

# APPLICATIONS



OF DATA SCIENCE

# Tidy Data Wrangling - Part A

## Applications of Data Science - Class 2

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# dplyr: Basic Data Verbs

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# Basic Data Verbs

- `filter()` rows based on one or more conditions
- `mutate()` one or more columns, usually based on existing columns
- `select()` the column(s) you want
- `arrange()` rows by one or more columns order
- `summarize()` or `summarise()` that single quantity off a column
- `pull()` a column as a vector, don't want it as a column no more

And the much beloved `group_by()`: do *whatever* by groups of one or more variables.

# Read in the data

```
library(tidyverse)

okcupid <- read_csv("~/okcupid.csv.zip")
```

Reminder:

```
dim(okcupid)
```

```
## [1] 59946    31
```

```
colnames(okcupid)
```

```
## [1] "age"          "body_type"    "diet"         "drinks"       "drugs"
## [6] "education"    "essay0"       "essay1"       "essay2"       "essay3"
## [11] "essay4"       "essay5"       "essay6"       "essay7"       "essay8"
## [16] "essay9"       "ethnicity"    "height"       "income"       "job"
## [21] "last_online" "location"     "offspring"    "orientation"  "pets"
## [26] "religion"     "sex"          "sign"         "smokes"       "speaks"
## [31] "status"
```

# mutate ()

Add a column `height_cm`, the height in centimeters:

```
okcupid <- okcupid %>%  
  mutate(height_cm = 2.54 * height)
```

💡 if you also load the `magrittr` package you could do:

```
okcupid %<>% mutate(height_cm = 2.54 * height)
```

# filter() and select()

Filter only women, select only age and height:

```
okcupid %>%  
  filter(sex == "f") %>%  
  select(age, height)
```

```
## # A tibble: 24,117 x 2  
##       age height  
##   <dbl> <dbl>  
## 1     32     65  
## 2     31     65  
## 3     24     67  
## 4     30     66  
## 5     29     62  
## 6     39     65  
## 7     26     64  
## 8     27     67  
## 9     22     67  
## 10    27     64  
## # ... with 24,107 more rows
```

Same but income over 100K, and select all essay questions:

```
okcupid %>%  
  filter(sex == "f", income > 100000) %>%  
  select(starts_with("essay"))
```

```
## # A tibble: 208 x 10  
##   essay0 essay1 essay2 essay3 essay4 essay5 essay6 essay7 essay  
##   <chr>   <chr>   <chr>   <chr>   <chr>   <chr>   <chr>   <chr>   <chr>  
## 1 "i lov~ "being~ "scraw~ "my bi~ "music~ "veget~ "makin~ "kicki~ "wow,  
## 2 "i'm s~ "curre~ "eatin~ "my po~ "pride~ "nothi~ "my ne~ "eatin~ "i'm  
## 3 "welco~ "piano~ "singi~ "my he~ "books~ "touch~ "diffe~ <NA>   <NA>  
## 4 "pureb~ "by da~ "being~ "my ha~ "to st~ "- wat~ "my ne~ "i try~ "ummm  
## 5 "i was~ "chick~ "using~ "lips ~ "armag~ "lust,~ "enter~ "makin~ <NA>  
## 6 "hello~ "i tal~ "anyth~ "my as~ "book:~ "my gu~ "every~ "i wor~ <NA>  
## 7 "life'~ "i'm j~ "getti~ "its b~ "otis ~ "1. so~ "the w~ "oh ma~ "i do  
## 8 "every~ "livin~ "being~ "my ey~ "dubst~ "dirty~ "how t~ "recov~ "i lo  
## 9 "love ~ "daily~ "i am ~ "my sm~ "love ~ "masca~ "if i ~ <NA>   "i am  
## 10 "<b>ph~ "i am ~ "pissi~ "my sm~ "book:~ "my do~ "who p~ "total~ "my d  
## # ... with 198 more rows
```



