Kiri Kuroda

Contents

R RStudio

R RStudio R RStudio R
[1]

0.1 R

https://cran.r-project.org OS

0.2 RStudio

https://www.rstudio.com RStudio “Free”

0.3

R RStudio R RStudio iOS Android `install.packages("  )  install.packag`

```
#
install.packages(c("tidyverse","gcookbook","GGally","devtools"))
```

0.4

RStudio `library(  )`

```
library(tidyverse) #
```

0.5 R

R RStudio

…… https://kazutan.github.io/JSSP2018_spring/intro_rstudio.html
R Markdown

[1]

Chapter 1

Anscombe's quartet

1.1

4 I, II, III, IV 11 x y x y

4 x y mean; *M* standard deviation; *SD* correlation coefficient; *r*

experiment

mean_x

sd_x

mean_y

sd_y

pearson_r

I

9

3.316625

7.500909

2.031568

0.8164205

II

9

3.316625

7.500909

2.031657

0.8162365

III

9

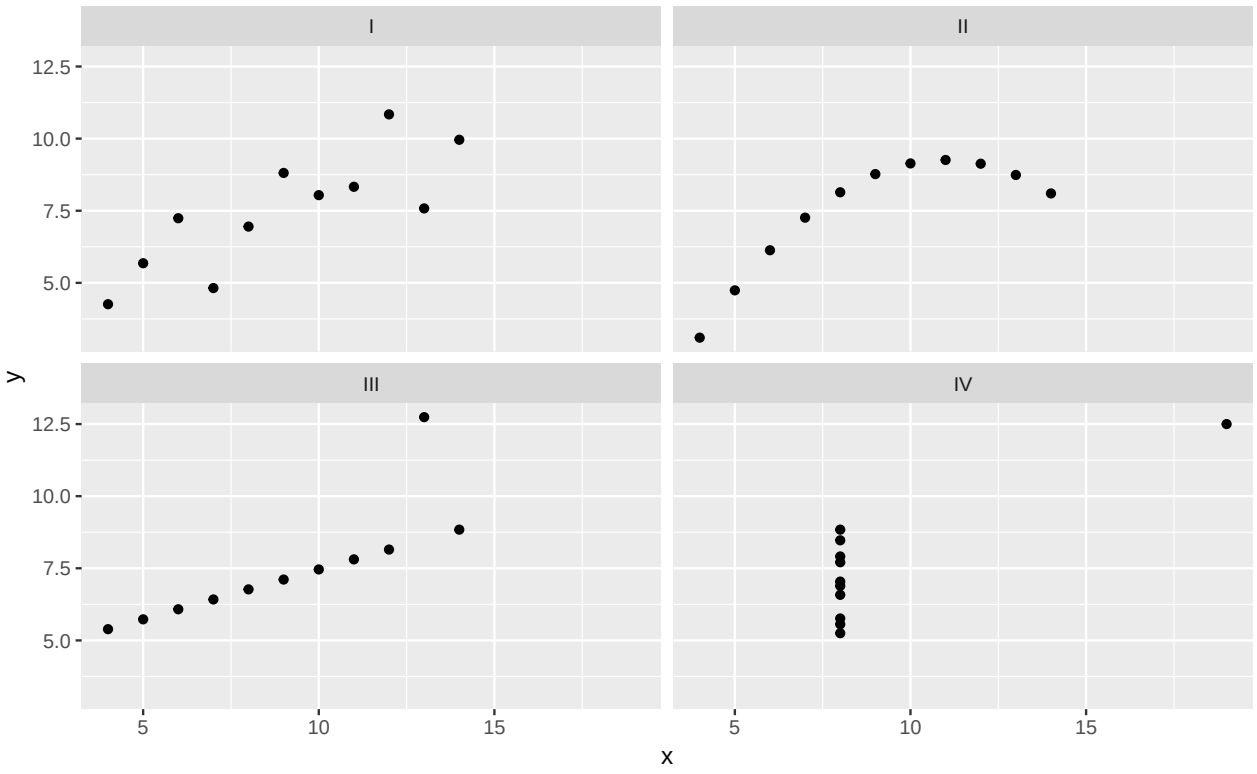


Figure 1.1: (ref:anscombe-scatter-plot)

3.316625

7.500000

2.030424

0.8162867

IV

9

3.316625

7.500909

2.030579

0.8165214

x y

……

x y

(ref:anscombe-scatter-plot)

x y

- distribution
- association

1.2 ggplot2

R **ggplot2** **tidyverse** 1 tidyverse ggplot2 R ggplot2 Ex el

-
- ugly!
-

……

R ggplot2

Chapter 2

2.1

ggplot2 library( )

```
library(ggplot2)

# *
#
#
#
```

R mtcars mtcars ?mtcars str( )

```
str(mtcars) #
```

```
## 'data.frame':    32 obs. of  11 variables:
##  $ mpg : num  21 21 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 ...
##  $ cyl : num  6 6 4 6 8 6 8 4 4 6 ...
##  $ disp: num  160 160 108 258 360 ...
##  $ hp  : num  110 110 93 110 175 105 245 62 95 123 ...
##  $ drat: num  3.9 3.9 3.85 3.08 3.15 2.76 3.21 3.69 3.92 3.92 ...
##  $ wt  : num  2.62 2.88 2.32 3.21 3.44 ...
##  $ qsec: num  16.5 17 18.6 19.4 17 ...
##  $ vs  : num  0 0 1 1 0 1 0 1 1 1 ...
##  $ am  : num  1 1 1 0 0 0 0 0 0 0 ...
##  $ gear: num  4 4 4 3 3 3 3 4 4 4 ...
##  $ carb: num  4 4 1 1 2 1 4 2 2 4 ...
```

11 variable 32 observation 32 ×11 head( ) 6

```
head(mtcars) #  6
```

```
##                   mpg cyl disp  hp drat    wt  qsec vs am gear carb
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

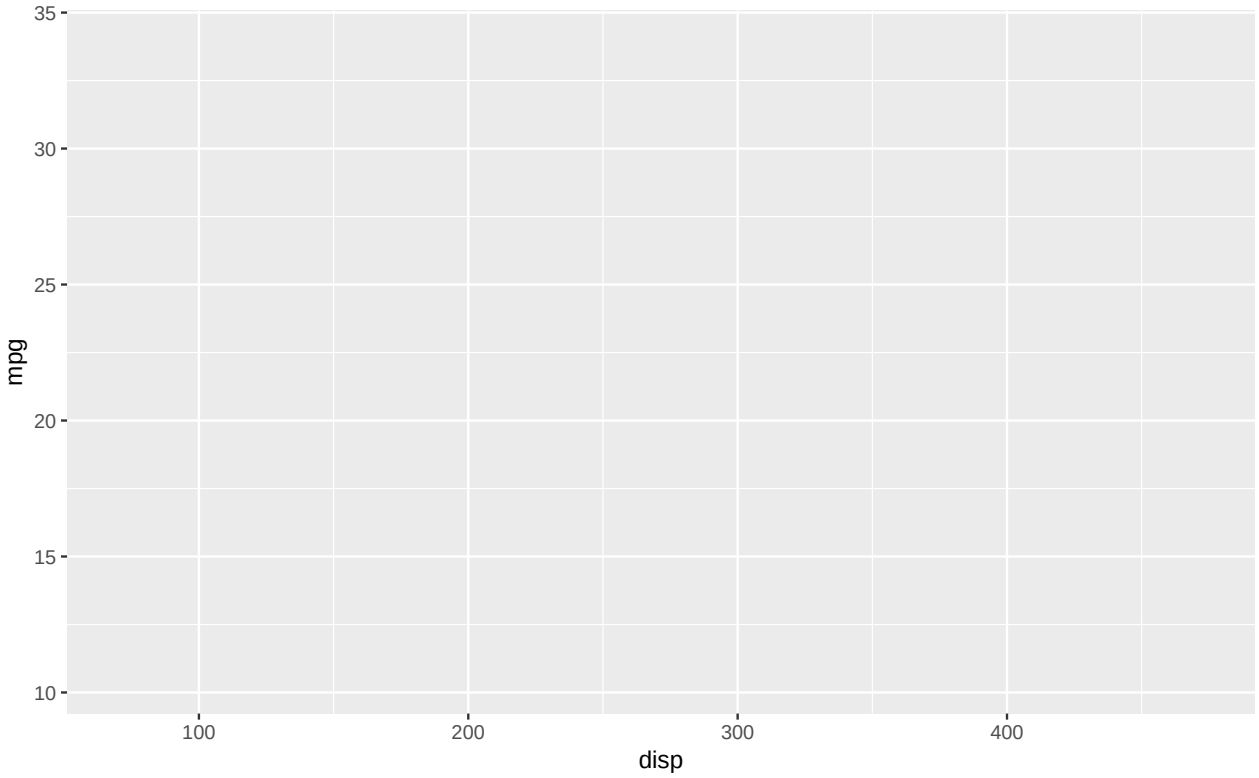


Figure 2.1:

11 2

- `disp`
- `mpg`

continuous variable quantitative variable

---

ggplot2

1. x y

ggplot2 `ggplot(data = , aes(x = x , y = y ))`

```
ggplot(data = mtcars, aes(x = disp, y = mpg))
```

[1]

2.

geometry `geom_xxxx()` `geom_point()`

+

```
ggplot(data = mtcars, aes(x = disp, y = mpg)) + #          +
  geom_point() #    point
```

[1] ggplot2 layer

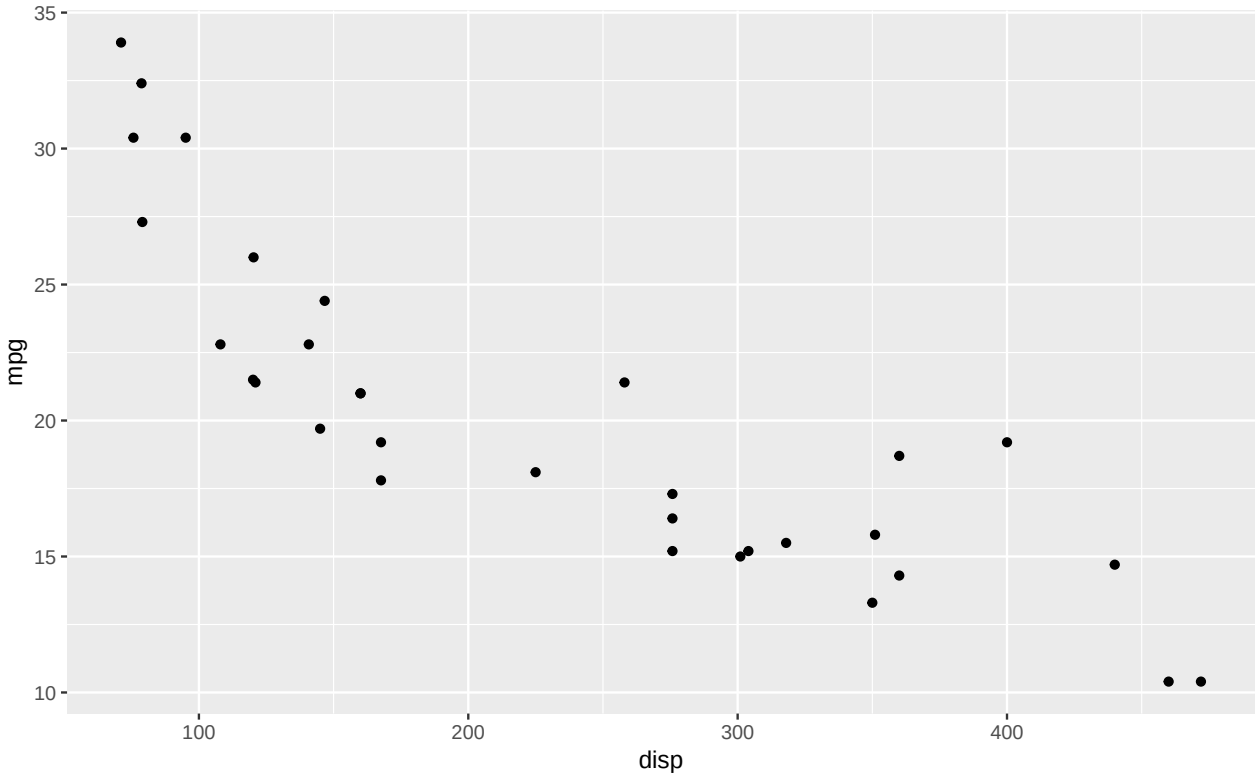


Figure 2.2: x y

x y `x = disp` `y = mpg` `data = mtcars` data, x, y

```
ggplot(mtcars, aes(disp, mpg)) +
  geom_point()
```

3.

OK 1

- `cyl` 4, 6, or 8

`cyl` OK

```
ggplot(mtcars, aes(disp, mpg, color = cyl)) + # color = cyl
  geom_point()
```

`aes()` `color = cyl` `cyl`

legend 1 4,5,6,7,8 4,6,8 3 discrete variable qualitative/categorical/factor variable [2]

`cyl` `factor()`

[2]

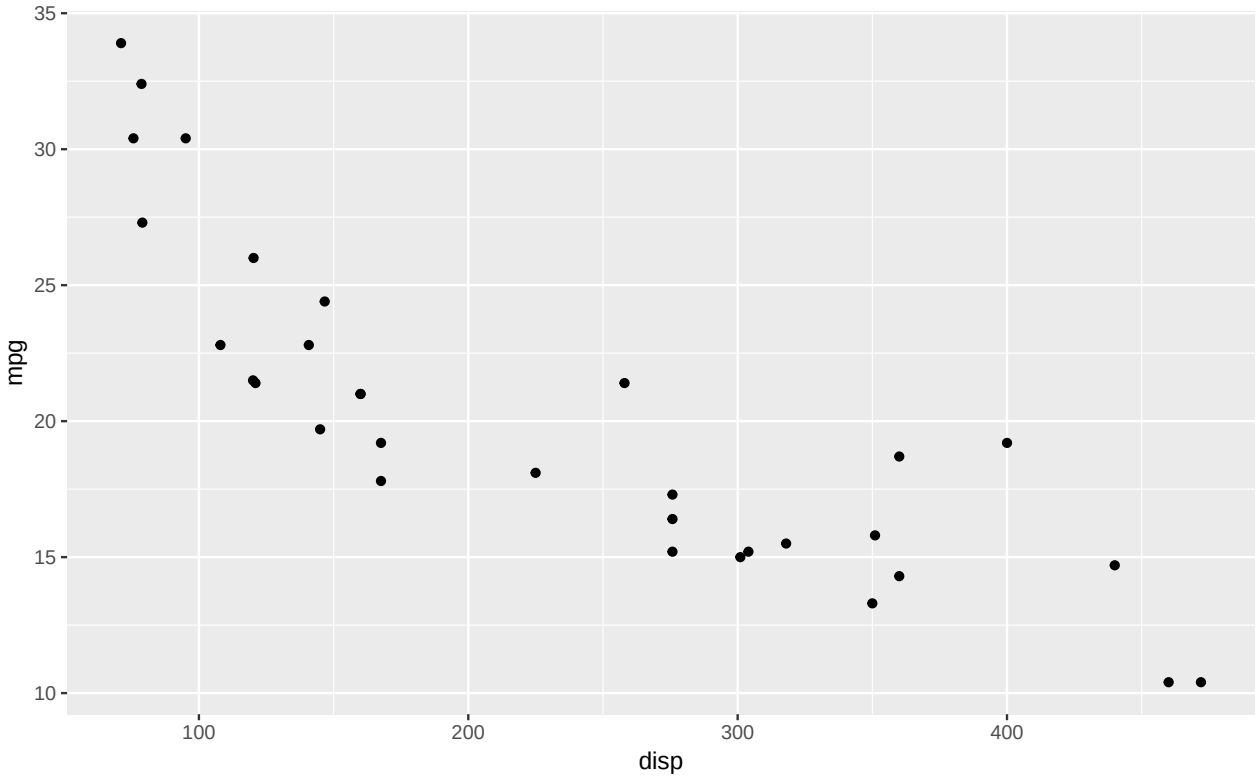


Figure 2.3: Figure 2.2

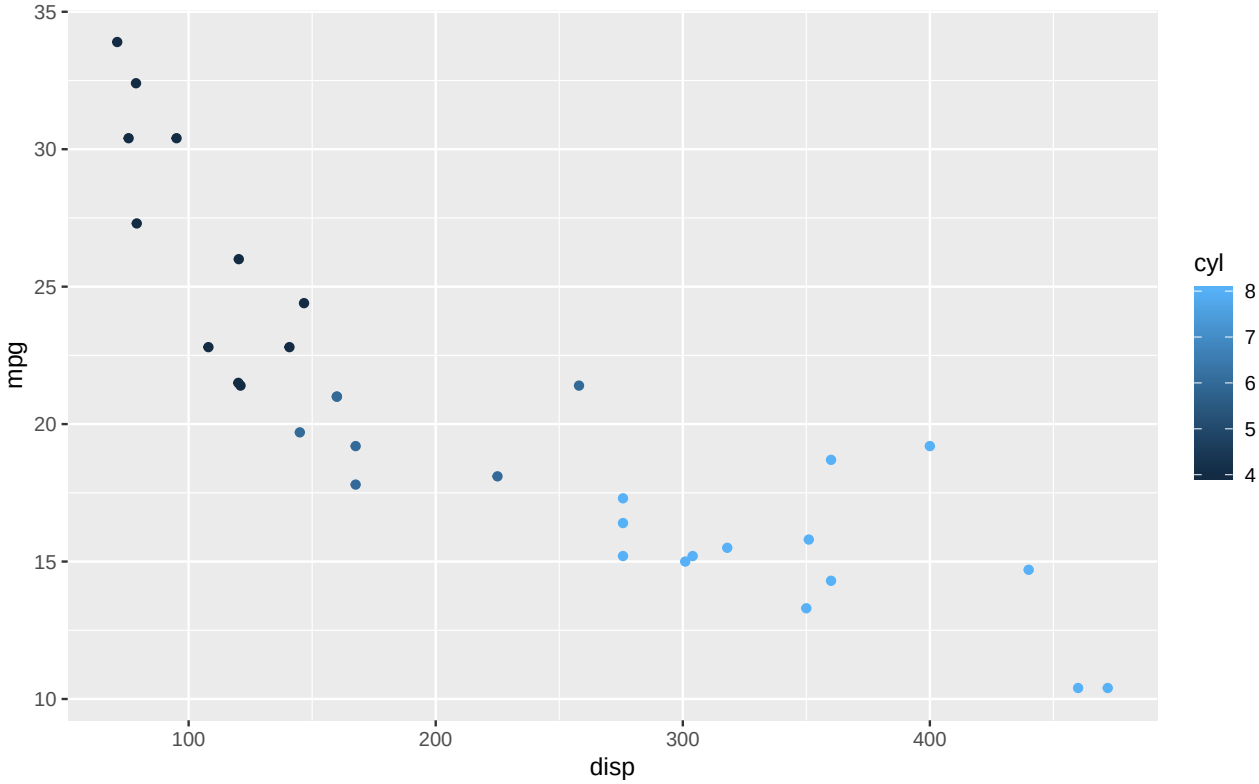


Figure 2.4:

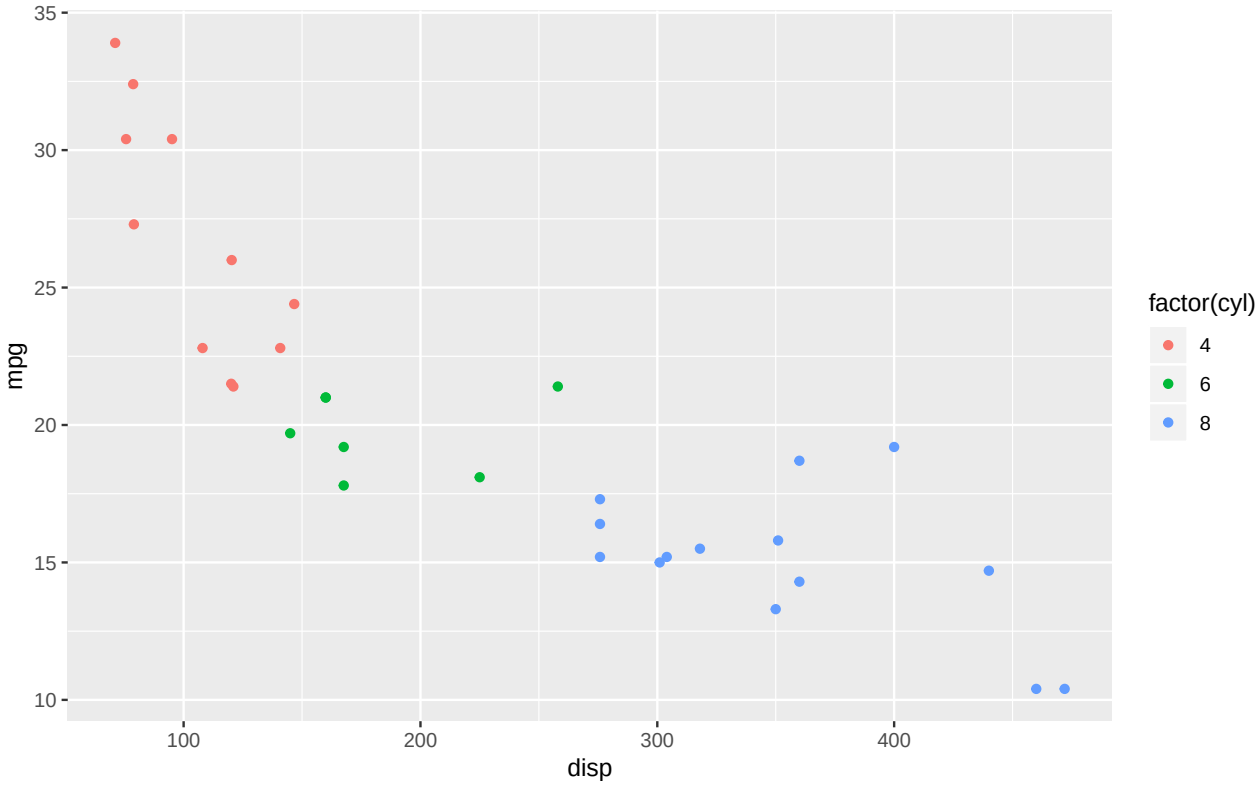


Figure 2.5:

```
ggplot(mtcars, aes(disp, mpg, color = factor(cyl))) + # factor(cyl)
  geom_point()
```

R `factor( )`

2.2

ggplot2

1. x y

- **y x**
-

2.

-
- x y [3]
-

3.

[3]

- `x` `y`
-

---

ggplot2 `geom_xxxx()`

geom
geom_bar()
geom_line()
geom_point()
geom_errorbar()
geom_pointrange()
geom_histogram()
geom_density()
geom_boxplot()
geom_violin()
geom_area()
geom_smooth()
geom_text()

`x` `y` `color` `aes()`

aes()	
x	x
y	y
color	
fill	
linetype	
size	
shape	

Chapter 3

```
library(ggplot2) #
```

3.1

3.1.1

bar graph; bar chart; bar plot

gcookbook `pg_mean` gcookbook

```
library(gcookbook)
```

```
head(pg_mean) #   3
```

```
##   group weight
## 1  ctrl  5.032
## 2  trt1  4.661
## 3  trt2  5.526
```

2

- `group` 3
- `weight`

x y `geom_bar()`

```
ggplot(pg_mean, aes(group, weight)) + # x group y weight
  geom_bar(stat = "identity") #   stat = "identity"
```

`stat = "identity"` `geom_bar()` `stat = "count"` [1]

`stat = "identity"` : stat_count() must not be used with a y aesthetic. [2]

[1]

[2] PC

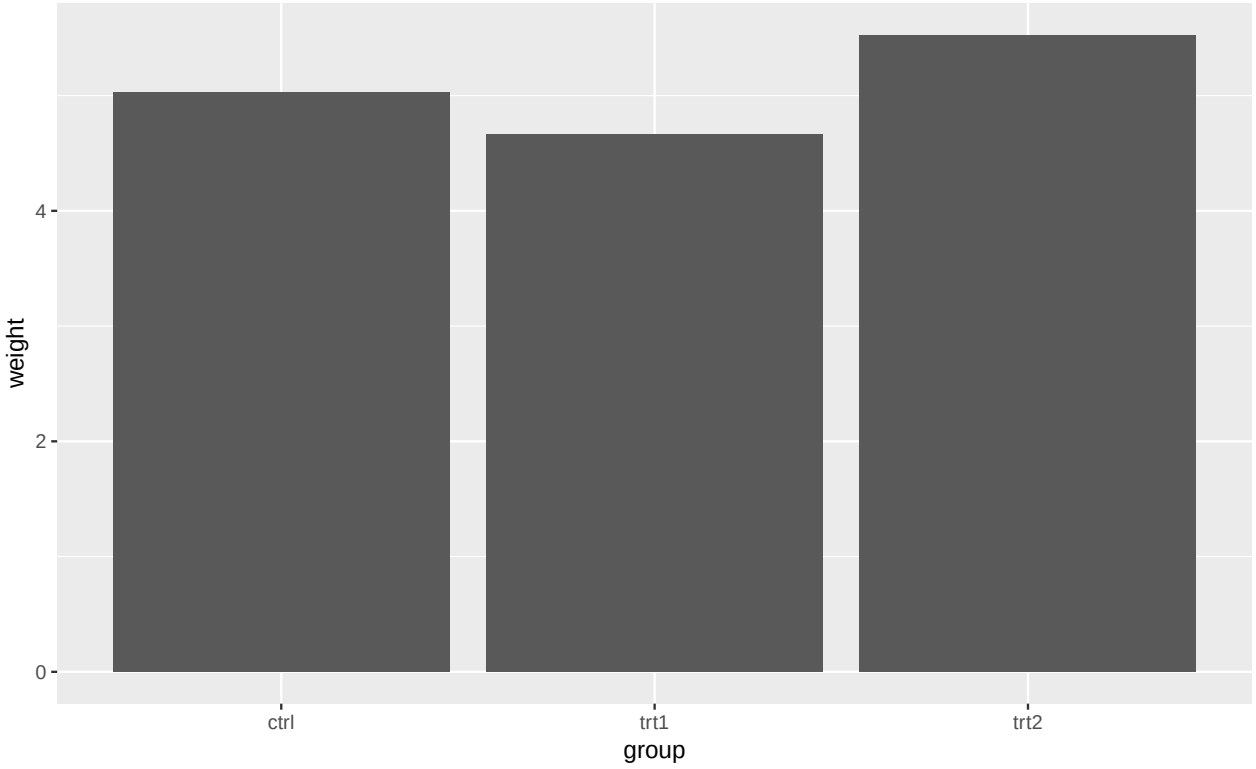


Figure 3.1: x y

3.1.2

1 gcookbook cabbage_exp

```
head(cabbage_exp) # 6
```

```
##   Cultivar Date Weight        sd  n         se
## 1      c39  d16   3.18 0.9566144 10 0.30250803
## 2      c39  d20   2.80 0.2788867 10 0.08819171
## 3      c39  d21   2.74 0.9834181 10 0.31098410
## 4      c52  d16   2.26 0.4452215 10 0.14079141
## 5      c52  d20   3.11 0.7908505 10 0.25008887
## 6      c52  d21   1.47 0.2110819 10 0.06674995
```

3

- Date d16, d20, or d21
- Cultivar c39 or c52
- Weight kg

[3] Date x Weight y Cultivar fill

