Reproducible science: Module 4

Data visualization in Tidyverse: the power of ggplot2

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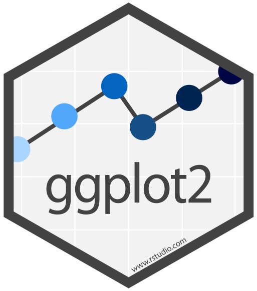
Acknowledgements

The content of this module are based on materials from:

olivier gimenez's materials

ggplot2: Introduction

- This package was created by Hadley Whickham check out its book;
- A powerful package for visualizing data;
- The package ggplot2 implements a grammar of graphics;
- Operates on data.frames or tibbles, not vectors like base R;
- Explicitly differentiates between the data and its representation;
- Consists on stacking different layers together, if you have ever worked with GIS, then this notion of layer would be familiar to you.



The ggplot2 grammar

Grammar element	What it is
Data	The data frame being plotted
Geometrics	The geometric shape that will represent the data
	(e.g., point, boxplot, histogram)
Aesthetics	The aesthetics of the geometric object
	(e.g., color, size, shape)

ggplot basics

1) The ggplot function and the data argument specify a data frame in the main ggplot function

```
#ggplot(data = df) where df= dataframe or tibble
```

2) The mapping aesthetics, or aes; most importantly, the variable(s) that we want to plot. aes() specify as an embedded argument in the ggplot() function

```
# ggplot(data = df, mapping = aes(x = h5_median, y = h5_index, color
```

3) The geometric objects, or geom; the visual representations specify, after a plus sign +, as an additional function

```
# ggplot(data = df, mapping = aes(x = h5_median, y = h5_index, color
```

Examples of plots

Scatter plots: Import data

We will continue using the precedent data on how twitting can predict citations.

```
# Set the url from where to download the data
url<-"https://doi.org/10.1371/journal.pone.0166570.s001"
# name the file to be downloaded and save as destfile object
destfile <- "twitter_cit_data.csv"
# Apply download.file function in R to download from url
download.file(url, destfile)
library(tidyverse)
```

```
## Warning: package 'ggplot2' was built under R version 4.1.1

## Warning: package 'readr' was built under R version 4.1.1
```

```
# Read the data file with read_csv() and save with name "citations_ra
citations_raw<-read_csv(file="twitter_cit_data.csv")
citations <- rename(citations_raw,
       journal = 'Journal identity',
       impactfactor = '5-year journal impact factor',
       pubyear = 'Year published',
       colldate = 'Collection date',
```

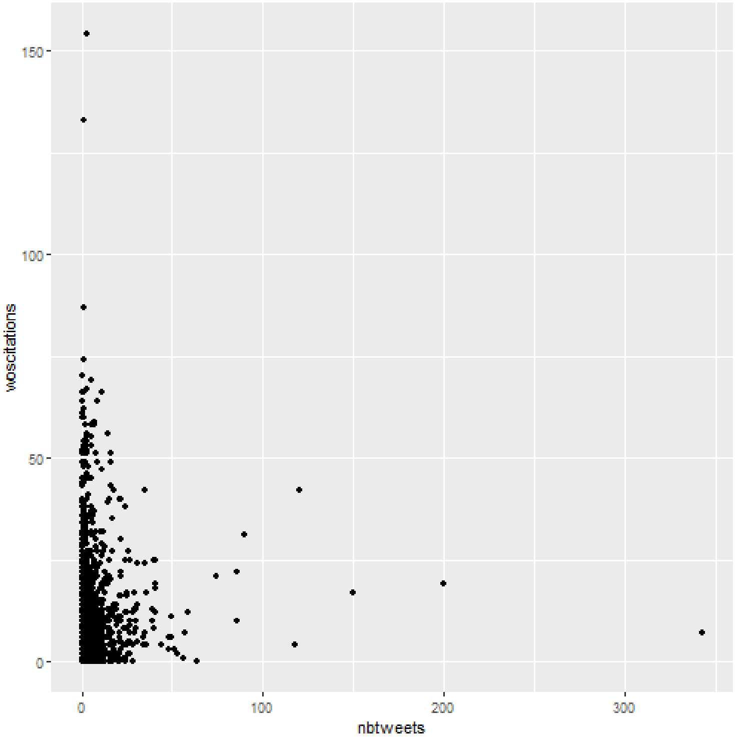
Scatter plot: Plotting

```
scatterplot<-citations %>%
  ggplot() +
  aes(x = nbtweets, y = woscitations) +
  geom_point()
```

- Pass in the data frame as your first argument;
- Aesthetics maps the data onto plot characteristics, here x and y axes
- Display the data geometrically as points

Scatter plot

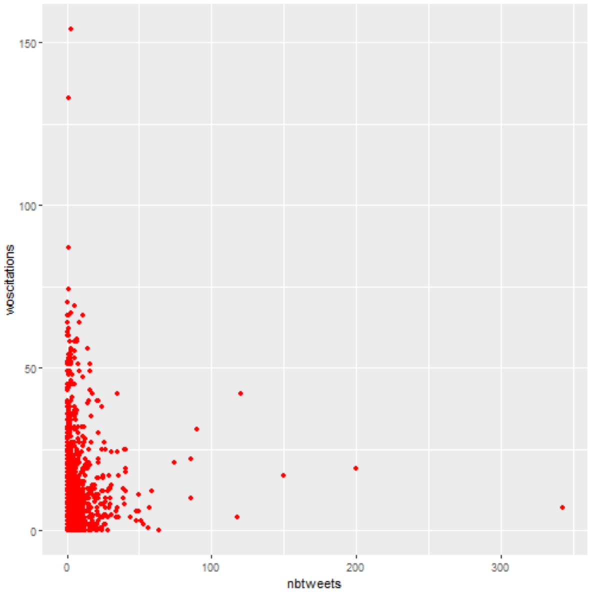
```
scatterplot
```



Scatterplots with colors

Puts all points in same color.

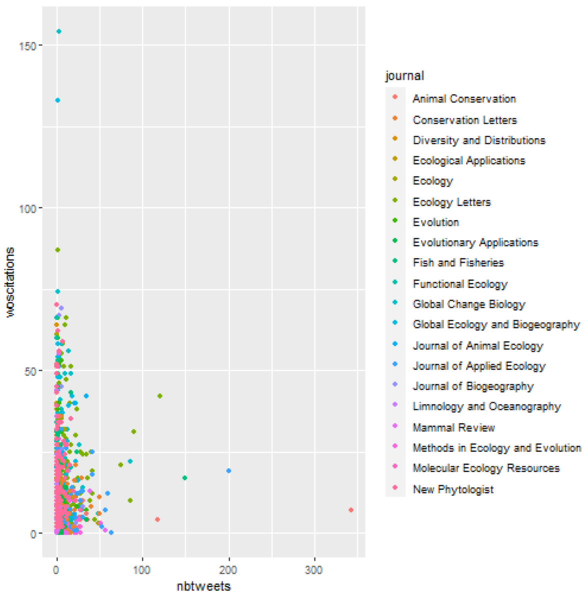
```
scatter_col<-citations %>%
  ggplot() +
  aes(x = nbtweets, y = woscitations) +
  geom_point(color = "red")
scatter_col
```



Scatterplots with color per species

Gives different color per species.

```
scatter_spcol<-citations %>%
  ggplot() +
  aes(x = nbtweets, y = woscitations, color = journal) +
  geom_point()
scatter_spcol
```



Scatterplots with shape per journal

Gives different shape per journal. First need to pick few journals. Let's do journal on ecology. Filiter these journals to three: JAE, JAppE, Ecol.

