An introduction to ggplot2

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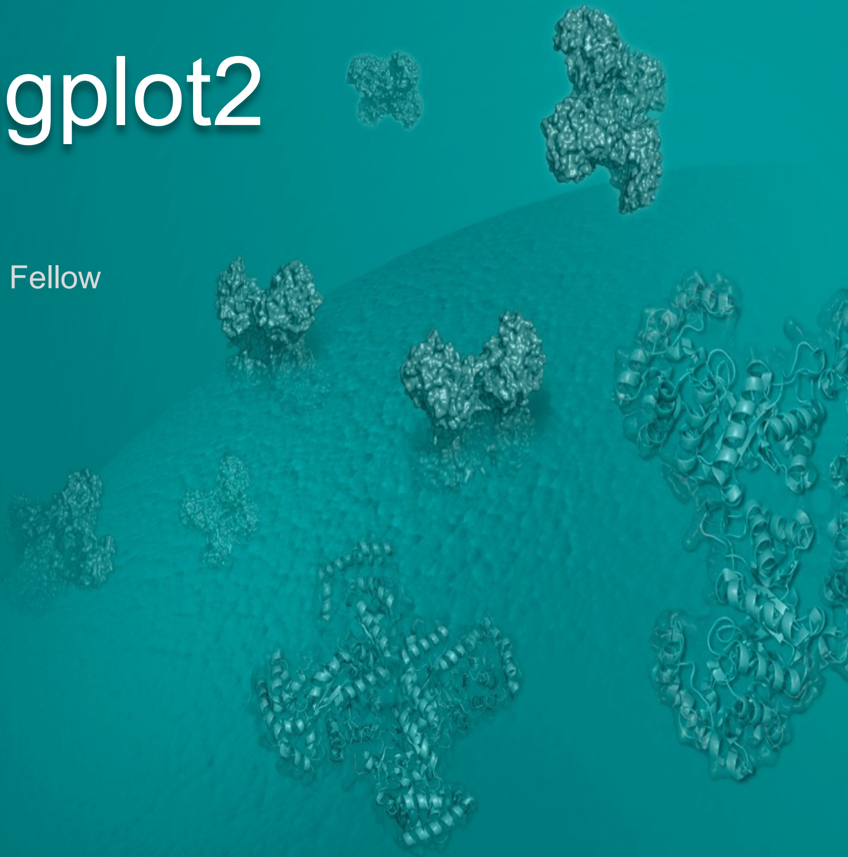
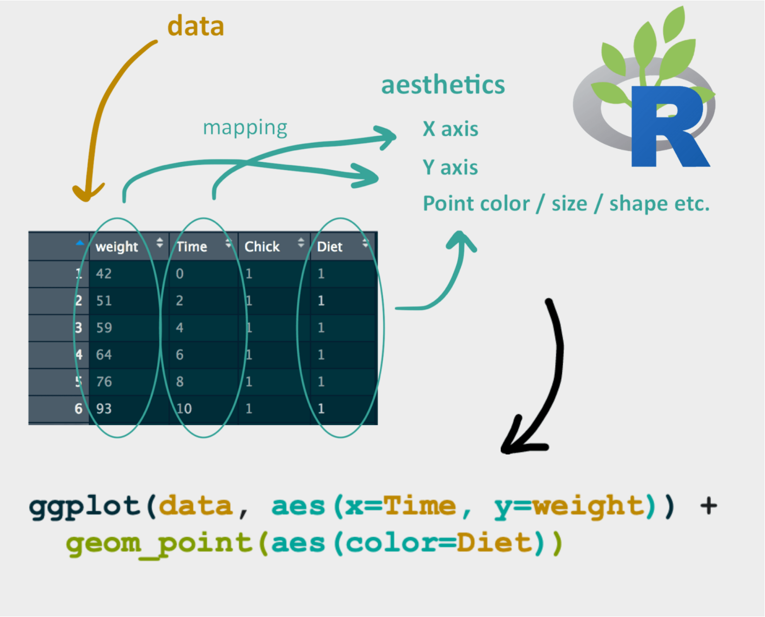


