

Presenting Results

1. Visualization

- “At their best, graphics are instruments for reasoning.”
 - Edward Tufte
- “Numerical quantities focus on expected values, graphical summaries on unexpected values.”
 - John Tukey
- “The greatest value of a picture is when it forces us to notice what we never expected to see.”
 - John Tukey
- “If I can’t picture it, I can’t understand it.”
 - Albert Einstein

- Given two variables where:

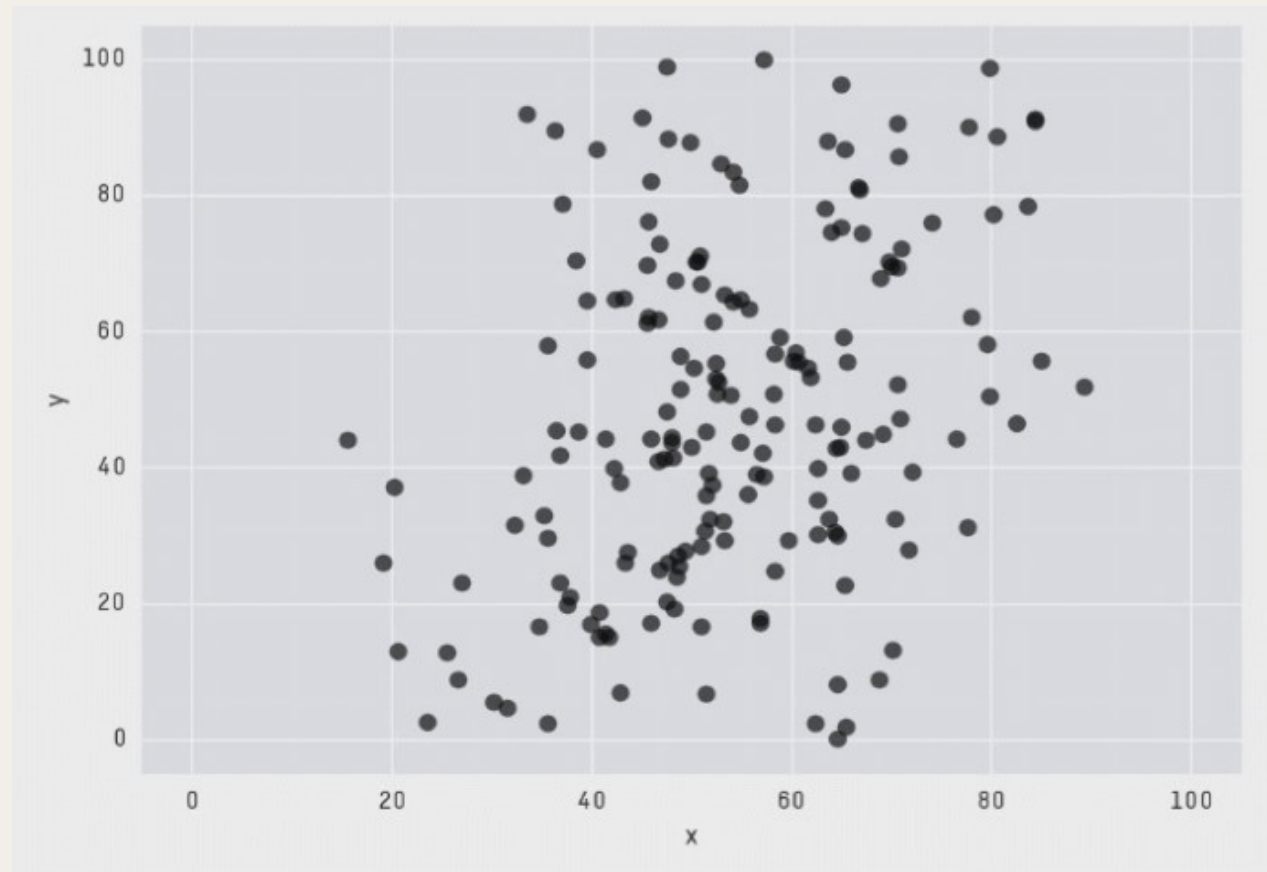
$$\bar{X} = 54.26 \ (SD = 16.76)$$

$$\bar{Y} = 47.83 \ (SD = 26.93)$$

$$r_{X,Y} = -.06$$

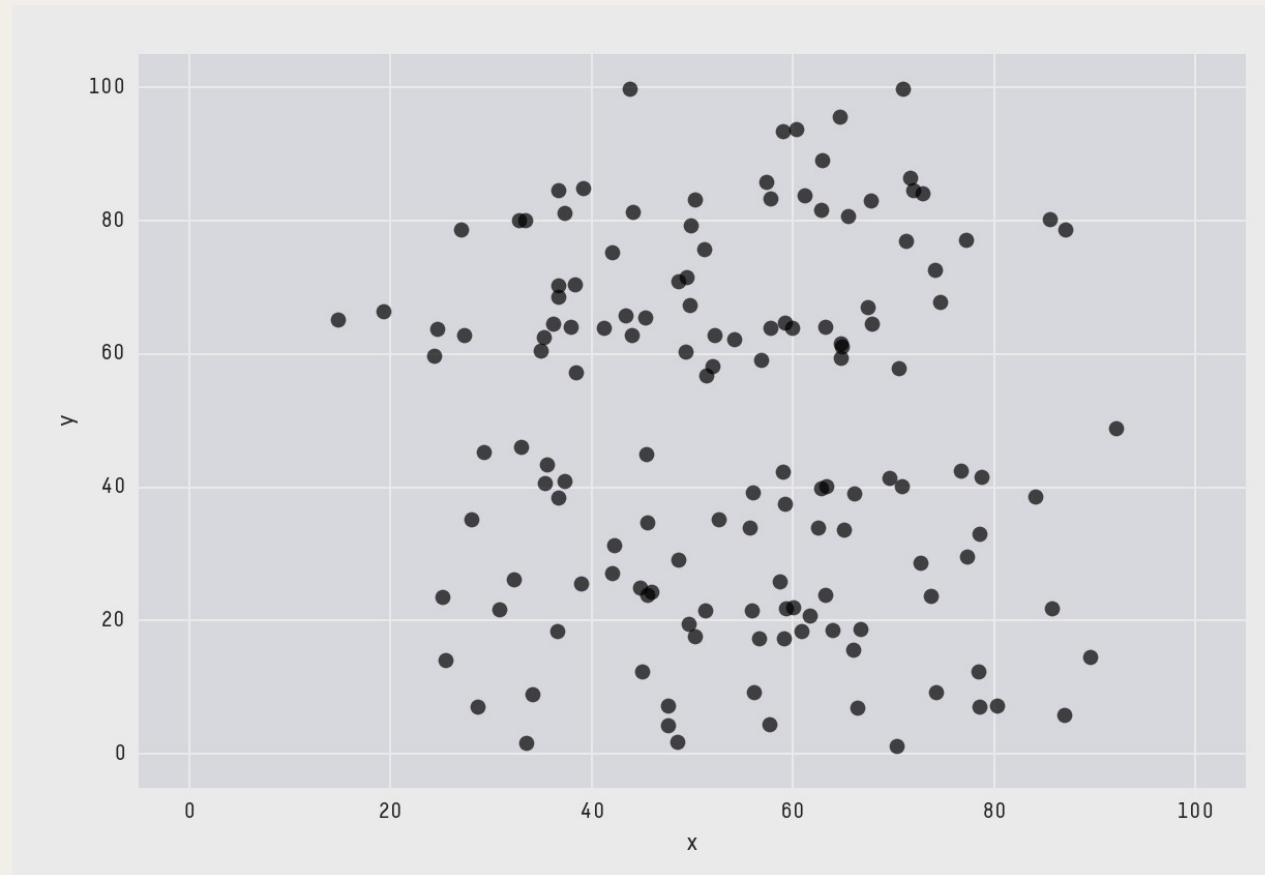
- What do these data look like?

This?



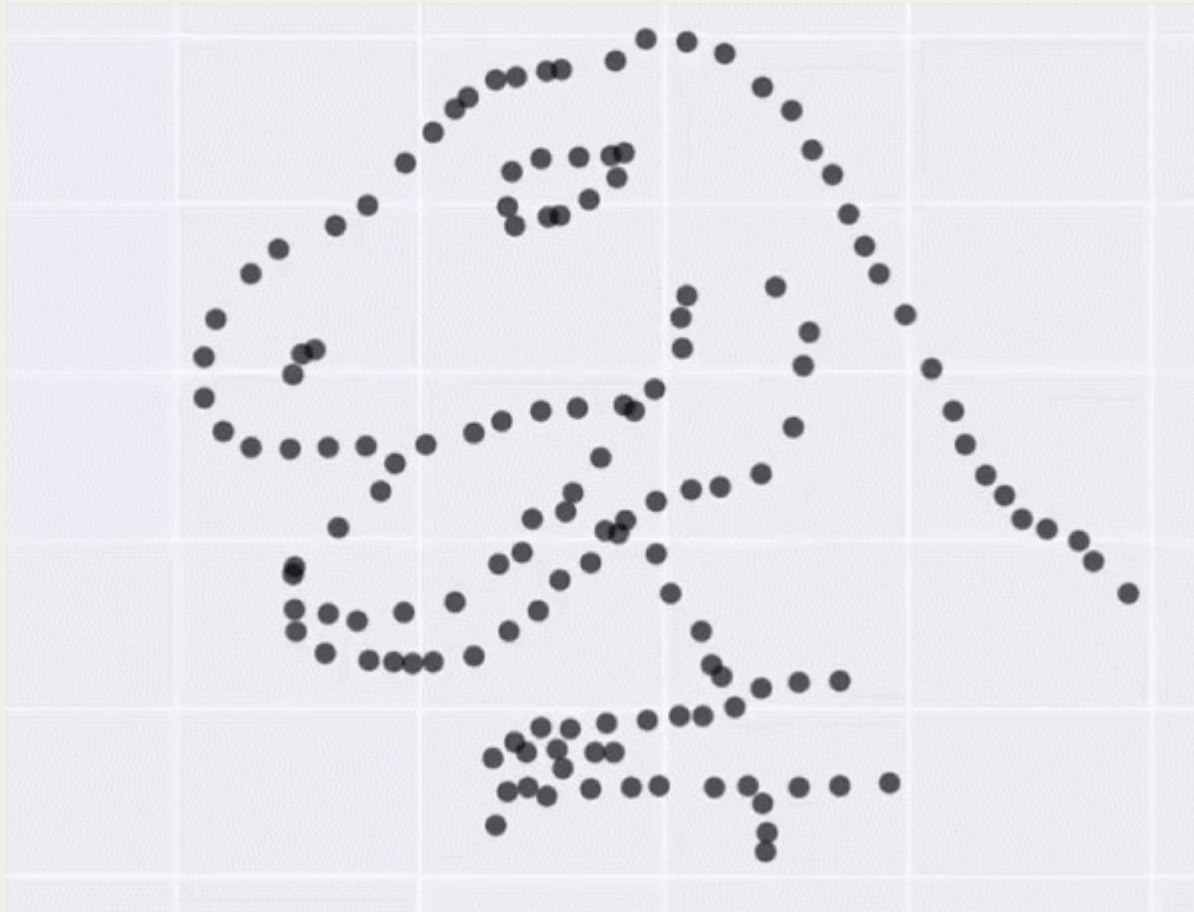
No, $\bar{X} = 54.02$, $\bar{Y} = 48.09$, $r_{X,Y} = .32$

This?



Yes, $\bar{X} = 54.26$, $\bar{Y} = 47.83$, $r_{X,Y} = -.06$

Or this?



Yes, $\bar{X} = 54.26$, $\bar{Y} = 47.83$, $r_{X,Y} = -.06$

Elements of Good Data Visualization

- Self sufficiency
- Efficient information transfer
- Data-to-ink ratio
- Follow conventions & readers' expectations

Bad Graphs

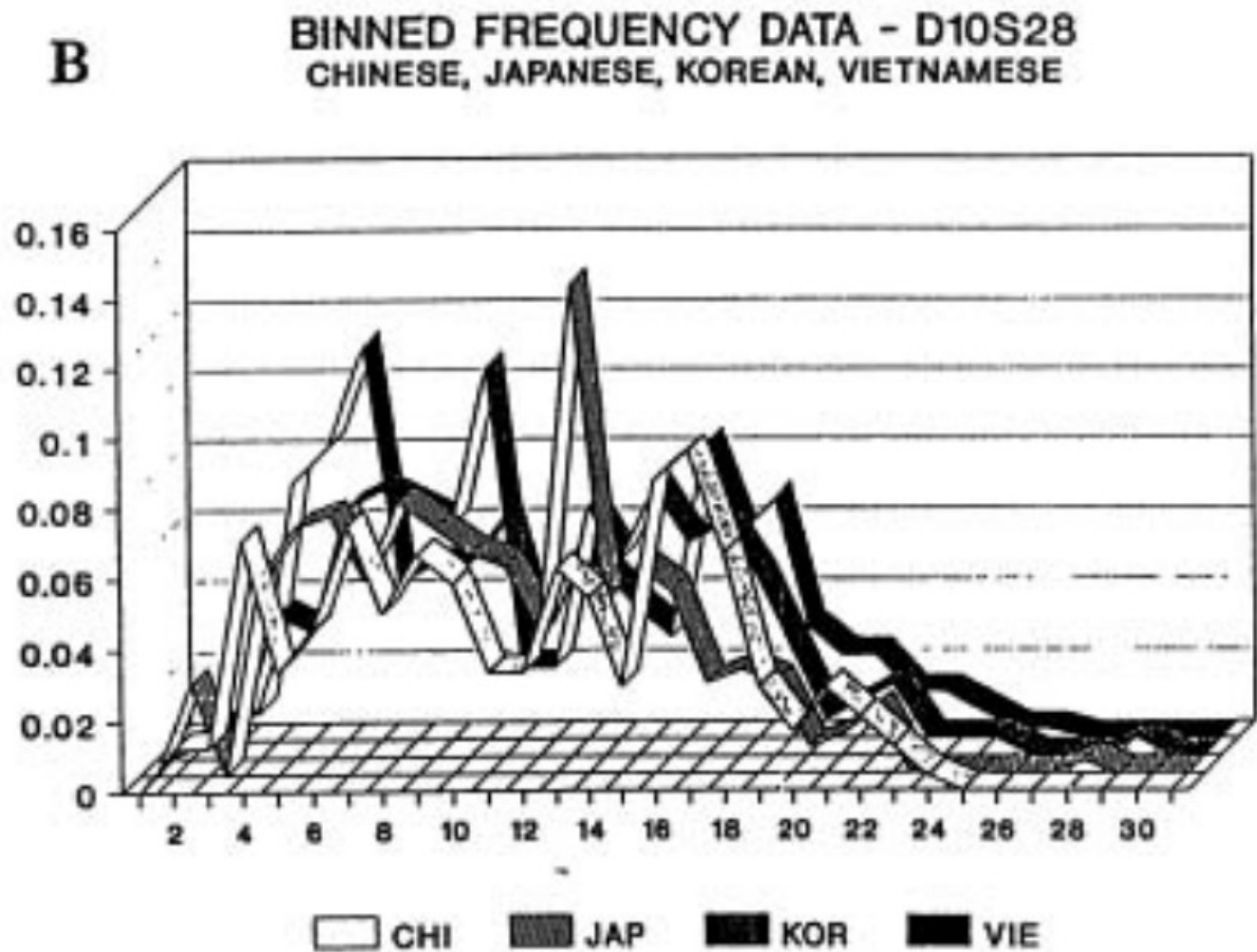


FIG. 4. *Fixed bin distribution (histogram) for two loci and four Asian subpopulations (used with permission from John Hartmann): the boundaries of the 30 bins (vertical axis) are determined by the FBI; these bins are not of equal length. Sample sizes (numbers of individuals) for Chinese, Japanese, Korean and Vietnamese are 103, 125, 93 and 215 for D4S139 and 120, 137, 100 and 193 for D10S28. The horizontal axis is the bin number; bins are not of equal length.*

Bad Graphs (cont.)

Distribution of All TFBS Regions

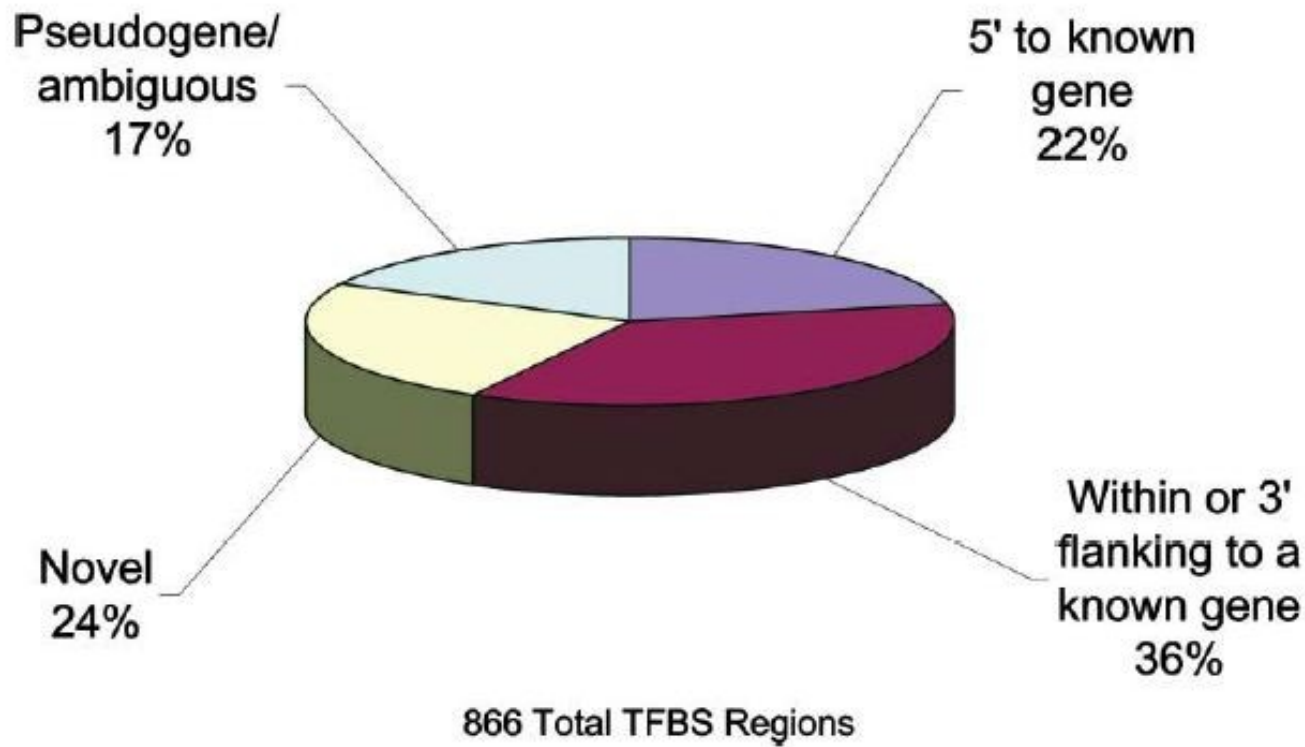


Figure 1. Classification of TFBS Regions

TFBS regions for Sp1, cMyc, and p53 were classified based upon proximity to annotations (RefSeq, Sanger hand-curated annotations, GenBank full-length mRNAs, and Ensembl predicted genes). The proximity was calculated from the center of each TFBS region. TFBS regions were classified as follows: within 5 kb of the 5' most exon of a gene, within 5 kb of the 3' terminal exon, or within a gene, novel or outside of any annotation, and pseudogene/ambiguous (TFBS overlapping or flanking pseudogene annotations, limited to chromosome 22, or TFBS regions falling into more than one of the above categories).

Bad Graphs (cont.)

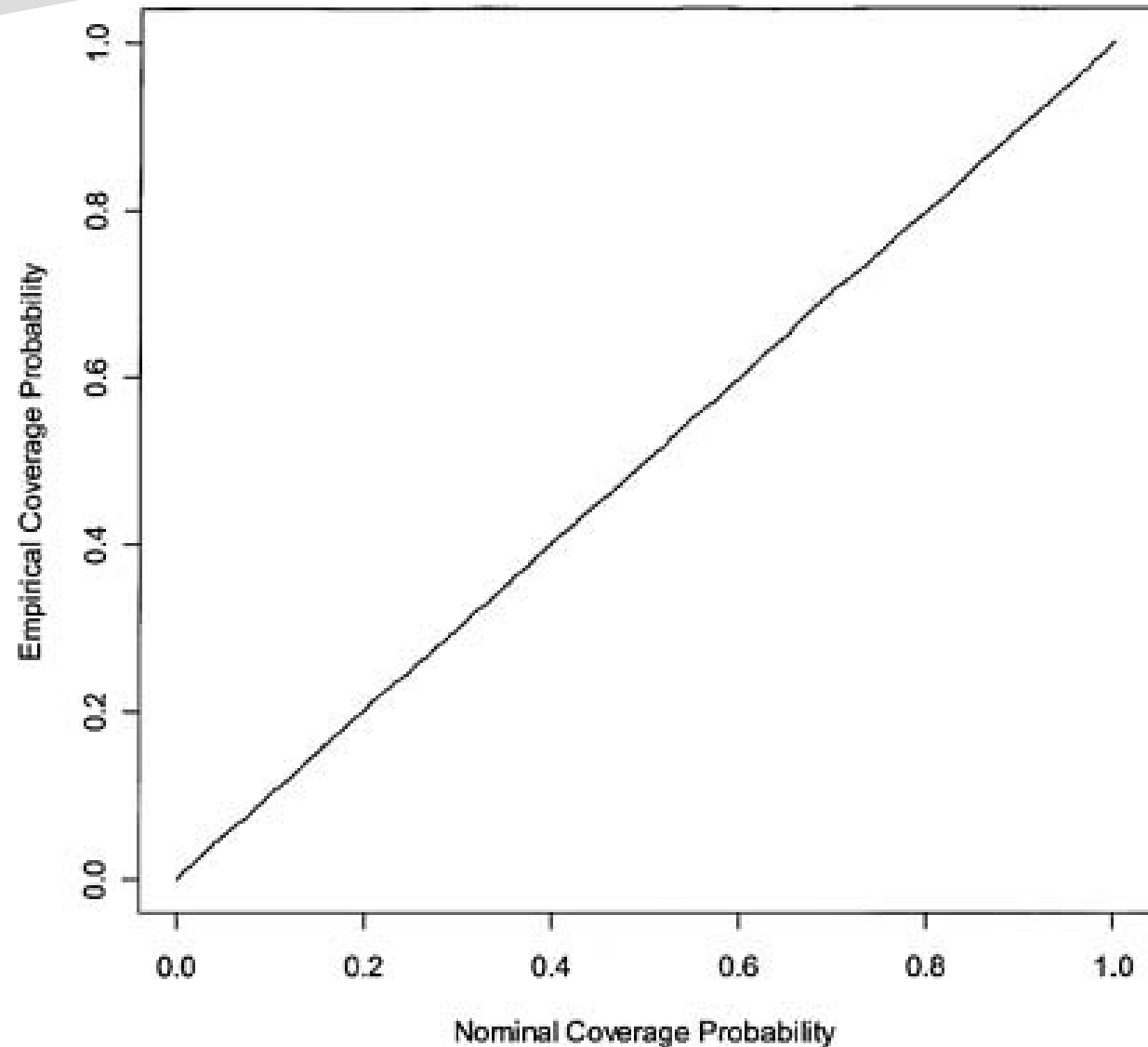
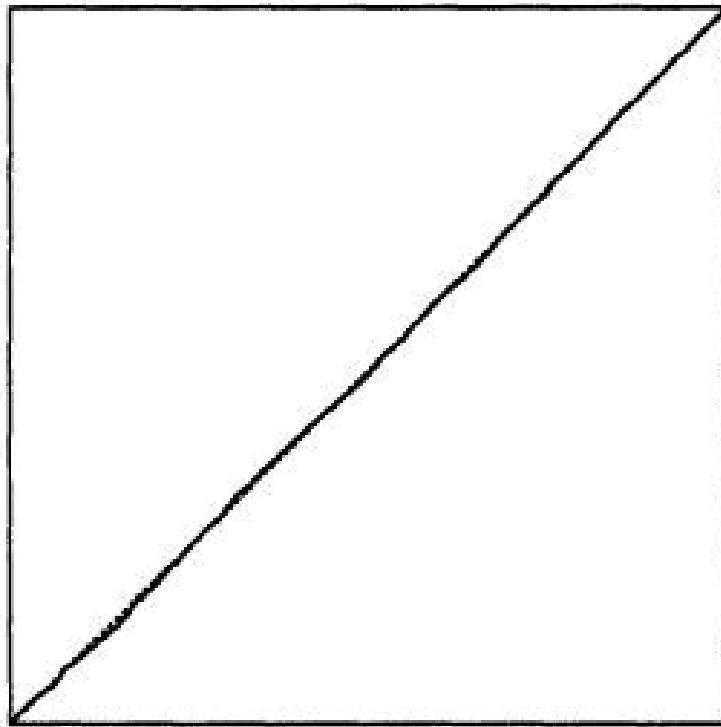
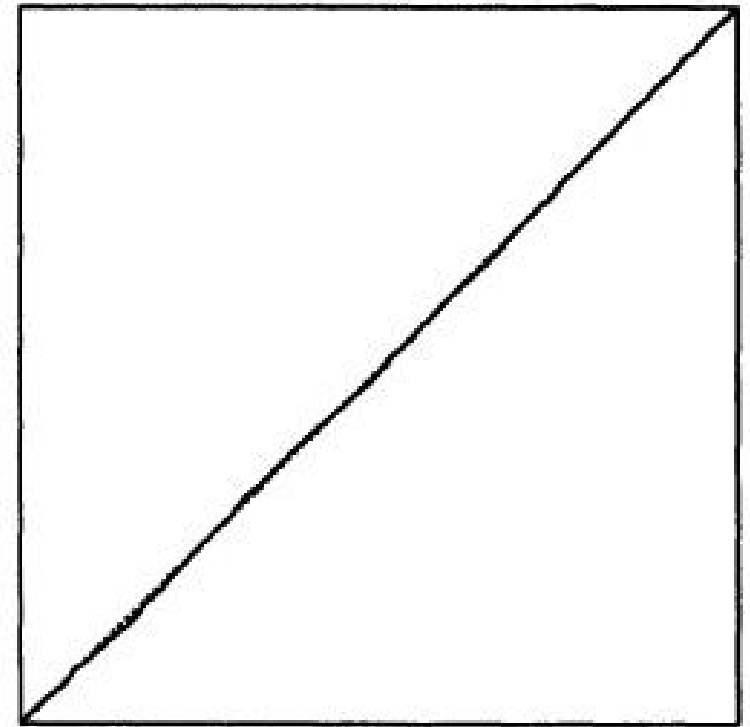


Figure 1 Empirical coverage of CIs for the relative-risk parameter β of haplotype 01100. Results are based on 10,000 simulated data sets with the same haplotype frequencies as the FUSION data. Haplotype 01100 has a multiplicative effect on disease risk, with $\beta = 0.35$.

Bad Graphs (cont.)



(a)



(b)

Figure 1. SRQ Plots of T_i/T_n (Vertical Axes) Against i/n (Horizontal Axes) for the Gibbs Sampler (a) and an Alternating Gibbs/Independence Sampler (b) for the Pump Failure Data Based on Runs of Length 5,000. Lines through the origin with unit slope are shown dashed; axis ranges are from 0 to 1 for all axes.

Bad Graphs (cont.)

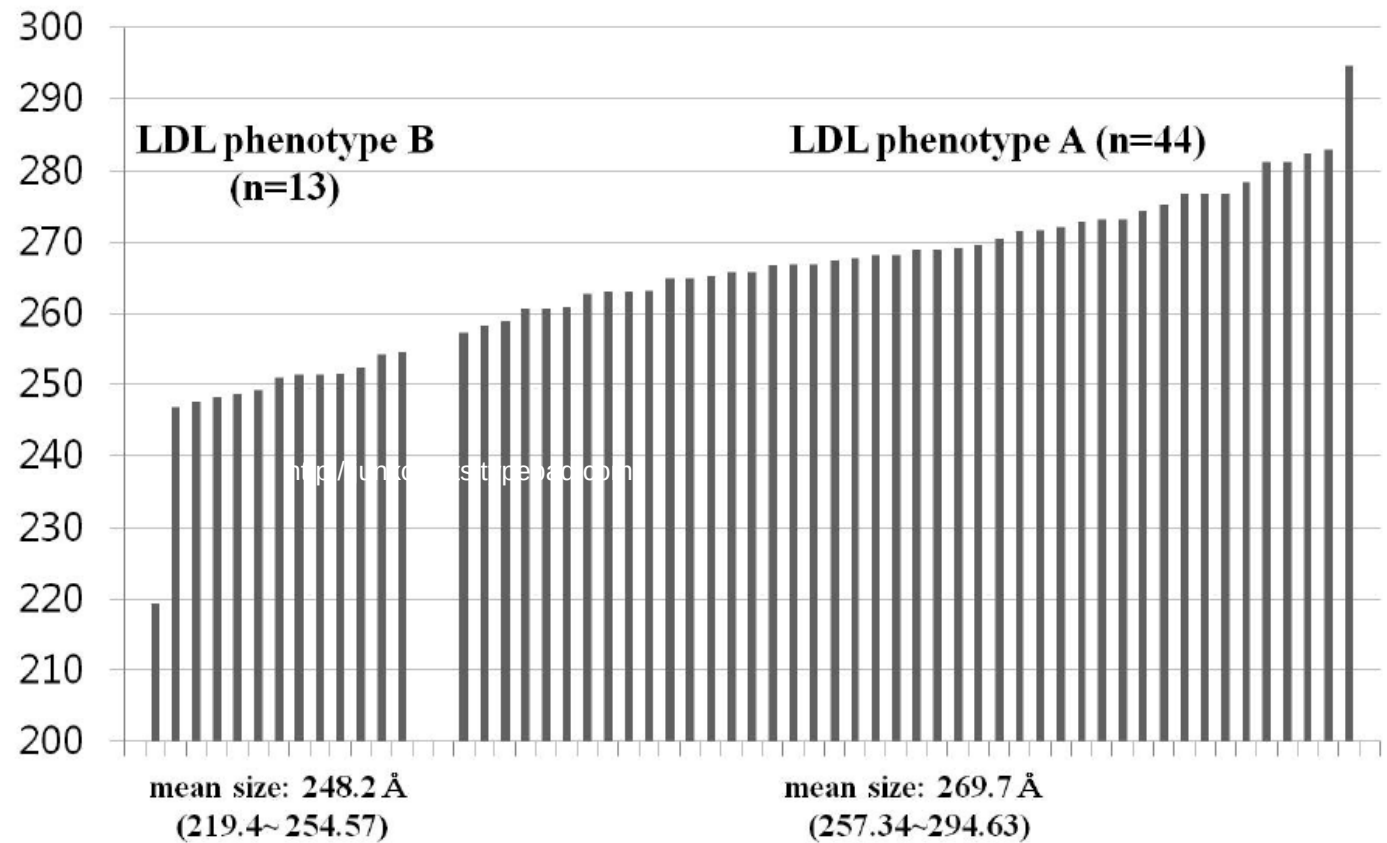


Fig. 1. Distribution of low-density lipoprotein (LDL) particle size in all study subjects (LDL phenotypes A and B). *LDL phenotype A group* (mean size: 269.7 Å, n = 44), subjects with buoyant-mode profiles [peak LDL particle diameter ≥ 264 Å] including intermediate LDL subclass pattern [$256 \text{ Å} \leq \text{peak LDL particle diameter} \leq 263 \text{ Å}$]; *LDL phenotype B group* (mean size: 248.2 Å, n = 13), subjects with dense-mode profiles [peak LDL particle diameter $\leq 255 \text{ Å}$]

Bad Graphs (cont.)

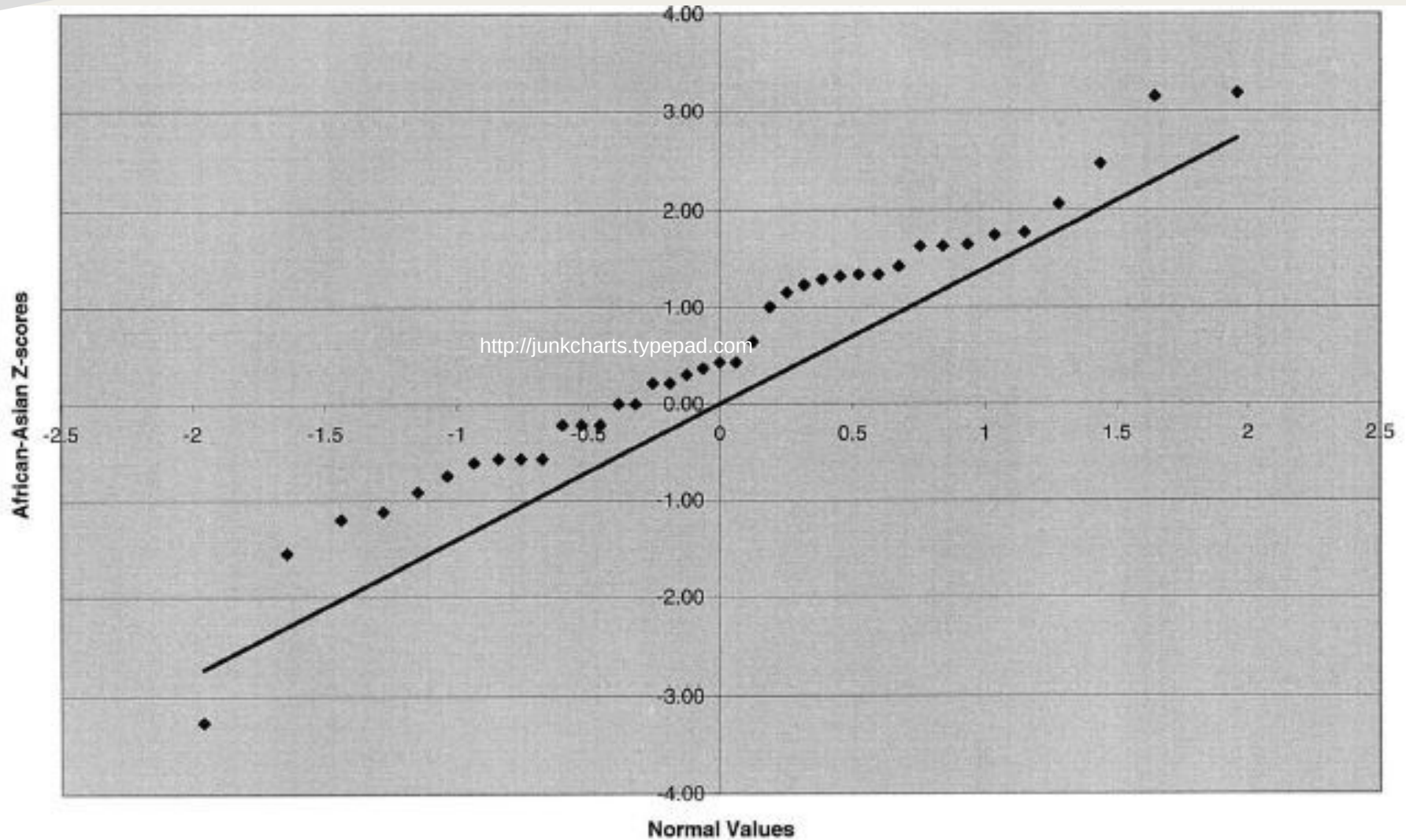
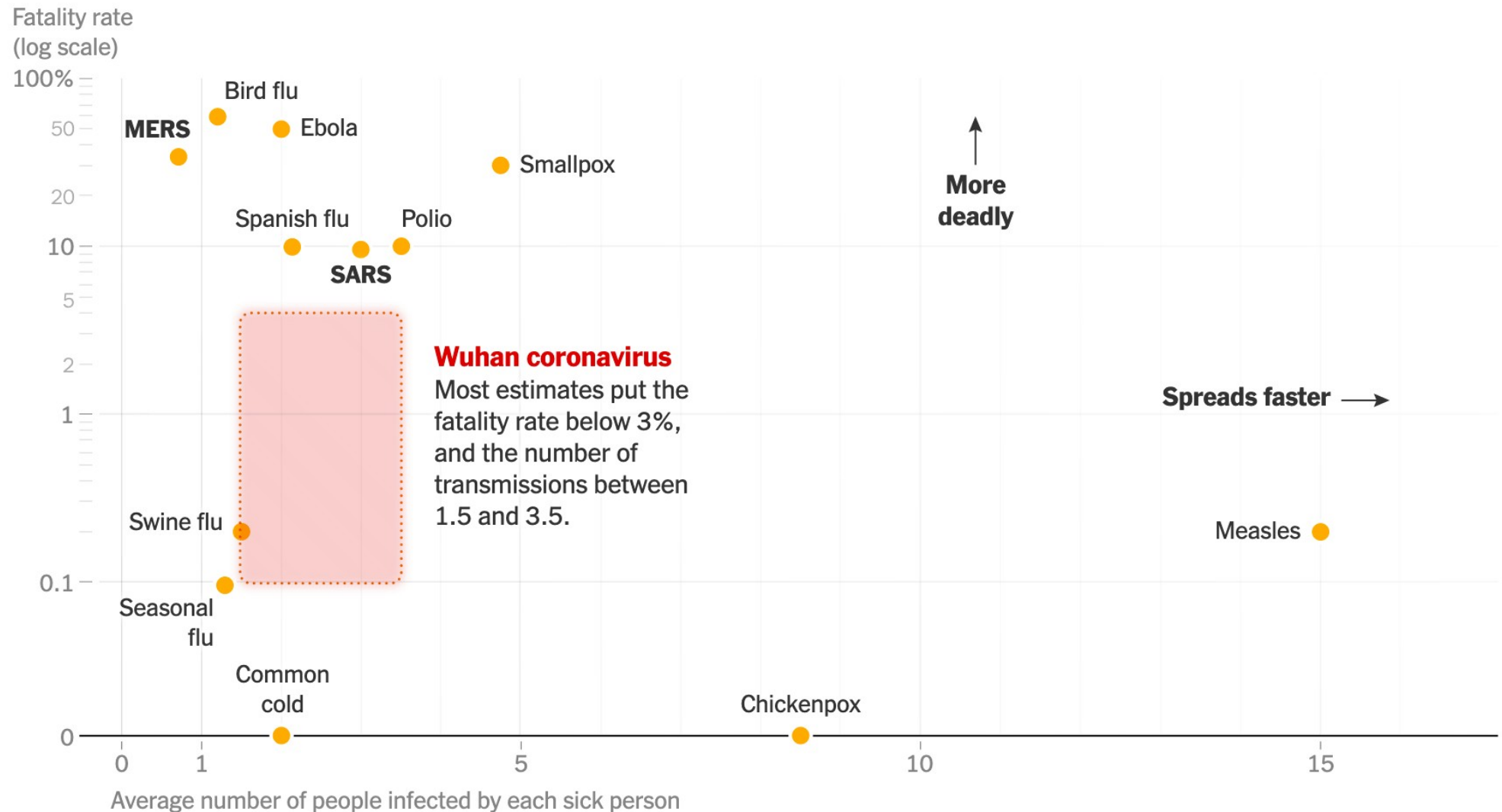


Figure 2 Q-Q plots of Z scores for telomeric interval-length differences. *a*, African Americans versus Asians. *b*, Whites versus Asians.

Bad Graphs (cont.)



Note: Average case-fatality rates and transmission numbers are shown. Estimates of case-fatality rates can vary, and numbers for the Wuhan coronavirus are preliminary estimates.

Bad Graphs (cont.)



Bad Graphs (cont.)

