Basic Data Operations

> Extended Materials
>
> You can find the original, extended version of this chapter here.

Data

We will continue to use the same `linelist` data we saw during Session 0. This is a fictional Ebola outbreak, expanded from the ebola_sim practice dataset in the `outbreaks` package.

```
linelist <- import("linelist_cleaned.rds")
```

The first 50 rows of `linelist`:

Show 5 entries Search:

case_id	generation	date_infection	date_onset	date_hospitalisation	dat
All	All	All	All	All	All
5fe599	4	2014-05-08	2014-05-13	2014-05-15	
8689b7	4		2014-05-13	2014-05-14	201
11f8ea	2		2014-05-16	2014-05-18	201
b8812a	3	2014-05-04	2014-05-18	2014-05-20	
893f25	3	2014-05-18	2014-05-21	2014-05-22	201

Showing 1 to 5 of 50 entries

Previous 1 2 3 4 5 … 10 Next

Select or re-order columns

Use `select()` from **dplyr** to select the columns you want to retain, and to specify their order in the data frame.

Here are ALL the column names in the linelist at this point in the cleaning pipe chain:

```
names(linelist)
```

```
 [1] "case_id"             "generation"          "date_infection"
 [4] "date_onset"          "date_hospitalisation" "date_outcome"
 [7] "outcome"             "gender"              "age"
[10] "age_unit"            "age_years"           "age_cat"
[13] "age_cat5"            "hospital"            "lon"
[16] "lat"                 "infector"            "source"
[19] "wt_kg"               "ht_cm"               "ct_blood"
[22] "fever"               "chills"              "cough"
[25] "aches"               "vomit"               "temp"
[28] "time_admission"      "bmi"                 "days_onset_hosp"
```

Keep columns

Select only the columns you want to remain

Put their names in the `select()` command, with no quotation marks. They will appear in the data frame in the order you provide. Note that if you include a column that does not exist, R will return an error (see use of `any_of()` below if you want no error in this situation).

```
# linelist dataset is piped through select() command, and names() prints just the column n
linelist %>%
  select(case_id, date_onset, date_hospitalisation, fever) %>%
  names()  # display the column names
```

```
[1] "case_id"             "date_onset"          "date_hospitalisation"
[4] "fever"
```

Remove columns

Indicate which columns to remove by placing a minus symbol "-" in front of the column name (e.g. `select(-outcome)`), or a vector of column names (as below). All other columns will be retained.

```
linelist %>%
  select(-c(date_onset, fever:vomit)) %>% # remove date_onset and all columns from fever t
  names()
```

```
 [1] "case_id"              "generation"           "date_infection"
 [4] "date_hospitalisation" "date_outcome"         "outcome"
 [7] "gender"               "age"                  "age_unit"
[10] "age_years"            "age_cat"              "age_cat5"
[13] "hospital"             "lon"                  "lat"
[16] "infector"             "source"               "wt_kg"
[19] "ht_cm"                "ct_blood"             "temp"
[22] "time_admission"       "bmi"                  "days_onset_hosp"
```

You can also remove a column using **base** R syntax, by defining it as `NULL`. For example:

```
linelist$date_onset <- NULL   # deletes column with base R syntax
```

Standalone

`select()` can also be used as an independent command (not in a pipe chain). In this case, the first argument is the original dataframe to be operated upon.

```
# Create a new linelist with id and age-related columns
linelist_age <- select(linelist, case_id, contains("age"))

# display the column names
names(linelist_age)
```

```
[1] "case_id"   "age"       "age_unit"  "age_years" "age_cat"   "age_cat5"
```

Column creation and transformation

In addition to selecting columns, we can create new columns with `mutate()`. The syntax is: `mutate(new_column_name = value or transformation)`. `mutate()` can also be used to modify an existing column.