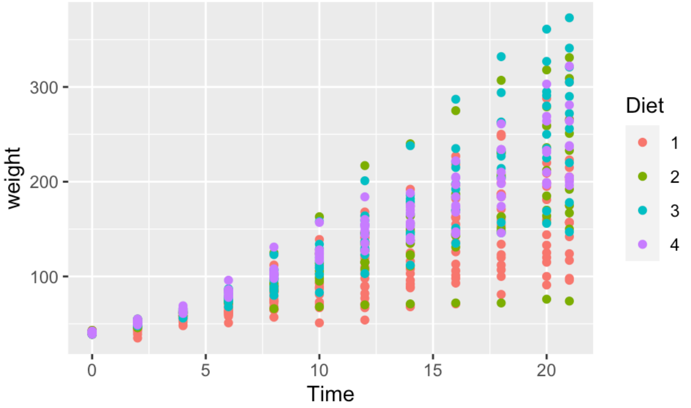
ggplot2

- A package that makes it more intuitive to create consistently nice-looking, high-quality figures



	weight	Time	Chick	Diet
1	42	0	1	1
2	51	2	1	1
3	59	4	1	1
4	64	6	1	1
5	76	8	1	1
6	93	10	1	1

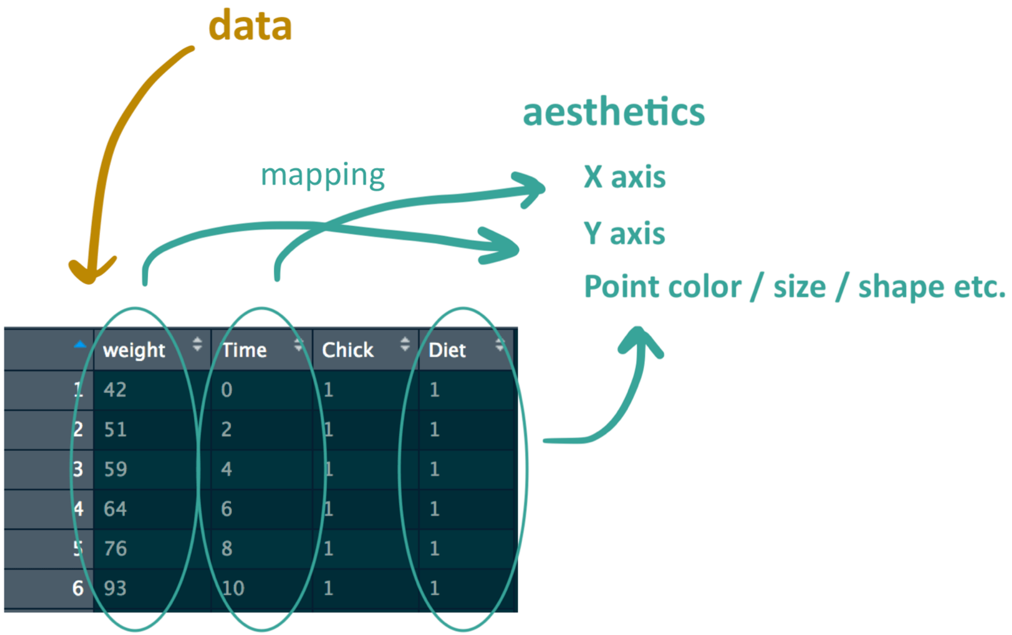
```
ggplot(data, aes(x=Time, y=weight)) +
  geom_point(aes(color=Diet))
```



Credit: https://www.rforecology.com/post/a-simple-introduction-to-ggplot2/

ggplot2

- Data
- Aesthetics: This includes things like which variable goes on the X axis, which variable goes on the Y axis, and what size, shape, or color you want your points/lines/bars/etc. to be.



data

mapping

aesthetics

X axis

Y axis

Point color / size / shape etc.

