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

14.3K Retweets **8.3K** Likes

761 14.3K 8.3K

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

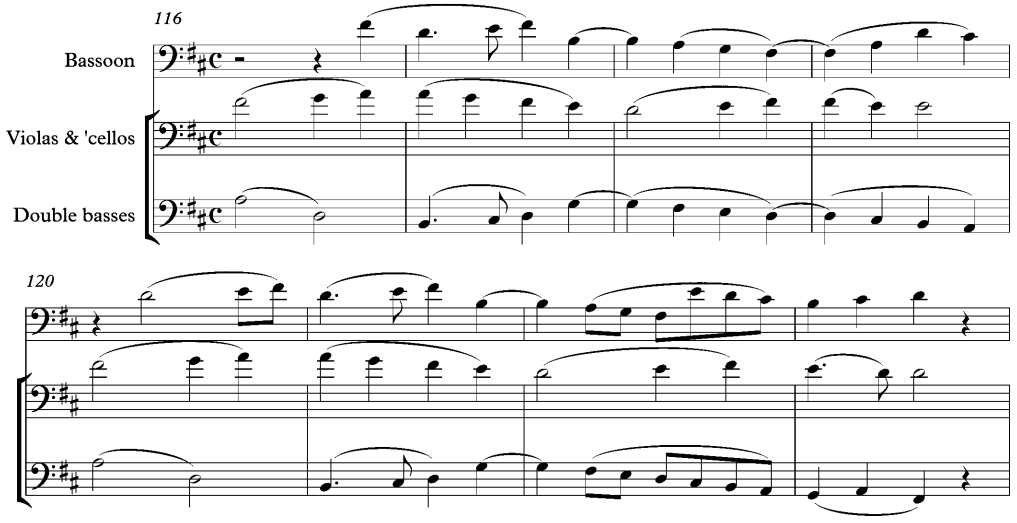
Nature

Nothing here is factual...

...but it all reveals truth

Cosette

King Lear



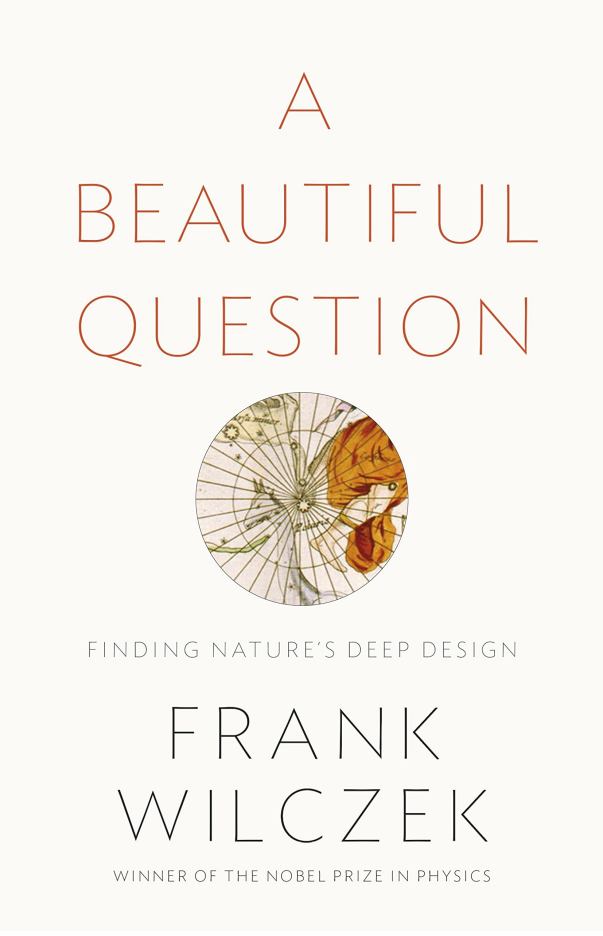
Beethoven's 9th symphony

Facts ≠ truth

Where does truth come when there are no facts?

