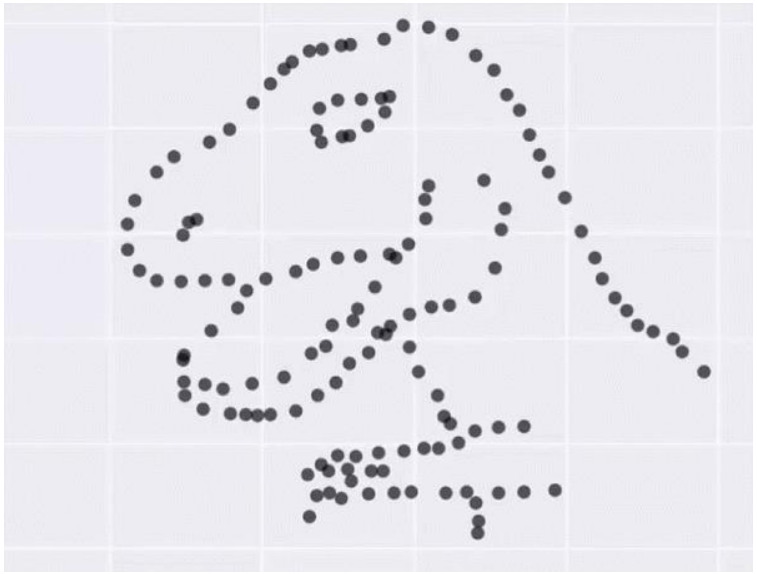
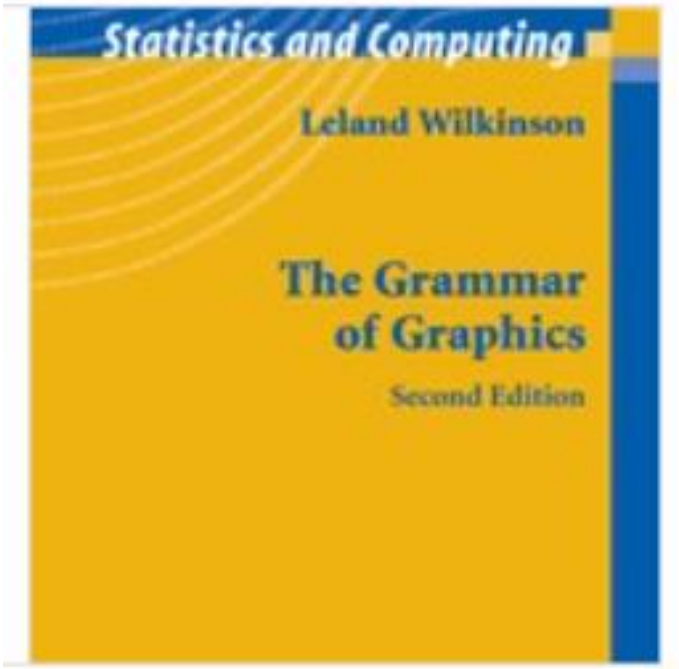
From Grammar of graphics to ggplot



