Wrangling

Basel R Bootcamp

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Where you're at...

1 - Loaded packages (like `tidyverse`) with `library()`

2 - Loaded external files as a new dataframe

3 - Explore dataframes

4 - Calculate descriptive statistics on specific columns

What's next?... **Wrangling!**

```
# Step 0) Load libraries

library(tidyverse)

# Step 1) Read file called baslers.txt
#  in a data folder with read_csv()
#  and save as new object baslers

baslers <- read_csv(file = "data/baslers.txt")

# Step 2) Explore data

View(baslers)   # Open in new window
dim(baslers)    # Show number of rows and columns
names(baslers)  # Show names

# Step 3) Calculate descriptives on named colums

mean(baslers$age)   # What is the mean age?
table(baslers$sex)  # How many of each sex?

# Step 4) ...
```

What is wrangling?

Transform

Change column names

Add new columns

Organise

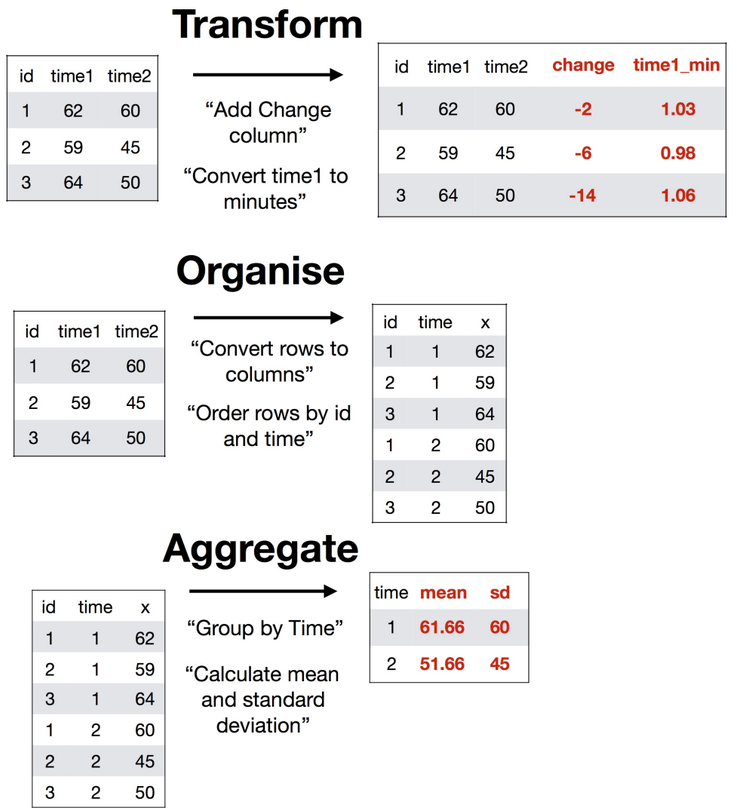
Sort data by columns

Merging data from two separate dataframes

Move data between columns and rows

Aggregate

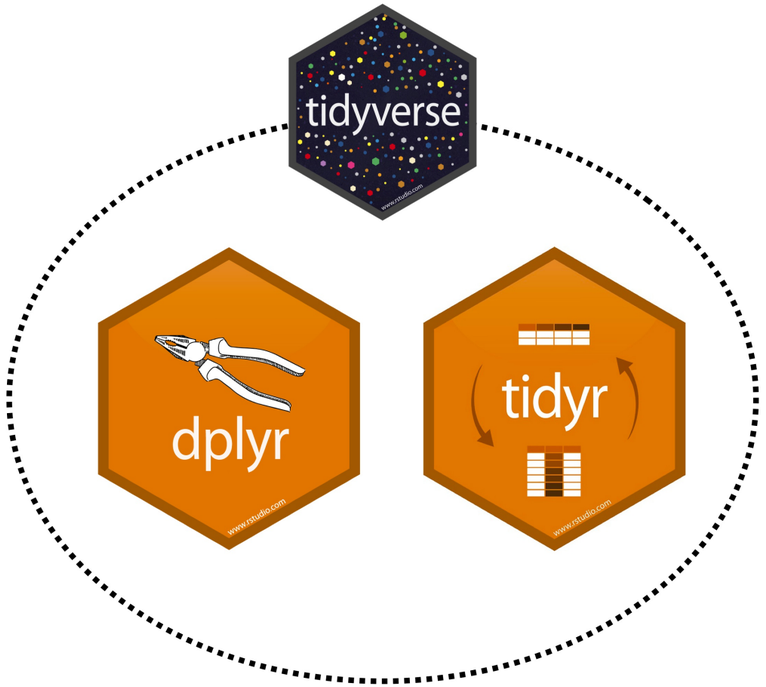
Group data and summarise



dplyr&tidyr

To wrangle data in R, we will use the `dplyr` and `tidyr` packages.

