Introduction to R - class 3 Data Wrangling 1

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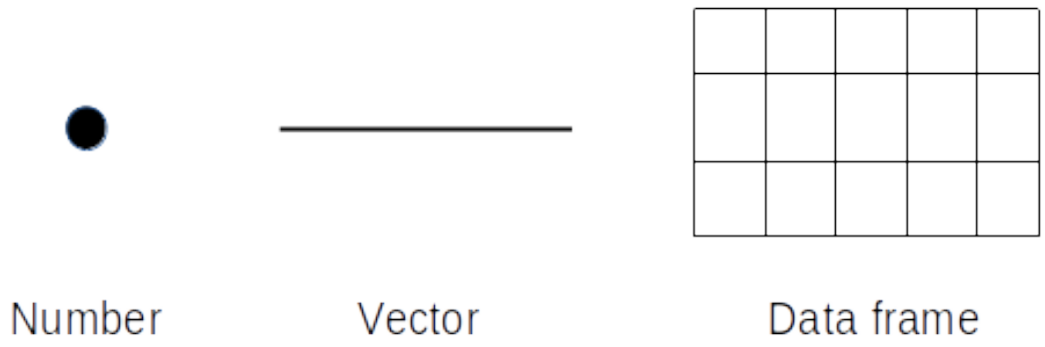
Data wrangling refers to the process of **transforming raw and basic data into a more useful, neat, and tidy form**. It includes everything from changing the appearance of tables and sorting their contents to making mathematical operations on the data and preparing it for various kinds of statistical analysis. In the first part, we will cover the data wrangling capabilities of base R.

Data frame



Data frame is something you probably know as a "table". However it has some unique characteristics:
1. **It always has a header**. It means that each column must have its unique name. If names are not provided R creates them automatically as **V** (as "variable") followed by the consecutive number.
2. **Table is always complete**. It means that each column has the same number of rows. If some data are missing R puts `NA` ("not available") in a given cell.
3. An individual column of a data frame, similarly to vectors, can contain **only one type of data**, but **different columns can be of different types**.

During most statistical analysis, you will be operating on data frames.

> **Curiosity**
> In R, there is also an object called matrix that will not be covered during this course. It looks and behaves similar to the data frame but all cells must contains the same type of data (often numbers). It is usually used in mathematics (matrix operations) and graphics (image encoding). Recently, the object called tibble is rising in popularity and possibly will replace data.frame in the near future. The differences between both are rather subtle and do not affect our exercises directly. If you want to read more, follow the link.

In the last class, we learned how to upload an existing file into R. Now we will learn how to modify data frames. Remember about the optimal coding workflow.

Another good habit to add to the ones we learned last time is checking your data once it is uploaded into the RStudio. You can do this in the following ways:

• visually inspect the file by either clicking on it in the environment (top right square) or by using the View(dataframe) function – reminder that R is case sensitive and View starts with a capital V
• ask R to display the top five rows of the data frame using the `head()` function, or the bottom 5 rows using the `tail()` function
• get a brief description of the data frame using the `summary()` function – this is particularly important, as it displays the type of data in each column of the data frame

Exercise 1

Upload class_3_data.xlsx into R and save it to a variable called `my_data`.

Exercise 2

View the uploaded data frame. View the top five rows of `my_data` data frame and generate a short description for it.

Types of data

All values inside one column must be of the same data type, but the columns can be of different types. Type of data within a column is defined by its class. The most popular classes are:

• `character` - strings (remember that numbers surrounded by quotation marks are also treated as strings)
• `factor` - strings with the levels carrying information about the number of occurrences and order of strings. Factors are commonly used when doing statistics in R, where they serve as indicators of the nominal scale. To read strings as factors set the `stringAsFactors` argument of importing function to `TRUE` (for R version >= 4.0.0).
• `numeric` - real numbers
• `integer` - only integers
• `logical` - logical values (`TRUE` or `FALSE`)

You can check the class of a value or a vector using the `class()` function. To use it on a data frame, you need to specify which columns you want to check. To check every column in a data frame, use the `str()` function.

Exercise 3

Check the class types of every column of the `my_data` data frame.

You can also convert different data types with the use of as… functions family e.g. `as.character()`, `as.factor()` ect.. Note, however, that not all conversions are permitted e.g. a letter cannot be converted into an integer. To change class of a column you need to replace whole column with the result of as… function. We will learn how to do it once we discuss subsetting.

Subsetting

Data frame can be **subsetted** (=accessed or displayed in a specific way) with the use of **coordinates** (indexes) enclosed within the **square brackets**. In case of data frames there are always 2 coordinates: `[row_number, column_number]`.

Note that **vectors have only one coordinate**, the position, so they can be called one-dimensional objects. **Data frames have two dimensions**: rows and columns.