Beauty

Beauty in science



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
```

Seems reasonable

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

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

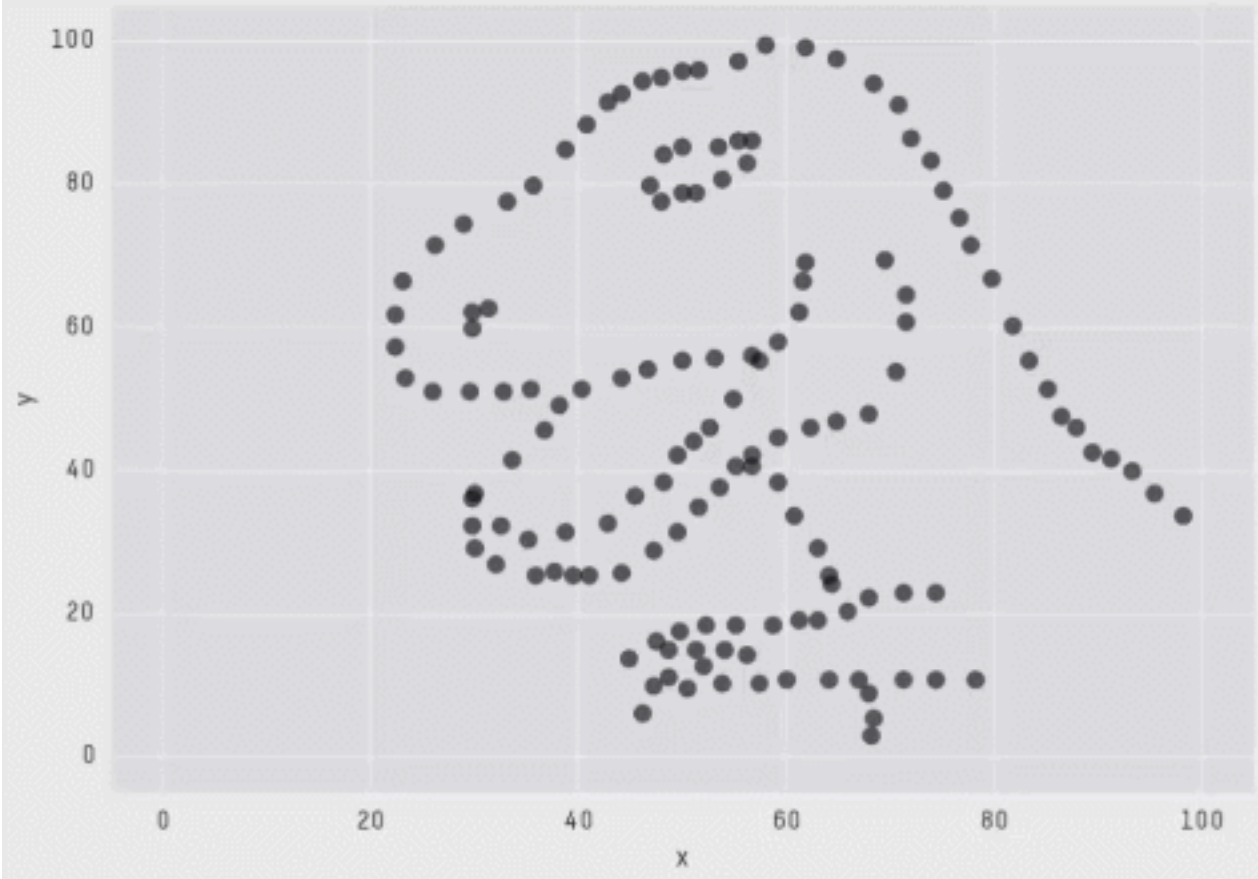
Seems reasonable

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

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

No correlation

oh no

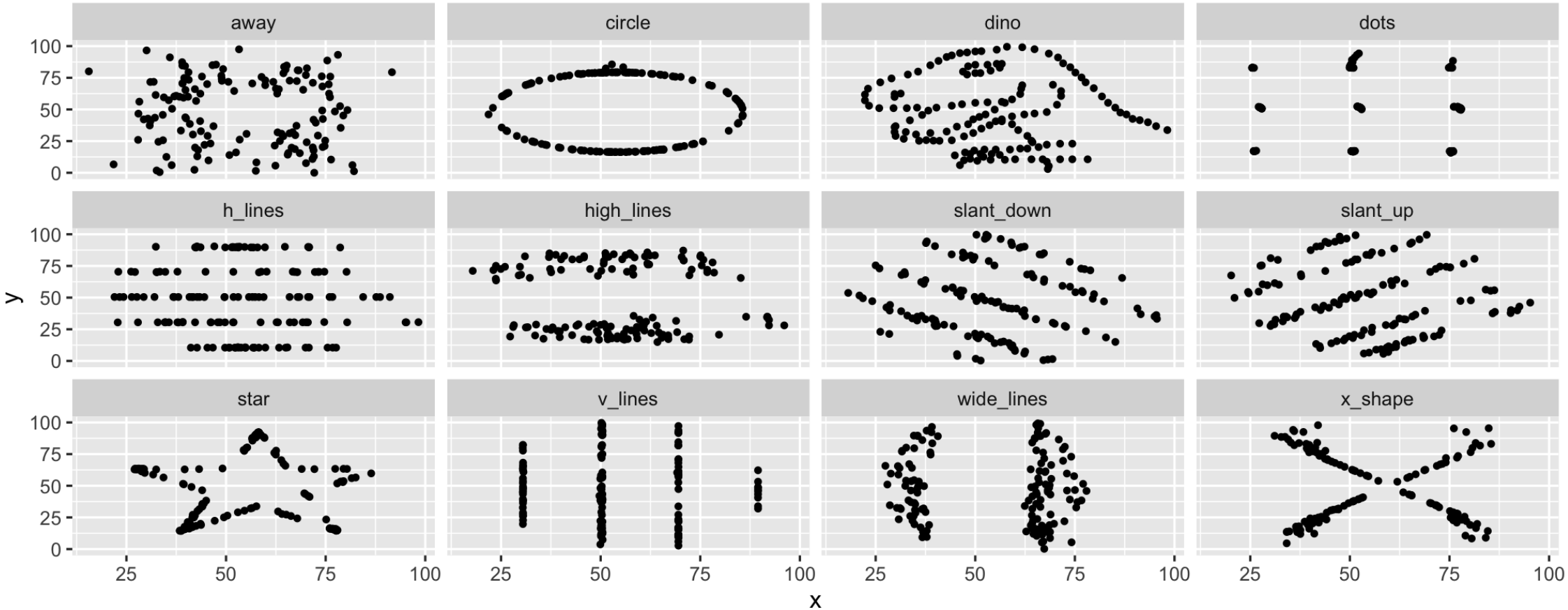


