# R Projects and data import

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# Prologue:

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## Feedback and exercises

- One of you filled out the feedback survey.
- Main take-aways:
  - If anything, the session was a bit too slow
  - If I do not get other signals, I will speed up in the next sessions
- What were the main problems with the exercises?

# Goals for today

I. Learn how to set up an R project

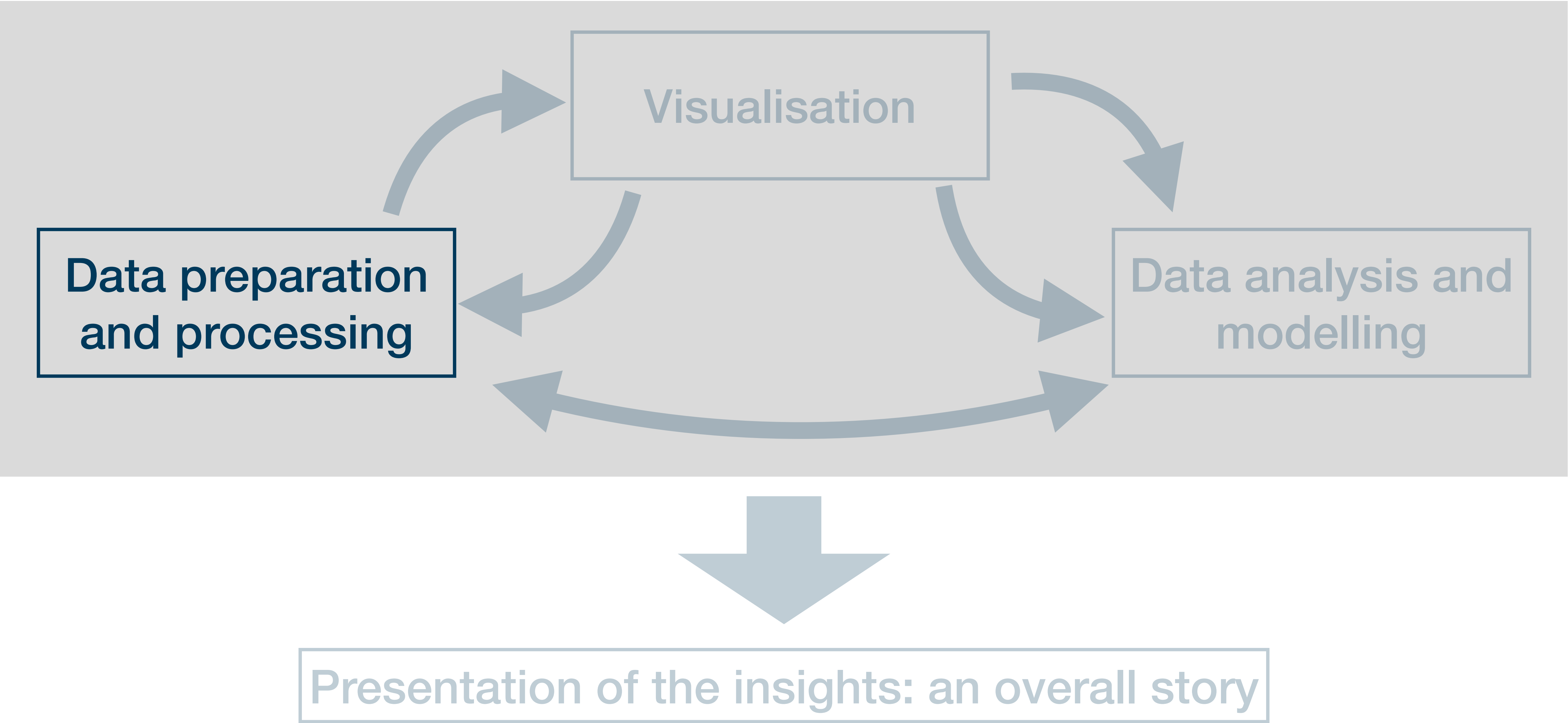
II. Learn how to use the here package and import data

III. Learn how to import data into R using `data.table::fread()`

# Data wrangling in R

# The role of data preparation

- Importing and preparing is the most fundamental task in data science
  - It is also largely under-appreciated 🙄


Visualisation
Data preparation and processing
Data analysis and modelling
Presentation of the insights: an overall story

# Data wrangling is an essential skill

- According to several surveys, data scientists usually spend **about 80% of their working time** with importing and preparing data

- At the same time, few people learn how to do it properly

- Although it might sound a bit boring in the first place, few skills will
  - …save so much time
  - …save you so much nerves and frustration
  - …help you making so many new friends

