Intro to R

Manipulating Data in R

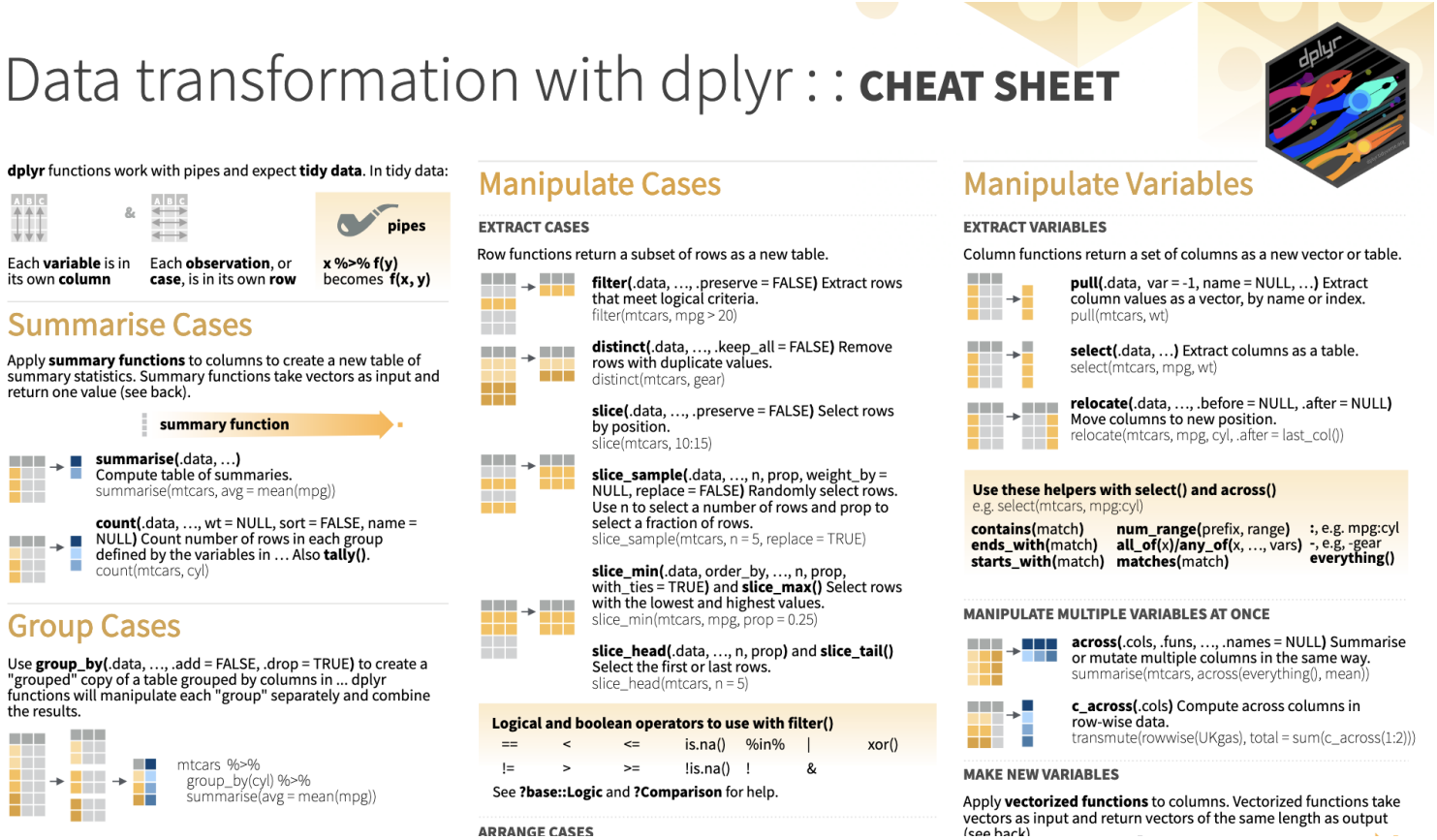
Reshaping Data

In this module, we will show you how to:

1. Reshape data from wide (fat) to long (tall)
2. Reshape data from long (tall) to wide (fat)
3. Merge Data/Joins

Cheatsheet

https://raw.githubusercontent.com/rstudio/cheatsheets/main/data-transformation.pdf



Data transformation with dplyr : : CHEAT SHEET

dplyr functions work with pipes and expect **tidy data**. In tidy data:

Each **variable** is in its own **column** & Each **observation**, or **case**, is in its own **row**

pipes x %>% f(y) becomes f(x, y)

Summarise Cases

Apply **summary functions** to columns to create a new table of summary statistics. Summary functions take vectors as input and return one value (see back).

summary function

summarise(.data, …)
Compute table of summaries.
summarise(mtcars, avg = mean(mpg))

count(.data, …, wt = NULL, sort = FALSE, name = NULL) Count number of rows in each group defined by the variables in … Also **tally()**.
count(mtcars, cyl)

Group Cases

Use **group_by**(.data, …, .add = FALSE, .drop = TRUE) to create a "grouped" copy of a table grouped by columns in ... dplyr functions will manipulate each "group" separately and combine the results.

```
mtcars %>%
  group_by(cyl) %>%
  summarise(avg = mean(mpg))
```

Manipulate Cases

EXTRACT CASES

Row functions return a subset of rows as a new table.

filter(.data, …, .preserve = FALSE) Extract rows that meet logical criteria.
filter(mtcars, mpg > 20)

distinct(.data, …, .keep_all = FALSE) Remove rows with duplicate values.
distinct(mtcars, gear)

slice(.data, …, .preserve = FALSE) Select rows by position.
slice(mtcars, 10:15)

slice_sample(.data, …, n, prop, weight_by = NULL, replace = FALSE) Randomly select rows. Use n to select a number of rows and prop to select a fraction of rows.
slice_sample(mtcars, n = 5, replace = TRUE)

slice_min(.data, order_by, …, n, prop, with_ties = TRUE) and **slice_max()** Select rows with the lowest and highest values.
slice_min(mtcars, mpg, prop = 0.25)

slice_head(.data, …, n, prop) and **slice_tail()** Select the first or last rows.
slice_head(mtcars, n = 5)

Logical and boolean operators to use with filter()

==	<	<=	is.na()	%in%	|	xor()
!=	>	>=	!is.na()	!	&	

See **?base::Logic** and **?Comparison** for help.