New columns

The most basic `mutate()` command to create a new column might look like this. It creates a new column `new_col` where the value in every row is 10.

```
linelist <- linelist %>%
  mutate(new_col = 10)
```

You can also reference values in other columns, to perform calculations. Below, a new column `bmi` is created to hold the Body Mass Index (BMI) for each case - as calculated using the formula BMI = kg/m^2, using column `ht_cm` and column `wt_kg`.

```
linelist <- linelist %>%
  mutate(bmi = wt_kg / (ht_cm/100)^2)
```

If creating multiple new columns, separate each with a comma and new line. Below are examples of new columns, including ones that consist of values from other columns combined using `str_glue()` from the **stringr** package.

```
new_col_demo <- linelist %>%
  mutate(
    new_var_dup    = case_id,              # new column = duplicate/copy another existing c
    new_var_static = 7,                    # new column = all values the same
    new_var_static = new_var_static + 5,  # you can overwrite a column, and it can be a ca
    new_var_paste  = stringr::str_glue("{hospital} on ({date_hospitalisation})") # new col
    ) %>%
  select(case_id, hospital, date_hospitalisation, contains("new"))        # show only new
```

Review the new columns. For demonstration purposes, only the new columns and the columns used to create them are shown:

```
   case_id                              hospital date_hospitalisation
1   5fe599                                 Other           2014-05-15
2   8689b7                               Missing           2014-05-14
3   11f8ea St. Mark's Maternity Hospital (SMMH)           2014-05-18
4   b8812a                          Port Hospital           2014-05-20
```

