

# Truth, beauty, and data

## Session 1

PMAP 8921: Data Visualization with R  
Andrew Young School of Policy Studies  
Fall 2023

# 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](#)

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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



King Lear

A musical score page for Beethoven's 9th Symphony, specifically the Choral Fantasy section. The page is numbered 116 and 120. It features three staves: Bassoon (top), Violas &amp; 'cellos (middle), and Double basses (bottom). The music consists of eighth-note patterns with various dynamics and rests. The bassoon staff has a prominent eighth-note pattern starting at measure 116. The violins and cellos provide harmonic support. The double basses provide a steady bass line.

Beethoven's 9th symphony

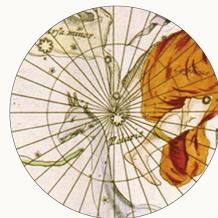
Facts  $\neq$  truth

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 ≠ 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 × 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
```

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

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

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

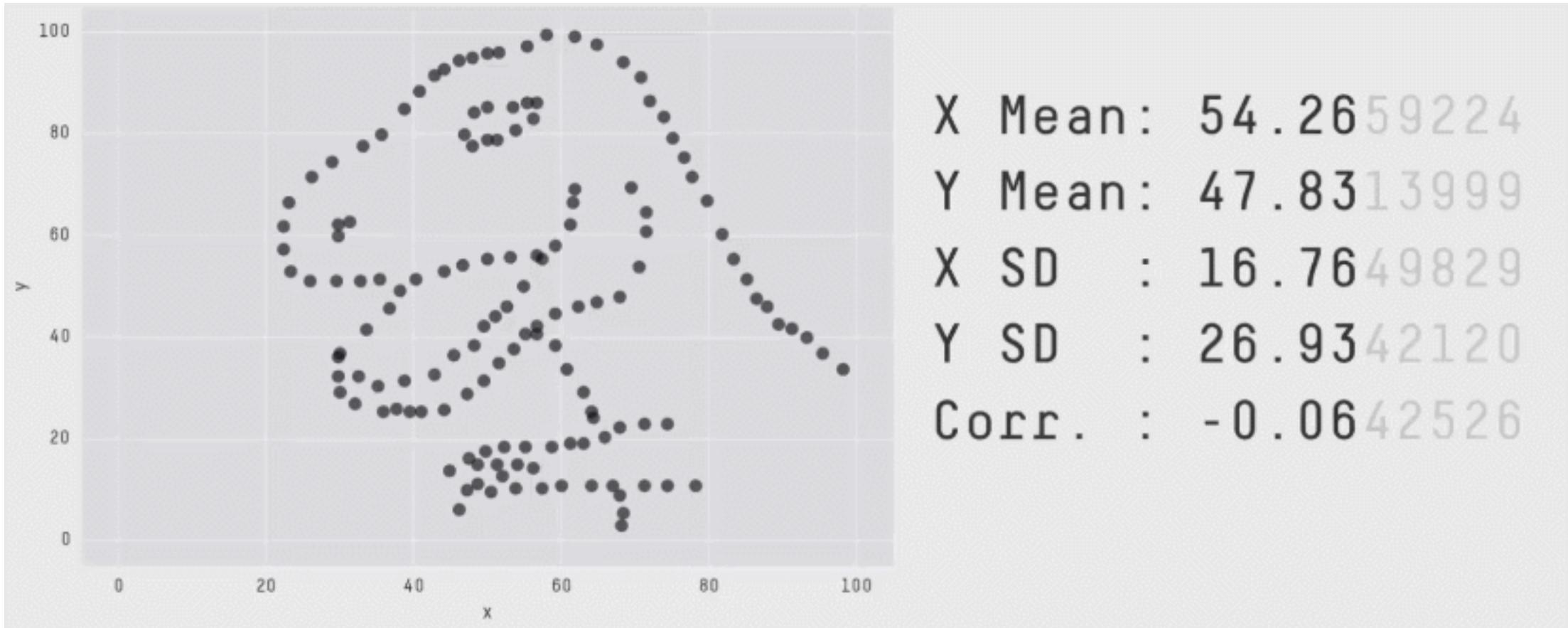
```
## [1] -0.06447185
```

**Seems reasonable**

**Seems reasonable**

**No correlation**

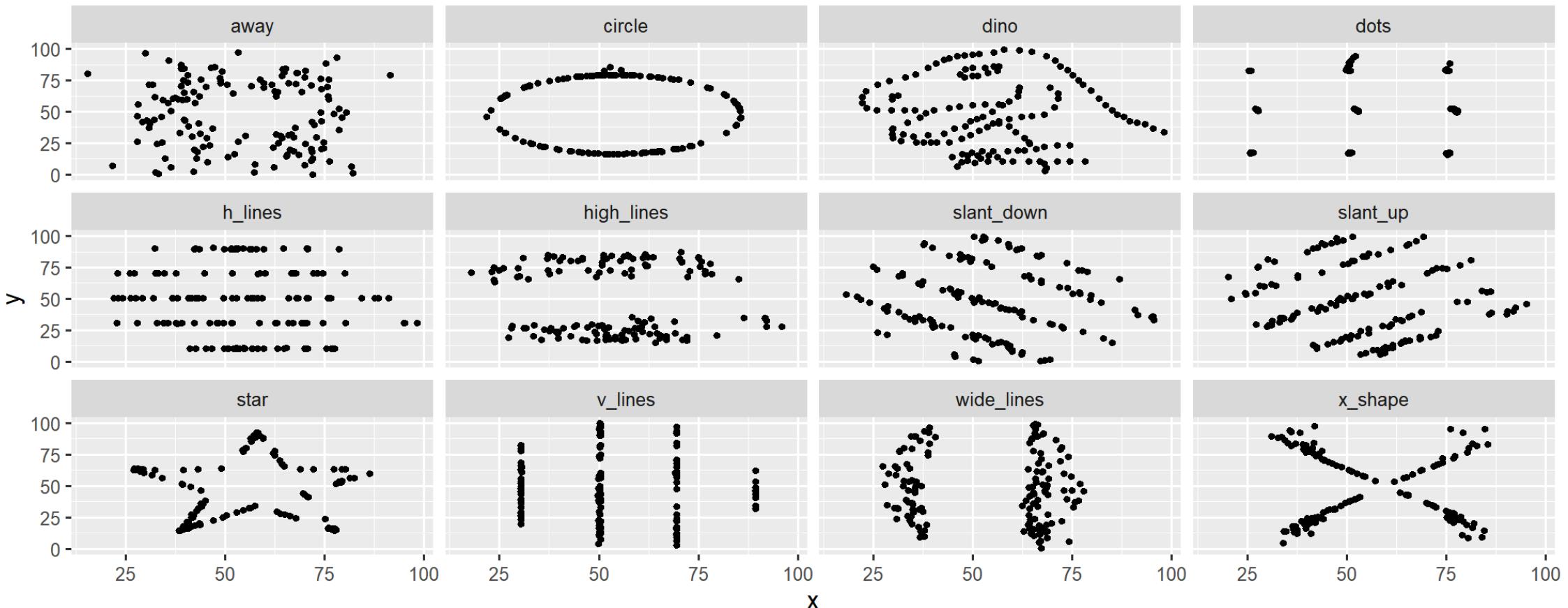
# oh no



The Datasaurus Dozen

