

# 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 × 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 × 10  
##   essay0      essay1 essay2 essay3 essay4 essay5 essay6 essay7 essay  
##   <chr>      <chr>  <chr>  <chr>  <chr>  <chr>  <chr>  <chr>  <chr>  
## 1 "i love it he... "bein... "scra... "my b... "musi... "vege... "maki... "kick... "wow,.  
## 2 "i'm silly. i... "curr... "eati... "my p... "prid... "noth... "my n... "eati... "i'm .  
## 3 "welcome... i... "pian... "sing... "my h... "book... "touc... "diff... <NA>    <NA>  
## 4 "purebred cal... "by d... "bein... "my h... "to s... "- wa... "my n... "i tr... "ummm.  
## 5 "i wasn't lik... "chic... "usin... "lips... "arma... "lust... "ente... "maki... <NA>  
## 6 "hello!<br />... "i ta... "anyt... "my a... "book... "my g... "ever... "i wo... <NA>  
## 7 "life's but a... "i'm ... "gett... "its ... "otis... "1. s... "the ... "oh m... "i do.  
## 8 "everything h... "livi... "bein... "my e... "dubs... "dirt... "how ... "reco... "i lo.  
## 9 "love to do a... "dail... "i am... "my s... "love... "masc... "if i... <NA>    "i am.  
## 10 "<b>physical ... "i am... "piss... "my s... "book... "my d... "who ... "tota... "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 × 10  
##   essay0      essay1 essay2 essay3 essay4 essay5 essay6 essay7 essay  
##   <chr>      <chr> <chr> <chr> <chr> <chr> <chr> <chr> <chr>  
## 1 "i love it he... "bein... "scra... "my b... "musi... "vege... "maki... "kick... "wow,.  
## 2 "i'm silly. i... "curr... "eati... "my p... "prid... "noth... "my n... "eati... "i'm .  
## 3 "welcome... i... "pian... "sing... "my h... "book... "touc... "diff... <NA> <NA>  
## 4 "purebred cal... "by d... "bein... "my h... "to s... "- wa... "my n... "i tr... "ummm.  
## 5 "i wasn't lik... "chic... "usin... "lips... "arma... "lust... "ente... "maki... <NA>  
## 6 "hello!<br />... "i ta... "anyt... "my a... "book... "my g... "ever... "i wo... <NA>  
## 7 "life's but a... "i'm ... "gett... "its ... "otis... "1. s... "the ... "oh m... "i do.  
## 8 "everything h... "livi... "bein... "my e... "dubs... "dirt... "how ... "reco... "i lo.  
## 9 "love to do a... "dail... "i am... "my s... "love... "masc... "if i... <NA> "i am.  
## 10 "<b>physical ... "i am... "piss... "my s... "book... "my d... "who ... "tota... "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 × 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 × 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 × 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 × 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 × 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 × 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 × 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 × 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
```



## To get rid of ties:

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

```
## # A tibble: 6 × 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 × 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 × 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 %>%  
  mutate(income = na_if(income, -1)) %>%  
  select_if(is.numeric)
```

```
## # A tibble: 59,946 × 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 %>%  
  mutate(income = na_if(income, -1)) %>%  
  select_if(is.numeric) %>%  
  mutate_all(log)
```

```
## # A tibble: 59,946 × 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 %>%  
  mutate(income = na_if(income, -1)) %>%  
  select_if(is.numeric) %>%  
  mutate_all(list(logged = log, sqrted = sqrt))
```

```
## # A tibble: 59,946 × 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 %>%
  mutate(income = na_if(income, -1)) %>%
  select_if(is.numeric) %>%
  mutate_all(list(logged = function(x) log(x + 1), sqrted = sqrt))
```

```
## # A tibble: 59,946 × 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) all(is.numeric(x) & (is.na(x) | x >= 0))

okcupid %>%
  mutate(income = na_if(income, -1)) %>%
  select_if(is_non_negative) %>%
  mutate_all(list(logged = function(x) log(x + 1), sqrted = sqrt))

## # A tibble: 59,946 × 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 %>%
  mutate(income = na_if(income, -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 × 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 × 4  
## # Groups:   drugs [4]  
##   drugs      age income sex  
##   <chr>    <dbl> <dbl> <chr>  
## 1 never      23 100000 m  
## 2 never      22      NA f  
## 3 never      44      NA m  
## 4 often      35 150000 m  
## 5 often      22      NA m  
## 6 often      19      NA f  
## 7 sometimes  22      NA m  
## 8 sometimes  36      NA m  
## 9 sometimes  35      NA m  
## 10 <NA>      29      NA m  
## 11 <NA>      39      NA f  
## 12 <NA>      29      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 × 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 × 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 × 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", "sl  
  summarise(mean_height = mean(height_cm, trim = 0.025))
```

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

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

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