

Truth, beauty, and data

Session 1

PMAP 8921: Data Visualization with R
Andrew Young School of Policy Studies
May 2020

Plan for today

Facts, truth, and beauty

Data, truth, and beauty

Beautiful visualizations

Class details

Facts, truth, and beauty

What is truth?

Core principles of the universe?

Underlying trends in society?

Something transcendental?

Reality?

How do we find truth?

Science!



Neil deGrasse Tyson @neiltyson



The good thing about Science is that it's true whether or not you believe in it.

10:41 AM · Jun 14, 2013 · [TweetDeck](#)

14.3K Retweets 8.3K Likes



But wait!

Beware of scientism!

"... promotion of science as the best or only objective means by which society should determine normative and epistemological values"

Science is not the only way

Art

Music

Literature

Religion

Nature

Nothing here is factual...

...but it all reveals truth



Cosette



Ling Lear

A musical score page for Beethoven's 9th Symphony, specifically the section starting at measure 116. The page shows three staves: Bassoon, Violas & 'cellos, and Double basses. The music consists of sixteenth-note patterns. Measure 116 starts with a rest for the Bassoon, followed by eighth-note pairs. Measures 117-118 show eighth-note pairs for the Bassoon and sixteenth-note patterns for the other instruments. Measures 119-120 continue with similar patterns. Measure 121 begins with a bassoon solo. Measure 122 concludes with a forte dynamic for the Double basses.

Beethoven's 9th symphony

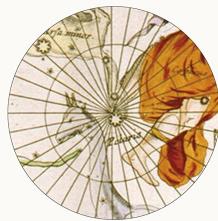
Facts \neq truth

Where does truth come when
there are no facts?

Beauty

Beauty in science

A
BEAUTIFUL
QUESTION



FINDING NATURE'S DEEP DESIGN

FRANK
WILCZEK

WINNER OF THE NOBEL PRIZE IN PHYSICS

This is also true for
science and math
and other more
factual realms

Rhetoric and beauty

λόγος • λέξις

Logos • Lexis

Res • Verba

Essence • Structure

Content • Form

Truth • Beauty

Content + form

**Art is how we translate core,
essential content (or truth!)
to different forms
for specific audiences.**

Truth is beautiful

Truth \neq facts

**Truth comes from aesthetic
combination of content and form**

Facts require beauty to be true

Data, truth, and beauty

Just show me the data!

```
head(my_data, 10)
```

```
## # A tibble: 10 x 2
##       x     y
##   <dbl> <dbl>
## 1 55.4  97.2
## 2 51.5  96.0
## 3 46.2  94.5
## 4 42.8  91.4
## 5 40.8  88.3
## 6 38.7  84.9
## 7 35.6  79.9
## 8 33.1  77.6
## 9 29.0  74.5
## 10 26.2  71.4
```

```
mean(my_data$x)
```

```
## [1] 54.26327
```