# Raw data is not enough

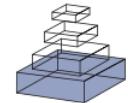
Each of these has the same mean, standard deviation, variance, and correlation



# 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**<sup>1,2\*</sup>

<sup>1</sup> Laboratory of Neurosciences, National Institute on Aging Intramural Research Program, Baltimore, MD, USA

<sup>2</sup> Department of Neuroscience, Johns Hopkins University School of Medicine, Baltimore, MD, USA

**Edited by:**

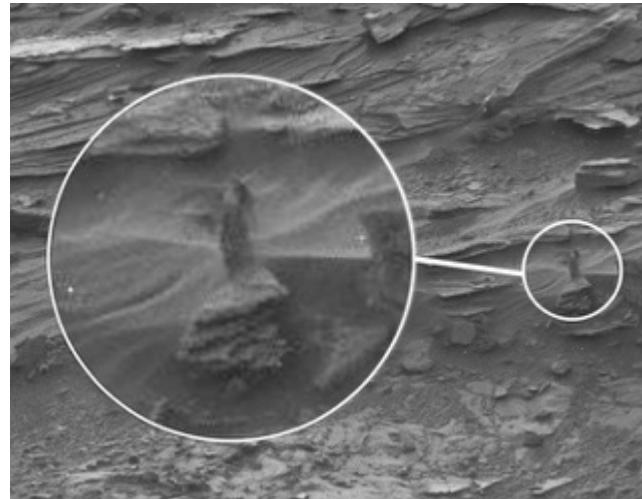
J. Michael Williams, Drexel University, USA

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)

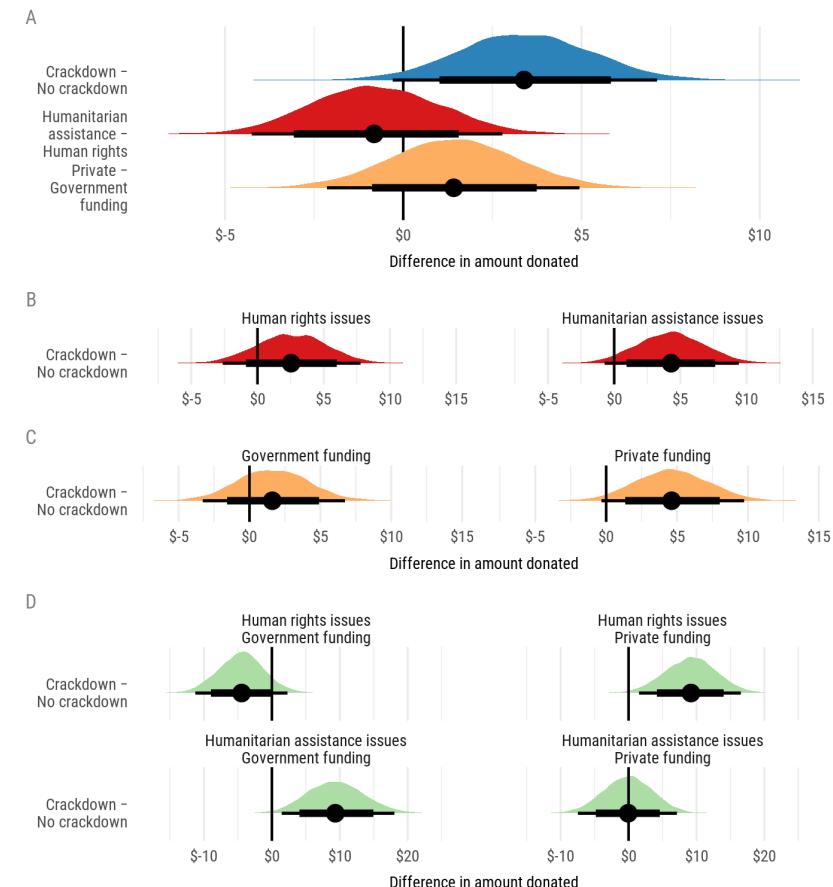
Pareidolia: seeing patterns that aren't there.