```
ggplot(cabbage_exp, aes(Date, Weight, fill = Cultivar)) + # x Date y Weight fill = Cultivar
  geom_bar(stat = "identity", position = "dodge") #   position = "dodge"
```

2 fill fill Cultivar [4]

[3]

[4] color geom_bar() color

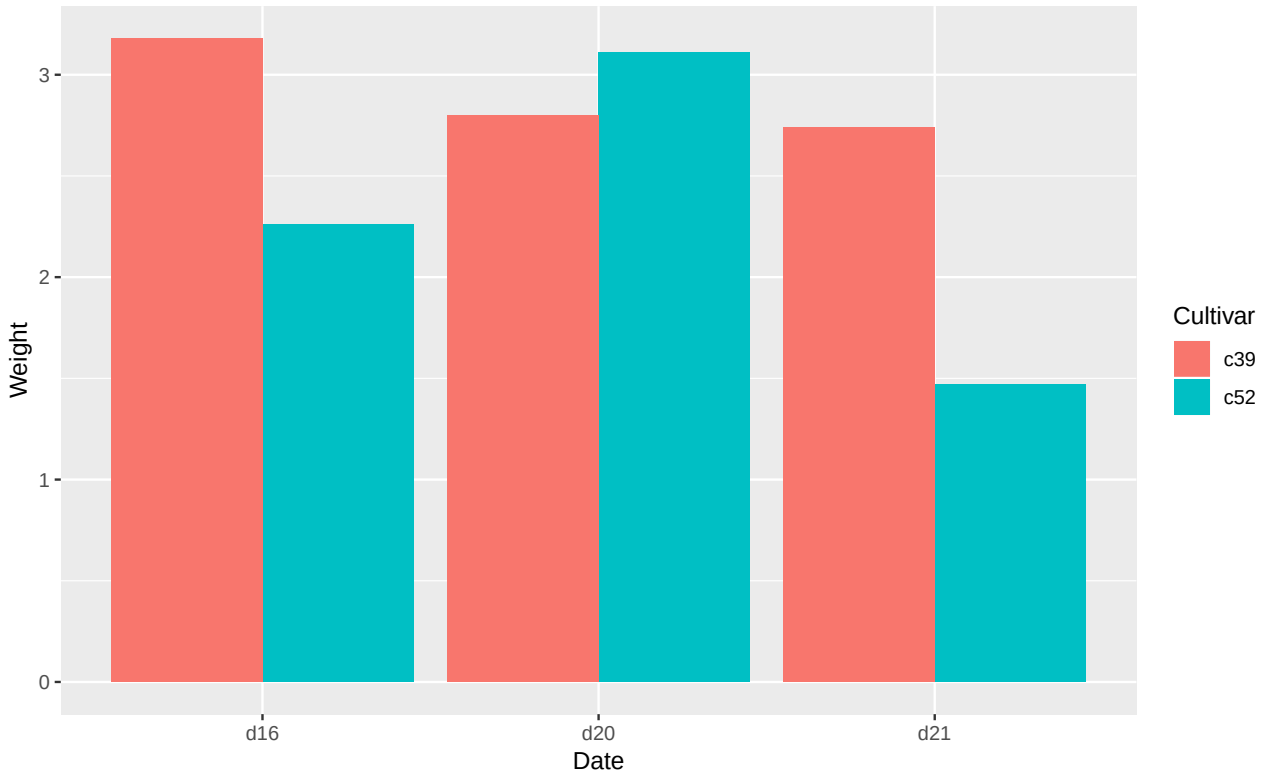


Figure 3.2:

position = "dodge" geom_bar() position = "stack" position = "fill" 100%

3.1.3

ggplot2 diamonds

```
head(diamonds) #  6
```

```
## # A tibble: 6 x 10
##   carat cut       color clarity depth table price     x     y     z
##   <dbl> <ord>     <ord> <ord>   <dbl> <dbl> <int> <dbl> <dbl> <dbl>
## 1 0.23  Ideal     E     SI2      61.5    55   326  3.95  3.98  2.43
## 2 0.21  Premium   E     SI1      59.8    61   326  3.89  3.84  2.31
## 3 0.23  Good      E     VS1      56.9    65   327  4.05  4.07  2.31
## 4 0.290 Premium   I     VS2      62.4    58   334  4.2   4.23  2.63
## 5 0.31  Good      J     SI2      63.3    58   335  4.34  4.35  2.75
## 6 0.24  Very Good J     VVS2     62.8    57   336  3.94  3.96  2.48
```

cut

- cut Fair, Good, Very Good, Premium, or Ideal

geom_bar() y

```
ggplot(diamonds, aes(cut)) + # x cut y
  geom_bar() #               stat = "identity"
```

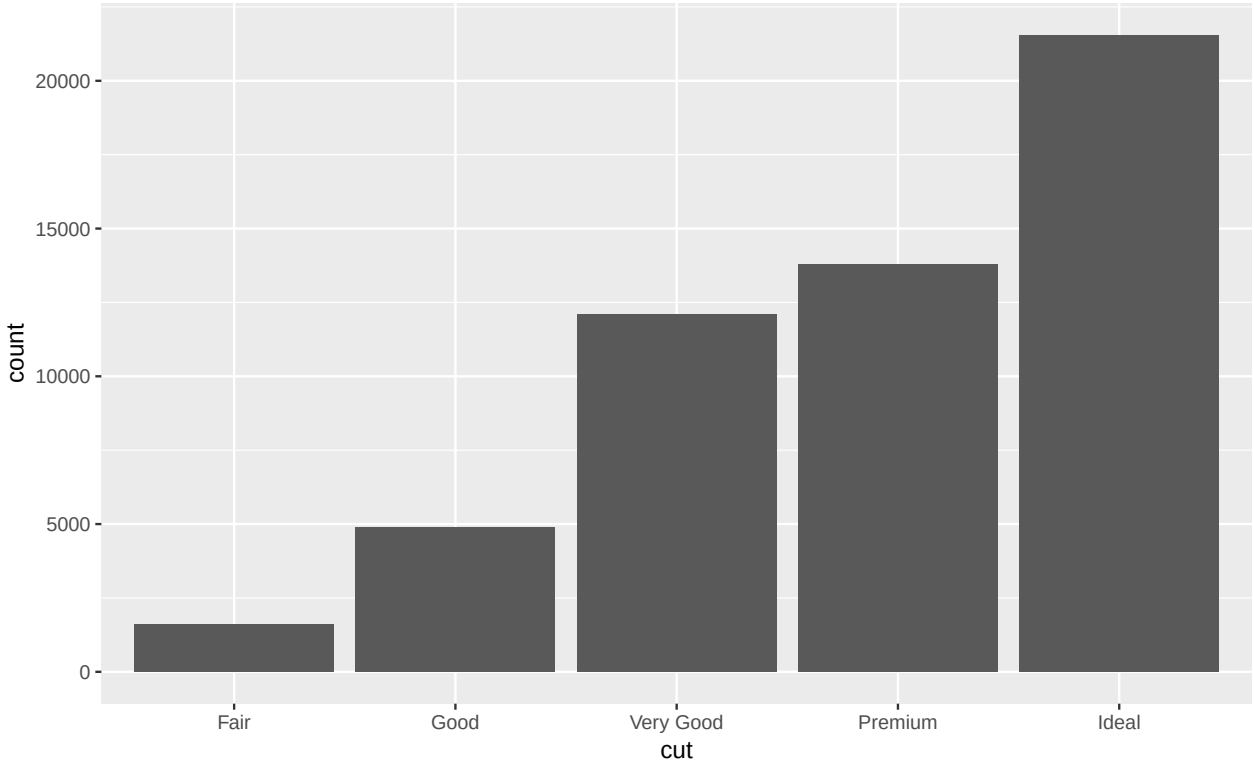


Figure 3.3:

3.2 Cleveland

gcookbook `tophitters2001` 2001 MLB 144

```
head(tophitters2001)
```

```
##          id   first   last           name year stint team lg   g  ab   r
## 1 walkela01   Larry Walker   Larry Walker 2001     1  COL NL 142 497 107
## 2 suzukic01  Ichiro Suzuki  Ichiro Suzuki 2001     1  SEA AL 157 692 127
## 3 giambja01   Jason Giambi   Jason Giambi 2001     1  OAK AL 154 520 109
## 4 alomaro01 Roberto Alomar Roberto Alomar 2001     1  CLE AL 157 575 113
## 5 heltoto01    Todd Helton    Todd Helton 2001     1  COL NL 159 587 132
## 6  aloumo01  Moises   Alou    Moises Alou 2001     1  HOU NL 136 513  79
##     h 2b 3b hr rbi sb cs  bb  so ibb hbp sh sf gidp    avg
## 1 174 35  3 38 123 14  5  82 103   6  14  0  8    9 0.3501
## 2 242 34  8  8  69 56 14  30  53  10   8  4  4    3 0.3497
## 3 178 47  2 38 120  2  0 129  83  24  13  0  9   17 0.3423
## 4 193 34 12 20 100 30  6  80  71   5   4  9  9    9 0.3357
## 5 197 54  2 49 146  7  5  98 104  15   5  1  5   14 0.3356
## 6 170 31  1 27 108  5  1  57  57  14   3  0  8   18 0.3314
```

- `name`

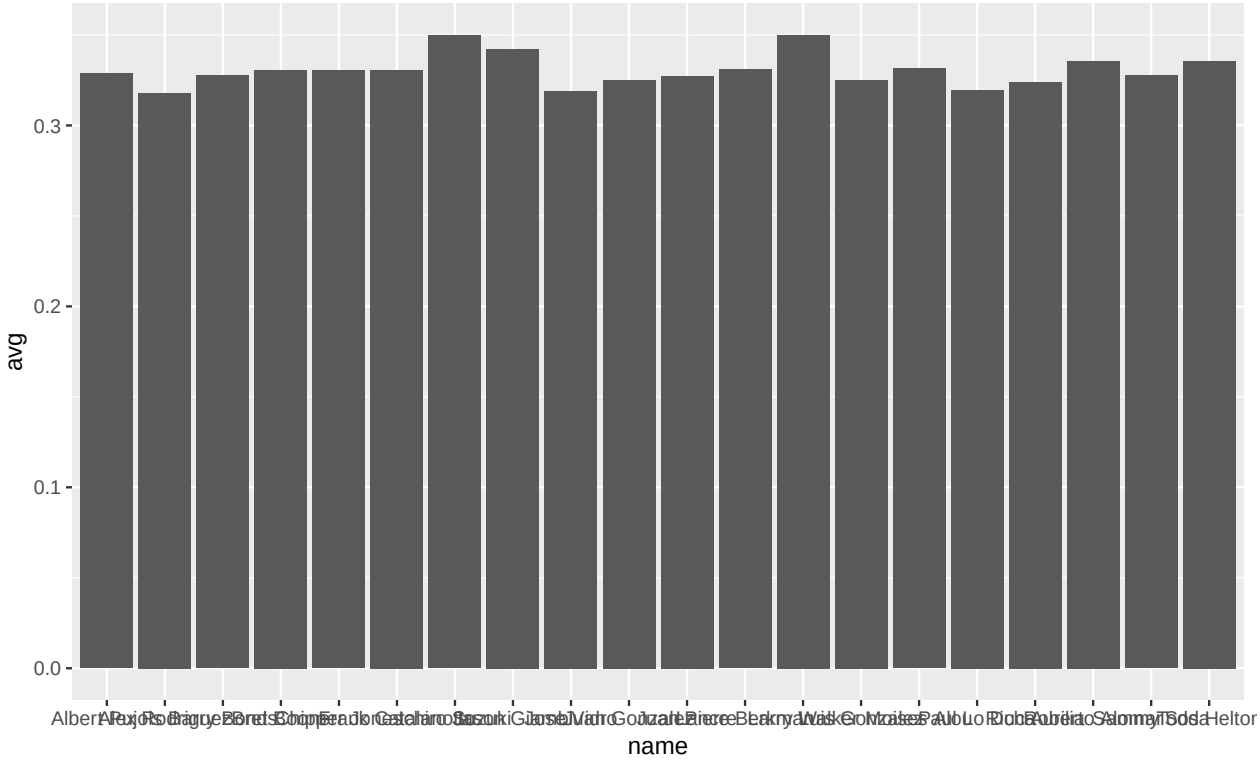


Figure 3.4: 2001 MLB 20

- avg

144 20 20 top20hitters

```
top20hitters = tophitters2001[1:20,] #  20   top20hitters
```

top20hitters

```
ggplot(top20hitters, aes(name, avg)) + # x name y avg
  geom_bar(stat = "identity") #
```

2

1.

- y = 0 [5] 0.3 y = 0

2.

-

---

1 **Cleveland** Cleveland dot plot

```
ggplot(top20hitters, aes(avg, reorder(name, avg))) + # x y   reorder()
  geom_point() #     stat = "identity"
```

1. ggplot(top20hitter, aes(avg, reorder(name, avg)))
   - x y

[5] y = 0

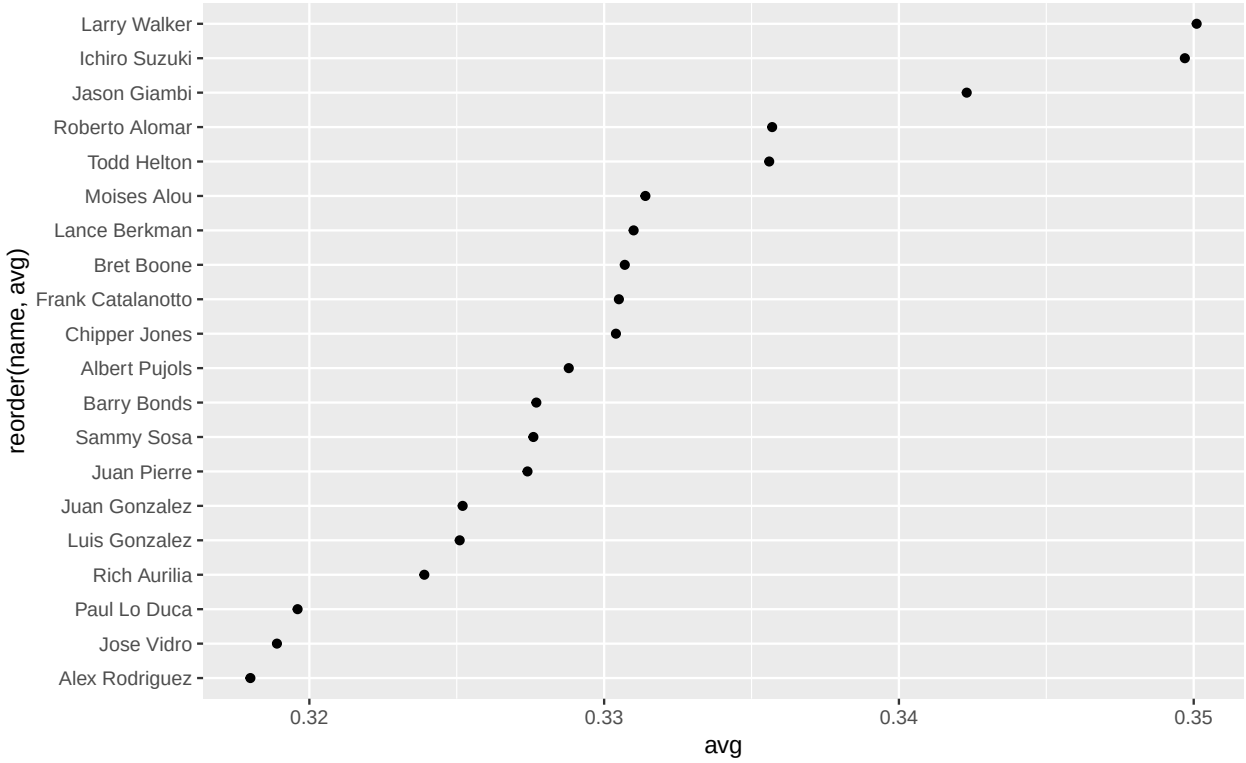


Figure 3.5: Cleveland 2001 MLB 20

- `reorder(name, avg)` `reorder(a, b)` a b `reorder()`

2. `geom_point()`
   -
   - `geom_point()` `stat = "identity"` `geom_bar()` `stat`

Cleveland [6] Figure 3.4 Figure 3.5

3.3

- `cabbage_exp` x `Cultivar` y `Weight` `Date`
- `diamonds` `clarity`
- gcookbook `uspopchange` `?uspopchange` `head(uspopchange)`

[6] lollipop plot; lollipop chart https://python-graph-gallery.com/lollipop-plot/

Chapter 4

Chapter 1 summary statistics descriptive statistics distribution

```
library(ggplot2) #
```

4.1

4.1.1

histogram x y

Chapter 1 gcookbook `tophitters2001` 2001 MLB 144 gcookbook

```
library(gcookbook)
```

```
head(tophitters2001) #    6
```

```
##          id   first   last           name year stint team lg   g  ab   r
## 1 walkela01   Larry Walker   Larry Walker 2001     1  COL NL 142 497 107
## 2 suzukic01  Ichiro Suzuki  Ichiro Suzuki 2001     1  SEA AL 157 692 127
## 3 giambja01   Jason Giambi   Jason Giambi 2001     1  OAK AL 154 520 109
## 4 alomaro01 Roberto Alomar Roberto Alomar 2001     1  CLE AL 157 575 113
## 5 heltoto01    Todd Helton    Todd Helton 2001     1  COL NL 159 587 132
## 6  aloumo01  Moises   Alou    Moises Alou 2001     1  HOU NL 136 513  79
##     h 2b 3b hr rbi sb cs  bb  so ibb hbp sh sf gidp    avg
## 1 174 35  3 38 123 14  5  82 103   6  14  0  8    9 0.3501
## 2 242 34  8  8  69 56 14  30  53  10   8  4  4    3 0.3497
## 3 178 47  2 38 120  2  0 129  83  24  13  0  9   17 0.3423
## 4 193 34 12 20 100 30  6  80  71   5   4  9  9    9 0.3357
## 5 197 54  2 49 146  7  5  98 104  15   5  1  5   14 0.3356
## 6 170 31  1 27 108  5  1  57  57  14   3  0  8   18 0.3314
```

144 `avg` x

```
ggplot(tophitters2001, aes(avg)) + # x avg          y
  geom_histogram() #
```

0.28 median mode

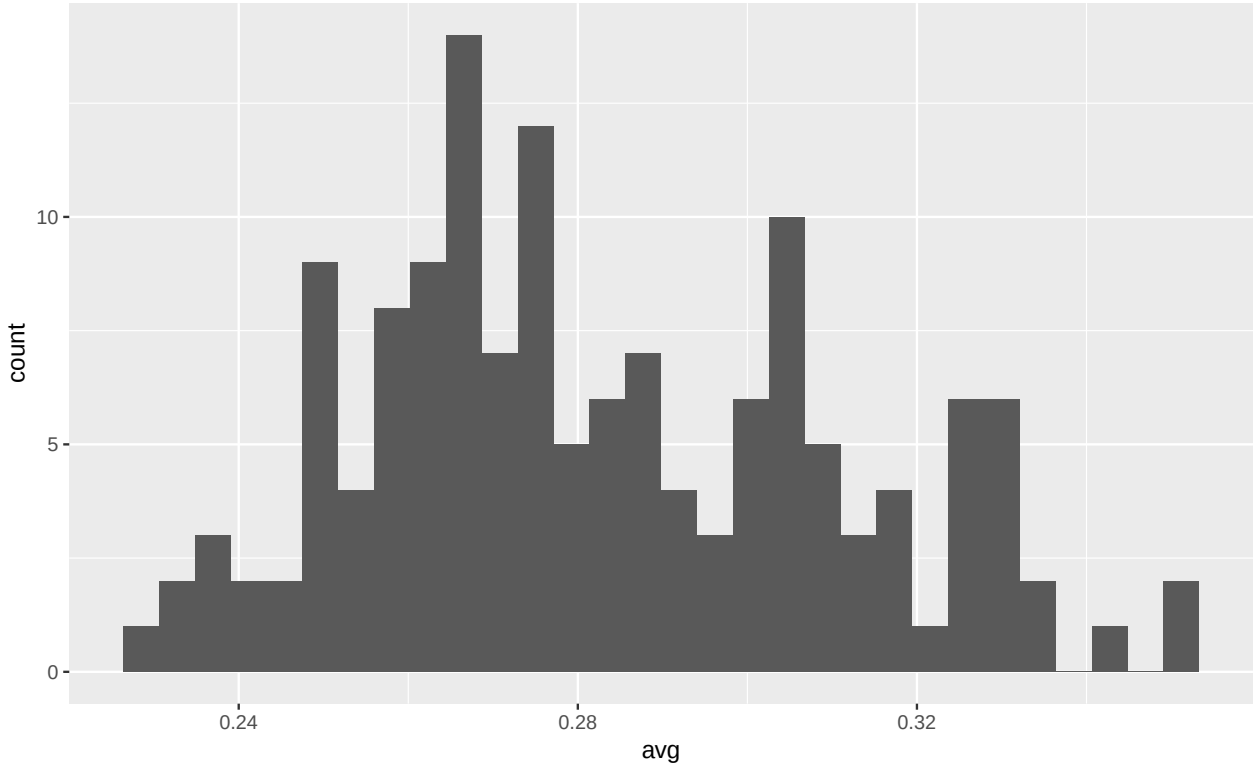


Figure 4.1: 2001 MLB 144

---

bin 1 1

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

0.001 0.01 0.1

```
ggplot(tophitters2001, aes(avg)) +
  geom_histogram(binwidth = 0.001) # binwidth = ...
```

```
ggplot(tophitters2001, aes(avg)) +
  geom_histogram(binwidth = 0.01) # binwidth = ...
```

```
ggplot(tophitters2001, aes(avg)) +
  geom_histogram(binwidth = 0.1) # binwidth = ...
```

4.1.2

`tophitters2001`

- `lg` AL or NL

`fill` `lg`

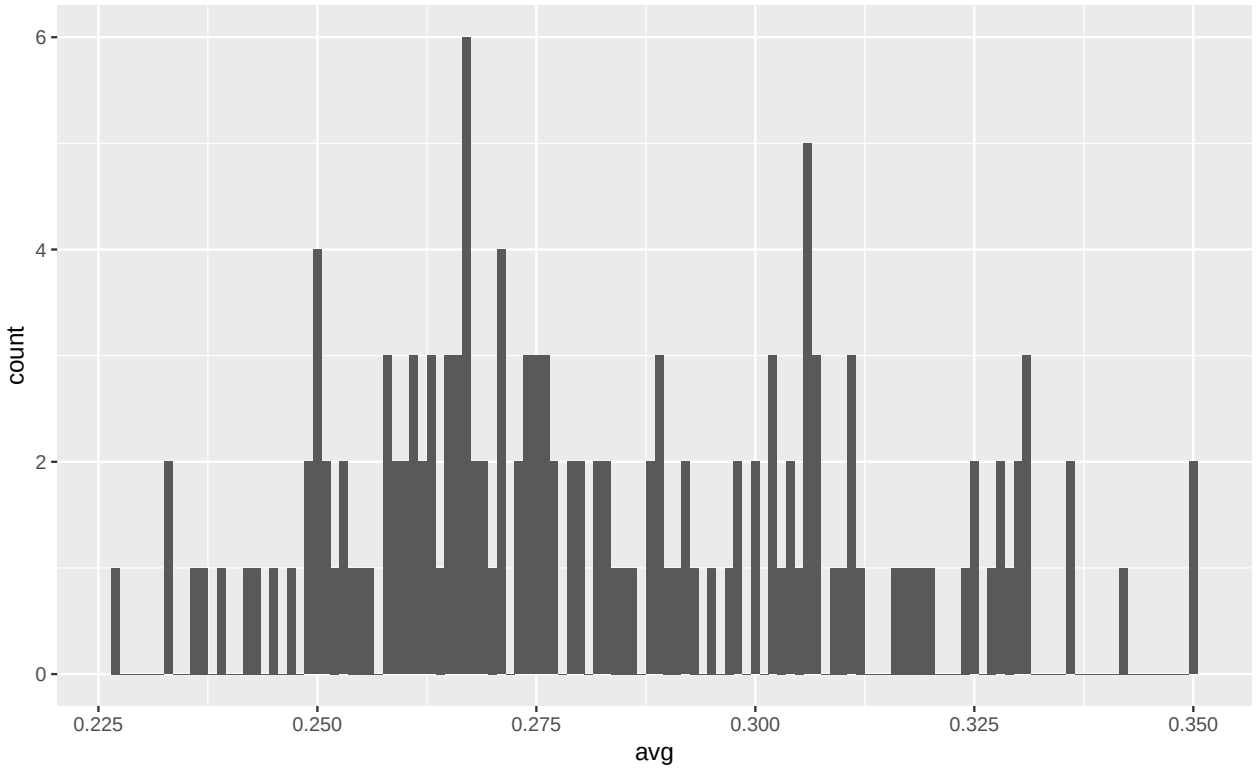


Figure 4.2:

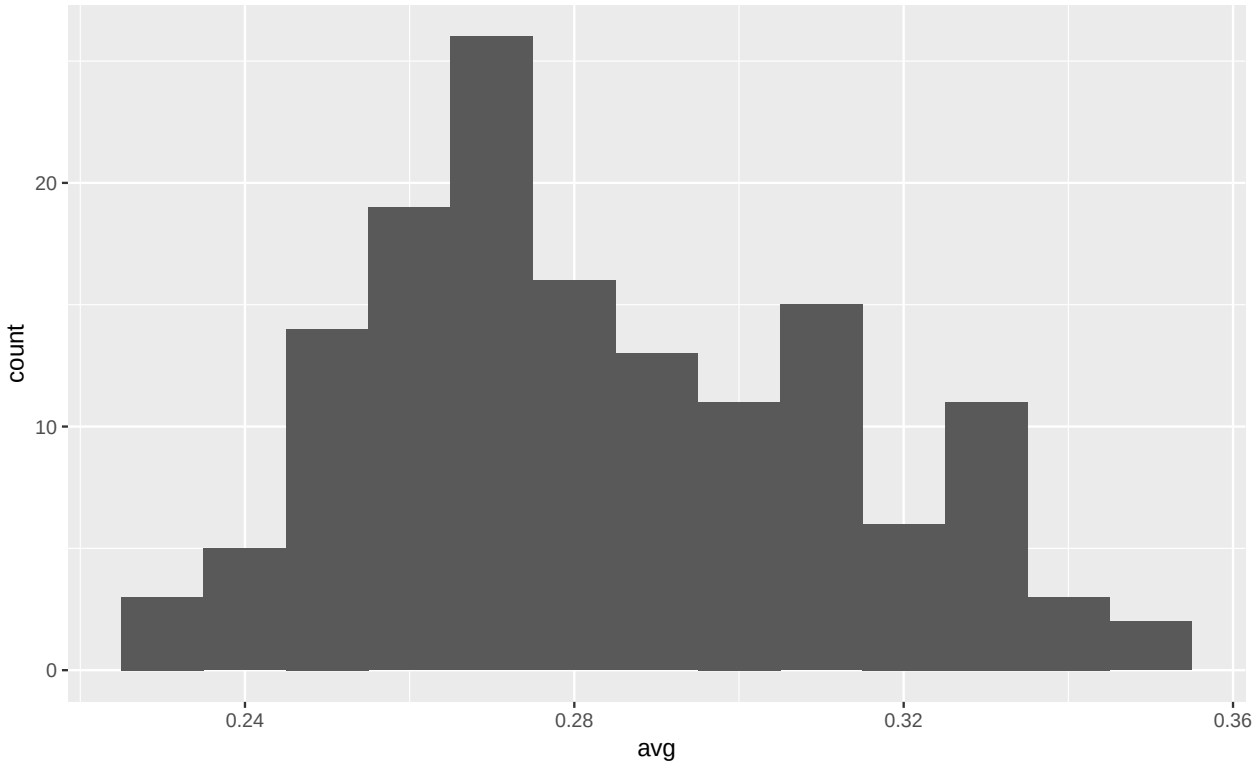


Figure 4.3:

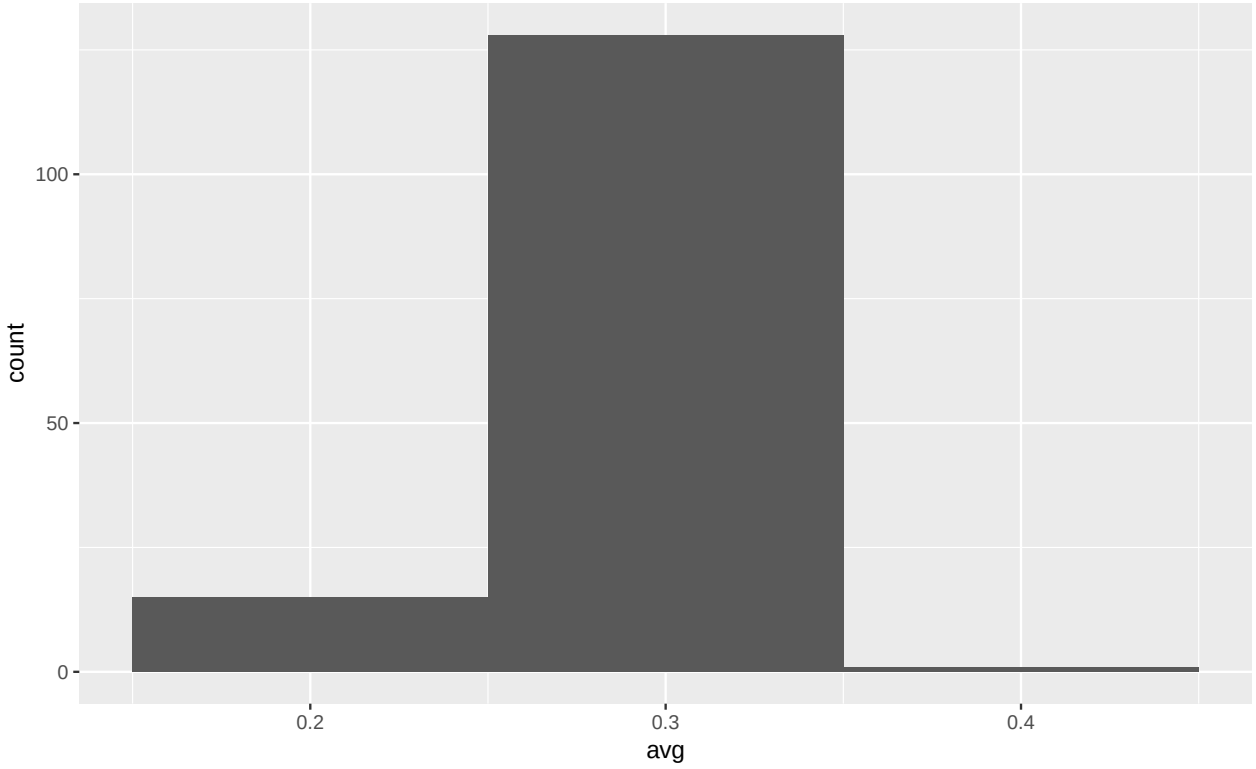


Figure 4.4:

```
ggplot(tophitters2001, aes(avg, fill = lg)) + # x avg fill
  geom_histogram(position = "identity") # position = "identity"
```

position = "identity" geom_histogram() position = "stack" position = "identity"

alpha 0 1

```
ggplot(tophitters2001, aes(avg, fill = lg)) +
  geom_histogram(position = "identity", alpha = 0.7) # 0    1
```

4.2

density plot raw data kernel-density estimation

geom_histogram() geom_density()

```
ggplot(tophitters2001, aes(avg, fill = lg)) + # x avg fill
  geom_density(alpha = 0.7) #    position = "identity"  geom_histogram(position = "identity")
```

y 5 10 1

geom_histogram() binwidth geom_density() adjust a

1, 4

(ref:density-plot-2)

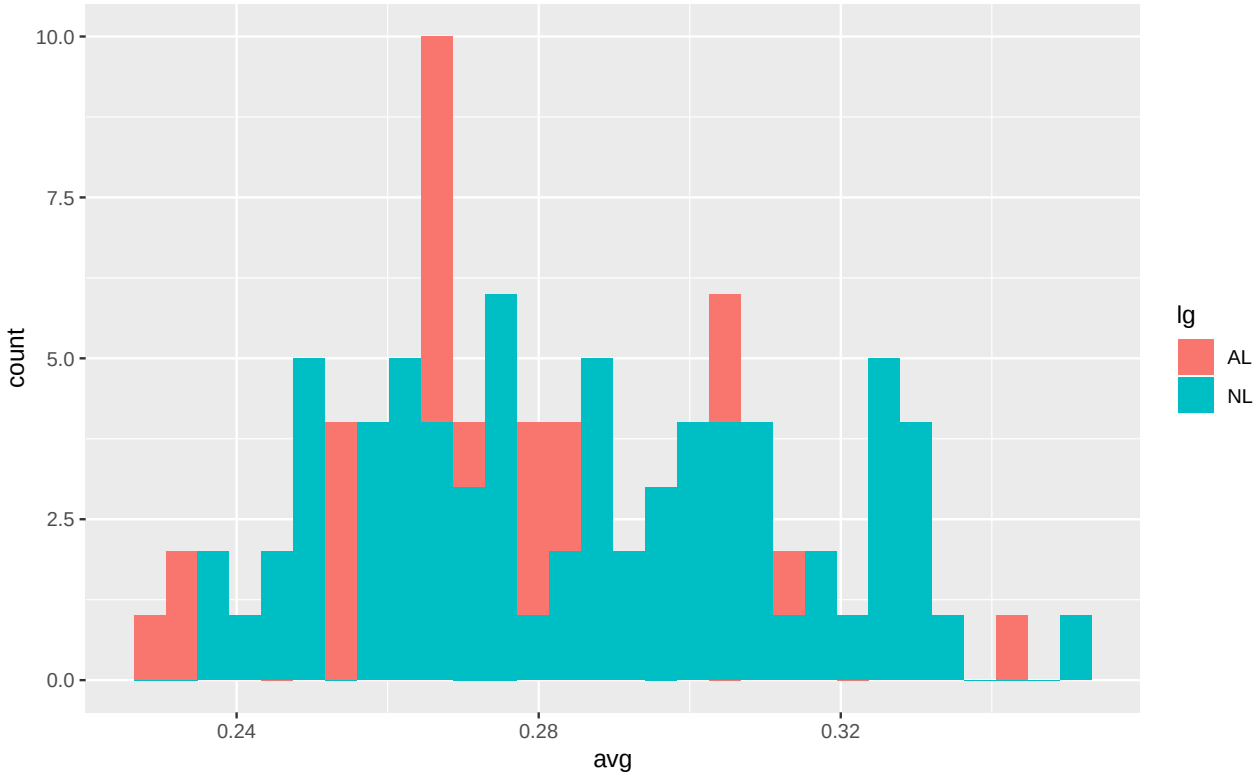


Figure 4.5:

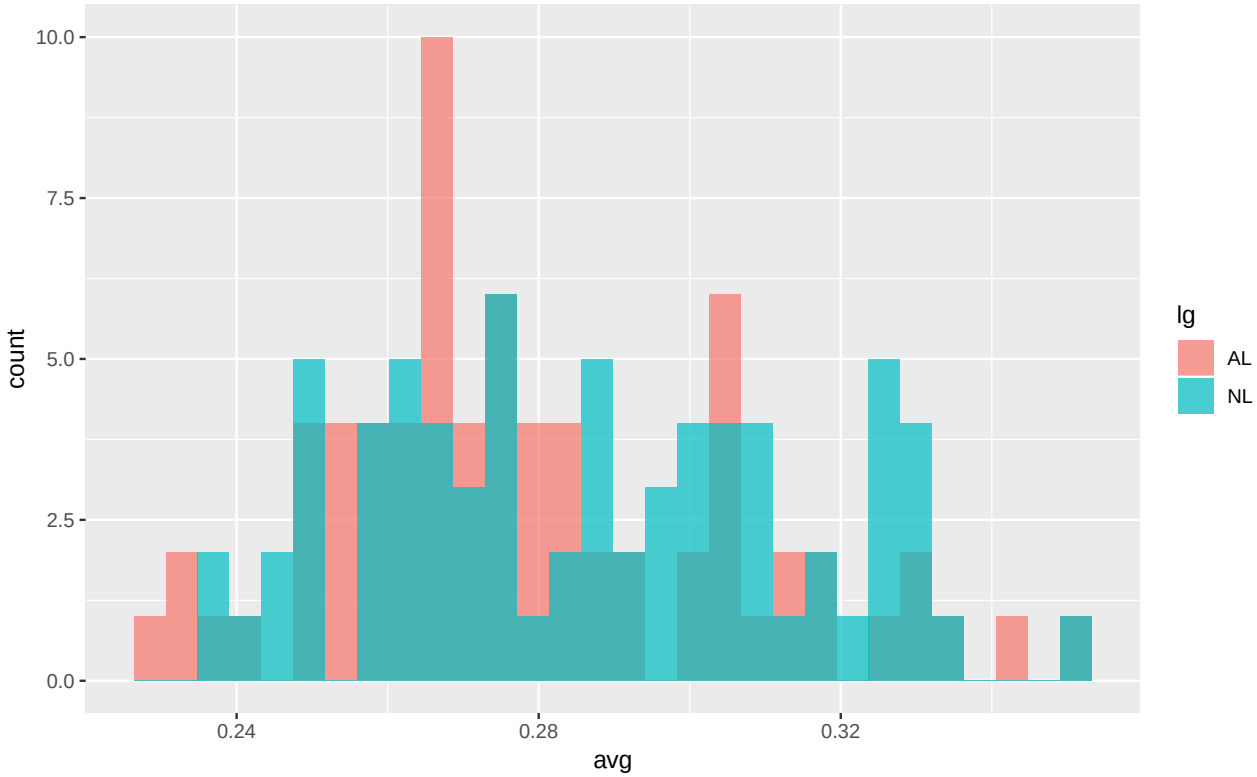


Figure 4.6: Figure 4.5

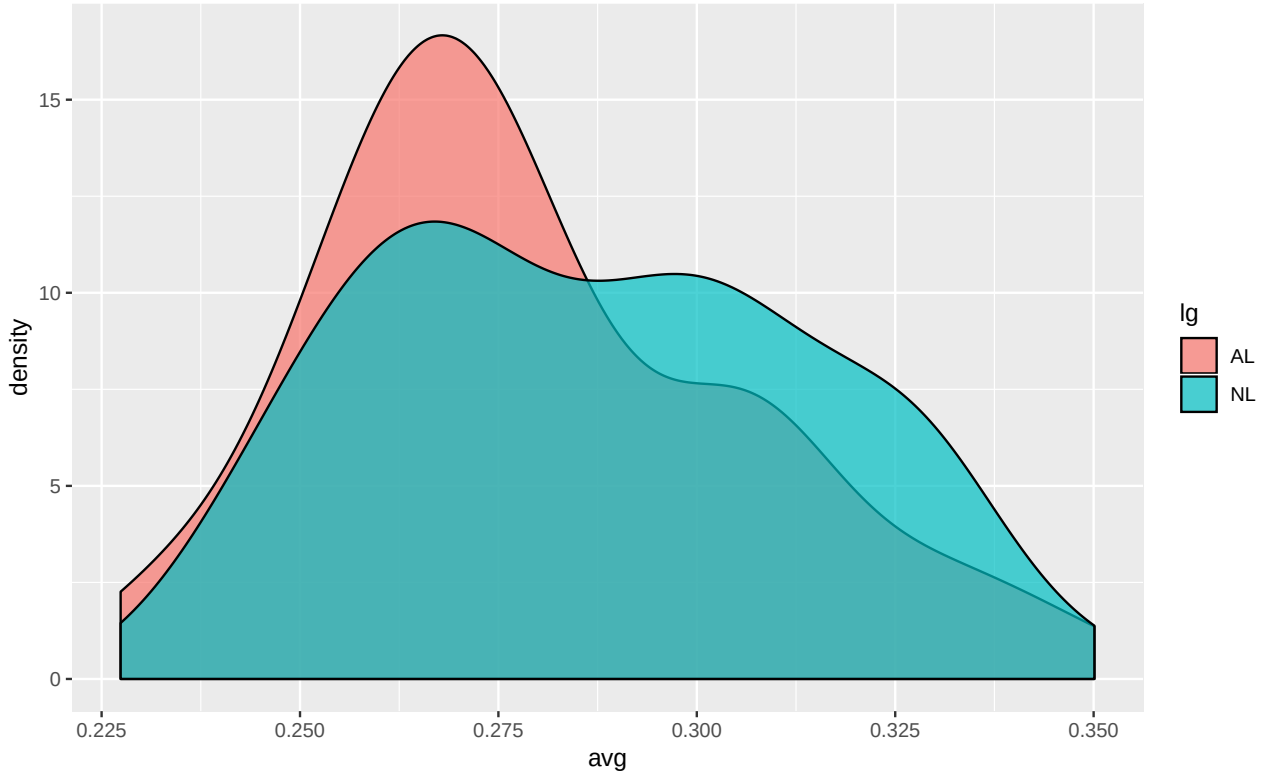


Figure 4.7:

```
ggplot(tophitters2001, aes(avg, fill = lg)) +
  geom_density(alpha = 0.7, adjust = 0.25) # adjust = ...
```

```
ggplot(tophitters2001, aes(avg, fill = lg)) +
  geom_density(alpha = 0.7, adjust = 1) # adjust = ...
```

(ref:density-plot-4)

```
ggplot(tophitters2001, aes(avg, fill = lg)) +
  geom_density(alpha = 0.7, adjust = 4) # adjust = ...
```

Chapter 2 **ggplot2**

```
ggplot(tophitters2001, aes(avg, y = ..density..)) + # y = ..density..
  geom_histogram(binwidth = 0.01) + #
  geom_density(alpha = 0.7) #
```

y = ..density.. geom_density() y geom_histogram() y 2 y ..

4.3

box plot; box-and-whisker plot

R PlantGrowth

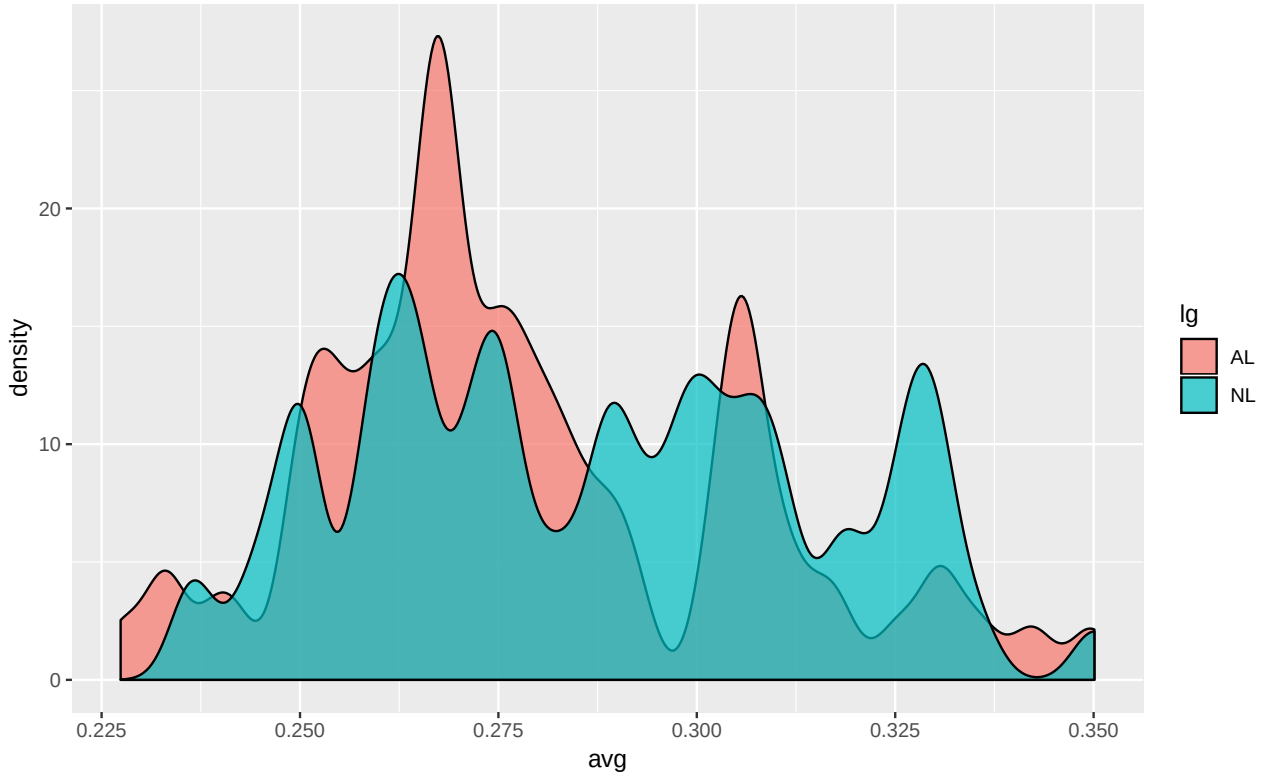


Figure 4.8: (ref:density-plot-2)

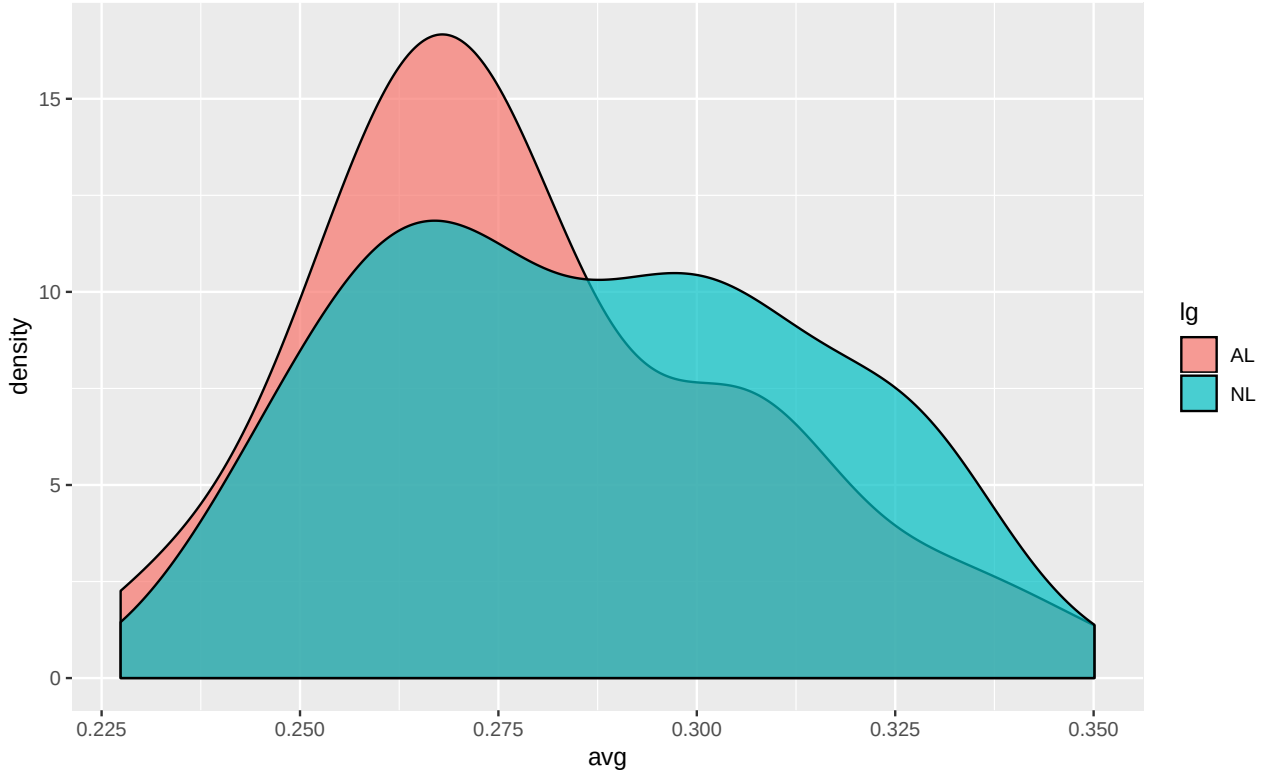


Figure 4.9:

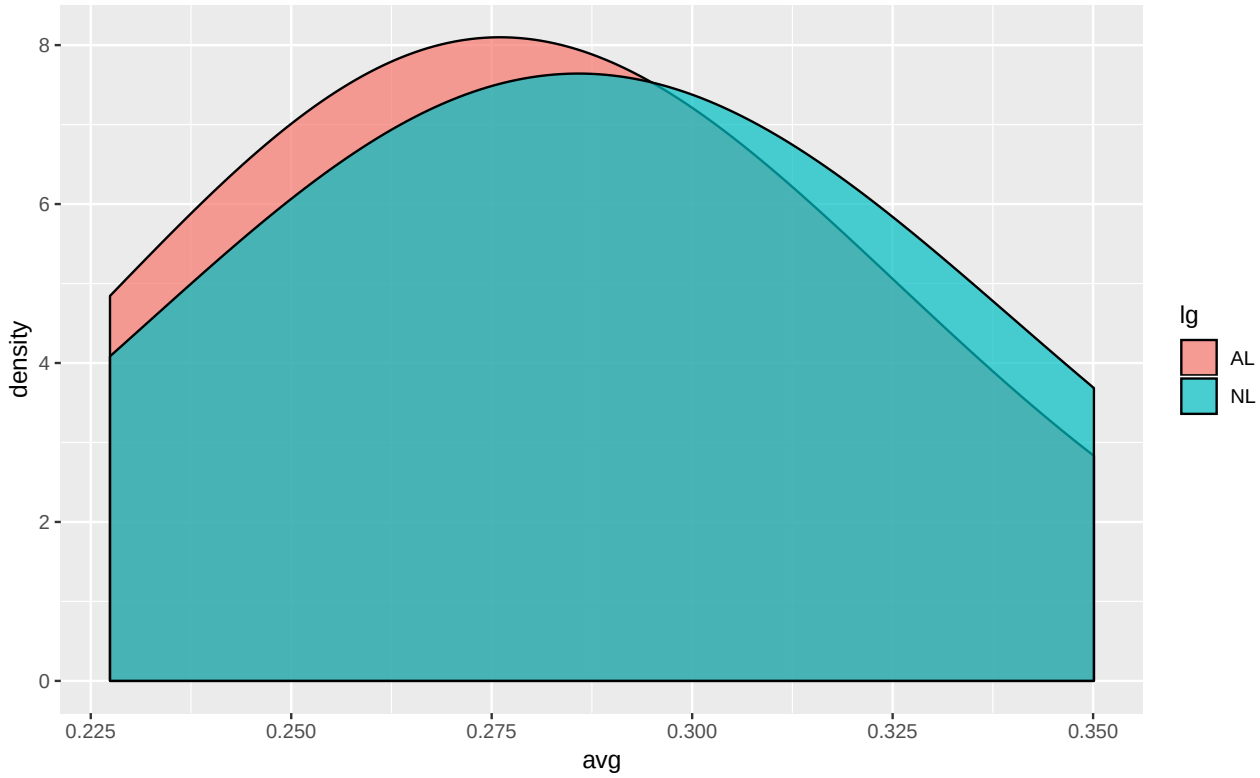


Figure 4.10: (ref:density-plot-4)

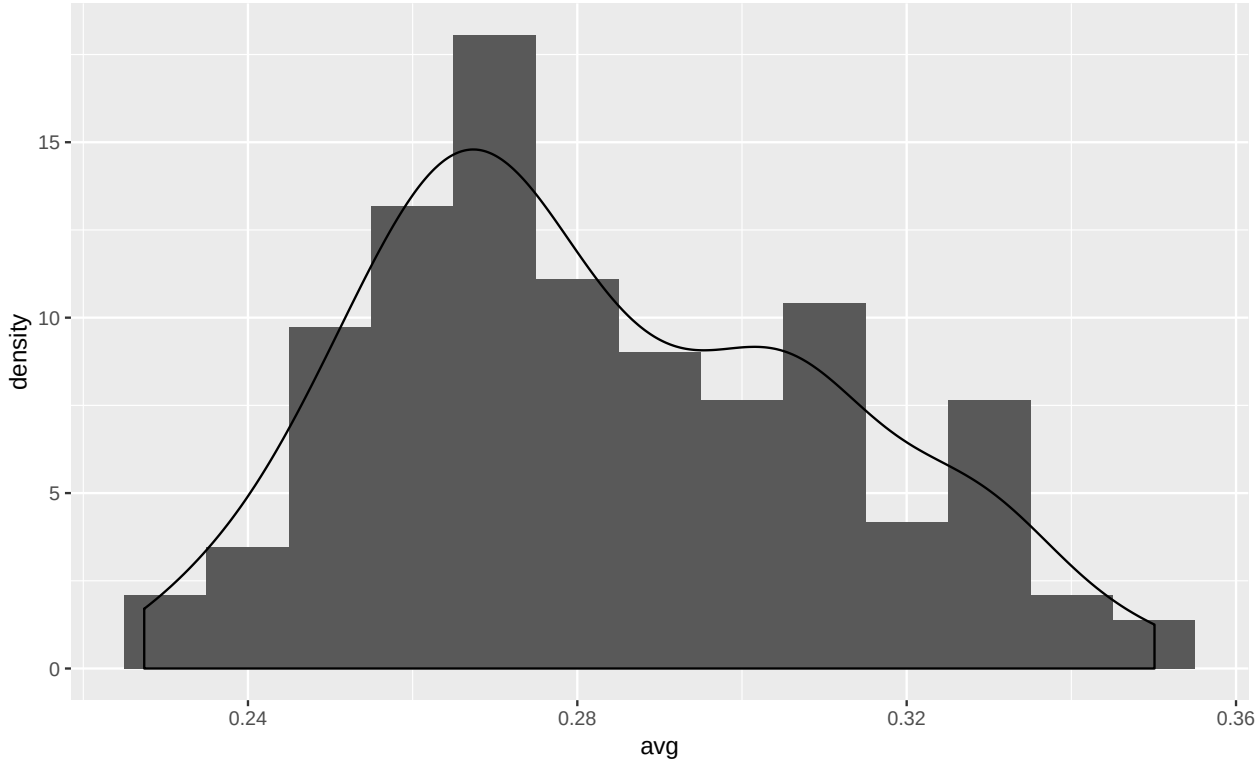


Figure 4.11:

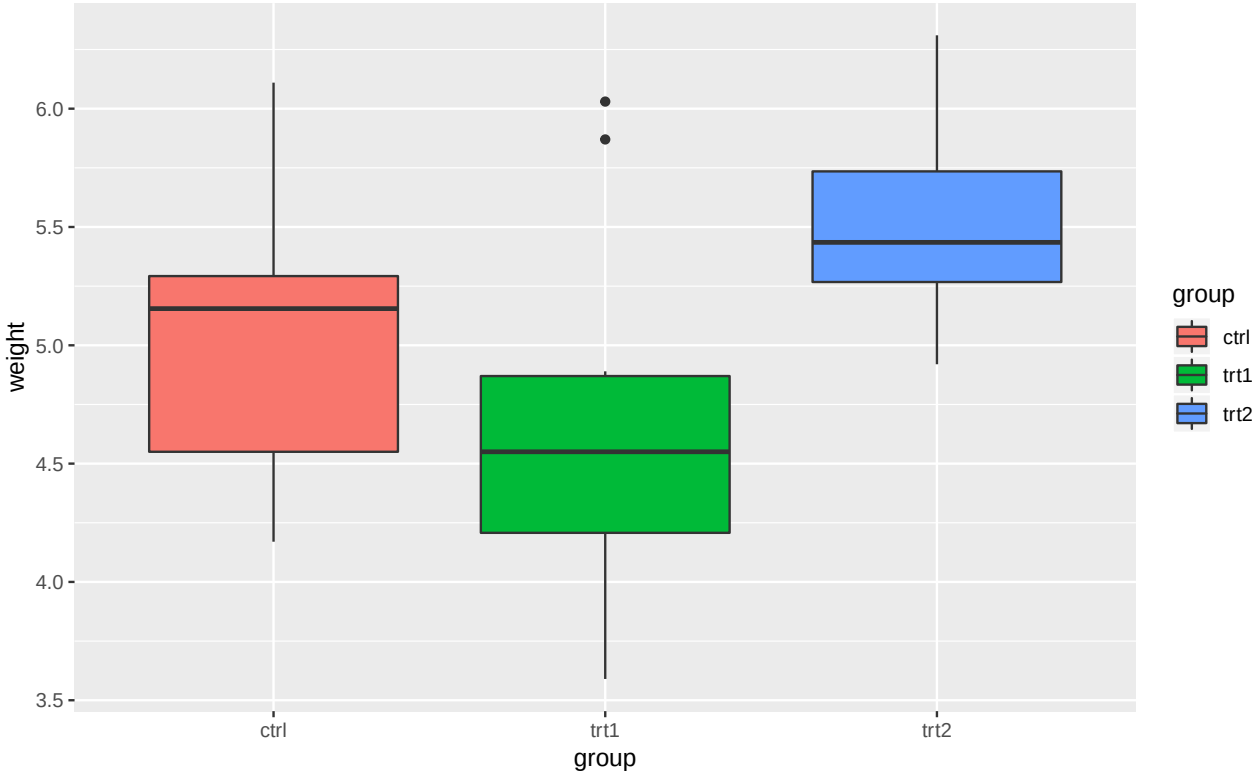


Figure 4.12: x y