Seems reasonable

```
mean(my_data$y)
```

```
## [1] 47.83225
```

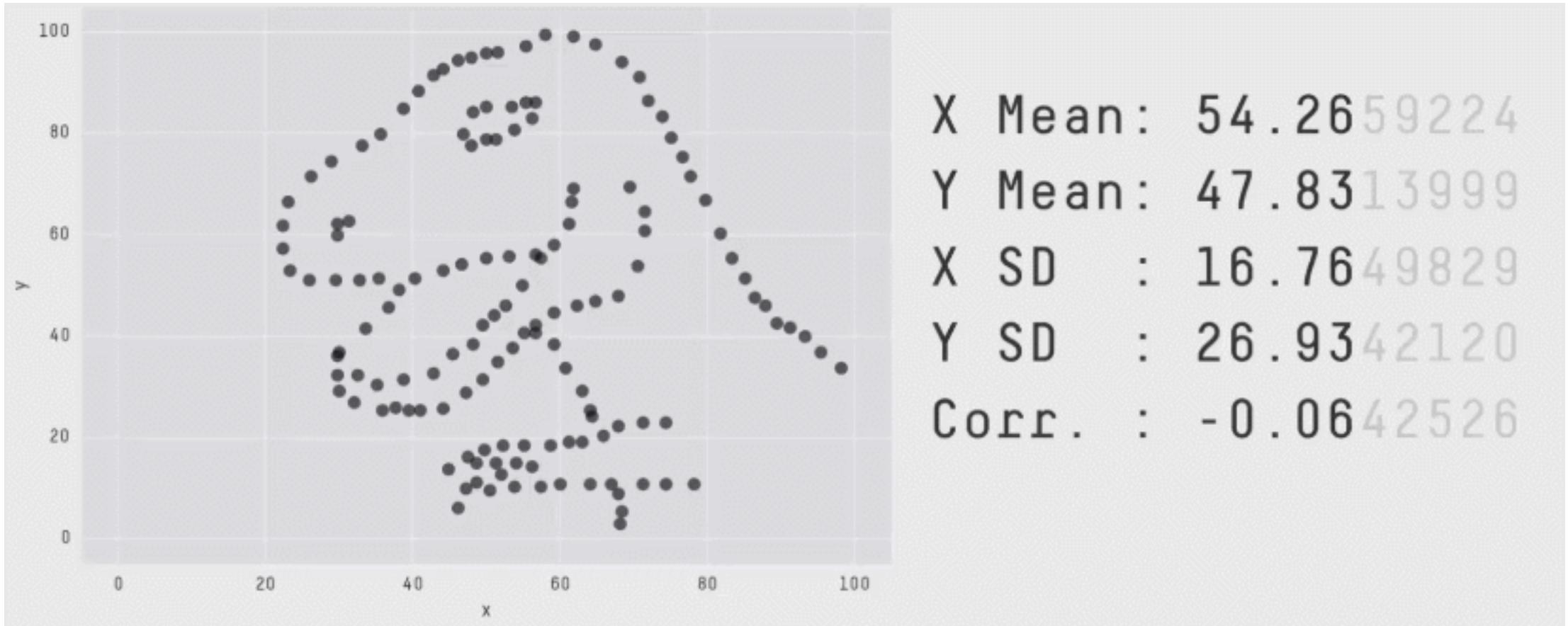
Seems reasonable

```
cor(my_data$x, my_data$y)
```

```
## [1] -0.06447185
```