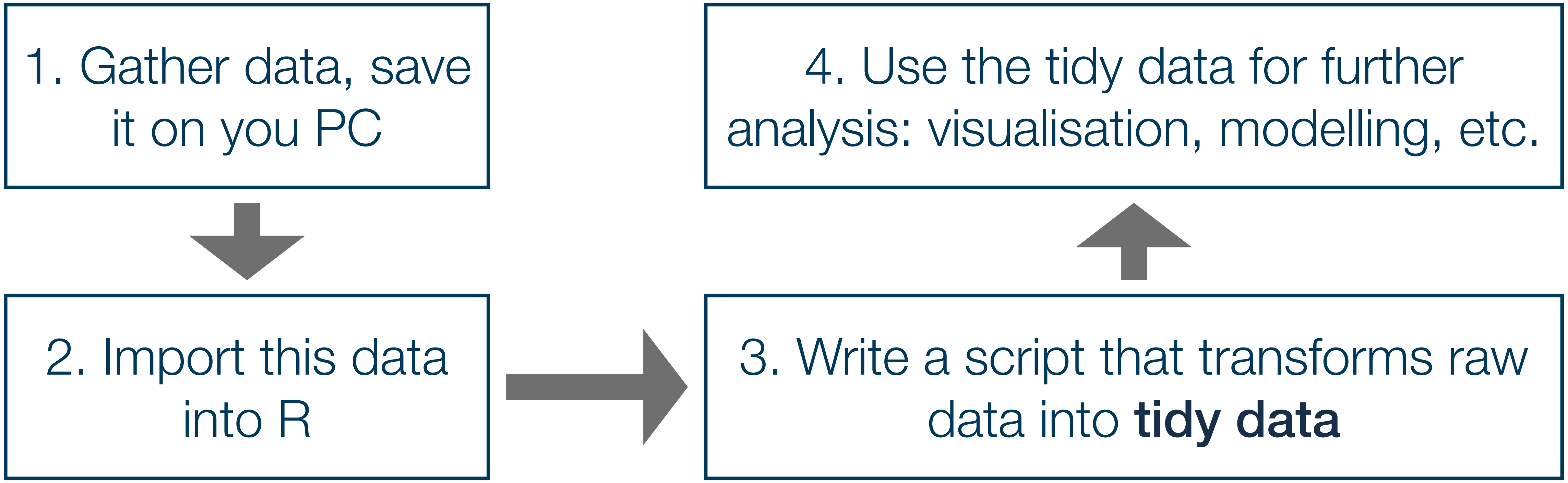
- …in the medium run as skills in data wrangling!

# Our goal

- The **goal**: learn about a **default directory structure** and a general way to **document everything** you do with your raw data
  - This will also facilitate the collaboration with future-you considerably
  - Nothing is worse than hating your past-you for not documenting correctly where data came from, or how it has been prepared
- Here we will learn a general workflow that, once mastered, helps you to avoid all editable problems **with certainty**
- A central idea is that all your research results must be **reproducible** from the raw data at any time
  - This implies that you **must not manipulate your raw data** at any cost
  - Raw data is what you download from the internet, gather through an experiment, or code yourself

