

# Advanced R Programming - Lecture 3

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(slides based on Leif Jonsson's and Måns Magnusson's)

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# Today

Best practices for scientific computing

R packages

Git and GitHub

Creating R packages

Documentation with ROxygen

Unit testing with testthat

R-Studio debugger

# Questions since last time?

# Best practices for scientific computing

Based on the article referred to on course page...

# 1. Write code for people

## 1. Write code for people

- 1.1 A program should not require its readers to hold more than a handful of facts in memory at once
- 1.2 Make names consistent, distinctive, and meaningful (Hungarian notation)
- 1.3 Make code style and formatting consistent
  - ▶ camelCase
  - ▶ PascalCase
  - ▶ snake\_case (Python: lower\_case\_with\_underscores)
  - ▶ kebab-case
  - ▶ *avoid* dot.case

# Let the computer do the work

## 2. Let the computer do the work

2.1 Make the computer repeat tasks

2.2 Save recent commands in a file for re-use (use `.Rhistory` file)

2.3 Use a build tool to automate workflows

# Make incremental changes

## 3. Make incremental changes

- 3.1 Work in small steps with frequent feedback and course correction
- 3.2 Use a version control system
- 3.3 Put everything that has been created manually in version control

# Dont repeat yourself (or others)

## 4. Dont repeat yourself (or others)

- 4.1 Every piece of data must have a single authoritative representation in the system
- 4.2 Modularize code rather than copying and pasting
- 4.3 Re-use code instead of rewriting it



# Plan for mistakes

## 5. Plan for mistakes

5.1 Add assertions to programs to check their operation

5.2 Use an off-the-shelf unit testing library

5.3 Turn bugs into test cases

5.4 Use a symbolic debugger

5.5 **ALWAYS CHECK CORRECTNESS OF INPUT!**

(also on exam ...)

# Optimize software only after it works correctly

6. Optimize software only after it works correctly
  - 6.1 Use a profiler to identify bottlenecks
  - 6.2 Write code in the highest-level language possible

But prepare code for optimal algorithm ...

# Document design and purpose, not mechanics

- 7. Document design and purpose, not mechanics
  - 7.1 Document interfaces and reasons, not implementations  
(but make sure that you are able to understand implementation)
  - 7.2 Refactor code in preference to explaining how it works
  - 7.3 Embed the documentation for a piece of software in that software

# Collaborate

## 8. Collaborate

8.1 Use pre-merge code reviews

8.2 Use pair programming when bringing someone new up to speed and when tackling particularly tricky problems

8.3 Use an issue tracking tool

# R packages

An environment with functions and/or data

The way to share code and data

4 000 developers (date?)

≈ 11100 packages (as of 19 July 2017)

# Package basics

## Usage

```
library()
```

```
::
```

```
:::
```

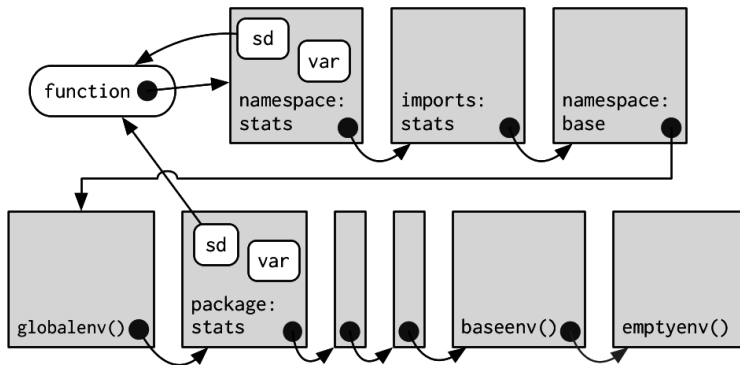
## Installation

```
install.packages()
```

```
devtools::install_github()
```

```
devtools::install_local()
```

# Package namespace



**Figure:** Package namespace (H. Wickham p.136)

## Package namespace

`library()`: **ATTACHES** a package, its functions are available in the search path

`requireNamespace()`: **LOADS** package's code, data, methods, etc., runs `onLoad()`. Package is available in memory but not in search path, package **not** attached, access its components by `::`

**NEVER** use `library()`, `require()` inside your package, CRAN forbids it

H. Wickham, R packages (p. 82–84)



# Which are good packages

## Examine the package

1. Who?
2. When updated?
3. In development?

# What is Version control?

Video!!