No correlation

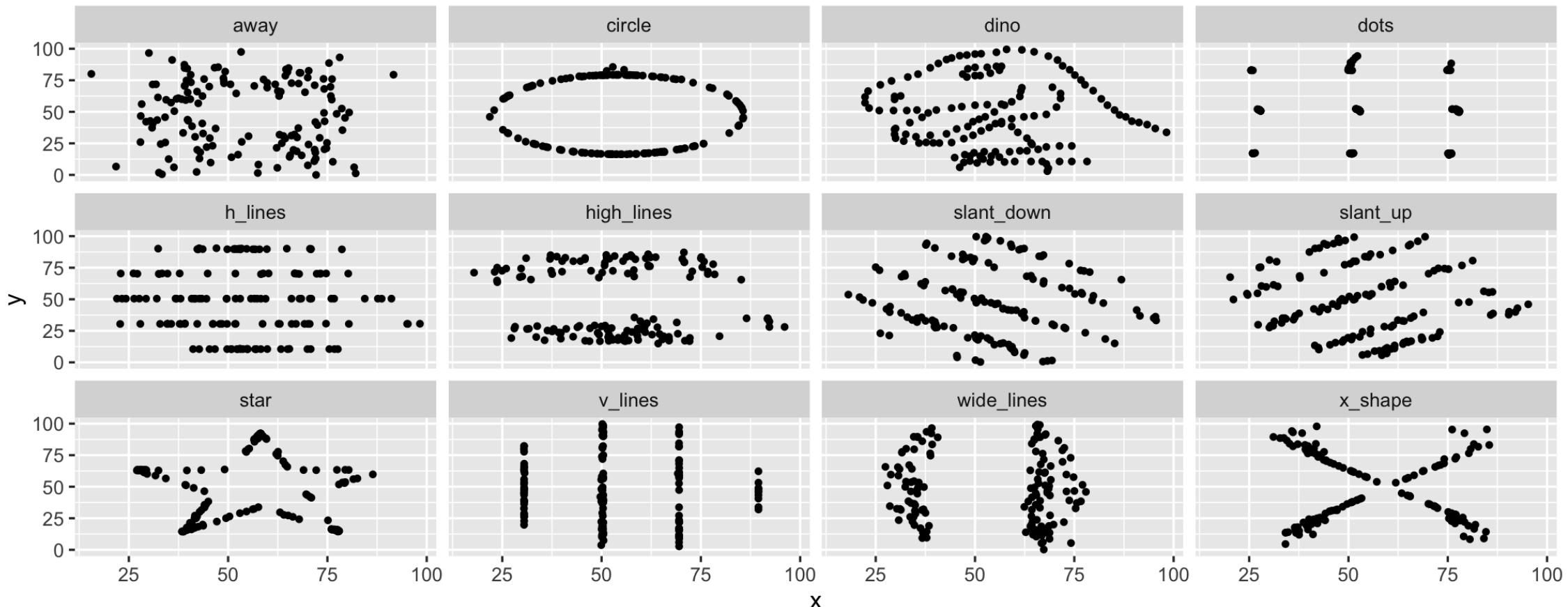
oh no



The Datasaurus Dozen

Raw data is not enough

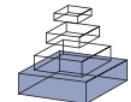
Each of these has the same mean, standard deviation, variance, and correlation



Humans love patterns

frontiers in
NEUROSCIENCE

REVIEW ARTICLE
published: 22 August 2014
doi: 10.3389/fnins.2014.00265



Superior pattern processing is the essence of the evolved human brain

Mark P. Mattson^{1,2*}

¹ Laboratory of Neurosciences, National Institute on Aging Intramural Research Program, Baltimore, MD, USA

² Department of Neuroscience, Johns Hopkins University School of Medicine, Baltimore, MD, USA

Edited by:

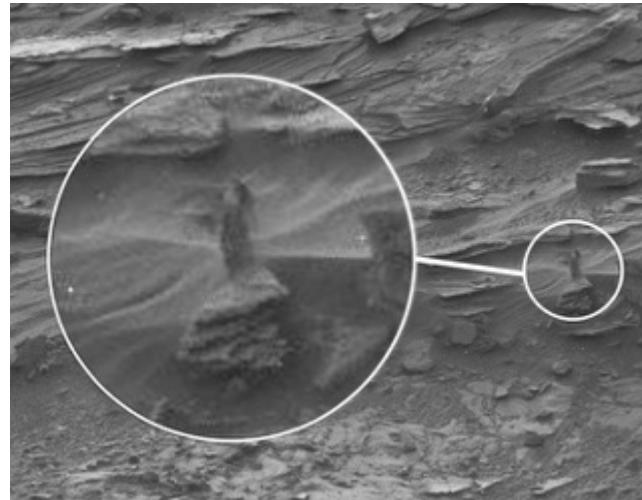
J. Michael Williams, Drexel University, USA

Humans have long pondered the nature of their mind/brain and, particularly why its capacities for reasoning, communication and abstract thought are far superior to other species, including closely related anthropoids. This article considers superior pattern

<https://doi.org/10.3389/fnins.2014.00265>

(Sometimes we love them too much)

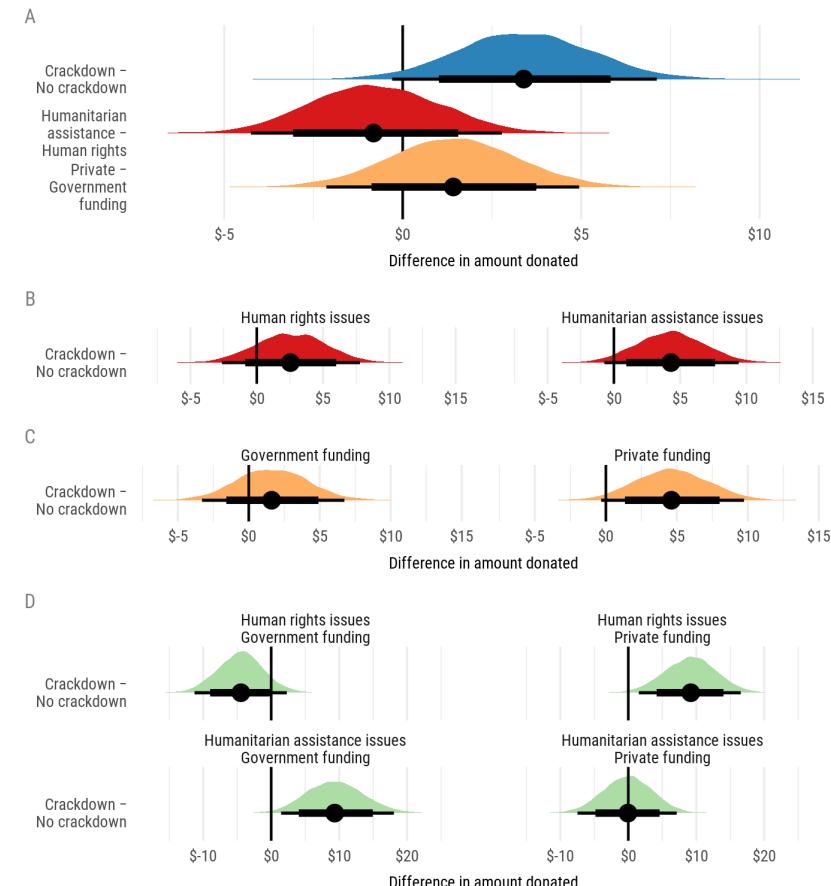
Pareidolia: seeing patterns that aren't there.