# How to keep your work transparent

- Raw data must not be changed, but is usually not in a state we can work with 🤨



1. Gather data, save it on you PC

2. Import this data into R

3. Write a script that transforms raw data into **tidy data**

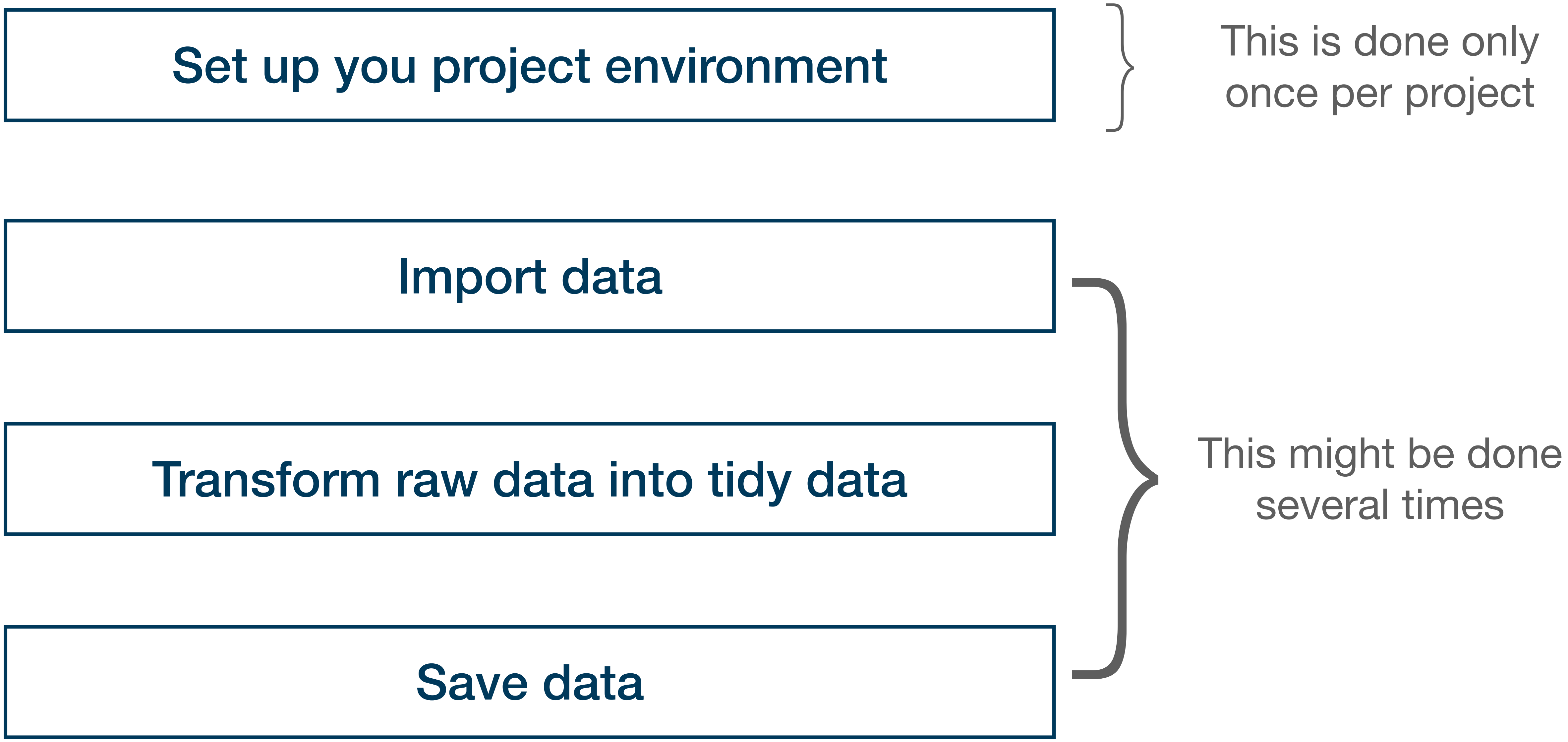
4. Use the tidy data for further analysis: visualisation, modelling, etc.

- Saving the scripts in steps 2 & 3 makes your work fully reproducible

- By looking into the script you will always know what you did to your raw data → you can also heal basically every mistake you made, not harm done!

# Outlook

- The remainder will be organised as follows:



Set up you project environment

This is done only once per project

Import data

Transform raw data into tidy data

Save data

This might be done several times

# Set up your R project

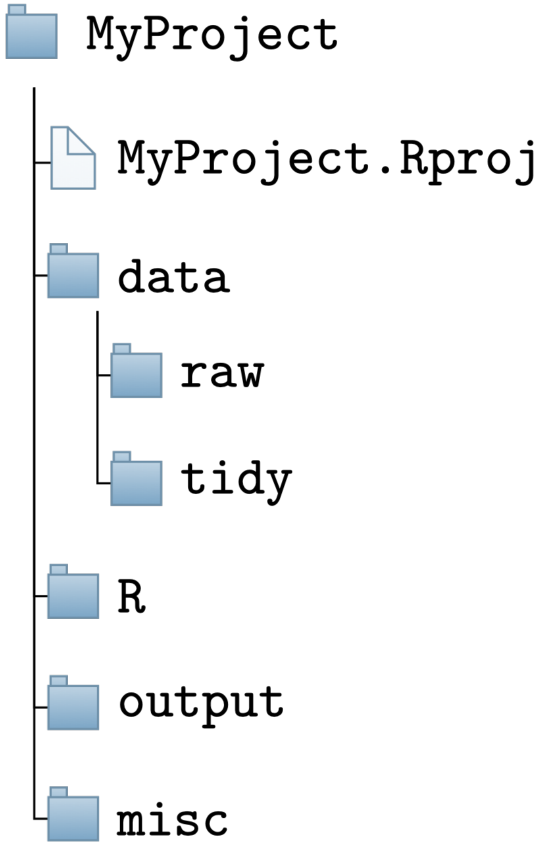
# Setting up your working environment

- Before we talk about importing raw data we need to discuss where the raw data should actually be saved

- A prerequisite for a transparent, reproducible, and easy-to-work-with project is the right directory structure

- Thus, for every task in R you should set up your project like this:

- All the relevant steps to set this up, and the rationality for this structure are described in the respective tutorial