ARRANGE CASES

Manipulate Variables

EXTRACT VARIABLES

Column functions return a set of columns as a new vector or table.

pull(.data, var = -1, name = NULL, …) Extract column values as a vector, by name or index.
pull(mtcars, wt)

select(.data, …) Extract columns as a table.
select(mtcars, mpg, wt)

relocate(.data, …, .before = NULL, .after = NULL) Move columns to new position.
relocate(mtcars, mpg, cyl, .after = last_col())

Use these helpers with select() and across()
e.g. select(mtcars, mpg:cyl)

contains(match)	**num_range**(prefix, range)	:, e.g. mpg:cyl
ends_with(match)	**all_of**(x)/**any_of**(x, …, vars)	-, e.g, -gear
starts_with(match)	**matches**(match)	**everything()**

MANIPULATE MULTIPLE VARIABLES AT ONCE

across(.cols, .funs, …, .names = NULL) Summarise or mutate multiple columns in the same way.
summarise(mtcars, across(everything(), mean))

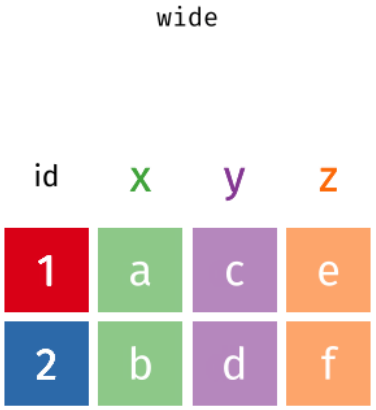
c_across(.cols) Compute across columns in row-wise data.
transmute(rowwise(UKgas), total = sum(c_across(1:2)))

MAKE NEW VARIABLES

Apply **vectorized functions** to columns. Vectorized functions take vectors as input and return vectors of the same length as output (see back).

What is wide/long data?

https://github.com/gadenbuie/tidyexplain/blob/main/images/tidyr-pivoting.gif



What is wide/long data?

Data is stored *differently* in the tibble.

Wide: has many columns

```
# A tibble: 1 x 4
  State   June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>   <chr>          <chr>         <chr>
1 Alabama 37.2%          36.0%         32.4%
```

Long: column names become data

```
# A tibble: 3 x 3
  State   name            value
  <chr>   <chr>           <chr>
1 Alabama June_vacc_rate  37.2%
2 Alabama May_vacc_rate   36.0%
3 Alabama April_vacc_rate 32.4%
```

What is wide/long data?

Wide: multiple columns per individual, values spread across multiple columns

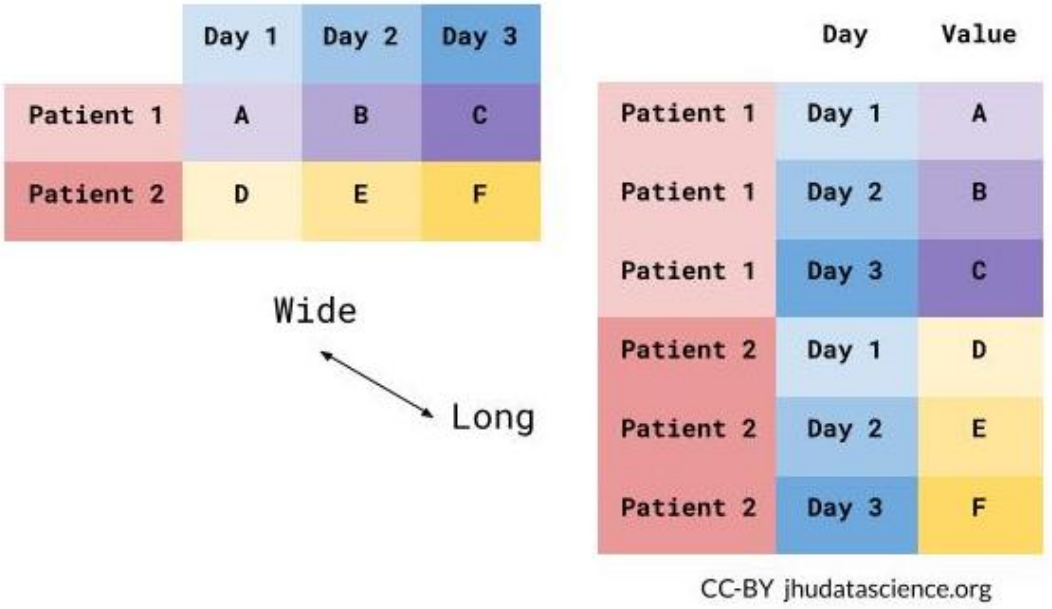
```
# A tibble: 2 x 4
  State   June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>   <chr>          <chr>         <chr>
1 Alabama 37.2%          36.0%         32.4%
2 Alaska  47.5%          46.2%         41.7%
```

Long: multiple rows per observation, a single column contains the values

```
# A tibble: 6 x 3
  State   name            value
  <chr>   <chr>           <chr>
1 Alabama June_vacc_rate  37.2%
2 Alabama May_vacc_rate   36.0%
3 Alabama April_vacc_rate 32.4%
4 Alaska  June_vacc_rate  47.5%
5 Alaska  May_vacc_rate   46.2%
6 Alaska  April_vacc_rate 41.7%
```

What is wide/long data?