Beauty is necessary to see patterns

Table 2: Mean values and differences in means for amount donated in “crackdown” (treatment) and “no crackdown” (control) conditions; values represent posterior medians

H_{1b}	Amount _{Treatment}	Amount _{Control}	Δ	% Δ	$p(\Delta \neq 0)$
Crackdown – No crackdown	16.34	12.93	3.39	26.3%	0.97
<i>Humanitarian assistance – Human rights</i>	14.06	14.85	-0.82	-5.5%	0.67
<i>Private – Government funding</i>	15.13	13.71	1.42	10.4%	0.79
H_{2b} and H_{3b}	Amount _{Crackdown}	Amount _{No crackdown}	Δ	% Δ	$p(\Delta \neq 0)$
Human rights issues	17.4	14.86	2.54	17.2%	0.83
Humanitarian assistance issues	15.91	11.68	4.3	36.9%	0.95
Government funding	13.83	12.24	1.61	13.1%	0.74
Private funding	18.95	14.23	4.62	32.4%	0.97
H_{2b} and H_{3b} (nested)	Amount _{Crackdown}	Amount _{No crackdown}	Δ	% Δ	$p(\Delta \neq 0)$
Human rights issues, Government funding	10.56	15.15	-4.46	-29.5%	0.91
Human rights issues, Private funding	23.76	14.5	9.19	63.8%	0.99
Humanitarian assistance issues, Government funding	21.42	11.89	9.35	77.9%	0.99
Humanitarian assistance issues, Private funding	15.69	15.72	-0.05	-0.3%	0.51



Point shows posterior median; thick black lines show 80% credible interval;
thin black lines show 95% credible interval

Beautiful visualizations

What makes a great visualization?

Truthful

Functional

Beautiful

Insightful

Enlightening

What makes a great visualization?

"Graphical excellence is the well-designed presentation of interesting data—a matter of substance, of statistics, and of design ... [It] consists of complex ideas communicated with clarity, precision, and efficiency. ... [It] is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space ... [It] is nearly always multivariate ... And graphical excellence requires telling the truth about the data."

Edward Tufte, *The Visual Display of Quantitative Information*, p. 51

What makes a great visualization?