MyProject

MyProject.Rproj

data

raw

tidy

R

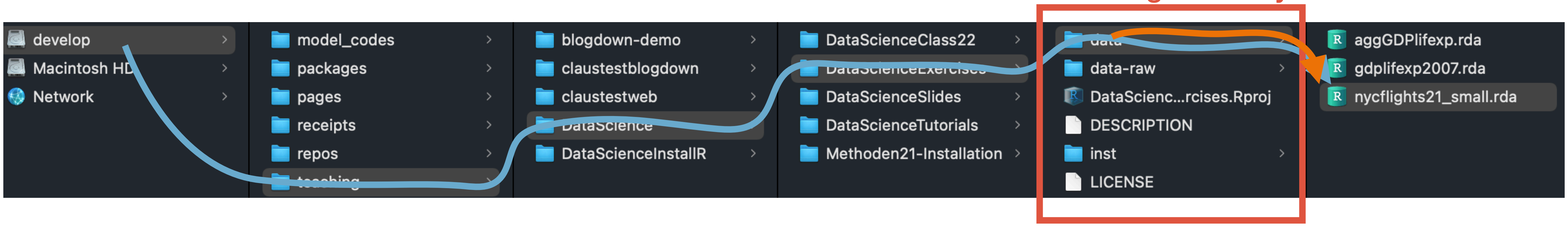
output

misc

# Paths and the here-package

- There are two ways in which you tell your computer where a certain file is located:
  - Via an absolute path: description starts at the root directory 🌲
  - Via a relative path: description starts at your current position in the file system

Working directory



- Assuming we are ‘located’ in the folder `DataScienceExercises`: and want to point to the file `nycflights21_small.rda`:
  - `“/Volumes/develop/teaching/DataScience/DataScienceExercises/data/nycflights21_small.rda"`
  - `"data/nycflights21_small.rda"`

# Relative paths and setwd()

- The relative path seems nicer…
  - Its shorter 😇 and you can share code without forcing others to adjust the path
- Problem: how to set our location to the directory `DataScienceExercises`?
- We can do this using `setwd()`, providing the absolute path to `DataScienceExercises` as an argument:
  - `setwd(“/Volumes/develop/teaching/ DataScience/DataScienceExercises")`
  - Then we can use “`data/nycflights21_small.rda`"
- Many people put `setwd()` at the top of their scripts
  - **BUT YOU MUST NEVER EVER DO THIS!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!**

# Why setwd() is evil and not to be used

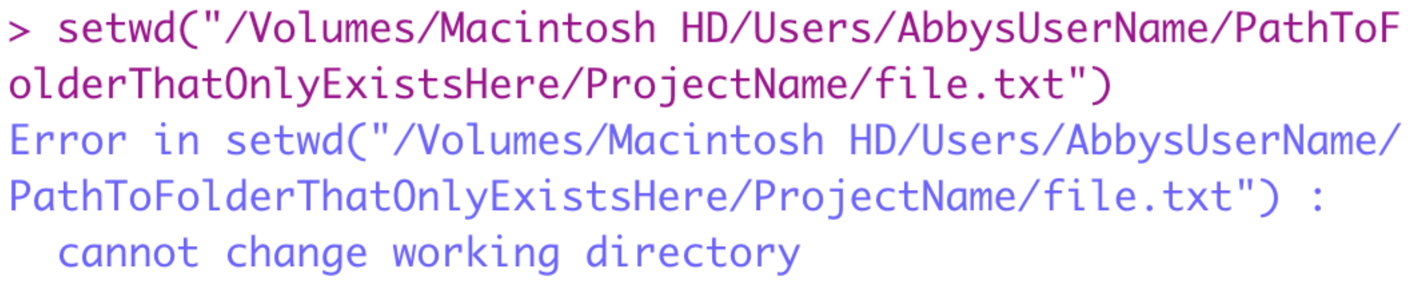
- You should never ever use `setwd()` in your scripts
- First, it does not help avoiding absolute paths because you have to provide an absolute path to `setwd()` 🤯
- Second, it makes people hate you:

Abby writes amazing_script.R 👩🏼‍💻

```
setwd("/Volumes/Macintosh HD/Users/AbbysUserName/
          PathToFolderThatOnlyExistsHere/ProjectName")
data_file <- data.table::fread("data/file.csv")
```