Data is wide or long **with respect** to certain variables.



Why do we need to switch between wide/long data?

Wide: **Easier for humans to read**

```
# A tibble: 2 x 4
  State   June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>   <chr>          <chr>         <chr>
1 Alabama 37.2%          36.0%         32.4%
2 Alaska  47.5%          46.2%         41.7%
```

Long: **Easier for R to make plots & do analysis**

```
# A tibble: 6 x 3
  State   name            value
  <chr>   <chr>           <chr>
1 Alabama June_vacc_rate  37.2%
2 Alabama May_vacc_rate   36.0%
3 Alabama April_vacc_rate 32.4%
4 Alaska  June_vacc_rate  47.5%
5 Alaska  May_vacc_rate   46.2%
6 Alaska  April_vacc_rate 41.7%
```

tidyr package

`tidyr` allows you to "tidy" your data. We will be talking about:

- `pivot_longer` - make multiple columns into variables, (wide to long)
- `pivot_wider` - make a variable into multiple columns, (long to wide)
- `separate` - string into multiple columns (review)

The `reshape` command exists. It is a **confusing** function. Don't use it.

`pivot_longer`...

Reshaping data from wide (fat) to long (tall): tidyr

`tidyr::pivot_longer` - puts column data into rows.

- First describe which columns we want to “pivot_longer”
- `names_to =` gives a new name to the pivoted columns
- `values_to =` gives a new name to the values that used to be in those columns

```
{long_data} <- {wide_data} %>% pivot_longer(cols = {columns to pivot},
                                            names_to = {New column name: contains old column names},
                                            values_to = {New column name: contains cell values})
```

Reshaping data from wide (fat) to long (tall): tidyr

```
wide_data
```

```
# A tibble: 1 x 3
  June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>          <chr>         <chr>
1 37.2%          36.0%         32.4%
```

```
long_data <- wide_data %>% pivot_longer(cols = everything(),
                                        names_to = "Month",
                                        values_to = "Rate")
long_data
```

```
# A tibble: 3 x 2
  Month           Rate
  <chr>           <chr>
1 June_vacc_rate  37.2%
2 May_vacc_rate   36.0%
3 April_vacc_rate 32.4%
```

Data used: Charm City Circulator

http://jhudatascience.org/intro_to_R_class/data/Charm_City_Circulator_Ridership.csv

```
circ <- jhur::read_circulator()
head(circ, 5)
```

```
# A tibble: 5 x 15
  day     date    orangeBoardings orangeAlightings orangeAverage purpleBoardir
  <chr>   <chr>             <dbl>            <dbl>         <dbl>            <db
1 Monday  01/11/…              877             1027           952
2 Tuesday 01/12/…              777              815           796
3 Wednes… 01/13/…             1203             1220          1212.
4 Thursd… 01/14/…             1194             1233          1214.
5 Friday  01/15/…             1645             1643          1644
# … with 9 more variables: purpleAlightings <dbl>, purpleAverage <dbl>,
#   greenBoardings <dbl>, greenAlightings <dbl>, greenAverage <dbl>,
#   bannerBoardings <dbl>, bannerAlightings <dbl>, bannerAverage <dbl>,
#   daily <dbl>
```

Reshaping data from wide (fat) to long (tall): tidyr

```
long <- circ %>%
  pivot_longer(starts_with(c("orange","purple","green","banner")),
               names_to = "var",
               values_to = "number")
long
```

```
# A tibble: 13,752 x 5
   day    date       daily var              number
   <chr>  <chr>      <dbl> <chr>             <dbl>
 1 Monday 01/11/2010   952 orangeBoardings     877
 2 Monday 01/11/2010   952 orangeAlightings   1027
 3 Monday 01/11/2010   952 orangeAverage       952
 4 Monday 01/11/2010   952 purpleBoardings      NA
 5 Monday 01/11/2010   952 purpleAlightings     NA
 6 Monday 01/11/2010   952 purpleAverage        NA
 7 Monday 01/11/2010   952 greenBoardings       NA
 8 Monday 01/11/2010   952 greenAlightings      NA
 9 Monday 01/11/2010   952 greenAverage         NA
10 Monday 01/11/2010   952 bannerBoardings      NA
# … with 13,742 more rows
```

Reshaping data from wide (fat) to long (tall): tidyr

There are many ways to select the columns we want. Use `?tidyr_tidy_select` to look at more column selection options.

```
long <- circ %>%
  pivot_longer( !c(day, date, daily),
                names_to = "var",
                values_to = "number")
long
```

```
# A tibble: 13,752 x 5
   day    date       daily var              number
   <chr>  <chr>      <dbl> <chr>             <dbl>
 1 Monday 01/11/2010   952 orangeBoardings     877
 2 Monday 01/11/2010   952 orangeAlightings   1027
 3 Monday 01/11/2010   952 orangeAverage       952
 4 Monday 01/11/2010   952 purpleBoardings      NA
 5 Monday 01/11/2010   952 purpleAlightings     NA
 6 Monday 01/11/2010   952 purpleAverage        NA
 7 Monday 01/11/2010   952 greenBoardings       NA
 8 Monday 01/11/2010   952 greenAlightings      NA
 9 Monday 01/11/2010   952 greenAverage         NA
10 Monday 01/11/2010   952 bannerBoardings      NA
# … with 13,742 more rows
```