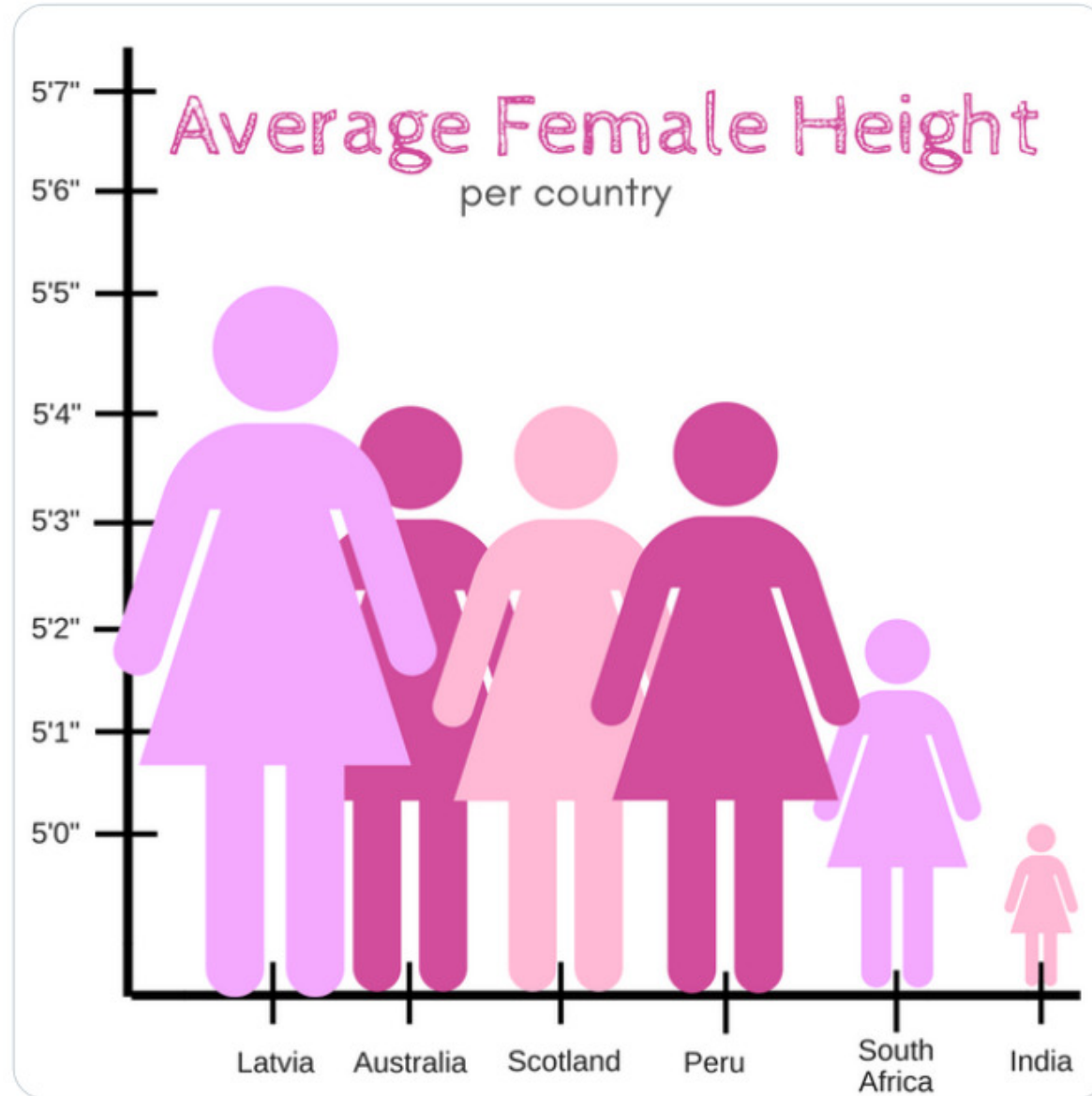


Sabah Ibrahim

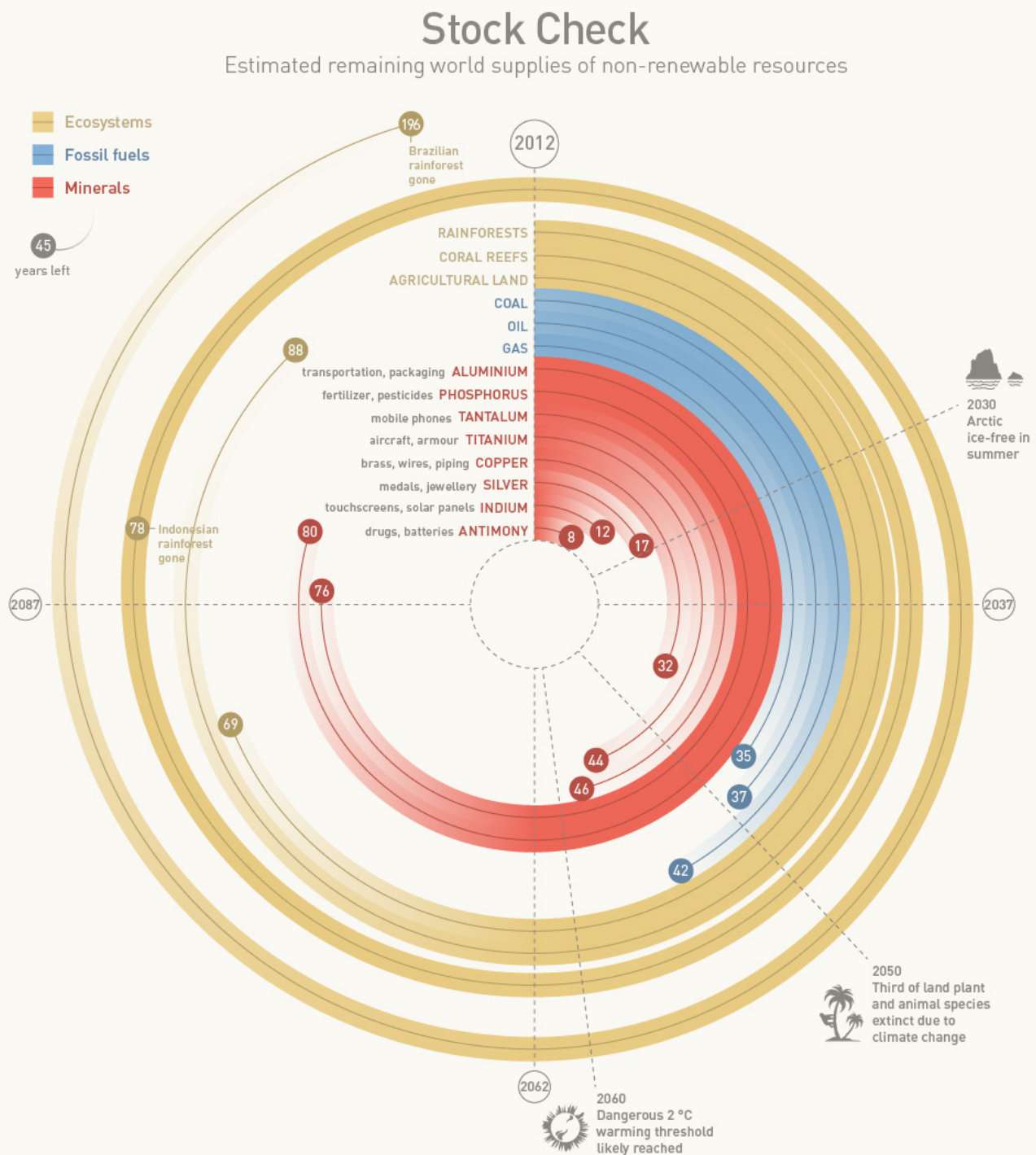
@reina_sabah



As an Indian woman, I can confirm that too much of my time is spent hiding behind a rock praying the terrifying gang of international giant ladies and their Latvian general don't find me



Bad Graphs (cont.)

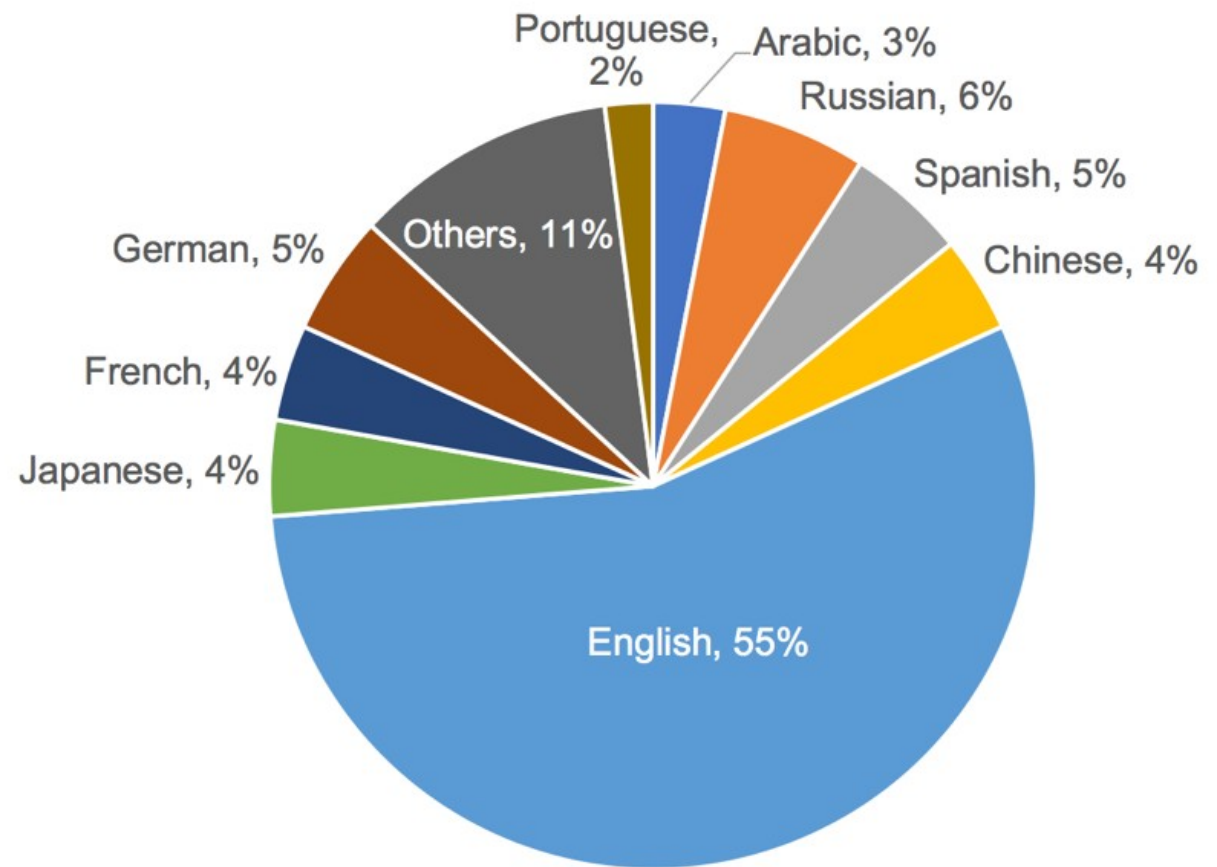


Sources: UN TEEB, US Geological Survey, BP, Worm et al (2006), London Metal Exchange. Figures are worldwide. Living natural resources dates are worst-case based on published estimates. Minerals and fossil fuel data based on known reserves currently economical to extract, assuming fixed % increase in usage per year. No provision made for changes in demand caused by new technologies, discoveries of new reserves or market forces. Agricultural land means land suitable for rainfed cultivation net of other land usage. Thirty year historic agricultural expansion rates are applied.

Bad vs. Better

Bad

Top Languages Used on the Internet



Data from Wikipedia

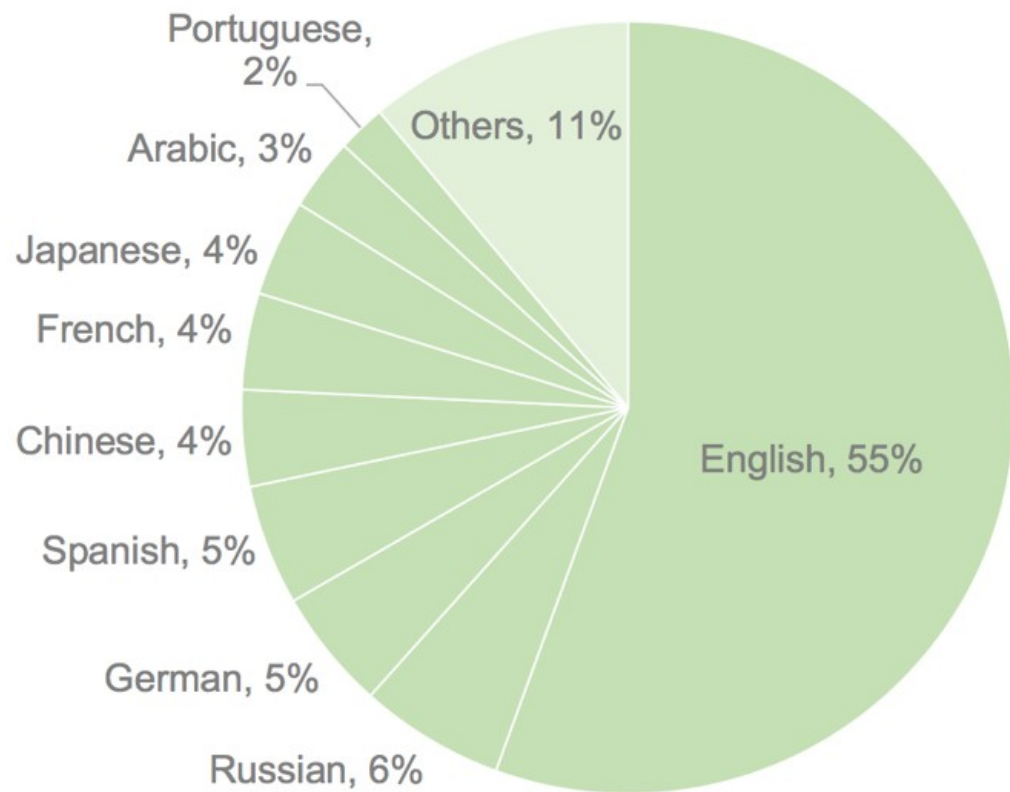
Kaiser Fung |
Junk Charts

Bad vs. Better

Better

- Follows common conventions:
 - Places the first slice at the top vertical
 - Sorts slices from largest to smallest
 - (Except “Others”)
- Introduces multiple colors only to encode data differences.

Top Languages Used on the Internet

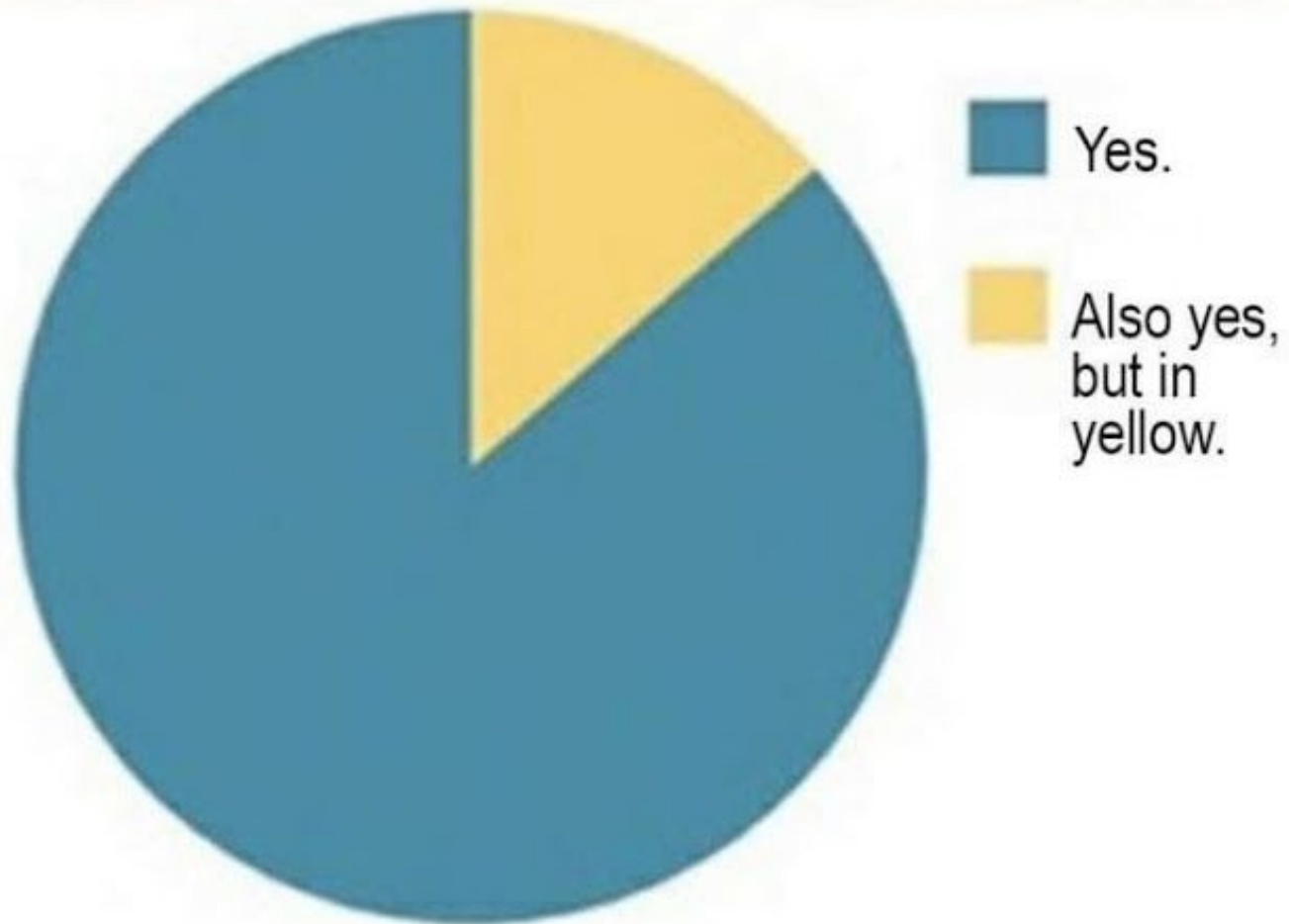


Data from Wikipedia

Kaiser Fung |
Junk Charts

Pie Charts

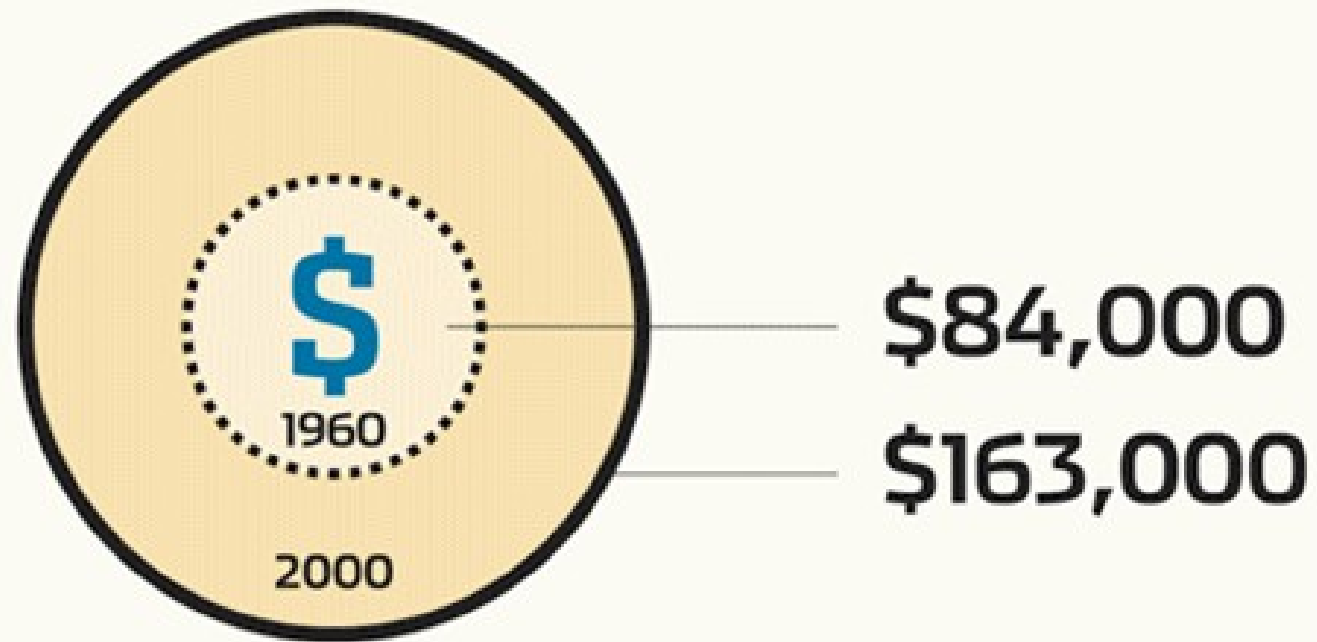
Should I have a beer tonight?



Pie Charts (cont.)

MEDIAN FAMILY INCOME

In the 14 most elite ZIP Codes (as of 1960, in today's purchasing power)

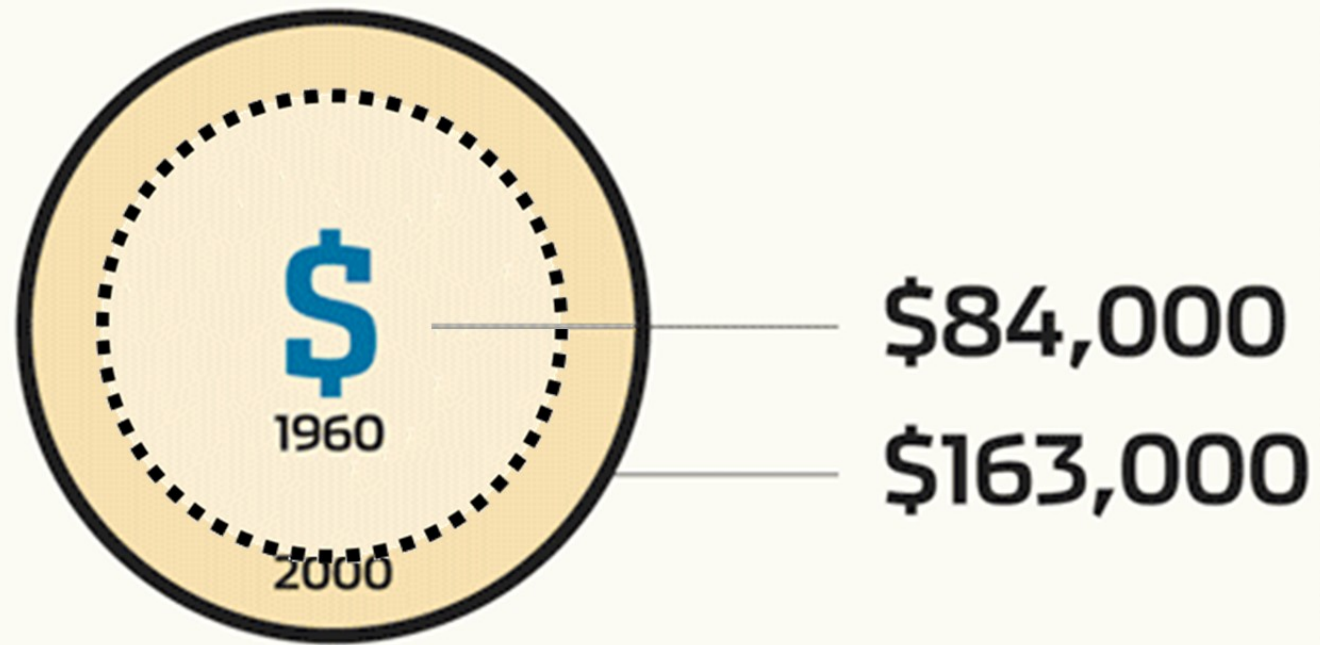


SOURCE: 'COMING APART'

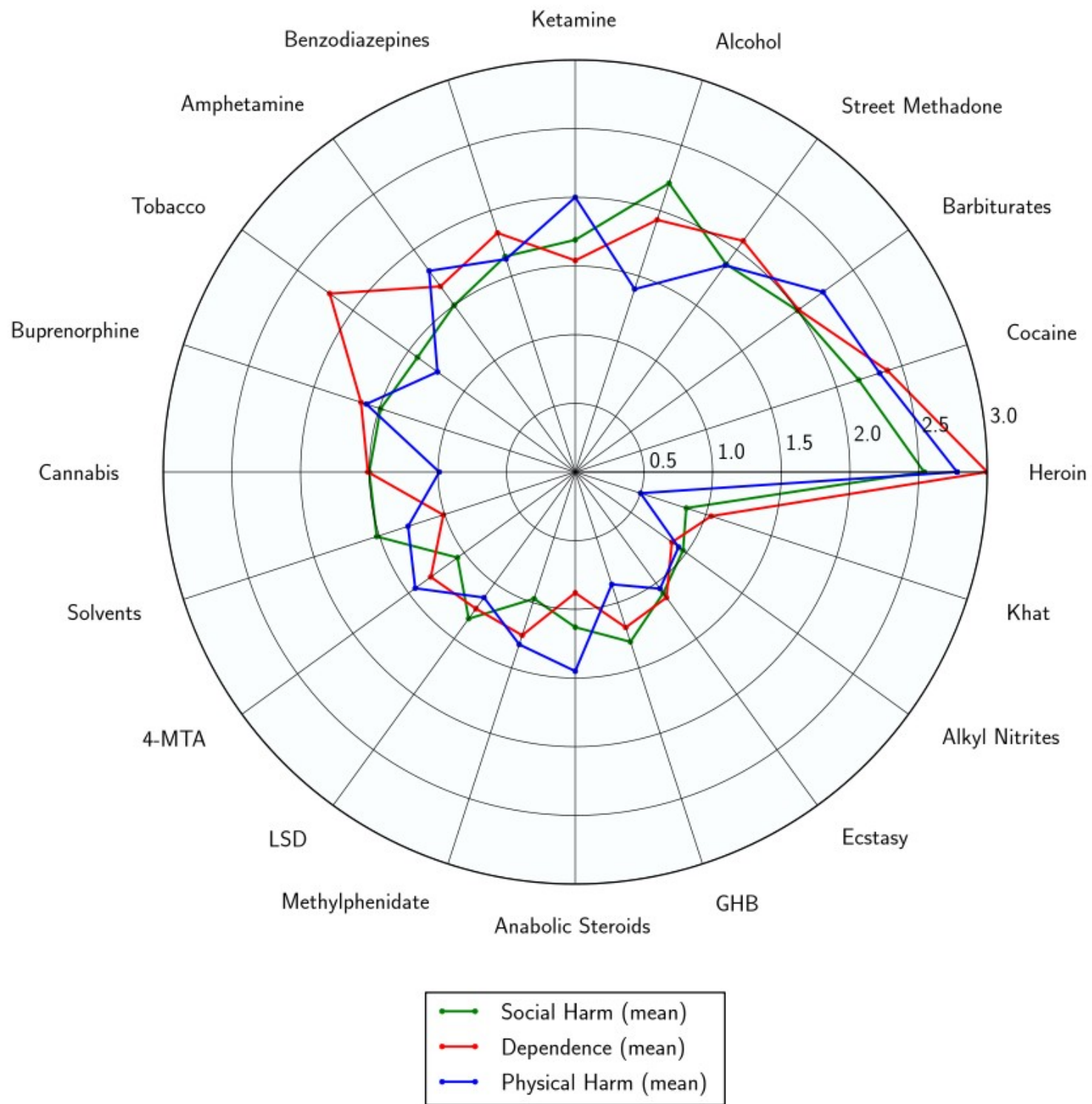
Pie Charts (cont.)

MEDIAN FAMILY INCOME

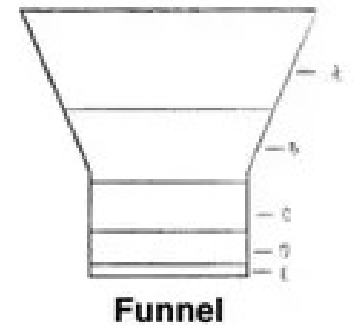
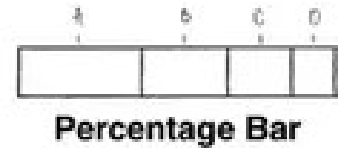
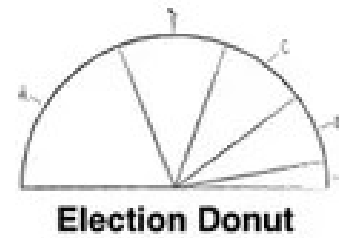
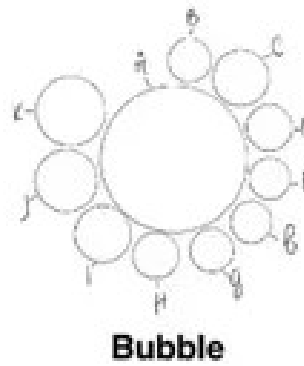
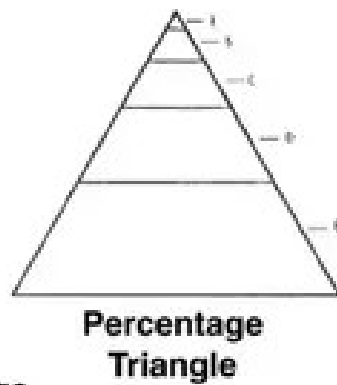
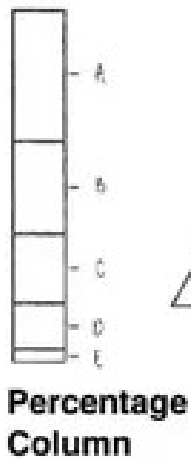
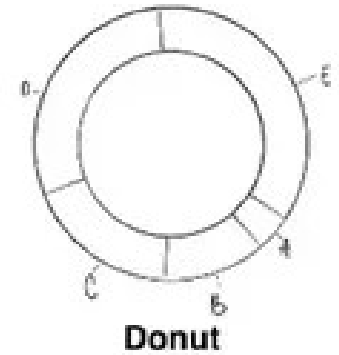
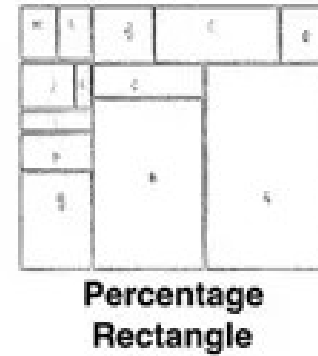
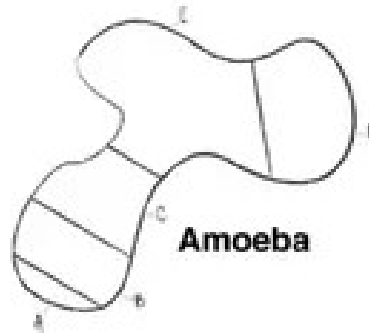
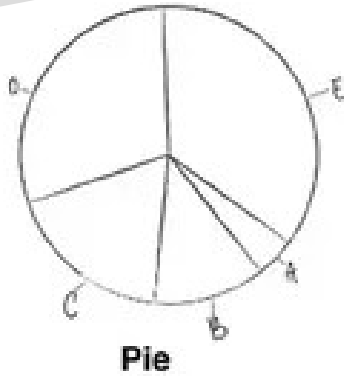
In the 14 most elite ZIP Codes (as of 1960, in today's purchasing power)



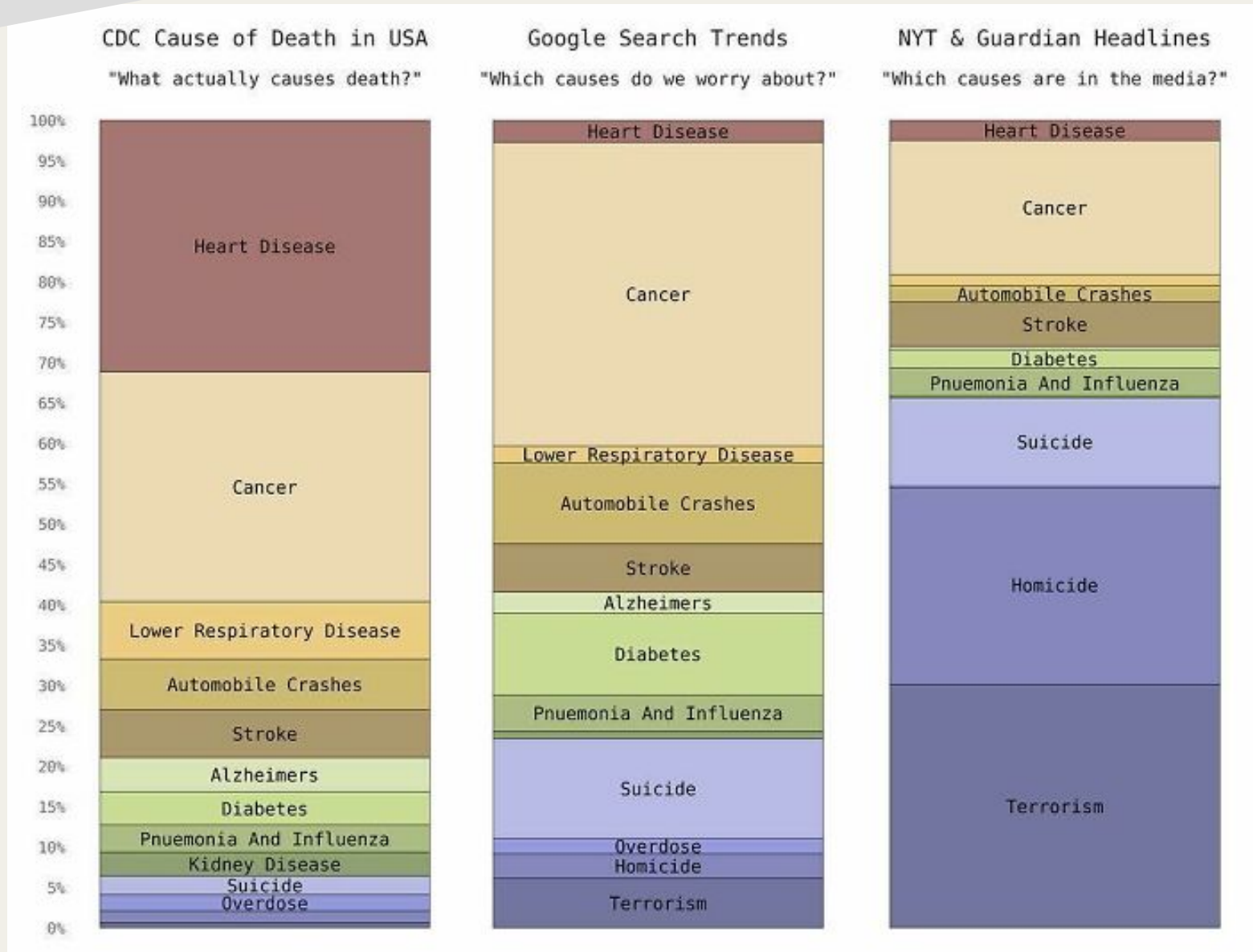
SOURCE: 'COMING APART'



Pie Charts: Some Alternatives



Pie Charts: Some Alternatives (cont.)

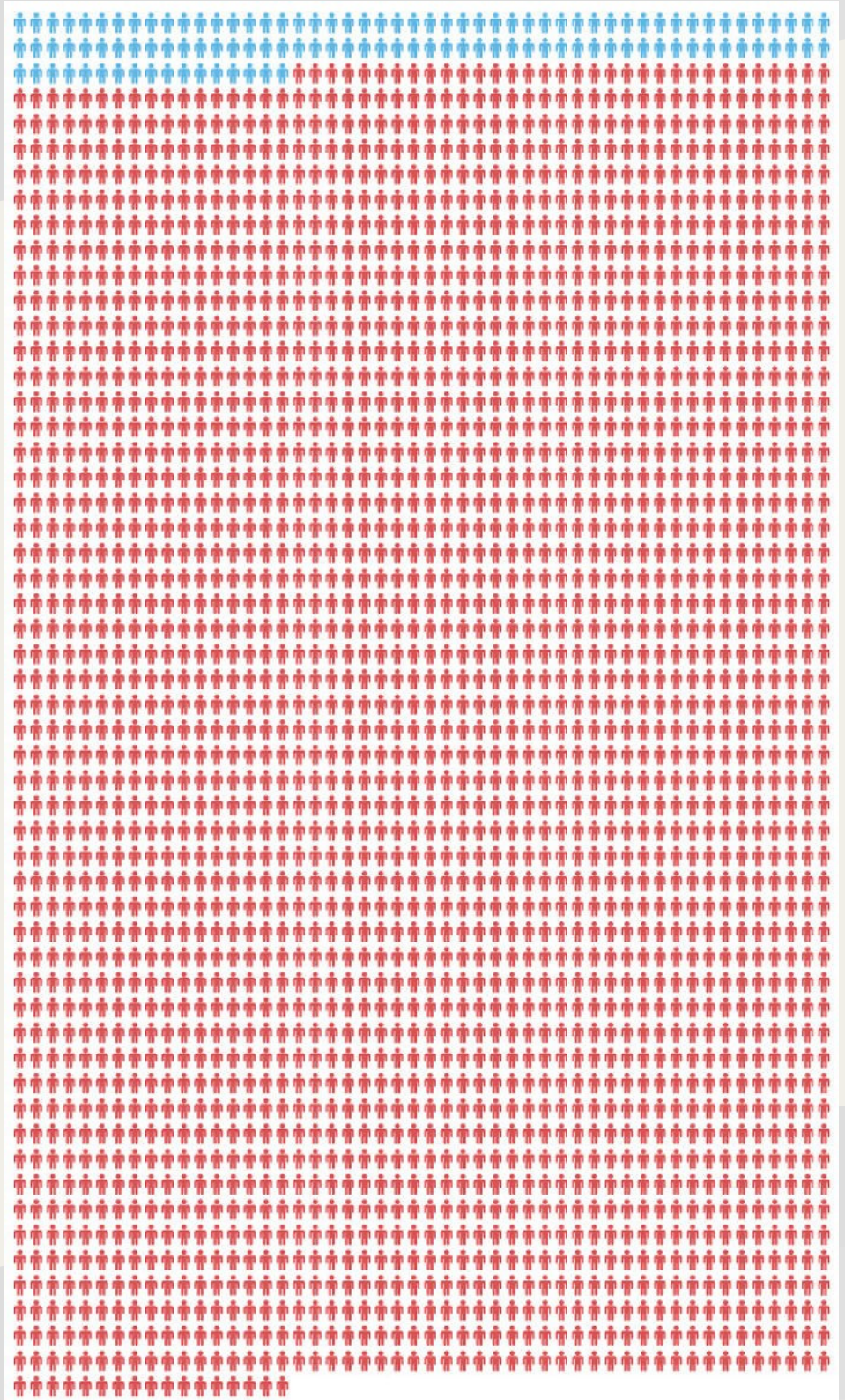


Pie Charts: Some Alternatives

People killed in terrorist
attacks 2015 – 2020

☺ Europe

☹ Africa

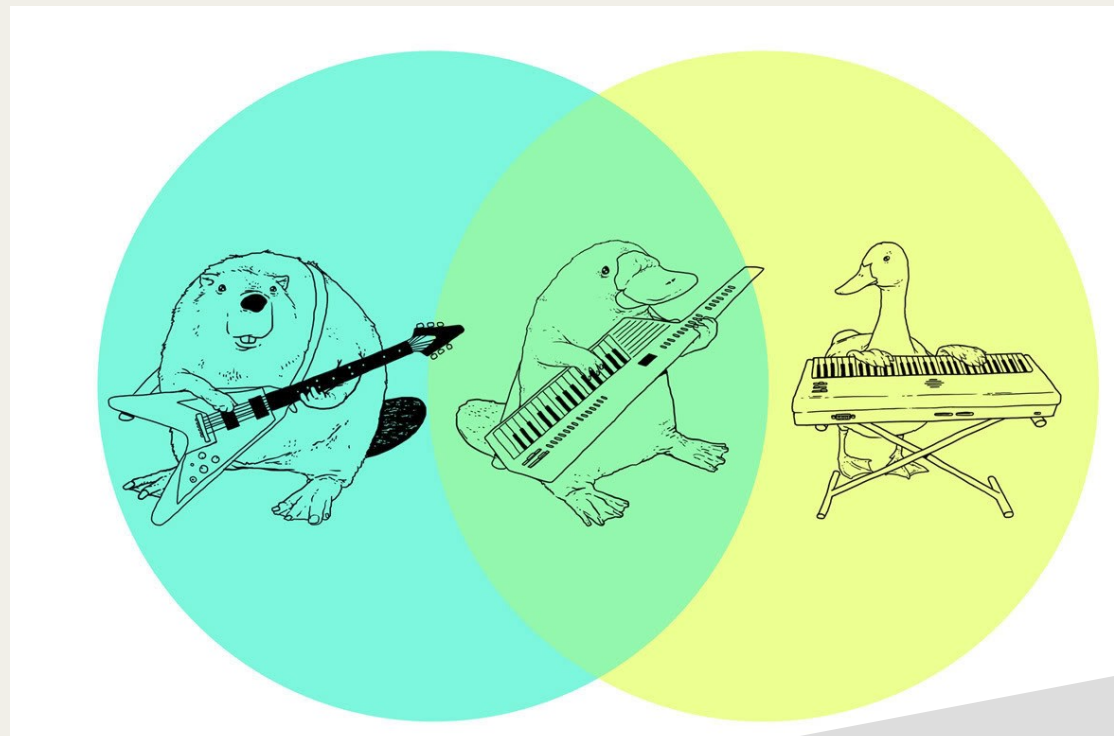


Elements of Good Data Visualization

- Self sufficiency
- Efficient information transfer
- Data-to-ink ratio
- Follow conventions & readers' expectations

Self Sufficiency

- Can the figure be understood on its own
 - E.g., can the figure be understood divorced from the numbers or data?

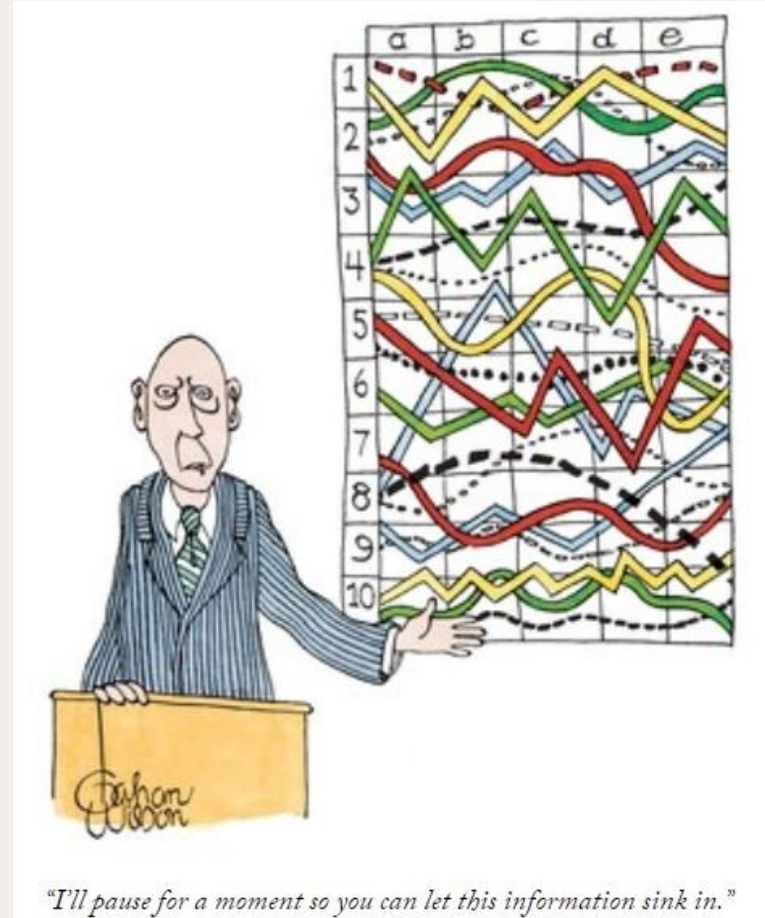


Elements of Good Data Visualization

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Efficient information transfer

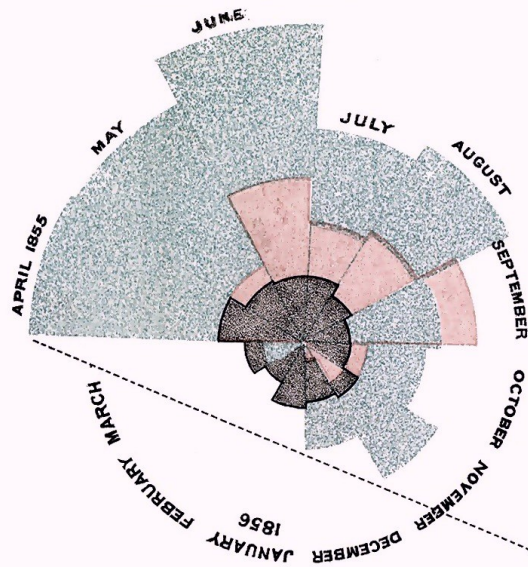
- How much information is conveyed
- How quickly & easily is it to understand
- N.b., many argue to convey a few, important pieces of information in a given figure



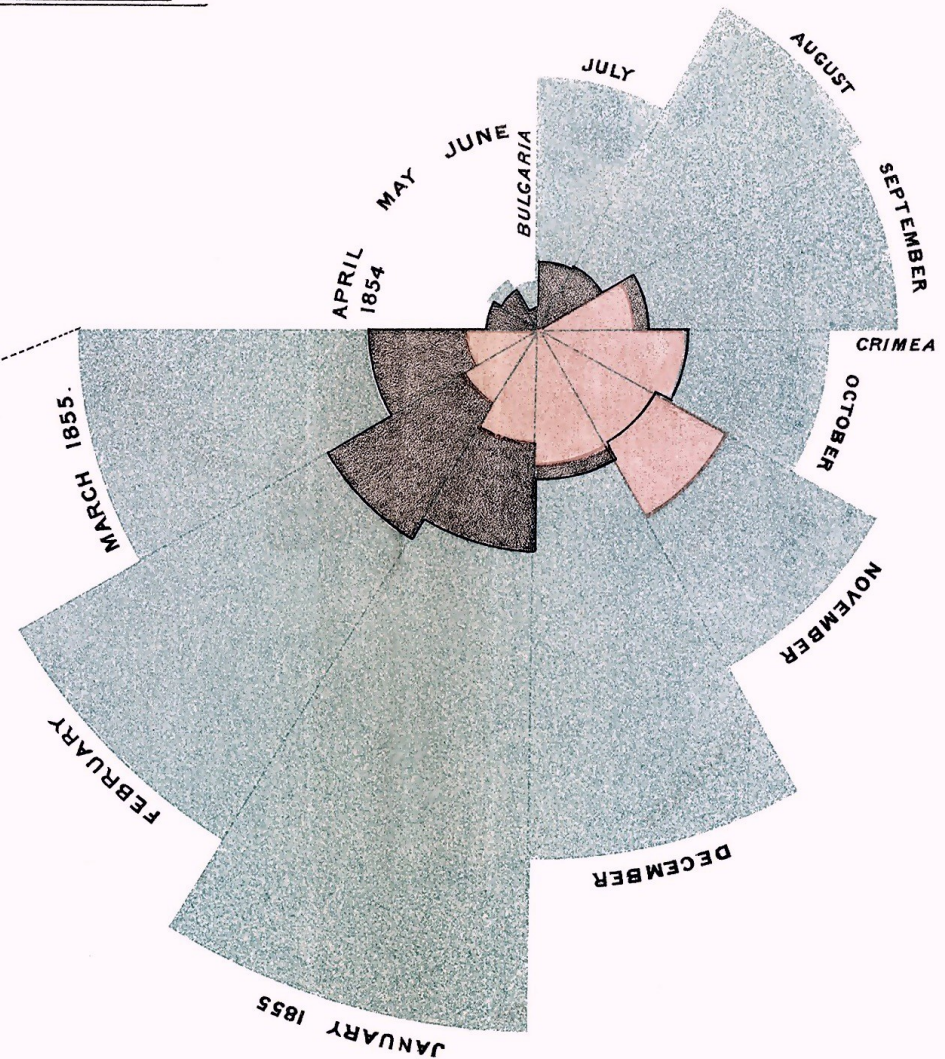
Efficient information transfer (cont.)