## Same but using a range of columns:

```
okcupid %>%  
  filter(sex == "f", income > 100000) %>%  
  select(essay0:essay9)
```

```
## # A tibble: 208 x 10  
##   essay0 essay1 essay2 essay3 essay4 essay5 essay6 essay7 essay8  
##   <chr>   <chr>   <chr>   <chr>   <chr>   <chr>   <chr>   <chr>   <chr>  
## 1 "i lov~ "being~ "scraw~ "my bi~ "music~ "veget~ "makin~ "kicki~ "wow,  
## 2 "i'm s~ "curre~ "eatin~ "my po~ "pride~ "nothi~ "my ne~ "eatin~ "i'm  
## 3 "welco~ "piano~ "singi~ "my he~ "books~ "touch~ "diffe~ <NA>   <NA>  
## 4 "pureb~ "by da~ "being~ "my ha~ "to st~ "- wat~ "my ne~ "i try~ "ummm  
## 5 "i was~ "chick~ "using~ "lips ~ "armag~ "lust,~ "enter~ "makin~ <NA>  
## 6 "hello~ "i tal~ "anyth~ "my as~ "book:~ "my gu~ "every~ "i wor~ <NA>  
## 7 "life'~ "i'm j~ "getti~ "its b~ "otis ~ "1. so~ "the w~ "oh ma~ "i do  
## 8 "every~ "livin~ "being~ "my ey~ "dubst~ "dirty~ "how t~ "recov~ "i lo  
## 9 "love ~ "daily~ "i am ~ "my sm~ "love ~ "masca~ "if i ~ <NA>   "i am  
## 10 "<b>ph~ "i am ~ "pissi~ "my sm~ "book:~ "my do~ "who p~ "total~ "my d  
## # ... with 198 more rows
```

💡 Many, many such gifts, see [tidyselect](#)

# summarize()

Find the average height of women

```
okcupid %>%  
  filter(sex == "f") %>%  
  summarize(avg_height = mean(height_cm, na.rm = TRUE))
```

```
## # A tibble: 1 x 1  
##   avg_height  
##   <dbl>  
## 1      165.
```

Notice we got a tibble. We could either pull this single number:

```
okcupid %>%  
  filter(sex == "f") %>%  
  summarize(avg_height = mean(height_cm, na.rm = TRUE)) %>%  
  pull()
```

```
## [1] 165.3638
```

Or pull the vector of heights first, then calculate their mean:

```
okcupid %>%  
  filter(sex == "f") %>%  
  pull(height_cm) %>%  
  mean(na.rm = TRUE)
```

```
## [1] 165.3638
```

Amazingly, this would also work:

```
mean(pull(filter(okcupid, sex == "f"), height_cm), na.rm = TRUE)
```

```
## [1] 165.3638
```

# group\_by()

But why settle for women only?

```
okcupid %>%  
  group_by(sex) %>%  
  summarize(avg_height = mean(height_cm, na.rm = TRUE))
```

```
## # A tibble: 2 x 2  
##   sex    avg_height  
##   <chr>    <dbl>  
## 1 f        165.  
## 2 m        179.
```

And you might want to consider `rename()` ing sex!

```
okcupid %>%  
  group_by(sex) %>%  
  summarize(avg_height = mean(height_cm, na.rm = TRUE)) %>%  
  rename(gender = sex)
```

## Group by multiple variables, get more summaries, arrange by descending average height:

```
okcupid %>%
  group_by(sex, status) %>%
  summarize(avg_height = mean(height_cm, na.rm = TRUE),
            med_height = median(height_cm, na.rm = TRUE),
            n = n()) %>%
  arrange(-med_height)
```

```
## # A tibble: 10 x 5
## # Groups:   sex [2]
##   sex    status    avg_height med_height      n
##   <chr> <chr>         <dbl>      <dbl> <int>
## 1 m     available    179.       180.   1209
## 2 m     married      179.       180.    175
## 3 m     seeing someone 179.       178.   1061
## 4 m     single        179.       178.  33378
## 5 m     unknown       177.       177.     6
## 6 f     available    166.       166.    656
## 7 f     married      166.       165.    135
## 8 f     seeing someone 165.       165.   1003
## 9 f     single        165.       165.  22319
## 10 f    unknown      161.       159.     4
```

# Pro tip: count ()

When all you want is, well, count, no need to group\_by:

```
okcupid %>% count(body_type, sort = TRUE)
```

```
## # A tibble: 13 x 2
##   body_type      n
##   <chr>      <int>
## 1 average    14652
## 2 fit        12711
## 3 athletic   11819
## 4 <NA>        5296
## 5 thin        4711
## 6 curvy       3924
## 7 a little extra 2629
## 8 skinny      1777
## 9 full figured 1009
## 10 overweight   444
## 11 jacked       421
## 12 used up      355
## 13 rather not say 198
```