X Mean: 54.2659224
Y Mean: 47.8313999
X SD : 16.7649829
Y SD : 26.9342120
Corr. : -0.0642526

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]*

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

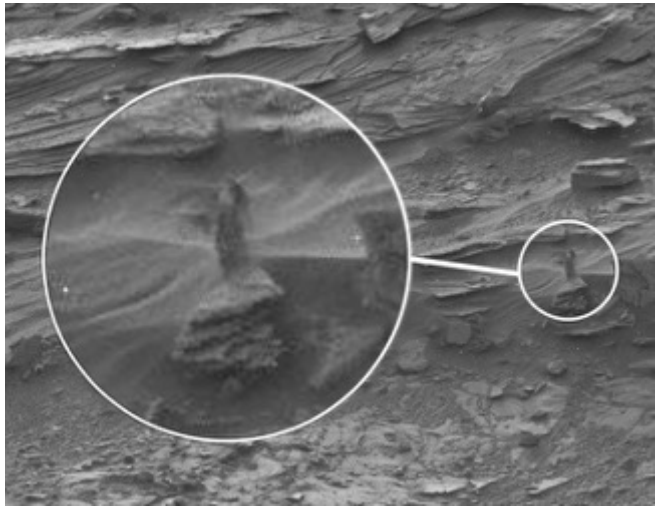
Edited by:
J. Michael Williams, Drexel University, USA

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)

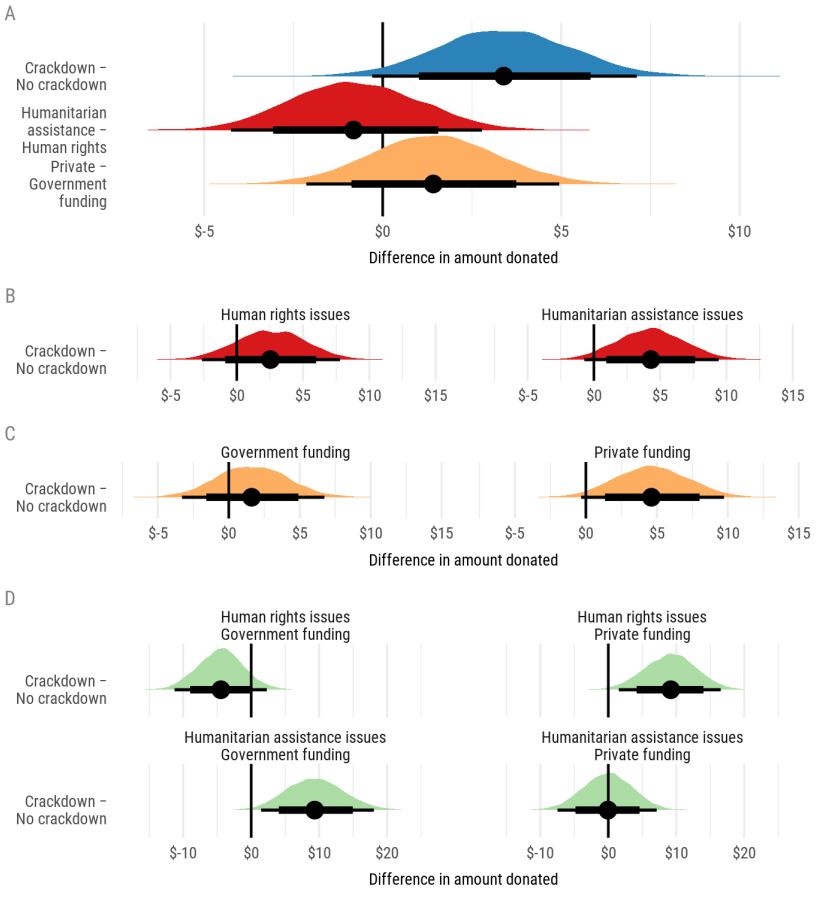
Pareidolia: seeing patterns that aren't there.



