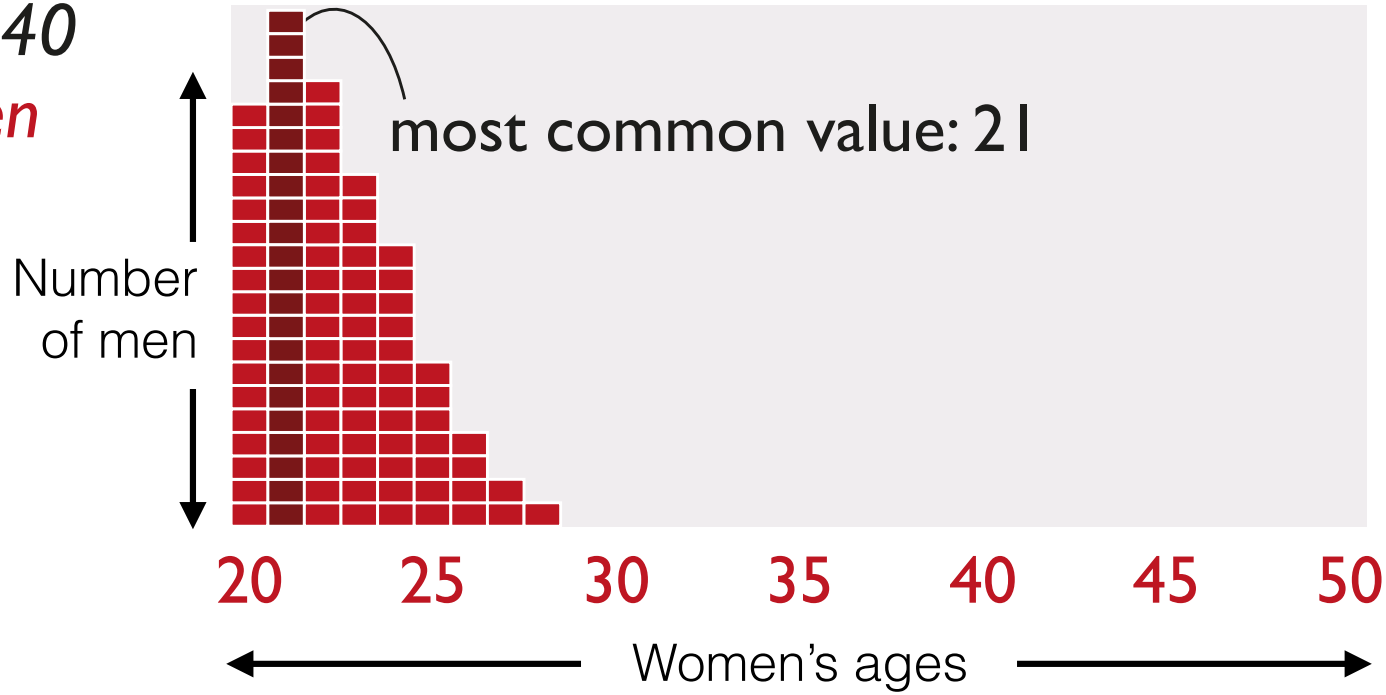
(from Dataclysm)

a man's age vs. the age of the women who look best to him



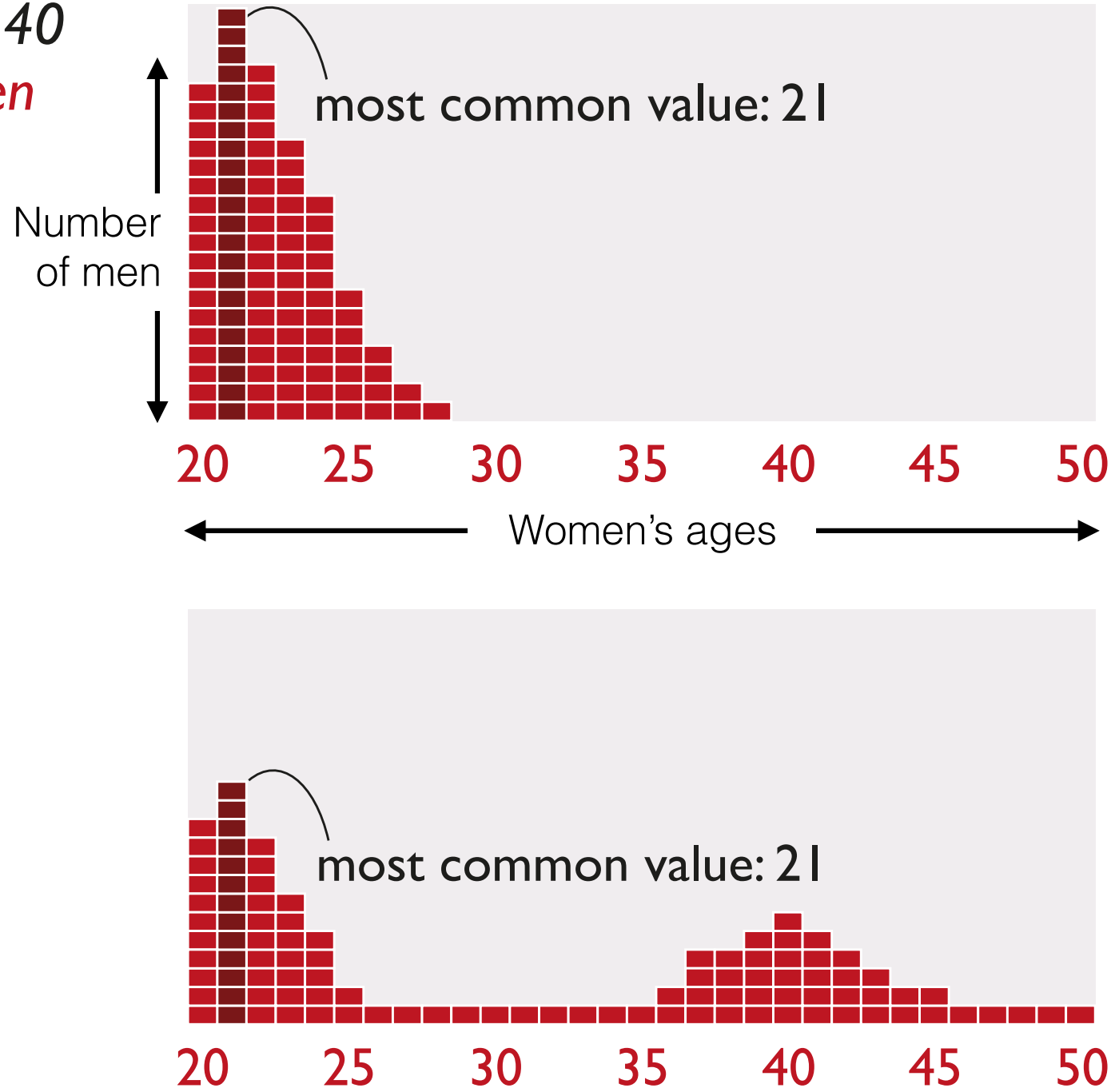
Sample of 100 men of 40
vs. the age of the women
who look best to them

=1 of men



Sample of 100 men of 40
vs. the age of the women
who look best to them

▬ =1 of men



Structure of communication graphics

755

Steroids or Not, the Pursuit Is On

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

Lines are cumulative home runs.