Reshaping data from wide (fat) to long (tall): tidyr

```
long %>% count(var)
```

```
# A tibble: 12 x 2
   var                 n
   <chr>           <int>
 1 bannerAlightings  1146
 2 bannerAverage     1146
 3 bannerBoardings   1146
 4 greenAlightings   1146
 5 greenAverage      1146
 6 greenBoardings    1146
 7 orangeAlightings  1146
 8 orangeAverage     1146
 9 orangeBoardings   1146
10 purpleAlightings  1146
11 purpleAverage     1146
12 purpleBoardings   1146
```

Cleaning up long data

We will use `str_replace` from the `stringr` package to put _ in the names

```
long <- long %>% mutate(
  var = str_replace(var, "Board", "_Board"),
  var = str_replace(var, "Alight", "_Alight"),
  var = str_replace(var, "Average", "_Average")
)
long
```

```
# A tibble: 13,752 x 5
   day    date       daily var                number
   <chr>  <chr>      <dbl> <chr>               <dbl>
 1 Monday 01/11/2010   952 orange_Boardings      877
 2 Monday 01/11/2010   952 orange_Alightings    1027
 3 Monday 01/11/2010   952 orange_Average        952
 4 Monday 01/11/2010   952 purple_Boardings       NA
 5 Monday 01/11/2010   952 purple_Alightings      NA
 6 Monday 01/11/2010   952 purple_Average         NA
 7 Monday 01/11/2010   952 green_Boardings        NA
 8 Monday 01/11/2010   952 green_Alightings       NA
 9 Monday 01/11/2010   952 green_Average          NA
10 Monday 01/11/2010   952 banner_Boardings       NA
# … with 13,742 more rows
```

Cleaning up long data

Now each `var` is Boardings, Averages, or Alightings. We use "`into =`" to name the new columns and "`sep =`" to show where the separation should happen.

```
long <- long %>%
  separate(var, into = c("line", "type"), sep = "_")
long
```

```
# A tibble: 13,752 x 6
   day    date       daily line   type        number
   <chr>  <chr>      <dbl> <chr>  <chr>        <dbl>
 1 Monday 01/11/2010   952 orange Boardings      877
 2 Monday 01/11/2010   952 orange Alightings    1027
 3 Monday 01/11/2010   952 orange Average        952
 4 Monday 01/11/2010   952 purple Boardings       NA
 5 Monday 01/11/2010   952 purple Alightings      NA
 6 Monday 01/11/2010   952 purple Average        NA
 7 Monday 01/11/2010   952 green  Boardings       NA
 8 Monday 01/11/2010   952 green  Alightings      NA
 9 Monday 01/11/2010   952 green  Average        NA
10 Monday 01/11/2010   952 banner Boardings       NA
# … with 13,742 more rows
```

pivot_wider...

Reshaping data from long (tall) to wide (fat): tidyr

`tidyr::pivot_wider` - spreads row data into columns.

- `names_from` = the old column whose contents will be spread into multiple new column names.
- `values_from` = the old column whose contents will fill in the values of those new columns.

```
{wide_data} <- {long_data} %>%
  pivot_wider(names_from = {Old column name: contains new column names},
              values_from = {Old column name: contains new cell values})
```

Reshaping data from long (tall) to wide (fat): tidyr

```
long_data
```

```
# A tibble: 3 x 2
  Month           Rate
  <chr>           <chr>
1 June_vacc_rate  37.2%
2 May_vacc_rate   36.0%
3 April_vacc_rate 32.4%
```

```
wide_data <- long_data %>% pivot_wider(names_from = "Month",
                                       values_from = "Rate")
wide_data
```

```
# A tibble: 1 x 3
  June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>          <chr>         <chr>
1 37.2%          36.0%         32.4%
```

Reshaping Charm City Circulator

```
long
```

```
# A tibble: 13,752 x 6
   day    date       daily line   type        number
   <chr>  <chr>      <dbl> <chr>  <chr>        <dbl>
 1 Monday 01/11/2010   952 orange Boardings      877
 2 Monday 01/11/2010   952 orange Alightings    1027
 3 Monday 01/11/2010   952 orange Average        952
 4 Monday 01/11/2010   952 purple Boardings       NA
 5 Monday 01/11/2010   952 purple Alightings      NA
 6 Monday 01/11/2010   952 purple Average        NA
 7 Monday 01/11/2010   952 green  Boardings       NA
 8 Monday 01/11/2010   952 green  Alightings      NA
 9 Monday 01/11/2010   952 green  Average        NA
10 Monday 01/11/2010   952 banner Boardings       NA
# … with 13,742 more rows
```

Reshaping Charm City Circulator

```
wide <- long %>% pivot_wider(names_from = "type",
                             values_from = "number")
wide
```

```
# A tibble: 4,584 x 7
   day       date       daily line   Boardings Alightings Average
   <chr>     <chr>      <dbl> <chr>      <dbl>      <dbl>   <dbl>
 1 Monday    01/11/2010  952  orange       877       1027    952
 2 Monday    01/11/2010  952  purple        NA         NA     NA
 3 Monday    01/11/2010  952  green         NA         NA     NA
 4 Monday    01/11/2010  952  banner        NA         NA     NA
 5 Tuesday   01/12/2010  796  orange       777        815    796
 6 Tuesday   01/12/2010  796  purple        NA         NA     NA
 7 Tuesday   01/12/2010  796  green         NA         NA     NA
 8 Tuesday   01/12/2010  796  banner        NA         NA     NA
 9 Wednesday 01/13/2010 1212. orange      1203       1220   1212.
10 Wednesday 01/13/2010 1212. purple        NA         NA     NA
# … with 4,574 more rows
```

Lab Part 1

Website

Joining in `dplyr`

- Merging/joining data sets together - usually on key variables, usually "id"
- `?join` - see different types of joining for `dplyr`
- `inner_join(x, y)` - only rows that match for `x` and `y` are kept
- `full_join(x, y)` - all rows of `x` and `y` are kept
- `left_join(x, y)` - all rows of `x` are kept even if not merged with `y`
- `right_join(x, y)` - all rows of `y` are kept even if not merged with `x`
- `anti_join(x, y)` - all rows from `x` not in `y` keeping just columns from `x`.