5	893f25	Military Hospital	2014-05-22
6	be99c8	Port Hospital	2014-05-23
7	07e3e8	Missing	2014-05-29
8	369449	Missing	2014-06-03
9	f393b4	Missing	2014-06-06
10	1389ca	Missing	2014-06-07
11	2978ac	Port Hospital	2014-06-08
12	57a565	Military Hospital	2014-06-15
13	fc15ef	Missing	2014-06-17
14	2eaa9a	Missing	2014-06-17
15	bbfa93	Other	2014-06-20
16	c97dd9	Port Hospital	2014-06-19
17	f50e8a	Port Hospital	2014-06-23
18	3a7673	Port Hospital	2014-06-24
19	7f5a01	Missing	2014-06-27
20	ddddee	Other	2014-06-28
21	99e8fa	Port Hospital	2014-06-29
22	567136	Port Hospital	2014-07-03
23	9371a9	St. Mark's Maternity Hospital (SMMH)	2014-07-09
24	bc2adf	Missing	2014-07-09
25	403057	Other	2014-07-11
26	8bd1e8	Missing	2014-07-11
27	f327be	St. Mark's Maternity Hospital (SMMH)	2014-07-13
28	42e1a9	Military Hospital	2014-07-14
29	90e5fe	Port Hospital	2014-07-14
30	959170	Central Hospital	2014-07-13
31	8ebf6e	Military Hospital	2014-07-14
32	e56412	Central Hospital	2014-07-17
33	6d788e	Missing	2014-07-17
34	a47529	Military Hospital	2014-07-18
35	67be4e	Other	2014-07-19
36	da8ecb	Missing	2014-07-20
37	148f18	Missing	2014-07-20
38	2cb9a5	Port Hospital	2014-07-22
39	f5c142	Port Hospital	2014-07-24
40	70a9fe	Port Hospital	2014-07-26
41	3ad520	Missing	2014-07-24
42	062638	Central Hospital	2014-07-27
43	c76676	Military Hospital	2014-07-25
44	baacc1	Other	2014-07-27
45	497372	Other	2014-07-31
46	23e499	Other	2014-08-01
47	38cc4a	Missing	2014-08-03

```
48  3789ee St. Mark's Maternity Hospital (SMMH)          2014-08-02
49  c71dcd St. Mark's Maternity Hospital (SMMH)          2014-08-02
50  6b70f0                              Missing          2014-08-04
   new_var_dup new_var_static
1       5fe599             12
2       8689b7             12
3       11f8ea             12
4       b8812a             12
5       893f25             12
6       be99c8             12
7       07e3e8             12
8       369449             12
9       f393b4             12
10      1389ca             12
11      2978ac             12
12      57a565             12
13      fc15ef             12
14      2eaa9a             12
15      bbfa93             12
16      c97dd9             12
17      f50e8a             12
18      3a7673             12
19      7f5a01             12
20      ddddee             12
21      99e8fa             12
22      567136             12
23      9371a9             12
24      bc2adf             12
25      403057             12
26      8bd1e8             12
27      f327be             12
28      42e1a9             12
29      90e5fe             12
30      959170             12
31      8ebf6e             12
32      e56412             12
33      6d788e             12
34      a47529             12
35      67be4e             12
36      da8ecb             12
37      148f18             12
38      2cb9a5             12
39      f5c142             12
```

```
40      70a9fe             12
41      3ad520             12
42      062638             12
43      c76676             12
44      baacc1             12
45      497372             12
46      23e499             12
47      38cc4a             12
48      3789ee             12
49      c71dcd             12
50      6b70f0             12
                                          new_var_paste
1                                   Other on (2014-05-15)
2                                 Missing on (2014-05-14)
3  St. Mark's Maternity Hospital (SMMH) on (2014-05-18)
4                           Port Hospital on (2014-05-20)
5                     Military Hospital on (2014-05-22)
6                           Port Hospital on (2014-05-23)
7                                 Missing on (2014-05-29)
8                                 Missing on (2014-06-03)
9                                 Missing on (2014-06-06)
10                                Missing on (2014-06-07)
11                          Port Hospital on (2014-06-08)
12                    Military Hospital on (2014-06-15)
13                                Missing on (2014-06-17)
14                                Missing on (2014-06-17)
15                                  Other on (2014-06-20)
16                          Port Hospital on (2014-06-19)
17                          Port Hospital on (2014-06-23)
18                          Port Hospital on (2014-06-24)
19                                Missing on (2014-06-27)
20                                  Other on (2014-06-28)
21                          Port Hospital on (2014-06-29)
22                          Port Hospital on (2014-07-03)
23 St. Mark's Maternity Hospital (SMMH) on (2014-07-09)
24                                Missing on (2014-07-09)
25                                  Other on (2014-07-11)
26                                Missing on (2014-07-11)
27 St. Mark's Maternity Hospital (SMMH) on (2014-07-13)
28                    Military Hospital on (2014-07-14)
29                          Port Hospital on (2014-07-14)
30                     Central Hospital on (2014-07-13)
31                    Military Hospital on (2014-07-14)
```

```
32                      Central Hospital on (2014-07-17)
33                               Missing on (2014-07-17)
34                     Military Hospital on (2014-07-18)
35                                 Other on (2014-07-19)
36                               Missing on (2014-07-20)
37                               Missing on (2014-07-20)
38                          Port Hospital on (2014-07-22)
39                          Port Hospital on (2014-07-24)
40                          Port Hospital on (2014-07-26)
41                               Missing on (2014-07-24)
42                      Central Hospital on (2014-07-27)
43                     Military Hospital on (2014-07-25)
44                                 Other on (2014-07-27)
45                                 Other on (2014-07-31)
46                                 Other on (2014-08-01)
47                               Missing on (2014-08-03)
48 St. Mark's Maternity Hospital (SMMH) on (2014-08-02)
49 St. Mark's Maternity Hospital (SMMH) on (2014-08-02)
50                               Missing on (2014-08-04)
```

> **Transmute**
>
> A variation on `mutate()` is the function `transmute()`. This function adds a new column just like `mutate()`, but also drops/removes all other columns that you do not mention within its parentheses.

Convert column class

Columns containing values that are dates, numbers, or logical values (TRUE/FALSE) will only behave as expected if they are correctly classified. There is a difference between "2" of class character and 2 of class numeric! There are ways to set column class during the import commands, but this is often cumbersome.

First, let's run some checks on important columns to see if they are the correct class. Currently, the class of the `age` column is character. To perform quantitative analyses, we need these numbers to be recognized as numeric!

```
class(linelist$age)
```

```
[1] "numeric"
```

To resolve this, use the ability of `mutate()` to re-define a column with a transformation. We define the column as itself, but converted to a different class. Here is a basic example, converting or ensuring that the column `age` is class Numeric:

```
linelist <- linelist %>%
  mutate(age = as.numeric(age))
```

In a similar way, you can use `as.character()` and `as.logical()`. To convert to class Factor, you can use `factor()`.