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

2.
APRIL 1855 TO MARCH 1856.



1.
APRIL 1854 TO MARCH 1855.

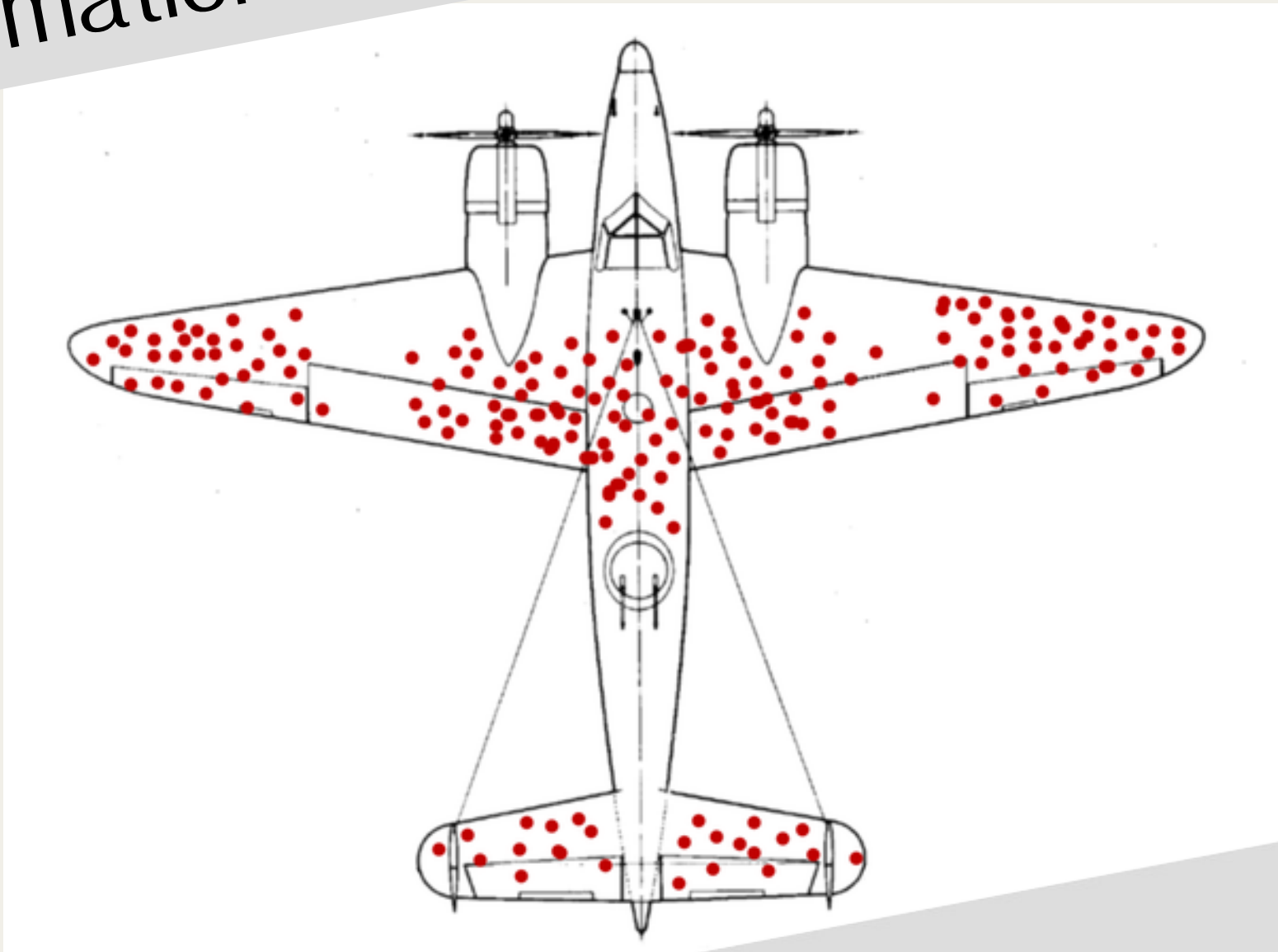


The Areas of the blue, red, & black wedges are each measured from the centre as the common vertex.
The blue wedges measured from the centre of the circle represent area for area the deaths from Preventable or Mitigable Zymotic diseases; the red wedges measured from the centre the deaths from wounds;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

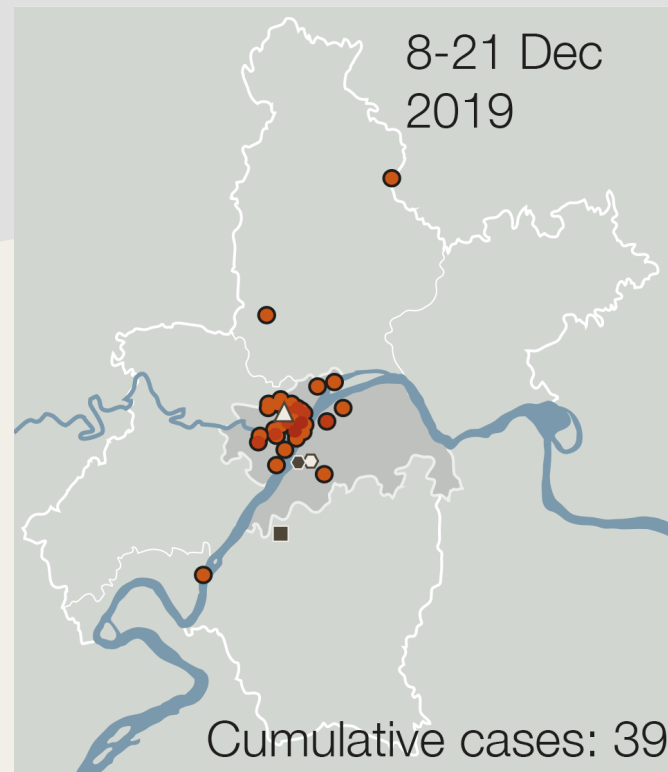


Snow, John (1849). *On the Mode of Communication of Cholera*. London: John Churchill.

Efficient information transfer (cont.)

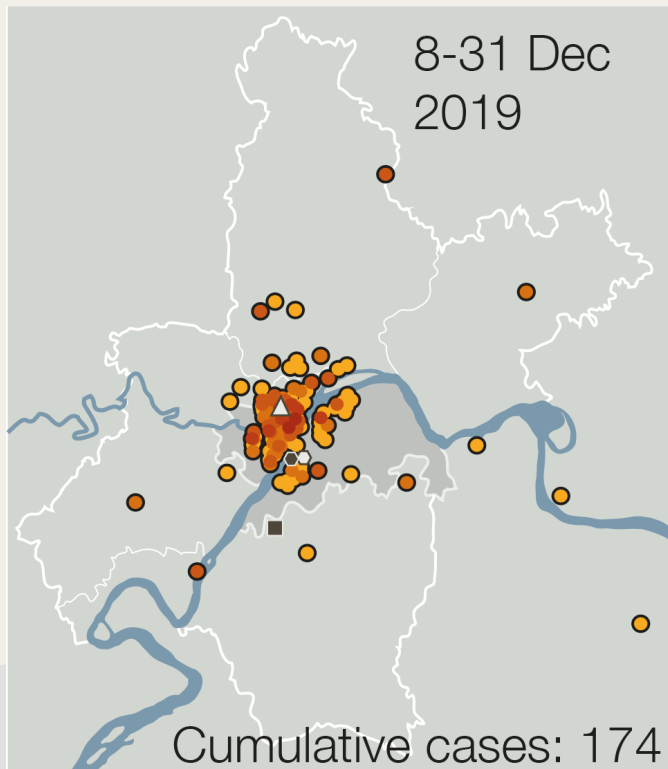
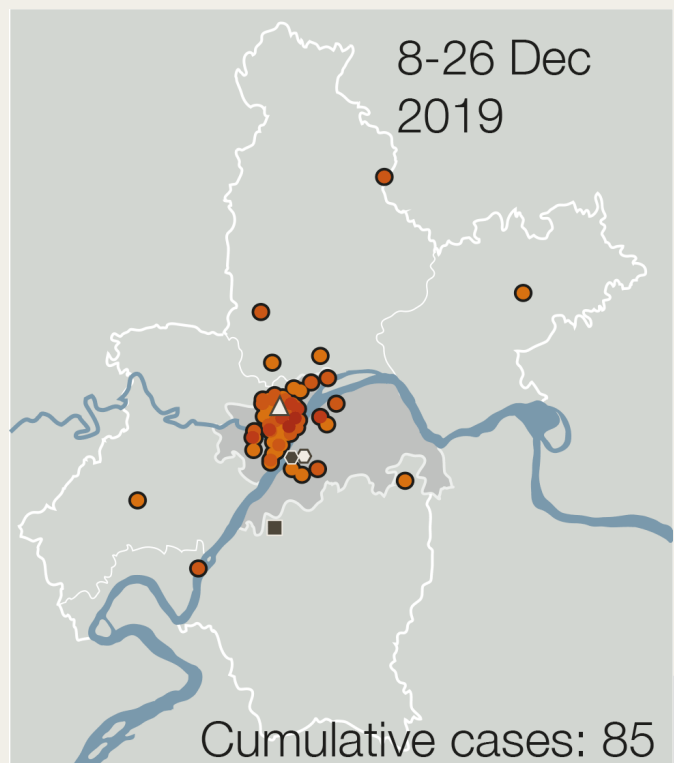


(Hypothetical) schematic of evidence presented to Abraham Wald & the rest of the Statistical Research Group, WWII



Huanan Market: A “wet” market where wild animals were illegally sold.

WIV: Wuhan Institute of Virology

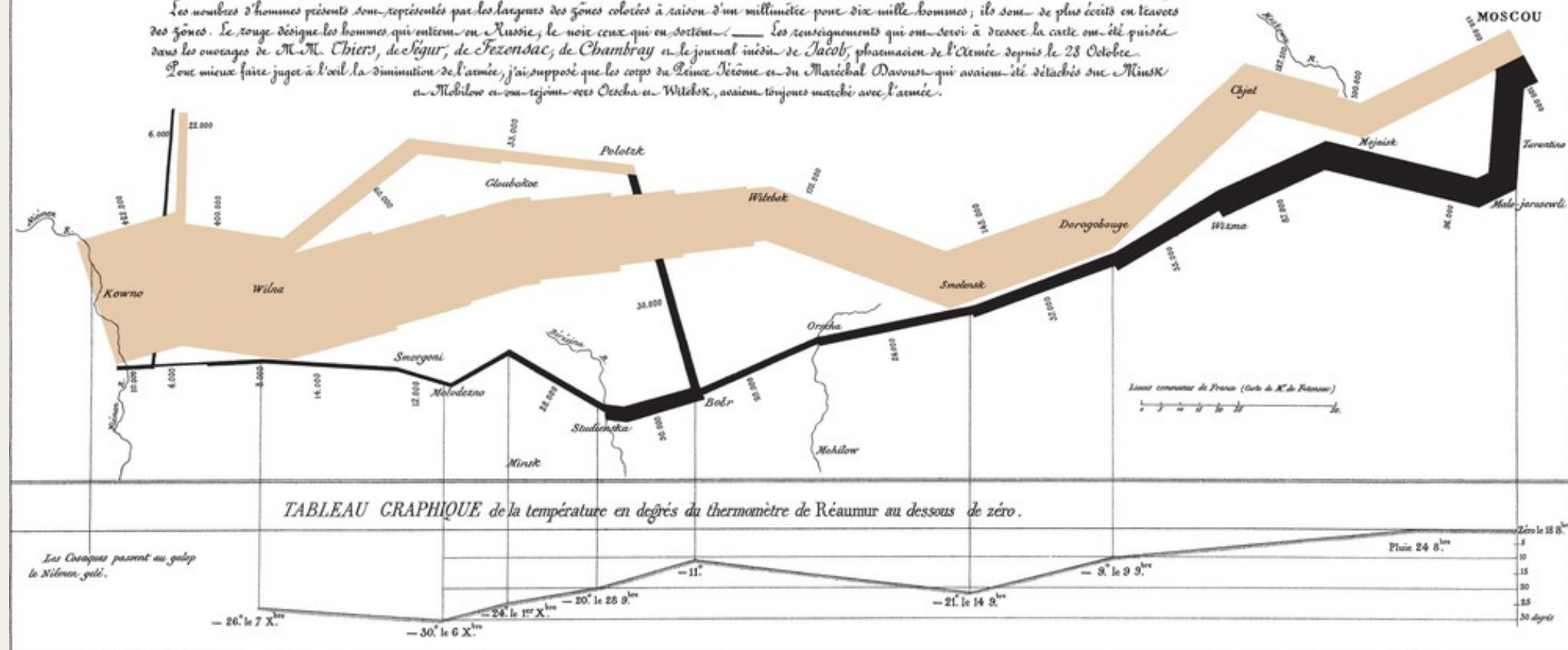


Cited in a Goats & Soda article from: Holmes, E. C et al. (2021, July 7). The Origins of SARS-CoV-2: A Critical Review (Version 1.0.2). *Zenodo*. <http://doi.org/10.5281/zenodo.5112546>

Efficient information transfer (cont.)

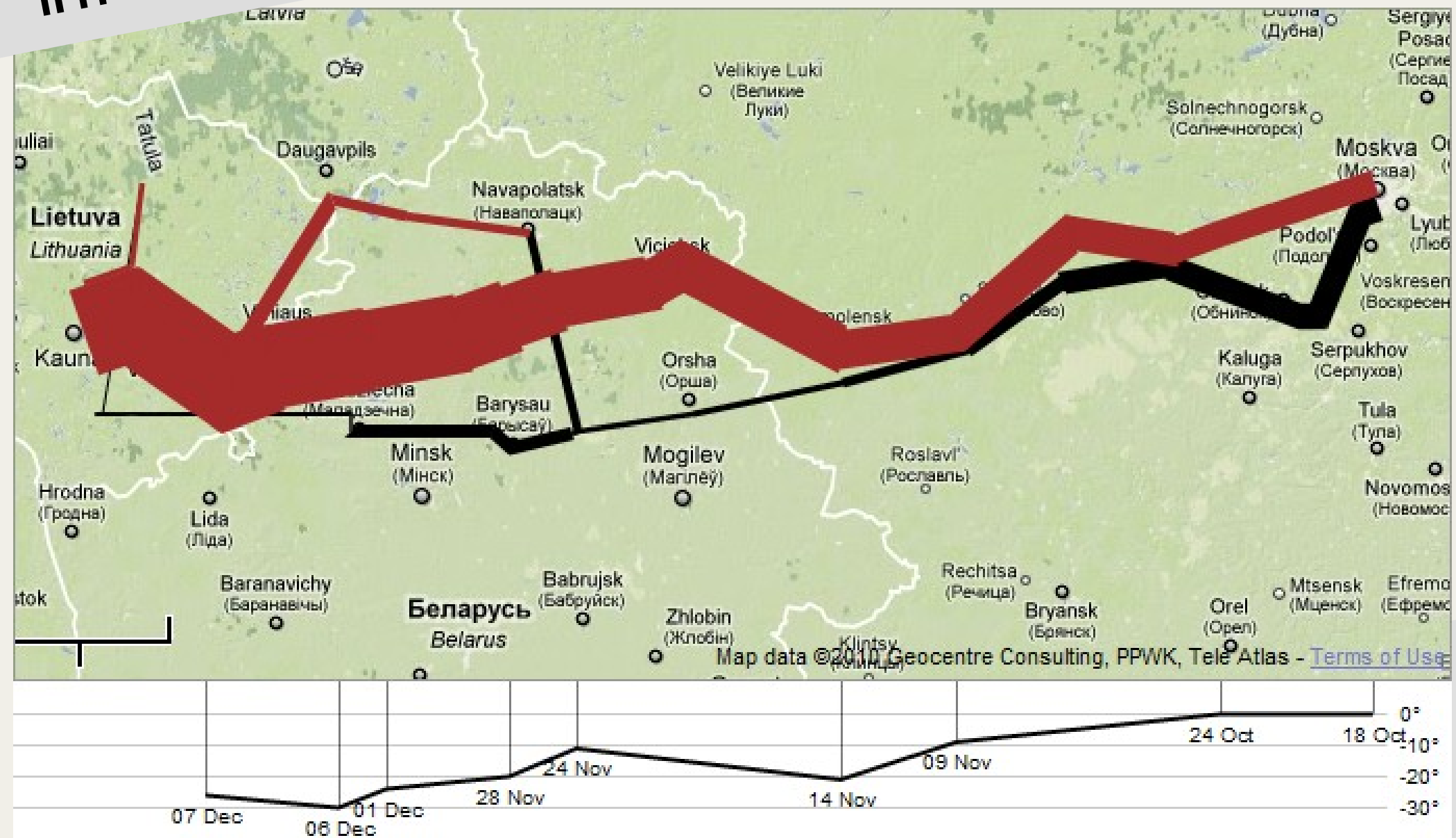
Carte Figurative des pertes successives en hommes de l'Armée Française dans la campagne de Russie 1812-1813.
Dressée par M. Minard, Inspecteur Général des Ponts et Chaussées en retraite. Paris, le 20 Novembre 1869.

Les nombres d'hommes présents sont représentés par les largeurs des zones colorées à raison d'un millimètre pour dix mille hommes; ils sont de plus écrits en travers des zones. Le rouge désigne les hommes qui entrent en Russie; le noir ceux qui en sortent. Les renseignements qui ont servi à dresser la carte ont été puisés dans les ouvrages de M. Thiers, de Ségur, de Fezensac, de Chambray et le journal inédit de Jacob, pharmacien de l'Armée depuis le 28 Octobre. Pour mieux faire juger à l'œil la diminution de l'armée, j'ai supposé que les corps du Prince Jérôme et du Maréchal Davoust qui avaient été détachés sur Minsk et Mohilow et qui rejoignent Oescha et Witebsk, avaient toujours marché avec l'armée.



Charles Joseph Minard

Efficient information transfer (cont.)



Efficient information transfer (cont.)

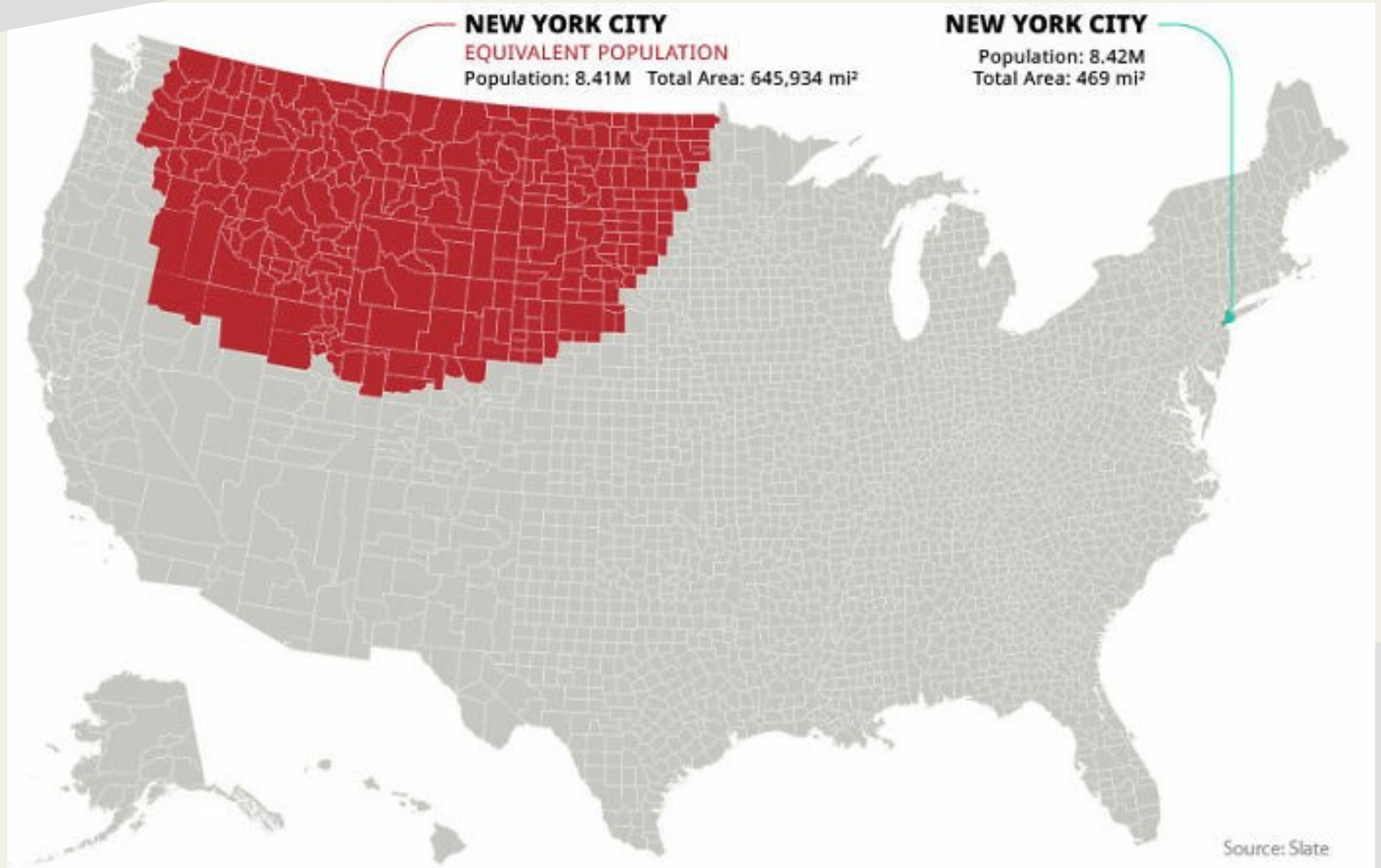
POPULATION OF THE UNITED STATES



● 50% LIVE HERE ● 50% LIVE HERE

M

Efficient information transfer (cont.)



Average of annual gun deaths per 100,000 people in each region from 2010-2020 *Nationwide rate: 11.4 gun deaths per 100,000 people*

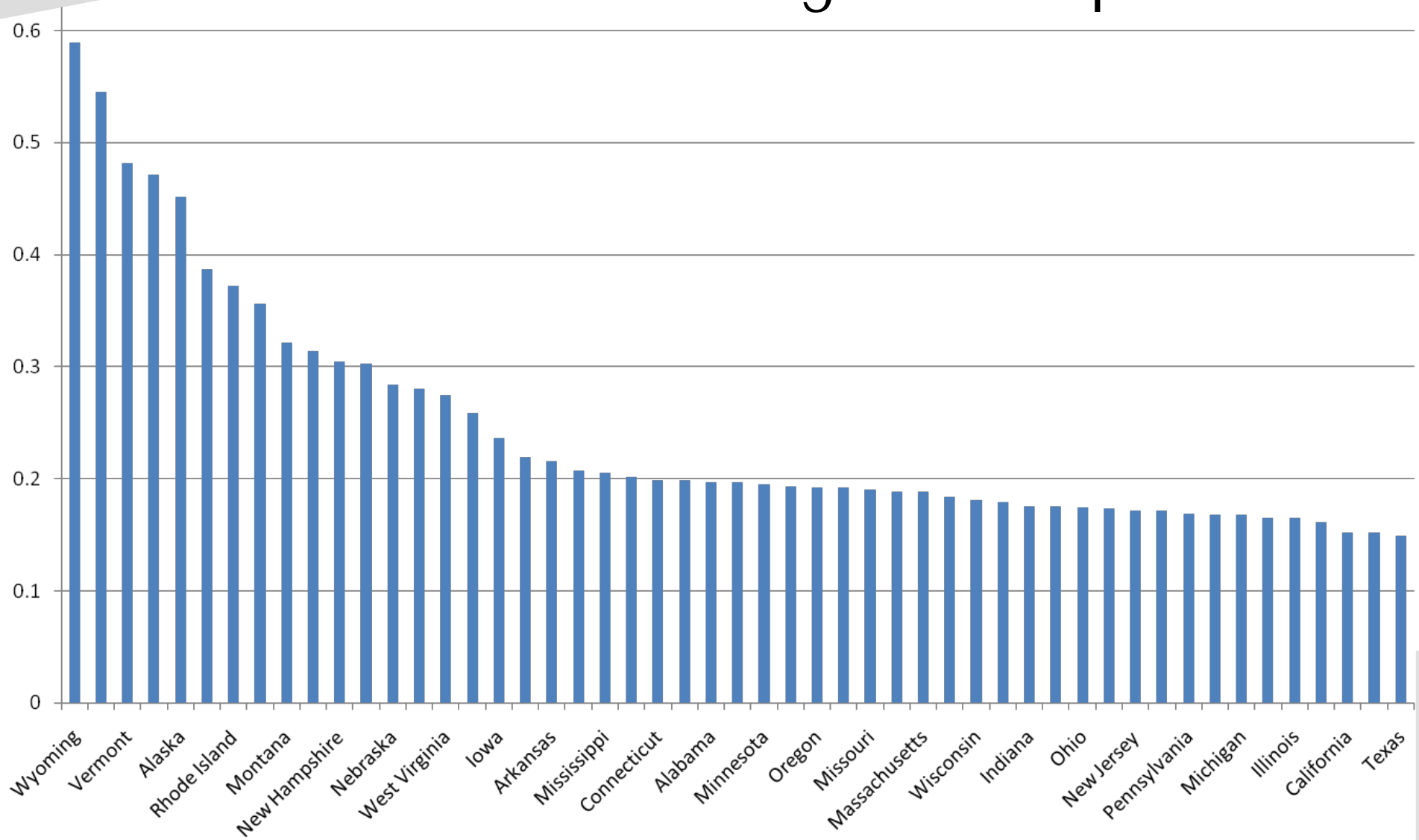


Notes: First Nation, Greater Polynesia, New France and Spanish Caribbean are not included among major regions. Rates are smoothed across counties due to CDC data suppression.

Source: Nationhood Lab at Salve Regina University
Grant Schwab/POLITICO

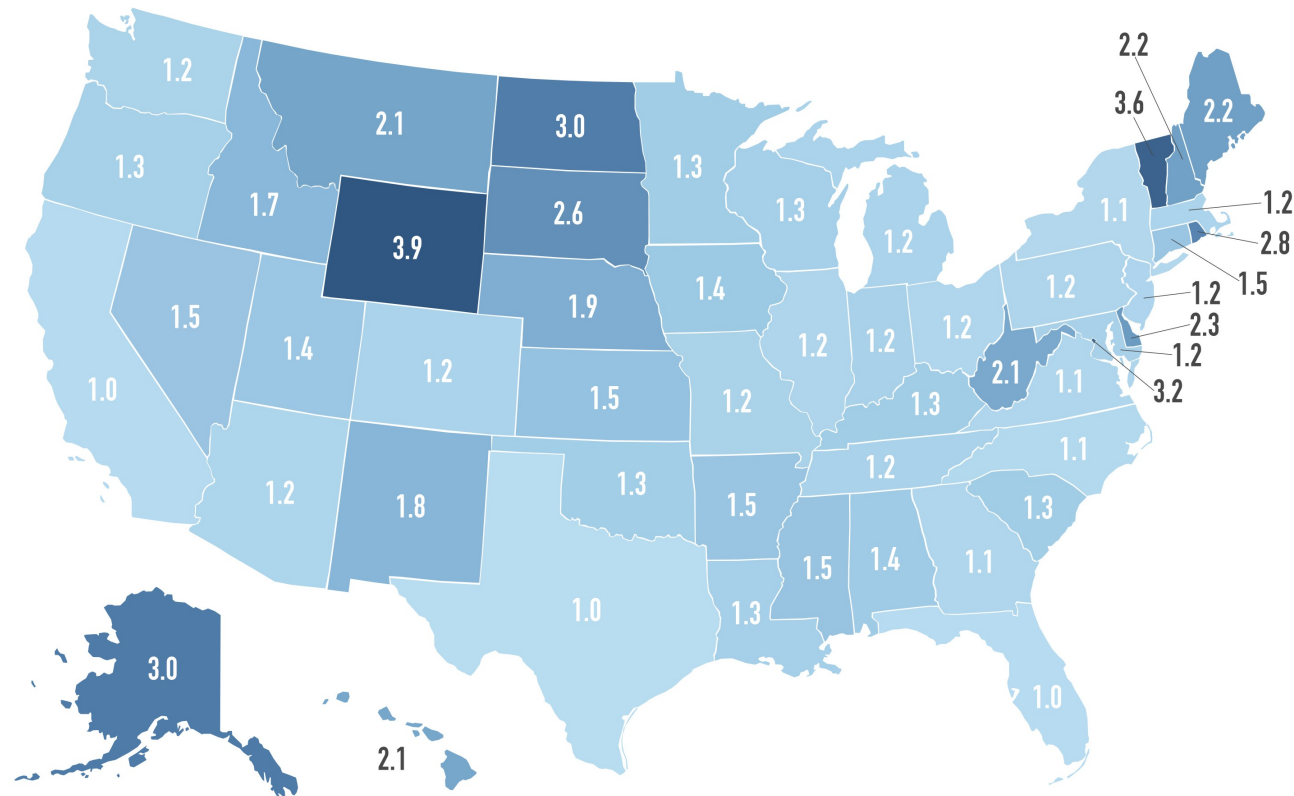
Efficient information transfer (cont.)

Electoral College Votes per Person



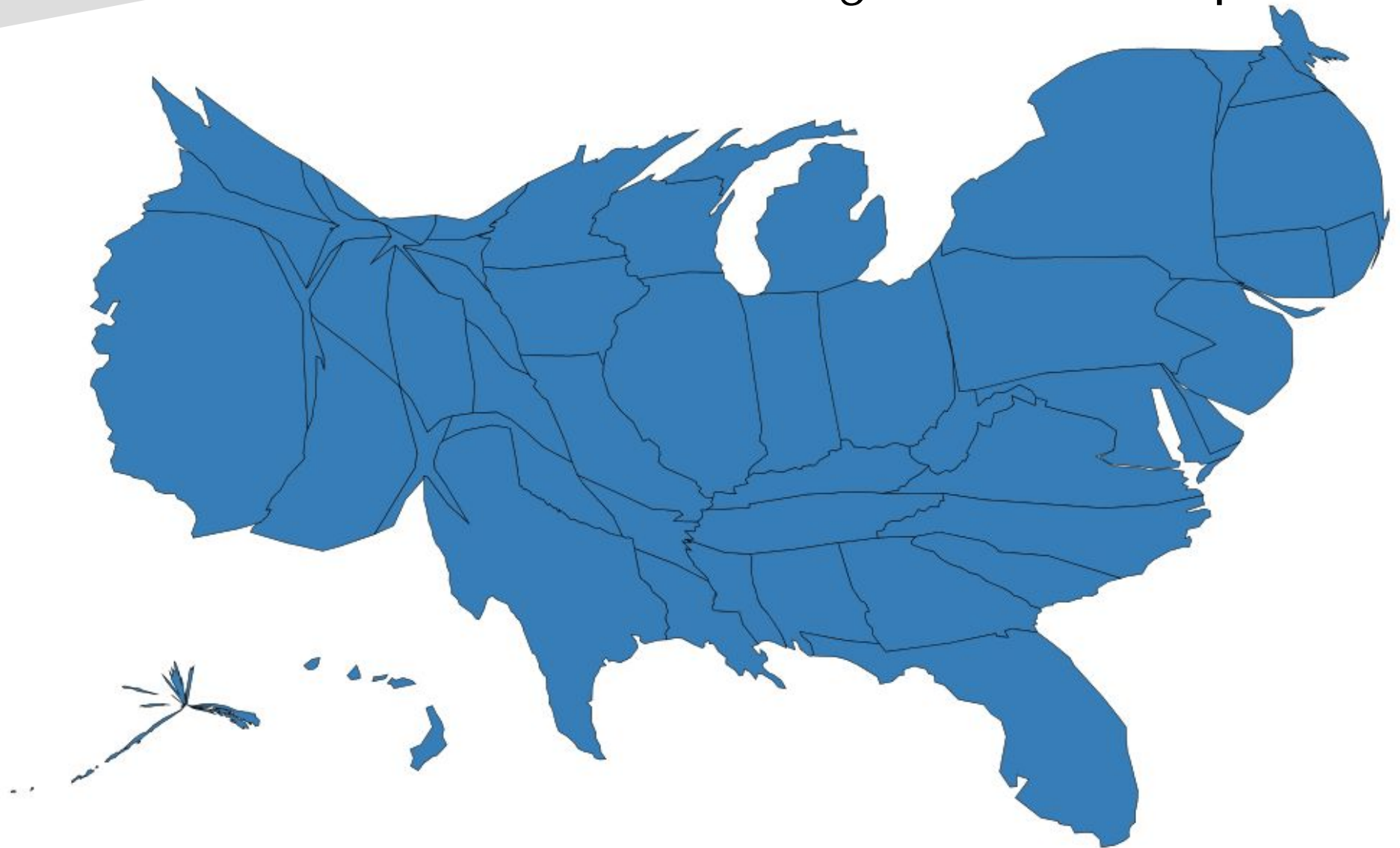
Efficient information transfer (cont.)

Votes per Person in US Electoral College System



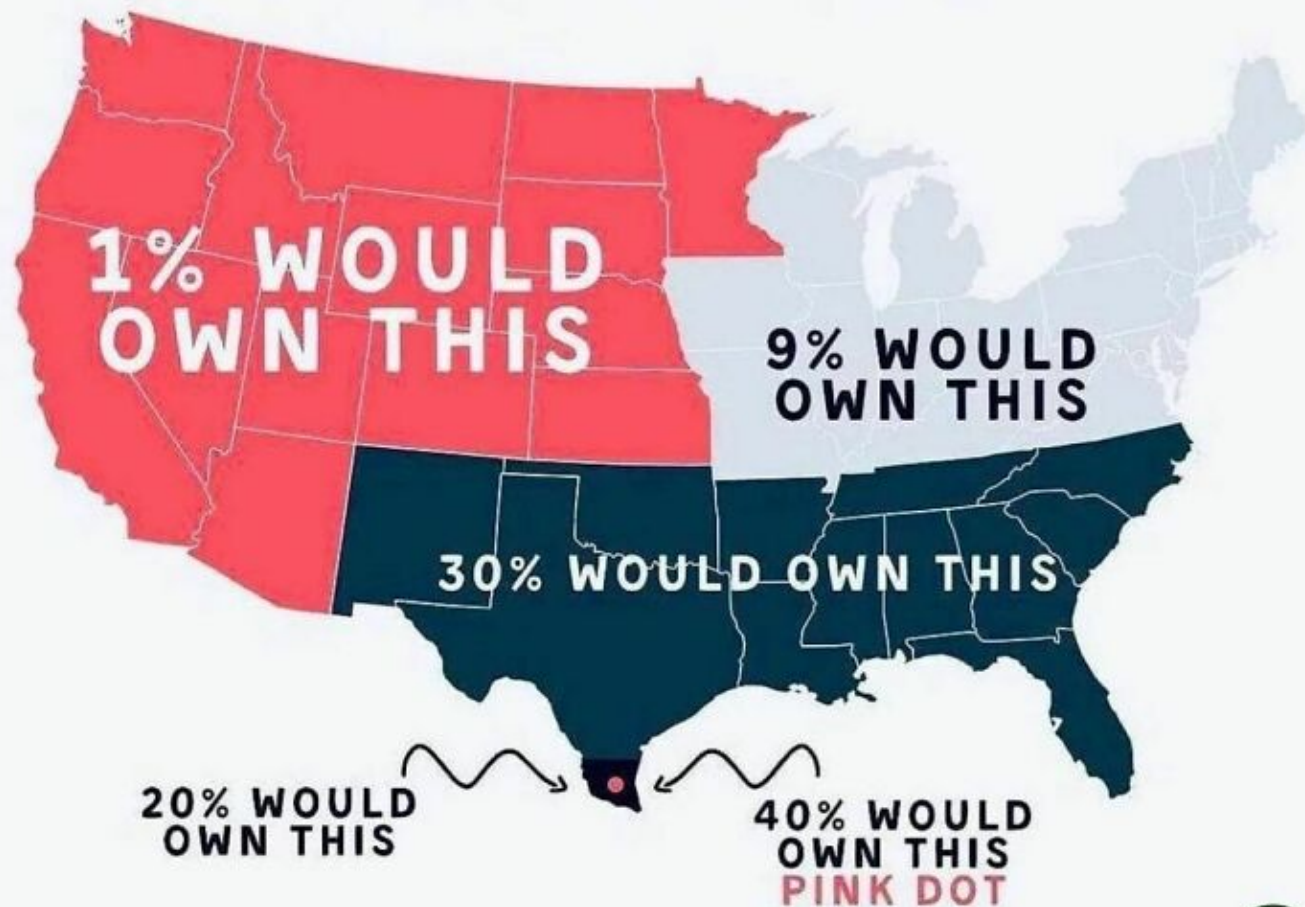
Efficient information transfer (cont.)

Number of College Graduates per State

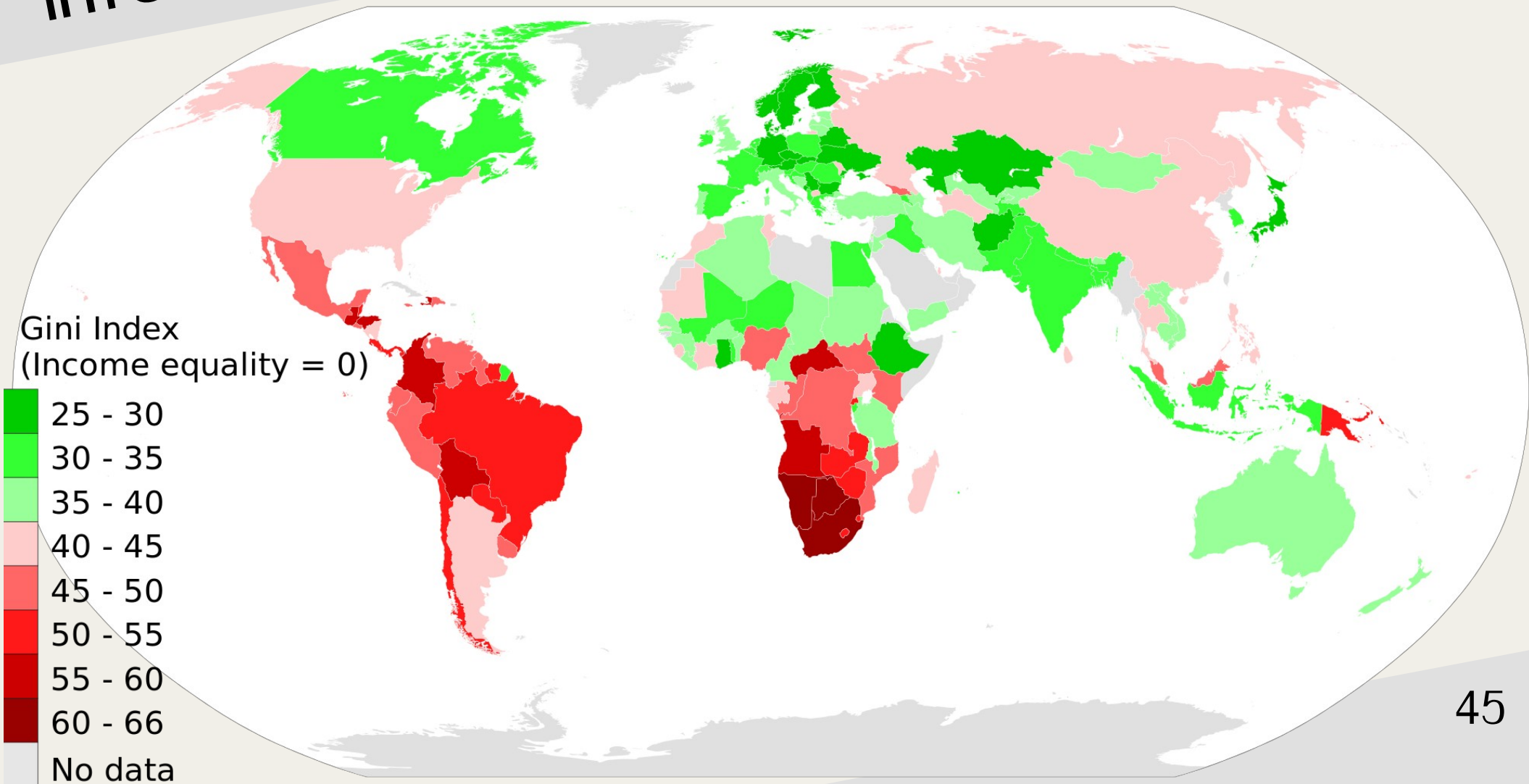


■ = 4,000 Graduates

If The United States Was Divided Like US Wealth



Efficient information transfer (cont.)