# Pro tip: add\_count ()

Add count without first creating an initial table, joining etc.:

```
okcupid %>%  
  mutate(id = row_number()) %>%  
  select(id, body_type, sex) %>%  
  add_count(body_type, name = "n_bt") %>%  
  filter(n_bt > 10000) %>%  
  head(5)
```

```
## # A tibble: 5 x 4  
##       id body_type sex    n_bt  
##   <int> <chr>    <chr> <int>  
## 1     2 average    m    14652  
## 2     5 athletic  m    11819  
## 3     6 average    m    14652  
## 4     7 fit      f    12711  
## 5     8 average    f    14652
```

# Beyond Basics

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# A simple answer to the religion question?

```
okcupid %>% count(religion)
```

```
## # A tibble: 46 x 2
##   religion                                n
##   <chr>                                <int>
## 1 agnosticism                          2724
## 2 agnosticism and laughing about it    2496
## 3 agnosticism and somewhat serious about it 642
## 4 agnosticism and very serious about it   314
## 5 agnosticism but not too serious about it 2636
## 6 atheism                             2175
## 7 atheism and laughing about it         2074
## 8 atheism and somewhat serious about it   848
## 9 atheism and very serious about it      570
## 10 atheism but not too serious about it  1318
## # ... with 36 more rows
```

# Recoding with case\_when()

```
okcupid <- okcupid %>% mutate(religion2 = case_when(  
  str_detect(religion, "agnosticism") | str_detect(religion, "athe  
  str_detect(religion, "buddhism") ~ "buddhist",  
  str_detect(religion, "christianity") | str_detect(religion, "cat  
  str_detect(religion, "judaism") ~ "jewish",  
  str_detect(religion, "hinduism") ~ "hindu",  
  str_detect(religion, "islam") ~ "muslim",  
  TRUE ~ "NA"))  
  
okcupid %>% count(religion2, sort = TRUE)
```

```
## # A tibble: 7 x 2  
##   religion2      n  
##   <chr>      <int>  
## 1 NA        27969  
## 2 atheist   15797  
## 3 christian  10545  
## 4 jewish     3098  
## 5 buddhist   1948  
## 6 hindu       450  
## 7 muslim     139
```

# Getting extreme observations with `slice_max()` and `slice_min()`

(`top_n()` and `top_frac()` were superseded by `slice_min()`/`slice_max()`)

```
okcupid %>%  
  select(sex, age) %>%  
  group_by(sex) %>%  
  slice_max(age, n = 3)
```

```
## # A tibble: 33 x 2  
## # Groups:   sex [2]  
##   sex      age  
##   <chr> <dbl>  
## 1 f      110  
## 2 f       69  
## 3 f       69  
## 4 f       69  
## 5 f       69  
## 6 f       69  
## 7 f       69  
## 8 f       69  
## 9 f       69  
## 10 f       69  
## 11 f       69  
## 12 f       69  
## 13 f       69  
## 14 f       69  
## 15 f       69  
## 16 f       69  
## 17 f       69  
## 18 f       69  
## 19 f       69  
## 20 f       69  
## 21 f       69  
## 22 f       69  
## 23 f       69  
## 24 f       69  
## 25 f       69  
## 26 f       69  
## 27 f       69  
## 28 f       69  
## 29 f       69  
## 30 f       69  
## 31 f       69  
## 32 f       69  
## 33 f       69
```

## To get rid of ties:

```
okcupid %>%  
  select(sex, age) %>%  
  group_by(sex) %>%  
  slice_max(age, n = 3, with_ties = FALSE)
```

```
## # A tibble: 6 x 2  
## # Groups:   sex [2]  
##   sex      age  
##   <chr> <dbl>  
## 1 f      110  
## 2 f       69  
## 3 f       69  
## 4 m      109  
## 5 m       69  
## 6 m       69
```

💡 Or use `rank()`

# Remove duplicates with `distinct()`

```
okcupid %>%  
  filter(diet == "kosher") %>%  
  distinct(body_type, drugs)
```

```
## # A tibble: 7 x 2  
##   body_type      drugs  
##   <chr>         <chr>  
## 1 fit          <NA>  
## 2 <NA>         never  
## 3 used up     <NA>  
## 4 fit         never  
## 5 skinny      never  
## 6 a little extra never  
## 7 jacked      never
```

💡 `distinct()` is much more powerful than `unique()`, see `?distinct`.