Sends file to Ellie 📧

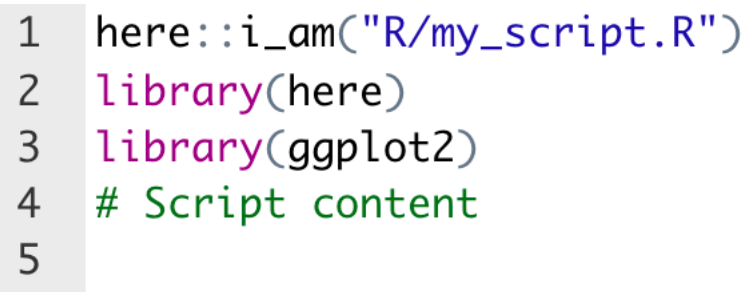
Ellie opens file and executes it 😀



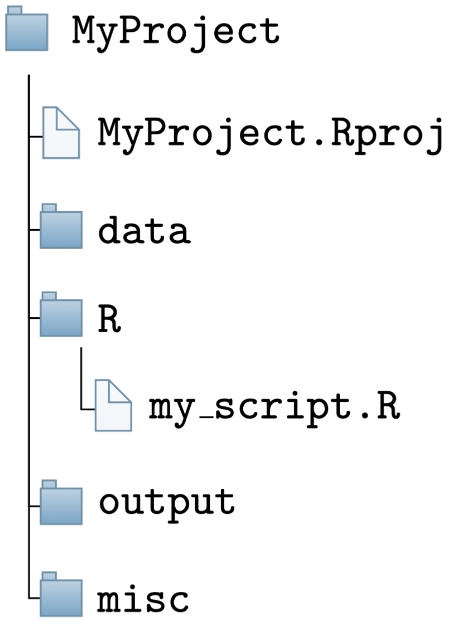
```
> setwd("/Volumes/Macintosh HD/Users/AbbysUserName/PathToF
olderThatOnlyExistsHere/ProjectName/file.txt")
Error in setwd("/Volumes/Macintosh HD/Users/AbbysUserName/
PathToFolderThatOnlyExistsHere/ProjectName/file.txt") :
  cannot change working directory
```

# The better alternative to setwd() is `here`

- Thankfully, there is a very simple solution: the package **here**
- It allows you to set an anchor ⚓ in you project directory
- Then you can create paths relative to this anchor using the function `here::here()`
    - These commands will always work on every machine
- Always put `here::i_am()` into the first line of your scripts
    - As an argument, provide the location of the script relative to the project root
- From now on, only provide paths relative to this root using `here::here()`



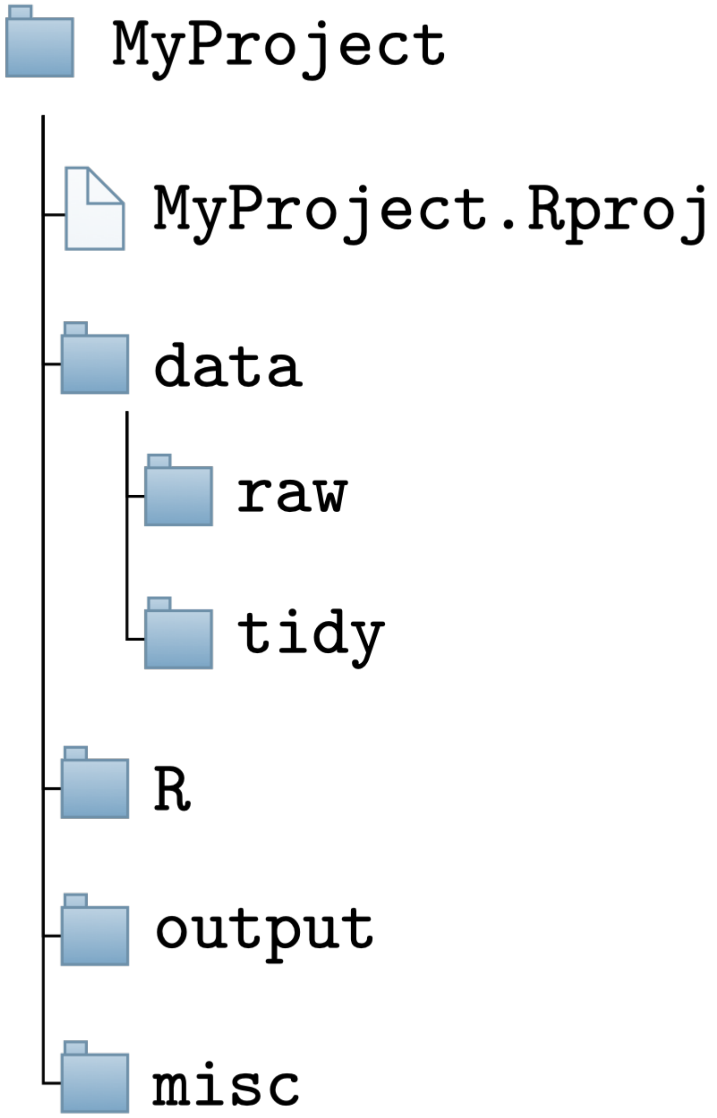
```r
here::i_am("R/my_script.R")
library(here)
library(ggplot2)
# Script content

```



```
MyProject
├ MyProject.Rproj
├ data
├ R
│ └ my_script.R
├ output
└ misc
```

# Your turn

- Create a new R-Project on your computer
- Create all the required folders
- Write an R script, put it into the right directory, and make it usable for the `here`-package
- Check out what the function `here::here()` returns and experiment with its use