Hank Aaron
755 homers
23 seasons

Babe Ruth
714 homers
22 seasons

Barry Bonds
708 homers
20 seasons

Bonds takes lead
Home runs after 16 seasons

Bonds	567
Aaron	554
Ruth	516

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

Bonds was injured last season. He played 14 games and hit 6 homers.

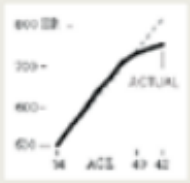
According to allegations in a book about Bonds, he began taking steroids before the 1999 season, his 14th in the league. Two seasons later, he hit 73 home runs, surpassing Aaron's career pace.

Homer Pace After Age 34

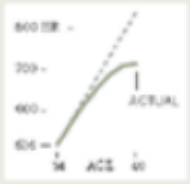
If the accusations are correct, Bonds was 34 in his first season on steroids. Here are projected home run paces for each player after age 34.

PROJECTED PACE BASED ON AVERAGE OF PREVIOUS FIVE SEASONS

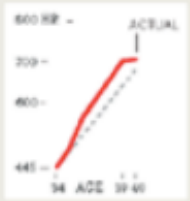
Aaron
Actual homers slightly outpace projected homers for five seasons.



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



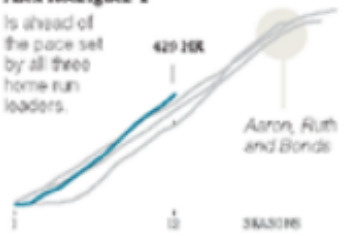
Bonds
From age 35 to 39, he averaged 14 more homers a season than projected.



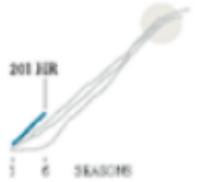
Note: Ages as of July 1 of each season.

Others Taking Aim

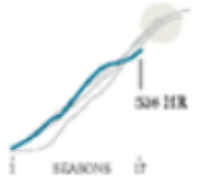
Alex Rodriguez ▲
Is ahead of the pace set by all three home run leaders.



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

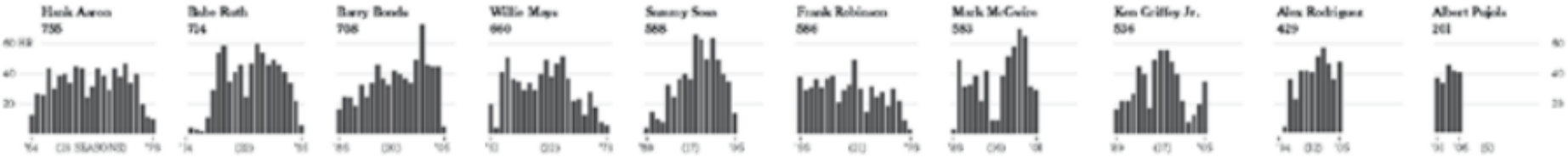


Ken Griffey Jr.
Many thought he would be the first to catch Ruth and Aaron until injuries limited his output.



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).



16 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 1960-69.

Three 60-homer seasons is record.

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

First to hit 70 in a season.

Only McGwire had more in the 90's.

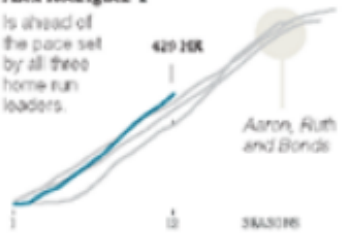
Youngest to reach 400 homers.

Second most ever in first five seasons.

E. Segel

Others Taking Aim

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



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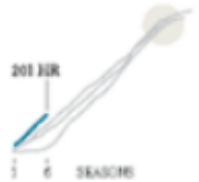