To count number of distinct obs look at `n_distinct()`

# The `_at()`, `_if()` and `_all()` families

Many of the verbs we've seen come with these suffixes:

```
okcupid %>%  
  select_if(is.numeric)
```

```
## # A tibble: 59,946 x 4  
##       age height income height_cm  
##   <dbl> <dbl> <dbl>    <dbl>  
## 1     22     75     -1     190.  
## 2     35     70  80000     178.  
## 3     38     68     -1     173.  
## 4     23     71  20000     180.  
## 5     29     66     -1     168.  
## 6     29     67     -1     170.  
## 7     32     65     -1     165.  
## 8     31     65     -1     165.  
## 9     24     67     -1     170.  
## 10    37     65     -1     165.  
## # ... with 59,936 more rows
```

Do you see something strange?

Take care of those missing observations for me without breaking the pipe:

```
okcupid %>%  
  na_if(-1) %>%  
  select_if(is.numeric)
```

```
## # A tibble: 59,946 x 4  
##       age height income height_cm  
##   <dbl> <dbl> <dbl>    <dbl>  
## 1     22     75     NA     190.  
## 2     35     70  80000     178.  
## 3     38     68     NA     173.  
## 4     23     71  20000     180.  
## 5     29     66     NA     168.  
## 6     29     67     NA     170.  
## 7     32     65     NA     165.  
## 8     31     65     NA     165.  
## 9     24     67     NA     170.  
## 10    37     65     NA     165.  
## # ... with 59,936 more rows
```

## Transform all my numeric columns with log:

```
okcupid %>%  
  na_if(-1) %>%  
  select_if(is.numeric) %>%  
  mutate_all(log)
```

```
## # A tibble: 59,946 x 4  
##       age height income height_cm  
##   <dbl> <dbl> <dbl>    <dbl>  
## 1  3.09   4.32  NA      5.25  
## 2  3.56   4.25  11.3    5.18  
## 3  3.64   4.22  NA      5.15  
## 4  3.14   4.26   9.90    5.19  
## 5  3.37   4.19  NA      5.12  
## 6  3.37   4.20  NA      5.14  
## 7  3.47   4.17  NA      5.11  
## 8  3.43   4.17  NA      5.11  
## 9  3.18   4.20  NA      5.14  
## 10 3.61   4.17  NA      5.11  
## # ... with 59,936 more rows
```



## Same but add sqrt and keep original columns:

```
okcupid %>%  
  na_if(-1) %>%  
  select_if(is.numeric) %>%  
  mutate_all(list(logged = log, sqrted = sqrt))
```

```
## # A tibble: 59,946 x 12  
##       age height income height_cm age_logged height_logged income_logged  
##   <dbl> <dbl> <dbl>    <dbl>    <dbl>      <dbl>      <dbl>  
## 1     22     75     NA     190.     3.09      4.32      NA  
## 2     35     70 80000     178.     3.56      4.25     11.3  
## 3     38     68     NA     173.     3.64      4.22      NA  
## 4     23     71 20000     180.     3.14      4.26      9.90  
## 5     29     66     NA     168.     3.37      4.19      NA  
## 6     29     67     NA     170.     3.37      4.20      NA  
## 7     32     65     NA     165.     3.47      4.17      NA  
## 8     31     65     NA     165.     3.43      4.17      NA  
## 9     24     67     NA     170.     3.18      4.20      NA  
## 10    37     65     NA     165.     3.61      4.17      NA  
## # ... with 59,936 more rows, and 5 more variables: height_cm_logged <dbl>,  
## #   age_sqrted <dbl>, height_sqrted <dbl>, income_sqrted <dbl>,  
## #   height_cm_sqrted <dbl>
```