```
head(PlantGrowth) #  6
```

```
##   weight group
## 1   4.17  ctrl
## 2   5.58  ctrl
## 3   5.18  ctrl
## 4   6.11  ctrl
## 5   4.50  ctrl
## 6   4.61  ctrl
```

2

- group ctrl, trt1, or trt2
- weight

3 fill

```
ggplot(PlantGrowth, aes(group, weight, fill = group)) + # x group y weight fill
  geom_boxplot() #
```

1

- interquartile range, IQR 25 75
- IQR × 1.5

[1] Tukey

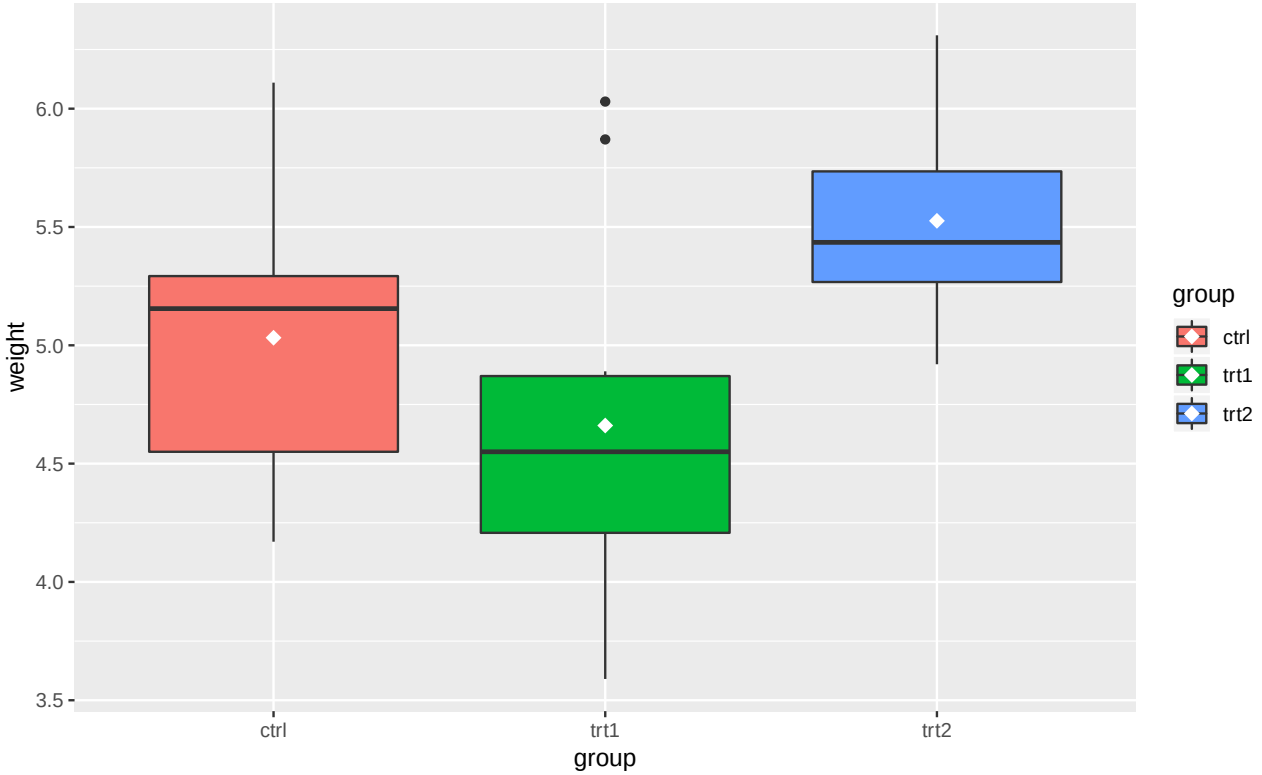


Figure 4.13:

- 50 percentile
- outlier IQR × 1.5

Wikipedia “Interquartile range” https://en.wikipedia.org/wiki/Interquartile_range

2

```
ggplot(PlantGrowth, aes(group, weight, fill = group)) +
  geom_boxplot() +
  stat_summary(geom = "point", fun.y = mean, color = "white", shape = "diamond", size = 3) #
```

`stat_summary()` y `weight` 3

4.4

violin plot 90°

`geom_violin()`

(ref:violin-plot) x y

```
ggplot(PlantGrowth, aes(group, weight, fill = group)) + # x group y weight fill
  geom_violin() #
```

`geom_density()` `geom_violin()` adjust

2

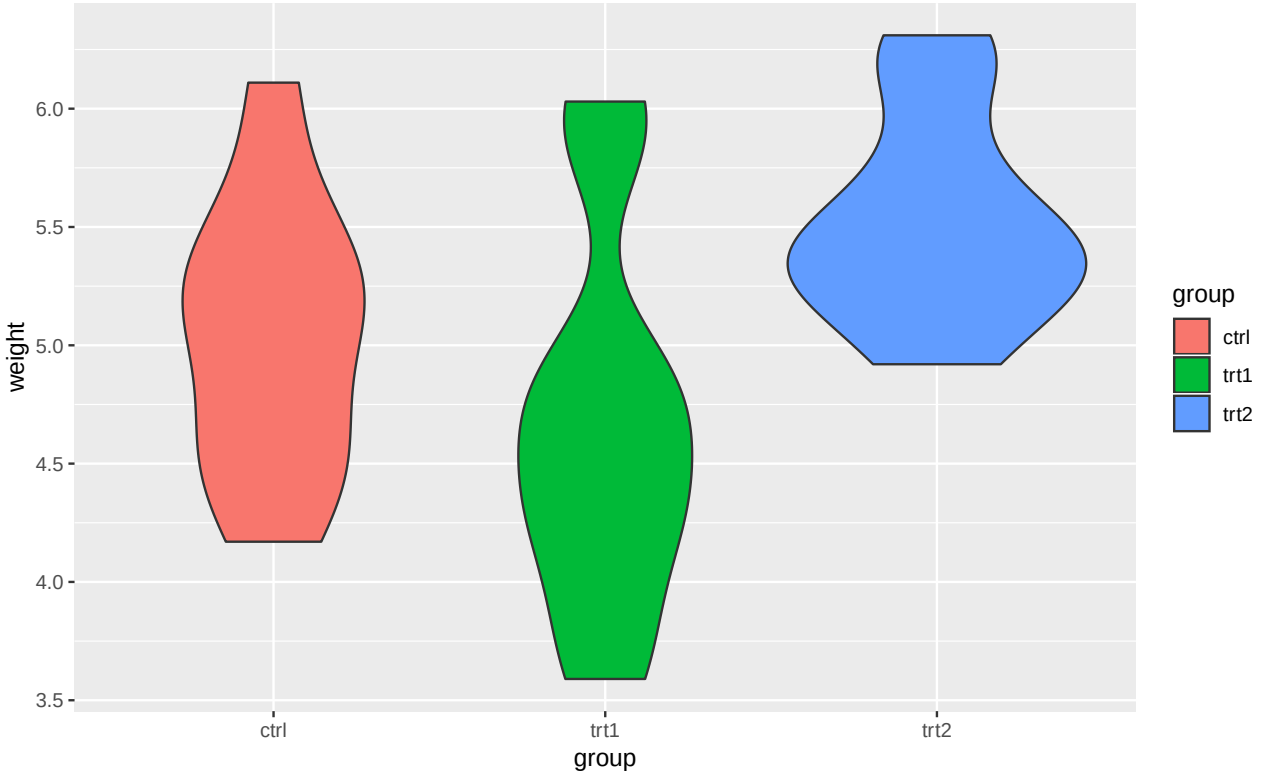


Figure 4.14: (ref:violin-plot)

4.5

strip plot 1 1

(ref:strip-plot)

```
ggplot(PlantGrowth, aes(group, weight, fill = group)) + # x group y weight fill
  geom_violin() + #
  geom_boxplot(outlier.shape = NA, width = 0.2) + #
  geom_point(position = position_jitter(width = 0.1, height = 0, seed = 1)) + #
  stat_summary(geom = "point", fun.y = mean, shape = "diamond", color = "white", size = 3) #
```

1 1

0. `ggplot(PlantGrowth, aes(group, weight, fill = group))`
   - x group y weight group
1. `geom_violin()`
   -
2. `geom_boxplot(outlier.shape = NA, width = 0.2)`
   -
   - `outlier.shape = NA`
   - `width` 1

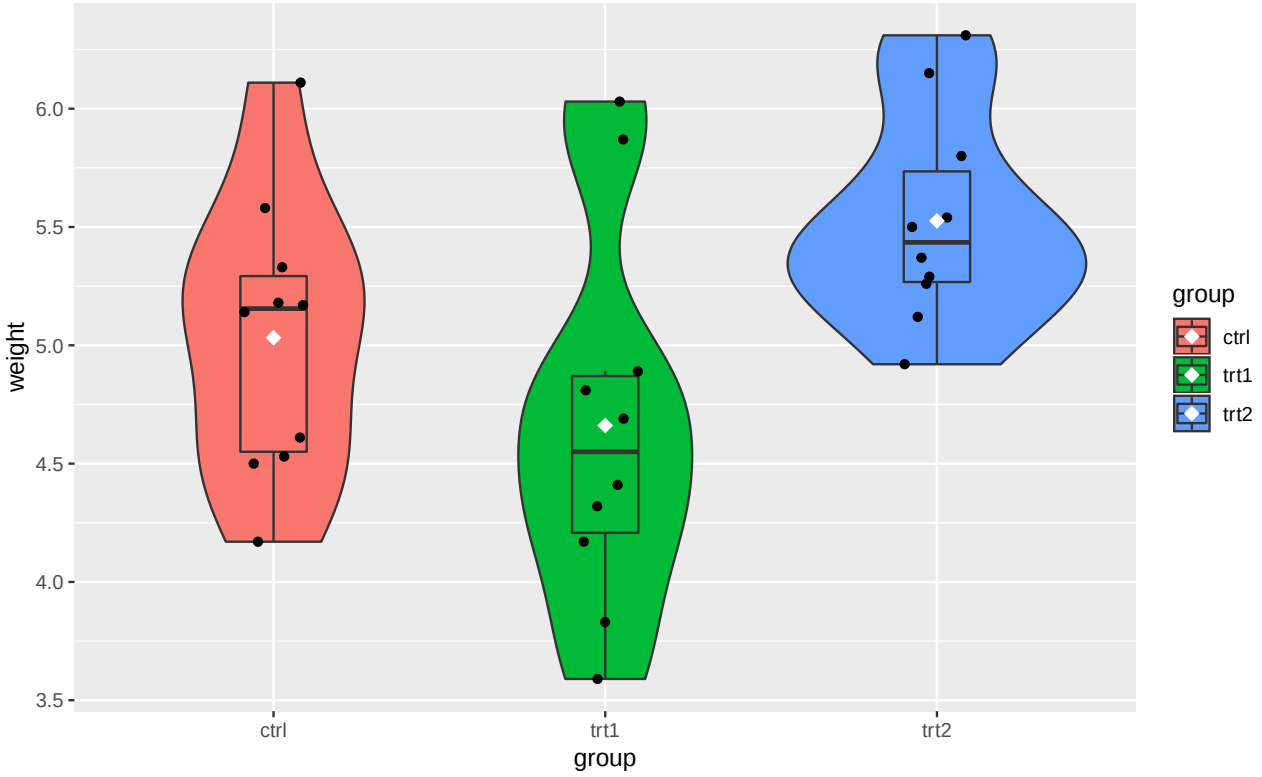


Figure 4.15: (ref:strip-plot)

3. `geom_point(position = position_jitter(width = 0.1, seed = 1))`
   -
   - `position = position_jitter()` jitter position
   - `width` x `seed` `seed`
   - y `height` 0
4. `stat_summary(geom = "point", fun.y = mean, shape = "diamond", color = "white", size = 3)`
   -

4.6

- R `iris` [3] `Species` `Sepal.Length`
- `Species` `Sepal.Width`

[3] https://en.wikipedia.org/wiki/Iris_flower_data_set

Chapter 5

scatter plot

```
library(ggplot2) #
```

5.1

R faithful [1]

```
head(faithful) #  6
```

```
##   eruptions waiting
## 1     3.600      79
## 2     1.800      54
## 3     3.333      74
## 4     2.283      62
## 5     4.533      85
## 6     2.883      55
```

- eruptions
- waiting

geom_point()

(ref:scatter-plot-1) faithful 2

```
ggplot(faithful, aes(eruptions, waiting)) + # x eruptions y waiting
  geom_point() #
```

5.2

Chapter 2 R mtcars Chapter 2 geom_point() color

```
ggplot(mtcars, aes(wt, mpg, color = factor(cyl))) + # factor( )
  geom_point()
```

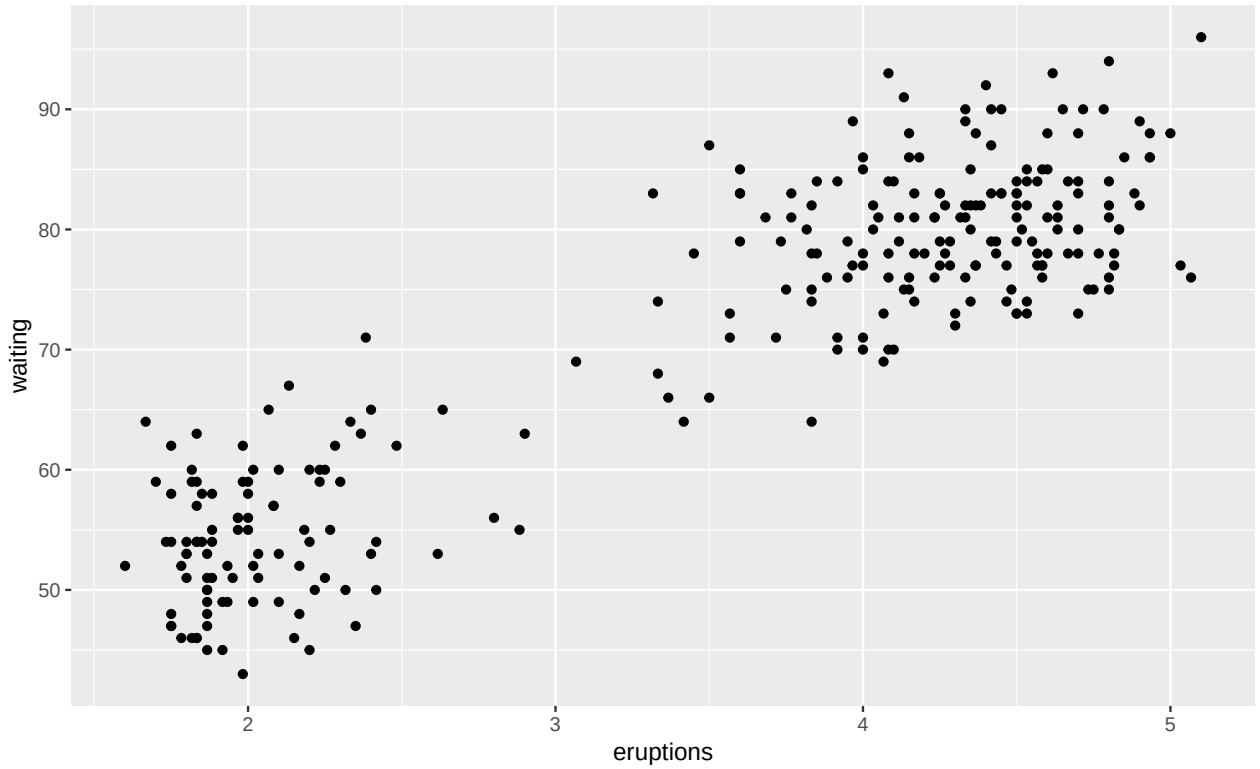


Figure 5.1: (ref:scatter-plot-1)

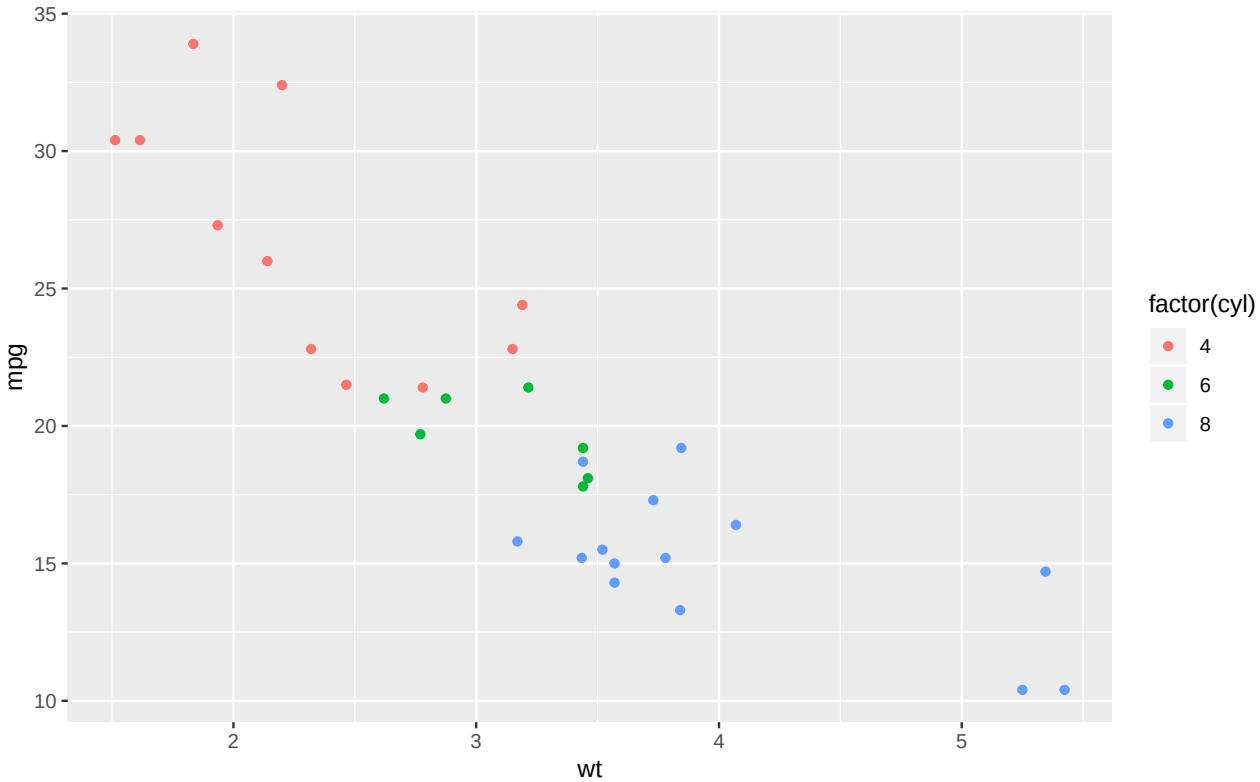


Figure 5.2:

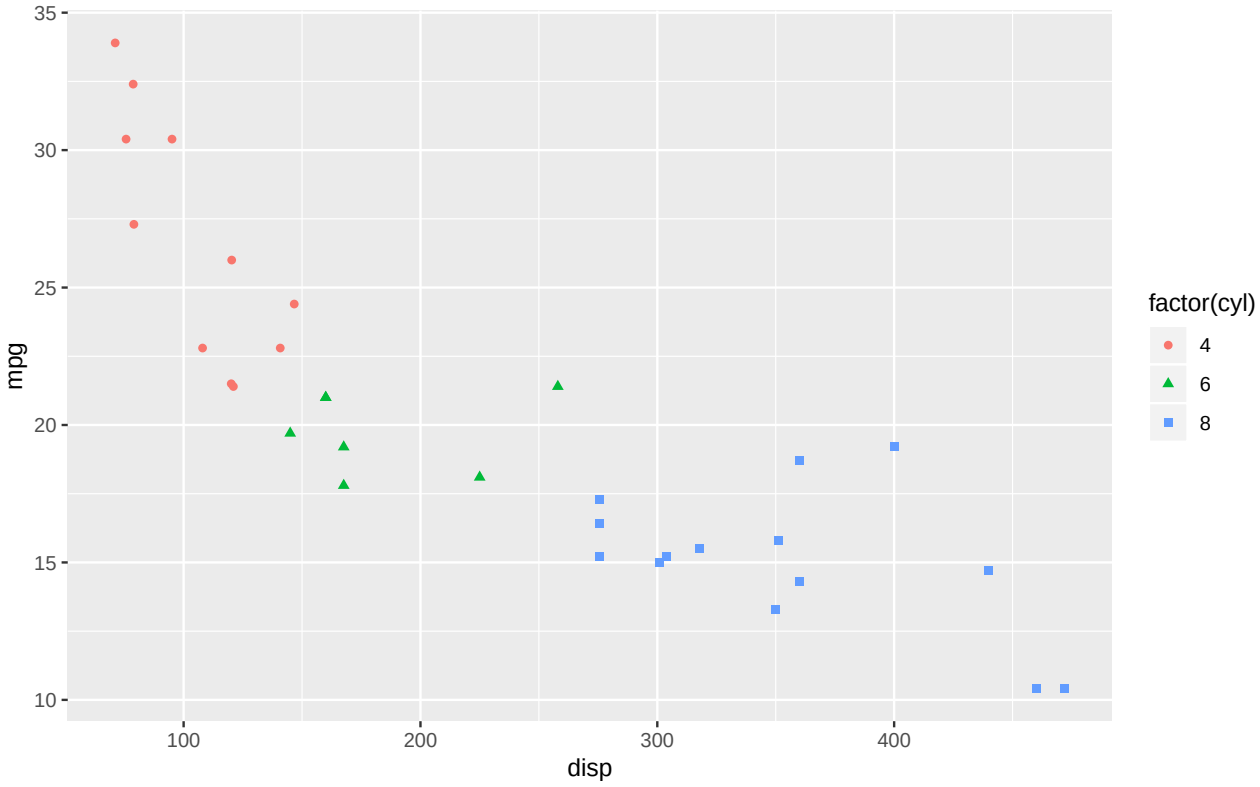


Figure 5.3: Figure 5.2

[2] shape

```
ggplot(mtcars, aes(disp, mpg, color = factor(cyl), shape = factor(cyl))) + # shape = factor(cyl)
  geom_point()
```

cyl

5.3

faithful 2 1 1 1

[3] GGally ggpairs() R iris GGally

```
library(GGally) #
```

ggpairs()

(ref:scatter-plot-matrix-1) ggpairs() iris

```
ggpairs(iris) #
```

Species ggplot2

[1] https://ja.wikipedia.org/wiki/
[2] redundant coding
[3]

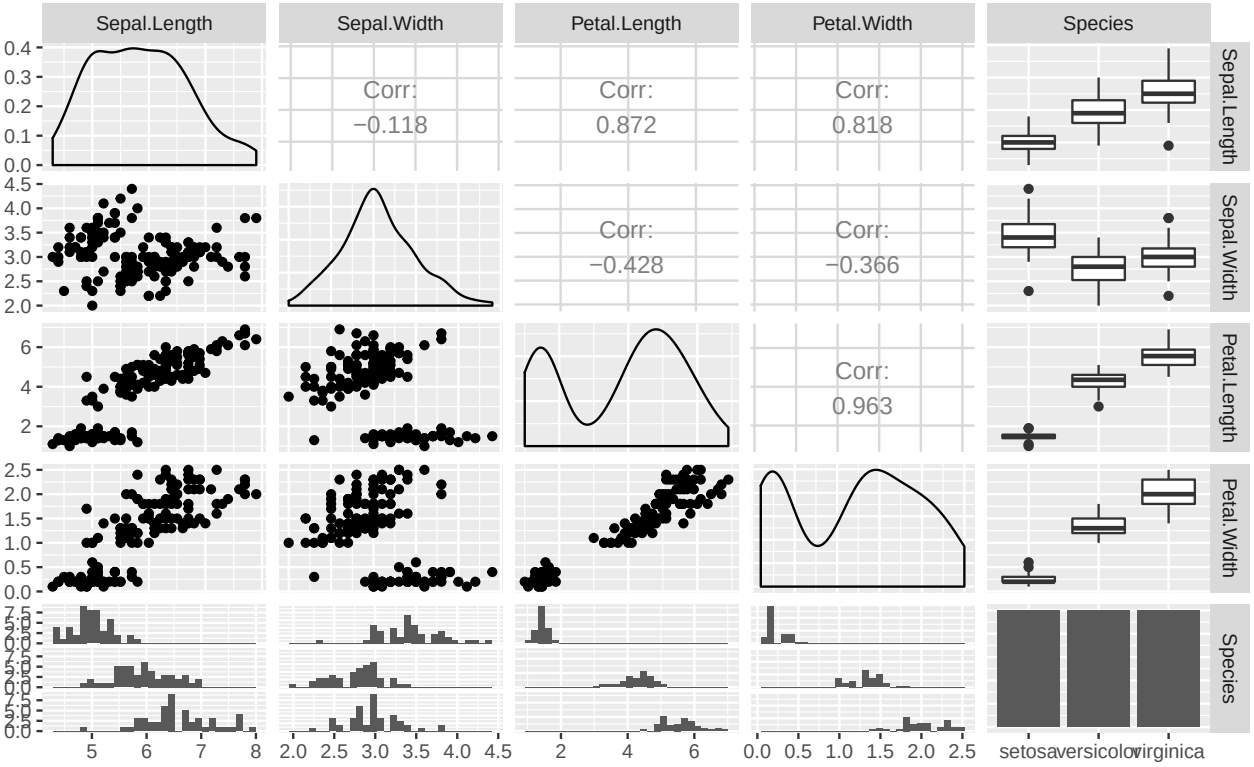


Figure 5.4: (ref:scatter-plot-matrix-1)

```
ggpairs(iris, aes(color = Species, alpha = 0.7)) # ggplot2
```

[4]

5.4

ggplot2 mpg