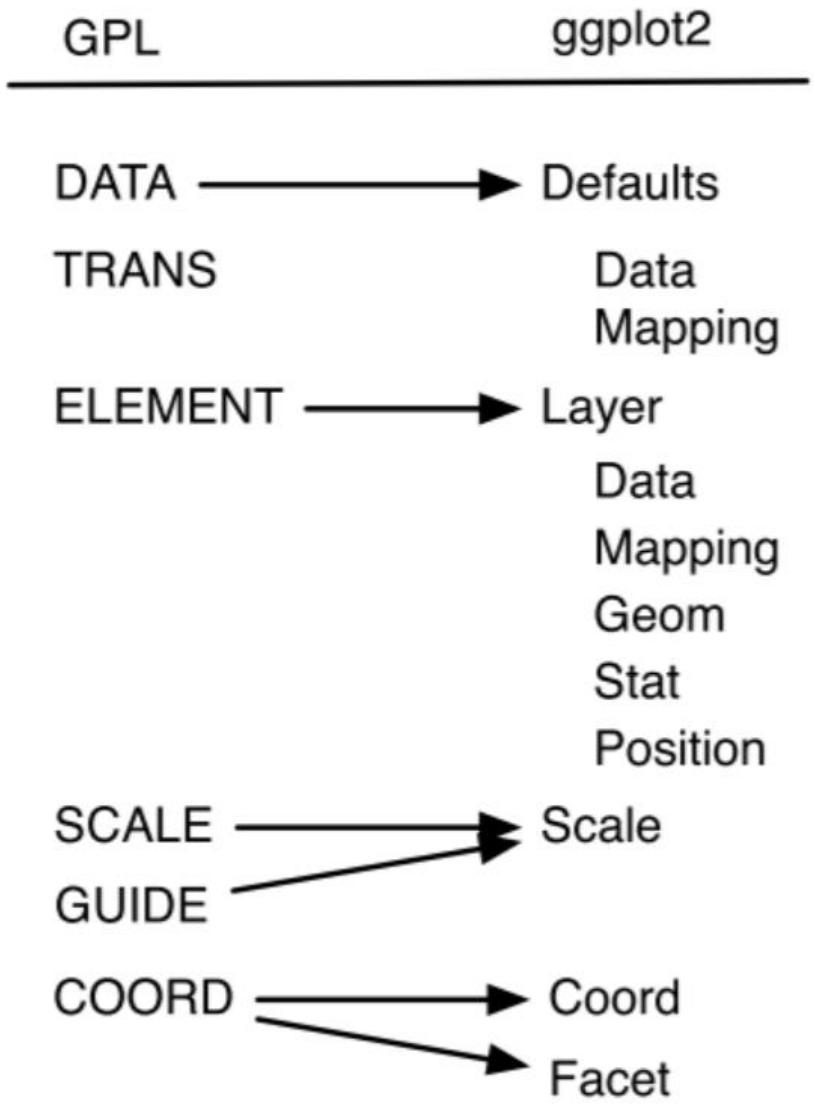
Maël Theulière, Hughes Pécout , Hélène Mathian,



1980

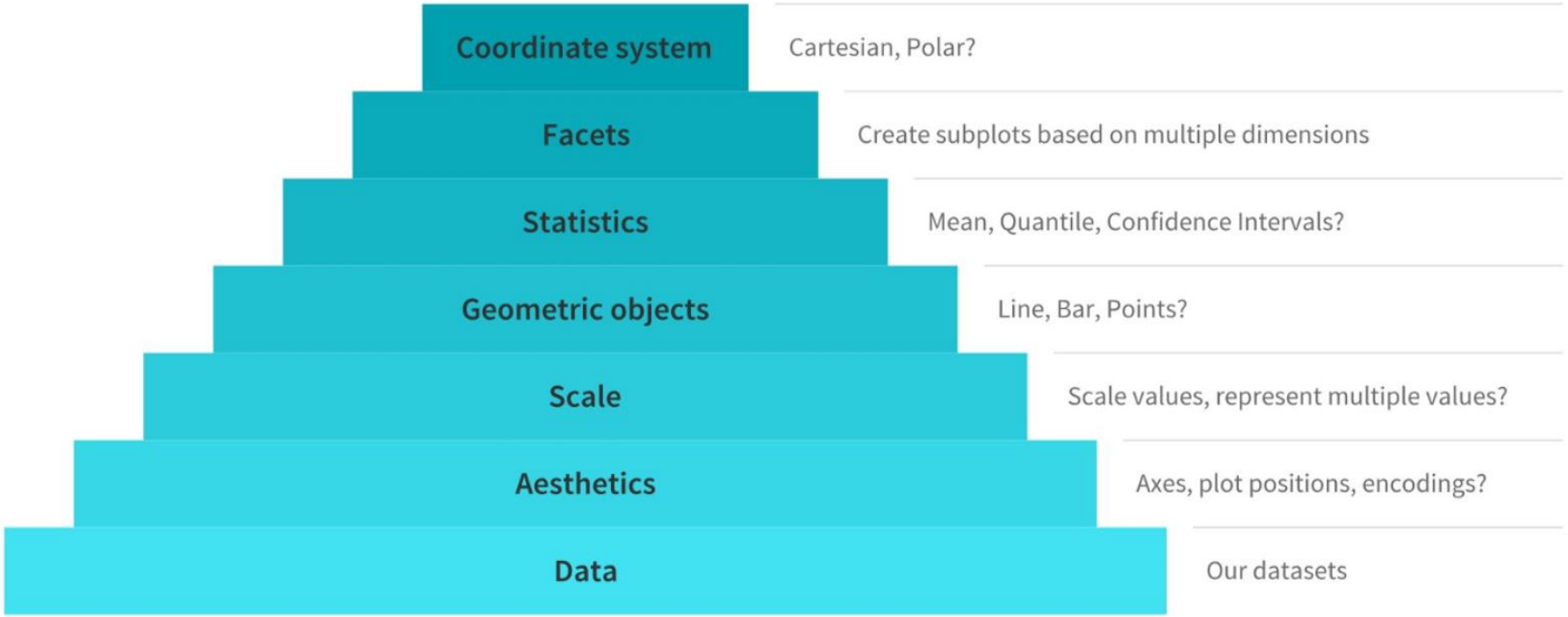
A layered grammar of graphics framework proposé par *Hadley Wickham*