## Same but take care of zeros under log:

```
okcupid %>%
  na_if(-1) %>%
  select_if(is.numeric) %>%
  mutate_all(list(logged = function(x) log(x + 1), sqrted = sqrt))
```

```
## # A tibble: 59,946 x 12
##       age height income height_cm age_logged height_logged income_logged
##   <dbl> <dbl> <dbl>    <dbl>    <dbl>      <dbl>      <dbl>
## 1     22     75     NA     190.      3.14      4.33      NA
## 2     35     70 80000     178.      3.58      4.26     11.3
## 3     38     68     NA     173.      3.66      4.23      NA
## 4     23     71 20000     180.      3.18      4.28      9.90
## 5     29     66     NA     168.      3.40      4.20      NA
## 6     29     67     NA     170.      3.40      4.22      NA
## 7     32     65     NA     165.      3.50      4.19      NA
## 8     31     65     NA     165.      3.47      4.19      NA
## 9     24     67     NA     170.      3.22      4.22      NA
## 10    37     65     NA     165.      3.64      4.19      NA
## # ... with 59,936 more rows, and 5 more variables: height_cm_logged <dbl>,
## #   age_sqrted <dbl>, height_sqrted <dbl>, income_sqrted <dbl>,
## #   height_cm_sqrted <dbl>
```

## Same but select only non-negative columns:

```
is_non_negative <- function(x) is.numeric(x) && (is.na(x) || x >=
okcupid %>%
  na_if(-1) %>%
  select_if(is_non_negative) %>%
  mutate_all(list(logged = function(x) log(x + 1), sqrted = sqrt))

## # A tibble: 59,946 x 12
##       age height income height_cm age_logged height_logged income_logged
##   <dbl>  <dbl>  <dbl>    <dbl>    <dbl>        <dbl>        <dbl>
## 1     22     75    NA      190.      3.14         4.33         NA
## 2     35     70  80000     178.      3.58         4.26        11.3
## 3     38     68    NA      173.      3.66         4.23         NA
## 4     23     71  20000     180.      3.18         4.28         9.90
## 5     29     66    NA      168.      3.40         4.20         NA
## 6     29     67    NA      170.      3.40         4.22         NA
## 7     32     65    NA      165.      3.50         4.19         NA
## 8     31     65    NA      165.      3.47         4.19         NA
## 9     24     67    NA      170.      3.22         4.22         NA
## 10    37     65    NA      165.      3.64         4.19         NA
## # ... with 59,936 more rows, and 5 more variables: height_cm_logged <dbl>,
## #   age_sqrted <dbl>, height_sqrted <dbl>, income_sqrted <dbl>,
## #   height_cm_sqrted <dbl>
```

On second thought `log` would probably be appropriate just for `income` and `height_cm` (not really, just for demo):

```
okcupid %>%
  na_if(-1) %>%
  mutate_at(c("income", "height_cm"),
            list(logged = function(x) log(x + 1), sqrted = sqrt))
  select(ends_with("logged"), ends_with("sqrted"))
```

```
## # A tibble: 59,946 x 4
##   income_logged height_cm_logged income_sqrted height_cm_sqrted
##   <dbl>          <dbl>          <dbl>          <dbl>
## 1      NA        5.25            NA           13.8
## 2    11.3        5.19        283.           13.3
## 3      NA        5.16            NA           13.1
## 4     9.90        5.20        141.           13.4
## 5      NA        5.13            NA           12.9
## 6      NA        5.14            NA           13.0
## 7      NA        5.11            NA           12.8
## 8      NA        5.11            NA           12.8
## 9      NA        5.14            NA           13.0
## 10     NA        5.11            NA           12.8
## # ... with 59,936 more rows
```

# across () and c\_across ()

The `_if()`, `_at()` and `_all()` families are so last year...

With a few exceptions (`select_if()`, `na_if()` ...) they have now been "superseded" by `across()`. So instead of `mutate_all()` we would do:

```
okcupid %>% mutate(across(everything(), log))
```

Instead of `mutate_at()` we would now do:

```
okcupid %>% mutate(across(c("income", "height_cm"), log))
```

And instead of `mutate_if()` we would do:

```
okcupid %>% mutate(across(where(is.numeric), log))
```

# Dealing with NAs

You've already seen `na_if()`. We could simply, always, keep those NAs in income:

```
okcupid <- okcupid %>%  
  mutate(income = ifelse(income == -1, NA, income))
```