```
head(mpg) #  6
```

```
## # A tibble: 6 x 11
##   manufacturer model displ  year   cyl trans      drv     cty   hwy fl
##   <chr>        <chr> <dbl> <int> <int> <chr>      <chr> <int> <int> <chr>
## 1 audi         a4      1.8  1999     4 auto(l5)   f        18    29 p
## 2 audi         a4      1.8  1999     4 manual(m5) f        21    29 p
## 3 audi         a4      2    2008     4 manual(m6) f        20    31 p
## 4 audi         a4      2    2008     4 auto(av)   f        21    30 p
## 5 audi         a4      2.8  1999     6 auto(l5)   f        16    26 p
## 6 audi         a4      2.8  1999     6 manual(m5) f        18    26 p
##   class
##   <chr>
## 1 compact
## 2 compact
## 3 compact
```

[4]

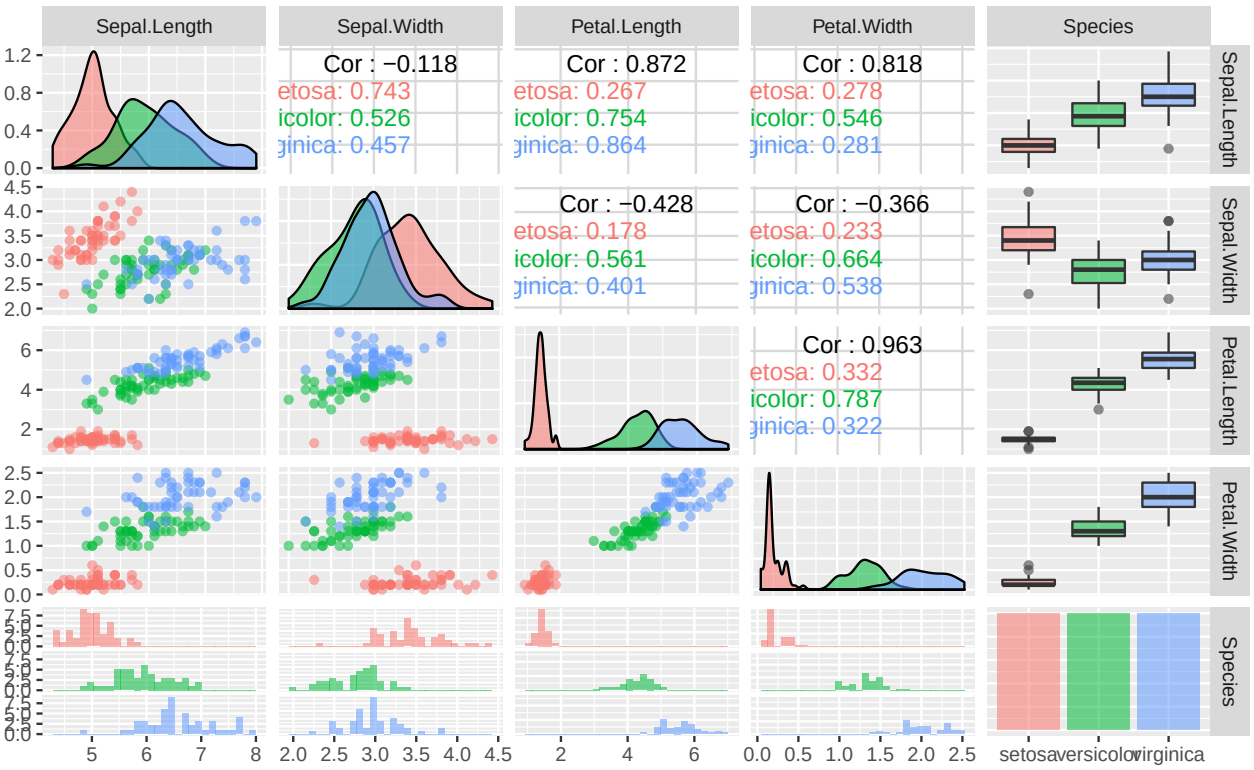


Figure 5.5: Figure 5.4

```
## 4 compact
## 5 compact
## 6 compact
```

- `displ`
- `hwy`
- `cyl` 4, 5, 6, or 8

3 `x displ y hwy color factor(cyl)`

```
ggplot(mpg, aes(displ, hwy, color = factor(cyl))) +
  geom_point()
```

mpg nrow( )

```
nrow(mpg)
```

```
## [1] 234
```

234 Figure 5.6

x y overplotting

7 Chapter 4 jittering

```
ggplot(mpg, aes(displ, hwy, color = factor(cyl))) +
  geom_point(position = position_jitter(width = 0.1, height = 0.4, seed = 1)) #
```

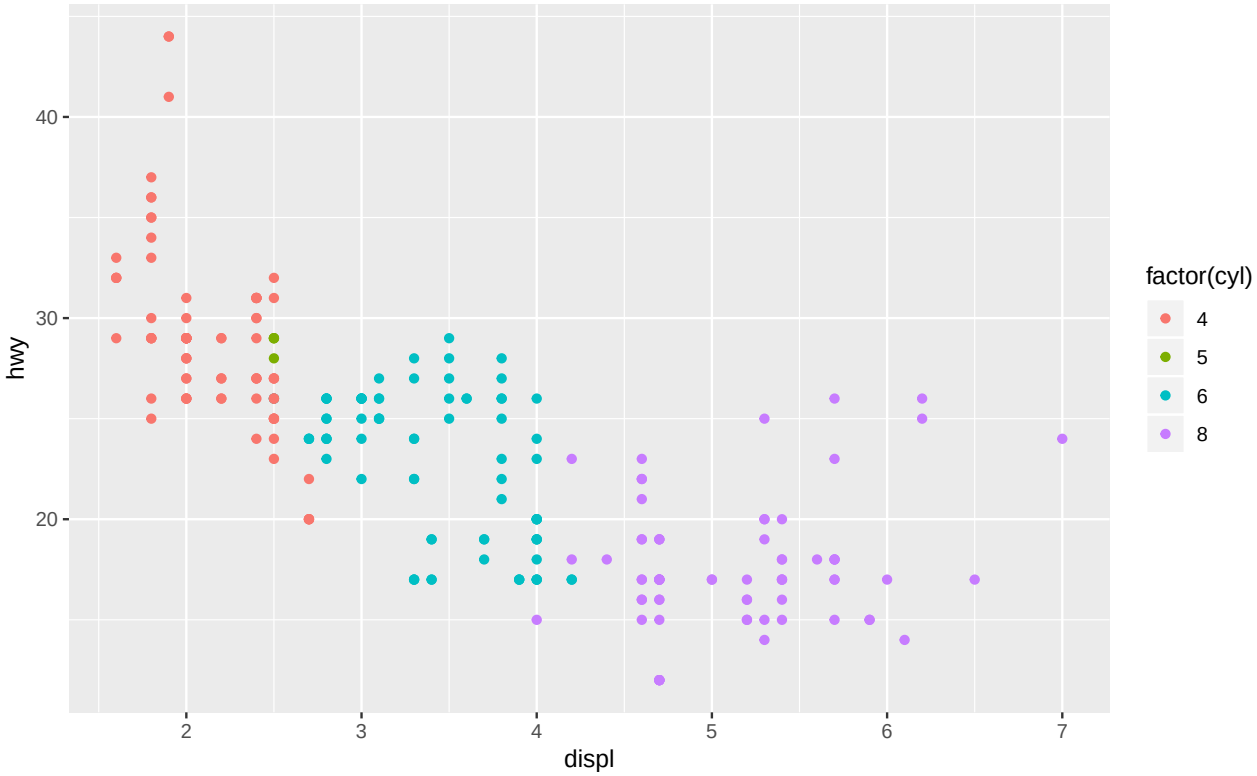


Figure 5.6:

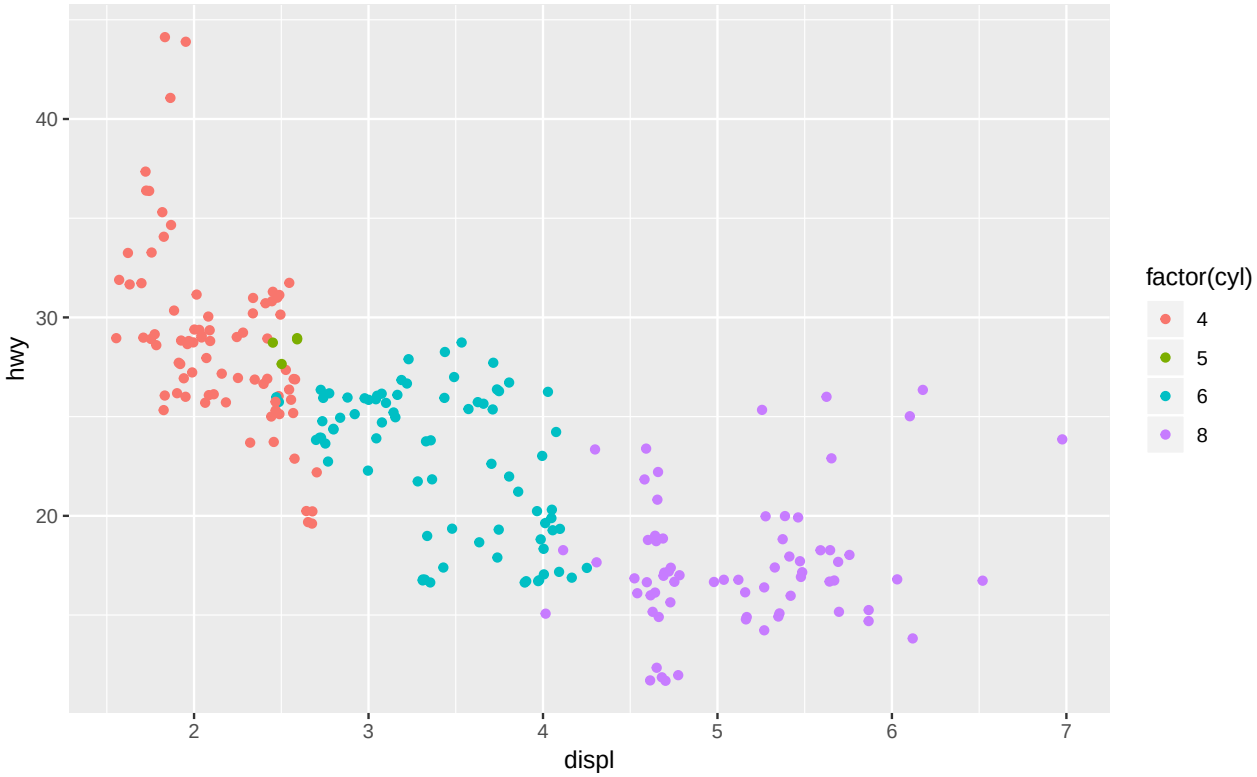


Figure 5.7:

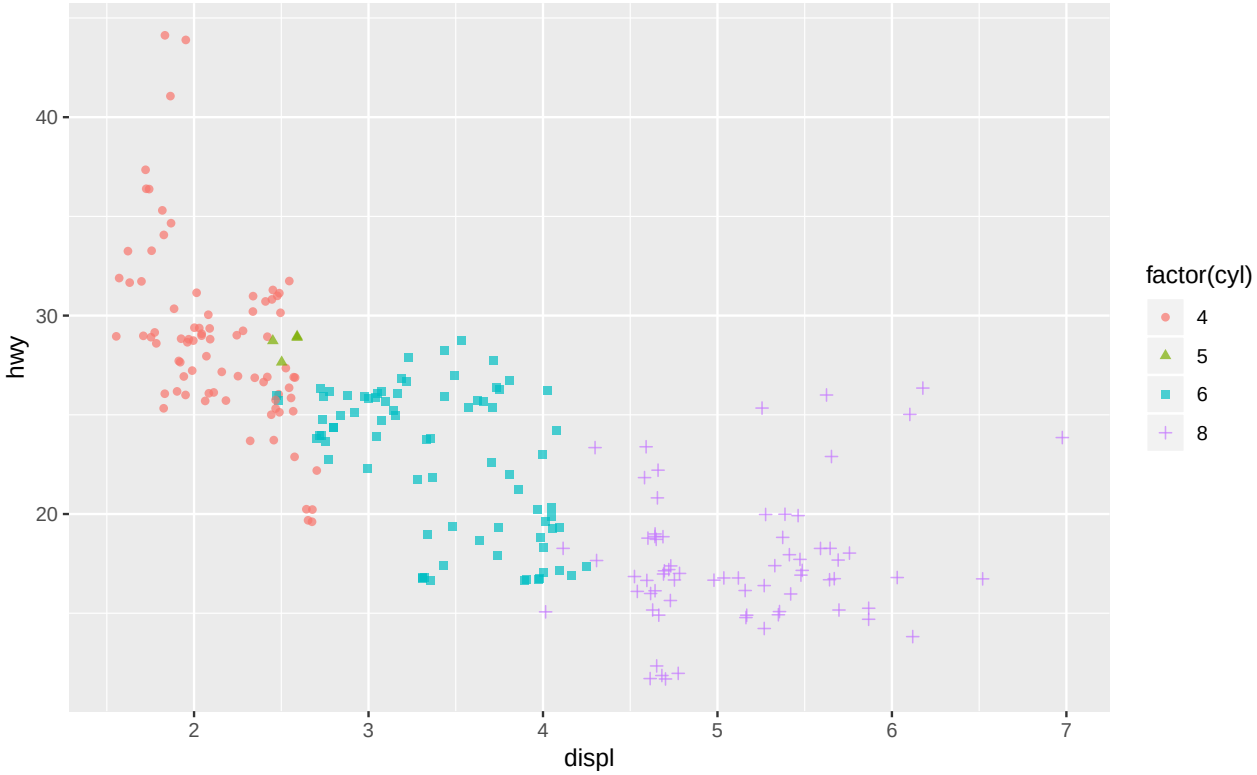


Figure 5.8: Figure 5.7

`position = position_jitter(width = ..., height = ..., seed = ...)` `width` `height`

```
ggplot(mpg, aes(displ, hwy, color = factor(cyl), shape = factor(cyl))) + # shape
  geom_point(position = position_jitter(width = 0.1, height = 0.4, seed = 1), alpha = 0.7) # alpha = 0.
```

5.5

- R `trees` `Girth` `Volume`
- gcookbook `heightweight`

Chapter 6

x line graph

```
library(ggplot2) #
```

6.1

gcookbook `aapl` Apple

```
library(gcookbook) #
```

```
head(aapl) #  6
```

```
##         date adj_price
## 1 1980-12-12  0.023268
## 2 1980-12-19  0.022863
## 3 1980-12-26  0.028731
## 4 1981-01-02  0.027921
## 5 1981-01-09  0.025797
## 6 1981-01-16  0.025089
```

- `date`
- `adj_price`

`geom_line()`

```
ggplot(aapl, aes(date, adj_price)) + # x date y adj_price
  geom_line() #
```

R `BOD` biochemical oxygen demand; BOD [1]

```
head(BOD) # 6
```

```
##   Time demand
## 1    1    8.3
## 2    2   10.3
```

[1] https://ja.wikipedia.org/wiki/

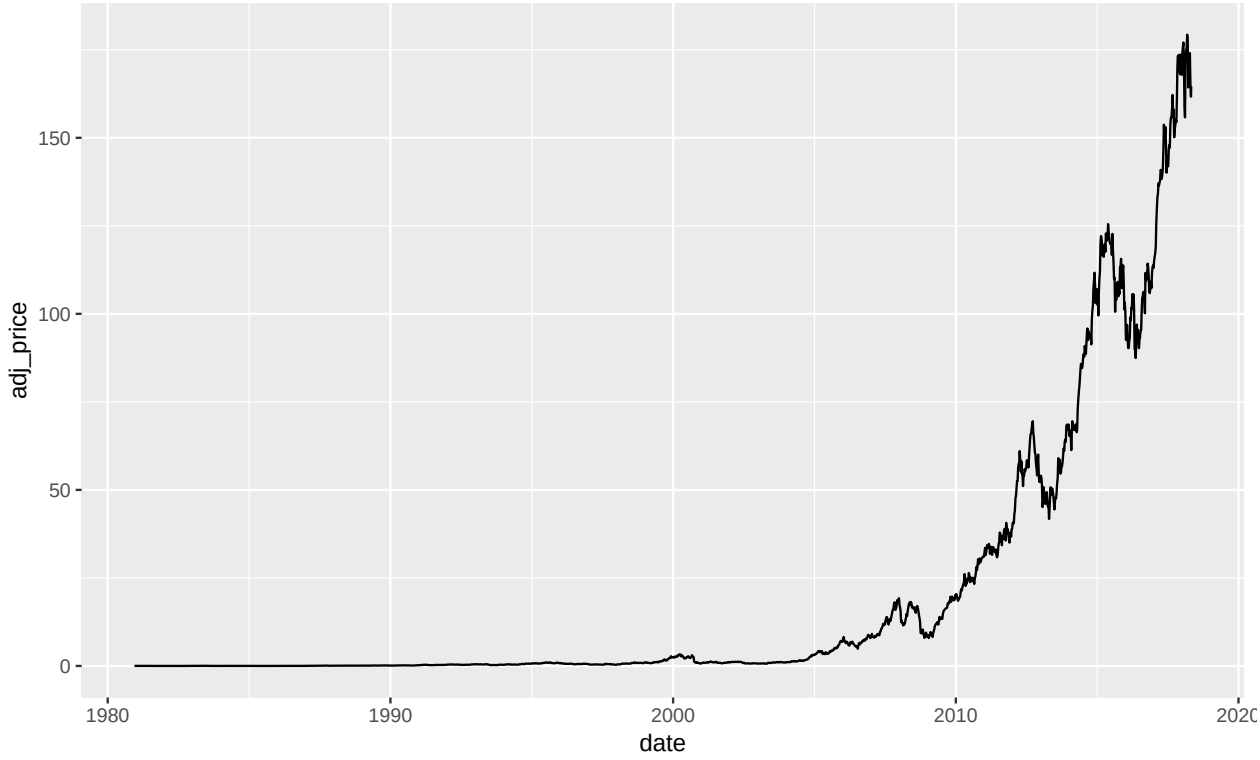


Figure 6.1: Apple

```
## 3    3   19.0
## 4    4   16.0
## 5    5   15.6
## 6    7   19.8
```

x Time y Demand BOD

```
ggplot(BOD, aes(Time, demand)) + # x Time y demand
  geom_line() + #
  geom_point() #
```

geom_point() BOD Figure 6.1

6.2

R ToothGrowth

```
head(ToothGrowth) #  6
```

```
##    len supp dose
## 1  4.2   VC  0.5
## 2 11.5   VC  0.5
## 3  7.3   VC  0.5
## 4  5.8   VC  0.5
## 5  6.4   VC  0.5
## 6 10.0   VC  0.5
```

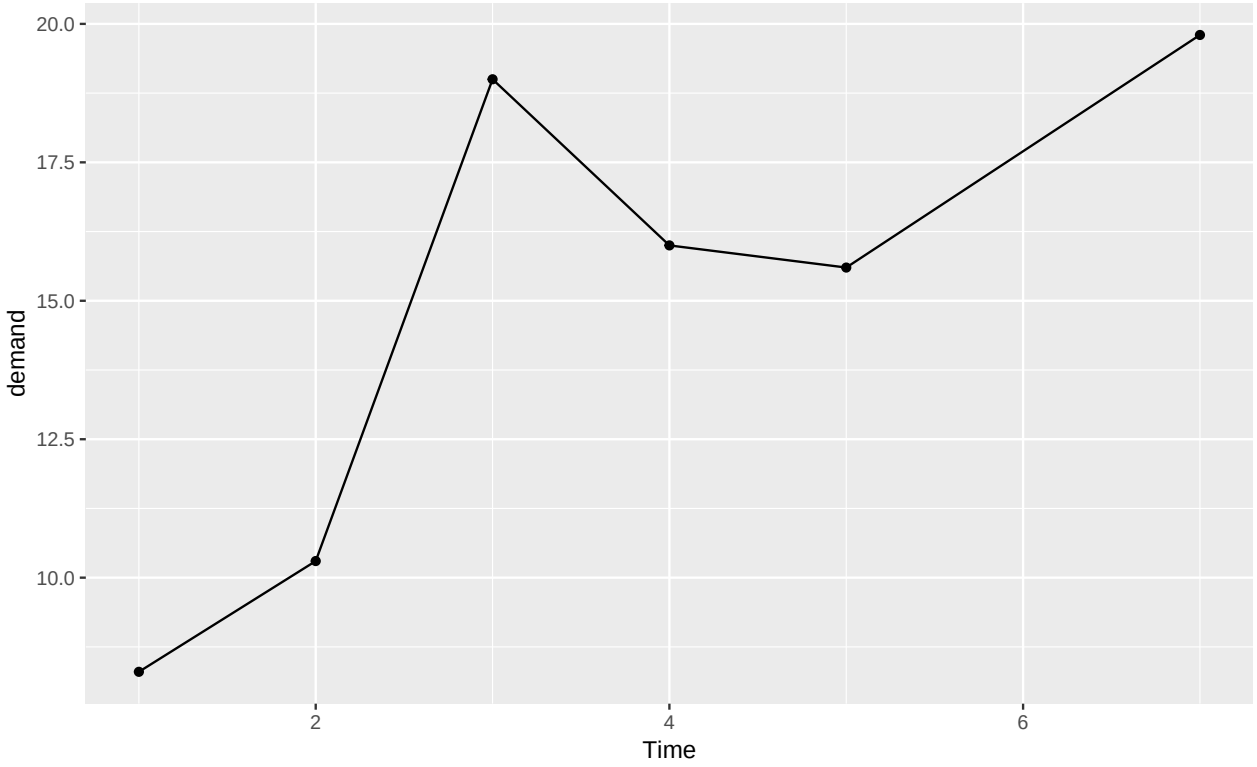


Figure 6.2: BOD

- len
- supp C VC or OJ
- dose C mg

supp dose len ToothGrowth tg_mean [2]

```
library(tidyverse) #
```

```
tg_mean = ToothGrowth %>% # ToothGrowth
  group_by(supp, dose) %>% # supp dose
  summarise(mean = mean(len)) # len

tg_mean
```

```
## # A tibble: 6 x 3
## # Groups:   supp [?]
##   supp   dose  mean
##   <fct> <dbl> <dbl>
## 1 OJ      0.5 13.2
## 2 OJ      1   22.7
## 3 OJ      2   26.1
## 4 VC      0.5  7.98
## 5 VC      1   16.8
## 6 VC      2   26.1
```

mean len

[2] Chapter 9

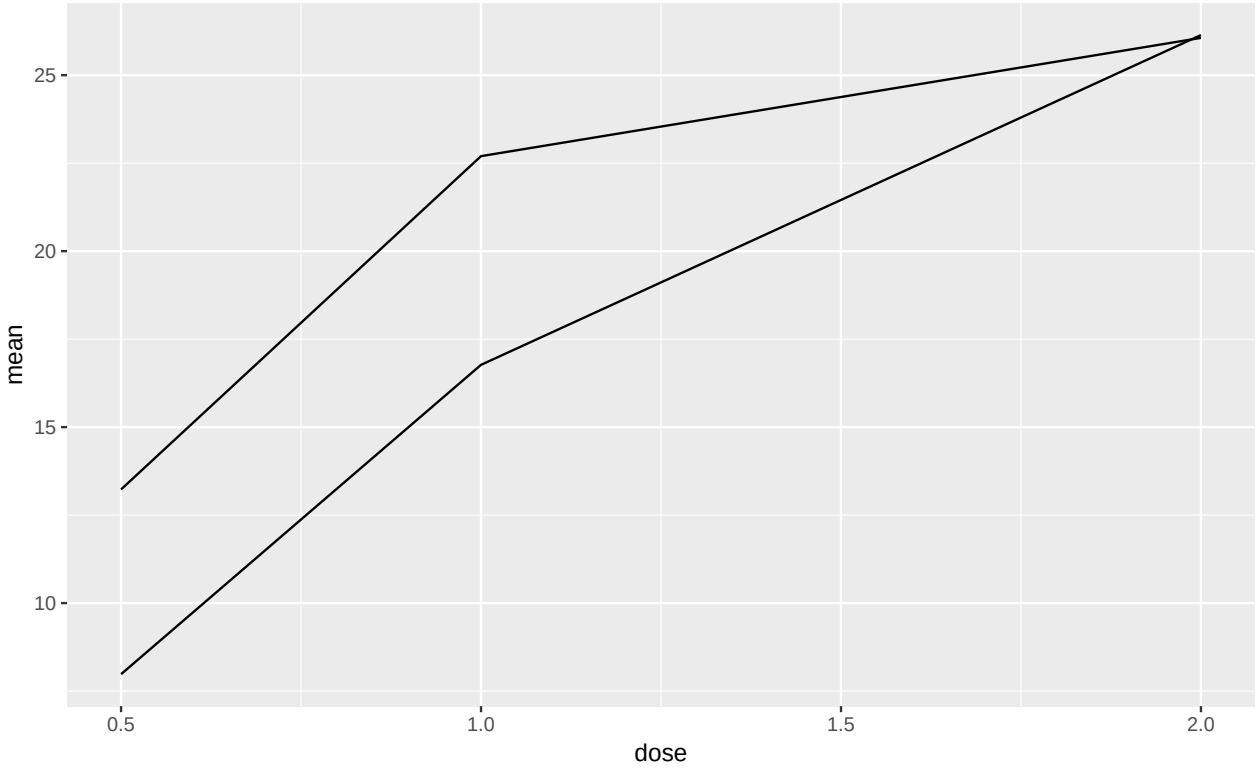


Figure 6.3: supp

supp dose mean

```
ggplot(tg_mean, aes(dose, mean, group = supp)) + # x dose y mean group = supp
  geom_line()
```

supp dose mean geom_line() group

color linetype geom_line() size

Chapter 5 shape geom_point() size

```
ggplot(tg_mean, aes(dose, mean, color = supp, group = supp, linetype = supp, shape = supp)) + # color li
  geom_line(size = 1.5) + # size
  geom_point(size = 5) #      size
```

6.3

area graph; area chart

gcookbook uspopage 1900 2002

```
head(uspopage)
```

```
##   Year AgeGroup Thousands
## 1 1900       <5       9181
## 2 1900     5-14      16966
## 3 1900    15-24      14951
## 4 1900    25-34      12161
```

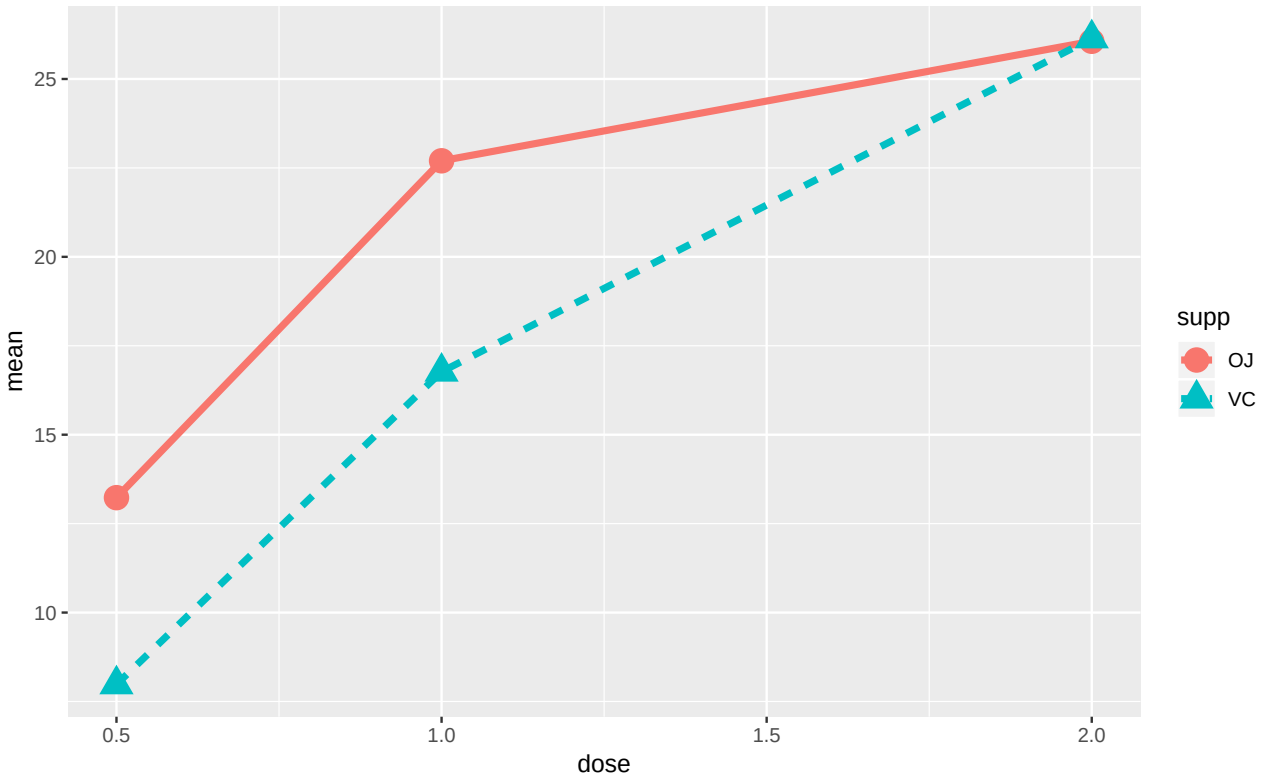


Figure 6.4: Figure 6.3 supp

```
## 5 1900    35-44      9273
## 6 1900    45-54      6437
```

- Year
- AgeGroup
- Thousands

geom_area() fill