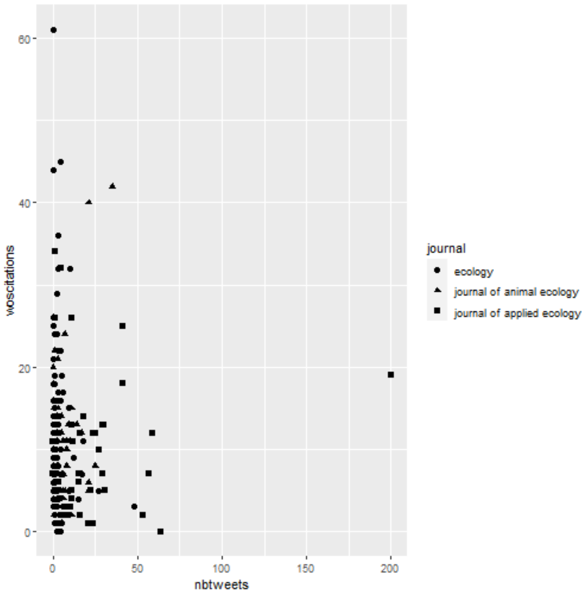
```
citations_ecology <- citations %>%
  mutate(journal = str_to_lower(journal)) %>% # all journals names lo
  filter(journal %in%
           c('journal of animal ecology','journal of applied ecology'
head(citations_ecology)
```

```
## # A tibble: 6 x 12
##   journal impactfactor pubyear Volume Issue Authors    colldate pubdate nb
##   <chr>          <dbl>   <dbl>  <dbl> <chr> <chr>      <chr>    <chr>
## 1 ecology         6.16    2014     95 12    Maglianes~ 3/19/20~ 12/1/2~
## 2 ecology         6.16    2014     95 12    Soinen     3/19/20~ 12/1/2~
## 3 ecology         6.16    2014     95 12    Graham an~ 3/19/20~ 12/1/2~
## 4 ecology         6.16    2014     95 11    White et ~ 3/19/20~ 11/1/2~
## 5 ecology         6.16    2014     95 11    Einarson ~ 3/19/20~ 11/1/2~
## 6 ecology         6.16    2014     95 11    Haav and ~ 3/19/20~ 11/1/2~
## # ... with 3 more variables: Number of users <dbl>, Twitter reach <dbl>,
## #   woscitations <dbl>
```

Scatterplots with shape per journal

Gives different shape per journal.

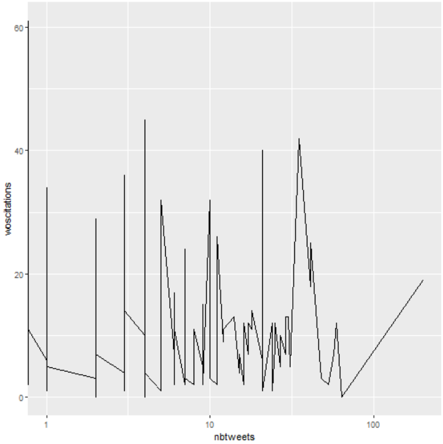
```
scatter_ecol<-citations_ecology %>%
  ggplot() +
  aes(x = nbtweets, y = woscitations, shape = journal) +
  geom_point(size=2)
scatter_ecol
```



Scatterplots with lines not points

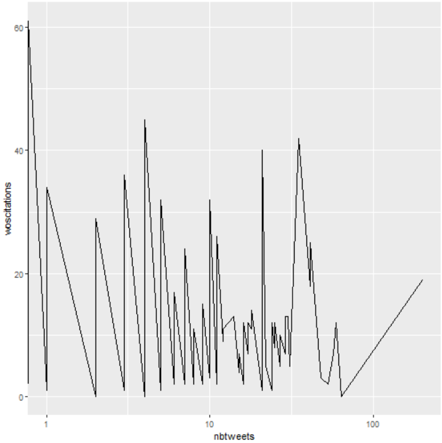
By now, you would guess this requires change in geom, so this should intuitively geom_line.

```
scatter_line<-citations_ecology %>%
  ggplot() +
  aes(x = nbtweets, y = woscitations) +
  geom_line() +
  scale_x_log10()
scatter_line
```



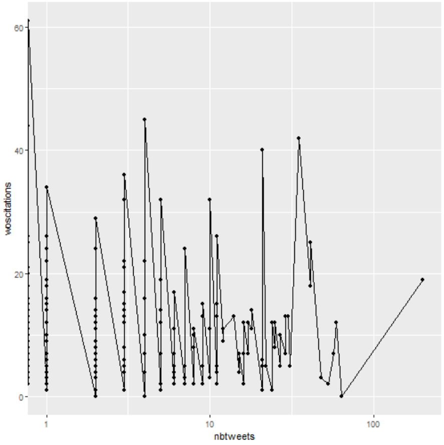
Scatterplots with sorting then add line

```
scatter_line2<-citations_ecology %>%
  arrange(woscitations) %>%
  ggplot() +
  aes(x = nbtweets, y = woscitations) +
  geom_line() +
  scale_x_log10()
scatter_line2
```



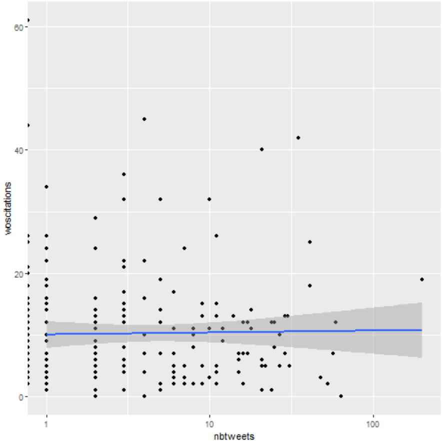
Scatterplots with line and points

```
scatter_line3<-citations_ecology %>%
  arrange(woscitations) %>%
  ggplot() +
  aes(x = nbtweets, y = woscitations) +
  geom_line() +
  geom_point() +
  scale_x_log10()
scatter_line3
```



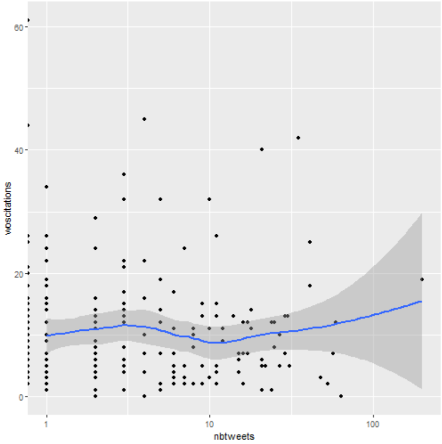
Scatterplots with trend line

```
scatter_line4<-citations_ecology %>%
  arrange(woscitations) %>%
  ggplot() +
  aes(x = nbtweets, y = woscitations) +
  geom_point() +
  geom_smooth(method = "lm") +
  scale_x_log10()
scatter_line4
```



Scatterplots with smoother

```
scatter_line5<-citations_ecology %>%
  arrange(woscitations) %>%
  ggplot() +
  aes(x = nbtweets, y = woscitations) +
  geom_point() +
  geom_smooth() +
  scale_x_log10()
scatter_line5
```



aes or not aes?

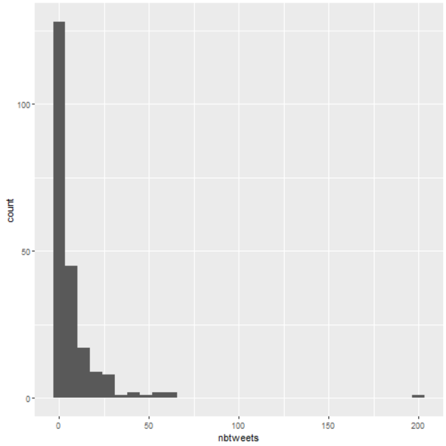
Before continuing to other type of plots, let break to see what we mean by aes().

- If we are to establish a link between the values of a variable and a graphical feature, ie a mapping, then we need an aes().
- Otherwise, the graphical feature is modified irrespective of the data, then we do not need an aes().