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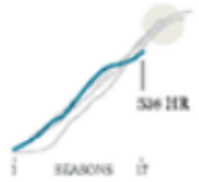
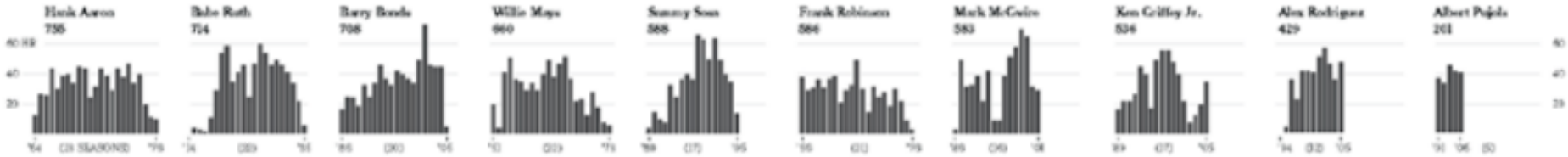
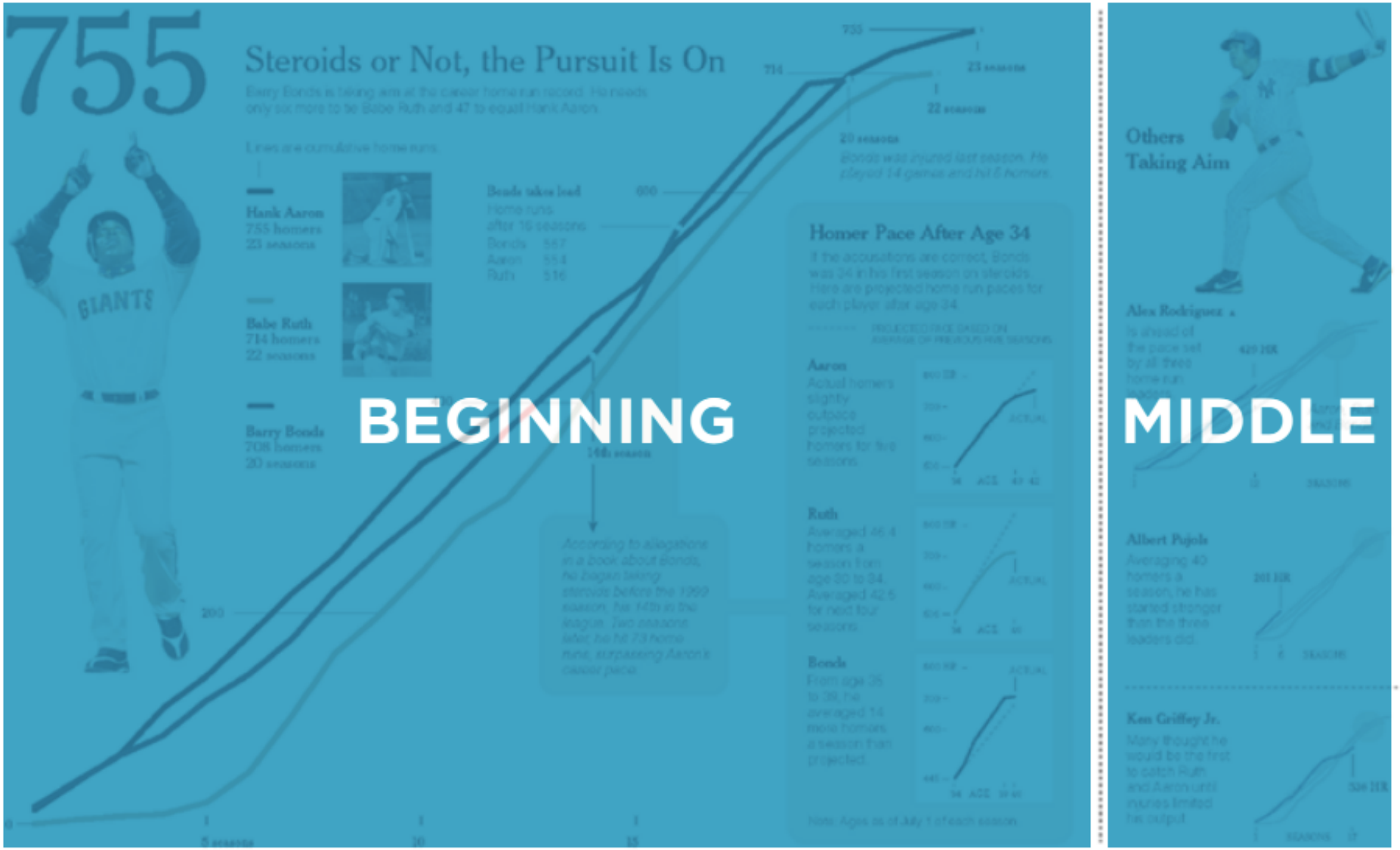


Differing Paths to the Top of the Charts

The top seven players on the career home run list, along with a look at Griffey (12th), Rodriguez (37th) and Pujols (3rd 257th).



E. Segel



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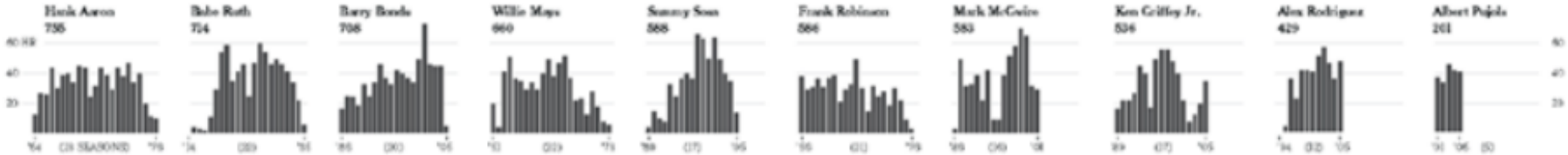

E. Segel


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
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.
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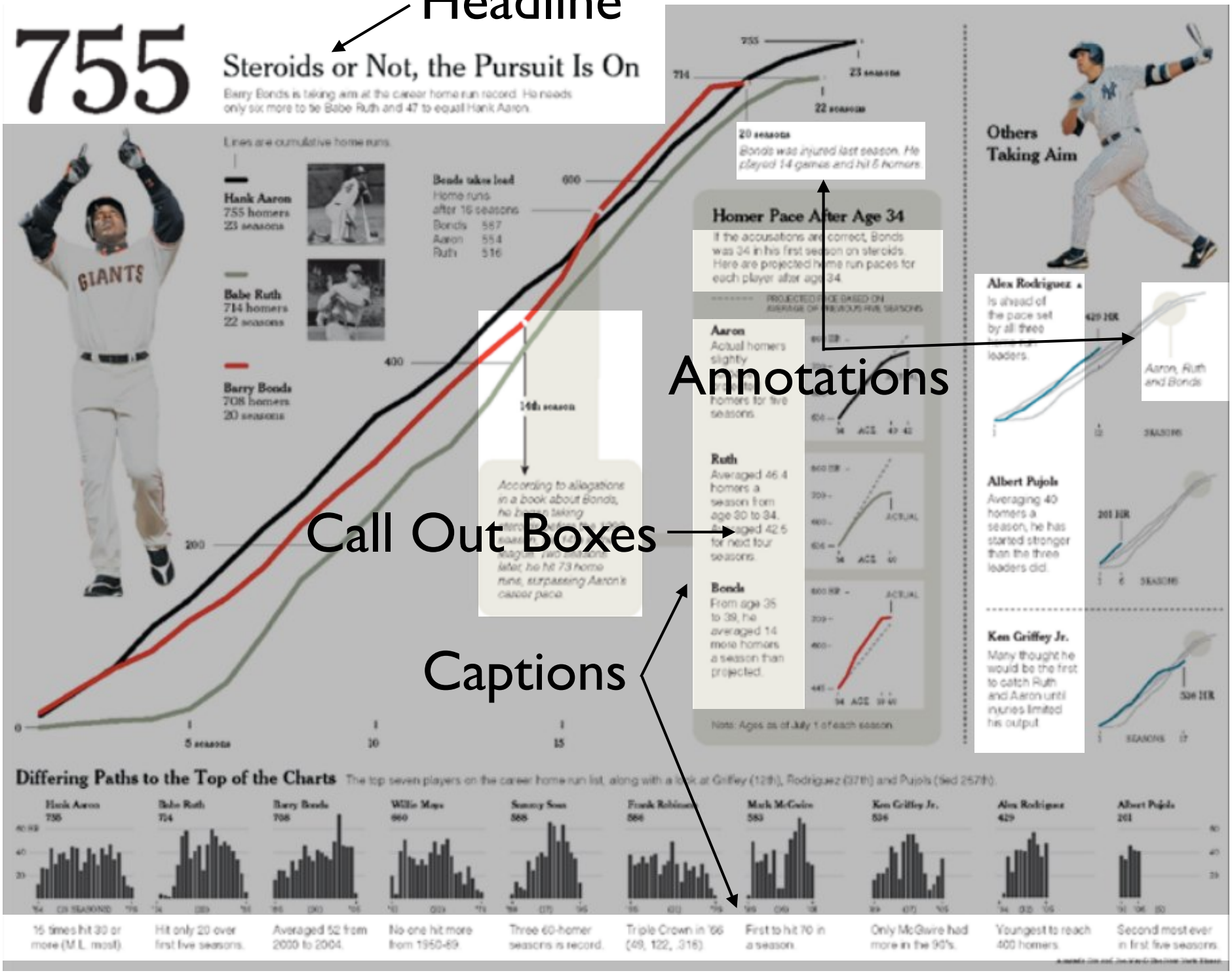
Aaron
Actual homers slightly outpace projected homers for five seasons.
Ruth
Averaged 46.4 homers a season from age 30 to 34. Averaged 42.6 for next four seasons.
Bonds
From age 25 to 29, he averaged 14 more homers a season than projected.
ACTUAL
PROJ.
Note: Ages as of July 1 of each season.
BEGINNING