MyProject

MyProject.Rproj

data

raw

tidy

R

output

misc

# Importing data

# Import functions

- Now that we have set up the project environment we can import data
- In the following we will assume that you raw data is stored in the folder `data/raw`
- The function we use to import a data set depends on the file type:

| csv/tsv files | .Rds/RData files | Specific formats |
|---|---|---|
| `data.table::fread()` | `readRDS()`<br>`load()` | `haven::read_dta()`<br>`haven::read_sas()`<br>`haven::read_spss()` |

- Basic procedure the same in all cases → focus on reading csv files here

# How to import data

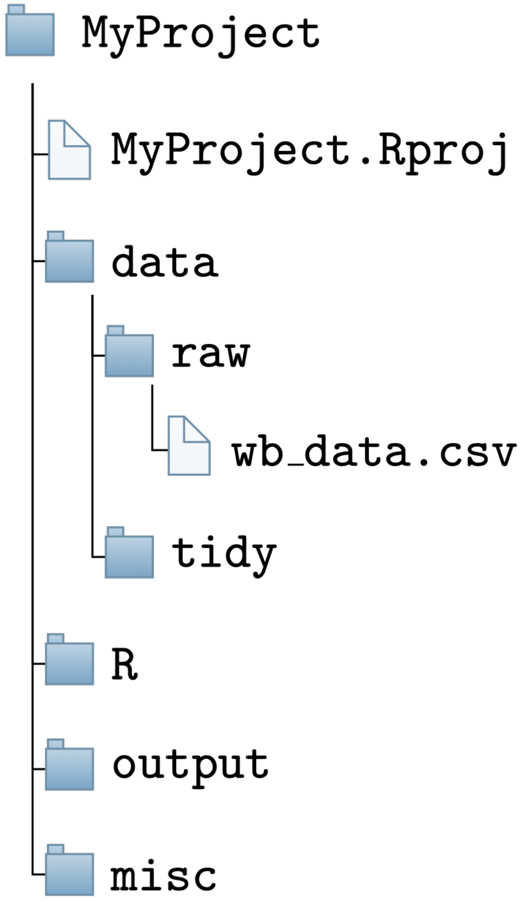
- Good practice: save path to file in a vector:

```
data_path <- here("data/raw/wb_data.csv")
```

- Since its a csv file we use `data.table::fread()`:

```
data.table::fread(file = data_path)
```

- This uses default options to import the file
  - Works often for clean data files
  - But for the sake of transparency and since data files are often not clean, we should specify several optional arguments
- In contrast to the exposition in Wickham and Grolemund (2022) I strongly recommend using `data.table::fread()`



# Your turn

- Download the zip file `fread_expls.zip` from the course homepage
- Copy the file `fread_expls-1.csv` into the data directory of your R project
- Write a script that imports the data set into your session

# How to use data.table::fread()

- *For documentation of the next steps, please refer to the tutorial on data import on the course page*
- In the following we will learn when and how to use the following arguments of `data.table::fread()`:
  - `file`: the relative path to the csv file you want to read → use `here::here()`
  - `sep`: symbol that separates columns
  - `dec`: symbol used as decimal sign
  - `colClasses`: what object type should be used for the columns?
- For other widely used commands check the tutorial and do the exercises
  - But note that there are even more specification options → `help(fread)`

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# How to use data.table::fread()

## Specifying column delimiters using sep

```
c_code; year; exports; unemployment
AT; 2013; 53.44; 5.34
AT; 2014; 53.39; 5.62
DE; 2013; 45.4; 5.23
DE; 2014; 45.64; 4.98
```

- Especially in Germany, columns are often separated via `;` instead of `,`
- We can pass a string to `sep` indicating how the columns are separated
  - In the above case: `sep = ";"`

# How to use data.table::fread()

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- For other widely used commands check the tutorial and do the exercises
  - But note that there are even more specification options → `help(fread)`