```
# Load packages individually

# install.packages('dplyr')
# install.packages('tidyr')

library(dplyr)
library(tidyr)

# Or just use the tidyverse!

# install.packages('tidyverse')

library(tidyverse)
```



The Pipe! %>%

`dplyr` makes extensive use of a new operator called the "Pipe" %>%

Read the "Pipe" %>% as "And Then..."

```
# Start with data
data %>% # AND THEN...

DO_SOMETHING %>% # AND THEN...

DO_SOMETHING %>% # AND THEN...

DO_SOMETHING %>% # AND THEN...
```

This is not a pipe (but %>% is!)

The Pipe! %>%

Task: Calculate the mean of a vector of `scores`

```
# Create a vector score
score <- c(8, 4, 6, 3, 7, 3)
```

Base-R method

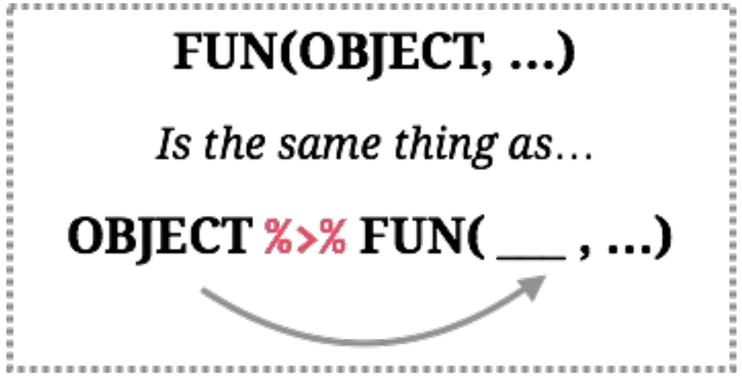
```
mean(x = score)
```

```
## [1] 5.167
```

Pipe %>% method

```
score %>%  # AND THEN
  mean()
```

```
## [1] 5.167
```



The **OBJECT** to the left of the pipe %>% becomes the first argument to the **FUN( )** to the right of the pipe

The Pipe! %>%

Task: Calculate the mean of a vector of `scores` and round to 1 digit.

```
# Create a vector score
score <- c(8, 4, 6, 3, 7, 3)
```

Base-R method

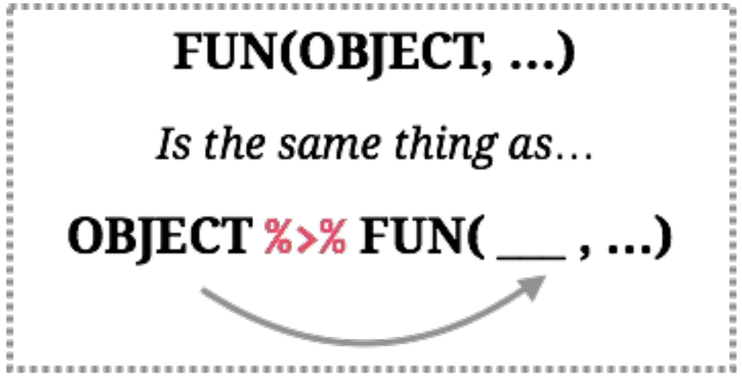
```
round(x = mean(score), digits = 1)
```

```
## [1] 5.2
```