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.
MIDDLE


Differing Paths to the Top of the Charts
The top seven players on the career home run list, along with a look at Griffey (128), Rodriguez (378) and Pujols (tied 267th).
Hank Aaron 755
Babe Ruth 714
Barry Bonds 708
Willie Mays 660
Sammy Sosa 588
Frank Robinson 586
Mark McGwire 583
Ken Griffey Jr. 534
Alex Rodriguez 429
Albert Pujols 201
16 times hit 30 or more (M.L. record)
Hit only 20 over first five seasons.
Averaged 52 from 2000 to 2004.
No one hit more from 1960-69.
Three 60-homer seasons is record.
Triple Crown in '66 (49, 122, .316).
First to hit 70 in a season.
Only McGwire had more in the 90's.
Youngest to reach 400 homers.
Second most ever in first five seasons.
END

E. Segel


Headline
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10
15
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714
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22 seasons
20 seasons
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Bonds
From age 35 to 39, he averaged 14 more homers a season than projected.
ACTUAL
AGE
Note: Ages as of July 1 of each season.
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Is ahead of the pace set by all three ... leaders.
Aaron, Ruth and Bonds
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.
SEASONS
Annotations
Call Out Boxes
Captions
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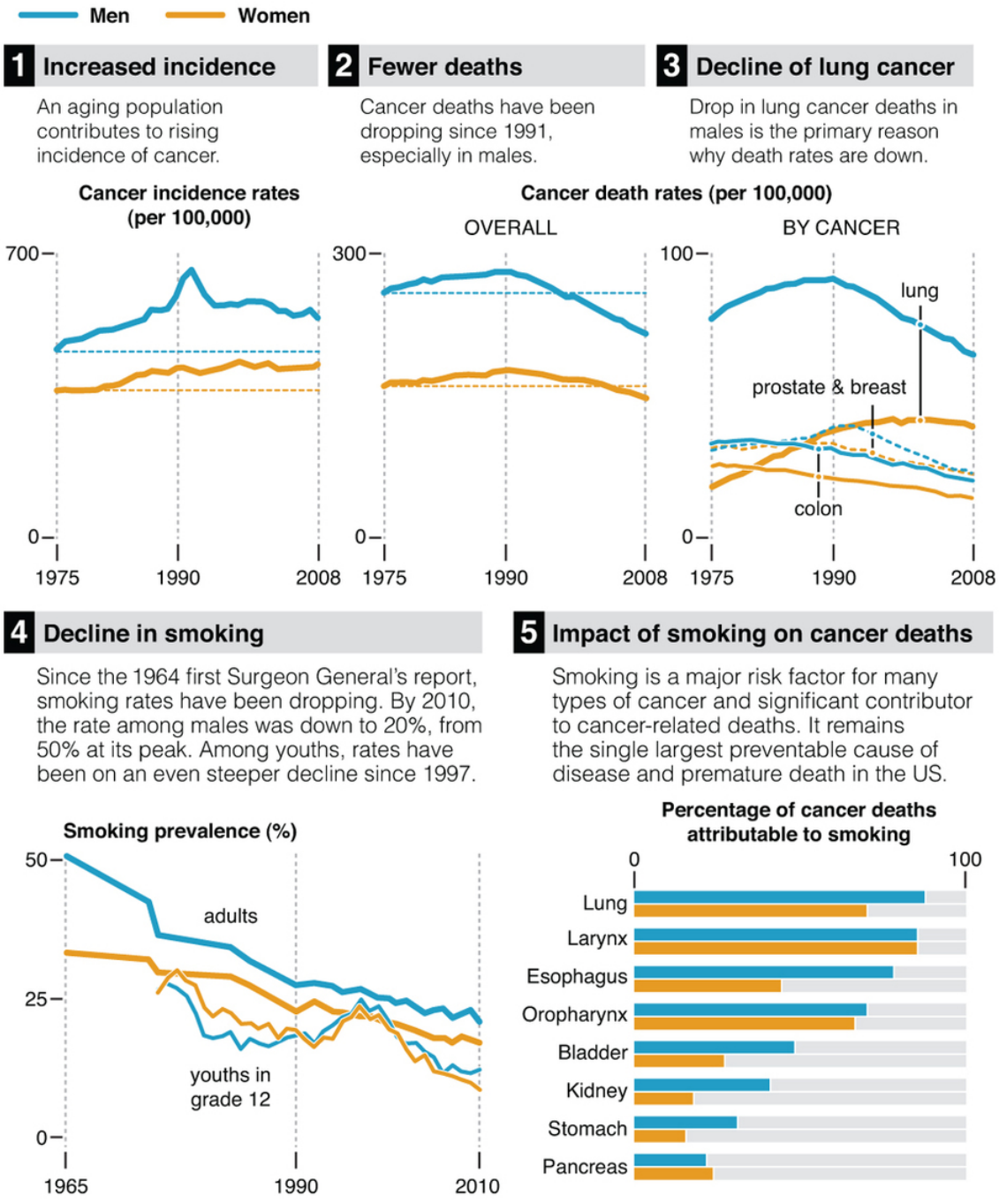
E. Segel

WHERE THERE'S SMOKE—THERE'S CANCER

Cancer rates are up, but mortality is down. New diagnostics and treatments are responsible for part of this trend. But the greatest single contributing factor is the decline in smoking—rates are at their lowest level in 50 years.



source: American Cancer Society Cancer Statistics 2012; Monitoring the Future (University of Michigan).