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	$\%\Delta$	$p(\Delta \neq 0)$
Crackdown – No crackdown	16.34	12.93	3.39	26.3%	0.97
Humanitarian assistance – Human rights	14.06	14.85	-0.82	-5.5%	0.67
Private – Government funding	15.13	13.71	1.42	10.4%	0.79
H_{2b} and H_{3b}	$Amount_{Crackdown}$	$Amount_{No\ crackdown}$	Δ	$\%\Delta$	$p(\Delta \neq 0)$
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)	$Amount_{Crackdown}$	$Amount_{No\ crackdown}$	Δ	$\%\Delta$	$p(\Delta \neq 0)$
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

Alberto Cairo, *The Truthful Art*

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

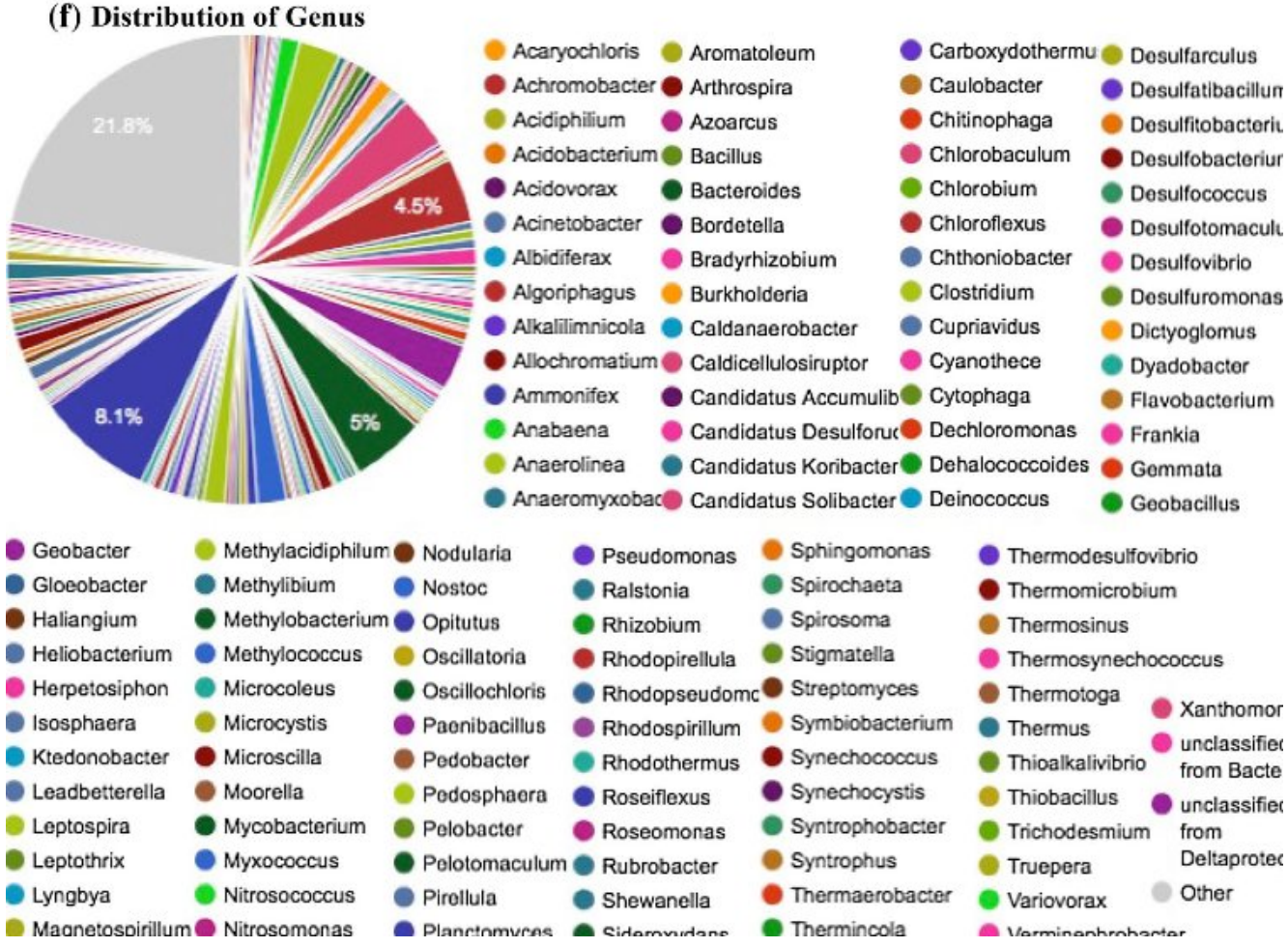
No substantive issues

No perceptual issues

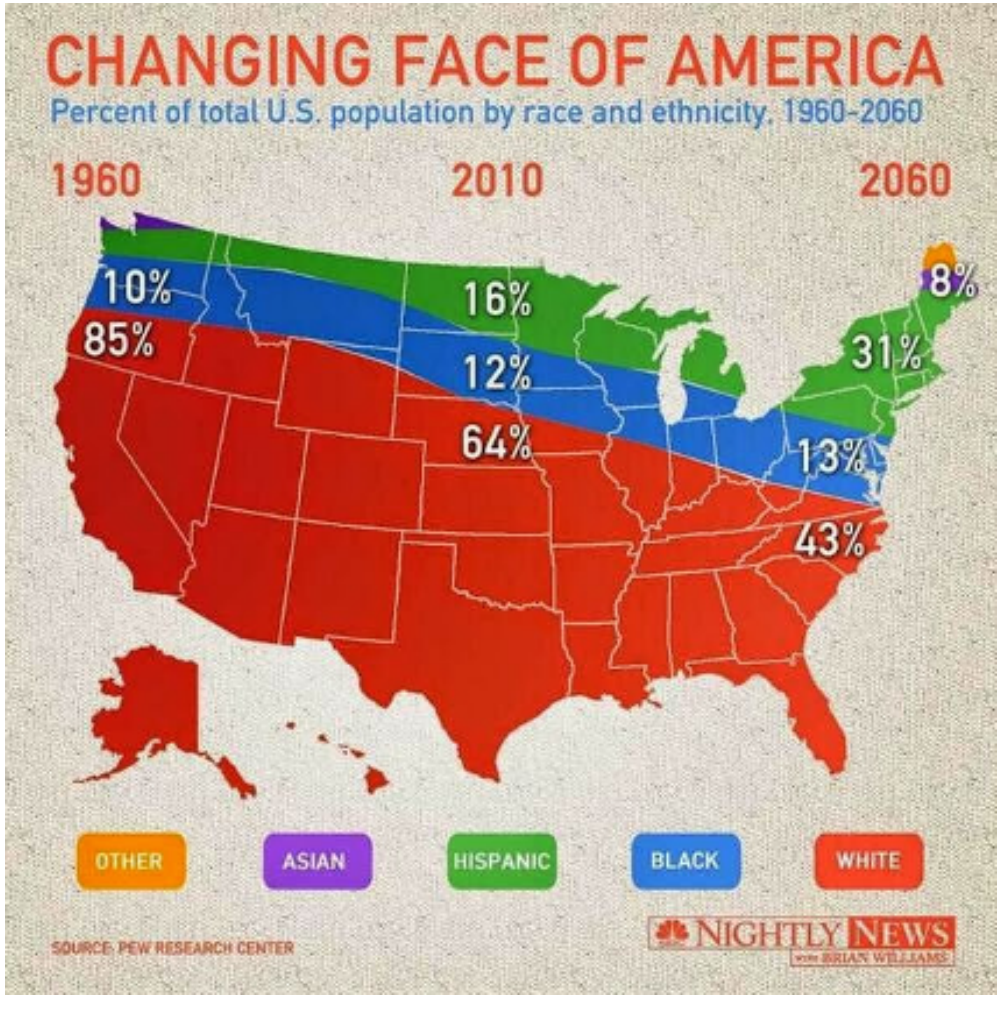
Honesty + good judgment

Kieran Healy, *Data Visualization: A Practical Introduction*

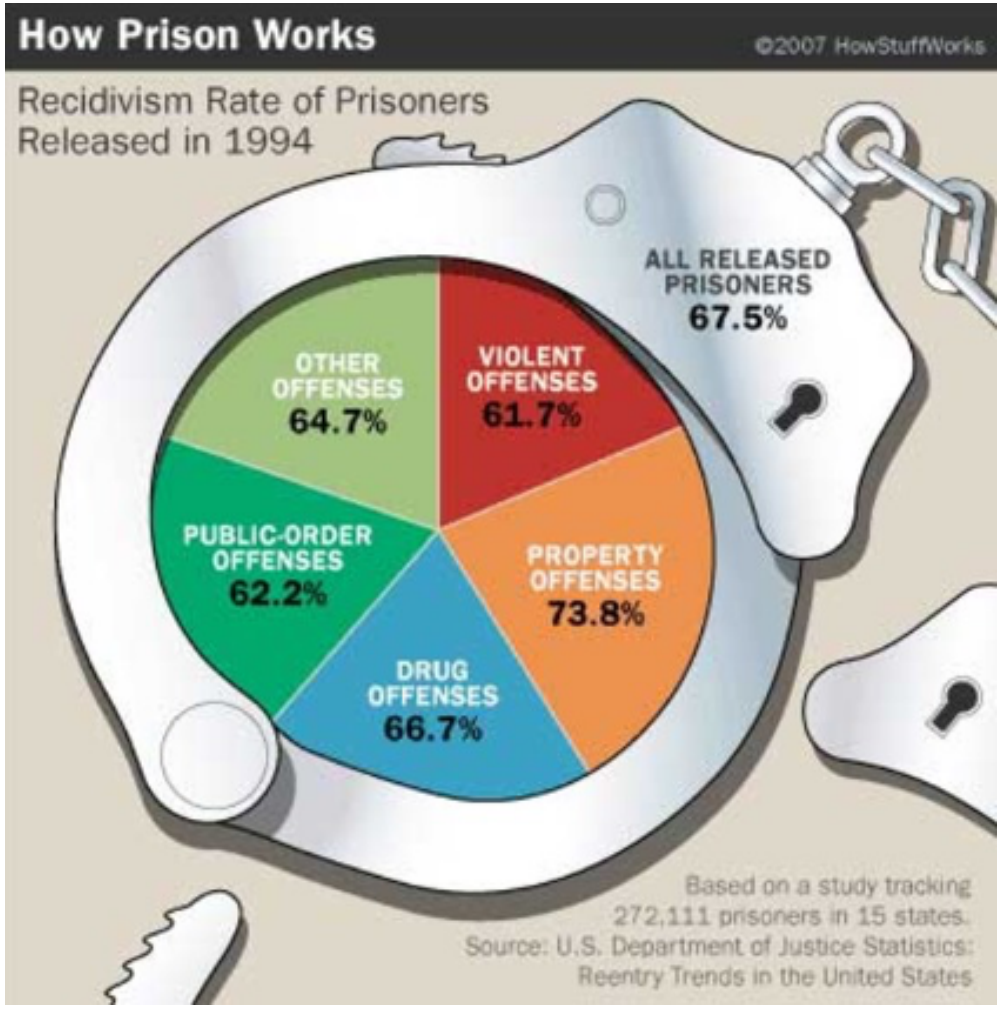
What's wrong?