Pipe %>% method

```
score %>%          # AND THEN
  mean() %>%       # AND THEN
  round(digits = 1)
```

```
## [1] 5.2
```

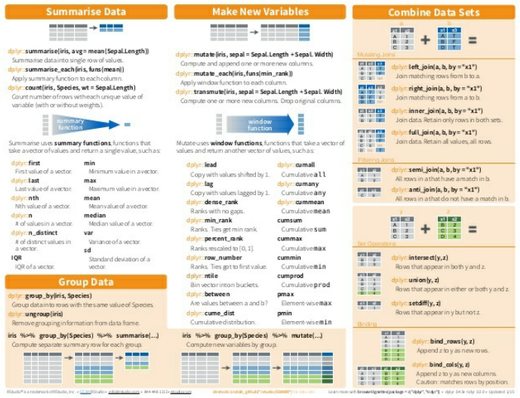


The **OBJECT** to the left of the pipe %>% becomes the first argument to the **FUN( )** to the right of the pipe

dplyr Functions

There are **dozens of wrangling functions** in dplyr.

For an overview, check out
dplyr.tidyverse.org



Wrangling Cheat Sheet

1) Change column name to sex

```
df %>%
    rename(sex = b)
```

2) Add new bmi column

```
df %>%
   mutate(bmi = weight / height ^ 2))
```

id	~~b~~ sex	weight	height	bmi
1	F	46	1.65	27.88
2	F	36	1.76	20.45
3	F	44	1.57	28.03
~~4~~	~~M~~	~~38~~	~~1.78~~	~~21.35~~
~~5~~	~~M~~	~~35~~	~~1.87~~	~~18.72~~

3) Only females

```
df %>%
  filter(sex == "F")
```

All 3 Steps at once!

```
df %>%
    rename(sex = b) %>%
    mutate(bmi = weight / height ^ 2)) %>%
    filter(sex == "F")
```

Transformation Functions

Function	Description
`rename()`	Change column names
`mutate()`	Create a new column from existing columns
`case_when()`	Recode values from a vector to another
`left_join()`	Combine multiple dataframes

```
patients_df   # Demographic data
```

```
## # A tibble: 5 x 3
##      id     b     c
##   <dbl> <dbl> <dbl>
## 1     1    37     1
## 2     2    65     2
## 3     3    57     2
## 4     4    34     1
## 5     5    45     2
```

rename

Change **column names** with `rename()`.

```
df %>%
  rename(NEW = OLD,
         NEW = OLD)
```

```
patients_df  # Original
```

```
## # A tibble: 5 x 3
##      id     b     c
##   <dbl> <dbl> <dbl>
## 1     1    37     1
## 2     2    65     2
## 3     3    57     2
## 4     4    34     1
## 5     5    45     2
```

Change the old name "b" to "age", and "c" to "arm"

```
# 0) Start with patients_df data
patients_df %>%

# 1) Change column names with rename()
  rename(age = b,  # New = Old
         arm = c)  # New = Old
```

```
## # A tibble: 5 x 3
##      id   age   arm
##   <dbl> <dbl> <dbl>
## 1     1    37     1
## 2     2    65     2
## 3     3    57     2
## 4     4    34     1
## 5     5    45     2
```

mutate

Calculate **new columns**, or change existing ones, with `mutate()`.

```
df %>%
  mutate(
   NEW1 = DEFINITION1,
   NEW2 = DEFINITION2,
   NEW3 = DEFINITION3,
   ...
  )
```