M. Krzywinski & A. Cairo

Application to modeling

IMAC

I: inferential goal (scientific question of interest)
M: model (all models are wrong, some are useful)
A: algorithms
C: conclusions and checking

The C is crucial: what did we learn? Was the model useful, and how well does it fit? How do we know whether the method is working? Do we understand how it is working? Do we need to iterate and improve the model? What are the limitations and future directions?

Communicating a model

Telecom Churn Problem

Survey 1000 customers , with an offer with an administrative cost of $3 and an offer cost of $100, an incentive for the customer to stay with us.

Want to predict for our 100000 customer base.

If a customer leaves us, we lose the customer lifetime value, which is some kind of measure of the lost profit from that customer.

Lets assume this is the average number of months a customer stays with the telecom times the net revenue from the customer per month. We'll assume 3 years and $30/month margin per user lost, for roughly a $1000 loss.

```
admin_cost=3
offer_cost=100
clv=1000 # customer lifetime value
```

- TN=people we predicted not to churn who wont churn. We associate no cost with this as they continue being our customers
- FP=people we predict to churn. Who wont. Lets associate a admin_cost+offer_cost cost per customer with this as we will spend some money on getting them not to churn, but we will lose this money.
- FN=people we predict wont churn. And we send them nothing. But they will. This is the big loss, the clv
- TP= people who we predict will churn. And they will. These are the people we can do something with. So we make them an offer. Say a fraction f accept it. Our cost is admin_cost + f*offer_cost + (1-f)*clv.

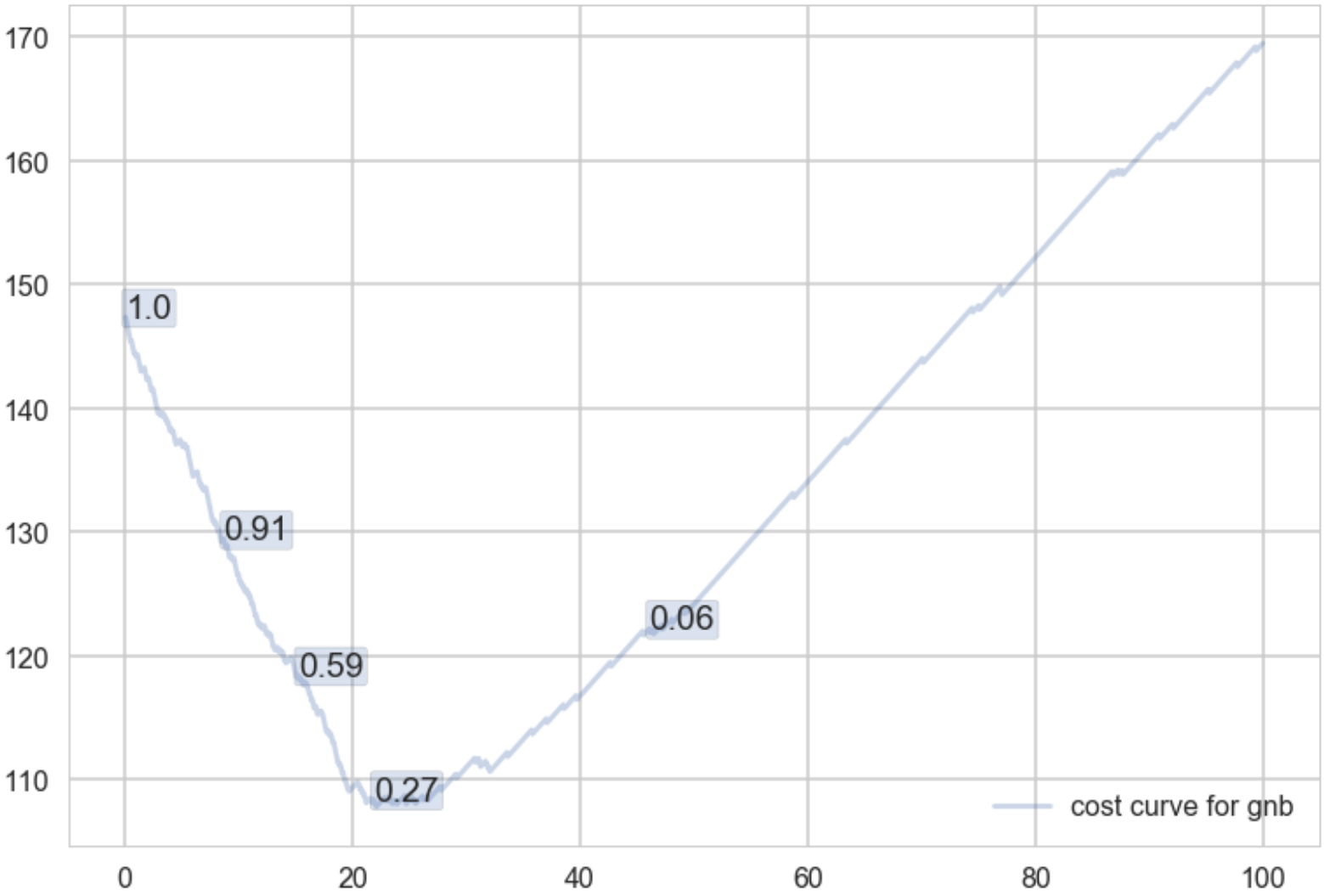
```
f = 0.5
tnc = 0.
fpc = admin_cost+offer_cost
fnc = clv
tpc = admin_cost + f*offer_cost + (1. - f)*clv
```

Observed	Predicted		
	0	1	
0	TN True Negative	FP False Positive	ON Observed Negative
1	FN False Negative	TP True Positive	OP Observed Positive
	PN Predicted Negative	PP Predicted Positive	