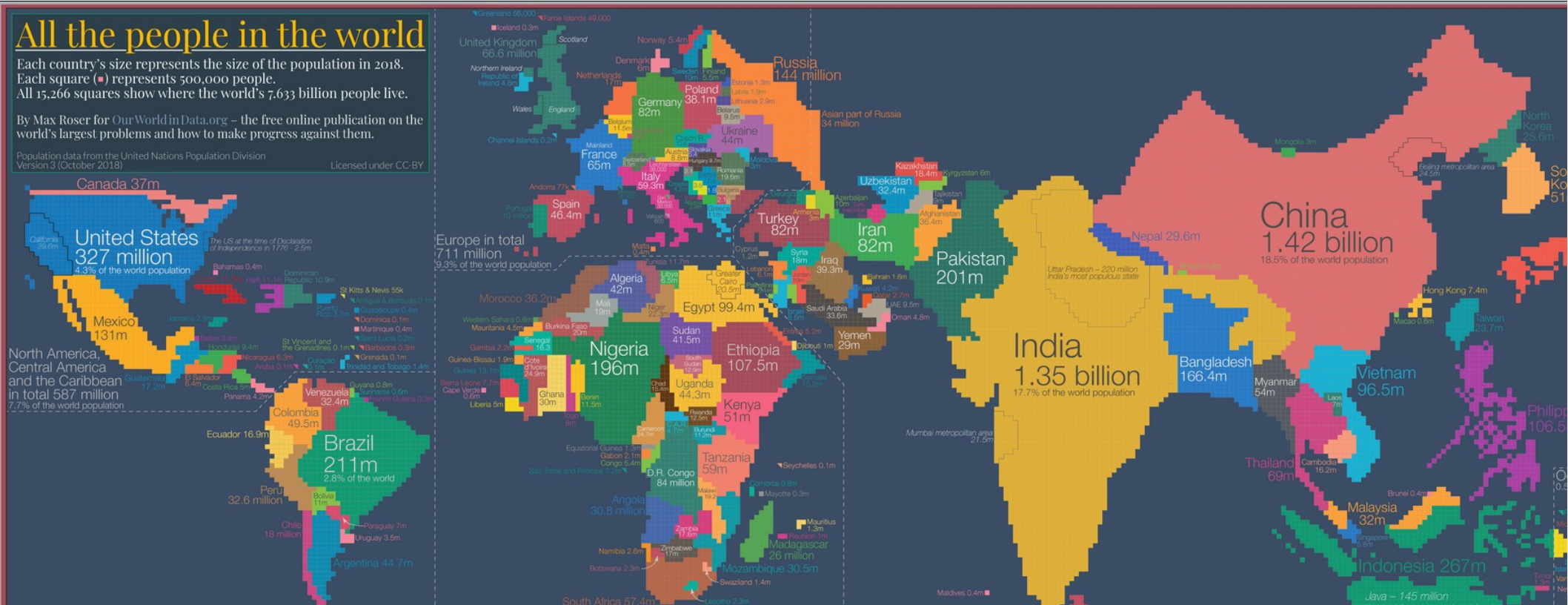
2014 values, source the World Bank

Efficient information transfer (cont.)

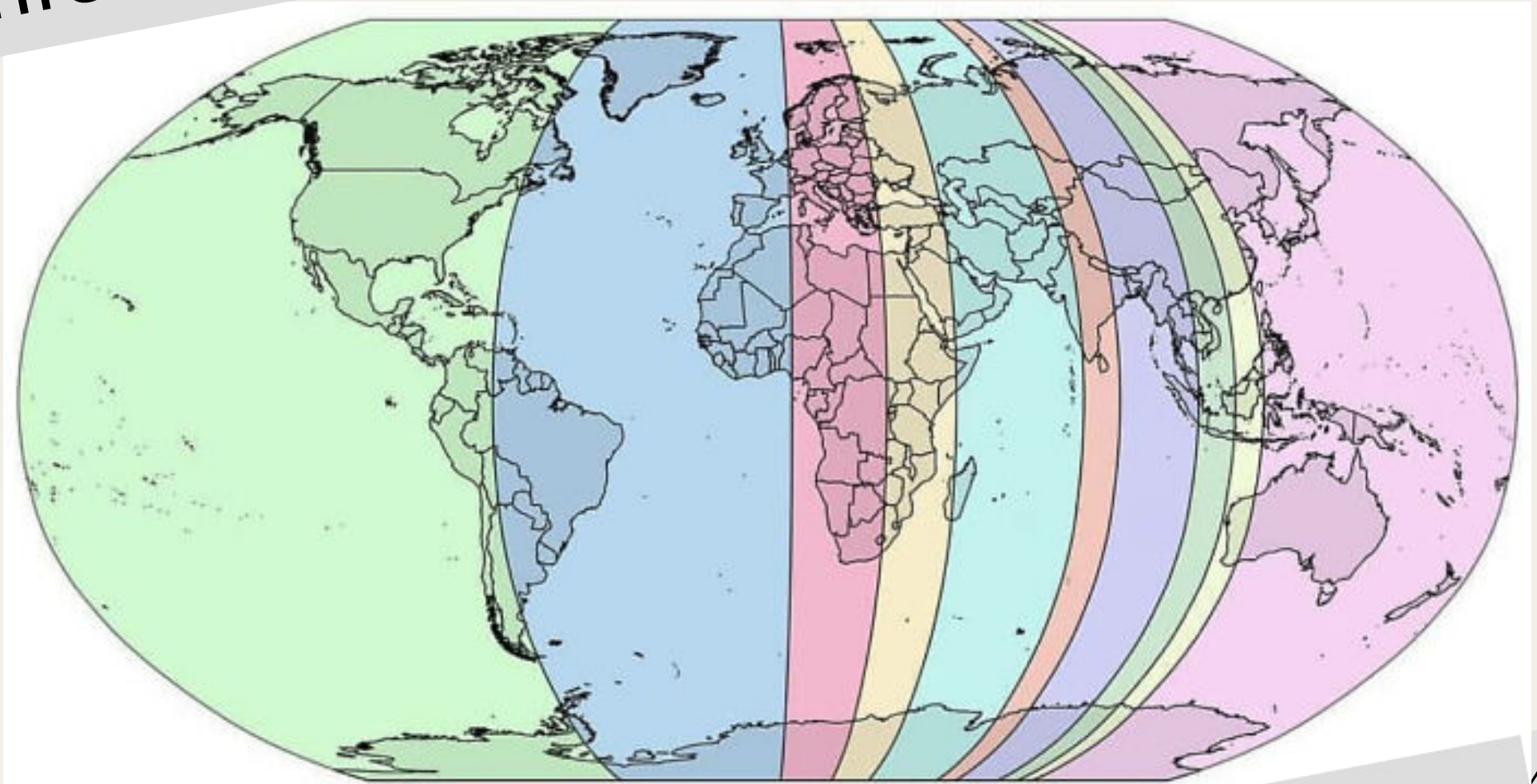
All the people in the world

Each country's size represents the size of the population in 2018.
Each square (■) represents 500,000 people.
All 15,266 squares show where the world's 7.633 billion people live.

By Max Roser for OurWorldinData.org – the free online publication on the world's largest problems and how to make progress against them.



Efficient information transfer (cont.)



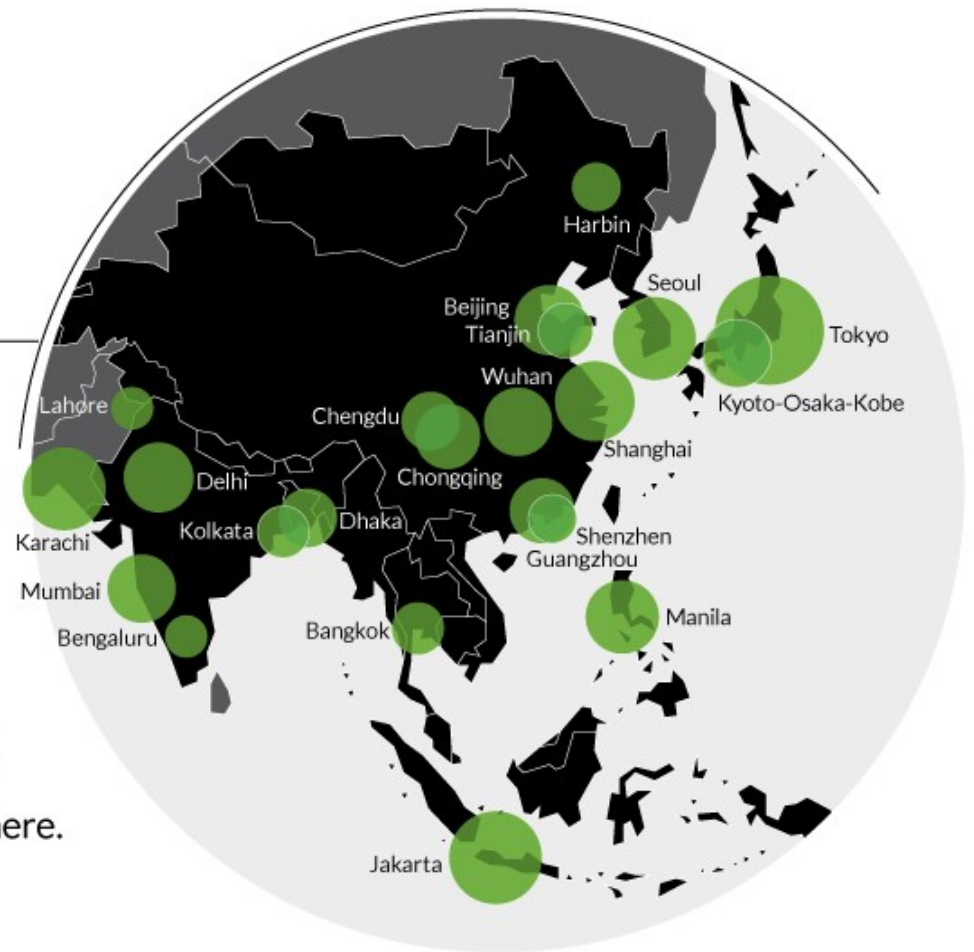
Each section contains 10% of the human population (c. 2020)

Efficient information transfer (cont.)



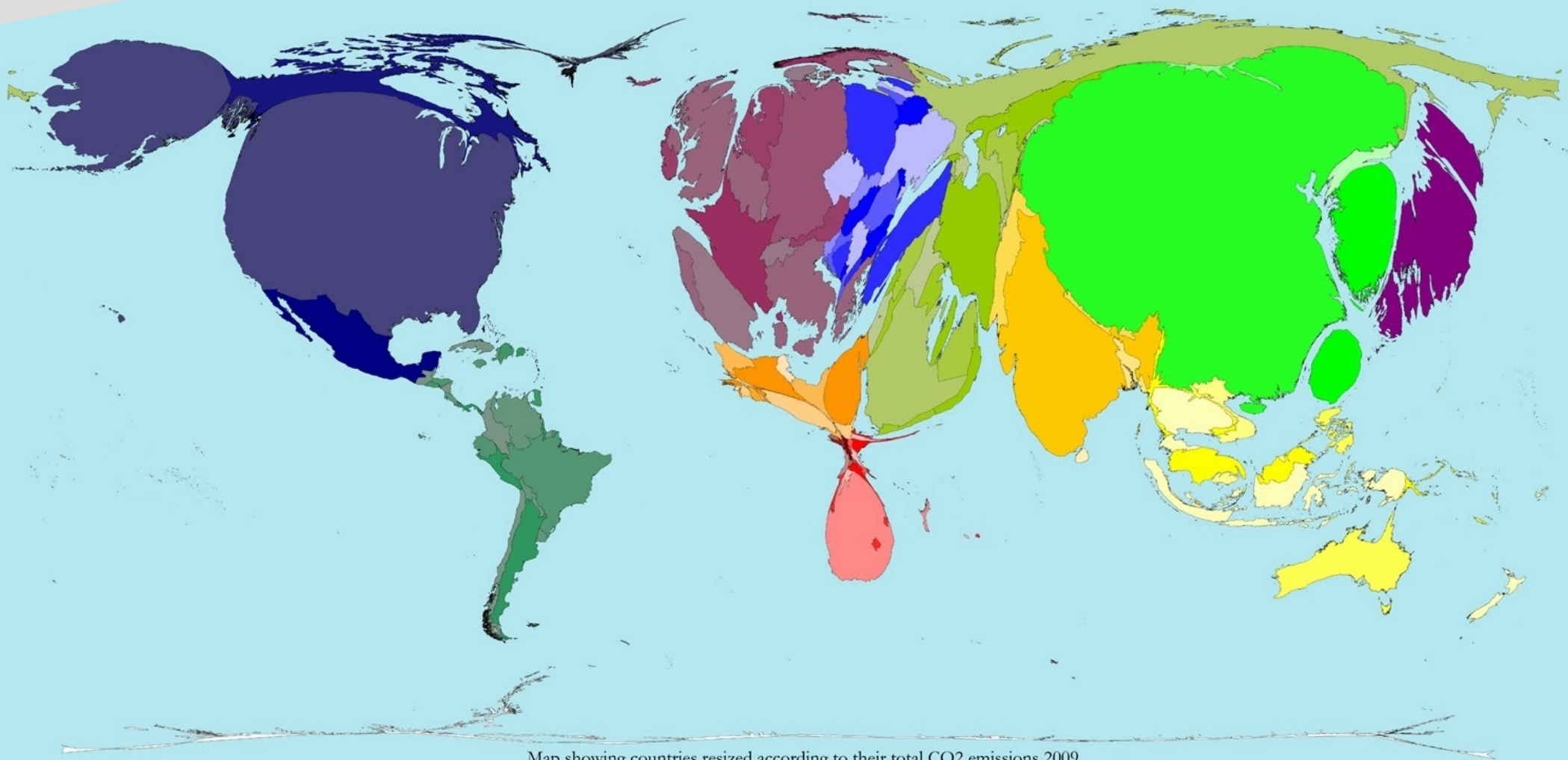
There are more people in
this circle than outside of it.

22 of the world's 37 megacities are located here.



Efficient information transfer (cont.)

Global CO₂ Emissions



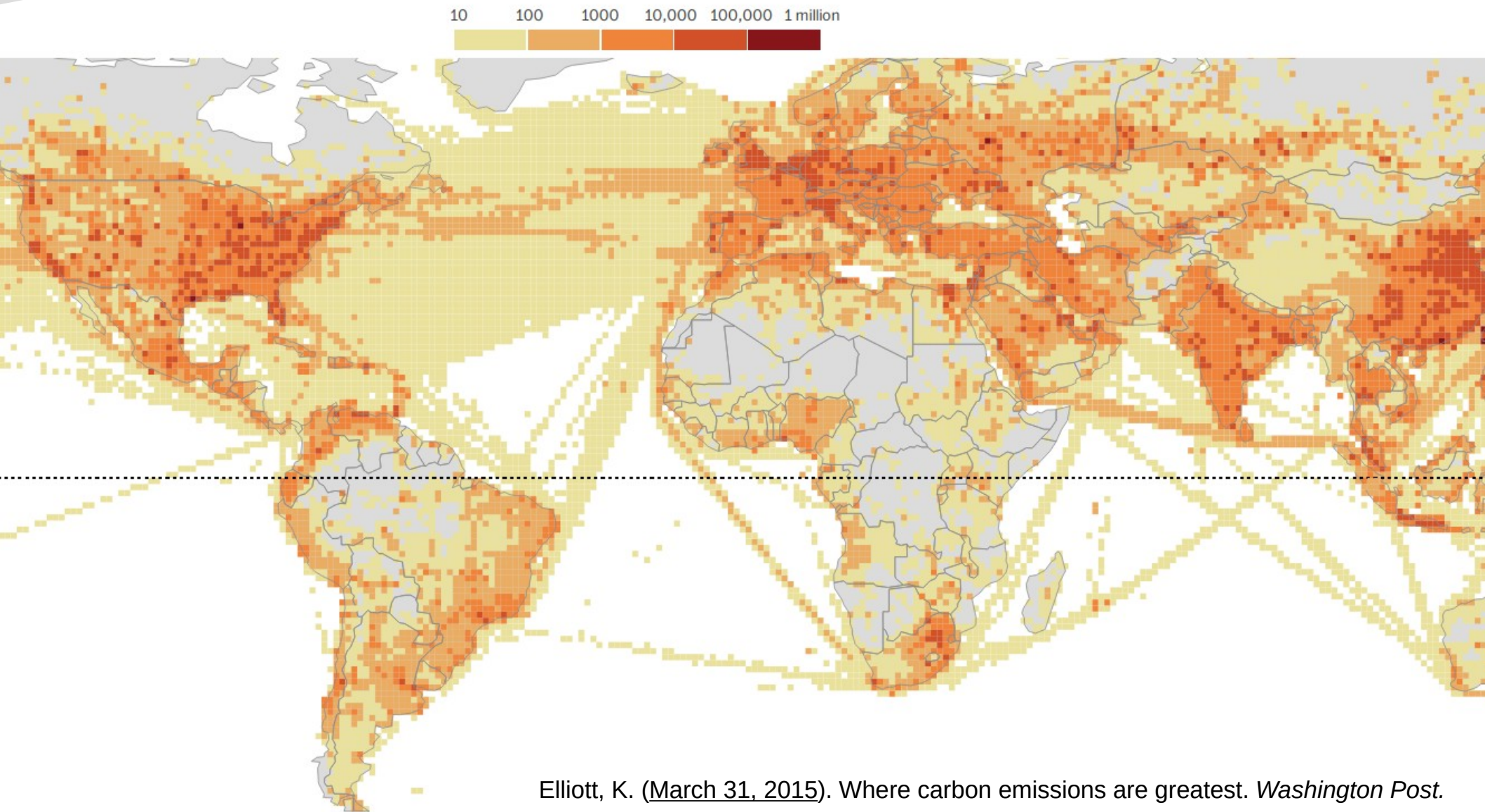
Map showing countries resized according to their total CO₂ emissions 2009

Data Sources: IWR (2009) & UNFCCC (2007)

Map created by Benjamin Hennig, Sasi Research Group, University of Sheffield - www.viewsoftheworld.net

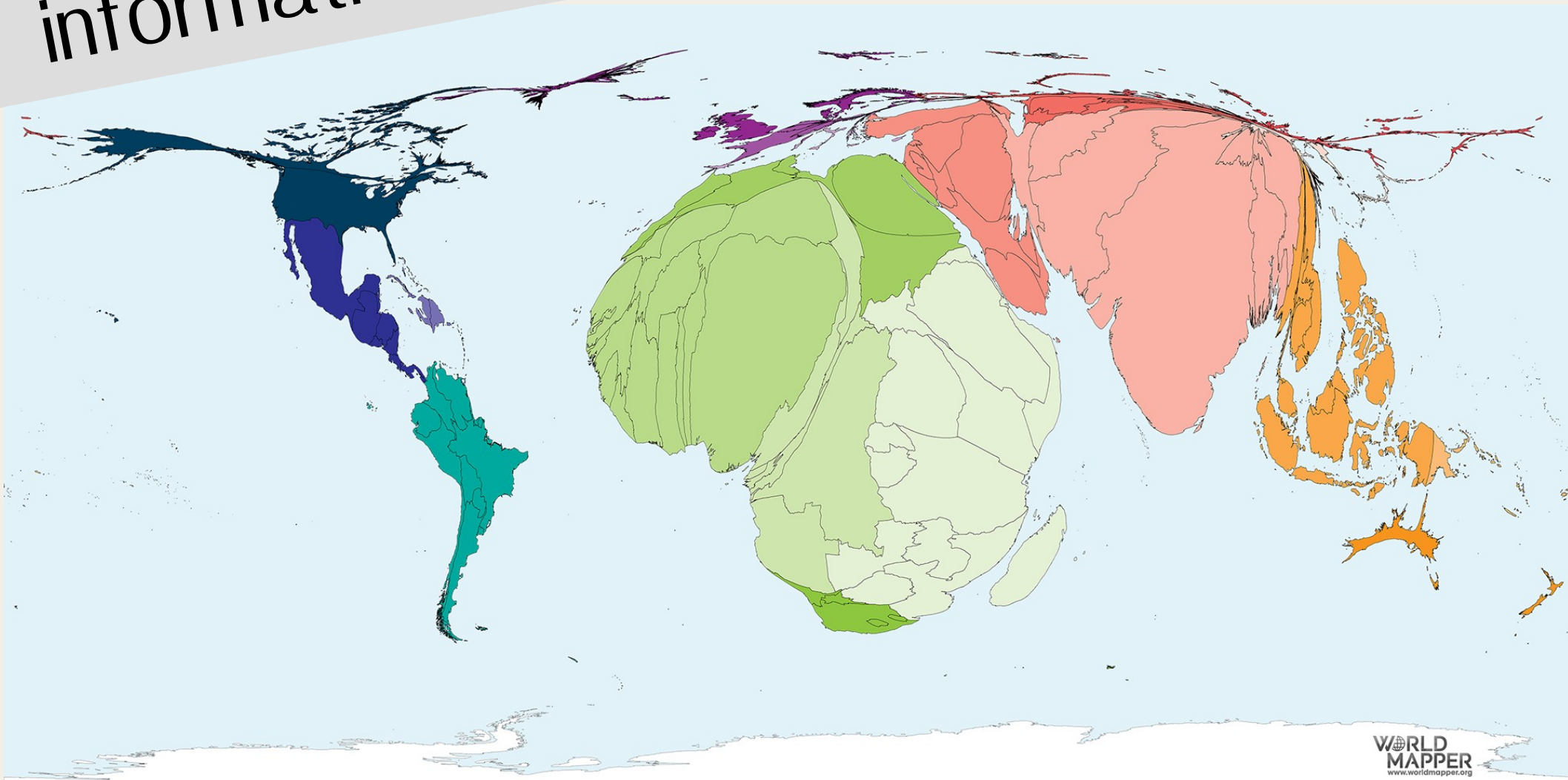
Efficient information transfer (cont.)

Fossil fuel emissions, 2001-2012 mean, grams of carbon dioxide



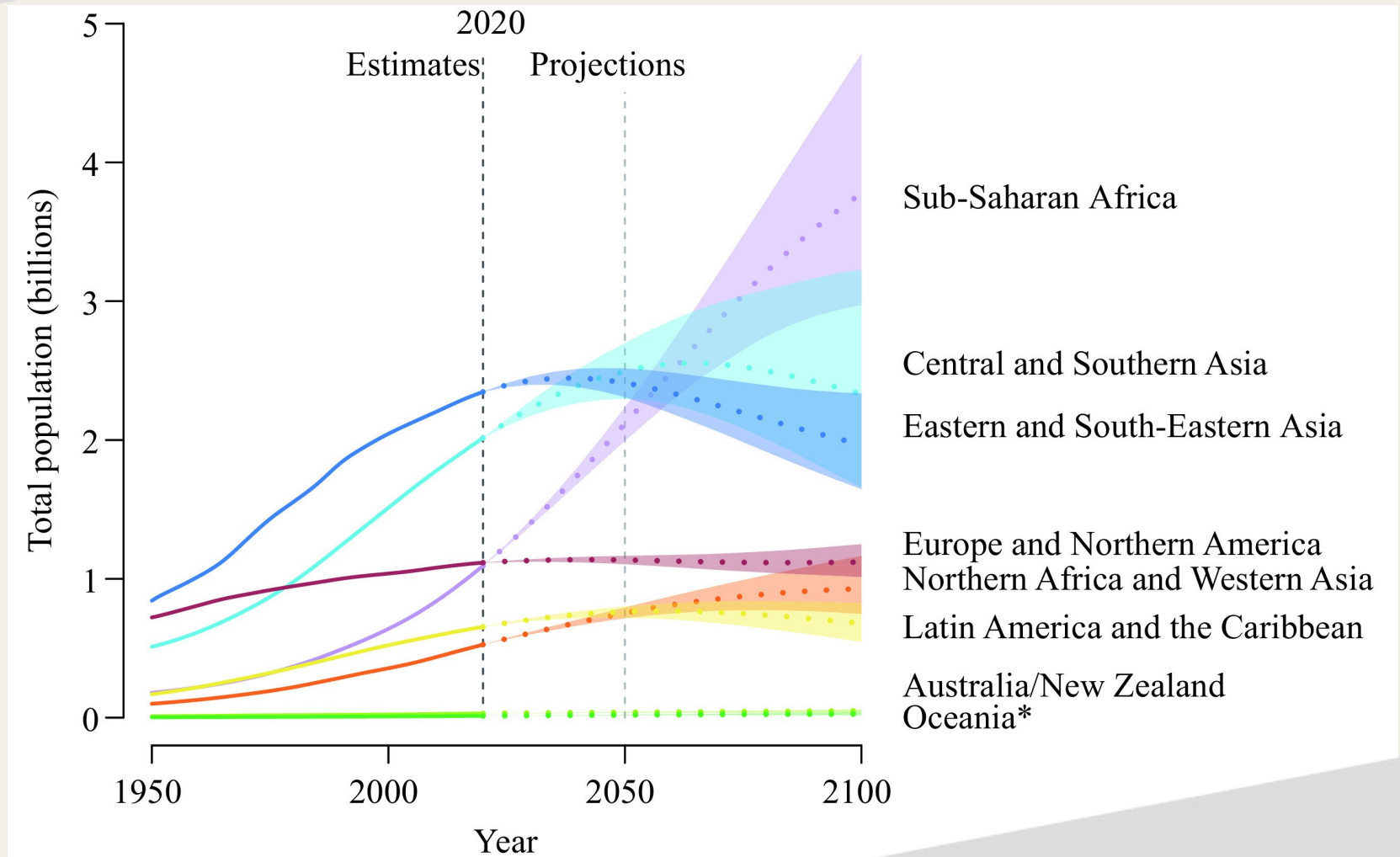
Elliott, K. (March 31, 2015). Where carbon emissions are greatest. *Washington Post*.

Efficient information transfer (cont.)



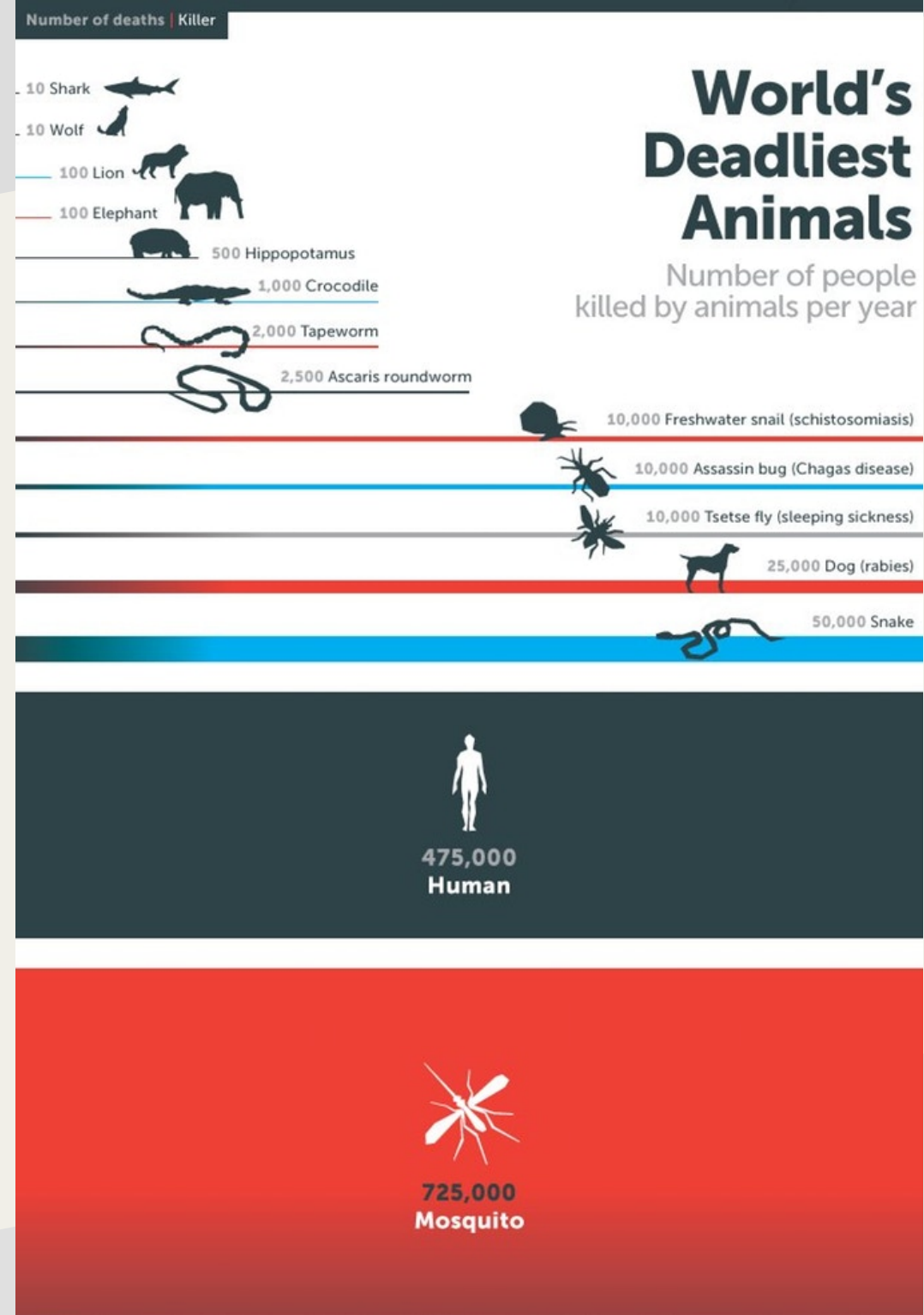
World population growth rates 2015 – 2050

Efficient information transfer (cont.)



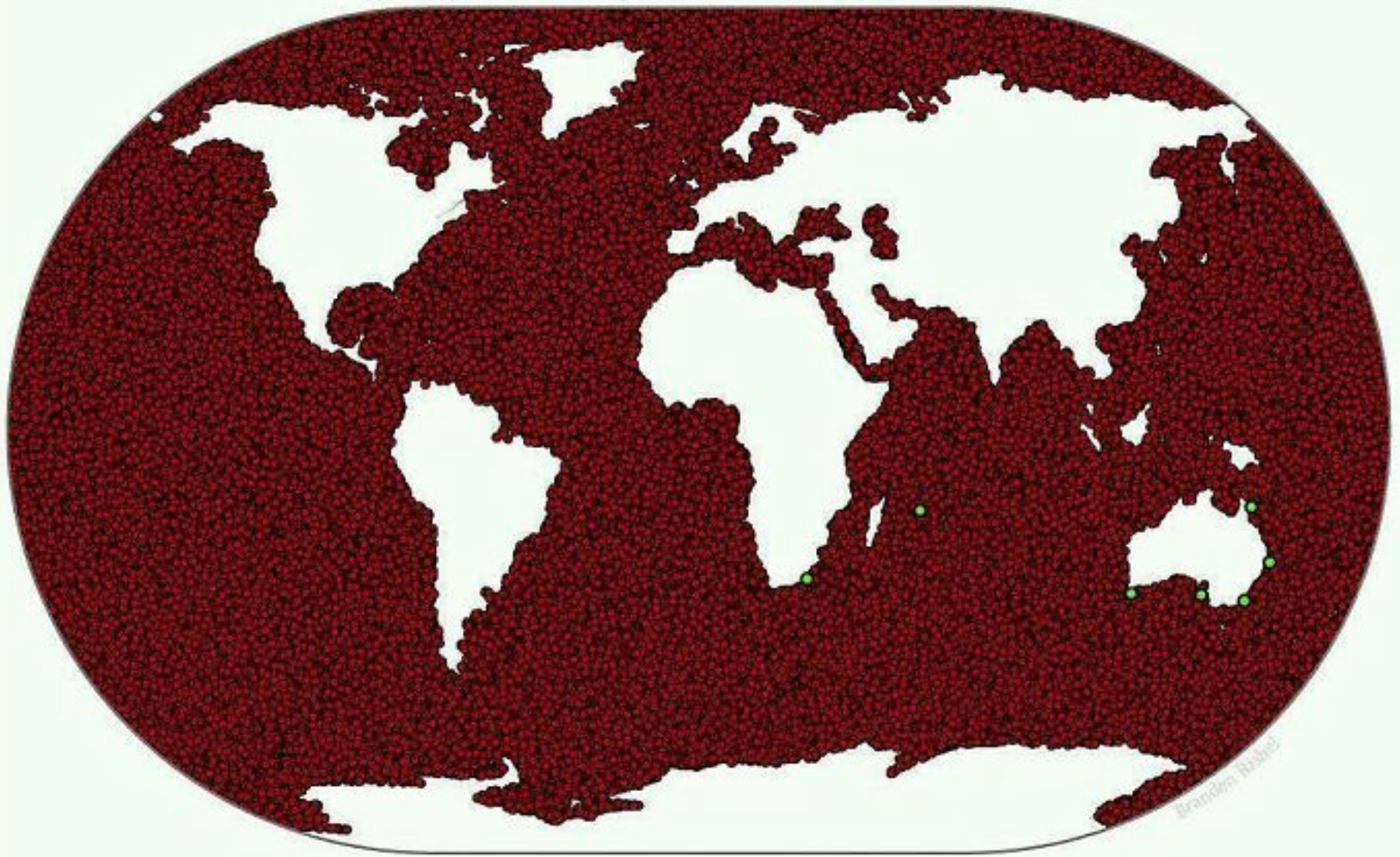
Source: Gu, D., Andreev, K., & Dupre, M. E. (2021). Major trends in population growth around the world. *China CDC weekly*, 3(28), 604–613.
<https://doi.org/10.46234/ccdcw2021.160>

Efficient information transfer



SOURCES: WHO; crocodile-attack.info; Kasturiratne et al. (doi.org/10.1371/journal.pmed.0050218); FAO (webcitation.org/6OgpS8SVO); Linnell et al. (webcitation.org/6ORL7DBUO); Packer et al. (doi.org/10.1038/2F436927a); Alessandro De Maddalena. All calculations have wide error margins.

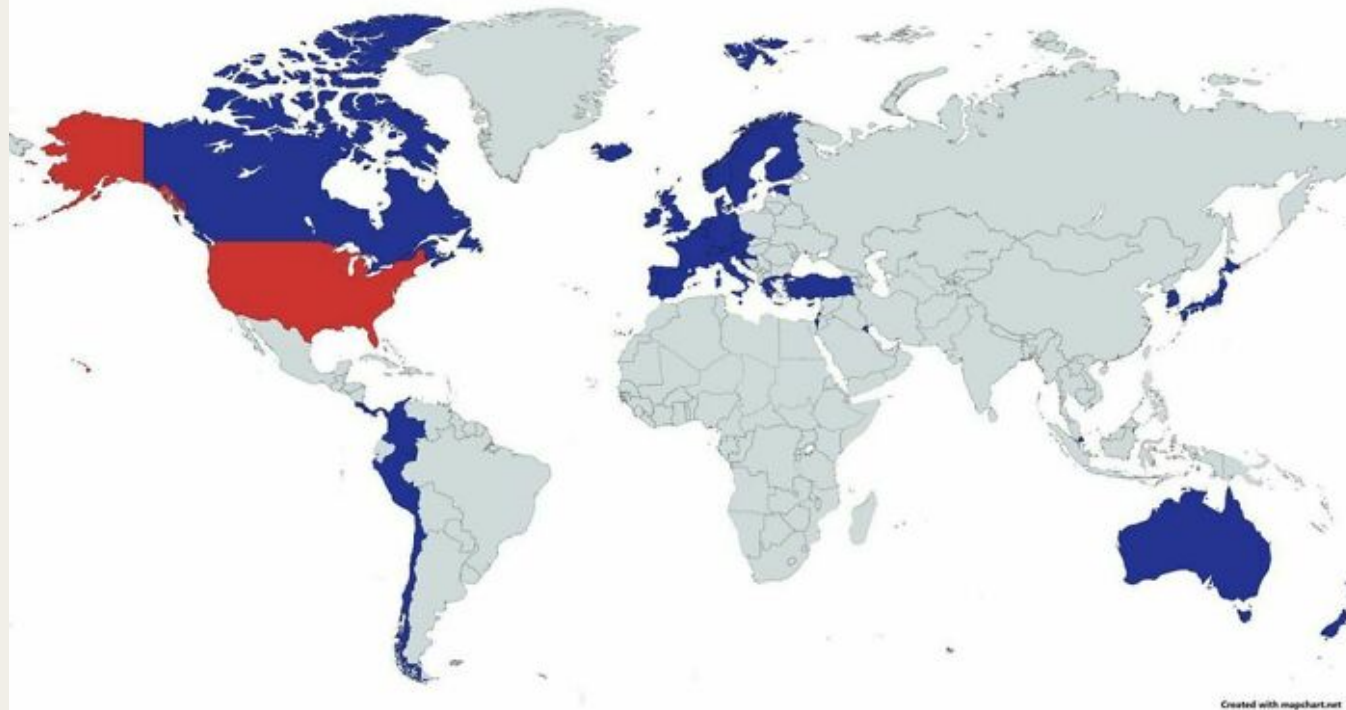
Sharks vs Humans: 2014



- Sharks killed by humans: 63,000,000–274,000,000
- Humans killed by sharks: 7

Efficient information transfer (cont.)

Countries With a Higher Life Expectancy than the United States

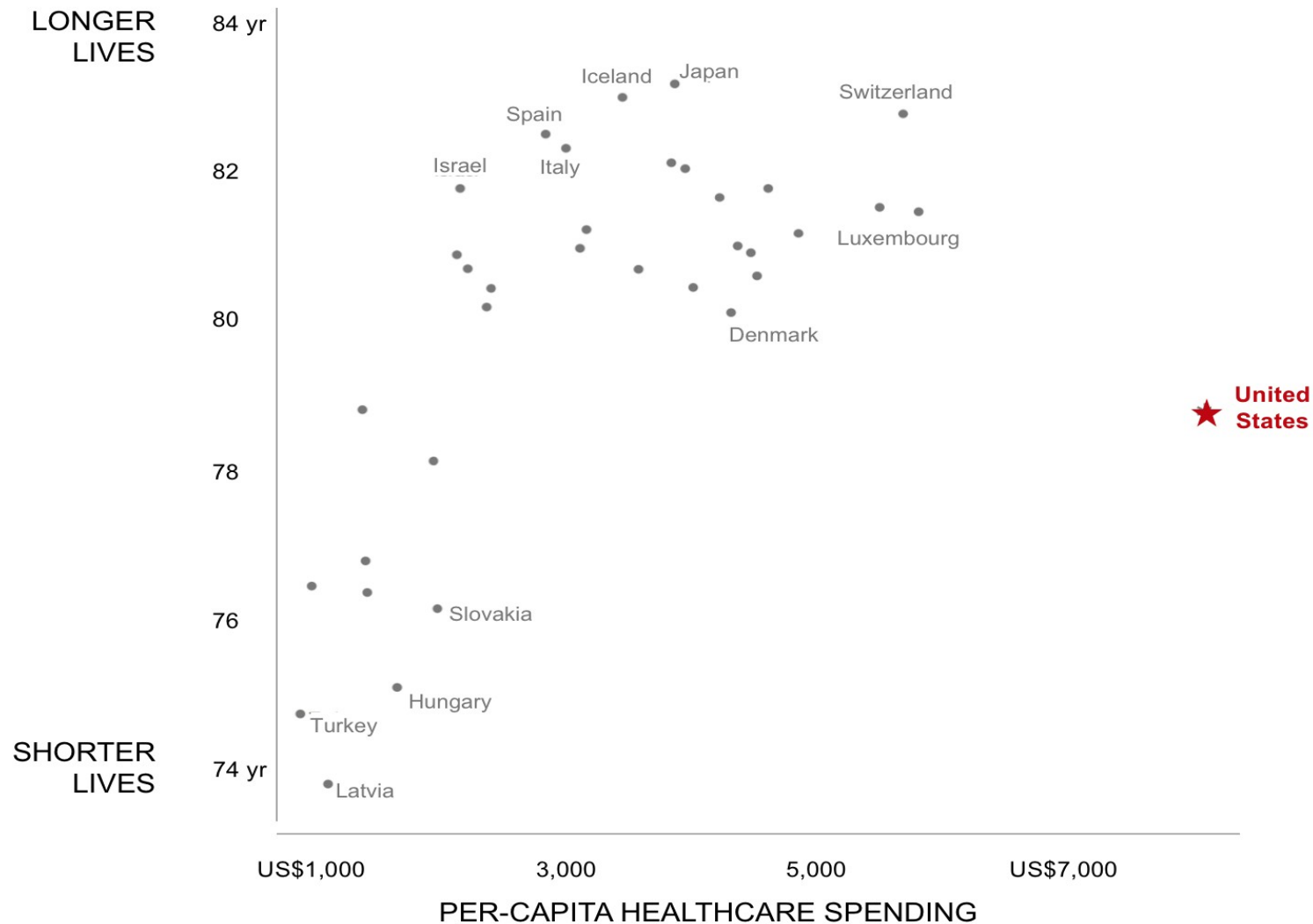


- United States
- Countries With A Higher Life Expectancy than The United States (WHO 2019)



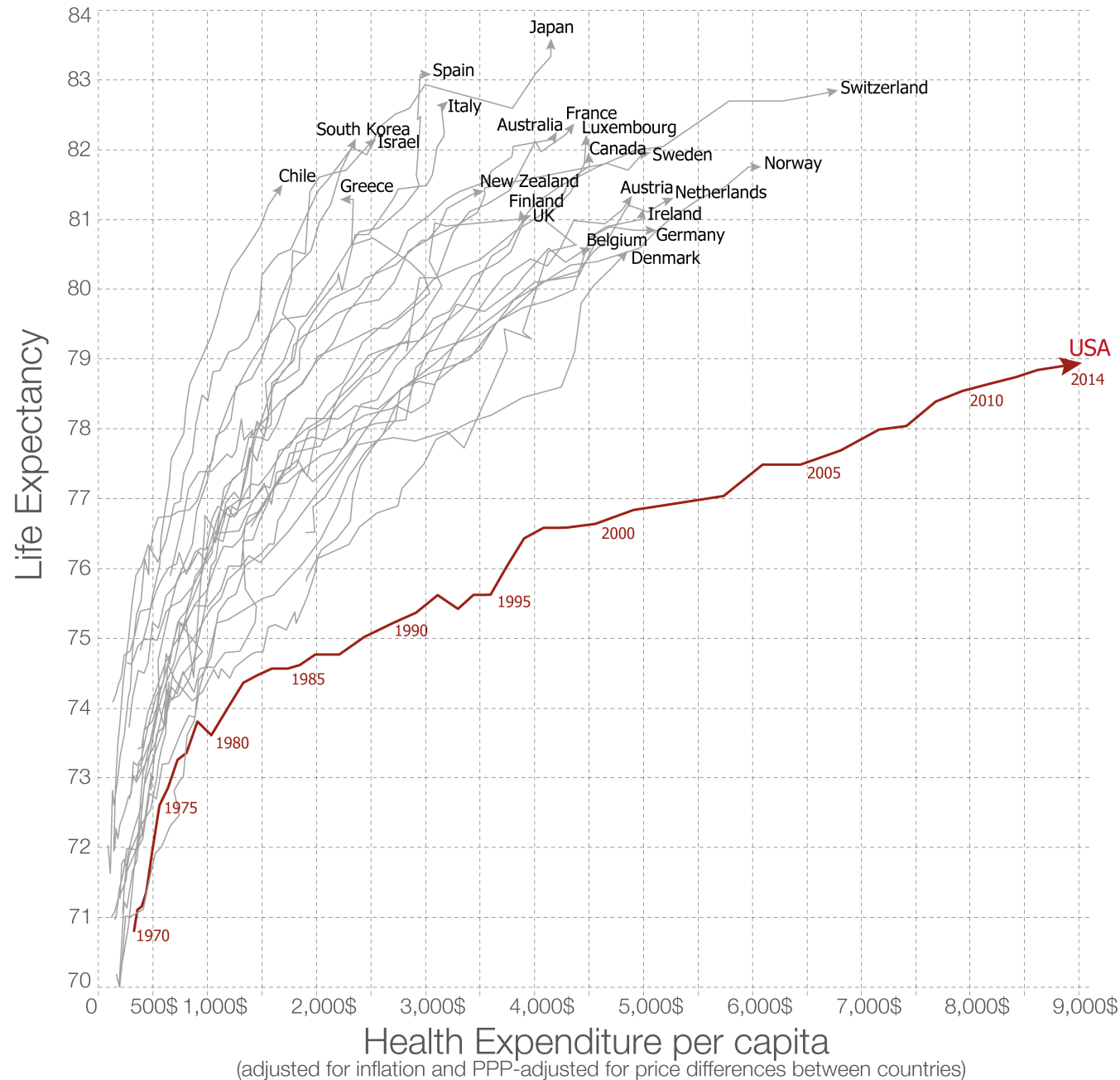
Efficient information transfer (cont.)

