

## 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	date_death
<div>All</div>	<div>All</div>	<div>All</div>	<div>All</div>	<div>All</div>	<div>All</div>
5fe599	4	2014-05-08	2014-05-13	2014-05-15	
8689b7	4		2014-05-13	2014-05-14	2014-05-15
11f8ea	2		2014-05-16	2014-05-18	2014-05-19
b8812a	3	2014-05-04	2014-05-18	2014-05-20	
893f25	3	2014-05-18	2014-05-21	2014-05-22	2014-05-23

## 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"              "infectior"        "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 names
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 to  
  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]	"infectior"	"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

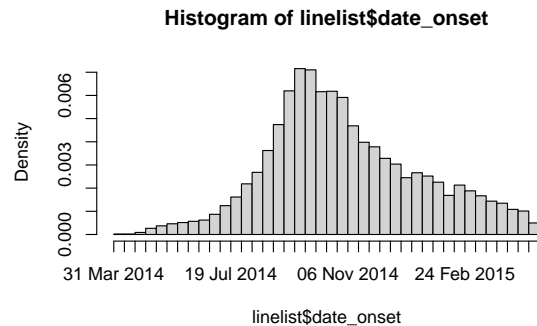
More complex logical statements can be constructed using parentheses ( ), OR |, negate !, `%in%`, and AND & operators. An example is below:

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.

Simply list the columns in the order they should be sorted on. Specify `.by_group = TRUE` if you want the sorting 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))
```