Calculate two new columns `age_months` and `age_years`

```
patients_df %>%

  rename(age = b,
         arm = c) %>%   # AND THEN...

# Create new columns with mutate()
  mutate(age_months = age * 12,
         age_decades = age / 10)
```

```
## # A tibble: 5 x 5
##      id   age   arm age_months age_decades
##   <dbl> <dbl> <dbl>      <dbl>       <dbl>
## 1     1    37     1        444         3.7
## 2     2    65     2        780         6.5
## 3     3    57     2        684         5.7
## 4     4    34     1        408         3.4
## 5     5    45     2        540         4.5
```

case_when

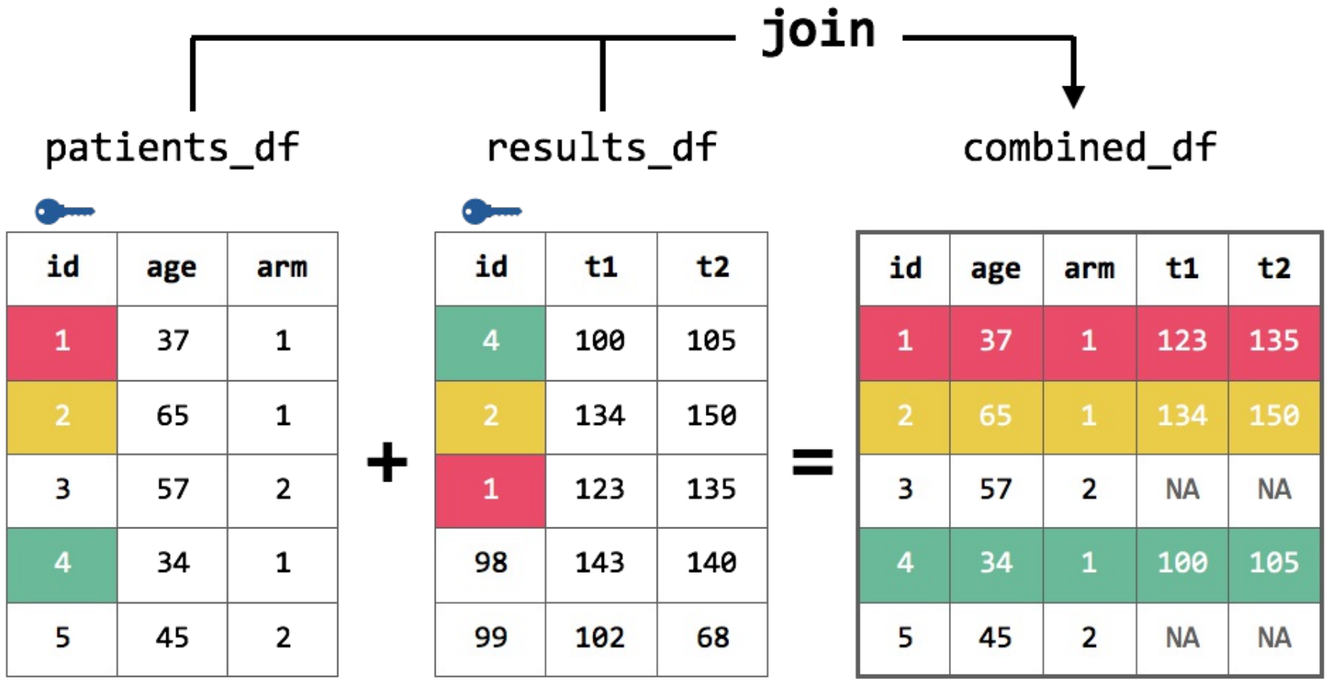
Use `case_when()` with `mutate()` to define **new columns based on logical conditions**.

```
# Using mutate(case_when())
df %>%
  mutate(
    NEW = case_when(
      COND1 ~ VAL1,
      COND2 ~ VAL2
    ))
```

```
patients_df %>%

  rename(age = b,
         arm = c) %>%

  # Create column arm_char based on values of arm

  mutate(arm_char = case_when(arm == 1 ~ "placebo",
                              arm == 2 ~ "drug"))
```

```
## # A tibble: 5 x 4
##      id   age   arm arm_char
##   <dbl> <dbl> <dbl> <chr>
## 1     1    37     1 placebo
## 2     2    65     2 drug
## 3     3    57     2 drug
## 4     4    34     1 placebo
## 5     5    45     2 drug
```