Filter rows

A typical cleaning step after you have cleaned the columns and re-coded values is to *filter* the data frame for specific rows using the **dplyr** verb `filter()`.

Within `filter()`, specify the logic that must be `TRUE` for a row in the dataset to be kept. Below we show how to filter rows based on simple and complex logical conditions.

Simple filter

This simple example re-defines the dataframe `linelist` as itself, having filtered the rows to meet a logical condition. **Only the rows where the logical statement within the parentheses evaluates to `TRUE` are kept.**

In this example, the logical statement is `gender == "f"`, which is asking whether the value in the column `gender` is equal to "f" (case sensitive).

Before the filter is applied, the number of rows in `linelist` is `nrow(linelist)`.

```
linelist <- linelist %>%
  filter(gender == "f")   # keep only rows where gender is equal to "f"
```

After the filter is applied, the number of rows in `linelist` is `linelist %>% filter(gender == "f") %>% nrow()`.

Complex filter

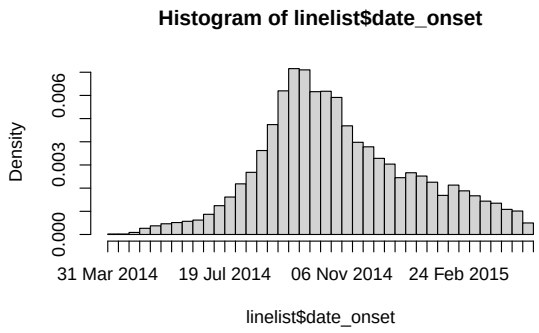
More complex logical statements can be constructed using parentheses `( )`, OR `|`, negate `!`, `%in%`, and AND `&` operators. An example is below:

Note: You can use the `!` operator in front of a logical criteria to negate it. For example, `!is.na(column)` evaluates to true if the column value is *not* missing. Likewise `!column %in% c("a", "b", "c")` evaluates to true if the column value is *not* in the vector.

* Examine the data

Below is a simple one-line command to create a histogram of onset dates. See that a second smaller outbreak from 2012-2013 is also included in this raw dataset. **For our analyses, we want to remove entries from this earlier outbreak.**

```
hist(linelist$date_onset, breaks = 50)
```



* How filters handle missing numeric and date values

Can we just filter by `date_onset` to rows after June 2013? **Caution! Applying the code `filter(date_onset > as.Date("2013-06-01")))` would remove any rows in the later epidemic with a missing date of onset!**

> ⚠ Conditions with NA
>
> Filtering to greater than (>) or less than (<) a date or number can remove any rows with missing values (`NA`)! This is because `NA` is treated as infinitely large and small.

Standalone

Filtering can also be done as a stand-alone command (not part of a pipe chain). Like other **dplyr** verbs, in this case the first argument must be the dataset itself.

```
# dataframe <- filter(dataframe, condition(s) for rows to keep)

linelist <- filter(linelist, !is.na(case_id))
```

You can also use **base** R to subset using square brackets which reflect the [rows, columns] that you want to retain.

```
# dataframe <- dataframe[row conditions, column conditions] (blank means keep all)

linelist <- linelist[!is.na(case_id), ]
```

Arrange and sort

Use the **dplyr** function `arrange()` to sort or order the rows by column values.

Simple list the columns in the order they should be sorted on. Specify `.by_group = TRUE` if you want the sorting to to first occur by any *groupings* applied to the data.

By default, column will be sorted in "ascending" order (which applies to numeric and also to character columns). You can sort a variable in "descending" order by wrapping it with `desc()`.

Sorting data with `arrange()` is particularly useful when making tables for publication, using `slice()` to take the "top" rows per group, or setting factor level order by order of appearance.

For example, to sort the our linelist rows by `hospital`, then by `date_onset` in descending order, we would use:

```
linelist %>%
   arrange(hospital, desc(date_onset))
```