Intro to R

Manipulating Data in R

Recap of Data Cleaning

- `is.na()`,`any(is.na())`, `count()`, and functions from `naniar` like `gg_miss_var()` can help determine if we have `NA` values
- `filter()` automatically removes `NA` values - can't confirm or deny if condition is met (need `| is.na()` to keep them)
- `drop_na()` can help you remove `NA` values from a variable or an entire data frame
- `NA` values can change your calculation results
- think about what `NA` values represent

Recap of Data Cleaning

- `recode()` can help with simple recoding (not based on condition but simple swap)
- `case_when()` can recode **entire values** based on conditions
  - remember `case_when()` needs `TRUE ~ varaible` to keep values that aren't specified by conditions, otherwise will be `NA`
- `stringr` package has great functions for looking for specific **parts of values** especially `filter()` and `str_detect()` combined
  - also has other useful string manipulation functions like `str_replace()` and more!
  - `separate()` can split columns into additional columns
  - `unite()` can combine columns
- Day 5 Cheatsheet

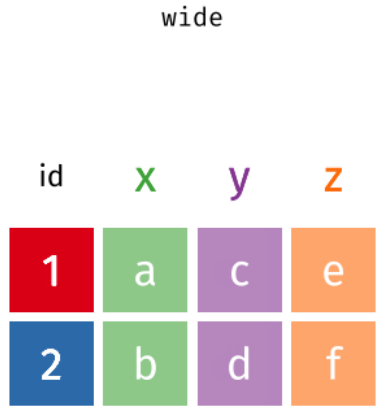
Manipulating Data

In this module, we will show you how to:

1. Reshape data from wide to long
2. Reshape data from long to wide
3. Merge Data/Joins

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 × 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 × 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

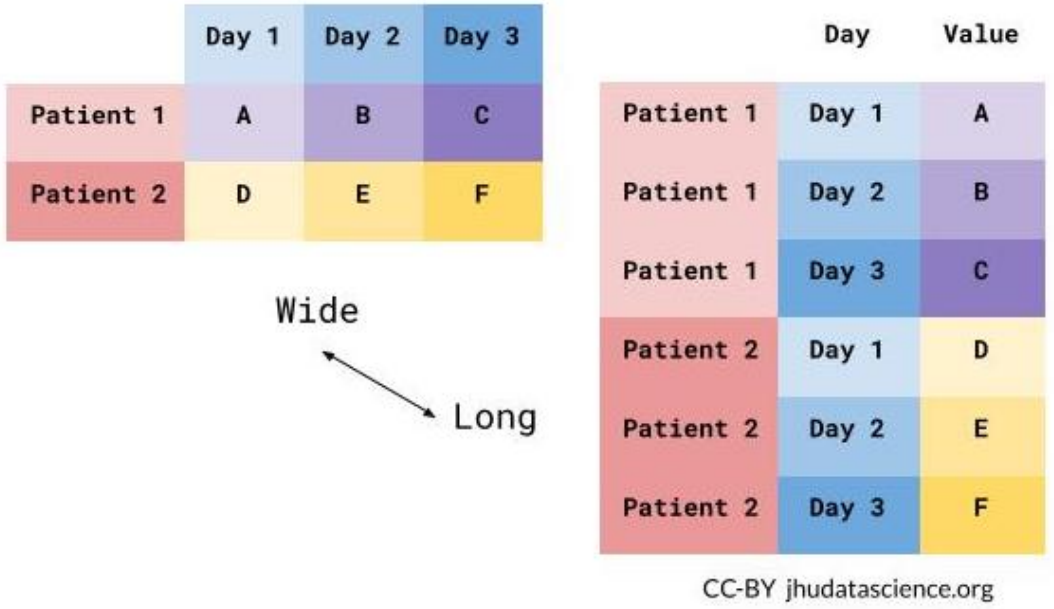
```
# A tibble: 2 × 4
  State   June_vacc_rate May_vacc_rate April_vacc_rate
  <chr>   <chr>          <chr>         <chr>
1 Alabama 37.2%          36.0%         32.4%
2 Alaska  47.5%          46.2%         41.7%
```

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

```
# A tibble: 6 × 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 × 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 × 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%
```

Pivoting using `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.