Merging: Simple Data

```
data_As
```

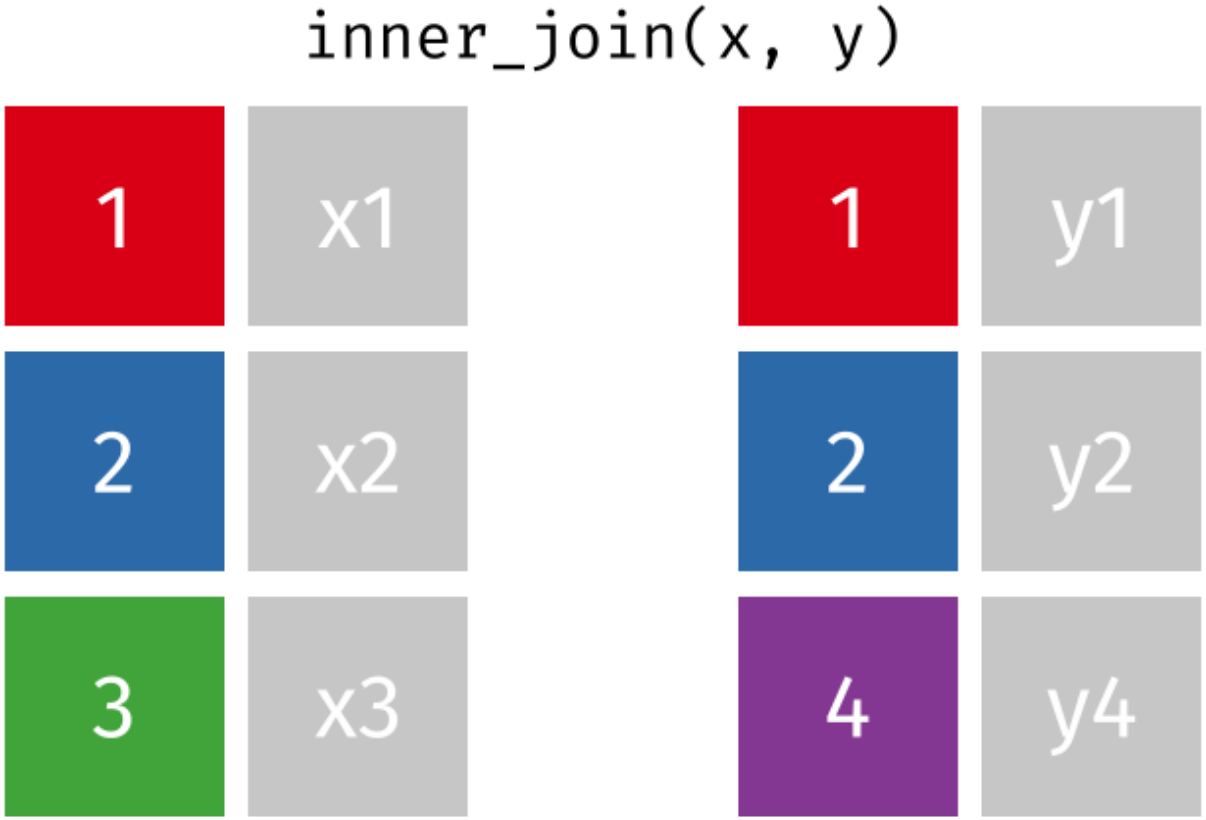
```
# A tibble: 2 x 3
  State   June_vacc_rate May_vacc_rate
  <chr>   <chr>          <chr>
1 Alabama 37.2%          36.0%
2 Alaska  47.5%          46.2%
```

```
data_cold
```

```
# A tibble: 2 x 2
  State  April_vacc_rate
  <chr>  <chr>
1 Maine  32.4%
2 Alaska 41.7%
```