# 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 <sub>Treatment</sub>	Amount <sub>Control</sub>	$\Delta$	% $\Delta$	$p(\Delta \neq 0)$
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 <sub>Crackdown</sub>	Amount <sub>No crackdown</sub>	$\Delta$	% $\Delta$	$p(\Delta \neq 0)$
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 <sub>Crackdown</sub>	Amount <sub>No crackdown</sub>	$\Delta$	% $\Delta$	$p(\Delta \neq 0)$
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

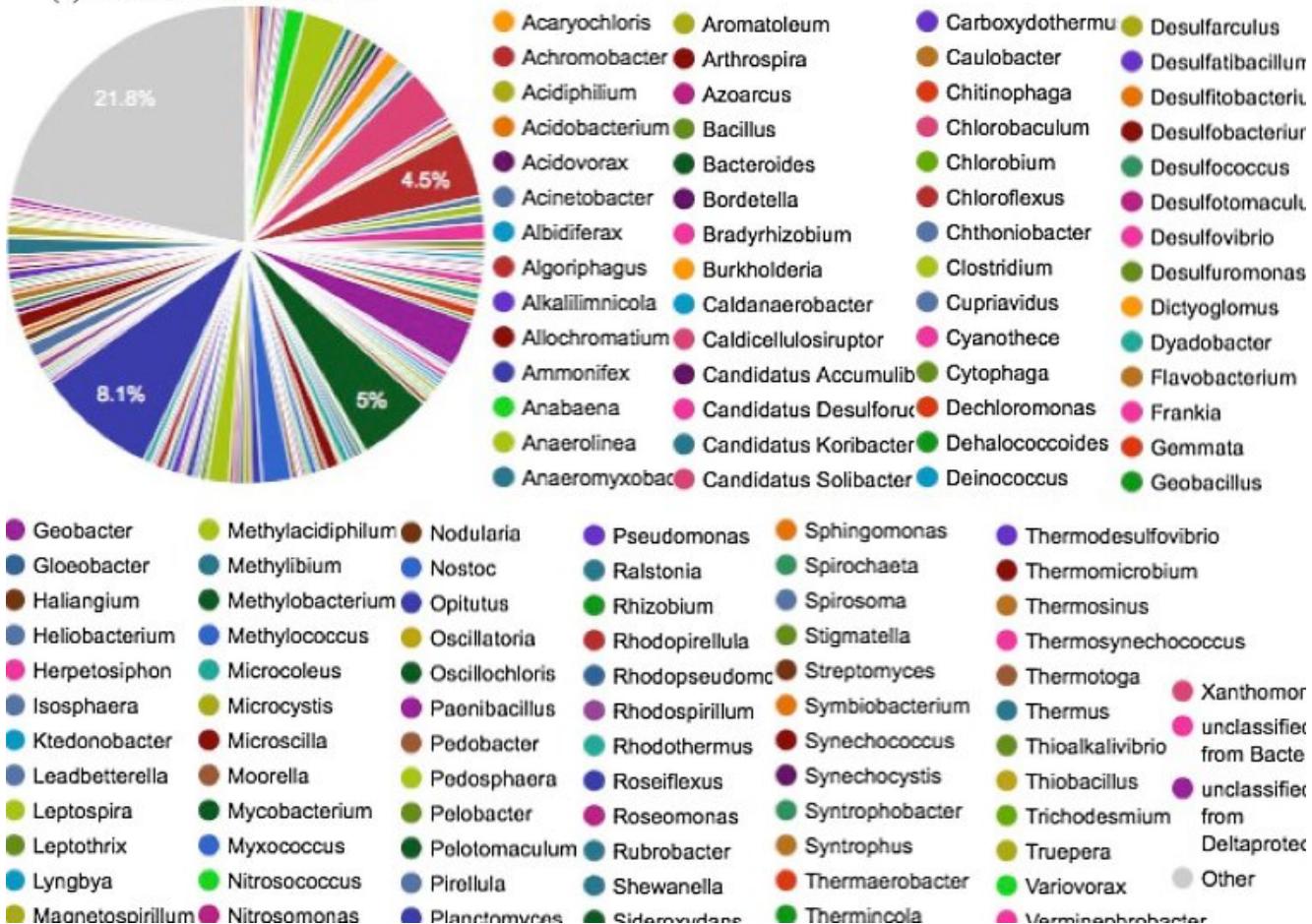
No perceptual issues

Honesty + good judgment

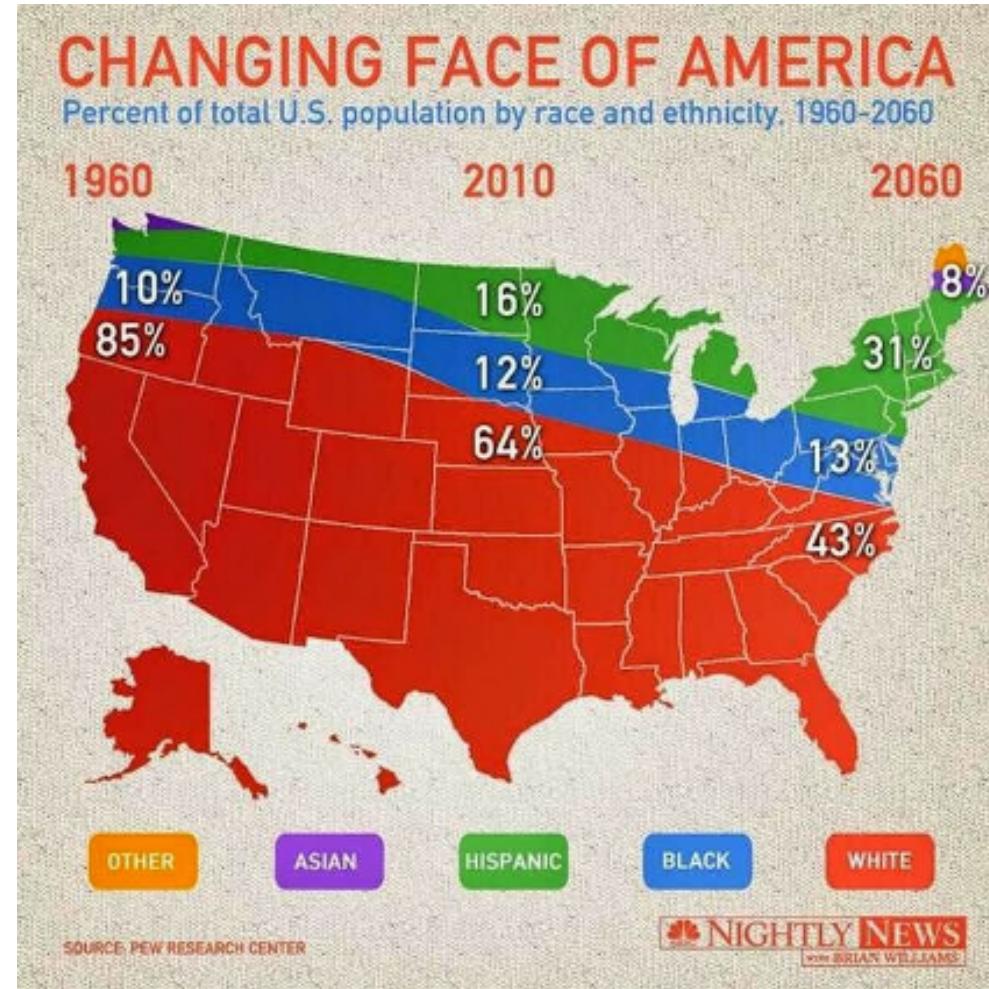
Kieran Healy, *Data Visualization: A Practical Introduction*

# What's wrong?

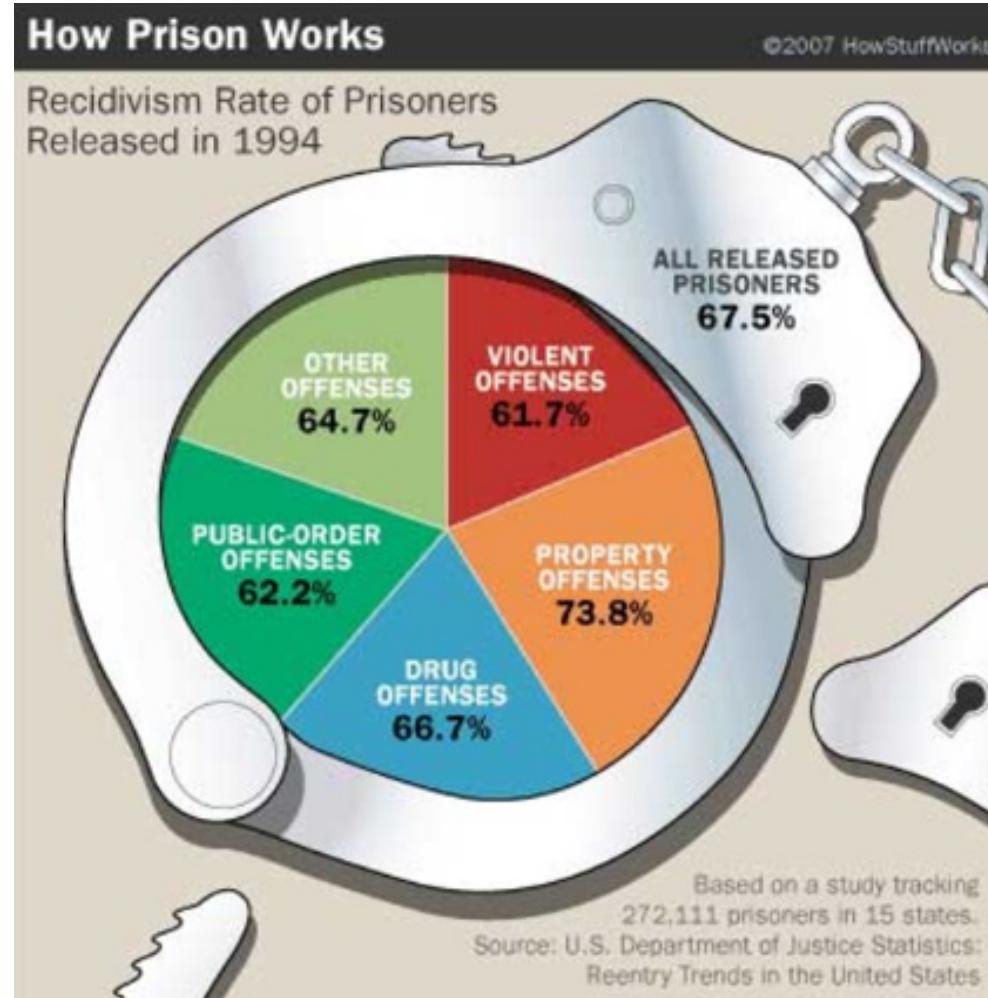
(f) Distribution of Genus



# What's wrong?



