

Introduction to Data Visualization

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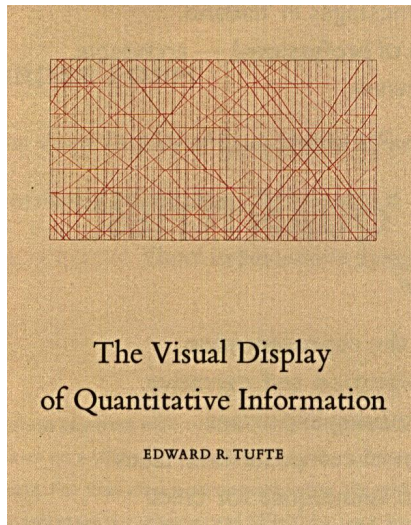
*This material is part of the **statsTeachR** project*

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Visualization excellence

In Tufte's words:

- ▶ consists of complex ideas communicated with clarity, precision, and efficiency.
- ▶ is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.
- ▶ is nearly always multivariate.
- ▶ requires telling the truth about the data.



Components of data graphics

Warm up

For each of the following graphics, work in pairs to

1. identify the variables displayed;
2. identify 2 features that you like and 2 that you don't;
3. sketch out the tidy data represented in the figure.

“Cities, traffic and CO₂”¹

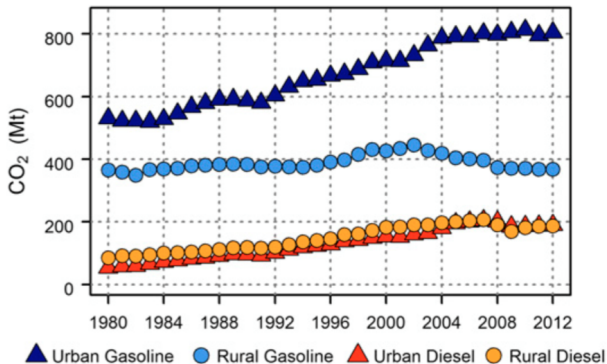
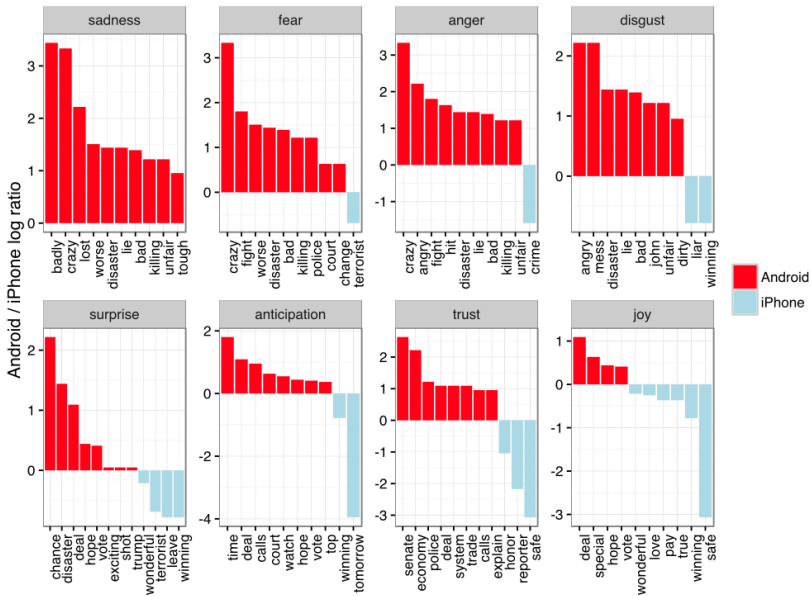


Fig. 2. Time series of US on-road CO₂ emissions. Urban roads accounted for 80% of total emissions growth since 1980. Rural road emissions have been declining since 2002.

¹ from “Cities, traffic, and CO₂: A multidecadal assessment of trends, drivers, and scaling relationships”, Gately et al, PNAS, 2015.

Trump tweets²



ggplot2

Choices for R graphics

You have three central choices for making graphics in R:

- ▶ "Base graphics"
- ▶ ggplot2
- ▶ lattice

Understanding the “grammar” of ggplot2

The grammar ...

- ▶ geom
- ▶ aesthetics ('aes')
- ▶ scales
- ▶ facets
- ▶ data
- ▶ ... and more here: <http://ggplot2.tidyverse.org/reference/>

What is a “geom”?

From Hadley:

- ▶ Geoms define the basic “shape” of the elements on the plot
- ▶ Basics: point, line, bar, text, hline, vline
- ▶ Statistics: histogram, smooth, density
- ▶ Others: boxplot, pointrange, linerange, ribbon

For more info check out the documentation:

<http://docs.ggplot2.org/current>

What are “aesthetics”?

Aesthetics define a mapping between data and the display.³

length	width	depth	trt
2	3	4	a
1	2	1	a
4	5	15	b
9	10	80	b



x	y	colour
2	3	a
1	2	a
4	5	b
9	10	b

³ Figure credits: [Hadley Wickham](#)

geom_point

Each geom has a different set of aesthetics.
What aesthetics do we need for geom_point?

geom_point

Each geom has a different set of aesthetics.

What aesthetics do we need for geom_point?

- ▶ x (required)
- ▶ y (required)
- ▶ alpha
- ▶ color
- ▶ fill
- ▶ shape
- ▶ size

`geom_line`

What aesthetics do we need for `geom_line`?

geom_line

What aesthetics do we need for `geom_line`?