Good aesthetics

No substantive issues

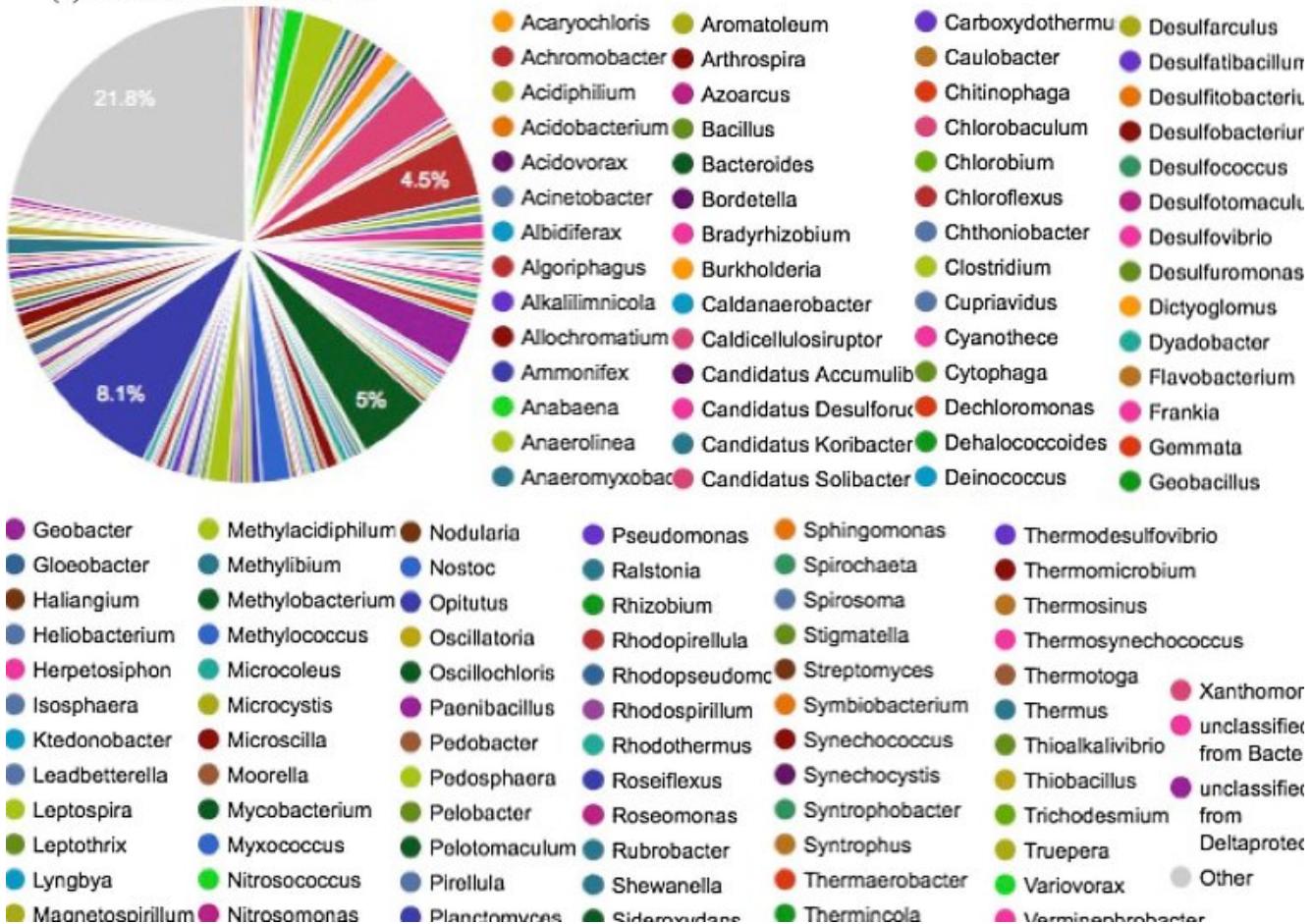
No perceptual issues

Honesty + good judgment

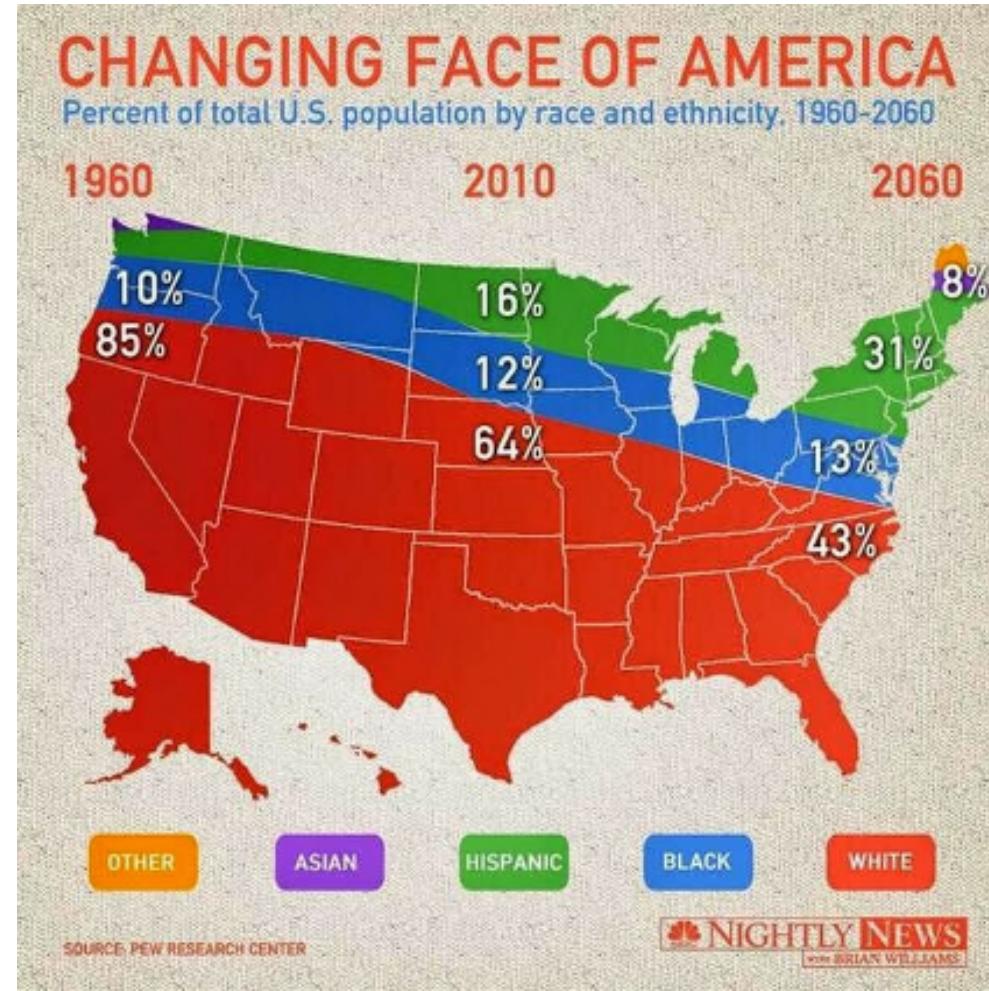
Kieran Healy, *Data Visualization: A Practical Introduction*