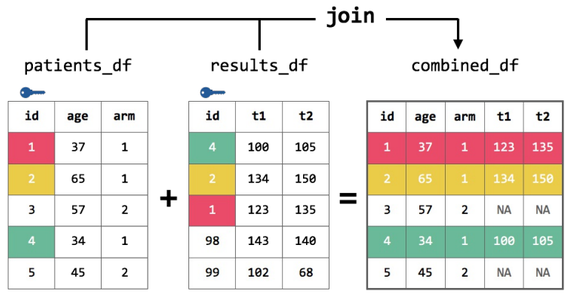
Joining data



left_join

Use `left_join()` to **combine two data frames** based on one or more key columns

```
# Join df2 to df1
#   using KEY as the key column
df1 %>%
  left_join(df2,
      by = c("KEY"))
```




```
# Join patients_df with results_df to create combined_df
combined_df <- patients_df %>%
  rename(age = b, arm = c) %>%
  mutate(arm_char = case_when(arm == 1 ~ "placebo",
                              arm == 2 ~ "drug")) %>%

# Join with results_df with left_join()
  left_join(results_df, by = "id")

# Show a few columns
combined_df %>%
  select(id, arm, age, t1, t2)
```

```
## # A tibble: 5 x 5
##      id   arm   age    t1    t2
##   <dbl> <dbl> <dbl> <dbl> <dbl>
## 1     1     1    37   123   135
## 2     2     2    65   143   140
## 3     3     2    57    NA    NA
## 4     4     1    34   100   105
## 5     5     2    45    NA    NA
```

Keep in mind

1 - Don't forget to start by assigning to a new (or existing) object with <-

2 - Keep adding new functions connected by the pipe %>%

3 - Order matters! You can refer to new columns in later code

```
# 0) Start with patients_df data
combined_df <- patients_df %>%

# 1) Change column names with rename()
  rename(age = b,
         arm = c) %>%  # AND THEN...

# 2) Create new columns with mutate()
  mutate(age_months = age * 12,
         age_decades = age / 10,
         arm_char = case_when(arm == 0 ~ "placebo",
                              arm == 1 ~ "drug")
         ) %>%  # AND THEN..

# 3) Add data from results_df with left_join()
  left_join(results_df, by = "id")
```

Organisation Functions

Organisation functions help you shuffle your data by **sorting rows** by columns, **filter rows** based on criteria, **select columns** (etc).

Function	Purpose	Example
`arrange()`	Sort rows by columns	`df %>% arrange(arm, age)`
`slice()`	Select rows by location	`df %>% slice(1:10)`
`filter()`	Select specific rows by criteria	`df %>% filter(age > 50)`
`select()`	Select specific columns	`df %>% select(arm, t1)`

arrange

Use `arrange()` to **arrange (aka, sort) rows** in increasing or decreasing order of one (or more) columns.

To sort in descending order, use `desc()`

```
# Sort combined_df by id
# then in descending order of age
combined_df %>%
  arrange(id, desc(age))
```

```
## # A tibble: 5 x 6
##      id   age   arm arm_char    t1    t2
##   <dbl> <dbl> <dbl> <chr>    <dbl> <dbl>
## 1     1    37     1 placebo    123   135
## 2     2    65     2 drug       143   140
## 3     3    57     2 drug        NA    NA
## 4     4    34     1 placebo    100   105
## 5     5    45     2 drug        NA    NA
```

filter

Use `filter()` to **select rows** (and remove others) based on criteria

For complex conditions, chain multiple logical comparison operators with & (AND) and | (OR)