Exercise 4

Return the value from 5th row and 3rd column of `my_data`.

Expected result:

```
## # A tibble: 1 x 1
##    mass
##   <dbl>
## 1    24
```

You can call for multiple values in the same time. To define range of coordinates, use **colon** separating range borders - e.g. `[row_number_1:row_number_2, column_number]`.

Exercise 5

Return first 5 rows for the last 2 columns of `my_data`.

Expected result:

```
## # A tibble: 5 x 2
##    mass score
##   <dbl> <dbl>
## 1    22    94
## 2    29    79
## 3    22    88
## 4    29    86
## 5    24    28
```

Tip: If you want to call for all rows or columns it is enough to leave blank space instead of the respective coordinate - e.g. ***`[,column_number]`***

Exercise 6

Now, save 4th column of `my_data` as a variable called `my_column_4`. Call the variable, so its content is displayed in console.

Expected result (first 10 rows):

```
## # A tibble: 30 x 1
##    score
##    <dbl>
##  1    94
##  2    79
##  3    88
##  4    86
##  5    28
##  6    22
##  7    32
```

```
##  8    36
##  9    76
## 10    74
## # i 20 more rows
```

Exercise 7

Return 3rd, 4th and 5th value from variable `my_column_4`.

Expected result:

```
## # A tibble: 3 x 1
##   score
##   <dbl>
## 1    88
## 2    86
## 3    28
```

Table can be also subsetted with the use of columns' (or rows') names.

Exercise 8

Return the same column (4th) but use column name instead of its number. Don't forget about quotation marks.

Expected results (first 10 rows):

```
## # A tibble: 30 x 1
##    score
##    <dbl>
##  1    94
##  2    79
##  3    88
##  4    86
##  5    28
##  6    22
##  7    32
##  8    36
##  9    76
## 10    74
## # i 20 more rows
```

One another way to obtain the whole column is to use **dollar sign** between table's and column's name. Such expression is automatically treated as a vector, so it can be directly subsetted to get a particular row. - e.g. `table$column_name[row_number]`.

Exercise 9

Return values from 5th to 15th row of mass column from `my_data`. Use dollar sign.

Expected result:

```
##  [1] 24 27 22 20 25 24 28 25 20 23 29
```

If desired rows (or columns) do not follow each other and the range option cannot be used, vector of coordinates should be provided.

Note that the outcome is no longer a table. As we asked for just one column, a series of numbers (vector) was returned.

> **Curiosity** Pulling one row from the data frame **will not result in a vector**. It is because a row can contain elements of different types what is not allowed for vectors.

Exercise 10

Create a vector with values 3, 5, 7, 9 and 12 and save it to a variable. Call it.

Expected result:

```
## [1]  3  5  7  9 12
```

Exercise 11

Return rows of `score` column corresponding to values in the vector created before.

Expected result:

```
## [1] 88 28 32 76 49
```

You can also subset everything except specified columns (or rows). To do this, put minus (`-`) before an index or vector of indexes.

Exercise 12

Return all columns of `my_data` except the 2nd one.

Expected result (first 10 rows):

```
## # A tibble: 30 x 3
##    individual  mass score
##    <chr>      <dbl> <dbl>
##  1 ind001        22    94
##  2 ind002        29    79
##  3 ind003        22    88
##  4 ind004        29    86
##  5 ind005        24    28
##  6 ind006        27    22
##  7 ind007        22    32
##  8 ind008        20    36
##  9 ind009        25    76
## 10 ind010        24    74
## # i 20 more rows
```

Simple operations on data frames/ tibbles

1. Replacement

Assign a given value to specific place in your table with the use of an arrow. It works just as with variables assignment - e.g.`table[row_number,collumn_number] <- new_value`

Exercise 13 Replace 5th value in the column `sex` with the label 'Unknown'. Call column `sex` and check whether it was indeed replaced.

Expected result:

```
##  [1] "M"       "M"       "M"       "M"       "Unknown" "M"       "M"
##  [8] "M"       "M"       "M"       "M"       "M"       "M"       "M"
## [15] "M"       "F"       "F"       "F"       "F"       "F"       "F"
## [22] "F"       "F"       "F"       "F"       "F"       "F"       "F"
## [29] "F"       "F"
```

2. Mathematical operations

You can use classical mathematical operators: `+`, `-`, `*` and `/`. Remember, however, that mathematical operations make sense only for **integer or numeric** data type.

Exercise 14 Recalculate and modify `mass` column to convert it from kilograms to pounds (1 kilogram equals around 2.20 pounds). Display modified column.

