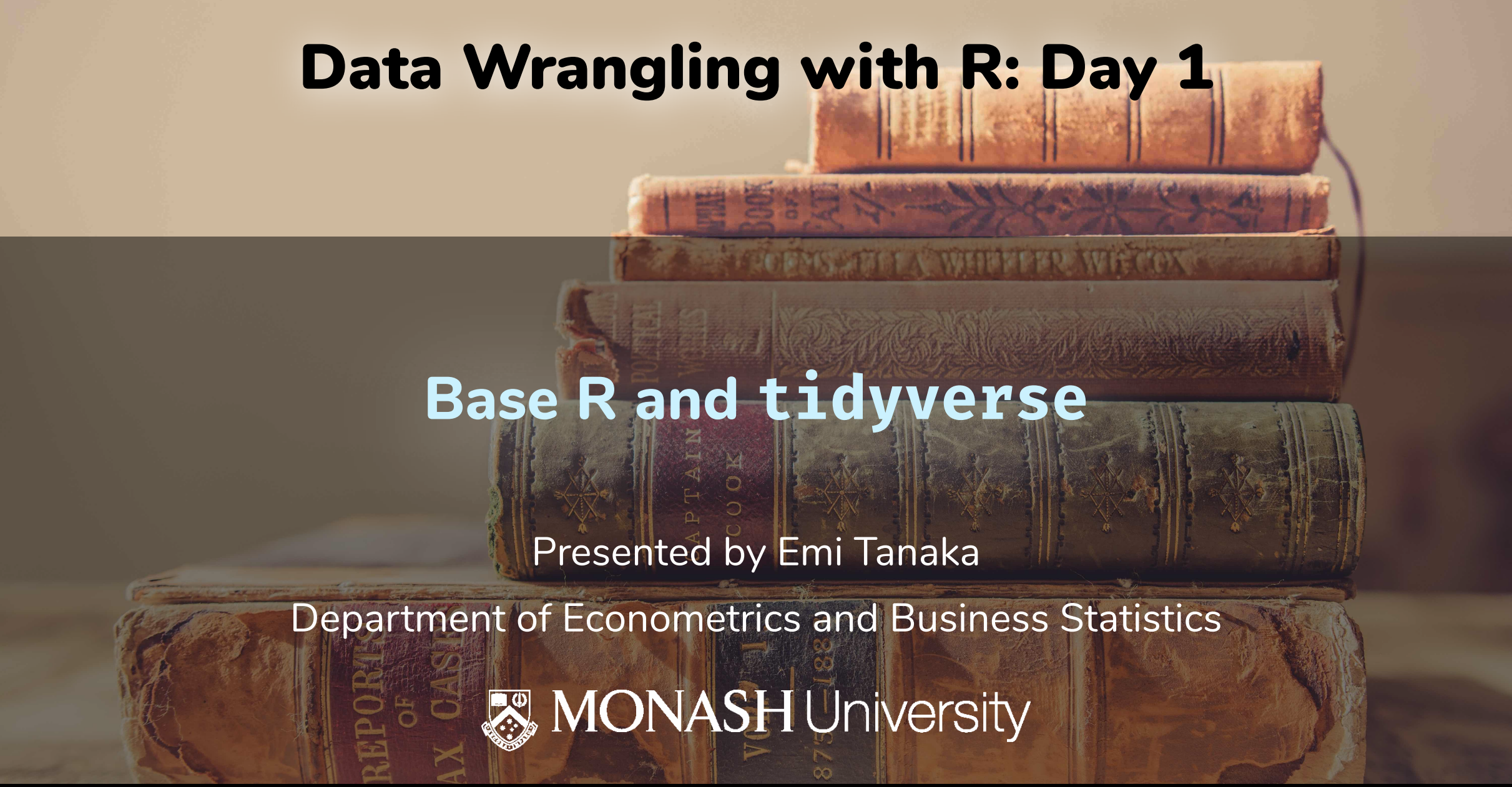
Data Wrangling with R: Day 1



Base R and `tidyverse`

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Base R

- **Base R** refers to the state of R when just launched in a clean interactive development environment (IDE, e.g. RStudio).
- In this state, R attached the following packages:
  - `base`,
  - `methods`, for complex reasons, you may need to explicitly call this when using Rscript and package development!
  - `stats`,
  - `graphics`,
  - `grDevices`,
  - `utils`, and
  - `datasets`.