- ▶ `x` (required)
- ▶ `y` (required)
- ▶ `alpha`
- ▶ `color`
- ▶ `linetype`
- ▶ `size`

more examples

The Bachelorette⁴

A rose for every season

The path of every winner on every season of the “Bachelor” and “Bachelorette”

①
Each petal is a week



②
Each section of the petal is a contestant



③
Size indicates a contestant's weighted number of dates through that point in the season ...



④
... as does order.



The Bachelorette  Broke up  Still together

 Trista + Ryan
2003



 Meredith + Ian
2004



 Jen + Jerry
2005



 DeAnna + Jesse
2008



 Jillian + Ed
2009



 Ali + Roberto
2010




 Ashley + J.P.
2011



 Emily + Jef
2012




 Desiree + Chris
2013



 Andi + Josh
2014



 Kaitlyn + Shawn
2015



 JoJo + Jordan
2016



For nearly all seasons, dates did not begin until week two. Dates are weighted so that a one-on-one counts as one date, a two-on-one counts as 0.5 dates, etc.



Contestant Nick was rejected by both Andi and Kaitlyn in their final ceremonies. He went on to be the bachelor in 2017.

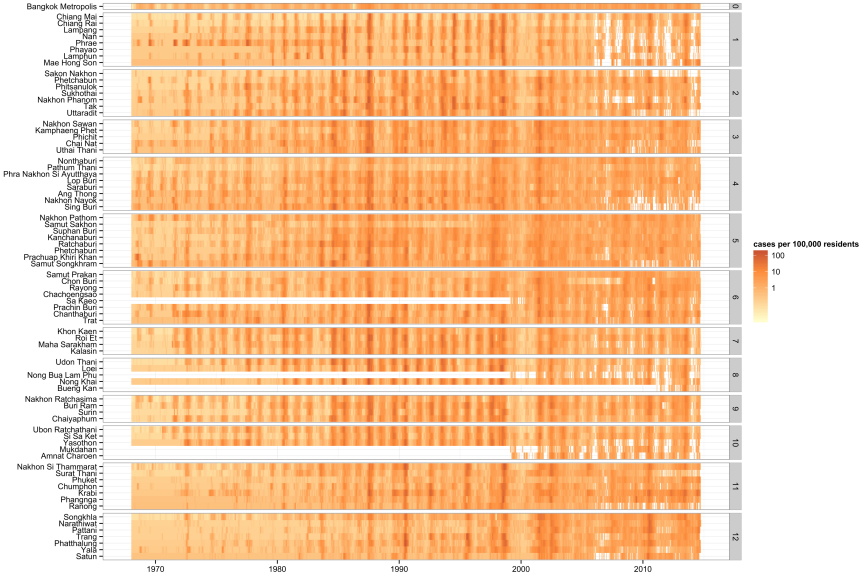


FiveThirtyEight

BASED ON DATA FROM ABC, WIKIPEDIA AND BACHELOR NATION WIKIA

⁴ <https://fivethirtyeight.com/features/the-bachelorette/>

Dengue cases in Thailand⁵



⁵ adapted from Reich et al, 2016.

Why do we visualize data?

Exploratory graphics

- ▶ The most valuable graphics are often the simple ones you make for yourself.
- ▶ Exploratory graphics can introduce you to a dataset.
- ▶ Key goal: understand the variation.
- ▶ What do you want to know about these data?

```
data(airquality)
head(airquality)
```

```
##      Ozone  Solar.R  Wind  Temp  Month  Day
## 1      41      190   7.4   67     5     1
## 2      36      118   8.0   72     5     2
## 3      12      149  12.6   74     5     3
## 4      18      313  11.5   62     5     4
## 5      NA       NA  14.3   56     5     5
## 6      28       NA  14.9   66     5     6
```

Exploratory summaries: airquality data

Some quick text-based/tabular summaries

```
nrow(airquality)
```

```
summary(airquality)
```

```
table(airquality$Month)
```

```
with(airquality, table(Month, Day))
```

Univariate graphics: airquality data

```
library(ggplot2)

p <- ggplot(airquality)

## better or worse than the table?
p + geom_bar(aes(x=factor(Month)))

## which of these do you prefer and why?
p + geom_density(aes(Ozone))
p + geom_histogram(aes(x=Ozone))
```

Multivariate graphics: airquality data

```
p + geom_boxplot(aes(x=factor(Month), y=Ozone))

p2 <- ggplot(airquality, aes(x=Temp, y=Ozone))
p2 + geom_point()
p2 + geom_point() + geom_smooth()
p2 + geom_point() + geom_smooth(se=FALSE)

p3 <- ggplot(airquality,
             aes(x=Temp, y=Ozone, color=factor(Month)))
p3 + geom_point() + geom_smooth(se=FALSE)
```

Multivariate graphics: pairs plots!

Pairs plots are sweet, but can take some time to render (especially for big-datasets).

```
library(GGally)  
ggpairs(airquality)
```


Your turn!

Try visualizing some of the NHANES data

```
library(NHANES)  
data(NHANES)  
?NHANES
```

Try mplot for learning ggplot2 syntax

```
library(mosaic)
## downsample the dataset to make it smaller
NHANES_samp <- sample(NHANES, size = 1000)
mplot(NHANES_samp)
```

Summary: Key principles of data graphics

- ▶ “**Show** the data”
- ▶ “Encourage the eye to **compare** different pieces of data”
- ▶ **Simplify** by maximizing the “data-ink ratio.”
- ▶ Leverage color, shapes, facets to highlight multivariate data.
- ▶ Annotate your figures with context.