Inner Join

https://github.com/gadenbuie/tidyexplain/blob/main/images/inner-join.gif



Inner Join

```
ij = inner_join(data_As, data_cold)
```

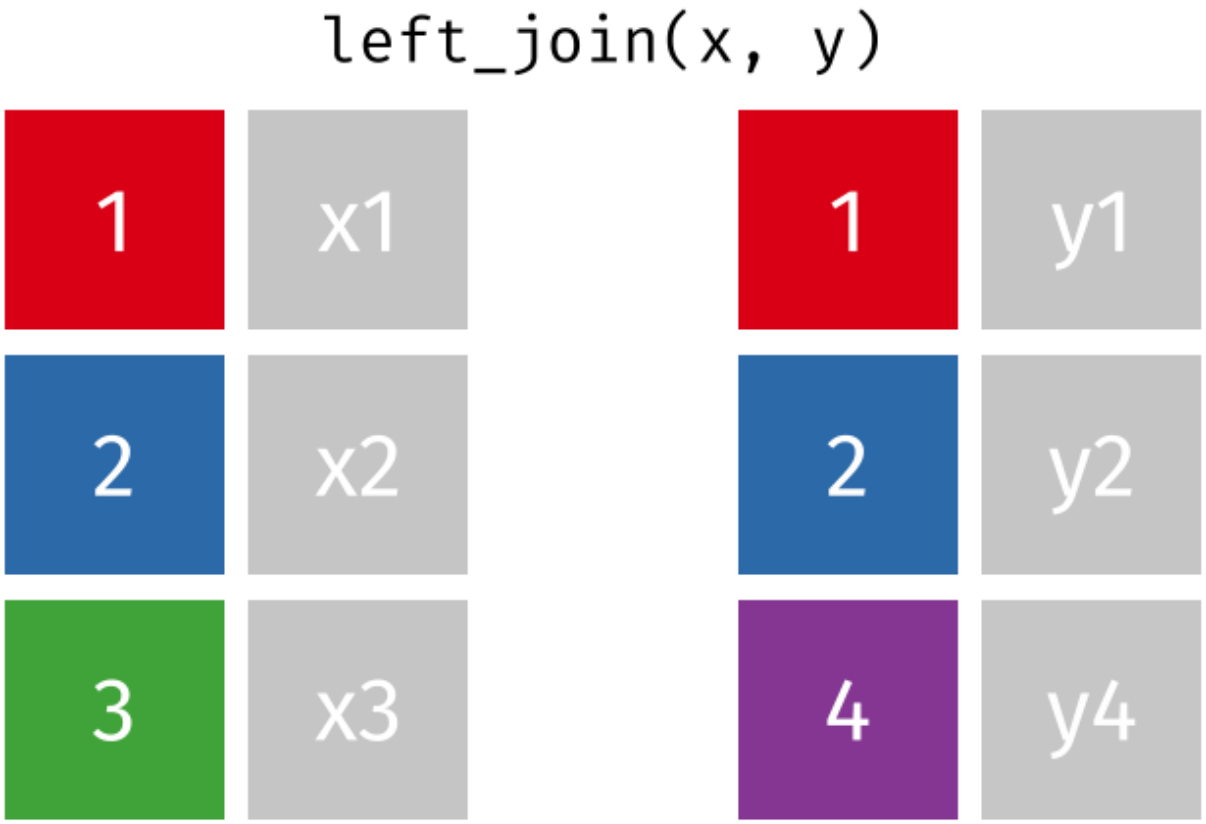
```
Joining, by = "State"
```

```
ij
```

```
# A tibble: 1 x 4
  State  June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>  <chr>          <chr>         <chr>
1 Alaska 47.5%          46.2%         41.7%
```

Left Join

https://raw.githubusercontent.com/gadenbuie/tidyexplain/main/images/left-join.gif



Left Join

```
lj = left_join(data_As, data_cold)
```

```
Joining, by = "State"
```

```
lj
```

```
# A tibble: 2 x 4
  State   June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>   <chr>          <chr>         <chr>
1 Alabama 37.2%          36.0%         <NA>
2 Alaska  47.5%          46.2%         41.7%
```

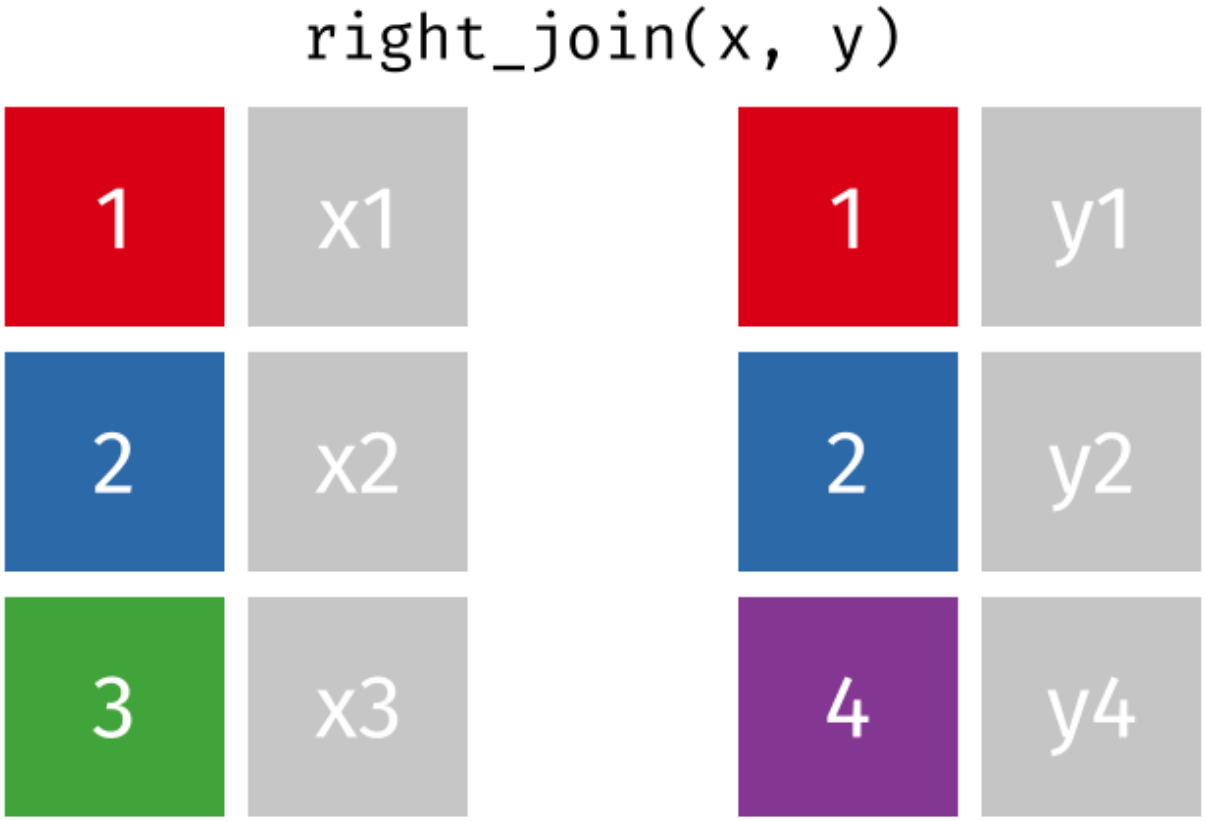
Install `tidylog` package to log outputs

```
# install.packages("tidylog")
library(tidylog)
left_join(data_As, data_cold)
```

```
Joining, by = "State"

left_join: added one column (April_vacc_rate)

           > rows only in x   1

           > rows only in y  (1)

           > matched rows     1

           >                ===

           > rows total       2

# A tibble: 2 x 4
  State   June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>   <chr>          <chr>         <chr>
1 Alabama 37.2%          36.0%         <NA>
2 Alaska  47.5%          46.2%         41.7%
```