	weight	Time	Chick	Diet
1	42	0	1	1
2	51	2	1	1
3	59	4	1	1
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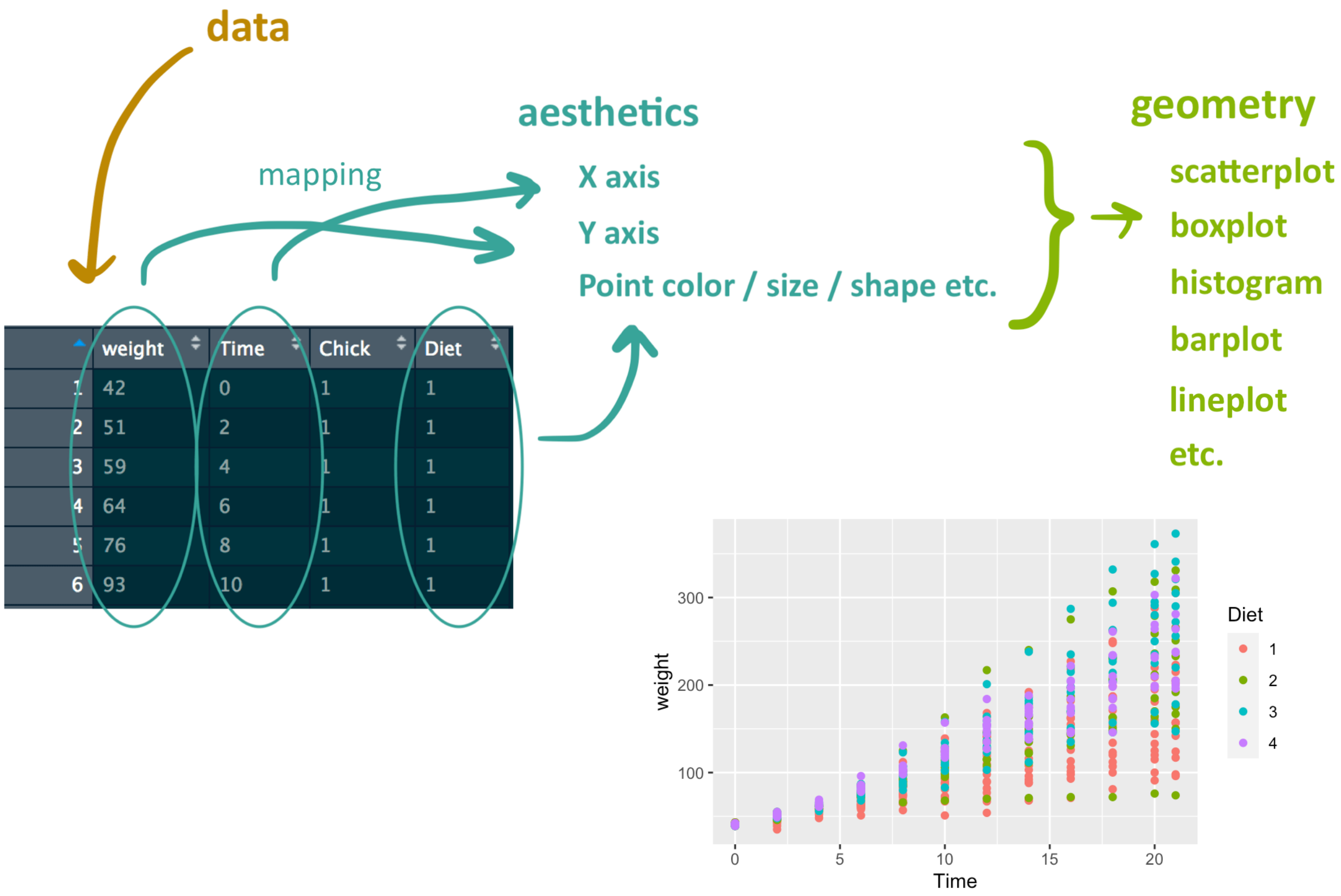
ggplot2

- Once you figure out how you want to map your data to aesthetic elements, then you present your data using a geometric object, like a scatterplot, boxplot, lineplot, etc.



data

mapping

aesthetics

X axis

Y axis

Point color / size / shape etc.

geometry

scatterplot

boxplot

histogram

barplot

lineplot

etc.