Histograms

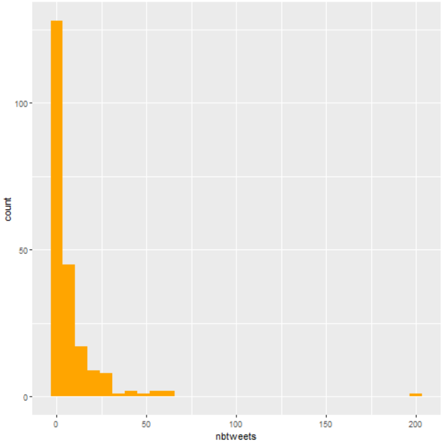
When you only provide x in the aes(), then ggplot will render a histogram.

```
histo<-citations_ecology %>%
  ggplot() +
  aes(x = nbtweets) +
  geom_histogram()
histo
```



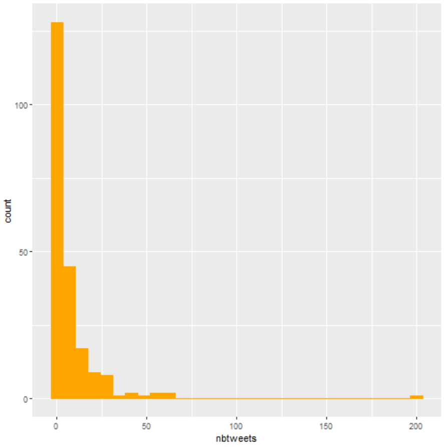
Histograms with bars in colors

```
histo2<-citations_ecology %>%
  ggplot() +
  aes(x = nbtweets) +
  geom_histogram(fill = "orange")
histo2
```



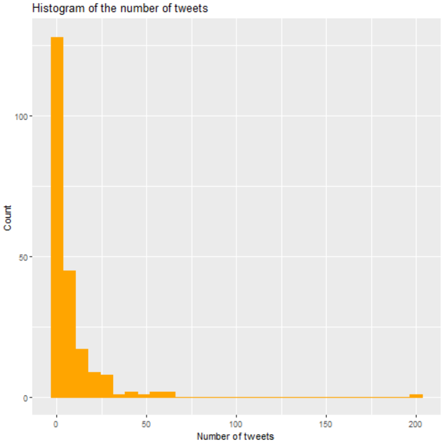
Histograms with bars filled and contour colors

```
histo3<-citations_ecology %>%
  ggplot() +
  aes(x = nbtweets) +
  geom_histogram(fill = "orange", color="orange")
histo3
```



Histograms with labels and title

```
histo4<-citations_ecology %>%
  ggplot() +
  aes(x = nbtweets) +
  geom_histogram(fill = "orange", color="orange")+
  labs(x = "Number of tweets",
       y = "Count",
       title = "Histogram of the number of tweets")
histo4
```



Histograms but group this by specific variable

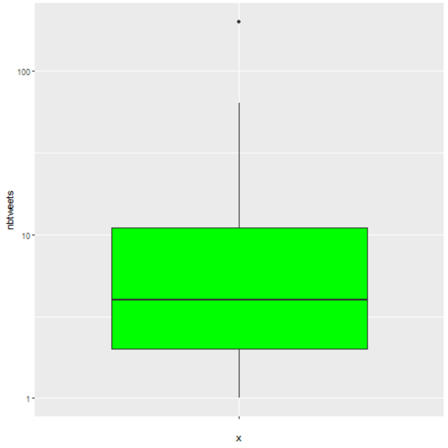
Here we want to have the histogram by journal.

```
histo5<-citations_ecology %>%
  ggplot() +
  aes(x = nbtweets) +
  geom_histogram(fill = "orange", color = "brown") +
  labs(x = "Number of tweets",
       y = "Count",
       title = "Histogram of the number of tweets") +
  facet_wrap(vars(journal))
histo5
```

Boxplots

Intuitively by now, you would guess this would have something like geom_boxplot(). Also, please keep in mind that we would not give x values for the aes(), but only y values.

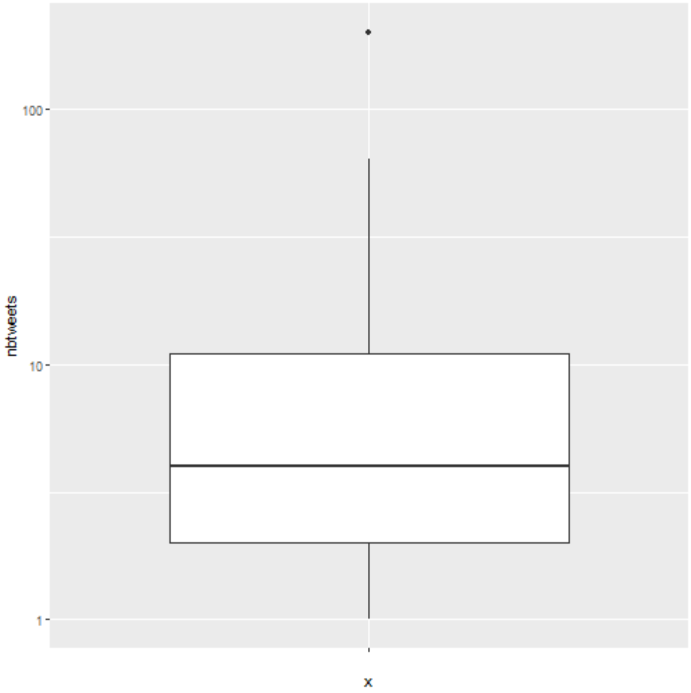
```
boxpl<-citations_ecology %>%
  ggplot() +
  aes(x = "", y = nbtweets) +
  geom_boxplot(fill="green") +
  scale_y_log10()
boxpl
```



Some other manipulations

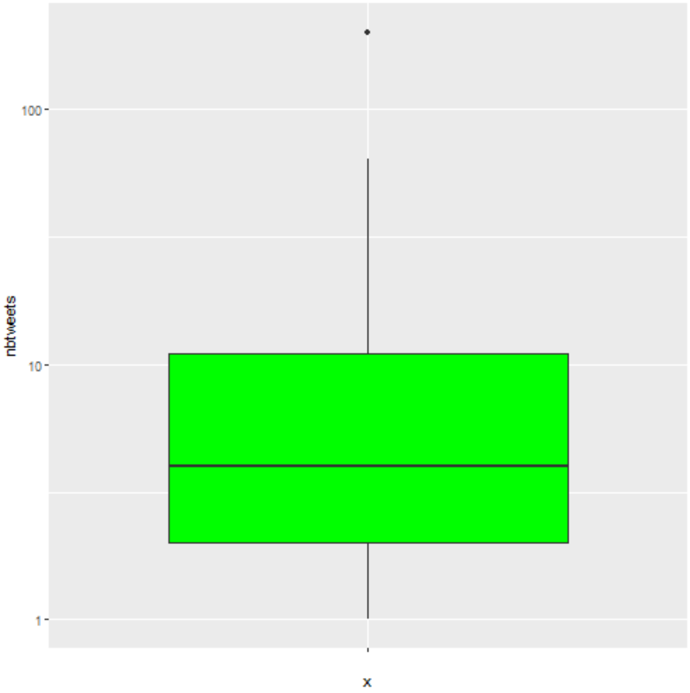
Boxplots

```
citations_ecology %>%
  ggplot() +
  aes(x = "", y = nbtweets) +
  geom_boxplot() +
  scale_y_log10()
```



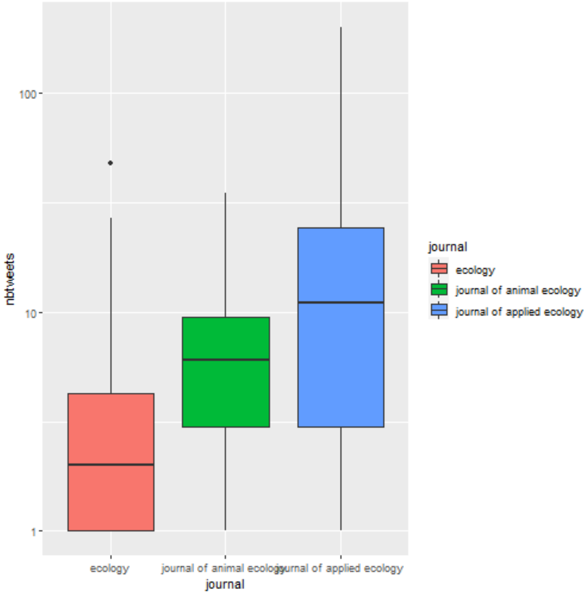
Boxplots with colors

```
citations_ecology %>%
  ggplot() +
  aes(x = "", y = nbtweets) +
  geom_boxplot(fill = "green") +
  scale_y_log10()
```