Du concept aux composantes de ggplot



Dipanjan (DJ) Sarkar

Une construction en couche



Dipanjan (DJ) Sarkar

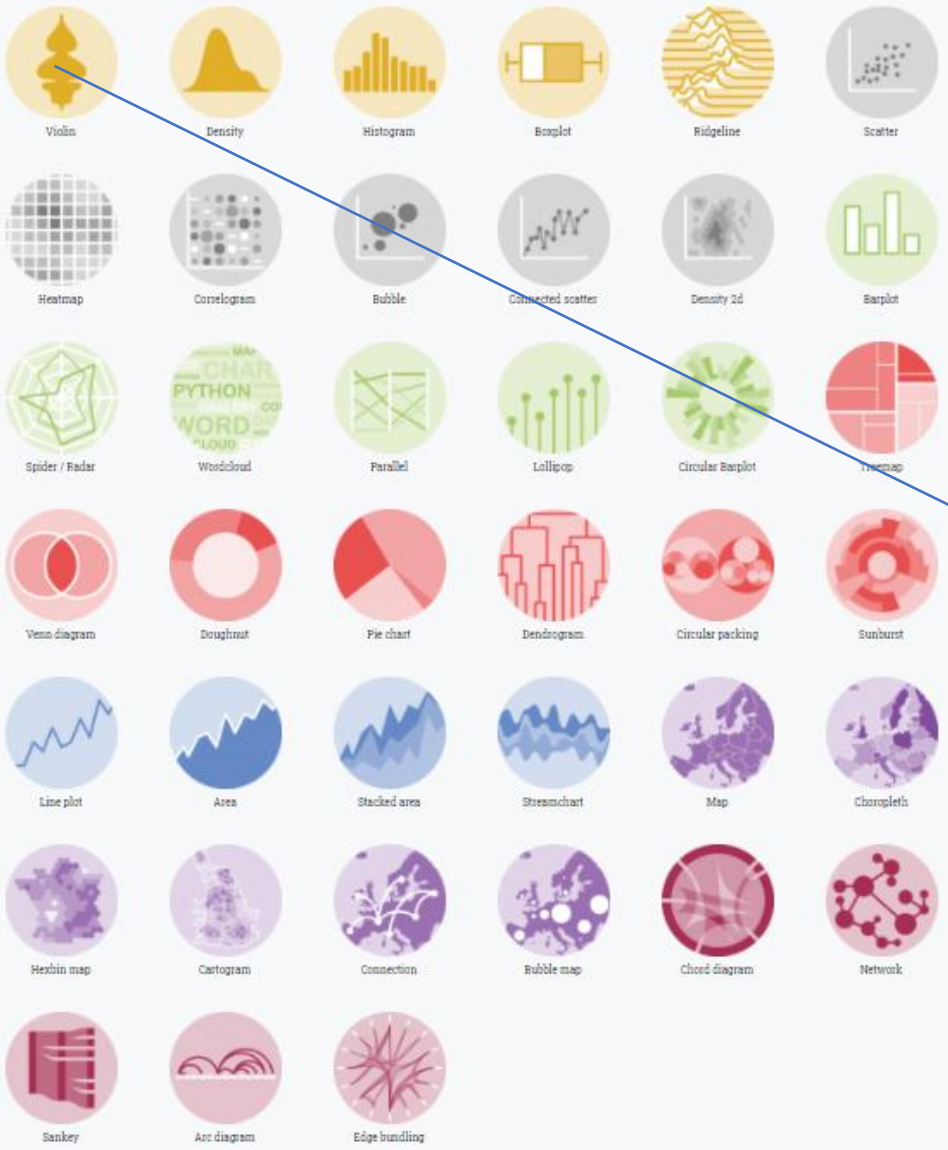
Pour mémoire

- **Data**: Always start with the data, identify the dimensions you want to visualize.
- **Aesthetics**: Confirm the axes based on the data dimensions, positions of various data points in the plot. Also check if any form of encoding is needed including size, shape, color and so on which are useful for plotting multiple data dimensions.
- **Scale:** Do we need to scale the potential values, use a specific scale to represent multiple values or a range?
- **Geometric objects:** These are popularly known as 'geoms'. This would cover the way we would depict the data points on the visualization. Should it be points, bars, lines and so on?
- **Statistics:** Do we need to show some statistical measures in the visualization like measures of central tendency, spread, confidence intervals?
- **Facets:** Do we need to create subplots based on specific data dimensions?
- **Coordinate system:** What kind of a coordinate system should the visualization be based on — should it be cartesian or polar?