== - is equal to

<, > - smaller/greater than

≤, ≥ - smaller/greater than or equal

&, && - logical AND

|, || - logical OR

Select patients over 30 given drug.

```
# Filter patients older than 30 given drug
combined_df %>%
  arrange(id, desc(age)) %>%
  filter(age > 30 & arm_char == "drug")
```

```
## # A tibble: 3 x 6
##      id   age   arm arm_char    t1    t2
##   <dbl> <dbl> <dbl> <chr>    <dbl> <dbl>
## 1     2    65     2 drug       143   140
## 2     3    57     2 drug        NA    NA
## 3     5    45     2 drug        NA    NA
```

select

Use `select()` to **select columns** (and remove all others)

```
# Select columns id, age
df %>%
  select(id, age)
```

Remove columns with `-`.

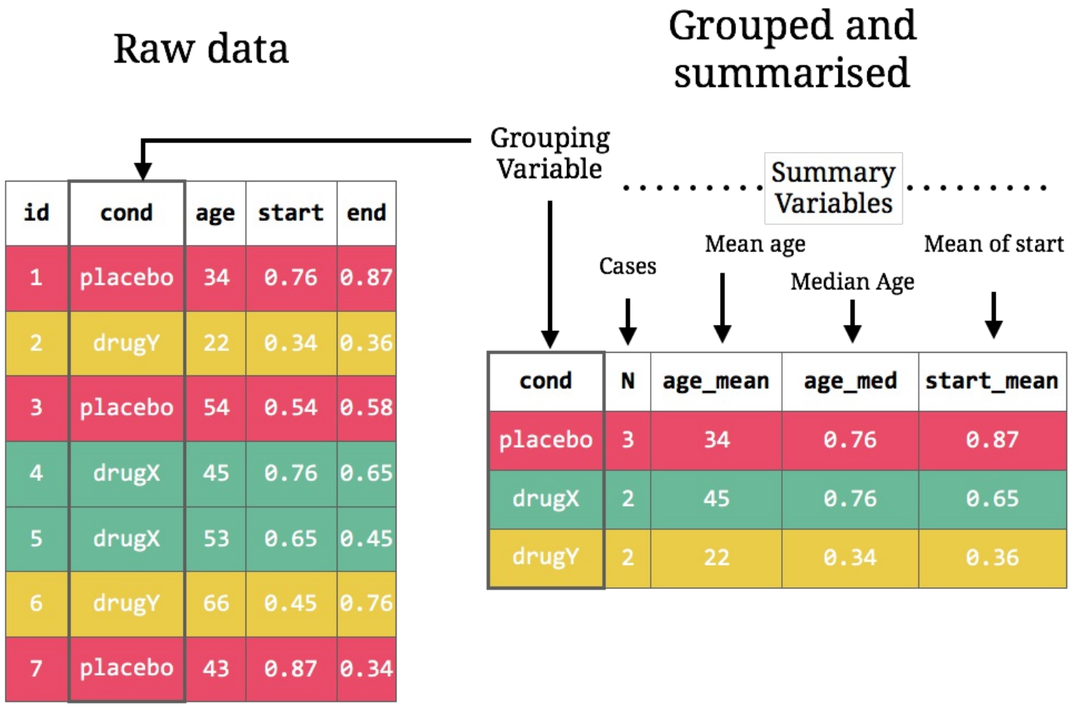
```
# Select everything BUT sex and id
df %>%
  select(-sex, -id)
```

Remove `age_months` and `age_decades` columnns.

```
combined_df %>%

  arrange(id, desc(age)) %>%

  filter(arm_char == "drug" & age > 30) %>%

# Drop age and arm columns
  select(-age, -arm)
```

```
## # A tibble: 3 x 4
##      id arm_char    t1    t2
##   <dbl> <chr>    <dbl> <dbl>
## 1     2 drug       143   140
## 2     3 drug        NA    NA
## 3     5 drug        NA    NA
```