You might see old functions `gather` and `spread` when googling. These are the old names for `pivot_longer` and `pivot_wider`, respectively.

pivot_longer...

Reshaping data from **wide to long**

`pivot_longer()` - puts column data into rows (`tidyr` package)

- First describe which columns we want to “pivot_longer”

```
{long_data} <- {wide_data} %>% pivot_longer(cols = {columns to pivot})
```

Reshaping data from **wide to long**

```
wide_data
```

```
# A tibble: 1 × 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())
long_data
```

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

Reshaping data from **wide to long**

`pivot_longer()` - puts column data into rows (`tidyr` package)

- 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 to long**

```
wide_data
```

```
# A tibble: 1 × 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 × 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/data/Charm_City_Circulator_Ridership.csv

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

```
# A tibble: 5 × 15
  day       date  orangeBoardings orangeAlightings orangeAverage purpleBoardin
  <chr>     <chr>           <dbl>            <dbl>         <dbl>           <db
1 Monday    01/1…             877             1027           952
2 Tuesday   01/1…             777              815           796
3 Wednesday 01/1…            1203             1220          1212.
4 Thursday  01/1…            1194             1233          1214.
5 Friday    01/1…            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 to long**

```
long <- circ %>%
  pivot_longer(starts_with(c("orange","purple","green","banner")))
long
```

```
# A tibble: 13,752 × 5
   day    date       daily name              value
   <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 to long

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))
long
```

```
# A tibble: 13,752 × 5
   day    date       daily name              value
   <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 to long**

```
long %>% count(name)
```

```
# A tibble: 12 × 2
   name                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(
  name = str_replace(name, "Board", "_Board"),
  name = str_replace(name, "Alight", "_Alight"),
  name = str_replace(name, "Average", "_Average")
)
long
```

```
# A tibble: 13,752 × 5
   day    date       daily name              value
   <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(name, into = c("line", "type"), sep = "_")
long
```

```
# A tibble: 13,752 × 6
   day    date       daily line   type       value
   <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 to wide**

`pivot_wider()` - spreads row data into columns (`tidyr` package)

- `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 to wide

```
long_data
```

```
# A tibble: 3 × 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 × 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 × 6
   day    date       daily line   type       value
   <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 = "value")
wide
```

```
# A tibble: 4,584 × 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
```

Summary

- `tidyr` package helps us convert between wide and long data
- `pivot_longer()` goes from wide -> long
  - Specify columns you want to pivot
  - Specify `names_to =` and `values_to =` for custom naming
- `pivot_wider()` goes from long -> wide
  - Specify `names_from =` and `values_from =`