<https://vimeo.com/41027679>

# Why version control?

1. Collaboration
2. Storing versions (properly)
3. Restoring versions
4. Understanding what happens
5. Backup

# Why git?

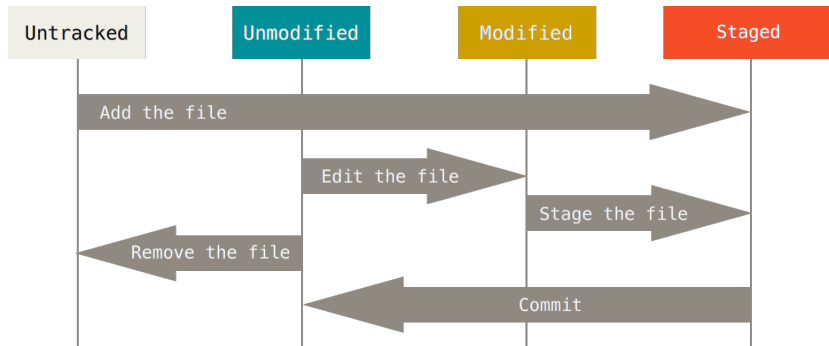
1. Simple to use
2. Distributed
3. Fast
4. Common in practice
5. R packages uses github
6. Integrated with R-Studio

# Why git?

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2. Distributed
3. Fast
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Created by Linus Torvalds! ;)

# Basic git



<https://git-scm.com/book/id/v2/Git-Basics-Recording-Changes-to-the-Repository>

# GitHub

1. Local (commit)
2. Remote (push/pull)
3. Barebone homepage (using md)
4. Collaborations
5. Issue tracker / Wiki / discussions

Public and private repos

Student accounts

# Merge conflicts

1. Competing commits from different contributors.
2. Git cannot resolve this by itself
3. Manually resolve.
4. Supporting merge tools.
  - 4.1 p4merge  
presentation by Agustìn Valencia and Marcos Mourao
  - 4.2 sublime merge  
<https://www.sublimemerge.com/>



# Setting p4merge as diff/merge tool for git

Agustín Valencia

Marcos Mourao

Use this presentation under GPLv3 License

# The merge issue

## About merge conflicts

Merge conflicts happen when you merge branches that have competing commits, and Git needs your help to decide which changes to incorporate in the final merge.

Source : <https://help.github.com/en/articles/about-merge-conflicts>

# Git way to solve merge conflicts

- Open the conflicting file in a text editor.
- Conflict markers:

```
Here are lines that are either unchanged from the common
ancestor, or cleanly resolved because only one side changed.
<<<<<< yours:sample.txt
Conflict resolution is hard;
let's go shopping.
=====
Git makes conflict resolution easy.
>>>>>> theirs:sample.txt
And here is another line that is cleanly resolved or unmodified.
```

- Manually delete the conflict markers and choose which version (or both) to maintain in your file.

Source: <https://git-scm.com/docs/git-merge>

```
let's create a conflict
Hey this is Agustin's second line
Agustin : Edit this line please <---
Thank you
```

```
let's create a conflict
Hey this is Agustin's second line
Agustin : Better no, I changed my mind
Thank you
```

Agustín: commit

```
let's create a conflict
Hey this is Agustin's second line
Marcos: I deleted your line and replaced it with a better one ;) <---
Thank you
|
```

Marcos: commit & push

Try to push  **CONFLICT !**

# Trying to push an outdated file

```
[158] agustinvalencia : ~/Documents/732A94 - Advanced R Programming/Repo
(09:34) -> git push
To https://github.com/agustinvalencia/732A94_Group_6_Work.git
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to 'https://github.com/agustinvalencia/7
hint: Updates were rejected because the remote contains work that you do
hint: not have locally. This is usually caused by another repository pus
hint: to the same ref. You may want to first integrate the remote change
hint: (e.g., 'git pull ...') before pushing again.
hint: See the 'Note about fast-forwards' in 'git push --help' for detail

[159] agustinvalencia : ~/Documents/732A94 - Advanced R Programming/Repo
(09:35) -> git pull
remote: Enumerating objects: 5, done.
remote: Counting objects: 100% (5/5), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 3 (delta 1), reused 3 (delta 1), pack-reused 0
Unpacking objects: 100% (3/3), done.
From https://github.com/agustinvalencia/732A94_Group_6_Work
 8847c54..15216e5 master    -> origin/master
Auto-merging conflict_test
CONFLICT (content): Merge conflict in conflict_test
Automatic merge failed; fix conflicts and then commit the result.
```



# Git diff

```
[(09:35) -> git diff
diff --cc conflict_test
index 394c7d3,01e91e3..0000000
--- a/conflict_test
+++ b/conflict_test
@@@ -1,7 -1,7 +1,11 @@@
    let's create a conflict
    Hey this is Agustin's second line

++<<<<<< HEAD
+Agustin : Better no, I changed my mind
+=====
+ Marcos: I deleted your line and replaced it with a better one ;) <-----
++>>>>>> 15216e5aa1bdc6a699f9400315f200f7e212574e

Thank you
```