What's wrong?

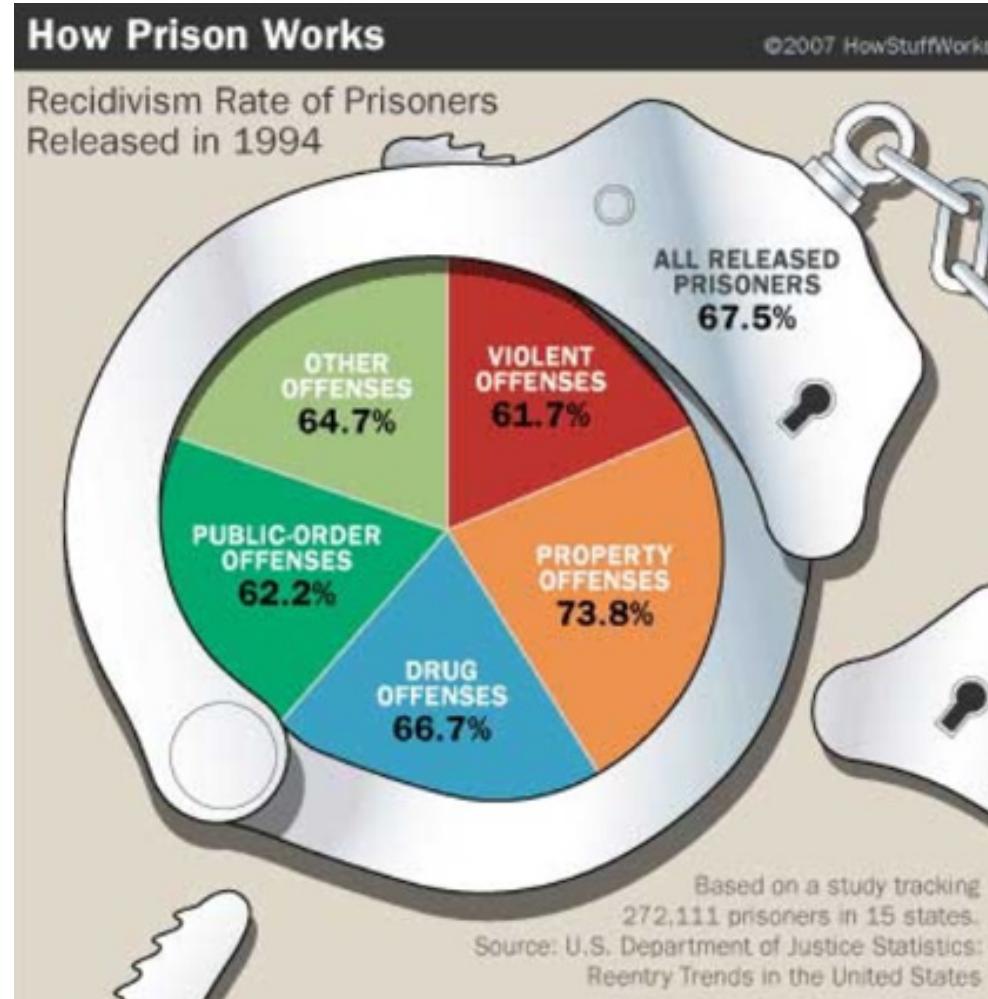
(f) Distribution of Genus



What's wrong?