Lab Part 1

Class Website

Lab

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
```

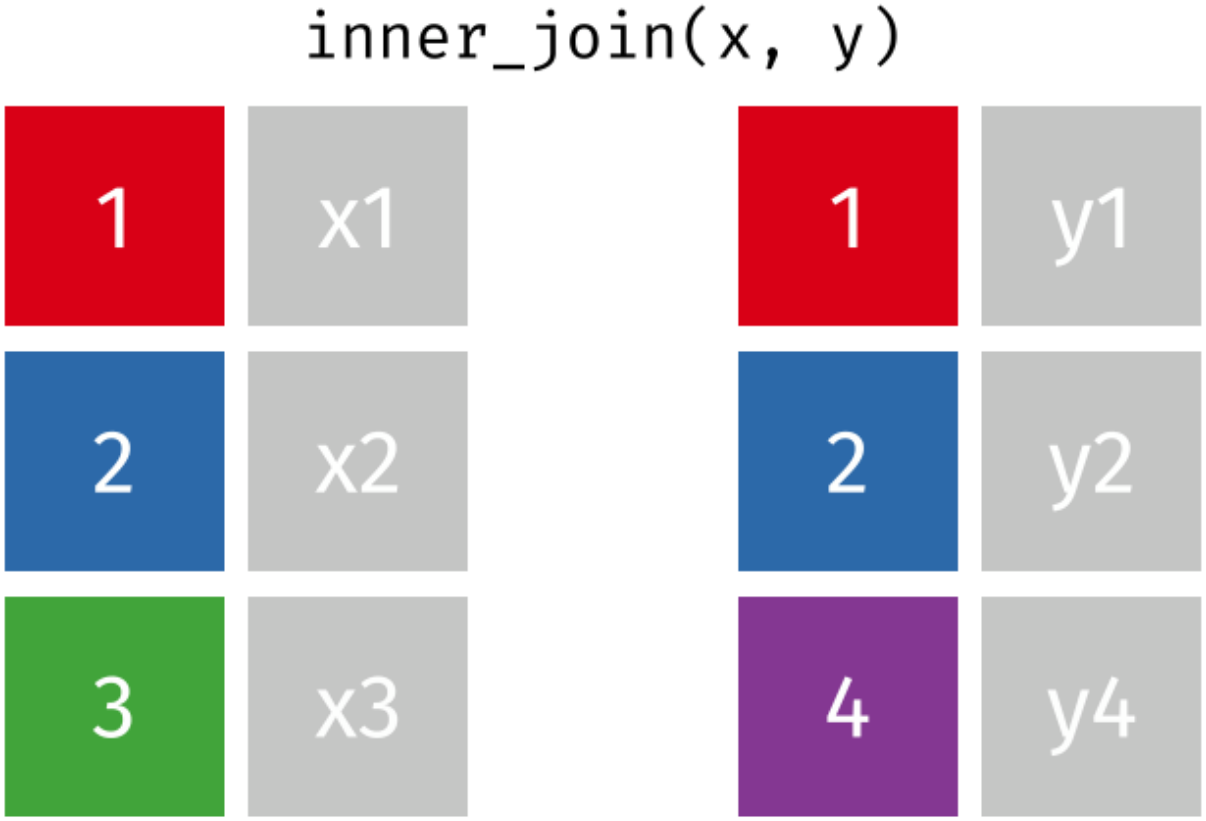
```
# A tibble: 2 × 3
  State   June_vacc_rate May_vacc_rate
  <chr>   <chr>          <chr>
1 Alabama 37.2%          36.0%
2 Alaska  47.5%          46.2%
```

```
data_cold
```

```
# A tibble: 2 × 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)
```

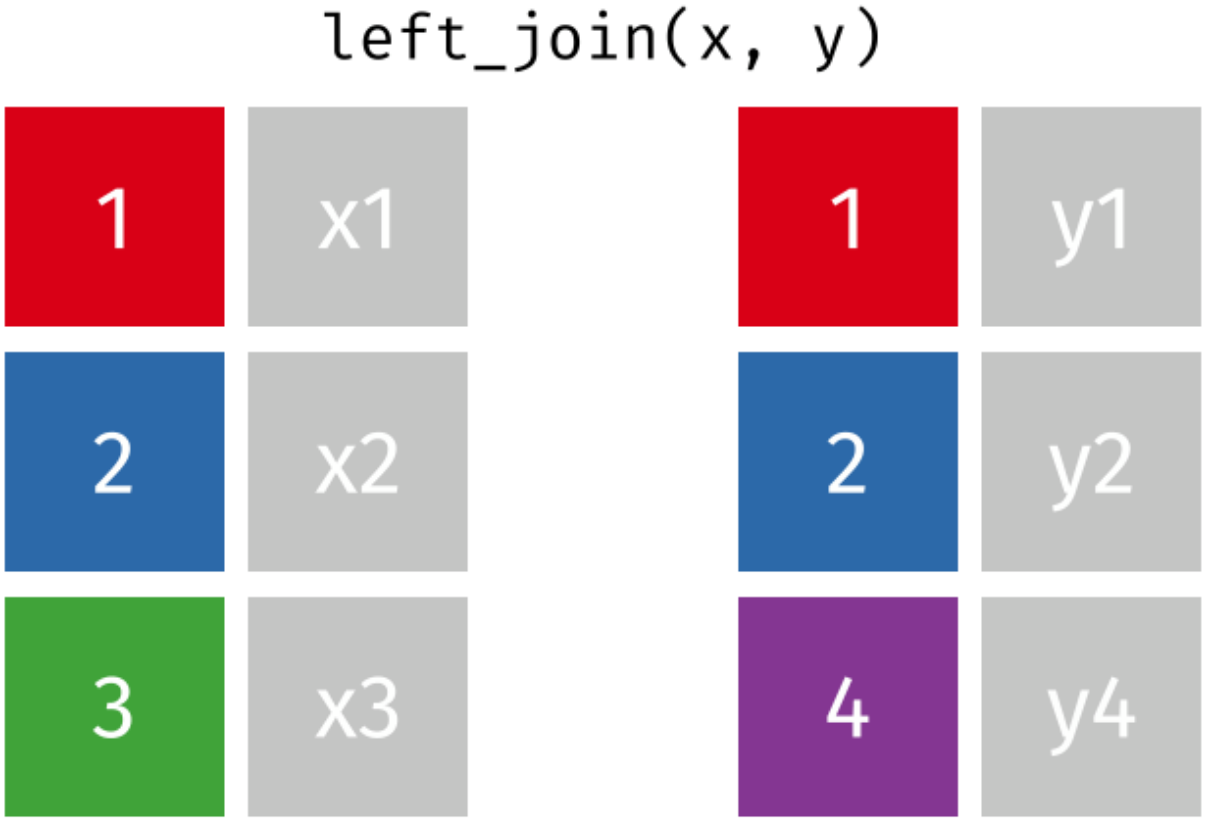
```
Joining, by = "State"
```