	weight	Time	Chick	Diet
1	42	0	1	1
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3	59	4	1	1
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5	76	8	1	1
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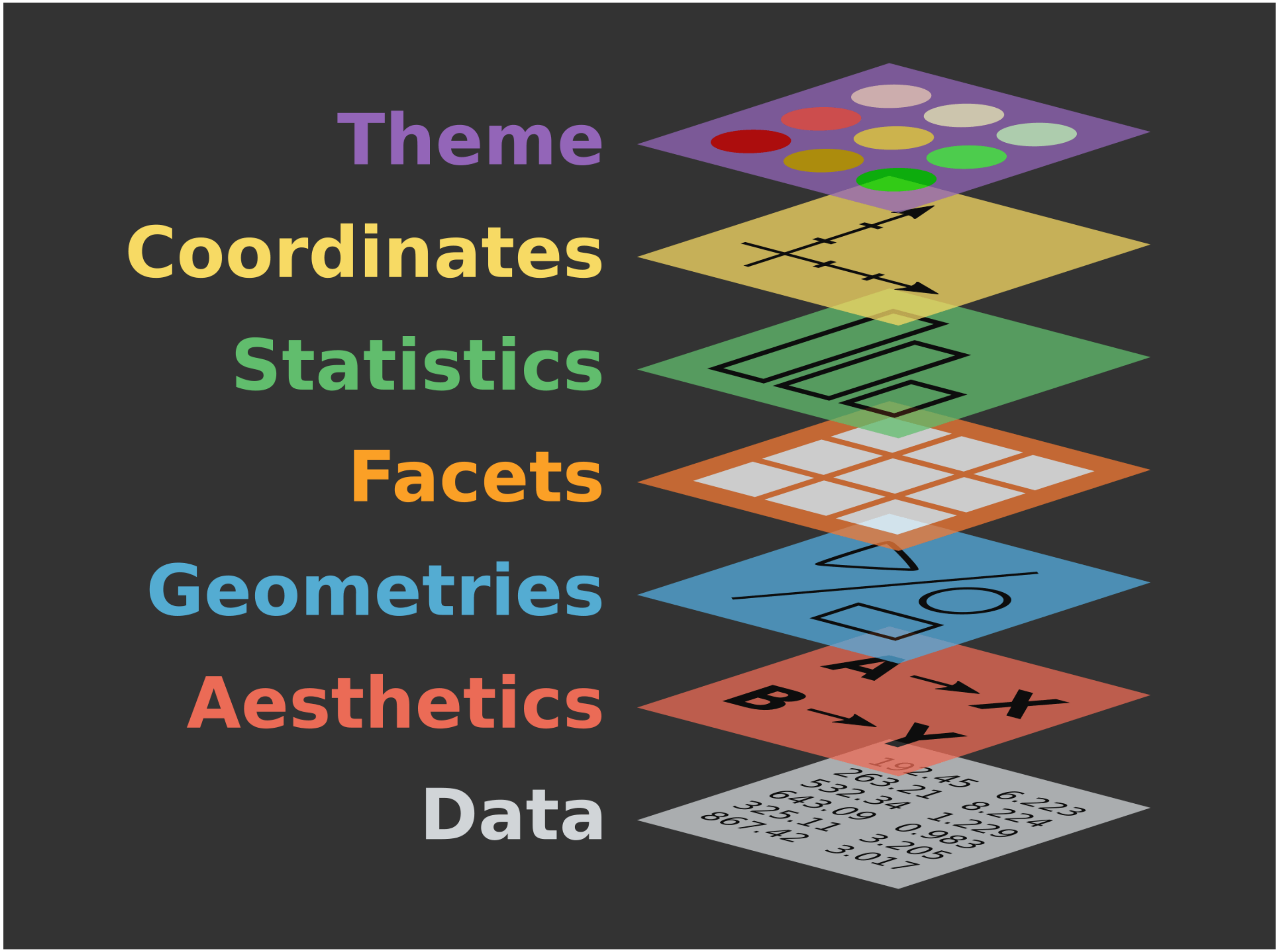
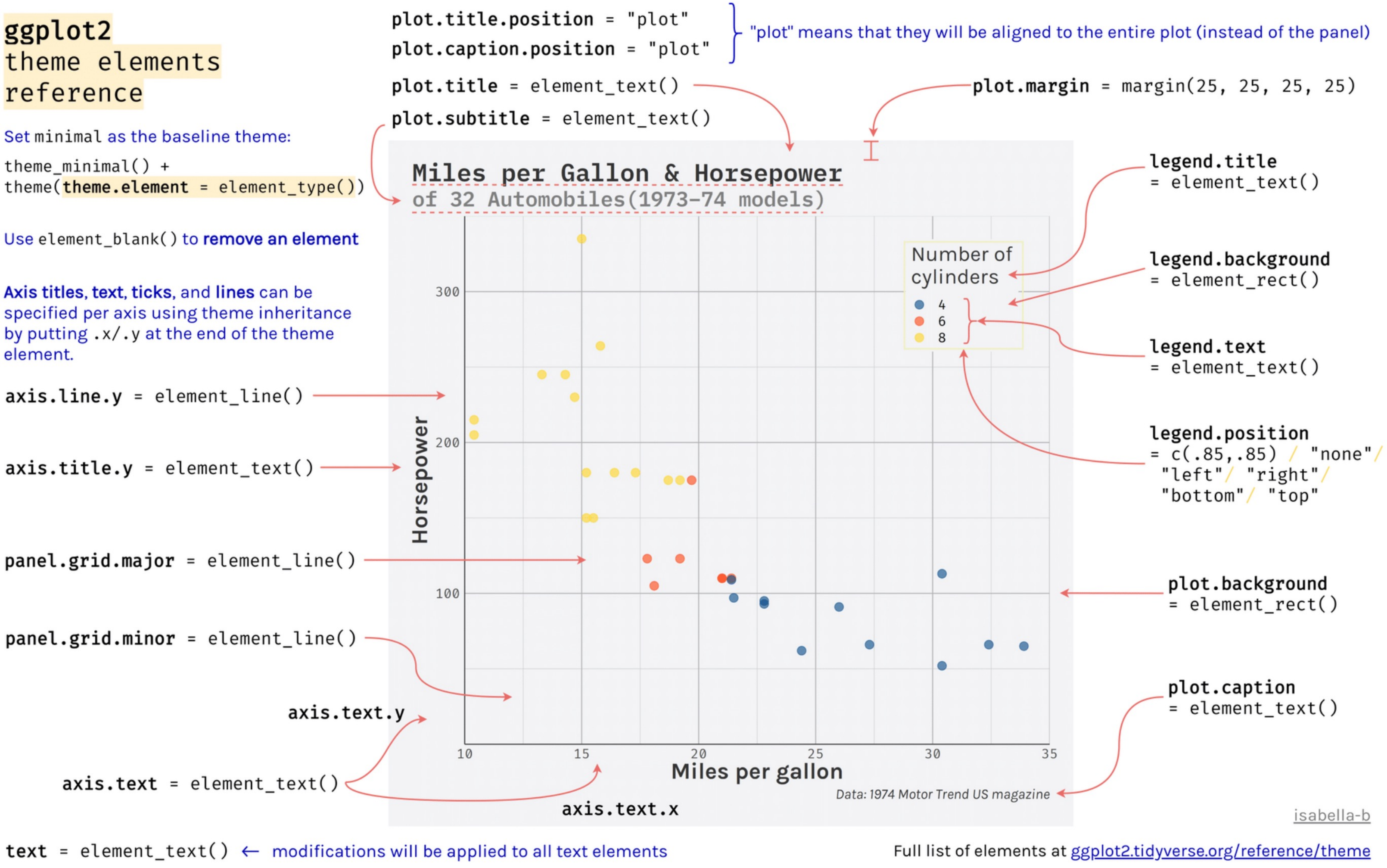
Ggplot2 – multiple layers