Expected result:

```
##  [1] 48.4 63.8 48.4 63.8 52.8 59.4 48.4 44.0 55.0 52.8 61.6 55.0 44.0 50.6 63.8
## [16] 61.6 57.2 48.4 46.2 57.2 50.6 68.2 59.4 59.4 74.8 72.6 55.0 46.2 39.6 74.8
```

Also, you can use simple summary functions from previous class (see Class 1).

Exercise 15 Calculate the mean value of the `score` column.

Expected result:

```
## [1] 57.53333
```

3. Simple summaries

- `nrow()` - number of rows
- `ncol()` - number of columns

Exercise 16 Return total number of cells within `my_data`.

Expected result:

```
## [1] 120
```

4. Deleting rows with missing data

Missing data, as stated before, are represented as `NA` (not-available) in R. Most of the functions will raise an error every time the `NA` is provided as the argument.

Exercise 17 Choose one cell and replace its value with `NA`. Do not add quotation marks as `NA` is an internal R symbol (just as). Print whole row.

Rows with missing data can be removed with `na.omit()` function. To save changes, the result of `na.omit()` function must be saved as a variable. **Note that, in practice, deleting missing data must be well justified. Make sure they do not provide any important information**.

Exercise 18 Check the number of rows of `my_data`. Remove the row with missing data. Replace variable `my_data` with modified table. Remember that it cannot be undone. Check if the number of rows have changed.

Adding new column or row

1. Adding new column is relatively simple. All you need to have is a vector. However, remember three things:
   - **length of vector must equal the number of rows of a data frame**
   - **order of values within a vector corresponds to the row numbers**
   - **name of vector will become name of the added column**

We are going to add a column with IDs of observations. Note that column with IDs is often necessary in statistical analysis. It is also inherent to the data in long format which is strongly advised.

Exercise 19

Create a vector with ID numbers starting from 100. Use one of functions introduced above to obtain the desired length of the vector. Call the vector ID.

Expected result:

```
##  [1] 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118
## [20] 119 120 121 122 123 124 125 126 127 128
```

You can combine data frames with the use of `cbind()` function in the following manner: `cbind(data_frame1,data_frame2)`. Note that a vector can be seen as a data frame with only one column.

Exercise 20

Place created IDs at the beginning of `my_data` (as first column). Overwrite my__data variable.

2. Adding new row is more complicated as **you cannot create a vector with different types of data**. Firstly you need to create a new data frame (similar to the old one) consisting of only new row (or rows). To do this use `data.frame()` function in the following manner: `data.frame(columnName1 = value1, columnName2 = value2,…)`.

Exercise 21

Create data frame `added_rows` with one row and following values: `130,ind031,F, 55.7, 77`. Columns' names should correspond to this of `my_data`. Call it.

Expected result:

```
##    ID individual sex mass score
## 1 130     ind031   F 55.7    77
```

> **Curiosity** To combine a data frame with more rows at the same time replace the values for each column with the vectors.

To stick data frames by rows use `rbind()` function in the following manner: `rbind(data_frame1,data_frame2)`

Exercise 22

Place created row at the end of `my_data`. Overwrite my__data variable. Print 5 last rows of `my_data` to check the operation result.

Expected result:

```
##     ID individual sex mass score
## 25 124     ind026   F 72.6    83
## 26 125     ind027   F 55.0    42
## 27 126     ind028   F 46.2    48
## 28 127     ind029   F 39.6    37
## 29 128     ind030   F 74.8    48
## 30 130     ind031   F 55.7    77
```

Sometimes we need to change the **class** of a column in a dataframe. This can be done using `as.[class]` functions: `as.numeric()`, `as.character()`, `as.factor()`, etc.

Exercise 23

Check the class of the column sex in `my_data` using the `class()` function. Now, override that and convert the column into a `factor` column. Check its type again to confirm the operation worked.

Expected result:

```
## [1] "character"
```

```
## [1] "factor"
```

Saving data frame

To save your data frame into a file use `write.table()` function.

Exercise 23

Save modified `my_data` to the .csv file. Include your surname in the file name.</span.

Homework

Prepare your homework in the form of a script file (.R) and call it "class_3_homework_Your_name.R". All exercises need to be performed on the **built-in `swiss` dataset**. To work on it, use this command: `my_data <- swiss` Include all subsequent steps in a script file. 1. With an R command, return the lowest percentage of Catholics. 2. With an R command, return the median percentage of live births living more than 1 year. Tip: check `swiss` dataset description for column details. 3. With an R command, add column with self-chosen ID for each observation and save the dataset as a `my_data` variable. Add `ID` before `Fertility` column. 4. With an R command, modify `my_data` by removing its 4 first rows. 5. Save a modified dataset to a .csv file

Upload both your R script and .csv to the "Class 3" tab on *Pegaz* platform.