The United States spent at least 50% more per capita on health care, yet its life expectancy in 2012 lagged most developed nations.



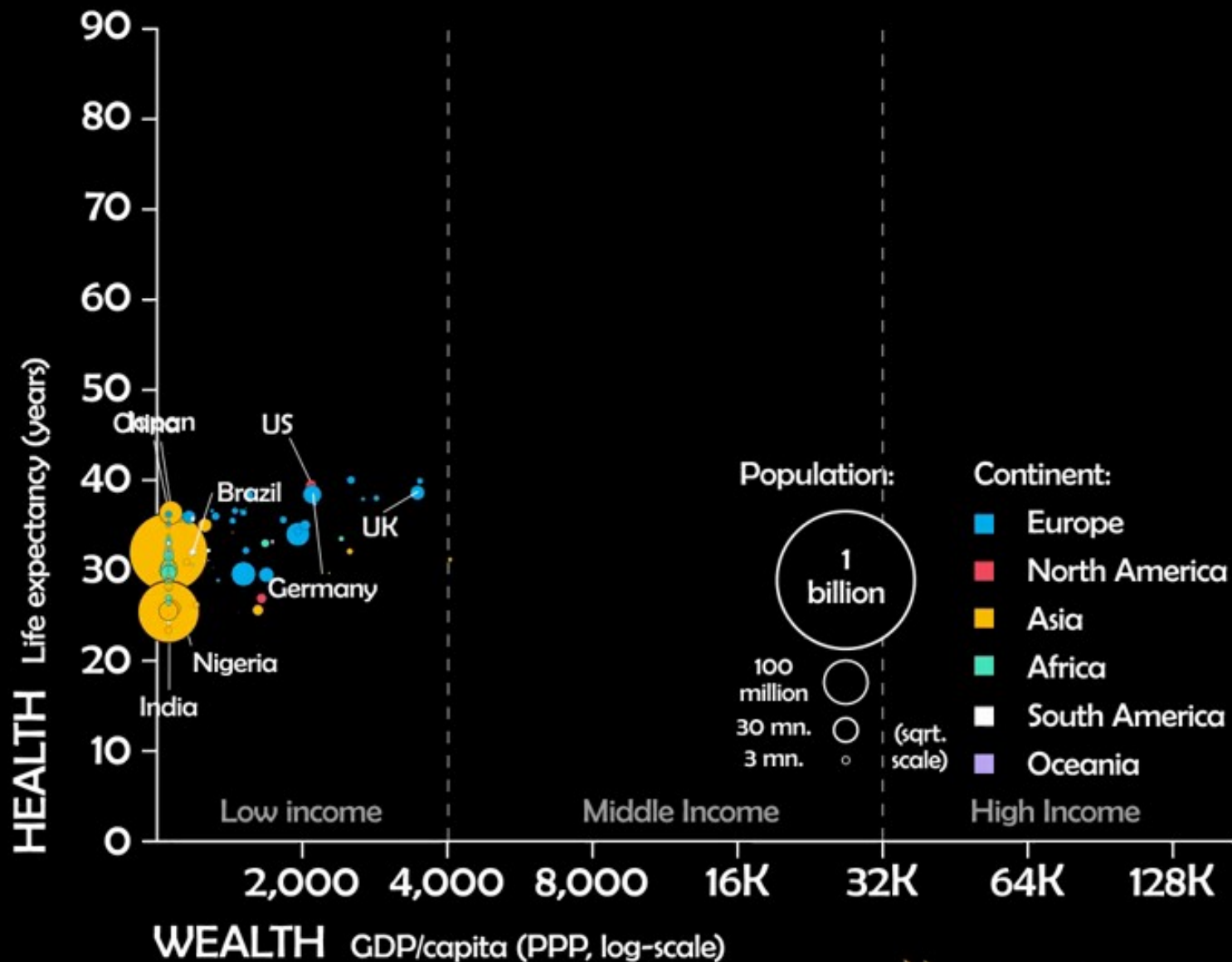
Life expectancy vs. health expenditure over time (1970-2014)

Health spending measures the consumption of health care goods and services, including personal health care (curative care, rehabilitative care, long-term care, ancillary services and medical goods) and collective services (prevention and public health services as well as health administration), but excluding spending on investments. Shown is total health expenditure (financed by public and private sources).



221 Years of Health and Wealth

Year: 1800



Source: Gapminder, based on Maddison Project, UN and World Bank data

Deaths Due to Complications from Abortions in the USA

Since the passage of Roe v Wade, in the early 70s, there has been a dramatic drop in abortion deaths.

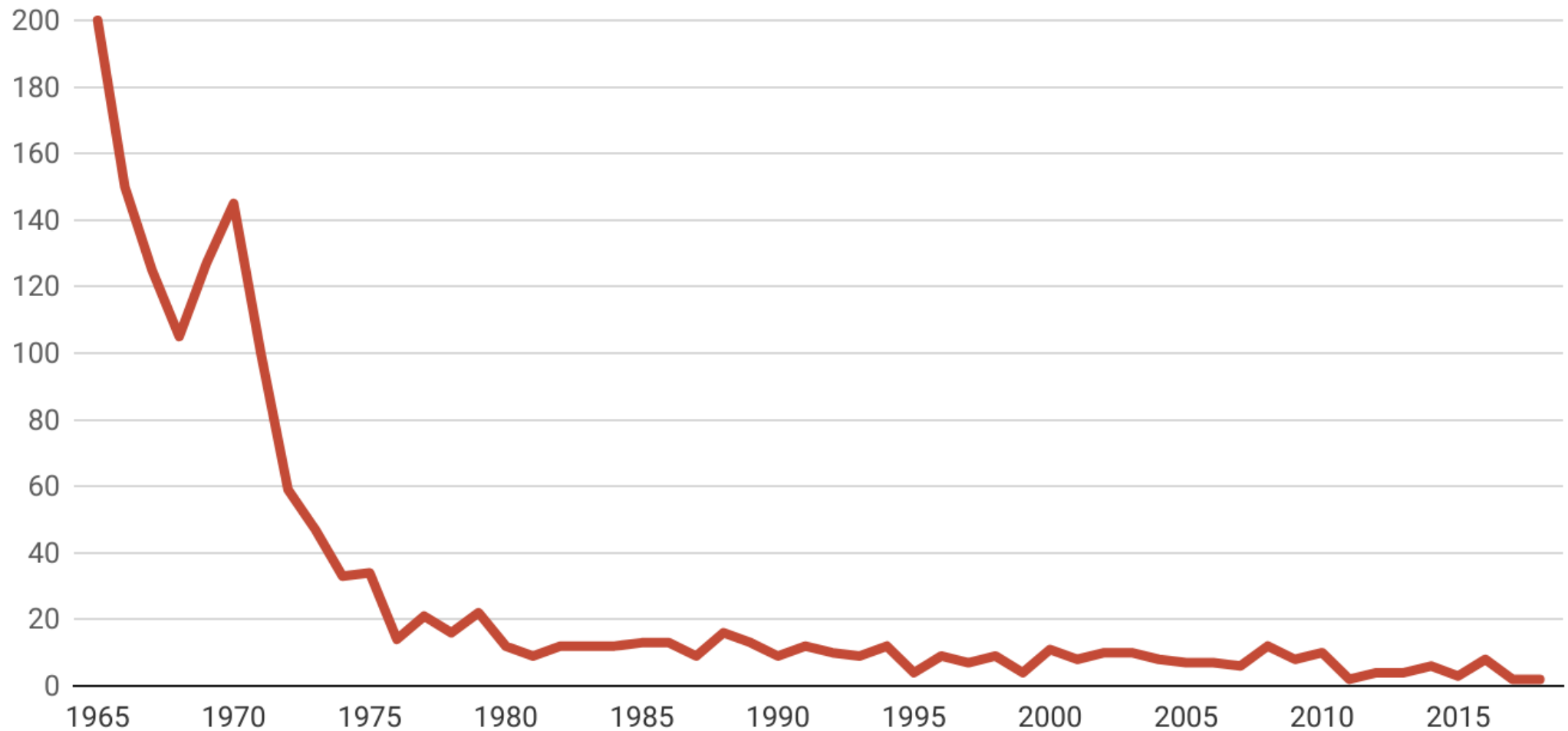
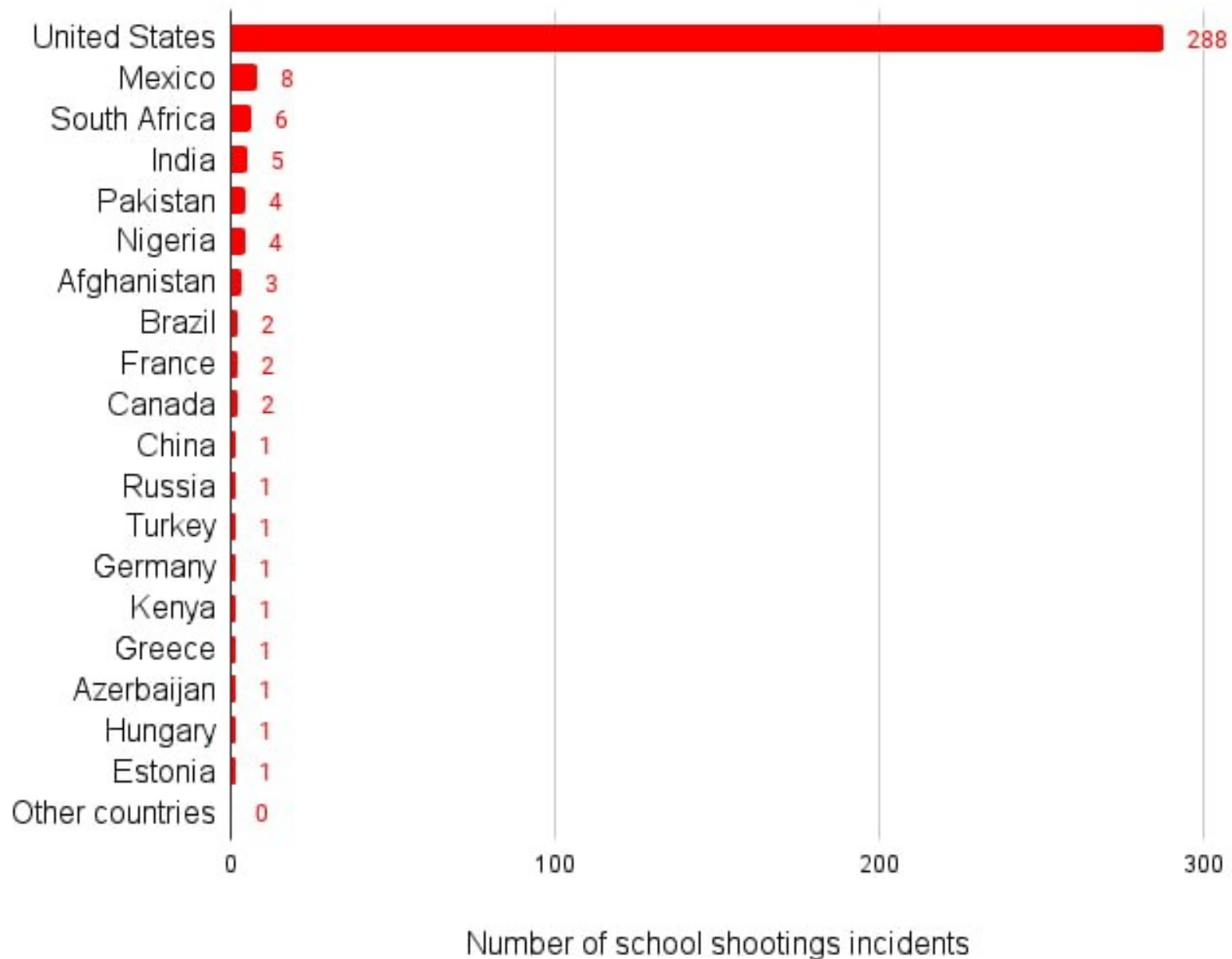
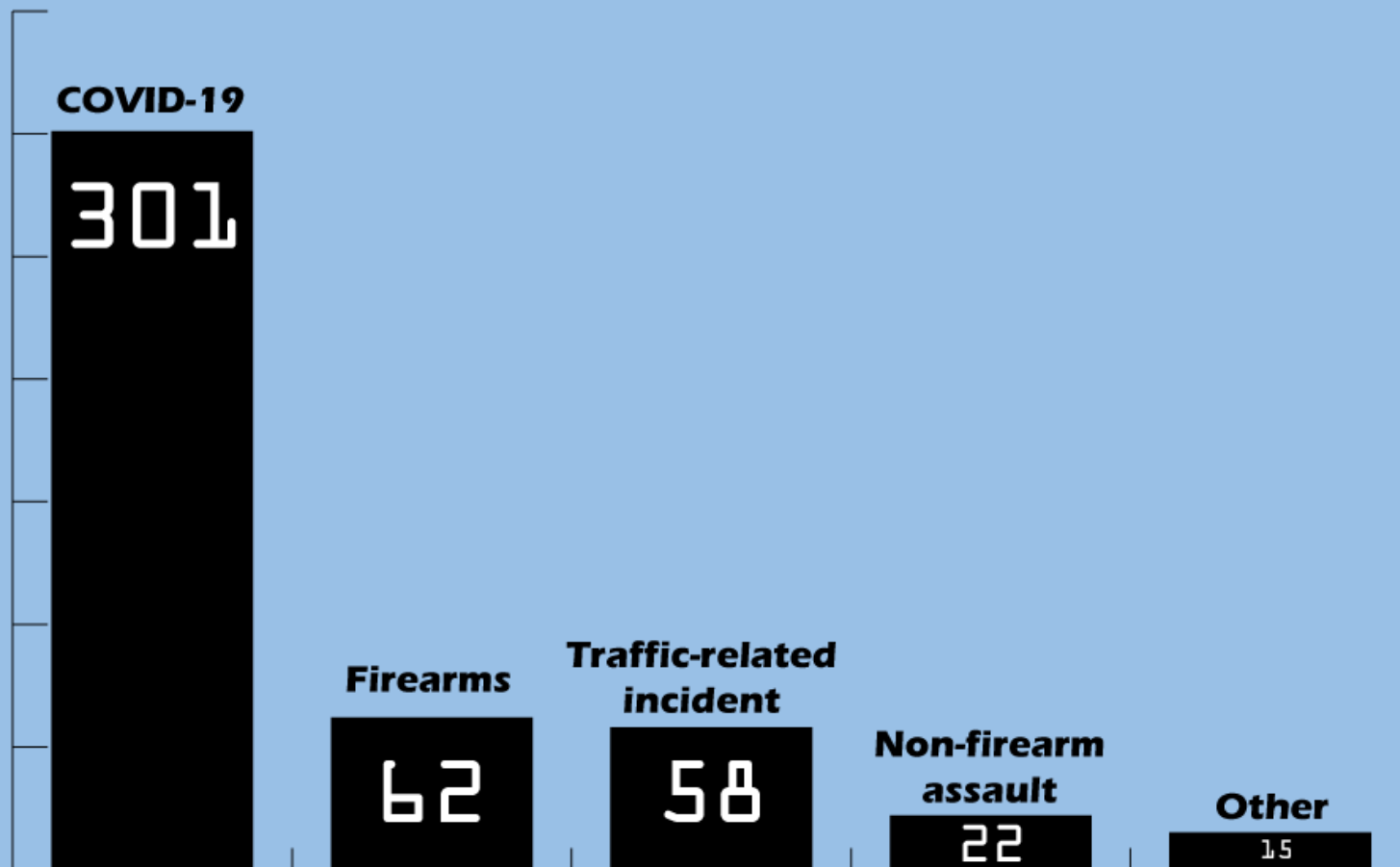


Chart: u/thedataracer • Created with Datawrapper

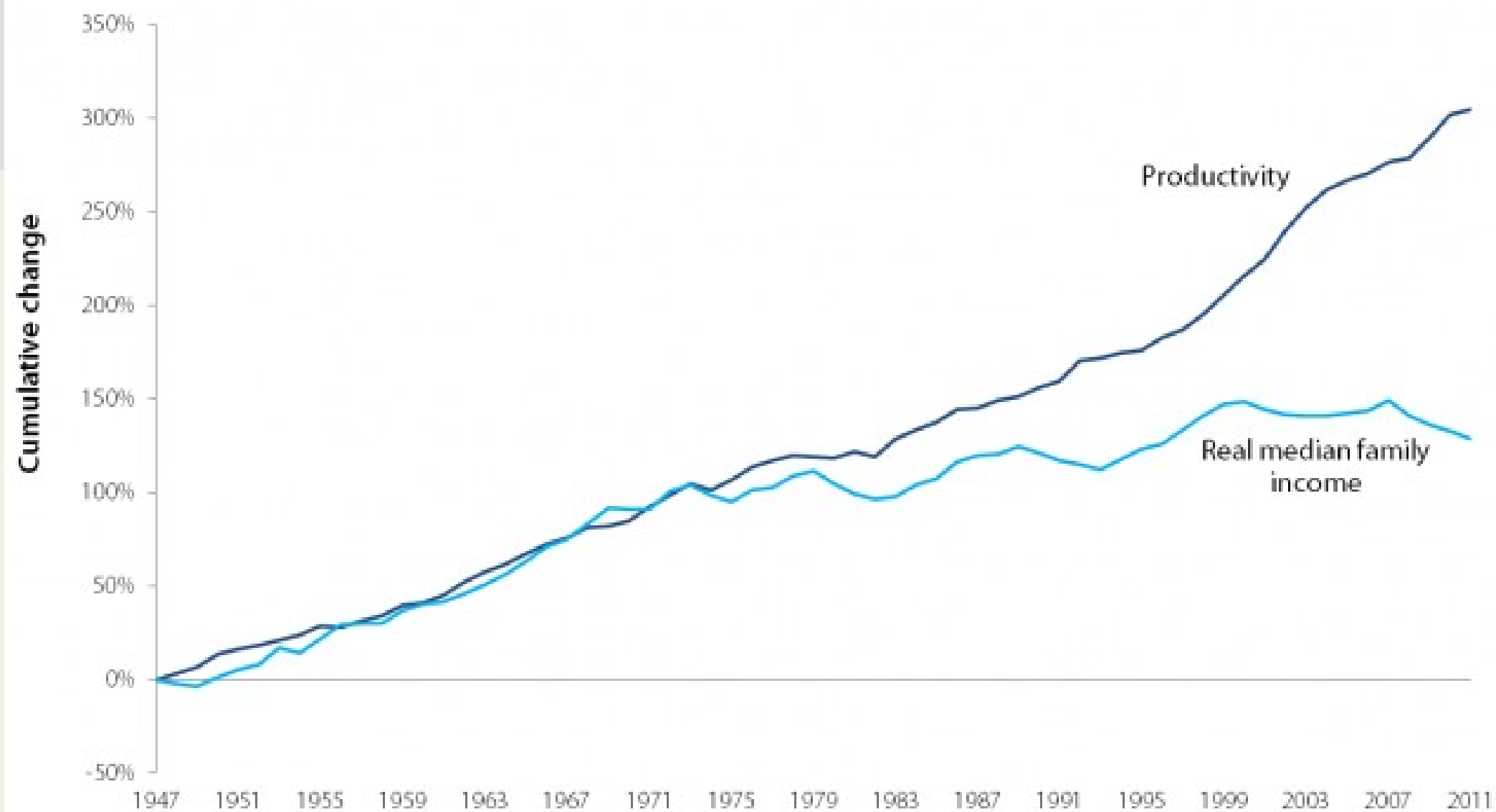
Countries with school shootings incidents (Jan 2009-May 2018)



458 law enforcement officers died in the line of duty in 2021



Created by TrueBirch using data from the National Law Enforcement Officers Memorial Fund. COVID-19 fatalities are only counted when an officer "died due to direct exposure to the virus during the commission of their official duties." Officers who died from a case of COVID-19 that did not have a proven link to "official duties" are not counted.

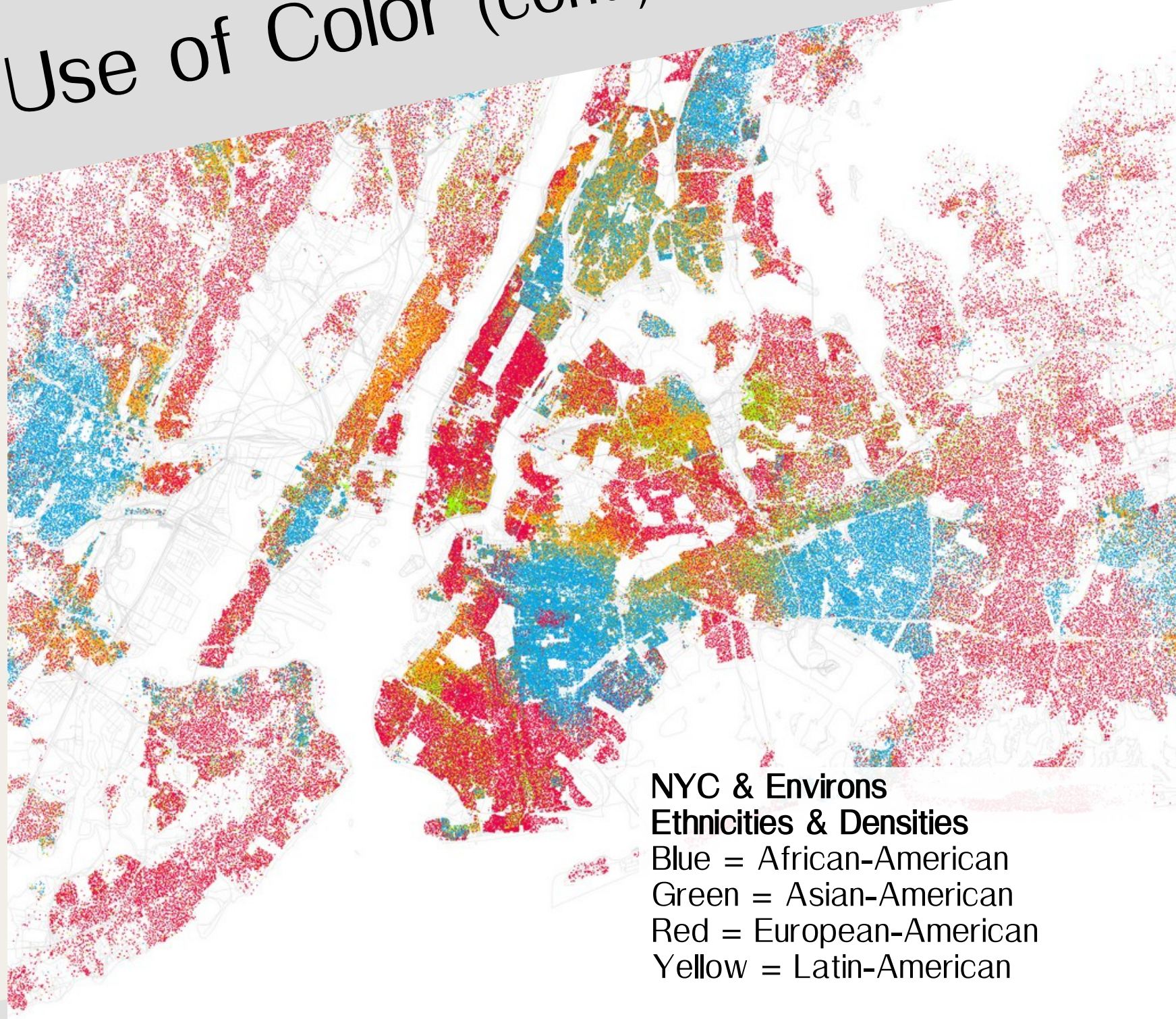


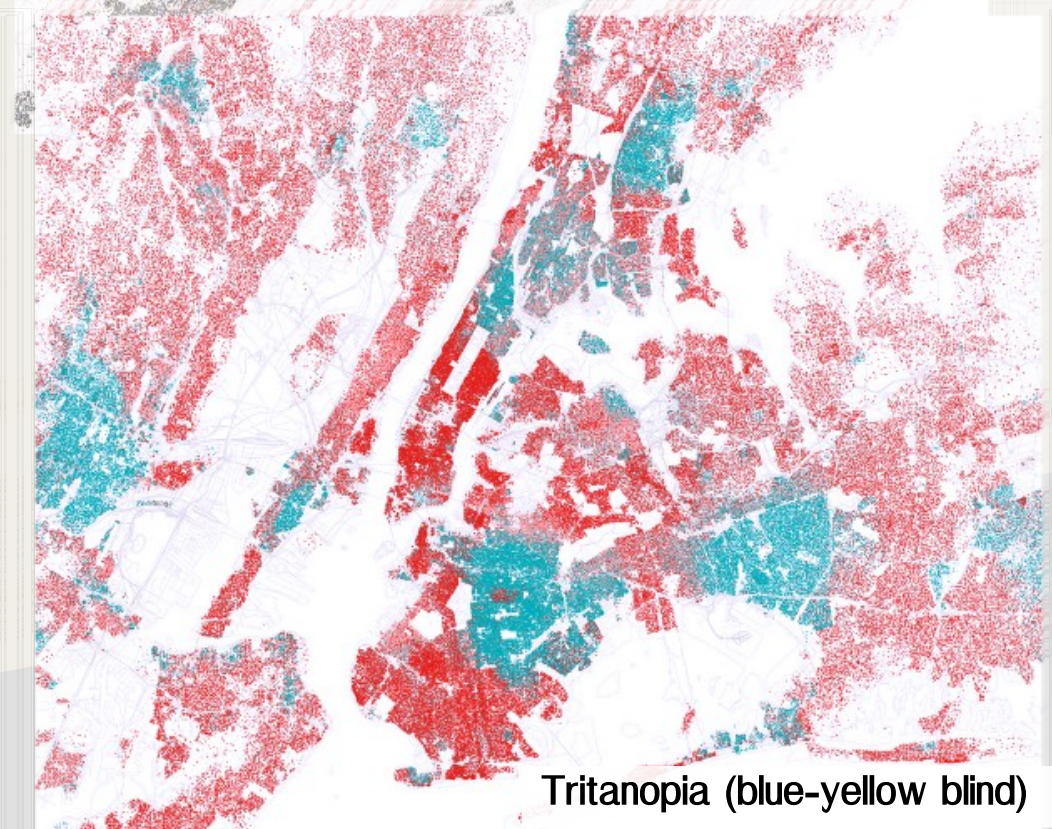
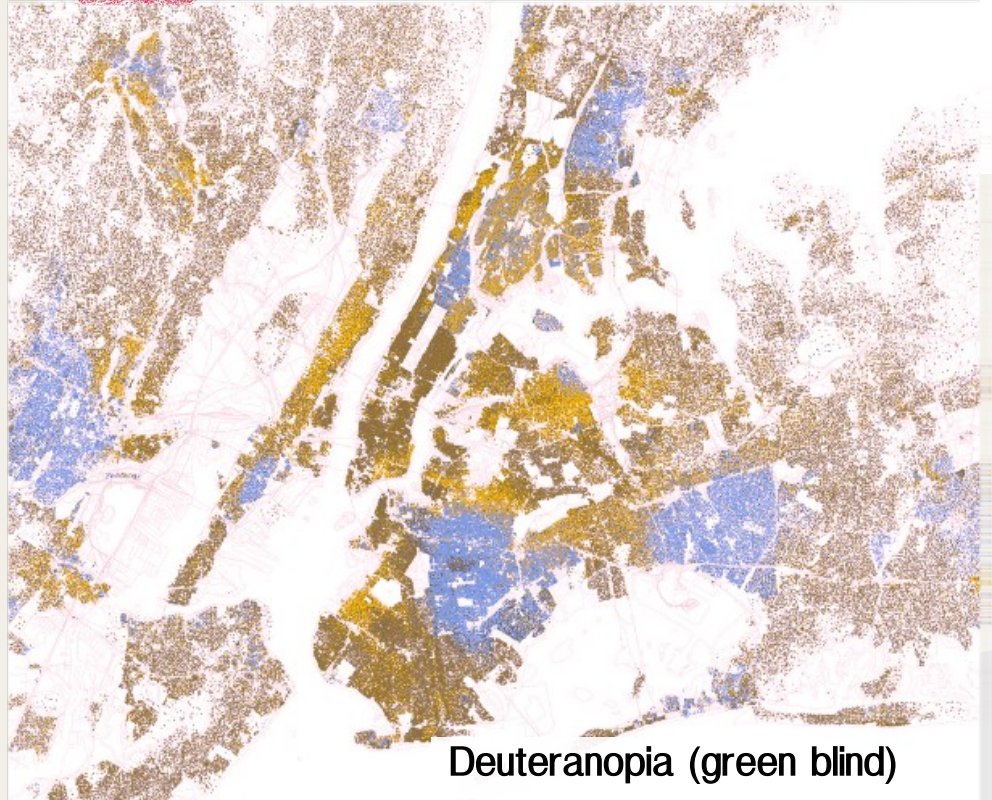
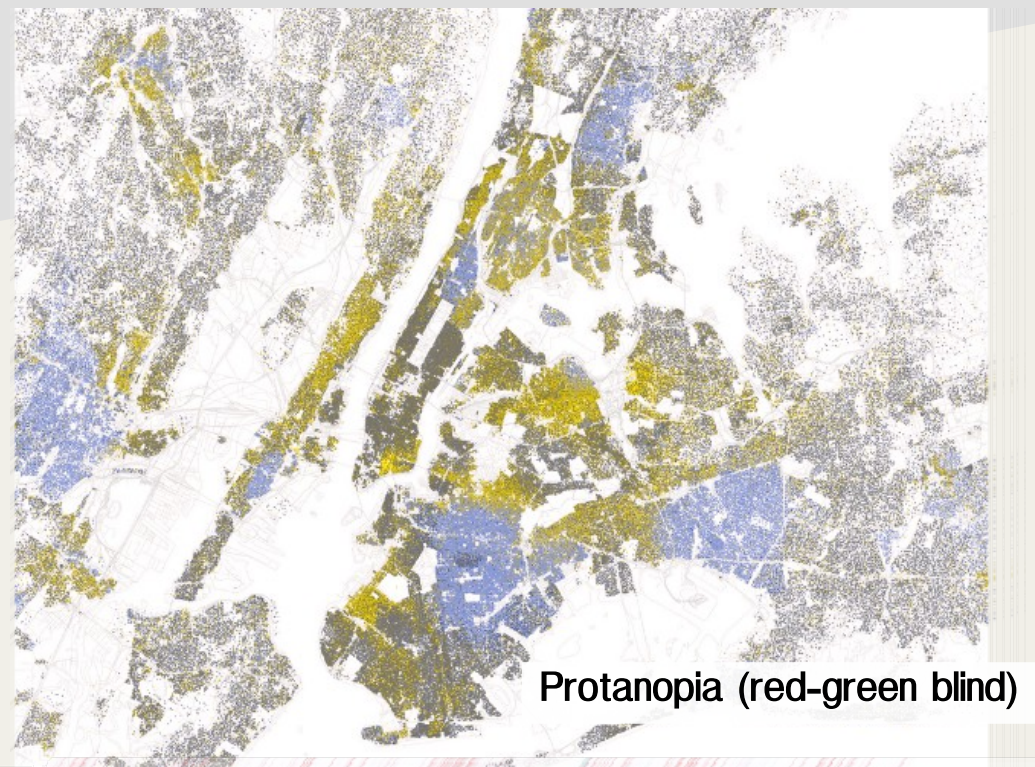
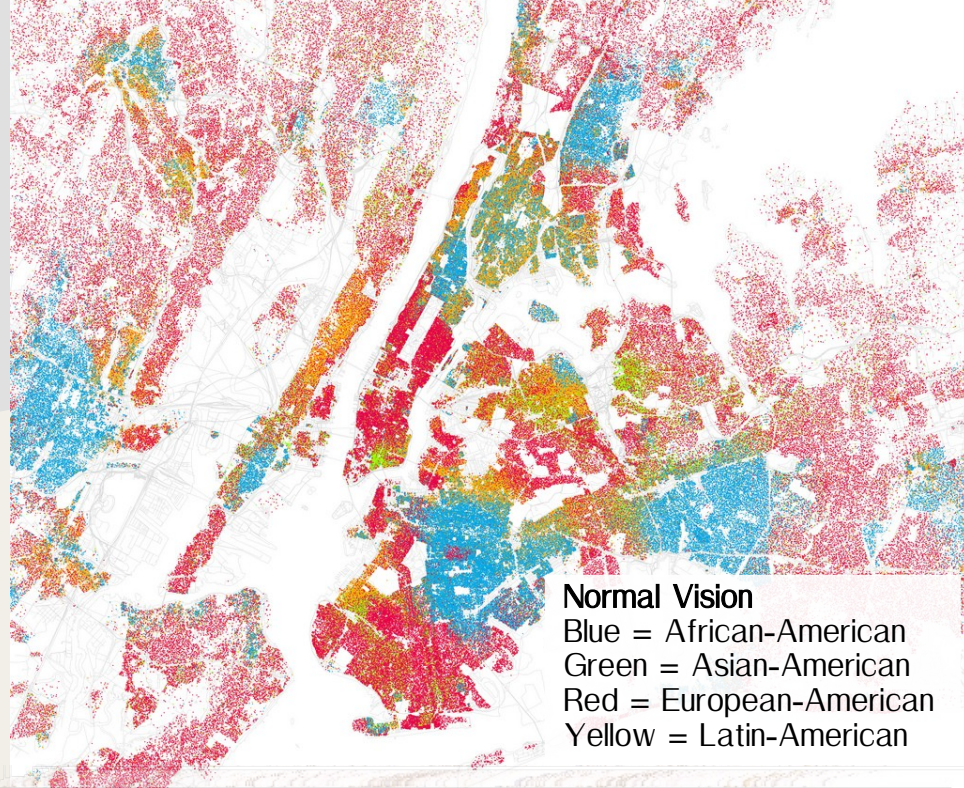
Source: Authors' analysis of Current Population Survey Annual Social and Economic Supplement *Historical Income Tables*, (Table F-5) and Bureau of Labor Statistics, *Productivity – Major Sector Productivity and Costs Database* (2012)

Good Use of Color

- Use a few contrasting colors
 - Black & grey scales are safe & easily reproduced
 - Good combinations to accommodate color blindness:
 - Indigo & orange (+ green + vermillion)
 - Deep purple & mint (+ orange + teal)
- Sites to get examples & check accessibility:
 - J*Fly Site about Color Blindness & Figures
 - Coblis: Simulates how images appear to different users
 - Colorgorical: Generate perceptually distinct images
 - ColorBrewer2: Has a “colorblind-safe” filter

Good Use of Color (cont.)

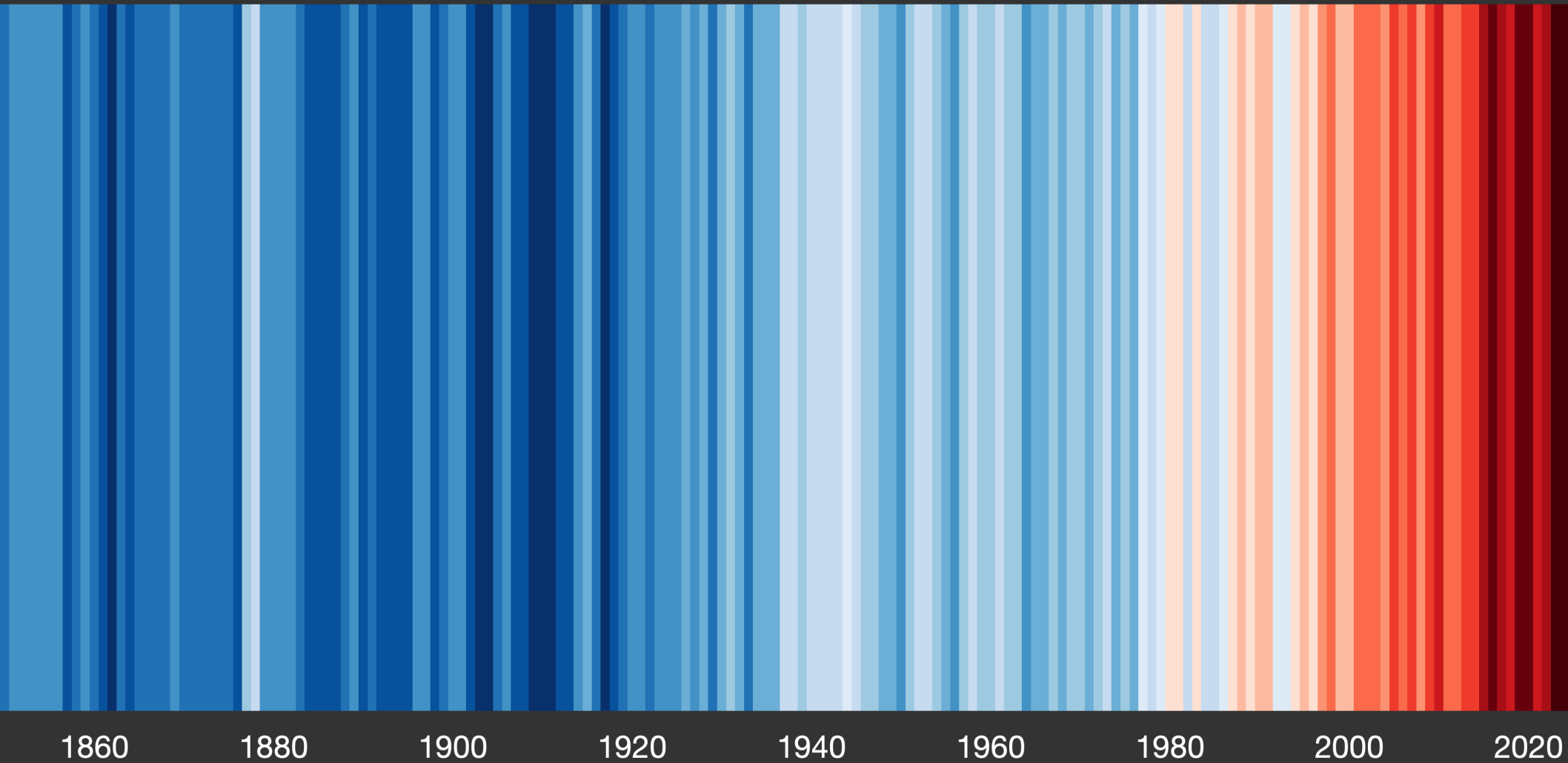




Good Use of Color (cont.)