Tidyverse

- What packages does `library(tidyverse)` load?
- **Tidyverse** refers to a collection of R-packages: `ggplot2`, `dplyr`, `tidyr`, `readr`, `purrr`, `tibble`, `stringr`, `forcats`, `DBI`, `haven`, `httr`, `readxl`, `rvest`, `jsonlite`, `xml2`, `lubridate`, `hms`, `blob`, `magrittr`, `glue` and more recently, `tidymodels`.
- Eight of these packages form the **core tidyverse**.

- `library(tidyverse)` is a short hand for `library(ggplot2)`, `library(dplyr)`, ..., `library(forcats)`

Base R and Tidyverse

- Tidyverse is not a substitute for Base R 📘
- Knowing Base R is essential to use Tidyverse effectively 📗
- Data wrangling in Tidyverse just gives you a different flavour of how you can do things in Base R 🍭
- All data wrangling can be achieved using Base R, so why load extra package(s) to deal with the data wrangling? 🤔
- Tidyverse packages share a common design philosophy, grammar and data structure
- This trains your mental model to do data science tasks in a certain manner which may make it easier, faster, and/or fun for you to do these tasks
- It's an opinionated approach so you should make a decision for yourself of what works for you *and* others that you share your work with

`data.frame` Base R

- In R, `data.frame` is a special class of `list`
- Every column in the `data.frame` is a vector of the same length
- Each entry in a vector have the same type, e.g. logical, integer, double (or numeric), character or factor.
- It has an attribute `row.names` which could be a sequence of integers indexing the row number or some unique identifier

```
cars
```

```
##    speed dist
## 1      4    2
## 2      4   10
## 3      7    4
## 4      7   22
```

```
mtcars
```

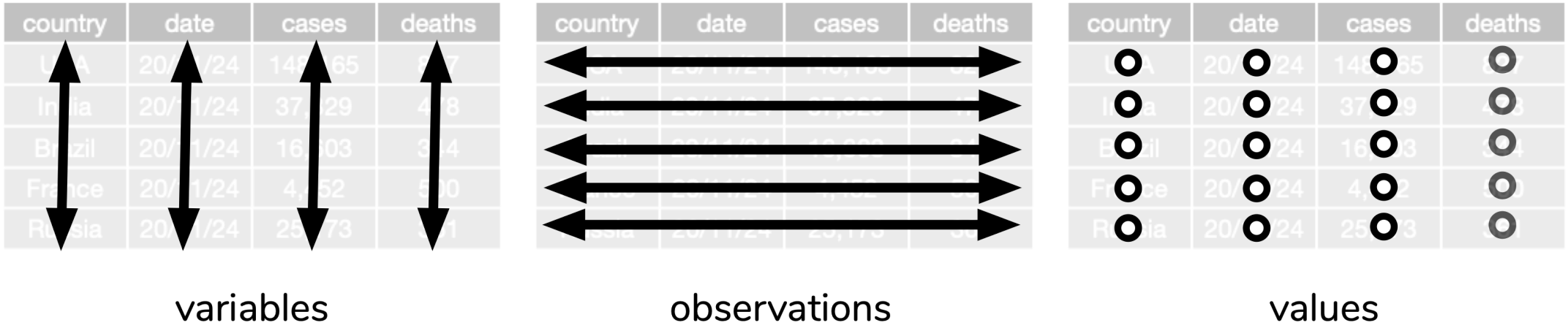
```
##                    mpg cyl  disp  hp drat    wt  qsec vs
## Mazda RX4         21.0   6 160.0 110 3.90 2.620 16.46  0
## Mazda RX4 Wag     21.0   6 160.0 110 3.90 2.875 17.02  0
## Datsun 710        22.8   4 108.0  93 3.85 2.320 18.61  1
## Hornet 4 Drive    21.4   6 258.0 110 3.08 3.215 19.44  1
```