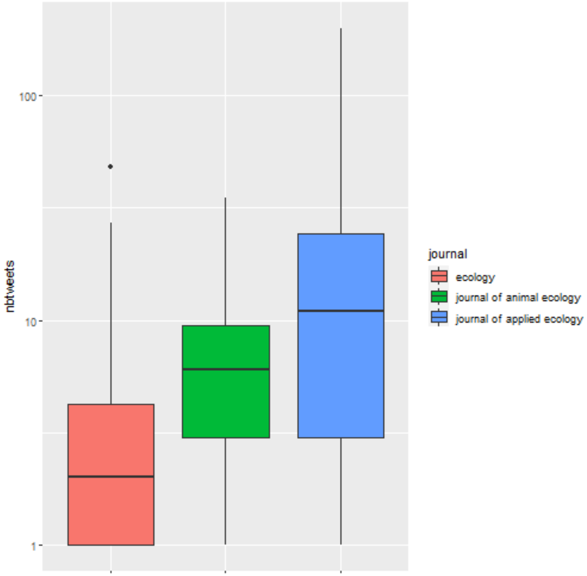
Boxplots with colors by species

```
citations_ecology %>%
  ggplot() +
  aes(x = journal, y = nbtweets, fill = journal) +
  geom_boxplot() +
  scale_y_log10()
```



Get rid of the ticks on x axis

```
citations_ecology %>%
  ggplot() +
  aes(x = journal, y = nbtweets, fill = journal) +
  geom_boxplot() +
  scale_y_log10() +
  theme(axis.text.x = element_blank()) +
  labs(x = "")
```



Boxplots, user-specified colors by species

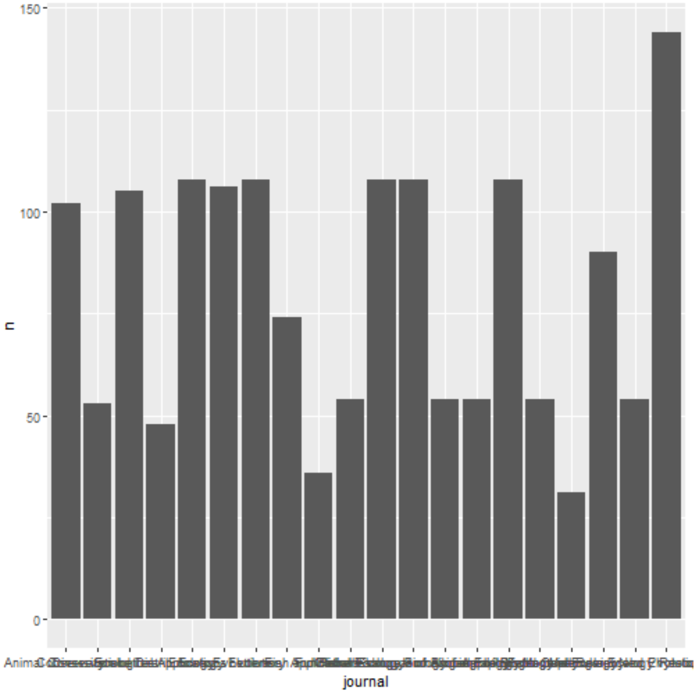
```
citations_ecology %>%
  ggplot() +
  aes(x = journal, y = nbtweets, fill = journal) +
  geom_boxplot() +
  scale_y_log10() +
  scale_fill_manual(
    values = c("red", "blue", "purple")) +
  theme(axis.text.x = element_blank()) +
  labs(x = "")
```

Boxplots, change legend settings

```r
citations_ecology %>%
  ggplot() +
  aes(x = journal, y = nbtweets, fill = journal) +
  geom_boxplot() +
  scale_y_log10() +
  scale_fill_manual(
    values = c("red", "blue", "purple"),
    name = "Journal name",
    labels = c("Ecology", "J Animal Ecology", "J Applied Ecology"))
  theme(axis.text.x = element_blank()) +
  labs(x = "")
```

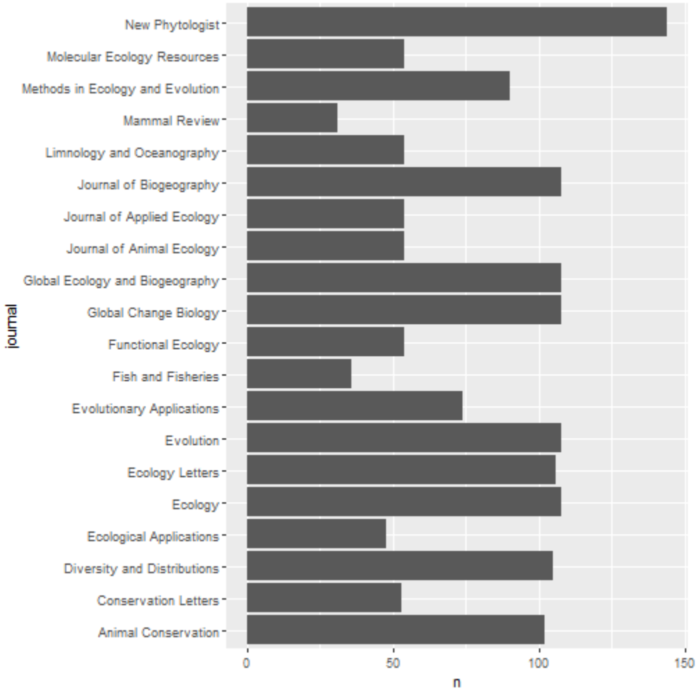
Ugly bar plots

```
citations %>%
  count(journal) %>%
  ggplot() +
  aes(x = journal, y = n) +
  geom_col()
```



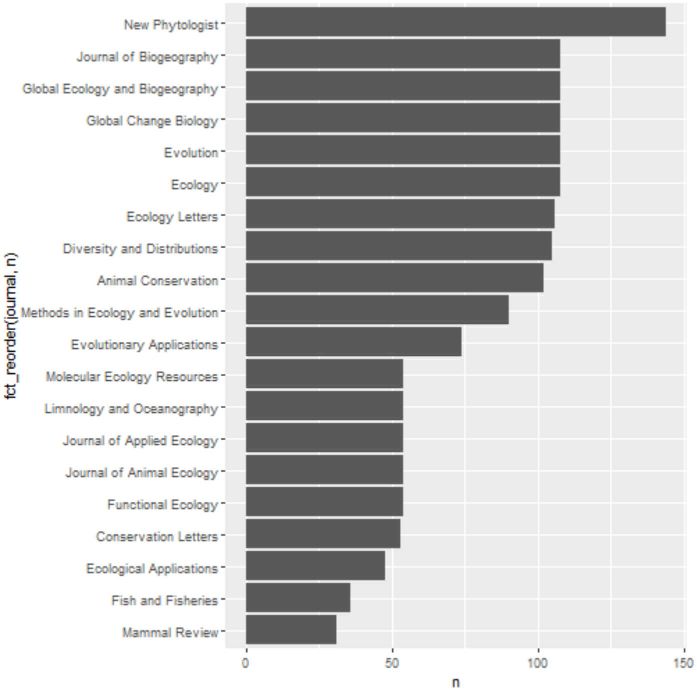
Idem, with flipping

```
citations %>%
  count(journal) %>%
  ggplot() +
  aes(x = n, y = journal) +
  geom_col()
```



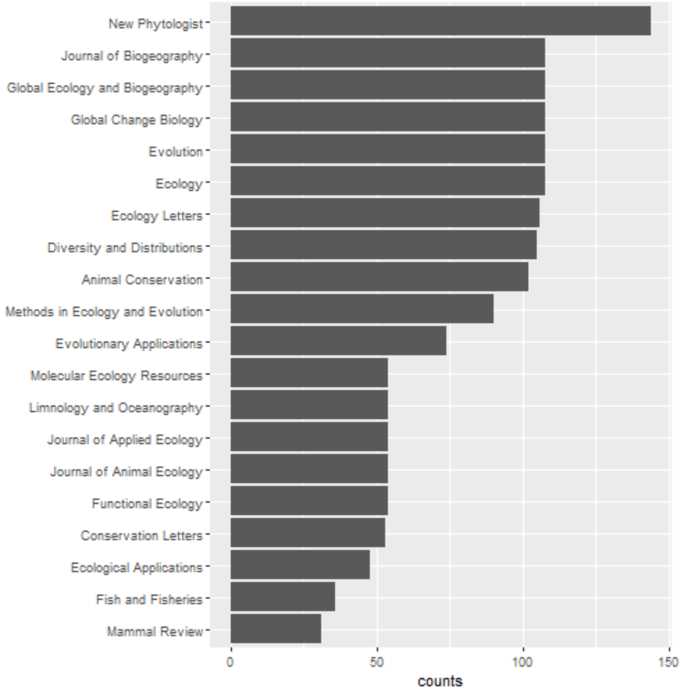
Idem, with factors reordering and flipping

```
citations %>%
  count(journal) %>%
  ggplot() +
  aes(x = n, y = fct_reorder(journal, n)) +
  geom_col()
```