Global temperature change (1850-2024)

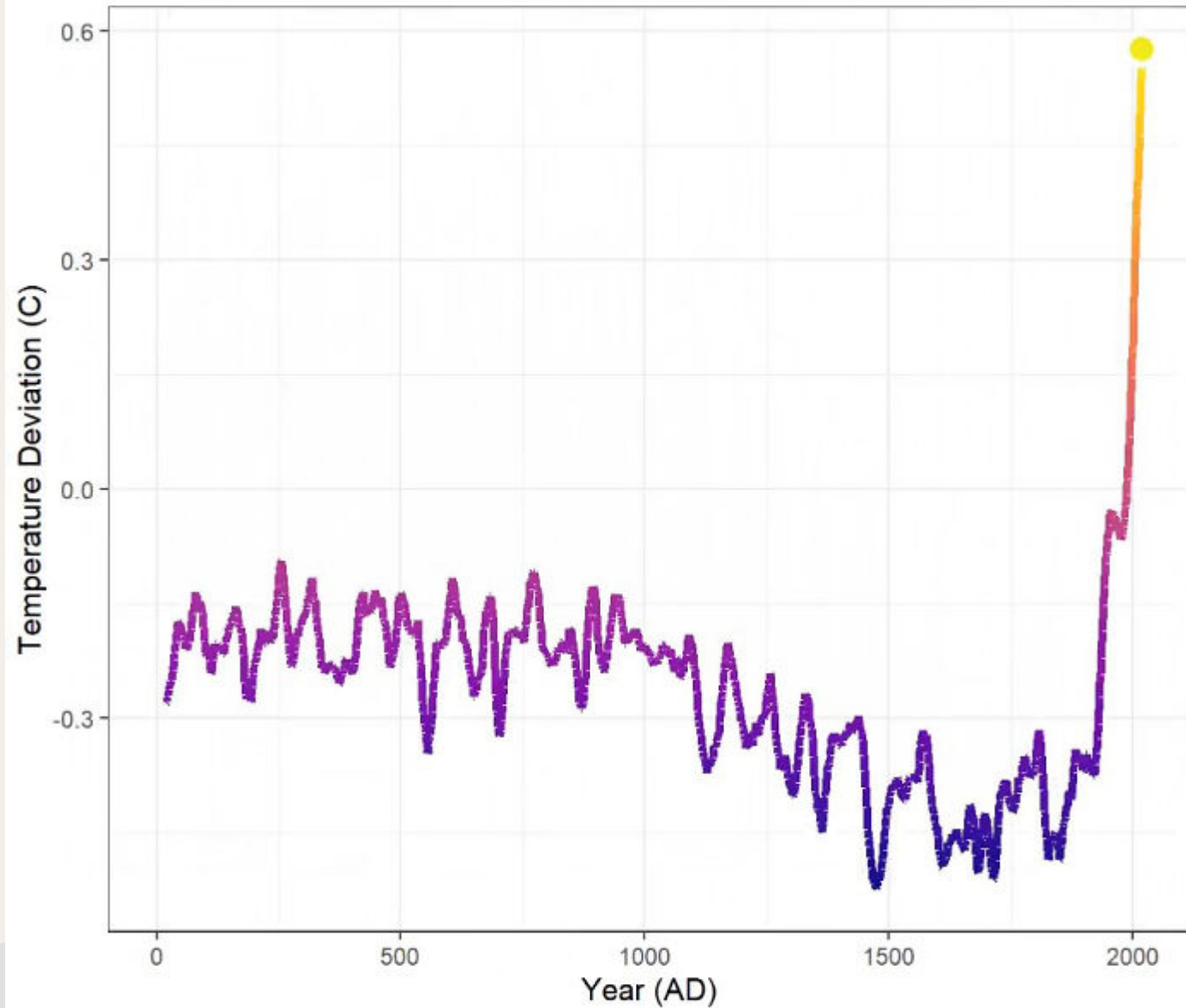
Ed Hawkins, National Centre for
Atmospheric Science, U. of Reading

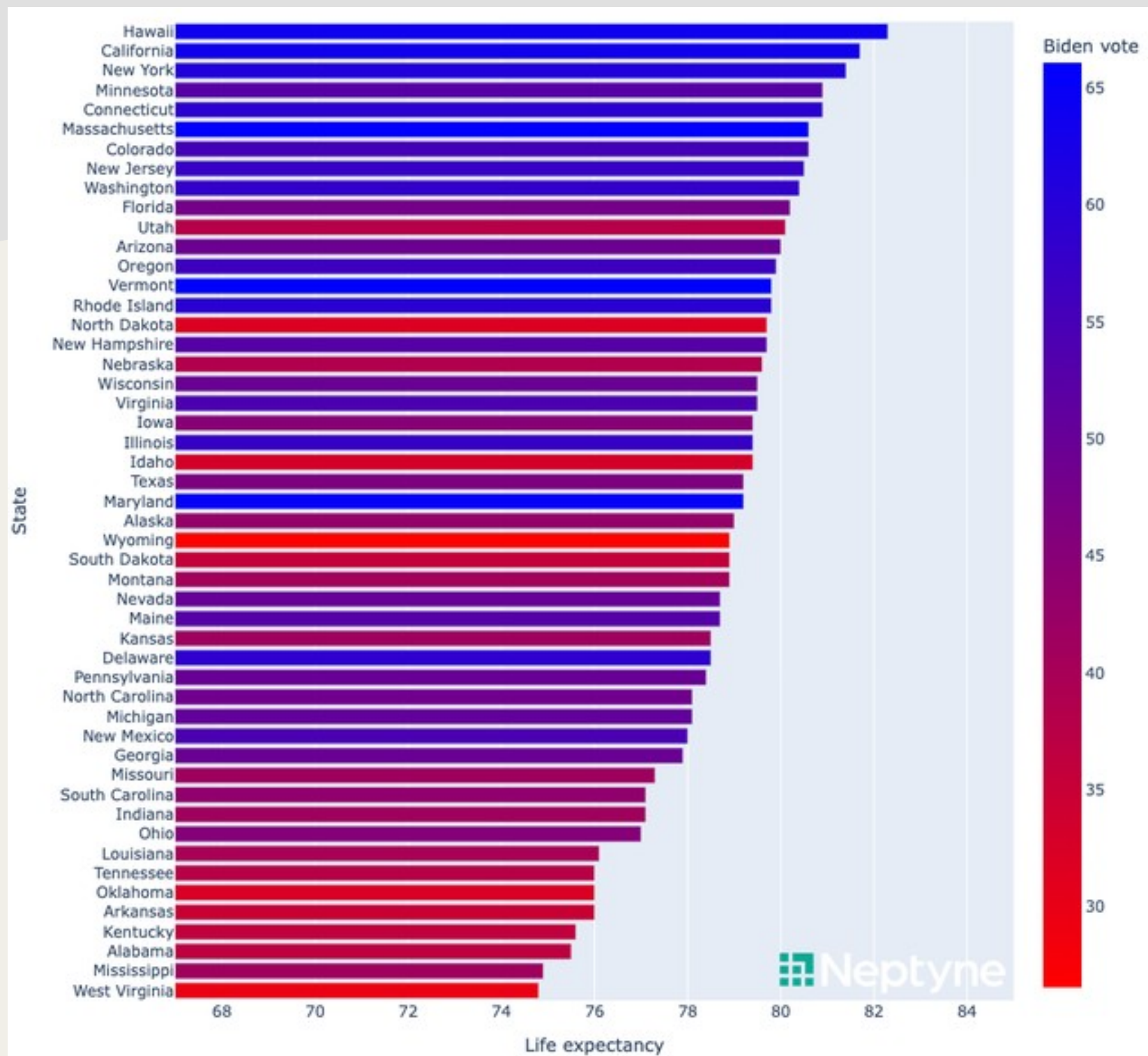


Good Use of Color (cont.)

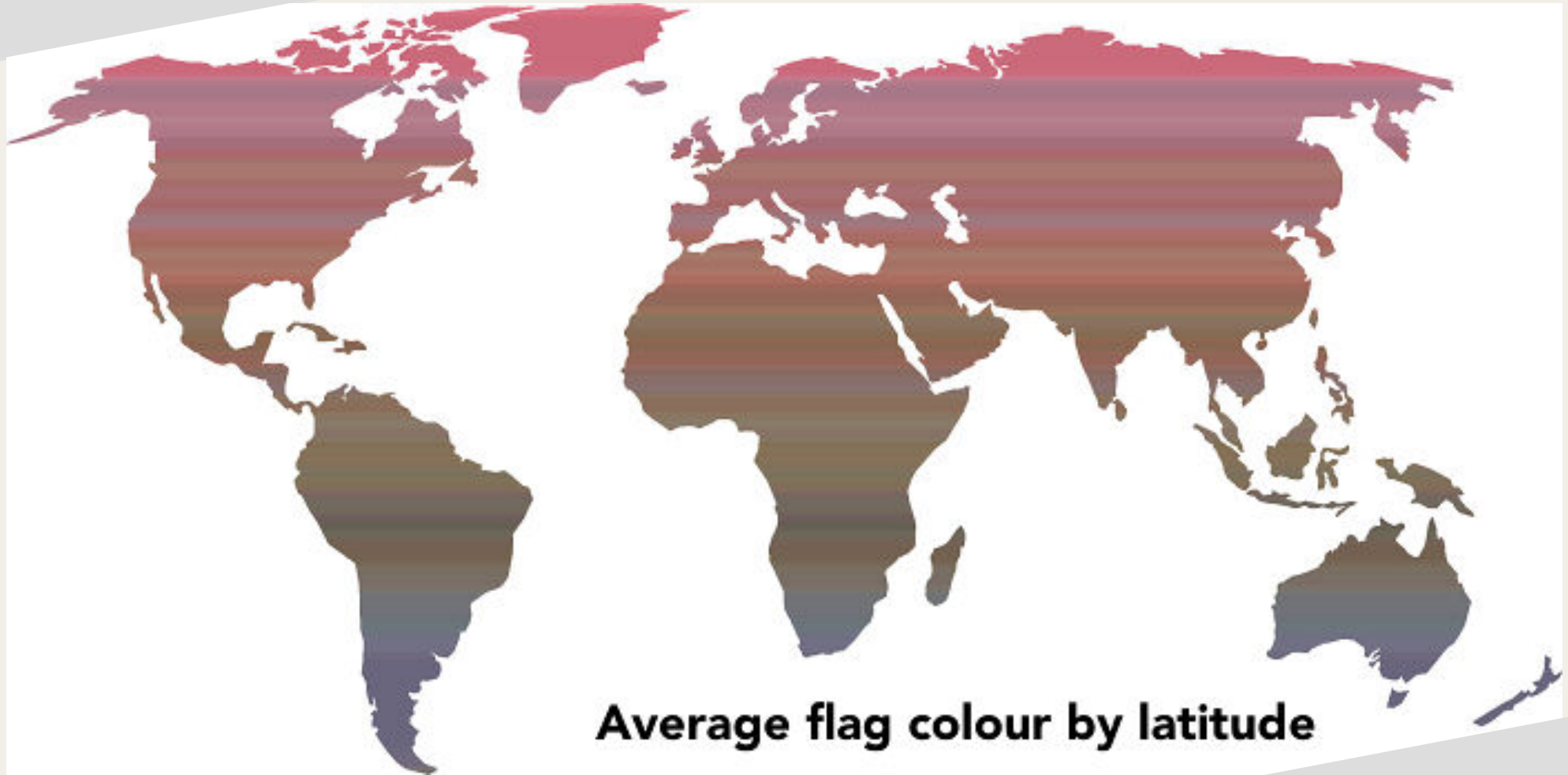
Global Temperature Trend from 0 to 2019 AD

Temperature Deviation (C) from 1961-1990 Average
Year: 2019



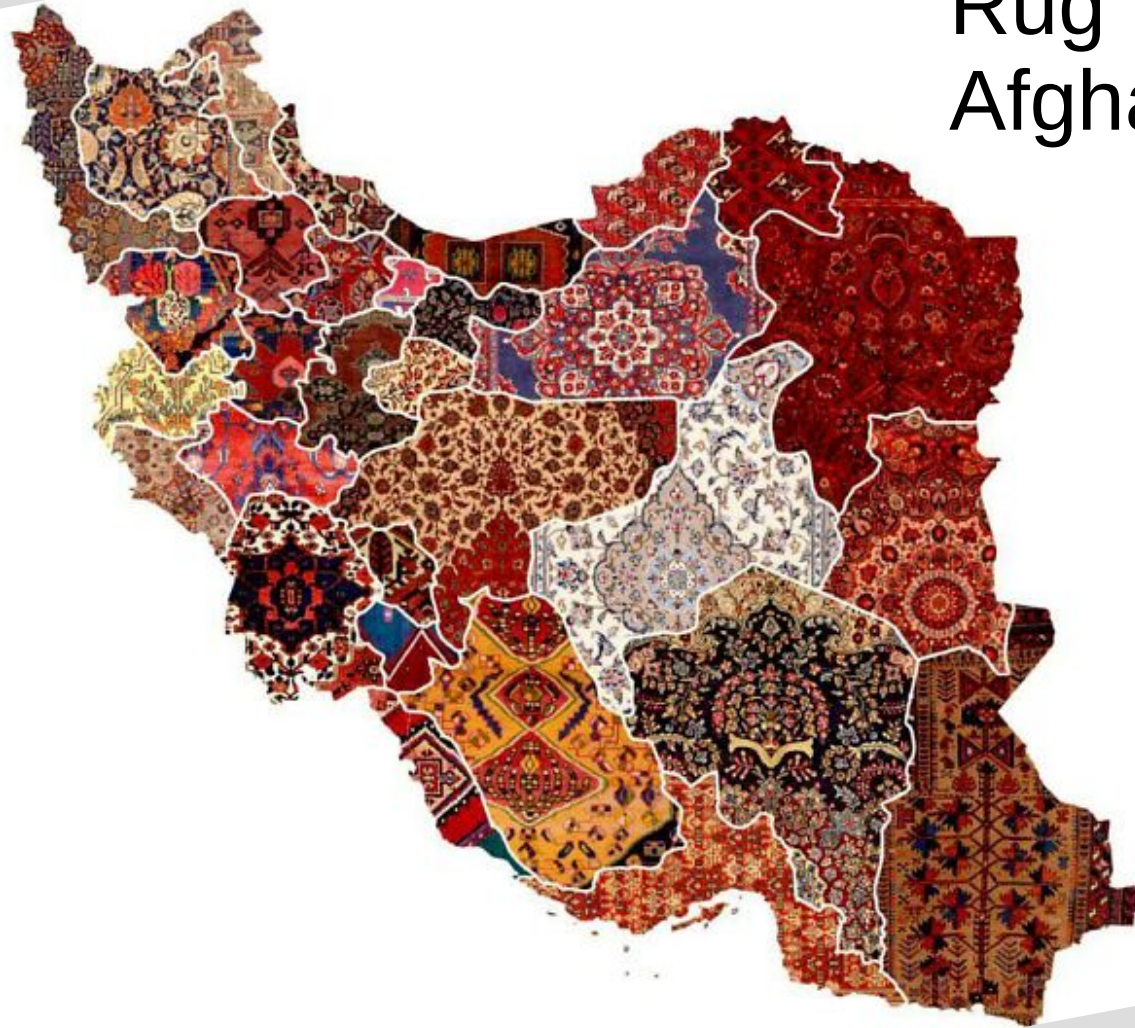


Good Use of Color (cont.)



Good Use of Color (end)

Rug Patterns of Afghanistan

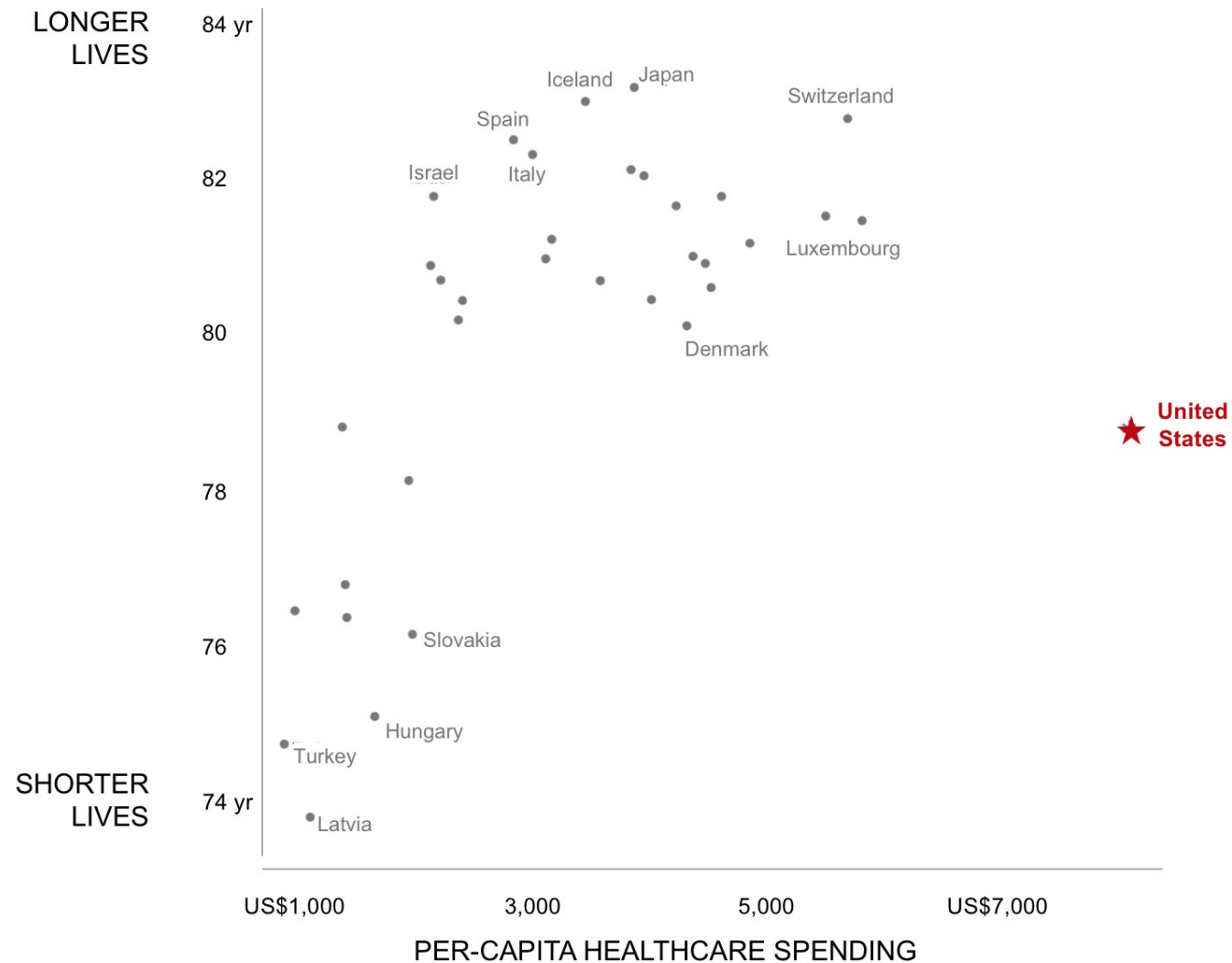


Elements of Good Data Visualization

- Self sufficiency
- Efficient information transfer
- Data-to-ink ratio
- Follow conventions & readers' expectations

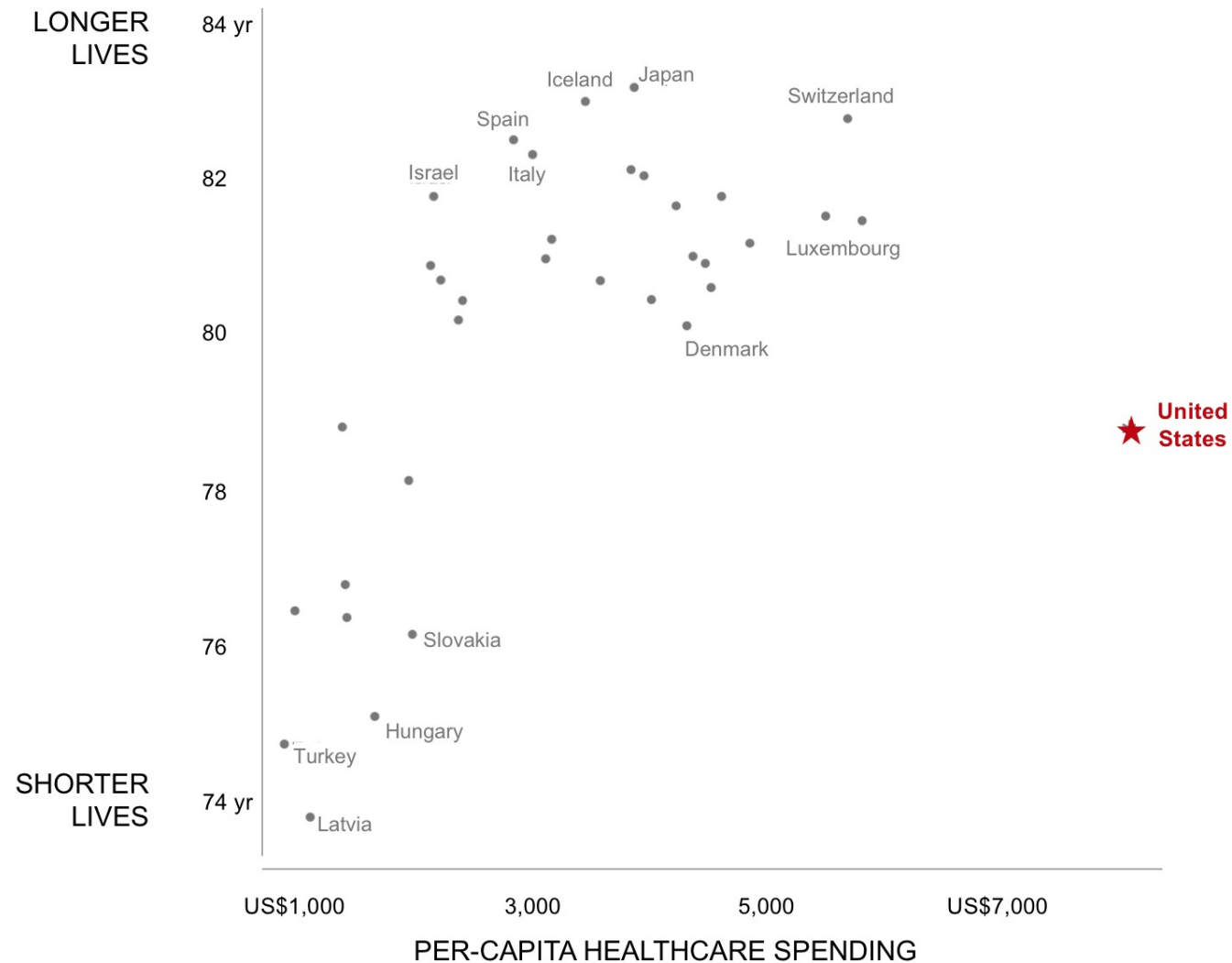
Efficient information transfer (cont.)

The United States spent at least 50% more per capita on health care, yet its life expectancy in 2012 lagged most developed nations.

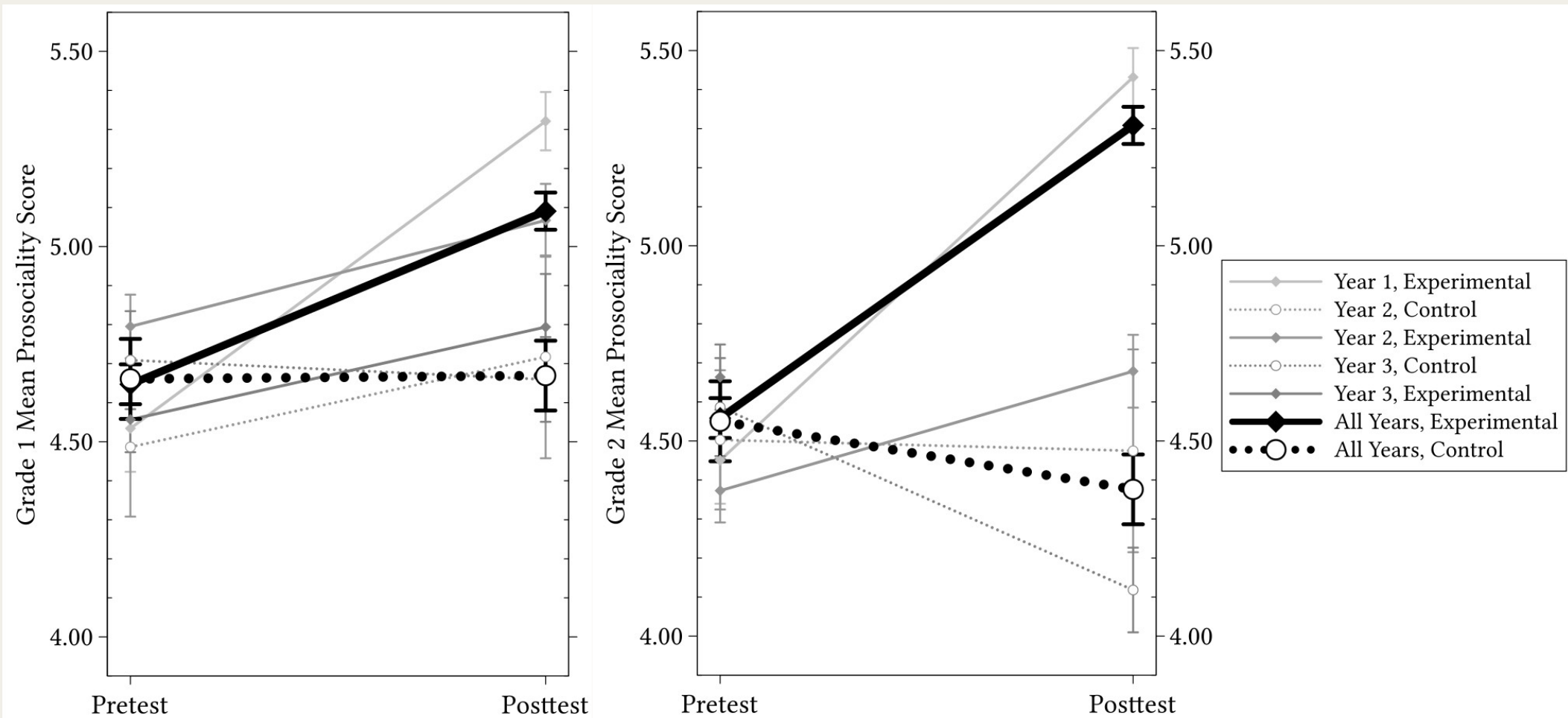


Efficient information transfer (cont.)

The United States spent at least 50% more per capita on health care, yet its life expectancy in 2012 lagged most developed nations.



Efficient information transfer (cont.)



Efficient information transfer (cont.)

- But too much is too much

Independent workers span all demographic groups

Responses from MGI Survey

Total independent workers
Million

■ Primary
■ Supplemental

% of
working-age
population

Participation in independent work

% of independent workforce
% of earners in each category who participate in independent work

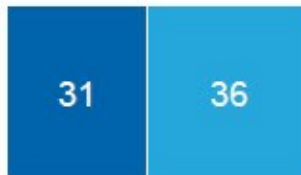
Youths¹

Women

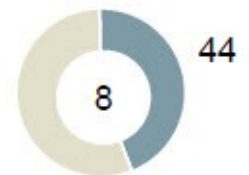
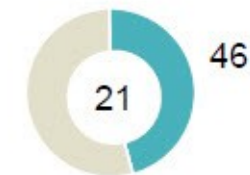
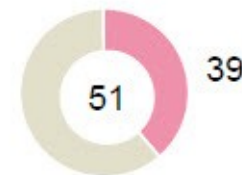
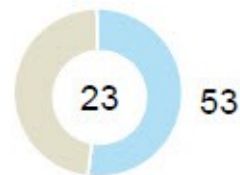
Low-income households²

Seniors³

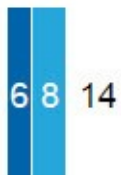
United States



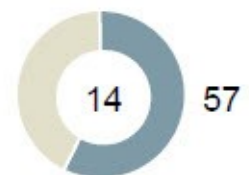
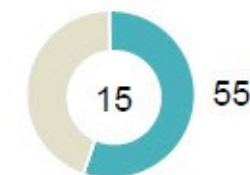
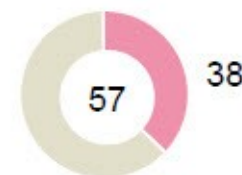
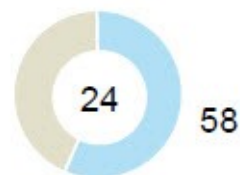
27



United Kingdom



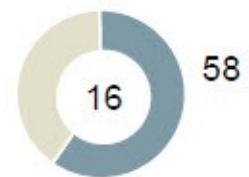
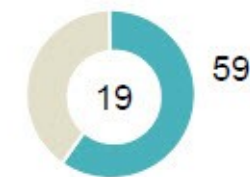
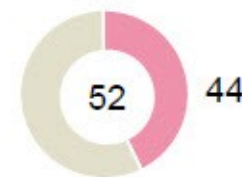
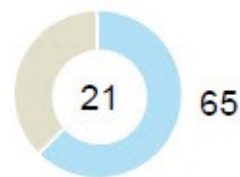
26



Sweden

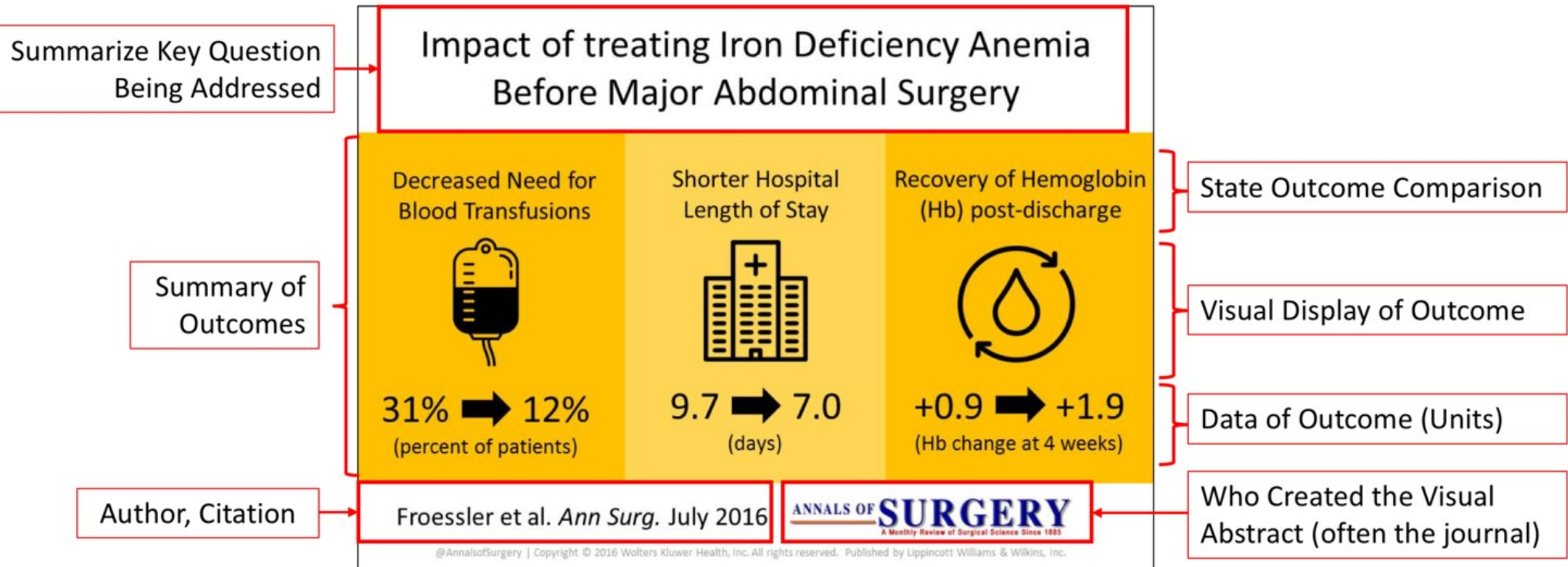


28



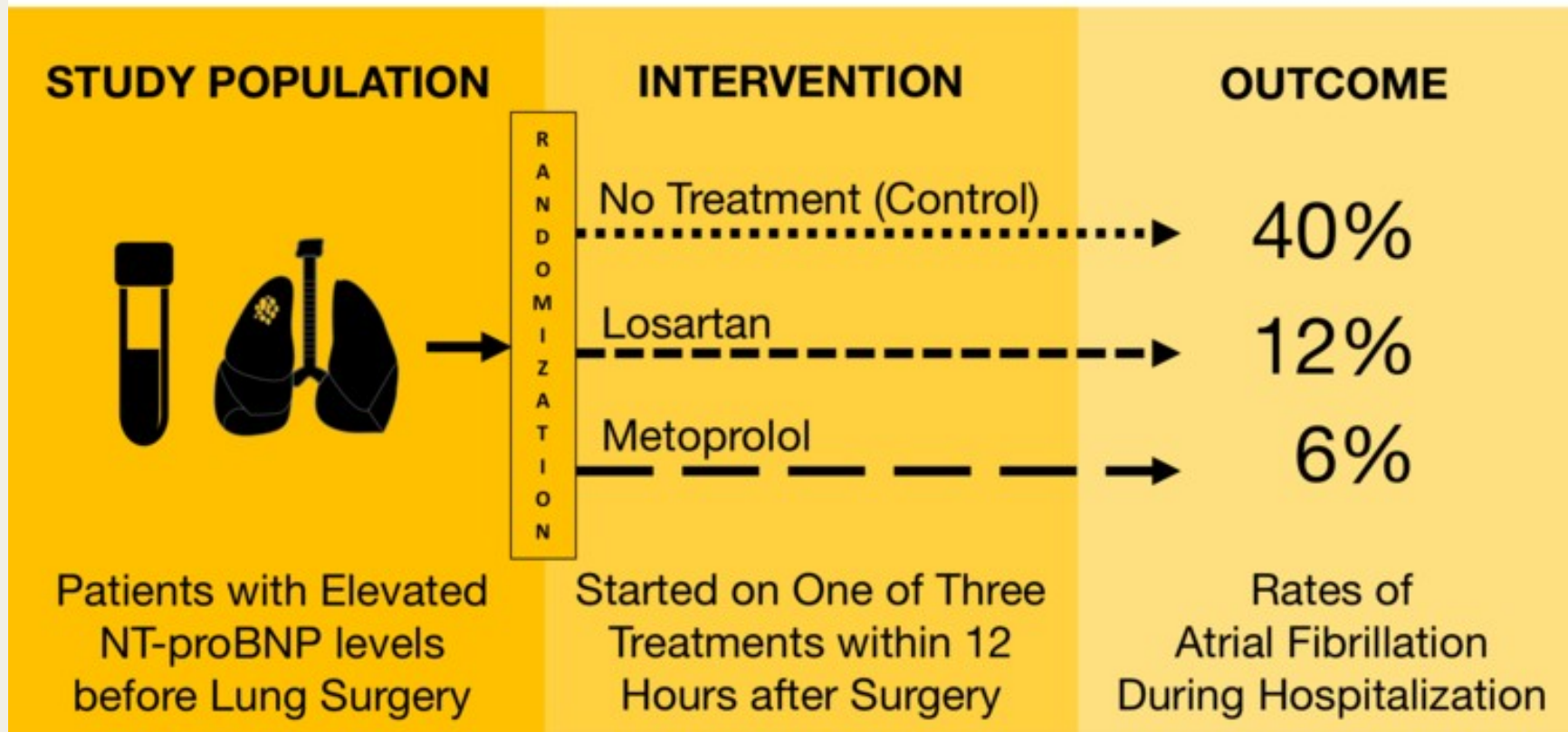
Efficient information transfer (cont.)

COMPONENTS OF AN EFFECTIVE VISUAL ABSTRACT



Efficient information transfer (cont.)

Reducing the Rate of Atrial Fibrillation after Lung Surgery: the PRESAGE Trial



Cardinale et al. *Ann Surg.* Aug 2016.

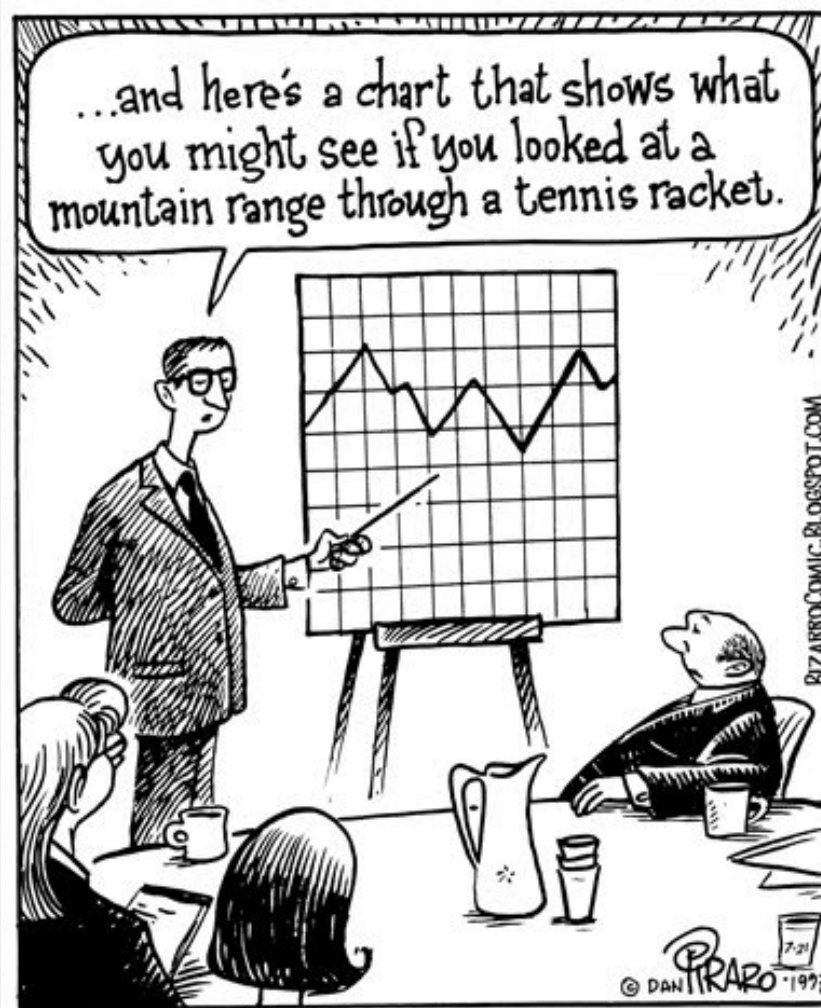
ANNALS OF SURGERY
A Monthly Review of Surgical Science Since 1885

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Elements of Good Data Visualization

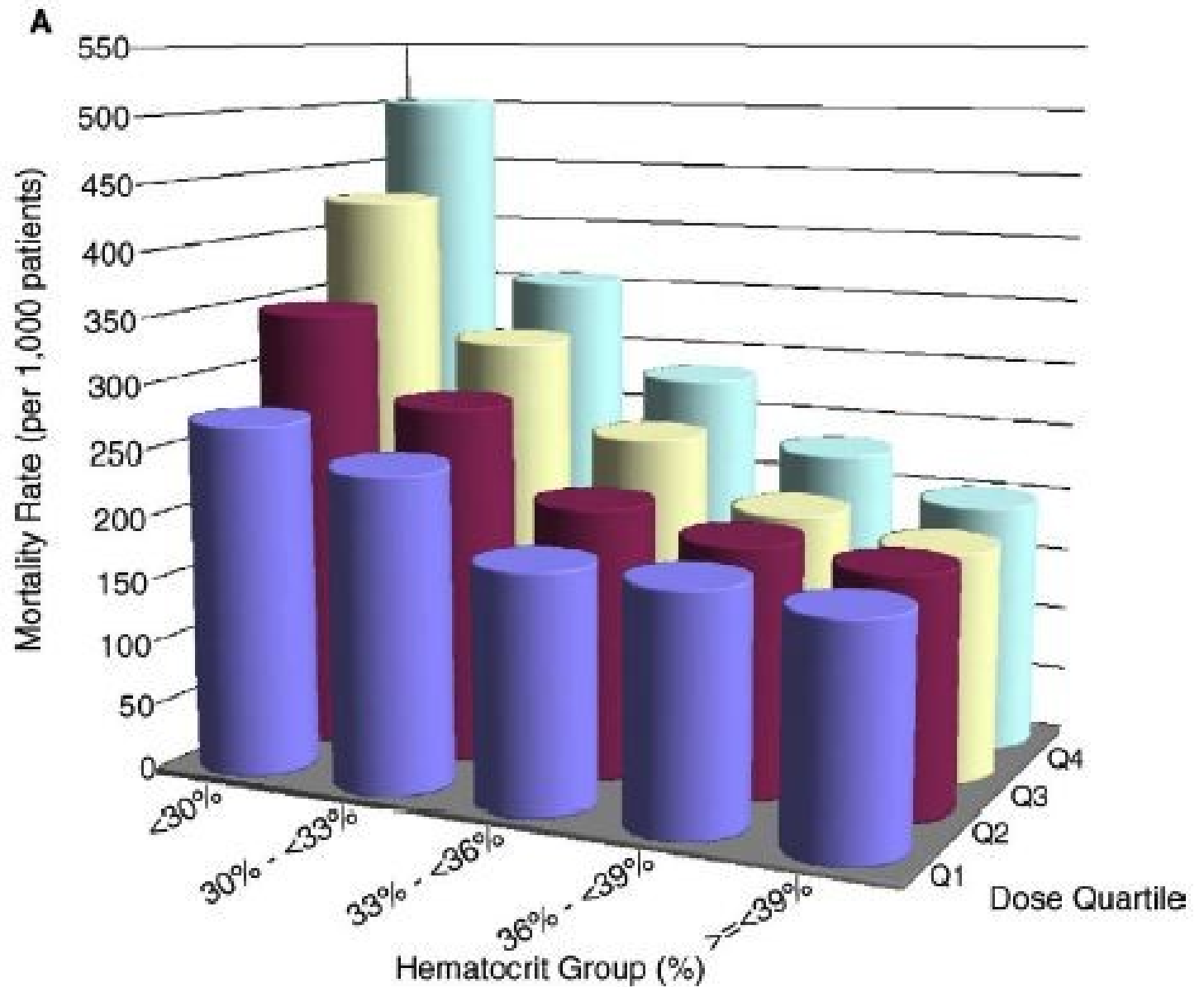
- Self sufficiency
- Efficient information transfer
- **Data-to-ink ratio**
- Follow conventions & readers' expectations

Data-to-Ink Ratio



Data-to-Ink Ratio

D.J. Cotter et al. / Journal of Clinical Epidemiology 57 (2004) 1086–1095

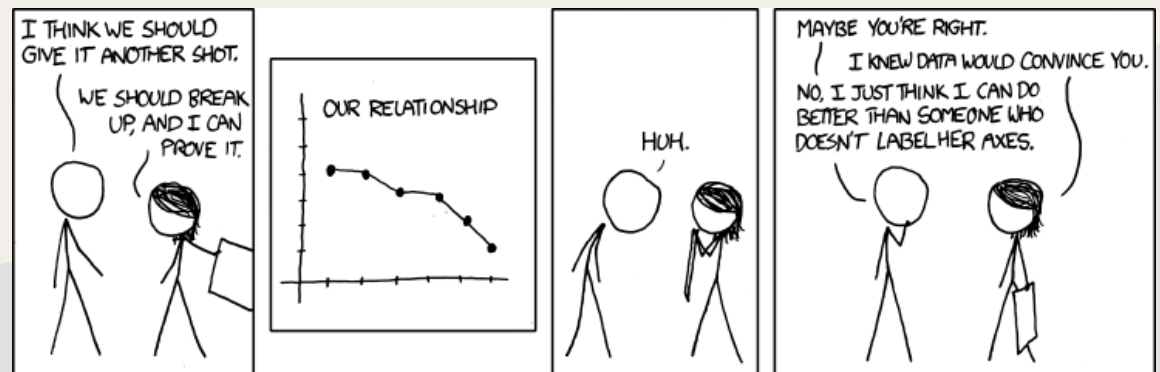


Elements of Good Data Visualization

- Self sufficiency
- Efficient information transfer
- Data-to-ink ratio
- Follow conventions & readers' expectations