```
ggplot(uspopage, aes(Year, Thousands, fill = AgeGroup)) + # x Year y Thousands fill = AgeGroup
  geom_area() #
```

6.4

- ggplot2 economics
- gcookbook worldpop geom_line() geom_point() log10( )

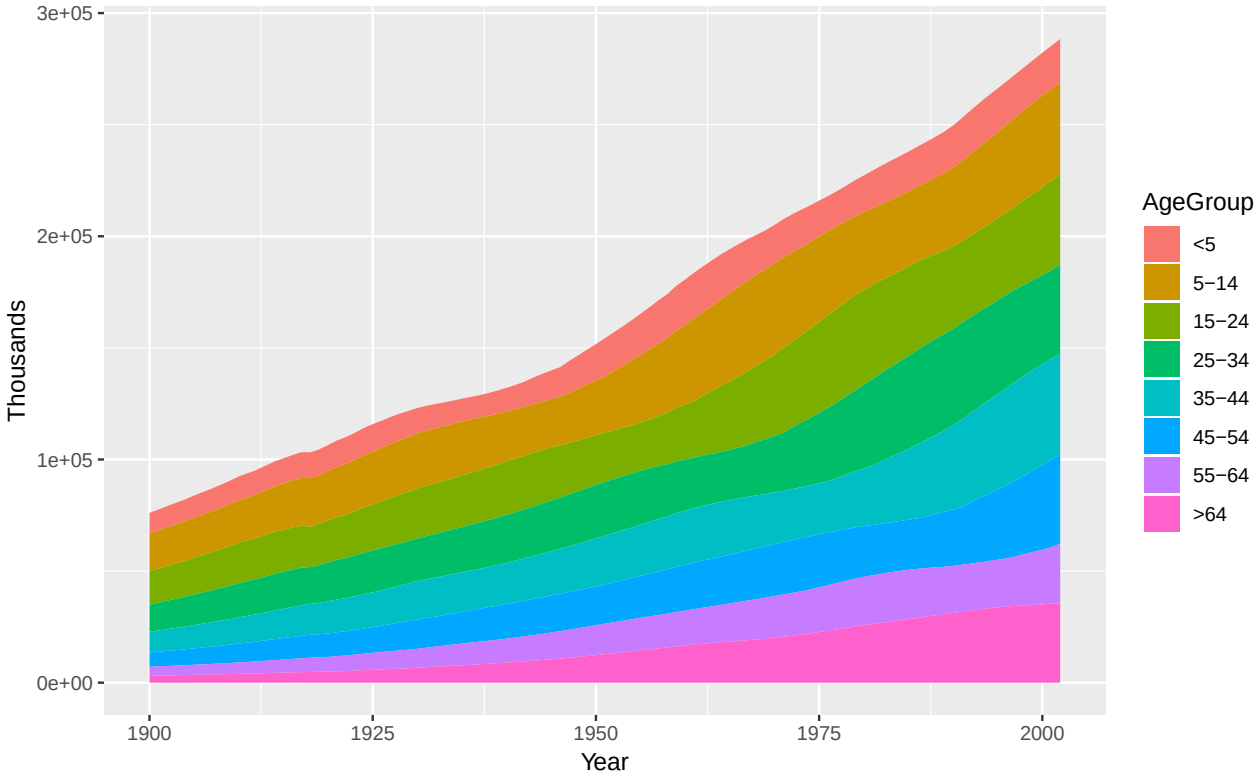

3e+05
2e+05
1e+05
0e+00
Thousands
1900
1925
1950
1975
2000
Year
AgeGroup
<5
5–14
15–24
25–34
35–44
45–54
55–64
>64

Figure 6.5:

Chapter 7

```
library(ggplot2) #
```

7.1

error bar standard error of the mean; *SEM*[1]

gcookbook `cabbage_exp`

```
library(gcookbook) #
```

```
head(cabbage_exp) #6
```

```
##   Cultivar Date Weight        sd  n         se
## 1      c39  d16   3.18 0.9566144 10 0.30250803
## 2      c39  d20   2.80 0.2788867 10 0.08819171
## 3      c39  d21   2.74 0.9834181 10 0.31098410
## 4      c52  d16   2.26 0.4452215 10 0.14079141
## 5      c52  d20   3.11 0.7908505 10 0.25008887
## 6      c52  d21   1.47 0.2110819 10 0.06674995
```

- `Cultivar` c39 or c52
- `Date`
- `Weight`
- `se`

(ref:errorbar-1)

```
ggplot(cabbage_exp, aes(Date, Weight, fill = Cultivar)) + # x Date y Weight Cultivar
  geom_bar(stat = "identity", position = "dodge") + #
  geom_errorbar(aes(ymin = Weight - se, ymax = Weight + se), position = position_dodge(width = 0.9), wi
```

[1] structural equation modeling; SEM

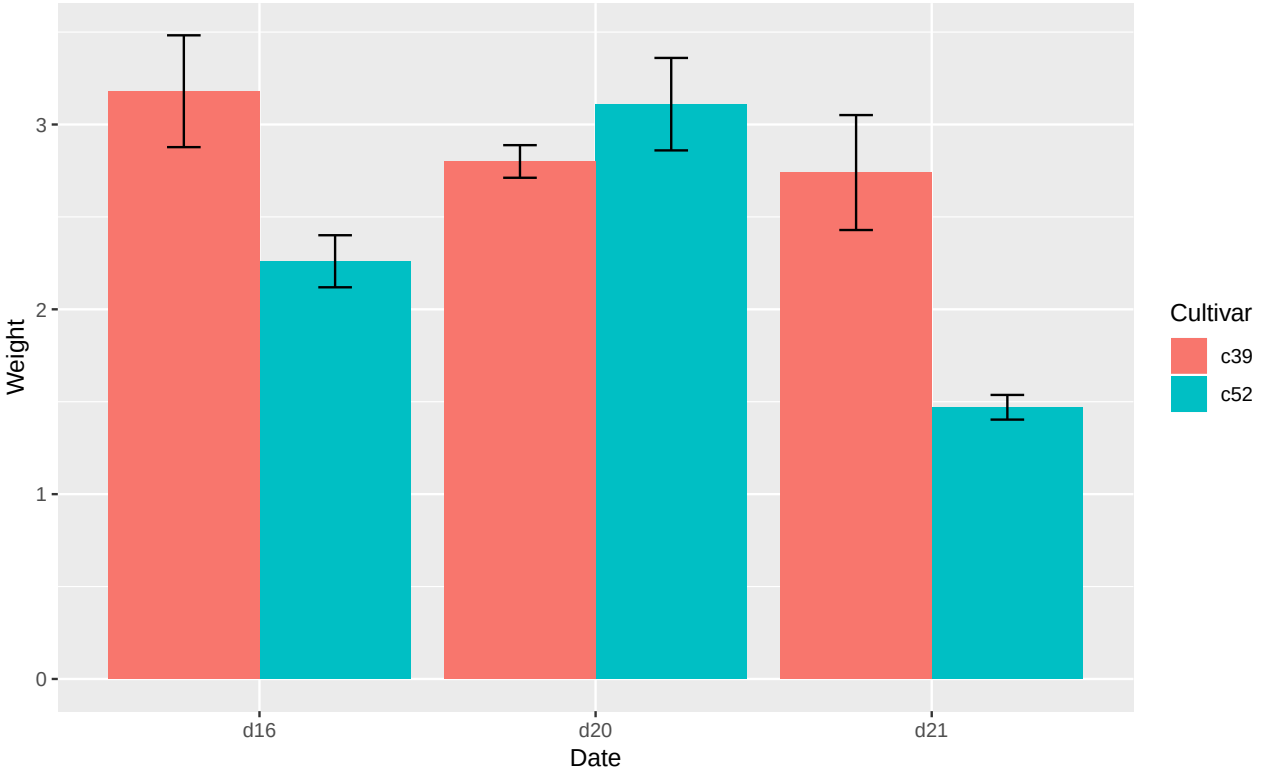


Figure 7.1: (ref:errorbar-1)

0. `ggplot(cabbage_exp, aes(Date, Weight, fill = Cultivar)`
   - x `Date` y `Weight` `Cultivar`
1. `geom_bar(stat = "identity", position = "dodge")`
   - `stat = "identity"` `Cultivar` `position = "dodge"`
   - Chapter 3
2. `geom_errorbar(aes(ymin = Weight - se, ymax = Weight + se), position = position_dodge(width = 0.9), width = 0.2)`
   - `ymin` `ymax` y
   - `position = position_dodge(width = 0.9)` 0.9 `width` 0.9 [2]
   - `width`

95% 95% confidence interval; 95% CI

7.2

`geom_errorbar()` `geom_ribbon()` gcookbook `climate`

```
head(climate)
```

```
##     Source Year Anomaly1y Anomaly5y Anomaly10y Unc10y
```

[2] `position = "dodge"` `position = position_dodge()`

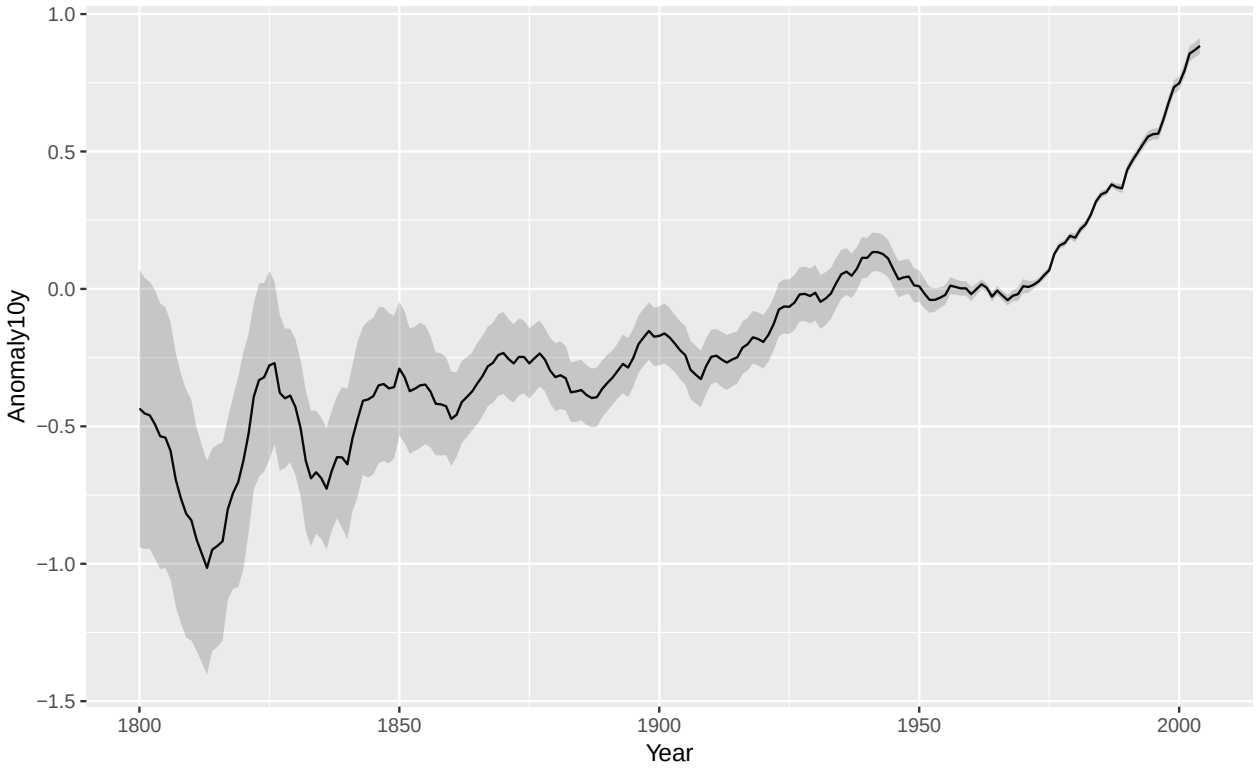


Figure 7.2: 95%

```
## 1 Berkeley 1800        NA        NA     -0.435  0.505
## 2 Berkeley 1801        NA        NA     -0.453  0.493
## 3 Berkeley 1802        NA        NA     -0.460  0.486
## 4 Berkeley 1803        NA        NA     -0.493  0.489
## 5 Berkeley 1804        NA        NA     -0.536  0.483
## 6 Berkeley 1805        NA        NA     -0.541  0.475
```

Source "Berkeley" clim

```
library(tidyverse) #
```

```
clim = climate %>% # climate
  filter(Source == "Berkeley") # Source "Berkeley"
```

- Year
- Anomaly10y 1951 1980
- Unc10y 95%

geom_ribbon() geom_errorbar() alpha

```
ggplot(clim, aes(Year, Anomaly10y)) +
  geom_line() +
  geom_ribbon(aes(ymin = Anomaly10y - Unc10y, ymax = Anomaly10y + Unc10y), alpha = 0.2) # alpha
```

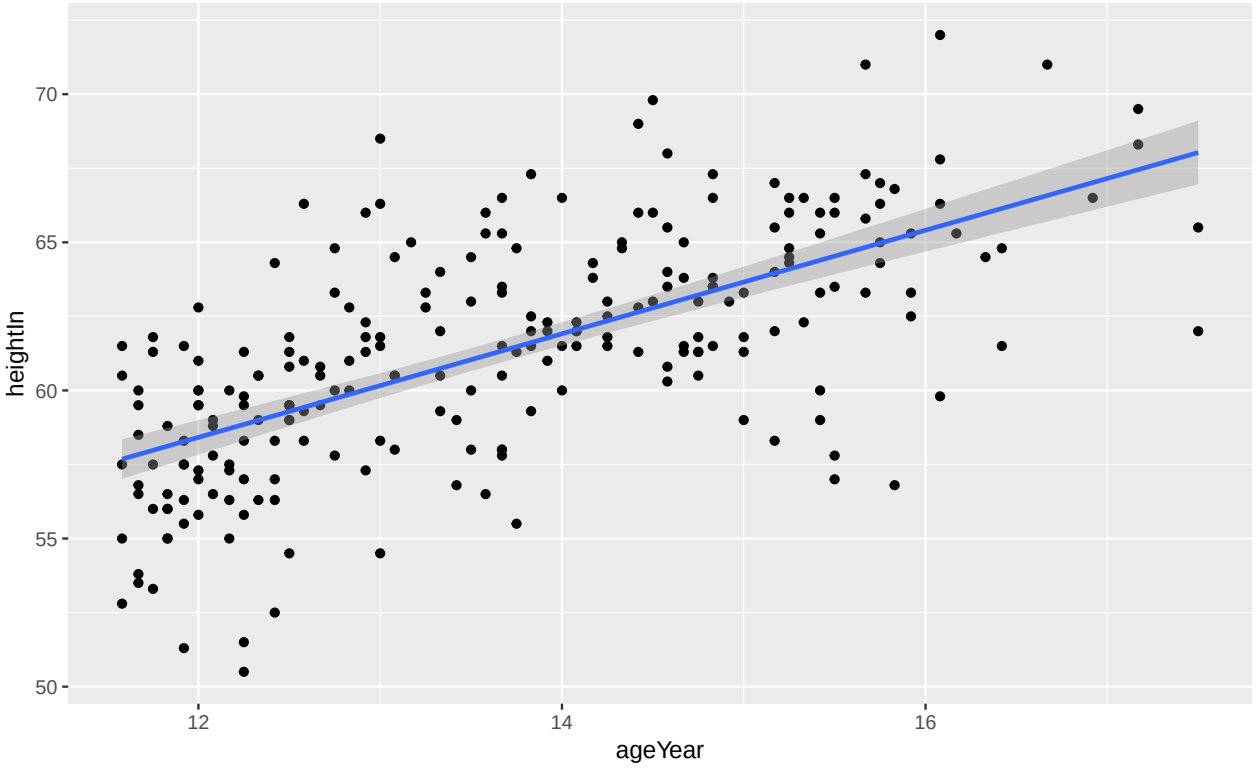


Figure 7.3: (ref:smooth-plot-1)

7.3

ggplot2 gcookbook `heightweight`

```
head(heightweight) #  6
```

```
##   sex ageYear ageMonth heightIn weightLb
## 1   f   11.92      143     56.3     85.0
## 2   f   12.92      155     62.3    105.0
## 3   f   12.75      153     63.3    108.0
## 4   f   13.42      161     59.0     92.0
## 5   f   15.92      191     62.5    112.5
## 6   f   14.25      171     62.5    112.0
```

`geom_point()` `heightIn` `WeightLb` `geom_smooth()` `method = lm` LOESS [3]
R `lm` linear model

(ref:smooth-plot-1) 95%

```
ggplot(heightweight, aes(ageYear, heightIn)) +
  geom_point() + #
  geom_smooth(method = lm) #      method = lm
```

`fill`

(ref:smooth-plot-2) 95%

[3] https://en.wikipedia.org/wiki/Local_regression

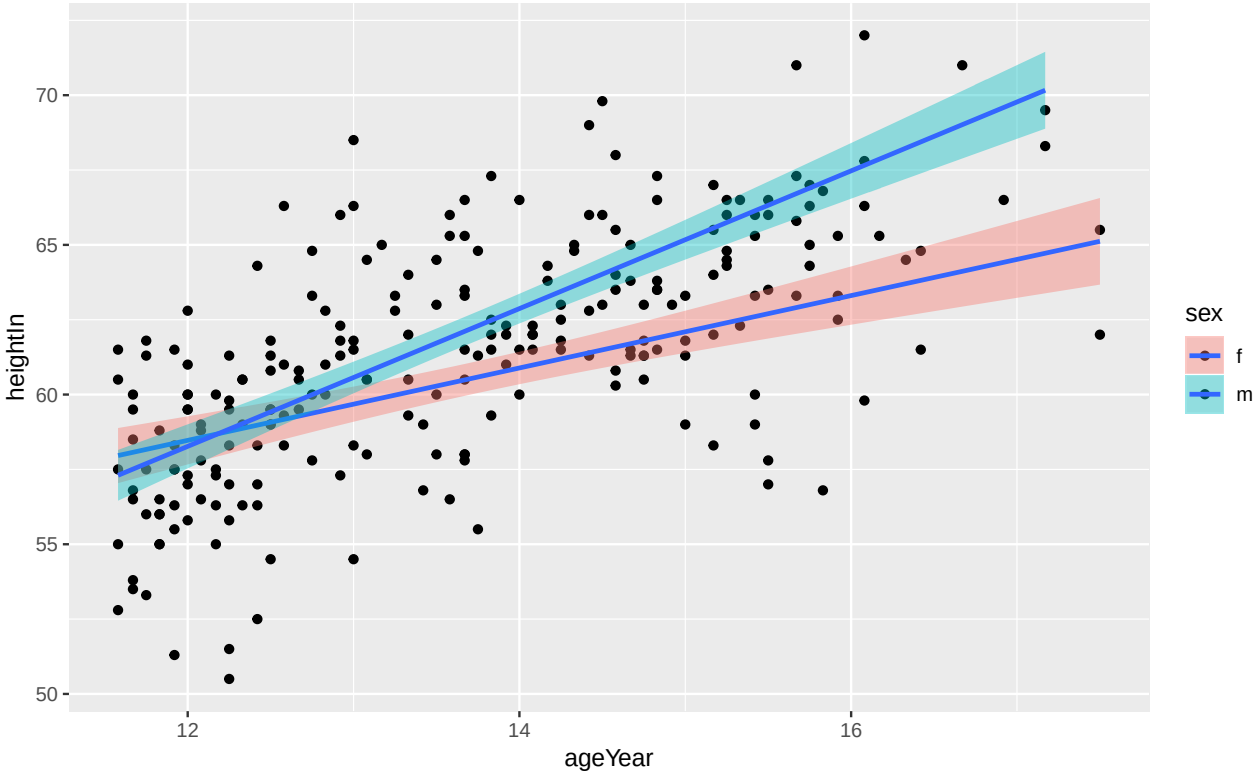


Figure 7.4: (ref:smooth-plot-2)

```
ggplot(heightweight, aes(ageYear, heightIn, fill = sex)) + # fill = sex
  geom_point() +
  geom_smooth(method = lm)
```

Google

7.4

- Figure 7.1 `cabbage_exp`
- R `faithful`

Chapter 8

ggplot2

```
library(ggplot2) #
```

8.1

[1] Figure 3.5 Cleveland x y ggplot2

coord_flip() coordination flip

Figure 3.3 diamonds cut coord_flip()

```
ggplot(diamonds, aes(cut)) + # x cut y
  geom_bar() + #             stat = "identity"
  coord_flip() #
```

8.2 Small multiple

1 Small multiple[2] Small multiple facet_grid() facet_wrap()

Chapter 5 mpg Figure 5.6 drv cyl facet_grid(~)

(ref:facet-1) facet_grid()

```
ggplot(mpg, aes(displ, hwy)) +
  geom_point() +
  facet_grid(drv ~ cyl) # drv   cyl
```

---

facet_wrap() 2 drv cyl nrow ncol

```
ggplot(mpg, aes(displ, hwy)) +
  geom_point() +
  facet_wrap(drv ~ cyl) #
```

facet_grid() facet_wrap() 1 ?facet_grid() ?facet_wrap()

[1] ……

[2] https://en.wikipedia.org/wiki/Small_multiple

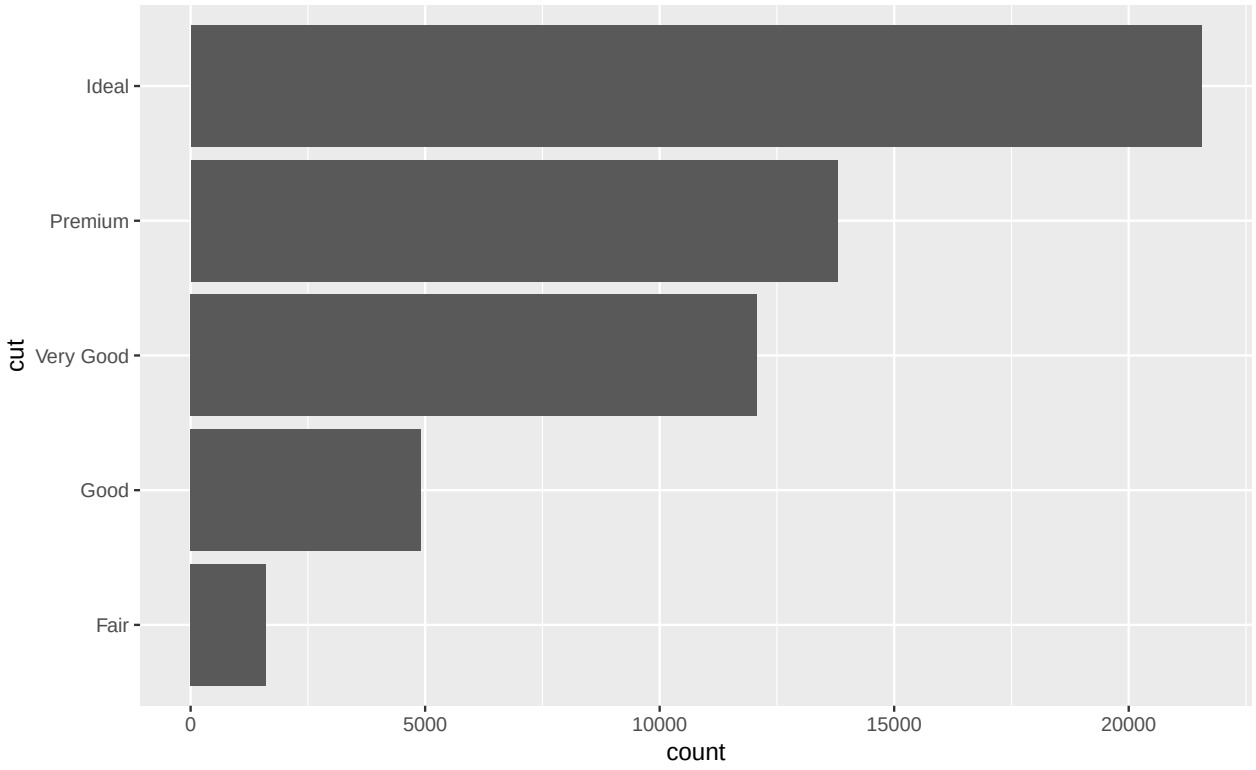


Figure 8.1: Figure 3.3

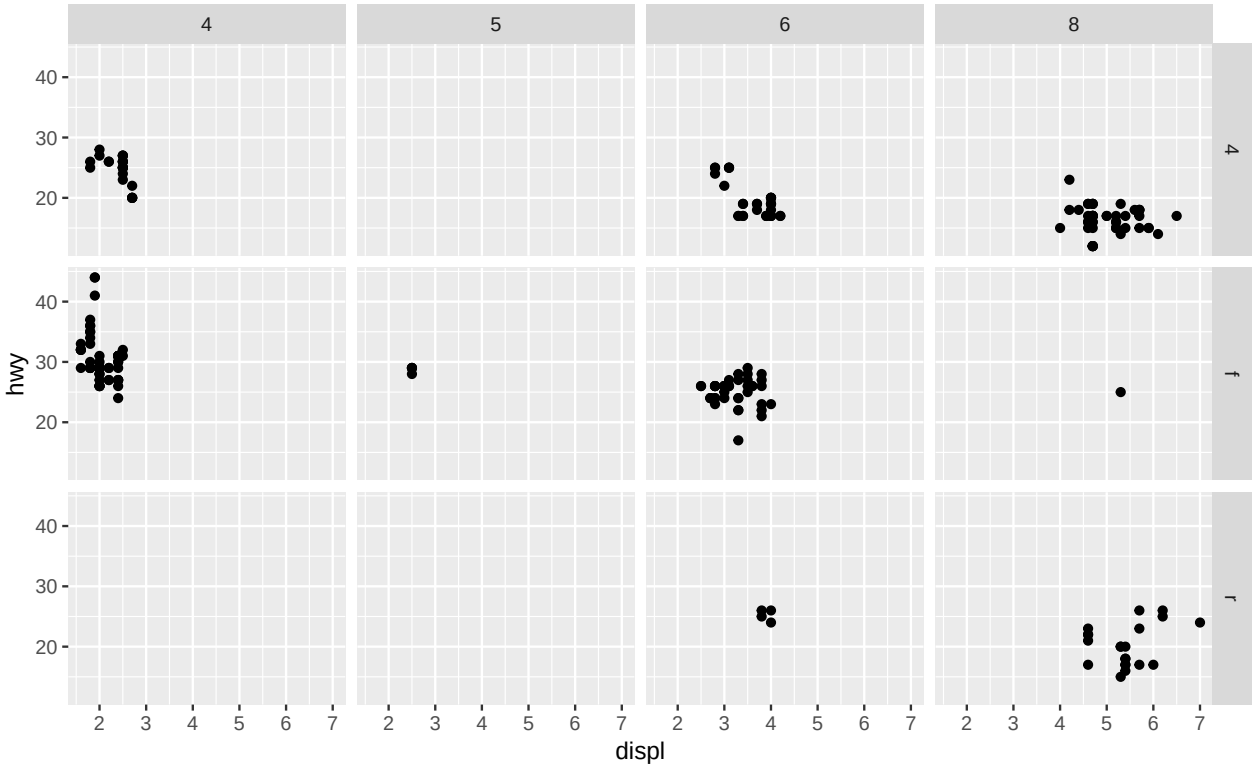


Figure 8.2: (ref:facet-1)

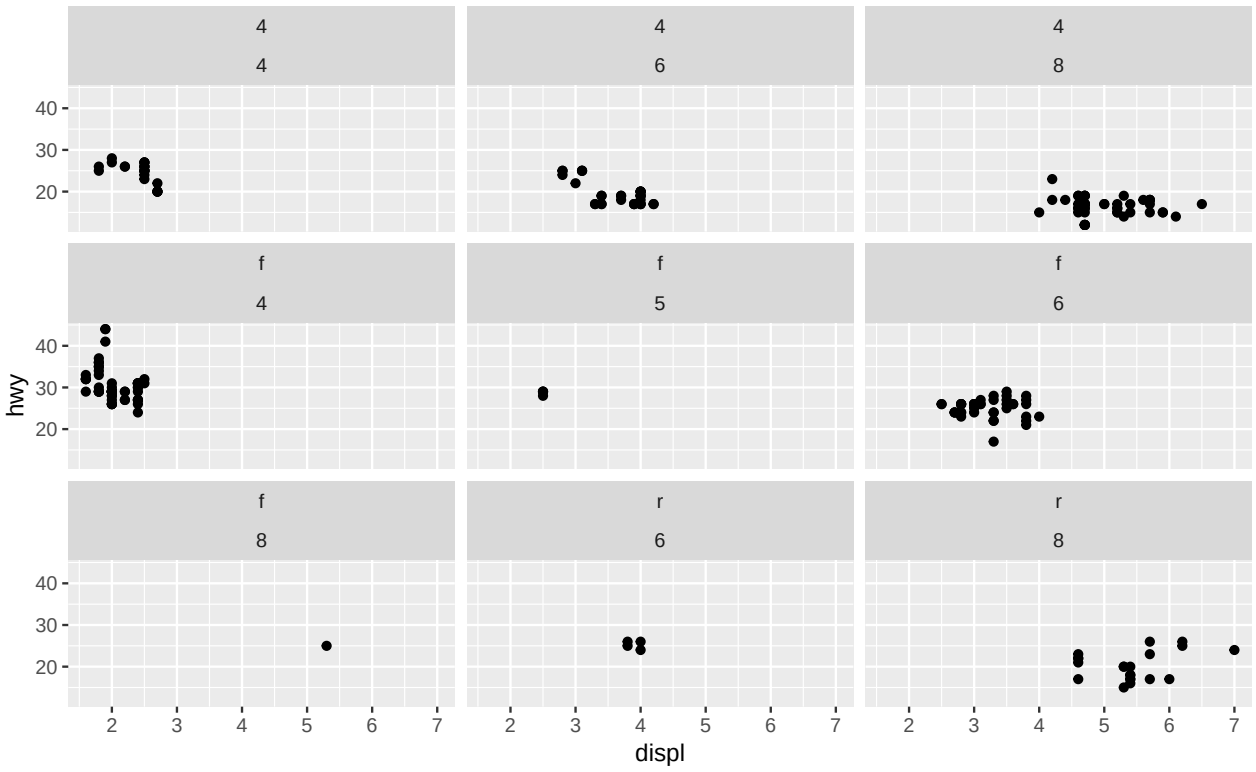


Figure 8.3: `facet_wrap()` Figure 8.2

8.3

`theme_xxxx()` `theme_gray()` ggplot2