# How to use data.table::fread()

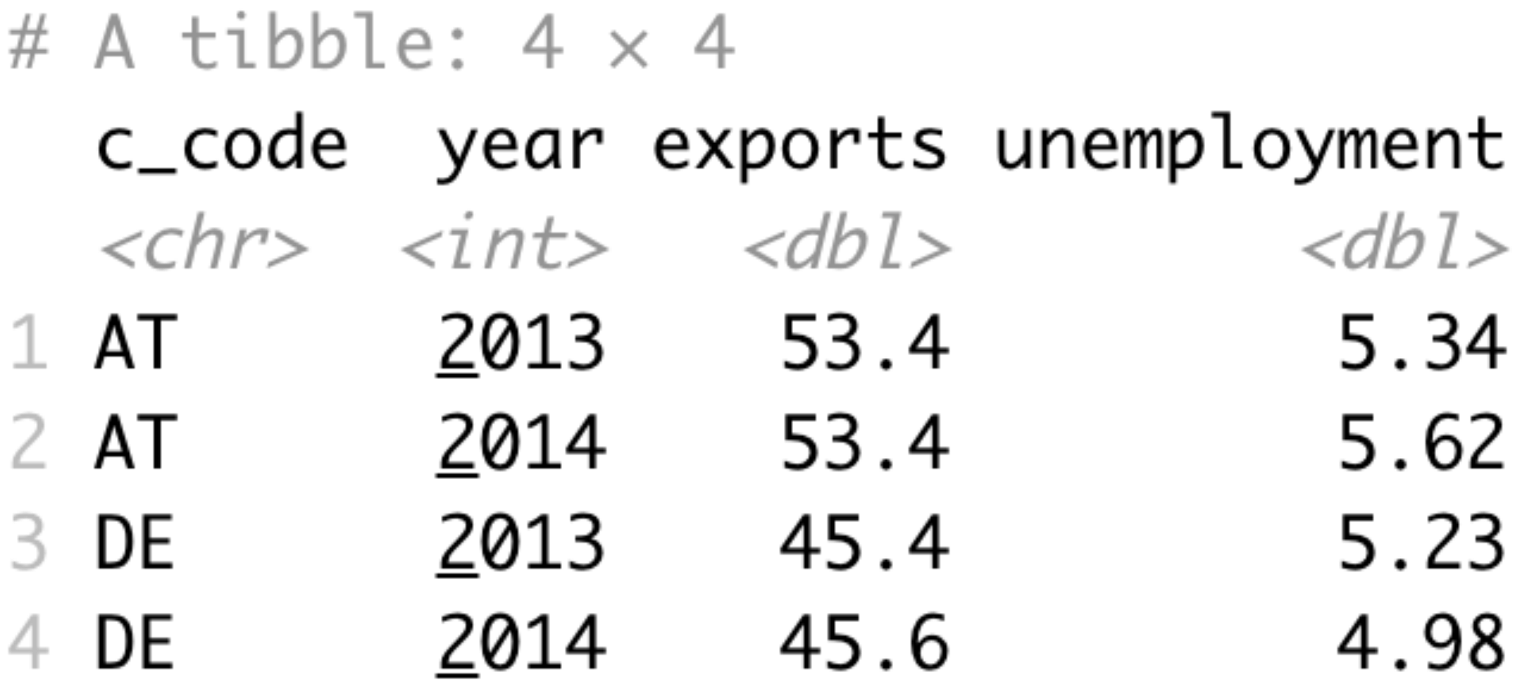
## Specifying decimal separators using dec

```
c_code; year; exports; unemployment
AT; 2013; 53,44; 5,34
AT; 2014; 53,39; 5,62
DE; 2013; 45,4; 5,23
DE; 2014; 45,64; 4,98
```

- Again in Germany, decimal places are often separated via `,` instead of `.`
- We can pass a string to `dec` indicating how the columns are separated
    - In the above case: `dec = ","`

# Your turn

- Copy the file `fread_expls-2.csv` into the data directory of your R project
- Write a script that imports the data set into your session such that the following `tibble` results:



```
# A tibble: 4 × 4
  c_code  year exports unemployment
  <chr>  <int>   <dbl>        <dbl>
1 AT      2013    53.4         5.34
2 AT      2014    53.4         5.62
3 DE      2013    45.4         5.23
4 DE      2014    45.6         4.98
```

# How to use data.table::fread()

- *For documentation of the next steps, please refer to the tutorial on data import on the course page*

- In the following we will learn when and how to use the following arguments of `data.table::fread()`:

  - `file`: the relative path to the csv file you want to read → use `here::here()`

  - `sep`: symbol that separates columns

  - `dec`: symbol used as decimal sign

  - `colClasses`: **what object type should be used for the columns?**

- For other widely used commands check the tutorial and do the exercises

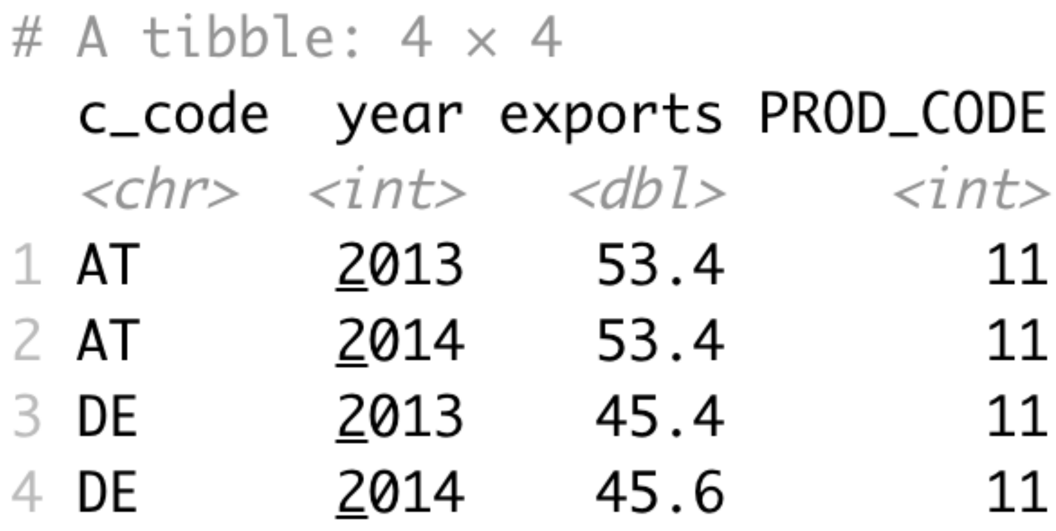
  - But note that there are even more specification options → `help(fread)`