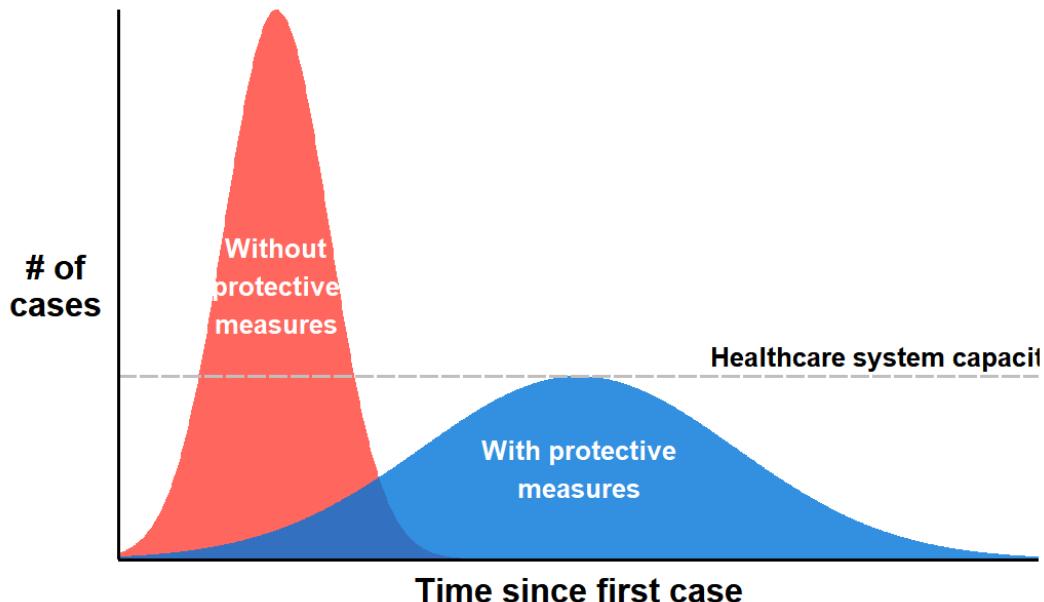
# What's wrong?



# 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



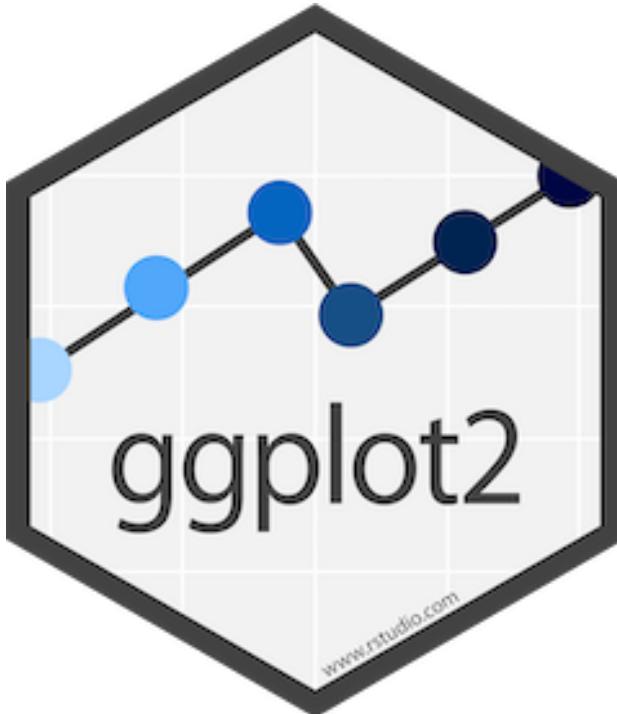
# Class technology

Flexibility  
and power