```
ij
```

```
# A tibble: 1 × 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 × 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

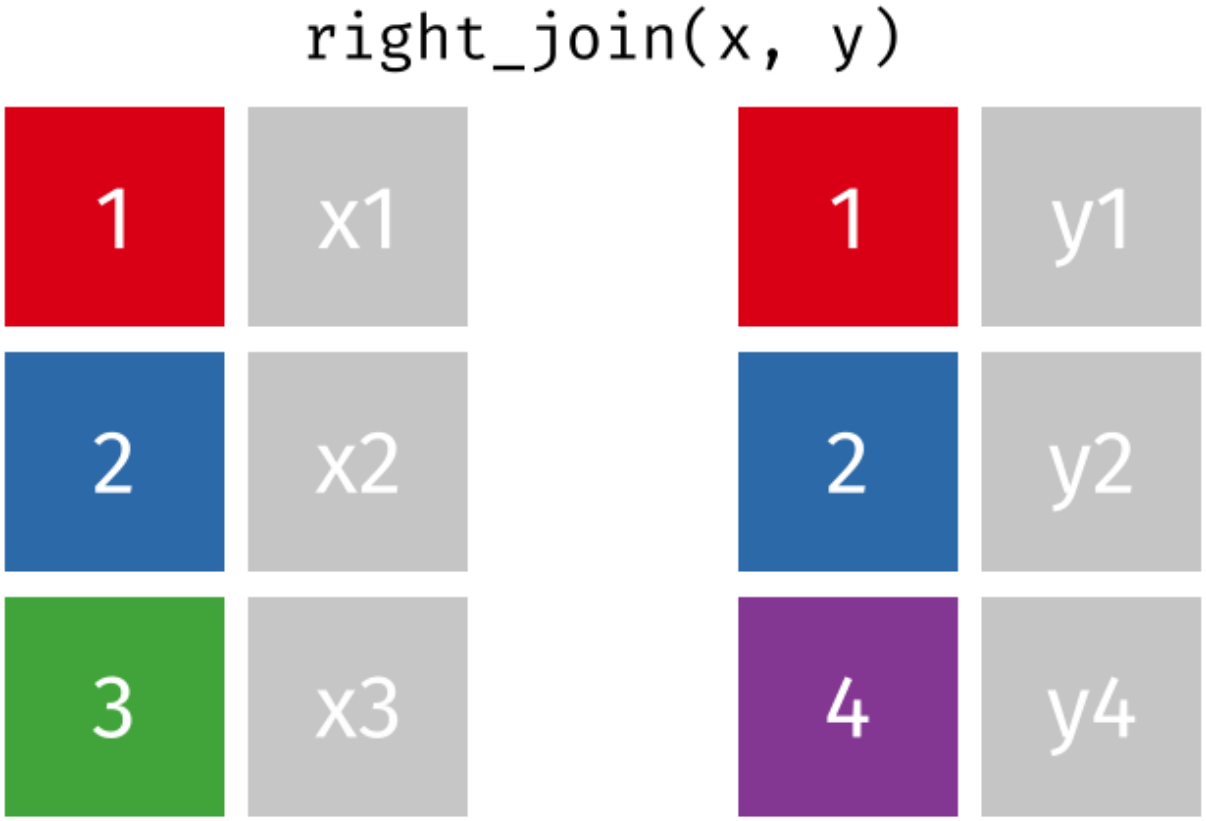
```
# install.packages("tidylog")
library(tidylog)
left_join(data_As, data_cold)
```

```
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 × 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 × 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)
```