Tidy data

🎯 The typical aim of data wrangling is to make data into a **tidy data**

Definition of a tidy data

- Each variable must have its own column
- Each observation must have its own row
- Each value must have its own cell



Wickham, Hadley. 2014. “Tidy Data.” Journal of Statistical Software, Articles 59 (10): 1–23.

Data wrangling with Base R

Subsetting by column Base R Part 1

By column names

```
mtcars[, c("mpg", "cyl")]
```

```
##                    mpg cyl
## Mazda RX4         21.0   6
## Mazda RX4 Wag     21.0   6
## Datsun 710        22.8   4
## Hornet 4 Drive    21.4   6
## Hornet Sportabout 18.7   8
## Valiant           18.1   6
## Duster 360        14.3   8
## Merc 240D         24.4   4
## Merc 230          22.8   4
## Merc 280          19.2   6
## Merc 280C         17.8   6
## Merc 450SE        16.4   8
```

By index

```
mtcars[, 1:2]
```

```
##                    mpg cyl
## Mazda RX4         21.0   6
## Mazda RX4 Wag     21.0   6
## Datsun 710        22.8   4
## Hornet 4 Drive    21.4   6
## Hornet Sportabout 18.7   8
## Valiant           18.1   6
## Duster 360        14.3   8
## Merc 240D         24.4   4
## Merc 230          22.8   4
## Merc 280          19.2   6
## Merc 280C         17.8   6
## Merc 450SE        16.4   8
```

Subsetting by column Base R Part 2

By column names

```
mtcars[c("mpg", "cyl")]
```

```
##                    mpg cyl
## Mazda RX4         21.0   6
## Mazda RX4 Wag     21.0   6
## Datsun 710        22.8   4
## Hornet 4 Drive    21.4   6
## Hornet Sportabout 18.7   8
## Valiant           18.1   6
## Duster 360        14.3   8
## Merc 240D         24.4   4
## Merc 230          22.8   4
## Merc 280          19.2   6
## Merc 280C         17.8   6
## Merc 450SE        16.4   8
```

By index

```
mtcars[1:2]
```

```
##                    mpg cyl
## Mazda RX4         21.0   6
## Mazda RX4 Wag     21.0   6
## Datsun 710        22.8   4
## Hornet 4 Drive    21.4   6
## Hornet Sportabout 18.7   8
## Valiant           18.1   6
## Duster 360        14.3   8
## Merc 240D         24.4   4
## Merc 230          22.8   4
## Merc 280          19.2   6
## Merc 280C         17.8   6
## Merc 450SE        16.4   8
```

Lists Base R

- Remember, `data.frame` is just a special type of `list` and inherit methods applied for `list`.

```
x <- list( int = 1:3,
           shop = c("apple", "pear"),
                  c(2020, 12, 1, 1.3))
x

## $int
## [1] 1 2 3
##
## $shop
## [1] "apple" "pear"
##
## [[3]]
## [1] 2020.0   12.0    1.0    1.3
```

```
x[c("int", "shop")]

## $int
## [1] 1 2 3
##
## $shop
## [1] "apple" "pear"
```

Double square bracket to access inside the list

```
x[["int"]] # or x$int

## [1] 1 2 3
```

list and data.frame Base R

```
x[, "int"] # this is a special operation for data frames
```

```
## Error in x[, "int"]: incorrect number of dimensions
```

```
mtcars[["cyl"]]
```

```
##  [1] 6 6 4 6 8 6 8 4 4 6 6 8 8 8 8 8 8 4 4 4 4 8 8 8 8 4 4 4 8 6 8 4
```

```
mtcars$cyl
```

```
##  [1] 6 6 4 6 8 6 8 4 4 6 6 8 8 8 8 8 8 4 4 4 4 8 8 8 8 4 4 4 8 6 8 4
```

```
mtcars["cyl"]
```

```
##                   cyl
## Mazda RX4           6
## Mazda RX4 Wag       6
## Datsun 710          4
```