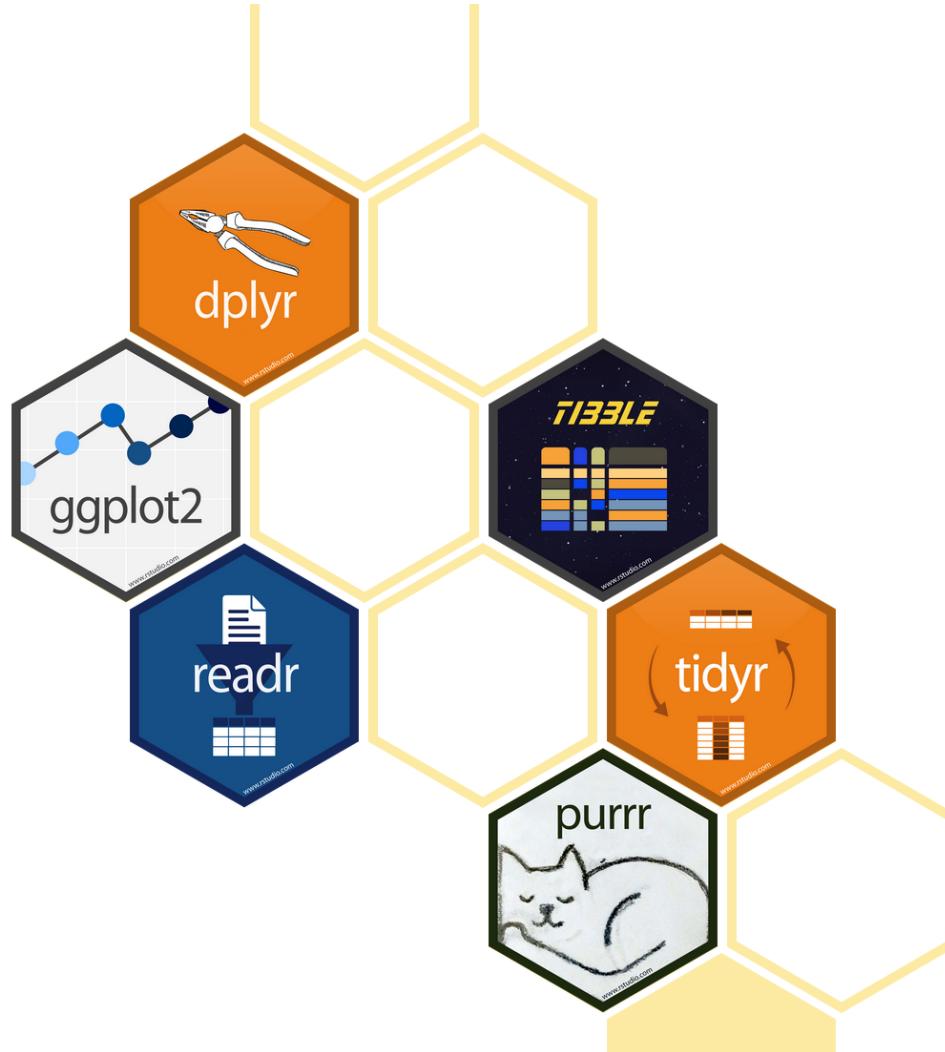


Barrier to entry  
(amount of coding required)

# 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



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