```
ggplot(mtcars, aes(wt, mpg)) +
  geom_point() +
  theme_gray()
```

`theme_bw()` `theme_classic()`

```
ggplot(mtcars, aes(wt, mpg)) +
  geom_point() +
  theme_bw()
```

```
ggplot(mtcars, aes(wt, mpg)) +
  geom_point() +
  theme_classic()
```

https://ggplot2.tidyverse.org/reference/ggtheme.html

8.4

`fill` `color` ggplot2

`scale_color_manual()` `color` [3] `fill` `scale_fill_manual()`

[3] Figure 8.7 NG

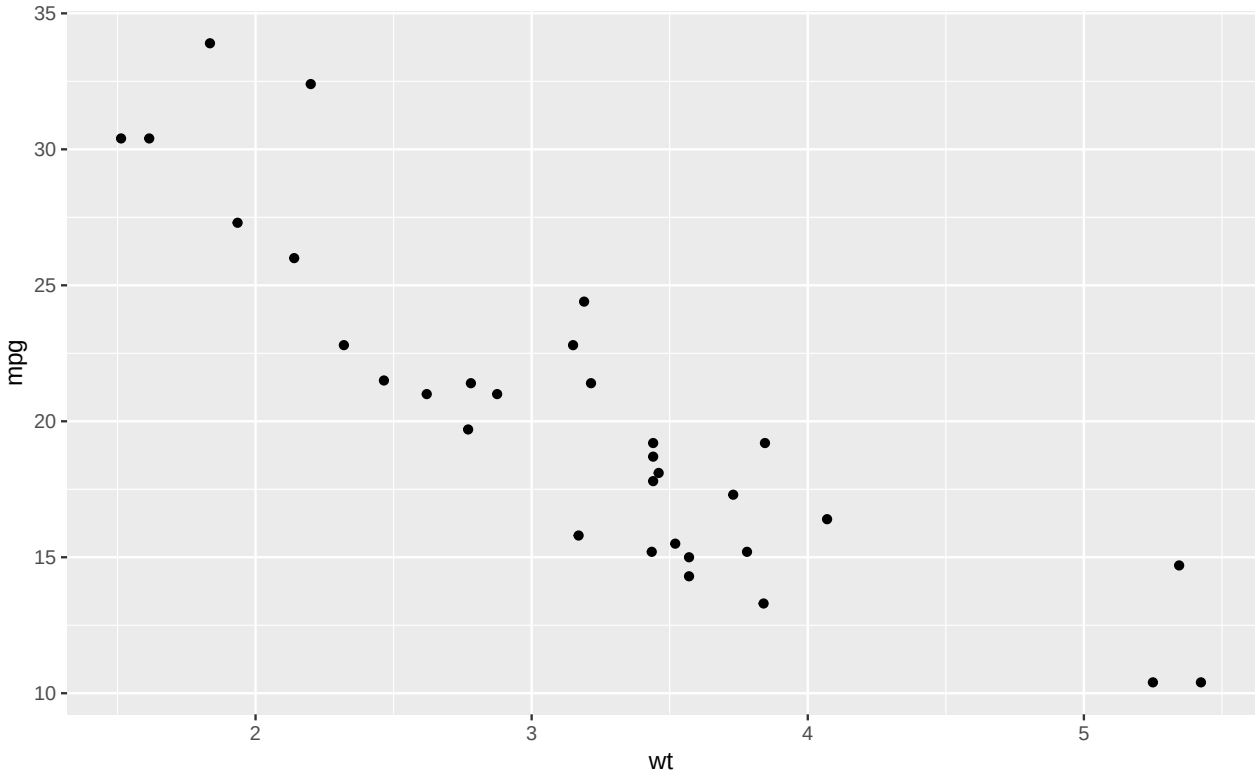


Figure 8.4: `theme_gray()`

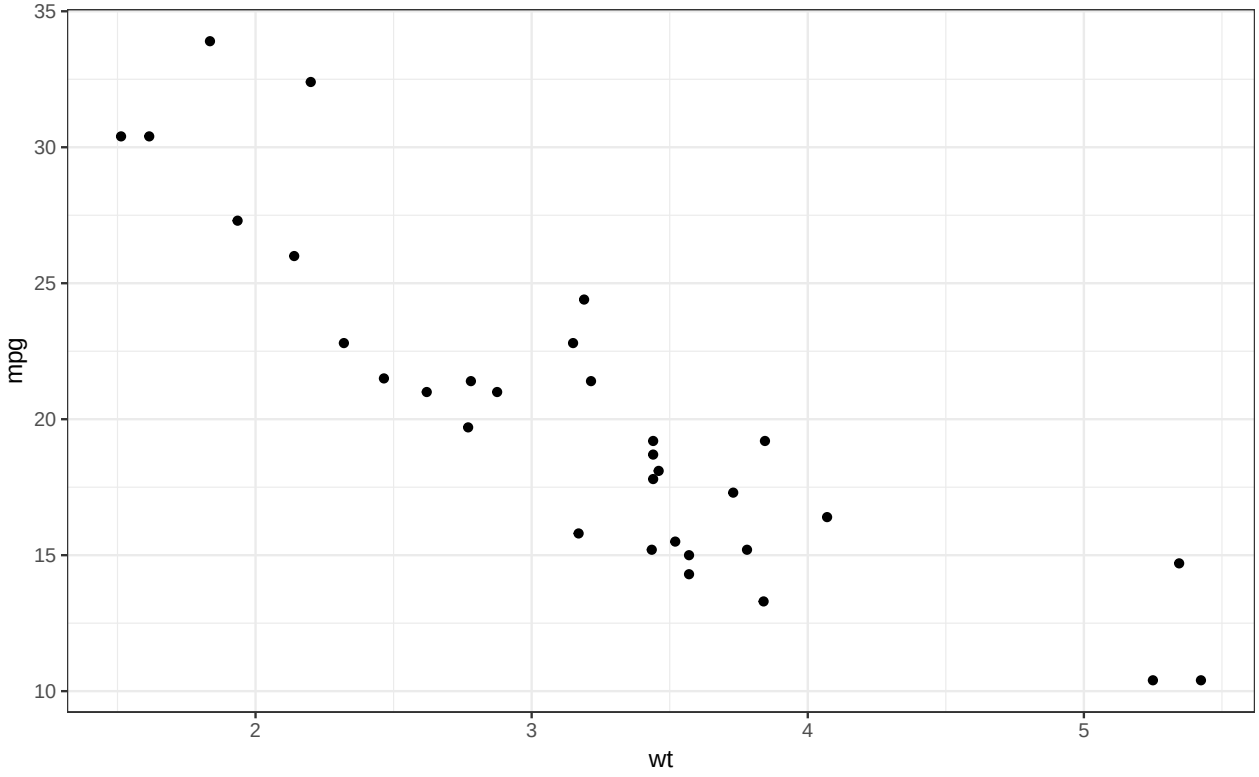


Figure 8.5: `theme_bw()`

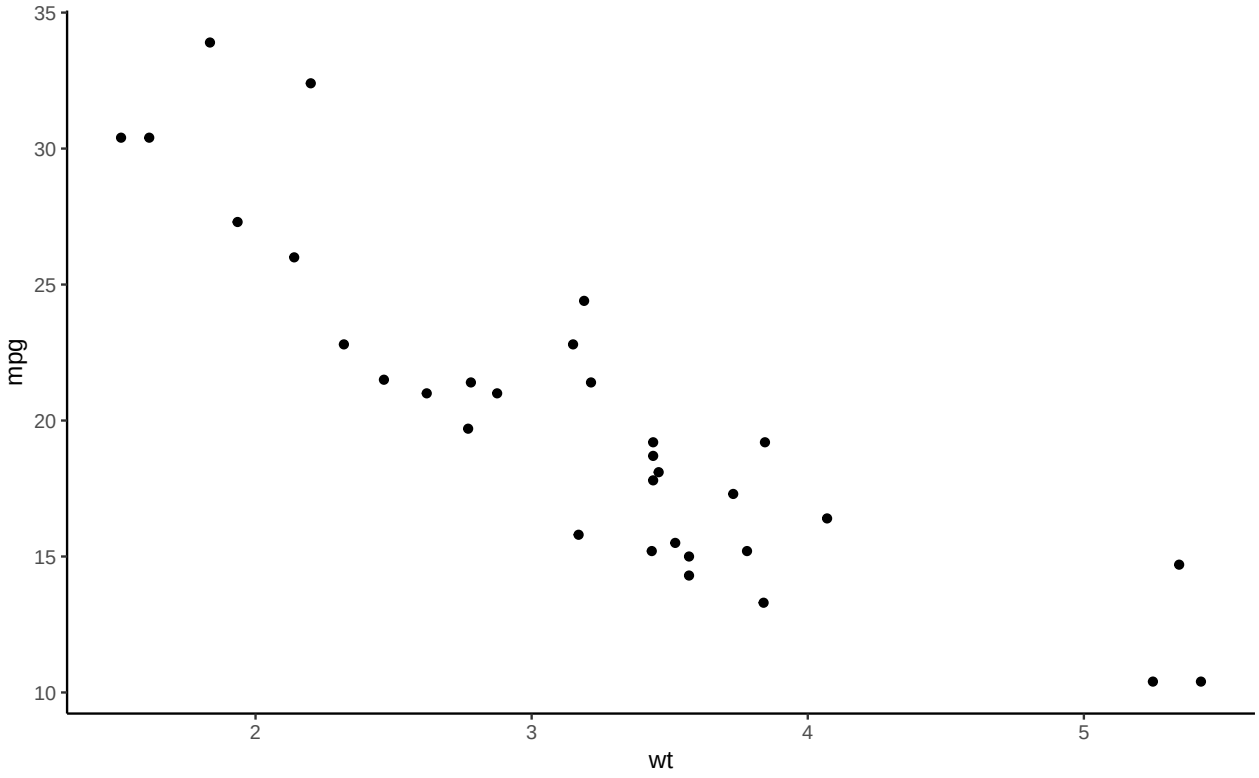


Figure 8.6: `theme_classic()`

```
ggplot(mtcars, aes(wt, mpg, color = factor(cyl))) +
  geom_point() +
  scale_color_manual(values = c("red","blue","green")) #
```

ggplot2 colorspace [4]

8.5

data exploration **data presentation** [5]

`labs()` `Title` `Subtitle`

(ref:label-1) `labs()`

```
ggplot(mtcars, aes(wt, mpg, color = factor(cyl))) +
  geom_point() +
  labs(x = "Weight (1,000 lbs)",
       y = "Miles/(US) gallon",
       title = "Title",
       subtitle = "Subtitle",
       caption = "Caption",
       tag = "Tag")
```

[4]
[5]

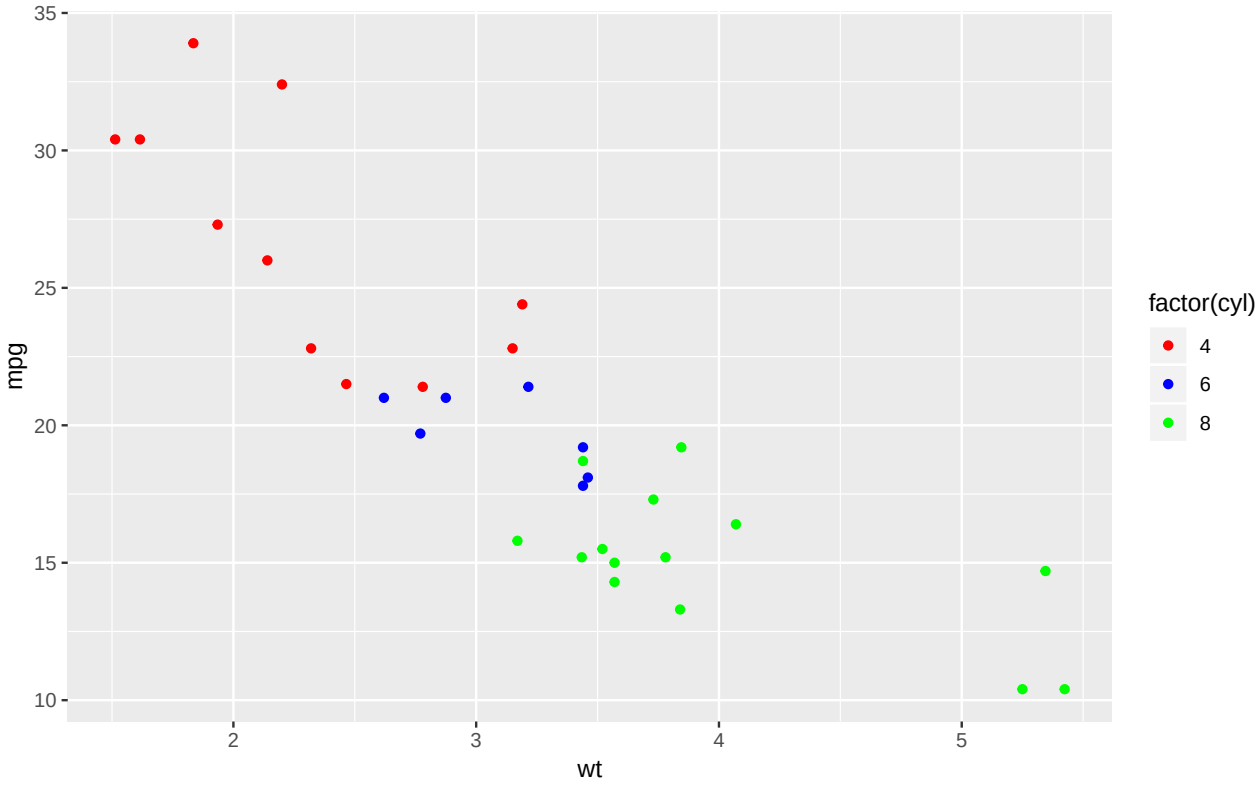


Figure 8.7: `scale_color_manual()`

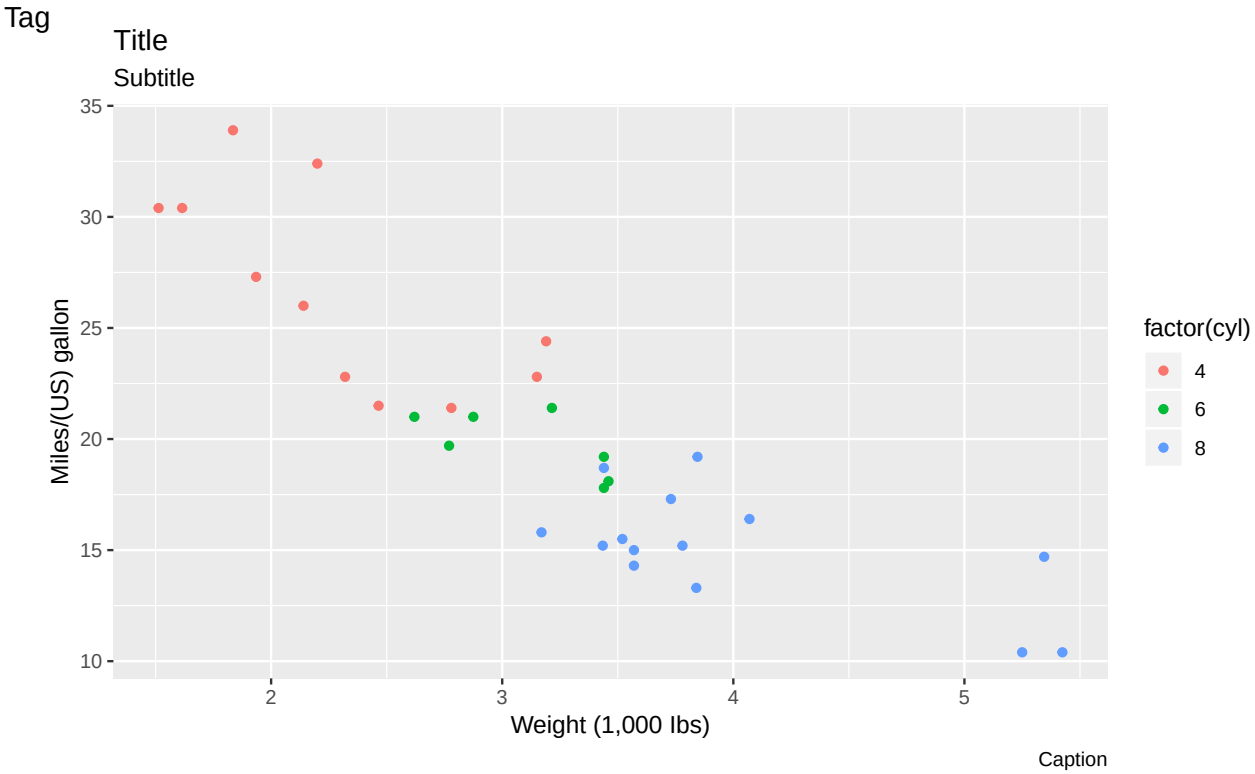


Figure 8.8: (ref:label-1)

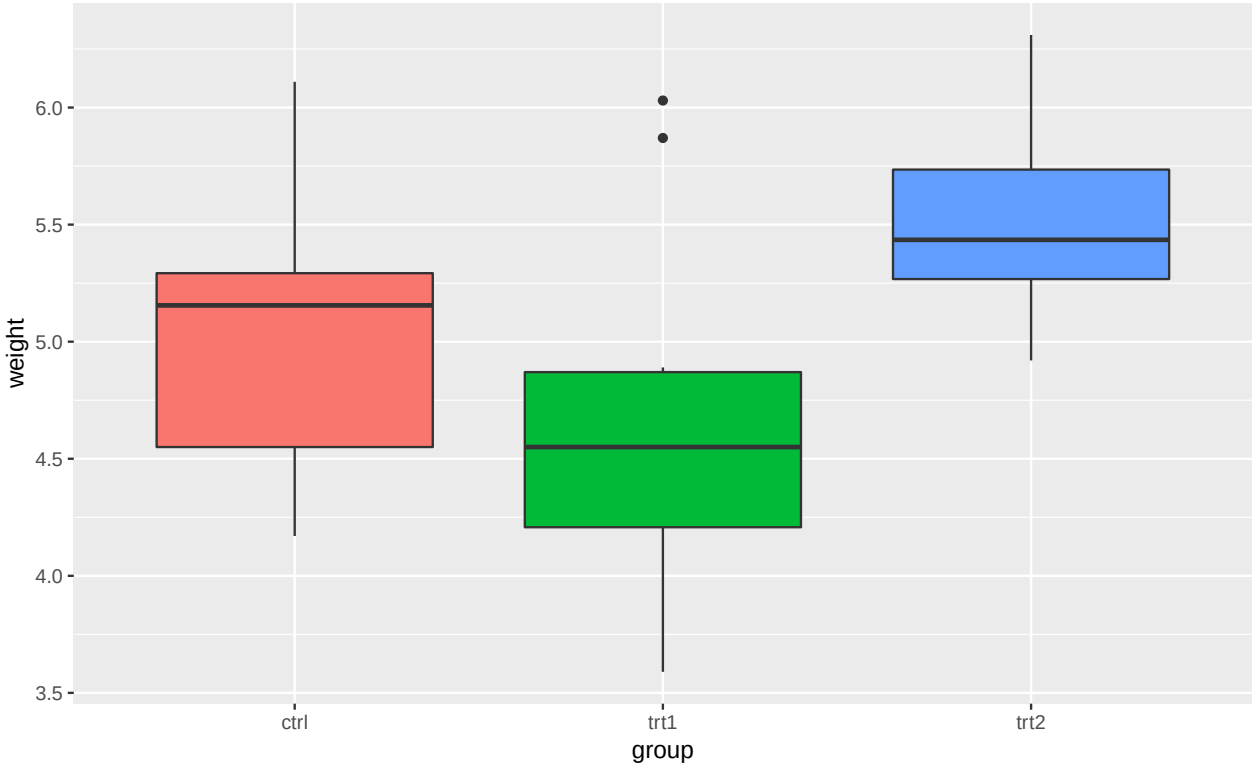


Figure 8.9:

8.6

Figure 4.12

```
ggplot(PlantGrowth, aes(group, weight, fill = group)) + # x group y weight fill
  geom_boxplot() + #
  guides(fill = FALSE) #     fill
```

8.7

1 patchwork patchwork

```
library(devtools)
install_github("thomasp85/patchwork") #
```

```
library(patchwork) #
```

patchwork

```
#    a panel_a
panel_a = ggplot(mtcars, aes(wt, mpg, color = factor(cyl))) +
  geom_point()

#    b panel_b
panel_b = ggplot(mtcars, aes(wt, disp, color = factor(cyl))) +
  geom_point()
```

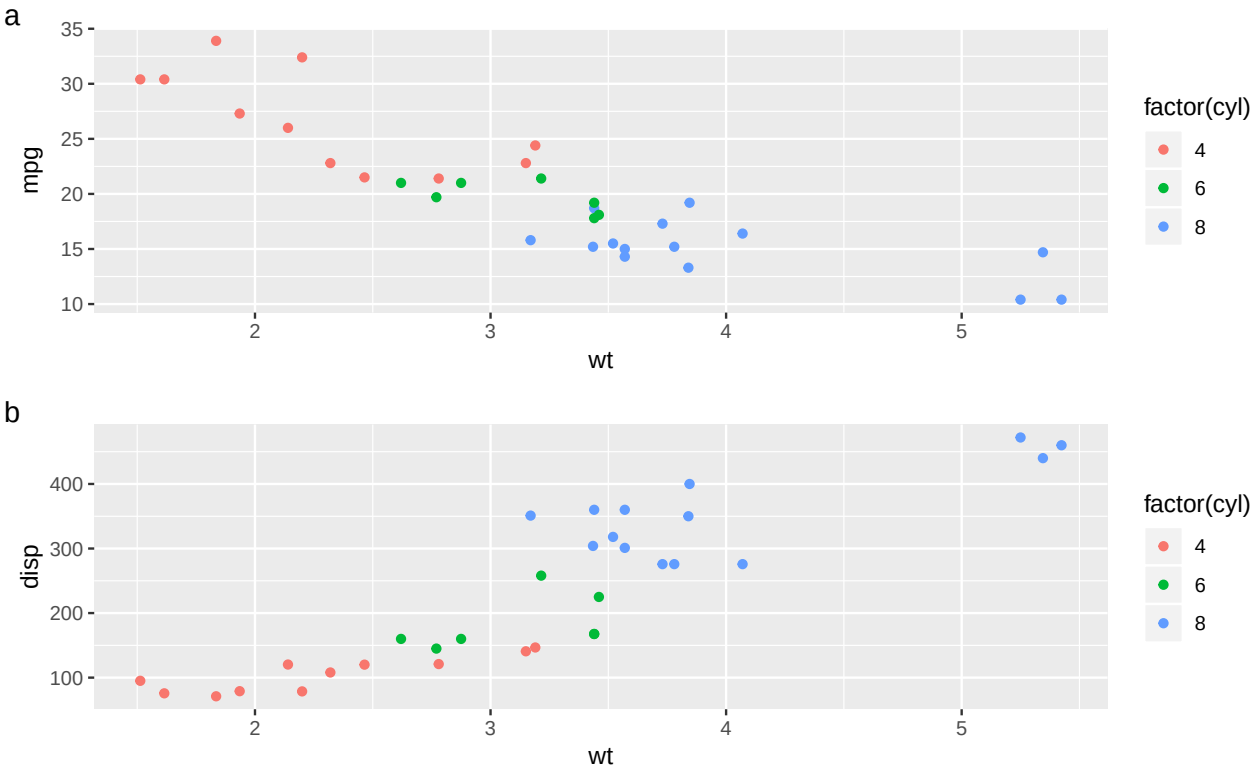


Figure 8.10: 2

```
# 2    1    panel_ab   1    ncol = 1
panel_ab = panel_a + panel_b +
  plot_layout(ncol = 1) +
  plot_annotation(tag_levels = "a") #

panel_ab
```

8.8

panel_ab “panel_ab.pdf” ggsave(" ", plot = , width = , height = , units = " ")

```
ggsave("panel_ab.pdf", plot = panel_ab, width = 14, height = 14, units = "cm")
```

PDF [6] PDF Google

8.9

- gcookbook heightweight

[6] PDF

Chapter 9

ggplot2 ggplot2 **tibble**

mtcars faithful

```
head(mtcars) #  6
```

```
##                   mpg cyl disp  hp drat    wt  qsec vs am gear carb
## Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
## Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
## Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
## Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
## Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

```
head(faithful) #  6
```

```
##   eruptions waiting
## 1     3.600      79
## 2     1.800      54
## 3     3.333      74
## 4     2.283      62
## 5     4.533      85
## 6     2.883      55
```