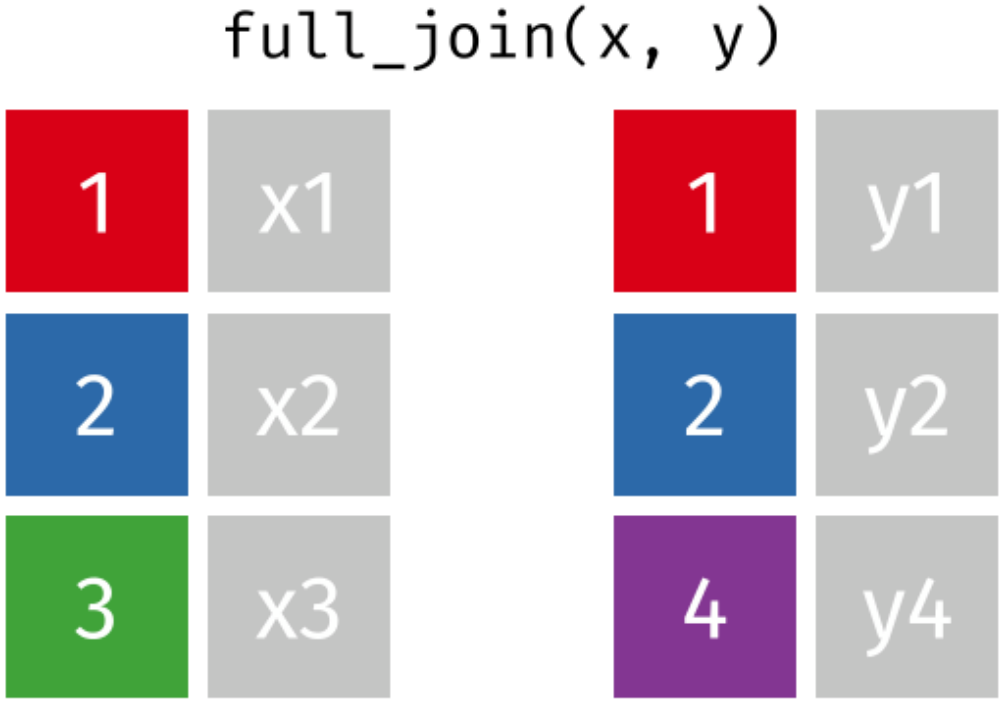
```
Joining, by = "State"
left_join: added 2 columns (June_vacc_rate, May_vacc_rate)
> rows only in x 1
> rows only in y (1)
> matched rows 1
> ===
> rows total 2
```

```
lj2
```

```
# A tibble: 2 × 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
```

```
fj
```

```
# A tibble: 3 × 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 × 2
  State   state_bird
  <chr>   <chr>
1 Alabama wild turkey
2 Alaska  willow ptarmigan
```

```
data_cold
```

```
# A tibble: 3 × 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.

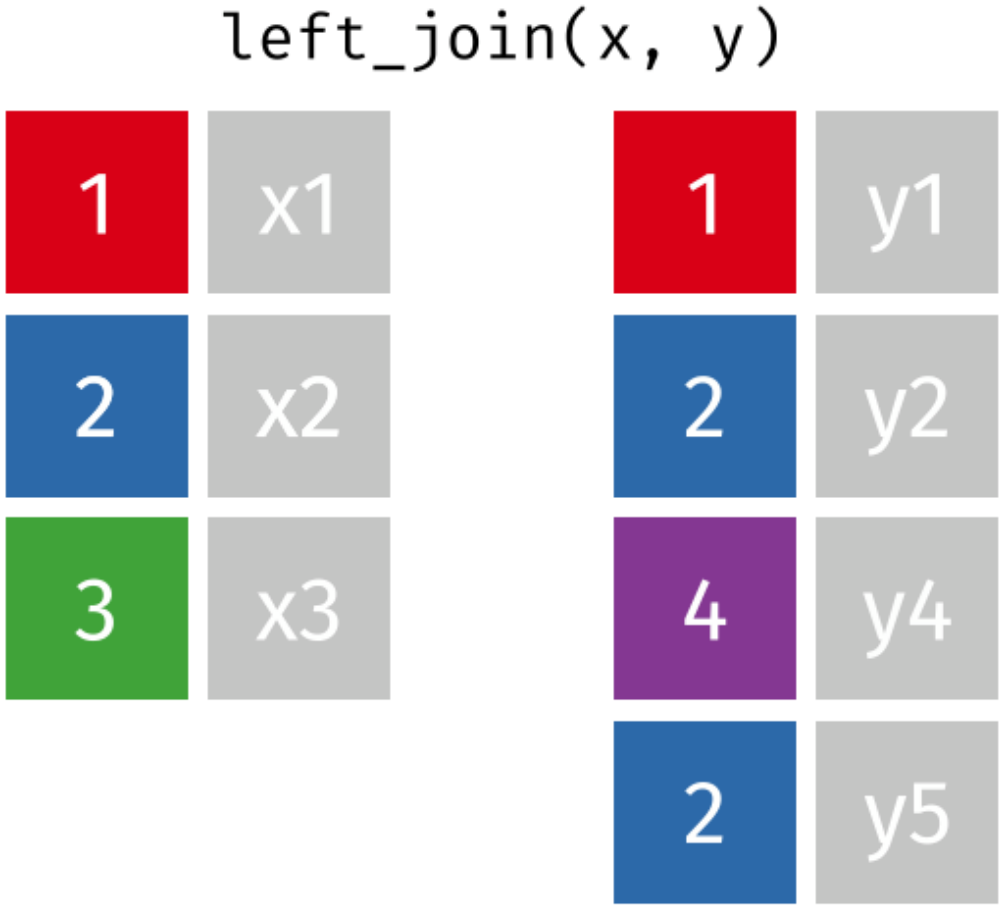
```
lj
```