# How to use data.table::fread()

## Specifying column types using colClasses

- Whenever numbers should be saved as character, the guessing algorithm of `data.table::fread()` often fails:

```
c_code,year,exports, PROD_CODE
AT, 2013, 53.44, 0011
AT, 2014, 53.39, 0011
DE, 2013, 45.4, 0011
DE, 2014, 45.64, 0011
```



```
# A tibble: 4 × 4
  c_code  year exports PROD_CODE
  <chr>  <int>   <dbl>     <int>
1 AT      2013    53.4        11
2 AT      2014    53.4        11
3 DE      2013    45.4        11
4 DE      2014    45.6        11
```

- We can specify the column types explicitly by passing a vector to `colClasses`:
    - `colClasses = c("character", rep("double", 2), "character")`
- Usually, this is often a good idea to make your code more transparent
- You can also combine it with `select` and only read selected columns (see tutorial)

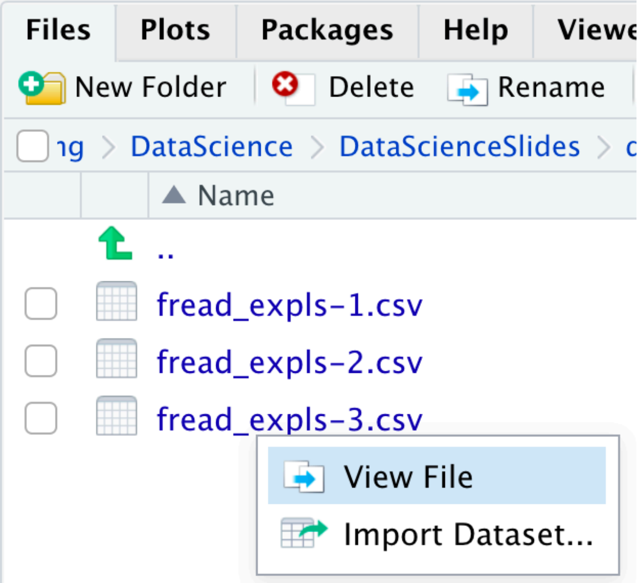
# A final exercise…

- Now read in the file `fread_expls-final.csv` and use all the arguments you consider to be necessary

- Make sure that the column `cgroup` is stored as a `factor`

- Then talk to you neighbour and compare your solutions

- Hint:
  - To get an idea about the raw data, click on the file and select “View File” to see it in its raw form → helps you to choose the right arguments:
  - Infeasible for very large files → use `nrows` and `select` to read a representative subset (see tutorial)



# And what about saving data?

- Saving data is much easier than reading data
- The only relevant question is about the format
  - If there are no good arguments for using a different format, go for csv
- This can be achieved by `data.table::fwrite()`with the main arguments:
  - `x`: the name of the object to be saved
  - `file`: the file name under which the object should be saved
- Example: save object `exp_tab` to file `data/exp_tab.csv`:

```
data.table::fwrite(
    x = exp_tab,
    file = here::here("data/exp_tab.csv")
)
```

# Data import as part of data preparation

**Make yourself comfortable before reading in data - expect frustration and pain!**

- General idea: you import the data and bind it to an R object - usually a `data.frame`
- Then you proceed with transforming this `data.frame` until it satisfies the demands for tidy data
- Then you save the data under a new name, save the script, and celebrate yourself 🎉🍾🥂
- We will cover the transformation steps in the next session

# Summary and outlook

- We now know how to organise our working directory and how to import data

- Next time we will learn how to transform imported raw data into tidy data
  - This is the kind of data that is the vantage point for visualisation and modelling

→ Learn to produce the data you have used as input for visualisations yourself

**Tasks until next week:**

1. Fill in the **quick feedback survey** on Moodle
2. Read the **tutorial on data import and project management**
3. Do the **exercises** provided on the course page and **discuss problems** and difficulties via the Moodle forum
4. **Create a project** that you can use in the next session and already download and allocate the raw data posted on the course page