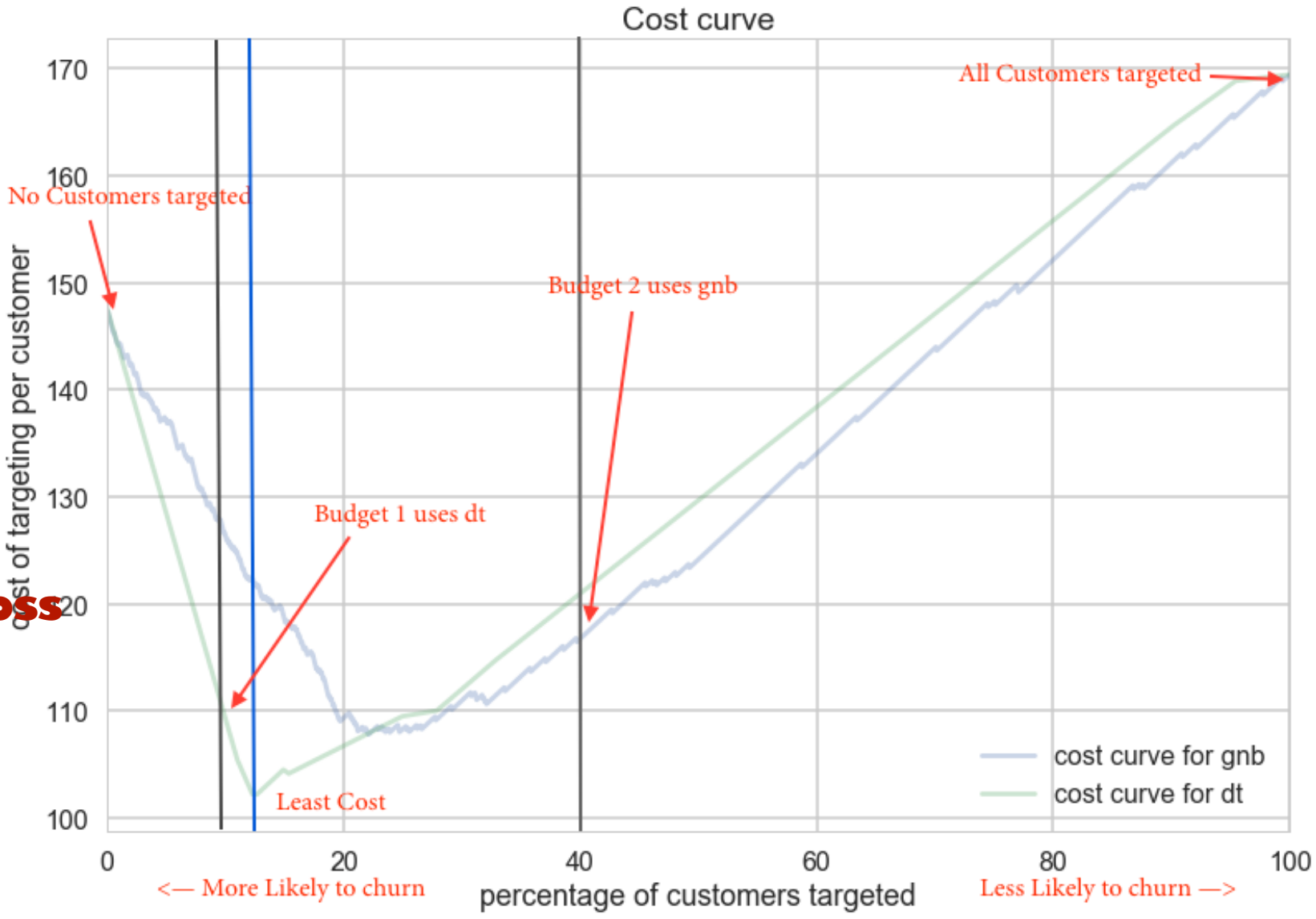
Observed	Predicted	
	0	1
0	TNC True Negative Cost	FPC False Positive Cost
1	FNC False Negative Cost	TPC True Positive Cost

Average Cost = TN x TNC
+ TP x TPC +
FN x FNC + TP x TPC

Observed	Predicted	
	0	1
0	TNC True Negative Cost 0	FPC False Positive Cost 103
1	FNC False Negative Cost 1000	TPC True Positive Cost 553


170
160
150
140
130
120
110
0
20
40
60
80
100
1.0
0.91
0.59
0.27
0.06
cost curve for gnb

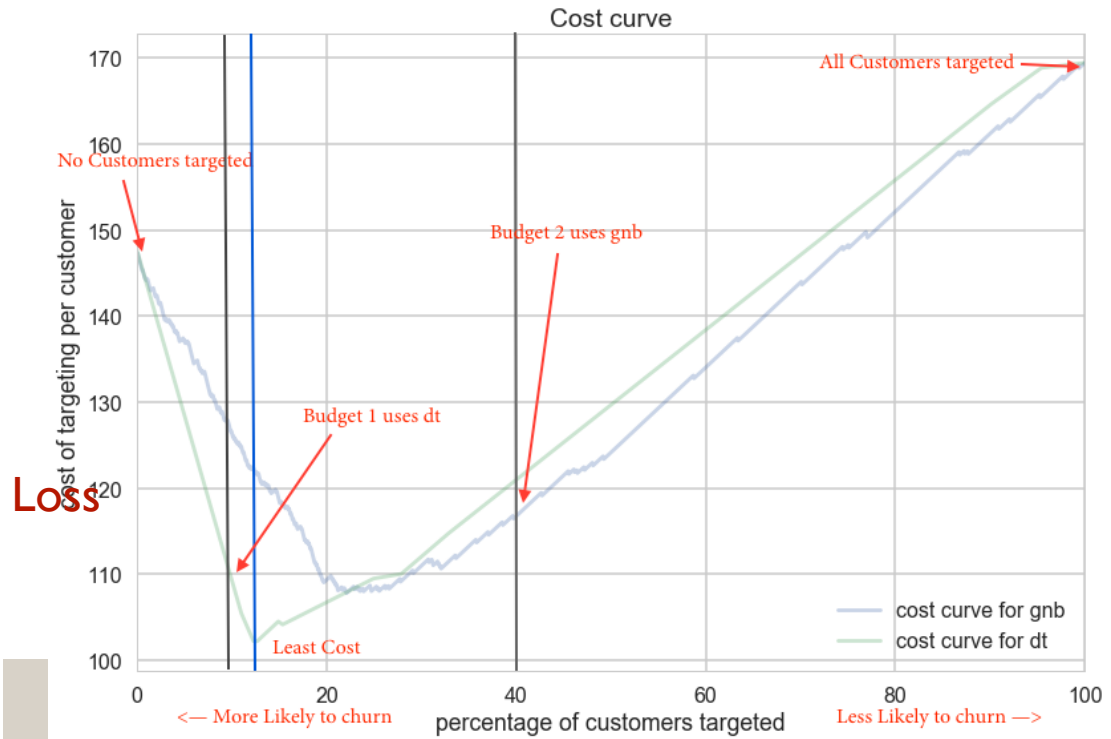
Annotated Diagram



Loss

made with Preview

Reduce churn and our cost by sending customers an offer



Loss

Making offers within Budget

This study was made on a pilot survey of 1000 customers from our 100000 customer base.