```
# A tibble: 3 × 4
  State   state_bird       vacc_rate month
  <chr>   <chr>            <chr>     <chr>
1 Alabama wild turkey      <NA>      <NA>
2 Alaska  willow ptarmigan 41.7%     April
3 Alaska  willow 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 × 5
  State   state_bird       vacc_rate month dup_State
  <chr>   <chr>            <chr>     <chr> <lgl>
1 Alabama wild turkey      <NA>      <NA>  FALSE
2 Alaska  willow ptarmigan 41.7%     April FALSE
3 Alaska  willow 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 × 4
  State   state_bird       vacc_rate month
  <chr>   <chr>            <chr>     <chr>
1 Alabama wild turkey      <NA>      <NA>
2 Alaska  willow ptarmigan 41.7%     April
3 Alaska  willow 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(x, y, 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 × 2
  State   state_bird
  <chr>   <chr>
1 Alabama wild turkey
2 Alaska  willow ptarmigan
```

```
data_cold
```

```
# A tibble: 3 × 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"
```

Summary

- Merging/joining data sets together - assumes all column names that overlap
  - use the `by = c("a" = "b")` if they differ
- `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`
- Use the `tidylog` package for a detailed summary
- `setdiff(x, y)` shows what in `x` is missing from `y`

Lab Part 2

Class Website

Lab

Image by Gerd Altmann from Pixabay