

## 1. Use make to automate your work

### 1. What is make?

Make is a tool we use to automate our research projects and make it reproducible. If you update a certain file and want to re-run the project, you can easily do so by simply running “make” in the terminal.

### 2. Get your setup ready!

Make sure you properly installed make by following the instructions on this page: <https://tilburgsciencehub.com/get/make>

### Remember the structure of a makefile (let's call it a recipe):

- **Targets:** Files that you want to build
- **Prerequisites:** Files you need to build the targets
- **Commands to build:** Series of steps to build the targets (indented with a tab!)

### 3. A makefile consists of a set of rules:

targets<sup>1</sup>: prerequisites<sup>2</sup>  
commands to build<sup>3</sup>

plot.pdf: plot.R table.csv  
R --vanilla < plot.R

Build the plot.pdf (1) using the plot.R script and table.csv file (2). The command line opens R and runs the plot.R script (3)

## 2. How to use make

### 1. Has somebody else already written a makefile?

Check the directory and see whether there is a makefile (without any file extension!). If it's there? Sit back, relax, open your command prompt or terminal and type... make

### 2. No makefile present? Follow the following steps to create one!

The first step is to make a proper directory structure. Below is an example we use in the tutorial:

- data → Store raw data files
- src → Stores source code to build the project. Within this folder, use subdirectories:
  - data preparation: Cleaning datasets
  - analysis: Analyzing cleaned data
- gen → Store generated files. Again, use subdirectories to structure your project
  - temp: Temporary files that still need transformations
  - output: Final documents (e.g., datasets or tables and figures from analysis)

### 3. Place the files in the corresponding folder

First, create a makefile in each subdirectory of your src folder. You can create a makefile by opening a new script in R and renaming it to “makefile” (without the .R!). For a project with subdirectories src/data-preparation and src/analysis, the file structure should look as follows:

```
/src/data-preparation    /src/analysis
- download.R            - plot.R
- clean.R               - makefile
- makefile
```

Don't forget to create the (sub)directories when referring to them in the respective script (e.g., type `dir.create("../gen/output")` and save an output file as `../gen/output/{file_name}`)

### 4. Writing your makefile(s)

Within the makefiles, write the necessary rules to run the code. An example for the data-preparation folder could look like this:

```
all: ../../data/reviews.csv ../../gen/temp/aggregate_df.csv

../../data/reviews: download.R
R -vanilla < download.R

../../gen/temp/aggregated_df.csv: ../../data/reviews.csv clean.R
R -vanilla < clean.R
```

If you have multiple prerequisites, make sure to separate each by a space!

### 5. Specifying long paths using variables [Optional – but recommended!]

If you noticed in step 4, constantly writing `../../` is quite cumbersome. Therefore, we introduce variables:

```
TEMP = ../../gen/temp
DATA = ../../data
```

In the makefile, refer to these variables using `$(VARIABLE)` (e.g., `$(TEMP)`). These variables make your script less prone to errors. The “all” target from step 3 now looks as follows:

```
all: $(DATA)/reviews.csv $(TEMP)/aggregate_df.csv

The “all” target tells make which files to build. Without this target, make will simply start running the first rule, followed by the second etc.
```

Recall: `../../` means go up 2 directories. For temp, you then `cd` into the gen/temp folder.

### 6. Finalizing your automation task

Finally, create an overall makefile that triggers the two makefiles in their respective subfolder. Place this makefile in the root directory.

```
all: analysis data-preparation

data-preparation:
make -C src/data-preparation

analysis: data-preparation
make -C src/analysis
```

Finally, type make in the terminal and see your project build itself! If you make any changes to a certain script, you only need to type make in the terminal to see your research project being rebuilt again, thus being a very efficient way to automate your work and make it reproducible!