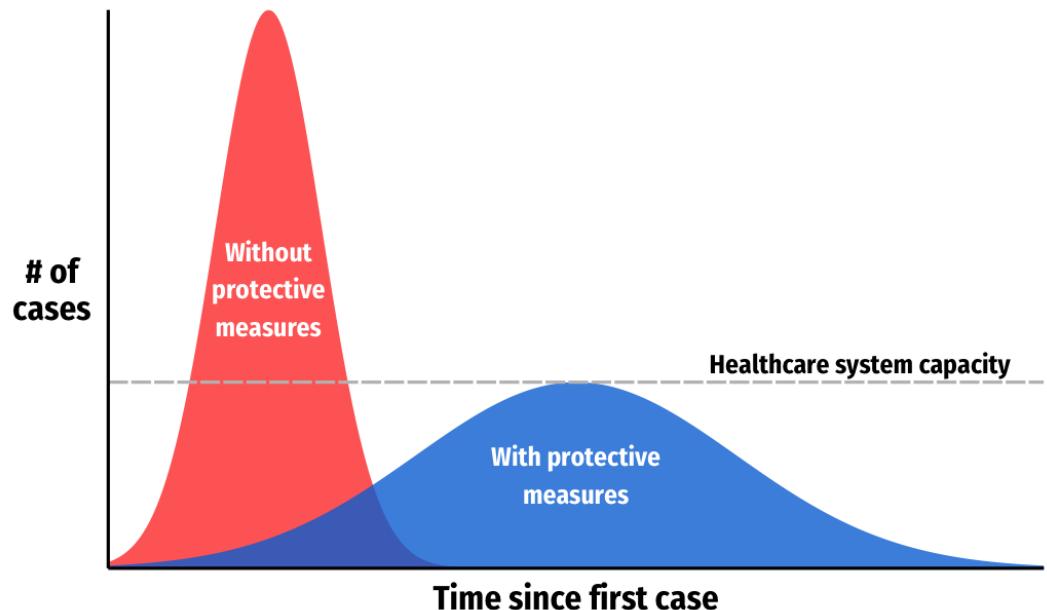
What's wrong?



What's right?

Flatten the curve!

Slow down community spread by social distancing



Carl T. Bergstrom @CT_Bergstrom · Mar 6
3. There is a lot of complicated epidemiological modeling behind this idea, but this graphic strips all of that away, and discards irrelevant details to provide a straightforward story that people find easy to grasp at a glance.

It *simplifies* and *highlights* what matters.

6 198 1.8K ↑

Show replies

Carl T. Bergstrom @CT_Bergstrom · Mar 6
4. I've seldom seen a piece of sci-comm matter so much. We have an opportunity to flatten the #COVID19 #coronavirus epidemic curve by aggressive social distancing and other measures.

But people don't understand what the point is, if the virus is going to circulate broadly.

8 313 2K ↑

Show replies

Carl T. Bergstrom @CT_Bergstrom · Mar 6
5. This graph provides the answer, powerfully and concisely.

And because of that, it has exploded across twitter and other media. I've used it myself a number of times. This graph is changing minds, and by changing minds, it is saving lives.