(f) Distribution of Genus
21.8%
4.5%
8.1%
5%
Acaryochloris
Achromobacter
Acidiphilium
Acidobacterium
Acidovorax
Acinetobacter
Albidiferax
Algoriphagus
Alkalilimnicola
Allochromatium
Ammonifex
Anabaena
Anaerolinea
Anaeromyxobac
Aromatoleum
Arthrospira
Azoarcus
Bacillus
Bacteroides
Bordetella
Bradyrhizobium
Burkholderia
Caldanaerobacter
Caldicellulosiruptor
Candidatus Accumulib
Candidatus Desulforuc
Candidatus Koribacter
Candidatus Solibacter
Carboxydothermu
Caulobacter
Chitinophaga
Chlorobaculum
Chlorobium
Chloroflexus
Chthoniobacter
Clostridium
Cupriavidus
Cyanothece
Cytophaga
Dechloromonas
Dehalococcoides
Deinococcus
Desulfarculus
Desulfatibacillun
Desulfitobacteriu
Desulfobacteriur
Desulfococcus
Desulfotomaculu
Desulfovibrio
Desulfuromonas
Dictyoglomus
Dyadobacter
Flavobacterium
Frankia
Gemmata
Geobacillus
Geobacter
Gloeobacter
Haliangium
Heliobacterium
Herpetosiphon
Isosphaera
Ktedonobacter
Leadbetterella
Leptospira
Leptothrix
Lyngbya
Magnetospirillum
Methylacidiphilum
Methylibium
Methylobacterium
Methylococcus
Microcoleus
Microcystis
Microscilla
Moorella
Mycobacterium
Myxococcus
Nitrosococcus
Nitrosomonas
Nodularia
Nostoc
Opitutus
Oscillatoria
Oscillochloris
Paenibacillus
Pedobacter
Pedosphaera
Pelobacter
Pelotomaculum
Pirellula
Planctomyces
Pseudomonas
Ralstonia
Rhizobium
Rhodopirellula
Rhodopseudomc
Rhodospirillum
Rhodothermus
Roseiflexus
Roseomonas
Rubrobacter
Shewanella
Sideroxydans
Sphingomonas
Spirochaeta
Spirosoma
Stigmatella
Streptomyces
Symbiobacterium
Synechococcus
Synechocystis
Syntrophobacter
Syntrophus
Thermaerobacter
Thermincola
Thermodesulfovibrio
Thermomicrobium
Thermosinus
Thermosynechococcus
Thermotoga
Thermus
Thioalkalivibrio
Thiobacillus
Trichodesmium
Truepera
Variovorax
Verminephrobacter
Xanthomor
unclassifiec
from Bacte
unclassifiec
from
Deltaprotec
Other

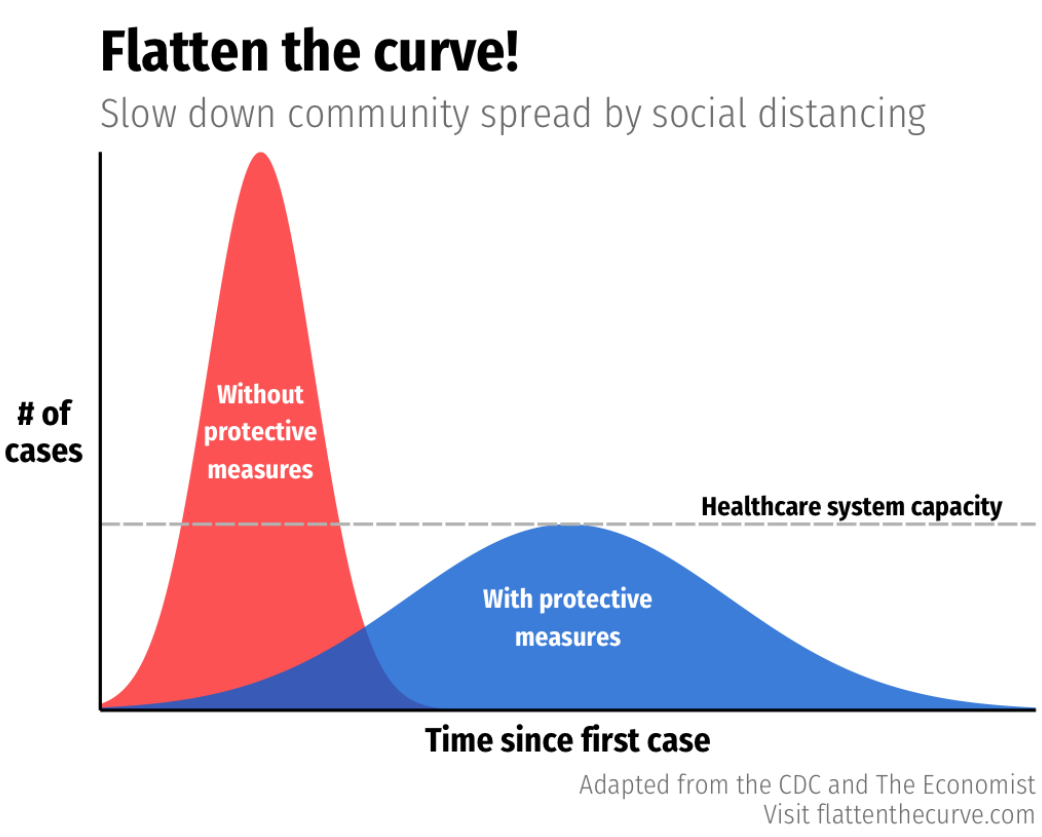
What's wrong?