Or:

```
okcupid <- okcupid %>%  
  mutate(income = na_if(income, -1))
```

Dropping NAs with, well, `drop_na()`:

```
okcupid_no_nas <- okcupid %>% drop_na()
```

Replacing NAs with, well, `replace_na()`:

```
okcupid_back_to_minus1 <- okcupid %>% replace_na(list(income = -1))
```

Could be useful for imputing NAs, say the median:

```
okcupid_na_income_imputed <- okcupid %>%  
  replace_na(list(income = median(.$income, na.rm = TRUE)))
```

# Sampling with `slice_sample()`

(`sample_n()` and `sample_frac()` were superseded by `slice_sample()`)

```
okcupid %>% select(drugs, age, income, sex) %>%  
  group_by(drugs) %>%  
  slice_sample(n = 3, replace = TRUE)
```

```
## # A tibble: 12 x 4  
## # Groups:   drugs [4]  
##   drugs      age income sex  
##   <chr>    <dbl>   <dbl> <chr>  
## 1 never      30      NA f  
## 2 never      22      NA m  
## 3 never      24      NA f  
## 4 often      21 1000000 m  
## 5 often      20      NA f  
## 6 often      29      NA m  
## 7 sometimes  26   20000 f  
## 8 sometimes  29      NA m  
## 9 sometimes  42      NA m  
## 10 <NA>      32      NA f  
## 11 <NA>      44      NA m  
## 12 <NA>      26      NA m
```



# Put it in a function

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# Compose a function which would accept an unquoted variable

```
count_var_for_gender <- function(var, gender) {  
  okcupid %>%  
    filter(sex == gender) %>%  
    count({{var}}, sort = TRUE)  
}  
  
count_var_for_gender(body_type, "f") %>% head(9)
```

```
## # A tibble: 9 x 2  
##   body_type      n  
##   <chr>      <int>  
## 1 average    5620  
## 2 fit        4431  
## 3 curvy      3811  
## 4 <NA>       2703  
## 5 thin       2469  
## 6 athletic  2309  
## 7 full figured   870  
## 8 a little extra  821  
## 9 skinny       601
```

# Making a data . frame function pipeable

```
transform_all_my_numerics <- function(df, transformation) {  
  df %>% mutate(across(where(is.numeric), transformation))  
}
```

```
okcupid %>%  
  transform_all_my_numerics(log) %>%  
  select_if(is.numeric)
```

```
## # A tibble: 59,946 x 4  
##       age height income height_cm  
##   <dbl> <dbl> <dbl>    <dbl>  
## 1  3.09   4.32  NA      5.25  
## 2  3.56   4.25  11.3    5.18  
## 3  3.64   4.22  NA      5.15  
## 4  3.14   4.26   9.90    5.19  
## 5  3.37   4.19  NA      5.12  
## 6  3.37   4.20  NA      5.14  
## 7  3.47   4.17  NA      5.11  
## 8  3.43   4.17  NA      5.11  
## 9  3.18   4.20  NA      5.14  
## 10 3.61   4.17  NA      5.11  
## # ... with 59,936 more rows
```

# invisible()

If your function does not return a `data.frame` make it!

```
print_n_rows <- function(df) {  
  cat("number of rows: ", nrow(df), "\n")  
  invisible(df)  
}  
  
okcupid %>%  
  filter(sex == "m", body_type %in% c("fit", "thin", "skinny")) %>%  
  print_n_rows() %>%  
  summarise(mean_height = mean(height_cm, trim = 0.025))
```

```
## number of rows: 11698
```

```
## # A tibble: 1 x 1  
##   mean_height  
##   <dbl>  
## 1      179.
```

## Or even better:

```
filter_and_print <- function(df, ...) {  
  df_filtered <- df %>% filter(...)  
  cat("number of rows: ", nrow(df_filtered), "\n")  
  df_filtered  
}  
  
okcupid %>%  
  filter_and_print(sex == "m", body_type %in% c("fit", "thin", "slim"),  
  summarise(mean_height = mean(height_cm, trim = 0.025))
```

```
## number of rows: 11698
```

```
## # A tibble: 1 x 1  
##   mean_height  
##         <dbl>  
## 1         179.
```

💡 for better living see `glue::glue("number of rows: {nrow(df)}")`