1

3

- **1** 3
-
- **2**

tidyverse

9.1 tidyverse

tidyverse `library(tidyverse)` ggplot2 tidyverse

```
library(tidyverse) #           ggplot2
```

ggplot2 mpg

9.2

9.2.1

mpg manufacturer

filter( )

```
mpg %>%
  filter(manufacturer == "audi") # manufacturer "audi"
```

```
## # A tibble: 18 x 11
##    manufacturer model      displ  year   cyl trans      drv     cty   hwy
##    <chr>        <chr>      <dbl> <int> <int> <chr>      <chr> <int> <int>
##  1 audi         a4           1.8  1999     4 auto(l5)   f        18    29
##  2 audi         a4           1.8  1999     4 manual(m5) f        21    29
##  3 audi         a4           2    2008     4 manual(m6) f        20    31
##  4 audi         a4           2    2008     4 auto(av)   f        21    30
##  5 audi         a4           2.8  1999     6 auto(l5)   f        16    26
##  6 audi         a4           2.8  1999     6 manual(m5) f        18    26
##  7 audi         a4           3.1  2008     6 auto(av)   f        18    27
##  8 audi         a4 quattro   1.8  1999     4 manual(m5) 4        18    26
##  9 audi         a4 quattro   1.8  1999     4 auto(l5)   4        16    25
## 10 audi         a4 quattro   2    2008     4 manual(m6) 4        20    28
## 11 audi         a4 quattro   2    2008     4 auto(s6)   4        19    27
## 12 audi         a4 quattro   2.8  1999     6 auto(l5)   4        15    25
## 13 audi         a4 quattro   2.8  1999     6 manual(m5) 4        17    25
## 14 audi         a4 quattro   3.1  2008     6 auto(s6)   4        17    25
## 15 audi         a4 quattro   3.1  2008     6 manual(m6) 4        15    25
## 16 audi         a6 quattro   2.8  1999     6 auto(l5)   4        15    24
## 17 audi         a6 quattro   3.1  2008     6 auto(s6)   4        17    25
## 18 audi         a6 quattro   4.2  2008     8 auto(s6)   4        16    23
##    fl    class
##    <chr> <chr>
##  1 p     compact
##  2 p     compact
##  3 p     compact
##  4 p     compact
##  5 p     compact
##  6 p     compact
##  7 p     compact
##  8 p     compact
##  9 p     compact
## 10 p     compact
## 11 p     compact
## 12 p     compact
```

```
## 13 p     compact
## 14 p     compact
## 15 p     compact
## 16 p     midsize
## 17 p     midsize
## 18 p     midsize
```

== == =

%>%

---

manufacturer "audi" model "a4" &

```
mpg %>%
  filter(manufacturer == "audi" & model == "a4")
```

```
## # A tibble: 7 x 11
##   manufacturer model displ  year   cyl trans      drv     cty   hwy fl
##   <chr>        <chr> <dbl> <int> <int> <chr>      <chr> <int> <int> <chr>
## 1 audi         a4      1.8  1999     4 auto(l5)   f        18    29 p
## 2 audi         a4      1.8  1999     4 manual(m5) f        21    29 p
## 3 audi         a4      2    2008     4 manual(m6) f        20    31 p
## 4 audi         a4      2    2008     4 auto(av)   f        21    30 p
## 5 audi         a4      2.8  1999     6 auto(l5)   f        16    26 p
## 6 audi         a4      2.8  1999     6 manual(m5) f        18    26 p
## 7 audi         a4      3.1  2008     6 auto(av)   f        18    27 p
##   class
##   <chr>
## 1 compact
## 2 compact
## 3 compact
## 4 compact
## 5 compact
## 6 compact
## 7 compact
```

manufacturer "audi" model "a4" |

```
mpg %>%
  filter(manufacturer == "audi" | model == "a4")
```

```
## # A tibble: 18 x 11
##    manufacturer model      displ  year   cyl trans      drv     cty   hwy
##    <chr>        <chr>      <dbl> <int> <int> <chr>      <chr> <int> <int>
##  1 audi         a4           1.8  1999     4 auto(l5)   f        18    29
##  2 audi         a4           1.8  1999     4 manual(m5) f        21    29
##  3 audi         a4           2    2008     4 manual(m6) f        20    31
##  4 audi         a4           2    2008     4 auto(av)   f        21    30
##  5 audi         a4           2.8  1999     6 auto(l5)   f        16    26
##  6 audi         a4           2.8  1999     6 manual(m5) f        18    26
##  7 audi         a4           3.1  2008     6 auto(av)   f        18    27
##  8 audi         a4 quattro   1.8  1999     4 manual(m5) 4        18    26
##  9 audi         a4 quattro   1.8  1999     4 auto(l5)   4        16    25
## 10 audi         a4 quattro   2    2008     4 manual(m6) 4        20    28
## 11 audi         a4 quattro   2    2008     4 auto(s6)   4        19    27
## 12 audi         a4 quattro   2.8  1999     6 auto(l5)   4        15    25
```

```
## 13 audi         a4 quattro   2.8  1999     6 manual(m5) 4        17    25
## 14 audi         a4 quattro   3.1  2008     6 auto(s6)   4        17    25
## 15 audi         a4 quattro   3.1  2008     6 manual(m6) 4        15    25
## 16 audi         a6 quattro   2.8  1999     6 auto(l5)   4        15    24
## 17 audi         a6 quattro   3.1  2008     6 auto(s6)   4        17    25
## 18 audi         a6 quattro   4.2  2008     8 auto(s6)   4        16    23
##    fl    class
##    <chr> <chr>
##  1 p     compact
##  2 p     compact
##  3 p     compact
##  4 p     compact
##  5 p     compact
##  6 p     compact
##  7 p     compact
##  8 p     compact
##  9 p     compact
## 10 p     compact
## 11 p     compact
## 12 p     compact
## 13 p     compact
## 14 p     compact
## 15 p     compact
## 16 p     midsize
## 17 p     midsize
## 18 p     midsize
```

manufacturer "audi" model "a4" !() !() [1]

```
mpg %>%
  filter(!(manufacturer == "audi" | model == "a4"))
```

```
## # A tibble: 216 x 11
##    manufacturer model              displ  year   cyl trans      drv     cty
##    <chr>        <chr>              <dbl> <int> <int> <chr>      <chr> <int>
##  1 chevrolet    c1500 suburban 2wd   5.3  2008     8 auto(l4)   r        14
##  2 chevrolet    c1500 suburban 2wd   5.3  2008     8 auto(l4)   r        11
##  3 chevrolet    c1500 suburban 2wd   5.3  2008     8 auto(l4)   r        14
##  4 chevrolet    c1500 suburban 2wd   5.7  1999     8 auto(l4)   r        13
##  5 chevrolet    c1500 suburban 2wd   6    2008     8 auto(l4)   r        12
##  6 chevrolet    corvette             5.7  1999     8 manual(m6) r        16
##  7 chevrolet    corvette             5.7  1999     8 auto(l4)   r        15
##  8 chevrolet    corvette             6.2  2008     8 manual(m6) r        16
##  9 chevrolet    corvette             6.2  2008     8 auto(s6)   r        15
## 10 chevrolet    corvette             7    2008     8 manual(m6) r        15
##      hwy fl    class
##    <int> <chr> <chr>
##  1    20 r     suv
##  2    15 e     suv
##  3    20 r     suv
##  4    17 r     suv
##  5    17 r     suv
##  6    26 p     2seater
##  7    23 p     2seater
```

[1] manufacturer "audi" manufacturer != "audi"

```
##  8    26 p     2seater
##  9    25 p     2seater
## 10    24 p     2seater
## # ... with 206 more rows
```

9.2.2

mpg manufacturer model trans drv

select( ) 1

```
mpg %>%
  select(manufacturer, model, trans, drv) # 4
```

```
## # A tibble: 234 x 4
##    manufacturer model      trans      drv
##    <chr>        <chr>      <chr>      <chr>
##  1 audi         a4         auto(l5)   f
##  2 audi         a4         manual(m5) f
##  3 audi         a4         manual(m6) f
##  4 audi         a4         auto(av)   f
##  5 audi         a4         auto(l5)   f
##  6 audi         a4         manual(m5) f
##  7 audi         a4         auto(av)   f
##  8 audi         a4 quattro manual(m5) 4
##  9 audi         a4 quattro auto(l5)   4
## 10 audi         a4 quattro manual(m6) 4
## # ... with 224 more rows
```

select() A G

```
mpg %>%
  select(manufacturer:drv) # manufacturer drv 7
```

```
## # A tibble: 234 x 7
##    manufacturer model      displ  year   cyl trans      drv
##    <chr>        <chr>      <dbl> <int> <int> <chr>      <chr>
##  1 audi         a4           1.8  1999     4 auto(l5)   f
##  2 audi         a4           1.8  1999     4 manual(m5) f
##  3 audi         a4           2    2008     4 manual(m6) f
##  4 audi         a4           2    2008     4 auto(av)   f
##  5 audi         a4           2.8  1999     6 auto(l5)   f
##  6 audi         a4           2.8  1999     6 manual(m5) f
##  7 audi         a4           3.1  2008     6 auto(av)   f
##  8 audi         a4 quattro   1.8  1999     4 manual(m5) 4
##  9 audi         a4 quattro   1.8  1999     4 auto(l5)   4
## 10 audi         a4 quattro   2    2008     4 manual(m6) 4
## # ... with 224 more rows
```

select(-)

```
mpg %>%
  select(-manufacturer) # manufacturer
```

```
## # A tibble: 234 x 10
##    model      displ  year   cyl trans      drv     cty   hwy fl    class
##    <chr>      <dbl> <int> <int> <chr>      <chr> <int> <int> <chr> <chr>
```

```
##  1 a4           1.8  1999     4 auto(l5)   f        18    29 p     compact
##  2 a4           1.8  1999     4 manual(m5) f        21    29 p     compact
##  3 a4           2    2008     4 manual(m6) f        20    31 p     compact
##  4 a4           2    2008     4 auto(av)   f        21    30 p     compact
##  5 a4           2.8  1999     6 auto(l5)   f        16    26 p     compact
##  6 a4           2.8  1999     6 manual(m5) f        18    26 p     compact
##  7 a4           3.1  2008     6 auto(av)   f        18    27 p     compact
##  8 a4 quattro   1.8  1999     4 manual(m5) 4        18    26 p     compact
##  9 a4 quattro   1.8  1999     4 auto(l5)   4        16    25 p     compact
## 10 a4 quattro   2    2008     4 manual(m6) 4        20    28 p     compact
## # ... with 224 more rows
```

9.3

9.3.1

```
          mutate(     = )
```

```
mpg %>%
  mutate(one = 1) #   one
```

```
## # A tibble: 234 x 12
##    manufacturer model      displ  year   cyl trans      drv     cty   hwy
##    <chr>        <chr>      <dbl> <int> <int> <chr>      <chr> <int> <int>
##  1 audi         a4           1.8  1999     4 auto(l5)   f        18    29
##  2 audi         a4           1.8  1999     4 manual(m5) f        21    29
##  3 audi         a4           2    2008     4 manual(m6) f        20    31
##  4 audi         a4           2    2008     4 auto(av)   f        21    30
##  5 audi         a4           2.8  1999     6 auto(l5)   f        16    26
##  6 audi         a4           2.8  1999     6 manual(m5) f        18    26
##  7 audi         a4           3.1  2008     6 auto(av)   f        18    27
##  8 audi         a4 quattro   1.8  1999     4 manual(m5) 4        18    26
##  9 audi         a4 quattro   1.8  1999     4 auto(l5)   4        16    25
## 10 audi         a4 quattro   2    2008     4 manual(m6) 4        20    28
##    fl    class     one
##    <chr> <chr>   <dbl>
##  1 p     compact     1
##  2 p     compact     1
##  3 p     compact     1
##  4 p     compact     1
##  5 p     compact     1
##  6 p     compact     1
##  7 p     compact     1
##  8 p     compact     1
##  9 p     compact     1
## 10 p     compact     1
## # ... with 224 more rows
```

  one 1

mutate() if_else() displ 3 good 3 bad engine

```
mpg %>%
  mutate(engine = if_else(displ < 3, "good", "bad"))
```

```
## # A tibble: 234 x 12
##    manufacturer model      displ  year   cyl trans      drv     cty   hwy
##    <chr>        <chr>      <dbl> <int> <int> <chr>      <chr> <int> <int>
##  1 audi         a4           1.8  1999     4 auto(l5)   f        18    29
##  2 audi         a4           1.8  1999     4 manual(m5) f        21    29
##  3 audi         a4           2    2008     4 manual(m6) f        20    31
##  4 audi         a4           2    2008     4 auto(av)   f        21    30
##  5 audi         a4           2.8  1999     6 auto(l5)   f        16    26
##  6 audi         a4           2.8  1999     6 manual(m5) f        18    26
##  7 audi         a4           3.1  2008     6 auto(av)   f        18    27
##  8 audi         a4 quattro   1.8  1999     4 manual(m5) 4        18    26
##  9 audi         a4 quattro   1.8  1999     4 auto(l5)   4        16    25
## 10 audi         a4 quattro   2    2008     4 manual(m6) 4        20    28
##    fl    class   engine
##    <chr> <chr>   <chr>
##  1 p     compact good
##  2 p     compact good
##  3 p     compact good
##  4 p     compact good
##  5 p     compact good
##  6 p     compact good
##  7 p     compact bad
##  8 p     compact good
##  9 p     compact good
## 10 p     compact good
## # ... with 224 more rows
```

9.3.2

```
                    rename(    =    )
```

```
mpg %>%
  rename(nen = year) # year nen
```

```
## # A tibble: 234 x 11
##    manufacturer model      displ   nen   cyl trans      drv     cty   hwy
##    <chr>        <chr>      <dbl> <int> <int> <chr>      <chr> <int> <int>
##  1 audi         a4           1.8  1999     4 auto(l5)   f        18    29
##  2 audi         a4           1.8  1999     4 manual(m5) f        21    29
##  3 audi         a4           2    2008     4 manual(m6) f        20    31
##  4 audi         a4           2    2008     4 auto(av)   f        21    30
##  5 audi         a4           2.8  1999     6 auto(l5)   f        16    26
##  6 audi         a4           2.8  1999     6 manual(m5) f        18    26
##  7 audi         a4           3.1  2008     6 auto(av)   f        18    27
##  8 audi         a4 quattro   1.8  1999     4 manual(m5) 4        18    26
##  9 audi         a4 quattro   1.8  1999     4 auto(l5)   4        16    25
## 10 audi         a4 quattro   2    2008     4 manual(m6) 4        20    28
##    fl    class
##    <chr> <chr>
##  1 p     compact
##  2 p     compact
##  3 p     compact
##  4 p     compact
##  5 p     compact
```

```
##  6 p     compact
##  7 p     compact
##  8 p     compact
##  9 p     compact
## 10 p     compact
## # ... with 224 more rows
```

9.4

group_by() summarise()

summarise() summarise(=) displ

```
mpg %>%
  summarise(mean_displ = mean(displ),
            sd_displ = sd(displ),
            min_displ = min(displ),
            max_displ = max(displ))
```

```
## # A tibble: 1 x 4
##   mean_displ sd_displ min_displ max_displ
##        <dbl>    <dbl>     <dbl>     <dbl>
## 1       3.47     1.29       1.6         7
```

summarise()

---

group_by( ) year summarise()

```
mpg %>%
  group_by(year) %>%
  summarise(mean_displ = mean(displ),
            sd_displ = sd(displ),
            min_displ = min(displ),
            max_displ = max(displ))
```

```
## # A tibble: 2 x 5
##    year mean_displ sd_displ min_displ max_displ
##   <int>      <dbl>    <dbl>     <dbl>     <dbl>
## 1  1999       3.28     1.26       1.6       6.5
## 2  2008       3.66     1.30       1.8       7
```

1999 2008

9.5

mpg

2 5 3 2

2 commute

```
commute = data.frame(
  "name" = c("takashi","takashi","takashi","takashi","takashi","hanako","hanako","hanako","hanako","hana
  "day" = c(1,2,3,4,5,1,2,3,4,5),
  "time" = c(10,13,12,11,14,9,15,14,10,16)
)

commute
```

```
##       name day time
## 1  takashi   1   10
## 2  takashi   2   13
## 3  takashi   3   12
## 4  takashi   4   11
## 5  takashi   5   14
## 6   hanako   1    9
## 7   hanako   2   15
## 8   hanako   3   14
## 9   hanako   4   10
## 10  hanako   5   16
```

shoes

```
shoes = data.frame(
  "day" = c(1,2,3,4,5),
  "shoes" = c("tabi","tabi","bare","tabi","bare")
)

shoes
```

```
##   day shoes
## 1   1  tabi
## 2   2  tabi
## 3   3  bare
## 4   4  tabi
## 5   5  bare
```

inner_join() inner_join(, by = " ") day

```
commute %>%
  inner_join(shoes, by = "day")
```

```
##       name day time shoes
## 1  takashi   1   10  tabi
## 2  takashi   2   13  tabi
## 3  takashi   3   12  bare
## 4  takashi   4   11  tabi
## 5  takashi   5   14  bare
## 6   hanako   1    9  tabi
## 7   hanako   2   15  tabi
## 8   hanako   3   14  bare
## 9   hanako   4   10  tabi
## 10  hanako   5   16  bare
```

shoes

```
shoes = data.frame(
  "hinichi" = c(1,2,3,4,5), # "day"   "hinichi"
  "shoes" = c("tabi","tabi","bare","tabi","bare")
)

shoes
```

```
##   hinichi shoes
## 1       1  tabi
## 2       2  tabi
## 3       3  bare
## 4       4  tabi
## 5       5  bare
```

```
commute %>%
  inner_join(shoes, by = c("day" = "hinichi")) # day hinichi
```

```
##       name day time shoes
## 1  takashi   1   10  tabi
## 2  takashi   2   13  tabi
## 3  takashi   3   12  bare
## 4  takashi   4   11  tabi
## 5  takashi   5   14  bare
## 6   hanako   1    9  tabi
## 7   hanako   2   15  tabi
## 8   hanako   3   14  bare
## 9   hanako   4   10  tabi
## 10  hanako   5   16  bare
```

left_join() right_join() https://dplyr.tidyverse.org/reference/join.html

9.6

X, Y, Z 3

```
set.seed(1) #
stocks = data.frame(
  time = as.Date('2009-01-01') + 0:9,
  X = rnorm(10, 0, 1),
  Y = rnorm(10, 0, 2),
  Z = rnorm(10, 0, 4)
)

stocks
```

```
##          time          X           Y          Z
## 1  2009-01-01 -0.6264538  3.02356234  3.6759095
## 2  2009-01-02  0.1836433  0.77968647  3.1285452
## 3  2009-01-03 -0.8356286 -1.24248116  0.2982599
## 4  2009-01-04  1.5952808 -4.42939977 -7.9574068
## 5  2009-01-05  0.3295078  2.24986184  2.4793030
## 6  2009-01-06 -0.8204684 -0.08986722 -0.2245150
```

```
## 7  2009-01-07  0.4874291 -0.03238053 -0.6231820
## 8  2009-01-08  0.7383247  1.88767242 -5.8830095
## 9  2009-01-09  0.5757814  1.64244239 -1.9126002
## 10 2009-01-10 -0.3053884  1.18780264  1.6717662
```

3

gather() gather(key = " ", value = " ",)

```
stocks_long = stocks %>%
  gather(key = stock, value = price, X, Y, Z) # X:Z   OK

stocks_long
```

```
##          time stock       price
## 1  2009-01-01     X -0.62645381
## 2  2009-01-02     X  0.18364332
## 3  2009-01-03     X -0.83562861
## 4  2009-01-04     X  1.59528080
## 5  2009-01-05     X  0.32950777
## 6  2009-01-06     X -0.82046838
## 7  2009-01-07     X  0.48742905
## 8  2009-01-08     X  0.73832471
## 9  2009-01-09     X  0.57578135
## 10 2009-01-10     X -0.30538839
## 11 2009-01-01     Y  3.02356234
## 12 2009-01-02     Y  0.77968647
## 13 2009-01-03     Y -1.24248116
## 14 2009-01-04     Y -4.42939977
## 15 2009-01-05     Y  2.24986184
## 16 2009-01-06     Y -0.08986722
## 17 2009-01-07     Y -0.03238053
## 18 2009-01-08     Y  1.88767242
## 19 2009-01-09     Y  1.64244239
## 20 2009-01-10     Y  1.18780264
## 21 2009-01-01     Z  3.67590949
## 22 2009-01-02     Z  3.12854520
## 23 2009-01-03     Z  0.29825993
## 24 2009-01-04     Z -7.95740678
## 25 2009-01-05     Z  2.47930299
## 26 2009-01-06     Z -0.22451496
## 27 2009-01-07     Z -0.62318203
## 28 2009-01-08     Z -5.88300954
## 29 2009-01-09     Z -1.91260022
## 30 2009-01-10     Z  1.67176624
```

---

spread() spread(key = , value =)

```
stocks_long %>%
  spread(stock, price)
```

```
##          time          X           Y          Z
## 1  2009-01-01 -0.6264538  3.02356234  3.6759095
## 2  2009-01-02  0.1836433  0.77968647  3.1285452
```

```
## 3  2009-01-03 -0.8356286 -1.24248116  0.2982599
## 4  2009-01-04  1.5952808 -4.42939977 -7.9574068
## 5  2009-01-05  0.3295078  2.24986184  2.4793030
## 6  2009-01-06 -0.8204684 -0.08986722 -0.2245150
## 7  2009-01-07  0.4874291 -0.03238053 -0.6231820
## 8  2009-01-08  0.7383247  1.88767242 -5.8830095
## 9  2009-01-09  0.5757814  1.64244239 -1.9126002
## 10 2009-01-10 -0.3053884  1.18780264  1.6717662
```

9.7

csv tsv xlsx `read_csv()` `read_tsv()` readxl `read_excel()`

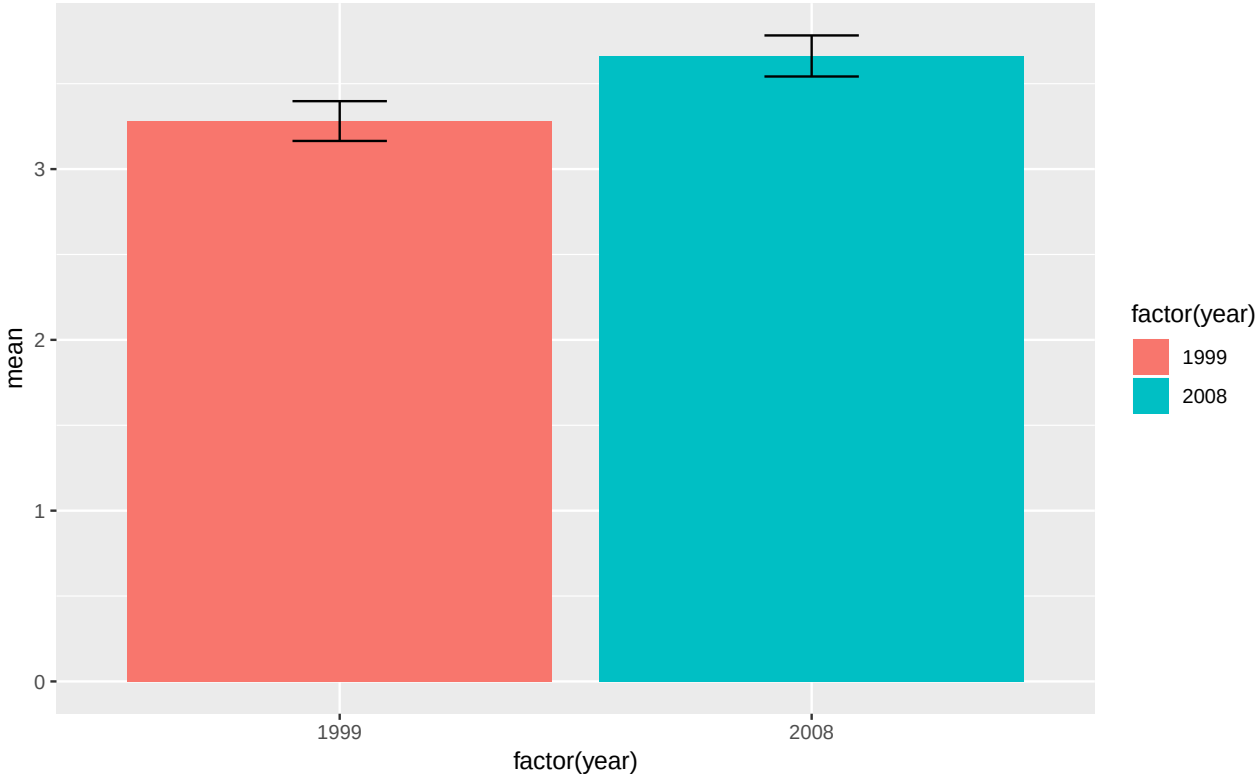
[2]

9.8 ggplot2

%>%

```
mpg %>%
  group_by(year) %>% # year
  summarise(mean = mean(displ),
            se = sd(displ) / sqrt(n())) %>% #       n()
  ggplot(aes(factor(year), mean, fill = factor(year))) + # data %>%
  geom_bar(stat = "identity") +
  geom_errorbar(aes(ymin = mean - se, ymax = mean + se), width = 0.2)
```

[2]


mean
3
2
1
0
1999
2008
factor(year)
factor(year)
1999
2008

- Winston Chang. *Cookbook for R.* http://www.cookbook-r.com/Graphs/
  - ggplot2
  -
  - *R ggplot2* https://www.amazon.co.jp/R - ggplot2 -Winston-Chang/ dp/4873116538
- Claus O. Wilke. *Fundamentals of Data Visualization.* https://serialmentor.com/dataviz/
  -
  -
  - GitHub
- Hadley Wickham. *Elegant Graphics for Data Analysis.* https://github.com/hadley/ggplot2-book
  - ggplot2
  -
  - *ggplot2: Elegant Graphics for Data Analysis (Use R!)* https://www.amazon.co.jp/ggplot2-Elegant-Graphics-Data dp/331924275X/ref=pd_lpo_sbs_14_t_0?_encoding=UTF8&psc=1&refRID=2MNMAP5V2NFH89YZG5AR
- Kieran Healy. *Data Visualization: A Practical Introduction.* https://socviz.co/index.html#preface
  - ggplot2 ※
  - *Fundamentals of Data Visualization*
  - *Data Visualization: A Practical Introduction.* https://www.amazon.co.jp/Data-Visualization-Introduction-Kieran dp/0691181624

```
sessionInfo()
```

```
## R version 3.5.2 (2018-12-20)
## Platform: x86_64-apple-darwin15.6.0 (64-bit)
## Running under: macOS Mojave 10.14.3
##
## Matrix products: default
## BLAS: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/libRblas.0.dylib
## LAPACK: /Library/Frameworks/R.framework/Versions/3.5/Resources/lib/libRlapack.dylib
##
## locale:
## [1] ja_JP.UTF-8/ja_JP.UTF-8/ja_JP.UTF-8/C/ja_JP.UTF-8/ja_JP.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] patchwork_0.0.1     GGally_1.4.0        gcookbook_2.0
##  [4] bindrcpp_0.2.2      formattable_0.2.0.1 forcats_0.3.0
##  [7] stringr_1.3.1       dplyr_0.7.8         purrr_0.3.0
## [10] readr_1.3.1         tidyr_0.8.2         tibble_2.0.1
## [13] ggplot2_3.1.0       tidyverse_1.2.1
##
## loaded via a namespace (and not attached):
##  [1] tidyselect_0.2.5   xfun_0.4           reshape2_1.4.3
##  [4] haven_1.1.2        lattice_0.20-38    colorspace_1.4-0
##  [7] generics_0.0.2     htmltools_0.3.6    yaml_2.2.0
## [10] utf8_1.1.4         rlang_0.3.1        pillar_1.3.1
## [13] glue_1.3.0         withr_2.1.2        RColorBrewer_1.1-2
## [16] modelr_0.1.2       readxl_1.1.0       bindr_0.1.1
## [19] plyr_1.8.4         munsell_0.5.0      gtable_0.2.0
## [22] cellranger_1.1.0   rvest_0.3.2        htmlwidgets_1.3
## [25] evaluate_0.12      labeling_0.3       knitr_1.21
## [28] fansi_0.4.0        highr_0.7          broom_0.5.1
## [31] Rcpp_1.0.0         scales_1.0.0       backports_1.1.3
## [34] jsonlite_1.6       hms_0.4.2          digest_0.6.18
## [37] stringi_1.2.4      bookdown_0.9       grid_3.5.2
## [40] cli_1.0.1          tools_3.5.2        magrittr_1.5
## [43] lazyeval_0.2.1     crayon_1.3.4       pkgconfig_2.0.2
## [46] xml2_1.2.0         lubridate_1.7.4    reshape_0.8.7
## [49] assertthat_0.2.0   rmarkdown_1.11     httr_1.4.0
## [52] rstudioapi_0.9.0   R6_2.3.0           nlme_3.1-137
```

```
## [55] compiler_3.5.2
```