`data.frame` inherits methods for `list`, but `list` does not inherit methods for `data.frame`

Subsetting by column Base R 

- If you subset *a single column* using `[, ]`, then by default the output is a vector and not a `data.frame`.

```
mtcars[, "mpg"]
```

```
##  [1] 21.0 21.0 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 17.8 16.4 17.3 15.2 10
## [16] 10.4 14.7 32.4 30.4 33.9 21.5 15.5 15.2 13.3 19.2 27.3 26.0 30.4 15.8 19
## [31] 15.0 21.4
```

- If you want to preserve the output as a `data.frame` then:

```
mtcars[, "mpg", drop = FALSE]
```

```
##                    mpg
## Mazda RX4         21.0
## Mazda RX4 Wag     21.0
## Datsun 710        22.8
```

Subsetting by row Base R Part 1

By index:

```
mtcars[3:1, ]

##                mpg cyl disp  hp drat    wt  qsec vs am gear carb
## Datsun 710    22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
## Mazda RX4 Wag 21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
## Mazda RX4     21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
```

If it has row names:

```
mtcars[c("Datsun 710", "Mazda RX4"), ]

##             mpg cyl disp  hp drat   wt  qsec vs am gear carb
## Datsun 710 22.8   4  108  93 3.85 2.32 18.61  1  1    4    1
## Mazda RX4  21.0   6  160 110 3.90 2.62 16.46  0  1    4    4
```

Subsetting by row Base R Part 2

Using a logical vector,

```
mtcars[mtcars$mpg > 31, ]

##                 mpg cyl disp hp drat    wt  qsec vs am gear carb
## Fiat 128       32.4   4 78.7 66 4.08 2.200 19.47  1  1    4    1
## Toyota Corolla 33.9   4 71.1 65 4.22 1.835 19.90  1  1    4    1
```

Or using **non-standard evaluation**:

```
subset(mtcars, mpg > 31)

##                 mpg cyl disp hp drat    wt  qsec vs am gear carb
## Fiat 128       32.4   4 78.7 66 4.08 2.200 19.47  1  1    4    1
## Toyota Corolla 33.9   4 71.1 65 4.22 1.835 19.90  1  1    4    1
```

Non-standard evaluation? We'll come back to this later.

Adding or modifying a column Base R

Append the new column:

```
df1 <- cbind(mtcars, gpm = 1 / mtcars$mpg)
```

Create a new column as you would a create a new object in a list:

```
df1$gpm <- 1 / df1$mpg
df1[["gpm"]] <- 1 / df1$mpg
```

Overwrite column if modifying an existing column:

```
df1$wt <- df1$gpm^2
df1[["wt"]] <- df1$gpm^2
```

Modify only a part of it:

```
df1$wt[df1$cyl==6] <- 10
```

Adding a row Base R

What do you notice with the order of the new entry?

```
df2 <- rbind(cars, data.frame(dist = 10, speed = 3))
tail(df2, 3)
```

```
##    speed dist
## 49    24  120
## 50    25   85
## 51     3   10
```

```
df2 <- rbind(cars, c(10, 3))
tail(df2, 3)
```

```
##    speed dist
## 49    24  120
## 50    25   85
## 51    10    3
```