Credit: https://r.qcbs.ca/workshop03/pres-en/workshop03-pres-en.html#1

ggplot2 – Theme



ggplot2 theme elements reference

Set minimal as the baseline theme:

```
theme_minimal() +
theme(theme.element = element_type())
```

Use `element_blank()` to **remove an element**

Axis titles, **text**, **ticks**, and **lines** can be specified per axis using theme inheritance by putting `.x`/`.y` at the end of the theme element.

```
plot.title.position = "plot"
plot.caption.position = "plot"
```

"plot" means that they will be aligned to the entire plot (instead of the panel)

`plot.title = element_text()`

`plot.subtitle = element_text()`

`plot.margin = margin(25, 25, 25, 25)`

`axis.line.y = element_line()`

`axis.title.y = element_text()`

`panel.grid.major = element_line()`

`panel.grid.minor = element_line()`

`axis.text.y`

`axis.text = element_text()`

`axis.text.x`

`legend.title = element_text()`

`legend.background = element_rect()`

`legend.text = element_text()`

`legend.position = c(.85,.85) / "none" / "left" / "right" / "bottom" / "top"`

`plot.background = element_rect()`

`plot.caption = element_text()`

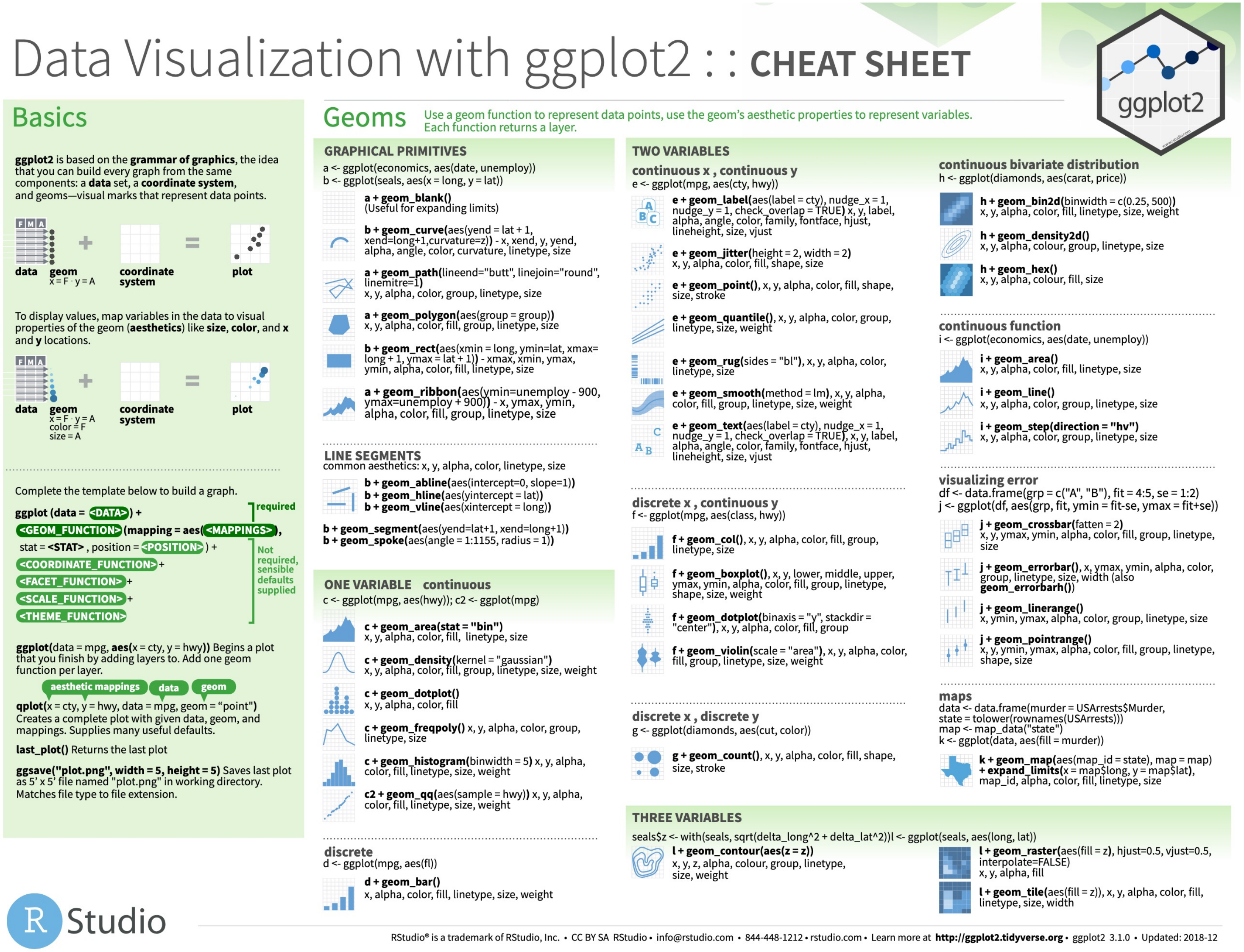
`text = element_text()` ← modifications will be applied to all text elements

Full list of elements at ggplot2.tidyverse.org/reference/theme

Miles per Gallon & Horsepower
of 32 Automobiles(1973-74 models)
Horsepower
300
200
100
10
15
20
25
30
35
Miles per gallon
Number of cylinders
4
6
8
Data: 1974 Motor Trend US magazine
isabella-b

Credit: https://r.qcbs.ca/workshop03/pres-en/workshop03-pres-en.html#71

You don’t need to remember everything…



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.

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

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=z)**)** - 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

RStudio

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Credit: https://www.maths.usyd.edu.au/u/UG/SM/STAT3022/r/current/Misc/data-visualization-2.1.pdf

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Reference

- The content and figures have been credited with links on the relevant slides. These sources are also excellent material for further reading.
    - https://www.rforecology.com/post/a-simple-introduction-to-ggplot2/
    - https://ggplot2.tidyverse.org/articles/ggplot2.html
    - https://r.qcbs.ca/workshop03/pres-en/workshop03-pres-en.html#1
- Some of the content, presented in the accompanying demonstration material, originate in the Introduction to ggplot2 with some of the text copied with a few edits.