Further cleaning

```
citations %>%
  count(journal) %>%
  ggplot() +
  aes(x = n, y = fct_reorder(journal, n)) +
  geom_col() +
  labs(x = "counts", y = "")
```

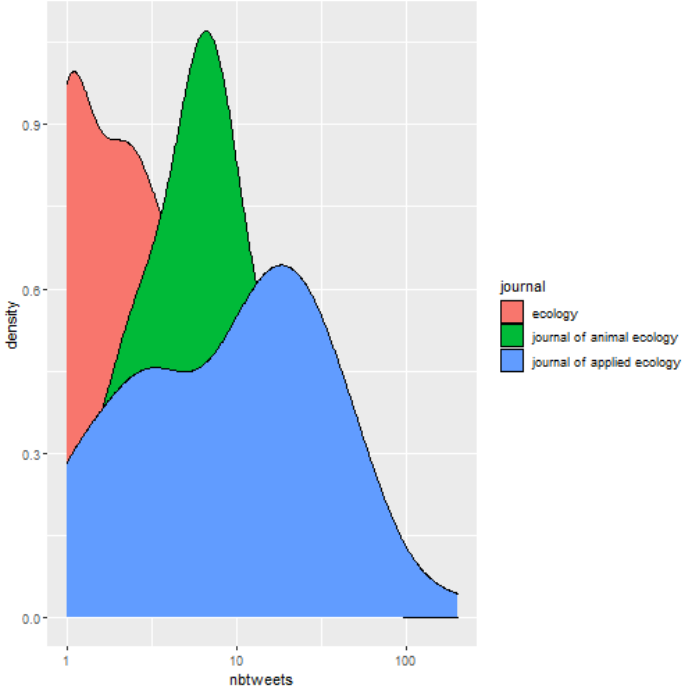


More about how to (tidy) work with factors

- Be the boss of your factors and
- forcats, forcats, vous avez dit forcats ?.

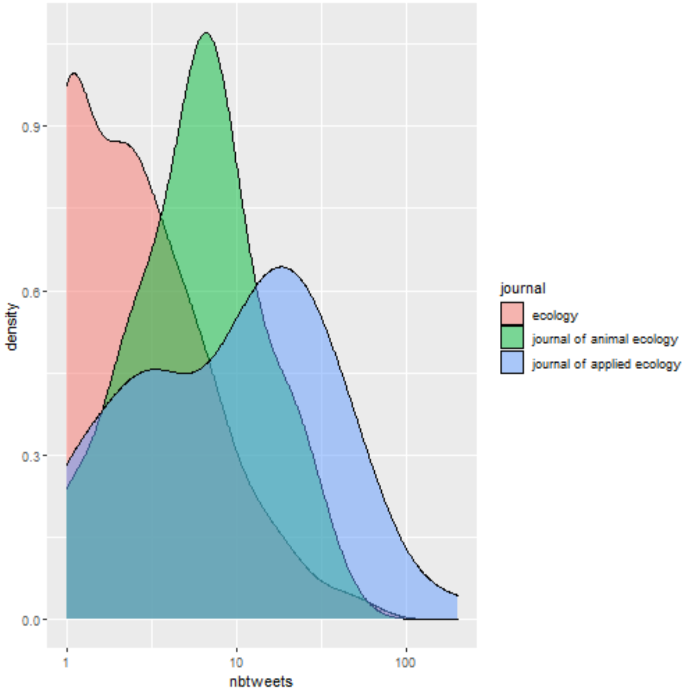
Density plots

```
citations_ecology %>%
  ggplot() +
  aes(x = nbtweets, fill = journal) +
  geom_density() +
  scale_x_log10()
```



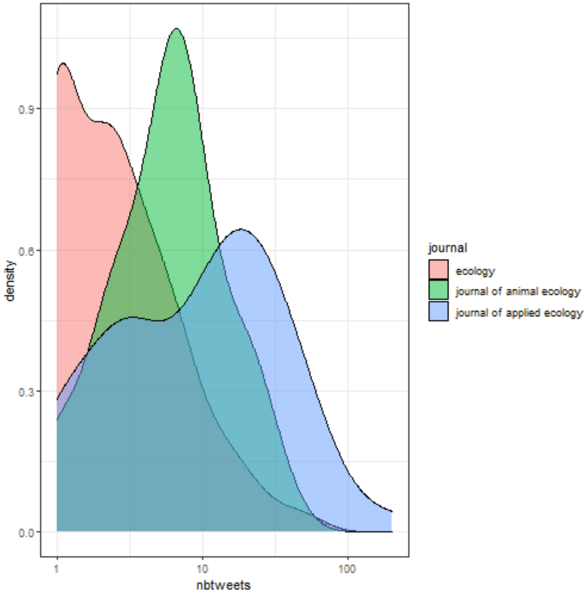
Density plots, control transparency

```
citations_ecology %>%
  ggplot() +
  aes(x = nbtweets, fill = journal) +
  geom_density(alpha = 0.5) +
  scale_x_log10()
```



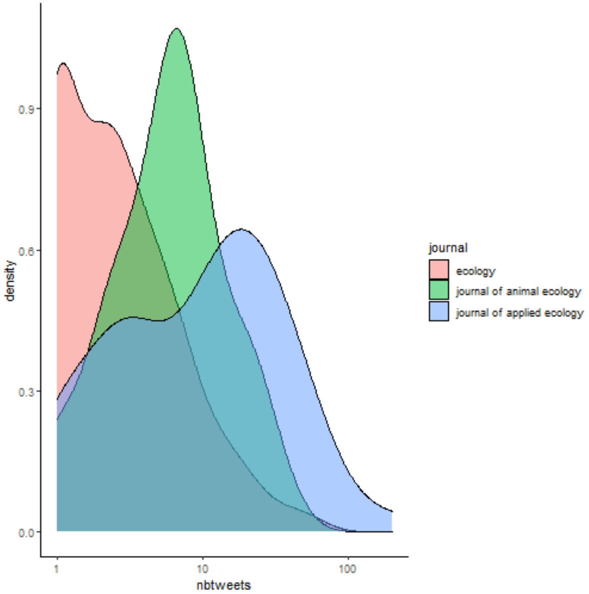
Change default background

```
# `B & W theme`
citations_ecology %>%
  ggplot() +
  aes(x = nbtweets, fill = journal) +
  geom_density(alpha = 0.5) +
  scale_x_log10() +
  theme_bw()
```



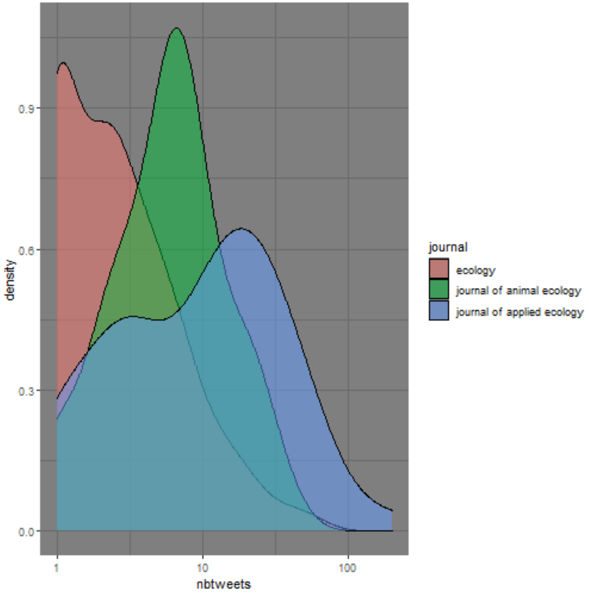
Change default background theme

```r
# `classic theme`
citations_ecology %>%
  ggplot() +
  aes(x = nbtweets, fill = journal) +
  geom_density(alpha = 0.5) +
  scale_x_log10() +
  theme_classic()
```



Change default background theme

```
# `dark theme`
citations_ecology %>%
  ggplot() +
  aes(x = nbtweets, fill = journal) +
  geom_density(alpha = 0.5) +
  scale_x_log10() +
  theme_dark()
```