A WORLD OF POSSIBILITIES

Here is an overview of all the graph types presented in this website.

Show all | Distribution | Correlation | Ranking | Part of a whole | Evolution | Map | Flow



from Data to Viz

https://www.data-to-viz.com/

VIOLIN

An alternative to boxplot to compare the distribution of several groups.

About

Violinplots allow to visualize the distribution of a numeric variable for one or several groups. It is really close from a boxplot, but allows a deeper understanding of the distribution.

Violins are particularly adapted when the amount of data is huge and showing individual observations gets impossible.

Common Mistakes

- If you have just a few groups, you are probably interested by ridgeline charts.
- If you compare groups with very different sample size, show it.
- Ordering groups by median value makes the chart more insightful.

Code

R graph gallery | Python gallery | D3.js gallery | Flourish

Read More

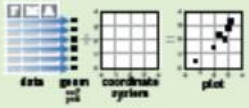
See the dedicated page.

Data Visualization with ggplot2 Cheat Sheet

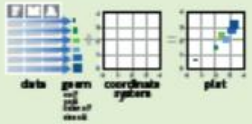
RStudio

Basics

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



To display data values, map variables in the data set to aesthetic properties of the geom like **size**, **color**, and **x** and **y** locations.



Build a graph with **qplot()** or **ggplot()**

aesthetic mappings · data · geom

qplot(x = cty, y = hwy, color = cyl, data = mpg, geom = "point")

Creates a complete plot with given data, geom, and mappings. Supplies many useful defaults.

ggplot(data = mpg, **aes**(x = cty, y = hwy))

Begins a plot that you finish by adding layers to. No defaults, but provides more control than qplot().

data

```
ggplot(mpg, aes(hwy, cty)) +
 geom_point(aes(color = cyl)) +
 geom_smooth(method ="lm") +
 coord_cartesian() +
 scale_color_gradient() +
 theme_bw()
```

add layers, elements with +

layer = geom + default stat + layer specific mappings

additional elements

Add a new layer to a plot with a **geom_*()** or **stat_*()** function. Each provides a geom, a set of aesthetic mappings, and a default stat and position adjustment.

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

One Variable

Continuous

a <- ggplot(mpg, aes(hwy))

- a + **geom_area**(stat = "bin") — x, y, alpha, color, fill, linetype, size — b + geom_area(aes(y = ..density..), stat = "bin")
- a + **geom_density**(kernel = "gaussian") — x, y, alpha, color, fill, linetype, size, weight — b + geom_density(aes(y = ..county..))
- a + **geom_dotplot**() — x, y, alpha, color, fill
- a + **geom_freqpoly**() — x, y, alpha, color, linetype, size — b + geom_freqpoly(aes(y = ..density..))
- a + **geom_histogram**(binwidth = 5) — x, y, alpha, color, fill, linetype, size, weight — b + geom_histogram(aes(y = ..density..))

Discrete

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

- b + **geom_bar**() — x, alpha, color, fill, linetype, size, weight

Graphical Primitives

c <- ggplot(map, aes(long, lat))

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

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

- d + **geom_path**(lineend="butt", linejoin="round", linemitre=1) — x, y, alpha, color, linetype, size
- d + **geom_ribbon**(aes(ymin=unemploy - 900, ymax=unemploy + 900)) — x, ymax, ymin, alpha, color, fill, linetype, size

e <- ggplot(seals, aes(x = long, y = lat))

- e + **geom_segment**(aes(xend = long + delta_long, yend = lat + delta_lat)) — x, xend, y, yend, alpha, color, linetype, size
- e + **geom_rect**(aes(xmin = long, ymin = lat, xmax= long + delta_long, ymax = lat + delta_lat)) — xmax, xmin, ymax, ymin, alpha, color, fill, linetype, size