Make an offer with an **administrative cost of $3** and an **offer cost of $100**, an incentive for the customer to stay with us.

If a customer leaves us, we lose the customer lifetime value (CLV), a **roughly $1000 loss**.

We assume that 50% of those customers targeted will stay with us.

If we do nothing we lose $150 per customer including CLV

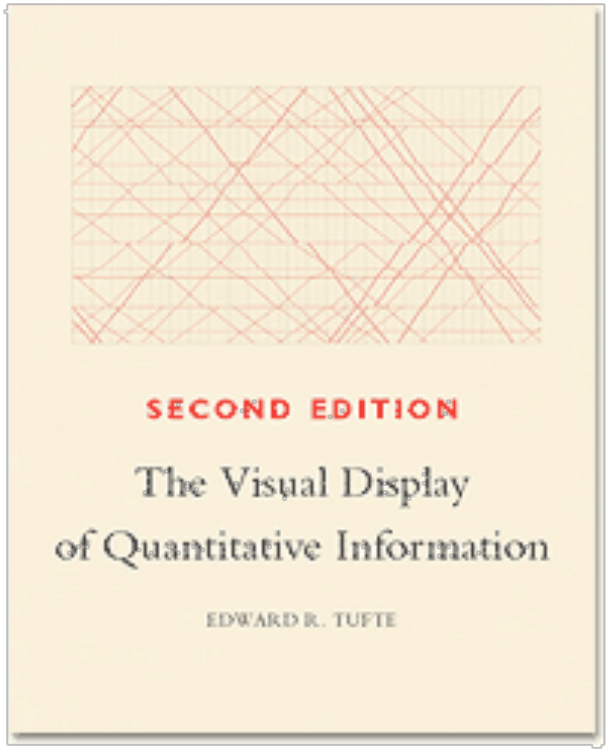
We ***choose which customers to target*** according to 2 different models, **dt** and **gnb:**

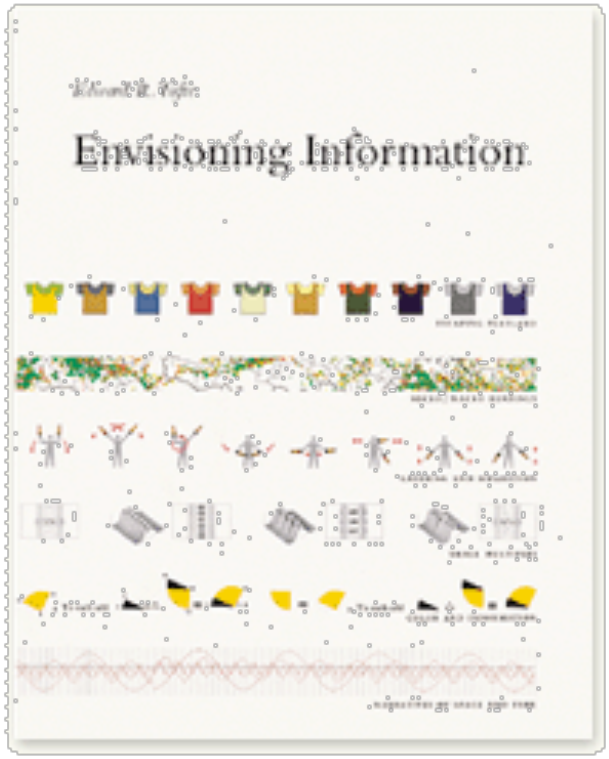
- Making an offer to 13% of our most likely to leave customers will cut this cost to a lowest value of $103 per customer according to the **dt** model, for a total cost of $1.34 million.
- If we only target 10% of the customers (Budget 1) using the **dt** model, we get by in 1.03 million but incur a loss of $110 per customer including CLV.
- If we target 40% of our customers, we need a budget (Budget 2) of $4.2 million. Here the **gnb** model performs better and we will choose customers according to it. We incur a loss of $116 per customer including CLV.