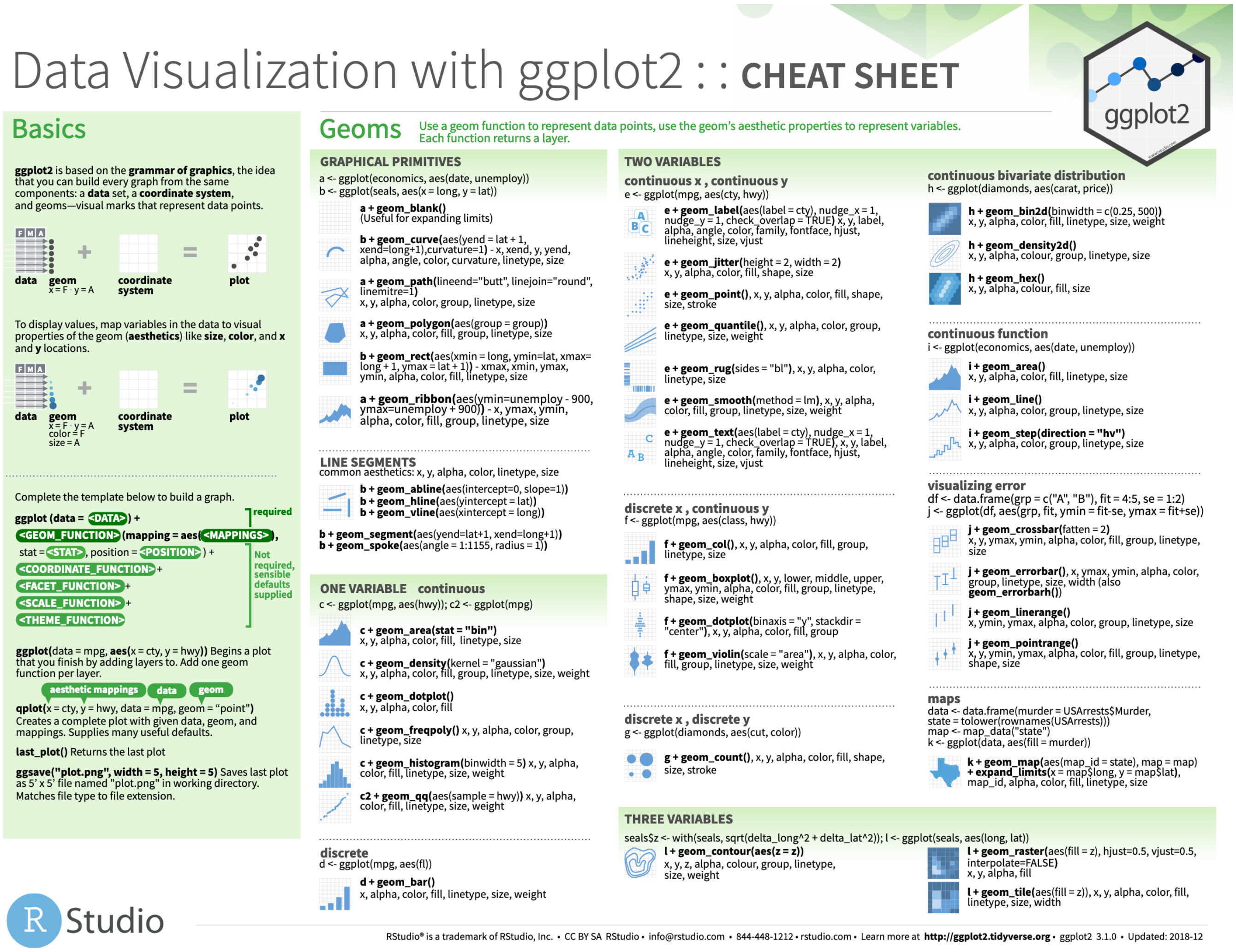
More on data visualisation with ggplot2

- Portfolio of ggplot2 plots
- Cedric Scherer's portfolio of data visualizations
- Top ggplot2 visualizations
- Interactive ggplot2 visualizations

To dive deeper in data visualisation with the tidyverse

- Learn the tidyverse: books, workshops and online courses
- R for Data Science and Advanced R
- Fundamentals of Data visualization
- Data Visualization: A practical introduction
- Tidy Tuesdays videos by D. Robinson
- Material of the 2-day workshop Data Science in the tidyverse held at the RStudio 2019 conference
- Material of the stat545 course on Data wrangling, exploration, and analysis with R at the University of British Columbia

The RStudio Cheat Sheets



Data Visualization with ggplot2 : : CHEAT SHEET

ggplot2

Basics

ggplot2 is based on the **grammar of graphics**, the idea that you can build every graph from the same components: a **data** set, a **coordinate system**, and geoms—visual marks that represent data points.

F M A
data
geom
x = F · y = A
+
coordinate system
=
plot

To display values, map variables in the data to visual properties of the geom (**aesthetics**) like **size**, **color**, and **x** and **y** locations.

Complete the template below to build a graph.

ggplot (data = <DATA>) +
<GEOM_FUNCTION>(mapping = aes(<MAPPINGS>),
stat = <STAT>, position = <POSITION>) +
<COORDINATE_FUNCTION> +
<FACET_FUNCTION> +
<SCALE_FUNCTION> +
<THEME_FUNCTION>

required

Not required, sensible defaults supplied

ggplot(data = mpg, **aes(**x = cty, y = hwy**))** Begins a plot that you finish by adding layers to. Add one geom function per layer.

aesthetic mappings
data
geom

qplot(x = cty, y = hwy, data = mpg, geom = “point"**)** Creates a complete plot with given data, geom, and mappings. Supplies many useful defaults.

last_plot() Returns the last plot

ggsave("plot.png", width = 5, height = 5) Saves last plot as 5’ x 5’ file named "plot.png" in working directory. Matches file type to file extension.

Geoms

Use a geom function to represent data points, use the geom’s aesthetic properties to represent variables. Each function returns a layer.

GRAPHICAL PRIMITIVES

a <- ggplot(economics, aes(date, unemploy))
b <- ggplot(seals, aes(x = long, y = lat))

a + geom_blank()
(Useful for expanding limits)

b + geom_curve(aes(yend = lat + 1, xend=long+1),curvature=1**)** - x, xend, y, yend, alpha, angle, color, curvature, linetype, size

a + geom_path(lineend="butt", linejoin="round", linemitre=1**)**
x, y, alpha, color, group, linetype, size

a + geom_polygon(aes(group = group)**)**
x, y, alpha, color, fill, group, linetype, size

b + geom_rect(aes(xmin = long, ymin=lat, xmax= long + 1, ymax = lat + 1)**)** - xmax, xmin, ymax, ymin, alpha, color, fill, linetype, size

a + geom_ribbon(aes(ymin=unemploy - 900, ymax=unemploy + 900)**)** - x, ymax, ymin, alpha, color, fill, group, linetype, size

LINE SEGMENTS

common aesthetics: x, y, alpha, color, linetype, size

b + geom_abline(aes(intercept=0, slope=1)**)**
b + geom_hline(aes(yintercept = lat)**)**
b + geom_vline(aes(xintercept = long)**)**

b + geom_segment(aes(yend=lat+1, xend=long+1)**)**
b + geom_spoke(aes(angle = 1:1155, radius = 1)**)**