Grouped Aggregation



id	cond	age	start	end
1	placebo	34	0.76	0.87
2	drugY	22	0.34	0.36
3	placebo	54	0.54	0.58
4	drugX	45	0.76	0.65
5	drugX	53	0.65	0.45
6	drugY	66	0.45	0.76
7	placebo	43	0.87	0.34

cond	N	age_mean	age_med	start_mean
placebo	3	34	0.76	0.87
drugX	2	45	0.76	0.65
drugY	2	22	0.34	0.36

group_by, summarise

Use group_by() to **group data** according to one or more columns

After grouping data, use summarise() to **calculate summary statistics** across groups of data

Statistical functions

Function	asdf
n()	Number of cases in each group
mean(), median(), max(), min() sum()	Summary stats

```
# Group data by arm, and calculate many
#  summary statistics
combined_df %>%
  group_by(arm) %>%
  summarise(
    N = n(),
    age_mean = mean(age),
    t1_mean = mean(t1, na.rm = TRUE),
    t2_mean = mean(t2, na.rm = TRUE)
  )
```

```
## # A tibble: 2 x 5
##   arm         N age_mean t1_mean t2_mean
##   <chr>   <int>    <dbl>   <dbl>   <dbl>
## 1 drug        3     55.7    143      140
## 2 placebo     2     35.5    112.     120
```

Reshaping data

Two key functions that allow you to `reshape` a dataframe between 'wide'and 'long' formats.

Some functions require data to be in a certain shape.

Two key tidyr functions

Function	Result
`gather()`	Move data from 'wide' to 'long' format
`spread()`	Move data from 'long' to 'wide' format

'Wide' vs. 'Long' data

```
# Wide format
stock_w
```

```
##   id t1 t2
## 1  a 10 20
## 2  b 20 26
## 3  c 15 30
```

```
# Long format
stock_l
```

```
##   id time measure
## 1  a   t1      10
## 2  b   t1      20
## 3  c   t1      15
## 4  a   t2      20
## 5  b   t2      26
## 6  c   t2      30
```

gather

```
# Show wide data
stock_w
```

```
##   id t1 t2
## 1  a 10 20
## 2  b 20 26
## 3  c 15 30
```

```
# "Gather" wide data to long
stock_w %>%
  gather(time,    # New group column
         measure, # New target column
         -id)     # ID column
```

```
##   id time measure
## 1  a   t1      10
## 2  b   t1      20
## 3  c   t1      15
## 4  a   t2      20
## 5  b   t2      26
## 6  c   t2      30
```

spread

```
# Show long data
stock_l
```

```
##   id time measure
## 1  a   t1      10
## 2  b   t1      20
## 3  c   t1      15
## 4  a   t2      20
## 5  b   t2      26
## 6  c   t2      30
```

```
# "Spread" long data to wide
stock_l %>%
  spread(time,    # Old group column
         measure) # Old target column
```

```
##   id t1 t2
## 1  a 10 20
## 2  b 20 26
## 3  c 15 30
```

Summary

1 - Start by assigning your result to a new object to save it!

2 - "Keep the pipe %>% going" to continue working with your data frame.

3 - The output of dplyr functions will (almost) always be a **tibble**.

4 - You can almost always include **multiple operations** within each function.

```
# Assign result to baslers_agg

baslers_agg <- baselers %>%

  # Change column names with rename()
  rename(age_years = age,
         weight_kg = weight)  %>% # PIPE!

  # Select specific rows with filter()
  filter(age_years < 40)  %>% # PIPE!

  # Create new columns witb mutate()
  mutate(debt_ratio = debt / income)  %>% # PIPE!

  # Group data with group_by()
  group_by(sex) %>% # PIPE!

  # Calculate summary statistics with summarise()
  summarise(income_mean = mean(income),
            debt_mean = mean(debt),
            dr_mean = mean(dr))
```

Practical

Link to practical