Two Variables

Continuous X, Continuous Y

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

- f + **geom_blank**()
- f + **geom_jitter**() — x, y, alpha, color, fill, shape, size
- f + **geom_point**() — x, y, alpha, color, fill, shape, size
- f + **geom_quantile**() — x, y, alpha, color, linetype, size, weight
- f + **geom_rug**(sides = "bl") — alpha, color, linetype, size
- f + **geom_smooth**(model = lm) — x, y, alpha, color, fill, linetype, size, weight
- f + **geom_text**(aes(label = cty)) — x, y, label, alpha, angle, color, family, fontface, hjust, lineheight, size, vjust

Discrete X, Continuous Y

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

- g + **geom_bar**(stat = "identity") — x, y, alpha, color, fill, linetype, size, weight
- g + **geom_boxplot**() — lower, middle, upper, x, ymax, ymin, alpha, color, fill, linetype, shape, size, weight
- g + **geom_dotplot**(binaxis = "y", stackdir = "center") — x, y, alpha, color, fill
- g + **geom_violin**(scale = "area") — x, y, alpha, color, fill, linetype, size, weight

Discrete X, Discrete Y

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

- h + **geom_jitter**() — x, y, alpha, color, fill, shape, size

Continuous Bivariate Distribution

i <- ggplot(movies, aes(year, rating))

- i + **geom_bin2d**(binwidth = c(5, 0.5)) — xmax, xmin, ymax, ymin, alpha, color, fill, linetype, size, weight
- i + **geom_density2d**() — x, y, alpha, colour, linetype, size
- i + **geom_hex**() — x, y, alpha, colour, fill size

Continuous Function

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

- j + **geom_area**() — x, y, alpha, color, fill, linetype, size
- j + **geom_line**() — x, y, alpha, color, linetype, size
- j + **geom_step**(direction = "hv") — x, y, alpha, color, linetype, size

Visualizing error

df <- data.frame(grp = c("A", "B"), fit = 4:5, se = 1:2)

k <- ggplot(df, aes(grp, fit, ymin = fit-se, ymax = fit+se))

- k + **geom_crossbar**(fatten = 2) — x, y, ymax, ymin, alpha, color, fill, linetype, size
- k + **geom_errorbar**() — x, ymax, ymin, alpha, color, linetype, size, width (also **geom_errorbarh()**)
- k + **geom_linerange**() — x, ymin, ymax, alpha, color, linetype, size
- k + **geom_pointrange**() — x, y, ymin, ymax, alpha, color, fill, linetype, shape, size

Maps

data <- data.frame(murder = USArrests$Murder, state = tolower(rownames(USArrests)))

map <- map_data("state")

l <- ggplot(data, aes(fill = murder))

- l + **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))

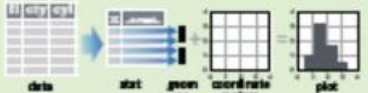
m <- ggplot(seals, aes(long, lat))

- m + **geom_contour**(aes(z = z)) — x, y, z, alpha, colour, linetype, size, weight
- m + **geom_raster**(aes(fill = z), hjust=0.5, vjust=0.5, interpolate=FALSE) — x, y, alpha, fill
- m + **geom_tile**(aes(fill = z)) — x, y, alpha, color, fill, linetype, size

Learn more at **docs.ggplot2.org** • ggplot2 0.9.3.1 • Updated: 3/15

Stats - An alternative way to build a layer

Some plots visualize a **transformation** of the original data set. Use a **stat** to choose a common transformation to visualize, e.g. a + geom_bar(stat = "bin")



Each stat creates additional variables to map aesthetics to. These variables use a common **..name..** syntax.

stat functions and geom functions both combine a stat with a geom to make a layer, i.e. stat_bin(geom="bar") does the same as geom_bar(stat="bin")

stat function | layer specific mappings | variable created by transformation

l + stat_density2d(aes(fill = ..level..), geom = "polygon", n = 100)

geom for layer | parameters for stat

1D distributions

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

a + **stat_bindot**(binwidth = 1, binaxis = "x")
x, y, | ..count.., ..ncount..

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

2D distributions

f + **stat_bin2d**(bins = 30, drop = TRUE)
x, y, fill | ..count.., ..density..

f + **stat_binhex**(bins = 30)
x, y, fill | ..count.., ..density..

f + **stat_density2d**(contour = TRUE, n = 100)
x, y, color, size | ..level..

3 Variables

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

m + **stat_spoke**(aes(radius = z, angle = z))
angle, radius, x, xend, y, yend | ..x.., ..xend.., ..y.., ..yend..

m + **stat_summary_hex**(aes(z = z), bins = 30, fun = mean)
x, y, z, fill | ..value..

m + **stat_summary2d**(aes(z = z), bins = 30, fun = mean)
x, y, z, fill | ..value..