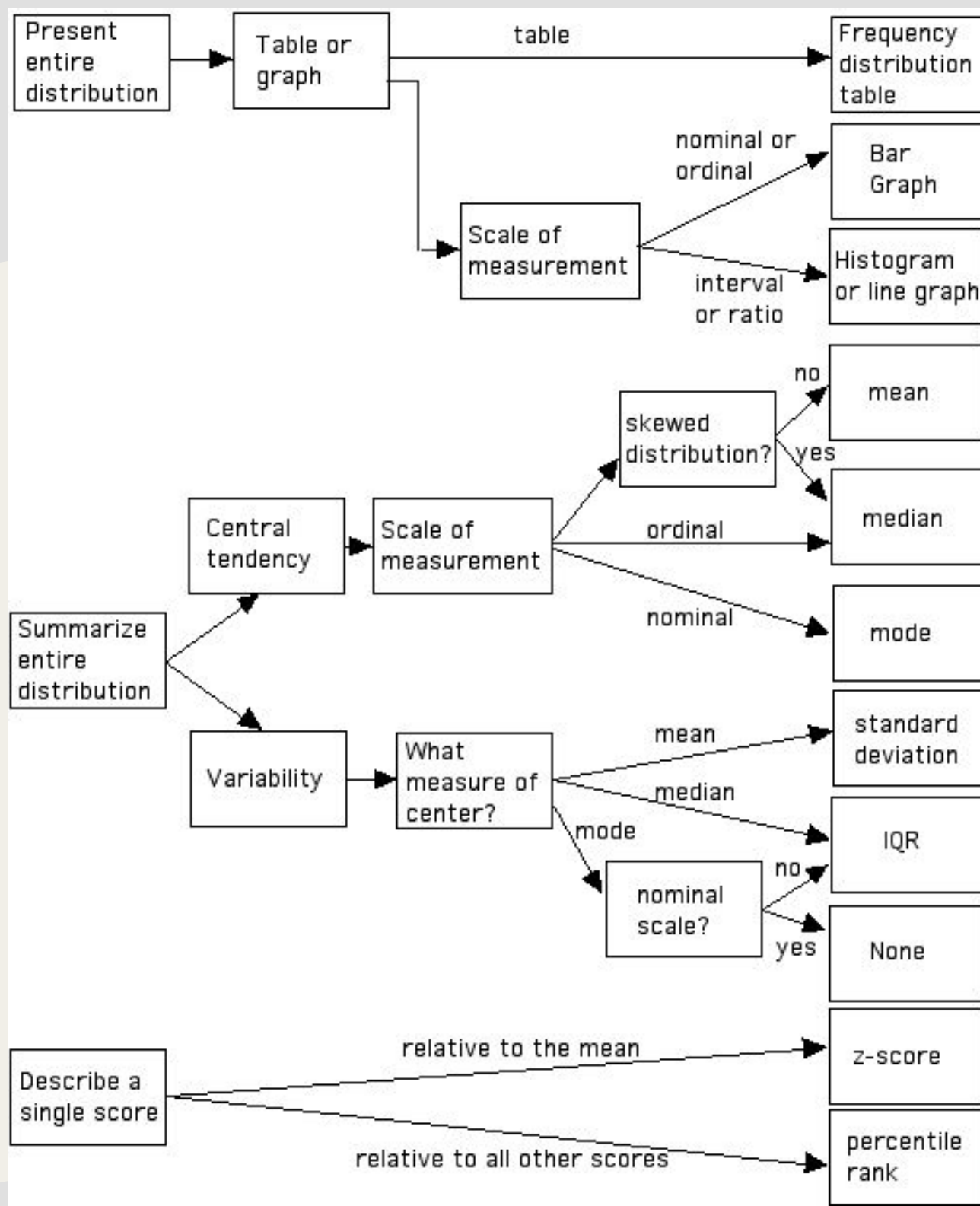
Follow conventions & readers' expectations

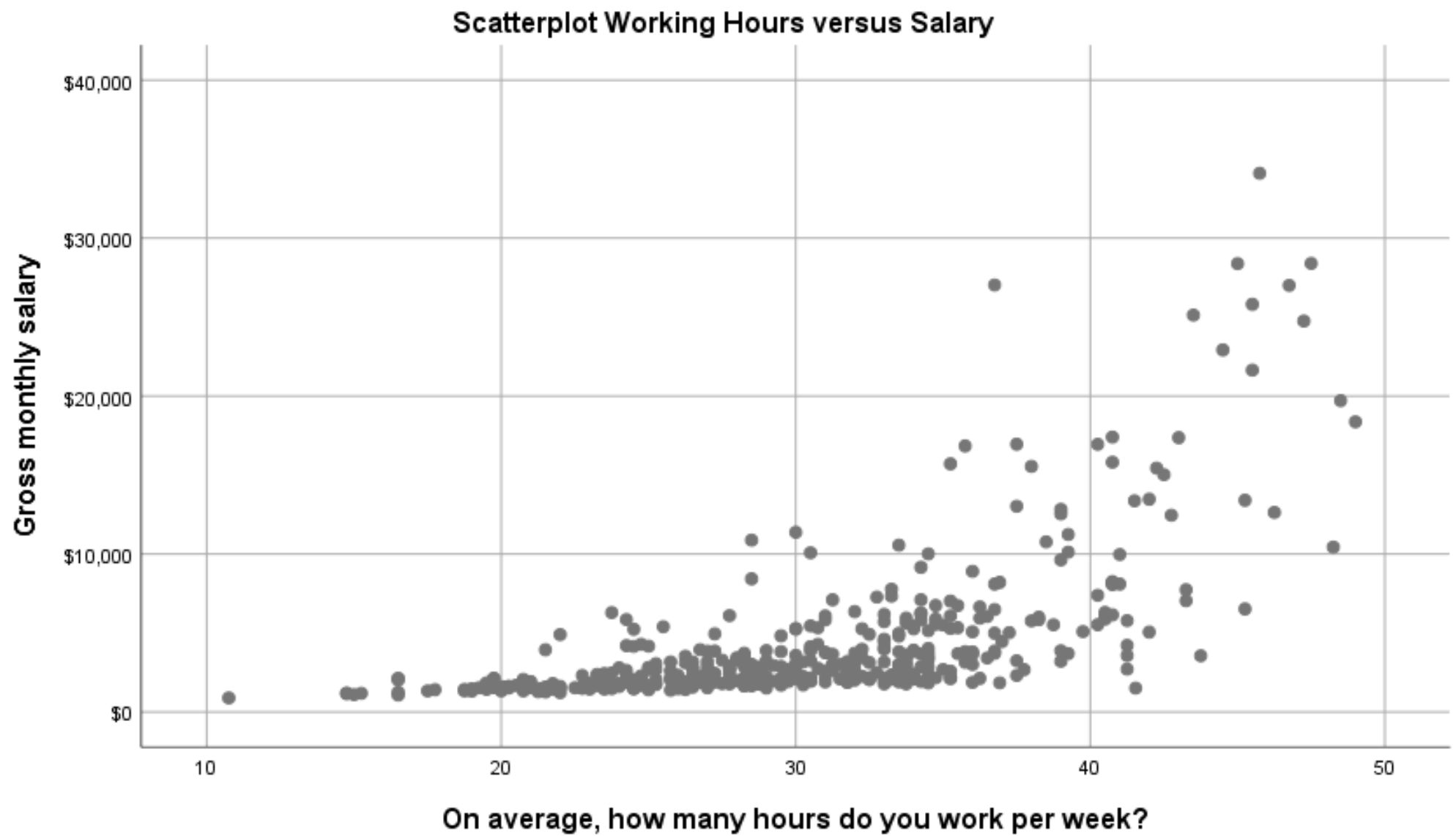
- Label axes, give titles, consider a legend
 - Use title as the figure's message
 - Consider labeling elements *within* the figure
- Time progresses from left to right
 - Or clockwise
- Changes in color track changes in conditions



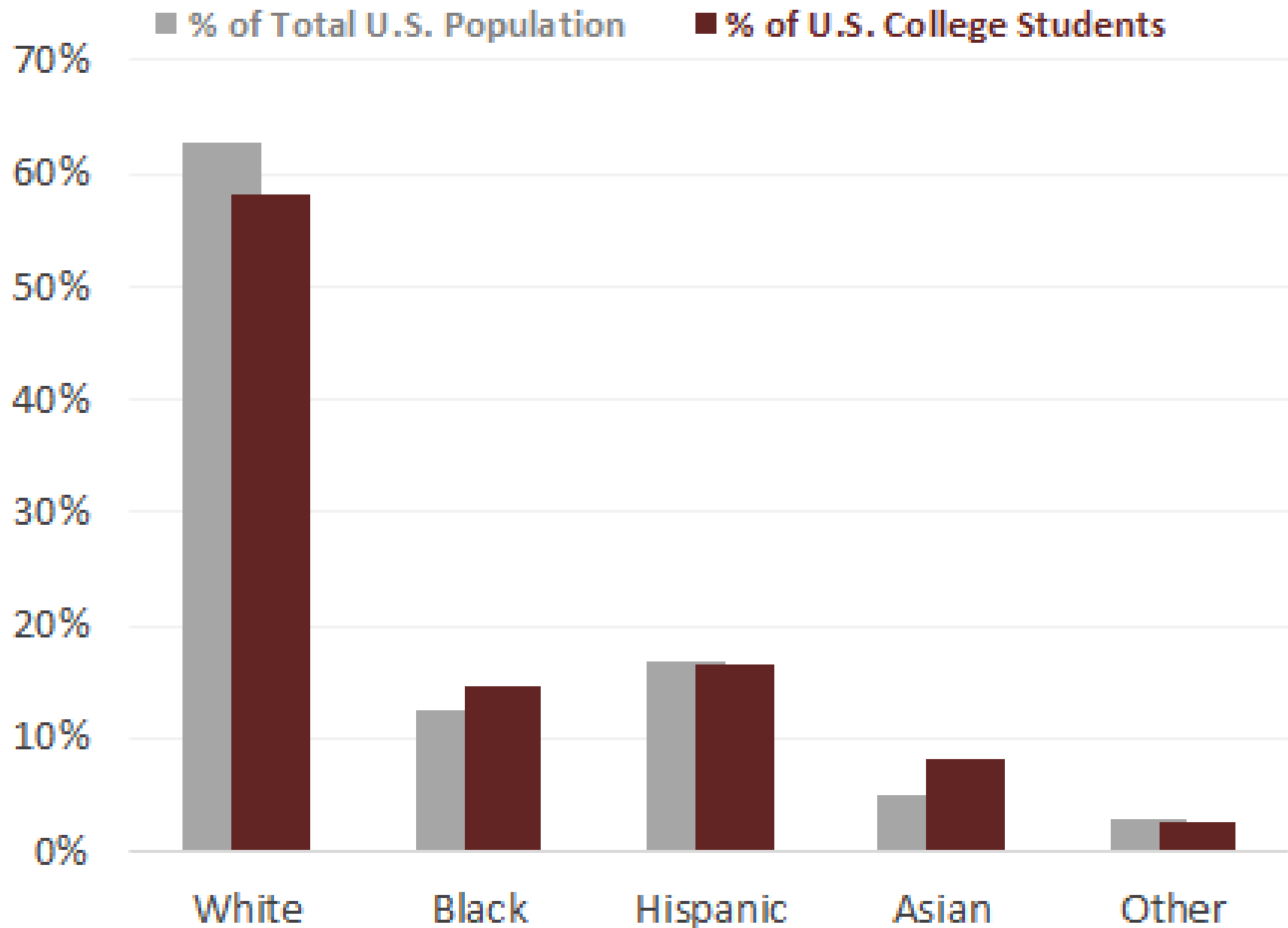
Follow conventions & readers' expectations (cont.)

- Use same scale for all parts of a figure
 - And between figures if possible
- Area of objects scale magnitude
 - But humans are bad at comparing areas
 - Lengths are much easier
- x-Axis on histograms & bar charts is zero
 - Or clearly marked as not



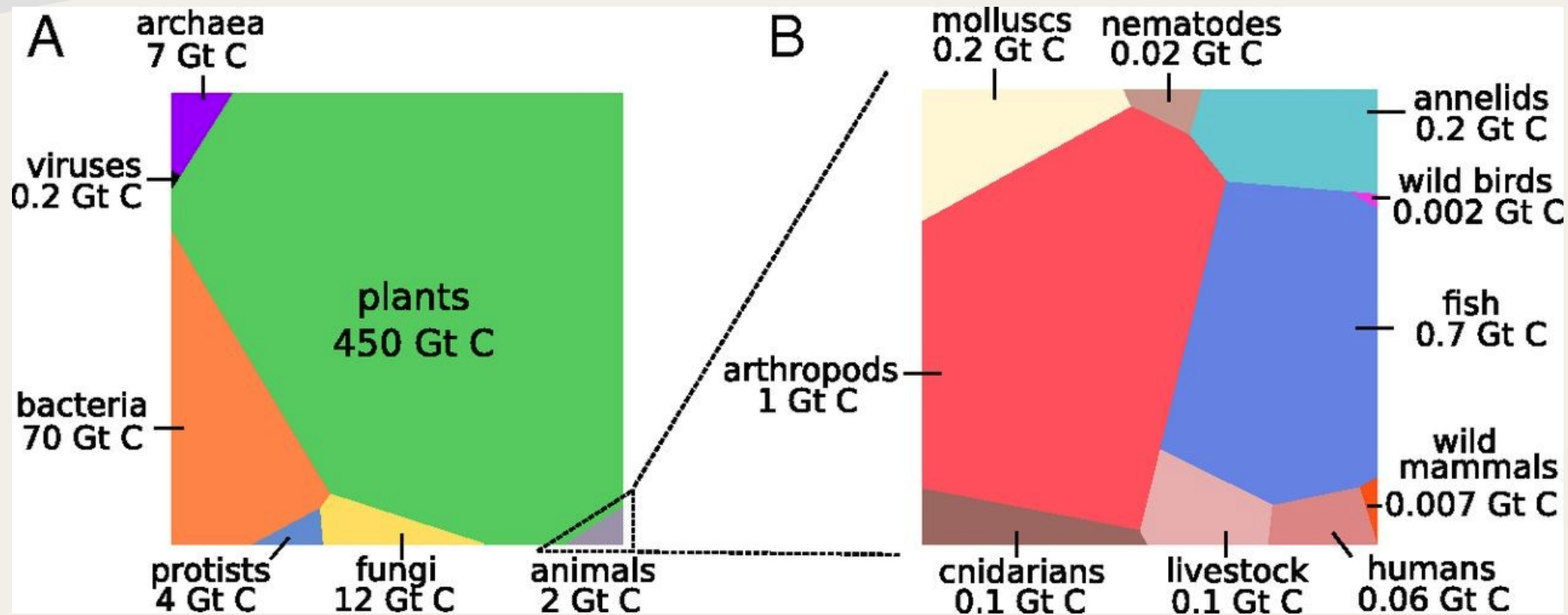


Share of College Enrollees by Race/Ethnicity



Data Source: U.S. Census Bureau

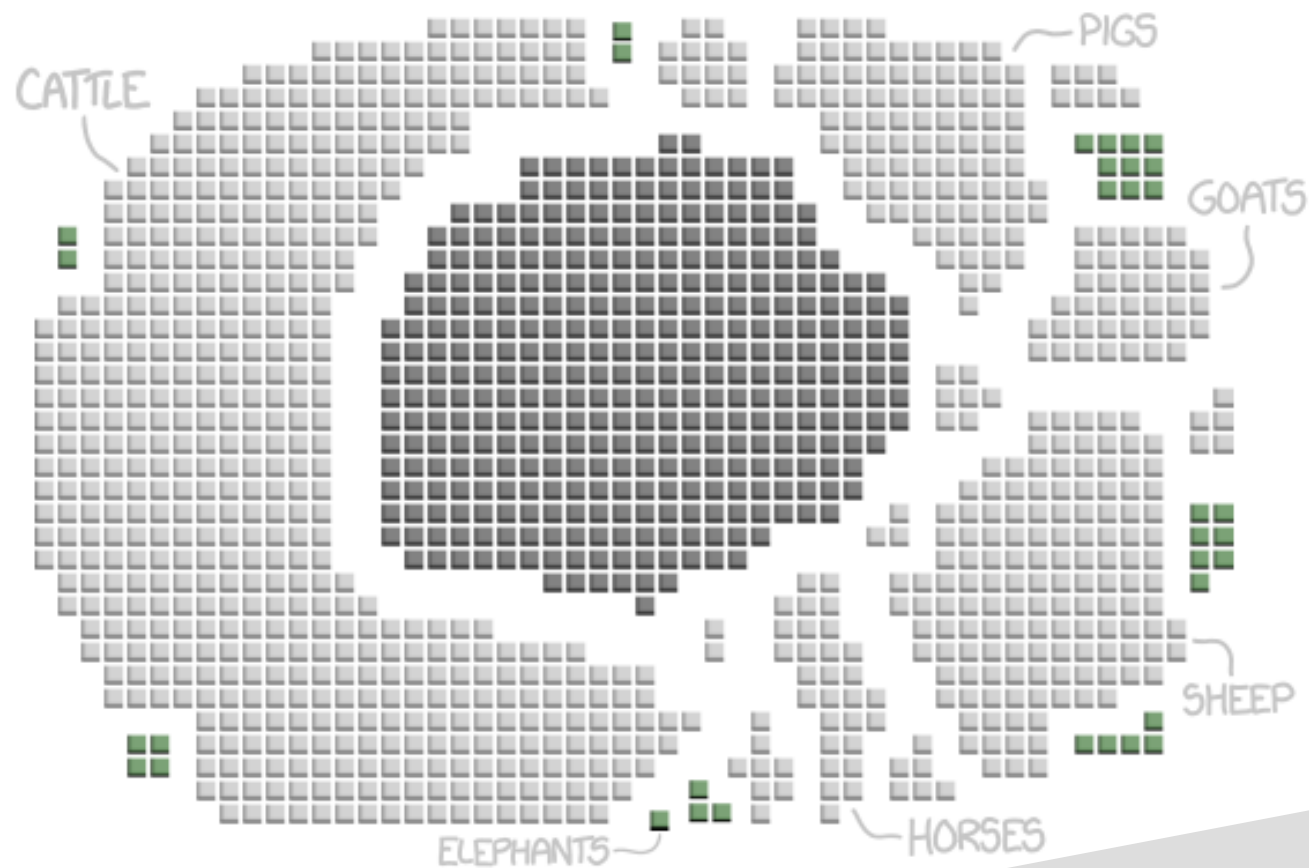
Proportions of Earth's Biomass

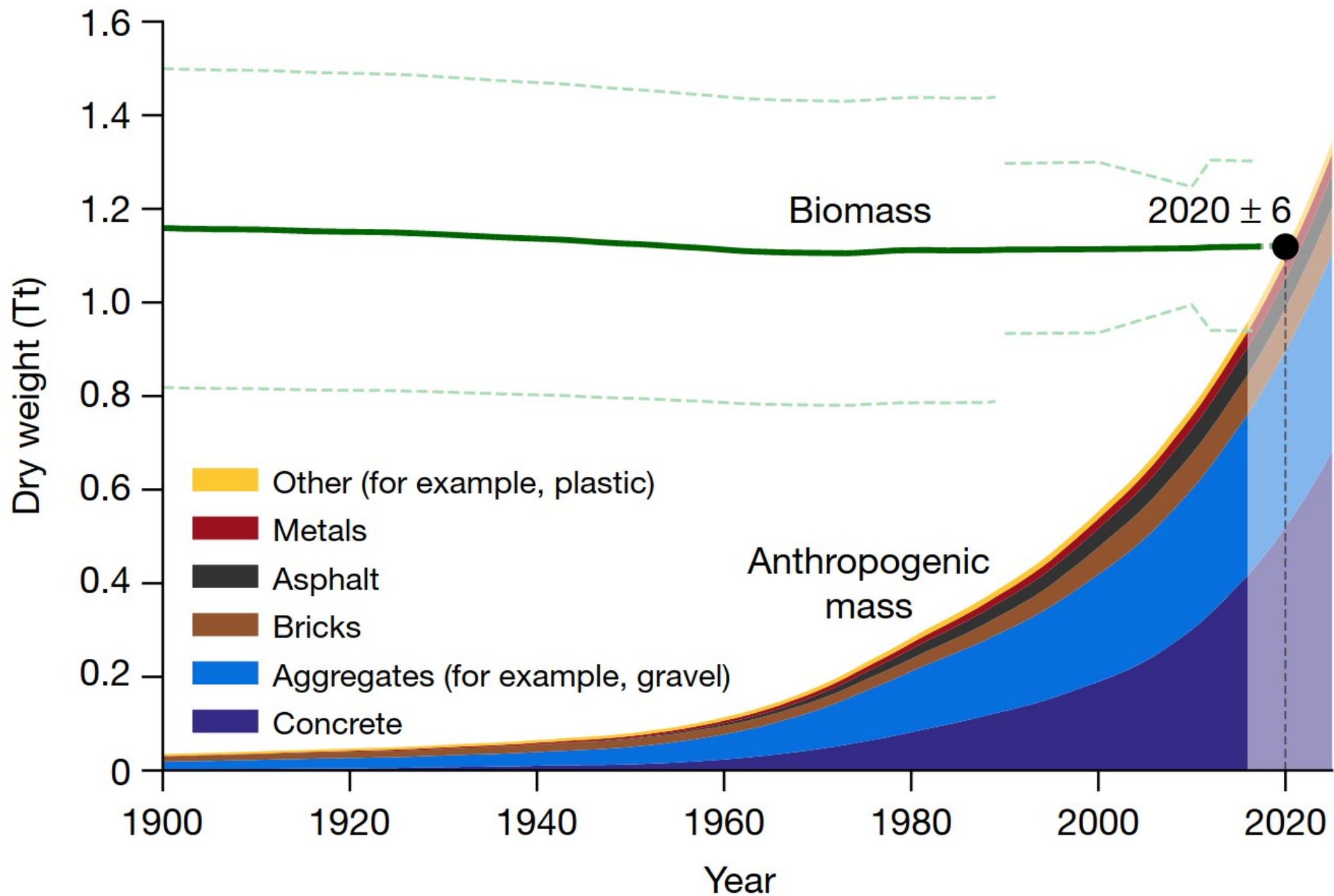


EARTH'S LAND MAMMALS BY WEIGHT

■ = 1,000,000 TONS

■ HUMANS ■ OUR PETS AND LIVESTOCK ■ WILD ANIMALS



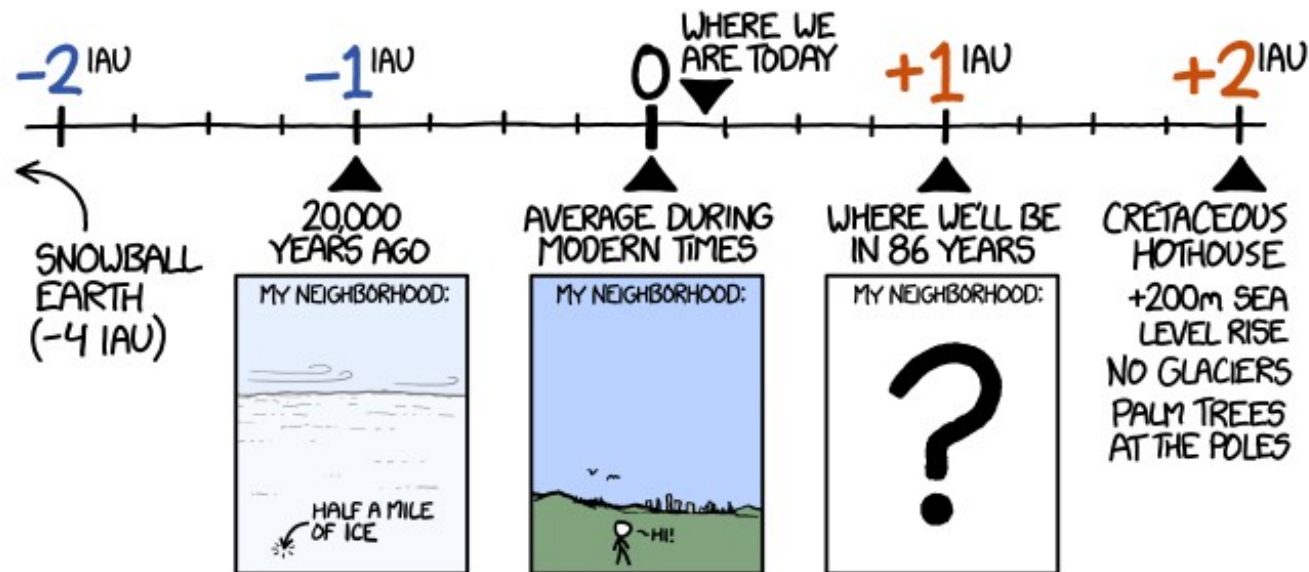


From Elhacham et al. (2020)

WITHOUT PROMPT, AGGRESSIVE LIMITS ON CO₂ EMISSIONS, THE EARTH WILL LIKELY WARM BY AN AVERAGE OF 4°-5°C BY THE CENTURY'S END.

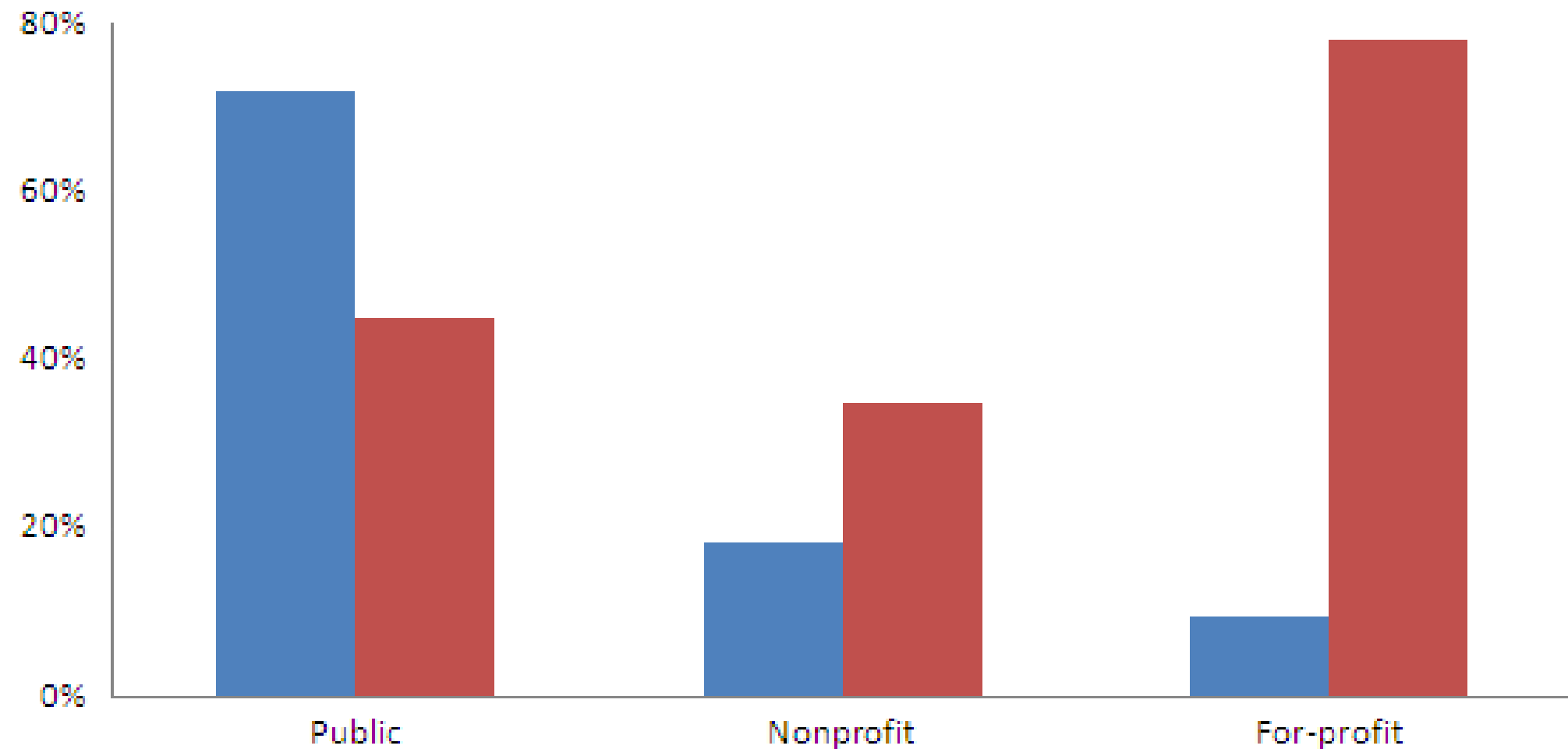
HOW BIG A CHANGE IS THAT?

IN THE COLDEST PART OF THE LAST ICE AGE, EARTH'S AVERAGE TEMPERATURE WAS 4.5°C BELOW THE 20TH CENTURY NORM.
LET'S CALL A 4.5°C DIFFERENCE ONE "ICE AGE UNIT."



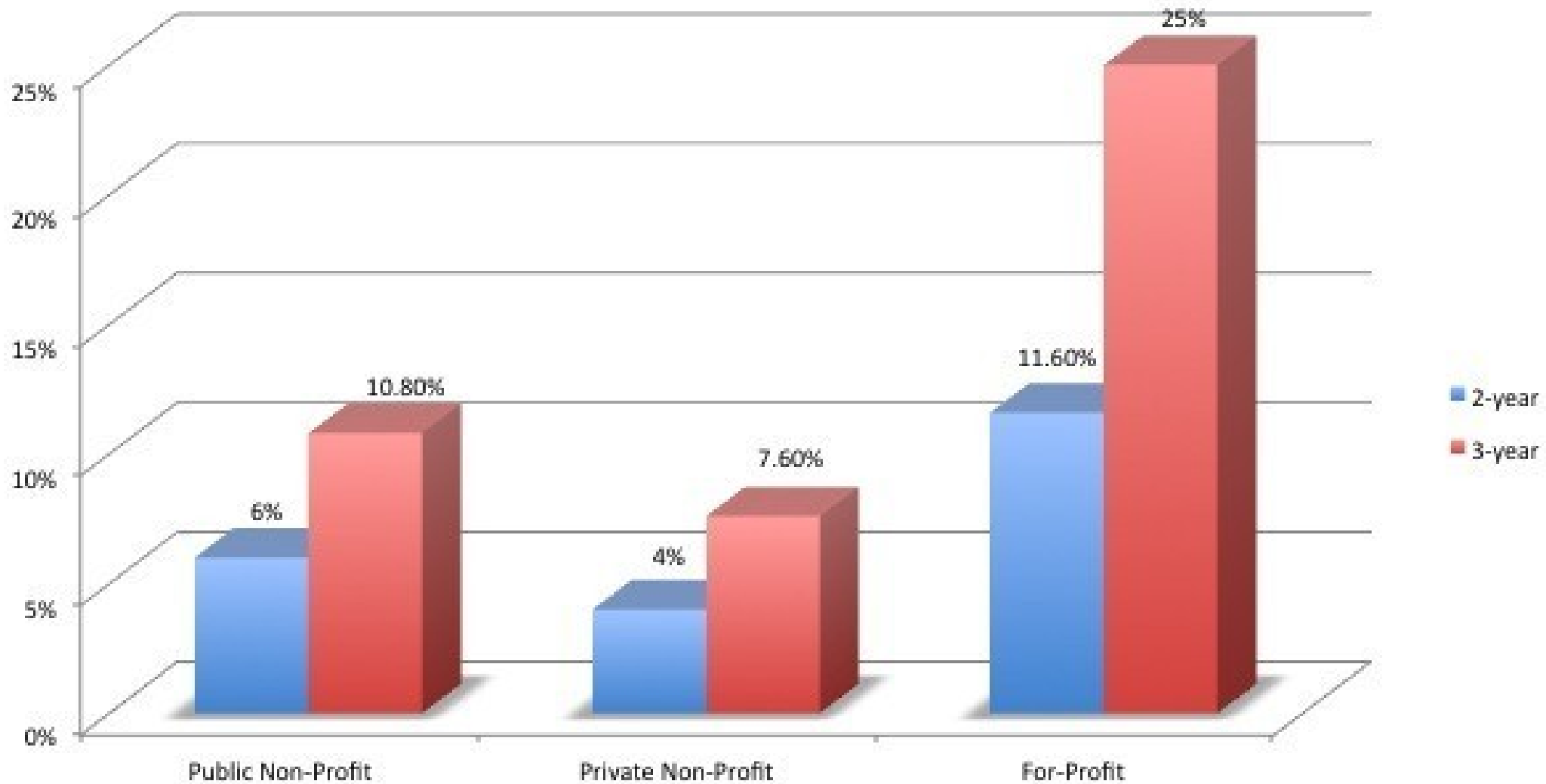
College enrollment and drop-out rates at different four-year institutions

- Percentage of total national student enrollment
- Percentage who fail to get a degree within six years



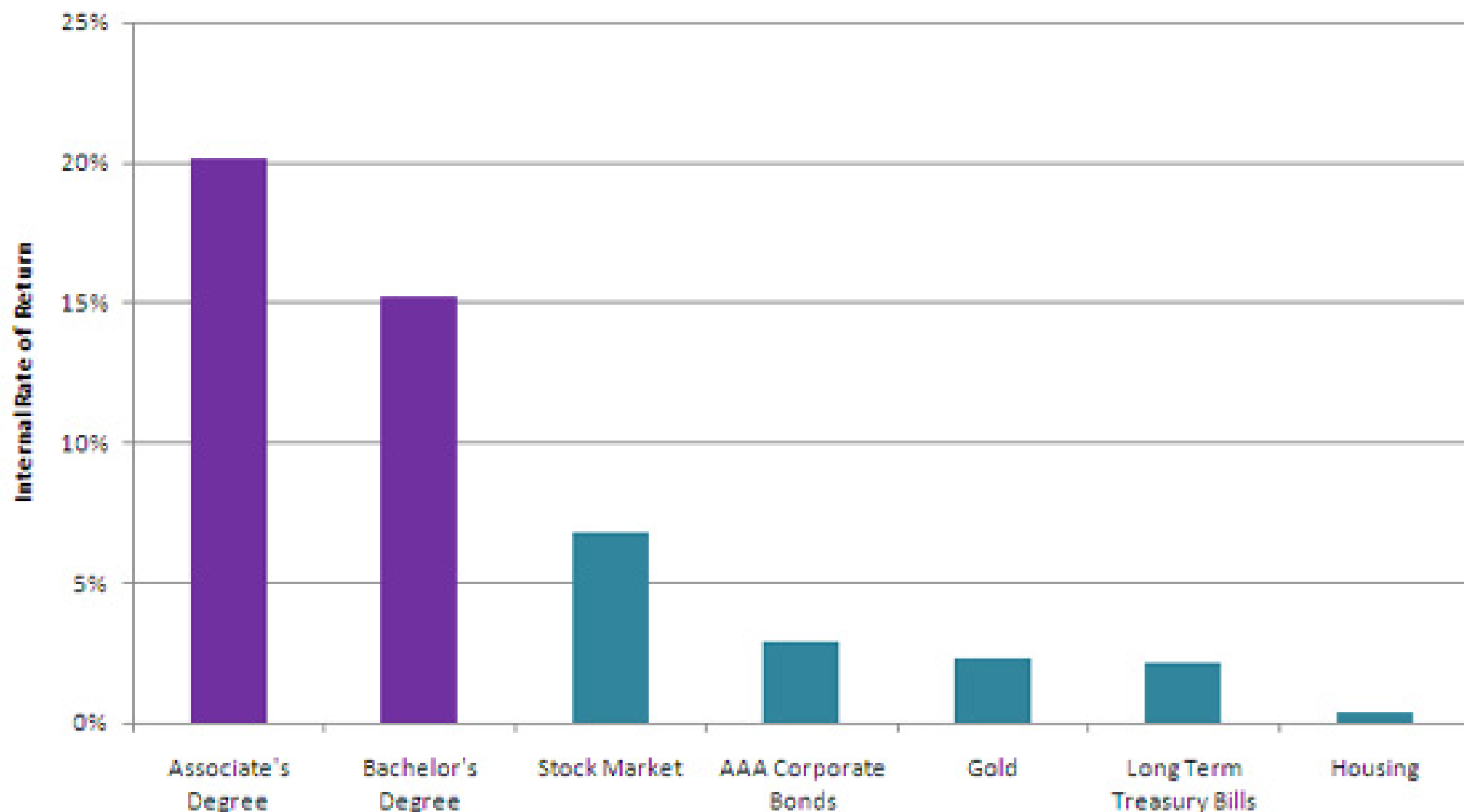
Source: NCES, Harvard Graduate School of Education

Student Loan Default Rates-By Education Sector



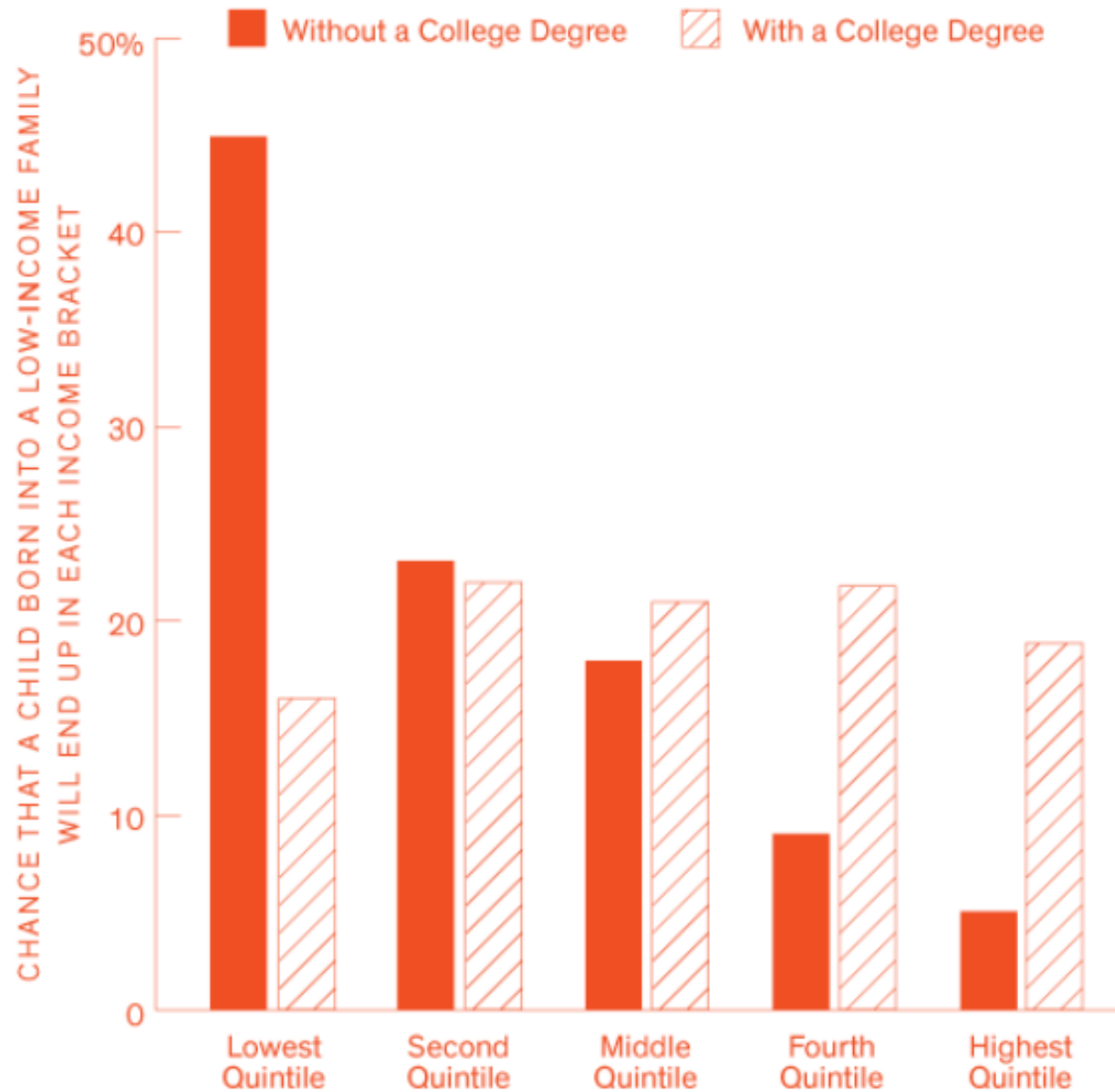
Source: U.S. Department of Education, based on students who began repaying loans in FY08

College Compared to Alternative Investments



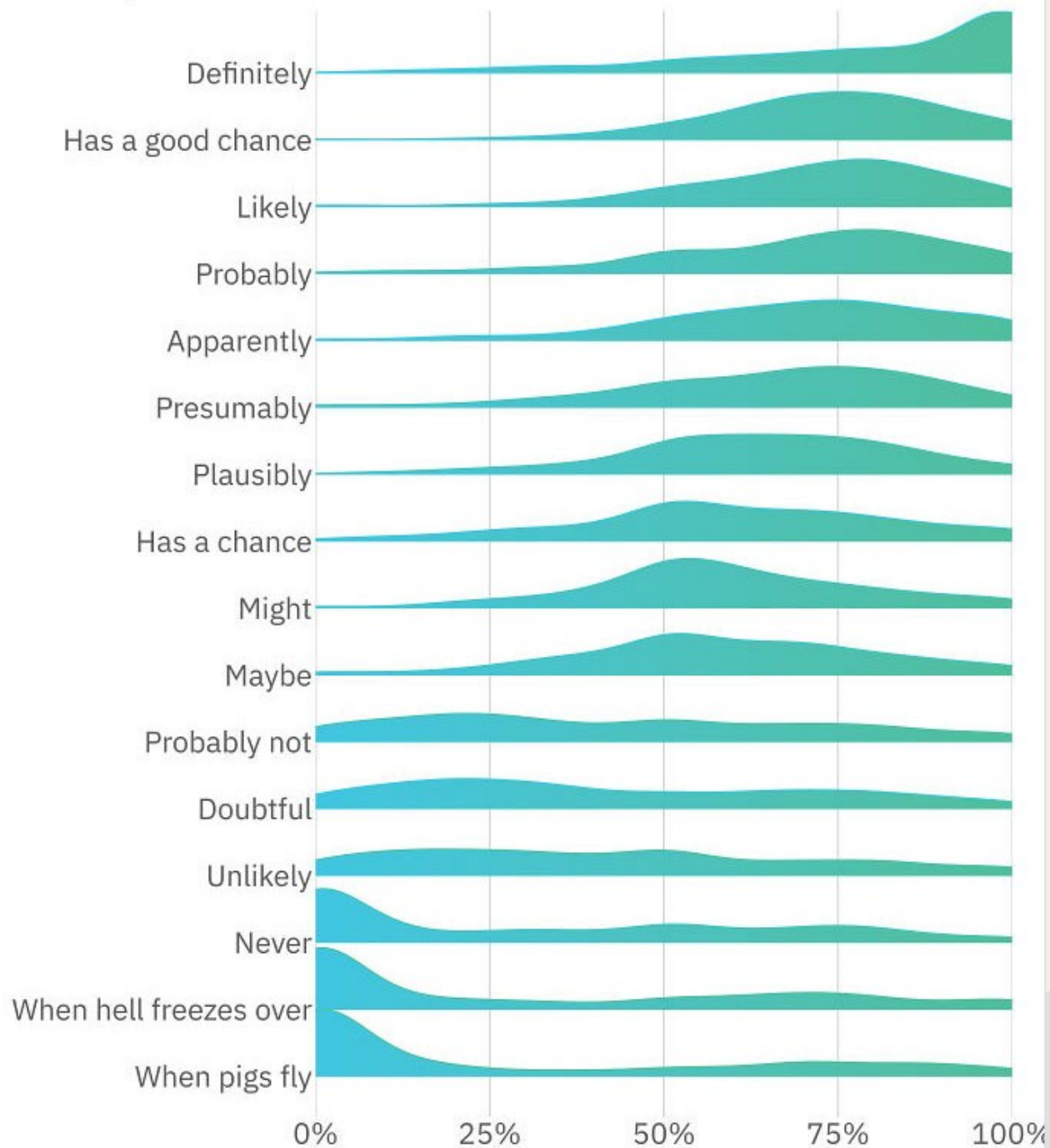
Note: Asset returns are geometric averages since 1950. Source: Author's calculations of IRR, values adjusted for inflation using the CPI-U; March Current Population Survey (CPS) 2007-2010 averages; National Mining Association; National Center for Education Statistics; Robert Shiller online data, Long Term Treasury Bills have 10 year maturities after 1953; Federal Reserve Bank of St. Louis.