ONE VARIABLE continuous

c <- ggplot(mpg, aes(hwy)); c2 <- ggplot(mpg)

c + geom_area(stat = "bin")
x, y, alpha, color, fill, linetype, size

c + geom_density(kernel = "gaussian"**)**
x, y, alpha, color, fill, group, linetype, size, weight

c + geom_dotplot()
x, y, alpha, color, fill

c + geom_freqpoly() x, y, alpha, color, group, linetype, size

c + geom_histogram(binwidth = 5**)** x, y, alpha, color, fill, linetype, size, weight

c2 + geom_qq(aes(sample = hwy)**)** x, y, alpha, color, fill, linetype, size, weight

discrete

d <- ggplot(mpg, aes(fl))

d + geom_bar()
x, alpha, color, fill, linetype, size, weight

TWO VARIABLES

continuous x , continuous y

e <- ggplot(mpg, aes(cty, hwy))

e + geom_label(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE**)** x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

e + geom_jitter(height = 2, width = 2**)**
x, y, alpha, color, fill, shape, size

e + geom_point(), x, y, alpha, color, fill, shape, size, stroke

e + geom_quantile(), x, y, alpha, color, group, linetype, size, weight

e + geom_rug(sides = "bl"**)**, x, y, alpha, color, linetype, size

e + geom_smooth(method = lm**)**, x, y, alpha, color, fill, group, linetype, size, weight

e + geom_text(aes(label = cty), nudge_x = 1, nudge_y = 1, check_overlap = TRUE**)**, x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

discrete x , continuous y

f <- ggplot(mpg, aes(class, hwy))

f + geom_col(), x, y, alpha, color, fill, group, linetype, size

f + geom_boxplot(), x, y, lower, middle, upper, ymax, ymin, alpha, color, fill, group, linetype, shape, size, weight

f + geom_dotplot(binaxis = "y", stackdir = "center"**)**, x, y, alpha, color, fill, group

f + geom_violin(scale = "area"**)**, x, y, alpha, color, fill, group, linetype, size, weight

discrete x , discrete y

g <- ggplot(diamonds, aes(cut, color))

g + geom_count(), x, y, alpha, color, fill, shape, size, stroke

continuous bivariate distribution

h <- ggplot(diamonds, aes(carat, price))

h + geom_bin2d(binwidth = c(0.25, 500)**)**
x, y, alpha, color, fill, linetype, size, weight

h + geom_density2d()
x, y, alpha, colour, group, linetype, size

h + geom_hex()
x, y, alpha, colour, fill, size

continuous function

i <- ggplot(economics, aes(date, unemploy))

i + geom_area()
x, y, alpha, color, fill, linetype, size

i + geom_line()
x, y, alpha, color, group, linetype, size

i + geom_step(direction = "hv")
x, y, alpha, color, group, linetype, size

visualizing error

df <- data.frame(grp = c("A", "B"), fit = 4:5, se = 1:2)
j <- ggplot(df, aes(grp, fit, ymin = fit-se, ymax = fit+se))

j + geom_crossbar(fatten = 2**)**
x, y, ymax, ymin, alpha, color, fill, group, linetype, size

j + geom_errorbar(), x, ymax, ymin, alpha, color, group, linetype, size, width (also **geom_errorbarh()**)

j + geom_linerange()
x, ymin, ymax, alpha, color, group, linetype, size

j + geom_pointrange()
x, y, ymin, ymax, alpha, color, fill, group, linetype, shape, size

maps

data <- data.frame(murder = USArrests$Murder,
state = tolower(rownames(USArrests)))
map <- map_data("state")
k <- ggplot(data, aes(fill = murder))

k + geom_map(aes(map_id = state), map = map**)**
+ expand_limits(x = map$long, y = map$lat**)**,
map_id, alpha, color, fill, linetype, size

THREE VARIABLES

seals$z <- with(seals, sqrt(delta_long^2 + delta_lat^2)); l <- ggplot(seals, aes(long, lat))

l + geom_contour(aes(z = z))
x, y, z, alpha, colour, group, linetype, size, weight

l + geom_raster(aes(fill = z), hjust=0.5, vjust=0.5, interpolate=FALSE**)**
x, y, alpha, fill

l + geom_tile(aes(fill = z)**)**, x, y, alpha, color, fill, linetype, size, width

R Studio

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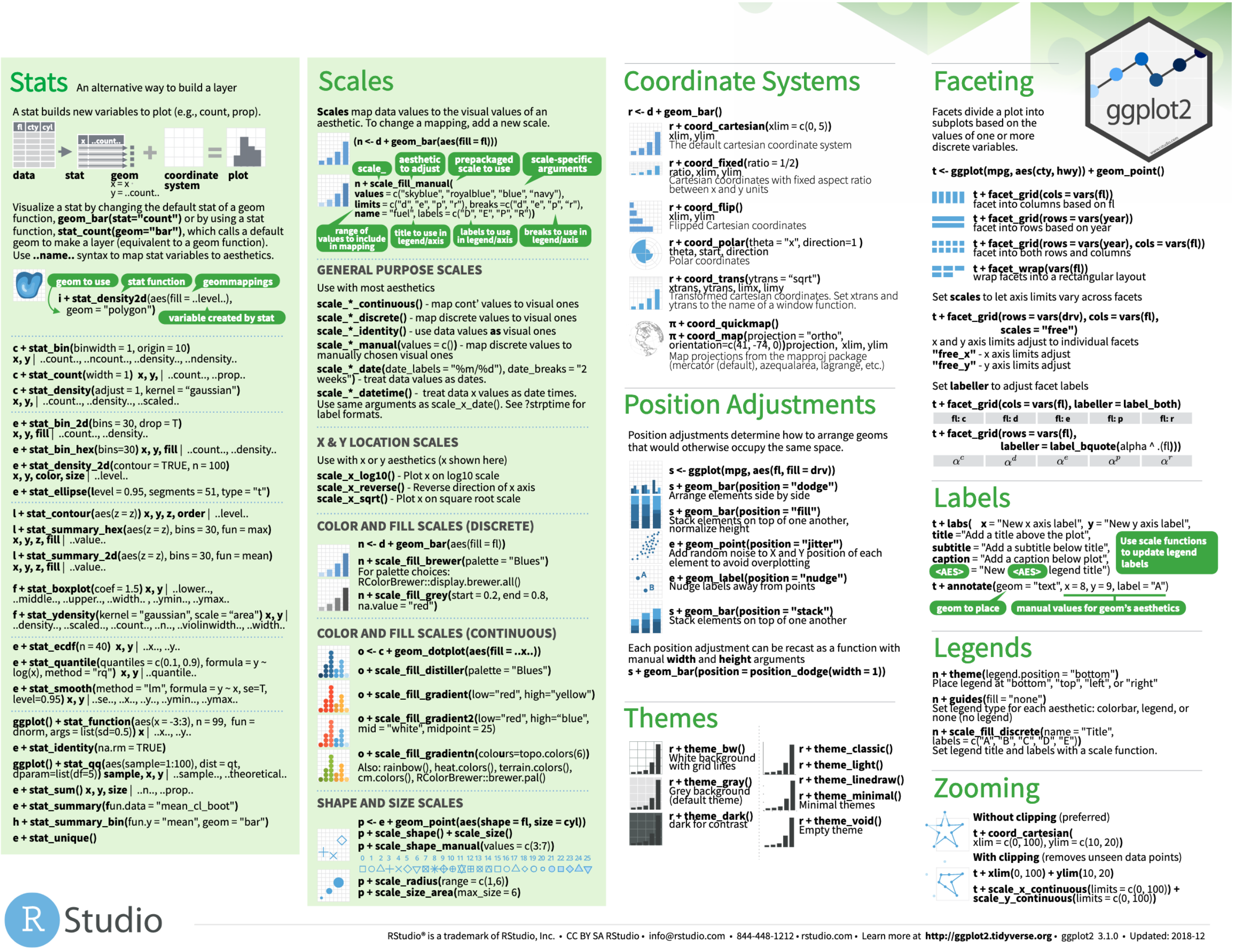
The RStudio Cheat Sheets



Stats An alternative way to build a layer

A stat builds new variables to plot (e.g., count, prop).

fl cty cyl → x ..count.. + =

data stat geom coordinate system plot
x = x
y = ..count..