Right Join

https://raw.githubusercontent.com/gadenbuie/tidyexplain/main/images/right-join.gif



Right Join

```
rj <- right_join(data_As, data_cold)
```

```
Joining, by = "State"

right_join: added one column (April_vacc_rate)

            > rows only in x  (1)

            > rows only in y   1

            > matched rows     1

            >                 ===

            > rows total       2
```

```
rj
```

```
# A tibble: 2 x 4
  State  June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>  <chr>          <chr>         <chr>
1 Alaska 47.5%          46.2%         41.7%
2 Maine  <NA>           <NA>          32.4%
```

Left Join: Switching arguments

```
lj2 <- left_join(data_cold, data_As)
```

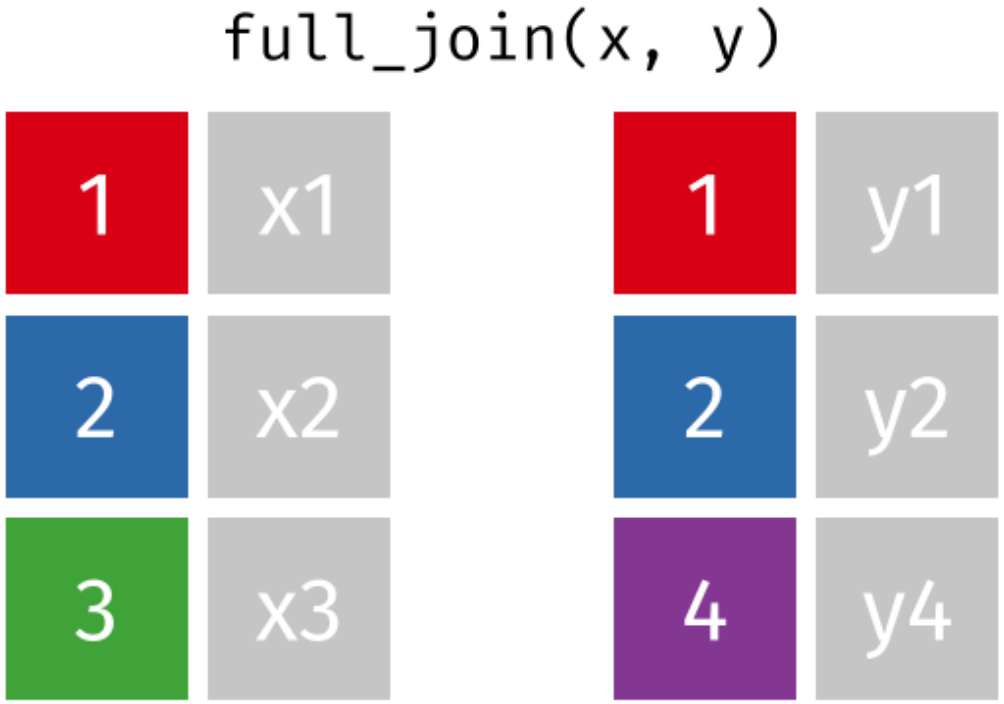
```
Joining, by = "State"

left_join: added 2 columns (June_vacc_rate, May_vacc_rate)

           > rows only in x   1

           > rows only in y  (1)

           > matched rows     1

           >                ===

           > rows total       2
```

```
lj2
```

```
# A tibble: 2 x 4
  State  April_vacc_rate June_vacc_rate May_vacc_rate
  <chr>  <chr>           <chr>          <chr>
1 Maine  32.4%           <NA>           <NA>
2 Alaska 41.7%           47.5%          46.2%
```

Full Join

https://raw.githubusercontent.com/gadenbuie/tidyexplain/main/images/full-join.gif



Full Join

```
fj <- full_join(data_As, data_cold)
```

```
Joining, by = "State"
```

```
full_join: added one column (April_vacc_rate)
           > rows only in x   1
           > rows only in y   1
           > matched rows     1
           >                ===
           > rows total       3
```

Full Join

```
fj
```

```
# A tibble: 3 x 4
  State   June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>   <chr>          <chr>         <chr>
1 Alabama 37.2%          36.0%         <NA>
2 Alaska  47.5%          46.2%         41.7%
3 Maine   <NA>           <NA>          32.4%
```

Watch out for "`includes duplicates`"

```
data_As
```

```
# A tibble: 2 x 2
  State   state_bird
  <chr>   <chr>
1 Alabama wild turkey
2 Alaska  williow ptarmigan
```

```
data_cold
```

```
# A tibble: 3 x 3
  State  vacc_rate month
  <chr>  <chr>     <chr>
1 Maine  32.4%     April
2 Alaska 41.7%     April
3 Alaska 46.2%     May
```

Watch out for "`includes duplicates`"

```
lj <- left_join(data_As, data_cold)
```

```
Joining, by = "State"

left_join: added 2 columns (vacc_rate, month)

           > rows only in x   1

           > rows only in y  (1)

           > matched rows     2    (includes duplicates)

           >                 ===

           > rows total       3
```

Watch out for "`includes duplicates`"

Data including the joining column ("State") has been duplicated.