Comparisons

g + **stat_boxplot**(coef = 1.5)
x, y | ..lower.., ..middle.., ..upper.., ..outliers..

g + **stat_ydensity**(adjust = 1, kernel = "gaussian", scale = "area")
x, y | ..density.., ..scaled.., ..count.., ..n.., ..violinwidth.., ..width..

Functions

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

f + **stat_quantile**(quantiles = c(0.25, 0.5, 0.75), formula = y ~ log(x), method = "rq")
x, y | ..quantile.., ..x.., ..y..

f + **stat_smooth**(method = "auto", formula = y ~ x, se = TRUE, n = 80, fullrange = FALSE, level = 0.95)
x, y | ..se.., ..x.., ..y.., ..ymin.., ..ymax..

General Purpose

ggplot() + **stat_function**(aes(x = -3:3), fun = dnorm, n = 101, args = list(sd=0.5))
x | ..y..

f + **stat_identity**()

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

f + **stat_sum**()
x, y, size | ..size..

f + **stat_summary**(fun.data = "mean_cl_boot")

f + **stat_unique**()

Scales

Scales control how a plot maps data values to the visual values of an aesthetic. To change the mapping, add a custom scale.

n <- b + **geom_bar**(aes(fill = fl))

n

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 any aesthetic:
alpha, color, fill, linetype, shape, size

scale_*_continuous() - map cont' values to visual values
scale_*_discrete() - map discrete values to visual values
scale_*_identity() - use data values as visual values
scale_*_manual(values = c()) - map discrete values to manually chosen visual values

X and Y location scales

Use with x or y aesthetics (x shown here)

scale_x_date(labels = date_format("%m/%d"), breaks = date_breaks("2 weeks")) - treat x values as dates. See ?strptime for label formats.
scale_x_datetime() - treat x values as date times. Use same arguments as scale_x_date().
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 | Continuous

n <- b + **geom_bar**(aes(fill = fl))

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

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

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

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

Shape scales

p <- f + **geom_point**(aes(shape = fl))

p + **scale_shape**(solid = FALSE)

p + **scale_shape_manual**(values = c(3:7))
Shape values shown in chart on right

Size scales

q <- f + **geom_point**(aes(size = cyl))

q + **scale_size_area**(max = 6)
Value mapped to area of circle (not radius)

Coordinate Systems

r <- b + 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 extras and strains to the name of a window function.

z + **coord_map**(projection = "ortho", orientation=c(41, -74, 0))
projection, orientation, 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

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

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

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_grey()**
Grey background (default theme)

r + **theme_classic()**
White background no gridlines

r + **theme_minimal()**
Minimal theme

ggthemes - Package with additional ggplot2 themes

Faceting

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

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

t + **facet_grid**(. ~ fl)
facet into columns based on fl

t + **facet_grid**(year ~ .)
facet into rows based on year

t + **facet_grid**(year ~ fl)
facet into both rows and columns

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

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

t + facet_grid(y ~ x, **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(. ~ fl, **labeller = label_both**)

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

t + facet_grid(. ~ fl, **labeller = label_bquote**(alpha ^ .(x)))

α^{c}	α^{d}	α^{e}	α^{p}	α^{r}

t + facet_grid(. ~ fl, **labeller = label_parsed**)

c	d	e	p	r

Labels

t + **ggtitle**("New Plot Title")
Add a main title above the plot

t + **xlab**("New X label")
Change the label on the X axis

t + **ylab**("New Y label")
Change the label on the Y axis

t + **labs**(title = "New title", x = "New x", y = "New y")
All of the above

Use scale functions to update legend labels

Legends

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

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

t + **scale_fill_discrete**(name = "Title", labels = c("A", "B", "C"))
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))

Quelques liens… en vrac

- https://rstudio.com/wp-content/uploads/2015/03/ggplot2-cheatsheet.pdf
- https://towardsdatascience.com/a-comprehensive-guide-to-the-grammar-of-graphics-for-effective-visualization-of-multi-dimensional-1f92b4ed4149
- https://ggplot2-book.org/getting-started.html#basic-use
- http://perso.ens-lyon.fr/lise.vaudor/graphit/

A vous de jouer!

URL d’accès ->
https://mael.shinyapps.io/introduction_a_ggplot_2/

URL raccourcie plus simple à écrire -
> https://frama.link/explo_ggplot2