CHANGING FACE OF AMERICA
Percent of total U.S. population by race and ethnicity, 1960-2060
1960
2010
2060
10%
85%
16%
12%
64%
8%
31%
13%
43%
OTHER
ASIAN
HISPANIC
BLACK
WHITE
SOURCE: PEW RESEARCH CENTER
NIGHTLY NEWS
with BRIAN WILLIAMS

What's wrong?


How Prison Works
©2007 HowStuffWorks
Recidivism Rate of Prisoners Released in 1994
ALL RELEASED PRISONERS
67.5%
OTHER OFFENSES
64.7%
VIOLENT OFFENSES
61.7%
PUBLIC-ORDER OFFENSES
62.2%
PROPERTY OFFENSES
73.8%
DRUG OFFENSES
66.7%
Based on a study tracking 272,111 prisoners in 15 states.
Source: U.S. Department of Justice Statistics: Reentry Trends in the United States

What's right?



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

→

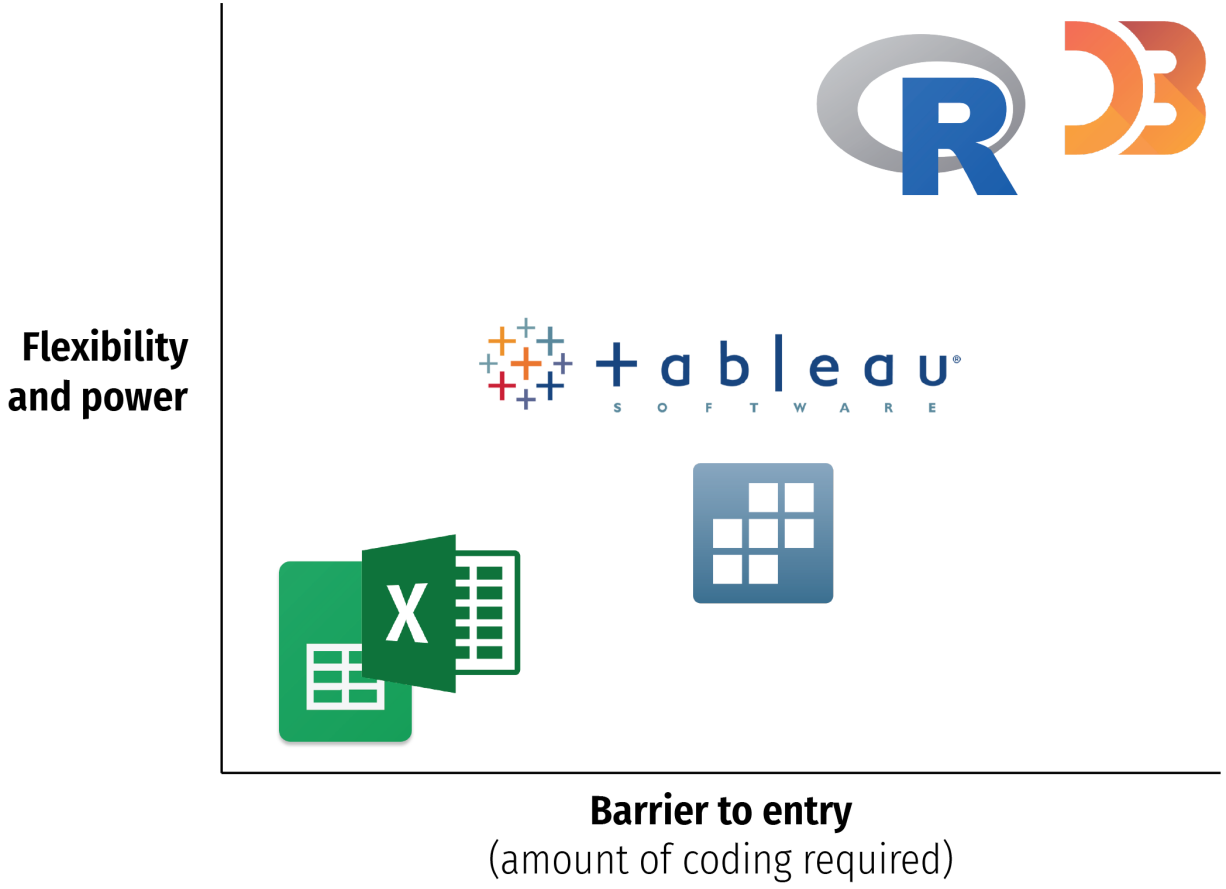
Special applications

Interactivity

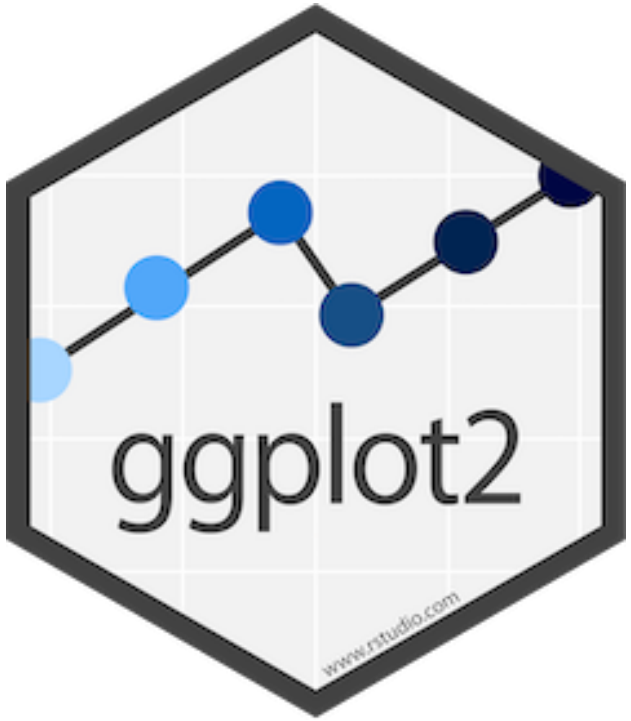
Time Space Text

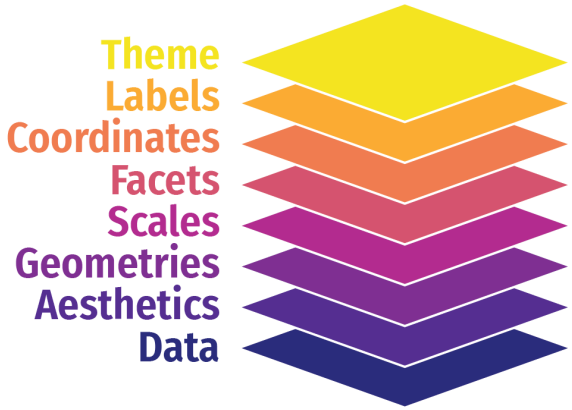
Enhancing graphics

Class technology

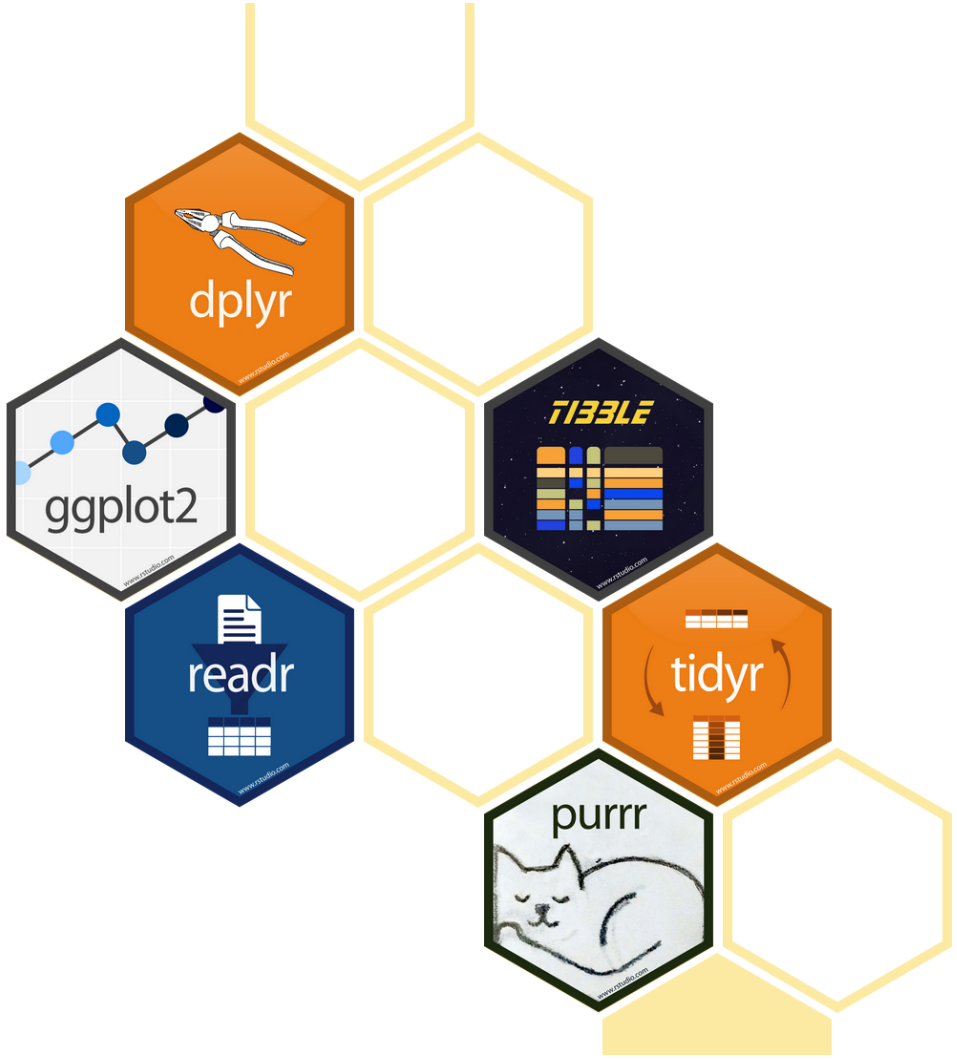


Class technology





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

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