THE ECONOMIC MOBILITY A COLLEGE DEGREE BRINGS



People born into the lowest economic quintile have a much better chance of escaping poverty as adults if they earn a college degree.

How probable is...



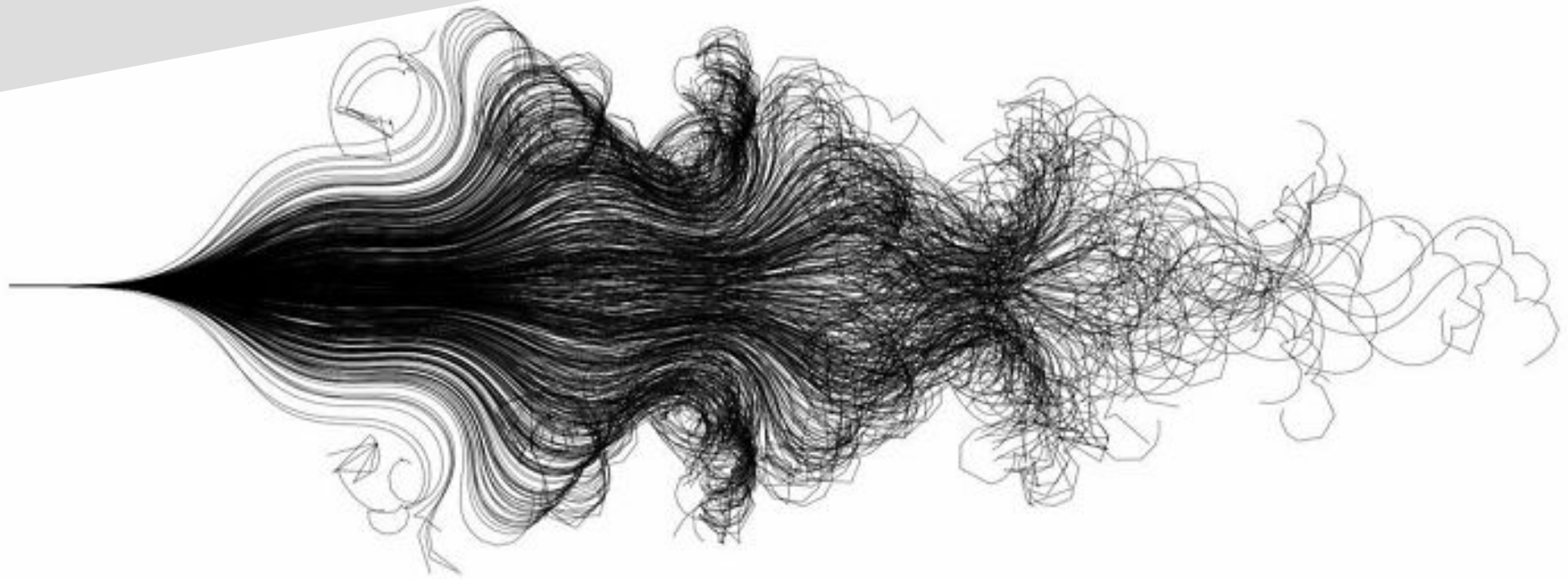
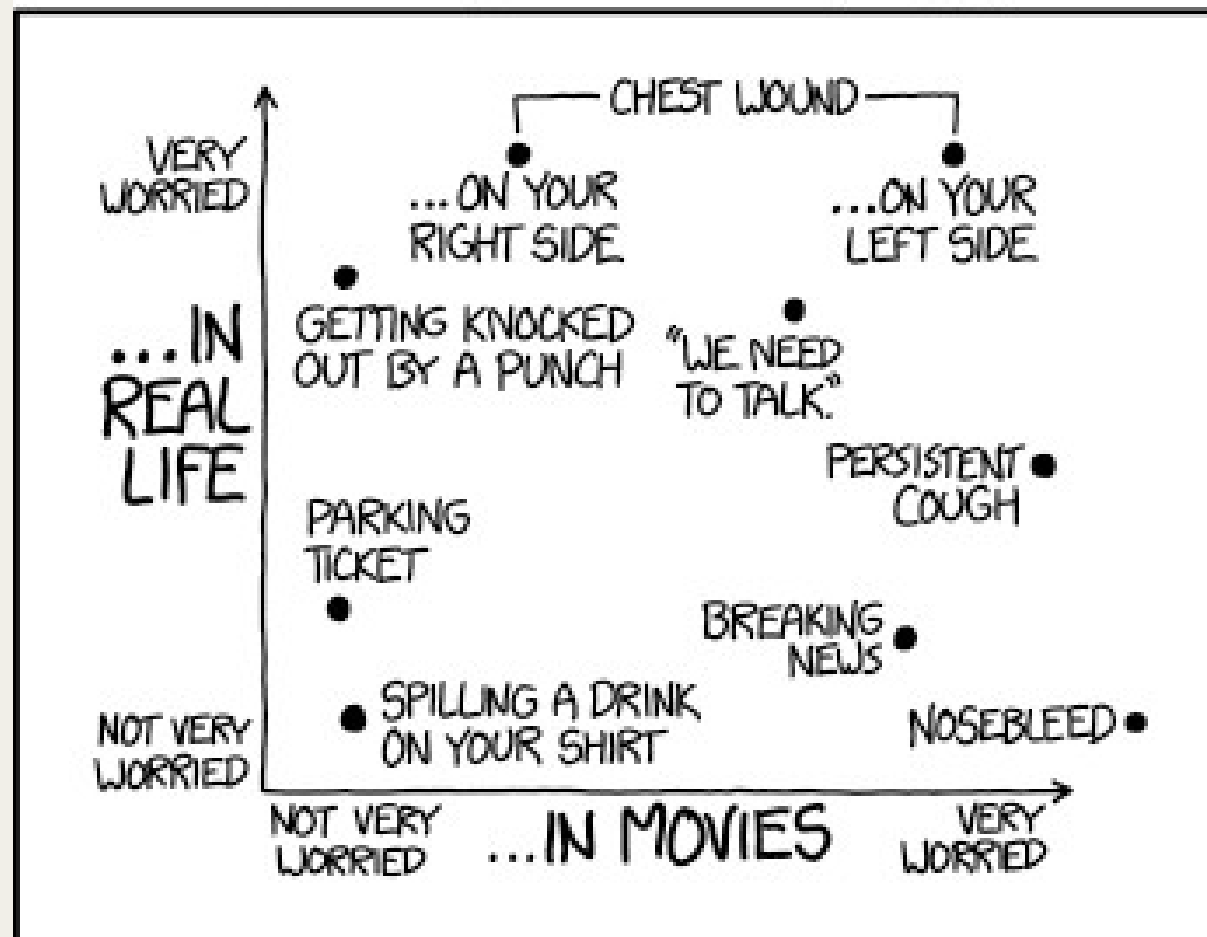


Figure 2: Instability of an unsteered bicycle. This shows 800 runs of a bicycle being pushed to the right. For each run, the path of the front wheel on the ground is shown until the bicycle has fallen over. The unstable oscillatory nature is due to the subcritical speed of the bicycle, which loses further speed with each oscillation.

HOW WORRIED SHOULD YOU BE WHEN VARIOUS THINGS HAPPEN TO YOU:



HOW EASY IT IS TO GROW UP
WITHOUT LEARNING [THING]

EASY

- 100 DIGITS OF PI
- LYRICS TO *WE DIDN'T START THE FIRE*

THAT CAT BITES ARE REALLY SERIOUS
AND IF BITTEN YOU NEED TO WASH THE
BITE AND CALL A DOCTOR IMMEDIATELY

THE RED FLAGS FOR AN
ABUSIVE RELATIONSHIP

THE SIGNS OF A STROKE

HOW BAD IT IS IF YOU
DON'T KNOW [THING]

COUGH INTO YOUR ELBOW,
NOT YOUR HAND

NOT
BAD

VERY
BAD

HOW TO RIDE A BIKE ●

THAT YOU HAVE TO EMPTY
THE DRYER LINT TRAP

- HOW TO ESCAPE
MOVIE QUICKSAND
- LYRICS TO *12 DAYS
OF CHRISTMAS*

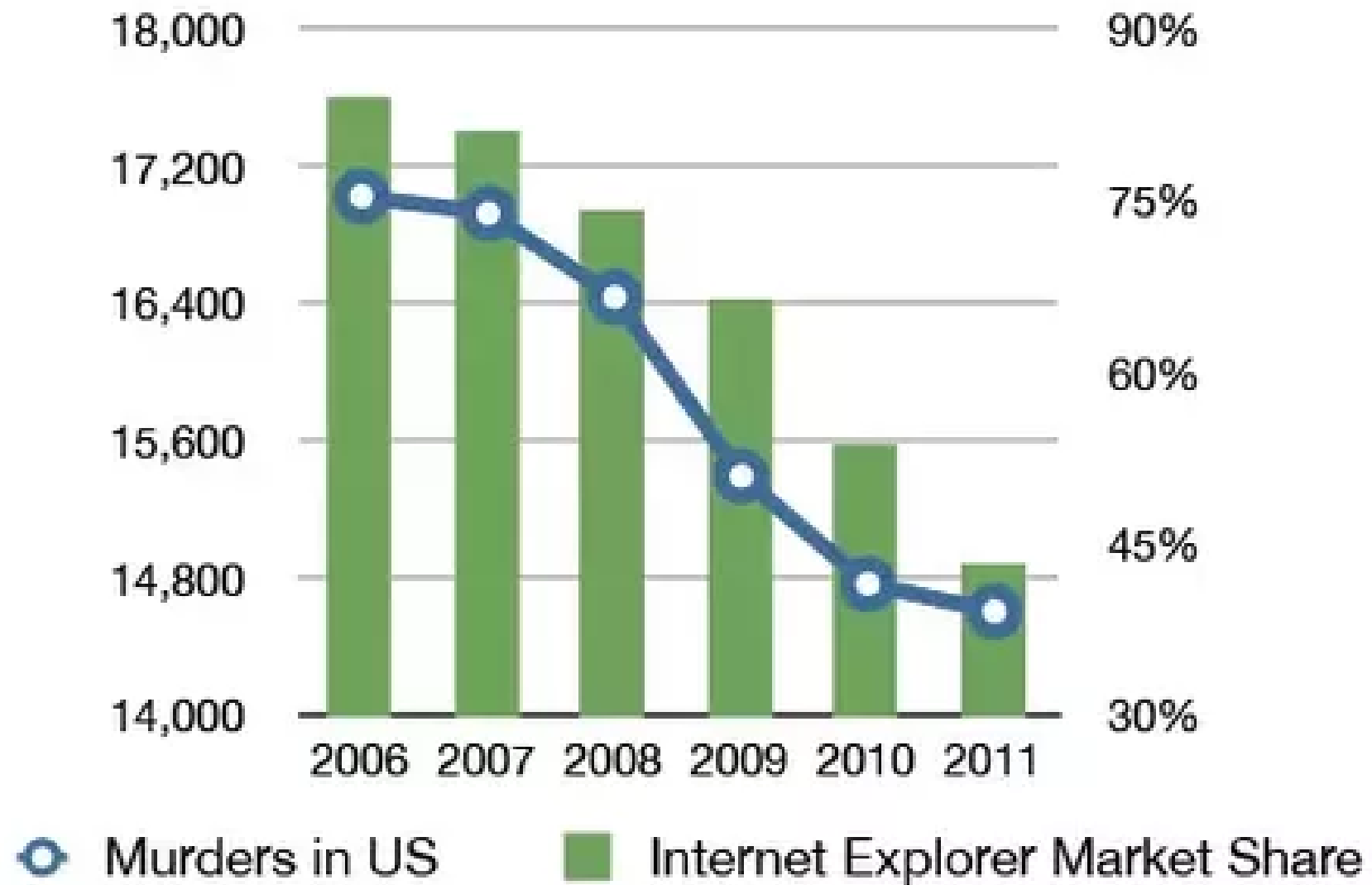
STOP, DROP, AND ROLL

- TV THEME SONGS

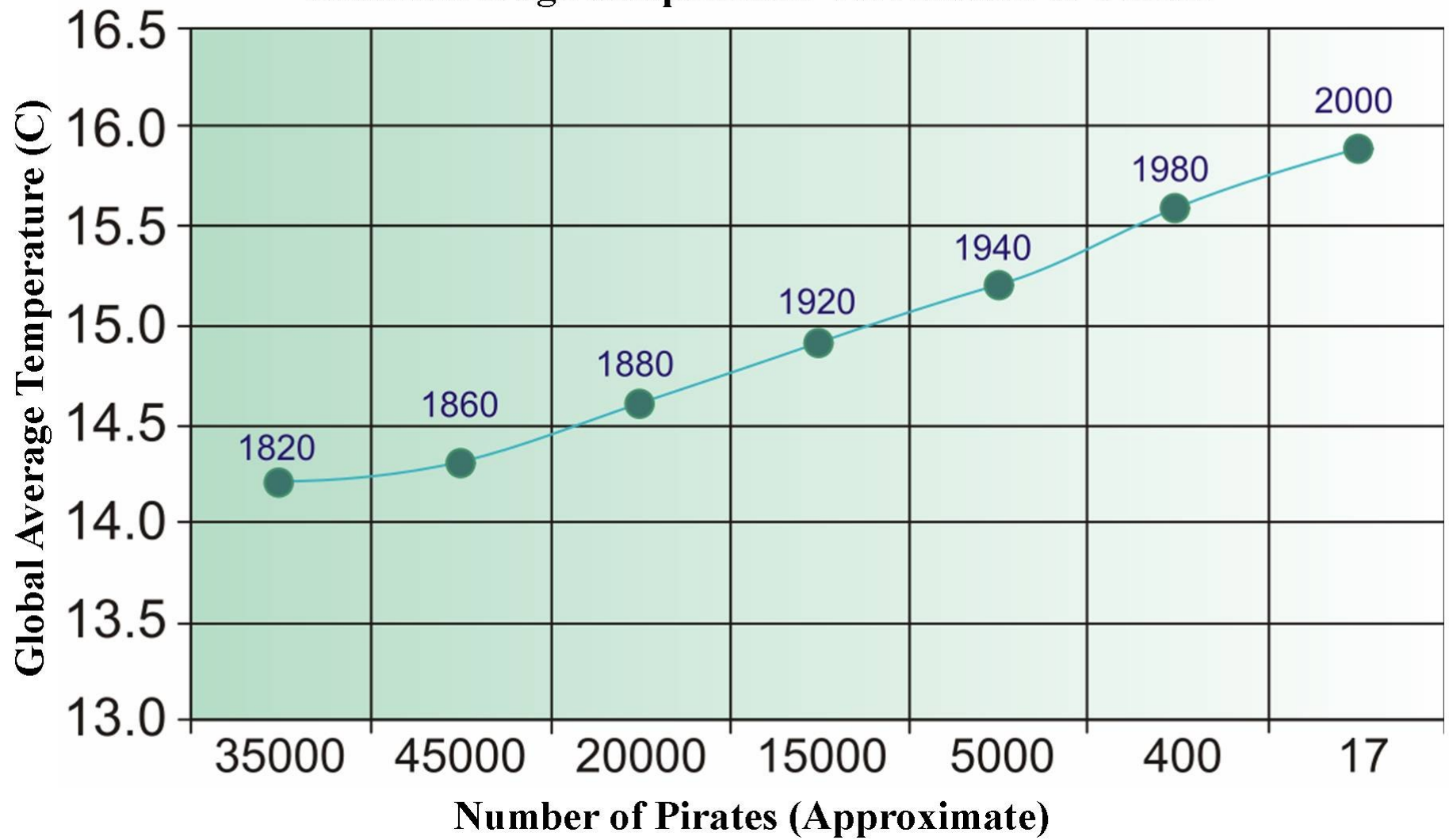
THAT YOU HAVE
TO PAY TAXES ●

HARD

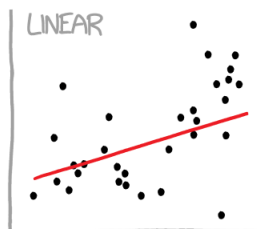
Internet Explorer vs Murder Rate



Global Average Temperature Vs. Number of Pirates



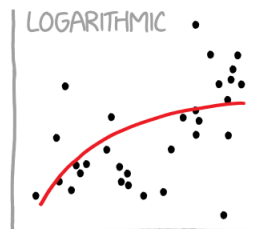
CURVE-FITTING METHODS AND THE MESSAGES THEY SEND



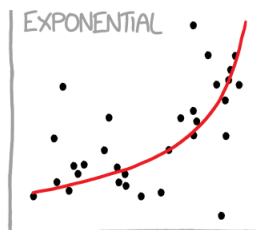
"HEY, I DID A REGRESSION."



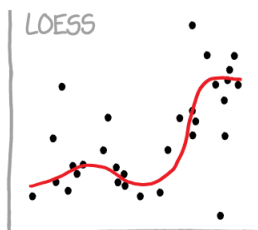
"I WANTED A CURVED LINE, SO I MADE ONE WITH MATH."



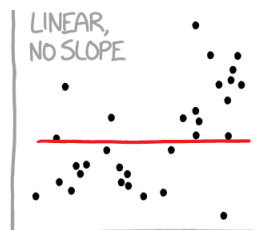
"LOOK, IT'S TAPERING OFF!"



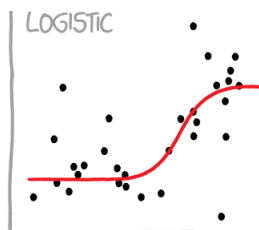
"LOOK, IT'S GROWING UNCONTROLLABLY!"



"I'M SOPHISTICATED, NOT LIKE THOSE BUMBLING POLYNOMIAL PEOPLE."



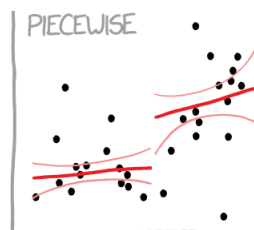
"I'M MAKING A SCATTER PLOT BUT I DON'T WANT TO."



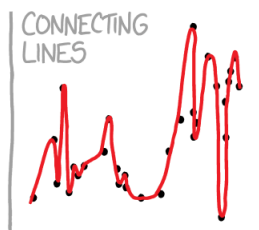
"I NEED TO CONNECT THESE TWO LINES, BUT MY FIRST IDEA DIDN'T HAVE ENOUGH MATH."



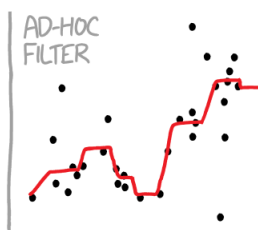
"LISTEN, SCIENCE IS HARD. BUT I'M A SERIOUS PERSON DOING MY BEST."



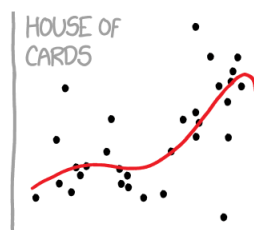
"I HAVE A THEORY, AND THIS IS THE ONLY DATA I COULD FIND."



"I CLICKED 'SMOOTH LINES' IN EXCEL."



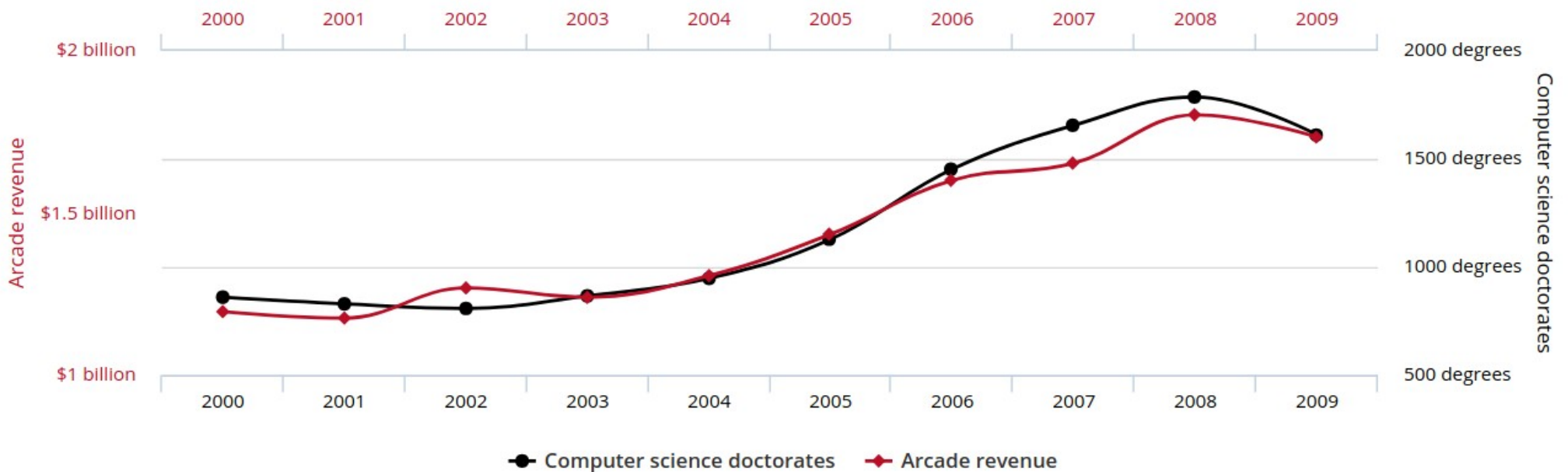
"I HAD AN IDEA FOR HOW TO CLEAN UP THE DATA. WHAT DO YOU THINK?"



"AS YOU CAN SEE, THIS MODEL SMOOTHLY FITS THE— WAIT NO NO DON'T EXTEND IT AAAAAA!!!"

Total revenue generated by arcades correlates with Computer science doctorates awarded in the US

Correlation: 98.51% ($r=0.985065$)

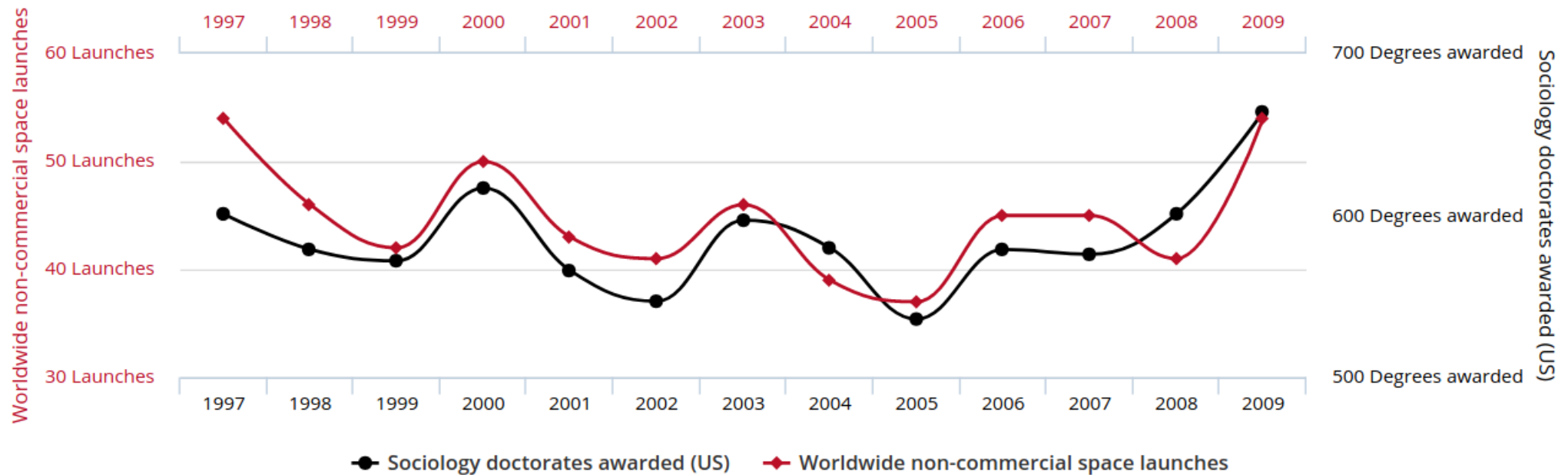


tylervigen.com

Data sources: U.S. Census Bureau and National Science Foundation

Worldwide non-commercial space launches correlates with Sociology doctorates awarded (US)

Correlation: 78.92% ($r=0.78915$)

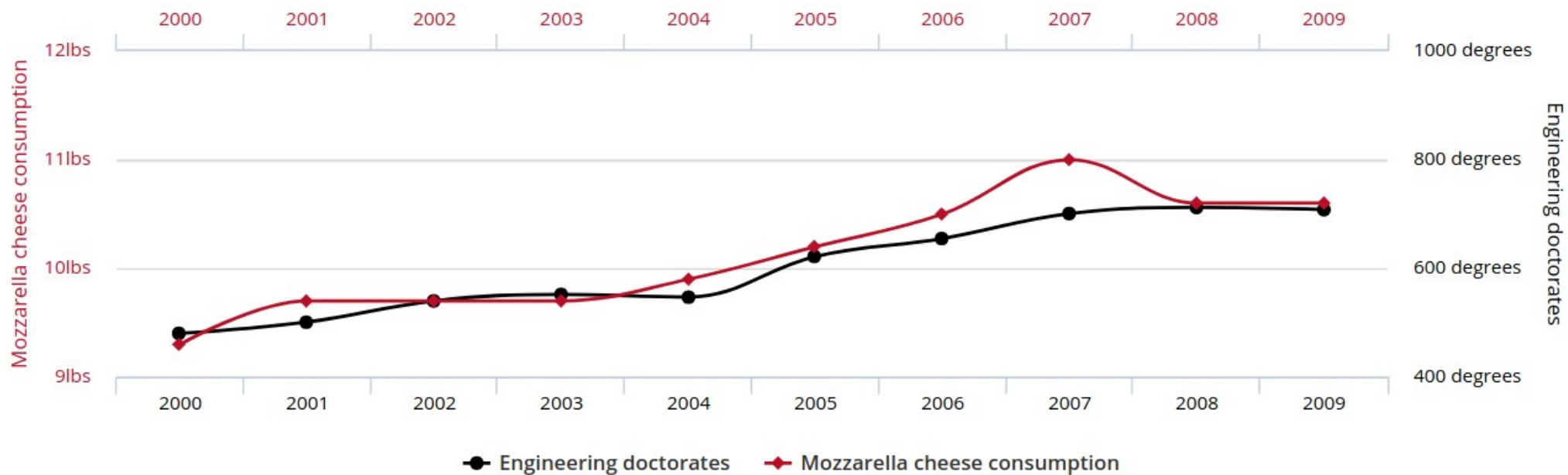


tylervigen.com

Data sources: Federal Aviation Administration and National Science Foundation

Per capita consumption of mozzarella cheese correlates with Civil engineering doctorates awarded

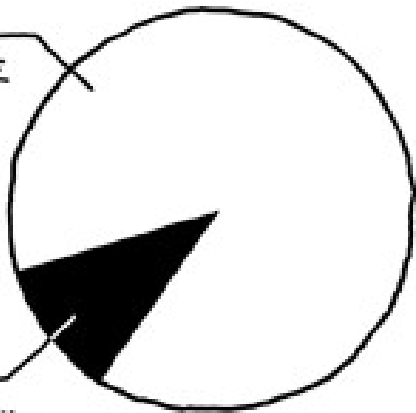
Correlation: 95.86% ($r=0.958648$)



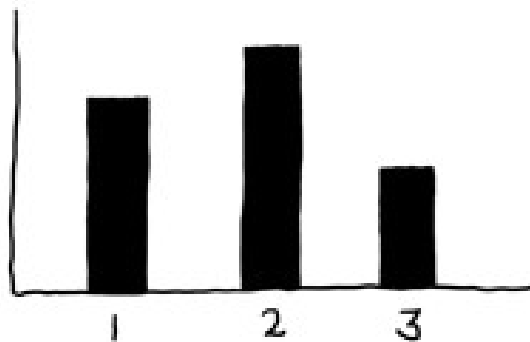
tylervigen.com

Data sources: U.S. Department of Agriculture and National Science Foundation

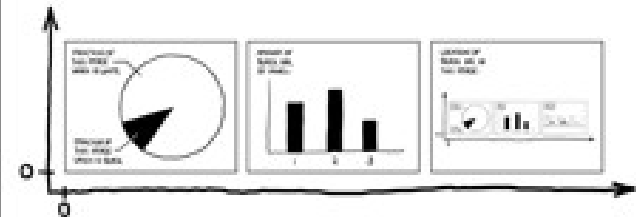
FRACTION OF
THIS IMAGE
WHICH IS WHITE



AMOUNT OF
BLACK INK
BY PANEL:



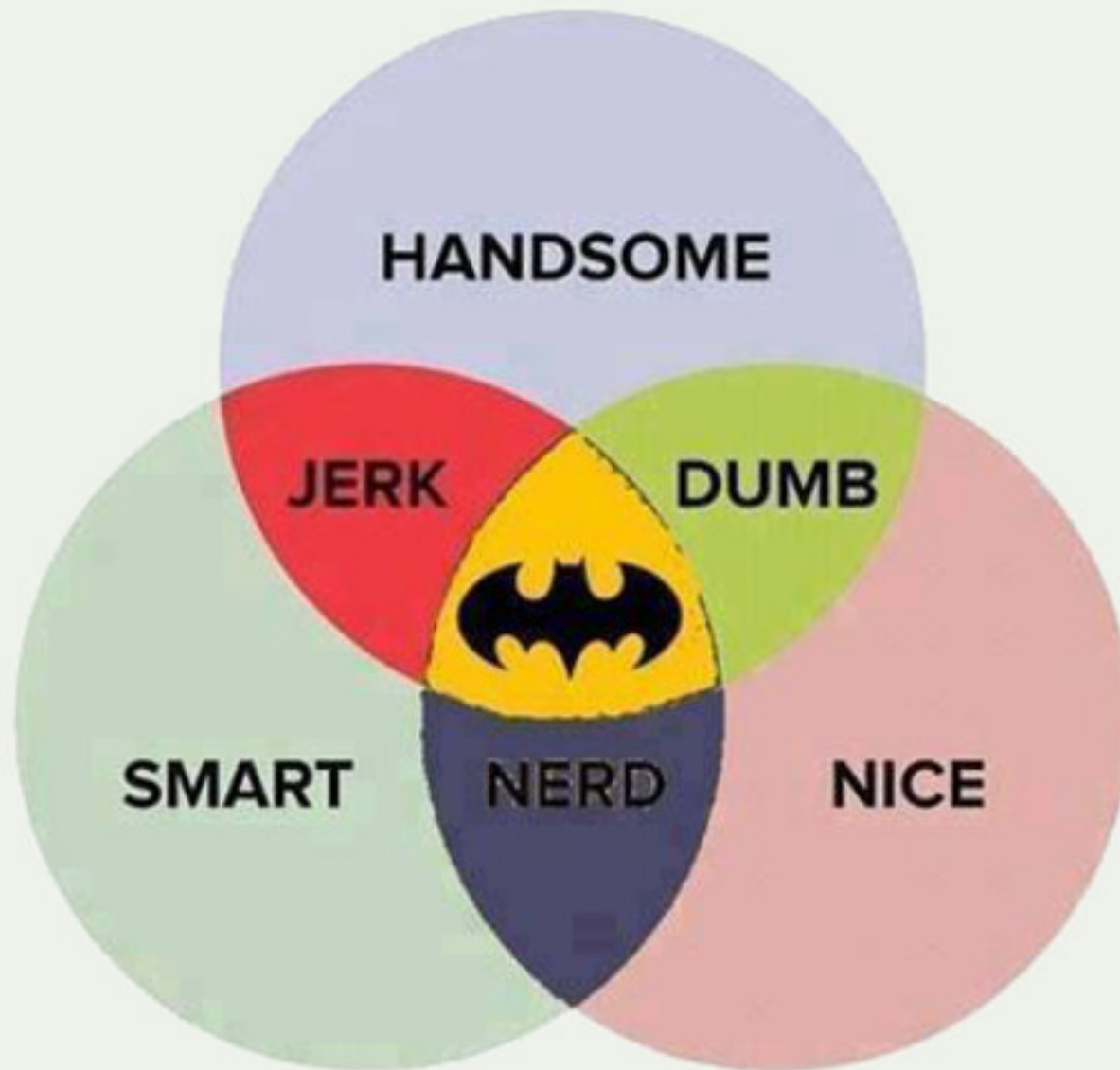
LOCATION OF
BLACK INK IN
THIS IMAGE:



The contents of any one panel are dependent on the contents of every panel including itself. The graph of panel dependencies is complete and bidirectional, and each node has a loop.



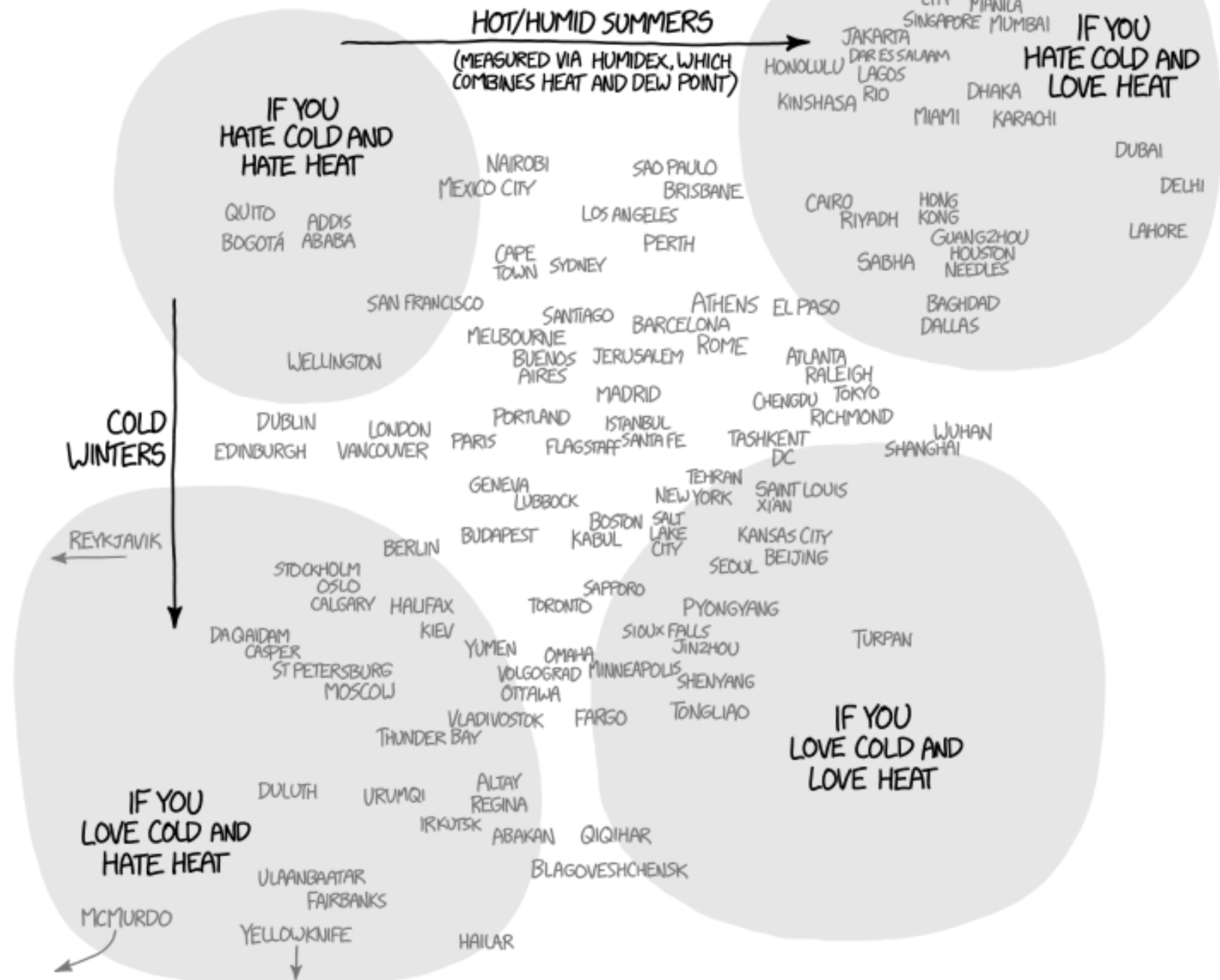
MEN

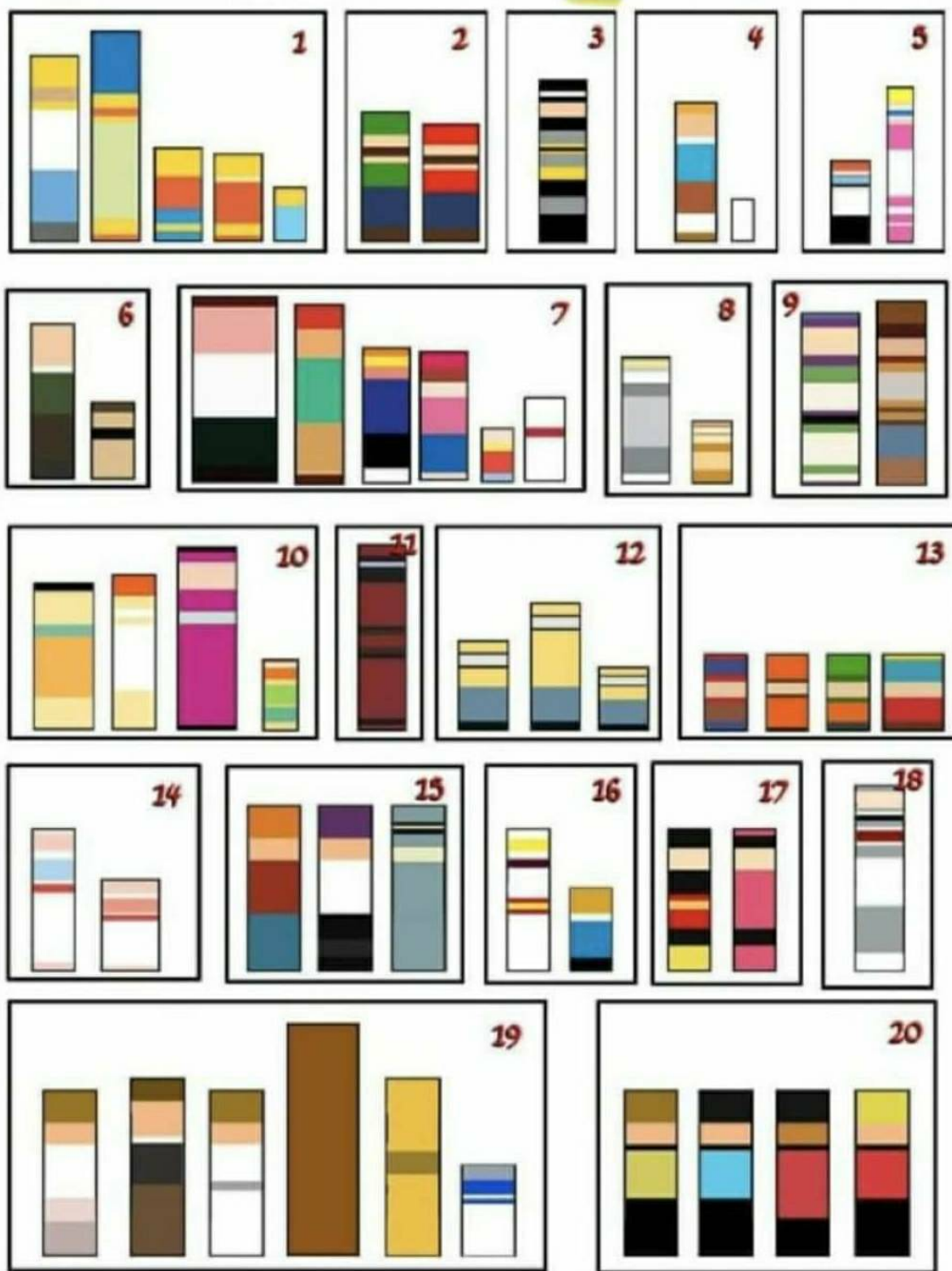


WHERE TO LIVE

BASED ON YOUR TEMPERATURE PREFERENCES

CLIMATE DATA FROM WEATHERBASE.COM





2. Text



Ranibow Sprinkle™

@Muffin_Chips

A bot wrote this obituary and I'm losing my mind

BUT OBITUARY

Brenda Tent retired from living at the age of old, surrounded by family and natural causes. A librarian from birth, Brenda was an avid collector of dust. She had a sweet heart and married her high school. She loved having hobbies and helping her sons to be disadvantaged youths. She had no horses but thought she did. The church gave her a choir because she sang like bird and looked like bird and Brenda was a bird. She owed us so many poems.



The funeral will be held in 1977 at heaven. In lieu of flowers, send Brenda more life.

Writing Results Sections

- Tell a story
 - Hopefully about how your data address your research goals / hypotheses
- Use figures & tables as talking points
 - Describe the figure (nearly restating the title & legend)
 - Guide the reader through the main points made by the figure
- Use statistics as “citations” to support assertions

Writing Results Sections (cont.)

- Text in Results can also clarify unclear points in figures
 - And qualifications to analyses
 - That may be further considered in Discussion & Limitations sections
- Results vs. Discussion sections:
 - **Results:** Just the facts (and how to understand them)
 - **Discussion:** Interpreting the facts, discussing their implications for research & practice

References & Resources

- Junk Charts (<https://junkcharts.typepad.com/>)
- U. of Leicester: *Presenting numerical data*
- *The unspoken rules of visualisation (and when to break them)*
- Tableau: *Data visualization beginner's guide: A definition, examples, and learning resources*
- Avinash Kaushik: *7 Data Presentation Tips*
- Lots more from United Nations Economic Commission for Europe
- Writing results for dissertations

THE END

More Resources

- XKCD's chart of the average temperature of the earth: <https://xkcd.com/1732/>. It's too long for here, but very eye-opening
- [Information Is Beautiful](#), an website devoted to presenting interesting data (many fields & interests). Including:
 - [The MicrobeScope](#): Deadliness, contagiousness, n sufferers, media coverage and more of various microbes
 - [Snake Oil Sports Supplements?](#) What can you take to actually improve performance, according to science?
 - The [longevity](#) of a married, happy-go-lucky, outdoors-loving, sex-mad, hippy, party girl in senior management with a cat
- [The Fallen of World War II](#), a gorgeously presented video of those deaths and the value of the Long Peace we're now loosing
- [3D Map of Galaxies](#), a rotating map of surveyed galaxies around the Milky Way (our to ~13 billion light years)
- VizWorld: A website about visualizations with a concentration on economics & "innovative thinkers" (<https://vizworld.com/>)