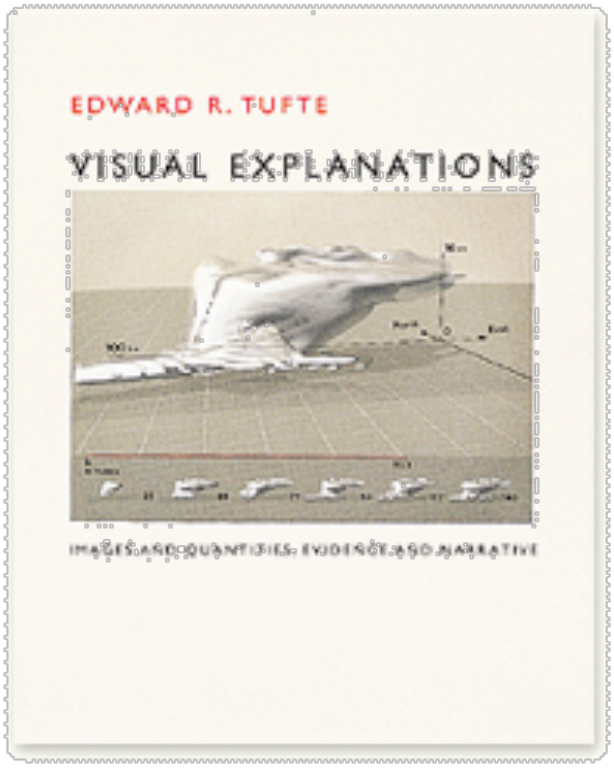
made with Pages

StoryTelling

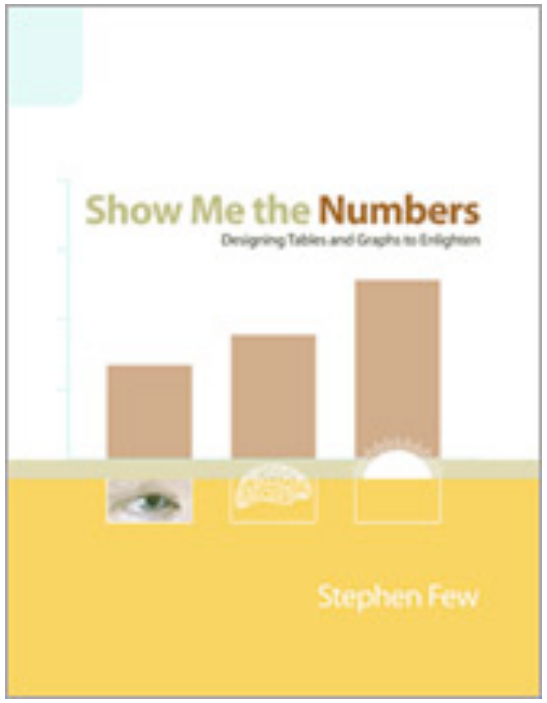
Edward Tufte

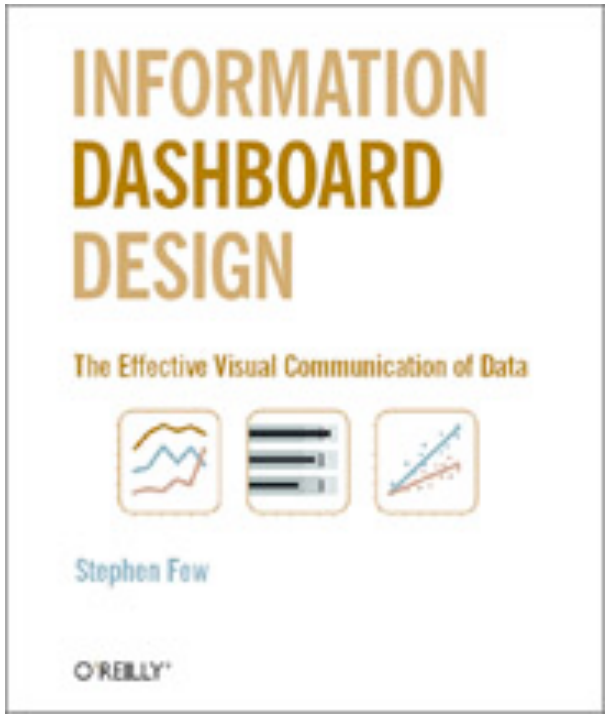




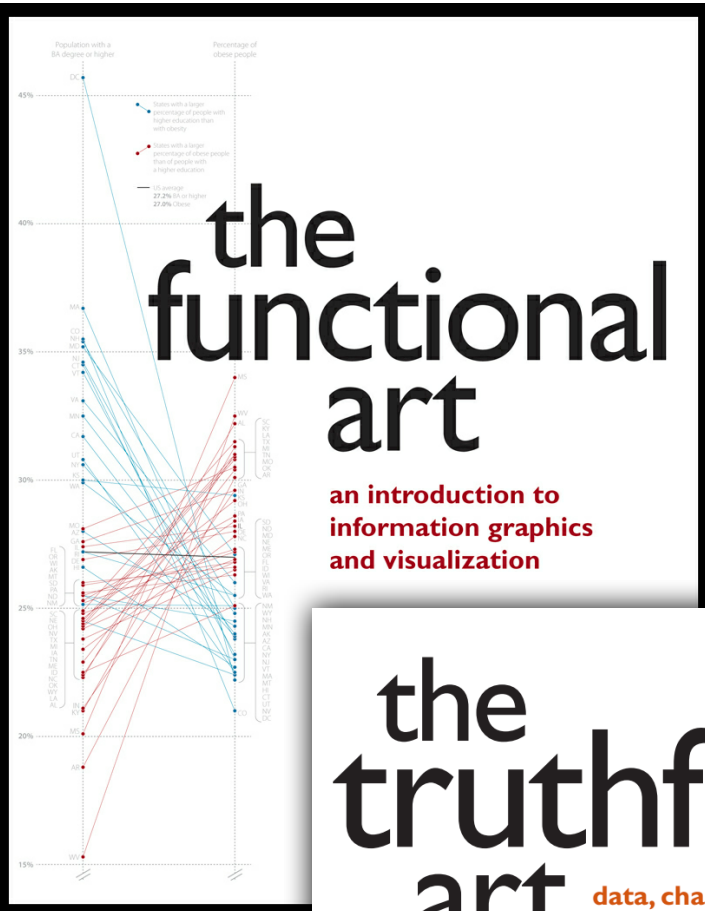


Stephen Few

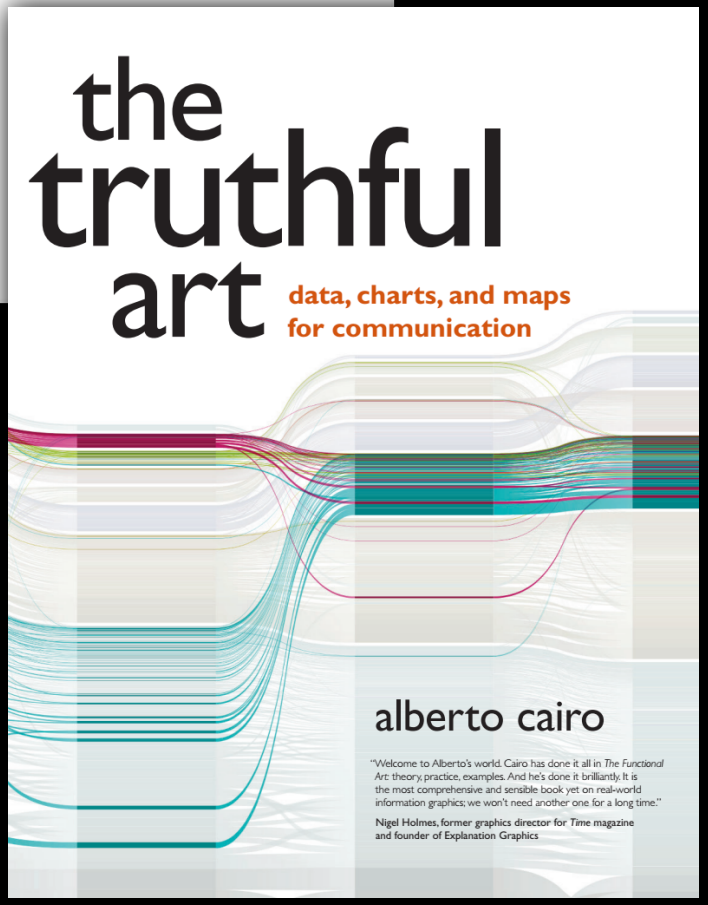

Show Me the Numbers
Designing Tables and Graphs to Enlighten
Stephen Few


INFORMATION
DASHBOARD
DESIGN
The Effective Visual Communication of Data
Stephen Few
O'REILLY


Now you see it
Stephen Few



2012



2016

I've always believed in the power of data visualization (the representation of information by means of charts, diagrams, maps, etc.) to enable understanding

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