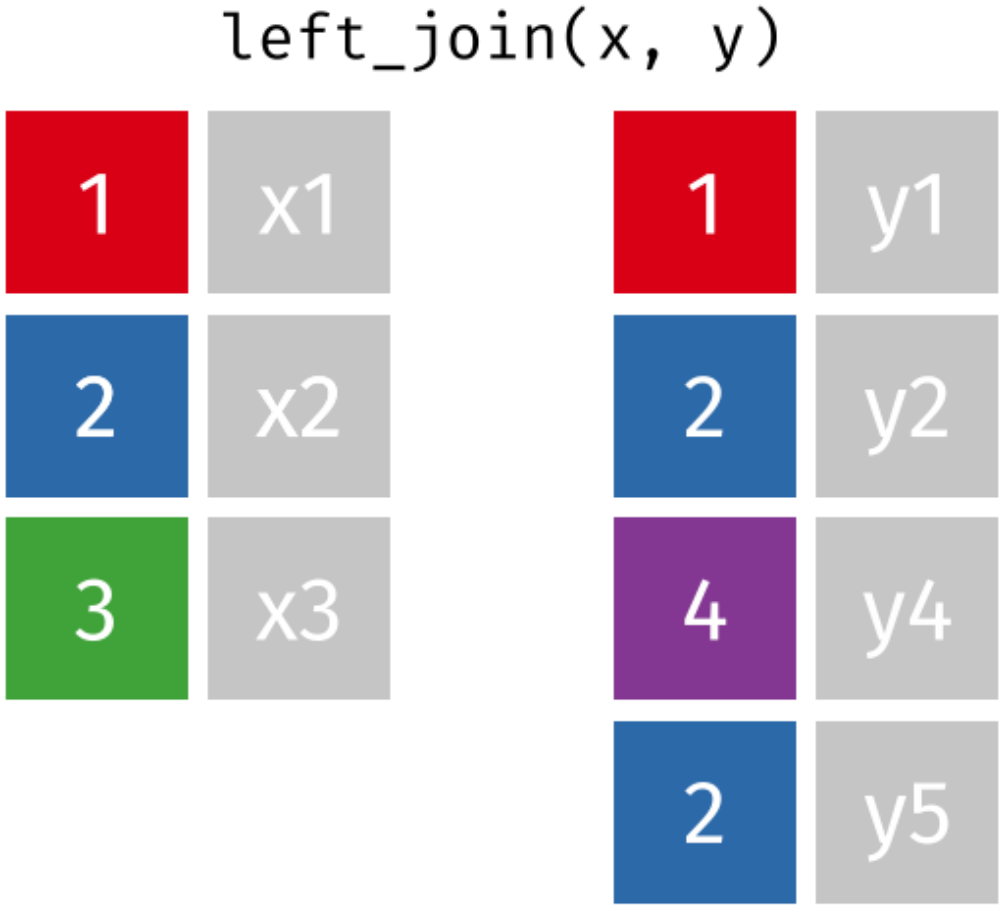
```
lj
```

```
# A tibble: 3 x 4
  State   state_bird        vacc_rate month
  <chr>   <chr>             <chr>     <chr>
1 Alabama wild turkey       <NA>      <NA>
2 Alaska  williow ptarmigan 41.7%     April
3 Alaska  williow ptarmigan 46.2%     May
```

Note that "Alaska willow ptarmigan" appears twice.

Watch out for "`includes duplicates`"

https://github.com/gadenbuie/tidyexplain/blob/main/images/left-join-extra.gif



Stop `tidylog`

```
unloadNamespace("tidylog")
```

Duplicated

- The `duplicated` function can give you indications if there are duplicates in a **vector**:

```
duplicated(1:5)
```

```
[1] FALSE FALSE FALSE FALSE FALSE
```

```
duplicated(c(1:5, 1))
```

```
[1] FALSE FALSE FALSE FALSE FALSE  TRUE
```

```
lj %>% mutate(dup_State = duplicated(State))
```

```
# A tibble: 3 x 5
  State   state_bird        vacc_rate month dup_State
  <chr>   <chr>             <chr>     <chr> <lgl>
1 Alabama wild turkey       <NA>      <NA>  FALSE
2 Alaska  williow ptarmigan 41.7%     April FALSE
3 Alaska  williow ptarmigan 46.2%     May   TRUE
```

Using the `by` argument

By default joins use the intersection of column names. If `by` is specified, it uses that.

```
full_join(data_As, data_cold, by = "State")
```

```
# A tibble: 4 x 4
  State   state_bird        vacc_rate month
  <chr>   <chr>             <chr>     <chr>
1 Alabama wild turkey       <NA>      <NA>
2 Alaska  williow ptarmigan 41.7%     April
3 Alaska  williow ptarmigan 46.2%     May
4 Maine   <NA>              32.4%     April
```

Using the `by` argument

You can join based on multiple columns by using something like `by = c(col1, col2)`.

If the datasets have two different names for the same data, use:

```
full_join(data_As, data_cold, by = c("a" = "b"))
```

Using "`setdiff`"

We might want to determine what indexes ARE in the first dataset that AREN'T in the second:

```
data_As
```

```
# A tibble: 2 x 2
  State   state_bird
  <chr>   <chr>
1 Alabama wild turkey
2 Alaska  williow ptarmigan
```

```
data_cold
```

```
# A tibble: 3 x 3
  State  vacc_rate month
  <chr>  <chr>     <chr>
1 Maine  32.4%     April
2 Alaska 41.7%     April
3 Alaska 46.2%     May
```

Using "`setdiff`"

Use `setdiff` to determine what indexes ARE in the first dataset that AREN'T in the second:

```
A_states <- data_As %>% pull(State)
cold_states <- data_cold %>% pull(State)
```

```
setdiff(A_states, cold_states)
```

```
[1] "Alabama"
```

```
setdiff(cold_states, A_states)
```

```
[1] "Maine"
```

Lab Part 2

Website