Visualize a stat by changing the default stat of a geom function, **geom_bar(stat="count")** or by using a stat function, **stat_count(geom="bar")**, which calls a default geom to make a layer (equivalent to a geom function). Use **..name..** syntax to map stat variables to aesthetics.

geom to use | stat function | geommappings

i + stat_density2d(aes(fill = ..level..),
geom = "polygon")

variable created by stat

c + stat_bin(binwidth = 1, origin = 10)
x, y | ..count.., ..ncount.., ..density.., ..ndensity..

c + stat_count(width = 1) **x, y,** | ..count.., ..prop..

c + stat_density(adjust = 1, kernel = “gaussian")
x, y, | ..count.., ..density.., ..scaled..

e + stat_bin_2d(bins = 30, drop = T)
x, y, fill | ..count.., ..density..

e + stat_bin_hex(bins=30) **x, y, fill** | ..count.., ..density..

e + stat_density_2d(contour = TRUE, n = 100)
x, y, color, size | ..level..

e + stat_ellipse(level = 0.95, segments = 51, type = "t")

l + stat_contour(aes(z = z)) **x, y, z, order** | ..level..

l + stat_summary_hex(aes(z = z), bins = 30, fun = max)
x, y, z, fill | ..value..

l + stat_summary_2d(aes(z = z), bins = 30, fun = mean)
x, y, z, fill | ..value..

f + stat_boxplot(coef = 1.5) **x, y** | ..lower.., ..middle.., ..upper.., ..width.. , ..ymin.., ..ymax..

f + stat_ydensity(kernel = "gaussian", scale = “area") **x, y** | ..density.., ..scaled.., ..count.., ..n.., ..violinwidth.., ..width..

e + stat_ecdf(n = 40) **x, y** | ..x.., ..y..

e + stat_quantile(quantiles = c(0.1, 0.9), formula = y ~ log(x), method = "rq") **x, y** | ..quantile..

e + stat_smooth(method = "lm", formula = y ~ x, se=T, level=0.95) **x, y** | ..se.., ..x.., ..y.., ..ymin.., ..ymax..

ggplot() + stat_function(aes(x = -3:3), n = 99, fun = dnorm, args = list(sd=0.5)) **x** | ..x.., ..y..

e + stat_identity(na.rm = TRUE)

ggplot() + stat_qq(aes(sample=1:100), dist = qt, dparam=list(df=5)) **sample, x, y** | ..sample.., ..theoretical..

e + stat_sum() x, y, size | ..n.., ..prop..

e + stat_summary(fun.data = "mean_cl_boot")

h + stat_summary_bin(fun.y = "mean", geom = "bar")

e + stat_unique()

Scales

Scales map data values to the visual values of an aesthetic. To change a mapping, add a new scale.

(n <- d + geom_bar(aes(fill = fl)))

scale_ | aesthetic to adjust | prepackaged scale to use | scale-specific arguments

n + scale_fill_manual(
values = c("skyblue", "royalblue", "blue", “navy"),
limits = c("d", "e", "p", "r"), breaks =c("d", "e", "p", “r"),
name = "fuel", labels = c("D", "E", "P", "R"))

range of values to include in mapping | title to use in legend/axis | labels to use in legend/axis | breaks to use in legend/axis

GENERAL PURPOSE SCALES

Use with most aesthetics

scale_*_continuous() - map cont’ values to visual ones
scale_*_discrete() - map discrete values to visual ones
scale_*_identity() - use data values **as** visual ones
scale_*_manual(values = c()) - map discrete values to manually chosen visual ones
scale_*_date(date_labels = "%m/%d"), date_breaks = "2 weeks") - treat data values as dates.
scale_*_datetime() - treat data x values as date times. Use same arguments as scale_x_date(). See ?strptime for label formats.

X & Y LOCATION SCALES

Use with x or y aesthetics (x shown here)

scale_x_log10() - Plot x on log10 scale
scale_x_reverse() - Reverse direction of x axis
scale_x_sqrt() - Plot x on square root scale

COLOR AND FILL SCALES (DISCRETE)

n <- d + geom_bar(aes(fill = fl))

n + scale_fill_brewer(palette = "Blues")
For palette choices:
RColorBrewer::display.brewer.all()

n + scale_fill_grey(start = 0.2, end = 0.8, na.value = "red")

COLOR AND FILL SCALES (CONTINUOUS)

o <- c + geom_dotplot(aes(fill = ..x..))

o + scale_fill_distiller(palette = "Blues")

o + scale_fill_gradient(low="red", high="yellow")

o + scale_fill_gradient2(low="red", high="blue", mid = "white", midpoint = 25)

o + scale_fill_gradientn(colours=topo.colors(6))
Also: rainbow(), heat.colors(), terrain.colors(), cm.colors(), RColorBrewer::brewer.pal()

SHAPE AND SIZE SCALES

p <- e + geom_point(aes(shape = fl, size = cyl))
p + scale_shape() + scale_size()
p + scale_shape_manual(values = c(3:7))

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
□ ○ △ + × ◇ ▽ ⊠ ✳ ◈ ⊕ ✡ ⊞ ⊠ ◪ □ ○ △ ◇ ○ ○ ○ □ ◇ △ ▽

p + scale_radius(range = c(1,6))
p + scale_size_area(max_size = 6)

Coordinate Systems

r <- d + geom_bar()

r + coord_cartesian(xlim = c(0, 5))
xlim, ylim
The default cartesian coordinate system

r + coord_fixed(ratio = 1/2)
ratio, xlim, ylim
Cartesian coordinates with fixed aspect ratio between x and y units

r + coord_flip()
xlim, ylim
Flipped Cartesian coordinates

r + coord_polar(theta = "x", direction=1)
theta, start, direction
Polar coordinates

r + coord_trans(ytrans = “sqrt")
xtrans, ytrans, limx, limy
Transformed cartesian coordinates. Set xtrans and ytrans to the name of a window function.

π + coord_quickmap()
π + coord_map(projection = "ortho", orientation=c(41, -74, 0))projection, xlim, ylim
Map projections from the mapproj package (mercator (default), azequalarea, lagrange, etc.)

Position Adjustments

Position adjustments determine how to arrange geoms that would otherwise occupy the same space.

s <- ggplot(mpg, aes(fl, fill = drv))

s + geom_bar(position = "dodge")
Arrange elements side by side

s + geom_bar(position = "fill")
Stack elements on top of one another, normalize height

e + geom_point(position = "jitter")
Add random noise to X and Y position of each element to avoid overplotting

e + geom_label(position = "nudge")
Nudge labels away from points

s + geom_bar(position = "stack")
Stack elements on top of one another

Each position adjustment can be recast as a function with manual **width** and **height** arguments
s + geom_bar(position = position_dodge(width = 1))

Themes

r + theme_bw()
White background with grid lines

r + theme_gray()
Grey background (default theme)

r + theme_dark()
dark for contrast

r + theme_classic()

r + theme_light()

r + theme_linedraw()

r + theme_minimal()
Minimal themes

r + theme_void()
Empty theme

Faceting

Facets divide a plot into subplots based on the values of one or more discrete variables.

ggplot2

t <- ggplot(mpg, aes(cty, hwy)) + geom_point()

t + facet_grid(cols = vars(fl))
facet into columns based on fl

t + facet_grid(rows = vars(year))
facet into rows based on year

t + facet_grid(rows = vars(year), cols = vars(fl))
facet into both rows and columns

t + facet_wrap(vars(fl))
wrap facets into a rectangular layout

Set **scales** to let axis limits vary across facets

t + facet_grid(rows = vars(drv), cols = vars(fl),
scales = "free")
x and y axis limits adjust to individual facets
"free_x" - x axis limits adjust
"free_y" - y axis limits adjust

Set **labeller** to adjust facet labels

t + facet_grid(cols = vars(fl), labeller = label_both)

fl: c | fl: d | fl: e | fl: p | fl: r

t + facet_grid(rows = vars(fl),
labeller = label_bquote(alpha ^ .(fl)**))**

α^c | α^d | α^e | α^p | α^r

Labels

t + labs(**x** = "New x axis label", **y** = "New y axis label",
title ="Add a title above the plot",
subtitle = "Add a subtitle below title",
caption = "Add a caption below plot",
<AES> = "New <AES> legend title")

Use scale functions to update legend labels

t + annotate(geom = "text", x = 8, y = 9, label = "A")

geom to place | manual values for geom’s aesthetics

Legends

n + theme(legend.position = "bottom"**)**
Place legend at "bottom", "top", "left", or "right"

n + guides(fill = "none"**)**
Set legend type for each aesthetic: colorbar, legend, or none (no legend)

n + scale_fill_discrete(name = "Title", labels = c("A", "B", "C", "D", "E")**)**
Set legend title and labels with a scale function.

Zooming

Without clipping (preferred)

t + coord_cartesian(
xlim = c(0, 100), ylim = c(10, 20)**)**

With clipping (removes unseen data points)

t + xlim(0, 100**) + ylim(**10, 20**)**

t + scale_x_continuous(limits = c(0, 100)**) +**
scale_y_continuous(limits = c(0, 100)**)**

RStudio

Thank you for listening!

Any questions now or email me at **dossa@xtbg.org.cn**

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