Sorting columns Base R

```
mtcars[, sort(names(mtcars))]
```

```
##                    am carb cyl  disp drat gear  hp  mpg  qsec vs    wt
## Mazda RX4           1    4   6 160.0 3.90    4 110 21.0 16.46  0 2.620
## Mazda RX4 Wag       1    4   6 160.0 3.90    4 110 21.0 17.02  0 2.875
## Datsun 710          1    1   4 108.0 3.85    4  93 22.8 18.61  1 2.320
## Hornet 4 Drive      0    1   6 258.0 3.08    3 110 21.4 19.44  1 3.215
## Hornet Sportabout   0    2   8 360.0 3.15    3 175 18.7 17.02  0 3.440
## Valiant             0    1   6 225.0 2.76    3 105 18.1 20.22  1 3.460
## Duster 360          0    4   8 360.0 3.21    3 245 14.3 15.84  0 3.570
## Merc 240D           0    2   4 146.7 3.69    4  62 24.4 20.00  1 3.190
## Merc 230            0    2   4 140.8 3.92    4  95 22.8 22.90  1 3.150
## Merc 280            0    4   6 167.6 3.92    4 123 19.2 18.30  1 3.440
## Merc 280C           0    4   6 167.6 3.92    4 123 17.8 18.90  1 3.440
## Merc 450SE          0    3   8 275.8 3.07    3 180 16.4 17.40  0 4.070
## Merc 450SL          0    3   8 275.8 3.07    3 180 17.3 17.60  0 3.730
```

Sorting rows Base R

```
order(mtcars$mpg)
```

```
##  [1] 15 16 24  7 17 31 14 23 22 29 12 13 11  6  5 10 25 30  1  2  4 32 21  3
## [26]  8 27 26 19 28 18 20
```

```
mtcars[order(mtcars$mpg),]
```

```
##                      mpg cyl  disp  hp drat    wt  qsec vs am gear carb
## Cadillac Fleetwood  10.4   8 472.0 205 2.93 5.250 17.98  0  0    3    4
## Lincoln Continental 10.4   8 460.0 215 3.00 5.424 17.82  0  0    3    4
## Camaro Z28          13.3   8 350.0 245 3.73 3.840 15.41  0  0    3    4
## Duster 360          14.3   8 360.0 245 3.21 3.570 15.84  0  0    3    4
## Chrysler Imperial   14.7   8 440.0 230 3.23 5.345 17.42  0  0    3    4
## Maserati Bora       15.0   8 301.0 335 3.54 3.570 14.60  0  1    5    8
## Merc 450SLC         15.2   8 275.8 180 3.07 3.780 18.00  0  0    3    3
## AMC Javelin         15.2   8 304.0 150 3.15 3.435 17.30  0  0    3    2
## Dodge Challenger    15.5   8 318.0 150 2.76 3.520 16.87  0  0    3    2
```

Calculating statistical summaries by group Base R

🎯 Calculate the *average* weight (`wt`) of a car for each gear type in (`gear`) `mtcars`

```
tapply(mtcars$wt, mtcars$gear, mean)
```

```
##        3        4        5
## 3.892600 2.616667 2.632600
```

🎯 Calculate the *median* weight (`wt`) of a car for each gear (`gear`) and engine (`vs`) type in `mtcars`

```
tapply(mtcars$wt, list(mtcars$gear, mtcars$vs), median)
```

```
##        0     1
## 3 3.8100 3.215
## 4 2.7475 2.550
## 5 2.9700 1.513
```

Session Information

```
devtools::session_info()
```

```
## ─ Session info ─────────────────────────────────────────────────────────────
##  setting  value
##  version  R version 4.0.1 (2020-06-06)
##  os       macOS Catalina 10.15.7
##  system   x86_64, darwin17.0
##  ui       X11
##  language (EN)
##  collate  en_AU.UTF-8
##  ctype    en_AU.UTF-8
##  tz       Australia/Melbourne
##  date     2020-11-26
##
## ─ Packages ─────────────────────────────────────────────────────────────────
##  package     * version date       lib source
##  anicon        0.1.0   2020-06-21 [1] Github (emitanaka/anicon@0b756df)
##  assertthat    0.2.1   2019-03-21 [2] CRAN (R 4.0.0)
```