# How the file looks now

```
let's create a conflict
Hey this is Agustin's second line

<<<<<< HEAD
Agustin : Better no, I changed my mind
=====
Marcos: I deleted your line and replaced it with a better one ;) <-----
>>>>>> 15216e5aa1bdc6a699f9400315f200f7e212574e

Thank you
█
```

# How we did it

```
[162] agustinvalencia : ~/
(09:42) -> git mergetool
```





# How to setup git to use p4merge

```
This is Git's per-user configuration file.
[user]
    name = agustinvalencia
# Please adapt and uncomment the following lines:
#     name = Agustin Valencia
#     email = valencia.ag@gmail.com

[merge]
    keepBackup = false
    tool = p4merge
[mergetool "p4merge"]
    cmd = /Applications/p4merge.app/Contents/Resources/launchp4merge
"\$PWD/\$BASE\" " \"\$PWD/\$REMOTE\" " \"\$PWD/\$LOCAL\" " \"\$PWD/\$MERGED\"
    keepTemporaries = false
    trustExitCode = false
    keepBackup = false

[diff]
    tool = p4merge
[difftool "p4merge"]
    cmd = /Applications/p4merge.app/Contents/Resources/launchp4merge
"\$REMOTE\" " \"\$LOCAL\" "
```

.gitconfig file

Source : <https://gist.github.com/SeanSSDing/d56d8b8aa4c79a05939b9ad3a6a63c8f>

# Why part of the course?

Writing performant code (best practice)

The way to collaborate (R ecosystem)

Combine code, data and analysis

Easy to distribute and reuse (public api)

Learn how to reuse code from other packages

# Package structure

# Package structure

## DESCRIPTION

## DESCRIPTION: Imports, Suggests, Depends (LABS!!)

Your package will nearly always use functions from other packages!

**Imports:** These packages have to be present (or installed) when your package is installed. However, attaching your package `library(your package)` will **load** them (not attach). To use functions from them it is recommended to call them in your package as `packagename::function()`.

**Suggests:** Your package can use these functions, but does not require them, e.g. datasets, for tests, vignettes. Before using functions from them you need to check if they are available, `requireNamespace()`

**Depends:** Packages here will be **attached**. **NOT** recommended, heavy on the environment, CRAN has a limit on the number of packages in Depends. Can be used to specify version of R.

H. Wickham, R packages (p. 34–36, 84)

# Package structure

DESCRIPTION

NAMESPACE

## NAMESPACE (LABS!!)

What is used from other packages and provided to others!

`importFrom(package, function)`: package has to be listed in DESCRIPTION, do not `import(package)` (i.e. all) but only what you need. No need to call function as `package::function` now but **RECOMMENDED**

`export(function)`: what you make available for your users

`exportPattern(regular expression)`: make available functions with name matching a pattern, e.g. does not start with .

`S3method(method, class)`: export S3 methods

S4 classes, methods import and export **see book**

`useDynLib`: Import a function from C

H. Wickham, R packages (p. 84–90)



## Imported functions (tips)

Do not call imported functions directly but through your own wrapper function.

1. Better control over what you pass: wrapper's interface.
2. Foreign package or function gets deprecated: change only in one place.

Use syntax `package::function()` for imported functions, as it makes code more clear and easier to update.

# Package structure

DESCRIPTION

NAMESPACE

R/

# Package structure

DESCRIPTION

NAMESPACE

R/

man/

# Package structure

DESCRIPTION

NAMESPACE

R/

man/

vignette/

# Package structure

DESCRIPTION

NAMESPACE

R/

man/

vignette/

tests/

# Package structure

DESCRIPTION

NAMESPACE

R/

man/

vignette/

tests/

data/

# Package structure

DESCRIPTION

NAMESPACE

R/

man/

vignette/

tests/

data/

scr/

# Package structure

DESCRIPTION

NAMESPACE

R/

man/

vignette/

tests/

data/

scr/

inst/



# Why roxygen2?

1. Performant code (docs close to code)
2. Automatically generates all man files
3. Simple to use
4. Handles NAMESPACE
5. Similar to JavaDoc and DOxygen

## roxygen2 syntax

[example]

`https://github.com/rOpenGov/sweidnumbr`  
`sweidnumbr`

Full support in R-Studio

# Why unit testing?

Fewer bugs

Better code structure

Faster restarts

Robust code - correct a bug only once

A must in complicated projects!

# Types of testing

1. White box testing
2. Black box testing
3. Probabilistic testing

# testthat

Unit testing framework for R  
Integrated with R-Studio

[example]

<https://github.com/rOpenGov/sweidnumbr/tree/master/tests>  
sweidnumbr testsuite

# Introduction to Debugging in R

Another Video!!

Debugging in R

<https://vimeo.com/99375765>

The End... for today.  
Questions?  
See you next time!