6 196 1.5K ↑

Thread by Carl T. Bergstrom

Class details

Goal for the class

**Recognize and create
beautiful and truthful
visualizations with real
world data**

Plan for the class

Foundations

Truth and beauty

Graphic design principles

Mapping data to graphics

Core types of graphics

Amounts Proportions

Uncertainty Relationships

Comparisons Annotations

Special applications

Interactivity

Time Space Text

Enhancing graphics

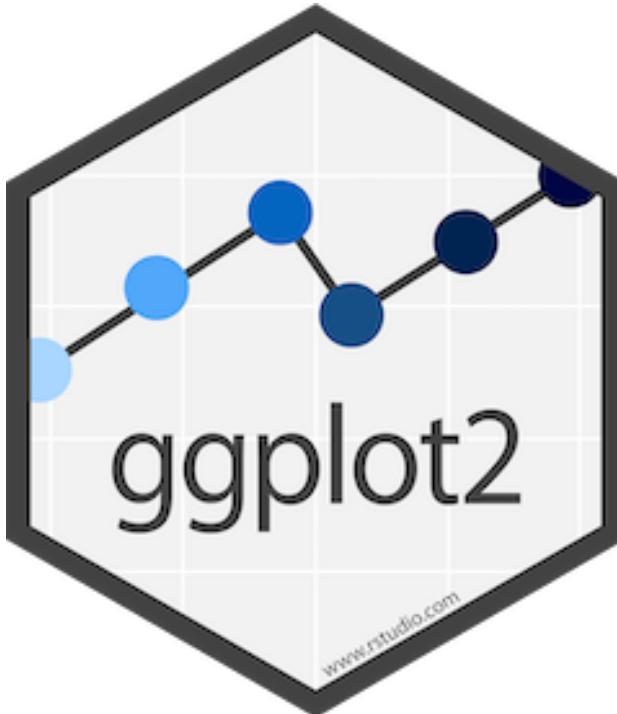
Class technology

Flexibility
and power

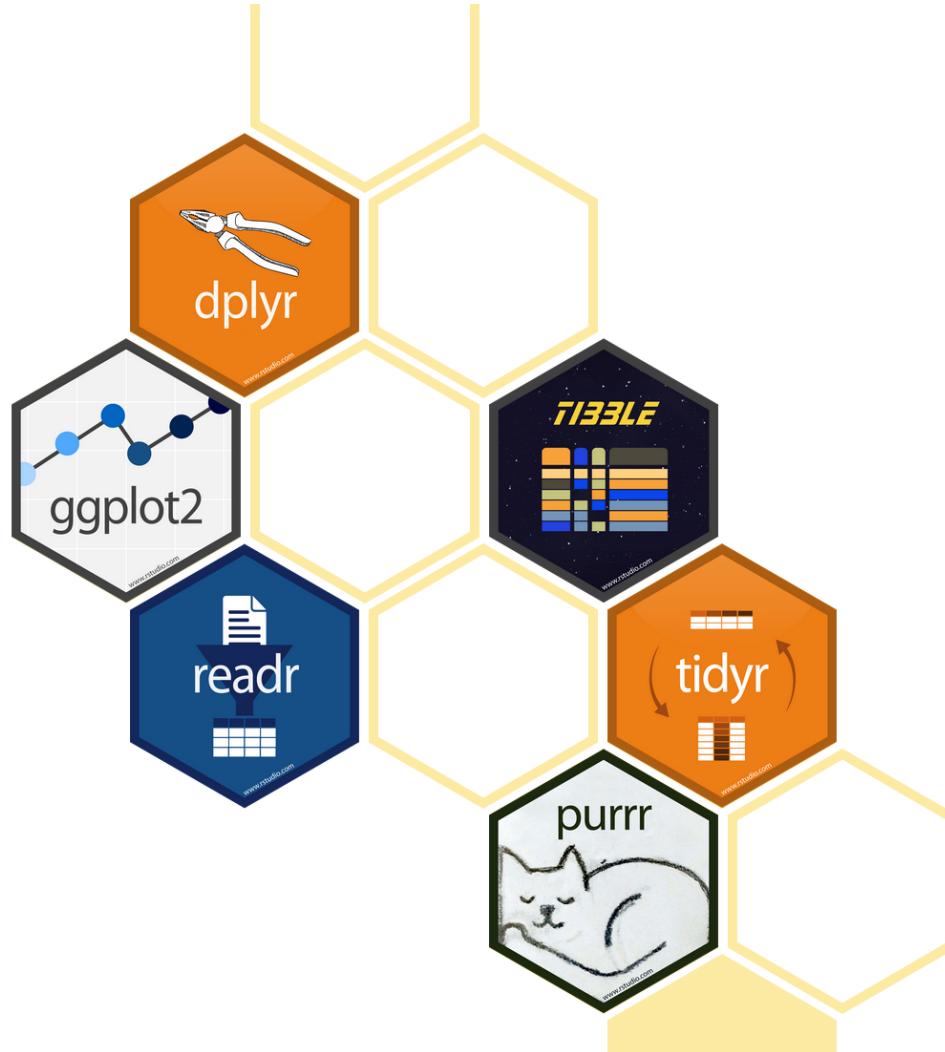


Barrier to entry
(amount of coding required)

Class technology



The tidyverse



Sucking

“There is no way of knowing nothing about a subject to knowing something about a subject without going through a period of much frustration and suckiness.”

“Push through. You’ll suck less.”

Hadley Wickham, author of `ggplot2`

Sucking



The New York Times

Opinion

SPORTING

(It's Great to) Suck at Something

By Karen Rinaldi

April 28, 2017



225

Karen Rinaldi, "(It's Great to) Suck at Something"