

Developing a Workflow to Maximize Reproducibility and Research Impact: Managing Data, Computer Code, and Projects for Success

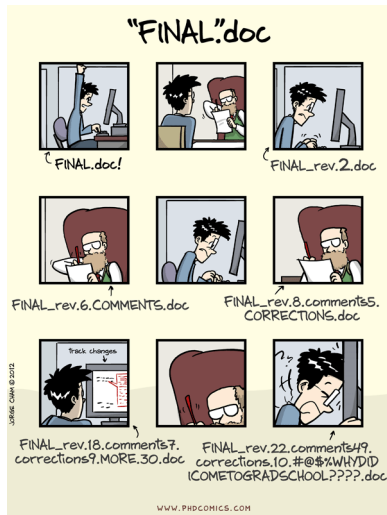
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Why worry about reproducibility?

Working towards future reproducibility makes my code easier for my collaborators (and me) to read, run, and debug today, and that's why I think reproducibility is a **win-win for all researchers.**"

-Althea



Why worry about reproducibility?

“[Reproducibility] provides security, saves time, and forces me to be more thoughtful about my workflow.” - Ethan Young

- ▶ make your life easier! Now, and in the future
- ▶ collaborations
- ▶ broader research impact
- ▶ increased citations
- ▶ transparency
- ▶ grant and journal requirements

Is my research reproducible?

- ▶ Are your research documents stored in these formats?

- ▶ .csv

- ▶ .txt

- ▶ .pdf

- ▶ .html

- ▶ .R/.Rdata

- ▶ YES!

- ▶ .doc/.docx

- ▶ .sas

- ▶ .xls/.xlsx

- ▶ any other proprietary file format

- ▶ NO!

Is my research reproducible?

- ▶ Is your code linear?
 - ▶ Clear environment often and at beginning of script
 - ▶ Don't save .Rdata or history
 - ▶ Each program should focus on one main task or analysis
 - ▶ Don't rely on manual commenting/uncommenting

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So, what's wrong here?

```
# What variables are significant?  
lm.out <- lm(weight ~ height, data = trial.data)  
remove(lm.out) # clear previous lm.out for each  
                 # new lm() definition above  
  
# Is the relationship significant?  
# (If not, clear and try a new regressor)  
summary(lm.out)
```

Is my research reproducible?

- ▶ Are your files easily shared with others?
 - ▶ Organized directory structure
 - ▶ Files relatively linked
 - ▶ Well-documented & commented
 - ▶ Consistency in coding practices

“The point of having style guidelines is to have a common vocabulary of coding so people can concentrate on *what* you are saying, rather than on *how* you are saying it.” - Google’s R Style Guide

Workshop Outline

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1. RStudio Projects for organizing data, code, and output
2. R-Markdown and R-Oxygen for documenting your code and creating reproducible reports
3. GitHub for version-control, collaborating and archiving

1. RStudio Projects

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- ▶ Raw data
- ▶ Processed data
- ▶ Analysis scripts
- ▶ Paper/Manuscript-related documents
- ▶ Sharing documents (“transmittals”)
- ▶ Metadata
- ▶ Maps or other deliverables

RStudio Projects provide an opportunity for you to organize and manage all of these types of folders in **one place** in a way that **relatively links** everything together and **eases sharing**.

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Up next, Activity 1!

Activity 1: Data management and updating

Here, we will read in and process three weeks of experimental data and do some preliminary analysis. Then, we will get a final (4th) week of data, which we will merge with the original data.

The goals are to:

1. Be introduced to RStudio
2. Create a framework for keeping data organized and up-to-date
3. Automatically update our analyses based on the master dataset

Context: Abundance data from ~75 invertebrate species sampled on various beaches along the Dutch coast.

Zuur, A.F., E.N. Ieno, and G.M. Smith (2007) Analysing Ecological Data. Springer, New York.

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Before we begin today, we need sync your individual versions of the workshop documents with Althea's master branch:

1. Open RStudio and your reproducibility_workshop.rproj. (File > Open Project...)
2. Open shell (Tools > Shell...)
3. Type in exactly, then press enter:

```
$ git fetch upstream
```

4. Type in exactly, then press enter:

```
$ git checkout master
```

5. Type in exactly, then press enter:

```
$ git merge upstream/master
```


Activity 1: Data management and updating

Now create a new folder in `student_folders/` for all of today's activities. Name the folder after yourself (or an alias).

Open a new R Script file and save it to that new folder as **“activity1a_data_processing.R”**

First, we will read in first three weeks of data and combine them, process the data a little bit, and save the merged/processed data for analysis.

Secondly, we will save another new R Script file as **“activity1b_data_analysis.R”** and do (preliminary) regression analysis.

Finally, we will pretend to have just gotten the final week's data in and update everything in a “reproducible” way.

1. RStudio Projects

Other links

<https://swcarpentry.github.io/r-novice-gapminder/02-project-intro/>

Data Mangement Tips

- ▶ Treat data as read-only
 - ▶ Don't use Excel, etc, to manipulate raw data
 - ▶ Use a single R program for all manipulation
 - ▶ Save “cleaned” or “processed” data in easily loadable formats
- ▶ Differentiate data types with folders *raw* versus *processed* versus *output* (e.g., linear regression objects, etc)
- ▶ Write dates in YYYYMMDD or equivalent format

Tips

- ▶ Don't use github with large files :-)
- ▶ Create new projects in GitHub first, then sync them with RStudio

Why R-Markdown for manuscripts?

“I can do reproducible work in R (making me happy) and format the output report in Word (making my collaborators happy)” - Richard Layton http://rmarkdown.rstudio.com/articles_docx.html